FOREWORD

This workshop manual provides complete maintenance and overhaul information in respect of the models listed below. Where necessary throughout this publication, reference to a particular model is indicated by the use of the model code designation applicable.

1500 Models		
PBCM	1500/XX	000001 Onwards
PBCA	1500/XX	
PBRM	1500/XX	
PBRA	1500/XX	
2500 Models		
PBCM	2500/XX	
PBCA	2500/XX	
PBRM	2500/XX	
PBRA	2500/XX	

"XX" denotes the basic body design, the designations for which are as follows:

DA — Drive Away Front End
CC — Chassis and Cab
VH — Van with Hinged Doors
VT — Van with Hinged Doors and Extra Sliding Door
VS — Van with Sliding Doors
LB — Light Bus
CB — Contractors Bus

The Model Designation is built up as follows:

1st two letters PB = 1500/2500 Series Forward Control Model

3rd letter: C = 1725 cc. 4 Cylinder Petrol Engine
or
R = Perkins 4·108V Diesel Engine

4th letter: M = Manual Change Gearbox
or
A = Borg Warner Automatic Transmission

OPTIONAL PERKINS DIESEL ENGINE

The overhaul information in Section A of this manual deals with the *petrol engine only* and therefore, all information applicable to the optional Perkins Deisel Engine is given in the Perkins Workshop Manual for this unit.

OPTIONAL AUTOMATIC TRANSMISSION

Overhaul information in respect of the Borg Warner Automatic Transmission is given in Workshop Manual Publication No. 907 (Part No. 6601254).

Locating Information.

The various units of the vehicle are dealt with in sections which are listed on page v of this manual, each being identified by a reference letter. Each section thus referred to, opens with an index page so that any particular operation may be picked out in the least possible time.

The page containing the list of units is so arranged that each section is immediately located by bending back the pages observing the black marker on the outer edge of the index page to each section. Where this black marker corresponds to the section required as listed on page v, open the manual and refer to the Section Index given on that page.

Page and Illustration Numbers run consecutively throughout each section preceded by the appropriate section letter, e.g., "Page B.5" or "Fig. B.9" are the page and illustration numbers respectively under the section "ENGINE".

Manufacturing Data is given at the beginning of this Manual and should be carefully studied when an overhaul is being carried out.

Service Tools. Certain operations detailed in this manual are facilitated by the use of specially designed service tools manufactured and distributed, as applicable, by:

Dunlop Rubber Company Ltd.,
Fort Dunlop,
Erdington,
Birmingham, 24,
England

or

Messrs. V. L. Churchill and Co. Ltd.,
London Road,
Daventry,
Northants,
England

The applications of these tools together with their reference numbers are quoted throughout this manual.

Service Bulletins which cover changes in Data, Design and Engineering are issued when these changes effect the information contained in this Manual. The bulletins are clearly titled and numbered and these references should be entered on the service bulletin record sheet at the end of the appropriate Section in this Publication.

GENERAL DATA

INDEX

GENERAL DATA

COOLING SYSTEM

Type of System	Pump and Fan
Type of Pump	Centrifugal
Fan:	
No. of Blades	Four
Diameter	14·5 in. (368 mm.)
Drive of Pump and Fan	"V" Belt from Crankshaft
Cooling System Control	Thermostatic – Fully Automatic
Thermostat:	
Opens at	85°/89° C. (185°/192° F.)
Fully open at	100°C. (213°F.)
Radiator type	"D" type matrix
Radiator Relief Valve	In Filler Cap. Pressure Valve commences to open at 9 lb. sq. in. (0·633 kg. sq. cm.)
Total Area of Radiator Block	229·5 sq. in. (145 sq. cm.)
Total Capacity of System	12·25 pints (7·0 litres)
Drain Tap Location:	
Radiator	Right hand radiator bottom pipe
Cylinder Block	On the left hand side of the cylinder block
Cylinder Head Water Distribution	Three detachable Brass Jets in Head
Fan Belt:	
Depth	0·31 in. (7·9 mm.)
Width at outside	0·375 in. (9·5 mm.)
Angle of "V"	40°
Outside length	37·25 in. (951·95 mm.)

ENGINE

Type	Overhead Valve Petrol Unit
Number of Cylinders	Four
B.H.P. (Gross)	58 at 4,300 r.p.m.
B.H.P. (Net)	54 at 4,300 r.p.m.
Torque (Net)	91 lb. ft. (12·6 kg. m.) at 2,000 r.p.m.
Maximum B.M.E.P.	130 lb. sq. in. (9·14 kg. sq. cm.) at 2,000 r.p.m.
Compression Ratio	7·5 : 1
Compression Pressure	125/135 lb. sq. in. (8·8/9·5 kg. sq. cm.)
Cylinder Bore Size (Nominal)	3·21 in. (81·5 mm.)
Stroke	3·25 in. (82·6 mm.)
Cylinder Capacity	105·1 cu. in. (1724 cc.)
Firing Order	1 : 3 : 4 : 2
Sump Capacity	7·5 pints (4·3 litres)
Ignition Timing (Static)	6–10° B.T.D.C. Premium fuel 6–8° B.T.D.C. Regular fuel

Manufacturing Data

Cylinder Block

Material	Cast Iron
Water Jackets	Full length of bore
Bore Grades	
A	3·2102/3·2106 in. (81·539/81·549 mm.)
B	3·2106/3·2110 in. (81·549/81·559 mm.)
C	3·2110/3·2114 in. (81·559/81·569 mm.)
D	3·2114/3·2118 in. (81·569/81·579 mm.)

Note: For service purposes a cylinder bore marked "AT" is grade "A", and a bore marked "BT" is grade "B" etc., the letter "T" being ignored. Its only use is in connection with the production selective assembly grading system.

Maximum oversize (with or without liners)	0·030 in. (0·76 mm.)
Cylinder liner – Outside dia.	3·357/3·358 in. (85·26/85·29 mm.)
– Interference fit	0·002/0·004 in. (0·05/0·10 mm.)

Cylinder Head

Material	Cast Iron
Gasket – Type	Varnished Steel Pressing

Valves

Position and Operation	Overhead – Push Rod and Rocker
Valve Clearance (Engine Hot)	Inlet 0·012 in. (0·31 mm.) Exhaust 0·014 in. (0·36 mm.)
Valve Timing	
Inlet opens	14° B.T.D.C.
Inlet closes	41° A.B.D.C.
Exhaust opens	50° B.B.D.C.
Exhaust closes	5° A.T.D.C.
Head Diameter	
Inlet	1·475/1·471 in. (37·45/37·35 mm.)
Exhaust	1·176/1·172 in. (29·87/29·76 mm.)
Angle of Seat in Cylinder Head	45° Inlet and Exhaust
Angle of Valve Face	45° Inlet and Exhaust
Stem Diameter	
Inlet	0·3110/0·3105 in. (7·9/7·89 mm.)
Exhaust	0·3100/0·3095 in. (7·87/7·86 mm.)
Valve Stem Clearance in Guide	
Inlet	0·0015/0·003 in. (0·038/0·076 mm.)
Exhaust	0·0025/0·004 in. (0·063/0·012 mm.)
Length of Valve (Inlet and Exhaust)	4·66 in. (118·36 mm.)
Valve Springs	
Type	Single – R.H. helix
Retention	Cup and Split Cotters
Fitted length	1·58 in. (40·13 mm.)
Free length	2·08 in. (52·83 mm.)
Load Fitted	83 lb. (37·65 kg.)
Valve Guides	
Outside Diameter	0·5640/0·5635 in. (14·3/14·27 mm.)
Length	Inlet 2·0 in. (50·8 mm.) Exhaust 2·15 in. (54·6 mm.)
Interference Fit	0·0045/0·0025 in. (0·114/0·063 mm.)
Fitted Height above Head	0·50 in. (12·7 mm.)

Camshaft

Number and Type of Bearings	Three: steel shell, white metal lined
Journal Diameter	1·7477/1·7470 in. (44·392/44·374 mm.)
Bearing Internal Diameter	1·750/1·749 in. (44·45/44·42 mm.)
Bearing Running Clearance	0·003/0·0013 in. (0·07/0·03 mm.)
End Float	0·003/0·002 in. (0·07/0·05 mm.)

Crankshaft	
Balance	Integrally Cast Counterweights
Number and Type of Bearings	Five: steel shell, white metal lined
Diameter of Main Journals "A"	2·375 in. (60·325 mm.)
Diameter of Main Journals "B"	2·365 in. (60·071 mm.)
Maximum Undersize for Regrinding	0·04 in. (1·01 mm.)
Diameter of Crankpin "A"	2·125 in. (53·975 mm.)
Diameter of Crankpin "B"	2·115 in. (53·721 mm.)
End Float	0·002/0·008 in. (0·05/0·203 mm.)
Main Bearing Running Clearance	0·0025/0·0010 in. (0·063/0·025 mm.)
Connecting Rod	
Material	Steel Forging
Type	"H" Section
Distance Between Centres	5·626/5·624 in. (142·9/142·8 mm.)
Big End Bearings	Steel Shell with Cooper-Lead Bearing, Indium coated
Big End Bore (without bearings)	2·2715/2·2710 in. (57·696/57·683 mm.)
Big End Running Clearance	0·002/0·0015 in. (0·05/0·03 mm.)
Big End, End Float	0·0125/0·0075 in. (0·318/0·191 mm.)
Small End Bore (Bushed)	
High Grade	0·9378/0·9377 in. (23·820/23·817 mm.)
Medium Grade	0·9377/0·9376 in. (23·817/23·815 mm.)
Low Grade	0·9376/0·9375 in. (23·815/23·812 mm.)
Gudgeon Pin	
Type	Floating
Location	Circlips
Diameter	
High Grade	0·9377/0·9376 in. (23·817/23·815 mm.) Painted white
Medium Grade	0·9376/0·9375 in. (23·815/23·812 mm.) Painted green
Low Grade	0·9375/0·9374 in. (23·812/23·809 mm.) Painted yellow
Piston	
Type	Slotted
Material	Aluminium Alloy Tin Plated
Length	3·25 in. (82·57 mm.)
No. of Rings	
Compression	Two
Scraper	One
Compression Height	1·850/1·845 in. (44·99/44·86 mm.)
Max. permissible weight variation per set	2 drams (3·55 grm.)
Diameter – Grade A	3·2096/3·2092 in. (81·524/81·514 mm.)
– Grade B	3·2100/3·2096 in. (81·534/81·524 mm.)
– Grade C	3·2104/3·2100 in. (81·544/81·534 mm.)
– Grade D	3·2108/3·2104 in. (81·555/81·544 mm.)
– Grade E (for service use only)	3·2112/3·2108 in. (81·564/81·555 mm.)
Oversize available (Grade B bore only)	0·030 in. (0·76 mm.)
Piston Skirt clearance (measured at right angles to gudgeon pin hole)	0·0014/0·0006 in. (0·035/0·015 mm.)
Gudgeon Pin Bore	
High Grade	0·9377/0·9376 in. (23·817/23·815 mm.)
Medium Grade	0·9376/0·9375 in. (23·815/23·812 mm.)
Low Grade	0·9375/0·9374 in. (23·812/23·809 mm.)
Ring Gap (fitted)	
Top Ring	0·032/0·024 in. (0·81/0·60 mm.)
Second and Scraper	0·014/0·009 in. (0·35/0·22 mm.)

Torque Wrench Data

Cylinder Head Bolts	48 lb. ft. (6·6 kg. m.)
Main Bearing Caps	55 lb. ft. (7·6 kg. m.)
Connecting Rod Cap Bolts	24 lb. ft. (3·3 kg. m.)
Flywheel Securing Bolts	40 lb. ft. (5·5 kg. m.)

LUBRICATING SYSTEM

Type of System	Pressure
Type of Pump	Eccentric Lobe Type
Type of Intake	Gauze Filter on Pump
Pump Drive	Skew Gear on Camshaft
Normal Pressure (Hot)	30/50 lb. sq. in. (2·1/3·5 kg. sq. cm.)
Filter Make	Fram
Filter Type	Throw Away Type Full Flow
Filter Capacity	1 pint (0·57 litre)
Pressure Relief Valve	Located in adaptor casting – Operates when oil pressure exceeds 48/52 lb. sq. in. (3·37/3·66 kg. sq. cm.)
By Pass Valve	Incorporated in filter unit – operates at a pressure difference of 7–9 lb. sq. in. (0·50–0·63 kg. sq. cm.)
Position of Filler	Top Rear of Rocker Cover
Dipstick	Left-Hand Side of Engine adjacent to Carburettor
Sump Capacity	7·5 pints (9·6 American pints – 4·3 litres)

FUEL SYSTEM

Fuel Tank

Capacity	9 gallons (40·9 litres)
Position	Transverse mounting behind rear axle.
Filler Cap	Captive type – situated in right hand rear quarter panel of body.

Fuel Lift Pump

Make	A.C. – Delco.
Model	UG Series 7950071.
Operation	Mechanical by eccentric on camshaft.
Pressure (at Pump Level)	1·5 to 2·5 lb. sq. in. (0·106 to 0·176 kg. sq. cm.)

Carburettor

Type	Zenith 34 IV
Choke	26 mm.
Main Jet	80
Compensator Jet	125
Slow Running Jet	45
Slow Running Air Bleed	1·4 mm.
Needle Valve	1·5 mm.
Needle Valve Washer	2·0 mm.
Pump Jet	50 (Short Stroke)

Air Cleaner

Make	A.C. – Delco
Type	Paper Element

Exhaust System

Type	Down pipe from exhaust manifold to silencer.
Silencer	Packed type.
Tail Pipe	Exhausting to drive side of vehicle.

CLUTCH

Operation	Hydraulic
Clutch	
Make	Borg and Beck
Type	Single Type Diaphragm Drive
Driven Plate Diameter	8½ in. (215·9 mm.) Wound Yarn
Thrust Bearing	Copper Impregnated Graphite Bearing Assembly
Free Movement of Pedal Operating Linkage	Self Adjusting. No Free Play.
Driven Plate Compressed Thickness	0·285 in. (7·24 mm.)
Number of Driven Plate Damper Springs	6
Master and Slave Cylinders	
Make	Lockheed
Master Cylinder Bore Dia. (Nominal)	0·7 in. (17·8 mm.)
Slave Cylinder Bore Dia. (Nominal)	1 in. (25·4 mm.)

PROPELLER SHAFT

Make	BRD or Hardy Spicer
Type	Open shaft reverse spline
Outside diameter	2·00 in. (50·8 mm.)
Overall length – manual	40·485 in. (1028·3 mm.)
– automatic	38·185 in. (970 mm.)
Length between centres – manual	32·8 in. (833 mm.)
– automatic	30·5 in. (774·7 mm.)
Universal joint	Needle roller
Lubrication	Universal joints are packed on assembly and greasers are provided to replenish the lubricant during use. Splines are lubricated by oil from the gearbox.

GEARBOX

Type	The gearbox provides four forward speeds and one reverse. Helical teeth gears in constant mesh are used on all forward gears which, are engaged by synchromesh action through dog clutches. A spur gear is employed for reverse which is of the sliding mesh type.
Ratios	
Fourth	Direct Drive
Third	1·516 : 1
Second	2·331 : 1
First	4·105 : 1
Reverse	3·887 : 1
Bearings	
Primary Shaft	Ball Bearing
Mainshaft	
Front	Needle Roller
Rear	Ball Bearing
Layshaft	
Front	Needle Roller
Rear	Needle Roller
Reverse Gear	Phosphor Bronze Bush
Oil Capacity	Initial Filling 3¾ pints (2·131 litres) Service Filling 3½ pints (1·989 litres)
Combined Filler and Level Plug	Accessible from underneath the vehicle

Manufacturing Data

Layshaft End Float	0·006/0·008 in. (0·152/0·203 mm.)
Adjustment of Layshaft	By selective assembly of the thrust washer at the front of the layshaft
Mainshaft End Float	End Float is controlled by ball bearing race limits
Selector Ball Spring	
Free Length	0·79 in. (20·07 mm.)
Spring Rating	10 lb. (4·53 kg.) at 0·65 in. (16·51 mm.)
Axial Load between Reverse Selector Fork and the Selector Shaft	40/45 lb. (18·15–20·4 kg.)
Change Speed Lever Ball Spring	
Free Length	0·83 in. (21 mm.)
Spring Rating	35 lb. (15·9 kg.) at 0·53 in. (13·5 mm.) fitted length
Reverse Stop Plunger Spring	
Free Length	3·10 in. (78·7 mm.)
Spring Rating	50 lb. (22·7 kg.) at 2·03 in. (51·6 mm.) fitted length

FRONT SUSPENSION

Type	Independent	
Design	Coil spring and swinging links	
Springs – Diameter of wire	0·70 in. (17·8 mm.)	
– Outer diameter	4·68 in. (118·8 mm.)	
– Static laden, length	10·60 in. (269·2 mm.)	
– Static laden load	1,750 lb. (793·80 kg.)	
– Free length	13·24 in. (336·3 mm.)	
– Spring rate	663 lb. in. (118·4 kg. cm.)	
– Loading for rough checking spring on vehicle		
1500 Series	2250 lb. (1020 kg.)	These given weights are laden front axle weights
2500 Series	2700 lb. (1225 kg.)	
Castor angle	– 1° 48′ ± ½°	with vehicle laden on to gap gauges
Wheel camber angle	¾° ± ¼°	
King pin inclination	8¼° ± ¼°	
Ackerman angle (toe out on turns) outer wheel	20°	
inner wheel	25½° ± ¼°	
Wheel lock angles outside lock	23½°	
inside lock	30¾°	
Toe-in (Track setting at periphery of tyre)	⅛ in. (3 mm.)	
Length of upper link	8·75 in. (222 mm.)	
Length of lower link	16·50 in. (419 mm.)	
Type of Bushes	Threaded steel	
Lubrication of bushes	Individual nipples	
Wheel movement – Laden to bump	2·93 in. (74·4 mm.)	
– Laden to rebound	3·62 in. (91·9 mm.)	
Limitation of movement	Rubber buffers	

REAR AXLE

Type	Semi-floating
Casing	Pressing – Banjo Type
Final Drive	Hypoid
Final Drive Ratio	5·125 :1 or 5·625 :1
Bearings – Bevel Pinion	Taper Roller
– Differential and Crown Wheel Assembly	Taper Roller
– Hub	Ball

Crown Wheel to Pinion Backlash	0·005/0·009 in. (0·127/0·299 mm.)	
Number of teeth – Crown Wheel / Bevel Pinion	41/8 = 5·125 ratio	45/8 = 5·625 ratio
Adjustment – Bevel Pinion	Shims	
– Differential Assembly	Shims	
Overall Ratios – Top Gear	5·125	5·625
– Third Gear	7·769	8·527
– Second Gear	11·95	13·10
– First Gear	21·01	23·06
– Reverse	19·93	21·88
Filler and Oil Level Plug	Left Side of Differential Housing	
Oil Capacity	1·75 pints (1 litre)	

REAR SUSPENSION

Type	Three-rated Spring, Semi-elliptic Leaf	
Bushes – Front	Bonded Steel and Rubber	
– Rear	Split Rubber	
Number of Leaves	6 plus 3 Auxiliary Leaves	
Thickness of Leaves	1500 and 2500 Series	1 Mainleaf × 0·25 in. (6·35 mm.)
	1500 Series	5 Leaves × 0·188 in. (4·76 mm.)
	2500 Series	5 Leaves × 0·203 in. (5·16 mm.)
	1500 and 2500 Series	2 Upper Auxiliary Leaves × 0·313 in. (7·94 mm.)
	1500 and 2500 Series	1 Lower Auxiliary Leaf × 0·438 in. (11·11 mm.)

Laden Length between Spring Eye Centres .. .. 47 in. (119·38 cm.) Nominal

Free Camber –

Clamped (U-Bolt Nuts Fully Tightened)	1500 Series	4·61 in. (117 mm.)*
	2500 Series	4·62 in. (117·4 mm.)*
Unclamped (U-Bolts not Fitted)	1500 Series	5·11 in. (130 mm.)*
	2500 Series	5·18 in. (131·4 mm.)*

*Measured between top face of mainleaf and line drawn through centres of spring eyes.

When free camber is checked with the springs on the vehicle, the vehicle body must be raised at the rear, supported on stands and the front pivot pin removed from each spring, thus ensuring that all load is taken off the springs.

Laden Camber and Load –

With Springs on Vehicle 1500 Series .. .. With vehicle laden at rear to an axle load of 2,100 lb. (953 kg.) –
Negative Camber 0·59 in. (14·99 mm.)
0·39 in. (9·91 mm.)

2500 Series .. .. With vehicle laden at rear to an axle load of 2,550 lb. (1,157 kg.) –
Negative Camber 0·66 in. (16·76 mm.)
0·46 in. (11·68 mm.)

Deflection and Load at which Auxiliary Leaves become Operative, with Spring off Vehicle –

Upper Auxiliary 0·313 in. (7·94 mm.) Thick	3·84 in. (97·5 mm.) deflection at 400 lb. (181·4 kg.)
Lower Auxiliary 0·438 in. (11·11 mm.) Thick	5·89 in. (149·6 mm.) deflection at 830 lb. (376·5 kg.)

Torque Loading of U-Bolts .. .. 35–40 lb. ft. (4·8–5·5 kg. m.)

STEERING

Steering Gear

Model	Cam Gear L.Q.
Type	Cam and Peg
Ratio	17:1
Diam. of Steering Wheel	16·5 in. (429 mm.)
End Float of Steering Inner Column	No perceptible end float and no binding
End Thrust of Cam	Taken on opposed ball bearings
Adjustment of Cam Bearings	By shims at each end of steering box casing
End Float of Rocker Shaft	No perceptible end float and no binding
Adjustment of Rocker Shaft End Float	By adjusting screw and locknut in side cover

Side Steering Rod

Type	Self adjusting ball pin and socket
Distance between Ball Pin Centres	14·13 in. (358 mm.) approximately

Intermediate Steering Rod

Type	Self adjusting ball pin and socket
Distance between Ball Pin Centres	8·7 in. (221 mm.)

Track Rods

Type	Self adjusting ball pin and socket

Manufacturing Data

Rocker Shaft Outer Diam.	1·1225/1·1238 in. (28·5125/28·545 mm.)
Rocker Shaft Bush – Internal Diam. (fitted)	1·1245/1·126 in. (28·5625/28·60 mm.)
Intermediate Relay Lever Bracket Bushes – Internal Diam. (fitted)	0·876/0·877 in. (22·25/22·275 mm.)
Intermediate Relay Lever Fulcrum Pin Diam.	0·8742/0·8747 in. (22·205/22·2175 mm.)
Main Relay Bracket Bushes – Internal Diam. (fitted)	0·876/0·877 in. (22·25/22·275 mm.)
Main Relay Fulcrum Pin Diam.	0·8745/0·8750 in. (22·213/22·225 mm.)

BRAKES

Make	Lockheed
Type of System	Hydraulic
Means of Operation – Footbrake	Hydraulic
– Handbrake	Mechanical on Front Wheels only
Front Brakes	Duo-Servo
Rear Brakes	Leading and Trailing Shoes
Brake Lining Material	Ferodo AM.14
Handbrake – Type	Ratchet and Pawl
– Location	On Wheel Arch at Driver's Side
Brake Drums – Material	Cast Iron
Brake Adjustment Location	Hole in Wheel and Brake Drum
Fluid Supply Tank Location	Top right-hand rear corner of engine compartment
Brake Fluid	Lockheed Super Heavy Duty Fluid

Manufacturing Dimensions

Brake Size

Front 1500 and 2500 Series	10 × 2¼ in. (254 × 57 mm.)
Rear 1500 Series	9 × 1⅓ in. (228 × 44 mm.)
Rear 2500 Series	10 × 2¼ in. (254 × 57 mm.)

Linings

Thickness	– Front L/S 1500 and 2500 Series ..	0·203/0·213 in. (5·15/5·41 mm.)
	– Front T/S 1500 and 2500 Series ..	0·243/0·253 in. (6·17/6·43 mm.)
	– Rear 1500 Series	0·193/0·203 in. (4·9/5·15 mm.)
	– Rear 2500 Series	0·203/0·213 in. (5·15/5·41 mm.)
Width	– Front 1500 and 2500 Series ..	2·25 in. (5·7 cm.)
	– Rear 1500 Series	1·69/1·72 in. (4·29/4·37 cm.)
	– Rear 2500 Series	2·25 in. (5·7 cm.)
Length	– Front L/S 1500 and 2500 Series ..	9·24 in. (23·5 cm.)
	– Front T/S 1500 and 2500 Series ..	10·5 in. (26·7 cm.)
	– Rear 1500 Series	8·28 in. (21·0 cm.)
	– Rear 2500 Series	9·24 in. (23·5 cm.)

Rivets

Diameter	0·140/0·144 in. (3·56/3·66 mm.)
Head Diameter	0·29 in. (7·37 mm.)
Shank Length – Front	0·25 in. (6·35 mm.)
– Rear	0·28 in. (6·11 mm.)
Bore Depth	0·11 in. (2·79 mm.)

Total Lining Area 1500 Series .. .. .. 146 sq. in. (941·9 sq. cm.)
2500 Series .. .. .. 172 sq. in. (1009 sq. cm.)

Brake Shoe Springs

			Free Length
Pull off Springs	Front		3·87/3·98 in. (98·3/101·1 mm.)
1500 Series	Rear		4·71/4·85 in. (119·6/123·2 mm.)
Tension Springs	Front		3·32/3·44 in. (84·3/87·4 mm.)
1500 Series	Rear		4·49/4·61 in. (114·0/117·1 mm.)
Pull off Springs	Front		3·87/3·98 in. (98·3/101·1 mm.)
2500 Series	Rear		5·73/5·93 in. (145·5/150·6 mm.)
Tension Springs	Front		3·32/3·44 in. (84·3/87·4 mm.)
2500 Series	Rear		5·14/5·23 in. (130·6/132·8 mm.)
			Fitted Length
Pull off Springs	Front		4·44 in. (112·8 mm.) at 38/42 lb. (17·24/19·0 kg.)
1500 Series	Rear		5·42 in. (137·7 mm.) at 18/24 lb. (8·2/10·9 kg.)
Tension Springs	Front		3·90 in. (99·1 mm.) at 14/16 lb. (6·4/7·3 kg.)
1500 Series	Rear		5·06 in. (128·5 mm.) at 14/18 lb. (6·4/8·2 kg.)
Pull off Springs	Front		4·44 in. (112·8 mm.) at 38/42 lb. (17·24/19·0 kg.)
2500 Series	Rear		6·22 in. (158·0 mm.) at 25/33 lb. (11·3/15·0 kg.)
Tension Springs	Front		3·90 in. (99·1 mm.) at 14/16 lb. (6·4/7·3 kg.)
2500 Series	Rear		5·53 in. (140·5 mm.) at 18/24 lb. (8·2/10·9 kg.)

Brake Drums

Internal Diameter – Front 1500 and 2500 Series..	10·000/9·995 in. (25·40/25·39 cm.)
– Rear 1500 Series	9·000/9·005 in. (22·86/22·87 cm.)
– Rear 2500 Series	10·000/9·995 in. (25·40/25·39 cm.)

Master Cylinder

Internal Diameter	0·75 in. (19·05 mm.)
Piston Return Spring – Free Length	3·16/3·31 in. (80·3/84·1 mm.)
– Fitted Length	2·18 in. (5·54 cm.) at 5·64/6·36 lb. (2·56/2·88 kg.)

Front Wheel Cylinder

Internal Diameter .. .. 0·625 in. (15·87 mm.)

Rear Wheel Cylinder

Internal Diameter .. .. 0·75 in. (19·05 mm.)

WHEELS AND TYRES

Road Wheels

Rim	5K × 15
Nominal rim diameter	14·97 in. (380·24 mm.)
Offset	0·75 in. (19·05 mm.)
Diameter of wheel bore	3·12 in. (79·25 mm.)
P.C.Rad. of stud holes	2·5 in. (63·5 mm.)
Diameter of stud holes	0·531 in. (13·5 mm.)

Tyre Sizes

Tyres (Tubeless)	
Van 1500 – (standard)	6·40–15–6 P.R. car.
– (optional)	6·40–15–6 P.R. C.V.
Passenger 1500	6·70–15–6 P.R.
Van and Passenger 2500	6·70–15–6 P.R. C.V.

Tyre Pressures

	Front		Rear	
	lb. sq. in.	kg. sq. cm.	lb. sq. in.	kg. sq. cm.
6·40–15–6 P.R.	36	2·5	32	2·2
6·40–15–6 P.R. C.V.	45	2·9	40	2·8
6·70–15–6 P.R.	30	2·1	26	1·8
6·70–15–6 P.R. C.V.	45	2·9	40	2·8

Increase tyre pressures by 5 lb. sq. in. (0·35 kg. sq. cm.) for high-speed running.

Maximum Permissible G.V.W.

	lb.	kg.
Van 1500 – with standard tyres	4,600	2,084
– optional tyres	5,000	2,265
Passenger 1500	5,000	2,265
All 2500 models	5,450	2,470

ELECTRICAL EQUIPMENT

Battery

Make	Lucas
Type	BT7A or STX13A
Location	Behind driver's seat
Capacity	BT7A 38 amp. hr. at 10 hr. rate STX13A 75 amp. hr. at 10 hr. rate
Voltage	12 volts
System (all models)	Negative earth

Alternator

Make	Lucas
Type	10AC, clockwise rotation when viewed from drive end
Mounting	Bracket mounted to cylinder block, with an adjusting strap at the front to effect fan belt adjustment
Drive	Endless belt from crankshaft pulley
Output control	Lucas Type 4 TR control unit
Nominal voltage	12 volts
Nominal d.c. output	33 amp.
Resistance of field coil	3·5 ohms at 20°C. (68°F.)
Maximum rotor speed	12,500 r.p.m.
Stator phases	3
Stator connection	Star
No. of rotor poles	8
No. of field coils	1
Slip-ring brushes:	
Length – new	$\frac{5}{8}$ in. (15·9 mm.)
Replace at	$\frac{5}{32}$ in. (4 mm.)

Brush spring tests:	
Load at $\frac{25}{32}$ in. (19·9 mm.)	4/5 oz. (113/142 grm.)
Load at $\frac{13}{32}$ in. (10·3 mm.)	7·5/8·5 oz. (212/241 grm.)
Assembly torque figures:	
Brush box fixing screws	10 lb. in. (0·115 kg. m.)
Diode heat sink fixings	25 lb. in. (0·288 kg. m.)
Through bolts	45/50 lb. in. (0·518/0·576 kg. m.)

Control Unit

Make	Lucas
Type	4 TR (37423)
Location	Mounted to a support plate secured to the cab scuttle, beneath the instrument panel

Alternator Field Isolating Relay

Make	Lucas
Type	6 RA (33252)
Location	Mounted to a support plate secured to the cab scuttle, beneath the instrument panel
Nominal voltage	12 volts
Cut-in voltage	6/7·5 volts
Drop-off voltage	4 volts
Resistance of winding	76 ± 7½% ohms

Fuse Unit

Make	Lucas
Type	4 FJ twin-fused – 033283
Location	Mounted to a support plate secured to the cab scuttle, beneath the instrument panel
Fuse capacity	35 amp.

Starter

Make	Lucas
Type	M35 G–1; anti-clockwise rotation viewed from front end
Control type	By hand cable to separate starter switch
Drive type	Lucas type SB
Lock torque	9·3 lb. ft. (1·28 kg. m.) 370–390 amp. at 7·7–7·3 volts
Brush spring tension	15–25 oz. (0·43–0·71 kg.)

Starter Motor (with **Automatic Transmission**)

Make	Lucas
Type	M35G with "Eclipse drive"; anti-clockwise rotation viewed from front end
Lock torque	7·7 lb. ft. (1·06 kg. m.) with 370 amp. at 7·5–7·1 volts
Torque at 1,000 r.p.m.	4·5 lb. ft. (0·62 kg. m.) with 215–235 amp. at 9·1–8·7 volts
Light running current	45 amp. at 9,500–11,000 r.p.m.
Brush spring tension	30–34 oz. (850–862 gm.)

Distributor

Make	Lucas
Type	25D4
Drive	Gear on camshaft
Direction of drive	Anti-clockwise, viewed from rotor end
Firing angles	0°, 90°, 180°, 270° ± 1°
Closed period	60° ± 3°
Open period	30° ± 3°
Contact breaker gap	0·015 in. (0·38 mm.)
Contact breaker spring tension measured at contacts	18–24 oz. (0·51–0·68 kg.)
Capacitor (condenser)	0·18–0·23 microfarad

Distributor

Ignition Centrifugal Advance

Decelerating on test rig — Distributor		Decelerating on engine — Crankshaft		
R.P.M.	Degrees	R.P.M.	Degrees	
3000	16–18	3500	24–28	*
2000	13½–15½	3000	21–25	*
1300	9–11	2000	15–18	*
700	5½–7½	1000	6–12	*
500	3–6	750	0–6	*
400	½–3½	Below 500	No advance	
Below 250	No advance			

* The static advance angle must be added to these figures when testing the distributor on the engine.

Ignition Vacuum Advance

Hg. in.	Distributor degrees	Crankshaft degrees
15	6–8	12–16
10	4½–6½	9–13
8	2¼–4¼	4½–8½
6	0–2	0–4
4	0–½	0–1

No vacuum advance below 2½ Hg. in.

Ignition Coil

Make	Lucas
Type	HA

Sparking Plugs

Type	Champion N9.Y. 14 mm. long reach
Gap	0·025 in. (0·63 mm.)

Ignition Timing (Static)

Premium Grade fuels	6°–10° B.T.D.C.
Regular Grade fuels	6°–8° B.T.D.C.

Horn

Make	Lucas
Type	9H

Flashing Direction Indicator

Make and type of flasher unit	Lucas FL5
Type of indicator	Self cancelling

Windscreen Wiper

Make	Lucas
Type	D.L.2 single speed, self parking

Battery Data

			BT7A	STX13A
Voltage			12	12
Ampere-hour capacity at 10 hr. rate			38	75
No. of plates per cell			7	13
Specific gravity of electrolyte	With battery fully charged	Climate ordinarily below 26°C. (80°F.)	1·270	1·270
		Climate ordinarily above 26°C. (80°F.)	1·210	1·210
	Re-charge if below	Climate ordinarily below 26°C. (80°F.)	1·200	1·200
		Climate ordinarily above 26°C. (80°F.)	1·240	1·240
*Specific gravity of filling acid		Climate ordinarily below 26°C. (80°F.)	1·260	1·260
		Climate ordinarily above 26°C. (80°F.)	1·210	1·210
Quantity of electrolyte to half fill one 2V. cell			$\frac{3}{8}$ pt. (0·2 litre)	$\frac{3}{4}$ pt. (0·4 litre)
Maximum permissible temp. of electrolyte during external charging		Climate ordinarily below 26°C. (80°F.)	38°C. (100°F.)	38°C. (100°F.)
		Climate ordinarily above 26°C. (80°F.)	49°C. (120°F.)	49°C. (120°F.)
Initial charge current (not applicable to dry charged batteries)			2·5 amp.	5 amp.
Re-charge current			4 amp.	7·5 amp.

*To produce an electrolyte of these specific gravities add 1 part by volume of 1·840 S.G. concentrated sulphuric acid to distilled water by volume as shown.

S.G.	
1·260	3·2 parts.
1·210	4·3 parts.

Indications of specific gravity readings Corrected to 15·5°C. (60°F.)		
State of charge	Temperature	
	Below 26°C. (80°F.)	Above 26°C. (80°F.)
Fully charged	1·270–1·290	1·210–1·230
Half charged	1·190–1·210	1·130–1·150
Fully discharged	1·110–1·130	1·050–1·070

Note: When Taking Specific Gravity Readings:—

The specific gravity of electrolyte varies with temperature. The specific gravity readings quoted in these tables are given for an electrolyte temperature of 15·5°C. (60°F.), which is adopted for ease of comparison as the reference temperature. Readings taken when the electrolyte temperature is other than 15·5°C. (60°F.) can be corrected to the reference temperature, as follows:—

(*a*) For every 2·8°C. **below** 15·6°C. (5°F. **below** 60°F.) **deduct** 0·002 from the observed reading in the hydrometer to obtain true specific gravity at (60°F.).

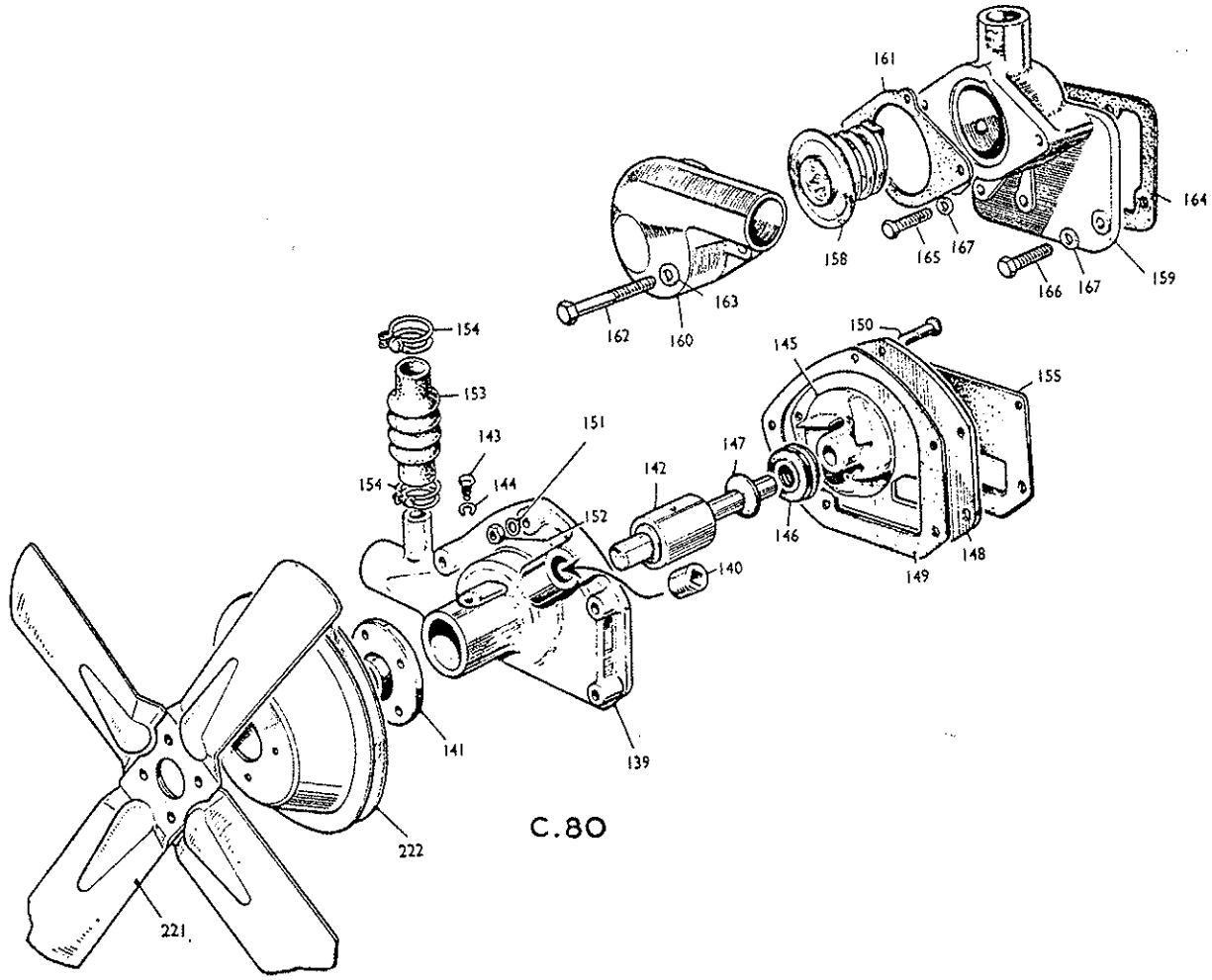
(*b*) For every 2·8°C. **above** 15·6°C. (5°F. **above** 60°F.) **add** 0·002 to the observed reading in the hydrometer to obtain true specific gravity at (60°F.).

The temperature must be that actually indicated by a thermometer immersed in the electrolyte and not the ambient temperature.

COOLING SYSTEM

SECTION A

INDEX



139 IMPELLER BODY
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164 JOINT
165 BOLT } Thermostat housing to
166 BOLT } cylinder block
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Fig. A.1. Water pump details

COOLING SYSTEM

DESCRIPTION

Water is circulated by an impeller type pump mounted on the cylinder block. It is driven by a vee belt which is also used to drive the alternator. The radiator cooling fan is bolted to the pump driving pulley.

Water is drawn from the bottom radiator tank through the bottom water hose and delivered into the cylinder block passing round the cylinder barrels. From the cylinder block the water passes into the cylinder head through three brass water jets. These cause the water to flow round the valve seats before leaving the cylinder head through the thermostat (when its valve is open), and top water hose to the radiator top tank.

Whenever possible clean rainwater, or softened water should be used, in preference to tap water.

The cooling system is not required to come into full operation until the engine has attained its normal working temperature, and it is desirable that this should be brought about as quickly as possible after starting the engine from cold.

To accomplish this, a thermostatically operated valve is located in a housing bolted to the front end of the cylinder head. This body, forming part of the hot water outlet pipe, is connected to the radiator top tank by a rubber hose.

The thermostat valve remains closed when the engine is cold, and when the engine is started from cold, water returns to the pump intake through a small by-pass pipe which connects the pump intake pipe with the engine side of the thermostat valve.

After starting the engine, the water temperature will rapidly rise, but circulation of the water through the radiator does not commence until a temperature of 85°C. (185°F.) has been reached in the cylinder head and cylinder block water jackets.

At this temperature the thermostat begins to open and water commences to flow through the radiator. The thermostat becomes fully open at an engine water outlet temperature of 100°C. (213°F.).

When the vehicle is used in very cold weather without anti-freeze in the cooling system, great care should be taken to ensure that the radiator is warm before attempting to drive the vehicle. If this is neglected there is a danger that the radiator may freeze if the vehicle is driven in temperatures below freezing point before the thermostat is open. In cold weather the bottom of the radiator should be blanked off so that its bottom tank keeps warm, because it is here that freezing commences.

FROST PRECAUTIONS

To avoid the possibility of the cooling system freezing whilst the vehicle is stationary, or whilst being driven in very cold weather, it is recommended that an anti-freeze mixture is used, and added in the quantities recommended by the anti-freeze manufacturers.

We recommend anti-freeze mixture based on inhibited ethylene glycol. Mixtures using alcohol as a base are not suitable, as this will cause loss of anti-freeze by evaporation.

Before putting anti-freeze compounds of any kind in the cooling system, it is imperative that the cylinder head and all hose connections should be checked for tightness, as these compounds have a very searching effect and should any leak into the sump, very serious damage may occur owing to the possibility of engine seizure. Do not exceed specified torque figures for cylinder head nuts, this is 41/43 lb. ft. (5·7/5·9 kg.m.).

Vehicles with anti-freeze mixture in the cooling system should have a label attached to the header tank of the radiator, to indicate the fact.

The following precautions are necessary on vehicles so marked:

(*a*) Never fill the radiator up to the overflow. Leave space for the natural expansion of the mixture to avoid unnecessary topping up and consequent dilution. Top up when the system is warm.

(*b*) If the cooling system has to be emptied run the mixture into a clean container and use again.

(*c*) If for any reason the mixture is lost and the system is filled with water, REMOVE THE ANTI-FREEZE LABEL ON THE HEADER TANK.

Heater (when fitted).

Where a heater unit is installed, a reliable anti-freeze mixture must always be used, because even when the cooling system is drained, a small amount of water remains in the heater unit. If this water freezes the heater unit will be seriously damaged.

When refilling the cooling system with anti-freeze mixture (or when refilling with water) it is essential

to **fully turn on** the water control tap located at the heater pipe connection in the cylinder head top face.

When anti-freeze is not used and low temperatures are likely to occur, the radiator and cylinder block should be drained before leaving the vehicle for a long time. Warm but not boiling water should be used when refilling and the lower part of the radiator blanked off until the engine has reached its working temperature.

CLEANING THE COOLING SYSTEM

Periodically, the entire cooling system should be cleaned, particularly in districts where, contrary to instructions, water having a high content of lime has been used for replenishing the radiator.

Remove the radiator filler cap.

Open drain tap in radiator bottom water pipe (or preferably remove the tap complete), when engine is still hot; also open or remove tap from left-hand side of the engine front support plate.

Allow time for engine to cool after all water has drained off. When cold, flush radiator through to remove all loose sediment by means of a hose inserted in the filler neck.

Allow to drain and then close the drain taps or refit if removed.

Fill system to normal level with a solution of cleansing compound (several reliable brands of which are available) and run the engine as directed by the makers of the compound.

It is important to drain off the cleansing compound directly it has been used for its recommended period.

Finally, flush the system thoroughly with running water by means of a hose, turn off drain taps and fill system to normal level with soft water or antifreeze mixture as required.

A furred radiator which is removed from a vehicle during overhaul should not be allowed to dry out as when this occurs the deposit inside will set hard and will not soften when the radiator is refilled and used again. Always cleanse the radiator immediately whilst still wet inside, or seal up the apertures and fill with water pending treatment. Alternatively, the radiator can be left immersed in a suitable tank of water.

Do not invert the radiator or lay it flat as this allows any sediment which has accumulated in the bottom tank to pass into the cooling ducts. Always store the radiator in its normal upright position.

When using flushing compounds it is important to avoid splashing the paintwork of the vehicle as they can have an injurious effect.

In very dusty conditions, and where insects are numerous, the radiator tube system should be kept clean by blowing through with compressed air from the engine side.

RADIATOR RELIEF VALVE

Incorporated in the filler cap is a valve which prevents the water from escaping through the overflow when at normal level. This can occur through the agitation of the water in circulating.

When water is heated and expansion takes place the internal pressure lifts the spring-loaded pressure valve off its seating in order to relieve excessive pressure through the overflow pipe.

In addition, this valve allows a small pressure build-up within the radiator. This raises the boiling point of the water a few degrees, which is an advantage in high altitudes, tropical conditions and hard driving.

When the engine temperature falls and contraction takes place there is a tendency for a partial vacuum to form within the cooling system. In order to prevent this tendency developing, resulting in the possible collapse of the radiator, the vacuum relief valve, situated on the underside of the pressure relief valve, is opened by atmospheric pressure via the radiator overflow pipe, allowing air to enter the cooling system, maintaining the correct pressure balance.

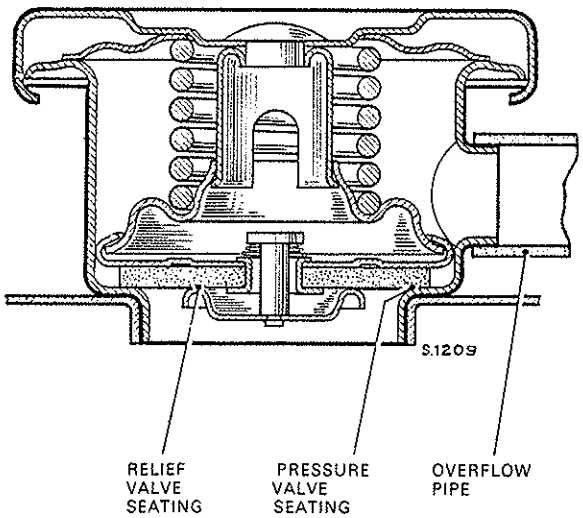


Fig. A.2. Sectional view of the radiator relief valve

WATER TEMPERATURE GAUGE (when fitted)

This instrument is electrically operated and consists of two units, the temperature element (transmitter) in the thermostat housing, and the temperature gauge in the instrument panel. These units are connected by a single insulated wire and temperature is only recorded when the ignition is switched on.

Removal of Element.

The radiator should be drained enough to allow removal of element without loss of water or antifreeze.

Remove the electrical connection and the element can then be unscrewed from the thermostat housing.

FAN BELT ADJUSTMENT

1. Slacken the nuts and bolts at bottom front and rear of the alternator.

2. Slacken the adjusting link locating bolt and the setscrew in the link slot.

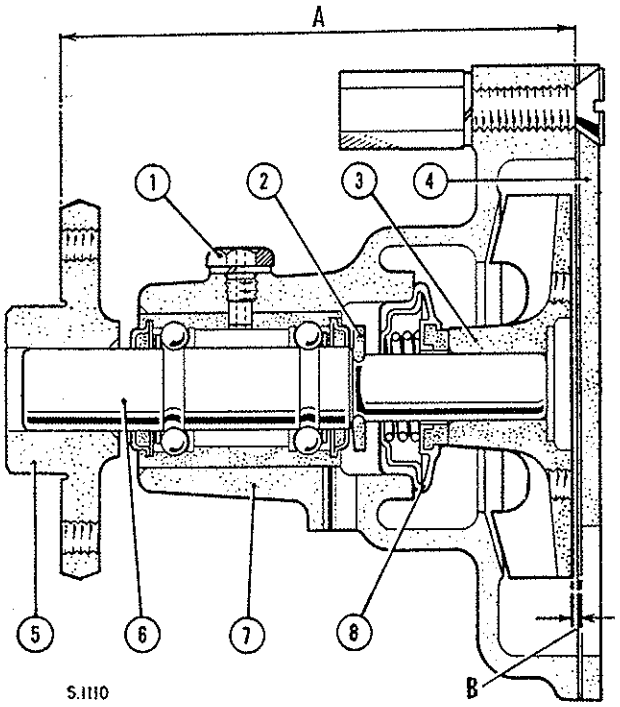
3. Move the alternator in the required direction until it is possible to depress the belt (without using undue pressure) approximately $\frac{5}{8}$ in. (16 mm.) in the centre of the long run between the water pump and cranckshaft pulleys.

4. Tighten all bolts and the setscrew. Finally, re-check the belt tension.

WATER PUMP

To Remove.

1. Drain the cooling system.



A = 4·00/4·01 in. (101·6/101·8 mm.)
B = 0·040 in. (1·02 mm.)
1 BEARING LOCATING SCREW
2 THROWER FLANGE
3 IMPELLER
4 BACK COVER PLATE
5 FAN PULLEY CENTRE
6 SPINDLE AND BEARING ASSEMBLY
7 PUMP BODY
8 SEAL UNIT

Fig. A.3. Sectional view of the water pump assembly

2. Remove the radiator top and bottom hoses and slacken the hose clips on the by-pass hose.

3. Disconnect the temperature gauge lead (when fitted). Remove the nuts and washers securing the thermostat housing and remove the housing and the joint.

4. Slacken the alternator mounting and adjustment bolts to pivot the alternator and enable the drive belt to be slipped over the alternator pulley.

5. Remove the four setscrews and spring washers securing the fan blade assembly and lift off the fan and the drive belt.

6. Disconnect the heater hose (if fitted).

7. Remove the bolts securing the water pump to the cylinder block and lift away the pump and the joint.

To Dismantle

1. Remove the bearing locating screw.

2. Remove the countersunk bolt and the nut securing the back cover plate. Remove the cover plate and the joint.

3. Support the pump body and press on the pump spindle at the impeller end. This will bring the impeller against the pump body and allow the spindle to be pressed out of the impeller and the pump body.

4. Remove the seal unit from the pump body.

5. Support the fan pulley centre on the underside and press out the spindle.

Inspection and Overhaul

1. Clean all deposits from the pump body and inspect the body for damage or cracks.

2. Remove the scale from the impeller blades.

3. Examine the spindle and bearing assembly. If the bearing is showing signs of wear or roughness, the spindle and bearing assembly must be renewed. Do not wash the bearing unit in petrol, paraffin or any form of cleanser. The unit is lubricated and sealed during manufacture and no further lubrication is required in service.

4. The thrower flange is located in a groove on the spindle and need not be removed unless damaged.

5. The pump seal unit has a carbon face which is held by means of a spring, in the seal unit, against the rear machined face of the impeller. If either of these parts are worn or if the pump is leaking at this point, these parts should be renewed. It is most important to have a smooth flat surface on the impeller in contact with the carbon face of the seal.

To Re-assemble.

1. Place the spindle and bearing assembly in the pump body with the larger spindle diameter to the front of the body and line up the location hole in the pump body with the corresponding hole in the bearing unit. Fit the bearing locating screw.

2. With the fan pulley centre placed on a suitable block under a press, chamfered end of bore uppermost (see Fig. A.4) insert the larger spindle diameter and press in until the front face of the pulley centre is positioned as shown by the dimension in Fig. A.3. This will ensure correct alignment of the water pump pulley with the crankshaft pulley.

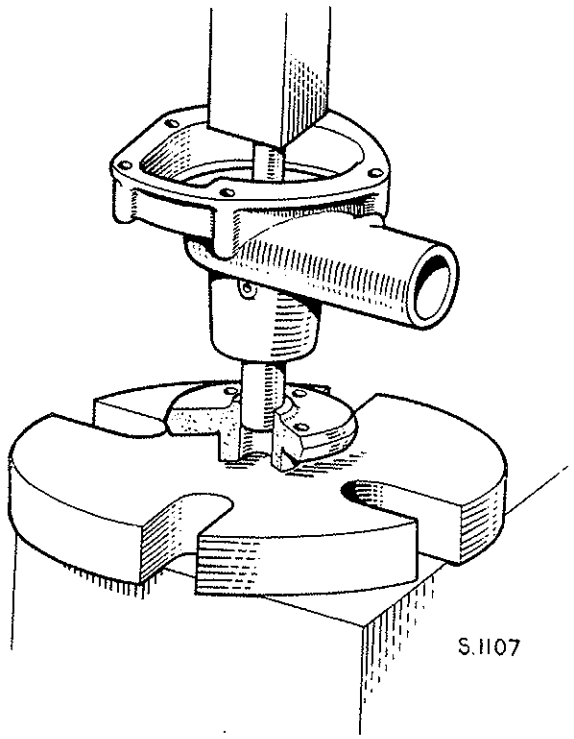


Fig. A.4. Pressing the fan pulley centre on the pump spindle

3. If the thrower flange has been removed, refit to the spindle, locating the flange in the groove on the spindle situated between the bearing unit and the seal unit.

4. Fit the pump seal unit on the smaller diameter of the spindle with the metal support of the seal facing towards the pulley end of the pump, and push firmly into the pump body until the larger rim of the seal locates on the shoulder inside the body.

5. Support the pump spindle end inside the pulley centre and press on the impeller with the blades facing inwards (see Fig. A.5). The rear face of the impeller must be 0·040 in. (1·02 mm.) below the level of the machined rear face of the pump body. This can be checked by means of a feeler gauge and straight edge placed across the rear face of the pump body (see Fig. A.6).

6. Fit the cover plate using a new joint and secure with the countersunk bolt and nut in the uppermost hole.

To Refit.

Reverse the removal procedure renewing any faulty joints or water hoses. Finally adjust the fan belt so that it is possible to depress the belt (without using undue pressure) approximately $\frac{5}{8}$ in. (16 mm.) in the centre of the long run between the water pump and crankshaft pulleys.

THERMOSTAT AND HOUSING

To Remove.

1. Drain the cooling system.

2. Remove the radiator top hose connection after releasing the two hose clips.

3. Unscrew the two nuts securing the water outlet housing and remove the housing and the joint.

4. Lift out the thermostat.

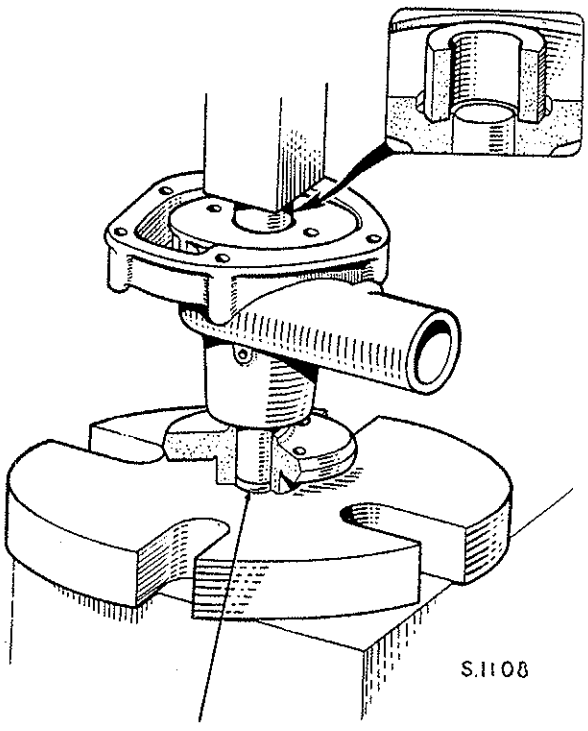


Fig. A.5. Pressing the impeller on the pump spindle *Inset shows packing piece under the head of the press ram*

5. To remove the thermostat housing, if necessary, after withdrawing the thermostat, release the by-pass

hose clips and the five nuts and washers securing the housing to the cylinder head. Remove the housing and the joint.

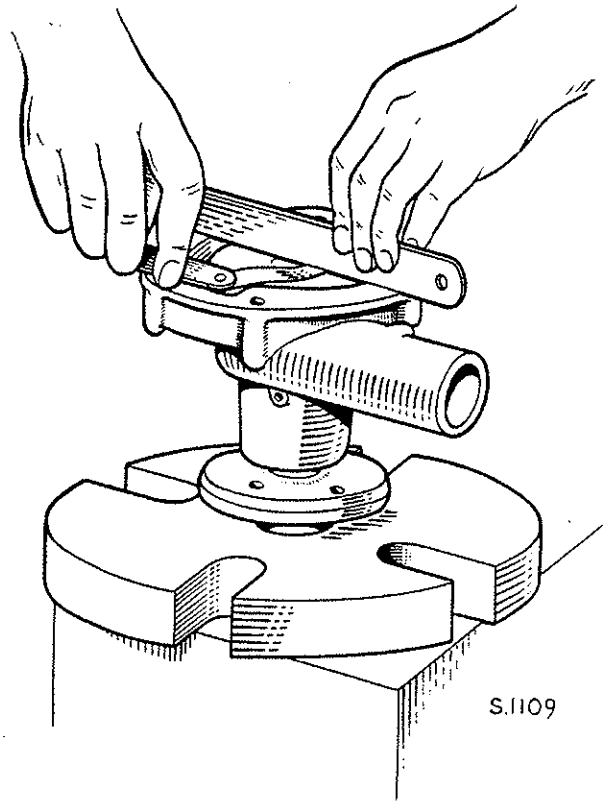


Fig. A.6. Checking the clearance of the impeller below the rear face of the pump body

Inspection and Overhaul.

Check the operation of the thermostat by suspending the unit, together with a reliable thermometer in a container of water. Heat the water slowly, noting the thermometer reading and stirring the water continually. The thermostat valve should commence to open at 85°C. (185°F.) and be fully open at 100°C. (213°F.).

If the thermostat is found to be open on removal from the engine, it may be assumed to be defective and should be renewed. Thermostats are sealed and their setting is not adjustable, therefore always renew if any doubt exists as to the correct operation or, in the event of a replacement not being immediately available, leave out the faulty thermostat, to eliminate possible serious overheating, until a new unit is to hand.

To Refit.

Reverse the removal procedure using a new joint if necessary.

RADIATOR

To Remove.

1. Drain the cooling system at the two drain taps provided, after releasing the radiator filler cap.

2. Remove the two engine compartment side covers situated beneath the right and left-hand seats. Remove the front engine cowling together with the hinged engine top cover.

3. Release the hose clips and slide back the radiator top and bottom hoses until they clear the radiator connecting pipes.

4. The relay lever and lever support bracket for the accelerator linkage are secured to the left-hand side of the radiator.

Disconnect the pedal control rod which is clipped to the lower arm of the relay lever.

Release the accelerator cable at the upper arm of the relay lever and at the cable abutment on the lever support bracket.

5. Unscrew the bolts and nuts at the four radiator side support brackets, noting that a plain washer is fitted under the bolt head whilst a plain and shake-proof washer is placed under the nut.

The sides of each half of the fan cowl are also secured by the same four mounting bolts and nuts but two further bolts and nuts attach the top of each fan cowl half to the fan guard which is integral with the radiator. Remove the two bolts and nuts and lift away the fan cowl halves.

6. The radiator can then be lifted up and removed.

To Refit.

Reverse the removal procedure and check for leakage at the hose connections after refilling the radiator on completion.

FAN COWL

The fan cowl is secured in two separate halves at the side support brackets for the radiator and, additionally, at each end of the fan guard which is integral with the radiator top rank.

To Remove.

1. Unscrew the two bolts and nuts securing the cowl to each end of the fan guard.

2. Release the bolts at each radiator side bracket and slide out the appropriate half of the cowl in turn.

To Refit.

Reverse the removal operation ensuring that adequate clearance for the fan blades is obtained on completion. Slotted holes in the cowl are provided for this purpose.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

ENGINE
SECTION B
INDEX

LUBRICATING SYSTEM

ENGINE

ROCKER COVER

To Remove and Refit.

1. Remove the four screws securing the rocker cover to the cylinder head and lift off the cover, taking care not to damage the joint.

2. Refitting is a reversal of the removal procedure. The joint should be replaced, if damaged.

3. To check the clearance, insert a feeler gauge of correct thickness between the valve stem and the rocker foot. The correct clearances with a hot engine are:

Inlet Valve	0·012 in. (0·30 mm.)
Exhaust Valve	0·014 in. (0·35 mm.)

When the rocker clearance is correct the feeler will be firm, but not tight, to move between the rocker and valve stem end, whilst pushing downwards on the adjustment screw slot with a screwdriver.

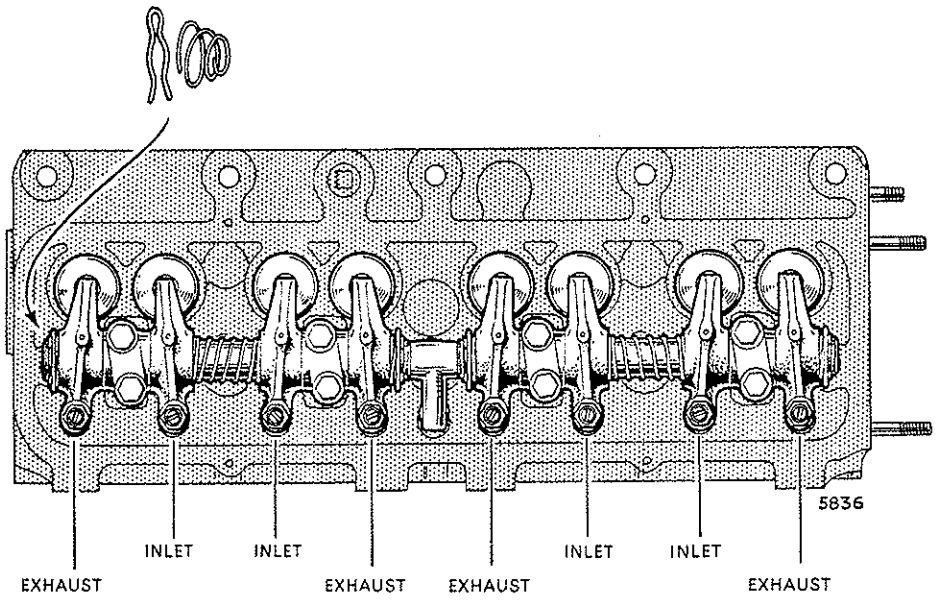


Fig. B.1. Valve rockers

VALVE ROCKER ADJUSTMENT

These adjustments must be made when the engine is very hot

1. Remove the rocker cover.

2. Turn the engine until the exhaust valve of No. 4 cylinder is fully open and, starting at this point, adjust the valves in the order given below, turning the engine progressively through two revolutions to complete the cycle of adjustment:

Adjust No. 1 exhaust with No. 4 exhaust fully open.
Adjust No. 2 inlet with No. 3 inlet fully open.
Adjust No. 3 exhaust with No. 2 exhaust fully open.
Adjust No. 1 inlet with No. 4 inlet fully open.
Adjust No. 4 exhaust with No. 1 exhaust fully open.
Adjust No. 3 inlet with No. 2 inlet fully open.
Adjust No. 2 exhaust with No. 3 exhaust fully open.
Adjust No. 4 inlet with No. 1 inlet fully open.

4. To adjust the clearance, slacken the locknut and turn the screw with a screwdriver until the correct clearance is obtained. Tighten the locknut and re-check the clearance. Check all valves in this manner, then refit the rocker cover.

ROCKER-SHAFT ASSEMBLIES

To Remove.

1. Remove the rocker cover after first releasing the carburettor throttle return spring hooked in the anchor bracket on the rocker cover. Unscrew the union nut and disconnect the oil pipe to the rocker shaft.

2. Remove the eight nuts securing the rocker standards to the cylinder head.

3. Lift out the rocker shafts and upper oil feed complete.

To Dismantle.

1. Remove the spring clip from one end of each assembly and take off the rockers, standard and springs, noting their correct order for re-assembly.

2. Inspect the rockers and shaft and renew if worn or scored.

To Re-assemble.

Assemble the components on the rocker shaft in the order shown in Fig. B.1, locating the standards on each shaft to allow the oil feed holes to face downwards.

To Refit.

Ensure that each rocker shaft assembly is fitted with its open end towards the oil feed "T" piece, which is then inserted between the two shafts with its elbows facing the pushrods.

The other ends of the shafts are plugged.

The rocker shafts are grooved and located by the rocker standard studs nearest to the valves. Upon re-assembly, the grooves should be located on the side nearest the valves.

PUSH RODS

To Remove and Refit.

1. Remove the rocker cover.

2. Remove the rocker shaft assembly.

3. When removing push rods, keep them in the same order as found and ensure that the tappets are not pulled out of their bores. A sharp tap on the side of the push rod will normally break the oil film on the ball end.

4. When the push rods have been replaced, reset the valve clearances and re-check the clearance when the engine is **hot.**

CYLINDER HEAD

The engine is fitted with a cast iron cylinder head. A steel cylinder head gasket is used.

To Remove.

1. Drain the cooling system.

2. Remove the air cleaner.

3. Disconnect the radiator top hose.

4. Remove the rocker cover.

5. Disconnect the thermometer lead (when fitted).

6. Disconnect the sparking plug leads.

7. Remove the screws securing the tappet cover to the cylinder head.

8. Disconnect the oil feed pipe to the rocker shaft.

9. Disconnect the heater pipe (if fitted).

10. Remove the eight bolts securing the rocker shaft assembly to the cylinder head. These bolts must be released evenly where they are loaded by any compressed valve springs.

11. Lift off the rocker shaft as an assembly holding its two ends so that it cannot fall apart at its centre oil feed brass "T" piece.

12. Remove the push rods taking care not to draw the tappets out of the cylinder block. The push rods should be placed in a suitable holder so that they can be replaced in their original positions.

13. Disconnect the fuel feed pipe and carburettor controls.

14. Remove the eight bolts and two nuts securing the cylinder head to the cylinder block.

15. Disconnect the exhaust pipe at its flange on the exhaust manifold.

16. Lift off the cylinder head with the manifolds and carburettor still attached.

17. Cover the open end of the exhaust pipe.

To Refit.

1. Reverse the removal procedure, ensuring that all joint faces are clean. Always use a new gasket. Jointing compound should not be used.

It is most important that the cylinder head is aligned correctly in order to position the machined location for the tappet cover in relation to the corresponding machined face on the cylinder block, before tightening the cylinder head bolts.

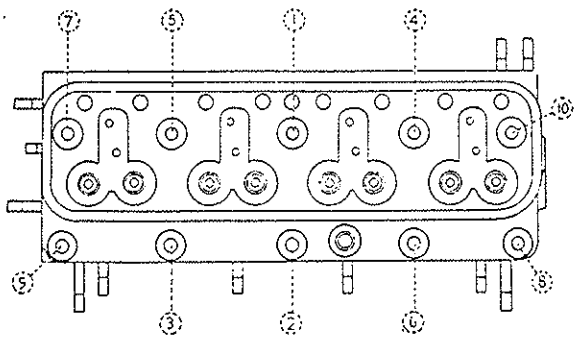


Fig. B.2. Cylinder head bolt tightening sequence

Do not displace the tappet cover gasket when lowering the head. Tighten the cylinder head bolts, using Churchill Tool R.G.225, to the correct torque figure in the sequence shown in Fig. B.2. before tightening the tappet side cover screws.

2. Adjust the valve clearances.

3. Reset the valve rocker clearances with the engine **hot.**

4. It is not necessary to retighten the cylinder head bolts after the engine is warm.

Compression Pressures.

An engine in good condition should give the compression pressure given in " GENERAL DATA " at the beginning of this manual.

These pressures should be taken at starter cranking speed with the throttle held fully open, all sparking plugs removed and the engine hot.

If the readings obtained are substantially below the given figure, the engine is in need of attention to the valves or piston rings, or possibly a rebore.

Decarbonising.

1. When the cylinder head has been removed for decarbonising the complete set of valves should be removed for cleaning, inspection and refacing as detailed in this section. The valve guides should also be checked for wear on their internal diameters and renewed if necessary. (See "**Valve Guides – To Renew**" in this section.)

2. When removing the carbon from each piston crown, it is always advisable to leave a ring of carbon adjacent to the cylinder bore as this helps to preserve a good seal, and to conserve oil. A convenient method of doing this is to turn the engine until the piston is slightly below the top dead centre position, and insert an old piston ring of correct size in the bore, and press it down on the piston. In this way all the carbon within the old piston ring may be removed, leaving a ring of carbon around the edge.

3. Place clean rag in the exposed area of the tappet chamber, as no carbon should be allowed to enter.

4. Remove the carbon from the tops of the pistons, the combustion chambers in the cylinder head and also from the valve ports. Clean out the inside of the exhaust manifold with a suitable scraper.

Care must be taken when decarbonising the tops of the piston, these being made of aluminium alloy. No pointed instrument or emery cloth may be used.

Do not on any account use abrasives for removing carbon, or damage will result.

5. Remove all loosened carbon, preferable by use of a compressed air line.

VALVES – TO REMOVE

To assist in this operation it is recommended that a valve spring compressor, Churchill Tool R.G. 6513A, is used.

1. Using the valve spring compressor, remove the split coned cotters. When carrying out this operation care should be taken to ensure that no damage is caused to the valve stem by the hardened steel cotters and spring cups.

2. Release the valve spring compressor and lift off the cup and valve spring.

3. Remove the valves.

Inspection and Overhaul

Valves

1. Examine for pits on the face, burning and distortion or cracks in the heads. Burnt or cracked valves must always be replaced. (See also "**Valves – To Reface**" in this section.)

2. Examine the seatings in the cylinder head, and if defective they should be re-cut. (See "**Valve Seatings**" in this section.) If the valve stems are appreciably worn the valves must be replaced.

3. Wear of valve stems may be checked by means of a micrometer and the stems should be checked from various angles and positions, as the stems of valves do not wear evenly. The stem diameter of new valves is :

Inlet	0·3105/0·3110 in. (7·887/7·899 mm.)
Exhaust	0·3095/0·3100 in. (7·861/7·874 mm.)

Valve Guides.

1. These may be checked for wear by using a new valve as a gauge. The valve stem should be a free sliding fit in the guide without excessive side-play.

2. When making the foregoing check both valve stem and valve guide must be free from carbon or burrs and free from oil.

Valve Springs.

1. If possible the loaded height of the springs should be checked. These dimensions should be as detailed under "GENERAL DATA".

A maximum loss of 10% on used springs is permissible.

2. The use of a dial type spring tester is strongly recommended.

3. A convenient alternative method of checking used valve springs is by comparing them with new springs. Place them end to end on a long bolt and compress them in a press (see Fig. B.3). Any loss will then be apparent as the weaker spring will close up first.

4. Cotters and spring cups are best compared with new parts visually, and renewed as necessary.

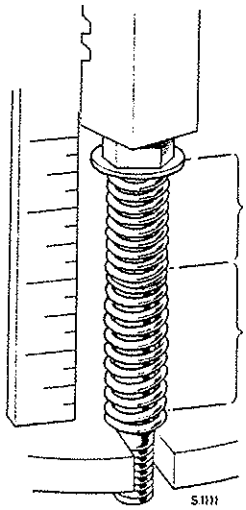


Fig. B.3. Checking valve springs

Valves – To Grind In.

This operation will be satisfactory only if the valves and seatings are found to be in good condition after dismantling and inspection, and there is no evidence of distortion or burning of the faces and heads of the valves. It is also necessary after new valves have been fitted or seatings re-cut. The valve stems must be free from wear and their guides in good condition.

1. Place a small amount of valve grinding paste (fine) evenly around the face of the valve to be ground, not allowing it to get on the stem or other parts.

2. Place the valve on its seating and by means of a suction grinding tool, rotate the valve from side to side through a few degrees only, using a light pressure. Frequently raise the valve and move round to a new position on its seating and continue grinding. (On no account should the valve be revolved through complete revolutions when grinding because rings will be formed on the face with detrimental effects.)

3. The grinding should be continued in this manner until a continuous but narrow seating has been obtained on both the valve and the seating. The seatings should not be more than 0·070 in. (1·78 mm.) in width. (See Fig. B.4.)

4. After thoroughly cleaning off all traces of grinding paste from the valve seating with a dry cloth, test by placing a small amount of engineers' marking on the

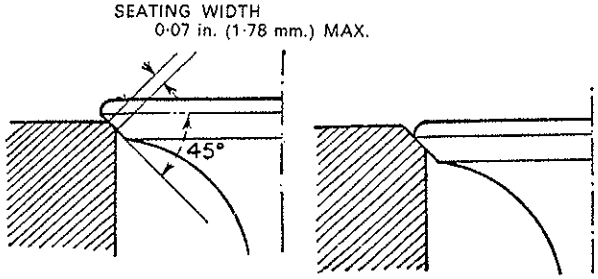


Fig. B.4. Valve seating

seating and revolving the valve in place not more than about $\frac{1}{8}$ in. (3 mm.) in each direction. A complete circle of marking should appear on both the valve face and seating, indicating a good seal.

To Refit.

1. The valve stems should be given a thin coating of oil when the valves are refitted.

2. The valve spring cups have a sealing ring in the lower end. When refitting, care should be taken to avoid damage to the sealing ring as damaged rings can cause oiling up of the sparking plugs. The sealing rings should be renewed if faulty.

Valves – To Reface.

1. If on inspection, it appears unlikely that the valves would clean up satisfactorily with ordinary grinding in, they must be refaced. If the seatings are also in bad condition they must be re-cut, but generally it will be found that these are better than the valves as regards condition unless the engine has been a very long time in service. It is quite practicable to reface the valves and grind them in on the seatings if the latter are in good order.

2. It is always better to replace a badly burnt or pitted valve as extended refacing will bring it very low on its seating by reason of the consequent reduction in the effective diameter of the valve face, and "pocketing" will result (see Fig. B.4). This condition is detrimental to the running of the engine and will cause overheating and loss of power. The valve face should be machined only until it is just true and clear of marks, to the standard angle of 45° for inlet and exhaust. These angles are reckoned from the top face of the valve head. Standard dimensions of valves are given in "GENERAL DATA" at the beginning of this manual. It should be noted that inlet and exhaust valves are of different sizes.

The refacing of these valves must not leave too thin an edge above the valve head seating. This applies particularly to exhaust valves which must be renewed if much refacing is needed.

3. A valve which has been refaced as described must also be finally ground in on its seating. The seating must be in good condition and the face not more than 0·070 in. (1·78 mm.) in width.

Valve Seatings.

1. A damaged or slightly burnt seating may be refaced with a 45° seating cutter or valve seat grinder. The latter is better for facing seat inserts.

2. A complete set of valve seat cutters is available under Churchill Tool Nos. 316 and 317. Individual items may be purchased separately, if required. It is most important that the cutter pilot should be a good fit in the valve guide. If necessary the valve guide should be renewed as the highest possible concentricity must exist between the seatings and the valve guide bore.

3. The seating should be re-cut with a 45° cutter until all marks have disappeared. **No lubricant** is required for this operation.

4. After re-cutting a seat its refaced valve should be inserted in the valve guide to check where the valve seats. If the valve comes too low in the seating, a new valve should be tried. If this valve comes too low in the re-cut seating, a 15° cutter should be used to reduce the width of the seating. Occasionally it is necessary to reduce the seating width from the bottom by means of a 75° cutter.

5. It is important to ensure that the finished seat width is not greater than 0·070 in. (1·78 mm.) and that the valve seats correctly as shown in Fig. B.4. After refacing the valve seats, the valves should be ground in and only a little grinding should be necessary to produce a good seating.

Valve Guides – To Renew.

1. The valve guides are driven out of the cylinder head from their valve spring end. It is not advisable to drive from the valve port end because the guide ends become brittle under the heat to which these ends are exposed.

2. New valve guides must have the prescribed interference fit in the cylinder head i.e. 0·0025/0·0045 in. (0·063/0·114 mm.). Oversize valve guides are available.

3. The guides should be driven into the cylinder head, from their upper end, until they project by 0·50 in. (12·7 mm.).

4. The valve guides must be fitted to their respective ports. Inlet valve guides are shorter than the exhaust valve guides. Both guides have a circular groove around their upper ends.

5. The valve guides can be driven out and driven in using Churchill Tool No. R.G.479.

Exhaust Valve Seat Inserts.

1. Exhaust valve seat inserts are not normally fitted to new engines but inserts are available for service use in four sizes i.e. standard, —0·002 in. (0·050 mm.), —0·005 in. (0·127 mm.) and —0·010 in. (0·254 mm.).

2. When inserts have to be used, new valve guides should be fitted and the cylinder head recessed deep enough to take the insert to a diameter that will give the insert an interference fit of 0·0025/0·0045 in. (0·063/0·114 mm.). The insert must be pressed in perfectly square until it seats on the entire bottom face of the recess.

3. The valve seat, on the newly fitted insert, should be cut at an angle of 45° to a width of 0·05/0·06 in. (1·27/1·52 mm.) and must be concentric to within 0·001 in. (0·025 mm.) of the valve guide bore.

TAPPETS

To Remove.

1. Remove the rocker cover, rocker shaft assemblies and push rods.

2. Remove the engine side cover, as follows:

(*a*) Remove the throw-away oil filter.

(*b*) Remove the distributor.

(*c*) Take out the securing screws and remove the side cover.

(*d*) Lift out the tappets. The tappets should be numbered in pencil on removal so that they can be refitted in their original positions.

3. Tappet faces in contact with the cams should be free from pitting and wear. Regrinding of the tappet faces is not recommended as it reduces the thickness of the hardened face.

To Refit.

Refitting is a straightforward reversal of the removal procedure. Note that the tappets should be refitted in the bores from which they were removed.

TIMING COVER AND TIMING CHAIN TENSIONER

To Remove.

1. Drain and remove the radiator.

2. Slacken the alternator mounting screws and remove the fan belt.

3. Unscrew the crankshaft jaw nut using Churchill Tool No. R.G.290 and pull off the crankshaft pulley.

4. Remove all the screws and nuts holding the timing cover in position and remove the cover.

5. Remove the tensioner, if necessary.

To Refit.

Reverse the removal procedure. In replacing the cover, the timing chain tensioner will again rest against the timing case side and correctly tension the timing chain. It is very important to centralise the cover, around the crankshaft pulley, using Churchill Tool No. R.G.89A, before fully tightening the bolts.

TIMING WHEELS AND CHAIN

To Remove.

1. Remove the timing cover.

2. Remove the split pin and plain washer from the tensioner pivot pin and lift off the tensioner blade.

3. Remove the setscrew, tab washer and plain washer from the front end of the camshaft.

4. Remove the oil thrower in front of the crankshaft sprocket.

5. Pull or lever off both the camshaft and crankshaft wheels simultaneously, using Churchill Tool Nos. R.G. 209 and 6312A.

Inspection and Overhaul.

1. Check the teeth of both timing wheels and the chain for wear. A new chain should not be used with wheels that are badly worn as this will cause rapid chain wear.

2. Ensure that the keyways in the timing wheels and the keys on the camshaft and crankshaft are not damaged or worn.

3. Examine the tensioner blade for wear and renew if necessary.

To Refit.

1. When refitting, set Nos. 1 and 4 pistons to T.D.C. so that the key is to the top of the crankshaft.

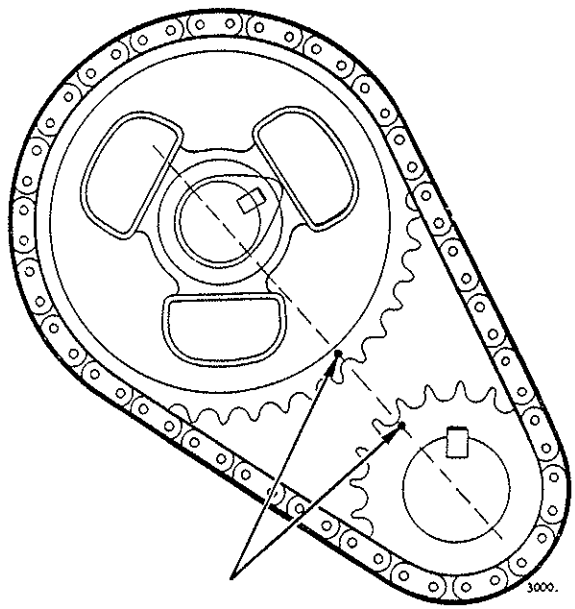
2. Push the crankshaft wheel onto the crankshaft until it is approximately 1·5 in. (38 mm.) from the shaft shoulder.

3. To obtain the correct valve timing, fit the chain to the crankshaft wheel and the camshaft wheel so that the dots on the camshaft and crankshaft wheels are in line (See Fig. B.5.)

4. Turn the camshaft until the key lines up with the keyway in the camshaft wheel.

5. Pull the camshaft wheel onto the camshaft by means of a washer and bolt screwed into the camshaft end, and drive the crankshaft wheel onto the crankshaft.

The camshaft wheel must not be driven onto the camshaft because this can force the camshaft backwards and displace the sealing disc at the outer rear end of the rear camshaft bearing.



TIMING WHEEL MARKINGS

Fig. B.5. Position of timing wheel marking when replacing timing chain

6. Fit a new camshaft sprocket fixing bolt and washer, securing with a new lock washer.

7. Fit a new crankshaft oil thrower.

8. Refit the chain tensioner and timing cover as previously detailed in this section.

The front face of the timing case is bolted to a pedestal bolt, and the free end of the tensioner rests on the inside of the timing case.

VALVE TIMING

To Check Timing Chain Replacement.

This is only necessary when incorrect replacement of the timing chain is suspected, in which case the following quick check can be made.

1. Remove the rocker cover and adjust No. 1 cylinder inlet valve rocker clearance to 0·019/0·020 in. (0·48/0·50 mm.) when No. 4 cylinder inlet valve is fully open. This is important as the valve timing cannot be checked at the normal valve rocker clearances.

2. Turn the engine until the pointer on the crankshaft gives a position of about 60° B.T.D.C.

3. Set up a clock gauge to show when No. 1 inlet valve begins to move. To do this the gauge stylus point must contact the valve spring cap. Set the gauge dial to read zero and turn the engine slowly until the gauge shows 0·001 in. (0·025 mm.) downward movement of the valve spring cap. Note the position of the crankshaft pulley marking, this should be approximately 19° B.T.D.C.

If the valve timing is one tooth out, the correct mark on the crankshaft pulley will be a considerably greater distance before T.D.C. or at some distance after T.D.C.

The valve opening point can also be found with reasonable accuracy by attempting to rotate the valve spring cap with the first finger and thumb. Directly the valve leaves its seat it is possible to slightly twist the valve and this movement will be seen on the spring coils. The actual opening point of a valve cannot be determined by noting when a thin feeler is gripped between the rocker and valve stem end or by rotating the push rod to find when the load comes on to the push rod.

4. Re-adjust No. 1 cylinder inlet valve to its normal clearance.

CAMSHAFT AND BEARINGS

To Remove.

1. Disconnect the electrical leads and remove the distributor as described in this section.

2. Drain the sump and remove the sump and oil pump.

3. Remove the tappets and fuel lift pump.

4. Remove the radiator (see "COOLING SYSTEM").

5. Remove the timing cover, crankshaft oil thrower, timing wheels and chain.

6. Remove the two setscrews, take off the camshaft thrust plate, and withdraw the camshaft gently to avoid damage to the bearings.

Inspection and Overhaul.

1. Wear on the camshaft bearings and journals will, under normal circumstances, be very slight as the bearings are adequately lubricated. However, if it becomes necessary to renew the bearings, the operation is simplified with the engine removed from the vehicle and the cylinder block stripped of the auxiliary components.

2. Using a suitable withdrawal tool, the front and centre bearings can be withdrawn forwards whilst the rear bearing is removed from the rear after removing the camshaft sealing disc.

3. Pull the new bearings into place ensuring that the oil feed holes are correctly aligned.

Note: The replacement bearing shells require no matching or reaming.

4. Refit the camshaft rear sealing disc ensuring that an oil-tight joint is made.

5. Examine the cams and bearing journals on the camshaft to ensure that they are free from heavy scores or pitting.

6. Inspect the teeth of the gear which meshes with the oil pump driving gear for wear or damage.

7. If the camshaft thrust plate is worn or scored it should be renewed.

To Refit.

Reverse the removal procedure correctly timing the camshaft, and refitting the oil pump as detailed in this section under "LUBRICATING SYSTEM".

PISTONS AND CONNECTING RODS

Big End Bearings.

Indium-coated copper lead bearings are fitted and must be used as replacements. These bearings require, and have a minimum, running clearance of 0·0015 in. (0·04 mm.) and are able to carry greater loads than white metal bearings, but they are harder and small particles do not bed themselves into the bearing metal. In consequence, scoring of the crankshaft big end journals will occur if abrasive particles reach the bearings. Regular oil changing and renewal of the oil filter element at the recommended mileages are therefore important.

To Remove.

1. Remove the cylinder head.

2. Drain and remove the oil sump.

3. Remove the self-locking nuts securing the big end bearing caps.

4. Remove the connecting rod caps with the bottom half big end bearings. No identifying numbers are stamped on either the connecting rod or connecting rod cap.

If the original parts are to be used again, it is essential that the big end caps are re-assembled to the same rods from which they were removed. To show the correct assembly, a forging flash is left on the oil squirt hole side of the connecting rod. This flash lines up with a similar flash on the connecting rod cap.

Each complete connecting rod should be refitted to the same piston and cylinder bore from which it was removed.

5. Push the pistons up the cylinder bores and withdraw the assemblies from above.

To Dismantle.

1. Remove the circlips, retaining the gudgeon pin in the piston, with circlip pliers.

2. Warm the assemblies, preferably in oil, and push out the gudgeon pins. Tight fitting gudgeon pins should not be driven out of cold pistons.

3. Remove the three piston rings from each piston.

Inspection and Overhaul.

Matching Pistons to Cylinder Bores.

1. Every effort is made in the course of manufacture to ensure that pistons and cylinders conform to their normal dimensions in machining. Normal production methods, however, allow for a minute variation in machined sizes, and for this purpose, the pistons and cylinders are classified in five different grades. In this manner the ideal clearance between pistons and cylinder bores can be maintained on all engines.

2. The variation between each grade letter diameter is 0·0004 in. (0·010 mm.) and the total difference between the highest and lowest cylinder bore limits is 0·002 in. (0·050 mm.). By means of the grading system the correct piston fit is obtained when pistons are fitted to new cylinder bores having similar grade letters as the pistons. The diameter difference between similar grade letters for the cylinder block and piston is the required clearance for the piston.

3. Check the cylinder bore diameter with a dial type measuring gauge, after setting its zero reading to 3·2100 in. (81·534 mm.) ring gauge.

From the size obtained subtract the mean piston clearance as shown under "GENERAL DATA" and from this size choose a suitable grade of piston, e.g.:

Bore size given by clock gauge 3·2116 in. (81·575 mm.)
3·2116 in. (81·575 mm.) — 0·0010 in. (0·025 mm.) = 3·2106 in. (81·549 mm.)
The nearest size to 3·2106 in. (81·549 mm.) is "D" grade and this would be the piston to use.

4. Replacement pistons are supplied as an assembly complete with gudgeon pin and piston rings. As these assemblies are graded in respect of gudgeon pin to piston boss fit, they must be retained in the assembly as supplied.

When replacing gudgeon pins only, the gudgeon pin bore in the piston must be honed to suit the grade for grade dimension of the gudgeon pin. Honing of the piston bosses is also necessary when fitting the 0·003 in. (0·076 mm.) oversize gudgeon pin.

The Delapena precision honing machine is recommended for this operation.

To Rebore the Cylinder Block and Fit Oversize Pistons.

1. When reboring cylinders to suit oversize pistons each bore is machined to the actual diameter of the piston to be fitted, plus the specified clearance in the bore.

2. The recommended bore finish is a "cross hatched" hone finish of 20 to 40 micro inches. This finish is equivalent to that obtained by thoroughly rubbing a used cylinder bore with partly worn No. 1 grade emery cloth to give a matt surface. The cutting tool of the boring machine should be set to bore the maximum diameter of the piston, measured at the bottom of the piston skirt at a right angle to the gudgeon pin, plus its prescribed clearance in the cylinder bore less a small amount of honing.

It is advisable to regrind and reset the cutter after completing each cylinder bore.

3. The honing operation allows the bore size to be taken to the size that will allow the piston to be correctly fitted as detailed under "Matching Pistons to Cylinder Bores".

4. Bores must be parallel and round to within 0·0004 in. (0·01 mm.). The use of a cylinder gauge used with a ring gauge, is recommended for taking measurements. The top, middle and bottom of each bore should be checked both in line with, and at right angles, to the gudgeon pin axis.

Service Replacement Cylinder Block.

1. It is normal practice to supply cylinder blocks separately but a set of suitably graded pistons can be supplied to suit any given block. Cylinder blocks complete with pistons are not serviced under one part number.

2. It is essential to ensure that each new piston is fitted into a bore of appropriate grade.

CYLINDER LINERS

To Fit.

These instructions apply to engines which are not fitted with liners during initial assembly.

If the fitting of liners is to prove really successful a high degree of skill on the part of the operator is required, coupled with first class precision equipment.

If, however, after considerable mileage, it should be decided to install liners, it is absolutely essential

that the procedure laid down in the ensuing paragraphs is rigidly adhered to, otherwise there is every possibility of the operation proving unsatisfactory.

1. The outside diameter of the service cylinder liner is given in the "GENERAL DATA".

2. Remove engine from chassis and dismantle.

3. Measure external diameter of liners.

4. Measure diameter of bores below piston ring travel.

5. Bore out the cylinder to suit liners, allowing for the prescribed interference fit of 0·002/0·004 in. (0·051/0·102 mm.). It is imperative that the correct figures are strictly adhered to. Every possible precaution must be taken to ensure concentricity and correct size for the full length of the bore.

6. Finish boring must not be attempted until all liners have been fitted.

7. Press in liners. To facilitate fitting, a "lead-in" is provided at the lower end of the liner.

8. When inserting the liners the load should be released several times during the first inch or so, thus allowing the liner to correct any misalignment. Press the liner home flush with the top of the cylinder block.

9. When each of the liners has been treated as above, the liners may be finish bored and/or honed to suit the new pistons, allowing for piston clearance as previously described.

10. Cylinder liners may be rebored only up to 0·030 in. (0·76 mm.) oversize.

To Renew.

1. The method used to remove liners will depend to a great extent on the facilities available. Liners may be drawn or pressed out from the bottom only. Check the cylinder for concentricity and correct size for the full length. If the diameter is in excess of the dimension given under "GENERAL DATA", the correct interference fit will not be obtained.

2. Provided that the conditions set out in para. 1 are correct, press in the new liners. Finally bore and hone the liners to suit the standard pistons.

PISTON RINGS

1. Top Chromium Plated Piston Ring.

This piston ring is chromium plated with the word "Vachrom" etched on one of its side faces. It may be fitted either way up and is Cargraph treated to assist bedding in. This treatment leaves it a dull grey and faintly red colour.

Where the need arises to fit new chromium rings to polished (part worn) bores, it will be necessary first to remove the glaze from the bores otherwise these rings would never bed down properly.

The procedure to be adopted in such cases is as follows:

(*a*) Mask off the bottom of the cylinders to prevent any abrasive matter reaching the crankshaft or crankcase.

(*b*) Make up a wooden dummy piston which will fit snugly into the bore. Wrap a piece of No. 1 or 1½ grade emery paper round the dummy.

(*c*) This dummy piston, with the emery round it should then be inserted into each cylinder in turn and moved up and down the bore for about 3 minutes (each cylinder) at the same time rotating it first one way and then the other until the entire cylinder wall is covered with criss-crossed abrasions.

(*d*) Wash down the bores thoroughly and dry them out ensuring that no foreign matter finds its way into the crankcase.
A very useful glaze remover can be obtained from:

Hepworth and Grandage Ltd.,
St. John's Works,
Bradford 4,
England.

This tool gives very satisfactory results if operated by hand or at very low speeds, but it should not be used at any higher speed.

2. Second Compression Ring.

To provide more rapid running in and also to assist in oil control, a stepped periphery compression ring is fitted in the second groove from the top of both standard and oversize pistons. It is most important that this ring is correctly fitted with the step downwards, that is, with the widest face towards the top of the piston. This face is marked "TOP" to indicate that it should be fitted uppermost. Incorrect fitting will result in higher oil consumption.

3. Scraper Ring.

One slotted type scraper ring is fitted in the third groove.

Care is needed when fitting these rings as the scraping edges are easily broken.

4. Fitted Ring Gaps and Clearances.

The correct ring gaps are given in "GENERAL DATA". These figures are easily obtained in grade A, B, C, and D cylinder bores, but slightly larger gaps are sometimes obtained when checking piston rings in cylinder bores that can take grade E pistons. Fit the rings first to the cylinder bore and check the ring gap with a feeler gauge.

(*a*) With a feeler gauge check for correct vertical clearance of the rings in the groove, which should be 0·0015/0·0035 in. (0·04/0·19 mm.) for both compression and scraper rings. (See Fig. B.6.).

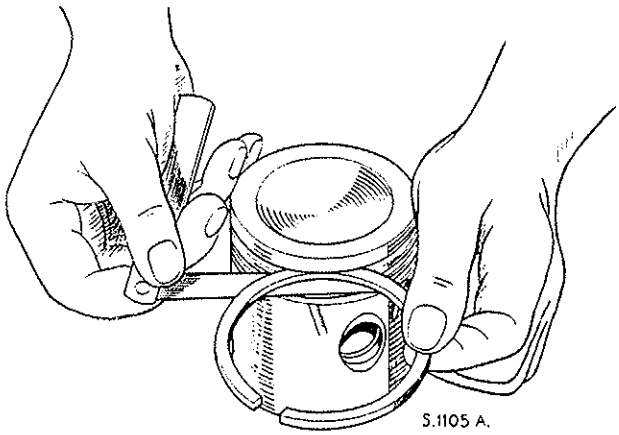


Fig. B.6. Checking piston ring side clearance

(*b*) Fit the rings to the pistons in such a way that the ring gaps are equally spaced out round the piston and not in line with one another, ensuring that the rings which are checked with No. 1 cylinder are fitted to No. 1 piston and so on.

GUDGEON PINS AND SMALL END BUSHES

1. The fit of the gudgeon pin in the piston bosses and small end bush is critical.

2. The original piston gudgeon pin and small end bush may be used again, only if the gudgeon pin is without shake both in the piston bosses and in the small end bush.

3. The gudgeon pin retaining circlips should be renewed.

4. The correct assembly of the piston on the connecting rod is shown in Fig. B.7.

5. When assembling gudgeon pins to pistons and connecting rods, the piston should first be warmed, preferably in oil, the piston bosses lined up with the small end bushes in the connecting rod, and the gudgeon pin inserted. It should be possible for the connecting rod to fall by its own weight when the piston and connecting rod assembly is held horizontal.

6. Gudgeon pins are classified into three grades, the dimensions of which are given under "GENERAL DATA". 0·003 in. (0·076 mm.) oversize gudgeon pins are available for service use.

7. Honing is recommended for finishing a new little end bush to size, or for enlarging this bush and the piston bosses to take 0·003 in. (0·076 mm.) oversize gudgeon pins. The Delapena precision honing machine is recommended for this operation.

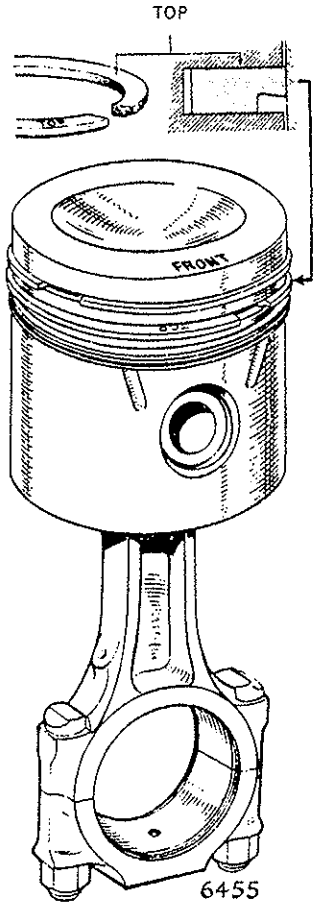


Fig. B.7. Piston correctly assembled to connecting rod

CONNECTING ROD ALIGNMENT

After fitting and honing, or reaming a new connecting rod little end bush to size, the connecting rod alignment should be checked using Churchill Tools 335, 336 and R.G. 336–5.

Connecting rod alignment should also be checked when the rubbing marks on the front and rear faces of the piston are not even around the piston skirt.

Connecting rods can be straightened in a large bench vice using special vice jaws.

To Refit.

1. When the rods are fitted, the oil squirt holes, drilled through the small projections immediately above the big ends, must face towards the right-hand (thrust) side of the cylinder walls, with the engine viewed from the rear.

2. Ensure that the pistons and connecting rods are correctly assembled, then insert the connecting rods and pistons into the cylinder bores from above in the opposite manner to that detailed for removal.

3. A piston ring compressor, Churchill Tool 38/U3, should be used to help the insertion of the piston into the cylinder and to prevent ring breakage.

The scraping edges of the slotted oil control rings are easily broken if an improvised ring compressor is used.

4. Tighten the cap nuts to a torque wrench reading of 24 lb. ft. (3·3 kg. m.).

Note: The original self-locking nuts must not be used again if they can be screwed on with finger pressure only.

These nuts are $\frac{11}{32}$ in. × 24 T.P.I. UNF. Care is needed to ensure that $\frac{3}{8}$ in. × 24 T.P.I. UNF nuts, used on other Rootes engines, are not fitted when replacement nuts are required. As the larger $\frac{3}{8}$ in. nuts have the same number of threads per inch they can easily be screwed on to the $\frac{11}{32}$ in. × 24 T.P.I. big end bolt thread and will strip the threads when tightened to about 12 lb. ft. (1·5 kg. m.) torque.

CRANKSHAFT

Main Bearings – To Remove and Refit.

1. The main bearing shells are white metal lined and are interchangeable.

Main bearing shells are available in standard size and undersizes as detailed in "GENERAL DATA".

If required, the main bearing shells can be removed for inspection, or renewed, provided that the crankshaft main bearing journals are not worn or scored, without removing the crankshaft from the engine.

2. Drain the engine oil.

3. Remove the sump and oil pump.

4. Remove the timing cover.

5. Remove the timing chain tensioner and its support pin, the support pin being screwed into the front main bearing cap.

6. Slacken all the main bearing fixing bolts by one or two turns.

7. Starting at one end of the crankshaft, remove the main bearing cap together with bearing and the corresponding top half bearing by pushing it around the crankshaft journal with a piece of thin metal from the opposite side to its locating lip.

Replace the main bearing cap and bearing to support the crankshaft before proceeding to remove the next main bearing cap.

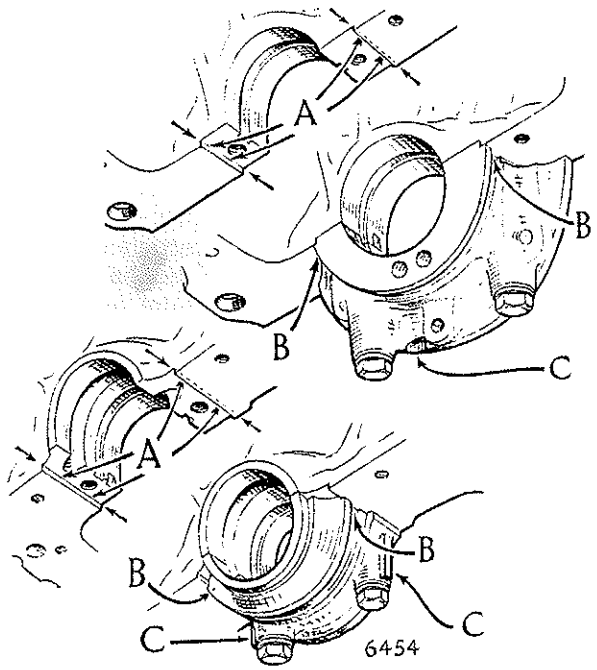


Fig. B.8. Places at which to use jointing compound on main bearing caps

8. Top half bearings are replaced in a reverse manner to that described for removal, noting the following points:

(*a*) Ensure that the locating lips engage correctly in their respective recesses.

(*b*) Bearings are stamped according to their sizes and on renewal the same size must be fitted except when an undersize crankshaft is fitted. In such cases the correct undersize bearings must also be fitted.

(*c*) When replacing bearing caps particular attention should be given to the cleanliness of the mating faces and the oil return thrower recess in the rear main bearing housing.

(*d*) Before replacing the front and rear main bearings a very small quantity of Wellseal (or other non-setting jointing compound) should be painted on to the sides of the cylinder block recess into which the bearing caps locate. See Fig. B.8.

(*e*) Ensure that the front main bearing cap is pulled up against the timing case before fully tightening the front main bearing cap bolts.

9. As each bearing is tightened up the crankshaft should be turned to ensure that it is free. The main bearing bolts should be tightened to a torque wrench reading of 55 lb. ft. (7·6 kg. m.).

Crankshaft End Float.

1. Crankshaft end float is taken by two semi-circular steel washers having white metal thrust faces. These faces are easily recognised by the two vertical oil grooves cut across the white metal. The washers are fitted with their white metal thrust faces towards the crankshaft thrust faces and may be removed by pushing them around the crankshaft centre journal after taking off the centre main bearing caps.

2. The crankshaft end float can be checked by using feeler gauges. The correct end float should be 0·002/0·008 in. (0·051/0·20 mm.). 0·005 in. (0·127 mm.) oversize thrust washers are available for use with crankshafts which have had the thrust faces reground at each end of the centre main bearing journal.

To Remove

1. Remove the engine from the chassis as detailed in this section.

2. Remove the cylinder head, the push rods and the tappets.

3. Remove the timing wheels and the timing chain.

4. Remove the engine front plate and the sump.

5. Remove the connecting rods and the pistons.

6. Remove the clutch and fly-wheel.

7. Unscrew the cap bolts and remove the bearing cap bolts and caps. Identify each shell bearing half with its correct bearing cap.

8. Lift out the crankshaft.

Inspection and Overhaul.

1. Check the main journals and the crankpin journals for wear, scores and ovality. Factory re-ground units are available in undersizes of 0·020 in. (0·508 mm.) and 0·040 in. (1·016 mm.).

Corresponding oversizes in main and big end bearings are also obtainable.

2. Check that the oilways in the crankshaft are clear.

3. Inspect the threads of the main bearing cap bolts for damage or stretching and renew as necessary.

To Refit.

1. Place the crankshaft in position ensuring that the top halves of the main bearing and thrust washers (centre) are correctly fitted into the crankcase.

Thrust is taken by two half washers fitted to the side faces of the centre main bearings in the cylinder block.

2. Fit the lower halves of the bearings together with the main bearing caps.

3. Refit the main bearing cap bolts ensuring that the machined front face of the front main bearing cap is in alignment with the machined front surface of the cylinder block.

Tighten the main bearing cap bolts to a torque wrench reading of 55 lb. ft. (7·6 kg. m.).

Note: When refitting the front and rear main bearing caps, the procedure detailed under **"Main Bearings – To Remove and Refit"** should be carried out.

4. Check the crankshaft end float as detailed in this section.

5. When the crankshaft is securely retained in position, fill the spaces indicated by the arrows "B" in Fig. B.8 with a quick setting compound and allow to dry. The use of this compound is to fill up possible oil leakage passages to the top ends of the cork strips used on both front and rear main bearing caps.

Remove any excess jointing material before re-fitting the sump.

6. Complete the operation by reversing the remaining removal procedure.

FLYWHEEL AND STARTER RING

To Remove.

1. Remove the gearbox and bell housing (see "GEARBOX").

2. Remove the clutch (see "CLUTCH AND PROPELLER SHAFT").

3. Remove the setbolts securing the fly-wheel in position.

4. It is advisable to screw a stud of suitable length into the top setbolt hole before levering off the flywheel to prevent possible damage to the starter ring should the flywheel fall accidentally.

5. Remove the flywheel from the crankshaft flange.

Inspection and Overhaul.

Flywheel.

Examine the clutch friction face of the flywheel. If this is scored, the face may be reground to restore the original smooth finish. When carrying out this operation, the whole of the flywheel face must be reground, and not only the friction area.

Starter Ring.

Inspect the starter ring teeth.

If these are damaged or worn excessively, the ring must be renewed as follows:

1. Using a suitable size drill, drill a hole through the starter ring between the bottom of two of the gear teeth, as deep as possible without entering the flywheel. Split the gear at this point with a sharp cold chisel and lift out the split gear off the flywheel, noting that the gear teeth chamfer sides come to the clutch side of the flywheel.

2. Ensure that the registering faces of the flywheel and the new starter ring gear are clean and free from burrs.

3. The new ring gear must be heated in an oven maintained at a temperature of 220°C. (428°F.) until it has attained this temperature. If the oven temperature exceeds this figure the gear will be softened and will wear rapidly.

The ring gear must not be heated by a naked flame.

4. Place the heated ring gear in position on the flywheel with the chamfered sides of the teeth toward the clutch side of the flywheel.

Ensure that the ring gear is bedding against the flywheel so that the ring gear is in its correct position as it cools down.

To Refit.

Reverse the removal procedure, noting the following:

1. It is important that the flywheel fits squarely on the crankshaft, should the dowel have come away with the flywheel when it was removed, tap it out of the flywheel and refit in the crankshaft.

2. Ensure that the surface of the crankshaft flange and the register in the flywheel are perfectly clean and free from burrs, otherwise the flywheel may not seat correctly on the crankshaft.

3. Tighten the setbolts to the correct torque and check for run-out at the outer edge of the flywheel clutch friction face. A total clock gauge reading of 0·003 in. (0·076 mm.) must not be exceeded.

PRIMARY SHAFT SPIGOT BEARING (in Crankshaft)

The primary shaft spigot bearing is of the self-lubricating bush type and is a push fit in the crankshaft and recess.

To Remove.

The bush is easily removed using an internal type extractor. An alternative method of removing an old bush is to fill it with grease, then insert a close fitting piece of steel bar. A hammer blow on the end of the bar will then cause the bush to come out.

To Refit.

The new bush should be pressed into position until flush with the rear face of the crankshaft flange.

ENGINE REMOVAL

1. Drain the engine oil and the cooling system.

2. Disconnect the battery terminals.

3. Remove the radiator (see "COOLING SYSTEM").

4. Disconnect the heater pipes (if fitted).

5. The forward end of the accelerator cable will have been disconnected for radiator removal. Release the cable at the carburettor throttle lever and also disconnect the choke control wire at the carburettor and at the seat panel. Withdraw both cables to ensure no damage is caused during engine removal.

6. Disconnect the fuel pipe at the inlet side of the fuel lift pump.

7. Disconnect the electrical leads at the following points:

(*a*) Alternator and starter motor.
(*b*) Oil pressure switch terminal or oil gauge pipe (when fitted).
(*c*) Water temperature element terminal (when fitted).
(*d*) Ignition coil and distributor.

8. Inspect the engine to ensure that all electrical leads feeding accessories have been removed.

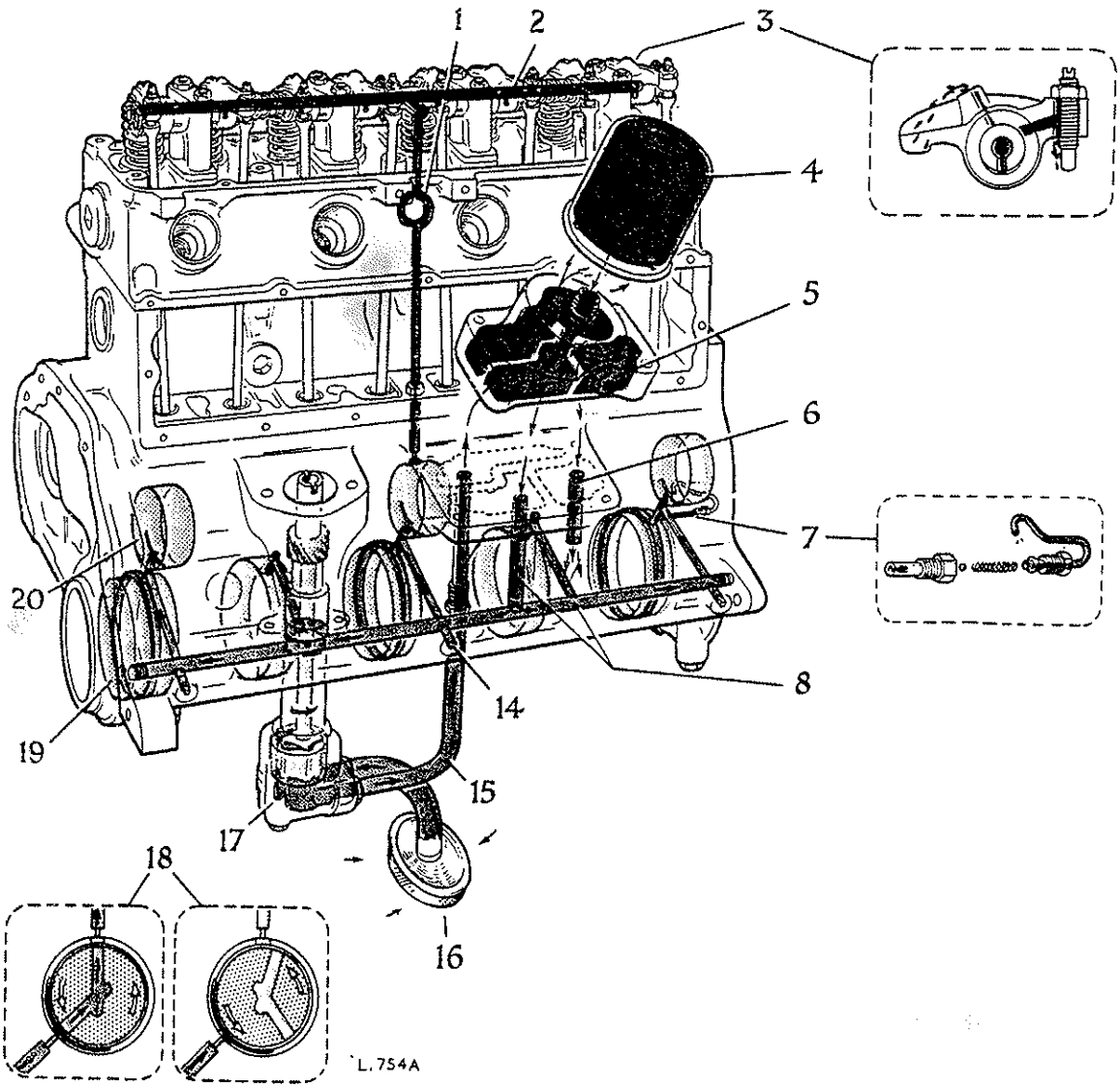
9. Remove the air cleaner and the elbow connection to the carburettor.

10. Unscrew the two stud nuts and remove the spring and plain washers at the exhaust pipe connection to the exhaust manifold.

11. Support the engine weight at the rear engine lifting hook and remove the gearbox (see "GEARBOX" section).

12. Remove the two stud nuts and spring washers on each end of the front engine mountings. Note the earth lead secured to the left-hand engine mounting.

13. Attach a further lifting sling to the front engine lifting hook and lift the engine sufficiently to clear the front engine mounting studs. Draw the engine as far forward as possible before lifting clear of the engine compartment. Turn the engine to enable withdrawal through the door aperture opposite the driving side.



1 FEED TO ROCKER SHAFT
2 ROCKER SHAFT OILWAY
3 VALVE ROCKER OIL DISTRIBUTION
4 FULL FLOW OIL FILTER
5 PRESSURE RELIEF VALVE
6 RELIEF VALVE DISCHARGE
7 OIL FEED TO TIMING CHAIN
8 OIL GALLERY FEED FROM FILTER
14 OIL PRESSURE SWITCH CONNECTION
15 OIL FEED – PUMP TO FILTER
16 SUMP FILTER
17 OIL PUMP
18 DRILLINGS IN JOURNALS REGULATING OIL FEED TO ROCKERS
19 MAIN BEARINGS
20 CAMSHAFT BEARINGS

Fig. B.9. The lubricating system.

LUBRICATING SYSTEM

DESCRIPTION

The lubricating system is shown in red in Fig. B.9.

Lubrication of all working parts of the engine is effected by the forced feed system, pressure being generated by a submerged oil pump, mounted in the right-hand side of the crankcase, and driven, in tandem with the distributor, through skew gears from the camshaft.

Oil is drawn through the submerged gauze filter and rises through the intake tube and oil pump to an internal delivery pipe, whence it is fed to the full flow filter before passing to the main oil gallery, situated along the right-hand side of the crankcase.

From there the oil is distributed into the oilways drilled in the main bearing support webs of the cylinder block, whence the oil is carried to all main and camshaft bearings. Drilled passages in the crankshaft allow oil to flow from the main bearings to the crankpins, where it lubricates the connecting rod big end bearings.

Oil squirt holes drilled through the big end bearings and connecting rod webs project oil on to the cylinder walls at each revolution of the crankshaft, thus ensuring adequate lubrication of the bores.

The timing gears and chain are lubricated by a jet of oil from a small hole drilled in the side wall of a small diameter pipe which is supplied with oil from the front main bearing oil feed. The oil pipe end passes through a hole in the cylinder block, and oil supplied in excess of the chain's requirements is returned direct to the sump.

The reason for this design is that the diameter of the oil pipe is thus larger than would be possible if it were designed to supply just sufficient oil for the chain's requirements. The advantage of this larger pipe is that blockage is less likely to occur should the oil become contaminated.

The feed end of the timing chain oil feed pipe is connected to a special union, screwed into the drilling (7) shown in Fig. B.9. In the union there is a small spring-loaded non-return ball valve which prevents oil draining from the gallery when the engine is stopped. This ensures a very rapid build up of oil pressure directly the engine starts, and oil flows past the non-return valve as the strength of its return spring is such that it allows the ball valve to lift off its seating whenever the engine is running.

The tappets are lubricated by oil draining back from the valve-operating mechanism.

A pressure relief valve is situated in the forward end of the oil filter body casting. This valve allows a proportion of the circulated oil to return direct to the sump when the pump pressure exceeds the normal pressure given in the "GENERAL DATA" section. Fitted into the upper end of the oil filter is a by-pass valve, which opens in the event of the oil filter element becoming choked, thus ensuring a supply of oil to the bearings and other vital parts in such circumstances.

The oil feed to the valve rocker gear is taken from the centre camshaft bearing through a drilling in the centre camshaft journal which acts as a rotary metering device. Oil flow occurs once every camshaft revolution when the drilling connects the centre camshaft bearing oil feed hole, the oil feed hole, and the oil hole feeding to the valve rocker oil feed pipe. See Fig. B.9 and its insert (18). By this means a controlled quantity of oil is fed at a much reduced pressure through an internal pipe to the valve rocker shaft.

Holes in the underside of the rocker shafts feed to each rocker bearing. Grooves in the rocker bearing surface pass oil to drillings in the rockers which feed oil to the push rod cup ends and valve rocker ends that contact the valve stems. Oil from the push rod cup ends overflows and runs down the push rods to lubricate the bottom ends of the push rods in the tappets. Drain holes in each tappet are provided to prevent the tappets from filling with oil.

The throw away type full flow filter (see Fig. B.9) is screwed to an adaptor casing (1) bolted on the right-hand side of the engine cylinder block.

Oil from the engine oil pump enters compartment "B" in the filter adaptor casting (1) and passes through eight port holes into the filter body. All oil entering the filter passes through the filter cartridge from the outside to the centre as shown in Fig. B.10 and then through the screwed spigot to compartment "A" in the adaptor casting. From there it enters the engine main oil gallery.

The entry ports on the underside of the filter are shrouded by a flexible anti-drain valve (3) and (4) which prevents the filter from draining during stand-still periods.

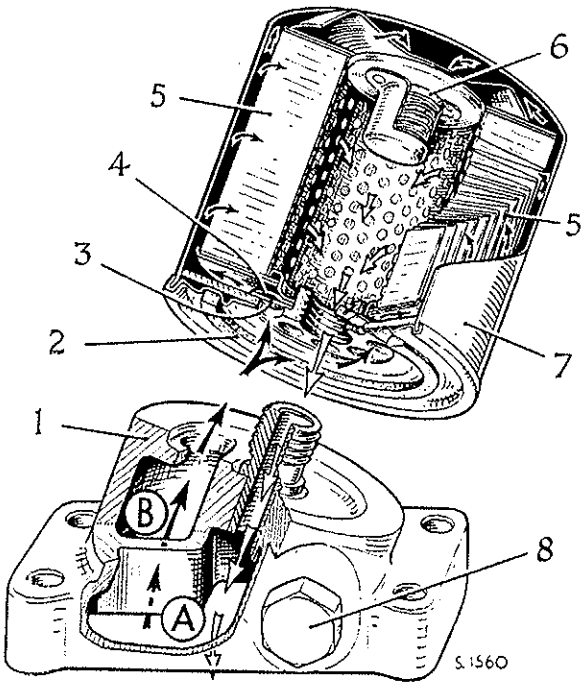
The throwaway filter unit must be renewed at every engine oil change.

A piston type relief valve, situated in compartment "C" in the filter adaptor casting, opens to return all excess oil delivered by the oil pump to compartment "B" when the oil pressure exceeds approximately 60 lb.sq.in. (4 kg.sq.cm.). The excess oil discharges into compartment "C" (see Fig. B.11) from where it drains into the engine sump.

The oil pressure relief valve can be removed as a complete unit with a $\frac{3}{16}$ A.F. ring spanner.

By-Pass Valve.

A by-pass valve (6) is fitted inside the throw away filter unit and forms part of this assembly as shown in Fig. B.10.



1 ADAPTOR CASTING
2 RUBBER GASKET
3, 4 ANTI-DRAIN VALVE
5 FILTER ELEMENT
6 BY-PASS VALVE
7 FILTER ASSEMBLY
8 RELIEF VALVE

Fig. B.10. Full flow oil filter

If the filter element (5) becomes choked, through neglect to change the filter assembly at the servicing

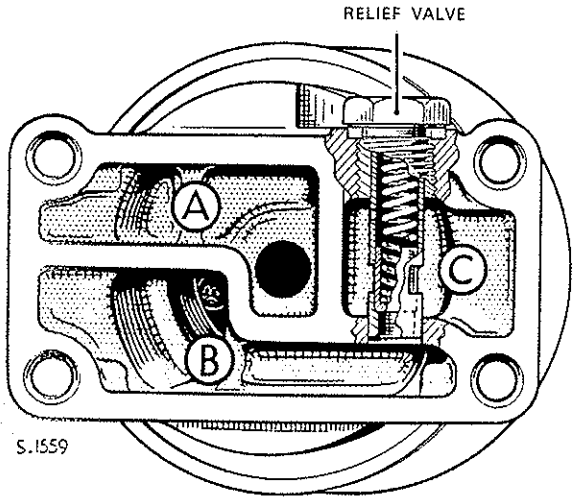


Fig. B.11. Throw away type full flow filter-oil pressure relief valve

periods, the by-pass valve (6) opens and allows oil to pass directly to the engine bearings without being restricted by the blocked element.

Opening of the by-pass valve can only occur when there is a pressure difference of over 7 lb.sq.in. (0·5 kg.sq.cm.), above and below the by-pass valve.

OIL PRESSURE

Oil pressure may vary considerably according to engine temperature, grade of lubricant, and condition of engine and oil pump. Normally, the pressure should be between 30 and 50 lb. sq. in. (2·1 and 3·5 kg. sq. cm.).

Tick-over pressure is not critical and the condition of the engine should be judged by its normal running pressure.

REASONS FOR LOW OIL PRESSURE

If abnormally low oil pressure is experienced, it may be due to one of the following reasons:

(*a*) Low oil level in sump.
(*b*) Pressure relief valve not working properly.
(*c*) Choked oil pump filter.
(*d*) Oil leaks caused by faulty unions and joints, or by cracked or broken pipes.
(*e*) Joint between the filter base and cylinder block face leaking between pressure compartment and discharge compartment. This sometimes causes a lower oil pressure when the engine is cold.
(*f*) Timing chain oil feed pipe loose or damaged.
(*g*) Dilution of oil in sump.
(*h*) Worn main and big end bearings.
(*i*) Worn oil pump components.

CRANKCASE DILUTION

Dilution of the lubricating oil may be brought about by the addition of poor quality oil, or by fuel leaking past pistons and rings. The latter condition may be due to worn bores, pistons and rings, and is most likely to occur in cold weather.

Symptoms of crankcase dilution are low oil pressure, rapid wear, overheating, loss of power and emulsification of oil. Emulsification of oil can also be caused by the presence of water due to condensation.

If inspection confirms that dilution has taken place, ascertain and correct the cause of it and drain the sump. Draining should be done immediately after a run, while the oil is hot, as it will then flow more easily. Refill with new oil of correct grade. Oil changes should then be attended to regularly and the correct grade of oil always used.

OIL SUMP

To Remove.

1. Drain the engine oil.

2. Remove the split pins and slotted nuts from the inner ends of the two track rods and release both ball joints using Churchill Extractor R.G.109C. Swing the track rod ends clear of the sump.

3. Remove the bell housing bottom front cover plate. It will be necessary to release the clutch slave cylinder to enable the cover to be removed.

4. Remove the setscrews securing the sump to the bottom face of the cylinder block. It is advisable to leave one setscrew in the centre position on each side of the sump until the weight of the sump can be taken by hand, to avoid distortion of the joint faces.

5. The sump can then be removed using the recess in the now exposed flywheel front face to gain additional clearance for the sump to be tilted and withdrawn clear of the main relay lever.

Inspection and Overhaul.

1. Thoroughly clean the sump by washing in paraffin.

2. Examine the sump for damage or splitting particularly along the joint faces with the cylinder block.

3. When the sump is removed, the opportunity should be taken to remove and clean the oil pump intake filter.

To Refit.

The front and rear main bearing caps must form oil tight joints with their respective locations at the sump ends in addition to the normal face joints along each side.

To accomplish this, a curved cork strip is fitted between the front and rear main bearing caps and their sump locations, whilst normal composition face joints are fitted to each side.

The sealing of each of these joints is most critical especially where the main bearing caps join the side faces of the sump location and great care must be taken in the assembly of the sump to the engine.

1. Fit new side face joints if the original joints are not considered serviceable using grease to retain them in position.

2. The cork strips should be fitted dry except at the ends of each corkstrip where a small quantity of quick setting jointing compound should be placed in the recesses into which the ends of the cork strips locate. Fit the cork strips into position after the side face joints have been fitted.

3. Offer up the sump and refit a setscrew in the centre position on each side of the sump.

4. Refit the remaining setscrews and tighten all setscrews progressively.

5. Refit the bell housing bottom front cover plate together with the clutch slave cylinder.

Note: If the hydraulic pipe leading to the slave cylinder has been disconnected, it is essential that the clutch hydraulic system is bled as detailed in "CLUTCH AND PROPELLER SHAFT".

6. Refit the inner ends of the track rods to the main relay lever using new split pins to secure the slotted nuts.

7. Refit the sump drain plug and fill the system with clean lubricating oil of the correct grade, checking the sump level by means of the dipstick.

OIL PUMP INTAKE FILTER

To Remove.

1. Drain the engine oil and remove the sump.

2. Slacken the intake pipe locknut and remove the filter.

Inspection and Overhaul.

1. Wash the filter gauze in petrol or paraffin and blow dry with clean compressed air.

2. If the filter gauze shows any signs of breaking up, it must be renewed.

To Refit.

1. Reverse the removal procedure ensuring that, when the locknut is tightened, the filter gauze body is parallel to the cylinder block sump face.

2. Fill the sump with the correct grade of oil.

OIL PUMP

A four lobe rotor mounted on the pump spindle drives a ring into which are machined five internal lobes. The outer diameter of the ring rotates in the circular bore of the oil pump body, which is offset from the pump spindle.

The action of the inner rotor on the outer rotor creates a strong pumping force by progressively increasing and reducing the clearance between each set of rotor lobes. The pump drive is taken from a skew gear on the camshaft.

To Remove.

1. Remove the distributor cap and turn the crankshaft until the distributor is pointing to the No. 1 firing

position and the crankshaft pulley timing mark lines up with the timing cover pointer at T.D.C.

2. Remove the distributor (see "ELECTRICAL EQUIPMENT" section).

3. Drain the engine oil and remove the sump.

4. Disconnect the oil delivery pipe at the pump and the internal crankcase connection.

5. Unscrew the two setscrews in the pump locating flange and withdraw the pump.

To Dismantle.

1. Remove the pump intake gauze filter.

2. Invert the pump and remove the setscrews securing the base plate to the pump body.

3. Lift out the outer rotor ring taking great care that this ring is not allowed to drop.

If the outer rotor ring is dropped it can easily crack.

Inspection and Overhaul.

1. Remove all traces of oil from the inside of the pump body and both rotors and check the following clearances:

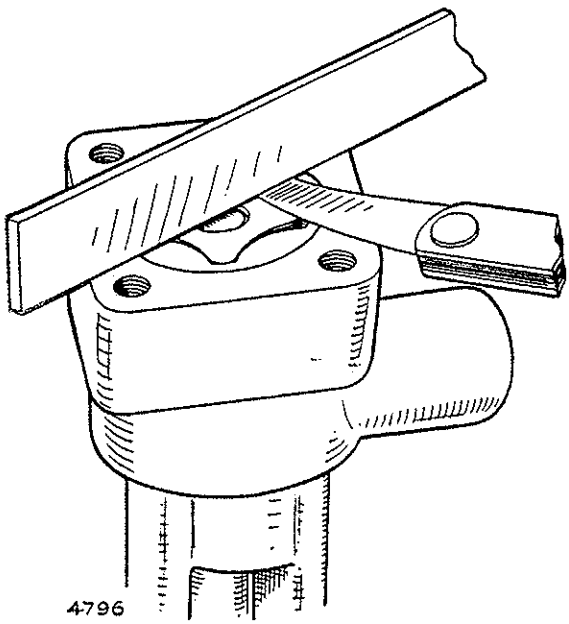
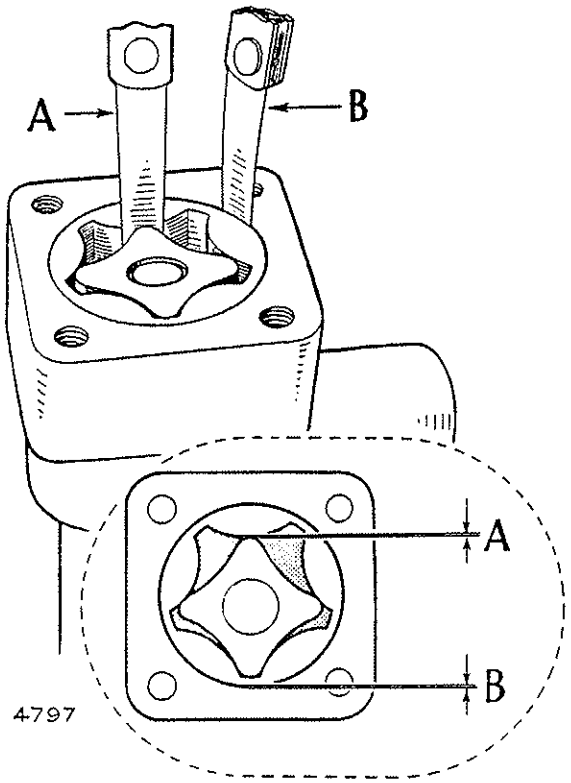


Fig. B.12. Checking the end float between the rotors and the pump body

(*a*) The end clearance between the inner and the outer ring and the pump body. The maximum and minimum are 0·003 in. (0·076 mm.) and 0·001 in. (0.025 mm.) when measured with a feeler and straight edge as shown in Fig. B.12.

(*b*) The side clearances "A" between the top of the lobes on the inner and outer rotor as shown in Fig. B.13.

The maximum and minimum clearances "A" are 0·006 in. (0.152 mm.) and 0·001 in. (0.025 mm.). New parts should be fitted if the maximum clearance is exceeded.



A = 0·006 in. (0·152 mm.) MAXIMUM
B = 0·008 in. (0·203 mm.) MAXIMUM

Fig. B.13. Checking the rotor lobe and driven ring clearance dimensions

(*c*) Clearance "B" (Fig. B.13.) between the outside of the outer rotor and pump body must not be greater than 0.008 in. (0.20 mm.) and not less than 0·005 in. (1·27 mm.). Should the clearance found be above the maximum figure a replacement pump should be fitted.

If wear necessitates the renewal of parts, the spindle c/w inner rotor and the outer driven ring must be renewed as a complete set.

Factory reconditioned oil pumps are also available in part exchange for the original.

3. Thoroughly clean out the oil delivery pipe before refitting. Also ensure that the pump intake filter is cleaned before refitting.

To Re-assemble.

Re-assembly is a reversal of the dismantling procedure using new pins to secure the pump driving gear to the spindle.

To Refit.

The distributor takes its drive from the helical gear on the oil pump spindle axially, through an offset tongue and slot type coupling which can only be coupled one way. It is essential, therefore, that the oil pump driving gear is meshed to the corresponding gear on the camshaft so that the driving slot in the end of the gear is timed in the correct relation to the camshaft.

In view of this, the oil pump must be refitted as follows:

1. Ensure that the engine is at T.D.C. with the piston of No. 1 cylinder in the firing position.

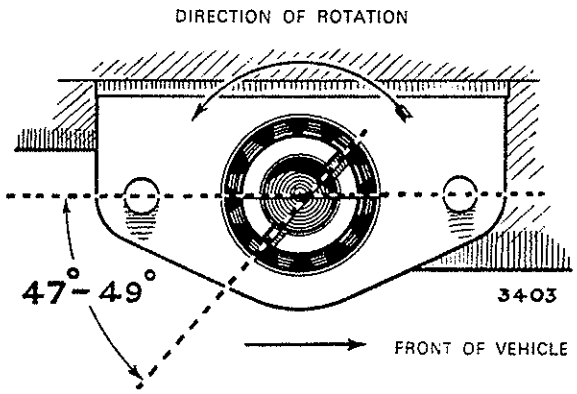


Fig. B.14. Showing the correct assembly of the oil pump with No. 1 cylinder at T.D.C. firing position

2. Refit the oil pump to the cylinder block with the distributor driving slot positioned as shown in Fig. B.14. No jointing is required between the pump face and the cylinder block face. Secure the pump with the two setscrews and spring washers.

3. Refit the sump as previously detailed taking care to fit the joints correctly.

4. Refit the distributor and check ignition timing (see "ELECTRICAL EQUIPMENT" section).

5. Refill the sump to the correct level with the recommended grade of lubricant.

THROW AWAY FILTER UNIT

To Remove.

Unscrew the filter element assembly from the filter base. A hexagon on the top of the element case facilitates this operation.

To Refit.

Clean the joint face on the adaptor casting and smear the joint ring on the bottom of the filter with clean engine oil.

Screw the filter into position until it just touches the joint face on the adaptor casting. **Then screw the filter a further half of a turn by hand only.** Run the engine and check for oil leaks.

If the filter unit is tightened beyond the recommended amount it will become very difficult to remove.

Top up the sump oil level to replace the oil used to fill the filter casing, and fill the sump to the correct oil level.

Note: If, in the course of service, it becomes necessary to renew the gasket between the adaptor casting and the engine block, it should be ensured that the correct gasket for the throw away filter is used.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

FUEL SYSTEM

SECTION C

INDEX

FUEL SYSTEM

DESCRIPTION

The fuel system consists of a fuel tank, a diaphragm type lift pump, a downdraught carburettor, an air cleaner and an intake manifold.

Fuel Tank.

The fuel tank is secured to the underframe at the rear of the rear axle casing and has a filler extension to the exterior of the right-hand rear quarter panel of the body where the captive type filler cap is located. The fuel tank gauge unit is connected to a gauge, calibrated in gallons, which is mounted in the speedometer head. The fuel tank also incorporates a breather pipe which follows the contour of the filler pipe and is clipped at both the tank and the upper filler pipe ends.

Fuel Lift Pump.

Fuel is drawn from the fuel tank and pumped to the carburettor by the A.C. fuel lift pump which is secured to the rear right-hand side of the cylinder block.

The lift pump consists of two main assemblies i.e., a body and a cover which clamp a diaphragm between their outer flanges.

The body assembly includes a rocker arm and a link, both of which pivot on a pin located in the body. Attached to the link is the lower end of a pull rod incorporated in the diaphragm assembly and seated in a bore in the centre of the body is an oil seal secured in position by a metal retainer staked to the pull rod bore. This oil seal is fitted to protect the diaphragm from the oil splash of the crankcase and seals the pull rod bore in the body. Two return springs are fitted in the body, one is fitted between the diaphragm and the pull rod bore and the other between the rocker arm and a protrusion formed integral with the body. The purpose of the rocker return spring is to maintain the rocker arm in constant contact with the eccentric on the camshaft.

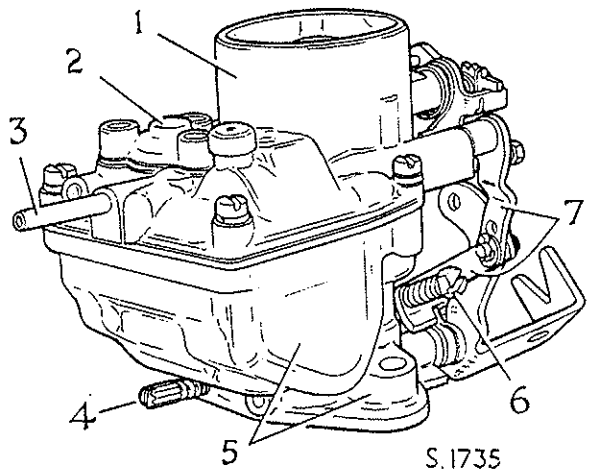
Two valves are assembled in the cover, one is operated by suction and the other operates by pressure; these valves connect with the pump inlet and outlet passages respectively and are held in position by a retainer screwed into the cover. The valves and seats form an assembly and are renewable and interchangeable as such. The inlet passage to the cover is filtered by a gauze screen and an inverted glass dome retained in position by a stirrup type retainer enables visual inspection of the fuel.

Carburettor.

The three main parts of the Zenith downdraught carburettor are:

(*a*) A float chamber, main body, and choke tube (venturi) made as a die casting (5). There is no separate choke tube.

(*b*) A top cover body held by four cheese head screws to the main body (1).



1 CARBURETTOR TOP BODY
2 ECONOMY VALVE COVER
3 FUEL INLET CONNECTION PIPE
4 SLOW RUNNING MIXTURE VOLUME CONTROL SCREW
5 CARBURETTOR MAIN BODY AND FLOAT CHAMBER
6 SLOW RUNNING SPEED ADJUSTMENT SCREW
7 ACCELERATOR PUMP OPERATING LEVER AND LINK (IN SHORT STROKE POSITION)

Fig. C.1. Zenith 34 IV carburettor

(*c*) An emulsion block having an extension that forms an inner venturi discharge within the large venturi (choke tube). All fuel jets and the accelerator pump are in the emulsion block, which can be removed from the top cover, with a screwdriver and a $\frac{7}{16}$ in. A.F. spanner.

Twin floats are used in the large float chamber set close to the throttle bore to give a high flooding angle. This controls the fuel level so that performance is not affected by steep inclines, fast acceleration, hard braking or surging on bends.

The fuel inlet (3) on the top body above the float chamber is a parallel tube, to allow the direct connection of a plastic fuel pipe.

An economy device (2), mounted on the top body operates by inlet manifold vacuum and weakens the mixture under part throttle conditions to give maximum fuel economy.

The accelerator pump lever (7) can be adjusted to have either a long or short stroke, to meet varying climatic conditions.

Air Cleaner.

Air drawn into the carburettor is filtered by the air cleaner mounted on the left hand side of the engine compartment. All models are fitted with a paper element type of air cleaner.

The air cleaner consists of a top cover and inlet tube, a pleated paper filter element with two sealing rings and lastly a bottom plate, secured together with a suitable fixing screw and flat washer.

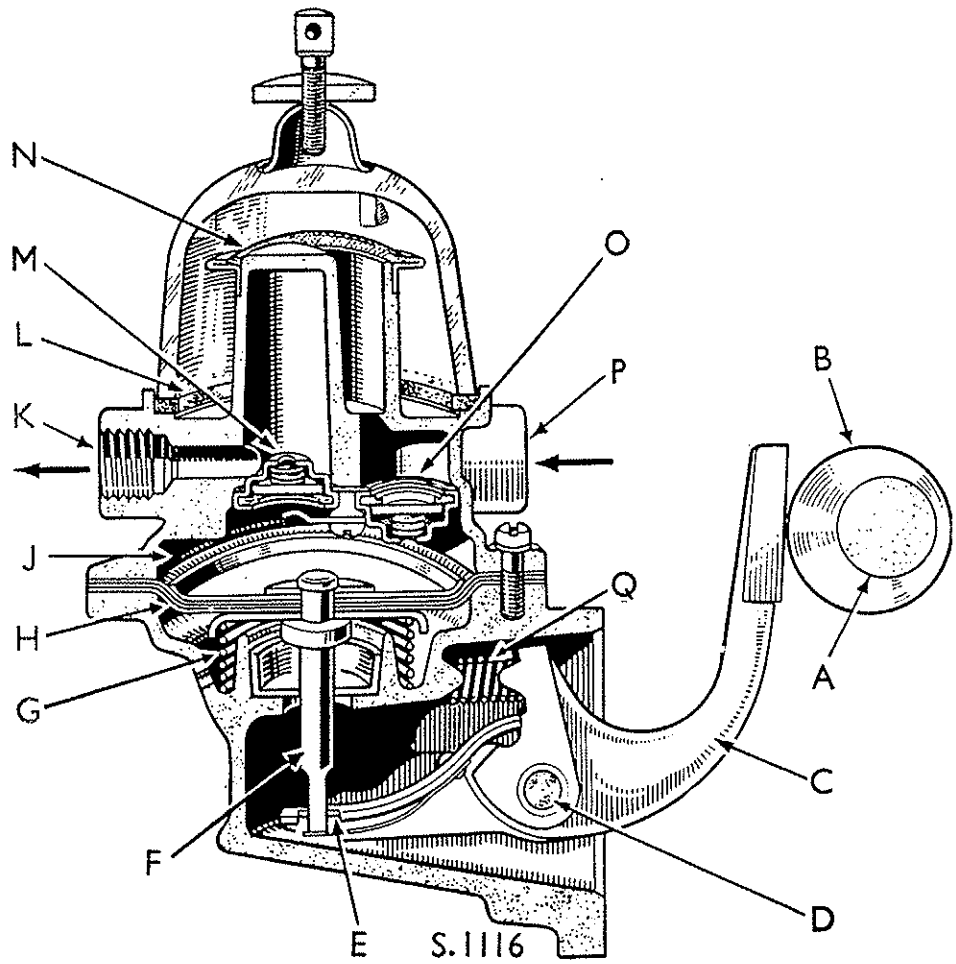
The positional relationship between the top cover and bottom plate is ensured by the use of a peg fitted to the bottom plate engaging with a matching slot in the top cover.

Manifolds.

One piece induction and exhaust manifolds are fitted to the left-hand side of the cylinder head and both manifolds are secured at the centre by studs and nuts. Collars are fitted to the two inner inlet ports in the cylinder head to locate the induction manifold and a drain pipe is attached to the base of the induction manifold by means of a loose olive and a nut. Gaskets are located between the two mating faces of the manifolds and also between the machined faces of the manifold branch ends and the cylinder head.

Exhaust System.

The exhaust pipe is secured to the exhaust manifold by means of a loose flange and two studs and nuts. A ring type gasket is interposed between a collar integral with the exhaust pipe and the outlet bore of the manifold. The opposite end of the exhaust pipe, is clamped to an extension tube of the silencer and on early models the clamp is in turn secured to a rubber mounted hanger bracket bolted to the underframe. A tail pipe, also supported by a hanger bracket, is clamped to the outlet end of the silencer to exhaust the gases away from the vehicle.



A. CAMSHAFT
B. ECCENTRIC
C. ROCKER ARM
D. ROCKER PIN
E. CONNECTING LINK
F. DIAPHRAGM PULL ROD
G. DIAPHRAGM RETURN SPRING
H. DIAPHRAGM
J. PUMP CHAMBER
K. OUTLET PASSAGE
L. BOWL GASKET
M. DELIVERY VALVE
N. FILTER GAUZE
O. SUCTION VALVE
P. INLET PASSAGE
Q. ROCKER ARM SPRING

Fig. C.2. Sectional view of the fuel lift pump

OPERATION

Fuel Lift Pump (see Fig. C.2).

As the engine camshaft (A) revolves, the eccentric (B) actuates the rocker arm (C) pivoted at the pin (D), to move the pull rod (F) together with the diaphragm (H) downwards against the pressure of the return spring (G) thus creating a depression in the pump chamber (J).

Fuel is drawn from the fuel tank and enters the pump at the inlet passage (P) passing through the filter gauze (N) and the suction valve (O) into the pump chamber (J).

On the return stroke, pressure of the spring (G) causes the diaphragm (H) to be pushed upwards, forcing the fuel from the chamber (J) through the delivery valve (M) to the outlet passage (K) and up to the carburettor float chamber via the fuel pipe. When the float chamber is full, the carburettor float will close the needle valve thus preventing a further flow of fuel from the lift pump chamber (J). This will force the diaphragm (H) downwards against the spring (G) and the diaphragm will remain in this position until the carburettor needle valve opens.

As the rocker arm (C) and the arm link (E) are separate parts, they break when fuel is not required thus absorbing the continued movement of the eccentric (B), but due to the pressure of the rocker arm spring (Q), the rocker arm is kept in constant contact with the eccentric (B) to eliminate noise. A spring steel blade is riveted to the underside of the arm link (E) to prevent the pull rod (F) from rattling in its socket.

Carburettor.

1. *Float Chamber.*

Fuel enters the float chamber through the connection (40) and the needle valve seating (39). The fuel flow is controlled by the needle (38) and twin floats (37). As the fuel level rises the floats lift, and their connecting arm lifts the needle (38) on to its seat (39) when the correct level is reached. Whilst the engine is running, fuel is used, and the floats lower to admit fuel through the needle valve.

Fuel in the float chamber surrounds the emulsion block, and passes through all submerged jets and channels to rise to the same level as that existing in the float chamber.

2. *Starting from Cold.*

When the choke control is pulled fully out into the cold starting position, the lever (7) allows a light spring (1) to **automatically** rotate the choke valve spindle and close the choke valve (10). Movement of the lever (7) also lifts the connecting rod (2) which opens the throttle to the correct fast idling position for cold starting.

After switching on the ignition and operating the starter, the engine should start and continue to run, because the choke valve opens a small amount **automatically** to allow the entry of enough air to prevent over-richening after the engine starts.

Whilst the engine is turning, before its start, the high depression on the jets, caused by the closed choke valve (10), increases their fuel discharge rates and provides the amount of fuel needed for cold starting.

The slight **automatic** opening of the choke valve, directly the engine starts, is caused by atmospheric pressure acting on the larger area of the upper side of the offset pivoted choke valve. This is possible because the pressure below the choke valve, when closed, is reduced below atmospheric directly the engine starts.

When the choke control is returned to its normal position, the lever (7) overrides any automatic movement of the choke valve spindle, and also reduces the fast idle speed to the normal idling speed.

3. *Slow Running.*

Under slow running conditions the throttle slow running speed adjustment screw is against its stop and the throttle almost fully closed. In this position the throttle allows enough air to pass to mix with the fuel metered by the slow running jet (24), and provide a suitable slow running mixture.

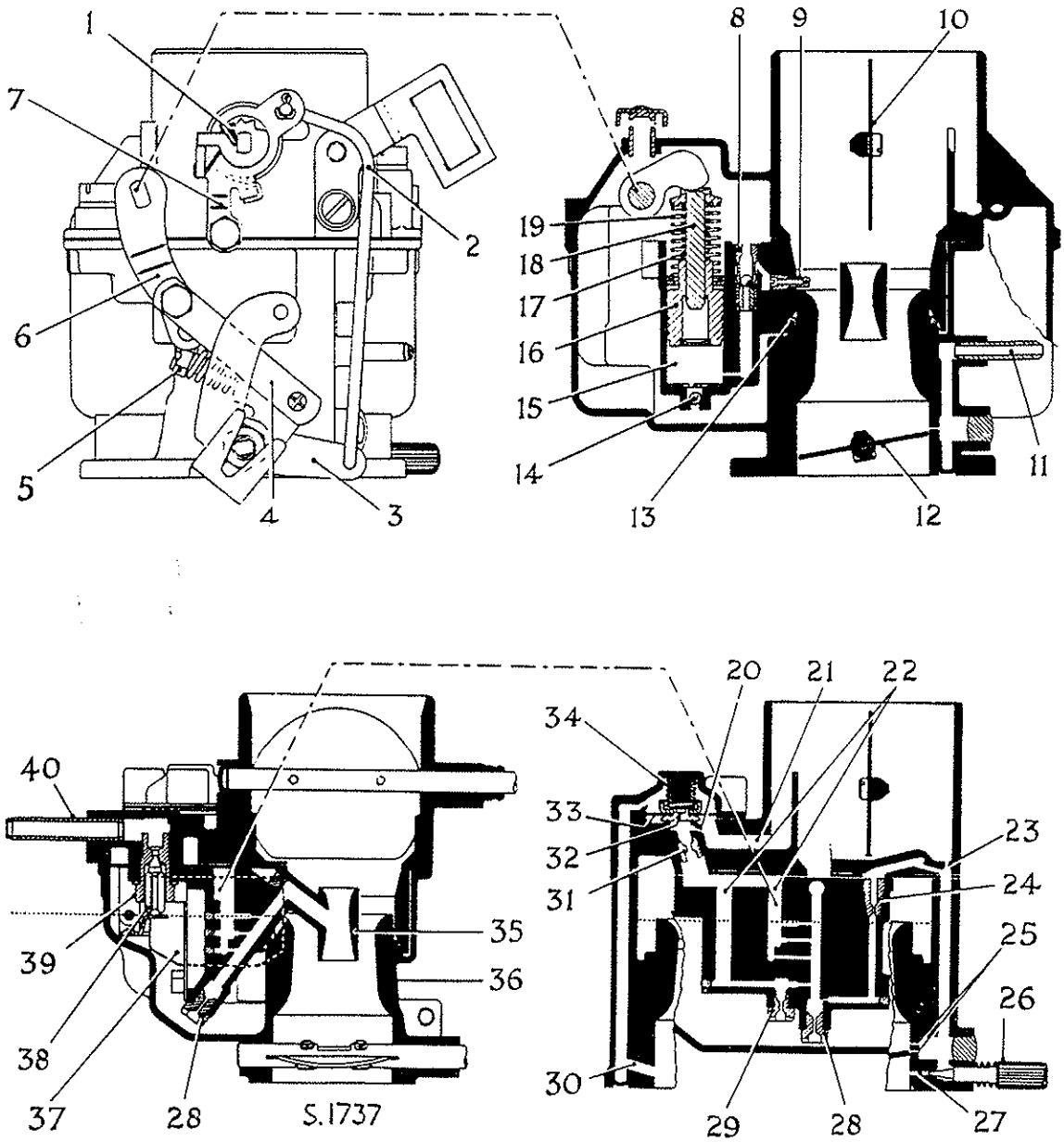
The volume control screw (26) is used to adjust the amount of fuel metered by the slow running jet and emulsified by air entering through the bleed hole (23). This bleed hole (23) prevents syphoning of the fuel from the float chamber, through the slow running fuel feed system when this system is not working.

The two small holes (25) communicate with the slow running fuel feed channel. Their purpose is to provide additional mixture before fuel commences to discharge from the main and compensating jets. This ensures smooth progressive increase of engine speed or torque, and freedom from hesitation as the throttle is opened from the slow running position.

4. *Part Throttle Driving.*

As the throttle is opened beyond the fast idling position, depression in the choke tube (36) causes discharge of emulsified fuel into the small venturi (35), which mixes with the air, flowing through the large choke or venturi (36) and throttle opening into the inlet manifold.

This fuel is metered by the main jet (28) and compensating jet (29) which feeds the capcaity wells (22).



1 CHOKE VALVE CLOSING SPRING
2 CONNECTING ROD
3 FLOATING LEVER ON THROTTLE SHAFT
4 ACCELERATOR PUMP CONNECTING LINK
5 SLOW RUNNING SPEED ADJUSTMENT SCREW
6 ACCELERATOR PUMP LEVER
7 CHOKE VALVE CONTROL LEVER
8 ACCELERATOR PUMP DELIVERY BALL VALVE
9 ACCELERATOR PUMP DISCHARGE JET
10 CHOKE VALVE
11 VACUUM ADVANCE CONNECTION
12 THROTTLE
13 RUBBER "O" RING
14 ACCELERATOR PUMP SUCTION BALL VALVE
15 ACCELERATOR PUMP BORE
16 ACCELERATOR PUMP PISTON
17 ACCELERATOR PUMP PISTON OPERATING SPRING
18 ACCELERATOR PUMP PLUNGER
19 ACCELERATOR PUMP PISTON AND PLUNGER RETURN SPRING
20 FULL THROTTLE AIR BLEED HOLE
21 AIR FEED PASSAGE TO ECONOMY DEVICE
22 CAPACITY WELLS
23 SLOW RUNNING PASSAGE AIR BLEED
24 SLOW RUNNING JET
25 PROGRESSION HOLES
26 SLOW RUNNING MIXTURE VOLUME CONTROL SCREW
27 SLOW RUNNING MIXTURE OUTLET
28 MAIN JET
29 COMPENSATING JET
30 VACUUM FEED PASSAGE TO ECONOMY DEVICE
31 VENTILATION SCREW
32 VALVE FACE ON DIAPHRAGM
33 DIAPHRAGM
34 DIAPHRAGM RETURN SPRING
35 SMALL VENTURI (PART OF EMULSION BLOCK)
36 LARGE VENTURI OR CHOKE TUBE (PART OF MAIN BODY)
37 TWIN FLOATS
38 FLOAT NEEDLE VALVE
39 FLOAT NEEDLE VALVE SEAT
40 FUEL INLET CONNECTION

Fig. C.3. Diagrammatic sectional view of the carburettor

The amount of fuel metered is dependent upon the action of the air bleed system in the emulsion block, which is controlled by the economy device.

Under part throttle driving conditions the economy device allows full air bleeding through the ventilation screw (31). This arrangement provides the weaker mixture that gives the economical consumptions obtained under this driving condition. Combustion of this weaker mixture is assisted considerably by the extra advance given by the vacuum advance mechanism.

5. *Economy Device.*

This consists of a diaphragm (33), diaphragm valve (32), diaphragm return spring (34) and cover cap. Inlet manifold depression is fed through the channel (30) to the upperside of the diaphragm (33) inside the cover cap. These parts operate to control the amount of air bleeding to the passages in the emulsion block.

Until the throttle is opened a considerable amount inlet manifold vacuum is sufficient to allow atmospheric pressure to lift the diaphragm (33) against its return spring (34) force. This lifts the valve face (32) on the lower side of the diaphragm away from its seating and allows the bleed air flow to be controlled by the ventilation screw (31).

With wide throttle openings, the inlet manifold vacuum decreases, and the diaphragm return spring (34) forces the diaphragm down so that the valve face (32) seats on to the valve seat face in the carburettor body. This reduces the air flow through the vent screw to the amount that passes through the small air bleed hole (20).

6. *Wide Throttle Driving.*

Under this driving condition the main jet (28) and compensating jet (29) still meter the fuel. They are affected by the much reduced air bleed to the emulsion block channels, and thus provide the required mixture under these driving conditions.

The reduced air bleed is brought about by the action of the economy device.

7. *Acceleration.*

Quick opening of the throttle causes a sudden inrush of air, through the choke tube, to which the main and compensating jets cannot immediately provide the fuel needed to ensure immediate engine response.

To overcome this, a temporary extra supply of fuel is needed, which is metered by the accelerator pump jet, whilst the accelerator pump piston is moving downwards. When the accelerator pump piston (16) is at the top of its stroke, the pump cylinder (15) is filled with fuel that enters through the pump suction non-return ball valve (14).

As the carburettor throttle opens, the piston rod (18) is forced down, and both the inner spring (17) and outer spring (19) are compressed. Expansion of the inner spring (17), that bears on the top face of the piston (16) forces the piston down which discharges fuel through the non-return ball valve assembly (8) and accelerator pump jet (9). Movement of the piston is limited by a stop on the lower end of the rod (18), and piston movement continues until the stop is reached after the rod has ceased to move downwards in advance of the piston.

The outer spring (19) returns the accelerator pump piston (16) and rod (18) to the top of its stroke, which recharges the cylinder with fuel, when the throttle is closed as the accelerator pedal is released.

The ball valve (8) has two seatings. The ball lifts on to its upper seating to close off the air vent hole in the top of the valve body, whilst the accelerator pump is operating, and returns to its lower seating at the end of the pump stroke. It then allows air venting of the accelerator pump jet (9) which prevents the jet from discharging under wide throttle openings and causing excessive fuel consumption.

The accelerator pump stroke is adjustable to suit climatic conditions as described under "ADJUSTMENTS" in this section.

STARTING PROCEDURE

1. Cold Starting.

When starting the engine from cold, pull the choke control out fully, switch on the ignition and operate the starter. **Do not depress the accelerator pedal.**

The engine should start almost immediately. When the engine has started, the choke control should be pushed in far enough to obtain even running and then, as soon as possible, to within about $\frac{1}{2}$ in. (12 mm.) of its fully back position. In this position the idling speed is increased enough to prevent stalling during the warming up period. When the engine has reached its normal operating temperature, the choke control must be pushed back as far as possible.

2. Hot Starting.

Switch on the ignition and operate the starter. If the engine does not start immediately, slightly depress the accelerator pedal whilst operating the starter.

3. Extremely Hot Conditions—Starting.

If difficulty is experienced under these starting conditions, press the accelerator pedal down fully and hold it in this position whilst operating the starter. **Do not agitate the accelerator pedal.**

6. The two sub-assemblies of the pump are now ready for fitting together and this is carried out as follows:

(*a*) Push the rocker arm towards the pump until the diaphragm is level with the body flanges.

(*b*) Place the upper half of the pump into the correct position as shown by the mark made on the flanges before dismantling.

(*c*) Install the upper screws and spring washers and tighten the screws until the heads just engage the spring washers.

(*d*) Continue to push the rocker arm towards the pump body so as to hold the diaphragm at the bottom of the stroke, and while held in this position finally tighten the cover securing screws alternately and securely.

7. Refit the filter gauze, the bowl gasket and the filter bowl, ensuring an air-tight joint is present between the bowl and the gasket.

Testing the Fuel Pump after Re-assembly.

The best method is by using an AC Delco bench test stand, on which the suction side of the pump is piped to a tin of paraffin at floor level and the outlet side of the pump connected to a stop tap and pressure gauge.

1. First flush the pump through to wet the valves and seats, and then completely empty it again by continuing to operate the rocker arm by hand with the suction pipe clear of the paraffin. Re-immerse the suction pipe in the paraffin and again operate the pump. Not more than 20 strokes should be necessary to secure delivery of paraffin from the pump outlet.

2. With the same apparatus a second test can be made by working the pump with the tap on the delivery side closed, pressure then being recorded on the gauge. After ceasing to work the pump, it should take several seconds for the pressure to return to zero, thus denoting that the valves are seating properly. Also, while there is pressure, the outer edge of the diaphragm visible between the pump body flanges, should be carefully examined for leakage and the securing screws tightened if necessary. When working the pump by hand a somewhat longer stroke is obtained and the pressure developed is apt to be higher than when fitted to the engine.

3. When the above apparatus is not available the pump should be tested using a container of clean paraffin as follows:

(*a*) Flush the pump by immersing it in the paraffin and working the rocker arm a few times to wet the valves and seats.

(*b*) Empty the pump by continuing to work the rocker arm above the bath.

(*c*) With the pump clear of the paraffin bath, place a finger over the inlet union and work the rocker arm several times.

(*d*) Remove the finger, when a distinct sucking noise should be heard, denoting that the pump has a reasonable degree of suction.

(*e*) Place a finger over the outlet union and work the rocker arm. The air drawn into the chamber should be held there for two or three seconds.

(*f*) Immerse the pump in paraffin. Holding a finger again over the outlet union, work the pump and examine the clamping flanges of the diaphragm for any sign of air leakage. Tighten the flange securing screws if necessary.

To Refit.

Reverse the procedure detailed for removal from the engine, noting the following points:

1. Ensure that the rocker arm is correctly positioned.

2. After refitting to the engine, the pump should be run for a short-time and pipe unions and pump examined for the possibility of fuel leakage.

3. From the foregoing description of the operation of the pump it will be appreciated that the pressure of fuel on the carburettor is determined by the spring (G, Fig.C.2), and the further this spring is compressed the greater will be the pressure. All parts of the pump and the cylinder block are machined to definite limits. It will, however, be appreciated that circumstances might arise in which all the lower limits exist on one particular engine, with the result that the spring will be compressed on the downward stroke to a greater extent than is normal, resulting in an excess pressure at the carburettor.

Excessive Fuel Pump Pressure can be a cause of poor fuel consumption. This can be checked and if necessary rectified as follows:

(*a*) Disconnect the pipe to the carburettor at the pump.

(*b*) A suitable pressure gauge, calibrated up to 6 lb. sq. in. (0·422 kg. sq. cm.) should then be fastened to, and as near as possible on the same level with, the outlet on the pump.

(*c*) Rotate the engine on the starter, and a reading of $1\frac{1}{2}$ to $2\frac{1}{2}$ lb. sq. in. (0·11 to 0·18 kg. sq. cm.) should be recorded on the gauge.

(*d*) To remedy excessive fuel pump pressure, it is advisable to first overhaul the fuel pump in order to ensure that the diaphragm has not stiffened in service.

(*e*) Should the diaphragm condition be satisfactory on inspection, additional flange gasket(s) may be inserted between the pump flange and the crankcase on refitting in order to obtain the correct pump delivery pressure of $1\frac{1}{2}$ to $2\frac{1}{2}$ lb. sq. in. (0·11 to 0·18 kg. sq. cm.).

Care should be taken to avoid the use of excessive packings because this will lead to starvation under full throttle conditions. Always check the pressure reading on completion of the operation.

Important Note: It must be clearly understood that the actual mounting on the engine affects the output pressure of the pump and thus these tests cannot be carried out unless the pump is mounted in its normal position. The use of jigs or other fixtures for testing AC pumps will not necessarily give the same results.

AIR CLEANERS

Maintenance.

The intervals at which the paper element type of air cleaner need to be serviced, will vary according to the conditions under which the vehicle is operating.

For town work, or areas where roads are good, every 12,000 miles (18,000 km.) is recommended. In territories where roads are bad and dust is prevalent servicing should be carried out more frequently.

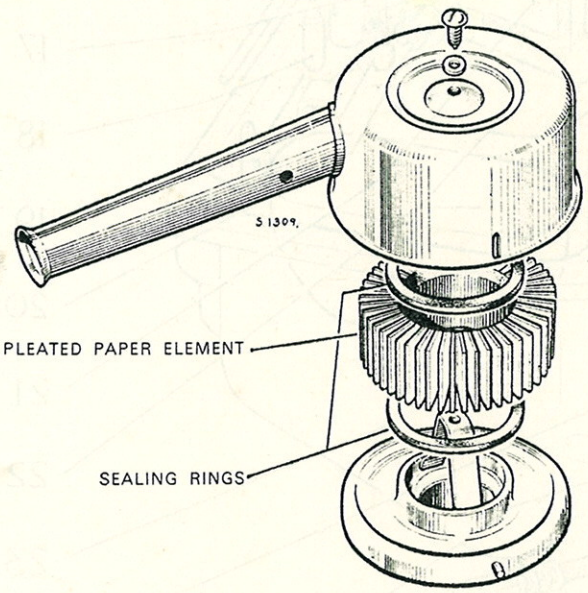


Fig. C.6. Paper element air cleaner

It is most important, with the paper element type of air cleaner, that the mileage interval between element changes is not exceeded, otherwise poor performance together with an increase in fuel consumption may result.

Operation.

Unfiltered air is drawn, by manifold depression, into the outer chamber surrounding the element, via the inlet tube. The air then passes through the paper element, thus trapping any particles of foreign matter carried into the cleaner by the air. The now filtered air is drawn from the inner chamber, through the outlet tube and hose to the carburettor air box and thus to the engine.

To Clean.

In no circumstances should any attempt be made to service the old element by washing, although in an emergency loose particles of dirt can be removed by the simple expedient of tapping the element itself. This is purely an emergency method however and should not be regarded as restoring the service life of the element.

The following procedure should be adopted to renew the element at the intervals indicated in the maintenance section.

1. Remove the retaining screw and washer and lift off the top cover.
2. Lift out the pleated paper filter element and remove the two rubber sealing rings.
3. Clean out the top cover and bottom plate ensuring that no foreign matter is allowed to enter the carburettor air intake.
4. Check the condition of the rubber sealing rings and renew if necessary
5. Place a new paper element in position on the bottom plate ensuring that the sealing rings are correctly fitted, one either side of the element.
6. Replace the top cover, aligning its slot with the locating peg fitted to the bottom plate.
7. Fit the retaining screw together with its washer.

Note: It is important that the paper filter elements are used dry.

THEY DO NOT REQUIRE OIL.

To Remove.

1. Disconnect the hose from the air cleaner outlet after releasing the hose clip.
2. Remove the air cleaner complete.

Inspection and Overhaul.

1. Remove the top cover and clean out the air cleaner as detailed under "**To Clean**".
2. Examine the sealing rings for deterioration or damage and renew if evident, otherwise unfiltered air may by-pass the filter element.

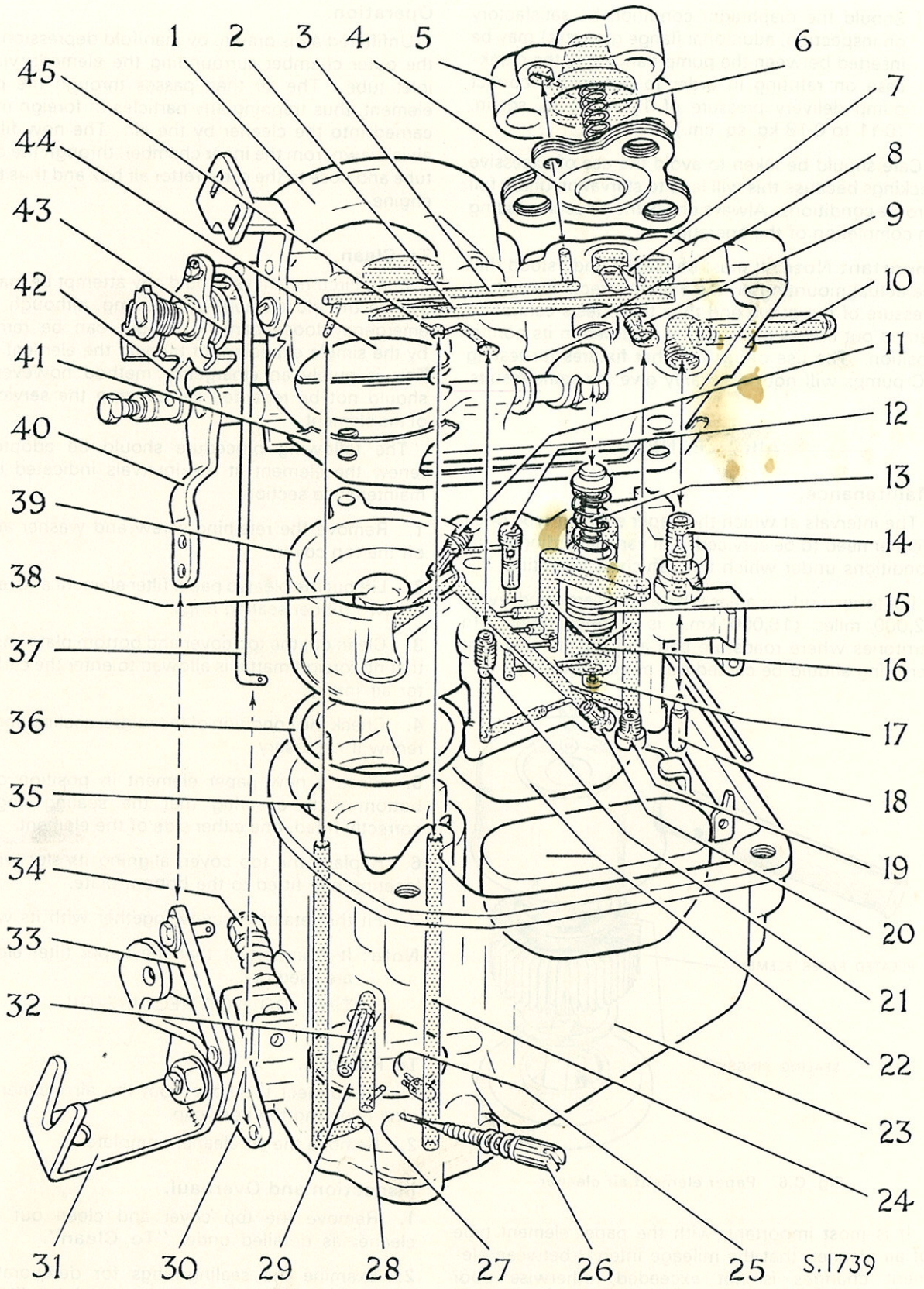


Fig. C.7. Carburettor—external and internal details, jets and drillings

3. Ensure that the inlet outlet tubes of the unit are clean.

To Re-assemble and Refit.

Reverse the dismantling and removal procedure ensuring that the element and sealing rings are correctly seated.

CARBURETTOR

To Remove.

1. Remove air cleaner.

2. Disconnect fuel feed pipe, throttle operating shaft and choke control.

3. Remove two nuts and washers holding the carburettor to its flange on the inlet manifold.

To Refit.

1. Before refitting the carburettor its flange should be checked for flatness on a small surface plate, or other suitable flat surface. Using a straight edge is not satisfactory.

2. After refitting the carburettor, the choke control inner cable should be adjusted as described under "ADJUSTMENTS" in this section.

Diagnosis of Faults.

The carburettor **cannot** function correctly if the ignition system, fuel supply system, compression or exhaust system are at fault. Unless known to be in perfect condition, these items must be checked as follows before dealing with complaints that can be caused by faulty carburation.

1. *Ignition System.*

(*a*) Check spark plug condition. Clean and set gaps.

(*b*) Check condition and tightness of H.T. and L.T. leads.

(*c*) Check condition and setting of contact breaker points and contact moving point spring tension.

(*d*) Ensure that the centrifugal and vacuum advance mechanisms are working correctly.

(*e*) Check ignition timing. Only small variations from the correct static timing are permissible.

2. *Fuel System.*

(*a*) Ensure that an adequate supply of fuel is being delivered to the float chamber.

(*b*) Check that fuel pump output pressure is correct to the figures given in the Data Section.

(*c*) Examine induction manifold and carburettor flange for air leaks.

(*d*) Check that the inlet manifold drain pipe is clean.

(*e*) Ensure that air cleaner is fitted correctly and not restricting air supply to carburettor, due to the element being dirty.

3. *Compression.*

(*a*) Check valve clearances and compressions.

(*b*) Ensure that the valves are not sticking.

4. *Exhaust System.*

Check that exhaust pipe has not become damaged or blocked.

5. *Excessive Fuel Consumption.*

Ensure that this complaint is not caused by heavy traffic conditions, hilly country or very adverse driving conditions.

KEY TO FIG. C.7

1 CARBURETTOR TOP BODY
2 AIR FEED PASSAGE TO ECONOMY DEVICE
3 VACUUM FEED PASSAGE TO ECONOMY DEVICE FROM 28
4 DIAPHRAGM
5 DIAPHRAGM COVER
6 DIAPHRAGM RETURN SPRING
7 FULL THROTTLE AIR BLEED HOLE
8 FLOAT CHAMBER AIR VENT
9 VENTILATION SCREW
10 FUEL INLET CONNECTION
11 ACCELERATOR PUMP DISCHARGE JET
12 ACCELERATOR PUMP DELIVERY BALL VALVE ASSEMBLY
13 ACCELERATOR PUMP PLUNGER
14 FLOAT NEEDLE VALVE SEAT
15 ACCELERATOR PUMP PISTON
16 CAPACITY WELLS
17 ACCELERATOR PUMP SUCTION BALL VALVE
18 FLOAT NEEDLE VALVE
19 COMPENSATING JET
20 MAIN JET
21 SLOW RUNNING JET
22 TWIN FLOATS
23 MAIN BODY AND FLOAT CHAMBER
24 SLOW RUNNING FUEL FEED PASSAGE
25 PROGRESSION HOLES
26 SLOW RUNNING MIXTURE VOLUME CONTROL SCREW
27 SLOW RUNNING MIXTURE OULET
28 VACUUM FEED TO ECONOMY DEVICE
29 THROTTLE
30 FLOATING LEVER ON THROTTLE SHAFT
31 THROTTLE LEVER
32 VACUUM ADVANCE CONNECTION
33 ACCELERATOR PUMP CONNECTING LINK
34 SLOW RUNNING SPEED ADJUSTMENT SCREW
35 LARGE VENTURI OR CHOKE TUBE (PART OF MAIN BODY)
36 RUBBER "O" RING
37 CONNECTING ROD
38 SMALL VENTURI (PART OF EMULSION BLOCK)
39 EMULSION BLOCK
40 ACCELERATOR PUMP LEVER
41 GASKET—UPPER BODY TO MAIN BODY
42 CHOKE VALVE CONTROL LEVER
43 CHOKE VALVE CLOSING SPRING
44 CHOKE VALVE
45 SLOW RUNNING PASSAGE AIR BLEED

(*a*) Check that the carburettor is not flooding intermittently due to a faulty needle valve and seating or defective float lever.

(*b*) Check that the jets in the carburettor are to the size specified in "GENERAL DATA". New jets should be fitted if it is suspected that any jet has been damaged by cleaning incorrectly with a metal point, or tampered with in any way. It should be noted that the main (20) and compensating jets (19) are cadmium plated, to distinguish them from other jets of similar size and shape, which have a brass finish. Although the brass finished and cadmium plated jets appear to be similar exactly, their flow characteristics are entirely different, and therefore **cadmium plated main and compensating jets must always be used in this particular carburettor.**

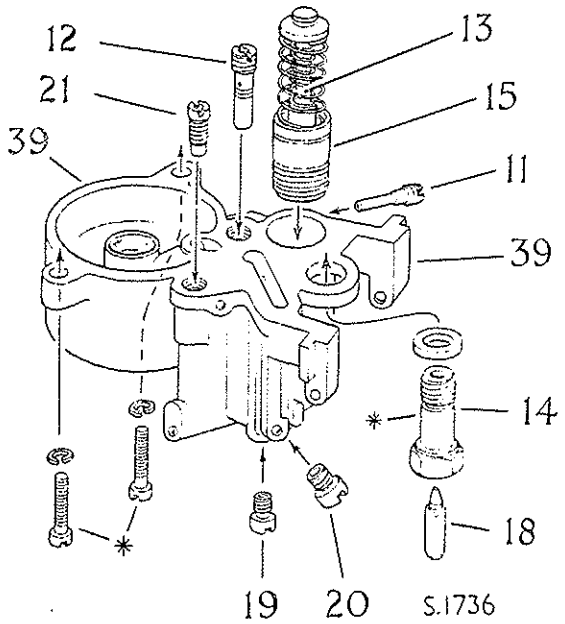


Fig. C.8. Exploded view of emulsion block

Washers are not fitted, or needed under these jets.

(*c*) Remove the air cleaner and check that the choke valve is opening fully when the choke control is pushed backwards to the full extent of its travel.

(*d*) Check that the slow running channel air bleed hole (45) is clear. Stoppage of this hole will allow the slow running jet to meter fuel throughout the whole throttle range and thus provide excess fuel.

Without the necessary air vent supplied by the hole (45), fuel can syphon from the float chamber through the slow running system.

(*e*) Dismantle the economy device to check the condition of the diaphragm and the two gaskets used on its upper and lower faces. If a replacement diaphragm is needed, also fit a new diaphragm return spring and gaskets. The tension of this spring is important as it controls the operation of the economy device. When re-assembling the economy device, see that the spring beneath the cover is in position and located squarely in the recess of the metal cup on the upper face of the diaphragm. The three screws that hold the cover to the carburettor top body, must be tightened evenly. A leakage under the cover face will affect the amount of depression needed to overcome the diaphragm return spring pressure that returns the diaphragm to the closed position. Incorrect action of the economy device diaphragm will increase the fuel consumption by preventing the supply of an economy mixture on part throttle openings.

(*f*) Remove the accelerator pump delivery valve (12) and check that its ball valve moves up and down quite freely. Sediment or gum can stick the ball valve to its upper seating, and this will allow fuel to be drawn from the accelerator pump, when the pump is not operating. This increases the fuel consumption. Usually any tendency for the ball to stick can be overcome by washing the valve assembly in methylated spirits.

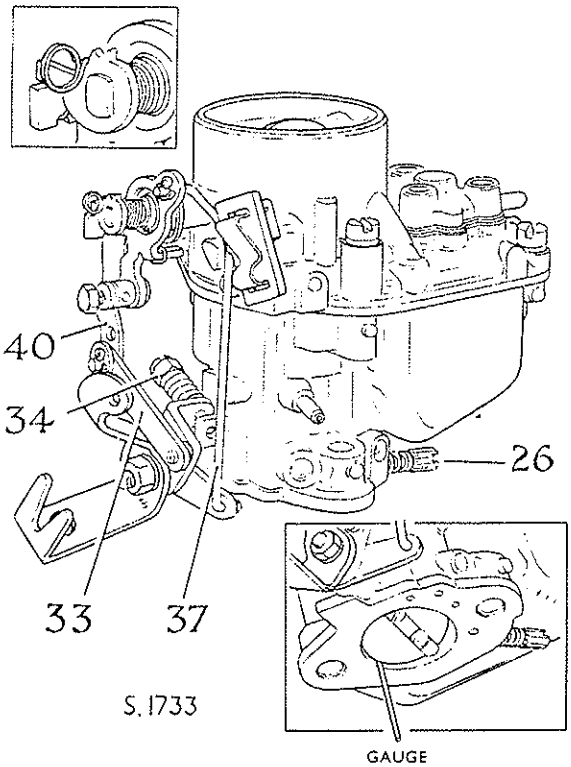


Fig. C.9. External linkage

(*g*) Check that the "O" ring (36) is in good condition and forming a seal between the emulsion block and carburettor body around the choke tube upper end.

6. *Insufficient Top Speed.*

(*a*) Check that the throttle is opening on to its full throttle stop when the accelerator pedal is fully depressed.

(*b*) Check that the main and compensating jets are those specified in "GENERAL DATA".

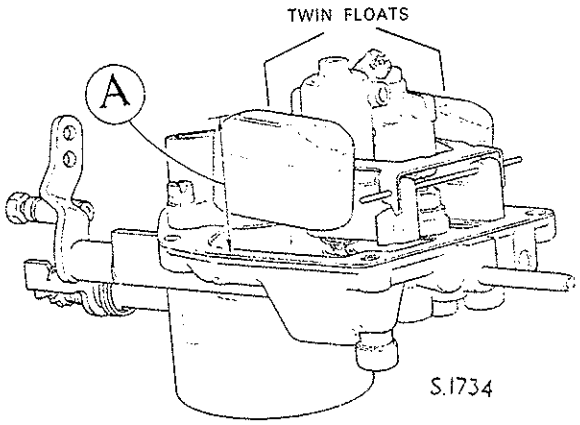
(*c*) Check that the main and compensating jets are not partially blocked and that their air bleed passages are clear, not forgetting the full throttle air bleed (7) drilling inside the economy device.

(*d*) Check that the needle valve seat is free from obstruction and that the float arm is not damaged.

(*e*) Check that the economy device spring (6) is in position. It can be lost by careless servicing of the carburettor.

7. *Faulty Slow Running.*

This is caused by an incorrect slow running mixture due either to wrong adjustment of the volume control screw (26), blocked or partly blocked slow running jet, or supply of excess air.



A = 1·26/1·30 in. (32/33 mm.)

Fig. C.10. Float level settings

(*a*) Remove the carburettor top body (1), emulsion block (39) and slow running jet (21). Blow through the jet and passage ways as shown in Fig. C.7. with clean compressed air. The long passage way, in the main body of the carburettor can be blown through without removing the carburettor from the inlet manifold, first from below through the volume control screw hole, after removing the volume control screw and blocking the upper end of the passage way a with finger, then from the top with the volume control screw replaced and rotated on to its seat. This ensures that the slow running outlet, and two progression holes are cleared. Check that the volume control screw point is not damaged. Adjust the volume control screw (26) so that it just seats by finger **not screwdriver** rotation and then rotate it back by $1\frac{1}{4}$ turns.

(*b*) Check that the volume control screw (26) and slow running speed adjustment screw (34) springs exert enough pressure under the screw heads to prevent them from rotating through the effects of engine vibration.

(*c*) Adjust the slow running mixture and speed as described under "ADJUSTMENTS".

8. *Flat Spot or Hesitation at Small Throttle Openings.*

The reason for this fault is a weak mixture occurring immediately the throttle opens from the slow running position, before the main and compensating jets come into operation.

The possible causes are :

(*a*) Incorrect adjustment of the slow running mixture volume control screw (26). See under "ADJUSTMENTS – **Slow Running**" as detailed in this section.

(*b*) Progression holes (25) blocked or partly blocked.

(*c*) Worn throttle spindle or other possible causes of air leakage into the induction system.

(*d*) Vacuum advance pipe disconnected from the carburettor, pipe or its connection loose, or vacuum advance diaphragm leaking.

9. *Poor Acceleration.*

Should the engine show signs of hesitation and lack of response when the throttle is opened suddenly, the following should be checked.

(*a*) Remove the air cleaner, and whilst looking into the carburettor, with the engine stopped, open the throttle suddenly over its whole range of movement. Fuel should then be discharged from the accelerator pump jet (11). If little or no fuel is discharged continue with the following procedure.

(*b*) Remove the carburettor top body (1), and emulsion block (39) from the top body. Check that the accelerator pump piston (15) moves freely in its cylinder and is returned by the outer spring around the plunger.

(*c*) Remove the accelerator pump delivery valve (12) and accelerator pump jet (11). Blow through these items and their feed passages with clean compressed air.

(*d*) With the piston (15) removed syringe fuel through the ball valve (17) at the base of the pump bore to make certain that the ball valve will seat on the downward stroke of the piston (15). **Do not attempt to remove the ball valve spring wire retainer.**

(*e*) Refit the accelerator pump piston (15), delivery valve (12) and the accelerator pump jet (11).

(*f*) Hold the emulsion block in a shallow tray of fuel so that the lower part of the accelerator pump is immersed in fuel. Operate the fuel pump. Fuel should then be discharged from the jet (11).

(*g*) Refit the emulsion block (39) to the carburettor top body.

(*h*) Remove the economy device cover and check that the diaphragm (4) is in good condition. During acceleration the valve face in the underside of the diaphragm (4) closes off the passage that allows full air flow through the ventilation screw (9). This reduces the air bleed, causing faster emptying of the capacity wells (16) which supplements the fuel supplied by the pump jet (11). Any air leakage through a faulty diaphragm gasket will alter the economy device action.

10. *Difficult Starting from Cold.*

Reasons that prevent the carburettor from providing the very rich mixture needed for cold starting conditions are:

(*a*) Lack of fuel supply to the carburettor float chamber.

(*b*) Choke control inner cable adjusted incorrectly, which stops the lever (42) from moving over its whole range of travel, onto its stop against the carburettor body, when the choke control is pulled fully out. This will prevent the choke valve from closing, and can also keep the throttle from opening to the fast idle position for cold starting and cold running.

(*c*) Choke valve not closing when the choke control is pulled out fully. This can occur even when the lever (42) operates correctly, because this lever does not close the choke valve, it only allows the light spring on the choke valve spindle outer end to rotate the choke valve spindle. Any stiffness in the choke valve spindle movement can prevent the choke valve from closing when the choke is pulled out. This can be very deceptive.

The choke valve action can be checked by pulling the choke control out. Checking that the lever (42) comes against its stop rotating the outer end of the choke valve spindle in a clockwise direction as far as possible, and then releasing the spindle. If the spindle is operating correctly the choke valve will then shut with a distinct snap sound.

(*d*) Interconnection rod (37) between choke operating lever (42) and floating lever (30) not opening the throttle to the fast idle position. To check and adjust this setting see under "ADJUSTMENTS".

(*e*) Gum has been known to form on the float needle and stick it to the needle valve seat when the engine has stopped. This prevented entry of fuel to make up fuel lost by evaporation as the engine cooled down and in consequence the engine could not start. If this occurs the whole fuel system should be cleaned out.

11. *Difficult Starting when Hot.*

The reason for this trouble is a very rich mixture caused by any one or more of the following faults.

(*a*) Rich fuel vapour in the inlet manifold due to pumping of the accelerator pedal.

(*b*) Carburettor flooding due to faulty needle valve and seat.

(*c*) Needle valve seat not properly tightened into top body of the carburettor.

(*d*) Fuel level in float chamber too high because of wrong setting of the float mechanism.

(*e*) Fuel supply pressure too high.

ADJUSTMENTS

1. Slow Running.

In addition to the carburettor slow running system, reliable and even slow running depends upon good ignition, correct ignition timing, correct valve clearances, even compressions and freedom from air leaks in the induction system.

If any one or more of these items are at fault adjusting the carburettor slow running adjustments will prove difficult.

This adjustment is made when the engine is **hot** in the following manner:

(*a*) Adjust the slow running speed adjustment screw (34) until the idling speed is a little faster than normal.

(*b*) Unscrew the slow running mixture volume control screw (26) in an anti-clockwise direction until the engine begins to "hunt", that is, runs on a rich slow running mixture which will decrease the engine speed. **The slow running mixture volume control screw is quite sensitive to adjust because it regulates the amount of fuel used for slow running. It does NOT control the air feed for slow running.**

(*c*) Screw in the volume control screw (26) just enough to stop the engine from "hunting".

(*d*) If the engine speed is now too high reset the throttle adjusting screw (34). This may cause a resumption of "hunting" and further adjustment of the slow running volume control screw (26) may be necessary.

(*e*) Check that the throttle returns to its stop each time that the accelerator pedal is released. Stiffness in the accelerator linkage can prevent this.

Any "hesitancy" or "flat spot", as the throttle is moved from the idling position, when starting from rest or driving slowly, is an indication that the slow running mixture is either too weak or too rich and that further slight adjustment may be needed.

2. Accelerator Pump Stroke.

The travel of the accelerator pump piston can be adjusted to give a short or long stroke, to meet summer or winter conditions.

This adjustment is made by altering the position of the link (33) connection in the fuel pump operating lever (40). In Fig. C.9 it is shown in the position that gives the shortest pump stroke.

3. Throttle Fast Idling Position—for Cold Starting.

The throttle fast idling position depends upon the length between the outer ends of the interconnecting rod (37). This length is set during the manufacture and normally should not require further adjustment.

When a complaint is made that starting is difficult under cold conditions the fast idle adjustment should be checked by one of the following methods. The second method, which requires removal of the carburettor, should always be used when making this adjustment for extreme cold starting conditions.

Method 1 – Without removing carburettor.

(*a*) Disconnect the choke control inner cable from the lever (42).

(*b*) Remove the idle speed adjustment screw (34) and take off its stop spring. Replace the screw and rotate it until it just contacts the carburettor body while the throttle is held fully closed.

(*c*) Screw in the slow running speed adjusting screw (34), to open the throttle, by a further ten half turns of screw rotation.

(*d*) Carefully bend the upper end of the connecting rod (37) so that the floating lever (30) just contacts the rear face of the lever, carrying the slow running speed adjustment screw (34), when the lever (42) is moved to the full extent of its travel.

(*e*) Check, by releasing the slow running speed adjustment screw (34) by half a turn and then moving the lever (42) over its whole range of movement. If the rod (37) has been set correctly the throttle lever (31) will just begin to move.

(*f*) Reconnect the choke inner cable to the arm and check that choke cable adjustment is correct.

(*g*) Remove the slow running speed adjustment screw (34) and refit its spring. Refit the screw and adjust so that the normal idling speed is obtained.

Method 2 – Removing the carburettor.

(*a*) Remove the carburettor from the engine.

(*b*) Obtain a gauge, for insertion between the throttle butterfly and throttle barrel 0·043 in. dia. (1·1 mm.). This can be the shank of a No. 57 drill or a wire of this diameter or wire flattened to this dimension.

(*c*) Move the choke lever (42) to the full extent of its travel. If the connecting rod (37) is correctly set the throttle will have opened just enough to allow the gauge to be inserted between the throttle edge and throttle bore, in a position at a right angle to the centre of the throttle spindle.

(*d*) If necessary carefully set the connecting rod (37) at its upper curved end, so that the throttle opens to the gauge thickness when the lever (42) is moved fully over.

(*e*) Replace the carburettor and adjust the choke cable.

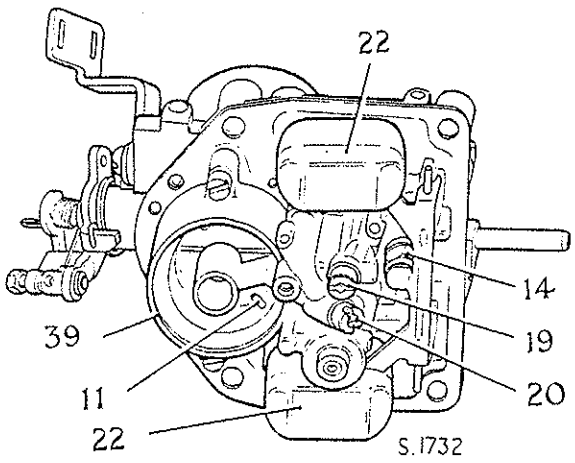


Fig. C.11. Carburettor with cover removed

4. Fuel Level.

To check the fuel level remove the carburettor top body and invert it so that the float holds the float needle on its seat. In this position the highest point of the float should be 1·26/1·30 in. (32/33 mm.) from the gasket face.

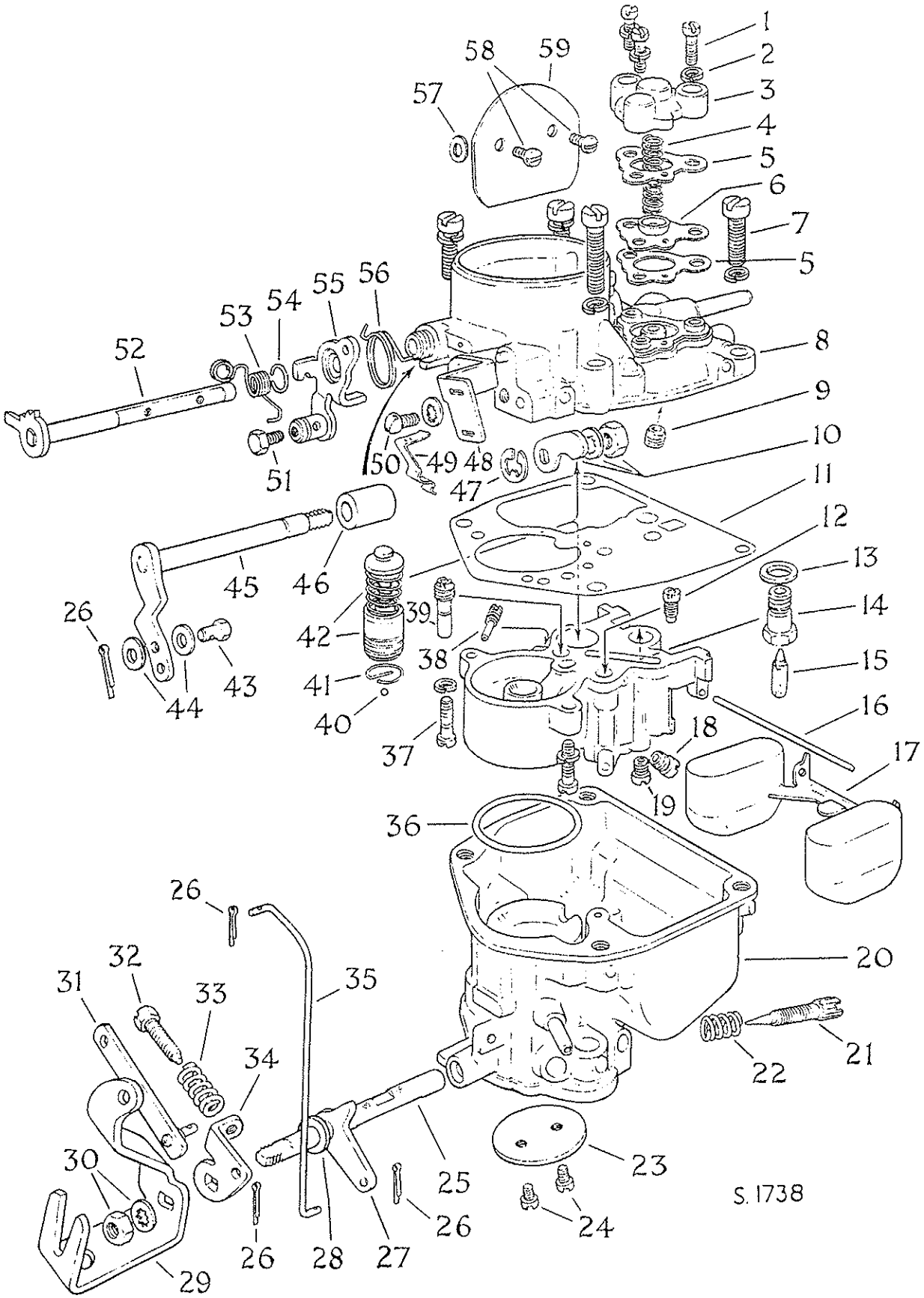


Fig. C.12. Exploded view of carburettor

If necessary bend the float arm, or tag on the float arm, as needed, or fit a thinner or thicker washer under the needle valve seating.

5. Choke Control.

The choke control inner cable should be adjusted so that its operating knob is about 0·08 in. (2 mm.) from the wheel arch cover panel, when the choke operating lever is against its "OFF" stop in the carburettor.

CLEANING IN POSITION

This carburettor can be completely cleaned without removing it from the engine, provided the following procedure is adhered to.

(*a*) Remove the air cleaner. Disconnect the rod (37) at its upper curved end, and the link (33) from the lever (40), noting which of the two holes in the lever to which the link is connected.

(*b*) Remove the fuel feed pipe from its connection (10).

(*c*) Remove the four cheese headed screws holding the top body (1) to the main body (23), and lift off the top body complete with emulsion block assembly (39) as shown in Fig. B.9

1. Cleaning Lower Body.

(*a*) Remove fuel from the float chamber bowl in the main body with a syringe and clean the bowl by blowing out with clean compressed air.

(*b*) Remove the volume control screw (26) and with a finger block off the upper end of the passage (24). Hold a compressed air feed nozzle in the volume control screw hole and blow air through the slow running outlet (27). Replace the volume control screw (26) and screw it lightly onto its seating.

(*c*) Blow air into the upper end of the passage (24). This cleans the progression outlet holes (25).

(*d*) Unscrew the volume control screw (26) one turn from its screwed down position.

(*e*) Disconnect the vacuum advance flexible feed pipe from its connection (32) and blow air through this passage and the passage connecting to the outlet (28).

This completes the cleaning of the carburettor lower body.

2. Cleaning Emulsion Block.

(*a*) Remove the twin float assembly (22) by withdrawing its pivot pin. Also remove the float needle valve (18).

(*b*) Remove the two cheese headed screws and float needle valve seating (14) and lift the emulsion block assembly, taking care to prevent the accelerator pump piston (15) assembly from becoming damaged, as it can fall out as the emulsion block is removed.

(*c*) Remove the slow running jet (21), pump discharge valve (12), pump jet (11), compensating jet (19) and main jet (2). **No attempt** should be made to remove the non-return ball valve (17).

KEY TO FIG C.12

1 FIXING SCREW
2 SPRING WASHER
3 ECONOMY DEVICE COVER
4 DIAPHRAGM RETURN SPRING
5 GASKETS ABOVE AND BELOW DIAPHRAGM
6 ECONOMY DEVICE DIAPHRAGM
7 TOP COVER FIXING SCREWS AND SPRING WASHERS
8 FLOAT CHAMBER COVER AND INTAKE
9 VENTILATION SCREW
10 ACCELERATOR PUMP INTERNAL LEVER, NUT AND SHAKEPROOF WASHER
11 GASKET
12 SLOW RUNNING JET
13 WASHER FOR NEEDLE SEATING
14 FLOAT NEEDLE VALVE SEATING
15 FLOAT NEEDLE VALVE
16 FLOAT ARM PIVOT
17 TWIN FLOATS
18 MAIN JET
19 COMPENSATING JET
20 COMBINED MAIN BODY AND FLOAT CHAMBER
21 SLOW RUNNING MIXTURE VOLUME CONTROL SCREW
22 SPRING FOR VOLUME CONTROL SCREW
23 THROTTLE VALVE
24 THROTTLE FIXING SCREW
25 THROTTLE SPINDLE
26 SPLIT PINS
27 FLOATING LEVER
28 PLAIN WASHER
29 THROTTLE LEVER
30 THROTTLE LEVER FIXING NUT AND SHAKEPROOF WASHER
31 ACCELERATOR PUMP LINK
32 SLOW RUNNING SPEED ADJUSTMENT SCREW
33 SPRING FOR ADJUSTMENT SCREW
34 THROTTLE STOP LEVER
35 INTERCONNECTION ROD
36 RUBBER "O" RING
37 EMULSION BLOCK FIXING SCREWS AND SPRING WASHERS
38 ACCELERATOR PUMP DISCHARGE JET
39 ACCELERATOR PUMP DISCHARGE VALVE
40 ACCELERATOR PUMP INTAKE BALL VALVE
41 INTAKE BALL VALVE RETAINER
42 ACCELERATOR PUMP PISTON, PISTON ROD AND SPRING ASSEMBLY
43 PIVOT PIN FOR PUMP LINK
44 WASHERS
45 ACCELERATOR PUMP SPINDLE AND LEVER
46 DISTANCE PIECE
47 RETAINING RING—ACCELERATOR PUMP SPINDLE
48 CHOKE CABLE BRACKET
49 CLIP—CHOKE CABLE TO BRACKET
50 BRACKET FIXING SCREW AND SHAKEPROOF WASHER
51 SET SCREW—CHOKE CABLE TO LEVER TRUNNION
52 CHOKE VALVE SPINDLE
53 CHOKE VALVE CLOSING SPRING
54 CIRCLIP
55 CHOKE VALVE CONTROL LEVER
56 CHOKE VALVE CONTROL LEVER RETURN SPRING
57 THIN BRASS WASHER—USED BETWEEN CHOKE VALVE AND CARBURETTOR BORE
58 CHOKE VALVE FIXING SCREWS
59 CHOKE VALVE

(*d*) Wash the jets and pump discharge valve in fuel. Also wash the accelerator pump, piston, piston bore, and non-return ball valve (17) with fuel.

(*e*) Blow through the non-return valve (17) from its lower side, all jets, the pump discharge jet (11) and the needle valve seat (14) with clean compressed air.

(*f*) Blow through all the passages shown in the emulsion block (39) in Fig. C.8

(*g*) Refit all parts to the emulsion block that were removed for cleaning.

3. Cleaning Top Body.

(*a*) Remove the economy device cover (5), spring (6) and diaphragm (4).

Inspect the condition of the diaphragm and renew if required.

(*b*) Blow through the passages (2) and (3), the anti-syphon drilling (45), and the ventilation screw (9). Make sure that the small full throttle air block drilling (7) and the vacuum hole in the cover (5) are clear.

(*c*) Blow through the fuel feed (10) and the air vent (8).

(*d*) Refit the economy device parts (4), (5) and (6), using new joints above and below the diaphragm (4).

4. To Re-assemble.

This is a reversal of the dismantling procedure. A new joint should be used between the carburettor top body and emulsion block, and carburettor lower body.

The accelerator pump operating link should be replaced in the same hole in the pump operating lever, from which it was removed, if this position gave satisfactory acceleration.

A fully exploded view is given in Fig. C.12.

ACCELERATOR LINKAGE

To Remove and Dismantle.

1. Release the pedal return spring fitted below the toe-panel between the pedal operating lever and the spring bracket.

2. Detach the turnbuckle which connects the pedal relay lever to the cross-shaft relay lever by releasing the spring clip fitted at each hooked end.

3. Unscrew the two setbolts, plain and shakeproof washers securing the accelerator pedal and housing to the toe-board. Lift away the assembly complete.

To dismantle this assembly, tap out the grooved tapered pin securing the relay lever to the pedal. The hole drilled in the top of the pedal housing will permit the pin to be withdrawn and the housing, lever and pedal can then be separated.

4. On **R.H.D.** vehicles, a cross-shaft is fitted which is removed as follows:

(*a*) Remove the tapping screws and setbolts securing the arched cover panel at the lower centre of the front body panel.

(*b*) Release the front end of the operating rod (cross-shaft to relay bracket on the radiator) at the spring clip connection to the left-hand cross-shaft relay lever.

(*c*) Remove the two split pins and plain washers at the accelerator pedal end of the cross-shaft. Unscrew the bolt, nut and shakeproof washer securing the right-hand lever to its retaining plate on the shaft.

(*d*) Remove the three setbolts securing the two cross-shaft support brackets to the underframe and withdraw the cross-shaft assembly.

The cross-shaft centre clamp bolt must be slackened and the cross-shaft removed in two parts, one from either side of the air ducting.

In order to obtain correct positional relationship of the two parts of the cross-shaft, a loose key is located within the clamp, fitting into slots machined in the ends of the cross-shaft. This key will become detached during the removal operation and should be retained for refitting on re-assembly of the cross-shaft.

5. On **L.H.D.** vehicles, a bell crank lever connects the turnbuckle to the operating rod (lever to relay bracket on the radiator). Release the operating rod at the spring clip on the bell crank lever arm and remove the split pin, washer and jaw pin retaining the bell crank lever to the support bracket. Remove the lever and remove the support bracket after releasing it from the underframe member.

6. Release the rear end of the operating rod (cross-shaft to relay lever – R.H.D. or bell crank lever to relay lever – L.H.D.) at the spring clip on the relay lever arm and withdraw the operating rod.

7. Disconnect the accelerator cable at the carburettor throttle lever and the abutment bracket mounted on the manifold. Also release the opposite end of the cable at the relay lever and abutment on the support bracket on the left-hand side of the radiator. Each end of the accelerator inner cable is secured by a jaw, jaw pin and split pin to the appropriate lever.

8. Unscrew the two setscrews and shakeproof washers securing the relay lever support bracket to the radiator. Remove the split pin and the plain washer to enable the relay lever to be separated from the support bracket.

To Re-assemble and Refit.

Re-assembly and refitting is a reversal of the removal and dismantling operation ensuring that new split pins and spring clips are fitted where necessary, that the key is refitted and that the ends of the cross shaft are pushed fully home before the clamp bolt is tightened.

Check and adjust the linkage on completion to eliminate any lost motion.

FUEL TANK

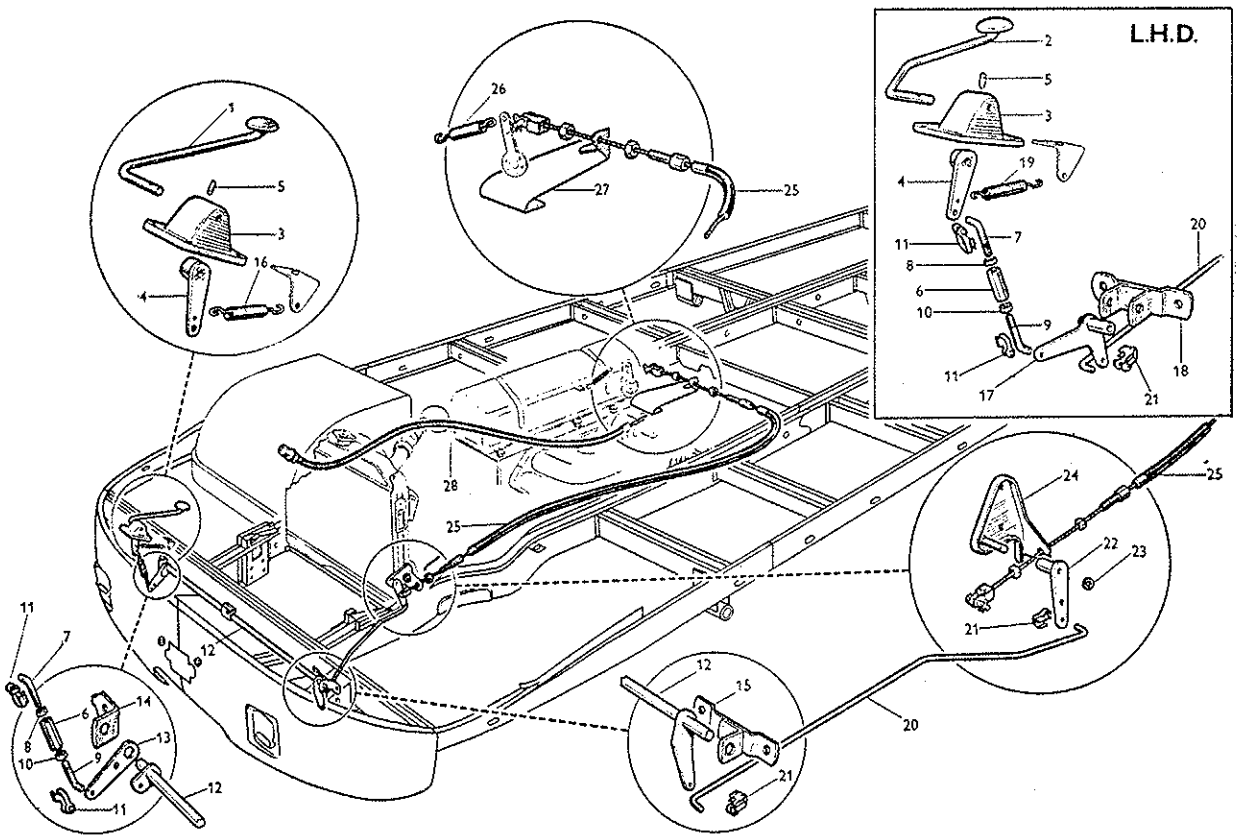
To Remove.

1. Drain the fuel tank by disconnecting the fuel pipe at the union in the tank.

2. Disconnect the electrical lead at the fuel tank gauge unit.

3. Release the clips at both the filler pipe hose and the breather pipe connection.

4. Remove the six setscrews and washers securing the rim of the fuel tank to the underframe and withdraw the tank complete with lower section of the filler pipe.



1 ACCELERATOR PEDAL ASSEMBLY
2 ACCELERATOR PEDAL ASSEMBLY, L.H.D.
3 FULCRUM HOUSING
4 OPERATING LEVER ASSEMBLY
5 SPIRAL PIN
6 TURNBUCKLE
7 TURNBUCKLE END
8 NUT
9 TURNBUCKLE END
10 NUT
11 LINKAGE CLIP
12 CROSS SHAFT ASSEMBLY, R.H.D.
13 CROSS SHAFT LEVER, R.H.D.
14 SUPPORT BRACKET, R.H.D.
15 SUPPORT BRACKET ASSEMBLY, R.H.D.
16 PEDAL RETURN SPRING, R.H.D.
17 BELLCRANK LEVER ASSEMBLY, L.H.D.
18 SUPPORT BRACKET ASSEMBLY, L.H.D.
19 PEDAL RETURN SPRING, L.H.D.
20 CONTROL ROD
21 LINKAGE CLIP
22 RELAY LEVER ASSEMBLY
23 WASHER
24 SUPPORT BRACKET ASSEMBLY
25 ACCELERATOR CABLE
26 THROTTLE RETURN SPRING
27 CABLE ABUTMENT BRACKET
28 CHOKE CONTROL ASSEMBLY

Fig. C.13. Layout of throttle controls (petrol models)

To Dismantle.

1. Release the six setscrews and washers and remove the filler pipe and joint.

2. Remove the six screws and withdraw the fuel tank gauge unit.

Inspection and Overhaul.

1. Thoroughly clean the tank internally and externally. To clean the tank internally, pour approximately ½ gallon (2·25 litres) of fuel inside and shake the tank vigorously. Drain off the fuel and blow out the tank with compressed air.

2. Examine the tank for splitting or damage.

3. Ensure that the union connection to the fuel pipe is unobstructed.

4. Check the filler pipe hose connection for splitting or damage and also the breather pipe.

To Re-assemble.

Reverse the dismantling operation using new joints.

To Refit.

Refitting is a reversal of the removal operation ensuring that the hose connections are made secure.

INLET AND EXHAUST MANIFOLDS

To Remove.

1. Remove the air cleaner, hose and the air box connected to the carburettor.

2. Disconnect at the carburettor the following:

(*a*) The fuel pipe from the lift pump.

(*b*) The vacuum pipe to the distributor.

(*c*) The starter (choke) control cable, both at the outer cable abutment and the inner cable at the starter lever.

(*d*) The throttle lever operating cable, and also release the cable at the adjacent abutment bracket.

3. Unscrew the brass union nut and remove the induction manifold drain pipe.

4. Remove the two nuts securing the exhaust pipe flange to the exhaust manifold and free the pipe and the flange from the manifold. Note the sealing ring gasket located on the exhaust pipe collar.

5. Unscrew and remove the nuts securing the manifolds to the cylinder head studs and lift the complete assembly clear of the engine taking care not to lose the two locating rings at the inner ports of the induction manifold.

To Dismantle.

1. Remove the carburettor from the induction manifold. The heat shield and the packing piece can then be lifted off the carburettor mounting studs.

2. Remove the throttle cable abutment bracket.

3. Separate the two manifolds after removing the nuts from the four securing studs. Lift off the metal joint located on the four studs.

Note: It will be noted when separating the inlet and exhaust manifolds that the metal joint is fitted with a deflector flap.

The purpose of this deflector is to correctly direct the gas flow, resulting in a more rapid warm-up of the engine when starting from cold.

It is most important, on re-assembly, to ensure that this joint is correctly refitted, as indicated on the face of the joint.

Inspection and Overhaul.

1. Inspect the manifolds for cracks and check for distortion on the faces that mate with the cylinder head.

2. Blow through the manifold drain pipe to clear away any obstruction. Ensure that the drain hole in the induction manifold is clear.

3. Examine the heat shield for damage and renew as necessary.

4. The manifold gasket should always be renewed.

To Re-assemble.

Reverse the dismantling procedure but do not tighten the four nuts securing the two manifolds at this stage.

Note: If the manifolds have been separated, the carburettor should not be fitted until the manifolds are refitted to the cylinder head, but if the manifolds have not been separated, the carburettor may be fitted prior to re-fitting the manifolds.

To Refit.

1. Clean the mating faces of the cylinder head and the manifolds.

2. Fit the two locating rings in their registers in the cylinder head.

3. Place the manifold gasket in position over the cylinder head studs.

4. Refit the manifold assembly and secure to the cylinder head tightening down by working from the centre and progressively outwards.

5. Tighten the four manifold securing nuts left slack during the re-assembly operation.

Note: By adopting this method, the induction and exhaust manifolds will be correctly fitted in alignment.

6. Secure the exhaust pipe flange to the manifold using a new sealing ring gasket if necessary.

7. The remaining operations are a reversal of the removal procedure, referring to "CARBURETTOR – To Refit".

EXHAUST PIPE AND SILENCER

See Section H of this Manual.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

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CLUTCH AND PROPELLER SHAFT

SECTION D

INDEX

CLUTCH AND PROPELLER SHAFT

CLUTCH

CLUTCH DESCRIPTION

A single type diaphragm clutch, using a copper impregnated graphite release bearing assembly is fitted to all petrol and diesel models.

The assembly consists of a pressed steel cover (9) (see Fig. D.1) a cast-iron pressure plate (4) and a steel diaphragm spring (7). Also there is no requirement for lubrication.

Note: Do not disturb the cover strap drive bolts.

The diaphragm spring is pinched between two fulcrum rings (3) which are secured to the cover by special rivets (8). A clutch release lever plate assembly (5) is attached to the diaphragm spring. Finally, three retractor clips (2) bolted to the pressure plate, clip over the rim of the diaphragm spring to ensure that the pressure plate retracts during clutch disengagement.

OPERATION

When the cover assembly and driven plate is bolted to the flywheel, the diaphragm spring comes under installation load and is deflected from its free shallow coned profile to an approximately flattened condition.

This deflection, via the outer fulcrum ring, provides the load on the pressure plate. Pressure on the clutch release plate will further deflect the diaphragm spring, retracting the periphery due to the leverage about the inner fulcrum ring. This action results in the diaphragm spring load being relieved from the pressure plate, thus disengaging the clutch.

The clutch is operated hydraulically by a hydrostatic slave cylinder. No adjustment is necessary or provided for.

Hydraulic withdrawal mechanism is employed, consisting of a master cylinder directly connected to the pedal and a hydraulic fluid pipe running to the slave cylinder, which in turn is attached by the slave cylinder push rod to the withdrawal lever. The clutch pedal and withdrawal lever linkage is self adjusting and no free play exists. Provision for bleeding the system is made on the slave cylinder. (See item 23, Fig. D.4).

Under no circumstances must the clutch be lifted or pulled by means of the clutch release plate, as the alignment of the clutch release plate will be destroyed.

Master Cylinder.

This unit (Fig. D.2) incorporates a fluid reservoir and a master cylinder. Directly in front of the main rubber cup (10), when the system is at rest, is a by-pass port (3) which ensures that the system is maintained full of fluid at all times, and allows full compensation for expansion or contraction of the fluid due to changes of temperature. It also serves to release additional fluid drawn into the cylinder from the annular space formed by the reduced skirt of the piston (12), through the small holes in the piston, after each clutch application. If this additional fluid is not released to the reservoir through the by-pass port, due to the holes in the piston being choked by foreign matter, pressure will build up in the system. In order that the rubber cup shall not tend to be drawn into the holes in the piston head, a piston washer (11), is interposed between the two parts; it is important that this washer be assembled as shown on the illustration.

Slave Cylinder.

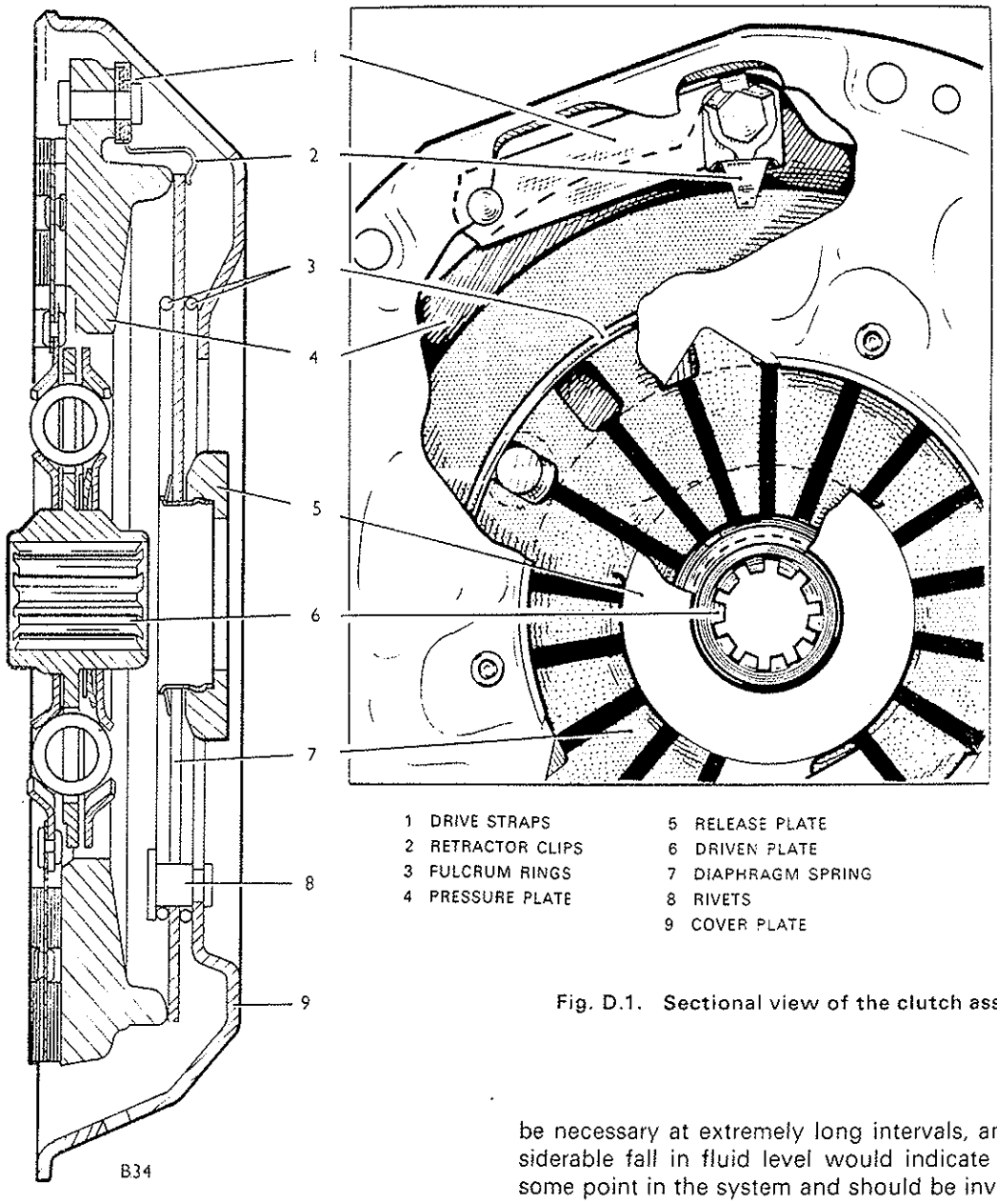
The slave or operating cylinder works on similar principles to the hydraulic brake wheel cylinder and consists of the following parts (see Fig. D.3):

A main body or cylinder assembly (2) inside which operate a piston (7), rubber cup (6), cup spreader (3), return spring (5), operating push rod to withdrawal lever (4), and rubber boot (8).

A bleeder screw (1) provides the only means of bleeding the hydraulic system. The operating push rod (4) is connected directly to the withdrawal lever by the push fork rod and a clevis pin. No adjustment is necessary between the release bearing and the release lever plate as the design of the clutch slave cylinder maintains the clutch release bearing in light contact with the release lever plate when the clutch is in the fully engaged position.

FLUID LEVEL IN MASTER CYLINDER

The hydraulic fluid is contained in a combined supply tank and master cylinder. Use only **clean** Lockheed Heavy Duty Brake Fluid to top up or to bleed the system.



1 DRIVE STRAPS
2 RETRACTOR CLIPS
3 FULCRUM RINGS
4 PRESSURE PLATE
5 RELEASE PLATE
6 DRIVEN PLATE
7 DIAPHRAGM SPRING
8 RIVETS
9 COVER PLATE

Fig. D.1. Sectional view of the clutch assembly

Re-use of fluid bled from the system is not recommended.

Replenish, if necessary, to keep the level $\frac{1}{2}$ in. (12·7 mm.) below the bottom of the filler hole boss. **Do not fill completely.** If the cylinder is over-filled, expansion of the fluid during hot weather may cause the clutch to drag. The addition of fluid should only be necessary at extremely long intervals, and a considerable fall in fluid level would indicate a leak at some point in the system and should be investigated. **Ensure that the air vent in the filler cap of the master cylinder is not choked;** blockage at this point would cause the clutch to drag.

BLEEDING THE CLUTCH HYDRAULIC SYSTEM

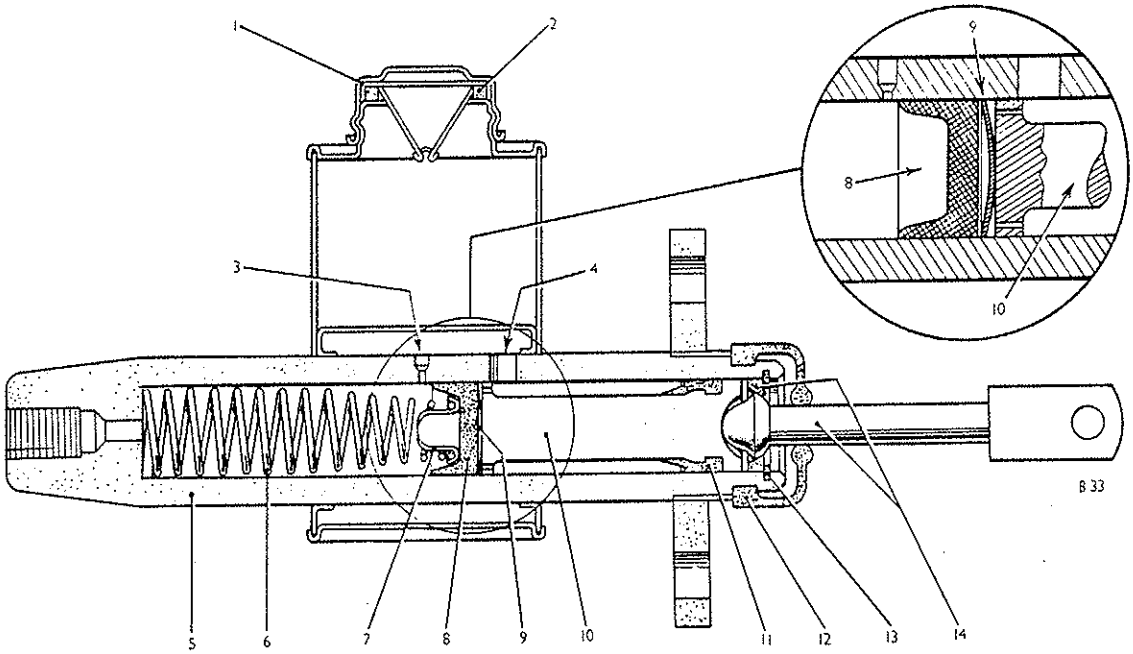
As there is no trap valve fitted in the clutch master cylinder, the normal bleeding procedure is not applicable; the following is the recommended method.

1. Fill the supply tank with brake fluid and keep it at least a quarter full throughout the operation. If this is not done, air will be drawn in necessitating a fresh start.

2. Attach a rubber tube to the bleeder screw (23) (Fig. D.4) on the slave cylinder, allowing the free end to be submerged in a little brake fluid in a clean glass jar.

CLUTCH LINKAGE ADJUSTMENT

No external adjustment to the clutch linkage is necessary or provided for, as both the clutch master and slave cylinders are designed for this purpose. The necessary clearance in the master cylinder between the push rod and the piston to ensure a full return of the piston is automatically obtained. There is no clearance at the clutch slave cylinder push rod as the clutch release bearing is maintained in

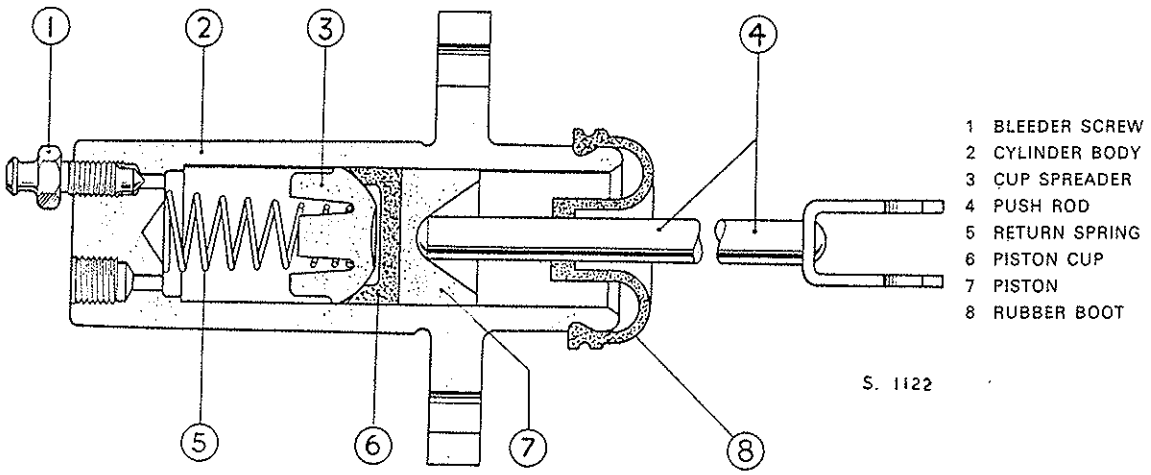


1 SUPPLY TANK CAP
2 SUPPLY TANK CAP WASHER
3 BY-PASS PORT
4 MAIN PORT
5 CYLINDER BODY
6 RETURN SPRING
7 SPRING RETAINER
8 MAIN CUP
9 PISTON WASHER
10 PISTON
11 SECONDARY CUP
12 RUBBER BOOT
13 CIRCLIP STOP
14 PUSH ROD AND COLLAR ASSEMBLY

Fig. D.2. Sectional view of the clutch master cylinder

3. Slacken the bleeder screw and depress the clutch pedal slowly; tighten the screw before the pedal reaches the end of its stroke and allow the pedal to return unassisted.

4. Repeat para. (3) until air bubbles cease to appear from the end of the tube in the jar.



1 BLEEDER SCREW
2 CYLINDER BODY
3 CUP SPREADER
4 PUSH ROD
5 RETURN SPRING
6 PISTON CUP
7 PISTON
8 RUBBER BOOT

Fig. D.3. Sectional view of the clutch slave cylinder

light contact with the release lever plate when the clutch is in the full engaged position.

CLUTCH PEDAL

To Remove.

1. Unscrew the setbolts retaining the cover panel, release the screws securing the steering gear rubber gaiter and lift out the panel and the foot pedal seals.

2. Disconnect the pipe leading to the clutch master cylinder and slacken the banjo end connection in the master cylinder to turn the end downwards.

3. With an assistant to slowly depress the clutch pedal, retain the resulting flow of hydraulic fluid from the banjo end connection, in a suitable container.

4. When the master cylinder is empty of hydraulic fluid, return the banjo union to its original position.

5. Remove the split pin from the clevis pin and depress the clutch pedal until the clevis pin aligns with the large circular hole in the pivot bracket. Tap out the pin.

6. Remove the split pin from the fulcrum pin in the pivot bracket and remove the plain and thackeray washers.

7. Tap out the fulcrum pin and withdraw the clutch pedal.

Inspection and Overhaul.

1. Examine the fulcrum pin and pedal bore for wear and renew as necessary.

2. Inspect the clevis pin for wear and renew as necessary.

To Refit.

Reverse the removal operation using new split pins and bleed the hydraulic clutch system on completion.

CLUTCH HOUSING AND WITHDRAWAL LEVER

The clutch housing and the gearbox are removed as an assembly. Therefore for details of removal and refitting the clutch housing, and the withdrawal lever refer to "GEARBOX".

CLUTCH MASTER CYLINDER

To Remove.

1. Unscrew the tapping screws and remove the protection plate covering the clutch and brake master cylinders.

2. Disconnect the pipe leading to the clutch master cylinder and slacken the banjo end connection in the master cylinder to turn the end downwards.

3. With an assistant to slowly depress the clutch pedal, retain the resulting flow of hydraulic fluid from the banjo end connection in a suitable container.

4. When the master cylinder is empty of hydraulic fluid, remove the two pedal return springs attached to the clevis pin ends.

5. Remove the split pin from the clevis retaining the push rod fork to the pedal and depress the clutch pedal until the clevis pin aligns with the large circular hole in the pivot bracket. Tap out the pin.

6. Remove the two bolts and nuts securing the master cylinder to the pivot bracket and detach the cylinder and the push rod.

To Dismantle.

1. Remove the rubber boot. Push the piston (13) down the bore of the cylinder sufficiently to enable the circlip (12) to be withdrawn. Detach the push rod and its collar.

2. Withdraw the piston, piston washer (15), main cup (16) retainer (17) and return spring (18) from the cylinder bore.

3. Using only the fingers, to prevent damage, remove the secondary cup (14) by stretching it over the end flange of the piston.

Inspection and Overhaul.

1. Inspect the cylinder bore and piston for scores or damage and renew if evident.

2. Ensure that the small holes drilled in the piston head are not obstructed.

3. It is usually advisable to renew the main and the secondary cups.

4. Ensure that the piston return spring is in good condition. Free length should be, 3·32/3·44 in. (84·32/87·38 mm.). Spring rating is 5·64/6·36 lb. (2.56/2·89 kg.) at 2·18 in. (55·37 mm.).

5. Check that the small breather hole in the supply tank cap is unobstructed.

6. Renew the rubber boot if it has deteriorated or has split.

To Re-assemble.

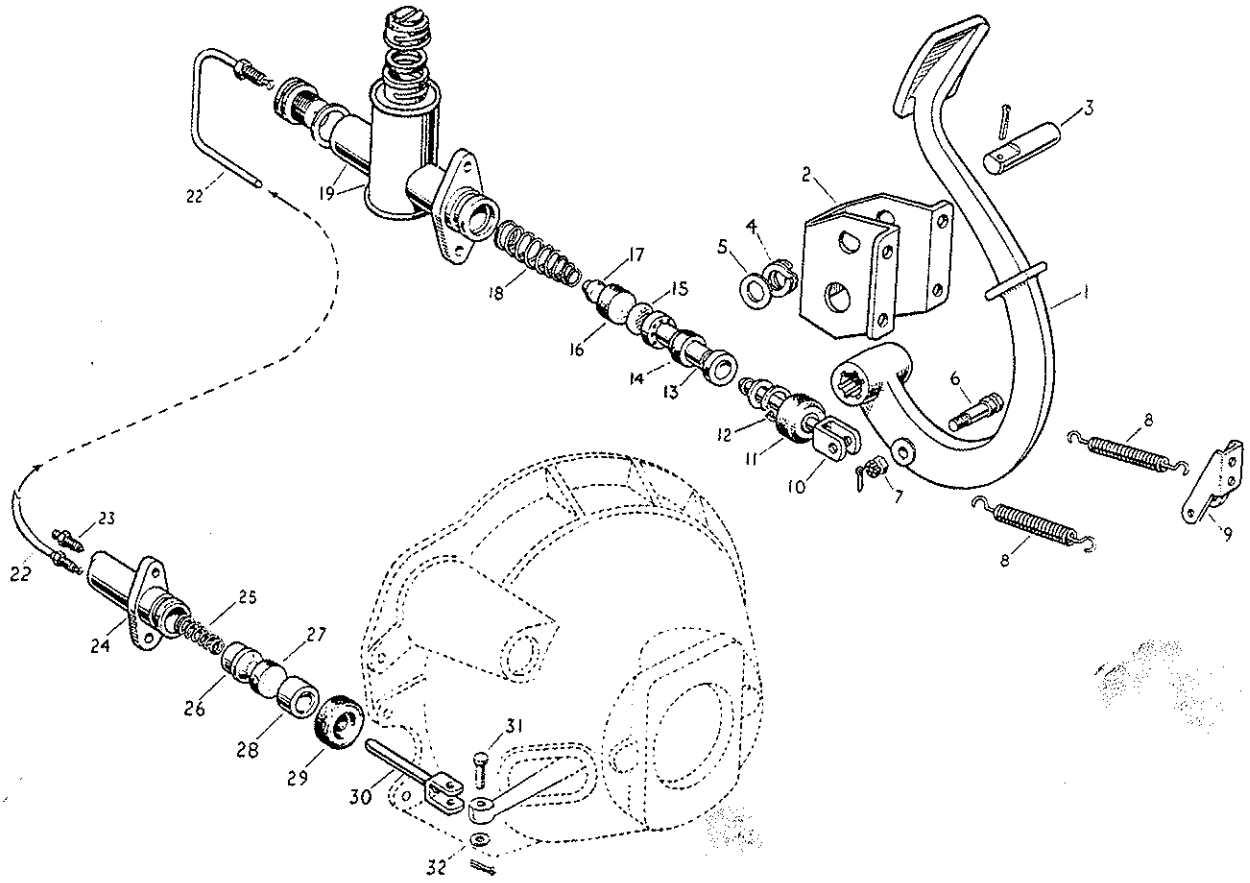
1. All components should be dipped in clean brake fluid and assembled wet. Fit the secondary cup on the piston with the lip facing the drilled piston head. Gently work the cup round the piston groove with the fingers to ensure that it is properly seated.

2. Assemble the retainer (17) to the smaller end of the return spring and insert the assembly into the cylinder.

3. Fit the main cup in the cylinder bore, lip foremost taking care not to damage or turn back the lip of the cup.

4. Assemble the piston washer as shown in Fig. D.2.

5. Fit the rubber boot over the fork end of the push rod. Insert the push rod complete with collar into the piston end cavity and push the piston down the



S.1118.

1 CLUTCH PEDAL
2 PIVOT BRACKET
3 FULCRUM PIN
4 THACKERAY WASHER
5 PLAIN WASHER
6 CLEVIS PIN
7 CLEVIS PIN NUT
8 RETURN SPRING
9 RETURN SPRING BRACKET
10 PUSH ROD AND COLLAR ASSEMBLY
11 RUBBER BOOT
12 CIRCLIP STOP
13 PISTON
14 SECONDARY CUP
15 PISTON WASHER
16 MAIN CUP
17 SPRING RETAINER
18 PISTON RETURN SPRING
19 SUPPLY TANK AND CYLINDER ASSEMBLY
22 HYDRAULIC PIPE
23 BLEEDER SCREW
24 SLAVE CYLINDER BODY
25 PISTON RETURN SPRING
26 CUP SPREADER
27 PISTON CUP
28 PISTON
29 RUBBER BOOT
30 PUSH ROD
31 CLEVIS PIN
32 PLAIN WASHER

Fig. D.4. Exploded view of the clutch pedal group, the clutch master cylinder and the clutch slave cylinder

cylinder bore to enable the circlip to be refitted evenly in the groove. Operate the cylinder several times to ensure that the push rod collar is retained by the circlip.

6. Slide the rubber boot along the push rod until the open end can be pushed into the groove on the exterior of the cylinder.

Note: Fill the boot with Lockheed 'Rubberlube' prior to refitting.

To Refit.

Reverse the removal operations. Fill the reservoir with clean brake fluid to the correct level and bleed the system as previously described. Check for leakage before and after applying firm pressure to the clutch pedal.

SLAVE CYLINDER

To Remove.

1. Disconnect the pipe leading to the slave cylinder.

2. Unscrew the two bolts and nuts securing the slave cylinder and slip the rubber boot free of the cylinder body. Remove the slave cylinder. The push rod and the rubber boot may be left attached to the withdrawal lever.

To Dismantle.

By applying a **low** air pressure to the fluid connection end, the internal parts can be expelled.

Inspection and Overhaul.

1. Inspect the cylinder bore and piston for scores or damage and renew if evident.

2. Renew the rubber cup.

3. Renew the rubber boot if it has deteriorated or is split.

To Re-assemble.

All components should be dipped in clean brake fluid and assembled wet.

1. Refit the return spring in the cup spreader groove and insert the assembly, spring innermost into the cylinder bore.

2. Re-assemble the cup in the cylinder bore, lip leading, ensuring that the lip is not turned back or buckled.

3. Insert the piston, flat face innermost.

4. Fill the boot with Lockheed 'Rubberlube' and locate the boot in the groove on the exterior of the cylinder body.

To Refit.

Reverse the removal procedure and bleed the system.

CLUTCH DRIVEN PLATE

To Remove and Refit.

The clutch housing and the gearbox are removed as an assembly. Therefore, for details of removal and refitting the clutch housing and the withdrawal lever, refer to the "GEARBOX" section of this Workshop Manual.

Remove the gearbox complete with the bell housing.

Remove the setscrews securing the clutch cover to the flywheel. It is important that these should be slackened off evenly in order to prevent undue strain being applied to the cover at any one point. Remove the clutch assembly together with the driven plate.

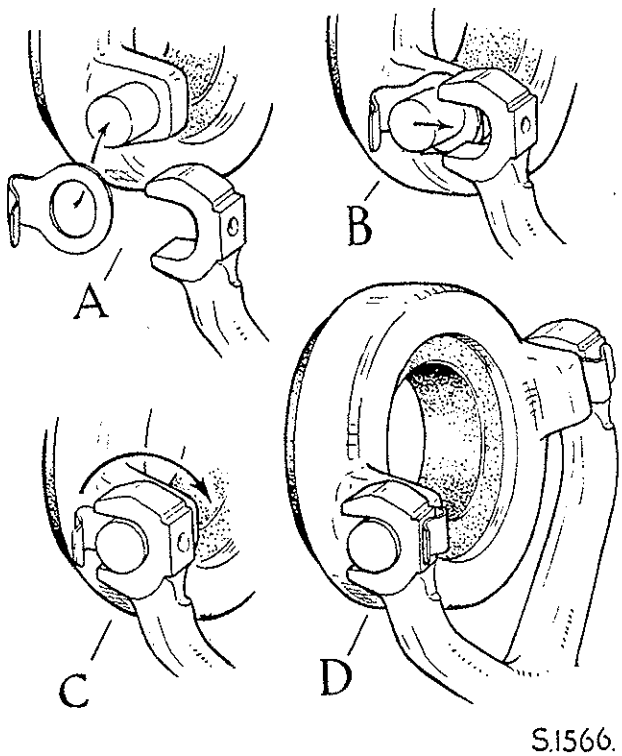


Fig. D.5. Fitting the release bearing

The driven plate should be examined for wear and damage as follows:

1. The internal splines of the hub should be checked for wear by placing the driven plate on to a new gearbox primary shaft and checking for backlash. If this is excessive, the driven plate must be renewed.

2. If oil has found its way on to the facings, the driven plate must be renewed. When refitting the clutch driven plate the smaller boss of the hub should face towards the flywheel, and the internal splines must be lubricated with a waterproof grease such as Shell SB. 2498 (Home) or S. 1926 (Export).

Place the driven plate in position using Churchill Tool R.G.41 (clutch centralising tool) fitted through the hub of the plate, so that the plate may be located correctly when the clutch cover is fitted.

The foregoing instructions must be strictly adhered to, otherwise it will be impossible to enter the gearbox primary shaft into the crankshaft spigot when refitting the gearbox.

Locate the clutch cover on its dowels. Tighten the securing screws evenly. Refit gearbox, complete with the bell housing, as detailed under "GEARBOX".

Refill the clutch master cylinder with fluid and bleed the hydraulic system from the slave cylinder bleeder screw.

COVER ASSEMBLY

No servicing should be attempted on this assembly, as the unit is built and balanced during manufacture, and must be renewed, if necessary, by a complete assembly. The removal and refitting operations are identical to those detailed for the "CLUTCH DRIVEN PLATE" in the previous sub-section.

RELEASE BEARING

The release bearing assembly is retained to the clutch fork by two spring steel clips, which are located by two flats on the reverse side of the fork (see Fig. D.5).

To Remove.

Rotate the clips over the end of the fork, and detach the bearing.

To Refit (See Fig. D.5.)

Place the retaining clips on the release bearing trunnions (A).

Push the bearing into place on the fork (B), with the retaining clips between the bearing and the fork.

Rotate each retaining clip into position (C) until it locates on the flat on the fork (D).

PROPELLER SHAFT

DESCRIPTION

All models incorporate fully sealed needle roller bearing type universal joints. The sliding splined sleeve of the propeller shaft is enclosed within the rear end cover of the gearbox and is driven by the splined rear end of the gearbox mainshaft. Oil from the gearbox lubricates the sliding splines and an oil seal fitted in the end of the gearbox rear cover prevents the possibility of leakage at this point. At the rear end of the propeller shaft, a fixed universal joint is bolted to the rear axle coupling flange. A "U" shaped propeller shaft guard is fitted to a crossmember of the body underframe.

LUBRICATION

The sliding sleeve and reverse spline is lubricated by oil from the gearbox and requires no attention other than periodic cleaning and checks for oil leaks.

The two universal joints are packed with lubricant during assembly and a greaser is fitted to each joint to enable the lubricant to be replenished at the recommended intervals.

PROPELLER SHAFT

To Remove.

1. Remove the bolts, nuts and shakeproof washers securing the propeller shaft to the rear axle coupling flange.

2. Lower and withdraw the propeller shaft in a rearward direction.

To Dismantle.

The needle bearing type universal joints are so designed that correct assembly is a very simple matter, no hand fitting or special tools being required.

The greaser fitted to each journal should be removed before commencing to strip the universal joints.

Individual parts of the needle roller bearing assemblies should not be renewed singly. If replacements are found to be necessary, the complete set of bearing parts comprising journal complete with needle bearing assemblies, cork gaskets, gasket retainers and snap rings should be fitted.

The journal and needle bearing assemblies are the only parts subject to wear after prolonged service, and when it becomes necessary to renew these for any reason, the work should be carried out as follows:

1. Remove the snap rings by pinching together the ring ends using a suitable pair of pliers and prise out with a screwdriver. If the ring does not readily snap out of the groove, remove the surrounding enamel, dirt, etc., from the yoke bore and tap the end of the bearing race lightly to relieve pressure against the ring.

2. After lifting out the snap rings, remove any accumulation of foreign matter from the yoke bores,

or burrs around the snap ring grooves, in order to provide easier extraction of the bearing races.

3. Support the propeller shaft and lightly tap the radius of the yoke ear with a copper hammer as shown in Fig. D.7.

The top needle bearing race will gradually emerge; turn the propeller shaft and finally withdraw the bearing with the fingers. Ensure that the bearing is removed in the bottom position to prevent loss of the needle rollers (see Fig. D.8.).

4. Repeat para. (3) operation on the opposite bearing race and separate the flange yoke or sleeve yoke from the propeller shaft.

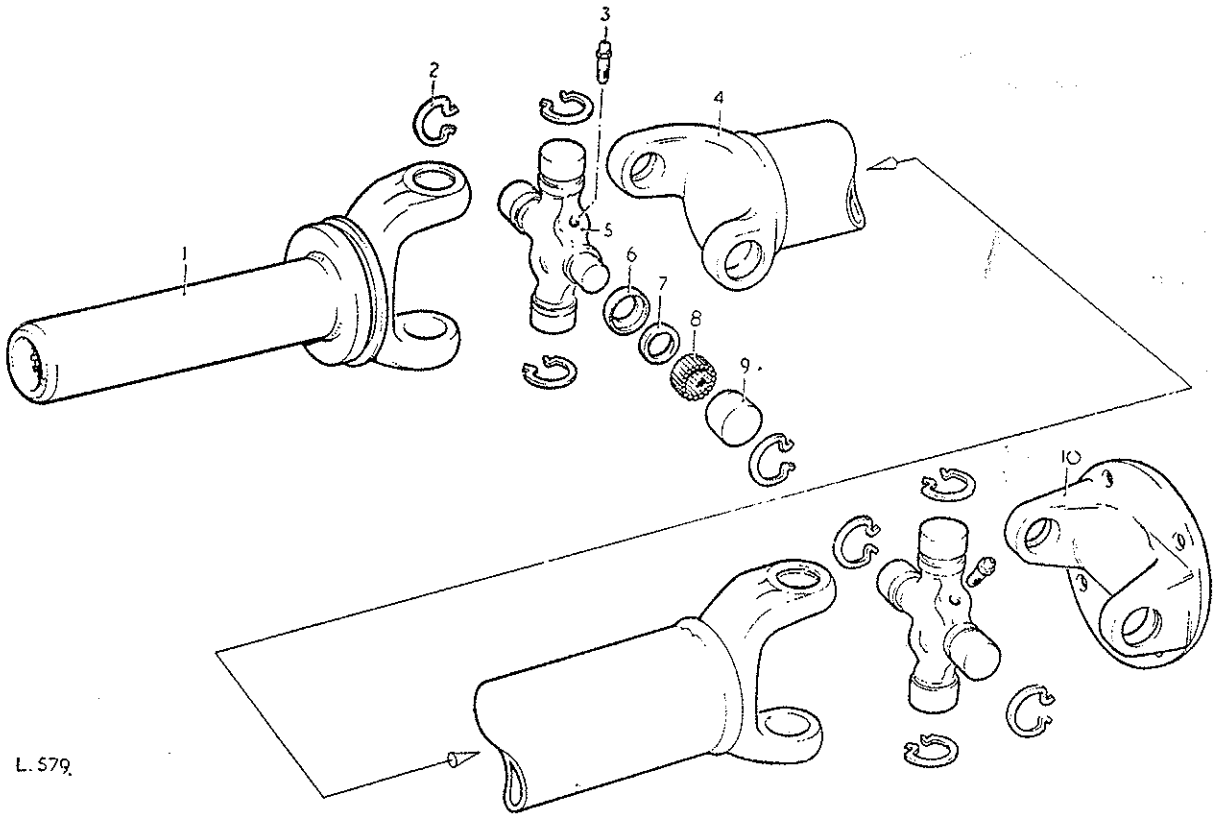
Inspection and Overhaul.

Clean all parts thoroughly with petrol.

1. Check the flange and sleeve yoke cross bores. If ovality exists, renew the flange or sleeve yoke.

2. If the inner yoke cross bores (on the propeller shaft) are oval, it is necessary to renew the propeller shaft as this yoke is welded to, and balanced with, the tubular shaft.

3. Examine the securing bolt holes in the flange yoke and the rear axle coupling flange for damage or elongation. Renew either part if evident.



1 SLEEVE YOKE
2 SNAP RING
3 GREASER
4 TUBULAR SHAFT ASSEMBLY
5 JOURNAL
6 GASKET RETAINER
7 CORK GASKET
8 NEEDLE ROLLERS
9 NEEDLE ROLLER HOUSING
10 FLANGE YOKE

Fig. D.6. Exploded view of propeller shaft

5. Support the two exposed journal pegs on wood or lead blocks to protect their ground surfaces and lightly tap the yoke ear to remove the bearing race. Reverse the universal joint and repeat the operation to tap out the remaining bearing. Ensure that the needle rollers are prevented from dropping and becoming lost.

6. Remove the journal cross from the flange yoke or sliding sleeve.

4. Check the journal crosses, bearing races and needle rollers for wear, and signs of rusting or pitting. The bearing races should be a light drive fit in the yoke bores. Needle rollers, bearing races and journal crosses must be renewed as complete assemblies.

5. Check for slackness of the internal splines of the front sliding sleeve, in relation to the external splines of the gearbox mainshaft.

To Re-assemble.

1. Ensure that all parts have been washed thoroughly in petrol.

2. Fill each bearing race half full with the recommended grease.

Should any difficulty be encountered when assembling the rollers, smear the walls of the housings with lubricant.

3. Coat the journal shoulders with jointing compound before fitting the gasket retainer, in order to provide a good seal. Wipe all traces of jointing compound from the journals, after the retainers have been fitted. Insert the cork gaskets into the retainers.

4. Insert the journal cross into the flange yoke, tilting it to engage in the yoke bores.

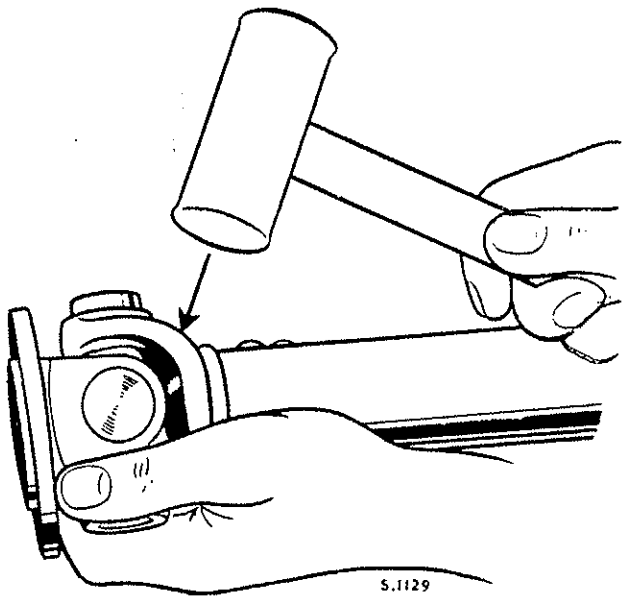


Fig. D.7. Removing the bearing cage by lightly tapping the yoke radius

5. Fit one of the bearing races in the yoke bore in the bottom position and using a soft round drift slightly smaller in diameter than the bearing, tap the race into the yoke bore until it is possible to fit the snap ring and at the same time centralise the journal cross in the yoke.

6. Carefully move the journal cross to allow the appropriate journal peg to protrude from the yoke bore and fit the next bearing race in the same manner as described in paragraph 5.

7. Refit the flange yoke and journal cross to the propeller shaft by repeating the operations in paragraphs 6 and 7.

8. When all the bearing races and snap rings are in position remove the excess of grease exuding through the tapped hole in the journal and refit the greaser securely.

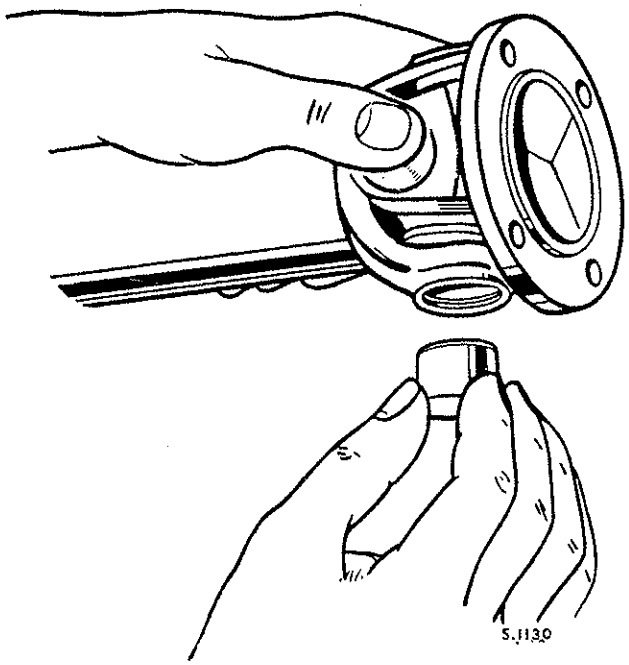


Fig. D.8. Removing the bearing cage in the bottom position

9. The re-assembly of the sliding sleeve yoke to the propeller shaft is identical to the flange yoke operation.

10. Ensure that all snap rings are seating correctly in their respective grooves and that the races are bearing against the snap rings.

To Refit.

Refitting is a reversal of the removal procedure with attention to the following points.

1. Before refitting the shaft, ensure that the splines and the sleeve of the sliding sleeve are free from dirt, grit or sharp edges. Lightly lubricate the splines before entry.

2. Always use new shakeproof washers under the nuts of the securing bolts and fit the bolts in the rear axle coupling flange with the bolt heads facing the differential unit.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
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GEARBOX

SECTION E

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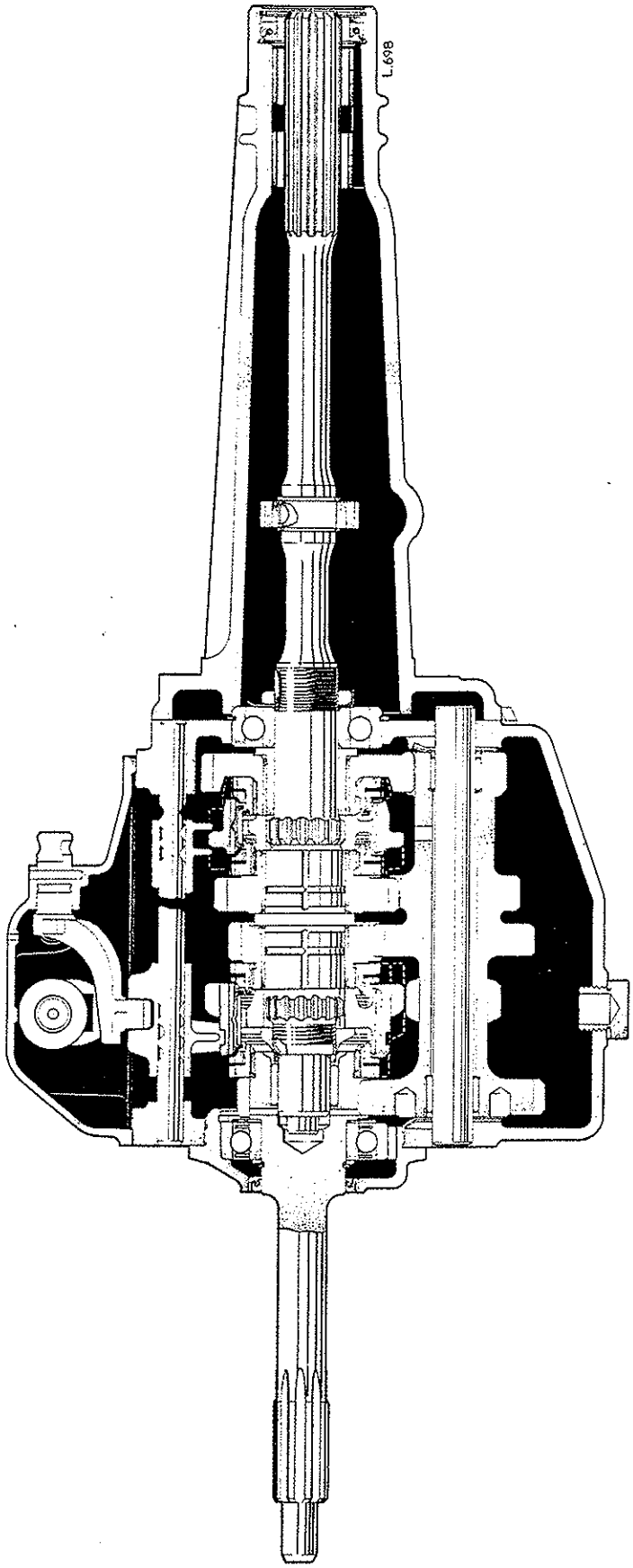


Fig. E.1. Sectional view of the gearbox assembly

GEARBOX

DESCRIPTION

The gearbox provides four forward speeds and one reverse. Helical teeth gears in constant mesh are used on all forward gears which are engaged by synchro-mesh action through dog clutches. A spur gear is employed for reverse which is of the sliding mesh type.

The drive from the engine is taken by the primary shaft which is splined at its forward end for mating with the clutch driven plate. Also, incorporated at the forward end is a spigot which registers with a bush pressed into the rear of the crankshaft. At the opposite end of the primary shaft, protected by a chip shield, is a ball bearing race which registers in the cover at the front of the gearbox casing. It is retained on the primary shaft by a spring ring and is located by a further spring ring fitted in a groove in the inside of the front cover. An oil seal pressed into the front cover prevents lubricant from escaping at this point.

Assembled in a counterbore in the rear end of the primary shaft are 23 needle rollers which support the spigot on the front of the mainshaft. The rear of the mainshaft is carried by a ball bearing race fitted in the gearbox casing and is located in the casing by a spring ring fitted in a groove on the circumference of the bearing outer race.

To the rear of the bearing is the speedometer drive gear key on the mainshaft extension and secured against longitudinal movement by circlips fitted into grooves in the mainshaft on each side of the drive gear. Assembled midway along the rear cover is an adaptor for the speedometer drive pinion. The pinion shank locates in the bore of the pinion bearing and to prevent oil from rising and passing along the inside of the speedometer cable, an oil seal is fitted in the bore of the pinion adaptor. Two bushes, pressed in the rear cover, support the front end of the propeller shaft and to safeguard against the lubricant seeping along the splines of the propeller shaft an oil seal is fitted in the farthest end of the cover.

The 3rd and 4th gear synchronising hub assembly is located on the mainshaft behind the primary shaft. It consists of a synchronising hub, a sliding sleeve, three shifting plates, and two synchro circlips. The hub which is splined internally is a push fit on the mainshaft splines and is retained by a nut securing the hub to a shoulder at 80 lb.ft. (11·06 kg.m.) torque. The outer circumference of the hub is splined for engaging selectively with the sliding sleeve and slotted longitudinally to accommodate three equally spaced shifting plates. A small protrusion formed midway along the shifting plate engages with a detent groove inside the shifting sleeve. The shifting plates are loaded in the sleeve by the two synchro circlips, one on each side of the synchronising hub, which register against the inside faces at the ends of the shifting plates.

A bushed 3rd speed gear is carried on the mainshaft between the 3rd and 4th gear synchronising hub assembly and a collar integral with the mainshaft. Thus, end float of the third gear is controlled by design, and is non-adjustable. Located on each side of the synchronising hub assembly are baulk rings which mate with the cones on the primary shaft and the 3rd speed gear respectively. The baulk rings incorporate a fine thread which is designed to break down the oil film rapidly as the rings engage with the respective gear cones. Each baulk ring also has three slots for engaging the ends of the shift plates and external dog teeth for engaging with the splines of the sliding sleeve. The bushed 2nd speed gear is located behind the collar integral with the mainshaft. A baulk ring, similar to those described previously, locates on a cone at the rear of the gear.

The 1st and 2nd speed synchronising hub is located on the mainshaft between the 2nd speed gear and the mainshaft rear bearing. It is splined internally to mate with the mainshaft splines, and located on each side of the synchronising hub assembly are baulk rings which mate with the cones on the 2nd and 1st speed gears respectively. Longitudinal slots on the outer circumference of the hub locate three equally spaced shifting plates, which are located similarly to the shifting plates on the 3rd/4th synchro-nising hub.

The bushed 1st speed gear operates on a collared steel bush placed on the mainshaft and abutting the rear main bearing. Thus end float of the 1st speed gear is controlled by design and is non-adjustable. A baulk ring similar to those described previously, locates on a cone at the front of the gear, with the change speed motion of the sliding sleeve, taking place in the recess of the gear.

The layshaft cluster gear is carried on needle rollers at the front and rear of the layshaft spindle which is a light push fit in the bore at the front face of the gearbox casing and a clearance fit in the rear bore of the casing. An abutment ring at the front and rear locate the needle rollers, together with steel backed phosphor bronze thrust washers which are positioned each end of the layshaft spindle against the casing, by tags fitting into recesses cast in the casing inside faces.

The layshaft spindle is retained to the casing by a plate which engages in a slot in the spindle and is bolted to the rear face of the casing.

The reverse gear is located on the nearside of the gearbox towards the front face, and is mounted in position by a stepped shaft passing through the front face of the gearbox and through a drilling in a web on the inside of the gearbox. The stepped shaft has two cut-aways, one on the larger diameter, to allow the rotation of the cluster gears and the other to prevent the shaft from rotating, by the use of a dowel pressed into the gearbox casing and passing over the flat on the end of the shaft.

The reverse gear is a straight tooth type and meshes, when in operation, with the teeth round the circumference of the sliding sleeve on the 3rd and 4th synchronising hub.

The selector forks are carried on rods assembled into the top of the gearbox casing. Spring loaded balls housed in bosses in the selector forks engage grooves machined in the selector rods to retain the gear in neutral, or the selected gear.

The gearbox top cover houses the selector and change speed lever shafts carrying the internal levers which operate in the slots machined in the top of the selector forks. Also incorporated in the top cover is the "neutral detent" mechanism, which operates on the internal change speed lever shaft to provide a detent to locate the neutral position of the shaft and to facilitate initial axial adjustment of the change speed lever during manufacture.

OPERATION

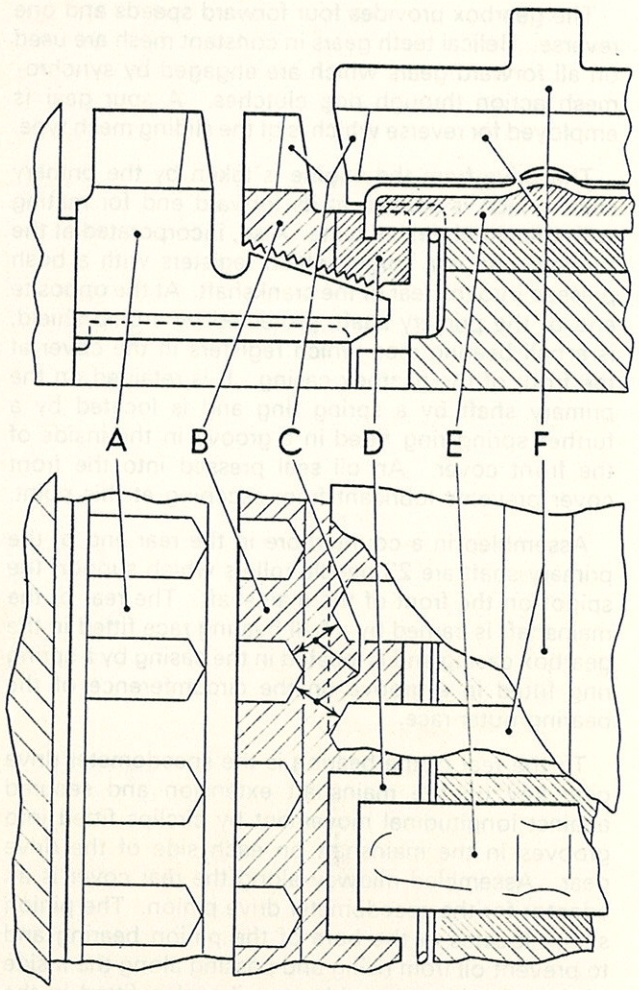
The gearbox mainshaft rotates at propeller shaft speed. With the clutch disengaged, the primary shaft, layshaft, and gears rotate freely.

Drive will be engaged by postively connecting the selected gear to the mainshaft. This is achieved by means of the sliding sleeves for 1st/2nd, and 3rd/4th. The sleeve slides on the external splines of the respective synchro hub and engages with dog-teeth on the selected gear. But before it can do so the speeds must be synchronised. The synchromesh mechanism operates thus (see Fig. E.2) :

Engaging gear from the neutral position, initial movement of the gear lever moves the sliding sleeve (F) pushing the shifting plate (E) and baulk ring (B) in the direction of (A) which is about to drive.

The baulk ring engages with the cone on the gear and the difference in speed between the gear and the baulk ring causes the baulk ring to be dragged round until it is constrained by the shifting plate.

Due to the designed width of the shifting plate recess (D) in the baulk ring, the teeth on the baulk ring are now out of register with those on the sliding sleeve by half a tooth width, such that the chamfered faces (C) of the teeth on the baulk ring and the sliding sleeve bear upon each other.



A = DOG TEETH OF THE SELECTED GEAR
B = BAULK RING
C = CHAMFERED FACES OF THE BAULK RING AND THE SLIDING SLEEVE
D = SHIFTING PLATE RECESS
E = SHIFTING PLATE
F = SLIDING SLEEVE

Fig. E.2. Operation diagram of the synchromesh mechanism

As the baulk ring is in contact with the gear cone and the baulk ring in contact with the sliding sleeve, the force exerted by the driver on the gear lever is pressing the baulk ring against the gear cone. Friction between the two mating surfaces will eventually cause them to rotate at the same speed and until this takes place, full engagement is prevented by the "out-of-register" position of the baulk ring teeth.

When synchronisation takes place, i.e., when there is no difference in speed, the baulk ring is no longer

dragged "out-of-register", and further pressure by the driver on the gear lever effects engagement.

The reverse gear is of the sliding mesh type and therefore is not engaged by synchromesh action. It is operated by sliding the reverse gear along the reverse shaft into mesh with both the layshaft and the mainshaft.

LUBRICATION

Gearbox.

A combined filler and level plug aperture is located on the side face of the gearbox and is accessible from beneath the vehicle.

At intervals of 6,000 miles (10,000 kms.), the oil should be completely drained and the gearbox refilled to the correct level with fresh clean oil of the recommended grade.

The correct oil level is to the bottom edge of the filler plug aperture. The oil level should never be allowed to drop below this level.

Change Speed Remote Control Mechanism.

The change speed level ball and pin in the top of the change speed housing assembly, the **reverse plunger** and the **relay shaft ball socket** are lubricated on assembly at the factory and normally should not require periodical lubrication. These parts should receive attention only during periodical workshop overhaul of the vehicle.

If, however, due to certain operating conditions, stiffness in the remote control mechanism is experienced when selecting gears, the linkage points mentioned above should be checked for lubrication and, if necessary, cleaned and relubricated with Shell 4768 Grease. As this operation involves partial dismantling of the remote control mechanism the work should be carried out by the nearest Distributor or Dealer.

The lubricating nipple located on the **relay shaft trunnion** must receive regular lubrication using Shell Retinax A or Shell Spirax 140 E.P. and at the same time the **universal joint** on the gear change relay shaft should receive oil can attention.

Under normal operating conditions no lubrication of the ball joints on the gear selector rod or the spherical bushes in the front and rear relay support brackets should be found necessary. If, however, tightness is experienced at these points, then oil can attention is permissible.

SPEEDOMETER DRIVE CABLE

To Remove.

1. Unscrew the knurled nut which connects the drive cable to the pinion adaptor assembled in the gearbox rear cover.

2. Unscrew the knurled nut securing the drive cable to the speedometer and then release the inner cable from the instrument.

3. Slowly draw the cable into the cab interior, after removing the grommet in the toe-panel, taking care not to damage any of the electrical leads.

Inspection.

1. Examine the inner cable at the squared ends and renew the cable if the corners have worn appreciably.

2. Check both cables for kinks or other damage and renew if necessary.

Note: Either cable may be renewed separately.

To Refit.

This is carried out by reversing the removal operation, smearing a film of light oil over the inner cable prior to installing it in the outer casing.

SPEEDOMETER DRIVE GEARS

To Remove.

1. Disconnect the drive cable at the gearbox.

2. Remove the two setscrews securing the pinion adaptor and lift out the adaptor and the joint. Remove the oil seal from the adaptor bore if necessary.

3. Remove the pinion bearing complete with the driving pinion. Separate the driving pinion from the bearing.

4. The speedometer drive gear on the mainshaft is removed in the following manner:

(*a*) Remove the propeller shaft.

(*b*) Drain the oil and suitably support the rear of the engine and gearbox assembly as the rear support for this assembly will be removed with the gearbox rear cover. Remove the rear cover.

(*c*) The speedometer drive gear is keyed to the mainshaft extension and secured against longitudinal movement by circlips fitted into grooves in the mainshaft on each side of the drive gear.

On removal of the circlips, the drive gear can be easily removed from the mainshaft.

Inspection and Overhaul.

1. Examine the teeth of the pinion and the spiral of the drive gear. If damaged or worn, the faulty component should be renewed.

2. Examine the condition of the oil seal and renew as necessary.

To Refit.

Refitting is a reversal of the removal procedure ensuring that the circlips are securely located in their grooves.

REMOTE CHANGE SPEED CONTROL

To Remove and Dismantle.

1. Ensure that the change speed lever is in the neutral position and unscrew the four setscrews securing the fulcrum housing to the floor panel.

2. Lift the lever and housing from the cab toe-panel.

3. Dismantle the change speed lever and fulcrum housing assembly as follows:

(*a*) Release the four screws securing the retaining cap on the top of the housing.

(*b*) Lift out the lever assembly. Remove the ball pin and tap off the spherical ball to release the closing disc and the cap spring from the lever.

(*c*) Release the two setscrews securing the reverse stop plunger cap to the housing noting that this cap is under compression from the plunger spring, and remove the cap, plunger and spring.

4. Remove the lockwire and unscrew the dowel screw retaining the lever ball socket to the front end of the change speed rod. Slide off the ball socket.

5. Release the setscrews securing the change speed rod front support bracket, to the body crossmember and slide the bracket off the rod.

1	GEAR CHANGE LEVER	15	GAITER
2	LEVER RETAINING CAP	16	TRUNNION ASSEMBLY
3	BALL SPRING CAP	17	TRUNNION BUSH
4	BALL SPRING	18	SUPPORT BRACKET
5	BALL	19	SELECTOR LEVER
6	PIN	20	RELAY SHAFT ASSEMBLY
7	FULCRUM HOUSING	21	SELECTOR ROD
8	REVERSE STOP PLUNGER	22	COUPLING
9	REVERSE STOP SPRING	23	COUPLING PIN
10	REVERSE STOP CAP	24	YOKE
11	CHANGE SPEED ROD	25	PIVOT PIN
12	SUPPORT BRACKET	26	COUPLING PIN SCREW
13	BALL SOCKET	27	CHANGE LEVER KNOB
14	BALL SOCKET SCREW	28	SELECTOR BALL JOINT
		29	SELECTOR LATCH LEVER

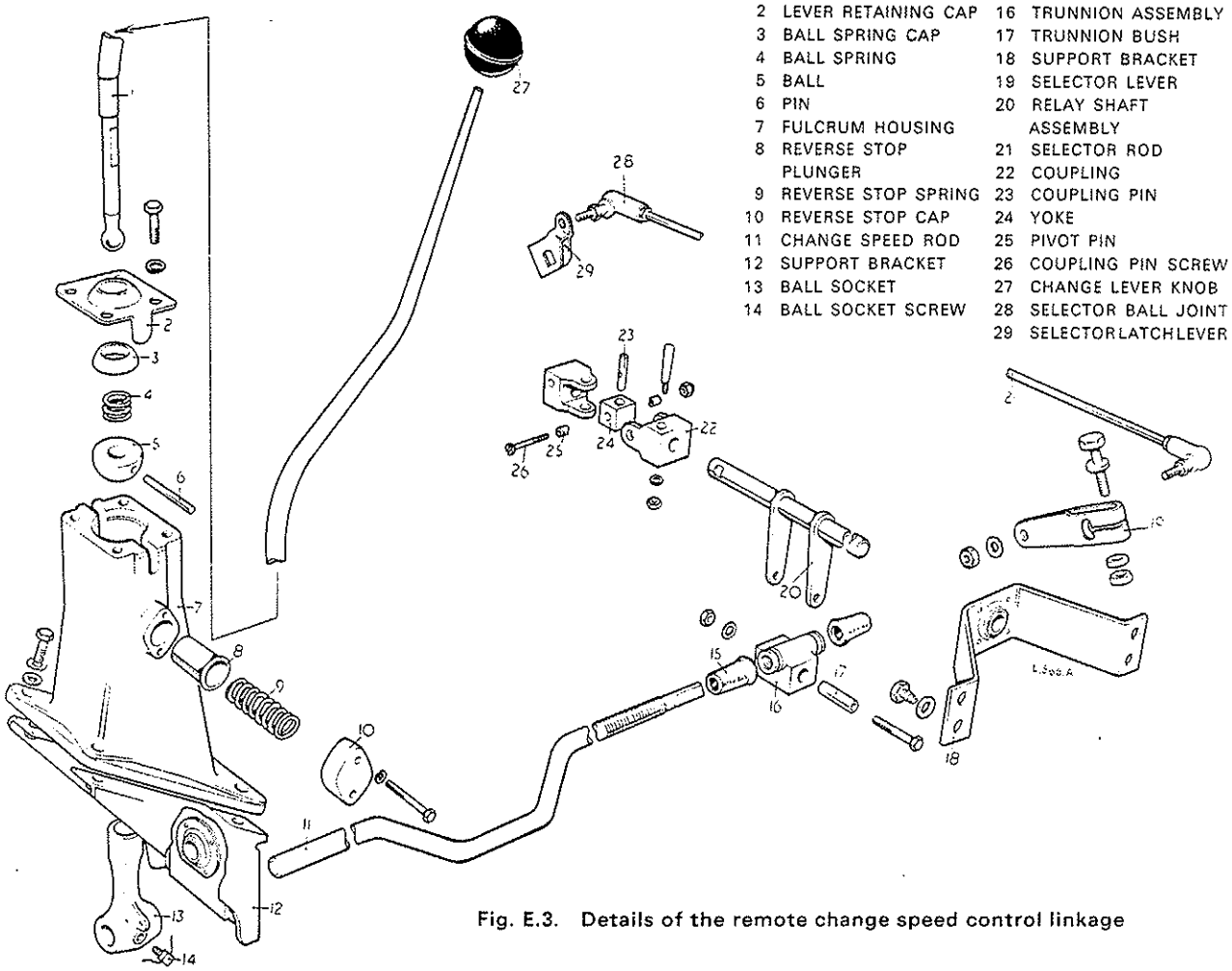


Fig. E.3. Details of the remote change speed control linkage

6. Slacken the nut securing the external selector lever to the gearbox safety latch and remove the lever.

7. Disconnect the selector lever from the change speed rod and withdraw the selector rod assembly complete with the selector levers.

8. Slide the front rubber gaiter clear of the trunnion and withdraw the rear rubber gaiter from the change speed rod.

9. Remove the nut, bolt and bush securing the trunnion assembly to the relay cross shaft assembly.

10. Withdraw the change speed rod and trunnion assembly, noting the distance from the trunnion assembly to the end of the rod before dismantling.

11. Remove the nut, washer and cotter pin securing the relay cross shaft assembly to the selector shaft coupling.

12. Release the four screws securing the cross shaft support bracket to the body underframe member.

13. Withdraw the relay cross shaft from the coupling and slide the rear support bracket from the end of the shaft.

Inspection and Overhaul.

Thoroughly clean all components before examination. Any component which is worn excessively should be renewed.

1. Inspect the change speed lever housing for wear or ridging on the ball seat and also inspect the corresponding ball of the lever for similar conditions. Check for wear at the ball pin slots and at the ball pin.

2. Check the flat on the change speed lever which engages with the reverse stop plunger for wear and also inspect the contact face of the plunger for wear.

3. Check the lever cap spring and the reverse stop plunger spring for weakness (see "GENERAL DATA").

4. Examine the spherical bushes in the front and rear support brackets for wear and renew the brackets if evident. The bushes should swivel in their retaining cups but should not be slack.

5. Inspect the ball joints of both operating rods for wear and ensure that the ball joints are free in operation

6. Examine the foot of the change speed lever and the corresponding seating in the ball socket for wear and renew as necessary.

7. Inspect the relay shaft for damage, particularly check the drilled holes for the dowel screws in the shaft for wear or elongation.

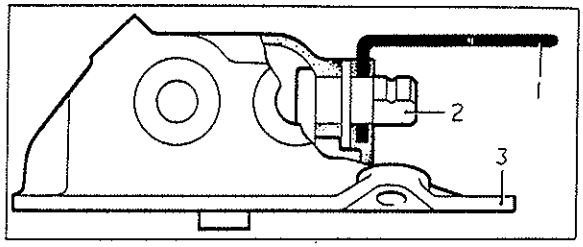
To Re-assemble and Refit.

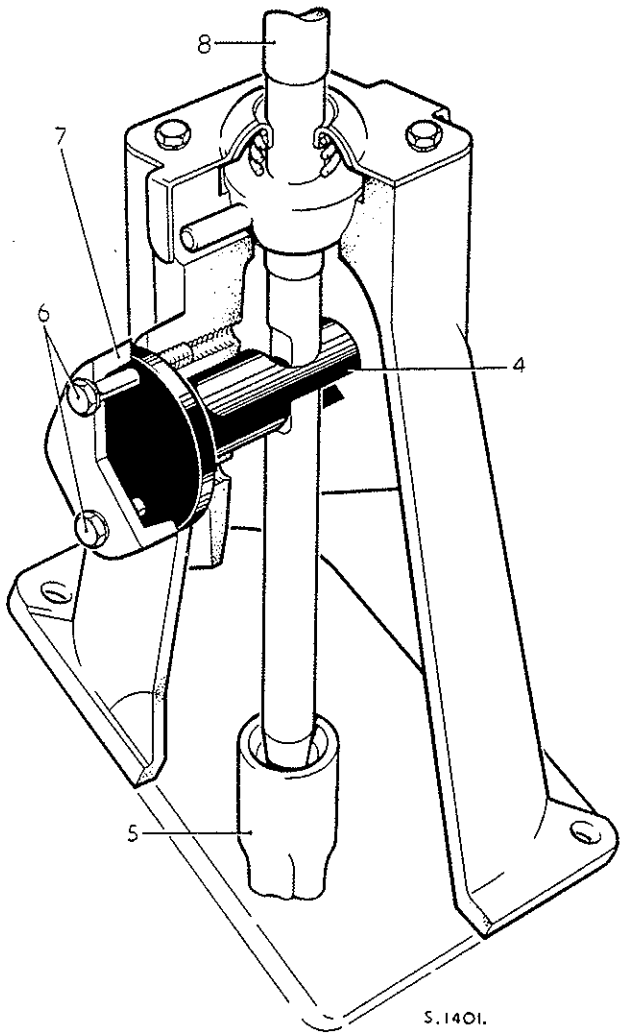
Re-assembly and refitting is a reversal of the removal and dismantling procedure, noting the following:

1. Under normal operating conditions, no lubrication of the ball joints on the gear selector rod or the spherical bushes in the front and rear relay support brackets should be found necessary. If, however, tightness is experienced at these points, then oil can attention is permissible.

2. Leave the trunnion and selector lever on the change speed rod disconnected.

3. Before assembling the reverse stop plunger, spring, and cap to the fulcrum housing, insert Churchill Tool R.G.255 into the reverse stop bore, keeping the slot in a vertical position. When the lugs of the tool are located on either side of the gear change lever, turn anti-clockwise until the two holes





1 SETTING PIN (R.G.255)
2 SELECTOR LATCH
3 TOP COVER
4 SETTING TOOL (R.G.255)
5 BALL SOCKET
6 REVERSE STOP BOLTS
7 REVERSE STOP CAP
8 GEAR CHANGE LEVER

Fig. E.4. Setting the remote control gear change mechanism using Churchill Tool No. R.G.255

in the flange are in line with those in the fulcrum housing, thus securing the lever in the third and fourth neutral position. Secure the flange of the tool

to the fulcrum housing using the reverse stop plunger cap and the two securing screws, as shown in Fig. E.4.

4. After locating the change speed lever ball in the change speed ball socket, secure the fulcrum housing to the toe-panel.

5. Ensure that the gearbox is in neutral and adjust the trunnion assembly until the holes in the relay cross-shaft levers line up with the bore of the trunnion bush. No force should be used to assist in this line up.

6. Secure the trunnion assembly to the relay cross-shaft.

7. Locate the selector latch into the third and fourth selector position by inserting the $\frac{3}{16}$ in. (4·76 mm.) pin (supplied with Churchill Tool R.G.255) through the drilled hole in the top cover of the gearbox.

8. Adjust the ball joint assembly on the selector rod so that the threaded end of the ball joint enters the hole at the top of the selector lever squarely without strain.

9. Remove the $\frac{3}{16}$ in. (4·76 mm.) pin from the selector latch and top cover.

10. Remove the Churchill Tool R.G.255 from the fulcrum housing and refit the reverse stop plunger, spring and cap, tightening the securing setscrews on completion.

GEARBOX ASSEMBLY

To Remove.

1. Drain the gearbox oil and disconnect the speedometer drive cable.

2. Remove the propeller shaft.

3. Disconnect the selector rod at the gearbox top cover external levers and the coupling on the change speed relay cross shaft assembly.

4. Remove the split pin, washer and jaw pin connecting the clutch slave cylinder to the withdrawal lever.

5. Disconnect the hydraulic pipe leading to the slave cylinder. Remove the two nuts, washers and bolts securing the slave cylinder to the clutch housing and remove the slave cylinder.

6. Disconnect the lead to the starter motor. Remove the two securing bolts and remove the starter motor.

7. Support the rear of the engine and remove the setscrews securing the clutch housing to the cylinder block. Leave one setscrew in position until the gearbox is ready for removal.

8. Release the setscrews retaining the clutch housing bottom cover plate and remove the plate.

9. With the rear of the engine firmly supported, remove the two self-locking nuts and plain washers at the rear mounting support plate fitted to the rear of the gearbox. Note the order in which the plain washers are assembled.

10. Remove the one setscrew remaining in the clutch housing for support and withdraw the gearbox and clutch housing assembly rearwards off the dowels in the cylinder block face and lift clear of the vehicle.

Note: Do not allow the gearbox and clutch housing assembly to hang unsupported in the clutch assembly otherwise damage will be caused to the clutch driven plate.

11. Extract the retaining clips (as detailed in the Clutch Section) and remove the clutch release bearing.

12. Release the screws securing the clutch housing and withdrawal lever bracket to the gearbox casing and remove the gearbox assembly.

13. Remove the split pin, withdraw the fulcrum pin to separate the withdrawal lever from the bracket. Note the positions of the plain and felt washers below the fulcrum pin and the thrust washer above the pin.

To Dismantle.

The dismantling and re-assembling of the gearbox will be simplified by the use of the following tools. Their uses are fully described in the ensuing operations.

(*a*) **Dummy Layshaft Spindle.** A $\frac{3}{4}$ in. (19 mm.) diameter bar which is 6·5 in. (165 mm.) in. length.

(*b*) **Dummy Selector Shafts as follows:**
One Shaft 4·95 in. × $\frac{7}{16}$ in. dia.
(125·7 mm. × 11·11 mm.)
Two Shafts 2·90 in. × $\frac{7}{16}$ in. dia.
(73·6 mm. × 11·11 mm.).
The longer shaft being used for the 1st/2nd selector shaft.

(*c*) **Shaft Loading Tester Clamp.** Any suitable clamp to attach to the selector shaft end.

1. Remove the cotter pin and tap off the external gear change lever.

2. Tap back the lockwasher tab end and unscrew the hook bolt nut on the external selector lever and remove the lever.

3. Remove the six bolts and lift off the top cover, plate and the joint.

4. Inside the top cover, tap back the tab end of the lockwasher and remove the bolt securing the internal gear change lever to the lever shaft. Remove the internal gear change lever.

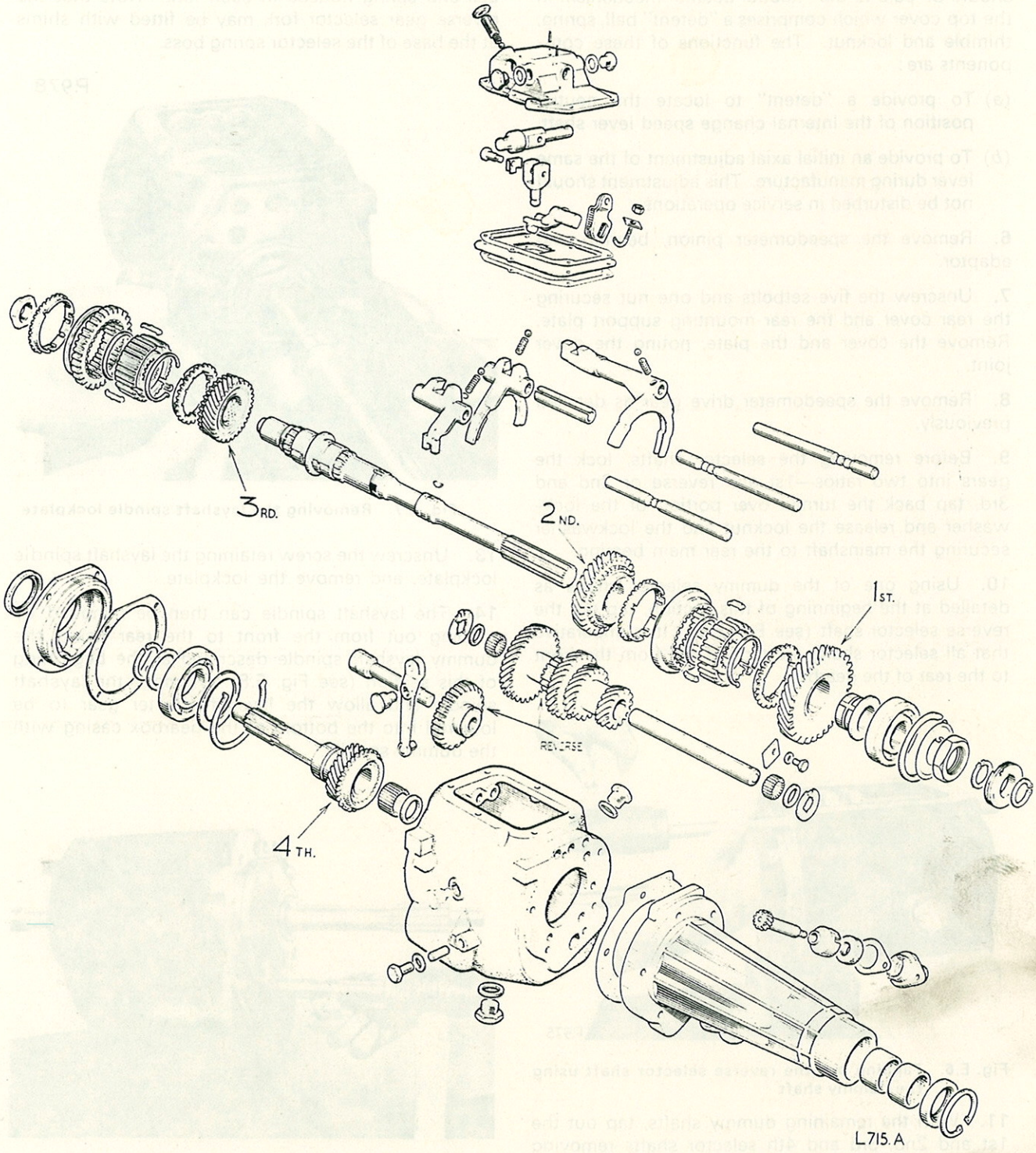


Fig. E.5. Gearbox components

5. At this stage of the dismantling, special attention should be paid to the "neutral detent" mechanism in the top cover which comprises a "detent" ball, spring, thimble and locknut. The functions of these components are:

(*a*) To provide a "detent" to locate the neutral position of the internal change speed lever shaft.

(*b*) To provide an initial axial adjustment of the same lever during manufacture. This adjustment should not be disturbed in service operations.

6. Remove the speedometer pinion, bearing and adaptor.

7. Unscrew the five setbolts and one nut securing the rear cover and the rear mounting support plate. Remove the cover and the plate, noting the cover joint.

8. Remove the speedometer drive gear as detailed previously.

9. Before removing the selector shafts, lock the gears into two ratios—1st and reverse or 2nd and 3rd, tap back the turned over portion of the lockwasher and release the locknut and the lockwasher securing the mainshaft to the rear main bearing.

10. Using one of the dummy selector shafts as detailed at the beginning of this section, tap out the reverse selector shaft (see Fig. E.6.) It is imperative that all selector shafts are tapped out from the front to the rear of the gearbox.

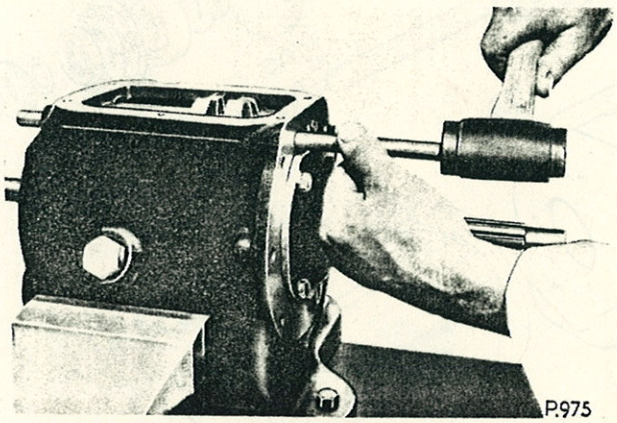


Fig. E.6. Tapping out the reverse selector shaft using the dummy shaft

11. With the remaining dummy shafts, tap out the 1st and 2nd, 3rd and 4th selector shafts removing the distance piece fitted to the 3rd and 4th selector shafts, and allowing the dummy shafts to remain in the bores of the selector forks to retain the selector ball and spring.

12. Lift out the three selector forks in the same order as the selector shaft removal and remove the dummy shafts taking care not to lose the selector ball and spring housed in each fork. Note that the reverse gear selector fork may be fitted with shims at the base of the selector spring boss.

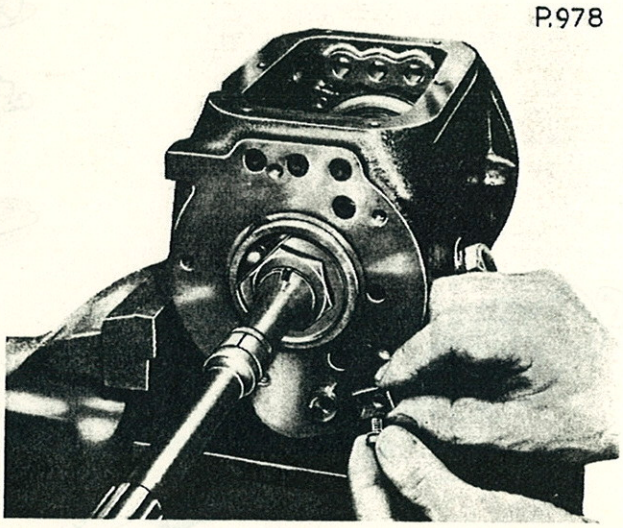


Fig. E.7. Removing the layshaft spindle lockplate

13. Unscrew the screw retaining the layshaft spindle lockplate, and remove the lockplate.

14. The layshaft spindle can then be removed by tapping out from the front to the rear using the dummy layshaft spindle described at the beginning of this section (see Fig. E.8). Remove the layshaft spindle and allow the layshaft cluster gear to be lowered into the bottom of the gearbox casing with the dummy spindle.

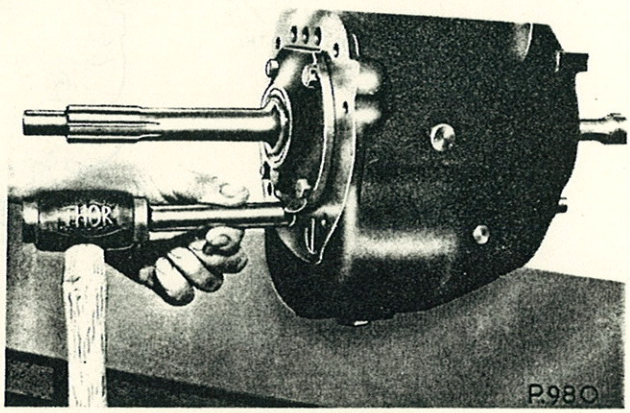


Fig. E.8. Tapping out the layshaft spindle using the dummy spindle

15. Remove the four screws on the front cover and withdraw the primary shaft and front cover assembly. Watch that the needle rollers of the mainshaft spigot bearing are not lost during this operation. Remove

the abutment ring and the 23 needle rollers from the primary shaft counterbore.

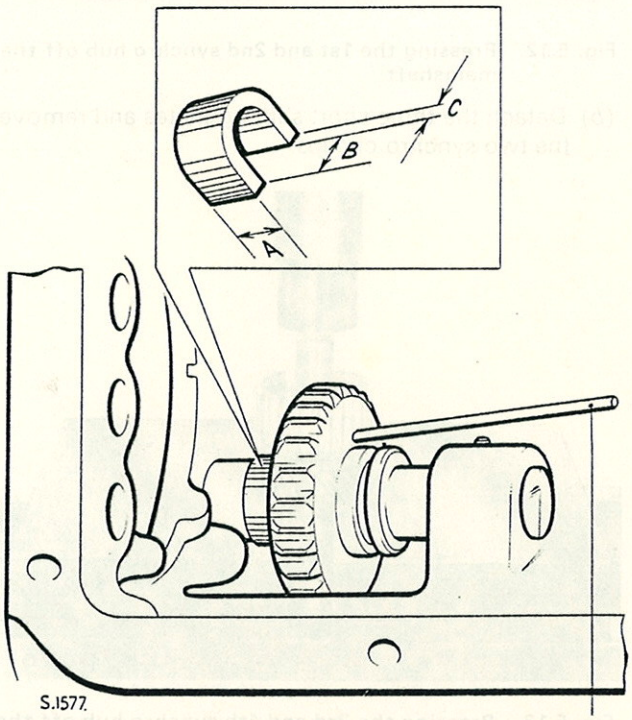
16. After withdrawing the primary shaft, remove the 4th speed gear baulk ring from the mainshaft and identify the ring to the primary shaft gear cone.

17. Support the mainshaft at its forward end and, with the aid of a mallet, tap the mainshaft assembly forward until it clears the rear bearing.

18. With the reverse speed gear in the reverse position, remove the mainshaft through the primary shaft aperture, withdrawing the 1st speed gear, baulk ring and stepped bush, through the top cover aperture of the gearbox.

19. After withdrawing the 1st speed gear, the corresponding baulk ring should be identified to the 1st gear cone.

20. Lift the layshaft cluster gear from the casing complete with the dummy spindle centralised in the gear. Withdraw the 27 needle rollers from each end of the cluster gear and remove the cluster gear abutment rings and phosphor bronze thrust washer from inside the front and rear of the gearbox casing.



A $\frac{5}{8}$ in. (16 mm.) B $\frac{5}{8}$ in. (16 mm.) C $\frac{3}{16}$ in. (4 mm.)

Fig. E.9. Reverse shaft removal tool

21. Press or tap the mainshaft rear bearing rearwards out of the casing and, if necessary, remove the bearing spring ring. If the spring ring is removed, a new ring must be fitted on re-assembly.

22. To remove the reverse gear idler shaft, a tool made locally to the dimensions given in Fig. E.9 should be inserted on the idler shaft in the position shown in the illustration. Using a soft metal drift applied against the gear wheel, through the casing rear aperture, drive the shaft out of the casing. Note that the drift must be applied against the base of the gear wheel and not against the thin shoulder of the selector groove.

23. Dismantle the primary shaft assembly as follows:

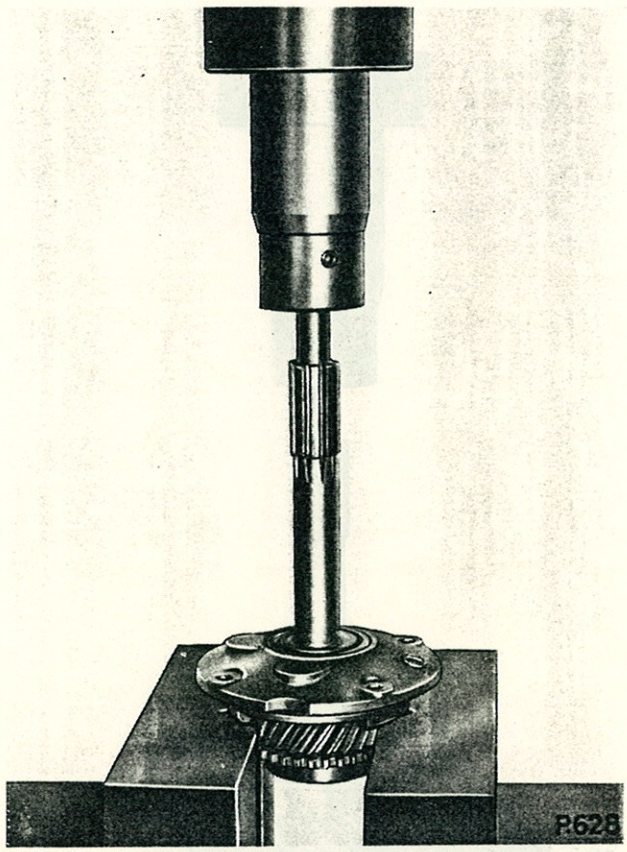


Fig. E.10. Pressing the primary shaft complete with the bearing out of the front cover

(*a*) Remove the retaining ring securing the primary shaft bearing outer casing in the front cover.

(*b*) Press the primary shaft assembly, complete with bearing out of the front cover (see Fig. E.10).

(*c*) Remove the spring ring and the abutment washer retaining the bearing to the primary shaft and press off the bearing (see Fig. E.11).

(*d*) Remove the bearing chip shield.

(*e*) The oil seal in the front cover is a press fit and should only be removed if it is necessary to renew the oil seal.

24. Dismantle the mainshaft assembly as follows:

(*a*) Press the 1st and 2nd speed synchro hub assembly and the 2nd speed gear off the mainshaft as shown in Fig. E.12. Separate the baulk ring from the gear and suitably identify the baulk ring to the gear cone.

(*b*) Secure the mainshaft in a vice using suitable **soft metal jaw clamps.**

(*c*) Remove the locknut from the front of the mainshaft.

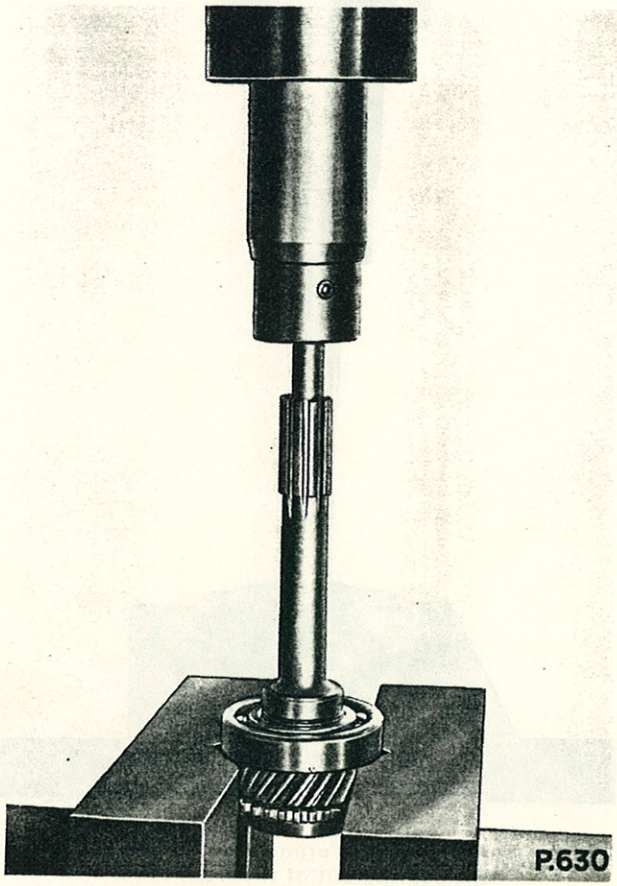


Fig. E.11. Pressing the bearing off the primary shaft

(*d*) Press the 3rd and 4th synchro hub off the mainshaft using the 3rd speed gear as a base (see Fig. E.13). Slide the reverse speed gear sliding sleeve from the 3rd and 4th synchro hub.

(*e*) Detach the three long shifting plates. Lift out the two synchro circlips positioned at each end of the synchro hub.

(*f*) Slide off the 3rd speed gear and separate the baulk ring from the gear. Suitably identify the baulk ring to the gear cone.

25. Dismantle the 1st and 2nd speed synchro hub assembly in the following order:

(*a*) Remove the 1st and 2nd speed sliding sleeve.

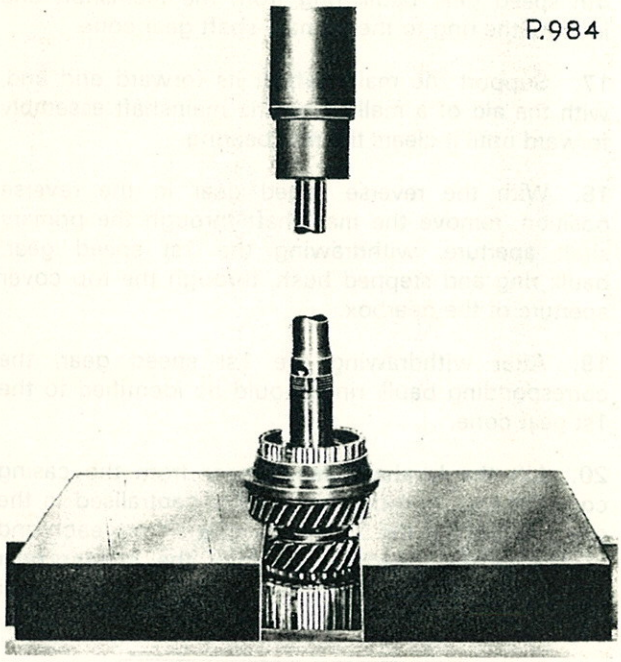


Fig. E.12. Pressing the 1st and 2nd synchro hub off the mainshaft

(*b*) Detach the three short shifting plates and remove the two synchro circlips.

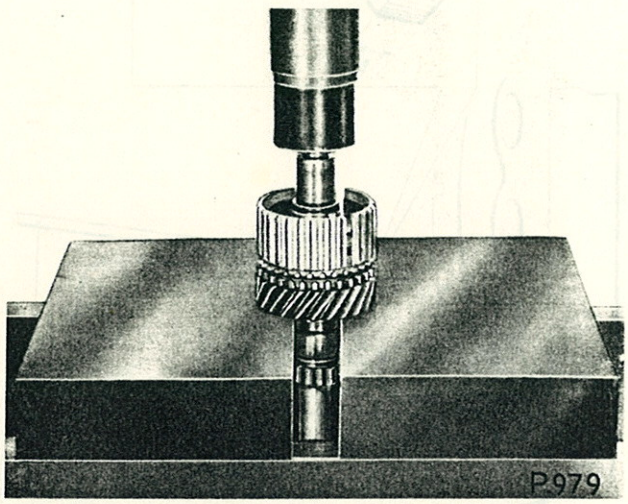


Fig. E.13. Pressing the 3rd and 4th synchro hub off the mainshaft

Inspection and Overhaul.

Thoroughly clean all components before inspection.

1. Casing. Check for wear at the bearing bores and examine the casing generally for cracks. Remove any burrs evident on the mounting faces for the covers.

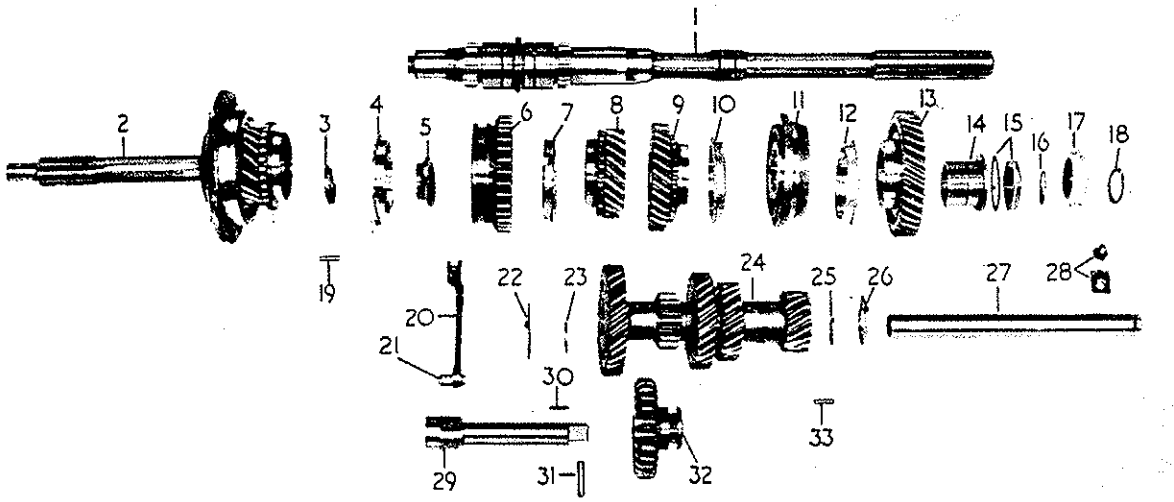
2. **Gear Teeth.** Examine all gear teeth for damage or wear and renew the gears as necessary.

3. **Bearings and Needle Rollers.** The ball bearing races should be cleaned in light machine oil and then checked for slackness and noisy operation which, if apparent, requires the renewal of the races.

Important: Under no circumstances must bearings be cleaned by blowing out with a high pressure airline as this practice causes flats to develop where the balls skid on the casing and materially reduces the useful life of the bearings.

grooves designed to break down the oil film rapidly as the baulk rings engage with their respective gear cones. Ensure that these grooves are not worn and renew if wear is evident. If the rings are to be refitted, thoroughly clean all foreign matter from the grooves.

Check the baulk rings for concentricity by marking the corresponding gear cone with a thin coating of engineers' marking blue and offer up the baulk ring. Examine the result obtained which should show a corresponding blue marking on the tops of the baulk ring grooves. Also, lay the ring flat on a surface plate and check for distortion by using a



1 MAINSHAFT
2 PRIMARY SHAFT ASSEMBLY AND 4TH GEAR
3 ABUTMENT RING
4 BAULK RING
5 NUT
6 3RD AND 4TH SPEED SYNCHRO HUB AND REVERSE GEAR ASSEMBLY
7 BAULK RING
8 2ND SPEED GEAR
9 3RD SPEED GEAR
10 BAULK RING
11 1ST AND 2ND SPEED SYNCHRO HUB ASSEMBLY
12 BAULK RING
13 1ST SPEED GEAR
14 BUSH
15 LOCKWASHER AND NUT
16 CIRCLIP
17 SPEEDOMETER DRIVING WHEEL GEAR
18 CIRCLIP
19 REVERSE RELAY SELECTION LEVER PIVOT PIN
20 REVERSE RELAY SELECTOR LEVER
21 SELECTOR PAD
22 THRUST WASHER
23 ABUTMENT RING
24 LAYSHAFT CLUSTER
25 ABUTMENT RING
26 THRUST WASHER
27 LAYSHAFT SPINDLE
28 LOCKING PLATE
29 REVERSE SHAFT
30 ROLLERS
31 LOCKING PIN
32 REVERSE IDLER WHEEL
33 ROLLERS

Fig. E.14. Gearbox components

4. **Primary Shaft.** Check the spigot which registers in the crankshaft pilot bush, and the counterbore which houses the needle rollers, for pitting and wear.

Insert the primary shaft into a new clutch driven plate and check for backlash on the shaft splines.

The gear cone which receives the baulk ring must be free from glazing or ridging.

5. **Baulk Rings.** Ensure that the dog teeth of the rings are in good condition. The tapered bores of the baulk rings incorporate fine, closely pitched 0·001 in. (0·025 mm.) feeler. Should the feeler enter between the ring and the surface plate, the ring should be rejected.

6. **Synchronising Hub Assemblies.** Slide the 3rd/4th and 1st/2nd sliding sleeve on the respective synchro hubs and ensure that the splines engage easily without backlash.

Check the condition of the chamfers on the sliding sleeve internal splines to ensure that each face is flat and free from burrs. Examine the shifting plates for wear, in particular at the centre protrusion. Renew the plates if excessively worn.

The synchro circlips should be renewed if they are weak, or show wear at the contact faces with the shifting plates.

7. Mainshaft. Check the mainshaft for wear at the spigot, the synchro hub splines, the collar integral with the shaft and the ground surfaces on which the bushes of the 2nd and 3rd speed gears operate. Fit the rear splines of the mainshaft in the front end of the propeller shaft and check for backlash.

8. Mainshaft Gears. Inspect the cones of the 1st and 2nd, and 3rd mainshaft gears for wear and scores. Check the gear bushes for wear and renew the gears if evident.

9. Reverse Gear and Shaft. Examine the gear bush, teeth and the shaft for wear and renew as necessary.

The two bushes pressed in the end of the rear cover should be checked for wear or scoring and renewed if evident. If renewal of any of these parts is evident it will be necessary to remove the circlip retaining the oil seal, before removing the worn part.

FIRST SPEED WHEEL END FLOAT

It is important when overhauling the all-synchro-mesh gearbox to ensure that, prior to re-assembly the first speed wheel on the rear of the mainshaft has correct running clearance.

In order to check end float, the following procedure should be carried out:

1. Fit the second speed wheel and baulk ring to the mainshaft, press on the 1st/2nd synchro hub, and fit the first speed wheel baulk ring and distance bush.

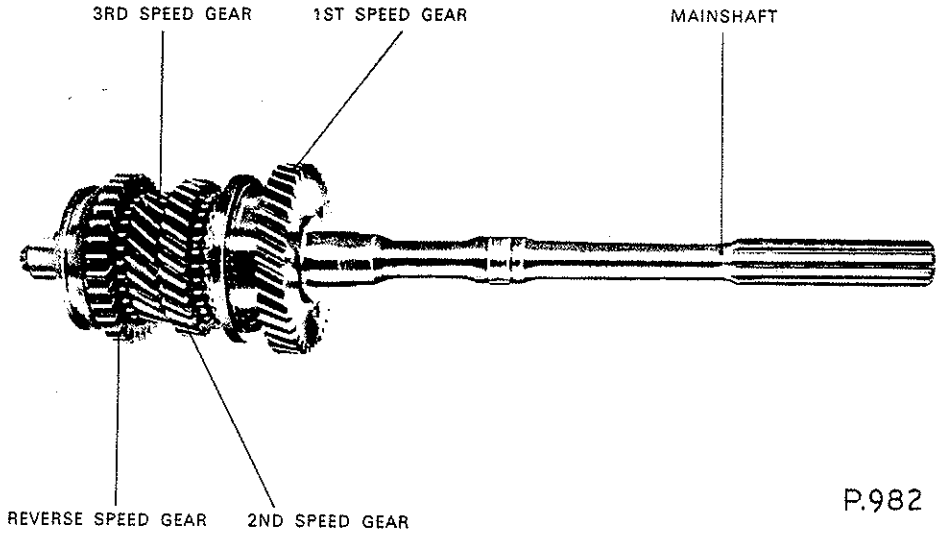


Fig. E.15. **Mainshaft assembly gear layout**

10. Selector Shafts and Forks. It will be noted that the 1st/2nd and 3rd/4th selector shafts are identical and carry the same part number, the only difference being that the 1st/2nd is fitted in the gear-box in the reverse direction to 3rd/4th selector shaft.

Check the selector pad fitted to the reverse relay selector lever, pivoted in the side of the gearbox casing, and renew if necessary. Inspect the selector shafts for wear particularly at the ball indent grooves. Check the selector forks for wear on the faces of the fork prongs due to the thrust of the gears, and also in the engagement slot for the internal gear change lever. Inspect the steel selector balls which locate on the selector rod grooves for pitting, wear or flat spots.

11. Front and Rear Covers. Inspect each cover for damage and burrs on the mating face of the gearbox casing. Examine the oil seal in each cover and renew if damaged or deteriorated.

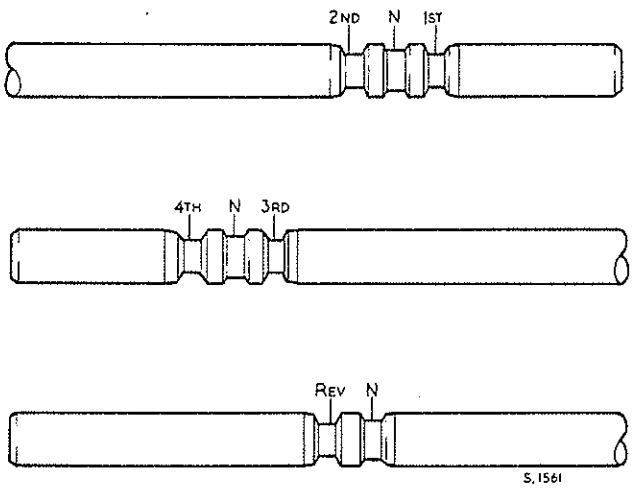


Fig. E.16. **Selector shaft identification**

2. Fit a suitable distance piece as shown. Fit the rear mainshaft nut and tighten to 10 lb. ft. (1·38 kg. m.). (It is important that this is not exceeded at this stage.)

3. Using a feeler gauge, check the distance between the rear face of the first speed wheel and the shoulder of the first speed distance bush as shown in Fig. E.17.

4. First speed wheel end float must be 0·004/0·009 in. (0·1/0·23 mm.).

Note: To assist in tightening the rear nut to the correct torque loading during assembly of the gearbox, it is recommended that Churchill Special Tool, R.G. 482 is used. When using this tool, the torque wrench should be set at 77 lb. ft. (10·65 kg. m.).

To Re-assemble.

Re-assembly is mainly a reversal of the dismantling procedure. During this operation, attention should be paid to the following points.

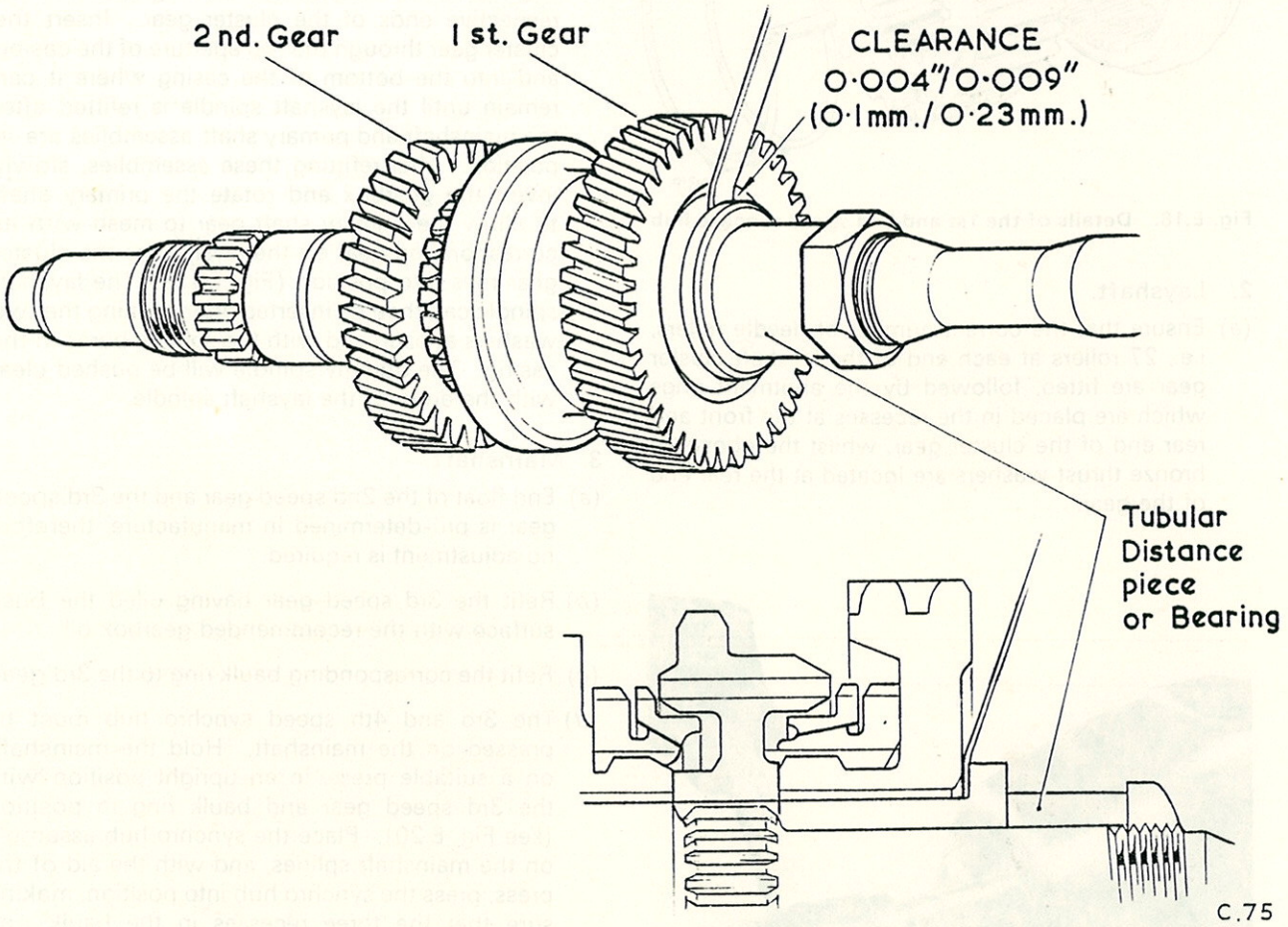


Fig. E.17. Checking end float

5. To obtain the correct end float, a first speed distance bush should be selected to provide the correct end float.

6. Should any difficulty be experienced in obtaining the correct gear end float, a new 1st/2nd synchro hub should be fitted.

7. After obtaining the correct clearance, dismantle and re-assemble, tightening the mainshaft nut to 80 lb. ft. (11·06 kg. m.).

1. 1st/2nd, and 3rd/4th Speed Synchro Hub Assemblies. Ensure that the synchro circlips are correctly located in the underside of the shifting plates and so arranged that the circlip locating hooks do **not** locate in the same shifting plate. The free ends of the synchro circlips must follow opposite directions from one another in relation to their respective locating hooks. Re-assemble the circlips so that one circlip passes across the underside of each of the three shifting plates (see Fig. F.18) and with the plain ends of the

circlips pointing in the opposite direction to each other.

Note: The 1st and 2nd speed synchro hub shifting plates are the shorter of the two sets.

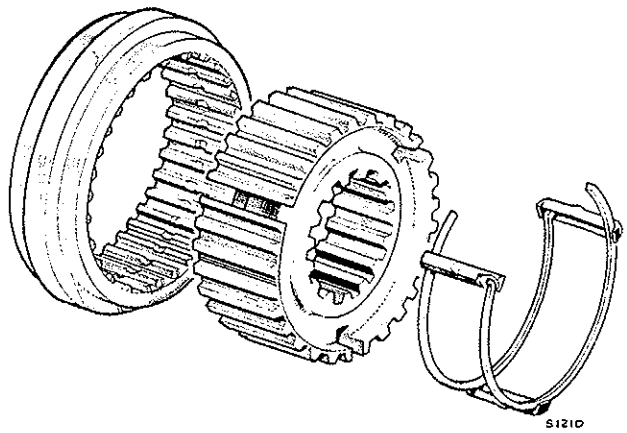


Fig. E.18. Details of the 1st and 2nd speed synchro hub

2. Layshaft.

(*a*) Ensure that the correct number of needle rollers, i.e., 27 rollers at each end of the layshaft cluster gear are fitted, followed by the abutment rings which are placed in the recesses at the front and rear end of the cluster gear, whilst the phosphor bronze thrust washers are located at the rear end of the gear.

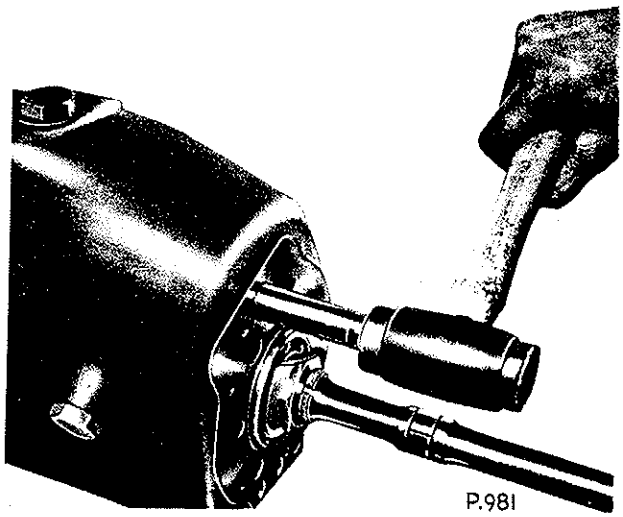


Fig. E.19. Refitting the layshaft spindle

Locate the tag ends of the front and rear phosphor bronze thrust washers in the casing slots noting that the steel side of the thrust washers is fitted against the gearbox casing in each case. The larger thrust washer is positioned at the front end.

(*b*) End float of the layshaft cluster gear between the front and rear thrust washers should be 0·006/0·008 in. (0·152/0·203 mm.). This clearance must be checked with the assembly in a dry condition and adjustment for end float is provided by selective assembly of the front phosphor bronze thrust washer.

(*c*) When re-assembling the layshaft assembly, retain the front and rear phosphor bronze washers in their positions against the casing with grease and enter the dummy layshaft spindle in the cluster gear with the needle rollers, and the abutment rings retained in position with grease to the respective ends of the cluster gear. Insert the cluster gear through the top aperture of the casing and into the bottom of the casing where it can remain until the layshaft spindle is refitted after the mainshaft and primary shaft assemblies are in position. After refitting these assemblies, slowly invert the gearbox and rotate the primary shaft to allow the primary shaft gear to mesh with its corresponding gear on the layshaft as the cluster gear rolls into position (Fig. E.19). The layshaft spindle can then be inserted after aligning the two washers at each end with the spindle bores in the casing. The dummy spindle will be pushed clear with the entry of the layshaft spindle.

3. Mainshaft.

(*a*) End float of the 2nd speed gear and the 3rd speed gear is pre-determined in manufacture, therefore no adjustment is required.

(*b*) Refit the 3rd speed gear having oiled the bush surface with the recommended gearbox oil.

(*c*) Refit the corresponding baulk ring to the 3rd gear.

(*d*) The 3rd and 4th speed synchro hub must be pressed on the mainshaft. Hold the mainshaft, on a suitable press, in an upright position with the 3rd speed gear and baulk ring in position (see Fig. E.20). Place the synchro hub assembly on the mainshaft splines, and with the aid of the press, press the synchro hub into position, making sure that the three recesses in the baulk ring coincide with the shifting plates in the synchro hub. It is essential that the hub is fully located against the mainshaft shoulder as the end float of the 3rd speed gear is controlled at this point.

(*e*) Renew the locknut which secures the 3rd and 4th speed synchro hub and gear at 80 lb. ft. (11·06 kg.m.) torque and retain by tapping the flange on the nut into the indentation on the mainshaft.

(*f*) The same pressing operation can be carried out for refitting the 2nd speed gear and 1st and 2nd synchro hub, as shown in Fig. E.21.

(*g*) The mainshaft rear bearing is a "two spot" classification of bearing fit as noted by two faint rings on the face of the bearing outer race. When refitting the rear bearing in the gearbox casing ensure that it is fully located in the casing bore by means of the retaining spring ring on the bearing outer diameter which should fully contact the casing rear face.

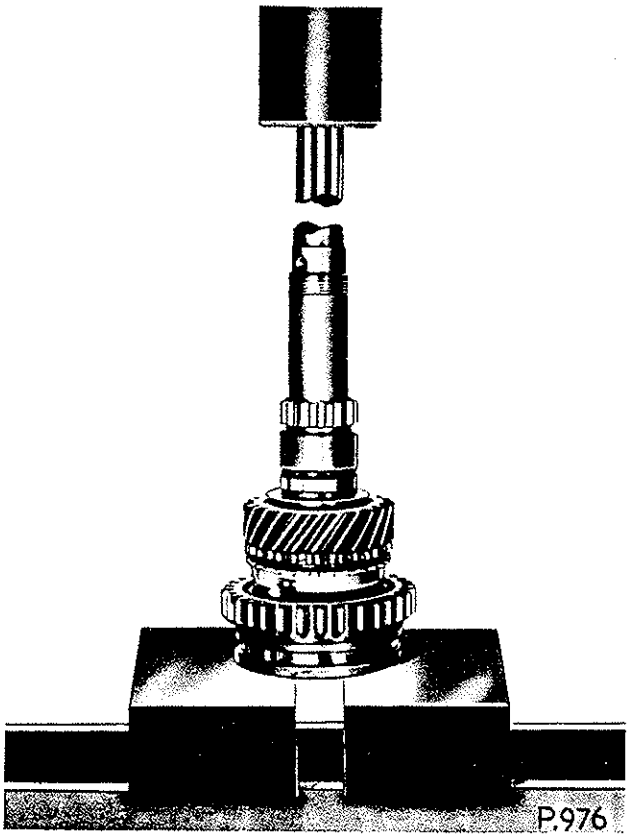


Fig. E.20. Refitting the 3rd and 4th synchro hub assembly

(*h*) To refit the mainshaft assembly to the gearbox, it is essential that the 1st speed gear with the collared steel bush is fully located against the inner race of the mainshaft rear bearing whilst maintaining the correct location of the rear bearing in the casing bore. To ensure this condition, re-assemble the mainshaft as follows:

(i) Position the gearbox casing on a suitable press so that the inner race of the rear bearing rests on the baseplate of the press but sufficient clearance must be present to allow the rear end of the mainshaft to pass through the baseplate cut-outs.

(ii) Insert the mainshaft through the front bore of the casing and refit the baulk ring and 1st speed gear to the mainshaft inside the casing.

(iii) Press the rear end of the mainshaft into the rear bearing until the collared steel bush locates against the 1st and 2nd synchro hub. It is essential that the bush is fully located as the end float of the 1st speed gear is controlled at this point. Secure with the lockwasher and the plain nut, engaging the internal lug of the lockwasher in the slot machined in the mainshaft threads. Fully tighten the nut and tap the lockwasher securely over one of the flats on the nut.

(iv) During the pressing of the mainshaft into the rear bearing, care must be taken to align the first speed shifting plates with the slots in the 1st speed baulk ring.

(*j*) The re-assembling of the speedometer drive gear, is a reversal of the removal procedure.

(*k*) Refit the rear cover using a new joint and coat the corresponding face of the gearbox casing with a suitable liquid jointing compound. Also, ensure that the cover setbolt threads are coated with non-setting jointing compound, prior to refitting.

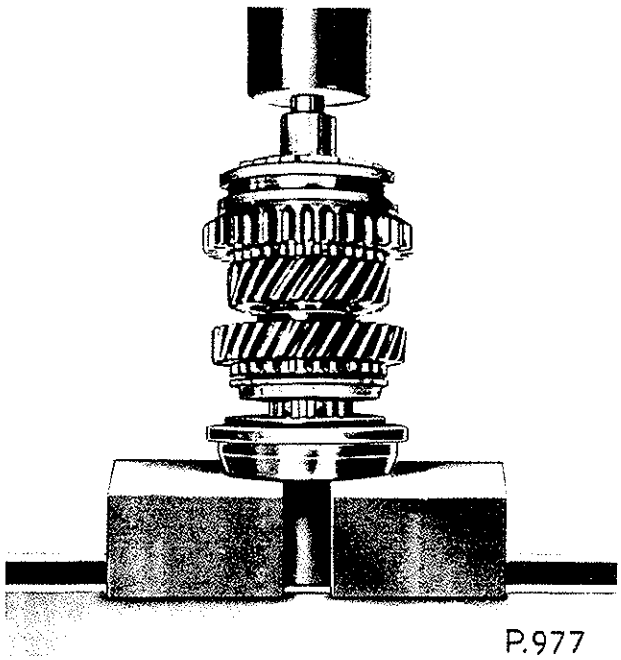


Fig. E.21. Refitting the 1st and and synchro hub assembly

4. Reverse Selector Shaft and Fork.

Before refitting the reverse selector shaft and fork, the checking of the axial load necessary to move the selector shaft groove across the ball in the selector fork, must be carried out as follows:

(*a*) Secure the selector fork in a vice using soft metal jaw clamps.

(*b*) Insert the original shim(s), selector spring and steel ball and depress the ball by means of a suitable punch to enable the selector shaft to be re-assembled to the fork bore.

(*c*) The axial load necessary to move the selector shaft groove across the ball in the fork is 40–45 lb. (18·15–20·41 kg.). This loading may be tested by means of a suitable spring balance which can be attached to the end of the selector shaft by means of a hand vice (see Fig. E.22).

(*d*) Adjust the axial load to the correct figure by the removal or addition of shims.

(*e*) As it will be necessary to separate the selector shaft from the fork for re-assembly to the gearbox, retain the adjusted ball and spring with a dummy selector shaft as used in dismantling.

5. **Primary Shaft and Front Cover.**

(*a*) Always renew the spring ring which locates in front of the primary shaft bearing on the primary shaft.

(*b*) A predetermined amount of float in the primary shaft and front cover assembly is provided for and

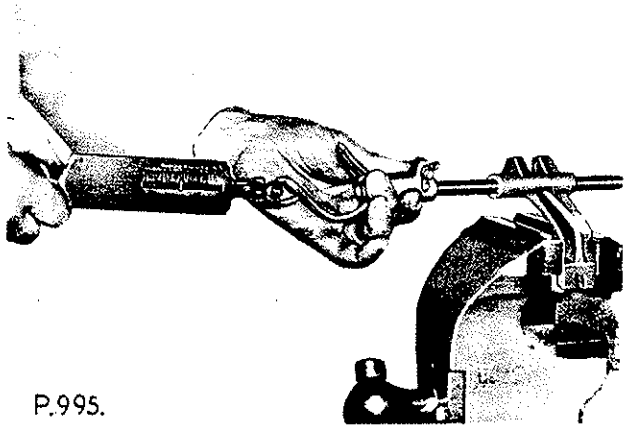


Fig. E.22. Checking the axial loading of the reverse selector shaft and fork using Churchill Tool R.G.62 with a spring balance

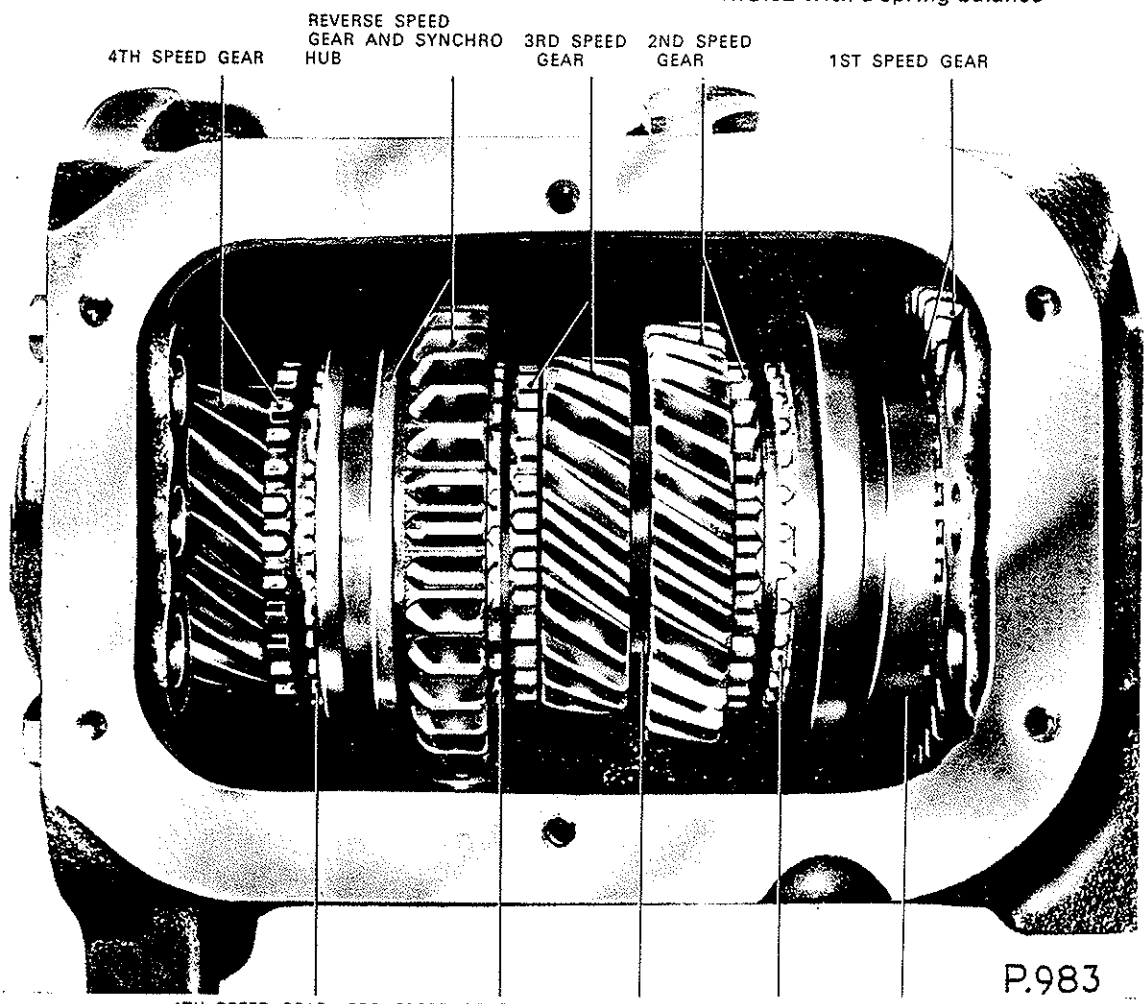


Fig. E.23. View of the mainshaft assembled in the gearbox casing

is controlled by the class of fit of the bearing race which is a "three spot" classification denoted by three faint rings on the face of the bearing outer race.

(*c*) Use a new joint when refitting the front cover and coat the corresponding face of the gearbox casing with a liquid jointing compound. Also, ensure that the cover setbolt threads are coated with non-setting jointing compound, prior to refitting.

Note: Two thicknesses of abutment washers are available for fitting between the ball bearing inner race and spring ring. If the space between the inner race and ring is insufficient to accommodate the thick washer use the thin washer.

6. Top Cover.

(*a*) When re-assembling the top cover ensure that the "neutral detent" ball and spring are fitted at the same time as the internal change speed lever shaft is tapped into position.

(*b*) The locating pins for the change speed lever shaft and the selector lever shaft must be peened over at **both ends.**

(*c*) Ensure that the bolt securing the internal change speed lever is not over-tightened and that the lever is free to swing on its shaft. Tap the ear of the lockwasher securely over one of the flats on the head of the bolt.

(*d*) Use a new joint when refitting the top cover, and coat the corresponding face of the gearbox casing with a suitable liquid jointing compound. Take care that the internal change speed lever and selector lever engage in the selector fork slots. Before finally tightening the cover securing bolts, position the top cover by tapping the cover edges with a hide mallet, in order to obtain unrestricted swing of the selector lever across the selector fork slots.

To Refit.

Refitting is a reversal of the removal operation with attention to the following points:

1. Do not allow the gearbox and clutch housing assembly to hang unsupported in the clutch assembly during refitting otherwise damage will be caused to the clutch driven plate and crankshaft bush.

2. If the original gearbox assembly is being refitted and the remote control operating rod lengths have not been disturbed, it will not be necessary to check and reset the linkage. If, however, a replacement gearbox is fitted, or the operating rod adjustment has been altered, check the setting of the linkage as described in this section.

3. After refitting the clutch slave cylinder and connecting the hydraulic pipe, the clutch hydraulic system must be bled as detailed under "CLUTCH AND PROPELLER SHAFT".

4. Refit the propeller shaft.

5. Refill the gearbox to the correct level with fresh oil of the recommended grade.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

INDEPENDENT FRONT SUSPENSION

SECTION F

INDEX

INDEPENDENT FRONT SUSPENSION

DESCRIPTION

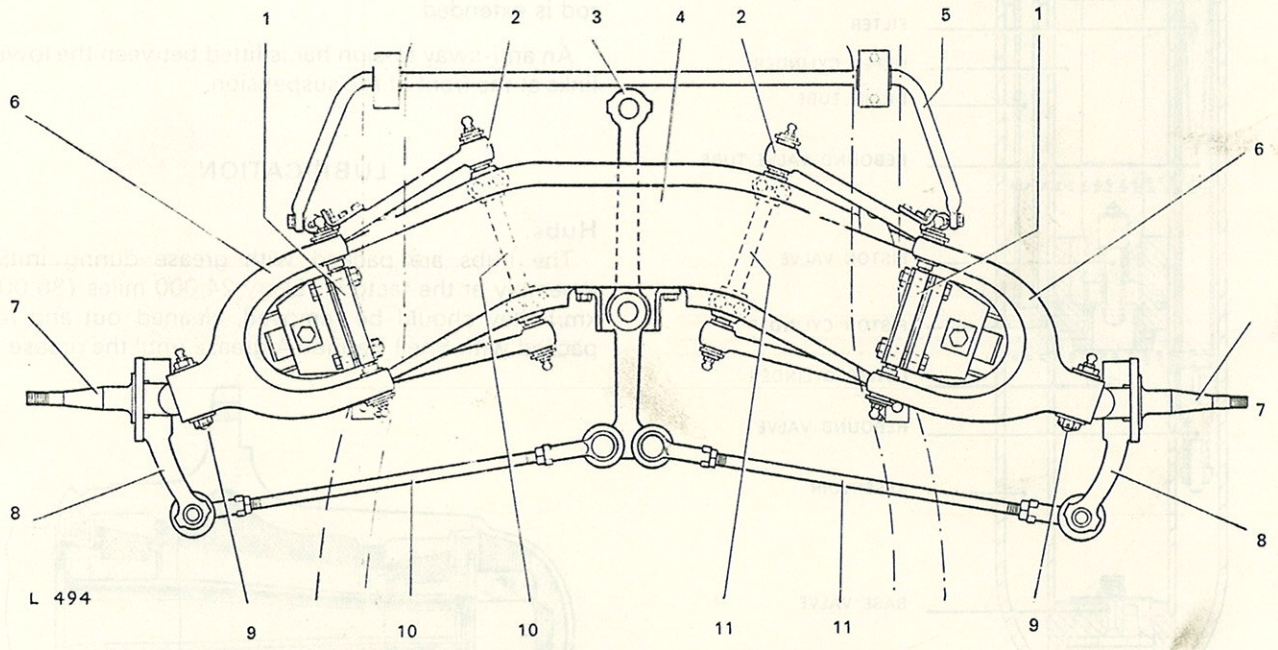
The independent front suspension is of the coil spring type operating through an upper and lower link to a stub carrier. These links are of different lengths, the upper being the shorter, in order to maintain the best possible front wheel track throughout the whole range of deflection of the spring. In this way, tyre wear is kept to a minimum.

Each lower link pivots on a fulcrum pin at its inner end. This fulcrum pin is clamped and dowelled on to the underside of the front suspension crossmember. The upper links each pivot on a fulcrum pin which is secured by bolts passing through both the top of the crossmember coil spring housing and a bracket on the underframe sidemember.

The hubs revolve on taper roller bearings. The outer race of each bearing is a press fit in the hub and the inner race is a sliding fit on the stub axle spindle. The outer bearing is retained by a large washer and castellated nut.

The hub flange carries the brake drum and road wheel.

The telescopic shock absorber assemblies are located, one through each of the coil springs, between the top of the crossmember spring housing and the lower link spring pan. The assemblies are mounted at the upper end by a threaded stem, mounting rubbers, support cups and securing nuts and at the lower end by a rubber bushed "eye" type fixing, which pivots about a mounting bracket secured to the spring pan.



1 UPPER FULCRUM PIN
2 LOWER LINK
3 MAIN RELAY LEVER
4 FRONT CROSSMEMBER
5 STABILISER BAR
6 UPPER LINK
7 STUB AXLE
8 STEERING ARM
9 UPPER EYE BOLT
10 TWO PIECE TRACK ROD
11 LOWER FULCRUM PIN

Fig. F.1. Layout of the front suspension

A stub carrier connects the outer ends of the upper and lower links and supports the king pin about which pivots a bushed stub axle. Thrust is taken on a washer located between the sealing washer and the bearing washer, these in turn locate between the lower face of the stub carrier boss and the stub axle respectively. The king pin is located and locked in the stub carrier by a cotter.

The internal construction of the shock abosrber consists mainly of a piston rod, a piston, a piston cylinder and an outer tube.

The piston rod is machined at the lower end to locate the piston, which in turn houses the piston valve. An oil seal housing carrying a spring loaded piston rod seal is pressed into the top of the outer tube. The

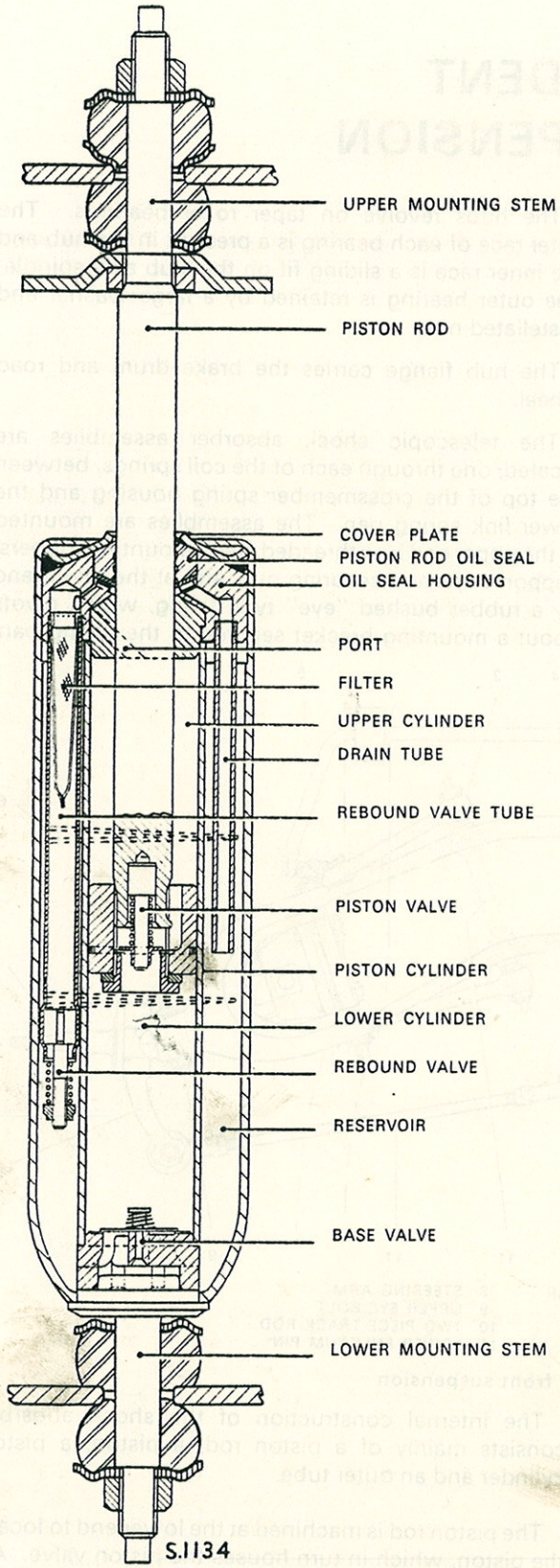


Fig. F.2. Front shock absorber arrangement

housing also positions the piston rod guide in the upper end of the piston cylinder. A cover plate abuts the oil seal housing and seats the reservoir seal against the wall of the outer tube. The outer tube is spun over the cover plate to positively seal the shock absorber assembly, by clamping the piston cylinder and the oil seal housing.

The oil seal housing retains both the rebound valve tube and the drain tube in their respective positions. A filter is located at the head of the rebound valve tube, whilst the foot of the tube carries the rebound valve.

The lower end of the piston cylinder is positioned over the base valve body, which is in turn located on a spigot of the lower mounting eye; this eye being secured to the rounded end of the outer tube.

Two baffles are sprung to the outside of the piston cylinder, to prevent the aeration of oil in the reservoir upon rapid movements of the piston and rod assembly, the reservoir being formed between the piston cylinder and the outer tube.

The piston cylinder is completely filled and the reservoir about half-filled with fluid when the piston rod is extended.

An anti-sway torsion bar is fitted between the lower links at the front of the suspension.

LUBRICATION

Hubs.

The hubs are packed with grease during initial assembly at the factory. Every 24,000 miles (36,000 km.) they should be removed, cleaned out and re-packed with Shell Retinax A grease until the grease is

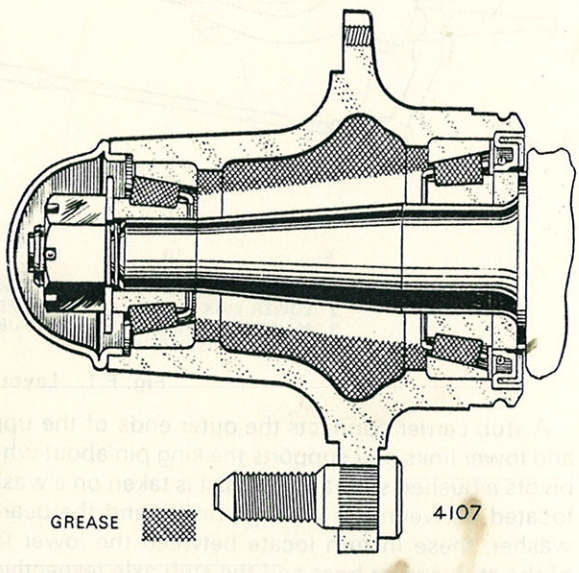


Fig. F.3. Sectional view of the front hub showing the correct application of the lubricant

level with the inside diameter of both outer races as shown in Fig. F.3. This can be achieved by packing the hub with grease and then scooping out the surplus with a **clean** straight edged piece of wood or metal.

Swivel Pins and Bushes.

Lubrication is effected by means of nipples fitted in the upper and lower bosses of the stub axles. Lubricate every 3,000 miles (4,500 kms.) with Shell Spirax 140 EP or Shell Retinax A.

Suspension Linkage.

Nipples are provided at each end of the top and bottom fulcrum pins and at the forward end of each outer eyebolt. Apply Shell Spirax 140 EP or Shell Retinax A every 3,000 miles (4,500 kms.).

Steering Relay Lever.

Lubricate every 3,000 miles (4,500 kms.) with Shell Spirax 140 EP or Shell Retinax A. A nipple is situated at the lower end of the lever fulcrum pin.

SERVICE TOOLS

All the Service operations described in this section can be carried out efficiently with the aid of ordinary tools and the following:

Coil Spring Compressor.

Churchill No. R.G. 50 D. and Adaptor R.G. 50 D–2.

Camber, Castor and King Pin Inclination Gauge.

Dunlop Gauge CG/4–5.

Wheel Turntables.

Dunlop Turntable and Run-on Ramps CG6.

Front Gap Gauges.

Churchill Static Laden Gap Gauges R.G.311 (1500 Series) and R.G. 401 (2500 Series).

Churchill and Dunlop equipment as recommended in this section may be obtained, as applicable, from:

Messrs. V. L. Churchill & Co Ltd.,
London Road,
Daventry,
Northants

or

Messrs. Dunlop Rubber Co. Ltd.,
Fort Dunlop,
Erdington,
Birmingham 24.

FRONT SUSPENSION DIMENSIONS AND SETTING

Preparation of the Vehicle.

When carrying out checks on the front suspension and steering dimensions the following requirements must be met.

1. The vehicle must be placed on a perfectly level floor or ramp.

2. Tyres must be inflated to their correct pressures.

3. For checking the front wheel track the vehicle must be in a laden condition.

4. For a complete geometry check the suspension system must be loaded down on to gap gauges by placing weights in the vehicle.

At the front, Churchill steel gap gauges are used between the lower link and bump rubber stops on the crossmember. At the rear, hardwood gap gauges, of local manufacture (see Fig. F.15) are placed between the top of the axle casing and the underframe, the blocks being shaped to clear the bump rubbers and to fit the axle casing as shown in Fig. F.4. The weights should be positioned directly over the front suspension and rear axle. It will be found that to grip the gauges, the approximate weights required will be:

	Front	*Rear*
All Models	910 lb. (412·7 kg.)	500lb. (226·8 kg).

Note: The rear gap gauges dimensioned in Fig. F.15 are suitable for both 1500 and 2500 Series vehicles.

Inclination Angles.

The following settings and dimensions will require checking in the event of excessive tyre wear, accident damage or following the replacement of component parts of the front suspension assembly. Details of the settings are given in "GENERAL DATA".

1. **Camber Angle** is the angle of inclination of the road wheel from the vertical when viewed from the front. This angle is adjustable. Inclination of the top of the wheel outward is termed positive camber and inclination inwards negative. It is most important that the correct angle is maintained at all times.

2. **Cators Angle** is the angle at which the king pin is tilted rearwards. This is not adjustable.

3. **King Pin Inclination** (K.P.I.) is the angle at which the king pin centre line is inclined from the vertical as viewed from the front of the vehicle. This angle is not adjustable and provided the stub axle assembly is undamaged it is correct when the camber angle is correctly adjusted.

4. **Front Wheel Toe-in** or track is the slight forward convergence given to the planes of the front wheels to promote steering stability and equalise tyre wear.

damage. If a steering arm is found bent it should be replaced. Straightening should not be attempted.

Ball Pin Heights.

After an accident in which steering damage is suspected, the ball pin heights should be checked.

The various ball joints in the steering linkage occupy positions that ensure the minimum front wheel reaction to suspension system movement caused by rough road surfaces. Incorrect ball pin heights alter the ball positions and tend to transmit "Road Shock" to the steering wheel.

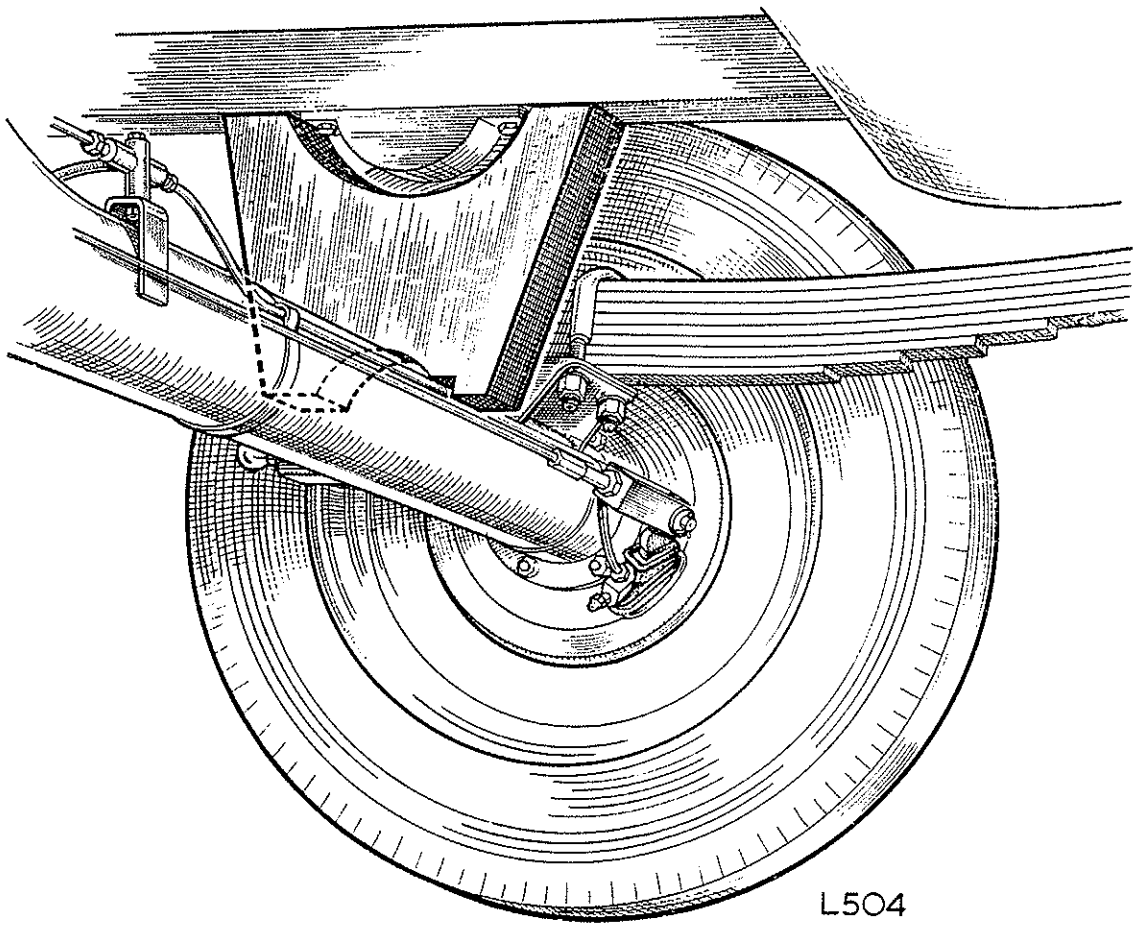


Fig. F.4. Rear gap gauge in position

5. **Ackerman Angle** (toe out on turns). The steering arms are so arranged that when the front wheels are turned the wheel nearest the inside of the bend follows an arc of smaller radius than the outside wheel.

6. **Ball Pin Height** is the dimension between the centre line of each lower link outer eyebolt and the underside of the steering arm ball pin boss.

Steering Arm Dimensions.

Steering arm dimensions are given in Fig. F.6. These will aid checking of steering arms after accident

Reference to Fig. F.5 will show that ball pin heights are given as a dimension from the centre lines of the lower link outer eyebolt. As these centre lines are rarely parallel to a level floor and vary with the castor angle, ball pin heights **cannot** be checked from a horizontal surface plate placed under the vehicle.

Manufacturing details of suitable equipment for checking ball pin height are illustrated in Fig. F.8.

The ball pin height dimensions are not affected by the suspension movement and can therefore be

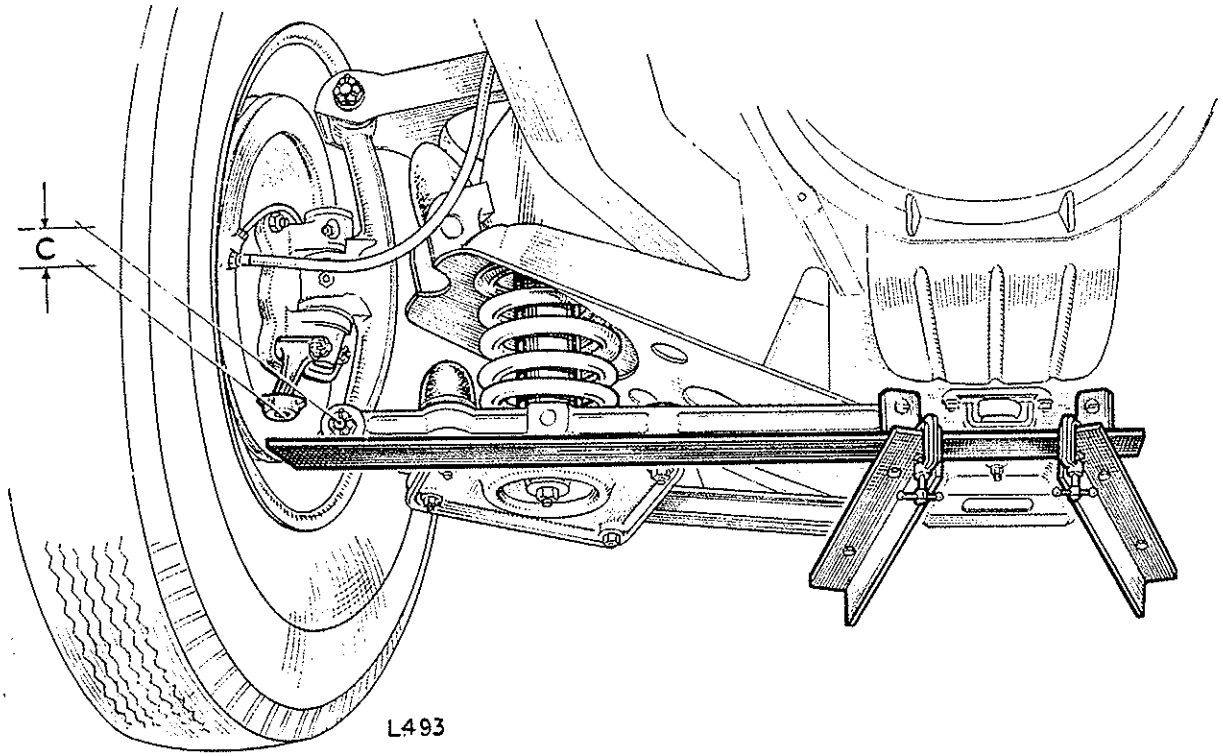
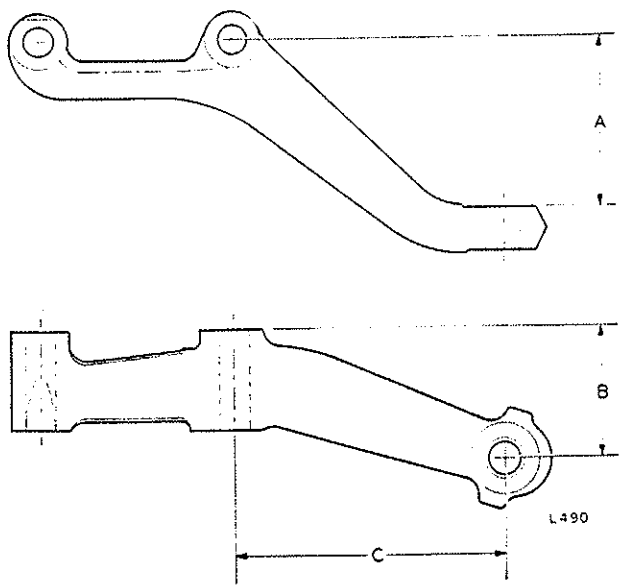


Fig. F.5. Ball pin height checking fixture in position
For dimension "C", see Fig. F.7.

checked with the vehicle in either a laden or unladen condition.

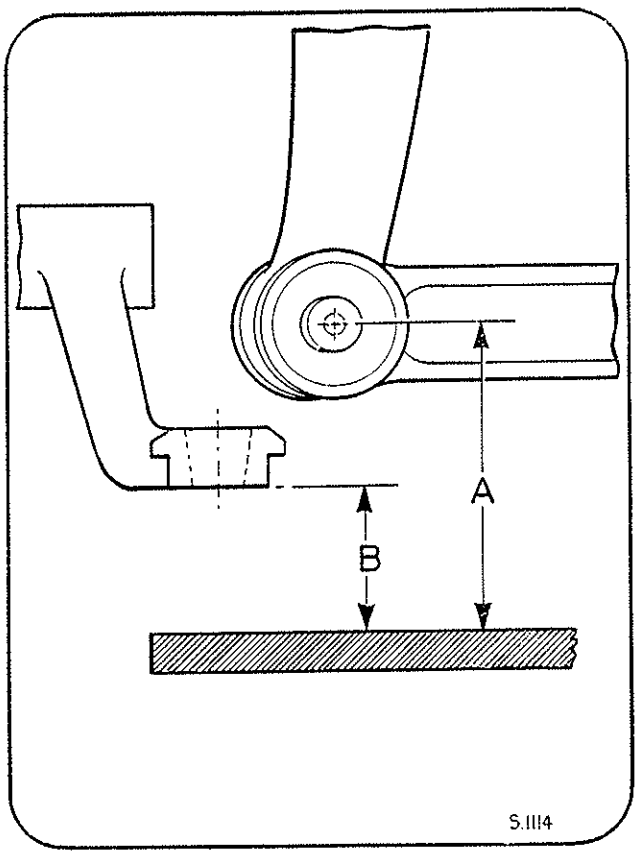
1. Remove both track rods to obtain access to the points from which the checking dimensions are taken.

2. Set up checking fixture as shown in Fig. F.5.



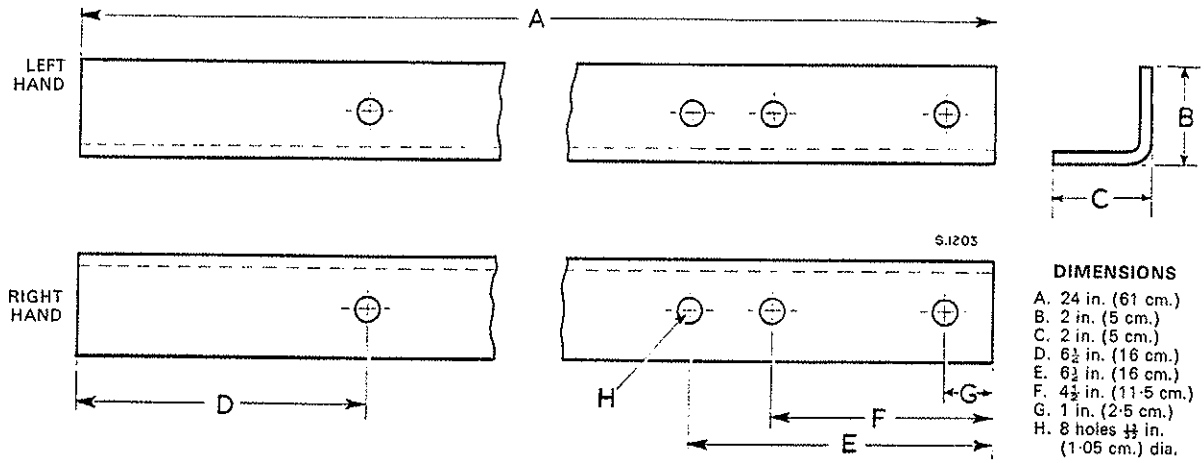
A. 2·52 in. (6·40 cm.)
B. 1·89 in. (4·80 cm.)
C. 4·00 in. (10·16 cm.)

Fig. F.6. Steering arm dimensions



A — B = C
C = 0.69/0·83 in. (17·5/21·0 mm.)

Fig. F.7. Checking ball pin height

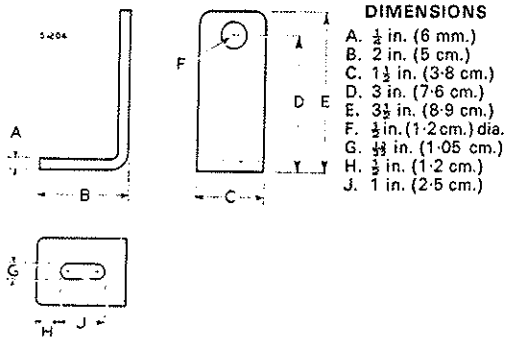


DIMENSIONS

A. 24 in. (61 cm.)
B. 2 in. (5 cm.)
C. 2 in. (5 cm.)
D. 6⅜ in. (16 cm.)
E. 6⅜ in. (16 cm.)
F. 4½ in. (11·5 cm.)
G. 1 in. (2·5 cm.)
H. 8 holes ⅝ in. (1·05 cm.) dia.

ITEM No. 1

Quantity required — 1 each, left hand and right hand
Material — 2 in. (5 cm.) angle iron

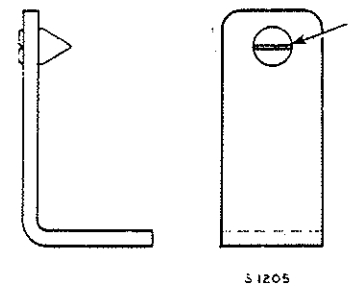


DIMENSIONS

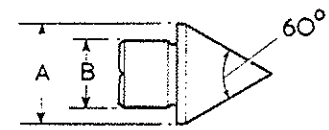
A. ¼ in. (6 mm.)
B. 2 in. (5 cm.)
C. 1½ in. (3·8 cm.)
D. 3 in. (7·6 cm.)
E. 3½ in. (8·9 cm.)
F. ½ in. (1·2 cm.) dia.
G. ⅝ in. (1·05 cm.)
H. ½ in. (1·2 cm.)
J. 1 in. (2·5 cm.)

ITEM No. 2

Quantity required — Four
Material — Mild Steel



This line to be deeply scribed on back of centre after welding centre into position. The line must be the actual centre point height above and parallel to the bracket bottom base.

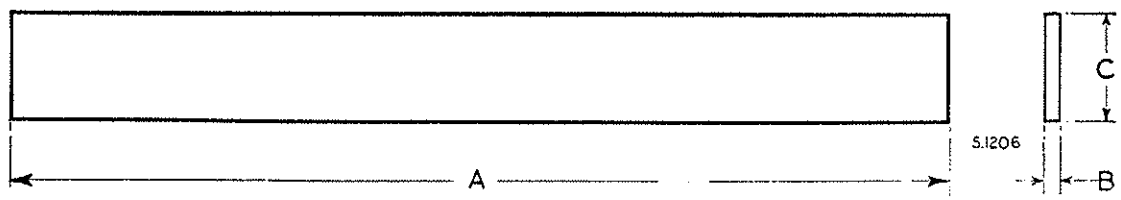


DIMENSIONS

A. ¾ in. (1·9 cm.)
B. ½ in. (1·2 cm.)

ITEM No. 3

Quantity required — Four
Material — Mild Steel



DIMENSIONS

A. 28 in. (71 cm.)
B. ⅜ in. (1 cm.)
C. 3 in. (8 cm.)

ITEM No. 4

Quantity required — One
Material — Mild Steel

Fig. F.8. Manufacturing details of the ball pin height checking fixture

3. The dimension between the lower link outer eyebolt centres and measuring position on the underside of the steering arms should be checked as shown in Fig. F.7.

4. If the dimension is in excess of, or below the correct figure, the cause should be found as some part or parts may be damaged or bent.

FRONT HUBS AND BEARINGS

To Check for Slackness in Bearings.

1. Jack up the front of the vehicle until the road wheels are clear of the ground. A block of wood should be placed between the jack and the front crossmember.

2. The bearing end float should now be checked by grasping the road wheel at the top and attempting to rock it back and forward. A very slight end float should be felt. If excessive rock is present (this must not be confused with wear in the swivel pin and bushes) adjustment must be carried out. This also applies if the hub does not spin freely due to the bearings binding.

To Adjust.

Carry out this operation with the road wheel clear of the ground.

1. Remove the nave plate and the road wheel.

2. Remove the brake drum after unscrewing the securing countersunk screws.

3. Remove the hub cap.

4. Take out the split pin from the castellated hub retaining nut.

5. The nut should be tightened using a torque spanner, to 15–20 lb. ft. (2·1–2·77 kg. m.)

6. To obtain the correct adjustment slacken back the nut 1–1½ flats, whichever is convenient to line up with the split pin hole.

7. The hub end float should now be checked with a dial gauge. A reading of between 0·005/0·009 in. (0·13/0·23 mm.) should be obtained.

8. Re-adjust if necessary.

9. Replace the split pin.

10. Refit components removed in paras. (1) and (2).

To Remove.

1. Slacken the road wheel nuts.

2. Jack up the front end of the van using a block of wood under the front crossmember.

3. Remove the road wheel.

4. Remove the brake drum after unscrewing the countersunk screws.

5. Remove the hub cap.

6. Withdraw the split pin and remove the castellated hub retaining nut and washer.

7. Pull the hub off the stub axle, at the same time holding a hand under the hub to catch the inner race and cage of the outer bearing.

To Dismantle.

1. Remove the inner race and cage of the inner bearing together with the oil seal and distance piece.

2. Remove the bearing outer races by tapping them out of hub with a drift.

Inspection and Overhaul.

1. Thoroughly clean components in paraffin and the bearings in thin oil.

2. Examine the bearings for cage distortion and damaged or pitted rollers. Check the outer races for wear and pitting. If either of these parts are faulty, the complete bearing must be renewed.

3. Check the fit of the bearing outer races in the hub. Renew the hub if the races are loose in their registers.

4. Renew the oil seal.

To Re-assemble.

1. Press the outer races of the two bearings into the hub registers. In each case the larger internal diameters must face towards the outside ends of the hub.

2. Pack the hub with Shell Retinax "A" grease (see Fig. F.3).

3. Grease the inner bearing (largest bearing) and place it in the hub.

4. Fit the distance piece and the oil seal into the hub.

To Refit.

1. Place the hub on the stub axle shaft.

2. Grease the outer bearing (smallest bearing) and place it in position.

3. Fit the plain washer and castellated nut. Tighten the nut to 15–20 lb. ft. (2·1–2·77 kg. m.) and then slacken back 1–1½ flats in order to line up the split pin hole with a slot in the nut.

4. Check end float with a dial gauge. This should be 0·005/0·009 in. (0·13/0·23 mm.). Adjust if necessary.

5. Fit a new split pin.

6. Fit hub cap tapping it firmly into position with a hammer. **Do not pack the hub cap with grease.**

7. Refit the brake drum and the road wheel.

KING PINS AND STUB AXLES

To Check for Wear.

1. Jack up the front axle until the road wheels clear the ground.

2. Attempt to rock the wheel. If excessive movement is felt (not to be confused with bearing play) the swivel pin and bushes should be renewed.

To Remove.

1. Remove road wheel.

2. Remove brake drum after unscrewing the securing countersunk screw.

3. Remove front hub as described under "FRONT HUBS AND BEARINGS" in this section.

4. Remove the two long bolts and nuts securing the steering arm, oil catcher and back plate to the stub axle flange, also the two short bolts and nuts at the top of the stub axle flange.

5. Remove the oil catcher and brake back plate. Secure the back plate so that it cannot hang on the brake hose.

6. Remove the nut and washer from the cotter securing the king pin in the stub axle carrier. Drive out the cotter in a rearward direction using a brass drift taking care not to damage the threads.

7. Remove the welch plugs from each end of the king pin by cutting into them with a small chisel or punch. Lift away the rubber ring from around the upper stub axle boss.

8. Remove the kin pin downwards using a suitable withdrawal tool. The king pin is drilled and tapped $\frac{3}{8}$ in. U.N.F. at its lower end to take an adaptor.

9. Remove the sealing washer, thrust washer and bearing washer by sliding them out from between the stub axle and stub axle carrier boss.

10. Raise the stub axle slightly on its carrier in order to break the adhesion of the rubber sealing ring before drawing the stub axle outwards and away from the stub carrier.

Inspection and Overhaul.

1. Check the stub axle for bend or distortion by mounting it between centres and then checking the flange and hub bearing diameters with a dial gauge. Renew the stub if either of these two conditions are evident.

2. Examine the king pin and stub axle bushes for wear. It is essential that when a new king pin is fitted the stub axle bushes should be renewed also (see "KING PIN BUSHES").

3. Examine the rubber sealing rings. If these are damaged in any way they should be renewed.

4. Inspect the sealing washer, thrust washer and bearing washer, renew if badly scored or excessive wear is evident.

To Refit.

1. Smear the rubber sealing ring with grease and place it in position in the recess in the upper boss of the stub axle.

2. Put a liberal smear of grease on all bush and king pin surfaces.

3. Place the stub axle carefully in position to avoid displacing the sealing ring.

4. Slide the sealing washer, thrust washer and bearing washer into position between the carrier boss and the lower boss of the stub axle, ensuring that they are positioned as shown in Fig. F.9. It is important that the grooved face of the thrust washer is placed against the chromed bearing washer.

5. It is important to see that the sealing ring and thrust washer group are in line so that they are not trapped when the king pin is pushed into position. This is greatly facilitated by some form of dummy king pin with a lead on one end.

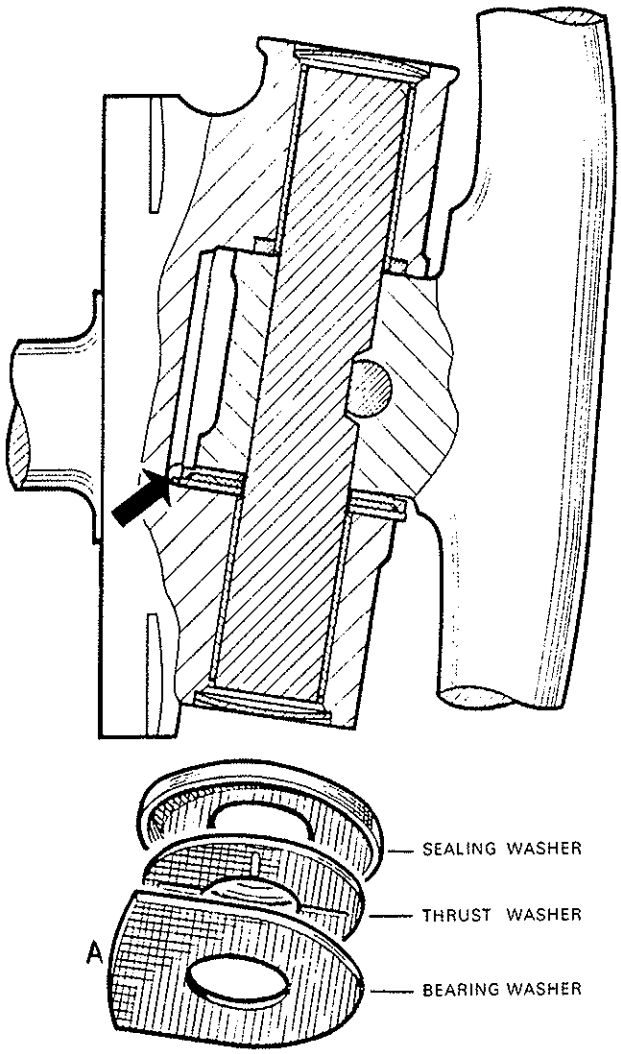
6. Push the king pin into position from the bottom making sure that the cotter groove is in line with the cotter hole in the stub carrier.

7. Knock in the cotter pin with its flat surface towards the king pin and its threaded end facing towards the front of the vehicle. The cotter must not be fitted the other way round as there will be no machined face for the nut to bed against.

8. Secure the cotter pin with the shakeproof washer and nut.

9. Replace the rubber ring used to seal the grease pressure relief hole.

10. Fit a new welch plug at each end of the king pin. When in position the welch plug should be struck with a drift at its domed centre to spread the plug in the recess.



The large radius of the bearing washer denoted by the letter "A" must be located towards the stub axle flange as indicated by the arrow.

Fig. F.9. Stub axle thrust washer arrangement

11. Peen over the metal of the stub axle bosses surrounding the plugs at four or five places in order to prevent them being forced out when the king pin and bushes are lubricated under high pressure.

12. Refit the brake back plate and oil catcher.

13. Refit the steering arm.

14. Refit the front hub assembly to the stub axle and adjust bearings.

15. Refit the brake drum.

16. Refit the road wheel.

KING PIN BUSHES

1. Due to the type of bush fitted, no broaching, honing or finishing of any kind is required as the bushes are supplied pre-finished with a self lubricating surface. Bushes should be fitted using Churchill tool RG.226, King Pin Remover and Replacer. Care must be taken, during the refitting of these bushes, to ensure that the pre-finish surface is not marked or damaged in any way, otherwise the self lubricating properties will be nullified.

2. Refit the stub axle.

Note: When re-assembling stub axles to the stub carrier it will be necessary to fit new welch washers at the outer ends of each stub axle boss. These should be expanded in position by striking in the centre. Take care not to collapse them inwards. In order to avoid the possibility of these blowing out when the king pin and bushes are lubricated under high pressure, it is recommended that each boss is peened over its washer. A blow with a round-nosed punch at four or five points round the boss will suffice.

SHOCK ABSORBERS

To Remove.

1. Jack up the vehicle under the centre of the front crossmember, using a block of wood between the jack and crossmember, and place stands under the underframe member.

2. Remove the road wheel.

3. Place a small jack under the bottom of the stub axle carrier and jack up the lower link to bring it just below the laden position.

4. Remove the nuts on the top end of the shock absorber and remove the metal support cups and mounting rubber.

5. Remove the lower shock absorber mounting bracket from the spring pan after releasing the two securing nuts and washers.

6. Withdraw downwards the complete shock absorber assembly through the spring pan aperture.

7. From the shock absorber lower eye remove the pivot bolt, after releasing the nut and washer, sliding the mounting bracket clear and withdrawing the distance tube from the shock absorber eye, followed by the split mounting rubbers.

Inspection and Overhaul.

Unless proper facilities are available including a shock absorber testing machine, repairs to this type of shock absorber are neither practical nor economical.

These units are completely sealed and no topping up, adjustment or other service is required apart from the checking of mountings and rubber bushes.

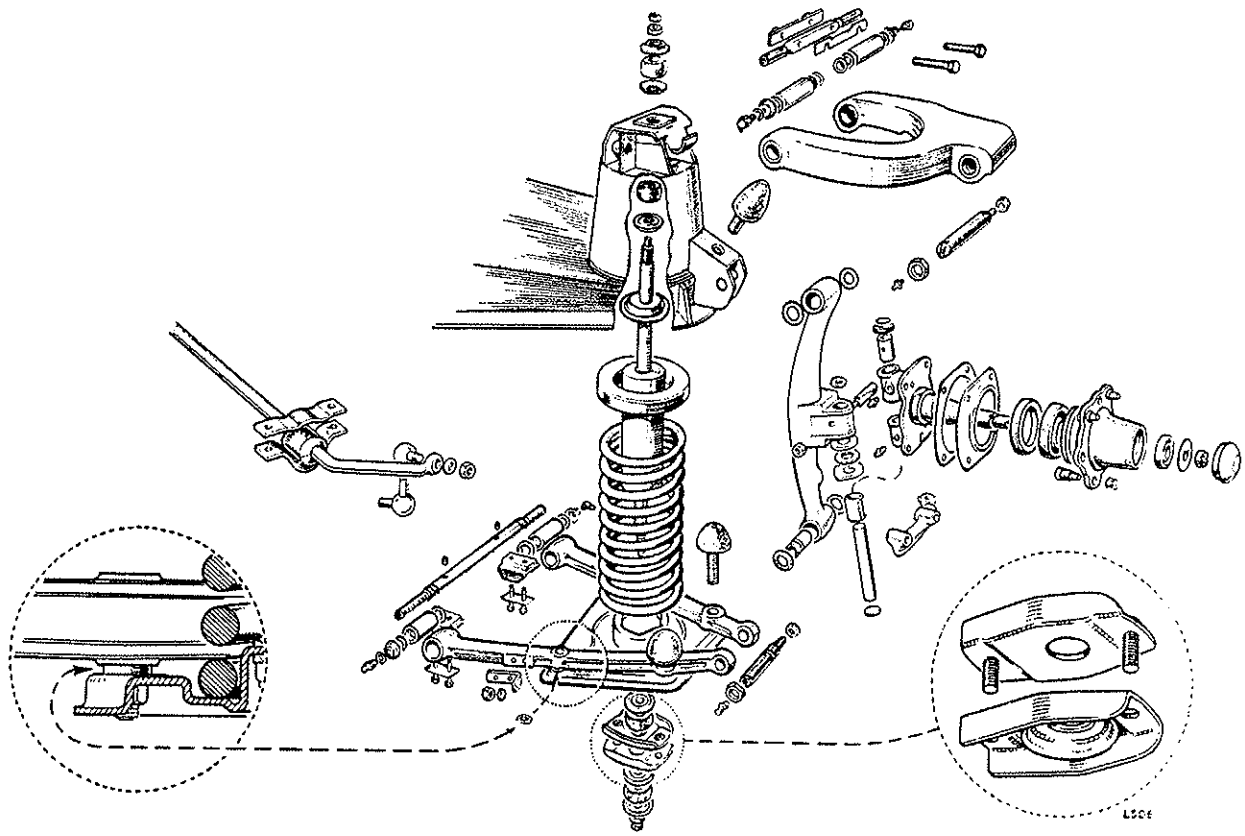


Fig. F.10. Front suspension details (near-side)

In the event of the shock absorber requiring attention it should be removed and a replacement unit fitted.

When there is any question of suspension not being adequately damped, the condition of the following should be considered: coil springs, tyre pressures, bump rubbers and bump rubber seats, as these carry the full bump load of the suspension.

If a shock absorbed does not appear to function satisfactorily an indication of its resistance can be obtained by carrying out the following check:

1. Place the shock absorber vertically in a vice, holding the lower mounting between two pieces of wood.

2. Grip the upper mounting firmly with the hands and prime the shock absorber by working it up and down several times to expel the air.

3. Move the piston (free top half) up and down through one complete cycle to check the nature of the movement.

4. Moderate and even resistance throughout the outward and inward stroke should be felt. If, however, the resistance is slightly erratic, or free movement cannot be eliminated by priming, then the shock absorber should be changed.

5. As only the "bleed" incorporated in the valves can be felt when operating the shock absorber manually even when new, no amount of hand testing will provide a true indication of the resistance of the shock absorbers at speeds obtained on bumpy roads. It will, therefore, be appreciated that a new shock absorber may appear to be weak when operated by hand, but this should not be taken as evidence of a fault. Air will bleed into the working parts of a shock absorber when not in use, particularly if it is stored in any position other than vertical, and this air must be expelled before the shock abosrber is tested.

To Refit.

1. Insert the split mounting rubbers and distance tube into the shock absorber eye and secure the eye (lower shock absorber mounting) to the mounting bracket assembly by means of the pivot bolt and nut locating the washer under the nut.

2. The location of the pivot bolt bore in the side plates of the mounting bracket is offset towards one end of the bracket. This offset of the pivot bolt bore must be positioned outwards towards the road wheel and to ensure this condition is maintained on assembly, an identification hole $\frac{1}{4}$ in. (6·35 mm.) in diameter, is drilled in the bracket base channel. To provide correct location of the mounting bracket on the spring pan,

the identification hole must be positioned nearest the road wheel.

3. The refitting of the top stem mounting details are a direct reversal of the removal procedure noting that the mounting rubbers are correctly compressed when the nuts on the end of the unit are fully tightened.

COIL SPRING

To Remove.

1. Jack up the vehicle under the centre of the front crossmember using a block of wood between the jack and the crossmember.

2. Remove the road wheel.

3. Remove the shock absorber.

4. Fit the Churchill Spring Compressor Tool R.G.50D and Adaptor R.G. 50D–2 compressing the spring sufficiently to take the load of the spring, to facilitate its subsequent release.

5. Remove the four nuts securing the spring pan to the underside of the lower link and release the spring compressor gradually until the spring is fully extended.

6. Remove the spring compressor, spring pan, and coil spring.

Note: It is essential that the spring pans are identified to their respective lower link assemblies, prior to removal, as any interchanging of the spring pans will cause faulty rebound operation.

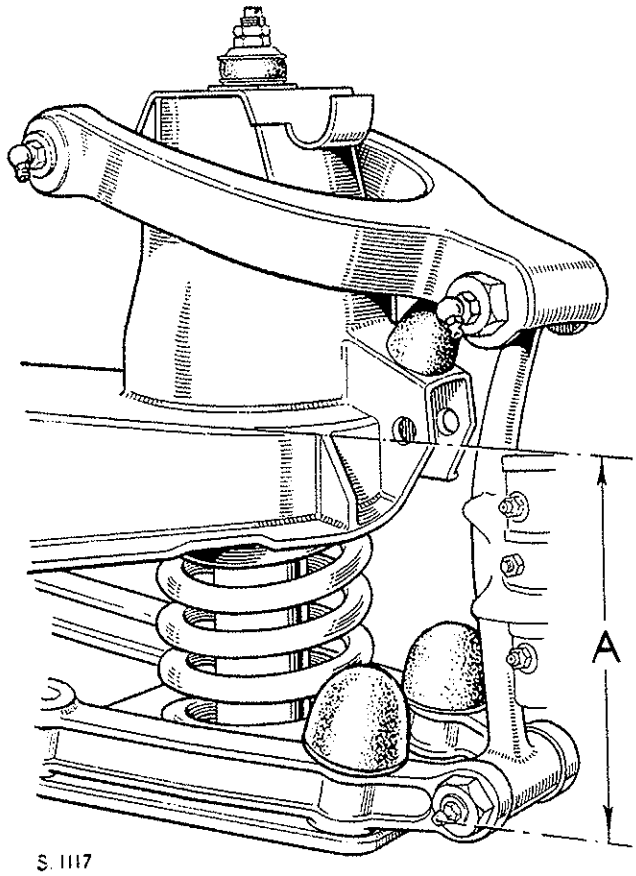
Inspection and Overhaul.

The coil spring should be checked against the data given. If required the springs can be roughly checked in position on the unladen vehicle by placing a load evenly across the cab and measuring the distance between the crossmember top fixing face and the centre of the grease nipple at the outer forward end of the lower link eyebolt (see Fig. F.11. and "GENERAL DATA" for details of loading).

To Refit.

1. Ensure that the washers are replaced between the spring pan and the lower link arms at each inner attachment point as shown in Fig. F.10. These washers tilt the spring pan in relation to the link arms and reduce the bowing of the springs on rebound.

2. Refit each spring pan to the correct lower link assembly as identified during the removal operation.



DIMENSION A = 5·75 in. (146 mm.)—1500 series
DIMENSION A = 5·00 in. (127 mm.)—2500 series

Fig. F.11. Rough checking of the front coil spring in position

STUB AXLE CARRIER

To Remove.

1. Jack up the vehicle under the centre of the front crossmember using a block of wood between the jack and crossmember.

2. Remove the road wheel.

3. Remove the stub axle assembly.

4. Remove the shock absorber.

5. Compress the road spring sufficiently to take the load of the spring. Churchill Spring Compressor Tool No. R.G.50D and Adaptor R.G. 50 D–2 should be utilised for this purpose.

6. Remove the locknut from the lower link eyebolt.

7. Remove the split pin and castellated nut and screw the eyebolt out of its threaded bushes.

8. Swing the lower end of the stub axle carrier out of the lower link fork and remove the two sealing rings.

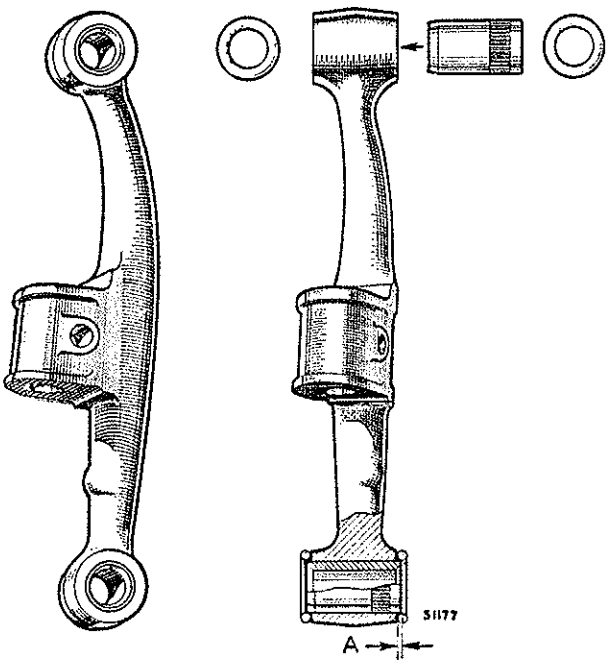
9. Remove the locknut from the upper eyebolt.

10. Remove the split pin and castellated nut and screw the eyebolt out of its threaded bushes.

11. Remove the stub axles carrier.

Inspection and Overhaul

1. The stub axle carrier should be carefully examined for signs of damage or excessive wear on the machined faces. If necessary the carrier should be renewed.



DIMENSION A = 0·092/0·100 in. (2·34/2·54 mm.)

Fig. F.12. **Fitting of threaded bushes to the stub axle carrier. The new bush is pressed in from the rear**

2. The sealing rings should be renewed if deterioration is evident.

3. The **original threaded bushes** are pressed in from the front until they project 0·100/0·092 in. (2·54/2·34 mm.) from the front face of the carrier boss and the external knurling on the bushes is then positioned towards the front end.

Note: **The bushes must only be pressed out forwards** (i.e., pressing from the rear face of the carrier eyes). **Replacements must always be pressed in from the rear** (knurled end last) to enable the knurling to engage a plain portion of the boss until they project 0·100/0·092 in. (2·54/2·34 mm.) from the rear face of the carrier boss (see Fig. F.12).

Before fitting new eyebolts or threaded bushes it is most important that the parts are selected so that they may be screwed together freely by hand. Clearance is provided between the threads of the fulcrum pins, eyebolts and their respective screwed bushes to allow for lubrication. This clearance must not be mistaken for wear.

To Refit.

The refitting procedure is the reversal of the removal instructions but particular attention should be paid to the following points while refitting the upper and lower links.

1. The upper and lower bosses of the stub axle carrier must be midway within the forks of the upper and lower links when fitted.

2. Before fitting the eyebolts, place the sealing rings on the upper and lower bosses of the carrier, one at each side. When the eyebolt is correctly located the rings can be slid outwards along the bosses into position.

3. The eyebolts must be screwed in from the front until the shoulder of the bolt butts firmly against the rear part of its respective link. Care must be taken to ensure that the arms of the link are not stressed by "spreading" particularly in the case of the lower link.

4. The locknuts must be fitted **before** the castellated nut and tightened very securely at the same time preventing the eyebolt from turning.

5. The castellated nuts should be tightened to 30 lb. ft. (4·148 kg. m.) and if the split pin hole is not in line with a slot in the nut, tighten the nut until the pin can be inserted.

UPPER LINK

To Remove.

1. Jack up the vehicle under the front crossmember using a block of wood between the jack and crossmember.

2. Remove the road wheel.

3. Remove the shock absorber.

4. Fit the Spring Compressor, Churchill Tool R.G. 50D and Adaptor R.G. 50D–2 and compress the spring sufficiently to take the load of the spring.

5. Remove the upper link eyebolt.

6. Before disconnecting the upper link attachment, care should be taken to secure the shims in position by wiring them to the fulcrum pin.

7. Remove the bolts and nut plate assembly securing the fulcrum pin to the coil spring housing.

8. Remove the upper link.

the identification hole must be positioned nearest the road wheel.

3. The refitting of the top stem mounting details are a direct reversal of the removal procedure noting that the mounting rubbers are correctly compressed when the nuts on the end of the unit are fully tightened.

COIL SPRING

To Remove.

1. Jack up the vehicle under the centre of the front crossmember using a block of wood between the jack and the crossmember.

2. Remove the road wheel.

3. Remove the shock absorber.

4. Fit the Churchill Spring Compressor Tool R.G.50D and Adaptor R.G. 50D–2 compressing the spring sufficiently to take the load of the spring, to facilitate its subsequent release.

5. Remove the four nuts securing the spring pan to the underside of the lower link and release the spring compressor gradually until the spring is fully extended.

6. Remove the spring compressor, spring pan, and coil spring.

Note: It is essential that the spring pans are identified to their respective lower link assemblies, prior to removal, as any interchanging of the spring pans will cause faulty rebound operation.

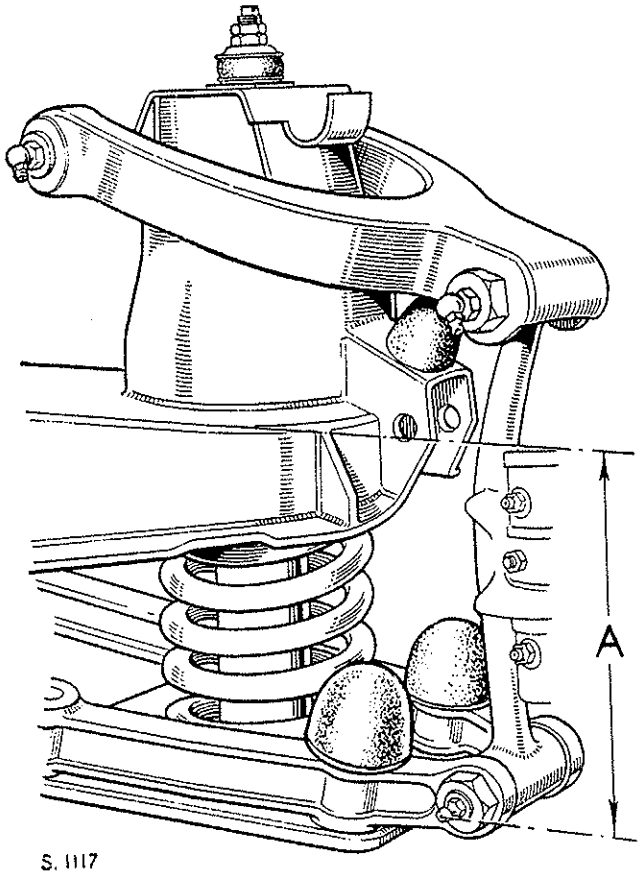
Inspection and Overhaul.

The coil spring should be checked against the data given. If required the springs can be roughly checked in position on the unladen vehicle by placing a load evenly across the cab and measuring the distance between the crossmember top fixing face and the centre of the grease nipple at the outer forward end of the lower link eyebolt (see Fig. F.11. and "GENERAL DATA" for details of loading).

To Refit.

1. Ensure that the washers are replaced between the spring pan and the lower link arms at each inner attachment point as shown in Fig. F.10. These washers tilt the spring pan in relation to the link arms and reduce the bowing of the springs on rebound.

2. Refit each spring pan to the correct lower link assembly as identified during the removal operation.



S. 1117

DIMENSION A = 5·75 in. (146 mm.)—1500 series
DIMENSION A = 5·00 in. (127 mm.)—2500 series

Fig. F.11. Rough checking of the front coil spring in position

STUB AXLE CARRIER

To Remove.

1. Jack up the vehicle under the centre of the front crossmember using a block of wood between the jack and crossmember.

2. Remove the road wheel.

3. Remove the stub axle assembly.

4. Remove the shock absorber.

5. Compress the road spring sufficiently to take the load of the spring. Churchill Spring Compressor Tool No. R.G.50D and Adaptor R.G. 50 D–2 should be utilised for this purpose.

6. Remove the locknut from the lower link eyebolt.

7. Remove the split pin and castellated nut and screw the eyebolt out of its threaded bushes.

8. Swing the lower end of the stub axle carrier out of the lower link fork and remove the two sealing rings.

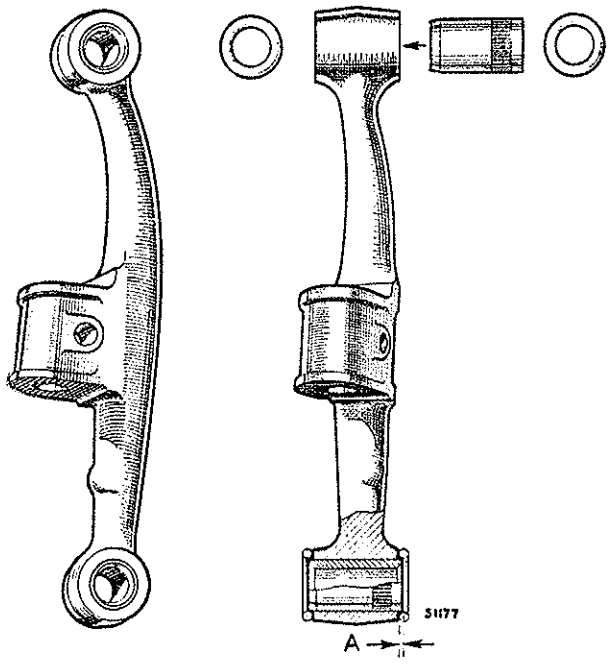
9. Remove the locknut from the upper eyebolt.

10. Remove the split pin and castellated nut and screw the eyebolt out of its threaded bushes.

11. Remove the stub axles carrier.

Inspection and Overhaul

1. The stub axle carrier should be carefully examined for signs of damage or excessive wear on the machined faces. If necessary the carrier should be renewed.



DIMENSION A = 0·092/0·100 in. (2·34/2·54 mm.)

Fig. F.12. **Fitting of threaded bushes to the stub axle carrier. The new bush is pressed in from the rear**

2. The sealing rings should be renewed if deterioration is evident.

3. The **original threaded bushes** are pressed in from the front until they project 0·100/0·092 in. (2·54/2·34 mm.) from the front face of the carrier boss and the external knurling on the bushes is then positioned towards the front end.

Note: **The bushes must only be pressed out forwards** (i.e., pressing from the rear face of the carrier eyes). **Replacements must always be pressed in from the rear** (knurled end last) to enable the knurling to engage a plain portion of the boss until they project 0·100/0·092 in. (2·54/2·34 mm.) from the rear face of the carrier boss (see Fig. F.12).

Before fitting new eyebolts or threaded bushes it is most important that the parts are selected so that they may be screwed together freely by hand. Clearance is provided between the threads of the fulcrum pins, eyebolts and their respective screwed bushes to allow for lubrication. This clearance must not be mistaken for wear.

To Refit.

The refitting procedure is the reversal of the removal instructions but particular attention should be paid to the following points while refitting the upper and lower links.

1. The upper and lower bosses of the stub axle carrier must be midway within the forks of the upper and lower links when fitted.

2. Before fitting the eyebolts, place the sealing rings on the upper and lower bosses of the carrier, one at each side. When the eyebolt is correctly located the rings can be slid outwards along the bosses into position.

3. The eyebolts must be screwed in from the front until the shoulder of the bolt butts firmly against the rear part of its respective link. Care must be taken to ensure that the arms of the link are not stressed by "spreading" particularly in the case of the lower link.

4. The locknuts must be fitted **before** the castellated nut and tightened very securely at the same time preventing the eyebolt from turning.

5. The castellated nuts should be tightened to 30 lb. ft. (4·148 kg. m.) and if the split pin hole is not in line with a slot in the nut, tighten the nut until the pin can be inserted.

UPPER LINK

To Remove.

1. Jack up the vehicle under the front crossmember using a block of wood between the jack and crossmember.

2. Remove the road wheel.

3. Remove the shock absorber.

4. Fit the Spring Compressor, Churchill Tool R.G. 50D and Adaptor R.G. 50D–2 and compress the spring sufficiently to take the load of the spring.

5. Remove the upper link eyebolt.

6. Before disconnecting the upper link attachment, care should be taken to secure the shims in position by wiring them to the fulcrum pin.

7. Remove the bolts and nut plate assembly securing the fulcrum pin to the coil spring housing.

8. Remove the upper link.

Removing Bushes.

1. Unscrew greasers and remove washer, caps and seals from fulcrum pin.

2. Assemble split tube between fork ends embracing the fulcrum pin. Secure tube with a spring clip.

3. Place link assembly on support on base of press.

4. Place a suitable driver on protruding end of fulcrum pin and operate press until bushes are clear of the bush housings.

5. Remove split tube, unscrew the bush positioned between the link arms and remove the seal and collar.

6. Withdraw the fulcrum pin from the link assembly, unscrew the second bush and remove the seal and collar.

Inspection and Overhaul.

1. The bushes are an interference fit in the link. Should it be evident that movement has occurred due to looseness of the bushes, the link and bushes should be renewed.

2. Clearance is provided between the threads of the fulcrum pins, eyebolts and their respective screwed bushes to allow for lubrication. The clearance must not be mistaken for wear.

Refitting Bushes.

1. Fit collar and seal to one end of fulcrum pin, screw bush on to pin, checking position with depth gauge.

2. Pass the unbushed end of the fulcrum pin through the bush housing in one arm of the link assembly.

3. Fit the second bush to the fulcrum pin, after fitting the collar and seal, obtaining the correct position of the bush with the depth gauge.

4. Enter the bushes into the bush housings of the link assembly making sure that the bolt holes are in line with the axis of the link assembly.

5. Assemble the split tube between the link arms embracing the fulcrum pin, with the slot in line with the bolt holes. Secure the tube with a spring clip. (Some difficulty may be encountered when fitting the split tube due to the overall length of the tube being 0·03 in. (0·762 mm.) greater than the distance between link arms. This 0·030 in. (0·762 mm.) provides the correct bearing pre-load when the bushes have been pressed into position and the split tube removed.)

6. Place the link assembly on the support on the base of the press and, using a driver to protect the exposed threads on the end of the fulcrum pin, press the fulcrum pin, complete with bushes, into the link assembly until the bolt hole lines up with the edges of the slot in the split tube.

7. Remove the split tube and fit the seals, caps, washers and greaser to the assembly.

To Refit.

1. Refitting is a reversal of the removal instruction. Care should be taken to refit the original shim to the upper link inner attachment.

2. Check Camber.

3. Check toe-in (track).

LOWER LINK

To Remove.

1. Jack up the vehicle under the front crossmember using a piece of wood between the jack and crossmember.

2. Remove the road wheel.

3. Disconnect the anti-sway bar from the lower link.

4. Remove the shock absorber.

5. Remove the coil spring.

6. Remove the lower link eyebolt.

7. Undo the four bolts securing the lower link fulcrum pin to the crossmember.

8. Remove the lower link complete with fulcrum pin taking care not to lose the two locating dowels.

Removing Bushes.

1. Remove greasers, caps and seals from each end of the fulcrum pin.

2. Assemble split tube between the legs of the link embracing the fulcrum pin. Secure the split tube with a spring clip.

3. Place link assembly on the support on the base of a press.

4. Place a suitable driver on protruding end of fulcrum pin and operate press until fulcrum pin bushes are clear of the bush housings.

5. Remove split tube and unscrew the bush, together with its sealing ring, which is now positioned between the legs of the link assembly.

6. Withdraw the fulcrum pin from the link assembly and unscrew the second bush and sealing ring.

Inspection and Overhaul.

1. The bushes are an interference fit in the link. Should it be evident that movement has occurred due to looseness of the bushes, the link and bushes should be renewed.

2. Clearance is provided between the threads of the fulcrum pin, eyebolts and their respective screwed bushes to allow for lubrication. This clearance must not be mistaken for wear.

Refitting Bushes.

1. Fit the "O" ring over the end of the fulcrum pin and screw on the bush, using the depth gauge to correctly position the bush on to the pin.

2. Pass the end of the fulcrum pin without the bush through the bush housing of the link.

3. Screw the second bush on to the fulcrum pin after fitting the "O" ring, again obtaining correct position with the depth gauge.

4. Enter the bushes into the bush housings of the lower link arms, ensuring that the dowel holes are at 90° to the axis of the link assembly and are facing upwards.

5. Assemble the split tube between the lower link arms embracing the fulcrum pin, with the slot in line with the dowel holes. Secure tube with a spring clip.

6. Place support on to base of a suitable press, positioning the link assembly on the support.

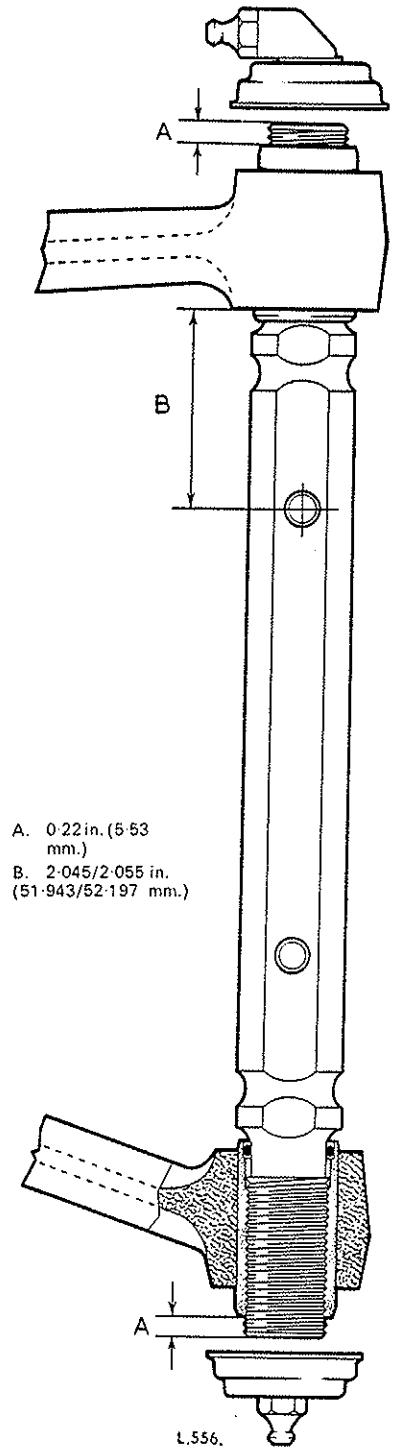
7. Fit a driver to the protruding end of the fulcrum pin and operate press until the dowel hole lines up with the edges of the slot in the split tube.

8. Refit the seals, caps and greasers to each end of the fulcrum pin with the angled greaser fitted at the rear, in line with the arm.

The fulcrum pin and bush assembly is now correctly assembled to the link as illustrated in Fig. F.13

To Refit.

Refitting is a reversal of the removal instructions. Ensure that the coil spring is fitted as previously detailed.



A. 0·22 in. (5·53 mm.)
B. 2·045/2·055 in. (51·943/52·197 mm.)

Fig. F.13. Assembly of lower link fulcrum pin

BALL JOINTS

The ball joints fitted to the steering rods are of the sealed type. These joints are fitted with Nylon-Molydisulphide inserts and are pre-packed with lubricant during manufacture. The ball joints require no attention during service other than routine cleaning and alignment checks.

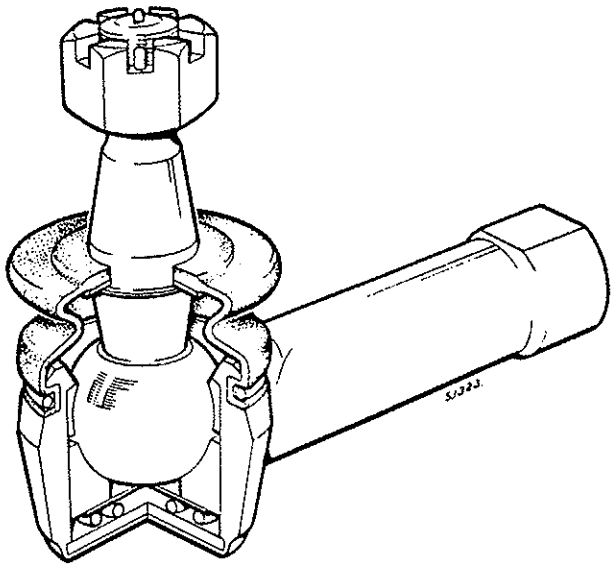


Fig. F.14. Sectional view of ball joint

FRONT SUSPENSION ASSEMBLY

To Remove.

1. Raise the vehicle by placing a jack under the crossmember using a piece of wood between the jack and crossmember.

2. Place stands under sidemembers of the underframe.

3. Remove road wheels. Also disconnect the handbrake secondary cable at the equaliser.

4. Remove shock absorbers.

5. Partly compress both front coil springs, using Churchill Spring Compressor R.G.50D and Adaptor R.G.50D–2.

6. Disconnect the anti-sway bar from the lower link.

7. Thoroughly clean the chassis unions of the flexible hydraulic brake pipes and then disconnect them at the chassis. The pipe ends should be protected and the unions sealed to prevent the entry of dirt into the hydraulic system.

8. Wire the shims to the upper link fulcrum pins and then remove the pin retaining bolts.

9. Lift the upper link fulcrum pins over the spring housings and tie them in the lips provided opposite the fulcrum pin mounting positions. This is to prevent the upper link, stub axle carrier and front hub falling down and hanging on the lower link.

10. Remove the intermediate steering rod connecting the front end of the main relay lever to the intermediate relay lever.

11. Loosen off the engine front rubber mountings.

12. Place wooden packing blocks under the engine sump so that the engine weight is supported.

13. Disconnect the engine front mountings.

14. Support the front crossmember and remove the four bolts securing the crossmember to the underframe sidemembers.

15. Lower the crossmember and draw out from beneath the vehicle.

To Dismantle.

1. Remove the inner ends of the track rods at the rear end of the main relay lever.

2. Remove the hubs, stub axles, coil springs, stub carriers, and upper and lower links as described in preceding pages.

3. Remove the four bolts securing the main relay lever bracket to the crossmember and withdraw the main relay lever through the crossmember aperture.

Inspection and Overhaul.

1. Refer to details given in preceding paragraphs relating to component parts.

2. See "STEERING" section for details of overhaul, relevant to the main relay lever and bracket assembly.

To Re-assemble.

1. Re-assembly is a reversal of the dismantling instructions. Care should be taken to refit the original shims to the upper link inner attachments.

2. Ensure that the coil spring is fitted correctly as previously detailed.

To Refit.

Refitting is a reversal of the removal instructions.

After reconnecting the hydraulic brake hoses it is essential to bleed the brake system in order to remove any air which may be present in the fluid lines (see "BRAKES" section). If any new parts have been fitted the wheel camber should be checked and adjusted first and when this is correct the wheel toe-in (track) should be reset. It is also advisable to make these checks after replacing the original components.

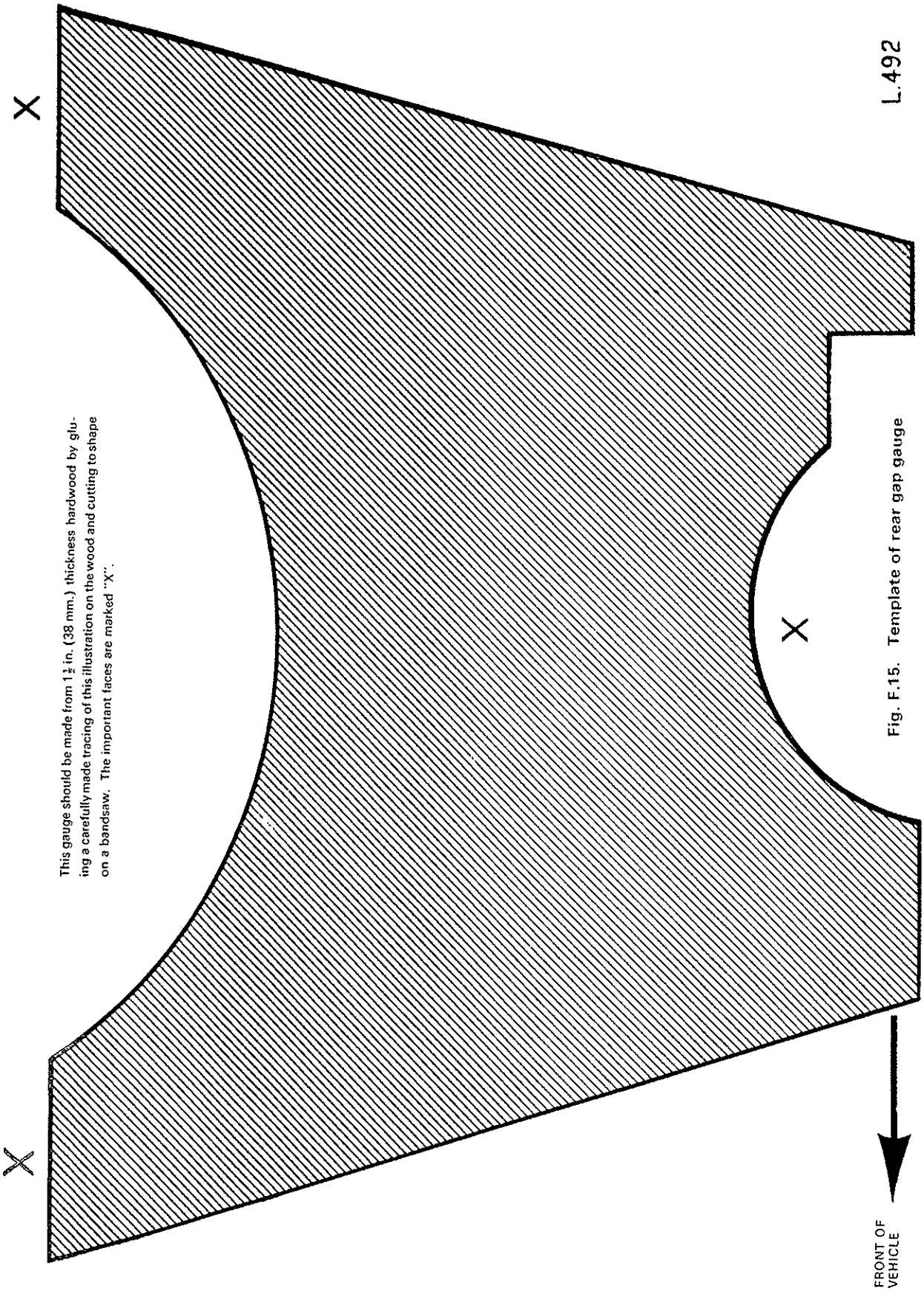


Fig. F.15. Template of rear gap gauge

Checking the Camber, Castor and King Pin Inclination Angles on the Front Suspension Jig.

The Dunlop CG/4–5, Camber, Castor and King Pin Inclination Gauge is approved for checking the steering geometry, but it should be noted that when checking the camber with this equipment, the wheels must be fitted to the drums, as the camber gauge registers on the walls of the tyres. As the Castor and King Pin Inclination Gauge is located on the stub axle nut, this nut must be tightened before the angle checks are made.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

REAR AXLE

SECTION G

INDEX

REAR AXLE

DESCRIPTION

The rear axle is of the semi-floating type incorporating a hypoid bevel drive. The pressed steel banjo type axle casing houses a crown wheel and pinion differential assembly and each side tube of the casing has a flange at its outer end, to which a brake back plate is fitted.

Provision is made for the adjustment of all bearings in the differential and bevel pinion assembly. The complete differential unit with the crown wheel and pinion is detachable from the axle casing assembly should it become necessary to carry out repairs or adjustment.

The differential assembly consists of a one piece housing containing two bevel wheels in constant mesh with two pinions. The bevel wheels are splined internally to take the axle shafts. The pinions are carried on a cross pin, which is held in position in the housing by a lock pin. Side thrust of the bevel wheels and pinions is taken on phosphor bronze thrust washers.

From the differential, the drive is taken by axle shafts to the hubs, which are integral with the shafts and supported by bearings in the ends of the axle tubes.

LUBRICATION

Every 6,000 miles (10,000 km.) the axles should be drained, flushed and refilled with fresh oil, using Shell Spirax 90 EP. (or if prevailing climatic temperature is below —23°C. (—10°F.) use Shell Spirax 80 EP.).

The drain plug is situated underneath the axle casing differential aperture on the right-hand side. A combined filler and level plug is fitted on the left-hand side of the differential housing.

BEVEL PINION HOUSING OIL SEAL

In the bevel pinion housing an oil seal (see Fig. G.2, Item 28) is fitted to the rear of the propeller shaft driver coupling. Whenever a replacement oil seal is fitted, the outside of the seal casing should be coated with a liquid jointing compound before the seal is pressed into position. This seal only operates in one direction and therefore it should be fitted with the sharp edge of the seal lip facing the rear axle. The seal should be renewed in course of any overhaul or repair operations which involve the dismantling of the bevel pinion assembly. If the seal is of the type with an outer coating of synthetic rubber, it should be dipped in oil before pressing into the housing.

HUB OIL SEALS AND DEFLECTORS

A conical oil deflector is located inside each end of the axle casing by the outer race of each rear hub bearing. (See also Fig. G.2.)

A lip type oil seal (40) mounted in a support plate (41) and backed up by an oil catcher, fitted to the hub side of each brake back plate, ensure adequate oil retention.

The annular oil catchers (42) drain through holes in the brake back plates, thus ensuring that excess oil is diverted from the brake shoes.

It is important that the drain holes from the catchers should be kept clear, otherwise the catchers may become overfilled and oil will eventually reach the brake linings. Also the joints between the catcher flange, the oil seal, support plate and the brake back plate must be sealed with liquid jointing compound.

AXLE DRIVING SHAFTS

To Remove.

It is most important that those responsible for the repair of this rear axle should know that the design of the rear hub bearing assembly is such that serious damage will result from any attempt to remove an axle driving shaft by any method other than the following:

1. Remove the road wheel.

2. Remove screw securing brake drum and withdraw the drum.

3. Release brake pipe connection from rear wheel cylinder.

4. Protect brake pipe connections against the ingress of foreign matter. Remove nuts and bolts securing brake back plate to flange on axle casing.

5. Draw out driving shaft complete with brake back plate and hub bearing, using Churchill Tool No. R.G. 16A and the Adaptor R.G.16A-2.

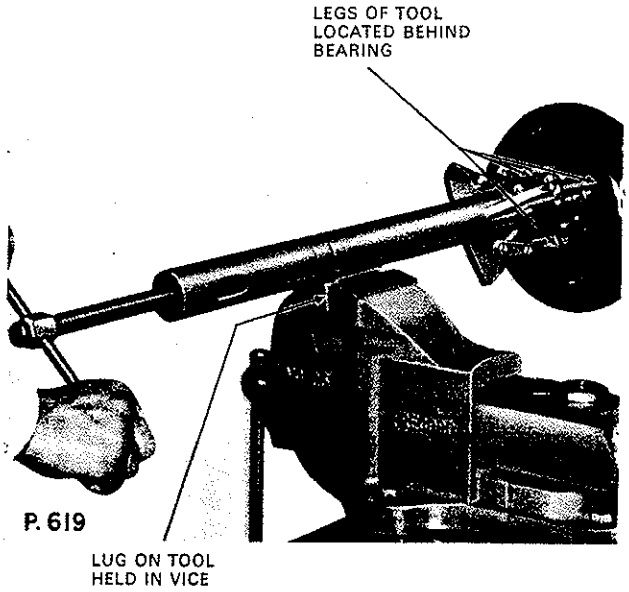


Fig. G.1. Removing the rear hub bearing from the axle shaft, using Churchill Tool R.G.330A

6. Secure the tool to the hub by means of the road wheel nuts and drive the sliding weight smartly away from the vehicle. **Do not attempt to drive out the shaft by striking the brake back plate, as this procedure can only cause damage.**

7. Remove the oil deflector (see Fig. G.2, Item 37) if this is not dislodged by the shaft.

To Dismantle (See Fig. G.2).

1. Secure the shaft in a vice.

2. Release the turned-up side of the tab washer (38).

3. Remove nut (39) (right-hand threaded in each case).

4. Draw off rear hub bearing (36) using the Churchill Tool No. R.G.330A. (See Figs. G.1 and G.12.)

5. Remove brake back plate, oil seal (40), support plate (41) and oil catcher (42) from shaft. Note the joints (43) on each side of support plate (41).

Inspection and Overhaul.

Examine the shaft generally for bend and the splines for wear or twist.

To Re-assemble.

Re-assembly is a reversal of the dismantling procedure. A new tab washer should be used and turned up closely against the side of the nut.

To Refit.

1. Refitting is a reversal of the removal procedure. The conical deflector should be fitted before entering the shaft assembly into the axle casing. The shaft and bearing can be tapped into place with a mallet. See also notes regarding hub oil seals and deflectors.

2. Bleed the hydraulic system (see "BRAKES" section).

DIFFERENTIAL UNIT

To Remove.

1. Drain oil from axle case.

2. Remove both axle driving shafts.

3. Disconnect propeller shaft from rear axle driver coupling.

4. Remove nuts securing the differential housing to the axle casing.

5. Lift out the assembly from axle casing.

To Dismantle.

1. Release tab washers and remove bolts securing caps of differential support bearings.

2. Remove caps, noting identification marking on one cap relative to its respective side.

These bearing caps must not be interchanged under any circumstances.

3. Lift off differential assembly complete with crown wheel and bearings, **taking care that the outer races of the bearings are not interchanged one side with the other. This is important.**

4. Remove crown wheel by releasing the tab washers (21) and withdrawing the eight securing bolts.

5. Knock out lock pin (18) securing cross pin (17) in differential box.

6. Push out cross pin. Differential pinions complete with thrust washers (16) can then be carried round and brought out through the wide openings in the differential box.

7. Differential wheels and thrust washers (15) can now be taken out of the differential box through the wide openings.

8. Should it be found necessary to renew the support bearings which carry the differential assembly, the old inner races may be withdrawn, using the Churchill Bearing Remover Tool R.G.4221B and Adaptor 2A, illustrated in Fig. G.12 and shown in operation in Fig. G.3.

Note the number and thickness of shims beneath the bearing on each side.

Inspection and Overhaul.

1. Examine the crown wheel for wear or pitting on the teeth. If the teeth are chipped or worn the crown wheel must be renewed. It is also essential to renew the pinion as the two components are carefully matched during manufacture and must always be fitted as a pair.

2. Check the bevel wheels for wear on the axle shaft splines and both the bevel wheels and pinions for wear or damage to the teeth.

3. Check the thrust washers for wear.

4. Examine the cross pin for wear or scoring.

5. Wash the bearings in thin oil and inspect them for wear, pitting or damage. Renew if necessary.

6. Check all setbolts for stretch and damaged threads.

7. Check the faces of both the crown wheel and differential box for burrs.

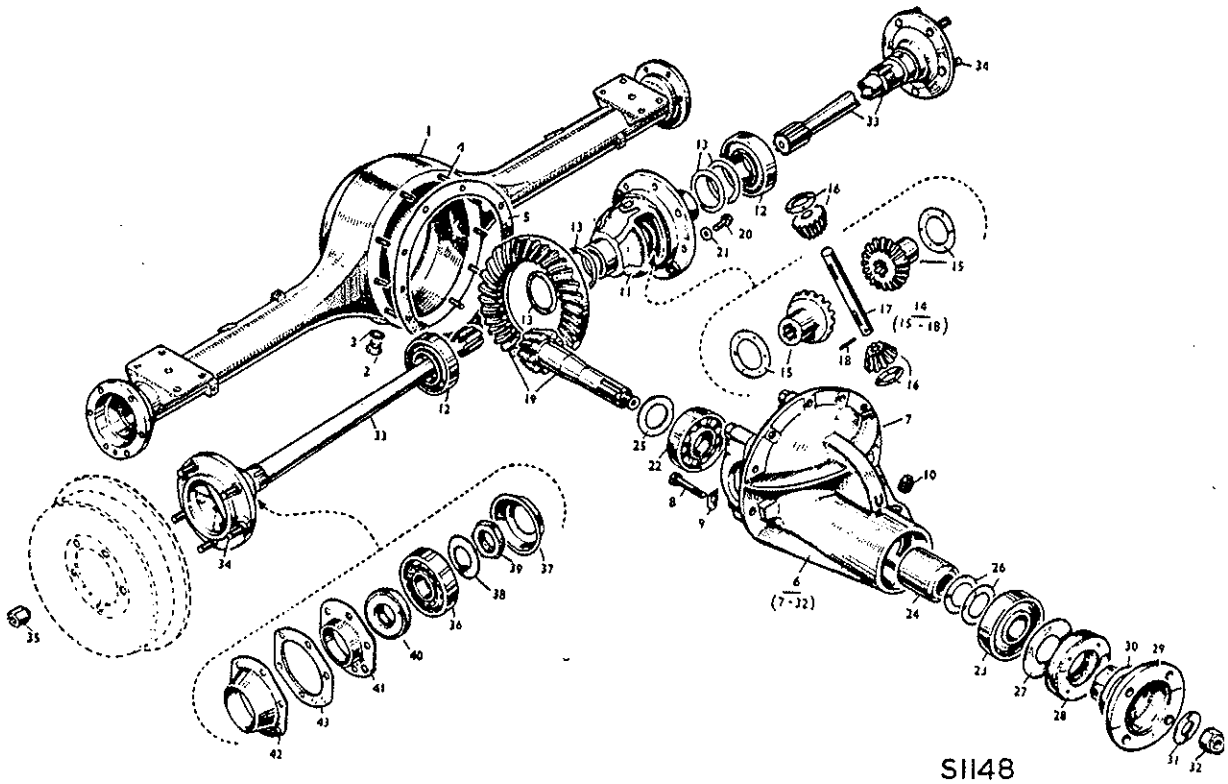
To Re-assemble.

1. Re-assembly is a reversal of the dismantling procedure. The fitting of the cross pin with its lock pin will be facilitated by turning the cross pin by means of a punch inserted in the lock pin hole. The end of the drilling in which the lock pin is located must be re-peened for security.

2. The tab washers on the crown wheel securing bolts should be renewed.

To Refit.

Refitting is a reversal of the removal procedure. A new joint should be used between the differential housing and the axle casing. The joint faces of these



1 AXLE CASING ASSEMBLY
2 DRAIN PLUG
3 DRAIN PLUG GASKET
4 CASING STUD
5 DIFFERENTIAL HOUSING JOINT
6 DIFFERENTIAL UNIT
7 DIFFERENTIAL HOUSING
8 CAP BOLT
9 TAB WASHER
10 COMBINED FILLER AND LEVEL PLUG
11 DIFFERENTIAL BOX
12 DIFFERENTIAL SUPPORT BEARING
13 BEARING SHIM
14 DIFFERENTIAL BEVEL WHEEL AND PINION SET
15 DIFFERENTIAL BEVEL WHEEL AND THRUST WASHER
16 DIFFERENTIAL PINION AND THRUST WASHER
17 PINION CROSS PIN
18 LOCK PIN
19 CROWN WHEEL AND BEVEL PINION SET
20 CROWN WHEEL SECURING BOLT
21 TAB WASHER
22 BEVEL PINION REAR BEARING
23 BEVEL PINION FRONT BEARING
24 BEARING SPACER
25 PINION REAR BEARING SHIM
26 PINION FRONT BEARING SHIM
27 OIL SHIELD
28 BEVEL PINION HOUSING OIL SEAL
29 DRIVER COUPLING
30 COUPLING OIL THROWER
31 WASHER
32 PINION CLAMPING NUT
33 AXLE DRIVING SHAFT
34 ROAD WHEEL STUD
35 ROAD WHEEL NUT
36 REAR HUB BEARING
37 OIL DEFLECTOR
38 TAB WASHER
39 BEARING SECURING NUT
40 REAR HUB OIL SEAL
41 SEAL SUPPORT PLATE
42 OIL CATCHER
43 SUPPORT PLATE JOINT

Fig. G.2. Rear axle details

two components must be clean and free from burrs and jointing compound should be used to ensure an oil tight seal.

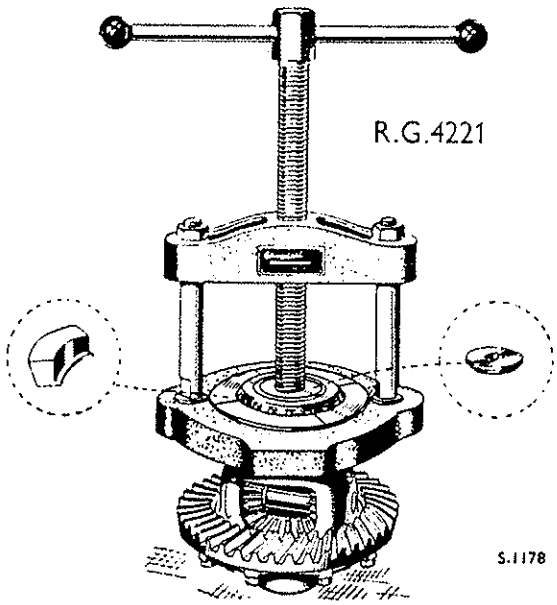


Fig. G.3. Removal of the inner race of the differential support bearing, using Churchill Tool R.G. 4221B and adaptor 2A (8A for the bevel pinion rear bearing).

BEVEL PINION

To Remove (see Fig. G.2).

1. Remove nut and washer and withdraw the propeller shaft driver coupling; this will come away easily as it is located on splines.

2. Tap out the bevel pinion, using a mallet to avoid damaging threads. The front bearing shims (26) and bearing spacer (24) which have become detached with the pinion shaft, should be removed.

To Dismantle (see Fig. G.2).

1. The inner race of the bevel pinion rear bearing should then be removed from the pinion using Churchill Tool No. R.G.4221B and Adaptor 8A illustrated in Fig. G.12. Remove the rear bearing shims (25), next to the pinion head.

2. To remove the front pinion bearing and oil shield (27) it will be necessary to withdraw the bevel pinion oil seal (use an internal claw type extractor).

3. Should the bearings require replacement, the outer races of the bevel pinion bearings can be removed by driving out with a hammer and drift, the drift being located on the inner face of the bearing in each case.

Inspection and Overhaul.

1. Wash the bearings in thin oil and inspect them for wear, pitting or damage. Renew complete bearing if necessary.

2. Fit the driver coupling to the splines and check for backlash. Renew the coupling if wear on splines is apparent.

3. Examine the pinion teeth; if these are damaged or pitted the pinion should be renewed together with the crown wheel with which it is matched during manufacture.

4. Inspect the oil seal.

To Re-assemble and Refit—Using Churchill Tool No. R.G.329.

1. Refit the bearing outer races, tapping them into position with a brass drift until they are hard against their locating shoulders in the differential housing.

2. Take the dummy pinion shaft and place on it the inner race of the rear bearing, the bearing spacer and any shims which were originally fitted between the spacer and the bearings. **Do not yet fit shims between rear bearing and dummy pinion head.** Make sure that the bearing inner race is correctly located and that no foreign matter is present between bearing, bearing spacer, and shims.

3. Fit the dummy pinion shaft to the differential housing, complete with both bearings, spacer tube and the original shims; fit the coupling nut and washer and tighten fully.

4. If the shimming adjustment is correct the bearings should be preloaded, i.e., tightened beyond the normal position for free movement. The extent of the preload is measured by testing the torque required to turn the shaft; this should be 10 lb. in. (0·115 kg.m.) for new bearings. When re-assembling the bevel pinion with the original bearings, the preload is 6 lb. in. (0·069 kg. m.).

5. The torque loading can be checked conveniently by means of an ordinary tension type spring balance of suitable calibration. This should be attached to a ring spanner, fitted to the coupling nut as a lever. The point of attachment of the gauge must be 10 in. (254 mm.) from the centre of the pinion shaft for new bearings, and 6 in. (152 mm.) for original bearings. When making the check, the lever should be arranged to point downwards and the gauge should operate at right angles to it. The actual reading shown on the scale when this method is employed should be 1 lb. (0·454 kg.) at the appropriate radius, if the torque loading is correct. To obtain the correct preload, shims should be added to or removed from the location between the bearing spacer and the front bearing.

6. Having established this preload, install the centre jig into the housing, using the two dummy bearings and replacing the two bearing caps with the securing bolts fully tightened (see Fig. G.4). A gap will exist between the end of the dummy pinion shaft and the centre jig. Measure the clearance with feeler gauges. This measurement is the thickness of the shims required to be placed next to the pinion head when re-assembled. In practice, however, it is found that, as the bearing is pressed on to the pinion shaft, the bearing alters in length to the extent of approximately 0·002 in. (0·051 mm.). This dimension (0·002 in.) should therefore be subtracted from the thickness of shims which would be required to fill the gap and added to the shims at the end of the spacer, between the bearings.

7. Remove the centre jig and dummy bearings and dismantle the dummy pinion shaft and assembly.

8. Take the actual bevel pinion shaft, and place on it the correct thickness of shims next to the pinion head.

9. Press on the inner race of the rear bearing using Churchill Tool R.G.4221B and Adaptor 8A.

10. Place the bearing spacer and then the shims with 0·002 in. (0·051 mm.) shim added, on the shaft and rebuild the whole into the housing.

11. Reverse the remaining dismantling and removal procedure, thus completing the assembly and adjustment of the pinion. When refitting the oil seal, the outer cage should be coated with quick drying jointing compound.

ADJUSTMENT OF CROWN WHEEL TO PINION

Having carried out the preceding operations, remove the differential support bearings, and shims as previously described. In their place fit the dummy bearings **without** shims. Place the differential box assembly, complete with dummy bearings in position in the housing. Replace the bearing caps and tighten the securing bolts.

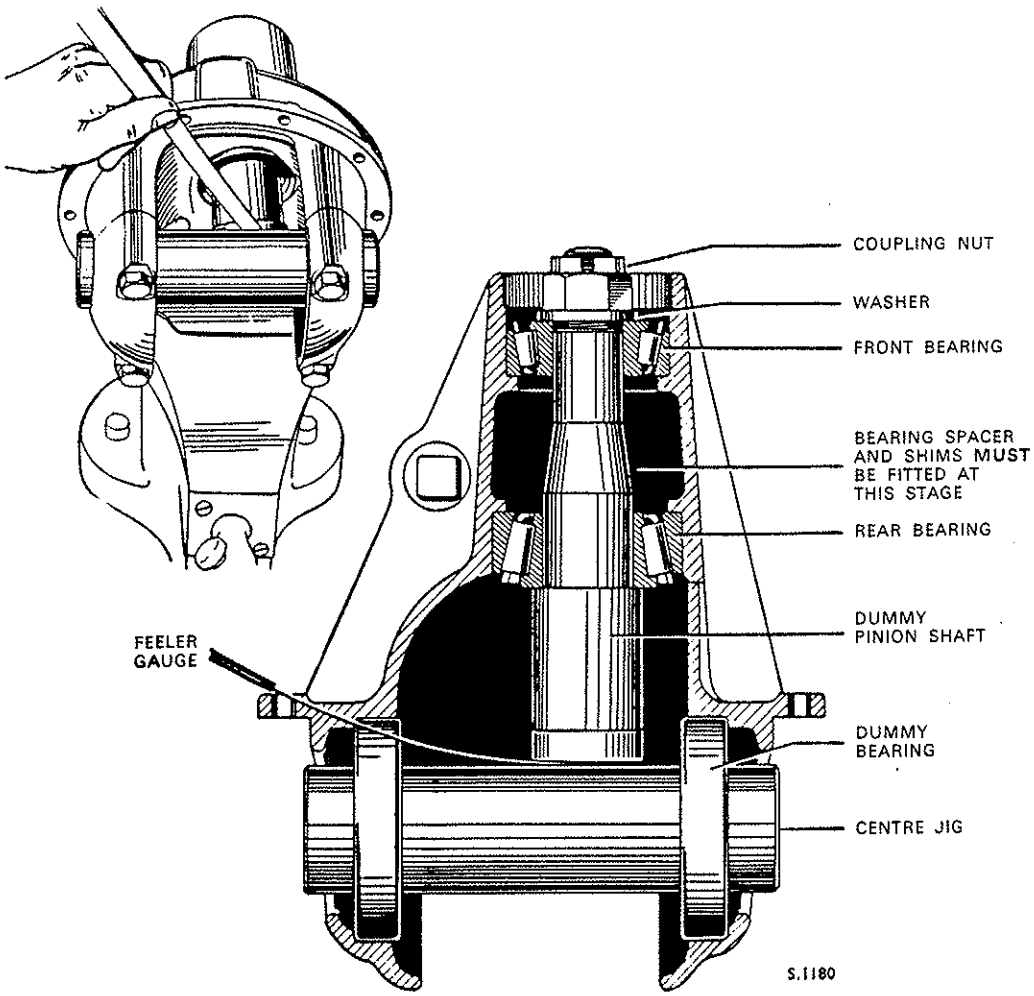


Fig. G.4. Method of determining correct shimming between the pinion head and rear bearing, using Churchill Tool R.G.329

Using a mallet, tap the dummy bearings into close contact with the differential box, in which position they must be maintained during all stages of the adjustment of crown wheel in relation to the bevel pinion.

Checking Backlash between Crown Wheel and Bevel Pinion.

1. Mount a clock or dial gauge as shown in Fig. G.5. The gauge should be attached to the casing in such a position that its stylus bears on the heel of one of the crown wheel teeth. Obviously, the stylus should be arranged so that the gauge registers the full amount of the backlash; therefore it will be found convenient to use the 90° adaptor as shown. This fitting is usually supplied with clock or dial gauge sets.

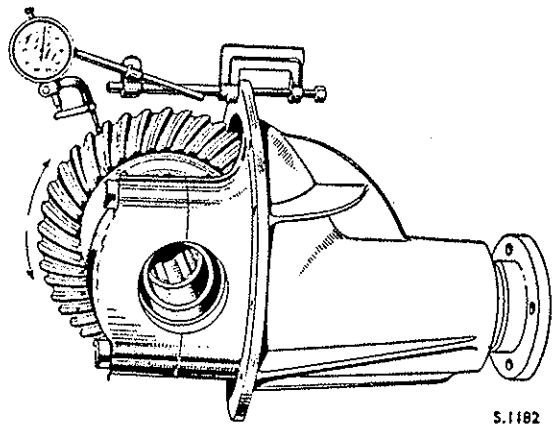


Fig. G.5. Checking backlash between the crown wheel and bevel pinion with a clock gauge and 90° adaptor

2. Having mounted the clock gauge, tap the differential assembly and crown wheel in the requisite direction so that the backlash between crown wheel and pinion is between 0·005 in. (0·127 mm.) and 0·009 in. (0·229 mm.) say 0·008 in. (0·2 mm.). When actually driving the differential assembly during THIS PROVISIONAL ADJUSTMENT, it is, of course, necessary to lift the clock stylus or the gauge may be damaged. Carry out the check for correct backlash in at least three equally spaced positions on the crown wheel teeth to ensure accuracy.

Checking for Correct Marking of Crown Wheel Teeth (see Figs. G.6 and G.10).

1. During the next operation, the maximum importance must be attached to the following procedure:

(*a*) Paint the teeth of the crown wheel thinly with a light paste made of yellow ochre powder and engine oil or any suitable proprietary marking compound and rotate the crown wheel to obtain an impression of the pinion tooth bearing on the crown wheel teeth.

(*b*) When correctly meshed, the marking to be obtained should be as shown in Fig. G.6, i.e., the area of contact on the teeth of the crown wheel is between the crest and the root of the tooth but is considerably nearer the toe (inner or thin end) than the heel (outer or thick end) of the tooth. Adjustment is effected by driving the assembly with a suitable tool, in the requisite direction, through the medium of the dummy bearings.

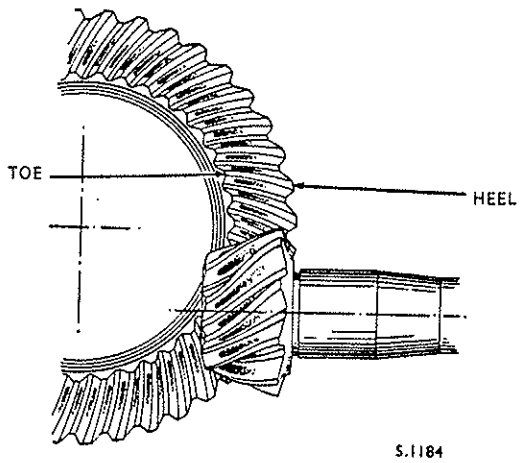


Fig. G.6. Correct marking of the crown wheel teeth

2. The final amount of backlash, whether nearer to 0·005 in. (0·127 mm.) or to 0·009 in. (0·229 mm.) will depend on the most favourable tooth marking obtainable.

Note: As the axial position of the bevel pinion in relation to the crown wheel is predetermined by the use of jigs, as previously described, adjustment for backlash and tooth marking is confined to the axial adjustment of the crown wheel assembly in relation to the bevel pinion.

Assessment of Correct Shimming for Actual Support Bearings to be used in Final Assembly of Differential and Crown Wheel Unit (see Figs. G.7 and G.8).

1. Having established the correct relationship of crown wheel to pinion in accordance with the preceding instructions, it is necessary that such relationships should be accurately maintained in the final assembly, when the actual support bearings to be used are fitted in place of the dummy bearings.

2. This is accomplished as follows:

(*a*) With the dummy bearings in the precise axial position in which they were set in arriving at the best possible tooth bearing indications obtainable, and, of course, closely in contact with the bearing abutment faces of the differential box, check accurately with the feeler gauges the spaces

existing between the bearing thrust abutment faces in the housing and outer faces of the dummy bearings. Fig. G.7 shows the method and precise points at which to insert the feeler gauge.

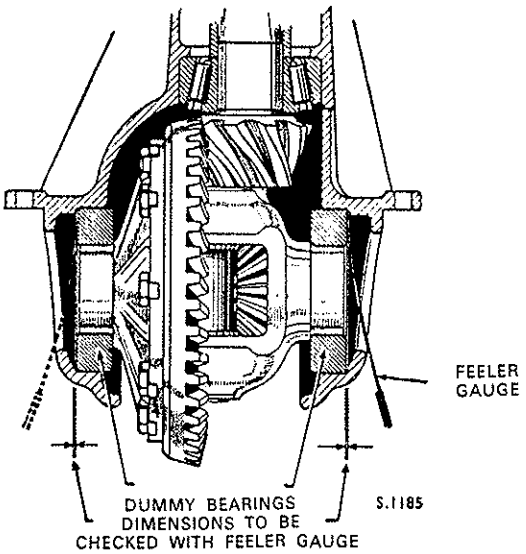


Fig. G.7. Checking shimming thickness required for the dummy bearings

(*b*) It will probably be found that the dimension varies between the two sides. These dimensions respectively, would be the correct shimming thickness required, only for the dummy bearings. Having reckoned the shims for each side, note each set in respect of the side to which it applies. **Take care these are not interchanged.**

(*c*) Now remove the crown wheel and differential assembly from the housing and take off the dummy bearings. The dummy bearings themselves are of precisely the same thickness.
It now remains to find the precise difference in thickness between the dummy bearing and the actual (and individual) bearings to be used. Individual roller bearing assemblies vary in overall length, even though new and of an identical type.

3. There are two practical methods of assessing the difference between the dummy bearing and the actual bearing ; they are as follows :

(*a*) Measurement of difference in thickness between dummy and actual bearing by use of a clock or dial gauge. (See Fig. G.8—left.)
A clock or dial gauge is mounted on a stand and placed on a surface plate together with the dummy bearing. Set the stylus of the gauge on the face of the dummy bearing and set the gauge to zero. Without altering the setting of the clock gauge, transfer stylus to the actual bearing assembly; if this bearing is effectively thicker (shows a plus reading on gauge), the reading now shown indicates the thickness in shims to be subtracted from the shims which were reckoned as correct for the dummy bearing. If the bearing is effectively thinner (shows a minus reading on dial gauge) the requisite number of shims should be added.

(*b*) In the absence of a clock gauge, the difference between the dummy bearing and the actual bearing can be ascertained by the use of feeler gauges and a straight edge in conjunction with a surface plate. (See Fig. G.8—right.)

(*c*) The clock gauge method is superior and should be used in preference to the feeler gauge.

4. Assess the shims required for each side separately and then add one 0·002 in. (0·051 mm.) shim to each side, to provide the correct bearing preload.

5. Finally, the appropriate shims and bearing inner race should be pressed on to its respective spigot on the differential box and an initial amount of lubricant (Shell Spirax 90 E.P.) should be applied to the bearings. The outer race of the bearing must be kept paired to its respective inner race, this is most important.

6. The entire assembly should then be refitted into the housing and the bearing caps tightened fully, using new tab washers for securing the bolts. Lock the tab washers securely.

7. This completes the adjustment and assembly of the unit and it is ready for rebuilding into the axle casing. Use a new joint and liquid jointing compound between the differential unit and axle casing.

8. Fill axle casing to level of filler orifice with fresh oil of the recommended grade.

REBUILDING DIFFERENTIAL UNIT

Emergency Method.

When circumstances arise where urgent attention to the crown wheel and pinion or bearings is required, and the special jigs are not readily available, the differential unit may be rebuilt as follows. The time taken to perform the operation will naturally be considerably lengthened :

1. Place 00·20/0·023 in. (0·508/0·584 mm.) thickness of shims next to the pinion head and press on the inner race of the pinion rear bearing.

2. Fit the distance tube and then the original shims on to the pinion shaft.

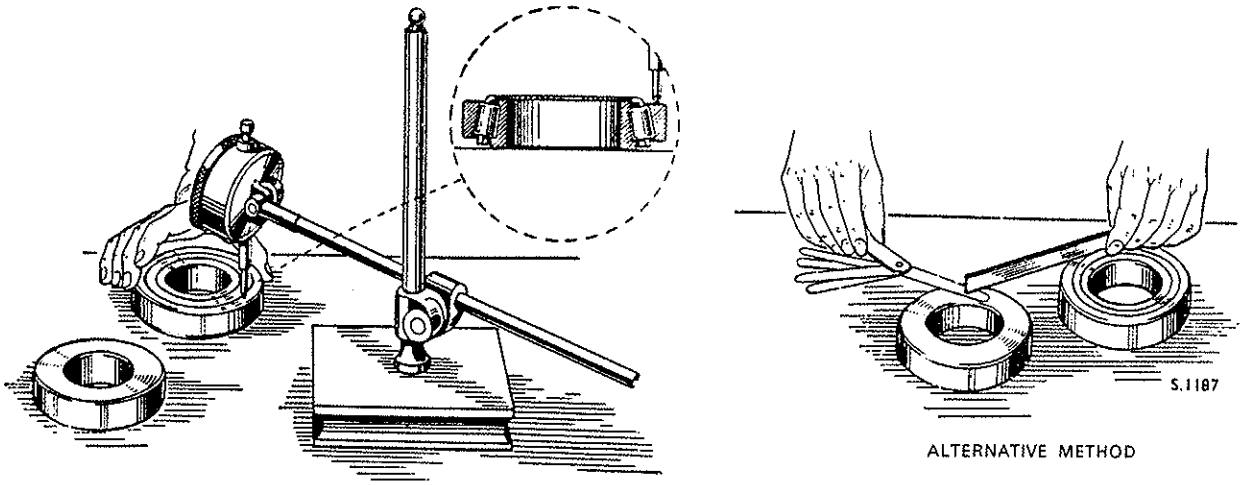


Fig. G.8. Measuring differences in thickness between the dummy bearing and the actual differential support bearing. (On the left: Measuring by means of a clock gauge (preferred method) and on the right using a straight edge and feeler gauges)

3. Ensure that the pinion bearing outer races (original or new) are correctly located against their shoulders in the differential housing.

4. Insert the pinion assembly into the housing; fit the pinion front bearing, but not the oil seal.

5. Fit driver coupling, nut and washer and tighten the nut fully.

6. The pinion bearings should now be preloaded.

The extent of the preload is measured by testing the torque required to turn the pinion shaft; this should be 10 lb. in. (0·115 kg.m.) for new bearings, and 6 lb. in. (0·069 kg.m.) for original bearings (approximately).

The torque loading (preload) can be checked conveniently by means of an ordinary type spring balance of suitable calibration. This should be attached to the driver coupling through the medium of any light gauge metal strip as a lever. This lever should be so arranged that the point of the attachment of the spring balance will be 10 in. (254 mm.) for new pinion bearings, or 6 in. (152 mm.) for original bearings, from the centre of the pinion shaft (see Fig. G.11). The reading on the spring balance should be 1 lb. (0·454 kg.).

7. Build the differential assembly, crown wheel and bearings into the housing. If it is necessary to remove the support bearings from each side of the differential box, note and mark the thickness of shims fitted between the bearing and the box on each side.

8. Refit each set of shims to its correct side and press on the inner race of the support bearings.

9. Ensure that each bearing outer race is fitted to its correct side and fit the assembly into the housing.

10. Fit the bearing caps. Fit and tighten the bolts.

11. Check the backlash which now exists between the teeth of the crown wheel and pinion. This should be between 0·006 in. and 0·010 in. (0·15 and 0·25 mm.). The bearings should be lightly pre-loaded in a similar manner to the pinion bearings.

12. If the backlash is too little, remove the assembly and both support bearings. Then take one shim from the crown wheel side and transfer it to the opposite side. Shims of 0·010, 0·005 and 0·003 in. (0·25, 0·13 and 0·08 mm.) are used. Shim for preload at the same time if necessary.

13. Refit bearings and differential assembly.

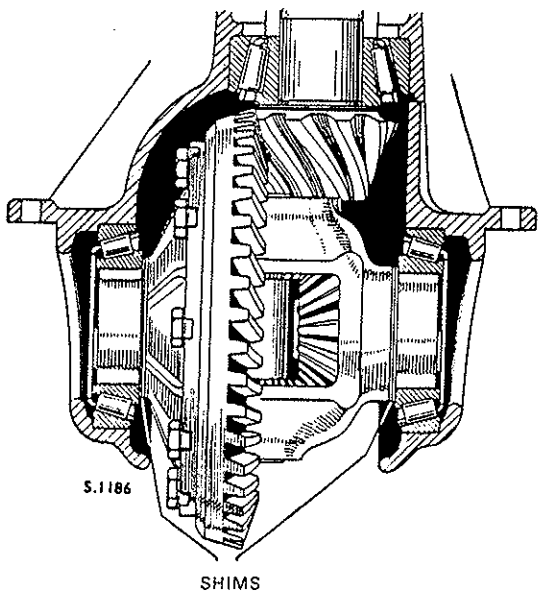


Fig. G.9. Differential support bearings assembled, with shims in position

TOOTH CONTACT CHART

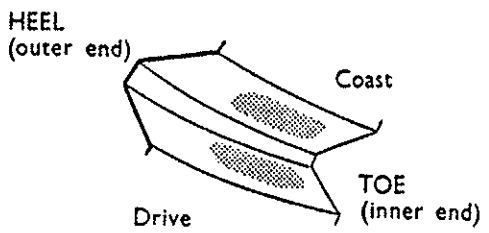
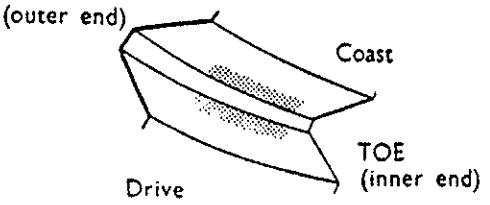
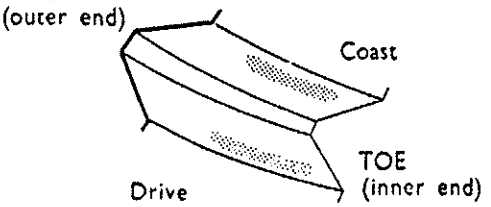
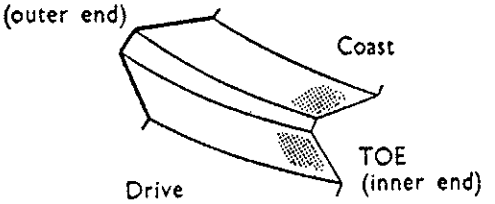
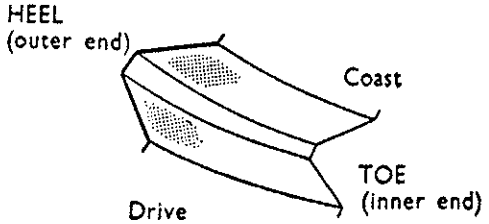
	Tooth Contact	Condition	Remedy
A		IDEAL TOOTH CONTACT evenly spread over profile, nearer toe than heel.	
B		HIGH TOOTH CONTACT heavy on the top of the drive gear tooth profile.	Move the Drive PINION DEEPER into MESH, *i.e.* Reduce the pinion cone setting.
C		LOW TOOTH CONTACT heavy in the root of the drive gear tooth profile.	Move the Drive PINION OUT of MESH, *i.e.* Increase the pinion cone setting.
D		TOE CONTACT hard on the small end of the drive gear tooth.	Move the Drive GEAR OUT of MESH, *i.e.* INCREASE BACKLASH.
E		HEEL CONTACT hard on the large end of the drive gear tooth.	Move the Drive GEAR INTO MESH, *i.e.* DECREASE BACKLASH *BUT* MAINTAIN MINIMUM BACKLASH.

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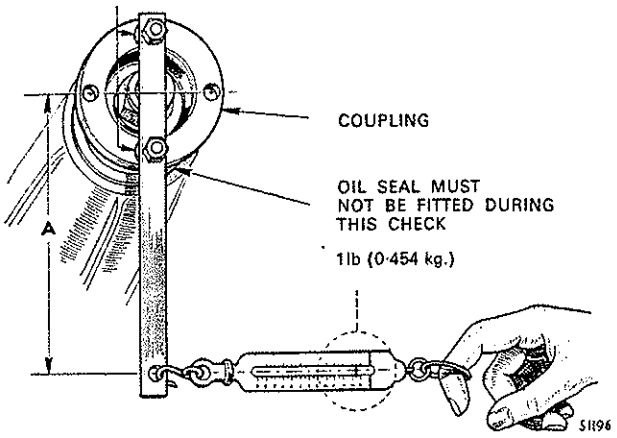
Fig. G.10. Specimen tooth engagement markings on the drive gear (crown wheel)

14. Paint the crown wheel teeth with marking compound and rotate the crown wheel whilst lightly loading the driver coupling to obtain an impression of the pinion teeth on the crown wheel teeth.



'A'—FOR NEW PINION BEARINGS IS 10 in. (25·4 cm.)
—FOR ORIGINAL PINION BEARINGS IS 6 in. (15·2 cm.)

Fig. G.11. Checking the torque loading (preload) on the bevel pinion bearings (emergency method)

15. Correct markings are shown in Fig. G.10 (upper illustration 'A').

16. If backlash is correct, incorrect marking denotes incorrect depth of pinion engagement.

17. This can be rectified by adding or removing shims next to the pinion head. Re-check marking and backlash until correct.

18. Withdraw the driver coupling and fit the pinion shaft oil shield and oil seal. Refit coupling.

PARCO-LUBRISING OF CROWN WHEEL

The crown wheel receives a special wear-resisting finish in manufacture known as the Parco-Lubrising Process. Supplies which have been so treated will be found to have a slightly matt surface on the gear teeth.

It is most important when taking crown wheels which have been treated by this process from stock, to fit to vehicles in service, that care is exercised in the method used to remove the preservative. Caustic soda or paraffin (kerosene) must not be used to remove the preservative—otherwise it is possible that the effect of the Parco-Lubrising may be wholly or partly nullified. Use only petrol, trichlorethylene vapour, or carbon tetrachloride.

AXLE CASING BREATHER

The rear axle breather hole is situated in the top of the axle casing, mid-way between the differential housing and the brake on the off-side. The aperture should be cleaned out from time to time with a piece of wire as it is essential that it is not obstructed by paint, mud, or other matter.

REAR AXLE ASSEMBLY

To Remove.

In the majority of cases it is quite unnecessary to remove the rear axle from the underframe, but in the event of this being necessary for any purpose the following procedure should be adopted:

1. Drain the axle case.

2. Jack up rear of vehicle so that the road wheels are clear of the ground and support the underframe on stands.

3. Remove road wheels.

4. Disconnect propeller shaft at rear driver coupling.

5. Remove rear shock absorbers (see "REAR SUSPENSION" etc.).

6. Disconnect rear brake hose at 3-way union on axle casing.

7. Protect brake connections from the ingress of foreign matter, lift hose upwards and tie to prevent loss of fluid.

8. Remove all spring U-bolts.

9. Withdraw axle from between springs.

To Dismantle.

1. Remove the axle drive shafts.
2. Remove the differential unit.

Inspection and Overhaul.

1. Examine the axle casing generally for damage.

2. Examine the breather aperture and clean out if necessary.

To Re-assemble.

Re-assembly is a reversal of the dismantling procedure.

To Refit.

1. Refitting is a reversal of the removal procedure. Bleed the hydraulic system on completion (see "BRAKES" section).

2. The correct torque loading for the U-Bolt nuts is 35 lb. ft. (4·8 kg.m.) with the road spring flat i.e., no camber.

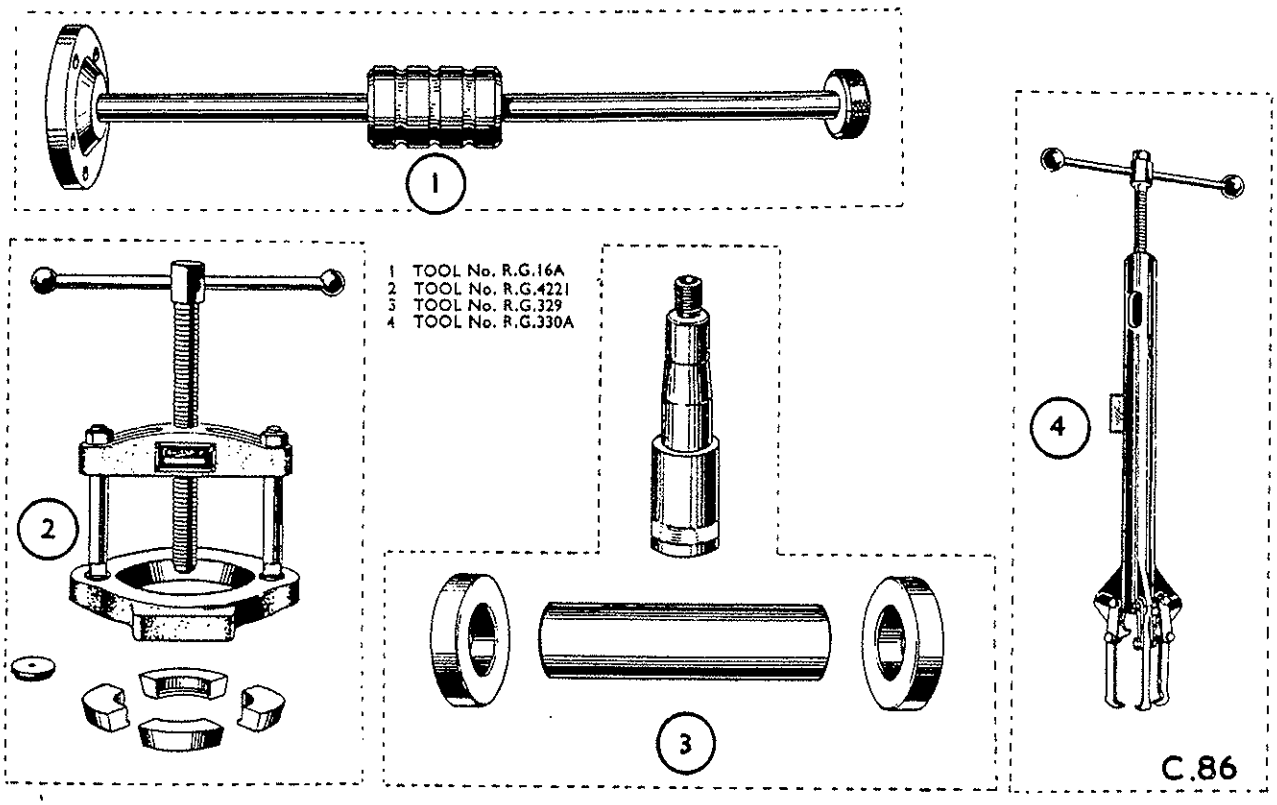


Fig. G.12. Churchill tools for hypoid rear axle overhaul

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF	SUBJECT

REAR SUSPENSION, SHOCK ABSORBERS AND UNDERFRAME

SECTION H

INDEX

REAR SUSPENSION, SHOCK ABSORBERS AND UNDERFRAME

DESCRIPTION

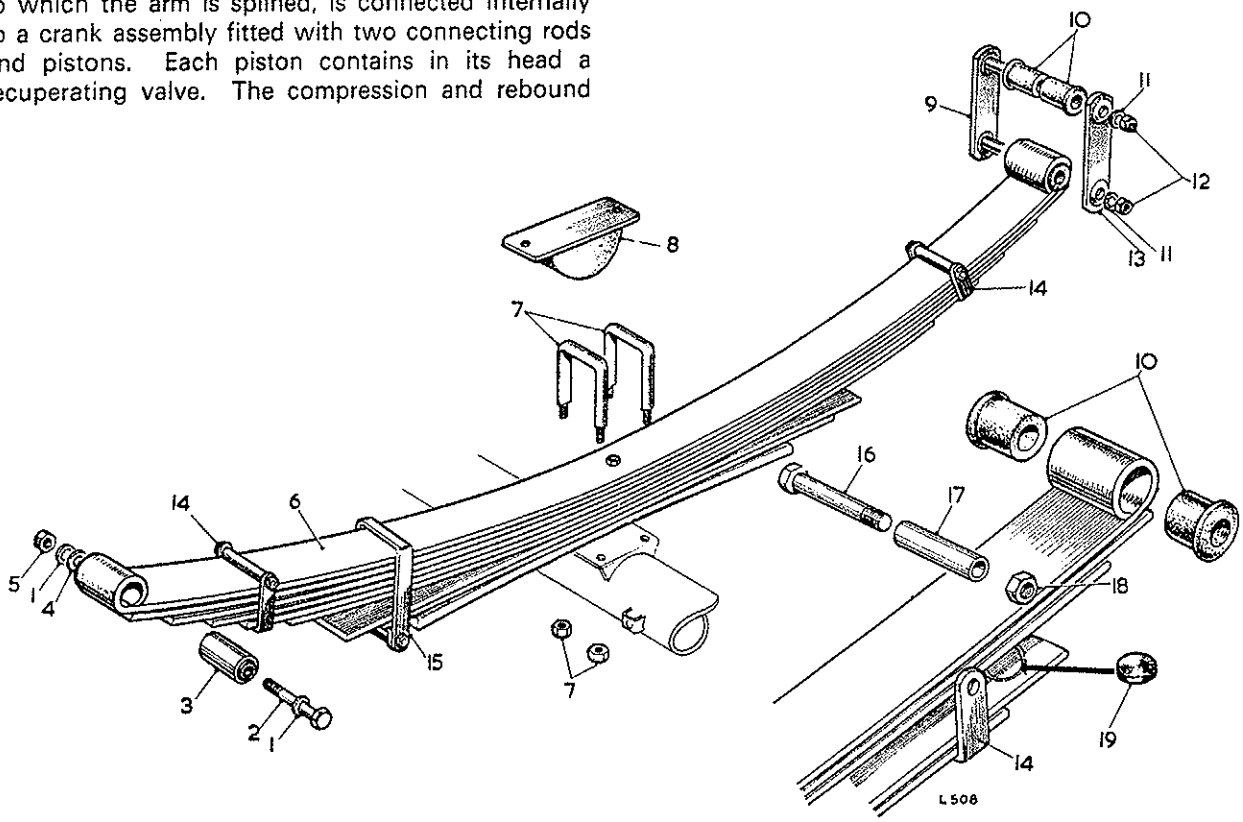
The rear suspension is by means of two semi-elliptic leaf springs each being shackled at its rear end to allow free movement under operating conditions. The front spring eye is fitted with a steel bonded rubber type bush, whilst the rear spring eye and the rear shackle bracket in the underframe are fitted with split rubber bushes.

Armstrong double acting, self regulating, piston type shock absorbers are fitted to brackets on the underframe above the axle casing. The outer end of each shock absorber arm is secured by a link to the axle casing. The spindle of the shock absorber to which the arm is splined, is connected internally to a crank assembly fitted with two connecting rods and pistons. Each piston contains in its head a recuperating valve. The compression and rebound cylinders of the shock absorber are connected by drillings to the valve chamber, at the base of the assembly, which contains the bump and rebound valves and springs.

LUBRICATION

The spring eye and shackle bushes require no lubrication. The spring itself should be kept clean and lightly oiled.

The fluid level of the rear shock absorbers should be checked periodically to ensure that the level is maintained at the bottom of the filler hole boss.



1 SHAKEPROOF WASHER
2 FRONT PIVOT PIN
3 SPRING FRONT EYE BUSH
4 PLAIN WASHER
5 PIVOT PIN NUT
6 REAR ROAD SPRING
7 SPRING U-BOLTS AND NUTS
8 BUMP RUBBER ASSEMBLY
9 OUTER SHACKLE PLATE AND PINS
10 SPRING REAR EYE AND UNDERFRAME BRACKET BUSHES
11 SHAKEPROOF WASHER
12 SHACKLE PIN NUT
13 INNER SHACKLE PLATE
14 SPRING CLIP No. 5 LEAF
15 SPRING CLIP ASSEMBLY AUXILIARY LEAF
16 SPRING CLIP BOLT
17 DISTANCE TUBE
18 CLIP BOLT NUT
19 THRUST BUTTON

Fig. H.1. Rear road spring details

REAR SPRING CAMBER

To Check.

Spring camber is the difference in height between the top face of the main leaf and a line drawn through the centre of the spring eyes. This will naturally vary with the weight carried. In order to check rear spring laden camber, load the vehicle at the rear, distributing the load equally along a line in the body corresponding to the rear axle casing centre line, by placing weights as quoted in "GENERAL DATA". Stretch a length of thread between the spring eye centres and measure the distance between the top of the main leaf and the thread. Positive camber means that the line of the thread will be **above** the main leaf of the spring. Reverse or negative camber means that the line of the thread will be **below** the main leaf. The correct camber dimension is given in "GENERAL DATA".

ROAD SPRING

To Remove.

1. Jack up the rear of the vehicle and support the body underframe on stands. Raise the rear axle so that all weight is taken off the spring.

2. Remove the road wheel.

3. Clean the exposed threads of the U-Bolts using a wire brush and oil with paraffin, or penetrating oil.

4. Remove the nuts from the U-Bolts.

5. Remove the U-Bolts.

6. Remove the nuts and washers and take off the inner shackle plate.

7. Withdraw the outer shackle plate complete with pins from the bushes in the underframe and spring eye.

8. Remove the front pivot pin after taking off the nut and washers.

9. Withdraw the spring.

To Dismantle.

1. Mark one end of each leaf to ensure that it is replaced in the same position on re-assembly.

2. Remove the spring clip bolts and distance tubes from the clips secured to No. 5 spring leaf.

3. Remove the nut and withdraw the spring clip bolt from the bracket secured to the bottom 0·313 in. (7·94 mm.) thick auxiliary leaf. Lift away the spring clip.

4. Grip the spring securely in vice holding it by the top and bottom leaves.

5. Unscrew the dowel bolt nut and remove the dowel bolt.

6. Release the vice gradually and remove the leaves.

7. Remove the thrust buttons.

Inspection and Overhaul.

1. Clean each spring leaf with paraffin.

2. Dry thoroughly and examine for cracks. These will often show up on the dry surface by the paraffin exuding along the line of the crack.

3. In the event of the fracture of a spring leaf, the other leaves particularly those above and below the broken leaf should be examined for cracks.

4. Examine the dowel bolt and renew if ridged or stretched. Check the thread and clean up if necessary.

5. Straighten any bent spring clips.

6. Check the thrust buttons for excessive wear and renew if necessary.

7. The "setting up" of spring leaves is not recommended and new or reconditioned springs are available.

8. Examine the spring eye and shackle bushes and renew if necessary.

To Re-assemble.

1. Before rebuilding, the leaves should be thinly smeared with graphite grease.

2. Re-assembly is a reversal of the dismantling instructions, but alignment of the leaves will be facilitated if a length of steel rod is passed through the dowel bolt holes. This will prevent damage to the dowel bolt thread when the bolt is inserted.

3. Before fitting the spring to the vehicle ensure that the edge of the leaves are flush with each other.

To Refit.

Refitting is a reversal of the removal instructions.

It is important to ensure that the end of the spring fitted with two spring clips is towards the front of the vehicle.

When finally tightening U-Bolts, shackle and pivot pins the spring should be in the laden condition.

SHOCK ABSORBERS

To Remove.

1. Disconnect the link from the shock absorber arm by removing the nut and drawing the link pin out of the arm.

2. Remove the two bolts and nuts securing the shock absorber body to its mounting bracket.

Inspection and Overhaul.

No adjustment of the shock absorbers is required or provided for and therefore no attempt should be made to dismantle the assembly.

In the event of a shock absorber becoming inoperative it should be removed and a replacement unit fitted.

When there is any question of the suspension not being adequately damped, the condition of the road springs and tyre pressures should also be considered.

If the shock absorber does not appear to function satisfactorily, an indication of its resistance can be obtained by carrying out the following check:

1. Place the unit in a vice, **holding it by the fixing lugs** to avoid distortion of the cylinder body.

2. Work the shock absorber arm through six to eight strokes to expel any air which may be present in the compression chamber.

3. Move the arm up and down through one complete cycle. A moderate resistance throughout the full stroke should be felt; if, however, the resistance is erratic and free movement of the lever arm is noted, it may indicate lack of fluid, in which case the shock absorber should be topped up as follows.

(*a*) Before removing the filler plug carefully clean the exterior of the shock absorber particularly in the vicinity of the filler hole boss. **This is important** as it is essential that no dirt or foreign matter enters the operating chamber.

(*b*) Top up with "Armstrong" Super (thin) Shock Absorber Fluid No. 624. While adding the fluid the lever arm should be worked through its full stroke to expel air from the operating chamber.

(*c*) Fill the body with fluid to the bottom of the filler hole boss.

4. If the addition of fluid gives no improvement a new shock absorber should be fitted.

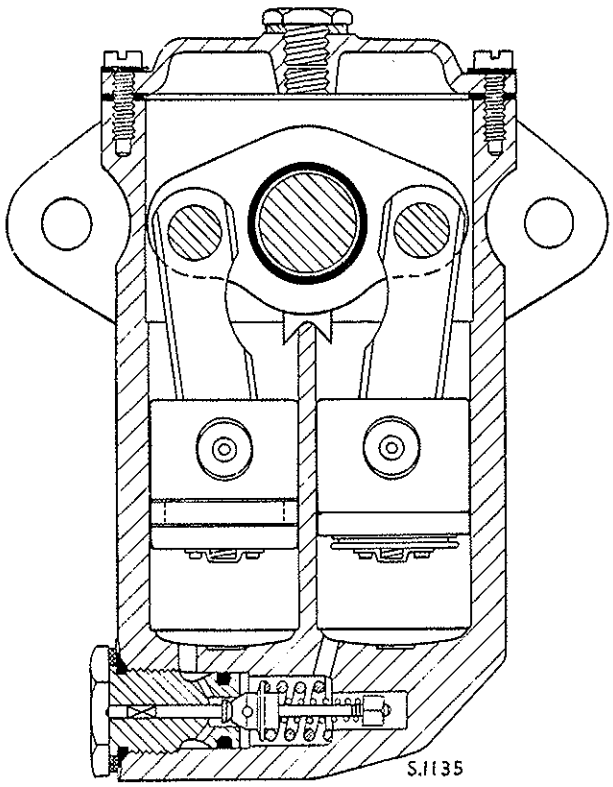


Fig. H.2. Rear shock absorber arrangement

5. Too much resistance i.e. when it is not possible to move the lever arm slowly by hand, probably indicates a broken internal part or a seized piston, in which case the shock absorber should be changed.

To Refit.

Refitting is a reversal of the removal instructions. The shock absorber arm should be operated a few times before reconnecting the link.

UNDERFRAME

DESCRIPTION

The body is of all steel construction having semi-unitary understructure consisting of:

(*a*) **Side Rails.** Inverted top hat section joined approximately at the half way position. The front section of the rails are fitted with closing plates.

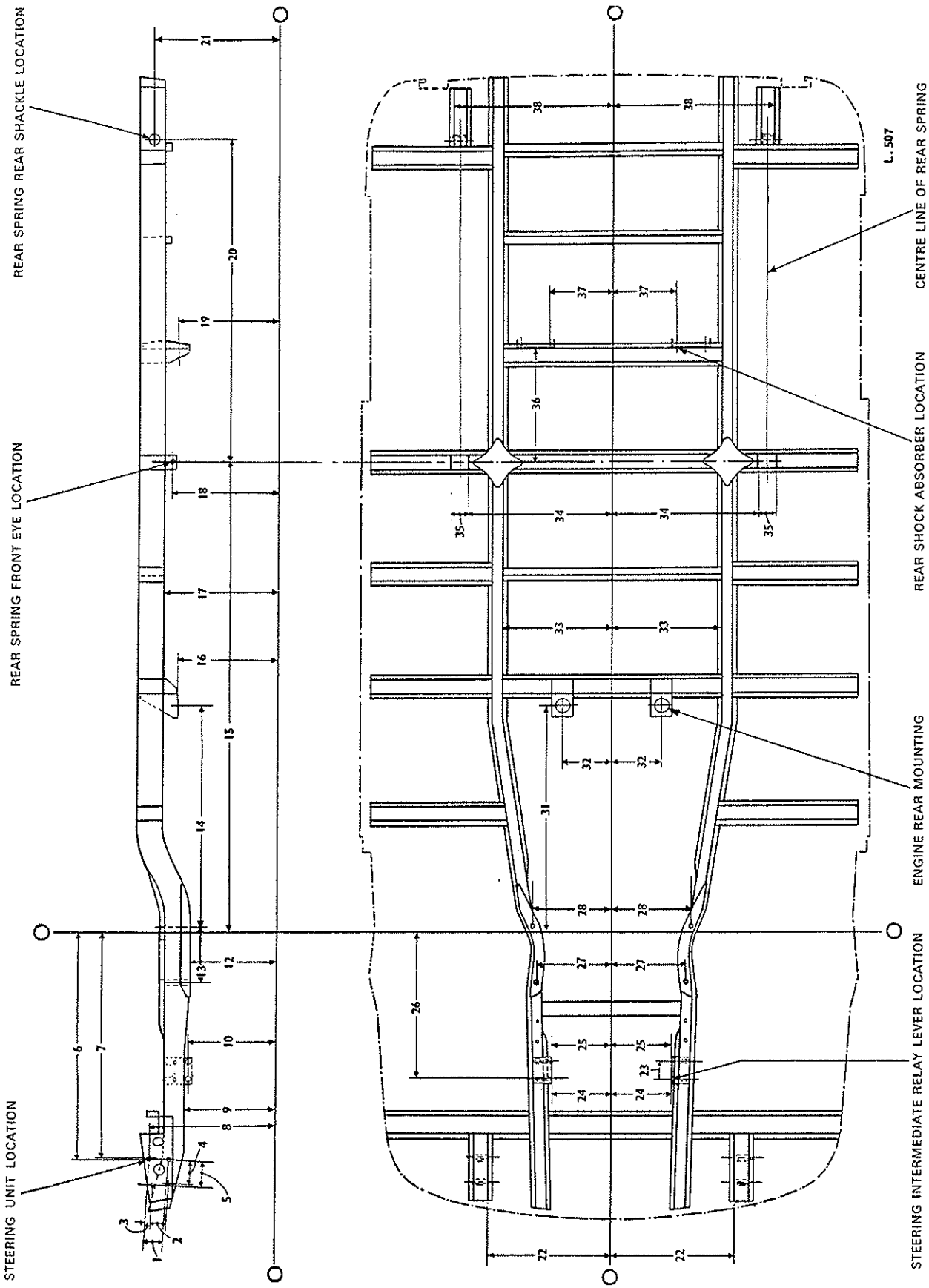


Fig. H.3. Body underframe dimensions—*See opposite page for key*

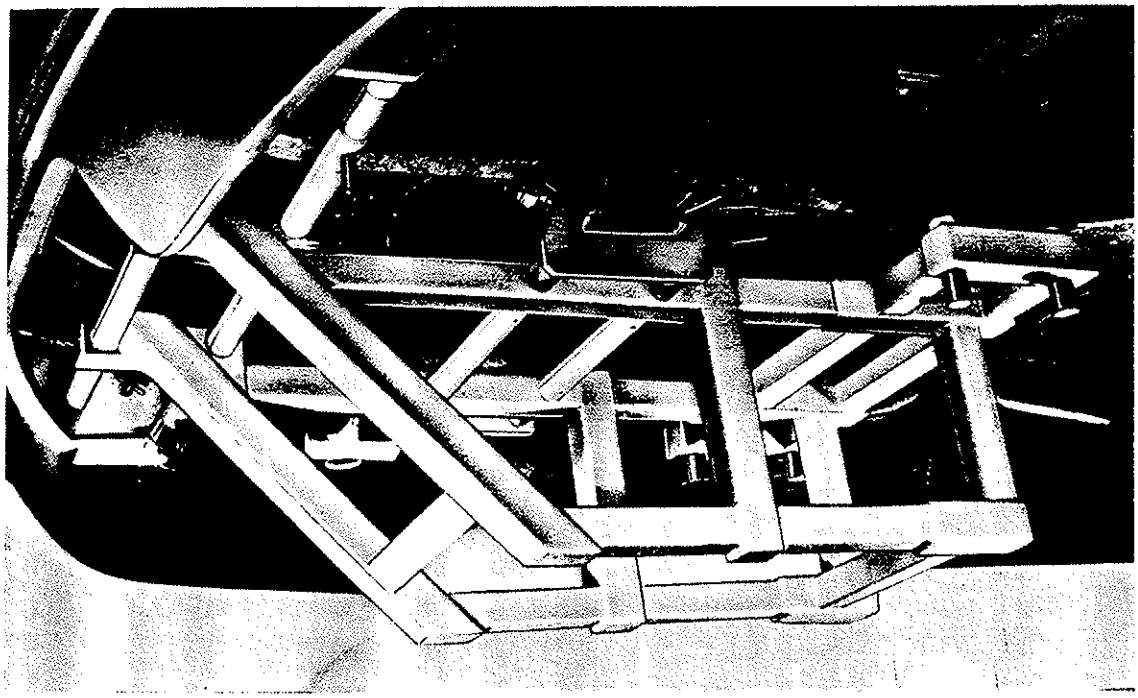


Fig. H.4. Checking front end alignment using Churchill Tool No. R.G.310A

(*b*) **Main Crossmember** is mounted at the front of the understructure and fitted with closing plates.

(*c*) **Longitudinals and Secondary Crossmembers** are box section and welded to the remainder of the frame.

The crossmembers extend outwards from the longitudinals and to these are welded the lower side sills which are separate from the body side panels.

TO CHECK ALIGNMENT

Reference should be made to the dimensions given in Fig. H.3 when checking and alignment of the underframe which has sustained accidental damage.

The checking of the underframe front end can be easily carried out with Churchill Tool No. R.G.310A.

This front end alignment jig registers at six points, three on either side of the under body frame. These location points being the steering box mounting holes, the holes in the steering relay lever mounting bracket, and the mounting holes for the front suspension crossmember.

Upon using this jig, if it is found a replacement part will be necessary, the jig can be used to locate the part and clamp it into position for welding. For this purpose, two sets of locating pins are supplied with the jig, one set of slightly smaller diameter, permits the jig to employ maximum allowed tolerance for initial checking, whilst the large diameter pins are used for the exact location of replacement parts.

Note: Under no circumstances should this jig be used in position whilst a straightening operation is being carried out.

KEY TO FIG. H.3

1. 2·72 in. (69·0 mm.)	8. 17·97 in. (456·0 mm.)	16. 14·19 in. (360·3 mm.)	23. 2·50 in. (63·5 mm.)	32. 7·00 in. (177·8 mm.)
2. 2·20 in. (55·9 mm.)	9. 13·09 in. (332·5 mm.)	17. 16·48 in. (418·6 mm.)	24. 8·43 in. (214·0 mm.)	33. 15·50 in. (393·7 mm.)
3. 0·78 in. (19·8 mm.)	10. 12·42 in. (315·5 mm.)	18. 15·19 in. (385·3 mm.)	25. 8·50 in. (216·0 mm.)	34. 20·56 in. (522·0 mm.)
4. 3·25 in. (82·5 mm.)	12. 12·25 in. (311·0 mm.)	19. 14·36 in. (364·7 mm.)	26. 20·77 in. (527·6 mm.)	35. 2·38 in. (60·5 mm.)
5. 3·34 in. (84·9 mm.)	13. 10·50 in. (266·7 mm.)	20. 45·44 in. (1154·0 mm.)	27. 10·62 in. (269·7 mm.)	36. 16·08 in. (408·5 mm.)
6. 32·11 in. (815·6 mm.)	14. 30·97 in. (786·6 mm.)	21. 17·87 in. (454·0 mm.)	28. 10·94 in. (277·9 mm.)	37. 9·06 in. (230·0 mm.)
7. 31·89 in. (810·0 mm.)	15. 66·50 in. (1689·0 mm.)	22. 17·39 in. (441·8 mm.)	31. 31·92 in. (310·3 mm.)	38. 22·75 in. (577·9 mm.)

EXHAUST PIPE AND SILENCER

To Remove.

Remove the exhaust pipe, silencer and tail pipe as a complete assembly.

1. Remove the two nuts securing the exhaust pipe flange to the exhaust manifold. Note the sealing ring gasket located on the exhaust pipe collar.

2. Remove the nuts and washers securing the hanger brackets to the underframe, and also remove the rubber mountings.

3. Free the exhaust pipe at the manifold and lift the whole assembly clear.

To Dismantle.

To separate the pipes from the silencer slacken the bolts and nuts of the two pipe clamps, and free the pipes from the silencer tube extensions. The hanger brackets can then be removed, noting that the brackets are located as follows:

R.H.D. and L.H.D.	Two hanger brackets; one at the rear end of the silencer and one at the tail pipe outer end.

Inspection and Overhaul.

1. Examine the rubber mountings for wear or deterioration and renew as necessary.

2. Inspect the silencer for holes, damage or splitting and renew as necessary.

3. Ensure that the pipes are clear and not obstructed in any way. To clean the exhaust and tail pipe of carbon, heat the pipes, using a welding torch, sufficiently to enable the carbon to flake off when the pipes are tapped with a piece of flat metal. Blow through the pipes with compressed air on completion to clear the carbon particles. Any small particles remaining will be blown clear by the exhaust gases when the engine is subsequently run.

To Re-assemble and Refit.

Reverse the removal procedure ensuring that the exhaust pipe flange face and the manifold mating face are clean. Use a new sealing ring gasket at the manifold location for the exhaust pipe if necessary.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

STEERING

SECTION J

INDEX

STEERING

DESCRIPTION

The steering gear assembly is mounted by means of a support bracket to the appropriate longitudinal member of the underframe, according to drive. A further bracket, attached to the facia panel, supports the outer column and a rubber gaiter screwed to the cab toeboard seals the steering casing aperture.

The inner column and cam of the steering gear form a single unit which is assembled in the steering casing and single row ball bearing races provide the seatings for the top and bottom shoulders of the cam. These ground shoulders form the inner cups of the bearing races and separate outer cups, retained by the bottom cover and outer column socket respectively, are used to locate the bearings in the casing bores.

Shims are fitted between the bottom cover and the casing and by varying the thickness of these shims, any end float in the inner column can be eliminated.

The rocker shaft assembly incorporates a peg that is mounted within a circle of rollers and which meshes with the cam on the inner column. The depth of meshing between the peg and the cam is controlled by an adjusting screw, secured by a lock-nut to the side cover. The nose of the adjusting screw bears upon a hardened steel disc pressed into the rocker shaft arm and situated opposite the point of contact for the screw is a plain flat thrust washer. Assembled below this washer are six disc springs, assembled in pairs with the convex faces of the discs at each end. Two phosphor bronze bushes pressed in the rocker shaft bore of the steering casing, provide the operating surfaces for the rocker shaft and an oil seal fitted in the outer end of the rocker shaft bore prevents the lubricant from escaping at this point.

The drop arm is carried on tapered splines machined in the outer end of the rocker shaft and is secured by means of plain nut and a lockwasher which is turned up against a convenient flat on the nut and also over the drop arm boss. A master spline on the rocker shaft matches a similar spline in the broached bore of the drop arm to correctly position the drop arm in relation to the rocker shaft and cam.

A side steering rod incorporating self adjusting ball joint sockets is secured to the lower end of the drop arm and the forward arm of the intermediate relay lever. This relay lever operates on a spring loaded fulcrum pin carried in a bushed bracket which is bolted to the underframe.

Connected to the rear arm of the intermediate relay lever is the intermediate steering rod fitted with identical self adjusting ball joint sockets. The opposite end of this rod is secured to the front end of the main relay lever which in turn pivots on a fulcrum pin in a bracket bolted to the rear face of the front suspension crossmember.

Dual track rods using identical self adjusting ball joint sockets link the rear end of the main relay lever to the steering arms.

Two steering stops are fitted, one on each side of the main relay lever aperture, on the front face of the front suspension crossmember. Each stop is provided with slotted securing holes to enable adjustment to be carried out for correcting the vehicle turning circles when necessary.

LUBRICATION

A plug fitted in the upper part of the steering box casing acts as a level and filler plug. Additionally, a rubber plug is fitted in the lower part of the outer column and must be removed when high pressure filling of the unit is carried out. For the level to be correct, the lubricant should be just level with the aperture obtained by removing the plug. Lubrication nipples are provided at each of the fulcrum pins of two relay levers.

ADJUSTMENTS

To Adjust Steering Column End Float.

The inner column and cam is correctly adjusted when the inner column can be rotated easily with no lift present. To correct, proceed as follows:

(*a*) The shims fitted between the bottom cover and the casing provide the means of adjustment. Remove shims if end float is present or add shims if binding is evident.

(*b*) After altering the thickness of shims, thoroughly tighten the bottom cover setscrews and again check for end float to ensure that it is correct.

To Adjust Rocker Shaft End Float.

An adjusting screw and locknut in the side cover provide the means of controlling end float of the rocker shaft. To adjust, proceed as follows:

Screw the adjusting screw in or out of the side cover until a slight highspot can be felt at the steering wheel with the road wheels in the straight ahead position.

The correct amount of torque required to move the rocker shaft over the "straight ahead" point of its travel is 6 to 20 lb. in. (6·9 to 23 kg. cm.). This torque reading must be measured at the steering wheel and with the side steering rod disconnected from the drop arm.

Note: The cam is designed to give an almost metal to metal contact with the rocker arm peg at the centre of travel, i.e., with the road wheels in the straight ahead position. The cam track is slightly relieved, each side of this point, and for this reason, some free movement will be felt at the steering wheel when on a lock.

To Correctly Set Steering Stops.

Two adjustable steering stops are located on the front face of the front suspension cross-member. To check and if necessary adjust the steering stops, proceed as follows:

(*a*) The operation should be carried out on a level surface and with all tyres to correct pressures. It is essential that the steering linkage is checked to ensure that no lost motion caused by slackness is evident.

(*b*) Mount the vehicle on suitable turning radius gauges. It is advisable to draw the vehicle forward on to the turning radius gauges over two small ramps, e.g., wood blocks approximately 2 in. (50 mm.) in thickness, and thus avoid disturbing the front suspension.

(*c*) Position the front wheels in the "straight ahead" position. Sight along each front wheel towards the rear wheel to ensure the wheels are "straight ahead".

(*d*) Set the gauges under each wheel to zero.

(*e*) Turn the steering wheel to the left until the gauge under the left hand wheel, i.e., the inner wheel of the left hand turn, registers $30\frac{3}{4}^{\circ}$ (see Fig. J.1). Retain the steering in this position and adjust the steering stop that is nearest the main relay lever until the stop just contacts the lever arm. Tighten the stop retaining setscrews securely to prevent movement of the stop when in use.

(*f*) Repeat operation (*e*) but turn the steering wheel to the right and set the other steering stop, with the right hand wheel, i.e., the inner wheel of a right hand turn, positioned at $30\frac{3}{4}^{\circ}$ on the turning gauge (see Fig. J.1). Lock the steering stop securely.

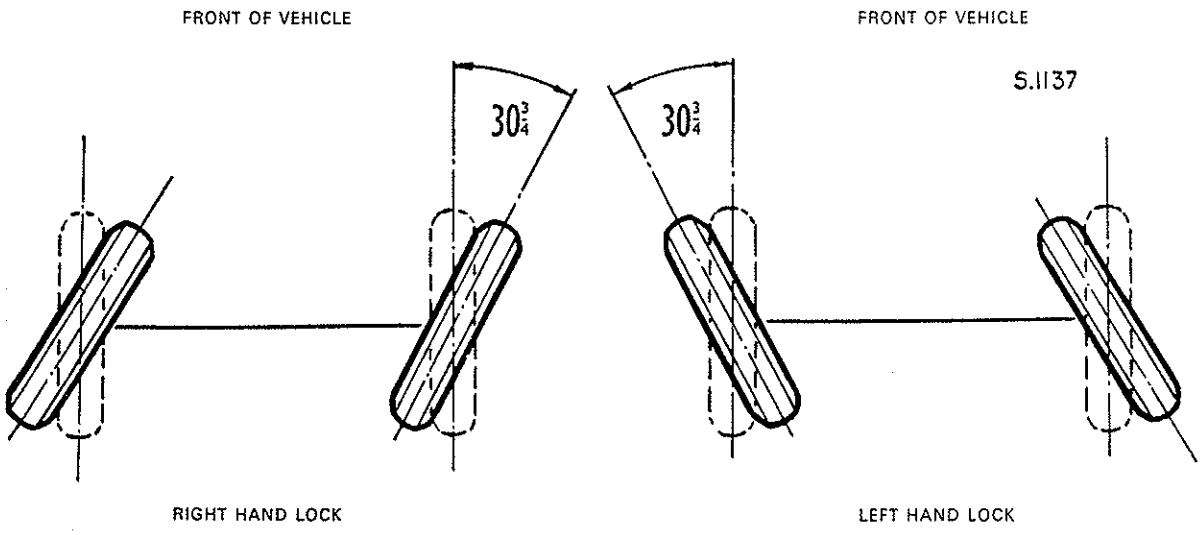


Fig. J.1. Correct wheel positions for setting the steering stops

Note: These instructions are applicable to both right and left hand drive.

STEERING WHEEL

To Remove.

1. Disconnect the battery leads.

2. Prise the horn push cap from the steering wheel. Retain the small cap return spring on removing the cap. Also, lift out the contact plunger located in the hub of the steering wheel.

3. Unscrew the securing nut from the centre of the inner column.

4. Remove the steering wheel by striking the underside of the wheel spokes at the innermost extremity with a **hide** hammer.

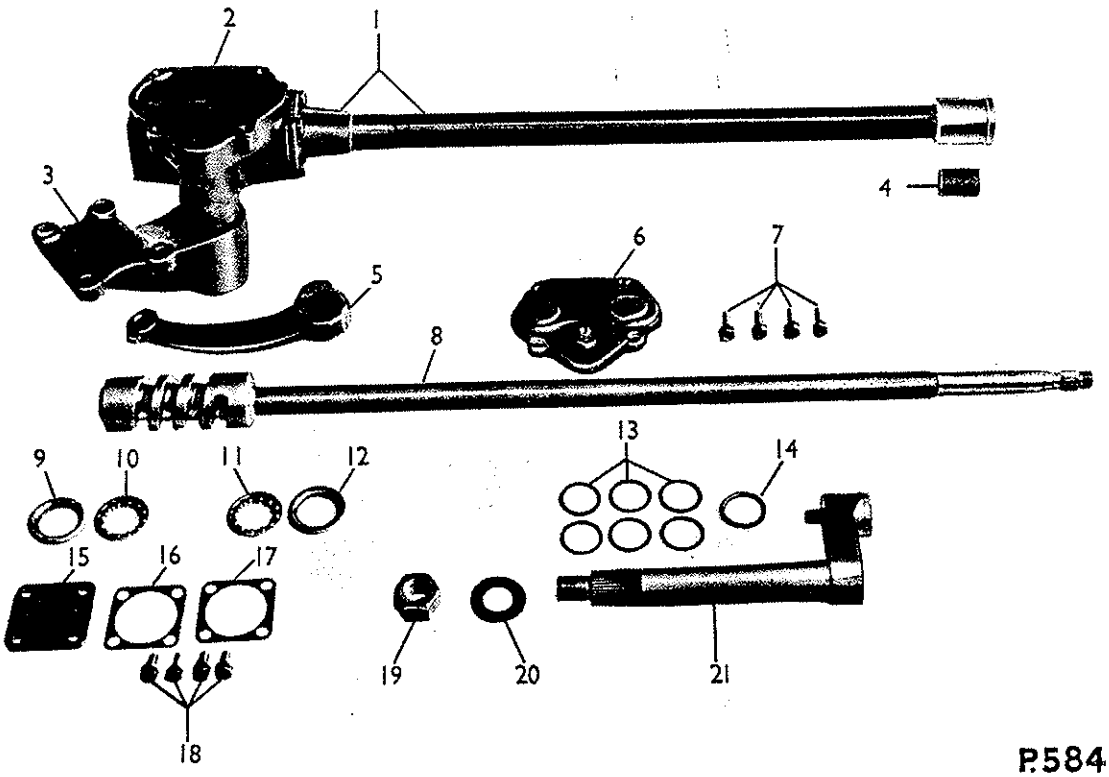
To Refit.

1. With the front wheels in the straight ahead position, place the steering wheel on the inner column splines with the spokes of the steering wheel aligned at the "three o'clock" and "nine o'clock" position.

2. Refit and tighten the inner column nut. Ensure that, on completion, the radiused arm projecting from the flasher indicator switch assembly is in contact with the plate on the base of the steering wheel hub.

3. Refit the horn push cap and return spring ensuring that the spring locates in the centre of the cap and on the top of the inner column.

4. Re-connect the battery leads and test the horn and flasher indicators for correct operation.



1 OUTER COLUMN AND SOCKET ASSEMBLY
2 STEERING CASING
3 SUPPORT BRACKET
4 FELT BUSH
5 DROP ARM
6 SIDE COVER
7 SIDE COVER SETSCREWS
8 INNER COLUMN AND CAM ASSEMBLY
9 LOWER BALL RACE CUP
10 LOWER BALL RACE
11 UPPER BALL RACE
12 UPPER BALL RACE CUP
13 DISC SPRINGS
14 THRUST WASHER
15 BOTTOM COVER
16 BOTTOM COVER SHIM
17 BOTTOM COVER JOINT
18 BOTTOM COVER SETSCREWS
19 DROP ARM RETAINING NUT
20 RETAINING NUT LOCKWASHER
21 ROCKER SHAFT ASSEMBLY

Fig. J.2. Exploded view of the steering gear assembly

STEERING GEAR ASSEMBLY

To Remove.

1. Disconnect the battery leads.

2. Remove the screws securing the rubber gaiter to the cab toeboard.

3. Unscrew the setbolts securing the toeboard cover panel and lift out the panel.

4. Disconnect the horn push and flasher indicator switch leads at the snap connectors under the instrument panel.

5. Remove the bolt and nut at the outer column support clamp, noting the tubular distance piece located between the two lugs of the clamp.

6. Disconnect the side steering rod at the drop arm using Churchill Extractor R.G.284 (see Fig. J.3).

7. Remove the four bolts and three nuts securing the steering casing support bracket to the underframe and withdraw the steering gear complete with steering wheel from the vehicle.

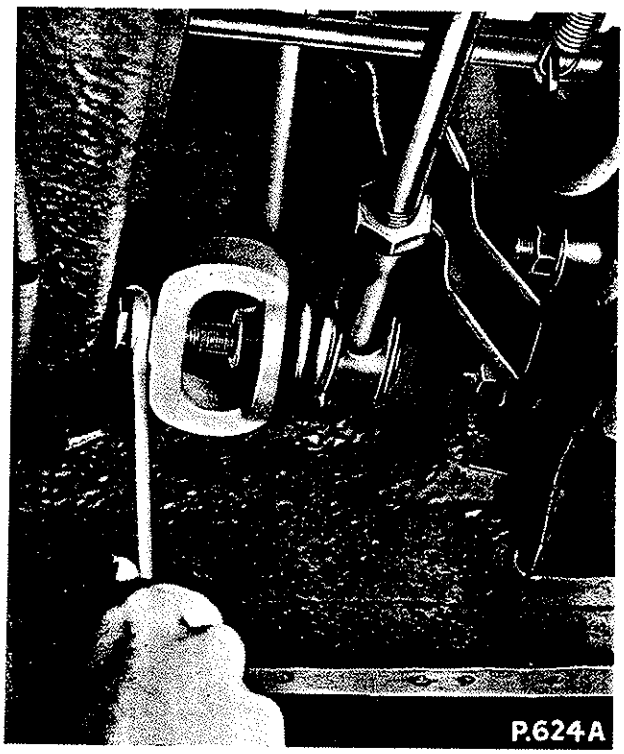


Fig. J.3. Disconnecting the side steering rod at the drop arm using the Churchill Extractor R.G.284

To Dismantle (see Fig. J.2).

1. Remove the steering wheel as detailed under "STEERING WHEEL".

2. Remove the screws securing the two halves of the flasher indicator switch casing and remove the casing. Release the screws on the indicator switch clamping ring and remove the switch complete with the lever from the outer column. Unscrew the bolt and nut securing the flasher switch striker ring to the steering gear inner column, and lift off the striker ring. Unless a complete dismantle of the steering gear is to be carried out it is not necessary to disturb the striker ring, or flasher indicator switch.

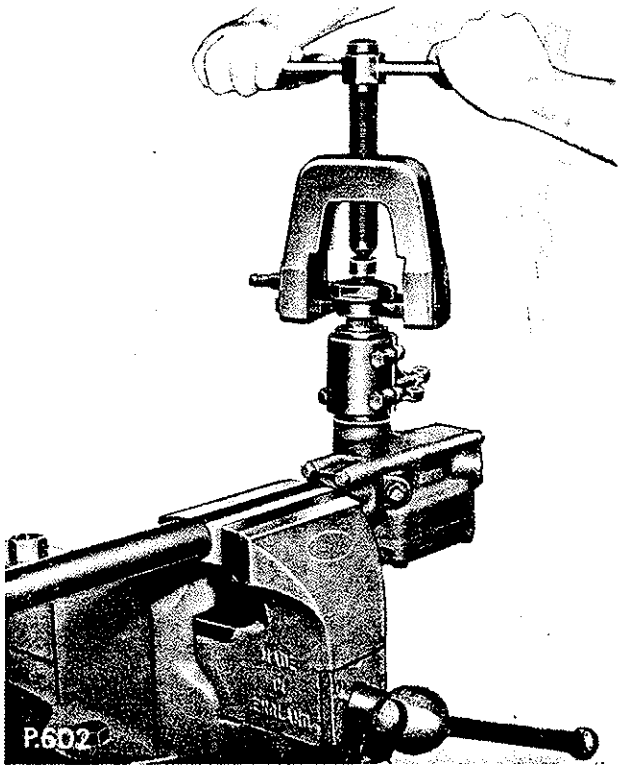


Fig. J.4. Removing the drop arm using Churchill Tool R.G.59A with Churchill Thrust Pad R.G.59A-1

3. Remove the drop arm using Churchill Tool R.G.59A and Thrust Pad R.G.59A–1, after tapping back the lockwasher and removing the retaining nut (see Fig. J.4).

4. Unscrew the two pinch bolts and remove the support bracket from the trunnion of the steering casing.

5. Unscrew the setscrews securing the side cover and remove the cover and the joint. Allow the oil to drain completely.

6. Withdraw the rocker shaft assembly through the side cover aperture. As the rocker peg and roller

assembly is staked in the rocker arm, it is only necessary to remove this assembly in order to fit a replacement.

7. On removing the rocker shaft assembly it will be possible to remove the six disc springs and the flat plain thrust washer which locate on the rocker shaft, noting their order of assembly to facilitate the refitting operation.

8. Remove the setscrews and washers retaining the outer column and socket assembly to the steering casing and lift the assembly clear of the inner column. Note the felt bush in the top of the outer column and the shims and joint placed under the column socket. Ensure that the shims are safely stored for their subsequent re-assembly.

9. Remove the setscrews and washers securing the bottom cover. Remove the cover, the shims, and the joint. Ensure that the shims are placed in a safe position for subsequent re-assembly.

10. The inner column and cam assembly can then be withdrawn through the bottom cover aperture complete with the lower ball race and outer cup. The upper ball race will also be removed at the same time but the upper ball race cup will need lightly tapping in order to separate it from the casing bore.

11. The oil seal in the end of the trunnion bore of the casing need only be removed if renewal is necessary.

Inspection and Overhaul.

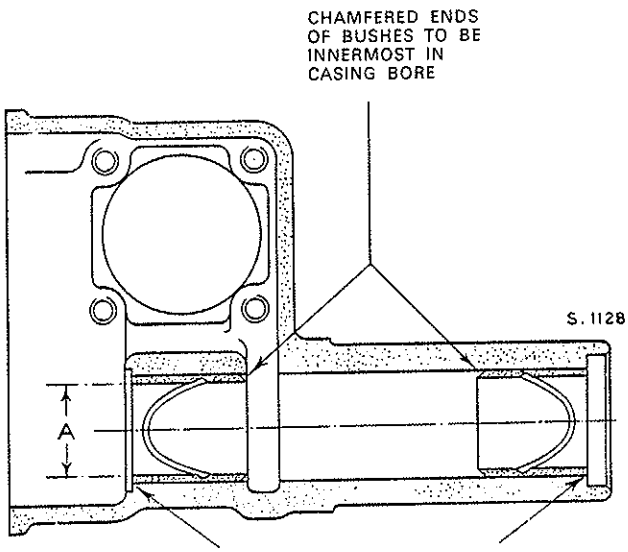
1. Examine the cam for excessive wear in the grooves and also the ball tracks formed in each end of the cam for signs of pitting.

2. Check the fit of the rocker shaft in the bushes of the casing. The rocker shaft should be a free fit but no slackness is permissible. Should wear be apparent, remove the oil seal, press out the bushes and fit new bushes as follows:

(*a*) Press in the new bushes to the dimensions given ensuring that the chamfered ends are always in the centre of the rocker shaft bore. (See Fig. J.5).

(*b*) After fitting, the bushes must be line bored to a diameter of 1·1245/1·126 in. (28·5625/28·60 mm.). The final diameters of the bushes must be concentric to within 0·0005 in. (0·013 mm.).

(*c*) Finally, press in the new oil seal until flush with the casing outer end.

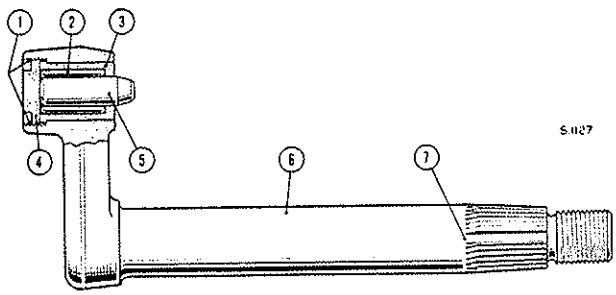


"A" INDICATES A FINISH BORED DIAMETER OF 1·1245/1·126 in. (28·5625/28·60 mm.). Final diameters to be concentric to within 0·0005 in. (0·013 mm.).

Fig. J.5. Steering casing bush dimensions

3. Inspect the peg for signs of wear on its contact surface. Ensure that it is free to rotate and that there is no excessive diametrical slackness. If found to be defective, the peg, needle rollers, housing and thrust plug must be renewed as an assembly and not as single items.
Renew as follows:

(*a*) To remove the worn assembly, unscrew the thrust plug in the top of the rocker shaft bore. This plug is prevented from working loose by the rocker shaft being staked at the slotted portion of the plug (see Fig. J.6), thus it will be necessary to use sufficient turning force on the plug to shear away this staking.



1 THRUST PLUG STAKING POINTS
2 NEEDLE ROLLERS
3 PEG AND ROLLER HOUSING
4 THRUST PLUG
5 ROCKER PEG
6 ROCKER SHAFT
7 MASTER SPLINE

Fig. J.6. Sectional view of the peg roller assembly in the rocker shaft

Once the plug is removed, the original peg roller and housing assembly can be pressed out of rocker shaft.

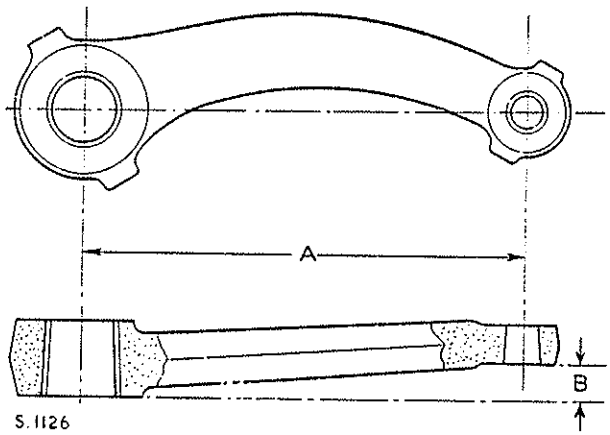
(*b*) Press in the new peg and roller assembly fully against the shoulder in the rocker shaft bore, having first ensured that the bore is clean and free from burrs. Screw in the thrust plug to a torque wrench reading of 20 lb. ft. (2·765 kg. m.). The rocker shaft threads must then be **securely** staked into the slots in the plug to prevent the plug from working loose.

4. Inspect the drop arm for cracks and distortion. If damage is suspected, check the arm against the dimensions given in Fig. J.7. If the dimensions do not correspond or cracks are detected, renew the drop arm. Ensure that the internal splines are in good condition.

5. Check the condition of the felt bush at the top of the outer column and renew if worn.

6. Examine the ball races for wear or pitting and check the working surface of the cups for signs of pitting or scoring.

7. Inspect the rocker shaft for wear or scoring. Examine the splines and thread for signs of damage.



A = 6·56 in. (166·6 mm.)
B = 0·420/0·480 in. (10·7/12·2 mm.)

Fig. J.7. Drop arm dimensions

8. Inspect the steering box casing for damage particularly at the cover faces and the bores into which are fitted the ball race cups.

9. Check that the six disc springs are in good condition and renew if necessary. Also examine the thrust washer for scoring and renew if evident.

To Re-assemble.

Re-assembly is a reversal of the dismantling procedure with the following additions:

1. When refitting each cover always use a new joint.

2. Refit the original number of shims at both the column socket face and the bottom cover face using new joints when re-assembling. Check that no end float is present.

3. Before refitting the rocker shaft, it is advisable to temporarily tape the splined end of the rocker shaft to prevent damaging the oil seal. Also re-assemble the flat plain thrust washer with the radiused inner diameter corresponding to the radius at the neck of the rocker arm and shaft as shown in Fig. J.8. The six disc springs should then be re-assembled to the rocker shaft in pairs. With the end discs having convex faces to the outside (see Fig. J.8). Refit the rocker shaft and remove the tape from the splines.

4. Refit the drop arm aligning by means of the master spline.

5. Check the rocker shaft for end float as previously described.

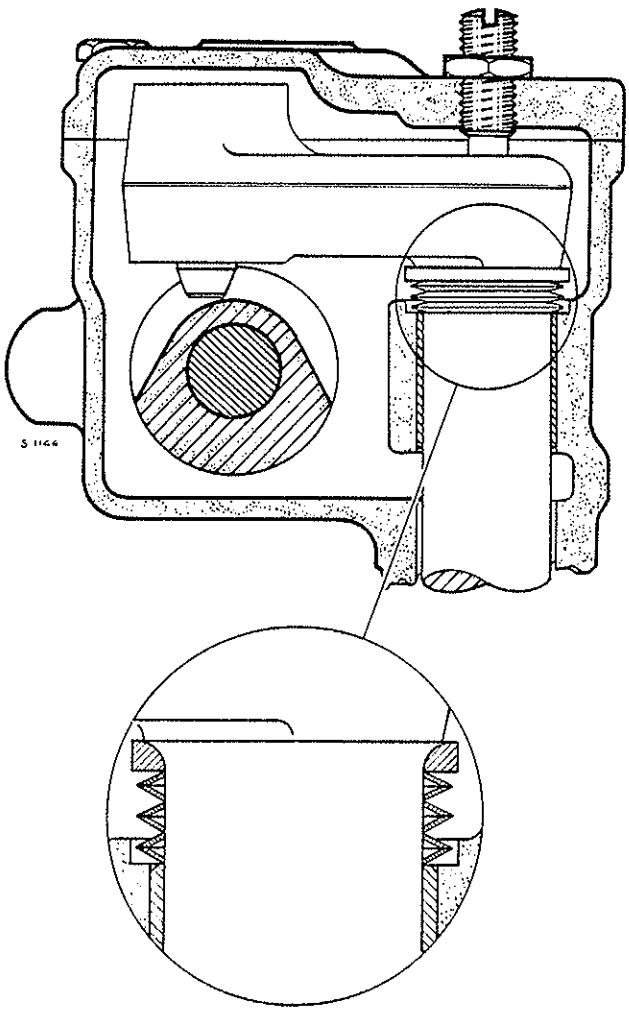


Fig. J.8. Sectional view of the steering casing and rocker shaft

Inset shows the correct method of assembling the disc springs and thrust washer.

6. To refit the striker ring to the inner column, position the ring with the striker arm central between the two striker pawls of the indicator switch. Tighten the clamp bolt and nut securely.

7. When refitting the flasher indicator switch and steering wheel, position the flasher switch on the column but do not fully tighten the two switch clamping screws. Refit the steering wheel and then adjust the height of the switch on the column until the flat on the switch lever body is 0·8 in. (20 mm.) from the plate on the base of the steering wheel hub (see details and illustration given in the "ELECTRICAL EQUIPMENT" section). Fully tighten the two clamping screws.

To Refit.

Refitting the steering gear assembly is a reversal of the removal procedure noting the following points:

1. Ensure that the horn and flasher indicator leads are refitted to their correct main harness snap connectors. The colour codes are as follows:

R. H. Flasher	..	Green and White.
L. H. Flasher	..	Green and Red.
Flasher Unit	..	Purple.
Horn	..	Brown and Black.

Check the operation of the horn and flashers on connecting the battery leads at the completion of the operation.

2. Refill the steering box casing to the correct level, i.e., the filler plug orifice, using the recommended grade of lubricant.

STEERING SIDE ROD

To Check for Wear.

The ball joints fitted to the steering rods are of the sealed type. These joints are fitted with Nylon-Molydisulphide inserts and are pre-packed with lubricant during manufacture. The ball joints require no attention during service other than routine cleaning and alignment checks.

To check for wear at these points, however, each ball joint assembly should be grasped and tested for up and down movement. Whilst each ball joint assembly should be free to articulate on its ball pin, no other movement between ball pin and socket should be present. As these ball joint assemblies are self-adjusting, no other means of adjustment is provided and they must be renewed as assemblies if wear becomes apparent.

To Remove.

1. Extract the split pin in each ball pin and remove the slotted nut.

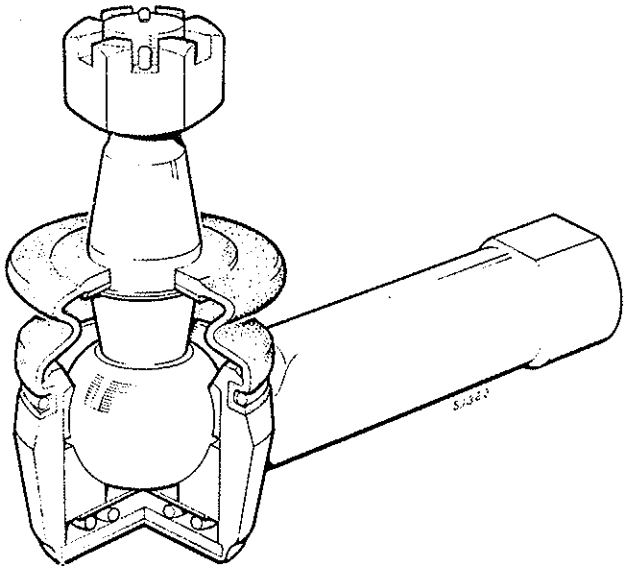


Fig. J.9. Sectional view of the steering rod ball joint

2. Using the Churchill Ball Pin Extractor R.G.284, release the ball pins from their respective bosses and lift away the steering rod (see Figs. J.3 and J.10).

To Dismantle.

1. Slacken the locknuts on the steering rod and thread the ball joint assemblies off the rod, noting that the threads of each assembly are opposite, i.e., left hand or right hand.

Note: The ball joint assemblies are sealed and should not be dismantled. They must each be renewed as a complete assembly when wear is evident.

2. Remove the rubber dust covers after releasing the cover circlips. Lift off the dished washer located on the neck of each ball pin.

Inspection and Overhaul.

1. Check the rod for bend and straighten if evident. **Do not use heat** to straighten the rod as this will destroy the temper of the metal.

2. Renew the rubber dust covers if they are split or deteriorated.

3. As stated in para. 1, each ball joint assembly must be renewed as a complete assembly if wear is evident.

To Re-assemble.

1. Screw the ball joint assemblies on to their respective ends of the rod according to the right or left-hand thread, but before tightening the locknuts, ensure that the distance between the ball pin centres is approximately 14·13 in. (358 mm.) with the ball pins at 90° to each other.

2. Refit the dished washers, the rubber dust covers and secure with the circlips.

To Refit.

1. With the front wheels pointing straight ahead, fit the side steering rod to the relay lever arm and add the slotted nut to the ball pin. Tighten the nut securely and insert a new split pin.

2. Position the drop arm in the centre point of its travel by counting the number of revolutions of the steering wheel from lock to lock and halving this number. With the front wheels set in the straight ahead position, fit the side steering rod to the drop arm.

Assuming that the ball pin centres are set as described in para. 1 under **"To Re-assemble"**, the steering rod should fit in the drop arm without strain, but due to the accumulation of manufacturing tolerances of the underframe, it may be necessary to adjust the side steering rod length to enable the ball pins to fit in the relay lever and the drop arm, with the steering wheel centralised and the front wheels in the straight ahead position. Add the slotted nut and new split pin to the ball pin after ensuring that the nut is tightened securely.

Fig. J.10. Disconnecting the side steering rod at the intermediate relay lever using the Churchill Extractor R.G.284

INTERMEDIATE RELAY LEVER ASSEMBLY

To Remove.

1. Disconnect the ball joint assemblies at each arm of the relay lever assembly as follows:

(*a*) Extract the split pin in each ball pin and remove the slotted nut.

(*b*) Using the Churchill Ball Pin Extractor R.G.284, release the ball pins from their respective bosses and swing each steering rod clear of the relative arm of the relay lever assembly.

2. Remove the four bolts, two nuts and eight washers securing the lever bracket to the underframe. Note the positions of the two plain and the six shakeproof washers in order that they are correctly positioned when re-assembling. Remove the relay lever assembly and the bracket complete.

To Dismantle.

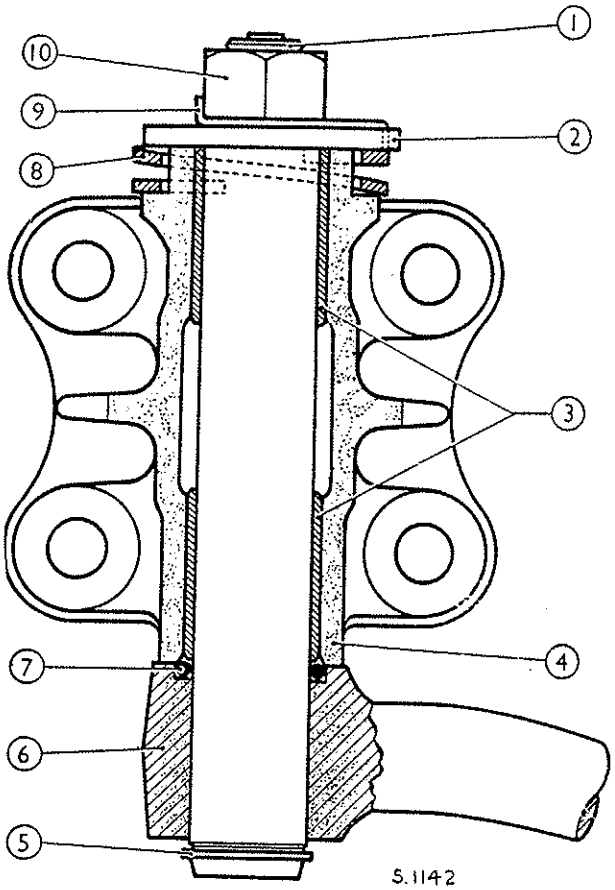
1. Unscrew the lubricating nipple and remove the fibre washer.

2. Tap down the tabwasher and remove the retaining nut. It will be noted that the nut is spring loaded by the spring below the thrust washer.

3. Lift off the thrust washer and the spring.

4. The relay lever assembly can then be removed from the bore of the bracket. A sealing ring is located in a groove in the boss of the relay lever.

5. The relay lever assembly consists of a cranked relay lever pressed on the fulcrum pin and a circlip is fitted in a groove below the lever. To dismantle this assembly, remove the circlip and press out the fulcrum pin.



1 FULCRUM PIN
2 THRUST WASHER
3 FULCRUM PIN BUSHES
4 LEVER SUPPORT BRACKET
5 CIRCLIP
6 RELAY LEVER
7 SEALING RING
8 THRUST SPRING
9 TABWASHER
10 RETAINING NUT

Fig. J.11. Sectional view of the intermediate relay lever and bracket assembly

Inspection and Overhaul.

1. Check for wear between the fulcrum pin and the bushes. If wear is evident, renew the bushes and, if necessary, the fulcrum pin. To fit new bushes, press out the old bushes and press in the two new replacements ensuring that the bushes do not protrude beyond the faces of the casting (see Fig. J.12). Press in each bush in the direction of the arrow stamped on the bush outer diameter, in order to correctly position the oil groove. Finally the bushes must be line reamed in position to a diameter of 0·876/0·877 in. (22·25/22·275 mm.).

2. Ensure that the spring is in good condition.

3. Examine the tapered bores at each end of the relay lever for wear, damage or burrs.

4. Renew the sealing ring.

To Re-assemble.

1. If the relay lever assembly has been dismantled, press in the fulcrum pin to the dimension given in Fig. J.13 and locate a new circlip in the groove below the relay lever.

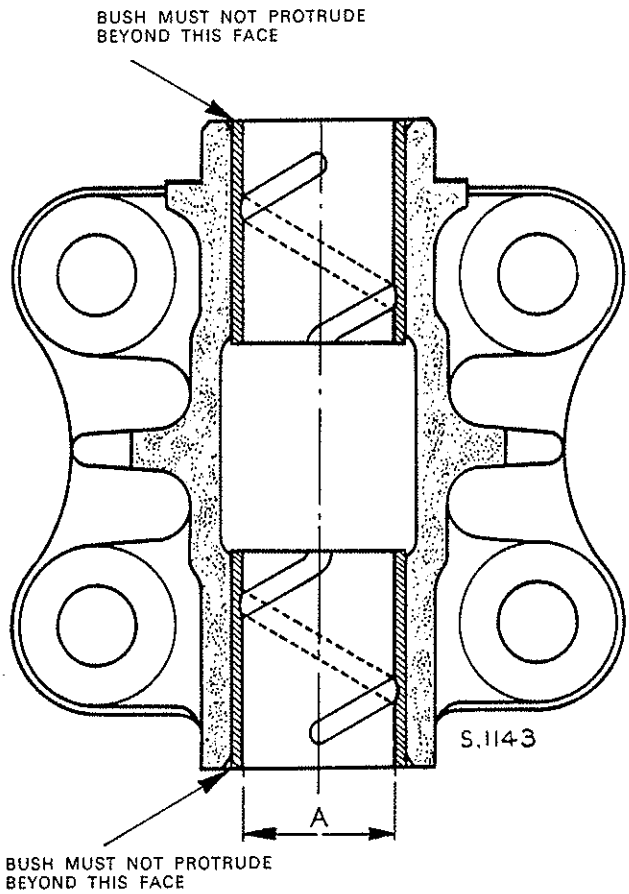
2. Slide the relay lever assembly in the bushes of the bracket after fitting a new sealing ring on the fulcrum pin above the relay lever.

3. Add the spring and then the thrust washer. Place a new tabwasher on the fulcrum pin flats and compress the spring to allow the retaining nut to be tightened down, to a torque wrench reading of 38 lb. ft. (5·25 kg. m.). Tap over the tabwasher on a convenient flat of the nut.

4. Screw in the lubricating nipple with the fibre washer.

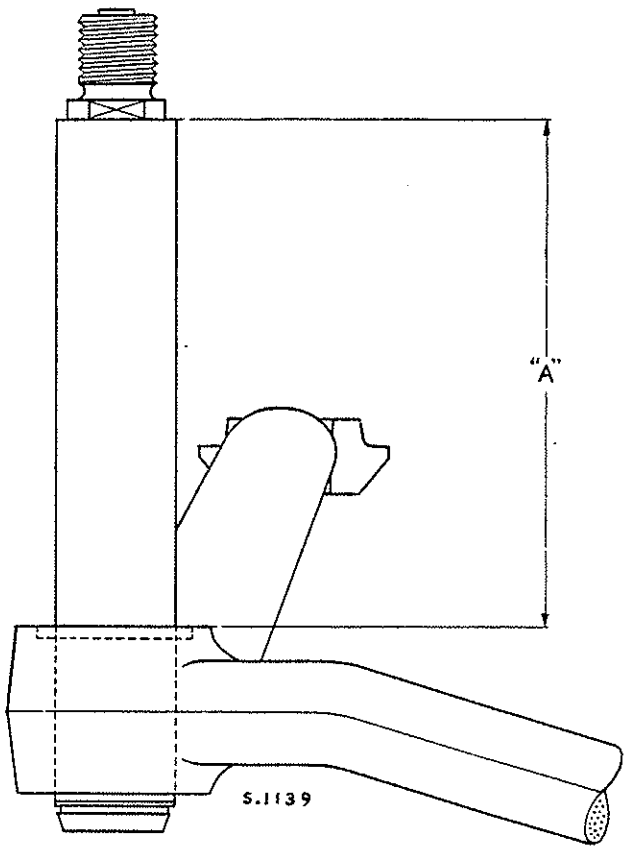
To Refit.

Reverse the removal procedure using a new split pin to retain the ball pin slotted nuts. Lubricate at the fulcrum pin nipple on completion of the operation.



A = 0·876/0·877 in. (22·25/22·275 mm.)

Fig. J.12. Intermediate relay lever bracket bush dimension



"A" = 3·633/3·639 in. (92·28/92·43 mm.)

Fig. J.13. Relay lever and fulcrum pin pressing dimension

INTERMEDIATE STEERING ROD

To Check for Wear.

The ball joints fitted to the steering rods are of the sealed type. These joints are fitted with Nylon-Molydisulphide inserts and are pre-packed with lubricant during manufacture. The ball joints require no attention during service other than routine cleaning and alignment checks.

To check for wear at these points however, each ball joint assembly should be grasped and tested for up and down movement. Whilst each ball joint assembly should be free to articulate on its ball pin, no other movement between ball pin and socket should be present. As these ball joint assemblies are self-adjusting, no other means of adjustment is provided and they must be renewed as assemblies if wear becomes apparent.

To Remove.

1. Extract the split pin and remove the slotted nut from each ball pin.

2. Using the Churchill Ball Pin Extractor R.G.284, release the ball pins from their respective bosses and lift away the steering rod.

To Dismantle.

1. Slacken the locknuts on the steering rod and thread the ball joint assemblies off the rod, noting that the threads of each assembly are opposite, i.e., left hand or right hand.

Note: The ball joint assemblies are sealed and should not be dismantled. They must each be renewed as a complete assembly when wear is evident.

2. Remove the rubber dust covers after releasing the cover circlips. Lift off the dished washer located on the neck of each ball pin.

To Re-assemble.

1. Screw the ball joint assemblies on to their respective ends of the rod according to the right or left hand thread, but before tightening the locknuts, **ensure that the distance between the ball pin centres is 8·70 in. (221 mm.) with the ball pins in alignment and in the same plane as each other.**

2. Refit the dished washers, rubber dust covers and circlips.

To Refit.

Reverse the removal procedure ensuring the ball pin centres are correctly set.

MAIN RELAY LEVER

To Remove.

1. Disconnect the ball joint assemblies at each arm of the relay lever assembly as follows:

(*a*) Extract the split pin and remove the slotted nut from each ball pin.

(*b*) The track rod ball joints in the rear arm of the main relay lever can be released using Churchill Extractor R.G.190C (see Fig. J.14). The intermediate steering rod ball joint in the front arm of the relay lever can be released using Churchill Extractor R.G.284. Swing each steering rod clear of the relay lever assembly.

2. Unscrew the four setscrews and shakeproof washers securing the support bracket to the rear face of the front crossmember. It may be necessary to slightly raise the engine on its mountings to provide sufficient clearance at the sump base to enable the relay lever and bracket assembly to be withdrawn.

Alternatively, removal of the sump will facilitate withdrawal of the assembly.

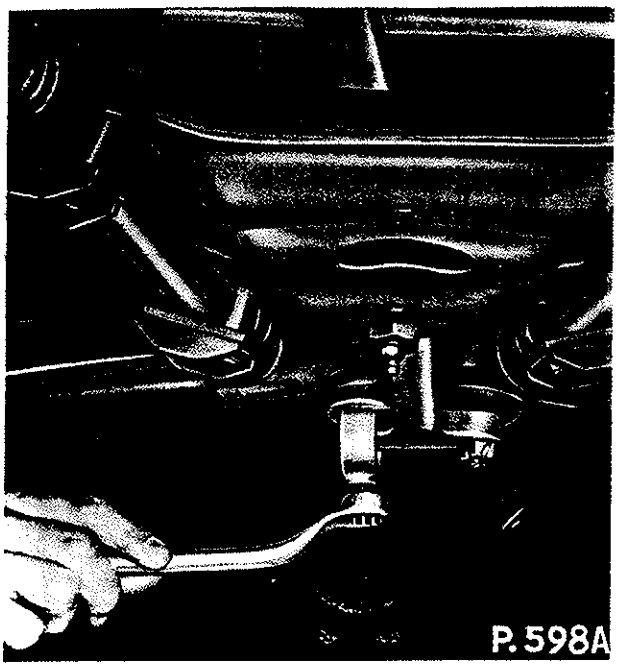


Fig. J.14. Releasing the track rod inner end ball joint using Churchill Extractor R.G.190C

To Dismantle (see Fig. J.15).

1. Tap down the lockwasher and remove the fulcrum pin nut.

2. Remove the fulcrum pin by lifting upwards out of the support bracket.

3. The relay lever assembly can then be withdrawn from the support bracket. A sealing ring is located at the top of the bushed bearing in the relay lever and a thrust washer covered by a rubber sleeve is positioned at the lower end of the bushed bearing. Note the position of these components before removal.

4. The bearing assembly containing the two bushes is a press fit in the relay lever and should only be dismantled if necessary.

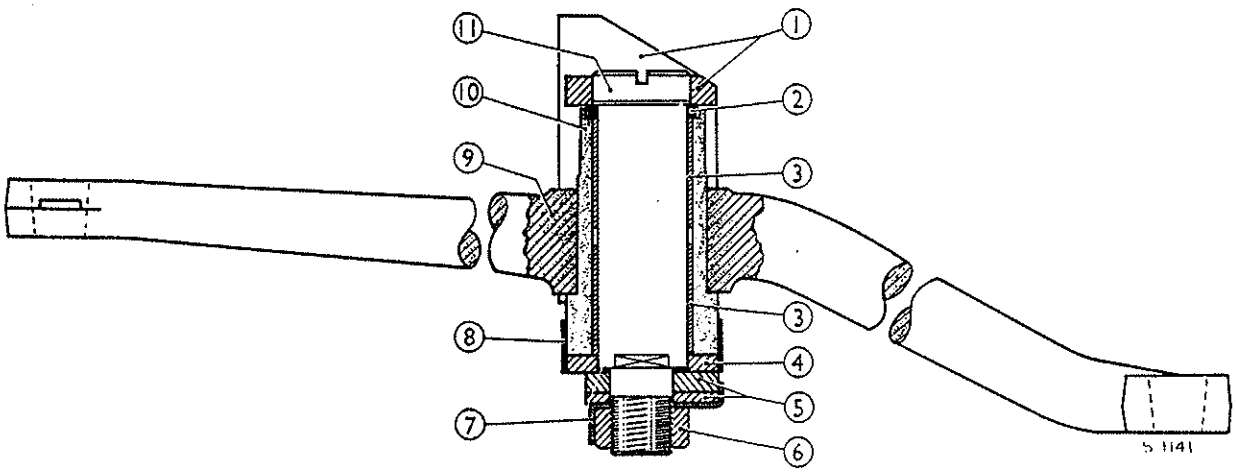
Inspection and Overhaul.

1. Check for wear between the fulcrum pin and the bushes. If wear is evident, renew the bushes and if necessary, the fulcrum pin. To fit new bushes, press out the old bushes and press in the new replacements ensuring that the bushes are flush with the faces as shown in Fig. J.16. Press in the bush in the direction of the arrow stamped on the outer diameter of each bush in order to correctly position the oil groove. Finally, the bushes must be line reamed in position to a diameter of 0·876/0·877 in. (22·25/22·275 mm.).

Note: If a new bearing is also being fitted, press the new bushes in the bearing and then press the bearing in the relay lever until the shoulder fully locates on the relay lever. The line reaming of the bushes must be carried out **after** the bearing assembly is pressed in the relay lever.

2. Examine the thrust washer for wear or scoring and renew as necessary.

3. Renew the sealing ring and the rubber sleeve if split or deteriorated.

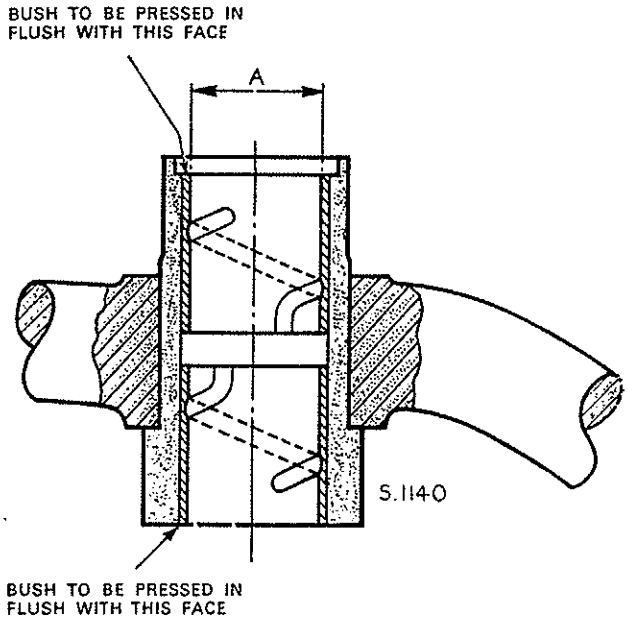


1 MAIN RELAY LEVER SUPPORT BRACKET (TOP FLANGE)
2 SEALING RING
3 BEARING BUSH
4 THRUST WASHER
5 MAIN RELAY LEVER SUPPORT BRACKET (BOTTOM FLANGE)
6 FULCRUM PIN NUT
7 LOCKWASHER
8 RUBBER SLEEVE
9 MAIN RELAY LEVER
10 RELAY LEVER BEARING
11 FULCRUM PIN

Fig. J.15. Sectional view of the main relay lever and support bracket assembly

4. Examine the two locating bores for the fulcrum pin in the support bracket for wear and elongation. Renew the bracket if evident.

5. Inspect the tapered bores at each end of the relay lever for wear, damage or burrs.



A = 0·876/0·877 in. (22·25/22·275 mm.)

Fig. J.16. Main relay lever bearing bush dimension

To Re-assemble (see Fig. J.15).

Reverse the dismantling operation noting the following points:

1. The sealing ring should be positioned under the fulcrum pin head in the recess at the top of the bearing assembly.

2. The thrust washer must engage the flats on the fulcrum pin just below the threaded diameter. Ensure that both the operating surfaces of the thrust washer and the support bracket are clean and free from burrs before re-assembling. The rubber sleeve must be fitted to seal the abutting faces of the thrust washer and the head of the bearing assembly.

3. After securely tightening the fulcrum pin nut, tap the new lockwasher over the flat of the nut which faces the longest section of the relay lever, i.e., facing the front of the vehicle.

To Refit.

Refitting is a reversal of the removal instructions using new split pins for the ball pin slotted nuts. Check the toe-in setting on completion.

TRACK RODS

To Check for Wear.

Wear can be checked in the track rod ball joints by grasping each ball joint assembly in turn and attempting to move it backwards and forwards. Whilst the ball joint should be free to articulate slightly on its ball pin no other movement between ball pin and socket should be present. As these ball joint assemblies are self-adjusting (see Fig. J.9), no other means of adjustment is provided and they must be renewed as an assembly if wear becomes apparent.

To Remove.

1. Extract the split pin and remove the slotted nut from each ball pin.

2. The inner ball pins of each track rod can be released from the main relay lever arm using Churchill Extractor R.G.190C (see Fig. J.14). The outer ball pins of each track rod can be released from the respective steering arm using Churchill Extractor R.G.284.

To Dismantle.

1. Slacken the locknuts on the track rods and thread the ball joint assemblies off the rod, noting that the threads of each assembly are opposite, i.e., left-hand or right-hand.

Note: The ball joint assemblies are sealed and should not be dismantled. They must each be renewed as a complete assembly when wear is evident.

2. Remove the rubber dust covers after releasing the cover circlips. Lift off the dished washer located on the neck of each ball pin.

Inspection and Overhaul.

1. Check the rod for bend and straighten if evident. **Do not use** heat to straighten the rod as this will destroy the temper of the metal.

2. Renew the rubber dust covers if they are split or deteriorated.

3. As stated in para. 1 **"To Dismantle"**, each ball joint assembly must be renewed as a complete assembly if wear is evident.

To Re-assemble.

1. Screw the ball joint assemblies on to their respective ends of the rod according to the right or left-hand thread, but before tightening the locknuts, ensure that they are screwed on an equal distance towards the centres of the rods.

2. Refit the dished washers, the rubber dust covers and secure with the circlips.

To Refit.

Reverse the operations for removal noting the following points:

1. Ensure that the ball pin shanks and the tapered bores of the steering and relay lever arms are clean and free from burrs before refitting the track rods.

2. Before refitting the track rods, check that the main relay lever is set at the centre of its travel between the two steering stops and that the front wheels are positioned at the straight ahead position.

3. Securely tighten the slotted nuts of the ball pins and lock with new split pins.

4. Adjust the length of each track rod to give the correct amount of "toe-in" to the front wheels.

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF.	SUBJECT

BRAKES

SECTION K

INDEX

BRAKES

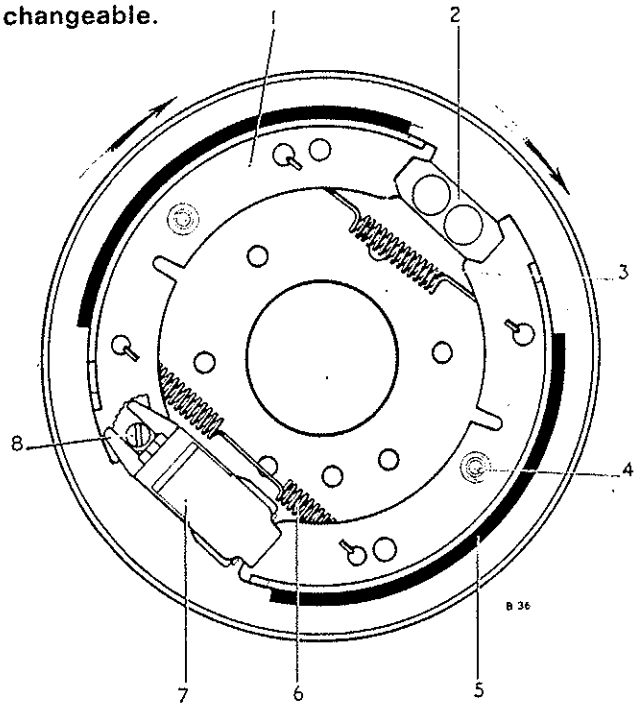
DESCRIPTION

The footbrake pedal applies the brakes on all wheels through a hydraulic system in which fluid from a reservoir is forced by the master cylinder piston to the wheel cylinders within the brake assemblies.

The handbrake, which is also the secondary brake, operates on the front wheels only and being mechanical in its operation is completely independent of the hydraulic system.

Brake Assemblies.

Front assemblies which are of the Duo-Servo type consist of two shoes with riveted linings, two pull off springs and a double acting wheel cylinder. Also contained within the assembly and attached to the leading shoe (the shoe with the shortest lining), is the handbrake operating lever. A push rod is fitted between the leading and trailing shoes. **The two shoes of a brake assembly are not interchangeable.**

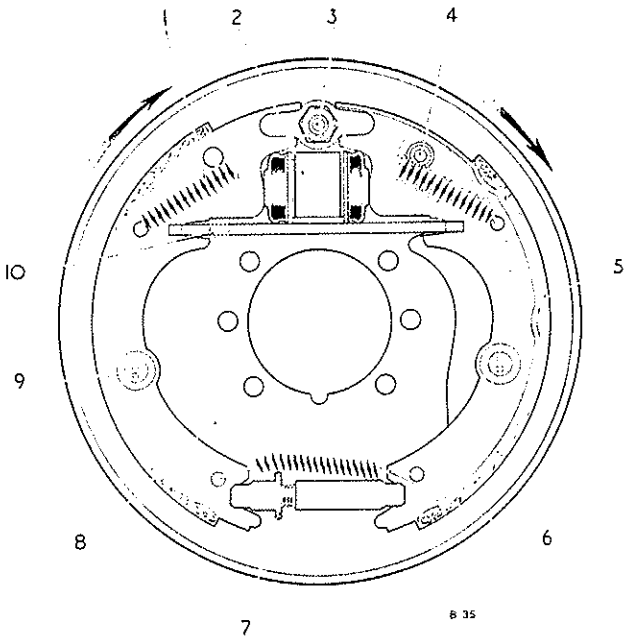


1 SHOE WEB
2 FIXED ANCHOR
3 TENSION SPRING
4 BEEHIVE SPRING
5 LINING
6 PULL-OFF SPRING
7 WHEEL CYLINDER
8 "MICRAM" ADJUSTER

Fig. K.1. Rear off-side brake (2500 models)

An adjuster is located between both shoes at the opposite end to the wheel cylinder and is held in position by a tension spring which also holds the adjuster pinion wheel in its set position. Hold down springs are used to keep the shoes square to the drum.

The shoes are anchored to the backplate at the wheel cylinder end by means of an anchor pin and the two return springs. The adjuster ends of the shoes are free and will therefore pivot from the anchor pin when the primary shoe contacts the revolving drum, thus providing a degree of servo assistance.



1 PULL-OFF SPRING
2 WHEEL CYLINDER
3 ANCHOR PIN
4 LEVER PIVOT
5 LEADING SHOE
6 TENSION SPRING
7 ADJUSTER WHEEL
8 BACKPLATE
9 HOLD-DOWN SPRINGS
10 ANTI-RATTLE SPRING

Fig. K.2. Front off-side brake

Upon application of the footbrake the wheel cylinder pistons move the shoes out towards the drum. As the leading shoe contacts the moving drum the turning action transmits a considerable load to the adjuster and thence to the trailing shoe. Since the trailing shoe is against the anchor pin, the shoe is pushed hard against the drum with a force far in excess of that which was initially transmitted by the wheel cylinder.

The operation of the front brake assemblies when the handbrake is used as a secondary brake, i.e. to bring moving vehicles to a halt, is similar to that described for the footbrake application with the exception that the shoes are brought into contact with the drum by the movement of the operating lever which is located at the rear of, and attached to, the leading shoe web. This movement of the operating lever in addition to moving the primary shoe into

contact with the drum, transmits the movement to the secondary shoe via the push rod which is located between both shoes.

Rear Assemblies each have two shoes with riveted linings, two pull-off springs and a single wheel cylinder. An adjuster is fitted in a slot in the tip of the leading shoe at the wheel cylinder end. The other end of the leading shoe abuts against a fixed anchor block in the backplate, the web of the shoe being free to slide in a slot in the block.

The trailing shoe is located in a similar manner between the anchor block and the closed end of the wheel cylinder. The shoes and cylinder are self centring.

Rear Wheel Cylinders one to each brake assembly, are fitted in a slot in the rear backing plate and are free to slide in the slot between the tips of the brake shoes. Each cylinder consists of a casting containing a double acting piston, which is hydraulically operated. The piston is fitted with a rubber seal. When operated the inner piston butts against the outer piston and applies a thrust to the tip of the leading shoe through the dust cover, "Micram" adjuster and mask.

A rubber boot is fitted round the wheel cylinder to exclude foreign matter.

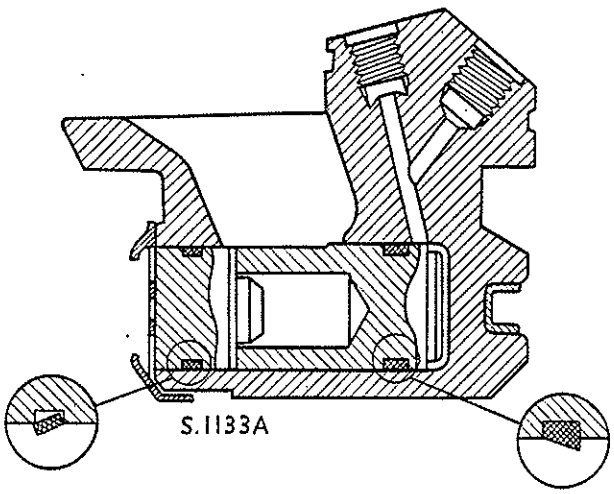


Fig. K.3. Rear wheel cylinder arrangement

Front Wheel Cylinders of the double acting type are fitted, one to each assembly. The cylinder is secured to the brake backplate by means of a spring clip. Rubber boots located around the outside of the cylinder and pistons prevent the ingress of dampness or foreign matter.

Master Cylinder.

A piston (9) is contained within the barrel, and has a rubber main cup (7) spring-loaded against its inner end. Between the cup and the piston a thin washer (8) is interposed to prevent the cup from being drawn into the small feed holes drilled around the piston head. The outer end of the piston carries a rubber secondary cup (10) and is formed with a depression to receive the spherical end of push-rod (13), which carries a piston stop and is retained by a circlip (12). A rubber boot (15), through which the push-rod passes, is fitted on to the barrel to prevent the intrusion of dirt and moisture.

At the end opposite to the push-rod, is the outlet connection and its inner face provides a seat against which a check-valve assembly (3) is loaded by the spring. The check valve assembly consists of a rubber body, into which is fitted a domed metal insert. A rubber flap integral with the body is located on the convex side of the metal insert to seal the four elongated holes equally spaced in the dome section of the insert. A bleed hole is drilled in the central section of the insert, which is not covered by the rubber flap.

Depressing the brake pedal causes the push-rod to thrust the piston along the bore of the master cylinder barrel, and the fluid thus displaced lifts the flap of the rubber check valve body away from the convex side of the metal insert, thus allowing unrestricted flow of the fluid to the brake wheel cylinders, via pipes. The entry of fluid into the wheel cylinders causes the pistons to move outward. The piston in each wheel cylinder acts on the tip of its respective shoe, bringing the brake shoe linings into contact with the brake drums.

Upon the removal of the load from the brake pedal, the return spring thrusts the master cylinder piston back against its stop, faster than fluid is able to return from the wheel cylinders; this creates a depression in the master cylinder, which draws the edge of the main cup away from the head of the piston and allows fluid from the tank to flow through the feed holes thus uncovered to make up the temporary deficiency. Meanwhile fluid returning from the wheel cylinders, being under load from the brake shoe pull-off springs, lifts the check valve body away from its seat and re-enters the master cylinder.

When the master cylinder piston is fully back against its stop, the main cup uncovers a small by-pass port in the barrel, and this allows the release of excess fluid to the tank, thus permitting the pull-off springs to return the brake shoes to the fully "off" position. The by-pass port also compensates for contraction or expansion of the fluid, due to changes in temperature, allowing fluid to be drawn into or escape from the system. Should this port become blocked the excess fluid would be unable to escape and the brakes would consequently drag.

The purpose of the check valve is to prevent the re-entry into the master cylinder of fluid pumped into the line during the "bleeding" operation; this ensures a fresh charge of fluid at each stroke of the brake pedal and a complete purge of air from the system.

LUBRICATION

Lubricating nipples are provided at the following points:

(*a*) Footbrake pedal pivot.

(*b*) Handbrake cable outer casing.

These should be lubricated every 1,000 miles (1,500 km.) with Shell Spirax 140 E.P. or Shell Retinax A.

3. Disconnect the hydraulic fluid outlet pipe by unscrewing the union nut at the master cylinder.

4. Slacken the banjo bolt and turn the banjo downwards taking care to catch any fluid which is released, in a container.

5. Tighten the bolt and slowly depress the pedal to expel the fluid from the master cylinder and supply tank.

6. When the master cylinder and tank are empty remove the split pin from the clevis pin retaining the push rod fork to the pedal lever and depress the brake pedal until the clevis pin aligns with the large circular holes in the pivot bracket.

7. Tap out the pin.

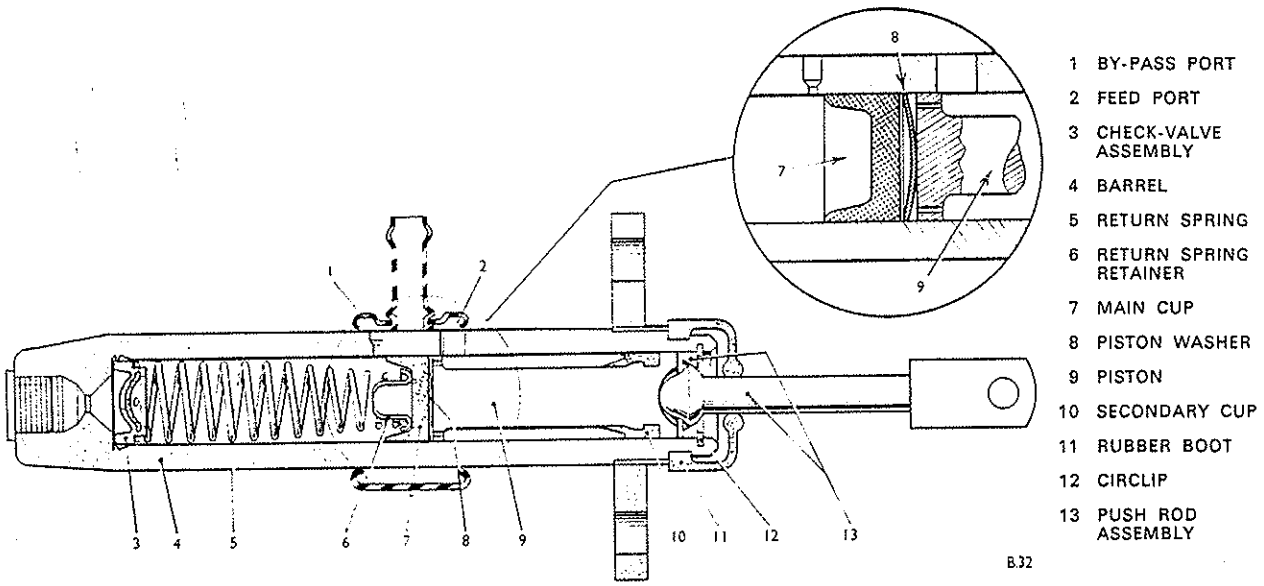


Fig. K.4. Master cylinder arrangement

The following points require oil can lubrication every 1,000 miles (1,500 km.):

(*a*) Footbrake pedal jaw pin.

(*b*) Handbrake lever pivot.

(*c*) Handbrake linkage pivots.

FOOTBRAKE PEDAL

To Remove.

1. Release the screws securing the steering column rubber gaiter.

2. Remove the setbolts retaining the toeboard cover panel and lift out the panel and pedal seal.

8. Remove the split pin from the pedal fulcrum pin in the pivot bracket and take off the plain and spring washer.

9. Tap out the fulcrum pin and withdraw the brake pedal.

Inspection and Overhaul.

1. Examine the fulcrum pin and pedal bore for wear and renew if necessary.

2. Inspect the clevis pins for wear and renew if necessary.

To Refit.

Refitting is a reversal of the removal instructions. It is advisable to use new split pins. Refill the fluid supply tank and bleed the system.

BRAKE SHOES

To Adjust.

Front Brakes

1. Place chocks behind the rear wheels and set the handbrake in the fully off position.

2. Remove the nave plate and jack up one front wheel until it is free to rotate.

3. Turn the wheel so that the hole in the wheel and brake drum is opposite the adjuster pinion wheel.

4. Using a screwdriver turn the adjuster until the brake shoe is in contact with the brake drum, then turn the adjuster one notch anti-clockwise; this should provide the correct clearance between the shoe and the drum. If closer adjustment is required spin the wheel and apply the footbrake hard. This will centralise the shoe after which a further adjustment check may be carried out.

5. Repeat all the above operations on the opposite front wheel.

Rear Brakes

1. Apply the handbrake.

2. Remove the nave plate and jack up the rear wheel until it is free to rotate.

Fig. K.5. Adjusting the rear brake shoes (off-side illustrated)

3. Turn the wheel so that the hole in the wheel and brake drum is opposite the slotted head of the "Micram" adjuster.

4. Using a screwdriver turn the adjuster until the brake shoes contact the drum (see Fig. K.5).

5. Apply the footbrake hard, to ensure that the wheel cylinder is centralised, and release the brakes. If after doing this the wheel is still locked, turn back the adjuster one, or if necessary two notches, to provide the correct shoe to drum clearance. If however the wheel is free to rotate after centralising turn the adjuster until the shoes are in contact with the drum and then turn the adjuster anti-clockwise one notch.

6. Repeat operations detailed in paras. (2) to (5) on the opposite rear wheel.

Note: There is only *one* "Micram" adjuster to each rear brake.

To Remove.

Rear

1. Apply the handbrake, jack up the vehicle and remove the nave plate and road wheel.

2. Slacken off the adjuster to its fullest extent.

3. Remove the brake drum having first removed the drum to hub locating screw.

4. On 2500 models it will be necessary to release the "beehive" springs securing the shoes to the back-plates.

5. Lever one of the brake shoes out of its solid abutment against the load of the tension spring. Do not overstretch the springs.

6. Disengage the tension spring from both shoes.

7. Pull the web of the trailing shoe (shoe without the adjuster) out of the slot in the wheel cylinder against the tension of the pull-off spring taking care not to overstretch the spring. Unhook the pull-off spring.

8. The leading shoe complete with its adjuster unit will now be free for withdrawal from the wheel cylinder and abutment.

9. Retain the wheel cylinder piston within the cylinder by means of a twist of wire or a suitable clamp.

Front

1. Place chocks behind the rear wheels, jack up the front of the vehicle and remove the nave plate and wheel.

2. Slacken off the adjuster to its fullest extent and fully release the handbrake.

3. Remove the brake drum having first removed the drum to hub locating screw.

4. Release the hold-down springs by compressing the spring slightly and turning the dished retaining washer to disengage it from the pin. Withdraw the pin from the rear of the backplate.

5. Disengage the adjuster from the shoe webs by pulling one of the shoes against the load of the tension spring. Unhook the spring from the webs of both shoes.

6. Push the handbrake lever fitted to the leading shoe towards the centre to disengage the nipple of the handbrake cable from the yoke on the end of the lever. Pull both shoes away from the axle simultaneously to release the handbrake cross lever and anti-rattle spring.

7. Pivot the leading shoe outwards away from the axle followed by an upward movement to remove the tension on the pull-off spring. Remove the spring and the brake shoe. Repeat the process for the other shoe. Unless replacement is necessary, do not remove the locknut holding the steady plate.

8. Remove the brake lever from the leading shoe by taking off the circlip to withdraw the pivot pin. Also retrieve the spring washer positioned between the lever and the shoe web, and the plain washer fitted under the circlip.

If no further dismantling is required, retain the wheel cylinder pistons by securing them within the body by a twist of wire or by a suitable clamp.

Inspection and Overhaul.

Examine all parts for damage and wear renewing if necessary.

If the brake linings are worn excessively or signs of grease are present, replacement shoes should be fitted. It is recommended that advantage be taken of the Factory Reconditioning scheme whereby replacement brake shoe and lining assemblies can be obtained in exchange for the old parts.

In territories where these facilities are not available, relining may be carried out as follows:

1. Mark the position of the lining across each end of the brake shoe with a scriber. This will ensure that the new lining may be fitted in the correct position.

2. Grip the shoe lightly in a vice, taking care not to distort the shoe. Drill away the riveting and punch out the rivets. Position the shoe in the vice so that it is held as near as possible to the rivet being removed.

3. Degrease the shoes using, if available, a trichlorethylene bath.

4. Thoroughly inspect each shoe for damage and cracks. Apply marking to the brake shoe platform and roll it against a flat surface, noting any high spots, which can be removed with the aid of a file.

5. Reline, using new linings, as follows:

Mount a rivet dolly in the vice. Place the lining correctly on the shoe and clamp in position, aligning the ends with the marks previously scribed and correctly positioning the rivet holes. Fit the rivets in pairs starting at the centre of the shoe and working outwards towards the ends. While riveting, hold the rivet head firmly against the anvil and secure with a suitable punch.

It must be noted that any foreign matter adhering to the underside of the lining may cause a high spot on the surface. Make sure there is no gap between the lining and the brake shoe platform.

It is not necessary to chamfer the heel and toe of the lining after fitting.

Difficulty may be experienced when fitting the brake drum after relined shoes have been assembled to the backplates. This is because an extra 0·010 in. to 0·015 in. (0·25 to 0·38 mm.) is allowed on the lining for grinding down, so that where grinding facilities are available, the brakes may be rendered efficient in a short time after assembly, i.e. little bedding in is required.

If grinding equipment is not to hand, and it proves impossible to fit the drum, the linings must be rubbed down as required. Bedding in may be assisted by chalking the linings, applying the brakes hard, and rectifying high spots. The utmost care must be taken to ensure that all abrasive particles are removed from the brakes, using an air jet, before the drums are finally fitted.

6. Reline with ready-made linings, if available, or with "made-up" linings, to the dimensions given, in "GENERAL DATA".

It is essential that the correct lining material is used or efficient braking may not be maintained. After cutting to the correct size the lining should be clamped to the shoe for drilling as indicated in Fig. K.6.

Correct drill size is 0·166 in. (No. 19) (4·2 mm.).

Counterbore size is 0·31 in. (7·9 mm.) and should not exceed the depth of 0·143 in. (3·63 mm.).

When "off the roll" lining is used, the heel and toe of each lining should be slightly chamfered after assembling to the brake shoe.

To Refit.

Before carrying out the following procedures apply Molybdenum disulphide grease to all metal to metal surfaces. Do not allow grease to contact rubber parts or the brake linings.

Front

1. Establish the identity of the leading shoe as the one having the shorter lining.

2. Refit the handbrake operating lever to the leading shoe in the following manner:

(*a*) Pass the pivot pin through the hole in the shoe web from the outside face.

(*b*) Place the dished washer over the pivot pin, concave face towards the web, followed by the handbrake operating lever.

(*c*) Secure in position by means of the flat washer and new circlip.

3. Locate the coiled end of a pull-off spring in the leading shoe web, and the opposite end of the spring around the anchor post above the wheel cylinder ensuring that the shoe is fitted towards the front of the vehicle.

4. Pull the shoe against the spring to locate the toe of the web under the steady plate fitted to the post. The shoe web will then rest against the head of the wheel cylinder piston.

Rear

1. Assemble one pull-off spring to the shoes ensuring that it locates in holes nearest to the wheel cylinder and is fitted beneath the shoe webs.

2. Position the ends of the shoes against the ends of the wheel cylinder.

3. Attach the other pull-off spring to the opposite end of the shoes.

4. Pulling the shoes apart, locate the ends in the slots of the fixed anchor block.

5. Pull the shoes apart at the cylinder end and locate the adjuster and masks (See Fig. K.7).

6. Refit the brake drum.

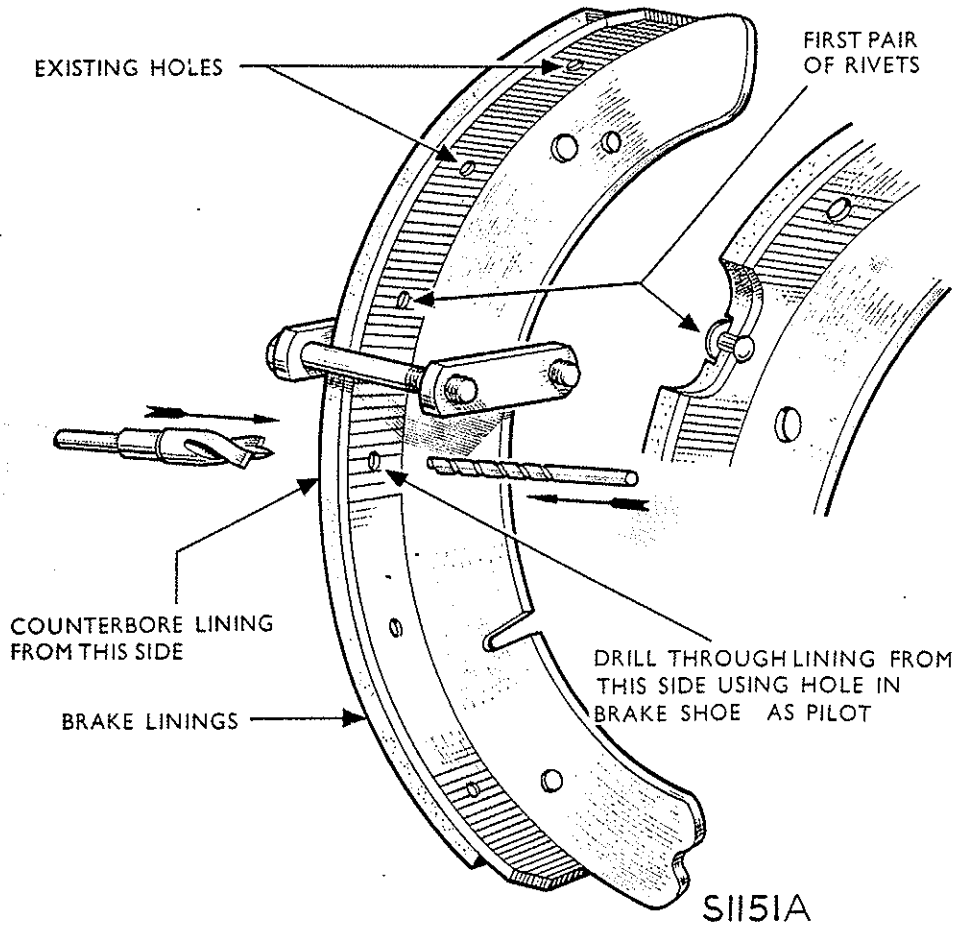


Fig. K.6. Method of fitting "off the roll" type brake linings (typical)

5. Install the handbrake push rod in position so that the cut-away portion at the end of the rod locates against the handbrake operating lever and the shoe web.

6. Fit the anti-rattle spring to the free end of the push rod and refit the remaining shoe in a similar manner to that described.

On completion of the refitting procedure, re-adjust the shoes as previously described.

WHEEL CYLINDERS

To Remove.

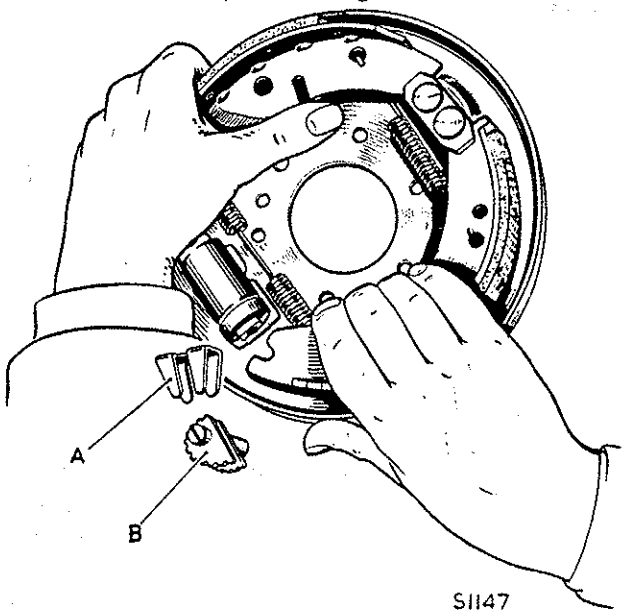
Front

1. Remove the brake shoes as previously described and thoroughly clean the exterior of the wheel cylinder.

2. Disconnect the flexible hose from the rear of the cylinder. This should be detached from the underframe bracket first.

3. Plug the end of the pipe and also the aperture in the cylinder to prevent loss of fluid.

4. Release the spring clip at the rear of the backplate and withdraw the cylinder and gasket.



"A" – MASK "B" – ADJUSTER

Fig. K.7. Fitting "Micram" adjuster

Rear

1. Remove the brake shoes.

2. Disconnect the union securing the hydraulic fluid pipe to the rear of the cylinder. Plug both apertures to prevent loss of fluid.

3. Remove the rubber boot.

4. Remove the wheel cylinder from the slot in the backplate.

To Dismantle.

Front

1. Disengage the rubber boots from the cylinder body and pistons.

2. Push the pistons carefully out of the bore.

3. Remove the rubber seals from each piston, taking care not to damage the piston especially the seal grooves.

Rear

1. Withdraw the outer piston complete with cover from the cylinder.

2. Apply a gentle air pressure to the fluid pipe connection and blow out the inner piston complete with rubber seal.

3. Remove the seals from both pistons using the tool shown in Fig. K.8. taking care not to damage the pistons or seal grooves.

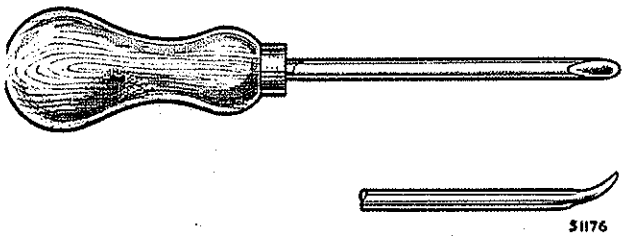


Fig. K.8. Removal tool for rubber piston seals

Inspection and Overhaul.

1. Wash all components in clean brake fluid and dry off with a clean non-fluffy cloth.

2. Examine the rubber seals for signs of swelling or deterioration and renew if necessary. It is advisable to renew all rubber parts.

3. Examine the pistons and bores for scores renewing if evident.

To Re-assemble.

Front

1. Ensure that hands are free from grease and dirt.

2. Refit new seals to the pistons so that the lip of the seal faces away from the smaller groove.

3. Fit the small diameter rim of each boot to the remaining groove of each piston.

4. Dip the assembly into clean brake fluid and insert the pistons into the cylinder bore in the wet condition, taking care not to damage the seals.

5. Fill each rubber boot with "Rubberlube" before locating the boots around the cylinder body.

Rear

1. Ensure that the hands are free from grease and dirt.

2. Dip all cylinder internal parts in clean brake fluid and assemble in the wet condition.

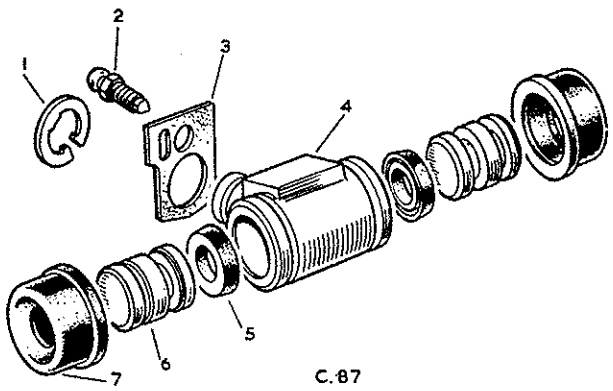
3. Fit the new seal to the inner piston with the lip of the seal facing away from the hollow end of the piston.

4. Insert the piston fully into the cylinder bore, flat end first, taking care not to damage the seal.

5. Fit the seal to the outer piston ensuring that it locates correctly in its groove and stands proud at its edge nearest the dust cover.

6. Coat the mouth of the bore, piston, seal and inner surfaces of the dust cover with "Rubberlube".

7. Insert the piston into the cylinder bore until it meets the head of the inner piston.



1 CIRCLIP
2 BLEED NIPPLE
3 GASKET
4 CYLINDER BODY
5 SEAL
6 PISTON
7 RUBBER BOOT

Fig. K.9. Front wheel cylinder details

To Refit.

Front

1. Place a new gasket on the mounting face of the cylinder body.

2. Insert the spigot of the body through the hole in the backplate and secure the cylinder by means of a new spring clip.

3. Remove plugs and connect the hydraulic pipe to the wheel cylinder.

4. Refit brake shoes, drums and wheels.

5. Bleed the system and adjust the brake shoes.

6. Apply footbrake hard several times to centralise the shoes. Re-check shoe adjustment.

Rear

1. Grease the surrounds of the cylinder locating slot on the rear side of the backplate.

2. Fit the cylinder to the backplate and check that it is free to slide in the slot.

3. Fill the rubber boot with "Rubberlube" and fit the boot over the cylinder body which projects from the rear of the backplate.

4. Remove the plugs and re-connect the hydraulic pipe.

5. Refit brake shoes, drums and wheels.

6. Bleed the system and adjust the brake shoes.

7. Apply footbrake hard several times to centralise the shoes and re-check the shoe adjustment.

MASTER CYLINDER

To Remove.

1. Unscrew the self tapping screws and remove the inspection cover in the floor panel thus revealing the master cylinder.

2. Disconnect the fluid outlet pipe by unscrewing the union nut.

3. Slowly depress the pedal to expel the fluid from the master cylinder into a container.

4. When the master cylinder and tank are empty remove the supply pipe from the master cylinder.

1 OUTER PISTON AND DUST COVER
2 SEAL
3 INNER PISTON
4 TAPER SEAL
5 CYLINDER BODY
6 RUBBER BOOT

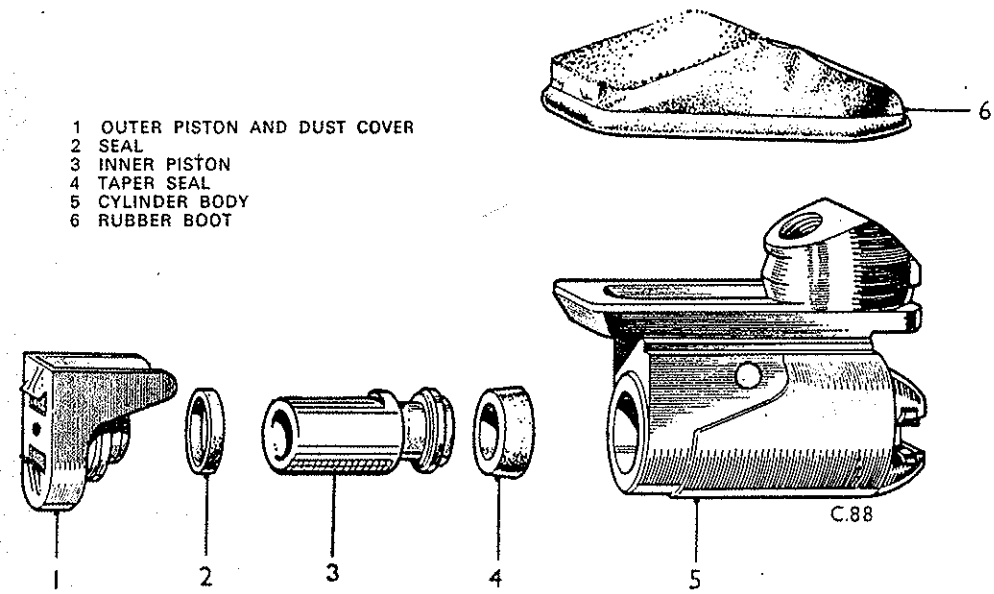


Fig. K.10. Rear wheel cylinder details

5. Remove the split pin from the clevis pin retaining the push rod fork and depress the brake pedal until the jaw pin aligns with the large circular holes in the pivot bracket.

6. Tap out the pin.

7. Remove the two bolts and nuts securing the master cylinder to the pivot bracket, detach the cylinder assembly complete with push rod, and the stiffener plate.

To Dismantle.

1. Detach the rubber boot from the end of the barrel and move it along the push rod.

2. Depress the piston and remove the circlip (10).

3. Remove piston stop and push rod.

4. Withdraw the piston (8), piston washer (6), main cup (5), spring retainer (4), spring (3) and check valve assembly (2).

5. Inspect the piston return spring for weakness (see "GENERAL DATA").

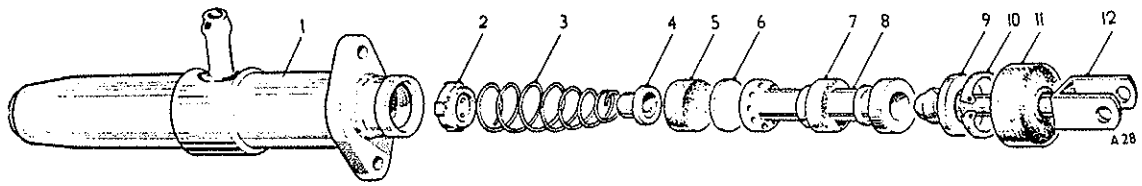
To Re-assemble.

1. Dip all parts in clean brake fluid and assemble wet.

2. Using the fingers only, stretch the secondary cup on to the piston with the small end towards the head (i.e. drilled end) and with the groove engaging the ridge, gently work round the cup with the fingers to ensure correct bedding.

3. Fit the spring retainer on the small end of the spring and locate the check valve in the large end, so that the step adjacent to the metal insert is located within the end coil.

4. Hold the cylinder barrel vertical and insert the spring, check valve end first, upwards into the cylinder barrel.



1 BARREL
2 CHECK VALVE ASSEMBLY
3 RETURN SPRING
4 RETURN SPRING RETAINER
5 MAIN CUP
6 PISTON WASHER
7 SECONDARY CUP
8 PISTON
9 & 12 PUSH ROD ASSEMBLY
10 CIRCLIP
11 RUBBER BOOT

Fig. K.11. Master cylinder details

5. Remove the secondary cup by carefully stretching it over the end of the piston.

Inspection and Overhaul.

1. Thoroughly clean all parts in clean Lockheed Brake Fluid and lay them out on a clean sheet of paper after drying them with a clean fluffless cloth.

2. Examine all rubber parts for deterioration. It is usually advisable to renew these whenever an overhaul is carried out.

3. Inspect the piston and barrel bore for scoring.

4. Check that the feed and by-pass drillings in the barrel are free from obstruction and that the piston head holes are clear.

5. Insert the main cup, lip foremost, taking care not to turn back or damage the lip.

6. Insert the piston washer with the concave side towards the cup (see Fig. K.11).

7. Insert the piston into the barrel, head foremost taking care not to damage the secondary cup.

8. If previously removed, stretch the rubber boot on to the push rod with the open end towards the spherical end of the rod.

9. The push rod should now be inserted.

10. Push the piston down the bore, locate the piston stop within the barrel and secure it by fitting the circlip at the end of the barrel. It is most important that the circlip is seated correctly in its groove.

11. Slide the rubber boot along the push rod until the rim of the open end can be pushed into the groove in the exterior of the cylinder barrel.

To Refit.

Refitting is a reversal of the removal instructions. The reservoir should be filled with clean brake fluid and the hydraulic system bled.

Check for leakage by applying a firm pressure to the pedal and inspecting all connections.

BRAKE DRUMS

To Remove.

1. Jack up the vehicle.
2. Remove the road wheel.
3. Turn the brake adjuster until the shoes are clear of the drum.
4. Remove the securing countersunk screw and pull off the drum.

Inspection and Overhaul.

1. Examine the friction surface of the drum for excessive scoring renewing the drum if necessary.
2. Check for ovality and renew if this is evident.

To Refit.

1. Replace drum and secure with the countersunk screw.
2. Replace road wheel and adjust brake.

HYDRAULIC PIPE LINE FLEXIBLE HOSES

To Remove.

During service operations which involve the removal or replacement of the flexible hoses, great care must be taken to avoid damaging them by twisting or straining. Proceed as follows referring to Fig. K.12.

1. Release the union nut.
2. Release the locknut securing the flexible hose end sleeve nut to the underframe bracket, ensuring at the same time that the hose does not turn by holding the sleeve nut with a spanner.
3. Withdraw the hose sleeve nut from the underframe bracket.
4. Unscrew the hose from the connection on the wheel cylinder (front brakes) or the three-way connector on the axle case (rear brakes).

Inspection and Overhaul.

Examine the hoses for deterioration and leakage and ensure that they are not obstructed, by flushing them with brake fluid and blowing out with air.

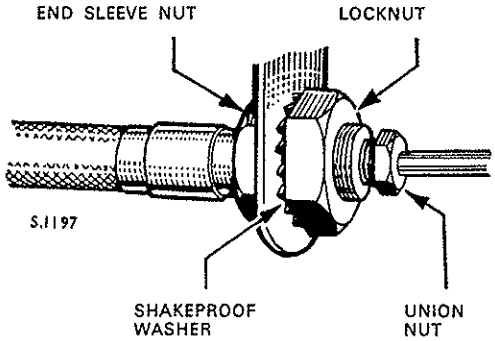


Fig. K.12. Flexible hose connection

To Refit.

1. It is important to fit the hose to the wheel cylinder or the three-way connector before connecting up to the underframe bracket.
2. Fit the hose end sleeve nut to the bracket and tighten the locknut at the same time holding the sleeve nut hexagon to prevent movement.
3. Refit the union nut.
4. Bleed the brakes and check for leaks with the brake pedal applied hard.

BRAKE FLUID RESERVOIR

The brake fluid is contained in a plastic tank located in the top right-hand rear corner of the engine aperture and is fed to the master cylinder by pipeline.

The level of the fluid should be checked at frequent intervals and when necessary replenished with the recommended Lockheed fluid. **Do not overfill.**

The addition of fluid should only be necessary after extremely long intervals and any appreciable fall in level would indicate a leak in the system and should be investigated.

Ensure that the vent hole in the filler cap is kept clear.

BLEEDING THE HYDRAULIC SYSTEM

Bleeding the system in order to expel all air is not a routine maintenance operation and should only be necessary when some portion of the equipment has been disconnected or fluid drained off so that air has been allowed to enter.

1. Fill the fluid reservoir with Lockheed Heavy Duty Brake Fluid and keep it at least half full throughout the whole operation.

2. Attach a rubber tube to the bleeder screw on the wheel cylinder and submerge the free end of the tube in some brake fluid in a clean glass jar.

3. Unscrew the bleeder screw for nearly one complete turn. Depress the brake pedal slowly and allow it to return without assistance; repeat this pumping operation with a slight pause between each depression of the pedal. Observe the flow of fluid being discharged into the glass jar and when air bubbles cease to appear, hold the pedal down firmly and securely tighten the bleeder screw.

4. Repeat on other wheels; one bleeder screw to each wheel.

2. Release the two screws securing the handbrake assembly to the body panel adjacent to the driving seat and lift away the assembly.

To Dismantle.

1. Grind away the riveting on the sector pivot pin on the end that carries the detachable plain washer, also grind away riveting on one of the pawl pivot pins.

2. Prise the washer free from the sector pivot pin.

3. Press the handbrake push button inwards, remove the two pivot pins, when the sector and pawl can be withdrawn.

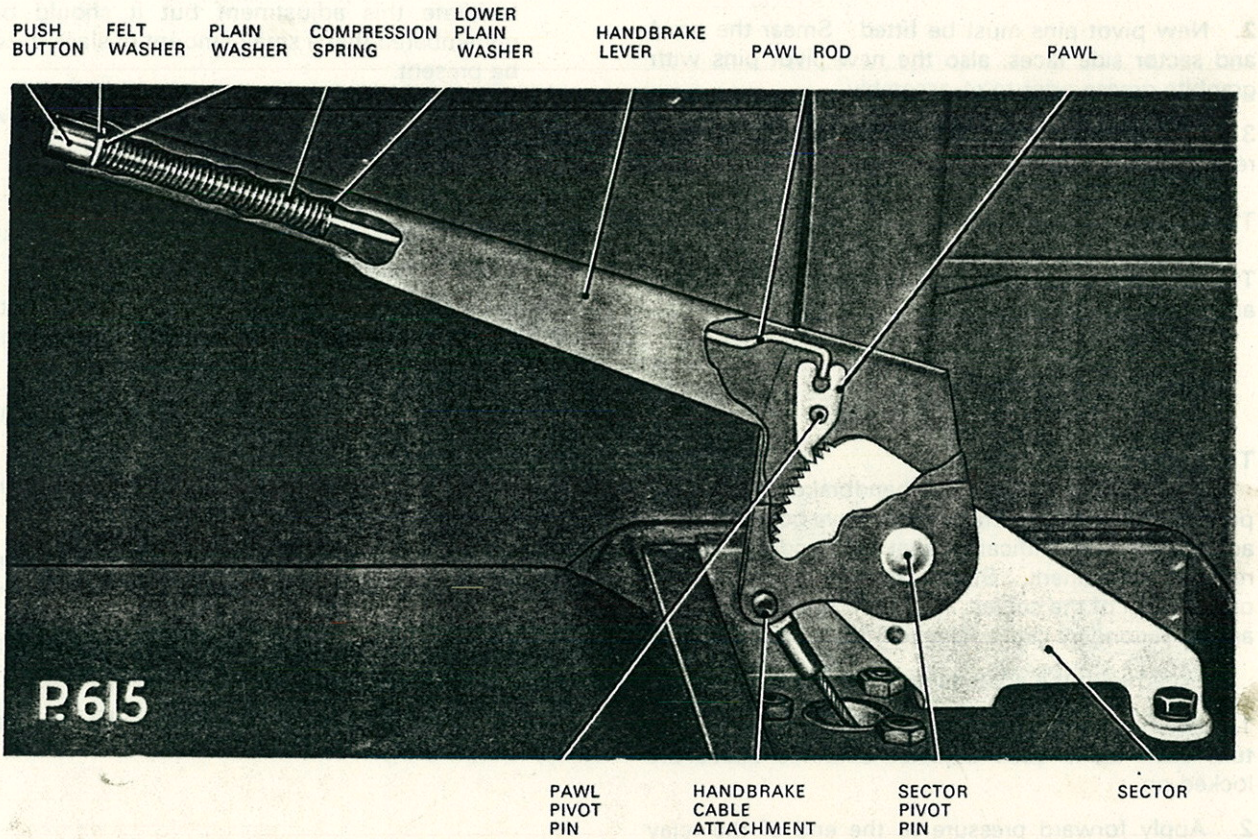


Fig. K.13. Cut-away view of the handbrake lever assembly

5. Clean fluid discharged from the system should be allowed to stand, protected from dust, for several hours until it is quite clear of air bubbles before being used again.

6. Dirty fluid should be discarded.

HANDBRAKE LEVER

To Remove.

1. Remove the nut and washer from the screw securing the end eye of the handbrake cable to the handbrake lever and withdraw the screw, and the bush.

4. Grip the push button and withdraw the rod assembly from the lever.

5. Remove the push button from the top of the pawl rod and withdraw the felt washer, plain washer, compression spring and lower plain washer from off the rod.

Note: The lower plain washer located at the base of the spring barrel, i.e. lever hand grip, provides a seating for the compression spring.

Inspection and Overhaul.

1. Check the teeth of the pawl and sector ratchet for excessive wear or damage and renew, if necessary.

2. Check the compression spring for weakness.

3. Inspect for wear on the end of the pawl rod, which mates with the pawl. Renew if necessary.

4. Examine the cable eye bush for excessive wear and renew, if necessary.

To Re-assemble.

Reverse the dismantling procedure to re-assemble the handbrake lever, noting the following:

1. Grease the pawl rod at positions where contact is made with lower plain washer and the pawl. When fitting the pawl rod assembly, ensure the lower plain washer seats squarely in the base of the spring barrel.

2. New pivot pins must be fitted. Smear the pawl and sector side faces, also the new pivot pins with graphite grease prior to re-assembly.

3. Securely rivet over both pivot pins as a final re-assembly operation.

To Refit.

Refitting is a reversal of the removal instructions. The handbrake cable should be checked for slackness and adjusted, if necessary.

HANDBRAKE CABLE

To Adjust.

If it is found that excessive handbrake travel is still present after the front brake shoes have been correctly adjusted, it is an indication that the handbrake cable requires adjustment. Stretch may have occurred in one or both of the cables, i.e. handbrake to relay lever and/or secondary cable, relay to front wheels.

Proceed with the adjustment as follows:

1. Set the handbrake in the fully off position and turn each brake shoe adjuster until the shoes are locked on.

2. Apply forward pressure to the end of the relay lever, to which the secondary cable equaliser is attached, to eliminate any slack in the handbrake cable.

3. With the lever held in this position measure the distance between the centre of the clevis pin securing the handbrake inner cable and the outer abutment bracket. This distance should be 3·75 to 4·25 in. (95 to 108 mm.) See Fig. K.14.

4. Should this distance be greater, adjust the outer cable by releasing the locknut on the front of the abutment bracket. Turn the nut on the inside of the bracket in an anti-clockwise direction so that the outer cable can be moved forward. Continue with this adjustment until the dimension in 3 above is obtained. Retighten the locknuts and slacken off the adjusters so that the shoes just clear the drums.

5. If after applying the handbrake it is found that too much travel still exists, the secondary cable will require adjustment. Tighten the shoes hard against the drums.

6. Release the handbrake and remove the clevis pin securing the equaliser to the relay lever. Move the equaliser back towards the rear of the vehicle to reduce the amount of slack in the secondary cable and re-insert the clevis pin through the equaliser securing it once more to the relay lever.

Note: Three holes are provided in the equaliser to facilitate this adjustment but it should be remembered that a small amount of slack *must* be present.

7. Re-adjust the brake shoes sufficiently to allow the wheels to turn freely.

To Remove and Refit

1. Disconnect the cable eye from the handbrake lever, noting the location of the cable eye bush.

2. Remove the setscrews securing the cable abutment housing to the body panel and withdraw the front end of the handbrake cable.

3. Release any clips securing the cable to the underframe.

4. Remove the split pin and clevis pin securing the rear end of the cable to the relay lever.

5. Release the front locknut which secures the outer cable to the abutment bracket and remove the rear locknut completely. Disengage the cable from its locating hole in the bracket so that the inner cable can be withdrawn through the slot provided.

6. Refitting the cable is a reversal of the removal procedure. Adjust as detailed.

HANDBRAKE SECONDARY CABLE

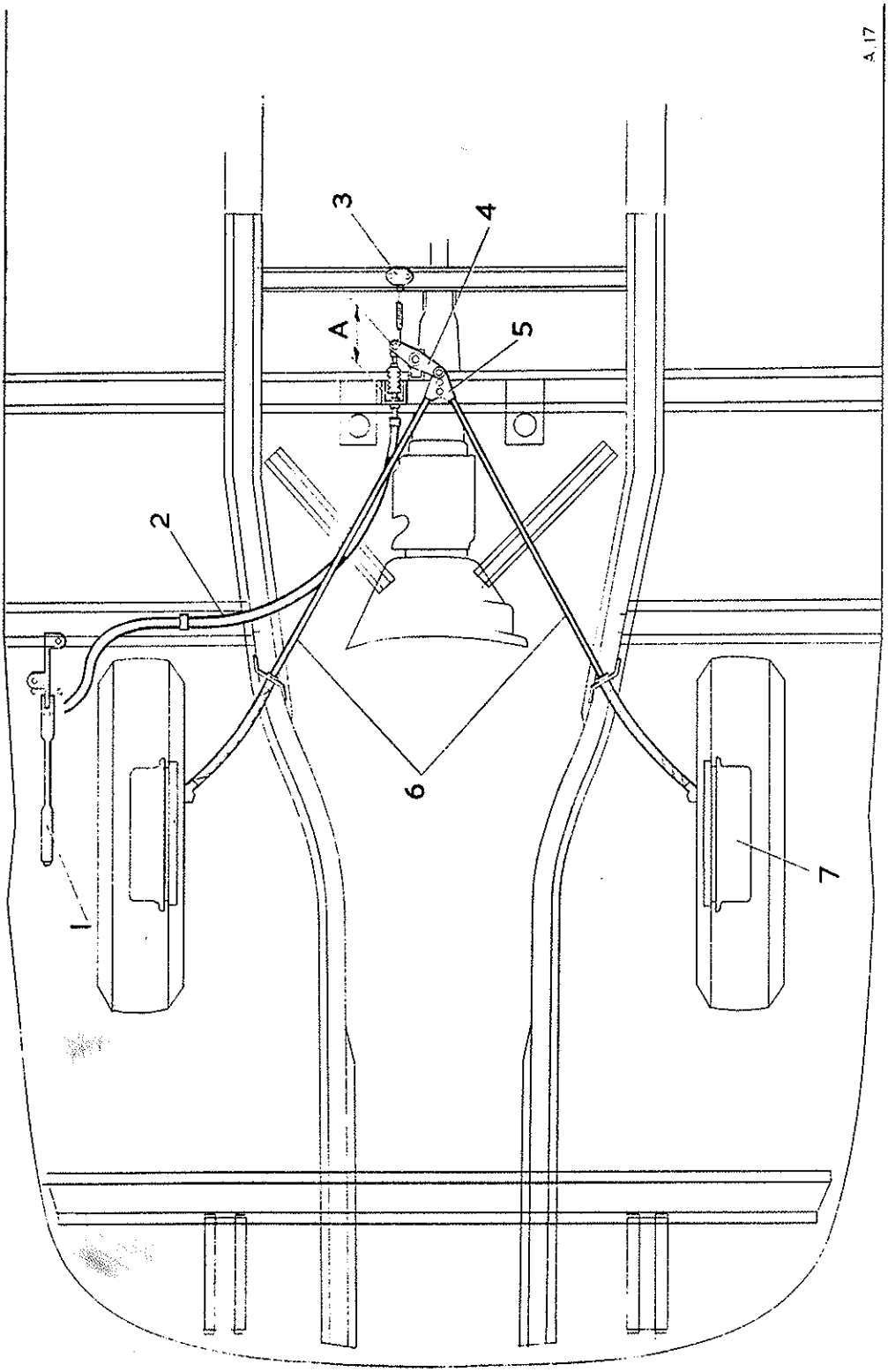
To Remove.

1. Place chocks behind the rear wheels, release the handbrake and jack up the front of the vehicle until the wheels are clear of the ground.

2. Remove the wheels and brake drums.

3. Remove the split pin and clevis pin securing the equaliser to the relay lever noting from which of the three holes the pin is removed.

4. Release the nippled end of the inner cable from its location on the actuating lever within the brake assembly.



1 HANDBRAKE LEVER
2 HANDBRAKE CABLE
3 STOP LIGHT SWITCH
4 RELAY LEVER
5 EQUALISER
6 SECONDARY CABLE
7 FRONT BRAKE ASSEMBLY

DIMENSION A – 3·75/4·25 in. (95/108 mm.)

Fig. K.14. Front wheel handbrake arrangement

5. Remove the locknut securing the short outer cable to its bracket on the underframe and disengage the cable from the bracket.

6. Unscrew the outer cable from the brake backplate and withdraw the cable from the brake.

To Refit.

1. Pass the nippled end of the cable through the hole in the brake backplate and locate the nipple to the actuating lever.

2. Screw the outer cable into the backplate and secure the opposite end to the bracket on the underframe by means of the locknut.

3. Having attached the cable at both wheels refit the equaliser to the relay lever and secure by means of the clevis pin, washer and split pin.

HANDBRAKE RELAY LEVER AND BRACKET

To Remove and Refit.

Disconnect the handbrake and secondary cables from the relay lever, also the spring which operates the handbrake stop light switch.

Release the setbolts securing the relay lever support bracket to the underframe crossmember and withdraw the bracket complete with relay lever.

Refitting is a reversal of the removal procedure.

SERVICE BULLETINS

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WHEELS AND TYRES

SECTION L

INDEX

WHEELS AND TYRES

MAINTENANCE

Routine maintenance of wheels and tyres, as detailed in the "MAINTENANCE HANDBOOK", consists of the following:

(*a*) Checking tyre pressures.

(*b*) Repositioning of wheels.

(*c*) Checking wheel tightness.

(*d*) Inspection for damage or abnormal wear.

Tyre Pressures.

Incorrect pressures cause excessive tyre wear, poor steering and ride characteristics, and can impair road holding. Pressures should be checked when the tyre is *cold* otherwise incorrect high pressures will be indicated.

Repositioning.

Repositioning is recommended in order to equalise tyre wear.

Diagonal interchanging provides a satisfactory first change as this reverses the direction of rotation for each wheel. Subsequent changes should be governed by the appearance of the tyre with the object of keeping wear uniform. Fig. L.1 illustrates two methods of interchanging.

Any sign of abnormal or excessive wear must be investigated and rectified. See "TYRE FAULT DIAGNOSIS".

Inspection.

Examine the tyres regularly for damage paying particular attention to tread damage, damage to the walls caused by scuffing against kerbs, and also, remove any objects which are imbedded in the tyres. Damage to the walls of the tyre should be dealt with immediately.

Wheel Nuts.

Whenever a wheel is removed and replaced ensure that the nuts are fitted correctly and fully tightened. Progressively tighten the nuts by diagonal selection thus ensuring that the wheel will centre itself correctly and prevent distortion.

When removing wheel nuts, slacken them slightly before lifting the wheel from the ground and completing the operation. Conversely, when refitting the nuts, tighten lightly before lowering the wheel to the ground then continue the tightening operation previously described.

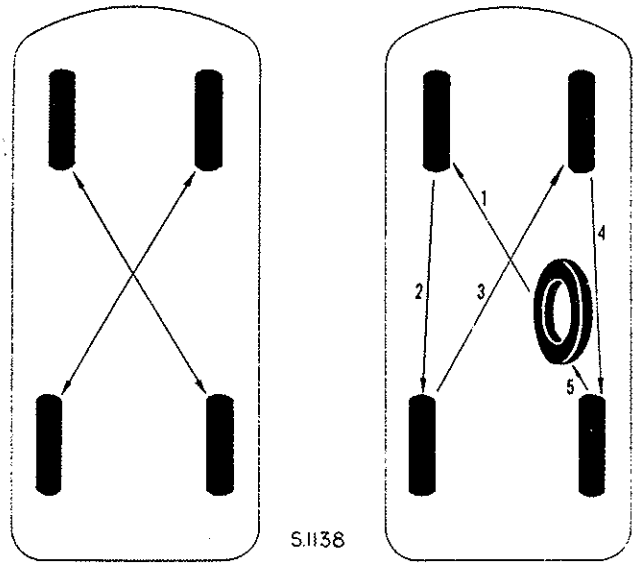

Fig. L.1

REPLACEMENT TYRES

When fitting replacement tyres it is recommended that tyres of a similar specification are fitted.

New tyres require a period of use to become flexible and speeds should be moderated for the first 100 miles (150 km.).

IMPORTANT: In the interest of safety, it is recommended that whenever a new tubeless tyre is fitted, a new snap-in valve is also fitted. This will ensure that the air seal at the rim hole is maintained throughout the life of the tyre.

TYRE FAULT DIAGNOSIS

Symptom	*Cause*	*Cure*
Rasped appearance—feather edges.	Misalignment or bent track rod.	Regular tyre inspection will quickly reveal this type of wear. Wheel alignment and steering layout should be checked.
Rapid wear on shoulders.	Under-inflation or overloading conditions which cause the centre of the tread to buckle inwards, resulting in excessive loading and consequently in more rapid wear of the outer ribs of tread pattern.	Ensure that tyres are inflated to correct pressures; avoid overloading.
Rapid wear in centre of tread.	Over-inflation reduces road contact area and concentrates the load on a small area in the centre of the tread which consequently wears very rapidly.	Ensure tyres are inflated to correct pressures.
Worn or polished circumferentially on inner sidewall of twins sometimes with fabric exposed.	Twins touching in service.	Check the tyre pressures. Check for correct wheel offset and oversized tyres.
Scuffing or kerbing damage-buttress or sidewall rubber worn away.	Driving up against kerbs, loading bays, etc.; backing into narrow opening or manoeuvring in confined areas.	Keep clear of kerbs, etc. Tyres showing signs of wear should be changed to alternative positions or reversed on their rims.
Rubber gouged away, or circumferential groove.	Projecting object fouling tyre; sometimes caused by settled springs or misaligned axle.	Remove the cause—inspect tyres frequently.
Scooped or irregular wear.	Faulty or loose wheel bearings, worn bushes or swivel pins.	As soon as irregular wear is observed a mechanical check should be made including wheel alignment. This type of wear usually occurs on front wheels—change damaged tyre to rear position.
Excessive localised wear in one area.	Ovality of brake drum, or high spot on drum causing wheel to be braked continuously in same position—badly adjusted unequalised brakes.	Check tyres regularly and ensure that brakes are operating correctly. Tyres can often be repaired providing the damage is not extensive.
Deflation damage—partial or complete collapse of sidewalls and general break-up of the tyre casing.	Driving on a totally deflated tyre, or long distances on a tyre holding only a few lbs. pressure.	Stop the vehicle immediately a deflated tyre is experienced—fit spare wheel and tyre.

Symptom	*Cause*	*Cure*
Concussion burst diagonal, or star fracture or double concussion fracture low on the wall due to "rim crush".	Tyre striking hard, or projecting object—more liable to occur when a tyre is over-inflated. When a tyre is under-inflated it is possible for the sidewall to be nipped between the rim of the wheel and the kerb resulting in "rim crush".	Maintain recommended pressures. Avoid kerbing and overloading. This type of failure often occurs some time after the impact blow was sustained.

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ELECTRICAL EQUIPMENT

SECTION N

INDEX

SWITCHES

INSTRUMENTS AND GAUGES

ACCESSORIES

ELECTRICAL EQUIPMENT

BATTERY

DESCRIPTION

The battery is of a 12 volt type having an ampere-hour capacity at a 10 hour rate of 38 (51 export). It has 7 plates per cell (9 plates export) and has the intercell connections located below a moulded one piece lid pierced at intervals to permit the use of a heavy discharge tester. The separators are of the dry type and have no diluting effect on the filling-in solution.

It is mounted in a tray situated on the front wheel box behind the driver's seat. The negative terminal is earthed to the bottom of the battery tray.

Important Notes.

1. The vehicle battery **must be disconnected** if either of the following operations are carried out on the vehicle:

(*a*) Electric Arc Welding.

(*b*) Boost Charging.

Failure to comply with this instruction will result in damage to semi-conductor devices, e.g. transistors, rectifiers, diodes etc., due to the high voltage and current values exceeding the rating of these devices.

2. The battery cables must be correctly connected i.e. Positive to Positive terminal, Negative to Negative terminal, otherwise permanent damage will occur.

3. Should it become necessary to use a slave battery to aid starting, always ensure that the jumper leads are connected positive to positive and negative to negative.

4. When using a fast-charger to start the engine it is essential that the 4TR control unit is disconnected from the circuit before starting. This is done by withdrawing the three-way connector from the control unit.

5. Never disconnect the battery whilst the engine is running.

To Remove.

1. Remove the two sleeved screws securing the battery lid and take off the lid.

2. Disconnect both battery cables at their terminals.

3. Unscrew the two battery frame securing nuts and take off the frame.

4. Lift out the battery.

Inspection and Overhaul.

1. Remove the vent plugs from the cells and examine the level of the electrolyte. The correct level is to the top of the separator guard. When necessary, add distilled water until this level is reached.

Distilled water must always be used for topping up whenever possible. In an emergency however, drinking water, clean rain water or melted snow may be used. Waters which must **not** be used include, sea or salt water, chlorinated water, chemically softened water or impure water.

If the battery is found to need an excessive amount of topping up the regulator setting should be checked to ensure that the charge rate is not too high. If one cell in particular requires frequent topping up the container should be examined for cracks.

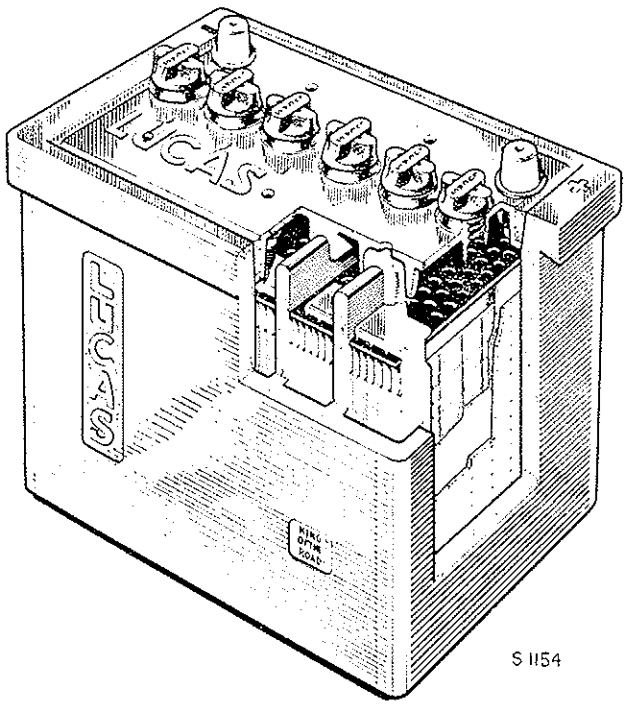


Fig. N.1. Sectioned view of battery

The use of a Lucas Battery Filler will be found helpful in topping up as it ensures that the correct electrolyte level is obtained automatically and also avoids over spill (see Fig. N.2).

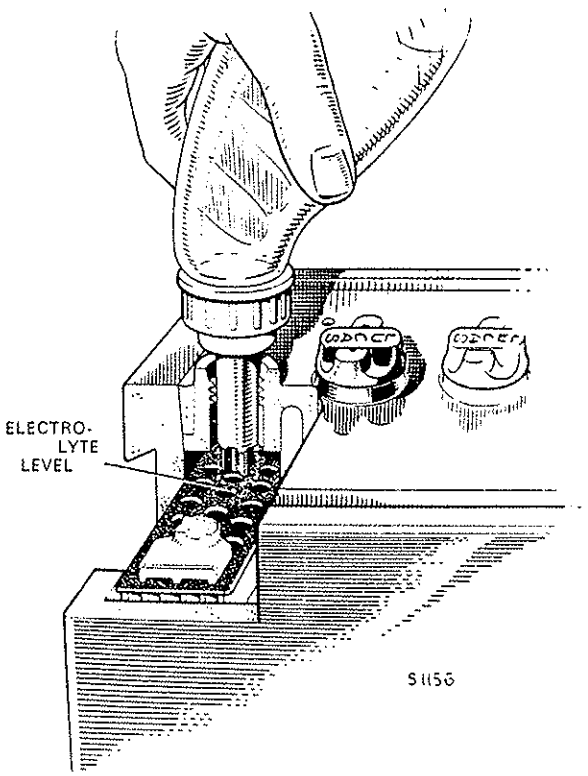


Fig. N.2. Topping-up, using Lucas battery filler

Note: (*a*) **Caution.** Do not hold a naked light near the vent holes when examining the cells, as there is danger of igniting the gas coming from the plates.

(*b*) Use a funnel when adding the distilled water, to minimise the risk of spilling it on to the top of the battery.

2. Ensure the air passages in the vent plugs are clear of obstruction.

3. Check the specific gravity of each cell with the aid of a hydrometer. The specific gravity readings and their indications are given under "GENERAL DATA".

The readings for each cell 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, has leaked from one of the cells or there may be an internal fault. **Never transfer the electrolyte from one cell to another.**

Examine the condition of the electrolyte in the hydrometer; it should be fairly clear; if very dirty the plates may be in bad condition.

4. Never leave the battery in a discharged condition for any length of time. To re-charge from an external source, charge at the appropriate recharge current given under "GENERAL DATA". The charge must be continued until voltage and specific gravity show no increase for three successive hourly readings. This period is usually about twelve hours for a battery which has previously been discharged, to return it to its normal capacity.

5. Clean the top of the battery.

6. Examine the battery generally for cracks.

7. Examine the battery support for weakness, especially if the electrolyte has been leaking.

8. Inspect the battery cable terminal posts. If corroded, clean and smear both the posts and the terminals with petroleum jelly.

9. Examine the earth connection to ensure that it is clean and free from rust or corrosion.

Note: If the vehicle is out of use for any length of time the battery should not be allowed to run down or to remain in a discharged condition. It should be re-charged about every two weeks from an independent supply.

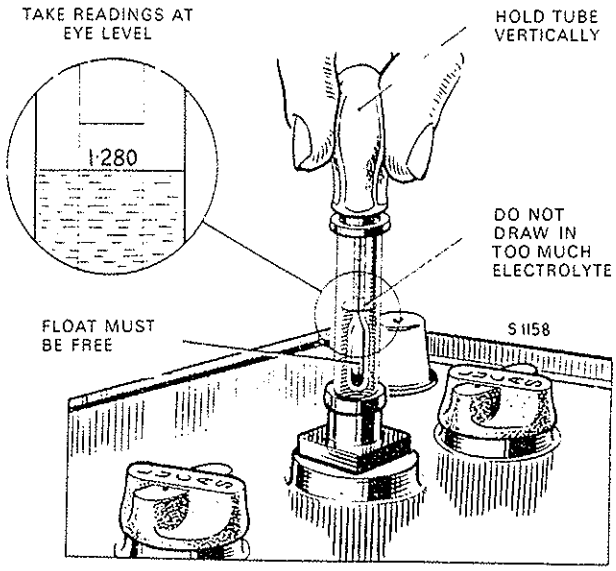


Fig. N.3. Taking hydrometer readings

Preparing a New Battery.

Batteries are normally supplied dry and uncharged to the home market and dry-charged to overseas markets. The difference lies in the fact that the latter

are dry-charged and sealed before leaving the factory, and when required for service it is only necessary to fill each cell with electrolyte of the correct specific gravity.

1. To Prepare the Electrolyte. The specific gravity of the electrolyte necessary to fill a new battery is given under "GENERAL DATA". The electrolyte is prepared by mixing distilled water and concentrated sulphuric acid in the proportions given. The mixing must be carried out in a lead lined tank or a glass or earthenware vessel. 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 cause violent and dangerous spurting of the concentrated acid.

Heat is produced by the mixture of acid and water. Allow the mixture to cool therefore before pouring it into the battery.

2. Uncharged Batteries. The temperature of the filling-in acid, battery and charging room should be above 0°C. (32°F.). Carefully break the seals in the filling holes and half fill each cell in the battery with electrolyte. The quantity of electrolyte to half fill each cell is given under "GENERAL DATA".

Chemical reaction will take place between the dilute acid and the plate, causing heat to be generated. The battery must therefore be allowed to stand for at least six hours before further electrolyte is added, so as to allow the heat generated by the first filling to be dissipated, thereby avoiding an excessive temperature rise, which would cause damage to the plates and container. After this period add enough electrolyte to fill each cell to the top surface of the separator guard. Allow to stand for a further two hours and then proceed with the initial charge. The initial charge current is given under "GENERAL DATA". Charge at this constant current until voltage and temperature-corrected specific gravity readings, show no increase over five successive hourly readings, noting the following:

(*a*) Throughout the charge the acid must be kept level with the top of the separator guard in each cell by the addition of acid solution of the same specific gravity as the original filling-in acid.

(*b*) If during the charge the temperature of the acid in any cell of the battery reaches the maximum permissible temperature (see "GENERAL DATA") the charge must be interrupted and the battery temperature allowed to fall at least 6°C. (10°F.) before charging is resumed.

(*c*) At the end of the first charge carefully check the specific gravity in each cell to ensure that it lies within the limits specified. If any cell requires adjustment, some electrolyte must be syphoned off, and replaced with either acid 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. Finally syphon off any electrolyte above the top of the separator guard.

3. Dry-charged Batteries. With the battery and acid at a temperature of between 15·5°C. (60°F.) and 38°C. (100°F.) fill each cell, in one operation, with the correct strength of acid. After 20 minutes the S.G. should be rechecked. If the temperature has not risen more than 5·5°C. (10°F.) and the S.G. has not fallen more than 10 points, the battery is ready for service.

In the event of these limits being exceeded the battery must be recharged at the normal rate.

To Refit.

Replace in a reverse manner to that used for removal, smearing the battery posts and the cable terminals with petroleum jelly.

ALTERNATOR

DESCRIPTION

The alternator is shown dismantled in Fig. N.4.

The stator comprises a 24-slot, 3-phase star-connected output winding on a ring-shaped lamination pack, housed between the slip-ring end and drive end brackets. The rotor is of 8-pole construction and carries a slip-ring fed field winding. It is supported by a ball-bearing in the slip-ring end bracket.

The brush gear for the field system is mounted on the slip-ring end bracket. Two carbon brushes bear against a pair of concentric brass slip-rings carried on a moulded disc attached to the end of the rotor.

The slip-ring end bracket also carries six silicon diodes connected in a 3-phase bridge circuit to give rectification of the generated A.C. output (see Fig. N.5).

The diodes and stator windings are cooled by air-flow through the alternator induced by a ventilating fan at the drive end.

A red-coloured plastic strip is attached to the output terminal to denote that the machine is to be employed on the negative earth system only.

OUTPUT CONTROL

The alternator output is controlled by an electronic voltage regulator unit, Type 4TR.

FIELD ISOLATING DEVICE

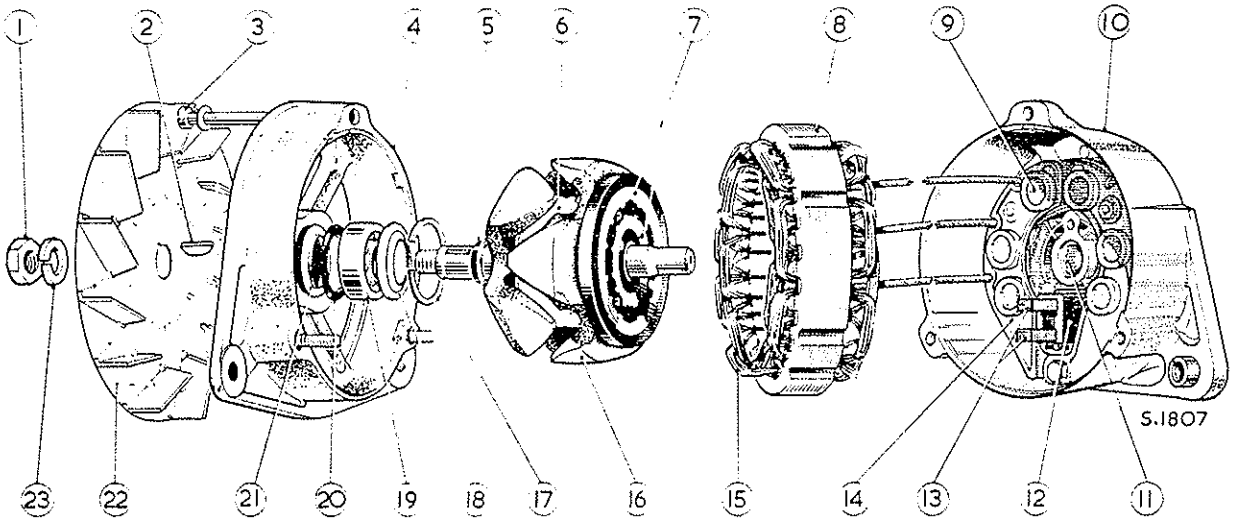
The voltage regulator and the alternator field windings are isolated from the battery when the engine is stationary. A 6 RA relay is used for this purpose and the normally open pair of contacts are connected in series with the field winding, the relay operating coil being energised when the starter/ auxiliary switch is turned to the "ON" position.

2. Start the engine and check that battery voltage is being applied to the rotor winding by connecting a voltmeter between the cable ends normally attached to the field terminals. Stop the engine.

3. Disconnect the battery earth cable.

4. Disconnect the cable from the alternator output terminal and connect a good-quality moving-coil ammeter of appropriate range between the output terminal and the disconnected cable.

5. Withdraw the cables from the alternator field terminals and, using a suitable pair of auxiliary cables, connect these terminals directly to the battery. For this test polarity matching is unimportant.



1 SHAFT NUT
2 KEY
3 THROUGH BOLTS
4 DRIVE END BRACKET
5 JUMP RING SHROUD
6 ROTOR (FIELD) WINDING
7 SLIP RINGS
8 STATOR LAMINATIONS
9 DIODE
10 SLIP-RING END BRACKET
11 NEEDLE ROLLER BEARING
12 BRUSH BOX
13 BRUSHES
14 DIODE HEAT SINK
15 STATOR WINDING
16 ROTOR
17 CIRCLIP
18 BEARING RETAINING PLATE
19 BEARING
20 "O" RING
21 "O" RING RETAINING WASHER
22 FAN
23 SPRING WASHER

Fig. N.4. Alternator, dismantled

WARNING LIGHT UNIT

A terminal marked "AL" is provided for use with the 3 AW warning light control.

LUBRICATION

The bearings are packed with grease during assembly and do not require periodic attention.

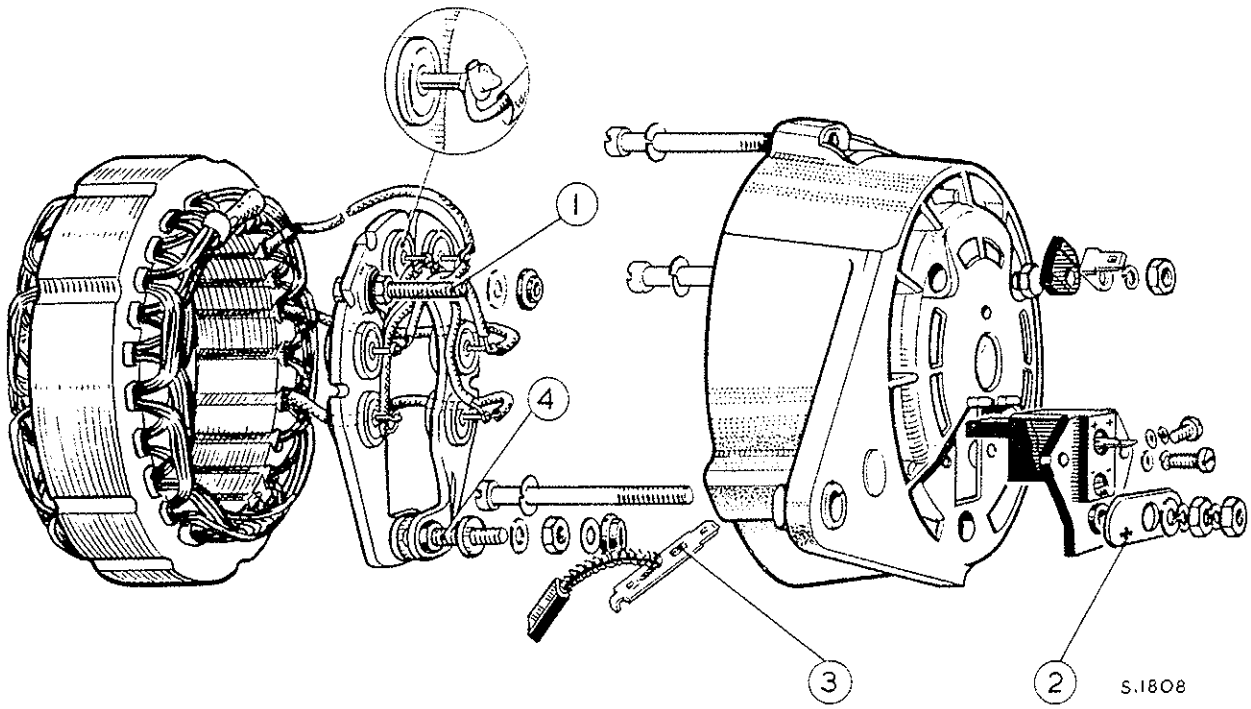
TO TEST THE ALTERNATOR IN POSITION ON THE VEHICLE

1. Check the fan belt tension as detailed in "COOLING SYSTEM".

Fig. N.6 shows the alternator output circuit.

6. Re-connect the battery earth lead. Start the engine and slowly open the throttle until the alternator speed is approximately 4,000 r.p.m. At this speed the ammeter reading should be approximately 32 amperes. If a zero reading results, stop the engine and disconnect the cables from the field terminals. Withdraw the two brush-box moulding retaining screws and remove the brushgear as detailed under "INSPECTION OF BRUSHGEAR" in this section.

Fit new brush and spring assemblies if necessary and re-test the alternator output. If the zero reading persists, the alternator must be removed from the engine and dismantled for a thorough inspection as detailed under "DISMANTLING THE ALTERNATOR" in this section.



1 WARNING LIGHT TERMINAL "AL"
2 OUTPUT TERMINAL PLASTIC STRIP
3 TERMINAL BLADE RETAINING TONGUE
4 OUTPUT TERMINAL

Fig. N.5. Slip-ring end, showing heat sinks withdrawn

A low output current reading will indicate either a faulty alternator or poor circuit wiring connections. Check the latter while keeping the alternator connected and running as previously detailed; connect a good quality voltmeter, of low range if available—between the alternator output terminal and the battery insulated terminal (see Fig.N.7) and note the voltmeter reading.

Now transfer the meter connections to the alternator frame and battery earth terminal (see Fig. N.8). and again note the reading.

If either of these readings exceed 0·5 volts there is high resistance in the charging circuit which must be traced and remedied.

If, however, these tests show that there is no undue resistance in the charging circuit (although the alternator output is low) proceed to dismantle the alternator as detailed in this section.

DISMANTLING THE ALTERNATOR

1. Disconnect the battery and alternator cables and remove the alternator from the vehicle.

2. From the drive end remove the shaft nut, spring washer and pulley.

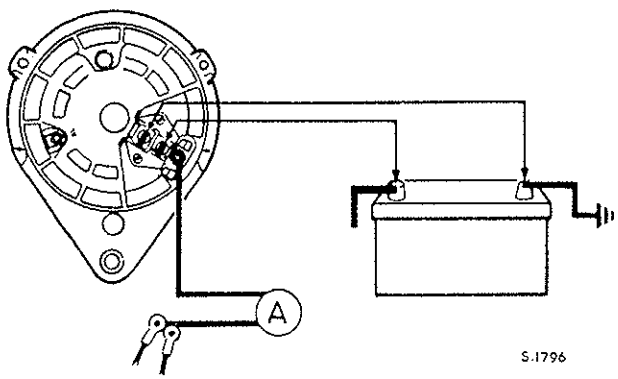


Fig. N.6. Alternator output test-wiring connections

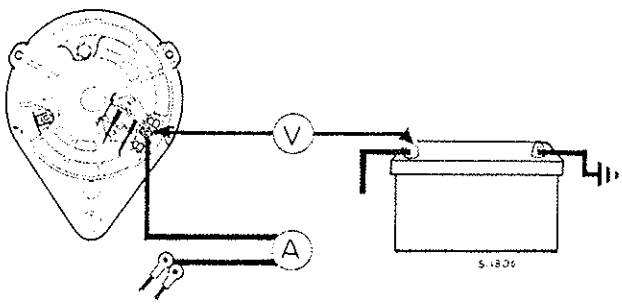


Fig. N.7. Charging circuit voltage drop test (insulated side)

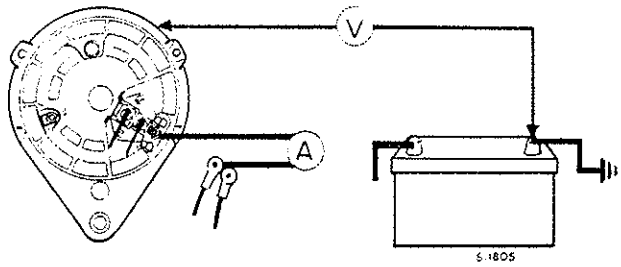


Fig. N.8. Charging circuit voltage drop test (earth side)

3. Unscrew and withdraw the three through bolts.

4. Identify the drive end bracket, lamination pack and slip-ring end bracket so that they may be re-assembled in the correct angular relation to each other.

5. Withdraw the drive end bracket and rotor from the stator. The drive end bracket and rotor need not be separated unless the drive end bearing requires examination or the rotor is to be replaced. In this event the rotor should be removed from the drive end bracket by means of a hand press, having first removed the shaft key and bearing collar.

6. From the slip-ring end bracket remove the terminal nuts, washers, insulating pieces, brushbox, screws and the 2 B.A. hexagon-headed bolt. Take care not to misplace the two washers fitted between the brushbox moulding and the end bracket.

7. Withdraw the stator and heat sink assemblies from the slip-ring end bracket.

8. Close up the retaining tongue at the root of each field terminal blade and withdraw the brush spring and terminal assemblies from the moulded brushbox.

INSPECTION OF BRUSHGEAR

1. Measure the brush length. A new brush is $\frac{5}{16}$ in. (15·9 mm.) long; a fully worn brush is $\frac{5}{32}$ in. (4 mm.) long and must be replaced at, or approaching, this length. The new brush is supplied complete with brush spring and "Lucar" terminal blade and has merely to be pushed in until the tongue registers. To ensure that the terminal is properly retained, carefully lever up the retaining tongue so that the tongue makes an angle of about 30° with the terminal blade.

2. The normal brush spring pressures are 4/5 oz. (113/142 grm.) with the spring compressed to $\frac{13}{32}$ in. (10·3 mm.) in length.

3. Check that the brushes move freely in their holders. If at all sluggish, clean the brush sides with a petrol-moistened cloth or, if this fails to effect a cure, lightly polish the brush sides on a smooth file.

Note: The brush which bears on the inner slip-ring is always associated with the positive pole of the electrical system, since the lower linear speed of the inner ring results in reduced mechanical wear and helps to offset the higher rate of electrical wear peculiar to the positive-connected brush.

INSPECTION OF SLIP RINGS

The surfaces of the slip-rings should be smooth and uncontaminated by oil or other foreign matter. Clean the surface using a petrol-moistened cloth, or if there is any evidence of burning, very fine glass-paper. On no account must emery cloth or similar abrasives be used. No attempt should be made to machine the slip-rings as any eccentricity in the machining may adversely affect the high-speed performance of the alternator. The small current carried by the rotor winding and the unbroken surface of the slip-rings mean that the likelihood of scored or pitted slip-rings is almost negligible.

ROTOR

1. Test the rotor by connecting either an ohmeter (see Fig. N.9) or the appropriate battery supply (see Fig. N.10) between the slip-rings.

The reading of resistance should be as given in "GENERAL DATA". If the alternative tests have been made, the value of the current should be approximately 3·4 amperes.

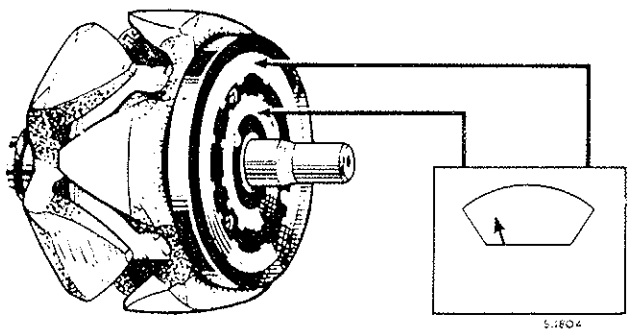


Fig. N.9. Measuring rotor winding resistance with ohmeter

2. Test for defective insulation between one of the slip-rings and one of the rotor poles using a 110 volt A.C. mains supply and a 15 watt test lamp (see Fig. N.11). If the lamp lights, the coil is earthing and a replacement rotor/slip-ring assembly must be fitted.

3. No attempt should be made to machine the rotor poles or to true a distorted shaft.

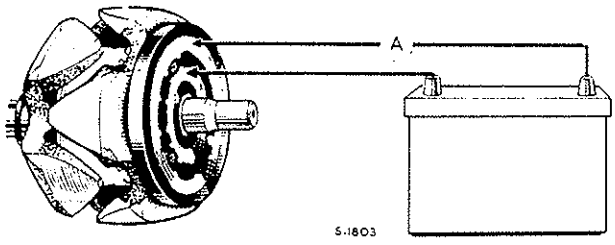


Fig. N.10. Measuring rotor winding resistance with battery and ammeter

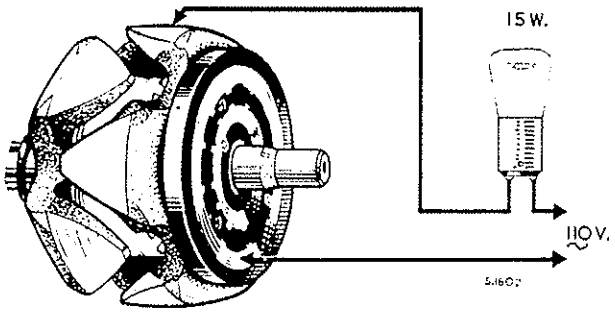


Fig. N.11. Insulation test of rotor winding

STATOR

1. Unsolder the three stator cables from the heat sink assembly, taking care not to overheat the diodes (see "ALTERNATOR DIODE HEAT SINK REPLACEMENT" in this section). Check the continuity of the stator windings by first connecting any two of the three stator cables in series with a 1·5 watt test lamp

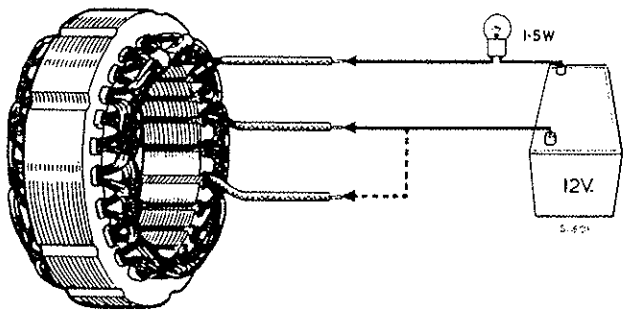


Fig. N.12. Stator winding continuity test

and a 12 volt battery as shown in Fig. N.12. Repeat the test, replacing one of the two cables by the third cable. Failure of the test lamp to light on either occasion means that part of the stator winding is open-circuit and a replacement stator must be fitted.

2. Test for defective insulation between stator coils and lamination pack with the mains test lamp (see Fig. N.13). Connect the test probes between any one of the three cable ends and the lamination pack. If the lamp lights, the stator coils are earthing and a replacement stator must be fitted.

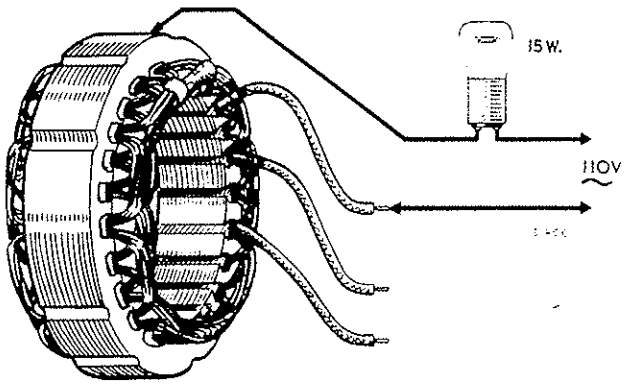


Fig. N.13. Stator winding insulation test

3. Before re-soldering the stator ends to the diode pins carry out the test under "DIODES" in this section.

DIODES

1. Each diode can be checked by connecting it in series with a 1·5 watt test bulb across a 12 volt D.C. supply and then reversing the connections (see Fig. N.14).

Current should flow, and the bulb light, in one direction only. Should the bulb light up in both tests or not light up in either, the diode is defective and the appropriate heat sink assembly must be replaced.

This procedure is adequate for service purposes. Any accurate measurement of diode resistance requires factory equipment. Since the forward resistance of a diode varies with the voltage applied,

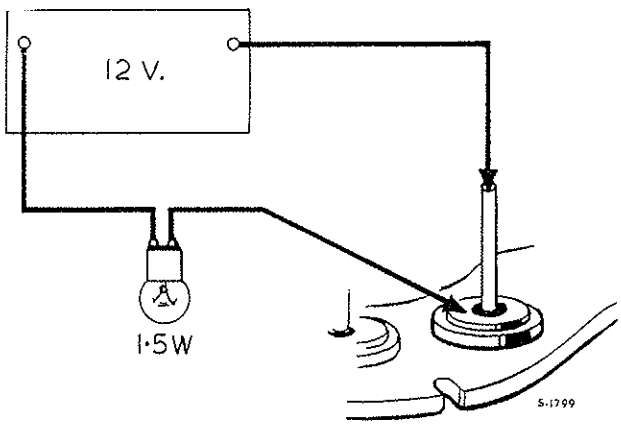


Fig. N.14. Simple diode test

no realistic readings can be obtained with battery-powered ohmeters. However, should a battery-ohmeter be used, a good diode will yield "Infinity" in one direction and some indefinite but much lower reading in the other.

Warning: Ohmeters of the type incorporating a hand-driven generator must never be used for checking diodes.

ALTERNATOR DIODE HEAT SINK REPLACEMENT

1. The alternator heat sink assembly consists of two parts, one of positive polarity and the other negative (see Fig. N.15). The positive portion carries three cathode base diodes marked red, and the negative portion three anode base diodes marked black. The diodes are not individually replaceable, but, for service purposes, are supplied already pressed into the appropriate heat sink portion.

2. When soldering the interconnections, "M" grade 45–55 tin-lead solder should be used.

3. Great care must be taken to avoid overheating the diodes or bending the diode pins. The diode pins should be lightly gripped with a pair of suitable long-nosed pliers (which act as a thermal shunt) and soldering must be carried out as quickly as possible.

4. After soldering, the connections must be neatly arranged around the heat sinks, to ensure adequate clearance for the rotor, and be tacked down with "MMM" EC1022 adhesive where indicated in Fig. N.16. The stator connections must pass through the appropriate notches at the edge of the heat sink.

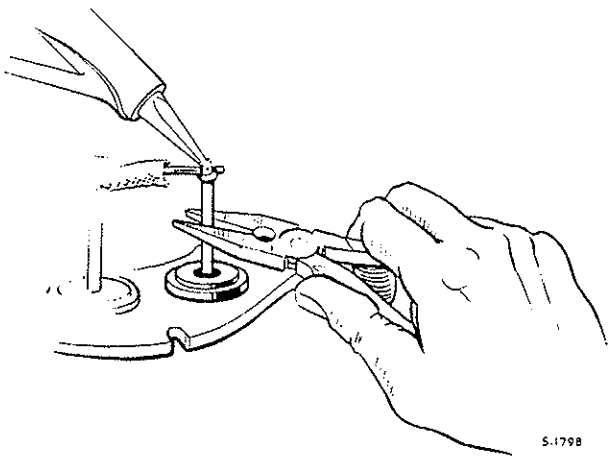


Fig. N.15. Use of thermal shunt when soldering diode connections

BEARINGS

1. Bearings which are worn to the extent that they allow excessive side movement of the rotor shaft must be renewed.

2. The needle-roller bearing in the slip-ring end bracket is not serviced separately. In the unlikely event of this bearing becoming unserviceable a complete end bracket assembly must be fitted.

3. The drive end ball-bearing retaining plate is secured either by screws, rivets or a circlip.

To release a riveted or screw-retained bearing plate file away the rivet heads and punch out the rivets or withdraw the screws, as applicable.

To release a circlip-retained bearing plate insert the tip of a screwdriver in the extractor notch and prise free the circlip.

Press the bearing out of the bracket, noting the order of assembly of the pressure ring and plate where these are fitted.

Before fitting the replacement bearing ensure that it is clean and if necessary, pack it with Shell Alvania No. 3 grease.

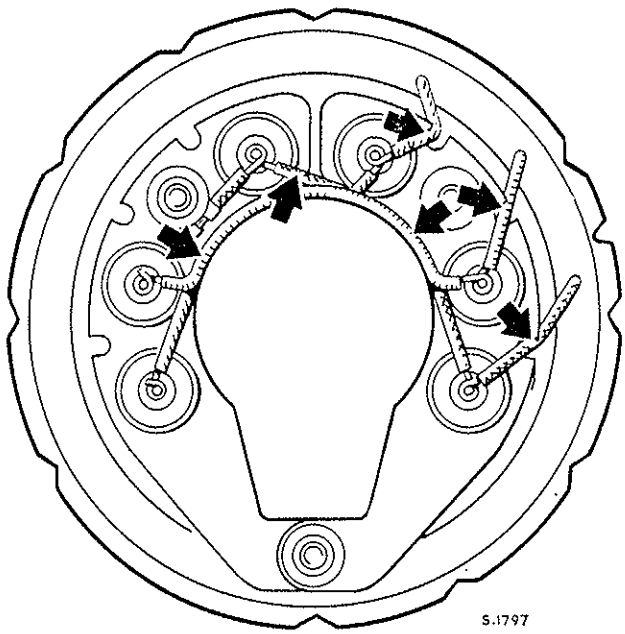


Fig. N.16. Heat sink cable securing points

Locate the bearing in the housing and press it home.

When refitting a circlip-retained bearing use a hand press to compress the assembly enough to allow the circlip to re-locate itself.

Refit new screws or rivets as necessary.

RE-ASSEMBLING THE ALTERNATOR

Re-assembly of the alternator is a reversal of the dismantling procedure detailed in this section, noting the following:

1. Carefully observe the tightening torque given under "GENERAL DATA".

2. Correctly align the drive end bracket, lamination pack and slip-ring end bracket.

3. Tighten the three through bolts evenly.

4. If the rotor and drive end bracket have been separated, the inner journal of the drive end bearing must be supported by a suitably-dimensioned tube for the re-assembling operation.

5. Do not use the drive end bracket as a support for the bearing while fitting the rotor.

ALTERNATOR OUTPUT CONTROL UNIT MODEL 4 TR

DESCRIPTION

This is an electronic control unit. In effect its action is similar to that of the vibrating contact type of voltage control unit, but switching of the field circuit is achieved by transistors instead of vibrating contacts, while a Zener diode provides the voltage reference in place of the voltage coil and tension spring system. No cut-out is required since the diodes incorporated in the alternator prevent reverse currents from flowing. No current regulator is required as the inherent self-regulating properties of the alternator limit the output current to a safe value.

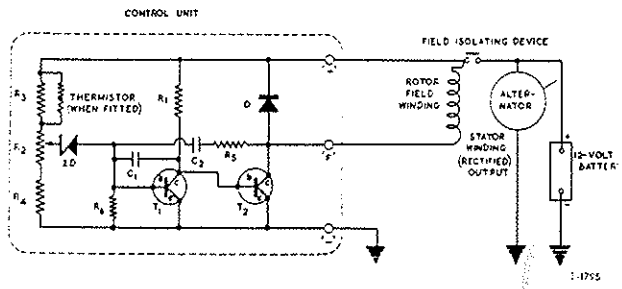


Fig. N.17. 4TR control unit—internal and external circuit

The control unit and the alternator field windings are isolated from the battery when the engine is stationary by means of an isolating relay.

A temperature compensation device is fitted. This takes the form of a thermistor connected in parallel with one of the Zener-basing resistors. The thermistor is a device whose resistance increases as the temperature falls and vice versa. Any alteration in its ohmic valve will cause the Zener diode to begin to conduct at a modified value of alternator output voltage, so matching the changes which take place in "on charge" battery terminal voltage due to temperature change.

Warning: The battery must never be disconnected while the alternator is running. Failure to observe this ruling will cause the control unit to be irreparably damaged.

Care must be taken at all times to ensure that the battery, alternator and control unit are correctly connected. Reversed connections will damage the semi-conductor devices employed in the alternator and control unit.

CHECKING AND ADJUSTMENT

Before checking and adjusting the control unit it must be established that the alternator and the charging circuit wiring are in good order. Check also the battery to control unit wiring which incorporates the field isolating device. To ensure proper working of the control unit, the resistance of this complete circuit—including the isolating device—must not exceed 0·1 ohm. Any unduly high resistance must be traced and remedied.

To Check

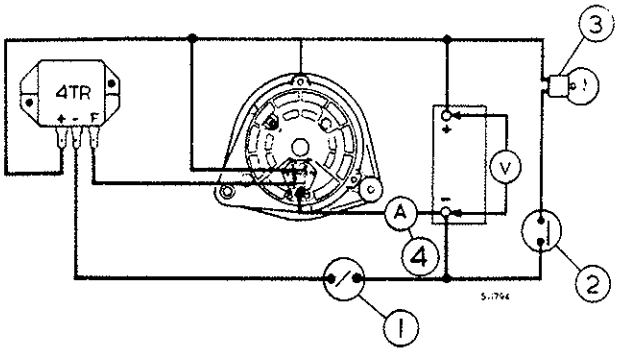
1. Leave the existing connections to the alternator and control unit undisturbed. Connect a voltmeter of 1% or better accuracy and appropriate range between the battery terminals and note the reading with all electrical equipment switched off. If available, use a voltmeter of the suppressed-zero type, reading 12/15 volts.

2. Fit an ammeter of suitable range in series with the alternator main output cable.

3. Switch on an electrical load of approximately 2 amperes, e.g. side and tail lighting. The test circuit is shown in Fig. N.18.

4. Start the engine and run the alternator at approximately 3,000 r.p.m. for at least eight minutes. (This will ensure that the system voltage has stabilised.) If the charging current is still greater than 10 amperes, continue to run the engine until this figure is reached. The voltmeter should now give a reading of 13·9/14·3 volts.

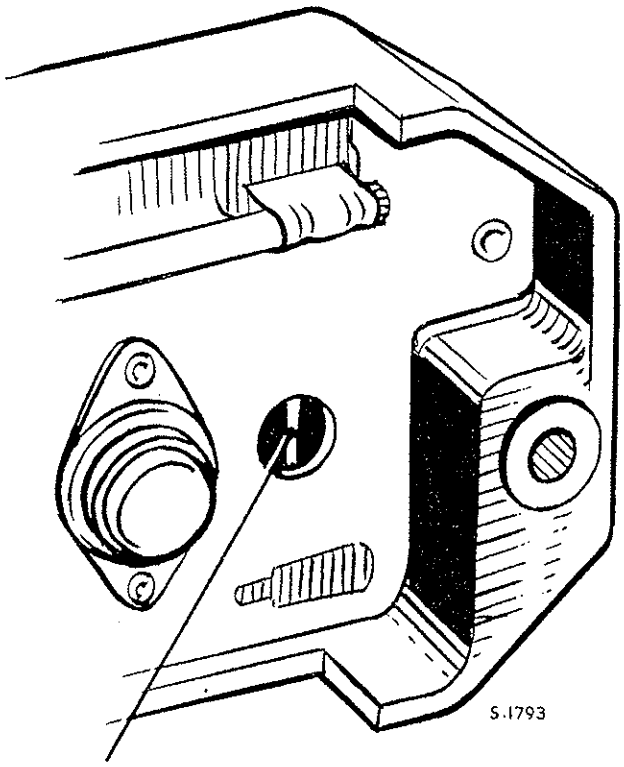
If the reading obtained is stable but outside these limits the unit can be adjusted to control at the correct voltage (see "**To Adjust**").



1 FIELD ISOLATING DEVICE
2 SIDE AND TAIL CIRCUIT SWITCH
3 SIDE AND TAIL LAMPS
4 AMMETER

Fig. N.18. 4TR control unit test circuit

If, however, the voltmeter reading remains unchanged (at open-circuit battery terminal voltage) or conversely, increases in an uncontrolled manner, then the control unit is faulty and a replacement unit must be fitted. Component parts are not serviced individually.



POTENTIOMETER ADJUSTER

Fig. N.19. Rear view of alternator control

To Adjust.

1. Stop the engine and withdraw the control unit mounting screws. Invert the unit and carefully scrape away the sealing compound which conceals the potentiometer adjuster (see Fig. N.19).

Check that the voltmeter is still firmly connected between the battery terminals.

2. Start the engine and while running the alternator at 3,000 r.p.m. turn the potentiometer adjuster slot, clockwise to increase the setting or anticlockwise to decrease the setting, until the required setting is obtained. Use care in making this adjustment, a small amount of adjuster movement causes an appreciable difference in the voltage reading.

3. Re-check the setting by first stopping the engine then again starting and running the alternator at 3,000 r.p.m.

4. Remount the control unit and disconnect the voltmeter.

ALTERNATOR FIELD ISOLATING RELAY MODEL 6 RA

General.

The purpose of the relay is to isolate the alternator field and output control unit when the starter/auxiliary switch is open. It carries a pair of normally open contacts, is actuated by a continuous rated winding and has four blade type terminals. The terminal markings are "C1", "C2", "W1" and "W2". Terminal "C1" is associated with the fixed contact post; "C2" with the moving contact; and "W1" and "W2" with the ends of the winding. The relay is protected with a metal case secured to the terminal base by gimping.

Maintenance.

Apart from an occasional inspection of the terminals and of the external wiring connections thereto, the relay requires no routine maintenance.

To Remove.

1. Disconnect the four leads at the blade terminals.

2. Remove the two tapping screws and lift the relay away.

Inspection and Overhaul.

1. As the relay has a permanently secured case, it should be replaced as a complete unit in the event of failure. However, where suitable facilities are available, the case can be removed for checking the contacts, mechanical settings or soldered connections.

The operating winding can, of course, be checked for continuity without removing the cover.

2. Adjusting Cut-in and Drop-off Voltages.

(*a*) The voltage required for the relay to cut-in is determined by the length of air gap between the

underside of the armature and bobbin core. The cut-in voltage is raised by increasing the gap, and lowered by decreasing it. The gap is adjusted by bending the armature stop plate with a suitably slotted tool.

(*b*) The drop-off voltage is determined by the pressure between contacts in the closed position. Adjustment is effected by bending the fixed contact post. Raising the height of the fixed contact post increases contact pressure and thus raises the drop-off voltage, while lowering the fixed contact reduces pressure and so lowers the drop-off voltage.

(*c*) A variable direct current supply of 0 to 15 volts is required for adjusting cut-in and drop-off settings, with a first grade moving coil 0–20 voltmeter connected across the relay operating winding.

(*d*) After adjustment cut-in settings should be checked by slowly raising the supply voltage from zero and drop-off settings by raising the voltage to 15 volts and then slowly reducing it to below the drop-off value.

(*e*) Before refitting the case ensure that the case, sealing gasket and relay assembly are clean.

(*f*) Place the sealing gasket in the case flange and insert the relay assembly.

(*g*) Press these components firmly together and secure at four points by crimping the case lip.

(*h*) Re-check cut-in and drop-off settings.

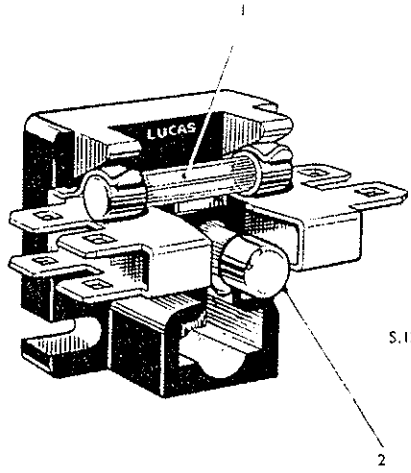
FUSE UNIT

LUCAS TYPE 5FJ

DESCRIPTION.

The fuse unit is mounted adjacent to the control box below the parcel shelf. It contains a single 35 ampere fuse bridging terminals "A3" and "A4" and protects the circuits of all accessories controlled by the ignition switch, e.g. stop lights, flashing indicators, fuel gauge, windscreen wipers, horn and heater (when fitted). A spare fuse is provided (see Fig. N.20).

Should a short circuit occur in the wiring circuit the fuse will blow. Before replacing the fuse however, the circuit should be examined carefully and the fault rectified.



1. FUSE (35 AMP.) PROTECTING: STOP LIGHTS, DIRECTION INDICATORS, SCREEN WIPERS, HORN, FUEL GAUGE, OIL PRESSURE, WARNING LIGHT, AND HEATER (WHEN FITTED)
2. SPARE UNIT

Fig. N.20. Fuse unit

STARTER MOTOR

LUCAS TYPE M35G-1

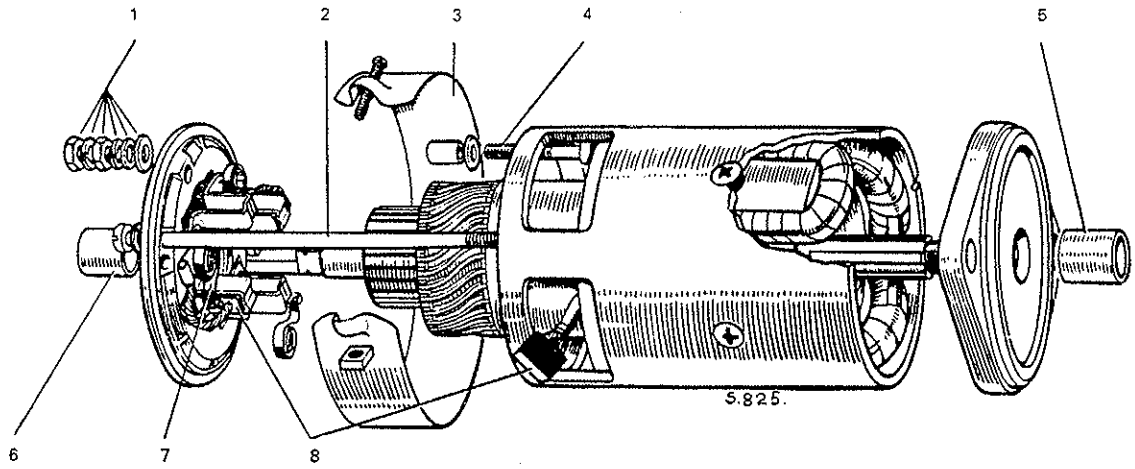
DESCRIPTION

The starter motor is a four pole, four brush machine having an extended shaft to carry the engagement gear or starter drive. The motor is of similar construction to a dynamo except that heavier gauge conductors are used in the armature and field coils, the latter being of aluminium strip.

The starter drive pinion is mounted on a screwed sleeve, which is carried on splines on the armature shaft. The sleeve is so arranged that it can move along the shaft against a compression spring to reduce the shock loading at the moment when engagement takes place.

OPERATION

When the starter switch is operated, the armature shaft and screwed sleeve rotate. The pinion is moved



1 TERMINAL NUTS AND WASHERS
2 THROUGH BOLT
3 COVER BAND
4 TERMINAL POST
5 BEARING BUSH (DRIVE END)
6 BEARING BUSH (COMMUTATOR END)
7 BRUSH SPRING
8 BRUSHES

Fig. N.21. Starter details

along the sleeve, due to inertia until it comes into engagement with the flywheel ring. The starter will then turn the engine.

As soon as the engine fires and starts to run under its own power, the flywheel will be driven faster by the engine than by the starter. This will cause the pinion to be screwed back along the sleeve so drawing the pinion out of mesh with the flywheel teeth. In this manner the drive safeguards the starter against damage due to being driven at high speeds.

A pinion restraining spring is incorporated in the drive. This spring prevents the pinion vibrating into mesh when the engine is running.

MAINTENANCE

Brushgear and Commutator.

The only maintenance normally required by the motor is the occasional checking of brushgear and commutator. About every 12,000 miles (20,000 km.) remove the metal band cover. Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If a brush is inclined to stick, remove it from its holder and clean its sides with a petrol-moistened cloth. Be careful to replace brushes in their original position in order to retain the "bedding". Bushes which have worn so that they will not "bed" properly on the commutator must be renewed.

The commutator should be clean, free from oil or dirt and should have a polished appearance. If it is dirty, clean it by pressing a fine dry cloth against it while the starter is turned by hand by means of a spanner applied to the squared extension of the shaft. If the commutator is very dirty, moisten the cloth with petrol.

Starter Drive.

If any difficulty is experienced with the starter motor not meshing correctly with the flywheel, it may be that the drive requires cleaning. The pinion should move freely on the screwed sleeve; if there is any dirt or other foreign matter on the sleeve it must be washed off with paraffin.

In the event of the pinion becoming jammed in mesh with the flywheel, it can usually be freed by

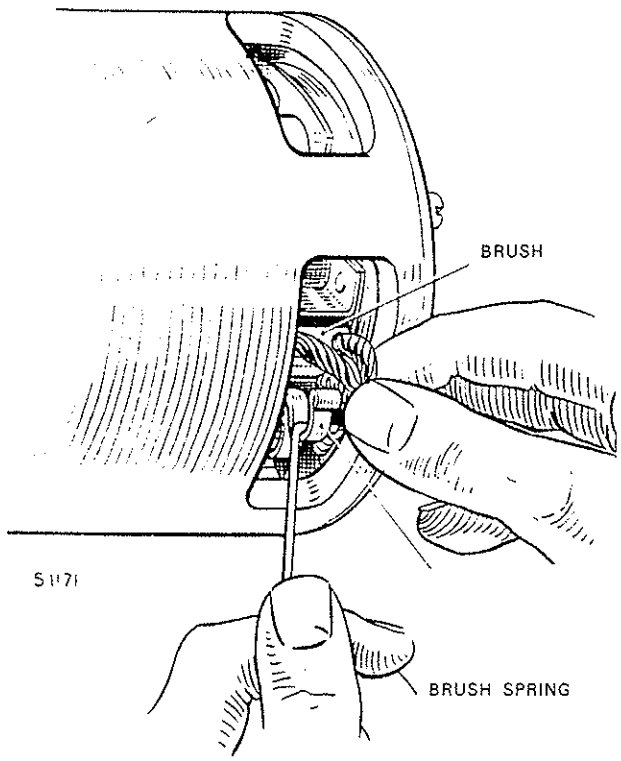


Fig. N.22. Checking the brush gear

turning the starter motor armature by means of a spanner applied to the shaft extension at the commutator end.

Testing in Position.

1. Switch on the lamps and operate the starter control. If the lights go dim, but the starter motor is not heard to operate, and indication is given that current is flowing through the starter motor windings, but that the armature is not rotating for some reason; possibly the pinion is meshed permanently with the geared ring on the flywheel. In this case the motor must be removed from the engine for examination.

2. Should the lamps retain their full brilliance when the starter switch is operated, check the circuit for continuity from battery to starter motor, via the starter switch, and examine the connections at these units. If the switch is found to be faulty, a new switch must be fitted. If the supply voltage is found to be applied to the motor when the switch is operated, an internal fault in the motor is indicated and the unit must be removed from the engine for examination.

3. Sluggish or slow action of the starter motor is usually caused by a poor connection in the wiring giving rise to a high resistance in the motor circuit. Check as described above.

4. If the motor is heard to operate, but does not crank the engine, indication is given of damage to the drive.

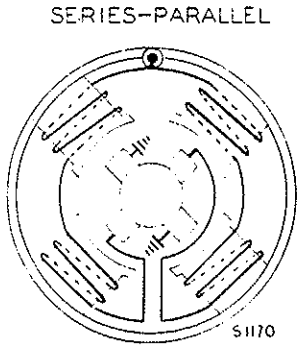


Fig. N.23. Starter motor internal circuit

To Remove.

If it is necessary to remove the motor from the engine, first proceed as follows:

1. Disconnect the cable from the negative battery terminal to avoid any danger of causing short circuits.

2. Disconnect the heavy cable from the starter motor.

3. Release the securing bolts and carefully withdraw the starter motor from beneath the vehicle.

Bench Testing and Examination of Brushgear and Commutator.

1. Secure the starter body in a vice and test by connecting it with heavy gauge cables to a 12 volt battery. One cable must be connected to the starter terminal and the other held against the yoke or end bracket. Under these light load conditions, the starter should run at a very high speed.

2. If the operation of the 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 with a smooth file. Always replace brushes in their original positions. If the brushes are worn so that they will not bear on the commutator or if the brush flexible connector is exposed on the running face they must be replaced (see "**Inspection and Overhaul**").

3. Check the tension of the brush springs with a spring scale (see Fig. N.24). The correct tension is 15 to 20 oz. (0·43 to 0·71 kg.) or 30 to 34 oz. (850–

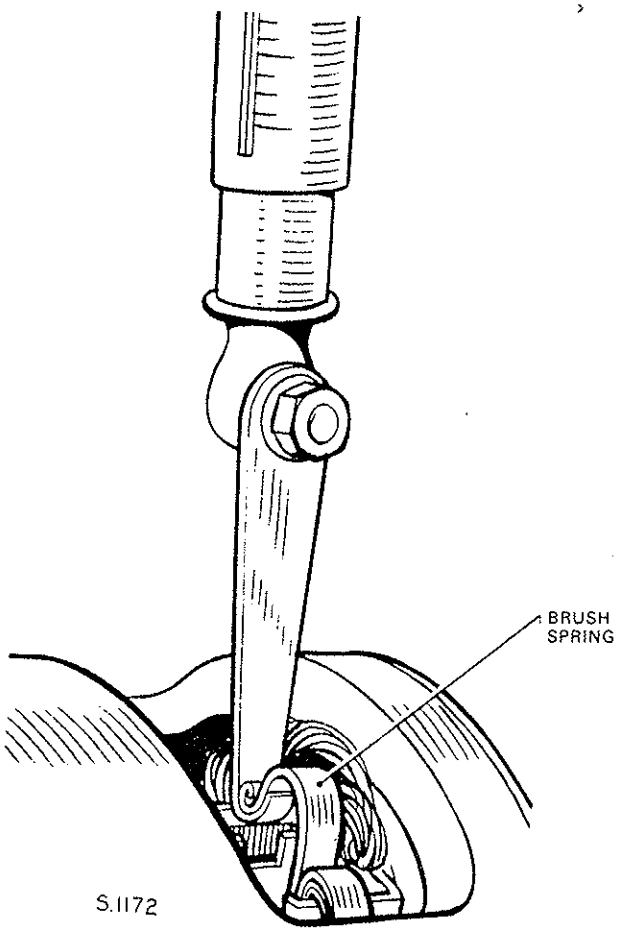


Fig. N.24. Checking brush spring tension

862 gm.) on Eclipse Drive. New springs should be fitted if the tension is low.

4. If the commutator is blackened or dirty, clean it by holding a petrol-moistened cloth against it while the armature is rotated.

5. Re-test the starter as described under para. (1) opposite. If the operation is still unsatisfactory, the unit must be dismantled for detailed inspection and testing.

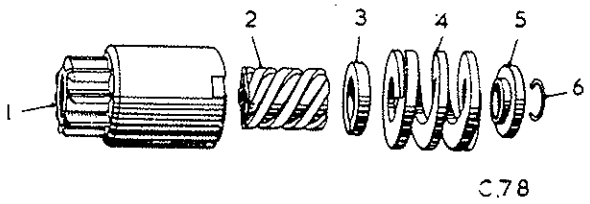
To Dismantle (see Figs. N.21 and N.25).

1. Remove the cover band, hold back the brush springs and lift the brushes from their holders.

2. Remove the terminal nuts from the terminal post.

3. Remove the two through bolts from the commutator end bracket, and withdraw the end bracket from the yoke.

4. Remove the driving end bracket complete with armature and drive from the starter motor yoke.



1 PINION AND BARREL ASSEMBLY
2 SCREWED SLEEVE
3 BUFFER WASHER
4 MAIN SPRING
5 SHAFT COLLAR
6 JUMP RING

Fig. N.25. Starter drive details

5. Compress the main spring (4) and remove the jump ring (6) and shaft collar (5). Lift off the main spring (4), buffer washer (3), screwed sleeve (2) and pinion and barrel assembly (1).

Note: Should either the barrel assembly or the screwed sleeve be damaged, then a replacement assembly and screwed sleeve must be fitted. These components must not be renewed individually.

Inspection and Overhaul.

Renewal of Brushes.

1. If brushes are allowed to wear beyond the minimum permissible length, the flexible leads embedded in each brush will damage the commutator. Brushes should be renewed when they are worn to $\frac{5}{16}$ in. (7·94 mm.).

2. Two of the brushes are connected to terminal eyelets attached to the brush boxes on the commutator end bracket and two are connected to tappings on the field coils (see Fig. N.26).

3. The flexible connectors must be removed by unsoldering and the connectors of the new brushes secured in their place by soldering. The brushes are pre-formed 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 petrol-moistened cloth. 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 in a lathe, rotate at a high speed and take a light cut with a very sharp tool. Do not remove any more metal than is necessary. Finally polish with very fine glass paper. The insulators between the commutator segments **must not be undercut.**

Armature.

Examination of the armature may reveal the cause of failure, e.g., conductors lifted from the commutator due to the starter drive being engaged while the engine is running and causing the armature to be rotated at an excessive speed. A damaged armature must in all cases be replaced—no attempt should be made to machine the armature core or to true a distorted armature shaft.

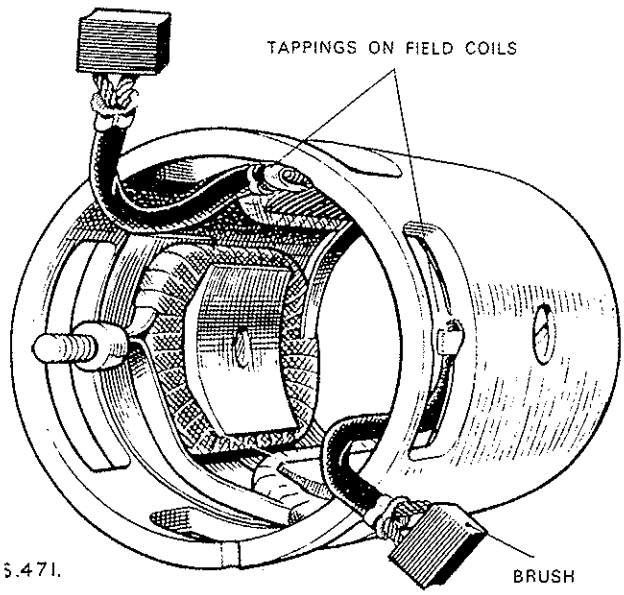


Fig. N.26. Brush connections to the field coil tappings

Field Coils.

1. **To Check.** Test the field coils for continuity by connecting a 12 volt battery with a 12 volt bulb in series between the tapping points of the field coils, at which the brushes are connected. Failure of the lamp to light indicates an open circuit in the wiring of the field coils (see Fig. N.27).

2. 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 may be checked with a 110 volt test lamp, the test leads being connected to one of the field coil tapping points and to a clean part of the yoke. Should the lamp light it indicates that the field coils are earthed to the yoke.

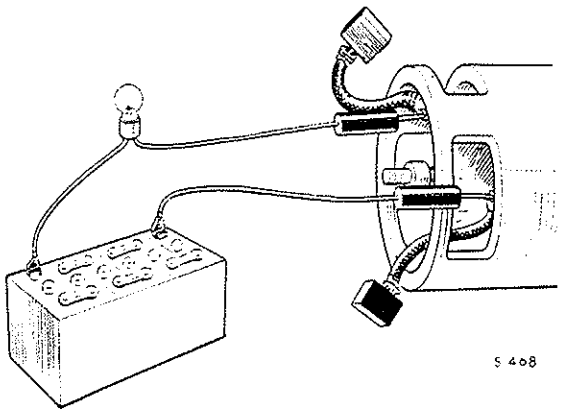


Fig. N.27. Testing field coil continuity

In either case, unless a replacement starter motor is available, the field coils must be renewed. To do this, carry out the procedure outlined below, using a pole shoe expander and a wheel-operated screwdriver.

3. **To Renew.** Remove the insulation piece which is provided to prevent the intercoil connectors from contacting the yoke.

4. **Mark the yoke and pole shoes in order that they can be fitted in their original positions.**

5. Unscrew the four pole shoe retaining screws by means of the wheel-operated screwdriver.

6. Draw the pole shoes and coils out of the yoke and lift off the coils.

7. Fit the new field coils over the pole shoes and place them in position inside the yoke. Take care to ensure that the tapping of the field coils is not trapped between the pole shoes and the yoke.

8. Locate the pole shoes and field coils by lightly tightening the retaining screws.

9. Insert the pole shoe expander, open it to the fullest extent and tighten the screws.

10. Finally tighten the screws by means of the wheel operated screwdriver.

11. Replace the insulation piece between the field connections and the yoke.

Bearing Bushes.

Bushes 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:

1. Press the bearing bush out of the end bracket.

2. Press the new bearing bush into the end bracket using a shouldered, highly polished mandrel of the same diameter as the shaft, which is to fit in the bearing (Fig. N.28). Porous bronze bushes must not be reamed after fitting, or the porosity of the bush may be impaired.

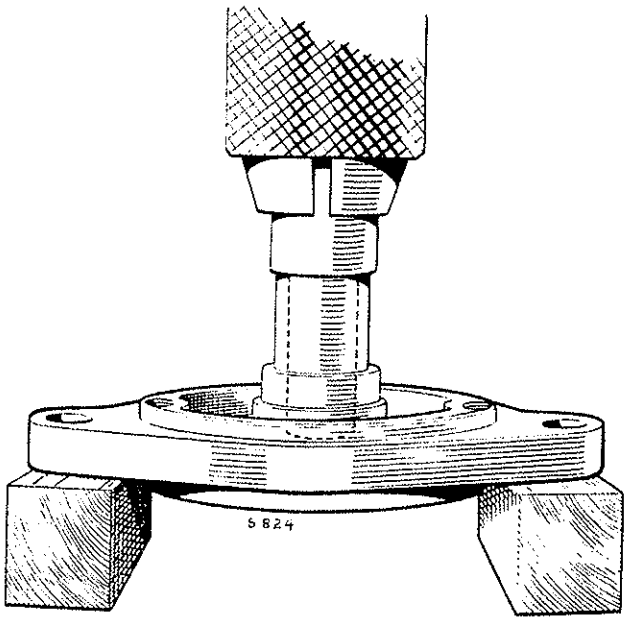


Fig. N.28. Fitting the bearing bush (drive end)

Note: Before fitting a new porous bronze bearing bush it should be completely immersed for 24 hours in clean thin engine oil. In cases of extreme urgency this period may be shortened by heating the oil to 100°C. (212°F.) when the time of immersion may be reduced to 2 hours, allowing the oil to cool before removing the bush.

To Re-assemble.

The re-assembly of the starter motor is a reversal of the dismantling procedure.

To Refit.

Refitting is a reversal of the removal procedure.

STARTER MOTOR

Eclipse Drive

STARTER DRIVE

Description and Operation.

The pinion is carried on a barrel type assembly which is mounted on a screwed sleeve. This sleeve is carried on a centre sleeve and is secured to the armature shaft by means of a peg and key. The barrel assembly is arranged so that it can move along the shaft against a compression spring to reduce the shock loading at the moment engagement takes place.

When the starter switch is closed the centre and screwed sleeves rotate, these being coupled by the main spring. Under its own inertia, the barrel assembly is propelled axially along the screwed sleeve until the pinion engages with the flywheel starter ring. The shock of engagement is largely absorbed by the main spring due to its capacity for being torsionally compressed. Armature to pinion torque is now transmitted through two paths, one via the main spring and anchor plate to the screwed sleeve, and the other from the centre sleeve to the screwed sleeve through the fibre washer compressed between them.

As soon as the engine fires and commences to run under its own power the flywheel will be driven faster by the engine than the starter. This will cause the barrel assembly to be screwed back along the sleeve, thus drawing the pinion out of mesh with the flywheel teeth. In this manner the drive safeguards the starter against damage due to being driven at high speeds.

A pinion restraining spring is incorporated in the drive, this spring prevents the pinion from vibrating into mesh when the engine is running.

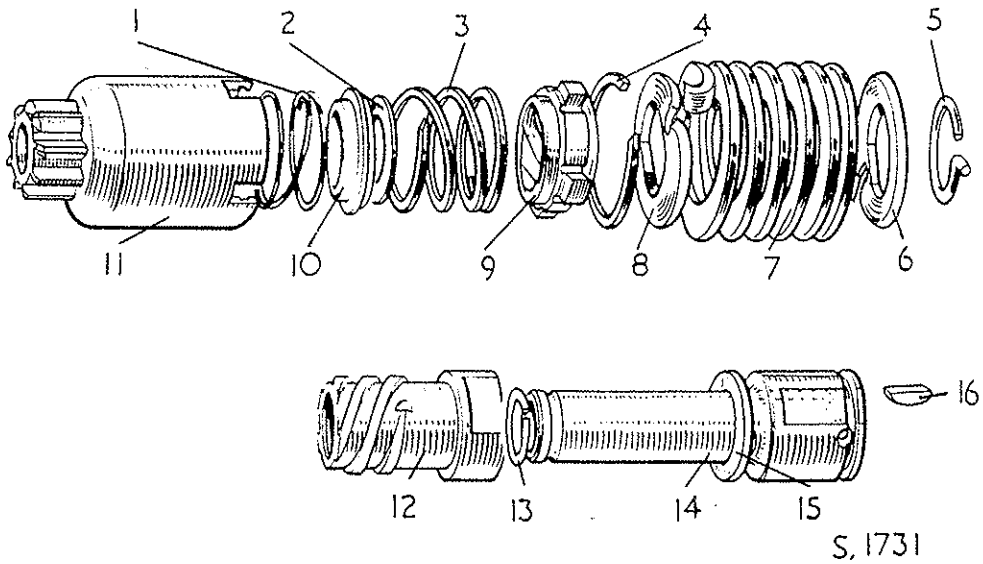
Maintenance

If any difficulty is experienced with the starter motor not meshing correctly with the flywheel, it may be that the drive requires cleaning. The barrel assembly should move freely on the screwed sleeve, if there is any dirt or other foreign matter on the sleeve it must be washed off with paraffin.

In the event of the pinion becoming jammed in mesh with the flywheel, it can usually be freed by turning the starter motor armature by means of a spanner applied to the shaft extension at the commutator end. This is accessible by removing the cap which is either a push fit or is secured by two screws.

To Dismantle (see Fig. N.29).

When the armature has been removed the drive



1 MESHING SPRING
2 WASHER
3 RESTRAINING SPRING
4 RETAINING RING
5 JUMP RING
6 ANCHOR PLATE
7 MAIN SPRING
8 ANCHOR PLATE
9 CONTROL NUT
10 LOCATION COLLAR
11 PINION AND BARREL ASSEMBLY
12 SCREWED SLEEVE
13 RETAINING RING
14 CENTRE SLEEVE
15 FIBRE WASHER
16 RETAINING PIN

Fig. N.29. Starter drive details

assembly can be removed from the armature shaft extension as follows:

1. Press in the anchor plate (11) and main spring (10) and pull out the retaining pin (15) and then slide the drive back along the shaft and remove the key (14). Withdraw the drive unit from the shaft.

2. Remove the retaining ring (4) from inside the end of the pinion and barrel assembly (6) which can then be slid off together with the meshing spring (1).

3. Compress the drive assembly enough to expose and remove the retaining ring (17).

4. Remove the location collar (7), washer (2), restraining spring (3), control nut (8) and withdraw the screwed sleeve (12).

5. Remove the anchor plate (9), main spring (10), and thrust washer (16). The other anchor plate (11) can be removed from the centre sleeve assembly (13) by withdrawing the jump ring (5).

IGNITION SYSTEM

DISTRIBUTOR DESCRIPTION

The distributor used on all models has the H.T. leads entering the cover from the top.

The H.T. brush in the distributor cover is of composite construction, the centre portion being made of resistive compound and the ends of softer carbon. The resistive portion gives a measure of radio interference suppression. Under no circumstances must a short non-resistive brush be used as a replacement for the longer resistive brush.

The H.T. cables are radio interference suppressed and during inspection and overhaul they should be carefully examined and renewed if the insulation is cracked or perished. When it becomes necessary to renew these cables, the correct replacements only should be used. The H.T. cables have a special internal construction consisting of graphite-impregnated stranded and woven rayon or silk having a resistance of 16,500 ± 30% ohms per yard.

With the introduction of the negative earth system the "SW" terminal and the "CB" terminal on the ignition coil are marked "+" and "—" respectively.

The distributor is mounted on the off-side of the cylinder block and is driven at half engine speed from the camshaft by an extension of the oil pump shaft, the connection being made by an offset coupling. Mounted on the distributor driving shaft immediately beneath the contact breaker, is an automatic timing control mechanism. It consists of a pair of spring loaded governor weights, linked by lever action to the contact breaker cam. At slow engine speeds, the spring force retains the cam in a position in which the spark is slightly retarded. Under the centrifugal force imparted by high engine speeds, the governor weights swing outwards against the spring pressure, to move the contact breaker cam and thereby advance the spark, to suit engine conditions at the greater speed.

The correct timing of the ignition for maximum efficiency is dependent not only on engine speed but also on the load. In addition to the centrifugally operated control, which advances or retards the ignition timing in accordance with engine speed, a vacuum operated mechanism, responsive to the engine loading is also incorporated in the distributor.

The inlet manifold of the engine is in direct communication with one side of a spring loaded diaphragm. This diaphragm acts through a lever mechanism to rotate the heel of the contact breaker about the cam, thus advancing the spark for part throttle conditions. The combined effects of the centrifugal and vacuum operated timing controls give added efficiency over the full operating range of the engine with a corresponding economy in fuel consumption. There is also a micrometer adjustment for making fine alterations in timing to allow for changes in running conditions, e.g. change of fuel.

The coil is positioned on the off-side of the cylinder head and mounted by means of a bracket.

OPERATION

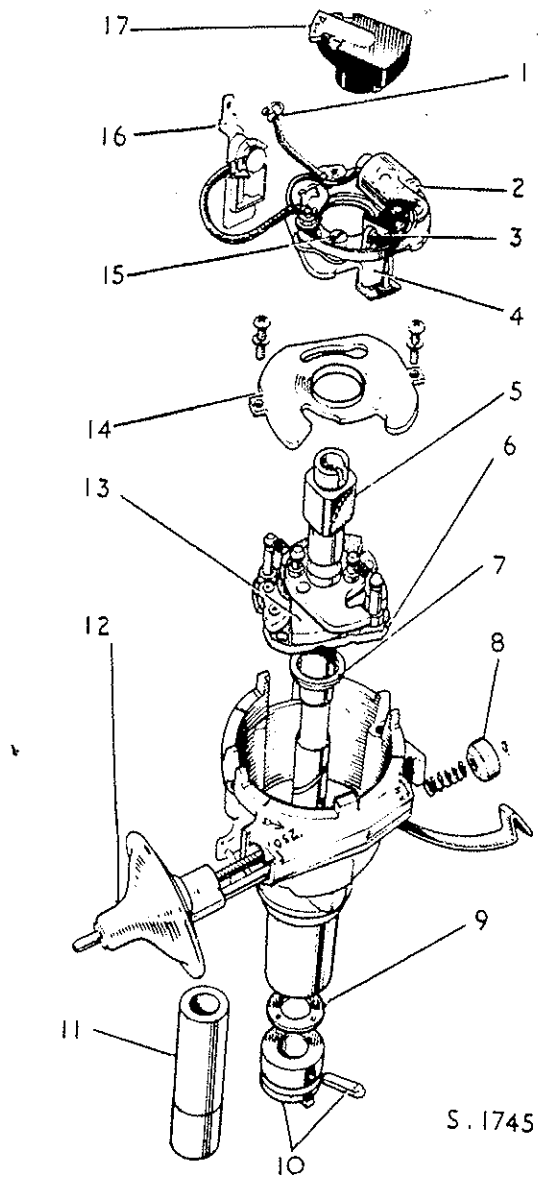
The coil ignition equipment consists of a high tension induction coil and a combined distributor, contact breaker and automatic timing control.

Ignition Coil.

Current flowing through the primary or low tension winding of the coil sets up a strong magnetic field about it. This current is periodically interrupted by the cam operated contact breaker and the subsequent collapse of the magnetic field across the secondary winding of the coil induces a high voltage in it. At the same time, the rotor arm in the distributor connects the secondary winding of the coil with one of the four metal electrodes, from which cables lead to the sparking plugs. In this way a spark is produced in the cylinder under compression at the correct time for ignition of the mixture.

Automatic Advance and Retard.

When the engine is idling with the throttle nearly closed, there is practically no vacuum since the take off point is on the atmospheric side of the carburettor



1 C.B. EARTH CONNECTION
2 CONDENSER
3 CONTACTS
4 CONTACT BREAKER MOVING PLATE
5 CAM
6 ACTION PLATE
7 DISTANCE COLLAR
8 VERNIER ADJUSTMENT NUT
9 THRUST WASHER
10 DOG AND PIN
11 BEARING BUSH
12 VACUUM ADVANCE CONTROL UNIT
13 CENTRIFUGAL ADVANCE CONTROL UNIT
14 CONTACT BREAKER BASE PLATE
15 FIXED CONTACT PLATE SECURING SCREW
16 L.T. TERMINAL
17 ROTOR ARM

Fig. N.30. Exploded view of distributor

butterfly valve and the controlling spring tension is not overcome. The result of opening the throttle is to bring the tapping on the engine side of the butterfly valve. This increases the degree of vacuum and the timing is advanced. This occurs up to about half throttle, after which greater opening causes a decrease in vacuum, thus retarding the timing. This system ensures maximum possible power under all conditions.

MAINTENANCE

Lubrication.

Take care not to allow oil or grease to come into contact with the contact breaker points.

1. Lightly smear the cam with Shell Retinax "A".

2. Remove the rotor arm by pulling it up vertically and apply a few drops of engine oil to the spindle to lubricate the cam bearing. It is unnecessary to remove the exposed screw since sufficient clearance is present to permit the passage of oil.

3. The automatic timing control should be lubricated with a few drops of engine oil, which can be applied through the aperture at the edge of the contact breaker plate.

Cleaning.

1. Thoroughly clean the moulded distributor cap, inside and out, with a soft dry cloth paying particular attention to the spaces between the metal electrodes. Ensure that the small carbon brush moves freely in its holder.

2. Examine the contact breaker. The contacts must be quite free from grease or oil. If they are burnt or blackened, clean them with very fine carborundum stone or emery cloth, then wipe them with a petrol-moistened cloth. Cleaning is facilitated by removing the contact breaker lever. To do this, remove the nut, washer insulating piece and connections from the spring anchor post. The contact breaker lever arm may now be removed from its pivot. After cleaning check the contact breaker setting. Turn the engine until the contacts show the maximum opening. This should measure 0·015 in. (0·38 mm.). If this measurement is incorrect keep the engine in the position giving the maximum opening, slacken the screw securing the fixed contact plate and adjust its position to give the required gap. Tighten the screw. Re-check the setting for other positions of the cam giving maximum opening of the points.

To Test on Vehicle.

Before starting to test make sure that the battery is not fully discharged as this will often produce the same symptoms as a fault in the ignition circuit.

Uneven Firing.

1. Run the engine at a fairly fast idling speed.

2. Short circuit each plug in turn with the blade of an insulated screwdriver placed across the terminal to contact the cylinder head.

3. Short circuiting the defective plug will cause no noticeable change in the running note. On the others, however, there will be a pronounced increase in roughness.

4. Having thus located the defective cylinder, stop the engine and remove the cable from the sparking plug terminal.

5. Re-start 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 in the sparking plug, and it should be removed, cleaned and adjusted, or a replacement fitted.

6. If, however, there is no spark, or only weak irregular sparking, examine the cable from the plug to the distributor for deterioration of the insulation, renewing the cable if the rubber is cracked or perished.

7. If the cable is fitted with radio or television suppressor, this should also be checked for damage or open circuit.

8. Clean and examine the distributor moulded cap for free movement of the carbon brush. If tracking has occurred, indicated usually by a thin line between two or more electrodes, a replacement distributor cap must be fitted.

Ignition Failure.

1. Spring back the clips on the distributor body and remove the moulded cap. Lift off the rotor, carefully levering with a screwdriver, if necessary.

2. Check the contacts for cleanliness and correct gap setting as described above.

3. Connect an ammeter in the low tension wiring, switch on the ignition and turn the engine. Observe the ammeter reading, which should rise with the closing and fall to zero with the opening of the contacts if the low tension wiring is in order. When the reading does not fluctuate, or contacts remain closed, a short circuit, is indicated. No reading indicates a broken or loose connection in the low tension wiring or badly adjusted or dirty contacts.

FAULT FINDING

A breakdown or excessive voltage drop in the low tension circuit can be caused by:

(*a*) Dirty or incorrectly adjusted contact breaker points.

(*b*) Faulty wiring, loose or dirty connections.

(*c*) Faulty ignition switch.

(*d*) Defective ignition coil.

A breakdown or loss of electrical energy in the high tension circuit can be caused by:

(*a*) Dirty or incorrectly adjusted spark plugs.

(*b*) Defective condenser.

(*c*) Defective coil.

(*d*) Defective H.T. leads.

(*e*) High tension leakage across the coil, distributor cap or rotor.

If there is no spark, or the spark is weak, short or intermittent, the cause of the trouble is in one or more of the following:

(i) The contact breaker points.

(ii) H.T. lead from coil to distributor.

(iii) Defective coil.

(iv) The primary circuit.

If the spark is satisfactory the fault will be located in the secondary circuit from the distributor to the spark plugs, not forgetting dampness or tracking within the distributor cap.

Low Tension Tests.

A complete check of the primary circuit can be made with a voltmeter having a range of 0–2 and 0–20 volts.

These tests will locate any excessive voltage drop in the circuit which will reduce the ignition coil H.T. output and cause difficult starting or poor performance.

Test No. 1.

Test the primary circuit as far as the S.W. terminal by checking the voltage at this terminal with the ignition switched on.

Connect the 0–20 voltmeter between the S.W. terminal and a good earth. Also connect a jumper lead between the distributor L.T. terminal and earth.

Note: The jumper lead is used to ensure that possible resistance in the contact breaker points, or earthing of the points will not affect the voltmeter reading. The lead must be large enough to carry the current and not create a resistance to its flow.

The voltmeter reading should be 11·7 volts and the cause of a lower reading must be found and rectified before carrying out further tests.

Low readings can be caused by a discharged or defective battery, loose or high resistance connections between the battery positive terminal and S.W. terminal on the coil, or high resistance in battery negative lead connections; also defective wiring or ignition switch.

Test No. 2.

Check the voltage at the coil under starting conditions by connecting the voltmeter and jumper lead as described in *"Test No. 1"*. The jumper lead will prevent the engine from starting.

Turn the engine over by means of the starter with the ignition switched on. Should the voltmeter reading be less than 9 volts it is an indication of either

a weak battery, defective cables or connections, or faulty starter motor which is taking excessive current from causing an abnormal voltage drop.

Test No. 3.

Check the contact breaker point resistance and earthing of the distributor by connecting the 0–20 voltmeter to the distributor L.T. terminal and cylinder block. The contact breaker points must be closed and the ignition switched on.

If it is found that the reading is below 2 volts disconnect the 0–20 voltmeter and connect the 0–2 voltmeter in its place.

Note: Contact breaker points must be inspected visually because it is possible for even badly worn points to contact without high resistance.

The voltmeter reading should not be higher than 0·2 volts. Higher readings are an indication of dirty or defective contact points, faulty earthing of the fixed contact, contact mounting plate or distributor body.

High Tension Tests.

Preliminary Checks.

1. Inspect all H.T. leads for looseness or corrosion at the terminal ends, breaks and cracked insulation. Replace defective leads.

2. Clean the inside and outside of the distributor cap and inspect for cracks, eroded contacts and signs of tracking between the contacts and around the area of the centre carbon brush.

3. Inspect the rotor for cracks and signs of burning on the end of the brass arm. Replace if defective.

To Test H.T. Leads.

Test the leads by means of a 12 volt supply and a 0–20 voltmeter. This will detect a break in the lead however small. A reading of approximately 1–4 volts will be obtained on a good H.T. lead.

Note: The use of H.T. current is not a satisfactory method of testing as the current is capable of jumping any small breaks and so appear to have continuity.

To Test Rotor Insulation.

Remove the distributor cap and attach a test length of H.T. cable, having a suitable rubber sleeve at one end, to the carbon brush holder inside the distributor cap ensuring that electrical contact is made to the carbon brush.

Turn the engine until the contact breaker points are closed. With the ignition switched on and the free end of the cable held $\frac{3}{16}$ in. (4·76 mm.) away from the cylinder block, open the contact points by means of a pencil. A spark should occur each time the points are opened thus proving that current is available.

With the rotor in position hold the free end of the cable approximately $\frac{1}{16}$ in. (1.59 mm.) away from the brass arm of the rotor and open the contact breaker points. *No spark should be seen.* If a spark does occur this is an indication that there is a leak in the rotor insulation and the rotor must be replaced.

Rotor Arm Gap.

A gap of 0·020 in. (0·50 mm.) should exist between the electrodes in the distributor cap and the rotor arm. This gap increases with erosion caused by the H.T. current and when it becomes excessive will cause misfiring at high engine speeds under wide throttle opening.

Tracking and Shorting.

These faults will occur when any of the following conditions make it possible.

(*a*) Moisture inside or outside the distributor cap.

(*b*) Dust and fine metal particles inside the distributor cap.

(*c*) A burnt out sparking plug with an excessive gap or an H.T. lead with an internal break.

Misfiring and difficult starting will result from the above.

Coil and Condenser.

Suitable test equipment is required to test the coil and condenser and if this equipment is not available then these units may only be checked by substitution.

Should the spark appear weak after the ignition circuits have been checked and proved satisfactory, a new condenser should be fitted. If this makes no improvement, a new coil should be tried.

To Remove.

1. Remove the high tension leads from the plug terminals noting their positions. Engine firing order is 1, 3, 4, 2, and the front cylinder is number 1.

2. Disconnect the high tension lead at the coil, also the low tension leads and remove the coil from its mounting bracket.

3. Remove the vacuum pipe from the distributor diaphragm union.

4. Remove the two nuts and washers securing the distributor clamping bracket to the crankcase and withdraw the distributor and bracket together.

To Dismantle.

In order to ensure that the various components are refitted correctly a careful note should be made of

the positions of the items as they are removed. In particular, note the relationship between the driving dog and the rotor arm and ensure that this is maintained when re-assembling the distributor.

1. Spring back the securing clips and remove the moulded cap.

2. Lift off the rotor arm.

3. Disconnect the vacuum unit link to the moving contact breaker plate.

4. Remove the two screws at the edge of the contact breaker base plate.

5. Lift off the contact breaker assembly complete with external terminal.

6. Remove the circlip on the end of the micrometer timing screw and turn the micrometer nut until the screw and vacuum unit assembly are free. Take care not to lose the ratchet and coil type springs situated under the nut.

7. Remove the complete shaft assembly, with the centrifugal timing control and cam foot, from the distributor body.

Contact Breaker.

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

2. Slide out the terminal moulding.

3. Lift off the contact breaker lever and the insulating washers beneath it.

4. Remove the screw securing the fixed contact plate, together with the spring and plain steel washers and remove the plate.

5. Withdraw the single screw securing the capacitor and contact breaker earthing lead.

6. Dismantle the contact breaker base assembly by turning the base plate clockwise and pulling to release it from the moving contact breaker plate.

Shaft and Action Plate.

1. Remove the screw inside the cam and lift out the cam and foot assembly.

2. Lift off the centrifugal timing control from the action plate.

Inspection and Overhaul.

High Tension Cables.

1. The high tension cables must be carefully examined and renewed if the rubber insulation is cracked or perished. Rubber covered 7 mm. diameter ignition cable should be used.

2. To connect new cables to the terminals in the distributor, remove the cap and slacken the screws on the inside of the moulding. Cut the cables to the length required and push them firmly into the holes in the moulding. Tighten the screws, which will pierce the rubber insulation to make good contact with the cable core. Ensure that the cables to the sparking plug are connected in the correct firing order.

3. Connect the cable to the ignition coil high tension terminal.

Contact Breaker Mechanism.

Ensure that the moving arm moves freely on the pivot. If necessary, remove the arm and polish the pivot pin with a strip of fine emery cloth. Replace the arm and lubricate with a drop of clean engine oil.

Driving Shaft Bush.

1. The bush should be checked to ensure that excessive wear is not present. If wear is apparent, the single bearing brush can be pressed out of the shank by means of a shouldered mandrel. The new bush should be soaked in thin oil for 24 hours prior to fitting to allow the pores of the bush to become filled with lubricant. In cases of extreme urgency this time may be shortened to 2 hours if the oil is heated to 100°C. (212°F.) and allowed to cool before removing the bush.

2. Press the bearing bush into the shank of the distributor body, using a shouldered mandrel of the same diameter as the shaft. **Do not ream the bush after fitting,** as this will affect its self lubricating properties.

To Re-assemble.

1. Place the cam and cam foot assembly over the shaft, engaging the pegs on the cam foot with the holes in the weights. Fit the securing screw.

2. Place the distance collar over the shaft, smear the shaft with clean engine oil and fit it into the bearing bush. Secure the driving dog to the shaft by means of a pin, positioning the dog in correct relation to the rotor arm, aligning the location marks made while dismantling.

3. Refit the vacuum unit into its housing and replace the springs, milled adjusting nut and circlip.

4. Re-assemble the centrifugal timing control. Ensure that the springs are not stretched or damaged.

5. Before re-assembling the contact breaker base assembly, lightly smear the base plate with clean engine oil.

6. Fit the moving contact breaker plate to the contact breaker base plate and secure.

7. Refit the contact breaker base into the distributor body.

8. Engage the vacuum unit link.

9. Insert the two base plate securing screws, one of which also secures one end of the contact breaker earthing cable.

10. Fit the capacitor into position.

11. Place the fixed contact plate in position and secure lightly. One plain and one spring washer must be fitted under the securing screw.

12. Place the insulating washers, etc., on the contact breaker pivot post and on the pillar, on which the end of the contact breaker spring locates.

13. Refit the contact breaker lever and spring.

14. Slide the terminal block into its slot.

15. Thread the low tension connector and capacitor eyelets on to the insulating piece and place these on to the pillar which secures the end of the contact breaker spring. Refit the washer and securing nut, **ensuring that the eyelets do not foul the H.T. cover and prevent the vacuum advance mechanism from functioning.**

16. Set the contact gap to 0·015 in. (0·38 mm.) and tighten the fixed contact securing screw.

17. Refit the rotor arm, locating the moulded projection in the arm with the cut-out in the shaft.

18. Refit the distributor cap.

To Refit.

To refit the distributor, reverse the procedure given for removal, connecting the high tension leads to the sparking plugs in the correct firing order sequence.

IGNITION TIMING

Two means of adjusting the timing are provided:

(*a*) A clamp screw mounted horizontally. This is the coarse adjustment and when it is slackened the body of the distributor can be rotated in its mounting plate.

(*b*) The vernier control. This provides an easy means of making small adjustments to the ignition timing to give the best performance from a particular fuel or to eliminate "pinking" when excessive carbon deposits have formed in the engine.

One turn of the vernier knurled adjustment is equivalent to three degrees of crankshaft rotation and one vernier adjustment spacing to four degrees of crankshaft rotation.

Note: The knurled adjustment should be rotated clockwise to retard and anti-clockwise to advance as shown by the letters "R" (retard) and "A" (advance) cast on the distributor body close to the knurled adjustment.

Timing Marks.

Timing marks, spaced at 5° intervals, are provided on the crankshaft pulleys. These take the form of seven or thirteen pointers on the rear face of the pulley.

When the engine is rotated in its running direction T.D.C. (top dead centre) is obtained when the **last** of these points comes opposite to the pointer on the timing case.

These timing marks are used to position or measure the number of crankshaft degrees B.T.D.C. (before top dead centre).

To carry out ignition timing with the engine in the vehicle, proceed with either Method 1, 2 or 3.

Note: The vacuum advance pipe is manufactured from a plastic material and therefore, need not be disconnected when carrying out ignition timing.

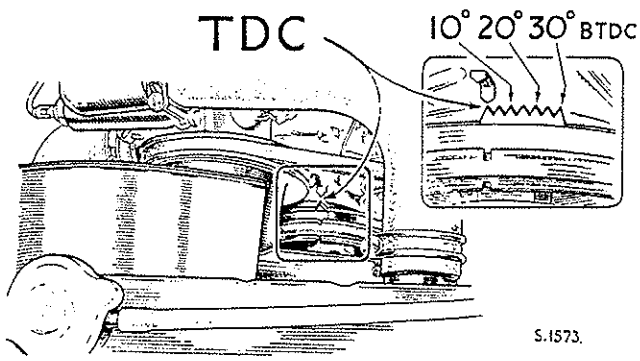


Fig. N.31. Location of timing cover pointer showing inset the timing pointers on crankshaft pulley with pointers positioned for T.D.C.

Method 1.

1. To obtain the static ignition timing point, proceed as follows:

Turn the engine until the required static timing position is reached. For instance, for a static ignition setting of 6°–8° B.T.D.C., turn the engine until it is 7° B.T.D.C. Rotate the crankshaft fully clockwise (viewed from the front of the engine) until almost 1½ of the 5° spaced timing pointers before the T.D.C. pointer, i.e., last pointer reaches the pointer on the timing cover. If a premium grade fuel is being used, a static ignition setting of 6°–10° is required which would be 1½ to 2 of the 5° timing pointers before T.D.C.

2. The piston of cylinders Nos. 1 and 4 are now positioned at the required distance B.T.D.C. to give static ignition timing point.

3. Set the distributor vernier control to the midway position (2 divisions showing on scale).

4. Remove the distributor cap and connect a 12 v. bulb between the low tension terminal of the distributor and a good earth. With the battery connected and ignition switched on, this bulb will light when the contact breaker points open.

5. Slacken the distributor clamp screw and rotate the body of the distributor anti-clockwise as far as possible.

6. Switch on ignition and, applying light finger pressure to the rotor in a clockwise direction, turn the distributor body clockwise until the bulb just lights.

7. Tighten the distributor clamp screw.

8. Check the setting by turning the crankshaft two revolutions clockwise until the bulb again lights, observing that the T.D.C. pointer on the crankshaft pulley must be the required distance before the pointer on the timing cover, or the correct pointer as determined at operation 1 is opposite the pointer on the timing cover.

9. Switch off ignition, remove bulb, and refit all parts.

Method 2.

1. To set the engine to T.D.C. Nos. 1 and 4 cylinders, proceed as follows:

Turn the engine in a clockwise direction (viewed from the front of the engine) until the last pointer on the crankshaft pulley is in alignment with the pointer on the timing cover.

2. This gives T.D.C. No. 1 and 4 cylinders.

3. Set the distributor vernier control so that only one division is showing on the scale.

4. Remove the distributor cap and connect a 12 v. bulb between the L.T. terminal of the distributor and a good earth. With the battery connected and ignition switched on, this bulb will light immediately the contact breaker points open.

5. Slacken the distributor clamp screw and rotate the body of the distributor anti-clockwise as far as possible.

6. Switch on the ignition and, apply light finger pressure to the rotor in a clockwise direction, return the distributor body clockwise until the bulb just lights.

7. Tighten the distributor clamp screw.

8. Check the setting by turning the crankshaft two revolutions clockwise to see if the bulb lights immediately the last pointer on the crankshaft pulley is in alignment with the pointer on the timing cover.

9. Switch off ignition, remove bulb and refit all parts.

10. The engine is now timed to fire at T.D.C. and should be advanced the required number of degrees by means of the vernier adjustment to give the correct static timing.

11. One division in the vernier scale corresponds to four crankshaft degrees, and one turn of the knurled knob corresponds to three crankshaft degrees.

12. Therefore if 8° B.T.D.C. is the setting needed the distributor will have to be advanced by two divisions on the vernier scale.

Method 3 (using Churchill Timing Light).

The use of a high intensity timing light is recommended for the rapid visual checking of the centrifugal and vacuum advance mechanism incorporated in the ignition distributor. This also provides the best method of setting the ignition timing to the recommended static figure.

The advantages of an Electronic Timing Light are:

(*a*) It is simple to use, and it is portable.

(*b*) It is the quickest method of setting and checking ignition timing.

(*c*) It enables ignition timing and action of the automatic advance mechanism to be checked under normal operating conditions without removing the distributor or any other items from the engine.

(*d*) It is possible to set or check ignition timing disregarding any backlash which may exist in the driving gears or slackness of the camshaft driving chain.

1. The pointer giving the required setting B.T.D.C., on the crankshaft pulley and the pointer on the timing cover should be cleaned and marked with white paint. For standard fuels having a setting of 6°–8° B.T.D.C., the correct position on the crankshaft pulley will be almost 1½ of the 5° spaced timing pointers before T.D.C. pointer. If a premium grade fuel is being used a static ignition setting of 6°–10° is required which would be 1½ to 2 of the 5° timing pointers before T.D.C.

2. Connect the electrical leads from the timing lamp according to the makers' instructions and run the engine at an idling speed of 400 r.p.m. (This is below the speed at which the centrifugal advance action begins.)

How the Timing Light Operates.

Correctly connected and with the engine running the timing light gives a high intensity flash every time the contact breaker points open for No. 1 cylinder. When this light is directed on to the crankshaft pulley, the pully will appear to be stationary. The distance between the painted pointer on the pulley and the painted pointer on the timing cover indicates the amount of ignition advance at varying speeds above idling.

Setting Ignition Timing.

1. The engine should idle at 400 r.p.m. and the relative positions of the pointer representing the static ignition setting on the crankshaft pulley and the pointer on the timing cover observed in the light given by the timing lamp.

2. For the static ignition timing to be correct, the painted pointer on the crankshaft pulley must exactly align with the pointer on the timing cover.

3. If necessary, the distributor can be adjusted to obtain this alignment, while the engine is still idling.

Checking the Centrifugal Advance Action.

Still observing the "Stationary" pointer on the crankshaft pulley, gradually increase the engine speed. The distance between the painted pointer on the pulley and the timing cover pointer will increase, i.e., the painted pointer on the pulley will move in an anti-clockwise direction away from the timing cover pointer, showing that the centrifugal advance mechanism has begun to operate over its speed range. Jerky movement of the pulley timing pointer whilst accelerating or decelerating indicates sticky centrifugal advance mechanism. (To check centrifugal advance only, the vacuum pipe connection to the diaphragm unit should be disconnected.)

The timing pointers on the crankshaft pulley allow the amount of centrifugal advance to be checked at an engine speed of 3,500 r.p.m. without removing the distributor from the engine.

To proceed:

(*a*) Disconnect the vacuum feed pipe from the distributor.

(*b*) Adjust the ignition timing, with a stroboscopic timing light as indicated under *"Setting Ignition Timing"*.

(*c*) At 3,500 r.p.m. the centrifugal advance is 26°—PLUS—the particular ignition timing angle B.T.D.C. Paint this position on the correct pointer of the pulley (for example with a static ignition setting of 6°–8° B.T.D.C., the centrifugal advance is 26°–7° B.T.D.C. and the correct pointer would be the seventh pointer from the T.D.C. pointer).

(*d*) Connect a tachometer to the engine and run it up to 4,000 r.p.m. and reduce to 3,500 r.p.m.

The painted pointer should then appear adjacent to the fixed pointer on the timing case to ±2°, when seen by the stroboscopic timing light.

Checking Vacuum Advance Action.

The throttle should be opened to give an engine speed of 1,200 to 1,500 r.p.m. or until the vacuum connection drilling in the carburettor has been uncovered by the butterfly valve. With the engine running under these conditions, the vacuum connection on the distributor diaphragm should be alternately disconnected and reconnected, whilst observing the appropriate timing pointer of the crankshaft pulley. This mark should retard and advance as the end of the vacuum pipe is removed and refitted.

SPARKING PLUGS

The sparking plugs are of great importance in maintaining a satisfactory engine performance and every care should be taken to fit the correct type when replacements are necessary.

There is little to be gained by experimenting with different plugs, as the make and type fitted in production are best suited to the requirements of the engine.

To Remove.

1. Lift up the engine cover. Pull off the cable terminal from the sparking plug.

2. Unscrew each plug using a well fitting box spanner taking care to clean the plug recesses in the cylinder head before the last thread is unscrewed. This will prevent and foreign matter entering the combustion chamber.

Note: The box spanner should be held square with the plug to eliminate any possibility of cracking the plug insulation.

Inspection and Overhaul.

1. Examine the plugs and any that appear dirty and oily should be washed thoroughly in petrol and allowed to dry.

2. Clean each plug on a sand blast type cleaner making sure that all traces of carbon deposit are removed. If necessary lightly brush the points and plug face with a small wire brush.

3. Examine the porcelain insulator for cracks and ensure that it is kept perfectly clean and free from grime and dust.

4. Any plugs which have cracked insulators or badly burnt points should be discarded and replacements fitted.

5. The gap between the plug points should be 0·025 in. (0·63 mm.). Check this with a gap gauge and adjust, if necessary.

6. The gap should be adjusted by bending the side electrode until the correct setting is obtained. **On no account must the adjustment be carried out by bending the centre electrode** as this may split the insulator.

7. Examine the copper plug washers and if they are worn or flattened, renew them.

To Refit.

1. When refitting sparking plugs, they should be screwed down as far as possible by hand before tightening with the box spanner. Always use a tubular box spanner to avoid possible damage to the insulator. **Do not use an adjustable wrench.**

2. Reconnect the H.T. cables.

3. Replace the engine cover.

LAMPS

DESCRIPTION

The lighting system includes two headlamps positioned about the body front panel, two sidelamps, two front flasher lamps, two combined stop/tail/flasher lamp units mounted in each rear body corner panel and a number plate illumination lamp fitted in the recess above the number plate on the lower rear body panel. An interior light with integral switch is positioned in the centre of the body header panel.

The **headlamps** which are flush fitting have sealed beam light units. The light unit is carried in a ribbed seating pan shaped to form a ball-and-socket type assembly within the lamp body, in which it is retained by a spring and two adjustment screws. This arrangement provides for the independent movement of the light unit in the horizontal and vertical planes by the adjustment of two screws only.

The **sidelamps and front flasher lamps** are mounted on plinths, each lamp consisting of a metal base assembly, a rubber gasket and a plastic lens which is secured to the base by two screws.

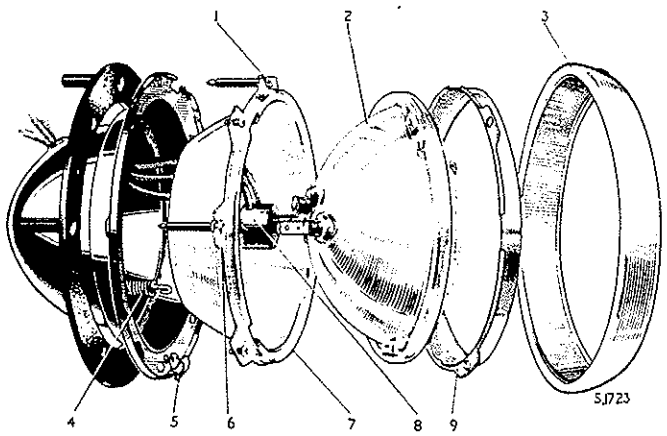
The **stop/tail/flasher/reflector lamps** are mounted flush to the body rear corner panel and the lamp is split into three sections. The upper section contains the single pole flasher bulb and holder, covered by an amber lens, which seats on a rubber sealing gasket and is secured to the lamp body by means of three screws. The upper amber lens provides a key for the top edge of the lower lens. The lower lens consists of two sections, the mid-section being a red reflector and the lower section houses a two pole stop/tail lamp bulb and holder, covered by a red lens. This bulb has staggered pins, thus ensuring that the bulb is correctly fitted and that the bright filament is connected to the stop lamp circuit. The lower lens seats on a continuation of the rubber sealing gasket previously detailed and is secured to the lamp body by means of a single screw on the bottom edge of the lens. Both bulb holders are positioned on a steel strip, which is secured to the rear of the lamp body pillar by means of a central screw. The complete lamp unit seats on a rubber surround on to the body panel and is secured by captive screws and nuts.

The **rear number plate illumination lamp** comprises a metal base and bulb holder, whilst two screws passing through the base plate secure the lamp to its bracket. A rubber pad, which surrounds the bulb holder, provides a seating for the deep domed-shaped glass cover, which protects the bulb from damage. A bridge shaped wire retains the glass cover and is positively located by the indentation at the top of the glass cover. The retaining wire is attached to pressed lugs on the lamp base plate and can swivel freely to permit cover removal.

The interior lamp consists of a moulded plastic cover and base, lugs along the sides of the cover key into mating slots in the lamp base, thus making the cover easily detachable upon firmly pressing one side of the cover inwards so that the lugs clear the slots in the lamp base.

The festoon bulb ends are supported in metal contacts, which are fixed to the lamp base, the continuation of one contact is bent to form a spring socket to carry the feed lead and connector thimble. The contact at the opposite end feeds into the slide switch, positioned on the lower edge of the lamp base. One side of this switch is earthed, via the lamp securing screw.

The **main beam warning lamp (U.S.A. and**



1 VERTICAL ADJUSTER
2 SEALED BEAM UNIT
3 FRONT RIM
4 TENSION SPRING
5 FRONT RIM RETAINING CLIP
6 HORIZONTAL ADJUSTER
7 SEATING RIM
8 ADAPTOR
9 UNIT RIM

Fig. N.32. Headlamp details

Canadian Models Only) is fitted to the instrument panel to the right of the centrally mounted speedometer. The red warning light indicates when the headlamp main driving beams are in operation.

BULB RENEWAL

It is advisable to renew bulbs after long service, before they actually burn out, as filaments may sag and cause a reduction in the performance of the lamp.

To assist in identification, Lucas bulbs bear a stamped number on the metal caps. **Ensure the replacement bulb is the same number as the original.**

Headlamps.

1. Carefully prise the front rim off the lamp.

2. Remove the three screws securing the unit rim and light unit to the seating rim and lift away the unit rim. Do not turn and disturb the setting of the two spring loaded beam adjustment screws as this would upset the alignment of the light unit.

3. Withdraw the light unit, when the unit can be removed from the adaptor.

4. Re-assemble the lamp by reversing the foregoing procedure ensuring that the projections on the light unit locate in the recesses in the seating rim.

Side and Flasher Lamps.

Access to the bulb is obtained by removing the two lens securing screws and lifting off the lens.

Stop/Tail/Flasher Lamps.

Access to the bulbs is obtained from inside the vehicle, after the cover, and centre screw on the lamp pillar have been released. The upper bulb is included in the flasher circuit wiring and is of the single pole type, whilst the lower is a two pole stop/tail lamp bulb, which has staggered pins, thus ensuring that the bulb cannot be wrongly fitted and the bright filament of the bulb is connected in the stop lamp circuit.

Rear Number Plate Illumination Lamp.

When bulb renewal is necessary, release the domed-shaped glass by sliding the retaining wire to one side. Remove the glass, thus exposing the bulb.

Warning Lights.

Removal of the bulbs in the ignition, oil pressure, and flashing direction indicator warning lights, also the main beam warning light (U.S.A. and Canadian Models Only) is carried out as follows:

1. Access to bulb holders is obtained from the rear of the instrument panel.

2. Pull out the bulb holder from its location, unscrew and renew the bulb, as necessary.

Note: The main beam warning light bulb has a bayonet type fixing and should be unplugged from its holder.

Instrument Illumination Lamps.

Withdraw the bulb holders from the speedometer head at the rear of the instrument panel, unscrew and renew the bulbs as necessary.

Interior Lamp.

1. Firmly press one side of the plastic lamp cover inwards so that the retaining lugs on the cover are clear of the slots in the lamp base and lift away the cover. Renew the festoon type bulb.

2. When refitting the cover first enter the lugs in the slots on one side of the lamp base and then press it into position.

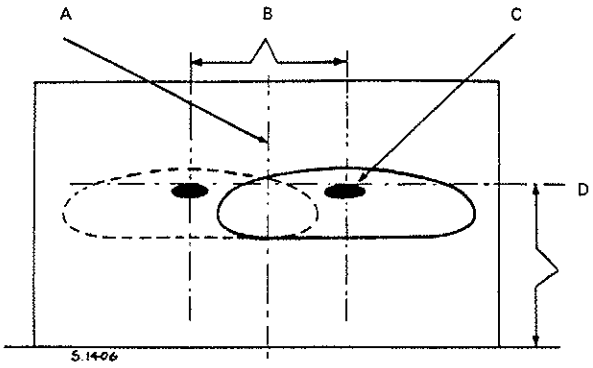
HEADLAMPS

To Set the Beams.

It is desirable to use a reputable brand of spirit level type headlamp aligner if the best standards of accuracy are to be obtained.

If this equipment is not available, proceed as follows:

1. Carefully prise the front rim off the lamp thereby exposing the two spring-loaded adjustment screws.



A CENTRE LINE OF VEHICLE
B DISTANCE BETWEEN LAMPS
C AREA OF CONCENTRATED LIGHT
D HEIGHT OF LAMP CENTRES FROM GROUND

Fig. N.33. Method of aligning headlamps

2. The screw at the top of the lamp controls the vertical setting and the screw on the side controls the horizontal setting.

3. When setting the lamps place the laden vehicle on a level surface squarely in front of a blank wall or screen at a distance of at least 25 ft. (7·5 m.).

To Remove.

1. Carefully prise the front rim off the lamp.

2. Remove the three screws securing the unit rim and light unit to the seating rim and lift the rim away. Lift the light unit clear after removing the adaptor.

3. Withdraw the two adjusting screws from the seating rim and, after releasing the tensioning spring, remove the seating rim.

4. Disconnect the headlamp leads from the main cable harness at the snap connectors.

5. Carefully drill the heads off the three pop rivets securing the headlamp body in position, then withdraw the body followed by the rubber seating gasket.

Inspection and Overhaul.

1. Examine the body seating gasket and renew if damaged or deteriorated.

2. Check the leads for damage and ensure that the snap connectors are in good condition.

3. Test the sealed beam filaments. Renew the sealed beam unit if cracked or damaged.

To Refit.

Reverse the removal procedure ensuring that the projections on the light unit fit into the slots of the light unit rim and that the leads are correctly connected to the main cable harness as shown in the wiring diagram.

Before refitting the front rim, set the headlamp beams as previously detailed in this sub-section.

SIDE AND FLASHER LAMPS

To Remove.

1. Remove the lens securing screws and withdraw the lens and gasket.

2. Remove the screws securing the bulb holder and base assembly to the plinth and withdraw this assembly together with the base rubber.

3. Disconnect the lamp leads from the main harness at the snap connectors, and lift the lamp clear.

Inspection and Overhaul.

1. If the lens is cracked or damaged it should be renewed. Clean the lens with a soft cloth before refitting.

2. Test the bulb filament, renew as necessary.

3. Check the leads for damage and ensure that the snap connectors are in good condition.

4. Ensure that both the lens gasket and base rubber are not damaged or deteriorated. Renew if necessary.

5. Examine the contact spring for weakness.

To Refit.

Reverse the procedure for removal, ensuring that the leads are correctly connected to the main wiring harness, as shown in the wiring diagram.

STOP/TAIL/FLASHER LAMPS

To Remove

1. Remove the cover from the inside rear body panel that shields the lamp.

2. Release the central screw from the bulb holder strip and withdraw the holder and bulbs. Disconnect the rear lamp leads from the cable harness at the snap connectors provided, when the bulbs and holders can be lifted clear. Withdraw the bulbs.

3. Remove the lamp body securing nuts, withdraw the lens and lamp assembly, also the rubber surround gasket from the outside rear body panel.

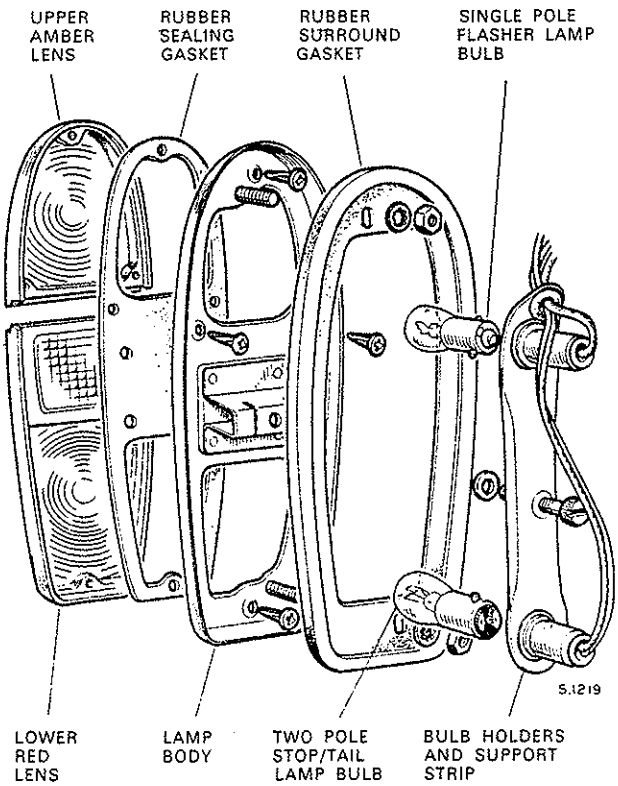


Fig. N.34. Stop/tail/flasher lamp details

Inspection and Overhaul.

1. Check the upper and lower lens for cracking and damage, which if found, necessitates the removal of the lens from the lamp body for renewal. Proceed as follows:

(*a*) Remove the screws securing the lens to the body of the lamp. Renew cracked and damaged lens. Clean original lens with a soft cloth before refitting.

(*b*) Examine the lens rubber sealing gasket for deterioration, renew as necessary.

(*c*) Locate the lens sealing gasket about the lamp body and position the upper and lower lens, so as to line up with the securing screw holes in the lamp body. Refit and tighten the securing screws, ensuring the lens seats squarely on the sealing gasket.

2. Test the bulb filaments.

Note: The lower stop/tail lamp bulb has staggered pins, thus ensuring that the bright filament is connected to the stop lamp circuit.

3. Examine the contact springs for weakness and the insulating pieces for damage.

4. Check the leads for damage and ensure the snap connectors are in good condition.

To Refit.

Carry out this operation by reversing the removal procedure, ensuring the leads are connected correctly in accordance with the colour coding and the wiring diagram as shown at the rear of this section.

REAR NUMBER PLATE ILLUMINATION LAMP

To Remove.

1. Release the two screws securing the lamp base to the support bracket.

2. Disconnect the illumination lamp lead from the cable harness at the snap connector provided, when the lamp can be lifted clear.

3. Slide the retaining wire to one side and remove the dome-shaped glass. Withdraw the bulb.

Inspection and Overhaul.

1. If the dome-shaped glass is cracked or damaged it should be renewed.

2. Examine the rubber seating pad on the lamp base, for deterioration.

3. Inspect the central contact spring for weakness and the insulating piece for damage.

4. Check the lead for damage and ensure the snap connector is in good condition.

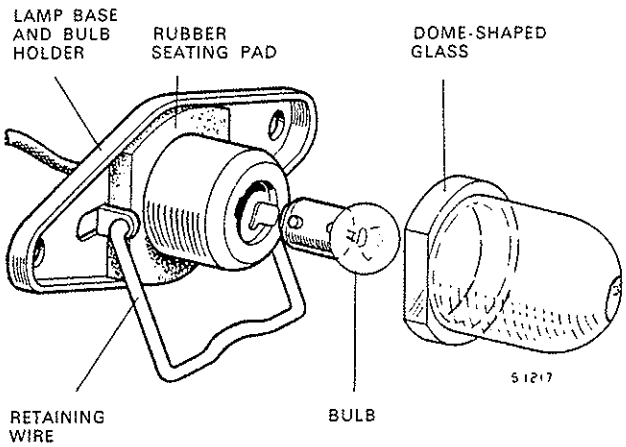


Fig. N.35. Rear number plate illumination lamp details

To Refit.

Refit the illumination lamp by reversing the procedure given for removal.

INTERIOR LAMP

To Remove.

1. Firmly press one side of the plastic lamp cover inwards so that the retaining lugs on the cover are clear of the slots in the lamp base and lift away the cover.

2. Withdraw the bulb.

3. Disconnect the feed lead from the spring socket within the lamp. Straighten the lead so it will pass freely through the lamp base upon removal of the lamp.

4. Remove the lamp fixing screws and lift away the lamp body.

Inspection and Overhaul.

1. If the plastic cover or lamp base is cracked or damaged, the complete lamp assembly must be renewed.

2. Test the festoon bulb filament.

3. Check the sliding switch positioned on the lower edge of the lamp for correct operation, and ascertain if the copper switch contacts are clean and bright, if corrosion exists, clean the contacts with the aid of fine emery cloth.

4. Inspect the lead for damage, also the connector thimble.

To Refit.

Carry out this operation by reversing the removal procedure, ensuring that the feed lead is located through the lamp base and into its respective spring socket, as the lamp assembly is finally positioned.

Note: One of the lamp fixing screws provides for earthing the lamp circuit.

MAIN BEAM WARNING LAMP (U.S.A. AND CANADIAN MODELS ONLY)

To Remove and Refit.

1. Release the bulb and holder from the rear of the instrument panel at the lamp lens sleeve.

2. Withdraw the lens sleeve from the panel, by applying pressure to the rear end of the sleeve.

3. The warning lamp can be refitted, by reversing the removal procedure.

SWITCHES

DESCRIPTION

A main lighting switch, a dipper switch, a direction indicator switch and a stop lamp switch are included in the appropriate circuits for controlling the lamps.

The **main lighting switch,** which forms an assembly with the ignition switch is mounted on the instrument panel to the left of the centrally positioned speedometer. Rotating the main switch in a clockwise direction to the first position completes the circuit to the side lamps, the tail lamps and the number plate illumination lamp, also the instrument illumination lamps. Rotating the main switch still in a clockwise direction to the second position completes the headlamp circuit, in addition to those mentioned previously.

The **dipper switch** is foot operated and positioned to the left of the clutch pedal. The headlamp bulbs have dual filaments and when the dipper switch is brought into operation the circuit is switched from the lower to the upper filaments to give a dipped beam.

The **direction indicator switch** is mounted on the steering column directly below the steering wheel. For the description and operation of this switch, see "DIRECTION INDICATORS".

The **stop lamp switch** is fitted to the brake pipe connector, positioned on the off-side wing valance, directly above the independent front suspension unit. This switch is operated automatically when the foot-brake is applied, being controlled by brake fluid pressure.

The **oil pressure switch** is located on the lower offside of the engine crankcase and is connected to the main engine oil gallery. The switch operates automatically when the oil pressure in the gallery reaches a pre-determined figure. This switch is connected in circuit with the oil pressure warning light on the instrument panel.

The **starter switch** is of the push type and is fitted to the engine front cowl on the driving side. The switch is interposed in the main battery negative feed lead to the starter motor and is hand operated.

The **wiper switch** is positioned on the left-hand instrument panel flange and is connected in the wiper motor circuit, so that when the switch contacts are closed ("ON" position) the circuit is completed and current is passed to the motor. The switch can be placed in the "OFF" position when the wiper blades are in any position on the screen, for a limit switch included in the wiper motor assembly "parks" the wiper arms automatically.

The **interior passenger lamp switch** (Bus

Models Only) is located on the front body header panel to the right of the interior lamp and operates the four interior lamps positioned about the rear body roof panel.

MAIN LIGHTING AND IGNITION SWITCH

To Remove and Refit.

1. Disconnect the negative lead from the battery post terminal.

2. Release the leads from the rear of the switch.

3. Remove the clamping screw from the securing wire and lift the wire from the slots in the switch body sides. Withdraw the switch complete from the front of the instrument panel.

4. The ignition barrel lock is located in the switch body by means of a spring loaded plunger. If it is required to remove the lock, compress the plunger with a piece of rod, inserted in the hole on the underside of the switch.

Note: The switch must be in the "OFF" position to align the hole in the metal case with the drilling through the moulding.

5. Withdraw the moulded switch knob upon depressing the knob retaining plunger.

6. Reverse the removal procedure to refit the switch, ensuring that the leads are connected as shown in the wiring diagram.

DIPPER SWITCH

To Remove and Refit.

1. Lift the floor mat to expose the dipper switch securing screws.

2. Remove the screws securing the dipper switch to the floor plate.

3. Raise the switch and disconnect the leads at the "Lucar" connectors provided. It can now be lifted clear.

4. To refit, reverse the removal procedure, ensuring that the leads are connected in accordance with the colour coding and wiring diagram.

STOP LAMP SWITCH

To Remove and Refit.

1. Disconnect the leads from the stop lamp switch at the "Lucar" connectors provided and unscrew the switch from the brake pipe connector. Seal the hole in the connector to prevent loss of brake fluid and entry of dirt.

2. After refitting the switch, bleed the hydraulic system, as detailed under "BRAKES" section.

Note: Do not operate the foot brake pedal while the stop lamp switch is removed and the temporary plug is in position.

HANDBRAKE STOP LIGHT SWITCH

The switch is bracket mounted beneath the body and is operated through spring and chain by the movement of the relay lever when the handbrake is applied.

To Remove.

1. Disconnect the battery.

2. Disconnect the chain from the switch lever and the leads from the switch terminals.

3. Release the setscrews, nuts and washers and withdraw the switch.

4. Remove the spring and chain from the relay lever.

Inspection.

Check the operation of the switch, if faulty it must be renewed. Also check the spring and chain for wear or damage, renewing if evident.

To Refit.

1. Refit the switch to the bracket and reconnect the leads to the switch terminals.

2. Attach the chain to the switch lever and the spring to the drilling in the relay lever.

3. With the handbrake in the released position, attach the free end of the spring to a link in the chain ensuring that as much slack as possible is taken up without causing tension on the switch lever.

4. If necessary, final adjustment may be carried out by moving the switch backwards or forwards within its elongated fixing holes.

5. Reconnect the battery.

OIL PRESSURE SWITCH

To Remove and Refit.

1. Disconnect the lead to the switch at the "Lucar" connector provided.

2. Remove the switch unit, using a suitable spanner applied to the hexagon on the switch. Do not run the engine while this switch is removed. Seal the hole

in the engine crankcase to prevent the entry of dirt, etc.

3. Refit the switch by reversing the removal procedure, fitting a new fibre washer over the threaded sleeve.

STARTER SWITCH

To Remove and Refit.

1. Hinge the engine cover forward, also the passenger seat (if fitted) to gain access to the starter switch.

2. Remove the negative lead from the battery terminal post.

3. Disconnect the leads from the switch terminals, noting the control box feed lead is connected at the switch, on the terminal which carries the battery negative lead.

4. Unscrew the switch cap, release the central switch securing nut and withdraw rearwards the complete switch from its mounting.

5. The starter switch is a sealed unit and should it become inoperative, the switch complete must be renewed.

6. To refit the switch, reverse the procedure given for removal, noting that the battery negative lead and control box feed lead are connected to the one terminal.

WIPER SWITCH

To Remove and Refit.

1. Release the switch clamp nut and withdraw the complete switch from the rear of the instrument panel, sufficiently to expose the leads.

2. Disconnect the two leads at the "Lucar" connectors and lift away the switch.

3. Reverse the removal procedure to refit the switch.

INTERIOR PASSENGER LAMP SWITCH (BUS MODELS ONLY)

To Remove and Refit.

1. Disconnect the lead from the interior lamp located on the front body header panel. Remove the screws securing the header panel, and lift away the panel sufficiently to expose the connectors on the lamp switch, which should be released. The header panel can now be completely withdrawn.

2. Release the switch clamp nut and withdraw the switch.

3. To refit the switch, reverse the procedure given for removal.

INSTRUMENTS AND GAUGES

INSTRUMENT PANEL

To Remove and Refit.

1. Disconnect the negative lead from the battery post terminal.

2. Release the knurled nut securing the speedometer cable to the rear of the speedometer.

3. Withdraw the three warning light bulb holders and the two instrument illumination light bulb holders from their respective locations at the rear of the speedometer.

4. Pull out main beam warning lamp bulb holder (U.S.A. and Canadian Models Only) from the rear of the lamp assembly.

5. Remove the instrument panel securing bolts, two off located at the top underside of the panel, and passing through the cab front rail, and two off located at a mid-position of the panel, and passing through brackets. attached to the lower edge of the cab front rail.

6. Raise the panel sufficiently to gain access to the lead connections at the switches and fuel gauge.

7. Disconnect all leads from the main lighting and ignition switch, the wiper switch and the fuel gauge, making special note of the lead locations to the gauge terminals.

8. Withdraw the panel.

9. To refit the instrument panel reverse the procedure given for removal in paras. (1) to (8) inclusive, ensuring the leads are connected correctly in accordance with the colour coding and the wiring diagram as shown at the end of this section.

SPEEDOMETER AND FUEL GAUGE

To Remove and Refit.

1. Proceed as detailed under "**INSTRUMENT PANEL. To Remove and Refit**", paras. (1) to (3) inclusive.

2. Disconnect the leads from the fuel gauge

making special note of the lead locations to the gauge terminals.

3. Remove the two knurled nuts and the P-shaped clips clamping the speedometer. Withdraw the speedometer and fuel gauge assembly from the front of the instrument panel.

4. Release the two screws securing the fuel gauge to the rear of the speedometer. Suitably place the fuel gauge so as to protect the scale and pointer, which are now exposed.

5. To refit, reverse the removal procedure given in paras. (1) to (4) inclusive, ensuring the leads are connected correctly in accordance with the colour coding and the wiring diagram.

FUEL TANK GAUGE UNIT

To Remove and Refit.

1. Drain sufficient fuel from the tank so as to bring the level below the gauge unit housing.

2. Disconnect the lead from the gauge unit at the connector provided.

3. Remove the securing screws and withdraw the gauge unit from the rear of the tank. When lifting out the gauge unit, be careful not to damage the float or arm, as this would cause a false reading on the fuel gauge upon refitting.

4. Clean all traces of the old sealing gasket from the gauge unit flange and the mating face on the fuel tank.

5. Reverse the removal procedure to refit the tank gauge unit, using a new sealing gasket to ensure a fuel tight joint results. The gauge cover plate is marked "TOP" for location purposes, ensure this side of the gauge is positioned facing towards the upper face of the fuel tank.

6. Check the gauge unit for correct operation, observing the fuel gauge on the instrument panel as the fuel tank is refilled. The ignition switch should be in the "ON" position whilst this check is carried out.

VOLTAGE STABILISER UNIT

This unit which is located behind the facia panel on the inside of the right-hand diaphragm panel, ensures a constant supply of voltage to the equipment which it serves, i.e. fuel and temperature gauges.

The mean voltage between "I" and earth is 10 volts. Renew the stabiliser if faulty, paying particular attention to the following precautions.

(*a*) Ensure that the cables from the instruments are connected to their correct terminals on the stabiliser.

(*b*) Ensure that the unit is mounted with its securing lug set vertically and the fixing hole at the bottom.

(*c*) Ensure that a good earth exists through its mounting lug.

Important: Failure to observe these precautions will result in inaccurate instrument readings.

To Remove

1. Disconnect the battery terminals.

2. Disconnect the leads from the stabiliser.

3. Unscrew the two self-tapping screws and withdraw the unit.

To Refit.

Refitting is a reversal of the removal procedure paying particular attention to the precautions previously listed.

ACCESSORIES

HORN

A single miniature wind tone horn, model 9H, is fitted to the front underbody crossmember and is connected through the fuse unit to the horn push button in the centre of the steering wheel.

If a horn fails to sound or its performance becomes uncertain, the fault need not necessarily be in the horn. First ensure that the trouble is not due to a loose or broken connection in the wiring of the horn circuit or to a discharged battery. A short circuit in the horn wiring will cause the circuit breaker contacts to open. In this event, examine the wiring for the fault and rectify accordingly.

Poor performance can also be caused by loosening of the mounting bolts, which should be checked and tightened as necessary.

If examination proves these points to be in order, the horn may need adjustment but this should not become necessary until the horn has been in service for a long period.

Adjustment.

Adjustment does not alter the pitch of the note but

merely takes up wear of moving parts. If a horn does not sound after making an adjustment, release the horn push instantly.

A small serrated adjustment screw is provided on that side of the horn at which the cables terminate.

Turn this screw anti-clockwise until the horn just fails to sound, then turn it back for about one quarter of a turn.

Important: It is essential that the central slotted stem and locking nut are not disturbed.

A 12-volt horn in correct adjustment will pass 3·0–3·5 amperes measured on a first grade moving coil 0—10A ammeter. If a suitable instrument is available, connect it in series with the horn and turn the adjustment screw clockwise to increase the current, or anti-clockwise to decrease it. When adjusting a horn by the aid of an ammeter, the aim is to obtain the best performance with the least current.

To Remove and Refit.

1. Detach the cable leads at the connectors on the horn and release the horn from the mounting bracket by unscrewing the two securing bolts.

2. Refitting is a reversal of the removal operation.

HORN PUSH

The horn push consists of a central push button under which is fitted a tapered coil spring. A contact plunger passes through a hole in the steering wheel boss connecting the horn push with a brass ring in the base of the steering wheel boss. A tongue in the flashing indicator control assembly is in contact with this ring so that the horn circuit is maintained during rotation of the steering wheel.

To Remove.

1. Remove the horn push cap assembly by levering off with a screwdriver. The assembly is a spring fit in the steering wheel boss.

2. Lift out the contact plunger and spring.

Inspection and Overhaul.

1. Examine the contact plunger and ensure that the ends are in good condition and free from grease or dirt.

To Refit

1. Replace the contact plunger with the brass end facing downwards (see Fig. N.37).

2. Replace the spring with the larger end uppermost and ensure that when the horn push cap assembly is refitted the spring locates in the centre of the cap and on top of the inner column.

DIRECTION INDICATORS

Description.

The flashing direction indicator system consists of a switch mounted on the steering column and a flasher unit situated below the parcel shelf adjacent to the fuse unit.

On moving the switch on the column downwards (for right-hand turns) or upwards (left-hand turns) the indicator lights flash intermittently at both the front and rear of the vehicle on the side, to which the turn is to be made.

At the front a bright filament is contained within each side lamp, while at the rear a separate bulb is illuminated behind an amber lens.

A green pilot (warning) light situated at the top of the speedometer dial gives an indication that the indicators are operating correctly. A self cancelling device incorporated in the switch is operated by a trip lever fixed to the steering inner column.

Operation.

The flasher unit depends for its operation on an electro-magnet in conjunction with the linear expansion of a piece of wire, which becomes heated as current flows through it.

The expansion and contraction of the wire controls the speed, at which the armature carrying the moving contact will move, as a result of the pull exerted by the electro-magnet and the sequence of operations is as follows:

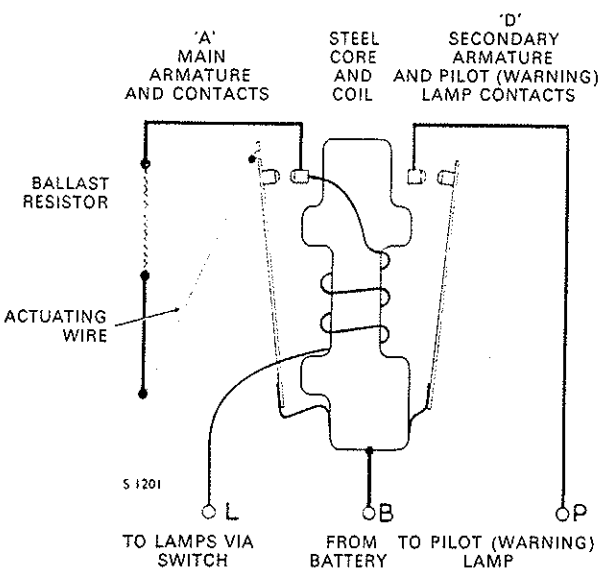


Fig. N.36. Flasher unit circuit

As current flows from terminal "B" to terminal "L" and the lamps, via the resistance wire and electro-magnet, the wire heats up and expands.

This allows the armature carrying one of the contacts to be attracted to the pole piece of the electro-magnet, closing contacts (A) and full voltage is then applied to the lamps, via the windings of the electro-magnet. Contacts (D) are also closed completing the pilot lamp circuit.

While contacts (A) are closed the resistance wire is short circuited and cools off. The taut section of the resistance wire contracts and pulls back the armature to open contacts (A).

The pilot lamp on the facia panel will not flash unless sufficient current to light the bright filaments in side lamp and rear flasher lamp is passing through the windings of the electro-magnet to close contacts (D). The flashing pilot lamp, therefore, gives the driver a clear indication that the direction indicators are working correctly.

It will be noted that in order to maintain the desired rate of flashing (British Ministry of Transport Regulations, 60–120 per minute) the filaments of the front and rear lamps are "pre-heated", via the resistance wire during "out" period of the flash.

Operation of the Direction Indicator Switch.

When the direction indicator switch is moved to give a left or right turn signal it connects the rear flasher lamp on that side of the vehicle to terminal "L" on the flasher unit. At the same time it also connects the bright filament in the side lamp to flasher unit terminal "L".

Maintenance.

Flasher units cannot be dismantled for subsequent re-assembly. A defective unit must therefore be renewed.

Checking for Faulty Operation.

A correctly operating direction signal will be indicated by a regular intermittent flashing of the green pilot lamp located on the speedometer dial in front of the driver. If, when the direction indicator is switched on, the warning (or pilot) lamp does not flash in the usual manner but remains unlit, first check that this is not due to filament failure in either the front or rear lamp on that side. This can be checked by turning the switch to the opposite side, if the pilot lamp now flashes, the circuit is in order and bulb replacement is indicated. On the other hand, if the pilot lamp still does not flash, inspect the indicator lamps. If these are working normally, failure of the pilot lamp bulb is indicated. If, however, the indicator lamps are not functioning, it will be necessary to proceed to check the wiring and flasher unit.

The efficiency of the flasher unit may be readily checked by plugging in a known substitute.

The inoperative side or rear flasher lamp bulbs should be checked for a burned out bright filament. Where it is found that neither lamp is burned out the wiring between the defective lamp and indicator switch must be checked.

If the direction indicator is entirely inoperative, check the fuse, flasher unit and circuit from the fuse unit up through the steering column switch in the order named.

FLASHER UNIT

To Remove.

Pull the flasher unit out of the socket situated beneath the parcel shelf.

Inspection and Overhaul.

If the flasher unit is found to be inoperative it should be replaced by a new unit as it is not possible to overhaul a faulty unit.

To Refit.

Plug the flasher unit firmly into its socket.

DIRECTION INDICATOR SWITCH

To Remove.

1. Disconnect the battery.

2. Remove the cowl after releasing the three securing screws.

3. Disconnect the switch leads at the snap connectors, taking note of their positions by means of the lead colour coding to facilitate re-assembly.

4. Remove the two screws securing the clamping strip and take off the switch assembly.

To Refit.

1. Secure the switch assembly to the column with the clamping strip without, however, fully tightening the clamping strip screws.

2. Position the switch so that the flat on the switch lever body is 0·8 in. (20 mm.) from the horn contact plate (see Fig. N.37).

3. Fully tighten the clamping strip screws.

4. Adjust the position of the trip lever on the inner column so that when the front wheels are in the straight ahead position it is situated centrally between the two switch cams.

5. Ensure the switch leads are connected correctly in accordance with the colour coding and the wiring diagram. Replace the cowl and secure with the three screws. Reconnect the battery.

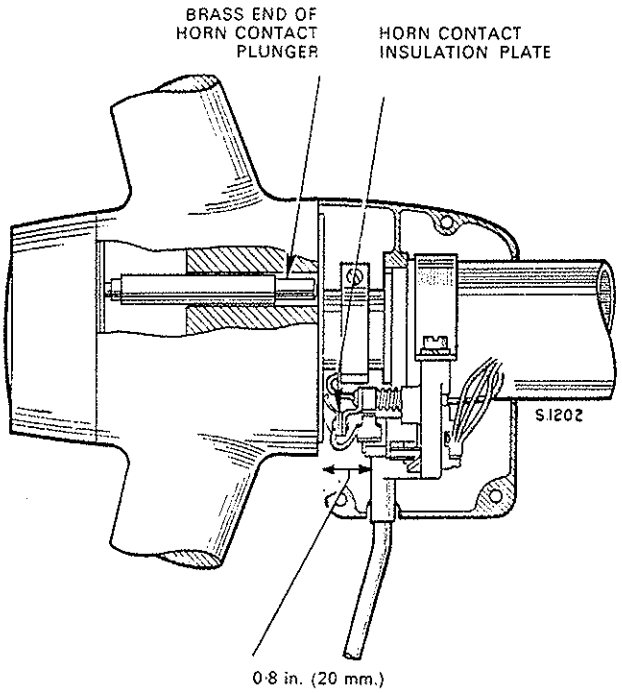


Fig. N.37. Location of direction indicator switch (also shown horn push contact plunger)

WINDSCREEN WIPER MOTOR

Description.

Twin windscreen wipers mounted at the top of the windscreen are driven by a single speed motor centrally placed behind the header panel and operated by a switch on the instrument panel.

The motor and gearbox unit together with the linkage drive is carried on a mounting bracket, which is secured to the vehicle at three points—centrally, by bolt-fixing, and at each wiper arm spindle where a hexagonal nut positions each spindle assembly above the windscreen. The conversion of the rotary armature motion to the oscillating movement of the wiper arms is achieved by a rotary link coupled to the motor output drive, pushing and pulling on connecting rods secured to the wiper arm spindles, via two smaller oscillating links. The motor output speed is reduced considerably from that of the armature by the incorporation of a single stage nylon reduction gear.

The arms and blades return automatically to the parked position irrespective of their siting on the windscreed at the instant of switching off. This self-parking feature is arranged by means of a limit switch located in the gearbox beneath the domed cover. For the greater part of each wiping cycle the contacts of this switch are closed and provide an earth return path for the motor current in parallel with that provided by the wiper control switch. The moving contact consists of a phosphor bronze blade carried by and in electrical contact with the earthed gear plate. This contact bears against a brass plate riveted to, but insulated from the domed cover. The brass plate consists of a disc, from which a sector has been cut and is connected to the motor windings by way of a cable and terminal tag positioned on top of the domed cover. On switching off at the wiper control switch, the motor continues to run until the moving contact passes on to the insulated sector portion and so interrupts the earth return circuit and stops the motor. The domed cover is angularly adjustable for obtaining the correct park position of the wiper blades (see Fig. N.39); the position of the cover determining the instant in the wiping cycle that the moving contact will reach the insulated portion of its travel.

The motor is fully protected from overloading by the incorporation of a temperature/current-operated thermostat. If the wiper blades are prevented from moving by, for example, packed snow or ice on the windscreen or should the linkage be damaged causing overloading, then the motor will be automatically disconnected from the supply before damage can occur. Normal working will be resumed when the motor has cooled, providing that the obstruction has been removed.

Lubrication.

The armature bearings, gearbox, linkage pivots and wiper arm spindles are lubricated during manufacture and require no periodic lubrication in service.

Testing on Vehicle.

Poor performance can be electrical or mechanical in origin and not necessarily due to a faulty motor, e.g.:

(*a*) Low voltage at the motor due to poor connections.

(*b*) A discharged battery.

(*c*) Excessive loading on the wiper blades.

(*d*) Wiper arm spindles binding in the bearing housings.

Using the origin of the fault when apparent, proceed as follows to determine the cause of failure.

1. Measuring Supply Voltage. Using a high grade moving coil voltmeter, measure the voltage between the motor supply terminal (to which the green cable is connected) and a good earthing point. This should be 11·5 volts with the wiper working normally. If the reading is low, check the battery, switch (by substitution), cabling and connections.

2. Measuring Light Running Current. If the normal running terminal voltage is correct, remove the arms and blades from the wiper spindle driving drums and measure the light running current with a high grade moving coil ammeter connected in the

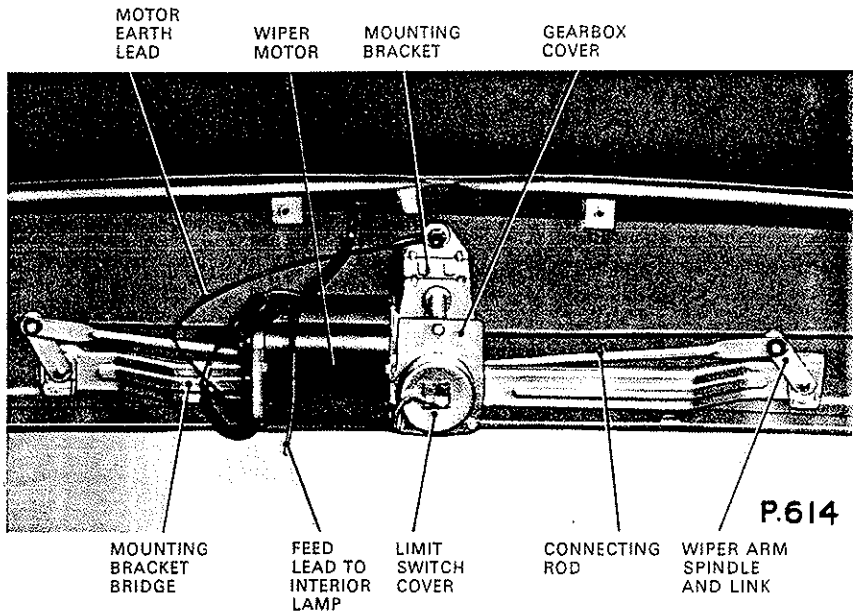


Fig. N.38. Windscreen wiper layout

supply cable. The current value should be between 3·0–3·7 amps. If higher than 3·7 amps. it will be necessary to remove the wiper motor complete with mounting bracket and test the motor again after disconnecting the rotary link from the motor drive. The current reading should not now exceed 3·4 amps. If it does, fit a replacement windscreen wiper motor or dismantle the unit for examination.

To Remove.

1. Remove the wiper arms (see Fig. N.40).

2. Disconnect the lead from the interior lamp. Remove the screws securing the header panel and lift away the panel.

3. Disconnect the earth and wiper motor leads. Release the single bolt securing the mounting bracket and remove the hexagonal nut and rubber bush from each wiper spindle. Withdraw the complete wiper assembly.

4. Disconnect the rotary link from the motor drive, taking care not to lose the washer fitted beneath the link.

5. Remove the three pillar screws and six washers and withdraw the motor from the mounting bracket.

(Note that the three washers, which fit directly under the screw heads have larger holes than the others.)

To Dismantle.

1. Note carefully the position of the pip on the domed cover before unscrewing the three self-tapping screws securing the gearbox cover.

2. Lift out the final gear and limit switch blade assembly from the gearbox.

3. Withdraw the circlip from the switch blade carrier noting particularly that the prongs of the circlip pass on either side of a small turned up tag on the slotted portion of the switch blade. The circlip must be positioned in like manner when refitted.

4. Unscrew and withdraw the two through bolts taking care not to lose the shakeproof washers.

5. Withdraw the commutator end cover.

6. Note carefully the side and position occupied by each brush to ensure refitment exactly the same way round and withdraw the brushgear, taking care not to overstretch the tension spring.

7. Unsolder the limit switch wire from its terminal on the domed cover.

8. Withdraw the yoke from the armature.

9. Unscrew the field coil assembly self-tapping securing screws and withdraw the assembly out of the yoke, noting carefully the hole occupied by each screw for subsequent re-assembly. Note also that the end of the pole piece nearest the commutator is chamfered.

10. Withdraw the armature and worm assembly from the gearbox.

Inspection and Overhaul.

1. Examine the final gear and limit switch assembly, particularly the gear teeth and motor output drive shaft. These should be free from damage or wear.

2. Check that the pressure exerted by the brushes on the commutator is 125 to 140 grammes.

Note: Windscreen wiper motor brushes should be renewed when they have worn to half their original length.

To Re-assemble.

Re-assembly is the reversal of the dismantling procedure previously described, noting the following:

1. The following parts should be lubricated before re-assembly taking great care to keep the commutator and brushgear free from oil and grease.

Three oil impregnated porous bronze bearings are fitted—one for the gear shaft and two for the armature shaft, the bearings for the latter being self-aligning. Oiline B.B.B. should be applied sparingly to these bearings, the felt backing washers and the armature shaft before assembly. It is important that the felt washers are not overloaded with oil.

Apply Oiline B.B.B. sparingly to the final gear shaft, and Ragosine Listate Grease to the driving pin and linkage pivots. Between 25 and 35 cubic centimetres of Ragosine Listate Grease is applied to the worm and gear on initial assembly. The brass switch plate and switch contact should be smeared with petroleum jelly.

2. **Armature End Play.** The adjusting screw in the side of the gearbox should be set and firmly locked to give 0·004–0·008 in. (10·2–20·3 mm.) end play of the armature. (This end play is pre-set when a "Wedglok" screw is used.)

3. **Brushgear.** After assembling the spring, the brush arms must clip on to and be free to move quite freely about the pivots, care being taken not to overstretch the tension spring when refitting. Ensure that no part of the brushgear or brushes can foul the commutator tags or connections and that the brushes are bedded correctly on the copper segments.

4. **Limit Switch Adjustments.** Slacken the three gearbox cover securing screws (see Fig. N.39).

R.H.D. Vehicles.

Rotate the switch cover in the direction of the arrow until the setting pip on top of the cover is at 90° to the figure "O" stamped on the gearbox cover.

L.H.D. Vehicles.

Rotate the switch in the direction of the arrow until the setting pip is at 270° to the figure "O".

Re-tighten the gearbox cover securing screws.

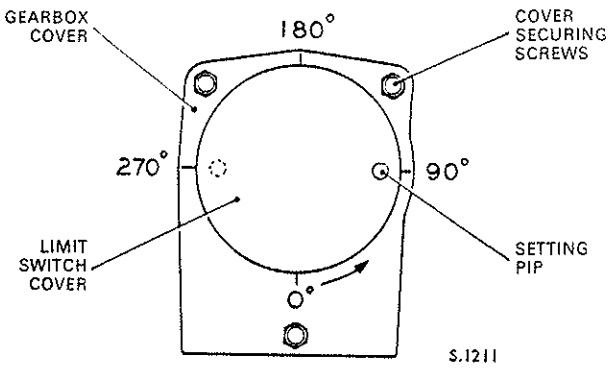


Fig. N.39. Setting wiper limit switch cover

To Refit.

Refitting the wiper motor assembly is a reversal of the removal procedure.

WIPER ARM AND BLADE ASSEMBLY

To Remove and Refit.

1. Lift the retaining clip on the wiper arm boss and slide the arm from the splined driving drum.

2. When refitting the arms and blades, first ensure that the wiper arm spindles are in the correct parking position by switching on the motor and then switching off and waiting for them to come to rest at the end of a cycle.

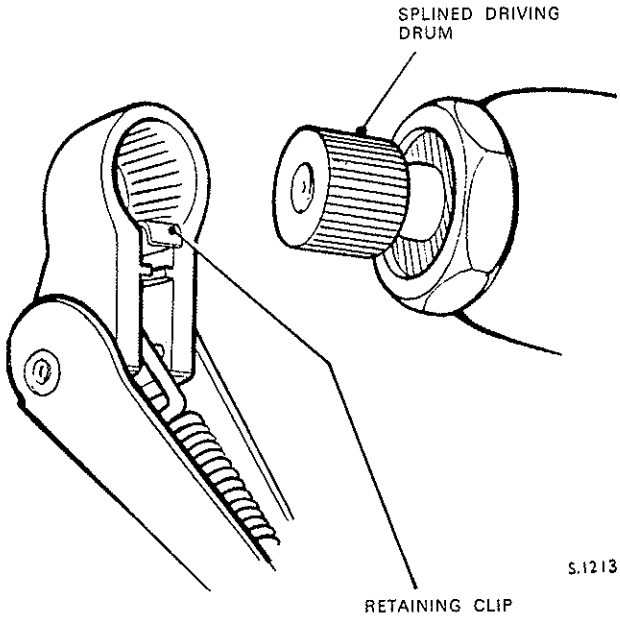


Fig. N.40. Wiper arm attachment

3. Fit the arms and blades to the splined driving drums on the wiper arm spindles at the correct parking angle, pressing the headpieces on until the retaining clip is heard to snap over the end of the drum.

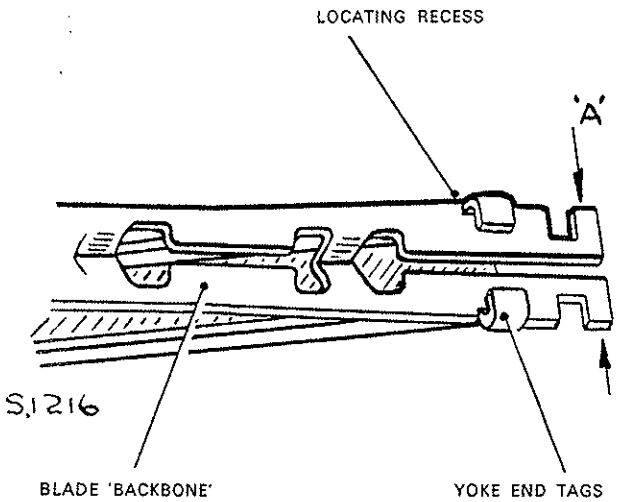
4. Wet the windscreen, switch on and note the wiped areas. If necessary, the position of the arms can be adjusted by removing and re-engaging them in the appropriate position, the pitch of the driving drum splines being 5°.

Note: Do not attempt to turn the arms on the spindles, but press back the retaining clip in the headpieces and withdraw the arms from the driving drums and refit in the desired position.

WIPER BLADES

To Remove.

Carefully ease the wiper blade away from the windscreen and grip the wiper arm, swivelling the blade free from its location on the wiper arm. Rest the arm end against the windscreen, interposing rag or thick cardboard to protect the windscreen.



"A" SQUEEZE BLADE "BACKBONE" SIDES INWARDS TO RELEASE AND WITHDRAW TO THE RIGHT.

Fig. N.41. Releasing the wiper blade "backbone" from the blade yokes

To Dismantle.

When it is required to renew the wiper blade element assembly, consisting of rubber element, blade "backbone" and rubber end caps, proceed as follows:

1. Remove one of the rubber end caps, positioned on the blade "backbone" by prising one side of the cap free from its locating recess, when it can be lifted away.

2. Slide the rubber wiper blade out of the slot in the blade "backbone".

3. The blade "backbone" is supported in the yokes on four pairs of tags and locked in position by recesses, which engage with one end pair of tags on the yoke. Release the blade "backbone", by squeezing together the sides of the locked end, thus freeing it for withdrawal.

To Re-assemble.

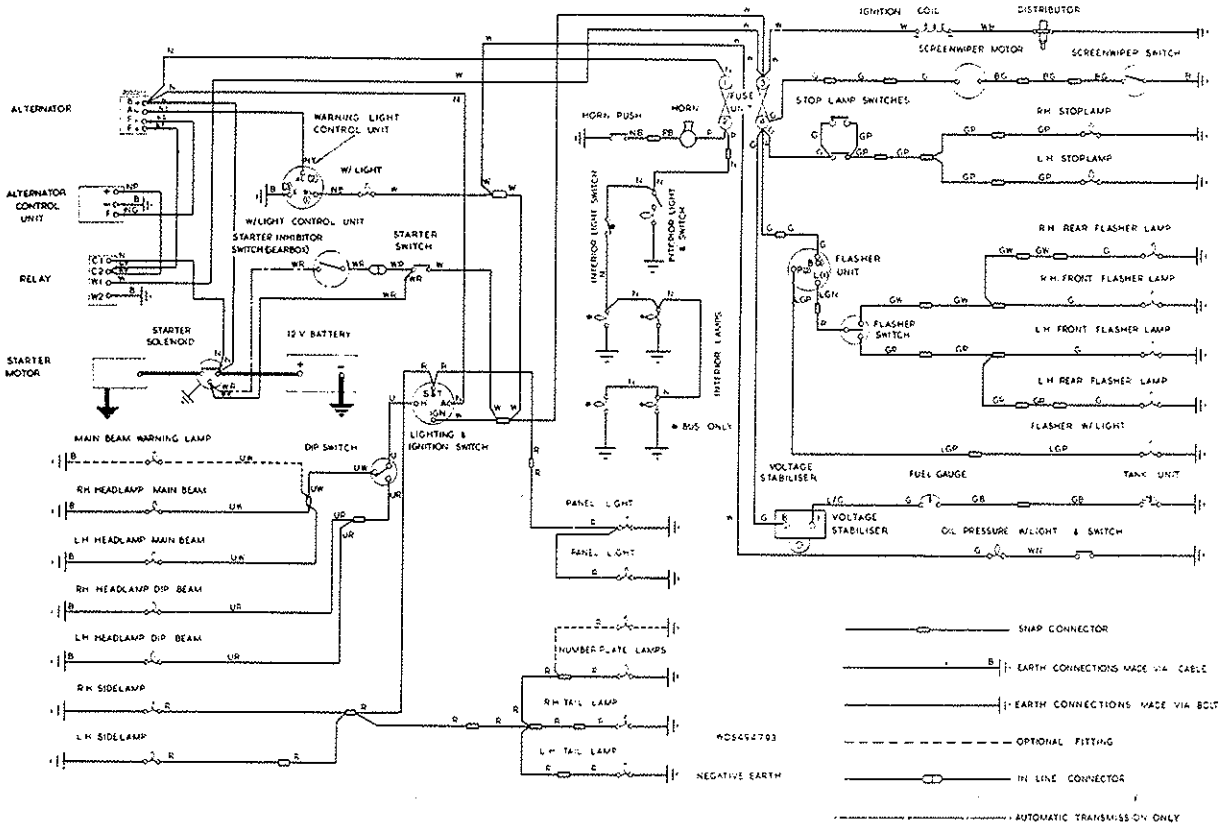
1. New wiper blade assemblies should be handled with care. It is particularly important to keep the rubber clean and free from oil and petrol and to avoid distortion of the blade "backbone".

2. Fit the new blade "backbone" to the yokes, ensuring that the end pair of yoke tags seat correctly in the locating recesses provided in the "backbone".

3. Enter the rubber blade flange into the slot in the "backbone" and slide the blade in until it abuts the assembled end cap. Press on the cap at the opposite end, until it seats correctly in the recesses formed in the "backbone", ensuring the thick section of the cap is positioned to the side carrying the blade elbow.

To Refit.

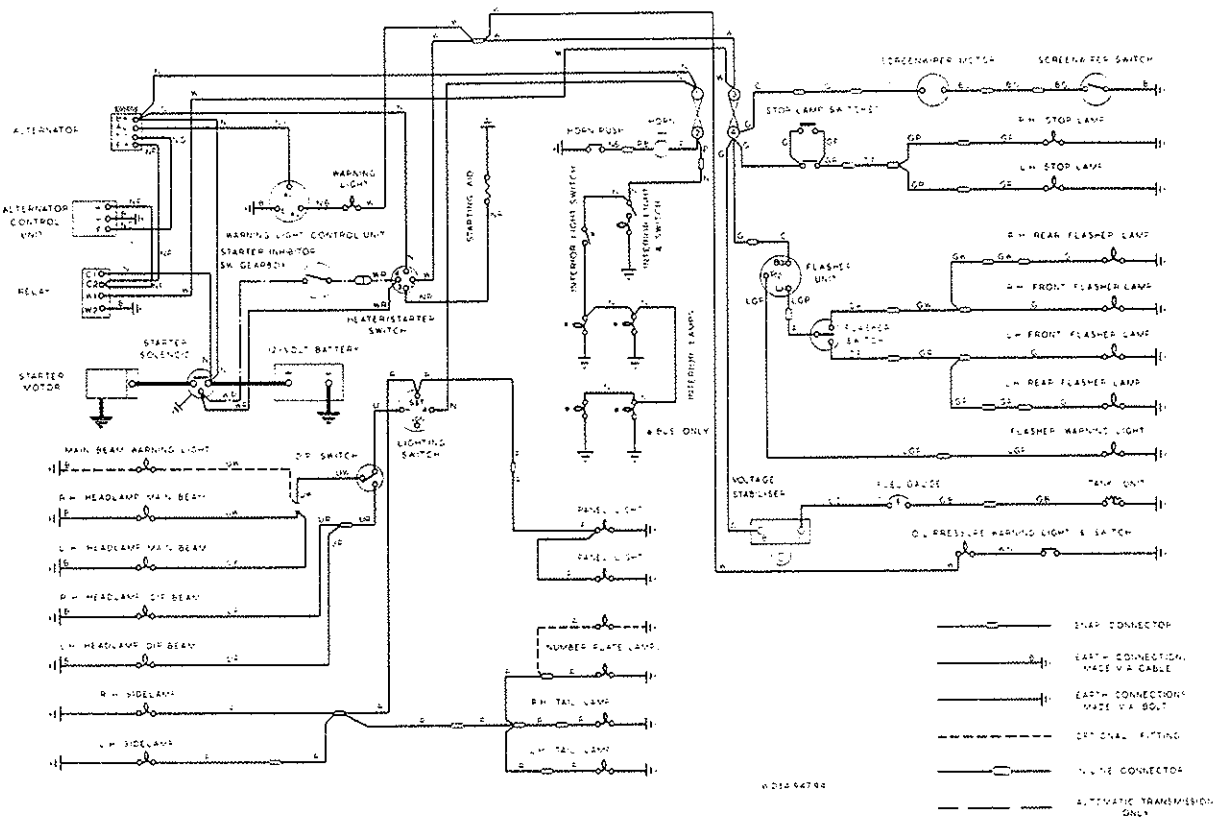
The wiper blades are readily refitted, by locating the end of the wiper arm into the spring loaded pocket provided in the blade elbow, swivelling the two components into engagement, when the pip on the arm will register in the hole situated on the blade elbow.



CABLE COLOUR CODE					
B	Black	R	Red	W	White
U	Blue	P	Purple	Y	Yellow
N	Brown	G	Green	L	Light

When a cable has two colour code letters, the first denotes the main colour and the second denotes the tracer colour.

Fig. N.42. Wiring diagram for petrol models



CABLE COLOUR CODE					
B	Black	R	Red	W	White
U	Blue	P	Purple	Y	Yellow
N	Brown	G	Green	L	Light

When a cable has two colour code letters the first denotes the main colour and the second denotes the tracer colour.

Fig. N.43. Wiring diagram for diesel models

SERVICE BULLETINS

Note:—This page is provided for recording references to Service Bulletins applicable to the preceding Section

SERVICE BULLETIN			WORKSHOP MANUAL	
DATE	VOLUME NO.	SECT/SHT. NO.	PAGE REF	SUBJECT

CAB AND BODY

SECTION O

INDEX

CAB AND BODY

DESCRIPTION

Front End.

This comprises of a one-piece front lower panel which is welded to the one-piece screen aperture panel at a point just below the windscreen. The toeboard is welded to the inner reinforcing panel and runs back to form the wheelarches and seat bases.

The inner reinforcing panel runs from the underside of the toeboard down to the front lower panel, and other panels and supports are added to carry the radiator. A battery tray is mounted behind the seat on each side of the seat bases and the necessary clamping arrangement is provided.

The front panel has a central ventilation aperture, covered by a chrome grille, and fitted with a controllable flap to provide fresh air at leg level and feed the heater (when fitted). A name badge is positioned between the headlamps.

A further aperture is incorporated into the front panel forming a radiator air intake. This is covered by a pierced anodised aluminium grille.

The air intake, together with the cooling duct mounted behind the front panel and secured to the front crossmember provides an adequate supply of cooling air for the radiator.

The location of the front number plate is between the two headlamp units, immediately above the air intake grille.

A full-width millboard parcel shelf runs across the underside of the facia panel and there is a P.V.C. fabric-covered ledge at the base of the windscreen, in which are cut the demister slots.

Two inspection covers are provided in each toeboard panel to enable the master cylinder and supply tanks for both the clutch and brake systems to be reached on R.H.D. and L.H.D. vehicles.

A moulded rubber floor mat is fitted to the front compartment, and an interior lamp is centrally placed in the front header panel.

A removable plaque is also fitted in the front header panel into which the optional clock can be fitted.

Engine accessibility is provided in the first instance by lifting of the central top engine cover to gain access to the radiator and engine oil fillers. This top cover is hinged at the front and retained at the rear by two toggle fasteners. For more detailed servicing it is necessary to remove the retaining screws and lift off the lower cover and the wheelarch covers, and in this instance it is necessary to remove any seats fitted.

Both top and lower covers are fitted with rubber sealing gaskets for dust, fume and draught insulation.

Windscreen.

This is a fixed one-piece wrap-around item made in 0·25 in. (6·35 mm.) toughened plate safety glass (export models are fitted with laminated safety glass) and retained by a plain black rubber weather strip.

Driver's Seat.

An adjustable driver's seat is fitted having a fore and aft adjustment of 4 in. (101 mm.) and the complete seat also tips forward.

The seat frame is made from tubular steel, the cushion is a foam rubber pad mounted on a base board which in turn seats on an interwoven steel wire frame. The squab consists of a polyurethene pad packed by a frame of snake wire springs and the entire seat is trimmed with red P.V.C. fabric.

Grab Handles.

To facilitate entry and exit, a grab handle is mounted on each of the screen posts.

Driving Mirrors.

Two exterior driving mirrors are fitted as standard and, in the case of the hinged door models, these are mounted on each door at the waist rail and on sliding door models they are mounted on each screen post.

Van Sides.

The panels are joined at floor level and there is also a vertical joint just forward of the rear corner.

Sills.

These are box section and welded to the side extremities of the floor.

Roof.

The roof panel is a two-piece pressing which extends forward over the top of the windscreen to form a peak. The panel has internal and external stiffening depressions and a continuous drip moulding is incorporated.

Floor.

This is of steel having longitudinal stiffening depressions to which wooden protection slats can be fitted as an extra, and a wheelbox is incorporated on each side.

A gearbox inspection cover is fitted in the front portion of the rear floor.

Front Doors (Hinged Type).

These doors have a half outer and half inner panel together with a framed top door so that a dropping window can be accommodated. The door is hinged at the front on concealed hinges and is fitted with a metal door check and retainer. The lock is of the rotary type with single pin striker and is push button operated from the outside. The push button incorporates a finger grip and is key locked on the right-hand door. The inside handles have remote links and on the left-hand door locks by reverse movement.

No draught ventilators with painted frames are fitted and the dropping glass is controlled by a single arm winder and handle. All door glass is made from 0·187 in. (4·76 mm.) toughened sheet.

Sponge rubber door seals are fitted all round the door apertures.

Front Doors (Sliding Type).

These doors slide on the outside of the van sides to avoid encroaching on load space and have inside panels with cut-aways below the waist line. The door is flush with the body contour at the front and projects approximately 1·375 in. (35 mm.) outside the body contour at the rear.

The sliding gear consists of continuous ball-bearing slides at the top and double roller wheels working in a guide rail inset in the sill at the bottom. A cover is fitted to the roof edge above the door to conceal the projection and the slides.

On the above models a door lock is fitted, incorporating a front and rear latch and also a forward locating spigot.

When the door is closed, the spigot registers in the hole of the front striker plate ensuring the correct position for securing the latch. Securing the door in the fully open position is automatically achieved by the rear latch of the lock being retained by the rear striker plate which is secured to the body pillar.

The rear rubber door stop is now fitted to the rear striker plate, and contacts the body of the door lock, therefore, when the door is secured in the open position, it is also cushioned against the rubber stop.

The window is of stove-enamelled metal channel and rubber weatherstrip construction with one fixed and one sliding glass panel. All door glass is made from 0·187 in. (4·76 mm.) toughened sheet.

Sponge rubber sealing is fitted at the "A" post and rubber section to the remainder of the door apertures.

Rear Doors (Two).

The doors shut at the vertical centre line and are each hung on two exterior hinges allowing a 90° opening. The inside panel is cut-away below the waist and a large fixed rubber glazed window of 0·187 in. (4·76 mm.) toughened sheet glass is fitted in each door.

Each door is fitted with a metal door check and retainer and a wedge shape rubber block at the bottom to prevent vibration.

The right-hand door is fitted with a key locked outside handle and the left-hand door has an interior two-way (i.e. up and down) handle to operate the catches at the top and bottom of the door.

Sponge rubber sealing is applied to both doors.

Jacking.

Provision is made for side lifting at two points on each side, one at the "B" post and one at the rear spring front eye with a pillar type jack.

WINDSCREEN

To Remove.

1. Remove the windscreen wiper arms, and the interior sun visors (when fitted).

2. The windshield is retained by the rubber weatherstrip around its periphery. No other form of fixing is used but the contacting surfaces are treated with "Seelastik" sealing compound. To break this seal, insert the point of a suitable wooden wedge and draw it around the outer edge of the windscreen.

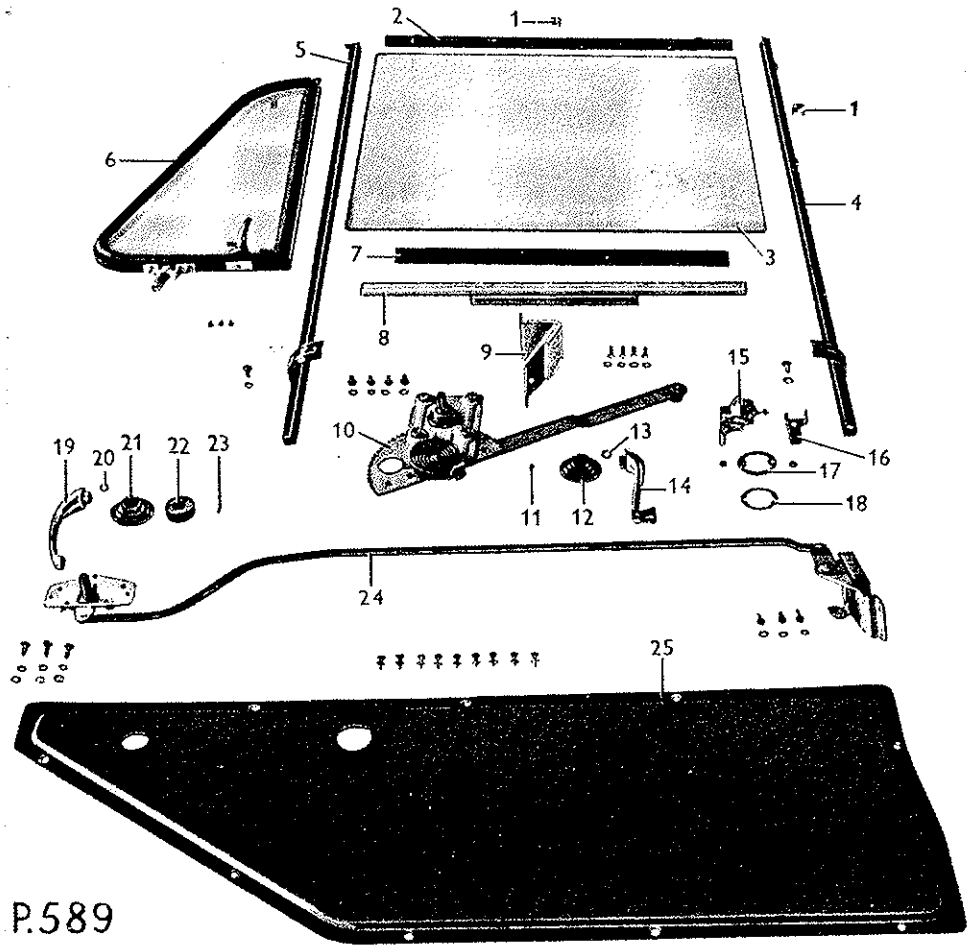
3. Apply hand pressure to one of the lower corners and force the windscreen outwards from the vehicle interior. An assistant outside the vehicle can then support the glass as it is released.

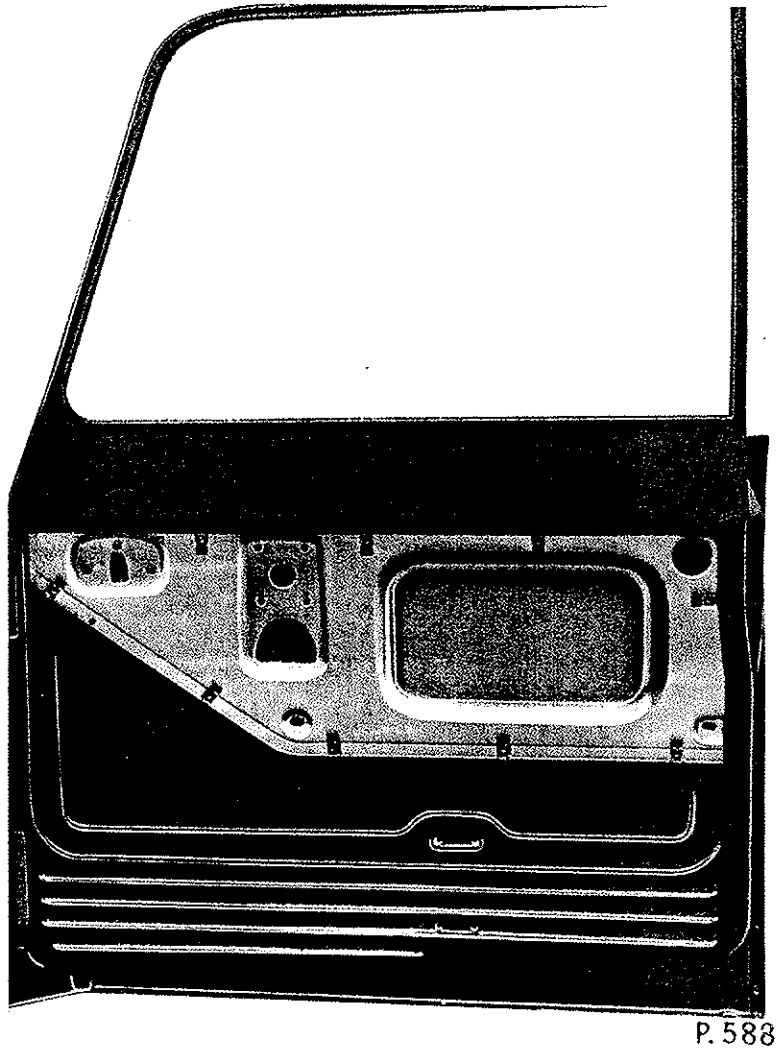
4. Remove the weatherstrip from the glass.

To Refit.

1. Clean the surfaces of the glass around the periphery, the channel of the weatherstrip and the aperture rim of the cab.

2. Apply a coating of "Seelastik" to the inner channel of the weatherstrip. Fit the weatherstrip to the glass with the joint in the centre of the bottom edge.





1 GLASS CHANNEL CLIP
2 TOP GLASS CHANNEL
3 DOOR DROPPING GLASS
4 'B' POST GLASS CHANNEL
5 FRONT GLASS CHANNEL
6 NO DRAUGHT VENTILATOR ASSEMBLY
7 BOTTOM GLASS CHANNEL SEAL
8 BOTTOM GLASS CHANNEL AND CAM PLATE
9 BOTTOM STOP - DROPPING GLASS
10 WINDOW REGULATOR ASSEMBLY
11 WINDOW REGULATOR HANDLE PIN
12 WINDOW REGULATOR HANDLE ESCUTCHEON
13 WINDOW REGULATOR HANDLE PAD
14 WINDOW REGULATOR HANDLE
15 EXTERIOR DOOR HANDLE ASSEMBLY
16 EXTERIOR DOOR HANDLE CONTACT PLATE
17 EXTERIOR DOOR HANDLE ATTACHMENT PLATE
18 EXTERIOR DOOR HANDLE GASKET
19 INTERIOR DOOR HANDLE
20 INTERIOR DOOR HANDLE PAD
21 INTERIOR DOOR HANDLE ESCUTCHEON
22 INTERIOR DOOR HANDLE ESCUTCHEON PAD
23 INTERIOR DOOR HANDLE PIN
24 DOOR LOCK REMOTE CONTROL ASSEMBLY
25 INTERIOR DOOR COVER PANEL

Fig. O.1. Front hinged door shell and interior components

3. Obtain two pieces of strong thin cord considerably longer than the outer periphery of the windscreen. Insert one cord into the outer channel of the rubber and the second cord into the inner channel so that loose ends are near to the centre at the lower edge.

4. Press the windscreen assembly into the aperture from the exterior of the vehicle after passing the ends of the cord from the inner channel into the interior of the vehicle. Work the lip of the weatherstrip over the edge of the aperture and at the same time, the inner cord should be pulled ensuring that the weatherstrip lip is brought over the inner edge of the aperture in the body. Pull out this cord completely.

5. Pull the cord in the outer channel and bring the outer lip of the weatherstrip over the body aperture outer edge.

6. Seal the weatherstrip to the outer surface of the body with "Seelastik" compound using a special gun, obtainable from Messrs. Expandite Ltd., Cunard Road Works, London, N.W.10, England, who also supply full operating instructions. In the absence of this special gun, it is suggested that an adaptor in the form of a short length of tubing with a flattened end could be fitted to a lubrication gun which has a screw type plunger.

Insert the nozzle of the gun between the outer surface of the sealing rubber and cab, operate the gun and work round the weatherstrip. Press the weatherstrip firmly to the body and remove all surplus sealing compound.

7. Refit the windscreen wiper arms, and the interior sun visors (when fitted).

FRONT DOOR (HINGED TYPE)

To Remove.

1. Remove the two screws retaining the door check arm to the body.

2. Remove the three screws securing each door hinge to the body "A" post and lift away the door complete.

To Dismantle.

1. Remove the interior door handle as follows:

(*a*) Using a suitable wooden strip that has been cut out to fit over the handle, depress the handle escutcheon and tap out the handle pin using a suitable metal drift (see Fig. O.2).

(*b*) On removing the pin, the handle, escutcheon and rubber pad can be withdrawn from the door.

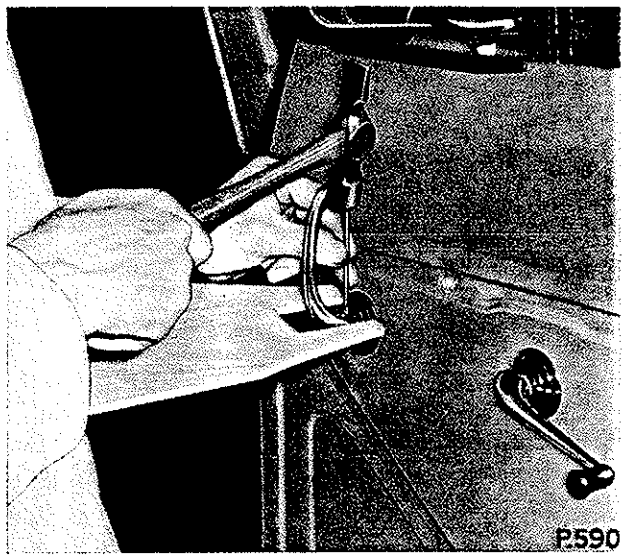


Fig. O.2. Tapping out the interior door handle pin to remove the door handle

2. Remove the window regulator handle in the same manner as the interior door handle (see Fig. N.6).

3. Release the nine screws retaining the door cover panel and remove the panel.

4. Remove the three screws securing the no draught ventilator to the external rim of the door.

5. Unscrew the two setscrews adjacent to the lower edge of the cover panel aperture which will release

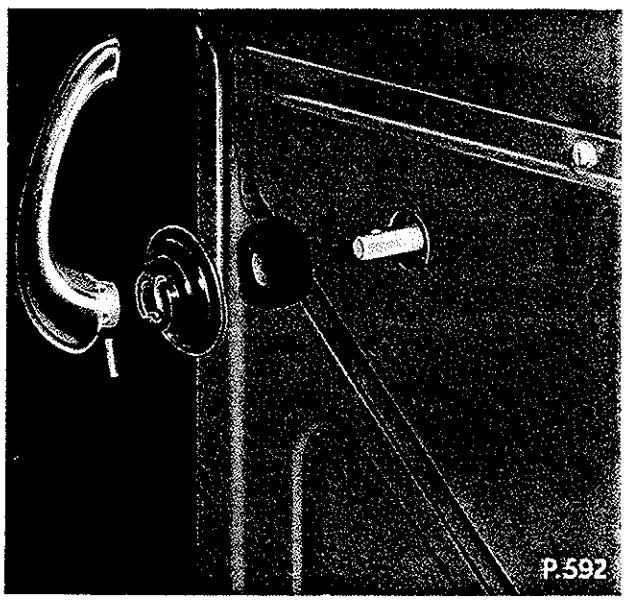


Fig. O.3. Exploded details of the hinged door interior locking handle

the window glass channels on either side of the dropping glass. The two channels are removed in a later operation.

6. Wind the dropping glass down to its lowest extremity and prise out the top glass channel which is retained by four clips.

7. The no draught ventilator and front dropping glass channel can then be lifted out of the door shell.

8. Prise out the dropping glass channel adjacent to the "B" post. The channel is retained by a setscrew (removed in para. 5) and three clips.

9. Wind up the dropping glass sufficient to enable the dropping glass to be lifted out of the door shell.

If it is necessary to renew the dropping glass bottom channel or the channel seal, proceed as follows:

(*a*) Before removing the original channel, mark the glass at the extremity of the channel to identify the position for fitting the new channel.

(*b*) Fit a new seal in the channel, ensuring equal spacing at each end (see Fig. O.4).

(*c*) After fitting the seal in the glass channel, fill the inner section of the seal with light oil along the full length of the seal.

(*d*) Place the dropping glass on a pad of thick felt to prevent damage and tap the channel on the lower edge of the glass (see Fig. O.5) until the channel is fully bedded and ensuring that the channel is located in the position marked prior to removing the original channel.

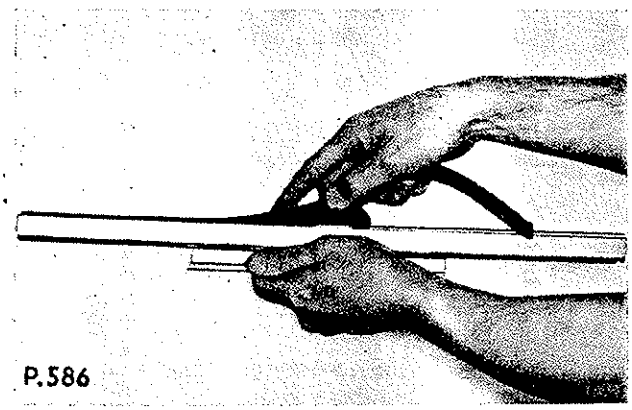


Fig. O.4. Fitting a new seal in the door dropping glass bottom channel

10. Unscrew the four setscrews and withdraw the dropping glass bottom stop which is secured inside the lower section of the door.

11. Remove the four screws and remove the window regulator assembly by withdrawing through the large opening in the cover panel aperture.

12. The door remote control mechanism is removed as follows:

(*a*) Remove the four screws securing the interior lock assembly at the front end of the remote control.

(*b*) Remove the three screws at the rear end of the remote control which is located in the external rear rim of the door shell.

(*c*) The complete remote control can them be lifted out of the door.

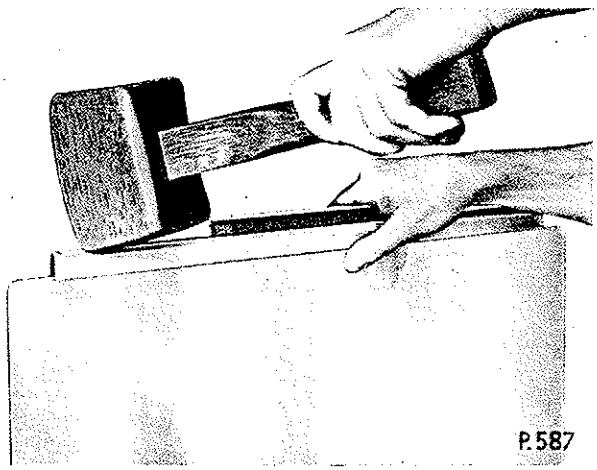


Fig. O.5. Tapping the dropping glass bottom channel, complete with seal, on the dropping glass

13. Inside the door shell, remove the centre pillar nut of the exterior door handle. Also inside the door shell unscrew the two nuts retaining the exterior door handle and lift away the handle and at the same time retain the interior components of the handle to prevent them dropping in the base of the door shell. Note the number of packing washers fitted on the centre pillar below the contact plate.

14. From inside the door shell, remove the two 4BA nuts and shakeproof washers and withdraw the screws securing the rubber buffer to the edge of the door. When removing the buffer, ensure that if a packing piece is fitted between the rubber buffer and the door, this is not lost.

To Re-assemble

Reverse the dismantling operation with attention to the following points.

1. To re-assemble the exterior door handle assembly, enter the outer portion of the assembly in the door aperture, after first fitting the rubber gasket, and secure with the retaining plate and the two nuts.

Fit the packing washers on the centre pillar now inside the door shell and follow with the contact plate with the narrow section of the plate pointing downwards. Secure the plate with the centre pillar nut and washer.

2. When fitting the two dropping glass window channels, do not tighten the two securing setscrews until after the door is re-assembled as final adjustment of the channels may be necessary to ensure correct operation of the dropping glass.

3. To re-assemble the no draught ventilator, after having fitted the two dropping glass channels, enter the ventilator in the top door aperture engaging the ventilator at the bottom front corner and also at the top rear corner to locate with the glass channel lip.

Having located at these two points, tap the ventilator fully into position with the flat of the hand.

Prise out the rubber weatherstrip flap on the exterior side of the door in order to seal the ventilator at the forward edge.

Finally, secure the ventilator to the door shell with the three screws.

To Refit.

Reverse the removal procedure.

FRONT DOOR (SLIDING TYPE)

To Remove.

1. Unscrew the three tapping screws and lift away the upper roller track cover panel.

2. Remove the four setscrews, four plain and four shakeproof washers securing the two support brackets to the sliding door. The door can then be lifted off clear of the vehicle.

To Dismantle.

1. The lower support and roller brackets can be removed from the door after removing the six screws and shakeproof washers.

2. The fixed and sliding windows in the door are removed as an assembly by prising up the rubber weatherstrip over the window aperture rim on the inside of the door. The complete window assembly can then be pushed out clear of the aperture from the inside of the vehicle, with an assistant supporting the assembly on the outside of the vehicle.

3. After lifting away the window assembly, the removal of the rubber weatherstrip will enable the fixed and sliding windows to be separated together with the glass channels and runners. Note the position of the rubber filler in the sliding glass channel for subsequent re-assembly.

4. To remove the door lock, depress the inside handle escutcheon using a similar wooden strip as that detailed for hinged door handles on page N.6 tap out the handle pin and remove the handle, escutcheon and rubber pad.

Unscrew the three screws retaining the outside handle escutcheon and remove the handle.

Finally, remove the door lock after releasing the securing setscrews.

To Re-assemble.

Re-assembly is a reversal of the dismantling operation. When re-assembling the window assembly to the door, run a length of strong thin cord around the securing lip of the weatherstrip before mounting the assembly in the door aperture. Position the assembly from the outside of the vehicle and press into the aperture.

By carefully pulling the cord ends, the weatherstrip inner lip will be lifted over the aperture edge to fully locate the glass assembly.

To Refit.

1. Engage the lower rollers with the guide rail in the bottom sill and position the door to enable the two upper support brackets to align with the tapped holes in the door. Secure the door to the brackets with the four setscrews with four plain and shakeproof washers.

2. Refit the upper roller track cover panel with the three tapping screws.

3. Check the sliding operation of the door and lubricate the ball and roller tracks with the recommended lubricant as necessary.

SLIDING DOOR TRACKS

To Remove.

1. Remove the sliding door as detailed.

2. Unscrew the four slotted screws retaining the door upper track to the track support brackets and remove the track. Note that the front slotted screw has a shakeproof washer and a nut. The door support brackets are released from the track after releasing the four slotted screws.

3. The front, intermediate and rear track support brackets can be removed from the body after removing the twelve tapping screws.

4. The door lower track is removed after unscrewing the seven setscrews securing the track to the body. Note that the three front setscrews have plain washers, shakeproof washers and nuts.

The centre setscrew has a shakeproof washer only whilst the three rear setscrews have shakeproof washers and tapping plates.

To Refit.

Refitting is a reversal of the removal procedure noting that the retaining screws are refitted to their original positions as described in the removal operation.

Lubricate the upper and lower tracks as necessary with the recommended lubricant on completion of the refitting operation.

REAR DOORS

To Remove.

1. Release the door check arm guide bracket secured to the door panel by releasing the two retaining setscrews.

2. Unscrew the two bolts and nuts securing each hinge to the door and withdraw the door.

To Dismantle.

Right-Hand Door

1. Unscrew the two screws securing the outside locking handle and remove the handle and the fibre packing piece.

2. Remove the four screws and withdraw the door lock.

3. The door check arm guide bracket will remain on the check arm when the door is removed. To release, slide the bracket along its guide slot until the arm pivot pin can be withdrawn through the large hole at the rear end of the slot.

4. To remove the rear door fixed glass, proceed as follows:

(*a*) To release the lip of the rubber weatherstrip, the "Seelastik" seal must be broken.

This is accomplished by inserting the point of a wooden wedge in the lip and drawing the wedge all around the outer edge of the glass.

(*b*) Insert the wedge in one of the top corners of the glass and ease it away from the door aperture.

(*c*) Apply hand pressure to the glass from the door interior side and push the glass complete with weathership clear of the door aperture.

5. Release the two screws securing the striker block to the door, and remove the block.

Left-Hand Door

1. The interior door lock two-way control mechansim is removed complete by unscrewing the twelve screws securing the upper and lower door catches and the interior locking handle assembly. The door catches are released from the remote control arms by pivoting the swivel pin 90° at each catch lever and withdrawing the pin through the slot in the end of the arm.

2. The check arm guide bracket is identical to the guide bracket on the right-hand door (see para. 3—*"Right-Hand Door"*).

3. The rear door fixed glass is removed in the same manner as the glass in the right-hand door (see para. 4 —*"Right-Hand Door"*).

4. Release the two screws securing the striker block sleeve to the door, and remove the sleeve.

To Re-assemble.

Reverse the dismantling procedure. To re-assemble the fixed door glass proceed as follows:

(*a*) With the weatherstrip mounted on the perimeter of the glass, run a length of strong thin cord around the securing lip of the weatherstrip and tie the ends of the cord to form a loop.

(*b*) Position the glass and weatherstrip in the door aperture with the cord loop accessible from the interior side of the door.

(*c*) With an assistant pressing the glass firmly and squarely in the aperture from the exterior side of the door, carefully pull the cord loop which will lift the weatherstrip lip over the edge of the aperture.

(*d*) Having fitted the glass in the door, seal the exterior lip of the weatherstrip to the door panel with "Seelastik". For this operation, a special gun is available from Messrs. Expandite Ltd., Cunard

Road Works, London, N.W.10, England, who also supply full operating instructions. In the absence of this special gun, it is suggested that an adaptor in the form of a short length of tubing with a flattened end could be fitted to a lubrication gun which has a screw type plunger. Insert the nozzle of the gun between the weatherstrip lip and the door panel, operate the gun and work around the complete length of the weatherstrip. Press the weatherstrip firmly to the panel and remove all surplus sealing compound.

To Refit.

Reverse the removal procedure.

DOOR LOCKS AND HINGES

Lubrication

Under normal climatic conditions lubricate generously with Shell Retinax A. Where temperatures fall below —26°C. (—15°F.) it is recommended that Shell Spirax 90 EP. be used.

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RECOMMENDED LUBRICANTS

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The following list shows the correct grade of lubricant to be used for each unit or lubrication point:

Unit	*Lubricant*
PETROL ENGINE	
Where prevailing climatic temperature is:	
Above 21°C. (70°F.)	Shell Super Motor Oil or Shell X100 30
27°C. to −7°C. (80°F. to 20°F.)	Shell Super Motor Oil or Shell X100 20W
0°C. to −18°C. (32°F. to 0°F.)	Shell Super Motor Oil or Shell X100 10W
Below −15°C. (5°F.)	Shell X100 Multigrade 5W/20
Upper Cylinder Lubricant	Shell Upper Cylinder Lubricant

For continuous high speed driving use Shell Super Motor Oil, or Shell X100 40

SPECIAL NOTE

The frequency at which the **petrol engine** sump should be drained and re-filled with fresh lubricant depends upon the type of conditions under which the vehicle operates, e.g.:

(*a*) When the engine is engaged in stop/start or combined stop/start and long distance operations – change the engine oil and the filter element every 3,000 miles (4,500 km.).

(*b*) When the engine is engaged in normal long distance running only – change the engine oil and the filter element every 6,000 miles (9,000 km.).

Unit	*Lubricant*
DIESEL ENGINE	
Where prevailing climatic temperature is:	
Above 27°C. (80°F.)	Shell Rotella S30 or Shell
27°C. to 7°C. (80°F. to 45°F.)	Shell Rotella S20/20W or Shell
7°C. to −18°C. (45°F. to 0°F.)	Shell Rotella S10W or Shell
DISTRIBUTOR	
Shaft and Cam Bearing	Engine Oil
Contact Breaker Pivot	Engine Oil
Cam Profile	Shell Retinax A
Automatic Timing (Spark) Control	Engine Oil
DYNAMO	Engine Oil
BATTERY TERMINALS	Petroleum Jelly
STEERING UNIT	Shell Spirax 90E.P.

RECOMMENDED LUBRICANTS

Unit	*Lubricant*
FRONT SUSPENSION AND STEERING LINKAGE	
Links, Steering Linkage, Relay Lever Fulcrum Pins and Swivel (King) Pins	Shell Spirax 140E.P. or Shell Retinax A
ACCELERATOR LINKAGE	Engine Oil
CHANGE SPEED REMOTE CONTROL MECHANISM	
Lever Ball, Ball Socket and Reverse Plunger	Shell Anti-sieze 4768 Grease
Change Speed Universal Joint	Engine Oil
Change Speed Trunnion	Shell Spirax 140E.P. or Shell Retinax A
GEARBOX (TRANSMISSION)	
All Climatic Temperatures	Shell Super Motor Oil
PROPELLER SHAFT	Shell Retinax A
REAR AXLE	
See Important Note at the end of this section	
Above −23°C. (−10°F.)	Shell Spirax Heavy Duty 90 Oil
Below −23°C. (−10°F.)	Shell Spirax Heavy Duty 80 Oil
From 1,000 miles (1,500 km.) onwards	
Above −23°C. (−10°F.)	Shell Spirax Heavy Duty 90 Oil or Shell Spirax 90E.P.
Below −23°C. (−10°F.)	Shell Spirax Heavy Duty 80 Oil or Shell Spirax 80E.P.
WHEEL HUB BEARINGS	Shell Retinax A
HANDBRAKE	
Cable	Shell Spirax 140E.P. or Shell Retinax A
Linkage	Engine Oil
CLUTCH AND BRAKE PEDAL PIVOTS	Shell Spirax 140E.P. or Shell Retinax A
FOOTBRAKE AND CLUTCH LINKAGE	Engine Oil
CLUTCH AND BRAKE MASTER CYLINDERS	Lockheed Super Heavy Duty Fluid
REAR SHOCK ABSORBERS	Armstrong Shock Absorber Oil No. 624
FRONT SHOCK ABSORBERS	No topping up necessary as each unit is sealed

Unit	*Lubricant*
BODY DOOR LOCKS, HINGES AND ENGINE COVER HINGES	Shell Spirax 90E.P. or Shell Retinax A
SLIDING DOOR UPPER TRACK ASSEMBLY	Shell Retinax A
SLIDING DOOR LOWER TRACK ASSEMBLY	Engine Oil

IMPORTANT NOTICE

Shell Spirax Heavy Duty 90 or 80 oil is used for initial filling at the factory (depending upon the climatic temperature in which the vehicle will be operating) and it is essential that this oil is used when refilling the rear axle at the first 500 miles (800 km.) oil change. Should it be necessary to top up prior to the oil change at 6,000 miles (9,000 km.) the appropriate Heavy Duty oil should be used.

At subsequent oil changes, i.e. every 6,000 miles (9,000 km.) either Spirax Heavy Duty or E.P. oil may be used.

New Units and Components

Where service action is taken involving the replacement of the crown wheel and pinion or the complete differential assembly, it is essential that the relevant Shell Spirax Heavy Duty oil be used for at least the first 1,000 miles (1,500 km.) otherwise the Warranty may be affected.

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OIL SEALS AND TAPER-ROLLER BEARINGS

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OIL SEALS AND BEARINGS

OIL SEALS

1. Before fitting, carefully examine the seal and remove all traces of dirt and grit. This should be done by wiping carefully with a cloth moistened with clean oil.

2. Leather Seals Impregnated with Wax. These seals should **not** be soaked in oil prior to fitting as their initial lubrication is provided for during manufacture. Smear the sealing lips with clean grease.

3. Synthetic Rubber Oil Seals. These require no preliminary soaking in oil, it being necessary only to smear the sealing lips with clean grease. It is most important when fitting to see that the sealing lip is not damaged, even by the slightest scratch and that the garter spring is correctly located when in position. The seal must be properly pressed home on the housing recess, **with the lip and garter spring side to face the oil.**

4. Examine the shaft and remove all roughness, burrs on the edges of keyways, screw threads, splines, shoulders, etc., over which the sealing lip is passed. In some cases, where the profile of a shaft over which a seal must pass during fitting is liable to cut the sealing lip, it is good practice to use a fitting sleeve with a lead-on taper and a diameter a few thousandths of an inch greater than the shaft. Where necessary a sheet of shim steel, copper or paper, well greased, should be wrapped around the shaft to cover such sharp edges as might damage the seal.

5. In most cases it will be necessary to press the seal into the housing first and subsequently enter the shaft. In all cases it must be stressed that as far as possible the sealing lips should be observed during fitting to **ensure that the garter spring does not become displaced** during the process. When passing the seal along the shaft, or entering the shaft in the seal, as the case may be, a slight rotary motion will assist the operation. Grease should be applied to the shaft.

6. Do not allow the assembly to rest for any length of time in an incomplete stage of fitting where it might cause the weight of the shaft or housing to be borne by the seal, resulting in damage or distortion to the latter.

7. Before pressing the seal into the housing the **outside** diameter should be lightly coated with a liquid jointing compound.

8. When pressing a **metal cased** seal into the housing, a firm uniform pressure should be exerted, preferably by means of an arbor press in combination with a suitable tool for a ram. The diameter of the tool should be slightly less than the outside diameter of the seal, e.g. 0·005 in./0·015 in. (0·13/0·38 mm.) smaller. Only if an arbor press or fitting tool is not available may the following method be adopted.

By means of gentle hammer blows applied to an intermediate metal ring, disc or tube of slightly smaller diameter than that of the seal (i.e. 0·005 in./0·015 in. smaller), or other protective piece, drive the seal into place. Care should be taken to apply blows uniformly around the **outside edge** of the seal face, and in no circumstances should the hammer be applied direct to the seal casing. Great care must be taken to see that the seal does not enter the recess in a tilted position.

Note: When pressing metal cased seals into position note that one of the three oil entry holes in the metal face adjacent to the oil must be **upwards** or at "12 o'clock" position so that a small quantity of oil is always retained in the bottom of the metal casing between the other two holes.

9. When pressing in a synthetic rubber type seal (without metal casing), great care is necessary. The leading edge of the recess into which it fits in the housing should be slightly chamfered in order to provide a lead, and the circumference of the seal should also be smeared with oil or grease to avoid cutting its outside diameter during fitting. This type of seal should only be inserted by means of a specially formed tool which is arranged to bear on the flat face of the seal.

Remember that the efficiency of the unit is dependent on the efficiency of the Oil Seal. Therefore treat the latter with care.

TAPER-ROLLER BEARINGS

The bearing assembly consists of two parts, the outer race or cup, and the roller assembly, i.e., roller secured in a cage on the cone or inner race. Usually the cone and roller assembly cannot be separated.

The cups fit in the housing.

The cones fit on the shaft.

1. Cups

(*a*) The cups should be an interference fit in their housings. If not, the housings should be replaced.

In no case must knurling, or the application of solder, or the use of liners other than pressed in steel, be resorted to.

(*b*) The cups must not be tilted when being pressed in, i.e., they must be in line with the bore in the housing throughout the operation of installation.

(*c*) The cups must be pressed right home against the abutment shoulder, preferably under a press. It should not be possible to enter a 0·002 in. (0·05 mm.) thickness gauge between the cup and abutment shoulder.

In fitting, use a tool which contacts all round the outer edge. On no account must pressure be applied to the roller track.

(*d*) Grease the seating for the cup, which should be assembled clean and smeared with lubricant after installation.

2. Roller Assemblies. Before placing in position, all old grease must be scrupulously cleaned out and the cages packed between the rollers with new lubricant of the correct grade.

The whole of the roller surfaces should likewise be covered with lubricant.

3. Cones on Stationary Shafts (e.g., Stub axles).

(*a*) The cones must be a "creep" fit on the shaft, the ideal being 0·0002/0·0013 in. (0·005/0·033 mm.) loose. This permits of easy removal and proper control of adjustment, and allows the cone to alter its axial position slightly when the load is eased momentarily. The seatings for the inner race must always be smeared with grease before the bearings are fitted.

(*b*) Hub bearings should be adjusted by tightening the hub nut using a torque spanner to obtain a reading of 15/20 lb. ft. (2·07/2·76 kg. m.).

Release the nut 1 to 1½ flats in order to provide end float, and to line up one of the two split pin holes in the stub axle, with the slots in the nut. Using a dial gauge check that the hub end float is between 0·005/0·009 in. (0·13/0·23 mm.). If the end float is not within these figures the nut must be further adjusted, and the end float again checked with a dial gauge.

When the correct adjustment has been obtained, lock the nut with a new split pin of correct diameter.

4. Cones on Revolving Shafts (e.g., Pinion Shafts).

The cones should be a press fit, but in some cases where bearing adjustment is made by moving one of the cones, it is not practicable to be more than a light push fit. If cones are loose enough to turn on the rotating shaft, overheating and rapid wear of seating will occur.

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SPECIAL TOOLS

SECTION S

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SPECIAL TOOLS

The following specially designed and recommended tools are supplied by:

Messrs V. L. Churchill & Co. Ltd.,
London Road,
Daventry,
Northants.

1725 Engine

R.G.89A	Timing Cover Centraliser
R.G.209	Camshaft Wheel Remover
R.G.225	Cylinder Head Nut Crowfoot Wrench
R.G.290	Starter Dog Nut Wrench
335	Connecting Rod Alignment Jig
336	Master Arbor (Multi-purpose)
R.G.336–5	Connecting Rod Aligner Adaptor
R.G.479	Valve Guide Remover/Replacer
R.G.6513A	Valve Spring Compressor complete with Foot
38U3	Piston Ring Compressor
316X	Valve Seat Cutter, Handle
316–10	Valve Seat Cutter, Pilot
317–20	Valve Seat Cutter, Exhaust
317G–20	Glaze Breaker, Exhaust
317–25	Valve Seat Cutter, Inlet

Diesel Engine 4.108

PD.1C	Valve Guide Remover and Replacer
PD.1C–1	Puller Bars
PD.1C–2	Replacing Stop
38U3	Piston Ring Compressor
PD.41B	Piston Height Gauge
PD.1555A	Small Adjustable Puller (alternative 155)
PD.155A–4	Puller Adaptors (alternative R.G.155–1)
No. 13	Tension Wrench
316X	Valve Seat Cutter, Handle
316–10	Valve Seat Cutter, Pilot
PD.317–18	Valve Seat Cutter, Exhaust
PD.317–22	Valve Seat Cutter, Inlet
317G–19	Glaze Breaker
7066	Circlip Pliers
336	Multi-purpose Con-rod Arbor
PD.336–5	Adaptor
6118	Valve Spring Compressor
PD.6118–1	Compressor Adaptor
PD.130	Fuel Pump Allen Screw Wrench
PD.150–5	Pads – Cylinder Liner Remover and Replacer

Hydraulic Clutch

R.G.522	Clutch Plate Centraliser

Gearbox

R.G.255	Remote Control Setting Jig and Pin
R.G.482	Mainshaft Nut Wrench

BW.35 Automatic Transmission

642	Electric Tachometer (Petrol)
CBW.35A	Bench Cradle
7066H	Circlip Pliers
CBW.37A	Clutch Spring Compressor
CBW.33	Mainshaft End Play Gauge
CBW.1A	Pressure Test Equipment
CBW.38A	Hydraulic Pressure Test Gauge Adaptor
*CBW.547A–50–2A	Rear Servo Adaptor
APES	$\frac{1}{2}$" Square × $\frac{3}{8}$" Plug Convertor
R.G.387	Torque Wrench
CBW.547A–50–3A	Inhibitor Switch Locknut Adaptor
CBW.547–50–4	Torque Wrench Adaptor
CBW.548	Torque Screwdriver
CBW.548–1	Torque Screwdriver Adaptor
CBW.548–2	Front Servo Adaptor
CBW.41	Rear Clutch Piston Replacer
CBW.42	Front Clutch Piston Replacer

*Used with R.G.387 and APES Convertor.

Steering

R.G.284	Drop Arm to Side Steering Rod Ball Joint Remover
R.G.59A	Drop Arm Remover
R.G.59A–1	Thrust Pad
R.G.190C	Ball Joint Remover

Front Suspension

R.G.50D	Coil Spring Compressor
R.G.50D–2	Adaptor (For R.G.50D)
R.G.311	Static Laden Gap Gauges (Front Set) (1500 Models)
R.G.401	Static Laden Gap Gauges (Front Set) (2500 Models)

Rear Axle

R.G.16A	Axle Shaft Remover
R.G.16A–2	Adaptor (For R.G.16A)
R.G.330A	Axle Shaft Bearing Remover
R.G.4221B	Hand Press
R.G.4221B–2A	Differential Bearing Remover and Replacer
R.G.4221B–8A	Pinion Bearing Remover and Replacer
R.G.329	Differential Assembly Jig

Body and Underframe

R.G.310A	Front End Alignment Jig

General Tools

R.G.387	Torque Wrench 6/40 lb. ft.
No. 12	Torque Wrench 20/100 lb. ft.
No. 13	Torque Wrench 50/170 lb. ft.
550	Driver Handle (Main Tool)
6312A	Universal Puller
7066	Circlip Pliers with three pairs of points

Torque wrenches in daily use should be checked at intervals, not exceeding three months, to ensure that accuracy is maintained.

ADDITIONAL EQUIPMENT SUPPLIED BY:

Dunedin Engineering Co. Ltd.,
73 Mortimer Street,
London, W.1.

BW.35 Automatic Transmission

Electrotak .. .. Electric Tachometer (Diesel)

Dunlop Rubber Co. Ltd.,
Fort Dunlop,
Erdington, Birmingham, 24.

Front Suspension

C.G.4 .. .. Camber Gauge
C.G.5 .. .. Castor and K.P.I. Gauge
C.G.6 .. .. Turntable and Run-on Ramps.