THE

Vanden Plas

4-LITRE PRINCESS

WORKSHOP MANUAL

NOTE

Refer to the end of the appropriate Section for the latest instructions when carrying out work on the vehicle.

Additional copies of this publication (Part No. AKD1499) can only be obtained from a Vanden Plas Distributor.

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INTRODUCTION

This Manual has been prepared to provide the service operator with the necessary information for the maintenance and repair of the Vanden Plas 4-litre Princess.

The Manual also serves as a ready-reference book for service supervision and covers items of procedure for the guidance of both the fully qualified and the less-experienced mechanic.

UNIT ARRANGEMENT

In the Manual the complete vehicle is divided into sections each of which deals with an assembly or major component and carries a reference letter.

NUMBERING OF PAGES AND ILLUSTRATIONS

The pages and illustrations are numbered consecutively within each section, and the section title and letter(s) are shown at the top of each page.

SERVICE TOOLS

Use of the correct tools contributes to an efficient, economic, and profitable repair. References have therefore been made to such tools throughout the Manual.

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VANDEN PLAS 4-LITRE PRINCESS

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GENERAL DATA

ENGINE

Type	40.
Number of cylinders	6.
Bore	3·437 in. (87·3 mm.).
Stroke	4·375 in. (111·1 mm.).
Capacity	243·6 cu. in. (3993 c.c.).
Firing order	1, 5, 3, 6, 2, 4.
Compression ratio	6·8 : 1.
Capacity of combustion chamber (valves fitted)	4·3 to 4·4 cu. in. (70·5 to 72·5 c.c.).
Valve operation	Overhead by push-rod.
B.M.E.P.	115 lb./sq. in. (8·08 kg./cm.²) at 2,000 r.p.m.
Torque	185 lb. ft. (25·5 kg. m.) at 2,000 r.p.m.
Oversize bore: 1st	·010 in. (·254 mm.).
Max.	·040 in. (1·016 mm.).

CRANKSHAFT

Main journal diameter	2·479 to 2·4795 in. (62·966 to 62·979 mm.).
Minimum regrind diameter	2·439 in. (61·95 mm.).
Crankpin journal diameter	2·1248 to 2·1253 in. (53·97 to 53·98 mm.).
Crankpin minimum regrind diameter	2·0848 in. (52·96 mm.).
Main bearings	
Number and type	4 shell-type.
Material—bottom and top halves	Steel-backed white metal.
Length: Front	1·75 in. (44·4 mm.).
Second and third	1·5 in. (38·1 mm.).
Rear	2 in. (50·8 mm.).
End-clearance	·002 to ·003 in. (·051 to ·076 mm.).
End-thrust	Taken on second bearing.
Running clearance	·001 to ·0025 in. (·025 to ·063 mm.).

CONNECTING RODS

Length between centres	7·246 to 7·250 in. (184·05 to 184·15 mm.).
Big-end bearings	
Material—bottom and top halves	Steel-backed white metal.
Bearing side-clearance	·008 to ·012 in. (·2032 to ·3000 mm.).
Bearing diametrical clearance	·0004 to ·0019 in. (·010 to ·047 mm.).

PISTONS

Type	Aluminium alloy. Split skirt.
Clearance—bottom and top of skirt	·0012 to ·0018 in. (·030 to ·046 mm.).
Oversizes	+·010 in., +·020 in., +·030 in., +·040 in. (+·254 mm., +·508 mm., +·762 mm., +1·02 mm.)

PISTON RINGS

Compression: Plain	Top ring. Chromium-faced.
Tapered	Second and third rings.
Width (plain)	·093 to ·094 in. (2·362 to 2·388 mm.).
Thickness	·132 to ·139 in. (3·353 to 3·531 mm.).
Fitted gap	·011 to ·015 in. (·28 to ·38 mm.).
Clearance in groove	·0017 to ·0037 in. (·043 to ·094 mm.).
Oil control type	Slotted scraper.
Width	·1552 to ·1562 in. (3·942 to 3·967 mm.).
Thickness	·130 to ·137 in. (3·302 to 3·480 mm.).
Fitted gap	·011 to ·015 in. (·28 to ·38 mm.).
Clearance in groove	·021 to ·029 in. (·533 to ·737 mm.).

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GENERAL DATA—*continued*

GUDGEON PIN

Type	Clamped.
Fit in piston	·0001 to ·0003 in. (·0025 to ·0076 mm.).
Fit in connecting rod	—·0005 to +·0002 in. (—·013 to +·005 mm.).
Diameter (outer)	·8748 to ·8750 in. (22·22 to 22·225 mm.).

VALVES AND VALVE GEAR

Valves

Seat angle: Inlet	45°.
Exhaust	45°.
Head diameter: Inlet	1·725 to 1·730 in. (43·815 to 43·942 mm.).
Exhaust	1·415 to 1·420 in. (35·941 to 36·068 mm.).
Stem diameter—inlet and exhaust	·341 to ·342 in. (8·681 to 8·694 mm.).
Valve lift	·390 in. (9·906 mm.).
Valve stem to guide clearance: Inlet	·00155 to ·00255 in. (·0394 to ·0648 mm.).
Exhaust	·00105 to ·00205 in. (·0267 to ·0520 mm.).
Valve rocker clearance: Running	·012 in. (·305 mm.) cold.
Timing	·021 in. (·533 mm.).
Timing markings	Gear teeth are marked.
Chain pitch and number of pitches	·375 in. (9·53 mm.). 62 pitches.
Inlet valve: Opens	5° B.T.D.C.
Closes	45° A.B.D.C.
Exhaust valve: Opens	40° B.B.D.C.
Closes	10° A.T.D.C.

VALVE GUIDES

Length: Inlet	2·141 in. (54·37 mm.).
Exhaust	2·828 in. (71·83 mm.).
Diameter: Outside—inlet and exhaust	·5635 to ·5640 in. (14·313 to 14·326 mm.).
Inside: Inlet	·3438 to ·3443 in. (8·732 to 8·745 mm.).
Exhaust	·3433 to ·3438 in. (8·719 to 8·732 mm.).
Fitted height above head	·75 in. (19·05 mm.).

VALVE SPRINGS

Free length—inlet and exhaust	2·172 in. (55·17 mm.).
Number of working coils	4½.
Load: Valve open—inlet and exhaust	125 lb. (56·69 kg.).
Valve closed—inlet and exhaust	71±2 lb. (32·2±·907 kg.).

TAPPETS

Type	Barrel.
Diameter	1 in. (25·4 mm.).
Length	2·656 in. (67·47 mm.).

ROCKERS

Bore of rocker arms	·8115 to ·8125 in. (20·612 to 20·637 mm.).
Rocker ratio	1·44 : 1.

CAMSHAFT

Journal diameters: Front	1·788 to 1·789 in. (45·41 to 45·54 mm.).
Centre front	1·768 to 1·769 in. (44·90 to 44·93 mm.).
Centre rear	1·748 to 1·749 in. (44·39 to 44·42 mm.).
Rear	1·622 to 1·623 in. (41·19 to 41·22 mm.).

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End-float	·003 to ·006 in. (·076 to ·152 mm.).
Bearings—number and type	4 thinwall steel-backed white metal.
Outside diameter (before fitting): Front	1·920 in. (48·77 mm.).
Centre front	1·900 in. (48·26 mm.).
Centre rear	1·880 in. (47·75 mm.).
Rear	1·754 in. (44·55 mm.).
Inside diameter (reamed in position): Front	1·790 in. (45·46 mm.).
Centre front	1·770 in. (44·96 mm.).
Centre rear	1·750 in. (44·45 mm.).
Rear	1·624 in. (41·25 mm.).
Clearance	·001 to ·002 in. (·025 to ·051 mm.).

ENGINE LUBRICATION SYSTEM

Oil pump

Type	Hobourn Eaton. Eccentric rotor.
Relief pressure valve operates	50 lb./sq. in. (3·52 kg./cm.²).
Relief valve spring: Free length	3 in. (76·2 mm.).
Fitted length	1·969 in. (50·01 mm.).

Oil filter

Type	Full-flow.
Capacity	2·75 pints (1·56 litres, 3·3 U.S. pints).

Oil pressure

Normal running	50 lb./sq. in. (3·52 kg./cm.²).
Idling (minimum)	15 lb./sq. in. (1·05 kg./cm.²).

TORQUE WRENCH SETTINGS

Cylinder head nuts	55 lb. ft. (7·6 kg. m.).
Main bearing nuts	80 lb. ft. (11·06 kg. m.).
Connecting rod bolts	50 lb. ft. (6·91 kg. m.).
Clutch assembly to flywheel	35 lb. ft. (4·84 kg. m.).
Bevel pinion nut	120 to 130 lb. ft. (16·6 to 18·0 kg. m.).
Flywheel securing bolts	50 lb. ft. (6·91 kg. m.).
Steering-wheel nut	41 lb. ft. (5·76 kg. m.).
Road wheel nuts	60 lb. ft. (8·3 kg. m.).
Crown wheel bolts	70 to 80 lb. ft. (9·7 to 11·06 kg. m.).

FUEL SYSTEM

Carburetter

Make and type	Stromberg DVA42.
Choke	1⅜ in. (34·93 mm.).
Main jet: Home	·063 in. (1·60 mm.).
Export	·061 in. (1·55 mm.).
By-pass jet: Home	·046 in. (1·17 mm.).
Export	·040 in. (1·02 mm.).
Needle seating	·113 in. (2·87 mm.).
Pump jet	68.
Idle bleed	75.
Feed jet	60.

AIR CLEANER

Type: Home	Oil-wetted gauze.
Export	Oil bath.

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GENERAL DATA—*continued*

FUEL PUMP

Make and type	S.U. LCS.
Delivery rate (max.)	12½ gal. (56 litres) per hr.

COOLING SYSTEM

Type	Pressurized radiator. Thermo-siphon, pump- and fan-assisted.
Thermostat setting	162° F. (72° C.).

IGNITION SYSTEM

Sparking plugs	Champion N8 (Champion XN8 if short-wave radio is fitted).
Size	14 mm.
Plug gap	·024 to ·026 in. (·610 to ·660 mm.).
Coil	Lucas HA12.
Distributor	Lucas DM6.
Distributor contact points gap	·014 to ·016 in. (·35 to ·40 mm.).
Timing	10° B.T.D.C.

CLUTCH

Make and type	Borg & Beck single dry plate.
Diameter	10 in. (25·4 cm.).
Facing material	Woven yarn.
Pressure springs	12.
Colour	Yellow.
Damper springs	6.
Colour	Light grey and cream.
Release lever ratio	5·5 : 1.

GEARBOX (AUTOMATIC)

Ratios: 1st	3·82 : 1.
2nd	2·63 : 1.
3rd	1·45 : 1.
Top	1·00 : 1.
Reverse	4·30 : 1.
Oil capacity (gearbox and torus)	20 Imp. pints (11·3 litres).
Working clearances: Intermediate shaft end-float	·005 to ·008 in. (·127 to ·203 mm.).
Governor tower run-out (maximum)	·005 in. (·127 mm.).
Governor drive flange run-out (maximum)	·002 in. (·051 mm.).
Governor sealing ring gap	·001 to ·006 in. (·025 to ·152 mm.).
Rear pump drive shaft end-float (minimum)	·002 in. (·051 mm.).
Front pump: Vanes diametrical clearance	·001 to ·003 in. (·025 to ·076 mm.).
Slide end clearance	·001 to ·002 in. (·025 to ·051 mm.).
Rotor end clearance	·001 to ·0015 in. (·025 to ·038 mm.).
Cover sealing ring gap	·005 to ·010 in. (·127 to ·254 mm.).
Bell housing to front casing nip	·003 to ·013 in. (·076 to ·330 mm.).
Reverse unit: Mainshaft end-float	·004 to ·015 in. (·102 to ·381 mm.).
Output shaft end nip	·004 to ·010 in. (·102 to ·254 mm.).
Reverse planet carrier end-float	·004 to ·010 in. (·102 to ·254 mm.).
Drum assembly: Oil delivery sleeve sealing ring gap	·001 to ·006 in. (·025 to ·152 mm.).
Front drum end-float on intermediate shaft	·005 to ·008 in. (·127 to ·203 mm.).

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All torque loadings quoted below apply to nuts and bolts assembled with gearbox fluid on the threads and the bolt and nut faces

Fluid coupling:	Torus cover drain plug	6 to 7 lb. ft. (·830 to ·968 kg. m.).
	Torus cover to flywheel	27 to 32 lb. ft. (3·733 to 4·424 kg. m.).
	Bell housing halves	27 to 32 lb. ft. (3·733 to 4·424 kg. m.).
	Bell housing to gearbox casing	70 to 75 lb. ft. (9·678 to 10·369 kg. m.).
	Mainshaft nut	50 to 60 lb. ft. (9·913 to 8·295 kg. m.).
	Relief valve retainer (front torus)	6 to 8 lb. ft. (·830 to 1·106 kg. m.).
Side cover and sump:	Throttle lever to spindle	10 to 12 lb. ft. (1·383 to 1·659 kg. m.).
	Selector lever to shaft	10 to 13 lb. ft. (1·383 to 1·797 kg. m.).
	Side cover to casing	10 to 12 lb. ft. (1·383 to 1·659 kg. m.).
	Sump to casing	10 to 13 lb. ft. (1·383 to 1·797 kg. m.).
	Sump drain plug	35 to 45 lb. ft. (4·839 to 6·221 kg. m.).
Control valve unit:	Control valve unit to casing	6 to 8 lb. ft. (·830 to 1·106 kg. m.).
	All others on valve unit	3 to 4 lb. ft. (·415 to ·553 kg. m.).
Parking brake bracket:	Parking brake bracket to casing	15 to 18 lb. ft. (2·074 to 2·489 kg. m.).
	Parking pawl support bolt	23 to 28 lb. ft. (3·180 to 3·871 kg. m.).
Front and rear servo units:	Front servo body to cylinder	6 to 8 lb. ft. (·830 to 1·106 kg. m.).
	Front servo to gearbox casing	23 to 28 lb. ft. (3·180 to 3·871 kg. m.).
	Front servo screwed plug	6 to 7 lb. ft. (·830 to ·968 kg. m.).
	Front servo valve body to servo	6 to 8 lb. ft. (·830 to 1·106 kg. m.).
	Rear servo strap to body	10 to 13 lb. ft. (1·383 to 1·797 kg. m.).
	Rear servo to gearbox casing	23 to 28 lb. ft. (3·180 to 3·817 kg. m.).
	Band adjusting screw locknuts	40 to 50 lb. ft. (5·530 to 6·913 kg. m.).
Rear pump and governor unit:	Rear pump and governor to casing	15 to 18 lb. ft. (2·074 to 2·489 kg. m.).
	Rear pump cover to pump body	8 to 10 lb. ft. (1·106 to 1·383 kg. m.).
	Governor body to drive flange	6 to 8 lb. ft. (·830 to 1·106 kg. m.).
	G2 valve retaining plate	3 to 4 lb. ft. (·415 to ·553 kg. m.).
Pressure control valve:	Pressure control valve to casing	40 to 50 lb. ft. (5·530 to 6·913 kg. m.).
Front pump and drive shaft:	Body to cover	12 to 15 lb. ft. (1·659 to 2·074 kg. m.).
	Pump to gearbox casing	10 to 13 lb. ft. (1·383 to 1·797 kg. m.).
Reverse unit:	Reverse housing to gearbox casing	28 to 33 lb. ft. (3·871 to 4·562 kg. m.).
	Drive flange to rear drum	10 to 13 lb. ft. (1·383 to 1·797 kg. m.).
Drum assembly:	Centre bearing cap to gearbox casing	40 to 50 lb. ft. (5·530 to 6·913 kg. m.).
	Rear unit annulus gear to rear drum	3 to 4 lb. ft. (·415 to ·553 kg. m.).
Gearbox casing:	Oil pressure check point plug	15 to 18 lb. ft. (2·074 to 2·489 kg. m.).

GEARBOX (SYNCHROMESH)

Number of forward speeds	4.
Synchromesh	Second, third, and fourth gears.
Ratios: Top	1·0 : 1.
Third	1·42 : 1.
Second	2·30 : 1.
First	3·38 : 1.
Reverse	4·09 : 1.
Overall ratios: Top	4·45 : 1.
Third	6·35 : 1.
Second	10·25 : 1.
First	15·06 : 1.
Reverse	18·27 : 1.
Speedometer gear ratio	2·67 : 1.

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GENERAL DATA—*continued*

STEERING

Type	Cam and peg.
Steering-wheel turns—lock to lock	3⅞.
Steering-wheel diameter	17 in. (43·18 cm.).
Camber angle	¾°.
Castor angle	¼°.
King pin inclination	5°.
Toe-in	⅛ in. (3·18 mm.).

FRONT SUSPENSION

Type	Independent. Coil springs.
Free length	12·63 to 12·83 in. (32·08 to 32·58 cm.).
Mean coil diameter	4·5 in. (11·43 cm.).
Number of effective coils	8.
Working load	3,450±100 lb. (1565±45·4 kg.).
Spring rate	1,069 lb. in. (12·29 kg. m.).
Dampers (front)	Armstrong lever hydraulic.
Damper settings: Rebound: Blow-off	2,150±200 lb. in. (24·7±2·3 kg. m.).
Time setting	104 r.p.m.
Compression: Blow-off	2,150±200 lb. in. (24·7±2·3 kg. m.).
Time setting	104 r.p.m.

REAR SUSPENSION

Type	Semi-elliptic leaf spring with anti-roll bar.
Spring details: Number of leaves	11.
Width of leaves	2·25 in. (57·15 mm.).
Working load	1,288 lb. (584 kg.).
Free camber	6·812 in. (173·04 mm.).
Dampers (rear)	Armstrong lever hydraulic.
Damper settings: Rebound: Blow-off	2,800±250 lb. in. (32·2±2·9 kg. m.).
Time setting	104 r.p.m.
Compression: Blow-off	1,250±125 lb. in. (14·37±1·4 kg. m.).
Time setting	104 r.p.m.

PROPELLER SHAFT

Type	Divided open shaft.
Make and type of joints	Hardy Spicer. Needle bearings.
Propeller shaft length (between centres of joints):	
Front: Synchromesh gearbox	19 in. (48·24 cm.).
Automatic gearbox	28 11/16 in. (72·9 cm.).
Rear: All models	38¾ in. (98·38 cm.).
Diameter	2 in. (50·8 mm.).

REAR AXLE

Type	Three-quarter-floating hypoid bevel.
Ratio	4·45 : 1.
Adjustment	Shims.

ELECTRICAL EQUIPMENT

System	12-volt. Positive earth.
Charging system	Compensated voltage control.
Battery	Lucas BT11A.
Battery capacity	72 amp.-hr. at 20-hr. rate
Starter motor	Lucas M45G.

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Dynamo	Lucas C45PV5.
Control box	Lucas RB106/2.
Cut-out: Cut-in voltage	12·7 to 13·3 volts.
Drop-off voltage	8·5 to 11·0 volts.
Reverse current	3·5 to 5·0 amps.
Regulator (at 1,500 r.p.m. dynamo speed):	
Open-circuit setting at 68° F. (20° C.)	16·0 to 16·6 volts.
For ambient temperatures other than 68° F. (20° C.) the following allowances should be made to the above setting:	
For every 18° F. (10° C.) above 68° F. (20° C.) subtract ·1 volt.	
For every 18° F. (10° C.) below 68° F. (20° C.) add ·1 volt.	

BRAKES

Type	Lockheed hydraulic. Vacuum servo-assisted.
Front	Leading and trailing shoes.
Rear	Leading and trailing shoes.
Drum size	12 in. (30·5 cm.).
Lining dimensions: Front and rear	9·43 in. × 3·0 in. (23·95 cm. × 7·62 cm.).
Lining area—total	226 sq. in. (1457·7 cm.²).

WHEELS

Type	Ventilated disc.
Size	5½K × 16.

TYRES

Size	7·00—16.
Tyre pressures: Normal: Front	26 lb./sq. in. (1·83 kg./cm.²).
Rear	28 lb./sq. in. (1·97 kg./cm.²).
Fully loaded: Front	28 lb./sq. in. (1·97 kg./cm.²).
Rear	30 lb./sq. in. (2·11 kg./cm.²).

CAPACITIES

	Imp.	*U.S.*	*Litres*
Engine sump (including filter)	18·5 pts.	22·2 pts.	10·55
Gearbox: Synchromesh	6·5 pts.	7·8 pts.	3·6
Automatic	20 pts.	24 pts.	11·36
Rear axle	3 pts.	3·6 pts.	1·7
Cooling system	28 pts.	33·6 pts.	15·6
Fuel tank	16 gal.	19·2 gal.	72·28

GENERAL DIMENSIONS

Wheelbase	11 ft. 0 in. (3·35 m.).
Overall length	17 ft. 11 in. (5·46 m.).
Overall width	6 ft. 2½ in. (1·89 m.).
Overall height	5 ft. 10 in. (1·77 m.).
Ground clearance	6½ in. (16 cm.).
Turning circle	45 ft. 6 in. (13·87 m.).
Track: Front	4 ft. 10½ in. (1·48 m.).
Rear	5 ft. 2½ in. (1·59 m.).
Kerbside weight (approx.)	41¾ cwt. (2121 kg.).

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WEIGHTS

Engine with clutch (dry)	687 lb. (311·5 kg.).
Engine with torque converter (dry)	727 lb. (330·2 kg.).
Synchromesh gearbox (dry)	125 lb. (56·7 kg.).
Automatic gearbox (dry)	173 lb. (78·36 kg.).
Power unit complete with:	
Synchromesh gearbox	812 lb. (368·2 kg.).
Automatic gearbox	900 lb. (408·56 kg.).

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REPLENISHING THE FUEL TANK

Considerable loss of fuel can occur as a result of filling the fuel tank until the fuel is visible in the filler tube. If this is done, and the vehicle is left in the sun, expansion due to heat will cause leakage, with consequent loss of and danger from exposed fuel.

When filling up the tank:

(1) Avoid overfilling the tank so that the fuel is visible in the filler tube.

(2) If the tank is inadvertently overfilled, take care to park the vehicle in the shade with the filler as high as possible.

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GENERAL INFORMATION

CONTROLS, INSTRUMENTS, SWITCHES

Hand brake

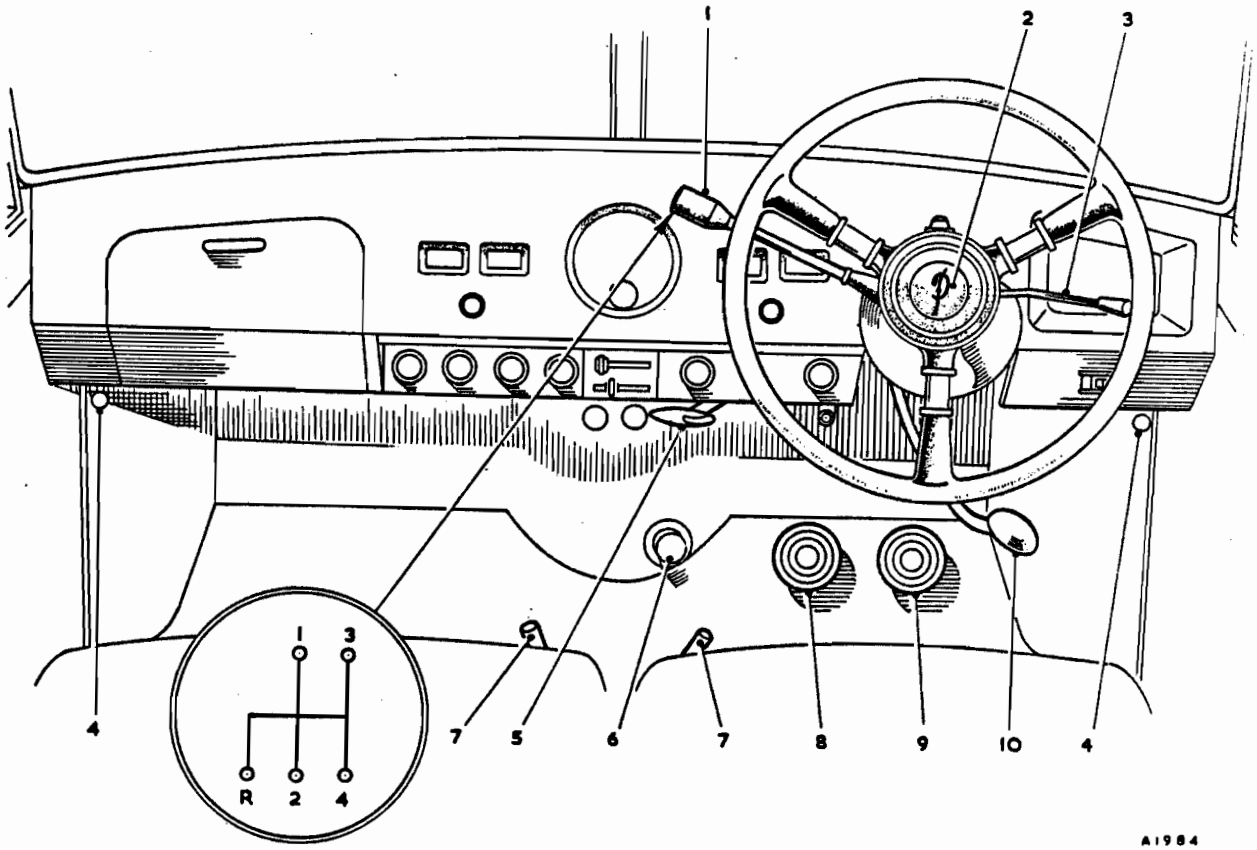
The pistol-grip hand brake is located beneath the fascia. A thumb-operated ratchet release button is incorporated in the handle. Pulling the handle outwards operates the rear wheel brake-shoes mechanically. To release the brake pull the handle outwards to take the load and then depress the ratchet release button.

Automatic transmission

Comprehensive operating and driving instructions for a car fitted with automatic transmission are given in Section FF.

Pedal controls (manual control gearbox)

The pedal controls are arranged in the orthodox positions—namely, the clutch pedal, brake pedal, and accelerator, reading from left to right.



The controls (manual control gearbox)

1. Gear lever.
2. Horn.
3. Indicator switch.
4. Bonnet opening control.
5. Hand brake.
6. Headlamp dip switch.
7. Seat adjuster lever (Saloon only).
8. Clutch pedal.
9. Brake pedal.
10. Accelerator pedal.

Gear lever (alternative synchromesh gearbox)

The gear change lever is located on the steering-column immediately below the steering-wheel. The four forward gears and reverse are engaged by moving the lever to the positions shown in the illustration inset. Pull the lever knob outwards before moving the lever to the reverse gear position. The reverse lamp is automatically switched on when reverse gear is engaged, provided the pilot lamps are switched on.

Flashing direction indicators and horns

The direction indicator lamps are operated by the small lever below the steering-wheel hub. The switch will only operate when the ignition is switched on, and a warning light in the switch lever flashes when the indicators are operating. The switch is self-cancelling, except when only a slight turn is made, in which case it will be necessary to return it by hand. The horns are operated by pressing the button in the centre of the steering-wheel.

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Headlamp beam dipping switch

The headlamp beam dipping switch is situated to the left of the foot pedals. It is of the repeating type, lowering the beams on one application and raising them on the next. A dark-red warning light in the fascia glows when the beams are in the raised position.

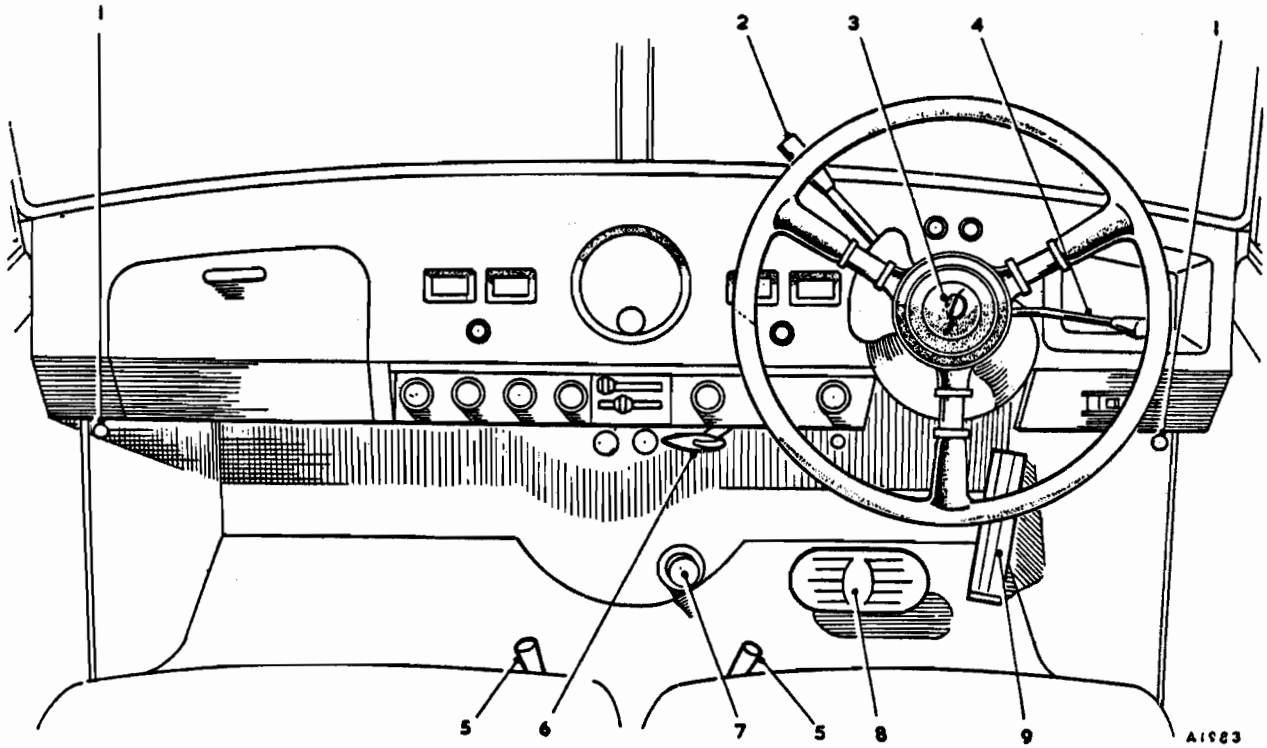
Seat adjustment (Saloon)

Both front seats are adjustable and are retained in position by a spring-loaded lever located below each seat. Release the catch and move the seat on its slides either forward or rearwards to the required position, and release the lever to re-lock the seat. The bench seat on the limousine is non-adjustable.

Bonnet lock

The two centre-hinged portions of the bonnet top are automatically locked when the bonnet is closed, and they can only be released by two controls operated from inside the car. These two controls are positioned beneath each end of the fascia, the left-hand control operating the left-hand bonnet top, and vice versa.

To open the bonnet the controls must be pulled and then left in this position, since to close the bonnet it is now only necessary to press down the bonnet sides, when the two catches automatically lock. If the fascia controls are pushed in after the bonnet has been opened it will prevent the bonnet from closing correctly.



The controls (automatic transmission)

1. Bonnet lock control.
2. Automatic transmission selector lever.
3. Horn.
4. Indicator switch.
5. Seat adjusting lever (Saloon only).
6. Hand brake.
7. Headlamp dip switch.
8. Brake pedal.
9. Accelerator pedal.

Power jacks

The built-in four-wheel hydraulic jacks, operated by an electric motor, raise all four wheels off the ground simultaneously. The operating control is located beneath the car floor immediately before the right-hand front seat. To gain access to the control the carpet is first lifted, and then a small steel panel in the floor is removed to reveal the jack control, which is a combined hydraulic valve and electric switch. To operate the jacks turn the control clockwise, when the red lamp will light. Then press the control downwards until the car is fully jacked. To lower the car simply turn the knob anti-clockwise. When replacing the carpet ensure that it is located under the chrome protection strip at the door opening.

Ignition switch

Turn the key in a clockwise direction to switch on. Do not leave the switch on when the engine is not running—the red warning light is a reminder. The ignition key is also used for locking both front doors.

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Choke control

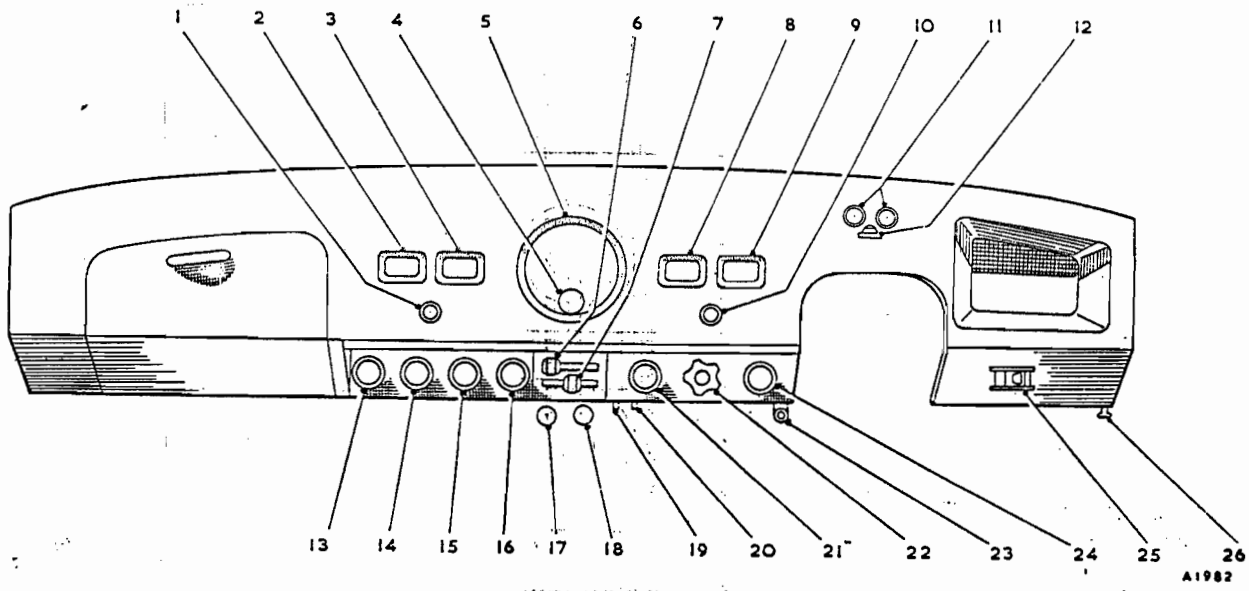
Pull out the control to its limit when starting the engine from cold. Push in the control as soon as the engine will run without its use.

Starter switch

Press the switch to start the engine and release as soon as the engine fires. If the engine does not start after a few revolutions, do not operate the starter again until the engine is stationary.

Steering-column adjustment

The telescopic steering-column may be adjusted to give the most suitable steering-wheel position for driving. To raise or lower the steering-wheel, first turn the locking ring surrounding the column immediately behind the steering-wheel centre. This ring should be slackened two or three turns, when it will be found that the steering-wheel can be moved as required. Finally, secure the steering-wheel in position by firmly tightening the ring.



The instruments and switches

1. Headlamp beam warning light.
2. Fuel gauge.
3. Water temperature gauge.
4. Clock.
5. Speedometer.
6. Heater control.
7. Demister control.
8. Ammeter.
9. Oil pressure gauge.
10. Ignition warning light.
11. Rear door warning light (automatic gearbox).
12. Rear door warning light (manual control gearbox).
13. Fog lamp switch.
14. Reading lamp switch.
15. Panel lamp switch.
16. Heater motor switch.
17. Choke control.
18. Air control.
19. Clock regulator.
20. Speedometer trip setting.
21. Windshield wiper control.
22. Ignition and lamp switch.
23. Windshield washer control.
24. Starter switch.
25. Partition raising switch (Limousine only).
26. Interior lamp switch.

Windshield wiper switch

The dual electric wipers are operated by a control mounted centrally on the fascia panel. To engage the wipers pull out the control knob. To park, push in the switch, when the wiper arms will automatically return to the parked position.

Windshield washer

Push in the control located beneath the starter switch; at the same time operate the windshield wipers. If this does not give the windshield the desired degree of cleanliness repeat the complete operation.

Lamp switch

The central moulding which surrounds the ignition switch. Turn clockwise to the first notch to switch on the pilot lamps and to the second to switch on the headlamps.

Fog lamps

The dual fog lamps are operated by a combined pull and push type of control knob. The left-hand lamp is switched on when the knob is pulled out to the first stop, and both lamps when the knob is rotated and pulled out to the second stop.

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Panel lamps

The four instrument illuminating bulbs are controlled by a rheostat switch. The switch panel illumination is controlled by the lamp switch.

Interior reading lamps

The rear compartment interior lamps are fitted with double-filament bulbs. For normal illumination the lamps are controlled by the switch at the bottom right of the fascia panel. Brighter illumination can be obtained by operating the switches on each rear compartment arm-rest.

The front compartment lamp is controlled by the panel switch marked 'READING'.

Step lamps

The step lamps are controlled by the lamp switch on the instrument panel and only illuminate when the pilot lamps are on and the rear doors are open.

Front door lock

Both front doors can be locked with the ignition key. In the case of the right-hand-side door turn the key clockwise to lock and anti-clockwise to unlock. The left-hand-side door has a similar action, excepting that the key must be turned anti-clockwise to lock and clockwise to unlock.

The front doors may also be locked from within the car by turning their interior locking handles to the uppermost position.

Rear door lock

The rear doors can be locked from inside by pushing down the interior locking handles. In the case of the limousine the right-hand-side door is locked by pushing the interior locking handle downwards and the left-hand-side door is locked from outside with the ignition key. Each door is provided with a safety lock which, when turned in the direction of the arrow, locks the interior door handle in position.

Fuel tank lock

The fuel filler is located beneath a lockable hinged cover, opened by the ignition key, on the rear left-hand wing.

Luggage compartment lid

To open the luggage compartment lid turn the handle in a clockwise direction after unlocking it with the key. The lid can be secured in the open position by tightening the two knurled locking nuts.

Luggage compartment interior lamp

The switch for this lamp is situated on the right-hand side of the luggage compartment interior, but will only operate when the pilot lamps are on.

Spare wheel

The lock on the spare wheel panel below the luggage compartment is locked by the luggage compartment key. After unlocking the panel turn the handle in a clockwise direction. The spring-loaded panel can then be slid down to expose the spare wheel. Close the panel by raising it sharply to its original position. The oil gun, wheelbrace, and starting-handle (not supplied on cars with automatic transmission) are each located alongside the spare wheel, which is secured in position by two clamps, with turnscrews, on either side of the wheel.

Speedometer

The speedometer registers the vehicle speed and total mileage. The speedometer trip figures can be set to zero by pushing the knob situated beneath the fascia panel to the left of the steering-column and turning it to the left.

Fuel gauge

The fuel gauge indicates the contents of the tank when the ignition switch is on. When the tank is being filled switch off to stop the engine. Then switch on again and the needle will record the amount of fuel entering the tank.

Clock

To start the electric clock and set the hands press the knob on the clock cable extension, situated to the left of the mileage reset knob, and rotate until engagement is felt.

Should the clock not start, press in and release the knob until ticking is heard. The clock regulator is located behind the fascia panel, and adjustment can be effected by means of a screwdriver.

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Oil pressure gauge

This gauge indicates the oil pressure in the engine. It does not show the quantity of oil in the sump.

The normal working pressure for the engine lubrication system is 50 lb./sq. in. (3·515 kg./cm.²) with 15 lb./sq. in. (1·055 kg./cm.²) minimum idling pressure. Should the engine full-flow Tecalemit oil filter need cleaning, the engine oil pressure will drop.

Water temperature gauge

This gauge records the temperature of the engine cooling system. The normal working temperature for the engine is 176° F. (80° C.), and, due to the action of the cooling system thermostat, this temperature is reached within a few minutes of running the engine under normal working conditions.

Ammeter

The ammeter indicates the flow of current into or out of the battery. With the automatic voltage control system little or no charge is shown when the battery is in a well-charged condition.

Ignition warning light

The ignition warning lamp glows red when the ignition is switched on and fades out when the engine is running and the dynamo is charging the battery.

Main beam warning light

The main beam warning light should glow red when the headlamps are switched on, with the two beams straight ahead. The light goes out when the headlamps are dipped.

Rear door warning lights

The rear door warning lights are mounted on the fascia panel just above the steering-column and operate when the ignition is switched on. The lights come on when the rear doors are open and go out when they are fully closed.

HEATING AND DEMISTING

The built-in Smiths heating and demisting unit utilizes water from the engine cooling system to heat air for circulation in the car interior and over the windshield for demisting and defrosting. The engine maintains a temperature of 176° F. (80° C.) in the cylinder block, and since the thermostat enables the engine to warm up very rapidly, heat is available for the car interior soon after starting.

Description

An electrically driven booster fan, bolted to the engine bulkhead, draws in air and forces it into the heater unit, also situated on the bulkhead. Here it passes through a water-heated radiator into a distribution chamber, where shutters, operated from the fascia panel, regulate its flow into the vehicle interior.

Even without the fan switched on air will be forced into the vehicle and onto the windshield by the ram effect caused by the vehicle's forward motion, provided the appropriate shutter in the heating and demisting unit and the air shutter are opened. At low vehicle speed, particularly when full heating or ventilation is required, the fan should be switched on. If necessary, the air supply to the vehicle interior can be entirely shut off, as, for instance, when in dense traffic, to prevent the entry of exhaust fumes, dust, etc.

Controls

The unit is controlled by two levers mounted on the fascia panel. The upper lever regulates the flow of air to the windshield for demisting or defrosting, whilst the lower lever regulates the flow of air to the vehicle interior for heating or ventilating. The booster fan is controlled by a pull-out switch situated on the fascia panel.

The control knob marked 'AIR', situated below the fascia panel, must be pushed in to open the shutter which controls the flow of air into the heater unit.

Instructions on the setting of the unit controls are given in Section R.

COMMUNICATING WITH THE COMPANY

For all inquiries the address is:

VANDEN PLAS (ENGLAND) 1923 LTD.,
Kingsbury Works, Kingsbury Road,
London N.W.9

Telephone: Colindale 1141 *Telegrams:* 'Vigilancy—Hyde—London'

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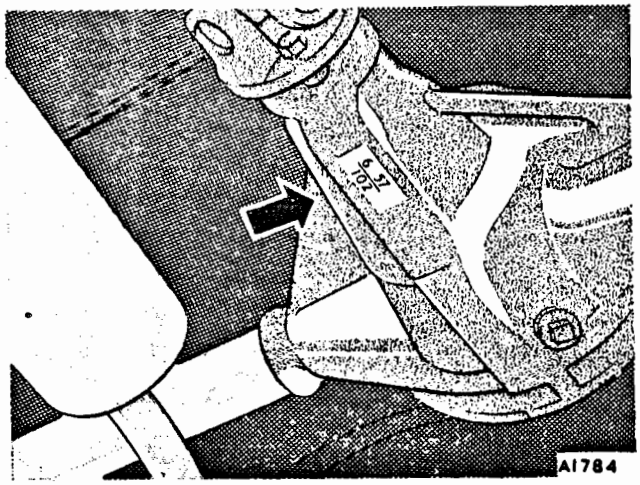
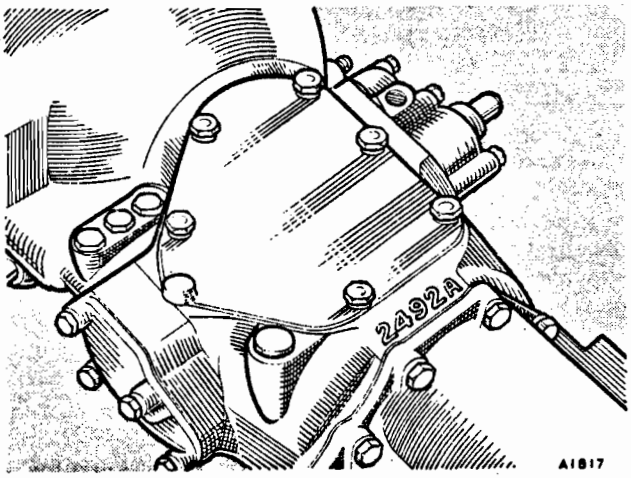
LOCATION OF MAJOR COMPONENT SERIAL NUMBERS

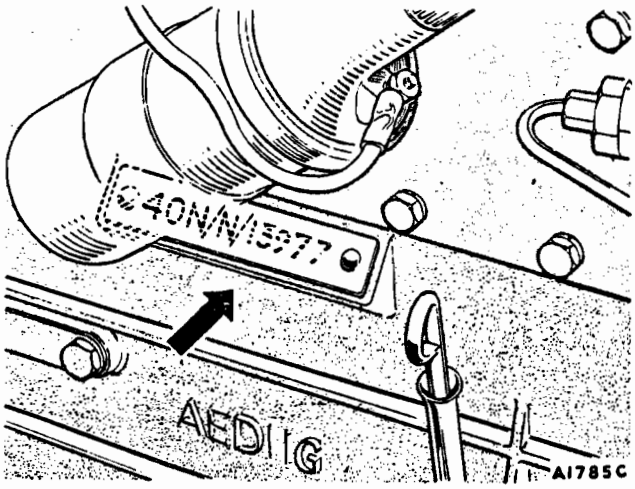
The major components of the vehicle have serial numbers. When in communication with the Company or your Dealer always quote the car and engine numbers. The registration number is of no assistance and is not required. The location of the major component serial numbers are illustrated below.



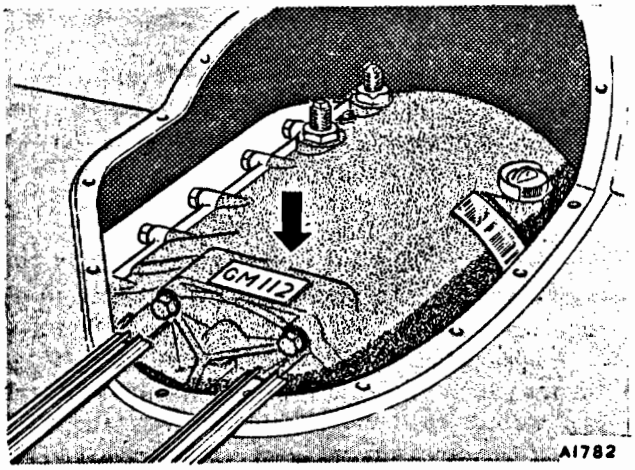
Axle Number. Stamped beneath the nose of the axle casing



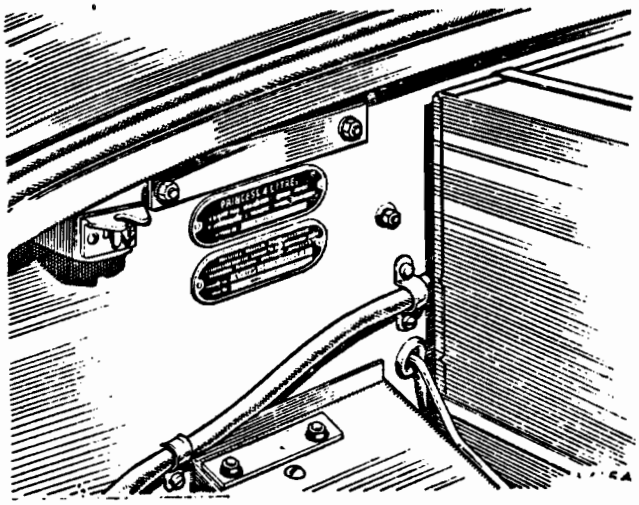
Gearbox Number (Synchromesh). Stamped on the top of the gearbox casing forward of the rear extension joint



Engine Number. Stamped on a plate secured to the right-hand side of the cylinder block



Gearbox Number (Automatic). Stamped on the top of the gearbox just forward of the rear casing joint



Body Number. Stamped on a plate located on the right-hand side of the dash panel beneath the bonnet. Car (Chassis) Number. Stamped on a plate located on the right-hand side of the dash panel beneath the bonnet and positioned under the body number plate

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CAR NUMBER IDENTIFICATION CODE

The car number symbol consists of three letters and one figure, followed by a fifth prefix letter (L) if the vehicle is left-hand drive and then by the serial number of the vehicle.

The first letter when related to the code provides an indication of the make of the vehicle—Vanden Plas, etc.

The second letter provides an indication of the model's cubic capacity.

The third letter indicates the type of body—4-door Saloon, etc.

The first figure indicates the series of model—1, 2, etc.

1st Prefix Letter—Name

A—Austin	R—Riley	
G—M.G.	W—Wolseley	
H—Healey	V—Vanden Plas	
M—Morris		

2nd Prefix Letter—Model (cubic capacity)

A—800–999 c.c.	G—1000–1399 c.c.
B—2000–2999 c.c.	H—1400–1999 c.c.
D—3000–3999 c.c.	L—Up to 799 c.c.

3rd Prefix Letter—Body type

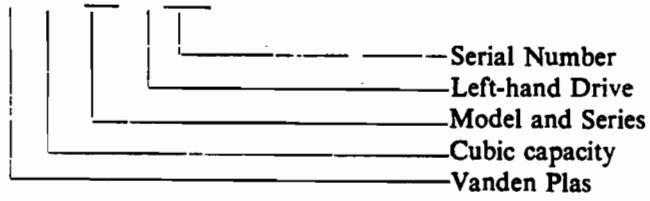
A—Ambulance	J—Convertible	P—Hardtop	T—4-seat Tourer
C—Chassis	K—Truck	Q—Chassis and Cab	U—Pick-up
D—Coupé	L—Hire Car	R—Chassis and Scuttle	V—Van
E—G.P.O. Engineers	M—Limousine	S—4-door Saloon	W—Dual-purpose
G—G.P.O. Mail	N—2-seat Tourer	2S—2-door Saloon	X—Taxi
H—Hearse			

4th Prefix—Series of model (1, 2, etc., used to record a major change).

5th Prefix (used when vehicles differ from standard R.H.D.) L—Left-hand drive.

Code Example

V / D / S4 / L110



POWER UNIT SERIAL NUMBER CODING

The engine number comprises a series of letters and numbers, presenting in code the capacity, make, and type of unit, gearbox and ancillaries fitted, and the type of compression together with the serial number of the unit.

1st Prefix Group—Cubic capacity, make, and type

1st Prefix number	8—803 c.c., 850 c.c.	26—2600 c.c.
	9—950 c.c.	29—2900 c.c.
	12—1200 c.c.	34—3400 c.c.
	15—1500 c.c.	38—3800 c.c.
	16—1600 c.c.	40—4000 c.c.
	22—2200 c.c.	51—5100 c.c.
	25—2500 c.c.	

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1st Prefix letter A, C, D, E, F, K, L, N, U, V, X, Y, Z, used by The Austin Motor Co. Ltd. for variations of engine type
B—B.M.C. Industrials
G—M.G.
H—Miscellaneous special
J—Commercial (M.C.C.)
M—Morris
R—Riley
W—Wolseley

2nd Prefix letter A–Z (omitting I, O, and Q) used for the variations of engine types

2nd Prefix Group—Gearbox and ancillaries

A—Automatic gearbox
M—Manumatic clutch
N—Steering-column gear change gearbox
O—Overdrive (Borg-Warner)
P—Police specification
U—Centre or side gear change gearbox

3rd Group—Compression and serial number

H—High compression
L—Low compression
} and serial number of unit

Code Example

40N / N/L 114

- 114 — Serial Number
- L — Low Compression
- N — Steering-column Gear Change Gearbox
- 40N — 4000 c.c. Vanden Plas

CLAIMS UNDER WARRANTY

Claims for the replacement of material or parts under Warranty must always be submitted to the supplying Distributor or Dealer, or, when this is not possible, to the nearest Distributor or Dealer, informing them of the Vendor's name and address.

PRESERVATIVE ON EXPORT CARS

To remove the hard film preservative from the external plated parts a cloth dipped in a solution of equal parts of white spirit and petrol (gasoline) should be used. Take care to keep this solvent from anything other than the plated components.

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MAINTENANCE ATTENTION

500 MILES (800 km.) FREE SERVICE

During the early life of the car, soon after it has completed 500 miles (800 km.), you are entitled to have it inspected free of charge by the Vanden Plas Dealer from whom you purchased it, or, if this should not be convenient, by any other Vanden Plas Dealer by arrangement. This attention given during the critical period in the life of the car makes all the difference to its subsequent life and performance.

This service includes:

1. Drain oil from engine, gearbox (not automatic), and rear axle, and refill.
2. Oil and grease all points of the car, and top up oil level in steering gearbox.
3. Tighten cylinder head and manifold nuts to recommended pressures.
4. Check fluid level in automatic transmission, and top up if necessary.
5. Check automatic transmission selector and governor linkages, and adjust if necessary.
6. Check tightness of valve rocker shaft brackets to recommended pressures.
7. Check valve rocker clearances, and reset if necessary.
8. Tighten fan belt if necessary.
9. Check all water connections, and tighten clips if necessary.
10. Examine and clean carburetter, and reset slow-running adjustment if necessary.
11. Examine, and adjust if necessary, sparking plug and distributor points.
12. Check working of automatic ignition controls and, if necessary, reset ignition timing.
13. Check front wheel alignment and steering connections. Adjust if necessary.
14. Check tightness of universal joint nuts, wheel nuts, damper mounting bolts, and spring bolts.
15. Check clutch pedal for free movement, and adjust if necessary.
16. Check fluid level in brake master cylinder supply tank, and top up if necessary.
17. Check braking system functionally, and bleed lines if necessary.
18. Check power steering system, and bleed if necessary. Top up reservoir.
19. Check electrical system functionally.
20. Examine batteries and top up to proper level with distilled water as required. Clean and tighten terminals.
21. Inspect hydraulic damper for leaks, examine fluid level, and top up if necessary. Check the front damper bolts for tightness.
22. Test tyres for correct pressure.
23. Check doors for ease in opening and closing. If necessary, lightly smear with a suitable lubricating agent all dovetails and striking plates.

AFTER THE FIRST 1,000 MILES (1600 Km.)

Change oil in automatic gearbox.

ALL MATERIALS CHARGEABLE TO THE CUSTOMER

PERIODICAL

Daily

Check oil level in crankcase. Top up if necessary.
Check water level in radiator. Top up if necessary.

Weekly

Test tyre pressures, and regulate if necessary.

1,000 miles (1600 km.) service

1. *Engine*
   Lubricate carburetter controls.
   Top up radiator.
2. *Fluid supply tanks*
   Check level of brake, power-steering, and hydraulic jack supply tanks, and top up if necessary.
3. *Brakes*
   Check brake pedal free travel and report if adjustment is required.
   Make visual inspection of brake lines and pipes.
4. *Hydraulic dampers*
   Examine all hydraulic dampers for leaks.
5. *Electrical*
   Check battery cell specific gravity readings and top up levels.
6. *Lubrication*
   Top up engine, steering gearbox, gearbox (not automatic), and rear axle oil levels.
   Lubricate all grease nipples and oiling points.
7. *Wheels and tyres*
   Check tyre pressures.
   Check wheel nuts for tightness.

2,000 miles (3200 km.) service

Carry out the **1,000 miles (1600 km.) service.**

3,000 miles (4800 km.) service

1. *Engine*
   Lubricate carburetter controls.
   Top up radiator.
   Check dynamo drive belt tension.

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3,000 miles (4800 km.) service—*continued*

2. *Ignition*
   Clean and adjust sparking plugs.
3. *Fluid supply tanks*
   Check level of brake, power steering, and hydraulic jack supply tanks, and top up if necessary.
4. *Brakes*
   Check brakes, and adjust if necessary.
   Make visual inspection of brake lines and pipes.
5. *Hydraulic dampers*
   Examine all hydraulic dampers for leaks.
6. *Body*
   Lubricate door hinges, bonnet lock, and operating mechanism.
7. *Electrical*
   Check battery cell specific gravity readings and top up levels.
8. *Lubrication*
   Change engine oil.
   Top up gearbox, rear axle, steering gearbox, and automatic gearbox (see Section FF and Recommended Lubricants).
   Lubricate all grease nipples and oiling points.
9. *Wheels and tyres*
   Check tyre pressures.
   Change road wheels round diagonally, including spare, to regularize tyre wear.

4,000 miles (6400 km.) service

Carry out the **1,000 miles (1600 km.) service.**

5,000 miles (8000 km.) service

Carry out the **1,000 miles (1600 km.) service.**

6,000 miles (9600 km.) service

1. *Engine*
   Lubricate carburetter controls.
   Top up radiator.
   Check dynamo drive belt tension.
   Lubricate water pump sparingly.
   Check valve rocker clearances, and adjust if necessary.
   Clean and re-oil the air cleaner.
   Clean carburetter and fuel pump filters.
2. *Ignition*
   Check automatic ignition control, lubricating drive shaft (one turn), cam, and advance mechanism.
   Check, and adjust if necessary, distributor contact points.
   Clean and adjust sparking plugs.
3. *Fluid supply tanks*
   Check level of brake, power steering, and hydraulic jack supply tanks, and top up if necessary.
4. *Brakes*
   Check brakes, and adjust if necessary.
   Make visual inspection of brake lines and pipes.
5. *Hydraulic dampers*
   Examine all hydraulic dampers for leaks, and top up if necessary.
6. *General*
   Tighten rear road spring seat bolts.
7. *Body*
   Check, and tighten if necessary, door hinges and striker plate securing screws.
   Lubricate door hinges, bonnet lock, and operating mechanism.
8. *Electrical*
   Check battery cell specific gravity readings and top up to correct level.
9. *Lubrication*
   Change oil in engine, gearbox (not automatic), overdrive, and rear axle.
   Fit new oil filter element.
   Top up oil level in steering gearbox and automatic gearbox.
   Lubricate all grease nipples and oiling points.
   Repack front hub caps with grease.
10. *Wheels and tyres*
    Check tyre pressures.
    Check wheel alignment.
    Change road wheels round diagonally, including spare, to regularize tyre wear.

7,000 miles (11200 km.) service

Carry out the **1,000 miles (1600 km.) service.**

8,000 miles (12800 km.) service

Carry out the **1,000 miles (1600 km.) service.**

9,000 miles (14400 km.) service

Carry out the **3,000 miles (4800 km.) service.**

10,000 miles (16000 km.) service

Carry out the **1,000 miles (1600 km.) service.**

11,000 miles (17600 km.) service

Carry out the **1,000 miles (1600 km.) service**

12,000 miles (19200 km.) service

1. *Engine*
   Lubricate carburetter controls.
   Check valve rocker clearances, and adjust if necessary.
   Clean and re-oil air cleaner.
   Check dynamo drive belt tension.
   Lubricate water pump sparingly.
   Clean carburetter and fuel pump filters.

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12,000 miles (19200 km.) service—*continued*

2. *Ignition*
   Check automatic ignition control, lubricating drive shaft (one turn), cam, and advance mechanism.
   Check, and adjust if necessary, distributor contact points.
   Fit new sparking plugs.
3. *Fluid supply tanks*
   Check level of brake, power steering, and hydraulic jack supply tanks, and top up if necessary.
4. *Steering*
   Check steering and suspension moving parts for wear.
5. *Brakes*
   Check brakes, and adjust if necessary.
   Make visual inspection of brake lines and pipes.
6. *Hydraulic dampers*
   Examine all hydraulic dampers for leaks, and top up if necessary.
7. *Radiator*
   Drain, flush out, and refill radiator.
8. *General*
   Tighten rear road spring seat bolts.
9. *Body*
   Check, and tighten if necessary, door hinges and striker plate securing screws.
   Lubricate door hinges, bonnet lock, and operating mechanism.
10. *Electrical*
    Check battery cell specific gravity readings and top up to correct level.
    Lubricate dynamo bearing.
    Check headlamp beam setting, and reset if necessary.
11. *Lubrication*
    Drain and flush out engine, filling with fresh oil.
    Change oil in gearbox (not automatic), overdrive, and rear axle.
    Fit new oil filter element.
    Lubricate all grease nipples and oiling points.
    Top up oil level in steering gearbox, and automatic gearbox.
    Repack front hub caps with grease.
12. *Wheels and tyres*
    Check tyre pressures.
    Change road wheels round diagonally, including spare, to regularize tyre wear.
    Check wheel alignment.

24,000 miles (38400 km.) service

Carry out the **12,000 miles (19200 km.) service,** with the following additions:

1. *Automatic transmission*
   Change oil in automatic gearbox.
2. *Engine*
   Remove engine sump and oil pick-up strainer.
   Clean the sump, pick-up strainer, and crankcase internally, and reassemble, filling with fresh oil.

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SECTION A

THE ENGINE

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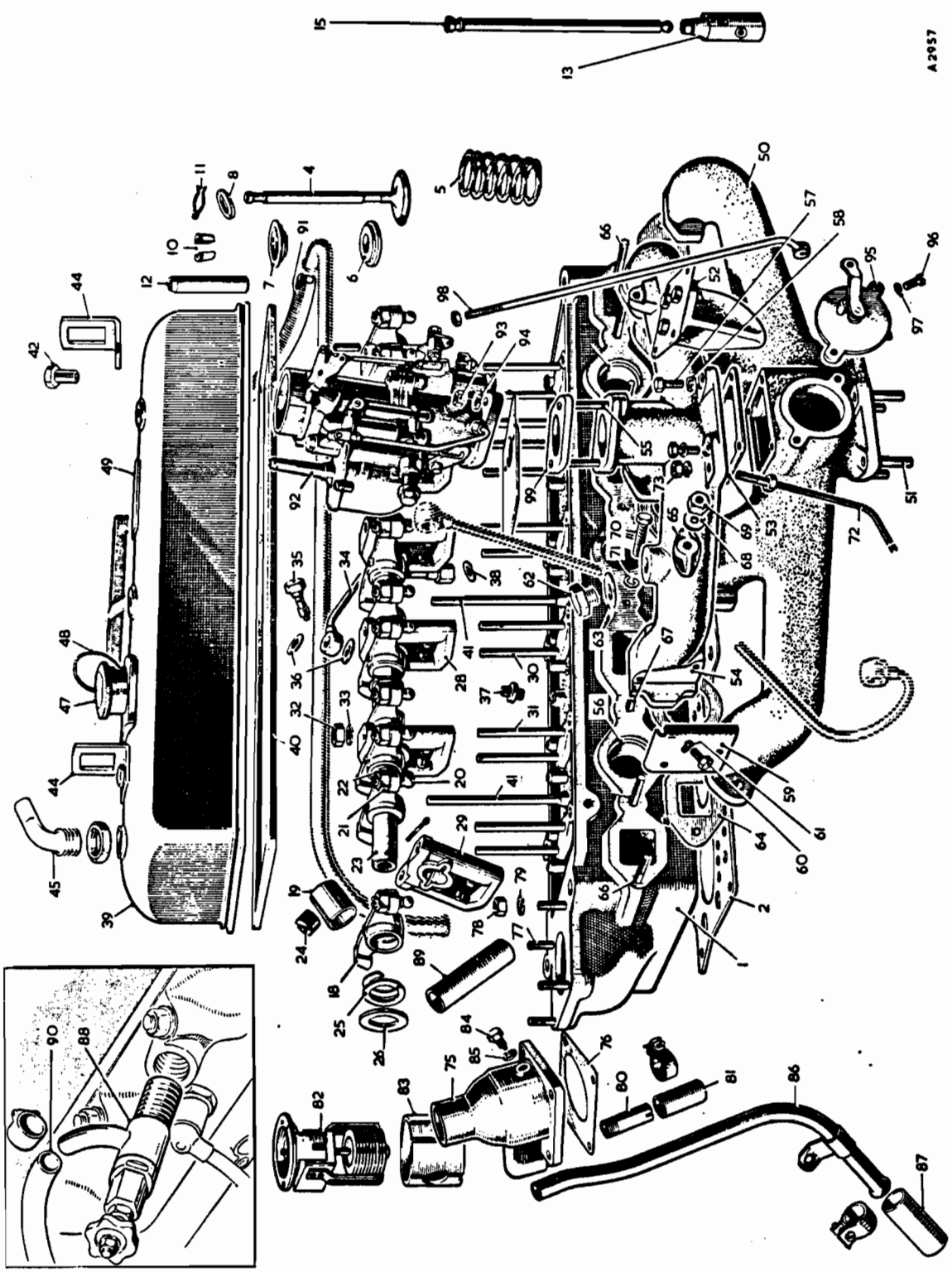
THE CYLINDER HEAD COMPONENTS



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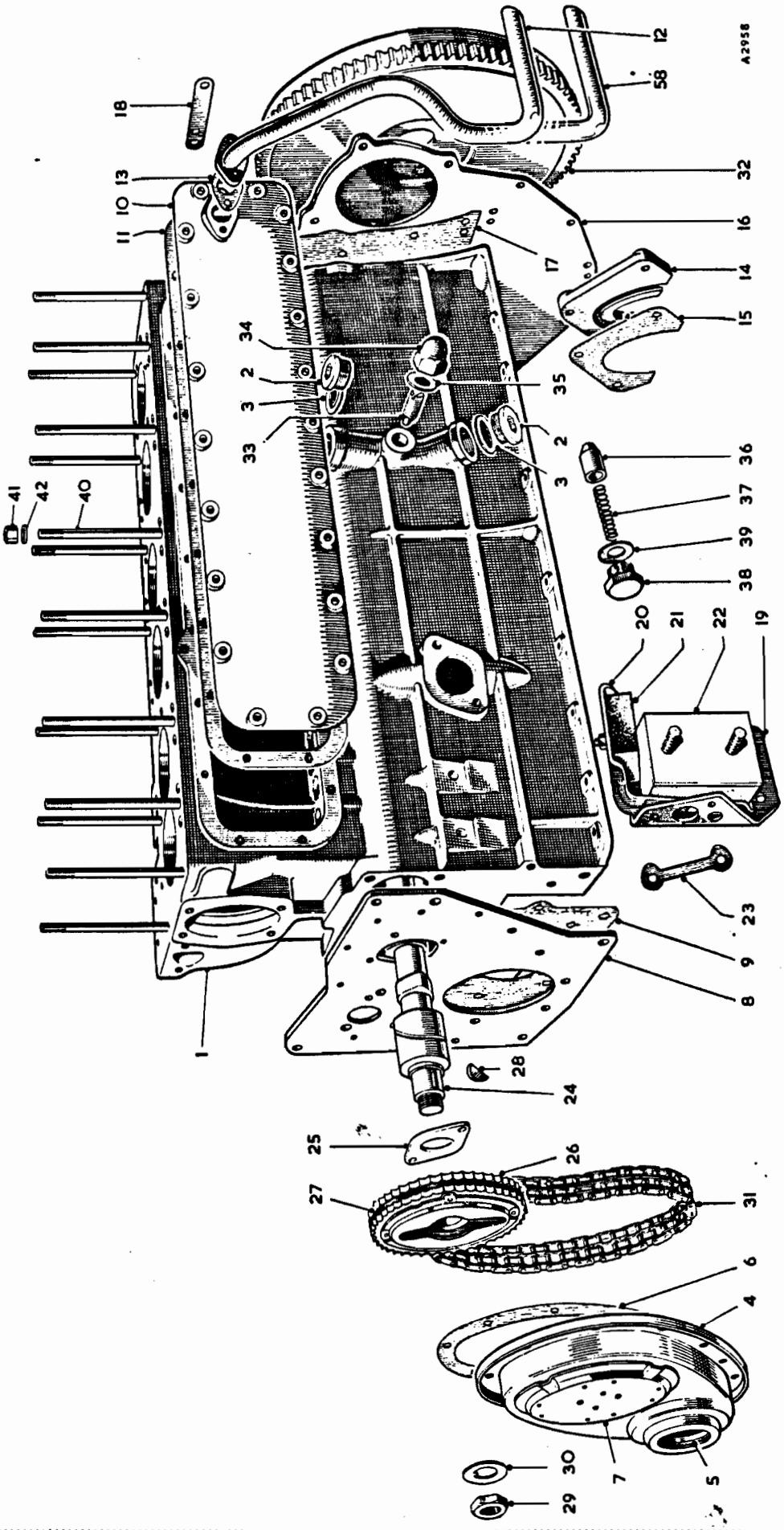
KEY TO THE CYLINDER HEAD COMPONENTS

No.	Description
1.	Cylinder head.
2	Joint washer.
4.	Valve.
5.	Valve spring.
6.	Valve spring collar (bottom).
7.	Valve spring cup.
8.	Valve oil seal.
10.	Valve cotters.
11.	Circlip—valve cotters.
12.	Valve guide.
13.	Tappet.
15.	Push-rod.
18.	Valve rocker.
19.	Valve rocker bush.
20.	Tappet adjusting screw.
21.	Locknut for adjusting screw.
22.	Rocker spacing spring.
23.	Rocker shaft.
24.	Screwed plug.
25.	Coil washer.
26.	Washer.
28.	Valve rocker bracket (tapped).
29.	Valve rocker bracket (untapped).
30.	Rocker bracket stud (short).
31.	Rocker bracket stud (long).
32.	Nut.
33.	Spring washer.
34.	Oil feed pipe.
35.	Locating screw.
36.	Fibre washer.
37.	Union.
38.	Fibre washer.
39.	Valve rocker cover.
40.	Joint washer.
41.	Valve rocker cover studs.
42.	Cap nuts.
44.	Engine sling brackets.
45.	Vent pipe.
47.	Oil filler cap.
48.	Cable.
49.	Nameplate.
50.	Exhaust manifold.
51.	Exhaust manifold studs.
52.	Hot-spot.
53.	Hot-spot joint washer.
54.	Induction manifold.
55.	Carburetter mounting stud.
56.	Induction port ferrules.
57.	Set screw.
58.	Washer.
59.	Induction pipe shield.
60.	Set screw.
61.	Spring washer.
62.	Plug.
63.	Washer.
64.	Joint washer.
65.	Manifold clamp.
66.	Manifold studs.
67.	Manifold studs.
68.	Washer.
69.	Nut.
70.	Set screw.
71.	Spring washer.
72.	Petrol drain pipe.
73.	Nut.
75.	Water outlet elbow.
76.	Joint washer.
77.	Elbow mounting stud.
78.	Nut.
79.	Spring washer.
80.	By-pass tube.
81.	Rubber connection.
82.	Thermostat.
83.	Thermostat sleeve.
84.	Locating pin.
85.	Fibre washer.
86.	By-pass tube.
87.	Rubber connection.
88.	Heater control tap.
89.	Rubber connection.
90.	Rubber connection.
91.	Hose connection.
92.	Carburetter.
93.	Nut.
94.	Spring washer.
95.	Automatic choke.
96.	Set screw.
97.	Spring washer.
98.	Choke rod.
99.	Insulating washer.

Early models only.

THE CYLINDER BLOCK COMPONENTS



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KEY TO THE CYLINDER BLOCK COMPONENTS

No.	*Description*
1.	Cylinder block.
2.	Screwed plug.
3.	Washer.
4.	Front cover.
5.	Felt seal.
6.	Joint washer.
7.	Sound insulation retaining cover.
8.	Engine front plate.
9.	Joint washer.
10.	Cylinder side cover.
11.	Joint washer.
12.	Crankcase vent pipe.
13.	Joint washer.
14.	Crankcase rear cover.
15.	Joint washer.
16.	Engine rear plate.
17.	Joint washer (bottom).
18.	Joint washer (top).
19.	Front support bracket.
20.	Front mounting buffer bracket.
21.	Rubber buffer.
22.	Rubber mounting.
23.	Lock washer.
24.	Camshaft.
25.	Camshaft locating plate.
26.	Camshaft gear.
27.	Tensioner.
28.	Key.
29.	Nut.
30.	Lock washer.
31.	Chain.
32.	Flywheel.
33.	Oil pump locating screw.
34.	Cap nut for locating screw.
35.	Washer.
36.	Oil release valve.
37.	Spring.
38.	Valve plug.
39.	Washer.
40.	Cylinder head stud.
41.	Nut.
42.	Washer.
58.	Crankcase vent pipe.

THE CRANKSHAFT AND SUMP COMPONENTS

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KEY TO THE CRANKSHAFT AND SUMP COMPONENTS

No.	Description
1.	Cork plugs.
2.	Shell main bearing.
3.	Upper thrust washer.
4.	Lower thrust washer.
5.	Crankshaft.
6.	Crankshaft gear.
7.	Key.
8.	Spacing collar.
9.	Oil thrower.
10.	Crankshaft pulley.
11.	Key.
12.	Vibration damper.
13.	Stud.
14.	Nut.
15.	Spring washer.
16.	Starting nut.
17.	Lock washer.
18.	Connecting rod.
19.	Big-end shell bearings.
20.	Big-end clamp bolts.
21.	Gudgeon pin clamp bolt.
22.	Spring washer.
23.	Piston.
24.	Top compression ring (chromium).
25.	Compression rings (tapered.).
26.	Scraper ring.
27.	Gudgeon pin.
28.	Oil pump and cover.
29.	Sump.
30.	Joint washer.
31.	Sump fixing screw.
33.	Spring washer.

THE ENGINE LUBRICATION SYSTEM

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GENERAL DESCRIPTION

The six-cylinder overhead-valve engine is built in unit construction with a single dry-plate clutch. The valves are set in line in the detachable cylinder head and are operated by rockers and push-rods from the camshaft on the right-hand side of the engine. Oil seals are fitted to the valves and there is the normal provision on the rockers for clearance adjustment. The camshaft is roller-chain-driven from the crankshaft. The chain is tensioned by a patent rubber tensioner incorporated in the camshaft gear. The end-thrust of the camshaft, which runs in four renewable white-metal-lined steel bearings, is taken by a plate secured to the front end of the cylinder block. The oil pump and distributor are driven from the camshaft. The pistons are of aluminium alloy and carry three compression rings and a slotted oil control ring. The hollow gudgeon pins are clamped in the 'H'-section connecting rods, which are fitted with steel-backed renewable big-end bearings. Four white-metal renewable bearings support the forged-steel counterbalanced crankshaft and the end-thrust is taken by split thrust plates on No. 2 main bearing housing. A centrifugal water pump with fan blades attached to the pulley is driven from the crankshaft by the dynamo belt.

LUBRICATION SYSTEM

The oil supply is carried in the sump below the cylinder block and the filler cap is fitted on the forward end of the rocker cover. The oil indicator dipstick is on the right-hand side of the engine and is marked to indicate the maximum and minimum levels. The camshaft-driven oil pump is mounted below the crankcase and is partially submerged in the oil reservoir.

Oil is drawn through a gauze strainer secured to the oil pump and passes through a drilling up the right-hand side of the crankcase to the oil filter, passing the non-adjustable pressure release valve. After leaving the full-flow oil filter the oil passes to the main oil gallery, which runs the length of the engine on the right-hand side. From the main oil gallery lubricant is fed to the big-ends, main bearings, and the four camshaft bearings.

Oil at a reduced pressure is taken through drilled passages in the cylinder block and cylinder head to an oil feed on the valve rocker shaft and is fed into the hollow rocker shaft. All rocker bearings are lubricated through drillings in the rocker shaft, and oilways in the forged-steel rockers carry lubricant to the push-rod cups and valve tips.

Two oil bleed holes are provided in No. 1 camshaft bearing, from which oil is fed to the camshaft gear and the timing chain. Lubrication for the cylinder bores is affected by a small jet hole in the top half of the connecting rod big-end bearing.

Section A.1

REMOVING AND REPLACING THE ENGINE

Where automatic transmission is fitted it is not advisable to attempt to remove the engine alone, and the engine and transmission assembly should be removed as one unit (see Section E).

Before any work is commenced it is advisable to place felt or some other protective material on the wings, etc., to prevent any damage to the paintwork.

Drain the water from the cooling system. If anti-freeze is used the coolant should be collected in a clean container. Disconnect the battery leads as a safety precaution, and then remove the bonnet as detailed in Section R. Remove the radiator as described in Section C and remove the horns. Remove the air cleaner as detailed in Section D.

Disconnect the sparking plug leads and remove the distributor cap completely to avoid possible damage. Disconnect the wiring from the dynamo terminals and remove the dynamo as detailed in Section N. Release the flexible oil gauge pipe from its connection on the cylinder block.

Unscrew the olive nut from the copper water drain pipe and remove the pipe. Detach the radio earthing cable from the cylinder head (where fitted). Disconnect the heater delivery pipe at the valve connection and the heater return pipe at its connection to the copper pipe at the rear of the head and pull the pipes clear of the engine.

Disconnect the throttle and strangler controls at the carburetter and remove the fuel delivery pipe.

Release the automatic advance retard vacuum pipe. Remove the securing nuts, and washers from the exhaust pipe flange and push the pipe downwards away from the manifolds.

Remove the oil filter bowl as detailed in Section A.3.

From beneath the chassis release the steering ball joints from the pivot arm and push the pivot arm sideways to allow sufficient room for engine withdrawal. To remove the ball joints turn the wheels to full lock each way to allow the joints to clear the sump. Fit suitable lifting brackets to the cylinder head, fit the lifting chains and take up the slackness in the chain. Release the front engine mounting brackets.

Support the front end of the gearbox with a screw-type jack. Remove the carpet from the gearbox cover, extract the screws and remove the cover. Remove the nuts and bolts securing the gearbox bell housing to the engine back plate, including those which secure the starter. Lay the starter to one side, with cable still attached.

Carefully hoist the engine a little at a time, at the same time pulling it forward clear of the gearbox bell housing. The engine can now be removed from the vehicle completely.

The replacement of the engine is a reversal of the above procedure. Before refitting the engine the clutch driven plate should be centralized, using Service tool 18G81 to ensure that the splines will engage with the gearbox first motion shaft. After completing the installation of the engine refill with oil if the lubricant has been drained.

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Section A.2

DRAINING THE SUMP

The sump on new and reconditioned engines must be drained and filled with new oil at the After Sales Service and then at intervals as stated in the Passport to Service. The sump should be allowed to drain for at least 10 minutes before the drain plug is replaced. The oil will flow more readily if it is drained while the engine is hot.

A new external oil filter element should be fitted at the periods stated in the Passport to Service.

Section A.3

EXTERNAL OIL FILTER

The external filter is a full-flow type, thus ensuring that all oil in the lubrication system passes through the filter before reaching the bearings. The element of the filter is of a star formation in which a special-quality felt, selected for its filtering properties, is used. Oil is passed to the filter from the pump at a pressure controlled by the engine oil release valve. Some pressure is lost in passing the oil through the filter element; this will only be a pound or two per square inch with a new element

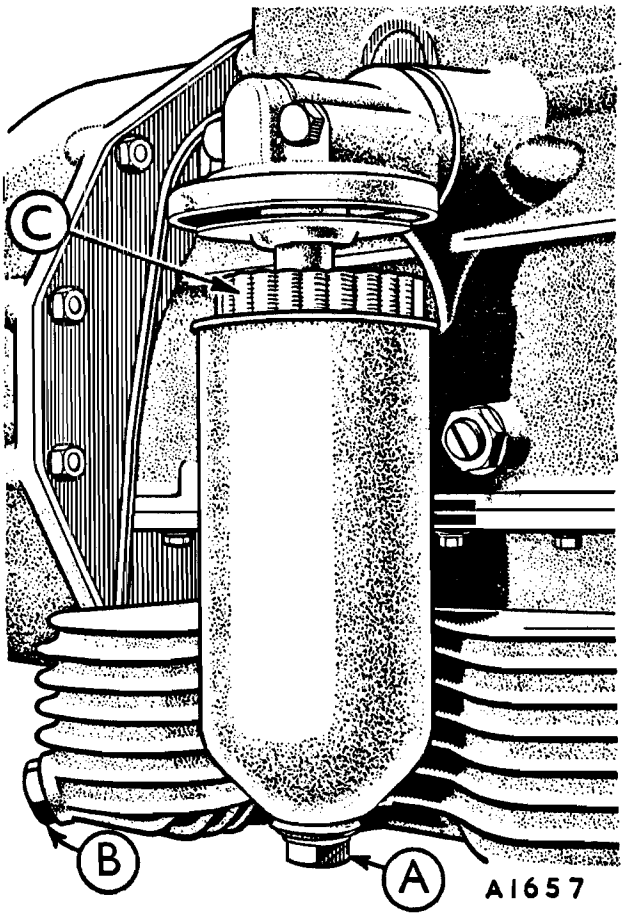

Fig. A.1

The Tecalemit full-flow oil filter

A. Central fixing bolt. B. Sump drain plug.
C. Filter element.

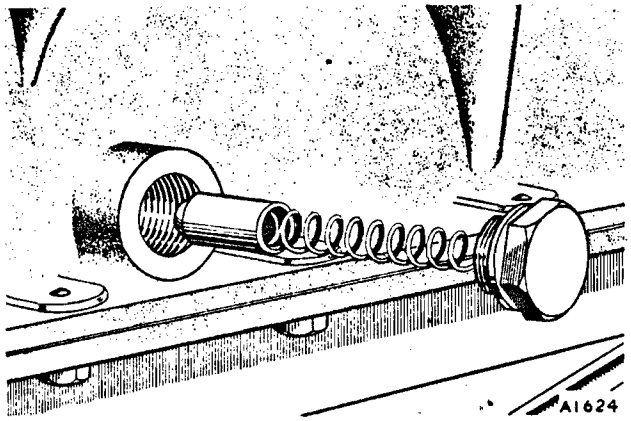

Fig. A.2

The oil pressure release valve assembly

but will increase as the element becomes progressively contaminated by foreign matter removed from the oil.

Should the filter become completely choked due to neglect, a balance valve is provided to ensure that oil will still reach the bearings. This valve is set to open at a pressure difference of 15 to 20 lb./sq. in. (1·05 to 1·4 kg./cm.²). The balance valve is non-adjustable and is located in the filter head casting. When the valve is opened unfiltered oil can by-pass the filter element and reach the bearings.

A new external oil filter element must be fitted at the periods stated in the Passport to Service.

Make certain that the correct element is obtained (see **'GENERAL DATA'** for the make of filter fitted).

To renew the element proceed as follows.

Unscrew the centre-fixing bolt, and the bowl complete with element can be removed. Withdraw the contaminated element and carefully cleanse the bowl. After ensuring that no fibres from the cleansing operation have been left in the bowl put in a new element, prime the filter, and refit to the head casting, tightening the centre-fixing bolt sufficiently to make an oiltight joint. Check the level of oil in the sump by means of the dipstick.

It is recommended that the filter container should not be disturbed other than for the fitting of a new element; to do so invites the hazard of added contamination from accumulated dirt on the outside of the filter entering the container and thus being carried into the bearings on restarting the engine.

Section A.4

OIL PRESSURE RELEASE VALVE

The non-adjustable oil pressure release valve is situated towards the rear of the right-hand side of the cylinder block behind the oil filter and is held in position by a hexagon nut sealed by a fibre washer. The release valve spring maintains a valve cup against the seating machined in the block.

The valve should be examined to ensure that the cup is seating correctly and that the release spring has not lost

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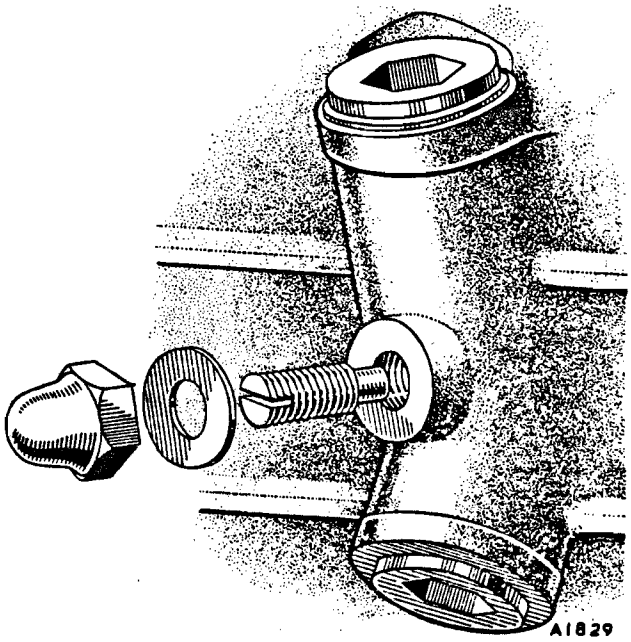

Fig. A.3

The oil pump locating screw with fibre washer and cap nut

its tension. The cup can be removed and ground into its seating with Service tool 18G69. The spring tension can be checked by measuring the length of the spring (see **'GENERAL DATA').**

Section A.5

OIL PRESSURE

Should there be a noticeable drop in pressure, the following points should be checked over:

(1) That there is a good supply of the correct grade of oil in the sump.

(2) That the oil gauge pipe has secure connections and is not fractured.

(3) That there is no air leakage between the oil pump cover and the pump body on the suction side of the pump or between the body and the delivery pipe unions.

(4) That the strainer in the sump is clean and not choked with sludge.

(5) That the bearings, to which oil is fed under pressure, have the correct working clearance. Should the bearings be worn and the clearances excessive, the oil will escape more readily from the sides of the bearings, particularly when the oil is warm and becomes fluid. This will cause a drop in pressure on the gauge compared with that shown when the bearings are in good order.

NOTE.—The automatic release valve in the lubrication system deals with any excessive oil pressure when starting from cold. When hot, the pressure drops as the oil becomes more fluid.

Continuous cold-running and the unnecessary use of the mixture control are often the causes of serious oil dilution by fuel and of a consequent drop in pressure.

New engines with new oil will give considerably higher pressure readings than those given under **'GENERAL DATA'.**

Particular attention is called to the recommended change of oil as stated in the Passport to Service.

Section A.6

REMOVING AND REPLACING THE OIL PUMP

Remove the sump as detailed in Section A.8. Unscrew the union at each end of the oil delivery pipe and remove the pipe. Unscrew the three nuts securing the strainer to the pump and remove the strainer. Remove the oil pump locating screw from the left-hand side of the crankcase (see Fig. A.3). After removing the domed locking cap the screw can be removed with a screwdriver. Note that there is a fibre washer beneath the nut.

The oil pump assembly can now be removed from the engine.

To replace the pump insert the pump body from beneath the crankcase, pushing the shaft right home to

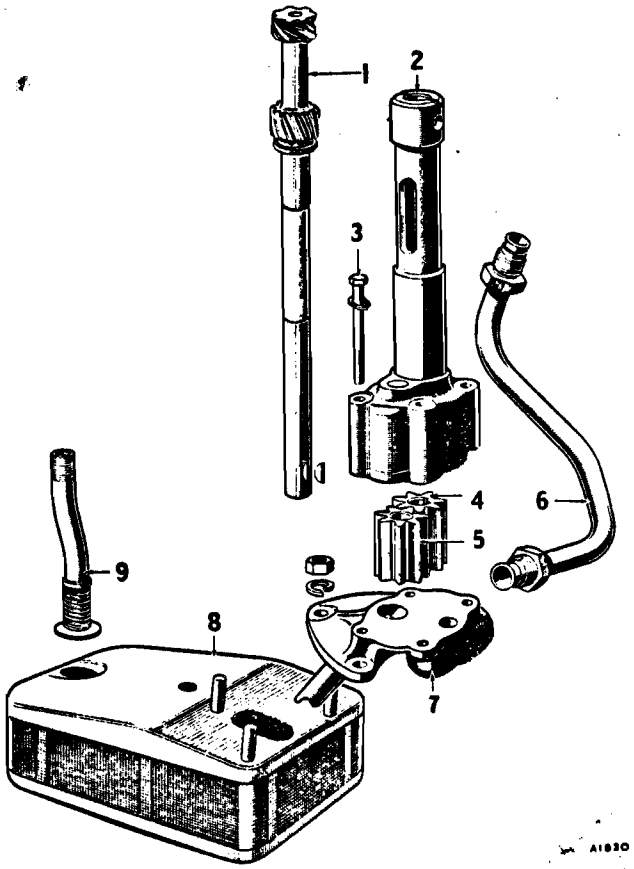

Fig. A.4

The components of the oil pump (gear type)

1. Driving spindle.
2. Pump body.
3. Set screw and washer.
4. Driving gear.
5. Driven gear.
6. Delivery pipe.
7. Bottom cover.
8. Oil strainer.
9. Return pipe.

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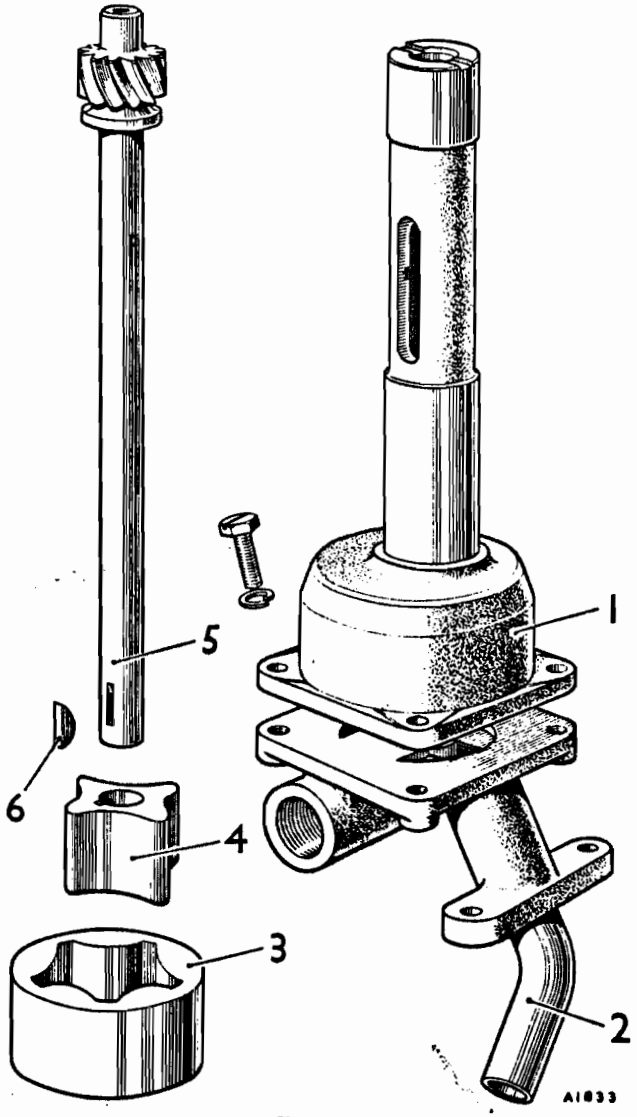

Fig. A.5

The components of the oil pump (Hobourn Eaton)

1. Pump body.
2. Bottom cover.
3. Outer rotor.
4. Inner rotor.
5. Drive shaft.
6. Key.

ensure that the driving gear is meshing with the gear on the camshaft.

Insert the oil pump locating screw and tighten. Refit the fibre washer and the domed locknut.

Section A.7

DISMANTLING AND REASSEMBLING THE OIL PUMP

Gear-type pump (Fig. A.4)

The oil pump bottom cover is secured to the pump body by four long set screws, and after removal of these screws the bottom cover and driven gear can be withdrawn. The driving gear is keyed to the driving spindle and will need to be tapped off. After removing the Woodruff key from the driving spindle the spindle can be withdrawn from the pump body. The reassembly of the gear-type pump is a reversal of the above procedure. The pump must be free from stiffness when rotated after the bottom cover set screws have been fully tightened.

Eccentric rotor oil pump (Fig. A.5)

The Hobourn-Eaton eccentric rotor oil pump is fitted to some models as an alternative to the gear-type pump described above. Before dismantling mark the cover flange and bottom cover to facilitate correct assembly. Remove the four set screws and remove the bottom cover. The outer rotor can be lifted out of the body and the inner rotor pulled from the shaft. The inner rotor is secured to the shaft by a Woodruff key. When reassembling, ensure that the key is in position between the shaft and the inner rotor. After tightening the bottom cover set screws make certain that the pump revolves freely.

Section A.8

REMOVING AND REPLACING THE SUMP

Drain the oil from the sump. Turn the front wheels to full lock and disconnect the ball joints from the centre steering pivot arm. Remove the 28 set screws which secure the sump to the crankcase and lower the sump carefully clear of the oil pump and strainer.

When refitting the sump to the engine pay particular attention to the condition of the sump sealing gasket. If the gasket is in good condition and has not been damaged during removal it may be used again, but if there is any doubt about its condition a new one should be fitted. Smear the crankcase face with grease, place the gasket in position, and refit the sump. Tighten the set screws evenly.

Refill the sump with oil.

Section A.9

MAIN AND BIG-END BEARINGS

Unless the bearing journals are badly worn the big-end bearings and the Nos. 2 and 3 main bearings may be renewed without removing the crankshaft. To renew the front and rear main bearings the engine must be removed from the car as in Section A.1. Liners are used for both the main and the big-end bearings, which are of the shimless type and are therefore non-adjustable.

Big-end bearings

Drain the engine oil and remove the sump as detailed in Section A.8 and the oil pump and strainer as described in Section A.6.

As the bearings are of the shimless type it is essential that no attempt should be made to adjust them when worn. Always fit new bearings in place of worn parts. If the crankshaft journals are found to be in an excessively worn condition it is advisable to fit a service reground crankshaft, complete with main and big-end bearings. Both the big-end and main bearing liners are located in position in their bearing housings by a small tag on one side of each half-bearing, and it should be

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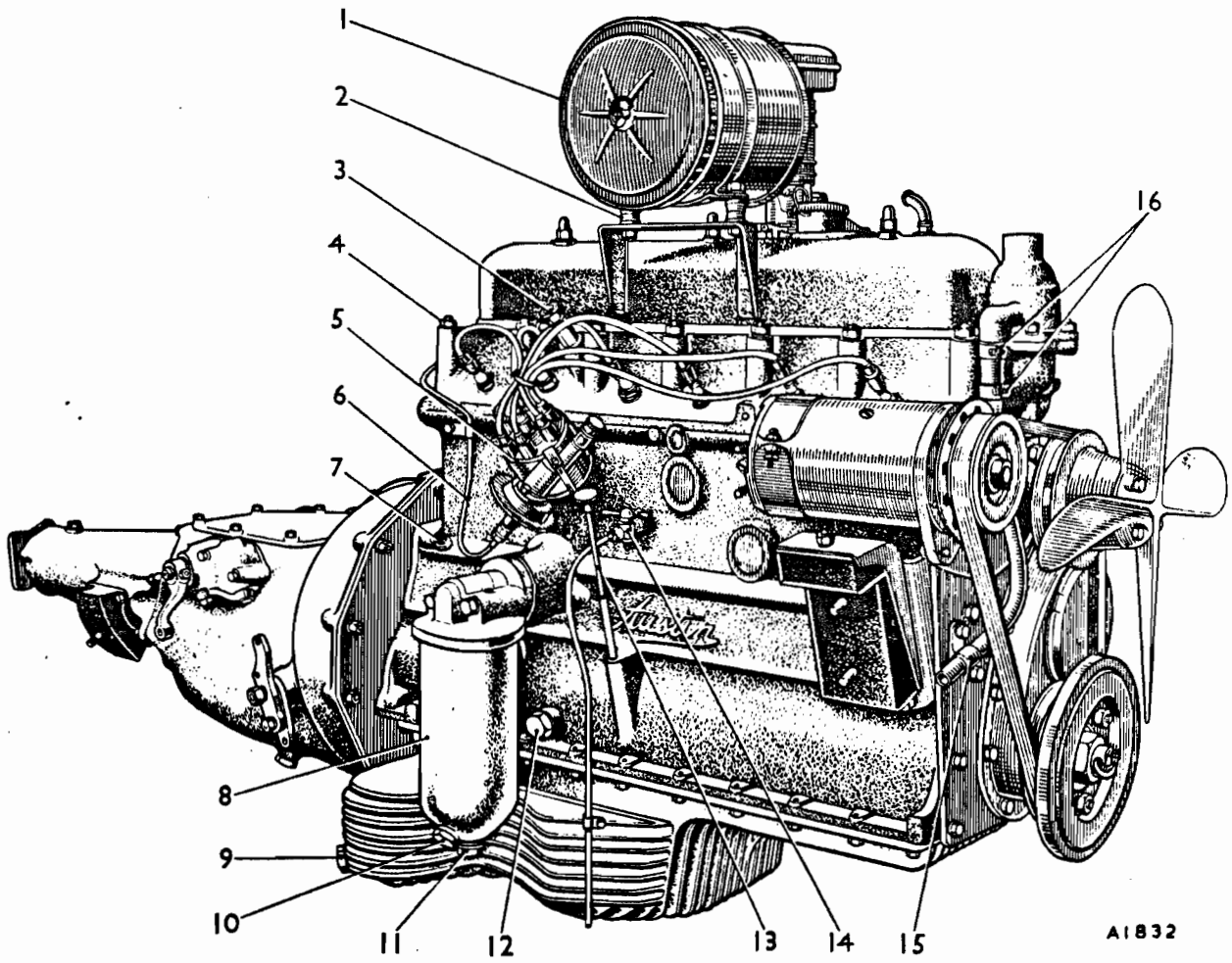

Fig. A.6

The power unit

1. Air cleaner and silencer.
2. Air cleaner securing stay.
3. Heater control valve.
4. Cylinder head nuts.
5. Distributor.
6. Vacuum pipe.
7. Oil gauge pipe union.
8. Tecalemit filter.
9. Sump drain plug.
10. Filter drain plug.
11. Filter fixing bolt.
12. Oil release valve.
13. Dipstick.
14. Cylinder block drain tap.
15. Thermostat by-pass pipe.
16. Hose clips—by-pass pipe.

noted that the bearings are fitted so that the tags come on the same joint edge of the bearing housing, although on opposite corners. To detach the big-end bearings unscrew the self-locking nuts and remove the bolts. Remove the connecting rod caps and extract the bearings. Care should be exercised to see that the bearing journals, etc., are thoroughly cleaned before installing new bearings. No scraping is required as the bearings are machined to give the correct diametrical clearance given under **'GENERAL DATA'.**

Main bearings

Nos. 2 and 3 main bearing liners may be renewed without removal of the engine and end plates necessary when dealing with the front and rear main bearings to ensure correct assembly. The front and rear main bearing caps are secured by bolts passing through the front and rear end plates, in addition to the normal studs.

To reach the two centre bearings remove the sump and oil pump and the bearing cap self-locking nuts. No. 2 main bearing takes the crankshaft end-thrust on washers on each side of the bearing housing. Each thrust washer consists of two semicircular halves, and the upper half of each is free to rotate with the crankshaft after the bearing cap is removed and may be withdrawn from the housing without removal of the crankshaft. The lower half of each washer is locked against rotation by a lug which registers in the bearing cap.

To remove the front and rear main bearings remove the engine from the car as described in Section A.1: remove the flywheel (Section A.31), the timing chain (Section A.27), the sump (Section A.8), the oil pump and strainer (Section A.6), and the front and rear engine plates.

Remove the nut securing the bearing caps to the cylinder block and withdraw the bearing cap.

When fitting new bearings no scraping is required as the bearings are machined to give the correct diametrical clearance.

In the case of a 'run' bearing it is always essential to

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thoroughly clean out all the oilways in the crankshaft and block, to wash out the engine base with paraffin (kerosene), and to clean the oil pump and strainer to ensure that no particles of white metal are left anywhere in the lubrication system.

Before replacing the rear main bearing cap thoroughly clean the horizontal joint surfaces and coat them lightly with Wel-seal (manufactured by Messrs. Wellworthy Ltd.) Sealing Compound. At the same time new sealing plugs should be fitted at each side of the front and rear bearing caps.

Section A.10

WATER PUMP

The water pump is of the centrifugal impeller type and is mounted on a common spindle with the fan in a casting fastened to the front of the cylinder block.

The water seal is effected by a spring-loaded hard-rubber-faced seal bearing on a seating on the impeller. It is necessary to remove and dismantle the pump and fan assembly to obtain access to the seal. Drain the water from the cooling system and remove the radiator (Section C.5).

Slacken the clips and disconnect the radiator hose and heater return pipe from the water pump.

Release the belt tension by slackening the dynamo pivot bolts and slotted link bolts. If necessary, remove the fan blades by withdrawing the four set pins. Remove the three nuts and one set bolt securing the pump to the front of the cylinder block and withdraw the pump from the studs. When the fan and water pump assembly has been removed from the engine the water pump may be dismantled as detailed in Section C.8.

Replacement of the fan and pump assembly is a reversal of this procedure, but the joint faces of the pump body and the cylinder block must be cleaned and a new joint seal must be fitted.

Section A.11

REMOVING THE ROCKER SHAFT ASSEMBLY

Disconnect the hose from the valve rocker cover breather pipe. Remove the air filter as detailed in Section D. Remove the three rocker cover securing bolts and the two engine lifting brackets. Lift off the rocker cover, taking care not to damage the cork gasket. Unscrew the oil feed pipe at the union on the cylinder head and remove the rocker shaft bracket fixing nuts and spring washers. Remove the rocker assembly, complete with brackets and rockers and oil feed pipes.

Section A.12

DISMANTLING THE ROCKER SHAFT ASSEMBLY

Remove the split pin from one end of the rocker shaft to release the thrust washer and double-coil spring. The oil feed pipe banjo bolt fitted to No. 3 bracket is also a dowel bolt locating the rocker shaft in position in the mounting brackets, and this bolt must be withdrawn to allow the bracket to be removed from the shaft. Note that a fibre washer is fitted either side of the oil pipe banjo. When reassembling the rocker gear commence with No. 3 bracket and secure the oil feed pipe with the washers in position, ensuring that the dowel on the banjo bolt locates in the rocker shaft. The brackets are fitted with the deepest side on the left-hand side of the engine, and the rocker shaft is fitted with the oilway screwed-in end plug to the rear. The front end plug is a drive fit. A split spring spacer is fitted between Nos. 4 and 5 rockers adjacent to No. 5 and between Nos. 8 and 9 rockers adjacent to No. 8.

Section A.13

REMOVING AND REPLACING THE ROCKER BUSHES

Remove and dismantle the rocker shaft as detailed in Sections A.11 and A.12.

To remove and replace worn rocker bushes the use of Service tool 18G21 is recommended; the bushes and the rockers can very easily be damaged by using improvised drifts. Place the rocker on the anvil and press the worn bush out (see Fig. A.7).

Place a new bush on the driver and position the bush with the butt joint at the top of the rocker bore and with the end of the oil groove picking up the oilway to the adjuster end of the rocker.

It will be necessary to drill the oil holes in the bush to coincide with the oilways in the rockers. The oil hole to the adjuster end can be drilled before the bush is

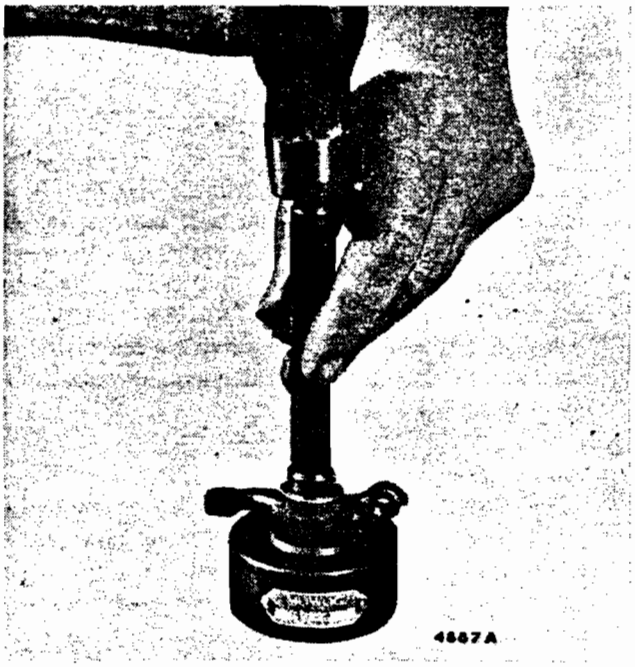

Fig. A.7
Removing a rocker bush, using tool 18G21

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fitted, extra care being taken to keep the holes of the bush and rocker in line during the pressing-in operation.

If the holes are drilled after fitting, the following procedure must be adopted; remove the adjuster screw and use a No. 43 drill, ·089 in. (2·26 mm.), to drill out the end plug and to continue the oilway through the bush. Replug the end after the operation with a new rivet and weld the plug into position. The oil hole in the top of the rocker barrel must be continued through the bush with a No. 47 drill, ·0785 in. (1·98 mm.).

Finally, burnish-ream the bush to the dimension given under **'GENERAL DATA'.**

Section A.14

CYLINDER HEAD

Removing

Drain the water from the cooling system.

If anti-freeze mixture is in use it should be drained into a suitable container for future use. Disconnect the positive cable from the battery. Slacken the hose retaining clips and remove the hose connecting the radiator to the outlet pipe on the thermostat housing which is attached to the front of the cylinder head. Disconnect the by-pass pipe from the under side of the thermostat housing on the right-hand side.

Disconnect the heater supply hoses at the rear of the cylinder head on each side. Remove the air cleaner and carburetter as detailed in Section D.8 and the manifolds as described in Section A.33. Remove the distributor vacuum pipe. Detach the high-tension cables and remove the sparking plugs, taking care not to damage the porcelain insulators.

Remove the three nuts securing the valve rocker cover and remove the cover. Remove the cylinder head nuts

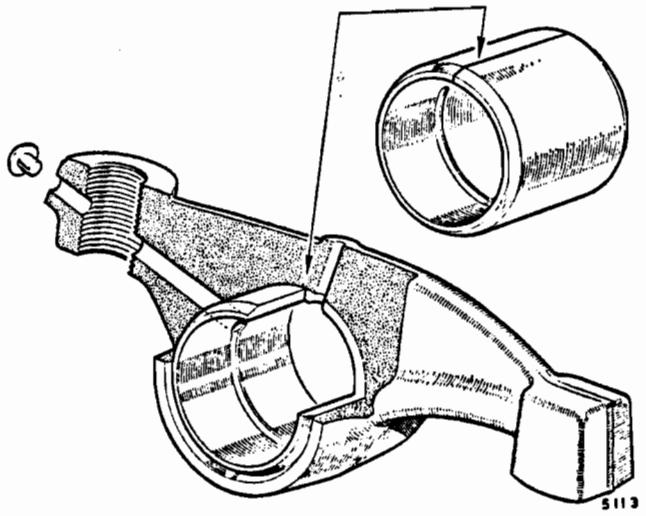

Fig. A.8

Ensure that the bush is positioned to align the end of the oil groove with the oilway from the rocker adjusting screw. The joint in the bush should be in the position indicated by the arrow

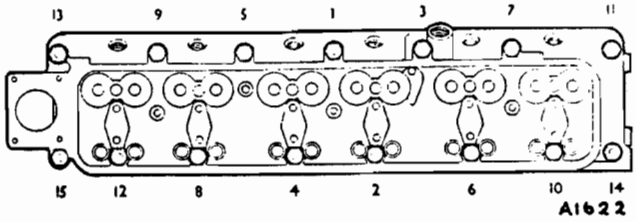

Fig. A.9

Cylinder head nut tightening sequence

and flat washers, slackening the nuts half a turn at a time in the order shown in Fig. A.9 until all pressure is relieved from the cylinder head. To break the cylinder head joint tap the head with a copper or hide mallet. Under no circumstances should a screwdriver blade be inserted into the joint as this may cause damage to the surface of the cylinder block or cylinder head. The removal of the cylinder head is best accomplished by using a rope sling beneath the rocker shaft.

Withdraw the push-rods from the cylinder block, keeping them in order of removal to facilitate replacement in their original positions. If necessary, remove the rocker shaft assembly as detailed in Section A.11.

Refitting

Make certain that the surfaces of both the cylinder block and the cylinder head are clean; it is not necessary to use jointing compound or grease for the gasket. Fit a new cylinder head gasket with the side marked 'TOP' uppermost.

If the rocker shaft has not been removed replace the push-rods in the cylinder block in their original positions. Lower the cylinder head gently over the studs and push-rods, ensuring that all the push-rod cups engage in tappet screw ball-ends. Reassembly is now a reversal of the removal instructions. Tighten the cylinder head nuts a little at a time in the sequence shown in Fig. A.9 to the correct torque wrench reading (see **'GENERAL DATA'**). Check the valve clearances as detailed in Section A.24. These, of course, must be finally adjusted after the engine has been completely reassembled and run for a short period.

After final assembly switch on the ignition and check the fuel system for leaks. Start the engine and run it until the normal working temperature is reached, checking the unit for water leaks as the temperature rises. Remove the rocker cover. Finally, tighten the cylinder head nuts with a torque wrench set to the recommended reading and re-check the valve clearances. Replace the rocker cover.

Section A.15

REMOVING AND REPLACING A PISTON AND CONNECTING ROD

The piston and connecting rods must be withdrawn from the top of the cylinder block.

Remove the cylinder head as detailed in Section A.14. Drain and remove the sump as detailed in Section A.8 and the oil pump as in Section A.6.

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Remove the big-end bearing cap nuts and the bearing cap. Release the connecting rod from the crankshaft and push the assembly upwards until the piston rings are above the cylinder bore. The bolt heads are anchored by a small peg in the top half of the cap. If these have been disturbed the big-end may not pass through the bore as the head of one of the bolts may have turned.

Withdraw the piston and connecting rod from the top of the cylinder block and refit the bearing cap. To avoid piston ring fracture it may be necessary to remove the ring of carbon or ridge from the top of the bores prior to pushing the piston upwards.

When used parts are replaced after dismantling it is essential that they are fitted in their original positions. In order to ensure this mark the caps and connecting rods on their sides which are fitted together with the number of the cylinder from which each was taken.

Replacement of the piston and connecting rod is a direct reversal of the above, but the piston ring gaps should be set at approximately 180° to each other. If the piston rings have been removed from the piston they must be replaced as detailed in Section A.17.

It is essential that the connecting rod and piston assemblies are replaced in their own bores and fitted the same way round. The gudgeon pin clamp bolt should be on the camshaft (left-hand) side of the engine. Use piston ring compressor 18G55A to make refitting an easy operation and to avoid broken piston rings.

Refit the big-end bearings in their original positions.

Section A.16

DISMANTLING AND REASSEMBLING A PISTON AND CONNECTING ROD

Slacken the clamping screw in the small-end of the connecting rod to release the gudgeon pin and remove the piston. Mark the gudgeon pins and pistons for reassembly to their original positions and to the original connecting rods.

Check the gudgeon pin and gudgeon pin bosses for wear with the dimensions given in **'GENERAL DATA'.**

Assemble the pistons to the connecting rods by inserting the gudgeon pins, which should be a push-fit at a temperature of 70° F. (21° C.). Secure each gudgeon pin in position with the little-end clamping bolt.

Section A.17

REMOVING AND REPLACING PISTON RINGS

If no special piston ring expander is available, use a piece of thin steel such as a smoothly ground hacksaw blade or a disused ·020 in. (·50 mm.) feeler gauge.

Raise one end of the ring out of its groove. Insert the steel strip between the ring and the piston. Rotate the strip around the piston, applying slight upward pressure to the raised portion of the ring until it rests on the land above the ring grooves. It can then be eased off the piston. Always remove and replace the rings over the top of the piston, never over the piston skirt.

Before fitting new rings clean the grooves in the piston to remove any carbon deposits. Care must be taken not to remove any metal, or side-play between the ring and groove will result, with consequent excessive oil consumption and loss of gastightness.

New rings must be tested in an unworn part of the cylinder bore to ensure that the ends do not butt together. The best way to do this is to insert the piston into the cylinder bore, push the ring down onto the top of the piston, and hold it there in order to keep the ring square with the bore. The correct ring gaps are given under **'GENERAL DATA'.**

After fitting new piston rings there may be a tendency to noisy operation unless attention is paid to any bore 'lip' which may be present in the cylinder. If there is any evident 'lip' it should be carefully removed with the aid of a hand scraper.

Section A.18

PISTON SIZES AND CYLINDER BORES

Oversized pistons are available ·010 in. (·25 mm.), ·020 in. (·508 mm.), ·030 in. (·762 mm.), and ·040 in. (1·016 mm.) above standard.

If the cylinder block is sleeved the maximum oversize is ·020 in. (·508 mm.).

A piston stamped ·020 is only suitable for a cylinder which has been bored out to ·020 in. (·508 mm.) above

Fig. A.10

Remove and replace the rings over the crown of the piston

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the standard bore size; similarly, pistons with other markings are only suitable for the oversize bore indicated.

After reboring an engine, or whenever fitting pistons differing in size from those removed during dismantling, ensure that the size of the piston fitted is stamped clearly on the top of the cylinder block alongside the appropriate cylinder bore.

Section A.19

REMOVING AND REPLACING THE VALVES

Remove the cylinder head as detailed in Section A.14.

Compress the valve springs, using valve spring compressor 18G45, and remove the valve circlip and the two cap retainers. Release the valve spring and remove the compressor, valve spring cap, and valve spring.

Withdraw the valve from the guide.

Keep the valves in their relative positions when removed from the engine to ensure replacement in their original valve guides, or stamp the head of each valve with a number to indicate its position in the cylinder head.

Split the two halves of the spring cap between which there is a rubber seal. Whenever the valves are removed the rubber oil seal should be renewed as its object is to prevent excess oil entering the valve guide.

To replace the valves place each valve in its guide and replace the valve springs and valve spring cap together with the new rubber oil seal. The oil seals are more easily fitted if they have been soaked in engine oil for a short period before use.

Refit the two cap retainers and secure them with the circlip.

Remove the valve spring compressor.

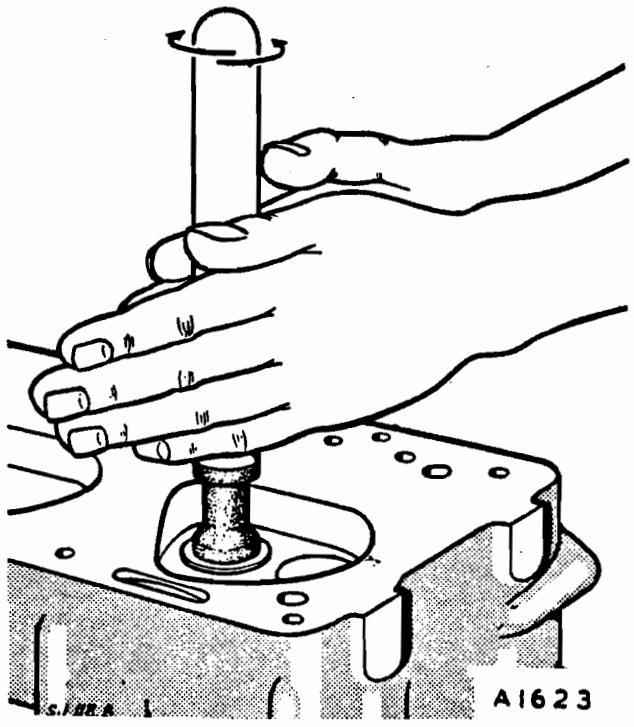

Fig. A.11

Allow the valve to rise occasionally from its seat to spread the grinding paste evenly over the valve face and seat

Section A.20

DECARBONIZING

Drain the cooling water from the engine and the radiator.

Remove the cylinder head as described in Section A.14. Withdraw the valves as described in Section A.19.

Remove the cylinder head gasket and plug the waterways with a clean rag.

If special equipment is not available for decarbonizing it will be necessary to scrape the carbon deposit from the piston crowns, cylinder block, and cylinder head, using a blunt scraper.

A ring of carbon should be left around the periphery of the piston crown and the rim of carbon around the top of each cylinder bore should not be touched. To facilitate this an old piston ring can be sprung into the bore so that it rests on top of the piston.

The cylinder head is next given attention. Sparking plugs must be cleaned and adjusted. Clean off the carbon deposit from the valve stems, valve ports, and combustion spaces of the cylinder head. Remove all traces of carbon dust with compressed air or with vigorous use of a tyre pump; then wash thoroughly with clean paraffin (kerosene) and dry off.

Fit a new cylinder head gasket when refitting the cylinder head.

Section A.21

VALVE-GRINDING

Remove the valves as detailed in Section A.19.

Each valve must be thoroughly cleaned and carefully examined for pitting. Valves in a pitted condition should be refaced with a suitable grinder or new valves fitted.

If the valve seats shown signs of pitting or unevenness they should be trued by use of the special service cutting tools illustrated at the end of Section A. These tools will save lengthy and wasteful grinding in. When using a cutting tool take care to remove only as much metal as is necessary to ensure a true surface. Worn valve seats usually have a glass-hard surface and a glaze breaker should be used to prepare the valve seat surface for any recutting that may be necessary. Narrowing cutters should be used to maintain the valve seats at the correct width as given under 'GENERAL DATA'.

When grinding a valve onto its seating the valve face should be smeared lightly with fine- or medium-grade carborundum paste and then lapped in with suction grinder 18G29. Avoid the use of excessive quantities of

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grinding paste and see that it remains in the region of the valve seating only.

A light coil spring placed under the valve head will assist considerably in the process of grinding. The valve should be ground to its seating with a semi-rotary motion and occasionally allowed to rise by the pressure of the light coil spring. This assists in spreading the paste over the valve face and the seat. It is necessary to carry out the grinding operation until a dull, even, mat surface, free from blemish, is produced on the valve seat and valve face.

On completion, the valve seat and ports should be thoroughly cleaned with a rag soaked in paraffin (kerosene), dried, and then thoroughly cleaned by compressed air. Valves should be washed in paraffin (kerosene) and all traces of grinding paste removed.

Fit new oil seals when refitting the valves.

Section A.22

REMOVING AND REPLACING VALVE GUIDES

Remove the cylinder head as detailed in Section A.14. Remove the appropriate valve and spring as in Section A.19. Rest the cylinder head with the combustion chambers facing upwards on clean wooden blocks with the valve guide to be removed over the space between them. Drive the valve guide downwards from the combustion chamber with a suitable-sized drift. The drift should be stepped in order to ensure correct location to obviate it slipping off the guide and damaging the port.

The new guide should be driven into position in the same direction—that is, inserting it through the valve seating and driving towards the top of the cylinder head. When finally positioned the valve guide should protrude $\frac{3}{4}$ in. (1·905 cm.) above the machined surface of the valve spring seating.

Section A.23

REMOVING AND REPLACING TAPPETS

Remove the valve rocker cover and slacken the valve adjustment screws to their full extent. With the aid of a screwdriver supported under the rocker shaft depress the valve and slide the rocker sideways free of the push-rod Withdraw the push-rod.

In the case of the rocker at each end of the shaft, it is necessary to remove the split pins and washers to enable the rocker to be pulled clear of the push-rod. Remove the two set screws securing the vent pipe to the side cover and release the pipe. Remove the 20 set screws securing the side cover and remove the cover and joint washer. Withdraw the tappets, keeping them in their correct order to ensure replacement in their original locations. Replacement is a reversal of the above sequence. If there is any sign of damage to the side cover gasket a new one should be fitted.

Section A.24

ADJUSTING VALVE ROCKER CLEARANCES

If the engine is to give its best performance and the valves are to retain their maximum useful life it is essential to maintain the correct valve clearance. Accordingly, it is recommended that the clearances should be checked at regular intervals as stated in the Passport to Service and any necessary adjustments made.

The clearance for both the inlet and the exhaust valves is ·012 in. (·305 mm.) when the engine is cold. The engine has been designed to operate with this valve clearance and no departure from it is permissible.

Provision for adjusting the valve clearance is made in the rocker arm by an adiustable screw and locknut.

The rocker adjusting screw is released by slackening the hexagon locknut with a spanner while holding the screw against rotation with a screwdriver. The valve clearance can then be set by carefully rotating the rocker screw while checking the clearance at the other end of the rocker with a feeler gauge. The screw is then relocked by tightening the hexagon locknut, at the same time holding the screw against rotation.

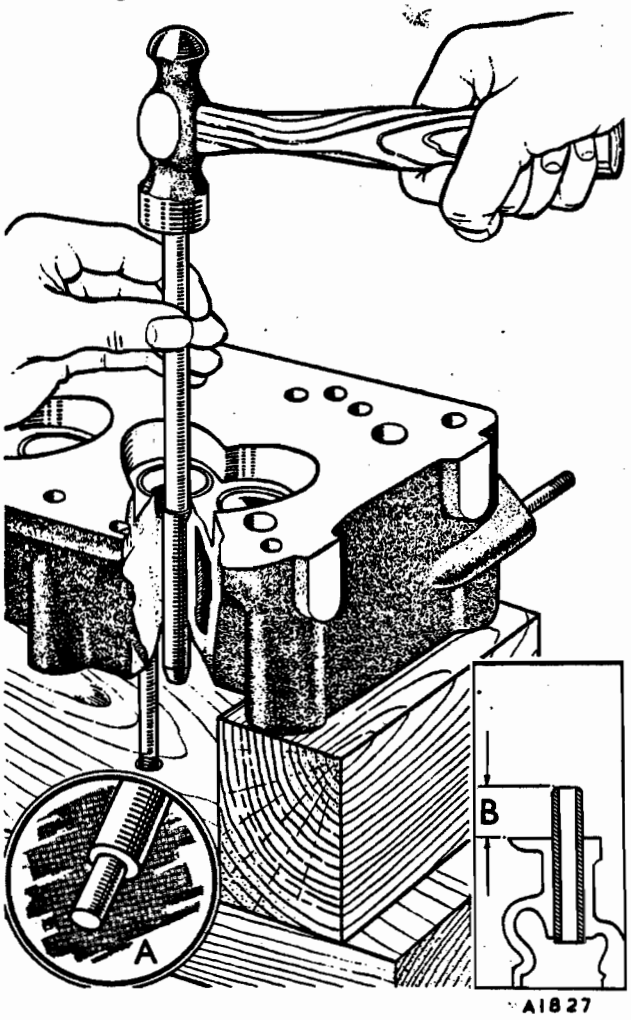

Fig. A.12

Fitting a valve guide, using a stepped drift (A). *In the fitted position the valve guide should be proud of the cylinder head* (B) *by* $\frac{3}{4}$ *in.* (1·905 *cm.*).

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It is important to note that while the clearance is being set the tappet of the valve being operated upon is on the back of its cam, i.e. opposite to the peak.

As this cannot be observed accurately the rocker adjustment is more easily carried out in the following order, and this also avoids turning the engine over more than necessary:

Adjust No. 1 rocker with No. 12 valve fully opened.
„ No. 7 „ „ No. 6 „ „ „
„ No. 9 „ „ No. 4 „ „ „
„ No. 2 „ „ No. 11 „ „ „
„ No. 5 „ „ No. 8 „ „ „
„ No. 10 „ „ No. 3 „ „ „
„ No. 12 „ „ No. 1 „ „ „
„ No. 6 „ „ No. 7 „ „ „
„ No. 4 „ „ No. 9 „ „ „
„ No. 11 „ „ No. 2 „ „ „
„ No. 8 „ „ No. 5 „ „ „
„ No. 3 „ „ No. 10 „ „ „

Section A.25

CHECKING VALVE TIMING

The correct valve timing is predetermined by the location of the timing marks described in Section A.28 and no provision for adjustment of the timing is made. If, however, incorrect assembly is suspected a check can be made as follows. Fit a degree plate to the crankshaft pulley or flywheel with the zero degree marking indicating T.D.C. on Nos. 1 and 6 pistons. This position is marked on the flywheel.

Set No. 1 cylinder inlet valve to the timing check clearance recommended in **'GENERAL DATA'** and then turn the engine until the valve is about to open.

NOTE.—This clearance is for valve-timing check only and must not be confused with the normal running tappet clearance also given in 'GENERAL DATA'.

The degree plate should now indicate that No. 1 piston is at 5° B.T.D.C.

Do not omit to reset the inlet valve to its correct running clearance when the correct timing is complete. The clearance given for the timing check is necessary to bring the opening position of the valve to 5° B.T.D.C. as it is not possible to check the valve timing accurately with the normal running valve clearance.

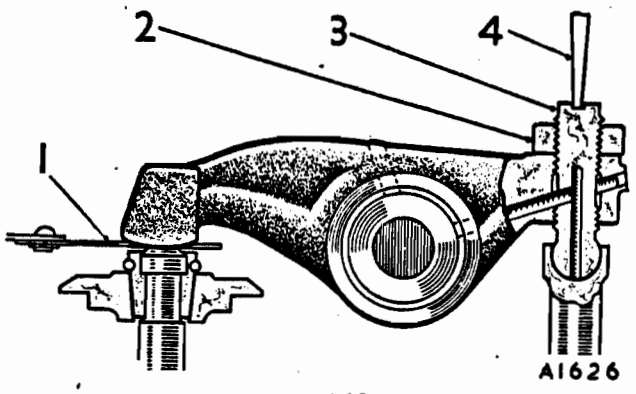

Fig. A.13

Adjusting the valve rocker clearance

1: Feeler gauge.
2. Locknut.
3. Adjusting screw.
4. Screwdriver.

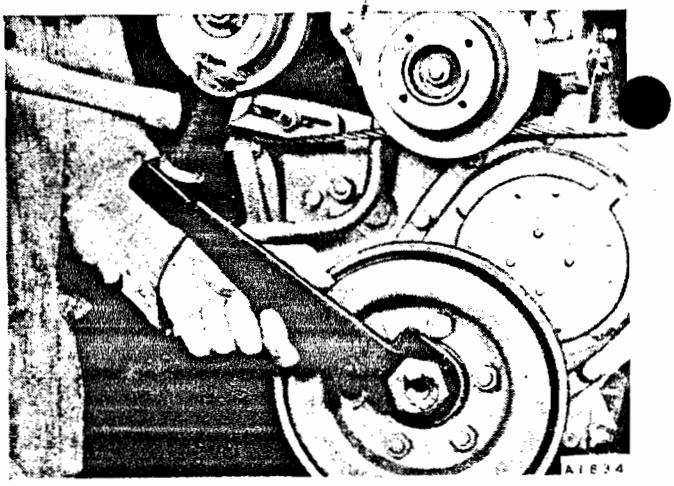

Fig. A.14

Removing the starting handle nut, using Service tool 18G96

Section A.26

REMOVING AND REPLACING THE TIMING COVER

Drain the cooling system and remove the radiator as detailed in Section C.

Slacken the dynamo attachment bolts sufficiently to release the belt.

Bend back the tab on the starting dog nut locking washer. Unscrew the starting dog nut, using Service tool 18G96, and remove the crankshaft damper and pulley. The pulley and vibration damper is a balanced unit and should not therefore be separated unless it is essential.

The timing cover is secured by seven large and five small bolts, each with a plain, oval-shaped washer. Remove the bolts and washers and remove the timing cover.

Care should be taken not to damage the timing cover gasket. It if is damaged clean the face of the cover flange and the front engine mounting plate, and fit a new gasket when reassembling.

The felt oil seal situated in the timing cover should also be renewed if necessary.

It should be noted that the oil thrower, which is located behind the crankshaft pulley, is fitted with its concave (hollow) side facing towards the timing cover.

Section A.27

REMOVING AND REPLACING THE TIMING CHAIN

To remove

Remove the timing cover as detailed in Section A.26. Remove the concave oil thrower from the crankshaft.

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Remove the camshaft gear securing nut and lock washer.

The camshaft and crankshaft chain wheels may now be removed, together with the timing chain, by easing each wheel forward a fraction at a time with suitable small levers.

To refit

The timing gears are marked with small indentations, and the timing is correct when the spot on the camshaft gear is in line with the spot on the crankshaft gear at their closest positions. Before refitting the timing wheels and chain turn the engine until No. 1 piston is at T.D.C. The timing wheels must now be arranged within the chain so that the wheels will locate correctly on the camshaft and crankshaft with the indentations in alignment. With the engine at T.D.C. place a straight-edge between the crankshaft and camshaft centres. The two indentations should lie on the centre-line. Refit the camshaft wheel lock washer and nut and the crankshaft oil thrower, concave side forward. Replace the remaining components as detailed in Section A.26.

Section A.28

REMOVING AND REPLACING THE CAMSHAFT

Drain and remove the sump as detailed in Section A.8 and withdraw the oil pump as detailed in Section A.6. Remove the distributor and driving spindle (Section B.1).

Remove the radiator as detailed in Section C.5 and remove the timing cover (Section A.26) and the timing chain (Section A.27). Remove the push-rods and tappets as detailed in Section A.23.

Unscrew the two set bolts securing the camshaft locating plate and draw the camshaft forward, rotating it slowly to assist withdrawal.

Replacement of the camshaft is a reversal of the above procedure. Refer to Section B.1 when replacing the distributor and distributor driving spindle.

Section A.29

REMOVING AND REPLACING CAMSHAFT LINERS

When new liners are to be fitted the engine must be removed from the car (Section A.1) and the engine plates and crankshaft removed from the engine.

Worn liners can be removed and new liners pressed into position with Service tool 18G124A used in conjunction with the appropriate adaptors.

To remove the front and rear liners

Insert the small end of adaptor 18G124F into the front camshaft liner from the inside of the cylinder block, thread the body of the tool onto the centre screw, and pass the screw through the adaptor from the front of the block. Place the slotted washer on the flat at the rear of the centre screw and insert the tommy-bar into the screw behind the slotted washer.

Tighten up the wing nut to withdraw the worn liner.

The rear liner is withdrawn by the same method, using the adaptor 18G124B and withdrawing the liner from the rear of the block.

To remove the centre liners

Insert the stepped pilot adaptor 18G124H into the camshaft front liner bore from the inside of the cylinder block and the adaptor 18G124E into the front centre liner from the rear, small end first. With the body of the tool positioned on the centre screw, pass the screw through the pilot adaptor located in the front liner and the adaptor in the front centre liner.

Place the slotted washer on the flat at the rear of the centre screw and insert the tommy-bar into the screw behind the slotted washer.

Tighten up the wing nut to withdraw the old liner.

The rear centre liner is withdrawn by the same method, using the stepped adaptor 18G124J in the rear liner with the adaptor 18G124D inserted into the rear centre liner from the front, small end first.

To replace the front and rear liners

Place the new liner on the smallest diameter of the adaptor 18G124F and insert the adaptor into the camshaft front liner bore from the inside, largest diameter first. Line up the oil holes in the liner and the cylinder block and make certain that they remain correctly positioned during the whole operation. Thread the body of the tool onto the centre screw and pass the screw through the adaptor from the front of the block. Position the larger of the two 'D' washers on the centre screw with the cutaway portion turned away from the butt joint of the liner; this joint must be covered by the washer. Place the slotted washer on the flat at the rear of the centre screw and insert the tommy-bar into the hole behind the slotted washer. Tighten the wing nut to pull the liner squarely into position.

The rear liner is replaced by the same method, using the adaptor 18G124B and pulling the liner into position from the rear of the block.

To replace the centre liners

Insert the stepped adaptor 18G124H into the front liner from the inside of the block. Place a new centre liner on the small end of the adaptor 18G124E and position the adaptor in the front centre liner bore from the rear, large diameter first. Ensure that the oil holes in the liner and the cylinder block are lined up and remain so during the whole operation.

With the body of the tool positioned on the centre screw, insert the screw through the pilot adaptor located in the front liner and the adaptor in the centre liner bore. Position the larger of the two 'D' washers on the centre screw with the cutaway portion turned away from the butt joint of the liner; this joint must be covered by the washer. Place the slotted washer on the flat of the screw

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and insert the tommy-bar to prevent the screw from turning. Tighten up the wing nut to pull the liner into position.

The rear centre liner is replaced by the same method, using the stepped adaptor 18G124J in the rear liner bore with the adaptor 18G124D inserted into the rear centre liner from the front, larger diameter first.

Section A.30

REAMING THE CAMSHAFT LINERS

Before the camshaft can be reassembled the liners must be reamed in line in order to obtain the correct clearance between the camshaft journals and their bearings. For this purpose use Service tool 18G123A, which comprises an arbor with tommy-bar and must be used with the adaptors listed below.

Camshaft liner reamer cutter 18G123B.
Camshaft liner reamer cutter 18G123C.
Camshaft liner reamer cutter 18G123D.
Camshaft liner reamer cutter 18G123E.
Camshaft liner reamer pilot 18G123AF.
Camshaft liner reamer pilot 18G123H.
Camshaft liner reamer pilot 18G123J.
Camshaft liner reamer pilot 18G123M.
Camshaft liner reamer pilot 18G123N.

Each cutter, though in one piece, incorporates a roughing and finishing cutter. It is therefore essential that the roughing portion enters the liner first. The cutters must be positioned on the arbor with the relieved flutes of the roughing cutter to enter first. A peg is retained in the centre groove of each cutter by means of a spring clip, and locates the cutter by engaging in a slot in the arbor.

All four liners can be reamed in one operation, provided the cutters and pilots are assembled on the arbor in the following sequence.

Insert pilots 18G123N and 18G123M into the front and centre rear liners respectively from the rear of the block. Slide and locate the cutter 18G123E to position '10' on the arbor. Pass the arbor through the pilot in the front liner. Slip the plain pilot 18G123J and cutter 18G123D onto the arbor. Push the arbor through the centre front liner. Slide cutter 18G123C onto the arbor. Pass the arbor through the pilot in the centre rear liner. Slip plain pilot 18G123H and cutter 18G123B onto the arbor. Locate the cutter 18G123D at position '5' on the arbor, cutter 18G123C at position '3', and cutter 18G123B at position '1'. Place a slack pilot 18G123AF in the rear liner.

Cover all oilways, bearings, and bores with clean cloth while reaming and blow out the oilways with a compressed-air line immediately afterwards. Before commencing to ream by turning the arbor in a clockwise direction apply paraffin or light oil. Do not use force.

The centre front liner and rear liner will be reamed together as the arbor pilots are in the front liner and centre rear liner. Clean away the swarf at frequent intervals, particularly before sliding the plain pilots 18G123H and 18G123J into position in the two reamed liners. Keep the cutter flutes clear of swarf at all times during the operation, preferably with air-blast equipment.

Continue the operation to ream the front liner and centre rear liner.

Free the cutters by turning them clockwise, withdraw the arbor, and remove the pilots. Clear away all swarf and apply oil to the liners before assembling the camshaft.

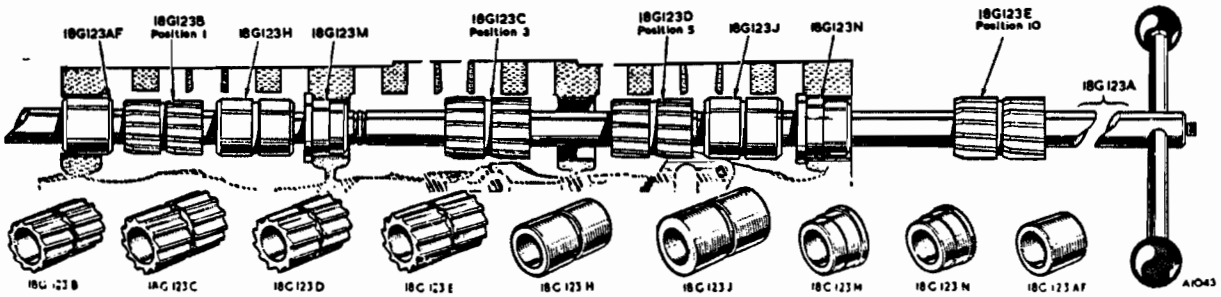

Fig. A.15

The cutters and pilots positioned for reaming the camshaft bearings

Section A.31

REMOVING AND REPLACING THE FLYWHEEL

Remove the gearbox (Section F) and the clutch (Section E).

Remove the four bolts securing the flywheel to the crankshaft after knocking back the locating tabs and withdraw the flywheel.

In order that the 1/6 mark on the flywheel can record the T.D.C. position of pistons Nos. 1 and 6 ensure that the mark is in line with the relative crank throws when replacing the flywheel.

See that the flywheel is correctly fitted on the dowels; replace the four bolts and their locking plates.

After tightening the bolts to the torque tightness figure quoted in **'GENERAL DATA'** securely fix them by bending the lock washer tabs over the flats.

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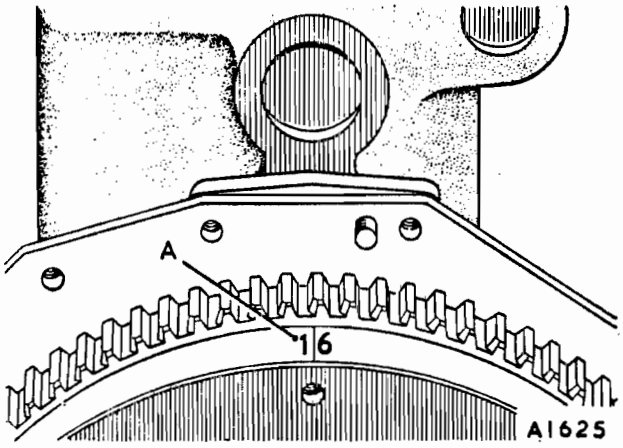

Fig. A.16
The timing mark (A) on the flywheel

Section A.32

REMOVING AND REPLACING THE CRANKSHAFT

Remove the engine as detailed in Section A.1. Remove the sump as in Section A.8 and the oil strainer and oil pump as in Section A.6.

Remove the flywheel as described in Section A.31 and take off the engine back plate.

Remove the timing chain as detailed in Section A.27 and take off the front engine plate.

Mark the big-end caps so that they may be fitted the right way round and in their correct order upon replacement. Remove the big-end bearing caps.

Mark the main bearing caps so that they may be replaced in their original positions, remove the self-locking nuts, and withdraw the caps.

Lift the crankshaft out of the bearings.

Replacement of the crankshaft is a reversal of the above operation.

IMPORTANT.—Before replacing the crankshaft thoroughly clean out all oilways.

Section A.33

REMOVING AND REPLACING THE MANIFOLDS

The manifolds are held in position on the left-hand side of the engine by eight nuts, six of which bear on steel clamps, the remaining two on studs which pass through the flange at each end of the exhaust manifolds. There are a further four set bolts which secure the inlet manifold to the exhaust manifold at the hot-spot joint.

To remove

The inlet and exhaust manifolds can be removed either as one unit or separately. First disconnect the delivery pipe from the carburetter and release the carburetter throttle and choke controls and the vacuum pipe to the distributor. Disconnect the servo vacuum pipe from the inlet manifold.

Remove the exhaust down pipe by unscrewing the five securing nuts and springing the pipe away from the manifold assembly. Remove the air cleaner as detailed in Section D. The fuel drain pipe must be disengaged at its union at the hot-spot flange and also at the clip secured by one of the engine side cover set pins.

The manifold securing nuts should now be removed and the manifold detached complete with the carburetter. Unscrew the four hot-spot nuts to separate the inlet from the exhaust manifold.

To refit

When refitting the manifolds see that the joint washers are in good condition and tighten the securing nuts evenly to ensure good joints.

It is important that the four nuts which secure the inlet manifold to the exhaust manifold hot-spot are not tightened down until after all the manifold securing nuts have been tightened. Failure to observe this precaution may result in damage to the manifold securing flange.

Section A.34

REMOVING AND REPLACING THE EXHAUST PIPE

Remove the five brass nuts and washers securing the exhaust pipe flange to the exhaust manifold. Slacken the two nuts on the clip behind the gearbox rear mounting cross-member and withdraw the front pipe.

Slacken the clip at the front end of the silencer and remove the centre pipe.

Remove the nut and bolt from the tail pipe clamp at the rear of the chassis, when the tail pipe and silencer assembly can be removed from the vehicle.

The replacement of the exhaust pipe is a reversal of the above procedure.

Section A.35

FITTING A FLYWHEEL STARTER RING

To remove the old starter ring from the flywheel flange split the ring gear with a cold chisel, taking care not to damage the flywheel.

Make certain that the bore of the new ring and its mating surface on the flywheel are free from burrs and are perfectly clean.

To fit the new ring it must be heated to a temperature of 572 to 752° F. (300 to 400° C.), indicated by a light-blue surface colour. Do not exceed this temperature, otherwise the temper of the teeth will be affected. The use of a thermostatically controlled furnace is recommended. Place the heated ring on the flywheel with the lead of the ring teeth next to the register on the flywheel.

The expansion will allow the ring to be fitted without force by pressing or tapping it lightly until the ring is hard against its register. This operation should be followed by natural cooling, when the 'shrink fit' will be permanently established and no further treatment required.

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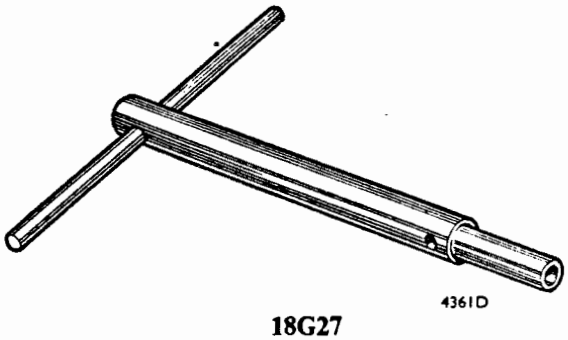
SERVICE TOOLS

18G27. Valve Seat Cutter and Pilot Handle

Both the pilot and the handle are used with the finishing cutter, the glaze breaker, and the narrowing cutter.



18G27

18G174D

18G174D. Valve Seat Cutter Pilot

18G28. Valve Seat Finishing Cutter—Exhaust

18G30. Valve Seat Finishing Cutter—Inlet

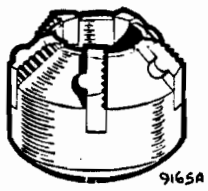
The use of these cutters will save lengthy and wasteful grinding in when the valve seats are pitted.

18G28 and 18G30

18G28A. Valve Seat Glaze Breaker—Exhaust

18G30A. Valve Seat Glaze Breaker—Inlet

Worn valve seats usually have a glass-hard face. These glaze breakers will prepare the seats for any cutting that may be necessary.



18G28A and 18G30A

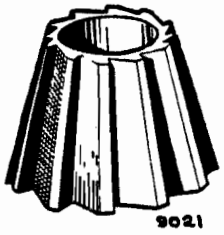
18G28B. Valve Seat Narrowing Cutter—Top—Exhaust

18G30B. Valve Seat Narrowing Cutter—Top—Inlet

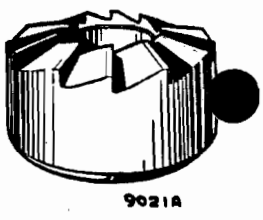
18G28C. Valve Seat Narrowing Cutter—Bottom—Exhaust

18G30C. Valve Seat Narrowing Cutter—Bottom—Inlet

These narrowing cutters will enable the valve seats to be maintained at their original dimensions. See under **'GENERAL DATA'.**



18G28C and 18G30C



18G28B and 18G30B

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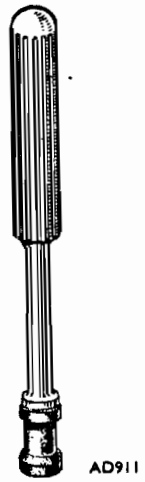
18G29. Valve Suction Grinder

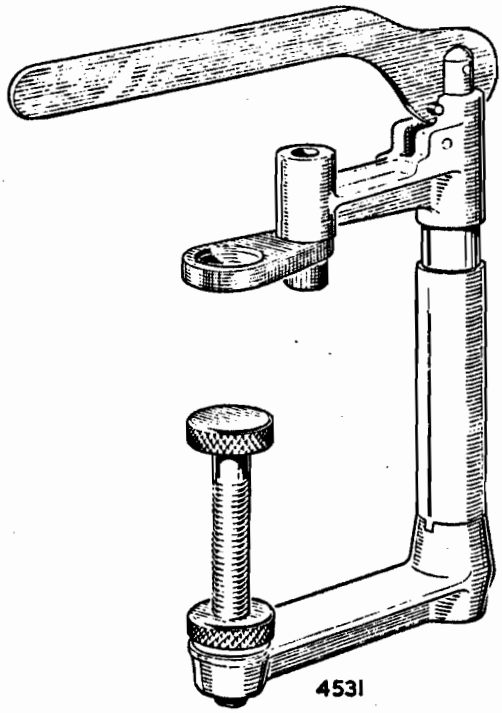
A metal handle complete with a detachable rubber suction pad. Replacement pads 18G29A are supplied separately.



18G29

18G45. Valve Spring Compressor

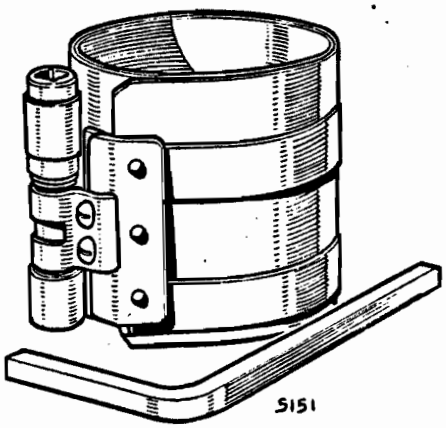
This tool is designed with cam and lever action which is both positive and speedy. The adaptor ring is specially shaped to facilitate the removal and replacement of split collets. Screw adjustment is also provided.



18G45

18G55A. Piston Ring Compressor

This compressor is easy to operate and will make piston assembly to the bore a quick and easy operation.



18G55A

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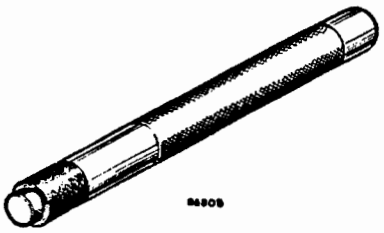
18G69. Oil Pump Release Valve Grinding-in Tool

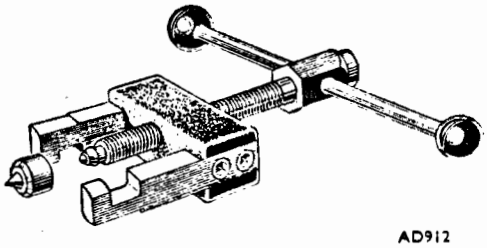
Designed to facilitate the removal and grinding in of the engine oil release valve. Tightening the set screw expands the rubber plunger, which ensures that the tool is a tight fit when inserted into the hollow oil release valve.



18G69

18G58. Camshaft Gear Remover

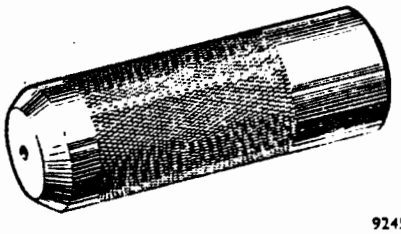
This tool will remove the tightest camshaft gear quickly and without damage. The centre drive screw incorporates a hardened steel ball to reduce friction: a separate thrust pad is provided for insertion between the camshaft and the ball to protect the end of the camshaft.



AD912

18G58

18G16. Crankshaft Gear and Pulley Replacer



9245A

18G16

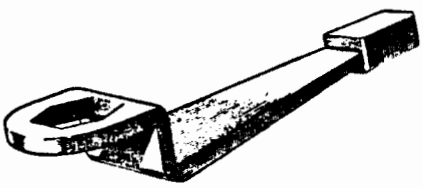
18G81. Clutch Centralizer

A0790B

18G81

18G96. Starting Nut Spanner

A 'shock'-type spanner designed to enable the starting dog nut to be removed without locking the crankshaft.



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18G96

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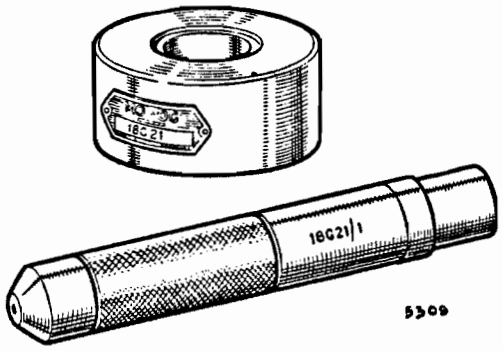
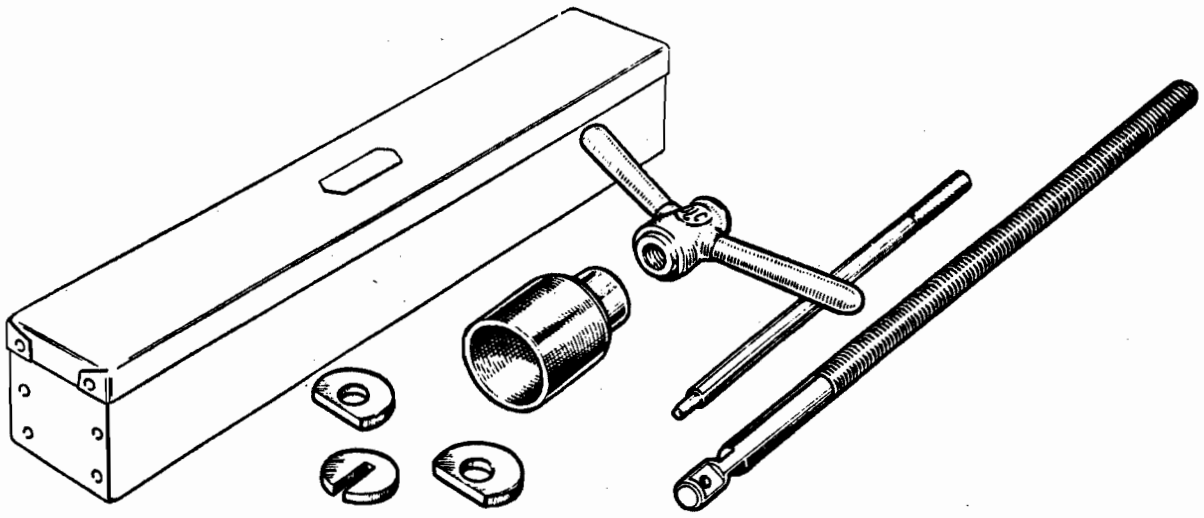
18G21. Valve Rocker Bush Remover and Replacer

The use of a light press is desirable when using this tool; alternatively, a copper-faced hammer may be used.



18G21

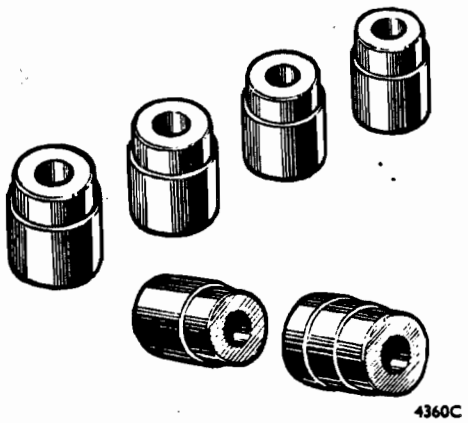


18G124A

18G124A. Camshaft Liner Remover and Replacer (basic tool)

Adaptors 18G124B, 18G124D, 18G124E, 18G124F, 18G124H, 18G124J.

This equipment consists of a basic tool 18G124A and various adaptors supplied separately. Liners can be removed and new liners pulled into the cylinder block without the damage invariably associated with the use of improvised drifts. Full operating instructions are included with each basic tool.



18G124B **18G124D** **18G124H**
18G124E **18G124F** **18G124J**

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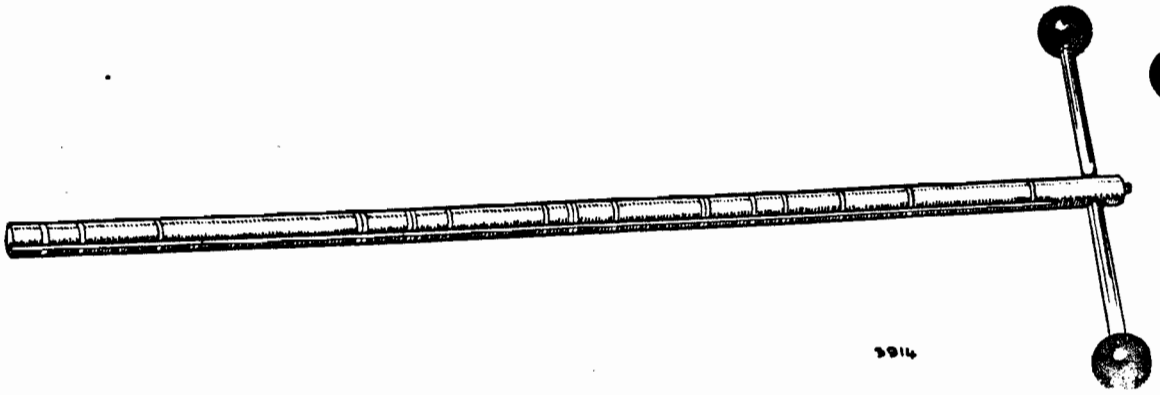
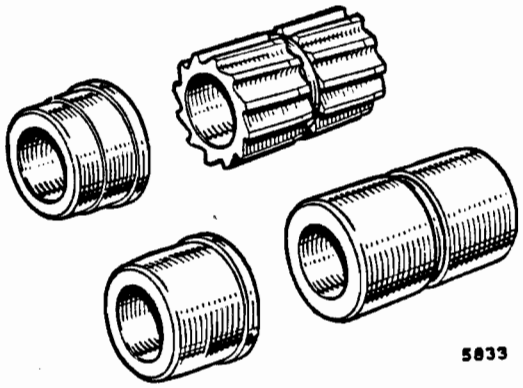


18G123A

18G123A. Camshaft Liner Reamer (basic tool)

Cutters: 18G123B, 18G123C, 18G123D, 18G123E.
Pilots: 18G123AF, 18G123H, 18G123J, 18G123M, 18G123N.

This equipment is essential when reconditioning cylinder blocks, otherwise camshaft liners cannot be reamed in line and in consequence the clearance between the camshaft journal and the liner will be incorrect. The basic tool must be used with the cutters and pilots supplied separately. Operating instructions are supplied with each basic tool.



5833

18G123AF
18G123H
18G123J
18G123M
18G123N

18G123B
18G123C
18G123D
18G123E

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SECTION B

THE IGNITION SYSTEM

	Section
Distributor	
Dismantling	B.4
Reassembling	B.5
Removing and replacing	B.1
High-tension pick-up brush	B.2
Ignition	
Coil	B.9
Testing	B.3
Timing	B.7
Replacement contacts	B.6
Sparking plugs	B.8

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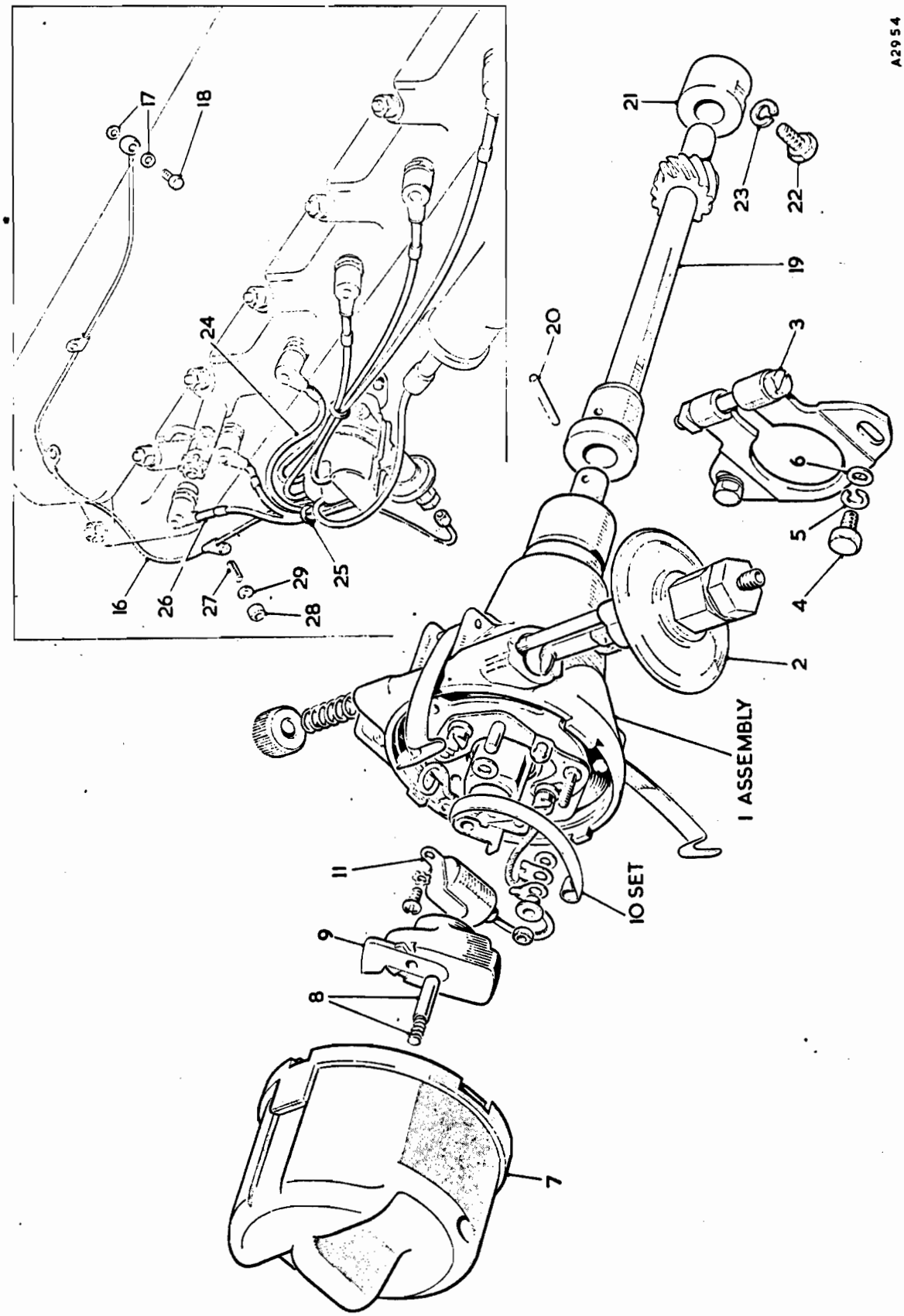
THE DISTRIBUTOR COMPONENTS



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KEY TO THE DISTRIBUTOR COMPONENTS

No.	*Description*
1.	Distributor with built-in vacuum control.
2.	Suction unit.
3.	Fixing plate.
4.	Set screw.
5.	Spring washer.
6.	Plain washer.
7.	Distributor cap.
8.	Carbon brush and spring.
9.	Rotor arm.
10.	Contact points (set).
11.	Condenser.
16.	Vacuum control pipe.
17.	Joint washer.
18.	Banjo bolt.
19.	Driving spindle.
20.	Peg for spindle.
21.	Bush for spindle.
22.	Set screw for bush.
23.	Spring washer.
24.	Ignition cable.
25.	Rings for plug leads.
26.	Identification sleeve.
27.	Vacuum pipe fixing stud.
28.	Nut.
29.	Spring washer.

Section B.1

DISTRIBUTOR (TYPE DM6)

To remove and replace

Remove the vacuum control pipe at the union. Lift off the distributor cap after springing back the two securing clips and disconnect the low-tension lead. Remove the clamping plate set screws. (Do not disturb the pinch-bolt or the timing will be lost.)

The driving spindle and spur gear are attached to the distributor shaft and will be withdrawn with the distributor.

Before replacing the distributor turn the engine until No. 1 piston is at T.D.C. on the compression stroke. Hold the distributor in its normal position relative to the engine (vacuum unit to the rear at right angles to the engine) and turn the rotor to the two o'clock position. As the spur gear engages, the rotor will turn in an anti-clockwise direction. When the gear is fully home the rotor should be opposite No. 1 electrode in the distributor cap and the distributor points should be just commencing to open. Refer to Section B.7 for instructions on obtaining the final setting.

Section B.2

HIGH-TENSION PICK-UP BRUSH

The H.T. pick-up brush is of composite construction, the centre portion consisting of a resistive compound and the two end portions of softer carbon. The resistive portion of this carbon brush, which is in circuit between the coil and the distributor, gives a measure of radio interference suppression. Under no circumstances must a short, non-resistive brush be used as a replacement for one of these longer, resistive brushes.

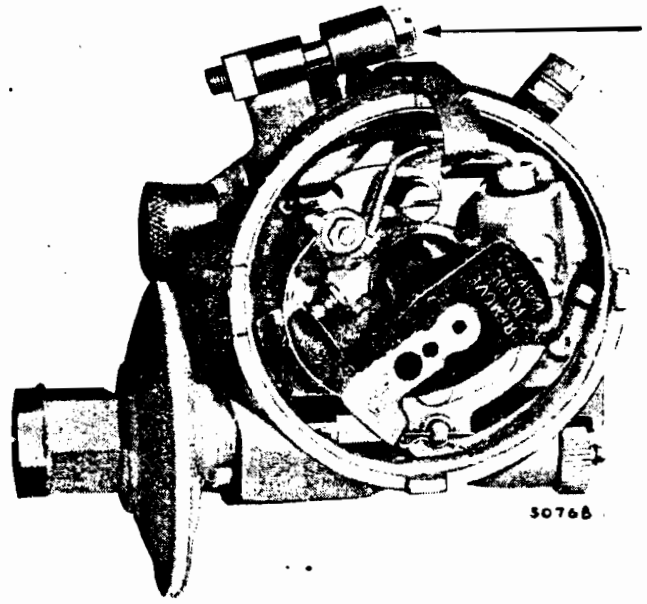

Fig. B.1

The distributor clamp plate pinch-bolt

Section B.3

TESTING

Before starting to test make sure that the battery is in good condition.

Testing in position to locate cause of uneven firing

Run the engine at a fairly fast idling speed. If possible, short-circuit each plug in turn with the blade of an insulated screwdriver or hammer head placed across the terminal to contact the cylinder head. Short-circuiting the plug in the defective cylinder will cause no noticeable change in the running note. With the others, however, there will be a pronounced increase in roughness.

If short-circuiting the sparking plugs is not possible, due to their being fitted with shrouded cable connectors, remove each plug connector in turn. Again, removal of the connection to the defective cylinder will cause no noticeable change in the running note, but there will be a definite increase in roughness when the other plugs are disconnected. Having thus located the defective cylinder, stop the engine and remove the cable from the sparking plug terminal.

Restart the engine and hold the cable end about $\frac{3}{16}$ in. from the cylinder head. If sparking is strong and regular the fault lies with the sparking plug, and it should be removed, cleaned, and adjusted, or a replacement fitted. If, however, there is no spark, or only weak, irregular sparking, examine the cable from the plug to the distributor moulded cover for deterioration of the insulation, renewing the cable if the insulation is cracked or perished, and clean and examine the moulded cover for free movement of the carbon brush. If a replacement brush is necessary it is important that the correct type is used. If tracking has occurred, indicated by a thin, black line between two or more electrodes or between one of the electrodes and the body, a replacement distributor cover must be fitted.

Testing in position to locate cause of ignition failure

Spring back the clips in the distributor head and remove the moulded cover. Lift off the rotor, carefully levering with a screwdriver if necessary.

Switch on the ignition, and whilst the engine is slowly cranked observe the reading on the vehicle ammeter, or on an ammeter connected in series with the battery supply cable. The reading should rise and fall with the closing and opening of the contacts if the low-tension wiring is in order. When a reading is given which does not fluctuate, a short circuit, or contacts remaining closed, is indicated. No reading indicates an open circuit in the low-tension circuit or badly adjusted or dirty contacts.

Check the contacts for cleanliness and correct gap setting. Ensure that the moving arm moves freely on the pivot. If sluggish, remove the arm and polish the pivot post with a strip of fine emery-cloth. Smear the post with wheel hub grease. Replace the arm.

If the fault persists, proceed as follows.

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Low-tension circuit-fault location

No reading is obtained in ammeter test. Refer to wiring diagram and check circuit for broken or loose connections, including ignition switch. Check the ignition coil by substitution.

Steady reading is obtained in ammeter test

Refer to wiring diagram and check wiring for indications of a short circuit. Check capacitor (either by substitution or on a suitable tester). Check ignition coil by substitution. Examine insulation of contact breaker.

High-tension circuit

If the low-tension circuit is in order remove the high-tension cable from the centre terminal of the distributor cover. Switch on the ignition and turn the engine until the contacts close. Flick open the contact breaker lever whilst the high-tension cable from the coil is held about $\frac{3}{16}$ in. from the cylinder block. If the ignition equipment is in good order a strong spark will be obtained. If no spark occurs a fault in the circuit of the secondary winding of the coil is indicated and the coil must be renewed. Carefully examine the high-tension cables and fit replacements if the insulation is cracked or perished.

To fit a new cable unscrew the moulded terminal nut and thread it over the new cable. Bare the end of the cable for about $\frac{1}{4}$ in. (6 mm.) and thread the exposed strands through the brass washer removed from the defective cable. Bend back the strands radially and screw the nut into the terminal moulding.

The cables from the distributor to the sparking plugs **must** be connected in the correct firing order.

Section B.4

DISMANTLING THE DISTRIBUTOR

When dismantling, carefully note the positions in which the various components are fitted, in order to ensure their correct replacement on reassembly. The amount of dismantling necessary will naturally depend on the repair required.

Spring back the securing clips and remove the moulded cover. Lift the rotor arm off the spindle, carefully levering with a screwdriver if it is tight.

Next take out the spring clip securing the vacuum unit link to the rotating contact breaker plate and remove the two recessed-head screws at the edge of the contact breaker base. Slacken the two nuts on the low-tension terminal and pull the connection from the contact breaker away from the terminal block. The contact breaker assembly can now be lifted off. Remove the circlip on the end of the micrometer timing screw and turn the micrometer nut until the screw and the vacuum unit assembly are freed. Take care not to lose the ratchet and coil springs located under the micrometer nut.

Before attempting to remove the shaft and action plate assembly first unscrew the complete lubricator from the distributor body and remove the spring and pad.

Tap out the dowel pin securing the distributor shaft to the driving spindle. To facilitate removal of the pin it may be necessary to clean out with a drill the metal peened over the entry.

Contact breaker

To dismantle the assembly further remove the nut, insulating piece, and connections from the pillar on which the contact breaker spring is anchored.

Lift off the contact breaker lever and the insulating washer beneath it. Remove the two screws securing the fixed contact plate, together with the spring and plain steel washers, and take off the plate. Withdraw the single screw securing the capacitor and contact breaker earthing lead. The contact breaker base assembly can be dismantled by removing the circlip and star washer located under the lower plate.

Shaft and action plate

To dismantle the assembly further take out the screw inside the cam and remove the cam and cam foot. The weights, springs, and toggles of the centrifugal timing control can now be lifted off the action plate. Note that a distance collar is fitted on the shaft underneath the action plate.

Section B.5

REASSEMBLING THE DISTRIBUTOR

The following instructions assume that complete dismantling has been undertaken.

(1) Reassemble the centrifugal timing control. See that the springs are not stretched or damaged. Place the cam and cam foot assembly over the shaft, engaging the projections on the cam foot with the toggles, and fit the securing screw.

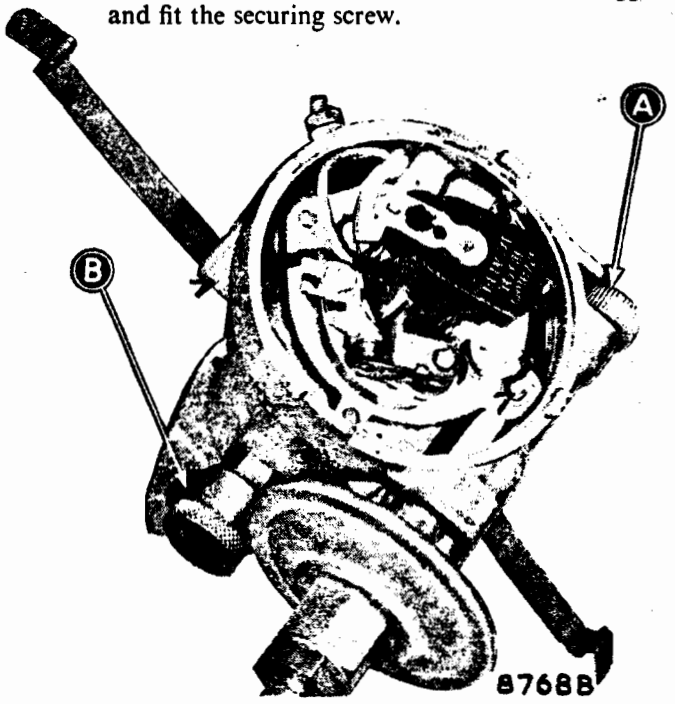

Fig. B.2

The distributor with the cap removed

A. Micrometer adjustment nut. B. Drive shaft greaser cap.

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(2) Place the distance collar over the shaft. Smear the shaft with clean engine oil and fit it into its bearing.
(3) If the driving spindle has been removed refit it, using a new dowel pin. Peen over the ends of the pin.
(4) Refit the vacuum unit into its housing and replace the springs, milled adjusting nut, and securing circlip.
(5) Refit the shaft lubricator.
(6) Replace the connection to the low-tension terminal on the inner side of the distributor body and tighten the nuts on the terminal post.
(7) Before reassembling the contact breaker base assembly lightly smear the base plate with clean engine oil. Fit the moving contact breaker plate to the base plate and secure with the star washer and circlip. Refit the contact breaker base into the distributor body. Engage the link from the vacuum unit with the bearing bush in the rotating plate and secure with the spring clip. Insert the two base plate securing screws, one of which also secures one end of the earthing cable.
(8) Fit the capacitor into position. The eyelet on the end of the contact breaker earthing cable is held under the capacitor fixing screw. Place the fixed contact plate in position and secure lightly with two securing screws. One plain and one spring washer must be fitted under each of these screws.
(9) Place the insulating washer on the contact breaker pivot post and on the pillar on which the end of the contact breaker spring locates. Refit the contact breaker lever and spring.
(10) Thread the low-tension connector and capacitor eyelets onto the insulating piece and place these on the pillar which secures the end of the contact breaker spring. Refit the washer and securing nut.
(11) Set the contact gap to ·014 to ·016 in. (·36 to ·04 mm.) and tighten the securing screws of the fixed contact plate.

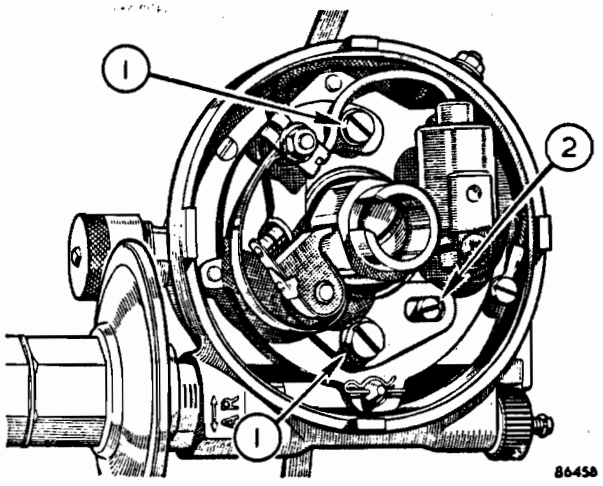

Fig. B.3

1. Fixed-contact plate securing screws.
2. Eccentric adjuster.

(12) Refit the rotor arm, locating the moulded projection in the rotor arm with the keyway in the shaft and pushing fully home. Refit the moulded cover.
(13) Before refitting the distributor to the vehicle fill the lubricator cap on the distributor body with a light graphited grease.

Section B.6

REPLACEMENT CONTACTS

If the contacts are so badly worn that replacement is necessary they must be renewed as a pair and not individually. The contact gap must be set to ·014 to ·016 in. (·36 to ·40 mm.); after the first 500 miles running with new contacts fitted the setting should be checked and the gap reset to ·014 to ·016 in. (·36 to ·40 mm.). This procedure allows for the initial 'bedding-in' of the heel.

Section B.7

IGNITION TIMING

The correct ignition setting (static) is 10° B.T.D.C. If the distributor has been removed refit it by the method described in Section B.1 and proceed as follows to obtain an accurate setting.

(1) Set the contact breaker points to ·014 to ·016 in. (·36 to ·40 mm.) when in the position of maximum opening.
(2) Turn the engine in the direction of rotation until No. 1 piston is at T.D.C. on its compression stroke. Attach a degree plate to the vibration damper on the crankshaft pulley, setting it in a position where it can be observed accurately. Turn the engine back and then bring it forward until the degree plate indicates that No. 1 piston is at 10° B.T.D.C. (turning the engine back in this way ensures that any slackness in the chain is taken up).
(3) If the timing has been disturbed slacken the clamp plate pinch-bolt and nut. This should not be necessary unless the position of the clamp plate has been previously altered. Normally sufficient adjustment will be provided by the slots in the plate.
(4) Rotate the distributor body anti-clockwise until the points are fully closed. Then slowly rotate it in a clockwise direction until the points just commence to open. Secure the distributor body in this position by tightening up the clamp plate pinch-bolt and nut and/or the two set screws securing the distributor clamp plate. Finally, check that the rotor arm is opposite the correct segment for No. 1 cylinder, which is at the top of its compression stroke.

IMPORTANT.—To obtain an accurate setting an electrical method should be used to determine the actual position at which the points break, and the following method can be used.

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With the low-tension lead connected to the distributor, turn on the ignition switch and connect a 12-volt lamp in parallel with the contact breaker points (i.e. one lead from the distributor low-tension terminal and the other to earth) and turn the distributor as detailed in paragraph (4) until the lamp lights, which indicates that the points have just opened.

Section B.8

SPARKING PLUGS

The sparking plugs are of the long-reach 14-mm. type, Champion N8.

The gaps of these plugs should be maintained at ·024 to ·026 in. (·610 to ·660 mm.). If the gap is allowed to become too wide misfiring at high speeds is liable to occur, and if too small, bad slow-running and idling will be the result.

Sparking plugs should be regularly inspected, cleaned, and tested. This is of vital importance to ensure good engine performance, coupled with fuel economy.

When removing the plugs from the engine use a box spanner: this will avoid possible damage to the insulators. Always remove the copper washers. The plugs should then be placed in a suitable holder which has holes drilled to admit the upper end of the plugs and marked to identify each plug with the cylinder from which it was removed.

The plugs should now be carefully examined.

Oil fouling will be indicated by a wet, shiny, black deposit on the insulator. This condition is usually caused by worn cylinders or pistons, or by gummed rings. Oil vapour is forced from the crankcase during the suction stroke of the piston, thus fouling the plugs.

Petrol fouling will cause a dry, fluffy, black deposit to be apparent on the plugs. This is usually caused by faulty carburation, but a faulty coil or leaking and worn-out ignition leads may have the same effect.

Under the above conditions, if the plugs otherwise appear to be sound they should be cleaned thoroughly, adjusted, and tested.

When preparing for cleaning, the plug washers should be removed and examined. The condition of these washers is important in that a large proportion of the heat from the plug insulator is dissipated to the cylinder head by them. The washer should therefore be reasonably compressed. A loose plug can be easily overheated, thus shortening plug life. On the other hand, do not over-tighten. All that is needed is a good seal between the cylinder head and the plug. Tightening too much will cause distortion of the washer with the possibility of blow-by, which will again lead to overheating and resulting danger. If there is any question of defect replace with new washers.

The plugs should now be thoroughly cleaned of all carbon deposit, resorting to scraping if necessary, removing as much as possible from the space between the insulator and shell. An oily plug should be washed out with petrol. If a plug-cleaning machine is available, 5 to 10 seconds in this will remove all remaining signs of carbon. Remember to thoroughly 'blow out' the plug after treatment under these conditions, in order to remove all traces of abrasive.

After cleaning thoroughly examine the plug for cracked insulator or worn-away insulator nose. Should either of these conditions be apparent, a new plug should be installed.

Carbon deposit on the threads of the plugs should be carefully removed by using a wire brush or, if available a wire buffing-wheel. Take care not to damage the electrodes or insulator tip. This often-neglected cleaning operation will lead to tight threads and resultant loss of heat dissipation due to the carbon deposit, thereby causing overheating.

The condition of the electrodes should now be noted and any signs of corrosion removed, if it is felt that the plugs are worthy of further use. This can be carried out with the use of a small file to carefully dress the gap area. The gap should then be reset to a clearance of ·025 in. (·635 mm.). When resetting, bend the side electrode only.

It is advisable whilst the plugs are under pressure in the testing machine to apply a spot of oil to the terminal end to check for air leakage. Excessive leakage here will tend to cause compression loss, rapid deterioration of the electrode, and overheating of the electrode tip. The top half of the insulator should also be carefully examined for any paint splashes or accumulation of grime and dust, which should be removed. Should there be any signs of cracks due to faulty use of the spanner, the plug should be renewed. When replacing the plug lead make sure that it is securely attached.

Clean the sparking plugs and adjust the gaps to the correct setting or fit new plugs at the periods stated in the Passport to Service.

Section B.9

IGNITION COIL

Description

The ignition coil consists of a laminated core, around which is wound the low-tension or primary winding, and the high-tension or secondary winding. The primary

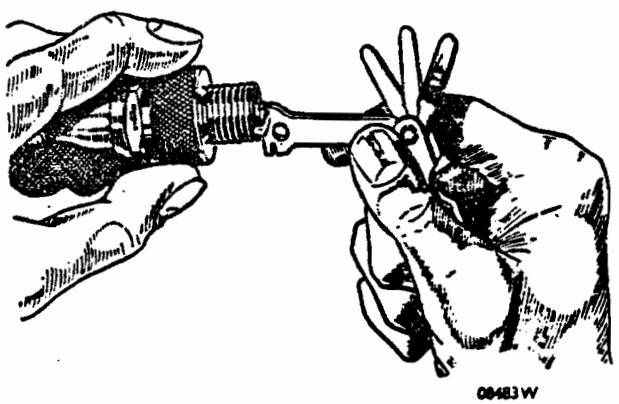

Fig. B.4

Reset the plug gap using the Champion gap-setting tool shown above

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winding consists of relatively few turns of thick wire when compared to the secondary winding, which has a large number of turns of fine wire. The primary winding is wound over the secondary winding in order to allow the heat produced to be dissipated more easily.

One end of each winding is connected to terminal 'CB', the remaining ends being connected to terminal 'SW' (primary) and the 'HT' terminal snout (secondary). This method of connection produces an auto-transformer effect and increases the high-tension voltage induced in the coil.

Maintenance

The coil case should be kept clean and free from moisture, paying especial attention to the moulding at the terminal end. The terminal connections should be inspected for tightness. To fit a new high-tension cable unscrew the moulded terminal nut and thread it over the new cable. Bare the end of the cable for about ¼ in. (6 mm.) and thread the exposed strands through the brass washer removed from the defective cable. Bend back the strands radially and screw the nut into the terminal moulding.

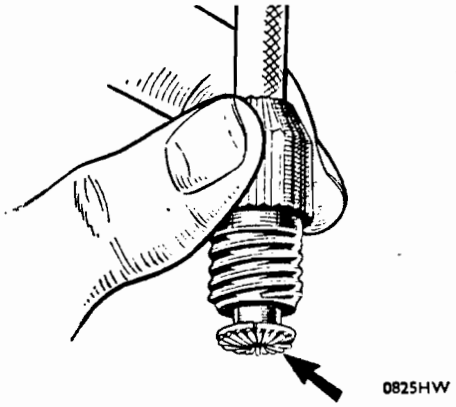

Fig. B.5

The correct method of fitting a high-tension cable to the ignition coil terminal nut

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SECTION C

THE COOLING SYSTEM

	Section
General description	
Cooling system	
Draining	C.2
Filling	C.4
Fan belt	C.6
Filler cap—removing	C.1
Overheating	C.10
Radiator	
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Removing and replacing	C.5
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Tools	End of Section
Water pump	
Dismantling	C.8
Removing	C.7

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GENERAL DESCRIPTION

Cooling is by impeller-assisted thermo-siphon circulation controlled by a thermostat. A fan is mounted on the pump spindle and driven by an endless belt from a pulley on the crankshaft. The system is pressurized and the relief valve incorporated in the radiator filler cap controls the pressure.

Do not remove the filler cap if the temperature of the coolant is above boiling-point or if the engine is running.

At the periods stated in the Passport to Service remove the water pump lubrication plug on the water pump casing and add a small quantity of grease. The lubrication of the pump must be done very sparingly, otherwise grease will flow past the bearings onto the hard rubber face of the water seal and impair its efficiency.

Section C.1

REMOVING THE FILLER CAP

The cooling system is under appreciable pressure while the engine is hot, and the radiator cap must be removed very carefully or left in position until the water has cooled. If it is necessary to remove the filler cap when the engine is hot it must be removed gradually, and the radiator filler spout is provided with a specially shaped cam to enable this to be done.

Unscrew the cap slowly until the retaining tongues are felt to engage the safety catch on the end of the spout cam, and wait until the pressure in the radiator is fully released before finally removing the cap.

It is advisable to protect the hand from escaping steam while removing the cap.

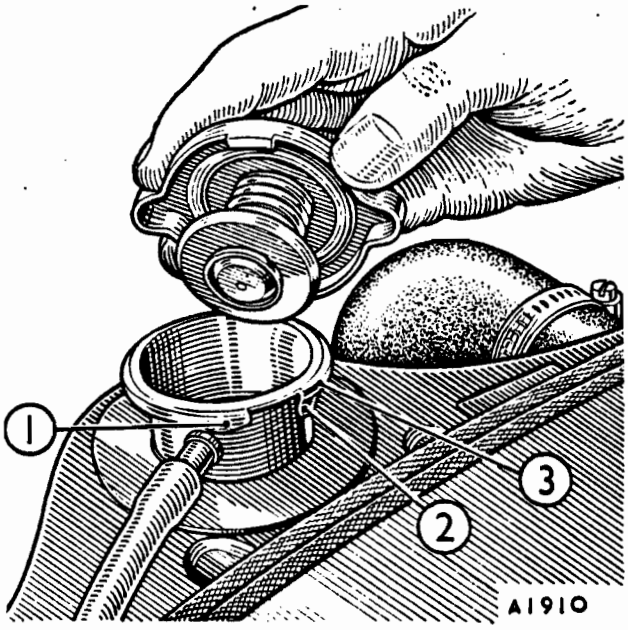

Fig. C.1

The radiator cap removed to show (1) *the cam,* (2) *the stop, and* (3) *the safety catch*

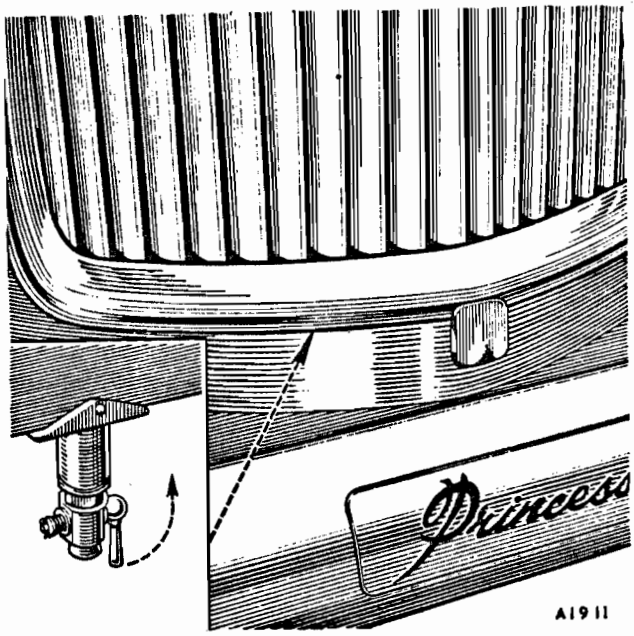

Fig. C.2

The radiator drain tap. Turn in the direction of the arrow to open the tap

Section C.2

DRAINING THE COOLING SYSTEM

Remove the radiator cap.

Open the two taps, one on the right-hand side of the radiator lower tank and the other on the right-hand side of the cylinder block below the distributor.

To make sure that the heater is drained it is necessary to disconnect the heater hoses.

When anti-freeze is in use, drain the coolant into a clean container for further use.

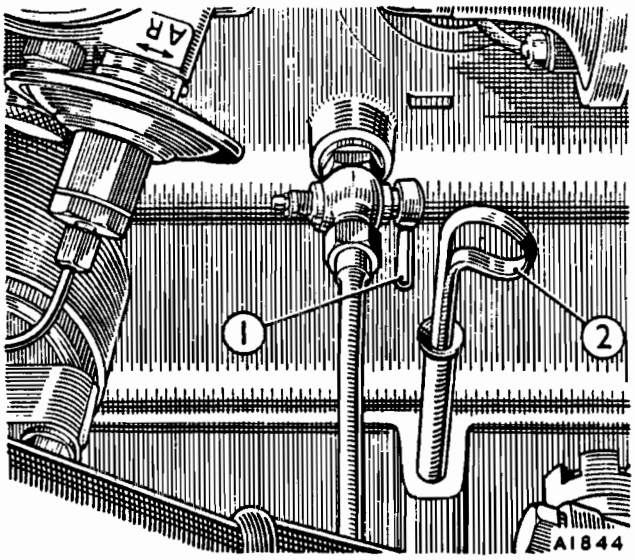

Fig. C.3

The cylinder block drain tap (1). *Pull the handle upwards to open the tap*

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GENERAL DESCRIPTION

A pressurized cooling system is used on this vehicle, making regular topping up unnecessary, but a check should be made periodically to ensure that there has been no loss of coolant due to leakage. A header tank connected to the outlet from the engine receives the normal coolant expansion when the system is in the process of heating up.

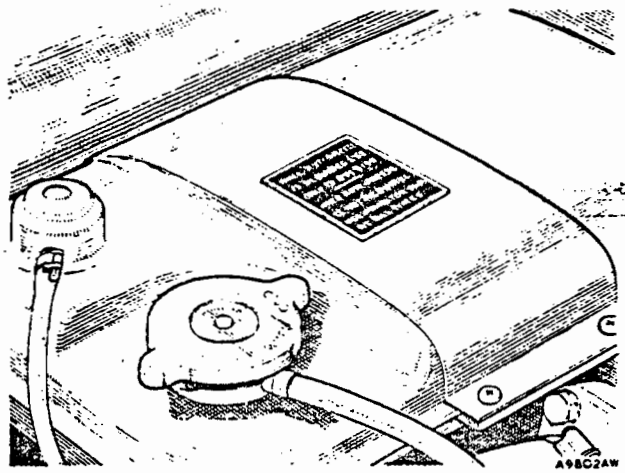

Fig. C.1

The cooling system filler tank cap is removed by turning in an anti-clockwise direction

Section C.1

DRAINING, FLUSHING, AND FILLING

Draining

Two draining points are provided; one is at the base of the bottom hose connecting pipe and the other is on the right-hand side of the cylinder block (early engines are fitted with a drain tap and later engines with a drain plug). Both must be opened and the radiator filler cap removed to drain the cooling system completely. Remember to collect the anti-freeze or inhibitor in a clean container for future use.

Flushing

To ensure efficient circulation of the coolant and to reduce the formation of scale and sediment in the radiator the system should be flushed out every 12 months with clean running water and allowed to run through until it comes out clean and refilled with an anti-freeze mixture or inhibitor mixture to the approved specification.

Where furring is excessive the radiator should be removed as in Section C.2 and flushed through in the reverse way to the normal flow, i.e. turn the radiator upside-down and let the water flow in through the bottom hose connection and out through the top. The use of radiator reverse-flush adaptor 18G 187 with 1 in. (25·4 mm.) diameter water hose is recommended for this purpose.

Filling

Water alone must not be used in the engine (except in emergency) as this could have a detrimental effect on the cooling passages.

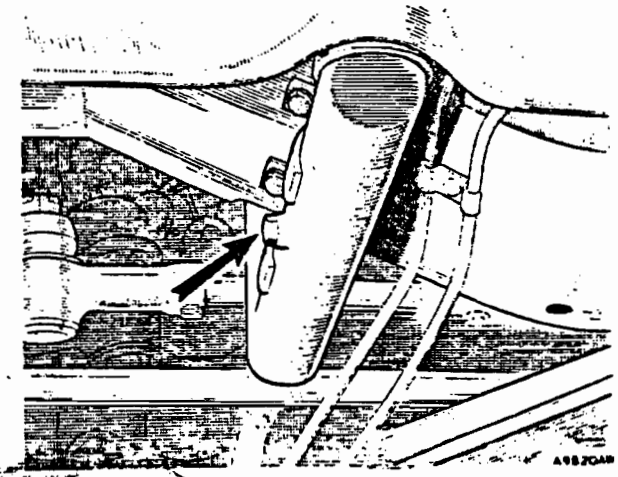

Fig. C.2

The radiator drain plug

An anti-freeze mixture conforming to British Standards Specification 3150 : 1959, or coolant inhibitor SQ36 should be used all the year round as instructed below.

Coolant inhibitor

The inhibitor SQ36 provides protection of the coolant passages against corrosion and should be used in territories where anti-freeze mixtures are not available.

A mixture of 3 fl. oz. (0·85 c.c.) to 8 pints (9½ U.S. pints, 4·5 litres) of water should be used.

Anti-freeze mixture

Anti-freeze mixtures conforming to the above specification, in addition to protecting the engine against frost, contain inhibitors to protect the coolant passages of the engine.

Under no circumstances should different types of anti-freeze be mixed.

Normally a 25 per cent. mixture of anti-freeze is adequate to meet most winter conditions. However, in

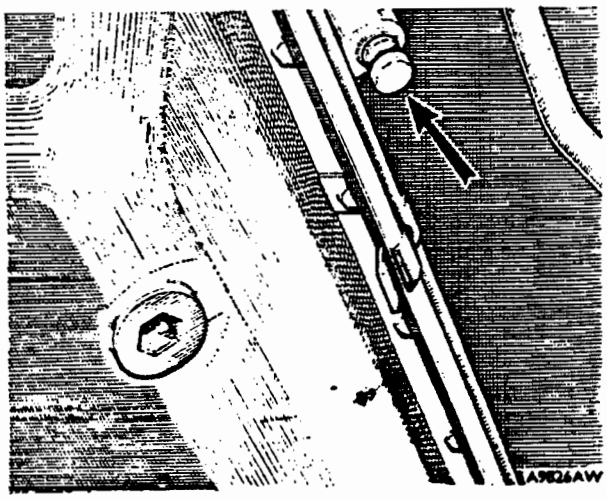

Fig. C.3

The cylinder block drain plug (later engines)

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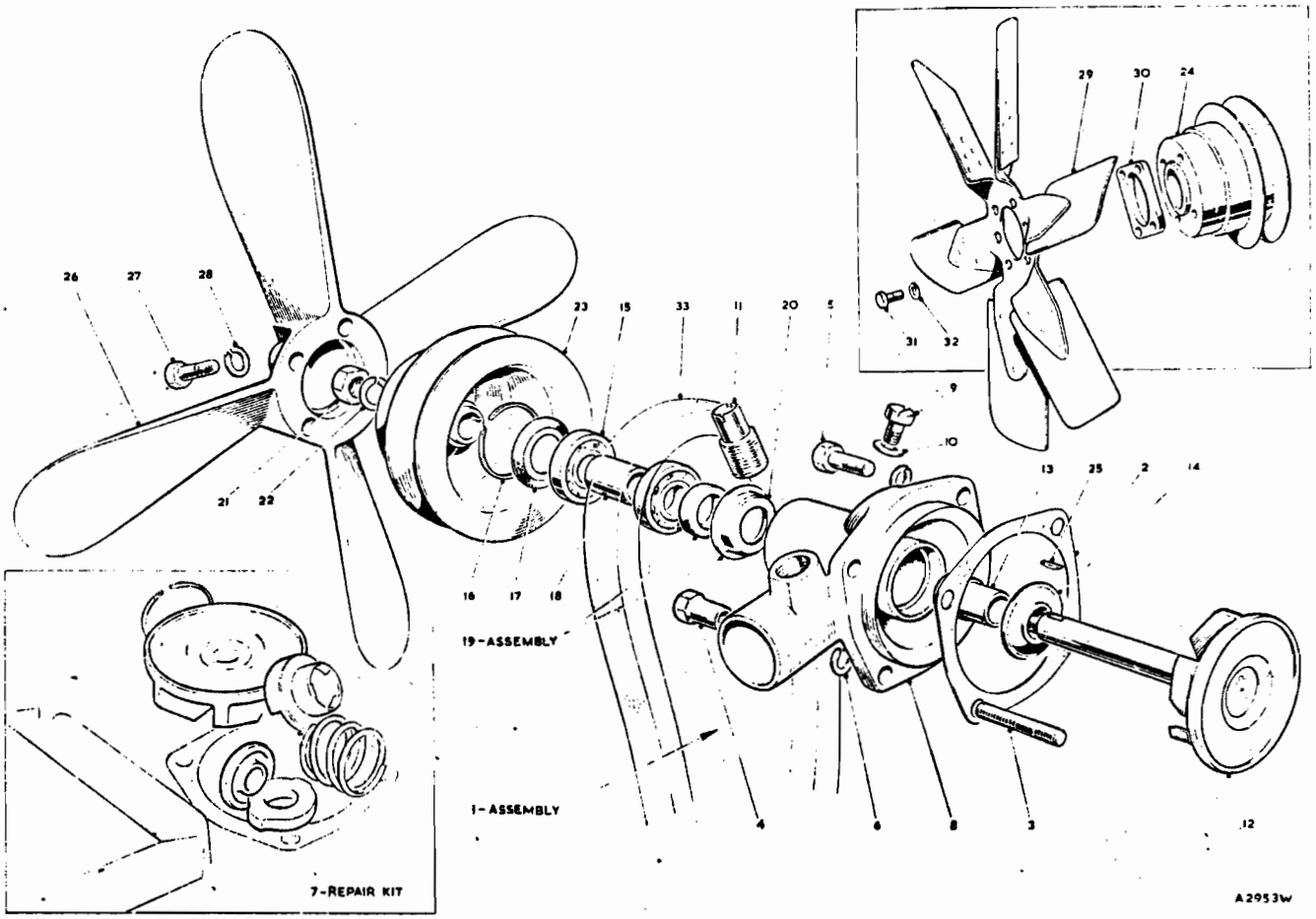

Fig. C.5

Water pump and fan components

1. Pump assembly.
2. Joint washer.
3. Cylinder block studs.
4. Nuts.
5. Set screw—top right-hand.
6. Spring washer.
7. Pump repair kit.
8. Water pump body.
9. Lubricator plug.
10. Washer.
11. Heater connection.
12. Spindle and vane assembly.
13. Distance piece for seal.
14. Seal assembly.
15. Ball bearing.
16. Spring ring.
17. Grease retainer.
18. Bearing distance piece.
19. Oil seal assembly.
20. Oil seal housing.
21. Pulley nut.
22. Spring washer.
23. Fan pulley—four-bladed fan.
24. Fan pulley—six-bladed fan.
25. Key.
26. Fan—four-bladed (normal climates).
27. Set screw.
28. Spring washer.
29. Fan—six-bladed (tropical climates).
30. Distance piece.
31. Set screw.
32. Spring washer.
33. Fan belt.

Do not damage the gasket by levering with a screwdriver. Make sure that the gasket is in good condition before refitting the pump.

Replacement of the fan and pump assembly is a reversal of this procedure, but care must be taken to see that the joint between the pump and cylinder block is in good condition. It is always advisable to fit a new gasket.

Section C.8

DISMANTLING THE WATER PUMP ASSEMBLY

Remove the nut, spring washer, and plain washer from the front end of the spindle and withdraw the fan pulley. Remove the Woodruff key and clean off any burrs from the keyway. Withdraw the circlip and the grease-retaining washer.

While holding the pump body tap the spindle and impeller assembly towards the rear with the aid of Service tool 18G61.

Withdraw the water seal and the vane distance piece from the rear of the pump body.

The water pump bearings and distance piece should be removed with Service tool 18G61. This tool comprises a driver, dummy bearing, and pilot.

Insert the driver (A) (Fig. C.6) into the rear bearing (D) and tap it downwards until the front bearing (E) and the distance piece (F) are released.

Position the dummy front bearing (B) in the pump body and screw the driver into the dummy bearing

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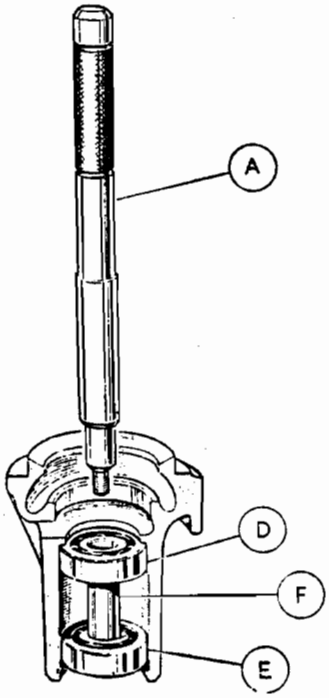

Fig. C.6

This cut-away view of the water pump shows the driver about to enter the rear bearing for removal. The bearing seal and retainer are not shown

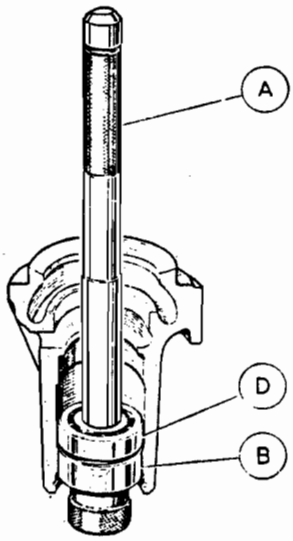

Fig. C.7

Here the dummy front bearing is in position with the driver screwed into it. This is the method of removing the rear bearing

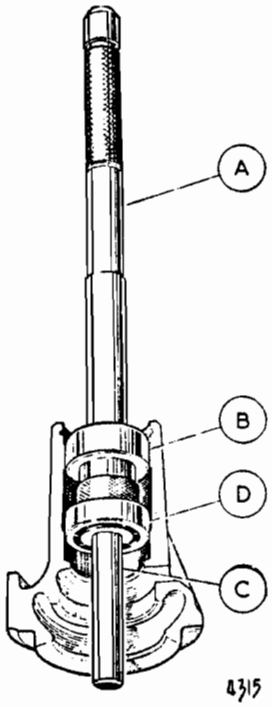

Fig. C.8

When reassembling the pump use the tool assembled as shown and thread the rear bearing onto the pilot with the bearing seal and retainer (seal and retainer not shown here)

(Fig. C.7). The rear bearing is now aligned with the housing and may be gently tapped out.

Remove the oil seal and oil seal cover.

Reassembly is a reversal of the dismantling procedure, but make sure that the seals are in good condition; any defective parts must be renewed. Thread the rear bearing onto the pilot as shown in Fig. C.8, together with the oil seal and oil seal cover.

Repack the bearing with grease to Ref. C (page P.2).

Section C.9

THERMOSTAT

In order to ensure maximum efficiency it is essential to keep the engine operating temperatures within certain limits. To assist this a bellows-type thermostat is fitted in the water outlet at the front of the cylinder head. The device consists of metallic bellows filled with a volatile liquid controlling a mushroom valve. When the engine is cold this valve is closed and the flow of water to the radiator is restricted. Due to this restriction, the temperature of the water in the cylinder head and cylinder jacket will rise very quickly, thus ensuring rapid warming up. The heat so generated will expand the bellows and thereby open up the valve, permitting a flow of water to the radiator.

The thermostat opening temperature is set by the manufacturer (see **'GENERAL DATA'**) and cannot be altered. During decarbonizing it is good policy to test the opening by immersing the thermostat in water raised to the requisite temperature. If the valve fails to open a new unit must be fitted.

Section C.10

OVERHEATING

Overheating may be caused by a slack fan belt, excessive carbon deposit in the cylinder head, running with the ignition too far retarded, incorrect carburetter adjustment, failure of the water to circulate, or loss of water.

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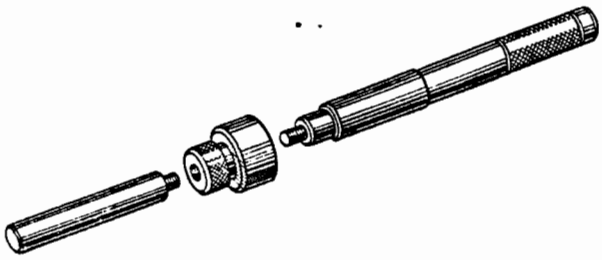
SERVICE TOOLS

18G61. Water Pump Bearing Remover and Replacer

This tool comprises three parts: a driver, a dummy front bearing, and a pilot. The rear bearing can be removed with this tool without damage to the pump body, as is invariably the case when improvised drifts are employed.



AD922

18G61

18G187. Radiator Reverse-flush Adaptors

The adaptors should be used in pairs, one for the radiator inlet and one on the outlet hose. The brass inlet pipe is 1 in. (25·4 mm.) diameter. This is the size of the water mains supply hose generally used; if there is any variation a reducing sleeve can be used.

9190A

18G187

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SECTION D

THE FUEL SYSTEM

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Air cleaner	D.11
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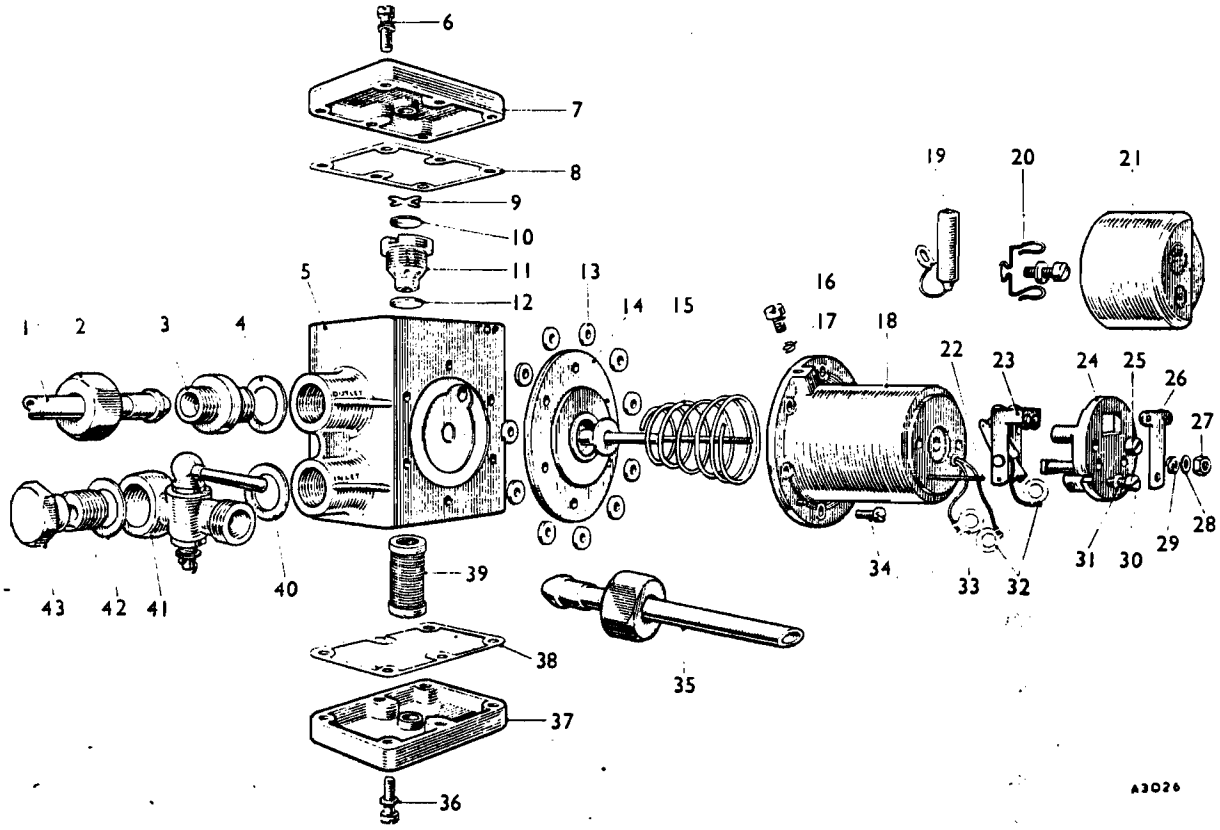
THE FUEL PUMP COMPONENTS



No.	Description
1.	Outlet pipe with nipple.
2.	Nut for nipple.
3.	Union.
4.	Gasket.
5.	Body—pump.
6.	Screw—lid to body.
7.	Lid—top.
8.	Joint washer.
9.	Spring clip—valve cage.
10.	Valve disc.
11.	Valve cage.
12.	Valve disc.
13.	Roller.
14.	Diaphragm.
15.	Armature spring.
16.	Earthing screw.
17.	Spring washer.
18.	Coil housing.
19.	Condenser.
20.	Spring clip—condenser.
21.	End cover.
22.	Spindle for rockers.
23.	Rocker and blade assembly.
24.	Pedestal.
25.	Pedestal screw.
26.	Spring blade assembly.
27.	Terminal nut.
28.	Lead washer.
29.	Spring washer.
30.	Screw for spring blade.
31.	Dished washer.
32.	Terminal tag (2 B.A.).
33.	Terminal tag (5 B.A.).
34.	Screw—coil housing to body.
35.	Inlet pipe and nipple.
36.	Screw for lid.
37.	Lid—bottom.
38.	Joint washer.
39.	Filter.
40.	Gasket.
41.	Fuel tap.
42.	Joint gasket.
43.	Bolt for tap banjo.

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Section D.1

CONSTRUCTION OF THE FUEL PUMP

The fuel pump is a 12-volt electric S.U. type LCS and is located on the right-hand side of the chassis, midway along.

The pump consists of three main assemblies: the body, the magnet assembly, and the contact breaker.

The body (17, Fig. D.1) is an aluminium die-casting, to which two identical cover-plates (4 and 18) are secured by six 2 B.A. screws with spring washers. Removal of the lower cover-plate (18) gives access to the fuel filter (see Fig. D.1), whilst the top plate covers the outlet valve cage (3). When the outlet valve cage is removed the inlet valve (14) is revealed. The valves consist of thin brass discs which should be assembled smooth side downwards.

The outlet valve can be extracted after the spring retaining circlip has been detached. Care should be taken not to distort the circlip or the correct valve lift may be affected.

A $\frac{3}{8}$ in. (9·52 mm.) diameter hole connects the space between the valves to the pumping chamber, which is a shallow depression in one face of the body casting. This space contains the diaphragm unit (20), which is clamped on its rim between the iron coil housing (7) and the main body (17).

A bronze rod (8) is screwed through the centre of the armature, to which the diaphragm is attached, and it passes through the magnet core to the contact breaker, which is located at the other end. A volute spring (22) is interposed between the armature and the end plate of the coil to return the armature and diaphragm.

The magnet consists of a cast-iron pot having an iron core (23), on which is wound a coil of copper wire which energizes the magnet. Between the magnet housing and the armature are fitted 11 spherical-edged rollers (5). These locate the armature centrally within the magnet at all times, and allow absolute freedom of movement in a longitudinal direction. The contact breaker consists of a small bakelite moulding carrying two rockers (9 and 10) which are both hinged to the moulding at one end and are connected together at the top end by two small springs arranged to give a 'throw-over' action. A trunnion is fitted into the centre of the inner rocker, and the bronze push-rod (8) connected to the armature is screwed into this. The outer rocker (9) is fitted with a tungsten point, which makes contact with a further tungsten point on a spring blade (12). This spring blade is connected to one end of the coil, and the other end of the coil is connected to the terminal (25).

In order to provide a good earth a short length of flexible wire connects the outer rocker to one of the screws which hold the bakelite moulding.

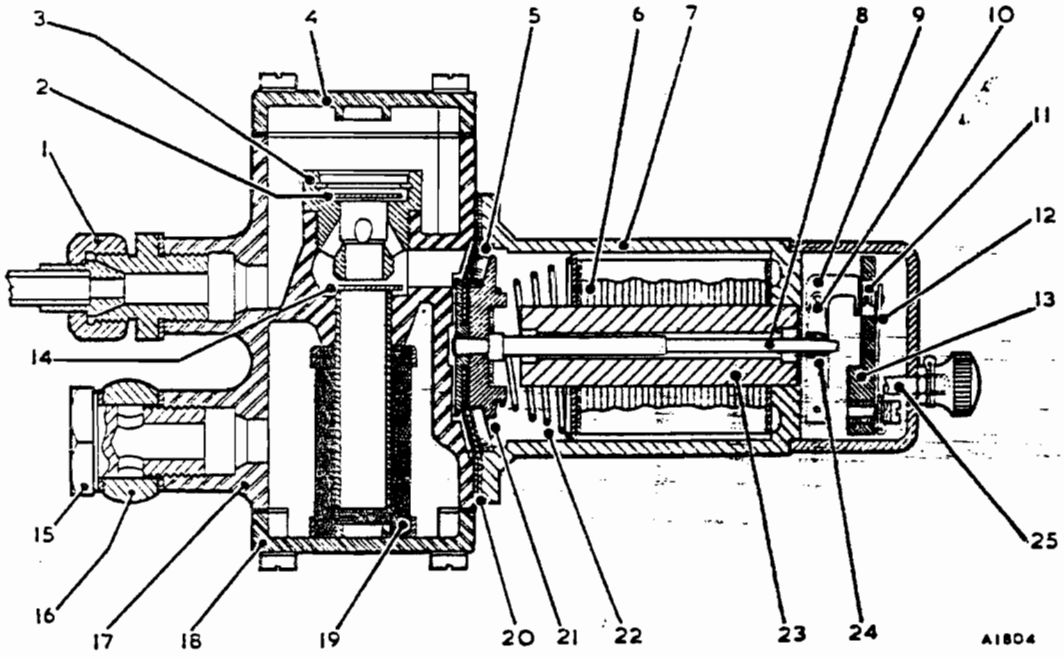

Fig. D.1

The LCS fuel pump components

1. Outlet union.
2. Outlet valve.
3. Outlet valve cage.
4. Top cover-plate.
5. Spherical rollers.
6. Magnet coil.
7. Iron coil housing.
8. Bronze rod.
9. Outer rocker.
10. Inner rocker.
11. Tungsten points.
12. Spring blade.
13. Bakelite moulding.
14. Inlet valve.
15. Banjo bolt.
16. Banjo tap.
17. Body.
18. Lower cover-plate.
19. Filter.
20. Diaphragm.
21. Armature.
22. Armature spring.
23. Magnet core.
24. Trunnion.
25. Terminal screw.

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Section D.2

ACTION OF THE FUEL PUMP

The action of the pump is as follows.

When the pump is at rest the outer rocker lies in the outer position and the tungsten points are in contact. The current passes from the terminal through the coil back to the blade, through the points, and to the earth return, thus energizing the magnet and attracting the armature. This comes forward, bringing the diaphragm with it and sucking fuel through the suction valve into the pumping chamber. When the armature has advanced nearly to the end of its stroke the 'throw-over' mechanism operates and the outer rocker flies back, separating the points and breaking the circuit. The spring (22) then pushes the armature and diaphragm back, forcing fuel through the delivery valve at a rate determined by the requirements of the engine. As soon as the armature gets near the end of this stroke the 'throw-over' mechanism again operates, the points again make contact, and the cycle of operations is repeated.

Section D.3

FUEL PUMP MAINTENANCE

Apart from keeping the contacts clean and removing the filter at regular intervals for cleaning, there is no maintenance required on the fuel pump.

The filter can be extracted by removing the pump body bottom cover, when it can be cleaned in fuel with a stiff brush. Never use rag to clean a filter.

Section D.4

TRACING FUEL PUMP TROUBLES

Should the pump cease to function, first disconnect the fuel delivery pipe from the pump. If the pump then works the most likely cause of the trouble is a sticking needle in the float-chamber of the carburetter. Should the pump not work, disconnect the lead from the terminal and strike it against the body of the pump after switching on the ignition. If a spark occurs it indicates that the necessary current is available at the terminals and that the trouble arises with the pump mechanism. If no spark can be detected, then it is an indication that the current supply has failed and that attention should be given to to the wiring and battery. If current is present, further investigation should be carried out by removing the bakelite cover which is retained by the terminal nut. Touch the terminal with the lead. If the pump does not operate and the contact points are in contact, yet no spark can be struck off the terminal, it is very probable that the contact points are dirty and require cleaning. These may be cleaned by inserting a piece of card between them, pinching them together, and sliding the card backwards and forwards.

Before carrying out any further tests make certain that the vent hole in the base of the pump body is not blocked with paint or foreign matter.

It is possible that there may be an obstruction in the suction pipe, which should be cleared by blowing air through it, or that some irregularity in the pump itself is preventing the correct movement. This may be due either to the diaphragm having stiffened, or to foreign matter in the roller assembly which supports the diaphragm, in which case the diaphragm should be removed and the whole assembly cleaned and reassembled in accordance with the instructions given in Section D.5.

On the other hand, if the points are not making contact see that the tips of the inner rocker (10) are in contact with the magnet housing. If they are not, it is an indication that the armature has failed to return to the end of its normal travel.

To cure this, loosen the six screws which attach the magnet housing to the pump body and make sure that the diaphragm is not sticking to the face of the magnet housing by carefully passing a penknife between the two. The hinge pin should then be removed and the six retaining screws tightened up again. The tips of the inner rockers will probably now be found to be making contact with the face of the magnet housing, but if they are not it will be necessary to remove and dismantle the whole magnet assembly in order to ascertain if an accumulation of foreign matter has caused a jam. Remember that whenever the magnet housing is removed care should be taken to see that the guide rollers (5) do not drop out.

Pump noisy

If the pump becomes noisy and works rapidly it is usually an indication that there is an air leak on the suction side of the pump. Check the level of the fuel in the tank and see that it is not too low.

The simplest way to test for air leakage is to disconnect the fuel pipe from the carburetter and place its end in a glass jar (approximately 1 pint or half a litre) and allow the pump to deliver fuel into it. If air bubbles appear when the end of the pipe has become submerged in the fuel it is a clear indication of an air leak on the suction side of the pump in the fuel feed pipe between the tank and the pump which should be found and cured. Check all the unions and joints, making sure that the filter union and inlet unions are all quite airtight.

Failure to deliver fuel

Should the pump continue beating without delivering fuel, it is probable that dirt has become lodged under one of the valves, in which case they should be dismantled by removing the top cover and unscrewing the valve cage, when they can be cleaned and reassembled.

If the pump struggles to operate and becomes very hot it is probable that the filter has become clogged or there is an obstruction on the suction side. The filter is readily removed for cleaning by unscrewing the six 2 B.A. screws securing the bottom plate.

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Section D.5

DISMANTLING AND REASSEMBLING THE FUEL PUMP

When a pump comes in for reconditioning the first thing to do is to determine whether it has been in contact with gum formation in the fuel, resulting in the parts in contact with the fuel becoming coated with a substance similar to varnish. These deposits cause the eventual destruction of the neoprene diaphragm. The easiest way to identify this deposit is to smell the outlet union. If an unpleasant, stale smell is noticed it indicates the presence of gum in the pump. The ordinary sharp, acrid smell of petrol (gasoline) denotes that no gum is present.

Assuming that trouble with gum formation is indicated, the whole of the parts coming into contact with fuel will have to be dismantled. Those made in brass or steel should be boiled in 20 per cent. caustic soda solution, given a dip in strong nitric acid, and then washed in boiling water. Those made in aluminium should be well soaked in methylated spirits and cleaned.

To dismantle the pump

First remove the six bottom cover securing screws and withdraw the filter, which may be found to be completely clogged with gum. Remove the top cover, the inlet valve retaining circlip, and the inlet valve disc. Unscrew the valve cage and withdraw the outlet valve disc.

Next undo the six screws holding the two main components of the pump together. All the components of the pump body—with the exception of the washer, but including the pump body itself—should now be cleaned to remove all trace of gum. New fibre washers should be used on replacement.

If there is no evidence of gum formation proceed as follows: first undo the six screws holding the two parts of the pump together. The action of the valves can then be checked by blowing and sucking in the inlet union to check the suction valve and in the outlet union to check the delivery valve. In the former case it should be possible to blow freely but not to suck air back, and with the latter to suck and not blow.

Clean the filter in fuel with a brush and swill out the body of the pump.

Next unscrew the diaphragm assembly from its trunnion in the contact breaker. This is done by rotating the whole assembly in an anti-clockwise direction. Take care not to lose the brass rollers fitted behind the diaphragm. The easiest method is to hold the body in the left hand and to rotate the diaphragm.

Now remove the contact breaker cover by taking off the nut which holds it in place on the terminal, and then undo the last nut on the terminal, which acts as a seating for the cover. Beneath this will be found a lead washer which is squeezed into the thread on the terminal. This should be cut away with a pocket-knife, allowing the terminal to be pushed down a short way so that the tag on the coil end is free on the terminal.

Remove the 5 B.A. screw holding the contact blade in position, together with its spring washer and the contact blade.

Remove the two long 2 B.A. screws holding the bakelite pedestal in place, together with their spring washers. Take off the contact breaker assembly, using great care to get the coil end tag over the terminal without damaging the coil end.

Push out the hinge pin sideways and the pump is completely dismantled, since the rocker mechanism is supplied only as a complete assembly.

Do not disturb the core of the magnet; it can only be located correctly with special press tools.

To reassemble the pump

When reassembling, see that all parts are clean. The valves (2 and 14) should be fitted with the smooth side downwards. Care should be taken that the valve retaining clip in the outlet valve cage (3) is correctly located in its groove. When refitting the top and bottom covers new gaskets should be used.

The contact breaker should be assembled on its pedestal in such a manner that the rockers are free in their mountings, without appreciable side-play. Any excessive side-play on the outer rocker will allow the points to get out of line, while excessive tightness will make the action of the contact breaker sluggish. To obtain the required freedom in cases of tightness it may be necessary to square up the outer rocker with a pair of thin-nosed pliers. **The hinge pin is case-hardened, and on no account should ordinary wire be used as a replacement. Always use the correct hardened pin.**

Should the spring contact breaker blade be removed, it must always be replaced bearing directly against the bakelite pedestal, i.e. underneath the tag.

When properly fitted the blade should rest against the ledge on the pedestal while the points are separated, and it should not be sufficiently stiff to prevent the outer rocker from coming right forward when the points are in contact. The points should make contact when the rocker is in its midway position. The simplest way to check this is to hold the blade in contact with the pedestal, taking care not to press on the overhanging portion, and ascertain that a ·030 in. (·76 mm.) feeler can be inserted between the white rollers and the cast-iron body of the pump. If necessary, the tip of the blade may be set to give the correct clearance.

NOTE.—The spring washer on the B.A. screw to which the earth connection is made should be fitted between the tag and the pedestal. The spring washer is not a reliable conductor, and the brass tag must bear directly against the head of the screw.

All four connections—namely, the two ends of the earthing tag and the two ends of the coil—should be soldered. The coil end leading to the terminal should be soldered to its tag and not to the retaining nut. In the case of the terminal screw which holds the bakelite cover in position similar considerations apply, the assembly being: spring washer (1), wiring tag (2), lead washer (3), and recessed nut (4) (see Fig. D.2). A lead washer has been found necessary at this point as some

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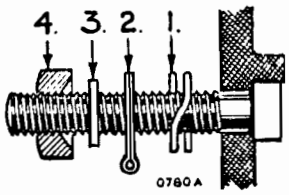

Fig. D.2

The correct sequence of assembly of the connecting components on the terminal screw

few cases of bad connection have been found. Under no circumstances must the spring washer be omitted, or the assembly shortened in any way. Any attempt to do so is likely to lead to breakage of the pedestal when the nut retaining the cover in position is tightened up.

The armature return spring should be fitted with its larger diameter towards the coil and its smaller diameter resting against the armature. This spring must not be stretched or otherwise interfered with, or the action of the pump will be affected.

Section D.6

RESETTING THE DIAPHRAGM FOR CONTACT BREAKER 'THROW-OVER'

If the armature and centre rod have been unscrewed it will be necessary to reset as follows:

(1) **Swing to one side the spring blade which carries the contact points.**

(2) Fit the impact washer in the recess of the armature.

(3) Screw the armature into position.

(4) Place the 11 guide rollers in position around the armature. **Do not use jointing compound on the diaphragm.**

(5) Hold the magnet assembly in the left-hand in an approximately horizontal position.

(6) Screw the armature inwards until the 'throw-over' ceases to operate, and then screw it back gradually, a sixth of a turn (or one hole) at a time, and press the armature in after each part of a turn until it is found that when it is pushed in slowly and firmly the 'throw-over' mechanism operates. **Unscrew the armature a further two-thirds of a turn** (four of the six holes). When a new diaphragm is fitted it is probable that considerable pressure will be required to push the armature right home.

(7) Place the cast-iron body in position on the main body, taking care to see that the drain hole in the cast-iron body is at the bottom and all the rollers are still in their correct positions.

If a roller drops out of position it will get trapped between the two ports, and this will cut a hole in the diaphragm.

Make sure that the cast-iron body is seating properly on the main body and insert the six securing screws. **Before tightening the screws down it is essential that the diaphragm should be stretched to its outermost position.**

This may be done by inserting a matchstick behind one of the white fibre rollers on the outer rocker, thus holding the points in contact (after first repositioning the spring blade into its normal position). If a current is then passed through the pump the magnet will be energized and will pull the armature and diaphragm forward, and while it is in this position the six screws should be tightened. Although the diaphragm-stretching operation can be effected by the matchstick method, a special tool for this purpose is available from the S.U. Carburetter Co. or their Distributors. The tool is a steel wedge, to be inserted under the trunnion in the centre of the inner rocker in order to stretch the diaphragm to its outermost position before tightening the six flange screws.

(8) Finally, check that when the spring blade is in its normal position the clearance hole in it is so positioned around the locking screw that each contact point, according to the operation of the outer rocker, **wipes over the centre-line of the other contact point** and that this action is not to one side of the centre on either contact. The width of the gap at the points is approximately ·030 in. (·76 mm.).

(9) The pump should now be placed on test, using a cut-away cover to enable the contact breaker action to be observed and at the same time to prevent the rocker hinge pin from falling out.

A test rig of the type illustrated in Fig. D.4 is advised; either petrol (gasoline) or paraffin (kerosene) may be used for testing purposes. Test figures are given in

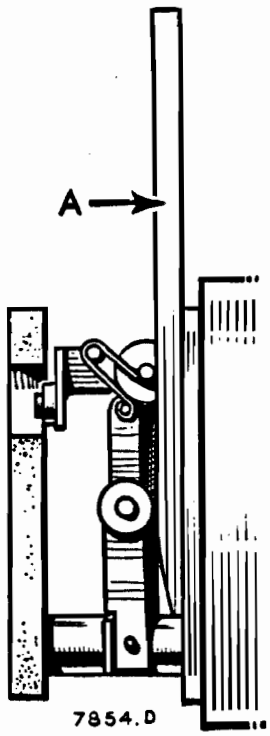

Fig. D.3

The use of a forked wedge (A) *to keep the armature in the correct position for fitting the diaphragm*

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'GENERAL DATA'. The use of a glass tube and rubber connections between the sump and the test tank is advised. When the pump is switched on it should prime itself promptly, and the paraffin, which is normally used for testing, should rise in the glass container until it flows over the top of the pipe having the $\frac{5}{32}$ in. (4 mm.) hole drilled in it 2 in. (5 cm.) below the top of the pipe. If the output of the pump is not up to normal the $\frac{5}{32}$ in. (4 mm.) diameter hole will be able to deal with all the paraffin pumped and the liquid will not flow over the top of the pipe. If a time-test is used, 12½ gallons (54·28 litres) of fuel per hour should be pumped.

These test rigs can be obtained complete from the Service Parts Department of the S.U. Carburetter Co. or their Distributors.

This, therefore, constitutes a simple form of flow-meter which establishes in a simple manner whether the pump is giving a sufficient output or not. If there is any air leak in the pump or in its connections, bubbles will been seen coming out of the pipe projecting downwards into the glass container. Bubbles will certainly come through here for a short while after starting up, but they should cease after the pump has been running for a minute or so. The tap should then be turned right off and the pump should stand without repeating its action for at least 12 seconds. If it repeats within this time the suction valve is not seating correctly.

The tap should then be turned on slowly to see if the pump idles satisfactorily and that the outer rocker comes forward till it makes contact with the pedestal, and while it is in this position the tip of the blade should be pressed inwards to reduce the stroke of the pump

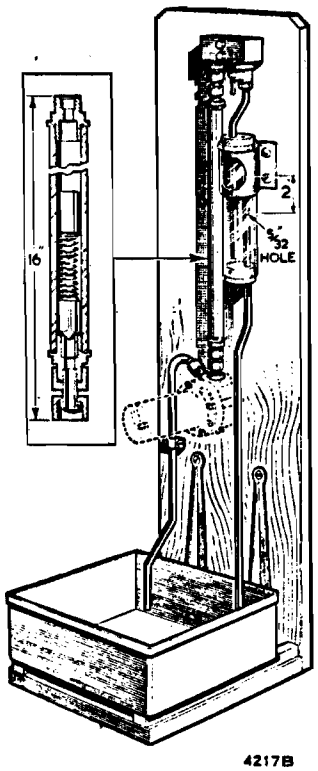

Fig. D.4
Checking rig

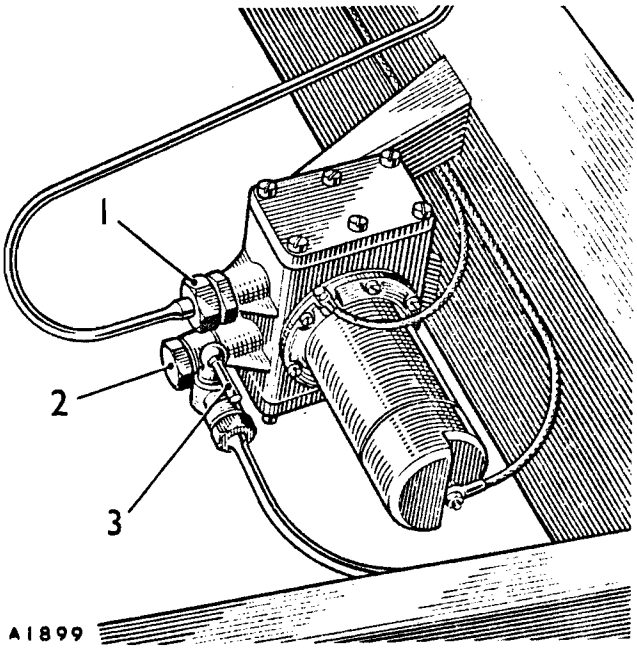

Fig. D.5
1. Outlet union. 2. Inlet union. 3. Stop tap.

gradually. However much this stroke is reduced, the pump should go on pumping normally until it fails altogether owing to there being no gap left. If instead of pumping it buzzes, this usually indicates excessive flexibility in the diaphragm. This, of course, is not likely to be experienced with a new diaphragm. Then, with the tap turned on fully, the pump should be tested on 10 volts and it should work satisfactorily under these conditions, although probably with a reduced output.

It is as well to let the pump run for 10 minutes or so before carrying out these various tests. The cover should then be fitted and held in place with two ordinary brass nuts fitted on the end of the terminal.

NOTE.—There are three important points which are repeatedly overlooked by operators. These seriously affect the functioning of the pump; they are:

(1) To keep the contact breaker blade out of contact while obtaining the correct diaphragm setting.

(2) To press firmly and steadily on the armature, instead of jerking it, while obtaining the setting.

(3) Omitting to stretch the diaphragm to the limit of its stroke while tightening up the body screws.

Section D.7

CARBURETTER CONSTRUCTION AND FUNCTION

The Stromburg carburetter, manufactured by the Zenith Carburetter Co. Ltd., is of the downdraught type. Embodied in the carburetter is a hand-controlled automatic strangler and fast-idler mechanism for cold-starting purposes. Also incorporated in the carburetter is the additional feature of an economy device operated by suction (or vacuum) which gives minimum fuel for normal running with maximum power at full throttle.

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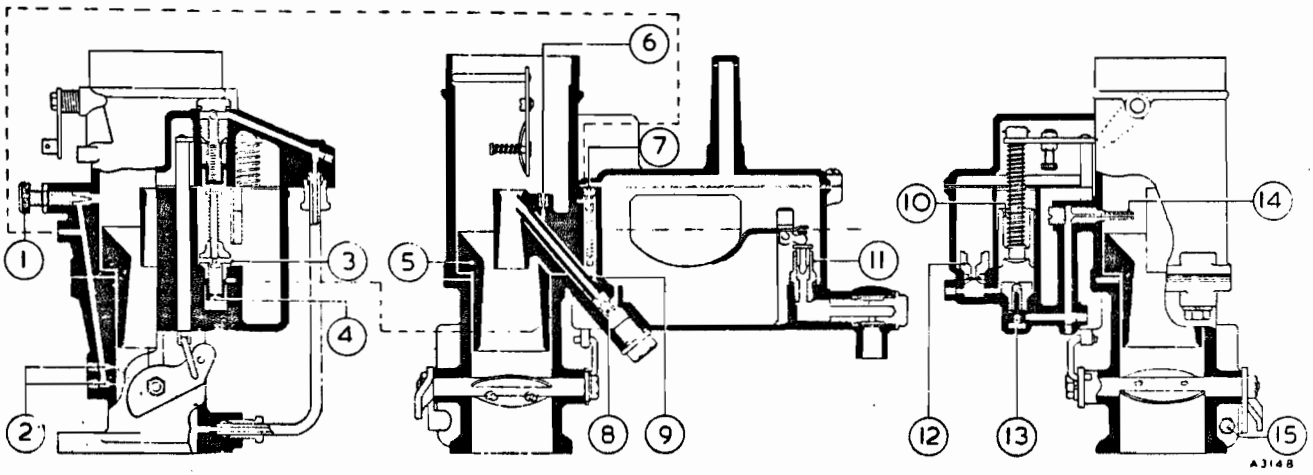

Fig. D.6

The carburetter in section

1. Air adjustment screw.
2. Idle discharge holes.
3. By-pass jet.
4. By-pass jet.
5. Large venturi.
6. High-speed bleed.
7. Idle tube.
8. Main metering jet.
9. Main discharge jet.
10. Pump piston.
11. Needle valve.
12. Pump suction valve.
13. Pump discharge valve.
14. Pump jet.
15. Throttle stop screw.

Description of operation

Main carburetter

From the lift pump the fuel enters the carburetter at the union and passes through the gauze filter before reaching the float needle. It then flows past the float needle until the pressure of the float closes the needle on its seating, preventing any further fuel from entering the float-chamber.

From the float-chamber the fuel then flows through the main metering jet (8) (Fig. D.6) and into the main discharge jet in which the fuel attains the same level as that in the float-chamber. In addition, the fuel maintains the same height in the idle tube (7).

Slow-running

Presuming the engine has been started and has reached a reasonable temperature, the fuel for slow-running is supplied from the idle tube (7). Upon leaving the tube the fuel is mixed with air which enters at the base of the air adjustment screw (1). This correctly proportioned mixture proceeds along the drilling down the barrel of the carburetter to the outlet (2), on the engine side of the throttle.

To increase the speed of the engine the throttle is opened, and to ensure a progressive action the discharge hole for the idling mixture higher up the barrel is uncovered and supplies the mixture.

A depression now exists in the small venturi, having the effect of drawing out the fuel that is in the main discharge jet. This is caught up and atomized by the inrushing air passing the throttle into the induction pipe.

When the fuel standing in the main discharge jet has been utilized the supply comes direct from the float-chamber via the metering jet (8).

As the name implies, this jet is calibrated to measure accurately the fuel now being supplied. The falling of the fuel level in the main discharge jet will have revealed a series of holes that are in communication with atmosphere through the high-speed bleed (6). Consequently, the fuel now issuing from the main discharge jet will be partly atomized by the air entering these holes and will be completely 'broken up' when entering the small venturi, to pass through the large venturi (5) into the induction system.

Accelerating

To ensure instant acceleration, when the throttle is suddenly opened a small governed quantity of fuel is ejected into the air stream by using an accelerating pump.

The pump piston rod is linked with the throttle lever; consequently, when the throttle is closed the pump piston (10) is drawn up and the cylinder is charged with fuel drawn from the float-chamber through the non-return pipe suction valve (12). Upon opening the throttle suddenly the piston is forced to descend and exerts pressure on the fuel in the cylinder. The only outlet for the fuel is through the pump discharge valve (13). Forcing the bore of this valve off its seating, the fuel will pass first through the pump discharge and then through the drilling leading to the pump jet (14). The fuel will then be ejected into the air stream through the pump jet.

Economy device

For normal cruising speeds at part-closed throttle the fuel flows from the float-chamber and is measured when passing through the metering jets. The quantity of fuel allowed to pass is the minimum necessary for normal running.

To obtain maximum power at all speeds, however, a greater supply is necessary. For this, advantage is taken of the depression or suction that exists on the engine side of the throttle as a controlling medium.

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When the engine is at high revs., with a partly closed throttle (e.g. at fast speeds on a flat or downgrade road), the depression on the engine side of the throttle is high. Under these conditions a normal 'lean' mixture is advisable, but when maximum power is demanded with the throttle wide open the depression is comparatively low; it is for such a condition that a richer mixture is required.

On the engine side of the throttle a hole is drilled, into which is attached one end of the suction pipe. The other end of this pipe is connected to the by-pass vacuum piston. In consequence, depression existing at the drilling will also exist at the head of the by-pass piston. A high degree of depression will have the effect of overcoming the tension of the piston onto the stem of the by-pass valve. When the depression or the suction at the drilling falls below a predetermined degree, however, the spring is no longer overpowered and it forces down the by-pass piston, which in turn depresses the stem from the by-pass valve. This will take the valve off its seating and an extra supply of fuel will be allowed to flow through the by-pass jet (3) direct to the base of the main discharge jet.

Section D.8

REMOVING AND REPLACING THE CARBURETTER

Disconnect and remove the air cleaner as described in Section D.11.

Slacken the choke control outer casing clamping screw on the abutment arm and detach the inner cable lever.

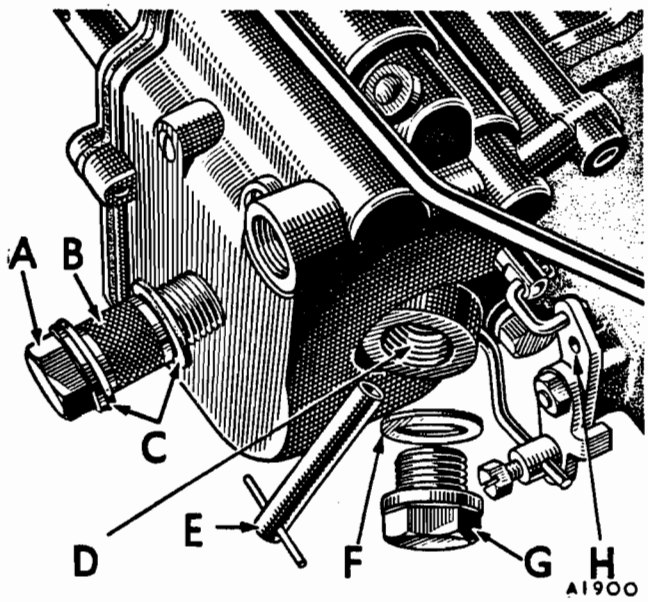

Fig. D.7

Carburetter details

A. Inlet union bolt.
B. Inlet union filter.
C. Fibre washers.
D. Main jet location.
E. Main jet plug key.
F. Main jet plug washer.
G. Main jet plug.
H. Pump lever.

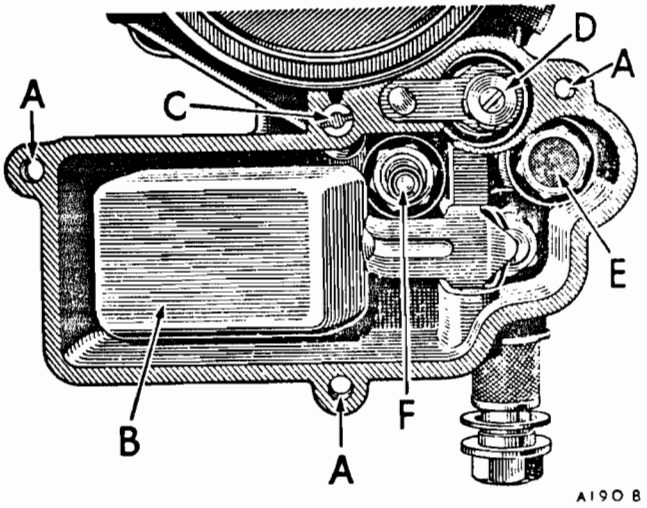

Fig. D.8

Float-chamber details

A. Cover securing points.
B. Float.
C. Slow-running jet.
D. Accelerating pump.
E. Accelerating pump suction valve.
F. By-pass economy valve.

Disconnect the ball joint connector from the throttle arm on the carburetter.

Disconnect the fuel feed pipe at the union at the base of the float-chamber and withdraw the fibre washers positioned on each side of the banjo union.

Disconnect the vacuum pipe from the base of the carburetter and remove the fibre washers positioned on each side of the banjo union.

Remove the two nuts and washers securing the carburetter flange to the manifold and lift the carburetter from the manifold. To replace the carburetter reverse the dismantling procedure, ensuring that all gaskets and fibre washers are in a serviceable condition. Fit new ones if at all doubtful.

Section D.9

CARBURETTER ADJUSTMENTS

Automatic hand-controlled strangler

There is an interconnection between the strangler and throttle so that when the strangler is closed for starting the throttle is opened slightly to ensure instant starting and rapid warming up.

The degree of throttle opening depends on the interconnection rod setting, which can be adjusted by means of a clamp screw at the throttle spindle end.

The interconnection rod should be set so that a gap of ·040 to ·045 in. (1·016 to 1·043 mm.) exists between the throttle plate edge and the carburetter bore when the strangler is fully closed.

Idling and low-speed adjusting

Adjustment to the idling and low speed must be carried out when the engine has reached its normal working temperature. Adjust throttle stop screw (15) to give the desired engine speeds. The idling air screw (1) controls the strength of the idling mixture, and the screw

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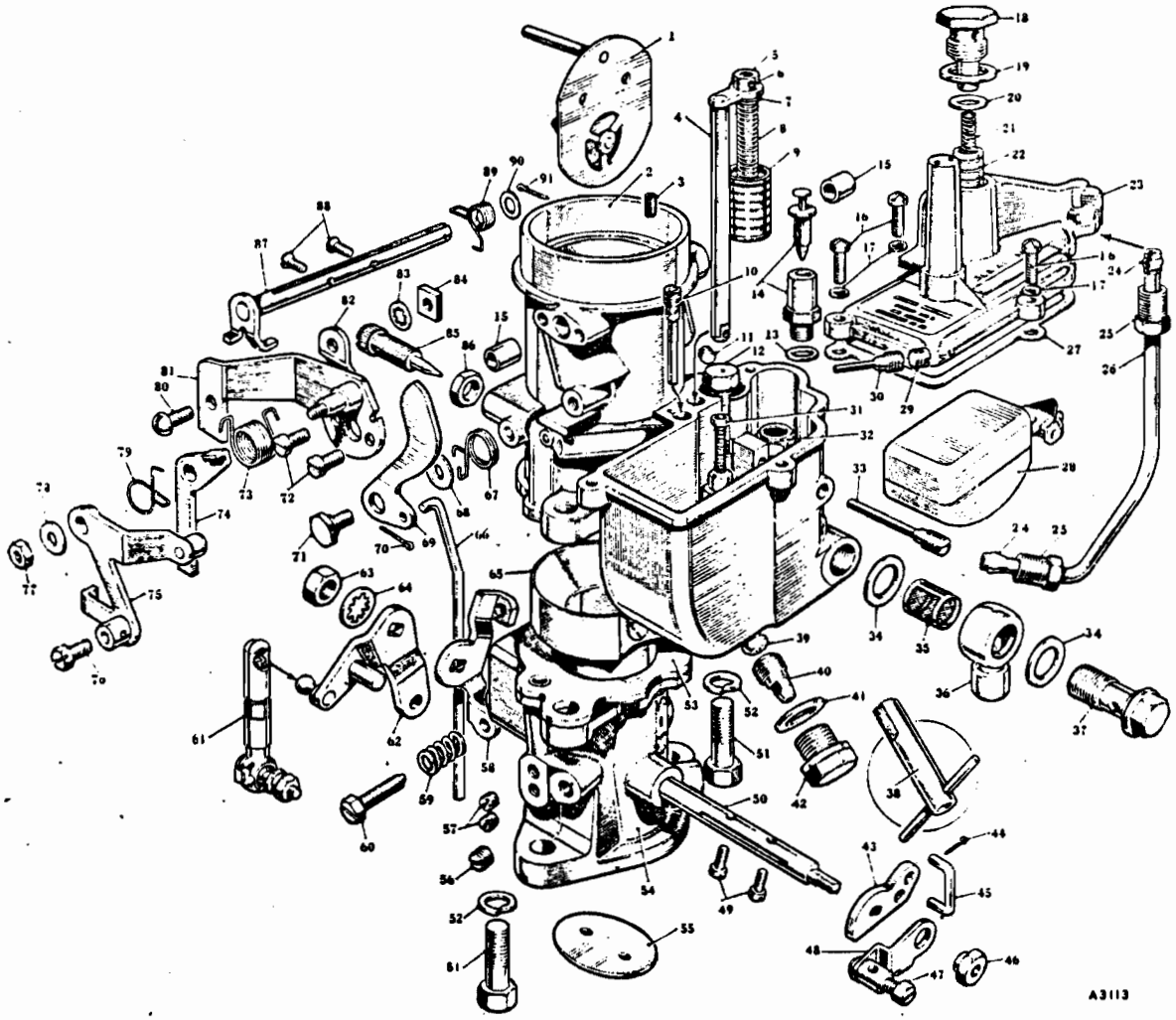
THE CARBURETTER COMPONENTS



No.	Description
1.	Strangler valve.
2.	Main body.
3.	High-speed bleed.
4.	Pump rod.
5.	Nut for piston rod.
6.	Split pin.
7.	Washer for pump spring.
8.	Pump spring.
9.	Pump piston.
10.	Idle tube.
11.	Plug for pump passage.
12.	Pump discharge valve.
13.	Washer for needle seating.
14.	Needle valve and seating assembly.
15.	Strangler spindle bush.
16.	Screw fixing float-chamber cover.
17.	Spring washer.
18.	Plug over piston.
19.	Washer.
20.	Washer.
21.	Spring for economy piston.
22.	Economy piston.
23.	Float-chamber cover.
24.	Compression washer.
25.	Plug for compression washer.
26.	Communication tube.
27.	Gasket for float-chamber cover.
28.	Float.
29.	Plug over pump discharge jet.
30.	Pump discharge jet.
31.	By-pass valve.
32.	Pump check valve.
33.	Float fulcrum screw.
34.	Fibre washer.
35.	Filter gauze.
36.	Filter elbow ($\frac{5}{16}$ in.).
37.	Plug for filter elbow.
38.	Jet key.
39.	Main discharge jet.
40.	Metering jet.
41.	Washer.
42.	Plug under metering jet.
43.	Pump lever.
44.	Split pin for pump link.
45.	Pump link.
46.	Nut for pump lever.
47.	Screw for swivel.
48.	Loose lever.
49.	Screw for throttle.
50.	Throttle stem.
51.	Bolt fixing throttle body to main body.
52.	Spring washer.
53.	Gasket (throttle body to main body).
54.	Throttle valve body.
55.	Throttle.
56.	Plug for auto ignition boss.
57.	Plug over idle discharge hole.
58.	Throttle stop (see item 62).
59.	Spring for stop screw.
60.	Throttle stop screw.
61.	Connector.
62.	Throttle lever and stop.
63.	Nut for throttle stem.
64.	Shakeproof washer.
65.	Venturi (1 $\frac{3}{16}$ in.).
66.	Fast-idle rod.
67.	Spring for cam lever.
68.	Washer.
69.	Cam lever.
70.	Split pin for fast-idle rod.
71.	Fulcrum screw for cam lever.
72.	Screw fixing tube holder.
73.	Spring for choke control lever.
74.	Stop for choke control lever.
75.	Choke control lever.
76.	Screw for swivel.
77.	Nut fixing choke control lever.
78.	Washer.
79.	Spring for choke control lever stop.
80.	Screw for tube holder clip.
81.	Tube holder.
82.	Tube holder clip.
83.	Shakeproof washer.
84.	Nut.
85.	Idle needle valve.
86.	Nut.
87.	Strangler spindle.
88.	Screw fixing strangler valve.
89.	Spring for strangler spindle.
90.	Washer.
91.	Split pin.

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should be adjusted until the position is found where the engine rhythm is most regular. Screwing in a clockwise direction gives a richer mixture, and vice versa.

Adjust the air screw by gently tightening the screw onto its seating and then unscrewing the least possible amount until a smooth engine rhythm is obtained without misfiring or roughness.

If a satisfactory adjustment cannot be obtained with any setting of the air screw the idle discharge holes (2) should be inspected by removing the plugs covering them. The idle tube (7) may be removed for inspection once the float-chamber has been lifted.

Part-throttle and high-speed adjusting

The main metering jet should be of a size sufficient to pass the required amount of fuel for smooth running at speeds from about 15 m.p.h. up to 45 to 60 m.p.h. (24 km.p.h. up to 72 to 96 km.p.h.). The size of the economizer or by-pass jet (3) is governed by the amount of extra fuel required to bring the mixture up to the full-throttle strength and is usually about 40 per cent. smaller in diameter than the metering jet.

Accelerating pump adjustment

The quantity of fuel delivered by the pump is controlled by the size of the pump discharge jet (14) and the duration of the charge by the pump springs. The stroke of the pump may be altered by changing the link from one of the two throttle arm holes to the other, the hole nearest the throttle spindle giving a less discharge, and vice versa. As a general rule, the link is connected to the outer position, which may be termed the winter setting.

Should the pump discharge appear to be excessive during the summer months, the link should be moved into the second position. It is inadvisable to attempt any other readjustment without having first consulted the carburetter manufacturers.

Fuel level adjustment

The standard of the fuel level in the float-chamber is $\frac{11}{16}$ in. (17·46 mm.) below the top face of the float-chamber and is easily examined by removing the float-chamber cover, when the height of the fuel level may be measured. It should be unnecessary to make any alterations unless the carburetter has been handled roughly.

When necessary, the level can be corrected by carefully bending the float arm where it meets the float. Bending the float arm upwards will raise the level, and the converse bend will lower the fuel level.

Section D.10

LOCATION AND RECTIFICATION OF FAULTS

The functioning of the carburetter is intimately connected with other elements of engine operation and troubles are often difficult to diagnose. Quite often the carburetter is blamed for faults for which it is not entirely responsible. These faults may be in the form of engine misfiring, refusal to start, or the developing of a high fuel consumption, etc. Faults which occur after previous good performances can usually be located more readily by following an orderly system of investigation, covering the different elements which are essential to operation.

Check the following points:

(1) Ensure that the fuel pump is working satisfactorily and that there is no restriction in the pipe between the fuel pump and the carburetter inlet.

(2) Ascertain that the ignition is functioning correctly.

(3) Check the compression in each cylinder.

(4) See that the ignition tuning is in accordance with the information given on page B.7.

When the carburetter is definitely proved to be the cause of the difficulty the following items should be checked.

Loss of speed

Check the throttle valve for full opening and the by-pass jet (3) to make sure that there is no blockage. In order to examine the by-pass jet remove the float-chamber and screw the jet valve out complete.

Flat spot at small throttle opening

Adjust the idling to give more regular engine rhythm. If the flat spot is still evident examine the idle holes (2) and the idle tube (7).

Flat spot at half-throttle

Withdraw and examine the metering jet for stoppage. Check the accelerating pump for blockage. If the throttle can be held on a flat spot and the running is continually uncertain the larger metering jet should be fitted.

High petrol consumption

Check the jets and float level for correct setting. If the setting is correct and the carburetter is still proved to be at fault the most probable cause is the sticking or leaking by-pass valve, permitting an unnecessary extra flow of fuel at part-throttle. Remove the economizer valve and examine for foreign matter, which must be removed by blowing with a high-pressure jet through the valve orifice. Clean also the ball valve at the base of the pump cylinder. If this valve is not seated correctly fuel will issue from the pump jet at all times.

Cleaning the jets

Jets must be cleaned out by using a blast of compressed air. Never use a wire or any hard substance to clean a jet. The orifices are carefully calibrated and any slight alteration of the orifice shape will affect the flow.

In the event of a change of jet size being required, do not attempt to clean or otherwise tamper with the jet but obtain a fresh jet of the desired size from the makers or authorized agents.

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Section D.11

AIR CLEANER

Oil-wetted type

The air cleaner and gauze should be washed in paraffin (kerosene) at the periods stated in the Passport to Service, or more often in very dusty conditions. After thoroughly drying the assembly re-oil the gauze element with clean engine oil and allow any surplus oil to drain off before refitting the air cleaner to the engine.

To remove the air cleaner disconnect the breather pipe from the rocker cover, unscrew the wing nut, and remove the end cover together with the gauze element.

Oil bath type

Cleaning and re-oiling

The air cleaner should be dismantled, cleaned, and refilled with fresh oil at the periods stated in the Passport to Service.

Disconnect the breather pipe from the rocker cover and also the oil bath mounting bracket stay. Slacken the clip immediately above the oil bath cover, unscrew the long centre-bolt, and remove the oil bath assembly together with its mounting bracket.

Empty the oil from the bath, thoroughly clean both the oil bath and the filter gauze in fuel, and allow to dry.

Refill the bath with clean engine oil, to the level indicated by the arrow embossed on the side of the bath, and reassemble.

Do not re-oil the filter gauze; this is carried out automatically by oil picked up from the shelf by the incoming air.

It is important to maintain the correct oil level in the cleaner. Too high a level will restrict the passage of air through the cleaner, resulting in increased fuel consumption, whereas too low a level will result in failure to keep the gauze saturated with oil.

Section D.12

REMOVING AND REPLACING THE FUEL TANK GAUGE UNIT

The fuel gauge unit is positioned on the forward face of the fuel tank.

Drain sufficient fuel from the tank to ensure that the level is below the bottom edge of the fuel gauge unit opening.

Disconnect the electrical lead from the tank unit.

Remove the six set screws securing the unit to the tank and withdraw the gauge unit, taking care not to strain or bend the float lever. When replacing the unit a new joint washer must be fitted; use a suitable sealing compound to make the joint fueltight.

Section D.13

REMOVING AND REPLACING THE FUEL TANK

Obtain a clean receptacle, remove the drain plug positioned centrally in the base of the tank, and allow the fuel to drain.

Disconnect the fuel feed pipe at its union on the forward face of the fuel tank.

Disconnect the electrical lead from the tank unit.

From the under side of the left-hand rear wing slacken the clip securing the filler hose to the connection of the tank. Seal the tank opening to prevent the possible ingress of foreign matter.

Disconnect the breather pipe on the right-hand side of the tank forward end. Similarly, seal this pipe also.

The fuel tank is secured to the under side of the spare wheel compartment by four bolts, passing through support brackets fixed to the front and rear faces of the tank.

Support the tank while each of the four nuts and spring washers are removed from the bolts.

When lowering the tank from position take care that the composition cushion between the tank and its seat is not damaged in any way.

To replace the fuel tank reverse the dismantling procedure.

Fit new hoses if and where necessary.

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Lift the piston and check that it falls freely and evenly, hitting the jet bridge with a soft, metallic click. Then fully lower the jet and re-check to see if there is any difference in the sound of the impact; if there is and the second test produces a sharper impact sound, the centring operation will have to be repeated until successful.

Allow the piston to fall sharply several times whilst gradually tightening the jet locking nut. This will greatly assist the centring of the jet.

Adjustments

Slow-running is governed by the setting of the jet adjusting nuts and the throttle adjusting screws, both of which must be correctly set and synchronized if satisfactory results are to be obtained.

Before blaming the carburetter settings for bad slow-running make certain that the trouble is not caused by badly adjusted distributor contact points, faulty plugs, incorrect valve clearance, or faulty valves and springs.

Slow-running adjustment and synchronization

When the engine is fully run in the slow running may require adjustment. This must only be carried out when the engine has reached its normal running temperature.

As the needle size is determined during engine development, tuning of the carburetters is confined to correct idling setting. Slacken the actuating arms on the throttle spindle interconnection. Close both throttles fully by unscrewing the throttle adjusting screws, then open each throttle by screwing down each idling adjustment screw one turn.

Remove the pistons and suction chambers and disconnect the mixture control cable. Screw the mixture adjusting screws until each jet is flush with the bridge of its carburetter, or as near to this as possible (both jets being in the same relative position to bridge of their respective carburetters). Replace the pistons and suction chamber assemblies and check that the pistons fall freely onto the bridge of the carburetters (by means of the piston lifting pins). Turn down each mixture adjusting screw two complete turns.

Restart the engine, and by listening to the hiss in the intakes, adjust the throttle adjusting screws until the intensity of the hiss is similar on both intakes, and a satisfactory idling speed obtained.

The mixture should be adjusted by screwing each mixture adjusting screw up to weaken or down to enrich by the same amount until the fastest idling speed is obtained consistent with even firing.

As the mixture is adjusted the engine will probably run faster, and it may therefore be necessary to unscrew the throttle adjusting screws a little, each by the same amount, to reduce the speed.

Now check the mixture strength by lifting the piston of the front carburetter approximately $\frac{1}{32}$ in. (1 mm.), when:

(1) If the engine speed increases, this indicates that the mixture strength of the front carburetter is too rich.

(2) If the engine speed immediately decreases, this indicates that the mixture strength of the front carburetter is too weak.

(3) If the engine speed momentarily increases very slightly, then the mixture strength of the front carburetter is correct.

Repeat the operation at the rear carburetter, and after adjustment re-check the front carburetter, since both carburetters are interdependent.

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

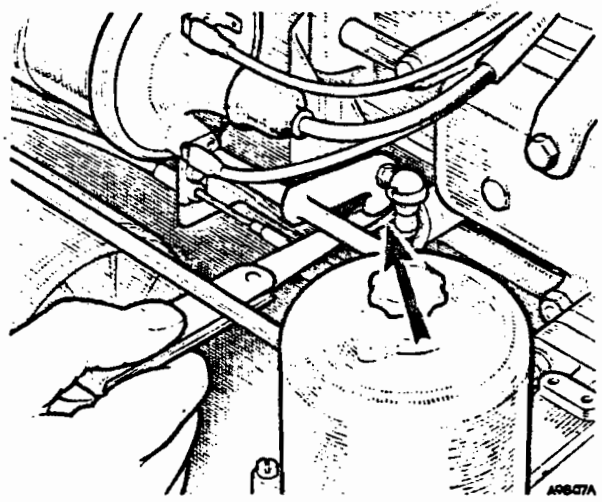

Fig. D.12

The feeler between the arm on the throttle cross-shaft and the fixed pad on the coil mounting bracket

Throttle linkage

Slacken the clamping screws on the throttle cross-shaft levers. This will ensure that the butterflies can be fully closed.

Insert a 0·012 in. (0·35 mm.) feeler gauge between the arm on the throttle cross-shaft and the fixed pad on the coil mounting bracket.

With the cross-shaft held in this position and the throttle stops hard against the slow-running screws, tighten the cross-shaft lever clamping screws, ensuring that the lever actuating pegs just make contact with the lower side of the throttle lever slots; also ensure that an end-float of between 0·010 and 0·015 in. (0·25 and 0·38 mm.) is maintained in the cross-shaft assembly.

Reconnect the mixture control cable, allowing $\frac{1}{16}$ in. (1·6 mm.) free movement.

Pull out the mixture control knob on the dash panel until the linkage is about to move the carburetter jets (a minimum of $\frac{1}{4}$ in. [6 mm.]) and adjust the fast-idle

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SECTION E

THE CLUTCH

	Section
General description	
Clutch	
Adjusting	E.1
Assembling	E.5
Dismantling	E.4
Pedal assembly—dismantling	E.2
Refitting	E.7
Release lever adjustment	E.6
Removing	E.3
Servicing	E.8
Tools	End of Section

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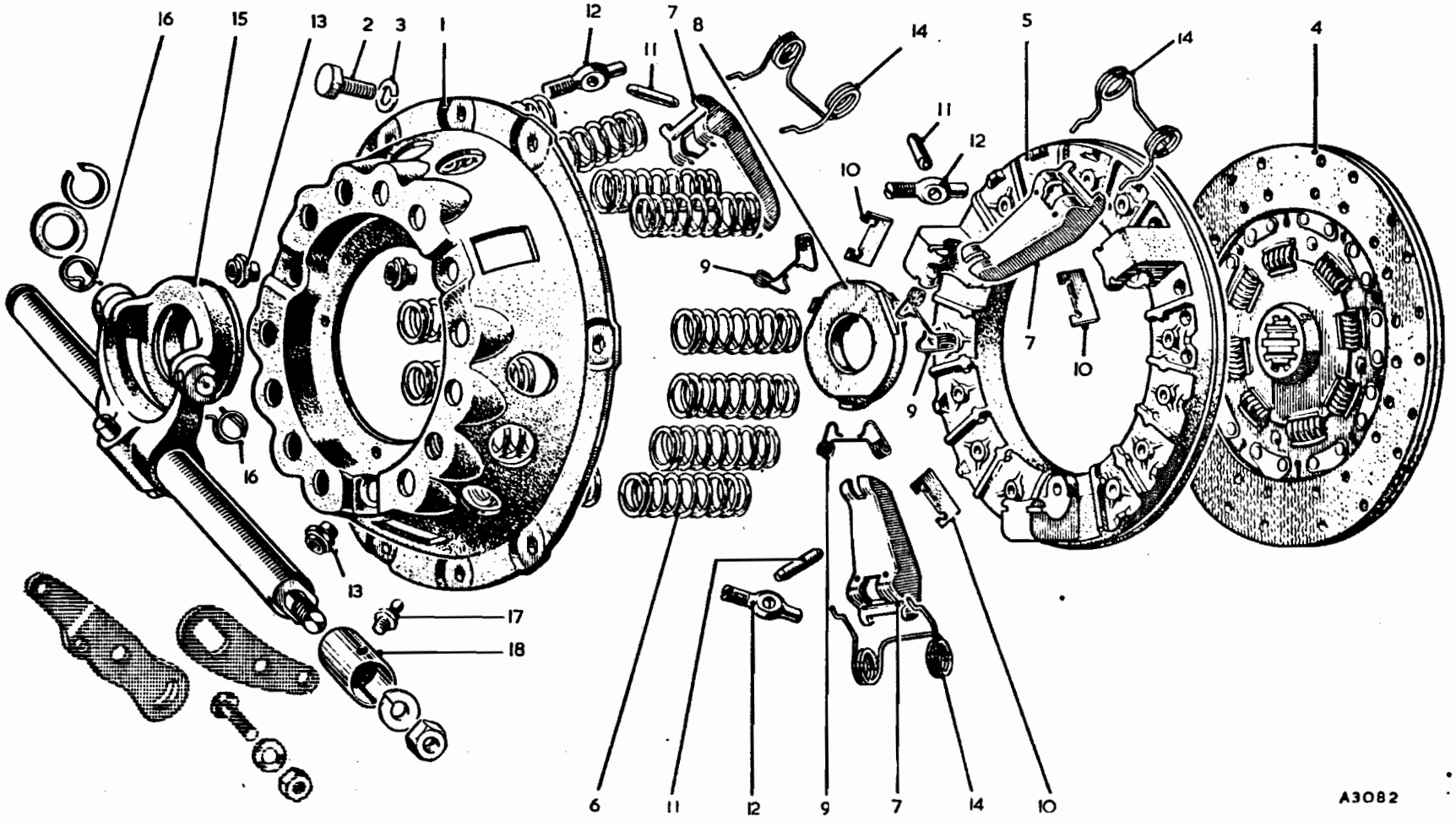
THE CLUTCH COMPONENTS



No.	Description
1.	Clutch cover.
2.	Set screw.
3.	Spring washer.
4.	Clutch plate.
5.	Pressure plate.
6.	Pressure plate springs.
7.	Release levers.
8.	Release plate.
9.	Release plate retaining springs.
10.	Knife-edge struts.
11.	Floating pin.
12.	Eyebolt.
13.	Adjusting nuts.
14.	Anti-rattle springs.
15.	Release bearing.
16.	Retainer.
17.	Lubrication nipple.
18.	Fork shaft bearing.

GENERAL DESCRIPTION

The clutch is of the single-plate dry-disc type actuated mechanically. Provision for adjustment to compensate for wear of the clutch plate is made in the clutch pedal linkage.

The general construction can be followed by reference to page E.2 and the following description.

Driven plate assembly

This consists of a splined hub and flexible steel driven plate (4), to the outer diameter of which are fixed the annular friction facings. This plate is attached to the splined hub by a spring mounting which provides a torsional cushion.

Withdrawal bearing assembly

This comprises the graphite release bearing (15) mounted in a cup attached to the throw-out fork, and a release plate (8) attached to the inner ends of the release levers (7) by means of the retainer springs (9). Release is accomplished by moving the release bearing forward into contact with the release plate and thus applying pressure to the release levers.

Cover assembly

Each release lever is pivoted on a floating pin (11) which remains stationary in the lever and rolls across a short flat portion of the enlarged hole in the eye-bolts (12). The outer ends of the eyebolts extend through holes in the clutch cover and are fitted with adjusting nuts (13) by means of which each lever is located in its correct position. The outer or shorter ends of the release levers engage the pressure plate lugs by means of struts (10) which provide knife-edge contact between the outer ends of the levers and the pressure plate lugs, eliminating friction at this point. Thus the pressure plate (5) is pulled away from the driven plate (4), compressing the 12 thrust coil springs (6) which are assembled between the pressure plate (5) and the clutch cover (1).

When the foot pressure is removed from the clutch pedal the clutch springs force the pressure plate forward against the driven plate, gradually and smoothly applying the power of the engine to the rear wheels.

Section E.1

ADJUSTING THE CLUTCH

The only adjustment necessary throughout the life of the driven plate linings is to restore, periodically, the free movement of the clutch pedal (i.e. movement of the pedal before the release bearing comes into contact with the release lever plate and commences to withdraw the clutch). As the driven plate linings wear the free movement of the pedal will gradually decrease, thus tending to prevent the clutch fully engaging and permitting too great a movement on withdrawal. When this free movement becomes reduced adjustment must be made to restore it to the correct amount, which is approximately 1 to 1 $\frac{5}{16}$ in. (25·4 to 27 mm.).

Correct free movement is gained by slackening the nut on the end of the clutch operating shaft, also the nut on the clamping bolt. The clutch pedal lever should then be depressed a sufficient amount to take up any clearance and at the same time to impose a slight load at the carbon ring release bearing. With the pedal in this position both the clutch operating shaft nut and the clamping bolt nut must be tightened. The design of the linkage is such that the correct free movement will be given after this pedal setting operation has been completed.

Originally the clutch free movement is set at the Works before the bodywork is mounted on the chassis. This setting is determined by the adjustment screw—Fig. E.1. With the pedal lever at rest on the toeboard buffer there should be a distance of 1 to 1 $\frac{13}{16}$ in. (25·4 to 49·21 mm.) between the centre-line of the lever and the first face of the gearbox cover.

Both these methods of adjustment apply equally to right- and left-hand-drive cars, irrespective of the fact that for a left-hand drive the pedal operating shaft is extended through the chassis frame to give the desired position for the pedal.

Section E.2

DISMANTLING THE PEDAL ASSEMBLY

Right-hand drive

To remove the pedal stalk from the supporting shaft it is first necessary to dismantle the operating linkage. The return spring must be unhooked from the rear operating lever. Then, both the upper and lower fork links should be released from the operating lever by extracting each split pin and by the removal of the swivel

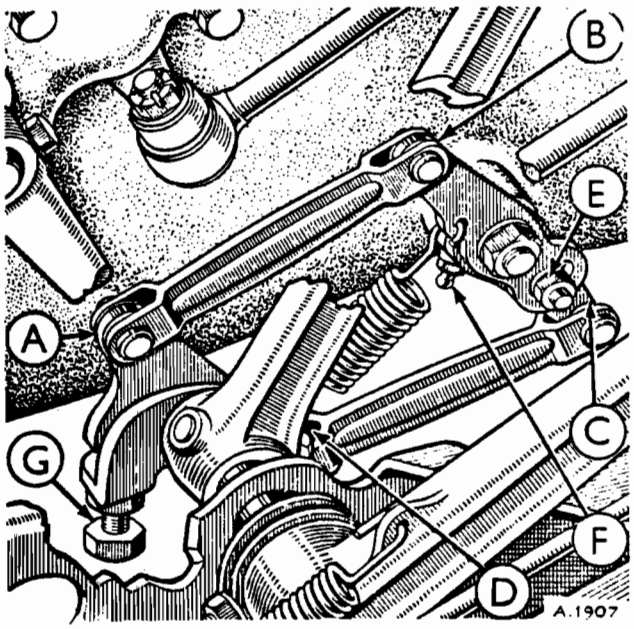


Fig. E.1

The clutch pedal lubrication and adjustment points

A, B, C, D. Felt joint washers.
E. Compensating linkage adjuster.
F. Clutch cross-shaft nipple.
G. Free movement adjuster.

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pins. Do not lose the felt washers in the process. Now remove the nut which secures the operating lever to the shaft and take off the spring washer, lever, distance washer, and adjusting bracket. Remove the nut and washers and tap out the cycle-type cotter pin securing the pedal stalk to the shaft. The pedal stalk may now be pulled off the shaft.

Left-hand drive

In the left-hand-drive position the clutch pedal assembly incorporates identical linkage to that employed for the right-hand-drive models, but the operating shaft is extended to protrude on the outside of the chassis side frame. The shaft is housed in a tube with zinc bushes at each end. To extract the shaft the pedal arm is taken off after the cycle-type cotter has been withdrawn. The linkage and adjustment bracket should then be removed from the inner end of the shaft, when the shaft can be withdrawn from its tube cover. This tube cover also carries the brake pedal.

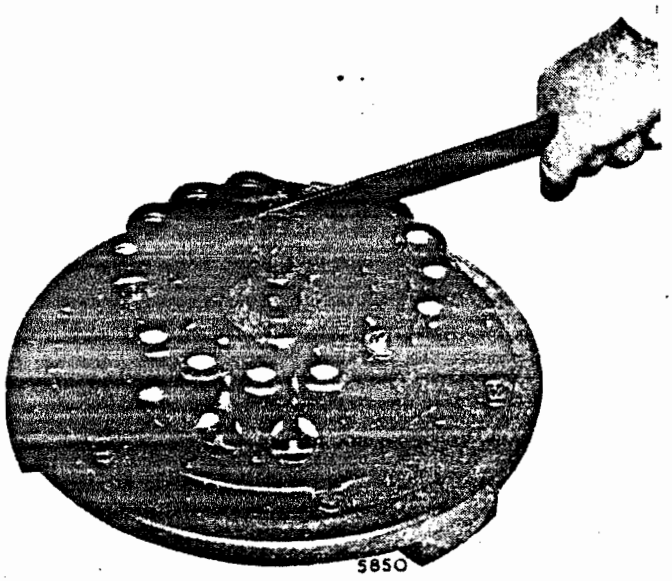

Fig. E.2

Compressing the springs with gauging fixture 18G99A

Section E.3

REMOVING THE CLUTCH

Remove the gearbox (Section F.1).

Loosen each of the hexagon bolts securing the clutch to the flywheel by slackening them a turn at a time until spring pressure is released (this should be done carefully to avoid distortion of the clutch cover flange).

The clutch cover can now be disengaged from the flywheel dowels and the whole assembly lifted from the flywheel, all parts except the driven plate remaining assembled to the cover.

Section E.4

DISMANTLING THE CLUTCH

Detach the retaining springs from the release lever plate and remove the plate and springs.

Place the clutch cover assembly on the base plate of clutch assembly gauging fixture 18G99A and screw the actuator into the central hole. Align the holes in the clutch cover with the tapped holes in the base plate, press the handle of the actuator downwards to clamp the clutch, and insert the tool set screws to secure the clutch to the base plate. Release and remove the actuator and remove the adjusting nuts from the three eyebolts.

Unscrew the set screws securing the clutch cover to the base plate half a turn at a time in a diagonal pattern to release the pressure of the clutch springs. Lift the cover off the clutch and carry out whatever additional dismantling may be necessary.

While stripping down the cover-plate assembly the parts should be marked so that they may be reassembled in the same relative position to each other, to ensure that the correct balance is maintained. When a new pressure plate is fitted it is essential that the complete cover and pressure plate assembly be accurately balanced, for which reason it is not a practical proposition to fit new pressure plates unless balancing facilities are available.

All parts are available for inspection when the cover is lifted off.

To remove the release levers grasp the lever and eyebolt between the thumb and fingers so that the inner end of the lever and the threaded end of the eyebolt are as near together as possible, keeping the eyebolt pin seated in its socket in the lever. The strut can then be lifted over the ridge on the end of the lever, making it possible to lift the eyebolt off the pressure plate. It is advisable to renew any parts which show signs of wear.

Section E.5

ASSEMBLING THE CLUTCH

Consult the code card to determine the correct spacers for the particular clutch; place the spacers on the base plate in the positions indicated on the code card and lay the pressure plate on the three spacers on the base plate. Place the springs on the pressure plate in a vertical position, seating them on their small locating bosses Thoroughly clean all parts and renew any which show appreciable wear.

Assemble the release levers, eyebolts, and eyebolt pins, holding the threaded end of the eyebolt and the inner end of the lever as close together as possible. With the other hand insert the strut in the slots of the pressure plate lug just sufficiently to allow the plain end of the eyebolt to be inserted in the hole in the pressure plate. Move the strut upwards into the slots in the pressure plate lugs, over the ridge on the short end of the lever, and drop it into the grooves formed in the lever.

Lay the cover over the parts, taking care that the anti-rattle springs are in position and that the springs are directly under the seats in the cover. Also make sure,

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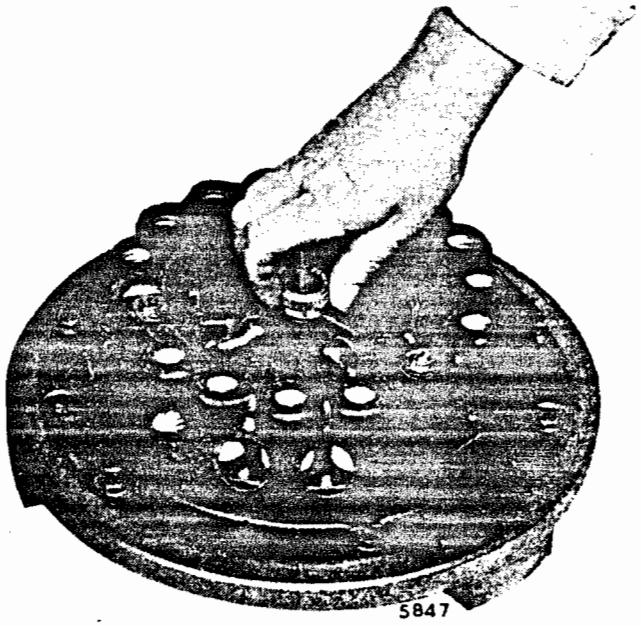

Fig. E.3

Adjusting the release levers, using gauging fixture 18G99A

if using the original parts, that the eyebolts, eyebolt nuts, pressure plate lugs, and cover are fitted in their correct relative positions, as marked when dismantling, to ensure correct balance being maintained.

Insert the tool set screws through the holes in the cover and screw them into the base plate, tightening them half a turn at a time in a diagonal pattern to prevent distortion of the clutch cover. Guide the eyebolts and pressure plate lugs through the holes in the cover during the tightening-down process. Replace the adjusting nuts on the eyebolts.

Section E.6

ADJUSTING THE RELEASE LEVERS

Satisfactory operation of the clutch is dependent upon accurate adjustment of the release levers so that the pressure plate face is maintained parallel to the flywheel face. This cannot be accomplished by setting the levers parallel to the face of the release bearings after the clutch has been assembled to the flywheel because of the variations in the thickness of the driven plate. For accurate adjustment universal gauging fixture 18G99A must be used.

With the assembly of the clutch completed (see Section E.5) screw the actuator into the base plate and work the handle a dozen times to settle the clutch mechanism. Remove the actuator. Screw the pillar firmly into the base plate and place the appropriate adaptor (see code card) on the pillar with the recessed side downwards; place the gauge finger in position.

Turn the adjusting nuts until the finger just touches the release levers, pressing downwards on the finger assembly to ensure that it is bearing squarely on the adaptor. Remove the finger and the pillar and replace the actuator; operate the actuator several times. Recheck with the finger assembly and make any necessary further adjustments.

Lock the adjusting nuts by staking the flange of the nut into the slot of the eyebolt.

After adjustment is completed unscrew the set screws securing the clutch cover to the base plate half a turn at a time in a diagonal pattern to release the pressure evenly and so prevent distortion of the clutch cover.

Fit the release lever plate to the ends of the release levers and secure it in position with the retaining springs.

Section E.7

REFITTING THE CLUTCH ASSEMBLY

Place the driven plate assembly on the flywheel with the longer-chamfered splined end of the driven plate hub away from the flywheel. Centralize the driven plate by means of special centralizing tool 18G81, which will fit the splined bore of the driven plate and the pilot bearing of the flywheel.

Locate the clutch cover assembly on the two flywheel dowels and secure with the holding screws, tightening the screws a turn at a time by diagonal selection to avoid distortion of the cover. Remove the centralizing tool after all screws have been securely tightened.

Section E.8

SERVICING THE CLUTCH

Spring pressure

A tolerance of not more than 10 lb. (4·5 kg.) pressure is allowable on the compression load of the operating springs when at their assembled height, and all clutch springs are tested for this before assembly.

The clutch operating springs are not affected by high clutch temperatures, as the pressure plate absorbs heat rapidly, the springs have only line contact, and a draught is continually passing under them when the engine is running.

Tolerances

Wear on the working faces of the driven plate is about ·001 in. (·02 mm.) per 1,000 miles (1600 km.) under normal running conditions. The accuracy of the alignment of the face of the release lever plate must be within ·015 in. (·38 mm.) at 1·00 in. (25·4 mm.) radius.

Driven plates

It is important that neither oil nor grease should contact the clutch facings.

Lubrication of the splines of the driven plate is provided at assembly only, when CS881 graphite grease or zinc-based Keenol is used.

It is essential to install a complete driven plate assembly when renewal of the friction surfaces is required. If

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the facings have worn to such an extent as to warrant renewal, then slight wear will have taken place on the splines and also on the torque reaction springs and their seatings. The question of balance and concentricity is also involved. Under no circumstances is it satisfactory to repair or rectify faults in clutch driven plate centres, and we do not countenance this as manufacturers.

Condition of clutch facings in service

It is natural to assume that a rough surface will give a higher frictional value against slipping than a polished one, but this is not necessarily correct. A roughened surface consists of small hills and dales, only the high-spots of which make contact. As the amount of useful friction for the purpose of taking up the drive is dependent upon the area in actual contact, it is obvious that a perfectly smooth face is required to transmit the maximum amount of power for a given surface area. The ideally smooth or polished condition will therefore provide proper surface contact, but a glazed surface entirely alters the frictional value of the facing and will result in excessive clutch clip. These two conditions might be simply illustrated by comparison between a piece of smoothly finished wood and one with a varnished surface; in the former the contact is made directly by the original material, whereas in the latter instance a film of dry varnish is interposed between the contact surfaces and actual contact is made by the varnish.

If the clutch has been in use for some little time under satisfactory conditions the surface of the facings assumes a high polish through which the grain of the material can be seen clearly. This polished facing is of light colour when in perfect condition.

Should oil in small quantities gain access to the clutch and find its way onto the facings, it will be burnt off as a result of the heat generated by the slipping occurring under normal starting conditions. The burning of this small quantity of lubricant has the effect of darkening the facings, but provided the polish of the facing remains such that the grain of the material can be distinguished clearly, it has little effect on clutch performance.

Should increased quantities of oil obtain access to the facing, then one of two conditions, or a combination of these, may arise, depending upon the nature of the oil:

(1) The oil may burn off and leave a carbon deposit on the surface of the facings, which assume a high glaze, producing further slip. This is a very definite, though very thin, deposit, and in general it hides the grain of the material.

(2) The oil may partially burn and leave a resinous deposit on the facings. This has a tendency to produce a fierce clutch, and may also cause excessive 'spinning' due to the tendency of the face of the linings to adhere to the surface of the flywheel or pressure plate.

(3) There may be a combination of conditions (1) and (2) which produce a tendency to 'judder' on clutch engagement.

Still greater quantities of oil produce a dark and soaked appearance of the facings, and the result will be further slip, accompanied by fierceness or 'juddering'.

If the conditions enumerated above are experienced the clutch driven plate should be replaced by a new one. **The cause of the presence of the oil must be traced and removed.** It is, of course, necessary for the clutch and flywheel to be cleaned out thoroughly before reassembly.

Where the release bearing is badly worn in service, either the complete assembly should be renewed or, if the bearing cup is in good condition, a new graphite ring only may be fitted. These graphite rings are inserted into their metal cup by heating the metal cup to a cherry red, then forcing the graphite ring into position. Immediately the ring is forced into position the whole should be quenched in oil. Alignment of the thrust pad in relation to its face and the trunnions should be within ·005 in. (·12 mm.).

In almost every case of rapid wear on the splines of the clutch driven plate misalignment is responsible.

Looseness of the driven plate on the splined shaft results in noticeable backlash in the clutch. Misalignment also puts undue stress on the driven member, and may result in the hub breaking loose from the plate, with consequent total failure of the clutch.

It may also be responsible for a fierce chattering or dragging of the clutch which makes gear changing difficult. In cases of persistent difficulty it is advisable to check the flywheel for truth with a dial indicator. The dial reading should not vary more than ·003 in. (·07 mm.) anywhere on the flywheel face.

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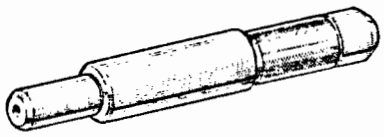
SERVICE TOOLS

18G81. Clutch Centralizer

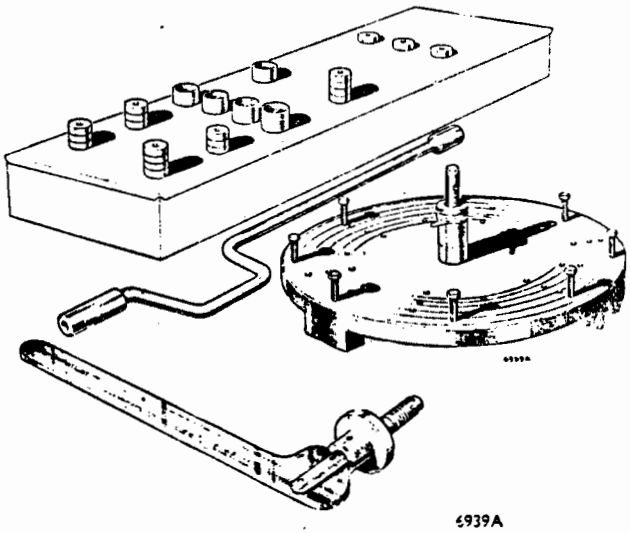


AC790B

18G81

18G99A. Clutch Assembly Gauging Fixture

With the use of this tool a clutch assembly can be quickly dismantled, rebuilt, and finally adjusted with a high degree of accuracy. This is a universal tool for clutch assemblies from 6¼ to 11 in. (158·75 to 279·4 mm.) diameter.



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18G99A

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SECTION F

THE SYNCHROMESH GEARBOX

	Section
General description	
Gearbox	
Assembling	F.7
Dismantling	F.3
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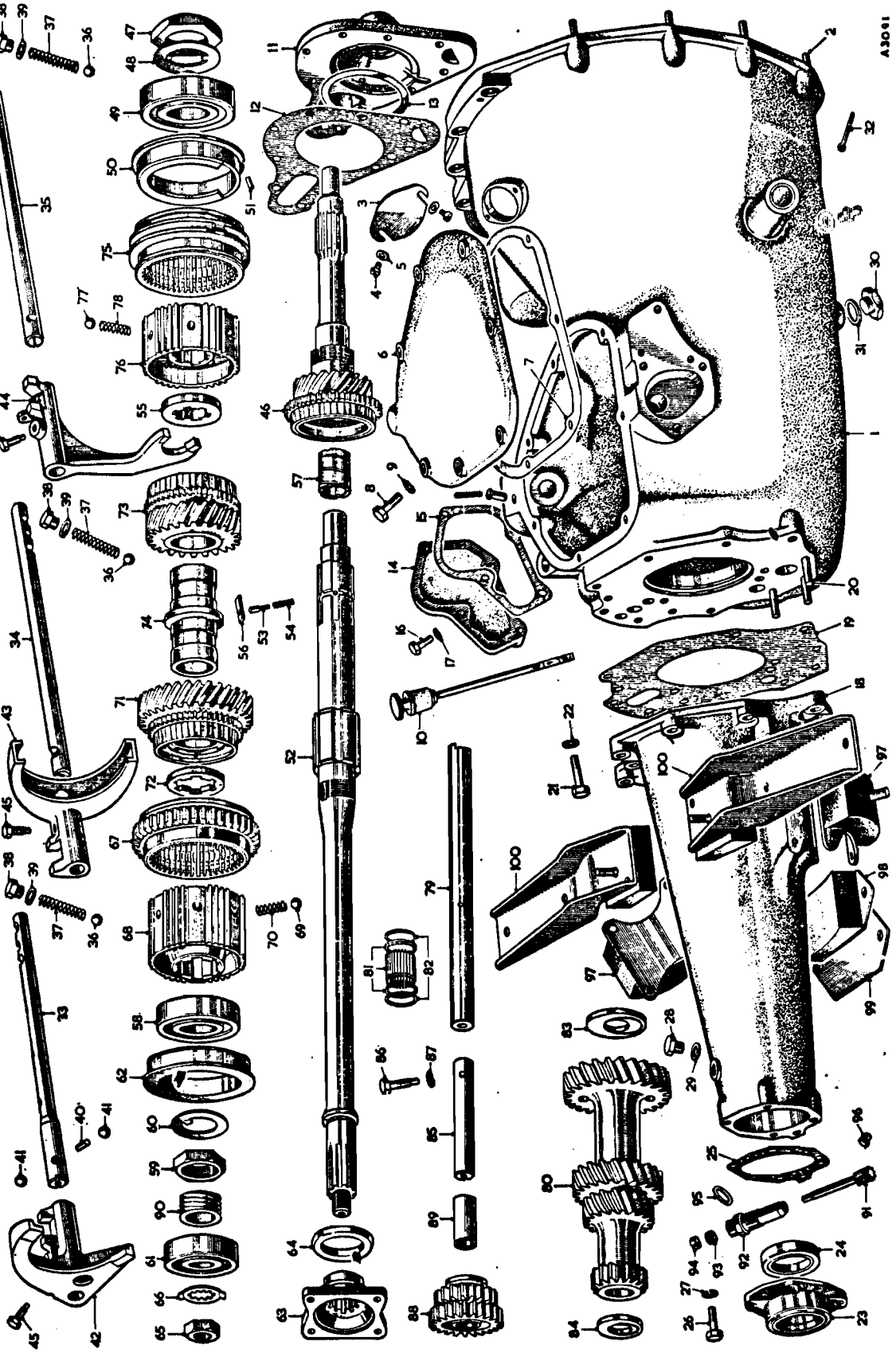
THE GEARBOX COMPONENTS



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KEY TO THE GEARBOX COMPONENTS

No.	Description
1.	Gearbox casing.
2.	Stud to engine plate.
3.	Inspection cover.
4.	Set screw.
5.	Spring washer.
6.	Top cover.
7.	Joint washer.
8.	Set screw.
9.	Spring washer.
10.	Oil dipper rod, cap, and seal.
11.	Front cover.
12.	Joint washer
13.	Shims.
14.	Side cover.
15.	Joint washer.
16.	Set screw.
17.	Spring washer.
18.	Rear cover.
19.	Joint washer.
20.	Studs in box.
21.	Set screws.
22.	Spring washer.
23.	Oil seal housing.
24.	Oil seal.
25.	Joint washer.
26.	Set screw.
27.	Spring washer.
28.	Filler plug.
29.	Fibre washer.
30.	Drain plug.
31.	Fibre washer.
32.	Split pin for clutch drain.
33.	First and second speed fork rod.
34.	Third and fourth speed fork rod.
35.	Reverse fork rod.
36.	Balls for fork rods.
37.	Springs.
38.	Plugs for springs.
39.	Joint washer.
40.	Interlock pin.
41.	Balls for interlock pin
42	First and second speed fork.
43.	Third and fourth speed fork.
44.	Reverse fork.
45.	Locating screws.
46.	First motion shaft with cone and adaptor.
47.	Nut for first motion shaft.
48.	Lock washer.
49.	Ball journal bearing—first motion shaft.
50.	Bearing housing.
51.	Locating peg.
52.	Third motion shaft.
53.	Peg.
54.	Spring.
55.	Thrust washer.
56.	Key.
57.	Bush - front - first to third motion shaft.
58.	Ball journal bearing - centre - third motion shaft.
59.	Nut for centre bearing.
60.	Lock washer.
61.	Ball journal bearing - rear - third motion shaft.
62.	Bearing housing.
63.	Flange—driving.
64.	Shield—flange.
65.	Nut.
66.	Lock washer.
67.	First speed wheel.
68.	Second speed synchronizer.
69.	Ball.
70.	Spring.
71.	Second speed gear.
72.	Thrust washer.
73.	Third speed gear.
74.	Sleeve.
75.	Third and fourth speed coupling sleeve.
76.	Synchronizer.
77.	Ball.
78.	Spring.
79.	Layshaft.
80.	Laygear.
81.	Needle-roller bearings.
82.	Spring rings.
83.	Thrust washer (front).
84.	Thrust washer (rear).
85.	Reverse shaft.
86.	Locking screw.
87.	Spring washer.
88.	Reverse wheel.
89.	Bush - reverse wheel.
90.	Speedometer wheel.
91.	Speedometer pinion.
92.	Bush - pinion.
93.	Oil seal.
94.	Retainer ring.
95.	Joint washer for bush.
96.	Thrust button.
97.	Rubber mounting.
98.	Lower buffer.
99.	Shims - buffer.
100.	Rebound rubber with bracket.

GENERAL DESCRIPTION

The gearbox provides four forward speeds and one reverse, with synchromesh on second, third, and top gears. Reverse gear is provided with a spring-loaded stop as a safety device against inadvertent engagement.

Engagement of the gears is effected by a short movement of a lever mounted on the steering-column.

The transmission mainshaft is extended in a housing which permits the use of a short propeller shaft and provides additional mainshaft bearings to give firmer positioning of the gears.

Section F.1

REMOVING AND REPLACING THE GEARBOX

Position the car over an inspection pit or, alternatively, raise the car completely on trestles placed beneath each wheel to provide adequate clearance for working.

Drain the oil from the gearbox whilst it is still warm.

Disconnect the cables from the battery terminals.

Unclip and fold back the carpet. Extract the 12 set screws securing the section of floorboard over the gearbox.

Release the exhaust flange coupling from the manifold and completely remove the section of the exhaust pipe from the car (see Section A.34).

The front propeller shaft must be disconnected from the gearbox flange and the rear propeller shaft from the centre bearing flange. Remove the front shaft and centre bearing from the car as described in Section G.

Unscrew the speedometer cable from its union in the rear cover.

Disconnect the gear engagement and gear selector operating rods from their respective levers on the gearbox.

Remove the nut and tap out the cotter pin securing the engagement lever on the gearbox shaft.

Unscrew and remove the nut and spring washer securing the clutch operating and adjustment lever to the clutch operating shaft.

Disconnect the two cables from the reversing light switch on the left-hand side of the gearbox and unclip the cable from the chassis cross-member which carries the gearbox rear mountings. Unscrew the four nuts and remove the washers from the bolts which hold the cross-member at each side to the main chassis frame.

Remove the nuts and withdraw the two long bolts passing through the cross-member and which hold one end of the bracket carrying the brake master cylinder.

Position a heavy-duty hydraulic jack beneath the engine sump as near as possible to the clutch bell housing and interpose a piece of wood between the jack and the sump. Raise the jack sufficiently to take the weight of the gearbox and engine.

Remove the four set screws securing the gearbox rubber mountings on each side. Above these mountings on each side is a bracket carrying a rubber buffer. Release each bracket from the chassis cross-member by extracting the two securing nuts and bolts.

Raise the jack slightly to take the weight of the gearbox off the rear mountings. Remove the bolts holding the chassis cross-member in position and withdraw the cross-member.

From around the bell housing unscrew and remove the eight nuts and spring washers from their respective studs, the two set bolts at the top and also the one remaining nut and bolt on the near side. The crankcase breather pipe will now be found to be free at its rear end.

Pass a double rope sling around the gearbox, spread out to balance the load. With an operator within the car to take the weight of the gearbox on the rope, ease the gearbox rearwards clear of the engine, taking care not to throw any strain on the mainshaft. Lower the gearbox to the floor.

Where a left-hand-drive model is concerned, the mounting bracket which carries the brake pedal master cylinder must be dismantled.

Before replacing the gearbox, which is a reversal of the above procedure, check that the clutch driven plate is centralized, using tool 18G81.

Section F.2

GEAR CHANGE CROSS-SHAFT AND CONTROL BOX

To dismantle the control box and cross-shaft, remove the engagement lever from the cross-shaft by removing the cotter pin. The cross-shaft may then be withdrawn from the housing. Remove the rubber washer from each side of the selector collar on the control shaft. The collar is secured to the shaft by a tapered pin which must be driven out if it is required to renew the collar.

Drive out the tapered pin from the outer selector lever and withdraw the lever. Turn the inner selector lever to gain access to the small end of the securing taper pin, drive out the taper pin, and withdraw the short shaft and inner selector lever.

With the shafts and levers withdrawn, the two oil seals may be removed should they require replacement.

To reassemble the control box enter the cross-shaft into the gearbox from the left-hand side, ensuring that the two rubber washers are in position on either side of the selector collar. Slide the inner change speed lever onto the shaft with its locking tab boss towards the rear of the gearbox. Secure the lever to the shaft with a cotter pin, tighten the nut, and bend over the locking tab.

Slide the control box joint gasket over the cross-shaft and assemble the control box to the gearbox by turning the assembly until the 'T'-piece on the inner selector lever can be engaged in the cross-shaft collar. Align the bolt holes and secure the assembly with four bolts.

Fit the outer change speed lever and secure on the shaft with a cotter pin, nut, and washer.

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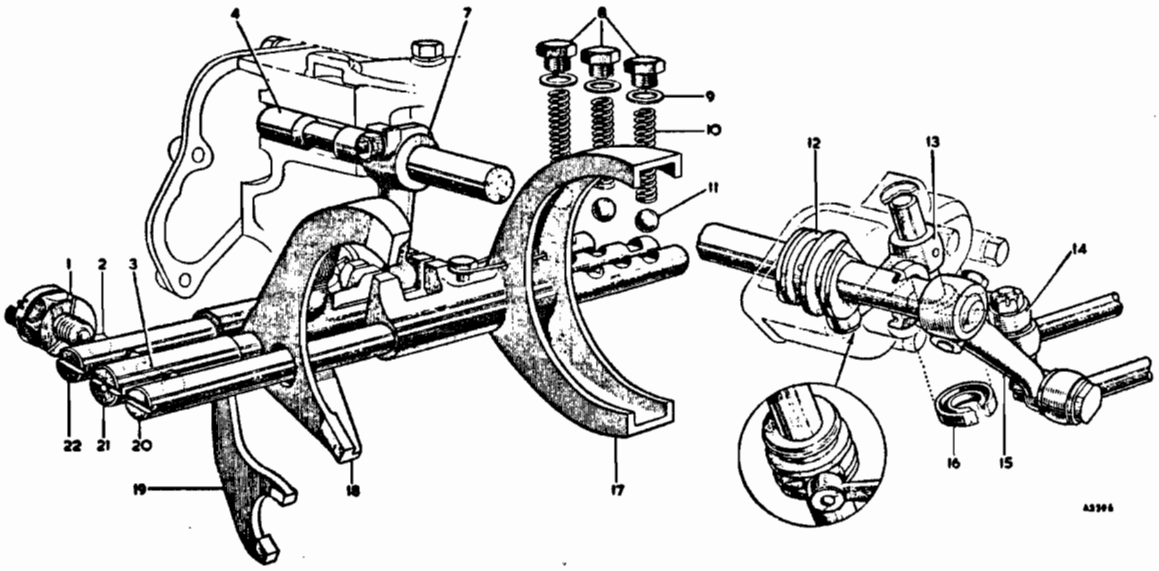

Fig. F.1

The selector forks, rods, and cross-shaft assemblies

1. Reverse light switch.
2. Fork rod locating ball.
3. Interlock pin.
4. Cross-shaft.
7. Change speed operating lever.
8. Cap bolts.
9. Washers.
10. Springs.
11. Selector locking balls.
12. Selector collar.
13. Selector lever (inner).
14. Selector lever (outer).
15. Engagement lever.
16. Oil seal.
17. Third and fourth selector fork.
18. First and second selector fork.
19. Reverse gear fork.
20. Third and fourth fork rod.
21. First and second fork rod.
22. Reverse fork rod.

Section F.3

DISMANTLING THE GEARBOX

If the gearbox has not been drained of oil, remove the plug situated beneath the box on the left-hand side and allow the oil to drain into a clean container.

Remove the retaining springs securing the release bearing and cup to the clutch operating shaft fork. Remove the nut and spring washer from the cotter pin securing the clutch fork to the cross-shaft. Tap out the cotter pin, having first placed a support behind the fork to prevent the shaft from springing. Withdraw the clutch shaft from the housing. The circlip and washer on the left-hand side of the shaft may be left in position.

The front cover is secured in the clutch bell housing by eight set bolts and two nuts. With these nuts and bolts released and the washers removed, ease off the front cover, taking care not to damage the joint washer. Remove the front cover shims.

From the top of the gearbox remove the seven set bolts and spring washers securing the top cover-plate in position and remove the cover, taking care again not to damage the joint washer.

Knock back the tab washer and slacken, but do not entirely remove, the nut from the cotter pin securing the change speed operating lever to the cross-shaft. (Remove the nut once the pin has been tapped free.) To facilitate the removal of the cotter pin from the operating lever engage third gear and tap the cotter pin from the lever.

Remove the gear change control box secured to the right-hand side of the gearbox by four set bolts and washers.

Knock back the locking tabs securing the driving flange nut.

With the aid of propeller shaft flange wrench 18G34A to hold the flange, unscrew the retaining nut. Withdraw the flange from the splines of the mainshaft. If difficulty is experienced a few gentle taps with a hide mallet will free the flange.

Remove the rear extension as described in Section F.4.

Withdraw the speedometer wheel from the shaft.

On the left-hand side of the gearbox, forward of the top cover opening, there are three cap nuts screwed into the casing, each retaining a spring and a steel ball. Remove the cap nuts, washers, and springs, leaving the steel balls to be withdrawn through the gearbox once the fork rods have been withdrawn.

Cut the locking wire and remove the set pins securing each fork to its respective rod. Withdraw the set pins.

From the rear of the gearbox, on the left-hand side, unscrew the reversing light switch. Also remove the steel ball fitted between the reverse light switch and the reverse fork shaft.

From the front of the gearbox, using a long suitable drift, tap the third and fourth speed fork shaft out through the rear of the casing. In a similar manner drive the first and second, and then the reverse, speed fork shafts from place.

Fitted between the reverse fork shaft and the first and second and the third and fourth fork shafts is a steel ball. A distance peg passing through the first and second speed

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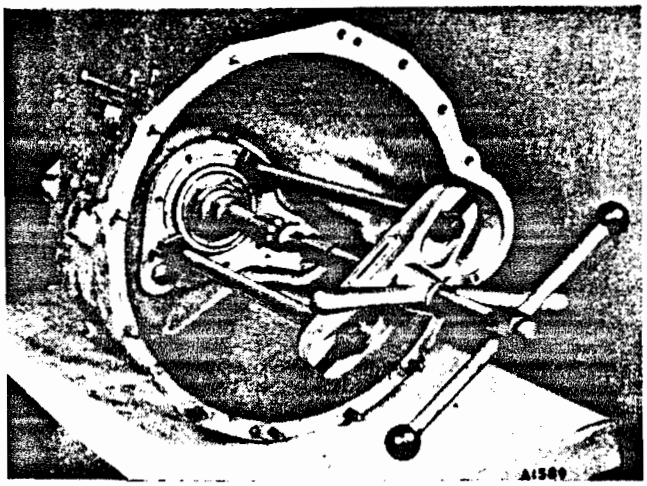

Fig. F.2
Removing the first motion shaft with Service tool 18G83

fork shaft keeps the two inner steel balls in position. These balls are retrieved once the fork rods are withdrawn from the box.

Lift each of three selector forks from out of the gearbox.

The layshaft should be tapped out from the rear, using a suitable soft drift, and extracted from the front of the gearbox case. The lay gears will fall to the bottom of the box, out of mesh, and may be retrieved later when the third motion shaft gears have been withdrawn.

Screw the threaded portion of remover 18G83 into the internal thread of the forward end of the first motion shaft (Fig. F.2). Screw in the handle of the remover until the first motion shaft complete with gears can be pulled through the gearbox front face.

With the aid of remover 18G84 (Fig. F.3), withdraw the third motion shaft rearwards until the bearing and housing are free from the gearbox. Wedge the bearing housing against the rear face of the gearbox and carefully drive the third motion shaft forward until the shaft and bearing are free of the bearing housing. Remove the bearing housing.

The third motion shaft complete with gears may now be tilted at its front end and manœuvred through the top opening of the gearbox.

The reverse gear shaft is secured in position by a locking screw, the head of which is accessible from beneath the gearbox casing on the left-hand side. Extract the locking screw and spring washer (plain copper washer on later cars), tap the reverse gear shaft free from the supporting lugs, and lift the gears from the box.

Section F.4

DISMANTLING AND REASSEMBLING THE REAR EXTENSION

Screw out the speedometer bush and pinion complete. Within the top of this bush there is an oil seal retained in place by a spring clip (see page F.2).

Remove the nine set bolts and three nuts securing the rear extension casing to main gearbox. Withdraw the casing from the main gearbox, carefully threading it over the mainshaft. If the casing adheres to the box, a gentle tap with a hide hammer should assist the removal. Take off the paper joint.

If necessary, the end cap of the rear extension can be dismantled by the withdrawal of four set bolts. The rear bearing can be tapped out and the oil seal extracted from the end cap.

Attach the paper joint washer to the face of the rear extension with a smear of grease, and pass the rear extension, complete with ball race, oil seal, and end cap, over the third motion shaft and lightly secure it to the end of the gearbox by nine set bolts and three nuts.

Slide the driving flange and dust cover over the splines on the end of the shaft, fit the lock washer, and securely tighten the nut, using wrench 18G33 to hold the flange. Knock the lock washer tabs over the nut flats. Tightening this nut before pulling up tight the rear end cover securing bolts ensures good alignment of the third motion shaft and gears. Securely tighten the rear end cover nuts and set bolts.

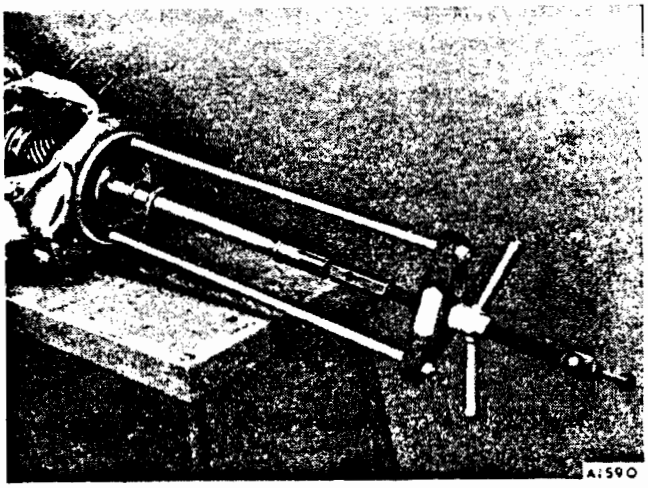

Fig. F.3
Using Service tool 18G84 *to withdraw the third motion shaft assembly*

The speedometer drive assembly, complete with oil seal and retaining spring clip, may now be screwed into position. On top of the rear cover there is a plug. This plug blanks off a priming hole through which oil should be fed to the speedometer wheel after the gearbox has been reassembled.

Section F.5

DISMANTLING AND REASSEMBLING THE THIRD MOTION SHAFT

To strip the gears from the shaft hold the shaft firmly in a vice with soft jaws, knock back the locking tab and unscrew the bearing retaining nut.

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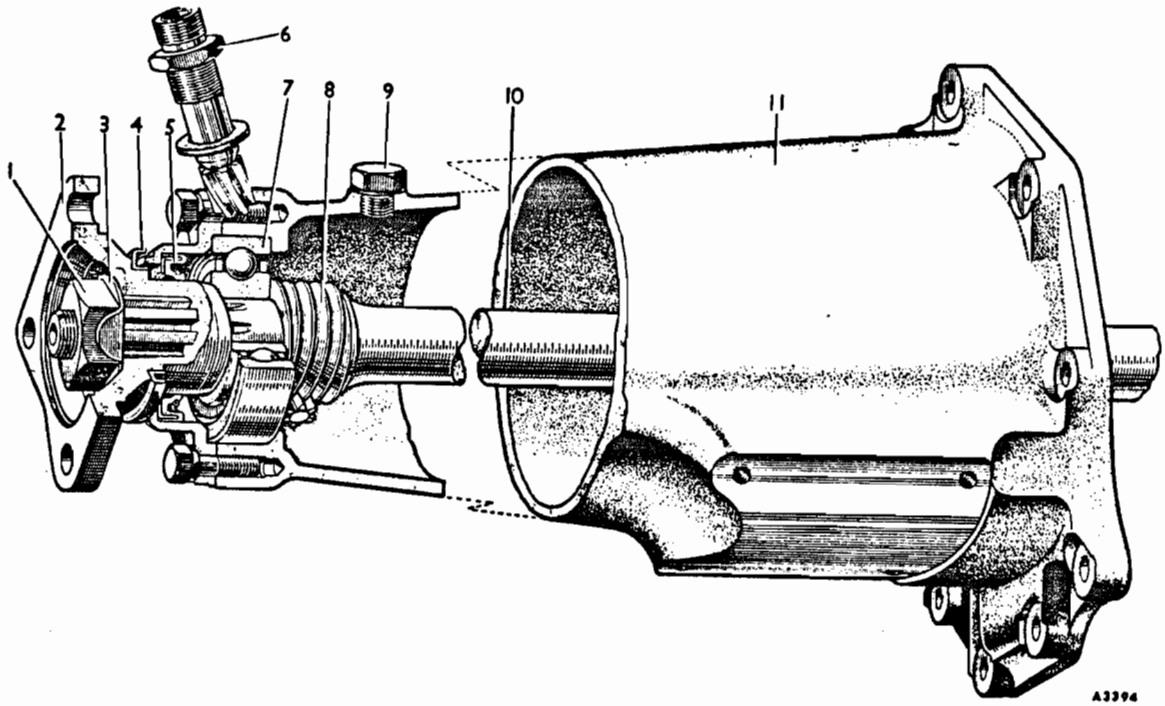

Fig. F.4

A cut-away view of the rear extension

1. Flange nut.
2. Driving flange.
3. Lock washer.
4. Shield.
5. Oil seal.
6. Speedometer pinion assembly.
7. Rear bearing.
8. Speedometer wheel.
9. Filler plug.
10. Third motion shaft.
11. Rear extension.

Drive or press the bearing from the shaft.

Withdraw the third and fourth gear synchronizer assembly.

Depress the spring-loaded plunger and remove the locking plate (see Fig. F.5) retaining the splined thrust washer on the forward end of the shaft. Still depressing the plunger, turn the thrust washer into line with the splines of the shaft and remove the thrust washer from the shaft.

Lift out the plunger and spring.

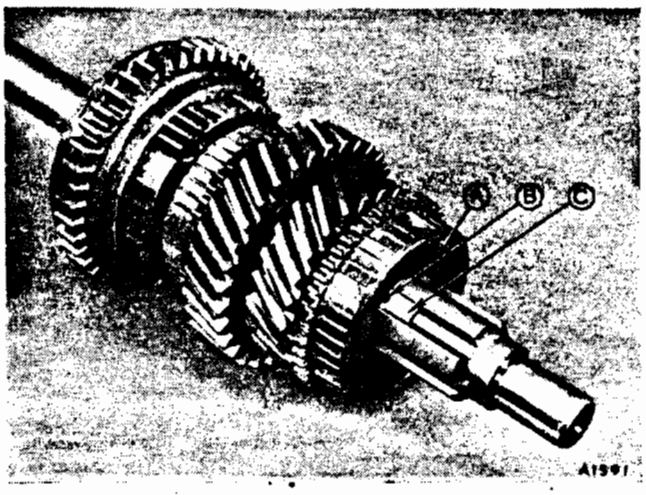

Fig. F.5

The third motion shaft gear assembly

A. Thrust washer. B. Spring-loaded plunger. C. Locking plate.

Withdraw the third and second speed constant mesh gears, together with the phosphor-bronze coupling sleeve from the shaft.

Remove the splined thrust washer separating the second speed constant mesh gear from the first gear unit and then slide the first gear assembly from the third motion shaft.

Should it be necessary to dismantle the synchronizer assembly further, the use of synchronizer unit assembly ring 18G73 will greatly facilitate the removal of the balls and springs.

Reassembly of the third motion shaft is a reversal of the dismantling procedure but note the following.

During manufacture, both the first speed gear and the third and fourth speed coupling sleeves are each paired with their respective synchronizers. Only mated pairs of these parts should therefore be refitted.

With the aid of synchromesh unit assembly ring 18G73 assemble the mated synchronizer and sleeve by rotating the synchronizer within the assembly ring until all the springs and balls have been inserted (see Fig. F.6). After fitting the balls and springs carefully slide the synchronizer sleeve (in the case of the third and fourth speed synchronizer) or the first gear ring (in the case of the second speed synchronizer) over the splines, at the same time withdrawing the assembly ring.

As the coupling sleeve or ring replaces the guide the balls find their correct location in the sleeve groove.

To facilitate assembling the splined thrust washer over the spring-loaded locking plunger, use a short piece of stiff wire bent a sufficient amount to allow the plunger

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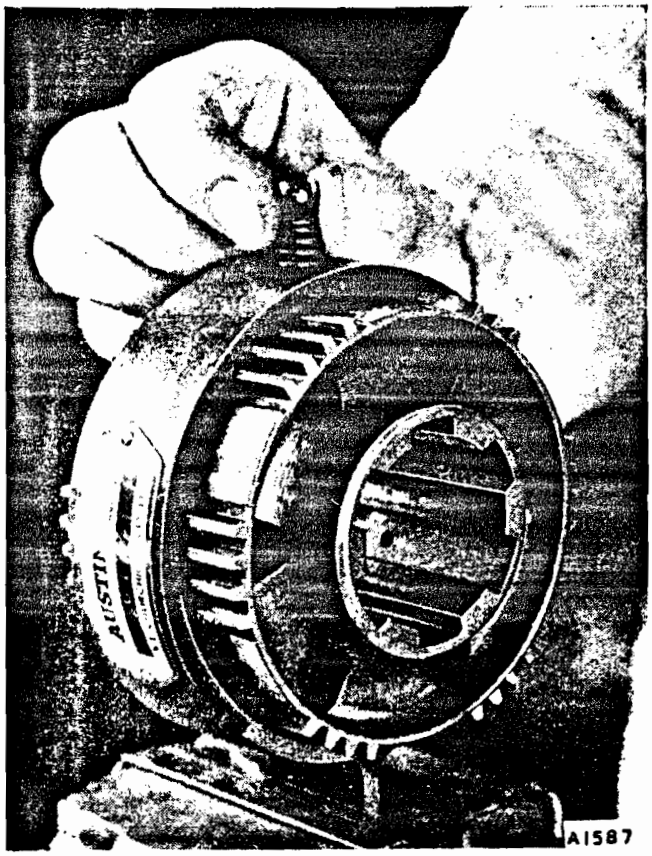

Fig. F.6

Fitting a ball and spring to the synchronizer assembly with the aid of assembly ring 18G73

to be depressed while the thrust washer is passed over. Turn the thrust washer until its splines are out of alignment with those on the shaft, again depress the plunger, and fit the small locking plate (see Fig. F.5).

Section F.6

DISMANTLING AND REASSEMBLING THE FIRST MOTION SHAFT

To remove the bearing from the first motion shaft knock back the locking tab and unscrew the shaft nut, using spanner 18G77, but note that the nut has a left-hand thread. Press or drive the bearing from the shaft.

Reassembly is a reversal of the above procedure. Tighten the bearing nut securely and knock over the locking tab.

Section F.7

ASSEMBLING THE GEARBOX

Before commencing the assembly of the gearbox ensure that all parts are perfectly clean. If a new gearbox casing is being used wash the casing thoroughly in paraffin (kerosene) to remove any traces of metal. Remove also any traces of burring from both internal and external surfaces.

Liberally coat all parts with oil as they are assembled.

Fit the reverse gears into the gearbox with the large gear to the front. Oil the reverse gear shaft and insert it into position in the box, securing it with the locating bolt and spring (on later cars, copper) washer.

Next, assemble the lay gears. Place the largest of the two thrust washers in position in the front of the gearbox and then place the gear cluster in the box. Fit the remaining thrust washer and then pass dummy layshaft 18G72 through the gearbox, which will align the gears and thrust washers, permitting the temporary fitting of the lay gear shaft.

An end-float of between ·001 and ·003 in. (·025 and ·076 mm.) must exist in the layshaft gear cluster. If the end-float exceeds this tolerance, which may be checked by the use of a dial gauge, the thrust washer must be renewed. The smaller thrust washer positioned at the rear is made in three thicknesses from ·216 to ·226 in. (5·48 to 5·74 mm.) in steps of ·002 in. (·051 mm.) to allow the correct end-float to be obtained.

After obtaining the correct end-float the lay gear shaft must be removed and replaced by dummy layshaft 18G72, which will hold the lay gears and thrust washers at a low level in the box to permit the reassembly of the remainder of the gearbox.

Fit the third motion shaft complete with gears by passing the assembly through the top of the gearbox, leading the extended shaft through the rear opening.

Whilst the shaft is supported pass the rear bearing over it from the rear end. Drive the bearing into position, using replacer 18G88 to ensure even location.

Fit the nut and lock washer over the shaft but do not tighten it until the remaining gears have been fitted. Tap into place the speedometer wheel.

Locate the third motion shaft bearing bush in the end of the first motion shaft. Position the first motion shaft, complete with gears and bearings, through the front of the gearbox. Align the cut-away portion in the bearing

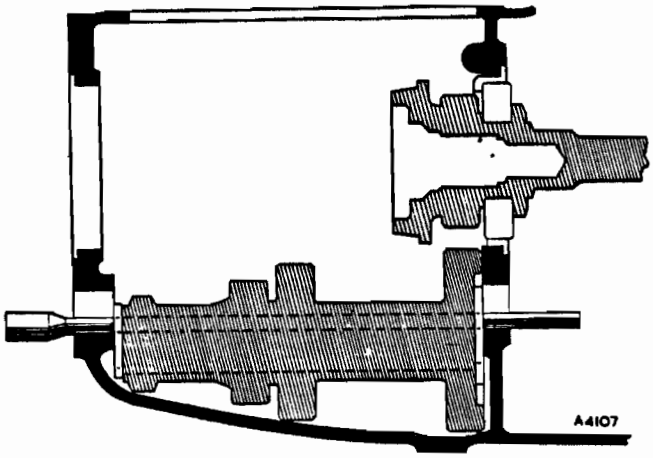

Fig. F.7

The lay gears and thrust washers must be held at a low level in the box to permit assembly of the third motion shaft. Use dummy layshaft 18G72 *for this purpose*

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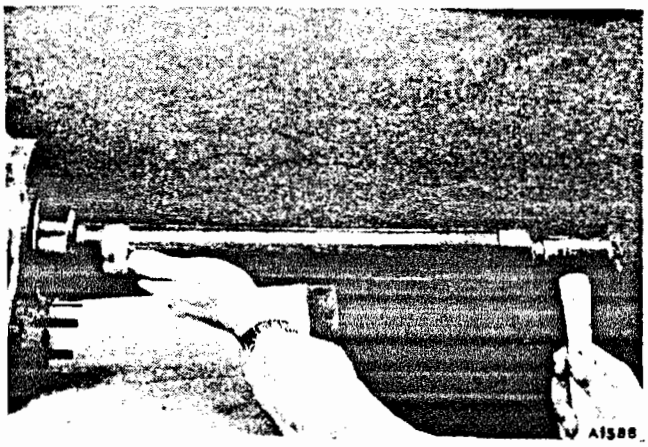

Fig. F.8
Using third motion shaft bearing replacer 18G88

housing with the dowel in the gearbox front face and use replacer 18G91 to drive the shaft and bearing into position.

Support the weight of the gears and drive the dummy layshaft through the box, closely followed by the layshaft proper. The end of the layshaft with the flat portion is fitted to the front of the gearbox. This flat portion must be aligned to fit a 'D'-shaped recess in the front cover.

The selector forks and rods should be fitted, but first of all ensure that the gears are in neutral and try each fork rod in the gearbox for freedom of movement.

Place the speed forks into place in the gearbox: reverse first, then first and second, and lastly third and fourth. Pass the third and fourth speed fork rod into its appropriate hole in the gearbox rear face and through its relative fork. Follow this by placing a steel ball in position and push home through the rear gearbox face and relative fork the first and second speed fork rod. This rod has an interlocking pin fitted in its rear end. Place a second steel ball through the side orifice and enter the reverse fork rod through the gearbox and fork.

The final steel ball which operates the reverse light switch should now be fitted and retained in position by fitting the reverse light switch.

Assemble to the front end of each fork rod a steel ball, spring, and cap nut. Tighten each cap nut.

Secure each fork to its rod by the spigoted set pin. A slot is provided in the rear end of each rod to enable them to be aligned with the holes in the fork. After tightening each fork set pin lock it in position with soft-iron wire.

Place the original shims in the bearing recess in the front cover, fit the joint washer, and secure the cover in position with the eight set bolts, two nuts, and spring washers.

If new gears or bearings have been fitted in the gearbox it is necessary to check, with the aid of a dial gauge, the amount the first motion shaft bearing protrudes from the front face of the gearbox. Before this procedure is carried out ensure that the bearing and bearing housing are fitted as tightly as possible into the gearbox front face.

Measure the depth of the bearing recess in the front cover. With a micrometer measure the thickness of the old joint gasket if available; if not, fit and tighten down the front cover with a new paper joint gasket in position to compress it, take off the front cover, remove the gasket, and measure its thickness. Add the thickness of the joint washer to the depth of the cover recess and subtract the amount by which the bearing protrudes from the casing. The result gives the thickness of the washer required.

Washers ·002 and ·004 in. (·051 and ·102 mm.) thick are available and it is advisable to use the least number possible to arrive at the correct thickness.

Note that a 'D'-shaped recess in the front cover fits over the end of the layshaft to prevent the shaft turning.

With the cover in position with its paper joint the bearing must be clamped without end-float, but care must be taken to make an oiltight joint.

Tighten the eight securing set bolts and two nuts evenly by diametrical selection.

Tighten the centre bearing retaining nut and securely lock in position with the tab washer.

To reassemble the rear extension see Section F.4.

Secure the side cover and paper joint washer to the gearbox by means of its four set bolts and washers.

Place the top cover joint washer in position and securely tighten the top cover with the seven securing set bolts.

Fit the clutch operating shaft, but first ensure that the circlip and washer are in place on the left-hand side of the shaft. Enter the shaft into the bushed hole on the left-hand side of the bell housing. Within the bell housing thread the clutch operating fork complete with carbon thrust ring over the shaft. Pass the shaft through the bushed hole on the right-hand side of the housing.

Lock the fork to the shaft by tapping in the cotter pin and secure in position with the nut and spring washer.

On the outside of the housing, on the right-hand side, fit the lower lever over the two flats of the shaft and then push on the upper lever; this should be a tight fit over the shaft. Fit the adjusting bolt through the elongated hole of the lower lever and the plain hole of the upper lever. The head of the bolt must be on the gearbox side. Fit the nut and washer to the bolt. Finally, place the plain nut and spring washer over the end of the operating shaft and lock up tight.

Final clutch adjustment must be made after the gearbox has been refitted to the vehicle and the pedal linkage is connected up.

Section F.8

GEAR CHANGE ADJUSTMENT

Correct gear selection and engagement is controlled by the length of the two rods connecting the selector levers on the gearbox to the operating levers of the gear change mechanism.

Each rod consists of two sections threaded R.H. and L.H. respectively. Each pair of sections is connected by a long adjusting nut which is locked in position with a locking nut at either end.

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The rod nearest to the engine controls selection, and the outer rod controls engagement.

Set the gear change lever in the neutral position. When viewed from the driver's seat, the lever should be approximately 30° above the horizontal. If this position is not correct, adjust the length of the outer control rod by means of its adjusting nut as necessary. Turn the adjusting nut clockwise (when viewed from the front of the car) to lower the lever, and anti-clockwise to raise it.

To adjust the inner (selection) rod correctly, slacken the lock nuts and turn the adjusting nuts on the inner rod anti-clockwise until the gearbox cross-shaft has moved outwards to its fullest extent.

Engage first gear and then screw the adjusting nut clockwise until by engaging and disengaging first gear it can be felt at the gear lever that the selector in the gearbox is just fouling the reverse selector.

When this point has been reached, screw back the adjusting nut three flats anti-clockwise.

Check all selector positions and tighten the lock nuts.

The adjustment of the selector rod is very critical, and it may be found more satisfactory to remove the floor cover over the gearbox, and detach the gearbox top cover. The effect of the adjustment on the inner control rod can then be easily seen, and the correct setting of the selector more readily obtained.

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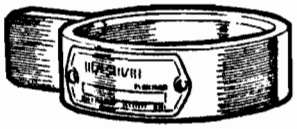
SERVICE TOOLS

18G72

18G72. Dummy Layshaft

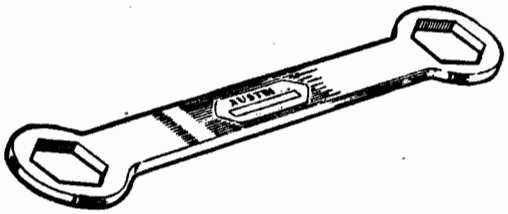
A pilot for lining up the gears and retaining the thrust washers in position prior to inserting the layshaft proper, it being necessary to drop the laygear for the first motion shaft to be inserted.



18G73

18G73. Synchromesh Unit Assembly Ring

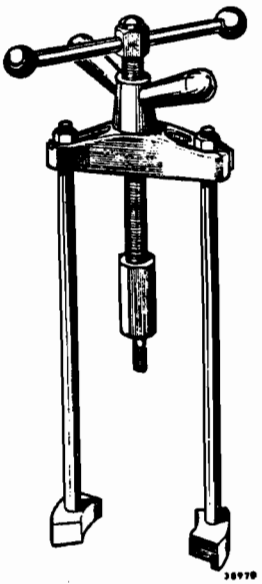
Designed to facilitate the assembly of mated synchronizer and sleeve by enabling the springs and balls to be inserted quickly and easily.



18G77

18G77. First Motion Shaft Nut Spanner

This sturdy spanner provides ample leverage to move the tightest nut.



18G83

18G83. First Motion Shaft Remover

This tool enables the first motion shaft to be withdrawn easily and without any possible damage to the gears. Improvised drifts should not be used for this operation.

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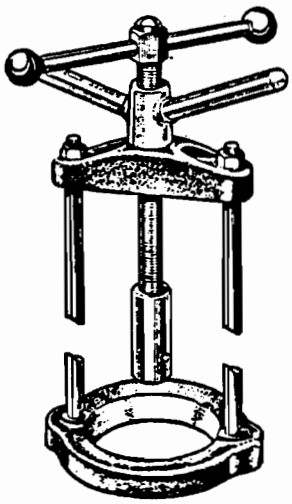
18G84. Third Motion Shaft Remover

This tool enables the third motion shaft to be withdrawn easily and without any possible damage to the gears. Improvised drifts should not be used.

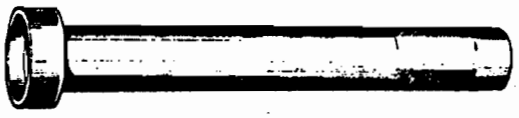


9230

18G84

18G88. Third Motion Shaft Assembly Replacer

The inside of the replacer is machined to suit the different diameters of the shaft so that the shaft will pilot in the tool and ensure that the bearing is located squarely in the gearbox case.

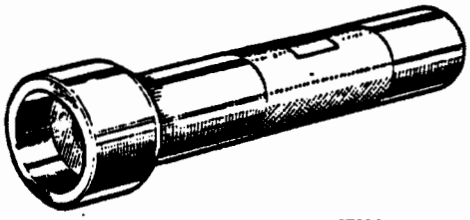


9213

18G88

18G91. First Motion Shaft Assembly Replacer

The use of this replacer will obviate the possibility of damage to the first motion shaft bearing and housing, ensuring their correct location in the gearbox housing.



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18G91

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SECTION FF

THE AUTOMATIC GEARBOX

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Section FF.1

INTRODUCTION

The fully automatic gearbox combines epicyclic gear trains, a fluid coupling, and a control valve unit that will select the correct gear for all varying road speeds and road conditions.

All gear changes are made automatically, there being no requirement for any assistance from the driver.

Four forward gears and a reverse are provided by the epicyclic gear trains, and the gear changes are so controlled as to give continuous drive to the road wheels during the changes.

However, to suit individual driving techniques, the driver is given a certain amount of control over the gear changing by means of a selector lever and quadrant mounted on the steering-column (see Fig. FF.1).

The quadrant is marked, giving the five possible positions for the selector lever, which is in turn connected by a series of rods and levers to a selector valve in the gearbox.

The markings on the selector quadrant correspond to the drive ranges and are 'N', '4', '3', '2', and 'R'.

To prevent the selector lever being incorrectly positioned a gate is provided between positions '2' and '3'. To select neutral 'N' and reverse 'R' the knob of the selector lever must be pulled out.

A further safety factor is the fitting of a micro switch to the selector linkage which breaks the starter motor circuit except when the selector lever is in the neutral position. The other micro switch that is fitted operates the reversing light.

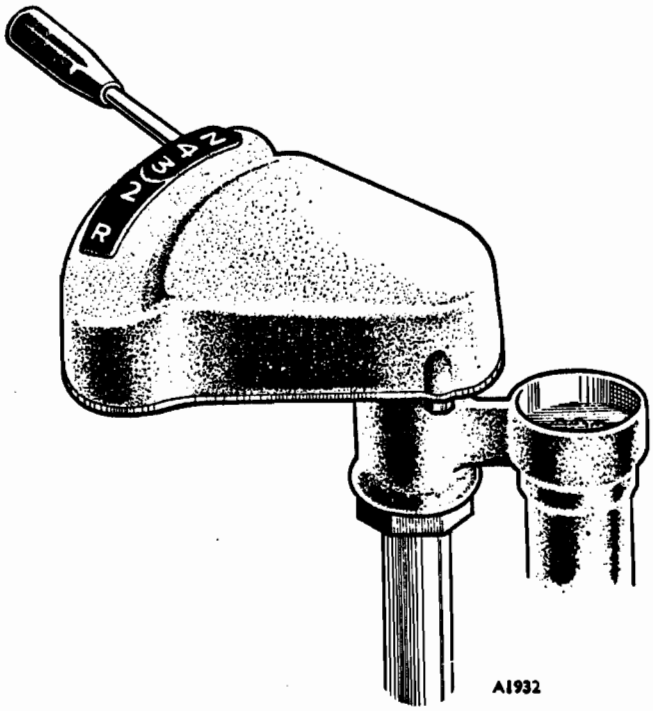

Fig. FF.1

The positions of the selector lever

The normal driving position is **range 4.** With the lever in this position all changes are fully automatic and the gearbox will select the appropriate gear for the road speed and throttle opening, changing up or down as necessary.

At light throttle opening the control will change from first to second gear at 5 m.p.h. (8 km.p.h.), from second to third gear at 9 m.p.h. (14 km.p.h.), and from third to top gear at 16 m.p.h. (25 km.p.h.). Greater acceleration will cause the up changes to occur at progressively higher speeds, until at full throttle the gearbox will change from first to second gear at 13 m.p.h. (21 km.p.h.), from second to third gear at 24 m.p.h. (38 km.p.h.), and from third to top gear at 51 m.p.h. (82 km.p.h.).

It will be appreciated that all road speed figures quoted are approximate and will vary with individual gearboxes about plus or minus 2 m.p.h. (3 km.p.h.).

Kick-down

If the need for sudden acceleration arises, the accelerator pedal may be pushed hard down beyond its normal travel when, provided the road speed is between 5 and 51 m.p.h. (8 and 82 km.p.h.), the gearbox will change down to a lower gear and remain in the lower gear until the accelerator pedal is released.

Range 3

This is known as the performance range. With the selector lever in this position the gearbox will change normally up to third gear, but will remain in third gear until approximately 51 m.p.h. (82 km.p.h.); above this speed top gear will be engaged.

This range is most useful for maximum acceleration at high speeds and when travelling in hilly country. To prevent over-revving of the engine a safety valve is incorporated in the control valve unit which will prevent range 3 engagement at speeds over 51 m.p.h. (82 km.p.h.).

Range 2

A fixed second gear. With the selector lever in this position the gearbox will not change up or down. The primary purpose of this range is for descending very steep hills, but its use will also be apparent under extremely icy conditions.

As stated above, the gearbox will not change gear automatically up or down in this range. It is possible, however, to engage first gear by kicking down.

It is emphasized that in ranges 4, 3, and 2 the drive is engaged, but at low throttle openings the car will remain stationary, when the hand brake is on, due to the slip in the fluid coupling. When the hand brake is released and the engine accelerated the car will move off, and in the case of ranges 4 and 3 change up automatically as the road speed increases.

Reverse (R)

It will be found possible to engage reverse when the car is moving forward at speeds of up to 10 m.p.h. (16 km.p.h.). This characteristic may be of use in an emergency but exerts great stress on the transmission

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and therefore should only be used as stated, **in an emergency.** A positive parking lock will operate when reverse is selected with the engine switched off. This is effected by a pawl on the gearbox casing engaging with teeth on the reverse annulus gear. A blocker, operated by oil pressure, prevents the engagement of this pawl when the engine is running.

Section FF.2

PRINCIPLES OF OPERATION

Mechanical layout and ratios

Varying combinations of two epicyclic gear trains, which are in series, provide the four forward speeds. Both gear trains are capable of direct drive (1 : 1); the front unit will also give a reduction of 1·45 : 1, the rear unit a reduction of 2·63 : 1.

The selection of required gears is effected by means of friction bands and clutches actuated by hydraulically operated servos and pistons which act directly on the bands and clutch plates.

With the clutches disengaged and the bands holding the drums stationary, the epicyclic gears are in reduction.

When the bands are released and the clutches are engaged two elements of the epicyclic gear trains are locked together to give a direct drive through the unit.

First gear

Both bands are applied, which means that both units are in reduction, giving a first gear ratio of 3·82 : 1.

Second gear

The front unit band is released and the multiplate clutch is applied, so that the front unit is now in direct drive and the rear unit in reduction. The second gear ratio is therefore 2·63 : 1.

Third gear

This gear is a complete reversal of second gear; that is, the front unit is now put back into reduction—band on, clutch off. The rear unit is put into direct drive—band off, clutch on—giving a third gear ratio of 1·45 : 1.

Fourth gear

The front unit is again put into direct drive and this, together with the rear unit, which is already in direct drive, gives the 1 : 1 top gear ratio.

Reverse gear

To obtain reverse another gear train is introduced which works in conjunction with the rear unit. This reverse unit idles in all forward gears and gives a further reduction, the reverse gear ratio being 4·3 : 1.

IMPORTANT.—Do not under any circumstances attempt to coast with the engine switched off.

Fluid coupling

To achieve smooth gear changes a fluid coupling is used. This comprises two identical torus members, splined to different but concentric shafts and mounted facing each other in an oil-filled chamber which is formed by the flywheel and a torus cover (see Fig. FF.2).

The higher the speed of the driving torus member the greater is the force exerted by the oil on the vanes of the driven member.

From 0 to 300 r.p.m. the fluid coupling is virtually inoperative and no appreciable power is transmitted to the driven member.

From 300 to 1,000 r.p.m. the coupling transmits power with increasing efficiency.

Above 1,000 r.p.m. the coupling forms an efficient connection between engine and gearbox.

This ensures that, when starting from rest, the drive is taken up smoothly and at higher speeds power losses are reduced to a minimum.

BAND AND CLUTCH CONDITIONS

Gear	*Front unit*		*Rear unit*		*Reverse unit*
	Band	*Clutch*	*Band*	*Clutch*	*Cone clutch*
Neutral, engine off ..	OFF	OFF	ON	OFF	OFF
Neutral, engine running	OFF	OFF	OFF	OFF	OFF
First gear	ON	OFF	ON	OFF	OFF
Second gear	OFF	ON	ON	OFF	OFF
Third gear	ON	OFF	OFF	ON	OFF
Top gear	OFF	ON	OFF	ON	OFF
Reverse	ON	OFF	OFF	OFF	ON
Reverse, engine off ..	OFF	OFF	ON	OFF	OFF, PAWL ENGAGED

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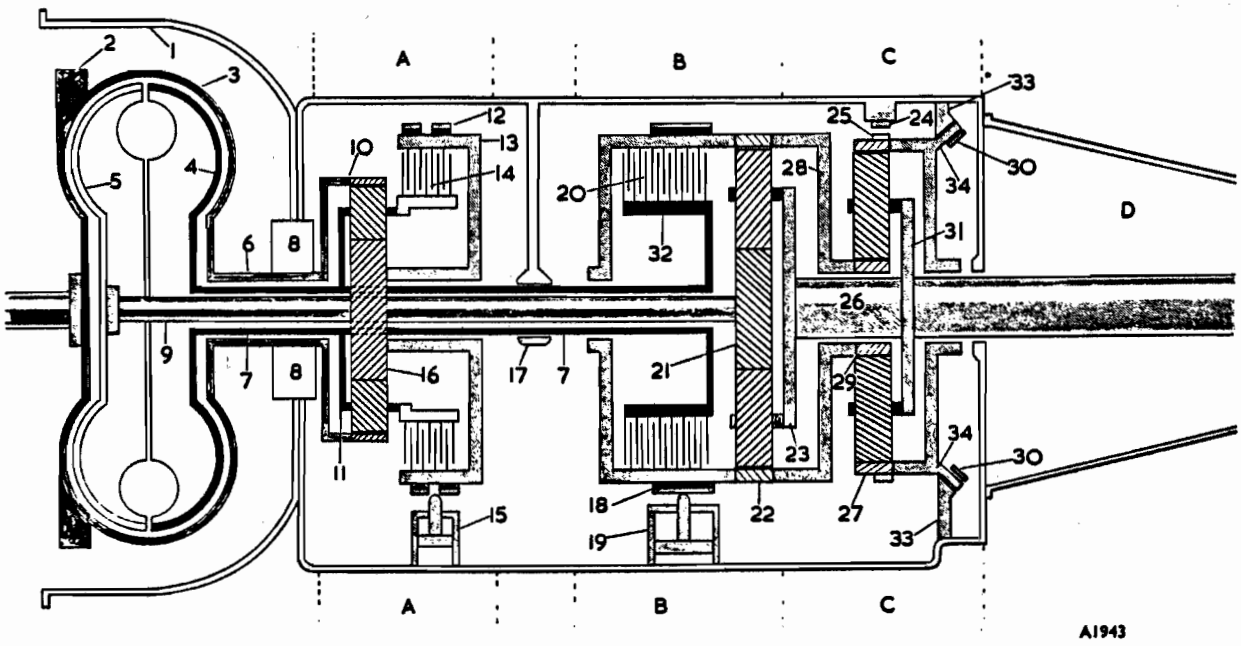

Fig. FF.2

Diagram of mechanical layout showing the fluid coupling

A. The front unit. B. The rear unit. C. The reverse unit. D. The rear casing.

Contrary to normal practice, although the fluid coupling is housed inside the flywheel housing, it is not driven directly by the flywheel (see Fig. FF.2). The drive is transmitted from the flywheel (2) by the torus cover (3) to the annulus (10) of the front unit (A) and then via the planet carrier (11) to the rear torus member (4) which is the driving member. The front or driven torus member (5) then transmits the drive to the sun gear (21) of the rear gear unit (B) via the mainshaft (9).

Due to this feature the r.p.m. of the driving torus member is less than the engine r.p.m., the drive having been passed through the front gear unit with the consequent 1·45 : 1 reduction.

This characteristic ensures that the tendency of the car to creep is greatly reduced when halted with the engine idling; therefore there is no necessity to engage neutral for short stops such as traffic-lights.

Assuming that the engine idling speed is 400 r.p.m., the speed of the driving member will be 270 r.p.m. approximately—that is, below the effective drive speed of the fluid coupling.

The efficiency of the gearbox is further increased when the rear unit (B, Fig. FF.2) is in direct drive—that is, in third and top gears. As previously stated, to obtain direct drive two members of an epicyclic gear train must be locked together. In the rear gear train, however, the two members are not directly locked: instead, the annulus of this unit (22) is locked by the multiplate clutch (20) to an extension of the front planet carrier (32), which is driven by the front unit annulus gear (10). The rear unit sun gear (21) is directly connected to the front torus member (5) and therefore rotates at the same speed as the front unit planet carrier and consequently the same speed as the rear unit annulus gear (22). The effect is now the same as if the rear unit annulus (22) and sun gear (21) were locked directly together. However, only part of the drive is transmitted through the fluid coupling; the remainder is transmitted directly through the rear clutch (20) to the output shaft (26). This feature reduces the percentage of torque loss in the fluid coupling and is known as 'split torque'. The slight loss of torque and consequent slight difference of r.p.m. between the rear unit sun gear and the annulus is compensated for by the differential action of the planet gears.

Automatic control

Hydraulic pressure, which is regulated by the road speed and the accelerator position, controls the automatic gear changes. This pressure is directed through shift valve ports to the appropriate clutch or servo piston.

The engine throttle is connected to a hydraulic valve which supplies a varying pressure, dependent on throttle opening, to the control valve unit. A further two hydraulic valves, which are controlled by a governor, supply two more varying pressures to the control valve unit. The governor is driven by the output shaft of the gearbox so that the governor speed and, consequently, the governor pressures are relative to road speed.

Three two-position shift valve assemblies, situated in the control valve unit, control the oil pressures to the servos and clutch pistons. The shift valves are positioned by governor and throttle pressures to control gear changes. Incorporated in the shift valves are return springs which also control the valve positions, as will be explained in due course. The 1—2 shift valve assembly controls up and down changes from first to second and second to first gears. The 2—3 shift valve assembly controls up and down changes from second to third and

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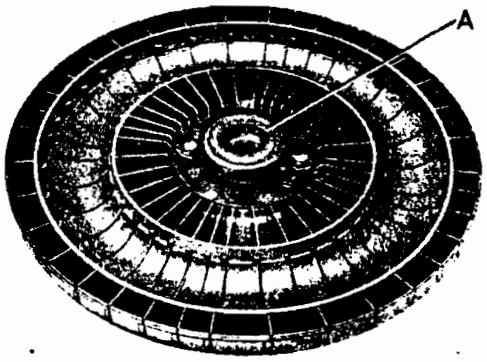

Fig. FF.3

Showing the relief valve at (A) *in the torus*

third to second gears. The 3—4 shift valve assembly controls up and down changes from third to top and top to third gears.

In first gear all the shift valves are in the rest position and band apply pressure is applied to the front servo only.

NOTE.—The front band servo is applied and released by oil pressure. The rear band servo is operated by springs and released by oil pressure.

As each valve moves to change gear, ports are opened to allow pressure to operate the appropriate clutch and servo pistons. In top gear all the shift valves have moved across.

This process is reversed for the down changes.

Two oil pumps, one driven by the input shaft and one by the output shaft, generate the oil pressure. This ensures that pressure is available when the engine is running or the car is moving.

The oil is drawn from the gearbox sump by the two pumps and is fed at approximately 60 to 90 lb./sq. in. (4·219 to 6·328 kg./cm.²) into a common outlet leading to the governor and the manually operated selector valve in the control valve unit. To prevent any loss of pressure when the rear pump is not operating, a spring-loaded non-return valve is situated between the two pumps. Oil is also delivered to the fluid coupling and for lubrication of the bearings, as will be explained later.

An indication of road speed in terms of oil pressure is provided by the governor. Two separate pressures are provided which increase at different rates. G.1 pressure builds up quickly to give accurate control at low speeds. G.2 pressure builds up slowly to give control at high speeds.

The governor prevents governor oil from flowing to the control valve unit when the car is stationary, but as it commences to move, centrifugal weights open valve ports and the oil is permitted to flow to the control valve unit, the pressures increasing progressively with car speed.

The control valve unit also contains the throttle valve which is connected by rods and levers to the engine throttle. This gives an indication of engine power in terms of oil pressure.

Oil at pump pressure is supplied to the throttle valve ports, which open and close in conjunction with the throttle and supply a variable pressure relative to throttle opening known as T.1 pressure.

T.1 pressure is supplied to a valve known as the T.2 valve; here the T.1 pressure is metered and a reduced pressure known as T.2 pressure results. This pressure, together with the shift valve return springs, acts on the shift valves in opposition to the governor pressure. It will be obvious, therefore, that the shift valves are positioned to select the lowest gear ratio when governor pressure is nil (car stationary) and move to select higher gears as the T.2 and spring pressure is overcome by governor pressure. The greater the throttle opening, therefore, means greater T.2 pressure and consequent delayed up changes, giving better acceleration in all gears when required.

The shift valve return springs mainly operate the down changes, as T.2 pressure is automatically cut off in the case of the 2—3 up change and reduced when the 1—2 and 3—4 up changes occur by the movement of the shift valves. Therefore, although governor pressure has to overcome the spring and T.2 pressure to change up, there is only the return spring, or the return spring and reduced T.2 pressure, to overcome the governor pressure for down changes. This means that the down changes occur at much lower speeds than the corresponding up changes.

For example, should the car be following another vehicle which cannot be overtaken at fairly constant speed, and should that speed be approximately the change up speed from third to top gear, the gearbox will not keep fluctuating between third and top gear due to the feature explained above.

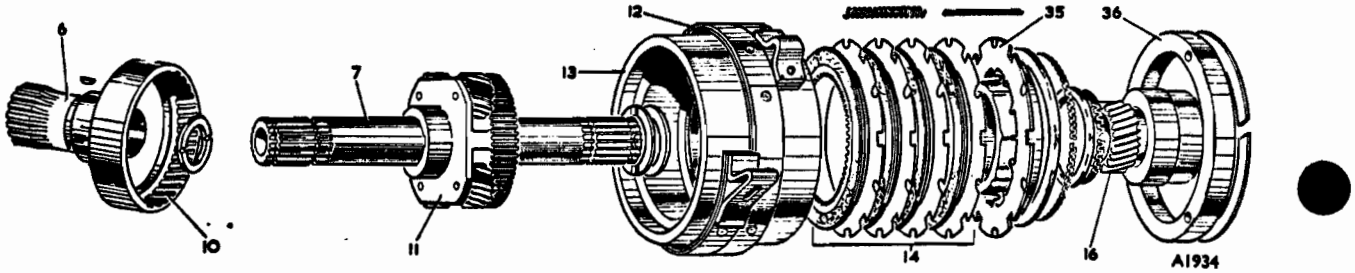

Fig. FF.4

Exploded view of the front unit

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As the gear ratios are selected the shift valves are positioned so as to supply oil pressure to three clutch operating pistons and two band operating servos which engage or disengage the clutches or apply and release the friction bands as previously listed (see page FF.2).

T.I pressure also acts on a compensating valve which supplies a compensator pressure to the front and rear servos to increase the holding force on the bands as the driving torque increases. Briefly, the functions of the oil pressures are as follows.

The main pressure is applied through the shift valve ports to the clutch pistons and band servos.

Compensator pressure is applied direct to the band servos.

Throttle pressure acts on the shift valves in opposition to governor pressure and the shift valves are therefore positioned to cut off main pressure from, or permit main pressure to pass to, the appropriate servo or clutch pistons.

Fluid coupling

The torus cover, which is connected to and revolves with the flywheel, houses the fluid coupling. The front pump supplies oil to completely fill the cover. The mainshaft, which is connected to the front driven torus, is centralized by a spigot bearing in the flywheel.

Transmission rattle caused by the turbulence of the fluid in the coupling is kept to a minimum by the design of the torus members (see Fig. FF.3).

Heat generated by the fluid friction is reduced to a minimum by the design of the torus vanes which control the circulation of oil in the housing and also by the constant flow of oil through the coupling.

The oil is passed out of the coupling through a relief valve (A, Fig. FF.3), and between the main and intermediate shafts to the gearbox bearings.

Great care is necessary to prevent oil leakage from the fluid coupling as the oil is under pressure from the pumps and centrifugal force.

Special attention must be paid to the oil seals between the torus cover and the front pump and also to the flange of the torus cover itself, which will prove useless if damaged even slightly.

Front epicyclic unit (see Figs. FF.4 and FF.5)

The drive from the torus cover (3) is transmitted via the tubular front drive shaft (6) to the front gear unit (A). The annulus of the front unit (10) is formed by the rear end of the tubular shaft and drives the four planet gears which rotate in the planet carrier (11). The planet carrier is splined to carry the composition-faced clutch plates, and is an integral part of the tubular intermediate shaft (7) which transmits the drive forward to the rear driving torus member (4) and also rearwards to the rear gear unit (B) in third and top gears. The driving torus (4) is splined to the intermediate shaft (7) and secured by a snap ring.

The front drum (13) driving and driven clutch plates, the clutch release springs, the clutch piston (35), and the clutch cover (36), of which the sun gear (16) is an integral part, comprise the remainder of the front gear unit.

The clutch pack fits into the drum with the composition-faced driving plates splined to the planet carrier (11) and the steel driven plates are linked to the drum (13). The clutch assembly fits into the rear of the drum and is secured by a large snap ring.

The driving plates are slightly corrugated to assist clutch release.

Oil leakage from the clutch piston is prevented by two seals, one on the outer edge of the clutch piston, the other on the clutch cover spigot.

The front friction band (12) is composed of a spring steel band to which is riveted a wear-resistant compound. The band passes twice around the drum; one end is connected to the servo operating rod, the other end abuts the band adjustment screw.

Direct drive through the unit is obtained when the band is released and the clutch piston is operated, compressing the clutch plates and thereby locking the sun gear (16) to the planet carrier (11).

Reduction is obtained when the drum (13) is held by the friction band (12) and the clutch (14) is disengaged. The drum together with the clutch cover and sun gear is held stationary. This allows the annulus (10) to drive the planet gears and transmit reduced drive via the planet carrier (11).

Rear epicyclic unit (see Figs. FF.5 and FF.6)

The rear drum is similar to the front except that more clutch plates are used and guide pins are fitted to the clutch springs. The rear unit annulus (22) is fixed to the drum, which is also drilled and tapped to take the flange (28) that transmits the drive to the reverse gear train (C).

The front drum is carried by the intermediate shaft (7), which is in turn supported in an oil delivery sleeve (37) clamped in the centre web of the main casing by a cap (17) and two bolts to form the main bearing of the gearbox. The rear drum is supported by the oil delivery sleeve.

The mainshaft (9) passes through the centre of the intermediate shaft (7) and carries the sun gear (21) of the rear unit. The front end of the output shaft (26) forms the planet carrier (23) of the rear unit and carries also a spigot bearing for the rear of the mainshaft. The planet gears rotate inside the annulus gear (22), which is attached to the rear drum.

The clutch hub (32), which is splined to the intermediate shaft (7), carries the driving clutch plates and the drum carries the driven clutch plates.

In reduction the rear friction band (18) holds the drum stationary; therefore the rear annulus (22) is held, the sun gear (21) drives the planet gears, which in turn give a reduced drive to the planet carrier (23). As previously stated, the planet carrier is part of the output shaft (26).

The rear friction band (18) is similar to the front one, except that it passes only once around the drum and is much larger to resist the increased torque.

In direct drive the clutch (20) locks the annulus gear (22) to the intermediate shaft (7), which is connected to the sun gear (21) through the fluid coupling. This feature, known as 'split torque', has been explained previously.

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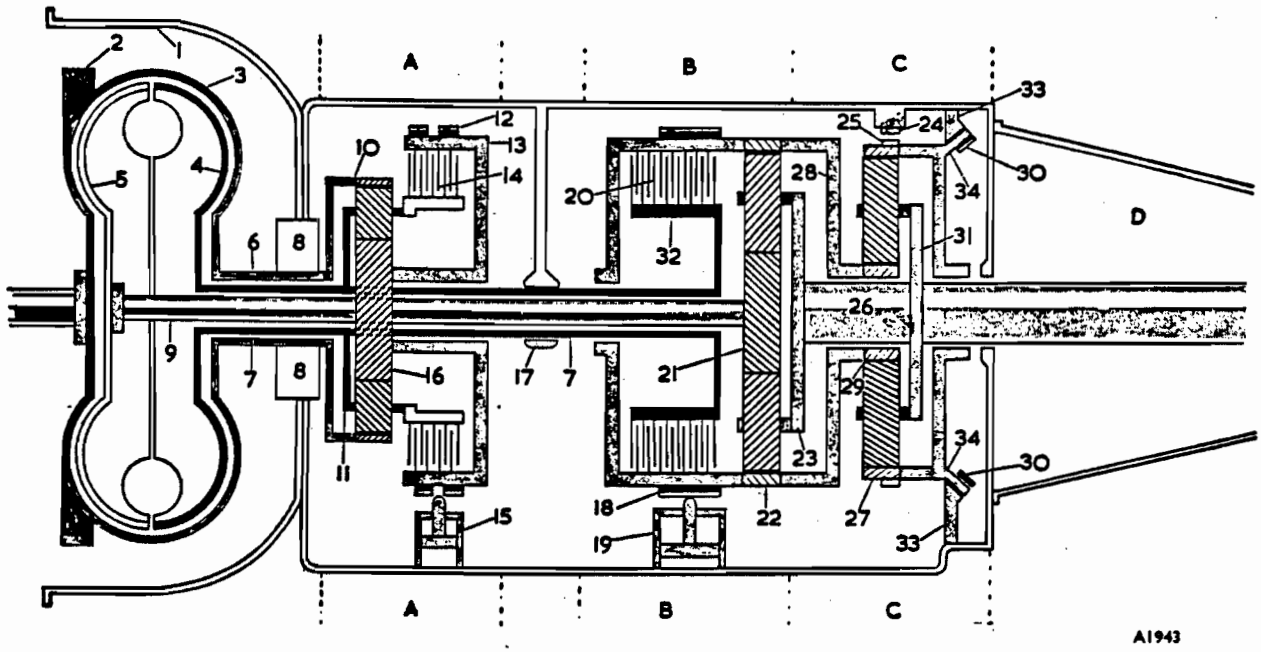

Fig. FF.5

Diagrammatic layout of automatic gearbox

A. Front unit.

1. Bell housing.
2. Flywheel.
3. Torus cover.
4. Driving torus.
5. Driven torus.
6. Front drive shaft.
7. Intermediate shaft.
8. Front pump.
9. Mainshaft.

B. Rear unit.

10. Front unit annulus.
11. Front unit planet carrier.
12. Front band.
13. Front drum.
14. Front clutch.
15. Front servo.
16. Front unit sun gear.
17. Centre main bearing.
18. Rear band.

C. Reverse unit.

19. Rear servo.
20. Rear clutch.
21. Rear unit sun gear.
22. Rear unit annulus.
23. Rear unit planet carrier.
24. Parking pawl.
25. Teeth for parking pawl.
26. Output shaft.
27. Reverse annulus.

D. Rear casing.

28. Flange—rear drum.
29. Reverse sun gear.
30. Reverse clutch piston.
31. Reverse planet carrier.
32. Rear unit clutch hub.
33. Reverse clutch cone.
34. Reverse clutch rotating cone.

Reverse epicyclic unit (see Figs. FF.5 and FF.7)

The reverse planet carrier (31), which is splined to the output shaft (26), carries the skew gear that drives the rear oil pump and the governor. The planet carrier has only three large planet gears, not four small ones as in the front and rear gear trains. The reverse annulus (27) runs free in all forward gears, but is held stationary by a cone clutch (30) when reverse is selected.

The sun gear (29) of the reverse gear unit (C) is driven by the flange (28) attached to the rear drum and rotates freely on the output shaft (26).

There are two stationary elements of the cone clutch, an inner and an outer friction cone which fit into the gearbox rear casing.

The internal cone (30) comprises a hydraulic piston which, when oil pressure is applied, moves axially on four guide pins and prevents the annulus gear (27) rotating. The cone is disengaged by six springs and rubber seals prevent oil leakage.

The external cone (33) is a split cone which fits into the rear casing and is keyed to prevent rotation.

A rotating cone (34) which completes the rear clutch assembly is an integral part of the reverse annulus.

Ball bearings in the gearbox rear casing (D) and the rear mounting bracket carry the output shaft.

The rear casing (D) also houses the final drive splines carrying the speedometer gear and the drive flange for the universal joint.

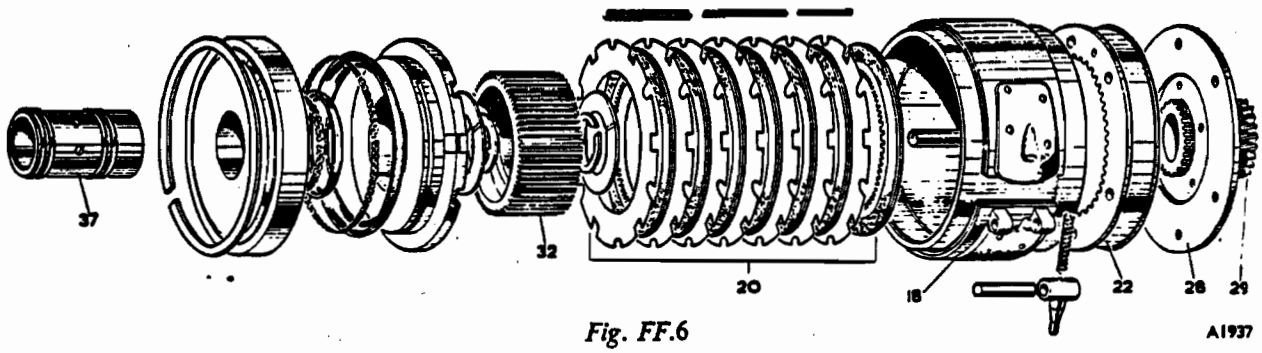

Fig. FF.6

Exploded view of rear unit

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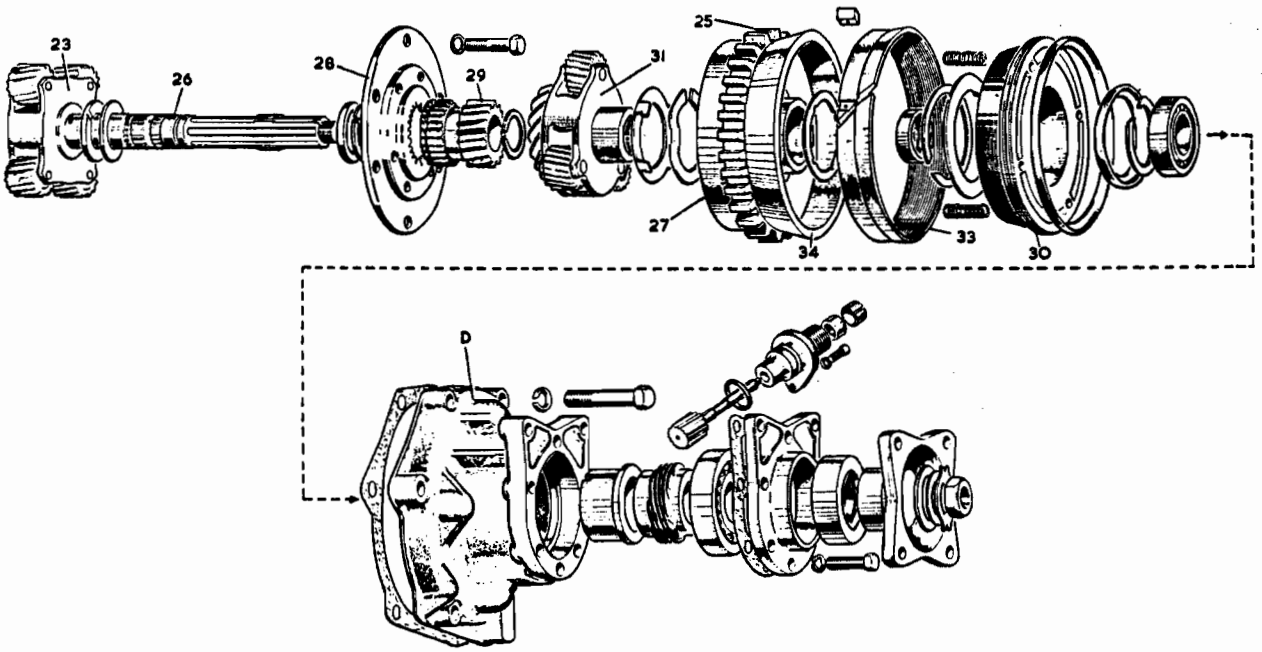

Fig. FF.7 A1938

Exploded view of reverse unit showing rear casing, bearings, and speedometer drive

Bearings and thrust washers

Plain bearings at the front and centre of the gearbox and ball bearings at the rear carry the complete rotating assembly. Phosphor-bronze thrust washers, backed by steel washers, transmit the axial thrust.

The front plain bearings are between the front end of the intermediate shaft, the front annulus gear shaft, and the front pump casing.

The intermediate shaft is supported between the front and rear drums by the centre plain bearing, which is also an oil delivery sleeve.

One of the ball bearings is housed in the front of the rear casing, the other is in the rear mounting bracket.

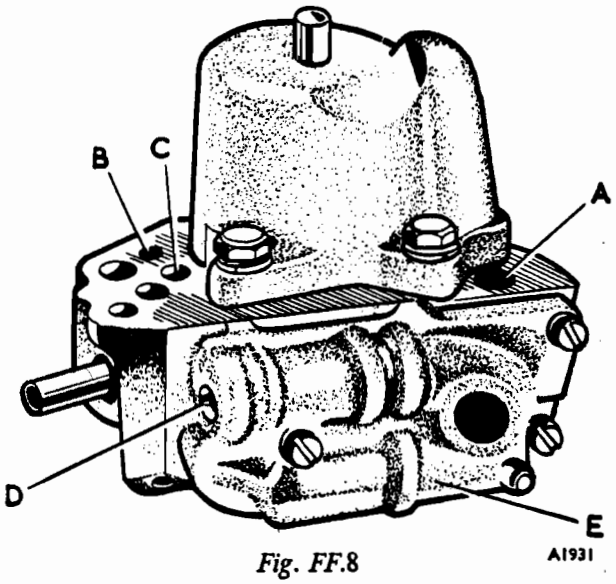

Fig. FF.8 A1931

Front servo

A. Front pump delivery duct.
B. Band apply duct.
C. Band release duct.
D. Exhaust valve.
E. Three range over-run control valve.

Thrust washers are situated as follows.

A pair of steel and phosphor-bronze washers between the rear torus hub and the end face of the annulus gear shaft.

One phosphor-bronze washer between the hub of the planet gear carrier and the front annulus gear.

A pair of steel and phosphor-bronze washers between the front sun wheel and the planet gear carrier.

A pair of steel and phosphor-bronze washers behind the front unit sun wheel bearing and retained on the intermediate shaft by a snap ring.

A phosphor-bronze washer on each side of the rear unit clutch hub.

A phosphor-bronze washer behind the reverse annulus gear.

A pair of steel and phosphor-bronze washers between the rear unit planet carrier and the reverse drive flange.

A selective adjustment washer between the rear unit sun wheel and the rear planet carrier controls the end-float.

Band servo units

Incorporated in both servo units are valves which synchronize band application with clutch release.

Front servo (*see Fig. FF.8, FF.9, and FF.10*)

The front servo unit consists of two casings which house a double piston assembly. The main body of the housing also contains a 4—3 gear change timing valve.

Three piston ring seals on the piston assembly divide the oil cylinder into four chambers: one chamber receives band apply pressure, one chamber receives compensating pressure which augments the apply pressure, and the remaining two chambers receive the band release pressure.

Front band apply and compensating pressures are fed to the unit in all drive ranges.

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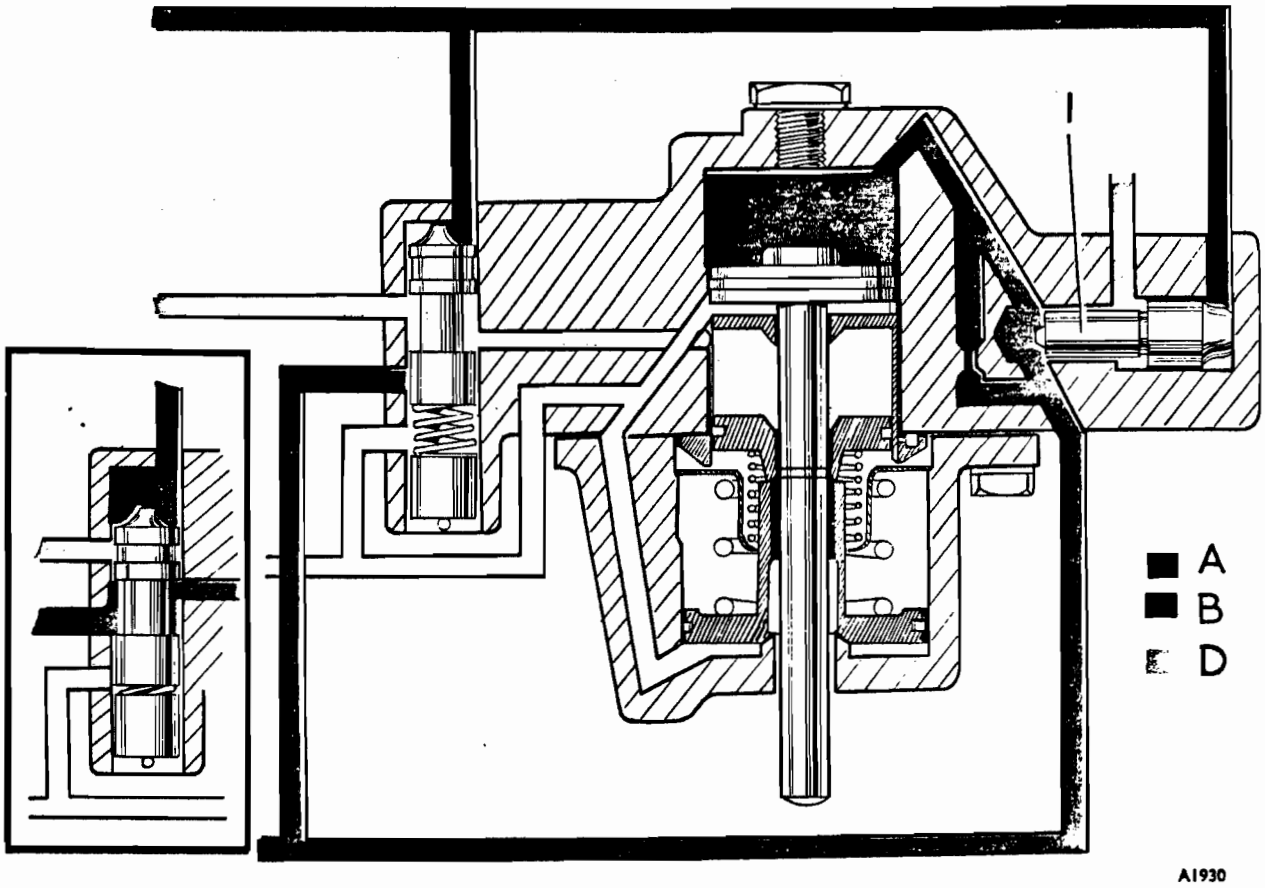

Fig. FF.9

Diagram of the front servo in the band apply position. (Inset) The action of the range three over-run control valve. The function of the 4—3 timing valve 1 will also be seen

A. Main pressure. B. Governor pressure. D. Compensating pressure.

In second and top gear band release pressure is applied which overcomes both band apply and compensating pressures due to the larger piston area in the release chambers.

A spring is incorporated in the servo which acts on the piston assembly to release the band when in neutral.

When new, a slight drag of the bands may transmit a small amount of torque to the road wheels when the selector is in neutral, but this will cease when the bands are bedded in.

The 4—3 timing valve is a plunger that restricts the oil flow to the apply piston during a 4—3 forced down change (kick-down). The purpose of this valve is to delay the application of the friction band until the front clutch is fully released. It is operated by governor pressure which overcomes compensator pressure and positions the valve as necessary.

Secured by three set screws to the main part of the servo housing is a valve body which contains:

(1) A main line exhaust valve that exhausts the system immediately pump pressure ceases.

(2) A non-return valve which prevents the front pump from feeding into the rear pump delivery line.

(3) A range three over-run control valve.

When at high speed in third gear—that is, when using range three—band apply pressure and compensator pressure are applied to the front servo to operate and hold the front band. However, when engine braking is required and the accelerator is released T.1 pressure and consequently compensator pressure will fall to zero. The loss of compensator pressure in the servo at high speeds would probably allow the band to slip.

To prevent band slip under these conditions is the purpose of the range three over-run control valve which is operated by governor pressure and puts band apply pressure to the compensator chamber in the servo, giving increased band holding force.

Rear servo (see Figs. FF.11, FF.12, and FF.13)

Due to the high torque transmitted by the rear gear train, a greater band hold is required and consequently the rear servo is much larger than the front one.

The oil compartment is divided by three piston ring seals into four chambers, two of which are band release pressure chambers and the other two, connected by a drilling down the centre of the operating push-rod, receive the compensator oil pressure which augments the band apply springs. A 'U'-shaped strap retains the band apply springs, the inner one being contained in the compensator cylinder.

Incorporated in the rear servo are two valves which are situated in the feed line to one of the band release chambers. The first valve is operated by compensator

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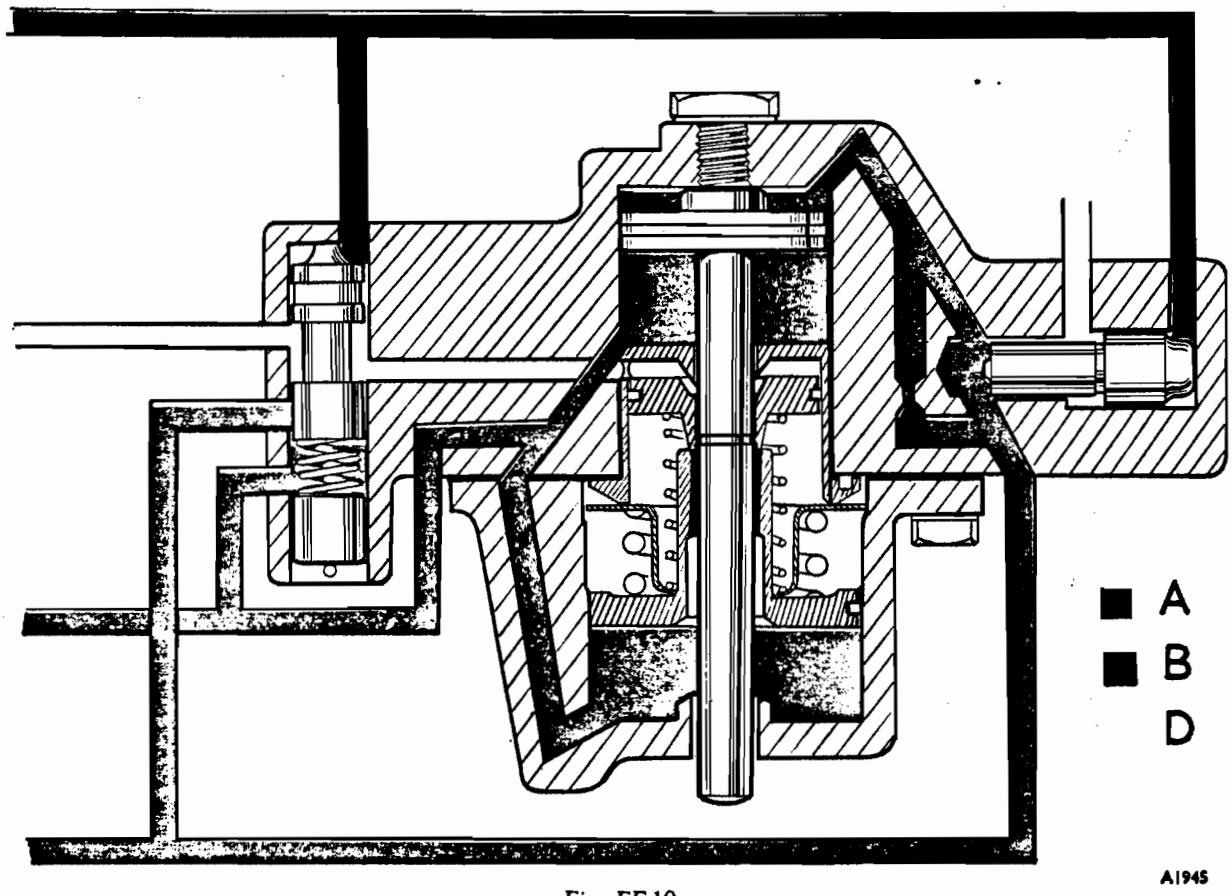

*Fig. FF.*10

Diagram of the front servo in the band release position

Note.—*Band release oil has been put behind the over-run control valve to cut off main pressure from the compensator pressure chamber*

A. Main pressure. B. Governor pressure. D. Compensator pressure.

pressure and allows unrestricted flow of servo release oil to the chambers, but restricts the exhaust of servo release oil to delay the band application for the 3—2 down change. The other valve **allows** the servo release pressure to exhaust quickly by by-passing the restrictor valve to give rapid band application when changing from reverse to forward drive and from neutral to drive. This valve is closed by main pressure, however, in second gear and above.

Front oil pump (*see Figs. FF.*14 *and FF.*16)

Keyed to the front drive shaft is the front oil pump. This pump is a variable-capacity unit and contains a rotor (1) with seven sliding vanes (2) which are located between inner vane rings (3) and a movable outer ring or slide (4).

Relative to the rotor the slide is capable of moving from a position of maximum eccentricity to an eccentric position diametrically opposite the maximum stroke position.

The oil displacement space between the rotor and the slide is therefore varied and the oil carried by the vanes will be forced out at the position of minimum clearance. Full eccentricity will give maximum delivery, a concentric position will give zero delivery, opposite eccentricity will enable the pump to return excess oil delivery from the rear pump to the sump. The slide is held in the maximum delivery position by a small spring (5) to prime the pump when starting. It will be seen therefore that the front pump controls the delivery of both pumps and supplies main pressure in accordance with the demands of the system.

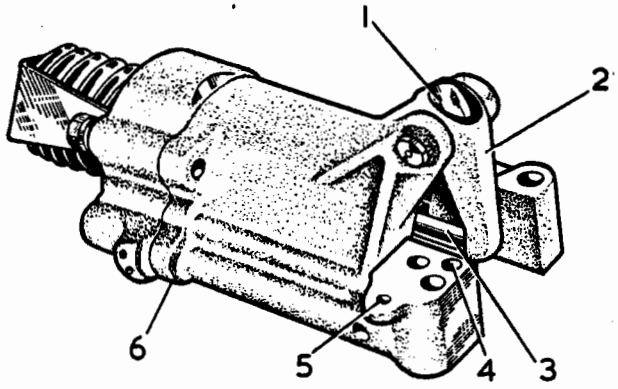

*Fig. FF.*11

Rear servo, showing:

1. Recess for rear band.
2. Band operating lever.
3. Band operating rod.
4. Band release oil duct.
5. Exhaust valve oil duct.
6. Exhaust valve housing.

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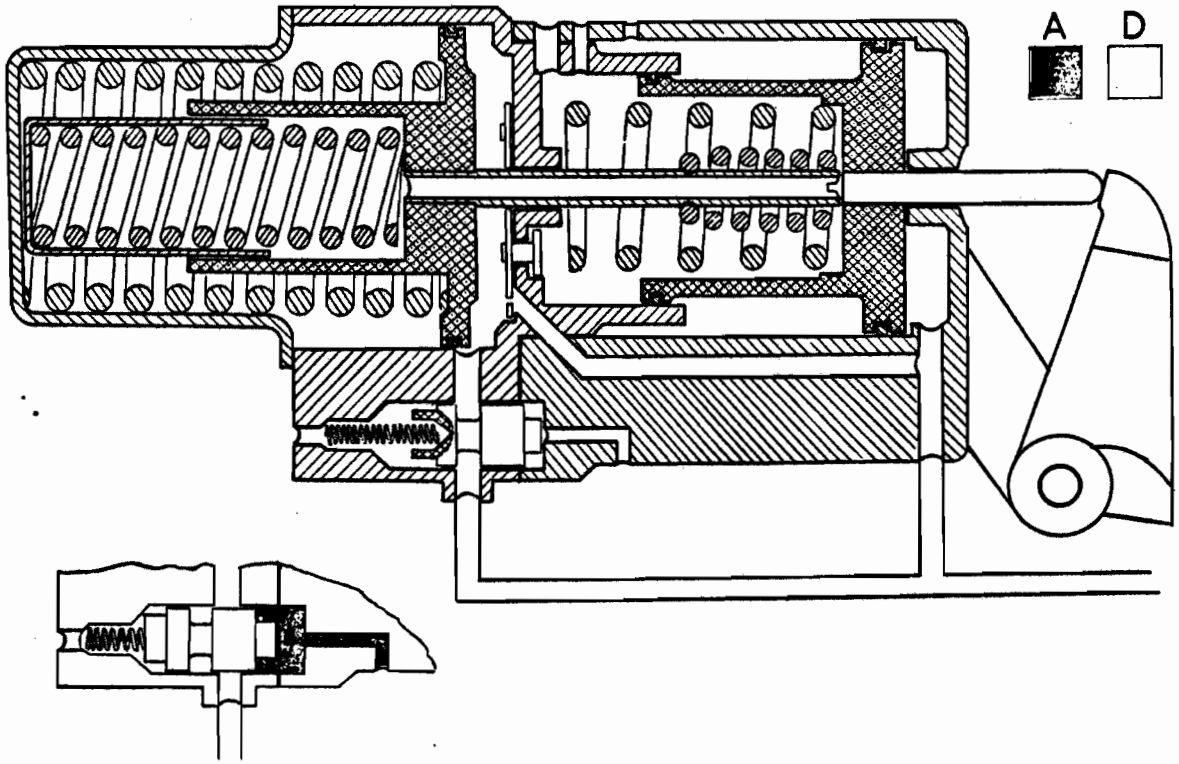

Fig. FF.12

Diagram of the rear servo in the band apply position, showing (inset) exhaust valve operation

A. Main pressure. D. Compensator pressure.

Incorporated into the front pump is a pressure control valve (6) which supplies a pressure to the outer face of the slide; this pressure, acting on the slide in opposition to the internal pressure, positions the slide to give the required pump pressure.

Acting on the pressure control valve is pump pressure tending to open the valve against a spring. T.1 pressure from the throttle valve assists the spring and tends to close the valve, thereby increasing the pump pressure. As previously stated, T.1 pressure increases with throttle opening, therefore the pump or main pressure will rise correspondingly.

A much greater main pressure is required, when reverse is selected, to operate the reverse cone clutch. This is effected by allowing main pressure to operate a reverse booster plug (8) in the pressure control valve assembly; this pressure closes the control valve still further and increases the pump pressure to the required amount.

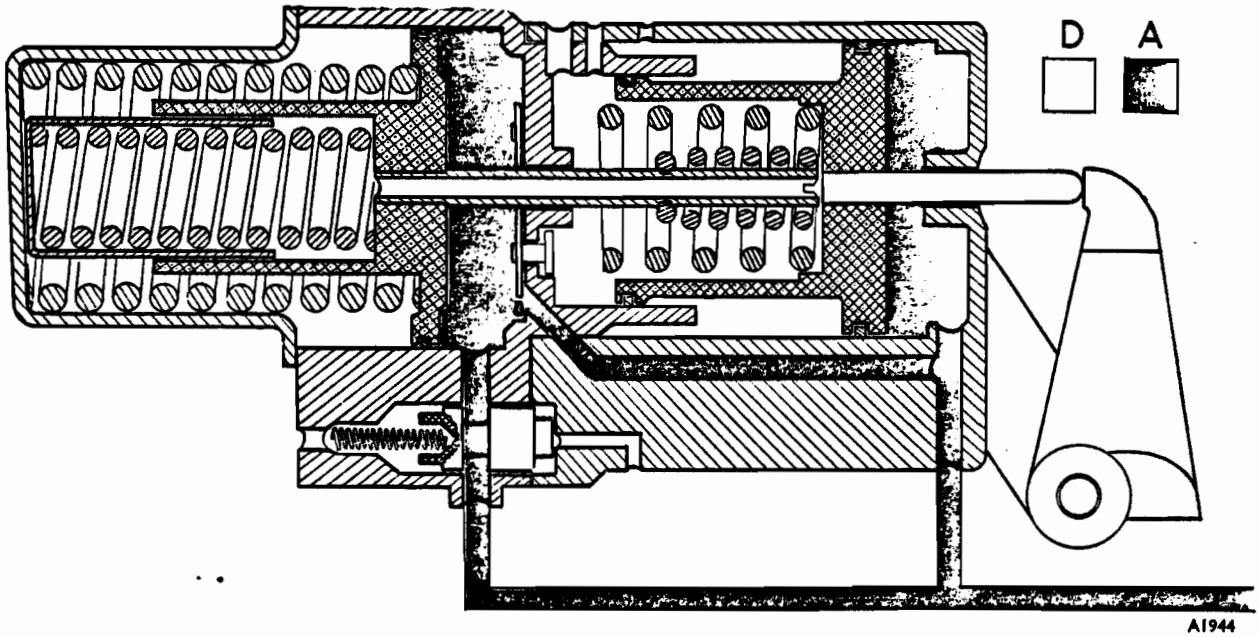

Fig. FF.13

Rear servo in the band release position

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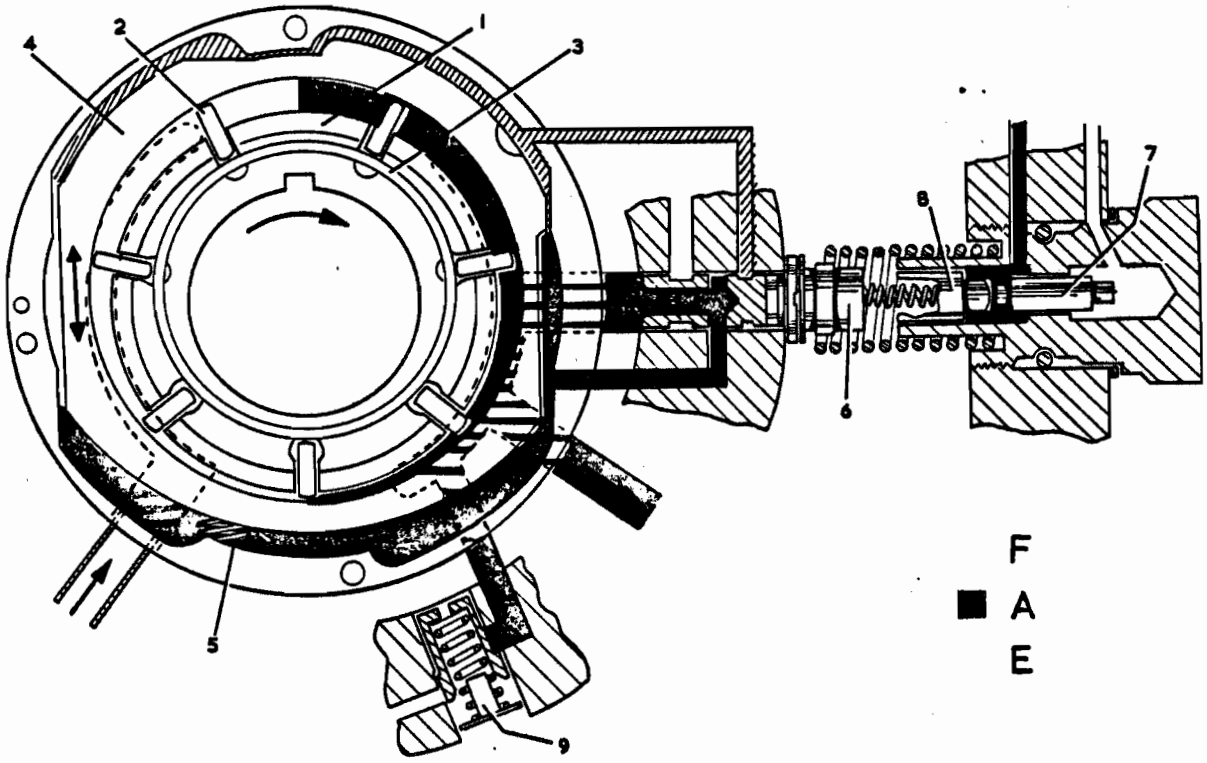

Fig. FF.14

Diagram of the front pump in the maximum delivery position

A. Main pressure.
E. Throttle pressure.
F. Oil drawn from sump.

1. Rotor.
2. Vanes.
3. Vane rings.
4. Slide.
5. Priming springs.
6. Pressure control valve.
7. T.1 plug.
8. Reverse booster plug.
9. Safety valve.

Incorporated in the front pump there is also a safety valve (9) to limit the maximum pressure in the system.

The oil is drawn from the sump filter and delivered by the pump to the front servo; here it is joined by the oil from the rear pump.

As previously stated, the oil from the rear pump has passed through a non-return ball valve, the purpose of which is to prevent front pump oil discharging into the rear pump. However, a small bleed is incorporated which by-passes the non-return valve to maintain oil in the pipe and rear pump when the car is stationary, or in reverse.

Rear oil pump and governor

A bronze skew gear on the reverse planet carrier drives the rear pump and governor (Fig. FF.15).

The pump consists of a small gear (1) in mesh with a larger annulus gear (2) which rotate in the pump casing. A crescent-shaped projection (3) from the pump casing separates the inlet and outlet ports. This forms a seal between the periphery of both gears and oil is carried in sealed pockets between the gear teeth from the inlet port to the discharge port (4). The pump is sealed by a flat plate (5) secured by four screws. Oil is drawn through an inlet pipe (6) from the sump filter and delivered to the front servo.

The governor consists of a small casting which is bolted to a flange (7); the flange is in turn pinned to the oil pump drive shaft. Oil at main pressure is fed to the governor through a stationary sleeve, which fits around three annular grooves separated from each other by four piston ring type seals (8). The oil is then fed through drillings to ports that are controlled by two valves operated by governor weights. The valves are known as the G.1 valve (9) and the G.2 valve (10).

Metered oil pressure tends to hold the valves in and centrifugal force tends to throw them out. As the G.1 governor weight (11) is heavier than the G.2 weight (12), the governor delivers two separate pressures, known as G.1 and G.2 pressures. Both pressures are directly relative to road speed and are fed through drillings in the sleeve to pipes leading to the control box.

Gearbox control

The selector lever on the steering-column and the throttle control are connected by a series of rods and levers to the two control levers on the gearbox.

These levers are mounted on concentric shafts which pass through oil seals in the gearbox side cover. The levers are splined to their shafts and can only be fitted in one position.

The lever on the inner shaft acts on the stem of the throttle valve in the control valve unit and controls the T.1 pressure.

The lever on the outer shaft operates the selector valve by means of a pin engaging in a groove in the valve.

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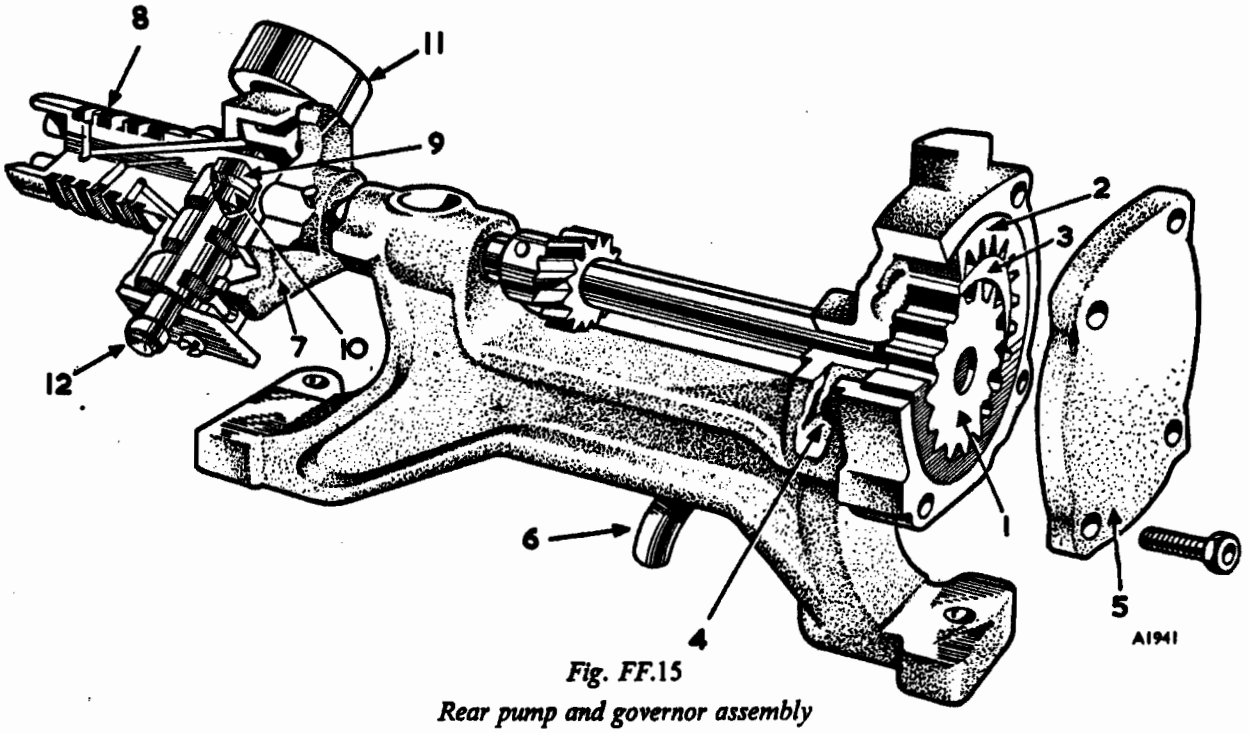

Fig. FF.15
Rear pump and governor assembly

A spring-loaded plunger engaging with notches in a plate attached to the shaft determines the five selector positions. A projection on the plate operates a blade which moves a cam to engage the parking pawl when reverse is selected and the engine is not running. The blade is spring-loaded so that it can be held out of engagement by the parking pawl blocker piston when the engine is running.

Oil circulation

The sump is filled through a filler neck on the right-hand side of the gearbox. The dipstick and a breather are incorporated in the cap of the filler neck. The two pumps (1 and 2) previously described draw the oil through a gauze filter (3) in the sump and supply oil for the fluid coupling, the control system, and lubrication of the gearbox (see Fig. FF.17).

The oil supply to the fluid coupling passes between the front drive shaft and the pump body. When the coupling is full a relief valve (4) opens to permit a flow between the main shaft and the intermediate shaft to lubricate the bearings and through drillings in the shafts to lubricate the clutches, gears, splines, and thrust washers of the rotating assemblies.

The oil from both pumps is carried to the front servo unit (5) and then through drillings to the control valve assembly (6) and back to operate the servo pistons. Drillings in the casing also supply the oil to the governor (7) via the governor sleeve (8), and the governor pressures (G.1 and G.2) are passed to the control valve assembly via two straight pipes.

Oil from the control valve assembly is supplied through drillings in the casing to the front and rear servo units (5) and (9), and also to the oil delivery sleeve (10) which forms the centre plain bearing between the front and rear drums. The sleeve is located by a dowel in the bearing cap and oil is passed through this sleeve to the front and rear clutches (11). Piston-ring-type seals prevent oil leakage.

Oil is also passed through a pipe from the control valve to the rear of the casing and thence through drillings to the reverse clutch (12).

An exhaust valve located in the main feed passage in the front servo opens under spring pressure when pump delivery ceases and allows quick release of pressures from the servos and control valves.

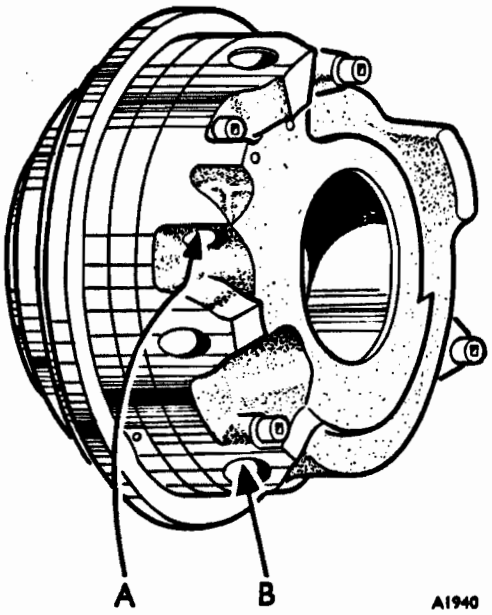

Fig. FF.16
Front pump
A. Inlet. B. Delivery.

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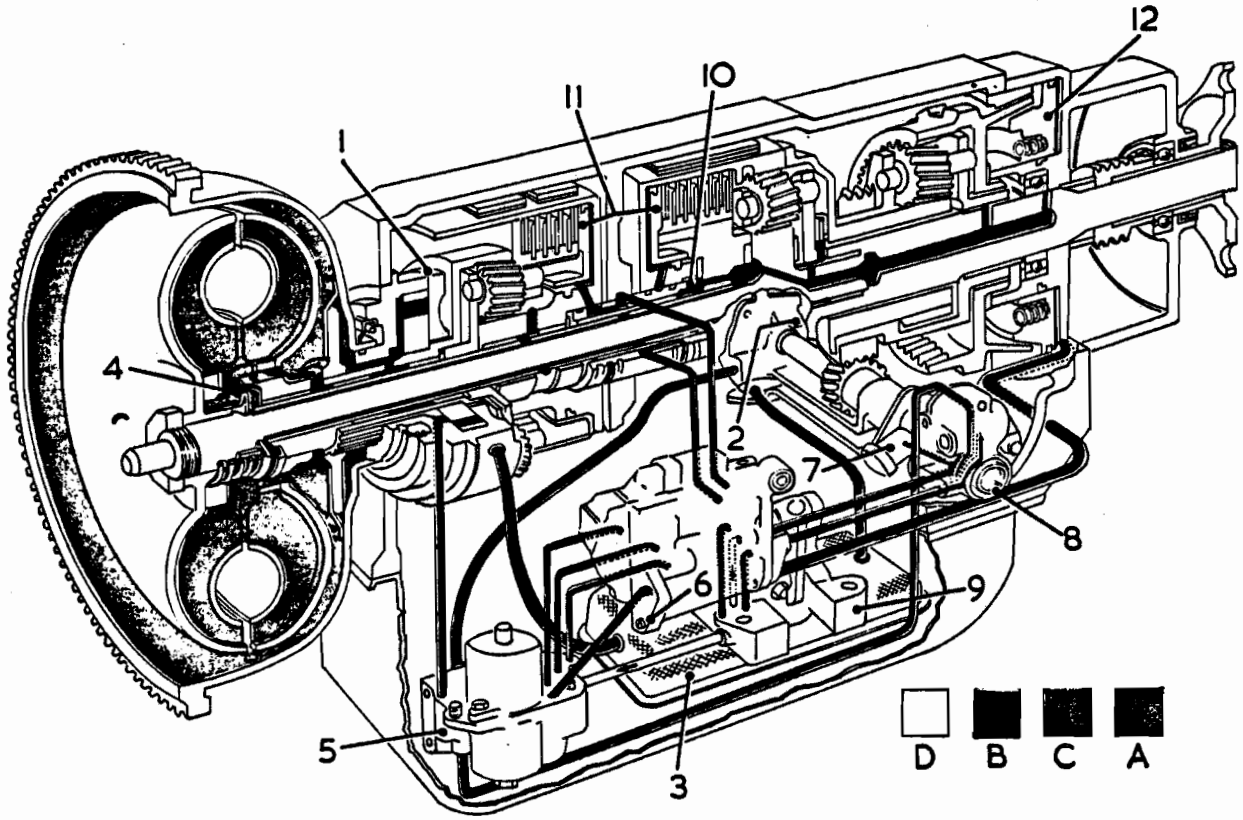

Fig. FF.17 A1948

Oil circulation diagram

A. Main pressure. B. G.1 pressure. C. G.2 pressure. D. Compensator pressure.

Section FF.3

RUNNING ADJUSTMENTS

When carrying out any maintenance, adjustment or repair the importance of cleanliness cannot be over-emphasized.

The smallest particle of dirt in the control system may interfere with the valve operation, with consequent damage or incorrect functioning of the gearbox.

The following procedure should be adhered to whenever commencing any work on the gearbox:

(1) Check the oil level.
(2) Examine for oil leaks.
(3) Lubricate all control joints.
(4) Ascertain that the engine is in good condition and correctly tuned.
(5) Road-test and check change points.
(6) Test for slip and noise.

Should any faults be found, further checks will be necessary to assist diagnosis and should commence:

(1) Control linkage.
(2) Oil pressure.
(3) Band adjustment.

WARNING.—When running the engine to check the gearbox with the car stationary the selector must never be

TABLE OF REGULAR ATTENTIONS

Attention required	*Mileage*
Adjust bands and control linkage	After first 1,000 miles
Check oil level Check for leaks Lubricate control linkage Road-test to check gear changes	Every 3,000 miles
Drain gearbox and refill with new fluid	After first 1,000 miles,* then every 24,000 miles
Clean oil breather in dipstick	Every 10,000 miles or six months

* Provided that the oil drained at 1,000 miles is filtered through a 30-mesh or finer gauze filter, it may be used again.

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moved from neutral unless the hand brake is fully on. If using high r.p.m. block the wheels and use the foot brake.

A starting handle dog is not fitted to the engines of cars having the automatic gearbox. This feature is to prevent any accident occurring through starting the car by hand when the drive is engaged.

Checking the oil level

This must be done with the engine running and having been running for at least three minutes to ensure that the fluid coupling is full.

Checking should be carried out as follows:

(1) Ensure that the hand brake is on, select neutral, start the engine, and warm up.
(2) Clean around the dipstick before removing.
(3) Clean the dipstick and check the level.
(4) If necessary, top up a little at a time to the 'F' (full) mark.
(5) Check for leaks.

Too much oil can be as harmful as too little. Should the gearbox be accidentally overfilled, oil can be drained slowly from the gearbox by removing the centre bolt from the bottom of the side cover.

It is important that only the recommended brands of automatic transmission fluid are used. They are as follows:

Make	*Type*
Mobil	Mobilfluid 200
Shell	Donax T.6
Castrol	Castrol TQ
Esso	Automatic Transmission Fluid 55
BP Energol	Energol Automatic
Duckham's	Nolmatic Oil A.T.F. Type A
Filtrate	Automatic Transmission Fluid Type A
Sternol	Sternol Lynx Fluid

Draining and refilling (see Fig. FF.18)

(1) Warm up the gearbox to its correct running temperature.
(2) Clean the area around the drain plug and remove the plug.
(3) Remove the lower bell housing cover, turn the engine to bring the fluid coupling drain plug to its lowest position, and remove the plug.
(4) Ensure that all the oil is drained from the gearbox and fluid coupling. **DO NOT** flush the system.
(5) Replace both drain plugs and tighten the sump plug to 45 lb. ft. (6·221 kg. m.) torque and the fluid coupling drain plug to 6 to 7 lb. ft. (·830 to ·968 kg. m.) torque. Sealing compound should be used sparingly on the threads of the fluid coupling drain plug.
(6) 20 Imperial pints (24 U.S. pints, 11·359 litres) of fluid are required for a new or overhauled gearbox. Ensure that the fluid and its containers are absolutely clean.

NOTE.—A gearbox that has just been drained will require approximately ¼ Imperial pint (1 U.S. pint, 426 c.c.) less than the amount stated above.

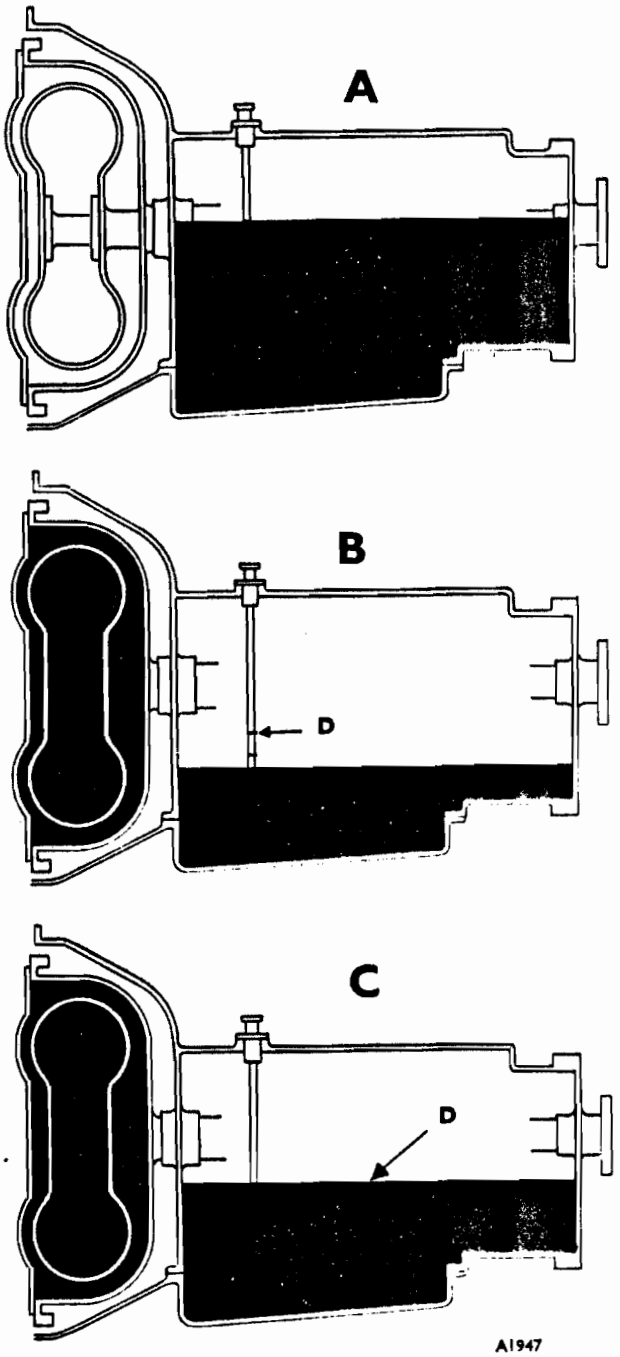

Fig. FF.18

Filling and topping up with oil

A. Pour in 12 pints with engine off.
B. Run engine to fill fluid coupling.
C. Top up to correct level.
D. Correct level as shown on the dipstick.

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(7) Clean around the dipstick, remove the dipstick, and clean the breather.
(8) Pour in 12 Imperial pints (14 U.S. pints, 6·815 litres) of fluid.
(9) Run the engine at a fast idle for five minutes. Ensure that the selector is in neutral and the hand brake is on.
(10) Stop the engine and add a further 6 Imperial pints (7 U.S. pints, 3·408 litres).
(11) Run the engine at a slow idle, check the level with the dipstick, and top up to the required level. Take care not to overfill.

Control joints

All control joints must be lubricated with grease, working it well into the working surface. Any excessive play in the joints may be rectified by tightening, but care must be taken to avoid altering the adjustment. If the play is too excessive it may be necessary to reset the linkage as described below.

Symptoms of maladjusted throttle linkage are:
(1) High or low up changes.
(2) Rough up changes.
(3) Slipping at light or heavy throttle up changes.
(4) Slips changing from second to third gear.
(5) Rough third to second down change.
(6) Kick-down does not operate correctly.

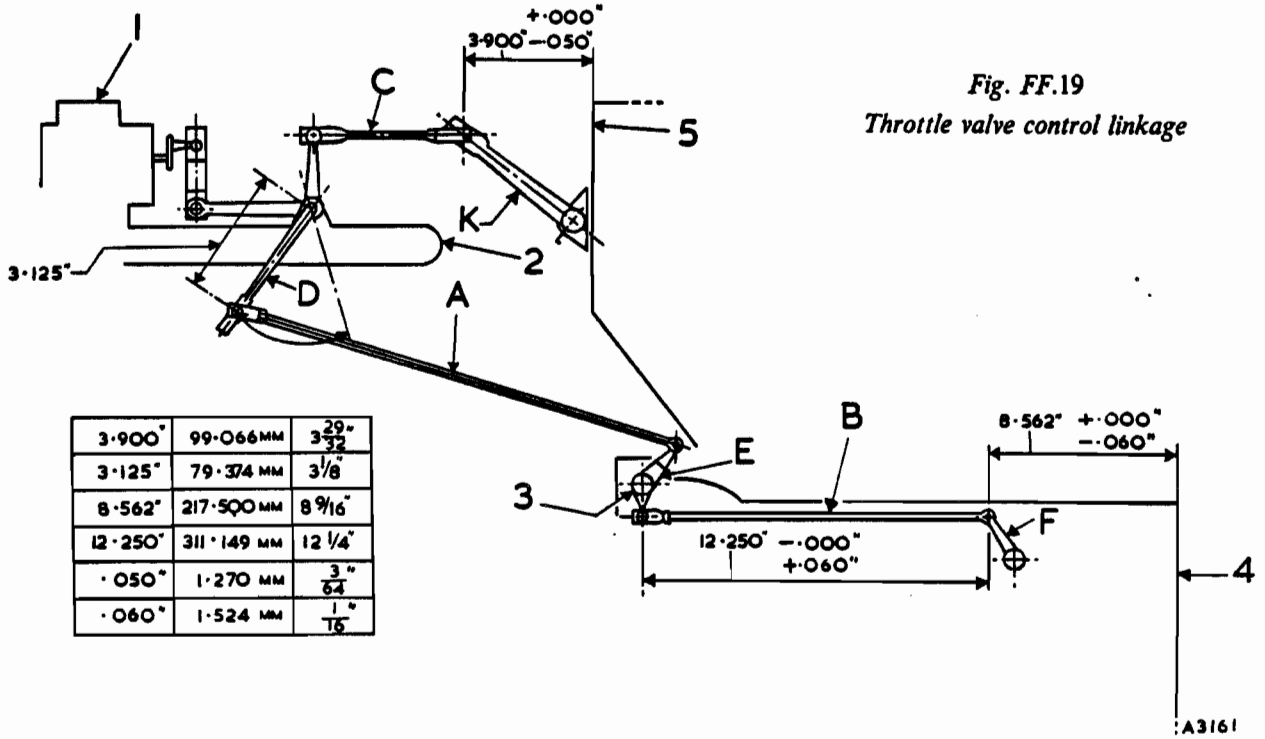
Maladjusted selector linkage can give the following:
(1) Up change to third when in range 2.
(2) Early range 3 engagement.
(3) No reverse, locking in or jumping out of reverse.
(4) No drive.

These symptoms listed above can, of course, be caused by other faults in the gearbox, but the linkages must be checked first.

Throttle valve linkage (see Fig. FF.19)

The correct adjustment and setting can be achieved by following the instructions given hereunder in conjunction with Fig. FF.19.

(1) Disconnect control rods (A) and (B) at their forward ball connections.
(2) Hold the lever (F) on the gearbox fully forward in the 'off stop' position and check that the hole in the lever is 8·562 in. (21·75 cm.) from the rear face of the gearbox (4). Should the measurement not agree, remove the lever, bend to suit, and replace.
(3) Adjust rod (B) to the length shown by adjusting the ball joint.
(4) Adjust rod (C), with the carburetter controls in the hot idle position, until the ball pin on the accelerator lever (K) lies at the horizontal distance of 3·900 in. (9·91 cm.) from the face of the scuttle (5).
(5) Hold the lever (F) in its fully forward position and adjust the rod (A) (by adjusting the ball joint) until it just fits into the hole in lever (D). This hole is 3·125 in. (7·94 cm.) from the axis of the spindle on the inlet manifold (2). Lever (D) on some early models will have two holes. The correct one must be ascertained by measurement.
(6) Make rod (A) two turns shorter by adjusting the ball joint.
(7) Check the behaviour of the car on the road, and if necessary make a further slight adjustment to rod (A) as follows:
(*a*) If the gearbox 'slips' between changes or if kick-down changes cannot be obtained, then the rod (A) should be shortened.
(*b*) If the changes are jerky or the gearbox gives 'kick-down' changes too readily, then the rod (A) should be lengthened.



3·900"	99·066 MM	3 29/32"
3·125"	79·374 MM	3 1/8"
8·562"	217·500 MM	8 9/16"
12·250"	311·149 MM	12 1/4"
·050"	1·270 MM	3/64"
·060"	1·524 MM	1/16"

Fig. FF.19
Throttle valve control linkage

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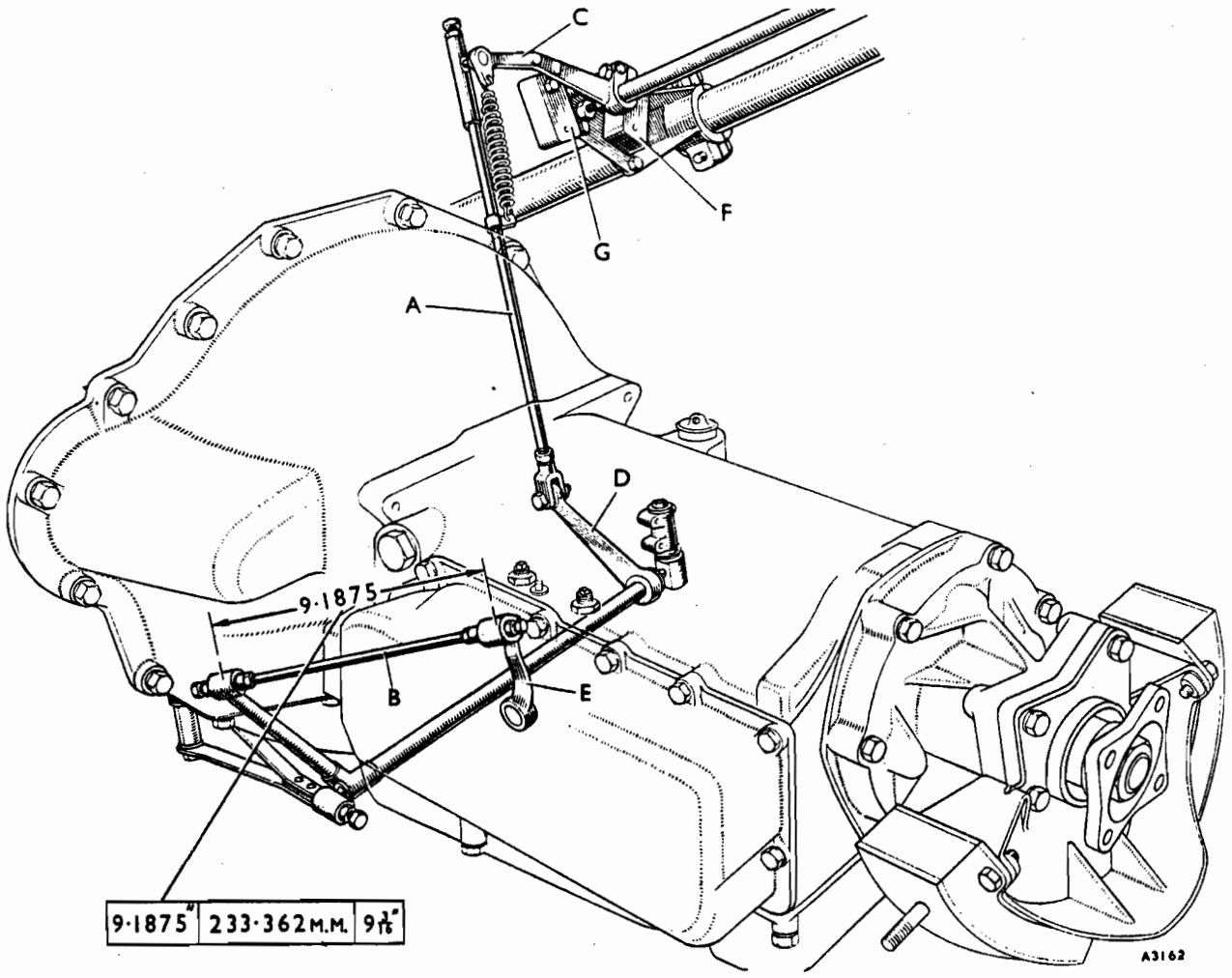

Fig. FF.20
The selector linkage

Selector linkage (see Fig. FF.20)

Adjustment of the selector linkage should not often be necessary and is quite simple to check and adjust.

As previously stated, a spring-loaded plunger engaging with notches in a plate determines the position of the selector valve (see [A], Fig. FF.22). These positions can be plainly felt by operating the control lever on the gearbox.

To check that the linkage is adjusted correctly select neutral and check that the control lever on the gearbox is correctly positioned, then select reverse and again ensure that the control lever is correctly positioned.

If adjustment is required:

(1) Disconnect rod (A) (Fig. FF.20).

(2) Position the selector lever on the steering-column in neutral and turn the control lever (E) on the gearbox until it is in neutral—that is, with the lever in its rearmost position.

(3) Check rod (B) and ensure that it is adjusted to the correct length (see Fig. FF.20).

(4) Reconnect rod (A), adjusting it to suit the positions of levers (C) and (D).

(5) Re-check linkage operation.

Micro switches for starter circuit (F) and reversing light (G) (see Fig. FF.20)

Any adjustment on the selector linkage may entail adjusting the micro switches which are operated by this linkage. The switches have elongated holes to allow for this adjustment to be carried out.

Band adjustment

This operation is necessary after the bands have bedded in—that is, after the car has completed 1,000 miles (1600 km.) approximately. It is preferable that this adjustment is made after 1,000 miles and not before. No further band adjustments should be required unless a servo unit has been removed or to rectify faulty operation of the gearbox.

Incorrectly adjusted bands may produce the following symptoms:

(1) Rough up changes.
(2) Slipping at light or heavy throttle up changes in all gears.
(3) Rough 3—2 down change.
(4) Rough 4—3 down change.
(5) Misses first and third gears.
(6) No reverse.
(7) Rough change. Neutral to drive.

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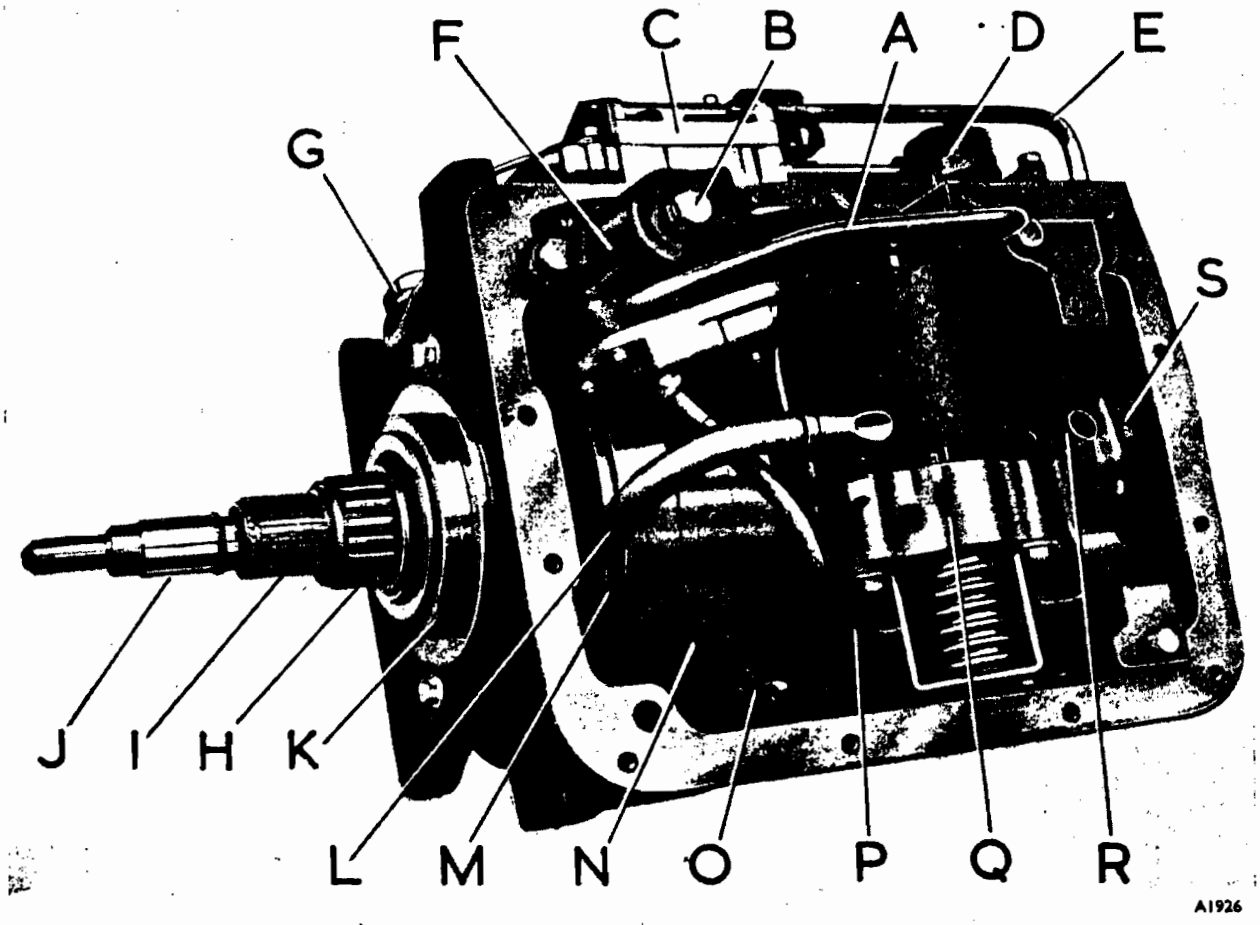

Fig. FF.21

General view of gearbox, sump and side cover removed

A. Main feed pipe to governor.
B. Front servo blanking plug.
C. Control valve unit.
D. Governor sleeve and parking bracket.
E. Reverse clutch oil pipe.
F. Front servo.
G. Pressure control valve.
H. Front drive shaft.
I. Intermediate shaft.
J. Mainshaft.
K. Front pump.
L. Inlet pipe front pump.
M. Front drum.
N. Front band.
O. Dipstick.
P. Pipe rear pump to front servo.
Q. Rear servo.
R. Inlet pipe rear pump.
S. Teeth for parking pawl on reversing annulus.

Periodic checks of the adjustment screw locknuts should be made to ensure that they are tight (40 to 50 lb. ft., 5·530 to 6·913 kg. m.).

The bands can only be adjusted correctly by using the band setting tools and carrying out the following procedure.

The oil from the gearbox must be drained before commencing this adjustment and the sump removed.

(1) Remove the gauze filter from the front and rear pump intake pipes.
(2) Remove the pipe from the front pump to the governor (A, Fig. FF.21).
(3) Slacken the locknuts on the band adjusting screws and slacken the screws.

Front band (see Fig. FF.22)

Unscrew the blanking plug (B, Fig. FF.21) from the front servo body and screw in the setting tool (18G490).

Turn the plunger nut by hand until the plunger touches the servo piston.

Centralize the band by turning the drum opposite to normal rotation, then, using a spanner, screw in the plunger five complete turns.

The knurled washer at the top of the setting tool should be gripped tightly by the tool. If it is loose and can be rotated, slacken the band adjustment screw until the washer is tightly gripped.

Then, holding the knurled washer as illustrated, tighten the band adjusting screw until the washer just slips.

Hold the adjusting screw firmly and tighten the locknut; check that the tension on the washer has not changed.

Slacken the plunger nut on the setting tool more than five turns to relieve the pressure on the screw threads of the tool and remove it from the servo. Refit the blanking plug.

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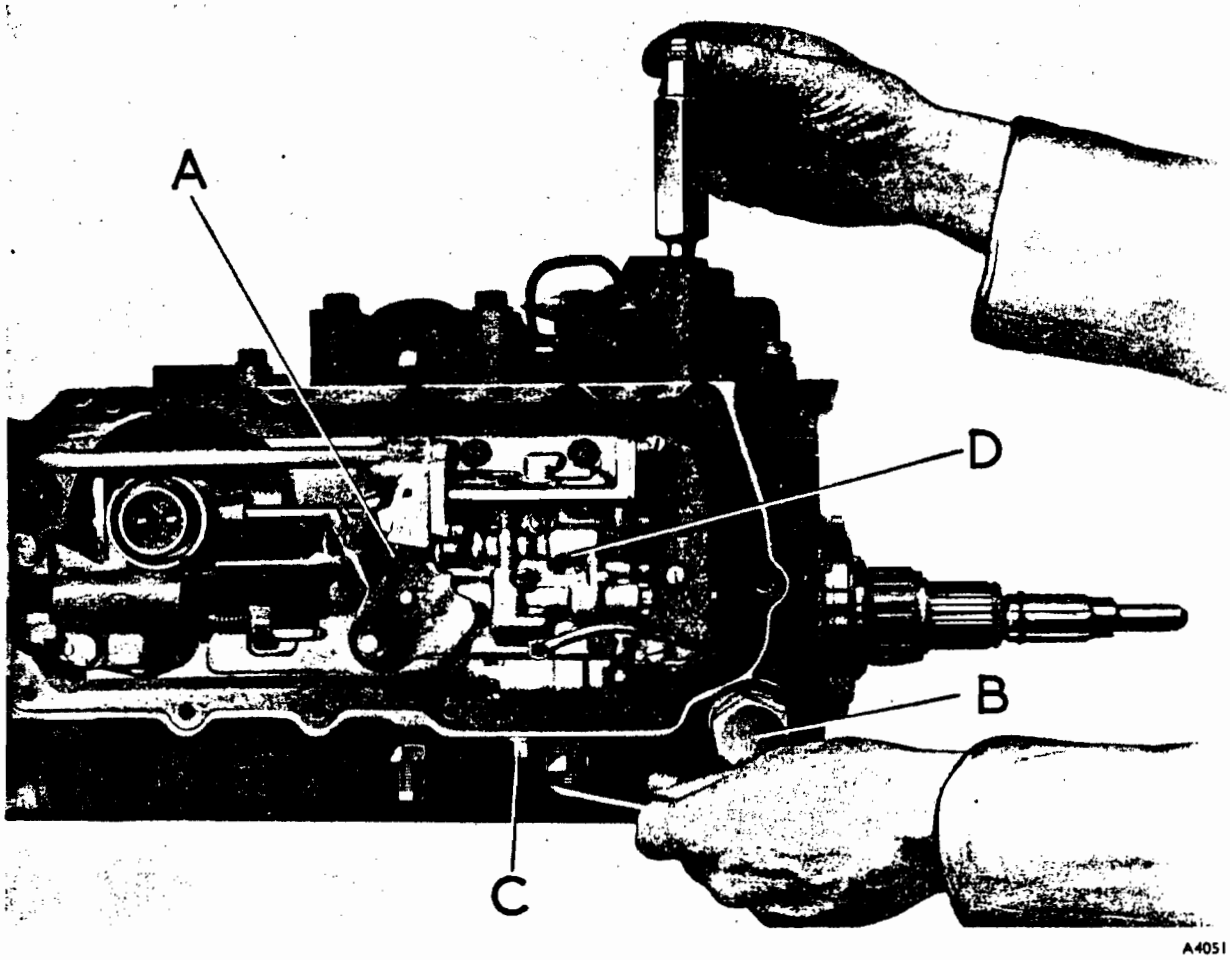

Fig. FF.22

Front band adjustment

A. Notched plate and plunger. B. Pressure control valve. C. Blanking plug, oil pressure take-off. D. Control valve unit.

Rear band (see Fig. FF.23)

Slacken the adjusting screw until there is a clearance between the operating rod and the operating lever. Centralize the rear band by turning the drum opposite to normal rotation.

The band setting gauge (18G489) must be held as illustrated with the cut-away leg (A) held firmly against the spring end of the servo, the other end resting on the servo operating rod. The band adjustment screw must now be screwed in until the face of the operating lever just touches the gauge.

Great care must be taken to ensure that the operating lever does not push the gauge or an incorrect setting will be obtained.

Should this occur, slacken the adjusting screw again and recommence the setting operation, which must be done with the operating lever moving towards the servo and never away from it.

Tighten the locknut to its correct torque loading and check that the setting has not altered.

Replace the governor pipe, the filter, and the sump and refill the gearbox as previously described.

Towing

Towing should be confined to as short a distance as possible and towing speed should not exceed 25 m.p.h. (40 km.p.h.).

Prior to towing, the gearbox must be examined for mechanical damage or leaks. On no account must the car be towed if the oil level is low or the gearbox is damaged in any way.

The rear band must be slackened by unscrewing the adjustment screw five turns and the selector lever must be in neutral when towing.

Should the oil level be low or the gearbox faulty and no facilities are available for transporting the car, then it is permissible to disconnect and remove the propeller shaft before towing.

Section FF.4

CHECKING FOR LEAKS

Fig. FF.24 illustrates the possible sources of oil leakage. Should oil leaks be discovered when checking, ascertain the point from which oil is leaking. The table on the following page gives the required action to rectify leakage.

In most cases rectification will entail the removal of the gearbox. Before removal, however, top up the

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gearbox to its correct level and carry out a road test to check change points and gearbox operation.

When replacing the gearbox, threads of bolts which may allow leakage should be treated to a light application of jointing compound. On no account must jointing compound be used internally as this may cause defective gearbox operation.

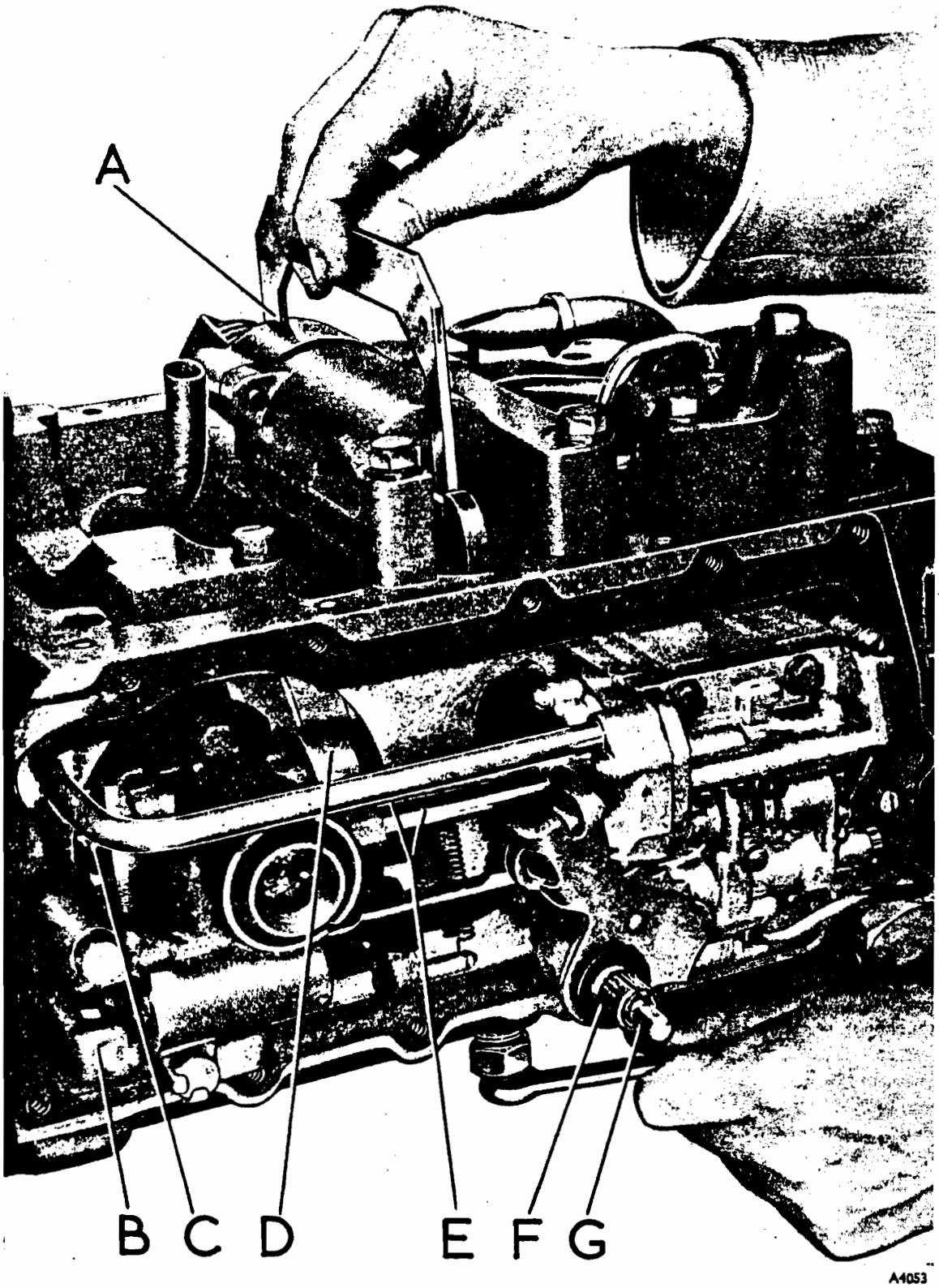

Fig. FF.23

Rear band adjustment

A. Cut-away leg.
B. Parking pawl.
C. Small governor weight.
D. Large governor weight.
E. Governor pipes.
F. Selector spindle.
G. Throttle valve spindle.

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Section FF.5

TESTING

Three types of test can be made to ascertain the operating efficiency of the automatic gearbox. They are:

(1) A road test to check gear changes.

(2) An oil pressure test.

(3) A stall test.

(1) **The road test** should be carried out and the change points checked with the table. Before commencing this or any test ensure that the engine is in good condition and correctly tuned, that the control linkage settings are correct, and that the oil is at the correct level.

When a gear change occurs it can be recognized by the change of engine and gearbox note.

At low throttle openings the change should be quiet and smooth, gradually getting more noticeable as engine torque increases.

An indication of band slip is given when the engine has either a tendency to speed up on the up changes or a tendency for the car to lose road speed on the down changes.

As each change occurs the speedometer readings, correct or otherwise, should be recorded and the complete test continued until all readings have been obtained.

The result should be compared with the table of change points and also with the fault diagnosis table should a defect exist.

The symptoms of faulty control linkages are included in the fault diagnosis table, but, as stated previously, these should be checked before commencing any work on the gearbox.

Slight variation from the figures quoted in the table are permissible, provided the changes are smooth and that no other symptom of incorrect operation exists.

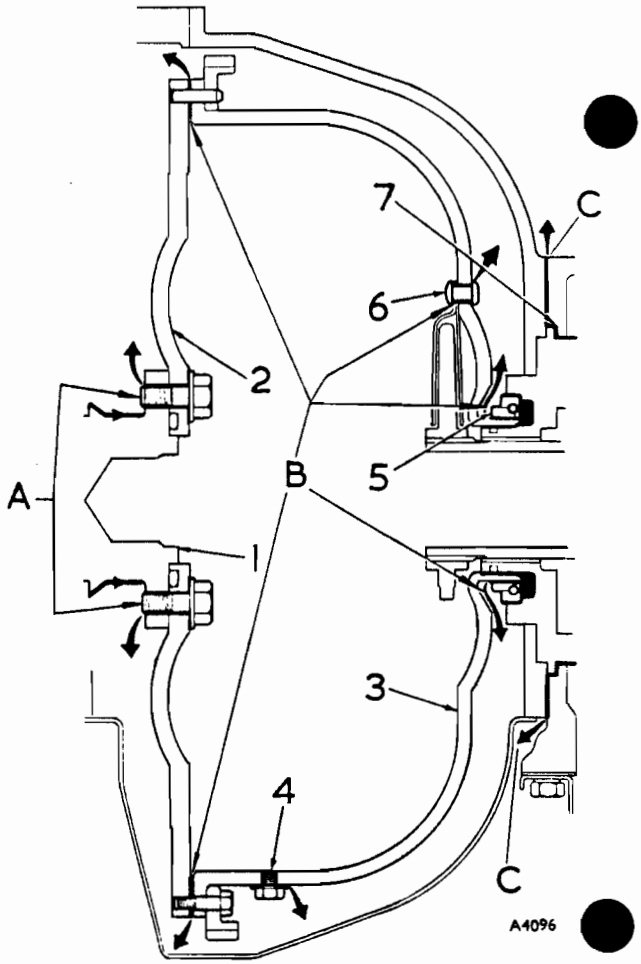

Fig. FF.24

Sources of leakage

1. Crankshaft.
2. Flywheel.
3. Torus cover.
4. Drain plug.
5. Front cover oil seal.
6. Damper rivets.
7. Front cover jointing.

OIL LEAKS

Source of leak	*Rectification*
A. Between flywheel and crankshaft flange (see Fig. FF.24)	Remove gearbox and flywheel and remake flywheel to crankshaft joint.
B. Torus cover and flywheel (see Fig. FF.24)	Check that torus cover drain plug is fitted correctly. Remove gearbox and fit a new joint washer between torus cover and flywheel. Check front cover oil seals and damper rivets.
C. Front of transmission behind bell housing (see Fig. FF.24)	Remove gearbox, remove front oil pump, remake front cover joint, check front oil seals.
D. Oil sump	Check drain plug. Fit new joint washer to sump.
E. Side cover	Check pressure line blanking plug. Fit new side cover joint washer. Check oil seals on throttle and selector shafts.
F. Rear of transmission	Remove gearbox, examine rear oil seal. Fit new joint washer to rear housing.

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(2) **The oil pressure test** can be carried out either in conjunction with the road test or with the car stationary and the rear wheels jacked up.

This test requires the fitting of an oil pressure gauge to a tapping in the gearbox casing which is provided for this purpose. This tapping is situated between the band adjustment screws on the left-hand side of the gearbox.

The table given on the following page gives the order in which the oil pressure tests must be carried out.

Run the engine for a few minutes prior to testing in order to warm up the gearbox oil.

(3) **The stall test** is used to ascertain that the full engine torque is transmitted by the gearbox without any band slip.

Run the engine for a few minutes to warm up the gearbox. Ensure that the engine is in good condition as low engine power will give an incorrect test result.

Block the road wheels, fully apply the brakes, place the selector in range 4, and apply full throttle.

The slip of the fluid coupling will absorb the torque and the engine speed is a measure of the torque being absorbed.

The engine must not be run at full throttle for longer than 30 seconds, and should the engine speed exceed the r.p.m. quoted below, close the throttle immediately.

The gearbox is satisfactory if, during the stall test, the engine revolutions are between 1,700 and 1,800 r.p.m. A low r.p.m. will indicate a faulty gearbox, probably caused by a faulty control valve unit or sticking governor valves. A high r.p.m. will indicate slip, the source of which can be traced by reference to the road and oil pressure test results.

When the test is completed select neutral and let the engine idle for a few minutes to circulate the oil and cool the fluid coupling.

Section FF.6

OIL PRESSURE

From the fault diagnosis table it will be observed that a considerable number of symptoms, indicating defects, are due to incorrect oil pressure. This fault can easily be proved or disproved by the oil pressure test, when a simple process of elimination will ascertain the cause.

Consistently incorrect pressures in all selector positions may be caused by faults in any of the following and should be checked in the order given.

The throttle control linkage can cause high pressure at low throttle openings and low pressure at high throttle openings and should be checked as previously described on page FF.18.

The pressure control valve can give high, low, or inconsistent pressure and must be removed for examination and cleaning as will be described.

Low pressure that may be caused by leaking pipes or joint faces will be found, after removal of the sump and side cover, by examining all pipes and units before removal.

The pump inlet pipes and filter should be examined as low oil pressure will result if any restriction is present. Front pump restriction can give faulty operation of the gearbox when the car is stationary or moving slowly, but rear pump restriction can only be ascertained when coasting with the engine switched off. When checking this, car speed must be kept below 20 m.p.h. (32 km.p.h.) and the test kept down to the shortest time possible.

Sluggish operation of the control valves in the control valve unit, the front or rear servo, or the governor may be caused by obstruction in the oil passages or kinked pipes on the pressure side of the system.

Too high or too low an oil pressure can be caused by the control valve unit and should be dealt with as will be described later.

CHANGE POINTS

RANGE 4

	Up changes (m.p.h.)			*Down changes (m.p.h.)*		
	1—2	2—3	3—4	4—3	3—2	2—1
Light throttle	5 (8)	9 (14·5)	16 (26)	10 (16)	5 (8)	3 (4·5)
Full throttle	13 (21)	24 (38·5)	51 (82)	44 (70·5)	14 (23)	6 (10)

RANGE 3

	1—2	2—3	3—4	4—3	3—2	2—1
Light throttle	5 (8)	9 (14·5)	51 (82)	51 (82)	5 (8)	3 (4·5)
Full throttle	13 (21)	24 (38·5)	51 (82)	51 (82)	14 (23)	6 (10)

NOTE.—Down changes on full throttle are kick-down changes.
Figures in parentheses are approximate km.p.h. equivalents.

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OIL PRESSURE TESTS

Test condition	*Selector range*	*R.P.M. or M.P.H.*	*Pressure lb./sq. in.*
Engine running, car stationary	4	375 r.p.m.	50 (minimum)
Engine running, car stationary	3	375 r.p.m.	50 (minimum)
Engine running, car stationary	2	375 r.p.m.	50 (minimum)
Engine running, car stationary	R	375 r.p.m.	130 (minimum)
Car reducing speed with throttle closed	4	18 to 20 m.p.h.	60 (minimum)
Car increasing speed at full throttle (not forced)	4	18 to 20 m.p.h.	85 to 93
Brakes fully on, half throttle	R	—	135 (minimum)
Coast with the engine stopped	4	Not more than 20 m.p.h.	50 (minimum)

Low pressure can be caused by the parking brake bracket and should be checked after removing the side cover and applying the air pressure test as will be described in the following section.

The rear pump and governor unit may cause low pressure and can also be checked by the air pressure test.

A defective main exhaust valve in the front servo will also result in low oil pressure.

High or low oil pressure can be caused by the front pump. It will be necessary to remove and partially dismantle the gearbox to rectify any defect.

Should the front torus relief valve stick, this will allow oil to drain from the fluid coupling when the engine is stopped.

Section FF.7

AIR PRESSURE CHECK AND INVESTIGATION

Before commencing these tests the sump, side cover, and control valve unit must be removed. The air pressure tests will in some cases ascertain that a unit is working correctly; in others it will indicate any sources of excessive oil leakage and so assist in making a correct diagnosis of defects.

Drillings in the gearbox casing, to which air pressure should be applied, will be revealed after removal of the control valve unit and the reverse clutch oil pipe. An adaptor should be connected to an air supply of approximately 80 lb./sq.in. (5·6 kg. cm.²). See Fig. FF.25 for identification of the oil passages.

Front servo

The front band will be applied when air pressure is applied to the front band apply passage. Small air leaks through the joint face of the servo to casing from 4—3 timing valve exhaust hole and from the front band release passage are permissible. Excessive leakage from the front band apply passage or the compensator passage will probably cause slipping on the 2—3 up change or when starting from rest.

Application of air pressure to the front band release passage will not operate the servo as it is returned by spring pressure; however, this test will indicate undue leakage.

A slight leakage is permissible past the piston ring gaps, but excessive leakage will cause slipping on the 3—4 up change and if very bad will cause missing of second and top gears. Slipping in range 3 may be caused by the over-run control valve sticking.

A slight leakage should occur when air is applied to the G.1 to 4—3 timing valve passage, but only from the valve retainer clip and the front band apply passage.

Incorrect positioning of the 4—3 timing valve by the retainer, or a sticking valve, may result in intermittent slipping, in all drive ranges, but most probably on the 2—3 up change and the 4—3 down change. This defect can also cause a rough 4—3 down change.

Rear servo

Pressure applied intermittently to the rear band release passage will operate the rear servo and release the rear band. Leakage will occur through the piston ring gaps but must not be sufficient to affect servo operation.

Slight leakage may occur from the servo to casing face joint and from the compensator passage, but from nowhere else. Slipping on the 2—3 up change or a rough closed throttle 3—2 down change will occur if this leakage is excessive.

A faulty restrictor valve, the exhaust valve sticking open, or the servo piston sticking when applying the band cannot be diagnosed with the air pressure test, but the result of these faults would be a rough 3—2 closed

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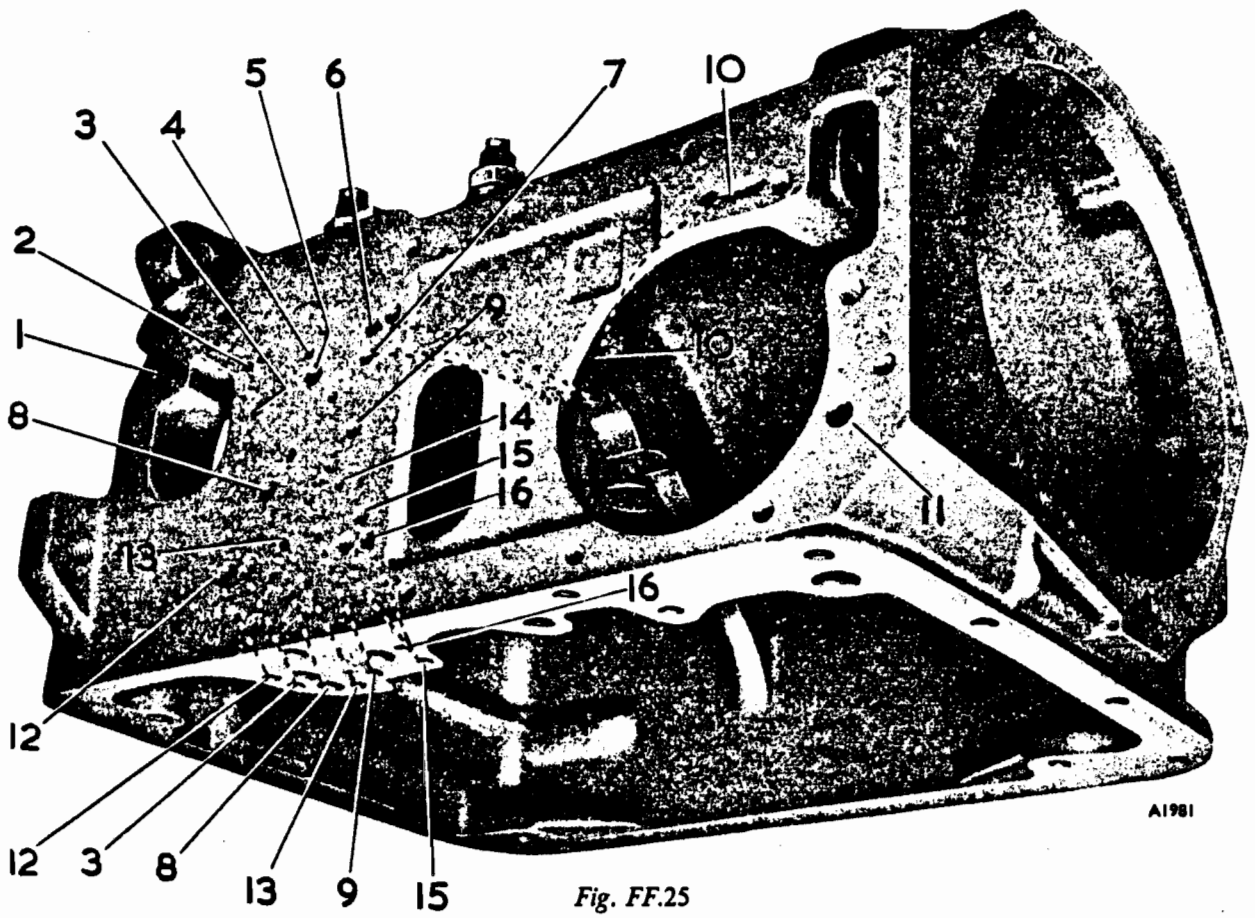

Fig. FF.25

Identification of oil passages

1. Reverse booster oil.
2. T.1 pressure.
3. Front band release.
4. Line pressure to blanking plug.
5. Exhaust.
6. Rear clutch apply.
7. Front clutch apply.
8. Main pump feed passage.
9. 1—2 oil to rear servo exhaust valve.
10. Governor feed.
11. Reverse clutch apply.
12. Front band apply.
13. G.1 pressure to front servo.
14. Exhaust.
15. Compensator pressure.
16. Rear band release.

throttle down change or slow band apply when changing from neutral or reverse to forward drive.

A slight leakage past the piston rings on both servos will occur when pressure is applied to the compensator passage. If this leakage is excessive it will cause slipping on all heavy throttle up changes.

Front epicyclic unit

Air pressure applied intermittently to the front clutch apply passage will cause the operation of the front clutch to be heard or felt. To check the source of any excessive air leakage it will be necessary to remove both servos so as to ascertain whether the leakage is from faulty clutch piston seals or a faulty oil delivery sleeve. Leakage from the latter may affect front or rear unit operation, or both.

A loose or badly fitted bearing cap may be the cause of leakage; this is easily rectified. Any other reason for the leakage will entail gearbox removal to check the front unit or oil delivery sleeve.

Pressure loss sufficient to allow the clutch to slip will cause slipping on the 1—2 and 3—4 up changes and, if excessive, missing second and top gears.

If, due to faulty gears, the front unit is locked first and third gears will be missed. This fault will not be indicated by air pressure test.

Rear epicyclic unit

Air pressure is applied to this unit's clutch apply passage and checked in the same way as the front unit. The symptoms shown if the clutch of this unit is slipping will be slip on the 2—3 up change.

If, as a result of leakage from the oil delivery sleeve, both clutches are slipping there will probably be no up change above first gear.

Reverse epicyclic unit

Test the reverse unit clutch in the same way as for the front and rear clutches. Excessive leakage will indicate faulty piston seals which will cause slipping or no drive in reverse. The gearbox must be removed and dismantled to rectify this fault.

After moving the selector lever from reverse, should the reverse clutch stick in engagement the transmission will lock. It may be possible to rectify this fault without

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dismantling by operating the transmission to free the clutch and burnish the clutch faces at the same time.

With the engine running and the brakes firmly applied, select reverse, increase the engine speed, then select range 2. As the change occurs reduce engine speed to idling. This procedure must not be carried out more than five times, and if the transmission is still not free it will be necessary to dismantle the gearbox for detailed examination.

If the transmission does free itself satisfactorily by using the above method the clutch should be burnished as follows.

Drive the car forward slowly and then select reverse while the car is moving. When the change is nearly complete select forward drive again.

Repeat this operation five or six times, then select range 4 and drive at about 20 m.p.h. (32 km.p.h.) for a few minutes to cool the gearbox.

Repeat the above procedure again and then road-test.

Governor and parking bracket

Excessive leakage from the parking brake bracket and governor can be checked by removing the governor feed pipe and refitting it so that the end of the pipe which fits into the front servo is clear of the side of the gearbox and the other end is in its correct position.

Press the governor weights inwards to close the ports and apply air pressure to the end of the pipe. Slight leakage will occur past the piston ring gaps in the governor sleeve, from the G.1 and G.2 passages and valves, and possibly from the parking and reverse blocker pistons. Little or no leakage should occur from the bracket to casing face joint. Excessive leakage from this unit would prevent up changes.

If, due to low governor pressure, the reverse blocker sticks in, reverse engagement would be possible at over 10 m.p.h. (16 km.p.h.). If, due to a leakage of main pressure into the governor passage (broken piston ring), the reverse blocker sticks out, it will prevent reverse engagement.

Clashing when reverse is engaged will be due to incorrect parking pawl operation.

There should be no tendency for the governor valves to stick, and if, during the air pressure check, the valves are moved outwards there should be an increase of the air flow from the G.1 and G.2 passages and the exhaust ports of the governor valves.

Excessive leakage due to sticking governor valves will cause high or low up changes slipping in ranges 4 and 3 or slipping with no drive in reverse.

During this air pressure diagnosis procedure the main pump feed passage, the exhaust port for the control valve unit, and the passage to the pressure gauge blank may also be checked.

A large escape of air from the rear of the front pump will result when air pressure is applied to the main pump feed passage. This pressure escapes from between the front drum and the front pump and will indicate that the feed line is clear or otherwise.

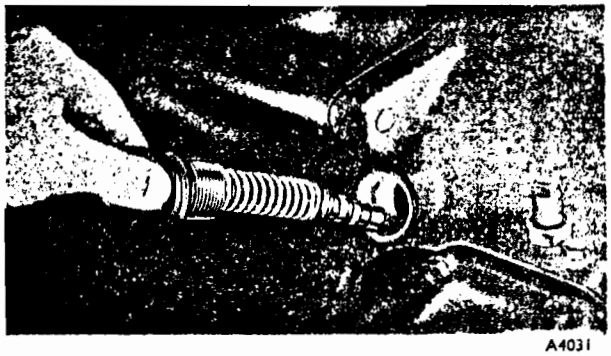

Fig. FF.26
The pressure control valve

The exhaust port for the control valve unit should give unrestricted flow through the casing.

Pressure control valve

The pressure control valve is spring-loaded and care must be taken when removing it to ensure that the damper spring, the reverse booster plug, and the throttle regulator plug do not fall out (see Fig. FF.26).

Clean the valve thoroughly and air-blast the reverse booster and throttle regulator plug passages. Check that the plugs and the pistons move freely in their bores and use petroleum jelly to retain the parts in position when reassembling.

Before refitting the pressure control valve it is advisable to motor the engine, using the starter, in order to flush the piston valve bore.

Do not use any cleaning solution other than clean gearbox fluid.

Control valve unit

When removing the control valve unit (this will be described later) check before removal that the four securing screws are tight. Should any leakage have been present between the face joints of this unit, the valve operation would have been seriously affected.

Fluid coupling

Except in the unlikely event of damage to the torus members, faulty gear changes or slipping should not be due to the fluid coupling. However, slipping, overheating, and possibly excessive vibration will occur if the torus members are damaged.

A leaking torus check valve may give temporary slipping on starting due to insufficient oil in the fluid coupling and will rectify itself as the coupling fills up.

To check this defect the dipstick is used, as leakage from the coupling check valve will raise the gearbox oil level. The following procedure should be carried out.

Check the oil level in the normal way, as previously described, then switch off the engine and wait 10 minutes. Re-check the oil level without running the engine, and if it has risen more than ½ in. (1·3 cm.) the leakage can be considered excessive and must be rectified.

To rectify any fault due to the fluid coupling it will be necessary to remove the gearbox.

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Section FF.8

NOISY OPERATION

The method of testing to isolate the source of any undue noise is as follows.

A low growl at idling speed which increases to a high-pitched whine as speed increases will be due to the planet gears. The front unit noise has a higher pitch than the rear unit and noise from the reverse planet gears will only be heard when accelerating in reverse. Accelerating through the gears in range 4, paying particular attention to the noise at the change points, will give an indication to the noisy unit. If the front unit is at fault the noise will be apparent in first and third gears, but if the noise is in first and second gears the rear unit will be at fault.

Slight gear noise in neutral disappearing when drive is selected and noise when slowing down in reverse may usually be attributed to the rear unit.

Noise from either of the oil pumps generally reaches a peak at certain revolutions. To diagnose which pump is noisy is quite straightforward due to the fact that the front pump only operates when the engine is running and the rear pump only when the output shaft is turning.

Commence the test with the engine running and the selector in neutral. Open the throttle slowly: this will indicate whether the noise is in the front pump or not.

Then select range 4 and drive until the noise is most audible, then quickly select neutral and switch off the engine. If the noise still persists and was not noticeable when the car was stationary, then the defect lies in the rear pump.

Noise from the rear pump will probably be due to one of two faults, the first being the driving gear.

A noise similar to axle whine can be produced by this drive and, if present, would be most noticeable about 20 m.p.h. (32 km.p.h.). This noise will probably be so like axle whine that to arrive at a definite diagnosis it may be advisable to disconnect the front end of the propeller shaft, select range 4, and run the engine at the speed at which the noise was most audible.

The other noise is a low growl which may appear at speeds above 35 m.p.h. (56 km.p.h.) and can be caused by the inner pump gear.

IMPORTANT.—The only time it is permissible or necessary to coast in neutral is during this test; the speed must not exceed 20 m.p.h. (32 km.p.h.) and must be kept to the absolute minimum time necessary to confirm or eliminate a rear pump fault. It is possible and, should the rear pump be faulty, probable that inadequate lubrication may result, but more important is the fact that the gearbox in this condition may operate incorrectly and serious damage may occur.

Unless the fluid coupling is damaged or wrongly fitted it is very unlikely to cause noise. Should any of the rotating parts be fouling, then a metallic scraping noise would result.

Increased gear noise in neutral could possibly be caused by worn splines on the torus members.

Section FF.9

ACCESSIBILITY OF UNITS

The following units can be removed without the removal of the gearbox:

(1) Pressure control valve.
(2) Control valve unit (after removal of the side cover).
(3) Parking brake bracket (after removal of the side cover and the control valve unit).
(4) Rear pump and governor (after removal of the side cover, sump control valve unit, parking brake bracket, and both servos).
(5) Front and rear servos (after removal of the sump; requires readjustment of the bands after replacing).

The following units can only be removed with the gearbox removed from the car:

(1) Fluid coupling.
(2) Front oil pump.
(3) Front epicyclic unit.
(4) Rear epicyclic unit.
(5) Reverse epicyclic unit.

Section FF.10

GEARBOX REMOVAL AND REPLACEMENT

General

Cleanliness cannot be over-emphasized whenever work is carried out on the gearbox. Thoroughly clean the casing before commencing any dismantling. Ensure that all tools used are clean and that all fluid used for cleaning together with the fluid containers are also clean.

When washing parts use a brush, compressed air, and clean fluid. Do not use rag.

All internal joints are made by specially machined faces. They must not be refaced, neither must jointing compound be used. When reassembling, always renew external joint washers.

It is advisable that all thrust washers are labelled when removed; this factor will greatly assist inspection and assembly when rectification is completed.

Only gearbox fluid must be used for oiling parts when reassembling and only petroleum jelly for any parts that require holding in position.

Removing

Although the removal of the gearbox alone is possible and is a comparatively straightforward operation, the replacement of this unit is difficult due to its weight and the importance of correctly fitting the torus cover and its joint washer to the flywheel.

In view of this fact the engine and gearbox must be removed as a unit in the normal manner as described in Section A.

When removing the engine great care must be taken to avoid bending or damaging any of the rods and levers which comprise the throttle and selector linkages.

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With the engine/gearbox assembly removed, ensure that the gearbox is adequately supported, when it can be removed from the engine as follows.

Remove the throttle valve and selector levers from the gearbox.

Remove the bell housing bottom cover and drain the gearbox and fluid coupling.

Remove the starter motor.

Remove the set screws (30 in all) which secure the torus cover to the flywheel.

Remove the set screws which connect the two halves of the bell housing.

The gearbox can now be removed from the engine.

Replacing

If fitting a replacement gearbox, it will be supplied without the fluid coupling and bell housing. This is because the two halves of the bell housing are machined together in pairs and the torus cover and inertia ring are fitted to the flywheel for crankshaft balancing.

The rear half of the bell housing, the torus cover, the inertia ring, the driving torus, and the driven torus, therefore, must be transferred from the old gearbox to the replacement.

A replacement engine will be supplied with its balanced torus cover and the bell housing. It is important that the torus cover and inertia ring remain with the correct crankshaft and flywheel.

Two dowels, one of larger diameter than the other, are fixed to the inertia ring; this ensures that the assembly cannot be incorrectly fitted to the flywheel. If balancing weights are fitted, particular attention must be paid to ensure that they are refitted in their correct positions.

When reassembling always fit a new torus cover to flywheel joint washer.

Reverse the removal procedure to refit the gearbox, fill the gearbox to the correct level with fluid as previously described, and check the control linkages.

NOTE.—When a new gearbox is fitted it is advisable to have the car positioned so that it can be driven forward on completion of the work. If reverse is selected immediately, before the whole of the unit is thoroughly lubricated and turned over, the extremely high oil pressure used to operate the reverse cone clutch may cause the cones to stick in engagement. Should this fault occur, the procedure given in Section FF.7 must be carried out.

Prior to road-testing run the engine with the selector in neutral for a few minutes and check for leaks.

Section FF.11

FLUID COUPLING

Removal of the fluid coupling can only be effected after removing the gearbox from the car. During this operation all parts should be thoroughly checked for signs of oil leakage, defects, and wear.

Check that the mainshaft nut is tight before removing it. If this nut is loose, noisy gearbox operation, with consequent wear, may have resulted.

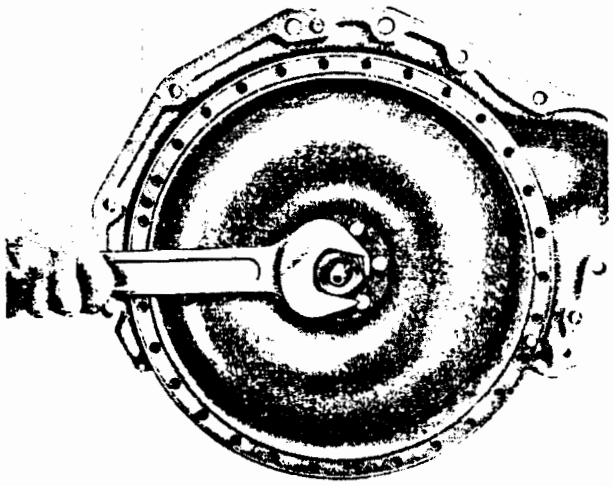

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Fig. FF.27

Removal of mainshaft nut

Excessive play in the splines of the torus members or the torus cover can also result in noisy operation of the gearbox and this should be checked before removal. Mark the mating splines for reassembly if the fit is satisfactory.

Dismantling

The mainshaft can be locked to facilitate the removal of the mainshaft nut by moving the selector lever on the gearbox to the reverse position, which will engage the parking pawl.

After removal of the mainshaft nut (Fig. FF.27) and locking plate the front or driven torus member can be withdrawn from the mainshaft splines. A sharp blow with a soft-faced hammer on the end of the mainshaft will free the splines if the torus member is difficult to remove.

Remove the snap ring from the intermediate shaft and remove the driving torus (Fig. FF.28).

Excessive intermediate shaft end-float may also cause noise. This can now be checked at this stage by pulling

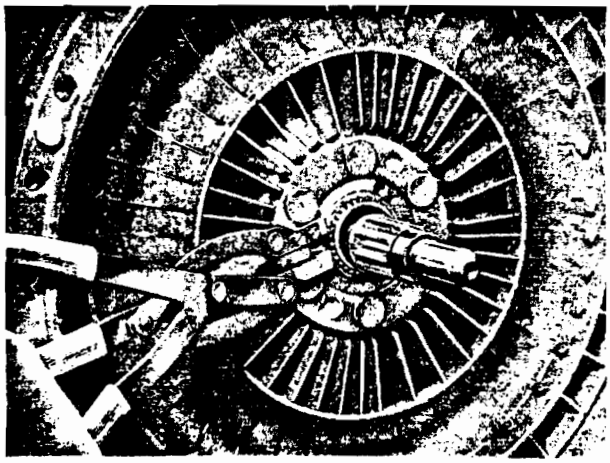

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Fig. FF.28

Removal of driving torus

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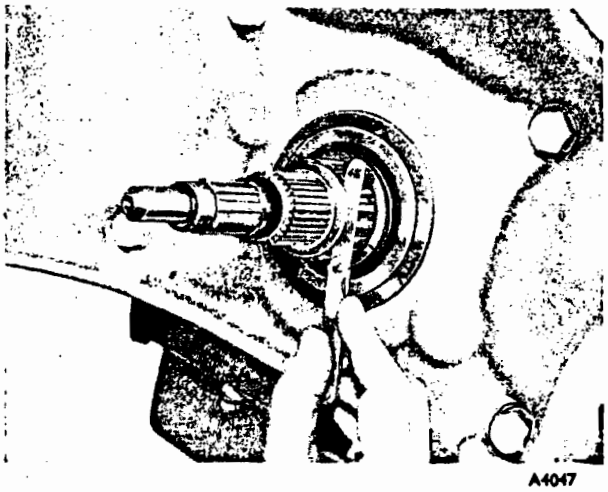

Fig. FF.29
Checking intermediate shaft end-float

the intermediate shaft forward and inserting a feeler gauge between the bronze washer and the end of the front drive shaft as in Fig. FF.29. The correct thickness of replacement steel washer required can now be ascertained, if the end-float is incorrect, by reference to the summary.

The torus cover should now slide freely off its splines; if not, it must not be rocked excessively, or the oil seals may be damaged. Push the cover backwards firmly, then jerk it forward off the shaft as shown in Fig. FF.30. Great care must be taken to ensure that the machined sealing surfaces of the torus cover neck are not damaged.

Do not place the torus cover on the bench or floor neck downwards; this will tend to damage the machined edge. This edge, if damaged, will render the oil seal in the front pump unserviceable when the cover is replaced.

If necessary, the rear half of the bell housing may now be removed.

The torus relief valve (A, Fig. FF.31) can now be checked for freedom of operation, and if there is no complaint of slip, as previously described in connection with this valve, then cleaning without dismantling should be sufficient. If it is necessary to remove the valve a new valve retainer should always be fitted.

Inspect the splines of the shafts, torus members, and torus cover for any signs of wear or damage.

Check all rivets and the torus vanes for slackness.

Examine the torus cover neck for damage and then remove the piston ring oil seal from the front drive shaft, fit it into the torus cover neck, and check the ring gap. This should be between ·002 and ·010 in. (·051 and ·254 mm.).

Inspect the torus cover to flywheel joint face for damage or distortion which may allow oil leakage.

Check both halves of the bell housing for cracks or damage.

Check the condition of the torus cover oil seal and, if necessary, fit a new seal into the front pump housing as described in Section FF.18.

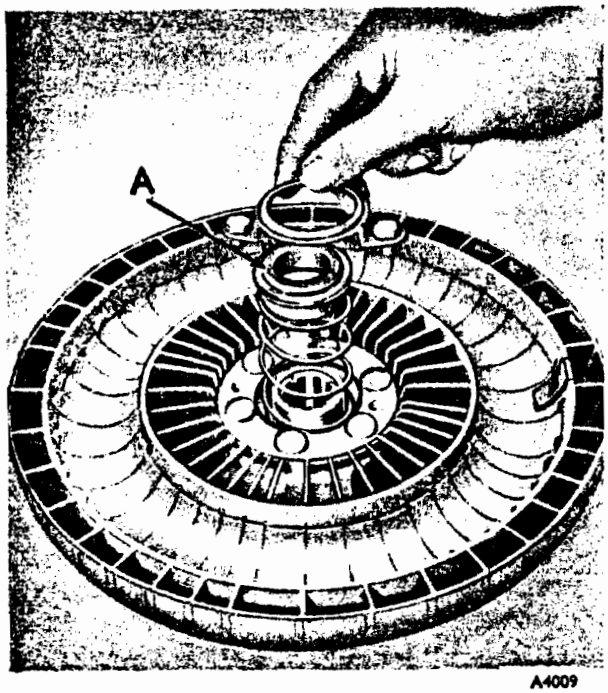

Fig. FF.31
Removal of torus relief valve

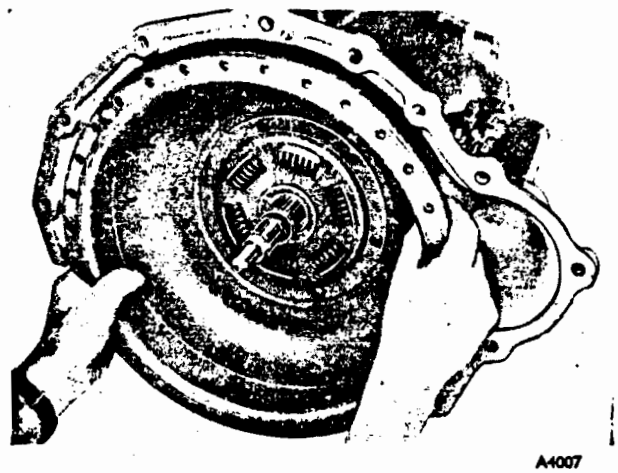

Fig. FF.30
Removing the torus cover

Reassemble the fluid coupling by reversing the dismantling procedure. Ensure that all snap rings are correctly positioned, new joint washers fitted, and that all set screws, nuts, and bolts are tightened to the correct torque loading given in the summary.

If the bell housing has been renewed check the 'nip' of the front oil pump flange as in Section FF.18.

Section FF.12

SIDE COVER, SUMP AND FILTER

It should only be necessary to remove these items when investigating defects, adjusting bands, or for periodically cleaning out the sump.

Carefully examine the side cover and sump for leaks, and prior to removal clean off the gearbox and also the

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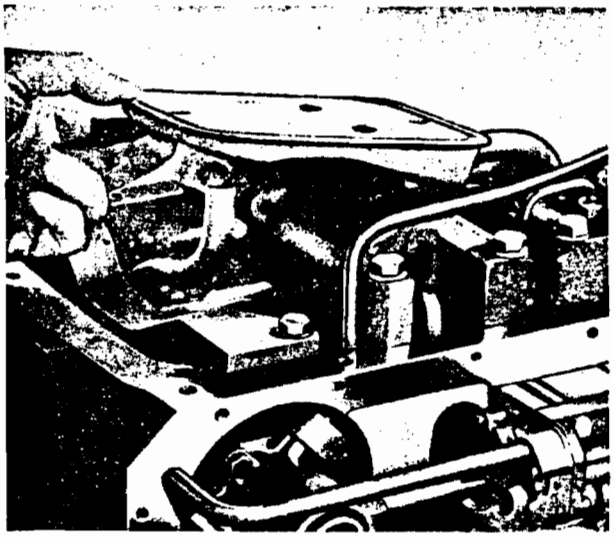

Fig. FF.32
Removal of the filter

chassis in the vicinity to eliminate the possible entry of dirt into the gearbox.

Before removing either the side cover or sump the gearbox must be drained.

The throttle and selector levers must also be removed prior to removing the side cover.

Examine the sump after removal for damage, cracks, sludge, or other deposits such as white metal or bronze powder, which may indicate incipient failure.

Remove the filter by easing it off the rear pump feed pipe and then sliding it backwards off the front pump feed pipe (see Figs. FF.32 and FF.33).

Examine and clean the filter thoroughly, using a brush; do not use rag.

Before refitting the filter, sump, and side cover check as far as possible the interior of the gearbox for cleanliness security of pipes, and that all nuts and bolts are tight.

Fit new joint washers when fitting the sump and side cover, refill the gearbox with fluid, and check for leaks.

Refit the throttle and selector levers and check the control linkages. The levers can only be fitted one way, due to offset splines.

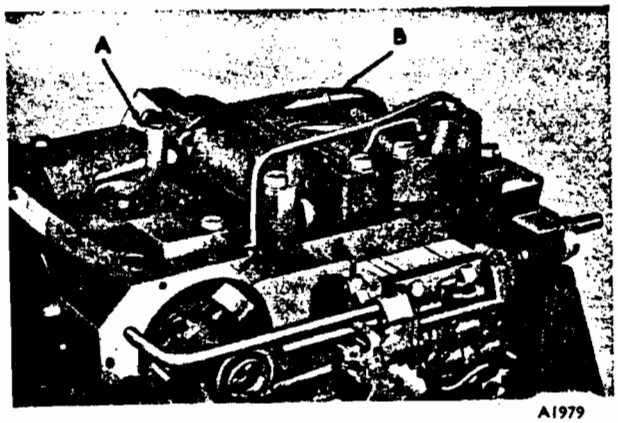

Fig. FF.33
Filter removed, showing:
A. Intake for rear pump. B. Intake for front pump.

Section FF.13

CONTROL VALVE UNIT

To remove the control valve unit, the side cover must be removed, and it is recommended that the sump be drained and removed to avoid oil spillage and the risk of foreign matter entering the sump while work is being carried out.

If after carrying out the fault diagnosis procedure faulty operation of the control valve unit is indicated, the unit must be changed.

When handling the control valve unit absolute cleanliness is imperative. Minute particles of fluff derived from cloth or even from the hands are sufficient to prevent correct operation of the unit, should these particles enter any of the valve bores.

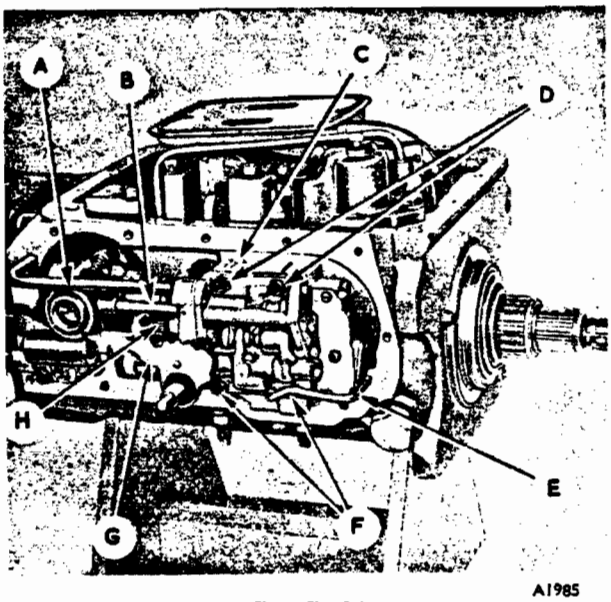

Fig. FF.34
Gearbox with side cover and sump removed, showing the disconnection points for the control valve unit

Whenever this unit is removed from the gearbox it should be protected by wrapping in waxed paper or placed in a clean tin or plastic container until required.

After removal of the sump and side cover, remove the pressure control valve oil pipe (E, Fig. FF.34) from its sockets at the front of the unit and the gearbox casing.

It may be found necessary to use slight leverage under the bends of the pipe in order to remove it. Remove the parking pawl spring (H).

The four bolts which secure the unit to the casing should now be checked for tightness as oil leakage from the face joints (C), with consequent faulty operation, may have been caused if these bolts are loose (see D and F, Fig. FF.34).

Ensure that the internal selector lever (G) is clear of the parking lever and remove the four securing bolts. Pull the control unit just clear of the gearbox casing and slide it towards the front end, as shown in Fig. FF.35, easing it sideways gently to free the reverse unit pipe (A) and governor pipes (B). These pipes can now be removed.

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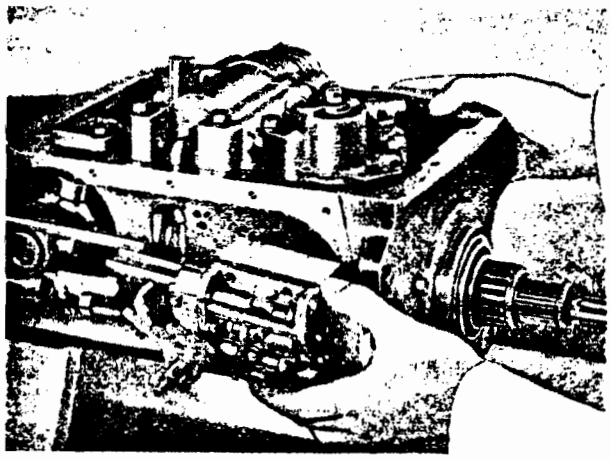

Fig. FF.35

Removing the control valve unit

Testing

The control valve unit can only be tested in service for correct operation by road test; however, the freedom of the shift valve groups and the overspeed or safety valve in their bores can be checked, prior to refitting the control valve unit, by further air pressure tests.

Air pressure applied intermittently to the G.1 passage (see Fig. FF.36) should cause the 1—2 shift valve group to move to and fro in its bore.

Cover the rear face of the unit with a sheet of transparent plastic which must be clean, flat, and rigid. This must be held in position by hand and will enable the movement of the valve groups to be observed, at the same time preventing the escape of air.

If plastic is not available, the areas as shown in Fig. FF.36 must be suitable covered.

Cover area (A) and apply air pressure intermittently to the G.1 oil duct; the 2—3 shift valve group should now move to and fro in its bore.

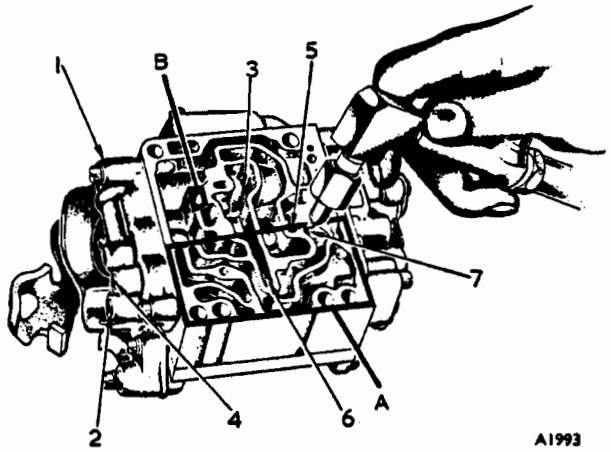

Fig. FF.36

Air pressure check points

1. Overspeed or safety valve.
2. G.1 oil duct.
3. 2—3 shift group.
4. G.2 oil duct.
5. 1—2 shift group.
6. 3—4 shift group.
7. G.1 passage.

With area (B) covered and air pressure applied intermittently to the G.2 oil duct, the 2—3 and 3—4 shift valve groups should move to and fro; the overspeed or safety valve should also move. It may, however, be difficult to observe the movement of the overspeed valve, but if a stiff piece of wire is inserted through the spring and allowed to rest on the valve it will indicate when the valve moves.

It will be noted that the 2—3 shift group will move when pressure is applied to both the G.1 and the G.2 oil ducts.

Refitting

Examine for cleanliness the mating faces of the unit and the gearbox casing.

Fit the governor oil delivery pipes in their bores in the parking bracket. Refit and align the reverse clutch oil pipe.

Engage the three oil pipes in the bores in the control valve unit, replace the four securing bolts, and tighten them evenly to the correct torque loading.

Fit the pressure control valve pipe into its sockets in the control valve unit and the gearbox casing and tap it gently home.

Replace the parking pawl spring, the side cover, and the sump.

Refit the control levers, check the throttle and selector linkages, and road-test.

Section FF.14

PARKING BRAKE BRACKET

To remove the parking brake bracket and governor sleeve assembly, first remove the side cover, the control valve unit, and the parking pawl spring from the bracket to the inner governor pipe.

Remove the reverse clutch oil pipe from its drilling in the gearbox casing.

Remove the parking pawl support bolt. This bolt is one of the rear housing securing bolts as well as acting as the pivot for the parking pawl (see Fig. FF.37).

The roller can now be removed from the crank pin on the parking brake bracket and the parking pawl will be left loose in the casing. The pawl cannot be removed until after the parking bracket.

Remove the two bolts which secure the parking bracket to the casing and slide the assembly off the governor tower. A sharp jerk may be necessary to remove the bracket if any difficulty is experienced. This will be due to the piston ring seals wearing slight grooves in the governor sleeve. The parking pawl may now be removed from the casing.

Unless previous fault diagnosis has indicated a fault in the reverse or parking pawl blockers, which are held in position by retaining pins, further dismantling is unnecessary. The head of the retaining pin for the reverse blocker must be cut off in order to remove the pin; the pin for the parking pawl blocker, however, is free.

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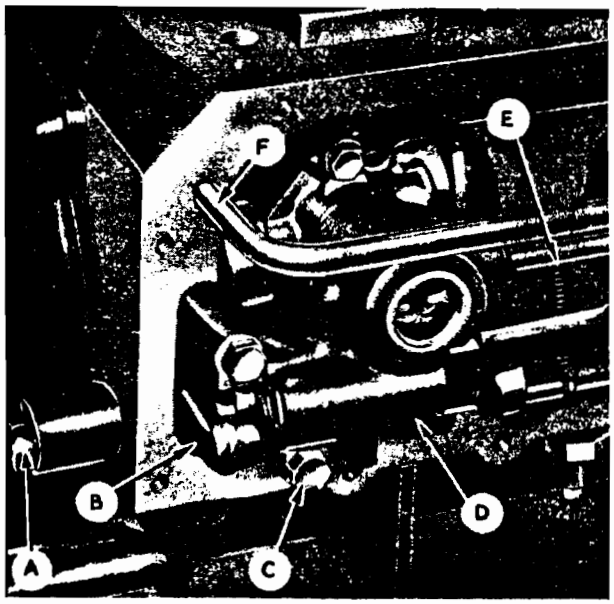

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Fig. FF.37

Parking brake bracket, showing:

A. Parking pawl support bolt.
B. Parking pawl.
C. Securing bolt with special lock washer.
D. Parking brake bracket.
E. Spring.
F. Reverse clutch oil pipe.

All parts of the bracket should be thoroughly cleaned. Use a compressed-air blast to clean all oil passages and slots in the casting and the reverse oil pipe.

The governor sleeve must be examined for excessive wear caused by the piston ring seals or malalignment of the sleeve.

Examine all other parts for wear, cracks, or damage, paying particular attention to the casting, the parking pawl, and the teeth on the reverse annulus.

Ensure that the support bolt turns freely in the bore of the parking pawl and that the reverse clutch oil pipe is not restricted or damaged and that it fits properly in the bore.

Reassemble the parking bracket by reversing the dismantling procedure. Care must be taken to ensure that the blockers are not replaced in the wrong bores, otherwise the parking pawl will be rendered inoperative.

A new retaining pin for the reverse blocker must be fitted; it should be inserted from the back of the casting and the outer end peened to lock the pin in position, as shown at (D), Fig. FF.38.

Air pressure applied intermittently to the points illustrated in Fig. FF.38 should cause the pistons to move in and out of their bores.

Cover the main oil pressure duct (B) in the bore of the sleeve and apply the air pressure to the main pressure duct (A) on the casting to test the parking pawl blocker. Pressure applied to the G.1 oil duct (C) will operate the reverse blocker.

If a new parking bracket is being fitted due to governor sleeve bore wear the oil sealing rings and the governor tower 'run-out' must be checked as detailed in Section FF.16.

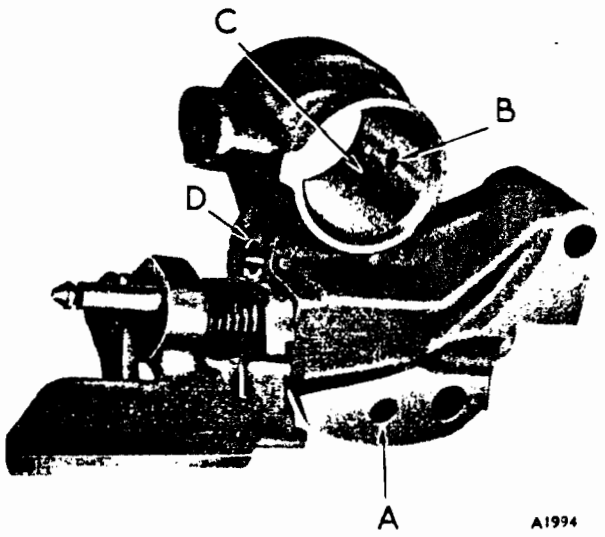

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Fig. FF.38

Parking brake bracket, showing air pressure check points

Place the parking pawl in the gearbox casing and align the sealing ring gaps on the governor tower at the top to facilitate assembly.

Lightly oil the governor tower and sealing rings and slide the governor sleeve on.

Replace the two securing bolts, ensuring that the special lock washer (D, Fig. FF.39) is on the bolt adjacent to the parking blocker retaining pin. Screw in the bolts until finger tight only.

After lubricating the roller crank pin (C) fit the roller (A) and move the parking pawl (B) into position. Replace

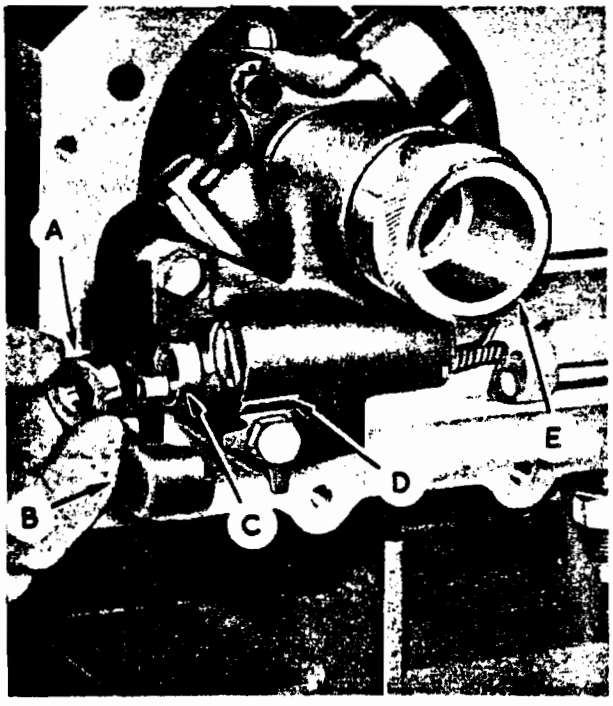

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Fig. FF.39

Refitting roller and parking pawl

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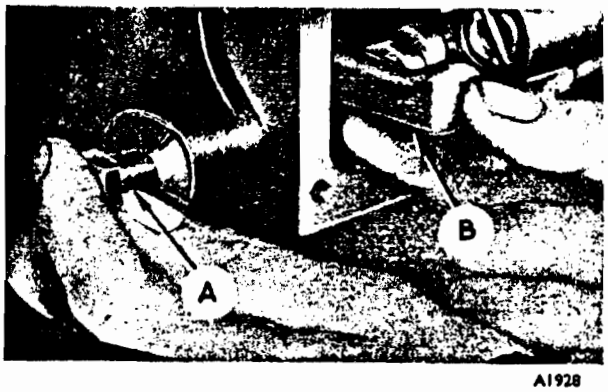

Fig. FF.40
Fitting the parking pawl

the support bolt together with a new tab washer, which also acts as an oil seal and must be in good condition (see Fig. FF.40).

Tighten the support bolt to the correct torque loading but do not lock it.

The reverse clutch oil pipe and the control valve unit may now be replaced as described in Section FF.13. Do not fit the parking pawl spring as this may interfere when aligning the governor sleeve.

The governor sleeve alignment tool (E, Fig. FF.39) must be inserted between the sleeve and the governor tower and the bracket positioned so that the tool slides in and turns freely. Tighten the parking brake bracket bolts to the correct torque loading and check the alignment again by removing and re-entering the tool in several positions.

Rotate the governor through a quarter of a turn and again check the alignment, repeating the check at each quarter of a turn of the governor. If the tool will not enter freely at any point slacken the securing bolts, align the sleeve, retighten the bolts, and repeat the complete check.

If difficulty is experienced when aligning the governor sleeve, in addition to the parking bracket bolts loosen also the two bolts which secure the rear oil pump and governor to the gearbox casing. Then enter the aligning tool, tighten all bolts to the correct torque loading, and carry out the complete check once more.

The slight movement allowed by loosening the pump governor bolts will probably be sufficient to align the governor sleeve correctly.

On completion, lock the parking bracket securing bolt with the special tab washer, ensuring that the extension piece locks the parking blocker piston retaining pin. The parking pawl support bolt (A, Fig. FF.40) is locked by bending one tab to the bolt head and two tabs against the rear casing.

Refit the parking pawl spring from the inner governor pipe to the pillar on the parking bracket. Check the parking pawl (B, Fig. FF.40) for correct operation and engagement with the reverse annulus by moving the selector lever to reverse.

Section FF.15

FRONT AND REAR SERVO UNITS

Both units can be removed with the gearbox *in situ* after removal of the sump and filter as in Section FF.12.

The front servo cannot be removed without first removing the rear servo, but the securing bolts of the front servo must be slackened to allow the rear servo removal. In view of this fact, the following operation is described as the removal of both units (see Fig. FF.41).

To release the pressure on the servo operating rods slacken both adjustment screw locknuts and unscrew the adjustment screws at least five turns.

It is advisable to hook a small piece of bent wire into the coils of a small band release spring which is fitted between the ends of the rear band. This is to prevent it falling out when the rear servo is removed.

Remove the main governor oil feed pipe (G) and the small compensator pipe (C) from the front and rear servo.

Slacken the securing bolts (D) of the front servo and remove the bolts (F) from the rear servo. Lever the rear servo gently away from the front until clear of the small oil transfer pipe (E) and withdraw the rear servo.

The rear band release spring may now be removed.

Remove the securing bolts (D) from the front servo and ease it away from the casing, twisting it gently to free it from the pipe (A) from the rear pump, at the same time withdrawing the servo from the front oil pump pipe (B).

All parts must be thoroughly cleaned, using a brush, compressed air, and filtered gearbox fluid. All oil ducts must be washed and blown through.

Clean and check all pipes for kinking, damaged ends, and that they fit correctly in their respective bores.

Check all set screws and blanking plugs for security.

All valves and pistons in both the front and rear servo are selectively fitted on initial assembly, and if fault diagnosis has indicated faulty operation of either servo the unit should be renewed.

When the servos are removed the opportunity should be taken of checking the condition of the band linings.

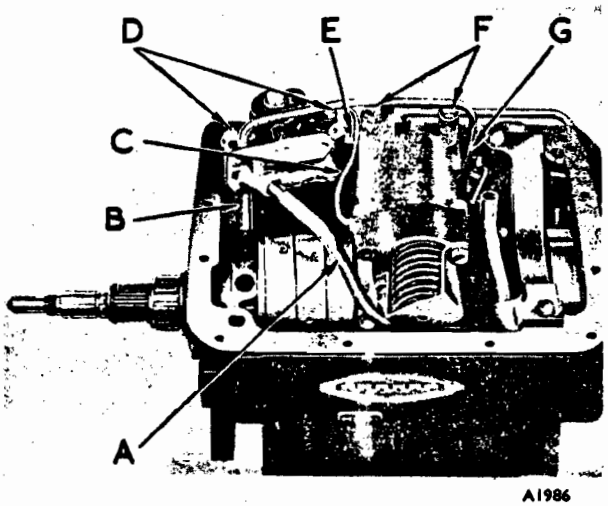

Fig. FF.41
Disconnection points for front and rear servos

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Do not, however, pull the bands away from the drums as they may bend and contact area may be lost.

The movement of the servo pistons can be checked by air pressure tests, but internal leaks or sluggish valves causing faulty operation will not be revealed by this test. See Figs. FF.42 and FF.43 for identification of oilways and valves.

Front servo (Fig. FF.42)

Air pressure applied to the band apply duct (A) of the front servo should cause the operating rod (F) to move out to its full extent.

Cover the front pump delivery duct (C) and apply intermittent air pressure to the other end of the duct. Oscillation of the exhaust valve (E) should be felt and will probably be heard.

Air pressure applied intermittently to the G.1 passage (G) will cause the three-range over-run control valve (D) to move to and fro in its housing.

Rear servo (Fig. FF.43)

Air pressure applied to the band release oil duct (B) of the rear servo should cause the operating rod (A) to move into the cylinders.

Intermittent air pressure applied to the 1—2 oil duct (C) should cause the exhaust valve to move to and fro in its bore (D). A piece of wire inserted in the pressure balance hole (E) will confirm movement.

To refit the servos to the gearbox first ensure that the delivery pipes from the front and rear pumps are secure in their respective bores.

Position the front band so that the slot for the servo operating rod is in the correct position and the other end of the band is engaged with the adjusting screw.

Replace the front servo with the operating rod engaged in the band slot, at the same time ensuring that the delivery pipes from the front and rear sumps engage in the correct bores in the servo. Fit the securing bolts loosely in position.

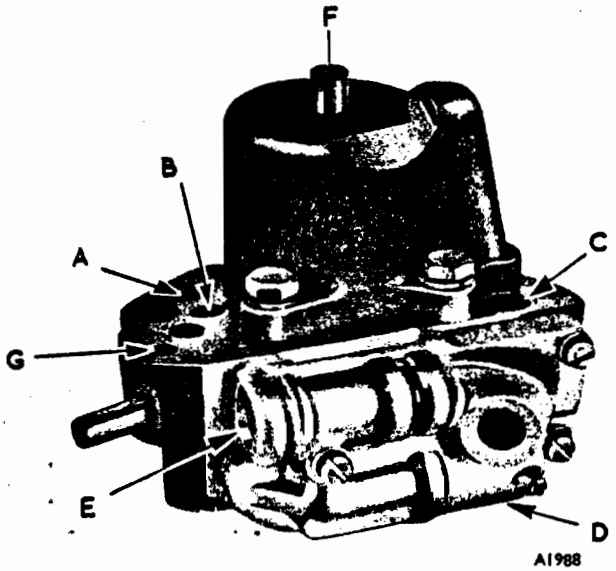

Fig. FF.42
Front servo

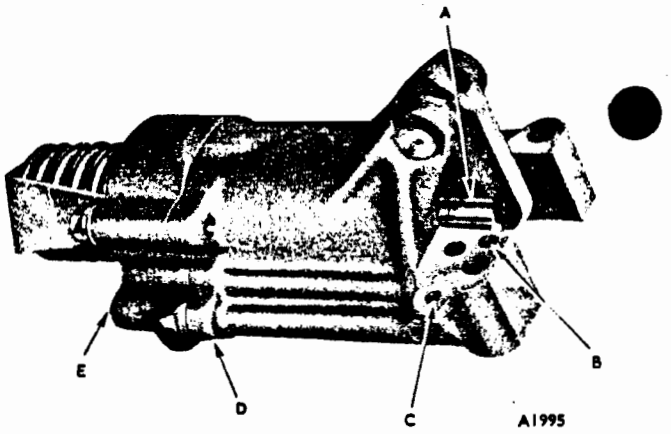

Fig. FF.43
Rear servo

Place the rear band release spring in position between the ends of the rear band, using petroleum jelly to hold it temporarily. Place the short end of the band operating strut in the spring coil and tie the ends of the rear band together to hold the spring in position while replacing the rear servo. Ensure that the wire is fixed so that it may be easily removed later.

Rotate the band until it engages with the adjusting screw.

Hold the operating lever of the rear servo against the operating rod and slide the rear servo forward into position, at the same time entering the oil transfer pipe into its bore and engaging the operating strut on the rear band with the socket on the servo operating lever.

Replace the rear servo securing bolts and tighten both front and rear servo bolts evenly to the correct torque loading. The rear servo must be supported during this operation and care must be taken to ensure that the oil delivery pipes from both pumps move smoothly into full engagement in the front servo.

Check that the rear band release spring is correctly positioned and remove the wire from the ends of the band.

The front and rear bands must now be adjusted as described previously on pages FF.20 and FF.22. If difficulty is experienced when centralizing the rear band hold a screwdriver against the riveted end of the band and shock it into position.

Refit the compensator pressure pipe and the governor oil delivery pipe. Replace the oil filter and sump and carry out a road test to check the operation of the gearbox.

Section FF.16

REAR PUMP AND GOVERNOR

To remove the rear pump and governor, after draining the gearbox, the following units must be removed:

The sump and side cover (Section FF.12).

The control valve unit (Section FF.13).

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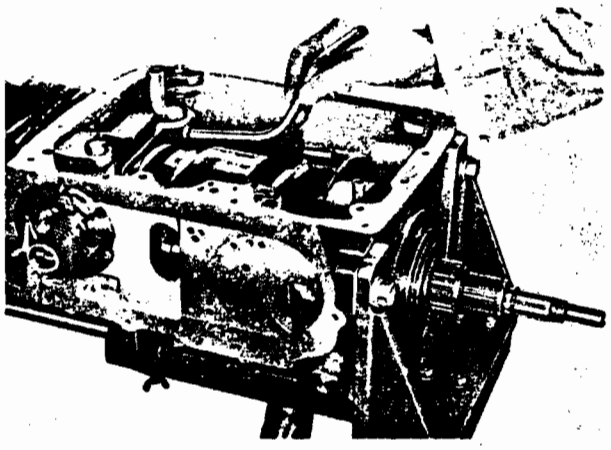

Fig. FF.44
Removing the rear pump delivery pipe

The parking brake bracket (Section FF.14).

The front and rear servo units (Section FF.15).

If the governor only requires removal there is no necessity to remove the servo units.

To remove the governor only, use a scriber and mark the edges of the governor drive flange and the governor body, for rematching on assembly, then remove the two securing set screws and remove the governor from the driving flange.

To remove the rear pump and governor, after removal of the servo units, remove the delivery pipe from the rear pump as shown in Fig. FF.44 and rotate the output shaft until the large (G.1) governor weight is towards the front of the gearbox.

Fig. FF.45
Removal of the rear pump and governor

Remove the two retaining set screws and withdraw the assembly from the gearbox (see Fig. FF.45).

Thoroughly wash and clean the assembly, using clean fluid, a brush, and compressed air.

Wear or damage to any part of the assembly, except for the piston ring seals, will entail renewal of the pump or governor or both.

NOTE.—Whenever a new pump is fitted the driving gear on the output shaft must be carefully examined and should also be renewed if excessively worn or if noisy on subsequent road test (see Section FF.20).

Governor

The piston ring oil seals and the G.2 valve and sleeve are the only removable parts on the governor assembly.

If either the G.1 or G.2 valve is unserviceable the governor assembly must be renewed.

The mating of the governor and driving flange faces should be checked with engineers' blue, and if distorted the whole assembly should be renewed. The surfaces must not be scraped.

The governor tower is unlikely to wear: if signs of wear are present the tower should be inspected in conjunction with the bore of the parking brake bracket. Wear will probably be caused by the tower running out of true and this condition must be checked, as will be described.

Check the oil sealing rings for freedom or excessive clearances in their grooves; if the rings appear worn insert them in the parking bracket bore and check the ring gap.

Rear pump

Remove the four set screws from the pump cover and remove the cover, mark the outer face of the annulus gear to ensure correct replacement, and withdraw the

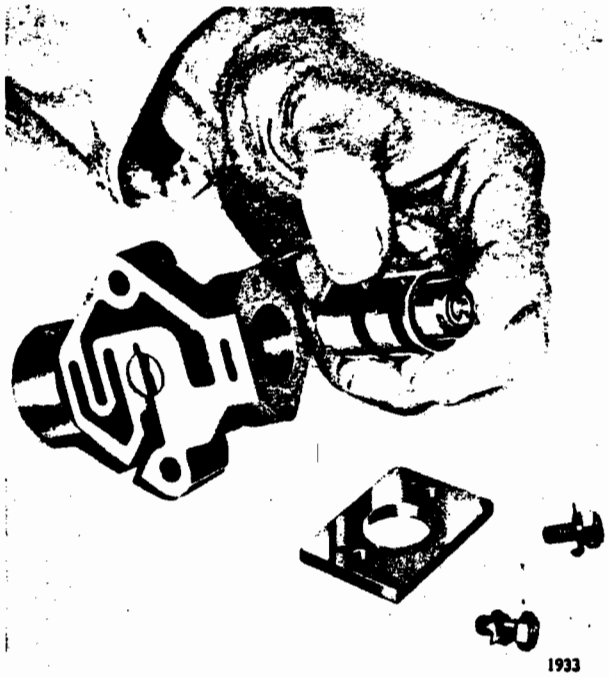

Fig. FF.46
Removal of G.2 valve

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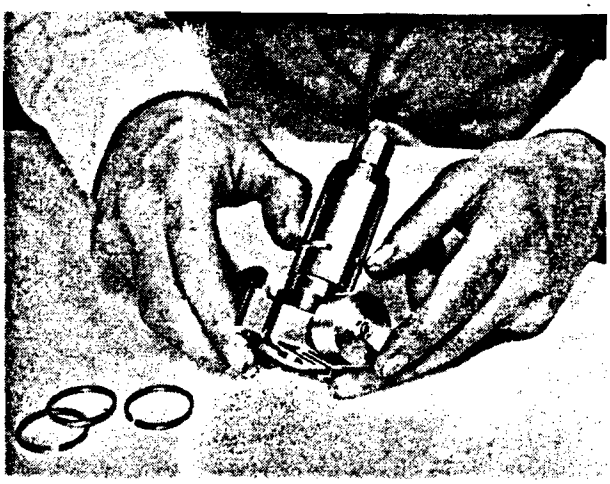

Fig. FF.47

Replacement of governor piston ring seals

annulus gear by tilting the assembly and shaking it into the hand.

Check the retaining pins of the governor drive flange and the steel skew-gear for security and check the mating of the pump cover and pump body faces with engineers' blue. Small burrs may be removed but the faces must not be scraped.

The annulus gear pockets and the inner face of the cover should be examined for scoring and wear; if any is present the drive shaft should be checked with a dial indicator for bow. If the scoring of the gear or cover face is severe or the drive shaft bowed the pump unit must be renewed.

Inspect the gears for worn or damaged teeth and the inlet pipe for security. If, during the fault diagnosis tests, the pressure was low, this should be used as a guide when assessing score or damage with a view to unit replacement.

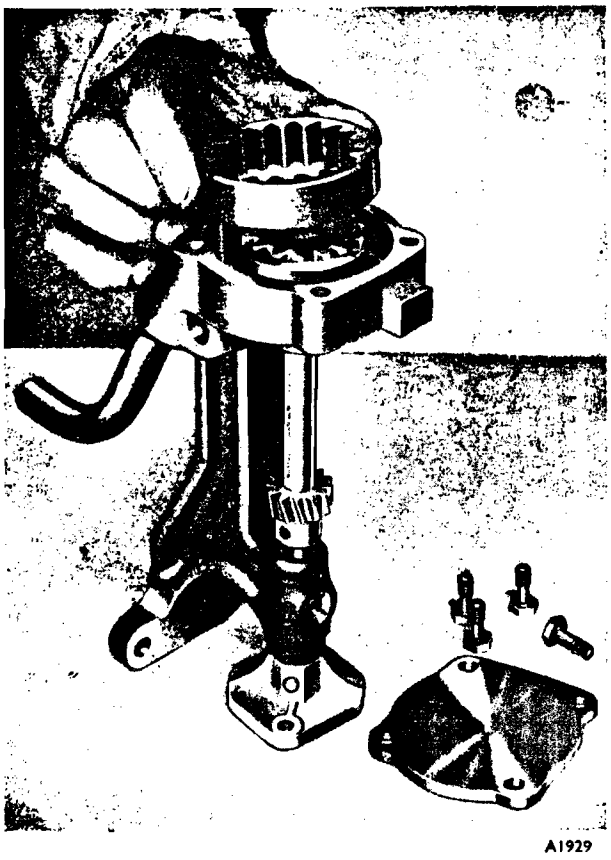

Fig. FF.48

Replacing the rear pump annulus gear

Assembly is the reverse of dismantling, and again the importance of cleanliness cannot be over-emphasized. Never use rag when cleaning.

The reassembling of the pump is straightforward. Ensure that the annulus is replaced correctly (Fig. FF.48), and when the cover has been refitted check that the drive shaft end-float is not less than ·002 in. (·051 mm.).

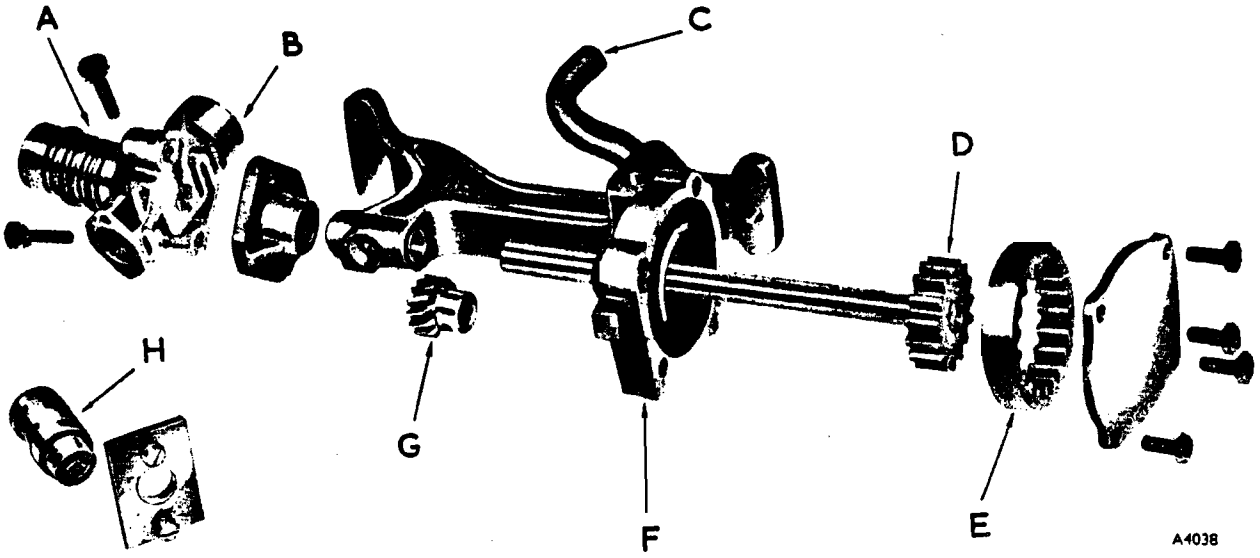

Fig. FF.49

Exploded view of the rear pump and governor

A. Governor piston ring seals.
B. G.1 governor weight.
C. Rear pump intake.
D. Pump driving gear.
E. Annulus gear.
F. Rear pump casing.
G. Rear pump driven gear.
H. G.2 valve and weight.

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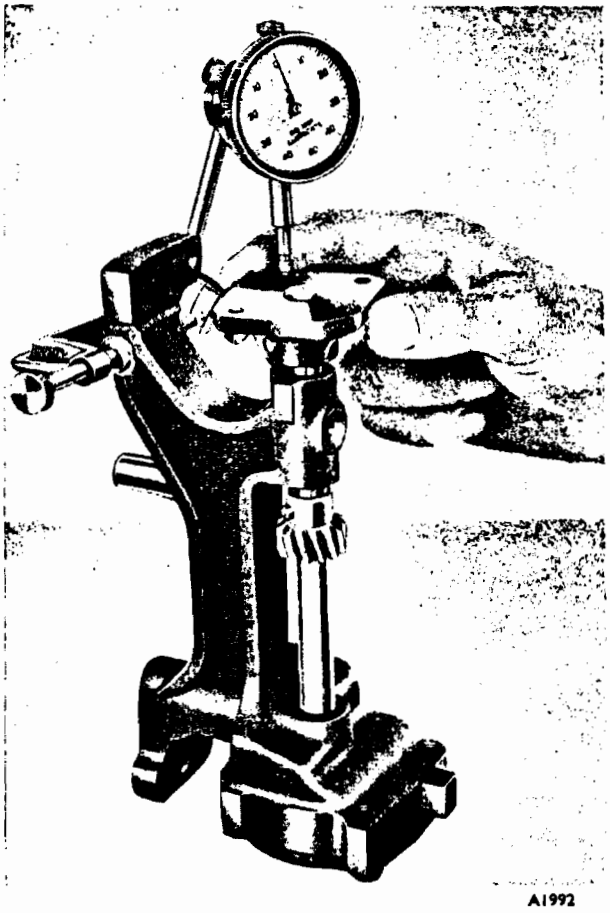

Fig. FF.50

Checking the run-out of the governor flange

Pour clean fluid into the inlet pipe and check for freeness of the pump by rotating the drive shaft.

Prior to refitting the governor to the drive flange the run-out of the flange must be checked as illustrated in Fig. FF.50. Turn the drive shaft several times and ensure that the run-out is within the limits quoted in the summary. Excessive run-out will entail the fitting of a new pump.

Fit the governor to the driving flange, and if neither unit has been changed see that the matching marks coincide; if a new unit has been fitted it should be marked after completing the governor tower run-out check as follows.

A dial indicator must be fitted as illustrated in Fig. FF.51 with the stem of the indicator approximately ·25 in. (6·35 mm.) from the end of the governor tower. Rotate the shaft several times, and should the run-out exceed the limits laid down, remove the governor from its flange, rotate it through 180°, and re-check. If the run-out is still excessive fit a new governor; if this does not bring the run-out within the limits a new rear pump and governor assembly must be fitted.

When all tests have been satisfactorily completed examine the mating faces of the gearbox and pump unit to see that they are free from burrs; then with the large (G.1) weight facing forward replace the assembly in position in the gearbox, at the same time rotating the drive shaft slightly to mesh the drive gear.

Refit and tighten the two securing screws.

Refit the servo units, parking bracket, control valve unit, side cover, and sump as described in Sections FF.15, FF.14, FF.13, and FF.12 respectively and refill with fluid.

On completion, carry out the road test, paying particular attention to the part of the test that led to the diagnosis of the fault.

Section FF.17

PRESSURE CONTROL VALVE

The removal, cleaning, and refitting of this valve has already been described on page FF.28. The following points, however, are now added.

Examine the inner and outer rubber cushions: if any sign of deterioration or damage is shown fit new ones after first dipping them in clean gearbox fluid.

The oil seal ring and joint washer should be removed from the blanking plug and the threads of the plug examined for picking up and dirt; also examine the threads in the gearbox casing.

Screw the plug into the gearbox and check for freeness. Fit a new seal ring and joint washer and assemble as described previously.

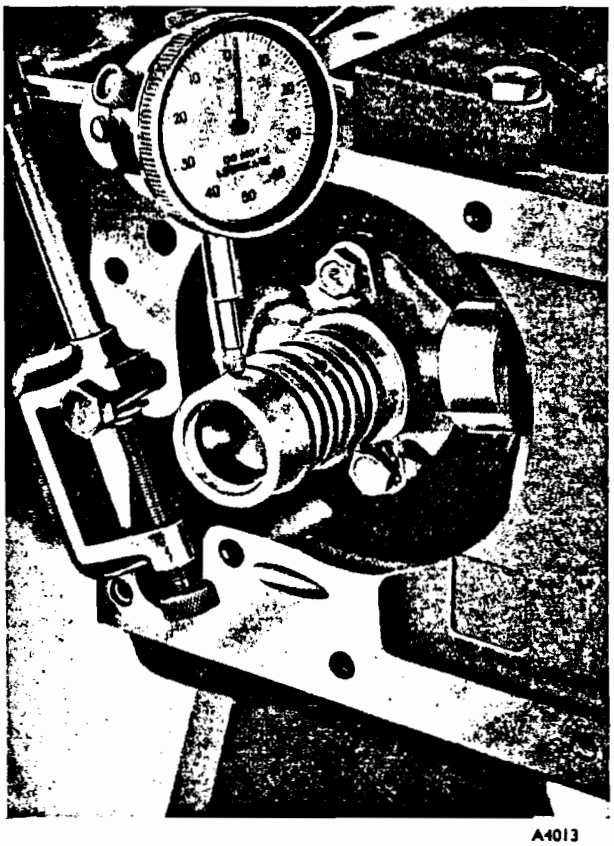

Fig. FF.51

Checking the governor tower run-out

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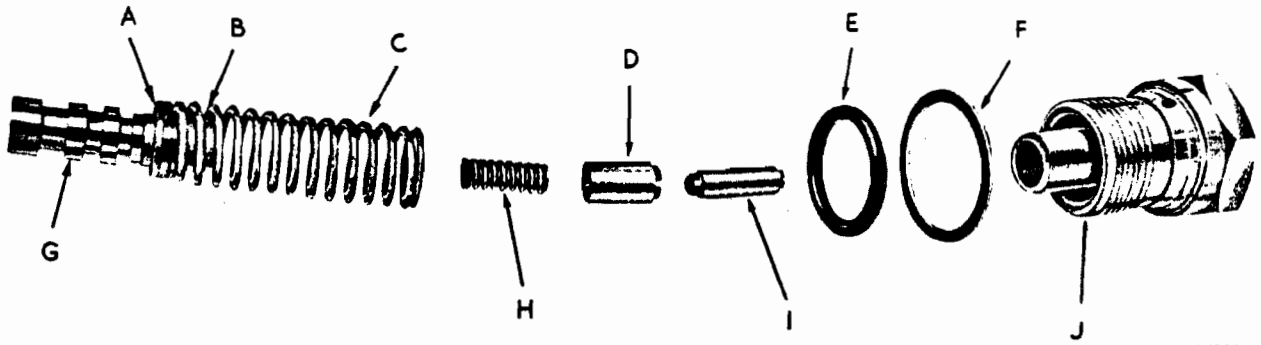

Fig. FF.52

Pressure control valve

A. Inner cushion.
B. Outer cushion.
C. Return spring.
D. Reverse booster plug.
E. Seal ring.
F. Joint washer.
G. Regulator valve.
H. Damper spring.
I. T.1 plug.
J. Blanking plug.

Section FF.18

FRONT PUMP AND DRIVE SHAFT

Removal of these units entails the removal of the gearbox from the car as in Section A.

The following units must then be removed:

Fluid coupling (Section FF.11).

Side cover, sump, and filter (Section FF.12).

Front and rear servo units (Section FF.15).

Pressure control valve (Section FF.17).

If required, the front pump can be removed from the gearbox without taking out the drive shaft; however, removal of the shaft is more convenient at this stage (see Fig. FF.53).

Remove the oil delivery pipe, front pump to front servo, from the front pump (see Fig. FF.54).

Remove the snap ring (Fig. FF.55), and the steel and phosphor-bronze thrust washers from the intermediate shaft. These three items (E, Fig. FF.53) should be tied

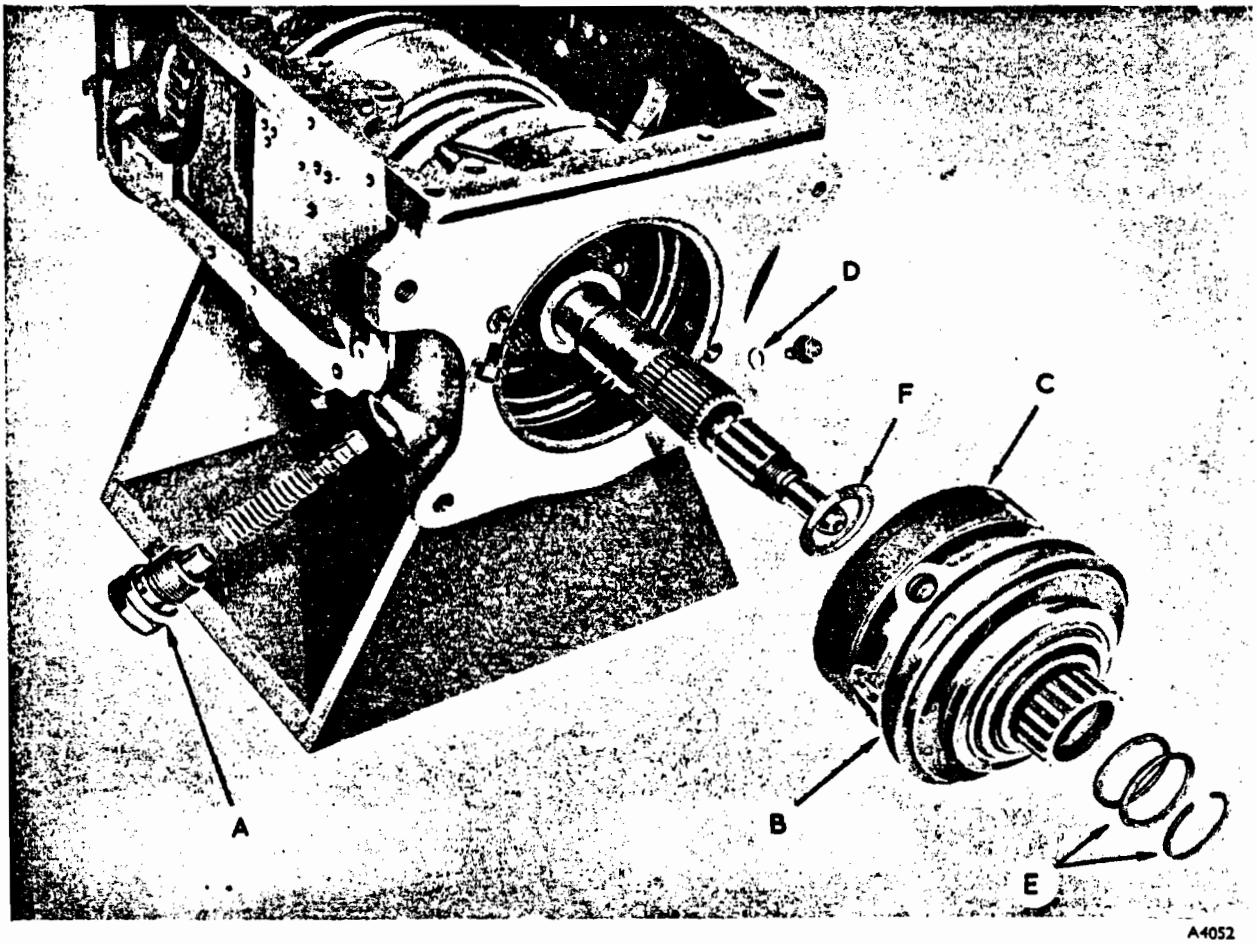

Fig. FF.53

Removing the front pump

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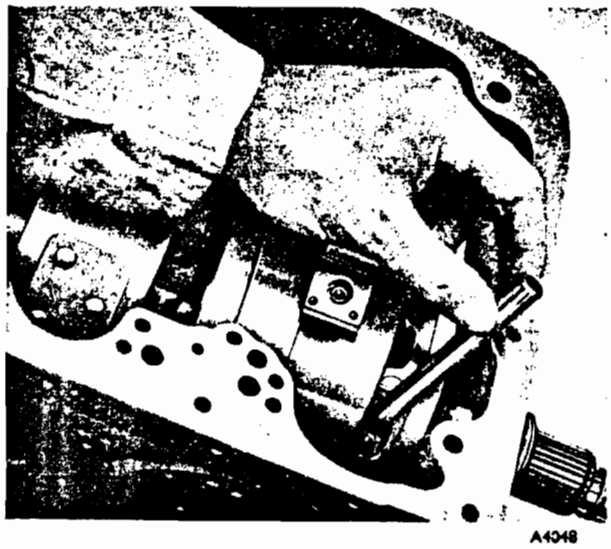

Fig. FF.54
Removal of front pump delivery pipe

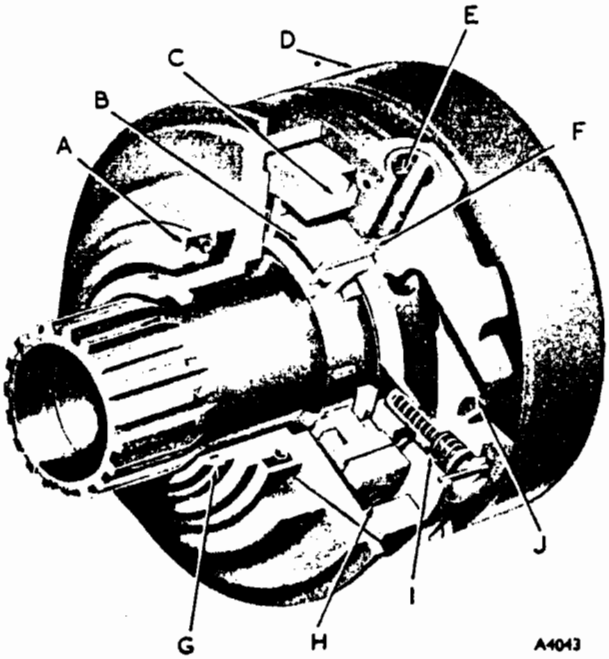

Fig. FF.56
Cut-away view of the front pump

together and labelled for ease of identification when reassembling.

The two pump retaining screws and the dowel washer (D, Fig. FF.53) should now be removed from the front of the casing as in Fig. FF.57. The pump together with the drive shaft can then be withdrawn from the gearbox. It may be necessary to use a soft drift on the rear face of the pump to loosen it.

The front drive gear thrust washer (F, Fig. FF.53) should now be removed from the intermediate shaft and labelled.

Dismantling of the front pump should only be carried out if faulty operation is suspected and then only for cleaning. Any parts that are worn or damaged will entail renewal of the pump unit.

Figs. FF.56 and FF.60 should be consulted for the location and identification of parts.

Slide the pump from the drive shaft and lay the pump on the bench, front cover downwards, and remove the four retaining screws. Lift the body from the front cover but do not turn the cover over as the pump parts will fall out and may be damaged (see Fig. FF.58).

Using an indelible pencil, mark the exposed side of the rotor to ensure correct refitting. The inner vane rings, the rotor, and the seven vanes may now be removed. The slide may also be removed after pushing it towards the priming springs, when the springs can also be removed (see Fig. FF.59).

The relief valve can now be removed from the pump body by depressing the spring guide and withdrawing the retaining pin, carefully release the pressure on the spring and remove the guide, spring, and valve as in Fig. FF.61.

Remove and discard the rubber oil seal ring from the pump intake bore in the body.

Remove the piston ring seal from the front cover.

The front torus cover neck oil seal should not be

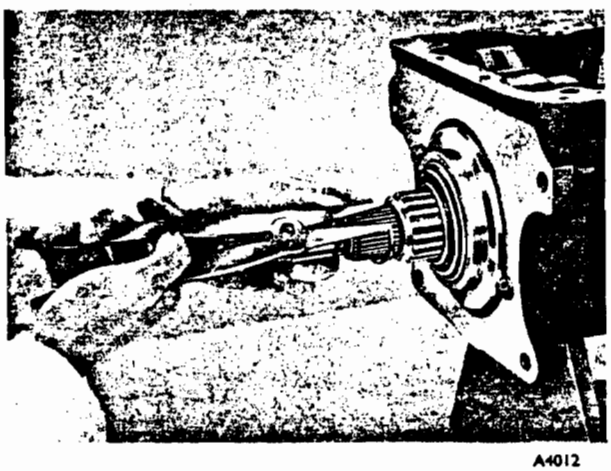

Fig. FF.55
Removal of the intermediate shaft snap ring

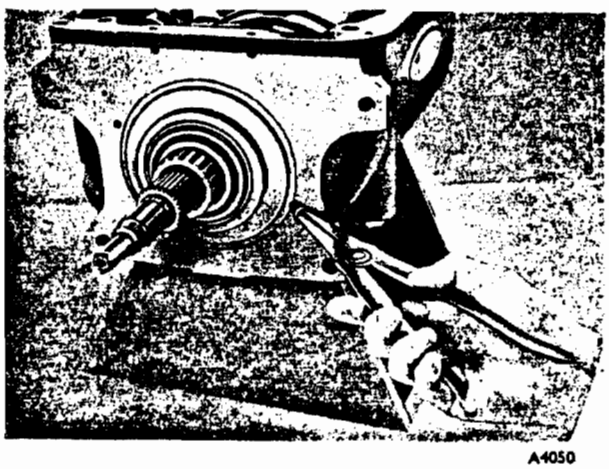

Fig. FF.57
Removal of the locating dowel ring

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Fig. FF.58
Lifting the body from the front pump cover

removed unless the seal needs renewing. This is due to the tight fit of the seal and the probable necessity of using a hammer and chisel. If the seal does require renewing great care must be taken when removing the old one not to damage the spring ring groove or the cover.

Thoroughly clean all parts and remove all traces of sludge, flush out all passages, and check that the passages and bleed holes are clear, blowing them through with compressed air.

All parts should now be examined for cracks and damage and particular attention paid to all sliding surfaces for any sign of scoring, burrs, or roughness.

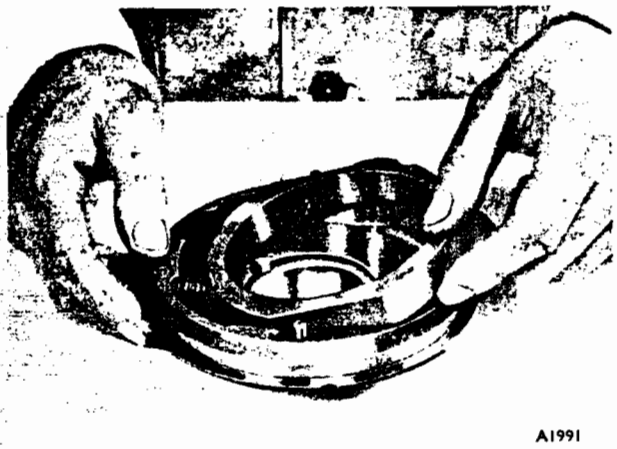

Fig. FF.59
Removing the pump slide

Check that the joint faces of the front cover and pump body mate correctly; small burrs may be removed but the faces must not be scraped.

Ensure that the dowels in the front cover are secure, that the pump slide moves freely in the front cover, and that the relief and pressure control valves are free in their respective bores.

Check the condition of the relief valve and priming springs and ensure that the pump vanes are free in their slots.

Check the piston ring oil seal as described in Section FF.11.

The drive shaft bush in the pump body must be examined for uneven wear, scores, flaking, and security. Slight even wear of the bush is normal and can be disregarded. Excessive wear or damage will entail the renewal of the complete pump.

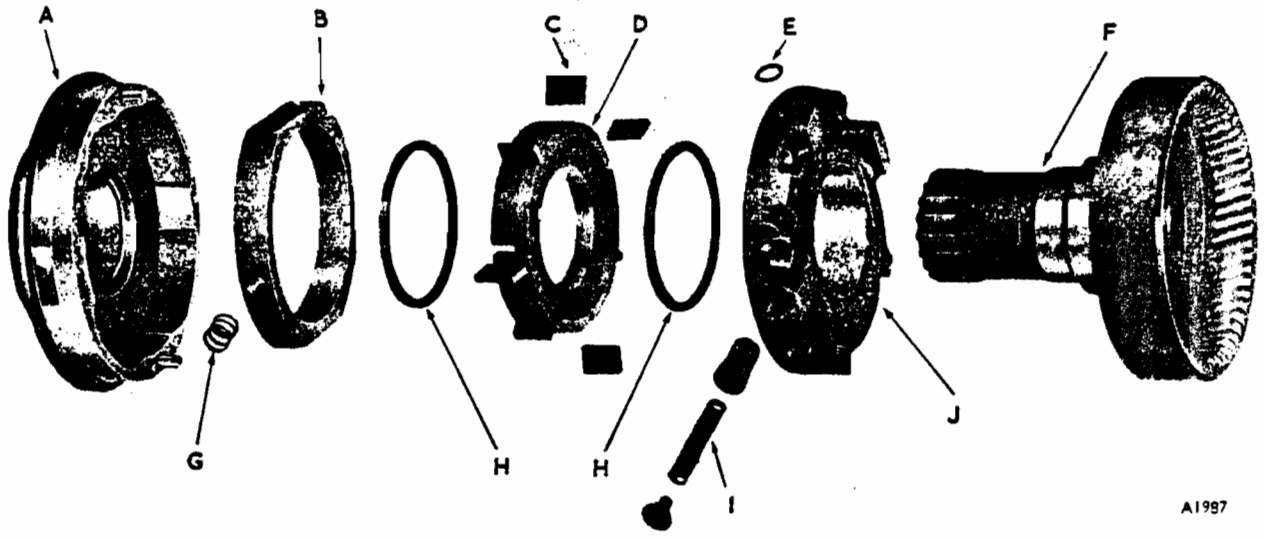

Fig. FF.60
Exploded view, front pump

A. Front cover.
B. Slide.
C. Vanes.
D. Rotor.
E. Intake seal ring.
F. Front drive shaft.
G. Priming springs.
H. Vane rings.
I. Relief valve.
J. Pump body.

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Fig. FF.61
Removing the relief valve

Examine:
The key in the drive shaft.
The keyway in the pump rotor.
The drive shaft splines and gear teeth.
The journal surface.
The two bushes in the bore of the drive shaft.
Inspect the steel and bronze thrust washers for ridges, and if the bronze washer is badly worn check the ends of the drive shaft splines to ensure that there is sufficient chamfer to prevent milling. Sharp edges should be stoned.

Assembling

When all parts have been carefully inspected, cleaned, and dried off with compressed air, lubricate all moving parts with fluid and rebuild as follows:

(1) Fit a new oil seal ring in the intake pipe bore as illustrated in Fig. FF.63.
Check that the ring is correctly fitted by inserting and withdrawing the pump intake pipe after ensuring that the end of the pipe has no sharp edges.

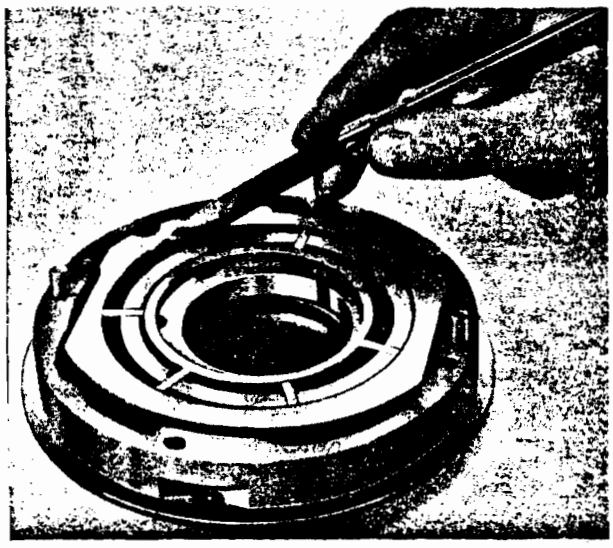

Fig. FF.62
Checking the diametrical clearance of the vanes

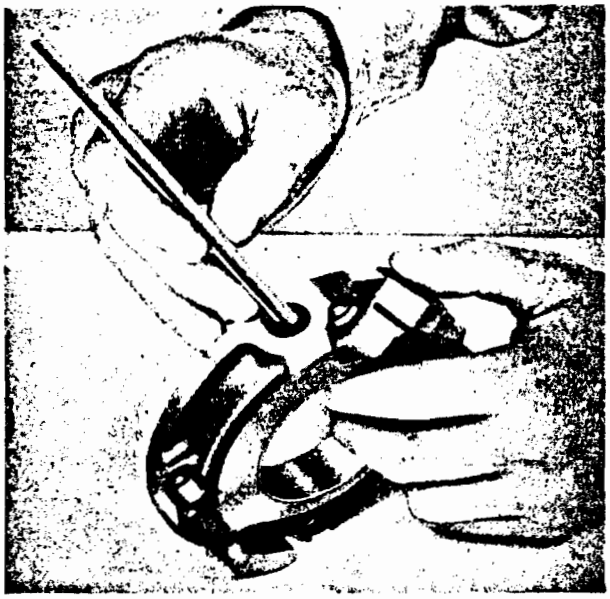

Fig. FF.63
Fitting a new oil seal in the intake pipe bore

(2) Refit the relief valve together with its spring, guide, and retaining pin.
(3) Assemble the pump slide together with its priming springs; check that the slide is free through the limits of its travel and that the priming springs return it correctly to the maximum delivery position.
(4) Replace one of the vane rings and then the rotor, ensuring that the marked face is uppermost.
(5) The seven vanes should now be replaced, positioning them according to the wear pattern on the radiused ends; the end that is polished along the whole of its length should contact the inner face of the slide.
(6) Refit the other vane ring and ensure that the vanes are correctly positioned between the vane rings and the slide. Revolve the rotor to check for freeness.

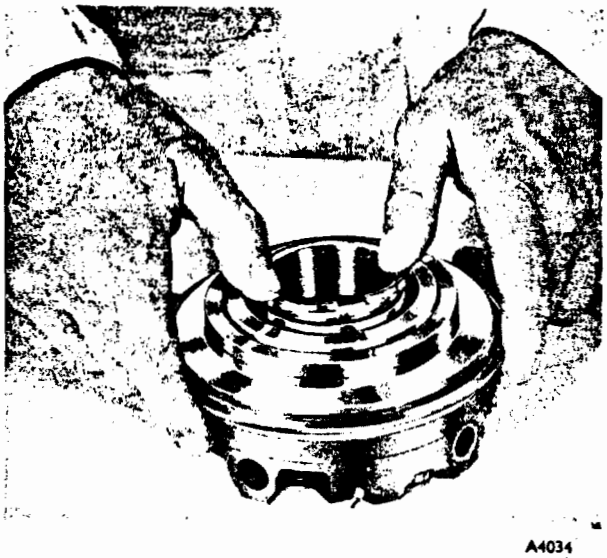

Fig. FF.64
Refitting the piston ring type oil seal to the front pump

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(7) The diametrical clearance of any vanes which appear excessively loose should be checked as illustrated in Fig. FF.62.
(8) The end clearance between the slide and the pump face should be checked and compared with the limits given under **'GENERAL DATA'** (see Fig. FF.65).
(9) Replace the pump body on the dowels of the front cover and tighten the four retaining screws to the correct torque loading. Rotate the pump to check for freeness and push against the internal bore of the rotor to ensure that the slide is free and that it is returned to its correct position by the priming springs.
(10) If a new front cover oil seal is to be fitted, first lubricate the seal with gearbox fluid and place it in position with the lip of the rubber inwards. Using a press, carefully insert the seal into its housing. Clean off any surplus fluid and apply sealing compound to the chamfer between the outer diameter of the seal and the front cover.
(11) Refit the oil seal ring into its groove (Fig. FF.64).
(12) Pour clean gearbox fluid into the intake bore of the pump and turn the rotor to ensure thorough lubrication.

Refitting the pump

Fit the bronze thrust washer over the intermediate shaft and position it against the planet carrier of the front unit. Liberally apply gearbox fluid and slide the drive shaft over the intermediate shaft into the main casing, turning it to mesh with the planet gears.

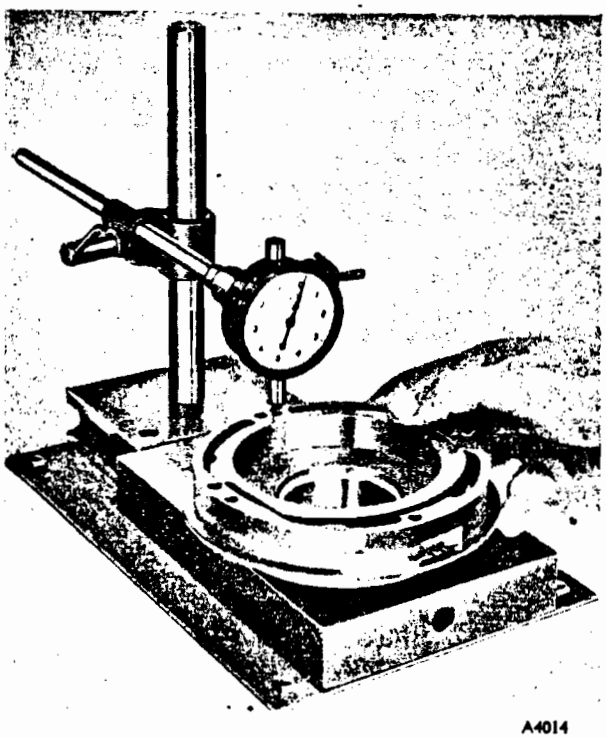

Fig. FF.65

Checking the end clearance between the slide and pump face

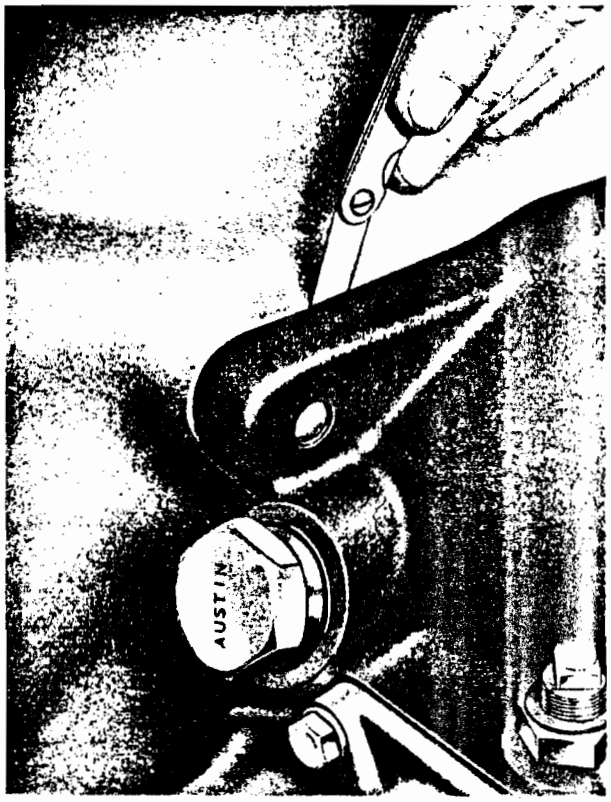

Fig. FF.66

Checking the front pump flange nip

Fit the bronze and then the steel thrust washers over the intermediate shaft and secure with the snap ring.

Fit a new rubber ring under the pump flange.

Lubricate the drive shaft bush in the pump body, line up the key of the drive shaft with the keyway in the pump, and slide the pump into position. The key should enter smoothly and not be forced.

Align the pump flange with the dowel washer location on the gearbox casing and insert the dowel washer. Fit the two retaining set screws, but before tightening to the correct torque loading ensure that the pressure control valve is lined up and moves freely in its bore.

If a replacement pump has been fitted check that the projection of the pump flange from the gearbox face is within the limits given under **'GENERAL DATA'**: this is to ensure the correct nip of the pump flange of the bell housing.

This check can be done either by:

(1) Using the special tool.
(2) Using a straight-edge and feeler gauges.
(3) Refitting the bell housing, lightly tightening the retaining set screws, and measuring the gap between the housing and the gearbox face as illustrated in Fig. FF.66.

If the clearance is incorrect change the rubber ring.

Fit the remaining assemblies in the following order:

Pressure control valve (Section FF.17).
Front and rear servo units (Section FF.15).
Side cover, sump, and filter (Section FF.12).
Fluid coupling (Section FF.11).

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Refit the gearbox to the engine and install the unit in the car (Section FF.10).

Testing

Fit the oil pressure gauge to the gearbox and run the engine in neutral at idling speed; the pressure should not be less than 50 lb./sq. in. (3·515 kg./cm.²).

Select reverse and check that the pressure at 1,200 r.p.m. is at least twice the pressure obtained when idling in neutral.

Carry out a road test and check the change points and correct functioning of the gearbox.

Section FF.19

SPEEDOMETER DRIVE

Secured to the rear casing of the gearbox by one set screw is the speedometer drive. Removal of this unit is straightforward and does not necessitate disturbing any of the other gearbox units.

Prior to dismantling spin the driving shaft and check visually for run-out; if eccentric renew the shaft. Thoroughly clean all parts, paying particular attention to the removal of all jointing compound from both joint faces. Check all parts for signs of excessive wear and pitting up and examine the squared end of the driving shaft for cracks, also the threads in the housing for damage. Check that the shaft end-float is between ·004 and ·006 in. (·102 and ·152 mm.).

When refitting the speedometer drive to the gearbox lightly smear the joint faces with sealing compound.

Section FF.20

REVERSE ASSEMBLY

Included in the reverse assembly are the reverse cyclic gears, rear extension casing, output shaft, and, for assembling and dismantling purposes, the mainshaft.

Before removing the reverse assembly the gearbox must be removed from the chassis as described in Section A, and the following units should be removed from the gearbox:

Fluid coupling (Section FF.11).
Side cover, sump, and filter (Section FF.12).
Control valve unit (Section FF.13).
Parking brake bracket (Section FF.14).
Front and rear servo units (Section FF.15).
Rear pump and governor (Section FF.16).
Speedometer drive (Section FF.19).

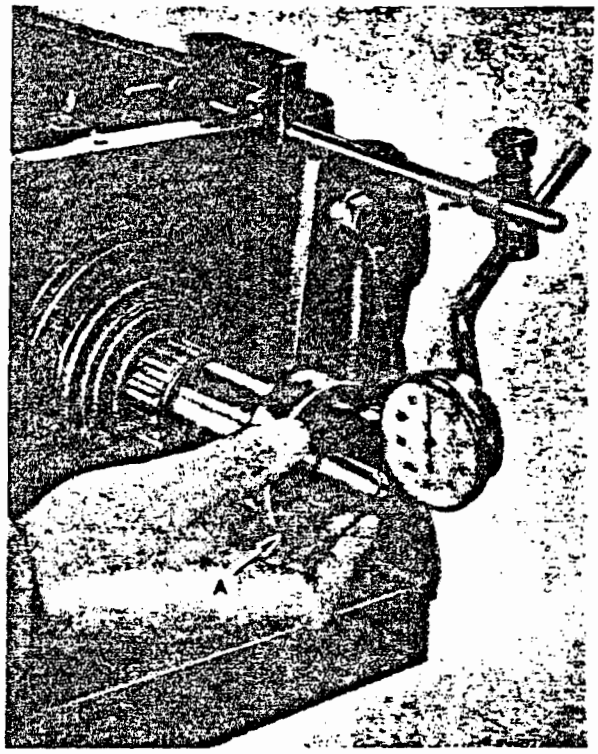

Fig. FF.68

Checking the mainshaft end-float

When removing the reverse assembly from the gearbox, and also when dismantling, all thrust and adjusting washers should be labelled for ease of identification when reassembling.

Prior to dismantling, however, the mainshaft end-float should be checked in order to assess the thickness of the adjusting washer which will be required when reassembling. This check should be carried out as follows.

Remove the spring ring from the mainshaft, screw on the end-float sleeve (A) as far as it will go, and mount a dial test indicator as shown in Fig. FF.68. A wedge should now be placed in position between the front end of the oil delivery sleeve cap and the front drum; tap it in lightly to take up the drum assembly end-float. Push the mainshaft rearwards and turn the indicator dial to zero. Pull the shaft forward and note the reading. This operation should be repeated to ensure that the correct reading of end-float is obtained. The existing adjusting washer (A, Fig. FF.69) can be retained, provided that the end-float is within the limits stated under **'GENERAL DATA'** and that it is otherwise serviceable. If the end-float is incorrect measure the thickness of

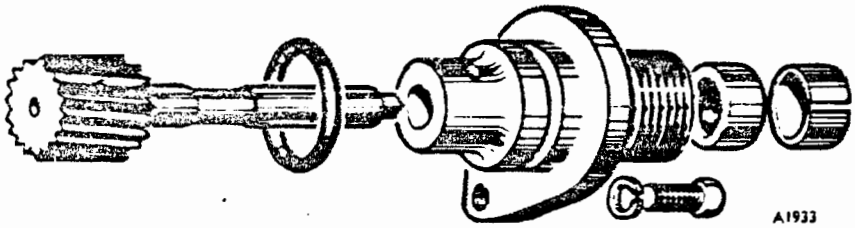

Fig. FF.67

The speedometer drive exploded

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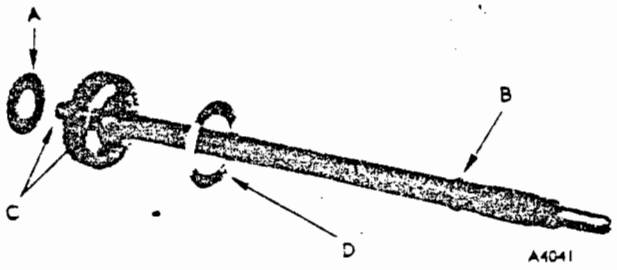

Fig. FF.69
Mainshaft

the adjusting washer and select a new washer to give the correct end-float on assembly.

On completion of this check, if only the reverse assembly is being removed, transfer the wedge from between the oil delivery sleeve and the front drum to a position between the oil delivery sleeve and the rear drum.

This wedge is necessary to prevent possible movement of the rear drum and its adjusting thrust washer. If, however, the gearbox is being completely dismantled it is not necessary to use the wedge.

The reverse assembly can be removed from the gearbox as a complete unit. However, if it is to be dismantled it will be found advantageous to loosen the coupling flange to output shaft securing nut while the assembly is bolted to the gearbox casing.

To prevent the output shaft turning when loosening the shaft nut the outer teeth of the reverse annulus gear must be wedged. This can be done by refitting the parking pawl and parking brake bracket. In addition, the rear drum must be prevented from turning; this can be effected by refitting the rear servo and tightening the adjusting screw.

The six bolts securing the reverse unit driving flange to the rear drum annulus gear must now be removed as shown in Fig. FF.70. To prevent the drum from turning during the loosening of these bolts it is necessary to clamp the rear drum. This can be done by refitting the rear servo. The rear band adjusting screw must, of course, be tightened sufficiently for the band to grip the drum and loosened each time the drum is turned and re-tightened while loosening each bolt.

Remove the five bolts which secure the rear casing to the main gearbox casing and withdraw the reverse assembly from the gearbox, taking care to retain the outer stationary cone key.

The mainshaft together with its thrust and end-float adjusting washers can now be removed (see Fig. FF.69).

Fit the rear clutch hub retainer (A) as shown in Section FF.21, Fig. FF.80, and remove the wedge.

Dismantling

Figs FF.71 and FF.72 should be consulted for identification of parts.

Remove the coupling flange to output shaft securing nut, tab washer, clamping washer, and the end nip adjusting washer, and remove the coupling.

Remove the bolts securing the end cover and remove the cover and mounting bracket. Tap the oil seal from its housing in the end cover.

To remove the output shaft set up the rear casing flange on blocks, rear end uppermost, to give at least 4½ in. (114·3 mm.) clearance between the output shaft planet carrier and the bench. Alternatively, place the casing over a suitable hole in the bench, or an overhanging platform, with a stop underneath to catch the output shaft as it leaves the casing.

Protect the output shaft threads and, using a press and distance piece or a hammer and drift, drive the output shaft downwards until the rear bearing becomes free on the shaft. Release the press and withdraw the rear bearing, speedometer drive gear locating washer, and the drive gear. Drive the output shaft through the remainder of the assembly and then, using a claw extractor, withdraw the front bearing and the distance sleeve from the shaft.

Remove the thrust washer from the reverse annulus gear and lift the annulus gear, distance piece, and the reverse planet carrier from the output shaft, taking care to avoid damage to the white-metal lining in the annulus gear. Remove the spring ring from the output shaft and lift off the reverse sun wheel and driving flange and the thrust and adjusting washers.

Place the annulus gear on the bench, outer stationary clutch cone uppermost, and expand and remove the outer clutch cone, using spring ring pliers shown in

Fig. FF.70
Removing the securing bolts of the reverse unit driving flange

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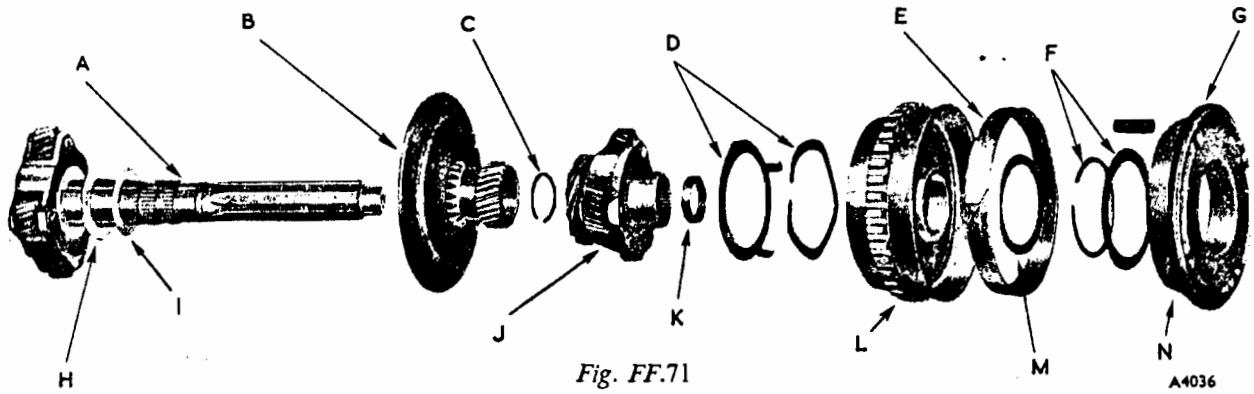

Fig. FF.71

Exploded view of the output shaft and reverse clutch

A. Output shaft.
B. Reverse unit driving flange.
C. Snap ring.
D. Cushion spring and retainer.
E. Outer stationary clutch cone.
F. Retainer and snap ring for clutch springs.
G. Reverse clutch piston oil seal (outer).
H. Thrust washer.
I. Backing washer.
J. Reverse planet carrier.
K. Distance piece.
L. Reverse annulus.
M. Thrust washer.
N. Inner cone and apply piston.

Fig. FF.73; avoid expanding the cone more than is required, otherwise distortion may result. The retainer and cushioning ring may now be removed from the other side of the annulus gear.

To remove the reverse clutch piston the springs must be compressed as shown in Fig. FF.74, using the clutch spring compressing tool or alternatively a press with a suitable adaptor. Apply pressure until the clutch spring retaining plate (A) is clear of the spring ring (B) and remove the ring from its groove. The retaining plate and the six clutch springs may now be removed. The inner clutch cone may now be removed from the rear casing.

If difficulty is experienced in withdrawing the cone from the rear casing apply an air pressure of approximately 70 lb./sq. in. (4·9 kg./cm.²) intermittently to the clutch apply duct as shown in Fig. FF.75. This will lift the cone sufficiently to allow withdrawal from the casing; do not attempt to rotate the cone as it is located by dowels. The outer sealing ring from the cone and the inner sealing ring from the neck of the casing may now be removed.

Thoroughly clean all parts before inspection, using compressed air, a brush, and filtered cleaning fluid. Examine the gear teeth, external and internal splines, bores, sealing ring grooves, and the mainshaft bearing

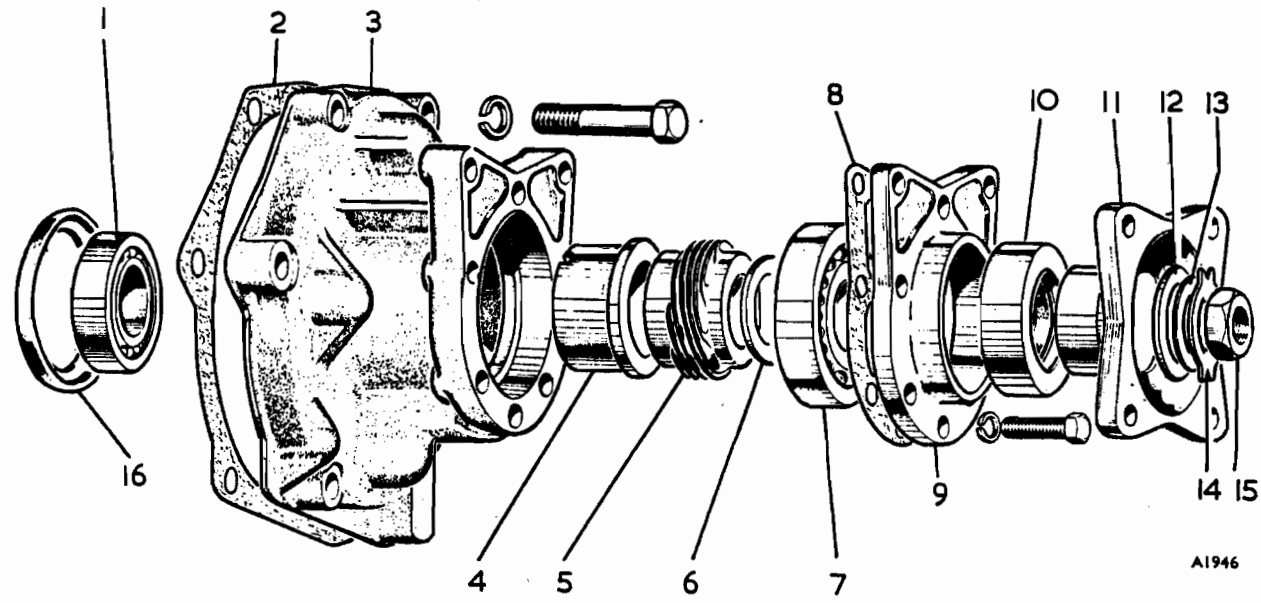

Fig. FF.72

Exploded view of the rear casing

1. Front bearing.
2. Joint washer.
3. Rear casing.
4. Distance sleeve.
5. Speedometer drive gear.
6. Speedometer drive gear locating washer.
7. Rear bearing.
8. Joint washer.
9. End cover.
10. Oil seal.
11. Coupling flange.
12. End nip adjusting washer.
13. Clamping washer.
14. Tab washer.
15. Coupling flange nut.
16. Reverse clutch inner seal.

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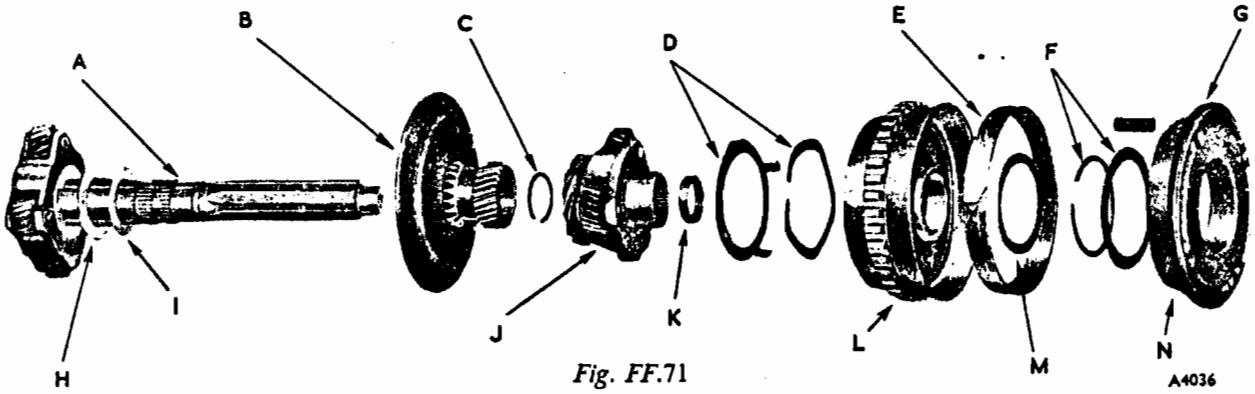

Fig. FF.71

Exploded view of the output shaft and reverse clutch

A. Output shaft.
B. Reverse unit driving flange.
C. Snap ring.
D. Cushion spring and retainer.
E. Outer stationary clutch cone.
F. Retainer and snap ring for clutch springs.
G. Reverse clutch piston oil seal (outer).
H. Thrust washer.
I. Backing washer.
J. Reverse planet carrier.
K. Distance piece.
L. Reverse annulus.
M. Thrust washer.
N. Inner cone and apply piston.

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Thoroughly clean all parts before inspection, using compressed air, a brush, and filtered cleaning fluid. Examine the gear teeth, external and internal splines, bores, sealing ring grooves, and the mainshaft bearing

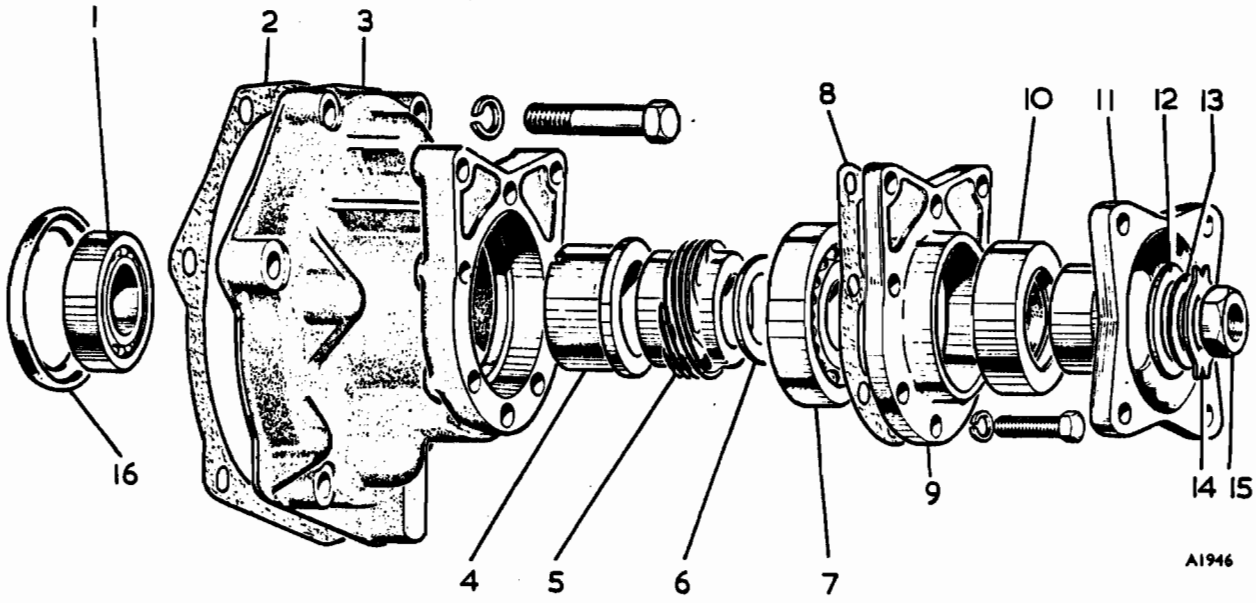

Fig. FF.72

Exploded view of the rear casing

1. Front bearing.
2. Joint washer.
3. Rear casing.
4. Distance sleeve.
5. Speedometer drive gear.
6. Speedometer drive gear locating washer.
7. Rear bearing.
8. Joint washer.
9. End cover.
10. Oil seal.
11. Coupling flange.
12. End nip adjusting washer.
13. Clamping washer.
14. Tab washer.
15. Coupling flange nut.
16. Reverse clutch inner seal.

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housing at the front end of the output shaft for residual sludge. Blow through the clutch apply oil duct in the extension casing and the oil passages at the rear end of the mainshaft to ensure that they are free of obstruction.

Examine all screw threads, paying particular attention to any which were tight on removal. Examine all gear teeth for damage and the end-thrust washers of the planet pinions for general condition.

The planet pinion carriers should be carefully examined paying particular attention around the pin bores for radial cracking; check the pins for tightness in their respective bores. These pins are a press fit initially and should remain tight.

Planet pinions must not be removed from or refitted to the carriers; if any part of a planet pinion assembly is found to be unserviceable the assembly concerned must be renewed.

If any part of the reverse planet carrier is unserviceable the assembly must be changed.

The rear pump drive gear is secured to the reverse planet carrier by a ball and snap ring.

The output shaft planet gear assembly, reverse sun gear, and the reverse planet gear assembly can be changed independently of their mating gears.

Output shaft

The bearing faces of the planet carrier, the shaft, and the thrust and backing washers must be examined for signs of scoring and uneven wear. Examine the mainshaft spigot bronze bearing in the hollow end of the output shaft.

The splines must be checked for fretting and twisting, which may indicate incipient failure.

The output shaft must be changed as an assembly if any part is found to be unserviceable.

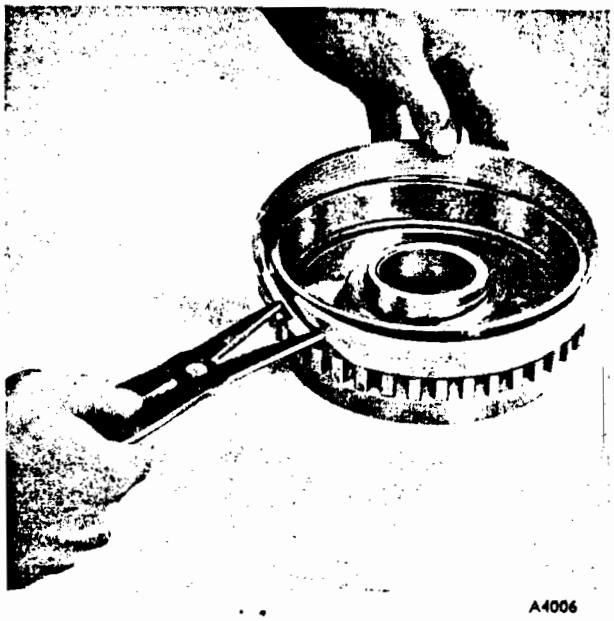

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Fig. FF.73

Removing the outer stationary cone from the reverse annulus

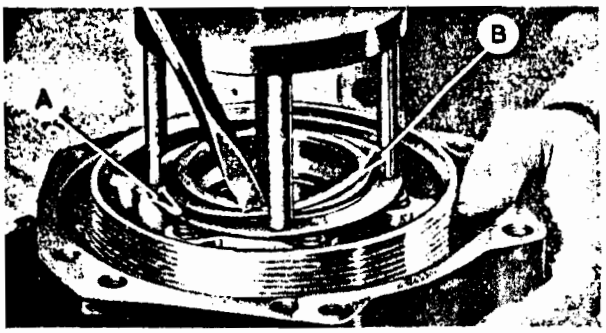

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Fig. FF.74

Removal of the reverse clutch springs retainer

The thrust and backing washers can be changed independently and should be changed if any doubt exists as to their serviceability.

Reverse sun gear and driving flange assembly

The driving flange and the thrust washer retainer should be checked for distortion and for tightness on their splines. The bronze bearing in the bore of the sun gear should be examined for scoring or uneven wear.

The thrust washer retainer under the driving flange should not be disturbed as this is a press fit and jig assembled. Any unserviceability will necessitate changing of the assembly.

Reverse planet carrier

The rear pump driving gear must be examined for excessive wear and also that it is tight on its mounting. The bearing surface on the extension and that of the cushioning ring must be examined for scoring and uneven wear.

The reverse planet carrier must be replaced if any part of the assembly is found to be unserviceable.

Reverse clutch assembly

The mating faces of the outer stationary clutch cone, the reverse annulus gear, and the inner stationary clutch cone must be examined for scoring, rough surfaces, signs of overheating, and uneven contact.

Examine the thrust washer and the bearing surface in the reverse annulus gear for scoring and uneven wear and the white-metal lining in the annulus gear bore for scoring, cracking, and for bad adhesion to the shell.

The clutch spring retainer should be checked for damage or distortion and the springs for collapsed coils. Check that the springs are all of the same length.

The outer stationary clutch cone should be examined in the vicinity of the keyway and the key dowel for any signs of cracking or looseness.

The cushioning ring retainer should be examined for wear on its bearing surface and for cracking at the bends of the lugs. Check that the cushioning ring has not lost its springiness and become flattened during service.

Unserviceability of either the reverse annulus gear, outer stationary clutch cone, and the inner stationary clutch cone will necessitate changing of these parts as an

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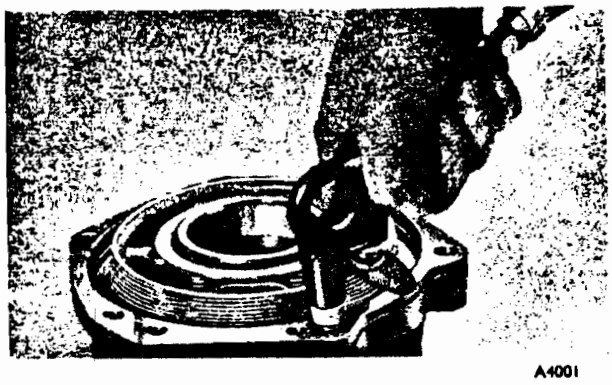

Fig. FF.75

Air pressure point for removal or testing reverse clutch

assembly. Other parts of the assembly can be changed independently but clutch springs should be changed as a set.

Bearings and housings

Examine the front and rear ball bearings for wear and the outer races and their housings for signs of spinning; the outer races should be a push fit in the housings.

Bearings can be changed independently of the shaft or extension casing, provided that due regard is given to the conditions of the housings and mountings.

Rear extension casing, speedometer drive gear, and coupling

Examine the extension casing for cracks in the vicinity of the bolt holes and bearing housings.

Examine the internal splines of the worm gear and coupling for signs of fretting or other damage and examine the bore of the distance sleeve for burrs which might become detached during assembling.

Check the coupling bolt holes for elongation.

All items in this assembly may be renewed independently.

Assembling

Prior to assembling, all parts must be clean and should be oiled lightly with clean gearbox oil. New gaskets, oil seals, and spring rings should be fitted where applicable; jointing compound must not be used except where stated.

Assess the thickness of the speedometer drive gear locating washer as follows.

Measure the length of the distance piece (A), front bearing (B), distance sleeve (C), and the speedometer drive gear (D), using a micrometer or vernier callipers; add these four measurements together and subtract the total from 3·609 in. (91·699 mm.). The remainder is the thickness of the locating washer (E, Fig. FF.76). A minus tolerance of ·005 in. (·127 mm.) is allowed, thus giving a total thickness of the four parts concerned plus the locating washer of 3·604 to 3·609 in. (91·542 to 91·699 mm.).

Stand the output shaft on end and assemble the thrust washer, backing washer, and the driving flange and reverse sun gear, taking care not to damage the bronze bearing in the sun gear bore as it passes over the shaft splines. Check that the washers are in the retainer on the under side of the driving flange and fit the spring ring to the groove in the shaft. The sun gear assembly should now be rotated to ensure that it is free on the shaft. Fit the reverse planet carrier, ensuring that the gears mesh correctly with the sun gear, and check that it rotates freely.

The distance piece should now be placed in position and the end-float of the reverse planet carrier checked by holding the distance piece against the shoulder on the shaft and inserting a feeler blade between the distance piece and the planet carrier as shown in Fig. FF.77. The output shaft or the reverse planet carrier, or both, must be replaced by selected parts if the end-float is not within the limits quoted under **'GENERAL DATA'.**

Lubricate the inner clutch cone outer seal and expand the seal gently into its groove with the seal lip facing away from the conical end of the clutch cone. Lubricate the inner seal and fit it to the groove in the neck of the extension casing with the lip facing the floor of the apply chamber. Ensure that both seals are fitted snugly into their grooves.

Place the extension casing on the bench, apply chamber uppermost, then, using a narrow flexible strip of metal approximately 1 in. (25·4 mm.) wide of the correct length, free from burrs and jagged edges, around the circumference of the apply chamber as a guide, lower the inner cone squarely into the guide seal first and turn it to engage the four dowels. Push the cone into the chamber until it reaches bottom and remove the guide. Check that the cone is home in the apply chamber.

Fit the six clutch springs into their sockets and lay the clutch spring retainer plate and spring ring in position on top of the springs. Using the clutch spring compressing tool, or a press and suitable adaptor, depress

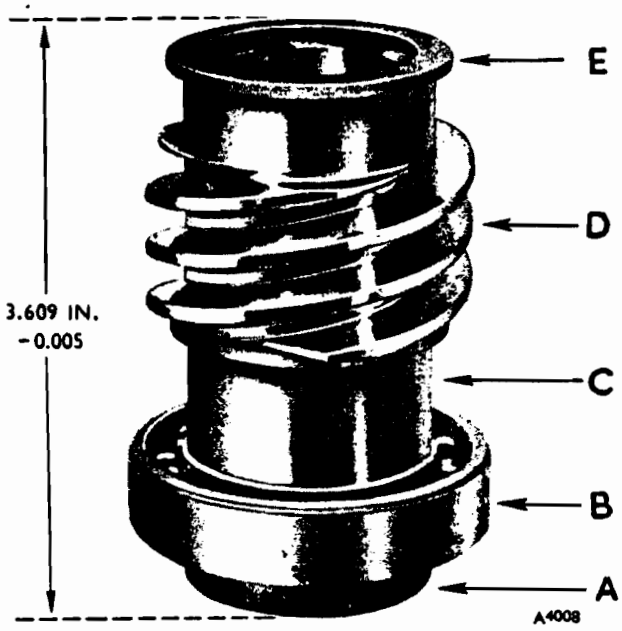

Fig. FF.76

Assessing the required thickness of the speedometer drive gear locating washer

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the retainer, taking care to keep all parts in a central position, until the spring ring can be fitted into the groove as shown in Fig. FF.74. With the spring in position tap it into the groove to ensure that it will not spring out under pressure. Release the pressure from the spring retainer.

Apply an air pressure of approximately 70 lb./sq. in. (4·9 kg./cm.²) to the clutch apply duct as shown in Fig. FF.75 to check the freedom of the cone in the apply chamber. The cone should move freely in and out of the chamber. The cone should be held out by air pressure and checked for leakage past the seal. A new seal must be fitted if any leakage occurs.

Lubricate the outer stationary clutch cone and expand it into position on the reverse annulus gear with the keyway facing the external teeth, as shown in Fig. FF.73; spring ring pliers should be used for this operation and care taken not to damage the inner face on the edge of the annulus gear cone. Do not expand the cone more than necessary owing to the risk of distortion and consequent loss of contact area.

The cushioning ring and retainer may now be fitted to the other side of the annulus gear. The retainer should be rotated to lock the lugs in the holes.

A new coupling oil seal should be fitted to the end cover with the blank side facing rearwards. Tap it gently into position, taking care not to damage the brass shell; any distortion of the outer wall may result in an oil leak between the seal and the housing in the end cover. During the final stages of reassembly, due to the freedom of the front bearing in its housing, the bearing itself, and not the extension casing, must be supported during fitting of the output shaft.

The reverse assembly can be assembled completely before refitting to the gearbox if a bench fixture for holding the assembly is available, otherwise the assessment of the output shaft end nip washer and the final tightening and locking of the securing nut are best left until the assembly is bolted to the gearbox casing. Ensure that a speedometer drive gear locating washer of the correct thickness as previously assessed is now available.

A tubular support, approximately 3¾ in. (92·2 mm.) long with an external diameter less than the outer race of the front bearing and a bore to accommodate the output shaft as it passes through the bearing, should be made up to support the bearing when assembling.

The reverse annulus gear together with the outer stationary clutch cone should now be refitted to the rear casing. Fit the front bearing into its housing.

The tubular support should be placed over a hole in the bench or set up to give end-clearance to the output shaft when it passes through the casing. The extension casings should be lifted onto the support so that the front bearing rests on the support tube. Enter the output shaft into the bearing, lowering the reverse planet carrier gears into engagement with the reverse annulus gear. Press or drive the output shaft through the bearing.

Turn the assembly over and stand it evenly on the output shaft planet carrier and fit the distance sleeve,

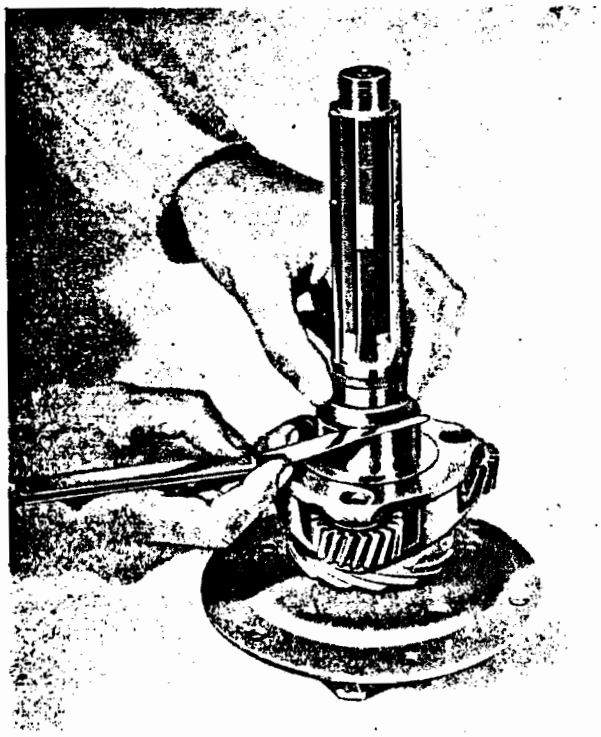

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Fig. FF.77

Checking the reverse planet carrier end-float

speedometer drive gear, speedometer drive gear locating washer, and the rear bearing. The distance sleeve and the inner race of the rear bearing are a tight fit on the shaft and will have to be pressed or driven into position.

Fit the speedometer drive and check the engagement of gears and freedom of rotation.

A thin coat of jointing compound should be applied to the face of the end cover and the cover bolted to the rear casing. Fit the gearbox mounting bracket.

Fit the coupling and apply a thin smear of grease where it passes through the seal. Check that the shaft threads project approximately ½ in. (12·7 mm.) above the base of the recess in the flange, indicating that the shaft has been pushed home correctly during assembly.

Refitting to the gearbox

Remove the rear clutch hub retaining plate, check that the clutch hub is engaged correctly in all clutch plates as described in Section FF.21, and fit the mainshaft together with its thrust and adjusting washer.

Fit a new gasket to the extension casing to gearbox casing joint and check that the outer clutch cone keyway is aligned with that in the gearbox casing; fit the key to the keyway, using petroleum jelly to hold it in position. Fit the assembly to the gearbox casing and insert and screw in the parking pawl support bolt for alignment purposes. Fit the remaining bolts and tighten them evenly.

Align the driving flange bolt holes with the holes on the rear drum and screw in the bolts, checking the output shaft for freedom of turning and the mainshaft for freedom of movement while the bolts are being tightened

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progressively. If the output shaft becomes stiff to turn, or locks, or the mainshaft cannot be moved, remove the reverse assembly and check that the rear clutch hub is, in fact, home in the rear drum and that the mainshaft end-float adjusting and thrust washers have not slipped from their respective recesses. If either of these washers have slipped and become trapped, it must be checked for damage or distortion and renewed if necessary. If new clutch plates have been fitted to the front or rear drums a certain amount of stiffness may be encountered, but it should be still possible to turn the output shaft by hand.

Check the end-float of the mainshaft as described under **'Dismantling'.** This is a routine assembly operation but may have to be carried out during investigation of stiffness described in the foregoing paragraph. Fit the mainshaft snap ring.

With the output shaft coupling in position, assess the thickness of the end nip adjusting washer as described below and fit the adjusting washer, clamping washer, tab washers, and securing nut. Tighten the nut and bend up the locking tabs.

Output shaft end nip

The end nip of the output shaft is set to ensure that all components are locked in their relative positions on the shaft.

The method of assessment of this washer for thickness is as follows.

In addition to the standard parts the following extra parts will be required for this operation. A slave adjusting washer of known thickness between ·040 and ·060 in. (1·016 and 1·524 mm.). A packing washer approximately ·100 in. (2·54 mm.) thick and of the same bore as the adjusting washer. After the coupling has been fitted place the slave washer and packing washer into the recess in the coupling, fit the clamping washer, and tighten the nut until all end-clearance has been taken up.

Remove the nut, clamping washer, and packing washer, refit the clamping washer, and refit, and tighten the nut. Mount a dial test indicator to read on the coupling flange. Push the shaft into the casing and set the indicator dial to zero. Pull the shaft outwards and note the reading. The thickness of the end nip adjusting washer required is: thickness of slave washer, plus dial test indicator reading, plus ·004 to ·010 in. (·102 to ·254 mm.); ·008 in. (·203 mm.) is used on initial assembly.

Measure the thickness of the existing adjusting washer and, if suitable and otherwise serviceable, refit it. If this washer is unsuitable select a washer to give the appropriate end nip.

Remove the nut, clamping washer, and the slave washer and fit the selected adjusting washer, clamping washer, tab washer, and nut. The reverse annulus gear teeth must now be wedged and the rear drum held while tightening the nut and bending up the locking tabs.

Refit the units listed at the beginning of Section FF.20.

The reverse assembly can be tested for correct functioning only by refitting the gearbox to the car and carrying out reverse and forward selection of gears.

Section FF.21

DRUM ASSEMBLY

This section covers the overhaul of the drum assembly, which comprises the front and rear clutch unit, the intermediate shaft, the oil delivery sleeve, and the front and rear bands. Before this assembly can be removed the engine and gearbox must be taken out of the car as described in Section A, and then the following units removed:

Fluid coupling (Section FF.11).
Side cover, sump, and filter (Section FF.12).
Control valve unit (Section FF.13).
Parking brake bracket and governor sleeve (Section FF.14).
Servo units (Section FF.15).
Rear pump and governor (Section FF.16).
Pressure control valve (Section FF.17).
Front pump (Section FF.18).
Reverse assembly (Section FF.20).

Removal from gearbox

Bend back the tabs of the centre bearing cap lock plate, unscrew the two retaining bolts, and withdraw the cap (Fig. FF.78). The drum assembly can now be lifted from the gearbox case, but care must be taken not to distort the bands as they are easily damaged. First lift the shaft sufficiently to allow the front band to be rotated so that both ends are accessible, then join them together with a suitable spring (A) or piece of wire; remove the assembly as shown in Fig. FF.79. This operation is best carried out with the aid of an assistant.

Dismantling

Place the assembly on a holding stand and, with the spring ring pliers, remove the spring ring retaining the rear hub (Fig. FF.80), then lift the rear drum assembly off the intermediate shaft.

Remove the thin steel thrust washer which is fitted between the spring ring retaining the oil delivery sleeve and the rear clutch hub.

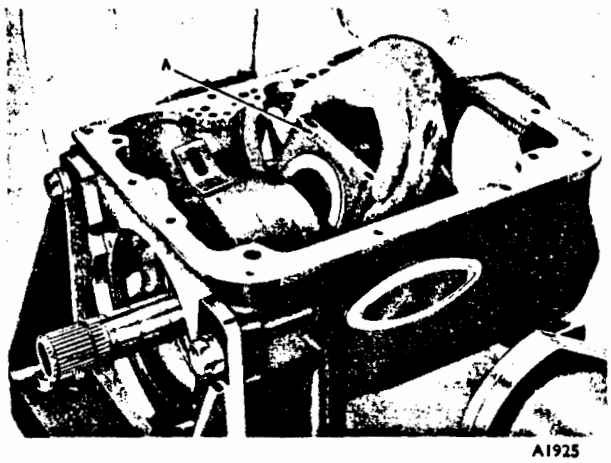

Fig. FF.78

Removing the centre bearing cap. The chamfer shown at (A) must always face the front end of the gearbox

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Remove the spring ring retaining the oil delivery sleeve and withdraw the sleeve (see Fig. FF.81).

Remove the front drum retaining ring as shown in Fig. FF.82, taking care not to scratch the surface of the intermediate shaft, and lift off the drum assembly. Withdraw the steel and bronze thrust washers from the recess in the front drum and label them for identification.

Remove and label the steel and bronze washers from the intermediate shaft.

Dismantling the front drum

Figs. FF.84 and FF.85 show exploded views of the front and rear units respectively.

Place the front drum assembly in a suitable press and apply sufficient pressure to the clutch cover to enable the spring ring to be prised from its groove as shown in Fig. FF.83. Remove the drum assembly from the press and separate the clutch cover from the drum by tapping the sun gear with a plastic hammer.

Remove the six inner and outer clutch release springs and then lift out the complete pack of clutch plates: it is important that the plates are not separated prior to inspection.

Remove the clutch piston from its annular housing in the clutch cover by tapping the sun gear sharply with a plastic hammer to jump it out of its position.

Using a blunt screwdriver, remove and discard the oil seal rings and expanders from their respective grooves in the clutch piston and cover.

Dismantling the rear drum

Remove the rear clutch hub retainer bracket (A, Fig. FF.80) and withdraw the hub and bronze thrust washer; the dismantling procedure is then similar to that described for the front drum. The clutch release springs of this unit are fitted with small guide pins, which should be removed with the springs.

The annulus gear is mounted to the rear drum with two set screws and should only be removed for renewal purposes.

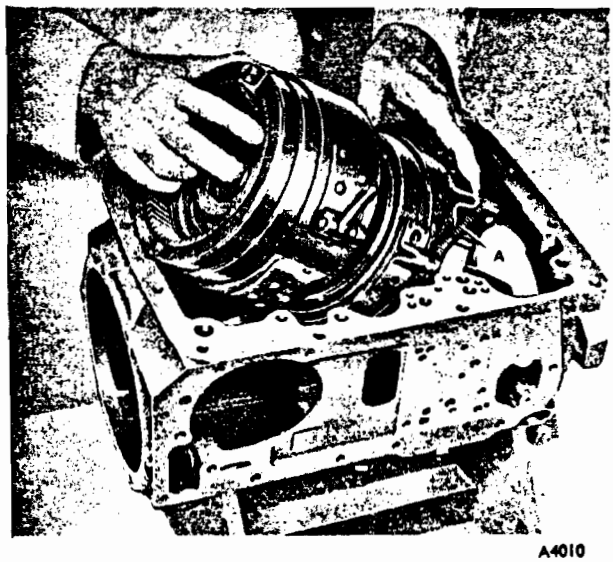

Fig. FF.79

Removal of the drum assembly

Fig. FF.80

Removing the snap ring securing the rear drum

Inspection

All parts must be thoroughly cleaned, with the exception of the pack of clutch plates, which should first be inspected as described later in this Section.

All surfaces of the clutch drums should be inspected for scores and grooves; only slight damage, which can be removed by stoning, is permissible. Check the clutch drive pins for security and, if loose, renew the drum.

The gear teeth of the rear drum annulus gear and the intermediate shaft planet pinions should be examined, and, if damaged, check the gears with which they mesh and renew the particular unit or assembly as required.

The splines of the clutch drums and the intermediate shaft should be examined for damage marks, burrs, and excessive uneven wear; only damage which can be rectified by light stoning should be accepted. If any splines are chipped the particular unit should be renewed.

The spring ring grooves of the intermediate shaft should be checked for burrs and ridges and the bearing surfaces for scores and scratches; smooth off with a stone if necessary. Check the planet carrier and the outer diameter of the pinion thrust washers for cracks. Check each planet gear by spinning it for smooth running and feel them for side-play which may indicate worn needle rollers or loose planet retaining pins. The front planet assembly must be renewed as a unit should

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Fig. FF.81

Removal of the oil delivery sleeve snap ring

any of the components become unserviceable; dismantling is not permitted.

The clutch release springs must be inspected for distortion and collapsed coils; slight wear indicated by brightness of the outer coil diameter is acceptable. The guide pins of the rear clutch springs must be examined for distortion and burred ends; check that they are all of equal length. Inspect the clutch pistons for scores, cracks, or distortions and ensure that the steel grooves are perfectly clean.

Examine the piston bore of the clutch covers for scores and the intermediate shaft bushes for security, signs of picking up, or heavy wear. Check the seal groove for cleanliness.

Inspect the oil delivery sleeve for scores; only damage which can be removed by light stoning is acceptable. Check the rings for freedom in their grooves and ensure that the grooves are clean. It is not necessary to remove the rings unless damage necessitates renewal.

Check the centre bearing cap and dowel pin for burrs and damage marks; light damage may be removed by stoning. If the dowel pin is loose or damaged it should be renewed.

Make sure that the oil passages of the cap are clear, then carry out a leakage check between the case and the cap and the sleeve in the following manner.

Checking the oil delivery sleeve

After dipping the sleeve into clean gearbox fluid, refit it into the gearbox case, locating the dowel pin of the cap in one of the two oil holes of the sleeve instead of its correct location; this blanks off the casing oilways. The cap must be fitted with the machined chamfer towards the front of the case and the bolts tightened evenly to the correct loading. (If the sleeve can be rocked, it should be renewed.) When air pressure is applied to the front and rear clutch passages, as shown for clutch testing in Fig. FF.86, there should be no leakage between the sleeve and the case and cap. In the case of a new oil delivery sleeve, slight leakage may be rectified by very

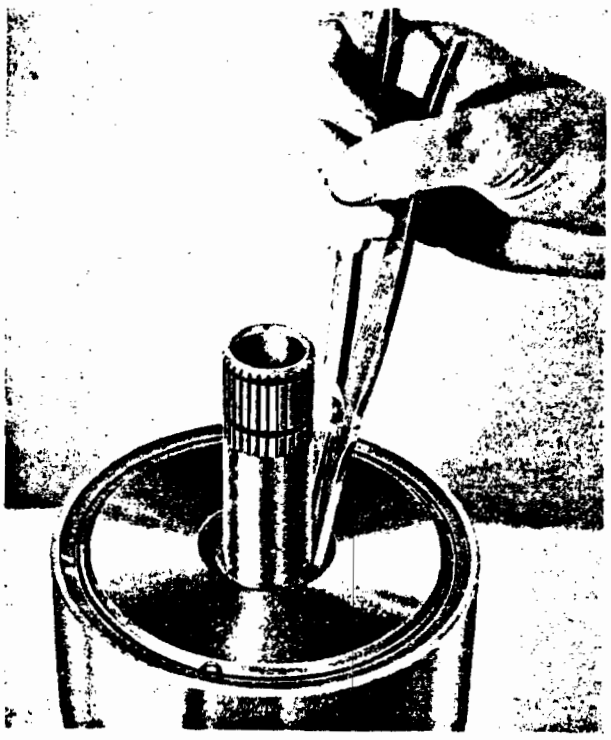

Fig. FF.82

Removal of the snap ring securing the front drum to the intermediate shaft

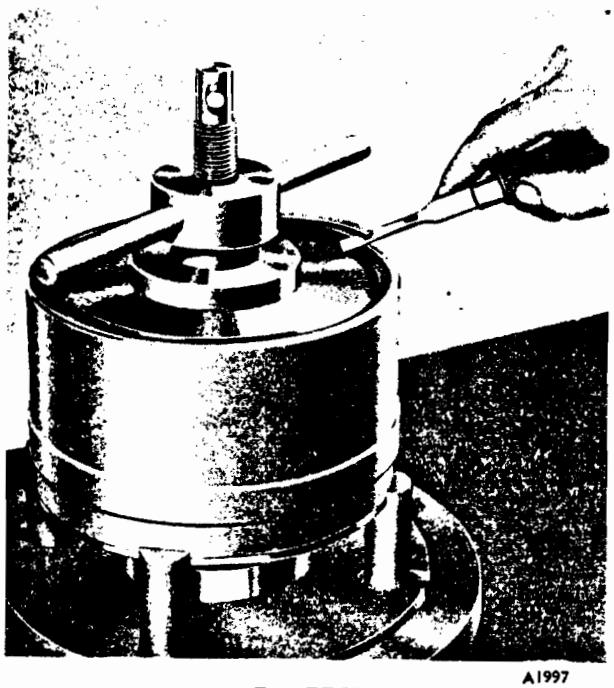

Fig. FF.83

Prising the spring ring from the front drum

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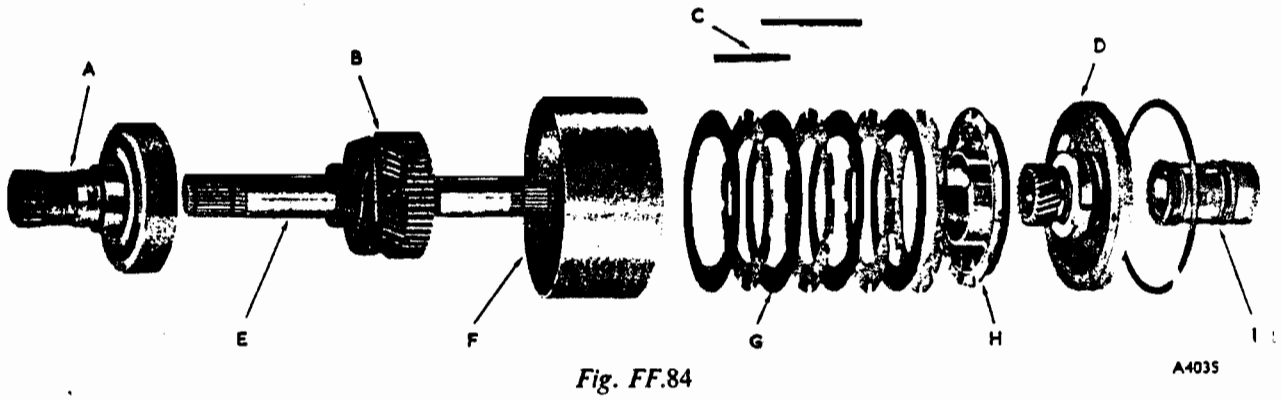

Fig. FF.84

Front drum, exploded view

A. Front drive shaft.
B. Front unit planet carrier and clutch hub.
C. Inner and outer clutch return springs.
D. Clutch cover.
E. Intermediate shaft.
F. Front drum.
G. Clutch pack.
H. Clutch piston.
I. Oil delivery sleeve.

careful dressing of the cap horns. Should this prove unsuccessful, the cap and casing must be renewed.

When the foregoing checks are satisfactory, remove the sleeve ready for reassembling. The clutch plates, which should have been retained together in the order in which they were fitted, should now be inspected, each surface in relation to that with which it mates. This is important as a rough surface of a driven plate may easily be the cause of excessive wear on the mating composition face of the drive plate.

At the clutch cover end of the pack it may be found that there are one or two extra steel plates. These spacing plates should be labelled and kept separately from the other plates as they are not hardened and vary in thickness.

Slight discoloration of the steel driven plates is acceptable, but heavy discoloration caused by excessive overheating may have upset the heat treatment and be the cause of future failure if the plate is not renewed. Check that the driven plates are not distorted by using a surface plate, and ensure that the finish of the surface is smooth and polished.

The composition surfaces of the drive plates should be carefully checked for lifting, flaking, and excessive wear. A plate will normally darken with use, but should it be almost black, indicating signs of burning, it must be renewed. If more than one plate is badly burnt the complete set of plates should be renewed. The surface contour of the drive plates is undulated; each plate should have six waves, which must not be less than ·015 in. (·381 mm.) deep. This can be checked by laying the plate on a surface plate and sliding a feeler gauge into the spaces so formed; if there is evidence of any other distortion the plate must be renewed.

Examine the drive plate serrations and the driven plate slots for burrs and signs of excessive wear. If necessary, remove any burrs and then check that the plates slide smoothly over their respective splines or driving pins.

Examine all thrust washers for cracks; if any washer is cracked, badly scored, or worn excessively, it should be renewed and the respective mating surfaces inspected for burrs, scoring, and sharp edges.

Examine the bands for loose rivets and worn linings; if the rivets are loose or if the face of the lining is worn down to the grooves or has started to lift from the steel band the particular band assembly must be changed. When inspecting bands care must be taken not to distort them in any way as they are surface-ground to fit the drums. If the lining is found to be badly impregnated

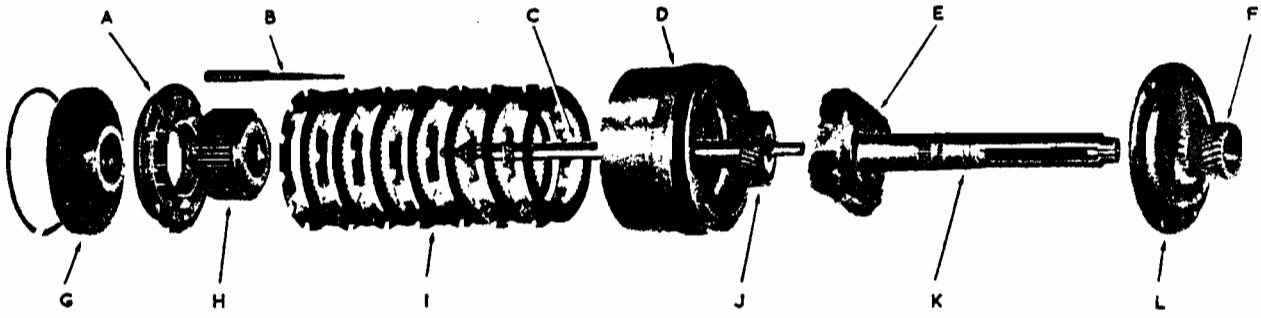

Fig. FF.85

Rear drum, exploded view

A. Clutch piston.
B. Clutch springs and guide pins.
C. Mainshaft.
D. Rear drum and annulus.
E. Rear planet carrier.
F. Reverse sun gear.
G. Clutch cover.
H. Clutch hub.
I. Clutch pack.
J. Rear unit sun gear.
K. Output shaft.
L. Reverse drive flange.

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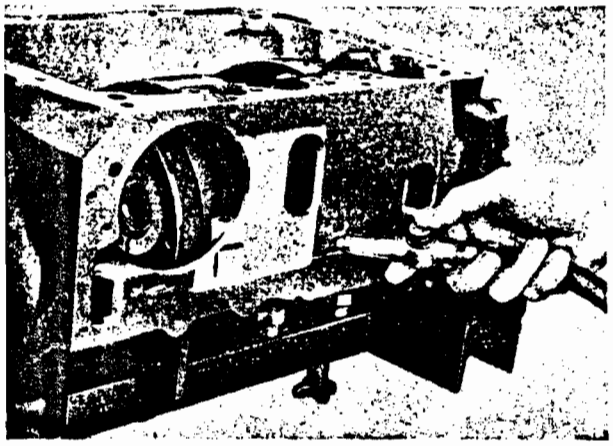

A4033

Fig. FF.86

Air pressure testing, front and rear clutches

with foreign matter, such as bronze caused by bush failure, it should be renewed.

Check the steel bands for distortion and cracks and the anchor ends for broken welds and worn sockets.

Check the rear band operating strut locating pin for security and the strut for play on the pin. If the play is excessive or the pin is loose, renew the complete band assembly.

Reassembling the front clutch

Fit a new seal and expander to the piston in the manner illustrated in Fig. FF.87: care must be taken to ensure that the rubber beds well down into its groove and that the expander does not protrude beyond the bottom edge of the rubber seal.

In a similar manner fit a new seal and expander to the clutch cover. After initially inserting the expander and seal into the groove a small wooden block should be placed between the seal and the inner circumference of the cover (Fig. FF.88). This will stop the tendency for the seal and expander to creep out of the groove during fitting. Remove the wooden block and check that the expander does not protrude below the seal.

The direction in which the protruding lip of the seal faces is important and must be as shown in the respective illustrations.

With the seals correctly in position the piston may now be inserted into the cover after first lubricating the rubbers. The lip of the outer seal should be initially introduced into the cover, using the side of a blunt screwdriver drawn over the seal edge as shown in Fig. FF.89, after which the two components can be manually pressed firmly together. Line up the square notches in the piston with the three holes in the cover.

Put the intermediate shaft into the holding fixture, clutch hub uppermost, place the front drum over the shaft so that it rests on the planet gears with its driving pins pointing upwards, lubricate the surfaces of the clutch plates with clean gearbox fluid, and then install them, fitting a composition drive plate first, then a steel driven plate, and so on alternatively until the complete pack is fitted.

Ensure that each composition plate slides freely over the clutch hub splines and that the steel plates are fitted with the square notches over the driving pins.

It should be noted that previously labelled spacing plates must be fitted last, but the thickness may have to be reassessed as described later.

Drop the six pairs of clutch release springs into their locating holes formed by the plates and then install the cover into the drum, sun gear first, making sure that the springs engage in the pockets of the clutch piston.

Remove the complete assembly from the intermediate shaft, and using a suitable press, apply sufficient pressure to the clutch cover to enable the spring ring to be fitted into its groove. Ensure that the ring beds firmly into its groove and then release the pressure. After removing the assembly from the press ensure that the outer shoulder of the clutch cover protrudes evenly through the inner circumference of the retaining ring; if necessary, lightly tap the cover into its correct position, using a plastic hammer.

The assembly of the clutch plates should now be checked, and this is best accomplished by placing the fingers on the teeth of the drive plates and lifting and

A1990

Fig. FF.87

Fitting a new clutch piston seal

A1989

Fig. FF.88

Fitting a new seal to the clutch cover

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turning the plates. When correct, the clearance should be just sufficient to allow free rotation without binding.

If the clutch is too free and the end-float can be felt, or if the plates are binding or solid, it will be necessary to alter the thickness of the spacing plate or plates accordingly.

These plates are supplied in various thicknesses and can be fitted singly or paired in any combination to give requisite clearance.

The total number of spacing plates fitted must not exceed two: they must never be fitted in any position other than between the clutch cover and the first steel driven plate.

Reassembling the rear clutch

If previously removed, refit the annulus gear, screwing up the set screws evenly; before final tightening tap the end face of the gear with a plastic hammer to ensure correct location. Assembling of the rest of the unit is now similar to that of the front clutch, with the exception that there is no need to mount it on the intermediate shaft. It is, however, advisable to temporarily fit the clutch hub to ensure that the drive plates slide freely on the splines. After assembly remove the hub and check and adjust the clutch plate clearance in the same way as described for the front clutch.

Refit the hub together with the large bronze thrust washer. The washer should be coated with petroleum jelly to ensure that it is retained in the deep counter-bore of the hub. Rotate the hub to engage the splines of the drive plates. When properly installed the hub should be level with, or slightly below, the counter-bore of the drum. Fit the hub retainer bracket, using a reverse drive flange retaining bolt.

After fitting the steel and bronze thrust washers inside the planet carrier on the intermediate shaft the drum assemblies may now be refitted to the shaft in the following order (clean gearbox fluid should be used liberally during assembly):

(1) Fit the front drum over the shaft onto the hub, rotating it backwards and forwards until all the drive plates are correctly located.

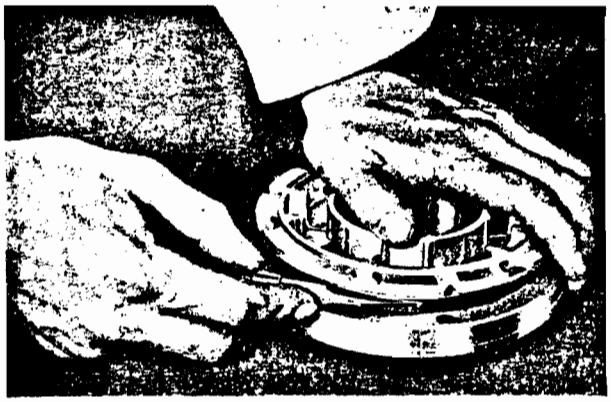

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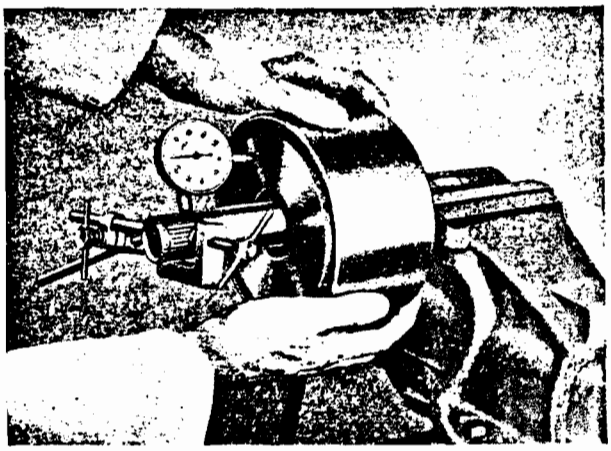
Fig. FF.89

Fitting the clutch cover to the clutch piston



A4016

Fig. FF.90

Checking front drum end-float

(2) In the following order fit the bronze washer, the steel (selective) washer, and the snap ring. The selective washer may have to be changed if, as a result of the following end-float check, the clearance is found to be outside the limits.

(3) Remove the shaft and drum from the holding fixture and place the shaft in a vice, using fibre clamps. Fit a dial indicator, mounted as shown in Fig. FF.90, and measure the end-float of the drum assembly. If the end-float is outside the limits given under **'GENERAL DATA'**, replace the steel thrust washer by one of suitable thickness.

(4) Place the assembly back in the holding stand and use the ring compressing tool (see Fig. FF.91) to fit the oil delivery sleeve; enter the end which has the rings nearest the end of the sleeve first. If the sleeve is too tight to fit by hand a plastic hammer may be used, as shown in the illustration; only light taps should be necessary. Push the sleeve fully home into the bore of the drum and refit the snap ring.

(5) Refit the thin steel thrust washer.

(6) Fit the ring compressing tool over the two exposed rings on the oil delivery sleeve. Slide the rear drum over the shaft and lower it carefully onto the delivery sleeve; when fully home remove the compressing tool.

(7) Fit the rear drum snap ring.

Refitting to the gearbox

Place the bearing cap in position on the oil delivery sleeve, machined flat forward, making sure that the dowel locates positively in its correct hole. Incorrect location of the dowel will be evident by the lock plate washer being forced up when the securing set screws are tightened. If this occurs, remove the cap, tap the dowel pin back into position, then check the delivery sleeve and the pin for damage before reassembling correctly.

Fit the front band over its drum so that the smaller of the two anchorage ends will locate with the front band adjusting screw when the assembly is installed.

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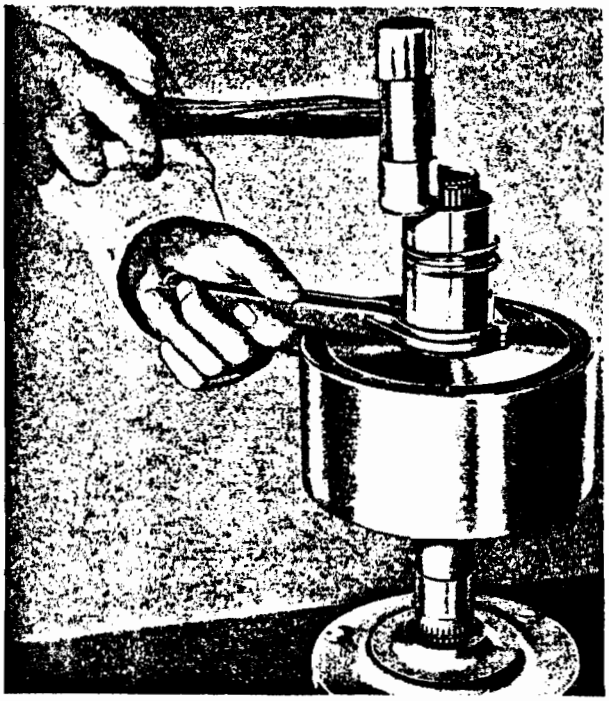

Fig. FF.91
Refitting the oil delivery sleeve

To retain the front band on the drum, during installation join the two ends together with a suitable spring or piece of wire.

Slide the rear band onto its drum and then install the assembly into the gearbox in the reverse manner to removal (Fig. FF.79); when in position remove the spring or wire from the front band.

An alternative method is to place the front band into position in the gearbox, insert the shaft assembly through the band, and whilst still tilted slide the rear band onto its drum.

Before securing the bearing cap ensure that the band anchorage ends are properly located on their respective adjusting screws, then fit the two bearing cap set screws together with a new tab washer and tighten evenly to the correct torque loading given under **'GENERAL DATA'.**

Ensure that the drums revolve smoothly on the intermediate shaft, then check the action of the clutches by blowing compressed air through the passages illustrated in Fig. FF.86. Correct operation can be both heard and felt. Check thoroughly for air leaks during this test.

Refit the remaining assemblies in the reverse order to that of dismantling and then road-test.

Section FF.22

GEARBOX CASING

When all units have been removed from the gearbox as described in the foregoing Sections the only removable parts which remain are the two band adjusting screws and the oil pressure test point blanking plug. Removal of these parts is quite straightforward.

Clean the casing and passages thoroughly with clean compressed air.

Inspection

Check all joint faces for burrs; light damage can be removed by careful stoning. Similarly, check the spigot bores in the front and rear ends of the case.

Inspect the screw threads of all tapped holes, making sure that the top threads have not been pulled or damaged to an extent which might upset the joint.

Check the fit of the band adjusting screws in their threads and gearbox case, also check the threads of the locknuts and the oil pressure point blanking plug.

Examine the gearbox casing for cracks and check the fit of the centre bearing cap together with the oil delivery sleeve as described in Section FF.21.

Using air pressure, check the continuity and interconnection of the oil passages as identified in Fig. FF.25 in Section FF.7. Wire may be used to clear a blocked passage, but care must be taken not to set up any burrs on the passage mouths.

After completing the inspection refit the band adjusting screws and the oil pressure check point blanking plug and tighten the blanking plug to the correct torque loading given under **'GENERAL DATA'.**

Section FF.23

FAULT DIAGNOSIS

Correct diagnosis and rectification of faults depends on (1) Servicing, (2) Testing, (3) Recording the results of each test, and (4) Consulting the fault diagnosis table on the following page.

The table is divided to show:

(A) Defects that can be diagnosed without dismantling the gearbox.

(B) Defects that can be diagnosed by air pressure tests and rectified by removal of units with the gearbox *in situ*.

(C) Defects that entail gearbox removal.

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FAULT DIAGNOSIS TABLE

Symptoms of defect	A Diagnosis without dismantling				B Removal of units					C Remove gearbox			
	Throttle linkage	Selector linkage	Oil pressure	Servo bands	Control valve unit	Parking bracket	Governor	Front servo	Rear servo	Reverse unit	Fluid coupling	Front unit	Rear unit
High or low up changes	*				*		*						
Rough up changes	*		*	*	*								
Slips—light throttle up changes	*			*									
Slips—heavy throttle up changes	*		*	*	*			*	*				
Slips 1—2 and 3—4			*	*				*	*			*	
Slips 2—3	*		*	*	*			*	*				
Up change to third gear in range 2		*			*		*						
Early 4 to 3 range		*			*		*						
Rough 3—2 closed-throttle down change	*		*	*	*				*				
No. 4—3 kick-down	*				*							*	
No. 3—2 kick-down	*				*								
Rough 4—3 down change			*	*	*			*					
No up change above first			*		*	*	*					*	*
Misses second and fourth								*	*				
Misses first and third				*				*				*	
No reverse—slips		*	*	*	*		*	*					
Locks in reverse		*	*						*	*			
Jumps out of reverse		*											
Reverse cannot be selected						*	*						
Possible rev. engagement over 10 m.p.h.						*							
Clashes when selecting reverse			*			*							
No forward drive after reverse										*			
No drive		*	*		*								
No drive when engine first starts			*								*		
Slips in range 3 but not range 2			*			*	*	*					
Intermittent slip in all drive ranges			*					*					
Rough changes neutral to drive				*					*				
Slow band apply neutral to drive								*	*				
No parking brake						*							
Rough down change after stopping	*				*								
Slips in range 3 on over-run								*					

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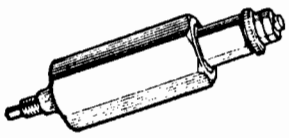
SERVICE TOOLS

18G490. Front Servo Setting Gauge

An essential tool when checking and adjusting the front band.



4470H

18G490

18G492. Gearbox Lifting Eyebolt

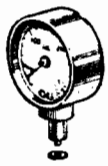
This attachment greatly facilitates removal and replacement of the heavy gearbox.

4469A

18G492

18G502A. Hydraulic Pressure Gauge (gauge only)

A pressure gauge head for use with 18G502B and 18G502J when carrying out hydraulic pressure tests on the automatic gearbox.

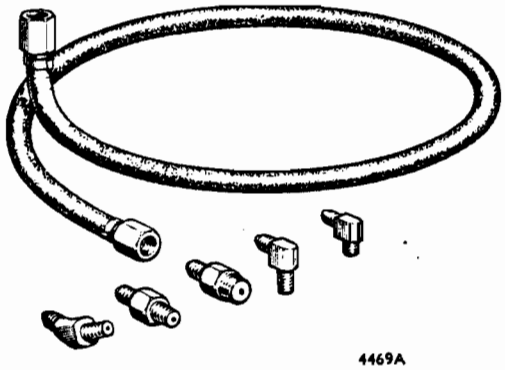


4469A

18G502A

18G502B. Hydraulic Pressure Gauge Pipe

A high-pressure flexible connecting tube with suitable adaptors for use with 18G502A and 18G502J.



4469A

18G502B

18G502J. Hydraulic Pressure Gauge Adaptor

This adaptor is designed to fit the tapping provided in the gearbox casing and is used with 18G502A and 18G502B.

18G502J

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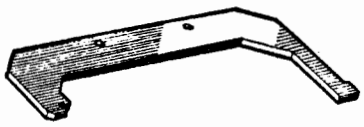
18G489. Rear Servo Setting Gauge

An essential tool for use when setting and adjusting the rear band.

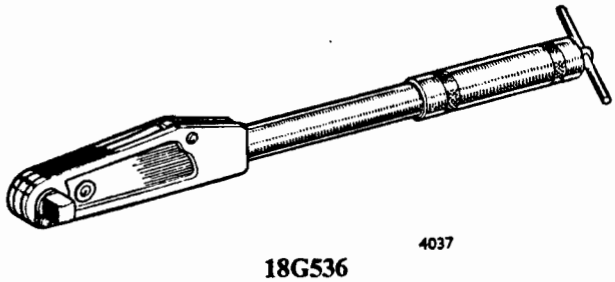


18G489

18G536. Torque Wrench—2 to 8 lb. ft. (·28 to 1·11 kg. m.)

18G537. Torque Wrench—5 to 30 lb. ft. (·69 to 4·15 kg. m.)

These two wrenches provide the torque range necessary for the reassembly of the automatic gearbox. 18G537 is suitable for use with standard sockets. 18G536 will utilize standard sockets when used with adaptor 18G536A.



18G536

18G537

18G536A. Torque Wrench Socket Adaptor

An adaptor which will make 18G536 suitable for use with standard sockets.

18G536A

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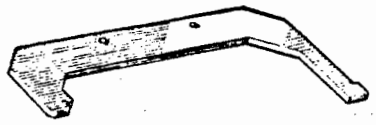
18G489. Rear Servo Setting Gauge

An essential tool for use when setting and adjusting the rear band.



18G489

18G536. Torque Wrench—2 to 8 lb. ft. (·28 to 1·11 kg. m.)

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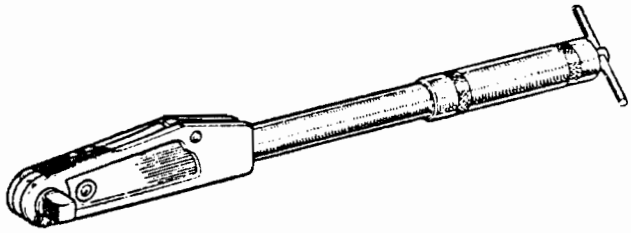

18G536
18G537

18G536A. Torque Wrench Socket Adaptor

An adaptor which will make 18G536 suitable for use with standard sockets.

18G536A

18G602. Governor Sleeve Alignment Gauge

A gauge to align the governor sleeve in the parking bracket tower.

18G602

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SECTION G

THE PROPELLER SHAFT

	Section
General description	
Lubrication	
Centre bearing housing	
Dismantling and reassembling	G.5
Propeller shafts	
Removing	G.1
Replacing	G.6
Universal joints	
Dismantling	G.2
Examination and checking for wear	G.3
Reassembling	G.4

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GENERAL DESCRIPTION

The propeller shafts and universal joints are of the Hardy-Spicer type with needle-roller bearings.

A short propeller shaft couples the gearbox flange to the main propeller shaft and the two shafts together have three universal joints. Each joint consists of a centre spider, four needle-roller bearing assemblies, and two yokes.

Because there are two propeller shafts an extra support for the transmission is necessary. This is provided in the form of a ball-bearing mounted in a bracket on the centre cross-member of the chassis frame to support the rear end of the front propeller shaft.

To accommodate fore and aft movement of the rear axle a sliding splined joint is incorporated in the forward end of the rear propeller shaft.

LUBRICATION

A lubricator is fitted to each of the three universal joints and two more are provided to lubricate the centre bearing and sliding spline coupling. These lubricators should be charged fully after overhauling and subsequently given three or four strokes with the lubricating gun filled with grease at the periods stated in the Passport to Service.

If a large amount of lubricant exudes from the oil seals the joints must be dismantled and new seals fitted.

Section G.1

REMOVING THE PROPELLER SHAFTS

Rear main propeller shaft

The removal procedure for the propeller shaft (excluding the front transmission shaft and bearing) is as follows.

Support the propeller shaft near the sliding joint by wood blocks or a sling from the chassis.

Remove all the nuts and bolts from the companion flange at the sliding joint end.

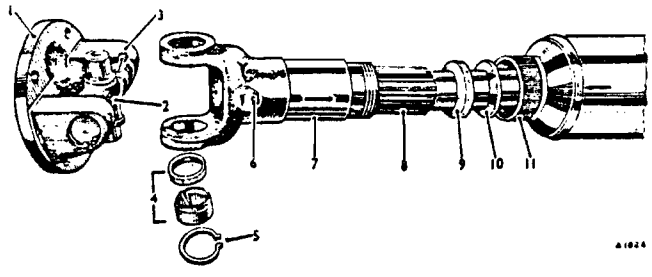

Fig. G.1

Exploded view of the front universal joint on the main propeller shaft

1. Flange yoke.
2. Spider.
3. Oil nipple.
4. Needle-bearing assembly.
5. Snap ring.
6. Oil nipple.
7. Sleeve yoke.
8. Splines.
9. Cork washer.
10. Steel washer.
11. Dust cap.

Unscrew by hand the dust cap at the rear of the sliding joint. Slide the splined sleeve yoke about ½ in. (12·7 mm.) towards the propeller shaft, thus disengaging the pilot flanges.

Next remove all the bolts securing the rear flange yoke to the axle companion flange and gently lower to a clean space on the ground.

The propeller shaft and the two universal joints can now be removed and dismantled to a further degree.

Front transmission shaft

Firstly, if the main propeller shaft has not already been removed, the flange yoke must be disconnected from the short shaft rear flange in the manner already described.

Following this operation, the complete bracket, supporting the bearing housing of the short shaft, must be released from the chassis frame. This is accomplished by removing the four nuts, bolts, and washers which secure the bracket to the chassis.

Now that these two preliminaries have been completed the shaft may be disconnected at the gearbox flange by releasing the four flange bolts. The whole unit can now be withdrawn rearwards.

Section G.2

DISMANTLING THE UNIVERSAL JOINTS

Rear main propeller shaft

The following directions apply to both universal joints of the main propeller shaft, except for the fact that the front joint can be separated from the propeller shaft, whereas the rear joint has one yoke permanently fixed to the tube.

Clean away the enamel from all the snap rings and bearing faces to ensure easy extraction of the bearings.

Remove the snap rings by pressing together the ends of the rings and extract with a screwdriver. If the ring does not come out easily, tap the bearing face lightly to relieve the pressure against the ring.

Now, holding the joint so that the splined sleeve trunnion is on top, tap the radius of the yoke with a lead or copper hammer (see Fig. G.2) and it will be found that the bearing will begin to emerge. If difficulty is experienced, use a small bar to tap the bearing from the inside, taking care not to damage the race itself. Turn the yoke over and extract the bearing with the fingers (see Fig. G.3), being careful not to lose any of the needles.

Repeat this operation for the other bearing and the splined yoke can be removed from the spider (see Fig. G.4).

Repeat the operation to remove the spider from the other yoke.

Front transmission shaft

The front universal and fixed yoke of the short transmission shaft are dismantled in an identical manner to their counterparts of the main propeller shaft.

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To dismantle the rear flange proceed as follows.

The driving flange is disengaged from the shaft splines by first knocking back the tabs of the lock washer and then removing the flange-securing nut and washer. Next bolt to the flange extractor 18G2 and, by turning the centre-bolt, withdraw the flange from the shaft. The shaft may now be carefully tapped through the bearing housing.

Section G.3

EXAMINATION AND CHECKING FOR WEAR

After long usage the parts most likely to show signs of wear are the bearing races and the spider journals of the universal joints. Should looseness or stress marks be observed, the assembly should be renewed complete, as no oversize journals or bearings are provided.

It is essential that bearing races are a light drive fit in the yoke trunnions. Should any ovality be apparent in the trunnion bearing holes, new yokes must be fitted.

With reference to wear of the cross-holes in a fixed yoke, which is part of the tubular shaft assembly, only in cases of emergency should this be replaced. It should normally be renewed with a complete tubular shaft assembly. The other parts likely to show signs of wear are the splined sleeve yoke, or splined stub shaft. A total of ·004 in. (·102 mm.) circumferential movement, measured on the outside diameter of the spline, should not be exceeded. Should the splined stub shaft require renewing, this must be dealt with in the same way as the fixed yoke, i.e. a replacement tubular shaft assembly fitted.

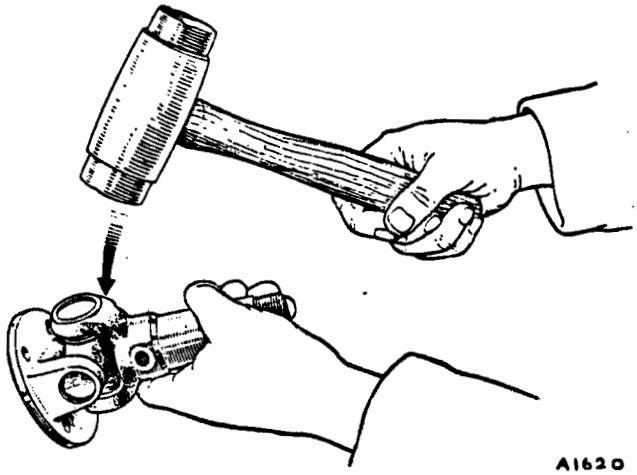

Fig. G.2

Tapping the front joint to extract the bearing

As far as the short transmission shaft bearing housing is concerned, the most likely features that may deteriorate are the rubber bush mountings and the oil seals. The rubber bushes should be inspected periodically to detect signs of the rubber perishing. An oil leak from the housing will denote a defective oil seal.

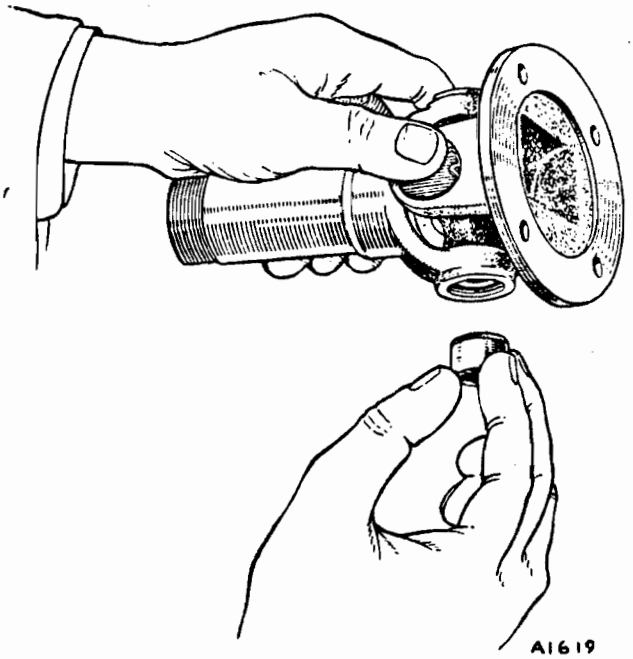

Fig. G.3

Removing a bearing complete with needle rollers

Section G.4

REASSEMBLING THE UNIVERSAL JOINTS

See that all drilled holes in the journals of the universal joints are clean and filled with oil. Assemble the needle rollers in the bearing races and fill with oil. Should difficulty be experienced in assembly, smear the walls of the races with vaseline to retain the needle rollers in place.

Insert the spider in the flange yoke. Using a soft-nosed drift about $\frac{1}{32}$ in. (2·38 mm.) smaller in diameter than the hole in the yoke, tap the bearing in position. It is essential that bearing races are a light drive fit in the yoke trunnions. Repeat this operation for the other three bearings. The spider journal shoulders should be coated with shellac prior to fitting the retainers to ensure a good seal.

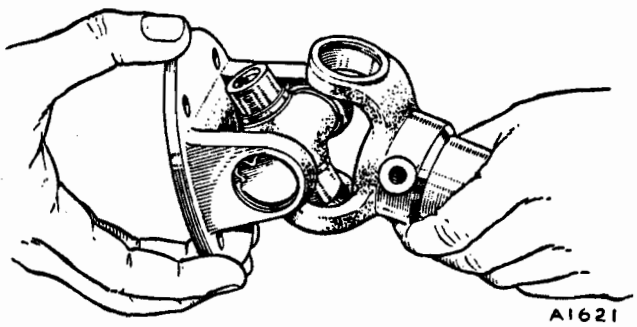

Fig. G.4

Separating the joint

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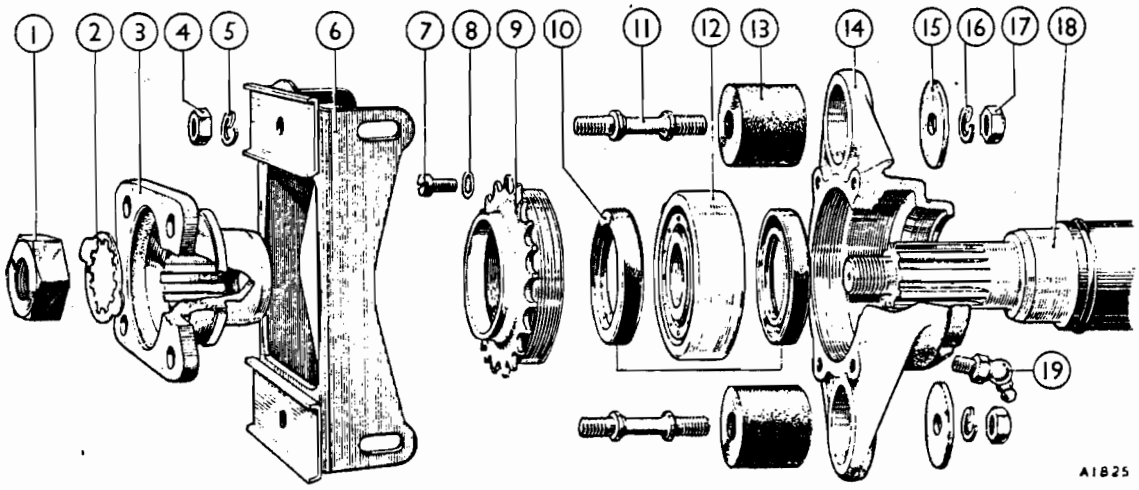

Fig. G.5

Exploded view of the centre bearing

1. Shaft nut.
2. Lock washer.
3. Driving flange.
4. Suspension nut.
5. Spring washer.
6. Mounting bracket.
7. Adjusting lock screw.
8. Lock washer.
9. Load adjusting collar.
10. Oil seal.
11. Mounting stud.
12. Bearing.
13. Rubber mounting blocks.
14. Bearing housing.
15. Mounting block.
16. Spring washer disc.
17. Nut.
18. Propeller shaft.
19. Lubricating nipple.

If the joint appears to bind, tap lightly with a wooden mallet, which will relieve any pressure of the bearings on the end of the journals. When replacing the sliding joint on the shaft be sure that the trunnions in the sliding and fixed yoke are in line. This can be checked by observing that arrows marked on the splined sleeve yoke and the splined stub shaft are in line. It is advisable to renew cork washers and washer retainers on spider journals, using a tubular drift.

Section G.5

DISMANTLING AND REASSEMBLING THE CENTRE BEARING HOUSING

The bearing housing rubber mountings are secured at the top and bottom by studs and nuts. By removing the nuts and washers from the longer portion of each of the stud threads the bracket may be released.

If the rubber bushes are to be renewed, in each case the nut and washer should be removed from the stud and the stud itself forced out of the bush.

The spur-type adjusting cap at the rear of the housing is locked in one of four possible positions by a cheese-head screw and washer. Having extracted this lock screw, the adjusting cap may be unscrewed from the casing, noting that the cap has a left-hand thread. Inside the adjusting cap is an oil seal which can be tapped or levered from its housing if necessary.

Another oil seal is situated behind the bearing and can be extracted in the same manner once the ball bearing has been gently tapped out of the housing, using a soft-metal drift for the purpose.

Reassembly is a fairly simple procedure, but the final bearing adjustment must be carefully carried out.

Insert an oil seal in the casing ensuring that the open face of the seal looks towards the centre of the housing. Next insert the ball bearing in the case and gently press or tap it fully home. Now place the second oil seal into the adjusting cap and again make sure that the open seal face looks towards the bearing. Screw inwards the spur-type adjusting cap, remembering that it has a left-hand thread.

Adjustment of the ball bearing loading is achieved by screwing the cap up tight to the bearing and then slackening the cap again until one of the serrations of the cap perimeter appears opposite one of the four tapped holes. The cap should then be locked by the cheese-head set pin.

Section G.6

REPLACING THE PROPELLER SHAFTS

Front transmission shaft

Wipe the companion flange and flange yoke faces clean, to ensure that the pilot flange registers properly and the joint faces bed evenly all round. Insert the bolts, tighten the nuts evenly all round, and securely lock them.

The rear end of the transmission shaft complete with the centre bearing and housing is now assembled to the chassis frame with the four nuts, bolts, and spring washers.

Rear main propeller shaft

Fit the front transmission shaft as described above.

Wipe the companion flanges and flange yoke faces clean to ensure that the pilot flange registers properly and the joint faces bed evenly all round. Insert the bolts, and see that the nuts are tightened evenly all round and are securely locked.

The dust cap must be screwed up by hand as far as possible. The sliding joint is always placed towards the front of the vehicle.

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SECTION H

THE REAR AXLE AND REAR SUSPENSION

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Spring bushes—removing and replacing	H.12
Tools	End of Section

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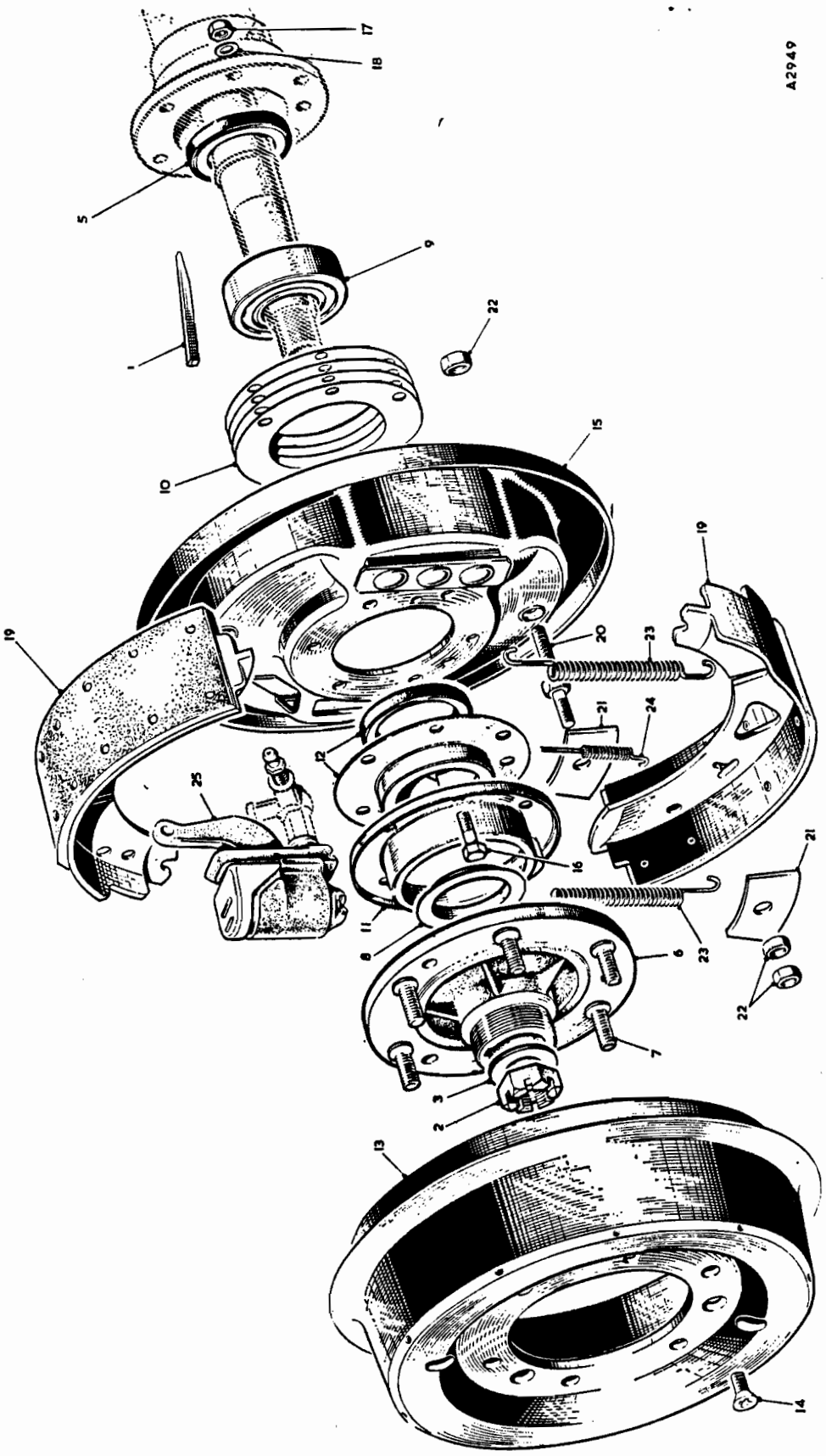
THE REAR HUB AND BRAKE COMPONENTS



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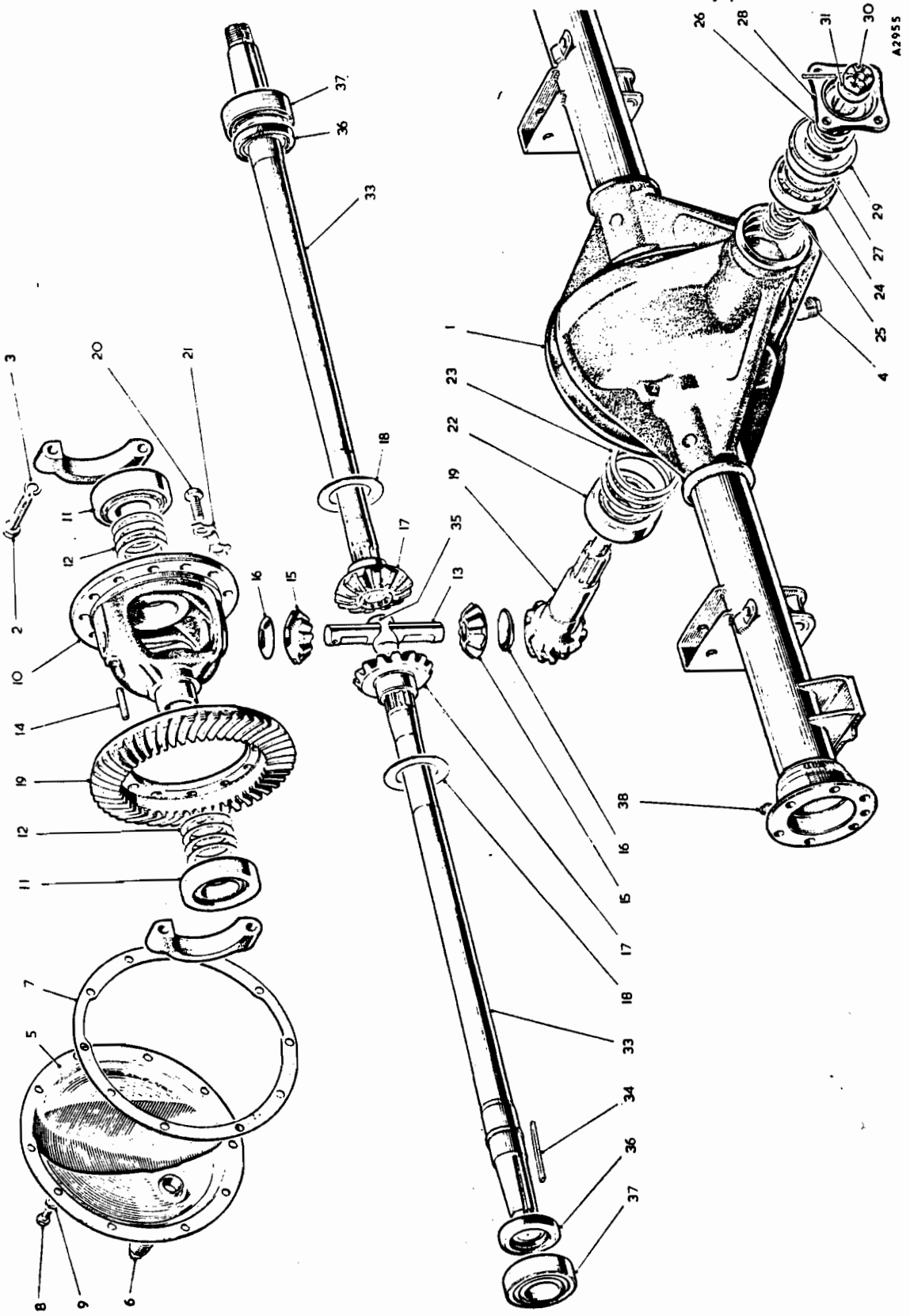
KEY TO THE REAR HUB AND BRAKE COMPONENTS

No.	*Description*	*No.*	*Description*	*No.*	*Description*
1.	Axle shaft key.	10.	Shims.	18.	Spring washer.
2.	Nut.	11.	Oil catcher.	19.	Brake-shoe.
3.	Washer.	12.	Oil seal assembly.	20.	Steady pin.
5.	Oil seal.	13.	Brake-drum.	21.	Washer.
6.	Hub.	14.	Screw—drum to hub.	22.	Adjusting and locknuts.
7.	Stud.	15.	Brake backplate.	23.	Pull-off springs.
8.	Oil thrower.	16.	Bolt for backplate.	24.	Bias springs.
9.	Taper-roller bearing.	17.	Nut.	25.	Rear wheel cylinder assembly.

THE REAR AXLE COMPONENTS



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KEY TO THE REAR AXLE COMPONENTS

No.	Description
1.	Rear axle case with bearing caps.
2.	Set screws for bearing caps.
3.	Spring washers.
4.	Drain plug.
5.	Rear cover.
6.	Filler plug.
7.	Joint washer.
8.	Set screws—cover to case.
9.	Spring washers.
10.	Differential case.
11.	Taper-roller bearings.
12.	Shims.
13.	Differential pinion shaft.
14.	Lock pin—pinion shaft to differential case.
15.	Pinions.
16.	Thrust washers.
17.	Differential wheels.
18.	Thrust washers.
19.	Bevel pinion and crown wheel.
20.	Set screws—crown wheel to differential case.
21.	Lock washers.
22.	Taper-roller bearings—pinion rear.
23.	Shims for bearings.
24.	Taper-roller bearings—pinion front.
25.	Shims for bearings.
26.	Oil seal—pinion.
27.	Oil slinger.
28.	Coupling flange.
29.	Dust shield.
30.	Nut for bevel pinion.
31.	Washer.
33.	Differential shaft.
34.	Keys for shaft.
35.	Spacer for shafts.
36.	Oil seal for shafts.
37.	Taper-roller bearings—shaft.
38.	Grease nipple for hubs.

GENERAL DESCRIPTION

The rear axle assembly is of the hypoid semi-floating type. All bearings are adjustable by means of shims, as also is the position of the pinion in relation to the crown wheel and the backlash between the gears.

Each axle shaft is splined at the inner end and engages the female splines in the differential wheel. The outer ends of the shafts are provided with tapers and keys, to which are attached the wheel hubs.

Each wheel is supported on a taper-roller bearing pressed onto the axle shaft. The side-thrust from the wheels is transferred from one shaft to the other by means of a thrust spacer fitted over the differential pinion shaft.

A cover on the rear of the gear carrier housing permits inspection and flushing of the differential assembly without removing or dismantling the axle.

The gear ratio of the axle is stamped on a plate attached to the assembly by one of the rear cover screws.

Suspension is by semi-elliptic springs secured to the chassis at each end by Silentbloc bushes. The axle is secured above each spring by means of 'U' bolts which also secure rubber rebound buffers on top of the axle tubes.

A lubricating nipple is secured in each 'U' bolt plate, providing means of lubricating between the spring leaves.

LUBRICATION

The axle is filled or topped up through the combined filler and level plug in the rear of the axle casing.

It is of the utmost importance that only Hypoid oils of the approved grades and manufacture be used if satisfactory service is to be obtained from the hypoid gears.

Inspect the oil level at the periods stated in the Passport to Service and top up if necessary to the level of the filler opening.

The wheel bearings are lubricated by means of a grease nipple located in the axle tube housing adjacent to the brake backplate. On the top side of the housing a vent hole is provided; the greasing operation should be continued until grease appears at this hole, indicating that the chamber is full. Do not overlubricate.

NOTE.—This is the sole lubrication for the hub bearing and must not therefore, under any circumstances, be neglected.

Section H.1

REMOVING AND REPLACING A REAR HUB

Jack up the rear of the car and place blocks beneath the springs as close as possible to the axle.

Remove the road wheel.

Release the hand brake.

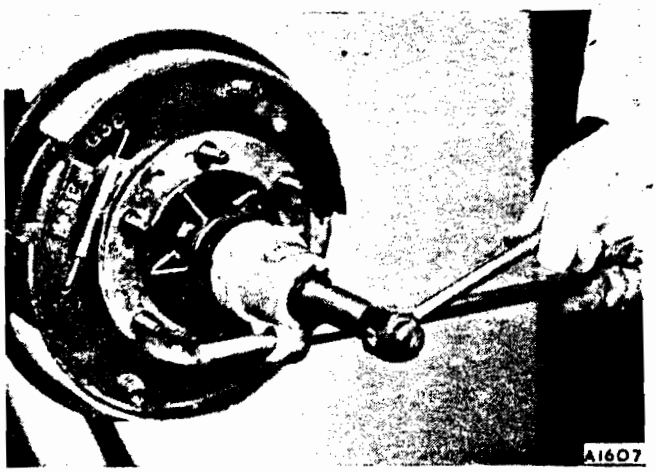

Fig. H.1

Using Service tool 18G8 with adaptor 18G8D to remove the rear hub

Remove the split pin and unscrew the slotted axle shaft nut and washer.

Remove the three countersunk screws and withdraw the brake-drum.

With the aid of Service tool 18G8 and adaptor 18G8D withdraw the hub from the axle shaft.

To replace a rear hub reverse the dismantling procedure, but ensure that the tapered surface on the shaft and also that in the hub are clean and free from burrs. Ensure also that the key is free from burrs and is a good fit in the keyway in the shaft.

Section H.2

REMOVING AND REPLACING A REAR AXLE SHAFT

Remove the brake-drum and rear hub as detailed in Section H.1.

Remove the backplate retaining bolts, the heads of which are shaped to locate against the face of the oil catcher plate assembly. The nuts and the washers pull up against the rear face of the axle tube flange.

Extract the split pin and withdraw the cotter pin from the hand brake cross-rod fork end. Disconnect the fork end from the hand brake lever on the back-plate.

Unscrew the banjo bolt securing the brake banjo adaptor to the wheel cylinder.

Withdraw the oil catcher assembly, the outer oil seal assembly, and the brake backplate, taking care not to lose the wheel bearing adjusting shims fitted between the brake backplate and the axle flange.

With the aid of Service tool 18G83 and pilot 18G129 withdraw the axle shaft and taper-roller bearing. The inner oil seal is pressed within the axle tube, and care must be taken when withdrawing the axle shaft that the splines on the inner end of the shaft do not damage the edge of the oil seal as the shaft is withdrawn.

Do not disturb the oil seal unless it is required to renew it.

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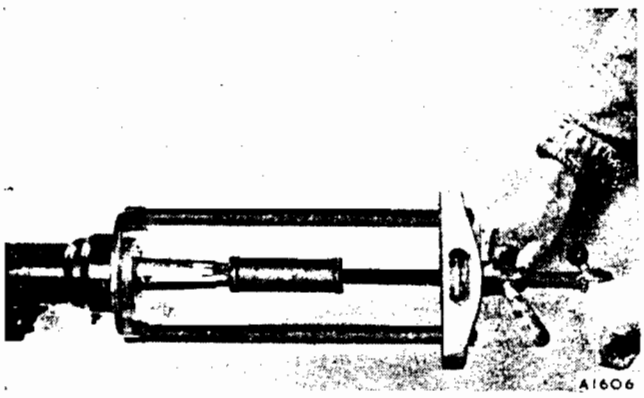

Fig. H.2
Withdrawing a half-shaft, using tool 18G83 *with pilot* 18G129

The inner race of the rear hub may be withdrawn from the shaft with the aid of remover 18G47C and adaptor 18G47K.

To replace the axle shaft press or drive the bearing inner race onto the shaft and assemble the taper-roller cage assembly and outer race onto it. Carefully enter the shaft into the axle tube, taking care not to damage the oil seal lip.

With the aid of 18G129, which is a two-part tool comprising a pilot and replacer, drive the bearing outer race into the axle tube. The outer race should protrude from the face of the axle flange by approximately $\frac{1}{16}$ in. (1·59 mm.).

The remainder of the reassembly procedure is a reversal of the dismantling procedure already outlined. Fit the same number of shims between the axle flange and the brake backplate that were removed.

If a new half-shaft or bearing has been fitted it may be necessary to add to or subtract from the shims fitted to obtain the necessary axle shaft end-float, which must be from ·004 to ·007 in. (·102 to ·178 mm.). Determine the approximate amount of shimming required by use of a feeler gauge and straight-edge (illustrated in Fig. H.3), having first lightly tapped the bearing outer race into the axle tube.

Shims are available in thicknesses of ·003, ·005, ·010, and ·030 in. (·076, ·127, ·254, and ·762 mm.). Adding shims increases end-play, subtracting shims decreases end-play. This applies with one shaft only. The shims required to give the established end-play should be approximately divided between the two sides when replacing both shafts, so as to retain the thrust spacer in a central position.

When refitting the oil seal assembly plates use new gaskets to ensure oil-tight joints, and make certain that the oil drain hole is positioned at the bottom.

Finally, grease the wheel bearings by means of the nipple located in the axle tube housing adjacent to the brake backplate. On the top side of the housing a vent hole is provided; the greasing operation should be continued until grease appears at this hole, indicating that the chamber is full. Do not overlubricate. Use grease to Ref. D, page P.2.

Section H.3

REMOVING THE DIFFERENTIAL UNIT

Drain the lubricant from the gear carrier housing and remove the gear carrier rear cover.

Remove the rear hub as described in Section H.1.

Remove both axle shafts as detailed in Section H.2.

Withdraw the two bolts securing each differential bearing cap and withdraw both caps.

Before the differential assembly can be withdrawn the axle case must be stretched. This is accomplished by means of Service tool 18G131A, which enables the operation to be done easily and without damage to the components. When using this tool tighten the turn-buckle one flat at a time only until the differential unit can be prised out. To facilitate this procedure each flat on the turn-buckle is numbered (see Fig. H.4), providing a check on the amount turned on the buckle. One complete turn of the screw will spread the case ·083 in. (2·10 mm.).

The differential unit may be prised out by means of two levers, one on each side of the differential case opening. During this operation use suitable packing between the levers and the gear carrier and ensure that no leverage is placed upon the axle stretcher.

Section H.4

DISMANTLING AND REASSEMBLING THE DIFFERENTIAL UNIT

Bend back the locking tabs on the drive gear securing screws and withdraw the screws. Remove the ring gear from the differential case.

With the aid of a small punch drive out the pinion shaft locking pin, secured in place by peening the case, and remove the pinion shaft. The pinion shaft locking pin can only be driven out in one direction, which is towards the gear ring side of the differential case.

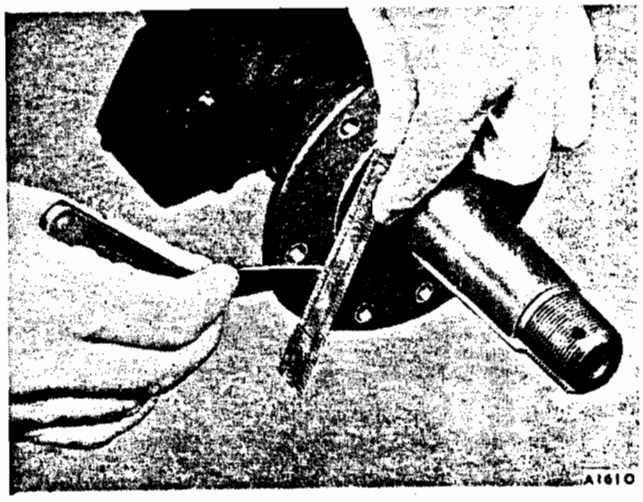

Fig. H.3
Using a straight-edge and feeler gauge to determine the amount of shimming required

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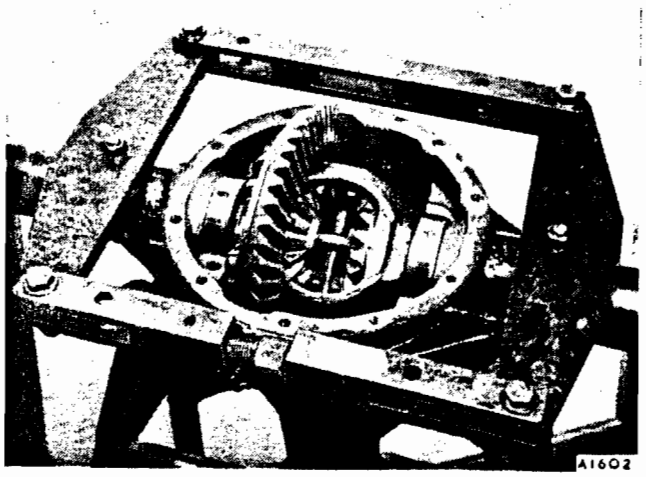

Fig. H.4
Axle stretcher 18G131A in use

Remove the pinion shaft and rotate the side gears by hand until the pinions are opposite the openings in the differential case; remove the differential gears, taking care not to lose the thrust washers fitted behind them.

Should it be necessary to withdraw the differential bearings, either for renewal purposes or altering the drive gear setting, Service tool 18G47C and adaptor 18G47L must be used. Note the shims fitted behind the bearing.

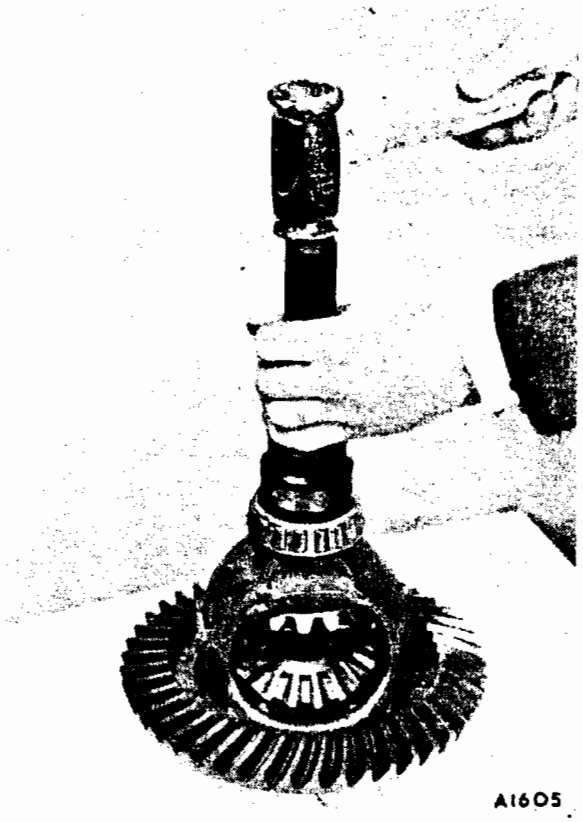

Fig. H.5
Replacing a differential bearing, using Service tool 18G134 and adaptor 18G134A

Use Service tool 18G134 and adaptor 18G134A to replace the differential bearings.

To reassemble the differential unit fit the side gears with the thrust washers in position.

Insert the differential pinions, through the opening in the differential case, and mesh them with the side gears. Hold the pinion thrust washers on the spherical thrust faces of the pinions and rotate the differential gear assembly into position.

Line up the pinions and thrust washers and install the pinion shaft with the axle shaft spacer in position.

Line up the locking pin hole in the pinion shaft with the hole in the differential case and fit the pinion shaft locking pin.

Using a punch, peen some of the metal of the differential case over the end of the locking pin to prevent it working loose.

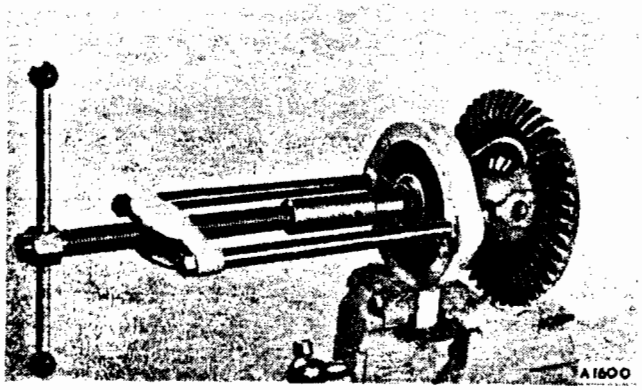

Fig. H.6
Removing a differential bearing, using tools 18G47C and 18G47L

Before assembling the drive gear to the differential case examine both contacting surfaces carefully for burrs. The limit of the run-out on a differential unit when assembled is ·005 in. (·127 mm.). It is essential therefore that both the ring gear and the differential case be perfectly clean.

Align the drive gear attaching bolt holes with those of the flange of the case, and gently tap the drive gear home on the case with a hide hammer.

Insert the drive gear bolts, using new lock straps, and tighten the bolts uniformly by diametrical selection to a torque figure of 70 to 80 lb. ft. (9·68 to 11·06 kg. m.).

Finally, bend the locking tabs round the bolt heads to prevent their working loose.

Section H.5

REPLACING AND RESETTING THE DIFFERENTIAL UNIT

If new differential bearings are to be fitted they should be assembled on the differential case without shims, making sure that the bearing cones and cups on the housing itself are perfectly clean.

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Place the differential unit complete with bearings in the axle case.

Using a suitably mounted dial gauge with the bottom of the dial indicator against the ring gear back face, insert two levers between the housing and the bearing cup and move the differential assembly to one side of the case.

Set the dial indicator to zero, move the differential assembly to the other side, and record the indicator reading. This reading gives the total clearance between the bearings and the abutment faces of the carrier housing.

To this reading must be added the preload figure of ·005 in. (·127 mm.). The total of the first indicator reading plus the correct preload gives the amount of shims to be used in the installation of the differential bearings, the shims being divided to give the gear position with correct backlash as detailed in Section H.9.

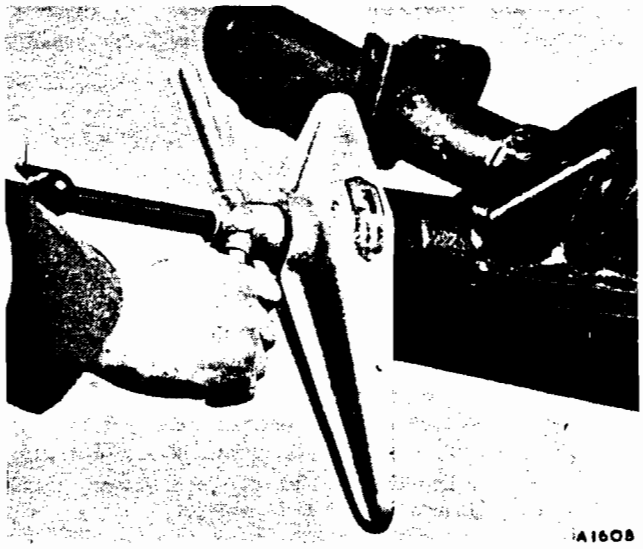

Fig. H.7

Use Service tool 18G135 to remove the front and rear bevel pinion bearing outer races

Section H.6

REMOVING THE BEVEL PINION

Remove the split pin and unscrew the pinion nut, using flange wrench 18G484 to prevent the pinion flange from turning. Withdraw the flange by tapping it gently with a hide hammer.

Press the pinion from the outer bearing. It is important that the pinion should be pressed and not driven out, to prevent damage to the outer bearing.

Remove the pinion from the gear carrier housing, keeping all shims intact.

To remove the bevel pinion front and rear outer races from within the gear carrier casing use Service tool 18G135. As the front outer race is withdrawn it will carry with it the oil slinger plate and the pinion oil seal.

Take care of the shims fitted between the rear outer race and the housing abutment face.

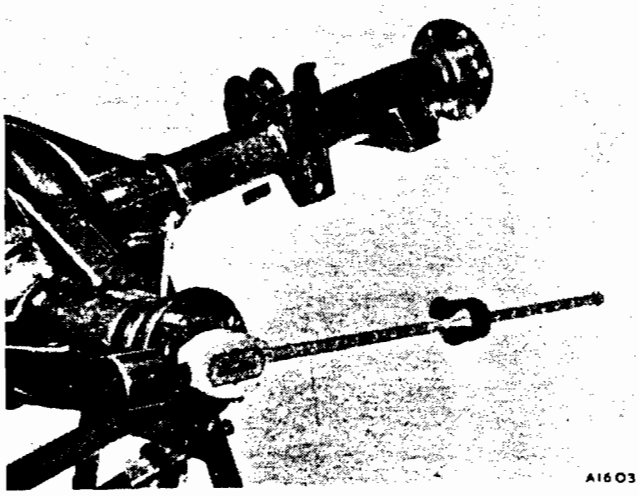

Fig. H.8

Checking the bevel pinion bearing preload with tool 18G207

To remove the rear bearing inner race from the bevel pinion use Service tool 18G47C with adaptor 18G47L.

Section H.7

REPLACING AND ADJUSTING THE BEVEL PINION

Reinstall the bevel pinion front outer race, using Service tool 18G135.

With the same tool reinstall the bevel pinion rear outer race.

Using a press, assemble the rear bearing inner race to the bevel pinion, ensuring that the pressure is exerted on the inner race only and not on the roller retainer.

The bevel pinion must now be correctly adjusted before further assembly is attempted. The gear end of the pinion is marked with the correct pinion setting as illustrated in Fig. H.13. The matched assembly serial

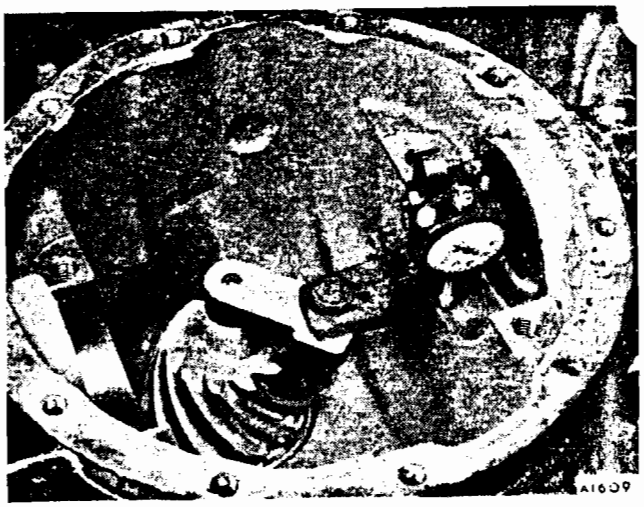

Fig. H.9

Checking the position of the bevel pinion, using 18G191

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number at the top is also marked on the drive gear, and care should be taken to keep similarly marked gears and pinions in their matched sets, as each pair is lapped together during manufacture. The letter and figure on the right refer to the tolerance on offset, or pinion drop, shown by dimension (A) in Fig. H.13. This letter and figure is repeated on the rear cover facing of the gear carrier housing.

When assembling a new crown wheel and pinion, an assembly bearing the same offset figures as those marked on the carrier should be fitted if optimum performance is to be gained. For instance, an L1 carrier requires L1 gears, or an H2 carrier requires H2 gears.

The number on the pinion at the bottom gives the cone setting distance of the pinion and may be zero (0), plus (+), or minus (−). When correctly adjusted a pinion marked zero (0) will be at the zero cone setting distance, which is dimension (B) illustrated in Fig. H.13, from the centre-line of the gear ring to the ground face on the gear end of the pinion; a pinion marked plus 2 (+2) should be adjusted to the nominal (or zero) cone setting plus ·002 in. (·051 mm.), and a pinion marked minus 2 (−2) to the cone setting distance minus ·002 in. (·051 mm.).

When the pinion bearing outer races have been installed in the gear carrier with the necessary original shims proceed with the pinion adjustment as follows.

Ensure that both front and rear inner and outer races are perfectly clean and place the rear roller assembly on the inner race. Assemble the pinion in the gear carrier.

Turn the axle over and use a suitable block of hard wood to support the pinion shaft.

Fit the front bearing inner race and roller assembly. Do not fit the preload shims, oil slinger, and oil seal assembly at this stage, but fit the pinion flange and tighten the nut until a preload of 8 to 12 lb. in. (·092 to ·138 kg. m.) is obtained.

Bevel pinion setting gauge 18G191 is used to check the position of the pinion shaft. Remove the keep disc from the base of the magnet and adjust the dial indicator

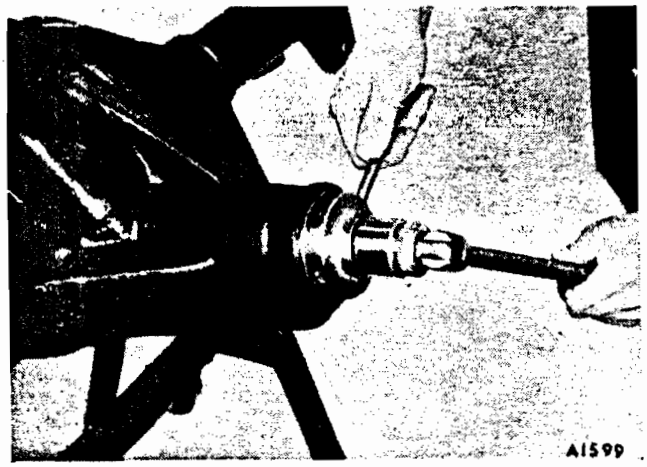

Fig. H.10

Refitting the bevel pinion oil seal

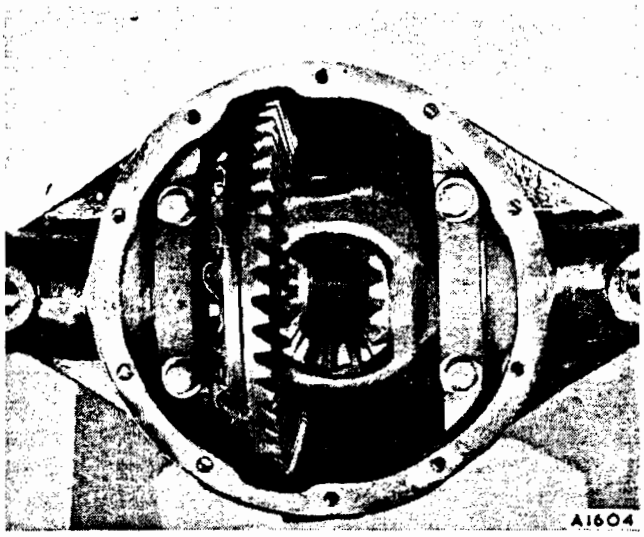

Fig. H.11

Make certain that the differential bearing cap markings are in their correct relationship when replacing the caps

to zero on the largest of the machine steps of the setting block, i.e. the one marked A125, A135.

Clean the pinion head and place the magnet and dial indicator in position (Fig. H.9). Move the dial indicator support arm until the foot of the gauge rests in the centre of the differential bearing bore at one side and tighten the knurled locking screw. The correct reading will be the minimum obtained, i.e. when the indicator spindle is at the bottom of the bore. Slight movement of the assembly will enable the correct reading to be ascertained easily.

Note any variation from the zero setting; it is important also to note the direction of any such deviation as well as the magnitude.

Repeat the check in the opposite bearing bore. Add the two variations together and divide by two to obtain a mean reading.

Do not forget to take into account any variation marked on the pinion head.

If the pinion setting is incorrect it is necessary to dismantle the pinion assembly and remove the pinion rear outer race, using remover 18G135. Add or remove shims, as required, from the pack located behind the rear outer race and reinstall the outer race. Adjusting shims are available in thicknesses of ·003, ·005, and ·010 in. (·076, ·127, and ·254 mm.).

Carry out the same procedure to check the pinion setting.

When the correct pinion setting has been obtained remove the pinion and fit the original preload shims behind the pinion front bearing inner race. Do not fit the oil seal. Refit the pinion driving flange and tighten the nut to a torque reading of 120 to 130 lb. ft. (16·59 to 17·97 kg. m.). Check the pinion bearing preload, using Service tool 18G207 (see Fig. H.8). The correct preload must be between 8 and 12 lb. in. (·092 and ·138 kg. m.). A preload which is less than the minimum figure will result in excessive deflection of the pinion under load,

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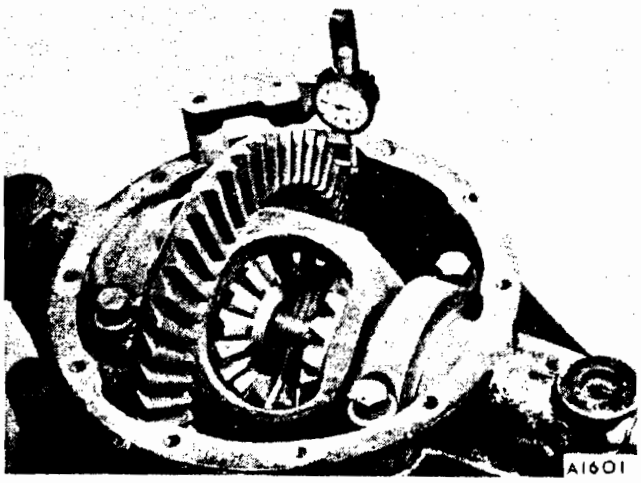

Fig. H.12

Checking the crown wheel backlash

whilst a figure in excess of the maximum quoted will lead to pitting and failure of the bearings.

To rectify the preload adjust the shim pack between the front bearing inner race and the pinion shank, but do not touch the shims behind the rear bearing outer race which control the position of the pinion. Shims are available in thicknesses of ·003, ·005, ·010, and ·030 in. (·076, ·127, ·254, and ·762 mm.).

Remove shims to increase the preload and add shims to decrease the preload.

The installation of the pinion oil seal and the oil slinger plate is usually effected after the fitting of the differential assembly, using bevel pinion oil seal replacer 18G137 as illustrated in Fig. H.10. Refit the pinion flange and slotted nut, tighten the nut to a torque figure of 120 to 130 lb. ft. (16·59 to 17·97 kg. m.), and lock in position with a split pin.

Section H.8

DIFFERENTIAL CROWN WHEEL ADJUSTMENT

With the bevel pinion installed, place the differential assembly in the axle casing. There should be no shims fitted between the differential casing and the inner races at this stage.

To facilitate the differential assembly installation, fit the axle stretching tool 18G131A, taking care not to tighten the turn-buckle a greater number of turns than was necessary upon removal.

Lower the differential assembly carefully into position, lightly tapping the bearings home with a hide hammer and carefully leading the gear teeth into mesh with those of the pinion.

Release the axle stretching tool.

Install a dial indicator on the axle casing with the indicator button on the back face of the drive gear.

Insert two small levers between the axle casing and the differential housing and move the assembly **away** from the pinion until the opposite bearing is seated against the axle casing register.

Set the dial indicator to zero, then move the differential assembly towards the pinion until the drive gear is meshed as deeply with the pinion as permissible. The reading now obtained is the amount of clearance between the drive gear and pinion, and from this figure must be subtracted the backlash allowance which is etched on the drive gear (e.g. B/L ·007). The resulting figure denotes the thickness of shims to be placed between the differential case and the differential bearing inner race, on the **drive gear,** or **left-hand**, side of the differential after removing the differential assembly from the axle casing. The necessary shims are taken from the pack determined previously and described in Section H.5.

Install the balance of the shims from the pack on the opposite, or right-hand, side of the differential.

As an example of differential and drive gear adjustment, assume that the total indicator reading obtained, as described in Section H.5, is ·083 in. (2·1 mm.). This figure plus the differential preload shim allowance of ·005 in. (·127 mm.) gives ·088 in. (2·23 mm.) as the total thickness of shims to be used.

Assume that a clearance of ·042 in. (1·07 mm.) exists between the drive gear and pinion, subtract the backlash which is etched on the gear—say, ·007 in. (·178 mm.)—from the ·042 in. (1·07 mm.) clearance. The ·035 in. (·900 mm.) difference denotes the thickness of shims to be placed between the differential case and the bearing inner race on the drive gear side of the differential. Shims ·053 in. (1·34 mm.) thick will now be left from the pack determined earlier, and these must be installed on the opposite side of the differential case.

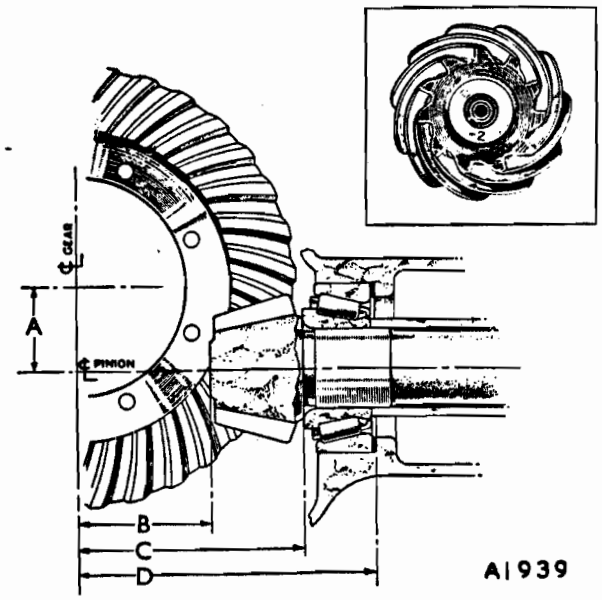

Fig. H.13

The correct engagement of pinion to crown wheel

A. Pinion drop: 1·750 in. (44·55 mm.).
B. Zero cone setting: 2·968 in. (75·385 mm.).
C. Mounting distance: 4·906 in. (124·6 mm.).
D. Centre-line to bearing housing: 6·131 to 6·121 in. (155·732 to 155·476 mm.).

The inset shows the pinion head marking.

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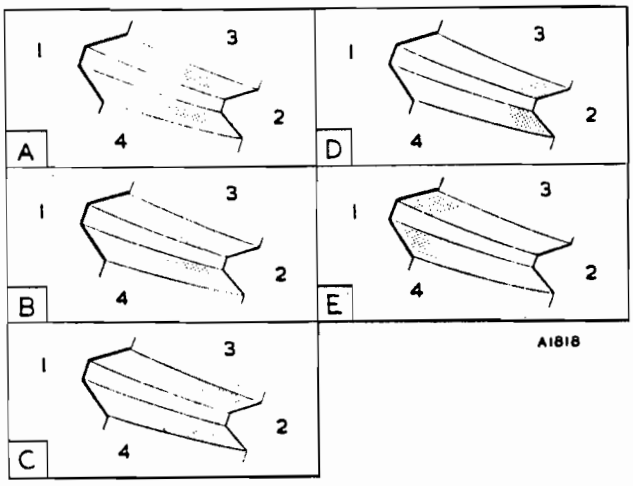

Fig. H.14

Examples of tooth contact marks on crown wheel

1. Heel (outer end).
2. Toe (inner end).
3. Coast side.
4. Drive side.

A. Ideal tooth contact—evenly spread over profile, nearer toe than heel.

B. High tooth contact—move pinion towards crown wheel.

C. Low tooth contact—move pinion away from crown wheel.

D. Toe contact—move crown wheel out of mesh, i.e. increase backlash.

E. Heel contact—move crown wheel into mesh, i.e. decrease backlash but maintain **minimum** backlash.

Once again assemble the axle casing stretching tool 18G131A to the casing and stretch the case, taking care not to exceed the figure that is marked on the turnbuckle indicating the degree of stretch.

Lower the differential assembly into position, lightly tapping the bearings with a hide hammer, ensuring that the gear teeth are led into mesh with those of the pinion.

Refit the bearing caps, ensuring that the numerals correspond with those on the axle casing. Tighten the bearing cap bolts lightly, remove the stretching fixture, and then finally tighten the bolts securely.

Section H.9

CHECKING BACKLASH AND GEAR TOOTH CONTACT

Mount a dial indicator on the gear carrier housing with the indicator foot against one of the drive gear teeth, as nearly in line with the direction of tooth travel as possible (see Fig. H.12). Move the ring gear by hand to check the backlash, which should be as etched on the gear.

If the backlash is not in accordance with the specification, transfer the necessary shims from one side of the differential case to the other to obtain the desired setting. To increase backlash remove shims from the drive gear side and install on the opposite side. To decrease backlash transfer shims to the drive gear side from the opposite side of the differential case.

As a further check after the correct backlash has been obtained paint eight to ten of the drive gear teeth with a smear of engineers' blue.

Move the painted gear teeth into mesh with the pinion until a good impression of the tooth contact is obtained. The resulting impression should be similar to that illustrated in (A), Fig. H.14.

Section H.10

REMOVING AND REPLACING THE REAR ROAD SPRINGS

Raise the rear of the car, using a jack positioned under the centre of the rear axle, and place a stand under the appropriate chassis side-member.

Remove the road wheel and lower the rear of the car until the chassis is supported by the stand and the rear spring is in the fully unloaded position.

Remove the nuts and withdraw the lower clip plate to release the spring from the rear axle. Raise the jack slightly to lift the weight of the axle from the spring.

Knock back the locking tabs and unscrew the nuts from the spring rear end shackle bolts, withdraw the bolts, locking washers, and shackle plates, and lower the rear end of the spring.

Unscrew the nut and withdraw the shackle bolt to release the front end of the spring.

The rear spring front and rear brackets are secured to the chassis members by set bolts. Remove the rear bracket if it is necessary to renew the Silentbloc bush.

To replace the road spring reverse the above procedure. Do not omit to replace the fibre seating pad between the axle seat and the spring leaf.

Section H.11

DISMANTLING AND REASSEMBLING A REAR SPRING

Straighten the bent-over leaf clips.

Grip the spring in a vice, with the vice jaws against the top and bottom leaves, adjacent to the centre-bolt.

Unscrew the centre-bolt nut and remove the spring washer and centre-bolt.

Carefully open the vice to separate the spring leaves.

Examine thoroughly the spring leaves for signs of damage or failure, and renew any defective leaves. Ensure that the rivets which secure the leaf clips to their respective leaves are tight. Thoroughly clean and grease the spring leaves.

Utilizing a rod of similar diameter to the centre-bolt and having a tapered end, assemble the spring leaves onto it and grip the assembly in the vice. Replace the rod with the centre-bolt, fit the spring washer, and tighten the nut.

Hammer the leaf clips over the spring leaves.

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Section H.12

REMOVING AND REPLACING THE SPRING BUSHES

The use of a press is recommended to remove the Silentbloc bushes from the front and rear spring eyes or from the rear shackle bracket. Use a suitably sized tubular steel drift to press out the bushes. Apply pressure to the outer bush of the assembly only.

Reassemble the bushes in a similar manner, ensuring that the outside of the bush is flush with the edge of the spring eye or shackle bracket.

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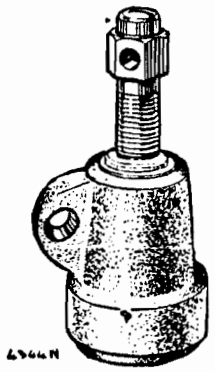
SERVICE TOOLS

18G8. Hub Assembly Remover (basic tool)

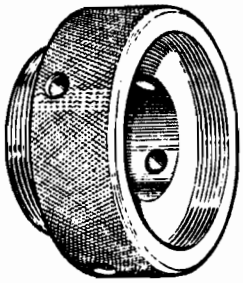
The tool has an internal thread for attachment to the hub and the end of the centre screw is provided with a hardened-steel ball to reduce friction when engaging the stub axle. Provision is also made for the use of a tommy-bar to prevent the tool from turning in operation.



18G8

18G8D. Rear Hub Remover Adaptor

For use with basic tool 18G8.

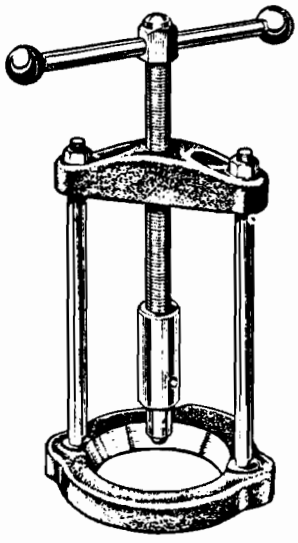


4345D

18G8D

18G47C. Differential Bearing Remover (basic tool)

A standardized basic tool which must be used with the appropriate adaptor. Adaptors for removing pinion bearings, differential bearings, and rear hub bearings are obtainable separately.



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18G47C

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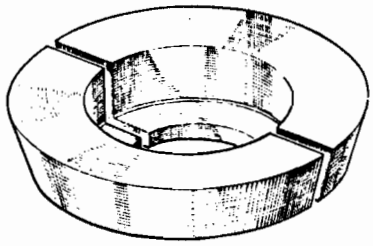
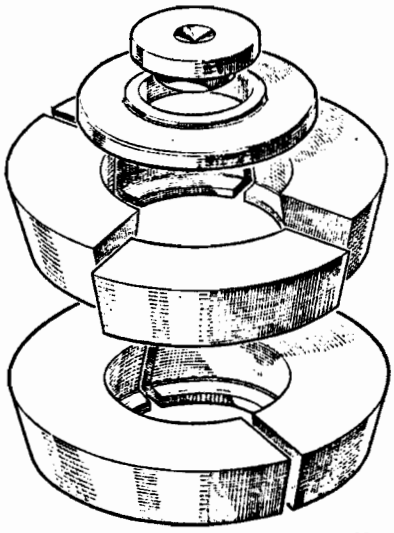
18G47K. Rear Hub Bearing Remover Adaptor
For use with basic tool 18G47C.

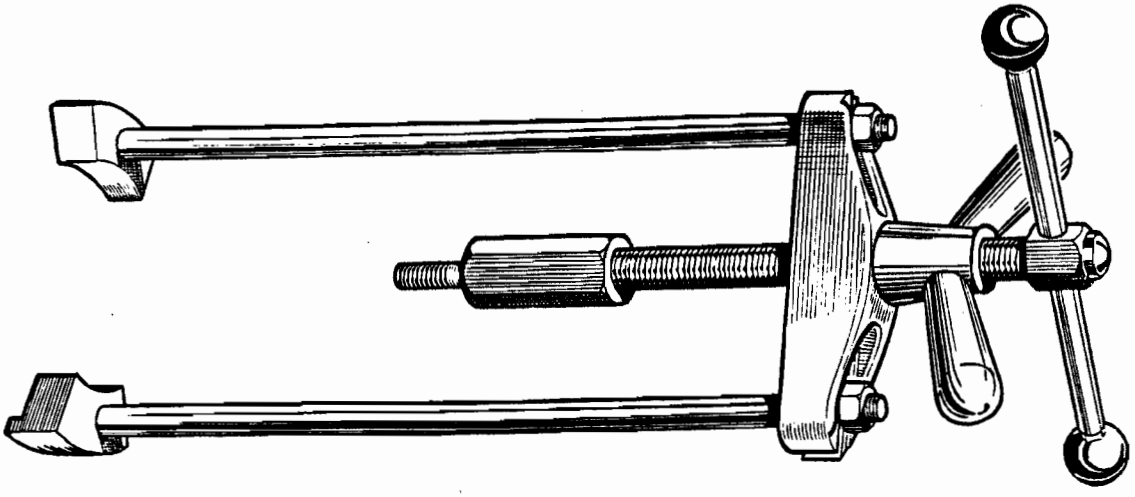


18G47K

18G47L. Differential Bearing Remover Adaptor
For use with basic tool 18G47C.



18G47L



18G83

18G83. First Motion Shaft Remover (basic tool)
Although by name a first motion shaft remover, this basic tool is used with the appropriate adaptor (pilot of 18G129) to withdraw an axle shaft.

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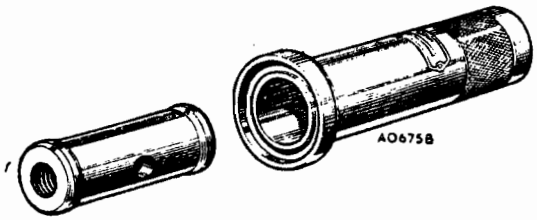
18G129. Rear Hub Bearing Replacer

A two-part tool comprising a pilot and a replacer. The pilot is screwed onto the differential shaft and the bearing driven into the axle tube with the replacer.

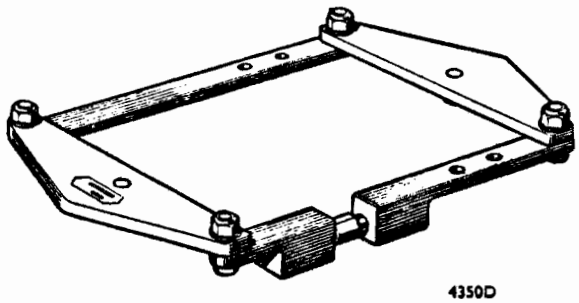
The pilot is also used with 18G83 for axle shaft removal.



18G129

18G131A. Rear Axle Casing Stretcher

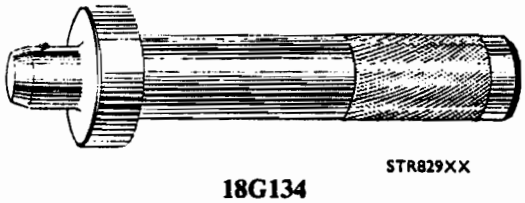
Before the differential assembly can be withdrawn the axle case must be stretched; this tool enables the operation to be done easily and without damage to the components.



18G131A

18G134. Bearing and Oil Seal Replacer (basic tool)

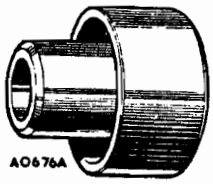
A detachable handle designed for use with a range of adaptors, supplied separately, which will deal with the replacement of the differential bearings.



18G134

18G134A. Differential Bearing Replacer Adaptor

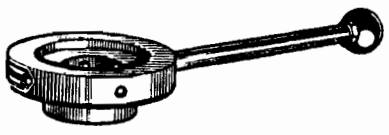
For use with 18G134.



18G134A

18G137. Bevel Pinion Oil Seal Replacer

The oil seal is placed over the bevel pinion shaft and aligned in the axle case. The tool is placed in position in front of the seal and the bevel pinion nut used to press the seal into position.



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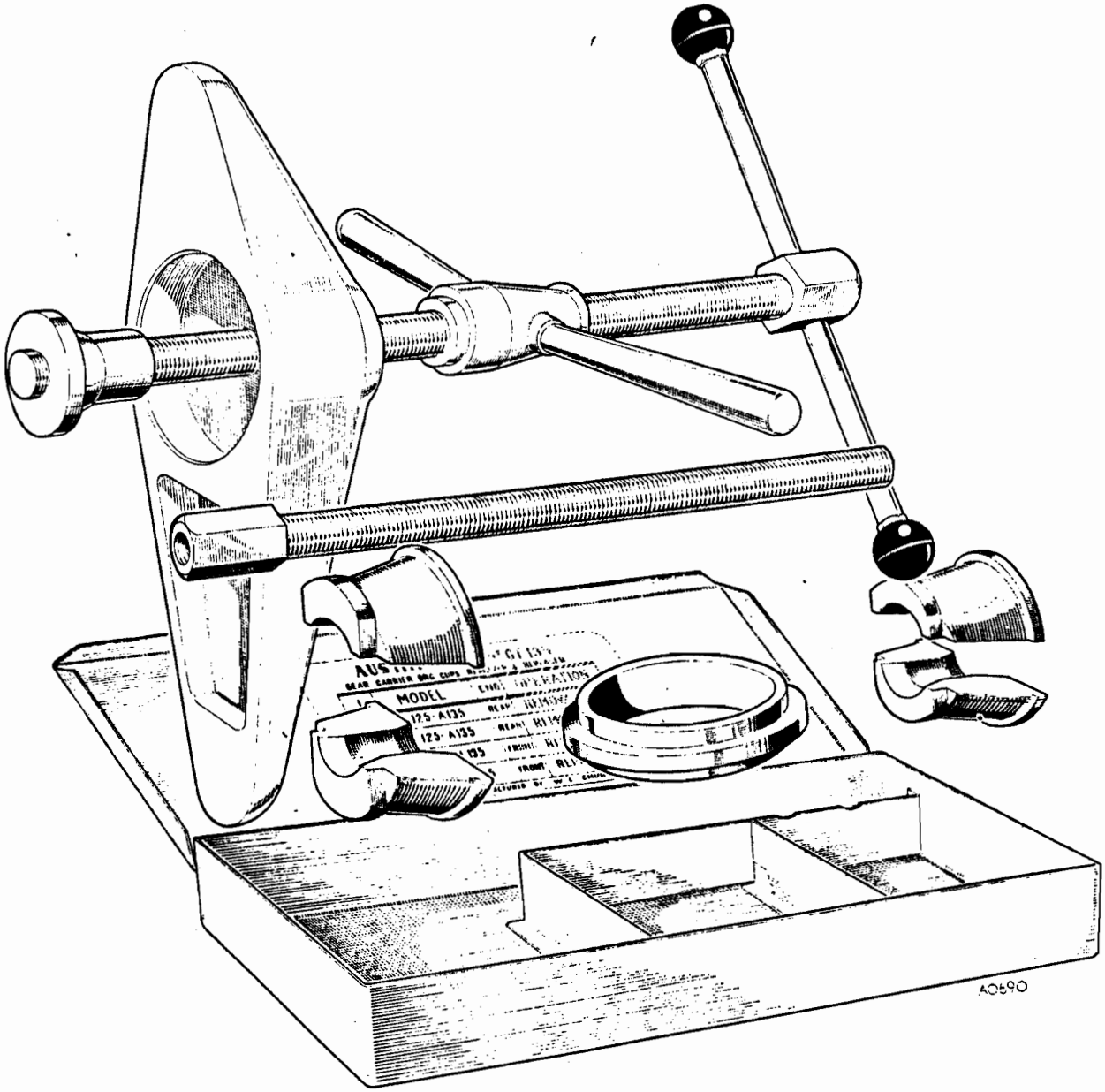
18G135. Bevel Pinion Bearing Outer Race Remover

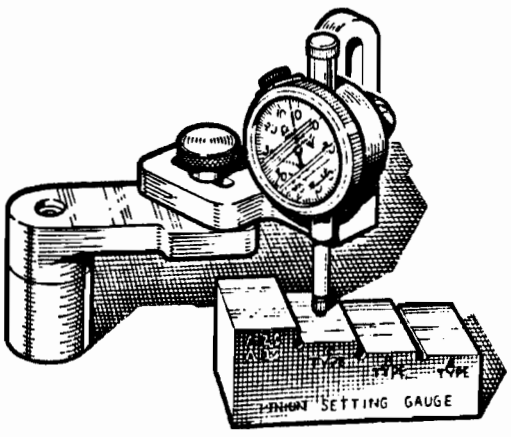
Comprising a body, centre screw and extension, with a tommy-bar, wing nut, guide cone, flanged ring, and two adaptors.



18G135

18G191. Bevel Pinion Setting Gauge

A gauge block and a dial indicator are essential to obtain accurate location of the pinion in the axle case.



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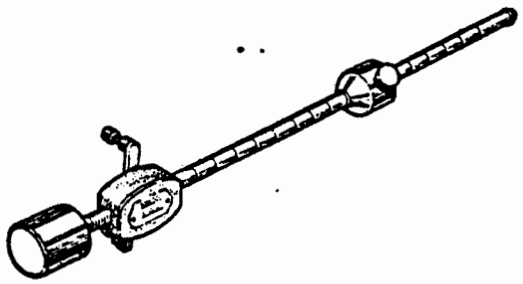
18G207. Bevel Pinion Bearing Preload Gauge

The movable arms of the tool are located in opposite holes of the bevel pinion flange and the weight moved along the rod to the poundage required.

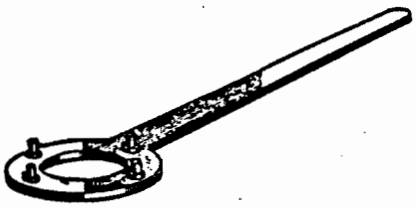


4348B

18G207

18G484. Bevel Pinion Flange Wrench

To facilitate the slackening and unscrewing of the bevel pinion flange nut this tool is invaluable. No damage to the flange is risked that other improvised methods may incur.



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18G484

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SECTION J

THE STEERING (Power-assisted)

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GENERAL DESCRIPTION

The power-assisted steering system comprises three basic components; the steering gearbox, the pump, and the reservoir. The pump is fitted to the engine and driven from the rear of the dynamo, and the reservoir is mounted on the left-hand valance.

The steering-arm is attached to the taper-splined end of the rocker shaft by a retaining nut and lock washer and is connected to the idler steering-arm on the opposite side of the car by the track-rod.

Movement of the steering gearbox steering arm is transmitted to the road wheels via the levers mounted on the swivel axles by non-adjustable tie-rods, each end of both the track- and tie-rods being fitted with a spring-loaded ball joint.

The dynamo is adapted to transmit drive to the oil pump through a flexible coupling. The armature shaft is supported at the commutator end by a prepacked ball bearing in place of the plain bearing bush used normally. The fan belts are 'V' sectioned, driving the double-grooved dynamo pulley.

The system is of the 'fail-safe' type so that, in the event of power-assistance failure, the driver is able to maintain full mechanical control of the steering.

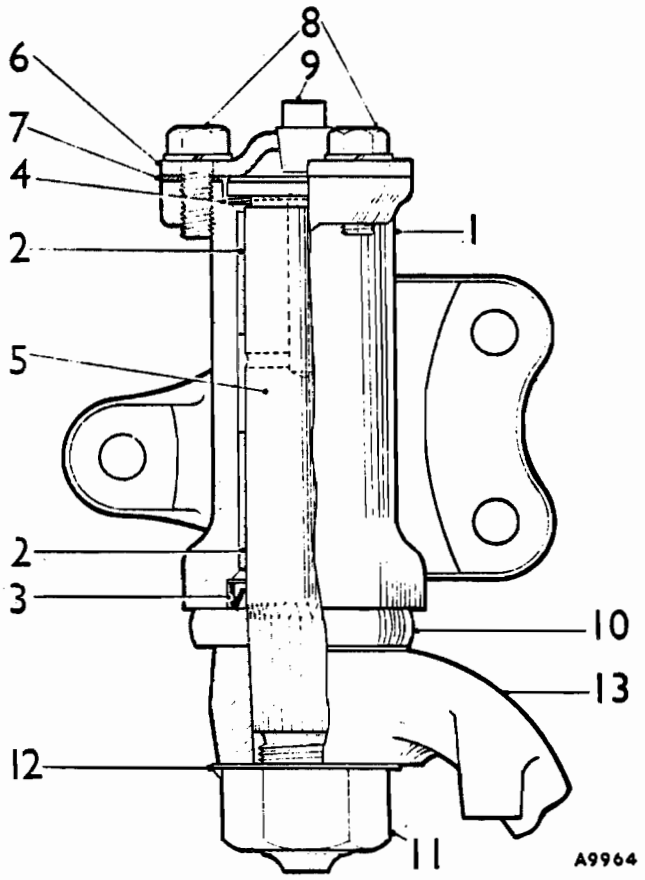

Fig. J.1
Steering idler components

1. Steering idler body.
2. Bush for idler shaft.
3. Oil seal.
4. Belleville washer.
5. Idler gear shaft.
6. Cover.
7. Joint for cover.
8. Screw for cover.
9. Filler plug.
10. Dust seal.
11. Nut for steering-arm.
12. Lock washer for nut.
13. Steering-arm for idler gear.

Section J.1

IDLER

Removing

Extract the split pins and detach the track-rod and tie-rod ball joints from the idler steering-arm.

Remove the self-locking nuts from the three bolts securing the idler to the underframe and remove the idler complete with steering-arm.

Dismantling

●Secure the idler in a vice, knock back the locking tab, unscrew the nut, and withdraw the steering-arm from the tapered splines of the idler shaft and lift off the dust seal. Use Service Tool 18G 1038 or 18G 1038 A, see Section J.18.●

Remove the three set screws and withdraw the cover from the opposite end of the idler body, noting the number of cover joint washers which are used to adjust the end-float of the idler shaft.

Withdraw the idler shaft and take out the Belleville washer.

Carefully remove the oil seal from the lower end of the idler body.

Assembling

If the body bushes require renewing press out the old bushes; after fitting, the inner diameter of the new bushes must be reamed and burnished in line to 1·125 $\pm \frac{\cdot 001}{\cdot 0005}$ in. (28·58 $\pm \frac{\cdot 025}{\cdot 012}$ mm.).

When reassembling, fit the oil seal with its sealing lip facing inwards, place the Belleville washer in position with its concave side facing upwards, and adjust the idler shaft end-float by adding or subtracting cover joint washers until the shaft is a running fit in the cover. Tighten the steering-arm securing nut, using torque wrench 18G 372 set to break at 125 lb. ft. (17·3 kg. m.).

Refitting

When refitting, which is a reversal of the above procedure, fully tighten the securing bolts and nuts and lock the ball joint nuts with new split pins.

Section J.2

STEERING-WHEEL

Removing

Disconnect the cable from the battery positive terminal.

Disconnect the four direction indicator wires and the horn wire from the snap connectors coupling them to the harness cable on the wing valance.

Slacken the three grub screws in the hub of the steering-wheel. Ensure that the wires are free to enter the olive nut at the lower end of the steering-column and withdraw the trafficator switch and horn ring assembly from the mast.

Unscrew the central nut and pull the wheel from the mast, using remover 18G 70 and adaptor 18G 70 A.

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KEY TO THE STEERING GEARBOX COMPONENTS

No.	Description
1.	Steering-box.
2.	Bush.
3.	Cork washer.
4.	Retaining disc.
5.	Oil plug.
6.	Washer.
7.	Outer column (synchromesh gearbox).
8.	Joint washer.
9.	Set screw.
10.	Spring washer.
11.	Ball bearing—outer column.
12.	Circlip.
13.	Inner column and cam—L.H. steering.
14.	Spring ring.
15.	Dust cover.
16.	Support collar.
17.	Side cover.
18.	Joint washer.
19.	Thrust screw.
20.	Locknut.
21.	Set screw.
22.	Spring washer.
23.	End cover with adaptor (bottom).
24.	Olive.
25.	Nut.
26.	Joint washer.
27.	Set screw.
28.	Spring washer.
29.	Ball cup—cam bearing.
30.	Ball and cage assembly.
31.	Shim.
32.	Rocker shaft.
33.	Cup—dust cover.
34.	Steering arm.
35.	Slotted nut.
36.	Washer.
37.	Striker sleeve.
38.	Clamping bolt.
39.	Nut.
40.	Dust cover support.
41.	Steering-wheel.
42.	Locking sleeve.
43.	Outer column (automatic transmission).
44.	Bush—synchromesh gear change bracket.
45.	Set screw for frame.
46.	Spring washer.
47.	Clamping bolt.
48.	Nut.
49.	Lock washer.
50.	Inner column and cam—R.H. steering.
51.	Bracket—steering-box.
52.	Screw—lock stop.
53.	Lock nut—lock stop screw.

GENERAL DESCRIPTION

The steering gear is of the cam and roller type in which the cam takes the form of a worm mounted on ball bearings in the steering-box. The rocker shaft is mounted in the steering gearbox in plain bearings; a lever integral with the shaft carries a conical peg, mounted in needle bearings, which engages with the cam. As the peg does not bottom in the cam groove adjustment for wear can be effected by adjusting the depth of engagement. This is carried out by means of the adjustment screw provided.

All the working parts are immersed in oil.

The steering drop-arm is attached to the taper-splined end of the rocker shaft by a retaining nut locked with a split cotter pin and is connected to the power cylinder when power-assisted steering is fitted and on standard vehicles to the draglink connected to the central steering lever.

Two adjustable track-rods connect the central steering lever, which is mounted centrally on the front cross-member, to each steering-arm mounted on the swivel axles. Both inner and outer ends of the track-rods are fitted with spring-loaded ball joints.

Section J.1

TESTING AND ADJUSTING THE STEERING-BOX

Lost motion in the steering-box will be evident by the presence of excessive free movement of the steering-wheel. To adjust the amount of free movement or backlash proceed as follows.

Turn the steering-wheel until the road wheels are in the straight-ahead position.

Disconnect the draglink, or power cylinder if power-assisted steering is fitted, from the steering drop-arm and test for slackness by moving the drop-arm from side to side.

To eliminate backlash slacken the locknut of the adjustment screw in the gearbox cover and, whilst rotating the steering-wheel a quarter-turn each side of the straight-ahead position, tighten the adjustment screw until a slight resistance is felt in the straight-ahead position. Tighten the adjusting screw locknut and check that the slight resistance is present when the steering-wheel passes the straight-ahead position.

As the steering-wheel is turned from lock to lock the degree of backlash at the end of the drop-arm is not the same at all steering positions, there being no backlash in the straight-ahead position and an increasing amount as the full-lock positions are reached.

Reconnect the draglink, or power cylinder, to the steering drop-arm and lock the securing nut with a split cotter pin.

Two adjustable lock stop screws are provided in the steering box to prevent damage to the steering box mechanism in the event of overloading on full locks.

To adjust the lockstop screws correctly, jack up the front of the vehicle, and slacken off both lock screws fully. Turn the steering to full lock and then screw in the appropriate lock stop screw until the screw can be felt to be in contact with the rocker arm inside the box. Turn the screw back one half turn and lock in this position with its lock nut.

Repeat this procedure on the other lock. Adjust the front lock stop screw when on right-hand lock, and the rear screw when on left-hand lock.

Section J.2

REMOVING AND REPLACING THE STEERING-BOX

Release the three grub screws which pass through the steering-wheel hub and disconnect the horn leads at the base of the column by means of the snap connectors; the top half of the stator column, together with the horn leads, can then be removed.

Next remove the circlip retaining the steering-wheel to the inner column, when the steering-wheel can be removed.

The flexible cover on the steering-column adjuster splines should now be removed, and also the steering-column top cover. The latter is in two halves and is removed by firstly taking out the four securing screws (two each side) and then removing two further securing screws inserted upwards through the forward end of the bottom cover; retrieve the rubber grommet.

The flashing indicator control lever is removed by releasing the two round-headed set screws from the clamping piece and then releasing the clamps securing the wiring to the steering-column.

Remove the two set pins from the first mounting bracket on the column and then the nuts and bolts, with spring washers, which secure the second mounting bracket. Retrieve the rubber grommet.

To remove the gear shift lever the locating screw for the locating plate boss must be taken out; turn back the tab washer and remove the special nut from the forward face of the boss; retrieve the tab washer. Remove the pinch-bolt from the gear operating lever, which is mounted on the gear change lever shaft. This lever is keyed to the shaft by means of a recess in the shaft which secures both the pinch-bolt and the Woodruff key. Pull the gear change operating shaft upwards and out from inside the car.

Remove the two bolts securing the bolts clamp to the steering-column and onto which are mounted the hydraulic brake and jack fluid reservoirs.

Remove the four set bolts and washers securing the base flange of the steering-box mounting bracket to the chassis frame.

On saloon vehicles take out the cushion from the driver's seat, release the seat adjustment, and slide the seat backwards off the runners.

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Remove the column by lifting the steering-box end and rotating the shaft so that the drop-arm takes up right-hand-lock position. As the box is raised rotate the shaft so that full left-hand lock is achieved. Finally, remove the column through the bonnet opening.

To remove the drop-arm release the pinch-bolts at the steering-box and actuator ends.

Pull the arm off the rocker shaft and actuator. When refitting ensure that the lining-up marks on the rocker shaft and drop-arm are in register so that correct right- and left-hand locks are obtained.

Refitting the steering is a reversal of the removal sequence, but care must be taken to ensure that there is no sign of strain when the column is firmly secured to the frame and fascia panel bracket. If automatic transmission is fitted the speed range selector lever linkage should be tested and adjusted for correct setting as described in Section FF.

Finally, test the steering gear again and refill the box with oil to Ref. B (page P.2).

Section J.3

DISMANTLING AND REASSEMBLING THE STEERING-BOX

Remove the side cover and drain off the oil, then withdraw the rocker shaft. With the gear mounted vertically in a vice—steering-box uppermost—release the four set screws holding the end cover in position and remove the end cover together with the shims. Remove the gear from the vice and push the inner column and cam through the box; this will also push out the bottom ball cup and ball cage.

Remove the outer column from the steering-box by taking out the four set screws, take off the shims, and push out the top ball cup and ball cage. The end of the steering-box from which the outer column is removed should be marked to ensure that it is reassembled correctly.

The upper end of the steering-column is fitted with a ball race. To remove this bearing it is merely necessary to take out the securing circlip, after which the ball race can be withdrawn.

Thoroughly clean the box and examine for wear in the rocker shaft bushes. These can be pressed out of the box from either end after removing the cork gland and the retaining disc. The new bushes can be pressed in and reamed in line and the cork gland and retaining disc fitted. Examine the rocker shaft for wear on the shank. Renew if badly worn or if the splines are twisted. At the end of the rocker shaft arm is a cam roller assembly and this should be thoroughly cleaned in paraffin (kerosene). Examine the revolving peg for radial slackness. A small amount of slackness is permissible, but if it is excessive the cam roller assembly must be renewed. The conical end of the roller must be free from flats or shoulders. The cam roller assembly is replaceable as a unit, the old one being pressed out and the new one pressed in. When fitting a new assembly it is very important that pressure should only be applied to the outer stationary housing of the assembly and not to the revolving part.

Examine the cam for excessive wear in the grooves and the ball tracks (formed at each end of the cam) for any signs of pitting. If the cam is defective for either of these reasons the cam and steering-tube must be renewed.

Examine the ball cups for pitting in the ball tracks, and renew if necessary.

Before reassembling ensure that all parts are clean and dry. Refit the outer column to the box. The end of the steering-box should be marked, but if this has not been done, or there is any doubt, the correct end for the column can be determined thus: looking at the side cover facing, and with the oil filler plug uppermost, the end for the column is on the left for right-hand-drive models and on the right for left-hand-drive. Before fitting lightly tap in one of the ball cups until the back of the ball cup is flush or nearly flush with the square facing of the steering-box. Replace the square shims and socket and secure with the four set screws.

Hold the steering-column in the vice with the steering-box uppermost and place one of the ball cages inside the ball cup. Insert the inner column with the cam uppermost through the square facing of the steering-box until the ball track of the cam rests on the ball cage; rotate the cam to see if the ball cage is seating properly in the ball cup. Place the second ball cage on the top of the cam and lightly tap in the second ball cup, making sure that the ball cup can be assembled nearly flush with the facing of the steering-box without any force other than the light tapping. Revolve the cam again to see that the top ball cage is seating properly in the ball cup. Replace the shims and end cover and secure with the four set screws.

Hold the steering-box in the vice with the column horizontal, fit the steering-wheel temporarily, and test the gear for end-float. Remove shims if necessary from either end to eliminate end-float. The steering-tube must be quite free after finally tightening up the flange bolts, but there must be no end-play.

Insert the rocker shaft, replace the side cover, and secure with the six set screws.

Fit the steering-arm temporarily without the nut by lightly tapping it onto the tapered splines. The gear can now be adjusted by the adjusting screw and locknut as described in Section J.1.

Section J.4

REMOVING AND REPLACING THE CENTRAL STEERING LEVER

Connecting the track-rods to the draglink is a central steering lever, pivoted in a bracket which is bolted to the rear of the front cross-member.

In the event of there being play at the pivot the bracket will have to be rebushed. Disconnect the track-rods and draglink from the central steering lever by removing the split cotter pin and slotted nut from each ball joint. The ball joint pins are tapered, and to remove them from the steering lever without damage gently tap the outside portion of the steering lever surrounding the

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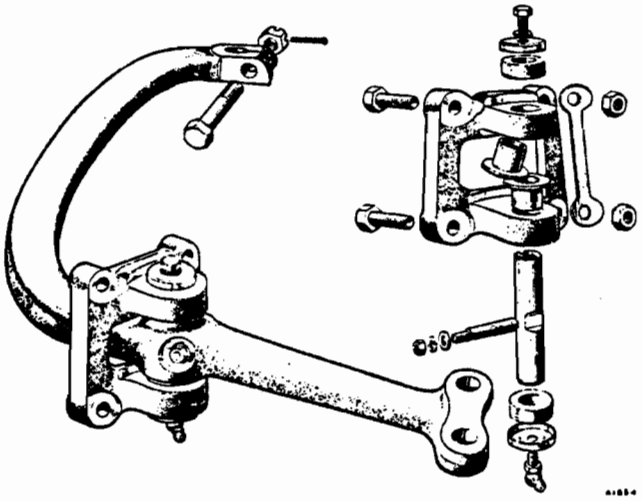

Fig. J.1

The central steering lever. On the right is an exploded view of the bracket and swivel pin

ball pin, when it will be found that the ball pin can easily be tapped from the lever.

Bend back the locking tabs and unscrew the four set screws securing the steering lever bracket to the frame. The bracket complete with lever may now be withdrawn.

Grip the bracket firmly in a vice and take out the bolt and oil nipple holding the top and bottom felt retainers in position. Unscrew the nut from the cotter which locks the lever to the pivot pin, remove the cotter, and carefully tap out the pivot pin.

Remove the old bushes and fit the new ones, using, if possible, a press. When reassembling ensure that the slot in the pivot pin is in line with the hole in the lever so that the cotter slides in freely. This also applies when fitting the clamping bolt through the end of the lever.

After securely tightening the bracket securing set screws bend over the locking tabs to prevent them working loose.

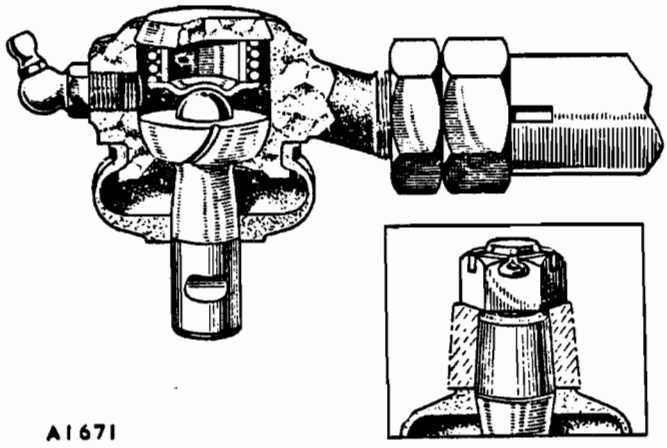

Fig. J.2

A sectioned view of the ball joint connector used on the steering draglink. Inset shows the type fitted to the track-rod

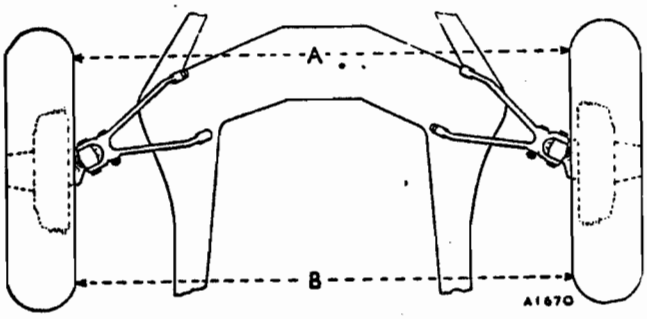

Fig. J.3

The toe-in must be adjusted so that (A) *dimension is* $\frac{1}{8}$ *in.* (3·18 *mm.*) *less than* (B)

Section J.5

ROAD WHEEL ALIGNMENT

When correctly adjusted the front wheels should toe in $\frac{1}{8}$ in. (3·18 mm.) in the straight-ahead position. To carry out any adjustments, first inflate the tyres to the standard pressure given in **'GENERAL DATA'.**

Where modern wheel alignment equipment is available adjustment will present no difficulty, but when this facility is not available the trammel method must be used.

Turn the wheels to their straight-ahead position and position the pointers of a set of alignment trammels to the wheel centre height.

Place the trammel at the front of the wheels and adjust it longitudinally so that both pointers register against the inside rim of each wheel. Mark the position of the pointers on each wheel rim with chalk, withdraw the trammel, and push the car forward so that the wheels make exactly half a revolution.

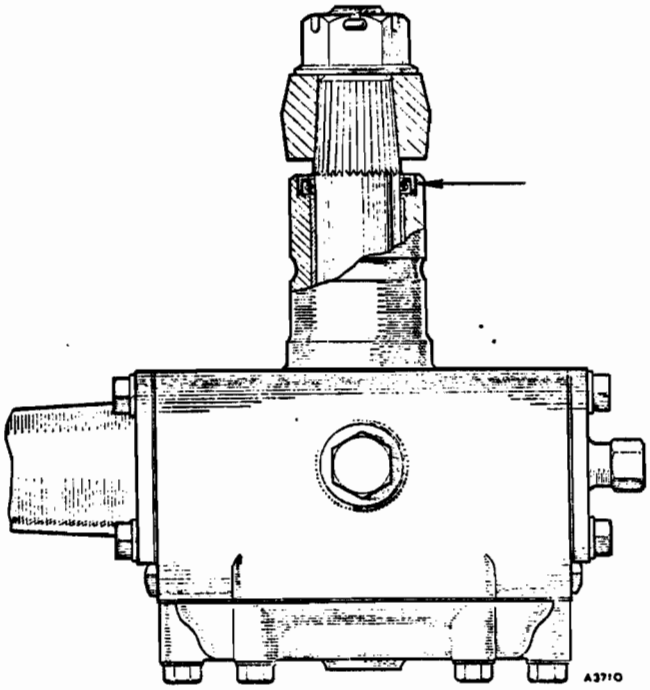

Fig. J.4

A sectioned view of the boss on the steering-box showing the later-type oil seal

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Move the trammel to the rear of the wheels so that one pointer registers with the chalk-mark on one of the wheels. For the alignment to be correct the distance between the other pointer and the mark on the other wheel should be $\frac{1}{8}$ in. (3·18 mm.).

Should the alignment be incorrect, slacken at each end of the track-rod the ball joint locknuts and tap from the end of the tube the hexagon-headed taper collets. By turning the tube, which is threaded left-hand at one end and right-hand at the other, the track can be adjusted as required. After adjustment the collets must be pressed back into the tube, which must be held to prevent it from turning, and the ball joint locknuts tightened.

Make a final check of the road wheel alignment.

Section J.6

STEERING-BOX OIL SEAL

The oil seal cork washer and retaining disc formerly fitted on the steering-box cross-shaft between the steering drop-arm and the casing are now deleted and a ring-type oil seal is pressed into a counterbore machined in the steering-box casing cross-shaft boss (see Fig. J.4).

Care must be exercised when withdrawing the cross-shaft from the later-type boss to prevent the shaft splines from causing damage to the knife-edge of the seal.

When fitting a new seal ensure that it is fitted with the open face of the seal on the inside.

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SECTION JJ

POWER-ASSISTED STEERING

	Section
General description	
Bleeding the system	JJ.6
Power cylinder	
Dismantling and reassembling	JJ.2
Oil scraper seal	JJ.7
Removing and replacing	JJ.1
Reservoir servicing	JJ.5
Steering pump	
Dismantling and reassembling	JJ.4
Removing and replacing	JJ.3

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GENERAL DESCRIPTION

The power-assisted steering equipment can be divided into three basic components: the power cylinder, which runs fore and aft along the vehicle and is incorporated between the draglink, steering-box, and a bracket on the chassis side-member; the pump, which is fitted to the engine and driven from the rear of the dynamo; and the reservoir, which is mounted on the valance above the pump.

Power cylinder

The power cylinder assembly incorporates a control valve connected directly to a double-acting power ram, coupled by flexible pipes to an oil pump driven from the rear of the dynamo. The system utilizes the standard steering-box and is so designed that, should the hydraulic power fail for any reason, normal manual steering will still be maintained.

The control valve end of the power cylinder is connected to the steering-box drop-arm (steering-box end arm) and to the central steering lever via a short draglink. At the rear end the power cylinder assembly is anchored to the frame via the power ram, but the cylinder body is free to move in response to increased pressure on either side of the piston. Oil flow to and from the control valve and power cylinder is carried by hoses connected to the oil pump and oil reservoir.

Control valve

The control valve (see Fig. JJ.1) provides the key to the whole system and consists mainly of a sliding spool with two lands which controls four ports in the valve body. The inlet port allows oil to enter under pressure from the pump, the outlet port returns it to the oil reservoir, and the two power ram ports conduct it to either side of the piston, which actuates the steering-arm through the power ball pin. To such fine limits is the whole mechanism built that fractional movement of the valve spool completely controls all four ports.

When the driver is exerting less than a certain minimum pressure on the steering-wheel the valve spool is centred by means of a precompressed spring and by the hydraulic forces acting upon reaction rings.

For steering efforts less than that required to overcome the valve preload the spool remains central and the fluid circulates freely on open circuit from the pump, through the valve, and back to the reservoir. There being no resistance to flow, no pressure build-up occurs and the steering remains purely manual (Fig. JJ.1).

For steering efforts greater than the valve preload the spool is displaced towards one end of the body by the manual ball pin, thus directing the fluid to the appropriate side of the piston (Figs. JJ.2 and JJ.3). The pressure quickly builds up until it is sufficient to overcome the resistance at the wheels, thus transmitting the required steering assistance. The flow of oil and resulting movement of the cylinder is maintained within the limits of the wheel travel so long as the driver continues to turn the steering-wheel enough to keep the spool displaced from its central position.

It is important to note that the driver always operates against a load which is derived from the spring preload plus the pressure build-up on the reaction rings. Since this pressure is dependent on the pressure of the oil pushing on the piston, it is proportional to the required steering force, thereby giving the driver the necessary 'feel of the road'.

As soon as the driver relieves the pressure on the steering-wheel the valve spool centralizes and balances the oil pressure. Once again the oil circulates freely, and normal castor action returns the piston to its central position.

If the steering-wheel is then turned in the opposite direction the function of the power cylinder ports is reversed and so the mechanism turns the wheels on the other lock.

Any sudden shock to the front wheels immediately operates the mechanism in reverse, so correcting the shock and preventing 'kick-back' at the wheel.

As the whole unit works in oil very little wear takes place. All connections consist of oil-resisting hose and special unions.

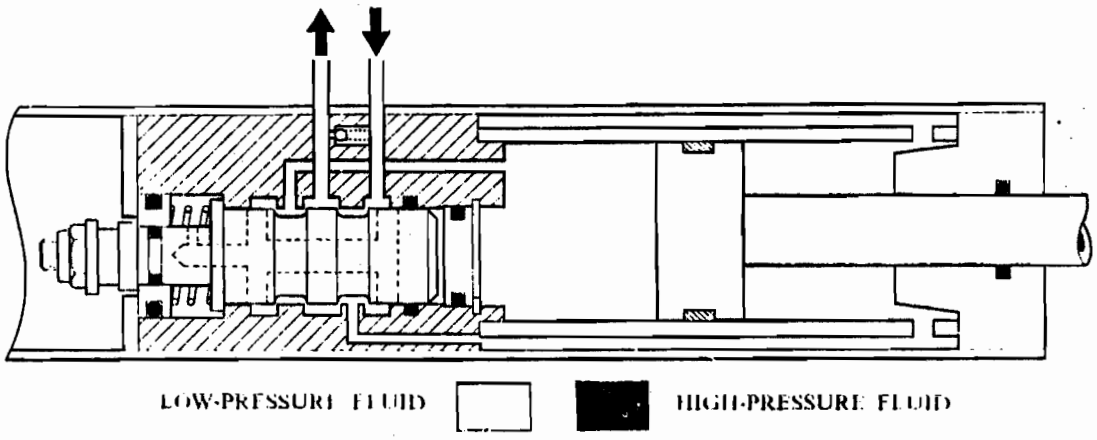

Fig. JJ.1

A section through the power cylinder showing the control valve spool in the central position with fluid circulating freely on open circuit from the pump, through the valve, and back to the reservoir. No resistance to flow, therefore no pressure build-up

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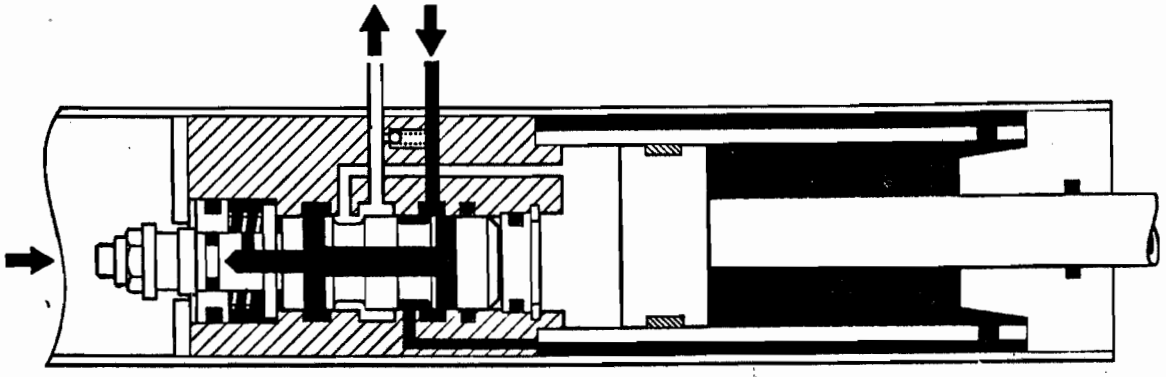

Fig. JJ.2

The control valve spool is moved rearwards and fluid is directed under pressure to the rear side of the piston. The power cylinder moves rearwards

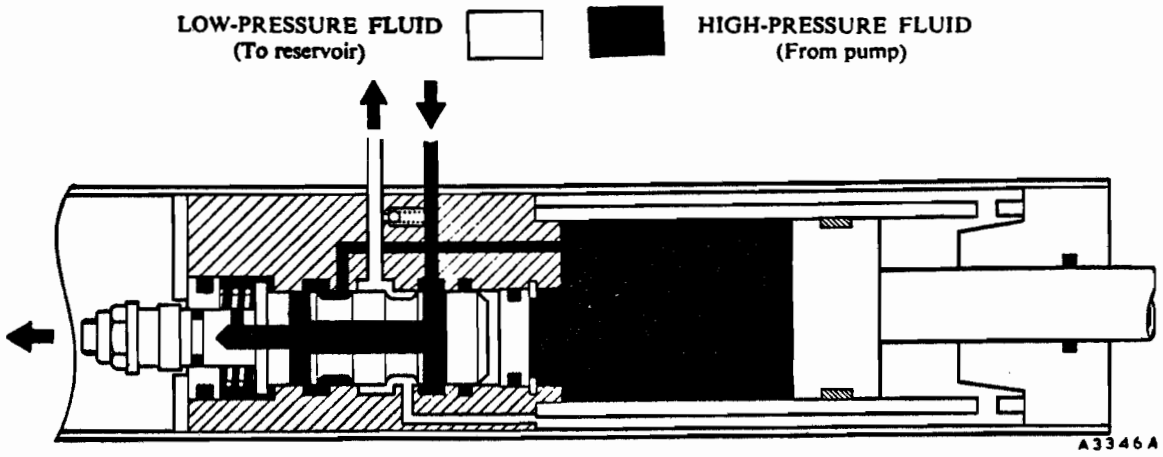

Fig. JJ.3

The control valve spool is moved forwards and fluid is directed under pressure to the forward side of the piston. The power cylinder moves forwards

Pump

The pump is of the eccentric bi-rotor type, the inner rotor, which has six lobes, being driven by the pump drive shaft. The drive shaft is supported by two bronze bushes in the pump body and cover.

The outer rotor has seven lobes and is driven by the inner rotor.

As the pump rotors turn, the spaces formed between the rotor lobes with each revolution increases and decreases in volume, propelling oil from the intake side of the pump to the flow control valve.

When the engine is idling the pump is operating at its minimum output, which is, however, sufficient to provide power assistance. To limit pump output at higher engine speeds a spool-type, spring-loaded flow control valve is provided in the pump body. The valve, which is hollow and closed at one end, has two metering orifices drilled through its walls. A pressure relief valve, which is also spring-loaded, is contained inside the flow control valve and is retained in position by means of a circlip. The flow control and pressure relief valve assembly is retained in the pump body by the oil outlet adaptor.

Oil from the pressure side of the pump flows into the chamber containing the flow control valve. A flat ground on the land at the closed end of the valve allows the oil to flow behind it (Fig. JJ.4). The oil also flows to the inside of the valve through the two metering orifices and from here, through the pressure relief valve and the pump outlet, to the power cylinder.

When the pump speed is increased due to an increase in engine speed the pump output builds up. This creates

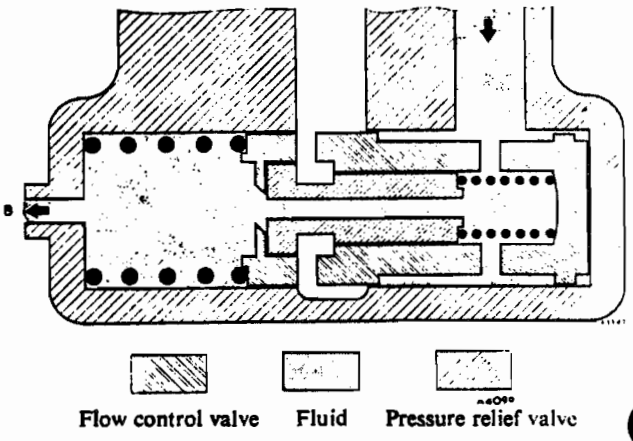

Fig. JJ.4

A section through the pump flow control valve in the low fluid pressure and low flow condition. Fluid passes through the valves to the pump outlet (B)

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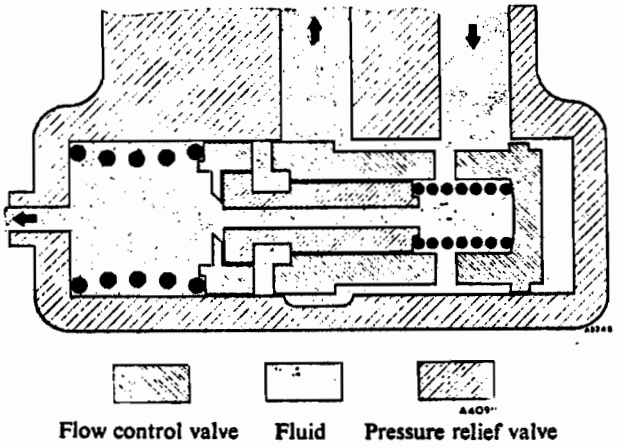

Fig. JJ.5

The flow control valve in the low fluid pressure and high flow condition. Pressure differential on the ends of the valve causes it to move against spring pressure and release fluid to the inlet side of the pump

a pressure differential between the outside and inside of the flow control valve, due to the restricted flow through the metering orifices. Since the pressure at the closed end of the valve (via the flat) exceeds the pressure on the spring-loaded end, the entire valve assembly moves and compresses the flow control valve spring. This movement uncovers an annular relief groove on the flow control valve body which permits the excess oil to flow through passages in the pump body back to the reservoir and the inlet side of the pump (see Fig. JJ.5). Thus the pump output is limited regardless of pump speed.

The pressure produced by the pump is ample to meet all normal requirements of the system, and therefore a pressure relief valve is installed within the flow control valve to limit the pressure. The two ends of the relief valve are of different diameters and the end with the largest area is fitted nearest the pump outlet in order that it may be acted upon by the pressure in the system. When the relief valve lifts, the movement uncovers ports in the flow control valve, allowing the fluid to return to the reservoir and the inlet side of the pump, thus preventing further pressure build-up (Fig. JJ.6).

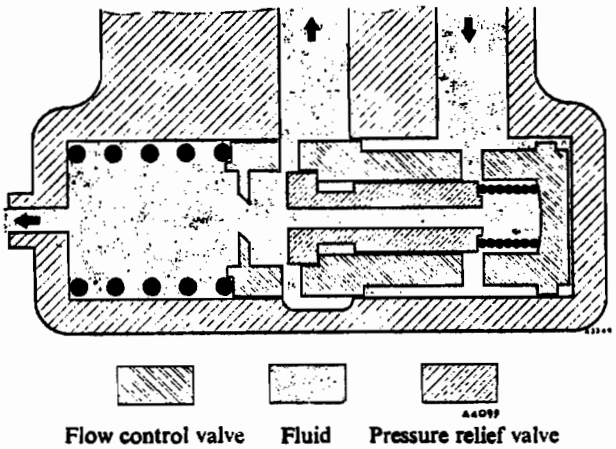

Fig. JJ.6

With high fluid pressure and low flow the flow control valve is seated, but high pressure lifts the valve from its seat and fluid returns to the inlet side of the pump

The relief valve action is the same, regardless of the position of the flow control valve in its box, since the action of the flow control valve is to control only the volume of fluid delivered by the pump.

Reservoir

The reservoir consists of a container mounted on the bonnet valance above the pump. Inside the reservoir is a paper oil filter held in position by a spring, the end of which butts against the top cover. This cover is secured by a long bolt which passes through the centre of the filter fixing spring, and through the filter itself. Oil is supplied direct to the pump via a rubber hose from the reservoir through a port in the body and is returned from the actuator unit via a hose to the inlet adaptor, which permits the return oil to discharge through the filter. The reservoir cover is provided with a small circular cap, which can be removed for purposes of checking the oil level and topping up. A small dipstick will be found hanging from the cap and will indicate the level of the oil.

Hydrosteer maintenance

Careful inspection of the complete hydraulic power steering should be made at regular intervals.

High-quality lubricating oil, having a viscosity rating equivalent to S.A.E. 10W, is satisfactory for all normal conditions. When temperatures are consistently below 10° F. (−12° C.) use S.A.E. 5W. Vegetable oils such as brake fluid or hydraulic damper fluid must **not** be used. (See **'RECOMMENDED LUBRICANTS'**, page P.2.)

The hydraulic oil serves to lubricate the internal working parts of the valve and cylinder assemblies. In addition, grease fittings are provided for the manual and power ball pins. Apply the grease gun regularly at the periods stated in the Passport to Service, using the lubricant recommended on page P.2.

No adjustments are required. The valve port openings are built into the valve and cannot be changed. The centring springs are preloaded by the space into which they fit and the preload cannot be changed.

Reservoir oil level

Check the fluid level regularly at the periods stated in the Passport to Service.

A dipstick is incorporated in the filler cap and the level must not be allowed to fall below the lower marking on the dipstick. The upper mark indicates the correct level.

Section JJ.1

REMOVING AND REPLACING THE POWER CYLINDER

Place a clean receptacle beneath the cylinder and disconnect the two pressure pipes. Allow the fluid to drain into the receptacle.

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Release the pinch-bolt from the steering drop-arm connection on the power cylinder.

Remove the two nuts situated at the rear face of the cylinder mounting bracket which is fixed to the chassis side-member.

The ball connection at the steering-lever must now be released by taking out its split pin, removing the castellated nut, and tapping out the pinch-bolt.

The cylinder is now free and can be removed from the car.

To refit the cylinder reverse the dismantling procedure. Bleed the system as described in Section JJ.6.

Section JJ.2

DISMANTLING AND REASSEMBLING THE POWER CYLINDER

Remove the power cylinder from the vehicle as described in Section JJ.1.

Drain all the oil from the cylinder by moving the piston rod in and out several times from one extreme end of its travel to the other.

Remove the anchorage parts from the end of the piston rod. The outer ball cup will have been removed on dismantling from the vehicle. Remove the split pin from the centre of the ball. The ball should then be firmly clamped in a vice equipped with suitable soft jaws and the ball removed from the rod by applying a spanner to the flats on the piston rod. Slide off the inner ball cup and the rubber abutment cover.

Remove the rubber dust excluder and its retaining clip from both the ball pin and the end extension. Remove the grease nipple and the two split pins from the ends of the unit.

From the ball pin end unscrew the lock ring and remove the outer ball cup, extension, inner ball cup, and Belleville washers.

Remove the split pin from the second lock ring and remove the lock ring, spacing tube, and steel plate.

Pull out the spring locking clip from its slot and unscrew the ball cup holder and ball cup. The manual ball pin can then be removed.

Unscrew the lock ring at the bearing end and remove the tightening-up washer. Remove the end bearing and piston rod assembly by pulling the inside face of the piston against the end bearing, thus pulling it from the inner tube. When removing parts from the piston rod, slide them off at the piston end of the rod in order to eliminate any possibility of damage due to dirt or burrs.

Remove the split pin, slotted nut, and steel washer securing the piston and remove the piston from the rod. The piston ring should also be removed.

Slide the bearing assembly off the rod from the piston end and remove the 'O' ring from the outside diameter.

Remove the vellumoid washer and gland seal from inside the housing.

The valve body, spool, and inner tube assembly may now be removed by a few light blows via a wooden block inserted in the ball pin end and resting on the ball cup.

Slide out the spool assembly. Extract the ball cup. Belleville washers, and backing plate by tapping the end of the operating sleeve on a wooden block.

Remove the inner tube from the valve body. It is a light press fit on the body and it should be removable without undue force.

Remove the circlip from the valve body and slide out the end cover. Remove the 'O' rings from the end cover and the bore of the valve body.

Unscrew the plug and pin at the cylinder end of the valve body, using a suitable Allen key, and remove the cylinder relief valve spring and ball.

Remove the split pin from the spool nut, unscrew the nut, and remove the washer. The operating sleeve, spacer, and stepped collar may now be removed. Slide off the reaction ring and remove the 'O' ring from its outer diameter. Remove the spring and reaction washer and extract the small 'O' ring from its location on the spool spindle.

Inspection of the power cylinder

Thoroughly clean all parts of the power cylinder and inspect for wear and damage.

Examine the spool and body for burrs and scoring. Burrs may be removed with very fine emery-cloth.

CAUTION.—Do not round off the sharp edges on the valve spool or the operation of the valve may be effected.

Smear the spool with a light film of oil and insert it into the valve body to check the fit. With all 'O' rings removed the spool should pass freely through the body.

Inspect the mating surfaces of the operating sleeve and locating sleeve for wear or damage. The surfaces should be free from burrs or scores.

Check the fit of the operating sleeve in the locating sleeve. The operating sleeve should slide freely within the locating sleeve when lightly lubricated.

Examine the inner tube, piston, piston ring, piston rod, and bearing for wear or scoring, and renew if necessary.

Examine the ball cup anchorage. Inspect the anchor ball and cups for signs of wear or hammering. Renew them if the correct adjustment is not obtainable by removing shims.

Normally during an overhaul all 'O' rings should be removed and discarded and new rings fitted on reassembly.

Assembly of the power cylinder

Valve body assembly

Assemble the cylinder relief valve ball and spring to the valve body and screw home the plug and pin.

If any of the locating pegs are loose or damaged, fit new pegs by tapping them lightly into the holes provided.

Assemble new 'O' rings into the valve body and onto the end cover, slide the end cover into the body, and secure with the circlip. Assemble a new 'O' ring on the outside diameter of the body.

CAUTION.—Extreme care must be taken when fitting 'O' rings to avoid damage to them which would cause subsequent leakage.

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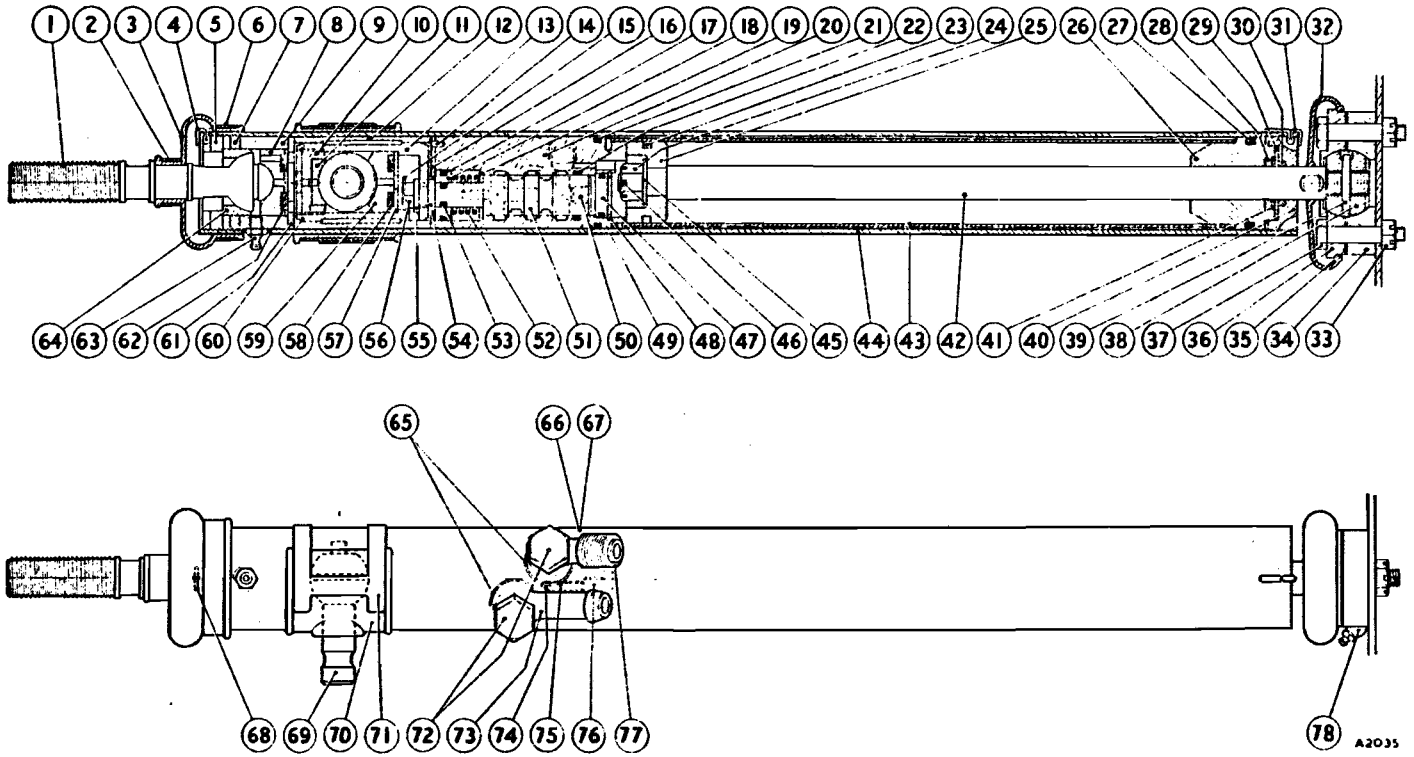

Fig. JJ.7

A sectioned view of the actuator unit

1. Draglink end.
2. Clip.
3. Rubber cap.
4. Split pin.
5. End cover.
6. Clip.
7. Lock ring.
8. Output ball cup.
9. Distance piece.
10. Ball cup holder.
11. Ball cup.
12. Locating sleeve.
13. Operating sleeve.
14. Locating pin.
15. Split pin.
16. Spacer.
17. 'O' ring on reaction ring.
18. Reaction ring.
19. Reaction washer.
20. Valve body.
21. 'O' ring on valve body.
22. 'O' ring on valve body.
23. Piston ring.
24. Slotted nut.
25. Piston.
26. Bearing.
27. 'O' ring on bearing.
28. Gland ring.
29. Washer.
30. Square-sectioned ring.
31. Split pin.
32. Rubber cap for anchor bracket.
33. Slotted nut.
34. Anchor bracket ball cup (outer).
35. Shim.
36. Anchor bracket ball cup (inner).
37. Bolt.
38. Anchor ball.
39. Anchor ball pin.
40. Bearing lock ring.
41. Vellumoid washer.
42. Piston rod.
43. Inner tube.
44. Outer tube.
45. Washer.
46. Split pin.
47. End cover.
48. Circlip.
49. 'O' ring on end cover.
50. Plug spool.
51. Spool.
52. Reaction spring.
53. 'O' ring on spool.
54. Collar.
55. Hardened washer.
56. Slotted nut on spool.
57. Backing plate.
58. Belleville washer.
59. Ball cup.
60. Spring locking clip.
61. Washer.
62. Belleville washer.
63. Grease nipple.
64. Output ball cup.
65. Dowty washer.
66. Plug—valve body.
67. Plug—valve body.
68. Split pin for lock ring.
69. Ball pin.
70. Dust cover.
71. Clip for dust cover.
72. Banjo bolt.
73. High-pressure banjo.
74. Relief valve ball.
75. Relief valve spring.
76. Relief valve plug and pin.
77. Low-pressure banjo.

Release the pinch-bolt from the steering drop-arm connection on the power cylinder.

Remove the two nuts situated at the rear face of the cylinder mounting bracket which is fixed to the chassis side-member.

The ball connection at the steering-lever must now be released by taking out its split pin, removing the castellated nut, and tapping out the pinch-bolt.

The cylinder is now free and can be removed from the car.

To refit the cylinder reverse the dismantling procedure. Bleed the system as described in Section JJ.6.

Section JJ.2

DISMANTLING AND REASSEMBLING THE POWER CYLINDER

Remove the power cylinder from the vehicle as described in Section JJ.1.

Drain all the oil from the cylinder by moving the piston rod in and out several times from one extreme end of its travel to the other.

To support the unit use a wooden block in which a hole 1⅞ in. (47·6 mm.) in diameter has been bored. Saw the block in half down the length of the hole, and the unit can then be safely secured in it.

Remove the anchorage parts from the end of the piston rod. The outer ball cup will have been removed on dismantling from the vehicle. Remove the split pin from the centre of the ball. Unscrew the ball by inserting a round punch in the hole provided in the ball and by applying a spanner to the flats on the piston rod. Slide off the inner ball cup and the rubber abutment cover.

Remove the rubber dust excluder and its retaining clip from both the ball pin and the end extension. Remove

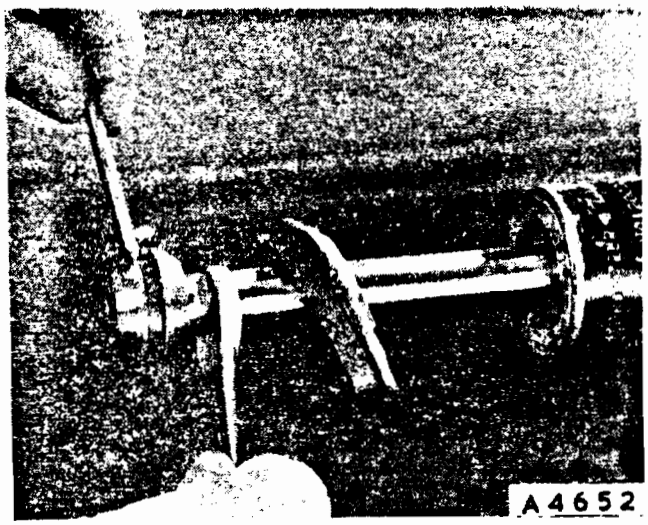

Fig. JJ.7

Unscrewing the anchor ball from the piston rod. Use a close-fitting spanner on the piston rod to avoid the possibility of any burring

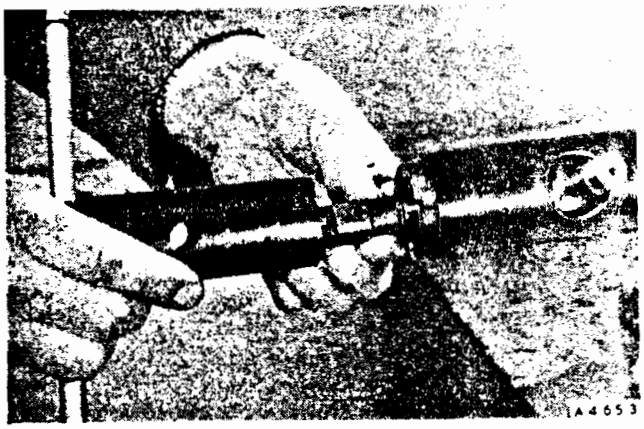

Fig. JJ.8

Using ball pin end plug spanner 18G608

the grease nipple and the two split pins from the ends of the unit.

From the ball pin end unscrew the lock ring, using spanner 18G608, having first removed the circlip and guide adaptor from within the spanner, and remove the outer ball cup, ball pin, inner ball cup, and Belleville washers.

Remove the split pin from the second lock ring, and, again using spanner 18G608, remove the lock ring, spacing tube, and steel plate.

Pull out the spring locking clip from its slot and unscrew the ball cup holder and ball cup, using spanner 18G609. The manual ball pin can then be removed.

Unscrew the lock ring at the bearing end with tool 18G608, having refitted the guide adaptor into the spanner, and remove the tightening-up washer. Remove the end bearing and piston rod assembly by pulling the inside face of the piston against the end bearing, thus pulling it from the inner tube. When removing parts from the piston rod ensure that the rod is clean and free from burrs in order to eliminate any possibility of damage to them.

Remove the split pin, slotted nut, and steel washer securing the piston and remove the piston from the rod. The piston ring should also be removed.

Slide the bearing assembly off the rod from the piston end and remove the 'O' ring from the outside diameter.

Remove the Vellumoid washer and gland seal from inside the housing.

The valve body, spool, and inner tube assembly may now be removed by a few light blows via a wooden block inserted in the ball pin end and resting on the ball cup.

Slide out the spool assembly. Extract the ball cup, Belleville washers, and backing plate by tapping the end of the operating sleeve on a wooden block.

Remove the inner tube from the valve body. It is a light press fit on the body and it should be removable without undue force.

Remove the circlip from the valve body and slide out the end cover. Remove the 'O' rings from the end cover and the bore of the valve body.

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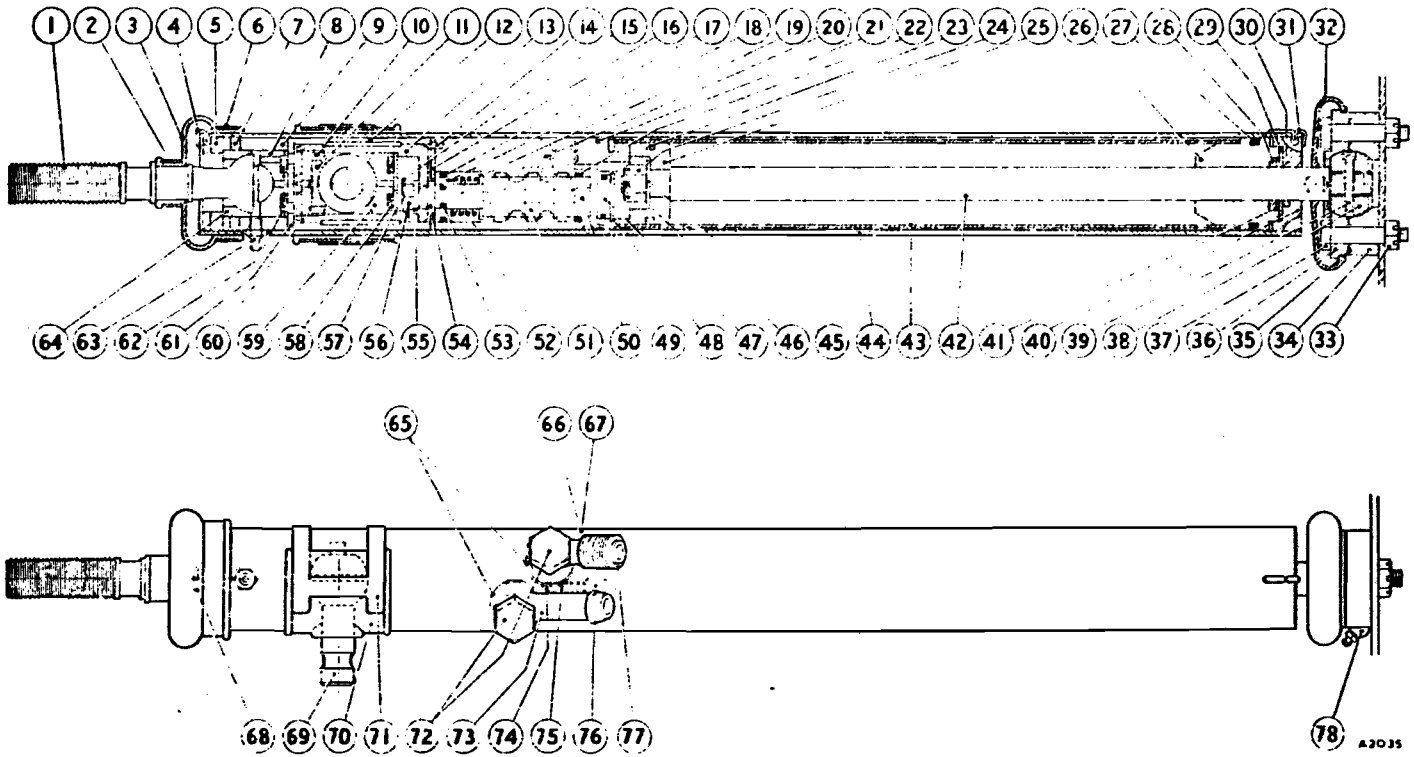

Fig. JJ.9

A sectioned view of the actuator unit

1. Draglink end.
2. Clip.
3. Rubber cap.
4. Split pin.
5. End cover.
6. Clip.
7. Lock ring.
8. Output ball cup.
9. Distance piece.
10. Ball cup holder.
11. Ball cup.
12. Locating sleeve.
13. Operating sleeve.
14. Locating pin.
15. Split pin.
16. Spacer.
17. 'O' ring on reaction ring.
18. Reaction ring.
19. Reaction washer.
20. Valve body.
21. 'O' ring on valve body.
22. 'O' ring on valve body.
23. Piston ring.
24. Slotted nut.
25. Piston.
26. Bearing.
27. 'O' ring on bearing.
28. Gland ring.
29. Washer.
30. Square-sectioned ring.
31. Split pin.
32. Rubber cap for anchor bracket.
33. Slotted nut.
34. Anchor bracket ball cup (outer).
35. Shim.
36. Anchor bracket ball cup (inner).
37. Bolt.
38. Anchor ball.
39. Anchor ball pin.
40. Bearing lock ring.
41. Vellumoid washer.
42. Piston rod.
43. Inner tube.
44. Outer tube.
45. Washer.
46. Split pin.
47. End cover.
48. Circlip.
49. 'O' ring on end cover.
50. Plug spool.
51. Spool.
52. Reaction spring.
53. 'O' ring on spool.
54. Collar.
55. Hardened washer.
56. Slotted nut on spool.
57. Backing plate.
58. Belleville washer.
59. Ball cup.
60. Spring locking clip.
61. Washer.
62. Belleville washer.
63. Grease nipple.
64. Output ball cup.
65. Dowty washer.
66. Plug—valve body.
67. Plug—valve body.
68. Split pin for lock ring.
69. Ball pin.
70. Dust cover.
71. Clip for dust cover.
72. Banjo bolt.
73. High-pressure banjo.
74. Relief valve ball.
75. Relief valve spring.
76. Relief valve plug and pin.
77. Low-pressure banjo.
78. Grease nipple.

Unscrew the plug and pin at the cylinder end of the valve body, using a suitable Allen key, and remove the cylinder relief valve spring and ball.

Remove the split pin from the spool nut, unscrew the nut, and remove the washer. The operating sleeve, spacer, and stepped collar may now be removed. Slide off the reaction ring and remove the 'O' ring from its outer diameter. Remove the spring and reaction washer and extract the small 'O' ring from its location on the spool spindle.

Inspection of the power cylinder

Thoroughly clean all parts of the power cylinder and inspect for wear and damage.

Examine the spool and body for burrs and scoring. Burrs may be removed with very fine emery-cloth.

CAUTION.—Do not round off the sharp edges on the valve spool or the operation of the valve may be affected.

Smear the spool with a light film of oil and insert it into the valve body to check the fit. With all 'O' rings removed the spool should pass freely through the body.

Inspect the mating surfaces of the operating sleeve and locating sleeve for wear or damage. The surfaces should be free from burrs or scores.

Check the fit of the operating sleeve in the locating sleeve. The operating sleeve should slide freely within the locating sleeve when lightly lubricated.

Examine the inner tube, piston, piston ring, piston rod, and bearing for wear or scoring, and renew if necessary.

Examine the ball cup anchorage. Inspect the anchor ball and cups for signs of wear or hammering. Renew them if the correct adjustment is not obtainable by removing shims.

Normally during an overhaul all 'O' rings should be removed and discarded and new rings fitted on reassembly.

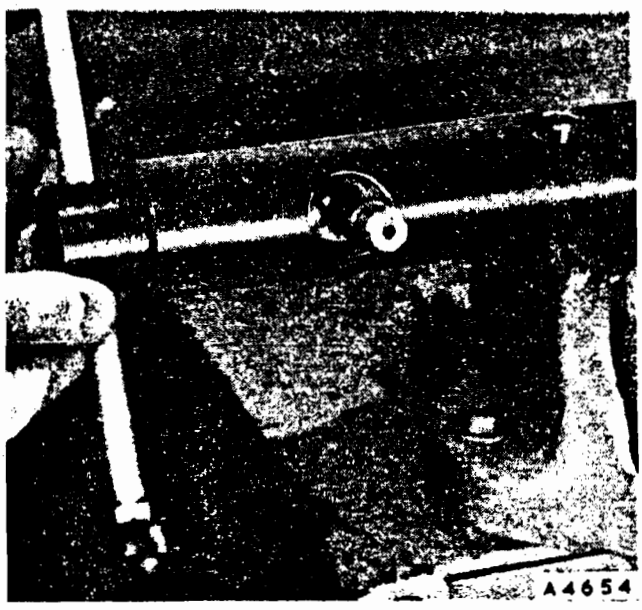

Fig. JJ.10

Unscrewing the ball cup with spanner 18G609

Assembly of the power cylinder

Valve body assembly

Assemble the cylinder relief valve ball and spring to the valve body and screw home the plug and pin.

If any of the locating pegs are loose or damaged, fit new pegs by tapping them lightly into the holes provided.

Assemble new 'O' rings into the valve body and onto the end cover, slide the end cover into the body, and secure with the circlip. Assemble a new 'O' ring onto the outside diameter of the body.

CAUTION.—Extreme care must be taken when fitting 'O' rings to avoid damage to them which would cause subsequent leakage.

Assemble the inner tube on the valve body. This is a light press fit and should be assembled carefully by means of a few light taps with a wooden mallet, lining up the slot in the inner tube with the locating peg.

Valve spool assembly

Fit new 'O' rings to the spool and reaction ring. Assemble the reaction washer, spring, and reaction ring to the spool. Both the reaction washer and ring are fitted to the spool, chamfer first.

Assemble the collar onto the threaded part of the spool and assemble the spacer to locate around the collar. The spacer should be positioned so that the holes in it line up with the corresponding holes in the valve body. Assemble the operating sleeve onto the collar and fit the steel washer and nut. The nut must be tightened to between 60 and 110 lb. in. (·691 to 1·26 kg. m.) with the split pin hole in the spool lined up. Turn the operating sleeve until the hole in the spool and the semicircle in the operating sleeve are in line. Insert a new split pin through the semicircle into the nut and spool and turn over the ends in a sideways direction, working from the open end of the operating sleeve.

NOTE.—It is important that the above procedure for split-pinning is adhered to.

Grease the operating sleeve and slide the locating sleeve over it.

Piston rod assembly

Assemble the piston ring onto the piston and then assemble the piston to the piston rod, flat face first. Fit the flat washer and slotted nut. Tighten the nut to 35 to 45 lb. ft. (4·84 to 6·22 kg. m.); do not overtighten as this may cause the piston to swell and bind in the tube. Secure the nut with a split pin.

Compress the piston ring and slide the piston rod assembly into the inner tube as far as it will go.

Final assembly

Slide the spool assembly into the valve body, taking care to prevent damage to the sealing edges. The assembly must be positioned so that the small hole in the spacer locates on the dowel in the end of the valve body.

Assemble the backing plate into the bore of the operating sleeve, chamfer first, and ensure that it is correctly seated. Place two Belleville washers back to back (inner

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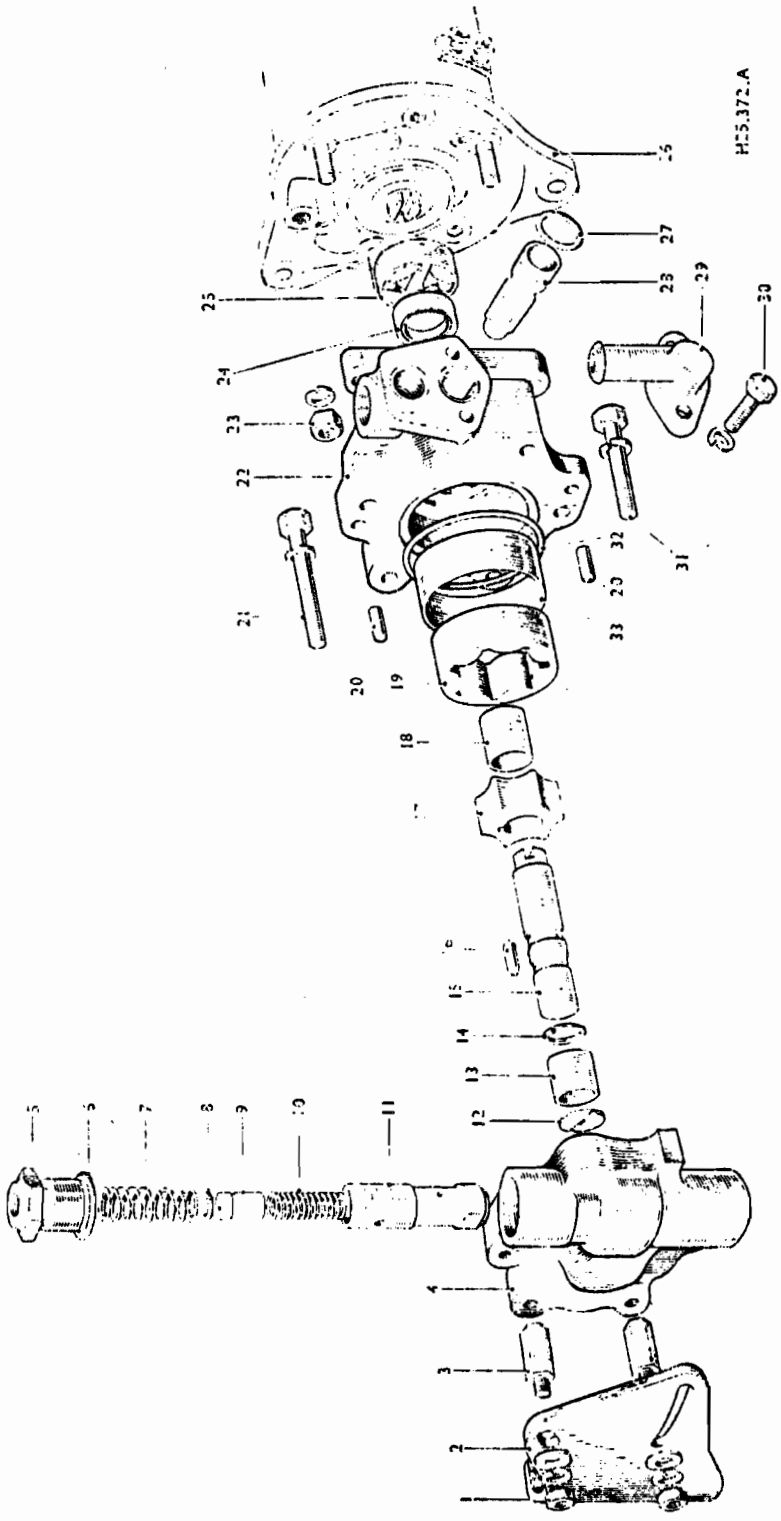

Fig. JJ.11
Exploded view of the steering pump

1. Nut.
2. Mounting bracket.
3. Distance piece.
4. Cover.
5. Adaptor.
6. 'O' ring.
7. Flow control spring.
8. Retaining ring.
9. Relief valve.
10. Relief valve spring.
11. Flow control valve.
12. Thrust washer.
13. Bush (in cover).
14. Snap ring.
15. Pump shaft.
16. Drive pin.
17. Rotor (inner).
18. Bush (in body).
19. Rotor (outer).
20. Dowel.
21. Bolt and lock washer.
22. Body.
23. Nut.
24. Oil seal.
25. Drive coupling.
26. Generator.
27. 'O' ring—venturi.
28. Venturi.
29. Adaptor (inlet).
30. Set bolt.
31. Bolt and lock washer.
32. 'O' ring.
33. Rotor sleeve.

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diameters together) in the recess of the inner ball cup. A smear of grease will help to retain the Belleville washers in position. Place the inner ball cup with the Belleville washers in position to the bottom of the operating sleeve. With a smear of grease to retain the outer ball cup, screw in the ball cup holder a few threads to retain it in position.

Hold the outer tube and slide the complete inner assembly into the outer tube from the anchorage end. Care should be taken to see that the hose ports in the valve body line up radially with the ports in the outer tube.

Insert a new gland seal, flat face outwards, carefully into the bearing and press home the seal.

Assemble a new 'O' ring onto the outer diameter of the bearing.

Onto the anchorage end of the outer tube assemble the bearing 'O' ring fitting tool 18G610, removing the sleeve protecting ring after the tool is correctly positioned as illustrated in Fig. JJ.12.

It is essential that the utmost care is exercised when fitting the end bearing in order not to damage the sealing edge of the gland seal; therefore before assembly it is imperative that any burrs which may exist on the edges of the spanner flats on the piston shaft are removed with the aid of a fine carborundum stone. Treat similarly the end shoulder of the piston rod adjacent to the anchor ball thread.

Slide onto the anchor ball thread of the piston rod the seal replacer 18G611.

Apply a liberal amount of oil to the inside of the 'O' ring fitting tool and to the 'O' ring on the end bearing. Slide the end bearing, complete with gland seal, over the end of the shaft and into the fitting tool, using the sleeve protecting ring to push the bearing firmly in as far as it will go. Leave the protecting ring inside the fitting tool and withdraw the complete tool assembly.

Fit the Vellumoid washer in position in the end bearing next to the gland seal, followed by the metal washer.

Fit the end bearing lock ring complete with the square-sectioned rubber ring and oil scraper. Early steering units were not fitted with this additional oil scraper, and when servicing such units opportunity should be taken to fit the modified lock ring. See Section JJ.7.

Screw the end bearing lock ring into the outer tube, using spanner 18G608 complete with guide adaptor, until the ports in the valve body line up longitudinally and a slot in the bearing is in line with the split pin hole. This operation should be carried out with the power cylinder horizontal, otherwise the spool will tend to fall out of the valve body. With a banjo adaptor and banjo pin, locate the valve body in the tube by screwing home.

Apply a liberal coating of grease to the spherical surface of the manual ball pin and assemble through the holes in the outer tube and sleeves, ensuring that the limit peg is located correctly in the two elongated slots provided. Screw home the outer cup to its limit using spanner 18G609. Screw back one-quarter of a turn and then line up the nearest slot to the two holes drilled in the circumference of the operating sleeve. This should provide the proper tension on the Belleville washers. Lock with the spring clip.

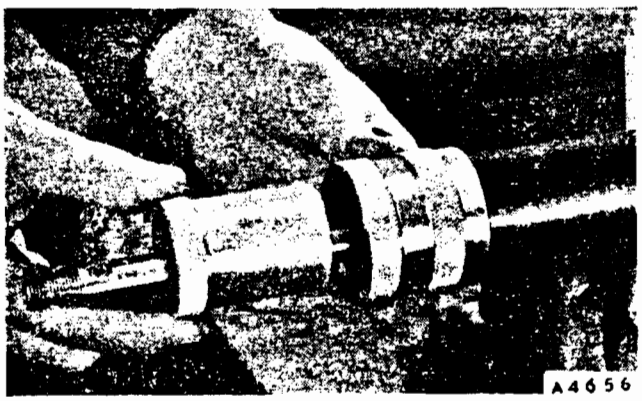

Fig. JJ.12

Withdrawing the sleeve protecting ring from the bearing 'O' ring fitting tool 18G610, in position on the power cylinder

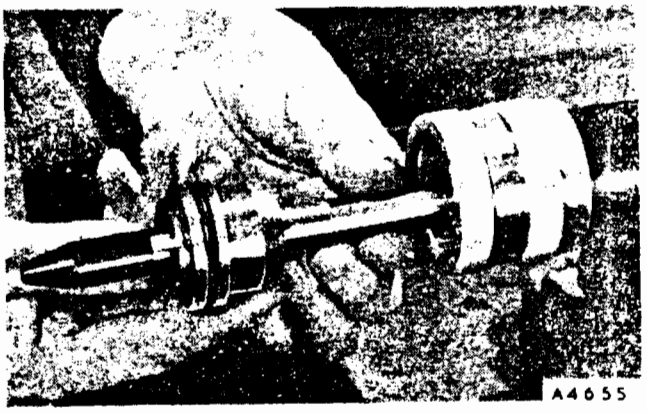

Fig. JJ.13

With the 'O' ring protecting tool in position, assemble the end bearing over the oil seal replacer 18G611

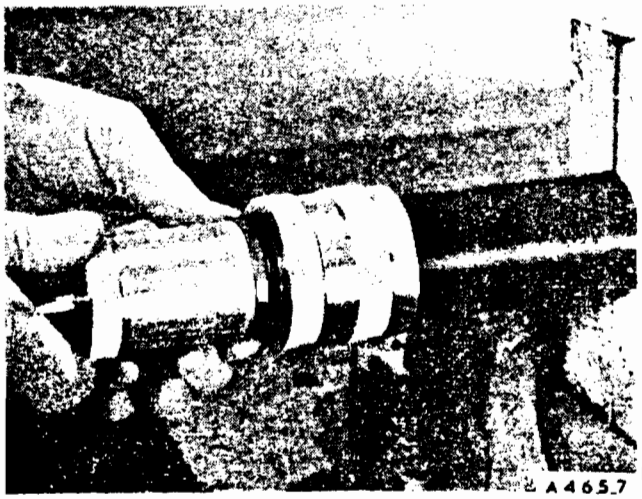

Fig. JJ.14

Enter the end bearing into the replacing tool and use the sleeve protecting ring to push the bearing firmly in

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Place the steel plate against the locating sleeve and assemble the spacing tube to it, locating the threaded hole into the hole in the outer tube. Screw in the greaser. Screw in the inner lock ring to the spacing tube with spanner 18G608. If necessary screw this lock ring and the end bearing lock ring in and out to centralize the valve body tappings with the holes in the outer tube. With this operation carried out, turn the spacing lock ring so that the nearest slot lines up with the split pin hole in the tube. Lock the assembly up solid with the end bearing lock ring. Fit a split pin to the lock ring inside the unit.

Using grease as before, place two Belleville washers back to back (inner diameters together) and assemble in the ball cup recess. Place the ball cup to the bottom of the spacing tube. Smear the extension with grease and fit the outer ball cup to it. Place in the end of the unit and assemble the lock ring over the extension. Screw up solid, using spanner 18G608 with the adaptor removed, and slacken off one-quarter of a turn. The reassembly of the unit may mean that the end split pin holes do not now line up with the slots. On no account must the lock rings be adjusted to line up. Re-drill the split pin holes with a $\frac{9}{64}$ in. (3·57 mm.) dia. drill and fit new split pins.

Assemble the rubber dust excluder and clip at the extension end, and also to the manual ball pin.

Slide the rubber abutment cover and inner ball cup onto the piston rod. Screw up the anchor ball and lock with a split pin. Replace the shims and bolt up the outer anchor cup. Check the anchor ball for end-float and remove shims as necessary to correct.

Section JJ.3

REMOVING AND REPLACING THE STEERING PUMP

Remove the two nuts and spring washers securing the pump support plate to the cylinder block. Remove the three nuts and spring washers securing the pump body to the rear end of the dynamo.

Pull the pump away from its mountings and, with a receptacle in position to catch the fluid, disconnect the inlet and outlet pipes from the pump.

Assembly is a reversal of the above procedure, but the system must be bled as detailed in Section K.

Section J.4

DISMANTLING AND REASSEMBLING THE STEERING PUMP

Withdraw the flexible drive coupling from the rear end of the pump. If necessary, remove the two set screws and spring washers securing the inlet elbow to the pump body, remove the elbow and 'O' sealing ring, and withdraw the venturi.

To remove the flow control valve unscrew the hexagon outlet adaptor and remove the 'O' sealing ring, flow control spring, and flow valve assembly. Release the circlip from inside the flow valve and withdraw the relief valve and spring.

Remove the bolts and spring washers securing the cover to the pump body and remove the cover. Two dowels are fitted between the cover and pump body. Remove the rotor and shaft assembly and, if necessary, drive the inner rotor from the shaft. The rotor is keyed to the shaft with a round drive pin. A thrust washer is fitted at the back of the bearing in the pump cover.

The shaft oil seal is located in a machined recess at the rear of the pump body. If necessary, remove the old seal and press a new one into position, ensuring that it fits squarely into the recess.

Inspection of pump

Wash all the parts in petrol (gasoline). Inspect the pump body and cover for signs of wear caused by rotation of the rotors and check the bushings in the body and cover for wear or scores. If the pump cover or bush in the cover is worn or damaged renew the cover and bush assembly.

Inspect the drive and driven rotors for wear, cracks, and scores. If either rotor is damaged or worn renew the pump body and rotor assembly. If the rotors appear to be in good condition install the drive rotor and pin on the rotor shaft, then install the driven rotor.

Check the clearance between the rotors at all points with the aid of a feeler gauge. If the clearance exceeds ·006 in. (·15 mm.) renew the pump body and rotor assembly.

Check the clearance between the top of the rotors and the surface of the pump body with a feeler gauge and straight-edge. If the clearance exceeds ·0025 in. (·06 mm.), renew the pump body and rotor assembly.

Check the clearance between the outside diameter of the driven rotor and the insert in the pump body. If the clearance exceeds ·006 in. (·15 mm.) renew the pump body and rotor assembly.

If all the clearances are within the given limits remove the rotors and shaft from the pump body.

Thoroughly dry the pressure relief valve and the bore of the flow control valve. Ensure that the relief valve moves freely within the flow control valve and that the control valve is free in the bore of the pump cover. If necessary, remove any burrs with very fine emery-cloth, then wash and thoroughly dry the parts.

The reassembly of the pump is a reversal of the above procedure. New 'O' sealing rings should be used throughout.

Section JJ.5

SERVICING THE RESERVOIR

The small cap should be removed at regular intervals to ensure that the correct oil level is maintained.

To remove the filter unscrew the securing bolt in the reservoir cover, which can be taken off and the filter withdrawn. Upon reassembly ensure that the cover is secure and sealing correctly.

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Section JJ.6

BLEEDING THE SYSTEM

Fill the reservoir with the recommended grade of oil (see Section P.1) to the correct level. The front of the vehicle should be jacked up until the road wheels are clear of the ground, then start the engine and allow it to tick over. Turn the wheels from lock to lock several times in order to allow the oil to circulate through the system to remove any air present, and, finally, recheck the oil level in the reservoir.

NOTE.—If, when the vehicle is jacked up, the steering is operated lock to lock by means of the road wheels, it should be done slowly, when it will move easily.

Should the power-assisted steering become noisy during movement of the wheels, it is usually an indication that air has entered the system. If air is present in the system a stream of air bubbles will be seen rising in the reservoir when the system is operated. Should it be found that air bubbles rise continually after repeated movement of the wheel, it is an indication that air is being drawn into the oil pump on the inlet side. Careful check should be made that the reservoir fluid level is correct and that all pipe connection joints are tight.

Section JJ.7

OIL SCRAPER SEAL

A modified end bearing lock ring is now fitted to 1½ in. (38·1 mm.) diameter Hydrosteer power steering units, in which is incorporated an additional oil scraper seal. The seal (Part No. 17H6450) is pressed into a recess machined in the end of the lock ring, the assembly being completely interchangeable with the earlier type.

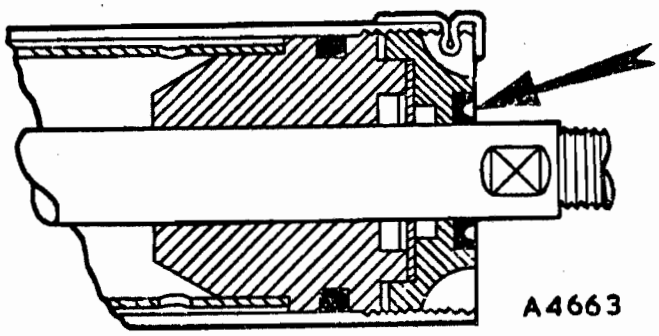

Fig. JJ.15

A sectioned view of the end bearing showing the additional oil scraper seal fitted to later units

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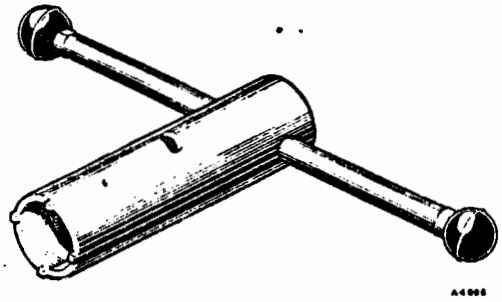
SERVICE TOOLS

18G608. End Plug and Lock Ring Spanner

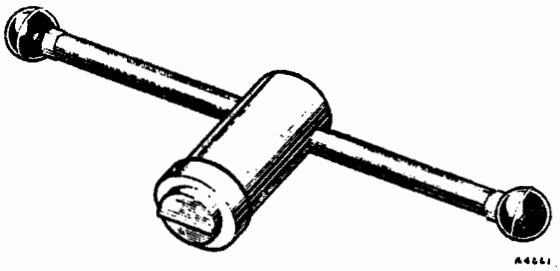
This spanner will effectively remove and replace without damage end plugs and lock rings on the 1½ in. (38·1 mm.) diameter Hydrosteer unit.



18G608

18G609. Ball Cup Spanner

Used on the 1½ in. (38·1 mm.) diameter Hydrosteer unit to remove and replace the ball pin cup.



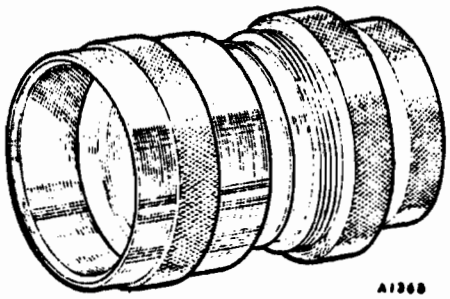
18G609

18G610. Bearing 'O' Ring Fitting Tool

The use of this fitting tool when replacing the end bearing in the outer tube on 1½ in. (38·1 mm.) diameter Hydrosteer units will prevent damage to the 'O' ring.

18G610A. Sleeve (Service replacement)

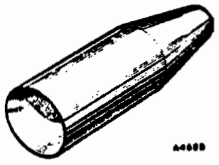
A Service replacement sleeve for 18G610.



18G610

18G611. Piston Shaft Oil Seal Replacer

When fitted over the anchor ball threads on the piston shaft the tool provides a lead for the bearing gland seal upon reassembly.



18G611

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SECTION K

THE FRONT SUSPENSION

	Section
General description	
Maintenance	
Coil spring—removing and replacing	K.2
Front hub—removing and replacing	K.1
Tools	End of Section
Suspension unit	
Dismantling and reassembling	K.5
Removing and replacing	K.4
Swivel pins and bushes—renewing	K.3

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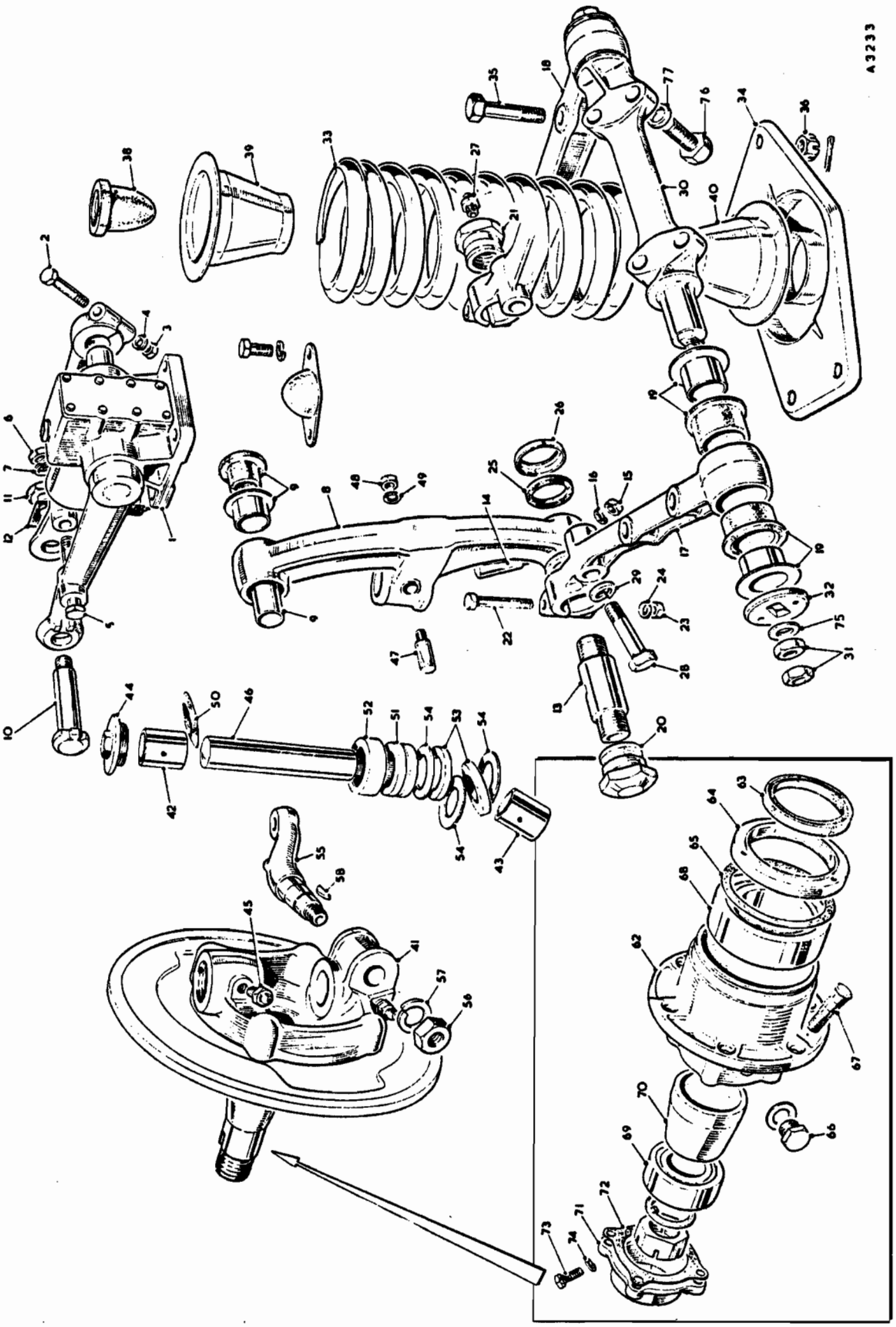
THE FRONT SUSPENSION COMPONENTS



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KEY TO THE FRONT SUSPENSION COMPONENTS

No.	Description
1.	Hydraulic damper.
2.	Clamping bolt.
3.	Nut.
4.	Spring washer.
5.	Bolt for damper arms.
6.	Nut.
7.	Spring washer.
8.	Carrier bracket.
9.	Carrier bearing (top).
10.	Fulcrum pin.
11.	Nut.
12.	Lock washer.
13.	Fulcrum pin—lower link.
14.	Cotter—fulcrum pin.
15.	Nut.
16.	Spring washer.
17.	Lower link (front).
18.	Lower link (rear).
19.	Bush—links inner.
20.	Bush—links outer.
21.	Bush—rear links outer.
22.	Bolt—clamping.
23.	Nut.
24.	Spring washer.
25.	Oil retainer (felt).
26.	Retainer cap.
27.	Grease nipple.
28.	Clamping bolt.
29.	Spring washer.
30.	Lower link bracket.
31.	Locknut.
32.	Special washer.
33.	Coil spring.
34.	Spring seat.
35.	Bolt.
36.	Nut.
38.	Spring bump rubber.
39.	Retainer.
40.	Striker plate.
41.	Swivel axle.
42.	Bush (top).
43.	Bush (bottom).
44.	Plug.
45.	Grease nipple.
46.	Pin—swivel axle.
47.	Cotter pin.
48.	Nut.
49.	Spring washer.
50.	Oil seal.
51.	Thrust bearing.
52.	Dust cover.
53.	Thrust washer (Oilite).
54.	Thrust washer—floating.
62.	Hub.
63.	Oil seal.
64.	Housing—oil seal.
65.	Joint washer.
66.	Lubricating plug.
67.	Wheel stud.
68.	Bearing (inner).
69.	Bearing (outer).
70.	Distance piece.
71.	Cap—hub.
72.	Joint washer.
73.	Set screw.
74.	Spring washer.
75.	Plain washer.
76.	Set screw—link bracket.
77.	Spring washer.

GENERAL DESCRIPTION

The independent front suspension is of the wishbone type. The lower wishbone pivots on rubber bushes carried by a bracket bolted to the under side of the main chassis member. The upper wishbone arms are formed by the lever arms of the double-acting hydraulic damper, which is mounted on the top of the main chassis member by four set bolts. At their outer ends the damper arms are secured to the swivel axle carrier bracket by a fulcrum pin and rubber bushes. The lower wishbone arms at their outer ends are secured to the swivel axle carrier bracket by means of fulcrum pins in screwed metal bushes.

The swivel axle pin is secured in its carrier bracket by means of a cotter pin. The swivel axle pivots about the pin on metal bushes; the thrust between the stub axle and the carrier bracket is taken by a thrust ball race on the steering-box side of the car and by two Oilite and three steel thrust washers enclosed within a steel cup carried between the stub axle and the centre boss of the carrier bracket on the opposite side.

Each wheel hub is mounted to the stub axle on two roller bearings. No adjustment is required or catered for, the amount of thrust or preload being predetermined by a distance piece.

MAINTENANCE

Normal maintenance is confined to the lubrication of the swivel pins, lower arm outer fulcrum pin, and hubs as detailed in Section P, and to the periodical examination and topping up of the hydraulic dampers as detailed in Section L.

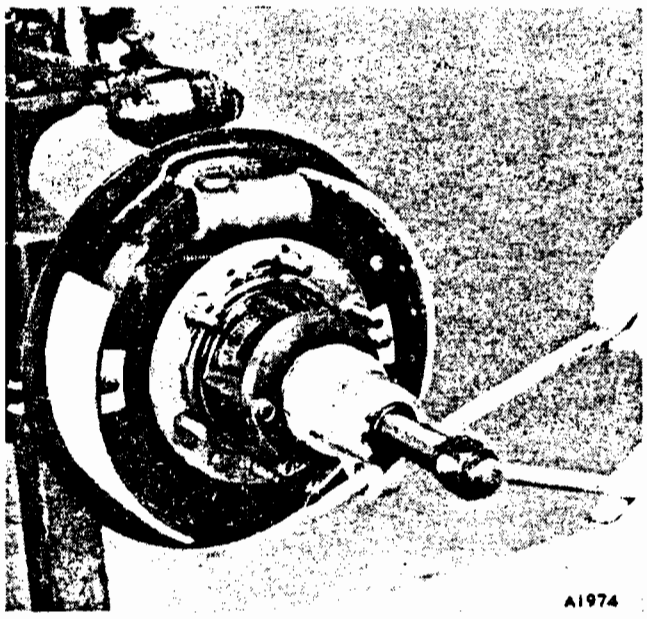

Fig. K.1

Using withdrawer 18G8 and adaptor 18G8E to withdraw a hub assembly

Section K.1

REMOVING AND REPLACING A FRONT HUB

Jack up the car on the side from which the hub is to be removed and remove the road wheel.

NOTE.—The left-hand front wheel has left-hand-threaded nuts.

Remove the three countersunk screws, and with a hide hammer gently tap the brake-drum clear of the front hub assembly.

Unscrew the four hub cap retaining screws and spring washers and withdraw the hub cap. Take care not to damage the joint washer.

Extract the split cotter pin securing the stub axle nut, unscrew the nut, and remove the keyed washer.

Assemble Service tool 18G8 and adaptor 18G8E to the hub and withdraw the hub assembly from the stub axle.

Behind the hub inner bearing is fitted a paper washer, oil seal, and oil seal housing (see Fig. K.2). To enable the oil seal and housing to be easily removed three grub screws are threaded into the housing. By tightening each of the screws evenly, a little at a time, the oil seal and housing will be forced out of the hub.

It is possible that the bearing inner race may be left on the stub axle, trapping the oil seal and oil seal housing behind it. In this event knock back the tabs of the lock washers beneath the backplate securing bolts, unscrew the bolts, and withdraw the backplate. Two small levers may now be used to prise the oil seal housing away, leaving the oil seal behind the bearing inner race. Two large levers must now be used to carefully prise off the inner race. Interpose suitable blocks of wood between the levers and the stub axle casting.

With the aid of a suitable soft-metal drift inserted through the hub and butting up to the rear of each bearing outer race, tap the bearings evenly from the wheel hub.

When reassembling the hub the inner or larger ball bearing should first be inserted into the hub with the side of the bearing marked 'THRUST' facing the distance piece.

Pack the hub with grease to Ref. D (page P.2) and then insert the distance piece so that the chamfered end faces the outer bearing.

Replace the outer bearing with the thrust side facing the distance piece. Whenever possible, a press should be used to replace bearings, but where no press is available use a soft-metal drift to replace both bearings, tapping them gently on diametrically opposite sides of the bearing to ensure that they move evenly into their respective housings on the hub.

Position a new joint washer over the inner bearing and gently press the oil seal housing complete with oil seal into the hub casing. When the seal housing is fully home, dip the three grub screws in shellac and replace them in the seal housing.

NOTE.—The lip of the seal and the shoulders on the housing face must face towards the hub bearings.

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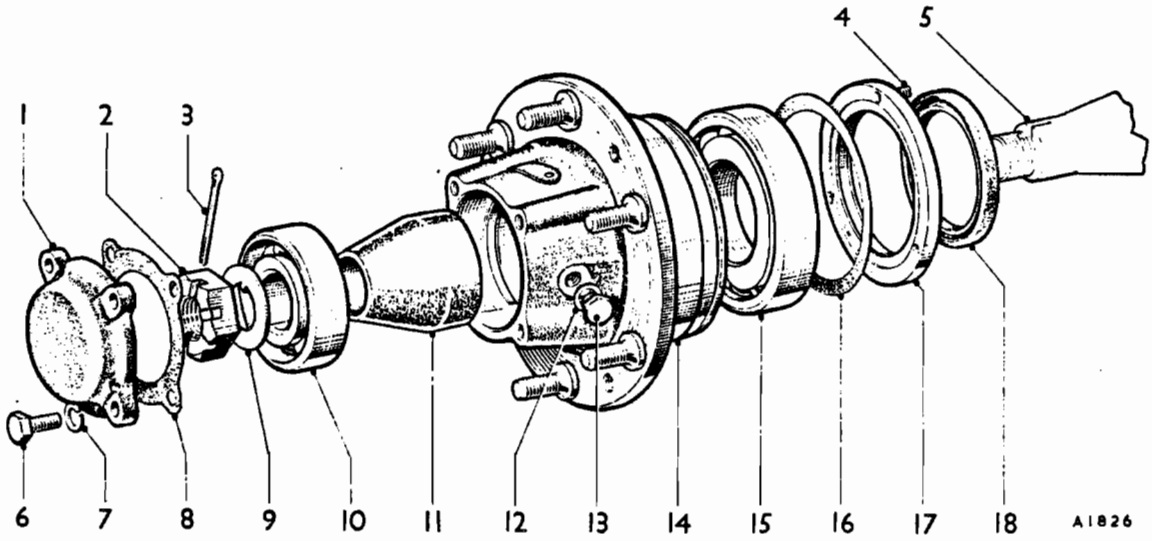

Fig. K.2

A front hub assembly

1. Hub cap.
2. Axle nut.
3. Split pin.
4. Grub screw.
5. Stub axle.
6. Set screw—hub cap.
7. Spring washer.
8. Joint washer.
9. Keyed washer.
10. Outer bearing.
11. Distance piece.
12. Joint washer.
13. Lubrication plug.
14. Hub.
15. Inner bearing.
16. Joint washer.
17. Oil seal housing.
18. Oil seal.

The remainder of the reassembling procedure is a reversal of the instructions given for removing.

In order to adjust the front hub bearings temporarily refit the road wheel and, holding it with both hands diametrically opposite to one another, rock the wheel and note the amount of movement between the brake backplate and the brake-drum.

Gradually tighten the hub retaining nut until all perceptible sideplay between the brake backplate and the brake-drum has been eliminated. The nut must then be tightened a further one-eighth of a turn and secured with a split pin. Do not overtighten.

Section K.2

REMOVING AND REPLACING A COIL SPRING

Jack up the side of the car from which the spring is to be removed and remove the road wheel.

Place coil spring compressor 18G76 in position on the suspension lower wishbones and fully tighten the central screw.

Extract the split pins and remove the four nuts and bolts securing the spring lower plate to the suspension arms.

Unscrew the central bolt of the compressor to release the tension from the coil spring, remove the compressing tool, and withdraw the spring lower plate, bump rubber striker plate, coil spring, and bump rubber with retainer.

Replacement of the coil spring is a reversal of the above procedure.

Section K.3

RENEWING THE SWIVEL PINS AND BUSHES

Jack up the side of the car from which the swivel axle is to be removed and remove the road wheel.

Remove the brake-drum and withdraw the hub as described in Section K.1.

Disconnect the brake flexible hose at its union on the brake backplate. To prevent unnecessary loss of fluid it is advisable to tie up the free end of the pipe to a convenient high point on the chassis.

Knock back the locking tabs and unscrew the brake backplate securing bolts from the stub axle casting. Withdraw the brake backplate.

Unscrew the nut and tap out the cotter pin securing the swivel pin in the swivel axle carrier bracket.

Unscrew the two bronze cover caps at each end of the swivel assembly, and withdraw the swivel pin downwards from the swivel axle carrier bracket.

With the aid of a press and Service tool 18G57 remove the old bushes from their housings in the stub axle casting.

It will be noted that a roller thrust bearing is fitted on the steering-box side of the car and that two Oilite and steel thrust washers are fitted on the opposite side of the car.

Use replacer 18G57 in conjunction with a press when fitting new bushes, and note that care must be taken to ensure that they are correctly located as follows.

In the lower bush the oil grooves extend to one edge of the bush and it is important that this bush is fitted into the swivel axle bottom bore so that the oil grooves lead towards the thrust bearing or top face of the bush bore.

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In the upper bush the oil grooves finish before reaching the edge of the bush.

In both cases, if the bushes are fitted into the swivel axle bores from the top and with the largest-chamfered edge leading the assembly will be correct.

The top edge of the lower bush and bottom edge of the upper bush must be flush with the respective faces of the swivel axle, and, finally, ensure that the oil holes in both bushes and in the swivel axle are in alignment.

After fitting, ream-finish the bushes, using bush reamer 18G71 with wrench 18G68.

Before the swivel pin can be replaced the thrust bearing, whether of the ball bearing or Oilite and steel thrust washer type, must first be correctly adjusted. To adjust the ball bearing it must be placed into its pressed-steel cap. Place the cap and bearing, open side face downwards, over the boss of the swivel pin carrier bracket and position the swivel axle over the carrier bracket. Check that the bearing is a good fit between the two pieces with a minimum amount of end-play.

Should up-and-down movement of the swivel axle be apparent in the case of the roller bearing, add shims beneath the bearing, in its cup, sufficient to take up the amount of movement. Shims are available ·004 and ·006 in. (·102 and ·152 mm.) thick.

On the thrust washer side the extra movement is accommodated by fitting varying thicknesses of thrust washer available in five sizes: ·068, ·072, ·073, ·077, and ·081 in. (1·72, 1·83, 1·85, 1·96, and 2·05 mm.) thick.

When the thrust bearing has been correctly adjusted oil the swivel pin bushes and drive the pin into position, entering it from below and working upwards. The tapped hole in the end of the swivel pin must point downwards and the pin should be driven home until the groove in the side of the pin registers with the cotter pin hole in the carrier bracket. Fit the cotter pin from the front and secure with a nut and spring washer. Replace the upper and lower swivel pin screw caps.

Reconnect the steering side-tube to the steering-lever.

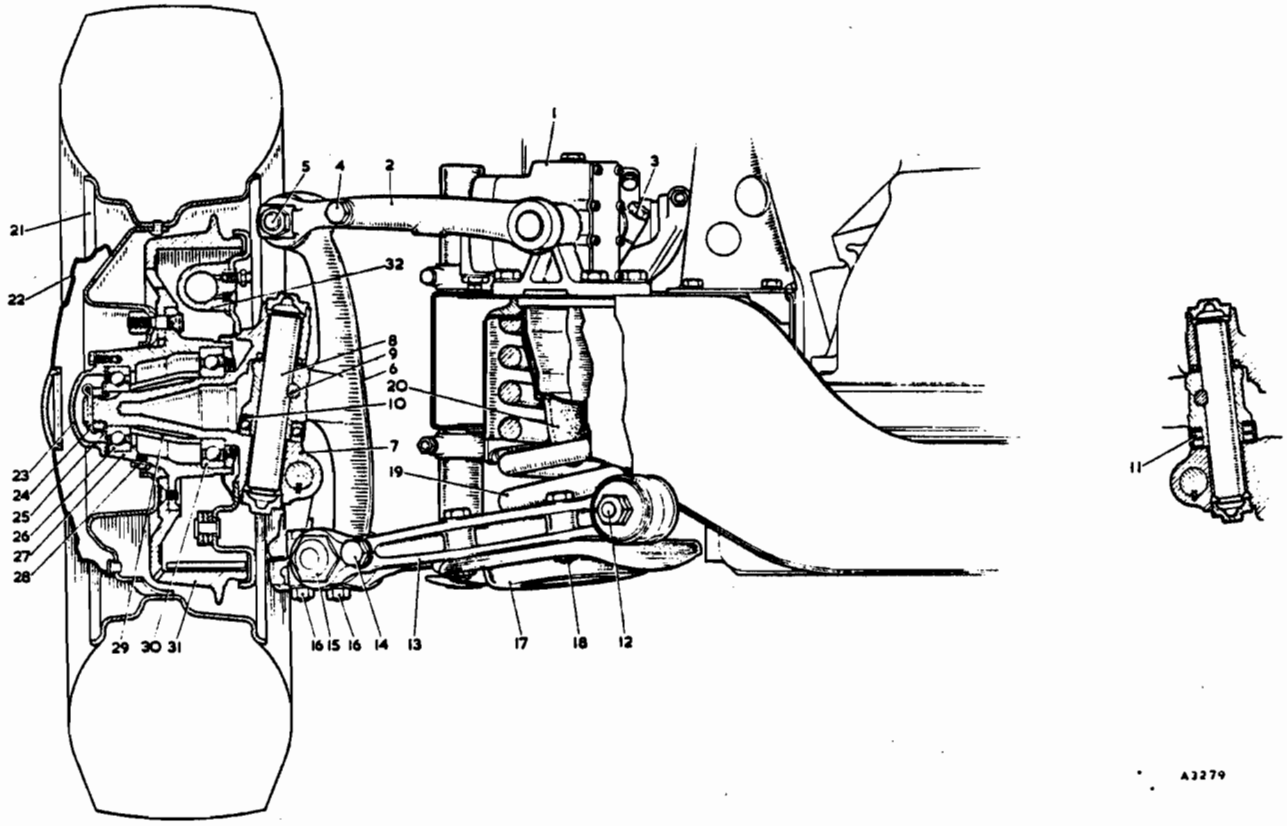

Fig. K.3

A section through the front suspension

1. Hydraulic damper.
2. Upper wishbone—damper arm.
3. Clamp bolt—plain arm.
4. Securing bolt—damper arm.
5. Upper fulcrum pin.
6. Carrier bracket.
7. Swivel axle.
8. Swivel pin.
9. Cotter pin—swivel pin.
10. Ball thrust race—steering side.
11. Thrust washers—opposite steering side.
12. Lower wishbone pivot bracket.
13. Lower wishbone.
14. Securing bolt—lower wishbone.
15. Screwed bush.
16. Clamping bolt—screwed bush.
17. Spring lower plate.
18. Securing bolt—spring plate.
19. Coil spring.
20. Bump rubber.
21. Road wheel.
22. Wheel disc.
23. Hub cap.
24. Nut—swivel axle.
25. Keyed washer.
26. Outer bearing.
27. Hub.
28. Lubrication hub.
29. Distance piece.
30. Inner bearing.
31. Brake-drum.
32. Hydraulic brake cylinder.

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The remainder of the assembly is a reversal of the dismantling procedure.

Bleed the brakes as described in Section M.1.

Section K.4

REMOVING AND REPLACING A SUSPENSION UNIT

Jack up the side of the car from which the assembly is to be removed and remove the road wheel.

Remove the coil spring as described in Section K.2.

Disconnect the steering side-tube and brake hose, and secure the end of the brake hose to a convenient high point on the chassis to prevent unnecessary loss of fluid.

With the suspension unit suitably supported, remove the four bolts holding the lower link bracket to the under side of the frame. Release the four bolts securing the hydraulic damper to the chassis frame and the suspension unit may be lifted clear.

To replace a suspension unit reverse the above procedure. See Section M.1 for correct procedure to adopt when bleeding the brakes.

Section K.5

DISMANTLING AND REASSEMBLING A SUSPENSION UNIT

With the assembly removed from the car, commence dismantling by slackening the clamping bolt securing the rear top wishbone or damper arm to the damper cross-shaft.

Release the nut and bolt securing the two damper arms together.

Knock back the locking tab and unscrew the nut from the top fulcrum pin. Drive out the fulcrum pin to disconnect the carrier bracket from the hydraulic damper.

Remove the two rubber bushes and the distance piece from the top of the carrier bracket.

Release the nut and locknut from the front and rear ends of the lower wishbone pivot bracket and remove the flat washers.

Slacken the two clamping bolts securing the lower wishbone outer bearing and screw out the two threaded bushes. Remove the lower wishbone arm clamping bolt and withdraw both arms. Note the two felt oil seals and retainers fitted between the lower wishbone arms and the swivel carrier bracket. If necessary, the lower fulcrum pin may be withdrawn from the swivel carrier bracket by removing the nut and tapping out the cotter pin.

Withdraw the rubber bushes from the wishbone arms and from the pivot bracket.

The reassembly of a front suspension unit is greatly assisted by the use of assembly and checking fixture 18G95 and checking plate 18G78. This method also ensures that the components are correctly positioned before the bearings are tightened—**most important**; the whole assembly is then easily transferred from the fixture to the car chassis.

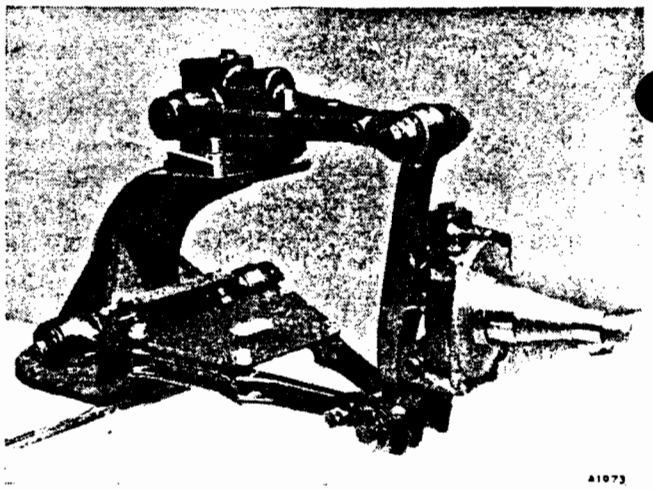

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Fig. K.4

Assembly of a front suspension unit, using fixture 18G95, checking plate 18G78, and a distance piece (A) measuring 1⅜ in. (41·27 mm.) and positioned as shown

Commence assembly by bolting the lower wishbone pivot bracket in position on the fixture.

Replace the screwed fulcrum pin in the swivel carrier bracket and secure with the cotter pin and nut. The oil hole in the fulcrum pin must face towards the rear of the car.

NOTE.—If the assemblies from both sides of the car are being assembled ensure that the correct carrier bracket for the side being worked upon is used as there is a right- and left-hand design.

Place the two felt oil seals and their metal retainers over each end of the fulcrum pin. The felt should face the swivel carrier bracket.

Refit the taper rubber bushes to the inner bearings on the lower wishbone swivel bracket and then place the wishbone arms in position between the swivel axle carrier and the inner pivot bracket.

Screw the two screwed bushes into position on the lower fulcrum pin with the lubricating nipple bush at the rear.

Fit the remaining rubber bushes to the inner pivot bracket, assemble the plain washer, and lightly secure with a nut.

Secure the hydraulic damper to the top of the fixture.

Place two rubber bushes in the bearing at the top of the swivel carrier bracket and loosely assemble the top wishbone arms. Lightly secure the top wishbone arms with the clamping bolt and insert the upper fulcrum pin, ensuring that the head of the pin registers correctly with the locking groove in the front wishbone arm.

The suspension assembly is now complete and ready for tightening, but first the assembly must be arranged in the normal load position. This position is obtained by placing a distance piece measuring 1·625 in. (41·27 mm.) in height between the top of the checking fixture and the under side of the front upper wishbone arm.

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Place the checking plate 18G78 in position on top of the lower wishbone arms, locating the four pegs in the spring seat fixing holes.

First tighten the top and bottom wishbone arm clamping bolts and then tighten the two nuts at the front and rear of the lower wishbone inner pivot bracket and lock with two locknuts. Tighten the upper fulcrum pin nut and lock in position by bending the tab washer over one of the flats of the nut. Tighten the rear top wishbone damper arm to the damper cross-shaft.

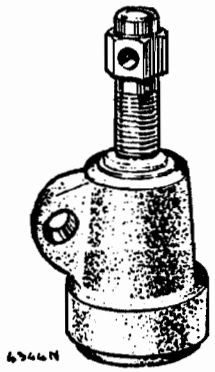
Finally, tighten the two screwed bushes of the lower fulcrum pin until tight and then screw them back one-eighth to one-quarter of a turn. Secure the screwed bushes by tightening the clamping bolts.

The assembly may now be removed from the checking fixture and assembled complete to the car.

SERVICE TOOLS

18G8. Hub Assembly Remover (basic tool)

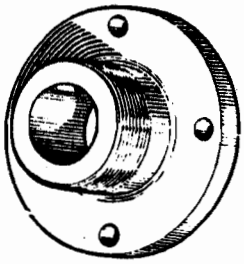
The remover is threaded for attachment to the hub and the end of the centre screw is provided with a hardened-steel ball to reduce friction when engaging the stub axle. Provision is also made for the use of a tommy-bar to prevent the tool turning in operation.



18G8

18G8E. Front Hub Remover Adaptor

This adaptor has an external thread so that it can be screwed in and used with basic remover 18G8.



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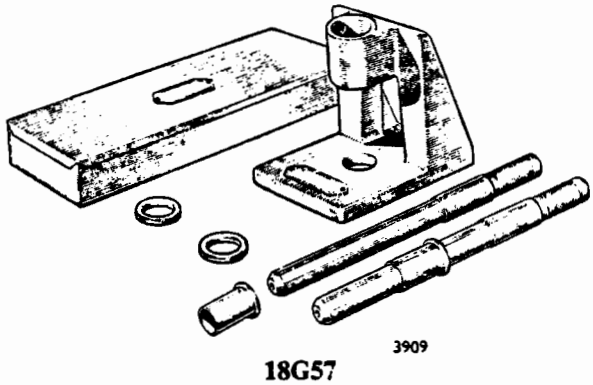
18G8E

18G57. Swivel Axle Bush Remover and Replacer

This tool enables the swivel axle bushes to be removed and fitted without the distortion which would occur if an improvised drift were used. The shoulder of the driver is recessed to prevent the split bushes from opening when being pressed into position. The tool must be used with a press.



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18G57

18G68. Swivel Axle Bush Reamer Wrench

For use with reamer 18G71, the weight of this wrench has been carefully determined to ensure that the reamer will pass through the bushes during rotation without any undue pressure by the operator.

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18G68

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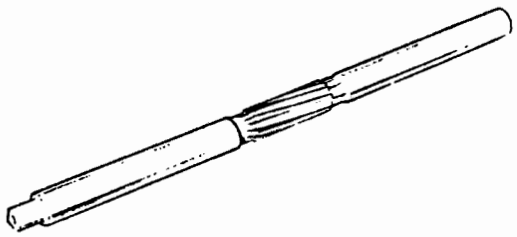
18G71. Swivel Axle Bush Reamer

This hand reamer has been designed to pilot in one bush while the other is being reamed. thus ensuring that the holes are directly in line.

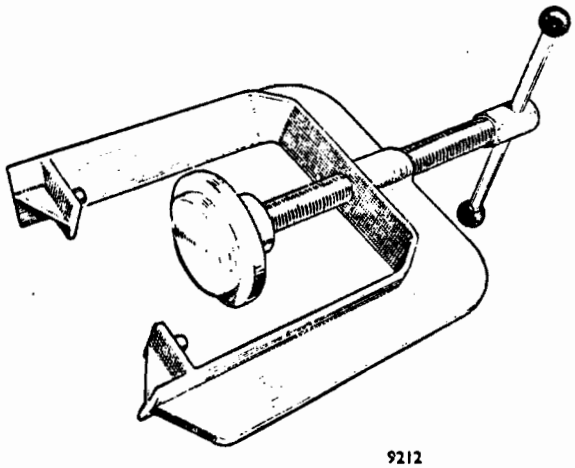


5337

18G71

18G76. Front Suspension Spring Compressor

The spring compressor thrust pad is ball-mounted to assist in lining up the spring and spring seat.



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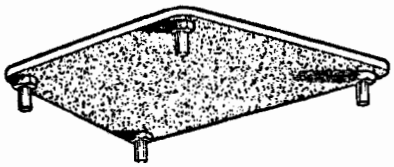
18G76

18G78. Front Suspension Checking Plate

The checking plate has four pegs which are precision-made and accurately positioned to enable the lower wishbone arms to be correctly aligned when assembling the suspension unit.



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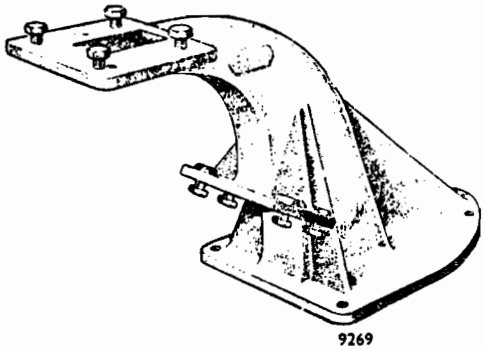
18G78

18G95. Front Suspension Assembly Fixture

Designed to serve the dual purpose of accurately assembling a front suspension unit for fitting as a replacement to a vehicle. and also as a means of checking a unit suspected of damage or misalignment. Checking plate 18G78 must be used in conjunction with this tool.



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18G95

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SECTION L

THE HYDRAULIC DAMPERS

	Section
General description	
Maintenance	
Front damper—removing and replacing	L.3
Rear damper—removing and replacing	L.4
Testing	L.1
Topping up with fluid	L.2

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GENERAL DESCRIPTION

The hydraulic dampers are of the Armstrong double-acting type, resistance being offered to both the compression and rebound of the road springs.

All working parts are submerged in oil and no adjustment is required or provided for. The dampers are carefully set at the Factory, using special equipment, and their design is such that they are capable of giving long service without attention other than the periodic checking and replenishment of the fluid.

A torsion type anti-roll bar, mounted transversely, is fitted to the rear suspension. The bar interconnects the rear dampers, each end of the bar being firmly attached to the damper lever arm.

MAINTENANCE

The hydraulic dampers should be examined for leaks every 1,000 miles (1600 km.), and at the recommended intervals (see **'MAINTENANCE ATTENTION'**) the fluid level should be examined, and topped up if necessary. At the same time, their anchorages to the chassis frame members should be checked and tightened as required.

When examining and replenishing the fluid level the filler plugs and surrounding area must be cleaned thoroughly before removing the plug. **This is most important as no foreign matter should be allowed to enter the operating chamber.**

Only Armstrong Super (Thin) Shock Absorber Fluid No. 624 should be used, but if this fluid is not available any good-quality mineral oil to Specification S.A.E. 20/20W may be used. **It should be noted that this alternative fluid is not suitable for low-temperature operation and is also deficient in various other ways.**

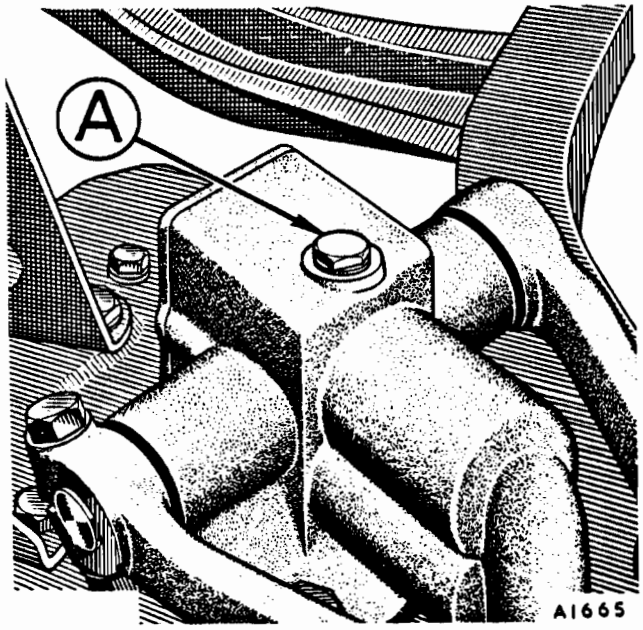

Fig. L.1
The front damper filler plug

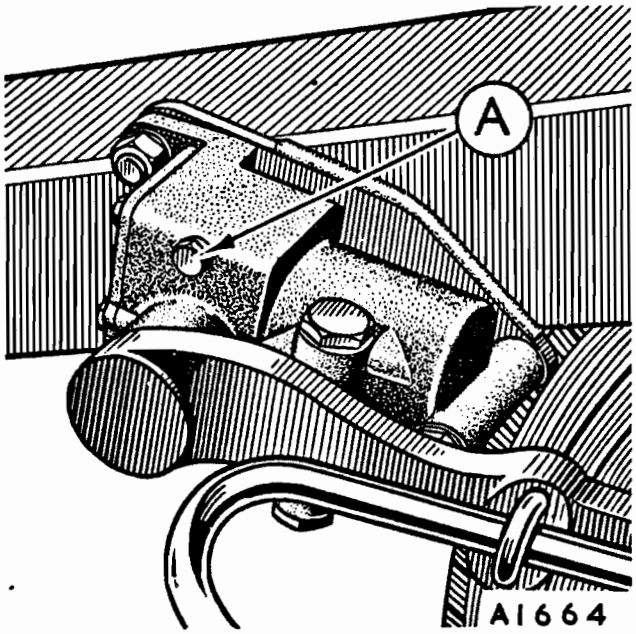

Fig. L.2
The arrow indicates the rear damper filler plug

Section L.1

TESTING HYDRAULIC DAMPERS

When there is any doubt that the road springs are adequately damped the condition of the springs and the tyre pressures should also be considered, as these have an appreciable bearing on the results obtained.

If the hydraulic dampers do not appear to function satisfactorily an indication of their resistance can be obtained by carrying out the following check.

Remove the dampers from the car.

Hold them in a vice and move the lever arm up and down through its complete stroke. A moderate resistance throughout the full stroke should be felt; if, however, the resistance is erratic, or free movement in the lever is noted, lack of fluid is indicated, or there may be air in front of the piston.

If the addition of fluid (added to the level given in Section L.2) and working the arm over its full range of travel a number of times give no improvement a new damper should be fitted.

Too much resistance, i.e. when it is not possible to move the lever arm slowly by hand, indicates a broken internal part or a seized piston; in such cases the damper should be changed for a new or reconditioned one.

If topping up of the damper fluid is necessary due to a leak, clean the exterior of the unit and determine the point from which the fluid is leaking. If the leak is from the lid, tighten down the lid screws and, if necessary to make an effective seal, renew the lid gasket. If the leak is from the valve plug, gently tighten the plug or, if necessary, renew the plug washer. Take care not to overtighten the plug.

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A squeak from the valve mechanism can often be silenced by removing the valve assembly from the damper and turning the valve about its spindle until a different seating position is obtained. Care must be taken to replace the valve assembly exactly as removed, except for the new seating position, and to ensure that no dirt is introduced into the damper. To prevent unnecessary loss of fluid when the valve is removed ensure that the car is not moved in any way.

A new valve assembly must be fitted if this procedure does not effect a cure.

Section L.2

TOPPING UP WITH FLUID

The front dampers may be replenished in position, provided the tops have been thoroughly cleaned to ensure that when the filler plug is extracted no dirt falls into the filler orifice.

This is most important, as it is absolutely vital that no dirt or foreign matter should enter the operating chamber.

The rear dampers should be removed from the vehicle as described in Section L.4.

The use of Armstrong Super (Thin) Shock Absorber Fluid No. 624 is recommended. (If this fluid is not available any good-quality mineral oil to Specification S.A.E. 20/20W should be used, but this alternative is **not** suitable for low-temperature operation.)

Fluid should be added to the level of the bottom of the filler plug hole.

Section L.3

REMOVING AND REPLACING A FRONT DAMPER

Jack up the front of the car and remove the appropriate road wheel.

NOTE.—The left-hand front wheel has left-hand-threaded nuts.

Place a stand under the lower plate of the suspension unit coil spring and lower the jack until the rebound buffer on the chassis is clear of the damper lever arm.

Knock back the locking tab and unscrew the nut from the swivel axle carrier upper fulcrum pin. Tap out the pin.

Unscrew the nut and spring washer from the damper arm clamping bolt and remove the bolt. Slacken also the bolt clamping the damper rear arm to the spindle.

Remove the four set bolts attaching the damper to the front suspension cross-member and withdraw the damper, springing the lever arms apart slightly to release them from the swivel pin upper trunnion bushes.

When handling dampers that have been removed from the car it is essential to keep the assemblies upright as far as possible, otherwise air may enter the operating chamber, resulting in free movement.

Replacement is a reversal of the removing procedure, but **before** fitting the upper fulcrum pin, work the damper arms a few times through their full travel to expel any air which may have found its way into the operating chamber.

Section L.4

REMOVING AND REPLACING A REAR DAMPER

Jack up the rear of the car, support the rear axle, and remove the appropriate road wheel.

Unscrew the nuts from the bolt and 'U' bolt securing the anti-roll bar to the arm of the damper to be removed.

Remove the three nuts and spring washers from the bolts securing the damper body to the main frame and withdraw the bolts.

Detach the link at the rear axle anchor bracket end and withdraw the damper complete with arm and link.

When handling dampers that have been removed from the vehicle for any purpose it is important to keep the assemblies upright as far as possible, otherwise air may enter the operating chamber, resulting in free movement.

Replacement of the dampers is carried out by reversing the above procedure, but before fitting the damper arm link to the rear axle anchor bracket it is advisable to work the damper arm through its full range of movement several times to expel any air which may have found its way into the operating chamber.

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SECTION M

THE BRAKING SYSTEM

Description	Section
Fault diagnosis	M.6
Front brakes	M.3
Maintenance	M.1
Master cylinder	M.2
Rear brakes	M.4
Vacuum servo unit	M.5

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DESCRIPTION

The Lockheed brake equipment consists of a vacuum servo-assisted hydraulic system used in conjunction with 12 in. (30·48 cm.) diameter by 3 in. (7·62 cm.) wide leading- and trailing-shoe brakes.

Each front brake incorporates a single, differential area wheel cylinder designed to apply a considerably greater thrust to the trailing shoe than to the leading shoe. In this manner compensation for the inherent geometrical inefficiency of the trailing shoe is provided and the rate of lining wear on both shoes is substantially equal. The rear brake assemblies are also of the leading and trailing-shoe type but incorporate a conventional sliding wheel cylinder designed to permit operation of the shoes by either the foot or hand brakes. Both front and rear brakes are manually adjustable, two adjusters being provided at each front brake and one only for each rear brake.

The master cylinder conforms with normal Lockheed practice but operates the brake through a tandem vacuum servo unit, deriving its power from atmospheric pressure and from the vacuum existing in the inlet manifold. It is possible to apply the brakes by direct unassisted pedal effort if the servo unit is inoperative.

Section M.1

MAINTENANCE

Should it be found necessary to dismantle any part of the braking system, scrupulous cleanliness is essential. Do not handle the internal parts of hydraulic units with dirty hands. After dismantling, place all metal parts in a tray of clean Lockheed fluid; then dry off with a clean, fluffless cloth and lay out in order on a sheet of clean paper. In general, it is advised that all rubber parts be replaced, and the use of a repair kit, which contains all of the rubber components for any particular unit, is strongly recommended.

Large components such as master cylinder and wheel cylinder bodies which are exposed to road grit and mud may, following dismantling, be swilled in any of the normal cleaning solvents such as trichlorethylene, but it is imperative that all traces of such solvents are removed prior to reassembly.

Immediately prior to reassembly dip all internal parts, including rubber ones, in clean brake fluid to provide initial lubrication and to facilitate assembly.

Periodically check the fluid level in the supply tank and replenish if necessary, to bring the level within 1 in., (2·54 cm.) of the filler cap. Take care not to spill fluid on the bodywork of the car, since it is injurious to paint.

The addition of fluid should only be required at long intervals. A considerable fall in the level is indicative of external leakage which must be traced and corrected immediately. To check for leaks apply firm pressure to the brake pedal, with the engine running, whilst an assistant examines the units, pipes, hoses, and fittings.

Bleeding the system

Bleeding the system (or expelling air) is not a routine operation and should only be necessary if air has been allowed to enter, e.g. during the servicing of a unit or the replacement of a flexible hose.

The following procedure should be adopted:

(1) Pump the brake pedal a number of times to destroy the vacuum in the servo unit, thereby ensuring that it does not operate during subsequent operations.
(2) Fill the supply tank with clean Lockheed fluid and maintain at least one-quarter full throughout the operation.
(3) Attach a rubber tube to the bleeder screw on one of the front wheel cylinders and allow the free end to be submerged in a little brake fluid in a clean glass jar. Open the bleeder screw one complete turn.
(4) Depress the brake pedal slowly, allowing it to return unassisted, repeating this pumping action, with a pause between each operation, until the flow of air bubbles into the glass jar ceases. Then press the pedal down whilst an assistant tightens the bleeder screw.
(5) Repeat these operations at the remaining front and rear wheel cylinders and finally, replenish the supply tank until the fluid level is within 1 in. of the top. **Use genuine Lockheed fluid or, if this is not available, any other fluid which conforms to Specification S.A.E. 70.R3.**

Relining brake-shoes

When relining the brake-shoes the same make and quality of lining specified for original equipment on the model must be used, otherwise the performance of the braking system may be seriously impaired.

NOTE.—Brakes should always be relined in axle sets.

To enable this to be accomplished in the easiest and most economical manner advantage should be taken of the Exchange Shoe Scheme, particulars of which will be forwarded by the Service Department.

NOTE.—This scheme only applies to the U.K.

If new linings are being fitted by the operator it is essential that they fit the shoes snugly. If this is not the case brake squeal and long brake pedal travel may result. It is also advised that the linings are ground to the correct radius after riveting to reduce the bedding-in period to a reasonable level. Both of these requirements are satisfied when Exchange Shoes are used.

Adjusting the brake-shoes

Front brakes

Jack up the wheel until it is free to revolve and then turn one of the two hexagonal-headed adjusters on the rear of the backplate in the direction shown in Fig. M.5 until the wheel is locked. Then turn back the minimum amount to free the wheel. Carry out the same operations on the other adjuster. Spin the wheel in a forward direction and, while it is spinning, apply the foot brake sharply to centralize the brake-shoes in the drum. Repeat the adjustment procedure. Adjust the brakes on the opposite front wheel in the same manner.

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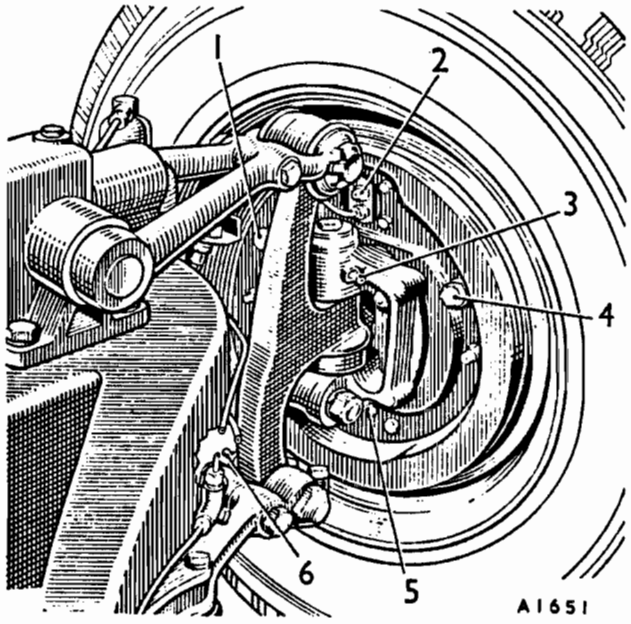

Fig. M.1

The lubrication and brake adjustment points (front wheel)

1. Brake adjuster.
2. Brake bleed nipple.
3. Swivel top nipple.
4. Brake adjuster.
5. Swivel lower nipple.
6. Outer fulcrum nipple.

Rear brakes

Release the hand brake. Jack up the rear of the vehicle until a back wheel is free to revolve. Turn one wheel in a forward direction and, while it is being turned, apply the foot brake sharply to centralize the brake-shoes in the drum. Rotate the wheel until the adjuster hole is above the Micram adjuster. Using a screwdriver, turn the adjuster **clockwise** until the wheel is locked and then back off the minimum number of notches to free the wheel. Repeat these operations at the other rear wheel (see Fig. M.2).

Hand brake

The hand brake linkage is set accurately before the car leaves the Works, and consequently should not require any further attention apart from oiling at the various joints and where nipples are provided.

Pedal adjustment

This is set when the vehicle is manufactured and should not need adjustment. If the adjustment has been disturbed reset the length of the rod connecting the master cylinder push-rod to the pedal so that the pedal can be depressed $\frac{3}{8}$ to $\frac{1}{2}$ in. (9·52 to 12·7 mm.) before the piston commences to move. This free play can readily be determined if the pedal is depressed by hand.

NOTE.—An incorrectly positioned floor-mat or floorboard may foul the pedal, preventing its complete return to the 'off' position, and may take up this free play when adjustment is actually correct.

Section M.2

MASTER CYLINDER

Description

The $\frac{7}{8}$ in. bore master cylinder has an integral fluid reservoir and is connected to a further supply tank to provide an additional reserve of fluid and to facilitate inspection of the fluid level.

The main body of the unit is an iron casting and has a highly finished bore to receive the working parts. The bore contains a steel piston fitted at one end with a secondary cup which serves to prevent the egress of fluid and the ingress of air. A return spring loads the rubber main cup against the head of the piston and a thin washer is interposed between the cup and the piston to support the cup over the six transfer ports which are drilled in the piston head. The piston is retained in the bore, against the load of the return spring, by a stop washer and circlip; a rubber boot prevents the ingress of foreign matter and water.

Situated in the end of the cylinder bore is the check valve assembly; it serves primarily to impose a measure of restraint to the rate at which fluid can enter the barrel on the return stroke of the piston and thereby facilitates the operation of bleeding the brakes. Unlike normal Lockheed check valves, the design incorporated in this unit does not preserve a small residual pressure in the system when the brakes are released, since a small hole is provided in the pressed valve body to place both sides of the assembly in communication with one another. The normal residual line pressure is intentionally absent since its presence may affect complete release of the vacuum servo unit.

Removing and dismantling

Drain the fluid from the master cylinder by opening a bleeder screw on one of the brake assemblies and then pumping the pedal until fluid ceases to issue.

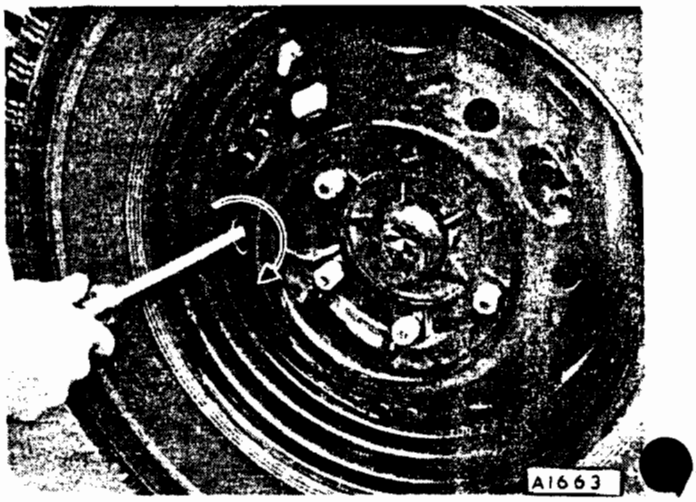

Fig. M.2

Access to the rear brake adjusting screw is gained through one of the holes in the wheel

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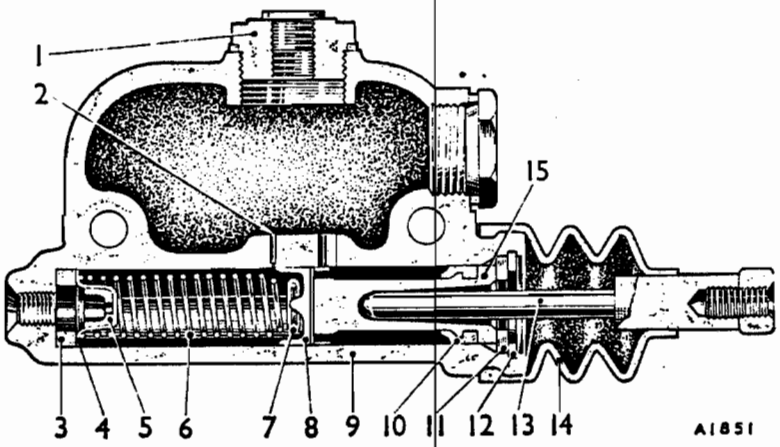
Fig. M.3

A sectional view of the master cylinder

*1.	Filler cap.	9.	Body.
2.	By-pass port.	10.	Secondary cup.
3.	Rubber washer.	11.	Piston stop.
4.	Valve body.	12.	Circlip.
5.	Rubber cup.	13.	Push-rod.
6.	Return spring.	14.	Rubber boot.
7.	Retainer.	15.	Piston.
8.	Rubber cup.		

* The plug depicted in the centre of the filler cup is not used when the cylinder is fitted to the vehicle. Its place is taken by the pipe connection to the supply tank.



Detach the pipes from the unit and detach the unit from its mounting on the vehicle.

Push the piston partially down the bore, remove the circlip, and collect the internal parts. Ease the secondary cup off the piston and remove the rubber valve cap from the valve body. With a hooked piece of brass wire withdraw the valve seal from the base of the cylinder bore.

Assembling and refitting

Ease the secondary cup onto the piston, paying close attention to Fig. M.3 to ensure correct assembly. Press the valve seal down the cylinder bore, fit the valve cup into the valve body, and insert the assembly into the cylinder, followed by the main cup. Position the piston washer on the cup, ensuring that its **concave** face is adjacent to the cup. Ease the piston into the cylinder and fit the stop washer and circlip.

Mount the unit on the chassis, reconnect the pipes, and adjust the push-rod to ensure that there is $\frac{3}{8}$ in. (9·6 mm.) free travel at the brake pedal pad before the push-rod contacts the piston. Failure to provide this clearance will result in dragging brakes.

Fill the supply tanks with clean Lockheed fluid (Specification S.A.E. 70.R1), and bleed the brakes in the manner already described.

Section M.3

FRONT BRAKES

Description

In a normal leading- and trailing-shoe design the drag of the leading shoe is at least twice the drag of the trailing shoe since, in pivoting at its trailing end, it enjoys a considerable measure of self-energization which augments the thrust of the wheel cylinder.

In this design a differential area wheel cylinder is provided; it contains a small piston of ·80 in. (20·3 mm.) diameter to operate the leading shoe and a larger 1·25 in. (31·75 mm.) diameter piston to operate the trailing shoe. In consequence, the difference in shoe efficiencies is compensated for by applying a greater thrust to the trailing shoe, and the rate of lining wear is substantially equal.

Each wheel cylinder contains a spring-loaded plunger to deter brake judder by providing a controlled, resilient member within the system to absorb vibrations.

Two slots are formed in each shoe between the shoe web and platform to reduce the likelihood of brake squeal.

Since the leading and trailing shoes are dimensionally interchangeable, identification plates are attached to them to avoid incorrect assembly.

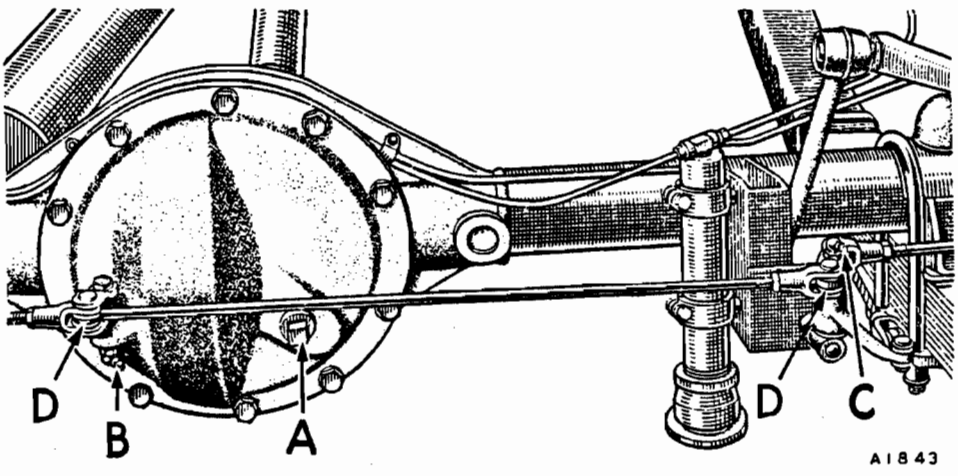


Fig. M.4

The hand brake balance lever

A. Rear axle filler plug.
B. Lubrication nipple.
C. Balance lever lubrication nipple.
D. Clevis pins.

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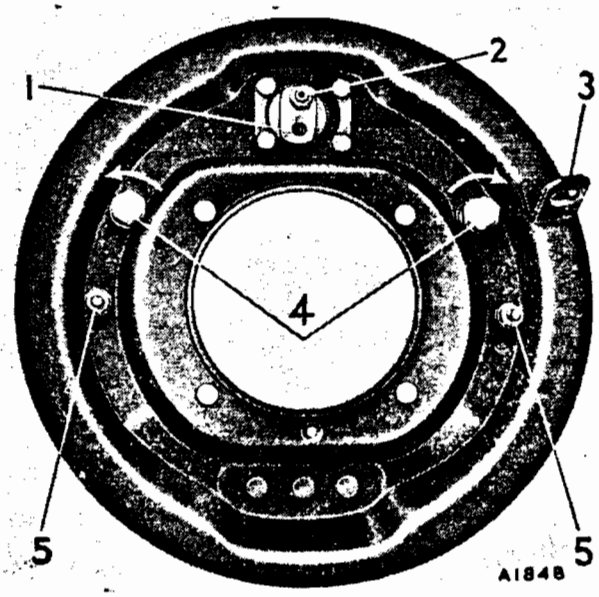

Fig. M.5

A front brake backplate

1. Brake pipe connection.
2. Bleed screw.
3. Brake hose bracket.
4. Shoe adjuster.
5. Brake-shoe steady posts.

Each front brake-shoe is provided with its own adjuster. This takes the form of a frictionally loaded cam, mounted in the backplate, which abuts a striker pin attached to the shoe.

The leading and trailing tips of each shoe are located within slots in the wheel cylinder pistons and in the abutment, this latter component consisting of a sandwich of steel plates riveted securely to the backplate. To ensure that the shoes are square relative to the backplate adjustable steady posts are provided.

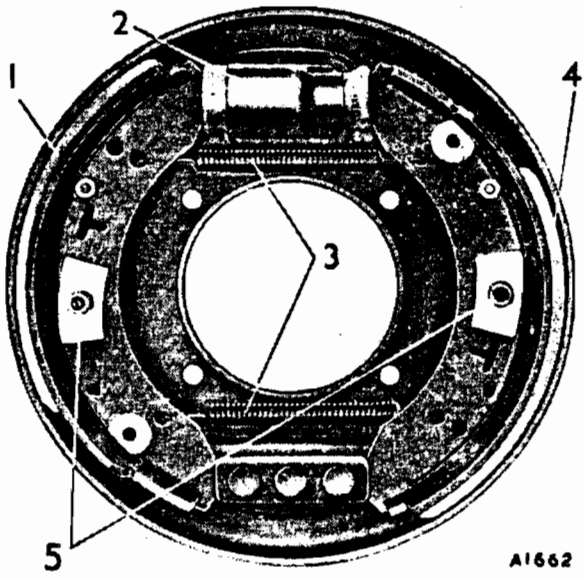

Fig. M.6

A front brake assembly

1. Trailing shoe.
2. Differential wheel cylinder.
3. Pull-off spring.
4. Leading shoe.
5. Steady posts.

Dismantling

Back off the adjusters to their full extent and remove the wheel and drum.

Unlock and remove the locknuts on the steady posts, lever one of the shoes from its location in the abutment, and then release the tension, whereupon the shoes will fall away.

The internal parts of the wheel cylinder can be withdrawn without removing the cylinder body from the backplate, but if the body is in any way defective, it must, of course, be removed, following detachment of the hose, and a replacement fitted. Disengage the larger rubber boot from the piston end and the wheel cylinder body; withdraw the piston end, the spring, and the piston pin.

Remove the other boot from the smaller piston and the body, and push the piston through the bore to expel the larger piston, the cup, the cup filler, and the taper spring. Ease the tapered seal from the groove in the smaller of the two pistons, using a small screwdriver or a scriber. Once removed, the seal must not be used again (see Fig. M.7).

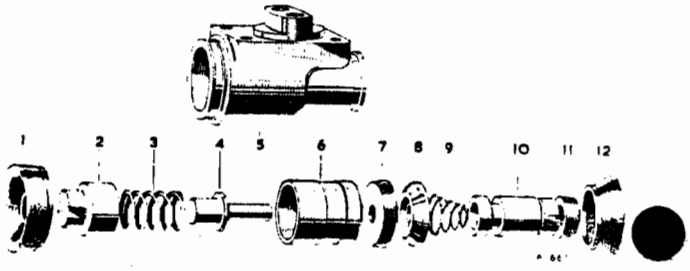

Fig. M.7

A front wheel cylinder (exploded)

1. Rubber boot.
2. Piston end.
3. Spring.
4. Piston pin.
5. Wheel cylinder body.
6. Large piston.
7. Piston cup.
8. Cup filler.
9. Taper spring.
10. Small piston.
11. Taper rubber seal.
12. Rubber boot.

Assembling

If the wheel cylinder has been dismantled, commence assembly by attaching the wheel cylinder body to the backplate, using the two locking plates and four set screws. Bend up the tabs of the locking plates to ensure security of the screws, and note particularly that the smaller end of the wheel cylinder body must face in the direction of forward drum rotation.

Fit the larger end of the tapered coil spring into the plastic cup filler and insert these parts, spring leading, into the larger end of the body. Follow up with the large rubber cup, lip foremost, insert the piston, flat face leading, and pass the stem of the piston pin through the piston, cup, and cup filler. Locate the coil spring on the piston pin and fit the slotted piston end and the rubber boot.

Ease the tapered seal into the groove in the small piston ensuring that its larger end is pointing **away from** the slotted end of this piston. This is most important. Insert the piston into the body, with the slotted end outermost, taking care to ease the seal past the edge of the bore. Stretch the smaller rubber boot onto the piston and the body.

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Locate one of the large oblong washers on each steady pin, engage one end of the pull-off spring in the hole adjacent to the identification plate in the leading shoe and the other end of the innermost of the pair of holes in the trailing shoe, paying attention to Fig. M.6 to ensure correct assembly and noting that the spring passes **underneath** the shoes.

Offer up the two shoes and spring to the backplate, engaging them in the slots in the wheel cylinder pistons. Locate the trailing tip of the leading shoe in the abutment, hook the remaining pull-off spring into the inner hole of the leading shoe and into the single hole adjacent to the identification plate in the trailing shoe. Then lever the trailing shoe outwards to engage it within the abutment.

Adjust the steady posts until the shoes are square and then tighten the locknuts on the rear face of the backplates. Fit the remaining large oblong washers on the steady posts, followed by the nuts and locknuts. Tighten the nuts until the large washers are in contact with the shoe; then slacken the nuts one-eighth of a turn and tighten the locknuts.

Reconnect the flexible hose to the wheel cylinder and fit the brake-drum and wheel; adjust and bleed the brakes in the manner described.

Section M.4

REAR BRAKES

Description

Each assembly incorporates a wheel cylinder which is free to slide within a slot in the backplate; thus, although the wheel cylinder is only single-ended, equal thrusts are given to each of the two shoes. The wheel cylinder may be operated either hydraulically by the foot brake or mechanically by the hand brake (see Fig. M.9).

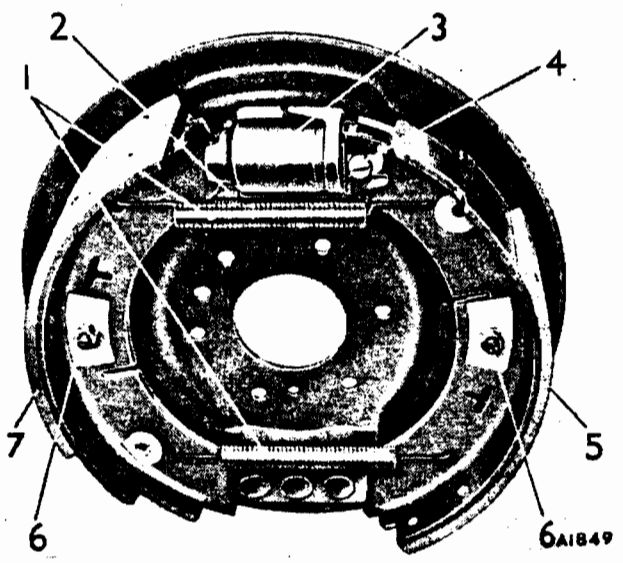

Fig. M.8

A rear brake assembly

1. Pull-off spring.
2. Bias spring.
3. Wheel cylinder.
4. Micram adjuster.
5. Leading shoe.
6. Steady posts.
7. Trailing shoe.

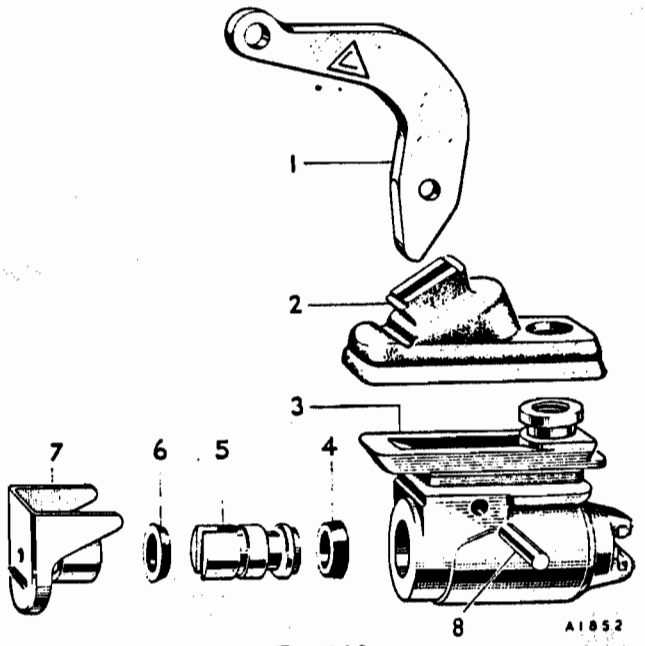

Fig. M.9

A rear wheel cylinder (exploded)

1. Lever.
2. Rubber boot.
3. Body.
4. Tapered rubber seal.
5. Inner piston.
6. Taper rubber seal.
7. Outer piston
8. Pivot pin.

A single Micram adjuster is provided, consisting of a serrated cam which is interposed between the tip of the leading shoe and the wheel cylinder piston. It is turned with the aid of a screwdriver passed through a hole in the brake-drum and is effective on both shoes due to the fact that the wheel cylinder is free to slide.

Both the shoes and the linings are identified in the same manner as the front brakes. Front and rear brake-shoes are not interchangeable.

A slot is cut into the web of each rear brake-shoe to serve as a deterrent to brake squeal.

Dismantling

Unlock and remove the nuts on the trailing shoe steady post and lever the shoe from the slots in the wheel cylinder and the abutment; then remove the other shoe.

If it is desired to dismantle the wheel cylinder, disconnect the hand brake linkage from the lever and detach the pipe. Pull the boot of the wheel cylinder and withdraw the outer piston. Fig. M.9 shows the cylinder in exploded form.

Slide the wheel cylinder forward in the backplate; then, pivoting it about its forward end, withdraw it from the slot in the backplate.

Push out the hand brake lever pivot pin, remove the hand brake lever, and expel the hydraulic piston by applying a gentle air pressure to the inlet connection. Ease the seals from the grooves in the pistons and discard them.

Assembling

Ease the tapered seal into the groove in the hydraulic piston, noting that it must be assembled with its larger diameter facing towards the flat end of the piston. **This is most important.**

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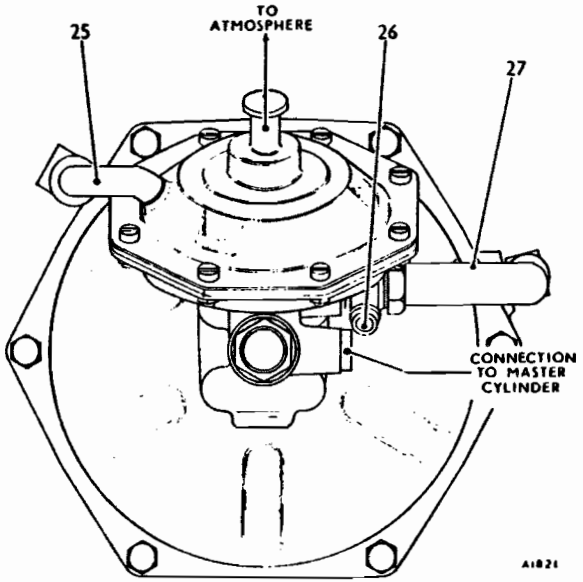
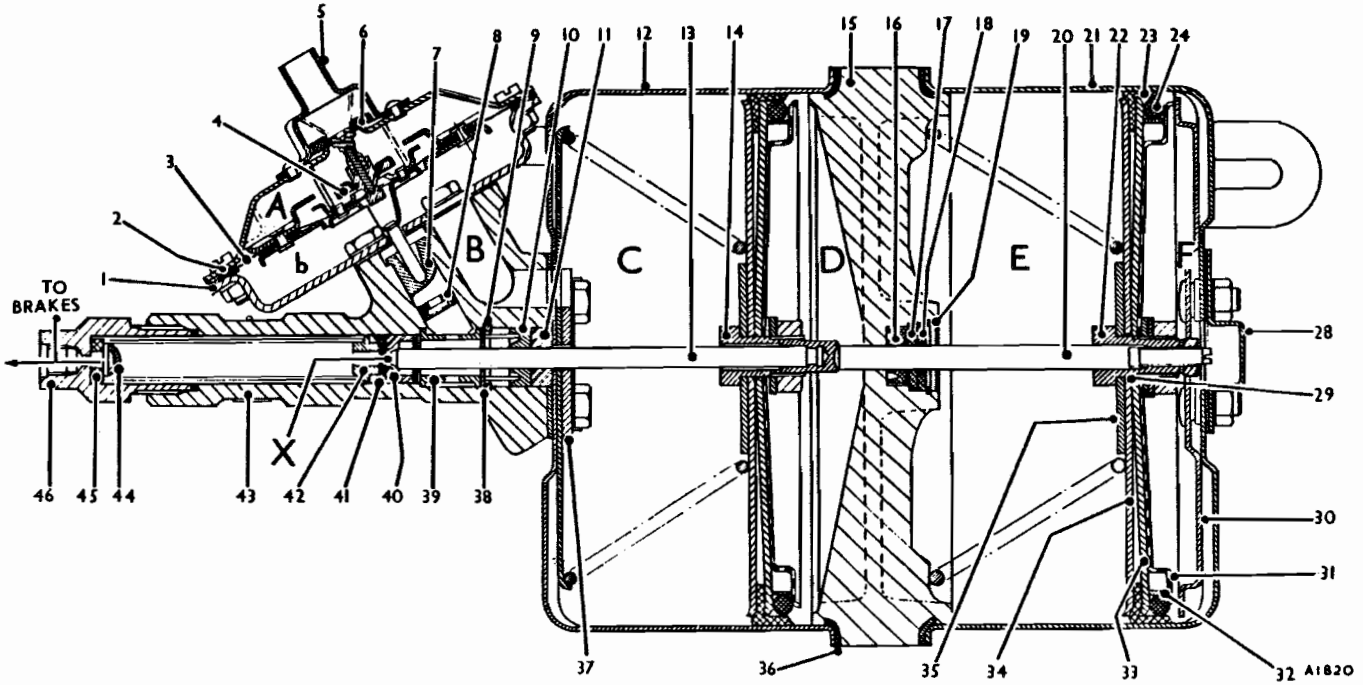
Fig. M.10

The tandem vacuum servo

1. Valve housing.
2. Valve cover.
3. Diaphragm assembly.
4. Valve.
5. Control valve cover.
6. Valve.
7. Air valve piston.
8. Seal.
9. Circlip.
10. Cap.
11. Spigot.
12. Vacuum cylinder (front).
13. Push-rod.
14. Hexagon.
15. Centre-piece.
16. Oil seal.
17. Lubrication.
18. Washer.
19. Circlip.
20. Push-rod.
21. Vacuum cylinder (rear).
22. Hexagon.
23. Piston leather.
24. Felt wick.
25. Connecting pipe.
26. Inlet manifold connection.
27. Connecting pipe.
28. End cap.
29. Seal.
30. End stop.
31. Retainer.
32. Wick retainer.
33. Piston plate.
34. Piston plate.
35. Locating washer.
36. Joint.
37. Plate.
38. Washer.
39. Distance piece.
40. Piston.
41. Rubber cup.
42. Spring retainer.
43. Slave cylinder.
44. Check valve.
45. Seal.
46. Adaptor.





Insert the piston into the cylinder, aligning the slotted end as shown on the drawing. Insert the hand brake lever and fit the pivot pin.

Engage the forward end of the cylinder within the slot in the backplate and slide it well forward; engage the rear end in the slot and slide it back to retain it within the slot. Fill the open end of the cylinder and the space around the hand brake lever with Lockheed Rubberlube Grease and fit the rubber boot. Ease the seal into the groove in the outer piston, again referring to the drawing to ensure correct assembly; then insert the piston into the cylinder.

Connect the linkage to the hand brake lever and fit the pipe. Place one of the large oblong washers on the leading shoe steady post. Mount the Micram adjuster and mask within the tip of the leading shoe and offer up the shoe to the backplate, engaging the mask with the ear formed on the piston dust cover. Fit the other large oblong washer and one of the two locknuts in order to retain the shoe in position. Fit an oblong washer to the trailing shoe steady post. Attach the long end of the bias spring to the lug positioned below the tip of the leading shoe. Connect one of the pull-off springs to the hole adjacent to the identification plate in the leading shoe, noting that the spring must lie **on top** of the shoe web. Offer up the trailing shoe; engage its **plain** end within the slot in the wheel cylinder. Connect the bias and pull-off springs to it, noting that the bias spring is fitted behind the shoe web and that both springs are connected to the same hole in the trailing shoe. Fit the remaining pull-off spring and lever the leading tip of the shoe outwards to engage it within the slot in the abutment. Fit the remaining oblong washer and the nuts to the steady post. Tighten the nuts on both steady posts until they nip the washers, slacken back one-eighth of a turn, and secure with the locknuts. Then slacken the locknuts on the other side of the backplate and adjust the steady posts until the shoes are square, after which the locknuts should be securely tightened.

Fit the drum, adjust and bleed the brakes as previously described, and replace the wheel.

Section M.5

VACUUM SERVO UNIT

Description

The tandem vacuum servo is a unit which provides the driver with a degree of assistance when applying the brakes, and is installed in the line between the master cylinder and the brake assemblies; power for its operation is supplied by atmospheric pressure and by vacuum from the engine inlet manifold. The unit consists mainly of two booster pistons mounted in tandem, a slave cylinder, and a control valve.

With the servo in the released condition the pistons are held off by means of springs, and whatever degree of vacuum exists in the engine inlet manifold is also present on each side of the booster pistons.

When the brake pedal is depressed fluid pressure created by the master cylinder causes the control valve to admit atmospheric pressure which acts upon the rear face of the pistons and drives them forward, so boosting the pressure within the slave cylinder and assisting the driver in applying the brakes.

Principle of operation

When the servo is at rest the valve piston (7) (page M.7) and the diaphragm (3) are in the normal position; valve (4) is open and valve (6) is closed, the valves being maintained in position by a tapered spring.

The slave cylinder (43) has connected to it a pipe assembly (27) leading to a connection in the centre-piece (15). A banjo connection (26) also communicates the pipe assembly with the engine inlet manifold so that, when the engine is running, vacuum is present within chambers (B) and (C) and also within chamber (E) this latter by way of the pipe (27). Additionally, whatever degree of vacuum exists within chamber (B) will also be transmitted to chamber (A), via the opening in the centre of the diaphragm (3), and to chambers (D) and (F) via the pipe (25).

Upon depressing the brake pedal fluid is displaced from the master cylinder to the wheel cylinders, via the slave cylinder, and passes through the holes in slave piston (40), cup (41), spring guide (42), and the check valve body (46)—the seal on the latter having been lifted from a number of holes through the body. Meanwhile, the fluid pressure generated by the master cylinder is also felt upon the rear face of the valve piston (7), which is displaced against the load of the diaphragm spring; this movement deflects the diaphragm (3) until it bears against the valve (4), and the seal thus formed isolates the suction source from chambers (A) (D), and (F). Continued movement of the piston opens the air valve (b), permitting air to enter chamber (A) and to pass to chambers (D) and (F) via the pipe (25).

This reduction in the degree of vacuum causes the vacuum pistons to move forward, the thrust of the rearward piston being transmitted through the push-rod (20); this causes the push-rod (13) to move nearer to the cup (41) and to seal off the hole in its centre, thus creating a locked 'line' of fluid to the brakes; continued movement of the pistons increases the pressure in the slave cylinder and the brake line, thereby assisting the driver in applying the brakes. The reduction of vacuum is, of course, also apparent within chamber (A), resulting in the creation of a pressure difference across the diaphragm in opposition to the force applied by the master cylinder pressure to the piston (7); when these opposing forces balance, the rearward deflection of the diaphragm allows the outer valve to close onto its seat and prevent further entry of air.

Greater effort upon the brake pedal increases the thrust upon the piston (7), which reopens the outer valve and allows a greater amount of effort to be performed by the vacuum pistons; when the opposing forces on the diaphragm are once more in balance the air valve will again close onto its seat. It will be apparent,

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therefore, that the diaphragm acts as a 'proportioning' device, ensuring that the performance of the servo is substantially progressive.

When the brake pedal is released pressure is removed from the valve piston (7), allowing the diaphragm spring to push the diaphragm back to its original position and thereby reconnecting chambers (A), (D), and (F) to the manifold. The springs are then able to return the vacuum pistons and slave cylinder piston to the 'off' position, causing the push-rod (13) to move away from the cup in the slave cylinder and so permit the fluid, which is under load from the brake-shoe pull-off springs, to lift the check valve body off its seat and return from the brakes to the master cylinder.

When the pressure in the brake 'line' drops to a predetermined value the check valve body resumes its seat, due to the spring loading, so trapping the residual pressure between the servo and the brake assemblies. This pressure, whilst not sufficient to cause brake drag, ensures that the wheel cylinder piston seals are kept in close contact with the cylinder bores, hence precluding the entry of air into the system.

Dismantling

Ease the two pieces of flexible hose away from the joints in the pipes. Remove the eight screws to detach the control valve cover (5) and collect the diaphragm, gasket, and spring; the valves cannot be removed from the cover.

Detach the valve housing (1) from the slave cylinders and expel the piston (7) with a bent piece of brass rod. Remove the seal (8) from the piston.

Scribe lines on the vacuum cylinder shells to ensure correct alignment of the connecting pipes when reassembling, and mark the positions occupied by the larger bolts which held the two shells together. Remove the six nuts to separate the two halves of the vacuum cylinder, taking care to sustain the internal spring load.

Remove from the bore of the aluminium centre-piece (15) the circlip, washer, and felt lubricator; drive out the oil seal. No attempt should be made to unscrew the pipes from the centre-piece.

The two vacuum pistons are of similar construction, but the one fitted to the rear cylinder has an adjustable push-rod, the setting of which controls the space between the slave cylinder piston (40) and the front piston rod (13). This adjustment should not be necessarily disturbed.

Both vacuum piston assemblies are dismantled in the same manner.

Grip the assembly in the vice by the hexagonal part of the centre-piece (22), unscrew the large nut, and lift off the various components.

Similarly, dismantle the other piston assembly.

Detach the slave cylinder (43) from the front vacuum cylinder. Collect the spigot (11), the cup (10), and the coil spring. Unscrew the adaptor (46), and collect the seal (45) and valve assembly (44), the return spring, and the spring retainer (42). Remove the circlip (9) and expel the remaining internal parts with the aid of a pencil inserted through the threaded end of the cylinder bore.

Assembling

Prior to assembly examine all parts and make any necessary replacements. If the bores of the vacuum cylinders are lightly corroded they may be polished with fine emery-cloth and steel wool, but if pitting or scoring is present new parts should be fitted. Soak all rubber parts and the hydraulic pistons in brake fluid before assembly. The wick lubricators should be soaked in S.A.E. 20 oil for 10 hours and allowed to drain for two hours. Ensure that the leather cups for the vacuum pistons are pliable; if not, they should be soaked in S.A.E. 20 oil. Where temperatures below 0° C. (32° F.) prevail use S.A.E. 5 oil for all lubrication purposes.

Commence assembly by engaging the seal (8) within the head of the air valve piston (7); insert the piston into the appropriate bore of the slave cylinder body (43) and then attach the valve housing (1), locate a gasket, the diaphragm assembly (3), and a further gasket on the valve housing, position the coil spring in the diaphragm, and offer up and secure the control valve cover (5).

Position the distance piece (39) in the bore of the slave cylinder and fit the washer (38) and the circlip (9), the coil spring, the cup (10), and the spigot (11). Locate the paper gasket on the spigot, aligned with the holes in the body, offer up the vacuum cylinder (12), followed by the plate (37), and secure the assembly with the locking plate and set screws; bend up the tabs of the locking plate to secure the set screw.

Assemble the oil seal (16), lubricator (17), washer (18), and circlip (19) in the bore of the centre-piece, noting that the oil seal must be assembled with its lipped face leading.

Assemble one of the vacuum pistons by gripping the push-rod in a vice by the hexagonal portion of the centre-piece. Fit the large plain washer and the appropriate of the two piston plates, paying close attention to the drawing to ensure that the correct plate is fitted and that it is facing in the direction shown. Place the piston leather on the plate and pass the rubber ring over the threaded part of the centre-piece. Fit the remaining piston plate and arrange the felt wick within the lip of the leather cup. Bend the spring steel wick retainer into a circle, with the barbs facing outwards; locate the retainer within the wick and engage its forked end within the tab.

Place the end stop on the threaded end of the centre-piece with its raised side downwards and with the cut-away portion over the bent end of the wick retainer. Fit the plain backing washer, the shakeproof washer, and, finally, the nut. Remove the assembly from the vice and deal with the other vacuum piston components in the same manner.

Smear the bores of both vacuum cylinders with S.A.E. 20 oil and insert the assembly which has the adjustable push-rod into the rear cylinder (21), taking care to avoid buckling or turning back the lip of the leather cup. Ensure that the three flexible rubber hoses are in position on their respective pipes and mount the slave cylinder in the vice with the vacuum cylinder uppermost. Locate the return spring within the cylinder and insert the vacuum piston assembly. Locate a paper gasket and the centre-piece of the vacuum cylinder, followed by the

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remaining gasket and the large coil spring. Offer up the rear vacuum cylinder, complete with vacuum piston, ensuring that the push-rod passes cleanly through the oil seal in the centre-piece; fit the six bolts, shakeproof washers, and nuts, and centralize the rubber hoses over the junctions in the pipes.

Insert the piston (40), hollow end leading, into the slave cylinder, and push it down the bore until it contacts the distance piece. Use a depth gauge to measure the distance between the outer face of the piston and the end of the bore, then pass the depth gauge through the hole in the piston and measure the distance between the end of the push-rod (13) and the end of the bore; the difference between these dimensions should be between ·06 in. (1·52 mm.) and ·07 in. (1·78 mm.) (this is the clearance [x] marked on page M.7). If the clearance is not within these limits remove the end cap (28) from the rear face of the servo and, after slackening the locknut, adjust the push-rod (20); when the required clearance is achieved tighten the locknut whilst holding the push-rod against rotation and refit the end cap.

Insert the rubber cup (41) into the bore, flat face first, and position the copper gasket at the end of the bore; locate the spring retainer (42) in the end of the long coil spring and insert the spring into the bore, with the retainer innermost. Push the seal (45) into the adaptor (46), position the check valve (44) on the end of the spring, and screw the adaptor firmly home.

Section M.6

FAULT DIAGNOSIS

Symptom	*No.*	*Possible fault*
(*a*) Excessive pedal travel	1	Excessive shoe clearance.
	2	Air in system.
	3	Excessive clearance between master cylinder push-rod and piston.
(*b*) Pedal goes to floorboards when constant effort is applied	1	Leak past main cup in master cylinder.
	2	External leakage from unit or pipe joint.
	3	Fluid leakage into vacuum cylinder of servo unit.
(*c*) Pedal feels hard	1	Insufficient vacuum from manifold.
	2	Collapsed, restricted, or disconnected vacuum pipe.
	3	Faulty vacuum servo for any of the following reasons: Worn slave cylinder cup. Seized vacuum piston(s). Seized air valve piston. Leaking diaphragm. Choked air filter.
(*d*) Brakes drag	1	Shoe steady posts over-adjusted.
	2	Shoes over-adjusted.
	3	Incorrect adjustment of master cylinder push-rod.
	4	Swollen main cup in master cylinder.
	5	Brake pedal linkage seized.
	6	No clearance between vacuum piston push-rod and slave cylinder piston in servo unit.
	7	Air valve piston seized in servo unit.
	8	Choked flexible hoses.
	9	Seized wheel cylinders.
(*e*) Unbalanced braking	1	Grease or brake fluid on linings.
	2	Choked flexible hose.
	3	Distorted drums.
	4	Linings not correct type.
	5	Tyres incorrectly inflated.
	6	Linings not bedded in.
	7	Suspension or steering faulty.
(*f*) Brakes grab	1	Linings not bedded in.
	2	Grease or brake fluid on linings.
	3	Linings not correct type.
	4	Excessive friction between pistons and cylinder in vacuum servo.

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INDEX

New and revised pages

for

VANDEN PLAS 4-LITRE PRINCESS WORKSHOP MANUAL AKD1499

Enclosed are new and revised pages as detailed below for the above Manual. Superseded pages should be removed and destroyed now.

Page Nos.	*Issue*	*Changes*
N.1/2	2	Amended: Wiring diagram—new style.
		Added: Key to wiring diagram.

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SECTION N

THE ELECTRICAL EQUIPMENT

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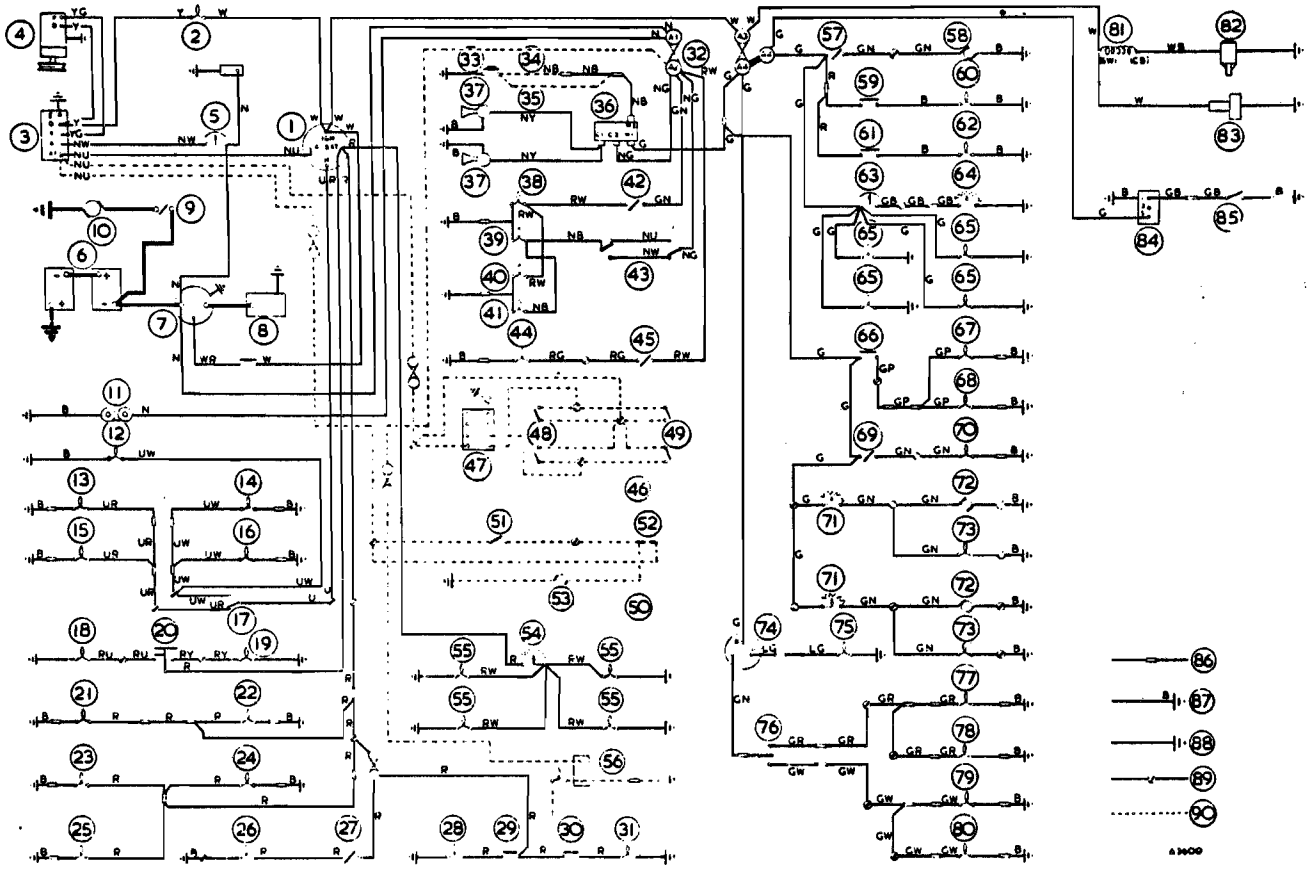
WIRING DIAGRAM



No.	Description
1.	Ignition and lighting switch.
2.	Ignition warning light.
3.	Control box.
4.	Dynamo.
5.	Ammeter.
6.	Two 6-volt batteries.
7.	Starter solenoid switch.
8.	Starter motor.
9.	Jack pump switch.
10.	Jack pump motor.
11.	Charging and inspection socket.
12.	Main beam warning light.
13.	L.H. headlamp dip beam.
14.	L.H. headlamp main beam.
15.	R.H. headlamp dip beam.
16.	L.H. headlamp main beam.
17.	Dipper switch.
18.	L.H. fog lamp.
19.	R.H. fog lamp.
20.	Fog lamp switch.
21.	L.H. sidelamp.
22.	R.H. sidelamp.
23.	L.H. tail lamp.
24.	R.H. tail lamp.
25.	Number-plate lamp.
26.	Luggage compartment lamp.
27.	Luggage compartment lamp switch.
28.	R.H. step light.
29.	R.H. door switch.
30.	L.H. door switch.
31.	L.H. step light.
32.	Fuse unit.
33.	Horn-push.
34.	Horn circuit—L.H.D.
35.	Horn circuit—R.H.D.
36.	Horn relay.
37.	Horn.
38.	R.H. interior light.
39.	R.H. reading light.
40.	L.H. interior light.
41.	L.H. reading light.
42.	Rear interior light switch.
43.	Reading light switches.
44.	Driver's reading lamp.
45.	Driver's reading lamp switch.
46.	Division glass circuit (optional).
47.	Division glass relay.
48.	Division glass switch—driver's.
49.	Division glass switch—passenger's.
50.	Blind motor circuit (optional).
51.	Blind motor switch.
52.	Automatic blind motor switch.
53.	Blind motor.
54.	Instrument illumination rheostat switch.
55.	Instrument lights.
56.	Clock (optional).
57.	Heater switch.
58.	Heater motor.
59.	L.H. rear door switch.
60.	L.H. rear door warning light.
61.	R.H. rear door switch.
62.	R.H. rear door warning light.
63.	Fuel gauge.
64.	Tank unit.
65.	Switch panel lights.
66.	Stop lamp switch.
67.	R.H. stop lamp.
68.	L.H. stop lamp.
69.	Reverse lamp switch.
70.	Reverse lamp.
71.	Heater rheostat.
72.	Heater motor.
73.	Heater warning light.
74.	Flasher unit.
75.	Flasher warning light.
76.	Flasher switch.
77.	L.H. front flasher.
78.	L.H. rear flasher.
79.	R.H. front flasher.
80.	R.H. rear flasher.
81.	Ignition coil.
82.	Distributor.
83.	Fuel pump.
84.	Wiper motor.
85.	Wiper switch.
86.	Snap connectors.
87.	Earth connections via cable.
88.	Earth connections via fixing bolts.
89.	Terminal blocks or junction box.
90.	Optional equipment circuits.

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GENERAL DESCRIPTION

The electrical equipment is of the 12-volt type incorporating compensated voltage control for the charging circuit. The positive earth system of wiring is employed.

The batteries are mounted under the floor on each side of the car behind the centre cross-member and are readily accessible for examination and maintenance attention after removing the section of floor covering.

The dynamo is mounted on the right of the cylinder block and driven by endless belt from the engine crankshaft. A rotatable mounting enables the belt tension to be adjusted.

The control box is sealed and should not normally need attention. the fuses being carried in a separate holder. The control box, fusebox, horn relay, and flasher unit are mounted on a platform located beneath the bonnet on the left-hand side.

The starter motor is mounted on the flywheel housing on the left-hand side of the engine unit and operates on the flywheel through the usual sliding pinion device.

The headlamps employ the double-filament dipping system. Both lamps are fitted with double-filament bulbs. both dipping either vertically or to the right or left according to the regulations existing in the country concerned.

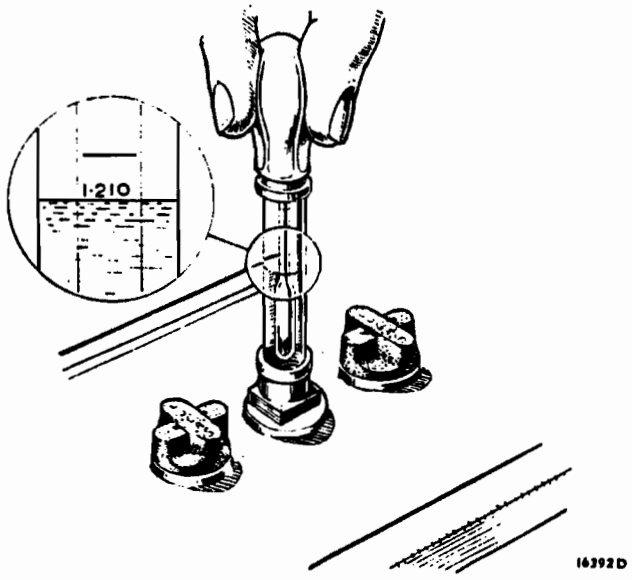

Fig. N.1

When using the hydrometer to ascertain the condition of the batteries take the reading at eye-level, ensuring that the float is free

Section N.1

BATTERY MAINTENANCE

In order to keep the batteries in good condition a periodical inspection should be made and the following carried out:

(1) Topping up

Remove the filler plug from each cell monthly or every 1,000 miles (1600 km.), and examine the level of the electrolyte in each. Add distilled water as required to bring the level of the electrolyte just above the top of the perforated plate covering the separators.

NOTE.—Do not use tap-water and do not use a naked light when examining the condition of the cells. Wipe away all dirt and moisture from the top of the batteries.

(2) Testing the condition of the batteries

Occasionally examine the condition of the batteries by taking hydrometer readings. There is no better way of ascertaining the state of charge of the batteries. The hydrometer contains a graduated float on which is indicated the specific gravity of the electrolyte in the cell from which the sample is taken.

The specific gravity readings and their indications are as follows:

	Home Trade and climates below 90° F. (32° C.)	*Climates frequently above 90° F. (32° C.)*
Cell fully charged	1·270 to 1·290	1·210 to 1·230
Cell about half-discharged ..	1·190 to 1·210	1·130 to 1·150
Cell completely discharged ..	1·110 to 1·130	1·050 to 1·070

The figures given in the table are corrected to an electrolyte temperature of 60° F. (15·5° C.) and the hydrometer readings obtained must also be corrected to suit the temperature of the electrolyte.

For every 5° F. (2·7 C.) above 60° F. (15·5° C.) add ·002.

For every 5° F. (2·7° C.) below 60° F. (15·5° C.) subtract ·002.

The readings for each of the cells should be approximately the same. If one cell gives a reading very different from the rest it may be that the electrolyte has been spilled or has leaked from one of the cells or there may be an internal fault. In this case it is advisable to have the batteries examined by a battery specialist. Should the batteries be in a low state of charge, they should be recharged by taking the car for a long daytime run or by charging from an external source of D.C. supply at a current rate of 7 amperes until the cells are gassing freely.

After examining the batteries check the vent plugs, making sure that the air passages are clear, and screw the plugs into position. Wipe the tops of the batteries to remove all dirt and moisture.

STORAGE

If the batteries are to be out of use for any length of time they should first be fully charged and then given a freshening charge about every fortnight.

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The batteries must never be allowed to remain in a discharged condition as this will cause the plates to become sulphated.

Section N.2

INITIAL FILLING AND CHARGING
(Dry Uncharged Batteries)

1. Preparation of electrolyte

When a new battery has been supplied dry it is necessary to fill the cells with electrolyte of the correct specific gravity.

The specific gravity of the filling-in solution should be the same as that required at the end of the charge (i.e. 1·270 for climates below 90° F. [32° C.] and 1·210 for climates frequently above 90° F. [32° C.]).

The electrolyte is prepared by mixing distilled water and concentrated sulphuric acid 1·835 S.G. The mixing must be carried out in a lead-lined tank or a suitable glass or earthenware vessel. Steel or iron containers must **not** be used. The acid must be added slowly to the water while the mixture is stirred with a glass rod. **Never add the water to the acid,** as the resulting chemical reaction may have dangerous consequences.

To produce electrolyte of the correct specific gravity use the following proportions of acid and distilled water:

To obtain specific gravity (corrected to 60° F. [16° C.])	*Add 1 part by volume of 1·835 S.G. acid to distilled water by volume as below*
1·270	2·8 parts
1·210	4·0 parts

Heat is produced by the mixture of acid and water and the mixture should therefore be allowed to cool before it is poured into the battery, otherwise the plates, separators, and moulded container may be damaged.

2. Filling in and soaking

The temperature of the filling-in solution, battery, and charging room should be above 32° F. (0° C.).

Carefully break the seals in the filling holes and half-fill each cell in the battery with electrolyte of the appropriate specific gravity. The quantity of electrolyte required to half-fill a two-volt cell is ½ pint (·28 litre).

Allow to stand for at least six hours, then complete the filling of the cells by the addition of more electrolyte of the same specific gravity as before until the level reaches the bottom of the filling holes, and allow the battery to stand for at least another two hours before commencing the first charge.

3. Duration and rate of initial charge

Charge at a constant current of 4·5 amps. until the voltage and temperature-corrected specific gravity readings show no increase over five successive hourly readings. This period is dependent upon the length of time the battery has been stored since manufacture, and will be from 40 to 80 hours, but usually not more than 60.

Throughout the charge the electrolyte in each cell must be maintained level with the top of the perforated plate covering the separators by the addition of electrolyte of the same specific gravity as the original filling-in solution.

If, during charge, the temperature of the acid in any cell of the battery reaches the maximum permissible temperature, i.e. 100° F. (38° C.) in climates ordinarily below 90° F. (32° C.), 120° F. (49° C.) in climates frequently above 90° F. (32° C.), the charge must be interrupted and the battery temperature allowed to fall at least 10° F. (5·5° C.) before charging is resumed.

At the end of the first charge, i.e. when specific gravity and voltage measurements remain substantially constant, carefully check the specific gravity in each cell to ensure that it lies within the limits specified. If any cell requires adjustment the electrolyte above the plates must be siphoned off and replaced with either electrolyte of the strength used for the original filling in or distilled water, according to whether the specific gravity is too low or too high respectively. After such adjustment the gassing charge should be continued for one or two hours to ensure adequate mixing of the electrolyte. Re-check, if necessary, repeating the procedure until the desired result is obtained.

Section N.3

INITIAL FILLING AND CHARGING
(Dry-charged Batteries)

'Dry-charged' batteries are supplied without electrolyte but with the plates in a charged condition. This ensures that there is no deterioration of the battery if it is stored for a period before use.

Filling the cells with electrolyte of the correct specific gravity (see Section N.2), **in one operation,** renders the battery capable of giving a starting discharge **one hour after filling.** The temperature of the filling-in solution, battery, and filling room should be maintained between 60° F. (16° C.) and 100° F. (38° C.). If the battery has been stored in a cool place it should be allowed to warm up to room temperature before filling.

When time permits, a freshening charge at the normal recharge rate of the battery will ensure that the battery is fully charged. During the charge keep the electrolyte level with the top of the perforated plate covering the separators by the addition of distilled water. Check the electrolyte specific gravity at the end of the charge; if 1·270 acid was used to fill the battery the specific gravity should now be between 1·270 and 1·290; if 1·210 acid was used, the specific gravity should be between 1·210 and 1·230.

Section N.4

TESTING THE DYNAMO

To test on vehicle when dynamo is not charging

(1) Make sure that belt slip is not the cause of the trouble. It should be possible to deflect the belt

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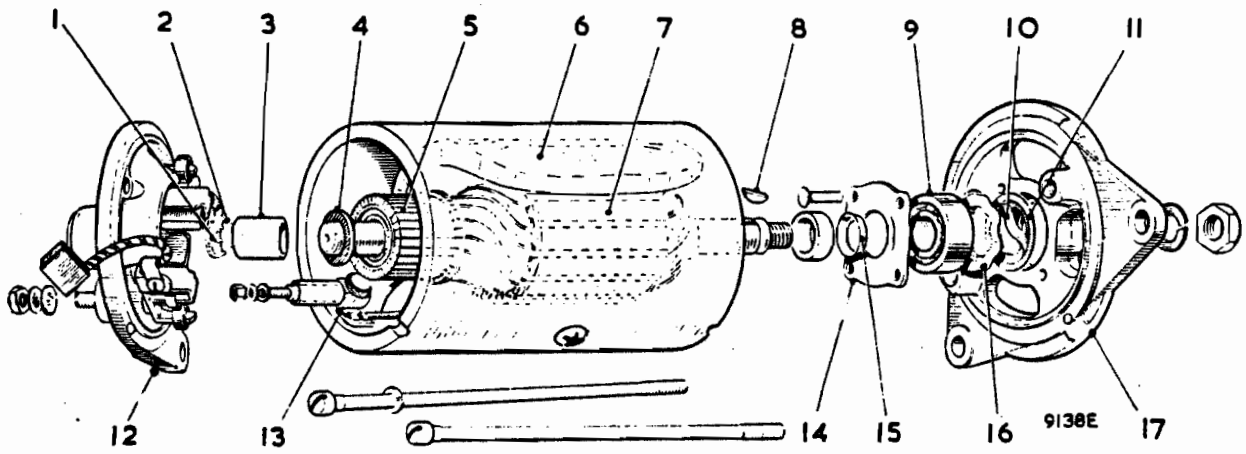

Fig. N.2

The windowless yoke dynamo

1. Felt pad.
2. Aluminium disc.
3. Bronze bush.
4. Fibre washer.
5. Commutator.
6. Field coils.
7. Armature.
8. Shaft key.
9. Bearing.
10. Felt washer.
11. Oil-retaining washer.
12. Commutator end bracket.
13. Field terminal post.
14. Bearing retaining plate.
15. Cup washer.
16. Corrugated washer.
17. Driving end bracket.

approximately ½ in. (12·7 mm.) at the centre of its longest run between the two pulleys with moderate hand pressure. If the belt is too slack tightening is effected by slackening the two dynamo suspension bolts and then the bolt and the nut of the slotted adjustment link (see Fig. C.4). A gentle pull on the dynamo outwards will enable the correct tension to be applied to the belt, and all the three bolts and the nut should then be tightened firmly.

(2) Check that the dynamo and control box are connected correctly. The dynamo terminal 'D' should be connected to the control box terminal 'D' and the dynamo terminal 'F' connected to the control box terminal 'F'.

Check the earth connections of the control box.

(3) After switching off all lights and accessories disconnect the cables from the dynamo terminals marked 'D' and 'F' respectively.

(4) Connect the two terminals with a short length of wire.

(5) Start the engine and set to run at normal idling speed.

(6) Clip the negative lead of a moving-coil-type voltmeter, calibrated 0–20 volts, to one dynamo terminal and the other lead to a good earthing point on the dynamo yoke.

(7) Gradually increase the engine speed, when the voltmeter reading should rise rapidly and without fluctuation. Do not allow the voltmeter reading to reach 20 volts. Do not race the engine in an attempt to increase the voltage. It is sufficient to run the dynamo up to a speed of 1,000 r.p.m.

If there is no reading check the brush gear.

If the reading is low (approximately 1 volt) the field winding may be faulty.

If the reading is approximately 6 volts the armature winding may be faulty.

Section N.5

REMOVING AND REPLACING THE DYNAMO

Disconnect the leads from the dynamo terminals.

Slacken the three attachment bolts and the nut securing the adjustment link to the engine and pivot the dynamo towards the cylinder block so that the fan belt may be removed from the dynamo pulley. The dynamo can then be removed by completely withdrawing the three attachment bolts.

Replacement of the dynamo is an exact reversal of the above procedure.

Section N.6

DISMANTLING AND REASSEMBLING THE DYNAMO

Remove the securing nut and take off the drive pulley. Extract the Woodruff key from the commutator shaft.

Release the field terminal nut and washers, and then unscrew and remove the through-bolts and take off the commutator end bracket. The driving end bracket together with the armature and its ball bearing, can now be lifted out of the yoke. Unless the ball bearing is damaged or requires attention it need not be removed from the armature. Should it be necessary to remove the bearing, the armature must be separated from the end bracket by means of a hand press.

Reassembly of the dynamo is a reversal of the dismantling procedure, except that when assembling the commutator end bracket the bushes must first be held clear of the commutator by partially withdrawing them from their boxes until each brush is trapped in position by the side pressure of its spring. The brushes can be released onto the commutator by a small screwdriver

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or similar tool when the end bracket is assembled to within about ¼ in. (12·7 mm.) of the yoke. Before closing the gap between the end bracket and the yoke see that the springs are in correct contact with the brushes.

Section N.7

SERVICING THE DYNAMO

Brushes

Test if the brushes are sticking. Clean them with petrol (gasoline) and, if necessary, ease the sides by lightly polishing with a smooth file. Replace the brushes in their original positions.

Test the brush spring tension with a spring balance if available. The correct tension is 25 to 33 oz. (709 to 935 gm.). Fit a new spring if the tension is low.

If the brushes are worn so that the flexible lead is exposed on the running face new brushes **must** be fitted. Brushes are preformed so that bedding to the commutator is unnecessary.

Commutator

A commutator in good condition will be smooth and free from pits or burned spots. Clean the commutator with a cloth moistened with petrol (gasoline). If this is ineffective carefully polish with a strip of fine glass-paper while rotating the armature. To remedy a badly worn commutator mount the armature (with or without the drive end bracket) in a lathe, rotate at high speed, and take a light cut with a very sharp tool. Do not remove more metal than is necessary. Polish the commutator with very fine glass-paper. Undercut the mica insulation between the segments to a depth of $\frac{1}{32}$ in. (·8 mm.) with a hacksaw blade ground down to the thickness of the mica.

Field coils

Test the field coils, without removing them from the dynamo yoke, by means of an ohmmeter connected between the field terminal and the yoke. The reading on the ohmmeter should be between 6·0 and 6·3 ohms. If this is not available connect a 12-volt D.C. supply with an ammeter in series between the field terminal and the dynamo yoke. The ammeter reading should be approximately 2 amps.

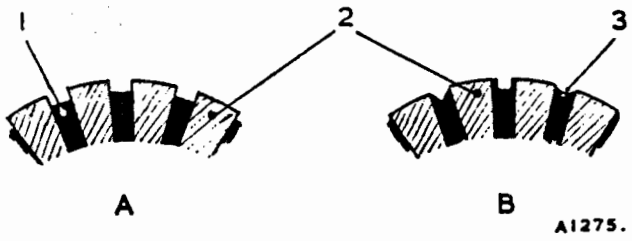

Fig. N.3

Undercutting the commutator (A) *the right way and* (B) *the wrong way*

1. Insulator. 2. Segments. 3. Insulator.

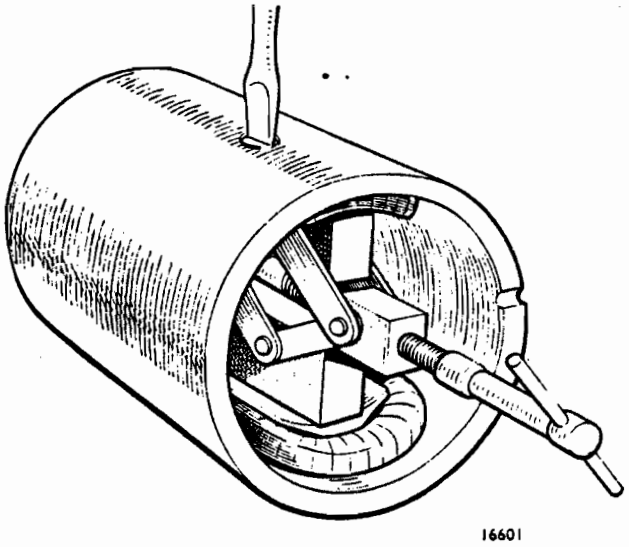

Fig. N.4

Expanding the pole-shoes in the yoke

A zero reading on the ammeter or an infinity ohmmeter reading indicates an open circuit in the field winding.

Current readings greater than 2 amperes or ohmmeter readings less than 6 ohms indicate failure of the insulation in one of the field coils.

In either case the field coils must be renewed in accordance with the following procedure, using a pole-shoe expander and wheel-operated screwdriver:

(1) Drill out the rivet to release the field coil terminal block from the dynamo yoke and remove the field coil connections.
(2) Remove the insulation piece which is provided to prevent the junction of the field coils from contacting the yoke.
(3) Mark the yoke and pole-shoes in order that they can be refitted in their original positions.
(4) Unscrew the two pole-shoe retaining screws by means of the wheel-operated screwdriver.
(5) Draw the pole-shoes and coils out of the dynamo yoke and lift off the coils.
(6) Fit the new field coils over the pole-shoes and place them in position inside the yoke. Take care that the taping of the field coils is not trapped between the pole-shoes and the yoke.
(7) Locate the pole-shoes and field coils by lightly tightening the fixing screw.
(8) Insert the pole-shoe expander, open it to the fullest extent, and tighten the screws.
(9) Finally, tighten the screws by means of the wheel-operated screwdriver and lock them by caulking.
(10) Replace the insulation piece between the field coil connections and the yoke.
(11) Refit the field coil connections to the terminal tags and re-rivet the terminal block to the dynamo yoke.

Armature

The testing of the armature winding requires the use of a voltage-drop test and growler. If these are not

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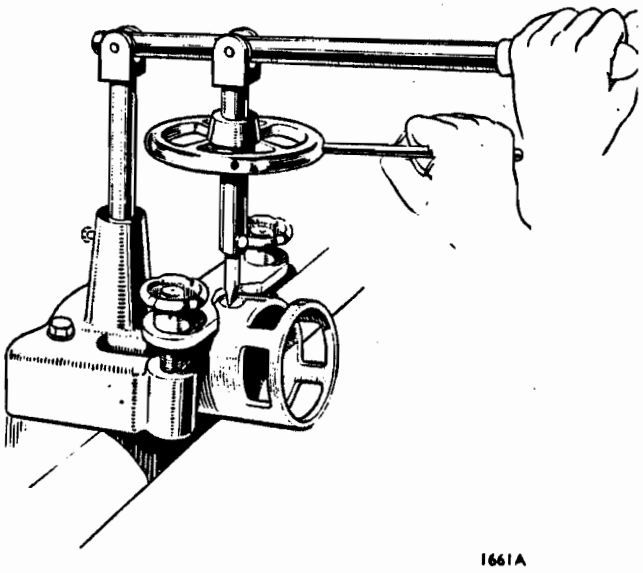

Fig. N.5

The use of a wheel-operated screwdriver is necessary to tighten or loosen the pole-shoe screws

available the armature should be checked by substitution. No attempt should be made to machine the armature core or to true a distorted armature shaft.

Bearings

Bearings which are worn to such extent that they will allow side-movement of the armature shaft must be renewed.

To fit a new bearing at the commutator end of the dynamo proceed as follows:

(1) Withdraw the old bearing bush from the end bracket. To do this screw an $\frac{1}{8}$ in. tap into the bush for a few turns and withdraw the tap complete with bush.

(2) Press the new bearing bush into the end bracket until it is flush with the inner face of the bracket, using a shouldered mandrel of the same diameter as the shaft which is to fit in the bearing.

NOTE.—Before fitting the new bearing bush allow it to stand completely immersed in thin engine oil for 24 hours to fill the pores of the bush with lubricant. In cases of urgency this period may be shortened by heating the oil to 100° C. (212° F.) for two hours and allowing the oil to cool before removing the bush.

The ball bearing at the driving end is renewed as follows:

(1) Drill out the rivets which secure the bearing retaining plate to the end bracket and remove the plate.

(2) Press the bearing out of the end bracket and remove the corrugated washer, felt washer, and oil-retaining washer.

(3) Before fitting the replacement bearing see that it is clean and pack it with a high-melting-point grease.

(4) Place the oil-retaining washer, felt washer, and corrugated washer in the bearing housing in the end bracket.

(5) Locate the bearing in the housing and press it home by means of a hand press.

(6) Fit the bearing retaining plate. Insert the new rivets from the inside of the end bracket and open the rivets by means of a punch to secure the plate rigidly in position.

Section N.8

TESTING THE STARTER

To test on the vehicle

Switch on the lamps (or connect a moving-coil 0–20 voltmeter between the battery terminals) and operate the starter control. If the lamps dim (or the voltmeter reading falls appreciably) but the starter does not crank the engine check by hand-cranking that the engine is not abnormally stiff.

Sluggish action of the starting motor may be due to a discharged battery. Check by removing the battery and substituting one known to be well charged.

If the starting motor still does not operate satisfactorily it must be removed from the engine for examination.

If the lamps do not dim (or the voltmeter reading remains unaffected), and the motor does not crank the engine, check by means of a voltmeter or battery-voltage test lamp that the circuit up to the supply terminal on the motor is in order.

If no voltage is indicated (or the test lamp does not light) check the circuit from the battery to motor via the starter switch.

A reading of battery voltage (or the test lighting with full brilliance) at the motor terminal indicates an internal open circuit in the starter motor and will necessitate the removal of the unit from the engine for examination. If the motor operates but does not crank the engine the drive mechanism is probably in need of cleaning or may have developed some other fault. In either event the starter must be removed from the engine.

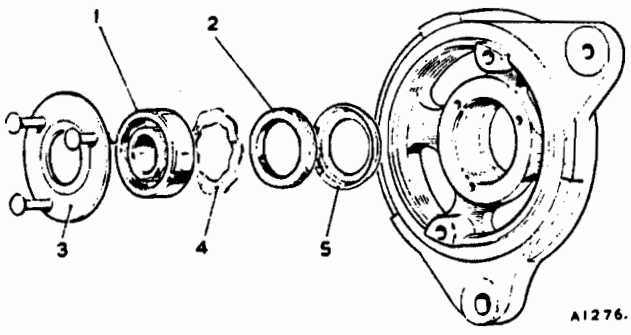

Fig. N.6

Components of the dynamo driving end bracket

1. Bearing.
2. Felt washer.
3. Bearing retaining plate.
4. Corrugated washer.
5. Oil-retaining washer.

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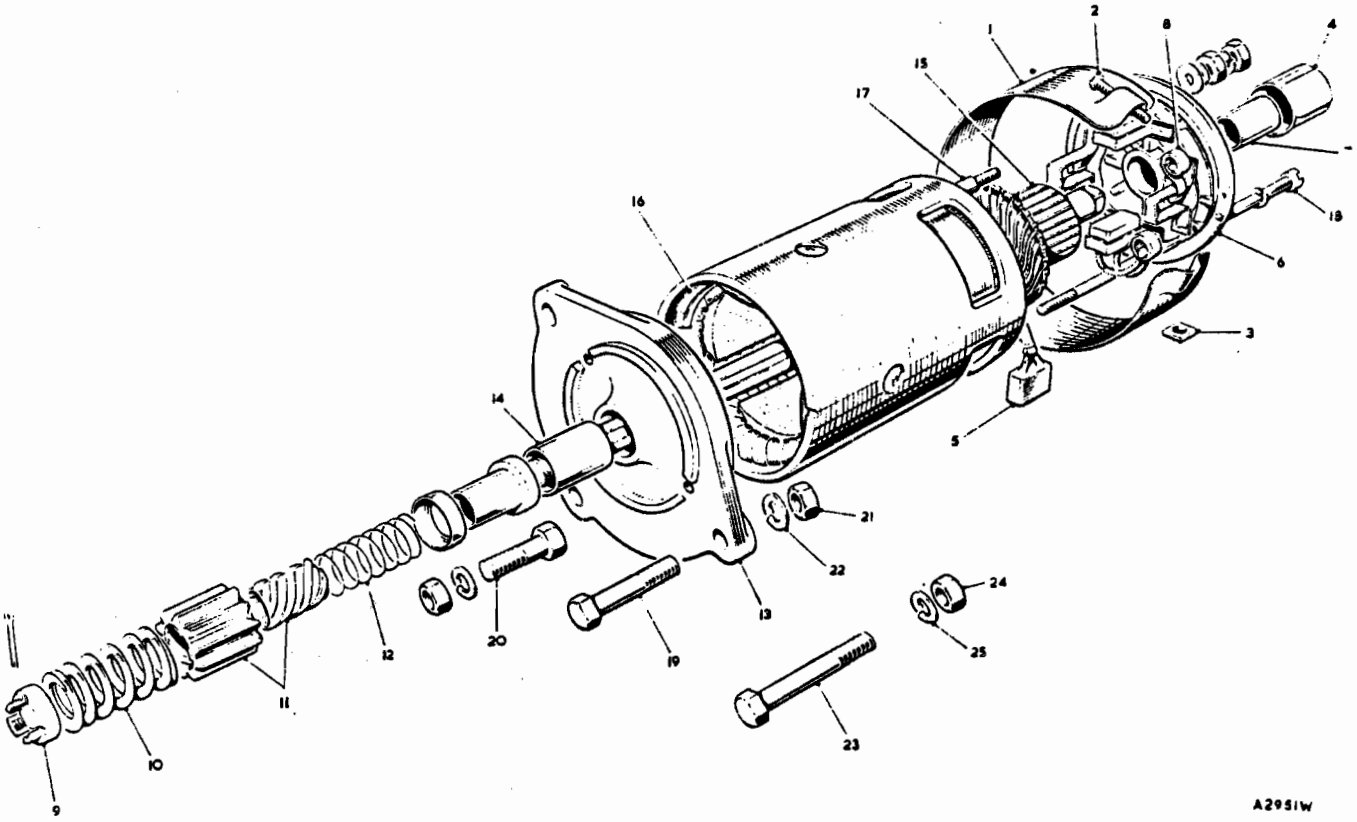

Fig. N.7

The starter components

1. Cover band.
2. Clamp screw.
3. Clamp screw nut.
4. End cap.
5. Brush.
6. Commutator end bracket.
7. Bearing bush.
8. Brush spring.
9. Shaft nut.
10. Main spring.
11. Pinion and sleeve.
12. Restraining spring.
13. Drive end bracket.
14. Bearing bush—drive end.
15. Commutator.
16. Field coil.
17. Terminal post.
18. Through-bolt.
19. Mounting bolt.
20. Mounting bolt.
21. Nut.
22. Spring washer.
23. Mounting bolt.
24. Nut.
25. Spring washer.

Section N.9

REMOVING AND REPLACING THE STARTER MOTOR

Disconnect the leads from the battery terminals.

Unscrew the nut and disconnect the main lead from the terminal on the starter motor.

Unscrew and remove the three nuts and bolts securing the starter motor to the clutch housing and withdraw the motor.

To replace the starter motor reverse the above procedure.

Section N.10

SERVICING THE STARTER MOTOR

Examination of commutator and brush gear

Secure the starter motor in a vice and test it by connecting two heavy-gauge cables between the motor and a 12-volt battery. One cable must be connected to the starter terminal and the other held against the body or end bracket. Under these light load conditions the starter should run at a very high speed without excessive noise and without excessive sparking at the commutator.

If the operation of the starter motor is unsatisfactory remove the cover band and examine the brushes and commutator. Hold back each of the brush springs and move the brush by pulling gently on its flexible connector. If the movement is sluggish remove the brush from its holder and ease the sides by lightly polishing on a smooth file. Always replace the brushes in their original positions.

If the brushes are worn so that they will not bear on the commutator, or a brush flexible connector is exposed on the running face, they must be renewed.

Check the tension of the brush springs with a spring scale. The correct tension is 30 to 40 oz. (850 to 1134 gm.). New springs must be fitted if the tension is low.

If the commutator is blackened or dirty clean it by holding a cloth moistened with petrol (gasoline) against it while the armature is rotated.

Retest the starter motor as described at the commencement of this Section. If the operation is still unsatisfactory the unit will have to be dismantled for detailed inspection and testing as detailed in Section N.11.

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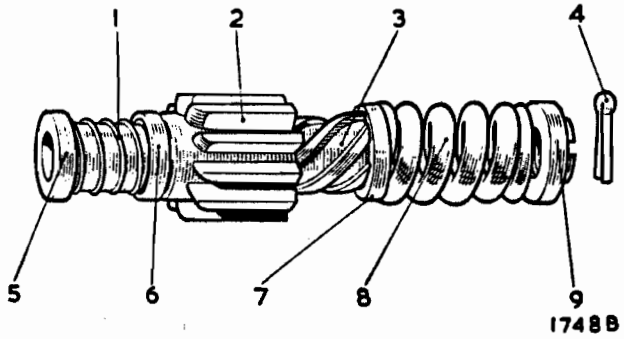

Fig. N.8

Components of the starter motor drive

1. Pinion restraining spring.
2. Pinion.
3. Screwed sleeve.
4. Split pin.
5. Sleeve.
6. Collar.
7. Washer.
8. Main spring.
9. Shaft nut.

Section N.11

DISMANTLING, TESTING, AND REASSEMBLING THE STARTER

Remove the cover band, hold back the brush springs, and lift the brushes from their holders.

Remove the nuts from the terminal post which protrudes from the commutator end bracket.

Unscrew the two through-bolts from the commutator end bracket and remove the bracket from the yoke.

Remove the driving end bracket, complete with armature and drive, from the starter motor yoke. If it is necessary to remove the drive end bracket from the armature it will slide off after the drive has been dismantled.

Brushes

If the brushes are worn to less than $\frac{5}{16}$ in. (7·94 mm.) in length they must be renewed.

Two of the brushes are connected to terminal eyelets attached to the brush boxes on the commutator end bracket and two are connected to the field coils.

The flexible connectors must be removed by unsoldering and the connectors of the new brushes secured in their place by soldering. The brushes are preformed, so that bedding to the commutator is unnecessary.

Commutator

A commutator in good condition will be smooth and free from pits and burned spots. Clean the commutator with a cloth moistened with petrol (gasoline). If this is ineffective carefully polish with a strip of fine glass-paper while rotating the armature. To remedy a badly worn commutator dismantle the starter drive (Section N.12) and remove the armature from the end bracket. Mount the armature in a lathe, rotate it at high speed, and take a light cut with a very sharp tool. Do not remove more metal than is necessary. Finally, polish with very fine glass-paper.

The insulators between the segments must not be undercut.

Armature

Examination of a faulty armature may reveal the cause of the failure—for example, the conductors may have lifted from the commutator due to the starter motor having been engaged while the engine was running, causing the armature to be rotated at an excessive speed. A damaged armature must always be renewed: no attempt must be made to machine the armature core or to true a distorted armature shaft.

To check the insulation of the armature connect an ohmmeter or a 110-volt A.C. test lamp between the armature shaft and the commutator segments. Faulty insulation (necessitating armature replacement) will be indicated by a low ohmic reading or lighting of the test lamp.

Field coils

Test the field coils for continuity by connecting 12-volt test lamp probes between each brush tapping.

Lighting of the lamp does not necessarily mean that the field coils are in order, as it is possible that one of them may be earthed to a pole-shoe or to the yoke. This must be checked with a 110-volt test lamp, the test leads being connected between the starter motor terminal and a clean part of the yoke. If the lamp lights defective insulation of the field coils or of the terminal post is indicated. In this event check that the insulating band is in position and examine the field coils and terminal connections for any obvious point of contact with the yoke.

If from the above tests the coils are shown to be open-circuited or earthed, and the point of contact cannot be readily located and rectified, either the complete starter motor or the field coils must be renewed. If the field coils are to be renewed, adopt the following procedure.

Mark the yoke and pole-shoes so that they may be replaced to their original positions.

Unscrew the four pole-shoe retaining screws with a wheel-operated screwdriver.

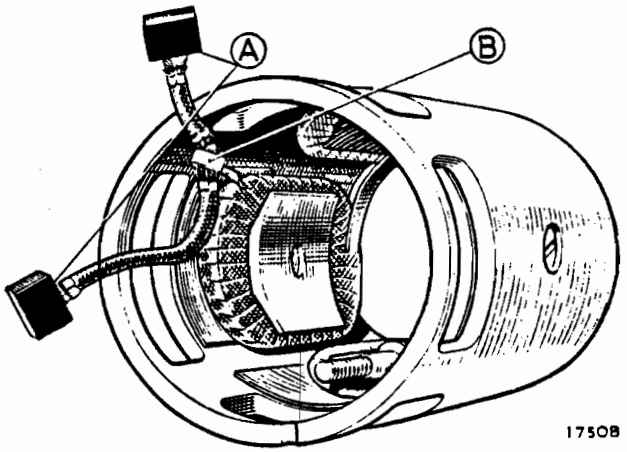

Fig. N.9

The starter brush connections

A. Brushes.
B. Tapping on field coils.

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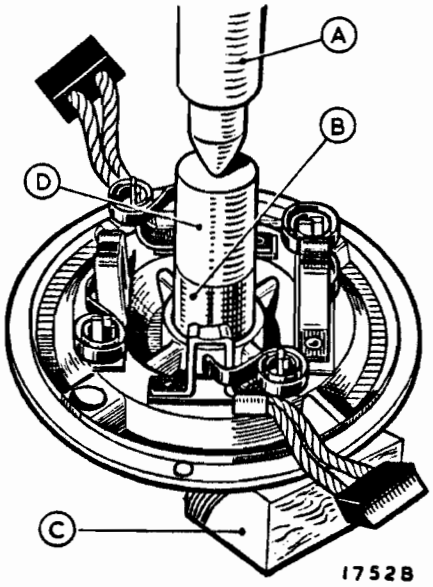

Fig. N.10

Fitting a new bush, using a shouldered mandrel

A. Hand press.
B. Bearing bush.
C. Supporting block.
D. Shouldered mandrel.

Remove the insulation piece which is provided to prevent the intercoil connectors from contacting with the yoke.

Draw the pole-shoes and coils out of the yoke and lift off the coils.

Fit the new field coils over the pole-shoes and place them in position inside the yoke. Take care that the taping of the field coils is not trapped between the pole-shoes and the yoke.

Locate the pole-shoes and field coils by lightly tightening the fixing screws.

Replace the insulation piece between the field coil connections and the yoke.

Fully tighten the screws with a wheel-operated screwdriver.

Commutator end bracket

Test the insulation of the commutator end bracket brush box, using a 110-volt A.C. test lamp. Wipe all traces of copper dust and dirt from the vicinity of the brush boxes before commencing the test. Connect the test lamp leads between the bracket and each insulated brush box in turn. Provided the insulation is in good order, the lamp will not light.

Bearings

Bearings which are worn to such an extent that they will allow excessive side-play of the armature shaft must be renewed. To renew the bearing bushes proceed as follows.

Press the bearing bush out of the end bracket.

Press the new bush into position in the end bracket, using a shouldered, highly polished mandrel of the same diameter as the shaft which is to fit in the bearing.

NOTE.—Before fitting a new porous bronze bearing bush it must be completely immersed for 24 hours in clean thin engine oil.

Porous bronze bushes must not be opened out after fitting or the porosity of the bush may be impaired.

The reassembly of the starter motor is a reversal of the dismantling procedure.

Section N.12

DISMANTLING AND REASSEMBLING THE STARTER DRIVE

Remove the armature as described in Section N.11.

Referring to Fig. N.8, remove the split pin (4) from the shaft nut (9) at the end of the starter drive. Hold the squared starter shaft extension at the commutator end by means of a spanner and unscrew the shaft nut (9). Lift off the main spring (8), washer (7), screwed sleeve with pinion (2), collar (6), pinion restraining spring (1), and the restraining spring sleeve (5).

If either the screwed sleeve or pinion are worn or damaged they must be replaced as a pair, not separately.

The reassembly of the drive is a reversal of the dismantling procedure.

Section N.13

CONTROL BOX

Description

The control box contains two units, a voltage regulator and a cut-out. Although combined structurally, the regulator and cut-out are electrically separate (see Fig. N.11).

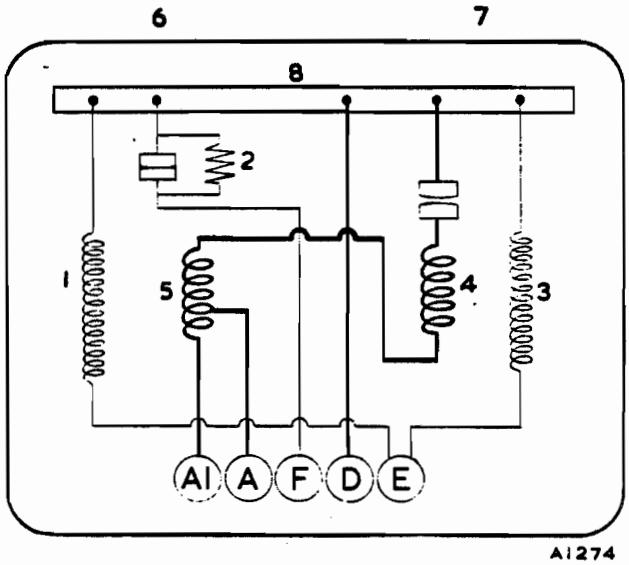

Fig. N.11

The control box wiring diagram

1. Shunt coil.
2. Field resistance.
3. Shunt coil.
4. Series coil.
5. Tapped series coil.
6. Regulator.
7. Cut-out.
8. Regulator and cut-out frame.

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Both are accurately adjusted during manufacture, and the cover protecting them should not be removed unnecessarily.

Regulator

The regulator is set to maintain the dynamo output between close limits at all speeds above the regulating point, the field strength being controlled by the automatic insertion and withdrawal of a resistance in the dynamo field circuit. When the dynamo output reaches a predetermined value the magnetic flux in the regulator core, induced by the shunt or voltage winding, becomes sufficiently strong to attract the armature to the core. This causes the contacts to open, thereby inserting the resistance in the dynamo field circuit.

The consequent reduction in the dynamo field current lowers the dynamo output, and this in turn weakens the magnetic flux in the regulator core. The armature therefore returns to its original position, and with the contacts closed the dynamo output rises again to its regulated maximum. This cycle is then repeated, and an oscillation of the armature is maintained.

As the speed of the dynamo rises above that at which the regulator comes into operation the periods of contact separation increase in length and, as a result, the mean value of the dynamo output undergoes practically no increase once this regulating speed has been attained.

The series or current winding provides a compensation on this system of control, for if the control were arranged entirely on the basis of voltage there would be a risk of seriously overloading the dynamo when the batteries were in a low state of charge, particularly if the lamps were in use simultaneously.

Under these conditions, with batteries of low internal resistance, the dynamo output rises and, but for the series winding, would exceed its normal rating. The magnetism due to the series winding assists the shunt winding, so that when the dynamo is delivering a heavy current into discharged batteries the regulator comes into operation at a somewhat reduced voltage, thus limiting the output accordingly. A split series winding is used, terminal 'A' being connected to the batteries and terminal 'A1' to the lighting and ignition switch.

By means of a temperature compensation device the voltage characteristic of the dynamo is caused to conform more closely to that of the batteries under all climatic conditions. In cold weather the voltage required to charge the batteries at a given rate increases, whilst in warm weather the voltage required is lower. The compensation device is in the form of a bi-metal spring located behind the tensioning spring of the regulator armature. By causing the operating voltage of the regulator to be increased in cold weather and reduced in hot weather the bi-metal spring compensates for the changing temperature characteristics of the batteries and prevents undue variation of the charging current which would otherwise occur. The bi-metal spring also compensates for effects to working values due to increases in resistance of the copper windings from cold.

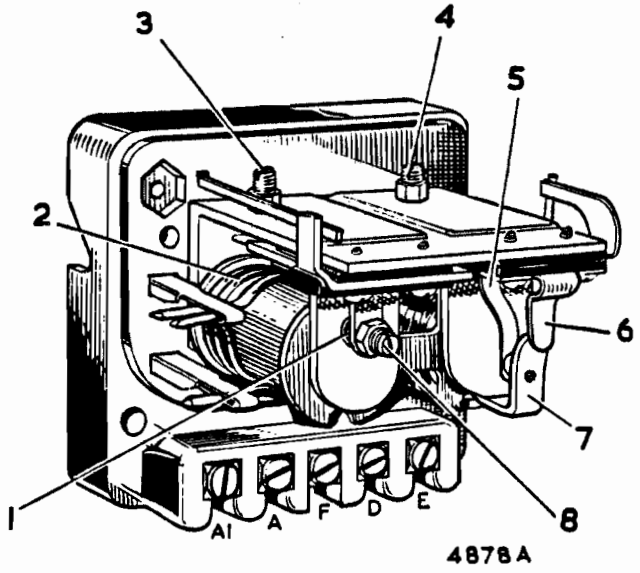

Fig. N.12

1. Regulator moving contact.
2. Regulator series windings.
3. Regulator adjusting screw.
4. Cut-out adjusting screw.
5. Fixed contact blade.
6. Stop arm.
7. Armature tongue and moving contact.
8. Regulator fixed contact screw.

Regulator adjustment

The regulator is carefully set before leaving the Works to suit the normal requirements of the standard equipment, and in general it should not be necessary to alter it. If, however, the batteries do not keep in a charged condition, or if the dynamo output does not fall when the batteries are fully charged, it may be advisable to check the setting and, if necessary, to readjust it.

It is important, before altering the regulator setting, when the batteries are in a low state of charge, to check that its condition is not due to a battery defect, to the dynamo belt slipping, or to a defective dynamo.

Electrical setting

The electrical setting of the control unit can be checked without removing the cover. Use a good-quality moving-coil voltmeter (0–20 volts).

Withdraw the cables from the control box terminals 'A' and 'A1' and connect these cables together.

Connect the negative lead of the voltmeter to the control box terminal 'D' and connect the other lead to terminal 'E'.

Run the dynamo at 3,000 r.p.m. and observe the voltmeter reading, which should lie between the appropriate limits given below, according to the ambient temperature.

Ambient temperature	*Open-circuit voltage*
10° C. (50° F.)	16·1 to 16·7
20° C. (68° F.)	16·0 to 16·6
30° C. (86° F.)	15·9 to 16·5
40° C. (104° F.)	15·8 to 16·4

An unsteady voltmeter reading may be due to dirty contacts, but if the reading is outside the appropriate limits the regulator must be adjusted.

Switch off the engine, remove the control box cover, restart the engine, and run the dynamo at 3,000 r.p.m.

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Turn the regulator adjusting screw (3, Fig. N.12) in a clockwise direction to raise the setting or in an anti-clockwise direction to lower the setting.

NOTE.—The operations of checking and adjusting the regulator should be completed within 30 seconds, otherwise false readings and settings, due to the heating of the shunt coil, will be made.

After adjustment a further check of the setting should be made by switching off and restarting the engine and then raising the dynamo speed to 3,000 r.p.m., when the open-circuit voltage must conform to the figures given above.

Refit the control box cover and restore the original connections.

Cleaning contacts

After long periods of service it may be found necessary to clean the regulator contacts. Clean the contacts by means of a fine carborundum stone or fine silicon-carbide paper.

Carefully wipe away all traces of dust or other foreign matter with methylated spirits.

Cut-out

The cut-out is an electro-magnetically operated switch connected in the charging circuit between the dynamo and the batteries. It automatically connects the dynamo with the batteries when the dynamo output exceeds that of the batteries and disconnects the two when the dynamo output falls below that of the batteries, and so prevents the batteries from discharging and possibly damaging the dynamo windings.

The cut-out consists of an electro-magnet fitted with an armature which operates a pair of contacts. The electro-magnet employs two windings, a shunt winding of many turns of fine wire and a series winding of a few turns of heavier-gauge wire. The contacts are normally held open and are closed only when the magnetic pull from the armature is sufficient to overcome the tension of the adjusting spring.

The shunt coil is connected across the dynamo. When starting, the speed of the engine and thus the output of the dynamo rises until the electro-magnet is strong enough to overcome the spring tension and close the cut-out contacts. The effect of the charging current flowing through the cut-out windings creates a magnetic field in the same direction as that produced by the shunt winding. This increases the magnetic pull on the armature so that the contacts are firmly closed and cannot be separated by vibration. When the speed of the dynamo falls to a point when its output is lower than that of the batteries current flows from the batteries through the cut-out series winding and dynamo in a reverse direction to the charging current. This reverse current through the cut-out will produce a differential action between the two windings and partly de-magnetize the electro-magnet. The spring, which is under constant tension, then pulls the armature away from the magnet and so separates the contacts and opens the circuit.

Like the regulator, the operation of the cut-out is temperature-controlled by means of a bi-metal tensioning spring.

Cut-out adjustment

If the regulator is correctly set but the batteries are still not being charged the cut-out may be out of adjustment. To check the voltage at which the cut-out operates remove the control box cover and connect the voltmeter between terminals 'D' and 'E'. Start the engine and slowly increase its speed until the cut-out contacts are seen to close, noting the voltage at which this occurs. It should be 12·7 to 13·3 volts.

An alternative method of determining the exact point of contact closure is to switch on an electrical load, such as a pair of headlamps, when the instant of contact closure will be indicated by a slight flick of the voltmeter pointer.

If the cut-out operates outside the above limits it will be necessary to adjust it to within the limits. To do this turn the adjusting screw (4, Fig. N.12) in a clockwise direction to raise the setting or in an anti-clockwise direction to reduce the setting.

Turn the screw only a fraction of a turn at a time and test the setting after each adjustment by increasing the engine speed from zero and noting the voltmeter reading at the instant of contact closure.

NOTE.—Like the regulator, the setting of the cut-out must be carried out as quickly as possible to avoid errors due to the heating of the shunt coil.

Having set the 'cut-in' voltage correctly, the cut-out 'drop-off' setting should now be checked, and adjusted if necessary so that the instant of contact opening occurs between 8·5 and 11 volts.

To check the voltage at which the contacts open remove the control box cover, disconnect the cables from the control box terminals 'A' and 'A1', and join these cables together. Connect the voltmeter between terminal 'A' or 'A1' and earth; start the engine and run up to speed.

Decelerate the engine slowly and observe the voltmeter pointer, which will return to zero immediately the cut-out contacts open. The opening of the contacts should occur between the limits of 8·5 and 11 volts.

Should the opening of the contacts occur outside these limits, the setting of the fixed contact must be adjusted to bring the drop-off voltage within the above limits.

Using a pair of thin-nosed pliers, carefully bend the fixed contact blade towards the bobbin to reduce the drop-off voltage or away from the bobbin to raise the drop-off voltage. After each adjustment, which should be very small, test the setting as described above, and readjust if necessary.

Restore the original connections and refit the control box cover.

Cleaning contacts

Do not use emery-cloth or a carborundum stone for cleaning cut-out contacts. If the contacts appear dirty,

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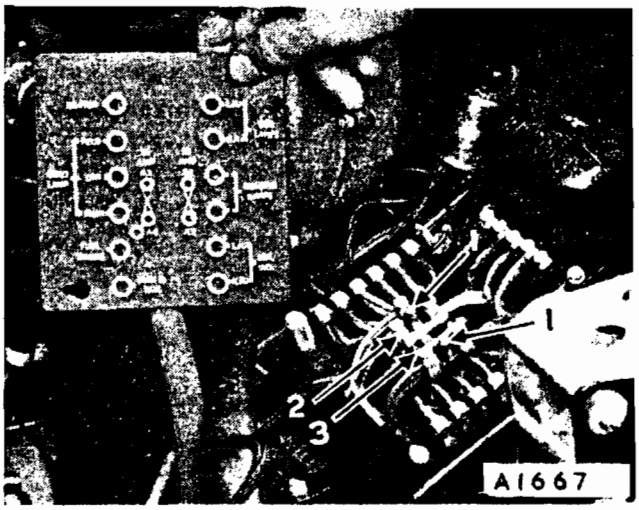

Fig. N.13
The fuse unit
1. Spare fuses. 2. 35-amp. fuse. 3. 50-amp. fuse.

rough, or burnt, place a strip of fine glass-paper between the contacts and then, with the contacts closed by hand, draw the paper through. This should be done two or three times with the rough side of the glass-paper towards each contact.

Wipe away all dust or other foreign matter, using a clean, fluffless cloth moistened with methylated spirits.

Section N.14

FUSES

The fuses are mounted in a separate holder located under the bonnet on the left-hand side.

The 50-amp. fuse between terminals '1' and '2' protects the accessories which operate irrespective of whether the ignition is on or off and the 35-amp. fuse between terminals '3' and '4' protects the accessories which operate only when the ignition is switched on.

Two spare fuses are provided, and it is important that only fuses of the correct value, marked inside the fuse tube, should be used.

Blown fuses

The units which are protected by each fuse can readily be identified by referring to the wiring diagram at the beginning of this Section.

A blown fuse is indicated by the failure of all the units protected by it and is confirmed by examination of the fuse, which can easily be withdrawn from the spring clips. If it has blown the fused state of the wire will be visible inside the glass tube. Before renewing a blown fuse inspect the wiring of the units that have failed for evidence of a short circuit or other faults which may have caused the fuse to blow, and remedy the cause of the trouble.

Section N.15

WINDSHIELD WIPER MOTOR

Normally the windshield wiper will not require any servicing apart from the occasional renewal of the rubber blades or adjustment of the parking position.

Should any trouble be experienced, first check for loose connections, worn insulation, etc., before dismantling the motor.

1. To detach the cable rack from the motor and gearbox

Unscrew the pipe union nut.

Remove the gearbox cover.

Remove the circlip and washer from the crankpin and final gear wheel.

Lift off the connecting link.

2. Commutator dirty

Remove the connecting leads to the terminals and withdraw the three screws securing the cover at the commutator end. Lift off the cover. Clean the commutator with a cloth moistened with petrol (gasoline) and carefully remove any carbon dust from between the commutator segments.

3. Brush lever stiff or brushes not bearing on commutator

Check that the brushes bear freely on the commutator. If they are loose and do not make contact a replacement tension spring is necessary. The brush levers must be free on their pivots. If they are stiff they should be freed by working them backwards and forwards by hand and by applying a trace of thin machine oil. Packing shims are fitted beneath the legs of the brushes to ensure that the brushes are central and that there is no possibility of the brush boxes fouling the commutator. If the brushes are considerably worn they must be replaced by new ones.

4. Motor operates but does not transmit motion to spindles

Remove the cover of the gearbox. A push-pull motion should be transmitted to the inner cable of the flexible rack. If the cross-head moves sluggishly between the guides lightly smear a small amount of medium-grade engine oil in the groove formed in the die-cast housing. When overhauling, the gear must be lubricated by lightly packing the gearbox with a grease to Ref. C (page P.2).

5. Thrust screw adjustments

The thrust screw is located on the top of the cross-head housing. To adjust slacken the locknut, screw down the thrust screw until it contacts the armature, and then turn back a fraction of a turn. Hold the thrust screw with a screwdriver and tighten the locknut.

6. To remove the motor

Detach the cable rack from the motor and gearbox as detailed above. Disconnect the lead. Remove the three nuts, spring washers, and rubber distance pieces securing the motor to the bracket on the valance and remove the motor.

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7. To set and adjust the parking position

If the motor is removed from the car slacken two of the cover screws and rotate the disc until the two rivets are at their farthest position from the cable.

Refit the motor to the car; remove the wiper blades, switch on the motor, and then switch off. Refit the blades to the splines in the parked position.

Further adjustment may be made by rotating the adjusting plate on the motor.

Section N.16

WINDSHIELD WIPER MAINTENANCE

Apart from the renewal of perished wiper blades, the windshield wiper requires no periodic maintenance. Efficient operation of the wiper blades is, however, dependent upon the cleanliness of the windshield, and oil and tar spots should be removed, using methylated spirits (denatured alcohol). Do not use silicon- or wax-based polishes for this purpose.

Section N.17

RENEWING THE WIPER BLADES

Lift the wiper blade clear of the windshield and raise the blade connecting link at its junction with the wiper arm. This will release the dowel on the arm from its location in the connecting link and allow the blade to be drawn off the end of the arm.

New blades are fitted by pushing the connecting link onto the end of the arm.

Section N.18

REMOVING AND REPLACING THE WIPER ARMS

The wiper arm is retained on the splined driving hub of the wheelbox spindle by a small spring clip.

Hold back the spring clip, using a small screwdriver, and withdraw the arm from the wheelbox spindle.

When replacing the arm, first place it on the hub in the parked position and then push it onto the hub until it is retained by the spring clip.

If necessary, adjust the parking position of the arms as described in Section N.15.

Section N.19

ELECTRIC HORNS

If one of the horns fails or becomes uncertain in its action it does not follow that the horn has broken down. First ascertain that the trouble is not due to a loose or broken connection in the wiring of the horn. If both horns fail or become uncertain in action the trouble is probably due to a blown fuse or discharged batteries. If the fuse has blown examine the wiring for the fault and replace the blown fuse with one of the spares provided.

The performance of a horn may be upset by a loose fixing bolt or by some component near the horn being loose. If, after carrying out the above examination, the trouble is not rectified the horn may need adjustment.

Adjustment does not alter the pitch of the note: it merely takes up wear of moving parts. When adjusting the horns short-circuit the fuse, otherwise it is liable to blow. Again, if the horns do not sound on adjustment release the push instantly.

When making adjustments to a horn always disconnect the supply lead of the other horn, taking care to ensure that it does not come into contact with any part of the chassis and so cause a short circuit.

Adjustment

Remove the fixing screw from the top of the horn and take off the cover. Detach the cover securing bracket by springing it out of its location.

Slacken the locknut on the fixed contact and rotate the adjusting nut until the contacts are just separated (indicated by the horn failing to sound). Turn the adjusting nut half a turn in the opposite direction and secure it in this position by tightening the locknut.

Section N.20

TESTING FLASHING DIRECTION INDICATORS

The flashing direction indicator lamps are operated by a switch on the steering-column through a flasher unit.

In the event of failure carry out the following procedure:

(1) Check the bulbs for broken filaments.

(2) Refer to the wiring diagram and check over the flasher circuit connections.

(3) Switch on the ignition and check that the terminal 'B' on the flasher unit is at 12 volts with respect to earth.

(4) Connect together terminals 'B' and 'L' at the flasher unit and operate the direction indicator switch.

If the flasher lights now work the flasher unit is defective and must be renewed.

Section N.21

HEADLAMPS—DESCRIPTION

The headlamps are built into the wings and are fitted with double-filament bulbs. The design is such that the bulb is correctly positioned in relation to the reflector, and no focusing is required when a replacement bulb is fitted.

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Anti-dazzle device

The double-filament bulbs are controlled by a foot-operated dipping switch deflecting both headlamp beams downwards to avoid dazzle.

Certain countries have lighting regulations to which the foregoing arrangements do not conform, and cars exported to such countries have suitably modified lighting equipment.

Section N.22

REMOVING THE LIGHT UNITS

The light units consist of a lamp glass, reflector, and a back-shell. The light unit is located to the front wing by three spring-loaded attachment screws in a domed shield attached to the wing. The back of the lamp is therefore sealed to give complete protection.

A dust- and weather-excluding rubber is fitted in the recess of the rim of the light unit and a plated rim is fitted over this to complete the weather-sealing.

To remove the light unit for bulb replacement unscrew the retaining screw at the bottom of the plated lamp rim and lift the rim away from the dust-excluding rubber.

Remove the dust-excluding rubber, which will reveal the three spring-loaded screws. Press the light unit inwards against the tension of the springs and turn it in an anti-clockwise direction until the heads of the screws can pass through the enlarged ends of the keyhole slots in the lamp rim.

This will enable the light unit to be withdrawn sufficiently to give attention to the wiring and bulbs.

Section N.23

REPLACING THE LIGHT UNITS

Position the light unit so that the heads of the adjusting screws coincide with the enlarged ends of the attachment slots. Push the light unit towards the wing to compress the springs and turn the unit to the right as far as it will go, that is, approximately ½ in. (12·7 mm.).

Replace the dust-excluding rubber on the light rim with its flanged face forward and refit the plated rim.

Section N.24

SETTING THE HEADLAMPS

The lamps should be set so that the main driving beams are parallel with the road surface or in accordance with local regulations.

If adjustment is required, this is achieved by removing the plated rim and dust-excluding rubber as indicated in Section N.22.

Vertical adjustment can then be made by turning the screws at the top of the lamp in the necessary direction.

Horizontal adjustment can be effected by using the adjustment screws on each side of the light unit (see Fig. N.14.).

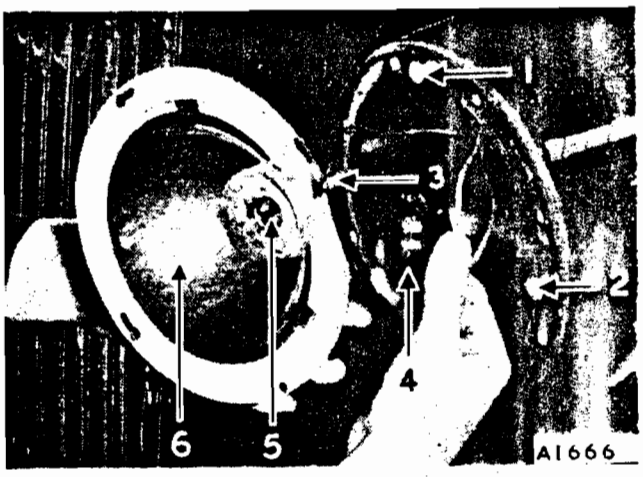

Fig. N.14

The headlamp assembly

1. Vertical adjustment screw.
2. Horizontal adjustment screw.
3. Horizontal adjustment screw.
4. Adaptor.
5. Bulb.
6. Light unit.

Section N.25

REPLACING HEADLAMP BULBS

Twist the back-shell anti-clockwise and pull it off. Withdraw the bulb from the holder.

Insert the replacement bulb in the holder, making sure that the slot in the periphery of the bulb flange engages the projection in the holder.

Engage the projections on the back-shell with the slots of the holder, press it on, and twist it clockwise until it engages with its catch.

Section N.26

CLEANING THE LAMPS

Care must be taken when handling headlamp reflectors to prevent them from becoming finger-marked.

Chromium-plated surfaces such as lamp rims should be washed with plenty of water, and when the dirt is completely removed they may be polished with a chamois-leather or soft dry cloth. **Do not use metal polishes on chromium plating.**

Section N.27

FOG LAMPS

Access to the bulb is gained by detaching the lamp unit after removal of the securing screw.

The bulb is retained in the reflector by a bulb adaptor which is easily removed by turning to left or right.

The lamps must be set so that the beams do not rise above the horizontal when the car is standing on level ground. To ensure this dip the beams very slightly to compensate for road inequalities or an extra-heavy loading in the rear of the car. In addition the beams can

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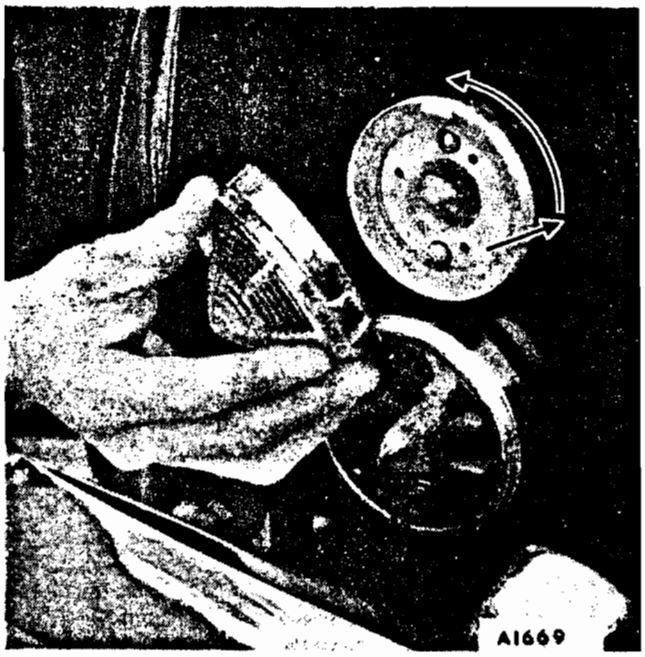

Fig. N.15

Stop tail and flashing indicator lamps. Push the lamp front inwards and turn anti-clockwise to gain access to the bulb

be swung slightly to the left in order to give additional illumination on the near side of the road.

To adjust the fog lamp beam slightly slacken the lamp-securing nut so that the lamp may be turned to the desired position. When tightening this bolt care must be taken to ensure that the lamp is not again turned and the alignment upset.

Section N.28

PILOT LAMPS

Remove the screw at the rear of the pilot lamp and withdraw the light rim together with the glass and bulb holder.

Squeeze the bulb holder prongs together and withdraw the rim, lens, and rubber sealing ring. To replace the unit locate the prongs of the bulb holder beneath the flange of the rim. having first ensured that the lens and sealing ring have been fitted.

Section N.29

TAIL, STOP, AND FLASHING DIRECTION INDICATOR LAMPS

To gain access to a tail and stop lamp or flashing direction indicator lamp bulb simultaneously push in and twist the lamp glass in an anti-clockwise direction. This will enable the glass to be removed, leaving the bulb accessible in its socket.

The tail and stop lamp bulb has a double filament. and the offset-peg. bayonet-type fixing ensures correct replacement in the holder.

The flashing direction indicator lamp bulbs do not have offset pegs and may be replaced either way round.

Section N.30

REAR NUMBER-PLATE LAMP AND REVERSING LAMP

To gain access to the reversing lamp bulb unscrew the two flange screws when the cover and glass can be removed to give access to the bulb.

Access to the rear number-plate lamp bulb may be gained when the cover, secured by a single screw, is removed.

Section N.31

LUGGAGE COMPARTMENT LAMP

Withdraw the holder upwards from within the transparent plastic cover and remove the festoon-type bulb from the spring clips.

Section N.32

INTERIOR LAMPS

The bayonet fitting bulbs for the interior lamps can be removed from their holders after removing one screw. rim, and glass from the lamp.

Section N.33

STEP LAMPS

Access to the step lamp bulb for replacement is obtained by folding back the rubber flange and removing the plated rim and lamp glass. Only the fingers should be used to fold back the rubber flange.

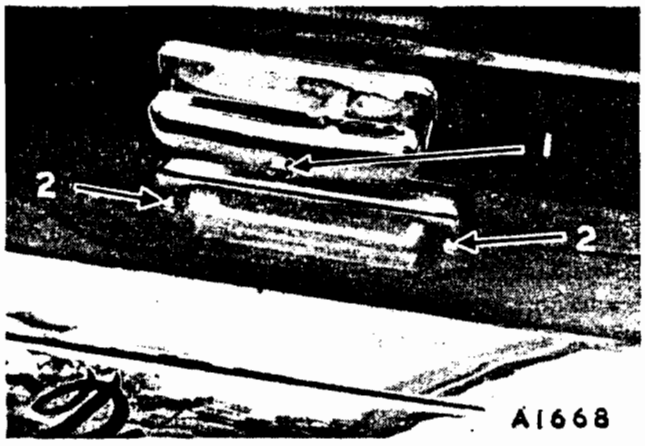

Fig. N.16

The rear number-plate and reversing lamps

1. Fixing screw for number-plate lamp glass.
2. Fixing screw for reversing lamp glass.

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Section N.34

PANEL LAMPS AND WARNING LAMPS

Four bulbs are used to illuminate the instruments and a further four bulbs are used to illuminate the control knob panel.

The various holders can be reached from the rear of the instrument panel when it is necessary to renew bulbs.

Warning lights

The bulb holders can be withdrawn from the back of the instrument panel to enable the ignition, main beam, and flashing direction indicator warning light bulbs to be unscrewed for renewal.

Section N.35

LUCAS ELECTRIC SCREENJET MODEL 28J

General description

A small permanent-magnet motor is mounted on top of a moulded cover screwed on a glass water container. Inside the container is a small centrifugal pump combined with an auxiliary reservoir. This assembly is attached to the under side of the moulded cover by means of a brass tube. Through this tube runs a spindle which couples the pump rotor to the electric motor.

Water from the container enters the auxiliary reservoir through a filter gauze and inlet orifices in the base of the pump. Each operation of the pump discharges the contents of the reservoir through the nozzle and so onto the windscreen.

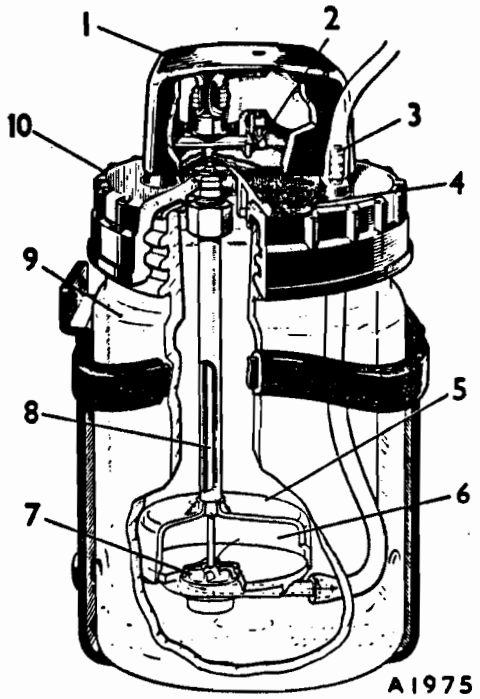

Fig. N.17

The screen washer

1. Motor unit.
2. Electrical contacts.
3. Connecting tube.
4. Filler cap.
5. Pump assembly.
6. Auxiliary reservoir.
7. Pump motor.
8. Motor spindle.
9. Glass container.
10. Moulded cover.

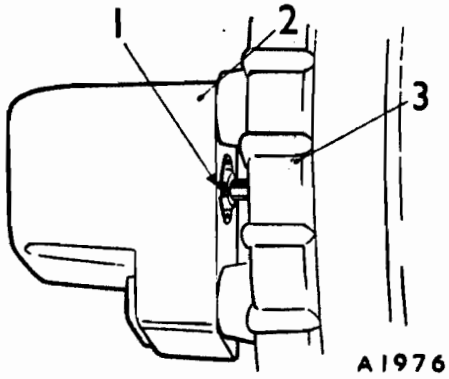

Fig. N.18

Lubrication of the screen washer

1. Oil here sparingly. 2. Motor unit. 3. Moulded cover.

When using the Screenjet an indication of the need to refill the container is given by the behaviour of the unit. The time taken for the auxiliary reservoir to refill increases as the water level in the container falls.

As soon as the water level has fallen to the top of the auxiliary reservoir the amount of water delivered to the windscreen will decrease with successive operations and the time the unit runs will, in proportion, become less.

If the water level is allowed to fall still further, until it is down to the bottom of the auxiliary reservoir, the automatic action will cease and water will be delivered to the windscreen only as long as the operating button is pressed. This will continue until the water level has fallen to the inlet orifices, when the pump will be above water level and no water will be available for delivery to the windscreen. Refilling the container will restore normal operation of the unit.

Filling up

The correct water level is at the bottom of the container neck, and refilling to this level becomes necessary when the water level has fallen so that the top of the auxiliary reservoir is uncovered. It is important that only **clean** water should be used when refilling. If possible, use soft water when filling the container, but if this is not obtainable and hard water has to be used, occasionally remove any deposits which may form around the nozzle outlet holes.

Cleaning the nozzle outlet holes

Unscrew the nozzle cap and clear the outlet holes by blowing or, if necessary, by pushing a length of wire or a pin through them. Operate the Screenjet with the cap removed. Replace the nozzle cap and tighten firmly.

Lubrication

If, after lengthy service, the motor begins to run more slowly, unscrew the moulded cover from the container, hold it as shown in Fig. N.18, and apply one or two drops of thin machine oil to the felt pad. Do not over-lubricate or excess oil may find its way into the water container when the cover is refitted, with consequent smearing of the windscreen.

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Section N.36

REPLACEMENT BULBS

	Volts	Watts	B.M.C. Part No.
Headlamps			
R.H.D. (Home)	12	60/36	17H5414
R.H.D. (Export)	12	42/46	3H1892
L.H.D. (Export)	12	42/36	3H1893
Europe—except France	12	45/40	3H921
Fog lamps	12	48	1F9034
Instrument panel and warning lights	12	2·2	2H4732
Luggage compartment lamp	12	3	4G867
Stop/tail and rear compartment lamps	12	21/6	1F9026
Flasher, reverse, and front interior lamps	12	21	1F9012
Direction indicator switch light	12	·75	27H57388
Sidelamps and step and rear number-plate lamps	12	4	1D9081

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SECTION O

THE WHEELS AND TYRES

	Section
Tyre	
Balance	O.5
Fitting	O.6
Maintenance	O.1
Removal	O.4
Repairing	O.7
Valves	O.2
Wheel—removing	O.3

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Section O.1

TYRE MAINTENANCE

Even tyre wear is promoted by occasionally interchanging the positions of the tyres on the car. The spare tyre should be brought into use with the others.

Attention should be paid to the following points, with a view to obtaining the maximum mileage from the tyre equipment of the vehicle.

Test the pressures of the tyres every 500 miles (800 km.) by means of a suitable gauge and restore any air lost. It is not sufficient to make a visual inspection of the tyres for correct inflation. Inflate the spare wheel tyre to the correct rear wheel pressure.

The correct tyre pressure figures will be found under **'GENERAL DATA'.**

Keep the treads free from grit and stones and carry out any necessary repairs. Clean the wheel rims and keep them free from rust. Paint the wheels if necessary.

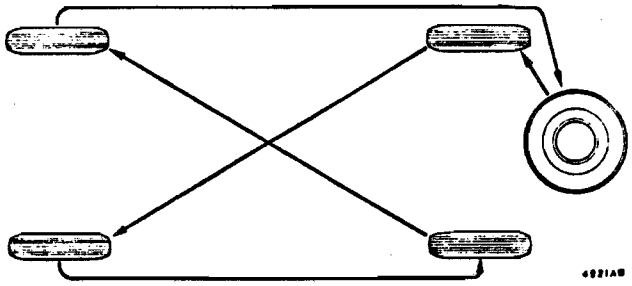

Fig. O.1

Interchange the road wheels diagonally, bringing the spare wheel into use

Keep the brakes adjusted correctly and in good order. Fierceness or uneven action of either the clutch or brakes has a destructive effect upon the tyres.

Misalignment is a very costly error. Suspect it if rapid wear of the front tyres is noticed, and correct the fault at once. See Section J.5 for details on front wheel alignment.

Should the tyres get oily, fuel should be applied sparingly and wiped off at once.

Avoid under- and over-inflation.

Avoid kerbing and other causes of severe impact.

Have any damage repaired immediately.

Section O.2

VALVES

A mushroom-headed rubber valve is used with tubeless tyres. The valve is secured in the wheel by a small stepped flange on the rubber valve and by the pressure of air inside the tyre.

A simple but effective tool (Fig. O.2) for fitting the valve can be made up from a 7 in. (177·8 mm.) length

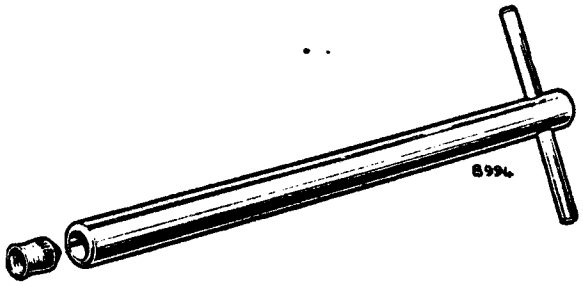

Fig. O.2

A simple tool for fitting tubeless tyre valves

of ½ in. (12·7 mm.) steel bar or 13 S.W.G. steel tubing. Using a letter 'S' drill, drill a hole in one end to a depth of approximately ⅝ in. (15·87 mm.).

Obtain an ordinary brass valve dust cap and solder the cap in the drilled hole.

The opposite end of the tool requires a hole drilling about ½ in. (12·7 mm.) from the end to accept a short piece of ¼ in. (6·35 mm.) diameter rod to provide a handle.

To fit the valve with the aid of the tool, first liberally coat the rubber valve and the perimeter of the valve hole in the wheel with soapy water. Insert the valve into the hole and screw on the special tool. A sharp pull will seat the valve correctly.

The valves may be tested for airtightness by rotating the wheel until the valve is at the top and inserting the end of the valve in a small container of water. If bubbles appear the seating is faulty and the valve interior should be replaced with a new one.

It is advisable to change the valve interiors every 12 months.

Valve caps, in addition to preventing dirt entering the valve, from a secondary air seal and should always be fitted.

Section O.3

REMOVING A WHEEL

Insert the flattened end of the wheelbrace between the lip of the hub cover and the road wheel, and, with a sideways movement of the wheelbrace, lever the hub cover from the road wheel.

Slacken each of the six nuts securing the road wheel to the hub half a turn.

NOTE.—Studs on the right-hand side have right-hand threads, studs on the left-hand side have left-hand threads.

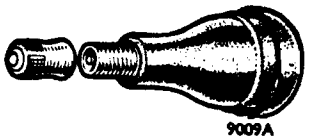

Fig. O.3

Valve for the tubeless tyre

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Raise the wheel from the ground by means of the Jackall system (see Section Q).

Completely unscrew the nuts and remove the wheel from its hub.

Refitting the wheel is a reversal of these instructions, ensuring that the wheel nuts are fitted with their chamfered ends towards the wheel and tightening them to a torque of 60 to 63 lb. ft. (8·3 to 8·71 kg. m.). The nuts should be tightened in the order 1, 4, 2, 5, 3, 6, imagining them to be numbered 1 to 6 in rotation.

Section O.4

TYRE REMOVAL

Remove the valve interior to completely deflate the tyre.

Push both cover edges into the well-base of the wheel and, at a point diametrically opposite, lever the cover edge over the rim of the wheel, using two levers at intervals of 6 in. (15 cm.) apart. Continue working round the wheel until the cover on one side is completely free.

NOTE.—Do not attempt to stretch the edges of the tyre cover over the rim edge and only use thin, narrow levers in good condition without rust or burrs. Do not widely space the levers.

Force is entirely unnecessary and is detrimental, as it tends to damage the wire edges. Fitting or removing is quite easy if the tyre edges are carefully adjusted into the rim base; if found difficult, the operation is not being performed correctly.

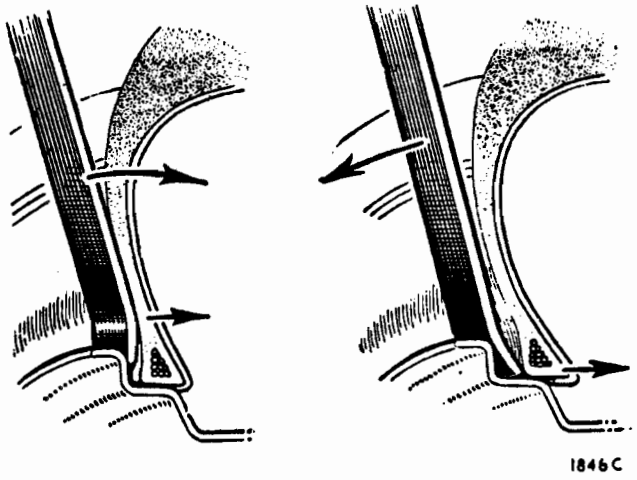

Fig. O.4

The tyres have wired edges and no attempt must be made to stretch them. If the cover fits tightly on the rim seating it should be freed by using the tyre levers as indicated

1. Insert lever between bead and rim, with curved side against tyre. Press lever towards tyre.
2. Insert second lever next to first lever with curved side outwards, and pull lever away from tyre. Repeat at intervals round tyre until bead is free. Several circuits of tyre may be necessary.

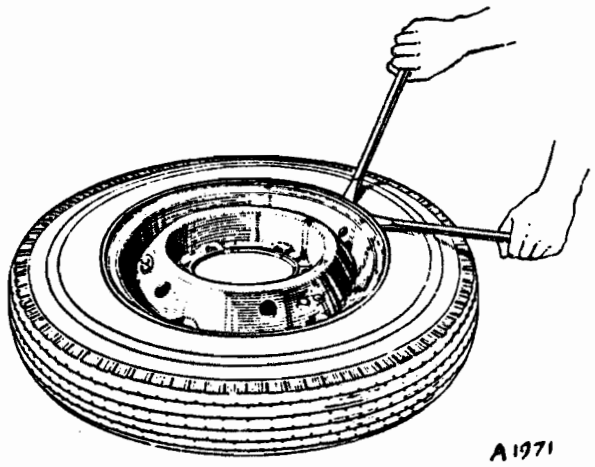

Fig. O.5

Press each bead in turn off its rim seat, using the tyre levers as shown, working in small steps round the rim

Stand the tyre and wheel upright, keeping the bead in the base of the rim. Lever the bead over the rim flange and at the same time push the cover away from the wheel with the other hand.

Section O.5

TYRE BALANCE

In order to obtain good steering it is of importance to ensure that the wheels with tyres fitted are in good balance. To assist this the tyre manufacturers are now marking their tyres with a white or green spot in the neighbourhood of the bead at the lightest point of the cover. When fitting tyres to the wheels ensure that they are assembled with the spot on the cover in line with the valve.

Special balance weights, which cover a range from ½ to 3½ oz. (14·2 to 99 gm.) in steps of ½ oz. are supplied for attachment to the wheel rim.

Their use is advised to maintain the correct balance for the wheels, which must be within 12 in. oz. (·85 cm. kg.).

Section O.6

TYRE FITTING

The tubeless tyre relies primarily on a good air seal between the tyre bead and the rim, and also between the rim and the valve. Great care is therefore necessary to avoid the slightest damage to the tyre bead, and the following instructions are of great importance.

Rim preparation

(1) Remove any visible dents in the flange by careful hammering.

(2) Clean the flange and rim seat with steel wool, emery, or other cleaning medium and remove all foreign matter, rust, rubber, etc. Paint need not

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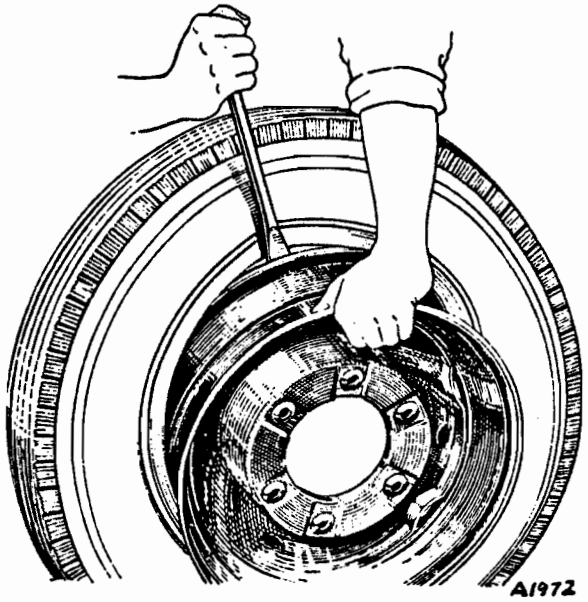

Fig. O.6

Lever the cover bead over the rim, using only levers that are in good condition to avoid damaging the sealing edge of the tyre

be removed but irregularities in the surface should be smoothed out. In extreme cases of rusting it may be necessary to use a wire brush or a file.

(3) File or buff away any high-spot at the butt-weld joint.

(4) Wipe the flange and bead seat with a water-moistened cloth.

Before fitting, moisten the beads of the tyre, the rim flange, and the tyre levers with water; **do not use petrol (gasoline).** Mount the tyre on the rim and push one edge of the cover over the edge of the rim; continue working round the tyre towards the valve position. The portion of the tyre first fitted should be kept pushed into the well-base of the wheel rim and then no difficulty will be encountered in fitting the last portion of the cover. **Do not forget that the white or green balance spot on the tyre must be in line with the valve position.**

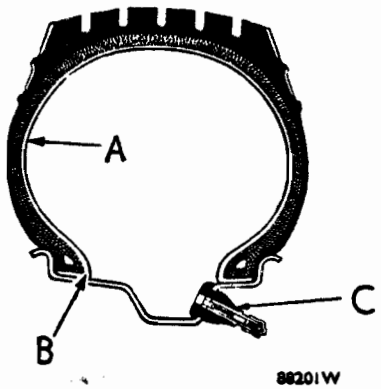

Fig. O.7

Section through a tubeless tyre

A. Air-retaining liner. B. Rubber air seal.
C. Rubber-sealed valve.

Before inflation, bounce the crown of the tyre on the ground at various points to snap home the beads of the tyre against the rim of the wheel and provide a partial seal. Refit the valve interior.

With the wheel in an upright position, inflate the tyre. If a seal cannot be obtained at the first rush of air bounce the tyre again with the air-line attached. In cases of difficulty apply a tourniquet of strong cord around the circumference of the tyre and tighten. Inflate to a maximum of 40 lb./sq. in. (2·8 kg./cm.²) until the beads are completely forced against both rim flanges.

If a pressure of 40 lb./sq. in. (2·8 kg./cm.²) will not seat the beads properly, deflate, lubricate the beads and rim with Tyre Bead Lubricant, centralize the tyre, and re-inflate. If the second attempt is unsuccessful, the wheel rim circumference is suspect and should be checked with a rim gauge if available, or replaced with a new wheel.

Allow the tyre to stand for a few minutes so that any free air trapped between the flange and the bead clinch can escape. Test the complete assembly in a water tank, paying special attention to the areas at the beads, valve, and wheel rivets.

After the beads have seated correctly and the leak test is satisfactory adjust the tyre to its correct running pressure.

Sealing leaks located during testing

Loss of air may occur at any or all of the following points:

(1) The area of the bead seat, showing as a leak at the top of the flange.

This is usually due to a high-spot on the rim and may be cured by holding the bead away from the rim to allow further cleaning.

(2) The wheel rivets. In this case, and in extreme cases of leakage in the area of the bead seat, it is necessary to remove the tyre. Before doing so mark the position of the leak on the tyre and rim.

Loss of air at the rivets can be cured by peening over the rivet heads.

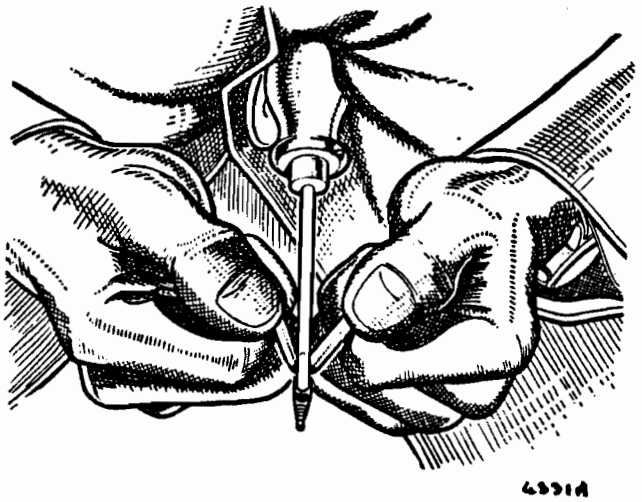

Fig. O.8

Rolling a plug into the needle eye

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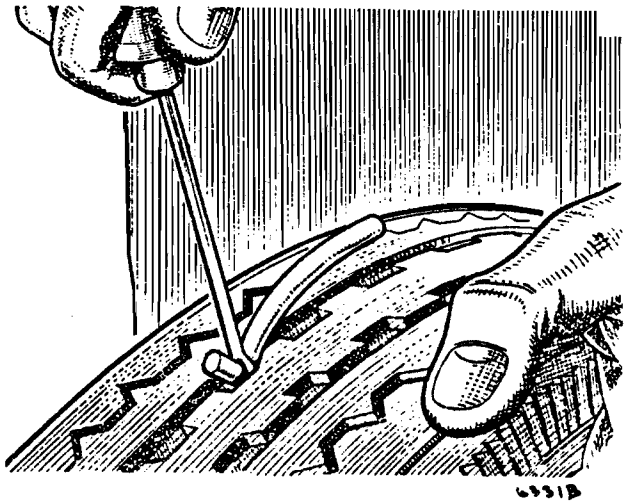

Fig. O.9

Inserting the plug and needle through the hole in the tyre

(3) The base of the valve or the valve interior. Provided the valve is correctly fitted, this may be due only to dirt under the valve seat. Clean the area of the valve seat on the wheel and fit a new valve interior.

Inflate the tyre to the correct pressure before fitting the wheel assembly to the vehicle.

Section O.7

REPAIRING TYRES

Penetrations

Normally a tubeless tyre will not leak as the result of penetration by a nail or other puncturing object, provided that it is left in the tyre. It is necessary to examine the tyres occasionally and to withdraw such objects at a time when loss of air pressure will cause least inconvenience.

Use of plugging kit—location and preparation

If a hole fails to seal mark the spot and extract the puncturing object, taking note of the direction of penetration. If the tyre is leaking and the puncturing object cannot be located by sight it is necessary to immerse the inflated tyre in water.

Dip the plugging kit needle into the flask of solution and insert it into the hole in the tyre, following the same direction as the penetration.

Repeat the operation until the hole is well lubricated with solution.

Repair

Select a plug about twice the diameter of the puncturing object, and stretch and roll it into the eye of the needle $\frac{1}{4}$ in. (6·35 mm.) from the end (Fig. O.8). After dipping the plug into the solution insert the needle into the hole and push the plug through the tyre (Figs. O.9 and O.10).

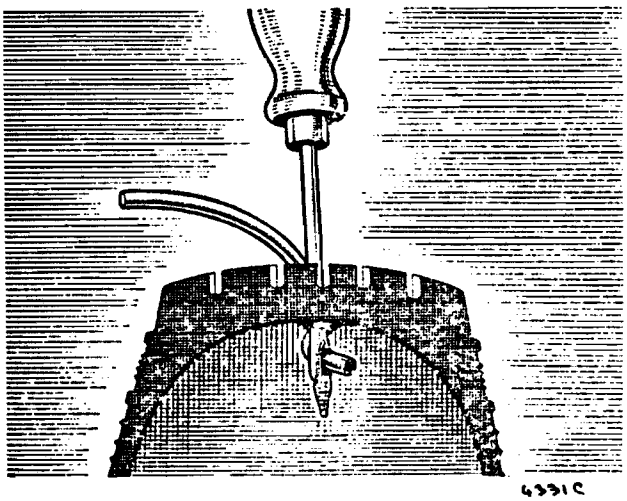

Fig. O.10

The inserted plug prior to withdrawing the needle

Withdraw the needle and cut off surplus plug about $\frac{1}{8}$ in. (3·18 mm.) from the surface of the tread. The tyre can now be inflated and used immediately. More severe injuries which are outside the scope of simple puncture repair methods are dealt with in nearly the same way as similar injuries to conventional covers.

If the tyre deflates on the road following an unusually large penetration a tube can be fitted to enable the vehicle to remain on the road until it is convenient for the necessary repairs to be carried out. (The valve used for the tubeless tyre must be removed before the fitting of the tube.)

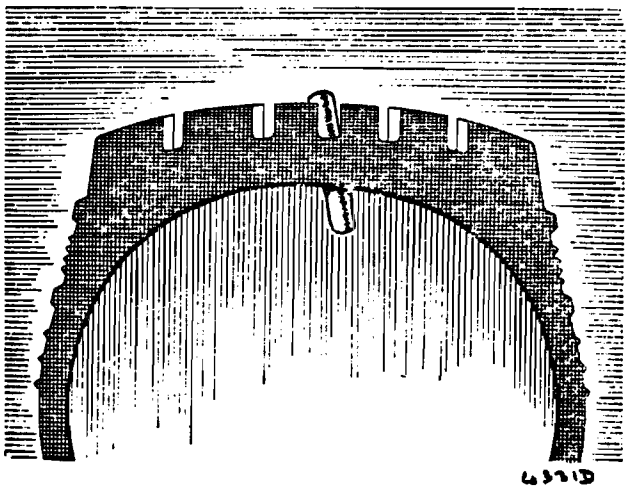

Fig. O.11

The plug cut off to the correct length

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SECTION P

LUBRICATION

Correct lubrication of any piece of mechanism is of paramount importance, and in no instance is it of greater importance than in the correct choice of lubricant for a motor-car engine. Automobile engines have different characteristics, such as operating temperatures, oiling systems, size of oilways, clearances, and similar technicalities, and the use of the correct oil is therefore essential.

	Section
Recommended lubricants	P.1
Engine	P.2
Gearbox and rear axle	P.3
Steering-box and grease points	P.4

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Section P.1 RECOMMENDED MONOGRADE LUBRICANTS

ENGINE AND AIR CLEANER

Climatic conditions	Duckham's	Castrol	Esso	Mobil	Shell	BP Energol	Filtrate	Sternol
Tropical and temperate down to 32° F. (0° C.)	Duckham's NOL Thirty	Castrol X.L.	Esso Extra Motor Oil 20W/30	Mobiloil A	Shell X—100 30	Energol S.A.E. 30	Medium Filtrate 30	Sternol W.W. 30
Extreme cold down to 10° F. (−12° C.)	Duckham's NOL Twenty	Castrolite	Esso Extra Motor Oil 20W/30	Mobiloil Arctic	Shell X—100 20W	Energol S.A.E. 20W	Zero Filtrate 20/20W	Sternol W.W. 20
Arctic consistently below 10° F. (−12° C.)	Duckham's NOL Ten	Castrol Z	Esso Motor Oil 10	Mobiloil 10W	Shell X—100 10W	Energol S.A.E. 10W	Sub-Zero Filtrate 10W	Sternol W.W. 10

GEARBOX (SYNCHROMESH)

All conditions	Duckham's NOL Thirty	Castrol X.L.	Esso Extra Motor Oil 20W/30	Mobiloil A	Shell X—100 30	Energol S.A.E. 30	Medium Filtrate 30	Sternol W.W. 30

REAR AXLE AND STEERING GEARBOX

All conditions down to 10° F. (−12° C.)	Duckham's Hypoid 90	Castrol Hypoy	Esso Gear Oil G.P. 90	Mobilube G.X. 90	Shell Spirax 90 E.P.	Energol E.P. S.A.E. 90	Hypoid Filtrate Gear 90	Ambroleum E.P. 90
Arctic consistently below 10° F. (−12° C.)	Duckham's Hypoid 80	Castrol Hypoy Light	Esso Gear Oil G.P. 80	Mobilube G.X. 80	Shell Spirax 80 E.P.	Energol E.P. S.A.E. 80	Hypoid Filtrate Gear 80	Ambroleum E.P. 80

LUBRICATING NIPPLES, WATER PUMP, WHEEL HUBS

All conditions	Duckham's L.B. 10 Grease	Castrolease L.M.	Esso Multi-purpose Grease H	Mobilgrease M.P.	Shell Retinax A	Energrease L. 2	Super Lithium Filtrate Grease	Ambroline L.H.T.

UTILITY LUBRICANT, OILCAN POINTS, ETC.

All conditions	Duckham's NOL Twenty	Castrolite	Esso Extra Motor Oil 20W/30	Mobiloil Arctic	Shell X—100 20W	Energol S.A.E. 20W	Zero Filtrate 20/20W	Sternol W.W. 20

AUTOMATIC TRANSMISSION

All conditions	Duckham's Nolmatic Automatic Transmission Fluid Type A	Castrol T.Q.	Esso Automatic Transmission Fluid	Mobilfluid 200	Shell Donax T. 6	Energol Automatic Transmission Fluid Type A	Filtrate Automatic Transmission Fluid Type A	Sternol Lynx

UPPER CYLINDER LUBRICANT

All conditions	Duckham's Adcoid Liquid	Castrollo	Esso Upper Cylinder Lubricant	Mobil Upperlube	Shell Upper Cylinder Lubricant	Energol U.C.L.	Filtrate Petroyle	Sternol Magikoyl

POWER-ASSISTED STEERING

Above 10° F. (−12° C.)	Duckham's NOL Ten	Castrol Z	Esso Motor Oil 10	Mobiloil 5W	Shell X—100 10W	Energol S.A.E. 10W	Filtrate Sub-Zero 10W	Sternol W.W. 10
Below 10° F. (−12° C.)	Duckham's NOL Five	Castrol Z.Z.	Esso Motor Oil 5W	Mobiloil 10W	Shell X—100 5W	Energol S.A.E. 5W	Filtrate Sub-Zero 5W	Sternol W.W. 5

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Multigrade motor oils

In addition to the recommended monograde lubricants listed we approve the use of these motor oils, as produced by the oil companies shown in our Manuals, for all climatic conditions unless the engine is in poor mechanical condition.

RECOMMENDED MULTIGRADE LUBRICANTS

Component	Engine and Gearbox (synchromesh)
Climatic conditions	All temperatures above −17·8° C. (0° F.)
MOBIL	Mobiloil Special
BP	B.P. Energol Visco-Static
SHELL	Shell X—100 Multigrade 10W/30
FILTRATE	Filtrate 10W/30 Multigrade
STERNOL	Sternol Multiplic
DUCKHAM'S	Q5500
CASTROL	Castrolite*
ESSO	Esso Extra Motor Oil 20W/30*

Approval is also given to Duckham's Q.20–50, B.P. Viscostatic 'Longlife' oil and to monograde or single-viscosity conventional lubricants supplied by companies listed in this chart.

* For temperatures below −12·2° C. (10° F.) use the S.A.E. 10W/30 grade oil. This is available in markets where such low temperatures prevail.

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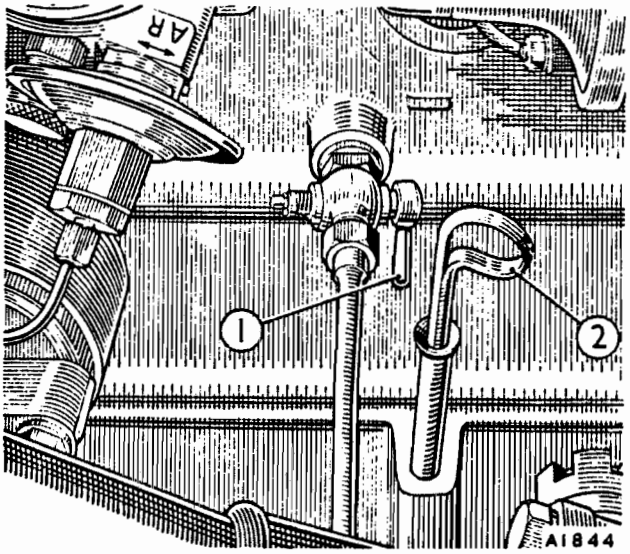

Fig. P.1

1. Cylinder block water drain tap. 2. Engine dipstick.

Section P.2

ENGINE

CHECKING OIL LEVEL

Inspect the oil level in the engine, and refill if necessary to the 'MAX' mark on the dipstick. The oil filler cap is on top of the engine valve cover and is released by turning it anti-clockwise.

OIL CHANGE

Drain the oil from the engine sump and refill with a recommended oil (Section P.1). The sump plug should be removed after a journey when the oil is warm and will drain easily.

The oil capacity is shown under **'GENERAL DATA'.**

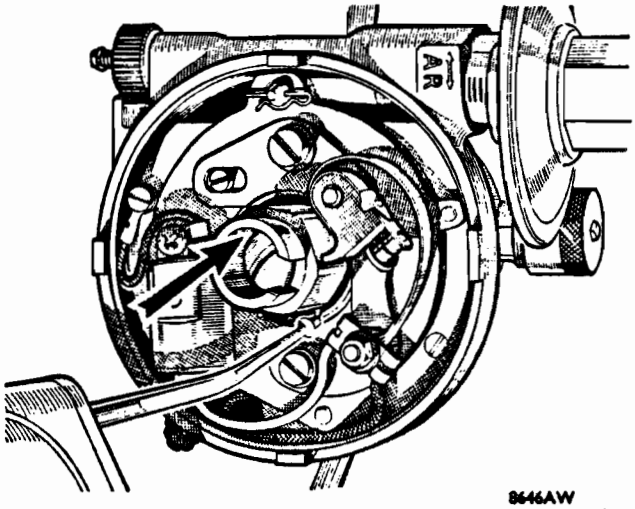

Fig. P.2

The distributor cam bearing and automatic advance lubricating points

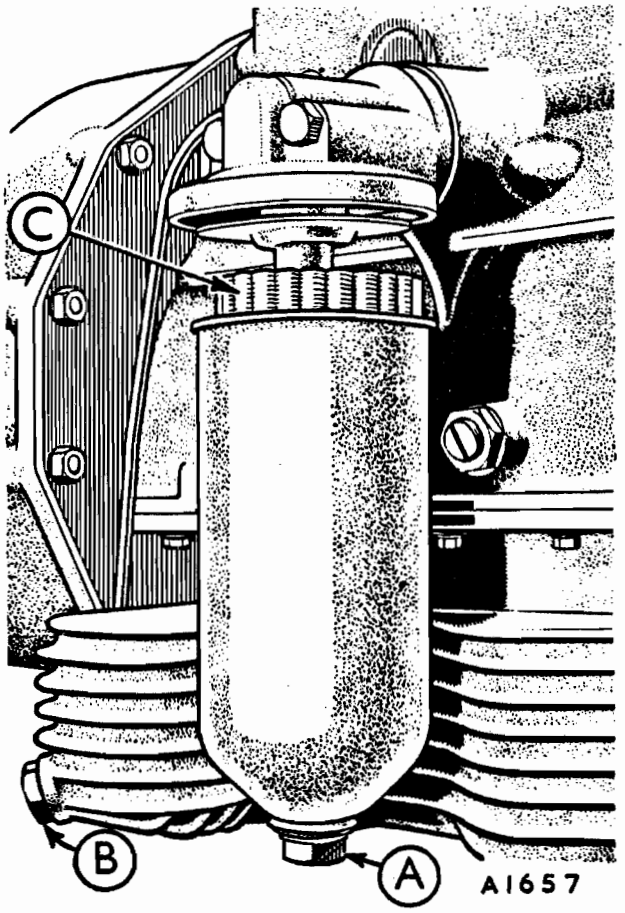

Fig. P.3

A. Filter centre-fixing bolt.
B. Oil sump drain plug.
C. Oil filter element.

OIL FILTER

Unscrew the central bolt to release the filter bowl, discard the old filter element, and wash out the filter bowl with fuel. Allow the filter bowl to dry thoroughly, install a new element of the correct type, and fill the bowl with new engine oil. Refit, ensuring that the filter bowl joint is in good order and that there are no oil leaks.

DISTRIBUTOR

Screw in the greaser (if fitted) one half-turn. When necessary, unscrew and refill the cap with one of the recommended lubricants (Section P.1).

Cam bearing

Lift the rotor off the top of the spindle by pulling it squarely and add a few drops of thin engine oil.

Cam

Lightly smear the cam with a very small amount of grease (see Section P.1). If this is not available clean engine oil can be used.

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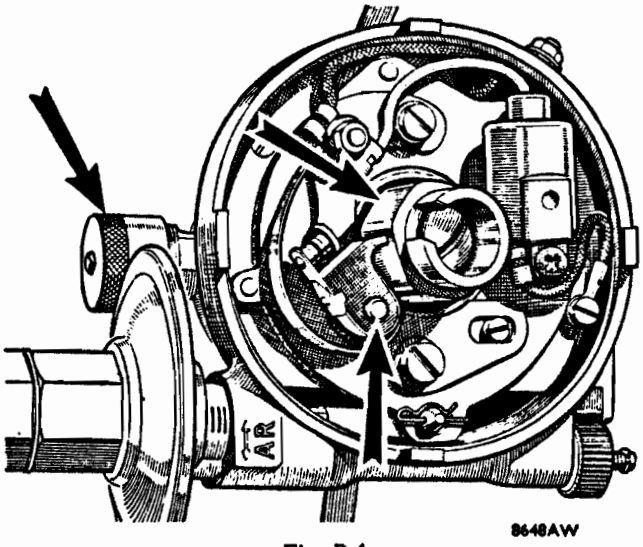

Fig. P.4

The distributor cam, drive shaft, and contact breaker pivot lubricating points

Automatic timing control

Carefully add a few drops of thin engine oil (Section P.1), through the hole in the contact breaker base. Do not allow the oil to get on or near the contacts. Do not over-oil.

Contact breaker pivot

Add a spot of clean engine oil to the moving contact pivot pin.

DYNAMO

Add one or two drops of oil (see Section P.1) to the dynamo commutator end bearing through the central hole in the rear end bearing plate.

Avoid over-lubrication.

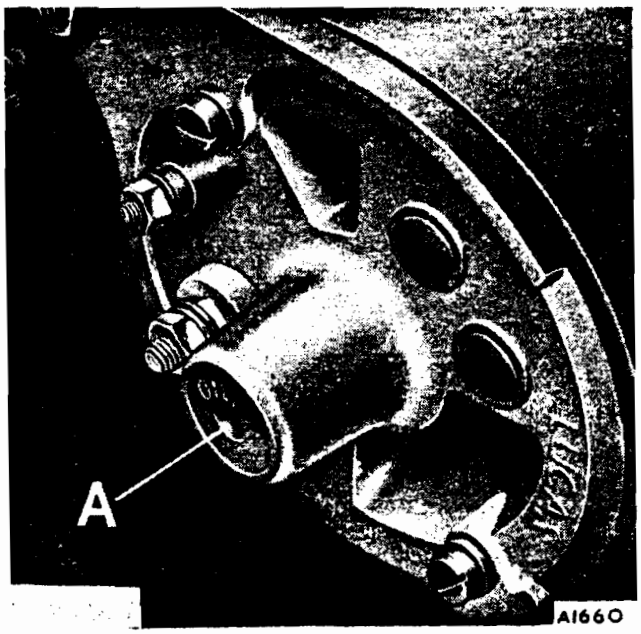

Fig. P.5

The dynamo bearing lubrication point

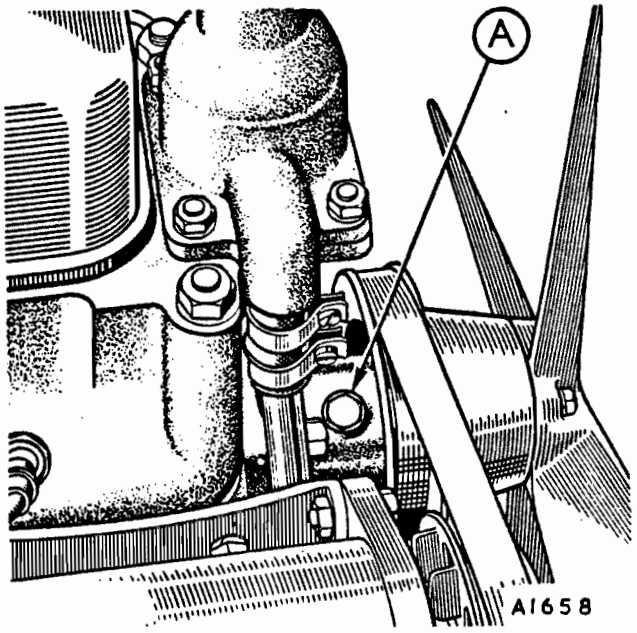

Fig. P.6

The water pump lubrication plug

NOTE.—This service is not necessary when the vehicle is fitted with power-assisted steering.

WATER PUMP

Remove the plug from the water pump, inject a small amount of grease (see Section P.1), and replace the plug. The lubrication of the pump must be done very sparingly, otherwise grease will seep past the bearings onto the face of the water seal and impair its efficiency.

AIR CLEANER

Gauze type

Remove the air cleaner and wash the gauze thoroughly in fuel. Soak the gauze in oil (see Section P.1) and

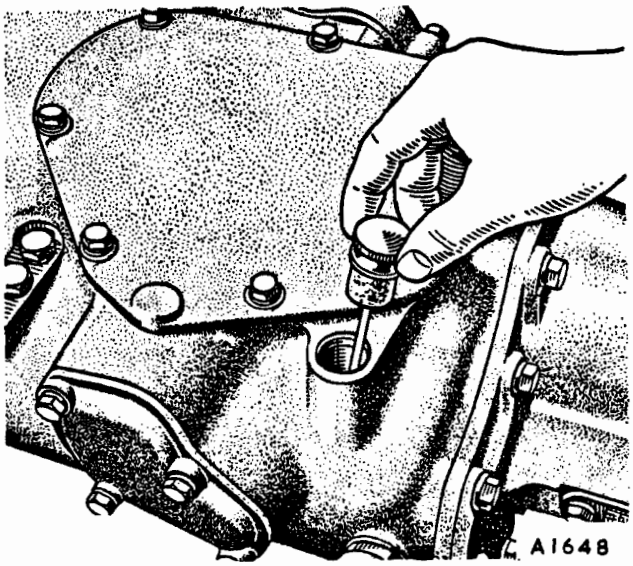

Fig. P.7

The combined gearbox oil level indicator and filler plug

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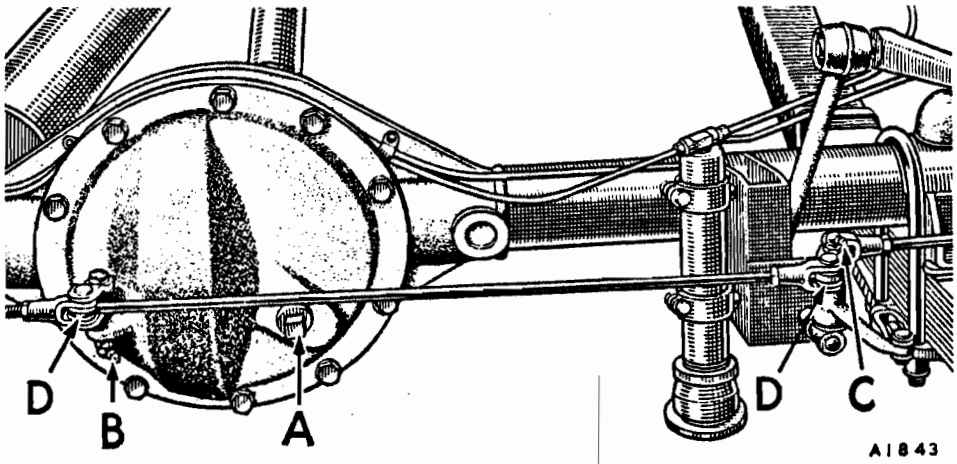

Fig. P.8

A. Rear axle combined filler and level plug.
B. Linkage pivot lubrication nipple.
C. Balance lever lubrication nipple.
D. Brake linkage felt washer joints.

allow the excess oil to drain off before refitting the air cleaner.

Oil bath type

Remove the air cleaner and empty the oil. Thoroughly clean the sludge from the oil container and wash the filter gauze.

Section P.3

GEARBOX AND REAR AXLE

GEARBOX

Check the level, and top up if necessary. The dipstick and oil filler are combined and are accessible by lifting the floor carpet over the gearbox and raising the hinged panel then visible.

Remove the dipstick and fill up to the indicated level.

AUTOMATIC TRANSMISSION

To check the automatic transmission oil level and top up with oil (see Section P.1), or drain as necessary, refer to the special instructions for this operation as given in Section FF.3.

REAR AXLE

Check the level, and top up if necessary. The filler plug is located on the rear of the axle case and also serves as an oil level indicator. After topping up allow time for any surplus oil to run out should too much have been injected. This is most important, as if the axle is overfilled the lubricant may leak through to the brake linings and lessen their efficiency. Use an oil as recommended on page P.2.

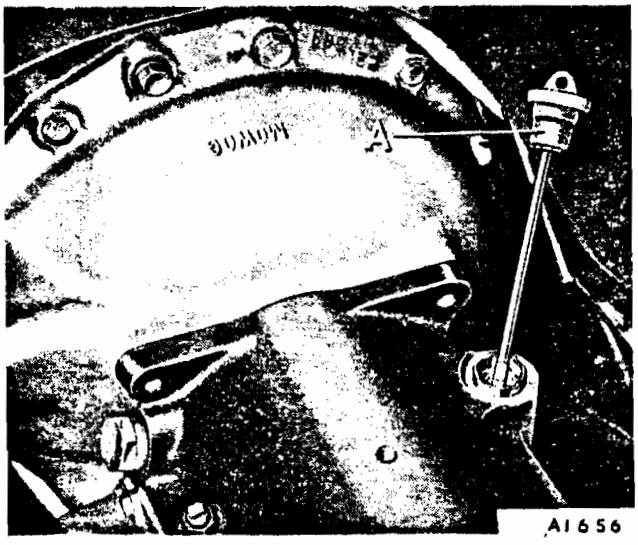

Fig. P.9

The automatic transmission combined filler plug and dipstick

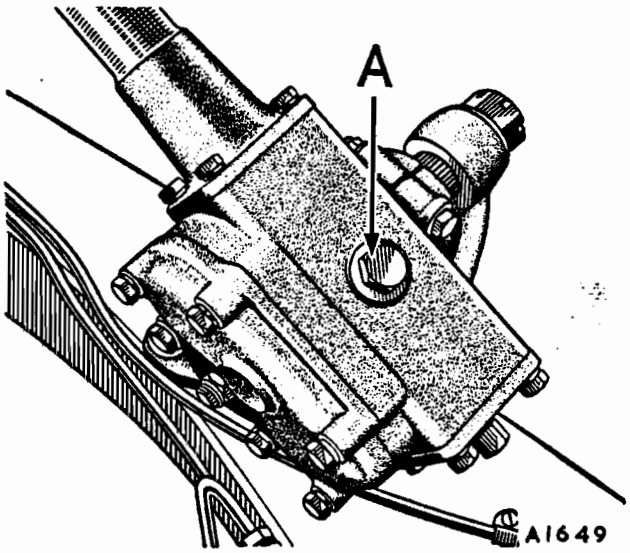

Fig. P.10

The steering gearbox combined oil filler and level plug

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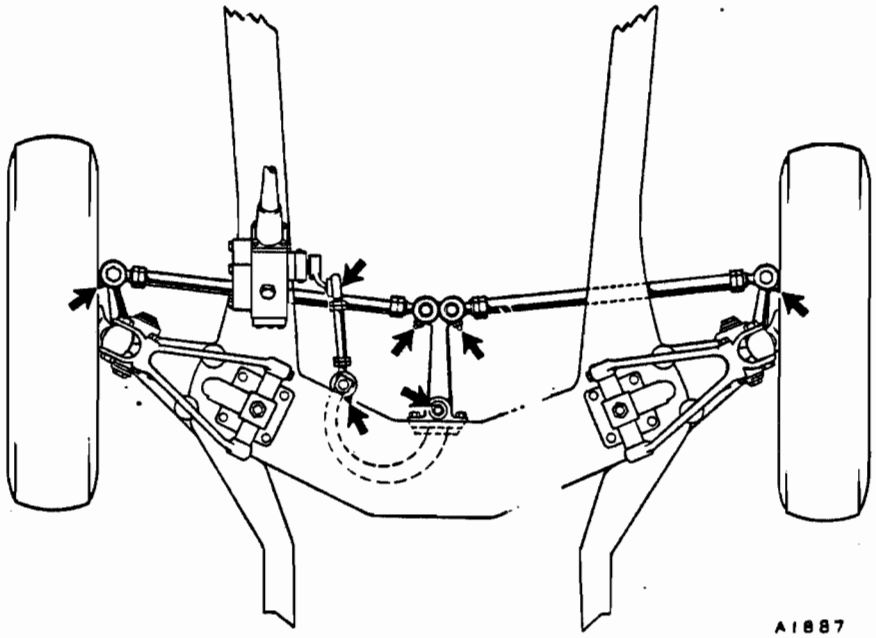

Fig. P.11
The lubrication points on the steering connections

Section P.4

STEERING-BOX AND GREASE POINTS

STEERING-BOX

Check the level, and top up if necessary. The correct level is flush with the bottom of the filler hole. Take care that no dirt or grit enters the steering-box when removing or replacing the filler plug. Use an oil as recommended on page P.2.

STEERING CONNECTIONS

All the nipples on the steering connections should be charged with grease. The nipples are located respectively at each end of the steering side-rod, at the steering connection pivot mounted centrally in the frame front cross-member, and at both ends of the left- and right-hand cross-rods.

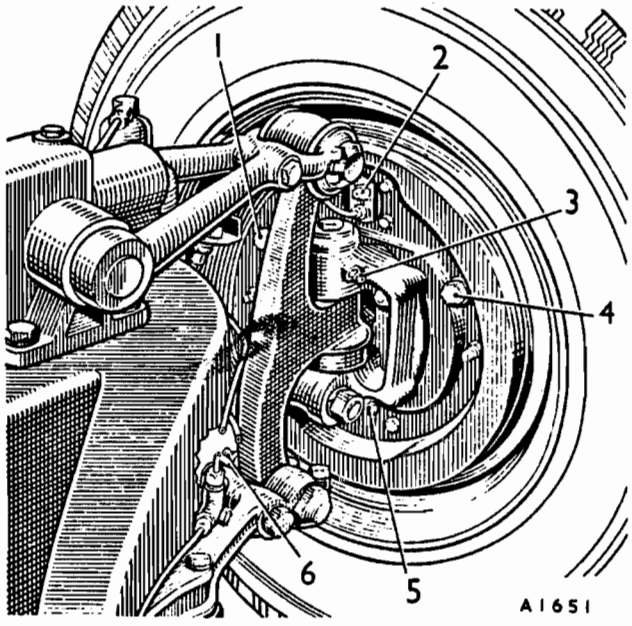

Fig. P.12

1. Brake adjuster.
2. Brake bleed nipple.
3. Swivel top nipple.
4. Brake adjuster.
5. Swivel lower nipple.
6. Outer fulcrum nipple.

SWIVEL AXLES

The nipples on the front swivel axles should be charged with lubricant from the grease gun (see page P.2). This task is best done when the car is partly jacked up, since the lubricant is then able to penetrate more easily to the thrust side of the bearings.

POWER STEERING UNIT

There are two nipples located on the power-assisted steering-unit, one at the front of the unit and one at the rear. Each should be given a charge of recommended lubricant.

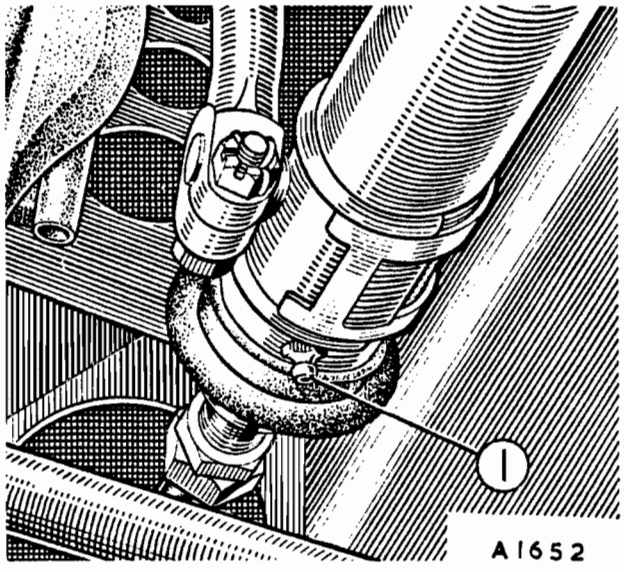

Fig. P.13
The power steering front lubrication point

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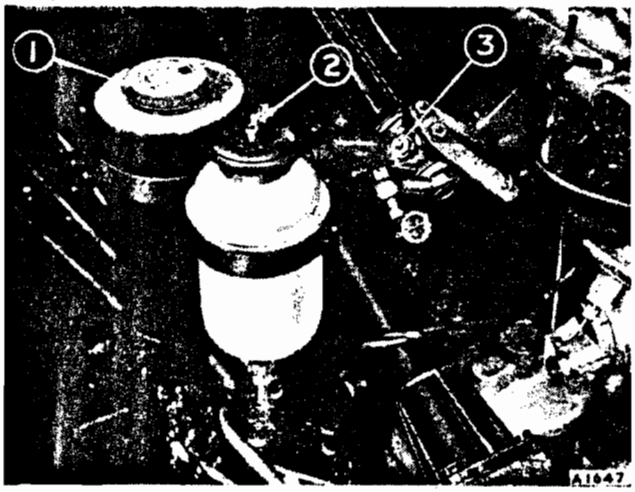

Fig. P.14

1. Jacking system reservoir.
2. Brake master cylinder reservoir.
3. Gear control lubrication nipple.

FRONT SUSPENSION

Give three or four strokes of a grease gun to the nipples on the lower suspension outer fulcrum pins.

GEAR CONTROL
(Synchromesh Gearbox)

Give the nipple at the lower end of the steering-column gear control linkage three or four strokes of the grease gun.

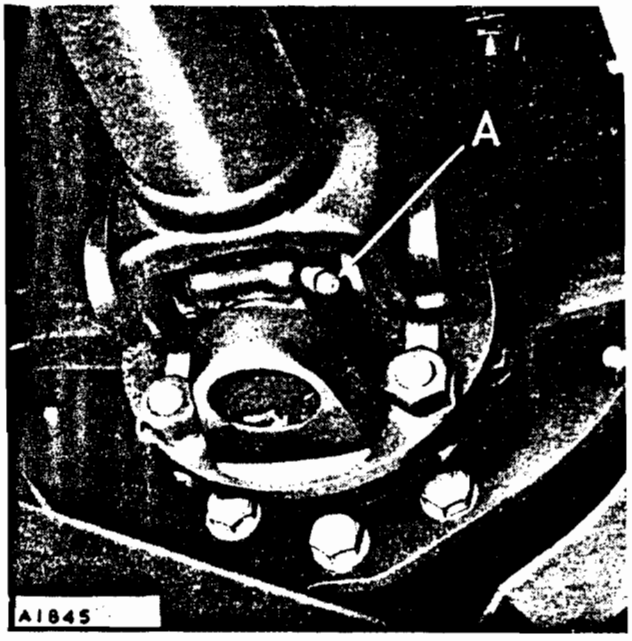

Fig. P.15

Propeller shaft front lubrication nipple

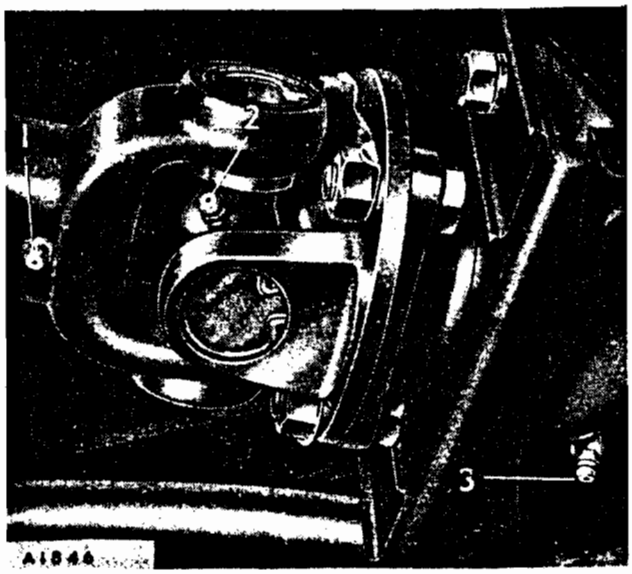

Fig. P.16

Propeller shaft lubrication points

1. Sliding spline.
2. Universal joint.
3. Centre bearing.

PROPELLER SHAFT

Give three or four strokes of the grease gun to the nipples on the four universal joints, the sliding yoke, and the propeller shaft centre bearing.

CLUTCH-OPERATING CROSS-SHAFT
(Synchromesh Gearbox)

Apply the grease gun to the nipples on the clutch-operating cross-shaft. This attention must be carried out sparingly or grease may reach the clutch linings.

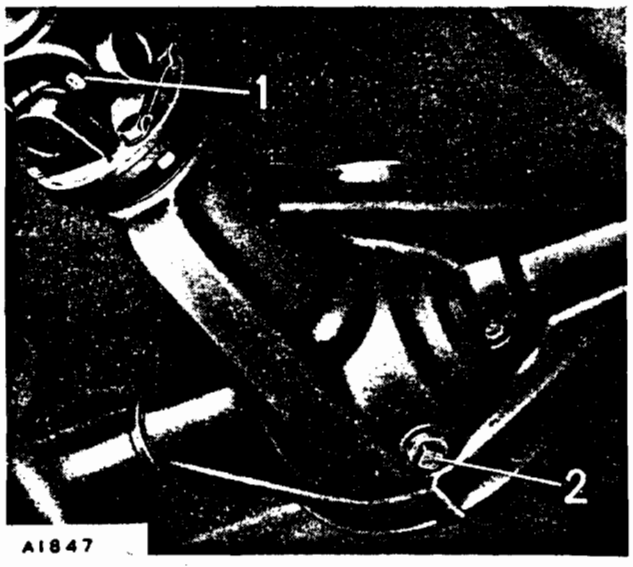

Fig. P.17

1. Rear propeller shaft lubrication nipple.
2. Rear axle drain plug.

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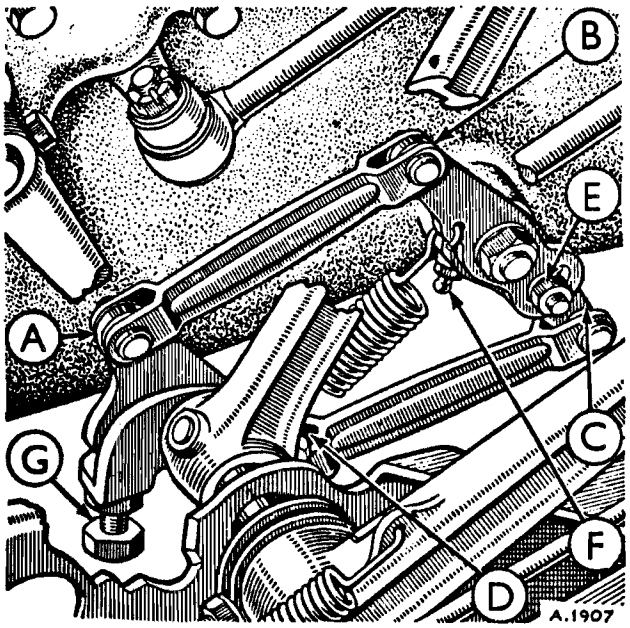

Fig. P.18

The clutch linkage felt washers are shown at (A), (B), (C), *and* (D)

E. Compensating linkage adjuster.
F. Clutch cross-shaft nipple.
G. Clutch free movement adjuster.

REAR ROAD SPRINGS

Apply the grease gun to the nipple on the extension of the rear spring centre-bolts. This nipple feeds grease to the spring leaves, and the task is best done when the car is partly jacked up to relieve the springs of load as the grease is then able to penetrate more easily between the leaves.

PEDAL SHAFTS

The nipple at the base of the brake pedal should be given three or four strokes of the grease gun. The single nipple supplies lubrication for both the brake and clutch pedal pivots.

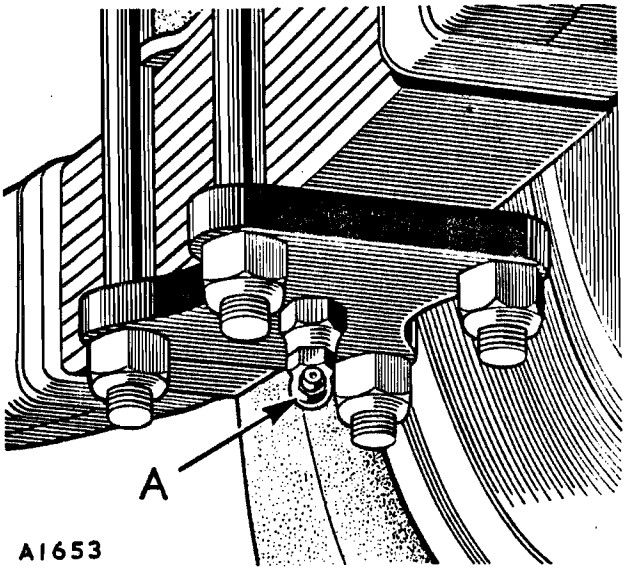

Fig. P.19

A. The rear spring lubrication nipple.

BRAKE-ROD PIVOT

The nipple on the brake-rod pivot, mounted to the left of the gearcase on the rear axle, and the rear axle brake balance lever nipple on the pivot opposite the centre cross-members of the frame should each be given a charge of lubricant with a grease gun filled with the recommended lubricant.

REAR HUBS

Apply the grease gun to the hub nipples. The nipples are located on the axle tube between the brake backplate and the spring.

Take care not to overfill the hubs with grease, or some may reach the brake-shoe linings and thereby impair the braking efficiency.

NOTE.—The periods at which the instructions in this Section should be carried out are given in the Passport to Service or Driver's Handbook.

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SECTION Q

THE JACKING SYSTEM

	Section
General description	
Maintenance	
Bleeding the system	Q.3
General servicing	Q.2
Operating the system	Q.1

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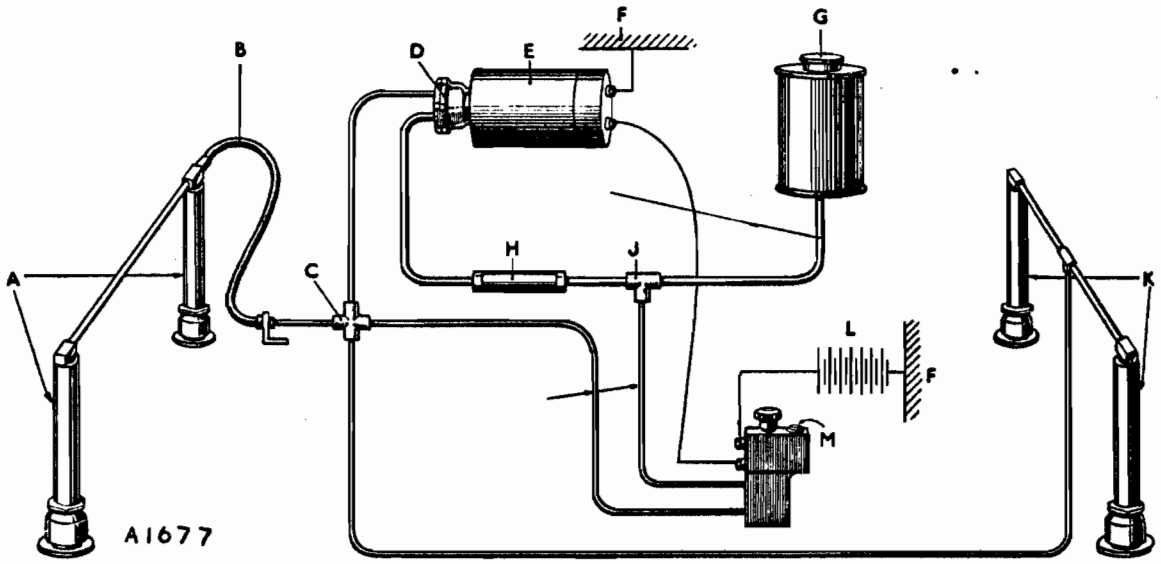

Fig. Q.1

The general layout of the hydraulic jacking system

A. Front jacks. B. Flexible hose. C. Four-way connection. D. Pump. E. Motor. F. Earth. G. Supply tank. H. Filter. J. Three-way connection. K. Rear jacks. L. Battery. M. Warning light.

GENERAL DESCRIPTION

The Red Jackall hydraulic jacking system comprises mainly of four tubular telescopic jacks, mounted two on the rear axle and two on the chassis side-members, near the front suspension units. These jacks are extended under fluid pressure by a radial piston pump, which draws fluid from a reservoir situated under the bonnet, and is driven by an electric motor.

The pump and control unit are secured along the outside of the chassis frame beneath the floorboards.

Only Red Jackall fluid must be used in the system. The specification of this fluid is B.S.S.148/B30.

MAINTENANCE

The system requires no special attention other than it be operated at least once a month and the fluid level in the reservoir be examined at the periods stated in the Passport to Service. Top up if necessary with Red Jackall fluid. Maintain the fluid level to within 1 in. (25·4 mm.) of the filler neck.

A 'pencil filter' is incorporated in the pipe-line between the reservoir and the pump, and at major overhauls it is recommended that the filter be removed and cleaned in fuel, using a stiff brush. The filter can be cleaned at any time if it is thought to be choked due to excess amounts of dust and dirt being allowed to enter the reservoir.

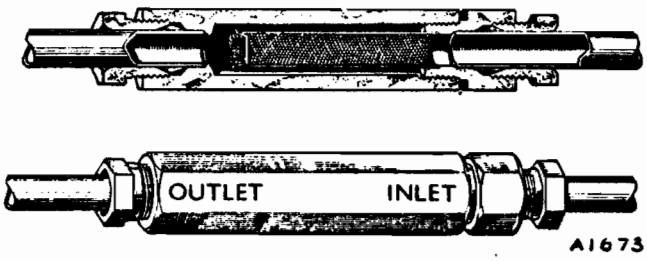

Fig. Q.2

The 'pencil-type' filter

Section Q.1

OPERATING THE SYSTEM

Remove the protector cap from the control unit.

The control knob marked 'valve' operates both the hydraulic and electrical circuits of the jacking system.

To raise the car rotate the control knob clockwise as far as possible. This action closes the hydraulic valve and the warning light will glow red. Press the control knob,

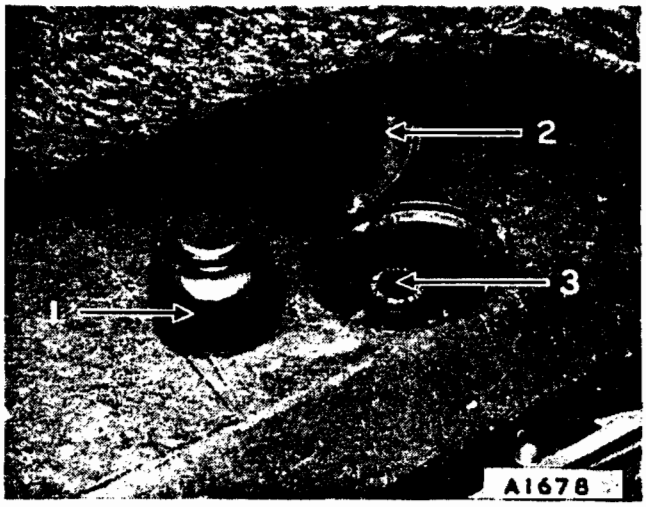

Fig. Q.3

The hydraulic jacking control

1. Rubber cover. 2. Hinged panel.
3. Combined valve and electric switch.

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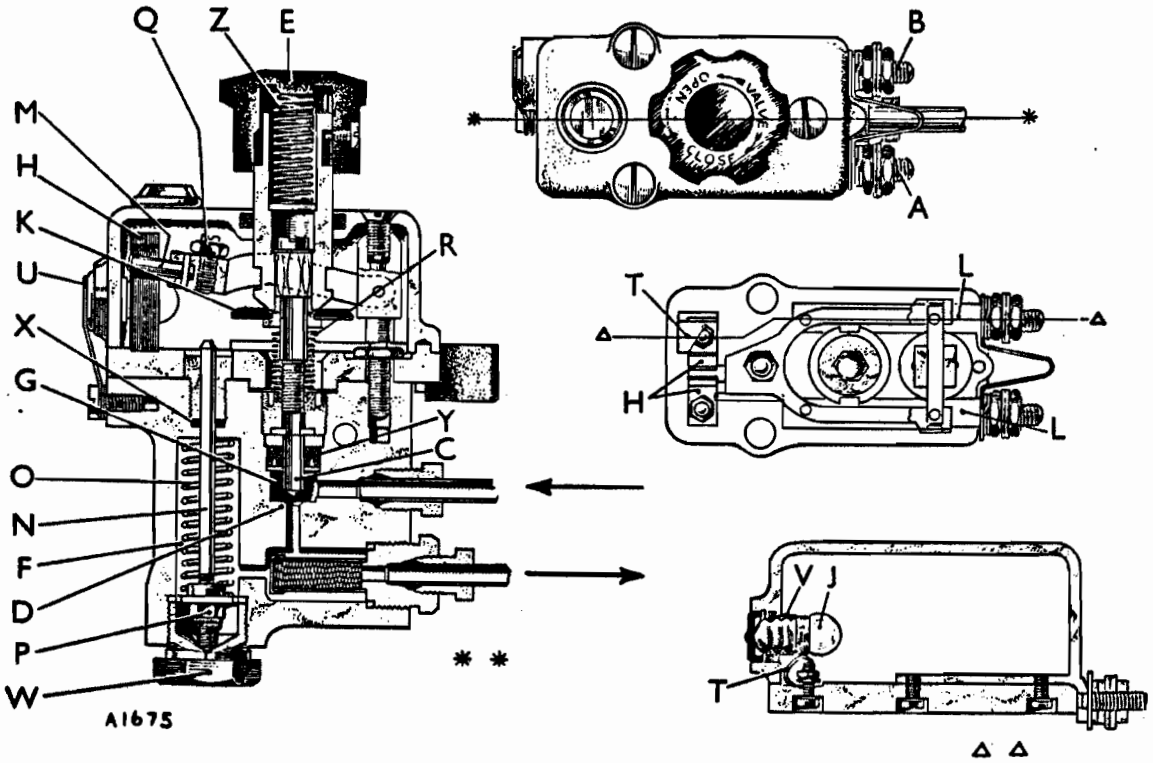

Fig. Q.4

The control unit in section

A. Battery terminal.
B. Motor terminal.
C. Release valve.
D. Valve seat.
E. Control knob.
F. High-pressure chamber.
G. Low-pressure chamber.
H. Warning light contacts.
J. Bulb.
K. Contact plate.
L. Contact strips.
M. Cut-out arm.
N. Knock-out plunger.
O. Plunger spring.
P. Locknut.
Q. Gap set screw.
R. Control return spring.
T. Warning light contact.
U. Bulb retainer clip.
V. Bulb holder.
W. Plug for access to plunger spring.
X. Knock-out plunger gland.
Y. Release valve gland.
Z. Contact spring.

thus switching on the power unit, and hold it down firmly.

When the vehicle is completely raised the current to the electric motor driving the pump is cut off automatically and the knob may then be released.

To lower the car turn the knob anti-clockwise about half a turn. The vehicle will lower gently to the ground, after which the knob should be further rotated in the same direction in order that the jacks may return to the fully closed position as quickly as possible.

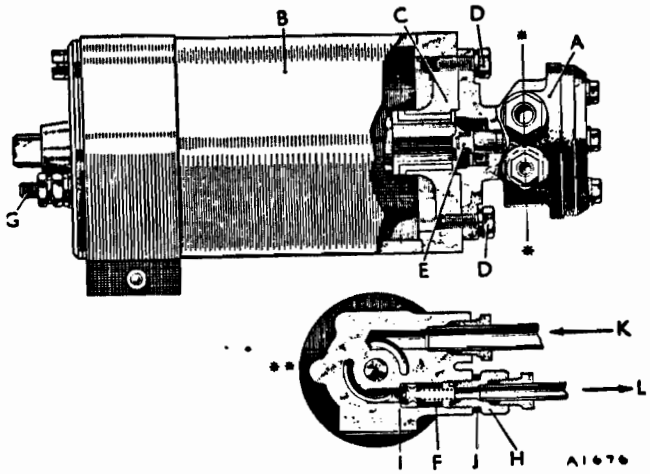

Fig. Q.5

The pump unit and electric motor

A. Pump.
B. Motor.
C. Locating spigot.
D. Bolts.
E. Oldham coupling.
F. Non-return valve.
G. Control unit terminal.
H. Adaptor.
I. Valve seat.
J. Sealing washer.
K. From fluid reservoir.
L. To jacks and control unit.

Section Q.2

GENERAL SERVICING

Should the system fail to operate, check the level of fluid in the reservoir and ensure that the batteries are fully charged before dismantling any part of the system.

The control unit is adjusted to cut out when the pressure of the fluid in the system reaches 2,400 to 2,600 lb./sq. in. (169 to 183 kg./cm.²). Should the setting require adjustment, remove plug (W) (Fig. Q.4), slacken the locknut

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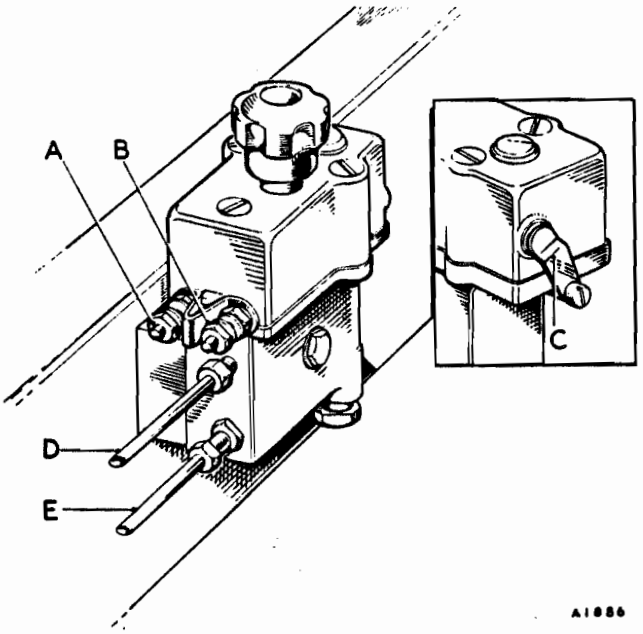

Fig. Q.6

The control unit

A. Battery terminal.
B. Motor terminal.
C. Lamp retainer clip.
D. To fluid reservoir.
E. From pump.

(P) from the knock-out plunger (N), and adjust the plunger until the required setting is obtained. Tighten the locknut and replace the plug.

The gap between the adjusting set screw (Q) in the cut-out arm (M) and the knock-out plunger (N) must be ·015 in. (·381 mm.). Slacken the locknut and rotate the screw in the required direction if it is necessary to reset the gap. Retighten the locknut, taking care not to disturb the setting.

Should a leak exist at one of the pipe unions and tightening the union nut does not cure it, unscrew the nut and examine the conical faces of the nipple. Renew the nipple if necessary, and ensure on reassembly that it is pushed well over the end of the pipe, otherwise the end of the nipple becomes 'peened' over and an effective seal is not obtained.

When dismantling any part of the system absolute cleanliness is essential. Any parts that have been washed in petrol (gasoline) must be thoroughly dried and lubricated with Red Jackall fluid on reassembly.

A blown warning light bulb may easily be replaced by swinging down the bulb holder retaining clip (C) (Fig. Q.6) and lifting out the bulb holder.

Section Q.3

BLEEDING THE SYSTEM

If at any time the jacking system has been drained of fluid, air may be trapped in the pump and it will be necessary to bleed it to restore the efficient working of the system.

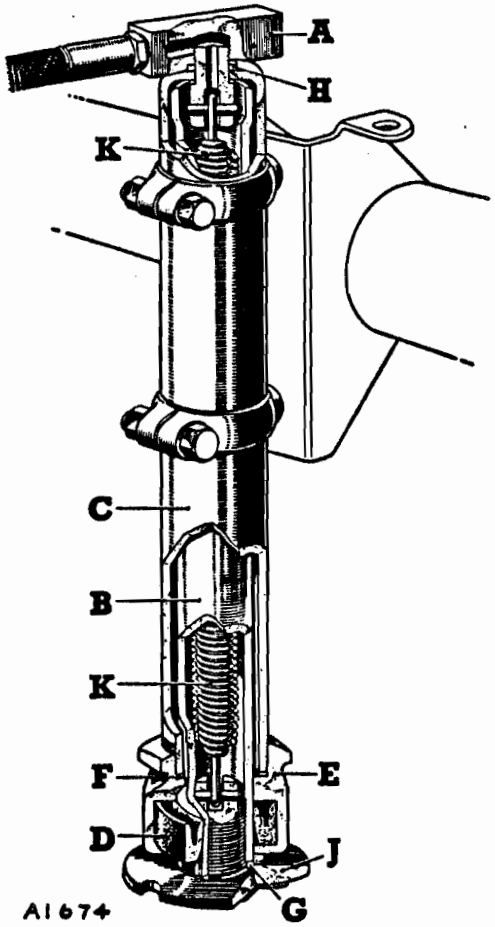

Fig. Q.7

The lifting jack

A. Elbow.
B. Inner tube.
C. Outer tube.
D. Gland.
E. Gland housing.
F, G, and H. High-pressure seals.
J. Foot.
K. Retraction spring.

Ensure that all connections between the pump and control unit and the respective jacking units are secure.

Remove the cover from the control unit valve and rotate the valve clockwise, press the control knob down to operate the motor for a few seconds, release the knob, and close the valve. Carry out this procedure several times, this will prime the pump, and after several runs it should extend the jacks in the normal manner.

If this method should fail to bleed the system satisfactorily, loosen the ¼ in. (6·35 mm.) dia. pipe connection on the pump and the adaptor into which this connection is fitted. Again operate the pump intermittently until the fluid leaving the loose connection is free from air bubbles. Tighten the connections firmly and operate the jacking system normally.

Check the fluid level in the reservoir, and top up if necessary.

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SECTION R

THE BODY

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Removing and replacing	R.6
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Windshield—removing and replacing	R.10

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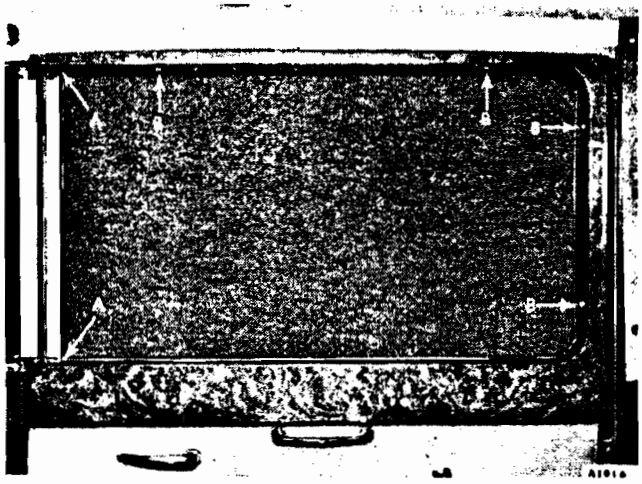

Fig. R.1

The arrows (A) indicate the two chromium-plated screws securing the forward edge of the polished wood surround. Arrows (B) indicate screws located beneath the glass silent channel which also secures the wood surround

Section R.1

REMOVING AND REPLACING THE DOOR TRIM

Wind down the window to the fully open position.

Pull away the silent channel from the inside front edge (rear door) or inside rear edge (front door) as far as the glass will permit. The channel is secured in position with rubber adhesive.

With the channel eased away remove the two screws located beneath it securing the polished wood surround. Remove the section of silent channel from the top of the door and extract the two wood surround securing screws. Two further screws (see Fig. R.1) must be removed before the wood surround can be withdrawn by easing it away from the top of the door and lifting upwards to disengage the lower metal locating tongues.

The door lock and window winding handles are removed by pushing in the escutcheons against the trim and rotating them until the fixing screws are exposed. Remove the screws and pull the handles off the shafts.

NOTE.—It is the handle fixing screw with the small projection which must be removed before the handles can be taken off. The smaller plain screw also fitted is not a securing screw.

In the case of the driver's door, the quick-lift handle can be removed by taking out its single central securing screw. Note the large spring washer fitted beneath the head.

On both front doors remove the three screws securing the arm-rest to the support bracket, withdraw the arm-rest, and extract the two screws securing the support bracket to the door.

On rear doors only remove the small grub screw securing the safety lock knob and withdraw the knob from its spindle. Also remove the two screws securing the door-pull handle.

Carefully extract the tacks securing the hide trim to the wooden door frame at the top. Pull away the hide and padding at the top edge and remove the screws and tacks securing the inner trim panel to the door frame. The complete trim panel may now be withdrawn from the remote control shafts and lifted slightly to disengage the keyhole slot plates in the trim panel from the securing screws (see Fig. R.3).

Should it be necessary to remove the lower step trim from the bottom of the doors, unscrew the four nuts located inside the door frame securing the trim assembly to the door.

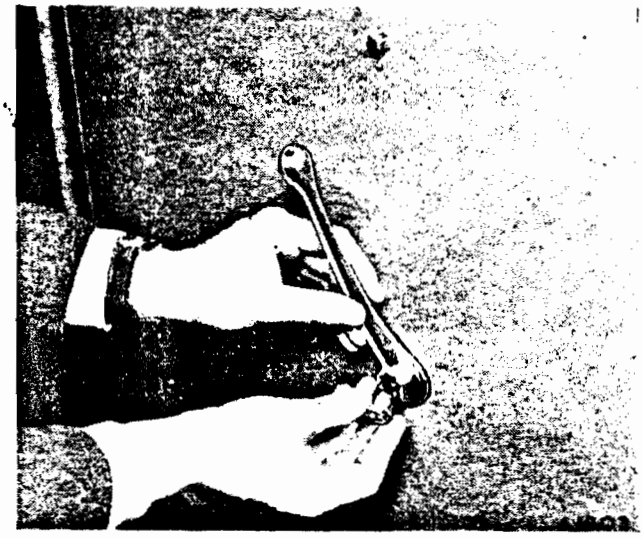

Fig. R.2

Removing the screw and lock washer securing the window quick-lift handle on the driver's door

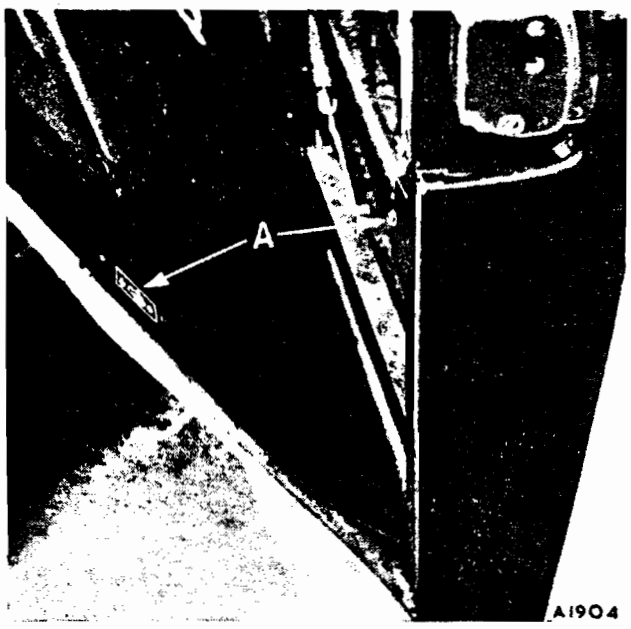

Fig. R.3

The arrows (A) indicate the keyhole slotted plate and securing screw on one side of the door trim panel

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Section R.2

REMOVING AND REPLACING A DOOR GLASS

Front door

Remove the door trim panel as described in Section R.1.

Remove completely the length of silent channel at the rear edge of the door by pulling it upwards.

Remove the two set screws connecting the window actuating lever channel to the glass support channel. When removing the glass from the driver's door the actuating lever must be held against the spring pressure whilst the glass is withdrawn through the top of the door. The lever can then be allowed to return to its upward position.

To replace the glass reverse the above procedure.

Rear door

Exactly the same procedure as outlined above for the front doors should be adopted, with the exception of the silent channel, which is removed from the front edge of the doors.

Reverse the dismantling procedure to replace the glass.

Section R.3

REMOVING AND REPLACING A DOOR LOCK

Remove the door trim panel as described in Section R.1.

Disengage the lock operating arm from the remote control mechanism by removing the split pin and plain washer from the connecting link.

The lock mechanism is secured to the edge of the door by three countersunk-headed screws (A) (Fig. R.4), the lower one of which should not be completely extracted from the lock as it also holds in place the rotary catch. The lock and operating arm can now be withdrawn from the door.

Replacement of the door lock is a reversal of the above procedure.

Section R.4

REMOVING AND REPLACING AN OUTER DOOR HANDLE

Remove the door trim panel as described in Section R.1.

Wind up the window to its full extent to enable access to be gained to the handle-securing set screw and washer located inside the door panel. Remove the small round-headed screw and washer (B) (Fig. R.4) adjacent to the door lock mechanism at the edge of the door. Withdraw the handle.

Reverse the above instructions to replace a handle.

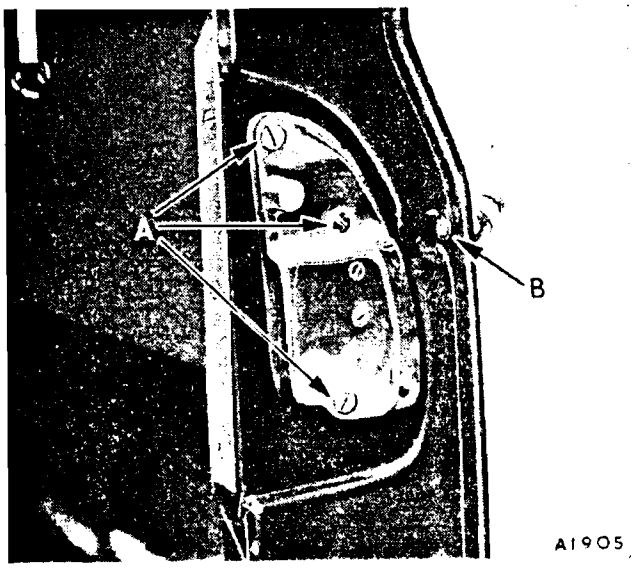

Fig. R.4

The countersunk-headed screws securing the door lock are indicated at (A). *Arrow* (B) *shows one of the securing screws for the outer handle*

Section R.5

REMOVING AND REPLACING THE WINDOW WINDING MECHANISM

Remove the door glass as described in Section R.2.

Remove the four screws (two nuts and bolts on the driver's door) securing the winder mechanism to the door frame and lift out the mechanism.

Reverse the above procedure to replace a winder mechanism.

Section R.6

REMOVING AND REPLACING A DOOR

Remove the pivot screw from the door check rod.

With the aid of an operator to take the weight of the door remove the countersunk-headed screws securing the door hinge to the body pillar and remove the door.

Reverse this procedure when replacing the door. Ensure that the securing screws are firmly tightened and that the door closes in a satisfactory manner.

Section R.7

REMOVING AND REPLACING THE BACK-LIGHT GLASS

Remove the six screws securing the polished wood surround in position and carefully withdraw the surround.

The glass is secured in position by means of small wooden support blocks tacked to the window frame. Extract the blocks and withdraw the glass.

On replacement use fresh Glasticon glazing compound to seal the glass to the body.

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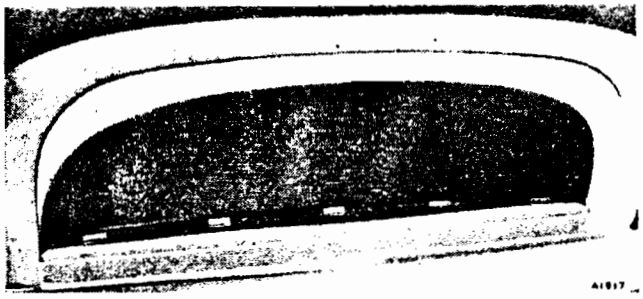

Fig. R.5

With the polished wood surround removed the back-light support blocks are readily accessible

Section R.8

REMOVING AND REPLACING A REAR SIDE GLASS

With ventilator

Take out the five screws securing the polished wood surround to the window frame and carefully remove the surround.

Remove the rubber sealing strips from the metal finisher plate at the forward lower edge of the window frame. Remove the four securing screws and withdraw the plate.

Removal of the finisher plate will expose two screws securing the base of the window channel; remove the two screws.

Remove the two screws from the channel support bracket at the forward upper edge of the window frame.

The flange of the window ventilator is secured to the window frame by seven screws which must be removed to completely release the window glass. Ease the top of the assembly towards the interior of the car and lift it upwards to clear the water drain box.

To replace the window assembly reverse the dismantling procedure.

Seal the glass with Glasticon glazing compound.

Carefully position and refix the rubber sealing strips to the metal finisher plate, using rubber adhesive.

Without ventilator

Carry out the procedure outlined in the first four paragraphs above.

The glass is secured in position by means of small wooden support blocks tacked to the window frame. Extract the blocks and withdraw the glass.

To replace the glass reverse the dismantling procedure.

Seal the glass with Glasticon glazing compound.

Carefully position and refix the rubber sealing strips to the metal finisher plate, using rubber adhesive.

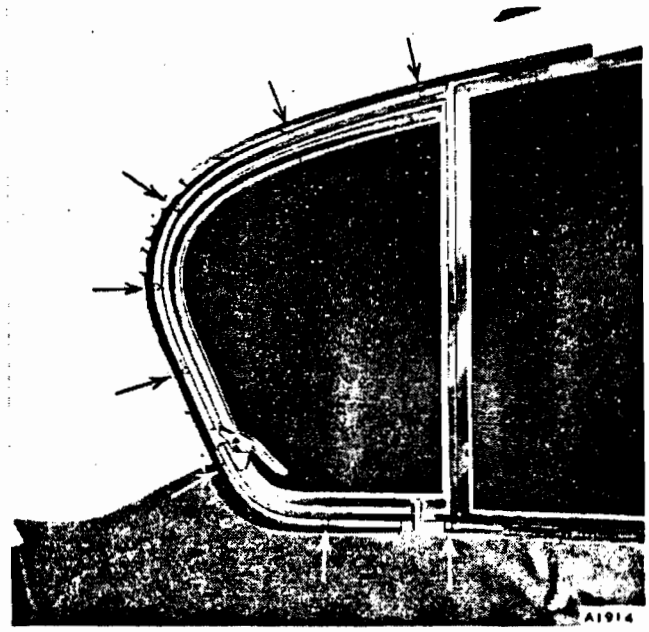

Fig. R.6

The arrows indicate the screws which must be removed from the ventilator flange in order to release the window glass

Section R.9

REMOVING AND REPLACING A FRONT DOOR VENTILATOR

Remove the door trim as described in Section R.1.

Remove the door glass as described in Section R.2.

Remove the screw from the door glass front silent channel, upper and lower ends.

The flange at the base of the ventilator is secured to the window frame by four screws (Fig. R.7), which must be removed. Remove the one remaining screw from the door leading edge securing the top of the ventilator.

Ease the top of the ventilator assembly towards the interior of the car and lift out.

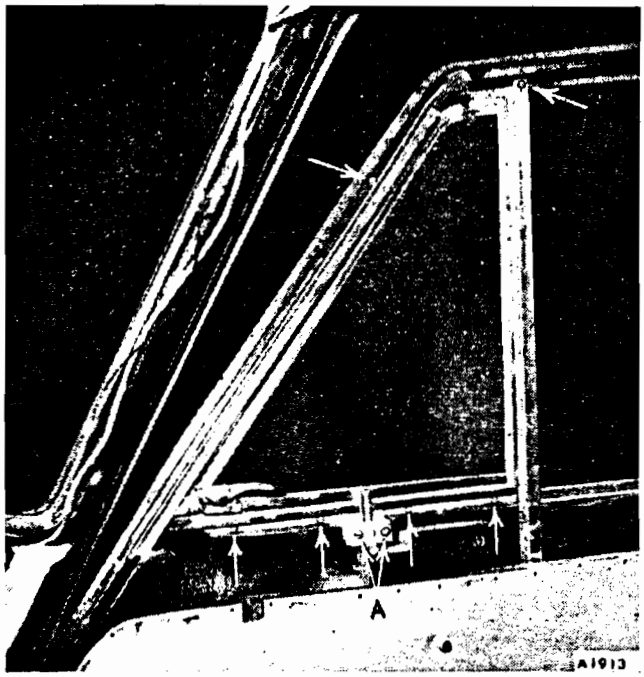

Fig. R.7

Indicated by the arrows are the front ventilator securing screws. The two screws (A) are the adjustment screws for the window swivel

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When replacing the ventilator, the procedure for which is a reversal of that given for dismantling, take care to replace neatly the piping between the ventilator and the door frame at the forward edge. Use Glasticon glazing compound to seal the assembly.

Section R.10

REMOVING AND REPLACING THE WINDSHIELD

Remove the fascia panel as described in Section R.13.

Remove the eight screws from the glass frame support brackets and, with the aid of an assistant, carefully push the windshield outwards from the interior of the car.

On replacement seal the windshield glass, using Glasticon glazing compound.

Section R.11

REMOVING AND REPLACING THE BONNET

Release the bonnet catches on each side.

Raise the right-hand side of the bonnet and remove the two nuts and bolts from the bonnet centre rod rear securing bracket. Raise the bonnet slightly at the rear and withdraw the bracket.

With the aid of an assistant on the opposite side, raise the bonnet at the rear to clear the scuttle and withdraw the bonnet and centre hinge rod from its front support bracket. Lower the bonnet from the car and place it preferably on trestles to avoid any risk of damage.

Replacement is a reversal of the removal procedure. Check that the bonnet closes and locks correctly after fitting.

Section R.12

REMOVING AND REPLACING THE RADIATOR COWL

Unscrew the two bumper securing bolts and withdraw the bumper.

Remove the bonnet as described in Section R.11.

Remove the two screws securing each fog lamp bracket to the chassis frame.

The radiator shell is secured by nine set bolts on each side. Access to three of these bolts is gained from under the wing, a further four bolts secure the under side of the cowl to the front wing apron, and access to these bolts is gained from beneath the car. The remaining two bolts are situated at the top of the cowl and are hidden beneath the short length of bonnet sealing strip, which must be removed to gain access to the set bolts.

With these points released, ease the wings outwards and withdraw the radiator cowl upwards.

To replace the radiator cowl reverse the dismantling procedure. Loosely assemble all the securing bolts but do not tighten them until the cowl is correctly positioned.

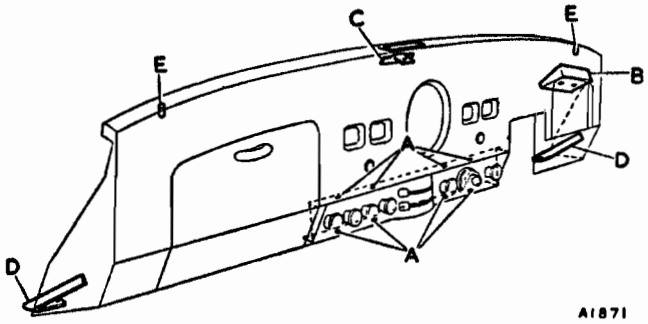

Fig. R.8

The fascia panel fixing points. The letters are referred to in Section R.13

Section R.13

REMOVING AND REPLACING THE FASCIA PANEL

Slacken the steering-column adjuster beneath the steering-wheel and pull the wheel back its full extent.

On cars fitted with automatic transmission remove the steering-column top cover as described in Section J, slacken the gear selector lever clamp bolts, and lower the lever downwards to provide clearance.

Remove the interior light switch from beneath the fascia panel on the driver's side by unscrewing the knurled securing ring and pushing the switch upwards to release it.

Remove the windshield washer switch, and to prevent possible damage remove also the rear-view mirror from the screen centre pillar.

Remove the switch knobs by depressing the spring-loaded locking pegs and pulling off the knobs. The two heater control knobs may be removed after unscrewing the small locking screw beneath each knob.

Remove the switch panel by unscrewing the eight securing screws (A) (Fig. R.8); four of these screws are located on the under side of the switch nameplate and a further four beneath the switch panel itself.

Extract the securing screws from the polished wood fillet at the top of the windshield and remove the fillet. Remove the two side fillets by withdrawing them upwards.

Unscrew the two screws from the top of the driver's glovebox (B) (Fig. R.8).

Remove the ashtray from the top of the fascia and, using a short box spanner or socket, remove the bolt and washer securing the fascia to the centre mounting bracket (C) (Fig. R.8). Note that the washer has a flat which must face to the rear when assembled to clear the set in the fascia bracket.

Remove the set bolt from each lower corner of the fascia, just above the bonnet release knob (D) (Fig. R.8).

Lift the fascia panel slightly to disengage the wooden dowels at each side at the top (E) (Fig. R.8), withdraw the glovebox from behind the fascia on the driver's side, and then completely remove the fascia panel.

Replacement of the fascia panel is a reversal of the dismantling procedure. Assemble the driver's glovebox

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before locating the fascia and assemble all securing bolts and screws before finally tightening them.

Section R.14

REMOVING AND REPLACING A FRONT WING

First remove the wing blanking plate by removing the nut and screw from the top of the wing above the blanking plate, the two nuts and screws from the bottom of the wing at the rear accessible through the end of the wing when the front door is open, and the two bolts from the rear end of the blanking plate beneath the body. Finally, remove the three nuts and screws securing the blanking plate to the flitch plate and remove the blanking plate.

Disconnect the fog lamp wire at the snap connector, unscrew the securing nut, and remove the fog lamp.

Remove the two set bolts from the rearmost top corner of the wing.

With an assistant to take the weight of the wing as it is released, remove the countersunk-headed screws securing the top of the wing to the flitch plate and note that on the left-hand side the windshield wiper motor is attached by three of these screws. Take out the remaining five screws securing the wing to the radiator shell and remove the wing.

Replacement is a reversal of the above instructions, but if a new wing is to be fitted it must be held in position on the car whilst the securing bolt holes are marked through from the body and the wing then removed while the holes are drilled out.

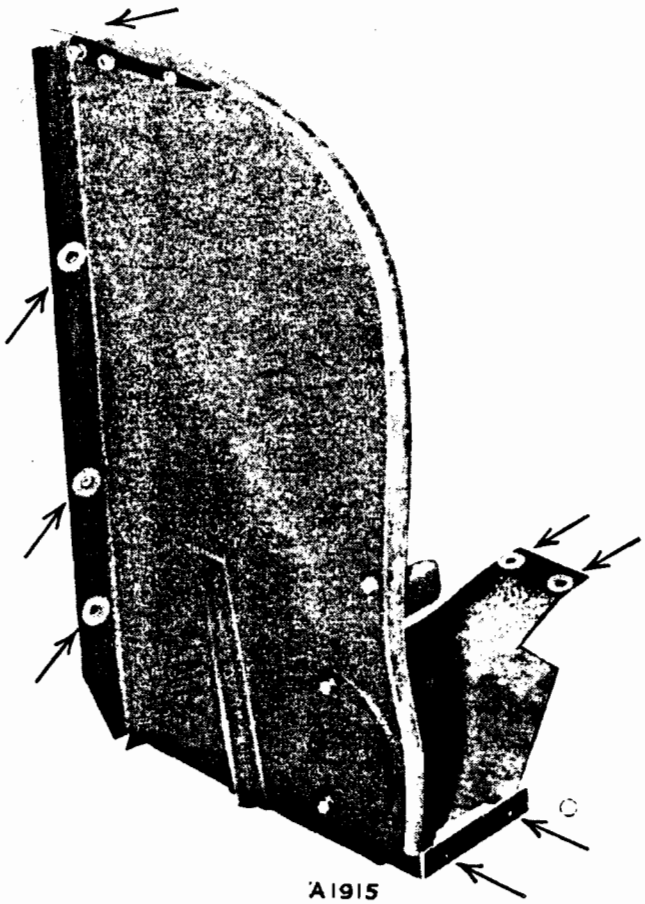

Fig. R.9

Indicated by the arrows are the securing points for a left-hand front wing blanking plate

Section R.15

REMOVING AND REPLACING THE ELECTRIC DIVISION MOTOR AND WINDING MECHANISM

(Optional Equipment)

Peel back the carpet from the base of the division at the rear. Carefully peel back the trimming cloth at the lower edge of the division trim panel and remove the screws exposed beneath it.

The trim panel is secured on either side by 'blind pins', and to release the panel it is necessary to pull the panel off the pins at either side and, when free, lower the panel downwards to release the top edge from beneath the top polished rail.

To remove the polished wood rail remove the nuts from behind the grab-handles, when the handles and rail may be released.

The motor and glass division winding mechanism may be removed as an assembly, after disconnecting the wiring to the motor, by extracting the four securing screws and moving the top of the assembly towards the rear as it is manœuvred and lifted out.

Replacement of the mechanism is largely a reversal of the above procedure. The 'blind pins' used to secure the trim panel must be removed from the division, and as the new pins are driven in, nip off the heads before tapping them home out of sight beneath the trim cloth. Secure the trim cloth and carpet in position with a suitable rubber adhesive.

Section R.16

CHASSIS ALIGNMENT

To check the body alignment of a car which has been damaged a system of diagonal and measurement checks from points projected from the underframe onto a level floor is used (see pages R.7 and R.8).

To ensure that the alignment check is performed accurately the car must first be raised so that its datum line (X) (see page R.8) is parallel with the floor. Use the comparative measurements given on page R.8) to achieve this condition. Elevate the rear of the car to a convenient working height, and then adjust the height of the front of the vehicle until the points given on page R.8 for the front and rear on both sides of the car are in the correct vertical position **relative to each other**; for example, if the rear point is 36 in. (91·4 cm.) from the floor and is quoted as 2 in. (5·1 cm.) above the vehicle datum line,

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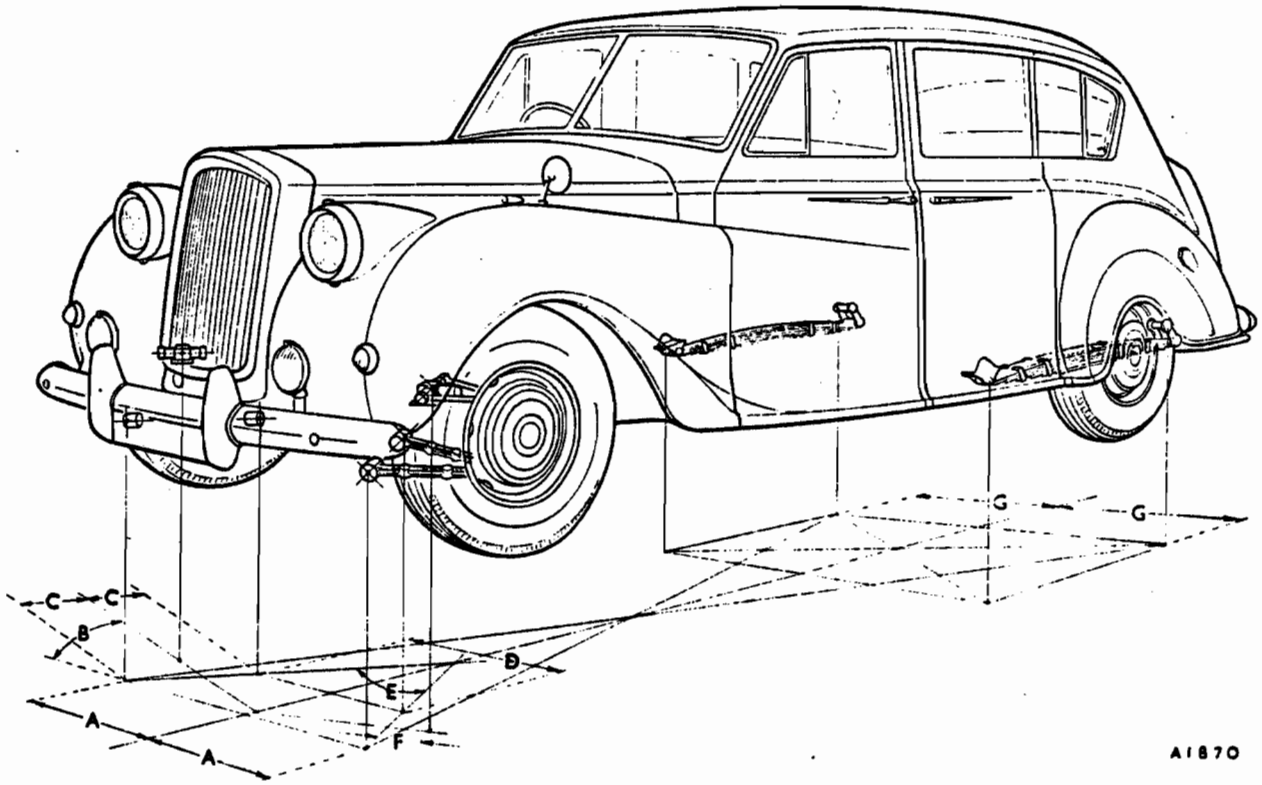

Fig. R.10

Chassis alignment checking diagram with dimensions

A	13 7/32 in. (335·76 mm.)	Centre-line of car to centre-line lower front wishbone inner pivot	E	50°	Combined angle of both suspension units
B	25°	Angle of trail of lower wishbone	F	5 11/32 in. (138·51 mm.)	Centre-line of bottom wishbone inner pivot and centre-line of damper pivot
C	16 13/16 in. (427·0 mm.)	Over front and rear faces of lower wishbone inner pivot	G	25 5/16 in. (643·34 mm.)	Over bolt heads of rear spring hangers
D	12 11/64 in. (310·75 mm.)	Between centres of both lower rear wishbone inner pivots			

the front point quoted as 1 in. (2·54 cm.) below the datum line must be 33 in. (83·8 cm.) above the floor.

At the same time, it will be helpful to check the **relative** heights of all the intermediate points given on page R.8 so that any distortion of the car in the vertical plane will be ascertained.

Chalk over the area of the floor directly below the points shown in Fig. R.10. Using a plumb-line, project the points from the car onto the floor, marking the positions with a pencilled cross. The centre between each pair of points can be established by means of a large pair of compasses and the central points marked on the floor. In addition, diagonals can be determined between any two pair of points and the points of intersection marked on the floor. At this stage a length of thin cord covered with chalk can be held by two operators in such a position that it passes through as many of the central points and intersections marked as possible. While the cord is held taut a third operator raises the centre of it and then allows it to spring back smartly to the floor. If the resulting white line passes through all the points the chassis alignment is satisfactory. Any points through which the white line does not pass will be in a position where the chassis frame is out of alignment.

Considerable deviations in the transverse and longitudinal measurements given on page R.7 confirm chassis misalignment. It must be understood that allowance must be made for normal manufacturing tolerances and that a reasonable departure from nominal dimensions can be permitted without detriment to road performance.

Section R.17

OPERATION OF THE FRONT HEATER UNIT

Two units are provided for heating and ventilating the car interior. The front unit mounted on the engine bulkhead has provision for demisting and defrosting the windshield and comprises a heater radiator, which is of the tube-and-fin type and rectangular in shape, with the water connection pipes extended to pass through an outer casing. Operation of the rear unit is described in Section R.19.

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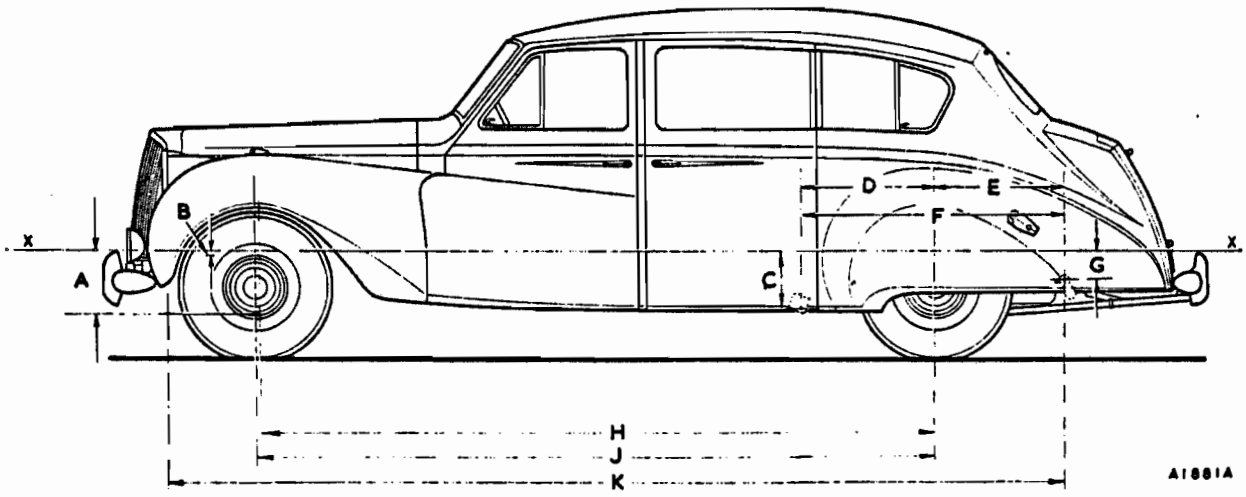

Fig. R.11

Longitudinal dimensions and vertical dimensions to datum line (X)

A	11 3/8 in. (281·78 mm.)	From datum to centre-line of lower wishbone inner pivot	F	52 7/8 in. (1·34 m.)	From centre-line rear spring front hanger bolt to rear spring rear hanger bolt
B	11/16 in. (16·27 mm.)	From datum to centre-line of damper pivot	G	6 13/16 in. (163·91 mm.)	From datum to centre-line of rear spring rear hanger bolt
C	11 13/16 in. (300·83 mm.)	From datum to centre-line of rear spring front hanger bolt	H	131 1/16 in. (3·345 m.)	From centre-line rear wheel to centre-line front datum
D	26 3/4 in. (679·85 mm.)	From centre-line rear wheel to centre-line rear spring front hanger bolt	J	132 3/4 in. (3·362 m.)	From centre-line rear wheel to centre-line front wheel (wheelbase)
E	26 1/4 in. (663·98 mm.)	From centre-line rear wheel to centre-line rear spring rear hanger bolt	K	174 in. (4·420 m.)	Centre-line rear spring rear hanger bolt to forward face of lower wishbone inner pivot

The ventilating unit consists of four main assemblies:
(1) Radiator unit.
(2) Air box, containing distribution valves.
(3) Outer casing.
(4) Water regulating valve.

The circulating blower is a centrifugal-type unit of high capacity and its use considerably increases the amount of air fed into the heater. The blower can be used when the car is stationary to compensate for the lack of ram effect into the air intake caused by the forward motion of the car.

If necessary, the air supply to the car interior can be shut off to prevent the entry of exhaust fumes or other forms of pollution.

A quadrant control is incorporated in the dashboard and has two levers, a screen air control lever which is the upper one and marked 'DEMIST DEFROST', and a ventilation control lever which is the lower one and marked 'VENTILATION'. The former operates, by means of a flexible cable, the demister/defroster valve of the unit; the latter operates the interior air valve and the water valve.

In addition to these two controls an on/off switch for the booster blower and an air intake control are provided.

When it is not desired to use the system either for heating or ventilating both control levers must be in the position marked 'OFF', with the booster blower switched off and the air intake control knob pulled fully out.

The following control settings are described and illustrated to cover the three basic conditions most likely to be met. A wide variety of other positions will present themselves as the use of the controls becomes more apparent.

Warm weather

To provide cold air ventilation the lower lever must be in the position marked 'COLD' and the upper lever in the position marked 'DEMIST'. Push in the air intake control knob.

Fresh, unheated air is fed into the chamber (C) (Fig. R.13) and is directed to the windshield, thus providing cool air at head level, via the space between the heater radiator and the outer casing. The water valve is closed when the lower lever is in the 'COLD' position, and therefore air passing through the unit radiator and into the car interior via outlet (B) (Fig. R.13) remains unheated.

If a greater supply of fresh air is required, switch on the booster blower. To increase the volume of air at head level the upper lever must be moved to the position marked 'DEFROST', when the flap valves in the heater unit will be positioned to provide maximum ventilation at windshield level (see Fig. R.14).

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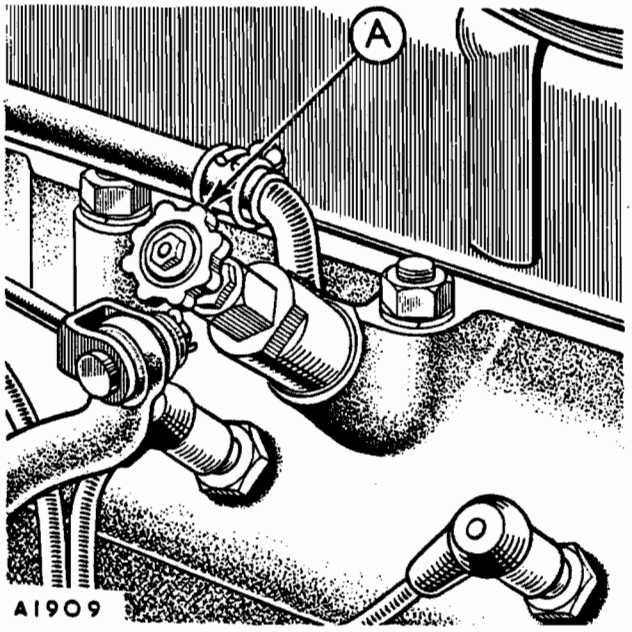

Fig. R.12

The heater unit water control valve, located on the right-hand side of the engine cylinder block, must be screwed in a clockwise direction to shut off the supply of water to the heater radiator

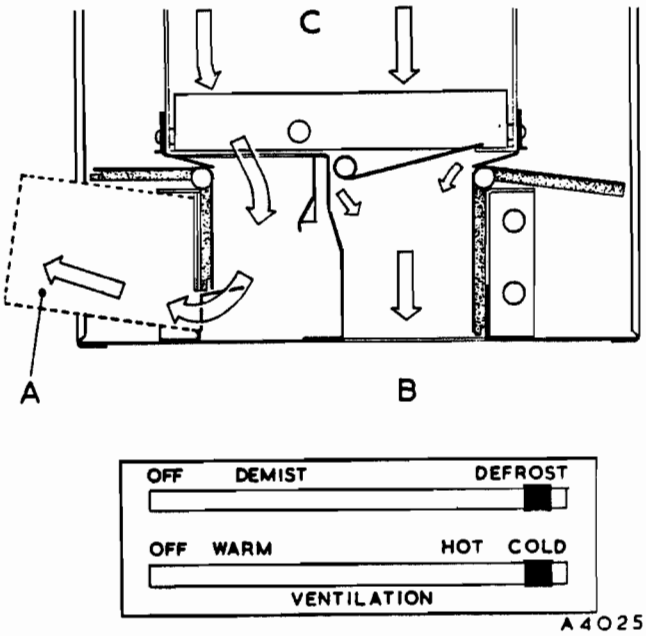

Fig. R.14

Warm weather—cold air ventilation

A. Increased volume of cold air to windshield.
B. Decreased volume of cold air to car interior.
C. Fresh air inlet—radiator cold.

Cold weather

In cold weather, when heating is required the lower lever must be adjusted between the 'WARM' and 'HOT' positions according to the degree of heating required.

The upper lever must be moved to the 'DEMIST' position.

Maximum heating is obtained by moving the lower lever to the 'HOT' position and the upper lever to a position directly in line with it (between 'DEMIST' and DEFROST') (see Fig. R.15). Switch on the booster blower.

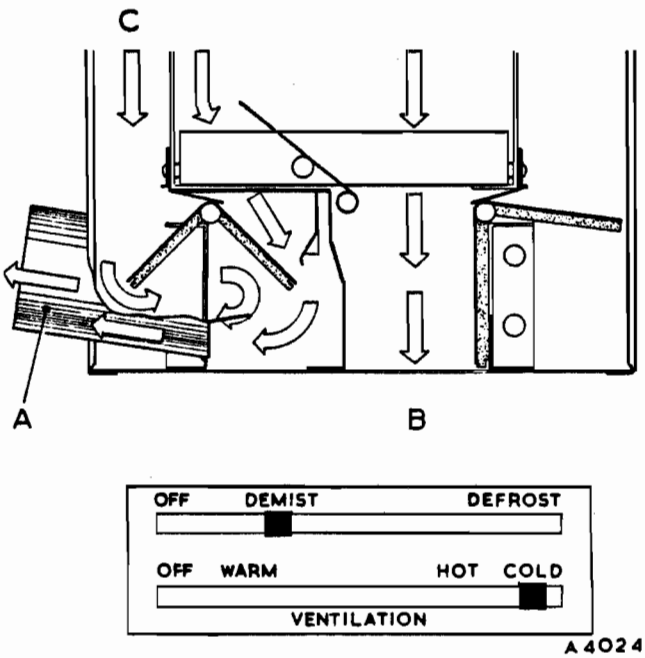

Fig. R.13

Warm weather—cold air ventilation

A. Cold air to windshield.
B. Cold air to car interior.
C. Fresh air inlet—radiator cold.

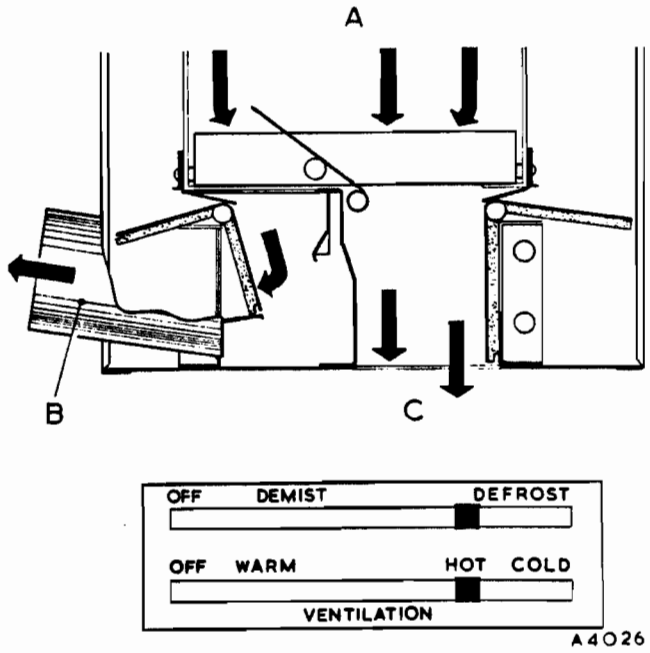

Fig. R.15

Cold weather—heating to windshield and car interior

A. Fresh air inlet—radiator hot.
B. Heated air to windshield.
C. Heated air to car interior.

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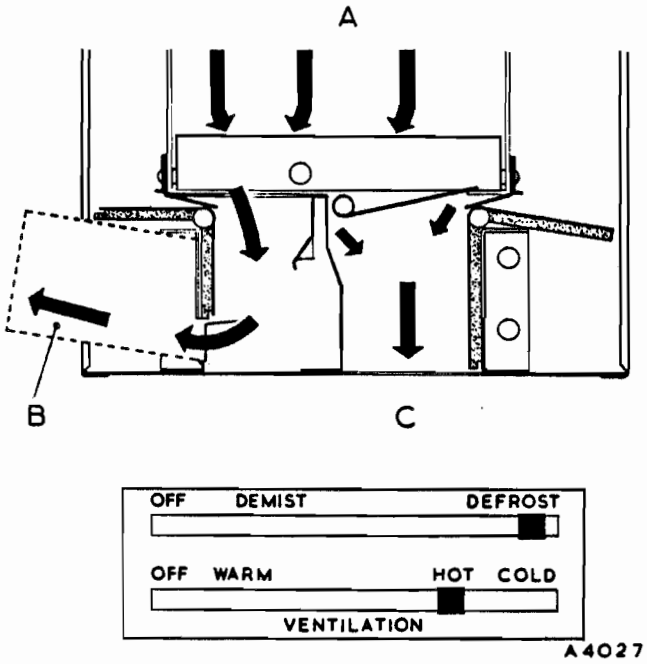

Fig. R.16

Freezing conditions—maximum heat to windshield

A. Fresh air inlet—radiator hot.
B. Volume of hot air to windshield increased.
C. Volume of hot air to car interior decreased.

Freezing conditions

To remove ice from the windshield move the upper lever to the 'DEFROST' position and the lower lever to the position marked 'HOT' (Fig. R.16). For extreme ice conditions move the lower lever to the 'OFF' position and switch on the booster blower.

Section R.18

ADJUSTING THE HEATER CONTROLS

Heating and ventilation control

(1) Move the lower, ventilation control, lever on the quadrant to the 'OFF' position. The ventilation valve lever (B) on the heater unit (Fig. R.17) should now be at its extreme forward position and a negligible amount of air should enter the car interior with the booster blower switched on.

(2) Move the ventilation control lever on the quadrant to the 'HOT' position. The ventilation valve lever (B) on the heater unit should now be at its extreme rearward position with the water valve lever (E) about to commence movement from the open position.

If the correct operation described in (1) or (2) above is not being obtained, the length of the inner cable must be adjusted. This may be carried out at the control end or the heater end, whichever is the most convenient. Slacken the clamping screw (G) in the cable trunnion, slide the cable through by an appropriate amount, and retighten the screw. Re-check as in (1) and (2) above.

(3) Move the ventilating control lever on the quadrant to the 'COLD' position. The lever on the water valve should be in the closed (vertical) position (Fig. R.19) and the water flow to the heater cut off. After two to three minutes (with the blower and engine running) air entering the car should be cold. If this is not so, it indicates that water is still flowing through the valve to the heater radiator. This may be checked by removing the top (return) water connection from the heater when the engine is running fast. The open end of the hose must, obviously, be plugged during the operation. If the water flow is not entirely cut off, proceed as follows.

(4) Unhook the spring (B) from its bracket (Fig. R.18) on the water valve and slacken the hexagon screw (A) to release the link rod. In the 'valve open' position (Fig. R.18) the water valve lever should move without any resistance, and as it reaches the 'valve closed' position (Fig. R.19) a slight resistance to movement should be felt, due to the sealing diaphragm pressing down on its seating inside the valve.

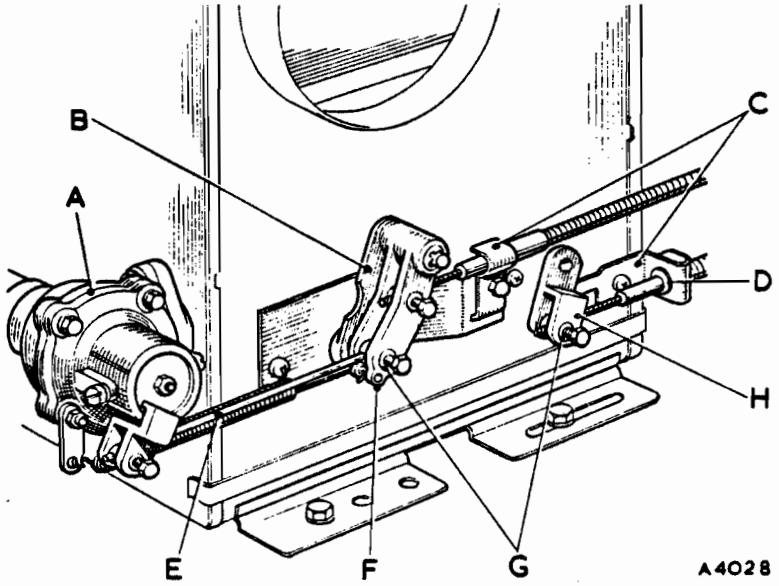

Fig. R.17

Heating and ventilation controls—heater unit

A. Water valve.
B. Ventilation valve lever.
C. Outer cable clamp.
D. Spring clip.
E. Operating link—water valve.
F. Over-ride lever.
G. Cable clamp.
H. Demister valve lever.

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(5) If this resistance is felt before the vertical position of the lever is reached, or no resistance is felt at all, the necessary adjustment must be made by slackening off locknut (c) (Fig. R.19) and giving a slight turn to the centre screw—clockwise to increase resistance, counter-clockwise to reduce it.

(6) If it is found impossible to achieve the necessary adjustment, the fault will be an internal one and will almost certainly be due to a deformed diaphragm.

The diaphragm is removed by unscrewing the four hexagon screws securing the two halves of the water valve body together.

The operation can in most cases be carried out without removing the heater unit from the car.

Fit a new diaphragm over the spigot of the centre screw and press the flange into the body recess. Replace the body fixing screws and readjust as above.

Demist and defrost control

(1) Move the demist control on the quadrant to the 'OFF' position. The demist valve lever (H) on the heater unit should now be at its extreme forward position and no air should pass through the windshield outlets with the blower motor switched on.

(2) Move the demist control lever to the 'DEFROST' position. The lever on the heater unit should now be in its extreme rearward position.

(3) If the correct operation described in (1) or (2) is not being obtained, adjustments must be made in a similar manner as described in paragraph (4) for for the ventilation control.

Section R.19

OPERATION OF THE REAR HEATER UNIT

The rear heater unit, located beneath the rear seat, consists of a radiator, fed with water from the engine cooling system, and an integral blower unit. Fresh air is drawn through the heater radiator and directed into the car interior at floor level.

The only control is a rheostat switch, fitted on each side of the passengers' seat, which operates the blower motor.

If unheated fresh air is required in the car interior the heater tap in the engine compartment must be turned off.

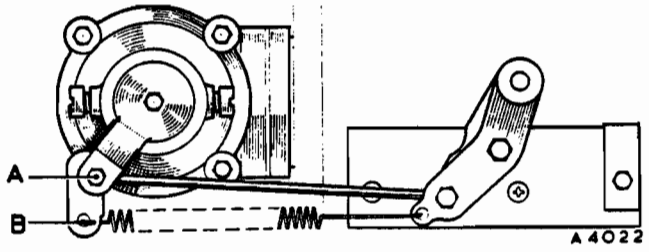

Fig. R.18

Water control valve in the open position

A. Clamping screw—link rod.
B. Spring anchor bracket.

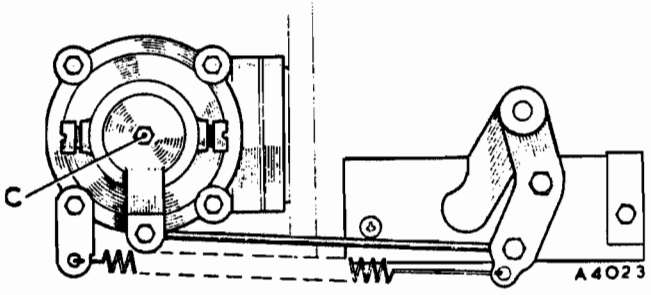

Fig. R.19

Water control valve in the closed position

C. Diaphragm adjusting screw.

Section R.20

REMOVING AND REPLACING THE FRONT BLOWER UNIT

Disconnect the blower motor wires from the fusebox on the left of the blower unit.

Slacken the clips around the rubber hoses connecting the blower unit to the air intake adaptor on the bulkhead and to the heater unit.

Remove the two bolts and plain washers securing the blower to its mounting bracket and lift off the blower unit.

To replace the blower unit reverse the removal instructions.

Section R.21

REMOVING AND REPLACING THE FRONT HEATER UNIT

Drain the cooling system as described in Section C.2.

Disconnect the inlet hose from the water valve and outlet hose from the outlet adaptor.

Slacken the outer cable clamping screw and the cable clamps from the ventilation valve and demister valve levers.

Remove the four set screws securing the heater unit to the scuttle shelf and lift off the unit.

To replace the unit reverse the dismantling procedure. Refer to Section R.18 for linkage adjustment procedure.

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Section R.22

PAINT REFINISHING INSTRUCTIONS

Operation	*Material*	*Thinning*	*Drying times*	*Application*	*Instructions*
Stripping original paint	Water-soluble paint remover, e.g. Sunbeam Anti-corrosives 'Stripolene 799'	—	—	Brush	Remove the original finish with a scraper after allowing paint-strip 10 minutes to react (repeat if necessary). Wash off thoroughly with cold water, rubbing with wire wool. Dry. Blow out crevices with compressed air. Strip a small area at a time to enable correct neutralizing of the stripper
Metal abrading	Emery-cloth, e.g. Howarth Blue Twill, grade 1½ M	—	—	Hand or disc	Paper thoroughly to ensure satisfactory key. Wipe with cleaner solvent or white spirits
Acid etching	Apply Deoxidine 125 (I.C.I.)	1 part Deoxidine, 1 part water	—	Brush	Apply solution generously and rub in with wire wool. Do not allow Deoxidine solution to dry off before the wash-off operation. Allow approximately five minutes to complete reaction. Wash thoroughly with cold water to remove all traces of Deoxidine solution, followed by a hot rinse. Thoroughly dry surfaces with a clean cloth and blow out crevices with compressed air
Priming	Synthetic primer G.I.P. No. S3178	6 to 1 with Z1048	½-hour to 4 hours	Spray	Apply one thin coat of synthetic primer (recommended for superior adhesion) or one thin coat of cellulose primer (recommended for good adhesion). The use of a primer coat enhances adhesion and gives the system a much greater safety factor
	or Grey cellulose primer G.I.P. C3971 MOD	50/50 with 2045M	¼-hour	Spray	
Applying stopper	Stopper Grey G.I.P. 824D or Stopper Brown G.I.P. 1543	—	6–8 hours, or overnight if possible	Glazing knife	Apply stopper in thin layers, allowing 15–20 minutes' drying between applications. Heavy layers result in insufficient drying, with subsequent risk of cracking
Filling	Primer Filler Grey G.I.P. C3663M	50/50 with 2045M	3–4 hours	Spray	Apply two or three full coats, allowing 15–25 minutes' drying time between coats

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Wet-sanding	Abrasive paper 280 grade	—	—	—	Rub down wet until smooth; a guide coat (a weak contrasting colour) may be used to ensure that the whole surface is rubbed level. Wash off thoroughly with water, sponge all sludge, wash off, dry with clean sponge. Dry off. Minimum of paint should be removed consistent with a satisfactory surface. Film thickness after rubbing should be ·0025 in. (·06 mm.) min.
Applying sealer or undercoat	Sealer Grey or Sealer White or Red undercoat (see B.M.C. Paint Scheme schedule)	50/50 with 2045M	15–20 minutes	Spray	Apply one coat, flash off
Dry-sanding or de-nibbing as required	320 grade paper	—	—	—	De-nib or dry-sand with 320 paper. Clean with white spirit. The grade of paper quoted is from the 3M Company (Minnesota Mining and Mfg. Co. Ltd.); the grade of paper may vary according to manufacture
Applying colour coats	B.M.C. body finishes (see B.M.C. Paint Scheme schedule)	50/50 2045M	5–10 minutes' flash between coats Overnight dry	Spray	Apply two double coats with a 5–10-minute flash between coats. Overnight dry
Flatting colour coat	320 or 400 paper (dependent on conditions)	—	—	Hand	Flat with 320 or 400 paper, dependent on conditions
Applying final colour coat	B.M.C. body finishes (see B.M.C. Paint Scheme schedule)	50/50 with 2045M	Overnight dry	Spray	Spray final double colour coat
Polishing	Cut and polish (see B.M.C. Paint Scheme schedule)	—	—	Hand or machine	The colour coat must be thoroughly dry before polishing. After cutting, burnish to a high gloss with a clean mop, and finally clear with a liquid polish, e.g. Apollo liquid polish

NOTE.—(1) For faster drying of undercoats or local repairs G.I.P. thinners 1523 may be used.

(2) Under extreme circumstances of heat and/or humidity retarder G.I.P. Z1694 can be used added to the 2045M thinners.

SECTION T

NORMALAIR
AIR-CONDITIONING SYSTEM
CHARGING AND SERVICING

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Section T.1

DESCRIPTION
(Refer to Figs. T.1 and T.3)

The system employs a mechanical compression means of refrigeration and utilizes a liquid refrigerant to absorb the heat from the air within the vehicle, thus lowering the temperature of the air. The system is controlled by one three-position switch operating the air-conditioning system and regulating the speed of the two fans located in the evaporator unit. The three positions are 'OFF', 'HALF', and 'FULL'; the air-conditioning system is switched on when either of the fan speeds is selected. The system comprises a compressor and clutch, a condenser, a liquid receiver, and an evaporator unit.

The compressor is mounted on the forward left-hand side of the engine and is driven by a belt connected to the crankshaft pulley through an electromagnetic clutch controlled by the three-position switch. The compressor discharge valve is connected to the inlet of the condenser, and the condenser outlet is connected to the liquid receiver. A copper pipe connects the outlet from the liquid receiver to the expansion valve in the evaporator unit. The evaporator unit incorporates an expansion valve controlling the flow of refrigerant into the evaporator matrix, two fans, and a low-pressure cut-out switch to protect the system by disengaging the clutch if pressure in the suction side of the system falls too low.

Operation of the system

Heat-laden refrigerant is drawn from the evaporator unit to the compressor, where it is compressed and passed on to the condenser in the form of super-heated vapour. Since the temperature of the high-pressure vapour is much higher than any normal atmospheric temperature, the vapour gives up its heat to the air flowing through the condenser matrix and is condensed to a liquid state. The condensed refrigerant flows from the condenser and is filtered, dried, and stored in the liquid receiver until required by the evaporator unit.

The liquid refrigerant is metered into the evaporator matrix by the expansion valve to supply the matrix with the correct quantity of refrigerant. The liquid refrigerant flowing through the unit absorbs heat from the air passing through the evaporator matrix and the air now cooled is recirculated into the interior of the vehicle. The heat absorbed causes the refrigerant to boil and turn into a vapour, which is drawn from the evaporator to the compressor and the cycle is repeated.

If the temperature of the evaporator matrix were allowed to fall too low moisture condensed from the air would freeze on the matrix, obstruct the air flow, and decrease the evaporator outlet pressure. This is prevented by the low-pressure cut-out switch. If the pressure at the evaporator outlet falls below the predetermined setting of the switch the circuit is broken and the compressor drive is automatically disengaged. As the temperature of the evaporator matrix increases, the outlet pressure through the 'T' piece is also increased and the circuit is restored, thus allowing the compressor drive to re-engage.

Section T.2

PRECAUTIONS (REFRIGERANT)

Refrigerant 12 rapidly freezes at normal temperatures and pressures and tends to freeze any object with which it may come in contact. For this reason goggles should be worn to prevent the liquid being splashed into the eyes when servicing the system. If liquid should enter the eyes, quickly apply three or four drops of a sterile mineral oil to absorb the refrigerant. Follow this by washing the eyes with a weak solution of boric acid and inform a doctor immediately.

Always discharge the refrigerant system in a well-ventilated area as large quantities of the vapour can displace the air and could cause suffocation in a small, poorly ventilated workshop.

Although not normally poisonous, Refrigerant 12 can become poisonous if it contacts an open flame. Take care, therefore, to avoid inhaling any fumes given off when using the flame-type leak detector.

Do not weld or apply heat on or near components of the system as this may increase the pressure of the refrigerant and cause damage to the components.

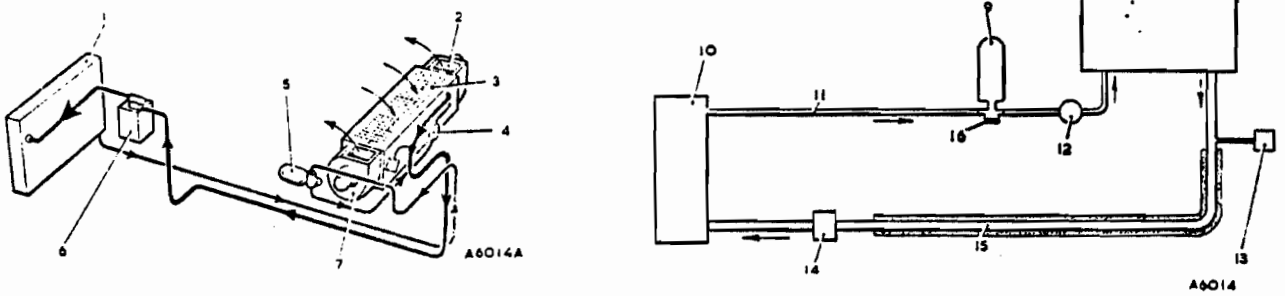

Fig. T.1

Layout of system

1 and 10.	Condenser.	4 and 12.	Expansion valve.	11.	Pipe—$\frac{3}{8}$ in.
2 and 7.	Fans.	5 and 9.	Liquid receiver.	13.	Low-pressure cut-out.
3 and 8.	Evaporator.	6 and 14.	Compressor.	15.	Pipe—$\frac{5}{8}$ in.

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Do not splash the refrigerant on any surface, as when it combines with water or moisture it forms a highly corrosive acid.

Before disconnecting a pipe or component bleed the charge slowly from the system in a well-ventilated area by opening one of the service valves. The refrigerant will then escape in the form of a vapour in a few minutes.

Seal open connections immediately to prevent the ingress of moisture, dirt, and other foreign matter.

Section T.3

EQUIPMENT

The equipment required during charging and servicing the Normalair air-conditioning system comprises the following:

(1) Compound pressure gauge: 0–30 in. vacuum, 0–90 lb./sq. in. (0–76 cm. vacuum, 0–6 kg./cm.²).
(2) Pressure gauge: 0–300 lb./sq. in. (0–21 kg./cm.²).
(3) Halide test lamp.
(4) Vacuum pump (capable of maintaining a vacuum of 28 in. [71 cm.] of mercury).
(5) Spring balance: 0–50 lb. (0–22 kg.).
(6) Refrigerant 12.
(7) Charging line.
(8) Cylinder connector.
(9) Locating tool (FC1601).
(10) Torque wrench: 0-360 lb. in. (4·14 kg. m.).
(11) Oven suitable for heating a compressor to 600° F. (315° C.).
(12) Tank of clean water heated to 120° F. (49° C.).
(13) Pipe flaring tool, standard S.A.E. Refrigeration Flare, suitable for ¼, ⅜, and ⅝ in. (6·35, 9·52, and 15·87 mm.) o/d copper piping.

Section T.4

LEAK TEST

Before initial charging, or if for any reason the refrigerant has escaped from the system, or if it is necessary to purge the system of moisture, testing, evacuation, and charging procedures must be carried out.

The leak test must also be used when replacement parts have been fitted, when repairs to the system have been carried out, or if the loss of refrigerant has been excessive due to leakage from a faulty connection.

(1) When the system has been installed check that all unions and joints are tight.
(2) Remove the end caps from the discharge and suction valves situated on top of the compressor (Fig. T.2). Rotate the spindle of each valve anti-clockwise to the fully back-seated position.
(3) Remove the blanking cap from the discharge valve service connection and connect the compound pressure gauge. Open the valve by turning the spindle one turn clockwise from the fully back-seated position.
(4) Remove the blanking cap from the suction valve service connection and connect the pipe from the refrigerant supply cylinder. **The cylinder must be vertical, with the valve uppermost.** Open the suction valve by rotating the valve spindle one complete turn clockwise from the fully back-seated position.
(5) Open the valve of the supply cylinder to allow refrigerant to enter the system; after a few seconds, when the pressure gauge ceases to rise, the system can be regarded as being full of gas. Back-seat the suction valve by rotating the spindle in an anti-clockwise direction.
(6) Light a Halide test lamp as instructed by the manufacturers. Complete a leak test by passing the open end of the leak detector tube slowly and progressively around and over each joint in turn. A slight leak will be indicated by the flame of the detector turning green; excessive leakage will turn the flame blue. When rectifying leaks by tightening loose joints take care not to strip the threads, and use two spanners when tightening the connections of movable unions. The engine must be switched off when carrying out the above test.

CAUTION.—Ensure that there is no danger from engine fuel or fumes when using the test lamp.

(7) Rectify any leaks and retest.
(8) When all leaks have been rectified close the valve on the supply cylinder and remove the charging line from the suction valve service connection, allowing all the refrigerant to escape from the system. Carry out the evacuation and charging procedures as detailed in Sections T.5 and T.6.

Section T.5

EVACUATION

(1) When all leaks have been rectified, and with the engine switched off, set the discharge and suction valves as for the leak test.
(2) Connect a vacuum pump to the suction valve service union (Fig. T.2).
(3) Start the pump and evacuate the system until a vacuum of at least 28 in. (71 cm.) of mercury is indicated on the compound pressure gauge. The pump should be kept running and evacuation continued for 10 minutes.
(4) Back-seat the suction valve by turning the spindle anti-clockwise, switch off the vacuum pump, remove the connection, and refit the end cap.
(5) Check that the system holds the vacuum for at least 10 minutes; there must be no leakage. If there are signs of leakage, repeat the leak test, rectify the leak, and evacuate the system again.
(6) When satisfied that the system will hold the vacuum, remove the end cap (Fig. T.2) and back-seat the discharge valve (anti-clockwise). Remove

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the compound pressure gauge and refit the discharge valve end cap and the blanking cap. The engine must be switched off while evacuating the system.

Section T.6

CHARGING

When fully charged the system contains 2·5 lb. (1·13 kg.) of refrigerant. To measure the refrigerant, suspend the charging cylinder by a suitable spring balance and note the weight of the cylinder before allowing the gas to enter the system. The correct amount of charge is obtained when the cylinder weight has decreased by 2·5 lb. (1·13 kg.). Under conditions of low temperature and pressure it may be found helpful to warm the supply cylinder while charging is taking place in order to assist vaporization of the liquid content. To warm the cylinder it should be suspended from the spring balance into warm water with the temperature not exceeding 125° F. (51° C.).

Carry out the evacuation test as detailed in Section T.5 and then proceed as follows:

(1) Remove the blanking cap and connect a source of Refrigerant 12 to the suction valve service connection, but do not fully tighten.

CAUTION.—Ensure that the supply cylinder is upright so that only gas will enter the system.

(2) Open the supply cylinder valve and bleed the charging line of air, then immediately tighten the supply connection to the suction valve service connection.

(3) Remove the caps from the discharge valve service connection, fit a high-pressure gauge, and rotate the valve spindle three complete turns clockwise from its fully back-seated position.

(4) Remove the end cap from the suction valve and rotate the valve spindle three complete turns clockwise from its fully back-seated position.

(5) Start the vehicle engine and switch on the air-conditioning system; gas will now be drawn in.

(6) Run the engine initially at idling speed, and slowly increase the revolutions as the pressure in the system increases. The low-pressure cut-out switch will operate during the initial stages of charging if the engine speed is too high. Experience will soon enable the system to be driven whilst charging.

CAUTION.—Maximum charging pressures vary according to outside air temperature, vehicle interior temperature, and engine speed. Observe the pressure gauge; if a sudden or sharp increase in charging pressure, or if a pressure exceeding 250 lb./sq. in. (17·58 kg./cm.²) is experienced, denoting blockage or severe overcharging of the system, the system must immediately be switched off and the fault traced and rectified.

(7) Observe the scale of the spring balance. Immediately the weight of the cylinder with its refrigerant content has decreased by 2·5 lb. (1·13 kg.), fully back-seat the suction valve. Check the sight glass at idling speed, and again after running the engine at half-throttle, for freedom from bubbles.

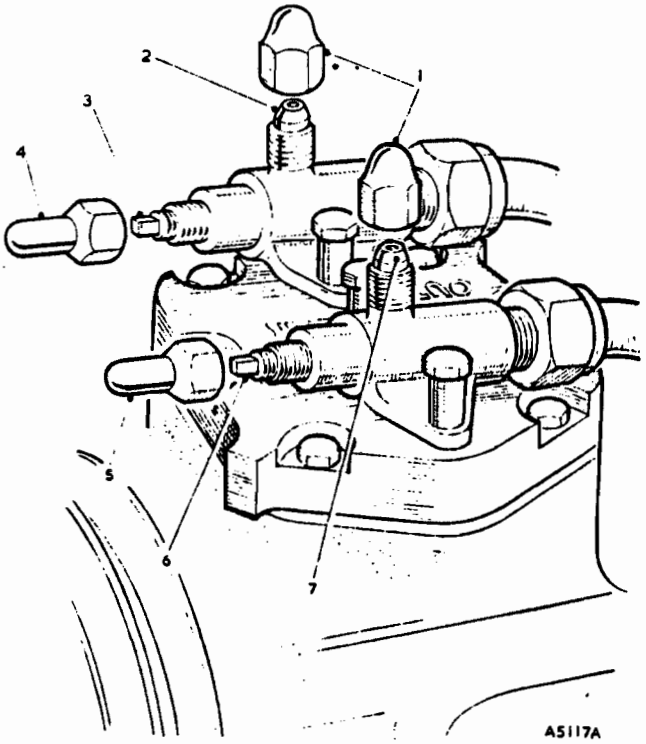

Fig. T.2

Details of compressor valves

1. Blanking caps.
2. Discharge valve service connection.
3. Discharge valve.
4. Discharge valve end cap.
5. Suction valve end cap.
6. Suction valve.
7. Suction valve service connection.

NOTE.—Immediately after starting the charging procedure the sight glass may appear clear and free from bubbles; this is because the glass is empty. The system is not charged until the bubbling and frothing stages are completed. Experience will soon show the difference between a full and an empty sight glass.

(8) When the system is fully charged close the valve of the supply cylinder and remove the charging line from the suction valve service connection. Refit the blanking and end caps and tighten up.

(9) Switch off the conditioning system and the vehicle engine and remove the pressure gauge. Refit the blanking cap and the end cap and tighten up.

Section T.7

TOPPING UP (REFRIGERANT)

Check the need for topping up by inspecting the sight glass on the liquid receiver in the luggage compartment when the system has been in operation for four or five minutes.

The appearance of bubbles in the sight glass when the system is in operation indicates that it is under-charged and requires topping up.

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Carry out the leak test and rectify any leaks (Section T.4).

(1) Remove the suction valve end cap and back-seat the valve by turning the spindle anti-clockwise (Fig. T.2).

(2) Remove the blanking cap and connect a refrigerant supply cylinder to the suction valve service connection. **Ensure that the cylinder is upright, with the valve uppermost, so that only gas will enter the system.**

(3) Open the supply cylinder valve and purge the charging line before completely tightening the connection to the suction valve service connection.

(4) Open the suction valve by turning the spindle three turns clockwise.

(5) Start the engine and switch on the air-conditioning system; gas will now be drawn in.

(6) Watch the sight glass, and immediately all bubbles have disappeared (at idling speed) fully back-seat the suction valve (anti-clockwise).

(7) Close the refrigerant supply cylinder valve and remove the charging line from the suction valve service connection. Refit the blanking cap and the valve end cap.

(8) Check for leaks in the vicinity of the valve with a Halide test lamp.

Section T.8

PRELIMINARY INSPECTION

(1) Check the compressor belt for tension and condition. Adjust or renew as necessary.

(2) Examine the condenser and evaporator matrices for obstruction, and clean as necessary (Fig. T.1).

(3) Check the compressor oil level (Section T.12).

(4) After the system has been inoperative for one or two hours check the temperature/pressure relationship:

(*a*) Fully back-seat the suction valve and remove the blanking cap.

(*b*) Fit a pressure gauge to the suction valve service connection and forward-seat the valve one quarter of a turn.

(*c*) Check that the pressure indicated by the gauge corresponds to that given in Table 1 in relation to the outside air temperature.

(*d*) If the pressure is normal, fully back-seat the suction valve, remove the gauge, and refit the blanking caps. If the system pressure differs from that given in Table 1, page T.13, refer to Section T.10, **'Static system pressure', (1).**

(5) Start the engine and switch on the air-conditioning system; check the operation of the fans and the magnetic clutch. Allow the system to operate for

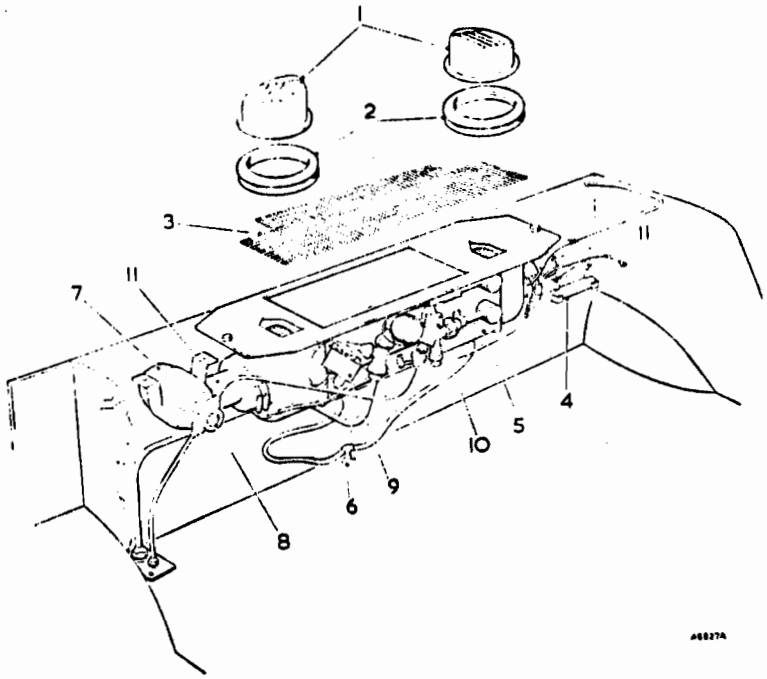

Fig. T.3

Details of installation in luggage compartment

1. Outlet duct.
2. Bezel—duct.
3. Grid—inlet/outlet.
4. Resistor.
5. Evaporator box.
6. Drain tube.
7. Liquid receiver.
8. Sight glass.
9. Low pressure cut-out.
10. Expansion valve.
11. Fan motor.

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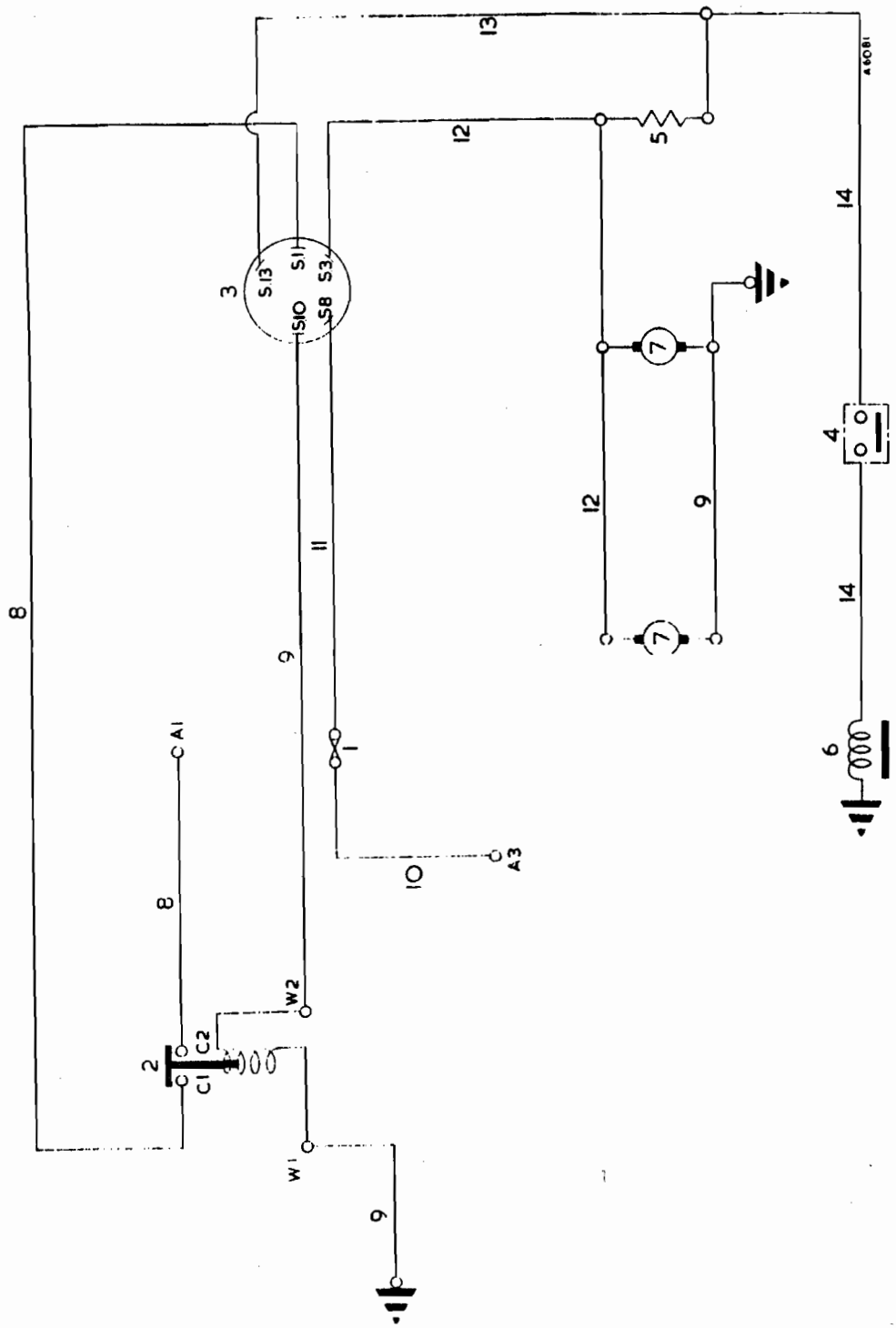

Fig. T.4
Wiring diagram

1. Fuse unit.
2. Relay.
3. Switch.
4. Low pressure cut-out.
5. Resistor.
6. Compressor clutch.
7. Fan motor.
8. Brown and green.
9. Black.
10. White.
11. Red.
12. Red and yellow.
13. Red and blue.
14. Red and brown.

10 to 15 minutes and check the refrigerant level; top up as required. If the fans and/or the clutch do not function correctly, apply the appropriate fault-finding procedure detailed in Section T.10.

Section T.9

PERFORMANCE CHECK

The following equipment is required in order to carry out a performance check on the air-conditioning system: a magnetic r.p.m. indicator to establish the engine speed: a hygrometer to indicate the atmospheric temperature and humidity; two thermometers to measure the temperature at the outlet ducts; a pressure gauge to measure the condenser pressure.

The performance check should be carried out with the vehicle doors and windows open, the engine maintained at a constant 1,250 r.p.m., and fans switched on 'FULL'. The condenser pressure must be maintained between 200 and 230 p.s.i.g. (14·1 and 16·2 kg./cm.² gauge).

NOTE.—To increase the condenser pressure restrict the air flow through the matrix, using paper or cardboard.

To decrease the condenser pressure under conditions of high atmospheric temperature and humidity place an electric fan in front of the matrix. In sandy or dusty conditions improvise a suitable duct between the fan and the radiator grille to prevent dust, etc., entering the matrix.

Install the magnetic r.p.m. indicator on the engine and arrange a thermometer at each evaporator outlet duct. Remove the end cap from the discharge valve and back-seat the valve. Remove the blanking cap and connect the pressure gauge to the service connection. Forward-seat the discharge valve one half-turn.

Proceed with the performance check as follows:

(1) Start the engine and switch on the air-conditioning system. Check that the fans and the magnetic clutch are operating correctly. Run the system for 10 to 15 minutes and check the sight glass (Fig. T.3); if foam or bubbling is apparent, indicating that the system is undercharged, carry out the topping-up procedure detailed in Section T.7.

(2) With the system fully charged, run the engine at 1,250 r.p.m., adjust the air flow through the condenser as necessary so that the pressure gauge indicates between 200 and 230 p.s.i.g. (14·1 and 16·2 kg./cm.² gauge), and record the 'wet' and 'dry' bulb temperatures indicated on the hygrometer.

(3) Refer to the system performance chart given in Table 2 and determine the maximum allowable discharge temperature for the 'wet' and 'dry' bulb temperatures indicated on the hygrometer in (2) above.

(4) The performance of the air-conditioning system can be considered satisfactory if the temperature indicated on both of the thermometers located at the evaporator outlets is at or below the temperature determined in (3) above.

(5) Should the discharge temperature be higher than that allowed in (2) above, apply the fault-finding procedure detailed in Section T.10.

(6) On satisfactory completion of the performance check, back-seat the discharge valve, remove the pressure gauge, and refit the blanking and end caps. Remove the two thermometers and the r.p.m. indicator.

Section T.10

FAULT-FINDING AND DIAGNOSIS

Static system pressure

(1) *No system pressure.* If no pressure is indicated on the gauge the system has lost the refrigerant charge. Carry out the leak test (Section T.4) and rectify any leak. After rectifying the leak evacuate (Section T.5) and recharge (Section T.6) the system.

(2) *High system pressure.* If the pressure gauge reading is higher than that given in Table 1 air is present in the system. Evacuate and recharge the system.

Fans do not operate correctly

(1) *Both fans inoperative.* Failure of both fans indicates a faulty electrical circuit. Renew any defective parts, and repair the circuit as necessary (Fig. T.4).

(2) *One fan inoperative.* Failure of one fan indicates either a faulty electrical circuit from the fan motor to the connectors or a defective fan motor. Check the circuit and, if correct remove and inspect the motor.

NOTE.—A noisy fan motor may be caused by excessive overall wear or a dry bearing felt.

Compressor does not operate

(1) *Faulty 'V' belt.* Check the tension and condition of the belt; renew or adjust as necessary.

(2) *Faulty electrical supply.* A faulty electrical circuit can be confirmed by switching on the ignition and the air-cooling system and creating a short between the electrical connection on the compressor clutch and one of the engine cylinder head bolts. If the lead does not spark a fault is confirmed; trace and rectify as necessary (Fig. T.4).

(3) *Defective clutch.* If the electrical circuit is not at fault remove and renew the clutch.

Compressor cuts out

Intermittent operation of the compressor may be due to the low-pressure cut-out switch (Fig. T.3) or to moisture in the system. In the former case this is quite normal, particularly during initial operation of the conditioning system, but when the pressure has risen above the cut-out point this should cease. In the latter case intermittent operation of the compressor is accompanied by loss of cooling efficiency and the appearance of frost forming on the inlet to the expansion valve. To remedy this fault allow the complete charge of refrigerant to

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escape from the system through the discharge valve service connection by removing the blanking cap and opening the valve from its fully back-seated position. Disconnect and renew the liquid receiver as detailed in Section T.11. If a new liquid receiver is not immediately available, the desiccant may be rejuvenated as detailed under **'Liquid receiver'** in Section T.11.

Failure of the compressor to restart after cutting out may be due to a faulty electrical circuit, a defective cut-out switch, damage to the capillary tube and bulb, or a restriction of the expansion valve.

(1) *Electrical supply.* Check the electrical circuit to trace the fault and renew any defective components, or repair the electrical system as necessary.

(2) *Low-pressure cut-out switch.* This can be confirmed by shorting out the switch. If the compressor re-starts, a faulty cut-out switch is indicated and should be renewed.

(3) *Capillary tube and bulb.* Check for damage and that the bulb is held in good contact with the outlet pipe from the evaporator. A damaged tube may also allow the refrigerant to escape; under these conditions the expansion valve (Fig. T.3) will not react to temperature changes, thus restricting the flow of the refrigerant and causing the low-pressure switch to disengage the compressor clutch. If no damage is visible carefully remove the bulb from its housing and hold it in the hand; if the compressor does not restart check the expansion valve for restriction and repeat the test. If the valve is free from restriction a damaged capillary tube and bulb is indicated and the expansion valve must be renewed.

NOTE.—The air-conditioning system must not be allowed to run any longer than is necessary with the bulb removed from its housing, since if the valve is serviceable and is responding correctly to temperature, a comparatively high temperature may cause liquid refrigerant to reach and damage the compressor.

(4) *Expansion valve restriction.* The appearance of frost on the inlet side of the expansion valve due to moisture, or to the fact that the fine gauze strainer on the inlet port side has become choked, will indicate blockage or sticking of the valve. In some cases the compressor may momentarily restart. Remedy by removing and cleaning the strainer or by renewing the expansion valve.

Compressor operates but air is not cooled

Failure of the system to cool the air in the interior of the vehicle may be caused by the loss of refrigerant from the system, restriction of the system, or a faulty compressor.

(1) *Loss of refrigerant.* Top up the system as detailed in Section T.7.

(2) *Restriction of the system.* If this should occur, caused by a kinked pipe, blocked valve, or similar damage, the refrigerating effect will be reduced. The fault can be traced by the temperature drop on the downstream side of the restriction. With the system in operation, check the various components by hand, and where an abnormal difference in temperature is felt along a length of pipe or between the inlet and outlet connections of a component, this will indicate the location of the defect. Inspect the component and rectify or renew.

(3) *Faulty compressor.* See (4) below.

Compressor operates but air is only partially cooled

This fault may be caused by the refrigerant system being undercharged and/or the evaporator matrices being dirty or blocked by air in the system, by the fan motors not functioning correctly, or by a faulty compressor.

(1) *Loss of charge.* Top up as detailed in Section T.7.

(2) *Evaporator and/or condenser matrices dirty or blocked.* Clean the matrices with an air-line.

(3) *Air in the system.* Allow the system to remain idle for one or two hours until all components are at the same temperature as the surrounding air and carry out the procedure detailed in Section T.10, (4).

(4) *Faulty compressor.* Remove the compressor and clutch and apply the leak and pumping tests detailed in Section T.11.

Section T.11

MINOR REPAIRS

The following paragraphs detail the procedure for the removal, repair, and reinstallation of the various components of the air-conditioning system. Where applicable,

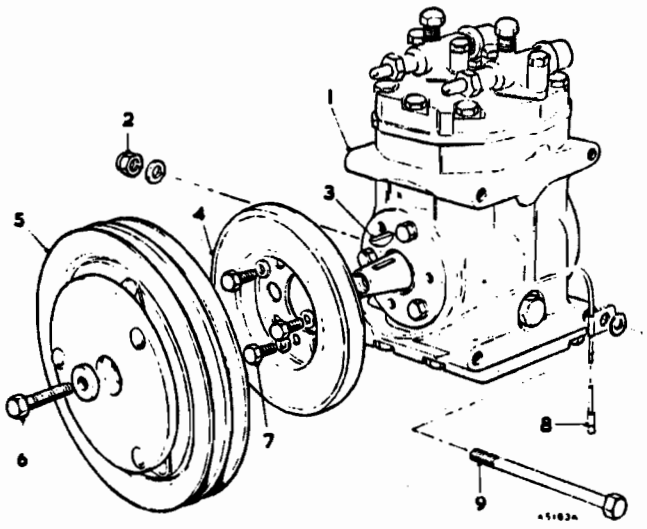

Fig. T.5

Compressor clutch

1. Compressor.
2. Stiffnut.
3. Woodruff key.
4. Clutch solenoid.
5. Pulley.
6. Self-locking bolt.
7. Set screw.
8. Lead.
9. Mounting bolt.

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test instructions are given after reassembling a component, thus proving its serviceability before reinstallation in the vehicle. Any of the parts, e.g. valve reeds, gaskets, etc., covered by the scope of these instructions may be renewed during the course of reassembly. The safety precautions detailed in Section T.2 should be observed when carrying out repairs to the refrigeration system.

Electrical circuit

Repairs to the electrical circuit, other than leads, can only be effected by renewal of the defective component(s). Removal and installation procedure, except for the low-pressure cut-out switch, are self-evident. If it is required to renew the loom it should be installed in accordance with the wiring diagram. After carrying out a repair to the electrical circuit check that the air-conditioning system operates correctly.

System pipes

If an obstruction is suspected in a system pipe the pipe may be removed or disconnected at both ends and the obstruction cleared by applying a source of air pressure through the pipe.

Repair of a pipe, other than clearing an obstruction, can only be effected by renewal. When renewing a copper pipe, use a suitable length of the appropriate diameter copper tube, together with the end fittings from the redundant pipe. Both ends of the new pipe must be flared, using a suitable pipe flaring tool, to retain the end fittings and to provide a gas-tight joint.

CAUTION.—The interior of the new piping must be clean and free from moisture, swarf, etc.

After completing the repair carry out the leak test (Section T.4), evacuation (Section T.5), and recharging procedures (Section T.6).

Rear parcel shelf components

Should it be required to renew either of the two outlet ducts or the metal grid, proceed as follows:

(1) Remove the outlet ducts by gently easing them from their respective rubber bezel.

(2) Lift the forward edge of the rear parcel shelf trim to clear the vehicle seat and slide the trim forward to release it from the two clips.

(3) Extract the staples and remove the grid.

(4) When reassembling, ensure that the new metal grid covers the two circular holes and the rectangular hole, and secure with staples as necessary.

(5) The assembly procedure is the reverse of dismantling.

'V' belt

To renew the compressor 'V' belt slacken the four mounting bolt nuts securing the compressor to the mounting bracket and the adjusting screw locknut on the adjuster plate. Rotate the adjusting screw anti-clockwise to lower the compressor and remove the 'V' belt. Fit a new 'V' belt and adjust the tension.

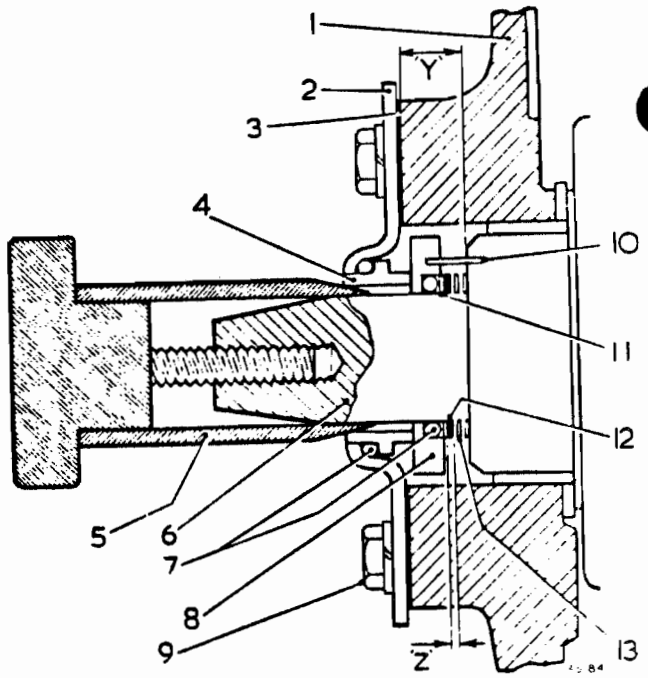

Fig. T.6

Carbon gland seal

1. Compressor cylinder block.
2. Seal plate.
3. Gasket.
4. Carbon block.
5. Locating tool.
6. Crankshaft.
7. 'O' rings.
8. Rotating block.
9. Set screw.
10. Locating dowel.
11. Rotary seal.
12. Shim (if required)
13. Dish springs.

Compressor clutch

Repair of the compressor clutch can only be effected by renewal. Should it be required to renew the magnetic clutch solenoid or the pulley, the procedure is as follows:

(1) Disconnect the clutch electrical lead from the RED/BROWN lead at the single connector.

(2) Slacken the four mounting bolts attaching the compressor to the adjustable mounting bracket. Unscrew the locknut and rotate the adjuster screw anti-clockwise to lower the compressor on the bracket. Remove the 'V' belt.

(3) Remove the self-locking bolt and special washer securing the clutch pulley to the compressor crankshaft. Screw a $\frac{5}{8}$ in.—14 UNC. bolt into the pulley bore to withdraw the pulley and remove the Woodruff key.

(4) Remove the three set screws and washers securing the clutch solenoid to the compressor and remove the solenoid.

(5) Examine all screw threads for damage and ensure that there is no undue stiffness, or excessive wear, when screwed into their respective mating threads. The self-locking bolt contains a nylon insert for locking purposes and its effectiveness should be checked.

(6) To assemble the clutch secure the clutch solenoid to the compressor with the three set screws and lock

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washers, and tighten evenly to a torque of 90 lb. in. (1·05 kg. m.).

(7) Fit the Woodruff key to the compressor crankshaft, align the clutch pulley keyway with the key, and slide the pulley into position, first ensuring that the tapered portion of the shaft is clean and free from dirt. Attach the pulley with the self-locking bolt and special washer and tighten up.

(8) Replace the 'V' belt and adjust.

(9) Connect the clutch electrical lead to the single connector and check that the air-conditioning system operates correctly.

Carbon gland seal

Should leakage of oil occur from the carbon gland seal, repair can only be effected by renewal of the carbon block and the 'O' rings. Proceed as follows:

(1) Discharge the refrigerant from the system (Section T.5) and disconnect the pipe connections at the discharge and suction valves. Remove the electrical lead and the 'V' belt drive from the clutch pulley.

(2) Remove the stiffnuts and washers from the mounting bolts and withdraw the compressor and clutch from the mounting bracket.

(3) Remove the clutch from the compressor as described above.

(4) Remove the three set screws and washers securing the carbon gland seal assembly to the compressor. Withdraw the seal plate, the carbon block and 'O' ring, the rotating block and 'O' ring, the rotary seal, and the two dish springs. Remove the gasket and shims (if fitted).

(5) Check the carbon gland seal locating dowel on the crankshaft for security and damage. The dowel should protrude between ·15 and ·16 in. (3·8 and 4·1 mm.).

(6) To ascertain whether shimming is necessary prior to fitting a new seal assembly measure the distance (Y), Fig. T.6, and subtract ·348 in. (8·83 mm.) from the measurement obtained to determine dimension (Z) and add shims to the nearest ·010 in. (·254 mm.).

(7) Assemble the new carbon gland seal, assembling the seal parts in the reverse order to that described for removal, operation (4), first locating a new gasket between the seal plate and cylinder block. The 'O' rings should be lightly smeared with oil (Shell Clavus 33) before assembly.

(8) Centralize the carbon gland seal assembly, using the locating tool (Part No. FC1601). Secure the seal to the cylinder block, using the six ¼ in. UNC. set screws and washers (three of which are used to secure the clutch solenoid). Tighten the set screws evenly to a torque of 90 lb. in. (1·05 kg. m.) and mark the three screws which are used to secure the clutch solenoid to facilitate subsequent removal after baking. Remove the locating tool.

(9) Place the compressor in an oven for one hour at a temperature of 200° F. (94° C.). Allow the compressor to cool to room temperature and tighten the seal attachment set screws to the required load —see operation (8).

(10) Carry out the leak test described in Section T.4.

(11) With the compressor held upright, remove one of the oil filler plugs from the compressor crankcase and add Shell Clavus 33 lubricating oil until the oil is level with the bottom of the oil filler plug hole. Refit the plug and tighten to a torque load of 360 lb. in. (4·2 kg. m.).

(12) Reassemble the clutch to the compressor as detailed under **'Compressor clutch'** on page T.9.

Locate the compressor on the adjustable mounting bracket and insert the four bolts through the compressor and bracket. Fit the washers and screw on the stiffnuts, but do not tighten. Replace the 'V' belt and adjust the tension as detailed under **'"V" belt'** on page T.9. Reconnect the clutch electrical lead to the single connector.

(13) Insert the filler sleeve in the suction port of the cylinder head. Locate the discharge and suction valves with new gaskets over their respective studs. The valves must be positioned so that the discharge valve spindle is adjacent to the word 'OUT' and the suction valve pipe connection is adjacent to the word 'IN' stamped on the cylinder head. Secure the valves with the four cap nuts and new washers and tighten to a torque load of 180 lb. in. (2·07 kg. m.).

(14) Fully back-seat both valve spindles and refit the end caps. Check for leakage in the vicinity of the discharge and suction valves and that the air-cooling system operates correctly. Retighten the cap nuts to the correct loading.

Compressor cylinder head

If it is required to remove the compressor cylinder head in order to effect a repair, remove the compressor and separate the clutch as detailed on page T.9 and proceed as follows:

(1) Remove the four cap nuts securing the discharge and suction valves to the compressor cylinder head. Remove the sealing washers from the valve caps and discard all washers and gaskets.

(2) Withdraw the filter sleeve situated in the cylinder head under the suction valve. Remove the six bolts and washers securing the cylinder head and separate the head and the valve plate from the cylinder block. This should be carried out by tapping under the projections on the valve plate, using a hide-faced mallet.

(3) Separate the valve plate from the cylinder head and discard the gasket.

(4) Remove the four bolts and spring washers securing the discharge valve reed assemblies to the valve plate and separate the guides, reeds, springs, and bridge pieces.

(5) Remove the suction valve reeds and discard the gasket located on the cylinder block.

(6) Clean the items removed with a suitable cleaning agent (trichlorethylene) and examine for damage,

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i.e. distortion, corrosion, fractures, overheating, and evidence of wear. All internal and external screw threads (bolts and studs) must be clean; ensure that there is no undue stiffness, or excessive wear, when screwed into their respective mating threads.

(7) Examine the suction valve reed spring pins and the cylinder head locating dowel pin for damage and security in the cylinder block. Clean the top of the cylinder block and recesses in the walls.

(8) Fit a new gasket to the cylinder block, locating its position by the dowel pin, then fit a suction reed over each pair of spring pins. It is most important that the reeds rest on the extending ears of the gasket.

(9) Assemble the discharge valve reed assemblies by locating two guides, a discharge reed, a leaf spring, and a bridge piece over each pair of discharge ports on the plain side of the valve plate. Attach each assembly with two bolts and spring washers, and tighten up.

(10) Locate the valve plate assembly, a new head gasket, and the cylinder head over the studs and locating pin in the cylinder block. Attach the head to the block with the six $\frac{5}{16}$ in. UNC. bolts and washers; the bolts must be finger tight only at this stage.

(11) Place the compressor in an oven for one hour at a temperature of 200° F. (94° C.). Allow the compressor to cool to room temperature and tighten the cylinder head bolts to the required load.

(12) Complete the assembly procedure as detailed in **'Carbon gland seal'**, (11) to (14).

Condenser

Repair of the condenser is limited to straightening of the corrugated fins of the condenser matrix.

Liquid receiver

Repair of the liquid receiver can only be effected by renewal. If a new unit is not immediately available for replacement, the desiccant may be rejuvenated as follows:

(1) Allow the complete refrigerant charge to vaporize and escape through the discharge valve service connection by removing the caps and rotating the valve three turns in a clockwise direction from its fully back-seated position.

(2) Slacken the unions securing the two pipes to the liquid receiver, and if any pressure is noticed, allow the trapped pressure to bleed off before disconnecting the pipes from the receiver.

(3) Blank off the two pipes and remove the nut securing the liquid receiver to the boot hinge bracket stiffener.

(4) Place the complete unit, with its pipe connections left open, in an oven maintained at 600° F. (315° C.) for a period of one hour.

(5) Connect a vacuum line to the outlet connection of the unit and draw the hot air from the oven for a period of one minute.

(6) Disconnect the vacuum line and repeat (4) and (5).

(7) Replace the unit in the oven and allow it to cool to room temperature.

(8) Refit the receiver and securely tighten the nut and the two pipe connections.

(9) Carry out the leak test and the evacuation and charging procedures.

Evaporator unit

In view of the nature of the cut-out switch, it is recommended that it be renewed as a complete unit in the event of defects. Similarly, it may be found more economical to renew the electric fan motors as complete units if repair beyond the renewal of the springs and brushes is required. However, for the benefit of qualified personnel who may wish to repair the motors the dismantling procedure is given.

(1) *Fan motors.* The fan motors and their associated components should be marked before being removed from the evaporator unit so that during assembly they may be replaced in their original positions. The procedure for removing and dismantling a fan motor is as follows:

(*a*) Disconnect the electrical leads from the fan motor at the single connectors.

(*b*) Support the volute and unscrew the self-tapping screws securing it to the evaporator. Slide the fan from its shaft.

(*c*) Remove the three 10—32 UNF. set screws together with their spring washers and nuts, and separate the motor from the volute.

(*d*) Remove the two nuts and washers and withdraw the end frame and the insulation washer.

(*e*) Disconnect the brush leads from the coil leads, using a soldering-iron, ensuring that the coil leads are suitably identified so as to replace them in their original positions. Remove the brush springs.

(*f*) Unscrew the brush gear retaining nuts from the through-bolts, and remove the brush gear assembly and the two brushes.

(*g*) Remove the spacing sleeves, the through-bolts, and the motor mounting bracket.

(*h*) Remove the armature, taking care that the washers are not left on the end frame and eventually lost.

NOTE.—The washers must be replaced in their original positions when the motor is reassembled.

(*j*) Ease the field stack assembly out of the end frame, using a suitable flat-edged tool, i.e. a screwdriver.

(*k*) Clean all fan motor components with a clean, dry, lint-free cloth.

(*l*) Check the end frame bearings for wear, using the armature shaft as a gauge. There must be no appreciable side-play; check that the bearings are not worn and/or scored, and replenish the bearing wicks with four or five drops of a light oil.

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(*m*) Check the carbon brushes for wear and for freedom of movement in their brush guides. The length of the brushes should not be less than $\frac{1}{8}$ in. (3·18 mm.). Renew as necessary.

(*n*) Using a suitable test apparatus, check the armature for shorts and open circuits. Clean up the commutator, using a fine-grade emery-cloth. If the commutator is grooved or worn, a light skim on a lathe will be required. Check that the armature shaft is free from scores on the bearing surfaces.

(*o*) Check the field coil assembly and leads with an ohmmeter; there must not be a discrepancy of more than 10 per cent. between the coils.

(*p*) Reassemble the fan motor, using the reverse procedure to that given for dismantling.

(*q*) On assembly, the armature shaft end-play should be between ·005 and ·025 in. (·127 and ·635 mm.).

NOTE.—After assembling the fan motor, connect it to a half-rated voltage, and while it is running lightly tap the end frame, using a small hide-faced mallet, to align the bearings. The armature should then rotate freely when turned between finger and thumb.

(2) *Expansion valve.* The expansion valve may be cleared of obstruction by removing and cleaning or renewing the strainer. Removal of the strainer can be effected by disconnecting the pipe from the inlet side of the valve, after discharging the refrigerant system, and withdrawing the strainer from the inlet port. Clean the strainer with trichlorethylene and blow through the gauze with a jet of clean, dry air, or renew as necessary. Replace the strainer, reconnect the pipe, and carry out the leak test, evacuation, and recharging procedures detailed in Sections T.4, T.5, and T.6. Should it be required to renew the expansion valve and the capillary tube and bulb, proceed as follows:

(*a*) Discharge the system of refrigerant and disconnect the pipes from the inlet and the outlet sides of the valve.

(*b*) Remove the bulb from its housing on the evaporator outlet pipe and ensure that the $\frac{3}{16}$ in. diameter rubber strip is not lost.

(*c*) Assembly procedure is the reverse of that given for dismantling.

NOTE.—Care must be taken not to damage the capillary tube and bulb during assembly. If required, the rubber strip may be stretched in the bulb housing to facilitate assembly of the bulb.

(*d*) Check that the bulb is held firmly against the evaporator outlet pipe by the rubber strip, and that the sorbo insulation is securely bound with aluminium wire.

(*e*) Carry out the leak test, evacuation, and recharging procedures.

(3) *Low-pressure cut-out switch.* The low-pressure cut-out switch is preset during manufacture and the control knob removed to prevent any further adjustment or inadvertent movement during service. Repair of the switch and tube can only be effected by renewal; the procedure is as follows:

(*a*) Discharge the system of refrigerant.

(*b*) Disconnect the electrical leads from the switch and the capillary tube from the 'T' piece attached to the evaporator outlet pipe.

(*c*) Take out the screws from the switch mounting brackets and remove the switch.

(*d*) Assembly procedure is the reverse of dismantling.

(*e*) Carry out the leak test, evacuation, and recharging procedures.

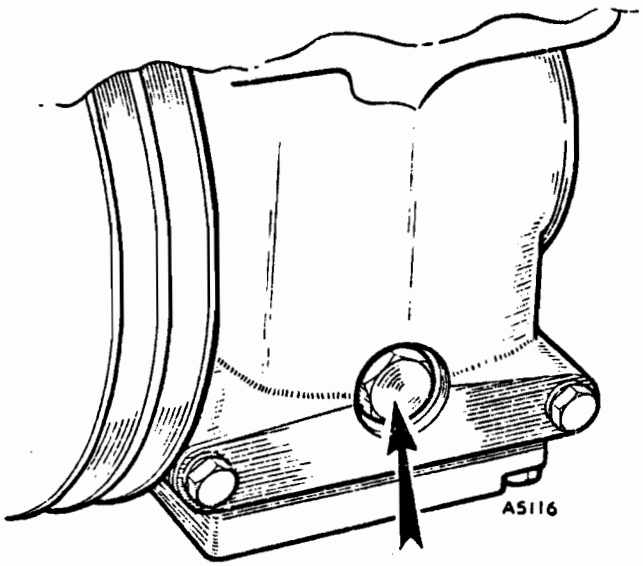

Fig. T.7

The compressor filler, level, and drain plug

Section T.12

CHECKING THE COMPRESSOR OIL LEVEL

The compressor contains the correct amount of lubricating oil when it leaves the manufacturer, but after the short-duration run-in of the system it is essential to check the level of the oil as a certain amount will have been deposited in the piping and components.

(1) Remove the two end caps and ensure that the discharge and suction valves are fully back-seated.

(2) Remove the blanking cap and connect a compound pressure gauge to the suction valve service connection. Fully front-seat the valve.

(3) Short out the low-pressure cut-out switch by connecting the brown/blue and brown/purple leads with a length of lead. Start the vehicle engine and switch on the air-conditioning system.

(4) Run the engine until the pressure gauge indicates approximately 5 lb./sq. in. (·352 kg./cm.^{2}), then switch off the compressor and immediately front-seat the discharge valve as quickly as possible.

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(5) Switch off the engine, remove the compound pressure gauge and the blanking cap from the discharge valve service connection, and allow a period of two minutes to elapse for the gas trapped in the compressor to escape.

(6) Slowly remove the oil filler plug from the compressor crankcase.

(7) Check that the oil in the crankcase is level with the bottom of the filler plug hole, and, if necessary, add Shell Clavus 33 lubricating oil to this level. Refit the filler plug, but do not tighten.

(8) Refit the blanking caps to the discharge and suction valve service connections.

(9) Ease the suction valve off its front seat to allow gas to bleed from the system into the compressor. Allow the gas to escape past the oil filler plug for a few seconds to purge the compressor of air, then **immediately** tighten up the oil filler plug to a torque load of 360 lb. in. (4·148 kg. m.).

(10) Fully back-seat both valves and fit the end caps. Disconnect the lead previously fitted and short out the low-pressure cut-out switch.

(11) Check for leaks with a leak detector in the vicinity of the filler plug.

(12) Start the vehicle engine and switch on the air-conditioning system. Observe the sight glass to ensure that the system is fully charged.

TABLE 1

Temperature/Vapour Pressure Relationship for Refrigerant 12 at Vapour Conditions

Air temperature		*Saturated vapour pressure*	
° C.	*° F.*	*lb./sq. in.*	*kg./cm.²*
2	35	33	2·32
4	40	37	2·60
7	45	42	2·95
10	50	47	3·30
13	55	53	3·72
16	60	58	4·07
18	65	64	4·50
21	70	70	4·92
24	75	77	5·41
27	80	84	5·90
29	85	93	6·53
32	90	100	7·03
35	95	110	7·73
38	100	117	8·22
41	105	127	8·92
43	110	137	9·63
46	115	147	10·33
49	120	157	11·03

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TABLE 2

System Performance Chart

| AMBIENT TEMPERATURE DRY BULB °F | AMBIENT TEMPERATURE WET BULB °F. | | |

LUBRICATION CHART

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KEY TO LUBRICATION CHART

DAILY

(1) ENGINE. Check oil level, and top up if necessary with new oil to Ref. A.

AFTER FIRST 500 MILES (800 Km.)

(2) ENGINE. Drain and refill with new oil to Ref. A.

(3) GEARBOX (SYNCHROMESH). Drain and refill with new oil to Ref. A.

(4) REAR AXLE. Drain and refill with new oil to Ref. B.

AFTER FIRST 1,000 MILES (1600 Km.)

(5) AUTOMATIC GEARBOX. Drain and refill with new oil to Ref. F.

EVERY 1,000 MILES (1600 Km.)

(6) GEARBOX (SYNCHROMESH). Check oil level, and top up if necessary with oil to Ref. A.

(7) REAR AXLE. Check oil level. and top up if necessary with oil to Ref. B.

(8) STEERING-BOX. Check oil level, and top up if necessary with oil to Ref. B.

(9) STEERING. Give the nipples on the steering connections. swivel axles, and suspension fulcrum pins a charge of lubricant to Ref. C.

(10) POWER STEERING UNIT. Give the two nipples a charge of lubricant to Ref. C.

(11) PROPELLER SHAFT. Charge the propeller shaft nipples with lubricant to Ref. C.

(12) GEAR CHANGE CONTROL. Charge the nipple at the lower end of the column with lubricant to Ref. C.

(13) REAR SPRINGS. Charge the nipple at the centre of each rear spring with lubricant to Ref. C.

(14) BRAKES. Charge the nipple on the brake pedal shaft with lubricant to Ref. C. Apply the gun also to the nipples on the hand brake rod pivots.

(15) CONTROL LINKAGES. Lubricate the hand brake, clutch, throttle, and gear change linkage joints with oil to Ref. E.

(16) FLUID SUPPLY TANKS. Check the levels of the brake, power steering, and hydraulic jack supply tanks, and top up if necessary.

(17) DISTRIBUTOR. Give the shaft lubricator one half-turn.

EVERY 3,000 MILES (4800 Km.)

(18) ENGINE. Drain and refill with new oil to Ref. A.

(19) AUTOMATIC GEARBOX. Check level and top up with oil to Ref. F.

(20) GEARBOX (SYNCHROMESH). Drain and refill with oil to Ref. A.

(21) REAR AXLE. Drain and refill with oil to Ref. B.

(22) AIR CLEANER, Remove, clean, and re-oil.

(23) DISTRIBUTOR. Lubricate distributor cam and automatic advance mechanism.

(24) FRONT HUBS. Remove wheels and inject grease to Ref. D through plug in wheel hubs.

(25) REAR HUBS. Inject grease through nipple behind brake backplate. Do not over-lubricate.

(26) OIL FILTER. Wash out filter bowl and fit new element.

(27) SHOCK ABSORBERS. Check levels, and top up if necessary.

(28) WATER PUMP. Remove plug and add a small quantity of oil to Ref C.

EVERY 12,000 MILES (19200 Km.)

(29) DYNAMO BEARING. Apply a few drops of oil to Ref. E to the hole provided in the bearing housing. **NOTE.—This attention is not required when the car is fitted with power-assisted steering.**

(30) CLUTCH. Give a charge of lubricant to Ref. C to the nipples on the clutch operating shaft.

(31) DISTRIBUTOR. Refill distributor shaft lubricator with grease.

EVERY 24,000 MILES (38400 Km.)

(32) AUTOMATIC GEARBOX. Drain and refill with new oil to Ref. F.

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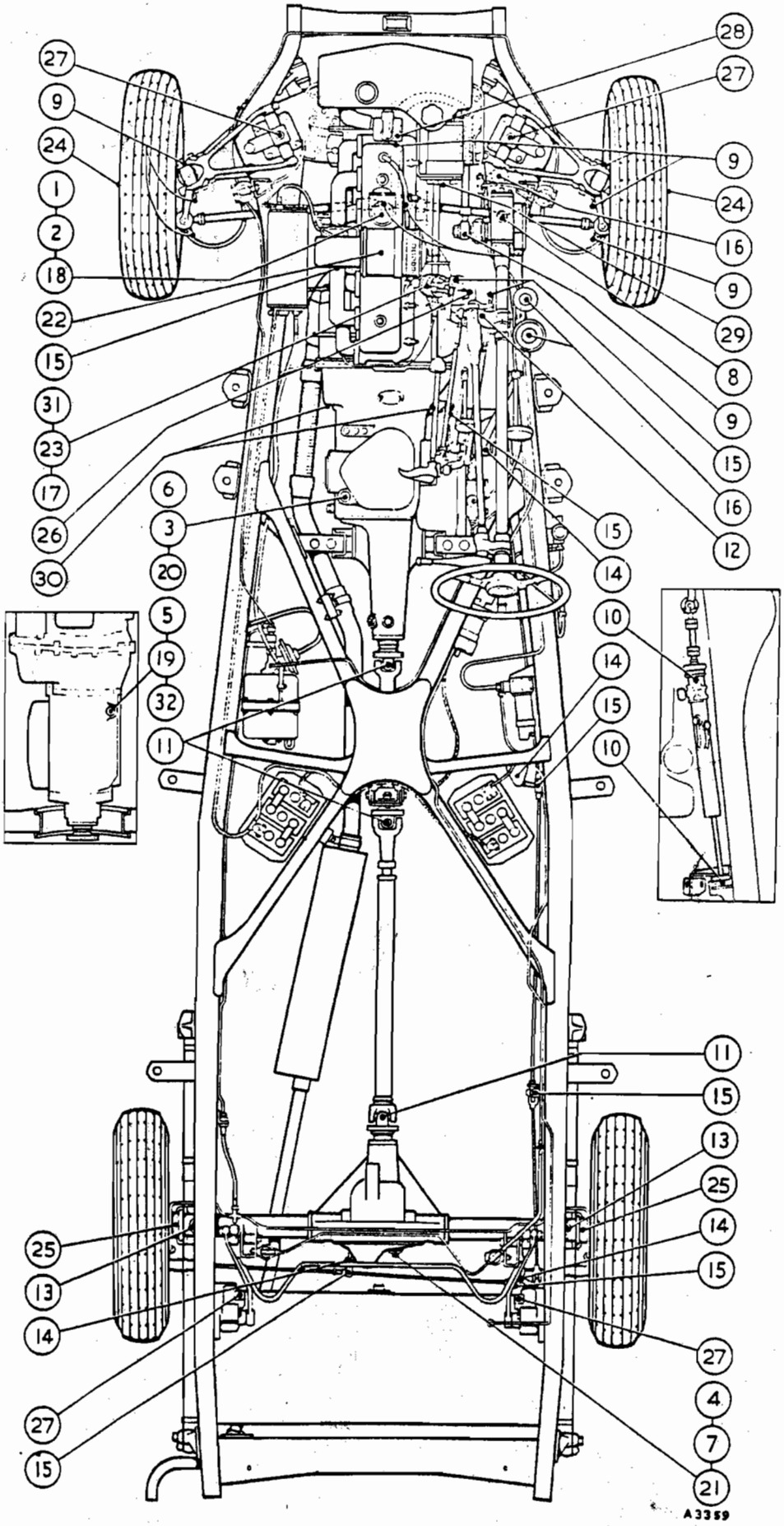
LUBRICATION CHART



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