THE

SUNBEAM

RAPIER and ALPINE

WORKSHOP MANUAL

A PRODUCT OF THE ROOTES GROUP

5th re-issue

WORKSHOP MANUAL

RAPIER and ALPINE

Series III to IV **Series I to IV**

Issued by

ROOTES SERVICE DIVISION · COVENTRY · ENGLAND

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NOTE

The Manufacturers, reserve the right to alter specifications at any time without notice.

INDEX TO SECTIONS

GENUINE PARTS

Whenever replacement parts are required, it is essential that only genuine replacement parts should be fitted.

Genuine replacement parts are manufactured to the same specification and are of the same quality as those originally fitted to the car—and they are guaranteed.

Insist on genuine parts. Dealers stock them.

FOREWORD

Every possible care is taken during the manufacture of Sunbeam cars to ensure that they leave the factory capable of giving many miles of trouble-free motoring. **Proper lubrication and maintenance are absolutely essential if satisfactory performance is to be maintained.** For details of the factory's recommendations, reference should be made to the Owners Handbook supplied with the car.

When undertaking any repairs or overhaul it is essential that the unit to be worked on is cleaned and *kept clean* while the work progresses. Dirt is detrimental to the correct functioning of a vehicle and conducive to a high rate of wear.

INDEX

The various units and systems of the vehicle are dealt with in sections which are listed on page 3, each being distinguished by a reference letter. Each section thus referred to opens with a contents and index page, so that any particular operation may be picked out in the shortest possible time.

GENERAL DATA

Comprehensive information regarding dimensions, tolerances and weights is given at the beginning of the Manual.

ROOTES SPECIAL TOOLS

Certain service operations are greatly facilitated by the use of the specially designed tools manufactured by Messrs. V. L. Churchill & Co., Great South West Road, Bedfont, Feltham, Middlesex, England. The use of these tools is described under the appropriate section headings.

DECENTRALIZED SERVICE

In order to provide the best possible service for Sunbeam owners, the Dealer Organisation throughout the world forms a link between the owner and the factory. All problems relating to the servicing of cars are dealt with through that Organisation, Dealers having behind them the backing of the Factory Service Department.

Owners who require advice or information which is not dealt with in this Workshop Manual should direct their enquiries to their Sunbeam Dealer. In all correspondence it is imperative that the full chassis number, including prefix and suffix letters is quoted and that reference is made to any previous correspondence. The chassis number, including the prefix and suffix letters, will be found on a plate fixed to the engine side of the scuttle, and it is also stamped on the right-hand side of the front portion of the chassis frame. The number is visible from under the bonnet.

The engine number will be found on the right-hand side of the cylinder block. This information may be required for customs purposes.

FROST PRECAUTIONS

Attention is drawn to the recommendations given in Section " A " (Cooling System). The importance of taking proper precautions against damage by frost cannot be over-emphasized.

ROOTES CONCESSIONAIRE COMPANIES & REGIONAL OFFICES

AUSTRALIA	Tel. No.
Rootes (Australia) Ltd., P.O. Box 100, Port Melbourne, S.C.7, VICTORIA Australia.	MJY.441
UNITED STATES OF AMERICA	
Rootes Motors, Inc., 42-32 Twenty First Street, Long Island City, NEW YORK, U.S.A.	Stillwell 6-2305
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EUROPE	Tel. No.
Rootes (Belgique) S.A., 126, Rue de Linthout, BRUSSELS, 4 Belgium.	33.94.58 and 33.96.05
Rootes Motors S.A., 6, Rond Point des Champs Elysees, PARIS, 8 France.	Elysees 04.37 and 04.38
Rootes Autos S.A., 10, Rue du Commerce, GENEVA, Switzerland.	022.25-32-30
Rootes Italia, S.p.A., Torre Velasca, Via Velasca 5 MILAN, Italy.	803.364
Rootes Autos (Deutschland) GmbH, Alleestrasse 33, DUSSELDORF, Germany.	81641/2
Rootes Motors A.B., Osthammarsgatan 64-66, STOCKHOLM, Sweden.	63.01.05
EAST AFRICA	
Rootes (Kenya) Limited, P.O. Box 3020, NAIROBI, Kenya.	20761/2/3
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Rootes (C.A.) (Pvt.) Ltd., P.O. Box 2382, Burnley Road, Workington, SALISBURY, Southern Rhodesia.	60641
SOUTH AFRICA	
Stanley Motors, Ltd., P O.Box 7712, Stanmot Building, 30, Eloff Street, JOHANNESBURG, Transvaal, South Africa.	J.23-1701/2
MIDDLE EAST	
Rootes Limited, P.O. Box 2289, BEIRUT, Lebanon.	21564
FAR EAST	
Rootes Limited, Room 1003/4, Union House, Chater Road, HONG KONG.	34209
Yamato Motor Co. Ltd.. 8, Oi-Sakashita-Cho, Shinagawa-Ku, TOKYO, Japan.	761-0121

Names and addresses of dealers in the different territories can be obtained from the above.

GENERAL DATA

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CONTENTS—*continued*

GENERAL DATA

GENERAL DIMENSIONS

Wheelbase—Alpine	7 ft. 2 in. (218·4 cm.)
—Rapier	8 ft. (243·8 cm.)
Track (front)—Alpine (disc wheels)	4 ft. 3 in. (129·5 cm.)
—Alpine (wire wheels)	4 ft. 3¼ in. (130·2 cm.)
—Alpine IV (disc wheels)	4 ft. 3¾ in. (131·4 cm.)
—Alpine IV (wire wheels)	4 ft. 4 in. (132·0 cm.)
—Rapier	4 ft. 1¾ in. (126·3 cm.)
—Rapier IV	4 ft. 3¾ in. (131·4 cm.)
(Rear)—Alpine (disc wheels)	4 ft. 0½ in. (123·2 cm.)
—Alpine (wire wheels)	4 ft. 2½ in. (128·3 cm.)
—Rapier	4 ft. 0½ in. (123·2 cm.)
Overall length (with overriders)—Alpine	12 ft. 11¼ in. (394·4 cm.)
—Rapier	13 ft. 6½ in. (412·7 cm.)
—Rapier IV	13 ft. 7 in. (414 cm.)
Overall height—Alpine	4 ft. 3½ in. (130·8 cm.)
—Rapier (saloon)	4 ft. 10½ in. (148·6 cm.)
—Rapier (convertible)	4 ft. 10 in. (147·3 cm.)
—Rapier IV	4 ft. 9¼ in. (145·4 cm.)
Overall width—Alpine	5 ft. 0½ in. (153·7 cm.)
—Rapier	5 ft. 1 in. (155 cm.)
Ground clearance (laden)—Alpine	4¼ in. (10·8 cm.)
—Rapier (saloon)	6 in. (15·2 cm.)
—Rapier (convertible)	5¾ in. (14·6 cm.)
Turning circle—Alpine	34 ft. (10·3 m.)
—Rapier	36 ft. (10·9 m.)
Weight (approx.) with fuel and water—Alpine I & II (soft top)	2184 lbs. (991 kg.)
—Alpine I & II (hardtop)	2218 lbs. (1006 kg.)
—Alpine III (soft top)	2223 lbs. (1008 kg.)
—Alpine III (GT)	2278 lbs. (1033 kg.)
—Rapier (saloon)	2352 lbs. (1067 kg.)
—Rapier (convertible)	2388 lbs. (1083 kg.)
—Rapier IV	2323 lbs. (1054 kg.)
—Alpine IV (soft top	2180 lbs. (989 kg.)
—Alpine IV (GT)	2230 lbs. (1012 kg.)
Towing capacity (MAX)—Rapier III	15 cwt. (762 kg.)
—Rapier IIIA, IV	17 cwt. (863 kg.)

Add 20 lbs. (9 kg.) to these figures if an overdrive is fitted

CAPACITIES

Engine—including filter	8 pints	(9·6 U.S. pints;	4·5 litres)
Gearbox	2¾ pints	(3·3 U.S. pints;	1·56 litres)
Gearbox and overdrive (if fitted)	4 pints	(4·8 U.S. pints;	2·25 litres)
Rear axle	1¾ pints	(2·1 U.S. pints;	1·0 litres)
Cooling system (with heater)—Alpine I & II	15 pints	(18 U.S. pints;	8·5 litres)
—Alpine III onwards	12½ pints	(15 U.S. pints;	7·1 litres)
—Rapier	13¼ pints	(15·9 U.S. pints;	7·57 litres)
Fuel tank—Alpine I & II	9 gallons	(10·8 U.S. galls;	40·9 litres)
—Alpine III onwards	11¼ galls.	(13·5 U.S. galls;	51 litres)
—Rapier	10 galls.	(12 U.S. galls;	45·5 litres)

ENGINE—GENERAL

No. of cylinders	4
Bore size (nominal)	3·11 in. (79 mm.) Ser. I Alpine, Series III Rapier
... ...	3·21 in. (81·5 mm.) Ser. II, III, IV Alpine, Series IIIA, IV Rapier.

"A" *grade is standard, but subject to grading as indicated below. Individual bores in any production engine may conform to any of these grades (i.e., bores in any one cylinder block may not conform to one grade).*
Grade (*stamped on two machined bosses at each end of the cylinder block just below cylinder head gasket*).

SERIES I ALPINE, SERIES III RAPIER			SERIES II, III, IV ALPINE. SERIES IIIA, IV RAPIER		
A.	3·1102 in./3·1106 in.	(78·999/79·009 mm)	A.	3·2102 in./3·2106 in.	(81·539/81·549 mm)
B.	3·1106 in./3·1110 in.	(79·009/79·019 mm)	B.	3·2106 in./3·2110 in.	(81·549/81·559 mm)
C.	3·1110 in./3·1114 in.	(79·019/79·029 mm)	C.	3·2110 in./3·2114 in.	(81·559/81·569 mm)
D.	3·1114 in./3·1118 in.	(79·029/79·040 mm)	D.	3·2114 in./3·2118 in.	(81·569/81·580 mm)

Stroke	3·00 in. (76·2 mm).
Capacity (Series I Alpine, Series III Rapier) ...	91·2 cu. ins. (1494 c.c.)
Capacity (Series II, III, IV Alpine, Series IIIA, IV Rapier)	97·1 cu. ins. (1592 c.c.)
Compression: ratio—Series I Alpine Series III Rapier	9·2:1
—Series II, III Alpine, Series IIIA, IV Rapier ...	9·1:1 (8·4:1 is available in certain export territories)
pressure—Series I Alpine, Series III Rapier	170/180 lbs. per sq. in. (average) (11·9/12·6 kg. cm.²)
—Series II, III, IV Alpine, Series IIIA, IV Rapier (9·1:1)	185/195 lbs. sq. in. (average) (13/13·7 kg. cm.²)
—Series II, III, IV Alpine, Series IIIA, IV Rapier (8·4:1)	160/170 lbs. sq. in. (average) (11·2/11·9 kg. cm.²)
Identification	Letter in engine number on cylinder back—H=High; L=Low.

PERFORMANCE

	B.H.P. gross	*B.H.P. nett*	*Developed at R.P.M.*	*Max. Torque Lbs. ft.*	*Kg.m.*	*Max. B.M.E.P. Lbs. sq. in.*	*kg. cm²*	*Developed at R.P.M.*
Alpine I	83·5	78	5300	89·5	12·4	148	10.4	3400/3800
Alpine II	85·5	80	5000	94	12·9	146	10·3	3800
Alpine III (Std) Zenith	87·7	82	5200	93	12·8	144	10·1	3600
Alpine III (GT) Zenith	80·2	75	5000	92	12·7	143	10·0	3600
Alpine III (Std) Solex	86	80·5	5000	93·4	12·9	145	10·1	3500
Alpine III (GT) Solex	82·5	77	5000	91	12·5	143	10·0	3500
Rapier III	78	73	5400	83	11·5	137	9·6	3500
Rapier IIIA	80	75	5100	88·2	12·2	137	9·6	3900
Rapier IV	84	78·5	5000	91	12·5	141	9·9	3500

ROAD SPEED/ENGINE SPEED

Road speed at 1,000 engine r.p.m.

	O/D TOP	TOP	O/D THIRD	THIRD	SECOND	FIRST	REVERSE
Alpine (std) 3.89 : 1 axle ratio	—	17.3mph (27.8kph)	—	12.4mph (19.7kph)	8.0mph (12.8kph)	5.1mph (8.1kph)	4.0mph (6.4kph)
Alpine (O/d) 4.22 : 1 axle ratio	19.8mph (31.8kph)	15.9mph (25.5kph)	14.2mph (22.8kph)	11.4mph (18.3kph)	7.4mph (11.9kph)	4.8mph (7.7kph)	3.7mph (5.9kph)

Alpine III (all models) 3.89:1 axle ratio	21.9mph (35.2kph)	17.6mph (28.3kph)	17.8mph (28.6kph)	14.3mph (23.0kph)	9.3mph (14.9kph)	5.9mph (9.5kph)	4.7mph (7.5kph)
Rapier (std) 4.55 : 1 axle ratio	—	16.0mph (25.7kph)	—	11.5mph (18.5kph)	7.5mph (12.0kph)	4.8mph (7.6kph)	3.8mph (6.0kph)
Rapier (std) 4.22 : 1 axle ratio	—	17.3mph (27.4kph)	—	12.4mph (19.9kph)	8.1mph (13.0kph)	5.2mph (8.3kph)	4.1mph (6.4kph)
Rapier (O/d) 4.78 : 1 axle ratio	19.1mph (30.5kph)	15.3mph (24.5kph)	13.7mph (22.0kph)	11.0mph (17.7kph)	7.1mph (11.3kph)	4.6mph (7.3kph)	3.6mph (5.7kph)
Rapier (O/d) 4.86 : 1 axle ratio	18.7mph (29.0kph)	15.0mph (24.1kph)	13.5mph (21.7kph)	10.8mph (17.3kph)	7.0mph (11.2kph)	4.5mph (7.2kph)	3.5mph (5.6kph)
Rapier (O/d) 4.44 : 1 axle ratio	20.4mph (32.8kph)	16.3mph (26.2kph)	14.6mph (23.4kph)	11.7mph (18.8kph)	7.6mph (12.2kph)	4.9mph (7.8kph)	3.9mph (6.2kph)
Rapier, Alpine IV (std)	—	17.6mph (28.3kph)	—	12.6mph (20.3kph)	8.2mph (13.2kph)	5.3mph (8.5kph)	4.2mph (6.7kph)
Rapier, Alpine IV (O/d)	20.2mph (32.5kph)	16.2mph (26.0kph)	14.5mph (23.3kph)	11.6mph (18.6kph)	6.3mph (10.1kph)	4.8mph (7.7kph)	3.2mph (5.1kph)

CYLINDER BLOCK

Material	Cast Iron	
Max. oversize with or without liners	0·040 in.	(1·02 mm.)
Linering size (Series I Alpine, Series III Rapier) ...	3·254 in. /3·255 in.	(82·65/82·67 mm.)
Linering size (Series II, III, IV Alpine, Series IIIA, IV Rapier)	3·354 in. /3·355 in.	(85·19/85·21 mm.)
Interference fit	0·002 in. /0·004 in.	(0·051/0·102 mm.)
Dia. of main bearing bore (without shells)	2·3947 in. /2·3955 in.	(60·82/60·84 mm.)

CYLINDER HEAD (for torque loading figures see table at end of section)

Material	Aluminium
Size of cylinder head studs	⅜ in. U.N.F.
Valve guide fit—see under "Valves".	
Gasket—Type	Pressing (Steel-Copper-Asbestos)
Thickness	·030 in. (·76 mm.) Compressed

VALVES

Position and operation	Overhead, push rods and rockers	
Head diameter—Inlet	1·436 in. /1·432 in.	(36·47/36·37 mm.)
—Inlet (from chassis Nos. B.3062665 and B.9117425)	1·475 in. /1·471 in.	(37·45/37·35 mm.)
Exhaust	1·176 in. /1·172 in.	(29·87/29·77 mm.)
Angle of seat in cylinder head—Inlet and Exhaust	45°	
Angle of valve face—Inlet and Exhaust	45°	
Valve stem diameter—Inlet	·3110 in. /·3105 in.	(7·90/7·89 mm.)
Exhaust	·3100 in. /·3095 in.	(7·87/7·86 mm.)
Valve stem clearance in guide—Inlet	·0010 in. /·0025 in.	(·025/·064 mm.)
Exhaust	·0020 in. /·0035 in.	(0·51/·089 mm.)

Length of valves (inlet and exhaust) ...	4·66 in.		(118·36 mm.)
Type of springs	Dual		
Spring retention	Cup and split cotters		
Valve spring—free length—Inner	1·93 in.		(4·9 cms.)
—Outer ...	2·23 in.		(5·66 cms.)
Valve spring—fitted length—Inner ...	1·43 in.		(3·63 cms.)
—Outer ...	1·55 in.		(3·93 cms.)
Valve spring—load fitted—Inner	35·9 lbs.		(16·32 kg.)
—Outer ...	70·8 lbs.		(32·20 kg.)
Guides—Inlet ... 2·0 in. (50·7 mm.)	long X	·5640/·5636 in.	(14·3/14·27 mm.) O/dia.
—Exhaust ... 2·15 in. (54·6 mm.)	long X	·5640/·5636 in.	(14·3/14·27 mm.) O/dia.
—Interference fit ·0025/·0045 in. (·063/·114 mm.)			

The valve guide protrusion from the valve spring pocket face is controlled by a circlip that fits in a groove in the outside of the valve guide. This circlip rests on the cylinder head recess below the valve spring pocket.

Rocker clearance (Engine hot)—Inlet ...	·012 in.	(·30 mm.)
Exhaust	·014 in.	(·35 mm.)
Timing—inlet opens	14° B.T.D.C.	
—inlet closes	52° A.B.D.C.	
—exhaust opens	56° B.B.D.C.	
—exhaust closes	10° A.T.D.C.	
Port diameter—Inlet	1·31 in.	(3·33 cms.)
Exhaust	1·06 in.	(2·69 cms.)

CAMSHAFT

No. of bearings	3	
Type of bearings (front, centre and rear) ...	Steel back white metal	
End thrust	Location plate at front	
Drive	Duplex chain	
Lubrication	Oil jet	
Chain tensioner	Spring blade	
End float	·002 in. /·004 in.	(·05/·10 mm.)
Journal diameters (front, centre and rear)	1·7477 in. /1·7470 in.	(44·392/44·374 mm.)

CRANKSHAFT (for torque loading figures see table at end of section)

Balance	Integrally forged counterweights	
No. of main bearings	3	
Type of main bearings	Steel shell white metal lined	
Dia. of main journals	2·2495 in. /2·2490 in.	(57·137/57·125 mm.)
Type of crankpin bearings	Steel shell with copper-lead bearing, indium lined	
Dia. of crankpin bearings (Series I Alpine, Series III Rapier)	1·8760 in. /1·8755 in.	(47·650/47·638 mm.)
Dia. of crankpin bearings (Alpine II, Rapier IIIA onwards)	2·0010 in. /2·0005 in.	(50·825/50·812 mm.)

Lubrication	Pressure	
End thrust	Thrust washer on centre bearing	
End float	·002 in. /·004 in.	(·05/·10 mm.)
Main bearing running clearance	·0010 in. /·0025 in. (on dia.)	(·025/·063 mm.)
Max. undersize for re-grinding	·06 in.	(1·52 mm.)
Size of main bearing bolts	$\frac{7}{16}$ in.	(11·1 mm.)

CONNECTING ROD (for torque loading figures see table at end of section)

Material	Steel forging	
Type	'H' section	
Distance between centres	5·751 in./5·749 in.	(146·3/146·25 mm.)
Small end bearings	Bushed	
Big end bearings	Steel shell with copper-lead bearing, indium coated	

Big end bore (without bearings) 2·0215 in./2·0210 in. (51·34/51·33 mm.) Series I Alpine, Series III Rapier
Big end bore (without bearings) 2·1465 in./2·1460 in./54·52/54·50 mm) Series II, III, IV Alpine, Series IIIA, IV Rapier

Small end bore size (bushed), graded:	SERIES I ALPINE, SERIES III RAPIER	SERIES II, III, IV ALPINE, SERIES IIIA, IV RAPIER
High grade (painted white)	·8753 in. /·8752 in. (22·233/22·230 mm.)	·9379/.9377 in. (23·822/23·820 mm)
Medium grade (painted green)	·8752 in. /·8751 in. (22·230/22·228 mm.)	·9378/·9377 in. (23·820/23·817 mm)
Low grade (painted yellow)	·8751 in. /·8750 in. (22·228/22·225 mm.)	·9377/.9376 in. (23·817/23·815 mm)

Big end, end float	·0012 in. /·0075 in.	(·030/·190 mm.)
Big end bearing running clearance	·0015 in. /·002 in.	(·038/·051 mm.)
Size of big end bolts	$\frac{5}{16}$ in. U.N.F. Series I Alpine, Series III Rapier	
	$\frac{11}{32}$ in. U.N.F. Series II, III, IV Alpine, Series IIIA, IV Rapier	
Lubrication	Squirt hole in big end	

GUDGEON PIN

Type	Tubular fully floating	
Diameter		
High grade (marked with white paint)	·8752 in. /·8751 in. (22·230/22·228 mm.)	Series I Alpine Series III Rapier
Medium grade (marked with green paint)	·8751 in. /·8750 in. (22·228/22·225 mm.)	
Low grade (marked with yellow paint)	·8750 in. /·8749 in. (22·225/22·223 mm.)	
High grade (marked with white paint)	·9377 in. /·9376 in. (23·817/23·815 mm.)	Series II, III, IV Alpine Series IIIA, IV Rapier
Medium grade (marked with green paint)	·9376 in. /·9375 in. (23·815/23·812 mm.)	
Low grade (marked with yellow paint)	·9375 in. /·9374 in. (23·812/23·810 mm.)	
Oversize available	·003 in./.076 mm.	
Method of location	Circlips	

PISTON

Type	Slotted
Material	Aluminium alloy tin plated.
Form	Taper and oval turned

No. of rings—Compression	Two	
—Scraper	One	
Compression—Height	1·850 in. /1·845 in.	(48·99/46·86 mm.)
—Identification (mark on crown)		High { M84 R92 } or HC
		Low { M78 R84 } or LC
Piston length	3·25 in. (85·57 mm.)	
Max. permissible weight variation between any two pistons in a set	2 Drams (3·55 grms.)	

Grade

SERIES I ALPINE, SERIES III RAPIER	SERIES II, III ALPINE, SERIES IIIA, IV RAPIER	SERIES IV ALPINE
A. 3·1088 /3·1092 in. (78·963/78·974mm.)	A. 3·2088 /3·2092 in. (81·503/81·514 mm.)	A. 3·2092 /3·2096 in. (81·514/81·524 mm.)
B. 3·1092 /3·1096 in. (78·974/78·984 mm.)	B. 3·2092 /3·2096 in. (81·514/81·524 mm.)	B. 3·2096 /3·2100 in. (81·524/81.534 mm.)
C. 3·1096 /3·1100 in. (78·984/78·994 mm.)	C. 3·2096 /3·2100 in. (81·524/81·534 mm.)	C. 3·2100 /3·2104 in. (81·534/81·544 mm.)
D. 3·1100 /3·1104 in. (78·994/79·004 mm.)	D. 3.2100 /3.2104 in. (81·534/81·544 mm.)	D. 3.2104 /3·2108 in. (81·544/81·554 mm.)
E. 3·1104 /3·1108 in. (79·004/79·014 mm.) *(For Service use)*	E. 3·2104 /3·2108 in. (81·544/81·554 mm.) *(For Service use)*	E. 3·2108 /3·2112 in. (81.554/81·564 mm.) *(For Service use)*
F. 3·1108 /3·1112 in. (79·014/79·024 mm.) *(For Service use)*		

Ring clearance (between ring and groove) ...	·0015 in. /·0035 in.	(·038/·088 mm.)
Ring gap—Top ring (Series I Alpine, Series III Rapier)	·012 in. /·020 in.	(·30/·51 mm.)
(Series II, III, IV Alpine, Series IIIA, IV Rapier)	.024 in. /·032 in.	(·1/·816 mm.)
—Second and third ring	·009 in. /·014 in.	(·23/·36 mm.)

LUBRICATION SYSTEM

Type of pump	Eccentric lobe type	
Types of intake	Gauze filter on pump	
Pump drive	Skew gear on camshaft	
Normal pressure	55/65 lbs. sq. in.	(3·8/4·5 kg./cm.²)
...	(Hot) at 50 m.p.h.	(80 k.p.h.)
Filter—Make	Fram or Tecalemit	
—Type	Full flow	
—Maker's element No.	Fram FC.41721.	Tecalemit FP.3305/101
—Model	Fram FF.42378.	Tecalemit PSK.1663
—Filter (cars with Solex carburettor) ...	Full-flow throw away type	

FUEL PUMP

Make and type	A.C. No. E/FP.1880B mechanical	
Operation	Lever by eccentric on camshaft	
Pressure	1½–2½ lbs./sq. in.	(0·11–0·18 kg./cm.²)

CARBURETTOR—Alpine I-III (early)

	Series I ★With gauze type air filter	Series II With gauze type air filter	Series II With dry element type air cleaner	Series III (Std.) With gauze type air filter	Series III (GT) With dry element type air cleaner
Make	2×Zenith	2×Zenith	2×Zenith	2×Zenith	2×Zenith
Type	36W.I.P.2	36WIP2 or 36WIP3	36WIP2 or 36WIP3	36WIP3	36WIA3

Settings (Sea level to 4,000 ft. [1219 m.])

Choke	28 mm.	30 mm.	30 mm.	28 mm.	28 mm.	29 mm.	29 mm.
Main discharge jet	016289	016289	016289	016219	016219	016289SE	016289
Main jet	130	142	142	112	112	127	105
By-pass jet ...	Blank	Blank	Blank	57	57	Blank	55
High speed bleed	100	100	100	60	60	100	120
Slow running ...	50	50	45	45	45	45	45
Progression holes	2×0·8	2×0·8	2×1·0	2×0·8	1×1·1, 1×1·0	1×1·0, 2×1·1	1×0·8, 1×1·1
Pump jet ...	50	†50 see below	70	70	70	90	90

CARBURETTOR TYPE NUMBER IS STAMPED ABOVE FLOAT CHAMBER

★Note: (Series I only) For export territories where dust is prevalent a dry element type air cleaner is available. This should be used only with 120 main jet, 180 high speed bleed and a No. 77 by-pass jet.

† 70 Accelerator pump jet is used if 7 mm. radius pump cam is fitted. Where this cam and jet is used, there is a 50 leak hole in the accelerator pump suction valve.

Altitude settings (differences above 4,000 ft. [1219 m])

	4000 ft. (1219 m.) to 7500 ft. (2288 m.)	7500 ft. (2288 m.) to 10000 ft. (3048 m.)	10000 ft. (3048 m.) to 12500 ft. (3812 m.)	12500 ft. (3812 m.) to 15000 ft. (4576 m.)	From 15000 ft. (4576 m.)
Main jet—Series I	125	120	117	115	112
—Series I (Export)	112	110	107	105	102
—Series II (gauze filter)	135	132	130	127	125
—Series II (dry element)	107	105	102	100	97
—Series III (Std.) (gauze filter)	120	117	115	112	110
—Series III (GT) (dry element)	100	98	95	93	90
By-pass jet—Series I (Export)	No change	72	72	70	67
—Series II (dry element)	No change	52	52	50	50
—Series III (GT) (dry element)	No change	50	50	48	48

CARBURETTOR—Alpine III (where fitted), Alpine IV, Rapier IV

Make	Solex compound (twin choke)
Type	32 PAIA

Settings

	Alpine III, Rapier IV Primary throttle STD.	Alpine III, Rapier IV Primary throttle GT. & RAP.	Alpine III, Rapier IV Secondary throttle STD.	Alpine III, Rapier IV Secondary throttle GT. & RAP.	Alpine IV Primary throttle STD. & GT.	Alpine IV Secondary throttle STD. & GT.
Choke	24mm	24mm	26mm	26mm	24mm	26mm
Main jet	120	117·5	155	130	120	155
Air correction	210	190	210	190	210	210
Pilot jet	60	60	60	60	60	60
Pilot air bleed	Nil	1·0	Nil	·8	1·0	1·0
Pump jet...	70	70	Nil	Nil	70	Nil

Float chamber—Pump back bleed	50	Alpine III, Rapier IV
Needle valve	2·5 x 1·0mm	Alpine III, Rapier IV
—Pump back bleed...	50	Alpine IV
—Needle valve	2·5 x 1·0mm	Alpine IV

CARBURETTOR—Rapier III-IIIA

Make	2 X Zenith	
Type	36-W.I.A. 2 or 36 WIA-3	36 WIA-3

Settings (Sea level to 4000 ft. [1219 m.])	*Series III*	*Series IIIA*
Venturi	28 mm.	29 mm
Main discharge jet	016289	016289
Main jet	115	117
By-pass jet	65	65
High-speed bleed	180	180
Slow running	50 (36WIA-2)45 (36WIA-3)	45
Progression holes	2 X 0·8	2 X 1·0
Pump jet...	50 or 70 *	70
Air cleaner and silencer	Oil bath (twin horn)	Oil bath (twin horn)†

NOTE: *when a 70 pump jet is used there is a 50 leak hole in the accelerator pump valve suction valve.*

*70 if 7 mm. radius accelerator pump cam is used or if WIA-3 carburettor is fitted.
†Later models are fitted with a dry (paper element) air clearer

Altitude settings (differences above 4,000 ft. [1219 m.])

	4000 ft. (1219 m.) to 7500 ft. (2288 m.)	7500 ft. (2288 m.) to 10000 ft. (3048 m.)	10000 ft. (3048 m.) to 12500 ft. (3812 m.)	12500 ft. (3812 m.) to 15000 ft. (4576 m.)	From 15000 ft. (4576 m.)
Main jet—Series III	110	107	105	102	100
—Series IIIA	112	110	107	105	102
By-pass jet—Series III	62	60	57	55	55
—Series IIIA	62	60	57	55	52

COOLING SYSTEM

Type of system	Pump and fan
Type of pump	Centrifugal
Fan—No. of blades (Alpine)	Six
—No. of blades (Rapier)	Four
—No. of blades (Alpine III only)	Four
—Diameter (Alpine)	12·70 in. (32·3 cm.)
—Diameter (Rapier)	14·5 in. (36·8 cm.)
—Diameter (Alpine III only)	12·5 in. (31·7 cm.)
Drive of pump and fan	"V" belt from crankshaft
Cooling system control	Thermostat
Radiator relief valve	A.C. (in filler cap)

Relief valve operating pressure—Alpine I,II ...	7 lbs. in.^{2}	(·49 kg./cm.^{2})
—Alpine III,IV ...	9 lbs. in.^{2}	(·63 kg./cm.^{2})
—Rapier III,IIIA ...	4 lbs. in.^{2}	(·28 kg./cm.^{2})
—Rapier IV ...	9 lbs. in.^{2}	(·63 kg./cm.^{2})
Fan belt—depth	·31 in.	(7·9 mm.)
—Width at outside	·375 in.	(9·3 mm.)
—Angle of "V"	40°	
—Length (outside circumference) ...	37·25 in.	(946·2 mm.)
Thermostat (bellows type)—Opens at (Alpine)	162°F	(72°C)
—Opens at (Rapier)	176°F	(79°C)
—Fully open at (Alpine)	185°F	(85°C)
—Fully open at (Rapier)	199°F	(92°C)
Thermostat (wax type)—Opens at (All models)	183°F	(84°C)
—Fully open at (All models)	200°F	(93°C)

IGNITION SYSTEM

Type of system	Coil and distributor
Firing order	1 : 3 : 4 : 2
Ignition control	Fully automatic—Vacuum and centrifugal
*Ignition timing—full retard	5°-7° (6·5-9mm) B.T.D.C. (Low comp.: 8°—10° (10·3-12·8mm) B.T.D.C.)
*Ignition timing—full retard (from chassis Nos. B.3062930 and B.9118359)...	9°—11° (11·5-14mm) B.T.D.C. (all ratios)
*Ignition timing—full retard (Rapier IV)	7°—9° (9-11·5mm) B.T.D.C.
Distributor—Maker's type...	Lucas DM.2.P.4 or Lucas 25.D.4
—Maker's despatch No.	40683B (Alpine I Rapier III)
—Maker's despatch No.	40766A or 40799 (Alpine II Rapier IIIA)
—Maker's despatch No.	40924B (Alpine III)
—Maker's despatch No.	40942A (Alpine IV, Rapier IV)
—Drive	Skewgear on camshaft and offset coupling
—Direction of drive	Anti-clockwise (viewed from above)
—Firing angles	0°, 90°, 180°, 270° ± 1°
—Contacts closed period	60° ± 3°
—Contact breaker gap	·015 in. (·38mm.)

	Distributor *R.P.M.*	*Degrees*
Ignition centrifugal advance	600	1½—4
(with distributor decelerating on test rig)	1400	8½—10
Despatch No's:- 40683B, 40766A, 40799, 40924B	2200	9—11
Ignition centrifugal advance	600	0—2
(with distributor decelerating on test rig)	1200	4—6
Despatch No:- 40942A	2000	8—10
Ignition vacuum advance (all distributors) ...	Hg in (inches of mecury)	
	5	½°—3°
	7	3°—5°
	8·25	4°—6°

** The mm. conversion is measured on the periphery of the crankshaft damper. From B.9204755 and B.3300001, 6 extra timing marks at 5° intervals B.D.T.C. have been added.*

Spark plugs—Make and type (All models except Alpine III, Rapier IV)	Champion N.5*
—Make and type (Alpine III, Rapier IV onwards) ...	KLG.FE75†
—Size	14 mm.
—Gap	·025 in. (·63 mm.)
Coil maker's No. (Alpine I and II)	LA.45053E
Coil maker's No. (Rapier III, Alpine III onwards)	HA.45102

* *For consistent high speed driving use Champion N.3.*

† *For consistent high speed driving use KLG. FE80.*
For racing use KLG. FE100.

CLUTCH

Make	Borg and Beck
Type	Single dry plate
Driven plate—Diameter	8·0 in. (20·32 cm.)
—Type	"Borglite"
Operation (Series I Alpine, Series III Rapier)	Hydraulic
Operation (Alpine II, Rapier IIIA onwards)	Hydrostatic
Thrust bearing	Carbon ring
Free movement at withdrawal lever outer end	·135 in. (·33 cm.) (Alpine, Series Rapier IIIA, IV—Nil)
Colour of cover springs (Series Alpine I, Rapier III) ...	Light grey
Colour of cover springs (Alpine II, III, Rapier IIIA) ...	Orange (6), Dark blue/white (3)
Number of cover springs (Alpine I, Rapier III) ...	6
Number of cover springs (Alpine II, III, Rapier IIIA)	9
Colour of driven plate springs	Light grey/violet
Number of driven plate springs	6
Driven plate compressed thickness	·285 in. (7·24 mm.)
Lever tip—Height (Alpine I, Rapier III)	1·815 in. (4·61 cm.)
—Height (Alpine II, III, Rapier IIIA)	2·14 in. (5·43 cm.)
Clutch assembly (with Solex carburettor).	
—Diaphragm spring	Not adjustable (see Section D)
—Thrust bearing	Carbon ring
—No. and colour driven plate springs	6, Violet/light grey

GEARBOX

Type	Four speed and reverse with control ring synchromesh
Synchromesh on	Top, 3rd and 2nd
Bearings—Mainshaft	Front spigot—needle roller; rear–ball bearing
—Layshaft	Needle roller
—Reverse gear	Phosphor bronze bush
Stemwheel spigot bearing type	"Oilite" bush

Gearbox ratios	All models except Alpine III	Alpine III
—Top	1·00 : 1	1·00:1
—Third	1·39 : 1	1·23:1
—Second	2·14 : 1	1·89:1
—First	3·35 : 1	2·96:1
—Reverse	4·24 : 1	3·75:1

Layshaft end float ... ·006 in. / ·008 in. (0·15/0·20 mm.)
Adjustment—Mainshaft ... None
—Layshaft ... Selective assembly

Speedometer gears—Alpine

	PINION	WHEEL	REVS/MILE (KM)	SPEEDO. HEAD		
Series I (std) 5.60 x 13 tyres	P.113464 (17 teeth)	P.113467 (5 teeth)	1020 640	1046560 1046611	(SN.6117/00) (SN.6117/03)	MPH KPH
Series I (std) 5.90 x 13 tyres	P.113464 (17 teeth)	P.113467 (5 teeth)	1000 620	1046609 1046612	(SN.6117/01) (SN.6117/04)	MPH KPH
Series II (std) 5.60 x 13 tyres	P.113464 (17 teeth)	1207201 (5 teeth)	1020 640	1046560 1046611	(SN.6117/00) (SN.6117/03)	MPH KPH
Series II (std) 5.90 x 13 tyres	P.113464 (17 teeth)	1207201 (5 teeth)	1000 620	1046609 1046612	(SN.6117/01) (SN.6117/04)	MPH KPH
Series II (std) 6.00 x 13 low profile & 5.90 x 13 RS.5 tyres	P.113464 (17 teeth)	1207201 (5 teeth)	1000 620	1206264 1206265	(SN.6117/11) (SN.6117/12)	MPH KPH
Series III, IV (std) 6.00 x 13 low profile & 5.90 x 13 RS.S tyres	P.113464 (17 teeth)	1207201 (5 teeth)	1000 620	1223587 1223588	(SN.5324/25) (SN.5324/26)	MPH KPH
Series I, II (O/d) 5.60 x 13 tyres	5037405 (1S teeth)	5037404 (4 teeth)	1000 620	1046609 1046612	(SN.6117/01) (SN.6117/04)	MPH KPH
Series I, II (O/d) 5.90 x 13 tyres	5037405 (1S teeth)	5037404 (4 teeth)	980 620	1046610 1046613	(SN.6117/02) (SN.6117/05)	MPH KPH
Series II (O/d) 6.00 x 13 low profile & 5.90 x 13 RS.S tyres	5037405 (1S teeth)	5037404 (4 teeth)	1000 620	1206264 1206265	(SN.6117/11) (SN.6117/12)	MPH KPH
Series III (O/d) 6.00 x 13 low profile & 5.90 x 13 RS.S tyres	5031066 (12 teeth)	K.25632 (5 teeth)	1408 880	1218031 1218032	(SN.5324/18) (SN.5324/19)	MPH KPH
Series IV (O/d) 6.00 x 13 low profile & 5.90 x 13 RS. 5 tyres	5031066 (12 teeth)	K.25632 (5 teeth)	1534 960	1223540 1223541	(SN.5324/23) (SN.5324/24)	MPH KPH

Speedometer gears—Rapier

	PINION	WHEEL	REVS/MILE (KM)	SPEEDO. HEAD		
Series III (std)	P.112163 (14 teeth)	P.115296 (6 teeth)	1600 980	1203400 1203401	(SN.5324/00) (SN.5324/01)	MPH KPH
Series IIIa (std)	1207586 (13 teeth)	1207585 (6 teeth)	1568 980	1203400 1203401	(SN.5324/00) (SN.5324/01)	MPH KPH
Series III (O/d)	5031066 (12 teeth)	K.25632 (5 teeth)	1600 980	1203402 1203403	(SN.5324/02) (SN.5324/03)	MPH KPH
Series IIIA (O/d)	5031066 (12 teeth)	K.25632 (5 teeth)	1632 1020	1208052 1208053	(SN.5324/04) (SN.5324/05)	MPH KPH
Series IIIA (O/d)	5031066 (12 teeth)	K.25632 (5 teeth)	1504 940	1219420 1219421	(SN.5324/14) (SN.5324/15)	MPH KPH
Series IV (std)	P.113464 (17 teeth)	1207201 (5 teeth)	1000 620	1223587 1223588	(SN.5324/25) (SN.5324/26)	MPH KPH
Series IV (O/d)	5031066 (12 teeth)	K.25632 (5 teeth)	1534 960	1223540 1223541	(SN.5324/23) (SN.5324/24)	MPH KPH

PROPELLER SHAFT (for torque loading figures see table at end of section)

Type	Open shaft (reverse spline)	
Outside diameter—Alpine	2·0 in.	(5·1 cm.)
—Rapier	2·75 in.	(6·9 cm.)
Overall length—Alpine (Std.)	39·34 in.	(99·9 cm.)
—Rapier (Std.)	51·84 in.	(131·6 cm.)
—Alpine (O/d.)	36·59 in.	(95·0 cm.)
—Rapier (O/d.)	48·72 in.	(123·7 cm.)
Length between centres—Alpine (Std.) ...	32·25 in	(81·9 cm.)
—Rapier (Std.) ...	46 in.	(116·8 cm.)
—Alpine (O/d.) ...	29·5 in.	(74·9 cm.)
—Rapier (O/d.) ...	42·88 in.	(108·9 cm.)
Universal joint	Needle roller	

REAR AXLE (for torque loading figures see table at end of section)

Type	Semi-floating	
Final drive ratio—Alpine (Series I, II) ...	3·89 : 1	(4·22 : 1 with Overdrive)
—Rapier (Spiral bevel axles)	4·55 : 1	(4·78 : 1 with Overdrive)
—Rapier (Hypoid bevel axles)	4·22 : 1	(4·86 : 1 or from chassis No. B3062492 4·44 : 1 with Overdrive)
—Alpine (all Series III)	3·89 : 1	
—Rapier (Series IV)	3·89 : 1	(4·22:1 with Overdrive)

Bearings—Bevel pinion	Taper roller					
—Differential and crown wheel assembly	Taper roller					
—Hub	Ball					
Crown wheel to pinion backlash	·005 in. / ·009 in.		(0·127/0·229 mm.)			
Number of teeth—Crown wheel (Alpine) ...	35	3·89	38	4·22		
—Bevel pinion (Alpine) ...	9		9			
—Crown wheel (Rapier) ...	41	4.55	43	4·78		
—Bevel pinion (Rapier) ...	9		9			
—Crown wheel (Rapier) ...	38	4.22	34	4·86	40	4·44
—Bevel pinion (Rapier) ...	9		7		9	
—Crown wheel (Rapier) ...	35	4·89	38	4·22		
—Bevel pinion (Rapier) ...	9		9			
Adjustment—Bevel pinion	Shims					
—Differential assembly	Shims					

OVERALL RATIOS

	O/d Top	Top	O/d 3rd	Third	Second	First	Reverse
Alpine 1,11 (std)	—	3.89:1	—	5.41:1	8.33:1	13.01:1	16.48;1
Alpine 1,11 (O/d)	3.39:1	4.22:1	4.72:1	5.88:1	9.04:1	14.13:1	17.90:1
Alpine 111 (all models)	3.12:1	3.89:1	3.85:1	4.80:1	7.38:1	11.53:1	14.61:1
Rapier 111 (std) (spiral bevel)	—	4.55:1	—	6.34:1	9.75:1	15.24:1	19.31:1
Rapier 111 (O/d) (spiral bevel)	3.83:1	4.78:1	5.34:1	6.65:1	10.23:1	15.99:1	20.25:1
Rapier 111,111A (std)	—	4.22:1	—	5.88:1	9.04.1	14.13:1	17.90:1
Rapier 111,111A (O/d)	3.90.1	4.86:1	5.43:1	6.76:1	10.40:1	16.25:1	20.59:1
Rapier 111A (O/d)...	3.56:1	4.44:1	4.96:1	6.18:1	9.51:1	14.87:1	18.83:1
Rapier, Alpine IV (std)	—	3.89:1	—	5.41:1	8.32:1	13.01:1	16.48:1
Rapier, Alpine IV (O/d)	3.39:1	4.22:1	4.72:1	5.88:1	9.04:1	14.13:1	17.90:1

FRONT SUSPENSION (for torque loading figures see table at end of section)

Type	Independent with unequal length wishbones	
Spring (Alpine) —Outside diameter (Series I, II)	3·87 in.	(9·84 cm.)
—Outside diameter (Series III only)	4·40 in.	(11·17 cm.)
—Static laden length (up to chassis No. B. 9106289 and Series III models)	7·375 in.	(18·73 cm.)
—Static laden length (from chassis No. B. 9106290)	7·85 in.	(19·93 cm.)
—Static laden loading(off car) ...	950 lbs.	(430·91 kgs.)
—Free length (up to chassis No. B. 9106289 and Series III models)	11·175 in.	(28·38 cm.)
—Free length (from chassis No. B. 9106290) ...	11·65 in.	(29·59 cm.)
Spring (Alpine IV)—Outside diameter	4·47 in.	(11·35 cm.)
—Static laden length	7·55 in.	(19·17 cm.)
—Static laden loading (off car)	1040 lbs.	(472 kg.)
—Free length	12·62 in.	(32·05 cm.)
Spring (Rapier)—Outside diameter (saloon) ...	4·51 in.	(11·45 cm.)
—Outside diameter (convertible)	4·46 in.	(11·35 cm.)
—Static laden length	7·75 in. ± ·10 in.	(19·68 ± ·25cm.)
—Static laden loading (off car)	1190 lbs.	(539·77 kgs.)
—Free length (saloon) ...	10·96 in.	(27·83 cm.)
—Free length (convertible) ...	11·52 in.	(29·26 cm.)
Spring (Rapier IV)—Outside diameter ...	4·55in.	(11·55 cm.)
—Static laden length ...	7·90±·1in.	(20±·25 cm.)
—Static laden loading (off car)...	1270 lbs.	(576 kg.)
—Free length ...	11·86in.	(30 cm.)
Castor angle—Alpine	3° 50′	
—Rapier	0° 30′ ± 15′	
Wheel camber angle	0° 30′ ± 15′	
Steering axis inclination	5° 15′ ± 15′	
Toe-in (track setting) *at wall of tyres* ...	⅛ in. (3 mm.)	*equivalent to an angle beetween the wheels of 17′ ±5′*

All steering angles and dimensions MUST be checked with the car on gap gauges. For full explanation see Section F.

Ackerman angles (toe-out on turns) ... ... Inner wheel 22° 45′ plus or minus ½°
Outer wheel 20°.

Wheel lock angle	24° on each outer lock
Hub bearings—Inner	Taper roller (Timken 1988/1922)
—Outer	Taper roller (Timken L.M.11949/L.M.11910)
—End float	·002/·007 in. (·05/·18 mm.)
Length of top link	7·625 in. (19·37 cm.)
Length of bottom link	12·85 in. (32·64 cm.)
Trunnion thrust washer end float	·015/018 in. (·38/·46 mm.)
Wheel movement—laden to rebound	2·80 in. (7·11 cm.)
—Laden to bump (Alpine) ...	2·10 in. (5·33 cm.)
—Laden to bump (Rapier) ...	2·75 in. (6·98 cm.)
Type of bushes	Threaded steel

REAR SUSPENSION (for torque loading figures see table at end of section) (Alpine)

	Series I	*Series II*	*Series III*
Type	Semi-elliptic	Semi-elliptic	Semi-elliptic
Springs—Length (between centres)	44 in. (111·76 cm.)	44 in. (111·76 cm.)	43·5 in. (110·49 cm.)
—Width	1·75 in. (4·45 cm.)	2·25 in. (5·72 cm.)	2·25 in. (5·72 cm.)
—Depth	1·547 in. (3·93 cm.)	1·172 in. (2·97 cm.)	*1·172 in. (2·97 cm.)
—Bushes	Rubber	Rubber	Rubber
Number of blades per spring ...	8	6	*6
Number of clips per spring ...	4	4	4
Laden camber—on or off car	1·25 in. (3·1 cm.) negative	·50 in. (1·2 cm.) negative	·70 in. (1·77 cm.) negative
Laden camber load (on car) Load to be evenly distributed approx. 20in. (50cm) rearwards from centre line of rear axle (in boot).	165 lbs. (75 kg.)	165 lbs. (75 kg.)	165 lbs. (75 kg.)

**From B.9203548 and all Series IV cars only 5 blades with a total depth of ·984 in. (2·5 cm.) are used.*

REAR SUSPENSION (for torque loading figures see table at end of section) (Rapier)

Type	Semi-elliptic	
Springs—Length (between centres)	47·01/46·89 in.	(119·40/119·10 cm.)
—Width	1·5 in.	(3·80 cm.)
—Depth	1·72 in.	(4·35 cm.)
—Bushes	Steel and rubber	
Springs (Rapier IV)—Depth	1·66 in. (4·21 cm.)	
—No. of blades	5 × $\frac{7}{32}$ in. (5·5mm) + 1 × $\frac{1}{4}$ in. (6·3mm) + 1 × $\frac{5}{16}$ in. (7·9mm)	
—Laden camber	1·25 in. (3·2cm.) negative	
No. of blades	6 × $\frac{5}{64}$ in. (5·9 mm.) + 1 × $\frac{5}{16}$ in. (7·9 mm.)	
No. of clips	3	
Laden camber—on car	1·0 in. (2·5 cm.) negative	
Laden camber—on car ... ... (springs with eccentric bush)	·45 in. (1·1 cm.) negative	
Laden camber load (on car) Load to be evenly distributed over centre line of rear axle (in boot).	395 lbs. (179 kg.)	

SUSPENSION CONTROL

Shock Absorber—Make (Alpine)	Armstrong
—Make (Rapier)	Girling
—Type	Hydraulic
—Linkage	Rubber bushed
Sway eliminator—Type	Torsion bar between front suspension links

STEERING (for torque loading figures see table at end of section)

Make and type	Burman "F" recirculating ball
Turns—lock to lock (Alpine)	3
—Lock to lock (Rapier)	3·15
Steering box ratio (straight ahead)	14·5 : 1 (16·4:1 from B3303416 R/H; B.3304752 L/H)
Total angular movement of drop arm—Alpine ...	65°
—Rapier ...	74°
Adjustment—Column pre-load	Shims (·0015 in. [·038 mm.])
—Rocker shaft end float	Shims (·004/·008 in. [·10/·20 mm.])

BRAKES (for torque loading figures see table at end of section)

Make—Alpine	Girling
—Rapier	Lockheed
Type of system	Hydraulic
Front brakes	Disc
Rear brakes	Leading and trailing shoe
Linings—Front	Don 55
—Front (Alpine III, Rapier IV)	M. 40
—Rear (Alpine and Rapier IV)	Don 24
—Rear (Rapier III, IIIA)	Ferodo DM53A
Handbrake—Type	Ratchet and pawl
Brake discs—Material	Cast iron
—Diameter (Alpine I, II)	9·5 in. (24·1 cm.)
—Diameter (Alpine III)	9·85 in. (25cm.)
—Diameter (Rapier)	10·8 in. (27·4 cm.)
Brake drums—Material	Cast iron
—Diameter	Rear 9 in. (228·6 mm.)
Brake lining (rear)	1·75 in. (44·4 mm.)
Access to master cylinder	Under bonnet

WHEELS AND TYRES (Alpine)

Road wheels—type	Pressed steel disc or wire
—Size	4J × 13
No. of wheel studs	4
Max. permissible "run-out" at wheel rim	·07 in. (1·8 mm.)
Max. permissible "lift" at wheel rim	·07 in. (1·8 mm.)
Jack—Type	Screw
—Location	Sockets below bumpers
Tyres—Size	5·60 × 13, 5·90 × 13 or 6·00 × 13
—Rolling radius	5·60 × 13—11·25 in. (28·6 cms.) 5·90 × 13—11·45 in. (29·0 cms.) 6·00 × 13—11·50 in. (29·2 cms.)

—Pressures (Series I, II)*

Normal motoring—5·60 × 13 tyres	Front: 22 lbs. sq. in. (1·55 kg. cm.²) Rear: 23 lbs. sq. in. (1·62 kg. cm.²)
" " —5·90 × 13 " —6·00 × 13 "	Front: 22 lbs. sq. in. (1·55 kg. cm.²) Rear: 23 lbs. sq. in. (1·62 kg. cm.²)
Fast motoring —5·60 × 13 "	Front: 25 lbs. sq. in. (1·76 kg. cm.²) Rear: 27 lbs. sq. in. (1·90 kg. cm.²)
" " —5·90 × 13 " —6·00 × 13 "	Front: 24 lbs. sq. in. (1·69 kg. cm.²) Rear: 25 lbs. sq. in. (1·76 kg. cm.²)

**For competition work or other circumstances when it may be required to drive continuously near maximum speed, we strongly recommend the use of 5·90x13 Road Speed tyres with minimum pressures of 28 lbs. per sq. in. (Front) and 30 lbs. per sq. in. (Rear) (1·97 and 2·11 kg./cm.). For prolonged touring at high speeds in all other circumstances, the pressures in the front and rear tyres should be increased by 6 lbs. per sq. in. (·42 kg/cm²).*

—Pressures (Series III onwards)

Normal motoring—6·00 × 13 tyres	Front: 24 lbs. sq. in. (1·69 kg. cm.²) Rear: 24 lbs. sq. in. (1·69 kg. cm.²)
—5·90 × 13 tyres	Front: 24 lbs. sq. in. (1·69 kg. cm.²) Rear: 24 lbs. sq. in. (1·69 kg. cm.²)
Prolonged high speed driving —6·00 × 13 tyres	Front: 24 lbs. sq. in. (1·69 kg. cm.²) Rear: 26 lbs. sq. in. (1·82 kg. cm.²)
—5·90 × 13 tyres	Front: 24 lbs. sq. in. (1·69 kg. cm.²) Rear: 26 lbs. sq. in. (1·82 kg. cm.²)

WHEELS AND TYRES (Rapier)

Road wheels—Type	Pressed steel disc
—Size	4J × 15 (Rapier IV 4½J × 13)
No. of wheel studs	4
Max. permissible "run-out" at wheel rim	·10 in. (2·54 mm.)
Max. permissible "lift" at wheel rim	·10 in. (2·54 mm.)
Tyres—Type and size	Dunlop 5.60 × 15 (Rapier IV Dunlop 6.00 × 13)
—Rolling radius—15 in. wheel	12·3 in. (31·24 cm.)
—13 in. wheel	11·5 in. (29·21 cm.)

—Pressures *	
Normal motoring — 5.60 × 15 tyres ...	Front: 24 lbs. in.^{2} (1·69 kg. cm.^{2})
	Rear: 24 lbs. in.^{2} (1·69 kg. cm^2)
Fully laden — 5.60 × 15 „ ...	Front: 24 lbs. in.^{2} (1·69 kg. cm.^{2})
	Rear: 28 lbs. in.^{2} (1·96 kg. cm.^{2})
—Pressures (Rapier IV) all conditions ...	Front and rear 27 lbs. in^2 (1·89kg. cm.^{2})
Jack—Type	Screw
—Location	Sockets below bumpers

**For fast driving, particularly when using high speed motorways which allow lengthly periods near maximum speed, pressures in front and rear tyres should be increased by 6 lbs. in.^{2} (·42 kg. cm2).*

BATTERY

Make	Lucas
Capacity and type	38 amp. hr. normal service
	51 amp. hr. (certain export territories)
Location—Alpine	Under rear floor
—Rapier	N/S wing valance
Voltage	12
System	Positive earth
Specific gravity reading	See Section N

Coil and Distributor

(See Ignition System)

CONTROL BOX

Make and type	Lucas RB. 106/2
Make and type (Alpine IV)	Lucas RB. 340

GENERATOR

Make	Lucas
Type	C.40—1
Drive	"V" belt from crankshaft (see also under Cooling System)
Control of output	C.V.C.
Brush spring tension (new)...	15/25 ozs. (·42/·71 kgs.)
Cutting-in speed	1250 to 1450 r.p.m. at 13 generator volts
Maximum output	22 amps. at 2050 to 2250 r.p.m. (max.) at 13·5 generator volts (on resistance load of ·61 ohm)
Field resistance	6·0 ohms

STARTER

Make	Lucas
Type	M.35.G
Control type	Solenoid
Drive type	Lucas "SB"
Lock torque	9·3 lbs. ft. (1·28 kg.m.) 370/390 amps at 7·7/7·3 volts
Brush spring tension	15/25 ozs. (·42/·71 kgs.)

LIGHTING

System	Earth return
Headlamp type	P.700
Sidelamp type—Alpine	L.594
—Rapier	L.539
—Rapier	L.662

LAMP BULBS

Head—	
Home and Export R.H.D.	Lucas No. 414 12V. 50/40W. (Sealed beam on Alpine III Rapier IV onwards)
Export L.H.D.	Lucas No. 410 12V. 45/40W.
„ France	Lucas No. 411 12V. 45/40W.
U.S.A. and Canada	Standard sealed beam unit

Note.—*It is important that the bulbs specified for each type of lamp are used. Otherwise the maximum anti-dazzle properties will not be obtained.*

Side front flasher	Lucas 380 12V. 21/6W.
Beam indicator	Phillips 12829 12V. 2W.
Ignition warning lamp	Phillips 12829 12V. 2W.
Panel illumination bulbs	Lucas 987 12V. 2·2W.
Stop/tail	Lucas 380 12V. 21/6W.
Rear flashing signals	Lucas 382 12V. 21W.
Rear number plate	Lucas 222 12V. 4W. or Lucas 989 12V. 6.W
Speedometer	Lucas 987 12V. 2·2W.
Direction indicator pilot lamp	Phillips 12829 12V. 2W.
Interior lamp (where fitted)	Lucas 254 12V. 6W. (festoon)
Revolution indicator (where fitted)	Lucas 984 12V. 3·6W.
Map lamp (where fitted)	Lucas 354 12v. 6W. (festoon)
Side Lamp-Alpine IV (capless)	Lucas 501 12v. 5W.

OTHER EQUIPMENT

Flasher unit—Make	Lucas
—Type	FL.3
Windscreen wiper—Make	Lucas
—Type	Dual arm, automatic park, dual speed
Horn—Make and type (early Alpine)	Lucas WT.618
—Make and type (later Alpine)	Clear-Hooter 725
—Make and type (Rapier)	Lucas windtone
Fuses	Lucas 4FJ unit, 2×35 amp.
Heater blower fuse	1x10 amp. (when fitted)

Alpine IV and Rapier IV

(Differences from B.94100001 and B.3100001)

CAPACITIES

Gearbox oil—Std	3½ pints	(4·2 U.S. pints; 1·9 litres)
—O/D	4½ pints	(5·4 U.S. pints; 2·5 litres)

CARBURETTOR SETTINGS (Rapier only)

Primary throttle main jet ... 115

GEARBOX

Gearbox ratios—Top	1·000:1
—Third	1·392:1
—Second	2·140:1
—First	3·353:1
—Reverse	3·569:1

SPEEDOMETER DRIVE GEARS

Standard gearbox only both Alpine and Rapier (Overdrive is not affected)

PINION	WHEEL	REVS	SPEEDO. HEAD
P.113464	1207201	1000	1224524 (SN. 5324/33) MPH
(17 teeth)	(5 teeth)	620	1224525 (SN. 5324/34) KPH

OVERALL RATIOS

	STANDARD	OVERDRIVE
O/D Top	——	3·387:1
Top	3·89 :1	4·22 :1
O/D Third	——	4·714:1
Third	5·413:1	5·877:1
Second	8·324:1	9·038:1
First	13·04 :1	14·158:1
Reverse	13·88 :1	15·07 :1

TORQUE LOADING FIGURES

ENGINE

Cylinder head (tighten when cold)	48 lbs. ft. (6·6 kg.m)
Crankshaft (mains)	55 lbs. ft. (7·6 kg.m)
Con. rod (big-end)—Series I Alpine, Series III Rapier	20 lbs. ft. (2·7 kg.m)
—Alpine, II Series Rapier IIIA Onwards ...	24 lbs. ft. (3·3 kg.m)
Flywheel	40 lbs. ft. (5·5 kg.m)

GEARBOX

Mainshaft nuts	80 lbs. ft. (11·0 kg.m)

REAR AXLE

Hypoid bevel pinion nut	110 lbs. ft. (15·2 kg.m)
Axle shaft	180 lbs. ft. (24·8 kg.m)

PROPELLER SHAFT

Universal joint—metal to rubber (where fitted)	50 lbs. ft. (6·9 kg.m)

FRONT SUSPENSION

Fulcrum pin to crossmember mounting bolts (upper)	48 lbs. ft. (6·6 kg.m)
Fulcrum pin to crossmember mounting bolts (lower)	32 lbs. ft. (4·4 kg.m)
Eye bolt—trunnion to link	40 lbs. ft. (5·5 kg.m) 85 lbs. ft. (11·7 kg.)
Ball pin—stub carrier to link	52 lbs. ft. (7·1 kg.m)
Ball pin—housing to link	33 lbs. ft. (4·5 kg.m)
Shock absorber to spring pan	6 lbs. ft. (·8 kg.m)
Crossmember to frame	62 lbs. ft. (8·5 kg.m)
Road wheel nut	48 lbs. ft. (6·6 kg.m)

REAR SUSPENSION

Rear spring "U" bolts—Alpine	42 lbs. ft. (5·8 kg.m)
—Rapier	16 lbs. ft. (2·2 kg.m)

STEERING

Box to frame	30 lbs. ft. (4·1 kg.m)
Relay lever to frame	30 lbs. ft. (4·1 kg.m)
Steering crosstube ball pin—centre	30 lbs. ft. (4·1kg.m)
—outer	28 lbs. ft. (3·8 kg.m)

BRAKES (Front)

Brake disc to hub	38 lbs. ft. (5·2 kg.m)
Caliper to adaptor	52 lbs. ft. (7·1 kg.m)
Steering arm to carrier and adaptor	38 lbs. ft. (5·2 kg.m) 60 lbs. ft. (8·2 kg.m)
Adaptor to carrier	38 lbs. ft. (5·2 kg.m)

BRAKES (Rear)

Backplate to casing	17 lbs. ft. (2·0 kg.m)
Wheel cylinder to backplate	12 lbs. ft. (1·6 kg.m)

COOLING SYSTEM

CONTENTS

COOLING SYSTEM

All threads are of the Unified series and the appropriate spanners must be used

GENERAL DESCRIPTION

Water is circulated by an impellor type pump mounted on the front of the cylinder block. It is driven by a vee belt which also drives the generator. The radiator cooling fan is bolted to the pump-driving pulley.

Alpine Service I and II

A cross flow radiator is used on these cars. Water is drawn from the bottom end of the right-hand (offside) vertical tank of the radiator and delivered into the cylinder block where it passes around the cylinder barrels. From the cylinder block the water flows into the cylinder head through one brass water jet and several water holes. The brass jet is used to direct the circulation of water in the cylinder head. Water passes from the cylinder head into the thermostat housing, and when the thermostat valve is open, into an aluminium header tank that is bolted to the thermostat housing immediately above the thermostat. The header tank is coupled to the top end of the left-hand (nearside) vertical tank of the radiator by the top water hose.

Rapier models and Alpine Series III

A vertical type of radiator is used on these cars. Water is drawn from the bottom tank of the radiator through the bottom water hose by the water pump, and passes through the engine to the thermostat housing in exactly the same way as described above. It then flows through the 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 cast-iron body bolted to the front end of the cylinder head.

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.

Water also flows through a pipe from the rear end of the cylinder head to the water-heated induction manifold jacket and from here to the suction side of the water pump.

After starting the engine, the water temperature will rapidly rise, but circulation of the water through the radiator does not commence until a suitable temperature has been reached in the cylinder head, cylinder block water jackets, and induction manifold jacket.

At this temperature the thermostat begins to open and water commences to flow through the radiator. The thermostat becomes fully open at the normal operating temperature.

The thermostat operating temperatures are given in the Data Section under "Cooling System".

Radiator Relief Valve (See Fig. 1)

Incorporated in the filler cap is a spring-loaded relief valve which prevents water loss through the overflow pipe when the water is at normal level.

In addition, this valve allows a small pressure to build up in the cooling system. This raises the boiling point of the water which is a great advantage in high altitudes and in tropical conditions.

As the cooling system temperature falls partial vacuum is formed. This is relieved by entry of air through the overflow pipe and the facuum release valve which is built into the pressure relief valve.

Details of the relief valve release pressures are given in the General Data Section under "Cooling System".

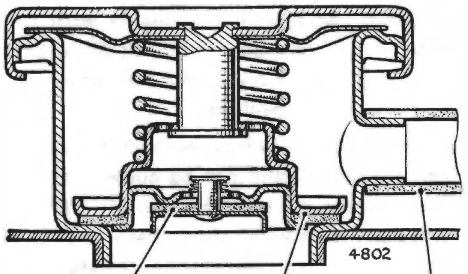

Fig. 1. *Radiator relief valve*

DRAINING THE COOLING SYSTEM

The radiator drain tap is situated under the offside (right-hand) of the radiator and the cylinder block drain tap on the front of the nearside (left) part of the engine front bearer plate. Both taps should be opened together by turning the taps in an anti-clockwise direction. When a car heater is fitted, the temperature control must be set to the HOT position.

REFILLING THE COOLING SYSTEM

Whenever possible clean rainwater, or softened water should be used in preference to water taken from a main supply.

If fitted the heater control must not be set to the HOT position.

Under extreme cold conditions, warm, but not boiling water, may be used if necessary. Water, or anti-freeze solution should be poured in slowly to prevent air locks.

After filling, the engine should be run for a short time and the level rechecked to ensure that no loss of water has occurred due to filling of the heater, if fitted.

FROST PRECAUTIONS

Without using anti-freeze

When the car 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 car 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.

Using anti-freeze

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, given in the Data Section under "Cylinder Head".

Cars with anti-freeze mixture in the cooling system should have a label attached to the header tank of the radiator, under the bonnet, to indicate the fact. The following precautions are necessary on cars so marked:—

(*a*) Never fill the header tank 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.

Heaters

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 have the water control valve, on the heater unit, fully open in order to prevent air becoming trapped in the heater system. The water valve is operated by the finger slide, and is fully open when the finger slide is in the maximum position on the temperature control panel.

COOLING SYSTEM—To clean

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 bottom of radiator (or preferably remove the tap complete), when engine is still hot; also open or remove tap from left-hand side of cylinder block.

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 cleansing solution (several reliable brands of which are available) and run the engine as directed by the makers of the solution.

It is most important to ensure that the cleansing solution used does not contain anything that will cause corrosion of the aluminium cylinder head.

Solutions containing caustic soda must not be used.

It is important to drain off the cleansing solution 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 anti-freeze 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 and 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 car 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.

THERMOSTAT

To remove and refit

The thermostat is situated in the thermostat housing at the front end of the cylinder head.

Drain radiator to below thermostat level.

Disconnect water hose connection to the header tank (*Alpine I and II*) or water outlet pipe (*Rapier and Alpine III*).

Remove the two bolts holding the header tank or water outlet pipe to the thermostat housing.

Remove header tank, or water outlet pipe, and lift out thermostat.

If the thermostat valve is found open on removal, it is defective, and a new unit should be fitted.

When refitting, a new joint should be used between the header tank, or water outlet pipe, and the thermostat housing.

To test

Suspend unit in a vessel of water with a reliable thermometer.

Heat the water slowly, noting the thermometer reading and stirring the water continually.

The thermostat valve should commence to open and be fully open at the temperatures given in the Data Section under "Cooling System".

Thermostats are sealed and their setting and manufacture is specialised work. Always renew if doubt exists. If a replacement is not immediately available, it should be left out, as a faulty unit could cause serious overheating.

RADIATOR—TO Remove and Refit

Drain cooling system.

Disconnect top and bottom water hoses.

Remove fixing bolts that secure radiator to baffle plates.

Replacement is made in reverse order. Fixing bolts and their cage nuts should be lubricated with thick oil to prevent rusting of the bolt threads.

WATER TEMPERATURE GAUGE

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 in the wiring harness, and temperature is only recorded when the ignition is switched on.

Removal of element

Drain the radiator enough to allow removal of element without loss of water or anti-freeze.

Disconnect battery.

Remove the insulated lead from element terminal.

Unscrew and remove element.

It is most important that the interconnecting cable between the gauge and the temperature element should not be shorted to earth when the ignition is switched on. If this occurs the temperature gauge winding will burn out and for this reason the battery should be disconnected or the end of the lead insulated when it is removed from the element terminal.

Removal of Temperature Gauge

Two electrical leads have to be disconnected and the two knurled instrument fixing nuts removed to allow the instrument head to be lifted out of the instrument panel.

To Check Temperature Gauge Reading

Remove the temperature element and earth its outer body to the thermostat housing and switch on the ignition. Immerse the element in a small container of almost boiling water and take the temperature of this water with a reliable glass thermometer. A comparison of the glass thermometer reading with the instrument will show if the later is reasonably correct.

WATER PUMP

To remove and refit

Remove radiator.

Slacken by-pass hose.

Remove thermostat housing.

Slacken dynamo mounting bolts.

Remove driving belt and fan blades.

Disconnect heater hose (if fitted).

Remove four bolts and withdraw pump.

Reassemble in the reverse order, renewing any faulty joints or water hoses. When replacing the fan belt adjust so that there is $\frac{5}{8}$" (16 mm.) belt slackness in the centre of the longest run of the belt.

To dismantle

A sectional view of the water pump is shown in Fig. 2. The impellor and fan pulley centre are a press

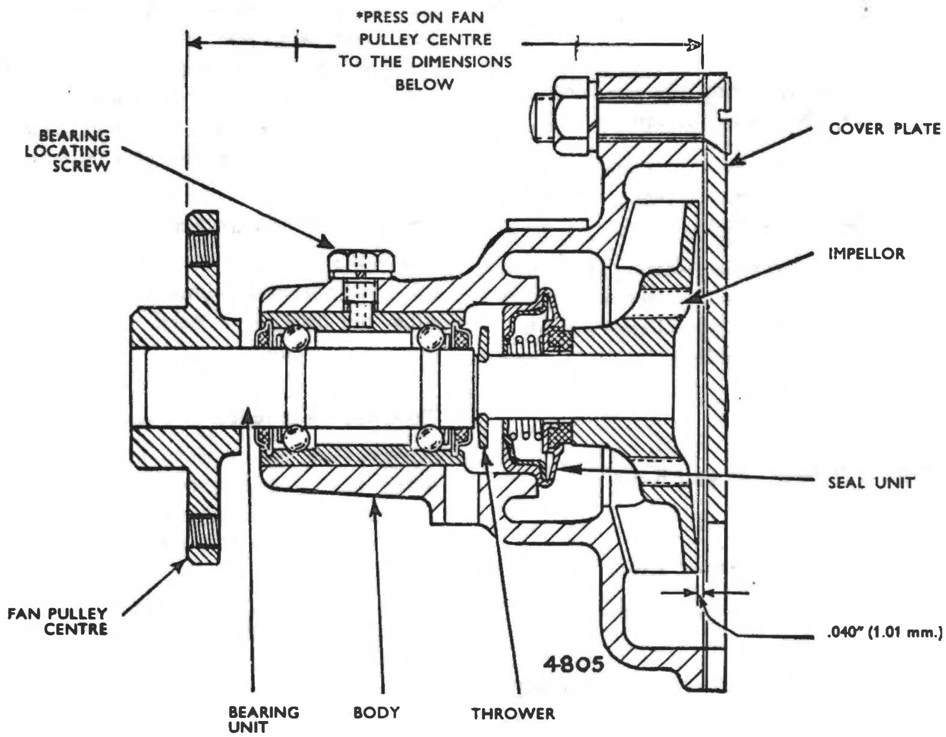

Fig. 2. *Sectional view of water pump*

ALPINE SERIES I AND RAPIER III 4·00"—4·01" (101·6—101·8 mm.)

ALPINE SERIES II AND III 4·865"—4·875" (121·5—123·8 mm.)

fit on the pump spindle which forms part of a specially constructed shaft and bearing unit.

The bearing unit is lubricated in manufacture only. There is no provision for renewal of the lubricant in service. It is therefore most important not to wash the complete pump in petrol (gasolene), paraffin (kerosene) or any other form of cleaning fluid, as these would enter the bearing and destroy the lubricant. Cleaning of the pump body should be left until the pump is dismantled.

The pump should be dismantled in the following manner:—

1. Remove bearing locating screw, see Fig. 2, and the countersunk bolt and nut holding on the back cover plate. Remove cover plate and its paper joint.

2. Support pump body and press on spindle at the impellor end. This will bring the impellor against the pump body and allow the spindle to be pressed out of the impellor and housing leaving the water seal in position.

3. Lift the water seal out of the pump body.

4. Carefully examine the spindle and bearing unit. If the bearing shows any signs of wear or roughness when rotated, the fan pulley centre should be supported on its underside and the spindle pressed out.

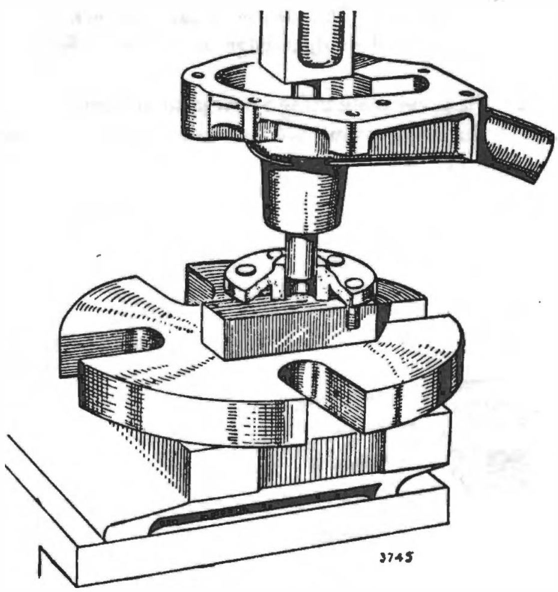

Fig. 3. *Pressing on fan centre*

5. Clean out all deposits from the pump body and inspect this item. If there are any signs of wear or deterioration in the bearing bore, or the face immediately behind the impellor the housing should be renewed.

The water seal has a carbon face mounted in a rubber housing. This face is held against the machined face on the rear of the impellor by a spring in the rubber housing of the seal. If either of these parts are worn, or if the pump is leaking these parts should be renewed.

It is most important to have a smooth flat face, square to the axis of the spindle, on the part of the impellor in contact with the carbon face of the seal.

To reassemble

1. Place the bearing unit in the pump body with the larger diameter of the spindle to the front of the housing, lining up the locating hole in the bearing with the threaded hole in the pump body.

2. Replace the bearing locating screw in the top of the pump body.

3. Place the fan pulley centre on a press table and press the larger diameter of the spindle into the pulley centre, as illustrated in Fig. 3 until the front face of the pulley is positioned as shown by the dimension in Fig. 2. This position ensures the correct alignment of the fan pulley to the crankshaft pulley.

4. Place the thrower disc in its groove on the spindle between the bearing and seal unit.

   Place the water seal on the smaller diameter of the spindle with the carbon face towards the back face of the water pump, and push the seal firmly into the housing. See Fig. 2.

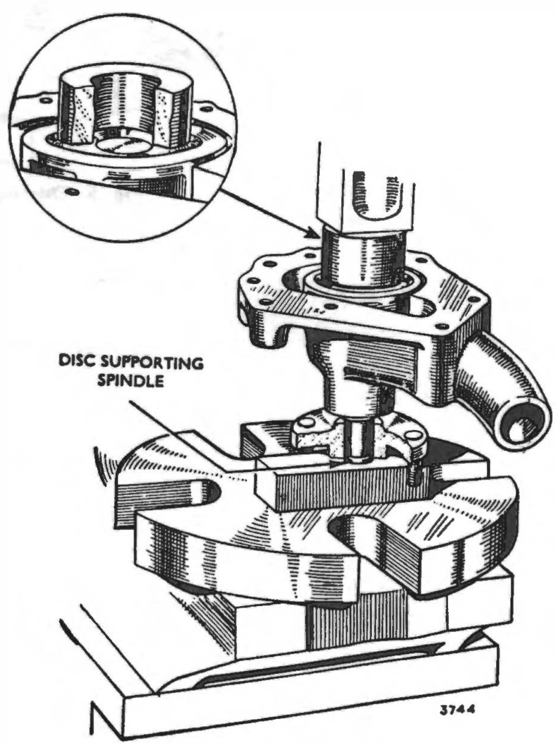

Fig. 4. *Pressing on pump impellor*

5. Support the pump spindle end inside the fan pulley centre as shown in Fig. 4 and press the impellor on to the shaft until the impellor is in the position shown in Fig. 2. It should be noted that a clearance of .040" (1·01 mm.) should exist between the outer face of the impellor and cover plate. This clearance can be checked with feelers and straight edge as shown in Fig. 5.

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

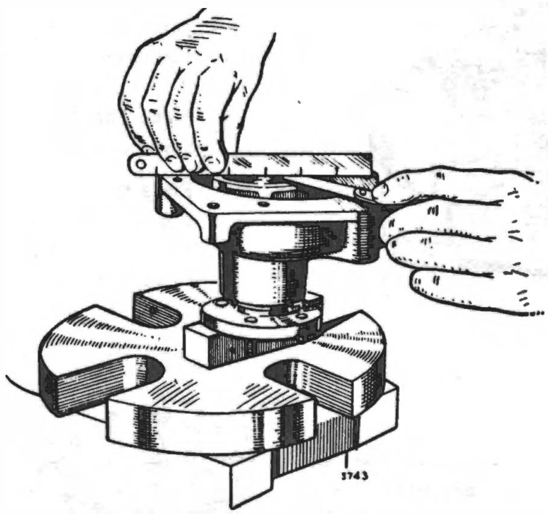

Fig. 5. *Checking impellor clearance*

ENGINE

The special tools mentioned herein are obtainable from Messrs. V. L. Churchill & Co., Limited Great South West Road, Bedfont, Feltham, Middlesex.

THREADS OF THE UNIFIED SERIES ARE EMPLOYED ON THIS ENGINE, AND THE APPROPRIATE SPANNERS MUST BE USED

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(44 Pages)

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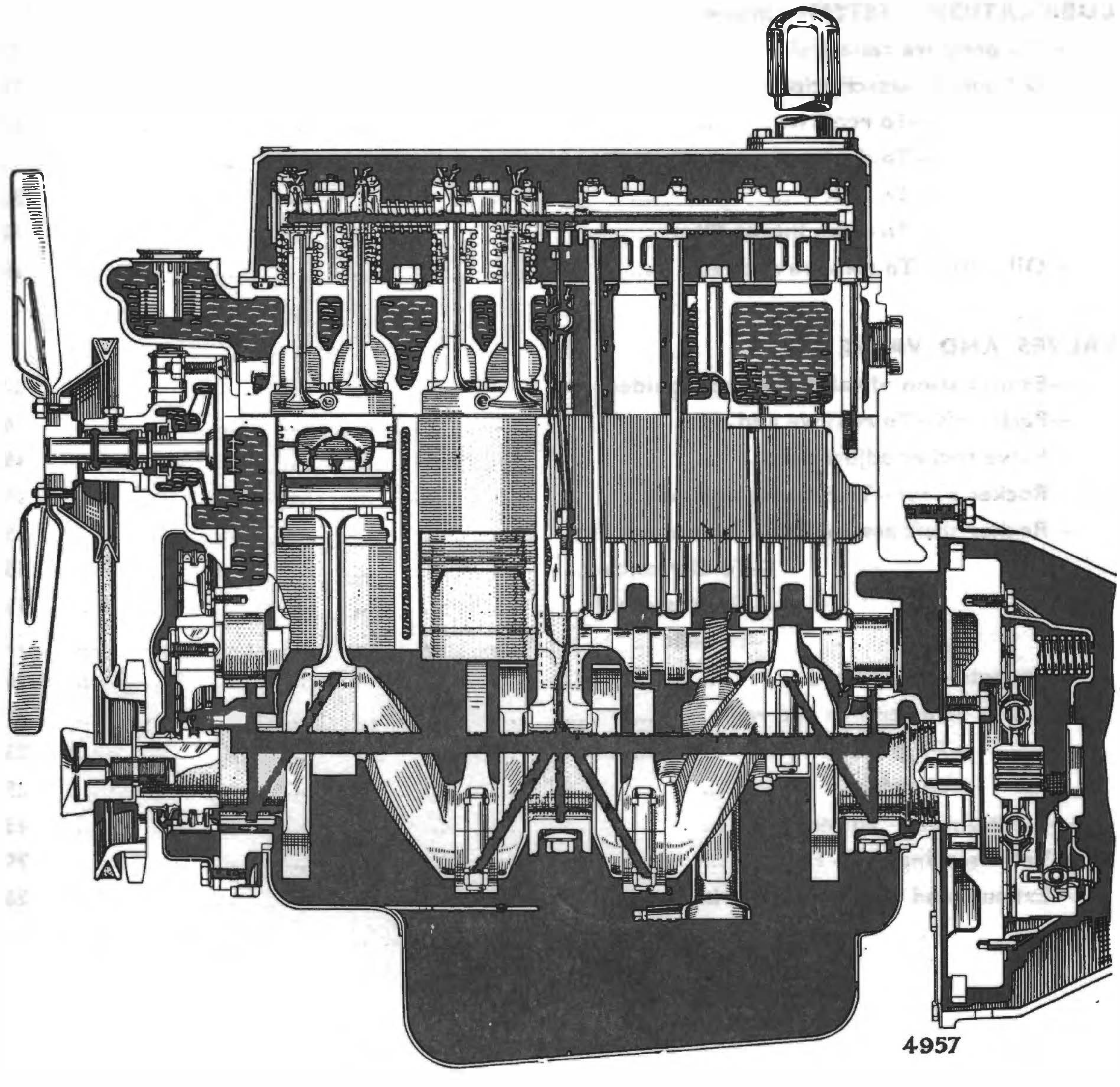


Fig. 1. ***Engine—longitudinal section (1494 c.c. engine shown)***

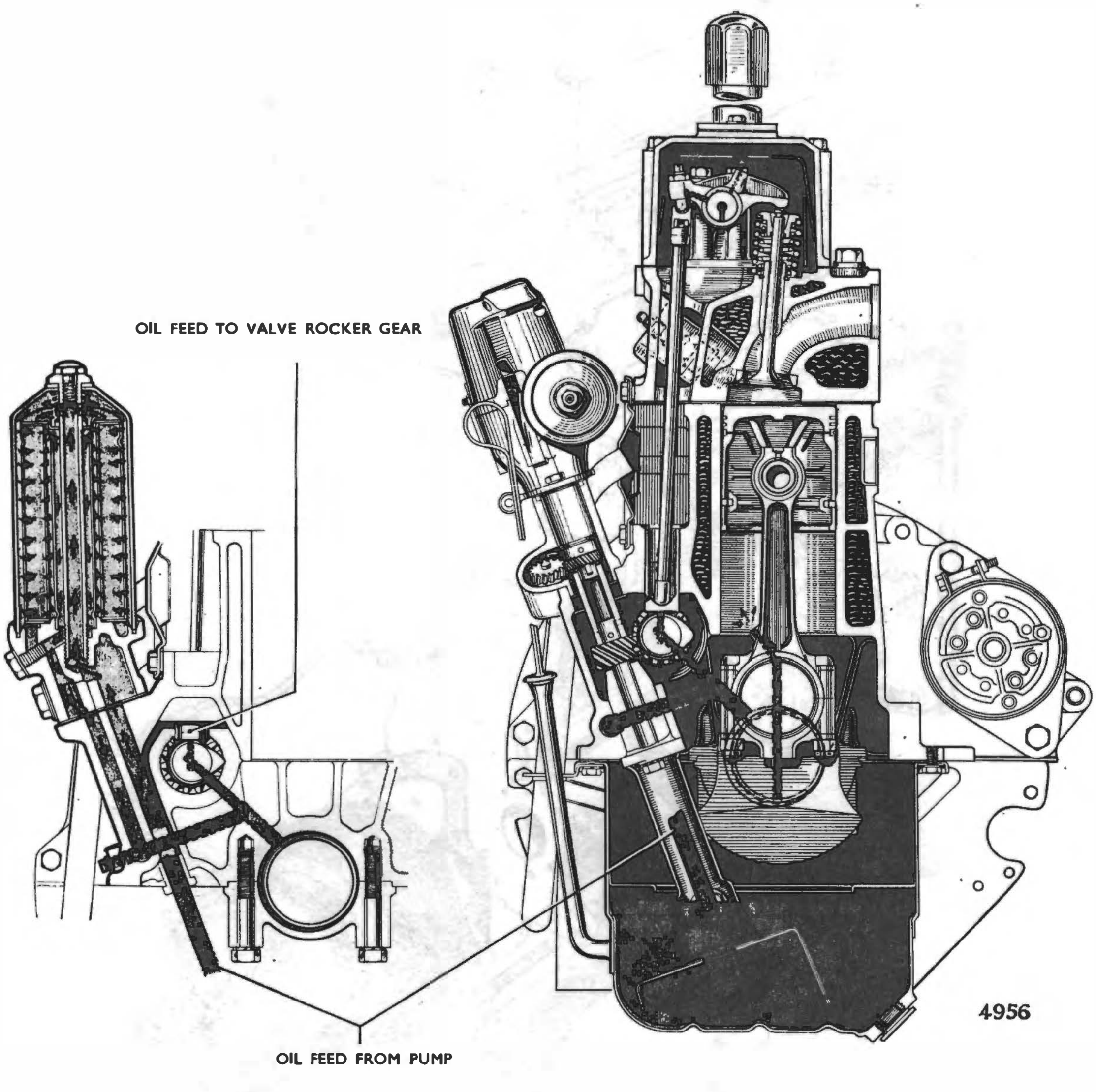


Fig. 2. *Engine—Cross section (1494 c.c. engine shown)*

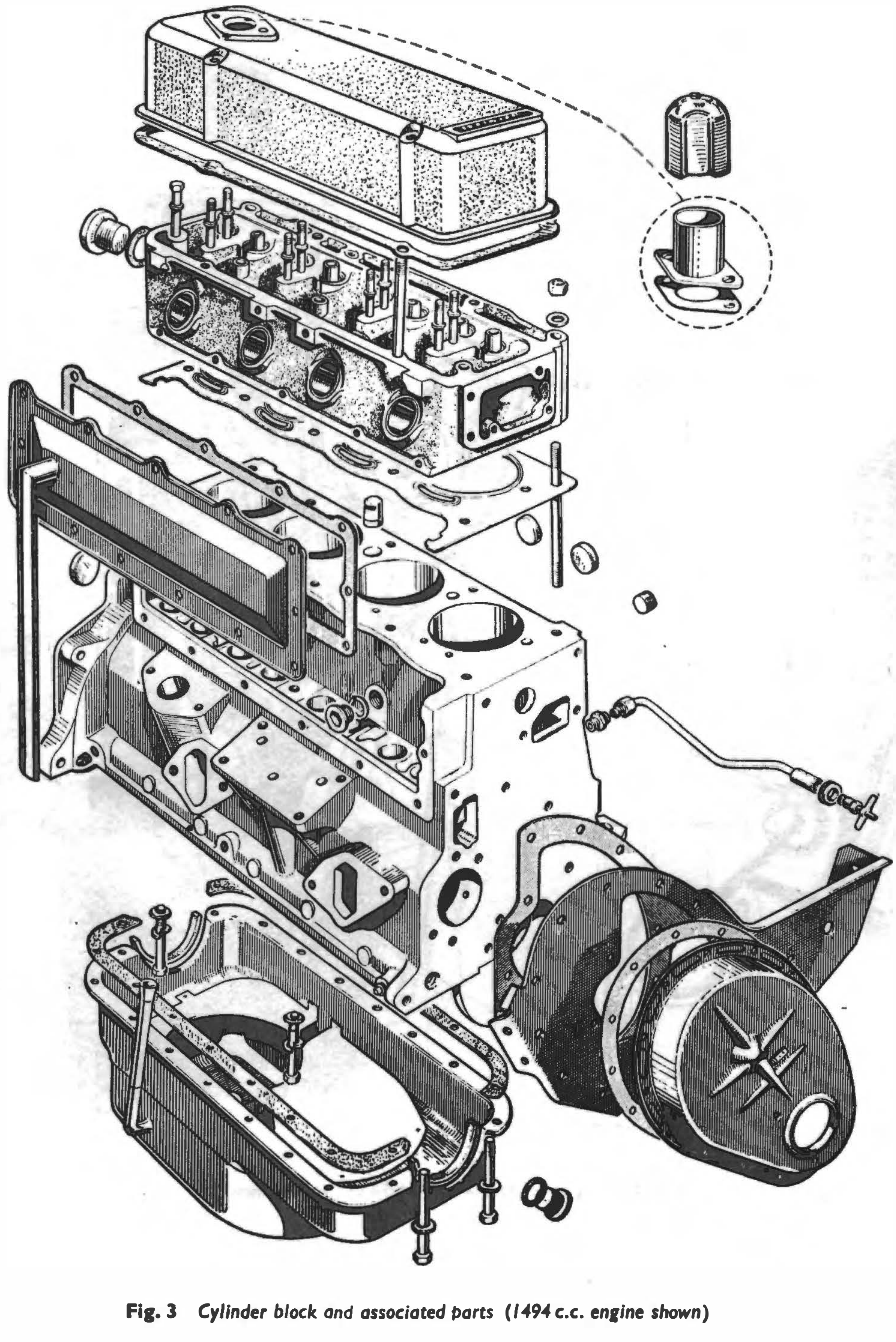


Fig. 3 *Cylinder block and associated parts (1494 c.c. engine shown)*

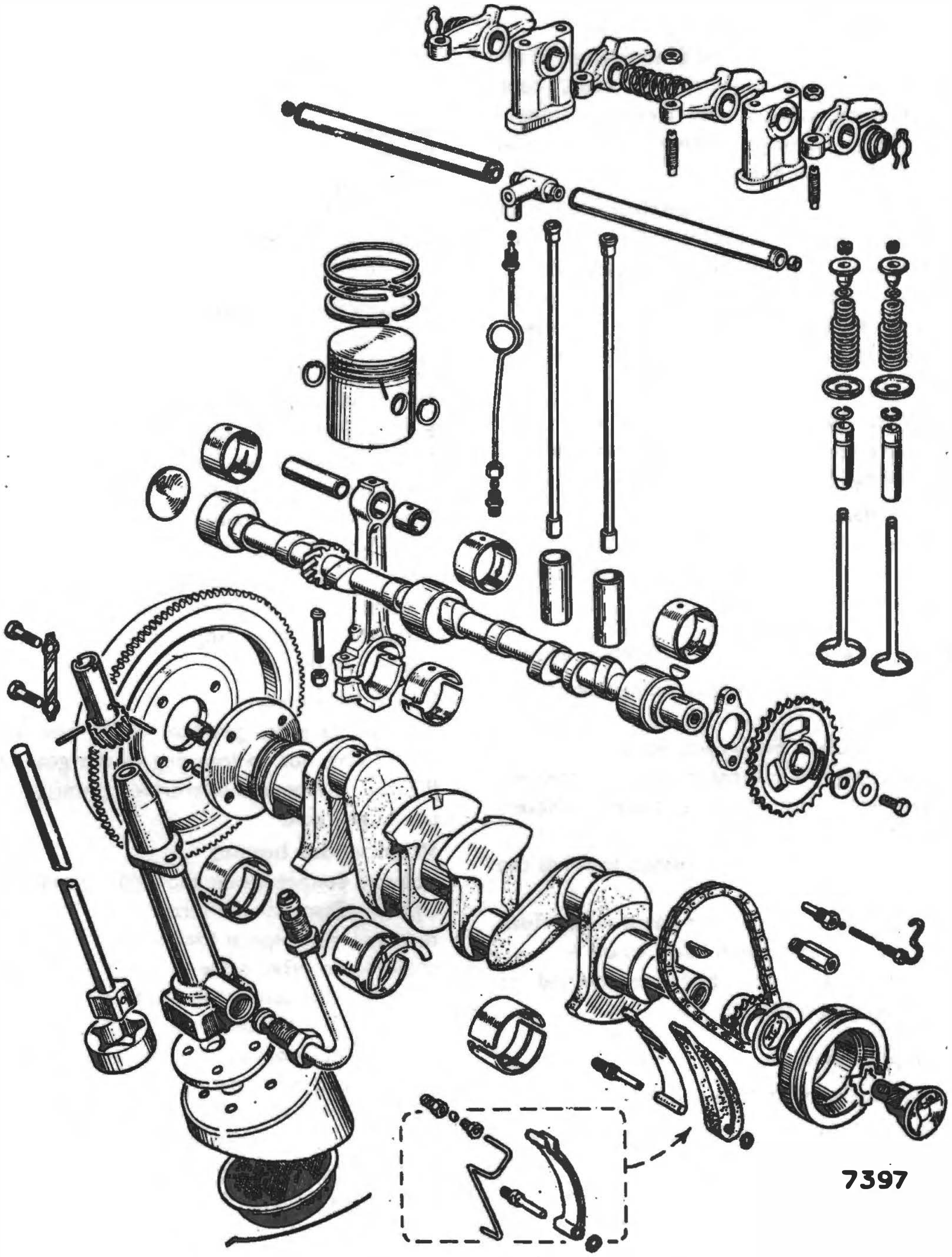


Fig. 4. *Exploded view of working parts (1494 c.c. engine shown)*

ENGINE

ENGINE (See Figs. 1 to 4)

Details and differences

Full particulars are given in the Data Section of the engine power output, compression ratio, compression pressure, valve rocker clearance, torque spanner settings, ignition timing and all other necessary settings and dimensions.

Some parts of the engine are interchangeable with other engines made by the Rootes Group. Other parts may look rather similar but are quite different and it is most important to ensure that the correct part is fitted. Reference should always be made to the appropriate parts list when ordering replacements.

These engines have an aluminium head with shrunk-in valve seat inserts. The valves are inclined at an angle of $4\frac{1}{2}°$ from the vertical.

A crankshaft damper consisting of a heavy metal ring suitably rubber bonded to the crankshaft pulley is used. This must never be replaced by another type of pulley.

1592c.c. engine differences from 1494c.c. engine

These are as follows and are given dimensionally in the Data Section.

1. Cylinder bore and piston size increased.
2. Crankshaft big end journal diameters increased.
3. Big and little end bearing bore diameters increased.
4. Gudgeon pin bore offset in piston towards the maximum thrust side.
5. New water pump to give increased water flow. For details of water pump See Section A.
6. Oil pump rotors and body lengthened to increase oil pump output.

1592 cc engine changes

From chassis number B3062665 *and* B9117425

Lighter flywheels and larger inlet valves are used with suitably enlarged inlet ports and seat inserts.
From chassis number B3062757 *and* B9117862

Inlet and exhaust valve stems are chrome plated.
Engines fitted to GT cars

These engines have cast iron exhaust manifolds.
From chassis number B.3053209, B.9106448 HC, B.9107189 LC *and* B.9106535 ME.*

A non return ball valve was fitted in the timing chain oil feed pipe union, to ensure rapid building up of oil pressure when starting.
From chassis B.3057270 HC, B.3057825 LC, B.9110982 HC *and* B.9111021 HC-ME.*
**Micro element air cleaner.*

Rubber rubbing block fitted on timing chain tensioning blade.
On Alpine Series IV onwards
Improved type piston with closer running clearance and twin outlet cast iron exhaust manifold fitted.

ENGINE—To remove

The engine is removed with the gearbox attached using a lifting sling that will allow the gearbox end to be lowered while raising the engine end.

Engine removal—Underneath work

Drain sump and gearbox. Remove propeller shaft. Disconnect exhaust at 'Y' junction (*Alpine*) or at exhaust manifold flange (*Rapier*).
Unbolt clutch operating cylinder. Do not disconnect fluid pipe. Disconnect speedometer cable. If necessary disconnect overdrive solenoid wire. Remove rear mounting crossmember after taking engine weight.

Work inside car

Remove carpets, gearbox cover and gear lever taking care not to lose peg in the gear lever ball. If fitted, disconnect overdrive operating switch on top of gearbox.

Work under bonnet

Remove bonnet, drain and remove radiator.
Offside—Disconnect thermometer lead at element terminal, fuel pipe at fuel pump intake union, tachometer drive cable at drive below distributor if fitted, oil pressure pipe connection, and L.T. feed wire at coil S.W. terminal.
Nearside—Disconnect heater water feed pipes at cylinder and water pump connections, dynamo and starter leads, throttle control, and choke control.
Remove outer exhaust manifold and scuttle bracing tube (*Alpine only*). Unbolt oil filler from rocker cover. Disconnect engine front mountings and lift out engine unit.

Engine—To refit

Refitting is a reversal of the removal procedure. The engine and gearbox should be filled with the correct grade of oil.

GENERATOR

To adjust belt tension

The generator is driven from the crankshaft by a belt which also drives the water pump and fan.

The belt is correctly tensioned when a total of ⅝" (16 mm.) movement can be obtained on the longest run of the belt.

To adjust the tension, slacken the nuts and bolts at the bottom front and rear of the generator, the link locating bolt and the screw through the slot in the strap. (See Fig. 5). Move the generator about its

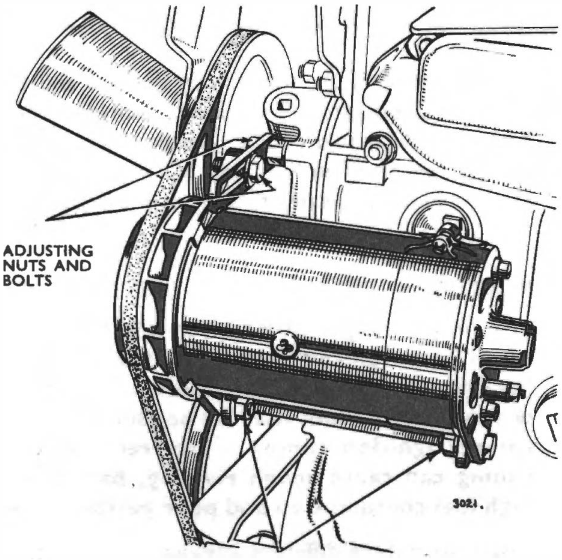


Fig. 5. *Generator belt adjustment*

bottom two fixing bolts until the correct belt tension is obtained, then retighten all bolts.

SPARKING PLUGS

Examination and cleaning

Figs. 6 to 10 illustrate the various conditions in which sparking plugs are found on removal and these are as follows:—

NORMAL CONDITION—look for powdery deposits ranging from brown to greyish tan. Electrodes may be slightly worn. These are signs of sparking plug used under normal conditions of mixed period of high speed and low speed driving. Cleaning and regapping of the sparking plugs is all that is required (see Fig. 6). White to yellowish powdery deposits usually indicate long periods of constant speed service or a lot of slow speed driving. Fig. 7 illustrates this condition. These deposits have no effect on performance if the sparking plugs are cleaned thoroughly at 3,000 mile (4,800 km.) intervals.

OIL FOULING—is usually identified by wet sludge deposits traceable to excessive oil entering the combustion chamber through worn rings and pistons, excessive clearances between intake valve guides and stems or worn and loose bearings, etc. See Fig. 8. Hotter sparking plugs may alleviate oil fouling temporarily but in severe cases engine overhaul is called for.

PETROL FOULING is usually identified by dry black fluffy deposits which result from incomplete combustion (see Fig. 9). Too rich an air-fuel mixture, excessive use of hand choke or faulty choke action can cause incomplete burning. In addition, defective contact breaker points or H.T. cables can reduce voltage supplied to the sparking plug and causes misfiring. If fouling is evident in only a few cylinders, sticking valves may be the cause. Excessive idling, slow speeds or stop-and-go driving can also keep plug temperatures so low that normal combustion deposits are not burned off.

BURNT OR OVERHEATED sparking plugs are usually identified by a white, burnt or blistered insulator nose and badly eroded electrodes (see Fig. 10). Inefficient engine cooling and improper ignition timing can cause general overheating. If only a few sparking plugs are overheated, the cause may be uneven distribution of the coolant. Severe service, such as sustained high speed and heavy loads, can also produce abnormally high temperatures in the combustion chamber, which necessitates use of colder sparking plugs.

Sparking Plugs—To clean and adjust

Plugs should be cleaned with an air blast cleaner and before setting the plug gaps the electrode tips should be filed lightly to remove all traces of burning.

The gap setting of sparking plugs is very important and points should be correctly set by bending the earthing (side) electrode. Never bend the centre electrode as this will crack the insulator tip. A suitable combined setting tool is illustrated in Fig. 11.

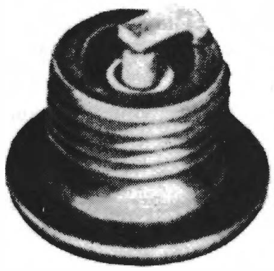


Fig. 6.

Fig. 7.

Fig. 8.

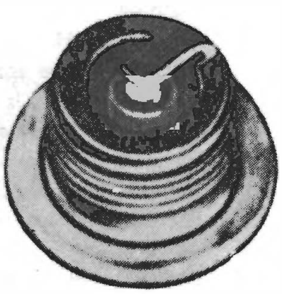


Fig. 9.

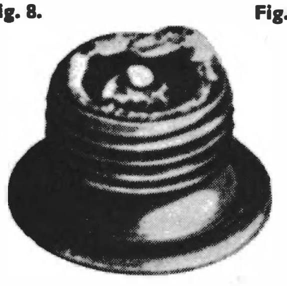


Fig. 10.

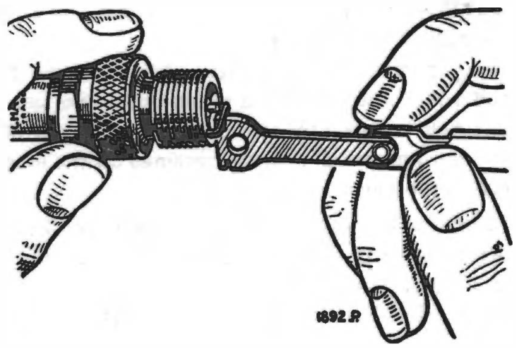


Fig. 11. *Setting sparking plug gap*

The plug threads should be wire brushed and the copper washers renewed if worn or badly flattened. Grease or oil should not be used on these threads as they can act as an insulator, and cause the H.T. current to jump to earth on the outside of the plug.

IGNITION TIMING AND DISTRIBUTOR

The modern high compression engine is very sensitive to ignition timing. In the following paragraphs detailed instructions are given of the various methods that can be used to obtain correct ignition timing. Incorrect ignition timing can cause rough running, bad idling, high fuel consumption and poor performance.

Distributors have different advance characteristics and it is most important that the correct distributor is used when a replacement unit is fitted. The possibility of a wrong unit having been fitted previously in service must not be overlooked.

Distributors may be identified by the despatch number on the plate fitted on the side of the distributor. Correct despatch numbers are given in the Data Section under "Ignition System".

The distributor is mounted on a bracket on the right-hand side of the engine and is driven by an extension of the oil pump spindle, the connection being made by an offset coupling. The rotor revolves in an anti-clockwise direction, viewed from above.

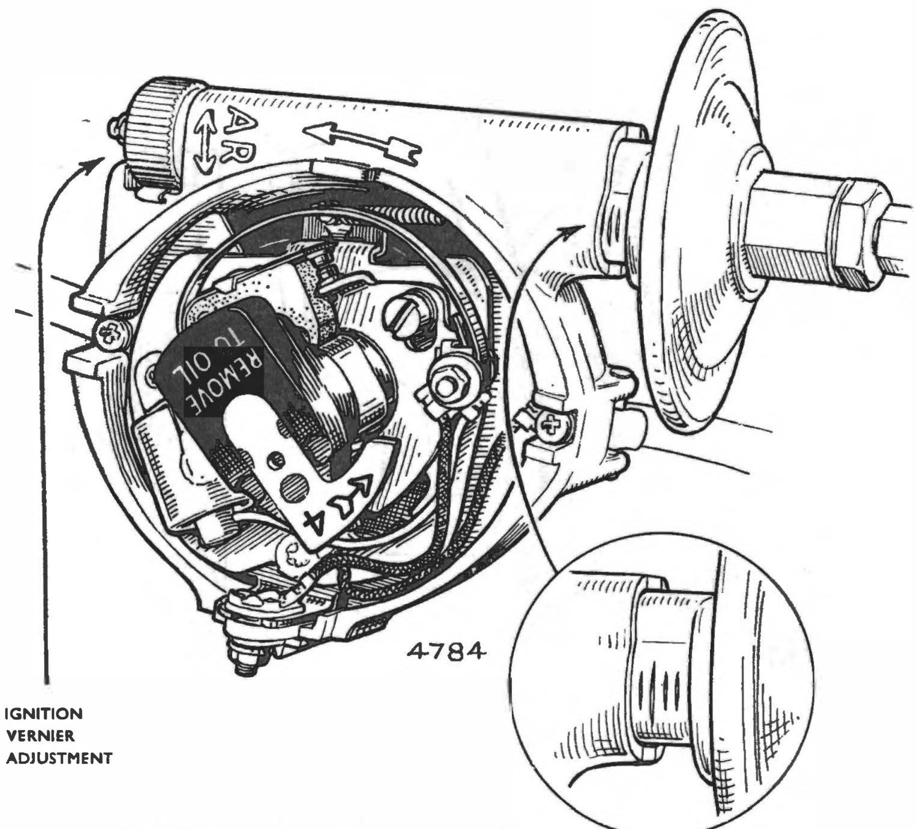


Fig. 12. *Distributor vernier control*

Two adjustments are provided for setting the ignition timing—

(*a*) A clamp screw mounted horizontally below the distributor. This is the main adjustment, and when it is slackened, the body of the distributor can be turned relative to the mounting plate.

(*b*) The vernier control shown in Fig. 12. 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. The knurled knob should be turned clockwise to retard and anti-clockwise to advance, one complete turn of the knob being equivalent to three crankshaft degrees, and one vernier division, shown in the inlet of Fig. 12. to four crankshaft degrees.

TO TIME IGNITION

Static ignition settings are given in the Data Section under "Ignition System".

Before checking the ignition timing it is most important to see that the contact breaker point gap is correctly set. This will ensure that the correct ignition timing is obtained each time the contact breaker points are cleaned and adjusted correctly.

Static ignition settings and contact breaker gap are given in the Data Section under "Ignition System".

As the contact breaker point gap decreases, through gradual wear of the moving point heel, the ignition timing becomes retarded. ·004" (·10 mm.) Reduction of contact breaker point gap retards the ignition by approximately 2° of crankshaft movement. This is equal to half a division on the Vernier control which is enough to reduce engine performance.

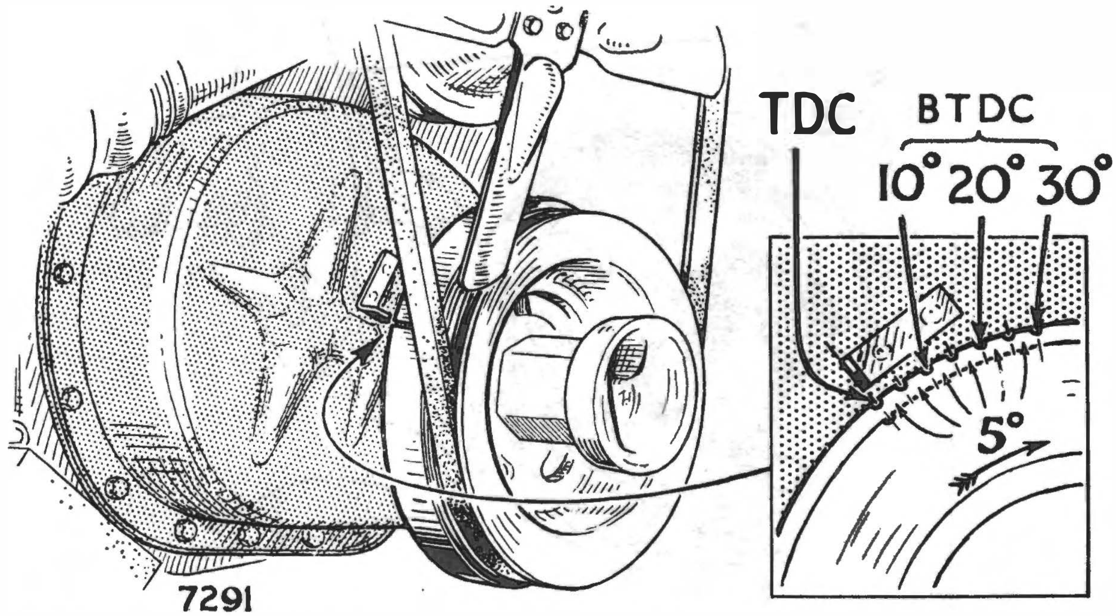


Fig. 13. *No. 1 and 4 cylinder T.D.C. pointers—Insert shows T.D.C. to 30° B.T.D.C. timing marks added from Rapier Series IV and later Alpine Series III.*

To Check Timing—Method 1

Fig. 13 shows the T.D.C. pointer on the timing case and the T.D.C. line on the damper rim opposite to each other.

Rotate the engine in its running direction until the T.D.C. line on the crankshaft damper rim is the required T.D.C. distance before the pointer on the timing case.

This distance, which is given in the Data Section under Ignition, corresponds to the degrees of advance before T.D.C. given for correct ignition timing.

If the 5° spaced timing marks exist, they should be used to set the engine to the static ignition timing angle B.T.D.C. See inset of Fig. 13.

Set the vernier control to the midway position (2 divisions showing on scale). See Fig. 12, top illustration.

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 the ignition switched on, this bulb will light when the contact breaker points open.

Disconnect the vacuum advance pipe to avoid straining it.

Slacken the distributor clamp screw and rotate the body of the distributor anti-clockwise as far as possible.

Switch on ignition and applying light finger pressure to the rotor in a clockwise direction, return the distributor body clockwise until the bulb just lights.

Tighten the distributor clamp screw.

Check the setting by turning the crankshaft two revolutions clockwise until the bulb again lights, observing the relative positions of the pointers.

The T.D.C. line or the correct timing mark on the crankshaft damper rim must be the required position before the pointer on the timing case.
Switch off ignition, remove bulb, and refit all parts.

STROBOSCOPIC TIMING LIGHT—Uses

The stroboscopic timing light provides a rapid and convenient means of setting the ignition timing and checking the action of the centrifugal and vacuum advance action of the distributor, provided its use is understood.

Correctly connected and with the engine running the timing light gives a high intensity flash every time No. 1 cylinder fires. When this light is directed on to the crankshaft pulley rim, the rim will appear to be stationary. It is this feature that makes it such a useful piece of equipment.

Its advantages are:—

1. It is simple to use and portable.
2. The ignition timing can be quickly checked while the engine is running, provided the engine speed can be set with a tachometer.
3. It enables a quick check to be made of the distributor centrifugal and vacuum advance mechanism, with the distributor in position, while the engine is running.
4. It is possible to set or check ignition timing regardless of any backlash that may exist in the distributor drive gears or camshaft driving chain.

Checking Ignition Timing—with stroboscopic timing light

THIS CANNOT BE DONE WITH THE ENGINE IDLING because at the correct idling speeds given in section C, pages 25 and 51, under slow running adjustment, the distributor centrifugal advance may have begun to operate.

It is therefore necessary to check the ignition timing at an engine speed of 1,000 r.p.m. using a reliable tachometer with the stroboscopic timing light, as explained in the following procedure.

1. Obtain the static ignition setting from the Data section, under ignition, noting that this is given in crankshaft degrees.
2. Add the crankshaft centrifugal advance for a crankshaft speed of 1,000 r.p.m. to the static ignition setting. The centrifugal advance angle for this engine speed on Alpine and Rapier engines is 3 crankshaft degrees BTDC.

   Example—in crankshaft degrees

   3° centrifugal advance BTDC + 8° static advance BTDC=11° ignition advance BTDC at 1,000 r.p.m.
3. Multiply the total number of degrees found in paragraph 2 by 1·28. This gives 14 mm. which is the number of millimetres before TDC for 11° BTDC on the crankshaft pulley damper rim. Set a pair of dividers to this calculated dimension and mark this distance before TDC on the damper rim. Paint this position with a narrow white line. Also paint the tip of the fixed TDC pointer. Quick drying white paint should be used.

Note: If the damper rim has a number of 5° spaced timing marks as shown in the inset of Fig. 13 it will not be necessary to mark off the metric measurement equivalent for 11° because this angle can be read off directly on the damper rim using the timing marks. The marks are spaced at 5° intervals.

4. Connect a tachometer and stroboscopic timing light to the engine and run it at 1,000 r.p.m. WITH THE VACUUM ADVANCE PIPE DISCONNECTED FROM THE DISTRIBUTOR to prevent any possible vacuum advance action.
5. Project the beam of the stroboscopic timing light on to the TDC pointer on the timing case. The white line on the crankshaft damper rim should appear opposite to the TDC pointer while the engine is running at 1,000 r.p.m. If necessary adjust the distributor to obtain this condition.

Checking the centrifugal advance action—at 2,500 engine r.p.m.

First check that the static ignition timing is correctly set to its average figure of 8° BTDC. Then remove any line painted on the pulley rim to correspond with this position and disconnect the vacuum advance pipe.

On Alpine and Rapier engines the ignition centrifugal advance angle at 2,500 r.p.m. is 24° BTDC.

This is 16° crankshaft centrifugal advance plus 8° static advance timing.

The 16° BTDC crankshaft centrifugal advance angle is twice the distributor centrifugal advance angle. This angle has been obtained by plotting the centrifugal advance figures given under " Ignition " in the Data section.

Mark 24° BTDC on the pulley rim. If the pulley has only a TDC mark this is 30·5 mm. BTDC when marked from TDC with dividers.

Start the engine and increase the speed from idling to 3,000 r.p.m. and then reduce to 2,500 r.p.m. The white line on the pulley rim should approach the fixed pointer on the timing case with increase of engine speed and appear adjacent to the fixed TDC pointer at 2,500 r.p.m., when observed by the stroboscopic timing light.

Jerky movements of the white line, marked on the pulley rim, while increasing or decreasing engine speeds, indicates that the centrifugal advance mechanism is sticking.
The distributor advance tolerance is ± 2 crankshaft degrees.

5. *Checking the vacuum advance action*

The throttle should be opened to give an engine speed of 1,200 to 1,500 r.p.m. With the engine running under these conditions, the vacuum connection on the distributor diaphragm should be alternately disconnected and reconnected whilst observing the line on the crankshaft damper rim. This should retard and advance as the end of the vacuum pipe is removed and refitted. Blockage of the vacuum feed pipe, vacuum feed hole, or jamming of the contact breaker point mounting plate, will prevent correct vacuum advance action.

Ignition timing—Road performance test

After setting the static ignition timing and checking centrifugal and vacuum advance action as previously described, a road performance test can be made by taking stop watch readings of the time taken to accelerate in top gear from 20 to 50 m.p.h. (32 to 80 k.p.h.) under full throttle conditions on a straight level road. Small adjustments are then made with the vernier control on the distributor until the lowest stop watch reading is obtained. Several test runs have to be made ON THE SAME ROAD.

This test requires considerable skill and should only be undertaken by those who have the necessary road testing experience.

It is emphasized that the distributor centrifugal and vacuum advance mechanism must be working correctly and if these are in any way suspect, after checking unit the distributor in position, the distributor should be removed and checked on a reliable test rig or distributor analyser. The use of a Crypton test equipment that allows the ignition advance angle to be read off against engine speeds with the distributor removed is recommended.

Distributor centrifugal and vacuum advance figures are given in the Data Section under "Ignition".

DISTRIBUTOR

To remove and refit

Remove high tension leads from plug terminals, noting their positions. Disconnect high tension lead at coil. Disconnect low tension lead at distributor body. Disconnect vacuum pipe. Remove two setbolts securing aluminium distributor housing to crankcase and withdraw distributor and housing together.

Refitting is a reversal of the above.

A special cranked ring spanner (VLC tool) ½" A/F hexagon is most suitable for removal of the bolts.

To fit replacement Distributor

Before fitting a replacement distributor turn the engine so that the timing mark on the crankshaft pulley (or damper) comes opposite to the pointer on the timing case when the distributor driving slots in oil pump gear are in the position illustrated in Fig. 36.

Install replacement distributor.

The distributor rotor is now adjacent to No. 1 H.T. connection in the distributor cap. No. 1 H.T. lead should be fitted to this connection and No. 1 cylinder spark plug and the other H.T. leads to give the correct firing order of 1, 3, 4, 2. The distributor rotor rotates in an anti-clockwise direction as seen when the distributor cap is removed.

Set the ignition timing by one of the methods previously described.

ROCKER COVER

To remove and refit

Remove four nuts securing rocker cover to cylinder head and lift off cover, taking care not to damage the joint. Refitting is a reversal of the above. The joint should be replaced if damaged.

VALVE ROCKER ADJUSTMENT

(See Figs. 14 and 15)

Remove rocker cover.

Turn the engine until the exhaust valve of No. 4 cylinder is fully open and, starting at this point, adjust valves in the order given below Fig. 15, turning the engine progressively through two revolutions to complete the cycle of adjustment.

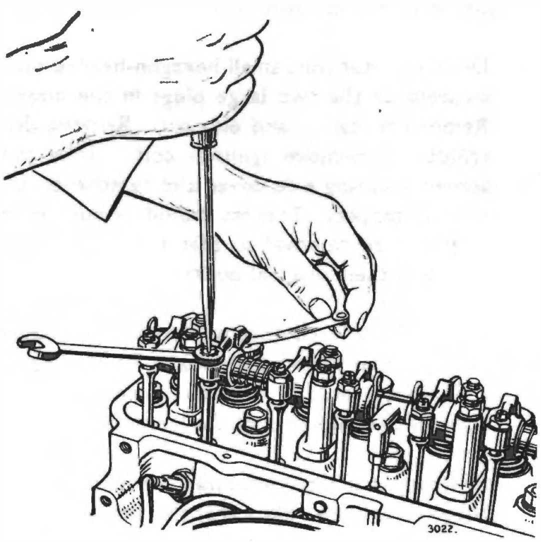


Fig. 14. *Valve rocker adjustment*

To check clearance, insert a feeler gauge of correct thickness between the valve stem and rocker foot. The correct valve clearances are given in the Data Section.

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

ROCKER SHAFT ASSEMBLIES

To remove

Remove rocker cover. Undo union nut and disconnect oil pipe to rocker shaft.

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

Lift out rocker shafts and upper oil feed complete.

To dismantle

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

Inspect rockers and shaft and replace if worn or scored.

To reassemble

Assemble the components on the rocker shaft in the order shown in Fig. 15, locating the standards on each shaft to allow the oil feed holes to face downwards. Note that the rockers are offset.

To refit (See Fig. 15)

Make sure 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 elbow facing the push rods.

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 reassembly the grooves should be located on the side nearest the valves.

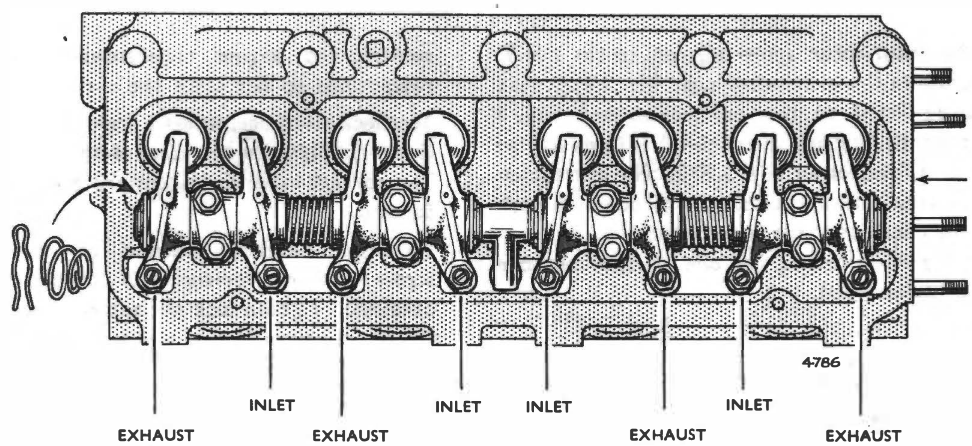


Fig. 15. *Plan view of valve rocker gear*

No. 1 exhaust is adjusted when No. 4 exhaust is fully open.
No. 2 inlet is adjusted when No. 3 inlet is fully open.
No. 3 exhaust is adjusted when No. 2 exhaust is fully open.
No. 1 inlet is adjusted when No. 4 inlet is fully open.
No. 4 exhaust is adjusted when No. 1 exhaust is fully open.
No. 3 inlet is adjusted when No. 2 inlet is fully open.
No. 2 exhaust is adjusted when No. 3 exhaust is fully open.
No. 4 inlet is adjusted when No. 1 inlet is fully open.

PUSH RODS
To remove and refit

The correct push rods for these engines are the tubular type, the diameter of which is given in the Data Section.

Remove rocker cover.

Remove rocker shaft assembly.

When removing push rods make sure 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.

When push rods have been replaced, reset the valve clearances and recheck clearance when the engine is HOT.

TAPPETS
To remove

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

Remove engine side cover, as follows:—

Drain oil filter (one small hexagon-headed plug adjacent to the two large plugs in the body). Remove container and element. Remove distributor. Remove ignition coil. Take out screws securing side cover and remove cover. Lift out tappets. Tappets should be numbered in pencil on removal so that they can be replaced in their original positions.

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.

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

TIMING COVER

To remove

Drain and remove radiator.

Slacken the generator mounting screws and remove fan belt.

Unscrew crankshaft jaw nut and pull off combined crankshaft pulley and damper. (Two tapped holes provided).

Remove all screws and nuts holding cover in position, and withdraw cover.

To refit

Reverse the above operations, taking great care to centralise the cover around the crankshaft pulley, before fully tightening the bolts. A timing cover centraliser (R.G. 89) is supplied by Messrs. V. L. Churchill.

TIMING WHEELS AND CHAIN

To remove

Remove timing cover.

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

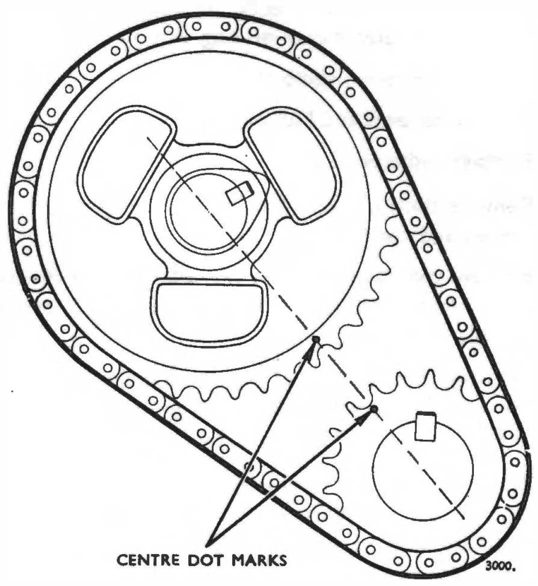


Fig. 16. *Timing wheel alignment*

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

Remove oil thrower in front of crankshaft sprocket.

Pull or lever off both camshaft and crankshaft wheels simultaneously.

To refit

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

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

To obtain the valve timing shown in Fig. 17, fit chain to crankshaft wheel and camshaft wheel so that the dots on the camshaft and crankshaft wheels are in line (See Fig. 16).

Turn camshaft until the key lines up with the key way in the camshaft wheel.

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

Replace camshaft sprocket fixing bolt and washer Secure bolt with a new lock washer.

Replace crankshaft oil thrower.

Refit chain tensioner and timing cover, making sure that the tensioner blade is correctly fitted.

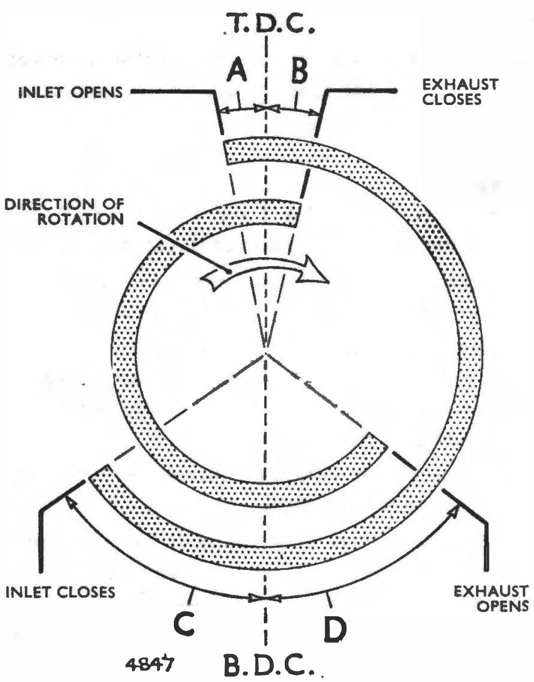
The front face of the timing case is bolted to a pedestal bolt, and the free end of the tensioner blade rests on the inside of the timing case.

Camshaft sprockets used on these engines have a small circular groove machined on the rear face just below the bottom of the sprocket teeth.

Check Valve Timing

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



Inlet valve open	(A)	14° B.T.D.C.
Inlet valve closes	(C)	52° A.B.D.C.
Exhaust valve opens	(D)	56° B.B.D.C
Exhaust valve closes	(B)	10° A.T.D.C.

Fig. 17. *Valve timing diagram*

2. Turn engine until the line on crankshaft damper rim is about 32 mm. (1¼″) before the pointer on the timing case.

3. Set up a clock gauge to show when the 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 ·001″ (·025 mm.) downward movement of the valve spring cap. Note the position of the T.D.C. groove in the crankshaft pulley. If the valve timing is correct it should be approximately 17 mm. before the timing cover T.D.C. pointer.

   If the valve timing is one tooth out, the 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 load comes onto the push rod.

4. Readjust No. 1 cylinder inlet valve to its normal clearance.

CAMSHAFT

To remove and refit

Disconnect electrical leads, remove distributor, bracket, and distributor driving shaft.

Drain and remove sump and oil pump.

Remove tappets and fuel pump.

Remove radiator.

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

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

Refitting is a reversal of this procedure, correctly timing camshaft, and replacing oil pump as explained under "Oil pump".

After replacing the timing wheels, the camshaft end float should be checked with a clock gauge. The end float must not exceed ·002″–·003″ (·050–·076 mm.). Oversize thrust plates are available for fitting if required.

CAMSHAFT BEARINGS

To remove

Using special tool (V. L. Churchill RG 32), the front and centre bearings can be withdrawn forwards.

The gearbox, clutch and flywheel, together with rear sealing disc will have to be removed to enable rear bearing to be withdrawn rearwards.

This operation will, in all probability, be carried out on most occasions when an engine is overhauled,

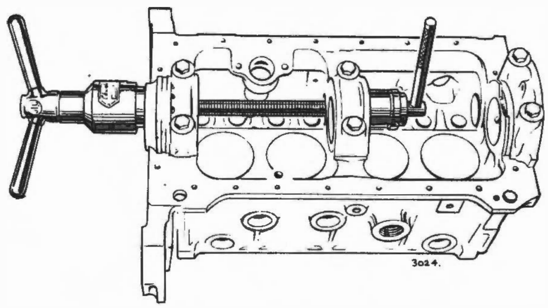


Fig. 18. *Camshaft bearing remover and replacer*

and will be facilitated with the cylinder block in a stripped condition.

Replacement bearing shells require no matching.

Operation of the special tool is shown in Fig. 18.

To refit

Using tool RG 32, draw in the bushes. Ensure that the oil feed holes are correctly aligned, and that the camshaft sealing disc is made oil tight.

INLET AND EXHAUST MANIFOLD

To remove

Drain cooling system as inlet manifold jacket is coupled to cylinder head and water pump.

Remove air cleaner.

Disconnect water hose from the water pump to the inlet manifold water jacket, and the water feed pipe at the rear and of the inlet manifold.

Loosen exhaust pipes from engine at the 'Y' junction in the exhaust pipe (*Alpine only*).

Disconnect exhaust pipe at exhaust manifold flange (*Rapier only*).
Disconnect throttle control rod, choke control and fuel feed pipes.

Remove clamps, long bolt, and nuts holding the manifold assembly to the cylinder head. Lift off manifolds leaving the carburettors on the inlet manifold to save disturbing the throttle synchronization.

To refit

Refitting is a reversal of the removal procedure.

Ensure that the inlet manifold locating rings are in position.

Refill the cooling system and check water connections on the inlet manifold for leaks.

If the carburettors have been removed the throttles should be synchronized and the slow running adjusted as described in Section C.

COMPRESSION PRESSURES

An engine in good condition should give the compression pressures given in the Data Section under "Engine—General". These pressures should be taken at starter cranking speed with the throttle held fully open, all sparking plugs removed and the engine hot. If readings are obtained substantially below these quoted, the engine concerned is in need of attention to the valves or piston rings, or possibly requires reboring.

CYLINDER HEADS

Aluminium alloy cylinder heads are used on these engines. Owing to the high expansion rate of the cylinder head material, valve guides, valve seat inserts, and sparking plug tubes can only be fitted or removed when the cylinder head has been uniformly heated to 200° C. (390°F.).

Valve stem diameters, valve head diameters, valve seat angles, valve stem clearances in the valve guide, and combustion chamber volume are given in the Data Section.

To remove

Drain cooling system.

Remove air cleaner where fitted.

Disconnect header tank to radiator hose, and overflow pipe from header tank.

Remove rocker cover.

Disconnect thermometer lead at bulb by gripping the rubber sleeve at the end of the lead and pulling out the snap connector from the bulb.

Disconnect sparking plug leads and remove coil.

Remove screws securing tappet side cover to cylinder head.

Remove oil feed pipe to rocker shaft.

Disconnect heater pipe (if fitted).

Remove 8 nuts securing rocker shaft to cylinder head.

Remove rocker gear and push rods taking care not to lift out the tappets when lifting out the push rods. The push rods should be placed in a suitable holder so that they can be replaced in the same position as found.

Disconnect fuel pipe connections and throttle control.

Alpine

Disconnect inlet manifold and exhaust manifolds at their cylinder head connections. Slacken off the two exhaust manifold clips at the 'Y' connection at the front end of the exhaust system. Remove inlet manifold complete with carburettors and pull exhaust back pipes clear of the cylinder head.

Rapier

This cylinder head can be lifted off with manifolds and carburettors attached after disconnecting the exhaust pipe at its flange joint.

Remove eight bolts and two nuts and washers securing cylinder head to cylinder block and lift off cylinder head.

Cylinder head gasket

All gaskets are stamped with the word "TOP" and must be fitted with the word uppermost. The gaskets are also stamped with their part number for identification purposes.

A copper and steel, asbestos type gasket is used on this engine.

To refit

Reverse the above procedure, ensuring that all joint faces are clean.

Always use a new gasket. Do not displace the tappet cover gasket when lowering the head. The cylinder head bolts should be tightened to a torque figure given in the Data Section under "Cylinder Head" in the order shown in Fig. 19, before tightening the tappet side cover screws. Adjust valve clearances.

The following procedure should be followed after refitting the cylinder head and fitting a new cylinder head gasket.

1. Run engine until it is thoroughly warmed up.
2. Allow engine to cool down and when COLD retighten the cylinder head.
3. Thoroughly warm up engine and reset the valve clearances.

It is essential to adhere strictly to the torque wrench figures quoted.

It is most important that the cylinder head is aligned so as to correctly 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.

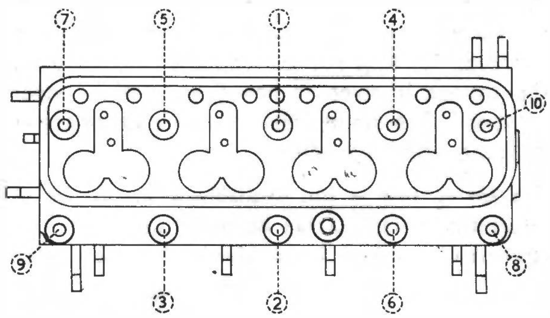


Fig. 19. *Tightening diagram for cylinder head*

DECARBONISING

When the cylinder head has been removed for decarbonising the complete set of valves should be removed for cleaning, inspection and refacing, (detailed instructions for these operations are given elsewhere in this section). The valve guides should also be checked for wear on their internal diameters and in this respect reference should be made to "VALVE GUIDES—TO RENEW".

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 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 piston edge.

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

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

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

Care must be taken when decarbonising the tops of the pistons, these being 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.

Having attended to the preceding operations and given the valves and seatings any attention that may be required, the engine may be reassembled.

VALVES

To remove

To assist in this operation it is recommended that a valve spring compressor (Churchill Tool D.6513) be used, as shown in Fig. 20.

Remove cylinder head.

Using the valve spring compressor, remove the split coned cotters. When carrying out this

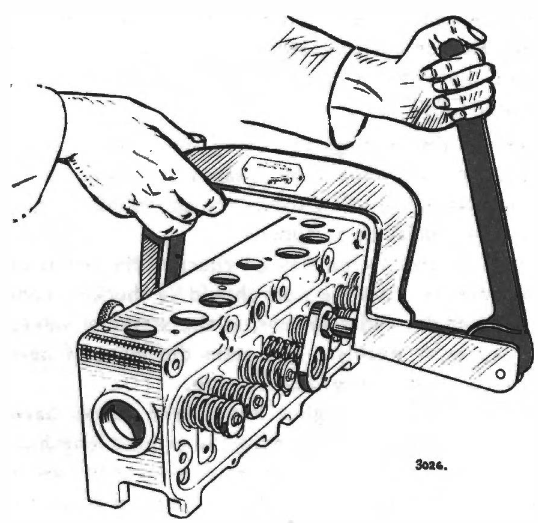


Fig. 20. *Use of valve spring tool*

operation care should be taken to ensure that no damage is caused to the valve stem by the hardened steel cotters and spring cups.

Release valve spring compressor and lift off cups and dual valve springs.

Remove the valves.

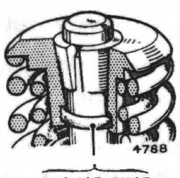


Fig. 21. *Valve spring cup showing sealing ring groove*

To refit

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

The valve spring cups have a sealing ring in the lower end. See Fig. 21. 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.

EXAMINATION OF VALVES, SPRINGS AND GUIDES, ETC.

Valves. Examine for pits on the face, burning and distortion or cracks in the heads. Burnt or cracked valves must always be scrapped. See also "VALVES —REFACING".

Examine the seatings in the cylinder head, and if defective they should be treated as subsequently described. If the valve stems are appreciably worn the valves must be scrapped.

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

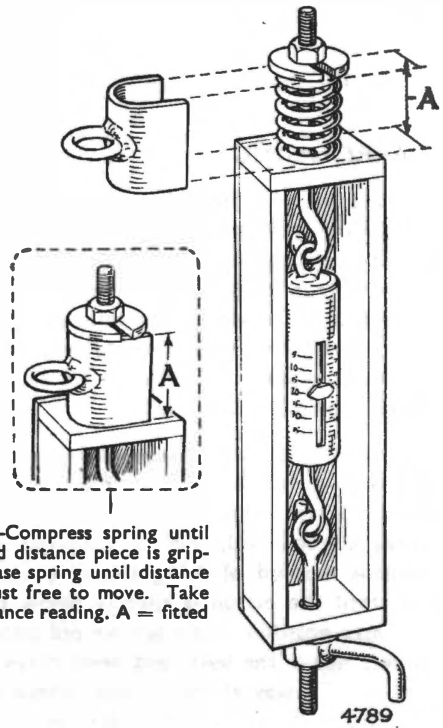
On the 1592 c.c. engine both valve stems have a ·001″ (·025 mm.) taper along the ground length of the valve stem. The smaller diameter is at the valve head end which is ·001″ (·025 mm.) less in diameter than the valve cap end diameter.

Guides. 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.

In making the foregoing tests both valve stem and valve guide must be free from carbon or burrs and free from oil.

Springs. If possible the load required to compress the valve springs to their fitted heights should be checked. The required load and length to compress the springs is given in the Data Section under "Valves". The use of a dial type valve spring tester is strongly recommended.

If a spring test is not available a simple rig as illustrated in Fig. 22 can be made and used. An alternative method is to check the used valve



To use.—Compress spring until 'U' shaped distance piece is gripped. Release spring until distance piece is just free to move. Take spring balance reading. A = fitted length.

Fig. 22. *Valve spring testing rig*

springs by comparing them with new springs. See Fig. 23. Place them end to end on a long bolt and compress them in a hand press. Any loss will then be apparent as the weaker spring will close up first. If either spring of a pair is weak both inner and outer should be replaced as a pair even though the outer spring in the original pair may appear to be satisfactory when compared with a new spring as

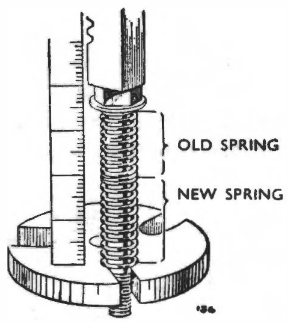


Fig. 23. *Checking valve springs*

described. Inner and outer valve springs are supplied in new pairs only and should not be interchanged.

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 examination, 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 recut. The valve stems must be straight and their guides must be in good condition.

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.

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, or rings will be formed on the faces with detrimental effects).

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

After thoroughly cleaning off all traces of grinding paste from the valve and seating with a dry cloth, test by placing a small amount of engineers' marking on the seating and revolving the valve in place not more than about ⅛" (3 mm.) in each direction. A complete circle of marking should appear on both valve face and seating, indicating a good seal.

VALVE GUIDES

To renew

Valve guides can only be fitted and removed when the cylinder head has been uniformly heated to a temperature of 200°C. (390°F.).

A suitable size gas or electric cooking stove fitted with a Rototherm or other type of thermometer in the oven door can be used for heating the cylinder head. The oven temperature should be maintained at 200°C. (390°F.) while the cylinder head is left in the oven for about 30 minutes.

A circlip is fitted to both inlet and exhaust valve guides and ensures that the guides are correctly fitted when the circlips come against the cylinder head.

Both valve guides are chamfered on the top ends. The inlet valve guide has a long chamfer at the valve port end and is slightly shorter in length than the exhaust valve guide.

A stand is needed for the cylinder head after it is heated. This consists of a piece of thick hardwood covered on one side with soft asbestos sheet to prevent damage to the cylinder head face. Eight holes should be cut through the board to give ample clearance around the valve guides, when the cylinder head is resting on its top face, to allow the valve guides to be driven out from the valve head ends. As an additional means of retaining heat a fairly close-fitting four-sided wood box, lined with asbestos can be placed around the cylinder head after it has been put on the bottom support board.

This will leave only one face exposed.

The valve guides can be driven out with a suitably stepped mild steel drift always provided that the cylinder head is heated to the proper temperature. THEY CANNOT BE DRIVEN OUT OF A COLD CYLINDER HEAD.

New valve guides must have a proper interference fit and can only be installed when the cylinder head has been heated to the proper fitting temperature. This usually requires the fitting of guides having an outside diameter of ·001" (·025 mm.) larger than the guides that are removed. The correct interference for these valve guides is given in the Data Section under "Valves".

The valve guide depth positioning circlips should be fitted to the valve guides before tapping the valve guides into the cylinder head.

The sharp edge of the top end of the valve guide must not be damaged as this edge is used to scrape excess oil from the valve stem.

After fitting, the valve guides should be reamed with a spiral fluted reamer, to give a valve guide bore diameter of ·3125–·3135 ins. (7·94–7·96 mm.).

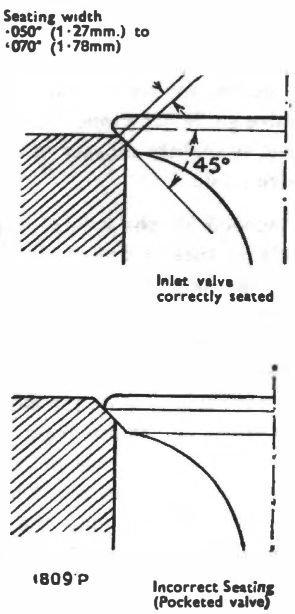


Fig. 24. *Valve seating*

VALVES

To reface

If, on examination of the valves it appears unlikely that they would clean up satisfactorily with ordinary grinding in, they must be refaced. If the seatings are also in bad condition they must be recut, but

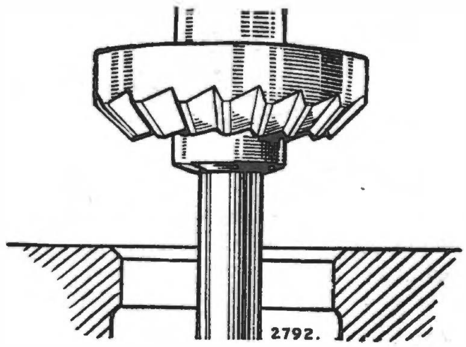


Fig. 25. *Use of 45° valve seat cutter*

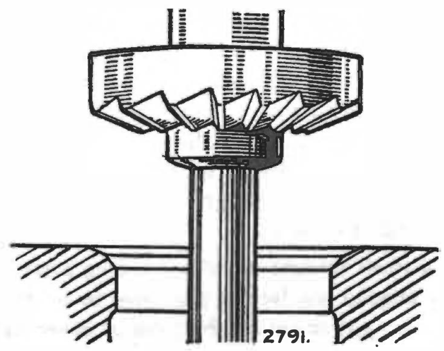


Fig. 26. *Use of 15° valve seat cutter*

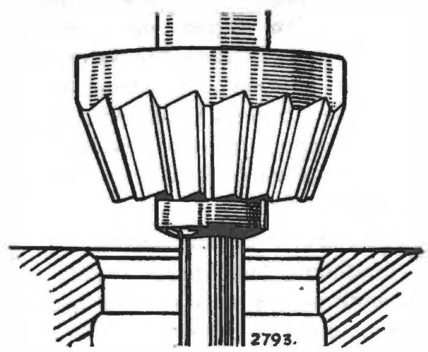


Fig. 27. *Use of 75° valve seat cutter*

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.

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. 24). 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 measured from the top face of the valve head. Standard dimensions of valves are given in the Data Section at the beginning of this manual.

The refacing of 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.

A valve which has been refaced as described must also be finally ground in on its seating (see "VALVES—TO GRIND IN"). The seating must be in good condition and the face not more than ·070" (1·78 mm.) in width.

VALVE SEATINGS

To recut

A damaged or slightly burnt seating may be refaced with a 45° seating cutter as illustrated in Fig. 25.

A complete set of valve seat cutters can be obtained from Messrs. V. L. Churchill (Tool No. R.G.316). 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 valve guide bore (See "VALVE GUIDES—TO RENEW).

The seating should be recut with a 45° cutter until all marks have disappeared. NO lubricant is required for this operation.

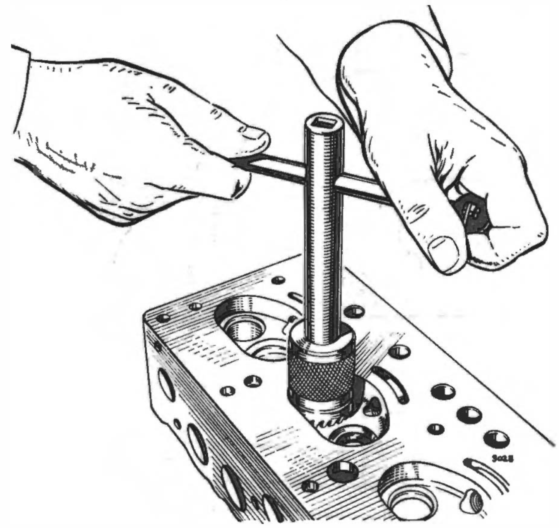


Fig. 28. *Use of valve seat cutting tool*

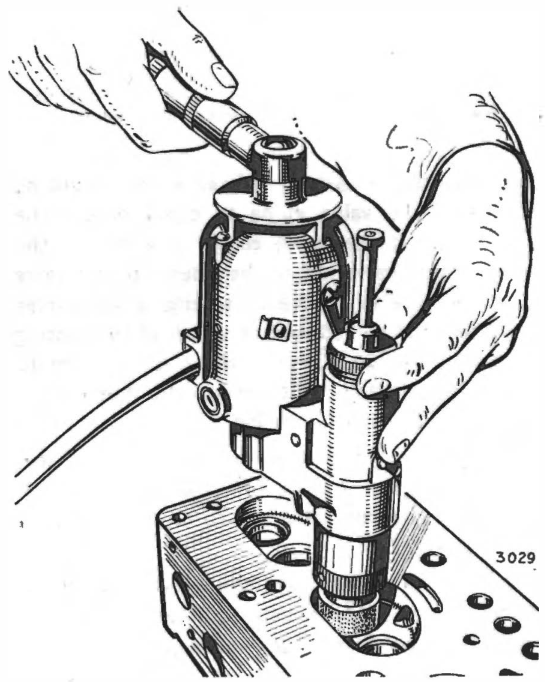
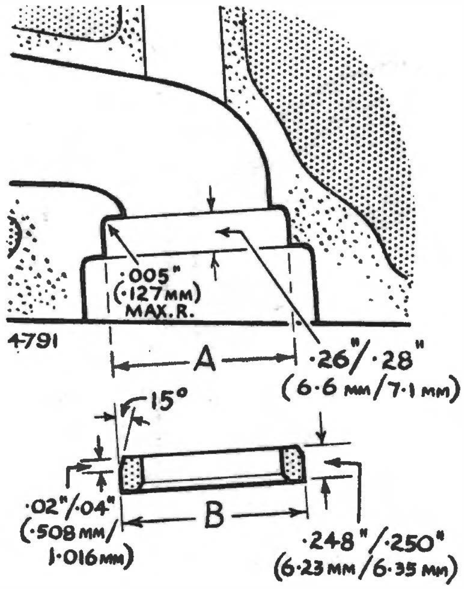


Fig. 29. *Use of valve seat grinder*



Exhaust
A = 1·312"/1·313" (33·33 mm./33·35 mm.).
B = 1·3155"/1·3165" (33.42 mm./33·44 mm.).

Inlet
A = 1·562"/1·563" (39·67 mm./39·70 mm.)
B = 1·5655"/1·5665" (39·76 mm./39·78 mm.).

Fig. 30. *Details of exhaust and inlet valve inserts*

After recutting 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 recut seating a 15° cutter should be used to reduce the width of the seating as shown in Fig. 26. Occasionally it is necessary to reduce the seating width from the bottom by means of a 75° cutter. See Fig. 27.

It is important to ensure that the finished seat width is not greater than ·07" (1·8 mm.) and that the valve seats correctly as shown in the upper picture in Fig. 24.

After refacing valve seats the valves should be ground in and only a little grinding should be necessary to produce a good seating.

Figs. 28 and 29 illustrates the use of a valve seat cutting tool and a valve seat grinder. The later is preferable for facing valve seat inserts.

EXHAUST AND INLET VALVE SEAT INSERTS (See Fig. 30)

These inserts can only be fitted when the cylinder head has been uniformly heated to 200°C. (390°F.). The equipment previously described under "VALVE GUIDES—TO RENEW", should be used.

Inserts cannot be extracted from a cold cylinder head as they are fitted ·010" to ·032" (·25 mm. to ·81 mm.) below the combustion chamber face which shrinks in above the inserts.

To remove

Old inserts can be removed by boring out until the insert collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the insert recess in the cylinder head.

To replace

From the chassis numbers given in this section on page 8, the inlet valve seat bores, and the inlet ports immediately behind the inlet valve seats, are enlarged by machining after the seats have been fitted to the cylinder head.

If an inlet valve seat is changed from these chassis numbers, it will be necessary to carefully enlarge the inlet valve seat bore, after the insert has been fitted in the cylinder head, so that the bore of the insert blends with the already enlarged inlet post behind the insert.

1. Check the valve recess diameter.
2. Select a suitable oversize valve seat insert and check its outside diameter.
3. Machine the cylinder head recess diameter to the best possible finish concentric to the valve guide centre so that the insert will have the correct interference fit (see Fig. 30).
4. Heat the cylinder head for 30 minutes from cold in an oven maintained at a temperature of 200°C. (390°F.).

5. Fit the insert ensuring that it beds on the bottom face of its recess.

6. The valve seat on the newly fitted insert, should be cut or ground at an angle of 45° to a width of ·05"–0·6" (1·27 mm.–1·52 mm.). The seat must be concentric to within ·001" (·025 mm.) of the valve guide bore.

LUBRICATION SYSTEM

General description

The direction of oil flow is shown by arrows in Figs. 1 and 2.

Fig. 31 shows the lubricating system and passages in more detail.

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 righthand side of the crankcase, and driven, in tandem with the distributor, through skew gears from the camshaft.

Oil is drawn through a 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 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.

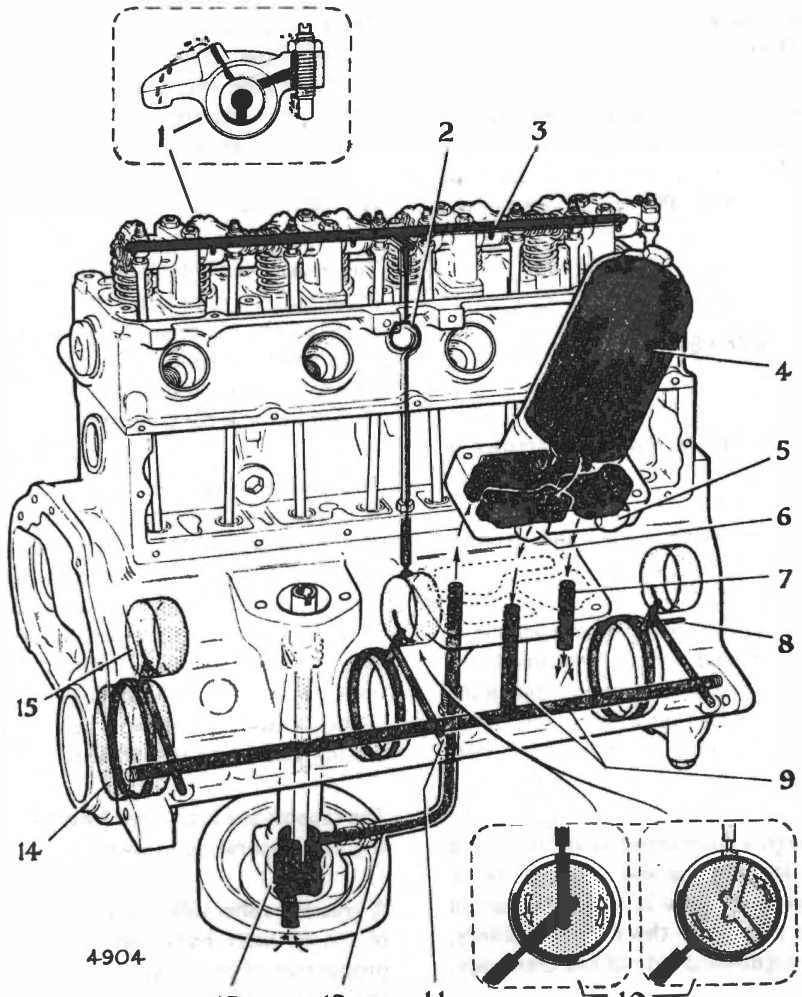
The reason for this design is that the diameter of the oil pipe is thus larger than would be possible if it were designed to supply just sufficient oil for the chain's requirements. The advantage of this larger pipe is that blockage is less likely to occur should the oil become contaminated.

The feed end of the timing chain oil feed pipe is connected to a special union, shown in Fig. 4. In the union there is a small spring-loaded non-return ball valve which prevents draining of the oil gallery when the engine is stopped. This ensures a very rapid build up of oil pressure directly the engine starts, and oil to immediately flow 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 oil is circulating.

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 approximately 50 lbs. per sq. in. (3·5 kgs. per sq. cm.). Fitted into the rear end of the oil filter body 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



1	Valve Rocker oilways.	9	Oil gallery and feed from filter.
2	Oil feed pipe.	10	Cross section through camshaft centre journal showing drilling in journal used to control oil feed to rocker gear.
3	Oil feed to rocker shaft.	11	Connection point for oil warning light switch or oil pressure gauge.
4	Full flow oil filter	12	Oil feed from oil pump to filter.
5	Oil pressure relief valve.	13	Oil pump.
6	Filter by-pass valve.	14	Main bearings.
7	Oil pressure relief valve discharge hole.	15	Camshaft bearings.
8	Oil feed to timing chain oil feed pipe.		

Fig. 31. *Oil passage ways in cylinder block and cylinder head*

centre camshaft bearing oil feed hole, and the oil hole feeding to the valve rocker oil feed pipe. See Fig. 31 and its inset (10). 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.

OIL SUMP (OIL PAN)

To remove and refit

Drain oil from sump by removing drain plug at left side.

Undo eighteen bolts securing sump to lower face of crankcase. It is advisable to leave one centre bolt on each side in place until the weight of the sump can be taken by hand, to avoid distortion of the joint faces.

To refit

As the sump face is in line with the horizontal axis of the crankshaft main bearings, a semi-circular cork joint is used between the front and rear main bearing caps and the sump, in addition to the normal face joints at each side.

The semi-circular cork joints should be fitted to the front and rear main bearing caps after fitting the cylinder block two bottom face side joints.

The thickness of the semi circular cork joint is ·180″ — ·190″ (4·5 — 4·88 mm.) or ·150″ — ·160″ (3·8 — 4·0 mm.). **These joints are not interchangeable.** The thin joint has replaced the thick joint and is recognised by its colour dyed ends. Where the thin joints are used the front and rear main bearing caps have a casting recess, or cast protrusions as shown in Fig. 32, by the letter (C). The identification used on the front main bearing caps can be seen with the sump in position. A small number of these bearing caps are without the casting marks and have rough ground grooves as illustrated.

When the cast identifying marks are seen (or the rough ground grooves) on the front and rear main

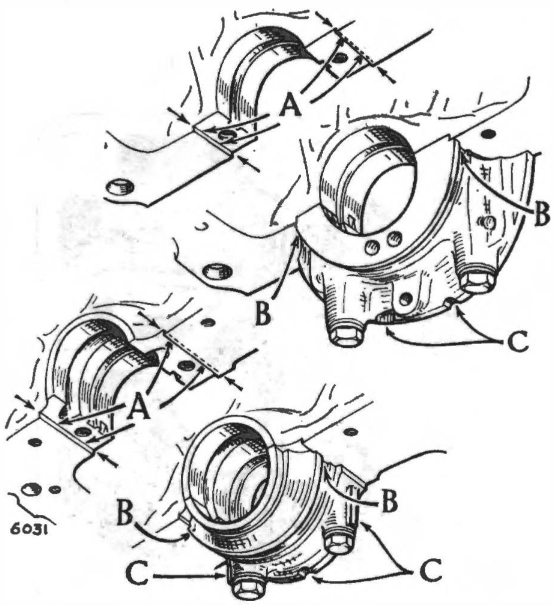


Fig. 32. *Places at which jointing compound is used when replacing sump and identifications used to show when THIN cork joints are fitted.*

bearing caps, the thin cork joint MUST be used. Both ends of each semi-circular corks must be square and come up to the ends of the two side joints.

All sump joints should be fitted dry, except when working from underneath, when the side joints have to be stuck to the cylinder block bottom face. A small quantity of quick setting compound should be applied to the ends of all joints at the points (B) Fig. 26 to ensure a satisfactory oil seal in the corners. The centre sump bolts should be fitted first and all bolts progressively tightened.

When dealing with difficult cases of oil leakage, the front and rear main bearing caps should be removed and " Wellseal " or other suitable non-setting jointing compound applied along the front and rear main bearing recess vertical locating faces (A) as shown in Fig. 32. The compound must be kept off of the horizontal butting faces. On replacing the main bearing caps the jointing compound is trapped in the small corner clearance between the outside edges of the bearing caps and the corner of the locating recess. This prevents oil leakage along the small clearance that must exist at these points and along which oil sometimes leaks.

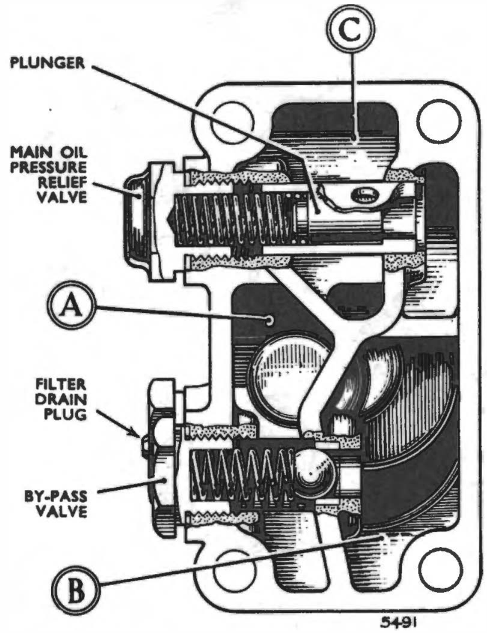


Fig. 33. *Oil filter base details*

FULL FLOW OIL FILTER

The following information applies to the renewable type of oil filter unit. Particulars of the throw away type of oil filter are given on page 45.

The full flow oil filter body is bolted to a flange on the right-hand side of the crankcase, and is divided internally to form three separate compartments (see Figs. 33 and 34).

Oil from the pump flows through a drilling in the crankcase to compartment "B" into which is screwed the hollow bolt retaining the element casing to the filter body. The oil passes through the hollow bolt and via a drilling just below the bolt head, into the filter casing.

The filter element bore is sealed at its ends by two Neoprene rings, the upper ring being fitted into a sleeve passing over the hollow bolt, and spring-loaded away from the top of the element casing. The lower ring is fitted into a groove formed in the top of the filter body.

All oil passing into the element casing flows through the element from its outside surface, through the element, up from the inside of the element and down through the steel tube fixed in the filter base to compartment "A" which feeds to the main oil gallery. See Fig. 34. The steel tube inside the filter prevents the oil draining out of the filter when the engine is not running.

Oil pressure relief valves

A ball or plunger type pressure relief valve is situated in compartment "C" and opens if the oil pressure exceeds approximately 50 lbs. per sq. in. (3·5 kgs. per sq. cm.), allowing a proportion of oil to flow back to the sump.

A by-pass valve normally closes a port connecting compartments "A" and "B" if the filter element is not restricted, as, in this case, pressure in these compartments will be equal.

If, however, the element becomes choked, pressure

On some 1494 c.c. and some 1592c.c. engines the filter drain plug is identified by a "Pip" on its hexagon head.

Later filters have no drain plug.

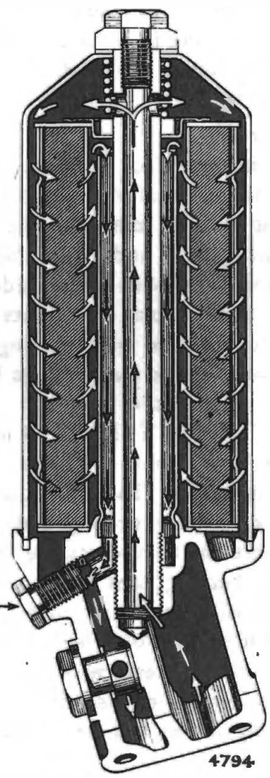


Fig. 34. *Section through oil filter*

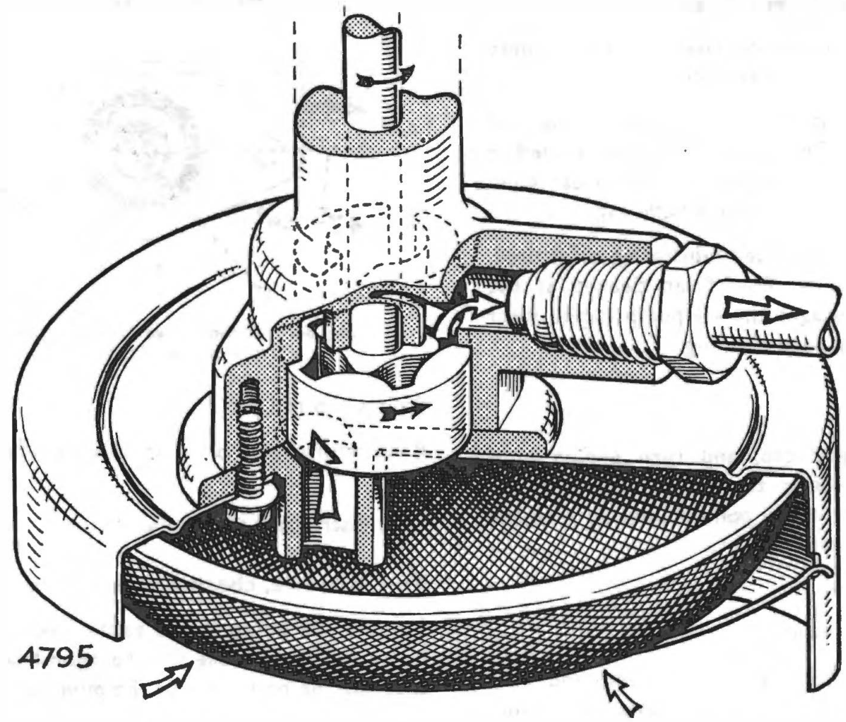


Fig. 35. *Oil pump—cut away view. White arrows show direction of oil flow*

will be appreciably reduced in compartment "A" due to starvation, and this will allow the by-pass valve to open, in turn ensuring a feed to the oil gallery in such conditions.

The oil pressure relief valve has a hexagonal head and is screwed into the front of the filter body casting.

The filter by-pass valve is similar and is screwed into the rear of the filter body casting.

To renew element

Drain filter by removing hexagon-headed plug details of which are given in Fig. 34

Remove centre bolt.

Take out the element and renew.

Run engine and carefully check for oil leaks.

Examine sump level after running engine as one pint of the oil will be taken to fill the filter.

OIL PUMP (See Fig. 35)

A four-lobe rotor mounted on the main 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 main spindle.

The action of the four-lobe cam on the five-lobe ring creates a strong pumping force by progressively increasing and reducing the clearance between each set of lobes. The pump itself is driven by skew gears from the camshaft.

Oil pump intake filter—to clean

Whenever the sump is removed the opportunity should be taken to clean this filter.

Remove spring clip from oil pump shroud and withdraw gauze. The gauze should be washed in petrol or paraffin and blown dry with clean compressed air. Do not dry with a fluffy rag.

Provided the recommended lubricating oil is used, and the external full flow filter cleaned at the recommended mileages the oil pump intake filter does not normally need cleaning.

To remove

Remove distributor cap, and turn engine until distributor is pointing to No. 1 firing position, and the crankshaft pulley pointer lines up with the timing cover pointer at T.D.C.

Remove distributor.

Remove sump (oil pan).

Disconnect oil delivery pipe from pump and from inside crankcase. Undo two setscrews at oil pump locating flange and remove pump.

To refit

The ignition distributor takes its drive from the helical gear on the oil pump shaft axially, through an offset tongue and slot type coupling which can only be coupled one way. It is essential that the oil pump helical gear is meshed to the corresponding gear on the camshaft so that the driving slot in the end of the gear is timed in correct relation to the camshaft. In view of this, the pump must be refitted as described below.

Ensure that the engine is at T.D.C. (top dead centre) with piston of No. 1 cylinder in firing position.

Replace the oil pump so that the distributor driving slot in the oil pump gear takes up the position shown in Fig. 36.

No jointing of any kind is required between pump face and cylinder casting.

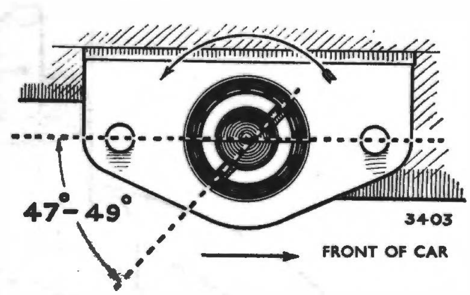


Fig. 36. *Oil pump drive correctly assembled—No. 1 cylinder T.D.C. firing.*

Refit sump (oil pan).

Refill with engine oil of specified grade to correct level.

Refit distributor and check ignition timing.

To dismantle, check clearances and overhaul

Remove the pump intake gauze filter. Invert the pump and remove the four hexagon-headed screws securing the base plate to the pump body.

Lift out the outer rotor ring taking care not to drop it. IF THIS ITEM IS DROPPED IT CAN EASILY CRACK.

Remove all traces of oil from the inside of the pump body and both rotors. Replace outer rotor.

The following clearances should be checked:—

1. End clearance between the inner and outer rotor ring and pump body. The maximum and minimum clearances are ·003″ (·076 mm.) and ·001″ (·025 mm.) when measured with a feeler and straight edge as illustrated in Fig. 37.

2. Side clearance between the top of the lobes on the inner and outer rotor as shown in Fig. 38.

   The maximum and minimum clearances "A" are ·006″ (1·52 mm.) and ·001″ (·025 mm.) New parts should be fitted if the maximum clearance is exceeded.

3. Clearance "B" between the outside of the outer rotor and pump body must not be greater than ·008" (·20 mm.) and not less than ·005" (·127 mm.). Should the clearance found be above the maximum figure a replacement pump should be fitted.

OIL PRESSURE

The normal oil pressure is given in the Data Section under "Lubrication". 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:—

Low oil level in sump.

Pressure relief valve not working properly, due to particles of foreign matter lodged between valve and seating.

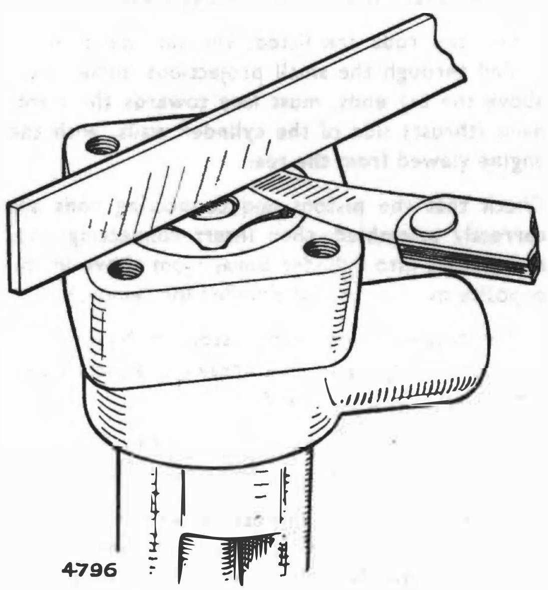


Fig. 37. *Checking pump rotor end clearance*

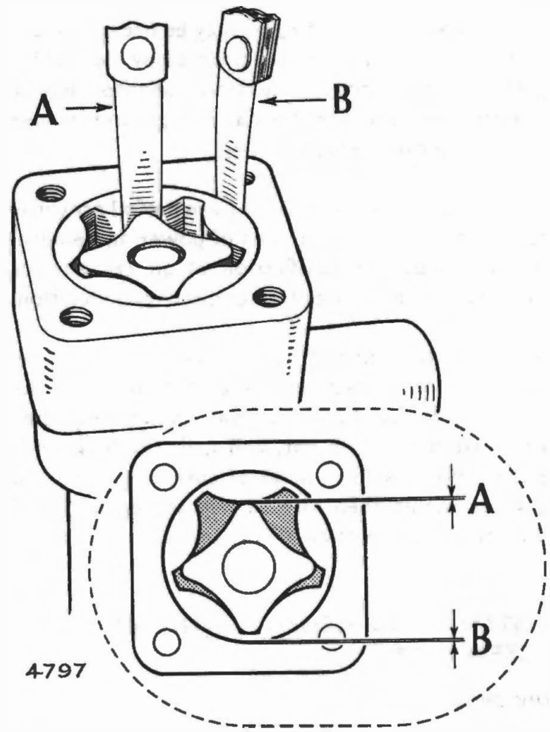


Fig. 38. *Checking rotor lip and outer rotor clearance in the pump body*

Choked oil pump filter.

Oil leaks caused by faulty unions and joints, or by cracked or broken pipes.

Joint between filter base and cylinder block face leaking between pressure compartment "B" and discharge compartment "C". This sometimes causes a lower oil pressure when the engine is cold. See Fig. 33.

Timing chain oil feed pipe loose or damaged.

Dilution of oil in sump (See following paragraphs).

Worn main and big end bearings.

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.

PISTON AND CONNECTING ROD ASSEMBLIES

Big ends

Indium-coated copper lead bearings are fitted to all new engines and must be used as replacements. These bearings require and have a minimum running clearance of ·0015" (·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 filter element at the recommended mileages are therefore most important.

Pistons

Most engines are fitted with flat top pistons but some engines have hollow crown pistons. The hollow crown pistons give a lower compression ratio which is used in certain export territories where the normal high octane fuels are not available. Fitting clearances are the same for both pistons.

To remove pistons and connecting rods

Remove cylinder head.

Remove sump.

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

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

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

If the original parts are to be used again it is essential that the big end caps are reassembled to the same rods from which they were removed. To show 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

To refit pistons and connecting rods

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.

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

To facilitate insertion of the pistons in the cylinders and to prevent piston ring breakage, a piston ring compressor should be used.

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

Suitable piston ring compressors are the Churchill tool No. R.G. 172A and the Hepworth and Grandage Size No. 1 "Marcone" piston ring compressor.

Tighten nuts to the correct torque given in the Data Section under "Connecting Rod".

IMPORTANT

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

The self-locking nuts must not be used again if they can be screwed on with the fingers.

To remove gudgeon pin

Remove circlips retaining gudgeon pin in piston with circlip pliers. Scrape away any carbon which may have accumulated in the outer ends of the piston bosses to facilitate removal of the gudgeon pin.

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

To assemble

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

New circlips of the correct size should be fitted. The smaller circlips used on the 1390cc and 1494cc engines must NEVER be fitted to pistons used in 1592cc engines.

Gudgeon Pin Fits

At room temperature of 70°F. (21°C.) the gudgeon pin should be a finger push fit in the piston and only just free in the connecting rod little end bush. It should be possible for the connecting rod to fall by its own weight when the piston and connecting rod assembly is held horizontal.

Gudgeon pins are classified into three grades. Grade diameters are given in the General Data section under Gudgeon Pin.

·003" (·076 mm.) oversize gudgeon pins are available for service use.

Delapena Precision Honing Machine

This honing machine, illustrated in Fig. 39, is recommended for honing new little end bushes to standard size or to +003" (·076 mm.) oversize. It can also be used to hone out the piston bosses to take the oversize gudgeon pin.

The following equipment is used with this machine:

Mandrel	SL.900
Truing sleeve	ST.900
Roughing stone	EF3J
Finishing stone	EF6J
Polishing stone	EF8J
Delapena connecting rod clamps	
Delapena honing fluid. (Standard)	

Complete instructions for the operation of this machine are contained in a booklet (Publication No. C.3/55) of which two copies are sent with each machine by the suppliers, Delapena & Sons Ltd., Zona Works, Cheltenham, England.

In using the Delapena honing machine it is stressed that the work must be kept as cool as possible at all times. Only by so doing can an accurate and round bore can be achieved. Heating of the little end boss which can occur due to pressure of the boss, can cause the boss to go "out of round" temporarily. This will not occur if a receptacle containing honing fluid is kept by the machine and the work dipped in it frequently.

Honing Little End Bush (See Fig. 40)

Fit the appropriate Mandrel in the machine with roughing stone and true up stone with truing sleeve; hone out the little end bush until it is ·0005" (·012 mm.) below the finished diameter. To determine this size, useful check gauges can be made by reducing a 1" (25 mm.) length of standard and oversize gudgeon pins to ·0005" (·012 mm.) below their finished diameter. Proceed with the honing, using a finishing stone in the mandrel.

The stone must be trued with the truing sleeve before honing is commenced. In performing this last stage of honing great care is necessary as

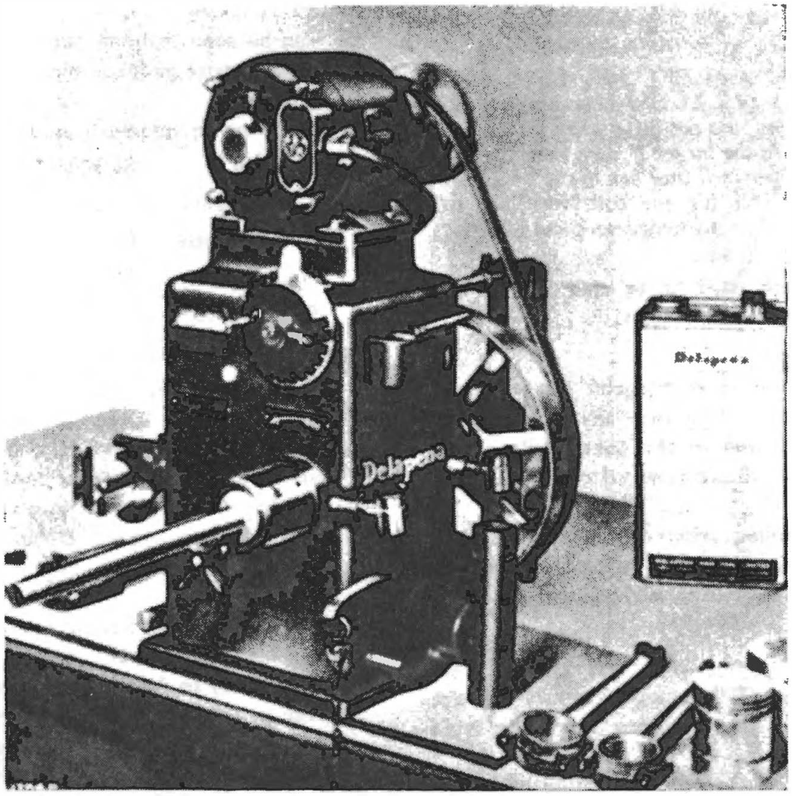


Fig. 39. *Delapena precision honing machine*

only ·0005" (·012 mm.) of material has to be removed in order to allow the gudgeon pin to enter.

Honing of Piston Bosses (See Fig. 41)

The piston bosses can be honed out to take the ·003" (·076 mm.) oversize gudgeon pin which should be a finger push fit with the piston at 70°F. (21°C.) The plug gauge, previously described, is used to determine when the boss bores are to within ·0005" (·012 mm.) of the required size.

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. The Churchill tool for this operation is illustrated in Fig. 42. Connecting rod alignment should also be checked when rubbing marking on the front and rear faces of the piston is not even around the piston skirt. Connecting rods can be straightened in a large bench vice using special vice jaws.

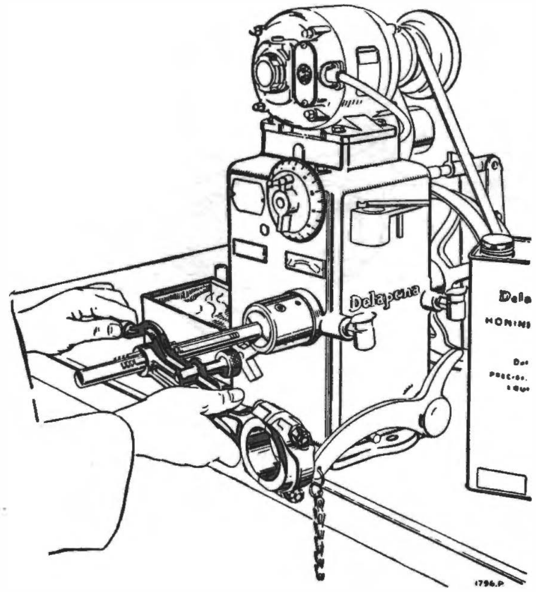


Fig. 40. *Honing connecting rod little end bush*

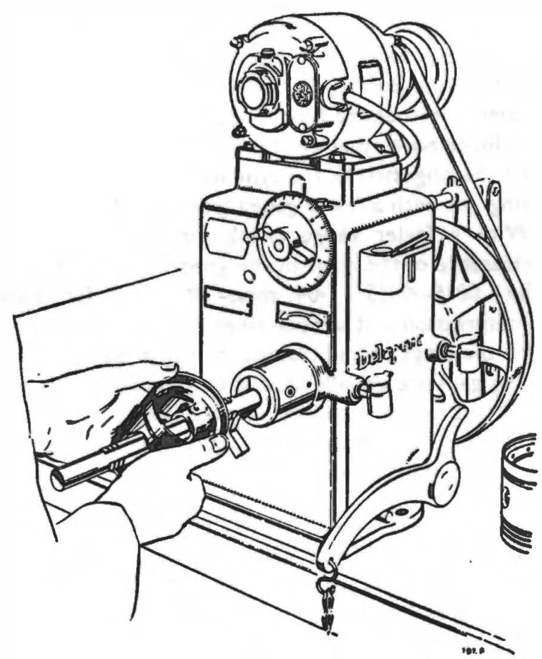


Fig. 41. *Honing piston bosses*

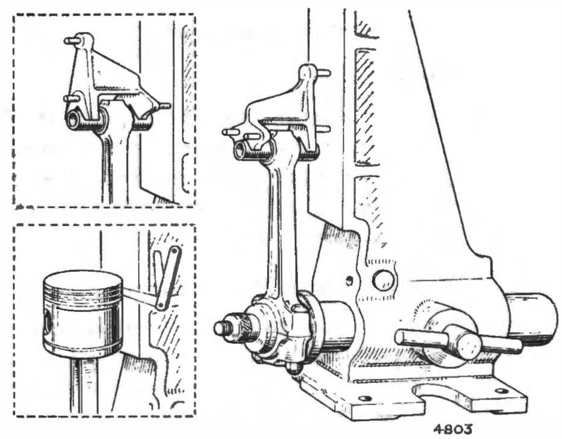


Fig. 42. *Checking connecting rod alignment*

PISTON RINGS

Top Compression Ring

This piston ring is chromium plated with the word "Vacrom" 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.

Second Compression Ring (See Fig. 43)

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 toward the top of the piston. This face is marked "TOP" to indicate

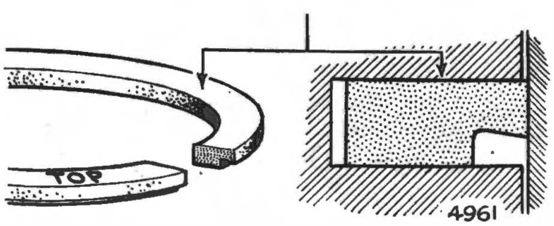


Fig. 43. *Correct method of fitting second compression ring*

that it should be fitted uppermost. Incorrect fitting will result in higher oil consumption.

Scraper ring

One slotted type scraper ring is fitted in the third groove. No piston ring is fitted to the fourth (lower) groove which is only provided on 1494 c.c. engines for the fitting of an extra piston ring after the engine has covered a very large mileage.

Top Chromium Plated Piston Rings

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 as otherwise these rings would never bed down properly.

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

1. Mask off the bottom of the cylinders to prevent any abrasive matter reaching the crankshaft or crankcase.
2. Make up a wooden dummy piston which will fit snugly into the bore with a piece of No. 1 or 1½ grade emery paper wrapped round it.
3. 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 crisscrossed abrasions.
4. Wash down the bores thoroughly and dry them out ensuring that no foreign matter finds its way into the crankcase.

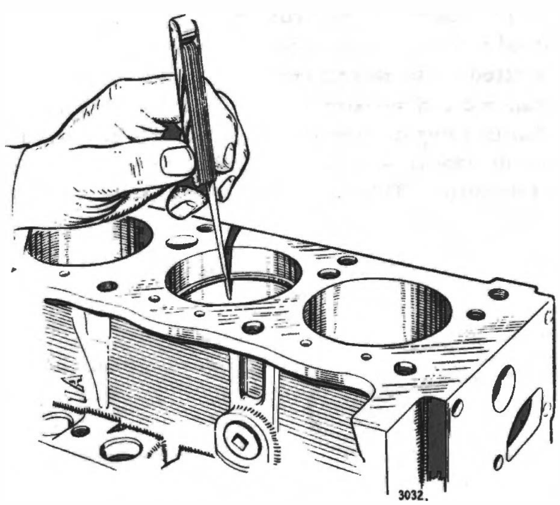


Fig. 44. *Checking piston ring gap*

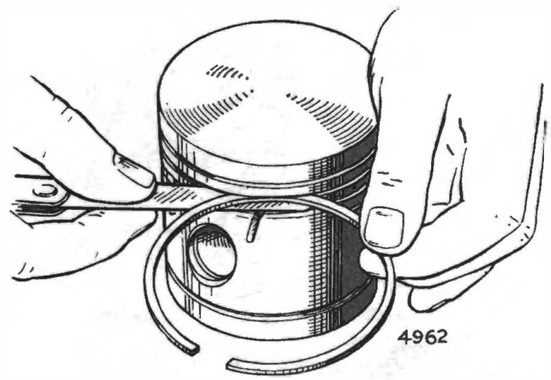


Fig. 45. *Checking piston ring side clearance (1494 c.c. piston shown)*

To fit

The correct ring gaps are given in the Data Section. 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 and F pistons. Fit the rings first to the cylinder bore and check the ring gap with a feeler gauge (see Fig. 44).

With a feeler gauge check for correct vertical clearance of the rings in the grooves, which should be ·0015–·0035" (·04 mm.–·19 mm.) for both compression and scraper rings (see Fig. 45).

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, making sure that the rings checked at No. 1 cylinder are fitted to No. 1 piston and so on.

EXPLANATION OF PISTON AND CYLINDER BORE GRADING LETTERS

Grade diameters are given in the Data Section under General and Piston.

The variation between each grade letter is ·0004" (·010 mm.) and the total difference between the highest and lowest cylinder bore limits, in which there are four grades is ·0016" (·040 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.

Example *(1494 c.c. engine dimensions used)*

Cylinder bore grade A		Piston grade A		Piston Clearance
3·1106"	—	3·1084"	=	·0022"
(79·009 mm.)	—	(78·953 mm.)	=	(·056 mm.)
3·1102"	—	3·1088"	=	·0014"
(78·999 mm.)	—	(78·963 mm.)	=	(·036 mm.)

Mean piston clearance is therefore ·0018" (·046 mm.)

Series IV Alpine and onwards, are fitted with pistons having a bottom skirt clearance of ·0006" - ·0014" (·015 mm - ·035mm) which gives a mean clearance of ·001" (·025 mm). It is therefore necessary to fit these pistons by measurement of the cylinder bore and piston as previously described. Should this be impossible the feeler pull method can be used as given in paragraph 4 provided it is realised that this will give the piston its maximum specified clearance of ·0014" (·035 mm) rather than the desired mean clearance of ·001" (·025 mm).

The cylinder grade letters are stamped on two machined bosses at each end of the cylinder block below the level of the cylinder head on the exhaust manifold side, and visible with the cylinder head in place. The piston grade is stamped on the top face of each piston.

FITTING PISTONS TO LOW MILEAGE ENGINES or THE APPLICATION OF PISTON GRADING IN SERVICE

After a new engine has been run for a few hundred miles the cylinder grade letter size no longer applies because the running in process will result in a slight initial increase in piston clearance.

If a piston, or pistons have to be changed under service conditions the following procedure must be followed.

1. Check the cylinder bore diameter with a Mercer, or other dial type bore measuring gauge, after setting its zero reading to a suitable size ring gauge. (see Section S)
2. From the size obtained subtract the correct piston clearance previously given and from this size choose a suitable grade of piston.

Example *(1494 c.c. engine dimensions used)*

Bore size given by clock gauge 3·1116".

3·1116" — ·0018" = 3·1098"

Nearest piston size to 3·1098" is D grade. Therefore fit a D piston.

3. If the cylinder bore is slightly damaged by seizure or is slightly tapered it should be honed out to take a larger grade, or ·005" (·127 mm.) oversize piston
4. In the absence of suitable cylinder bore measuring equipment pistons may be fitted by checking their clearance with a feeler gauge and spring balance as shown in Fig. 46.

   To do this invert the piston and insert in the bore with a ·0015" (·038 mm.) x ½" (12·7 mm.) wide feeler in line with the thrust face of the piston skirt as shown in Fig. 46.

   A pull of 3-4 lbs. (1·36—1·81 kgs.) is needed to withdraw the feeler with a correctly fitting piston, **when the cylinder bore has been wiped clean from an oiled condition.** If the cylinder has been rebored or honed, it should be well oiled and wiped **clean** with clean lintless cloth.

TO REBORE CYLINDER BLOCK AND FIT OVERSIZE PISTONS

Oversize pistons are supplied for rebored cylinders, and conform to grade B diameter plus the requisite oversize.

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

For service use with rebored cylinders, oversize pistons will not be supplied to any specific grade, since grading is incidental to manufacture.

The recommended bore finish is a "cross hatched" hone finish of 20–40 micro inches. This is equivalent to that obtained by thoroughly rubbing a used cylinder bore with partly worn number one grade emery cloth.

The cutting tool of the boringmachine should be set

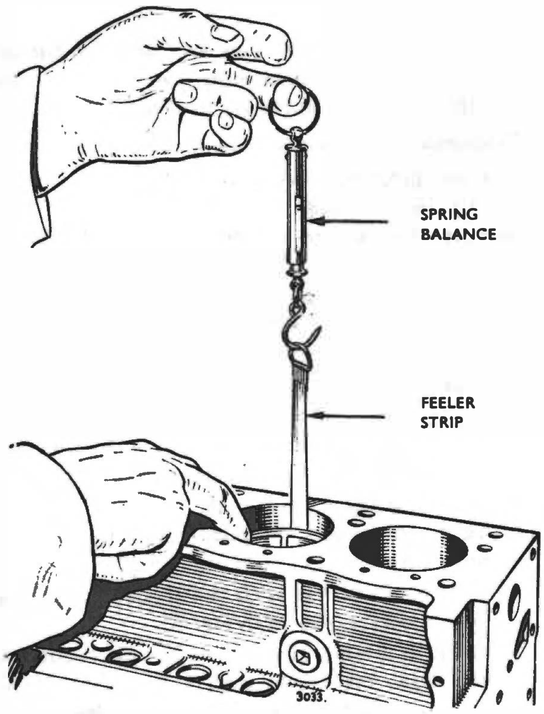


Fig. 46. *Checking piston clearance with feeler and spring balance*

to bore the maximum diameter of the piston plus its prescribed clearance in the cylinder bore less a small amount for honing.
The honing operation allows the bore size to be taken to the size that will allow the piston to be correctly fitted using a feeler to check the clearance as previously described and illustrated in Fig. 46.
It is advisable to regrind and reset the cutter after completing each cylinder bore.
Bores must be parallel and round to within ·0004″ (·01 mm.). The use of a cylinder gauge such as a Mercer is recommended for taking measurements. 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

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.
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. Some engines, however, are fitted with liners during production and these should be dealt with as described under "CYLINDER LINERS—To renew".
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, as otherwise there is every possibility of the operation proving unsatisfactory.

1494 c.c. Engine

The outside diameter of the cylinder liner is 3·257″–3·258″ (82·72–82·75 mm.). Cylinders should be bored to 3·254″–3·255″ (82·65–82·67 mm.).

1592 c.c. Engine

The outside diameter of the cylinder liner is 3·357″–3·358″ (85·267–85·293 mm.). Cylinders should be bored to 3·354″–3·355″ (85·191–85·217 mm.).

Remove engine from chassis and dismantle.
Measure external diameter of liners.
Measure diameter of bores below piston ring travel.
Bore out the cylinders to suit liners, allowing for the prescribed interference fit of ·002″–·004″ (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.
Finish boring must not be attempted until all liners have been fitted.
Press in liners. To facilitate fitting, a "lead-in" is provided at the lower end of the liner.
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.

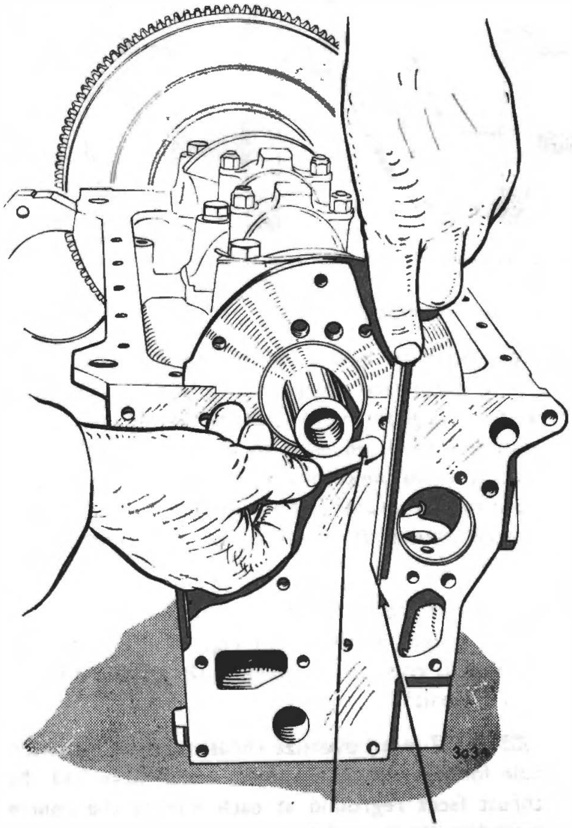


Fig. 47. *Checking front main bearing cap alignment with straight edge and ·0015" feeler*

Press the liner home flush with the top of the cylinder block.

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

Cylinder liners may be rebored only up to ·040" (1·02 mm.) oversize.

To renew
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 on the previous page, the correct interference fit will not be obtained.

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

CRANKSHAFT

Identification

For purposes of identification the letters and figures E.N.16 are embossed on both crank webs connecting No. 1 and No. 2 crankpins, and No. 3 and No. 4 crankpins, see Fig. 48. Crankshafts without this identification must not be used for replacements.

Main Bearings

The main bearing shells for these engines are white metal lined and are interchangeable.

Main bearing shells are available in standard size and undersizes as detailed in the General Data Section under "Crankshaft".

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

When carrying out this operation the following procedure should be followed:

Drain engine oil.

Remove sump and oil pump.

Slacken all main bearing fixing bolts one to two turns. Starting at one end of the crankshaft remove the bottom main bearing cap, 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 bottom bearing and cap to support the crankshaft before proceeding to remove the next main bearing cap.

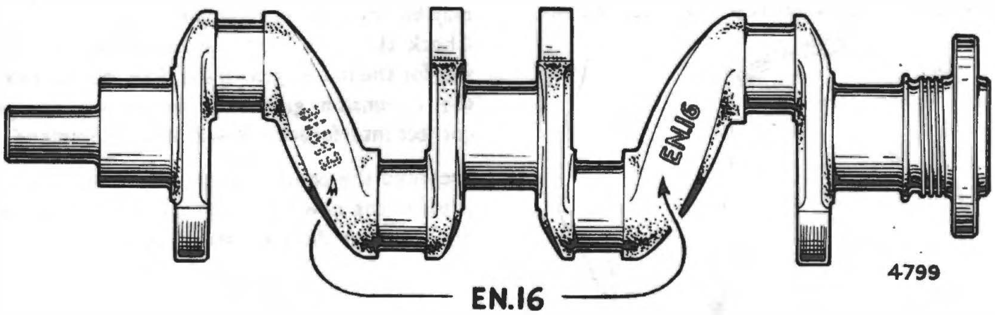


Fig. 48. *EN 16 identification marks on crankshaft*

Top half bearings are replaced in a reverse manner to that described for removal. The following points should be noted:—

(a) Ensure that 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 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 bearing a very small quantity of Wellseal (or other non-setting jointing compound) should be painted onto the sides of the cylinder block recess into which the bearing caps locate. See Fig. 32 under "OIL SUMP—to refit".

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

As each bearing is tightened up the crankshaft should be turned to ensure that it is free. The correct torque wrench figure for the main bearing bolts is given in the Data Section under "Crankshaft".

Crankshaft end thrust

Crankshaft end thrust 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.

Endfloat of the crankshaft can be checked by using feeler gauges as shown in Fig. 49. The correct endfloat is given in the General Data Section under "Crankshaft".

·005″ (·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.

Crankshaft—To remove

Remove engine from chassis.

Remove cylinder head, push rods and tappets.

Remove timing wheels and chain.

Remove engine front plate and sump.

Remove connecting rods and pistons.

Remove clutch (See Section D) and flywheel.

Remove main bearing cap bolts, and caps.

Lift out crankshaft.

Crankshafts having oval or scored journals should be replaced by factory reground units. These are available in the undersizes given in the Data Section

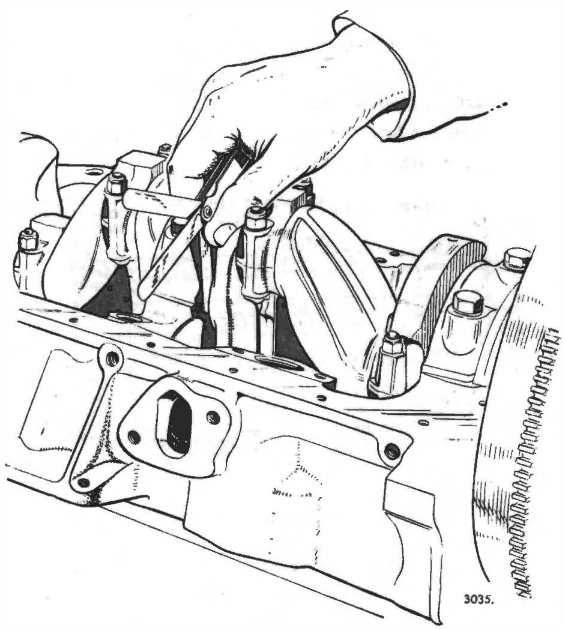


Fig. 49. *Checking crankshaft end float*

under "Crankshaft". Similar dimensioned oversize main and big end bearings can also be obtained.

Crankshaft—To refit

Check that oilways are clear.
Place crankshaft in position, checking that top halves of the main bearings 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 bearing in the cylinder block.
Fit lower halves of bearings together with main bearing caps.
Replace main bearing cap bolts. Check that the machined front face of the front main bearing cap is in alignment with the machined front surface of the cylinder block (See Fig. 47).
Tighten bolts to the correct torque given in the Data Section under "Crankshaft".
Check endfloat of crankshaft as previously described.
Reassemble engine to instructions given in foregoing section, and refill sump with fresh engine oil.

Crankshafts—Regrinding

The correct, and maximum permissible undersizes are given in the Data Section under "Crankshaft". These must be used when regrinding crankshafts. Not more than ·005″ (·127 mm.) can be removed from each thrust face at the ends of the crankshaft centre journal.

FLYWHEEL

To remove and refit

Remove gearbox and bell-housing. (See Section E).

Remove clutch. (See Section D).

Knock flywheel tabwashers clear of setbolts.

Remove setbolts.

Remove flywheel from crankshaft flange. It will be found expedient to screw a stud of suitable size into the top setbolt hole before levering off flywheel, to prevent the flywheel from falling accidentally with possible damage to the starter ring.

To replace, reverse the above order of operations. observing the following notes:—

> It is important that the flywheel fits squarely on crankshaft. Should the dowel have come away with the flywheel when it was removed, tap it out of the flywheel and refit in crankshaft.
>
> Make sure that surface of crankshaft flange and register in the flywheel are perfectly clean and free from burrs, as otherwise the flywheel may not seat properly on the crankshaft.
>
> Tighten set bolts to 37–43 lbs. ft. (5·11–5·94 kg.m.) and check for run-out at outer edge of flywheel clutch facing. A total clock gauge reading of ·003″ (·076 mm.) must not be exceeded.
>
> Lock setbolts with new lockwashers.

STARTER RING GEAR

To renew

The starter ring is shrunk on to the flywheel, and in the event of wear developing on the teeth of the ring the complete flywheel and ring can be renewed (as described above) and the original returned for reconditioning by the manufacturers. However, if suitable equipment is available, the starter ring may be removed and replaced by adopting the following method.

Place flywheel in a suitable container of clean COLD water, supporting the assembly in the container by placing three or four metal blocks under the starter ring. Arrange the flywheel assembly so that it is partly submerged in water, starter ring uppermost (i.e., the complete starter ring must be *above* the water line, and it is recommended that the ring itself be approximately $\frac{3}{16}$" (5 mm.) clear of the water level, as shown in Fig. 50.

Heat the starter ring evenly round its circumference (using an oxy-acetylene welding torch) thus expanding the ring, which will allow the flywheel itself to drop out. Remove flywheel from the water and thoroughly dry it.

Check height of securing lip by means of straight-edge and feeler gauge. This dimension should be ·008" (·203 mm.). If the height of the lip is greater than ·008" (·203 mm.) it must be reduced by means of a lathe. In carrying out this operation it is most important that the flywheel is located by the dowel holes.

Check the surface of the flywheel on which the clutch driven plate operates. If badly scored, or worn, regrind to restore smooth surface.

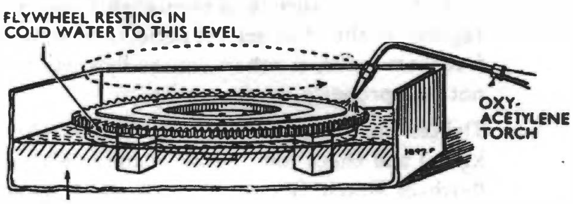


Fig. 50. *Removing worn flywheel ring gear*

Ensure that registering faces of flywheel and starter ring are clean and free from burrs.

To fit a new starter ring after completion of the operations as detailed above, proceed as follows:—

Heat the new gear ring by suspending it from wire hooks in a container of clean engine oil which has been heated to 220°C. (428°F.) until the ring has attained the same temperature as the oil (See Fig. 51).

To eliminate the possibility of fire, keep the container covered by a metal lid to prevent flame from reaching the surface of the oil.

Do not allow starter ring (or thermometer) to rest on bottom of container or a false temperature may result.

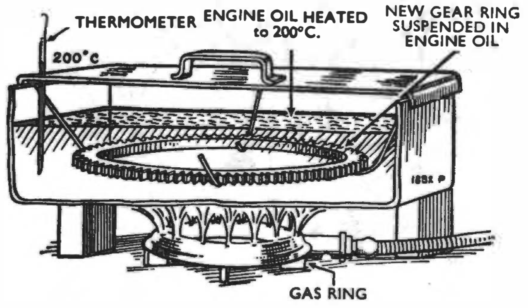


Fig. 51. *Heating flywheel ring gear*

Lift the heated ring from the oil by means of the wire hooks and quickly wipe away surplus oil with a lintless rag.

Place the new ring in position on the flywheel *with chamfered sides of teeth to the clutch side of the flywheel.*

Make sure that the ring is completely over the securing lip and bedding against its locating face.

On cooling, the ring will contract and thus firmly grip the flywheel.

FLYWHEEL CENTRE BEARING

To remove and refit

The clutch spigot bearing is of self-lubricating bush type, and a push fit in crankshaft end recess. To remove the bush for replacement, use a small internal type extractor. If the old bush is too tight to remove by this method, thread it with an $\frac{11}{16}$" tap, when it may be removed by screwing in an ordinary $\frac{11}{16}$" bolt. 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.

It is most essential that the new spigot bush should be soaked in engine oil for 24 hours before fitting, preferably at room temperature.

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

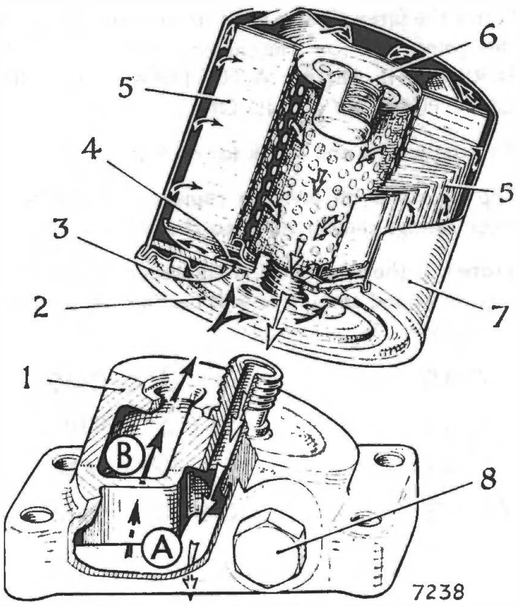


Fig. 52. *Throw away type full flow filter—internal construction*

FULL FLOW OIL FILTER—Throw away type (See Fig. 52)

The throw away type full flow oil filter is screwed to an adaptor casting (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. 52 and thence through the screwed spigot to compartment "A" in the adaptor casting. From here 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 standstill periods.

The throw away filter unit must be changed at the recommended periods given in the "Owners Handbook".

Oil pressure relief valve. (See Fig. 53)

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 lbs. sq. in. (4 kg. sq. cm.). The excess oil discharges into compartment "C" from where it drains into the engine sump.

The oil pressure relief valve can be removed as a complete unit with a 13/16 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. 52.

If the filter element (5) becomes choked, through neglect to change the filter assembly at the servicing periods, the by-pass valve (6) opens and allows oil to pass directly to the engine bearings without being restricted by the blocked element (5).

Opening of the by-pass valve (6) can only occur when there is a pressure difference of over 7 lbs. per sq. in. (0·5 kg. sq. cm.), above and below the by-pass valve.

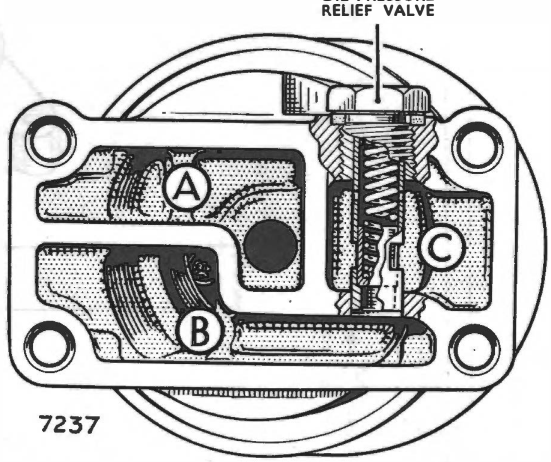


Fig. 53. *Throw away type full flow filter—oil pressure relief valve*

Changing throw away filter unit. (See Fig. 52)

To remove—

The rubber joint ring (2) on the filter base tends to stick to the adaptor casting (1) joint face, and if the filter cannot be removed by hand it can be unscrewed with a strap wrench, which can be made from the particulars given in Fig. 54.

To fit—

Clean the joint face on the adaptor casting (1) and smear the joint ring (2) on the bottom of the filter with clean engine oil.

Screw the filter (7) into position until it just touches the joint face on the adaptor casting. THEN SCREW THE FILTER A FURTHER ONE THIRD OF A TURN BY HAND ONLY.

Run the engine and check for oil leaks.

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

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

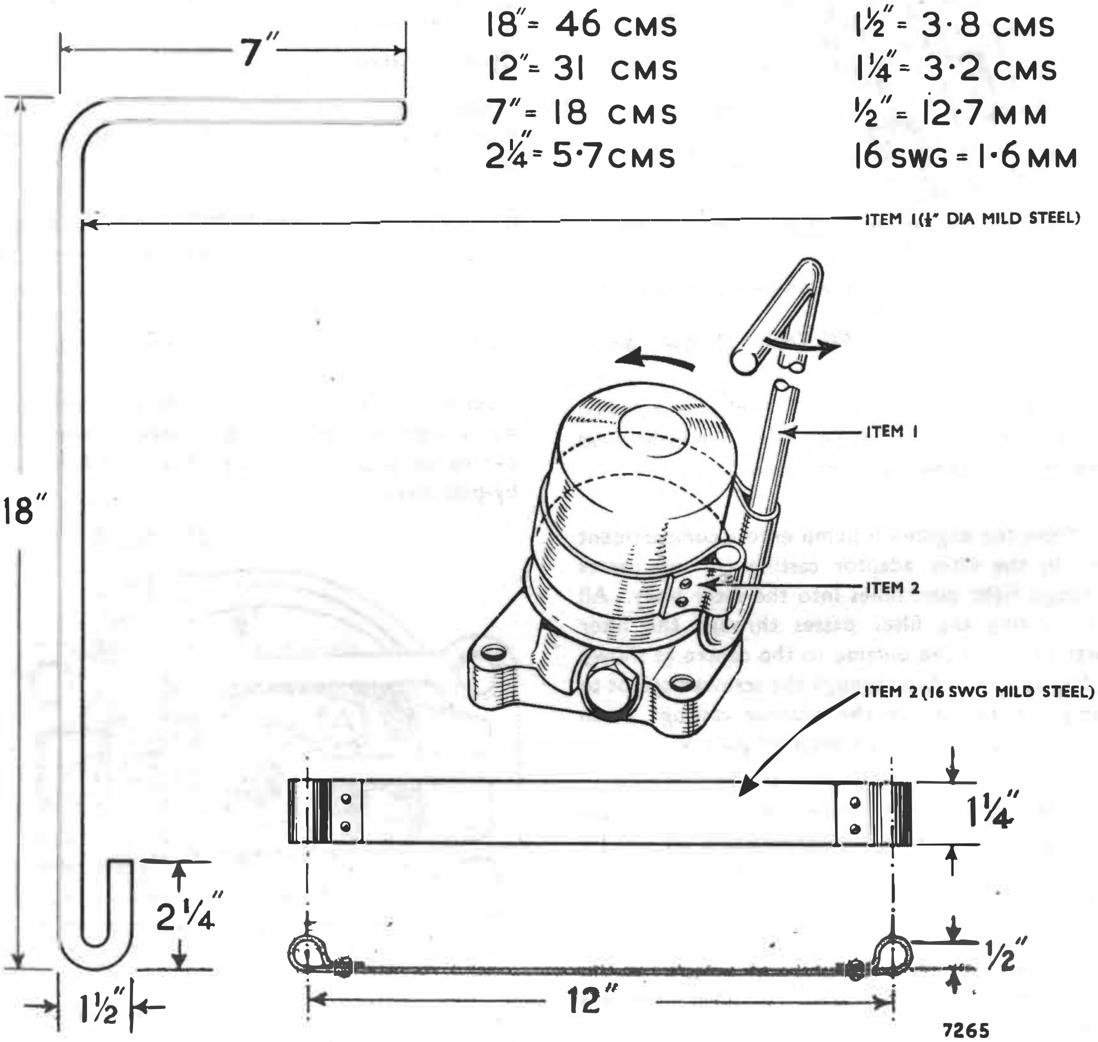


Fig. 54. *Strap wrench—for removing throw away oil filter*

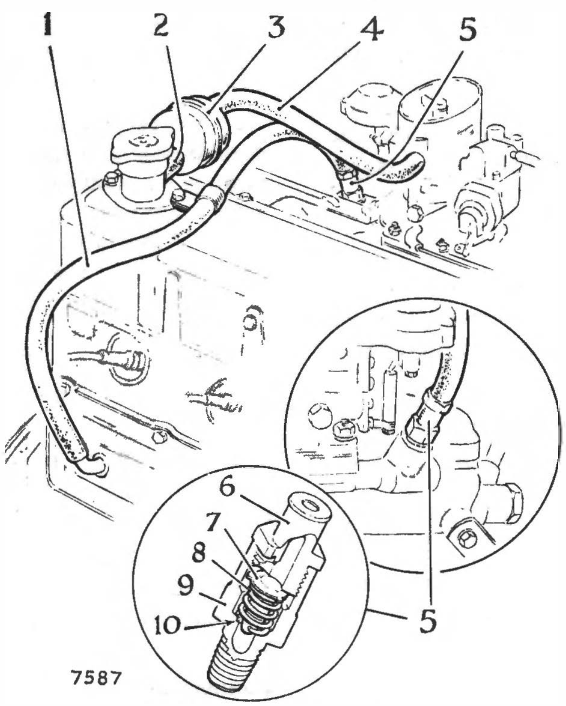


Fig. 55. *Closed crankcase ventilation system.*

CLOSED CRANKCASE VENTILATION SYSTEM

This crankcase ventilation system is fitted to the engines of cars supplied to areas where regulations forbid the discharge of crankcase fumes direct into the atmosphere.

Description See Fig. 55

The system consists of hoses (1) (2) and (4), a flame trap (3), and ventilation regulator (5) the outlet end of which is screwed into the inlet manifold.

Details of the regulator valve are shown in the illustration inset. It consists of an outlet connection (6) screwed into the main body (9) that houses the valve (7) and the valve opening spring (8).

The flame trap (3) was not fitted to the first arrangement of this system which had a direct hose connection from the oil filter tube on the rocker cover to the ventilation regulator (5), and a crankcase air intake gauze filter which screwed into the tappet chamber cover. Particulars of the first type of regulator valve were given in section C page 59.

Operation

When the engine is idling the inlet manifold depression is high enough to draw the regulator valve (7) onto its seat (10), and under this condition crankcase fumes pass directly into the carburettor through the pipe (2) flame trap (3) and pipe (4).

As the throttle opens the inlet manifold depression decreases and the spring (8) lifts the valve (7) from its seat. This allows the crankcase fumes, and air to be drawn from the tappet cover through the pipe (1) and for ventilation air to be drawn from the "clean" side of the air cleaner, into the crankcase rocker cover through the pipe (4), flame trap (3) and pipe (2).

On the first arrangement air was drawn into the crankcase through the gauze filter on the tappet cover.

Servicing

This must be carried out at the recommended intervals given in the owner's handbook or more frequently where short journeys or slow speed driving are usual.

Neglect of servicing will cause sludge and water formation inside the engine which will increase engine wear.

Regulator valve—cleaning

Dismantle and check the condition of the valve seat (10) and valve (7). If they are worn a new regulator valve assembly should be fitted.

The condition of the spring (8) is very important as it controls the opening and closing of the valve (7) against inlet manifold vacuum. If damaged or corroded it must be replaced.

When re-assembling, the valve unit make sure that the spring (8) is correctly located in the body (10) and that the valve (7) is not tilted across the body.

Regulator valve—testing

Refit the valve unit to the inlet manifold leaving the connecting hose off of the inlet end. Run the engine and check the valve operation by making the following tests.

1. Check that the engine idles correctly. When idling it should be possible to push the valve (7) hard against its seat; with a suitable rod, without affecting the slow running performance.

2. Check that the valve (7) opens when the engine speed is suddenly increased by opening the throttle from idling. Do not exceed 3,000 RPM. Valve movement can be seen by putting a short length of thin wire (approx. 12 ins.—4 cms.) into the inlet end of the regulator. When the engine speed is suddenly increased the valve (7) should lift from its seat. This will be shown by the test wire lifting about 2—3 mm. Sudden closing of the throttle should allow the engine to idle correctly.

3. If the correct operation cannot be obtained a new spring (7) should be fitted. THESE SPRINGS MUST NOT BE STRETCHED OR FULLY COMPRESSED.

4. Remove wire used to indicate valve movement and connect rubber hose (1) to the valve inlet end after making sure that it is not obstructed by sludge.

Connection hoses

If necessary these should be removed and cleaned internally.

Flame trap—where fitted

The flame trap should be washed in kerosene (paraffin) and inverted so that it drains dry. THE FLAME TRAP MUST BE REFITTED IN THE POSITION SHOWN IN FIG. 55. Incorrect positioning of the flame trap will allow it to gradually fill up with oil and prevent the crankcase ventilation system from operating.

Air intake filter—if fitted.

This filter should be cleaned in the same way as the flame trap.

FUEL SYSTEM

CONTENTS

CONTENTS—*continued*

FUEL PUMP

The A.C. mechanically operated pump is mounted on the right-hand side of the engine and operated by an eccentric on the camshaft. A gauze filter and glass cover bowl are incorporated with the pump.

DETAILS OF OPERATION (See Fig. 1)

As the engine camshaft revolves an eccentric (7) actuates the fuel pump rocker arm (6) pivoted at (8) which pulls the pullrod (11) together with the diaphragm (13) downwards against spring pressure (12) thus creating a depression in the pump chamber (15). Fuel drawn from the tank enters the glass bowl from the pump intake (3). After passing through the filter gauze (17) and the inlet valve (1) it enters the pump chamber (15).

On the return stroke, pressure of the spring (12) pushes the diaphragm (13) upwards forcing fuel from the chamber (15) through the outlet valve (16) and outlet (14) to the carburettor. When the

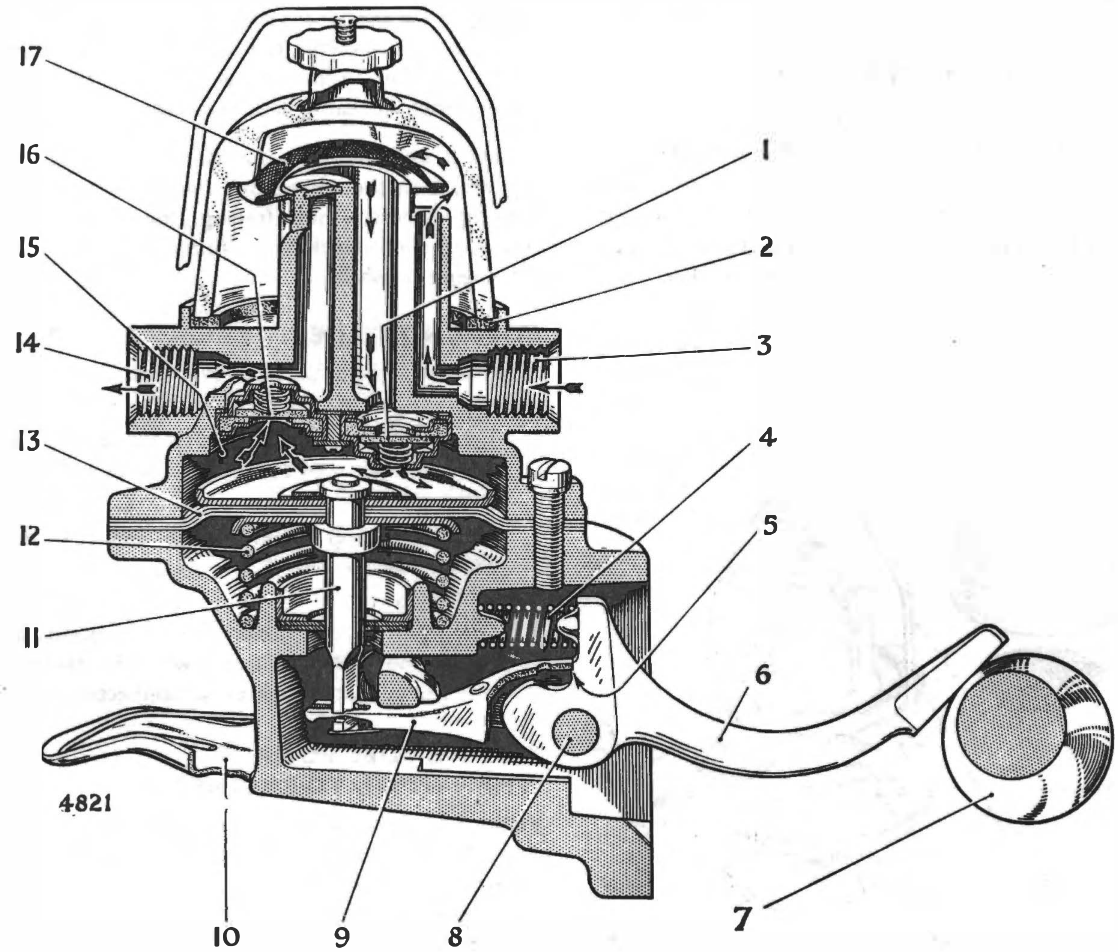


Fig. 1. Sectional view of fuel pump and fuel filter

carburettor bowl is full the float will shut the needle valve, thus preventing any flow of fuel from the pump chamber (15). This will hold the diaphragm (13) downwards against the spring (12) pressure and it will remain in this position until the carburettor requires further fuel and the needle valve opens.

The rocker arm (6) operates the connecting link (9) by making contact at (5) and this construction allows idling movement of the rocker arm when there is no movement of the fuel pump diaphragm.

The spring (4) keeps the rocker arm (6) in constant contact with the eccentric (7) to eliminate noise.

GLASS BOWL FILTER (See Figs. 1 and 2)

To gain access to the filter gauze for cleaning, first remove the glass bowl, after slackening the securing screw and swinging the fixing clamp to one side.

The washer (2) and filter (17) can then be removed from the main casting. Wash the filter in clean fuel, and replace it before fitting the washer.

When refitting see that the washer is in good condition and properly seated. Do not over-tighten the securing screw or the excessive pressure will cause rapid deterioration of the joint.

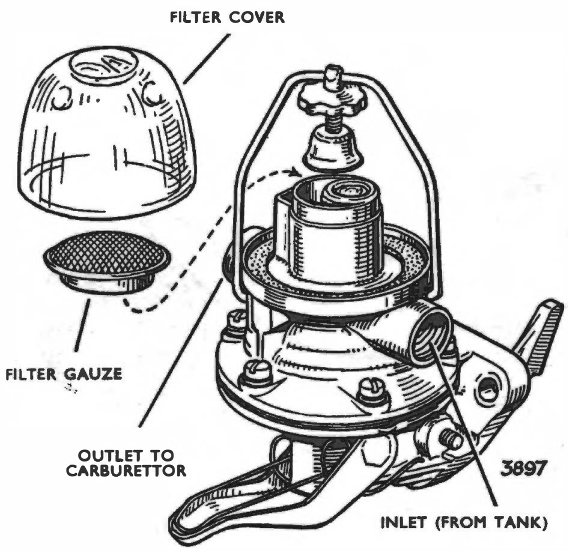


Fig. 2. *Fuel pump filter*

HAND PRIMER

The hand primer shown in Fig. 2 is for use when, for any reason, the carburettor float chamber or pump bowl has become empty. A few pulls upwards of the hand primer on these occasions will fill the float chamber with fuel and ensure easy starting without prolonged use of the starter and consequent excessive drain on the battery.

Owing to the special construction of the pump it is impossible to overfill the carburettor, as after several strokes with the hand primer this will become free, indicating that the carburettor is full.

Should it be found that the hand primer will not operate, turn the engine one revolution with the starting handle, thus freeing the fuel pump operating lever mechanism from the eccentric on the engine camshaft.

FUEL SHORTAGE AT CARBURETTOR

If the pump should fail to deliver fuel to the carburettor the following points should be checked:—

1. That fuel is available in the tank and that the unions in the pipe connecting the tank to the pump are tight.
2. That the pump filter is clean and that the washer below the filter cover is in good condition.
3. The action of the pump, proved by revolving the engine with the starter with the delivery pipe (pump to carburettor) disconnected.

TESTING FUEL PUMP WHEN FITTED TO ENGINE

With the engine switched off, the pipe to the carburettor should be disconnected at the carburettor end, leaving a free outlet from the pump. The engine can then be turned over by hand or by the starter. There should be a well-defined spurt of fuel at every working stroke of the pump, that is once every two revolutions of the engine.

TO REMOVE FUEL PUMP FROM ENGINE

Disconnect the fuel pipes by undoing their unions on the fuel pump body. Remove the two nuts holding the pump to the engine crankcase and lift away pump carefully noting the number of joints used between the pump mounting face and the crankcase face.

TO DISMANTLE FUEL PUMP (See Fig. 4)

Before commencing to dismantle the pump thoroughly clean the exterior and make a mark across the two flanges of the pump housing, as a guide when reassembling.

Remove the six securing setscrews (11) and separate the two halves of the main casting.

Turn the diaphragm and pull-rod assembly (13) through an angle of 90°, when it may be disconnected from its securing slot in the connecting link (20) and withdrawn. Remove diaphragm spring (14).

Do not attempt to separate the four diaphragm layers.

Remove one circlip (24) from the rocker arm pin and withdraw the pin (23).

The rocker arm (22) together with the connecting link (20), spring (21) an washers (19) may now be removed.

Withdraw the valve retainer screw (10) from inside the upper casting and remove the retainer plate (9), valve assemblies (7) and valve retainer gasket (8).

INSPECTION OF PARTS

Thoroughly clean all parts in paraffin. Those parts that comprise the valve assemblies and retainers should be washed separately from the other dirtier components.

The diaphragm and pull rod assembly should be renewed if there is any sign of hardening or cracking.

Where any part of the hand priming mechanism is broken the complete set of parts must be renewed, the outer ends of the spindle being riveted over by hand tools after correctly locating the various components.

All badly worn parts must be renewed and very little wear may be tolerated on the rocker arm pin, holes and engagement slot in link, holes in rocker arm, contact face of rocker arm or pull rod.

The valve assemblies cannot be dismantled but should be tested for air-tight seatings by suction, and renewed where necessary.

Check the valve retaining joint very carefully for damage or distortion; it is advisable to renew this gasket after dismantling as any fault preventing correct seating of the valve assembly will greatly decrease the efficiency of the pump.

Test the diaphragm spring, although this seldom requires replacement. Where necessary ensure that the replacement spring has the same identification colour and consequently the same strength as the original.

All gaskets and joints should be renewed as a matter of routine, including the fabric oil seal washers located round the diaphragm pull-rod.

TO REASSEMBLE FUEL PUMP

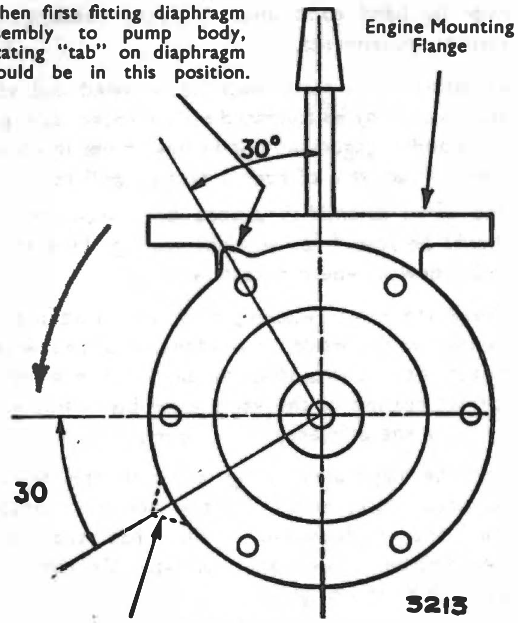
Refit valve retainer gasket, valves, valve retainer, and secure in position with two retaining screws. The valves must be assembled in the pump as illustrated in Fig. 1. If fitted in any other way the pump will not operate.

Assemble link, packing washers, rocker arm and rocker arm spring in the body.

Insert rocker arm pin through the hole in the body, at the same time engaging the packing washers, link, and the rocker arm, then spring the retaining clips into the grooves on each end of the pin. The rocker arm pin should be a tap fit in the body.

The fitting of the rocker arm pin can be simplified by first inserting a piece of 0·240″ (6 mm.) diameter rod through the pin hole in one side of the body far enough to engage the rocker arm washers and link, and then pushing the rocker arm

When first fitting diaphragm assembly to pump body, locating "tab" on diaphragm should be in this position.



After engaging notches in bottom of pull rod with slot in link and turning quarter turn to the left, tab on diaphragm should be in this position.

Fig. 3. *Fitting diaphragm assembly*

pin in from the opposite side, removing the temporary rod as the pin takes up its proper position.

Place the diaphragm spring in position in the pump body. Place the diaphragm assembly over the spring (the pump rod being downwards) and centre the upper end of the spring in the lower protector washer.

Press downwards on the diaphragm, at the same time turning the assembly to the left in such a manner that the slots on the pull rod will engage the fork in the link, ultimately turning the assembly a complete quarter turn to the left, which will place the pull rod in the proper working position in the link, and at the same time permit the alignment of the holes in the diaphragm with those in the pump body flanges. When first inserting the diaphragm assembly into the pump body, the locating "tab" on the outside of the diaphragm should be at the position shown in Fig. 3. After turning the diaphragm assembly a quarter turn to the left the "tab" should be in the position indicated by the dotted outline.

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

Push the rocker arm towards the pump until the diaphragm is level with the body flanges.

Place the upper half of the pump into the proper position, as shown by the mark made on the flanges before dismantling.

Install the cover screws and spring washers and tighten until the heads of the screws just engage the washers.

Important

Before finally tightening screws, push rocker arm towards pump using about a 4" (10 cms.) length of tube slipped over the end of the rocker arm so as to hold the diaphragm at the bottom of its stroke. Hold in this position and tighten screws alternately. After assembly the edges of the diaphragm should be about flush with the two clamping flanges.

Any appreciable protrusion of the diaphragm indicates incorrect fitting, in which case special care should be paid to maintaining inward pressure on the rocker arm while the diaphragm screws are finally tightened alternately and securely.

Refit filter gauze and cork seating gasket in position.

Refit filter bowl as previously described.

TO TEST FUEL PUMP AFTER ASSEMBLY

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

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 (kerosene.) Again operate pump. Not more than 16 strokes should be necessary to secure delivery of paraffin from the pump outlet.

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 this 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 two clamping flanges—should be carefully examined for leakage and the retaining 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.

When the above apparatus is not available the pumps should be tested, using a pan of clean paraffin as follows:—

> Flush the pump by immersing it in the paraffin and working the rocker arm half a dozen times, then empty the pump by continuing to operate it while held above the bath. Then with the pump clear of the paraffin bath, place the finger over the inlet union (marked "in") and work the rocker arm several times. Upon removing the finger a distinct suction noise should be heard, denoting that the pump has developed a reasonable degree of suction. Afterwards the finger should be placed over the outlet union and after pressing the rocker arm inwards the air drawn into the pump chamber should be held under compression for two or three seconds; this should be done with the pump immersed in paraffin and the clamping flanges of the diaphragm watched for any signs of air leakage.

TO REFIT PUMP TO ENGINE

Reverse the procedure outlined for removal from engine. Ensure that the rocker arm is correctly positioned. After refitting the pump, the engine should be run for a short time and pipe unions and pump examined for any signs of fuel leakage.

EXCESSIVE FUEL PUMP PRESSURE

As explained under, "Details of Operation" the pressure of fuel on the carburettor is determined by the spring (12, Fig. 1), 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, and if all the lower limits exist on one particular engine, 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 heavy fuel consumption. This can be checked and if necessary rectified as follows:—

1. Disconnect the pipe to the carburettor at the pump.
2. A mercury manometer or a suitable reliable pressure gauge calibrated up to 6 lb. per sq. in. (0·422 kg. per sq. cm.) should then be connected to and as near as possible, on the same level with the outlet on the pump.
3. Rotate the engine on the starter, and a reading similar to that given in the Data Section under "Fuel System" should be recorded on the gauge.

To remedy excessive output pressure additional packings should be fitted between the fuel pump flange and cylinder block pump mounting face.

Excessive output pressure can be caused by stiffening up of the pump diaphragm, and diaphragm condition should be checked on any pump that has been in service for a long time.

Care should be taken to avoid the use of an excessive number of packings as this can cause fuel starvation under full throttle conditions.

The pump output pressure should always be rechecked after adding packings.

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 A.C. pumps will not necessarily give the same results.

1 Body.
2 Retainer—glass cover.
3 Glass bowl.
4 Gasket—bowl.
5 Cover.
6 Filter gauze.
7 Valve.
8 Gasket—valve.
9 Retaining plate—valve.
10 Screw—valve retainer.
11 Screw No. 10 U.N.F.
12 Washer $\frac{3}{16}$" spring.
13 Pull rod and diaphragm.
14 Spring—diaphragm.
16 Priming lever.
17 Washer—oil seal.
18 Retainer—oil seal.
19 Washer—rocker pin.
20 Link.
21 Return spring rocker arm.
22 Rocker arm.
23 Pin—rocker arm.
24 Circlip—rocker arm pin.
25 Primer spring.
26 Joint pump to insulator.
27 Heat insulator.
28 Joint—insulator to cylinder block.
29 Outlet union.
30 Banjo bolt.
31 Fibre washer.

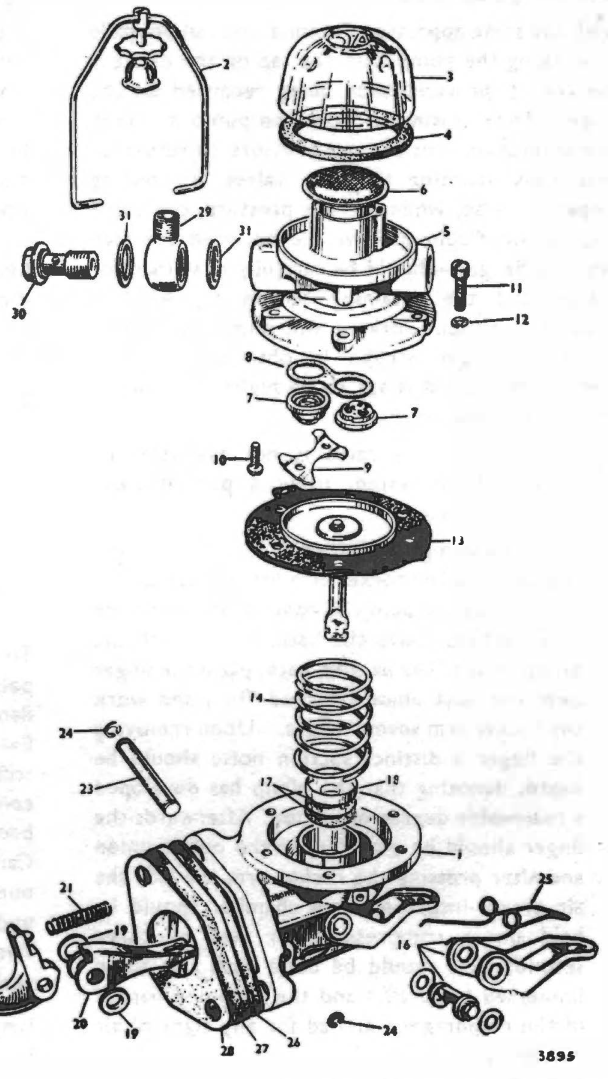


Fig. 4. *Exploded view of fuel pump*

CARBURETTOR

GENERAL DESCRIPTION

The following carburettors and air cleaners are fitted as standard equipment

Alpine

Twin Zenith WIP 36 downdraught carburettors fitted with separate removable gauze type air intake filters.

Rapier

Twin Zenith WIA 36 downdraught carburettors connected to a single oil bath air cleaner by a common air box.

WIP carburettors have the by-pass fuel supply system blanked off. WIA carburettors have a by-pass jet supplied through a by-pass valve which is controlled by a diaphragm and spring operated by inlet manifold depression.

36 denotes that the throttle bore size is 36 mm. and WI the carburettor type.

Both these carburettors have a modified accelerator pump operating mechanism which gives a more rapid action of the accelerator pump during early stages of throttle opening.

Jet sizes, orifice hole sizes and setting dimensions are given in the Data Section at the front of this manual.

By removing six cheese-headed screws, the top body of the carburettor can be removed, allowing easy access to the following items: float and float needle and seat, slow running jet, the combined by-pass valve and jet, the accelerator pump and its check valve, discharge nozzle, and delivery ball valve.

The main jet can be removed by using a spanner on its external hexagon head which is situated on the underside of the float chamber.

The three main components of the carburettor, the various passage-ways, jets, valves and mechanical linkage are shown in Figs. 5 and 6, An exploded view of the carburettor is given in Fig. 18 and the names of the various parts on the adjoining page.

A heat insulating joint of 5 mm. thickness is used between the throttle spindle body and the main body, to reduce heat flow from the manifold to float chamber and jets. This arrangement has the advantage of keeping the throttle warm which prevents icing up in cold damp weather. Four $\frac{1}{4}''$ B.S.F. recessed cheese-headed screws are used to hold these parts together.

Under extremely hot operating conditions fuel will sometimes boil in the carburettor after the engine has been stopped. To deal with this the main discharge jet drillings and high speed bleed are arranged to act as an anti-percolating device keeping the boiling fuel bubbles inside the carburettor.

CARBURETTOR OPERATION

The carburettor has to supply a correct fuel/air mixture to meet the following operating conditions.

1. Good starting from cold.
2. Slow running or fast idling.
3. Cruising (part throttle running).
4. Acceleration without flat spots.
5. Full power (full throttle) requirements.

The way in which these requirements are met by the various parts of the carburettor are fully described and illustrated in the following pages.

Float Chamber (See Fig. 7)

Petrol enters the carburettor through the inlet at the base of the float chamber, and then passes through the float needle seating. The needle is attached to the cylindrical float by means of a wire clip. As petrol is admitted, the float rises and pushes the needle down to its seat, thus cutting off the flow when the correct level is reached in the float chamber. This action is entirely automatic and continues all the time the carburettor is being fed with fuel.

From the float chamber fuel passes to the main jet, accelerator pump suction valve, and to the by-pass

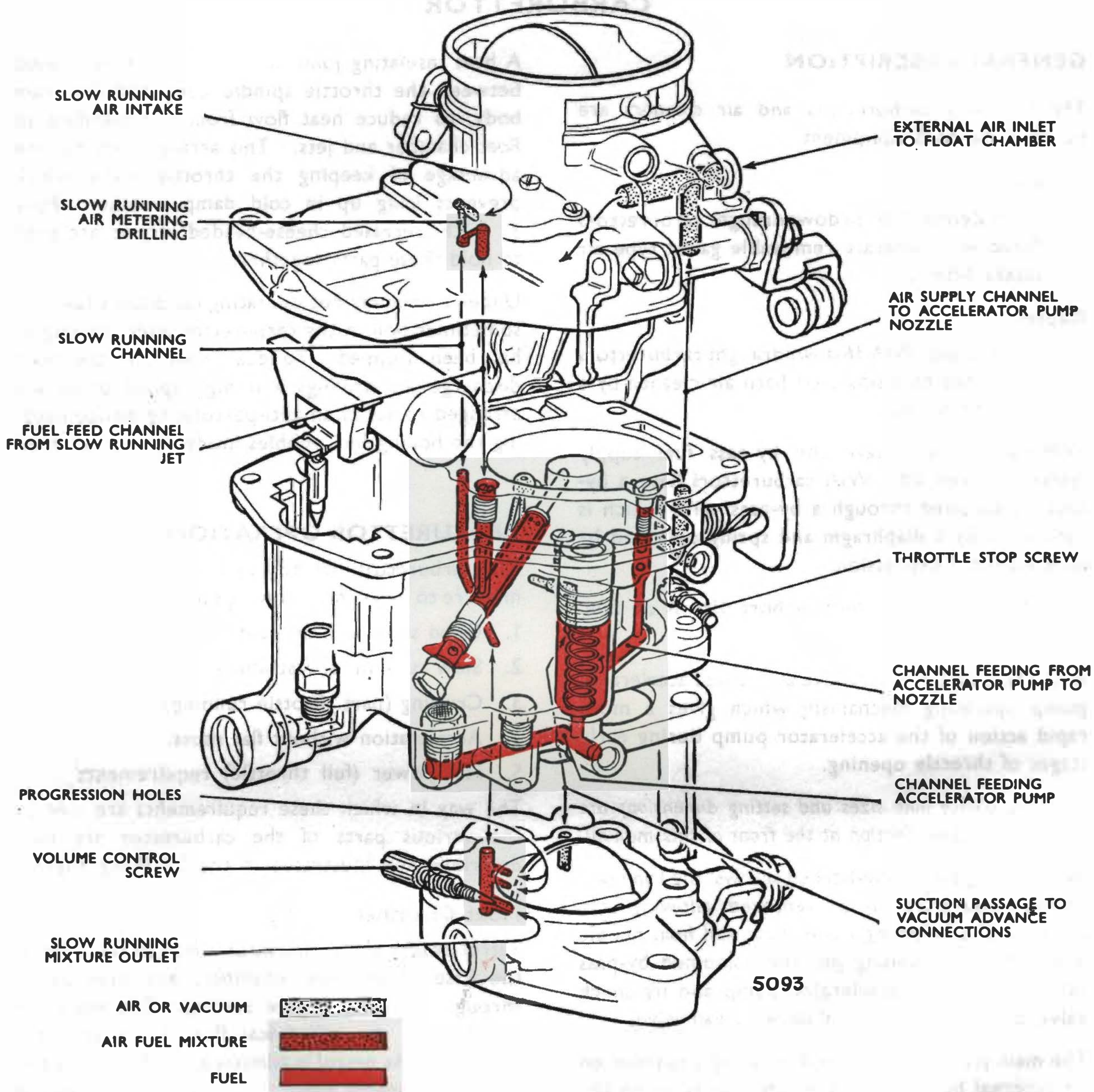


Fig. 5. *Zenith WIP 36 carburettor. Arrangement of channels*

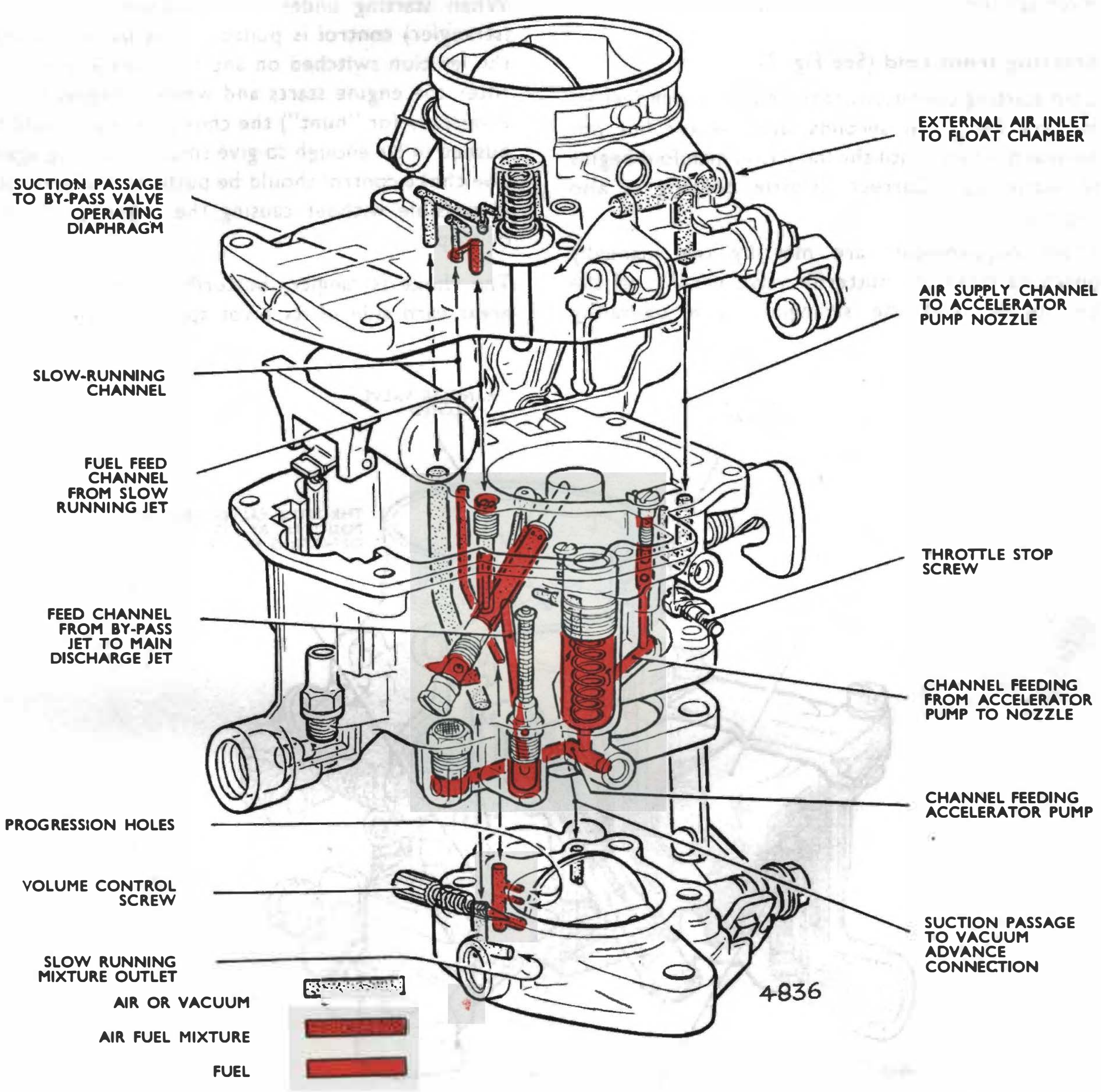


Fig. 6. *Zenith WIA 36 carburettor. Arrangement of channels*

valve. The latter is only used on WIA carburettors.

The float chamber is vented to atmosphere by a hole entering adjacent to the accelerator pump lever spindle.

Starting from cold (See Fig. 7)

Cold starting conditions require a very rich fuel/air mixture for a few seconds, and weaker but not normal mixture, until the induction manifold begins to warm up. Correct throttle opening is also important.

These requirements are met by the manually operated strangler butterfly valve closing off the air supply, and the strangler valve operating mechanism opening the throttle to the correct starting position, when the choke control is pulled out to start the engine.

When starting under cold conditions, the choke (strangler) control is pulled out as far as possible, the ignition switched on and the starter operated. After the engine starts and when it begins to run erratically (or "hunt") the choke control should be pushed in far enough to give smooth running again. The choke control should be pushed in fully as soon as possible without causing the engine to misfire or stop.

The choke (strangler) butterfly valve has unequal areas each side of its pivot spindle and the valve

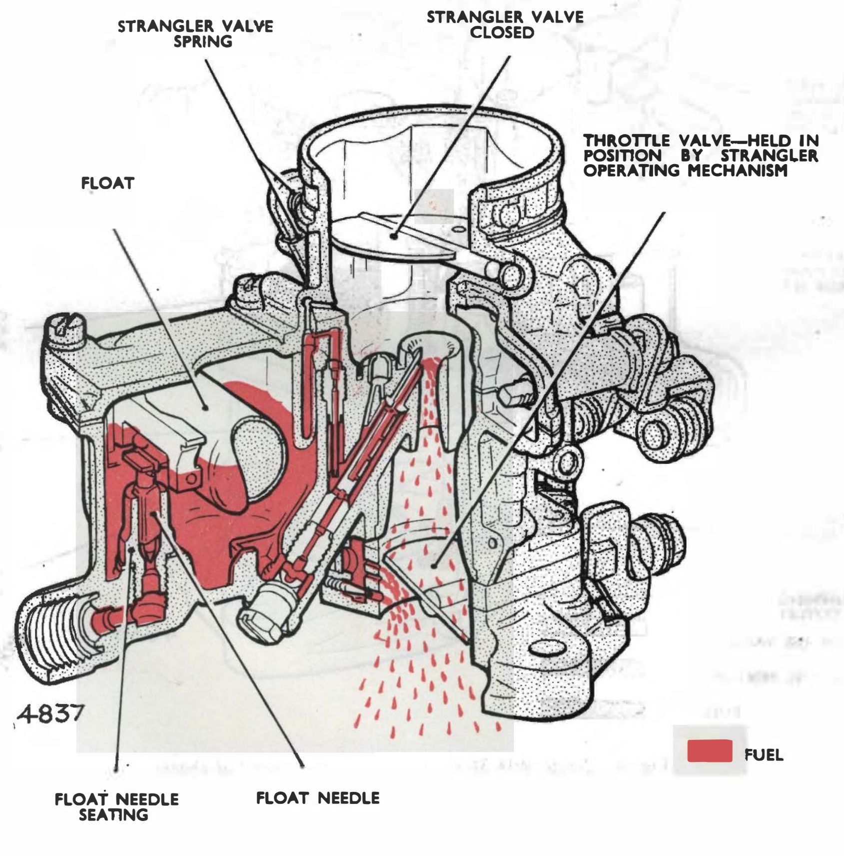


Fig. 7. *Cold starting operation*

can open against a light spring, even when the choke control is still pulled out.

When the engine starts, with the choke valve closed, air pressure acts on the larger pivoted area of the choke butterfly valve, opening it a small amount against its light control spring and the lower pressure in the carburettor intake.

This allows entry of sufficient air to prevent over-choking of the engine when starting from cold.

The carburettor strangler mechanism and various positions taken by the cam lever are shown in Fig. 8 and the carburettor action when starting, in Fig. 7.

Slow running (See Fig. 9)

With the throttle in the idling position, the mixture is supplied by the idle jet which draws fuel through the crossholes at the lower end of the main discharge jet. This fuel, which is metered by the small calibrated hole in the bottom of the idle tube, is partly emulsified by air drawn from the air intake through the air bleed hole and the mixture then passes along an internal channel to the idling orifice.

Idling is adjusted by means of the throttle stop screw and the volume control screw (See Fig. 9). If screwed in, the throttle screw will open the throttle

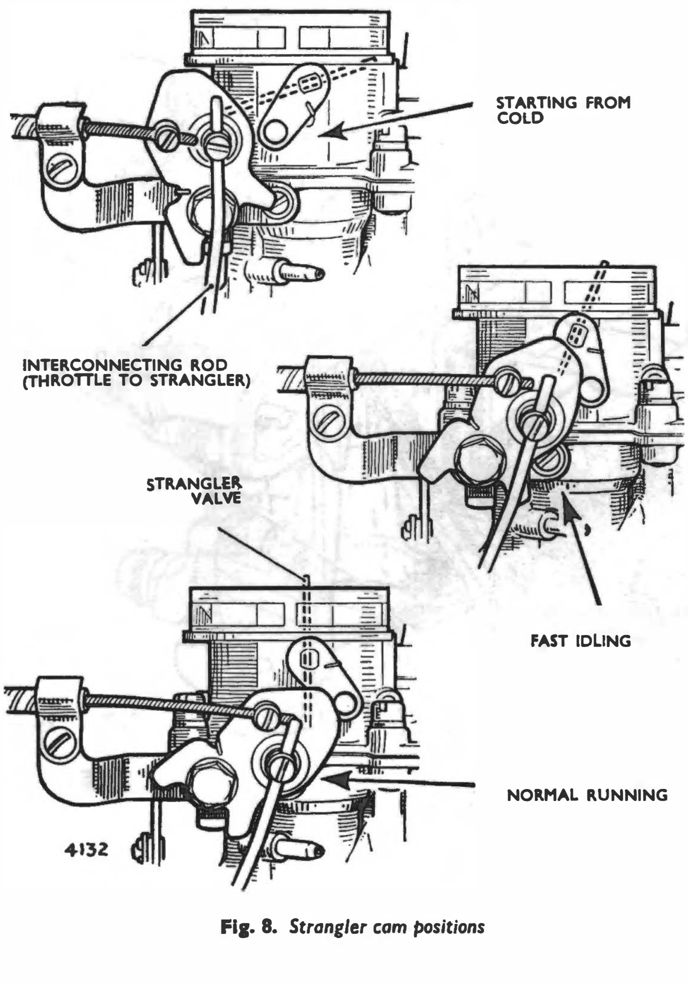


Fig. 8. *Strangler cam positions*

wider and increase the engine speed and when unscrewed the speed will be reduced.

The strength of the idling mixture is established by the size of the idle jet and that of the air bleed. The jet size is variable, but the air bleed is drilled in the carburettor casting and is not intended to be altered.

The volume control screw which has a tapered tip, and is on the engine side of the throttle, controls THE AMOUNT of idle mixture passed to the engine.

To weaken the mixture, the screw should be turned clockwise; conversely it must be unscrewed to make the mixture richer.

The two small holes at the throttle edge break into the idle channel. These assist in the transfer from the idle system to the main metering system as the throttle is opened, and provide a smooth and progressive action during that period; they are known as "progression holes", and are not adjustable. It is important that they are not tampered

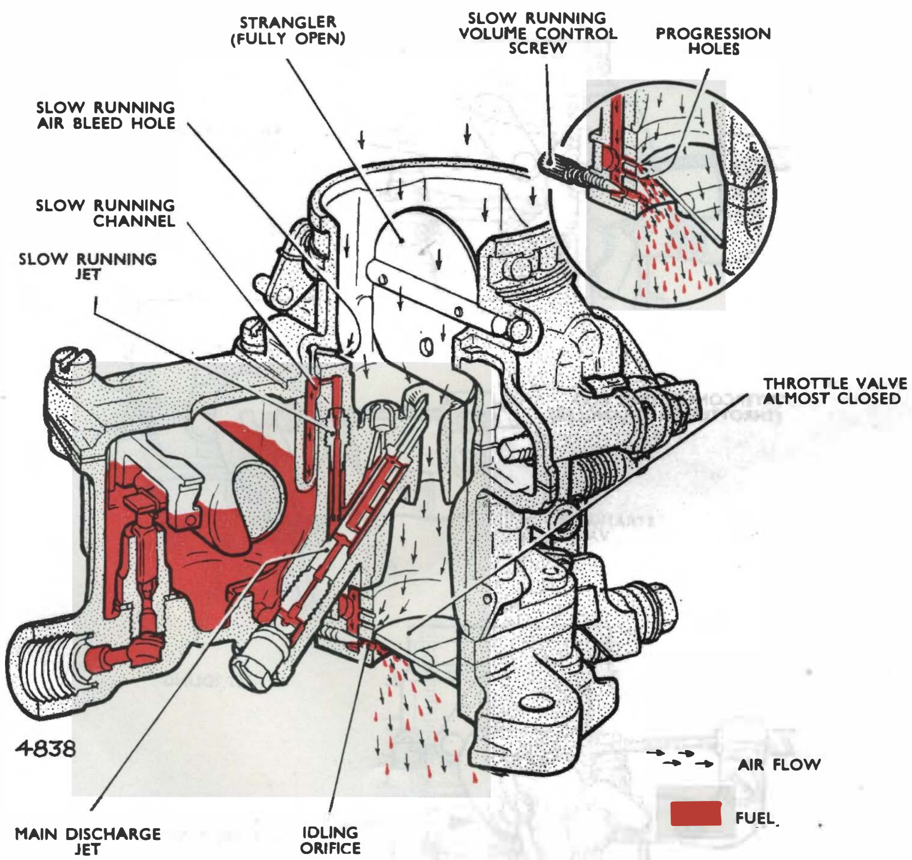


Fig. 9. *Idling operation conditions*

with. Fig. 9 illustrates carburettor action under idling conditions, and the inset, the progression holes which operate on fast idling.

Part and full throttle operation (See Fig. 10)

As the throttle is opened beyond the slow running position, the main carburettor comes into action and suction at the small venturi draws fuel from the main discharge jet.

When the fuel level falls in the main discharge jet a series of holes which are in communication with the atmosphere through the high speed bleed are uncovered. The fuel issuing from the main jet is consequently partly atomised by air entering these holes and is completely broken up when entering the small venturi. It then passes through the large venturi to the induction system.

On the WIP carburettor the discharge characteristic of the main discharge jet is such that a correct mixture is given over the light throttle to full throttle range.

On the WIA carburettor part throttle operation is similar to the WIP carburettor, but at wider throttle openings fuel is supplied by a by-pass jet as well as by the metering jet, as described in the following paragraphs.

Some carburettors are fitted with an accelerator pump nozzle with a sloping end as shown in inset 'A' of Fig. 13. This type of nozzle allows fuel to be drawn from it when the air velocity, past its sloping end, is high enough to create the depression required

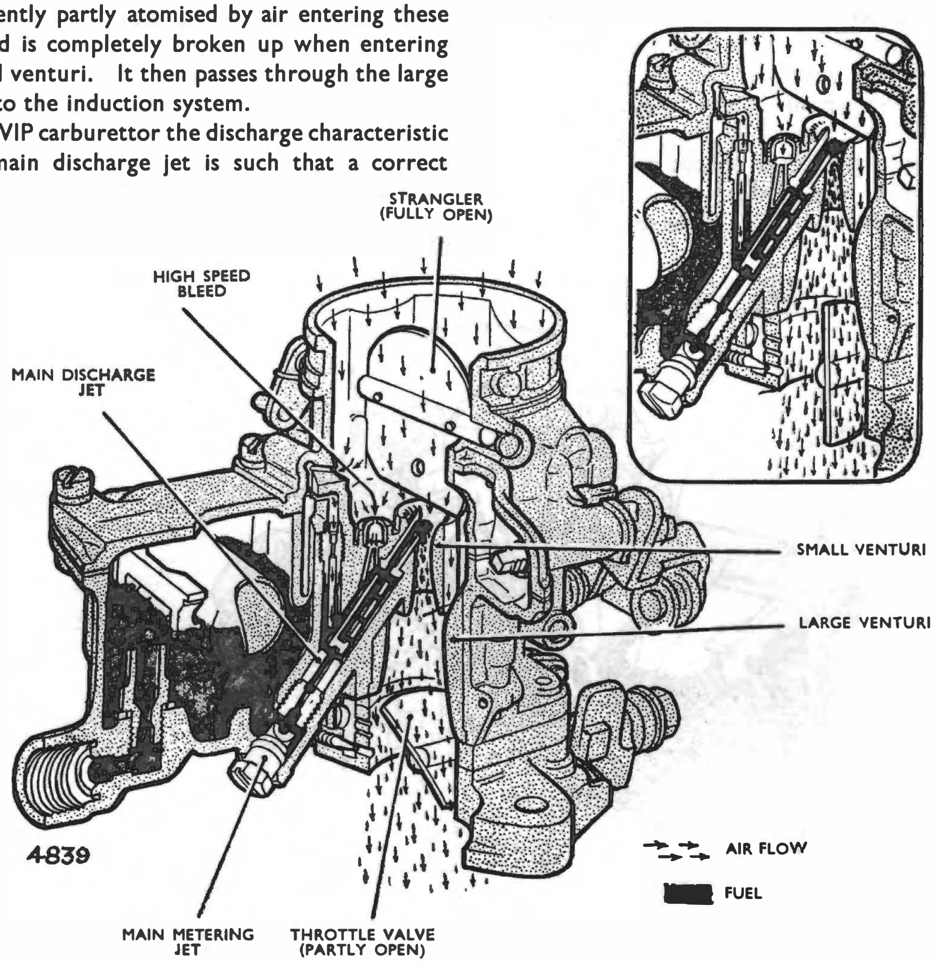


Fig. 10. *Part throttle (cruising) operating condition.*
Full throttle operating condition shown in inset above

to cause a fuel discharge. This fuel supplements that already metered by the main jet, and by-pass jet on WIA carburettors. It is metered by a drilling in the nozzle and is only supplied to the air stream under wide throttle driving conditions.

The by-pass jet (See Figs. 11 and 12)
WIA Carburettors only
In this carburettor the main jet supplies the correct amount of fuel necessary for normal cruising speeds at part throttle. For maximum power at all speeds more fuel is required than that provided by the main metering jet. This extra fuel is metered through a by-pass jet which can only pass fuel when the by-pass valve is open.

The opening and closing of the by-pass valve is controlled by the action of the by-pass valve operating diaphragm which is situated below the bottom of a cover held by three screws to the top part of the carburettor. This cover forms an air-tight compartment that is connected by a passage-way to the engine side of the throttle valve (see Figs. 6 and 12).

At all light running and at cruising speed the inlet manifold depression is high and suction lifts the diaphragm and its plunger extension against its return spring and the by-pass valve remains closed.

At about three-quarters throttle opening the engine suction in the inlet manifold becomes insufficient to hold the diaphragm and its plunger up against its return spring pressure. The spring then pushes the diaphragm and plunger downwards, overcoming the pressure of the weaker by-pass valve spring and forcing the by-pass valve off its seat. This allows extra fuel to pass through the by-pass jet and into the main discharge jet to supplement the supply given by the metering jet. The rating (strength) of the diaphragm return spring is very carefully chosen and the spring must not be altered in any way.

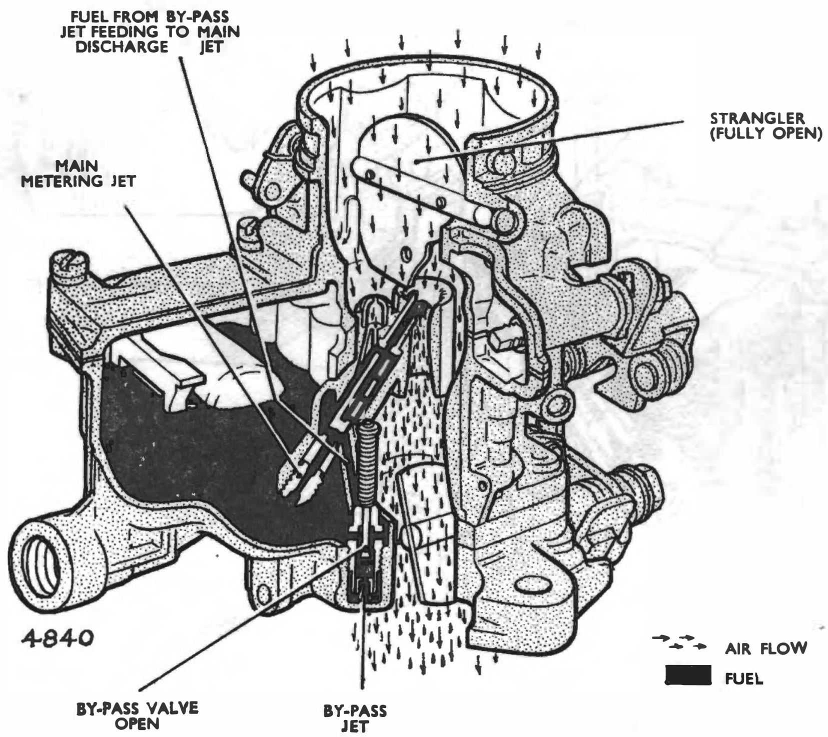


Fig. 11. *By-pass jet in operation—WIA carburettors only*

At about three-quarters throttle opening the engine suction in the inlet manifold becomes insufficient to hold the diaphragm and its plunger up against its return spring pressure. The spring then pushes the diaphragm and plunger downwards, overcoming the pressure of the weaker by-pass valve spring and forcing the by-pass valve off its seat. This allows extra fuel to pass through the by-pass jet and into the main discharge jet to supplement the supply given by the metering jet. The rating (strength) of the diaphragm return spring is very carefully chosen and the spring must not be altered in any way.

The accelerator pump (See Figs. 12 and 13)

To ensure immediate acceleration when the throttle is suddenly opened, a controlled and metered supply of fuel is required. This is provided by the accelerator pump, the object of which is to overcome any tendency for a lag in acceleration when the carburettor is adjusted to give a low consumption at normal road speeds. It is directly connected to the throttle spindle by suitable linkage, so that every time the throttle is snapped open a small quantity of metered fuel is injected into the air stream.

When the pump piston is at the top of its stroke,

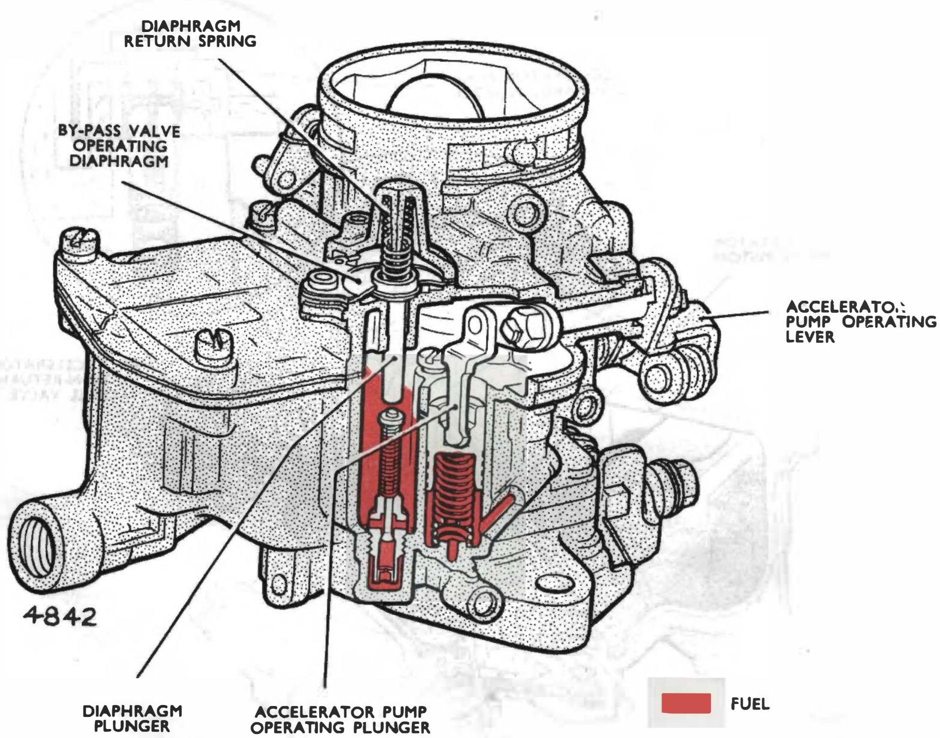


Fig. 12. *By-pass valve and accelerator pump operating mechanism*

the cylinder is charged with petrol admitted from the floatchamber through the non-return valve. The piston is spring-loaded, and is retained in its cylinder by a shouldered screw. When the throttle is opened, the piston is forced down by the pump linkage, discharging a stream of petrol via an internal passage through the non-return pump discharge ball valve and pump discharge nozzle into the air stream.

The pump discharge nozzle consists of a small die casting shown in section in the inset of Fig. 13. Fuel is fed into the nozzle centre and discharged under the pressure exerted by the fuel pump through a small calibrated hole into a space in the nozzle. This space is in communication with the float chamber air vent hole leading to the outside of the carburettor. From this space the fuel enters the main air stream by a larger hole in an emulsified state.

If the pump discharge ball valve is not seating properly, this arrangement assists in preventing a continuous fuel discharge from the nozzle by relieving it of the depression in the area of the venturi.

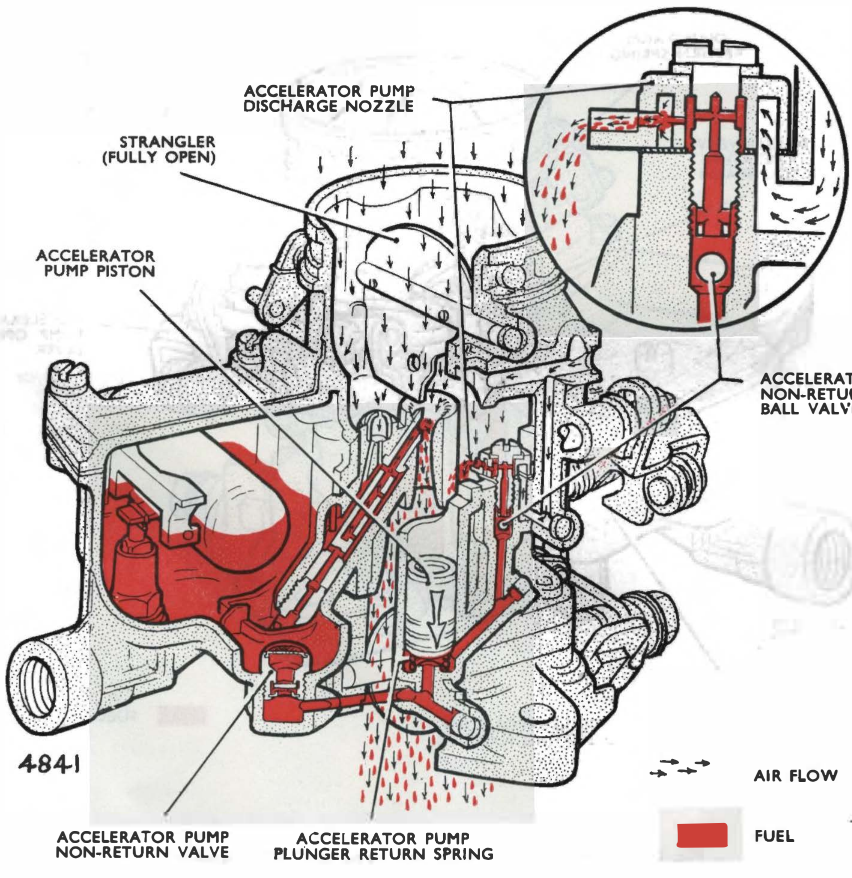


Fig. 13. *Accelerator pump operating*

The accelerator pump stroke takes place over the throttle opening range shown in illustrations A and B.

Over the latter part of the throttle opening shown in B and C, no accelerator pump action takes place.

Movement of the accelerator pump operating arm into the hole 'L', shown in the inset, increases the accelerator pump stroke.

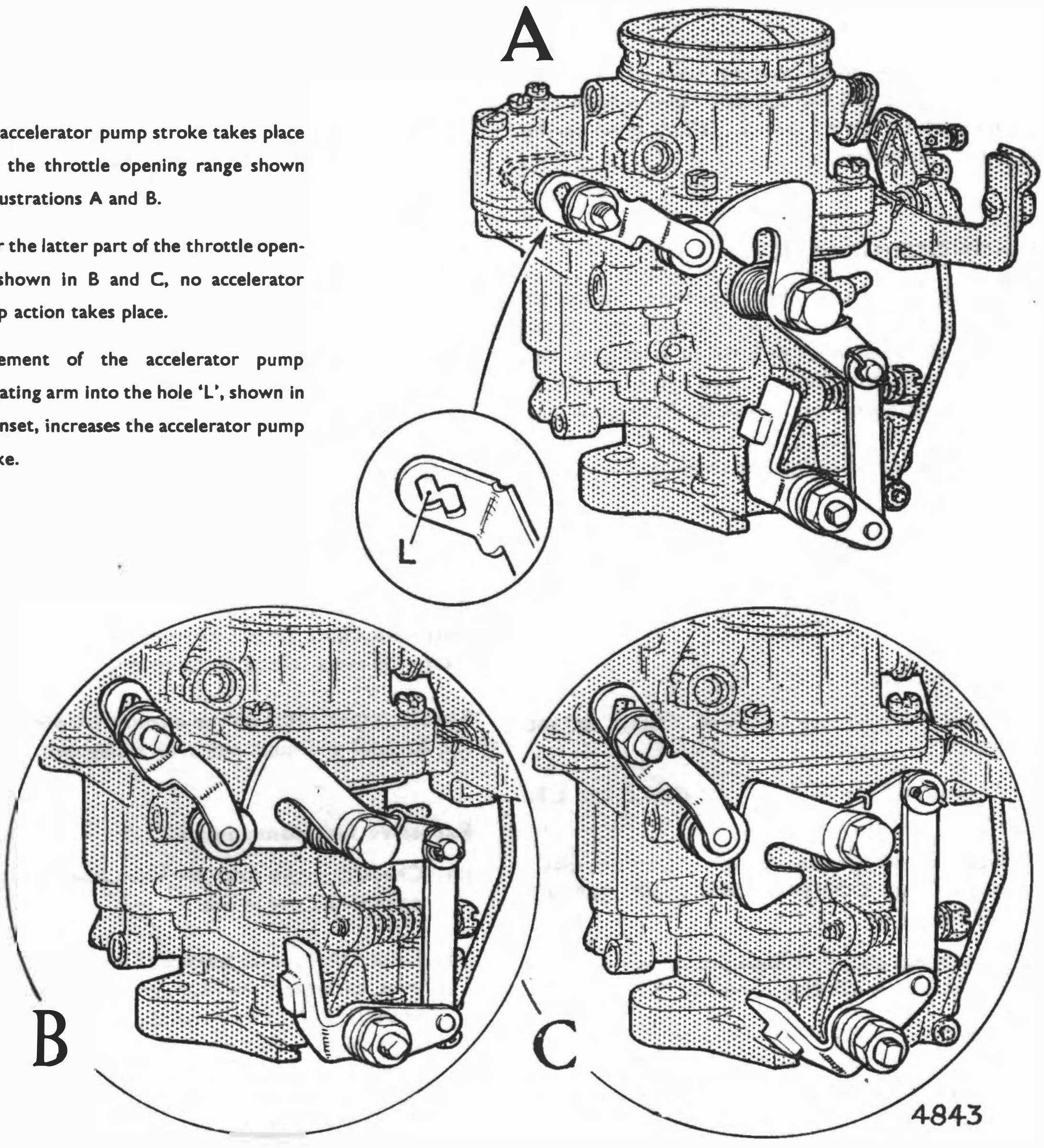


Fig. 14. *Accelerator pump operating linkage*

Provision is made for varying the pump travel, and long or short strokes may be arranged. These positions are shown and explained in Fig. 14.

Fig. 13 shows the accelerator pump in action. When this occurs the pump suction valve in the float chamber closes and the delivery valve, a steel ball, is lifted off its seat as shown. There is no spring above the steel ball.

DIAGNOSIS OF FAULTS

Since the function of the carburettor is closely connected with other items of engine operation, troubles are sometimes difficult to trace and the carburettor is often blamed when it is not at fault. When performance has previously been good any troubles can be quickly located by following an orderly system of investigation covering the various items.

Unless known to be in perfect condition, the following items should be checked before making carburettor adjustments.

Ignition system

1. Check sparking plug condition. Clean and set gaps.
2. Check condition and tightness of H.T. and L.T. leads.
3. Check condition and setting of contact breaker points and CONTACT BREAKER SPRING TENSION.
4. Ensure that the centrifugal and vacuum advance mechanism is working correctly.
5. Check ignition timing. Only small variations from the correct static timing are permissible.

Fuel system

6. Ensure that an adequate fuel supply is being delivered to float chamber.
2. Examine induction manifold and carburettor flange for air leaks.
3. Ensure that air cleaner (or silencer) is fitted correctly and not restricting air supply to carburettor. Servicing particulars are given at the end of this section.
4. Check that fuel pump output pressure is correct to the figures given in General Data section of this manual.

Compression

1. Check valve clearances and compressions.
2. Make sure valves are not sticking.

Exhaust system

1. Check that exhaust pipe has not become damaged or blocked.

If the carburettor has been proved faulty a systematic check should be carried out in order to locate the exact source of the trouble.

Random adjustments on the carburettor are useless and harmful and must never be attempted.

Excessive fuel consumption

(*a*) Check that the strangler valve (choke) is fully open when not in use.

(*b*) Ensure there is no leakage of petrol at the fuel inlet, or where the main jet is screwed in the underside of the float chamber. The latter has a synthetic rubber ring to provide the seal and in good condition this ring is effective. In fitting a new ring to the main jet and plug, roll the ring from the threaded end of the jet to ensure it is not damaged in the fitting, and see that it is seating in the recess machined in the body of the plug portion of the jet.

(*c*) Check that main metering jet is as specified and that it is properly tightened.

(*d*) On WIA carburettors check that by-pass valve is not sticking or leaking. If this occurs too much fuel will be fed to the main discharge jet under part throttle conditions. The valve assembly must be removed and any foreign matter removed by blowing through the valve orifice.

(*e*) Check that the gaskets between the carburettor bodies and both sides of the by-pass valve operating diaphragm on WIA carburettors are not allowing air leakage. The condition of the diaphragm should also be checked.

If air leaks exist the diaphragm return spring can open the by-pass valve too early which will allow too much fuel to be supplied under cruising (part throttle) conditions.

(*f*) Check that the ball beneath the screw securing the pump discharge nozzle is in position. See Fig. 13. It can easily be lost in dismantling the carburettor if the body is inverted after removal of the screw securing the pump discharge nozzle, or if the accelerator pump is operated with the screw removed.

If the carburettor has been assembled without this ball or if there is dirt under the ball or the ball seating faulty, the manifold depression may at certain speeds draw fuel from the pump nozzle. This will, of course, increase the fuel consumption.

With the air intake elbow removed it is possible to see the pump discharge nozzle and if the engine is run at a high speed no fuel should come from the nozzle after completion of the accelerator pump stroke.

(*g*) Check that the fuel level in the float chamber is correct.

Insufficient top speed

(*a*) See that throttle valve is opening fully over the range provided by the particular carburettor stop plate arrangement.

(*b*) Check the fuel supply to the float chamber. Fuel pump output pressure should be checked. A condition can arise when, due to worn fuel pump linkage or improperly fitted pump, the pump output is too low under full throttle conditions.

(*c*) On WIA carburettors see that the by-pass jet is clear and of the specified size. To do this the by-pass valve must be removed from the float chamber, but no attempt must be made to remove the jet orifice cup from the valve body. The jet number is stamped on the hexagon of the body.

Bad slow running

(*a*) Check the synchronisation of the throttles and reset the slow running volume control screws as described later in this section under ADJUSTMENTS. If slow running cannot be correctly set check each carburettor for the following possible causes.

(*b*) Check that the idle jet is clear.

(*c*) Blow through the slow running system passages with clean compressed air.

(*d*) Ensure that the joint fitted between the top part of the carburettor and the float chamber is correctly fitted. Air must not leak into the slow running system passageways.

(*e*) Make certain that the screws securing the throttle barrel to the main body of the carburettor are tight, and that the hole is clear which carries the mixture through the main body, heat insulator, and throttle body. A little jointing compound should be used between insulator faces and body faces.

(*f*) Remove the slow running volume control screw and see that its tapered end is in good condition. If worn, it should be changed. The spring under the screw head must be long enough to prevent the screw from vibrating from its set position.

(*g*) Check that the throttle spindle is not badly worn. Wear at this point allows an excessive amount of air to enter the carburettor under slow running conditions.

Poor performance at small throttle opening

(*a*) Adjust the idling speed to give smooth running, just off rich or "hunting" condition at 600 r.p.m. With twin carburettors a flat spot or deadness at low speeds is generally caused by the carburettors not being properly synchronised.

(*b*) If the flat spot is still evident, check that the idle and progression holes are clear.

(*c*) Check that the idle jet is clear.

(*d*) Check float chamber fuel levels.

Poor acceleration

(*a*) Make certain the calibrated orifice in the pump discharge nozzle and the drillings in the screw securing the nozzle through which the petrol must pass on its way to the pump nozzle are clear. See inset Fig. 13.

(*b*) Check that the pump piston works freely and is not stuck down. Provided the pump cylinder is clean, the spring beneath the piston will ensure the return of the piston.

(*c*) See that the non-return (suction) valve to the pump cylinder is clean and will close effectively, and that the assembly is screwed tightly into the base of the float chamber.

(*d*) Two settings are available for the pump stroke by using one of the two holes in the pump outside operating lever. The lever is normally set in the hole which gives a short pump stroke. The hole 'L' is used to give a long pump stroke, See Fig. 14. This hole provides the means required to vary the quantity of fuel delivered by the accelerator pump. If the pump link is in the short position, try the linkage in the hole giving maximum length of piston travel.

(*e*) *WIA Carburettors only*

Remove the by-pass diaphragm cover and check that the stem on the insert fitted in the centre of the diaphragm will move freely. On snap opening of the throttle, the lower depression in the manifold will permit the spring above the diaphragm to force this stem down and open the by-pass valve to provide additional fuel apart from that coming from the metering jet and from the pump nozzle. Therefore, any obstruction in the by-pass jet or incorrect operation of the by-pass valve will affect acceleration.

(*f*) Flat spots or hesitation on slow progressive throttle opening can be caused by incorrect adjustment of the slow-running mixture or by the progression hole or holes in the throttle barrel being partially obstructed.

Difficult starting from cold

Ensure there is petrol in the float chamber, and that it is replenished by fresh petrol from the fuel pump within a few seconds of rotating the engine by the starter. A clip fixing the needle to the float arm ensures that the needle is lifted from the seating, eliminating any question of the needle sticking in the closed position, due to formation of gummy deposit from petrol or additives.

See that both strangler flaps in the air intakes close completely when the choke (strangler) control is operated. From examination of the strangler control on the carburettor it will be seen that there is no mechanical connection between the choke cable and the spindle on which the strangler flap is fitted. Movement of a cam lever on the side of the air intake permits the spring loading of the strangler spindle arm to close the flap in the air intake. Therfore, undue friction by reason of bent strangler spindle, binding bearings or a broken spring could explain non-closure of the flap in the intake. Removal of the air cleaner connection will enable this to be checked, or alternatively the strangler valve movement can be checked by pulling the choke control fully out and operating the strangler spindle lever by hand. The correct position for the strangler spindle lever, when the choke is pulled fully out, is shown in Fig. 8.

Check that the throttle opens when the strangler valve is fully closed. This amount of throttle opening is very important and must agree with the measurement given in the Data Section under Carburettor, Fast idle. The correct method of making this adjustment is given under ADJUSTMENTS.

The choke control should not move back after being pulled out. When correctly fitted the choke control should hold the strangler valves closed when it is pulled fully out, and released. It should also enable a fast idle speed to be held when moved out a short distance and released. If the choke control cable is too free in operation, so that it falls or creeps back when released, it can be stiffened up by slightly bending the inner cable to give more internal stiffness.

Difficult starting when hot

This is caused by a rich mixture produced by flooding of the carburettor or incorrect use of the strangler. Any fuel that runs into the inlet manifold should drain away through the inlet manifold drain pipe and a check should be made to see that this pipe and its ball valve end are clear.

Provided the carburettor is not constantly flooding, the engine can usually be started after gently opening the throttle to its fully open position and rotating the engine on the starter with the ignition switched on.

ADJUSTMENTS

The only adjustments that may need attention in service are:—

(*a*) Synchronisation of throttles and slow running adjustment.

(*b*) Throttle, fast idling for starting.

(*c*) Accelerator pump stroke.

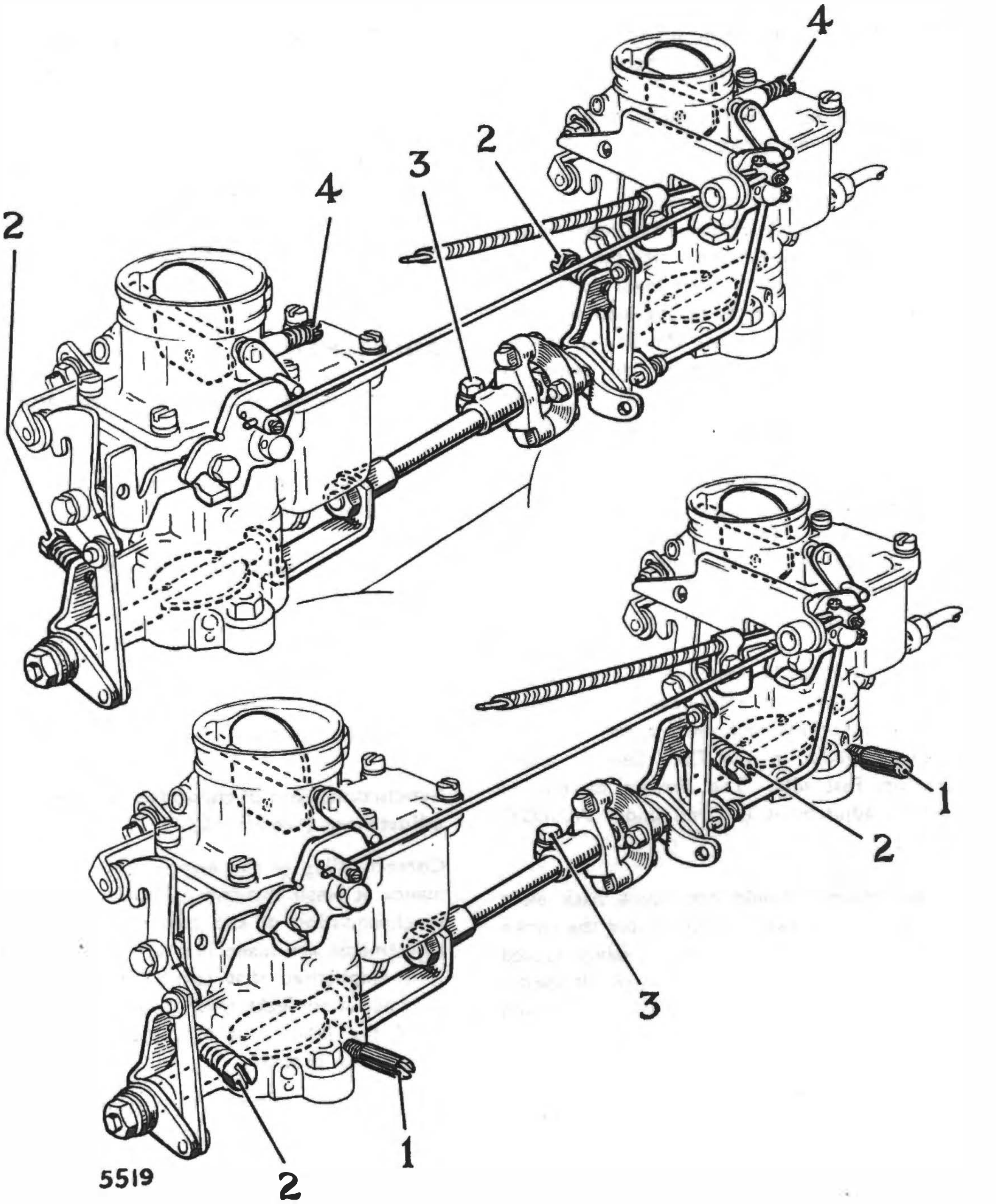
(*d*) Fuel level.

(*e*) Choke control.

Synchronisation of throttles and slow running adjustment (See Fig. 15)

Correct idling of the engine, and proper performance at small throttle openings are ensured by synchronisation of the two carburettors. These adjustments are made in the following order but it is emphasised that correct adjustment cannot be made if air leaks exist in the induction system or if the ignition is incorrectly timed, or not functioning properly.

1. Loosen the clamp bolt (3) to allow independent movement of each throttle.
2. Unscrew throttle stop screws (2) until both throttles are in the fully closed condition, and the screw ends clear of their abutments.
3. Holding the throttles in the shut position tighten the coupling clamp bolt (3).



1. Volume control screw. *(not fiitted if item 4 is used)*
2. Slow running speed adjustment screw.
3. Coupling yoke clamp bolt.
4. Slow running air adjustment screw. *(not fitted if item 1 is used)*

Fig. 15. *Synchronisation of throttles and slow running adjustment*

4. Screw in front carburettor throttle stop screw (2) until it just touches its abutment as the throttles are held closed; then screw in a further $1\frac{1}{2}$ turns in a clockwise direction.

5. Screw in the volume control screw (1) or the slow running air control screws (4) by hand. A screwdriver must not be used as it would damage the screw seatings. Screw back screw (1) three-quarters of a turn or screw (4) one and a quarter turns in an anti-clockwise direction.

6. With the engine warmed up to its normal operating temperature adjust the control screws (1) or (4) on the front carburettor to give the smoothest possible idling. Then adjust the rear carburettor in a similar manner. Re-adjust front carburettor if necessary. Rotation of screw (1) in a clockwise direction weakens, and anti-clockwise rotation enrichens the slow running mixture. Rotation for the screw (4) is exactly opposite.

7. If idling speed is now incorrect, increase or decrease speed as required by adjustment of the front throttle stop screw (2). This correction of idling speed may require slight re-adjustment of the screws (1) or (4).

   Idling speed must always be adjusted by the throttle stop screw (2) and idling mixture by the screws (1) or (4).

8. The correct slow running speed for a HOT engine is 750 to 850 r.p.m. with the slow running mixture set just off of the rich ("hunting") condition.

   When the slow running is correct, adjust the rear carburettor slow running throttle stop screw (2) until it just touches its abutment. This must be very carefully carried out. The screw must actually touch the abutment but not so hard as to increase the slow running speed.

   A final check of the slow running should be made after replacing the air cleaners.

9. After the slow running is correct a check must be made to ensure that under full throttle conditions the rear carburettor does not reach its full throttle stop, before the front carburettor. If this occurs undue strain will be placed on the throttle coupling which can upset throttle synchronisation. The full throttle stops on the rear carburettor can be filed if necessary.

10. If "hesitancy" occurs when accelerating under traffic driving conditions, it is an indication that the carburettors are not properly synchronised. Synchronisation can be checked by holding a suitable length of carboard tubing over each carburettor intake, after removing the air cleaners and listening for the "progression hiss" as the engine speed is increased from idling to about 1,000 r.p.m. Both carburettors should make the same sound which is quite distinct to hear.

    If necessary the clamping bolt (3) can be loosened off and the throttles adjusted to obtain this condition.

    After retightening the clamping bolt (3) it is important to ensure that both throttle screws (2) come against their abutment when the engine is idling.

11. A very useful and inexpensive gauge known as the "Synchro-Test" can be used to balance the carburettors. This gauge saves a lot of time and may be obtained under reference number B.91 from:—

    Crypton Equipment Limited,
    Bridgwater, Somerset, England.

    Full operating instructions are supplied with each gauge.

Throttle, fast idle for starting (See Fig. 16)

This adjustment ensures that the throttle is open to the best position for cold starting when the strangler is fully closed and can only be made with carburettor removed from the engine.

To make this adjustment slacken the set screw on the fast idle rod connection on the strangler-

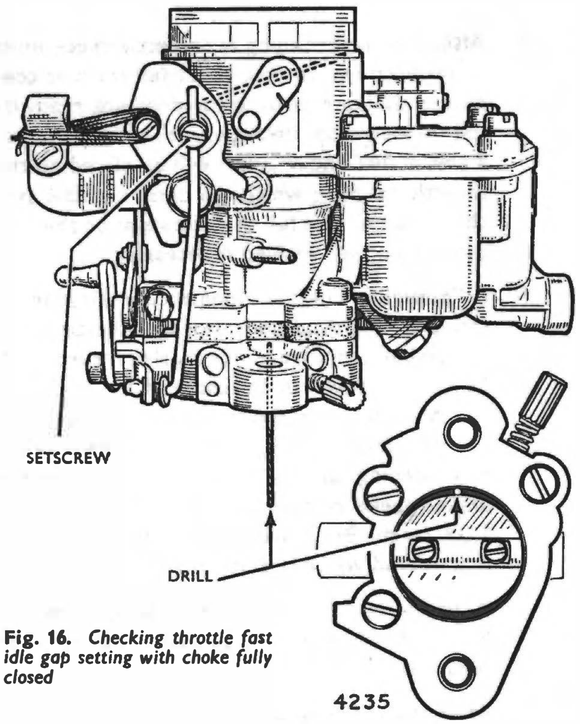


Fig. 16. *Checking throttle fast idle gap setting with choke fully closed*

operating cam. Tie this cam in its full over starting position. Insert a No. 70 drill shank, or a wire ·028 ins. (0·7mm) dia, between the throttle and the carburettor body in line with carburettor fixing bolt holes as shown in Fig. 16 inset. Tighten the adjustment set screw.

Release strangler-operating cam.

Again pull strangler cam to its full over position and check that throttle valve is open to the drill diameter dimension.

Accelerator pump stroke (See Fig. 14)

Two holes are provided at the fulcrum shaft end of the outside cranked operating arm of the accelerator pump. This arm is normally fitted with the fulcrum shaft in the nearest hole to the arm crank. In this position the short pump stroke is given. The long pump stroke is obtained by fitting the fulcrum shaft in the hole 'L', farthest from the arm crank. See Fig. 14.

Fuel level

This adjustment is rarely needed. The correct fuel level is 19 mm. below the float chamber top face when the carburettors are supplied with a head of fuel giving a similar pressure to that of the correct fuel pump output pressure.

The fuel levels must be similar and can be checked with both carburettors in position in the following manner:—

1. Disconnect the fuel pump delivery pipe and connect a reliable pressure gauge or mercury manometer to this point.
2. Fit up a small tank of fuel (a quart oil tin) to feed fuel to both carburettors through a rubber tube. This tube should be connected to the fuel pipe at the end previously removed from the fuel pump delivery union.
3. Run the engine at a fast idle speed on the fuel in the small tank and note the fuel pump output pressure. This should be 1½-2½ P.S.I. (·11-·18 kg. sq. cm.) and if the pump output is outside these limits it should be corrected by adding or removing packings between the fuel pump and cylinder block.
4. Remove both carburettor tops and hold float fulcrum blocks in position by means of two carburettor top cover screws and washers.
5. Support the fuel tank at a height above the carburettor float chamber top face that will give the same pressure as that obtained when the fuel pump pressure was checked.

   The approximate heights for the following pressures are:—

1½ P.S.I.	(·11 kg. sq. cm.)	5 feet (1·5 metres)
2 ,,	(·14 ,,)	6½ ,, (1·9 ,,)
2½ ,,	(·18 ,,)	8 ,, (2·4 ,,)

   A tank height of 6½ ft. ABOVE THE CARBURETTOR FLOAT CHAMBER TOP EDGE is usually sufficiently accurate as a slight difference in fuel pressure only makes a small alteration of fuel level.
6. Remove fuel from both carburettor float chambers and turn on fuel from tank. The fuel should then come to the correct level from the float chamber top edge.

   Alteration to the fuel level, if required, is made by adding or taking aluminium washers from under the float valve seat.

Choke control—To adjust (See Fig. 15)

1. Slacken the two set screws holding the choke operating cable and the choke interconnecting rod to the spindle (1) shown in Fig. 15.

2. Close choke valves and tighten the set screw to secure the connecting rod in the spindle of the front carburettor strangler cam. Also check the tightness of set screw securing the connecting rod at its rear end. Recheck that both choke valves close TOGETHER when the connecting rod is moved as far back as possible.

3. Check that choke control outer cable is properly clamped at its fixing point on the front carburettor.

4. Pull choke control knob out about $\frac{1}{8}$" (3 mm.) and tighten the inner cable by its securing set screw in the spindle (1), Fig. 15, on the front carburettor. This will ensure that the choke control cams will be pushed back against their stops when the choke control is pushed in.

5. Pull choke control out and check that both choke valves are fully closed and remain closed when the control knob is released. If there is insufficient internal friction in the control cable to keep the choke from moving when the choke control knob is released at the full out position, the internal cable should be removed and bent so as to give more stiffness in operation.

DISMANTLING FOR CLEANING

(See Figs. 17 and 18)

Before a carburettor is dismantled it should be thoroughly cleaned externally.

1. Remove split pin, washer and pin from connecting link at its connection on the accelerator pump operating cam.

2. Remove six cheese-headed screws holding top of carburettor to carburettor body.

3. Lift out float. The float needle is attached to the float by a clip.

4. Remove four cheese-headed screws holding throttle body to carburettor body, and lift out venturi after removing its locating screw.

5. Remove metering jet, which also holds the main discharge jet in position. This jet is a push fit into the carburettor body and may be extracted by pulling on a suitable taper tap screwed into the exposed uncalibrated end of the jet. Sometimes these jets are a loose fit and fall out the exposed uncalibrated end of the jet. Some-after removing the metering jet. Great care is needed to ensure that they are replaced as illustrated in Fig. 10. It is not necessary to remove the main discharge jet when cleaning the carburettor as it can be blown through with compressed air.

6. Remove slow running jet.

7. Remove accelerator pump suction (intake) valve. This has a fine gauze cover.

8. On WIA carburettors remove by-pass valve. The by-pass jet is fitted into the bottom of the by-pass valve body and the jet itself must not be removed.

9. Remove shouldered cheese-headed screw keeping the accelerator pump piston in its cylinder barrel which is bored in the carburettor body. Lift out brass piston and its return spring. There is no valve at the bottom of the pump cylinder.

10. Keeping the carburettor in a vertical position remove the cheese-headed screw securing the accelerator pump discharge nozzle. Remove nozzle and its paper joint and note that a small steel ball without spring is fitted below the nozzle-securing screw. This ball is the accelerator pump delivery valve. Turn the carburettor upside down over a small box to catch the small steel ball.

11. On WIA carburettors remove three screws securing the economy device cover and the diaphragm with its plunger and spring.

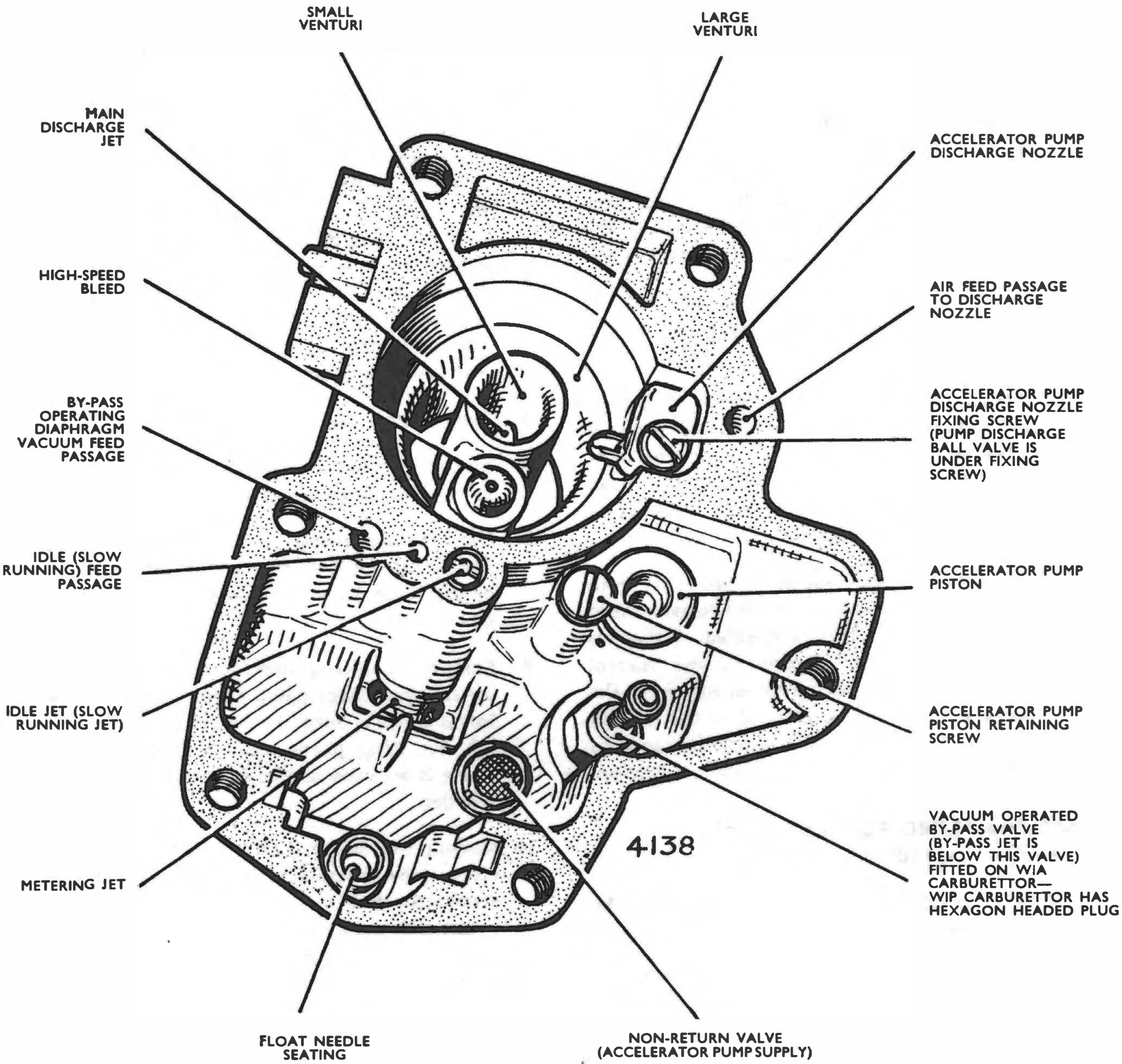


Fig. 17. *Parts visible with top of carburettor removed*

The carburettor is now dismantled sufficiently for cleaning. There is no need to remove the high speed bleed and this cannot be done without damaging it.

INSPECTION AND CLEANING

A list of jet sizes and other specifications for the carburettor is given in the "Data" section at the beginning of this manual.

Check that all jets and orifices are clean and undamaged. When cleaning do not pass a wire or any similar hard material through the jet orifice. These orifices are carefully calibrated and the slightest alterations of size will affect the flow through them.

If a change of jet size is necessary, obtain a new jet from the makers. Do not attempt to ream or otherwise tamper with the old one.

Inspect all valve seats and ensure that they are perfectly clean and free from foreign matter. All parts should be washed with clean fuel and all passage-ways in the carburettor bodies should be blown through with **CLEAN** compressed air. An exploded view of the carburettor is shown in Fig. 18 and the names of the various parts given on the adjoining page.

Reassembly

This is of course a reversal of the dismantling procedure. Close attention should be given to the following points:—

1. The top cover gasket should be renewed to ensure that no air leaks into the slow running passage-ways.
2. Joints on each side of the by-pass valve operating diaphragm should also be renewed.
3. On WIA carburettors, diaphragm spring must seat squarely in the metal cup on the top of the diaphragm when replacing the cover.
4. The small gasket below the accelerator pump discharge nozzle should be renewed.
5. The synthetic rubber ring fitted in the groove around the metering jet just above its hexagon head, must be in good condition.
6. The accelerator pump delivery valve ball must be replaced before inserting the discharge nozzle screw.

   THIS BALL MUST NOT BE TAPPED ON OT ITS SEATING.

   If this is done, it may jam into the hole immediately below its seating.
7. A little jointing compound should be used on the heat insulator faces when refitting the throttle body to the main carburettor body.

AIR INTAKE SILENCERS—Alpine

The removable air intakes can become partly blocked with dust which may eventually restrict the air flow enough to reduce top end performance or increase fuel consumption.

These gauzes should be occasionally removed and cleaned by washing in paraffin (kerosene). After cleaning they should be blown dry with compressed air, or alternatively allowed to drain dry.

OIL BATH AIR CLEANER AND SILENCER—Rapier

The intervals at which the oil bath air cleaner needs to be serviced will vary according to the conditions under which the car is operating.

For town work or areas where the roads are relatively dust free, every 3,000 miles (4,800 km.) can be taken as a guide, although in territories where the roads are bad and dust is prevalent, servicing should be carried out more frequently.

To clean and re-oil Air Cleaner

1. Slacken clip on hose connecting top of air box to air cleaner.
2. Undo the thumb screw in centre of air cleaner and lift off cover. Remove oil bath container.

(Continued on page 32)

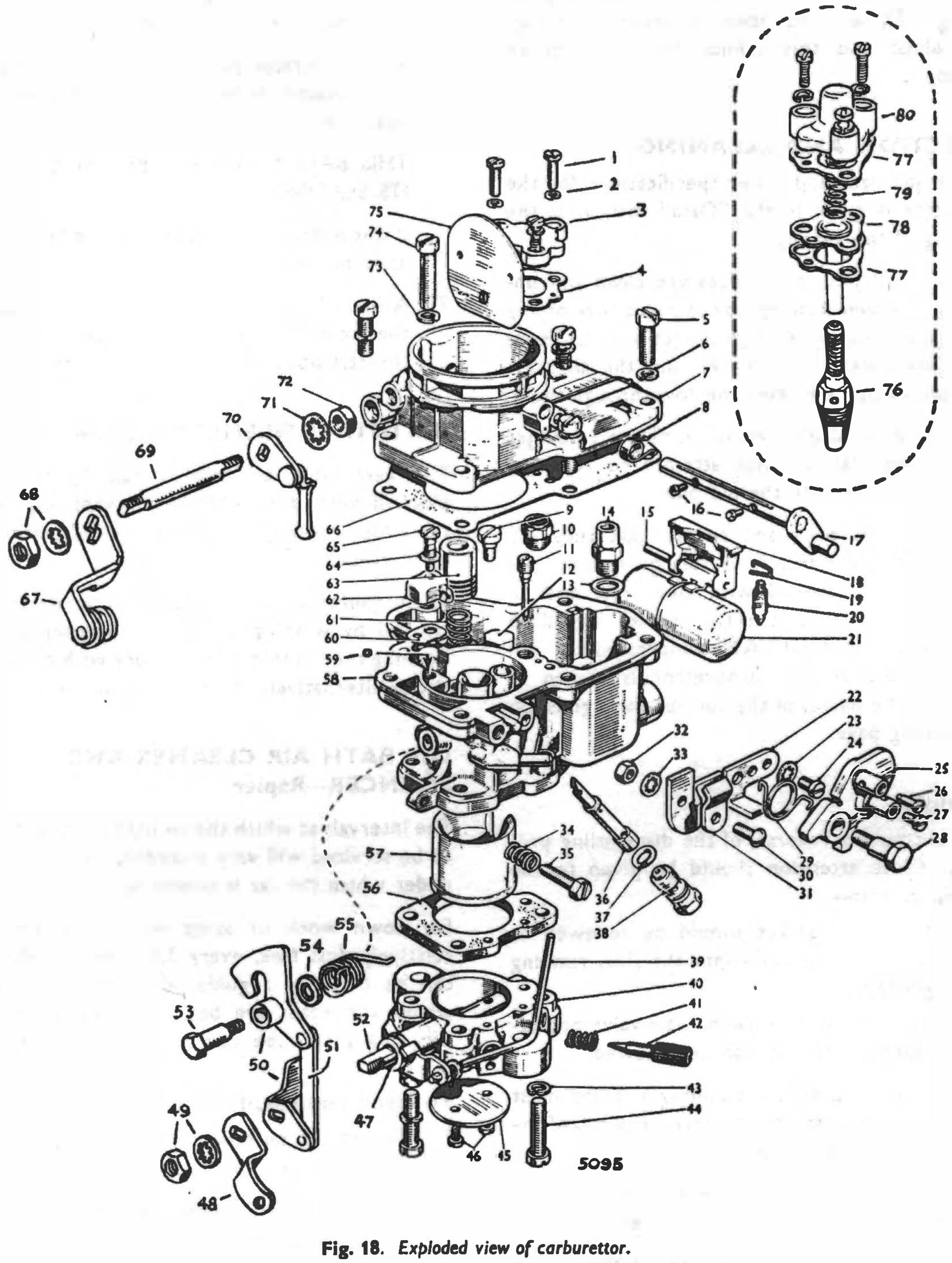


Fig. 18. *Exploded view of carburettor.*
Items 76 to 80, shown in inset, are only used on the WIA carburettor

CARBURETTOR PARTS—See Fig. 18.

1 Cover screw.
2 Spring washer.
3 Cover.
4 Cover joint.
5 Screw $\frac{1}{4}$" B.S.F. × $\frac{3}{4}$", cheese head.
6 Washer $\frac{1}{4}$" spring.
7 Float chamber cover.
8 Spring controlling automatic opening of choke.
9 Accelerator pump piston retaining screw.
10 Accelerator pump check valve.
11 Idle jet.
12 Blanking plug. (*WIP carburettor only*).
13 Joint (gasket)—needle valve seating.
14 Needle valve seating.
15 Float pivot.
16 Screw, special—butterfly to spindle.
17 Choke spindle complete with lever.
18 Float pivot bracket.
19 Clip—needle valve.
20 Needle valve.
21 Float.
22 Bracket assembly—control cable.
23 Washer $\frac{3}{16}$" shakeproof.
24 Screw No. 10 U.N.F. × $\frac{7}{16}$", fillet head.
25 Cam lever—choke control.
26 Screw securing choke control cable.
27 Screw, special—fast idle rod to swivel.
28 Screw—choke control lever swivel.
29 Spring—choke control lever.
30 Screw 2 B.A. × $\frac{1}{2}$", cheese head.
31 Clip.
32 Nut 2 B.A.
33 Washer $\frac{3}{16}$" shakeproof.
34 Slow running speed screw spring.
35 Slow running speed adjusting screw.
36 Main discharge jet.
37 Sealing ring—metering jet.
38 Metering jet.
39 Floating lever complete with rod.
40 Carburettor throttle body.
41 Slow running volume control screw spring.
42 Slow running volume control screw.
43 Washer $\frac{1}{4}$" spring } Throttle body to main body.
44 Screw $\frac{1}{4}$" B.S.F. × 1" cheese head } Throttle body to main body.
45 Throttle butterfly.
46 Screw—butterfly to spindle.
47 Bearing—floating lever.
48 Throttle lever. } Throttle spindle.
49 Nut and shakeproof washer. } Throttle spindle.
50 Stop plate complete with link and cam.
51 Link, attached to stop plate and cam.
52 Throttle spindle.
53 Shouldered bolt.
54 Washer.
55 Cam return spring.
56 Heat insulator—throttle body to main body.
57 Choke tube (Venturi).
58 Main body.
59 Accelerator pump discharge ball valve.
60 Accelerator pump discharge nozzle gasket.
61 Accelerator pump piston spring.
62 Accelerator pump discharge nozzle.
63 Accelerator pump piston.
64 Nozzle retaining screw gasket.
65 Accelerator pump discharge nozzle retaining screw.
66 Float chamber cover gasket.
67 Accelerator pump operating roller and lever.
68 Nut and shakeproof washer.
69 Accelerator pump operating spindle.
70 Accelerator pump internal operating lever complete with push rod.
71 Washer $\frac{5}{16}$" shakeproof.
72 Nut.
73 Washer $\frac{1}{4}$" spring.
74 Screw $\frac{1}{4}$" B.S.F. × $1\frac{1}{2}$", cheese head.
75 Choke butterfly.
76 By-pass valve and jet. } *WIA carburettor only.*
77 Diaphragm gaskets. } *WIA carburettor only.*
78 Diaphragm and plunger. } *WIA carburettor only.*
79 Diaphragm return spring } *WIA carburettor only.*
80 Diaphragm cover. } *WIA carburettor only.*

3. Swill the filter gauze (which is attached to the cover) in paraffin (kerosene) and blow dry with an air line or allow to drain thoroughly.
4. Clean out the oil bath and refill with clean engine oil up to the level mark.
5. Replace the oil bath container, refit the filter cover with gauze and tighten thumb screw.
6. Tighten the clip on the hose connection on the air box above the carburettors.

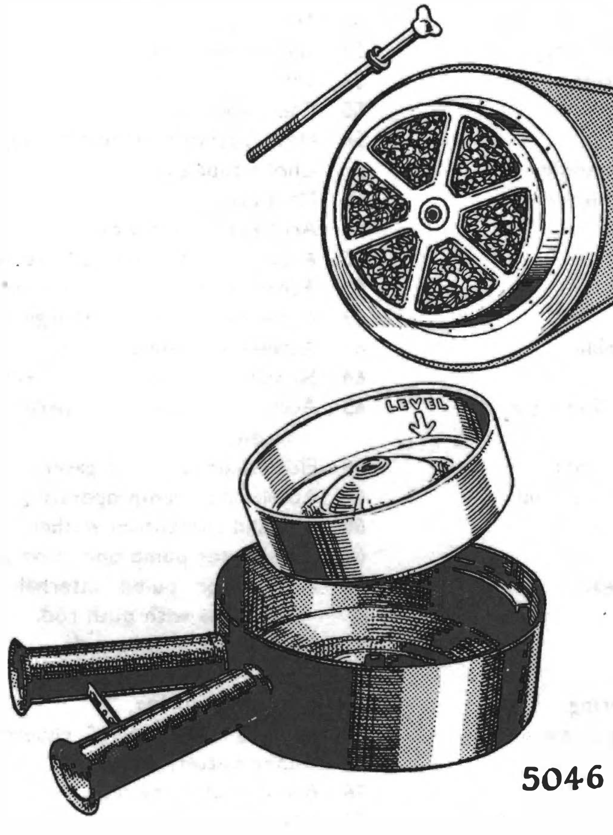


Fig. 19. *Oil bath air cleaner used on Rapier*

CLUTCH AND PROPELLER SHAFT

SECTION D

CONTENTS

CLUTCH UNIT

Description

Alpine Series I and Rapier Series III cars

An 8″ single dry plate A type clutch is fitted incorporating a copper impregnated graphite (MY3D) release bearing which is self-lubricating. No attention in the way of lubrication to the release bearing is necessary.

Alpine Series II, III and Rapier Series IIIA cars

An 8″ single dry plate A.S. (Strap drive) type clutch is fitted.

The essential difference between this type of clutch and the A type clutch lies in the method whereby torque is transmitted from the cover to the pressure plate. Instead of the normal arrangement, wherein lugs on the pressure plate pass through slots in the cover, three pairs of spring steel straps, attached at one end to the cover and at the other, to the pressure plate, are employed. The straps are arranged tangentially so that they can deflect during clutch operation without disturbing the concentricity of the assembly, so ensuring the maintenance of the initial accurate balance. This form of construction also eliminates any friction between cover and pressure plate, thereby reducing the operating effort.

Late Alpine III, and IV, and Rapier IV cars have a diaphragm type clutch. See index.

Hydraulic withdrawal mechanism is employed· consisting of a master cylinder directly connected to the pedal (Fig. 2), and a hydraulic fluid pipe running to the operating cylinder, which in turn is attached by a rod to the withdrawal lever.

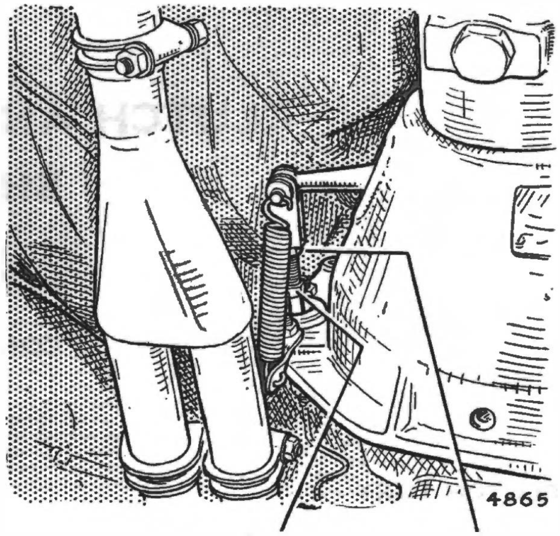
Provision for bleeding the system is made on the operating cylinder. (See item 40, Fig. 3.).

Adjustment

Alpine Series I and Rapier Series III Cars

The only external adjustment is to the operating piston rod attached to the clutch withdrawal lever. Adjustment between pedal and master cylinder is pre-set and is not provided for in service.

Adjustment, when necessary, should be effected by slackening the locknut at the back of the fork on the withdrawal lever outer end, and turning the



PISTON ROD HEXAGON LOCKNUT

Fig. I. *Pedal adjustment, (Adjustable clutches only)*

piston rod (Fig. 1). Free movement at the outer end of the withdrawal lever should be about $\frac{3}{32}$″ (2·4 mm.).

Alpine Series II, III and Rapier Series IIIA

There is no clearance at the clutch slave cylinder and the operating piston rod. No adjustment is necessary or provided for.

The pedal on Alpine Series II, III *and IV* cars has a two position adjustment (see inset Fig. 2). The position can be changed by securing the pedal (46) to the master cylinder push rod (58), with the clevis pin (73) in either of the two holes provided in the pedal.

MASTER CYLINDER

Description (*Alpine, Rapier III and IIIA onwards*)

This unit (Fig. 4) incorporates a fluid reservoir and a master cylinder. Directly in front of the main rubber cup (8), when the system is at rest, is a by-pass port (X) 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 (10), through the small holes in the piston, after each application. If this additional fluid is not released to the reservoir through the by-pass port, due either to the hole being covered by the main cup as a result of incorrect pedal adjustment, or to the holes 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 (9) is interposed between the two parts; it is important that this washer be assembled as shown on the illustration.

To remove (Fig. 2)

Disconnect the pressure pipe (75) from the cylinder barrel, and the clevis pin (73) from the clutch pedal. Remove the fixing bolts and detach the cylinder and push rod. Unscrew the filler cap and drain the fluid into a clean container.

Slightly compress the external return spring (56), and remove the retaining cap (57). Slide the spring off the piston rod.

To dismantle (Fig. 4)

Push the piston (10) down the bore of the cylinder and remove the circlip (13). Withdraw the piston, piston washer (9), rubber cup (8), retainer (7) and return spring (6). Using only the fingers to prevent damage, remove the secondary cup (11) by stretching it over the end of the piston.

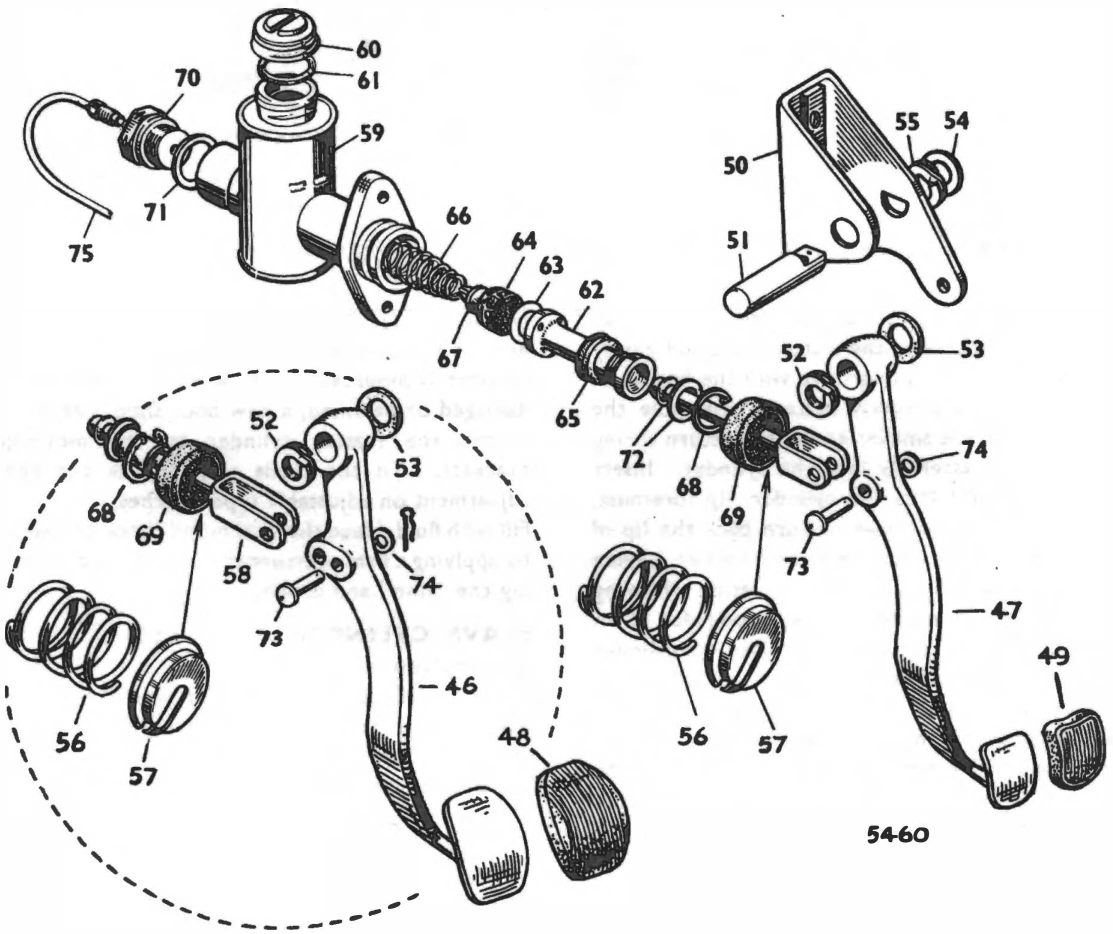


Fig. 2. Exploded view—Master cylinder and pedal linkages (Inset Alpine Series II and III cars)

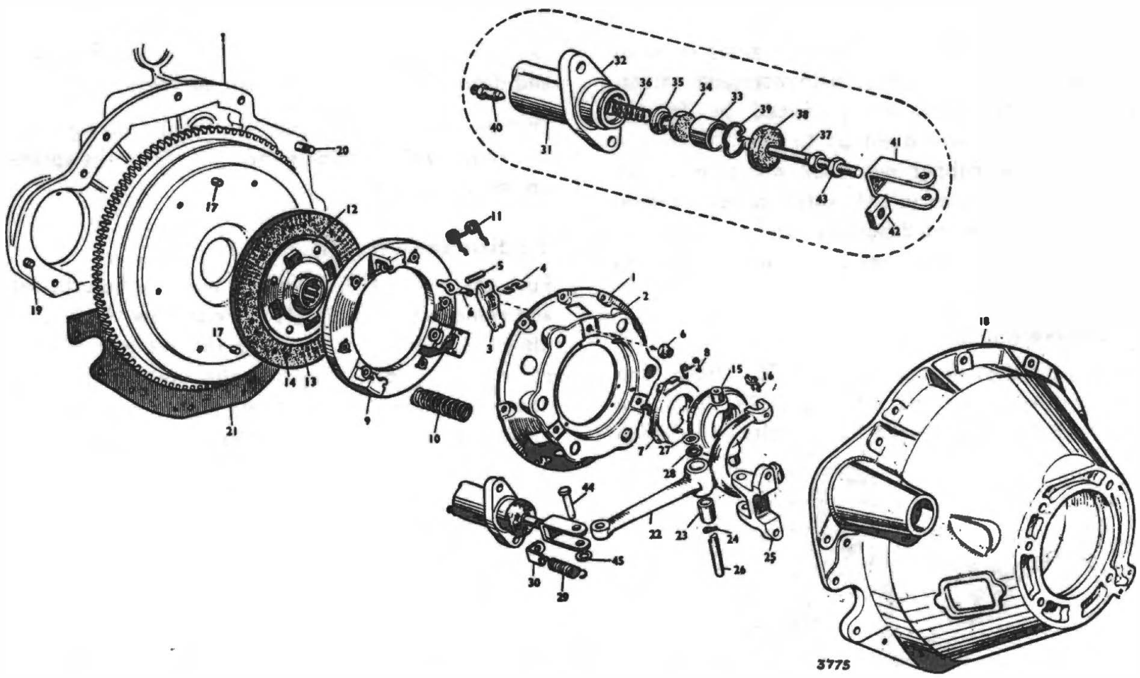


Fig. 3. *Exploded view—Clutch components and slave cylinder (Alpine Series I, II and Rapier Series III cars)*

To assemble

Fit the secondary cup (11) on the piston (10), so that the lip of the cup faces the piston head, and gently work the cup round the groove with the fingers to ensure that it is properly seated. Assemble the retainer (7) on the smaller end of the return spring and insert the assembly into the cylinder. Insert the main cup (8) into the cylinder, lip foremost, taking care not to damage or turn back the lip of the cup; follow up with the piston washer, paying particular attention to the illustration showing method of assembly. Insert the push rod (14or 15) in the piston and press the piston (10) into the cylinder taking care not to damage or turn back the lip of the second cup (11). Fit the circlip (13) ensuring that it beds evenly in its groove and that the collar in the push rod is retained by the circlip. Fill the reservoir with clean hydraulic fluid and test the master cylinder by pushing the piston inwards and allowing it to return unassisted; after a few applications, fluid should flow from the outlet connection in the cylinder head.

To refit

Fit the boot (12) on the cylinder (5) so that the vent hole in the boot will be at the bottom when the cylinder is mounted on the vehicle. If the boot is damaged or perished, a new boot should be fitted. Attach the master cylinder to the mounting brackets. Fit the clevis pin. Check the pedal adjustment on adjustable type clutches.

Fill with fluid, bleed the system and check for leakage by applying a firm pressure to the pedal and inspecting the "line" and connections.

SLAVE CYLINDER (Figs. 3 and 5)

Description

The slave or operating cylinder works on similar principles to the hydraulic brake wheel cylinder and consists of the following parts:—

A main body or cylinder assembly (32) inside which operate a piston (33), rubber cup (34), cup filler (35), return spring (36), operating rod to withdrawal lever (37), rubber boot (38) and piston-retaining circlip (39). (On Alpine Series II, III and Rapier Series IIIA cars onwards no piston-retaining circlip is fitted).

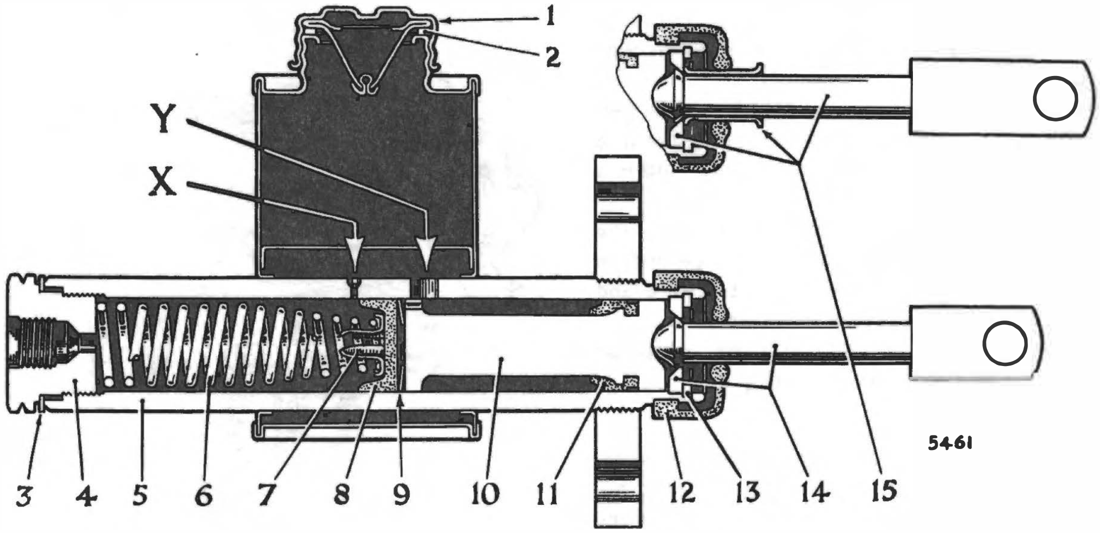


Fig. 4. *Master cylinder, sectional view*

1. Filler Cup
2. Washer
3. Outlet Plug Washer
4. Outlet Plug
5. Cylinder
6. Return Spring
7. Spring Retainer
8. Main Cup
9. Piston Washer
10. Piston
11. Secondary Cup
12. Rubber Boot
13. Stop Circlip
14. Push Rod (Alpine Series I and Rapier cars)
15. Push Rod (Alpine Series II cars)

A bleeder screw (40) provides the only means of bleeding the hydraulic system. On Alpine Series I and Rapier Series III cars the operating rod (37) affords the clutch pedal adjustment by screwing it in or out of the rectangular nut (42) which is housed in the withdrawal lever jaw (41). This linkage is locked by the nut (43).

To remove from car

Disconnect the pipe (75, Fig. 2) from the slave cylinder. Unhook the return spring at the end of the withdrawal lever and remove the slave cylinder fixing screws. The push rod (37) and boot (38) may be left attached to the car. (A return spring is not fitted to Alpine Series II, III and Rapier Series IIIA cars onwards).

To dismantle

Remove the circlip (39, Fig. 3) from the bore (Alpine Series I and Rapier Series III cars). Apply a LOW air pressure to the fluid connection to expel the internal parts.

To assemble

Fit the spring (36) in the cup filler (35) and insert these parts, spring innermost, into the bore of the body (32). Follow up with the cup (34) lip leading, ensuring that the lip is not turned back or buckled, then insert the piston (33) flat face innermost.

Fit the circlip (39) (Alpine Series I and Rapier Series III cars).

To refit

Offer up the slave cylinder to its mounting, with the push rod entering the bore and fit the fixing screws. Stretch the large end of the boot onto the body.

Adjustable cylinders are fitted to the front of the bell-housing flange. Non-adjustable cylinders to the rear.

Reconnect the pipe.

Bleed the system.

BLEEDING THE SYSTEM

As there is no check 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 (40) —Fig. 3) on the slave cylinder, allowing the free end to be submerged in a little brake fluid in a clean glass jar.
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 (3) until air bubbles cease to appear from the end of the tube in the jar.

Clutch Helper Device (See Fig. 6)

On early Rapier cars a clutch helper device is fitted. This consists of an overcentre spring mounted between the pedal and the pedal stanchion. On the pedal it is mounted at a point below the pedal fulcrum. On the pedal stanchion it is attached to a small bracket which is adjustable for position.

To adjust clutch helper device

Slacken off the bolt (A) securing the upper spring mounting bracket (B) to the pedal stanchion (C). Insert a $\frac{3}{8}''$ (9·5 mm.) diameter pin in the hole (D) in the pedal stanchion.

Slide the bracket backwards or forwards as appropriate in order to achieve ·2" to ·25" (5 mm. to 6·3 mm.) offset of the spring axis to the rear of the pedal fulcrum (E) with the pedal butting the $\frac{3}{8}''$ (9·5 mm.) diameter pin.

RELEASE BEARING

To remove and refit

Disconnect pipe to clutch operating cylinder.

Remove gearbox complete with bell-housing (See Section E of this manual).

Remove spring clips securing release bearing to withdrawal lever and withdraw the release bearing. When reassembling always renew spring clips.

Reassembly is a direct reversal of the above operations.

Bleed the hydraulic system after refitting pipe.

CLUTCH DRIVEN PLATE

To remove and refit

Remove gearbox complete with bell-housing (See Section E of this manual).

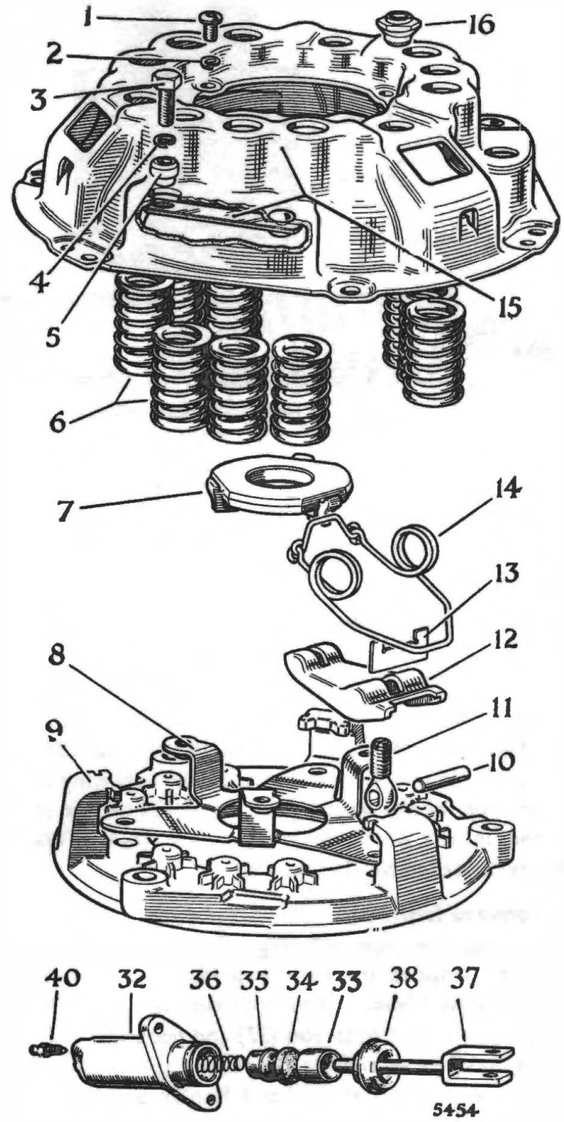


Fig. 5. *Exploded view of clutch and slave cylinder (Alpine Series II, III and Rapier Series IIIA cars).*

Remove setscrews securing clutch cover to flywheel. Slacken off evenly to prevent undue strain being applied to the cover at any one point. Remove clutch assembly and driven plate.

Note.—It is essential that the driven plate hub internal splines should not be assembled dry. For this reason a small amount of waterproof grease is

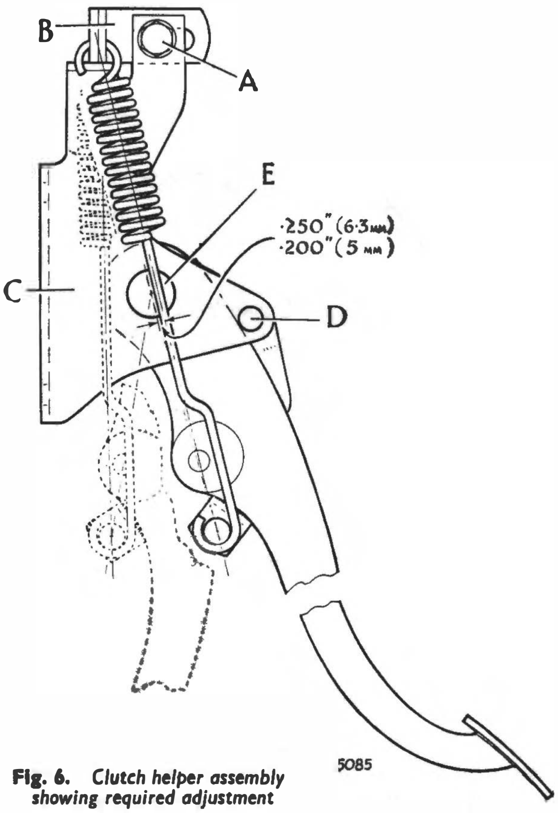


Fig. 6. *Clutch helper assembly showing required adjustment*

applied to these splines on a new driven plate as supplied. This grease is white. Always check that it is present before assembling the plate to the stem-wheel. Shell SB.2498 is suitable for this purpose.

Place driven plate in position with a suitable mandrel fitted through the hub of the plate, so that it may be located correctly when the clutch cover is fitted. **The smaller boss of the driven plate hub faces towards the flywheel.**

This procedure is most important, otherwise it will be impossible to enter the gearbox primary shaft through the clutch plate into the spigot bearing. A gearbox stem-wheel forms an ideal mandrel for this purpose.

Enter clutch cover on dowels.

Tighten the six securing setscrews evenly.

Refit gearbox, complete with bell-housing (see Section E of this manual).

Bleed hydraulic system at operating cylinder.

Note.—On a new replacement clutch assembly it will be found that there are three small L-shaped "keepers" between the release levers and the clutch cover. These are painted red and are fitted to enable a clutch unit to be fitted to a flywheel without the necessity of compressing the springs in the cover into position by means of the fixing bolts. **The L-shaped pieces must be removed after the fixing bolts have been finally tightened. Do not allow them to fall into the clutch cover.**

PRESSURE PLATE ASSEMBLY

To dismantle, reassemble and adjust

Dismantling of the cover assembly is not recommended and where possible an exchange unit should be fitted. If however, dismantling and adjusting is unavoidable, use of the Churchill Clutch Servicing Equipment No. 99A is advised.

Two methods are given, first using the 99A Equipment and an alternative method if this equipment is not available.

Before dismantling mark the release levers (12), cover and pressure plate (9) to ensure they are reassembled in the same relative positions which retains the original balance of the assembly. Renewal of the cover or pressure plate will require the assembly. Renewal of the cover or pressure plate will require the assembly to be rebalanced, using suitable equipment.

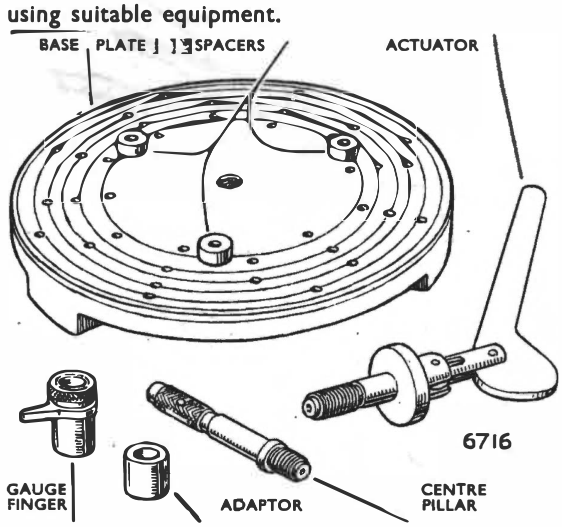


Fig. 7. *99A Equipment with spacers in position*

To dismantle

Using 99A Equipment

With the base plate on a flat surface, wipe the work face and place the No. 2 Spacers in position over the letter given on the code card. Place the clutch on the spacers while aligning the mounting holes in the cover with the appropriate tapped holes in the base, and check that the spacers are approximately below the release levers. Remove the release lever plate and screw the actuator into the centre hole in the base plate, press down the handle and clamp the cover assembly. Screw the set bolts provided firmly into the base plate through the holes in the cover. Remove the actuator.

Remove the adjusting nuts (16, Fig. 5). On Alpine Series II, III and Rapier Series IIIA cars, remove the three bolts (3, Fig. 5) securing the straps to the pressure plate, using a box spanner through the three holes in the cover, and the spider securing screws (1, Fig. 5).

Unscrew the cover clamping bolts evenly and lift off the cover.

Note the position and colour of the thrust springs.

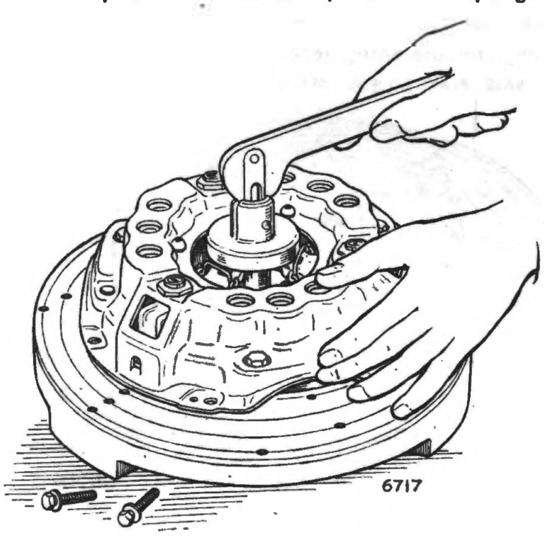


Fig. 8. *Clamping clutch using 99A Equipment*

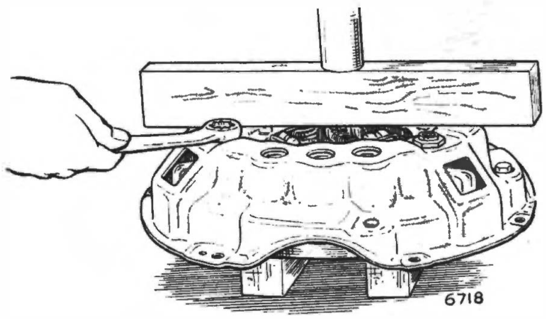


Fig. 9 *Clamping clutch using press*

Remove the eye bolts, levers, struts, spider plate and anti-rattle springs. Clean all component parts for examination.

Alternative method

Place suitable blocks under the pressure plate face which will allow the cover to move down over them. Using a press with a block across the cover compress the assembly (Fig. 9) and dismantle in the same order as in paragraph 1.

To reassemble

After carrying out the necessary servicing of component parts ensure that original components are identified for assembly to their original positions.

Points of lubrication during assembly

Cover	—	Eyebolt nut seats
Release lever pins	—	Total length
Struts	—	Contact edges
Release lever plate	—	Release lever lands

The above items to be lightly smeared with Shell S.B.2498 grease.

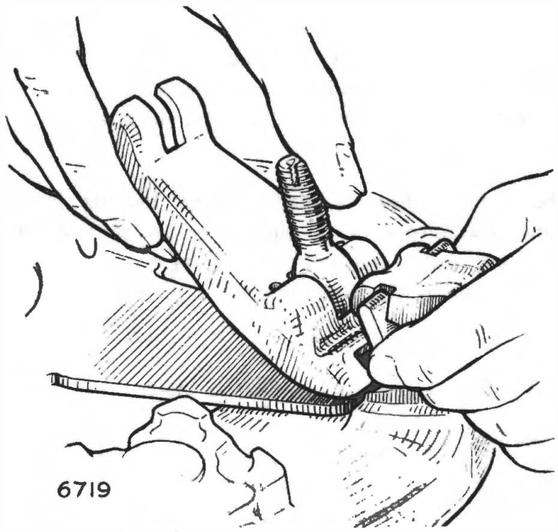


Fig. 10. *Removing the release levers*

Using 99A Equipment

Fit the spider plate (Alpine Series II, III and Rapier IIIA) and struts into position with the assembled release levers, eye bolts and pins to the pressure plate. Place the pressure plate over the spacers in position on the base plate.
Position the thrust springs (6).
With the anti-rattle springs (14) located, place the cover in position over the springs and locate the mounting holes of the cover to the tapped holes in the base plate. Fit the bolts and tighten evenly on Alpine Series II, III, Rapier IIIA before the cover is fully compressed to the base plate, fit the ferrules (5) and bolts (3) with new spring washers to the drive straps and screw the bolts lightly into the pressure plate. This allows the pressure plate to be moved in relation to the cover to obtain correct location of the straps to the pressure plate. Secure the spider (8) to the cover. Screw the cover down evenly to the base plate. Tighten the strap bolts (3) to a torque reading of 180-300 lbs./ins.
Screw the adjusting nuts onto the eyebolts until they are flush.

Alternative method

Assembly of the component parts is the same as described in the preceding paragraph, using the press and blocks in the same manner as when dismantling the assembly.

Adjusting the Release Lever Height Using 99A Equipment

With No. 2 Spacers in the correct position on the base plate and the assembly firmly bolted to the base plate. Screw in the actuator and operate the lever about a dozen times to settle the release mechanism. Remove the actuator.
Screw the centre pillar firmly into the base and place over it adaptor 99A-3 recessed face down. Fit the gauge finger. Holding the gauge finger firmly in contact with the adaptor, turn the adjusting nuts until the release levers make contact with the finger. Remove the gauge finger, adaptor and pillar, fit the actuator and again operate the levers. Replace the pillar and accessories and check the lever setting, making any necessary adjustments. Finally, lock the adjusting nuts by peening the collar of each nut into the eyebolt slot. Fit the release lever plate.

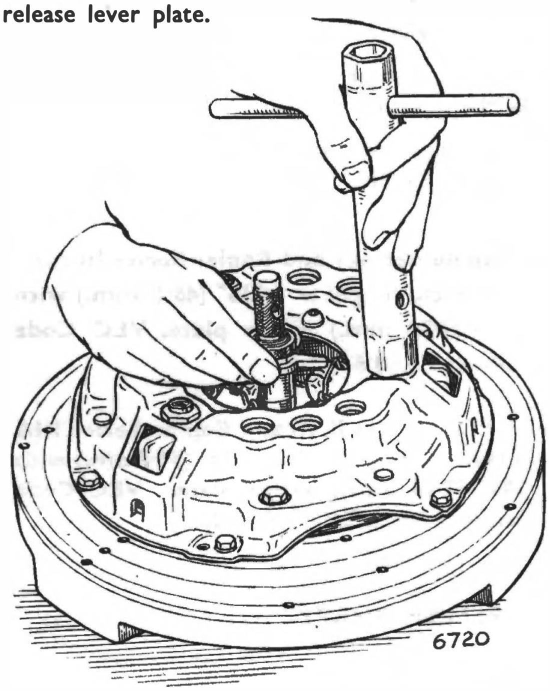


Fig. 11. *Setting height of release levers*

Alternative methods

The methods described below are not highly accurate and should only be used when the Churchill fixture is not available.

Using a new driven plate clamp the clutch assembly to a flat surface having a hole large enough to take the protruding boss of the driven plate, until the clutch cover makes firm even contact with the flat surface.

Alternatively, remove the flywheel from the engine (or use a spare flywheel) and lay flat on a surface plate. Using a scribing block measure the height of the flywheel face from the surface plate then set the scribing block pointer to a dimension as given below.

Lay a new clutch driven plate in its correct position on the flywheel. Bolt the cover assembly to the flywheel and with the scribing block adjust the release levers until the pointer makes contact with the tips. Release the cover assembly clamping bolts, turn the driven plate 90° reclamp the cover and recheck the lever tip height.

Fit the release lever plate, check that it is level and stake the adjusting nuts.

Finally recheck to ensure that the adjustment has not been disturbed.

On Alpine Series I and Rapier Series III cars, the lever tip height is 1·815" (46·1 mm.) with a ·285" (7·24 mm.) gauge plate. VLC Code Numbers 2 and 6.

On Alpine Series II, III and Rapier Series IIIA cars the lever tip height is 2·14" (54·4mm.) with a ·285" (7·24 mm.) gauge plate. VLC Code Number 2 and adaptor 99A-3.

PROPELLER SHAFT

General

A needle roller bearing propeller shaft, which is so designed that assembly is very simple, is fitted to the car. The sliding spline portion of the propeller shaft is enclosed within the rear end of the gearbox.

Later cars are fitted either with a needle roller bearing rear universal joint incorporating a bonded rubber vibration damper as shown in C, Fig. 12, or a metal to rubber rear universal joint as shown in B, Fig. 12.

Both types have a needle roller bearing front universal joint with a sliding spline enclosed within the rear end of the gearbox. Sliding parts are thus lubricated by the gearbox system.

To remove and refit propeller shaft

(See Fig. 16)

Remove bolts and nuts from the rear driver coupling. Shakeproof washers are fitted under the nuts of the bolts. Always use new shakeproof washers when refitting.

The heads of the four bolts in the coupling on the rear axle should face the differential unit.

On models fitted with the vibration damper, remove nuts from the rear axle coupling. Shakeproof washers are fitted under the nuts. Always use new shakeproof washers when refitting. On models which are fitted with the metal to rubber universal joint, two nuts and bolts are used to connect the shaft to the rear axle coupling. Note which way the bolt heads are facing so as to ensure correct replacement. Tighten to a torque of 48/53 lbs. ft. (6·6/7·3 kg. m.)

Lower and withdraw the shaft in a rearward direction.

Before refitting the shaft ensure that the splines and the sleeve of the sleeve yoke assembly are free from grit or sharp edges and are lightly lubricated.

Inspect the dust cover for damage. (Dust shields are not fitted to later models).

To dismantle and rebuild universal joints

The needle bearing type universal joints are so designed that correct assembly is a very simple

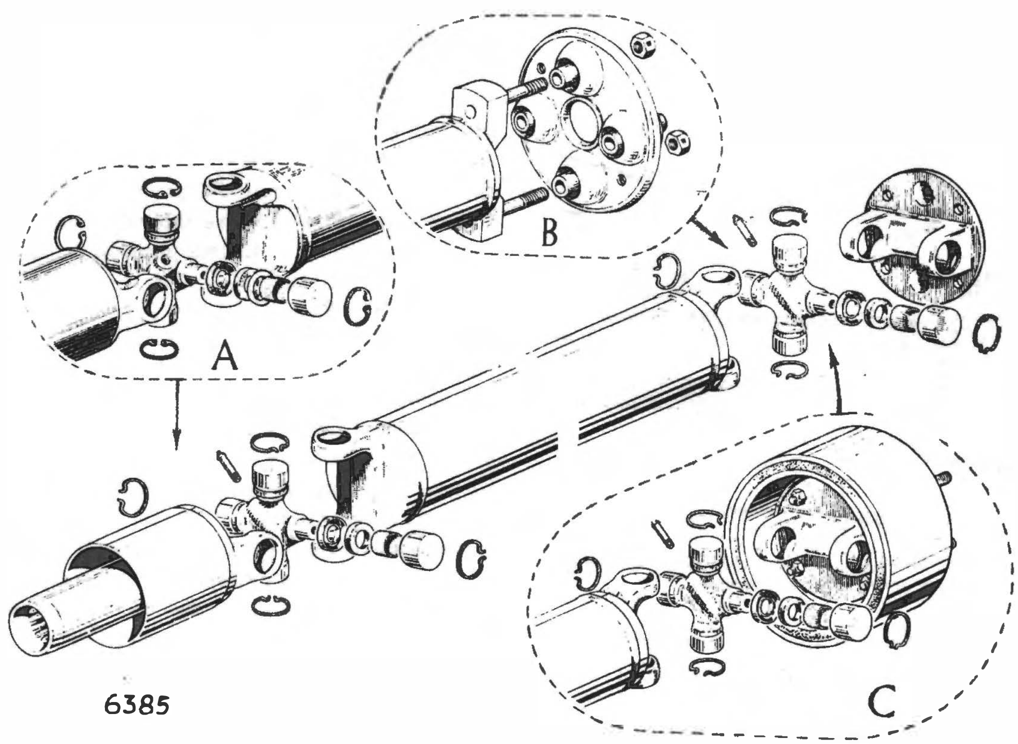


Fig. 12. *Exploded view of propeller shaft.*

matter, no hand fitting or special tools being required.

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 gaskets and retainers, needle bearing assemblies and snap rings should be fitted.

On models having a propeller shaft with sealed bearings, no grease nipples are provided and no lubrication is required; a sealing washer is fitted between the cork gasket and the bearings: (see inset A of Fig. 12.).

For models which are fitted with the bonded metal to rubber universal joint at the rear end, these also do not require lubricating (see inset B of Fig. 12).

The journal and needle bearing assemblies are the only parts subject to wear after prolonged service and when it becomes necessary to replace these for any reason the work should be carried out as follows:—

To dismantle

Remove snap rings (Fig. 12) by pinching ends together with a pair of pliers. If a ring does not readily snap out of the groove, remove enamel from the yoke holes and tap the end of the bearing lightly, which will relieve pressure against the ring.

Holding the joint in one hand, tap gently with a piece of copper or copper hammer on the radius of the ear of the yoke, as shown in Fig. 13.

The needle bearing will gradually emerge and can finally be removed with the fingers. Be sure to hold the bearing in a vertical position and when free remove race from the bottom side so as to avoid dropping the needle rollers (see Fig. 14).

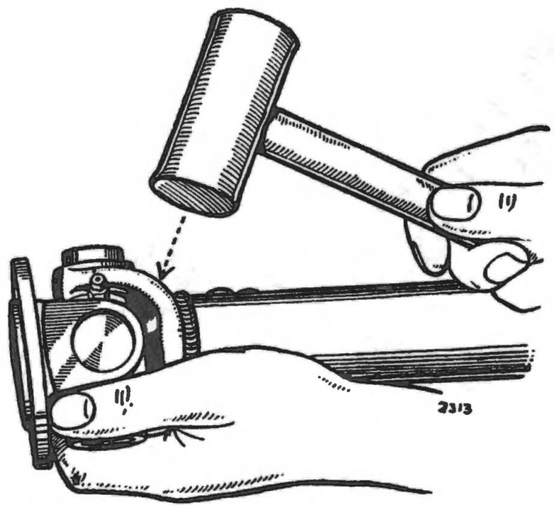


Fig. 13. *To extract bearings after removal of snap ring, tap on ears of yoke with copper hammer*

Repeat this operation for the opposite bearing.
Support the two exposed journal pegs on lead blocks (to protect ground surface) and tap the ears of the flange yoke to remove the race.
Reverse assembly and repeat the operation.
Wash all parts in petrol or paraffin.
If parts are not worn, repack the lubricated type of bearings with Shell Spirax 140 E.P. Repack the sealed type of bearings with Shell Dentax 250. Make sure that the joints of oil channels are filled with lubricant. With the rollers in position fill the race about one-third full. Should any difficulty be encountered when assembling the rollers in the housing, smear the wall of the race with vaseline. Install the new gaskets and gasket retainers on the journal assembly. The journal shoulders should be coated with shellac or other suitable jointing prior to fitting retainers so as to ensure a good oil seal. It is also useful to have spare snap rings available as replacements in the event of damaging a ring in assembling the joint.
On cars which are fitted with a rear coupling, of the type illustrated in inset C, Fig. 16, the rear universal joint is dismantled in exactly the same way as the front joint after removing the coupling. For cars which are fitted with a metal to rubber universal joint, (inset B, Fig. 16), the rear joint cannot be overhauled in service, and in the event of damage a new joint must be fitted. Normally, no purpose will be served by removing the joint from the propeller shaft, but if this becomes necessary, the universal joint and the propeller shaft should be marked before they are separated so that they can be replaced in the same position on assembly.

To reassemble

Insert journal in flange yoke holes.
Using a soft, round drift with a flat face, about $\frac{1}{32}$in. (·79 mm.) smaller in diameter than the hole in the yoke, tap the bearing into position.
Repeat this operation for the other three bearings.
Fit new snap rings and be sure that these are firmly located in the grooves.
When assembled, if joint appears to bind, tap the lugs lightly with a wooden mallet, which will relieve pressure of the bearing on the end of the journal. It is essential that no play exists between the roller races and the bores of the yokes. If the yoke cross-holes have worn oval, the yokes must be replaced. In the case of the inner yokes renewal can only be effected by fitting a new propeller shaft, since this yoke is welded to, and balanced with, the tubular shaft.

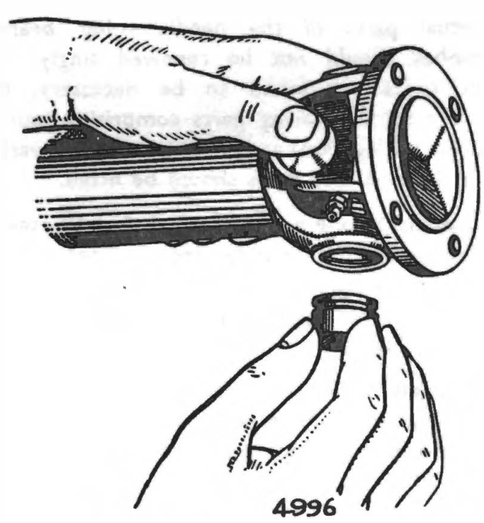


Fig. 14. *Fitting needle roller bearings*

DIAPHRAGM CLUTCH (Later Models)

Description

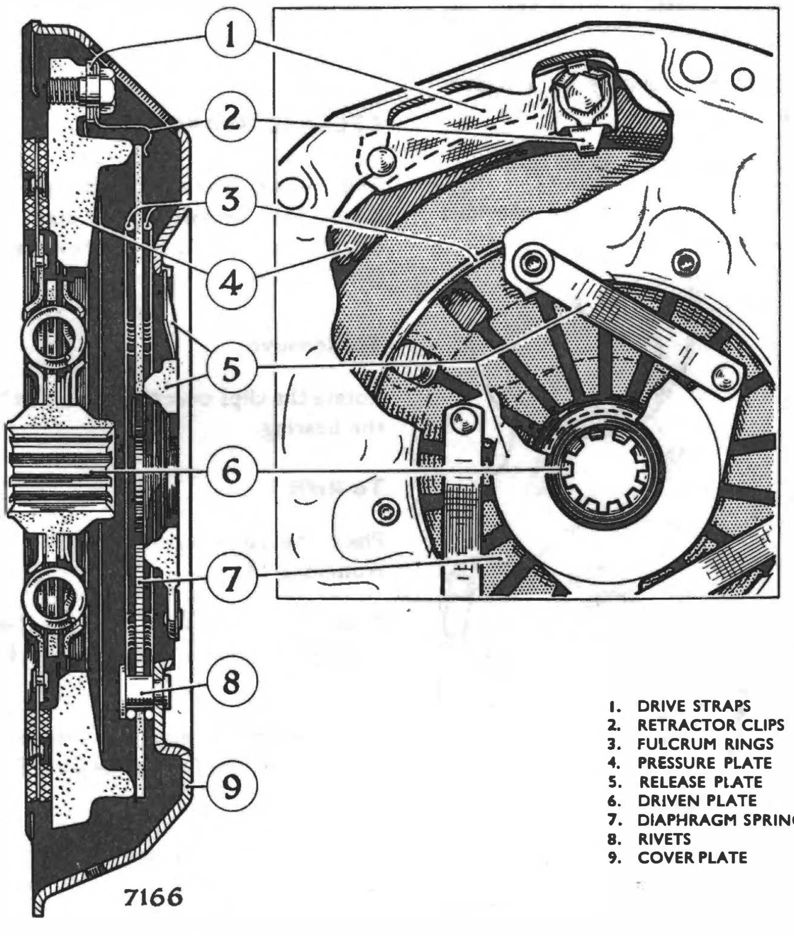
A single dry plate type clutch is fitted, incorporating a copper impregnated graphite release bearing which is self lubricating.

No attention with regard to lubrication is necessary.

The assembly consists of a pressed steel cover (9) and a cast iron pressure plate (4) which are linked together by three flat steel straps, (1), and a steel diaphragm spring (7). 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 release plate assembly (5) is attached to the cover (9) by three spring steel straps, each rivetted at one end to the cover, and at the other end to the release plate (5). 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.



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. 15. *Sectional view of Diaphragm Clutch.*

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 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.

For details of the hydraulic system see previous paragraphs in this section.

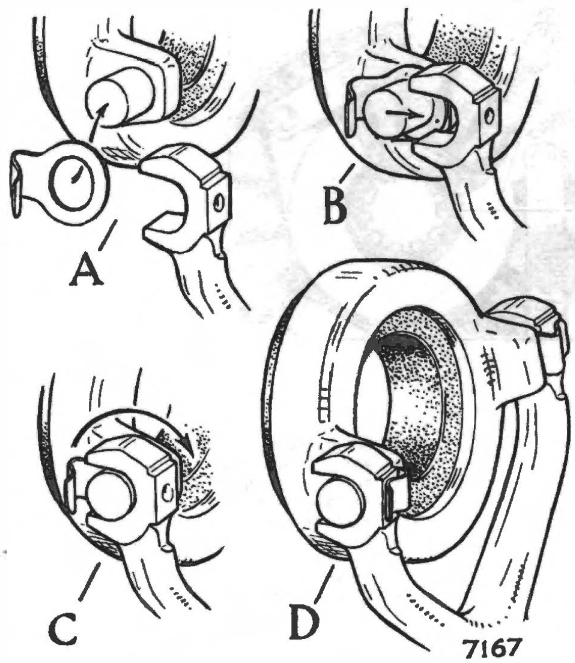


Fig. 16. *Fitting Release bearing.*

Under no circumstances must the clutch be lifted or pulled by means of the thrust plate or the straps will be bent and the alignment of the thrust plate destroyed.

Clutch Driven Plate.

To Remove and Refit. See previous paragraphs in this section.

COVER ASSEMBLY

No servicing should be attempted on this assembly, as the unit is built and balanced during manufacture, and must be replaced, if necessary, by a complete assembly.

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. 16).

To Remove

Rotate the clips over the end of the fork, and detach the bearing.

To Refit

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). (See Fig. 16).

CLUTCH REMOVAL AND INSTALLATION

See previous paragraphs in this section.

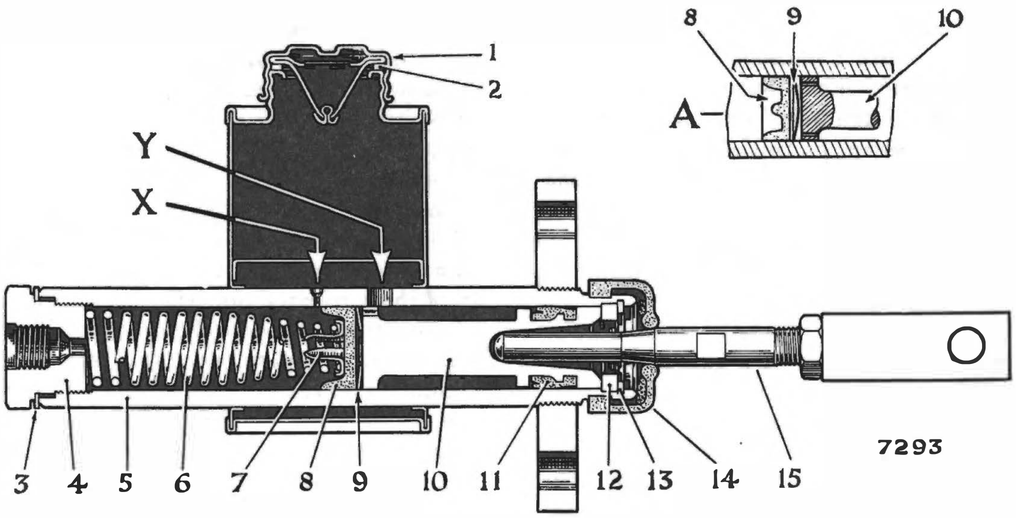


Fig. 17 *Sectional view of master cylinder*

1. FILLER CAP
2. WASHER
3. GASKET
4. OUTLET PLUG
5. BODY
6. SPRING
7. SPRING RETAINER
8. MAIN CUP
9. PISTON WASHER
10. PISTON
11. SECONDARY CUP
12. PISTON COLLAR
13. CIRCLIP
14. RUBBER BOOT
15. PUSH ROD ASSEMBLY

Y. MAIN PORT
X. BY-PASS PORT

MASTER CYLINDER (*Rapier IV and Alpine IV*)

Adjustment

Measure the clutch pedal free play, using feeler gauges between the pedal stem and the pedal stop, located behind the parcel tray. This should be .040" (1 mm.).

Adjust as follows:—

Push back the pedal return spring and cap and loosen the master cylinder push rod locking nut, preventing the push rod from turning using a spanner on the two flats on the rod.

Turn the master cylinder push rod until the correct clearance has been obtained. Turning clockwise will reduce the clearance, anti-clockwise will increase the clearance When correct, retighten the locknut.

Any alteration to the setting of the pedal stop will affect the clutch and brake pedal clearance and should remain undisturbed as far as possible. Before removing the stop (if necessary) mark the position and recheck the clutch and brake pedal clearance after refitting the stop in the position previously marked.

NOTE:

A groove is formed round the edge of the master cylinder outlet plug (see item on fig. 17). This identifies it from the brake master cylinder, which has no groove. Clutch and brake master cylinders are not interchangeable, as the clutch master cylinder has no check valve. On cars with Servo assisted Brakes the Brake Master cylinder is larger.

Description

This unit (Fig. 17) incorporates a fluid reservoir and a master cylinder. In front of the main rubber cup (8), when the system is at rest, is a by-pass port (X) which ensures that the system is full of fluid at all times, and allows full compensation for movement of the fluid due to changes of temperature. It also serves to release fluid drawn into the cylinder from the annular space formed by the reduced skirt of the piston (10), 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 either to the hole being covered by the main cup as a result of incorrect pedal adjustment, or to the holes being choked by foreign matter, pressure will build up in the system. In order that the rubber cup shall not be drawn into the holes in the piston head, a piston washer (9) is interposed between the two parts; it is important that this washer be assembled as shown on the illustration. (A Fig. 17).

To remove (Fig. 2)

Disconnect the pressure pipe from the cylinder barrel. Remove the fixing bolts and detach the cylinder and push rod. Unscrew the filler cap and drain the fluid into a clean container. It is not necessary to remove the clevis pin from the pedal, just withdraw the cylinder from the push rod. There is no circlip.

To dismantle (Fig. 17)

Push the piston (10) down the bore of the cylinder and remove the circlip (13). Withdraw the piston, piston washer (9), rubber cup (8), retainer (7) and return spring (6). Using only the fingers to prevent damage, remove the secondary cup (11) by stretching it over the end flange of the piston.

To assemble

Fit the secondary cup (11) on the piston (10), so that the lip of the cup faces the piston head, and gently work the cup round the groove with the fingers to ensure that it is properly seated. Assemble the retainer (7) on the smaller end of the return spring and insert the assembly into the cylinder. Insert the main cup (8) into the cylinder, lip foremost, taking care not to damage or turn back the lip of the cup; follow up with the piston washer, paying particular attention to the illustration showing method of assembly (Fig. 17A). Insert the push rod (14) in the piston and press the piston (10) into the cylinder taking care not to damage or turn back the lip of the secondary cup (11). Fit the circlip (13) ensuring that it beds evenly in its groove and that the collar in the push rod (14) is retained by the circlip. Fill the reservoir with clean Lockheed brake fluid and test the master cylinder by pushing the piston inward and allowing it to return unassisted; after a few applications, fluid should flow from the outlet connection in the cylinder head.

To refit

Fit the boot (12) on the cylinder (5) so that the vent hole in the boot will be at the bottom when the cylinder is mounted on the vehicle.

Attach the master cylinder to the mounting bracket. Check the pedal adjustment (see page 15), fill with fluid, bleed the system and check for leakage by applying a firm pressure to the pedal and inspecting the "line" and connections.

SLAVE CYLINDER

For details see previous paragraphs in this Section.

GEARBOX AND OVERDRIVE

SECTION E

CONTENTS

GEARBOX

GENERAL DESCRIPTION

A four-speed gearbox is fitted having synchromesh on the upper three ratios. Of these, second and third employ helical gears, and are in constant mesh.

The synchronised gears are engaged by dog-clutches, whereas first has sliding gear engagement. Reverse is engaged by a sliding idler pinion. Top gear is direct drive.

The synchromesh is of baulking ring type. Spring-loaded shifting plates locate the baulking ring relative to the sliding sleeve. The baulking ring impinges on a cone machined on the gear.

Overdrive is available as factory fitted optional equipment. It is engaged by a switch mounted on the steering column and controlled by an isolator switch mounted in the gearbox top cover. The isolator switch permits engagement of overdrive in third and top gears only.

GEARBOX—To remove and refit (see Overdrive Section where applicable.)

Alpine

Place car on ramp or over a pit.
Disconnect positive lead from battery.
Drain radiator.
Drain gearbox. Replace plug.
Remove top water hose.
Remove floor cover and gear lever.
Disconnect throttle linkage.
Disconnect exhaust system from branch pipes and remove.
Place jack under rear of engine and detach rear cross-member from underframe.
Disconnect speedometer cable and hydraulic clutch pipe.
Remove lower bellhousing bolts.
Disconnect clutch slave cylinder from bellhousing.
Lower engine and remove gearbox crossmember.
Remove starter and upper bellhousing bolts.
Withdraw gearbox and bellhousing rearwards and downwards.

Rapier

Place the car on a ramp or over a pit.
Disconnect positive lead from battery.
Drain radiator.
Drain gearbox. Replace plug.
Undo clip and remove top hose.
Remove rocker cover. (It may be necessary to remove rocker shaft complete if heater is fitted).
Disconnect accelerator control linkage.
Remove engine rear lifting brackets.
Disconnect exhaust flange from manifold.
Disconnect front exhaust hanger bracket.
Remove propeller shaft rear coupling bolts, disconnect coupling and remove shaft rearwards.
Rapier IV. Unscrew gear-lever knob. Remove ashtray. From behind and above blower switch, remove wing nut fixing which retains upper edge of console to lower edge of facia. Remove single screw from ashtray aperture. Remove front and rear gearbox tunnel covers.
Jack up engine at rear.
Remove bolts securing engine rear mounting bracket to frame.
Disconnect speedometer cable.
Disconnect clutch slave cylinder from bellhousing.
Disconnect starter cable and remove starter motor.
Remove gear lever.
Disconnect wires from overdrive solenoid and gearbox isolator switch (if overdrive fitted).
Lower rear of engine.
Remove nuts and bolts securing bellhousing to engine.
Remove gearbox and bellhousing rearwards and downwards.
Reverse the above procedure for refitting.
Check oil level.
Bleed clutch hydraulic system. (See Section D, "Bleeding the System").
Check that the clutch is operating and adjusted correctly.

Note:—Do not in any way tilt the gearbox when removing or refitting, as a great strain is thus imposed on the clutch driven plate.

TOP COVER

To remove and refit

Remove oil level dipstick. (No dipstick is fitted to gearboxes with oil level/filler plug.)

Remove gearbox cover bolts and lift off main cover without damaging the paper joint.

Refitting is a reversal of the above, taking care to ensure that the internal change speed lever and its selector safety latch engage in the selector fork gaps.

Before finally tightening cover securing bolts, position main cover by tapping its edges with a mallet, in order to obtain unrestricted "swing" of the selector safety latch across the selector fork gaps.

To remove gear lever

Slide grommet up gear lever.

Remove four setscrews securing spring retaining cap to top cover casing.

Withdraw gear lever.

To dismantle and reassemble

Early Alpine (Fig. la)

Remove rubber boot from below the gear lever socket mounting.

Remove cover plate with reverse stop spring and plunger from the side of the gear lever mounting.

Remove 3 setscrews securing the lever spring retaining cap to the extension casting and take off the cap, spring and cupped washer. Lift out the gear lever. Note the spring-loaded ball at the lower end of the lever. This is positively located in its drilling to prevent dropping out during dismantling.

Release locking wire from the square headed bolt securing the internal shift lever to the remote control shaft. Remove the bolt and withdraw the shaft through the rear of the casing. This will also release the safety latch and spacing washers, one at each end of the latch.

To reassemble pass the remote control shaft into the cover from the rear.

Locate the safety latch spacing washers in position with grease, and hold the safety latch and internal shift lever in place whilst passing the shaft through the remaining parts.

Line up the holes in the shaft and internal shift lever, fit, tighten and relock the square headed bolt.

Ensure that the spring-loaded ball is in position in the lower end of the gear lever and fit the level, cupped washer, spring and cap.

Fit the reverse stop plunger, spring and cap.

Refit the rubber boot below the lever socket.

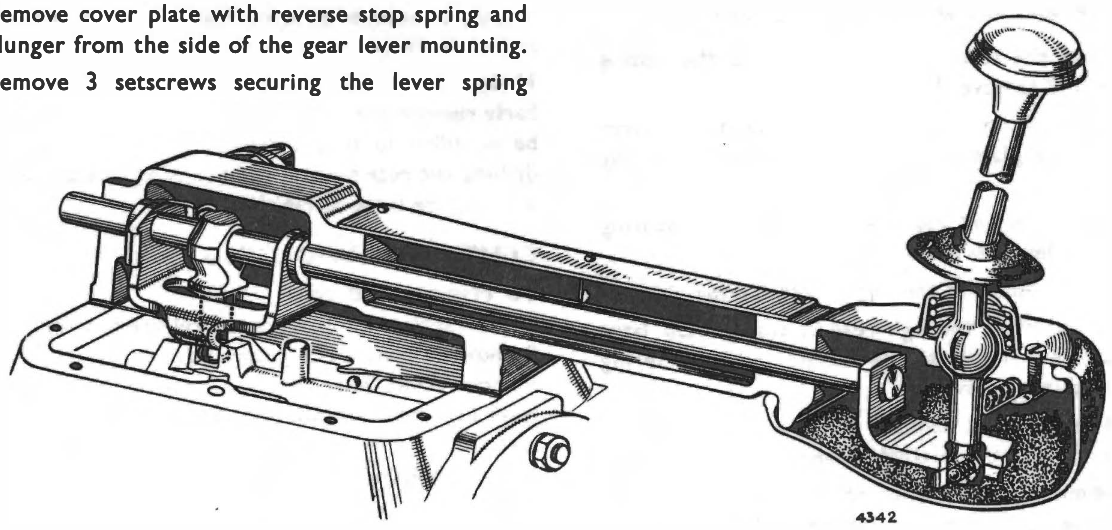
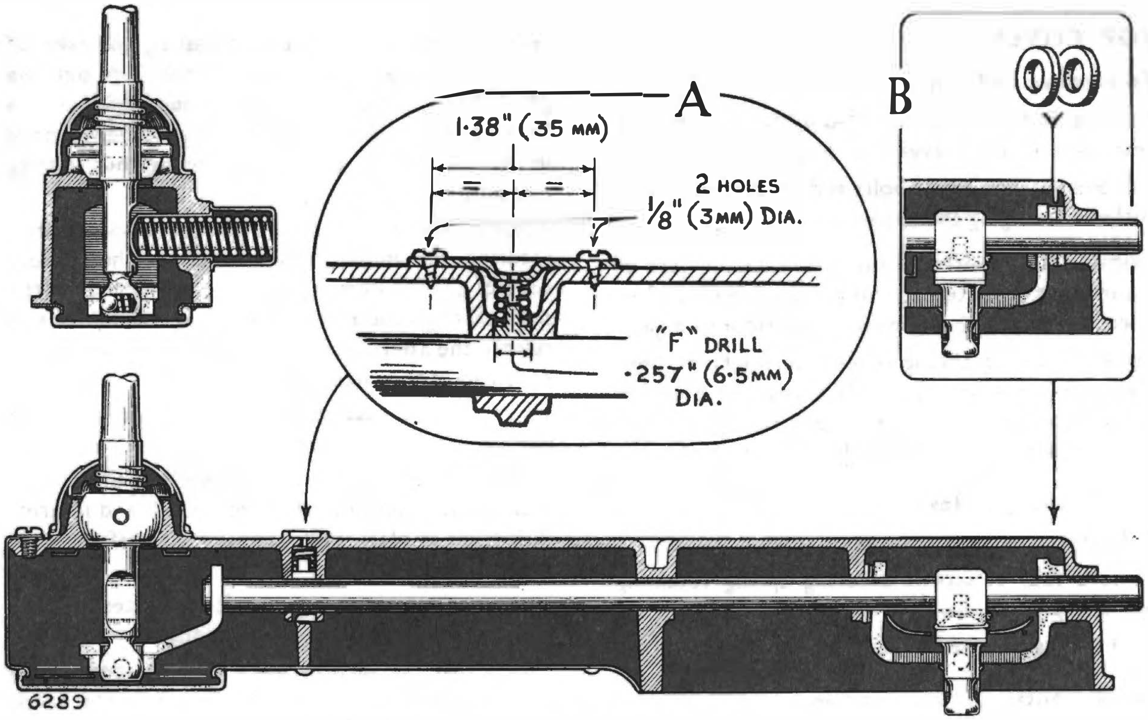


Fig. la. *Sectional view of top cover assembly, early Alpine cars*



A. DETAILS TO FIT DAMPER AND SPRING TO EARLY COVERS
B. SPACING WASHERS ON EARLY COVERS

Fig. 1b. *Sectional view of top cover Rapier and late Alpine*

Rapier and late Alpine cars (Fig. 1b.)

Remove the seven setscrews securing the closing plate and remove the plate.

Remove the two setscrews securing the reverse bias spring plate and remove the plate, bias spring and plunger.

Detach wire and remove locking screw securing selector lever to operating shaft.

Note the position of the safety latch spacing washers.

Slide out shaft through rear of casing. On later cars this will release the damper pad and spring located in the cover.

The safety latch, selector lever, and washers will now have become detached, and may be removed.

Care must be taken when refitting that the washers are inserted in their correct positions.

When the selector lever locking screw is refitted it must be secured by wire, which should be looped round the lever.

Note

Early remote control central change top covers can be modified to take a damper pad and spring by drilling the rear bearing and fitting a plate and two screws (see Inset A, Fig. 1b.)

CLUTCH BELLHOUSING

To remove and refit

Extract springs securing clutch release bearing.

Remove release bearing assembly.

Remove bolts and washers securing withdrawal lever bracket to bellhousing and extract withdrawal lever.

Remove bolts and washers securing bellhousing to gearbox.

Remove bellhousing from gearbox spigot.

Refitting is a reversal of the above instructions.

REAR COVER
To remove and refit

Remove speedometer pinion and bush.
Remove rear mounting plate (two bolts and one nut). Remove the remaining two bolts and washers securing rear cover to casing and remove cover.
Remove paper joint.

Refitting is a reversal of the above instructions.

If the rear bushes are worn or scored, a cover complete with finished bushes is available. Alternatively, if boring facilities are available, new bushes may be fitted and bored to 1·380/1·379" (35·05/35·02 mm) within ·0015" (·038 mm) total indicator reading at 90 deg. to the front face of the cover.

A strengthened cover with a circlip to retain the oil seal, and a propellor shaft with no dust shield are fitted to later cars. (To give interchangeability with the new rear cover, which supersedes the old, replacement shafts for early or later cars will not be fitted with a dust shield).

TOOLS FOR DISMANTLING AND REASSEMBLING GEARBOX

The dismantling and reassembling of the gearbox will be simplified by the use of the following tools, their uses being fully described in the ensuing instructions.

The first two tools can be made up to the dimensions given.

1. Dummy layshaft spindle $\frac{3}{4}$" (19 mm.) diameter x 6$\frac{1}{2}$" (165·1 mm.) long—made up.
2. Dummy selector shaft $\frac{7}{16}$" (11·1 mm.) diameter x 5" (127 mm.).—3 required.
3. Selector shaft loading tester clamp. (Churchill No. R.G.62 or any suitable clamp to attach to the end of the selector shaft).
4. Circlip pliers V.L.C. 7065 ("C" and "A" points).
5. Socket spanner RG.317 for mainshaft front nut.

SELECTOR SHAFTS AND FORKS
To remove and refit (Figs. 2 and 3)

It is imperative that these are removed REARWARDS only. Use dummy selector shaft as described under "TOOLS".

Carefully tap out reverse selector shaft (64). Note the distance piece (66) at the rear of the selector fork.

Carefully tap out the 1st and 2nd and 3rd and 4th selector shaft (55 and 59).

Remove the selector forks.

Adjustment of axial load between 3rd and 4th selector shaft and fork

This operation should be carried out before assembling the 3rd and 4th speed selector shaft and fork into the gearbox; proceed as follows:—

Grip the 3rd and 4th speed selector fork in a vice; insert shim/s, spring and ball, then the selector shaft, depressing the ball by inserting a punch.

The axial load necessary to move the selector shaft groove across the ball in the fork should be 25 lbs (11·3 kg.) to 30 lbs. (13·6 kg.). This may be tested by means of a suitable spring balance, attached to the end of the selector shaft by a hand vice or the Churchill selector shaft loading tester VLC No. RG.62. Adjust axial load to the above figure by addition or removal of shims. As it will be necessary to detach the selector shaft from the fork in order to assemble to the gearbox it will be necessary to retain the adjusted ball and spring in the fork by means of a dummy selector shaft as previously described.

With the above exception, refitting is a reversal of the preceding instructions.

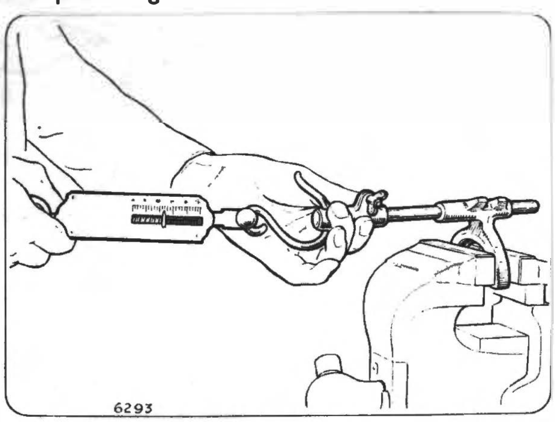
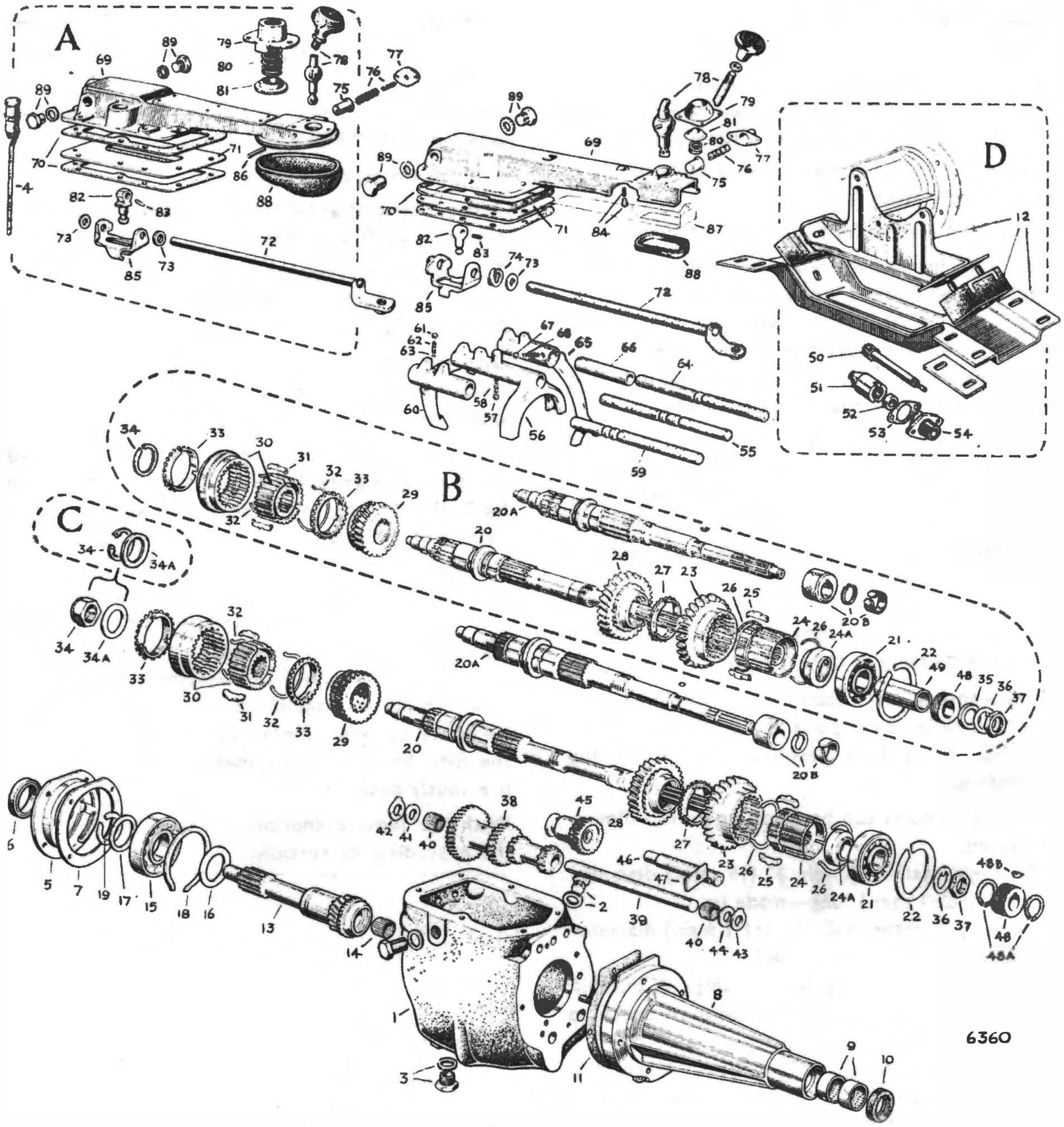


Fig. 2. *Checking of axial load of 3rd and 4th selector shaft and fork.*



A. TOP COVER, EARLY ALPINE
B. MAINSHAFT, EARLY CARS
C. CIRCLIP AND DISTANCE PIECE (SOME LATER MAINSHAFTS)
D. REAR MOUNTING AND SPEEDO DRIVE.

Fig. 3. *Exploded view of gearbox.*

FRONT COVER ASSEMBLY

To remove and refit (Fig. 3)

The front cover assembly can only be withdrawn after the layshaft cluster (38) has been lowered into the bottom of the gearbox casing (1).

Remove top and rear covers and selectors as previously described.

Remove the four securing setscrews from the front cover (5).

Remove setscrew and washer securing lock plate (47).

Remove lock plate by sliding it downwards.

Displace layshaft (39) by entering dummy layshaft from the front, pushing it rearwards until clear of the fixed thrust washer (43) so lowering the layshaft cluster assembly to the bottom of the casing.

It is essential that the layshaft spindle is entered and removed through the rear of the casing. The hole in the front of the casing is of smaller diameter than that in the rear, and incorrect removal and refitting will destroy the oil-sealing thereby obtained.

The front cover assembly should now be withdrawn from the casing.

Do not lose the needle rollers (14) from the mainshaft spigot bearing.

Remove the fourth speed baulking ring (33) from the synchrohub (30).

In order to maintain efficient functioning of the synchronising mechanism it is advisable to correlate each baulk ring to its mating cone by some form of identification, e.g., using a sharp instrument, scribe in a prominent position the numbers 2, 3 and 4 indicating second, third and fourth speeds.

When refitting the front cover assembly it is essential that the drain hole is placed in the six o'clock position, and a new paper joint fitted between the gearbox casing and the front cover.

To dismantle and reassemble (Figs. 3 and 4)

Remove circlip (18) securing bearing (15) in front cover (5).

Press stemwheel assembly, complete with bearing, out of front cover.

Remove circlip (19) securing bearing (15) and abutment washer (17) to stemwheel (13).

Press bearing off stemwheel.

Remove bearing shield (16). (Do not omit this on reassembly).

Remove oil seal. (This is a press fit in the cover).

Reassembly of the front cover assembly is a reversal of the preceding instructions with particular attention to the following points:—

The circlip (19) securing the bearing to the stemwheel must always be renewed.

In this assembly a predetermined amount of float is provided for and is controlled by the class of fit of the members of the ball bearing.

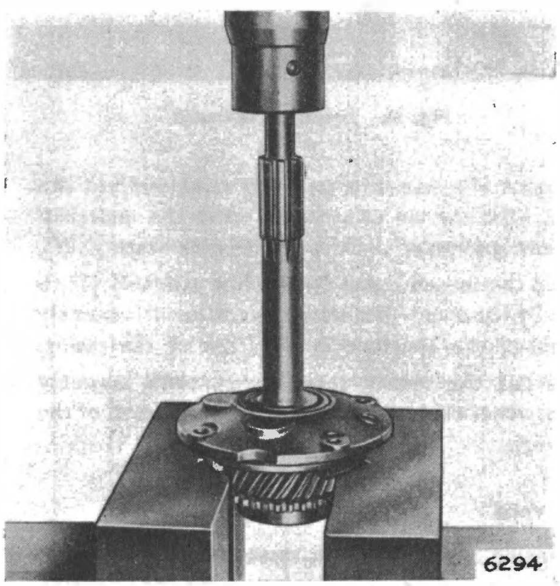


Fig. 4. *Pressing stem wheel out of cover*

MAINSHAFT ASSEMBLY

To remove (Figs. 3, 5a and 5b)

Remove top and rear covers, selectors and front, cover.

On early cars (inset B, Fig. 3) release lockwasher (36) and undo nut (37), securing bearing to shaft and remove distance piece (49) and speedo gear (48).

On later cars, the speedo securing circlips (48A), speedo gear and key (48 and 48B) must be removed before removal of the nut (37) and lockwasher (36).

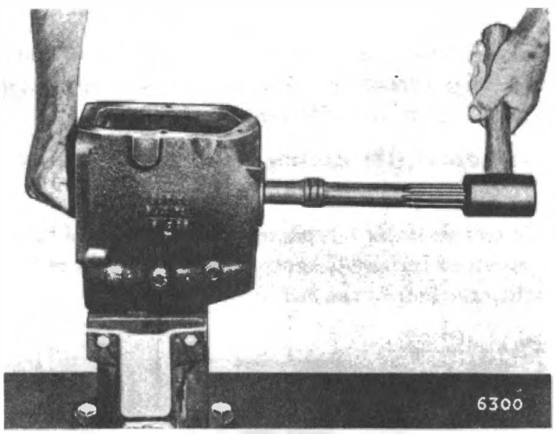


Fig. 5a. *Driving out mainshaft*

Support the mainshaft assembly at its forward end and, with the aid of a mallet, drive the mainshaft assembly forward until free of the rear bearing (21).

Hold the second speed synchrohub assembly (23 to 26) by hand and withdraw the mainshaft assembly through the aperture in the front of the casing.

Lift out the second speed synchrohub assembly and wheel through the aperture in the top of the casing.

To refit

Refitting of the mainshaft assembly is a reversal of the preceding instructions with particular attention to the following:—

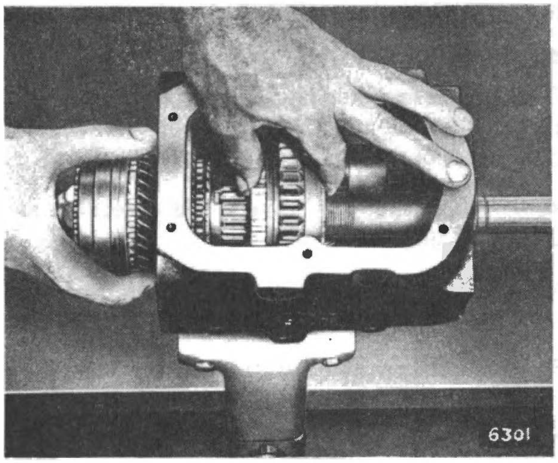


Fig. 5b. *Removing mainshaft*

Oil the inner surface of the second speed baulking ring (17) and secure it to its mating cone by light hand pressure in order to safeguard against the baulking ring floating and becoming trapped during the driving rearward of the mainshaft into the bearing.

During the driving in of the mainshaft to the rear bearing care must be taken to align the second speed shifting plates (25) with the slots in the second baulking ring (27); also the first speed wheel (23) and the 3rd and 4th speed sliding sleeve (30) should be retained in position on their respective hubs (24) and (30) by hand.

It is essential that the rear main bearing (21) is positioned so that it is held firmly against the second speed hub distance piece (24A).

To ensure this condition, place the gearbox on a press so that the bearing inner track rests on the base plate and the mainshaft passes through the V-notches. Place a protector sleeve over the stemwheel spigot and press the shaft through the bearing until the hub distance piece is securely held between the bearing and the second speed hub (see Fig. 6a).

To dismantle and reassemble (Figs. 3, 5c-5f)

Remove second speed wheel (28) and separate the baulk ring from the gear. Mark the baulk ring to ensure it is reassembled to the correct gear.

Secure mainshaft in vice, **using soft metal clamps.**

Remove front mainshaft circlip or nut (34).

Remove the third and fourth synchrohub (30) from mainshaft. (This is a press-fit).

Fig. 5c. *Pressing of 3rd and 4th synchrohub*

Remove the third speed wheel (29) and separate the baulk ring from the gear. Mark the baulk ring to ensure that it is reassembled to the correct gear.

Remove the third and fourth sliding sleeve.

Remove three shifting plates (short) (31).

Remove two synchro circlips (32) from synchrohub.

Dismantle the second speed synchrohub as follows:—

Remove first speed wheel (23) from hub (24).

Detach the three long shifting plates (25).

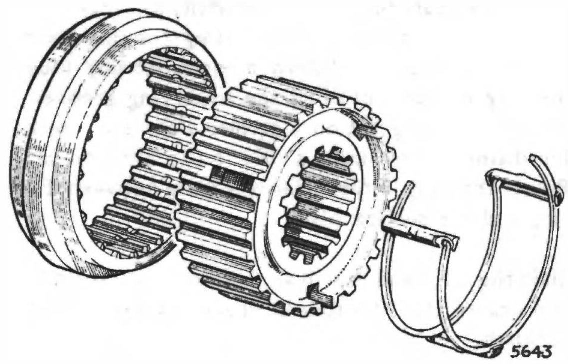


Fig. 5d. *Arrangement of 3rd and 4th speed synchrohub*

Remove the large shouldered distance piece (24A) from the rear end of the hub. The front and rear circlips (26) can then be withdrawn.

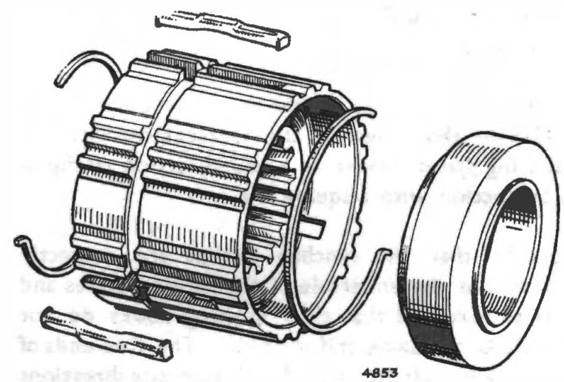


Fig. 5e. *Arrangement of 2nd speed synchrohub circlips*

Reassembly of the mainshaft is a reversal of the preceding instructions with particular attention to the following:—

Ensure that the dog teeth of the baulk rings are in a good condition and that the grooves in the tapered bore of the baulk rings are not worn and are clean.

The gear cone that receives the baulk ring must be free from glazing or ridging.

Check the baulk rings for concentricity by "blueing" the corresponding cone and rotating the ring upon it. The results should show a corresponding blue marking on the tops of all the baulk ring grooves. Also lay the ring flat on a surface plate and check for distortion by using a ·001" (·025 mm.) feeler. Reject the ring if the feeler will enter between the ring and the surface plate.

Slide the third and fourth sliding sleeve on the hub and ensure that the splines engage easily without backlash.

Check the condition of the chamfers on the sliding sleeve internal splines to ensure each face is flat and free from burrs.

Examine the shifting plates for wear particularly at the centre protrusion and check that in each set all three are the same length. (The second speed synchro hub shifting plates are the longer of the two sets).

The synchro circlips should be renewed if they are weak or show wear at the contact faces with the shifting plates. Never fit a round-section circlip in conjunction with a square one.

Ensure that the synchro circlips are correctly located in the underside of the shifting plates and are so arranged that their 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. Reassemble the circlips so that one circlip passes across the underside of each of the three shifting plates and with the plain ends of the circlips pointing in opposite directions to each other.

The second speed synchro-hub circlips must be assembled in exactly the same way as for a third and fourth speed hub.

Test the baulking rings will slide freely within the sliding sleeve and the hub recess. Carry out this test with the sleeve assembled to the hub with the shifting plates and circlips in position.

End location of 3rd speed hub

On mainshafts fitted with a spring ring (34, inset B, Fig. 3) to locate the third and fourth synchro hub the thickest possible spring ring should be fitted by selective assembly of the five thicknesses of spring ring available. Ensure that the spring ring is fully located in the groove in the mainshaft. Always use a new spring ring.

On mainshafts fitted with a circlip to locate the third and fourth synchro hub (see inset C Fig. 3) a distance piece (34A) is interposed between the synchro hub and the circlip. The thickest possible distance piece that can be inserted between the synchro hub and the circlip should be fitted by selective assembly of the four thicknesses of distance piece available. Ensure that the circlip is fully located in the groove in the mainshaft. Always use a new circlip.

On later cars the third and fourth speed hub is secured by a nut and washer (1 and 2, Fig. 5f). Tighten the nut to a torque of 80 lb. ft. (11 kg. m. using a deep socket (Churchill RG 317) and with a suitable punch peen the flange of the nut into the indentation in the mainshaft (3, Fig. 5f). Always use a new nut on reassembly.

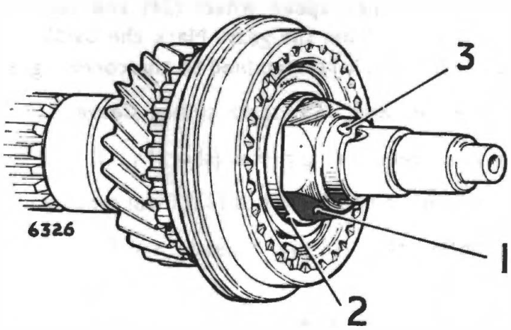


Fig. 5f. *Nut and washer securing 3rd and 4th speed synchro hub*

Poor Synchromesh

When a gearbox is stripped to rectify a complaint of this nature, the following items require particular attention:—

1. *Replacement baulk rings.* These must be thoroughly cleaned, paying special attention to the grooves in the cone faces. Check carefully for damage and burrs.
2. *Sliding sleeves and hubs.* Check for burrs, especially the edges of the shifting plate slots in the hub, and stone off if necessary. Offer up the baulk ring to the hub (without the sliding sleeve or shifting plates) and rotate. Any restriction between the limits imposed by the shifting plates will impair the operation of the synchro.
3. *Gear wheel synchro cones.* Examine the cone face. If annular ridges are found, change the wheel. Chech the new wheel for burrs.
4. *Reassembly.* Lap the new baulk ring to the synchro hub cone, using coarse metal polish.

LAYSHAFT ASSEMBLY

To remove and refit (mainshaft removed)

Extract the layshaft assembly complete with rollers (40, Fig. 3) abutment ring (41) and floating steel thrust washer (103) through the aperture in the front of the casing.

Remove the two bronze thrust washers (42) and (43).

Replacement is a reversal of the preceding operation with particular attention to the following:—

End float of the layshaft cluster between the thrust washers should be ·006in./·008in. (·152/·203 mm.). This clearance should be checked with the assembly in a dry condition and adjusted by selective assembly of floating thrust washer.

After insertion of needle rollers, place abutment ring in recess at the front of the cluster.

REVERSE WHEEL

To remove and refit (mainshaft and layshaft removed)

Withdraw rearwards, the reverse wheel spindle (46) from the casing.

Remove reverse wheel (45).

Replacement is a reversal of the preceding instructions.

REAR BEARING

To remove from casing

Support the gearbox on its face and press out the bearing. Should the bearing circlip (22, Fig. 1,) be removed from the bearing a new circlip must be fitted.

GEARBOX

To reassemble

During the assembly the following points must be borne in mind:—

Absolute cleanliness is essential.

Use a liberal supply of clean oil when assembling movable parts finally.

Check movable parts for freedom of movement.

Always fit new paper joints.

Seal gearbox casing at front end of layshaft spindle with a good brand of sealing compound.

All external setscrews must be dipped in a good quality non-setting jointing compound before assembling.

1. Fit reverse wheel and shaft into casing (gears to the rear).
2. With the aid of thick grease position the bronze layshaft thrust washers (large one to the front) in the casing.
3. See that there are twenty-seven needle rollers at each end of the layshaft cluster. Locate them with thick grease.
4. Fit abutment ring into the front of the cluster and lower cluster complete with dummy shaft into the casing, and then fit the rear floating steel thrust washer.
5. Pass the first and second synchrohub and second speed wheel assembly through the top of the casing with bevelled first speed teeth to the rear and enter the mainshaft through the front of the casing, passing its rear end through the first and second synchro assembly, and the bearing aperture in the casing.

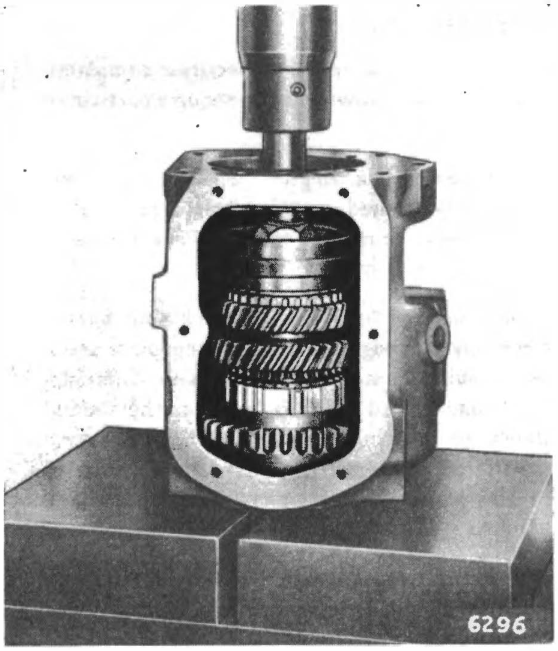


Fig. 6a. *Pressing mainshaft into rear bearing*

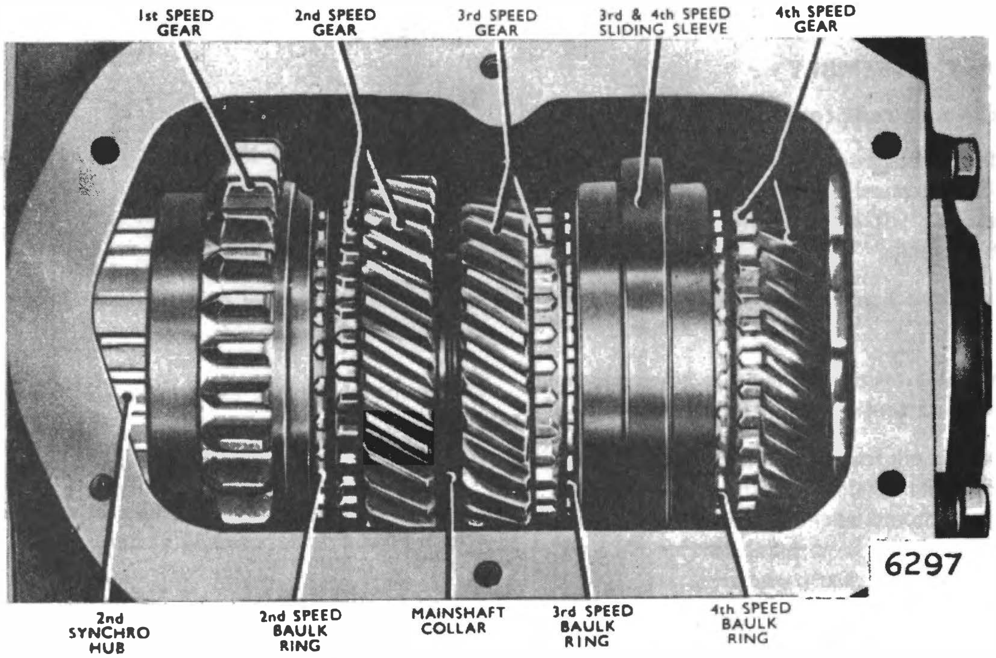


Fig. 6b. *Mainshaft assembled in the gearbox casing*

6. Fit the rear bearing and press it right home. On early cars (Inset B Fig. 3) fit the spacer (49), speedometer gear (48), spacer (35), lockwasher and nut (36) and (37). On cars fitted with the later type mainshafts (Insets C and D, Fig. 3), fit the lockwasher and nut (36 and 37), speedo gear and circlips (48 and 48A).

7. Ensure that the twenty-seven needle rollers are in position in the stemwheel and then fit the front cover and stemwheel assembly with the drain hole in the six o'clock position.

8. Invert gearbox and insert layshaft spindle through rear of casing, ensuring that the thrust washers at each end are correctly positioned.

9. Fit layshaft and reverse spindle lock plate.

10. Place gearbox upright and fit third and top, first and second and reverse forks. Fit reverse distance piece and shaft with long end of shaft to the front. Fit first and second and third and top shafts.

11. Refit rear cover and check that shafts are free and that all gears can be selected.

12. Fit top cover, taking care to position it so that the internal selector lever moves freely across the slots in the forks.

OVERDRIVE

The Laycock-de Normanville Overdrive unit gives an increase in propeller shaft speed of 24·67%, that is, it has a ratio of 0·802 : 1.

WORKING PRINCIPLES

At the top of Fig. 7, the unit is shown diagrammatically in direct drive. The cone clutch, which is fixed to an extension of the sunwheel, is held to the rear by spring pressure so that the inner friction band contacts the outside of the annulus. This locks the gear train, and the drive is transmitted directly through the uni-directional clutch. Any over-run or reverse torque is taken by the cone clutch.

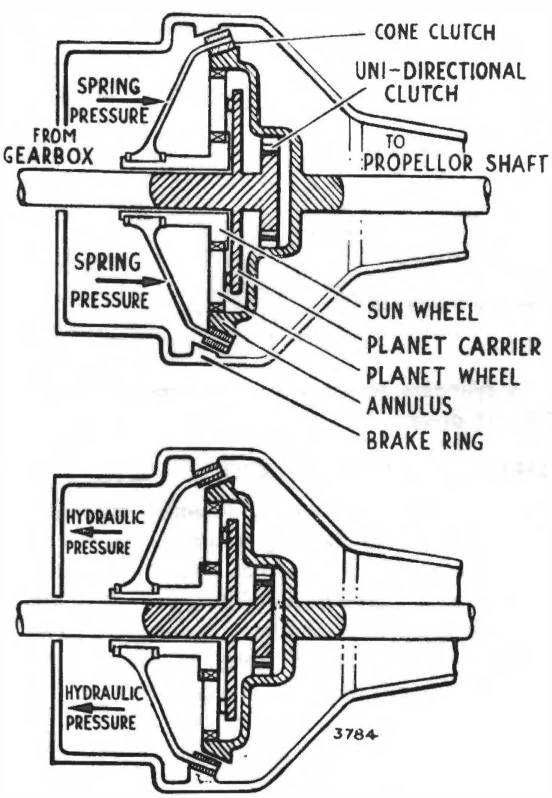


Fig. 7. *Diagrammatic sections*

The lower illustration in Fig. 7 shows the unit in overdrive. The cone clutch is held forward by hydraulic pressure so that the outer friction band of the clutch is locked to the stationary brake ring. As the cone clutch is splined to the sunwheel, the sunwheel is also held stationary. The planet carrier is splined to the input shaft, and is driven by it. The planet wheels are thus driven round the stationary sunwheel, and in so doing rotate the annulus and tail shaft at a speed greater than that of the input shaft.

THE HYDRAULIC SYSTEM (See Fig. 7)

A cam, keyed to the gearbox mainshaft, operates the plunger of a pump, which forces oil via its discharge valve, into the relief valve. The line pressure is kept constant by introducing a relief valve into the system.

From the pump, oil under pressure is passed to the operating cylinders via the operating valve

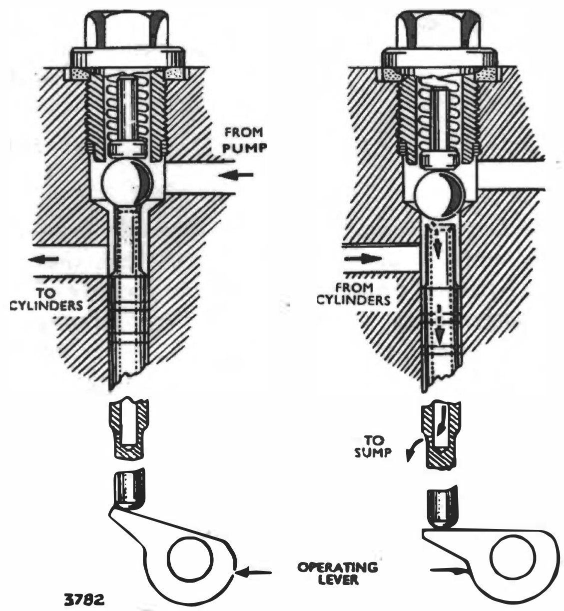


Fig. 8. *Operating valve*

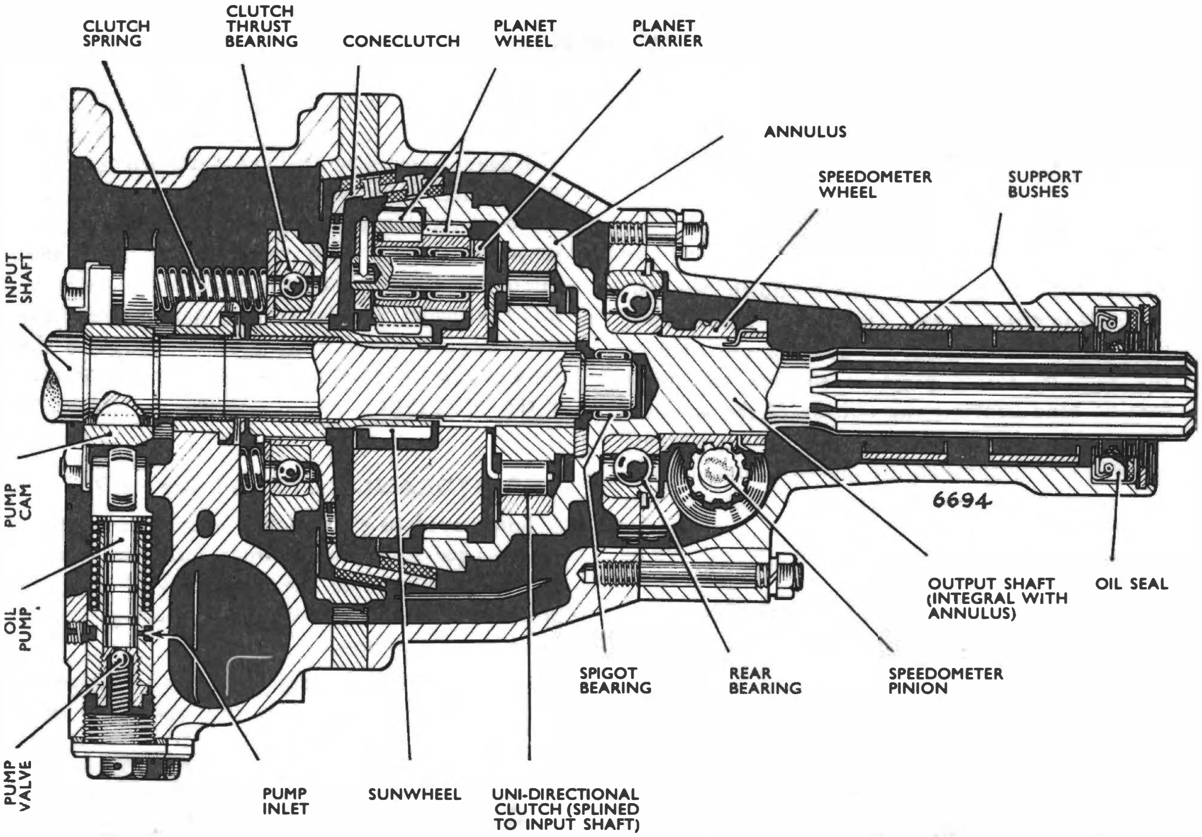


Fig. 9. *Sectional view of overdrive unit*

shown diagrammatically in Fig. 8. When the overdrive control is operated the valve is lifted, thus holding the ball off its seat against the pressure of the plunger spring. Oil then passes to the operating cylinders forcing the pistons forward. When the overdrive control is moved to the disengaged position, the spring plunger pushes the ball on to its seat, and the valve falls away from the ball. Oil from the cylinders then returns through the centre of the valve to the sump. Near the bottom of the valve is a small jet which slows down the emptying of the cylinders, to provide smooth re-engagement of direct drive.

CONTROL OF OVERDRIVE

The overdrive is actuated by a solenoid, controlled by a switch on the steering column. An isolator switch mounted in the gearbox top cover ensures that overdrive can be obtained only in third or top gear. Both these switches are connected in series with the operating coil of a relay, and the solenoid is energised through the relay contacts.

Self Cancelling Switch. (Fig. 13A)

When the overdrive switch is moved to the direct drive position, battery feed is applied to terminal W1, de-energising the relay coil. The contacts will open and the circuit to terminal C1 and the overdrive solenoid broken. Overdrive will disengage and the warning light will go out. The overdrive switch will return to the central position.

When the gear lever is moved out of the 3rd/4th gear position the gearbox switch will open and the circuit from the fuse unit broken. If overdrive had been engaged the relay coil will become de-energised, the contacts will open and overdrive will be disengaged. The warning light will go out. As the overdrive switch will have returned to the central position, it will be necessary to re-select overdrive, if required, after a gearchange is made from 2nd to 3rd gear. This ensures that overdrive is not engaged on changing from 2nd to 3rd gear.

A resistance in the lighting switch dims the warning light when the side lights are switched on. (Alpine III only).

LUBRICATION AND MAINTENANCE

The oil in the overdrive unit is common with that in the synchromesh gearbox and the level should be checked at the gearbox. To drain the gearbox and overdrive units, the gearbox and overdrive drain plugs must be removed.

Note:—*The overdrive drain plug is the one nearest the left side of the unit. The pump valve plug in the centre, and the relief valve plug on the right are wired together, and are not removed unless attention to valves is required.*

It is essential that the approved lubricant is used when refilling. Trouble may be experienced if some types of extreme pressure lubricants are used because the planets act as a centrifuge to separate the additives from the oil.

The combined capacity of synchromesh gearbox and overdrive units is 4 pints (4·4 American pints, 2·3 litres). If the units have been drained and refilled the oil level should be rechecked after the car has been run, since a certain amount of oil will be retained in the hydraulic system.

It must be emphasised that any hydraulically controlled transmission must have clean oil at all times, and great care must be taken to avoid the entry of dirt whenever any part of the case is opened. This applies to adding oil to the transmission and to servicing the unit. Any dirt or even lint from a wiping cloth that finds its way into a valve may cause serious difficulty. When the unit is dismantled for any service work the parts must be thoroughly cleaned and kept covered with an oily lintless cloth until reassembled. Similar care should be taken when handling the hydraulic valves, etc., since scratches or nicks might cause leakage on reassembly.

DIAGNOSIS OF FAULTS

When positioning the vehicle for the removal of the Overdrive, care must be taken that the vehicle is *NOT* brought to a halt by stalling in gear.

When transmitting torque in forward direct drive, the rollers of the unit directional clutch are forced towards the crest of the facets of the inner member, and if the vehicle is brought to a halt by stalling in gear, the rollers can lock in the drive position, thereby preventing the removal of the Overdrive unit.

If the overdrive unit does not operate properly, it is advisable first to check the level of oil and, if low, to top up with fresh oil and test the unit again before making any further investigations.

BEFORE COMMENCING ANY DISMANTLING OPERATIONS IT IS IMPERATIVE THAT THE OVERDRIVE SWITCH IS OPERATED TEN TO TWELVE TIMES WITH THE ENGINE STOPPED, IGNITION SWITCHED ON AND TOP GEAR ENGAGED TO RELEASE ANY HYDRAULIC PRESSURE FROM THE SYSTEM.

Faulty units should be checked for defects in the order listed below:

Overdrive does not engage

1. Insufficient oil in the gearbox.
2. Solenoid not operating due to fault in electrical system.
3. Control mechanism out of adjustment.
4. Insufficient hydraulic pressure due to leaks or faulty relief valve—Test pressure.
5. Leaking operating valve due to foreign matter on ball seat or broken valve spring.
6. Leaking pump non-return valve due to foreign matter on ball seat or broken valve spring.
7. Pump not working due to choked filter.
8. Damaged gears, bearings or shifting parts within the unit requiring removal and inspection of the assembly.

Overdrive does not release

IMPORTANT—This calls for immediate attention. Do not reverse car, as selection of reverse in overdrive can cause extensive damage.

1. Control mechanism out of adjustment or fault in electrical circuit.
2. Blocked restrictor jet in valve.
3. Sticking clutch.
4. Damaged parts within the unit necessitating removal and inspection of the assembly.

Clutch slip in overdrive

1. Insufficient oil in gearbox
2. Control mechanism out of adjustment.
3. Insufficient hydraulic pressure due to leaks, or foreign matter in valves.
4. Worn or carbonised clutch lining.

Clutch slip in reverse or freewheel condition on overrun

1. Control mechanism out of adjustment.
2. Blocked restrictor jet in valve.
3. Worn or carbonised clutch linings.
4. Insufficient pressure on clutch due to broken clutch springs.

Hydraulic knock

This knock occurs once per mainshaft revolution in direct drive and can be eliminated by relieving the hydraulic pressure in the direct drive position by scoring the operating valve ball seat in the casing as follows :—

Remove the operating valve as described on page 19. Grind a screwdriver blade as shown in Fig. 10 and holding it centrally, give a *light* tap, indenting two grooves in the seating. Alternatively score the seating with a sharp pointed scriber (one score should be sufficient if deep enough).

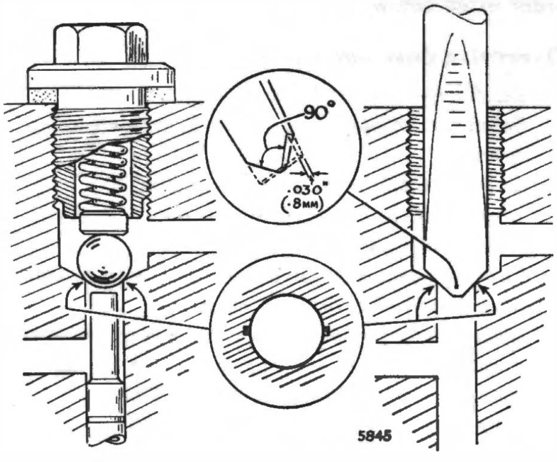


Fig. 10. *Scoring operating valve ball seat*

Remove Pump Valve, springs plug and replace with spring and plug Part No. 5039588.

It is essential that no foreign matter is allowed to enter the unit and that undue force is not used when striking the tool causing the operating valve bore to be belled out at the edge of the indents. If this occurs ream by hand the valve bore with a $\frac{1}{4}$" reamer, suitably greased, to clear the obstruction. Re-assemble the removed components and test.

This does not apply after Laycock Nos. 3082, 3083.

ADJUSTMENT OF CONTROLS

The operation of the controls can be checked by means of the hole in the solenoid lever on the right-hand side of the unit, accessible from under the car after removal of the cover plate. The controls are operating correctly when a $\frac{3}{16}$" diameter rod can be passed through the hole in the solenoid lever into the hole in the overdrive casing (see Fig. 11) with ignition switched on, top gear engaged and the steering column switch in the overdrive position.

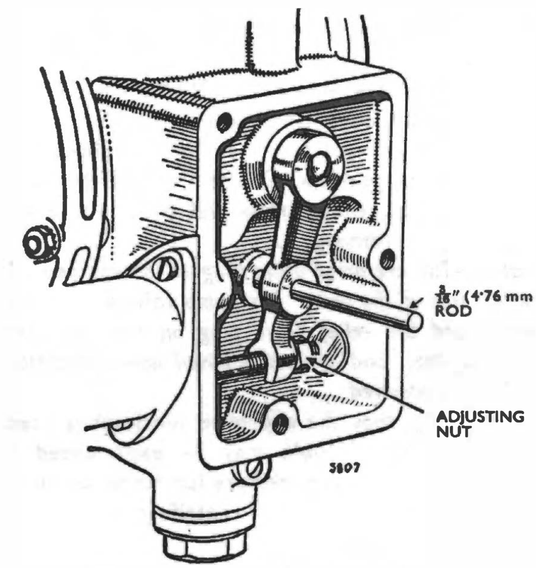


Fig. 11. *Checking setting lever position*

If the solenoid operates, but does not move the setting lever far enough to allow the rod to be inserted, the solenoid plunger must be adjusted. Adjustment is effected by screwing the self-locking nut on the plunger in or out, with the plunger pushed into the solenoid as far as it will go. The solenoid spindle must be held against rotation by using a suitable spanner. All units have two milled flats on the spindle for spanner access. The fork on the solenoid lever should just contact the nut with the $\frac{3}{16}$" (4·76 mm.) rod in position.

Ensure that with the control in the overdrive position the setting rod can be inserted, and that the solenoid current does not exceed 2 amperes. If the current is maintained in the order of 15 to 17 amperes, it is an indication that the solenoid plunger is not moving far enough to switch from the operating to the holding coil, and the plunger must be readjusted. This is important, as high amperage will cause solenoid failure.

If the solenoid does not operate, the electrical circuits should be checked. Circuit diagrams are shown in Figs. 13, 13A and 14.

Overdrive Isolator Switch Adjustment

The isolator switch is mounted in the gearbox top cover. It is operated, that is to say closed, by an abutment on the selector lever safety latch when the latter moves into the third and top gear plane.

Correct adjustment is most important because:—

1. The switch must ensure engagement of overdrive when this is selected in third and top gears and must maintain the electrical circuit to keep overdrive "in".
2. The switch must ensure that Overdrive does NOT engage in first, second or reverse gears.

To Check Adjustment:—

1. Switch on the ignition but do not start the engine.
2. Move the overdrive facia switch to OVERDRIVE.
3. Engage third or top gear; the safety latch will move over to the left pressing on the switch plunger. The switch is then closed.
4. As the switch CLOSES a distinct "click" from the overdrive relay will be heard and the warning light will illuminate on later Alpine and Rapier cars.
5. Move the gear lever back into NEUTRAL and through the neutral "gate" towards first and second.
6. The isolator switch should OPEN as the lever is moved through the NEUTRAL "gate" denoted by a further audible "click" from the relay and the warning light going out on later Alpine and Rapier cars.

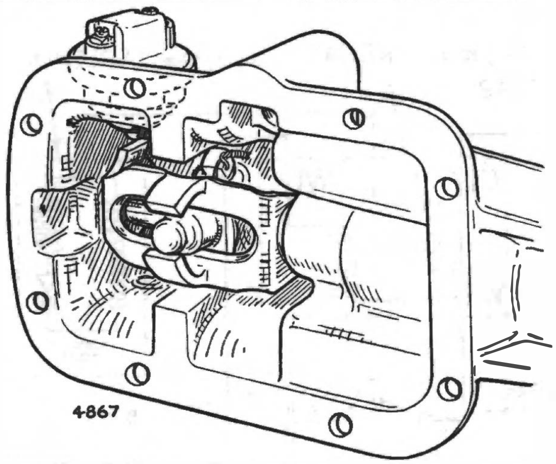


Fig. 12. *Gearbox top cover showing selector lever and safety latch with isolator switch abutment*

7. The isolator switch MUST be fully OPEN in the first and second speed range and will automatically be OPEN in the reverse range.
8. Engage first or second gear, operate the steering column switch and ensure that the overdrive relay and solenoid do not operate—denoting isolation of overdrive in first and second gears.
9. Road test to confirm correct adjustment—Overdrive will engage and remain engaged in third and top with steering column switch at Overdrive, and WILL NOT engage in first and second.

To Adjust:—

1. Remove rubber cover from switch and disconnect leads.
2. Unscrew switch from gearbox top cover and remove shims.
3. Screw switch up and down in top cover to obtain the setting previously described.
4. Measure with feelers the gap between the switch head and the top cover face.
5. Insert shims to the required thickness and tighten switch in top cover.
   The required shims are obtainable under the part number P.112524.
6. Check setting as described under "Isolator Switch—To check adjustment".

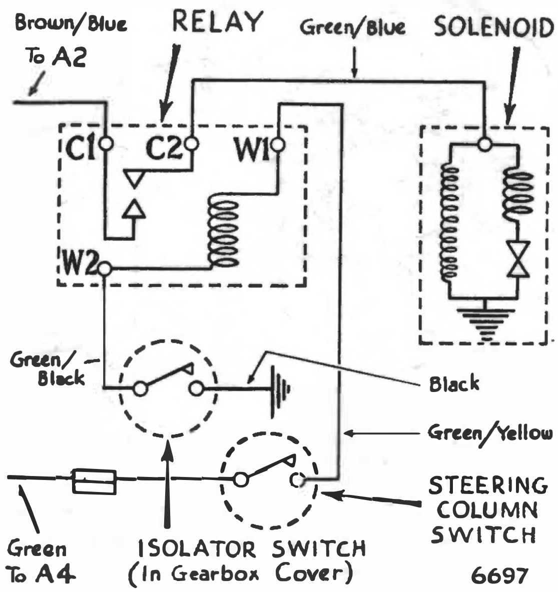


Fig. 13. *Circuit diagram Alpine I and II*

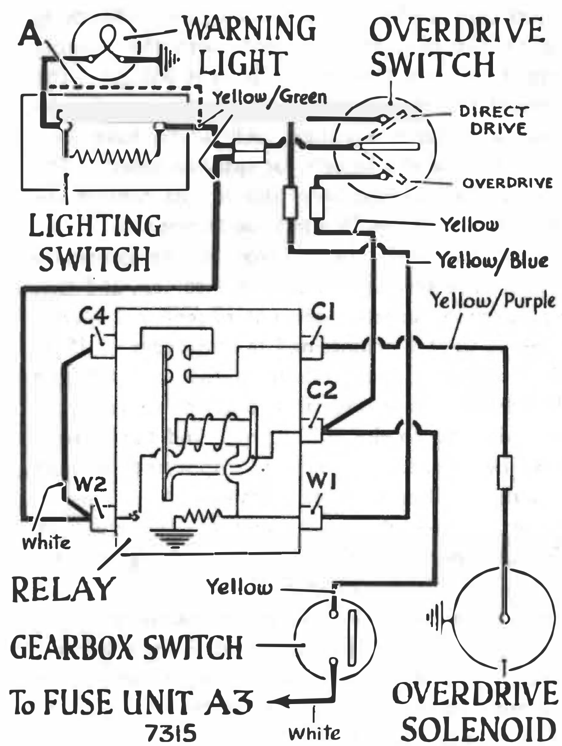


Fig. 13A. *Circuit diagram Self Cancelling Switch. (A Rapier and Alpine IV).*

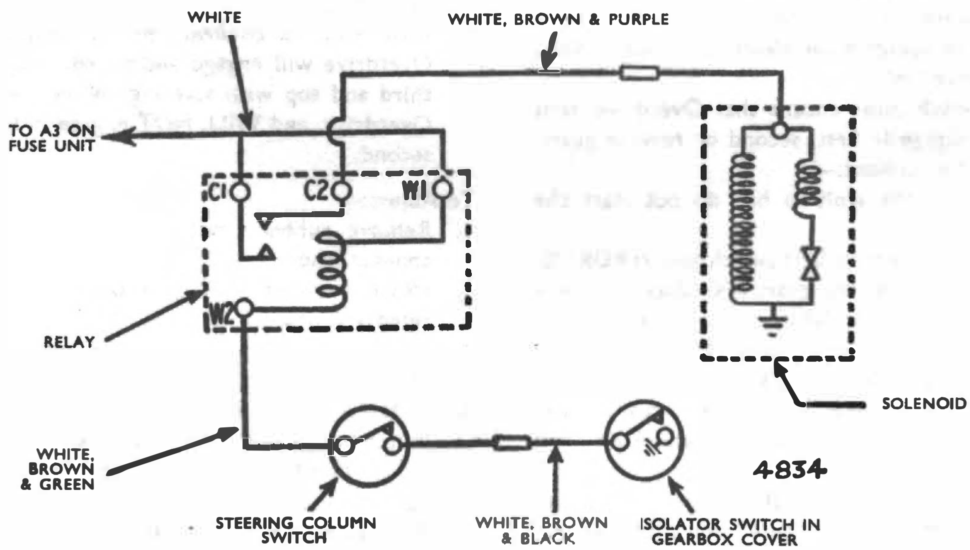


Fig. 14. *Circuit diagram (early Rapier)*

TESTING OIL PRESSURE

Release the hydraulic pressure as previously described.

Remove the operating valve plug and fit in its place the special adaptor (VLC. L.188). Use an oil pressure gauge reading to 800 lbs. per sq. in. (56·24 kgs. per sq. cm.) using a pipe union to fit the $\frac{1}{8}$" B.S.P. internal thread in the adaptor.

Jack up the rear wheels of the car, start the engine and engage top gear and overdrive with the engine ticking over slowly.

A pressure of 480—500 lbs. per sq. in. (approx.) (33·75—35·15 kgs. per sq. cm.) should be recorded.

THE OPERATING VALVE (See Fig. 8)

To gain access to the operating valve, remove the cover plate from the floor centre, on the driver's side. With the ignition on, top gear engaged and engine stopped, move the overdrive switch into and out of the overdrive position ten or twelve times to release hydraulic pressure.

Remove valve plug, take out plunger and spring and remove ball with a magnet.

The valve can be removed with a tapered piece of wood, but care must be exercised to avoid damage to the seating at the top of the valve.

Near the bottom of the valve will be seen a small hole breaking through to the centre drilling. This is the jet for restricting the exhaust of oil from the operating cylinders. Ensure that this jet is not choked.

If the unit fails to operate and the ball valve is found to be seating and lifting correctly check that the pump is functioning.

Jack up the rear wheels of the car, then with the engine ticking over and the valve plug removed, engage top gear. Watch for oil being pumped into the valve chamber. If none appears check the relief valve and pump valve.

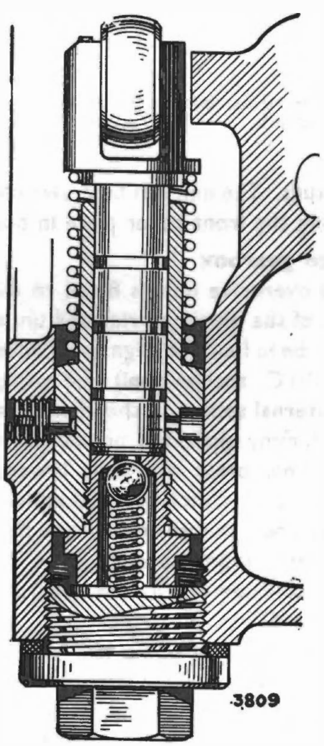


Fig. 15. *Oil pump and valve*

THE RELIEF VALVE

Access to the relief valve is gained through a plug in the bottom of the main casing (33 Fig. 19).

To dismantle

Release the hydraulic pressure as previously described. Remove the drain plug and drain off oil.

Remove the valve plug, this will release the valve spring and plunger (and ball on early units).

Remove the valve body.

Inspect the "O" ring, spring and plunger etc. for damage. The plunger (ball on early units) should be a sliding fit in the valve body.

THE PUMP VALVE (See Fig. 15)

Access to the pump valve is gained through the centre plug in the bottom of the main casing.

To dismantle

Proceed as follows:—

1. Release the hydraulic pressure as previously described. Remove the drain plug and drain off oil.

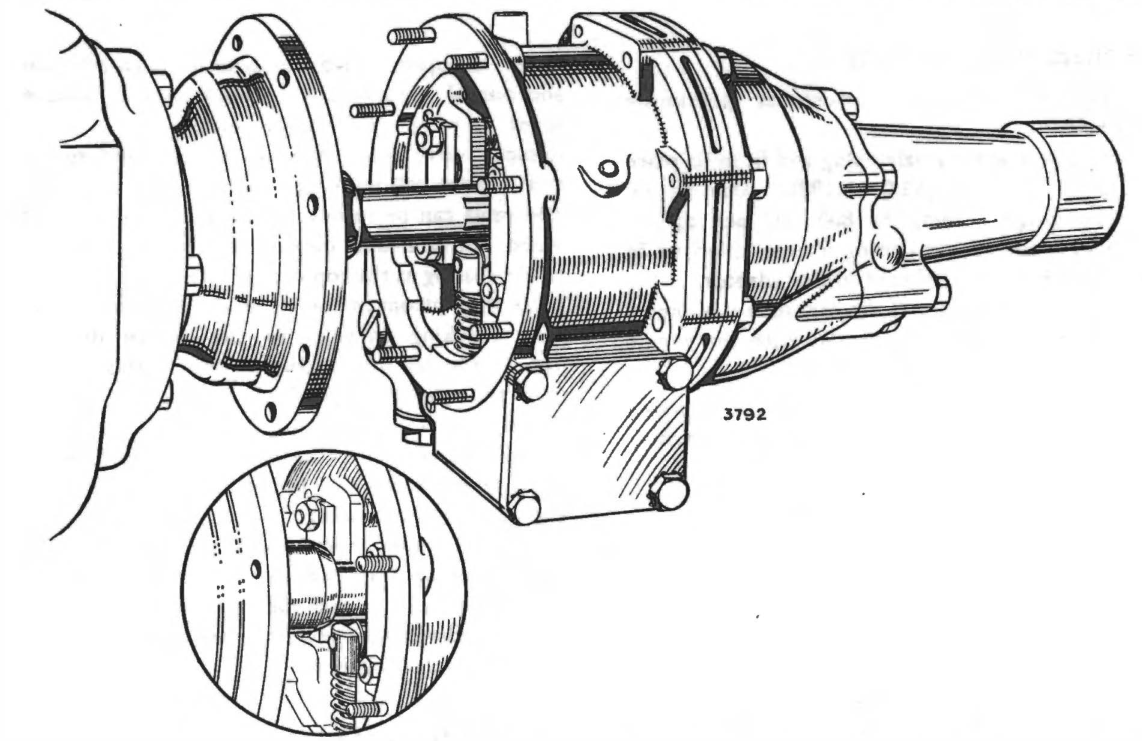


Fig. 16. *Overdrive ready for fitting to gearbox (Later units are fitted with an external balance pipe and a plug replaces the breather)*

2. Unscrew the valve cap and take out the spring and ball.

Reassembly is the reverse of the above operations. Ensure that the soft copper washer between the valve cap and pump housing is nipped up tightly to prevent oil leakage.

GEARBOX AND OVERDRIVE UNITS

To remove

Alpine I, II

Remove engine-gearbox-overdrive unit as described in Section B—"Engine—To remove and refit".

Alpine III onwards. See "Gearbox—To remove and refit".

Rapier

See "Gearbox—To remove and refit".

OVERDRIVE UNIT

To remove from gearbox

The unit is split at the front cover plate (adaptor plate) which is attached to the front housing by eight $\frac{5}{16}$" studs. The unit can be drawn off the main shaft, leaving the front cover plate in position.

To refit to gearbox

Before the overdrive unit is fitted to the gearbox the splines of the planet carrier and uni-directional clutch must be in line. To align them, insert dummy mainshaft (VLC. special tool) and engage it first with the internal splines of the planet carrier.

Turn the dummy shaft and planet carrier and, at the same time, press the shaft inwards until it engages the roller clutch internal splines.

Turn the gearbox mainshaft to locate the cam with its highest point facing upwards. The lowest point will then coincide with the overdrive pump plunger (Fig. 16).

The two splines and the pump cam will now be lined up correctly, and it is most important that neither the gearbox mainshaft nor the overdrive coupling driver is turned until the unit is fitted to the gearbox. The edge of the cam facing the overdrive unit is chamfered to enable the pump plunger to "ride" on to the cam as the overdrive and gearbox flanges come together.

SPECIAL TOOLS

A complete range of special tools are available for overhauling the Overdrive Unit.
They are obtainable from:—

Messrs. V. L. Churchill & Co. Ltd.,
Great South West Road,
Bedfont, Feltham,
Middlesex, England.

TO DISMANTLE

Assuming that the overdrive front cover has been retained on the gearbox as described, dismantle the overdrive unit in the following order, with the front end uppermost:—

Remove the operating valve, as described under the heading "The Operating Valve". This will allow air to enter the cylinders of the operating pistons and will thus facilitate removal of these pistons.

To remove the oil pump (rarely necessary) unscrew the valve seat in the valve orifice using VLC. Key L.213. Remove the body retaining screw. Screw VLC. Tool L.205 into the pump body and withdraw the body.

Remove 3 setscrews securing operating lever cover

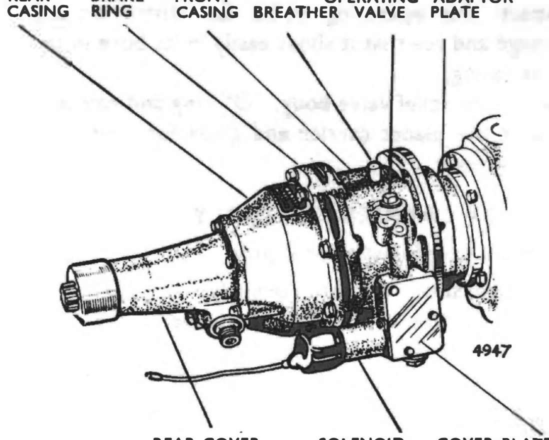


Fig. 17. *Side view of unit (Later units have an external balance pipe and a plug replaces the breather)*

assembly to the o/s of the unit (adjacent to solenoid). Remove cover.

Remove 2 screws securing solenoid to casing. Ease plunger out of operating lever yoke and remove solenoid.

Release the lockwashers securing the four ¼" nuts retaining the operating piston bridge pieces. Remove the nuts, lockwashers and bridge pieces and withdraw the operating pistons by gripping their spigots with pliers.

Disconnect the balance pipe, if fitted.

Loosen and progressively remove the eight ¼" nuts around the centre flange of the casing. This will gradually release the four clutch springs. Remove front half of casing complete with brake ring. Take the four clutch springs off their pegs on the thrust plate.

The brake ring is spigoted into each half and will normally come away with the front half of the casing. A few light taps with a mallet around its flange will remove the ring from the rear casing.

Lift out the clutch sliding member complete with the thrust bearing and sunwheel. If the cone clutch sticks in the brake ring, a light tap with a mallet on the rear end of the casing will free it.

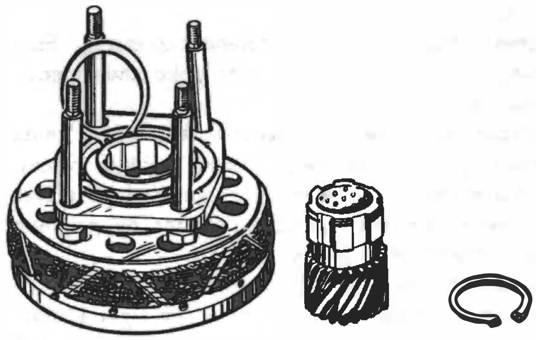
Remove the sunwheel from the sliding cone clutch member by withdrawing the sunwheel circlip from its groove in the forward end of the sunwheel hub.

Remove the thrust bearing and the thrust plate by removing the large circlip and pressing out the cone clutch hub from the thrust plate and bearing. Remove bearing from thrust plate assembly using VLC. Special Tool.

Remove planet carrier assembly. If necessary to remove roller clutch, first remove circlip and brass locating ring which is in an annular recess in front of the clutch.

Place fitting ring (VLC. Special Tool L.178) centrally over the front of the annulus and lift the inner member of the uni-directional clutch into it. This will ensure that the rollers do not fall out of the inner member. Remove the fitting ring and place the parts in a suitable container. Remove the spring ring, located between the hub and the cage.

Remove the bronze thrust washer fitted between the clutch inner member and the front face of the annulus.



3794
Fig. 18. *Cone clutch and sunwheel details*

A caged needle roller bearing is fitted in the annulus centre spigot. If it is necessary to remove this, use VLC. Special Tool.

Remove the speedometer drive pinion and bush, located by one dowel screw.
Remove the rear oil seal (if necessary) by screwing the taper thread of the outer member of the VLC. special tool into it and tightening the centre bolt against the rear of the tail shaft.

To remove annulus, first remove tail shaft casing, then remove circlip around rear ball bearing and drive out annulus and rear bearing forwards.

To remove rear bearing disengage lockwasher and remove ring nut securing speedometer driving gear and rear bearing with the special spanner supplied by VLC. Remove gear. Using the VLC. special tool, draw off the ball bearing.

Inspection

When the unit has been dismantled, each part should be thoroughly cleaned and inspected to determine whether any parts should be replaced.

As a guide the planned new dimensions are given at the end of this section. Inspect the front casing for cracks, damage, etc. Examine the bores of the operating cylinders for scores and wear. Check for leaks from the plugged ends of the oil passages.

Examine the clutch sliding member assembly. Ensure that the clutch linings are not burned or worn. Inspect the bolts locating the clutch springs and bridge pieces and see that they are not distorted. Ensure that the ball bearing is in good condition and rotates freely.
Inspect the clutch springs for distortion or collapse.
Inspect the teeth of the gear train for damage.
If the sunwheel bush is worn, the gear will have to be replaced, since it is not possible to fit a new bush in service, because it has to be bored to the pitch line of the teeth.

Inspect the face of the sunwheel front thrust ring in the front casing. This should be renewed only if deeply scored, and it is only subjected to sunwheel rotation whilst overdrive is in course of selection.

Inspect the uni-directional clutch. See that the rollers are not chipped and that the inner and outer members of the clutch are free from damage. Make sure that the outer member is tight in the annulus. Ensure that the spring is free from distortion.

Inspect the ball race on the output shaft and see that there is no roughness when it is rotated slowly.
Examine the tail shaft sleeve (reverse spline) bushes.
Inspect the mainshaft splines for nicks and burrs.
See that the oil holes are open and clean.
Inspect the oil pump for wear on the pump plunger and roller pin. Ensure that the plunger spring is not distorted. Inspect the valve seat and ball and make sure that they are free from nicks and scratches.
Inspect the operating valve for distortion and damage and see that it slides easily in its bore in the front casing.
Inspect the relief valve body, "O" ring and ball, etc.
Inspect the planet carrier and gears for tooth and bearing wear.

PLANET CARRIER ASSEMBLY

To remove planet wheel pins

This operation is not normally necessary, but should a pivot pin or planet wheel roller cage require renewing, adopt the following procedure:
Support the carrier on a suitable hollow abutment through which the pin will pass.
Using a suitable drift, drive the pin out, shearing the small Mills pin.
Temporarily replace the planet wheel pin and,

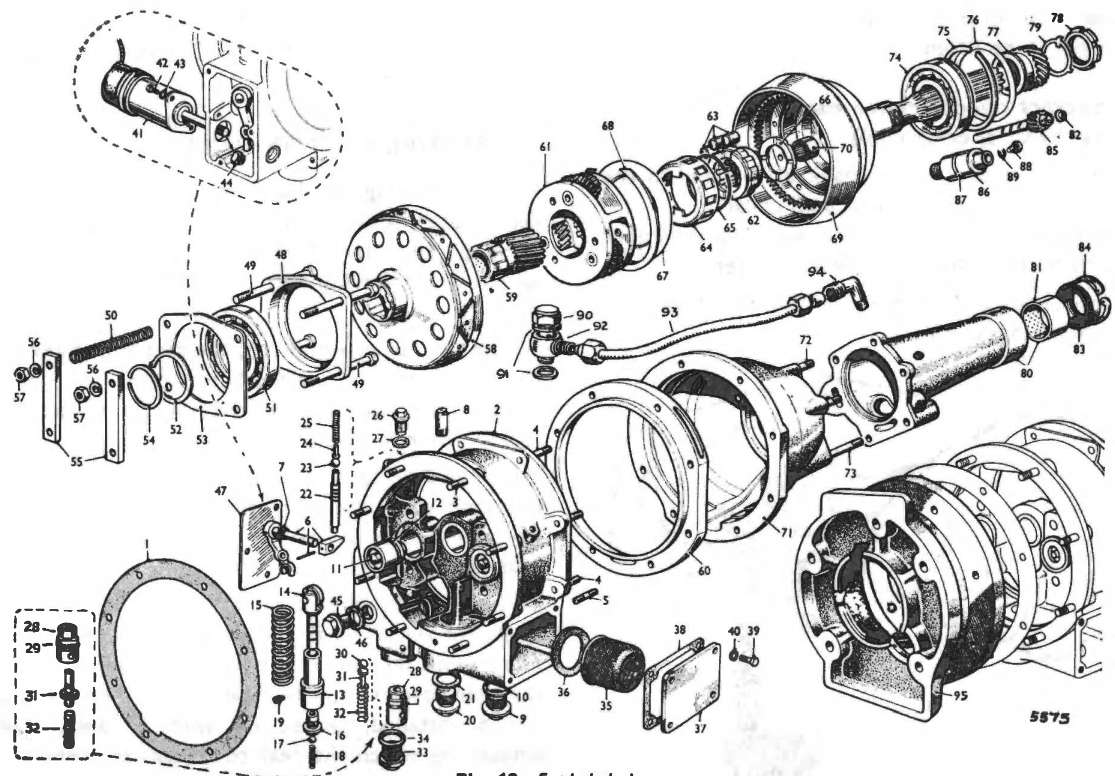


Fig. 19. *Exploded view*

1 Joint—Overdrive to gearbox adaptor.
2 Front casing.
3 Stud—Overdrive to gearbox adaptor.
4 Stud—Front casing to brake ring and rear casing.
5 Stud—Front casing to brake ring and rear casing.
6 Operating lever assembly.
7 Seating ring—Operating shaft.
8 Breather or plug.
9 Drain plug.
10 Drain plug washer.
11 Operating piston.
12 Piston ring (rubber).
13 Pump body.
14 Plunger.
15 Plunger spring.
16 Valve body.
17 Ball } Pump operating.
18 Spring } Pump operating.
19 Pump body retaining screw.
20 Cover plug } Pump.
21 Cover plug washer } Pump.
22 Operating valve.
23 Ball } Operating valve.
24 Plunger } Operating valve.
25 Spring } Operating valve.
26 Plug } Operating valve.
27 Washer } Operating valve.
28 Relief valve body.
29 Rubber ring } Relief valve. (Inset shows relief valve assy. from Chassis Nos. Rapier B.3010530 Alpine B.9009213
30 Ball }
31 Plunger }
32 Spring }
33 Plug }
34 Washer }
35 Filter.
36 Rubber joint—Filter.
37 Filter cover plate.
38 Filter cover plate gasket.
39 Set-screw securing filter cover plate.
40 Washer.
41 Solenoid and joint to casing.
42 Set-screw—Solenoid to casing.
43 Washer.
44 Nut—solenoid to valve lever.
45 Plug } Solenoid and valve lever adjustment.
46 Washer } Solenoid and valve lever adjustment.
47 Valve lever cover.
48 Bearing housing.
49 Pin } Clutch release.
50 Spring }
51 Bearing }
52 Circlip }
53 Retainer plate }
54 Snap ring } Clutch release.
55 Bridge plate }
56 Tab washer }
57 Nut }
58 Clutch cone.
59 Sunwheel.
60 Brake ring.
61 Planet carrier with wheels.
62 Ratchet } Free wheel.
63 Rollers }
64 Roller cage }
65 Circlip }
66 Thrust washer.
67 Retaining plate.
68 Circlip.
69 Annulus.
70 Mainshaft bearing.
71 Rear casing.
72 Stud—Rear casing to rear cover.
73 Stud—Rear casing to rear cover
74 Rear bearing.
75 Circlip.
76 Shim.
77 Speedometer wheel.
78 Locknut.
79 Tab-washer.
80 Rear cover.
81 Bush.
82 Thrust button, speedometer pinion.
83 Rear oil seal.
84 Circlip.
85 Speedometer pinion.
86 Bearing.
87 Oil seal.
88 Locking screw.
89 Washer.
90 Banjo bolts } Fitted from Chassis Nos. Rapier B.3005253 Alpine B.9005038
91 Washers. }
92 Banjo union }
93 Balance pipe }
94 Elbow union }
95 Gearbox adaptor.

using its small hole as a guide, drill out the broken end of the Mills pin in the carrier.

Note:—The drill size must be smaller than the new Mills pin to be fitted.

To extract needle roller cages (using VLC. special tool)

Secure the square ended shank of the tool in the vice and remove wing nut and all collars.
Slide the gear over the spindle and allow the roller cage to butt against the spindle shoulder.

Fit main body and wing nut and press the gear off the roller cages.

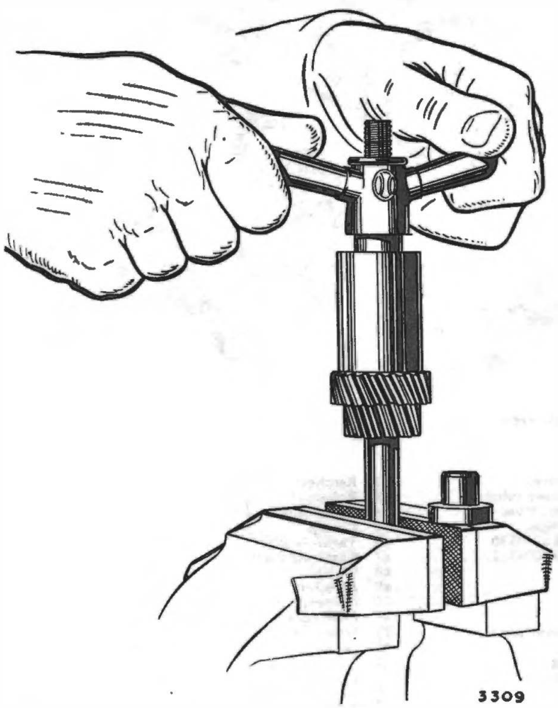


Fig. 20. *Removing roller cages*

To replace roller cages

Fit guide bush, flange downwards, over the shank of the tool. Place gear over guide bush followed by one roller cage, spacing collar and wing nut and press the cage right home.

Remove gear and collars, fit one collar, the gear inverted, second cage and collar. Screw second cage into position.

Treat each gear similarly and refit to the planet carrier, ensuring that the new Mills pins are a good driving fit in their holes.

REASSEMBLING THE UNIT

Fit rear bearing, circlip groove uppermost, over the output shaft, driving it into position against its locating shoulder behind the annulus. Fit speedometer driving gear, lockwasher and slotted nut.

Fit the annulus assembly into the rear casing and fit the circlip into the bearing outer track.
Ensure that the rear bearing circlip is located against the rear face of the casing.

The rear bearing is located at its rear end by the tail shaft cover assembly, and a shim is inserted into the recess of the cover to ensure that the bearing is trapped.

If a new bearing is fitted and it becomes necessary to assess the thickness of shims required, place two or more shims into the rear cover recess and offer up the rear cover to the rear casing with bearing and circlip installed, measuring with a feeler the amount by which the rear cover fails to meet the casing.

Remove the rear cover again, measuring the thickness of shims previously inserted, and subtract the gap already checked by feeler gauge from the thickness of the shims. This will assess the actual shimming required.

The rear cover can then be fitted and then the speedometer drive bush and pinion.

If the spigot roller bearing in the centre of the annulus is to be replaced, use VLC. special tool to insert bearing.

Assemble the spring into the roller cage of the uni-directional clutch. Fit the centre member into the cage and engage it on the other end of the spring.

Engage the slots in the inner member with the tongues on the roller cage and see that the spring rotates the cage to urge the rollers up the ramps of

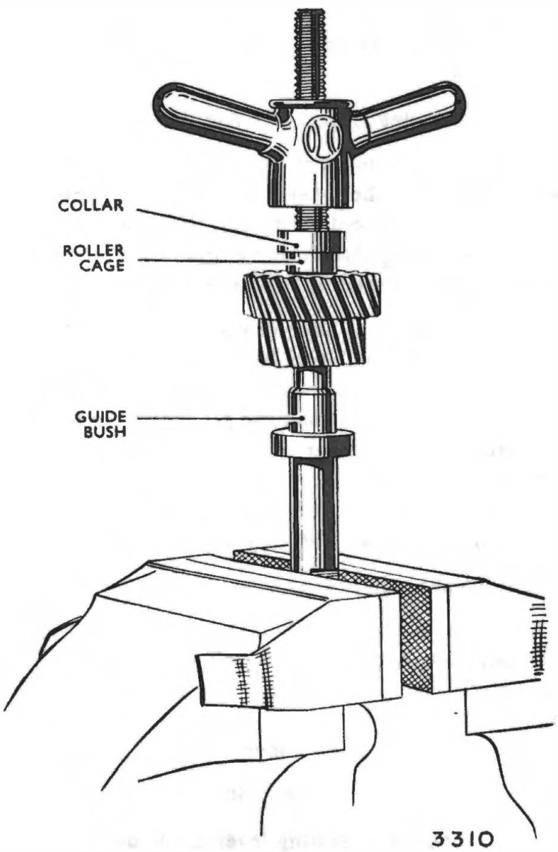


Fig. 21. *Fitting first cage*

the inner member. The cage is spring-loaded anti-clockwise when viewed from the front.
Place this assembly, front end downwards, into the fitting ring (VLC. L.178) and fit the rollers through the slots in the tool, turning the clutch clockwise. Replace the thrust washer and uni-directional clutch inner member with its rollers, cage and spring, using tool VLC. 178 to enter the rollers into the outer member.

Fit the brass protector ring into its groove in front of the roller clutch assembly. Fit circlip into recess to hold the brass ring in position.
Position the gears in the planet carrier by rotating each planet wheel until the etched line coincides with the etched line on the planet carrier.

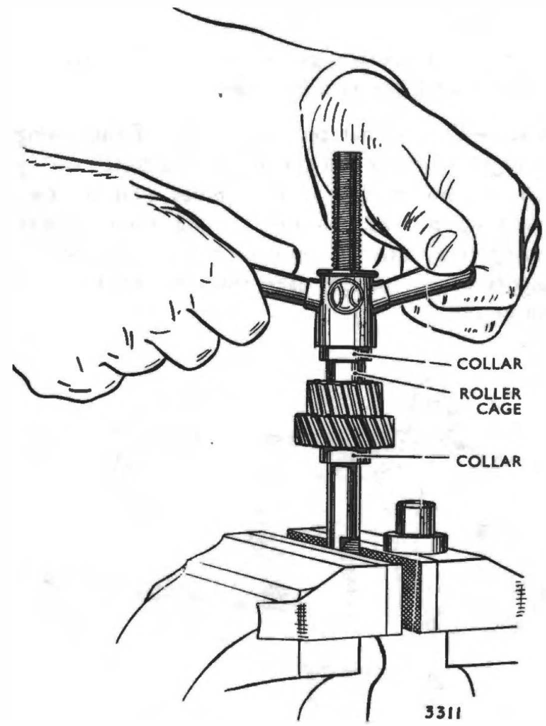


Fig. 22. *Fitting second cage*

Fit the planet carrier, pass the sunwheel splines into the open ends of the cone clutch member and fit the small circlip at the forward end of the sunwheel. Press the clutch bearing into the thrust plate, fit the 4 bolts of the thrust ring and then fit the clutch bearing assembly into the forward end of the cone clutch hub, securing the assembly in place by the large circlip on the hub. Fit the clutch assembly complete with sunwheel into the casing, engaging the sun and planet wheels. Fit the spacer plate over the bolts of the thrust ring bearing assembly and fit the 4 springs. Fit the front casing with the brake ring (large end of the taper towards the rear casing).

Carefully position the clutch ring bolts, which are shouldered, through the holes in the front casing. The clutch spring pressure will now be felt as the two halves of the casing go together, and it will be necessary to push the front half towards the rear half, start the nuts on the studs, securing the two halves of the casing together and gradually tighten the nuts until the two faces meet.

Note.—Ensure that the two halves of the casing go together easily and check that the clutch spring bolts are not binding in their holes. Fit the two operating pistons, carefully easing their rubber sealing rings into the cylinder bores. The centre spigots of the pistons face towards the front of the unit.

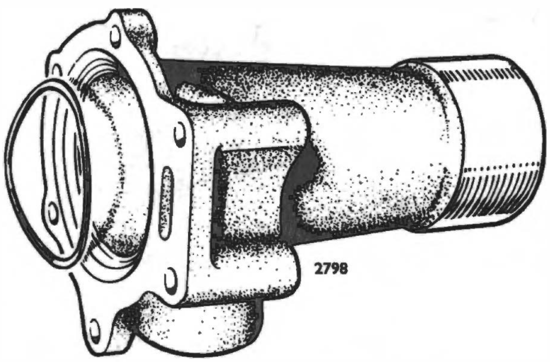


Fig. 23. *Rear cover and bearing shim*

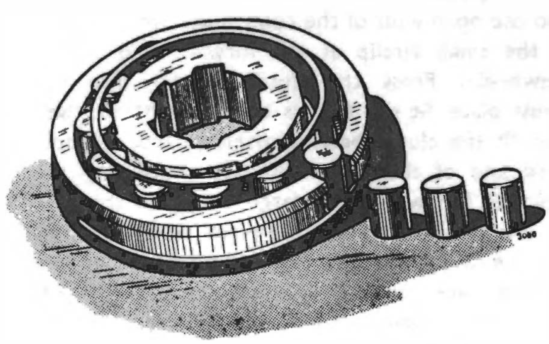


Fig. 24. *Assembling roller clutch*

If new "O" rings are fitted to the pistons, use VLC. special tool.

Fit the two bridge pieces, nuts and lockwashers.

Fit the solenoid plunger to the operating lever arm before installing the operating valve and spring; then fit the solenoid. Fit the operating valve assembly, ensuring that the lower operating plunger engages with the small cam on the operating shaft.

If the pump body has been removed (rarely necessary), insert its small end into the casing in the middle plug orifice at the bottom of the casing with the oil inlet port in the annular groove of the body facing towards its similar port in the main casing. Gently tap the body into position until the groove lines up with the grub screw hole at the bottom of the casing front face. Fit grub screw and tighten.

Fit pump valve, cap and washer.

Fit the relief valve assembly and plug in the right-hand bottom position of the casing and the drain plug in the left-hand bottom position. Fit and secure filter side cover plate. Insert the pump plunger and spring from above.

Fit the balance pipe. (Later Unit).

Do not yet fit the operating lever cover plate as it will be necessary to adjust the setting lever after finally fitting the unit to the car.

The assembly is now ready for fitting to the gear box unit.

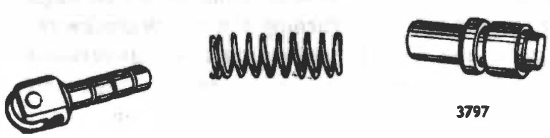


Fig. 25. *Oil pump components*

OVERDRIVE UNIT—DIMENSIONS AND TOLERANCES

Parts and Description	*Dimensions New*		*Clearance New*
Pump			
Plunger diameter	$\frac{3}{8}$"—·004" —·0008"	(9·525—·100) (—·020 mm.)	
Bore for plunger in pump body ...	$\frac{3}{8}$"+·0008" —·0002"	(9·525+·020) (—·005 mm.)	+·0016" (+·040 mm.) +·0002" (+·005 mm.)
Plunger spring fitted load at top of stroke	9 lbs. 7$\frac{1}{4}$ ozs.	(4·287 kgs.)	
Pump plunger spring free length ...	2"	(51 mm.)	
Valve spring load	3·15 lbs. at $\frac{9}{16}$" long	(1·428 kgs. at 14·29 mm.)	
Pin for roller	$\frac{1}{4}$"±·00025"	(6·350±·006 mm.)	
Bore for pin in roller	$\frac{1}{4}$"+·002" +·001"	(6·350+·050 mm.) (+·025 mm.)	+·00225" (+·056 mm.) +·00075" (+·020 mm.)
Gearbox Mainshaft			
Shaft diameter at sunwheel bush ...	$\frac{7}{8}$"—·001" —·002"	(22·225—·025) (—·050 mm.)	
Sunwheel bush internal	·877" ·878"	(22·276 mm.) (22·301 mm.)	+·005" (+·127 mm.) +·003" (+·076 mm.)
Shaft diameter at rear steady ...	$\frac{9}{16}$"+·0000" —·0005"	(14·288+·0000) (—·013 mm.)	
Torrington bearing	B·97		
Piston Bores			
Operating piston bore	$\frac{7}{8}$"±·0005" dia.	(22·225±·013 mm.)	
Clutch			
Clutch movement, $\frac{1}{16}$" nominal (1·6 mm.) from direct to overdrive			
Clutch spring free length	1·667"	(42·342 mm.)	

Relief valve — Summary of changes	**Introduction points**
1. Deep bore, 2" (50·8 mm.) long valve, $\frac{3}{16}$" (4·76 mm.) dia. ball.	First production to 32/1450/7781
2. Short bore, $1\frac{9}{32}$" (32·54 mm) long valve having $\frac{5}{16}$" (7·94 mm.) dia. spigot. $\frac{3}{16}$" (4·76 mm.) dia. ball ...	32/1450/7782 to 32/1536/1843
3. Short bore, $1\frac{7}{32}$" (31·0 mm.) long valve having $\frac{9}{16}$" (14·28 mm.) di . spigot. $\frac{3}{16}$" (4·76 mm.) dia. ball ...	32/1536/1844 to 25/3013/1965
4, As above with $\frac{5}{16}$" (7·94 mm.) dia. ball	Units from 25/3036 and 25/3037
5. As above with $\frac{5}{16}$" (7·94 mm.) dia. plunger	Units from 25/3046/1402 and 25/3047/3038
Relief valve spring free length ... 1·328" (33·73 mm.)	$\frac{3}{16}$" (4·76 mm.) dia. relief valve ball
1·182" (30·02 mm.)	$\frac{5}{16}$" (7·94 mm.) dia. relief valve ball and plunger type relief valve.

NOTE. Short bore casings having ball type relief valve (Paras 2, 3 and 4) may be modified to the later plunger type relief valve (Para 5). The new valve and associated parts are available as a kit.

ADDITIONAL INFORMATION

Adjustment of controls

From late Series IV models onwards, the control is fitted with an adjustable stop pad. (See Fig. 26). Carry out all checks and adjustments, detailed on Page 16, as necessary.

When these are completed, release the locknut (A). Fig. 26.

With the $\frac{3}{16}$ in. (4.76 mm) dia. rod (B) in position and the adjusting nut (C) on the solenoid plunger (D) touching the fork (E), screw in the stop pad (F), until the inner face of the recess in the pad (F) makes contact with the end of the adjusting nut (C).

Then screw the stop pad (F) back three full turns.

When correctly set, the clearance between the end of the adjusting nut (C) and the inner face of the recess in the stop pad (F), should be .150 in (3.8 mm).

By following the method given here, the clearance is correct, without the need to take measurements.

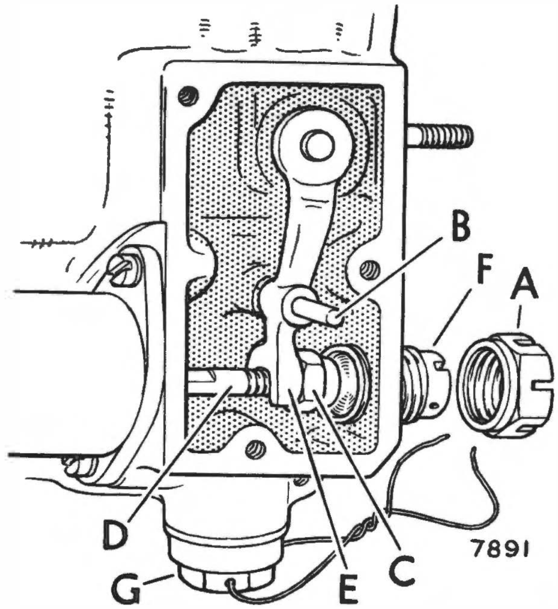


Fig. 26. *Stop pad adjustment*

Finally, tighten the locknut (A), and secure by wire-locking to the relief valve plug (G).

FRONT SUSPENSION
AND
SHOCK ABSORBERS

CONTENTS

FRONT SUSPENSION

SCREW THREADS OF THE UNIFIED SERIES ARE USED ON THIS UNIT

GENERAL DESCRIPTION

Series I to IIIA Models

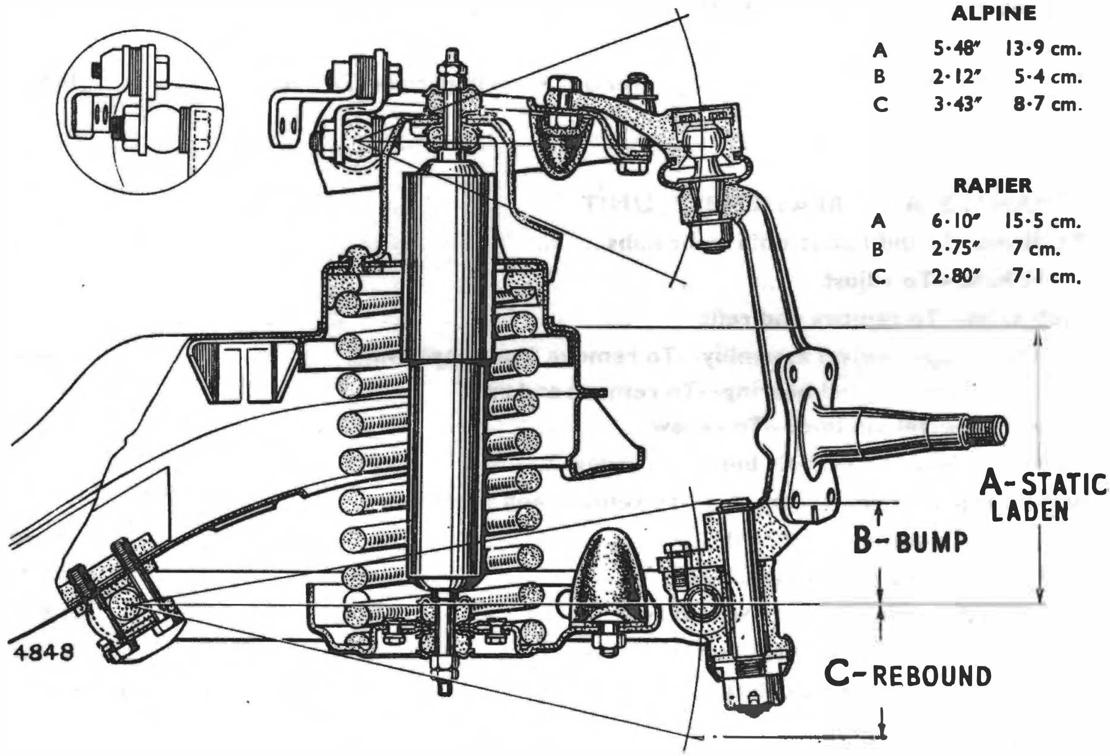
The front suspension is of the coil spring and unequal length wishbone type, employing long inner fulcrum pins threaded at each end to carry the bushes of the upper and lower links. Provision for camber adjustment is made by the insertion of shims between the upper fulcrum pin and its bracket location on the crossmember (Fig. 1, inset, and Fig. 13, inset).

The stub axle is located, by means of a ball socket assembly, directly into the outer end of the upper link and by means of a short swivel pin into the trunnion. A short threaded eyebelt completes the connection between trunnion and lower link. Thrust is taken via a nut and thrust washer to the lower face of the stub axle swivel.

This design obviates the necessity for a separate stub axle carrier, thus affording a saving in unsprung weight. A sectional view of the near side of the front suspension is shown in Fig. 1.

On Alpine Series II and III Models onwards the top swivel bearing assembly is self-lubricated and requires no attention. No grease nipple is fitted.

In the following paragraphs detailed instructions are given for checking and correcting such items as track (toe-in) and wheel camber and for checking the castor and steering axis inclination angles. To avoid inaccuracies in steering geometry, and consequent excessive tyre wear, it is most important that these procedures are observed.



ALPINE

A	5·48″	13·9 cm.
B	2·12″	5·4 cm.
C	3·43″	8·7 cm.

RAPIER

A	6·10″	15·5 cm.
B	2·75″	7 cm.
C	2·80″	7·1 cm.

Fig. 1. *Sectional view of front suspension on near side*

TO CHECK AND ADJUST FRONT SUSPENSION DIMENSIONS AND SETTINGS

The following settings and dimensions will require checking in the event of early tyre wear, tyre squeal or accident damage. When accident damage has occurred the underframe alignment should be checked.

1. **Wheel camber angle.** This angle is adjustable and is the angle of inclination of the road wheel from the vertical when viewed from the front. Inclination outwards is termed positive camber and inclination inwards negative camber.
   The correct camber angle is given in the Data Section. It is most important that this angle is obtained whenever it is necessary to adjust wheel camber.

2. **Castor angle.** This is the rearward tilt of the axle carrier pivot and is not adjustable. The castor angle varies with the vehicle load and is greatest when the rear of the vehicle is heavily laden.

3. **Steering axis inclination (K.P.I.)** or the angle at which the axle carrier centre line is inclined from the vertical as viewed from the front of the car. 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.**

5. **Ackerman angles or toe-out on turns.** This is important as incorrect wheel alignment under these conditions gives rise to excessive tyre wear and tyre squeal when cornering.

6. **Ball pin heights.** These are:—
   (*a*) The dimensions between the lower link outer fulcrum pin centre and the centre of the taper hole in the underside end of the steering arm.
   (*b*) The lower link inner taper fulcrum pin centre line and the underside centre of the taper hole in the end of the drop arm or relay lever.

The method of checking and adjusting these settings is given in the following paragraphs.

Tools and appliances

In addition to the tools listed in Section 'S', the following equipment will be required:—

Camber, castor and steering axis inclination gauge with 2 turntables.

Front wheel track alignment gauge (1 required).

Any reputable brand of equipment may be used but the use of Weaver and Churchill gauges is described herein.

Should the equipment locate on the wall of the tyre or wheel rim, it is necessary to ensure that the tyre and road wheel run "true" within the specified limit, and that the gauge is held on that part of the tyre having no extremes of run-out.

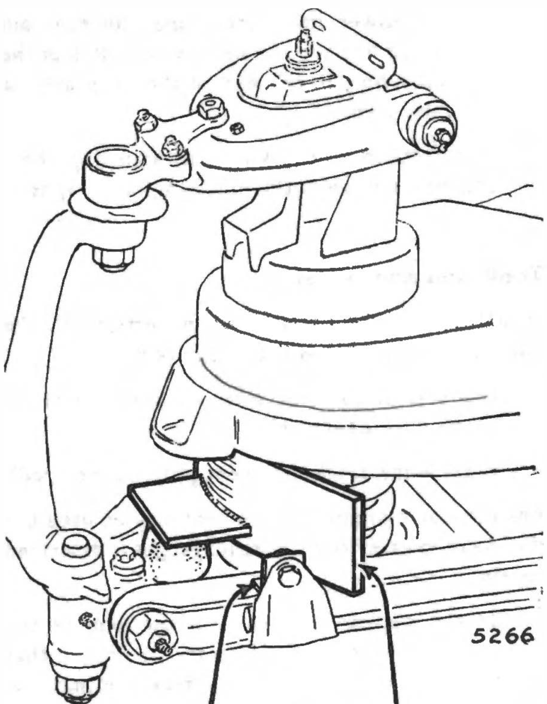
When the instrument locates on the stub axle itself, it is essential that it is firmly fixed, after removal of the hub cap, to the hub retaining nut, so that there is no relative movement between the gauge and the stub axle.

The equipment described may be obtained from:—

Messrs. V. L. Churchill & Co. Ltd.,
Great South West Road,
Bedfont, Feltham,
Middlesex,
England.

and

Weaver Manufacturing & Engineering Co. Ltd.,
Bedford,
England.



Gap gauge must not rest on stabilizer clip bracket. *Steel gap gauge.*

Fig. 2. *Front suspension loaded down onto steel gap gauge*

The Churchill equipment consists of tracking gauge and camber/castor and steering axis inclination checking gauge.

The Weaver equipment consists of turntable and wheel alignment indicator.

The Weaver wheel alignment indicator will be found to be unsuitable for cars fitted with centre lock wire wheels due to recessing of the stub-axle end nut within the hub. The Churchill camber gauge should therefore be used.

Illustrations of the various tools in use are given in the following pages.

PREPARATION OF VEHICLE

When carrying out checks on the front suspension and steering dimensions, the following requirements must be met. It should be noted that item 5 entirely supersedes previous methods of obtaining the static laden condition.

1. The car must be placed on a perfectly level floor or level ramp.

2. Tyres must be inflated to their correct pressures and have the same amount of wear.

3. For checking the front wheel track the car should be in a normally laden condition.

4. Both front wheels must be checked for "run-out". To do this, spin each wheel, holding a piece of chalk close to the sidewall of the tyre.

   By moving the chalk progressively nearer the tyre until it makes contact, the point of greatest "run-out" will be marked.

   Always set the wheels so that the points of "run-out" are well away from the points of contact of any gauges which may be used.

   Therefore when checking camber, castor and steering axis inclination set the "high-spots" horizontally opposite one another, and when checking toe-in set them vertically.

5. The car is loaded on to four gap gauges by placing weights at the front of the car. The amount required is approximately 300 lb. (136 kg.) evenly distributed on a platform, comprising of a wooden plank supported by two suitably cranked steel bars $\frac{7}{8}$ in. (22 mm.) square inserted into the front jacking sockets.

   At the front, steel gap gauges are used, see Fig. 2 or 28. At the rear, hardwood gap gauges are used; these are shaped to clear the hydraulic pressure pipes, the bump rubbers and fit round the axle casing, see Fig. 3. Normally the rear end of the car is lifted by hand to enable the rear gap gauges to be positioned and suubseqently gripped in position by the lowering of the car. When these gap gauges are a slack fit, a small weight is placed on the rear end of the car to bring it on to the gap gauges.

6. Keep the front wheels in the straight ahead position and gently move the car forward; the front wheels on to the turntable gauges and the rear wheels on to wooden ramps the same thickness as the turntable gauges. Stop the car without applying the brakes, so the free condition of the turntable gauges is not disturbed. Lock all four wheels by blocking the brake pedal in the " on " position.

To check toe-in

IMPORTANT: If the tyre wear is excessive, a complete steering geometry check should be made.

The correct toe-in is given in the General Data Section and it is of the utmost importance that this adjustment is maintained. The steering unit and steering wheel must be in the mid position and the front wheels must, at the same time, be in the straight ahead position. The alignment gauge demonstrated herein is the Churchill Tracking Gauge 95 B.

Lock the vertical arms parallel by means of the knurled locking collars. (See Fig. 5).

Push the dial pointer back into its sheath and retain it there with the clamping screw under the dial head. (See Fig. 6).

Loosen knobs B and C (Fig. 5) so that the gauge can be adjusted to the width of the car.

Place the gauge in front of the front wheels with the dial at the right-hand side of the car, and adjust for width so that the fixed pointer is resting against the outer wall of the left-hand front tyre and the sheath of the dial pointer is approximately ¾ in. (19mm.) from the outer wall of the right-hand front tyres.

Tighten knobs B and C.

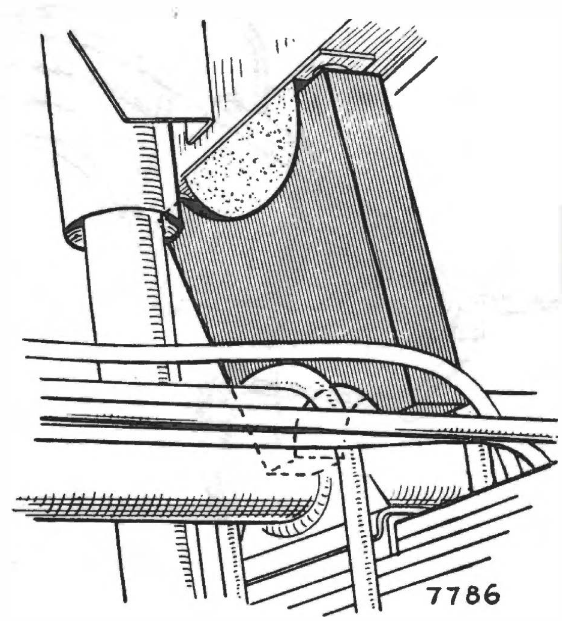


Fig. 3. *Rear gap gauge in position, ensure that the rear bottom corner is clear of the hydraulic pressure pipes*

Adjust the vertical pointer arms, by slackening knobs D and E, so that both pointers are at hub height.

Mark each tyre where the pointers make contact, with chalk.

Release the dial pointer from its sheath.
Release the knurled locking collars.

Rotate the dial to "Zero" and secure in that position with clamp screw at the side of the dial.
Retract the dial pointer and lock in its sheath.

Lock the vertical pointer arm with the knurled locking collars.

Remove the tracking gauge, and place it to one side of the car.

Roll the car forward so that the wheels turn through 180°, bringing the chalk marks to the hub height at the rear of the front wheels.

Place the gauge under the car at the REAR of the FRONT wheels with the dial pointer to the left-hand side of the car. (See Fig. 6).

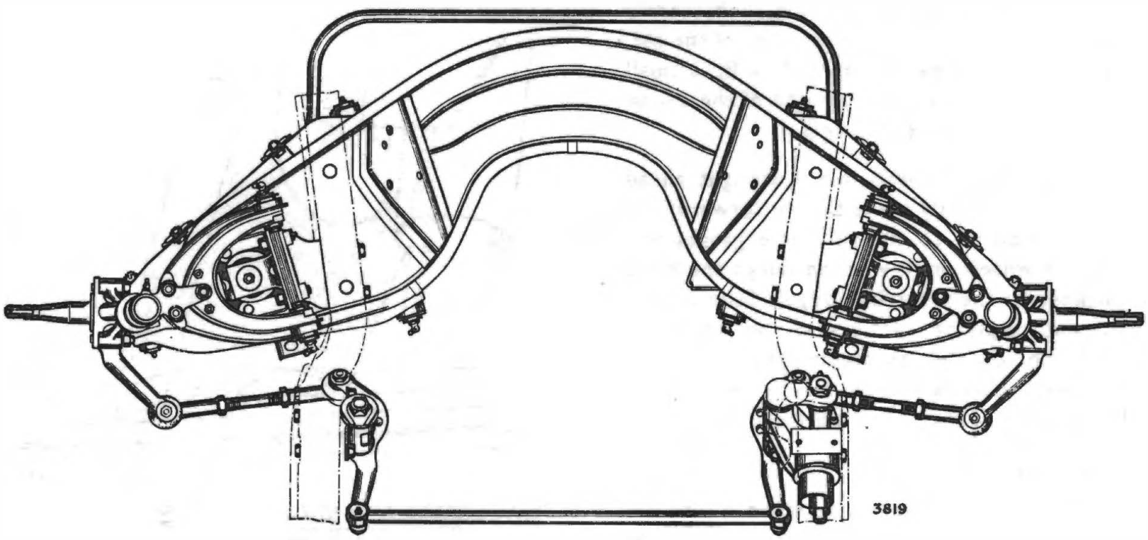


Fig. 4. *Plan view of steerage linkage*

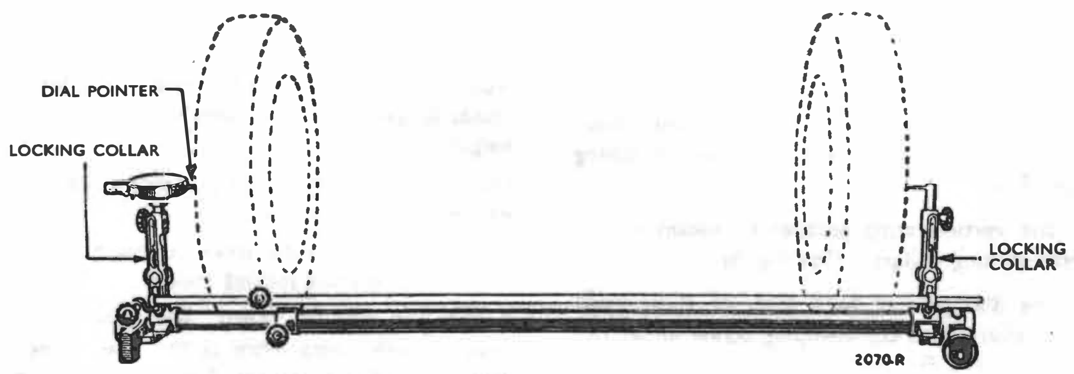


Fig. 5. *Churchill tracking gauge in position at front of front wheels*

Release dial pointer so that it comes into contact with the chalk mark on the tyre wall, and check the free movement of the gauge.

Take the reading on the dial. (See Fig. 6).

If correct, retract the dial pointer and remove the gauge.

To adjust track (toe-in) setting

Leave the gauge in position.

Slacken the locknuts at each outer track rod ball joint.

Note the difference between the dial reading and the recommended setting and HALVE this figure. Adjust the track by rotating each track rod equally until the pointer on the dial has moved the amount of this final figure in the required direction. (Any adjustment made at the rear of the wheels is duplicated at the front of the wheels in the opposite direction so that the effective adjustment made to the track is double the amount shown on the dial). Re-tighten the track rod end lock-nuts.

When tightened, it is important that the sockets at either end of each track rod are centrally disposed with the ball pins so that the track rod may be free to turn slightly.

If the wheels are badly out of alignment, this may be due to a track rod (cross tube) having bent through accidental damage. In such cases the track rod should be renewed.

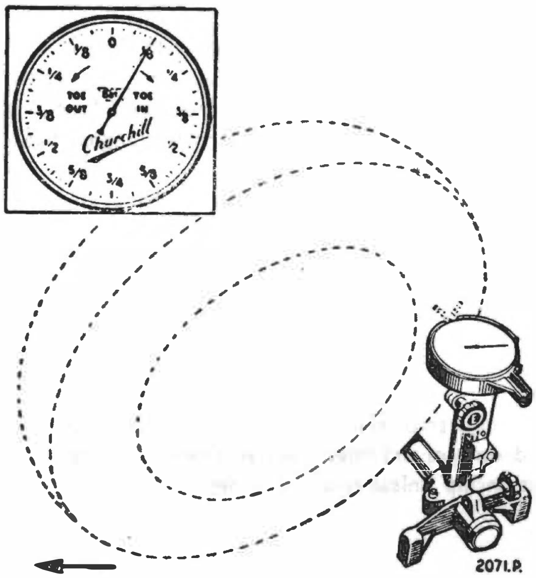


Fig. 6. *Tracking gauge in position at rear of front wheels. Inset shows reading of $\frac{1}{8}$" toe-in. Track must be adjusted to the toe-in figure given in the General Data Section under Front Suspension*

Example of correction to track setting, using the Churchill 95 B track gauge:

If required track setting is $\frac{3}{16}$" (4·7 mm.) toe-in.
Gauge shows $\frac{5}{16}$" toe-in.
Excess is ($\frac{5}{16}$"—$\frac{3}{16}$") $\frac{1}{8}$".
Half of $\frac{1}{8}$" is $\frac{1}{16}$".
$\frac{5}{16}$" less $\frac{1}{16}$" is $\frac{1}{4}$".

Adjust track until indicator shows $\frac{1}{4}$" toe-in.

Re-check track toe-in setting after adjustment.

Important

With optical gauges or any type that does not require the road wheels to be turned through 180° it is vital that the wheel run-out should be checked and the points of maximum run-out set in the vertical position.

Setting of outer track rods

If new track rods are being fitted after accident damage, or if excessive tyre wear is present, the following procedure should be observed to ensure correct Ackerman (toe-out on turns) when the wheel track is correct.

1. Disconnect each outer track rod inner ball joint from the drop arm and idler lever.
2. Count the number of steering wheel turns from lock to lock (in the steering unit).
3. Obtain the midposition of the steering unit by turning the wheel back half this amount from full lock, **and keep it in this position.** N.B. It is most important that great accuracy is observed when carrying out items 2 and 3, and it is recommended that the steering unit is marked appropriately and a datum line or pointer is used to achieve this.
4. If necessary, reposition the steering wheel on its splines so that the spokes are straight across.
5. Reconnect track rods to drop arm and idler lever.
6. Prepare the car for a steering geometry check as described in this section under TO CHECK AND ADJUST FRONT SUSPENSION DIMENSIONS AND SETTINGS.
7. Check the measurement at the front of the car between the centre of each tyre tread and the greaser on the lower link inner fulcrum pin.
8. These measurements should be equal on each side with the steering unit and idler lever in the straight ahead position.
9. Adjust each outer track rod until these measurements are equal. **The track rods**

may not necessarily be of equal length when this has been done—ignore this.

10. Check the front wheel toe-in before tightening the track rod lock nuts and adjust both outer track rods EQUALLY to obtain the correct toe-in.

Important

Attention is drawn to the vital importance of maintaining correct alignment of steering ball joints.

If any misalignment exists, angular deflection of the pins under conditions of bump and rebound may cause the sides of the pins to contact the necks of the ball joint housings. This condition is liable to promote a high rate of wear resulting in early failure.

Therefore the importance of checking this point, after track rod adjustment, cannot be over-emphasized.

When track has been adjusted or the ball joint lock nuts slackened for any purpose, it is essential to make sure that the pins are CENTRAL IN THEIR HOUSINGS when the vehicle is in the static laden condition.

It is recommended that the ball joint alignment is checked as a routine measure during the 12,000 miles (19,200 km.) service.

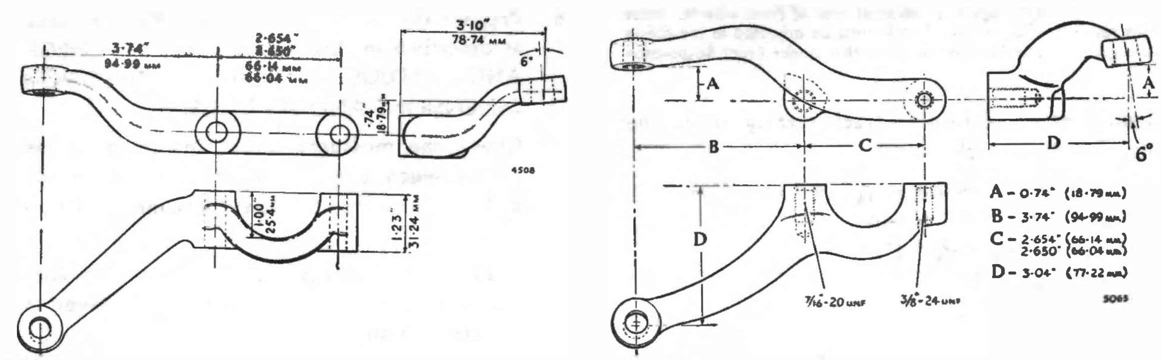
Ackerman angles (toe-out on turn)

When the front wheels are turned from the straight ahead position to negotiate a left- or right-hand bend the arc described by the front wheel nearest the inside of the bend is of smaller radius than the arc described by the outside wheel.

In order that each front wheel shall follow its respective arc, the inside wheel, or the wheel nearest the centre of turn, requires more "lock", *i.e.*, it must be turned through a greater angle, than the outside wheel.

To achieve this, the steering arm attached to each stub axle is set inwards when viewed from above, and the steering drop arm and idler lever must be disposed correctly to their respective steering arms. This is ensured by correct outer track rod adjustment.

The centre track rod is not adjustable and therefore the drop arm and idler lever will remain in correct relationship unless this rod is bent.



ALPINE **RAPIER**

Fig. 7. *Steering arm dimensions*

To check Ackerman angles

Prepare the car as described in "Preparation of vehicles", THIS IS IMPORTANT. Check the front wheel camber angle, front wheel alignment and correct as necessary.
Set the front wheels in the straight ahead position on two turntable gauges. Level the car by raising the rear wheels with packing pieces the same thickness as the turntable gauges.
Move the right hand front wheel through a 20° turn to the left and note the gauge reading of the turntable gauge under the left hand front, wheel. Move the left hand front wheel through the 20° turn to the right and note the gauge reading of the turntable gauge under the right hand front wheel.
When these gauge readings are outside the specified "inner wheel" figure given in the "General Data Section", one or more of the following faults can be suspected which must be corrected.

(*a*) The outer track rod lengths are not correctly set. They should be adjusted as described in earlier paragraphs under "Setting of Outer Track Rods".

(*b*) A track rod is bent.

(*c*) A steering arm or arms are bent.

Fig. 7 gives the correct dimensions of the steering arm.

Bent parts should be renewed as it is not advisable to straighten them.

Wheel lock angles—To adjust

Set the front wheels in the straight ahead position on two turntable gauges. Move the right hand front wheel through a 24° turn to the left. Adjust the lock stop, located on the top face of the lower link trunnion, on the LEFT hand side of the car. The bolt must be slackened off and the eccentric disc beneath its head rotated until it contacts the stub axle lug and retighten the bolt.
Move the left hand front wheel through a 24° turn to the right.

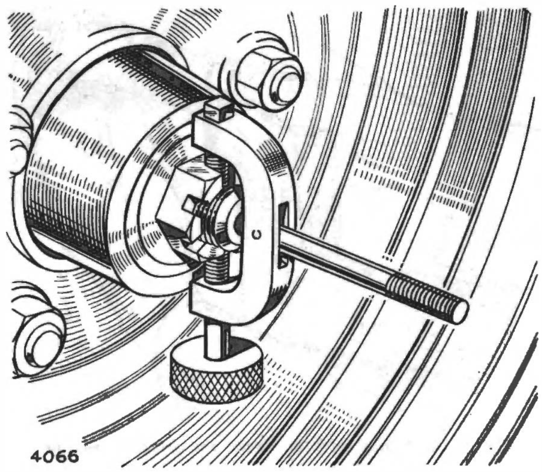


Fig. 8. *Gauge fixing method*

Adjust the lock stop, located on the top face of the lower link trunnion, on the RIGHT hand side of the car. The bolt must be slackened off and the eccentric disc beneath its head rotated until it contacts the stub axle lug and retighten the bolt.

CASTOR, CAMBER and STEERING AXIS INCLINATION ANGLES

To check

IMPORTANT—The vehicle must be loaded on to gap gauges as described under "Preparation of Vehicle".

Application of the Weaver gauge

(See Figs. 8, 9 and 10)
Loosely assemble the adaptor clamp, spring and sleeve into the bracket of the gauge. Wipe away grease from spindle nut and thrust washer.

Ensure that split pin ends do not overlap thrust washer face. Secure the adaptor clamp to the spindle nut by locating the clamp point and tapered adjusting screw in opposite castellations. Finally tighten the knurled adjusting screw.

Hold the gauge and adaptor sleeve against the bearing thrust washer, making sure that the sleeve is centred on the washer.

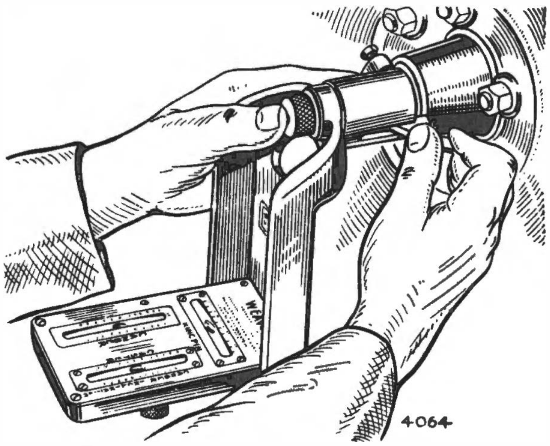


Fig. 9. *Clamping adaptor sleeve and gauge to spindle*

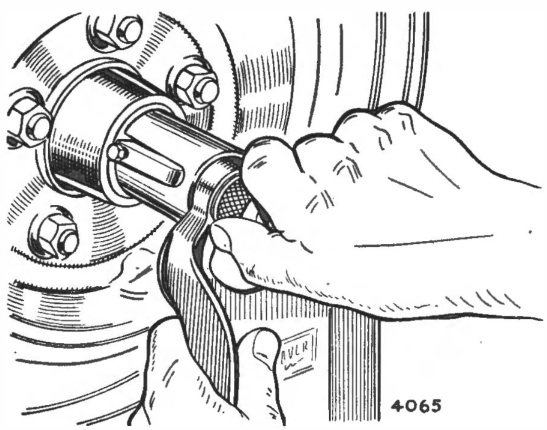


Fig. 10. *Tightening knurled centre nut*

If the outer diameter of the washer does not fully locate the bore of the sleeve, slip a suitable adaptor washer (provided) over the slotted nut, between the adaptor sleeve and bearing thrust washer.

Tighten knurled centring nut until it holds the gauge firmly against the bearing thrust washer. Level the gauge panel by adjusting the steering axis inclination scale flush with the panel and moving gauge until bubble is at zero.

Reading camber

Note the position of the spirit bubble in relation to the scale.

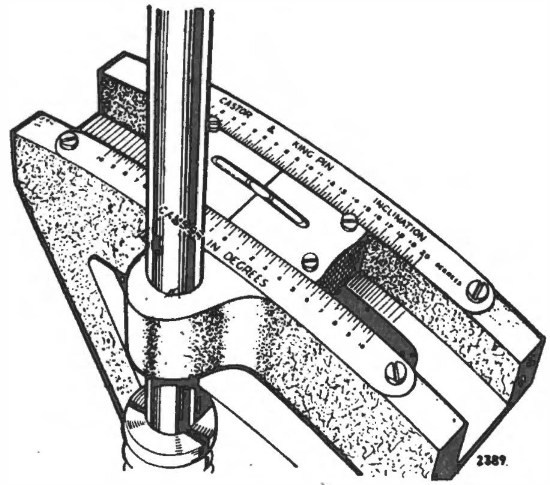


Fig. 11. *Churchill camber checking gauge No. VLC.121L showing a typical reading of ¾° positive camber*

Camber is POSITIVE if the bubble is in black figures, and NEGATIVE if in red figures.

For the correct camber angle, see General Data Section.

Reading castor and steering axis inclination

Turn the wheel to which the gauge is fitted, to a 20° back turn (nearside wheel to the left, offside wheel to the right) as indicated on the turntable.

Set adjustable castor and steering axis scales with spirit level bubbles to zero.

Turn the wheel to a 20° forward turn as indicated on the turntable.

Read castor and steering axis scales in relation to their spirit level bubbles.

The correct steering axis inclination angles see General Data Section. For castor angle see under following heading of "CASTOR ANGLE READINGS".

Make a note of all readings.

Proceed as above with the gauge on the other wheel

Castor inaccuracies are seldom encountered, unless major accident damage is involved.

CASTOR ANGLE READINGS

Vehicle loaded on to gap gauges

The designed castor angle given in the "General Data Section" can only be obtained by loading the vehicle down to the static laden condition, front and rear. A considerable weight is needed to do this which makes this method of checking the castor angle too difficult to use in Service Repair Shop.

To overcome this difficulty the gap gauges illustrated in Figs. 2 and 3 are used and these require only a reasonable amount of weight for loading down purposes.

With the vehicle loaded onto gap gauges the following castor angles should be obtained:

Alpine $+ 3° 10'$ ($3\frac{1}{6}°$)
Rapier $+ 0° 25'$ (approx. $\frac{1}{2}°$)

This figure differs from that given in the Data Section because of the higher rear end condition obtained when the car is loaded onto the gap gauges.

CASTOR ANGLE

To check, using Churchill camber gauge (see Fig. 12).

Jack up the front of the car (using a block of wood between the jack and the front crossmember).

Check wheels for "run-out" and position with maximum "run-out" in the horizontal as described in "To Check and Re-set Wheel Camber".

Place turntables under each front wheel and wood packing of the same height as the turntables under each rear wheel, to keep the vehicle level.

Remove the locking pins, one from each turntable.

The wheels must be in the straight ahead position. Slide the turntable scales (degrees of turn) round so that the "zero" is in line with the pointer and lock the scales (see Fig. 12).

Apply the Castor, Camber, Steering Axis Inclination Checking Gauge (Churchill 121L and U is illustrated) to the wall of the tyre of the left-hand front wheel, **making sure that the contact points of the gauge to the tyre are clear of the normal bulge of the tyre, above the contact area of tyre to ground.**

Turn the scale of the gauge on its pillar so that it is parallel with the road wheel and set the spirit level slide to the mid-way position on the castor and steering axis scale.

Set the gauge vertically on the road wheel by moving the top of the pillar backwards or forwards until the air bubble is central between the hair lines on the spirit level.

Turn the scales at right angles to the road wheel with the scale to the **front** of the pillar of the gauge (to front of the pillar in relation to the car). In this position the gauge will measure the outward "tilt" of the stub axle on each 20° lock.

Turn the road wheels to 20° in the left-hand lock.

Move the spirit level slide until the air bubble is central between the hair lines on the spirit level.

Take the reading shown on the Castor and Steering Axis Inclination scale.

Turn the road wheels to 20° in the right-hand lock.

Move the spirit level slide until the air bubble is central between the hair lines on the spirit level.

Take the reading shown on the Castor and Steering Axis Inclination scale.

Deduct the first (left lock) reading from the second (right lock) reading to obtain the castor angle in degrees.

The gauge must now be transferred to the right-hand front wheel and set up vertically as previously described with **wheels in the straight ahead position** (turntable scales reading "zero").

The castor angle check is carried out on the right-hand side in exactly the same way as described for the left-hand side. Turn the scale at right angles to the road wheel and to the **front** of the pillar of the gauge. First take the left lock reading and then the right lock reading and deduct the **first** reading **from** the **second** reading.

WHEEL CAMBER

To check, using the Churchill camber gauge (See Figs. 11 and 12)

The correct wheel camber angle is given in the Data Section.

Jack up car and check each front wheel for 'run-out' (see "Preparation of Vehicle").

After lowering the front of the car, and removing the jack, and having set the wheels in the required position, the car must be rolled backwards two or three yards in a straight line and then forward until the front wheels are again in the required set position.

Apply wheel camber checking gauge to the wall of the tyre, **ensuring that the contact points of the gauge to the tyre are clear of the normal bulge of the tyre, above the contact area of the tyre to ground.** When using the Churchill Camber Gauge VLC.121L, check the camber angle by moving the slide until the bubble registers accurately between the two indicator marks on the spirit level glass; then note the camber reading in the camber scale, indicated by the scribed line on the slide (see Fig. 11).

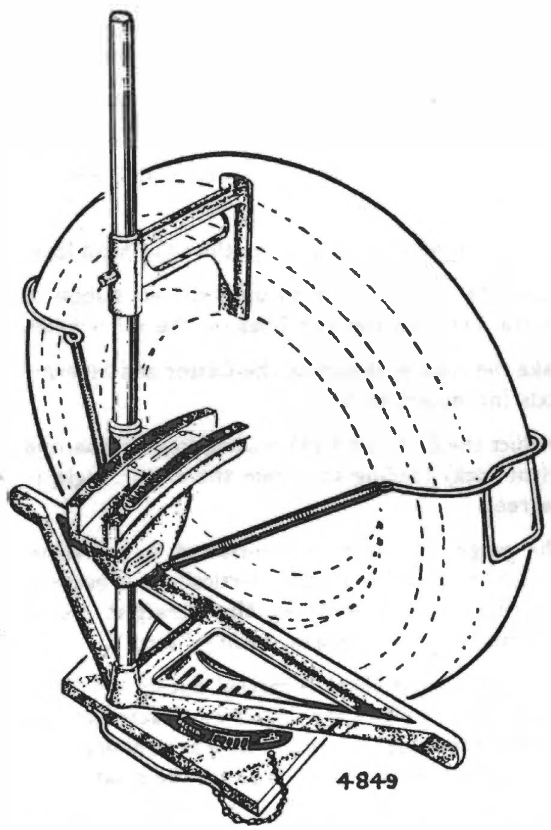


Fig. 12. *Churchill camber/castor gauge and turntable VLC.121U in position*

For camber readings the indicator carrier may be used either side of the main pillar of the gauge, *i.e.*, 180° apart.

Regardless of which side of the main pillar the indicator happens to be, the camber reading will be positive if, in order to bring the bubble between the indicator marks, the slide is moved towards the road wheel side of the zero mark (see Fig. 11).

If after checking it is found that the camber angle is incorrect, no adjustments should be made until the castor and king pin inclination angles have also been checked.

This is because a bent stub axle carrier or other damaged part can be the cause of incorrect camber angle.

To check the accuracy of the camber gauge VLC.121L hold the instrument against any known upright and take two readings, one with the spirit level carrier on the right-hand side of the pillar and the other reading with the carrier on the left-hand side of the pillar. If the two readings do not agree, then the instrument has suffered damage and a correction will have to be applied to all future readings or the instrument returned to the makers for rectification.

STEERING AXIS INCLINATION

To check

The correct steering axis inclination is given in the Data Section.

It is important that the camber check is carried out before making a check of the steering axis inclination

Jack up the front of the car (using a block of wood between the jack and the front crossmember).

Check the wheels for "run-out" and position with the maximum "run-out" in the horizontal as described in "Preparation of Vehicle".

Lock the wheels by applying the footbrake, and keep the brake applied by wedging a wooden spar between the pedal and the front seat.

It is most important that the wheels are properly locked when they are moved from lock to lock during the actual check.

Place turntables under each front wheel, and wood packing of the same height as the turntables under each rear wheel, to keep the vehicle level.

Remove the locking pins one from each turntable (see Fig. 12).

The wheels must be in the straight ahead position. Slide the turntable scales (degrees of turn) round so that the "zero" is in line with the pointer and lock the scales.

Apply the gauge (Churchill 121L and U is illustrated) to the wall of the tyre of the left-hand front wheel **making sure that the contact points of the gauge to the tyre are clear of the normal bulge of the tyre, above the contact area of the tyre to the ground.**

Turn the scale of the gauge on its pillar so that it is parallel with the road wheel and set the spirit level slide to the mid-way position.

Note. This is not zero on the castor and steering axis inclination scale.

Set the gauge vertically on the road wheel by moving the top of the pillar backwards or forwards until the air bubble is central between the hair lines on the spirit level.

For checking the steering axis inclination the scale must be **parallel** to the road wheel and will measure the angle through which the stub axle moves downwards from the straight ahead position on each 20° lock.

Turn the road wheels to 20° in the left-hand lock. Move the spirit level slide until the air bubble is central between the hair lines on the spirit level.

Take the reading shown on the Castor and Steering Axis Inclination scale.

Turn the road wheels to 20° in the right-hand lock. Move the spirit level slide until the air bubble is central between the hair lines on the spirit level. Note the reading shown on the Castor and Steering Axis Inclination Scale.

Deduct the **first** (left-hand) reading **from** the **second** (right-hand) reading to obtain the steering axis inclination in degrees.

The steering axis inclination is checked on the right-hand side in the same way as described for the left-hand side, with the scale **parallel** to the road wheel.

First take the left lock reading and then the right lock reading; deduct the **first** reading **from** the **second** reading.

CAMBER ANGLE

To adjust (See Figs. 13 and 14)

If, on checking, it is found necessary to effect an adjustment to the wheel camber, proceed as follows:—

Remove the front wheel.

The upper link inner attachments can now be seen.

SLACKEN the nuts retaining the upper fulcrum pin (32) to the crossmember.

SLACKEN the bolts between brackets (33 and 35) to permit the selection of shims. On later Series IV Cars onwards these brackets are not used therefore this operation is unnecessary.

To increase the camber angle move the required number of shims from position (A) to position (B) (See Fig. 13).

To decrease the camber angle remove the required number of shims from position (C) and add a similar thickness of shims to position (A)—OR if shims are found in position (B) remove from this position and insert in position (A).

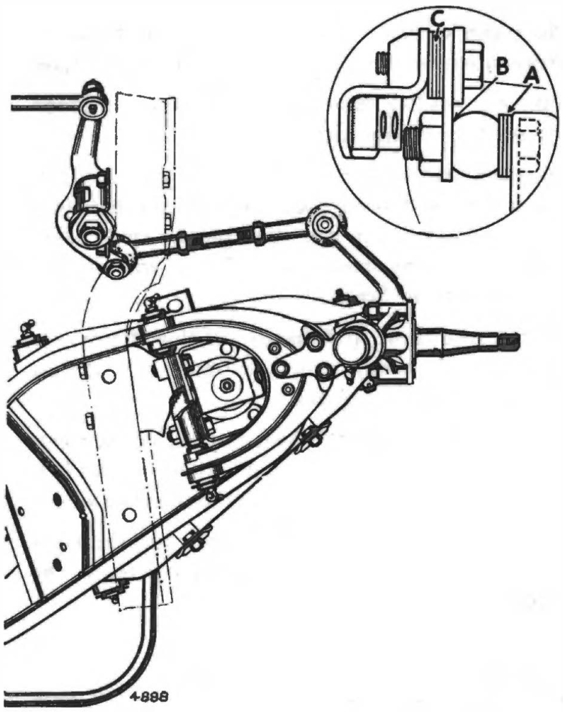


Fig. 13. *Plan view of front suspension showing camber shim positions*

On later Series IV Cars onwards, the fulcrum pin bracket is not used thus Position C is not evident; therefore the shims are added to or removed from Position A to decrease or increase the wheel camber respectively.

Note. Small shims are somtimes found at either end of these shim locations, and should be placed in their previous positions.

The purpose of these small shims is to ensure correct alignment of the upper and lower link, which is necessary to give free movement of the axle carrier, or to deal with any lack of parallelism between the frame bracket and frame.

It is most important to ensure that all shim fixing bolts are properly tightened and not in any way thread bound and giving false impression of tightness.

The relationship of the wheel camber angle to track or "toe-in" is such that the track setting must always be checked following a wheel camber re-set.

After correcting the camber figure by adjustment, the steering axis inclination angle should be again noted, to ensure that the stub axle is not bent or damaged.

This particularly applies when accident repairs are being undertaken.

Checking steering ball pin heights

After accident damage, or in a case of excessive tyre wear, these dimensions should be checked. If they are outside of the limits shown in Fig. 23 the wheels will not remain in track as the suspension system reacts to rough road surfaces.

The dimensions are taken between the following points after removing both outer track rods:

(*a*) The lower link outer fulcrum pin centre and the underside centre of the taper hole in the end of the steering arm.

(*b*) The lower link inner fulcrum pin centre and the centre of the taper hole in the Swing and Idler Levers on their underside face.

Steering ball pin heights are checked by means oı a scribing block used on the simple tool illustrated in Figs. 21 and 23. This tool is necessary as it enables measurements to be taken from the lower link fulcrum pin centres which are the correct datum points.

The tool can be cheaply and easily made from angle iron and bright strip steel. Its details are shown in Fig. 22 with convenient alternative metric dimensions.

Note. It is impossible to check ball pin height dimensions from a level surface plate because the fulcrum pins lie at the castor angle and not in a horizontal plane.

The following procedure should be followed when making these checks:—

1. Ensure that the wheels are in a straight ahead position noting steering wheel position. Remove both outer track rods and check that front wheels and steering wheel positions remain unaltered.

2. Remove greasers from both ends of each lower link inner fulcrum pin.

3. Fit up tool as illustrated in Fig. 21 making sure that no slackness exists between centres and greaser holes.

4. The centres of the large end of the taper holes are found by means of the adjustable adaptor which can be made on any small lathe. This item is shown in Fig. 24. Alternatively the taper part of a discarded ball socket can be put into the taper hole and cut off and filed flush at the largest end of the taper hole. It is then a simple matter to mark the centre of the now flush fitting taper shaft.

5. Using scribing block measure the height of the scribed lines immediately behind the centres on brackets, item 3, from the measuring surface, item 4, see Fig. 21. These heights should be equal.

6. Measure the height of the centre made on the drop arm and idler lever (See Fig. 23).

7. From these dimensions subtract those taken of the respective centre heights. If the ball pin heights are correct the results should be the dimensions shown in Fig. 23.

8. The steering arm ball pin heights are checked in a similar manner except that the centre height is taken from the greaser centre at the rear of the lower link outer fulcrum pin. Owing to the nearly level underside face of the steering arm outer end, it is possible to check the steering arm dimension without plugging its taper hole.

TO REMOVE AND REFIT UNIT

(See Fig. 14)

Raise the car by placing a jack with a block of wood or other suitable packing under the front cross-member.

Place stands under the sidemembers of the under-frame.

Remove the road wheels.

Disconnect the main hydraulic fluid pipe at the right-hand side front connector. Wherever it is necessary to disconnect the brake hoses, do not allow hydraulic brake fluid to come in contact with the bodywork, otherwise damage to paint will result.

Place wooden blocks under the sump to support the engine.

Disconnect front engine mountings from cross-member.

Remove the two outer track rods from the steering arms by discarding the split pins, removing the castellated nuts and using a suitable extractor. DO NOT DISTORT THE STEERING ARMS IN ANY WAY.

Detach the two fulcrum pin brackets from the underframe by withdrawing two bolts each and indentifying any shims. On later Series IV Cars onwards, this operation is unecessary as the fulcrum pin brackets are not used.

Withdraw the four crossmember bolts and washers, access to these bolts is gained through the holes in the underside of the crossmember, remove the front suspension from under the car by lowering the jack.

Reverse this procedure for refitting, ensuring that all location points are clean and free from rough edges and burrs.

After reconnecting the hydraulic brake hoses it is essential to bleed the brake system in order to remove air.

TO DISMANTLE AND REASSEMBLE UNIT (UNIT ATTACHED TO CHASSIS)

To dismantle and reassemble the front hubs (See Fig. 14)

Slacken the road wheel nuts.

Jack up the front end of the car (using a block of wood under the front crossmember).
Remove the road wheel.

When removing centre-lock wheels it will be advisable to note the condition of the O-ring (synthetic rubber sealing ring) positioned just inward of the splines on the hub. This ring prevents lubricant from the hub getting on to the brake disc.

Remove the disc brake caliper, (See Section K, Brakes).
Remove the hub cap (2).

Remove the split pin from the castellated nut (3).
Remove the castellated hub retaining nut.
Remove the large special plain washer (4).

Pull the hub off the stub axle (6), at the same time holding a hand under the hub to catch the bearing cage of the outer taper bearing (7).

Remove the bearing cage of the inner taper bearing (8), and seal (10).

The outer shells for each of the hub bearings can now be removed from the hub by tapping them out with a suitable drift.

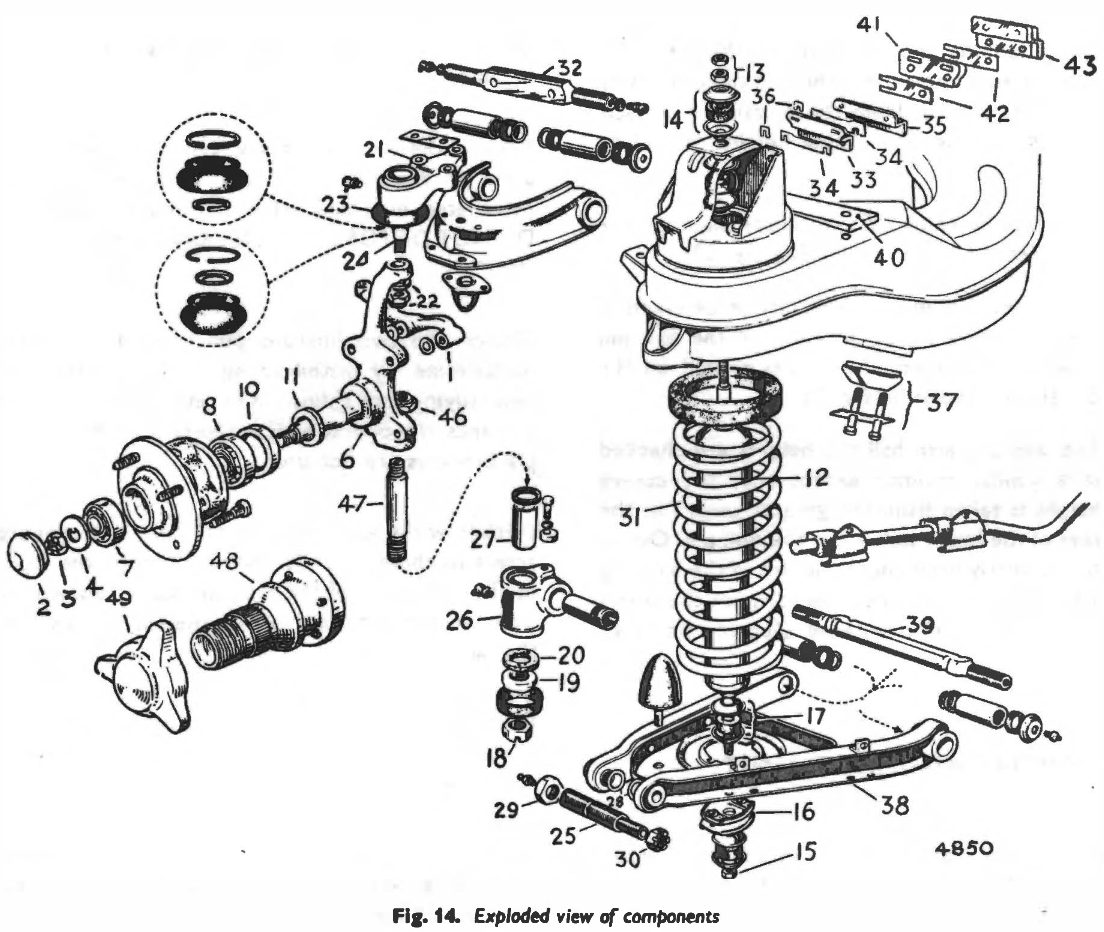


Fig. 14. *Exploded view of components*

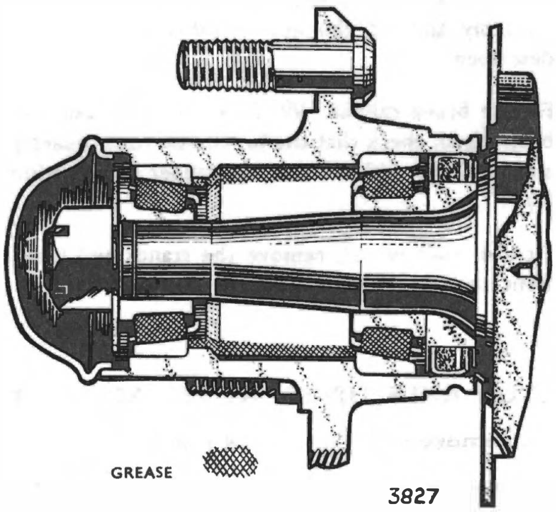


Fig. 15. *Correctly packed hub*

It should be noted that the hub distance piece is a press fit on the stub axle on Alpine cars; on Rapier cars it is loose and may be removed.

To reassemble the front hub and to refit to the stub axle (6), particular attention must be given to points such as greasing and adjustment, and the following procedure should be adopted:

Press into the hub the outer shells of each of the two taper bearings (7 and 8). (In each case, the larger internal diameter must be outwards from the respective ends of the hub).

Pack the hub and bearings with grease of the correct grade (see Section P). The amount required is one capful distributed evenly within the hub shell as shown in Fig. 15.

THE HUB DUST CAP WHEN FITTED MUST NOT CONTAIN GREASE.

From Chassis No. 9008452 a $\frac{1}{16}$" (1·5 mm.) diameter hole is drilled in the centre of the hub grease cap and wire wheel locknut, to relieve any build up to pressure that may occur within the hub.

The hub should then be fitted to the stub axle, the hub outer bearing roller race, washer and nut fitted, and the bearings adjusted.

To adjust

It is important that the following procedure be used. Tighten the hub nut using a torque spanner to obtain a reading of 15—20 lbs. ft. (2·07—2·76 kg.m.). Release the nut 1 to $1\frac{1}{2}$ 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 test indicator, check the hub end-float which should be within the figures given in the "General Data Section".

When the endfloat is not within these figures, the castellated nut must be further adjusted and the endfloat again checked with the dial test indicator.

When the correct adjustment has been obtained, lock the nut with a **new split pin of correct diameter.**

Fit hub cap (2), tapping firmly into position with a hammer.

Refit disc brake caliper and bleed brakes.
Refit the road wheel.

To remove and refit stub axle (See Fig. 14)

Removal

Remove front shock absorber (12) as follows:—
Load the vehicle to a laden condition. This is important to avoid straining the shock absorber and its mountings.

Undo the two nuts (13) at the upper spindle fixing and remove upper rubber and cup washers (14). Slacken the two nuts at the lower spindle fixing (15), (but do not remove).

Remove the nuts around the shock absorber lower plate (16) lift the lower plate to clear the studs and revolve it through 90°, when, due to its shape, it will pass downwards, complete with shock absorber and its remaining upper rubber and cup washers (17), through the lower link spring pan.
Jack up car.

Remove the road wheel.

Undo the bolts securing the steering arm, caliper and dust shield to the axle carrier. Note the position of any shims.

Remove the front hub assembly from the axle (see "To Dismantle and Reassemble the Front Hubs").

Using spring compressor (VLC Special Tool RG.195) passed up through the coil spring in place of the shock absorber, take the "load" off the spring to enable the stub axle assembly to be released from the upper and lower links.

Remove split pin, castelated nut (18), adjusting nut (19) and thrust washer (20) from base of lower swivel pin.

Remove the nut and washer (22) securing the upper swivel assembly to the stub axle.

Remove the upper swivel assembly (21) from the stub axle, using a suitable extractor.

Lift out stub axle and swivel pin from its bushing in the lower link, leaving the upper swivel on the link.

Refitting

Fit the sealing ring to the swivel pin (47) and feed the swivel pin into the lower link trunnion (26) and refit the upper swivel assembly (21) to the top end of the stub axle (6) with a nut and washer (22).

Fit the thrust washer (20) and adjusting nut (19) to the protruding swivel pin (47) and follow with the castellated nut (18). Set the endfloat to the figure given in the "General Data Section" with the adjusting nut (19).

Holding the adjusting nut with one spanner, tighten the castellated nut (18) until the two nuts (18 and 19) are locked together and fit a new split pin. Fit the rubber seal around the adjusting nut (19) and thrust washer (20).

Remove the spring compressor but do not fit the shockabsorber until the car is standing on the roadwheels.

Fit the brake disc shield, steering arm, front hub assembly and set the hub endfloat as previously described.

Fit the brake caliper. When a new stub axle has been fitted, check that the brake disc runs squarely and centrally within the brake caliper (see Section K).

Fit the front wheel, remove the stands and jacks. Refit the shockabsorber.

STUB AXLE UPPER SWIVEL ASSEMBLY

To remove from upper link (See Fig. 14)

If this operation is carried out on the vehicle, the shock absorber and front wheel must be removed and the spring compressor used, as already described.

Remove rebound rubber to give access to the head of the inner securing bolt.

Remove the three nuts and bolts securing the upper swivel assembly (21) to the upper link.

TRUNNION (See Fig. 14, No. 26)

To renew swivel pin bush

This involves removal of the lower link eyebolt (25), thrust washer (20) and nuts (18 and 19) at the bottom of the swivel pin (47).

Remove trunnion (26) from stub axle.

Press out bush (27) from lower trunnion and press in new bush using the necessary parts of the broaching kit (see Section S).

Broach bush and reassemble all parts.
The bush should be pressed in so that the bottom edge is ·38″ (9·65 mm.) from the thrust face on the trunnion and the hole aligns with the greaser-tapping.

To renew threaded eyebolt bush (Fig. 14)

The threaded bush is externally knurled at one end, and pressed in with the knurling to the front on new cars. It follows that the bush must be pressed out towards the front of the trunnion assembly, i.e., the reverse way to which it went in, as otherwise the knurling will damage the parent bore of the trunnion.

When a new bush is fitted in service, it must be pressed in from the rear end of the trunnion, with the knurling to the rear, so that the knurling engages a plain portion of the parent bore.

Reassemble stub axle to upper and lower links as previously described, using new thrust and sealing washers.

Before fitting the lower eye bolt, place the sealing rings (28) on the bosses of the trunnion, one each side; when the eye bolt is properly located, the rings can be slid outwards along the bosses into position. If these sealing rings show any signs of deterioration, they should be renewed.

The eye bolt must be screwed in from the rear until the shoulder of the bolt butts firmly against the front inner face of its link, but care must be taken to ensure that the arms of the link are not stressed by "spreading".

The locknut (29) must be fitted **before** the castellated nut, and tightened very securely, at the same time holding the eye bolt (25) from turning.

The castellated nut (30) should be tightened to the figure given in the "General Data Section". When the castellations do not align with the split pin hole, tighten the nut to the next castellation.

SERVICE REPLACEMENT SWIVEL PINS

Stub axle, to renew lower swivel pin

As the design of the stub axle and swivel pin calls for a very high degree of interference fit, it is essential that a press, having a capacity of at least ten tons, is available. A special service swivel pin pack P.48890 is supplied, in which the circlip is replaced by two locknuts.

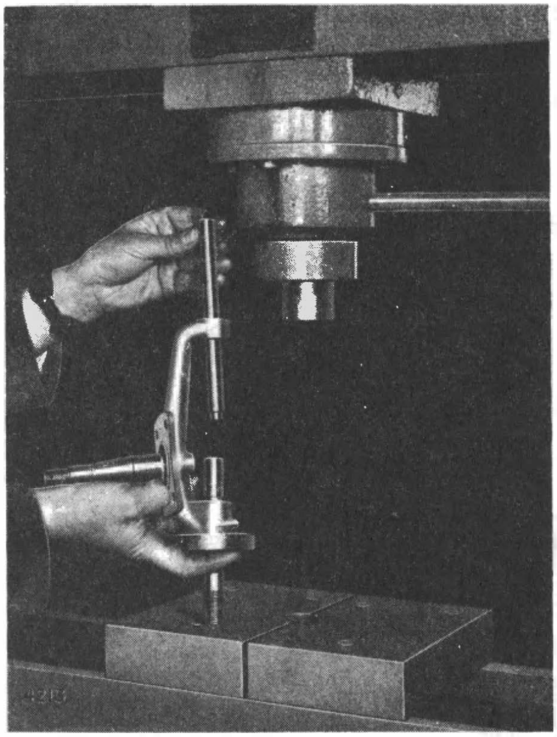


Fig. 16. *Preparation for removing pin, using special tool RG.193*

Swivel pin removal and replacement tools, to be used with the press, are provided by Messrs. V. L. Churchill to the following numbers:—

R.G. 193—Swivel pin remover.
R.G. 192—Swivel pin replacer.

Swivel pin
To remove

1 Pass the large abutment collar over the swivel pin and place the stub axle assembly on the bed plate of the press, with the stub axle supported by the collar (Fig. 16).

2 Remove the circlip from the upper end of the pin and place the short drift, with deep recess upwards, over the pin end (from which the circlip is removed).

3 Pass the long drift through the tapered hole in the upper yoke and insert its spigoted end in the deep recess of the short drift.

4 Carefully press out the swivel pin, ensuring that the assembly does not become tilted while pressing.

To refit

1. Assemble the two halves of the jacking tool and insert it between the upper and lower yokes of the stub axle, locating the spigoted end in the tapered hole of the upper yoke.
2. Ensure that the counterbored end of the jack sleeve is concentric with the swivel pin hole in the lower yoke. Tighten the jack with a tommy bar to hold the assembly rigid.
3. Locate the upper face of the upper yoke on the bed of the press, pass the smaller threaded end of the swivel pin through the lower yoke (now uppermost) and start the pin in its hole.
4. Pass the hollow drift over the pin and press in the pin until the hollow drift abuts the lower yoke.
5. This will press the pin the correct distance into the yoke. The pin should project 3·27/3·26" (83/82·8 mm.). This dimension is important and should be checked.
6. Remove assembly from press and remove jack.
7. Fit and tighten one locknut. Fit second locknut and tighten.

TO REMOVE AND REFIT TOP LINK

(See Fig. 14)

Remove front shock absorber (see "Stub axle removal").

Jack up the car under the front crossmember, (using a block of wood between the jack and the crossmember). Place the car on stands below each sidemember.

Remove the road wheel.

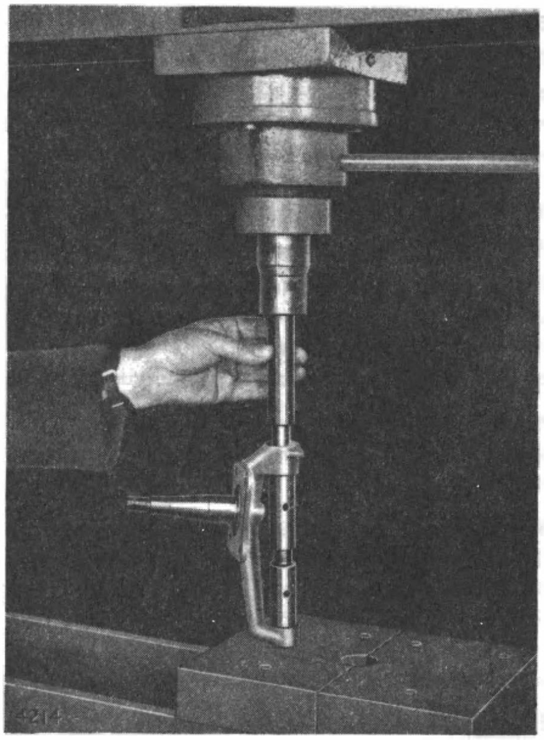


Fig. 17. *Pressing swivel pin into position*

Fit the road spring compressor tool and compress the road spring sufficiently to take the load of the spring (31).

Remove upper swivel from axle carrier (VLC tool).

Remove the top link, fulcrum pin bracket and shims from between the crossmember, fulcrum pin and underframe by withdrawing four bolts and washers and indentifying any shims to their respective positions.

On later Series IV Cars onwards, the fulcrum pin bracket is not used thus it will only be necessary to withdraw the two fulcrum pin to crossmember bolts.

Refitting is a reversal of the above procedure.

Check camber, castor and Steering Axis Inclination.

Check toe-in.

TO REMOVE AND REFIT BOTTOM LINK
(See Fig. 14)

Remove front shock absorber (see "Stub axle removal").

Jack up the car under the front crossmember (using a block of wood between the jack and the crossmember). Place the car on stands below each sidemember, and remove road wheel.

Fit the road spring compressor tool and compress the road spring sufficiently to take the load of the spring (31).

Remove the lower link eyebolt (25).
Disconnect stabilizer bar and remove four bolts securing bottom link fulcrum pin to the crossmember.

Release spring compressor gradually until road spring and bottom link can be removed.

Refitting the bottom link (38) is a reversal of these operations except for the following:—

Ensure that the rubber insulating ring is in place when placing the road spring in position.

Compress the spring until the fulcrum pin can be rebolted to the crossmember. The bolts should be tightened to the figure given in the "General Data Section" and secured with new lockwashers.

Ensure that sealing rings are correctly fitted when replacing the eyebolt.

The stabilizer bar bushes should be assembled with graphite as this prolongs their life.

TO REMOVE AND REFIT FRONT ROAD SPRING (See Fig. 14)

Remove front shock absorber.

Jack up the car under the front crossmember, (using a block of wood between the jack and the crossmember). Place the car on stands below the sidemember, and remove road wheel.

Fit the spring compressor tool and compress the road spring sufficiently to take the load of the spring (31).

Remove lower link eyebolt (25).

Disconnect stabilizer bar and remove four bolts securing bottom link fulcrum pin to the crossmember.

Release spring compressor gradually until road spring and bottom link can be removed.

Refitting the road spring (31) is a reversal of these operations except for the following:—

Ensure that the rubber insulating ring is in place when placing the road spring in position.

Compress the spring until the fulcrum pin can be rebolted to the crossmember. The bolts should be tightened to the figure given in the "General Data Section" and secured with new lockwashers.

Ensure that sealing rings (28) are correctly fitted when replacing the eyebolt.

TO CHECK FRONT SPRINGS
If required the front springs can be roughly checked in position by the following method:

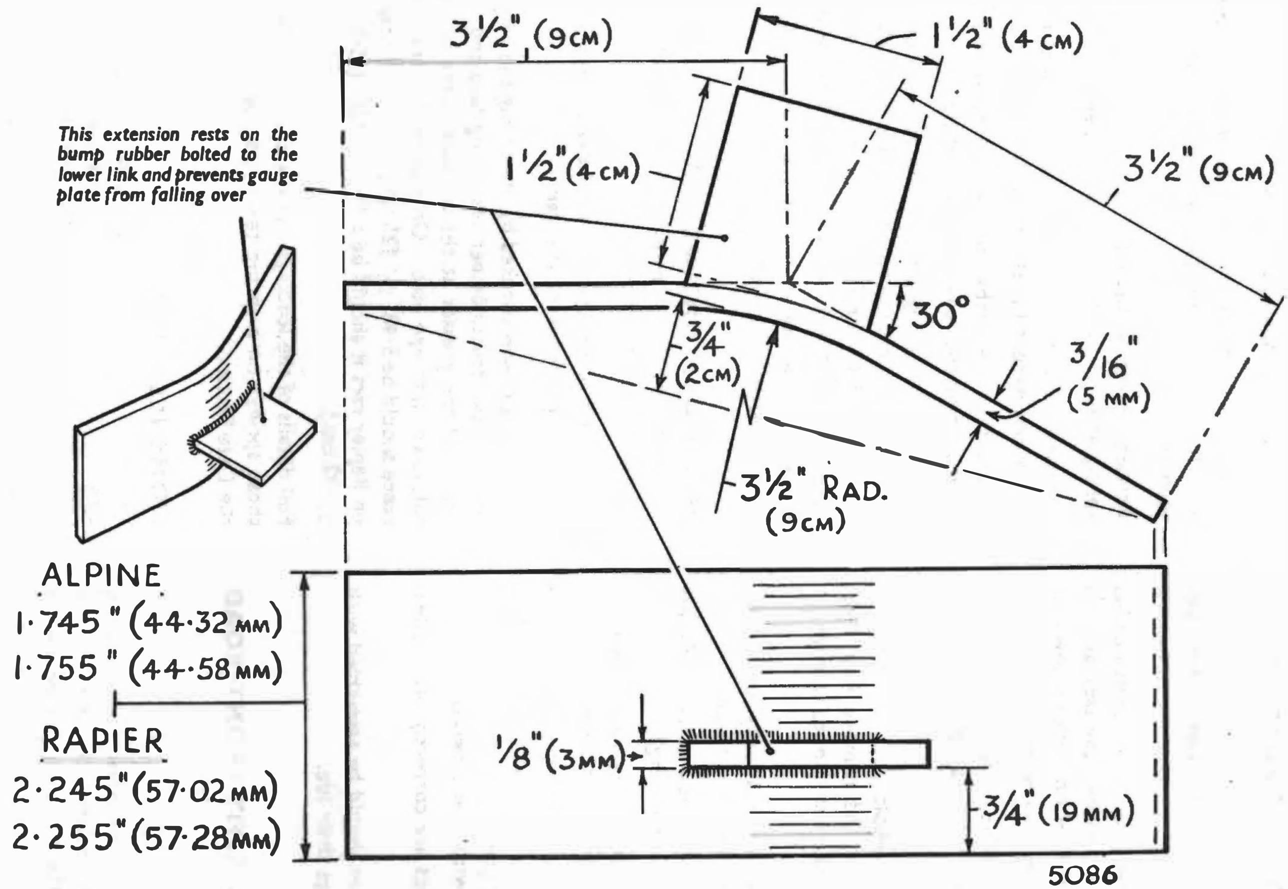
Place a load of 300 lbs. (136 kgs.) evenly across the front compartment of the car.

Each spring is now checked by measuring the height between the crossmember top fixing face and the centre of the greaser at the forward outer end of the lower link eye bolt. On Alpine cars this distance should be 5·48″ $\pm$ ·125″ (13·9 cm. $\pm$ ·32 cm.); on Rapier cars it should be 6·10″ $\pm$ ·125″ (15·5 cm. $\pm$ ·32 cm.).

Full details of the loadings and lengths for checking these springs on a spring testing rig, are given in the Data Section.

NOMENCLATURE

Upper link	—	Upper control arm.
Lower link	—	Lower control arm.
Fulcrum pins	—	Control arm shafts.
Eye bolts	—	Pivots.
Stub axle	—	Steering knuckle.
Stub axle carrier	—	Knuckle support assembly.
Track rod	—	Tie rod.
Steering arms	—	Steering knuckle arms.



MATERIAL $\frac{3}{16}$" (5 mm.) MILD STEEL

Fig. 18. *Details of front gap gauge, Alpine and Rapier*

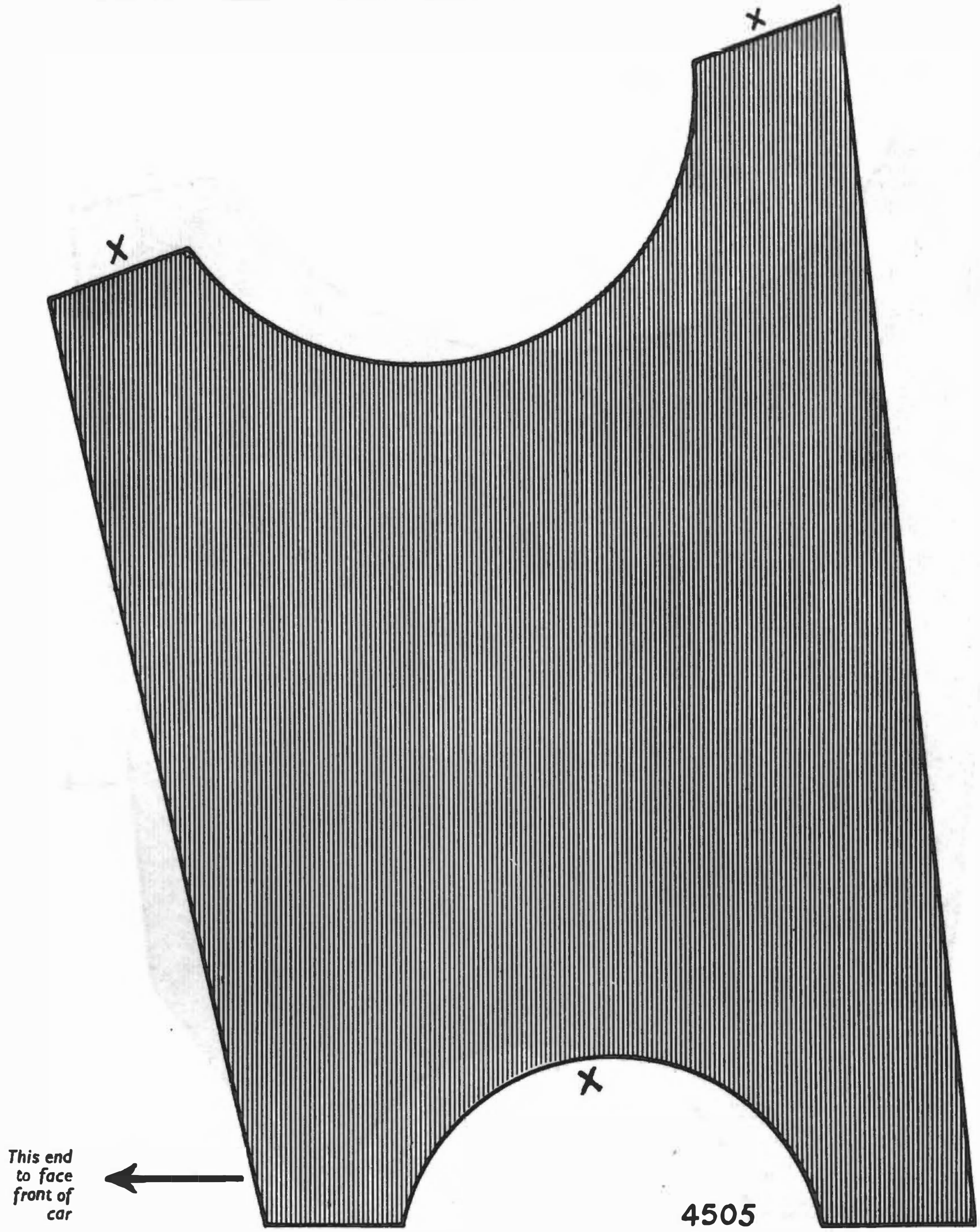


Fig. 19. *Rear gap gauge, Rapier*

This item should be made from 1" (25mm.) thickness hardwood by glueing a carefully-made tracing of this illustration to the wood. The important faces are marked with an "X".

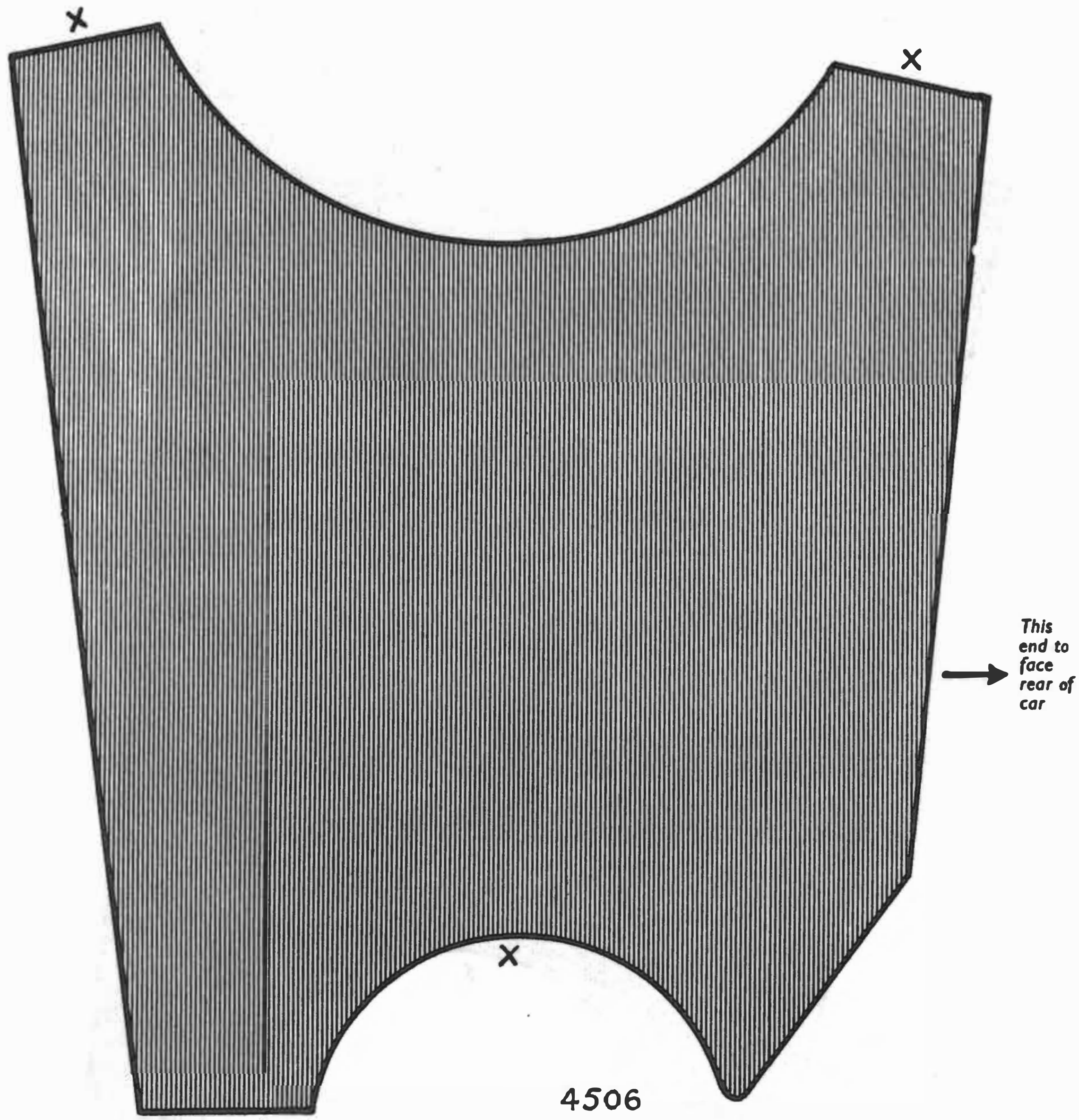


Fig. 20. *Rear gap gauge, Alpine*

This item should be made from 1" (25mm.) thickness hardwood by glueing a carefully-made tracing of this illustration to the wood. It can then be cut to shape on a bandsaw. The important faces are marked with an "X".

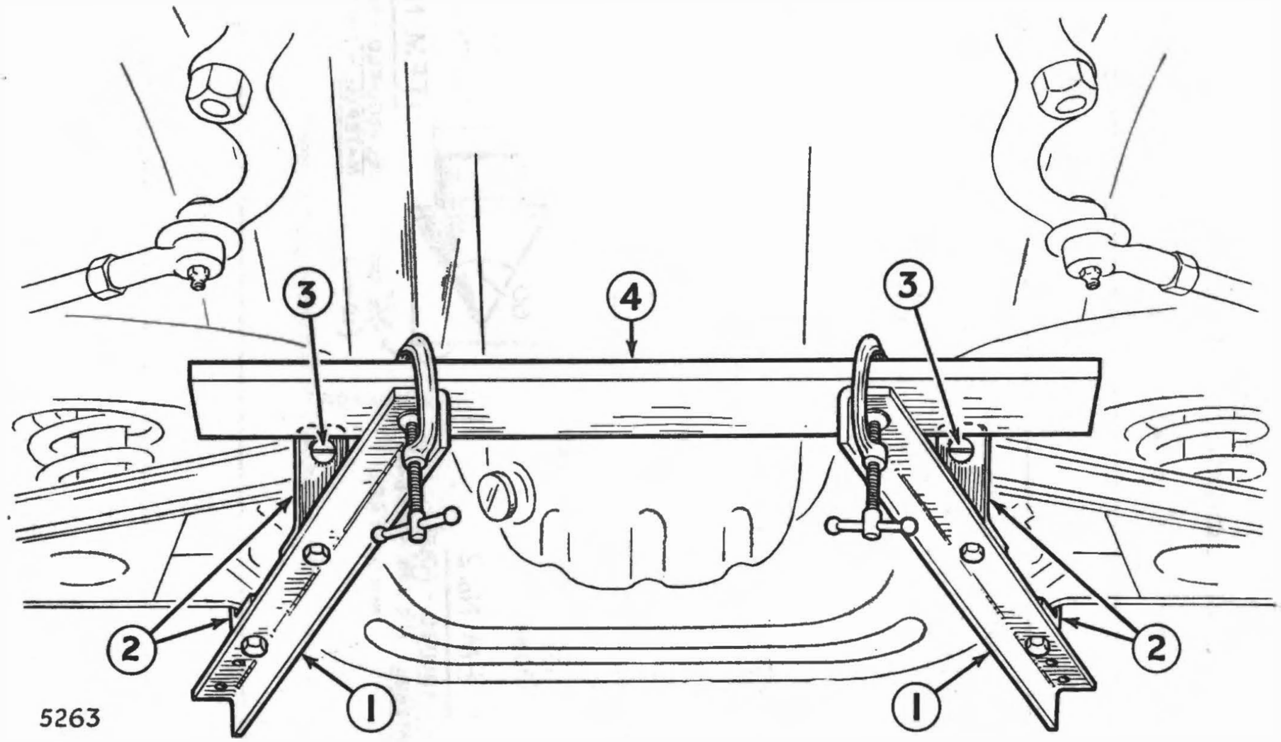


Fig. 21. *Ball pin height checking fixture in position. Details of items 1 to 4 in Fig. 22*

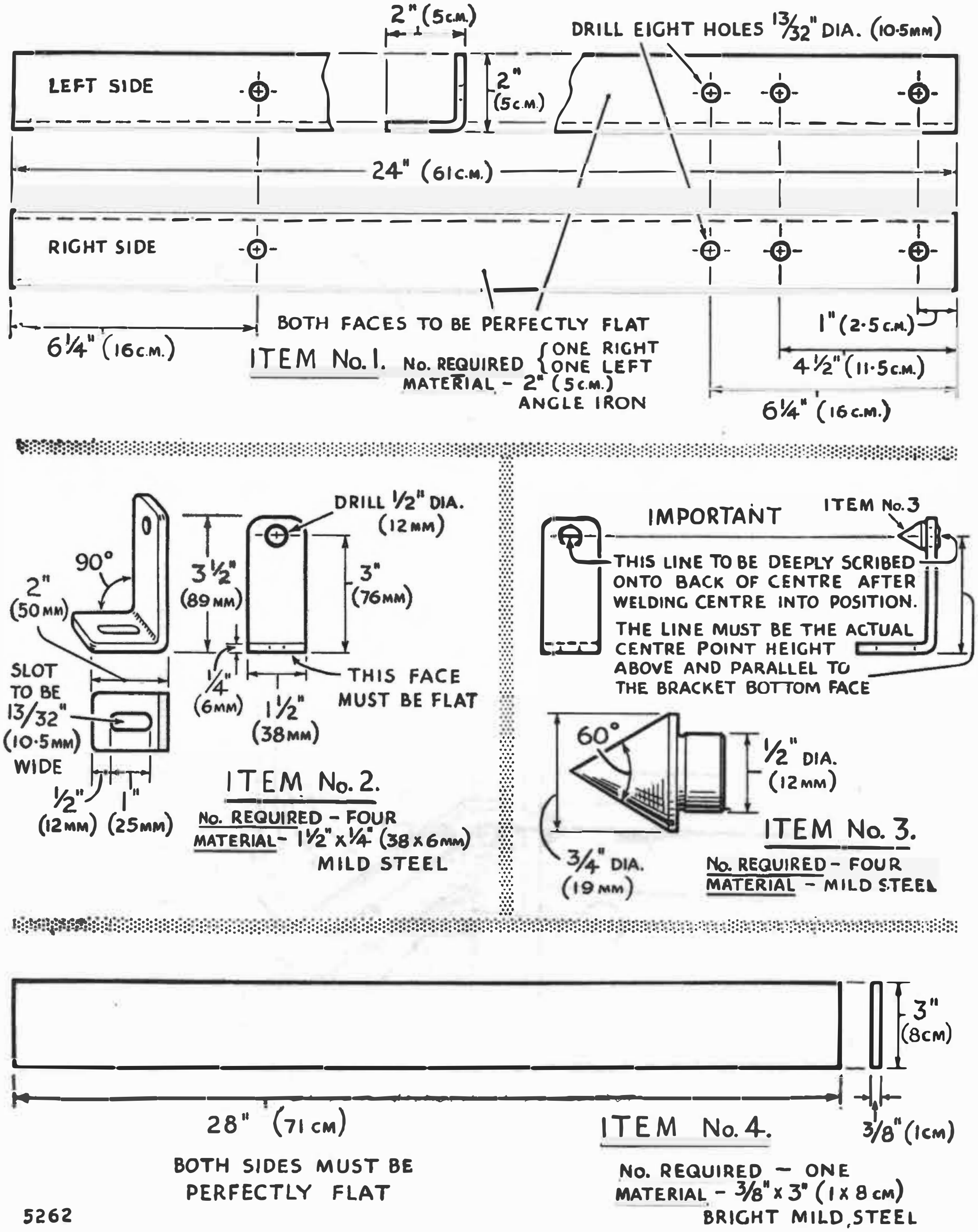
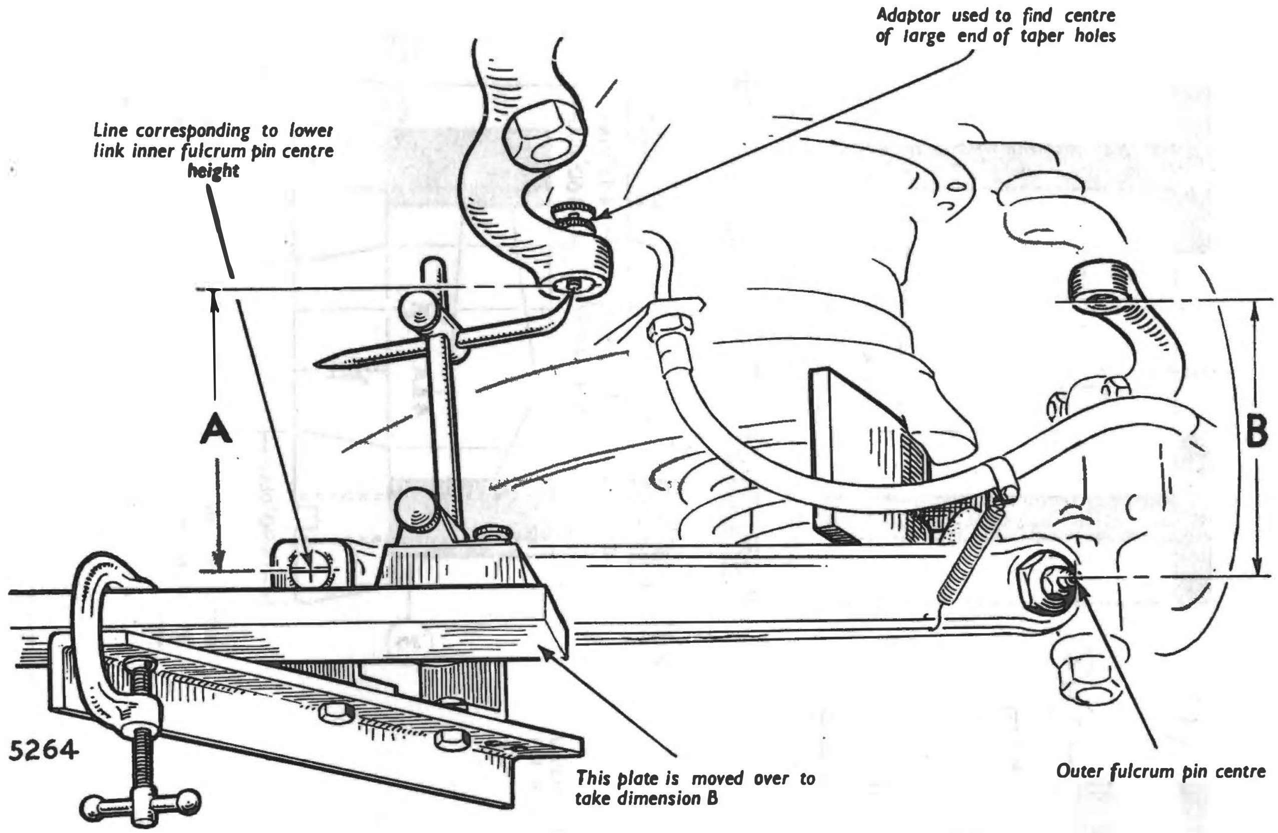
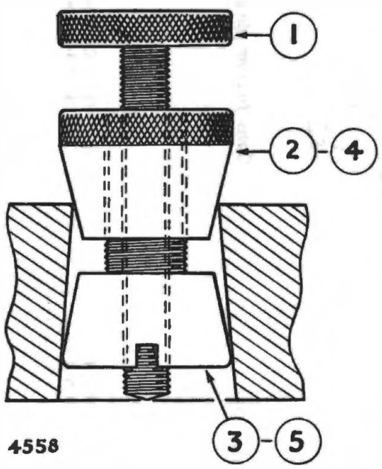


Fig. 22. *Details of ball pin height checking fixture parts*



A = Idler lever	**6·01" (152·65 mm.)** **5·83" (148·08 mm.)**	**A = Swing lever**	**6·00" (152·40 mm.)** **5·86" (148·84 mm.)**	**B =**	**5·94" (150·87 mm.)** **5·78" (146·81 mm.)**

Fig. 23. *Ball pin height checking fixture in use*



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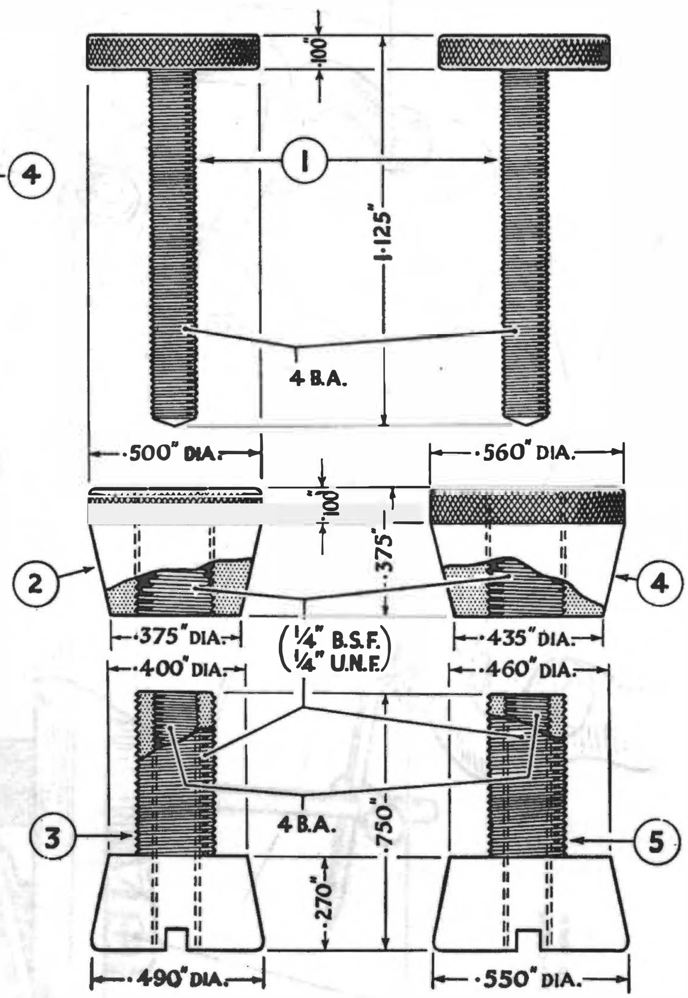


Only items 1, 4 and 5 are required for the models described in this manual.

1·125" = 28·5 mm.	·400" = 10·2 mm.	·560" = 14·2 mm.
·500" = 12·7 mm.	·270" = 6·9 mm.	·435" = 11·0 mm.
·490" = 12·45 mm.	·100" = 2·5 mm.	·460" = 11·7 mm.
·375" = 9·5 mm.	·750" = 19·1 mm.	·550" = 13·95 mm.

Fig. 24. *Details for adaptor for finding centre of large end of taper holes when checking ball pin heights*

FRONT SHOCK ABSORBER

Armstrong Direct-Acting Telescopic Dampers are fitted.

The body of the shock absorber is telescopic and is mounted more or less vertically through the coil spring between the suspension cradle and wishbone spring pan on the front member. It is therefore direct-acting, no links or levers being required.

SERVICING

Unless proper facilities are available including a shock absorber testing machine, it is almost invariably found that to attempt repairs to the modern telescopic shock absorbers is neither practical nor economical.

These units are completely sealed, no topping up, adjustment, or other service is required apart from periodical checks of mountings and rubber bushes, which can be carried out without the aid of special tools.

In the event of any shock absorbers requiring attention, it is strongly recommended that the faulty unit should be removed and a replacement shock absorber fitted.

Removal and refitting instructions for front shock absorbers are contained in this section.

CONSTRUCTION

The assembly consists mainly of a piston rod (C) attached to the upper mounting (A) with a piston incorporating the piston valve (M) attached to the lower end. This is housed in a cylinder (H and P) with a larger diameter concentric to form a reservoir (Q) and a lower mounting (S). In detail the piston rod has a former and dust shield (B) attached immediately below the upper mounting stem, and is suitably machined at the lower end with the piston to house the piston valve (M). The cylinder is located at the lower end by a spigot on the piston rod guide which in turn is housed in the outer tube. This piston rod guide forms a bearing for the piston rod, holds the rebound valve and drain tubes in position and contains the spring-loaded piston rod seal (D). The cylinder, piston rod guide and reservoir seal are retained in the outer tube. Baffles (K and N) are sprung on to the outside of the cylinder (P) to prevent aeration of the fluid in the reservoir (Q) by the rapid movements of the suspension.

The cylinder is completely filled and the reservoir about half-filled with fluid when the piston rod is extended.

Operation

The functioning of the shock absorber with its unique principle of "one-way" oil circulation, is described below with references to the illustration.

As the wheel rises on fast bump strokes, when the piston is moving relatively towards the base valve (R) fluid pressure opens the piston valve (M) against the coil spring load and fluid passes through the ports in the piston valve (M) from the lower half of the cylinder (P) to the upper part of the cylinder (H). The excess fluid displaced from the cylinder by the piston passes via the ports (F) in the piston rod guide (E) through the filter (G) and down the rebound valve tube (L) opening the rebound valve (O) against the coil spring load into the reservoir (Q).

On the slow bump strokes, damping is controlled by calibrated bleed grooves on the face of the base valve (R).

On the fast rebound strokes when the piston is moving relatively towards the piston rod guide (E) the piston valve (M) closes and again fluid passes through the ports (F) in the piston rod guide (E) through the filter (G) down the rebound valve tube (L) opening the rebound valve (N) against the coil spring load and into the reservoir (Q). At the same time the lower part of the cylinder (P) is replenished with fluid as the base valve (R) opens to allow recuperation from the reservoir (Q).

On slow rebound strokes, fluid passes through a calibrated bleed groove in the face of the piston valve seat.

Any fluid which passes between the piston rod and the piston rod guide bearing is prevented from escaping by the multi-lip piston rod seal (D). Undue internal fluid pressure on this seal is relieved as the fluid passes through a port to the drain tube (J), the lower end of which is immersed in the reservoir fluid to prevent aeration.

TESTING

When there is any question of suspension not being adequately damped, the condition of the following should be considered: road springs, tyre pressures, bump rubbers and bump rubber seats, as these carry the full bump load of the suspension. If a shock absorber does not appear to function satisfactorily an indication of its resistance can be obtained by carrying out the following check:—

Remove the shock absorber from its mounting. Place the shock absorber vertically in a vice, holding by the lower spindle between two pieces of wood.

Grip the dirt shield firmly with the hands and prime the shock absorber by working it up and down several times to expel the air.

Move the piston (free top half) up and down through one complete cycle to check the nature of the movement.

Moderate and even resistance throughout the outward and inward stroke should be felt. If, however, the resistance is slight, erratic, or free movement cannot be eliminated by priming, then the shock absorber should be changed.

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 absorber is tested.

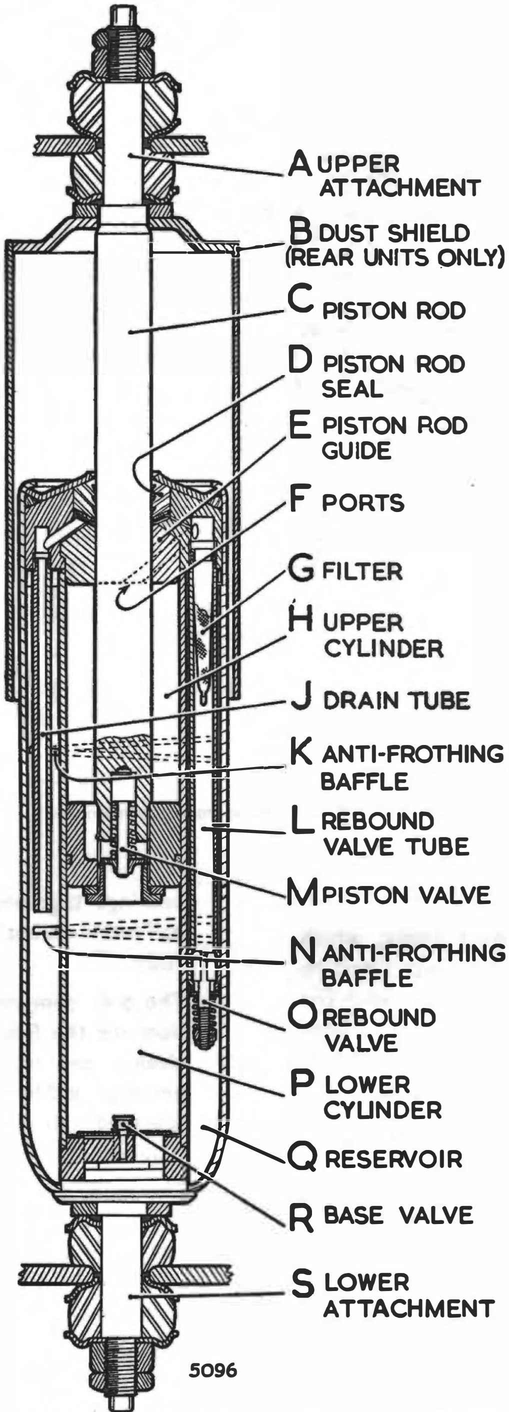


Fig. 25. *Diagrammatic section of telescopic shock absorbers*

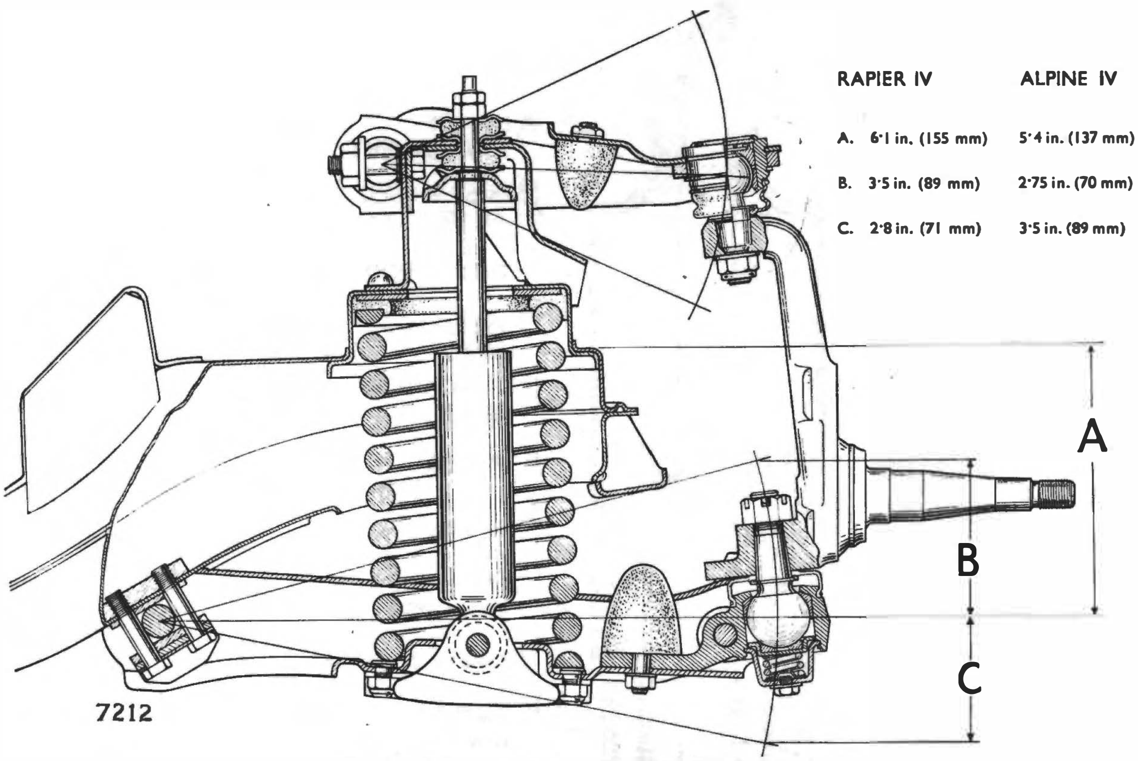


Fig. 26 *Part sectional view of front suspension unit*

SERIES IV MODELS

It is important that the following pages, which concern the new front suspension units fitted to Series IV Models are read in conjunction with the foregoing pages of this Section and reference must be made to the "General Data Section" for all dimensions.

GENERAL DESCRIPTION Fig. 26

The front suspension unit fitted to the Series IV Models is similar in design to the earlier vehicles but there are the following changes:—

i All lubrication nipples have been eliminated by the fitting of metal and rubber bonded bushes to the inner ends of the top and bottom links, pre-packed upper and lower swivel bearings together with similarly pre-packed ball joints on both ends of the two outer track rods.

The only components which require lubrication are the front hubs; these are removed, cleaned and repacked with new grease, the bearing endfloat checked and set within specified limits during the reassembly sequence.

ii The inner ends of the top and bottom links have pressed-in metal and rubber bonded bushes which require no lubrication and assist in reducing the transmission of road surface noises to the interior of the car.

iii The bump and rebound rubbers have a single stud and nut fixing, the bump rubber stud passes through the cast body of the lower

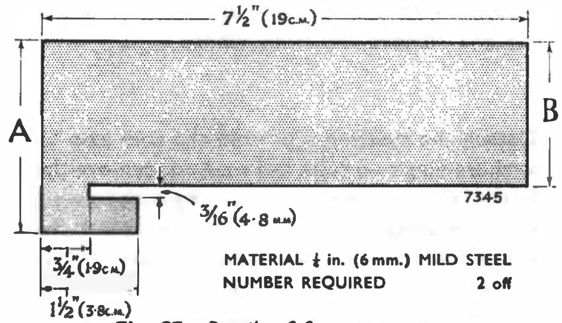


Fig. 27. *Details of front gap gauges*

ALPINE IV. A = 2¾ in. (7·0 cm.), B = 2 in. 5·1 cm.)
RAPIER IV. A = 3 in. (7·6 cm.), B = 2¼ in. 5·7 cm.)

swivel bearing while the stud of the rebound rubber passes only through the pressing of the top link.

iv The swivel bearings are both of the ball type and are pre-packed with lubricant during manufacture and subsequent lubrication is unnecessary, thus no lubrication nipple is provided.

The upper swivel bearing is splined and pressed into the outer end of the top link and locked in position with a circlip.

The lower swivel bearing is fitted into the outer end of the bottom link and secured by one horizontal bolt and the stud of the bump rubber mounted inside the bottom link.

v The steering lock stops have been redesigned to accommodate the fitting of the new lower swivel bearings; they are not adjustable.

vi The shock absorbers have eye type attachments at their lower ends with rubber bushes inserted into the eye and a horizontal bolt secures the shock absorber to a bracket which, in turn, is attached to the underside of the bottom link by nuts and washers.

The upper shock absorber attachment remains unchanged.

PREPARATION OF VEHICLE

Gap gauges

New front gap gauges will be required and these can be made locally to the dimensions given in Fig. 27.

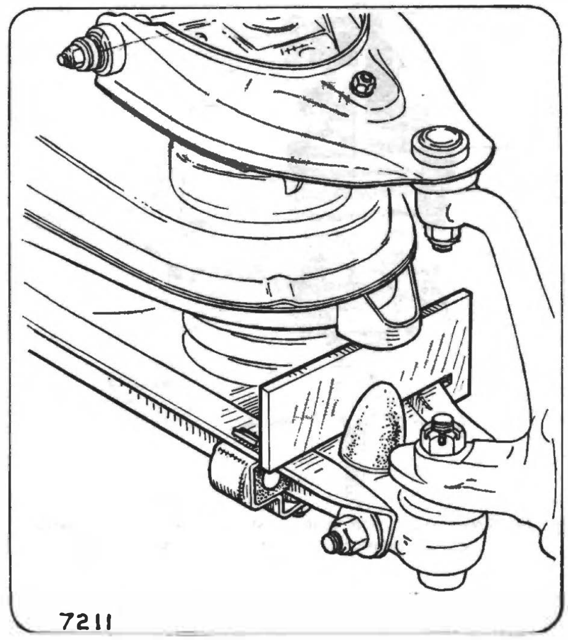


Fig. 28 *Front gap gauge in position with front suspension unit loaded down*

The new gap gauges are used in a similar manner to those described earlier in this section being fed in vertically into the suspension units from the rear between the coil springs and bump rubbers until the cut-out in the gap gauges locate the rear edge of both bottom links. See Fig. 28.

The rear gap gauges remain unchanged and dimensions for their manufacture will be found in Fig. 19 for the Rapier Series IV Models.

The suspension must be loaded down on to the gap gauges.

A loading platform can be built with a stout plank of wood supported by two suitably cranked steel bars ⅞ in. (22 mm.) square inserted one in each front jacking bracket.

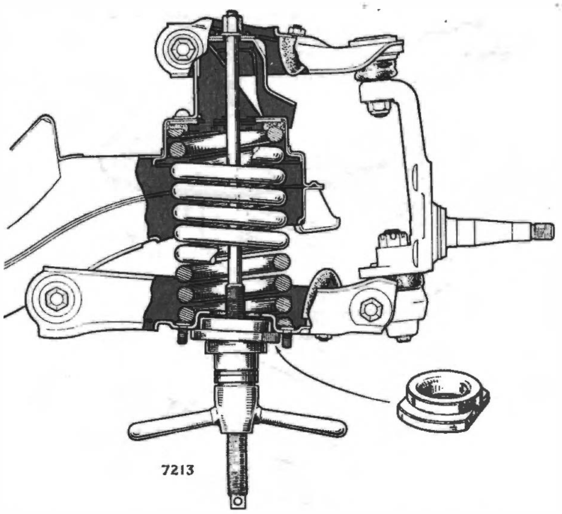


Fig. 29 *Front suspension unit in static laden position with spring compressor RG. 50D in position*

WHEEL LOCK ANGLES

The steering lock stops are small levers welded to the upper face of each bottom link, adjacent to its outer end and a cast lug in the base of each stub axle.

BALL PIN HEIGHTS—To check

It has been found possible, in practice, to determine any inaccuracies that may exist in the front suspension unit by checking camber, castor, king pin inclination angles, front wheel alignment and Ackerman angles; thus rendering a steering ball pin height check unnecessary.

STUB AXLE—To remove and refit

1. Remove the shock absorber from the suspension unit, see under "Shock absorber—To remove and refit"; fit and tension the spring compressor RG. 50D to bring the bottom link to the horizontal position (Fig. 29).

2. Apply the handbrake, jack up the front of the car and remove the front wheel.

3. Detach the steering arm from the stub axle by withdrawing two bolts and washers, remove the brake caliper from the stub axle by withdrawing the remaining bolt and washer, suspend the brake caliper nearby without straining the flexible hose. Remove the brake disc and hub assembly from the stub axle by discarding the split pin and removing the castellated nut and "D" washer. Remove the brake disc guard from the stub axle by withdrawing three bolts and washers.

4. Remove the stub axle from the upper and lower swivel bearings by detaching the nuts from the tapered ball pins and using a suitable extractor, RG. 191A.

5. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

i The nuts of the tapered ball pins are tightened to the torque given in the " General Data Section ".

ii Pack the hub and bearings with grease of the correct grade (see Section P), the amount required is one capful, distributed evenly within the hub shell as shown by the cross hashings in Fig. 15. The bearing endfloat is set, see under "Front Hubs—To adjust" and a new split pin is used to lock the castellated nut.

iii The brakes are adjusted, by pumping the brake pedal until solid resistance is felt.

iv A full front suspension and steering check is carried out.

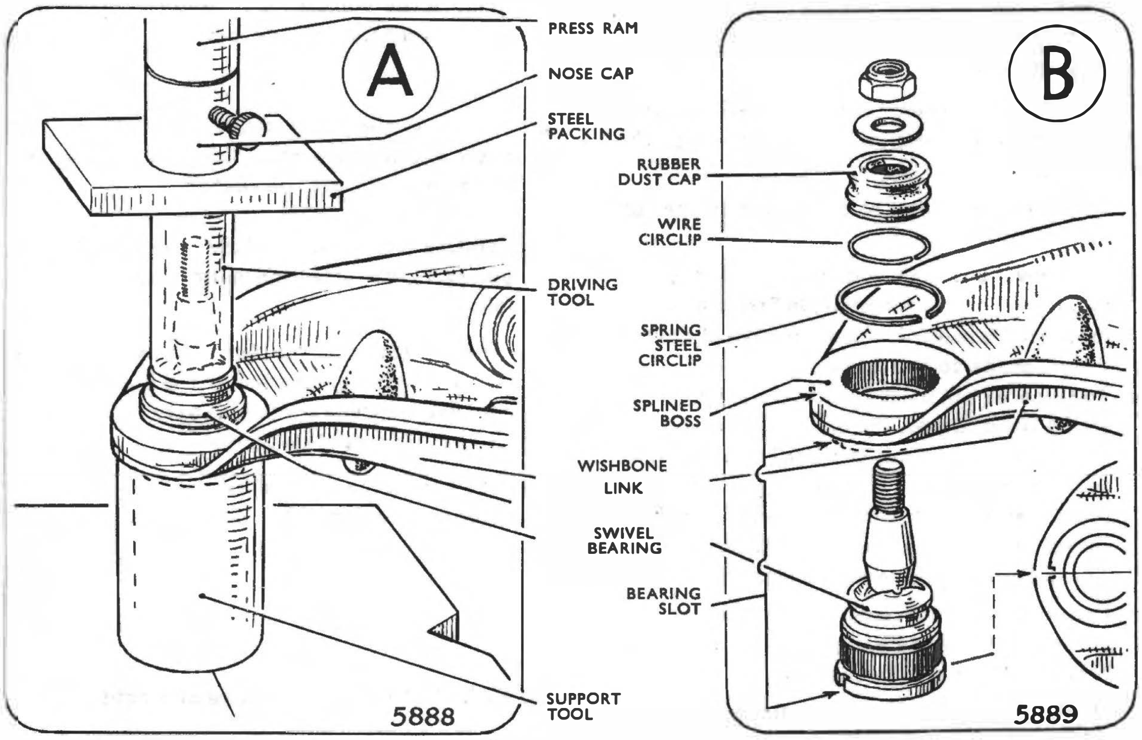


Fig. 30 *"A" pressing out swivel bearing from top link and "B" showing correct position of alignment slot when refitting swivel bearing*

STUB AXLE UPPER SWIVEL BEARING— To remove and refit (Fig. 30)

The upper swivel bearing cannot be removed and refitted without first removing the top link from the stub axle and crossmember. The head of the swivel bearing body carries a slot which indicates the maximum angular travel of the tapered ball pin and must always be positioned towards the outside of the link boss furthest from the fulcrum pin.
A workshop press is used in conjunction with the special tool RG. 319 which consists of:—

i Drive tool ii Support tool
iii Replacing tool

1. The top link and camber shims are removed from the crossmember as described earlier in this Section.
2. Remove the rubber dust cover and washer from the swivel bearing body and tapered pin respectively by releasing the wire circlip.
3. Release the spring steel circlip from the groove in the swivel bearing body adjacent to the boss in the outer end of the top link.
4. Stand the support tool on the press bed and mount to top link above so the tapered ball pin points upwards and the support tool locates the link boss around the swivel bearing body.
5. Position the driving tool over the tapered ball pin so it locates the swivel bearing body; check the vertical alignment of all components

beneath the press ram, eject the swivel bearing by applying steady pressure and remove it from the press bed.

6. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—
   i Check the condition of the splines in the top link.
   ii The swivel bearing is fed through the top face of the top link, tapered ball pin first, so the slot in its head is towards the outer edge of the top link opposite to the fulcrum pin.
   iii The tapered ball pin is fed into the support tool so the latter locates the link boss and position the replacing tool on the head of the swivel bearing; check the vertical alignment of all components beneath the press ram, press the swivel bearing into the link boss by applying steady pressure and remove from the press bed
   iv Ensure the spring steel circlip locates the groove in the swivel body adjacent to the boss in the underside of the top link.
   v Locate the washer on the tapered ball pin followed by the rubber dust cover and secure with the wire circlip.

STUB AXLE LOWER SWIVEL BEARING—To remove and refit

1. Remove the shock absorber from the suspension unit, see under "Shock absorber—To remove and refit"; fit and tension the spring compressor RG. 50D to bring the lower link to the horizontal position. (See Fig. 29).
2. Apply the handbrake, jack up the front of the car and remove the front wheel.
3. Detach the lower swivel bearing from the stub axle by removing the nut from the tapered ball pin and using a suitable extractor RG. 191A; support the stub axle and hub assembly by positioning a block of wood between the rebound rubber and its abutment face on the crossmember.
4. Remove the bump rubber from the upper face of the bottom link by detaching a nut and washer.
5. Withdraw the lower swivel bearing from the outer end of the bottom link by removing the horizontal bolt, nut and washer.
6. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—
   i The horizontal bolt through the swivel bearing body is fully tightened after the bump rubber nut has been fully tightened to the torque given in the "General Data Section".
   ii The nut on the tapered ball pin is tightened to the torque given in the "General Data Section"
   iii A full front suspension and steering is carried out.

BOTTOM LINK—To remove and refit

1. Remove the shock absorber, compress the front spring with the special tool RG. 50D and detach the tapered ball pin of the lower swivel bearing from the stub axle, see under "Stub axle lower swivel bearing—To remove and refit". (See Fig. 29.)
2. Remove the stabiliser bar from the bottom link by removing two nuts, bolts, washers and clips
3. Detach the fulcrum pin of the bottom link from the underside of the crossmember by withdrawing four bolts, washers and two clamps.
4. Progressively release the spring compressor and remove the bottom link, front spring and insulator.
5. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

i The insulator is fitted to the top of the front spring and then fed into the crossmember.

ii Compress the front spring until the fulcrum pin of the bottom link can be fitted to the underside of the crossmember.

iii Tighten the four fulcrum pin bolts and the nut of the tapered ball pin to the torque given in the "General Data" Section.

iv A full front suspension and steering check is carried out.

FRONT SPRING—To remove and refit

The front spring is removed as described under "Bottom Link— To remove and refit" but in this instance there is no necessity to detach the lower swivel bearing from the bottom link.

The spring compressor is slackened off and removed from the crossmember, then the stub axle and bottom link are moved outward and downward so the front spring with its insulator can be withdrawn from below the crossmember.

The refitting is the reverse of the removal sequence and the fulcrum pin bolts tightened to the torque given in the "General Data Section".

To check front springs

Full details of the lengths and loadings for checking the front spring on a spring testing rig are given in the "General Data Section".

While it is possible to check the front spring heights by taking the height of the car and comparing it with one known to be in excellent condition, the possibility of incorrect spring(s) or packing piece(s) that may be fitted, particularly to unknown second-hand cars, makes this method of checking very unreliable.

SHOCK ABSORBERS—To remove and refit

A change has been made to the shock absorber attachment to the bottom link but can be removed from the crossmember in a similar manner to that described under "Stub axle—To remove and refit" earlier in this section but particular attention must be given to the following:—

i After detaching the upper shock absorber attachment from the crossmember, remove the two nuts and washers which secure the lower shock absorber mounting bracket to the underside of the bottom link and withdraw the shock absorber downward.

ii Remove the lower mounting bracket from the shock absorber eye by withdrawing a nut, washer and bolt; eject the tubular distance piece from the centre of the rubber bushes and withdraw the latter from the shock absorber eye.

iii Refitting is the reverse of the removal sequence but the rubber bushes are inserted into the shock absorber eye, long tapered end first and the mounting bracket set at an angle.

iv The shock absorber is fed into the bottom link in its fully extended condition and so the mounting plate is inclined downward and outward.

LINK BUSHES—To renew

To carry out this operation a workshop press is required and no attempt must be made to remove or refit the link bushes without supporting the arms of the top or bottom links. Special tools are available for this purpose, as follows:—

i Plain support tube   ii Slotted support tube
iii Driving tube   iv Mushroom driver

which comprises Churchill Special Tool Set Number—RG. 318.

Two of the tubes are plain and one is slotted. The slot allows the fitting of the tube around the fulcrum pin when fitting the link bushes. The operational procedures are the same for the top and bottom links.

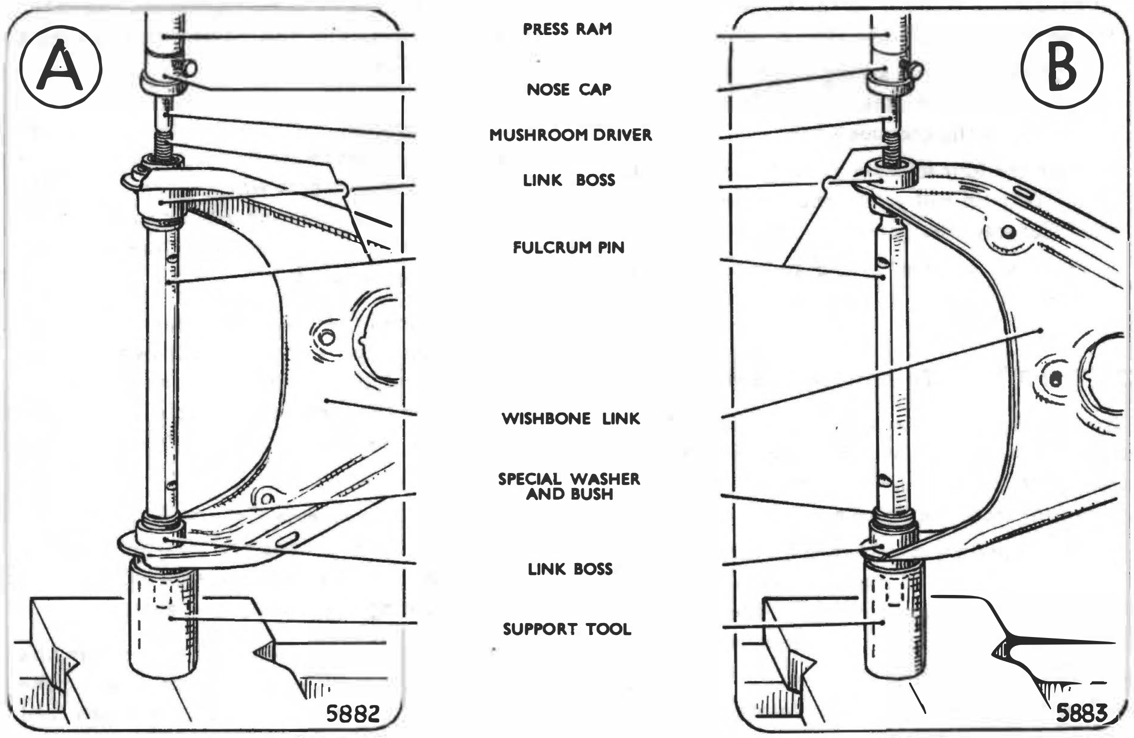


Fig. 31 *Illustrating method of removing bushes from the links in a workshop press using special tool RG. 318*

To remove link bushes (Fig. 31)

1. Remove the link from the crossmember as described under the appropriate heading; in the instance of the bottom link identify one end of the fulcrum pin to the link arm.
2. Remove the self-locking nuts and plain washers from both ends of the fulcrum pin.
3. Stand the link on its side in the press, as illustrated at " A ".
4. Place the plain support tube under the lower arm of the link, ensuring that the tube is correctly located around the outside of the link bush.
5. Position the mushroom driver between the nose cap of the press ram and the upper end of the fulcrum pin, at the same time applying a little pressure on the ram to enable the assembly to be supported.
6. After making sure the fulcrum pin is in the vertical position, apply further pressure on the ram until the bush is pressed out clear of the link.
7. The link bush complete with fulcrum pin and two special washers are now separated from the link and can be drawn clear.
8. Proceed to remove the bush from the opposite side of the link. The procedure is similar to the first link but it will be necessary to temporarily refit the fulcrum pin with one of the special washers positioned between the link bush and the shoulder of the fulcrum pin, see Fig. 31 at "B."

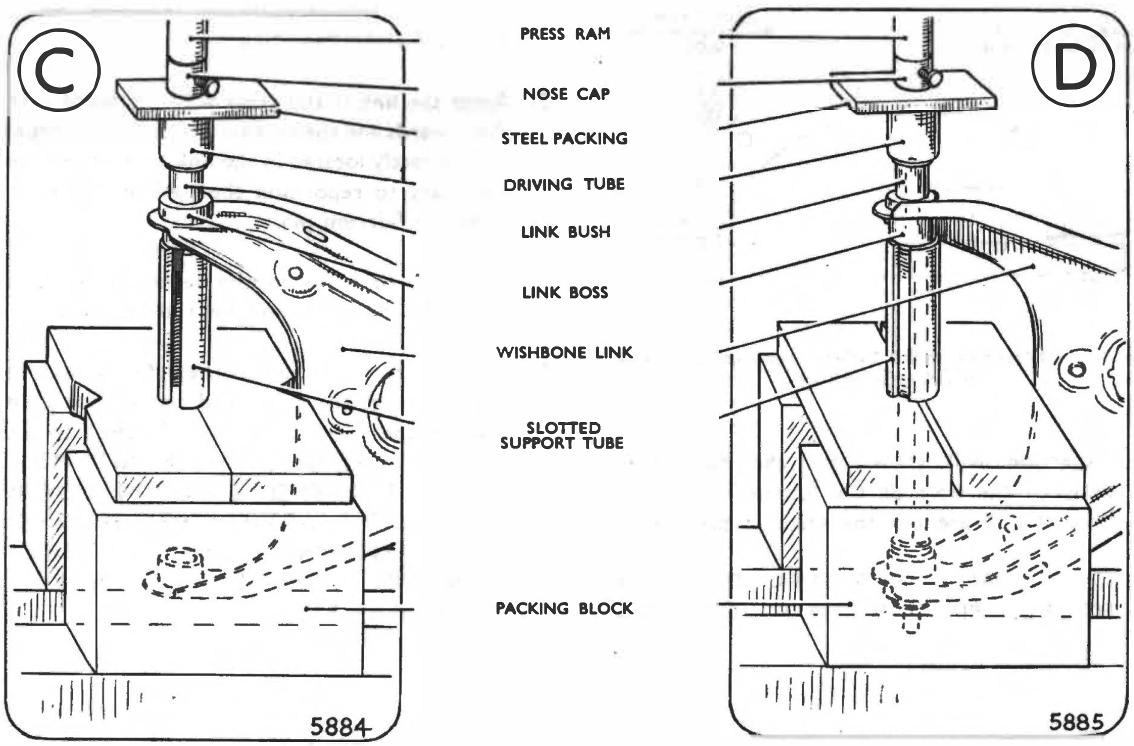


Fig. 32 *Illustrating method of fitting bushes to a link in a workshop press using special tool RG. 318*

To fit link bushes (Fig. 32)

It is strongly recommended that new bushes and new special washers are fitted and the old link bushes and washers discarded. It will be necessary to use the slotted support tube and the driving tube in the manner illustrated.

The procedure is as follows:—

1. With the aid of packing blocks, set up the link in the press with the upper arm supported by the slotted tube as shown at "C". Ensure that the slotted tube is properly located below the boss of the link.

2. Place the link bush and driving tube in position between the nose cap of the press ram and the entrance of the boss, at the same time lowering the ram a little to support the assembly.

3. After making sure the assembly is vertical and the link bush is centrally located in the entrance of the boss, apply pressure gradually, preferably in stages, to the press ram until the link bush is fully home in the boss.

4. Remove the link from the press and install the fulcrum pin complete with two new special washers in the link according to the identification markings, ensuring that the special washers are correctly seated with their chamfered sides inwards towards the shoulders of the fulcrum pin.

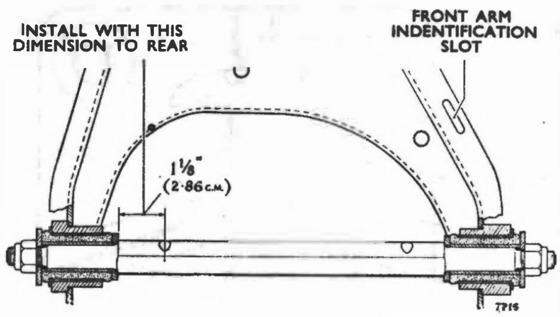


Fig. 33 *Sectional view of link bushes showing correct method of fitting fulcrum pin*

Inspection will show that the dimensions between the slots on the fulcrum pin of the bottom link are not the same at both ends.

IT IS VITALLY IMPORTANT, THAT THE FULCRUM PIN IS FITTED SO THAT THE GREATER DIMENSION IS TO THE REAR ARM OF THE LINK. (See Fig. 33).

5. Reset the link in the press with the fitted bush downwards and the threaded end of the fulcrum pin correctly located in the link bush. It will be necessary to reposition the packing blocks to clear the fulcrum pin.

6. Continue to press in the second link bush, following the procedure for the first bush.

7. When both link bushes have been fitted, remove the link from the press bed and fit the plain washers and self-locking nuts LOOSELY to the ends of the fulcrum pin. THE NUTS MUST NOT BE TIGHTENED UNTIL THE LINK IS FITTED TO THE CAR WITH THE SUSPENSION IN THE NORMAL LADEN CONDITION, OTHERWISE DAMAGE TO THE LINK BUSHES WILL RESULT.

REAR AXLE

CONTENTS

(23 Pages)

REAR AXLE

HYPOID BEVEL DRIVE

GENERAL DESCRIPTION

A rear axle of the semi-floating type with detachable taper mounted hubs, incorporating a hypoid bevel drive is fitted to Alpine and some Rapier cars. In design it is essentially straight forward, but as the position of the pinion relative to the crown wheel requires accurate adjustment involving the use of special tools, it should remain undisturbed as far as possible.

Crown wheel and bevel pinion adjustment is provided by disposition of shims adjacent to the taper roller bearings carrying the differential housing and the bevel pinion shaft, described in detail in this section.

The complete differential assembly is detachable from the axle casing after removal of the axle shafts, when major attention to the unit is required. The axle shafts are fully machined and supported at their outer ends on ball bearings.

BEVEL PINION HOUSING OIL SEAL

(Figs. 1 and 3)

In the bevel pinion housing an oil seal (27), is fitted just to the rear of the propeller shaft driven coupling (32). Whenever a replacement oil seal is fitted, the outside of the cage should be coated with a liquid jointing compound before the seal is pressed into position. These seals operate most effectively in one direction, and thus they should be fitted with the lip and spring facing the rear axle. They are easily removed and replacements can be pressed into position.

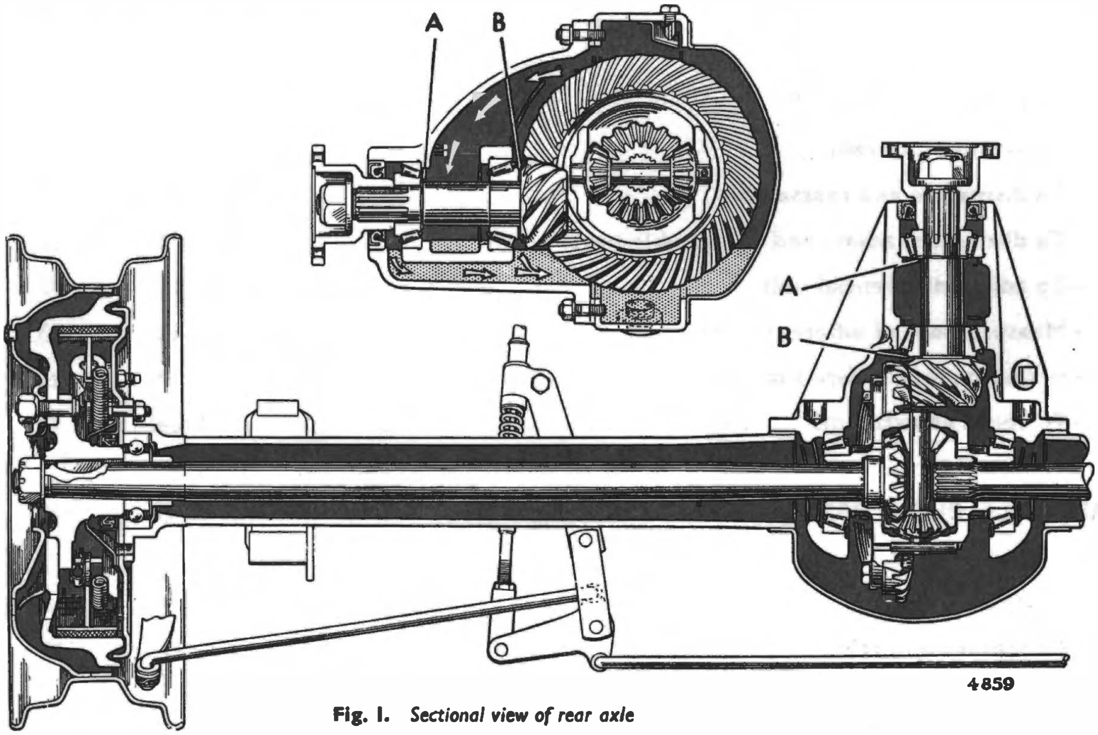


Fig. 1. *Sectional view of rear axle*

HUB OIL RETAINERS (Figs. 1 and 3)

An oil splash guard (38), which consists of an outer ring overlapping an inner ring (37), is supplemented by an oil seal (39). The oil seal is replaceable after removal of the rear hub (described in a later paragraph), and the three plain bolts and two dowel bolts passing through the dust shield, seal housing (40), brake backing plate and axle casing flange. Care should be taken on replacing these bolts that they are fitted in the correct holes.

The hub may be removed for oil seal replacement without removing halfshaft using Tool RG. 188-B as shown in Fig. 2.

AXLE SHAFT—To remove and refit

Rapier cars have unequal length axle shafts. The longer shaft is fitted to the right-hand side of the car, the short shaft is fitted to the left-hand side. Alpine cars have shafts of equal length.

The drive shafts (and differential wheels) on early Alpine and Rapier cars have 17 splines, Later cars have shafts (and wheels) with 25 splines.

Shafts can be identified by the letter stamped on the outer end of the shaft as follows :-

Rapier (17 splines)	*Right-hand shaft—*	*'C'*
	Left-hand shaft—	*'A'*
Alpine (17 splines)	*Both shafts —*	*'B'**
Rapier (25 splines)	*Right-hand shaft—*	*'H'*
	Left-hand shaft—	*'D'*
Alpine (25 splines)	*Both shafts —*	*'E'*

**Early shafts unstamped.*

To remove

Serious damage will result from any attempt to remove an axle driving shaft by any method other than the following:—

Remove road wheel.

Remove all road dirt from brake backing plate around its fixing to the axle tube flange.

Remove setscrew securing brake drum.

Remove brake drum.

Release brake pipe connections from rear of backing plate.

Protect brake pipe connections against the ingress of foreign matter.

Remove nuts and bolts securing brake backing plate to flange on axle casing.

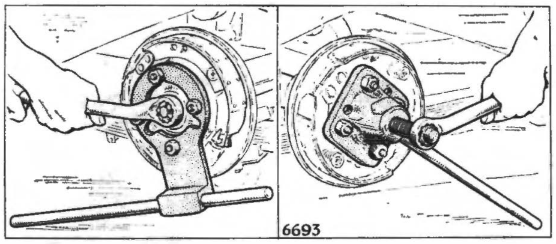


Fig. 2. *Removing hub for oil seal renewal*

Cars with disc wheels

Fit the axle shaft removing tool (VLC .No. RG.16A) and adaptor (RG.16A-4 or 188-B) over the four wheel studs and secure it by the nuts.

Cars with centre-lock wire wheels

Screw the four extension legs (VLC .No. RG.16A-5) into the brake drum securing holes. Fit the axle shaft removing tool and secure it with nuts.

Move the sliding weight sharply along the shaft of the tool against its outer abutment in order to draw the shaft out of the axle casing.

Remove the shaft complete with brake back plate, oil seal, dust excluder and hub.

Remove outer ring of splash guard from bearing recess. (See item 38, Fig. 3).

To refit (Fig. 3)

Ensure that the brake backplate and axle casing flange around the bearing recess are free from road dirt. It is essential that the bearing remains clean during assembly.

Fit outer member of splash guard (38), into bearing recess (Fig. 1), with recessed centre inwards. A little grease smeared around the housing will help to keep the guard in place whilst entering the shaft and bearing.

Pass the shaft into the casing and ease the splines into those of the axle shaft end wheels (19).

Pushing the shaft inwards, enter the bearing in its recess and carefully drive the assembly into position until the bearing outer face is flush with the end of the recess.

Ensuring that all remaining parts are clean, fit back-plate, oil seal and housing and dust shield to axle casing flange. Fit the five bolts, nuts and spring washers.

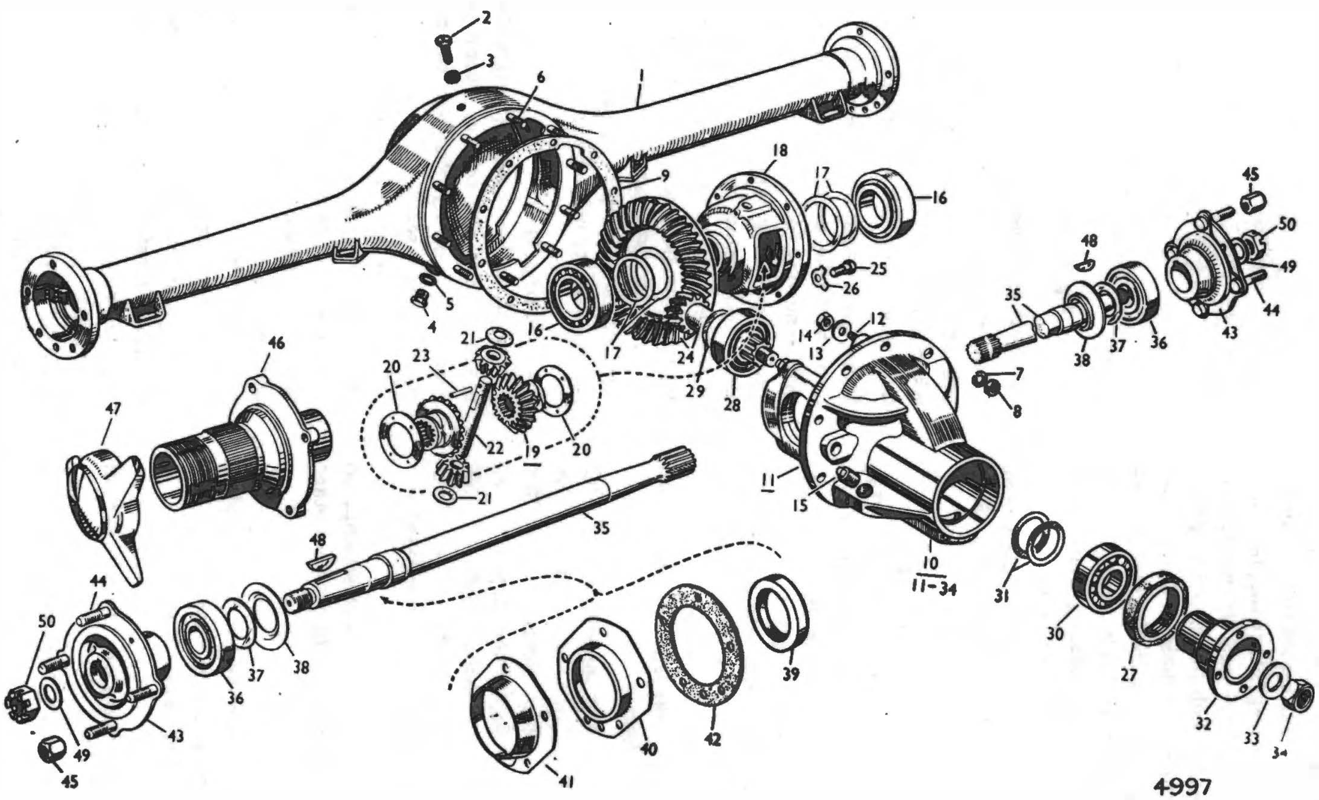


Fig. 3. *Exploded view of rear axle (Hypoid Bevel Drive)*

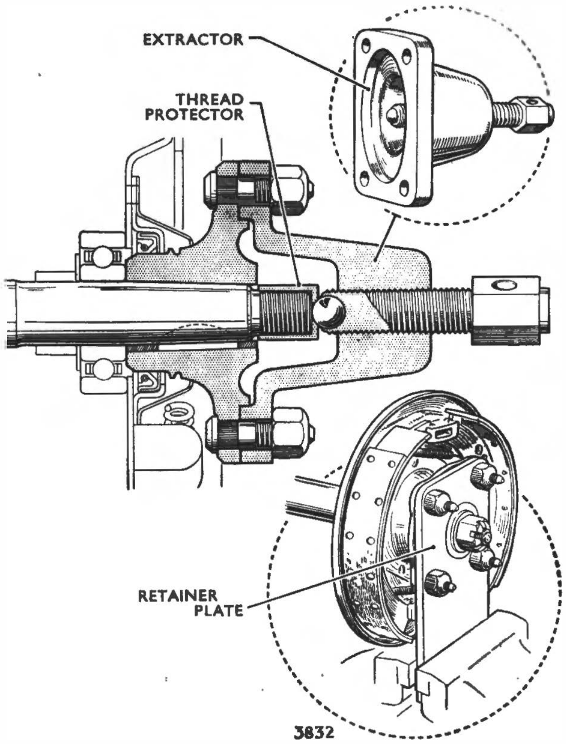


Fig. 4. *Hub retainer and extractor in use*

Take care that the bolts are fitted in the correct holes; i.e. that the dowel bolts are fitted in the reamed holes.

The five bolts through the backing plate and axle tube flange may be fully tightened as soon as the hub is right home. This ensures that the oil seal is correctly centralised in relation to the machined surface on the hub.

The axle shaft assembly is now correctly located, and the brake gear, drum, etc., can be refitted and the pipes reconnected.

Finally, bleed the brakes.

To remove hub from axle shaft—after shaft removal (See Fig. 4)

Cars with disc wheels

Attach retaining plate (part of hub removing kit RG. 188A or 188B) to the four wheel studs, using the existing nuts.

Clamp the plate securing the shaft in the vice (Fig. 4).

Remove split pin, loosen and remove hub retaining nut (50).

Remove washer (49).

Release vice, remove retaining plate and fit extractor tool (part of hub removing kit RG.188A or 188B) over the wheel studs, placing the short protector over the shaft thread, and securing it with the four wheel nuts.

Cars with centre-lock wire wheels

Attach the retaining plate (part of hub removing kit RG. 188A) to the hub by means of the set-screws supplied.

Clamp the plate securing the shaft in the vice.

Remove split pin (there are holes for this purpose in the side of the hub), loosen and remove hub retaining nut.

Remove washer.

Release vice, remove retaining plate and fit the four extension pieces (RG.16A-5) to the hub by screwing the threaded end of each piece into the brake drum securing holes. Place longer type protector over shaft thread, fit extractor to the extension legs securing it with the four wheel nuts.

Secure the assembly in the vice by the flats provided on the extractor, screw in the centre bolt of the tool to take the load, and smartly tap the end of the extractor bolt. Remove hub and extractor. The dust shield, oil seal, carrier and backplate can now be removed. Remove key from tapered end of shaft.

Rear hub bearings—To remove from axle shaft and refit (See Figs. 1 and 3)

To remove

Remove hub, brake gear, etc. as previously described.

Slide the solid ring (part of VLC kit No. RG.188A-1) over the splined end of the axle shaft until the ring impinges on the inner race of the hub bearing. Screw in the four extension legs and fit the extractor and short protector. Rotation of the centre bolt of the extractor will pull the hub bearing off the axle shaft.

To refit

The lateral location of the hub bearing is controlled by a sleeve on the inner side of the bearing against which the latter is located by the hub when fully positioned on its taper.

It is essential that the hub bearing is always tightly compressed between the sleeve and the hub. Therefore, when fitting a new hub bearing, the following procedure should be adopted:—

Fit the split bush (part VLC kit RG.188A-1) to the solid ring. **Note.** It is not necessary to dismantle the tool to fit the split bush. The bearing may be left resting on the tapered portion of the axle shaft and the split bush inserted in the solid ring with the extractor in the fully released position. Alternatively, before fitting the split bush, and after screwing back the extractor centre bolt, the bearing may be removed between the legs of the extractor. Slide the assembly over the axle shaft with the flanged side of the bush away from the spline, until it butts the sleeve.

Fit the four extension legs, short protector, and extractor.

Rotate the centre bolt of the extractor until the sleeve has been pulled $\frac{1}{32}$" (·8 mm.) in the direction of the outer end of the axle shaft.

Remove split bush.

Remove axle shaft from tool assembly.

Pass the splash guard (37), and bearing (37), over the end of the shaft. Press the bearing onto the shaft.

Fit key and hub and fit the retaining plate (VLC tool) over the wheel studs, securing it by the nuts. Place the whole assembly in a vice, fit the nut and tighten with a torque spanner to 180 lbs. ft. (25 kg.m.).

It can be checked that compression has been obtained by attempting to rotate the inner splash guard which is interposed between the sleeve and the bearing inner race.

Fit split pin. (Later cars have self-locking nuts fitted.)

The assembly may now be refitted to the axle casing (see "Axle-shaft—To refit").

Note:

As the inner track of the hub bearing is an interference fit on the axle shaft it is essential that bearings of the correct type are used.

Bearing sleeves are not supplied separately.

DIFFERENTIAL UNIT—To remove and refit (Fig. 3)

Drain oil from axle case.

Remove both axle driving shafts as previously described.

Disconnect propeller shaft from rear axle driven coupling.

Remove nuts (8) and washers (7), securing differential housing to axle case.

Lift out assembly.

When replacing the assembly the operations are a reversal of the above.

The joint faces must be clean and free from burrs.

Use a new joint and coat both faces with a jointing compound.

Important. Bleed brakes on completing re-assembly of rear axle unit.

REAR AXLE BREATHER

ALPINE. The breather is a set-screw with a $\frac{3}{32}$" (2·38 mm.) diameter hole drilled through it, mounted on top in the centre of the casing.

RAPIER. The breather hole is $\frac{3}{32}$" (2·38 mm.) in diameter and is drilled directly on top of the right-hand side of the sleeve of the axle casing 14·2" (360·1 mm.) from the centre of the banjo casing.

The breather hole should be kept clear at all times.

DIFFERENTIAL UNIT—To dismantle and reassemble (Fig. 3)

Remove assembly from axle.

Remove caps over bearings supporting differential assembly.

Lift off differential assembly complete with crown wheel and bearings. Remove crown wheel and bearings taking care that outer races of bearings are not interchanged, one side with the other.

The crown wheel is secured to the differential box by eight setscrews (25), which are each locked in position by a tabwasher (26).

Knock out taper pin (23), securing cross pin (22), in differential box.

Push out cross pin; differential pinions complete with thrust washers (21), can then be carried round and brought out through the wide openings in differential box.

On no account should an attempt be made to remove the differential pinions from the differential box without first removing the crown wheel. Due to recessing of the differential box within the crown wheel, removal of the cross-pin is obstructed by the teeth of the crown wheel.

Differential wheels, and thrust washers (20), can now be taken out of differential box through the same openings.

Reverse the above procedure for reassembly of the differential gears.

When refitting the crown wheel to the differential box the following points must be carefully observed.

1. The faces of both crown wheel and differential box should be thoroughly clean, and free from burrs or bruises otherwise there is every possibility of misalignment after reassembly. Using a dial indicator check run out which should not exceed ·003 in.

2. The tabwashers for the eight setscrews should be renewed and screws tightened to 45-55 lb. ft.

3. Bearing cap nuts tightened to 50-55 lb. ft.

If bearings or crown wheel and pinion are renewed, refer to the instructions laid out in the following paragraphs.

NOTE:—Should it be found necessary to renew the bearings which carry the differential assembly, the old inner races may be withdrawn by means of the VLC tool RG4221B and adaptors RG4221B-20. Inner and outer portions of these bearings must be renewed as a pair, as is the case with all bearings of this type. It is not permissible to renew either inner or outer portion separately in any circumstances.

BEVEL PINION—To dismantle, adjust, and reassemble (See Figs. 1, 3, 5 and 6)

To dismantle

Remove the differential unit from the axle.

Remove the differential assembly complete with crown wheel and bearings, as previously described.

Remove the self-locking nut (34), and washer (33), securing the propeller shaft coupling. For this purpose the flange holding wrench VLC tool RG.48 will be required.

Draw the coupling (32) off the pinion shaft.

Tap the bevel pinion rearwards out of the housing

Use a soft metal drift to prevent damage to threads.

The inner bearing race and the shims at A and B (Fig. 6) will be detached with the pinion, and should be removed.

To remove the inner bearing race from the pinion an arbor press or the VLC Hand-press RG.4221B will be required. Support the race by means of the adaptors RG.4221B-21 and apply pressure to the threaded end of the shaft.

Remove the shims, but do not discard them.

Remove the oil seal from the front of the housing.

HYPOID BEVEL DRIVE

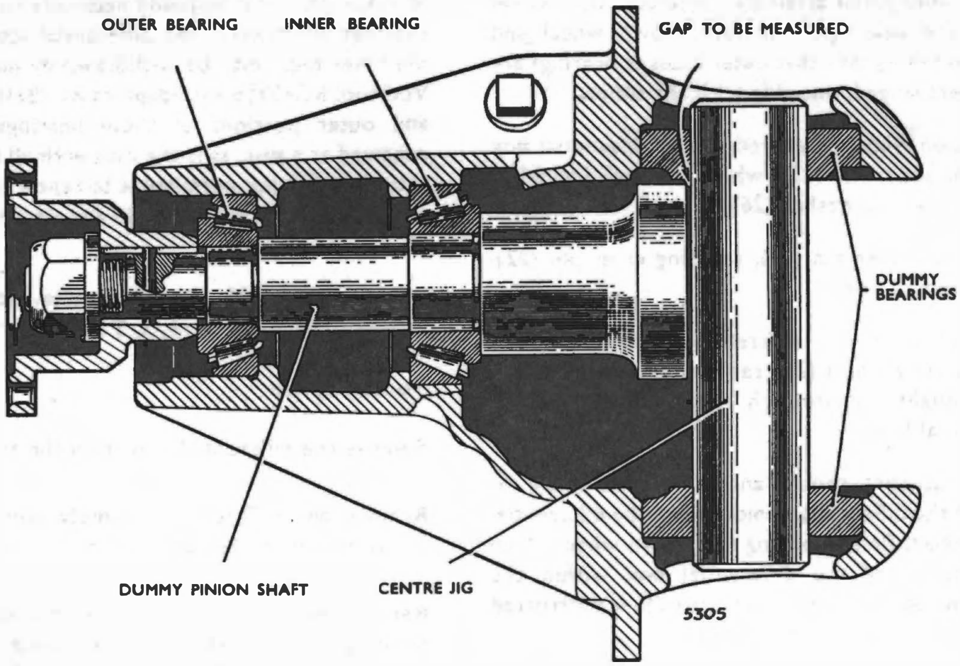


Fig. 5. *Jigs used in the adjustment of bevel pinion preload and bevel pinion position relative to crown wheel axis*

To adjust

The bevel pinion assembly must be correctly adjusted in two respects.

1. Position of the pinion relative to the axis of the crown wheel.
2. Preload of the bearings.

To obtain the degree of accuracy necessary in these adjustments, VLC kit No. R.G.295B will be required.

To adjust position of pinion relative to crown wheel axis.

Note in Fig. 6, the shims positions denoted A and B.

For this purpose a small number each of the following shims will be required, having the thicknesses given:—

9071049	...	...	0·003" (0·08 mm.)
9071050	...	...	0·005" (0·13 mm.)
9071051	...	...	0·010" (0·25 mm.)
9071132	...	...	0·020" (0·50 mm.)
9071069	...	...	0·003" (0·08 mm.)
9071070	...	...	0·005" (0·13 mm.)
9071071	...	...	0·010" (0·25 mm.)
9071133	...	...	0·020" (0·50 mm.)

Take the dummy pinion shaft and place on it the inner bearing. DO NOT FIT ANY SHIMS BETWEEN THE BEARING AND THE PINION HEAD.

Insert the assembly into the casing.

HYPOID BEVEL DRIVE

Fit the outer bearing.

Fit the coupling driver, washer and dummy nut.

Progressively tighten the dummy nut to absorb all end float and until a slight resistance is felt to turn the pinion flange by hand.

Fit the dummy bearings into the differential.

Fit the centre jig through them.

Replace the two bearing caps and tighten the four securing nuts.

It will be observed that there is a gap between the end of the dummy pinion shaft and centre jig.

Measure this gap using feeler gauges.

Note this measurement and at the same time note any measurement engraved on the head of the actual pinion.

This figure records, in thousandths of an inch, any variation in position of the tooth form relative to the inner bearing shoulder which may have occurred during manufacture.

It may be preceded by either a minus sign or a plus sign.

If it is preceded by a minus sign add this amount to the measurement taken of the gap.

If the sign is a plus subtract the amount from the measurement of the gap.

The resulting measurement, would be the thickness of shims to be added to the actual pinion at points A and B, to position the pinion relative to the crown wheel axis. In practice, however, it is found that, as the bearing is pressed to the actual pinion, the bearing alters length approximately ·002 in. (·05 mm.). Therefore, ·002 in. (.05 mm.) should be subtracted from the thickness of shims at point B.

Remove the dummy pinion from the casing.

Place the shims B onto the actual pinion and press on the inner bearing race (lightly oiled). Use an arbor press and a tubular drift or the hand press RG.4221B and adaptor RG.4221B-21.

On later pinions fit the shim abutment washer, the bevelled edge against the pinion outer shoulder. On these pinions the distance from behind the pinion head to the abutment shoulder has been reduced from 2·828 in. (71·83 mm) to 2·716 in. (68·98 mm).

Place onto point A on the actual pinion the same thickness of shims as at point B plus ·018 in. (·46 mm.).

Insert the pinion into the casing and fit the outer bearing (lightly oiled). Do not fit the oil seal at this stage.

Replace the coupling, washer and nut.

To obtain pre-load

The bearings are pre-loaded when a resistance is felt when turning the pinion flange by hand with the nut tightened to a torque as given in General Data.

Rotating the pinion, tighten the nut progressively.

FAILURE TO ROTATE THE PINION MAY RESULT IN A FALSE PRE-LOAD.

If the pinion becomes locked before the nut is tightened to the correct torque additional shims are required at point A.

If the correct nut torque figure is reached and no resistance is felt when turning the pinion by hand, shims must be removed from point A.

To test for correct pre-load

The pre-load is assessed by measuring the torque required to rotate the shaft.

The torque should be 6-12 lb. ins. (·07-·14 kg.m.) for new bearings, or 4-8 lb. ins. (·05-·09 kg.m.) when the original bearings are fitted.

The torque can be checked using a length of cord approximately 3 ft. (1 meter) long attached to a spring balance.

Take four or five turns of the cord around the coupling as shown in Fig. 5A. Rotate the coupling by pulling on the spring balance. Note the reading on the balance scale as the coupling is rotating. It is important that the reading is taken as the coupling is rotating, not the reading as the coupling starts to rotate.

The reading on the scale should be 6-12 lbs. (2·7-5·4 kg.) for new bearings or 4-8 lbs. (1·8-3.6 kg.) when the original bearings are fitted.

The torque loading can also be checked conveniently using VLC tool RG.300 and adaptor RG.300-1A.

Too high a torque indicates that more shims must be added to point A. Too low a torque indicates that shims must be removed.

NOTE. 0·001 in. (0·025 mm.) in shim thickness makes a difference of approximately 4 lb. ins. (0·05 kg.m.).

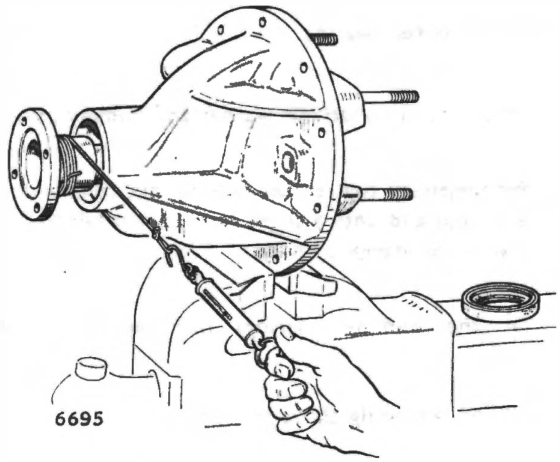


Fig. 5A. *Checking torque loading (pre-load) of pinion bearings*

The torque loading can be checked conveniently using VLC tool RG.300 and adaptor RG.300-1A.

Remove the nut, coupling driver and washer.

Fit the oil seal. The outer case of the oil seal should be coated with a quick-dry jointing compound.

Fit the coupling driver, washer and a new self-locking nut. Tighten the nut to a torque as given in General Data.

If it is found that new bearings are required, the old bearing outer tracks may be removed by means of the VLC extractor RG.1105.

When refitting new bearings the following must be observed:—

Inner and outer races of bevel pinion bearings must not be renewed separately as these are mated in manufacture.

Failure of a bearing necessitates renewal of the complete bearing assembly, comprising inner race, rollers, cage, and outer race.

HYPOID BEVEL DRIVE

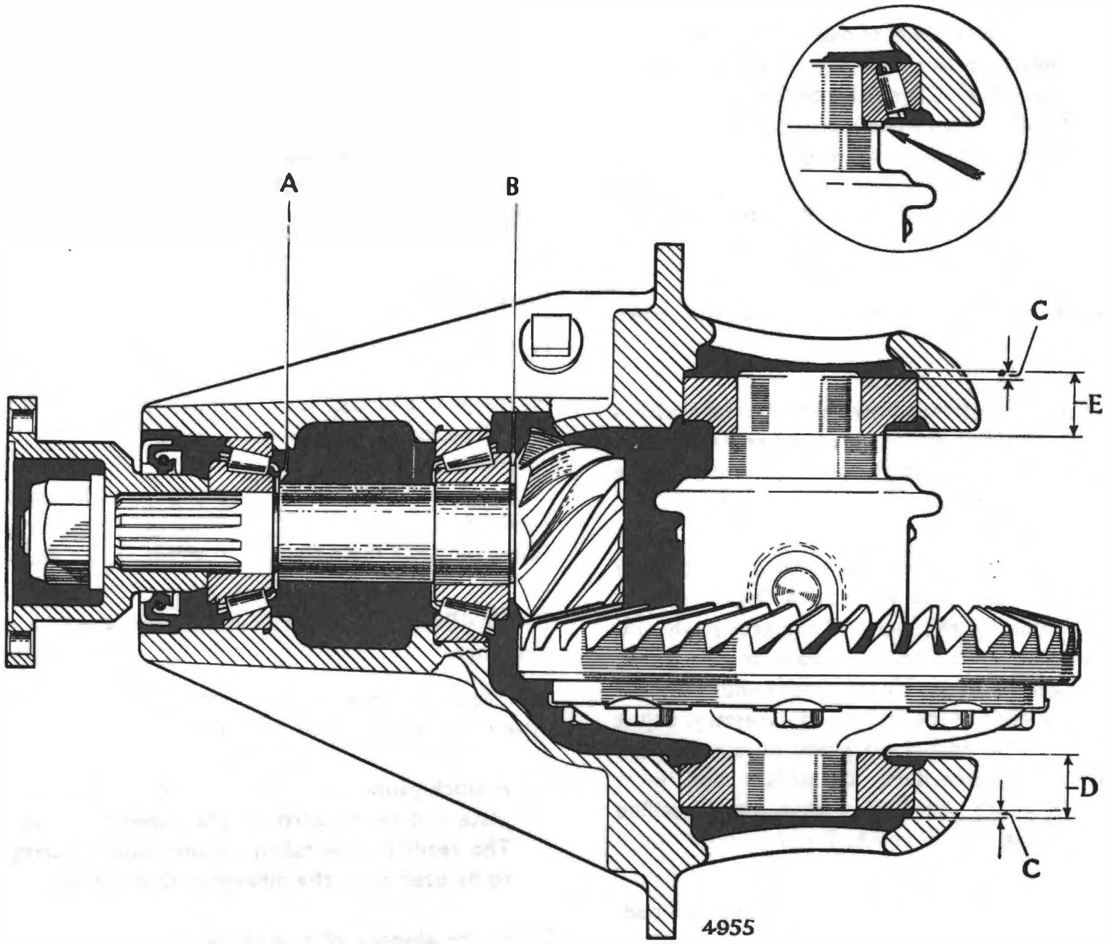


Fig. 6. *Adjustment of crown wheel and differential box bearings. Note also the shimming positions for pinion adjustment*

DIFFERENTIAL UNIT—To adjust and refit

Note in Fig. 6, the shim and bearing thicknesses C, D, and E.

Having carried out the preceding operations, remove the differential box bearings (as previously described) and shims. In their place fit the dummy bearings without shims, their inner faces abutting the differential box. Place the differential box assembly (complete with the dummy bearings), in position in the housing, replace the bearing caps and lightly tighten the securing nuts. Mount a dial indicator on the differential housing with the stylus against the heel of one of the crown wheel teeth, as nearly in line with the direction of tooth travel as possible. Check the backlash by moving the drive gear (crown wheel), preventing the pinion from rotating. Adjust to between 0·005—0·009 in. (0·13—0·23 mm.) by driving the appropriate dummy bearing inward using VLC tool 292 and handle 550.

Check for backlash at three positions on the crown wheel.

Paint the teeth of the crown wheel thinly with a light paste made of dry red lead and engine oil and rotate the wheel to obtain an impression of the pinion tooth bearing.

When correctly meshed, the marking so obtained should be as shown in example A, Fig. 7, *i.e.* the area of contact of the teeth, of the crown wheel is between the crown and the base of the tooth, but is slightly nearer the toe (inner end) than the heel (outer end) of the tooth. If necessary, adjust the crown wheel (drive gear) into or out of mesh as previously described, to obtain the most favourable tooth marking within the specified backlash limits. See D and E, Fig. 7.

If markings as shown in B and C, Fig. 7 are obtained, a readjustment of the pinion is necessary.

Having obtained the correct adjustment, measure the gaps between the outer faces of the dummy bearings and the casing points (C and D, Fig. 7)

Now measure the difference in thickness between the dummy bearing and the actual bearing used for each side. (See "Measurement of bearings".)

If the actual bearing is thicker than the dummy bearing, the amount must be subtracted from the measurement of the gap.

If the actual bearing is thinner than the dummy bearing, the amount must be added to the measurement of the gap.

The result gives the thickness of the shims required for each side, but 0·002 in. (0·05 mm.) must be added to each side to provide the required pre-load for the bearings.

Make a careful note of these measurements.

For example, side C:—

Measurement of Gap C	+0·033 in. (0·84 mm.)
Actual bearing 0·003 in. (0·07 mm.) thicker than dummy bearing ...	—0·003 in. (0·07 mm.)
Pre-load	+0·002 in. (0·05 mm.)
Shims required (Side C)	0·032 in. (0·82 mm.)

DIFFERENTIAL UNIT—Measurement of bearings

This requires great accuracy and may present a little difficulty. Two methods may be used.

1. A clock gauge is suitably mounted on a surface plate and set to zero on the dummy bearing. The reading then taken on the actual bearing to be used gives the difference (See Fig. 8).

2. In the absence of a clock gauge the difference between the dummy and the actual bearing can be ascertained by the use of feeler gauges and a straight edge, if both are placed on a surface plate (See Fig. 8).

REAR AXLE—To remove and refit

As described in the foregoing operations, 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.

Remove rebound straps (*Alpine cars I and II only*).

HYPOID BEVEL DRIVE

TOOTH CONTACT CHART

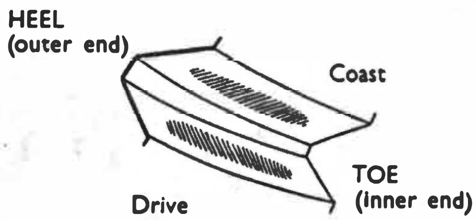
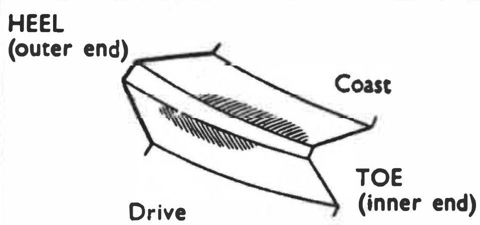
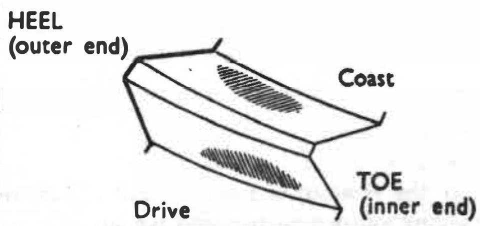
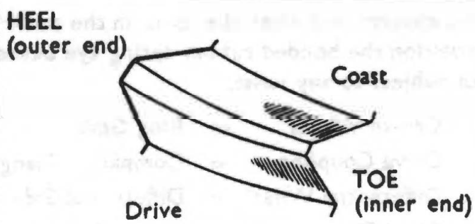
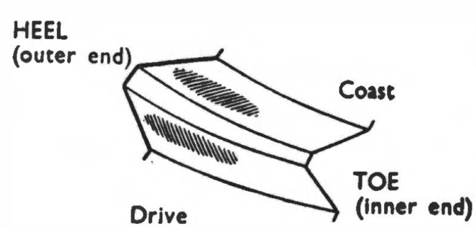
	Tooth Contact	Condition	Remedy
A		IDEAL TOOTH CONTACT evenly spread over profile, nearer toe than heel.	
B		HIGH TOOTH CONTACT heavy on the top of the drive gear tooth profile.	Move the Drive PINION DEEPER into MESH, *i.e.* Reduce the pinion cone setting.
C		LOW TOOTH CONTACT heavy in the root of the 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. 6102

Fig. 7. *Specimen tooth markings on drive gear (crown wheel)*

HYPOID BEVEL DRIVE

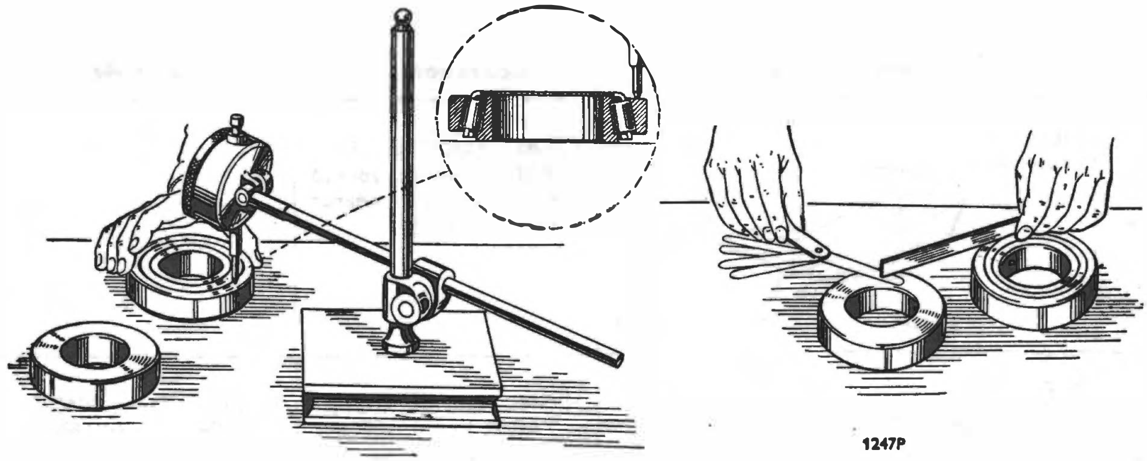


Fig. 8. *To measure height of differential bearing on surface plate*

Jack up rear of car so that the road wheels are clear of the ground and support the underframe on stands.

Remove road wheels.

Disconnect propeller shaft at rear driver coupling.

Remove rear shock absorbers.

Disconnect hand brake cable from linkage.

Disconnect rear brake hose at 3-way union on axle casing.

Protect brake hose from ingress of foreign matter, lift hose upwards and tie to prevent loss of fluid.

Remove all spring U-bolts.

Withdraw axle from between springs.

Re-assembly is a reversal of the above operations.

Bleed brakes (See Section K).

When refitting the axle to the springs, the U-bolts must be tightened with a torque spanner to the torques specified in the Data Section.

The final tightening of the spring "U" bolts, shackle assemblies, and pivot pins, should be carried out after the removal of the jacks and stands, the car standing unladen on the road wheels.

This ensures that when the car is in the static laden condition the bonded rubber spring eye bushes are not subject to any twist.

Crown Wheel	=	Ring Gear
Drive Coupling	=	Companion Flange
Differential Wheel	=	Differential Side Gear
Bevel Pinion	=	Pinion Gear

REAR AXLE

SPIRAL BEVEL DRIVE

GENERAL DESCRIPTION

A semi-floating rear axle with detachable taper-mounted hubs incorporating a spiral bevel final drive is fitted to some Rapier cars.

Crown wheel and bevel pinion adjustment is provided by disposition of shims adjacent to the taper roller bearings carrying the differential housing and the bevel pinion shaft, described in detail in this section.

The complete differential assembly is detachable from the axle casing after removal of the axle shafts, when major attention to the unit is required. The axle shafts are fully machined and supported at their outer ends on ball bearings.

BEVEL PINION HOUSING OIL SEAL

(Fig. 9)

In the bevel pinion housing an oil seal is fitted just to the rear of the propeller shaft drive coupling.

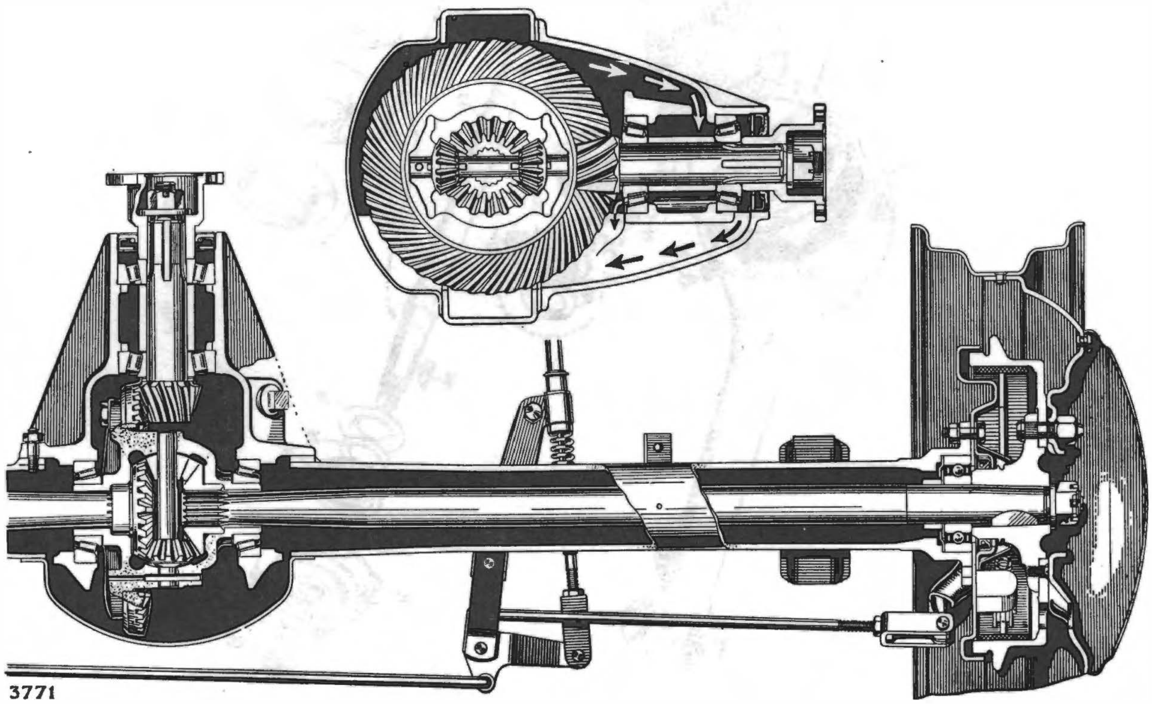


Fig. 9. *Cross section of rear axle*

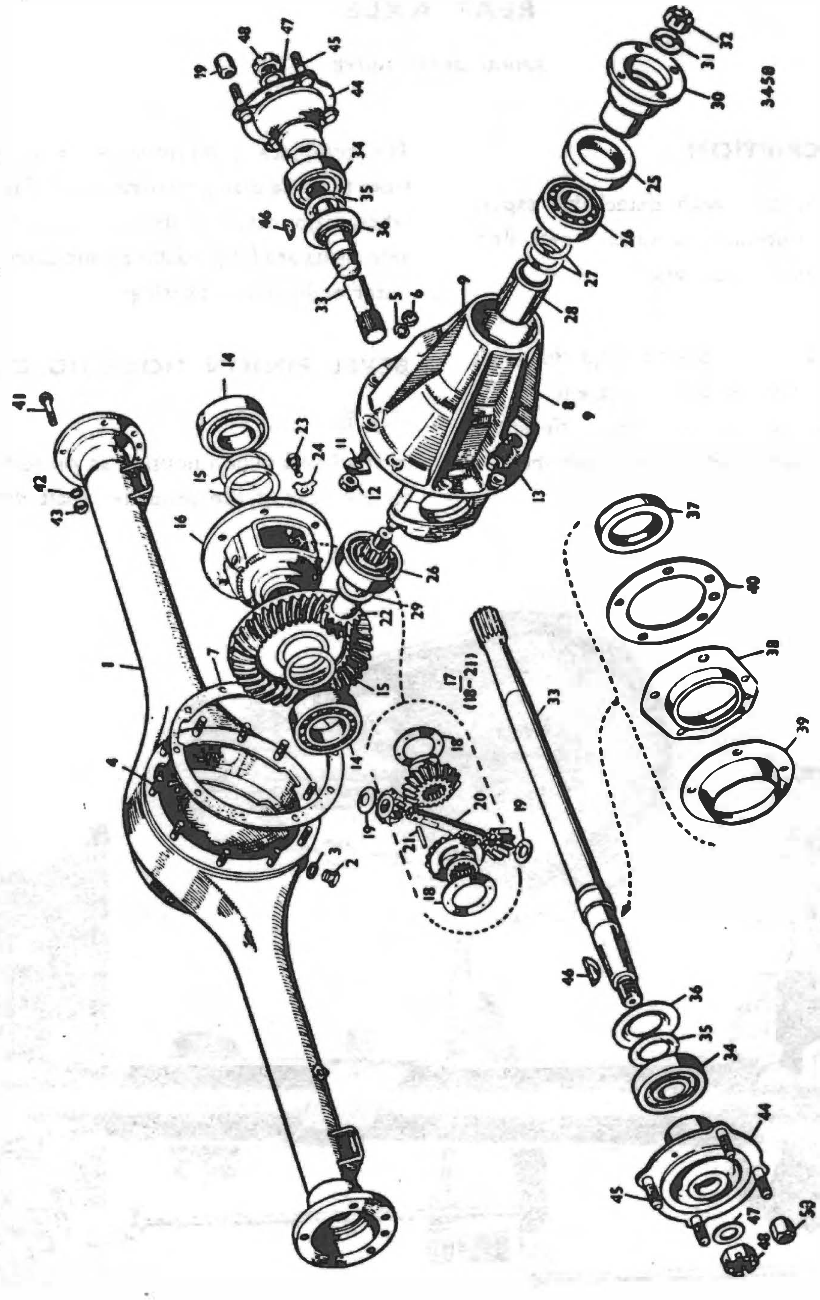


Fig. 10. Exploded view of rear axle (spiral bevel drive)

Whenever a replacement oil seal is fitted, the outside of the cage should be coated with a liquid jointing compound before the seal is pressed into position. These seals operate most effectively in one direction, and thus they should be fitted with the lip and spring facing the rear axle. They are easily removed and replacements can be driven into position, using a hollow drift of correct diameter.

HUB OIL RETAINERS (See Figs. 9 and 10)

An oil splash guard which consists of an outer ring sandwiched between the rear hub bearing outer track and its abutment in the axle casing, overlapping an inner ring retained between the bearing inner track and its abutment on the axle shaft, is supplemented by an oil seal located in a housing adjacent to the inside face of the brake backing plate, the lip of this seal operating on the machined outer diameter of the rear hub. An effective oil sealing arrangement is thus obtained.

The oil seal is replaceable after removal of the rear hub (described in a later paragraph), and the five nuts and bolts passing through the dust shield, seal housing, brake backing plate and axle casing flange.

AXLE SHAFT—To remove and refit

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:—

Remove road wheel.

Remove all road dirt from brake backing plate around its fixing to the axle tube flange.

Remove setscrews securing brake drum.

Remove brake drum.

Release brake connections from rear of backing plate.

Protect brake connections against the ingress of foreign matter.

Remove nuts and bolts securing brake backing plate to flange on axle casing.

Fit the axle shaft removing tool (VLC. No. RG.16) over the four wheel studs and secure it by the nuts.

Move the sliding weight sharply along the shaft of the tool against its outer abutment in order to draw the shaft out of the axle casing.

Remove the shaft complete with brake backplate, oil seal, dust excluder and hub.

Remove outer ring of splash guard from bearing recess. (See item 36, Fig. 10.)

To refit

Ensure that the brake backplate and axle casing flange around the bearing recess are free from dirt. It is essential that the bearing remains clean during assembly.

Fit outer member of splash guard into bearing recess (Fig. 9) with recessed centre inwards. A little grease smeared around the housing will help to keep the guard in place whilst entering the shaft and bearing.

Pass the shaft into the casing and enter the splines into those of the axle shaft end wheels.
Carefully drive the shaft assembly inwards until the bearing is fully home in its recess.
Fit the five bolts through the dust excluder, oil seal casing and backplate. Turn the hub to centralize the oil seal before tightening the nuts. Re-connect brake hoses, fit brake drum and road wheel.
Bleed brakes, as described in Section K of this manual under the heading "Bleeding the System."

To remove hub from axle shaft (after shaft removal)

Attach retaining plate (part of hub removing kit RG.188) to the four wheel studs, using the existing wheel nuts.

Clamp the plate securing the shaft in vice. (Fig. 4).

Remove split pin, loosen and remove hub retaining nut (48), (Fig. 10). *On some cars a self-locking nut is used and no split pin fitted.*

Remove washer (47), (Fig. 10).

Release vice, remove retaining plate and fit extractor tool (part of hub removing kit RG.188) over the wheel studs, placing the short protector over the shaft thread, and securing it with the four wheel nuts.

Secure the assembly in the vice by the flats provided on the extractor, screw in the centre bolt of the tool to take the load, and smartly tap the end of the extractor bolt—remove hub and extractor. The dust shield, oil seal, carrier and backplate can now be removed. Remove key (item 46, Fig. 10) from tapered end of shaft.

REAR HUB BEARINGS—To remove from axle shaft and refit

To remove

Remove hub, brake gear, etc., as previously described.

Slide the solid ring (part of VLC kit No. RG.188A-1) over the splined end of the axle shaft until the ring impinges on the inner race of the hub bearing. Screw in the four extension legs and fit the extractor and short protector. Rotation of the centre bolt of the extractor will pull the hub bearing off the axle shaft.

To refit

It is essential that the hub bearing is always tightly compressed between the sleeve and the hub. Therefore, when fitting a new hub bearing, the following procedure should be adopted:—

Fit the split bush (part of VLC kit RG. 188A-1) to the solid ring. **Note.** It is not necessary to dismantle the tool to fit the split bush. The bearing may be left resting on the tapered portion of the axle shaft and the split bush inserted in the solid ring with the extractor in the fully released position. Alternatively, before fitting the split bush, and after screwing back the extractor centre bolt, the bearing may be removed between the legs of the extractor

Fit the four extension legs, short protector, and extractor.

Rotate the centre bolt of the extractor until the sleeve has been pulled $\frac{1}{32}$" (·8 mm.) in the direction of the outer end of the axle shaft.

Remove split bush.

Remove axle shaft from tool assembly.

Pass the splash guard inner (35), and bearing (34), over the end of the shaft. Press the bearing onto the shaft.

Fit key and hub and fit the retaining plate (V.L.C. tool) over the wheel studs, securing it by the nuts. Place the whole assembly in a vice, fit the nut and tighten with a torque spanner to 180 lbs. ft. (24·89 kg.m.)

Fit split pin.

The assembly may now be refitted to the axle casing. (See "Axle-shaft—To refit").

Special points to observe when refitting hub to axle shaft

The lateral location of the hub bearing is controlled by a sleeve on the inner side of the bearing against which the latter is located by the hub when fully positioned on its taper. It is essential, therefore, that when a new bearing is fitted to the axle shaft, the inner race should be subject to a degree of compression between the sleeve and the hub. The method of obtaining this compression is described under the heading "Rear Hub Bearings—To refit". It can be checked that this compression has been obtained by attempting to rotate the inner splash guard which is interposed between the ring and the bearing inner race.

As the inner track of the hub bearing is an interference fit on the axle shaft it is essential that bearings of the correct type are used.

NOTE: Bearing sleeves are not supplied separately.

DIFFERENTIAL UNIT—To remove and refit (See Fig. 10)

Drain oil from axle case.

Remove both axle driving shafts as previously described.

Disconnect propeller shaft from rear axle driver coupling.

Remove nuts securing differential housing to axle case.

Lift out assembly.

When replacing the assembly the operations are a reversal of the above.

The joint faces must be clean and free from burrs. Use a new joint and coat both faces with a jointing compound.

Important. Bleed brakes on completing reassembly of rear axle unit. This operation is described in Section K under the heading "Bleeding the System".

REAR AXLE BREATHER

The breather hole is $\frac{3}{32}$" (2·4 mm.) in diameter and is drilled directly on top of the right-hand side of the sleeve of the axle casing 14·2" (360 mm.) from the centre of the banjo casing.

The breather hole should be kept clear at all times.

DIFFERENTIAL UNIT—To dismantle and reassemble (See Fig. 10)

Remove assembly from axle as previously described.

Remove caps over bearings supporting differential assembly.

Lift off differential assembly complete with crown wheel and bearings.

Knock out taper pin (21) securing cross pin (20), in differential box.

Push out cross pin; differential pinions complete with thrust washers (19) can then be carried round and brought out through the wide openings in differential box.

Differential wheels, and thrust washers (18) can now be taken out of differential box through the same openings. The crown wheel is secured to the differential box by six setscrews (23), which are locked in position by tabwashers (24). If it is necessary to remove this for any purpose, two important points should be carefully observed during reassembly:—

1. The faces of both crown wheel and differential box should be thoroughly clean, otherwise there is every possibility of misalignment after reassembly.
2. The tabwashers for the six setscrews should be renewed.

Reverse the above procedure for reassembly of the differential gears. *If the bearings or crown wheel and pinion are renewed, refer to the instructions laid out in the following paragraphs.*

NOTE:—Should it be found necessary to renew the bearings which carry the differential assembly, the old inner races may be withdrawn by means of a claw type bearing withdrawer. Inner and outer portions of these bearings must be renewed as a pair, as is the case with all bearings of this type. It is not permissible to renew either inner or outer portion separately in any circumstances.

BEVEL PINION—To dismantle, adjust and reassemble (See Figs. 11 to 13)

Suitable jigs as illustrated are available from Messrs. V. L. Churchill & Co. Ltd., Tool No. RG.328 (H.329C). When adjustment is necessary it can be carried out by the use of these jigs, which are shown in operation in Figs. 12 and 13.

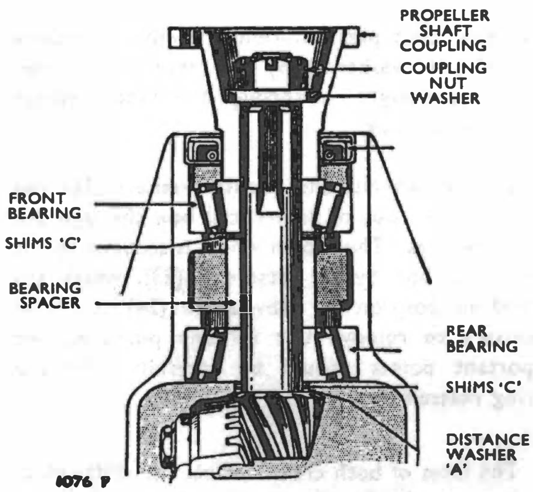


Fig. 11. *View of bevel pinion assembly*

Remove the differential assembly complete with crown wheel and bearings as previously described.

Remove split pin, nut and washer and withdraw propeller shaft driver coupling. *On some cars a self-locking coupling nut is used and no split pin fitted.* For this purpose the flange-holding wrench VLC. tool RG.48 will be required. Tap out the bevel pinion, using a soft metal drift to avoid damaging the threads. The inner race of the rear bearing, distance washer A, shims B and C and bearing spacer, which have become detached with the pinion shaft, should be removed. (Fig. 11).

The inner race of the bevel pinion bearing should be removed from the pinion by means of an arbor press using a suitably shaped drift block to support the inner race, or using the VLC Hand-press RG. 4221-B with the adaptor RG.4221-6. Pressure should be applied to the threaded end of the shaft. A thread protector must be used.

Inner and outer races of bevel pinion bearings must not be renewed separately as these are mated in manufacture. Failure of a bearing necessitates renewal of the complete bearing assembly, comprising inner race, rollers and cage and outer race. Remove the oil seal from the nose of housing, as preload is checked **without** the seal.

Now take the dummy pinion shaft (see Fig. 12) and place on it the inner half of the rear bearing, the bearing spacer and any shims which were originally fitted between this and the bearings.

Do not yet fit Shims or Washer between Inner Bearing and Pinion Head.

Make sure that the bearing inner race is fully "home" and that no foreign matter is present between bearing, bearing spacer, and shims.

Fit the dummy pinion shaft, complete with both bearings, spacer tube and the original shims; fit the dummy coupling nut and washer and tighten fully (see Fig. 12). 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 5-9 lbs. ins. (0·6-0·10 kg.m.) for new bearings. When reassembling the bevel pinion with the original bearings, the preload is slightly less; the torque required to turn the shaft in this instance is 3-7 lbs. ins. (0·04-0·08 kg.m.).

The torque loading can be checked conveniently by means of an ordinary tension type spring balance of suitable calibration. This should be attached

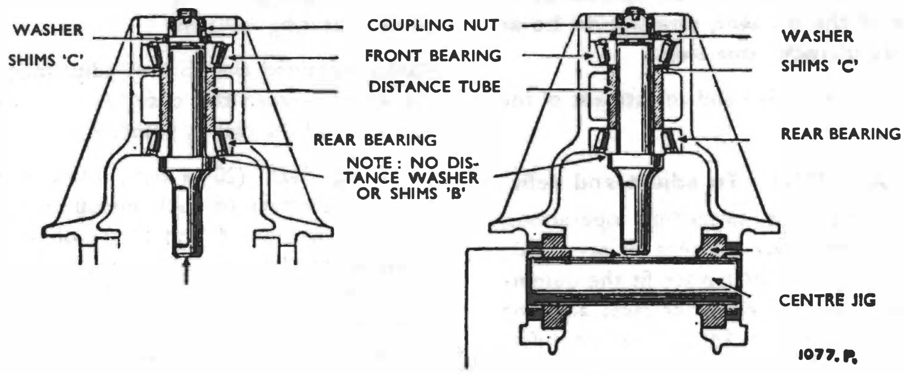


Fig. 12. Measure with distance washers and feelers **Fig. 31.**

Jigs used in adjusting bevel pinion bearing preload and bevel pinion in relation to axis of crown wheel
V. L. Churchill RG. 328

to a ring spanner, fitted to the dummy pinion nut as a lever. The point of attachment of the gauge must be 4" (101·6 mm.) from the centre of the pinion shaft.

When making the check, the lever should be arranged to point downwards, and the gauge operated at right angles to it. The reading shown on the scale should be 1¼-2¼ lbs. (·57-1·02 kilogrammes) at the 4" (101·6 mm.) radius of the lever for new bearings. After reassembly with the original bearings the reading shown on the scale should be ¾-1¾ lbs. (0·34-0·79 kilogrammes) at the 4" (102 mm.) radius of the lever.

To obtain the correct preload, shims should be added to or removed from the location between the bearing spacer and the front bearing. Having established this preload, fit the centre jig into the casing, using the two dummy bearings and replacing the two bearing caps with the securing nuts fully tightened. (See Fig. 13).

A gap will exist between the end of the dummy pinion shaft and the centre jig. Place the distance washer shown at "A" in Fig. 11, in this gap and measure the remaining clearance with feeler gauges. This measurement is the thickness of the shims (B), required to be built on to the pinion shaft when reassembled. 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 ·002" (·05 mm.). This dimension (·002") should therefore be subtracted from the thickness of shims which would be required to fill the gap and added to the shims (C), at the end of the distance piece, between the bearings.

Remove the centre jig and dummy bearings and dismantle the dummy pinion shaft and assembly. Now take the **actual** bevel pinion shaft, and place on it the distance washer (chamfer towards gear) followed by the correct thickness of shims (B). Press on the inner race of the rear bearing.

Place the bearing spacer and then the shims (C), with ·002" (·05 mm.) shim added for bearing expansion on the shaft, and rebuild the whole into the housing.

When refitting the oil seal, the outer cage should be coated with quick drying jointing compound.

It is essential that, of the three apertures in the rear face of the oil seal, one should be at the top, or "12 o'clock" position.

This completes the assembly and adjustment of the pinion.

DIFFERENTIAL UNIT—To adjust and refit

Having carried out the preceding operations, remove the differential box bearings (as previously described) and shims. In their place fit the dummy bearings without shims, their inner faces abutting the differential box (See Fig. 14). Place the differential box assembly (complete with the dummy bearings), in position in the housing, replace the bearing caps and lightly tighten the securing nuts. Paint the teeth of the crown wheel thinly with a light paste made of dry red lead and engine oil and rotate the wheel to obtain an impression of the pinion tooth bearing. When correctly meshed, the marking so obtained should be as shown in example A, Fig. 7, i.e., the area of contact of the teeth of the crown wheel is between the crown and the base of the tooth but is considerably nearer the toe (inner end) than the heel (outer end) of the tooth. Adjustment is effected by using a suitable length of tubing to drive the appropriate dummy bearing inwards.

Having obtained the correct adjustment, measure the gaps between the outer faces of the dummy bearings and the casing, points A, Fig. 14.

By adding ·8125″ (20·64 mm.) (the thickness of the dummy bearings) to each measurement at point A, the dimensions C and D are obtained. Now measure the thickness of the actual bearings to be used and subtract these from dimensions C and D. (See under "Differential Unit—measurement of bearings"). The result gives the thickness of the shims required for each side, but 0·002″ (0·05 mm.) must be added to each side to provide the required preload for the bearings. Make a careful note of these measurements. Remove differential box from casing and dismantle the dummy bearings. Place the shims in position. (Fig. 14). Press on the bearings. Replace the differential box in the housing and refit the caps.

The bearing recesses are machined to such limits that the outer member of the bearings will be gripped securely when the bearing cap nuts are tightened.

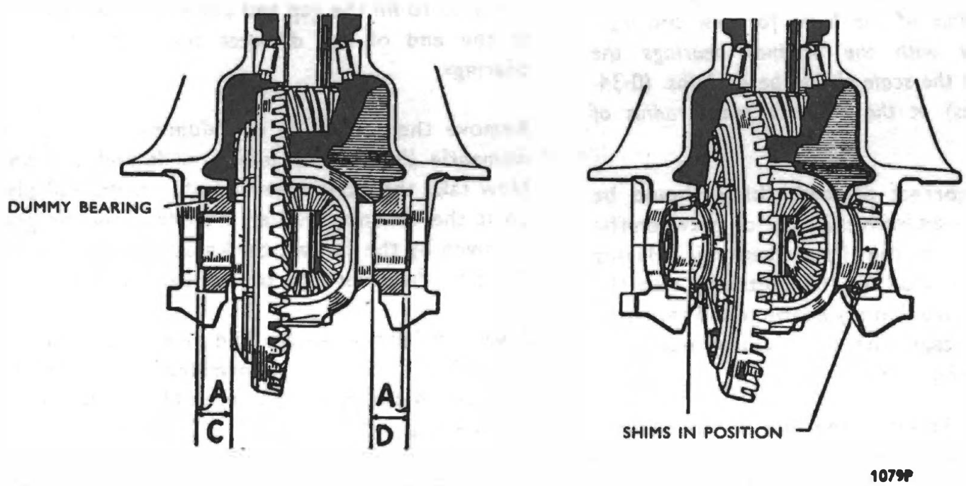


Fig 14. *Adjustment of crown wheel and differential box bearings*

DIFFERENTIAL UNIT—Measurement of bearings

This requires great accuracy and may present a little difficulty. Two methods may be used.

1. A clock gauge is suitably mounted on a surface plate and set to zero on the dummy bearing.

   The reading then taken on the actual bearing be used gives the difference. (See Fig. 8.)

2. In the absence of a clock gauge the difference between the dummy and the actual bearing can be ascertained by the use of feeler gauges and a straight edge, if both are placed on a surface plate. (See Fig. 8).

DIFFERENTIAL UNIT—Adjustment of bearings

The foregoing instructions may appear somewhat complicated, but no difficulty should be experienced if the measurements are set out in the manner indicated, it being essential, of course, to deal with each side separately, e.g. side "C":—

Dummy Bearing ...	·8125″	(20·64 mm.)
Gap "A" ... (say)	·012″	(0·30 mm.)
Whence Dimension "C"	·8245″	(20·94 mm.)
Actual Bearing ... (say)	·8130″	(20·65 mm.)
Difference	·0115″	(·292 mm.)
Preload	·002″	(·051 mm.)
Total shimming required	·0135″	(·343 mm.)

CHECKING OF ADJUSTMENTS

If it is considered desirable to check the adjustment effected by use of jigs, this may be done after the assembly of the differential unit by lightly coating the teeth of the crown wheel with a light paste of red lead and engine oil. The crown wheel should then be revolved in both directions when the marking shown in example A, Fig. 7 should be obtained on the pinion.

Backlash must be measured at three positions of the crown wheel and must be 0·005-0·009″ (0·13-0·23 mm.).

A dial indicator gauge must be used; the body of which is secured to the differential housing.

The reading is then taken off the thrust side of a crown wheel tooth, by means of moving the crown wheel in each direction. The pinion is at all times prevented from rotating.

REAR AXLE—To remove and refit

As described in the foregoing operations, 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:—

Remove rebound straps.

Jack up rear of car so that the road wheels are clear of the ground and support the underframe on stands.

Remove road wheels.

Disconnect propeller shaft at rear driver coupling.

Remove rear shock absorbers.

Disconnect handbrake cable from linkage.

Disconnect rear brake hose at 3-way union on axle casing.

Protect brake hose from ingress of foreign matter, lift hose upwards and tie to prevent loss of fluid.

Remove all spring U-bolts.

Withdraw axle from between springs.

Reassembly is a reversal of the above operations.

Bleed brakes. (See Section K.)

NOTE:—The rear road springs are rubber mounted, the rubber being interposed between the axle casing brackets and the road springs. When refitting the axle to the road springs, the "U" bolts must not be overtightened as this will destroy the insulation effect of the rubber.

The U-bolts must be tightened with a torque spanner to the torques specified in the Data Section.

Crown Wheel	=	*Rear Gear*
Drive Coupling	=	*Companion Flange*
Differential Wheel	=	*Differential Side Gear*
Bevel Pinion	=	*Pinion Gear*

REAR SUSPENSION

CONTENTS

(14 Pages)

REAR SUSPENSION

GENERAL

The rear suspension is by means of two semi-elliptic springs which are secured to the rear axle casing.

Both spring eyes and the rear shackle bracket are fitted with bonded rubber bushes. Thrust buttons are interposed between the leaf ends which are held in alignment by rubber lined bundle clips.

On later Rapier and Alpine III cars, an eccentric rubber bush is fitted in the front spring eye.

The rear suspension is damped hydraulically. On Rapier, Girling telescopic dampers are used. On Alpine, I and II Armstrong lever type dampers are fitted.

Bump and rebound checking is by means of a rubber abutment and on Alpine I and II cars, a Balata strap as well.

Alpine III have telescopic dampers and no Balata strap.

REAR SPRING

To remove

Jack up the car and support it by means of chassis stands or suitable blocks of wood placed under the chassis frame just forward of the front eyes of the springs.

Remove the road wheel on that side of the car from which the spring is to be removed.

Clean the projecting threads of the 'U' bolts, dampers, and mounting bolts, using a wire brush and oil with paraffin or penetrating oil.

Remove shock absorber.

Remove Nyloc securing nuts and washers from 'U' bolts. Jack up rear axle until it is parted from the spring and support it with suitable blocks of wood.

Remove 'U' bolts.

Tap out lower shackle pin and shakeproof washer after removing nut with washer, and lower rear end of spring to floor.

Remove the front pivot pin in a similar manner to the lower shackle pin.

The spring is now free to be taken away.

To refit

Refitting is a direct reversal of the preceding operation.

The final tightening of the spring "U" bolts, shackle assemblies and pivot pins should be carried out after the removal of the jacks and stands, the car standing unladen on the road wheels.

This ensures that the spring eyes are not subject to excessive twist when in the bump or rebound position.

Tighten the "U" bolt nuts to the figures given in General Data

To dismantle

Remove spring—(See preceding operation).

Before dismantling mark one end of each leaf with a centre punch. This ensures that the leaves are replaced in the position they occupied prior to dismantling.

Remove the bundle clips. To do this first remove the bolts and carefully open out each clip a sufficient amount to enable the clip to be removed from the spring. Do not damage or lose the rubber packing.

Grip the spring securely in a vice, holding it by bottom and top leaves.

Unscrew dowel bolt and replace with a suitable length of M.S. rod of same diameter as the dowel bolt.

Release vice and leaves will separate.

Remove thrust buttons.

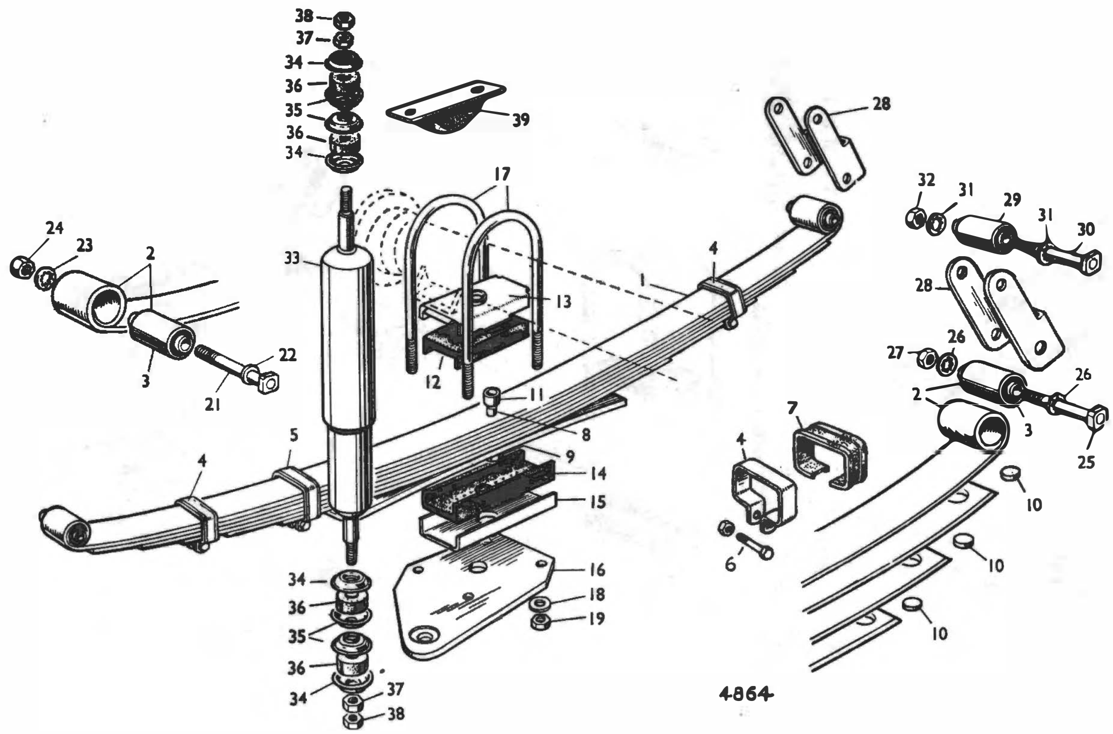


Fig. 1. *Exploded view of Rapier rear suspension (without eccentric bush)*

1 Rear spring.
2 Main leaf.
3 Spring eye bush.
4 Bundle clip.
5 Bundle clip.
6 Bolt and nut securing bundle clip to spring.
7 Rubber lining.
8 Dowel bolt.
9 Dowel bolt securing nut.
10 Thrust button.
11 Dowel bolt sleeve.
12 Top clamp rubber.
13 Rubber retainer.
14 Bottom clamp rubber.
15 Rubber retainer.
16 Clamp plate.
17 'U'-bolt.
18 Washer.
19 Nyloc nut.

(12–19: securing spring to axle casing.)

21 Pivot Pin
22 Washer
23 Washer.
24 Nut.

(21–24: front spring eye to frame.)

25 Shackle pin.
26 Washer.
27 Nut.

(25–27: rear spring eye to frame.)

28 Shackle.
29 Shackle bush.
30 Shackle pin.
31 Washer.
32 Nut.

(30–32: shackle to frame.)

33 Shock absorber.
34 Retaining washer.
35 Separating washer.
36 Rubber washer.
37 Nut.
38 Locknut.

(34–38: securing shock absorber to frame and axle.)

39 Rubber abutment (bump stop).

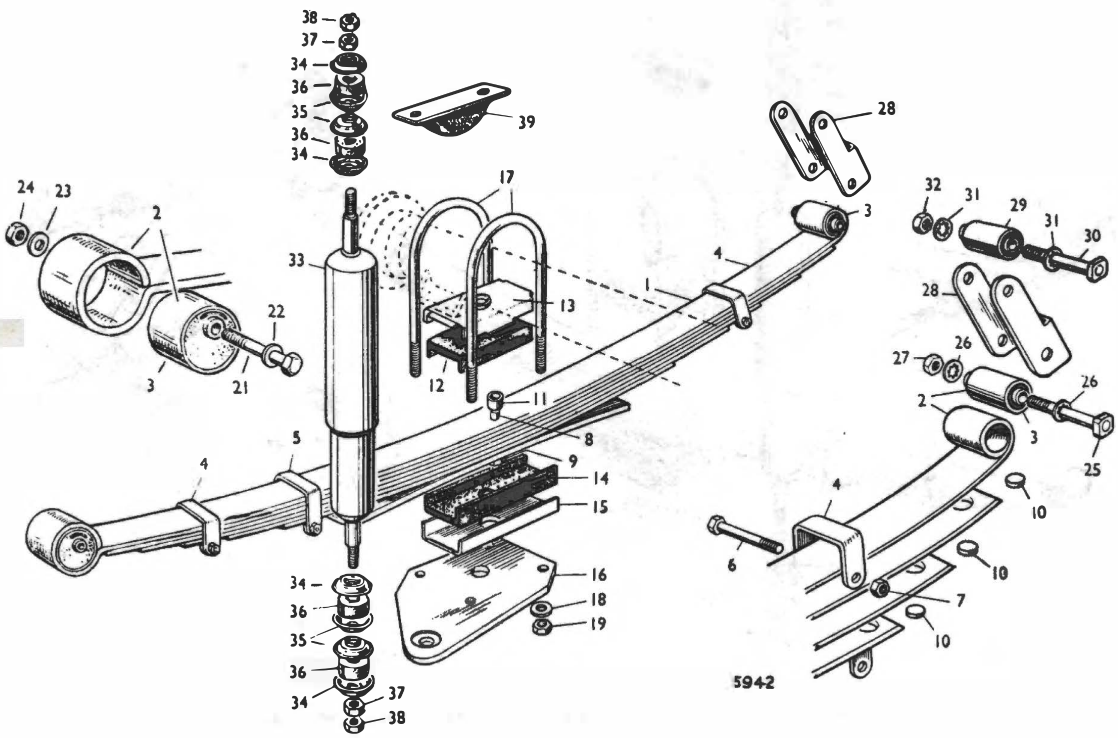


Fig. 2. *Exploded view of rear suspension (with eccentric bush)*

1 Rear spring.
2 Main leaf.
3 Spring eye bush.
4 Bundle clip.
5 Bundle clip.
6 Bolt and nut securing bundle clip to spring.
7 Rubber lining.
8 Dowel bolt.
9 Dowel bolt securing nut.
10 Thrust button.
11 Dowel bolt sleeve.
12 Top clamp rubber.
13 Rubber retainer.
14 Bottom clamp rubber.
15 Rubber retainer.
16 Clamp plate
17 'U'-bolt.
18 Washer.
19 Nyloc nut.

(12–19: securing spring to axle casing.)

21 Pivot Pin
22 Washer
23 Washer.
24 Nut.

(21–24: front spring eye to frame.)

25 Shackle pin.
26 Washer.
27 Nut.

(25–27: rear spring eye to frame.)

28 Shackle.
29 Shackle bush.
30 Shackle pin.
31 Washer.
32 Nut.

(30–32: shackle to frame.)

33 Shock absorber.
34 Retaining washer.
35 Separating washer.
36 Rubber washer.
37 Nut.
38 Locknut.

(34–38: securing shock absorber to frame and axle.)

39 Rubber abutment (bump stop).

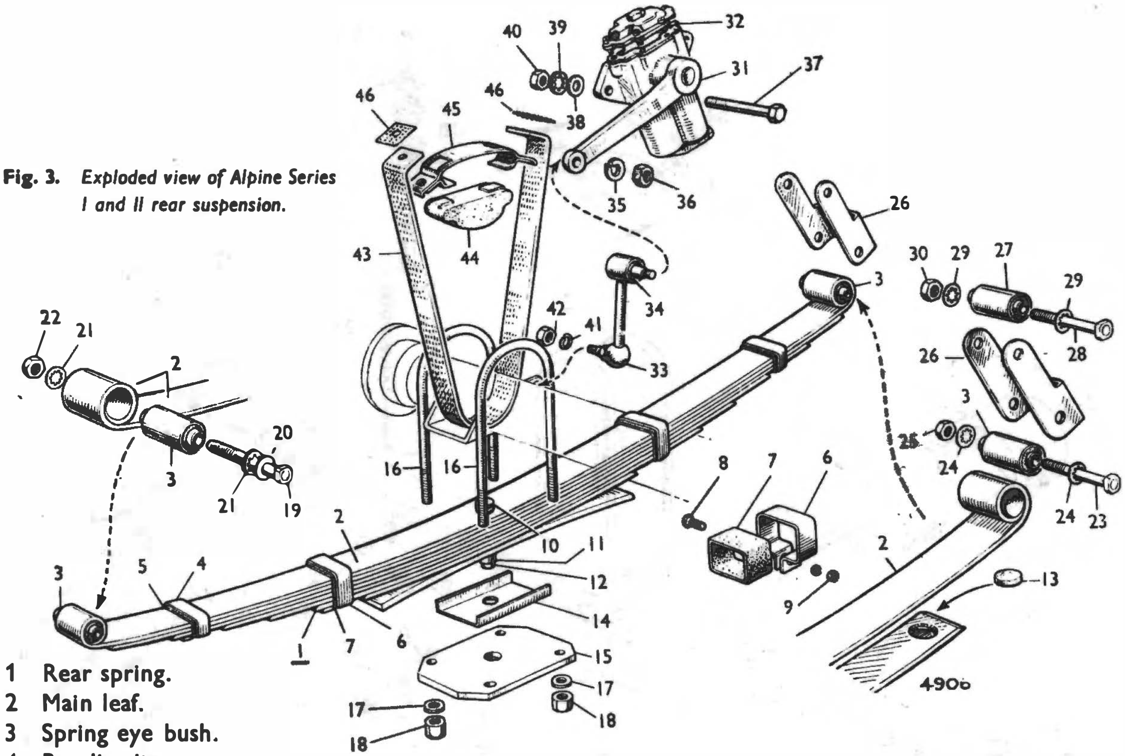


Fig. 3. *Exploded view of Alpine Series I and II rear suspension.*

1 Rear spring.
2 Main leaf.
3 Spring eye bush.
4 Bundle clip.
5 Rubber lining.
6 Bundle clip.
7 Rubber lining.
8 Bolt. } securing bundle.
9 Nut. } clip to spring.
10 Dowel bolt.
11 Dowel bolt locating collar.
12 Dowel bolt securing nut.
13 Rubber thrust button.
14 Location plate. }
15 Clamp plate. } securing spring to
16 'U'-bolt. } axle casing.
17 Washer. }
18 Nyloc nut. }
19 Pivot pin. }
20 Washer. }
21 Washer. } front spring eye to frame.
22 Nut. }
23 Shackle pin. }
24 Washer. } rear spring eye to frame.
25 Nut. }
26 Shackle.
27 Shackle bush.
28 Shackle pin. }
29 Washer. } Shackle to frame.
30 Nut. }
31 Shock absorber.
32 Gasket.
33 Link.
34 Rubber bush—link.
35 Washer. }
36 Nut. } link to shock absorber.
37 Bolt. }
38 Washer. }
39 Washer. } shock absorber to frame.
40 Nut. }
41 Washer. }
42 Nut. } link to rear axle.
43 Rebound strap.
44 Rubber abutment (bump stop).
45 Abutment bracket.
46 Lockwasher.

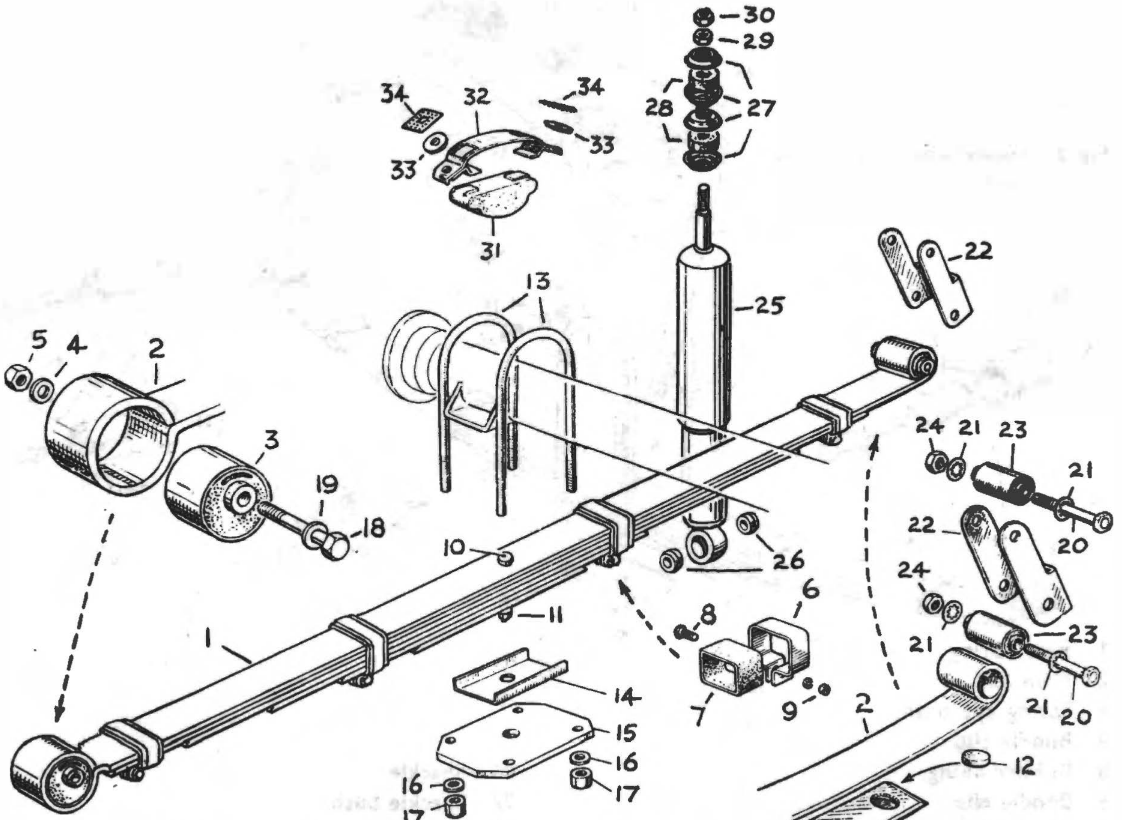


Fig. 1. *Components of the rear suspension Alpine III*

1. REAR SPRING
2. MAIN LEAF
3. BUSH, SPRING EYE
4. WASHER
5. NUT
6. CLIP
7. RUBBER LINER
8. BOLT
9. NUT
10. DOWEL BOLT
11. NUT
12. THRUST BUTTON
13. "U" BOLT
14. LOCATION PLATE
15. CLAMP PLATE
16. WASHERS
17. NYLOC-NUTS
18. PIVOT PIN
19. WASHER
20. SHACKLE PINS
21. WASHERS
22. SHACKLE ASSEMBLY
23. BUSH
24. NUTS
25. SHOCK ABSORBER
26. BOTTOM BUSHES
27. RETAINING WASHERS
28. RUBBER BUSHES
29. NUT
30. LOCK NUT
31. BUMP RUBBER
32. ABUTMENT BRACKET
33. PACKING PIECE
34. LOCK WASHER

Examination

Clean the spring leaves thoroughly using paraffin.

Check thrust buttons for excessive wear and, if necessary, replace with new ones.

The spring leaves should be examined for cracks, particularly if one of them is fractured.

A crack will often show due to exudation of paraffin along the line of the crack.

All faulty leaves should be replaced by new ones.

The "setting up" of spring leaves is not recommended and in the case of a weak spring a new or factory reconditioned assembly should be fitted.

To rebuild

Before rebuilding the spring the leaves should be thoroughly lubricated with graphite grease.

Rebuilding is the reversal of the dismantling instructions, but alignment of the leaves will be greatly facilitated if a length of steel rod of suitable diameter is inserted through the dowel bolt hole, otherwise damage to the threads of the dowel bolt may occur.

When the leaves have been fully pressed home the rod should be removed, the dowel bolt fitted, and the nut tightened. Carefully refit the bundle clips together with the rubber packing. The clamp bolt should not be over-tightened as damage to the rubber packing and distortion of the clip may result.

Before refitting the spring to the chassis, check that the leaves are lying flush on each other.

Bushes may be pressed out of the spring or frame for renewal purposes.

The use of a suitable withdrawal tool is recommended.

Front eye bush (eccentric type)

If a new front eye bush is fitted it is imperative that it is pressed in so that the pivot pin location is at the top of the spring eye.

A tolerance of $\pm \frac{1}{32}$ in. (·8mm) must not be exceeded. To ensure that this is maintained, the spring should be scribed as shown at (A) in Fig. 4 before fitting.

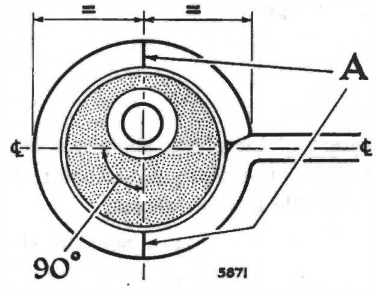


Fig. 4. Method of marking spring eye.

To check rear spring camber

Spring camber is the difference height in between the top of the master leaf and a straight line joining the spring eye centres.

As will be appreciated this varies according to the weight carried in the vehicle.

In order to check the rear spring laden camber LOAD THE VEHICLE BY PLACING WEIGHTS TO THE VALUE SHOWN IN THE GENERAL DATA SECTION UNDER THE HEADING "REAR SUSPENSION".

Stretch a length of thread between the spring eye centres and measure the distance between the top of the master 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.

For correct spring camber see "General Data" at the beginning of the manual.

SHOCK ABSORBERS

ALPINE I and II

The suspension is controlled by Armstrong hydraulic shock absorbers, which are of the double-acting self-regulating type.

Servicing

No adjustment of the shock absorbers is required or provided for, therefore no attempt should be made to dismantle the movement.

Servicing of the shock absorbers in the Home market is confined to the periodic checking of the securing bolts.

Normally no periodical replenishment of the fluid is required, but if for any reason "topping up" is found to be necessary, the shock absorber must be removed from the car.

It is recommended, however, especially overseas, that the fluid level is checked at the same time as the securing bolt check is carried out.

Testing

When there is any suggestion of the suspension being inadequately damped, the condition of the road springs and the tyre pressures should also be checked.

If the shock absorbers do not appear to function satisfactorily, an indication of their resistance can be obtained by carrying out the following check:—
Remove the shock absorbers from their mountings.

Place the shock absorber in a vice (holding it by the fixing lugs to avoid distortion of the cylinder Body).

Before carrying out the check, work the shock absorber through six to eight strokes to expel any air present in the compression chamber.

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 a lack of fluid.

If the addition of fluid (added as described below) gives no improvement, a new shock absorber should be fitted.

Too much resistance, *i.e.*, when it is not possible to move the lever slowly by hand, probably indicates a broken internal part or a seized piston; in which case the shock absorbers should be changed.

Topping up the fluid

Remove the shock absorber from its mounting.

Before removing the filler plug, carefully clean the exterior of the shock absorber especially in the vicinity of filler plug boss.

(This is important as it is essential that no dirt or foreign matter enters the operating chamber).

Use only Armstrong Shock Absorber Fluid No. 624.

Whilst adding fluid the lever arm should be worked through its full stroke to expel any air from the operating chamber.

Fill the body with fluid to the bottom of the filler hole threads.

After refitting the shock absorber to its mounting, but before reconnecting the link, it is advisable to work the lever arm a few times through the full stroke to ensure that no air is present.

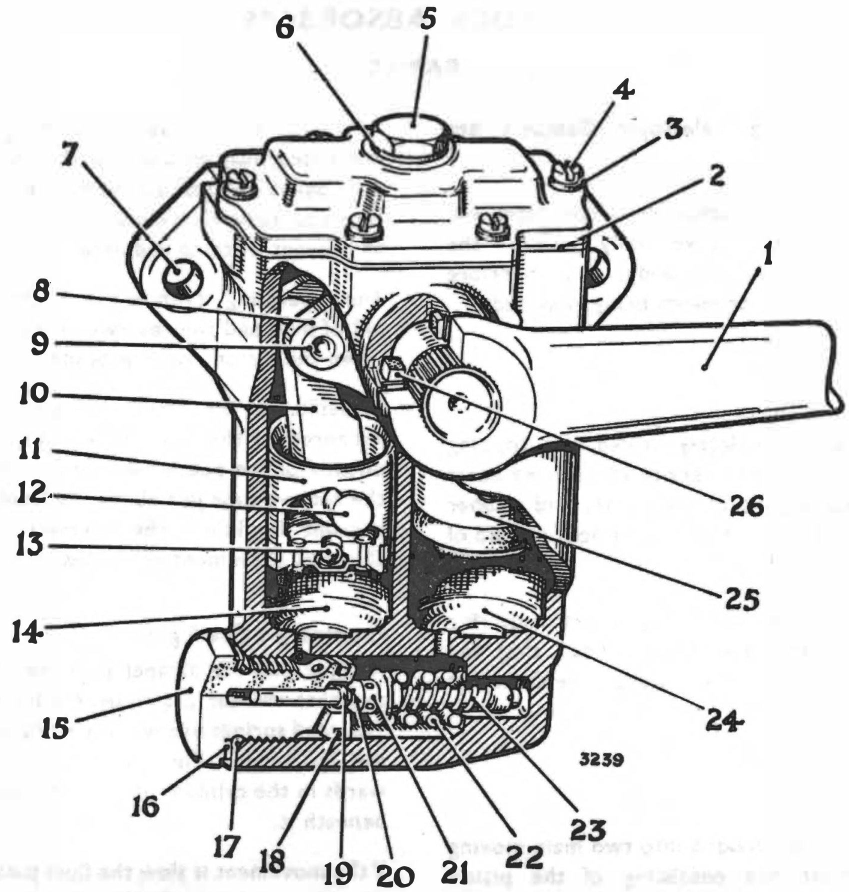


Fig. 5. *The Armstrong hydraulic shock absorber*

1 Arm.
2 Gasket.
3 Shakeproof washer.
4 Lid screw.
5 Filler plug.
6 Filler plug washer.
7 Mounting holes.
8 Crank plate.
9 Crank pin.
10 Connecting rod.
11 Compression piston.
12 Piston pin.
13 Recuperation valve.
14 Compression or bump cylinder.
15 Valve screw.
16 Valve screw compression washer.
17 Rubber 'O' ring.
18 Valve screw inner seal.
19 Rebound valve.
20 Leak groove.
21 Compression valve.
22 Compression spring.
23 Rebound spring.
24 Rebound cylinder.
25 Rebound piston.
26 Gland packing.

SHOCK ABSORBERS

RAPIER

Girling Direct-Acting Telescopic Dampers are fitted.

The body of the shock absorber is telescopic and is mounted more or less vertically between the spring pad brackets and the body. It is therefore direct-acting, no links or levers being required.

Servicing

These units are completely sealed, no topping up, adjustment, or other service is required apart from periodical checks of mountings and rubber bushes, which can be carried out without the aid of special tools.

In the event of the shock absorbers requiring attention, it is strongly recommended that the faulty unit should be removed and a replacement shock absorber fitted.

Construction

The assembly can be divided into two main moving parts, the upper one consisting of the piston rod with the piston attached to its lower end and the outer tubular shroud attached at the top just below the stem. The lower part consists of a cylinder and an outer reservoir tube which terminates in a base cup and is welded to the stem, and at its upper end is a welded cap. This cap forms part of an assembly which houses the seal on the piston rod, compresses the static seal rubber, and locates the piston rod bearing—usually referred to as the piston rod guide. The piston rod seal is of synthetic rubber and has multi-wiping lips and all except one, face inwards. The outer lips act to exclude dirt, etc., and faces outwards.

Any fluid which exudes past the guide bearing is prevented from escaping further by the seal and a port below the seal allows fluid to return into the reservoir tube via a closed circuit drain tube fitted to prevent frothing and aeration.

The operating cylinder is normally completely full of fluid and the reservoir tube is about half full when the piston rod is extended.

A baffle, in the form of a pressed steel collar anchored to the drain tube is fitted between the outside of the operating cylinder and the inside of the reserve tube just above the level of the fluid, to prevent the fluid in the reserve tube being shaken about by movement of the suspension.

Operation (See Fig. 6)

Assume that the damper is in the midway position and that the car passes over a bump in the road. The road springs flex and the damper is compressed and shortened. The piston in effect moves downwards in the cylinder applying pressure to the fluid beneath it.

If the movement is slow the fluid passes through the metering restriction in the valve disc (A) and enters the upper part of the cylinder.

If the movement is fast the fluid passes through the spring-controlled compression valve also at (A) which is quite lightly loaded. The ported sleeve in the piston remains closed.

Downward movement of the piston displaces a greater volume of fluid than the lesser volume above the piston. Hence during a slow movement the excess can find a restricted way out to the reservoir via a groove machined in the valve disc of the compression valve assembly (B) in the base

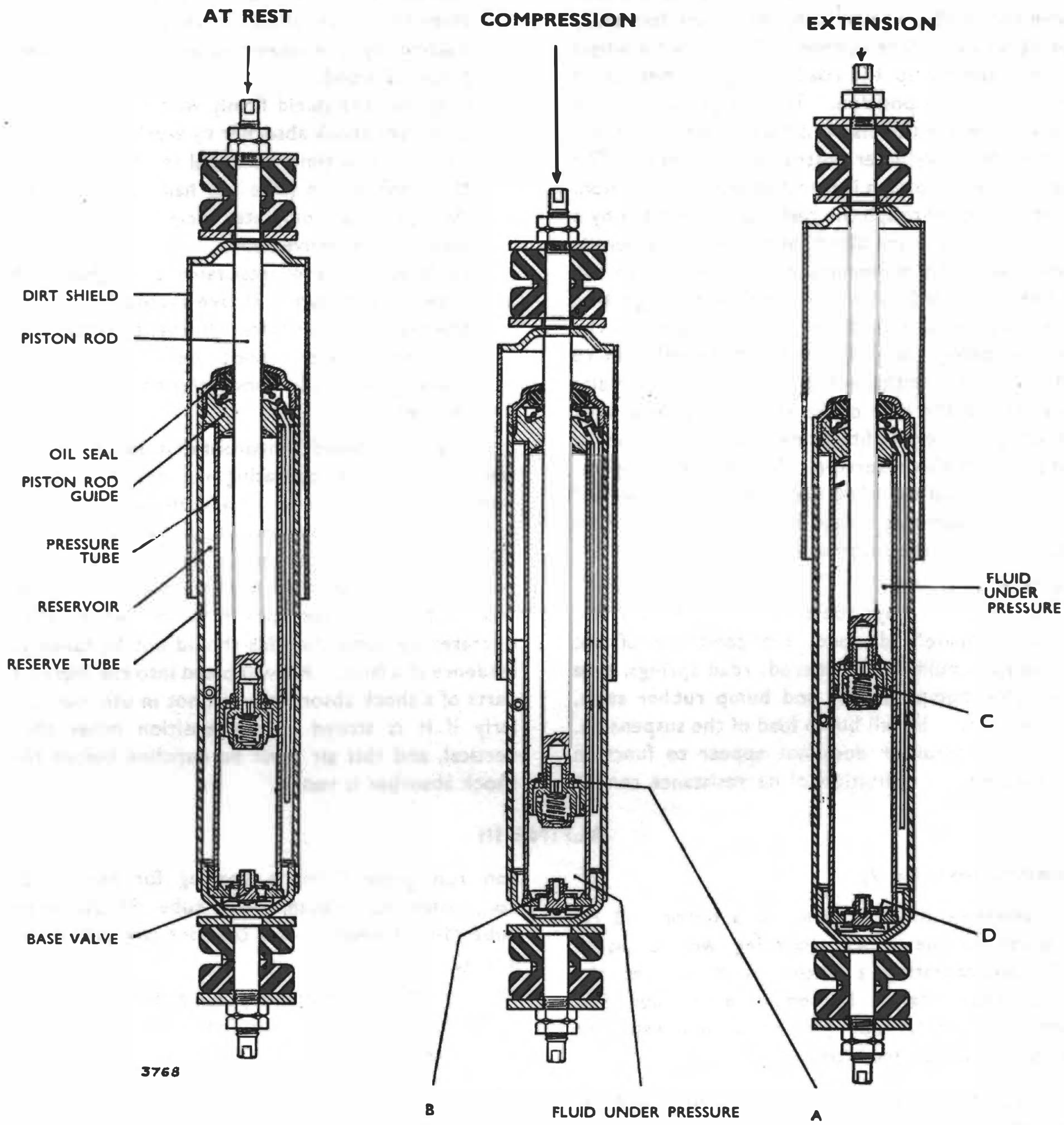


Fig. 6. *Diagrammatic sections of telescopic shock absorbers.*

of the cylinder. If, however, the downward movement of the piston is a fast one the slotted sleeve valve also at (B), controlled by the strong laminated spring washer will be opened. When the car wheel is over the bump the road spring commences to return to zero position. The damper then is in the state where the piston is moving away from the bottom of the cylinder, instead of towards it. The fluid above the piston is thus put into compression. Fluid can pass through the restriction provided by a calibrated slot in the bleed shim if the movement is slow, but if the movement is fast it will open the spring-controlled valve (C) and flow through that way. While this is happening the fluid in the cylinder below the piston will not be sufficient to fill the space. In this event the large diameter disc valve (D) in the base of the cylinder opens against its comparatively light spring and allows fluid to return from the reservoir tube and fill the space. It will be realised that the cylinder, above and below the piston is always maintained full of fluid provided from the reserve tube.

Testing

When there is any question of suspension not being adequately damped, the condition of the following should be considered: road springs, tyre pressures, bump rubbers and bump rubber seats, as these carry the full bump load of the suspension. If a shock absorber does not appear to function satisfactorily an indication of its resistance can be obtained by carrying out the following check:—

Remove the shock absorber from its mounting. Place the shock absorber vertically in a vice, holding by the lower spindle between two pieces of wood.

Grip the dirt shield firmly with the hands and prime the shock absorber by working it up and down several times to expel the air.

Move the piston (free top half) up and down through one complete cycle to check the nature of the movement.

Moderate and even resistance throughout the outward and inward stroke should be felt. If, however, the resistance is slight, erratic, or free movement cannot be eliminated by priming, then the shock absorber should be changed.

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 absorber is tested.

ALPINE III

Construction (Fig. 7)

The assembly consists mainly of a piston rod (2) attached to the upper mounting with a piston (20), incorporating a piston valve (21) at the lower end. This is housed in a cylinder (25) within the outer tube (24) to form a reservoir (6) and a lower mounting.

In detail the piston rod has a dirt shield (1) attached immediately below the upper mounting. The cylinder (25) is located at the end by a spigot on the piston rod guide (17) which in turn is housed in the outer tube (24). This piston rod guide forms a bearing for the piston rod, holds the rebound valve tube (9) and drain tube (18) in position and contains the piston rod seal (3).

The cylinder is completely filled and the reservoir about half-filled with fluid when the piston rod is extended.

Operation

The functioning of the shock absorber with its principle of "one-way" oil circulation, is described with references to the illustration.

As the wheel rises on fast bump strokes, when the piston is moving relatively towards the foot valve (13) fluid pressure opens the piston valve (21) against the coil spring load and fluid passes through the ports (7) in the piston valve from the lower half of the cylinder (A) to the upper part of the cylinder (B). The excess fluid displaced from the cylinder by the piston passes via the ports (5) in the piston rod guide (17) through the filter (6) and down the rebound valve tube (9) opening the rebound valve (10) against the coil spring load into the reservoir (C).

On the slow bump strokes, damping is controlled by calibrated bleed grooves on the face of the foot valve (13).

On the fast rebound strokes when the piston is moving relatively towards the piston rod guide (17) the piston valve (21) closes and again fluid passes through the ports (5) in the piston rod guide (17) through the filter (6) down the rebound valve tube (9) opening the rebound valve (10) against the coil spring load and into the reservoir (C). At the same time the lower part of the cylinder (A) is replenished with fluid as the foot valve plate (12) opens to allow recuperation from the reservoir (C).

On slow rebound strokes, fluid passes through a calibrated bleed groove in the face of the piston valve seat.

Any fluid which passes between the piston rod (2) and the piston rod guide bearing is prevented from escaping by the multi-lip piston rod seal (3).

Undue internal fluid pressure on this seal is relieved as the fluid passes through a port to the drain tube (18), the lower end of which is immersed in the reservoir fluid to prevent aeration.

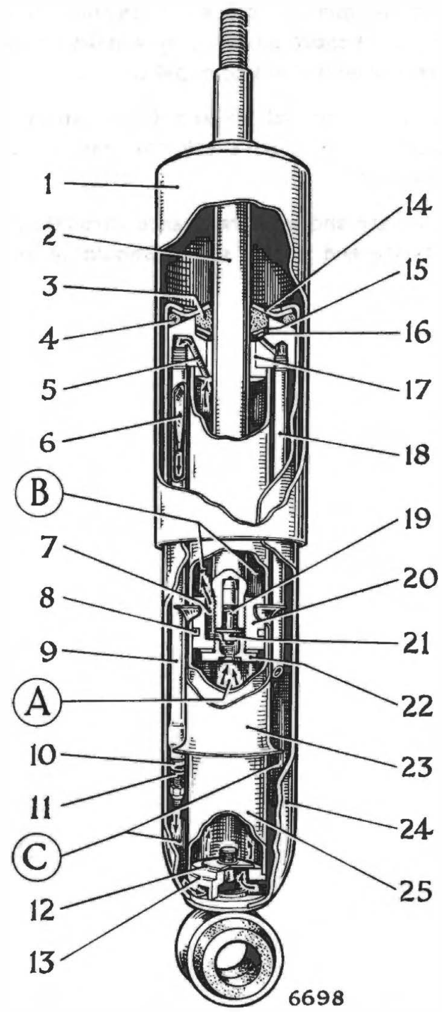


Fig. 7. *Details of shock absorber Alpine III*

Testing

When there is any question of suspension not being adequately damped, the condition of the following should be considered: road springs, tyre pressures, bump rubbers, and bump rubber seats, as these carry the full bump load of the suspension.

If a shock absorber does not appear to function satisfactorily an indication of its resistance can be obtained by carrying out the following check:—

> Remove the shock absorber from its mounting. Place the shock absorber vertically in a vice, holding by the lower eye between two, pieces of wood.

Grip the dirt shield firmly with the hands and prime the shock absorber by working it up and down several times to expel the air.

Move the top half up and down through one complete cycle to check the nature of the movement.

Moderate and even resistance throughout the outward and inward stroke should be felt. If, however, the resistance is slight, erratic or free movement cannot be eliminated by priming, then the shock absorber should be changed.

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 fault.

STEERING GEAR

RAPIER & ALPINE

CONTENTS

STEERING GEAR

STEERING COLUMN COWLING

Description

The plastic cowling is made in two halves.

In the case of the Alpine the two halves are held together by spring clips, while on the Rapier the two halves are held together by two screws. On both models the cowling is positively located on the steering column by dowels. The cowling encloses the indicator switch.

To remove—(Alpine)

1. Give the off-side half of the steering column cowl a sharp pull to release the spring clips from the steering column.

   If an overdrive is fitted, disconnect the overdrive switch wiring at the two snap connectors under the facia panel.
2. Release the near-side half of the cowling in a similar manner and ease it clear of the indicator switch.

To remove—(Rapier)

1. Remove the two clamping screws.
2. Part assembly, easing one side over the flasher switch.

To refit

The procedure in both cases is a reversal of the removing instructions. When refitting, take great care to ensure that both halves fit together correctly before tightening the screws and that the flasher switch aperture clears the flasher switch lever. If necessary reposition the switch.

DIRECTION INDICATOR SWITCH

Description

The switch for the flashing direction indicators is secured to the steering column by a clip, and locates on a raised key in the outer column immediately below the steering wheel hub.

A cancelling ring clamps around the upper end of the inner column. When the steering wheel is returned to the straight ahead position, a pawl on the cancelling ring operates a trip mechanism on the switch which cancels the flasher. For wiring details, see Section N.

To remove

1. Disconnect battery.
2. Remove column cowling as previously described.
3. Mark the position of the indicator switch on the steering column (to facilitate correct re-assembly) and remove by withdrawing the clamping screws.
4. Disconnect wiring at snap connectors under facia panel near steering column to release switch.

To refit

1. Locate switch on column keyway, set it axially so that the pawl of the striker ring fully engages the trip mechanism, but does not foul the steering column cowling. The position of the switch relative to the column cowling may easily be checked with the switch side of the cowling fitted and the other side removed to give access for adjustment.
2. Refit the other half of cowling.
3. Reconnect the wiring at snap connectors.
4. Reconnect battery.

OVERDRIVE SWITCH

The overdrive switch when fitted to the Alpine is mounted in the off-side half of the steering column cowling and will be removed with it. (See "Steering Column Cowling—to remove and refit"). Furthur dismantling is unnecessary when removing and refitting the steering unit.

In the case of the Rapier, the overdrive switch is mounted on the off-side of the steering column by a clip. The procedure for removing the overdrive switch in this case is identical to that given for the removal of the direction indicator switch.

HORN RING, COVER AND MOTIF ASSEMBLY

Description

The horn ring consists of a circular central plate with two spokes, to which the outer ring is joined. The horn ring is secured to the underside of the centre cover by three screws. The upper and lower contact plates are connected to each other by studs and nuts, but are held apart by three light springs. The whole unit is retained in the hollow centre of the steering wheel boss by three grub screws clamping on to the lower contact plate.

The lower contact plate is earthed by the grub screws to the steering column, via the splined centre of the steering wheel boss. A wire from the horn is attached to an insulated terminal on the direction indicator switch feeding a spring-loaded plunger which is in constant contact with a slip ring recessed into the lower face of the steering wheel centre boss. From this slip ring a wire with a snap connector feeds the upper contact plate. For further wiring details see Section N.

To remove and refit

1. Disconnect the battery.
2. Slacken three grubscrews recessed into, and equally spaced around the steering wheel boss.
3. Lift up horn ring assembly, withdraw snap connector from its socket inside steering wheel boss and then remove the assembly.

Reverse this procedure for refitting, ensuring that the lower contact plate of the horn ring assembly is correctly and securely located over the key inside the wheel boss.

STEERING WHEEL

To remove

1. Remove horn ring assembly as previously described.
2. Undo centre securing nut using special tool RG.197.
3. Mark position of steering wheel boss on splines, if existing wheel is to be refitted.
4. Draw off wheel.

To refit

1. Place wheel over column splines in correct position and push on. With the wheels in the straight ahead position the spokes should be horizontal.
2. Refit and tighten centre securing nut.
3. Refit horn ring assembly.

STEERING UNIT

Description (See Figs. 1 & 2)

The unit is known as the "F" type recirculating ball unit.

Movements of the inner column and worm (23), are transferred to the nut (14), through the medium of recirculating balls (16) housed within the nut. Movement of the nut is transferred to the rocker shaft arm (13), which causes the rocker shaft to rotate and turn the drop arm (swing lever), (19), which is secured to the rocker shaft by a tapered spline, a nut and lock-washer. A felt bush and washer (1), are fitted at the upper end of the steering column (2). Ball bearings (15 & 20), fitted at each end of the worm, support the inner column (23), inside the steering box (9). Shims (4) control the inner column end float. The rocker shaft is located by the top cover (8), end float being controlled by shims (5). A double coil spring (10) and damper button (11), serve to damp the rocker shaft against road reaction.

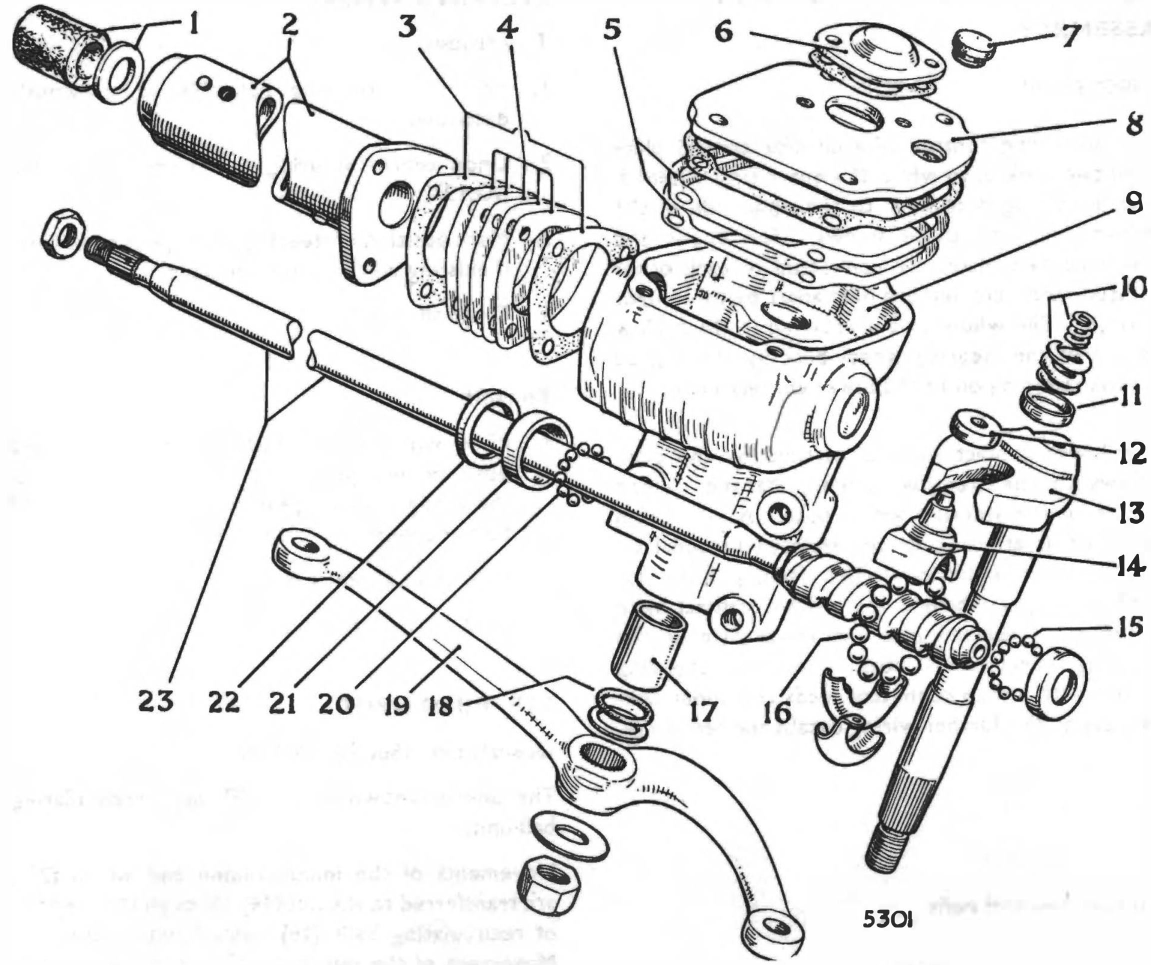


Fig. 1. *Exploded view of "F" type steering unit*

1 Felt bush and washer.
2 Outer column.
3 Paper gaskets (joint washers).
4 Shims.
5 Shims.
6 Spring cap.
7 Filler plug.
8 Top cover.
9 Steering box.
10 Double coil spring.
11 Damper button.
12 Guide roller.
13 Rocker shaft.
14 Nut.
15 Steel balls (lower track).
16 Steel balls (nut).
17 Rocker shaft bush.
18 Oil seal.
19 Drop arm (swing lever).
20 Steel balls (upper track).
21 Upper track.
22 Distance piece.
23 Inner column and worm.

To remove from car—(Alpine)
(Left-hand drive cars only)

1. Disconnect and remove the bonnet which is attached to its hinges by eight bolts.
2. Remove battery cover panel in rear compartment by withdrawing the securing screws and disconnect the battery at the positive terminal.
3. Separate the inner and outer steering column cowls. See under "Steering Column Cowling—to remove and refit".
4. Remove the direction indicator switch as previously described, and the striker ring from the inner column. Also remove the overdrive switch if fitted.
5. Remove the horn ring assembly as described under "Horn Ring Assembly—to remove and refit".
6. Remove the steering wheel as previously described.
7. Remove the bolts securing the left-hand side scuttle bracing tube to the bulkhead and the forward mounting.
8. Disconnect the brake fluid reserve tank from its mounting on the wing valance. Disconnect the brake fluid pipe at the master cylinder union and remove the reserve tank and pipe from the car, draining the fluid into a suitable container.
9. Disconnect the steering column hanger clip from hanger on the bulkhead leaving the hanger itself in position.
10. Jack up the front of the car and remove the nut and tab washer securing the drop arm to the rocker shaft.
11. Mark the rocker shaft and drop arm with a punch at two adjacent points to facilitate correct assembly.
12. Loosen off the three bolts securing the steering unit to the front side member to enable the drop arm remover to be fitted.
13. Remove the drop arm from its spline using special tool RG.198.
14. Lower the jack.
15. Remove the bolts securing the steering column to the upper column bracket under the facia panel, leaving the bracket itself in position.
16. Disconnect and remove the facia crash roll pad. This is secured by nuts and bolts to the underside of the facia panel and to the steering column bracket.
17. Remove the facia reinforcement which is held by two spire fixings and two nuts at each end.
18. Remove the three bolts securing the steering unit to the front side member.
19. Lower the upper end of the steering column clear of the facia panel.
20. Remove the steering column grommet from the hole in the bulkhead.
21. Draw the steering unit back against the bulkhead and twist it through 180 degrees so that the rocker shaft is facing vertically upwards. Tilt the steering box upwards and lift out through the bonnet aperture.

To Refit

1. Position the steering unit horizontally with the splined end of the steering column inserted into the hole in the bulkhead, and the rocker shaft pointing vertically upwards.
2. Push the steering column through the hole in the bulkhead, turning the complete unit through 180 degrees as it becomes clear of the radiator header tank.
3. Refit the steering column grommet in the hole in the bulkhead.
4. Loosely attach the steering column to the dash and bulkhead brackets, and bolt the steering box to the front side member.

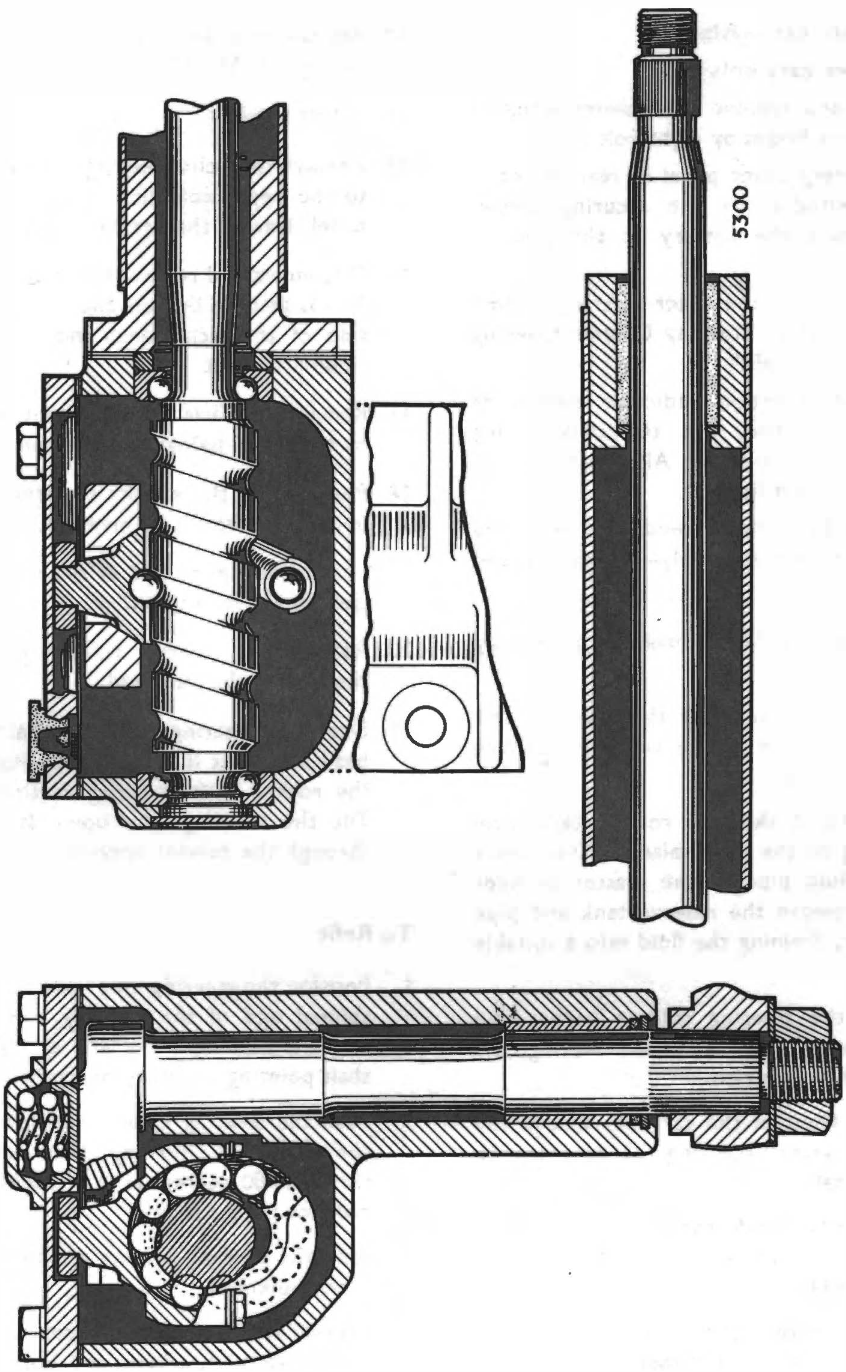


Fig. 2. *Sectional view of "F" type steering unit*

5. Check the alignment of the steering column clip relative to the upper column bracket. If there is malalignment, remove the steering box from the front side member and refit with packing washers as required. It is most important to ensure that there is no tension in the steering column.
6. Tighten the nuts and bolts securing the steering column to the dash and bulkhead brackets.
7. Jack up the car and refit the drop arm on to its correct splines. Secure with a nut and new tab washer. Lower the jack.
8. Refit the bonnet, dash reinforcement, crash roll pad, trafficator switch, overdrive switch, steering column cowls, handwheel, horn switch assembly, scuttle bracing tube, brake fluid reserve tank and pipe, battery terminal and battery cover. The fitting procedures for all these items will be the reversal of those given under "To remove".
9. Test.

To remove from car—(Alpine)
(Right-hand drive cars only).

Operations 1.—6. as for left-hand drive cars.

7. Remove the bolts securing the right-hand side scuttle bracing tube to the bulkhead and the forward mounting.
8. Remove the dipstick.
9. Remove the distributor from the engine. (See under Section B—"Distributor—to remove and refit").
10. Disconnect tachometer drive from the engine.
11. Remove the fuel pump from the engine. (See under Section C).
12. Drain the oil from the filter housing by undoing the hexagonal headed drain plug. (See Section B, Fig. 35). Remove the outer casing and filter element by undoing the centre bolt.
13. Disconnect the steering column hanger clip from the hanger on the bulkhead, leaving the hanger itself in position.
14. Jack up the front of the car and remove the nut and tab washer securing the drop arm to the rocker shaft.
15. Mark the rocker shaft and drop arm with a punch at two adjacent points to facilitate correct re-assembly.
16. Loosen off the three bolts securing the steering unit to the front side member to enable the drop arm remover to be fitted in place.
17. Remove the drop arm from its spline using special tool RG.198.
18. Lower the jack.
19. Disconnect and remove the facia crash roll pad. This is secured by nuts and bolts to the underside of the facia panel and to the steering column bracket.
20. Remove the bolts securing the steering column to the upper column bracket under the facia panel.
21. Remove the facia reinforcement which is held by two spire fixings and two nuts at each end.
22. Remove the three bolts securing the steering unit to the front side member.
23. Lower the upper end of the steering column clear of the facia panel.
24. Remove the steering column grommet from the hole in the bulkhead.
25. Ease the steering unit forward until the steering box is positioned immediately behind the header tank. Twist the steering unit through 180° so that the rocker shaft is facing vertically upwards. Tilt the steering box upwards and lift out through the bonnet aperture.

To refit

1. Position the steering unit horizontally with the splined end of the steering column inserted in to the hole in the bulkhead, and the rocker shaft pointing vertically upwards.
2. Push the steering column through the hole in the bulkhead, turning the complete unit through 180 degrees as it becomes clear of the radiator header tank.

3. Refit the steering column grommet in the hole in the bulkhead.
4. Loosely attach the steering column to the dash and bulkhead brackets, and bolt the steering box to the front side member.

   Check the alignment of the steering column clip relative to the upper column bracket.
5. If there is malalignment, remove the steering box from the front side member and refit with packing washers as required. It is most important to ensure that there is no tension in the steering column.
6. Tighten the nuts and bolts securing the steering column to the dash and bulkhead brackets.
7. Jack up the car. Refit the drop arm on its correct splines and secure with a nut and new tab washer. Lower the jack.
8. Refit the dash reinforcement, crash roll pad, trafficator switch, overdrive switch, steering column cowls, hand wheel, horn switch assembly, dipstick, oil filter outer casing and element, petrol pump, distributor, and scuttle bracing tube. The fitting procedures for all these items will be the reversal of those given under "to remove".
9. Reconnect tachometer drive.
10. Test.

To remove from car—(Rapier)

1. Disconnect the battery at the positive terminal.
2. Remove the steering column cowling as previously described.
3. Remove the direction indicator switch, as previously described, and the striker ring from the upper end of the inner column. Also remove the overdrive switch if fitted.
4. Remove the horn ring assembly as previously described.
5. Remove the steering wheel as previously described.
6. Disconnect the parcel tray on the driver's side and drop it clear of the steering column.
7. Jack up the front of the car and remove nut and tab washer securing the drop arm to the rocker shaft.
8. Loosen the three bolts securing the steering unit to the front side member to enable the drop arm remover to be fitted.
9. Remove the drop arm using special tool No. RG.198.
10. Lower the jack.
11. Disconnect the steering column support clip from the upper column bracket leaving the bracket itself in position.
12. To simplify the withdrawal of the steering unit, move the front seat back as far as it will go and loosen off the bolts securing the clutch and brake master cylinders to the bulkhead.
13. Remove the three bolts securing the steering unit to the front side member.
14. Lower the upper end of the steering column and remove the column grommet from hole in the bulkhead.
15. Raise the forward end of the unit, twist it sideways and ease out over the bonnet aperture.

Note.—On left-hand drive cars it will also be necessary to remove the battery and cradle before the steering unit can be withdrawn.

To refit

1. Position the steering unit so that the splined end of the column is inserted into the hole in the bulkhead and the rocker shaft is pointing upwards.
2. Push the steering column through the hole in the bulkhead, turning the rocker shaft the right way round as it comes clear of the bonnet aperture.
3. Refit the bulkhead grommet.
4. Secure the unit to the front side member and check the alignment of the upper column bracket and support clip. If the support clip

cannot be secured to the upper column bracket without being strained into place, shims should be inserted between the steering unit and front side member to ease the condition. It may also be necessary to file the upper column bracket. It is most important to ensure that there is no tension in the steering column.

5. Jack up the car, refit the drop arm onto its correct splines and secure with nut and new tab washer. Lower the jack.
6. Retighten the bolts securing the clutch and brake master cylinders to the bulkhead.
7. Refit steering wheel, horn ring assembly, direction indicator switch, and striker ring, overdrive switch, steering column cowling and battery terminal. The fitting procedures for these items will be a reversal of those given under "to remove".
8. Test.

To dismantle (See Fig. 1)

1. Remove steering unit from car as previously described.
2. Thoroughly clean the outside of the unit.
3. Remove the spring cap (6), double coil spring (10), and damper button (11).
4. Undo bolts securing top cover (8), to the steering box and remove together with joints and shims (5). Drain off oil.
5. Remove guide roller (12), from the main nut (14).
6. Withdraw the rocker shaft (13).
7. Undo the three bolts securing the outer column (2), to the steering-box (9), and remove together with paper gaskets (3), shims (4), and distance piece (22).
8. Unscrew the inner column (23), from the nut (14), and withdraw through the aperture in the upper end of the box. This operation will release the twelve balls (20), from the upper track (21), which should be immediately recovered.

   The nut assembly is supplied complete and there is no advantage to be gained by dismantling it.
9. Lift out the main nut assembly and remove the thirteen steel balls (16).
10. Remove the twelve balls (15) from the lower track.
11. If necessary remove the top bush (1), from the outer column. The rocker shaft bush (17), is also a renewable item.

To re-assemble (See Fig. 1)

1. Smear the lower track with grease and insert the twelve balls (15).
2. Smear the transfer channel of the main nut with grease and load with thirteen balls (16).
3. Pass the main nut assembly (14), through the cover plate aperture and hold it in position whilst the inner column is passed through the top aperture of the box. Revolve the inner column in order to screw it into the main nut assembly and gently lower onto the bottom bearing.
4. Smear the upper track (21), with grease and slide it over the inner column. Insert twelve balls and place the upper track squarely in position in the top aperture of the steering box.
5. Slide the distance piece (22), over the inner column (23), followed by the outer column (2), taking great care not to disturb the upper track. Bolt the outer column to the steering box but do not fully tighten the bolts at this stage.
6. Refit the rocker shaft (13), locating the arm on the spigot of the nut assembly.
7. Refit the guide roller (12).

To pre-load the inner column bearings

8. Using a feeler gauge, measure the gap between the bottom face of the outer column and the upper face of the steering box.

9. Remove the outer column, taking great care not to disturb the upper track (21), and refit together with shims equal in thickness to the gap previously measured less 0·0015" (0·038 mm.). Take into account the thicknesses of the paper gaskets (joint washers), (3), which are as follows:—
   K.29826 ... 0·002" (0·051 mm.).
   K.21724 ... 0·005" (0·127 mm.)

To adjust rocker shaft end float

10. Refit the top cover (8) together with a small quantity of shims (5), and two paper gaskets (joint washers).

11. With the spring cap (6) removed, measure the gap between the rocker shaft (13), and top cover with a feeler gauge. Alternatively, clamp a dial test indicator to the steering box so that the stylus bears on the top of the rocker shaft, move the rocker shaft up and down and check the indicator reading. With the steering in the straight ahead position, the clearance or reading on the gauge should be 0·004"-0·008" (0·10-0·20 mm.).

12. Remove the top cover (8) and adjust the thickness of shims to achieve the required end float.

13. Fit the damper button (11), double coil spring (10), and spring cap (6), securing with two bolts and washers.

14. Top up the unit with the correct grade of oil (see Section P), and refit the filler plug (7).

15. Refit the steering unit to the car as previously described.

BURMAN TELESCOPIC STEERING UNIT

A Burman telescopic steering unit is similar in design to the previous steering unit and the changes are confined to the steering wheel end. The upper end of the inner steering column is swaged out to accommodate a sliding splined extension and locking device. There is 2½in. (63·5 mm.) of height adjustment for the steering wheel.

STEERING COLUMN COWLING

The steering column cowling is fabricated in two halves, upper and lower. The upper half is held in position on the steering column by a clip and four screws; the lower half is secured to the upper by three screws.

To remove and refit

1. Remove the lower cowling from the upper by withdrawing three screws from the underside of the lower cowling.

2. Detach the overdrive switch, if fitted, from the upper cowling and lay aside.

3. Remove the upper cowling from the steering column by withdrawing four bolts and a clip.

4. Refitting is the reverse of the removal sequence but particular attention must be given to the following.

   i. The upper cowling is located by a dowel fitting a drilling in the outer column.

   ii. The upper cowling securing clip is fitted so the spire nut is fitted toward the front of the car.

   iii. The overdrive switch, if fitted, or a blank is positioned between the edges of the two cowlings before the lower is fitted.

   iv. Check that there is a gap of 0·050 in. (1 mm.) between the top edge of the cowlings and the steering wheel centre when the latter is in its lowest position.

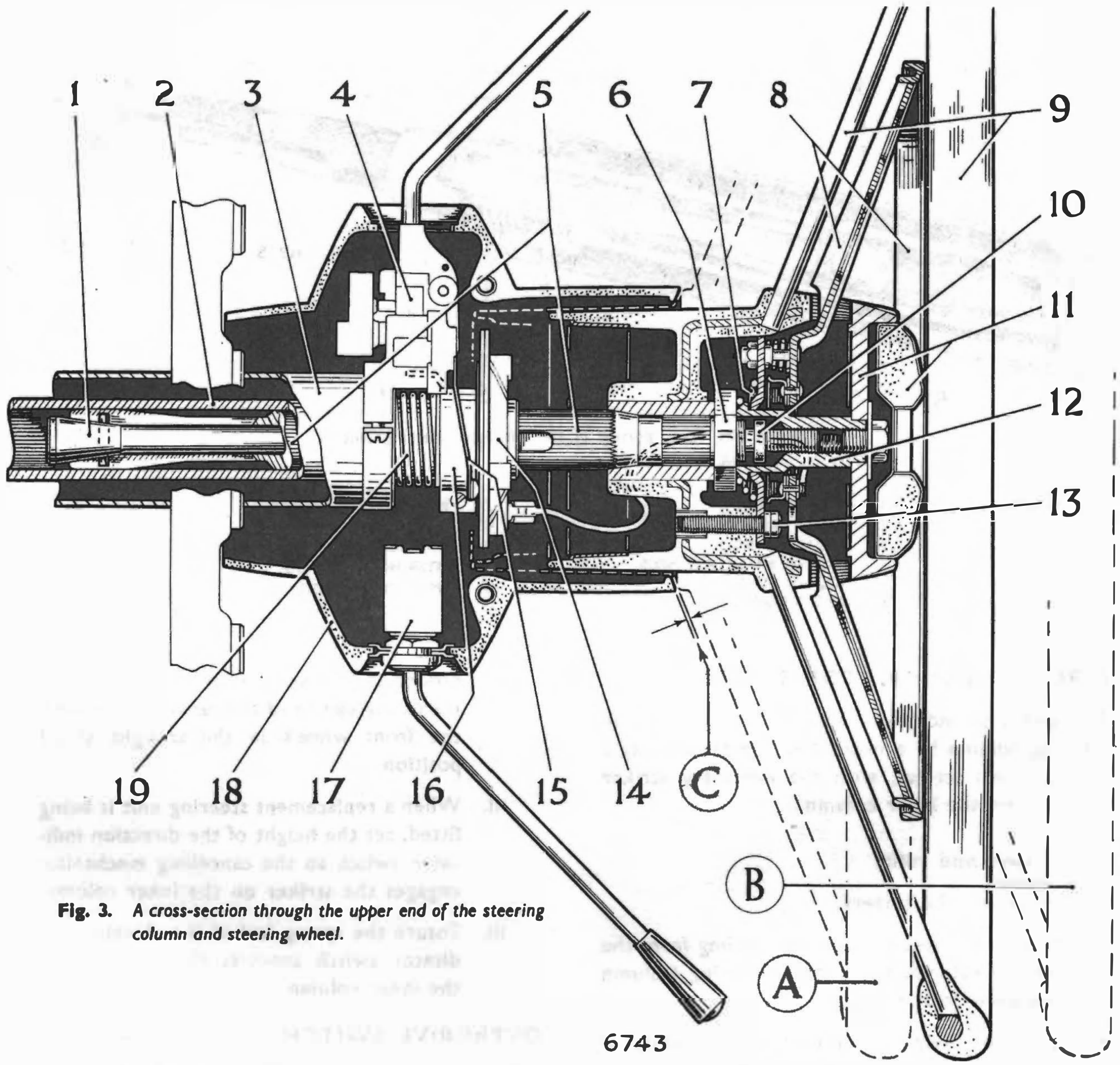


Fig. 3. *A cross-section through the upper end of the steering column and steering wheel.*

1. EXPANDER BOLT.
2. INNER COLUMN.
3. OUTER COLUMN.
4. DIRECTION INDICATOR SWITCH.
5. SPLINED EXTENSION PIECE.
6. STEERING WHEEL NUT.
7. CONICAL SPRING.
8. HORN RING.
9. STEERING WHEEL
10. SPLIT NYLON BUSH.
11. STEERING WHEEL ADJUSTING NUT AND MOTIF.
12. EXPANDER BOLT EXTENSION.
13. SCREW, HORN RING ASSEMBLY TO STEERING WHEEL.
14. SLIP RING.
15. LEAF SPRING.
16. STRIKER RING.
17. OVERDRIVE SWITCH.
18. STEERING COLUMN COWLING.
19. COLUMN BEARING SPRING.

A. LOWER POSITION OF STEERING WHEEL.
B. UPPER POSITION OF STEERING WHEEL.
C. 0·050 IN. (1 MM.) CLEARANCE

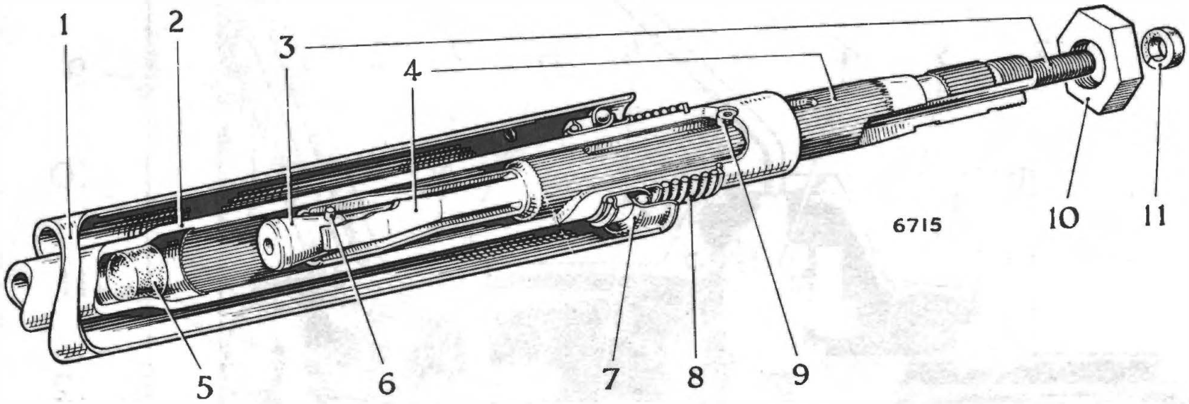


Fig. 4. *The upper portion of the telescopic steering unit in cut away section.*

1. OUTER COLUMN.
2. INNER COLUMN.
3. EXPANDER BOLT.
4. SPLINED EXTENSION PIECE.
5. RUBBER BUNG.
6. CROSS DOWEL.
7. BALL BEARING RACE.
8. SPRING AND CIRCLIP.
9. DOWEL.
10. STEERING WHEEL NUT
11. SPLIT NYLON BUSH.

DIRECTION INDICATOR SWITCH

The direction indicator switch is located on the steering column by a raised key and secured by a clip and two screws, with the cancelling striker mounted on the inner column.

To remove and refit

1. Disconnect the battery.
2. Remove the steering column cowling from the steering column, see under "Steering Column Cowling—To remove and refit".
3. Mark the height of the direction indicator switch on the outer column and remove by withdrawing two screws and washers.
4. Mark the position of the striker on the inner column and remove by slackening off the pinch bolt.
5. Refitting is the reverse of the removal sequence but particular attention must be given to the following points.

   i. Ensure the striker points horizontally towards the centre of the car or switch with the front wheels in the straight ahead position.

   ii. When a replacement steering unit is being fitted, set the height of the direction indicator switch so the cancelling mechanism engages the striker on the inner column.

   iii. Ensure the spring leaf of the direction indicator switch contacts the slip ring on the inner column.

OVERDRIVE SWITCH

The overdrive switch, if fitted, is mounted on a plate and positioned between the upper and lower steering column cowlings on the opposite side to the direction indicator switch.

To remove and refit

1. Disconnect the battery.
2. Remove the lower steering column cowling from the upper by withdrawing three screws.

3. Withdraw the overdrive switch from the upper cowling and disconnect at the snap connectors.
4. Refitting is the reverse of the removal sequence.

HORN RING ASSEMBLY

The horn ring fitted to the telescopic steering units differs from that described earlier in this Section to accommodate the varying height of the steering wheel on the inner column.

The upper contact plate is incorporated in the horn ring and the complete assembly is retained in the centre of the steering wheel by three screws fitted internally through the lower contact plate.

The motif is a press fit in the centre of the steering wheel adjusting nut which is set in the centre of the steering wheel.

The live cable from the horns connects with an insulated spring leaf mounted on the direction indicator switch and the spring leaf is set to connect with a slip ring mounted on but insulated from the inner column of the steering column.

A cable, fitted to a Lucar connector on the upper face of the slip ring, passes through holes in the steering wheel centre and lower contact plate to connect with the upper contact plate. The length of the cable is such that it allows for the adjustable height of the steering wheel.

The lower contact plate is "earthed" to the inner column by a conical shaped coil spring.

Pressure applied to the horn ring "tilts" the upper contact plate onto the lower thus completing the circuit. The three coil springs between the contact plates returns the horn ring to the "off" position when pressure is removed from the horn ring.

To remove and refit Fig. 3

1. Disconnect the battery.
2. Lift the steering wheel (9) to its highest position.
3. Remove the lower steering column cowling from the upper by withdrawing three screws, disconnect the cable from the Lucar connector on the upper face of the slip ring (14).
4. Prise the motif from the centre of the steering wheel adjusting nut (11).
5. Remove the steering wheel adjusting nut (11) from the top of the expander bolt extension (12) by withdrawing a bolt and washer.
6. Remove the horn ring (8) from the steering wheel centre (9) by withdrawing three screws (13) and washers, easing the cable through its hole in the steering wheel centre (9).
7. Refitting is the reverse of the removal sequence but particular attention must be given to the following.
   i. The amount of "tilt" on the horn ring required to sound the horns can be increased or decreased by slackening or tightening the three self-locking nuts on the underside of the lower contact plate but it is essential that the contact surfaces are kept an equal distance apart all the way round.
   ii. Ensure the split nylon bush (10) is at the bottom of the thread on the expander bolt (1).

STEERING WHEEL

Adjusting the height (Fig. 3)

1. Slacken off the steering wheel (9) by gripping the adjusting nut (11) in the centre of the steering wheel and rotating it anti-clockwise.
2. Slide the steering wheel (9) up or down the steering column to the desired height.
3. Lock the steering wheel (9) by rotating the adjusting nut (11) clockwise.

To remove and refit (Fig. 3)

1. Remove the horn ring assembly (8) from the steering wheel centre (9) see under "Horn Ring Assembly—To remove and refit".
2. Remove the conical spring (7) from inside the steering wheel centre by unscrewing the expander bolt extension (12).
3. Remove the steering wheel nut (6) from the steering wheel centre (9) using the special tool R.G. 197.
4. Identify the position of the steering wheel centre (9) on the splined extension piece (5) if the existing steering wheel is to be refitted and remove from the splined extension piece (5)
5. Refitting is the reverse of the removal sequence but particular attention must be given to the following.
   i. The front wheels are set in the straight ahead position and the steering wheel is fitted so the two spokes are in the horizontal position.
   ii. The conical spring is fitted, small end downward on top of the steering wheel nut before the expander bolt extension is fitted and the contact surfaces are smeared with Shell Grease S.B. 2498.

TELESCOPIC STEERING UNIT (Fig. 3)

The inner column (2) of the telescopic steering unit is similar to that of the rigid units but the hollow upper end is swaged out and its internal surface splined to accommodate the splined extension piece (5).

The upper end of the splined extension piece (5) has external splines, taper and thread, similar to the rigid units and the steering wheel (9) is fitted in the normal manner. Midway along its length is a single axial groove which locates the protruding end of a dowel pressed into the swaged portion of the inner column (2). The dowel retains the splined extension piece within the inner column (2) and limits its upward and downward travel to predetermined amounts. The lower end is slotted and has an internal taper to accommodate the cross dowel and male taper of the expander bolt (1) fitted in the hollow centre of the splined extension piece (5).

An expander bolt extension (12) screws onto the protruding thread of the expander bolt (1) and the steering wheel adjusting nut (11) is located by two flats and attached by a bolt. The bolt extension (12) has a small flange on its lower end which will bear against the underside face of the horn ring (8) and releases the expander bolt (1) as the steering wheel adjusting nut (11) is slackened off.

A split bush (10), situated beneath the expander bolt extension (12) and fitted on the protruding end of the expander bolt (1) prevents the bolt dropping out of the splined extension piece (5) when the bolt extension (12) is removed. The inner column (2) is also plugged with a rubber bung to prevent the expander bolt (1) dropping into the hollow centre of the inner column (2) should ever the nylon bush (10) be inadvertantly removed.

To remove and refit

1. Remove the horn ring assembly from the steering wheel centre, see under "Horn Ring Assembly—To remove and refit".
2. Remove the steering wheel—see under "Steering Wheel—To remove and refit".
3. Remove the slip ring from the inner column followed by the striker by slackening the nut and bolt of the striker.
4. Remove the direction indicator switch from the steering column, see under "Direction Indicator Switch—To remove and refit".
5. Remove the steering unit from the car, see under "Steering Unit—To remove from car Alpine".
6. Refitting is the reverse of the removal sequence.

To dismantle and reassemble (Fig. 4)

The dismantling and reassemble sequences for the telescopic steering unit is similar to the rigid unit concerning the steering box which is fully described earlier in this Section but the following additions must be noted.

1. Before dismantling the steering box remove the ball race at the top ends of the inner and outer columns.

   Push the splined extension piece (4) inward to the limit of its travel, remove the split nylon bush (11) from the expander bolt (3) and the steering wheel nut (10) from the splined extension piece.

   Withdraw the ball bearing race from between the inner and outer column (1 & 2) removing the circlip and bearing tension spring (8).

2. Remove the inner column (2) as described for rigid steering units and dismantle the upper end of the inner column as follows:—

   Withdraw the splined extension piece (4) from the swaged portion of the inner column (2) by extracting the dowel (9) this is tapped to facilitate removal and discarded after extraction.

   Remove the expander bolt (3) from the hollow centre of the splined extension piece (4).

3. The assembly sequence is the reverse of the dismantling sequence but particular attention must be given to the following.

   The tapered end of the expander bolt (3) and the long splines of the extension piece (4) are smeared with Shell S.B. 2498 grease.

   The expander bolt (3) is fed into the splined extension piece (4) so the cross dowel (6) through the tapered end locates in the cuts in the end of the splined extension piece (4) and retained within by fitting the split nylon bush (11) onto the threaded end.

   The splined extension piece (4) is fed into the swaged portion of the inner column (2) so the groove aligns with the dowel hole.

   A new dowel is pressed into the inner column to such a depth that it does not hamper the movement of the splined extension piece.

   The splined extension must be lowered to the fullest extent before the split nylon bush (11) is removed.

STEERING RELAY LEVER ASSEMBLY

The steering relay lever assembly is fitted on the opposite side to the steering unit and relays the movement of the front wheel nearest the steering unit to the other.

The rear end of the steering unit swing lever is connected to the rear end of the relay lever by the centre track rod and movement is transferred to the second front wheel by a short outer track rod fitted to the front end of the relay lever.

The pin in the relay lever is a heavy interference press fit and must never be separated; the circlip on the lower end of the pin is a safety precaution and no useful purpose is served by removing it.

Series I to IIIA Models (Fig. 5)

The bush bearings in the support bracket of the steering relay lever assembly are of the Clevite type and a lubrication nipple is provided for periodical lubrication.

Series IV Models onwards (Fig. 6)

The support bracket bush bearings are of the P.T.F.E. type with P.T.F.E. washers fitted above and below the end faces of the support bracket. No

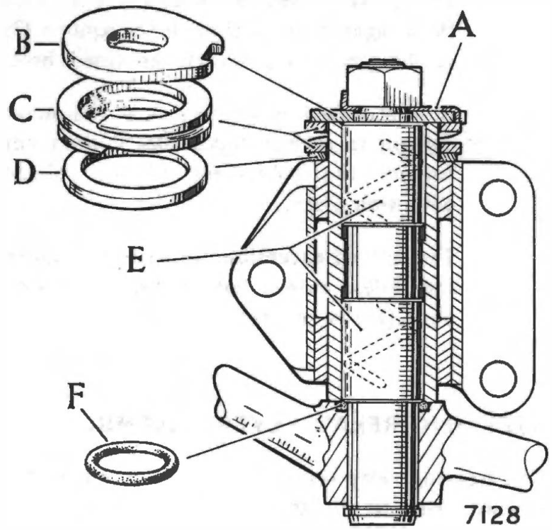


Fig. 5. *Cross section view through steering relay lever assembly, note the position of the lubrication groove in the bush bearings.*

A. TABWASHER
B. THRUST WASHER
C. SPRING
D. WASHER
E. BUSH BEARINGS
F. SEALING RING

periodical lubrication is necessary and the greaser is blanked off with a short bolt, but during re-assembly all parts must be coated with Shell Retinax " A " Grease. The Belleville washer pack, situation below the support bracket, is tensioned during re-assembly by setting the castellated nut on the upper end of the relay lever pin to load the Belleville washers.

To remove and refit

1. Detach the steering relay lever assembly from the front chassis side member on the opposite side to the steering unit by removing three nuts, bolts and washers.

2. Remove the outer and centre track rods from the front and rear ends of the relay lever by discarding the split pin and removing the castellated and self locking nuts respectively from the tapered ball pins and using a suitable extractor RG. 191A; withdraw the relay lever assembly from beneath the car.

3. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

   (i) Set the steering and relay levers in the straight ahead position and fit the centre rod to the rear ends of both levers; failure to observe this instruction will put unnecessary strain on the rubber bushes, in the ends of the centre rod and result in shortening the life of the bushes.

   (ii) Fit a new split pin to the castellated nut on the tapered ball pin of the outer track rod.

   (iii) Check the front wheel alignment (toe-in), see under " Front wheel alignment (toe-in) — To check, Front Suspension, Section F."

To dismantle and reassemble

Series I to IIIA (Fig. 5)

1. Identify the relay lever to the nearest end of the support bracket to facilitate re-assembly; withdraw the relay lever and pin from the support bracket by releasing the tabwasher, removing the nut, tabwasher, thrust washer, spring and washer.

2. Extract the sealing ring from the upper face of the relay lever, when it is seen to be well worn.

3. As the pin is a heavy interference fit in the relay lever no useful purpose is served by separating them.

4. Re-assembly is the reverse of the dismantling sequence but particular attention must be given to the following:—

   (i) Ensure the sealing ring is in good condition and recessed correctly in the relay lever groove.

   (ii) The pin of the relay lever is fed into the support bracket so the front lower bolt hole is closer to the short end of the relay lever.

   (iii) The nut is slackened off to give an assembled endfloat of 0·007 in. (0·18 mm) and then locked with the tabwasher.

   (iv) Lubricate the relay lever assembly through the lubrication nipple provided.

Series IV Models onwards (Fig. 6)

1. Identify the relay lever to the nearest end of the support bracket to facilitate assembly; withdraw the relay lever and pin from the support bracket by discarding the split pin and removing the castellated nut, thrust washer, narrow sealing ring, distance piece, P.T.F.E. and bearing washers from above the support bracket.

2. Remove the wider sealing ring, bearing and P.T.F.E. washers followed by the Belleville washer pack from the upper face of the relay lever.

4. As the pin is a heavy interference fit in the relay lever, no useful purpose is served by separating them.

5. Re-assembly is the reverse of the dismantling sequence but particular attention must be given to the following:—

   (i) In the interests of good steering it is advisable to fit a new pack of Belleville washers.

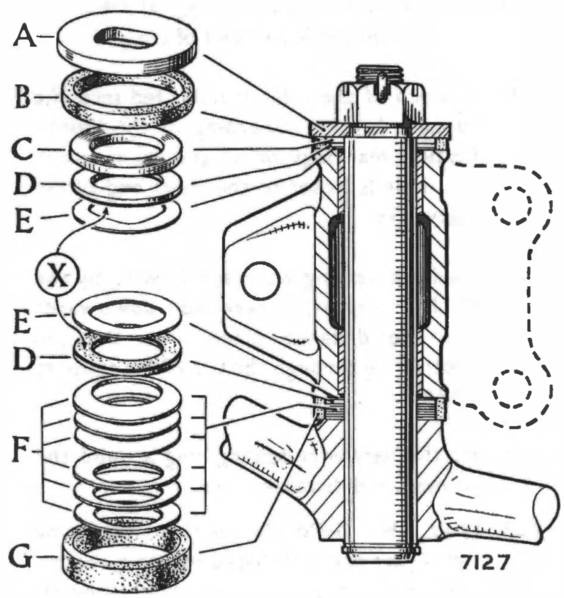


Fig. 6. *Cross section view through later steering relay lever assembly, note the method of assembly for the Belleville washer pack.*

A. THRUST WASHER
B. NARROW SEALING RING
C. DISTANCE PIECE
D. P.T.F.E. WASHER
E. BEARING WASHER
F. BELLEVILLE WASHER PACK
G. SEALING RING
X P.T.F.E. SURFACE

   (ii) Ensure the upper end of the relay lever pin is free from burrs and coat all parts with Shell Retinax " A " Grease.

   (iii) Assemble the six Belleville washers into two parallel packs of three each and place together so the raised outside edges are in contact with one another and feed onto the pin.

   (iv) Position the P.T.F.E. washer, dark face upwards, on the pin followed by the bearing washer.

(v) Fit the wider sealing ring around the washers on the lower end of the pin.

(vi) The pin of the relay lever is fed into the support bracket according to the identification markings or so the front lower bolt hole is closer to the short end of the relay lever.

(vii) Feed the bearing washer, following by the P.T.F.E. washer, darker side downwards and the distance piece onto the pin protruding through the top of the support bracket.

(viii) Fit the narrower sealing ring around the washers and distance piece.

(ix) Load the Belleville washer pack by tightening the castellated nut to a torque of 60 lbs. ft. (8·3 kg.m.) and slackening off $1\frac{1}{2}$ flats, fit a new split pin in the nearest position *back*, DO NOT TIGHTEN THE CASTELLATED NUT.

Steering relay lever bush bearings.

To renew the steering relay lever bush bearings, it will be necessary to remove and dismantle the relay lever assembly, see under " Steering Relay Lever — To remove and refit; To dismantle and re-assemble."

Series I to IIIA Models

The bush bearings used in this relay lever assembly are of the " Clevite " type which require periodical lubrication.

The bush bearings are pressed into the support bracket so the ends having the start and finish of the lubrication groove are towards the lubrication nipple in the centre of the support bracket and until the outer ends of the bush bearings are flush with the two end faces of the support bracket.

Series IV Models onwards

The bush bearings used in this relay lever assembly are of the P.T.F.E. type and do not require periodical lubrication.

IT IS IMPORTANT THAT THE BEARING SURFACE IS NOT DISTURBED BY THE SPIGOT OF THE PRESSING TOOL OR BY REAMING OR SCRAPING.

The bush bearings are pressed into the support bracket so the outer ends are just below the two end faces of the **support bracket, without disturbing the bearing surface of the bush bearing.**

BRAKES

CONTENTS

BRAKES—ALPINE

GENERAL

Girling type disc brakes are fitted to the front wheels and Girling drum brakes to the rear wheels. All four brakes are hydraulically operated pressure being generated in the master cylinder by application of the brake foot pedal. The handbrake operates the rear brakes by an independent mechanical linkage.

MAINTENANCE

The brake linings should be examined for wear at regular intervals. The front brake friction pads must be renewed when the friction material has worn down to a minimum of $\frac{1}{16}$ in. (1·59 mm) in thickness. (See under "Brake Pads—to remove and refit").

Brake adjustments

The front brakes are self adjusting; the rear brakes should be adjusted as follows:—

Chock up one of the front wheels to prevent the car from rolling, release the handbrake, and jack up one rear wheel.

Turn the adjuster situated at the rear of the backplate (arrowed in Fig. 1), in a clockwise direction until solid resistance is felt.

Slacken back the adjuster until the drum is able to rotate (usually two clicks). A slight drag may be felt from the trailing shoe but this should not be sufficient to prevent the wheel from being turned by hand.

Spin the wheel and apply the brakes hard to centralise the shoes in the drum and re-check adjustment.

Repeat for other rear wheel.

Normally adjustment of the rear brakes will automatically adjust the handbrake. When the handbrake is correctly adjusted there is four to six notches of handbrake movement before the wheels are locked. If with the rear brakes in correct adjustment, there is excessive handbrake free travel, the handbrake should be adjusted as follows:—

Chock up one of the front wheels, release the handbrake and jack up both rear wheels.

Lock the shoes by means of the adjusters (arrowed in Fig. 1).

Take up the slack in the linkage at the compensator situated beneath the rear axle, (see Fig. 1), by slackening off the locking nut, removing the jaw pin, and screwing in the jaw as necessary.

Re-adjust brakes as previously described.

A lubricator is provided on the handbrake cable, on Series I and II Models.

On the Alpine II and III there is provision for relocating the master cylinder push-rod in another position on the brake pedal. This in effect moves the pedal pad approximately 1½ in. (4cm) further away from the driver. The inset of Fig. 2, Section D shows a similar arrangement on the clutch pedal

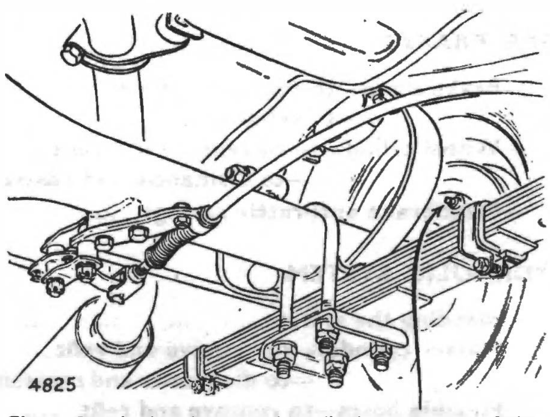


Fig. 1. *Rear brake adjuster and handbrake compensator linkage on Series I to II Models.*

Brake fluid level

The fluid level in the master cylinder reservoir should be checked at regular intervals and should be kept within ½ in. (12 mm) of the filler cap orifice Never fill completely since the expansion of fluid in hot weather may cause the brakes to build up and the shoes to bind.

Before removing the filler cap to top up, clean the area around the filler cap to prevent dirt entering the reservoir. Ensure that the air vent in the filler cap is not choked; blockage at this point could cause the brakes to drag.

The addition of fluid will be required at regular intervals due to the repositioning of the front wheel pistons as a result of friction lining wear, but a rapid fall in fluid level would indicate a leak at some point in the system which should be traced and rectified.

Use only the specified type of brake fluid for replenishment purposes. (See Section P). Care should be taken not to spill any of the fluid on the car body since the fluid is injurous to paint.

The brake hoses should be checked at regular intervals for leakage, chafing and general deterioration. If there is any doubt replace the hoses. It is advisable in any case to replace the hoses every five years. For removal instructions see under "Flexible hoses—to remove and refit".

To check for leaks, apply a firm pressure to the brake pedal whilst an assistant examines the units, pipes, hoses and fittings.

It is also advisable to occasionally check for tightness the brake mounting bolts and hydraulic unions. It is important not to overtighten the bleed screws and unions, since this may very easily result in stripped threads. The specified torque figures for the bleed screws and pipe unions are as follows:—

Bleed screws		
(conical pointed)	5–7·5 lbs. ft.	(70–104 kg. cm.)
Feed pipe unions		
(male)	7–8 lbs. ft.	(97–111 kg. cm.)
(female)	8–10 lbs. ft.	(111–138 kg. cm.)

FRONT BRAKES

DESCRIPTION

Each brake consists of a high quality cast iron disc which is attached to and rotates with the hub, and a cast iron caliper which straddles the disc and is rigidly attached to the axle carrier.

The caliper houses two hydraulic pistons operating on a pair of brake pads, the pistons are protected by dust covers and sealing between the pistons and caliper is effected by rubber rings fitted in grooves in the caliper bores.

A metal splash guard is fitted to protect the inner face of the disc from grit. On Series I and II models, these guards are attached by brackets under the heads of the steering arm and caliper attachment bolts, but on Series III models onwards the guards are attached to the hub side of the stub axle carriers with three bolts each.

On Series II models, after chassis No. B.913936, anti-squeal shims are fitted between the pistons and brake pads.

On Series I and II models, anti-rattle springs can be fitted in Service should any brake pad rattle be experienced.

Upon application of the brakes, the hydraulic pressure generated in the system causes the pistons to apply equal pressure to each brake pad in proportion to the foot effort applied to the pedal.

When the brakes are released, the hydraulic pressure is relieved and the pistons and brake pads remain in position for the next application. In this manner, pad wear is automatically taken up thus no manual adjustment is required.

After negotiating a ford, water splash or when driving on flooded roads, it may be necessary to dry out the brakes to restore full braking power by a few light applications of the brake pedal. It is also advisable to do this after or during prolonged driving in wet weather, under circumstances where the brakes are not in use, such as may occur on motorways etc.

BRAKE PADS

The friction linings are bonded and riveted to their backing plates and can therefore only be renewed by the fitment of complete new brake pad assemblies.

It should not be necessary to bleed the system after replacing the brake pads.

When replacing the brake pads, the opportunity should be taken to examine the condition and fitting of the rubber dust covers (item 17 Fig. 2). The method of removing the dust covers is given under "Calipers—to dismantle".

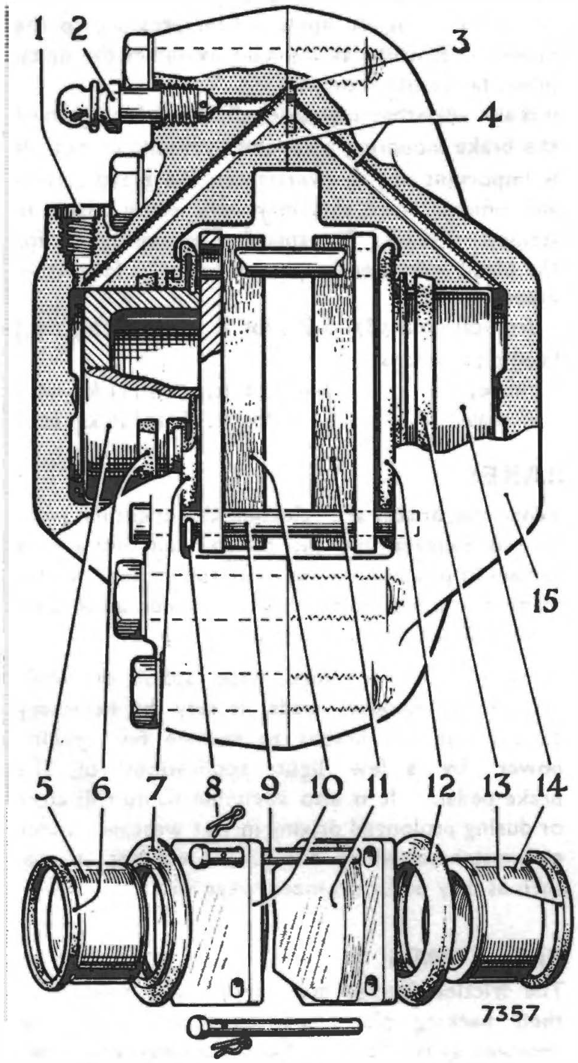


Fig. 2. *Exploded view of caliper assembly, Series II models onwards.*

1.	FLEXIBLE HOSE CONNECTION
2.	BLEED SCREW
3.	FLUID CHANNEL SEAL
4.	INTERNAL FLUID CHANNELS
5. & 14	PISTONS
6. & 13	PISTON SEALING RINGS
7. & 12	DUST COVERS
8.	RETAINING CLIPS
9.	RETAINING PINS
10. & 11	BRAKE PADS
15.	CALIPER BODY

To remove and refit (Figs. 2 and 2a)

1. Apply the handbrake, jack up the front of the car and remove the road wheel.

2. Withdraw the two brake pads from the caliper and when fitted, the anti-rattle springs and anti-squeal shims by removing the two retaining clips and pins.

3. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

   (i) Check the fluid level in the master cylinder reservoir to assess the possibility of overflowing when the pistons are pressed into the calipers. The overflowing can be staunched by wrapping the reservoir in an absorbent cloth or by syphoning off some of the fluid.

   (ii) Ensure the discs and pads are free of dirt and grease.

   (iii) When fitted insert the anti-squeal shims, "D" shaped apertures are downward, between the pistons and pads. (See Fig. 2a).

   (iv) When fitted, ensure the tongues of the anti-rattle springs bear against the pad backing plates and the retaining pins pass through the slotted ends. (See Fig. 2a).

   (v) Pump the brake pedal until solid resistance is felt.

ALPINE

CALIPERS

To remove and refit

1. Apply the handbrake, jack up the front of the car and remove the road wheel.

2. Detach the caliper from the stub axle carrier by withdrawing two bolts and identifying any packing washers, shims and splash guard brackets that may also be held by these bolts.

3. Suspend the caliper nearby without straining the flexible hose. When it is necessary to remove the caliper from the car, disconnect the feed pipe from the flexible hose and remove the flexible hose from the support bracket, see under "Flexible hoses—To remove and refit".

4. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

   (i) When refitting the original calipers; any packing washers, shims and splash guard brackets must be refitted to their original positions.

   (ii) When fitting replacement calipers to Series I and II models, check that the caliper is centrally astride the disc to within 0·025 in. (0·64 mm). Measurements are taken between the four machined faces inside the caliper and the disc. Any off-centre is corrected by positioning shims between the caliper and stub axle carrier with an equivalent thickness of packing washers between the front steering arm lug and the stub axle carrier.

   On Series III models onwards, machining limits made packing washers and shims unnecessary.

   (iii) Bleed the hydraulic system when the caliper has been removed from the car, see under "Bleeding the hydraulic system".

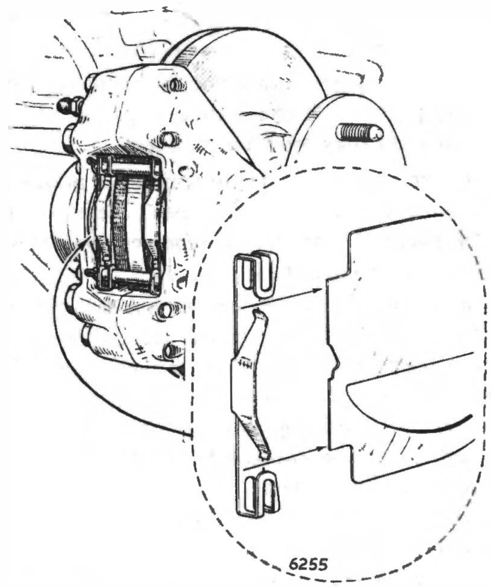


Fig. 2a. Series I and II models. The illustration shows the pad retaining pins passing through the slotted ends of the anti-rattle springs and the tongues bearing against the pad backing plates. The inset shows the outward end of the anti-squeal shim cut off to accommodate the anti-rattle spring, when both are fitted to the same caliper.

   (iv) Pump the brake pedal when solid resistance is felt.

To dismantle (See Fig. 2)

1. Remove the calipers as previously described.

2. Clean off the dirt from the outside of the calipers and remove the brake pads (10 and 11) as previously described.

3. Withdraw the pistons (5 and 14) from the caliper bodies, taking care not to damage the bores.

4. Remove the dust covers (7 and 12).

5. Remove the sealing rings (6 and 13) by inserting a screwdriver under the rings and prising them out, taking great care not to damage the locating grooves. If the sealing rings are worn or damaged they must be replaced.

No attempt should be made to remove the bridge bolts joining the two halves of the caliper. There is no point in doing so, and in addition, the torque figures to which the bolts are tightened are critical.

If, in an emergency, the caliper has been split and in the event of the fluid channel seal (3) being undamaged, the caliper and caliper bolts should be thoroughly cleaned, dried and reassembled and the bolts tightened to the torque readings given below. After reassembling the unit should be checked for fluid tightness under maximum pedal pressures.

It should be understood that this will only provide a temporary remedy, and the unit should be returned to the manufacturers for overhaul at the first opportunity.

Bridge bolt—inner	720 *lb in.* (830 *kg cm*)
Bridge bolt—outer	540 *lb in.* (622 *kg cm*)

To reassemble

1. Thoroughly clean the caliper bores with methylated spirits and allow to evaporate, then lubricate with clean brake fluid.
2. Carefully refit the sealing rings into the larger of the two annular grooves in each of the caliper bores.
3. Fit the dust covers back into position with the projecting lips inserted into the smaller grooves in the caliper bores.
4. Insert the pistons, closed ends first, into the bores. Fit the outer lips of the dust covers into the grooves in the pistons.
5. Push the pistons to the bottom of their cylinders and refit the brake pads as previously described.
6. Refit the calipers to the vehicle as previously described.

SPLASH GUARDS

Splash guards are fitted to protect the inner faces of the discs against grit.

On early Series I models they are secured by brackets to the steering arm forward mounting bolts and caliper lower mounting bolts. On later Series I models* and on all Series II models, the splash guards are retained on the stub axles by distance pieces and are secured to the lower bosses of the stub axle carrier by nuts, brackets and bolts.

On Series III models onwards, the splash guards are secured to the hub side of the stub axle carrier by three bolts each.

To remove and refit

Early Series I models only

1. Apply the handbrake, jack up the front of the car and remove the road wheel.
2. Remove the splash guard from the stub axle carrier by withdrawing the bolts from the front steering arm lug and lower caliper lug, identifying any packing washers and shims that may be on these bolts.

Later Series I and Series II models*

1. Remove the caliper from the stub axle carrier, see under "Caliper—To remove and refit", suspend nearby without straining the flexible hose.
2. Remove the hub assembly from the stub axle, see under "Front hub—To remove and refit" in Section F.
3. Support the distance piece from below, grind the outside edge to cut through the case hardening and split the distance piece with a cold chisel and hammer blows.
4. Detach the splash guard from the mounting brackets by removing three nuts and washers.

Series III models onwards

1. Proceed with the first two operations for Late Series I and Series II models.
2. Remove the splash guard from the stub axle carrier by withdrawing three bolts and washers.

Refitting is the reverse of the removal sequence, but particular attention must be given to the following:—

*The later type of splash guard was introduced on Series I models from chassis number B 9006694

Series I models only

Ensure that any packing washers and shims are refitted to their original positions.

Later Series I and Series II models*

Immerse the distance piece in boiling water and while still hot tap the distance piece onto the stub axle with a tubular drift until it clamps the splash guard to the stub axle carrier. The hub end float is set, see under "Front hubs—To adjust" in Section F.

Series III models onwards

The hub end float is set, see under "Front hubs—To adjust" in Section F.

All Models

Ensure that the splash guard does not foul the brake disc.

DISCS

Run-out

Excessive run-out on the discs will cause knocking back of the pistons which may create increased pedal travel when the brakes are applied.

Before checking the run-out, hub end-float should be eliminated by tightening the hub retaining nut, readjusting it at the end of the test. (See Section F, "Front Hubs—to adjust"). After tightening the retaining nut, check that the hub can still be rotated.

A dial test indicator should then be clamped to the caliper body so that the stylus bears on the disc at a point approximately 1 in. (25·4 mm) from the outer edge. Revolve the disc and check the indicator reading; the maximum reading on the gauge should not exceed 0·004 in. (0·10 mm).

When the disc has suffered damage or has become excessively scored, it must be renewed.

To remove and refit

1. Apply the handbrake, jack up the front of the car and remove the road wheel.
2. Remove the caliper from the stub axle carrier, see under "Caliper—To remove and refit" and suspend nearby without straining the flexible hose.

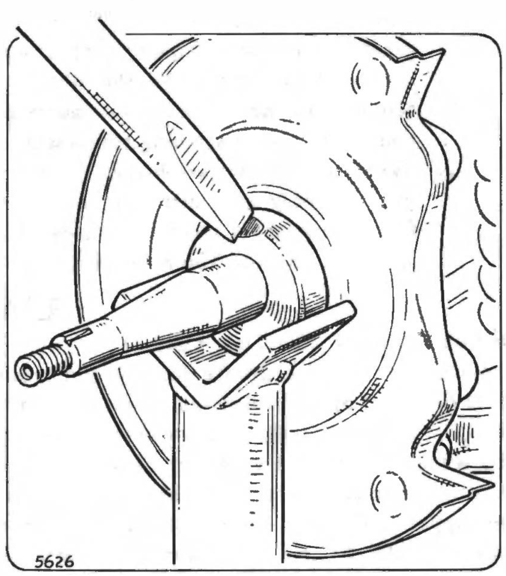


Fig. 3a. *Method of removing distance piece.*

3. Remove the hub assembly from the stub axle, see under "Hubs—To remove and refit" in Section F.
4. Remove the disc from the hub by withdrawing four bolts and tab washers or washers.
5. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—
   (i) Ensure the fitting faces of the hub and disc are free from dirt and burrs before assembly. In the instance of replacement discs ensure its protective coat is washed off.
   (ii) The four bolts are tightened to the torque given in the "General Data Section" but when tab washers are used on the bolts, do NOT turn up the tabs until AFTER the disc run-out has been checked.
   (iii) The hub assembly is fitted, see under "Front Hub—To remove and refit", but the hub end float is set AFTER the disc run-out has been checked.

(iv) The disc run-out is checked, see under "Disc Run-out". When the run-out is greater than the specified figure, the disc can be repositioned on the hub in an attempt to obtain a more satisfactory combination of machining tolerances.

(v) When tab washers are fitted, remove the hub assembly and turn the tabs of the four tab washers over the heads of the four bolt and the hub refitted.

(vi) Set the hub end float, see under "Front hubs—To adjust" in Section F.

(vii) When a replacement disc is fitted to Series I and II models position the caliper centrally astride the disc, using packing shims and washers see under "Caliper—To remove and refit".

(viii) Only when the caliper has been removed completely from the car is it necessary to bleed the hydraulic system of air.

REAR BRAKES

DESCRIPTION (See Figs. 4 and 5)

The rear brakes incorporate leading and trailing shoes operated by a wheel cylinder. Adjustment for lining wear is by a wedge type mechanical adjuster. The wheel cylinder, on each rear brake, is situated on the backplate directly opposite the adjuster. The upper ends of the brake shoes locate in the adjuster links (9 and 3), whilst the lower ends locate in the wheel cylinder piston (13) and body (15) respectively. The shoes are supported by platforms formed in the backplate, and are held in position by two hold-down leaf springs (11) and pegs (12) which pass through holes in the backplate. The shoes are linked together by return springs (1 and 2), situated between shoe webs and the backplate.

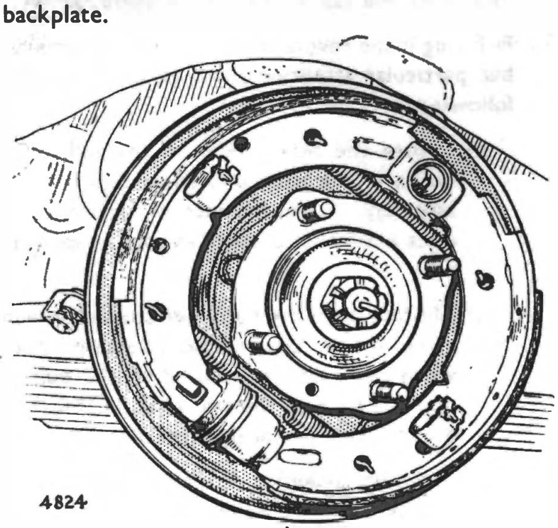


Fig. 4 *Rear brake assembly—right-hand side illustrated*

When hydraulic pressure is applied, the piston operates the leading shoe and the cylinder body reacts by sliding on the backplate to operate the trailing shoe. When the pressure is released, the shoes are returned to their original positions by the return springs.

Adjuster (See Fig. 5)

The adjuster has a light alloy housing (10) which is spigoted and bolted firmly to the inside of the backplate. The housing carries two opposed steel links (3 and 9), their outer ends slotted to take the shoe flanges, and the inclined inner faces bearing on the cone of the hardened steel wedge (8), the axis of which is at right angles to the links. The wedge has a finely threaded spindle and a square end which projects on the outside of the backplate. By rotating the squared end clockwise, the wedge is screwed inwards forcing the links apart and thus expanding the fulcrum of the brake shoes.

Wheel Cylinders (See Fig. 5)

Each wheel cylinder consists of a die-cast aluminium body (15) containing a seal (14) and a piston (13), with dust cover (5) secured to the body by a clip (4). A bleed screw (16) is also incorporated in the body with a rubber dust cap over the nipple end. A spring plate (18) and retaining plate (7) hold the wheel cylinder in position on the backplate, but allow the body to slide laterally.

Handbrake (See Fig. 5)

A cable linkage connects the handbrake lever to the levers (6) housed in each rear wheel cylinder which operate the leading shoes. The trailing shoes are operated by reaction through the wheel cylinder bodies (15) which slide in the backplates.

BRAKE SHOES

General

It will be noted that the brake shoe linings are off-set on the shoe platforms to which they attached. The

ALPINE

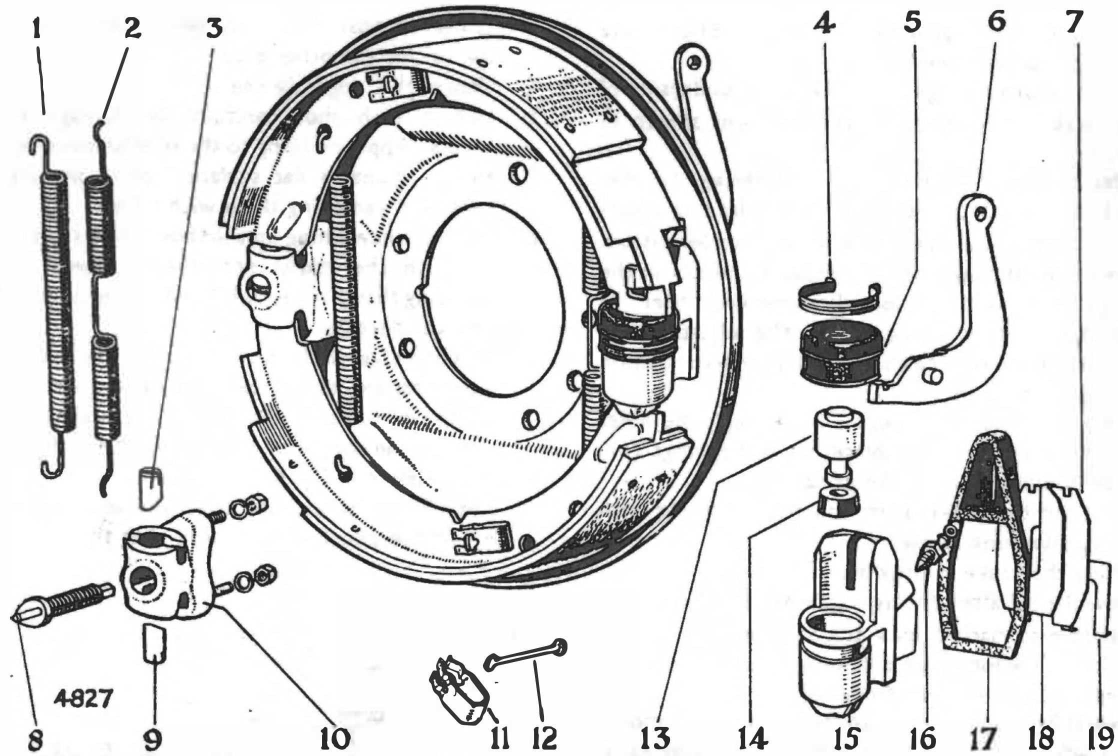


Fig. 5. *Exploded view of rear brake*

1	RETURN SPRING	7	RETAINING PLATE	13	PISTON
2	RETURN SPRING	8	WEDGE	14	SEAL
3	ADJUSTER LINK	9	ADJUSTER LINK	15	CYLINDER BODY
4	DUST COVER CLIP	10	ADJUSTER HOUSING	16	BLEED SCREW
5	DUST COVER	11	LEAF SPRING	17	DUST COVER
6	HANDBRAKE LEVER	12	PEG	18	SPRING PLATE
				19	DISTANCE PIECE

end of the shoe at which the greater length of platform is exposed is known as the "toe" whilst the other end is called the "heel".

When fitting replacement shoes always fit a new set of shoe return springs.

To remove

Chock the front wheels, jack up the rear of the car and remove a road wheel.

Slacken off all available shoe adjustment by rotating the square-headed adjuster anti-clockwise, (arrowed in Fig. 1).

Remove the countersunk screw securing the brake drum to the hub and remove the drum.

Remove the hold-down springs and pegs by compressing the springs and sliding them from under the peg heads.

Pull the leading (rear-most) shoe out of the slot in the adjuster link and then lift the other end of the shoe clear of the wheel cylinder piston and handbrake lever.

Disconnect the return springs, and remove the shoes.

Repeat the above operations for the opposite rear wheel.

To refit (See Fig. 5)

Smear the shoe platforms and the operating and abutment ends of the new shoes with (white) brake grease. Keep all grease off the linings of new replacement shoes and do not handle the linings more than necessary.

Lay the shoes on a bench with the "toe" of one shoe adjacent to the "heel" of the other.

Fit the return springs (1 and 2) to the underside of the brake shoe flanges in the positions shown in Fig. 4.

Offer up the shoes complete with springs to the backplate and locate the toe of the leading (rear-most) shoe in the slot in the wheel cylinder piston. The handbrake lever should locate in the slot in the flange of the leading shoe. Position the "heel" of the leading shoe in the slot in the adjuster link. Prise over the trailing shoe into its relative position as shown in Fig. 4.

Insert the hold-down pegs (12) through the holes in the backplate and replace the leaf springs (11) smeared with white brake grease.

Clean out the brake drum and refit, securing with the countersunk screw.

Adjust the brake as previously described.

Immediately after fitting replacement shoes it is advisable to slacken back the adjuster one further click to allow for possible lining expansion, reverting to normal adjustment afterwards.

Several hard applications of the brake pedal should be made to ensure all the parts are working satisfactorily and the shoes bedding to the drums. Refit road wheel, lower the jack and test.

The above instructions hold true for both rear brakes.

To reline

It is strongly recommended that advantage be taken of the Factory Reconditioned Service Unit Scheme, whereby replacement brake shoe assemblies can be obtained in exchange for the old ones. In territories where these facilities are not available, relining may be carried out as follows:—

1. Remove the brake shoes as previously described.
2. Mark the position of the lining across each end of one of the brake shoes with a scriber. This will ensure that the new lining will be fitted in the correct position.
3. Grip the shoe *lightly* in a vice, in order not to distort the shoe. Cut away the portion of each rivet which protrudes through the underside of the brake shoe platform with a sharp chisel. Position the shoe in the vice so that it is held as near as possible to the rivet being removed. Repeat for the other shoe.
4. Thoroughly degrease the shoes.
5. Inspect each shoe carefully for damage and cracks. Apply marking to the shoe platform and roll it against a flat surface, noting any high spots and removing them with a file.
6. Place the new lining on the shoe, lining the ends up with the marks previously scribed, first ensuring that there is no foreign matter adhering to its underside.
7. Mount a rivet dolly in the vice. Fit the rivets in pairs starting at the centre pair and working outwards towards the ends. Each shoe will require ten copper or brass rivets of the dimensions shown in Fig. 6. When riveting, hold the head firmly against the anvil and secure using a suitable punch. Make sure that there is no

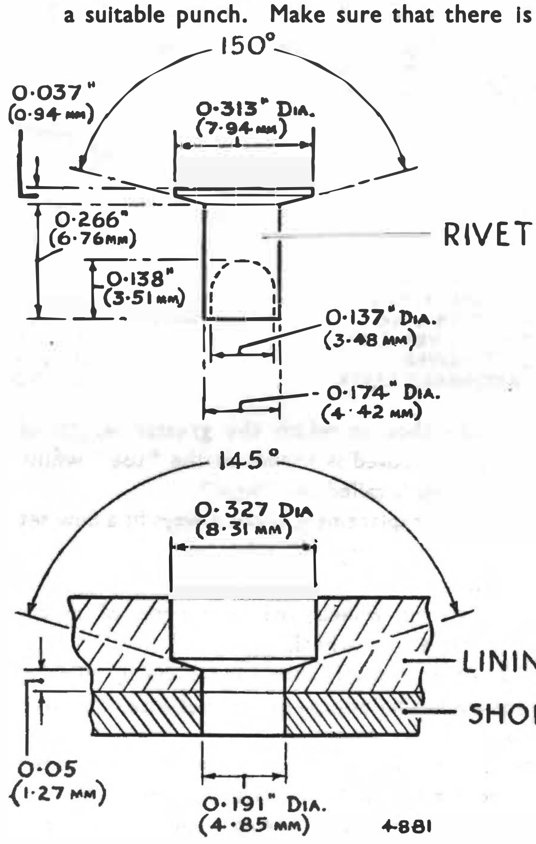


Fig. 6. *Rivet details*

gap between the lining and the brake shoe platform.

8. Refit the brake shoes as previously described.

It is not necessary to chamfer the heel and toe of the new lining after refitting.

The utmost care must be taken to ensure that all abrasive particles are removed from the brakes before the drums are finally fitted.

Should replacement linings not be available, linings can be made up to the following dimensions:—

Linings

Thickness	0·19"	(4·8 mm.)
Width	1·75"	(44·5 mm.)
Length	8·64"	(219·5 mm.)

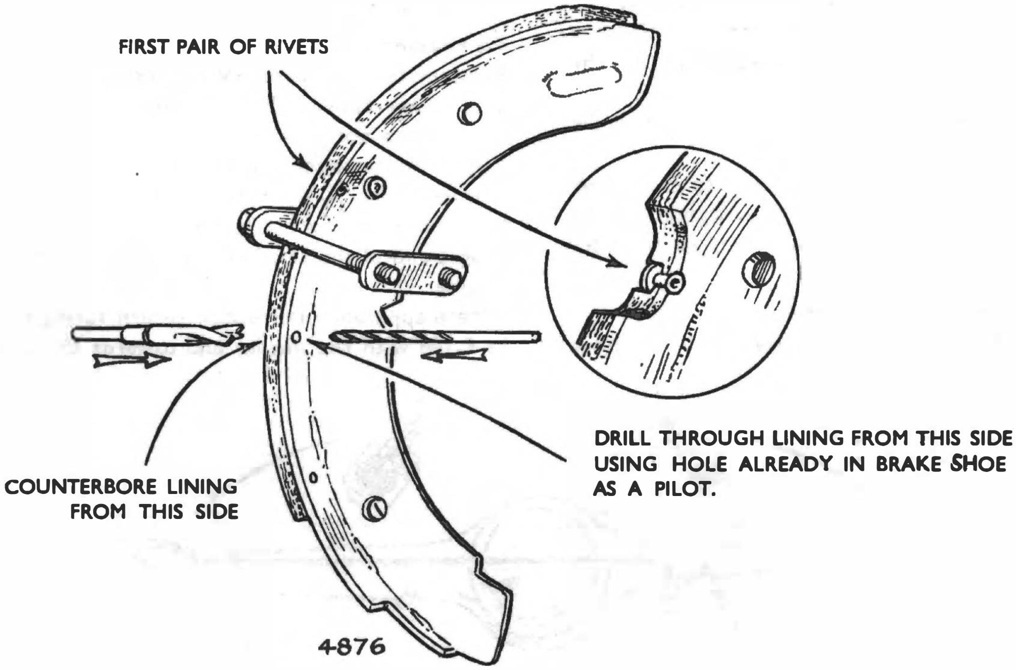


Fig. 7. *Method of drilling "off the roll" linings when these have to be used*

The linings should be bored to the dimensions shown in Fig. 6 to receive the rivets. The holes should be positioned to line up with those already in the brake shoes. This may easily be done by clamping the linings to the brake shoes and using the shoes as templates. (See Fig. 7).

It is essential that a good lining material is used or efficient braking may not be maintained.

When lining "off the roll" is used, the heel and toe of each lining should be slightly chamfered after fitting to the brake shoe.

No attempt should be made to reline the brake pads on the front brakes.

WHEEL CYLINDERS

To remove (See Fig. 5)

Remove the rear brake shoes as previously described.

Disconnect the handbrake operating rod from the handbrake lever (6) protruding through the backplate by removing the clevis pin.

Disconnect the pressure pipe union from the wheel cylinder.

Remove the dust cover (17) from the rear of the backplate.

Using a screwdriver, prise the retaining plate (7) and spring plate (18) apart, and pull the retaining plate from beneath the neck of the wheel cylinder. Withdraw the handbrake lever (6) from its position between the backplate and the wheel cylinder. Remove the spring plate (18) and distance piece, (19) and withdraw the wheel cylinder from the backplate.

To refit (See Fig. 5)

Insert the neck of the wheel cylinder (15) through the slot in the backplate.

Fit the distance piece (19) between the cylinder neck and the backplate, with the open end away from the handbrake lever location and the cranked lips facing away from the backplate.

Fit the spring plate (18) between the distance piece (19) and the backplate also with the open end away from the handbrake lever location and the cranked tips facing away from the backplate.

Replace the handbrake lever (6). Locate the retaining plate (7) between the distance piece and the spring plate with its open end facing towards the handbrake lever. Tap into position until the two cranked tips of the spring plate locate in the retaining plate.

Refit the rubber dust cover (17), and reconnect the handbrake linkage.

Reconnect the pressure pipe union to the wheel cylinder, taking care not to over-tighten. (The torque figures for the pipe unions are given under "Maintenance").

Refit the brake shoes as previously described.

Bleed the brakes as subsequently described under "Bleeding the system".

To dismantle (See Fig. 5)

Remove the wheel cylinder from the backplate as previously described.

Release the clip (4) and remove the rubber dust cover (5).

Remove the piston (13) complete with rubber seal (14). This operation may be simplified by applying gentle air pressure to the fluid pipe connection.

Remove the seal from the piston by easnig it over the piston flange.

Where applicable, remove the piston return spring fitted between the piston and the end of the cylinder bore.

To reassemble

Reassembly is a reversal of the dismantling procedure given above. The following points should however be noted:—

Before reassembling make sure that all parts are free from dirt. Clean with brake fluid.

Ensure that the rubber seal is fitted with the lip or widest end of the seal facing the closed end of the cylinder.

Where applicable, the piston return spring should be fitted with the smaller end towards the piston.

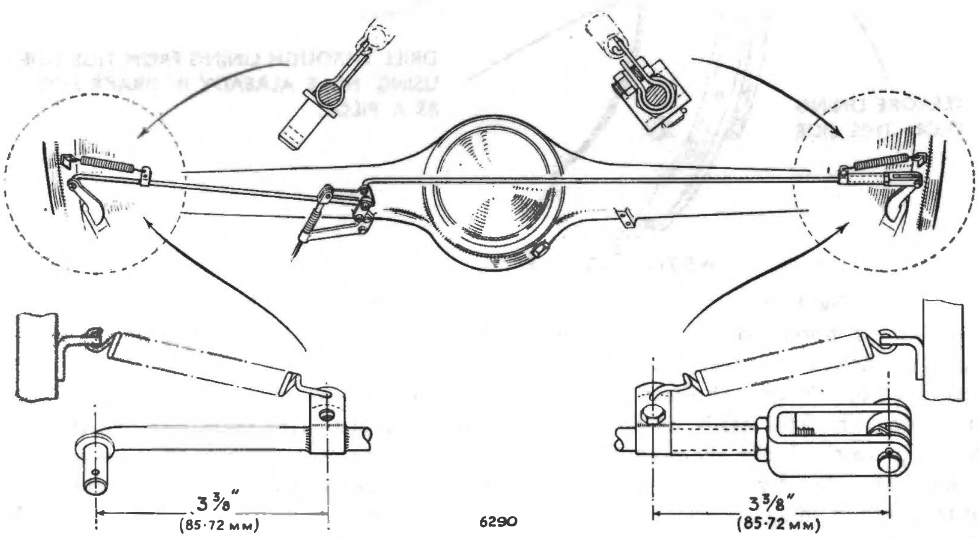


Fig. 7A. *Handbrake anti-rattle springs*

HANDBRAKE ANTI-RATTLE SPRINGS

The anti-rattle springs shown in Fig. 7A must be in equal tension, otherwise binding may occur on one side. An important factor controlling the tension of the springs is the positioning of the brake rod anti-rattle spring clips. On cars built after chassis B9110954, the clips are positively located on the adjustable side by a distance piece and are welded onto the rod on the non-adjustable side. On cars built prior to this chassis number, the dimensions given in Fig. 7A should be carefully checked in cases of brake binding. Check also that the clips are in correct alignment as shown in the end views.

HYDRAULIC SYSTEM

GENERAL

Great cleanliness is essential when dealing with any part of the hydraulic system, and especially so where the brake fluid is concerned. Dirty or aerated fluid must never be added to the system.
Use only the specified type of brake fluid for topping up the reservoir. (See Section P).

BLEEDING THE SYSTEM

"Bleeding" (expelling air) the hydraulic system is not a routine maintenance operation and should only be necessary when a portion of the hydraulic system has been disconnected or if the level of the brake fluid in the reservoir has been allowed to fall so low that air has entered the master cylinder.
Always keep a careful check on the fluid level in the reservoir during bleeding. It is most important that the master cylinder be kept at least half full otherwise air may be drawn in necessitating a fresh start.
Two people are required to carry out the operation.

Procedure

1. With all the hydraulic connections secure and the reservoir topped up with fluid, remove the rubber cap from the near-side rear wheel cylinder bleed screw and fit the bleed tube, immersing the free end of the tube in a jar containing a little clean brake fluid.
2. Unscrew the bleed nipple three-quarters of a turn, operate the brake with a fairly fast full stroke, tightening the bleed screw at the end of the stroke before allowing the pedal to fly back unassisted. Any check to the return of the pedal or master cylinder piston will prevent effective bleeding. One or two faster applications should now be made, tightening the bleed screw at the end of each downward stroke and opening again after the pedal has fully returned. Repeat the applications until the fluid entering the jar is completely free of air bubbles, then tighten up the bleed screw. Make sure that the bleed screw is fully tightened before the pedal reaches the end of its final stroke.
3. Repeat the above operations for each of the remaining three brakes, finishing at the wheel nearest the master cylinder.
4. Top up the reservoir to its correct level of $\frac{1}{2}$" (13mm) below the bottom of the filler cap orifice.

Care should be taken not to over-tighten the bleed screws since this may very easily result in stripped threads. For the correct torque figures see under "Maintenance".

MASTER CYLINDER

Description (See Fig. 8)

The master cylinder is situated under the bonnet on the bulkhead immediately in front of the brake pedal. On right-hand drive cars the fluid reservoir is cast integrally with the cylinder body, and is connected with it hydraulically by a drilling into the centre of the end of the pressure cylinder. On left-hand drive cars the fluid reservoir is mounted separately on the wing valance and is connected to the end of the pressure cylinder by a metal pipe and union nuts. (See inset).
When pressure is applied to the brake pedal, the plunger (8) moves up the bore of the cylinder and the valve seal (4) closes the port to the reservoir. The seal is held initially on its seat by spring washer

(5) and by fluid pressure in the drilling at the back of the valve stem (7). As the plunger continues to move up the bore, fluid is forced through the pipe line to the wheel cylinders. On the return stroke, the plunger moves back down the bore. With the final movement of the plunger the seal is lifted from its seat allowing free flow of fluid between the master cylinder reservoir and wheel cylinder.

To remove

Disconnect the pressure and feed pipe* unions from the cylinder collecting the brake fluid in a suitable container.

Remove the clevis pin from pedal at push rod location.

Remove the two bolts† passing through the master cylinder flanges.

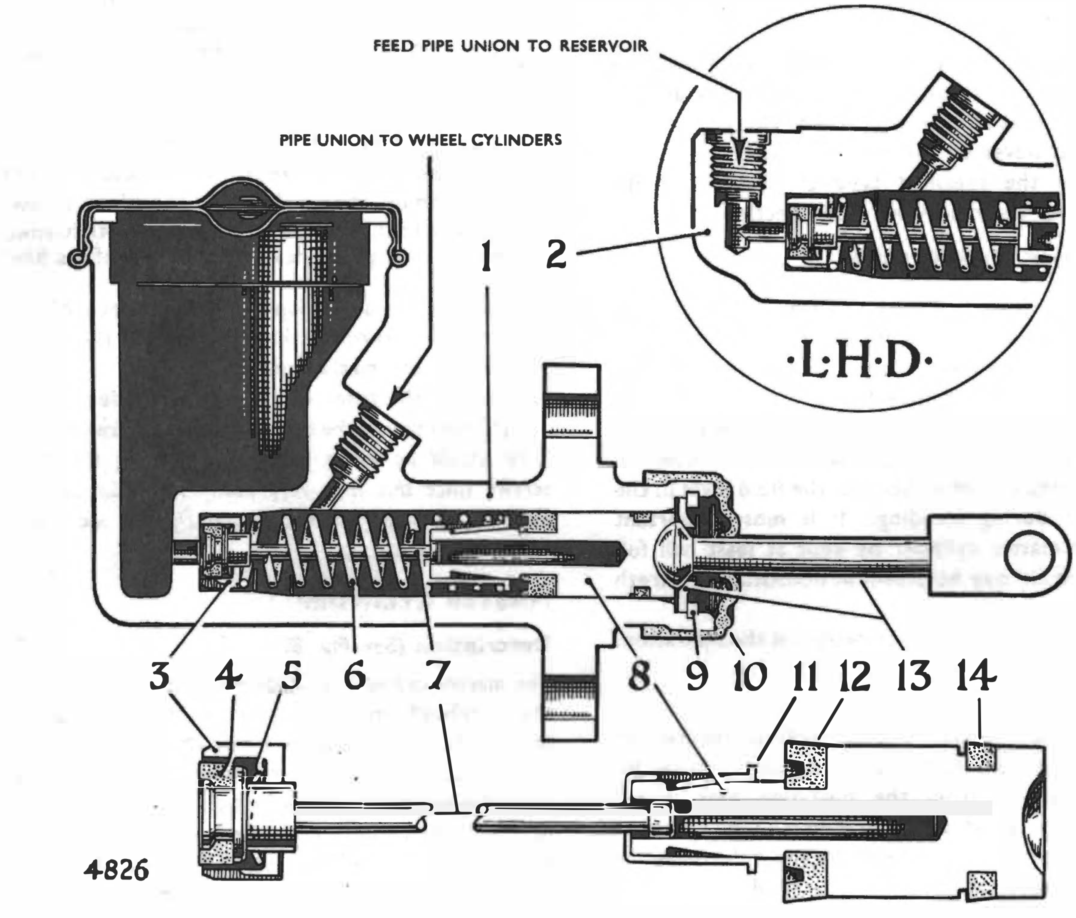


Fig. 8. *Sectional view of master cylinder*

1 Cylinder body and reservoir (R.H.D.)
2 Cylinder body (L.H.D.)
3 Valve spacer.
4 Valve seal.
5 Spring washer.
6 Plunger return spring.
7 Valve stem.
8 Plunger.
9 Circlip.
10 Rubber dust cover.
11 Thimble.
12 Plunger seal.
13 Push rod and dished washer.
14 Plunger seal.

**Left-hand drive cars only*

†The upper bolt is superseded by a stud and nut from chassis number B 9006694

Remove the master cylinder from the bulkhead by easing it forward. Note the position of the packing.

To refit

Refitting is a reversal of the above instructions.

Care should be taken not to over-tighten the pipe unions. (See under "Maintenance" for torque figures).

After refitting, the brakes should be bled as described under "Bleeding the system".

To dismantle (See Fig. 8)

Remove the master cylinder from the car as previously described.

Clean off all dirt and grease from the outside of the master cylinder.

Drain the residue fluid from the pressure cylinder and reservoir into a suitable container.

Depress and withdraw return spring cap to release return spring.

Pull back the rubber dust cover (10).

Remove the circlip (9) with a pair of long nosed pliers thus releasing the push rod and dished washer (13).

When the push rod assembly (13) has been removed, the end of the plunger (8) will be exposed. Remove the plunger (8); this operation can be simplified by inserting a low pressure air nozzle in the fluid outlet port.

Separate the thimble (11) and return spring (6) from the plunger (8) by levering the thimble leaf over the shouldered end of the plunger.

Depress the plunger return spring (6) and slide the valve stem (7) through the elongated hole of the thimble and withdraw. Remove valve spacer (5). Take care not to lose the spacer spring washer (5) which is located under the valve head.

Remove seals (12, 14, and 4) from the plunger and the valve head. Seal (14) is omitted from later master cylinders.

Examine all parts, especially the seals, for wear or distortion and replace with new parts where necessary.

To reassemble (See Fig. 8)

It is essential that all internal parts are meticulously cleaned with brake fluid before reassembly. Do not use petrol, paraffin, trichlorethylene or any other similar agents to wash the parts.

Replace the valve seal (4) sc that the flat side is correctly seated on the valve head with its lip facing outwards. The spring washer (5) should then be located with the dome side against the underside of the valve head, and held in position by the valve spacer, the legs of which face towards the valve seal.

Replace the plunger return spring (6) on the spacer (3). Insert the thimble (11) into the spring and depress until the valve stem (7) engages through the elongated hole of the thimble, making sure that the stem is correctly located in the centre of the thimble. Also check that the return spring is placed centrally on the spacer.

Refit plunger seals (12 and 14) onto the plunger (8) with the projecting lips facing towards the thimble. (See inset). Seal (14) is omitted from later master cylinders.

Insert the reduced end of the plunger (8) into the thimble (11) until the thimble engages under the shoulder of the plunger. Press home the thimble leaf.

Smear the plunger (8) well with rubber-proof grease (red) and insert the assembly into the bore of the cylinder (1), valve end first, easing the plunger seal lips over the edge of the bore.

Refit the push rod assembly (13) to the cylinder securing it with the circlip (9) which should engage into the groove machined in the cylinder bore.

Refit the rubber dust cover (10) into position by stretching it over the end of the barrel.

Refit return spring and return spring cap.

Refit the master cylinder to the car as previously described.

FLEXIBLE HOSES

Do not attempt to clear the bore of a flexible hose by probing. If a hose is choked or perished, fit a replacement.

To remove (See Fig. 9)

Disconnect the metal fluid pipe by unscrewing the union nut from the hose union.

Hold the hexagon of the flexible hose end sleeve at one side of the support bracket and unscrew the locknut from the other side to release the hose and washer.

Unscrew the hose at its other end, allowing the hose to rotate.

To refit (See Fig. 9)

Refitting is a reversal of the above instructions. It is important not to attach the hose to the support bracket until its other end has been secured.

Feed the hose sleeve into the support bracket, apply a spanner to the hexagon and set the run of the hose clear of all obstructions that could cause chafing. Secure the hose with the washer and nut while holding the sleeve hexagon to prevent the hose from rotating.

When fitted, slide the hose locating plate onto the support bracket so the plain hole is on the feed pipe side; feed the hose sleeve into the plate and bracket, locating the sleeve hexagon within the plate so the run of the hose is clear of all obstructions that could cause chafing. Secure the hose with the washer and nut.

Check that no chafing can occur under conditions of bump and rebound, by bouncing the car up and down. This check should be carried out with the front wheels in the straight ahead position and on right and left-hand locks.

Be careful not to over-tighten hose unions since this may very easily result in stripped threads. For the specified torque figures see under "Maintenance".

After fitting the hose(s) it will be necessary to bleed the brakes as described under "Bleeding the system".

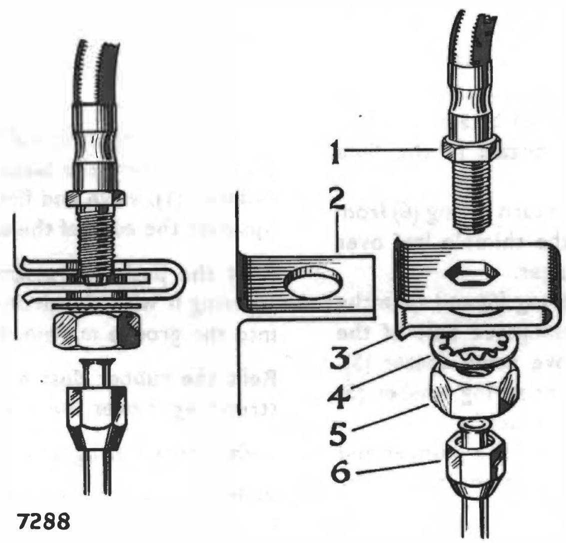


Fig. 9. *Flexible hose connection - In some instances the locating plate (3) is omitted.*

1. SLEEVE HEXAGON
2. SUPPORT BRACKET
3. LOCATING PLATE
4. WASHER
5. NUT
6. FEED PIPE UNION NUT

BRAKES — RAPIER

GENERAL

Lockheed PM34 disc brakes are fitted to the front wheels and Lockheed drum brakes to the rear wheels. All four brakes are hydraulically operated, pressure being generated in the master cylinder by application of the brake foot pedal. The handbrake operates the rear brake shoes by an independent mechanical linkage.

MAINTENANCE

The front brake friction pads should be examined for wear at regular intervals and renewed when the friction material has worn to a minimum of $\frac{1}{16}$" (1·6 mm.) in thickness (see under "Brake Pads—To remove and refit").

Brake Adjustments

The front brakes are self adjusting; the rear brakes should be adjusted as follows:—
Place chocks in front of and behind one of the front wheels to prevent the car from rolling, and release the handbrake.

Remove the nave plates and jack up one rear wheel until it is free to rotate

Turn the wheel so that the hole is opposite the slotted head of the "micram" adjuster Using a screwdriver, turn the adjuster in a clockwise direction until solid resistance is felt. (See Fig. 10).

Slacken back the adjuster until the brake drum can be rotated (usually two clicks). A slight drag may be felt from the trailing shoe but this should not be sufficient to prevent the wheel from being turned by hand.

Spin the wheel and apply the brakes hard to centralise the shoe in the drum and re-check adjustment. When correctly adjusted there should be $\frac{1}{4}$" (6·3 mm.) free movement of the brake pedal pad before the plunger in the master cylinder begins to move.

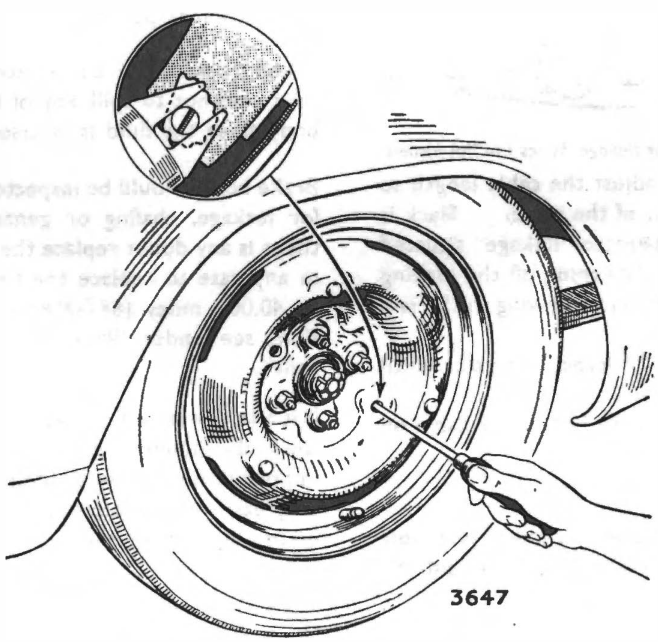


Fig. 10. *Rear brake adjustment*

Repeat for the other wheel.

Normally adjustment of the rear brakes will automatically adjust the handbrake. If, however, with the rear brakes in correct adjustment, there is excessive handbrake free travel, adjust as follows:—
Turn each rear brake "micram" adjuster clockwise as far as it will go, so that the rear brakes are locked on hard.

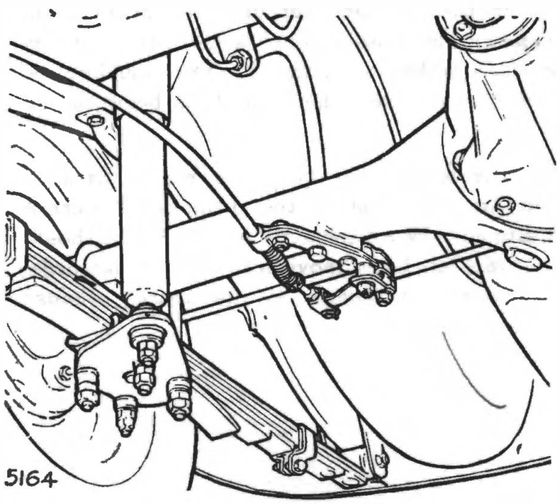


Fig. 11. *Handbrake compensator linkage. Series I to IIIA Models.*

With the handbrake off, adjust the cable length so that the slack is taken out of the cable. Slack is taken up at the compensator linkage situated beneath the rear axle by slackening off the locking nut, removing the jaw pin, and screwing in the jaw as necessary (See Fig. 11).
Release each rear brake "micram" adjuster until the brakes are free to rotate.
A lubricator is provided on the handbrake cable on Series I to IIIA Models.

Brake fluid level

The fluid level in the master cylinder reservoir should be checked periodically and should be kept within $\frac{1}{2}$ in. (13 mm) below the filler cap orifice. Never fill completely since the expansion of fluid in hot weather may cause the brakes to build up. Brake build up can also be caused by the by-pass port being blocked. (See item B, Fig. 18).

Before removing the filler cap, to top up, clean the area around the filler cap to prevent dirt entering the reservoir. Ensure that the air vent in the filler cap is not choked.

The addition of fluid will be required at regular intervals due to the repositioning of the front wheel pistons as a result of friction lining wear, but a rapid fall in fluid level would indicate a leak at some point in the system which should be traced and rectified.

To check for leaks, apply a firm pressure to the brake, pedal whilst an assistant examines the units, pipes hoses and fittings.

Use only the specified type of brake fluid for replenishment purposes. (See Section P).

When topping up the master cylinder reservoir take care not to spill any of the fluid on the car body since the fluid is injurious to paintwork.

Brake hoses should be inspected at regular intervals for leakage, chafing or general deterioration. If there is any doubt replace the hoses. It is advisable in any case to replace the hoses every three years or 40,000 miles (64,000 km) For removal instructions see under "Flexilbe hoses—to remove and refit".

It is also advisable to occasionally check for tightness the brake mounting bolts and hydraulic unions. It is important not to overtighten unions, since this may very easily result in stripped threads. The specified torque figures for the tube nuts are 6·25-7·0 lb. ft. (86-106 kg cm).

RAPIER

FRONT BRAKES

DESCRIPTION

Each brake consists of an 11 in. (279 mm) diameter high quality cast iron disc which is attached to and rotates with the hub, and a cast iron caliper which straddles the disc and is rigidly attached to the axle carrier. The caliper houses two hydraulic piston assemblies operating a pair of brake friction pads. The pistons are protected by dust seals which are held in place by metal retainers. Hydraulic sealing between the cylinders and the pistons is effected by rubber rings positioned in grooves in the body. A metal shield is fitted to protect the inner face of the disc against grit.

Upon application of the brake pedal the hydraulic pressure generated in the system causes the co-axially aligned pistons to apply equal and opposite pressure by the brake pads onto the rotating disc in direct proportion to the foot effort applied at the pedal.

The movement of the piston extrudes the rectangular sectioned seal from the cylinder bore as

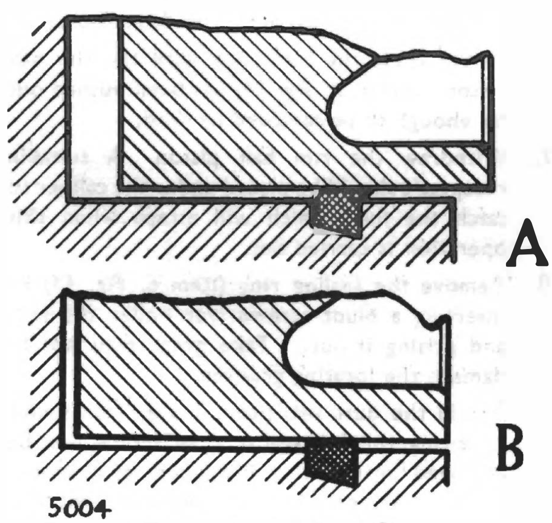


Fig. 12. *Piston seal conditions*

illustrated in Fig. 12(A). On releasing the brake pedal, the seal moves back to its original position, taking the piston with it, as illustrated in Fig. 12(B), thus providing clearance between friction pads and the discs when the brakes are not in use.

After negotiating a ford, water splash, or when driving on flooded roads, it may be necessary to dry out the brakes to restore full braking power by a few light applications of the brake pedal. It is also advisable to do this after or during prolonged driving in wet weather, under circumstances where the brakes are not in use, such as may occur on motorways etc.

BRAKE PADS

The friction linings are bonded to their pressure plates and can therefore only be renewed by the fitment of complete new brake pad assemblies.

The brake pads are supplied in a kit together with new steady springs and split pins.

To remove (See Fig. 14)

1. Jack up the car and remove the appropriate road wheel.
2. On the rear of each caliper (2) there are two steady springs (5) which are held in place by two split pins. On earlier cars, retaining pins of the type shown in the inset of Fig. 13 were used. To remove depress the steady springs and withdraw the pins. The steady springs may now be removed.
3. Remove the brake pad assemblies (10) by rotating them within the caliper and withdrawing.

To refit

1. Clean off any dirt from the protruding portions of the pistons.
2. Push the pistons to the bottom of their cylinder bores by levering with a screwdriver against the edge of the disc. Whilst this is being carried out, a check should be made on the fluid level in the master cylinder in the case displaced fluid returning to the reservoir causes it to overflow.
3. Offer up the brake pad assemblies to the caliper with the outside edges facing away from the caliper. The outside edge of a brake pad may be identified by a rectangular boss on the pressure plate. The earlier design of brake pad did not have this boss and the outside edge in this case can only be identified by the fact

that the pressure plate extends beyond she friction lining along that edge (see Fig. 13). Enter the pads, lower ends first, into the caliper and rotate until correctly positioned.

4. Fit the new springs and split pins or retaining pins. Where the retaining pins are supplied, make sure that the steady springs are securely located between the shoulders of the pins (see inset Fig. 13). Make sure that the steady springs are fitted the right way round; with reference to Fig. 13, it will be seen that each steady spring is shaped like the letter 'H', having a pair of long and a pair of short legs. When assembled the long legs of the two springs should be facing each other.
5. Pump the brake pedal until solid resistance is felt.
6. Refit the road wheel.
7. Lower the jack and road test the car.

It should be noted that bleeding of the brakes is unnecessary when replacing the brake pad assemblies.

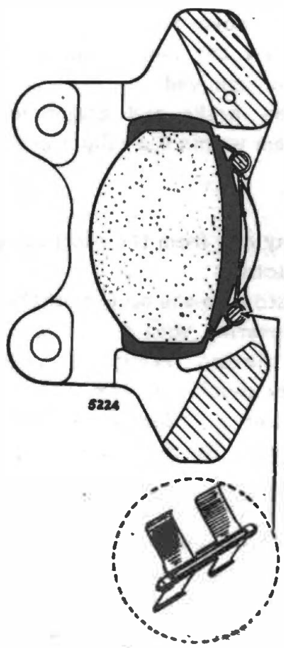


Fig. 13. *Section through caliper (early type of brake pad and retaining pin shown)*

CALIPERS

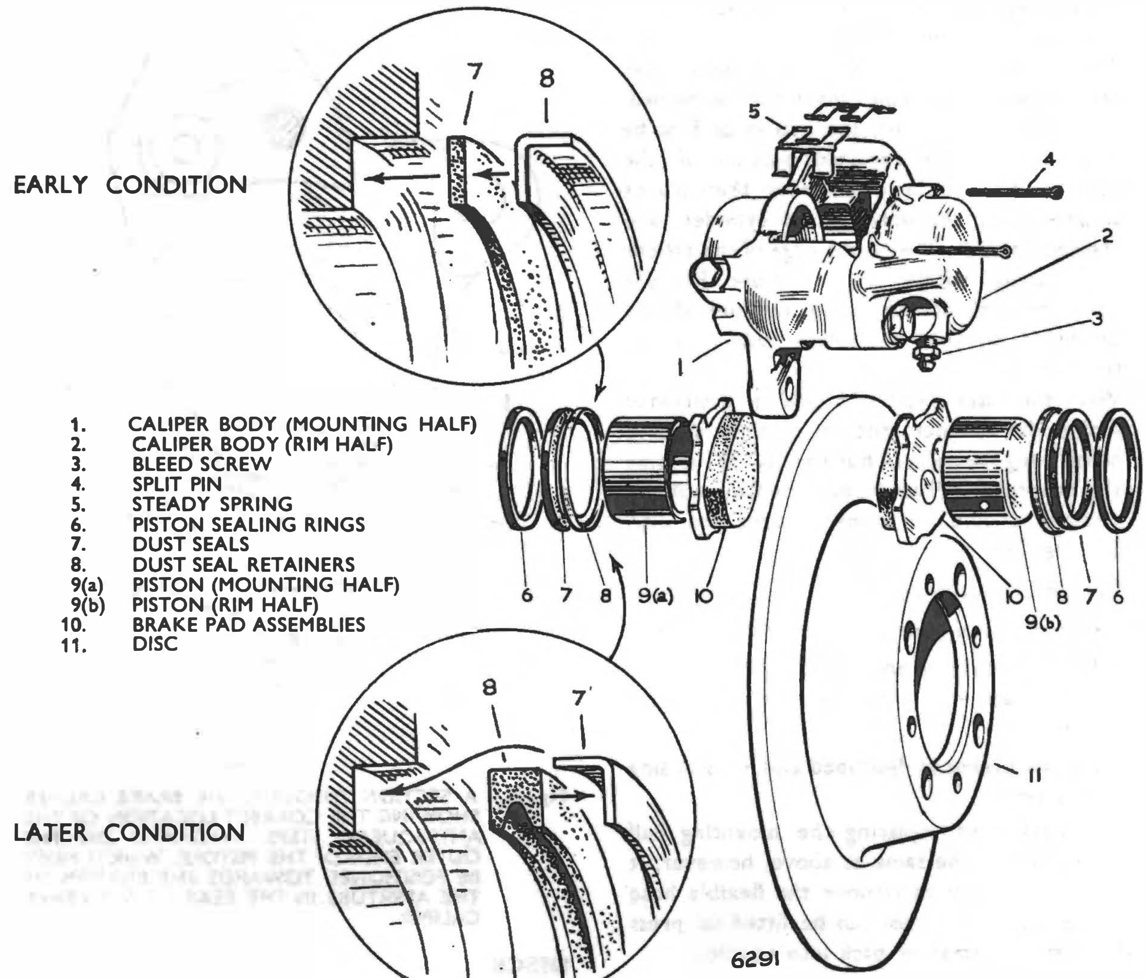
If the rubber sealing rings (item 6, Fig. 14) are worn or damaged, they should be replaced immediately. Before refitting seals, seal retainers and pistons, they should be coated with Lockheed Disc Brake Lubricant.

To dismantle and reassemble

Special tool number RG 331 will be required when carrying out this operation.

1. Apply the handbrake, jack up the front of the car and remove a road wheel.
2. Undo the two bolts securing the caliper to its adaptor plate and swing the caliper clear of the disc. .In order to prevent any strain on the brake hose the caliper must now be suitably supported.
3. Clean off all dirt from the outside of the calipers.
4. Remove the brake pads as previously described.
5. Retain the mounting half piston (item 9(a), Fig.14) in its cylinder using special tool No. RG.331 carefully avoiding the brake hose.
6. Gently apply the footbrake until the rim half piston (item 9(b), Fig. 14) has been pushed out far enough to be removed by hand.
7. Withdraw the rim half piston. A suitable receptacle should be placed under the caliper to catch the fluid which will escape when this operation is carried out.
8. Remove the sealing ring (item 6, Fig. 14) by inserting a blunt screwdriver under the ring and prising it out. Take great care not to damage the locating grooves.
9. Should the dust seal (item 7, Fig. 14) require renewing, the dust seal retainer should first be removed by inserting the blade of a screw-driver between the retainer and seal and carefully prising out. The dust seal can then be lifted out. When renewing the dust seals, always fit new dust seal retainers.
10. Ensure that the caliper bore and component parts are completely free from any foreign matter.

RAPIER



1. CALIPER BODY (MOUNTING HALF)
2. CALIPER BODY (RIM HALF)
3. BLEED SCREW
4. SPLIT PIN
5. STEADY SPRING
6. PISTON SEALING RINGS
7. DUST SEALS
8. DUST SEAL RETAINERS

9(a) PISTON (MOUNTING HALF)
9(b) PISTON (RIM HALF)

10. BRAKE PAD ASSEMBLIES
11. DISC

Fig. 14. *Exploded view of brake caliper*

11. Smear the sealing ring with lubricant (having first made sure that it is quite dry) and carefully refit into the groove in the caliper bore. Gently work round the seal with the fingers to ensure correct seating.

12. Open the bleed screw (item 3, Fig. 14).

13. Coat the pistons (9a and b) with lubricant and offer up squarely to the caliper bores so the anti-squeak steps, machined on the outer ends of the pistons, are towards the bottom of the aperture in the rear of the brake caliper as shown in Figure 15.

    Care must be taken to ensure that the piston enters the bore squarely.

14. Smear the new dust seal with disc brake lubricant, having first made sure that it is quite dry.

15. Two types of seal and retainer assemblies have been fitted in conjunction with this caliper. The earlier type of seal has a rectangular section, whilst the later type is "U" sectioned. To fit the earlier type, the seal must first be positioned in the recessed portion of the cylinder bore. The retainer is then placed squarely over the bore of the cylinder, and pressed home flush with the edge of the caliper bore using special tool number RG 331 complete with adaptor. The retainer should be fitted so that its hollow side is facing towards the disc.

    With the later type, the seal is positioned within the retainer, and the retainer pressed home using special tool number RG 331 **minus** the adaptor. When fitted, the flange of this retainer should be facing towards the disc. See Fig. 14.
16. Tighten the bleed screw.
17. Refit the brake pads as previously described.
18. Refit the caliper into position and secure it to its adaptor plate with two bolts and a new tab washer.
19. Bleed the brakes as described under "Bleeding the System".

    The method of replacing the mounting half sealing ring is the same as above; however, it will be necessary to remove the flexible hose before the special tool can be fitted to press the dust seal retainer back into position.

Caliper bridge bolts

No attempt should be made to remove the bridge bolts joining the two halves of the caliper. There is no point in doing so and, in addition, the torque figure to which the bolts are tightened is critical. If, in an emergency, the caliper has been split, a new fluid channel seal, lock plates and bolts must be fitted. The caliper must be thoroughly cleaned before reassembly, and the bolts tightened to a torque reading of 35 *to* 40 *lbs. ft.* (4·8 to 5·5 kg.m) *After reassembly, the unit should be checked for fluid tightness under maximum pedal pressures.*

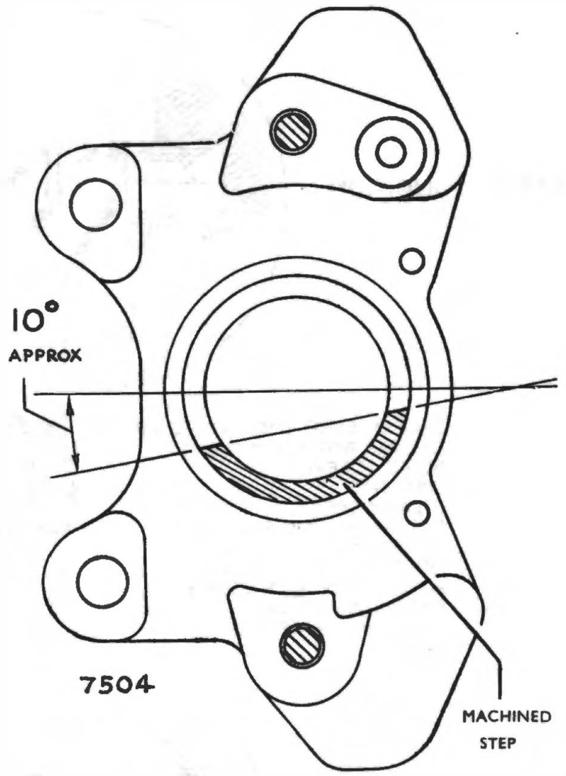


Fig. 15 A SECTION THROUGH THE BRAKE CALIPER SHOWING THE CORRECT LOCATION OF THE ANTI-SQUEAK STEPS, MACHINED ON THE OUTER ENDS OF THE PISTONS, WHICH MUST BE POSITIONED TOWARDS THE BOTTOM OF THE APERTURE IN THE REAR OF THE BRAKE CALIPER.

DISCS

Run-out

Excessive run-out of the discs will cause knocking back of the pistons which may create excessive pedal travel when the brakes are applied.

Before checking the run-out, hub end-float should first be eliminated by tightening the retaining nut, re-adjusting it at the end of the test. (See Section F, "Front Hubs—to adjust"). After tightening the retaining nut, check that the hub can still be rotated. A dial test indicator should then be clamped either to the stub axle carrier or to the caliper body so that the stylus bears on the disc at a point approximately 1 in. (25·4 mm) from the outer edge.

Revolve the disc and check the indicator reading; the maximum reading on the gauge should not exceed 0·004 in. (0·10 mm).

When the disc has suffered damage or has become excessively scored, it must be renewed.

To remove and refit

1. Apply the handbrake, jack up the front of the car and remove the road wheel.
2. Remove the caliper from the stub axle carrier, see under "Caliper—To remove and refit" and suspend nearby without straining the flexible hose.
3. Remove the hub assembly from the stub axle, see under "Hubs—To remove and refit" in Section F.
4. Remove the disc from the hub by withdrawing four bolts and tab washers or washers.
5. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—
   (i) Ensure the fitting faces of the hub and disc are free from dirt and burrs before assembly. In the instance of replacement discs ensure its protective coat is washed off.
   (ii) The four bolts are tightened to the torque given in the "General Data Section" but when tab washers are used on the bolts, do NOT turn up the tabs until AFTER the disc run-out has been checked.
   (iii) The hub assembly is fitted, see under "Front hub—To remove and refit" but the hub end float is set AFTER the disc run-out has been checked.
   (iv) The disc run-out is checked, see under "Disc Run-out". When the run-out is greater than the specified figure, the disc can be repositioned on the hub in an attempt to obtain a more satisfactory combination of machining tolerances.
   (v) When tab washers are fitted, remove the hub assembly and turn the tabs of the four tab washers over the heads of the bolt and the hub refitted.
   (vi) Set the hub end float, see under "Front hubs—To adjust" in Section F.
   (vii) When a replacement disc is fitted to Series I and II models, position the caliper centrally astride the disc, using packing shims and washers see under "Caliper—To remove and refit."
   (viii) Only when the caliper has been removed completely from the car is it necessary to bleed the hydraulic system of air.

REAR BRAKES

DESCRIPTION (See Fig. 16)

The rear brakes incorporate leading and trailing shoes operated by a single wheel cylinder. The lower ends of the shoes locate in slots in the wheel cylinder piston (3) and body (11), whilst the upper ends pivot about an abutment (16), situated directly opposite the wheel cylinder on the backplate (12). The shoes are supported by platforms formed in the backplate and are held in position by two damper springs and pegs which pass through holes in the backplate (see item 18). The shoes are linked together by pull-off springs (13 and 15), situated between shoe webs and backplate.

When hydraulic pressure is applied, the pistons in the wheel cylinders are thrust outwards operating the leading shoes (14) and the cylinder bodies react by sliding in their slots in the backplates to operate the trailing shoes (17). When the pressure is released the shoes are returned to their original positions by the pull-off springs.

Adjustment for lining wear is made possible by a "micram" adjuster (1) which is attached together with its mask (2) to the top edge of each leading shoe.

Handbrake (See Fig. 11)

A cable linkage connects the handbrake to levers housed in each rear wheel cylinder.

Each lever (6) is retained in its cylinder body by a pin (7). When the handbrake is applied, the linkage pulls on the levers which pivot about their pins and force the outer pistons (3) in the wheel cylinders outwards. The pistons in turn operate the leading shoes and the cylinder bodies react as before to operate the trailing shoes.

On certain cars the lever (6) is extended by a pressing but for later cars the length of the lever was increased in manufacture. The extension, in either form, increases the efficiency of the handbrake for the same effort applied to the handbrake lever at the side of the driver's seat.

BRAKE SHOES

It will be noted that the brake shoe linings are off-set on the platforms to which they are attached. The end of the shoe at which the greater length of platform is exposed is known as the "toe" whilst the other end is called the "heel".

The leading and trailing shoes are identical except that the "micram" adjuster and mask are attached to the toe of the leading shoe.

To remove

Chock the front wheels, jack up the car and remove a road wheel. Make sure that the handbrake is fully released. Slacken off all available adjustment by

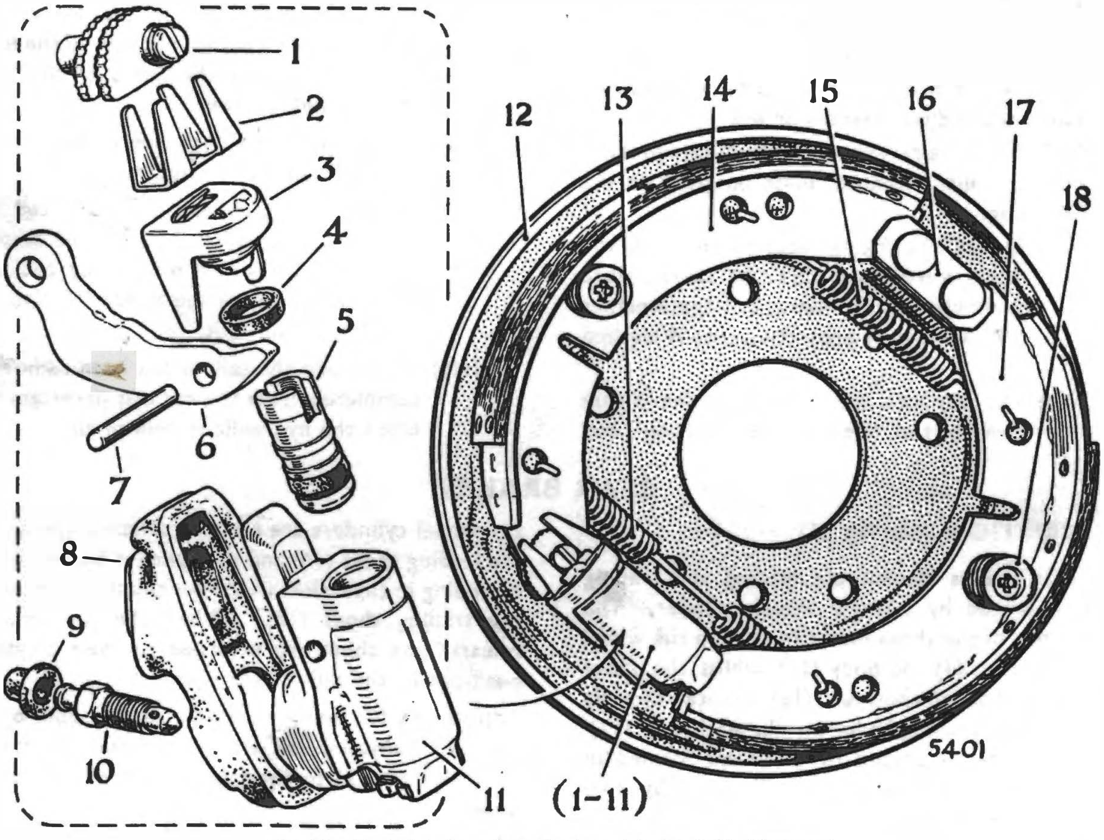


Fig. 16. *Exploded view of rear brake—right-hand side illustrated*

1. Micram Adjuster.
2. Mask.
3. Outer Piston.
4. Seal (Outer Piston).
5. Inner Piston.
6. Handbrake Lever.
7. Pivot Pin.
8. Rubber Boot.
9. Dust Cap.
10. Bleed Screw.
11. Cylinder Body.
12. Backplate.
13. Pull-Off Spring.
14. Brake Shoe Assembly.
15. Pull-Off Spring.
16. Abutment.
17. Brake Shoe Assembly.
18. Damper Spring Assembly

turning the "micram" adjuster anti-clockwise to the full extent using a screwdriver. (See Fig. 10).

Remove the brake drum and distance piece, when fitted, from the axle flange by withdrawing a countersunk screw. A light blow on the side of the brake drum will loosen it and facilitate removal.

Release the damper spring assemblies (item 18, Fig. 16) by depressing the cups and turning the pegs through ninety degrees. The pegs may be withdrawn from the rear of the backplate.

Disengage the leading (rearmost) shoe from the locating slots in the wheel cylinder piston and abutment by pulling it against the tension of the pull-off springs. The trailing shoe will then automatically be released.

Remove the "micram" adjuster and mask from the toe end of the leading shoe.

To refit (See Fig. 16)

Lay the shoes on a bench with the toe of the leading shoe adjacent to the heel of the trailing shoe.

Connect the two-coiled pull-off spring (13), between the toe of the leading shoe and the heel of the trailing shoe, with the longer coil nearest the leading shoe. Use the outer of the two holes when hooking it to the heel end of the trailing shoe.

Similarly connect the single-coil pull-off spring (15), between the heel of the leading shoe and the toe of the trailing shoe, with the coiled portion facing inwards. Use the inner of the two holes when hooking it to the heel end of the leading shoe. Both springs should be fitted to the *underside* of the brake shoe flanges.

Fit the "micram" adjuster (1) and mask (2) into the slot at the toe of the leading shoe.

Offer up the shoes complete with pull-off springs to the backplate and locate the leading shoe in the slots in the wheel cylinder piston (3) and abutment (16).

Prise the trailing shoe into position with its ends ocating in the wheel cylinder body (11) and abutment. Refit the damper spring assemblies (18), (reversal of the removal procedure).

Refit the brake drum and distance piece, when fitted; secure with the countersunk screw and adjust the brakes as described under "Maintenance".

Lower the jack and remove the chocks.

To reline

It is strongly recommended that advantage be taken of the Factory Reconditioned Service Unit Scheme whereby replacement brake shoe and lining assemblies can be obtained in exchange for the old ones. In territories where these facilities are not available relining may be carried out as follows:—

1. Remove the brake shoes as previously described.
2. Mark the position of the lining across each end of one of the brake shoes with a scriber. This will ensure that the new lining will be fitted in the correct position.

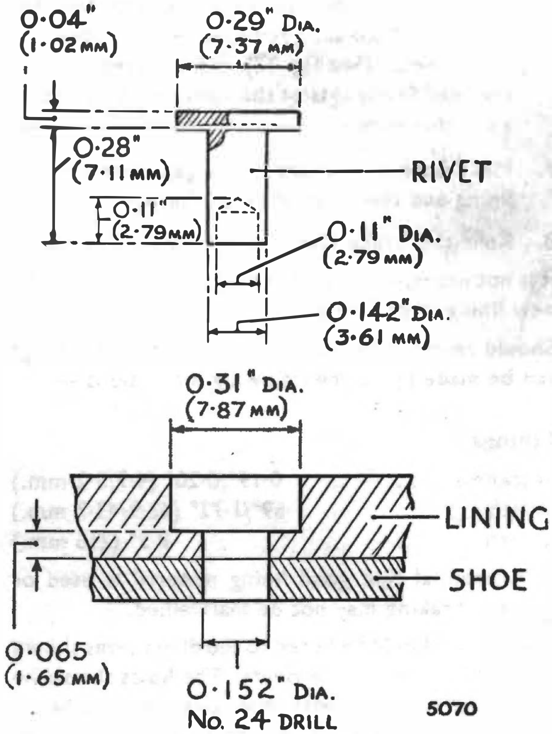


Fig. 17. *Rivet details*

3. Grip the shoe *lightly* in a vice, in order not to distort the shoe. Cut away the portion of each rivet, which protrudes through the underside of the brake shoe platform, with a sharp chisel. Position the shoe in the vice so that it is held as near as possible to the rivet being removed Repeat for the other shoe.

4. Thoroughly degrease the shoes.
5. Inspect each shoe carefully for damage and cracks. Apply marking to the brake shoe platform and roll it against a flat surface noting any high spots and removing them with a file.
6. Place the new lining on the shoe, first ensuring that there is no foreign matter adhering to its underside, and line up the ends with the marks previously scribed. Mount a rivet dolly in the vice. Fit the rivets in pairs to line up with the holes in the brake shoe platforms. Start at the centre of the shoe and work outwards towards the ends. Each shoe requires twelve copper or brass rivets. (See Fig. 17). When riveting, hold the head firmly against the anvil and secure using a suitable punch.
7. Make sure that there is no gap between the lining and the brake shoe platform.
8. Refit the brake shoes as previously described.

It is not necessary to chamfer the heel and toe of the new lining after fitting.

Should replacement linings not be available, linings can be made up to the following dimensions:—

Linings

Thickness	0·19"/0·20" (4·9/5·2 mm.)
Width	1·69"/1·72" (42·9/43·7 mm.)
Length	8·5" (216 mm.)

It is essential that good lining material is used or efficient braking may not be maintained.

The linings should be bored to the dimensions shown in Fig. 17 to receive the rivets. The holes should be positioned to line up with those already in the brake shoes. This may easily be done by clamping the linings to the brake shoes and using the shoes as templates. (See Fig. 7).

When lining "off the roll" is used, the heel and toe of each lining should be slightly chamfered after fitting to the brake shoe.

No attempt should be made to reline the brake pads on the front brakes.

WHEEL CYLINDERS (See Fig. 16)

Each wheel cylinder consists of a die-cast aluminium body (11) containing two pistons. The outer piston (3) has a metal dust cover welded to it and is grooved to accommodate a rectangular sectioned seal (4). The inner piston (5) is slotted to receive the heel of the handbrake lever and is fitted with a tapered seal. A rubber boot is also fitted.

When the footbrake is applied the inner piston is forced outwards taking the outer piston with it. When the handbrake is applied, however, only the outer piston is moved.

A bleed screw (10) is incorporated in the cylinder body with a rubber dust cap (9) over the nipple end

To remove

Remove the brake shoes as described under "Brake shoes—to remove".

Unscrew the union nut securing the brake fluid pipe to the wheel cylinder.

Disconnect the handbrake cable from the wheel cylinder lever by removing the clevis pin but when a lever extension is fitted disconnect the lever extension from the lever by removing a nut, bolt and washer.

Remove the rubber boot and bleed screw from the wheel cylinder.

The wheel cylinder can now be manœuvred from the brake drum side of the backplate.

To refit

Refitting is a reversal of the above instructions.

It is important to ensure that the rubber boot is correctly located in the groove along the wheel cylinder and around the union boss. Care should be taken not to trap the boot between the wheel cylinder and backplate.

When a lever extension is fitted ensure that the fold of the pressing is towards the centre of the car.

It will be necessary to bleed the brakes after refitting as described under "Bleeding the brakes".

To dismantle (See Fig. 16)

Remove the wheel cylinder from the backplate as previously described.

Withdraw the outer piston (3).

Push out the handbrake pivot pin (7) and remove the lever (6).

With the bleed screw (10) in position, remove the inner piston (5) by applying gentle air pressure to the fluid pipe connection.

Remove the rubber seals from each piston. It should be noted that the metal dust cover cannot be removed from the outer piston.

To reassemble (See Fig. 16)

Fit the tapered rubber seal into the groove in the inner piston with the lip facing away from the slotted end of the piston.

Fit the rectangular sectioned seal (4) into the groove in the outer piston.

Insert the inner piston (5) into the wheel cylinder body closed end first and with the longest slot in the piston adjacent to the slot in the body. Take great care when easing the lip of seal past the edge of the bore not to damage or turn back the lip.

Place the handbrake lever (6) in position and refit the securing pin.

Refit the outer piston (3) into the bore.

Refit the wheel cylinder onto the backplate as previously described.

HYDRAULIC SYSTEM

GENERAL

Great cleanliness is essential when dealing with any part of the hydraulic system, and especially so where the brake fluid is concerned. Dirty or aeriated fluid must never be added to the system. Use only the specified type of brake fluid for topping up the reservoir. (See Section P).

BLEEDING THE SYSTEM

"Bleeding" (expelling air from) the hydraulic system is not a routine maintenance operation, and should only be necessary when a portion of the hydraulic system has been disconnected or if the level of the brake fluid in the master cylinder reservoir has been allowed to fall so low that air has entered the system.

Always keep a careful check on the fluid level in the reservoir during bleeding. It is most important that the master cylinder be kept at least half full otherwise air may be drawn in necessitating a fresh start.

1. Ensure that all connections are secure, the fluid reservoir is topped up with brake fluid and kept topped up during the whole operation. Remove the rubber cap from the bleed screw of the left hand rear wheel cylinder, fit a bleed tube and immerse its free end in a glass vessel containing some brake fluid.

2. Slacken off the bleed screw $\frac{1}{2}$ to $\frac{3}{4}$ of a turn and depress the brake pedal with full strokes allowing its return to be as quick as possible; any check on its return will prevent effective bleeding. Actuate the brake pedal in this manner until the brake fluid entering the vessel is free of air and tighten the bleed screw on the next downward stroke ensuring that it is fully tightened before the pedal reaches the bottom of its stroke. Remove the bleed tube and glass vessel, refit the rubber cap.

3. Repeat operations 1 and 2 at each of the remaining bleed screws, finishing at the right hand front. In the instance of late Rapier Series IV Cars onwards repeat operations 1 and 2 at the front brakes only as the right hand rear wheel cylinder has no bleed screw.

4. Top up the reservoir to the correct level, refit the filler cap ensuring its seal is in good condition and its air vent is unobstructed.

Care should be taken not to over-tighen the bleed screws since this may very easily result in stripped threads. For the correct torque figures see under "Brakes" in the "General Data Section"

RAPIER

MASTER CYLINDER

Description (See Fig. 18)

The master cylinder is situated under the bonnet on the bulkhead, immediately in front of the brake pedal. It consists of a fluid reservoir soldered to a cylinder body, containing a piston, seals and other parts as illustrated in Fig. 18.

On depressing the foot pedal, the push rod (11) moves the piston (9) down its bore. The displaced fluid in front of the piston is forced through holes in the check valve (4), lifting the rubber seal clear of the holes to provide an unblocked passage to the wheel cylinders. On releasing the brake pedal the return spring (5) thrusts the piston (9) back against its stop faster than fluid is able to return from the wheel cylinders. This creates a partial vacuum in the cylinder, which causes fluid to be drawn past the lip of the main cup (7) from the reservoir via the main port (A) and the small holes in the head of the piston (9). Meanwhile fluid returning from the wheel cylinders lifts the check valve (4) away from its seat and re-enters the master cylinder.

When the piston has fully returned, a small by-pass port (B) is uncovered which allows release of excess fluid to the reservoir, and also compensates for contraction and expansion of the fluid due to changes in temperature.

The purpose of the check valve (4) 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 pedal.

To remove

Disconnect the metal fluid pipe from its connection at the front of the cylinder by unscrewing the union nut, collecting any escaping fluid in a suitable container.

Disconnect the push rod from the brake pedal by removing the clevis pin.

Remove the two bolts securing the master cylinder to the bulkhead.

The master cylinder can now be removed by easing it forwards.

To refit

Refitting is a reversal of the above instructions. Care should be taken not to over-tighten the feed pipe union nut. (See under "Maintenance" for torque figure).

After refitting, the brakes should be bled as described under "Bleeding the system".

To dismantle (See Fig. 18)

Remove the master cylinder from the car as previously described.

Remove the filler cap (1) and drain the brake fluid into a clean container.

Depress and withdraw return spring cap to release return spring.

Detach the rubber boot (13) from the end of the barrel.

Depress the push rod to relieve the load of the spring (5) and remove the circlip (12).

Remove the piston (9), piston washer (8), main cup (7), retainer (6), return spring (5), and check valve (4). The removal of the main cup may be simplified by applying gentle air pressure to the pipe connection at the end of the barrel.

Remove the secondary cup (10) by stretching it over the end flange of the piston (9).

To reassemble (See Fig. 18)

It is important that all parts are meticulously cleaned with brake fluid before reassembly. Do **not** use petrol, trichlorethylene or any other similar cleaning agents to wash the parts.

Fit the secondary cup (10) onto the piston (9) so that the lip of the cup faces towards the head (drilled end) of the piston. Gently work the cup round the groove with the fingers to ensure that it is properly seated.

Fit the spring retainer (6) onto the small end of the spring (5) and the check valve (4) into the large end. Insert the spring assembly into the cylinder bore, large end first.

RAPIER

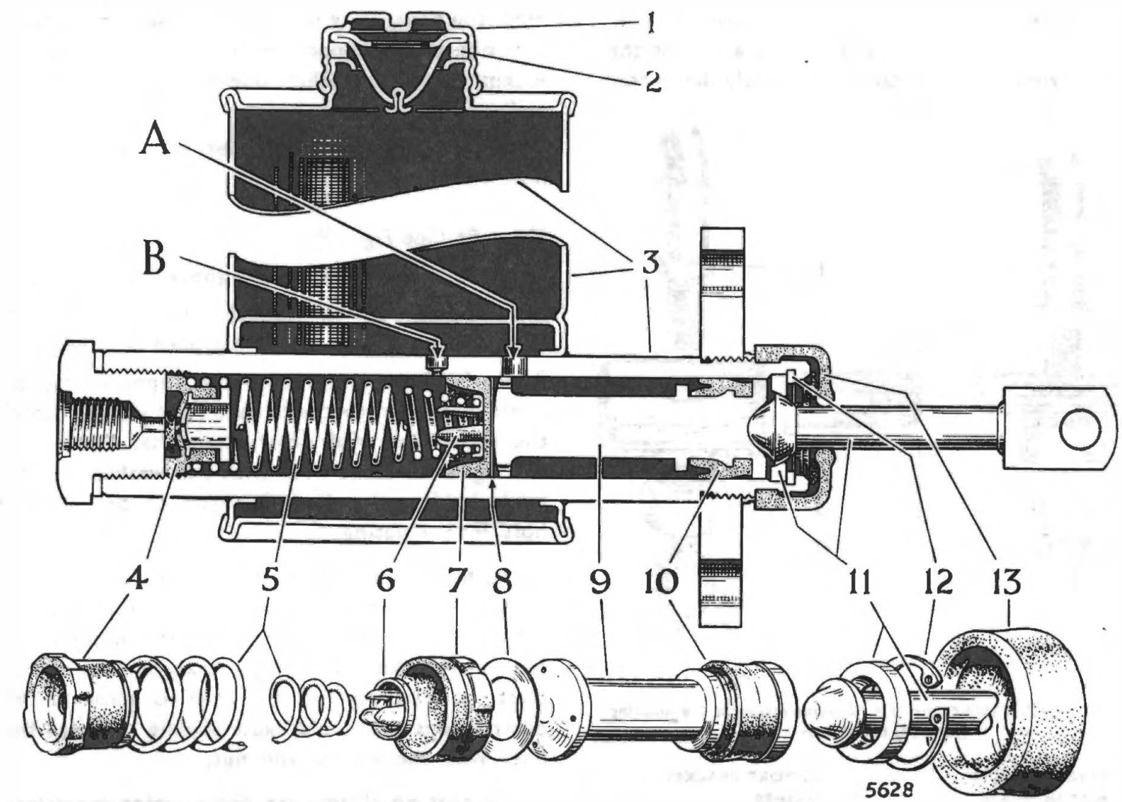


Fig. 18. *Master Cylinder*

1. FILLER CAP
2. WASHER
3. MASTER CYLINDER BODY
4. *CHECK VALVE
5. RETURN SPRING
6. SPRING RETAINER
7. MAIN CUP
8. WASHER
9. PISTON
10. SECONDARY CUP
11. PUSH ROD ASSEMBLY
12. CIRCLIP
13. RUBBER BOOT

A. MAIN PORT
B. BY-PASS PORT

*On earlier models the shape of this item differs from that shown.

Insert the main cup (7) into the cylinder bore, lip foremost, taking care not to damage or turn back the lip.

Insert the piston washer (8) into the barrel with the curved edge towards the main cup, followed by the piston, head (drilled end) innermost.

Push the piston inwards with the end of the push rod (11) and secure the push rod by fitting circlip (12). Make sure that the circlip beds evenly in its groove and that the collar is properly retained by the circlip.

Refit the return spring and cap.

Refit the boot (13) into position by stretching it over the end of the barrel and into its groove.

Fill the reservoir and test the master cylinder by pushing the push rod and piston inwards and allowing it to return unassisted; after a few applications fluid should flow from the outlet connection in the cylinder head.

RAPIER

Top up the reservoir to its correct level of ½ in. (13mm) below the filler cap orifice, and refit the master cylinder to the car as previously described.

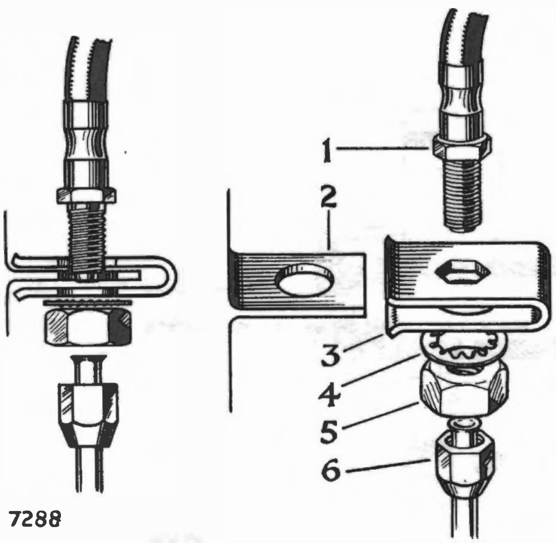


Fig. 9. *Flexible hose connection. In some instances the locating plate (3) is omitted.*

1. SLEEVE HEXAGON
2. SUPPORT BRACKET
3. LOCATING PLATE
4. WASHER
5. NUT
6. FEED PIPE UNION NUT

FLEXIBLE HOSES

Do not attempt to clear the bore of a flexible hose by probing. If a hose is choked or perished, fit a replacement.

To remove (See Fig. 19)

Disconnect the metal fluid pipe by unscrewing the union nut from the hose union.

Hold the hexagon of the flexible hose end sleeve at one side of the support bracket and unscrew the locknut from the other side to release the hose and washer.

Unscrew the hose at its other end, allowing the hose to rotate.

To refit (See Fig. 19)

Refitting is a reversal of the above instructions.

It is important not to attach the hose to the support bracket until its other end has been secured.

Feed the hose sleeve into the support bracket, apply a spanner to the hexagon and set the run of the hose clear of all obstructions that could cause chafing. Secure the hose with the washer and nut while holding the sleeve hexagon to prevent the hose from rotating.

When fitted, slide the hose locating plate onto the support bracket so the plain hole is on the feed pipe side; feed the hose sleeve into the plate and bracket, locating the sleeve hexagon within the plate so the run of the hose is clear of all obstructions that could cause chafing. Secure the hose with the washer and nut.

Check that no chafing can occur under conditions of bump and rebound, by bouncing the car up and down. This check should be carried out with the front wheels in the straight ahead position and on right and left-hand locks.

Be careful not to overtighten the tube (union) nut since this may very easily result in stripped threads. For the specified torque figure, see under "Maintenance".

After fitting the hose(s) it will be necessary to bleed the brakes as described under "Bleeding the system'

GIRLING VACUUM SERVO UNIT

The Girling Vacuum Servo Unit is installed in the brake hydraulic system between the master cylinder and the brake assemblies on the roadwheels with master cylinder outlet pipe connected to the vacuum servo unit and the servo hydraulic outlet is connected to the brake assemblies. The force required to augment the drivers effort is obtained by admitting atmospheric pressure to a vacuum cylinder containing a piston.

The pressure difference thus created across the piston produces a thrust load which is used to increase the hydraulic pressure available at the brake assemblies.

In the Girling Vacuum Servo Unit, the piston in the vacuum cylinder is normally subjected to vacuum on both sides and this principle is known as "Suspended Vacuum System". The vacuum is obtained from the inlet manifold of the engine and therefore servo assistance is only available while the engine is running.

Between the engine inlet manifold and the vacuum servo unit is a non-return valve which prevents air or petrol fumes entering the servo unit.

Operation (Fig. 20)

When air, at atmospheric pressure, is admitted to the vacuum cylinder (19) by a composite control valve the piston (5) drives the piston rod (18) and the output piston (25) down the hydraulic output cylinder (28) providing a considerable increase of hydraulic pressure to the brake assemblies on the roadwheels.

The control valve, operated by hydraulic pressure from the master cylinder, exercises a precise control over the pressure increase and the brakes are applied exactly in proportion to the pressure applied to the foot pedal.

When the servo unit is at rest with no pressure in the hydraulic system, the vacuum valve (22) of the control valve is open and permits vacuum from the inlet manifold to temporarily communicate with the second side of the piston (5) in the vacuum cylinder (19) thus vacuum on both sides of the piston (5) is equal.

When pressure is applied to the brake pedal, hydraulic pressure is exerted throughout the braking system and equally on both ends of the valve control piston (10 & 13). As one end of this control piston is larger than the other, an equal pressure per square inch on both its ends causes a proportionally greater thrust to be exerted on the larger end moving the control piston and results in the "Tee" shaped lever (11) opening the air valve (31) to the atmosphere and closing the vacuum valve (22). Air is admitted to the second side of the piston (5) destroying the temporary vacuum, driving the piston (5) forward. The piston rod (18) seals the centre hole in the output piston (25) and continued movement applies additional pressure to the hydraulic pressure proceeding to the brake assemblies and also to the small end of the valve control piston (13).

The movement of the output piston (25) continues until the thrust on the small end of the valve control piston (13) by the higher pressure to the brake assemblies, overcomes the thrust on the large end of the control piston (10), by the lower pressure from the master cylinder. The valve control piston (10 & 13) is thus moved back and closes the air valve (31); at this point both valves are closed and the brakes held on.

When the brake pedal is released the lower pressure from the master cylinder is reduced at the large end of the valve control piston (10) which moves back towards its rest position causing the "Tee" shaped lever (11) to open the vacuum valve (22) drawing the air from the second side of the piston (5) in the vacuum cylinder (19), the piston (5) returns to its rest position and with it the output piston (25) relieving the hydraulic pressure in the brake assemblies. The piston rod (18) is withdrawn from the centre hole in the output piston

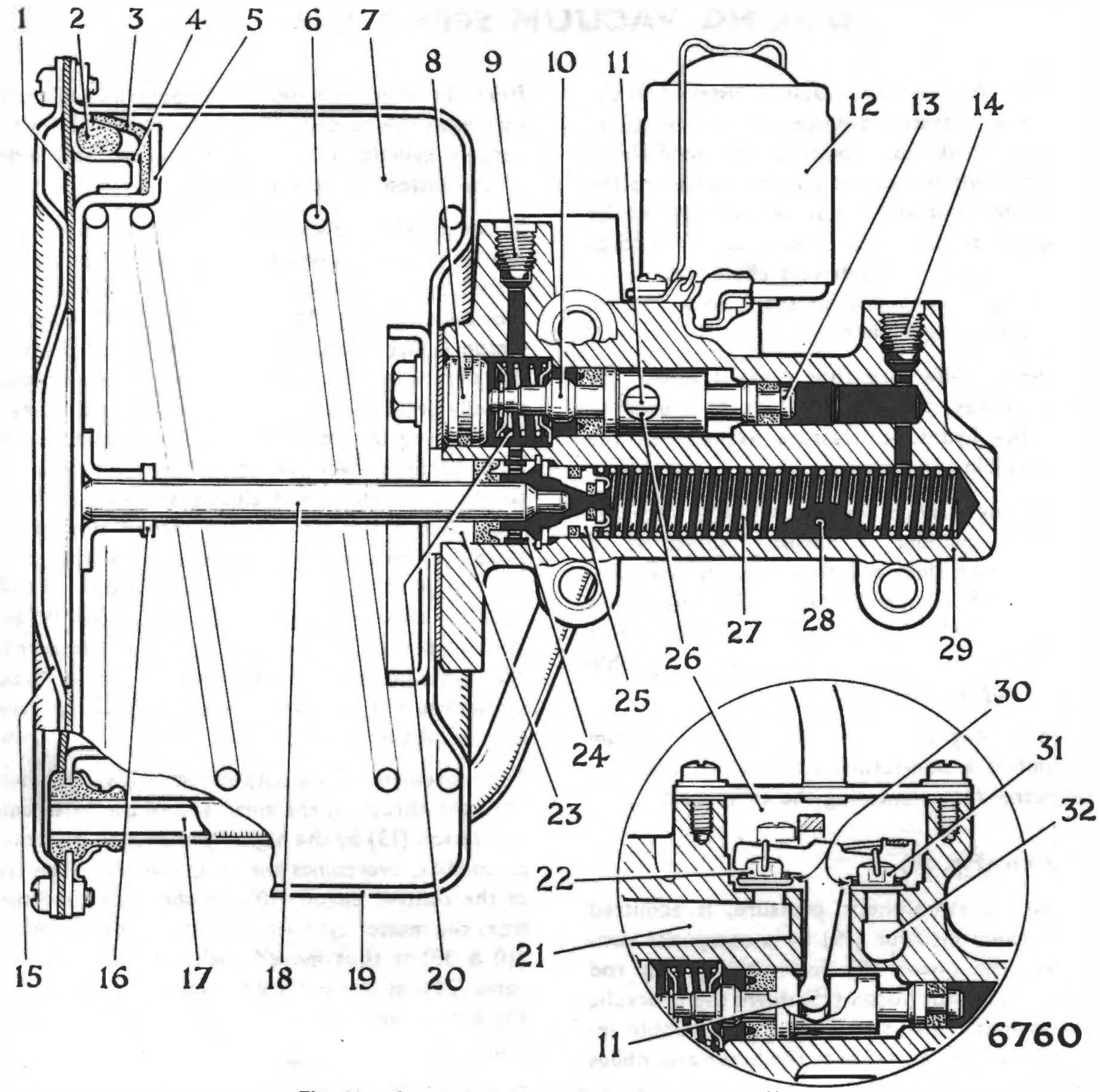


Fig. 20. *Cross section view of Girling Vacuum Servo Unit*

1 END COVER GASKET
2 PISTON BACKING RING
3 PISTON SEAL
4 PISTON SEAL RETAINER
5 PISTON
6 PISTON RETURN SPRING
7 CONSTANT VACUUM
8 END PLUG
9 HYDRAULIC INLET PORT
10 VALVE CONTROL PISTON, LOW PRESSURE END
11 "T" SHAPED LEVER
12 AIR FILTER ASSEMBLY
13 VALVE CONTROL PISTON, HIGH PRESSURE END
14 HYDRAULIC OUTLET PORT
15 END COVER
16 PISTON BUFFER
17 TRANSFER TUBE
18 PISTON ROD
19 VACUUM CYLINDER
20 CONTROL PISTON SPRING
21 VACUUM INLET
22 VACUUM VALVE
23 BEARING BUSH
24 NYLON SPACER
25 OUTPUT PISTON
26 VALVE CHEST
27 OUTPUT PISTON SPRING
28 OUTPUT CYLINDER
29 CAST BODY
30 VALVE SPRINGS
31 AIR VALVE
32 AIR INLET

(25) allowing a flow of hydraulic fluid between the brake assemblies and the fluid reservoir of the master cylinder.

If the brake pedal pressure was increased instead of being decreased the control valve operates to give additional assistance until the thrust on each end of the valve control piston is balanced or until the limit of available vacuum is reached. Conversely, if the pedal pressure is only reduced, the control valve operates to reduce the hydraulic pressure in the brake assemblies until, again, a state of balance of the valve control piston is reached.

SERVICING

Whenever possible the Girling Vacuum Servo Unit should be returned to the manufacturers for replacement but if this is not possible the renewing of all seals as contained in the Service Kit should provide a satisfactory unit providing **the internal working surfaces are in good condition.**

There should be no sign of corrosion, pitting, scoring or steps on the piston rod, pistons or bores and the surfaces should be smooth to the touch.

When dismantling, absolute cleanliness is essential. Wash the hands and lay out a clean sheet of paper on which to work and place the parts. Take care of all highly finished working surfaces on pistons, rods and bores. Clean hydraulic parts with Girling Cleaning Fluid, Alcohol or Girling Brake and Clutch Fluid (Crimson) and do not allow any other fluid, oil or grease to touch them. Special care should be exercised when removing or refitting the circlip in the hydraulic output cylinder and when re-assembling the vacuum cylinder to the body. On some servo units a screw and locknut is fitted to the end cover, IN NO CIRCUMSTANCES MUST THE SCREW BE DISTURBED.

AIR FILTER

The air filter element is of a moulded cellular construction and should be renewed in accordance with the instructions given in the Owners Instruction Book.

To renew

Remove the cover from the top of the servo unit by moving aside the spring clip and discard the soiled filter beneath. Clean the base plate and cover, position the clean filter on the base plate followed by the cover and secure the cover with the clip.

Alternately, remove the cover by withdrawing the centre screw, discard the soiled filter beneath but salvage the rubber washer. Clean the rubber washer and cover, position the rubber washer on the servo unit followed by the clean filter and cover; secure the cover with the centre screw.

SERVO UNIT

To remove and refit

1. Detach the vacuum pipe from the cast body of the servo unit by releasing the union nut.
2. Detach the hydraulic inlet and outlet pipes from the cast body by releasing the union nuts, trapping any escaping hydraulic fluid in a drip tray.
3. Remove the servo unit from the bracket in the engine compartment by withdrawing three bolts and washers; one nut, bolt and washer.
4. Refitting is the reverse of the removal sequence but the hydraulic system must be bled of air as previously described.

To dismantle and re-assemble (Fig. 20)

1. Grip the servo unit in a vice by the two lower lugs on the cast body.
2. Remove the piston assembly (5) spring (6) gasket (1) and end cover (15) from the vacuum cylinder (19) by removing the transfer pipe retaining plate and seven nuts and bolts while controlling the pressure of the spring (6). When fitted DO NOT DISTURB THE SCREW AND LOCKNUT IN THE END COVER (15).
3. Remove the vacuum cylinder (19) and gasket from the cast body (29) by withdrawing three bolts, washers and a clamping plate and easing the grommet in the flange of the cylinder from the transfer pipe (17).

4. Remove the cover and transfer pipe (17) from the valve chest (26) by withdrawing four screws and washers.

5. Remove the valve retainer and flat horse-shoe spring from inside the valve chest (26) by withdrawing two screws.

6. Withdraw the valves (22 & 31) and "Tee" shaped lever (11) complete from inside the valve chest (26) by applying light pressure to the plug (8) in the end of the control piston bore.

7. Remove the cast body (29) from the vice and withdraw the control piston assembly from the top bore by tapping the mounting flange of the cast body on a wooden block.

8. Dismantle the control piston assembly by compressing the piston spring, easing off the circlip and removing the spring and retainers.

9. Remove the two seals from the control piston and one from the plug (8).

10. Withdraw the piston rod bearing bush (23) from the output piston bore and using a hooked tool remove the gland seal beneath followed by the nylon spacer (24).

11. Mount the cast body vertically in the vice by one of the mounting lugs and fit the compression tool to press the output piston (25) into the bore. For the compression tool details see Fig. 21.

12. Using circlip pliers fully compress the circlip in the bore and carefully lift out the circlip exercising great care not to damage the bore, otherwise a brake failure may result.

13. Release the compression tool when the piston spring (27) will push out the washer followed by the output piston (25) the latter is then discarded

14. Refitting is the reverse of the removal sequence but particular attention must be given to the following.

    i All seals must be renewed and lubricated with Girling Brake Fluid; lubricate the bores and pistons with Girling Red Rubber Grease.

    ii Fit a new output piston (25) as the piston rod seal can only be fitted during manufacture and confirm that the taper seal has the larger diameter nearer the reduced end of the piston.

    iii Fit the spring (27) to the output piston (25) feed into the bore, spring first, followed by the washer and hold in position with the compression tool and clip the tool under the mounting flange of the cast body (29).

    iv Ensure that the circlip does not foul the side of the bore and fits snugly into its groove; this operation must be unhurried and the circlip pliers must be secure on the circlip, for any damage to the bore can result in brake failure. Remove the compression tool from the cast body.

    v Fit the nylon spacer (25) into the bore, large end first, followed by the gland seal, lip end first and finally fit the bearing bush (23).

    vi Fit the control piston to the bore so the transverse hole aligns with the hole in the valve chest (26).

    vii It is unlikely that the two nylon valves (22 & 31) will need renewing but when it is necessary their faces should be lapped on a piece of glass with fine lapping paste to ensure they are airtight.

    Fit the valves (22 & 31) and "Tee" shaped lever (11) complete so the horseshoe spring location above the air valve (31) is away from the two securing screws inside the valve chest (26). It will be necessary to compress the end plug (8) to locate the end of the "Tee" shaped lever (11) in the control piston.

viii Fit a new rubber grommet in the flange of the vacuum cylinder (19) and locate a new gasket on the mounting face of the cast body (29).

ix Fit the vacuum cylinder (19) and clamping plate with the centre hole of the cylinder over the protruding bearing bush (23) and transfer pipe (17) ensuring there will be space over the grommet for the passage of air when the end cover (15) is fitted but leave the three bolts slack.

x Position the piston (5) and return spring (6) inside the vacuum cylinder (19) and push it down through the full stroke several times to align the bearing bush (23); remove the piston (5) and return spring (6) and tighten the three cylinder attachment bolts taking care not to displace the vacuum cylinder (19) on the flange of the cast body (19). If the cylinder is displaced it can cause the brakes to "hang-on".

xi Remove the sponge rubber backing ring (2) from the piston flange and fit the new one from the service kit. Smear the special lubricant, supplied in the kit, on the leather seal (3) of the piston (5).

xii Smear the piston rod (18) with Girling Red Rubber Grease and with the return spring in front offer up the assembly to the vacuum cylinder (19).

xiii Position the end cover (15) with a new gasket (1) on top of the piston (5) and press down, taking care the piston rod (18) enters the bearing bush (23) without damage.

xiv Secure the end cover (15) with the nuts and screws.

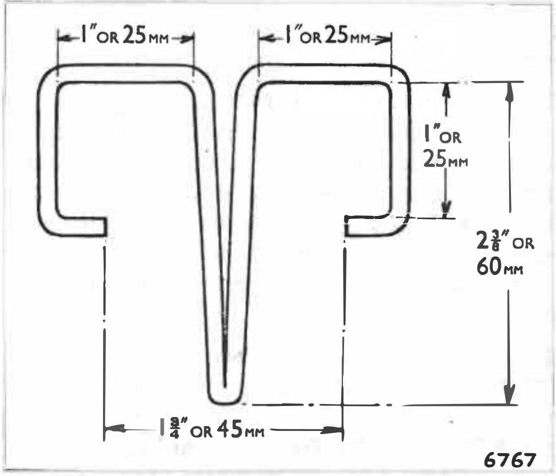


Fig. 21. *The compression tool*

COMPRESSION TOOL (Fig. 21)

The compression tool, necessary to compress the output piston, is made from a 12 in. (30 cm.) length of $\frac{1}{8}$ in. (3 mm.) diameter iron wire.

Bend the wire back on itself in the centre to make the middle "leg" of the tool. Follow with the six other bends as shown in the illustration, finally cutting the two ends so there is $1\frac{3}{4}$ in. (45 mm.) between them.

The centre "leg" is inserted into the output cylinder bore and pressed down until the two ends can be sprung apart and clipped under the mounting flange of the cast body. The tool is then pushed aside towards the control cylinder bore to allow room to insert the circlip pliers.

TESTING EQUIPMENT

To make comprehensive tests, of the vacuum servo unit, requires complex and expensive equipment and this kind of testing is outside the capacity of many Service Workshops.

A number of simple tests can be made when the servo unit is installed which gives some useful information and these tests are described hereafter. The only piece of equipment required is a $\frac{3}{8}$" x 24 U.N.F. pipe union to fit into the hydraulic inlet port.

The use of these tests will assist in diagnoses and will provide assurance after servicing, but the tests are not exhaustive and so cannot equal the standard of the testing which is done in the factory by the specially designed equipment. If a vacuum servo unit gives cause for doubt it is always best to replace it with a factory tested unit when ever possible.

IT IS ASSUMED THAT ANY FAULTS CONNECTED WITH THE BRAKE SYSTEM, SUCH AS FLUID CONTAMINATION, LACK OF ADJUSTMENT, AIR IN THE HYDRAULIC SYSTEM, FLUID LEAKS, ETC., HAVE BEEN RECOGNISED AND ELIMINATED.

Test 1

1. Fit the servo unit to the mounting bracket and before connecting, the air or fluid pipes fit a bleed screw to the fluid outlet port and the special adaptor to the fluid inlet port.
2. Connect the vacuum pipe from the engine inlet manifold to the adaptor and remove the air filter element.
3. Start the engine and while "ticking over" place the fingers over the air inlet port of the air filter and the vacuum port to determine if there is any suction at either orifice
4. If suction can be detected, it indicates that the bores are scored or the components incorrectly assembled
5. Remove the adaptor.

Test 2

1. Connect the vacuum pipe from the inlet manifold to the vacuum port.
2. Connect the fluid inlet and outlet pipes to their respective ports and bleed the hydraulic system of air.
3. Start and run the engine. While the brake is being applied, it should be possible to hear the hiss of the air inlet and with the hand on the vacuum cylinder feel the movement of the piston inside the vacuum cylinder.

Test 3

1. Start and run the engine for half a minute then switch off and leave for two minutes.
2. Apply the brake and the servo unit should operate and the operation should be detected as described in Test 2.

Test 4

Start and run the engine, apply the brake hard and hold it on for fifteen to twenty seconds. There should be no perceptible creep in the brake pedal.

If there is any creep, it indicates leaks or scored bores in the components.

Test 5

1. Jack up the front roadwheels.
2. Start and run the engine.
3. Apply the brake and release.
4. The front roadwheels should be free to move half a second after the release of the pedal.

Tests 2 to 5 can be used to test a suspect Vacuum Servo Unit before it is removed from the car.

IF THE RESULT IS UNSATISFACTORY ON:—

Test 2. It means the servo unit is not working at all, which could be caused by a lack of vacuum, possibly a faulty non-return valve, or a fault within the servo unit.

Test 3. It indicates leaking gaskets, air valve or rubber grommet. Clamp the vacuum hose and repeat Test 3. If satisfactory, the non-return valve is faulty. To test for a leaking air valve run the engine and place the finger over the air inlet. If the suction is only slight the air valve is satisfactory and the leak is elsewhere.

Test 4. The source of the trouble can only be found by elimination. Check for leaks. If no leak of hydraulic fluid is evident clamp each hose successively and repeat the test each time. Finally plug the master cylinder outlet and test. If creeping of the pedal is evident when the hoses are clamped and the pedal is solid when the master cylinder outlet is plugged, the servo unit is faulty.

Test 5. If the brakes remain on, disconnect the vacuum pipe, operate the brakes to eliminate all the vacuum in the servo unit and repeat the test. If the brakes remain on, the fault is not in the servo unit. If the brakes now release normally, the fault is in the servo unit and the alignment of the piston in the vacuum cylinder is suspect.

FAULT FINDING CHART

FAULT	CAUSE	ACTION
Hard pedal—Apparent lack of servo assistance with engine running.	i Lack of vacuum.	i Check vacuum connections
	ii Restricted hose.	ii Check hose and renew if necessary.
	iii Rubber grommet.	iii Fit new parts from Service kit.
	iv Blocked air filter.	iv Examine air filter element and renew if necessary.
	v Faulty output piston.	v Fit new parts from Service Kit.
	vi Major fault in servo unit.	vi Fit new servo unit.
Brakes hanging on.	i Misaligned vacuum piston.	i Check as Test No. 5.
	ii Swollen rubber grommet or piston backing ring.	ii Fit new parts from Service Kit.

FAULT	CAUSE	ACTION
Slow action of servo unit	i Swollen rubber grommet. ii Blocked filter or restricted air inlet.	i Fit new parts from Service Kit. ii Examine air filter element and renew if necessary. Renew vacuum hose.
Lack of servo assistance on heavy braking.	Leak in servo vacuum.	Check for leaks.
Loss of fluid.	i Failure of seal or seals. ii Scored bore.	i Fit new parts from Service Kit. ii Fit new servo unit.

THE LOCKHEED VACUUM SERVO UNIT

GENERAL

The purpose of the vacuum servo unit is to lower the pedal pressure required to produce a given braking effect. This is achieved, essentially, by allowing fluid pressure from the master cylinder to operate a valve situated in the servo unit, which admits air to one side of a diaphragm contained within a vacuum cylinder (the vacuum being derived from the engine's inlet manifold).

The difference in pressure thus created across the diaphragm induces it to flex towards the low pressure side, taking with it a push rod which boosts the line pressure of the brake fluid going to the brakes. This operation is described in more detail under the heading "Principles of Operation".

The design of the servo unit is such that, if for any reason the servo fails to function, there remains an unrestricted passage for brake fluid to pass from master cylinder to wheel cylinder, so that normal unassisted braking is still available.

MAINTENANCE

Servo Air Filter

The filter in the air valve cover of the servo unit should be cleaned at regular intervals.
The procedure is as follows:—

1. With the ignition switched off, pump the foot brake to destroy any vacuum in the servo unit.

2. Remove the air valve cover assembly (item 19, Fig. 22) by withdrawing the five securing screws.

3. Lift the air valve (item 20, Fig. 23) off its seat and blow compressed air at low pressure into the filter chamber. Do not lubricate the filter or attempt to remove it from the air valve cover.

4. When renewing the filter, fit a complete air valve cover.

DESCRIPTION

The unit is installed in the hydraulic braking system between the master cylinder and the wheel cylinders; that is to say, the outlet pipe from the master cylinder is connected to the inlet of the servo unit and the servo unit outlet is connected by pipes to the brake wheel cylinders.

The servo unit may be considered in three sections:

1. **The Slave Cylinder** from which pressure is applied to the brakes.

2. **The Vacuum Cylinder** which supplies the force required to operate the slave cylinder.

3. **The Control Valve Gear** which regulates the actions of the other two sections.

Reference should be made to Fig. 22 for details of the parts which comprise these three sections.

PRINCIPLES OF OPERATION

The operation is shown diagrammatically in Fig. 24. The reference numbers used correspond with those used in the exploded view (Fig. 22) and sectional view (Fig. 23).

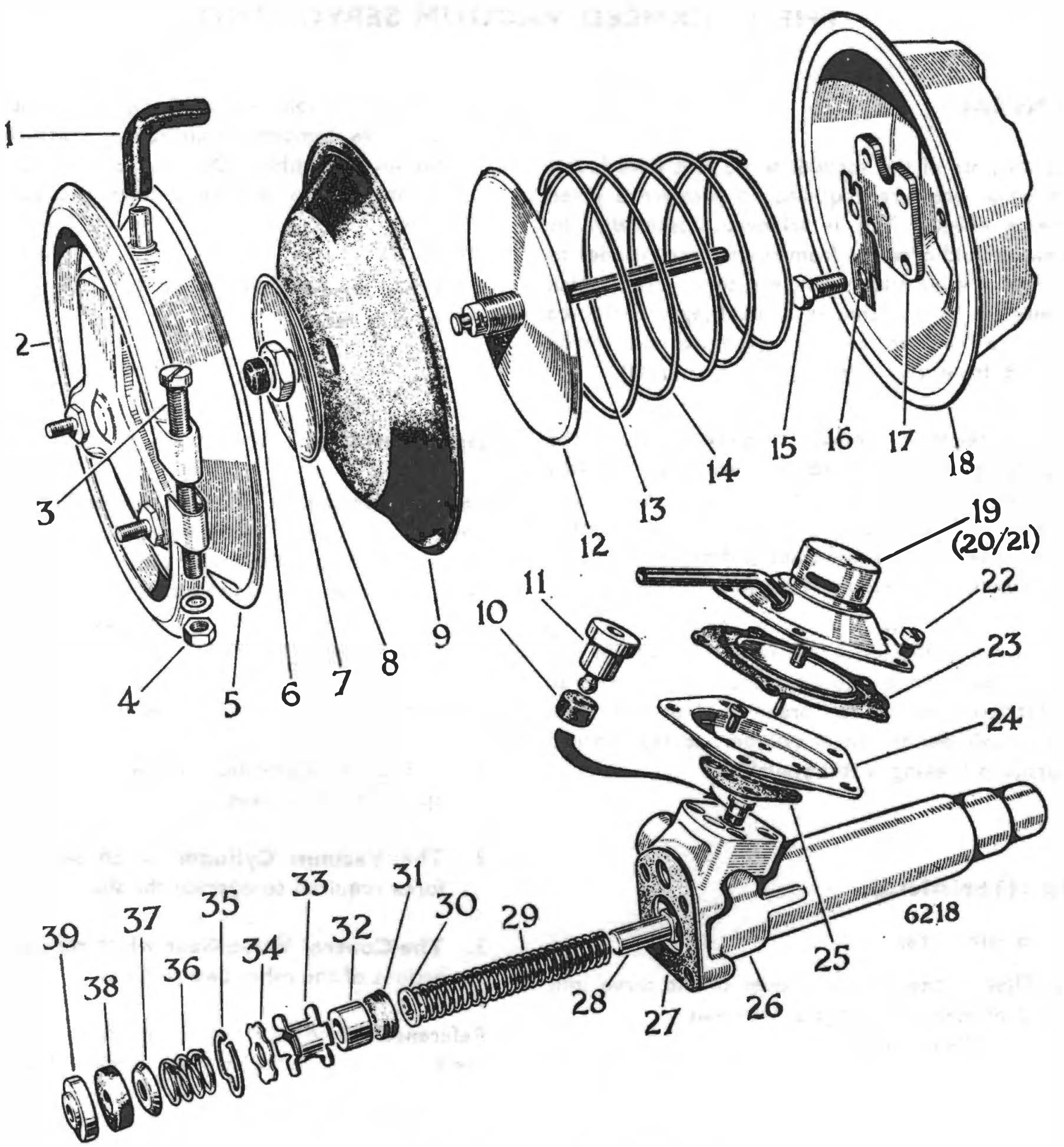


Fig. 22 *Servo unit—exploded view*

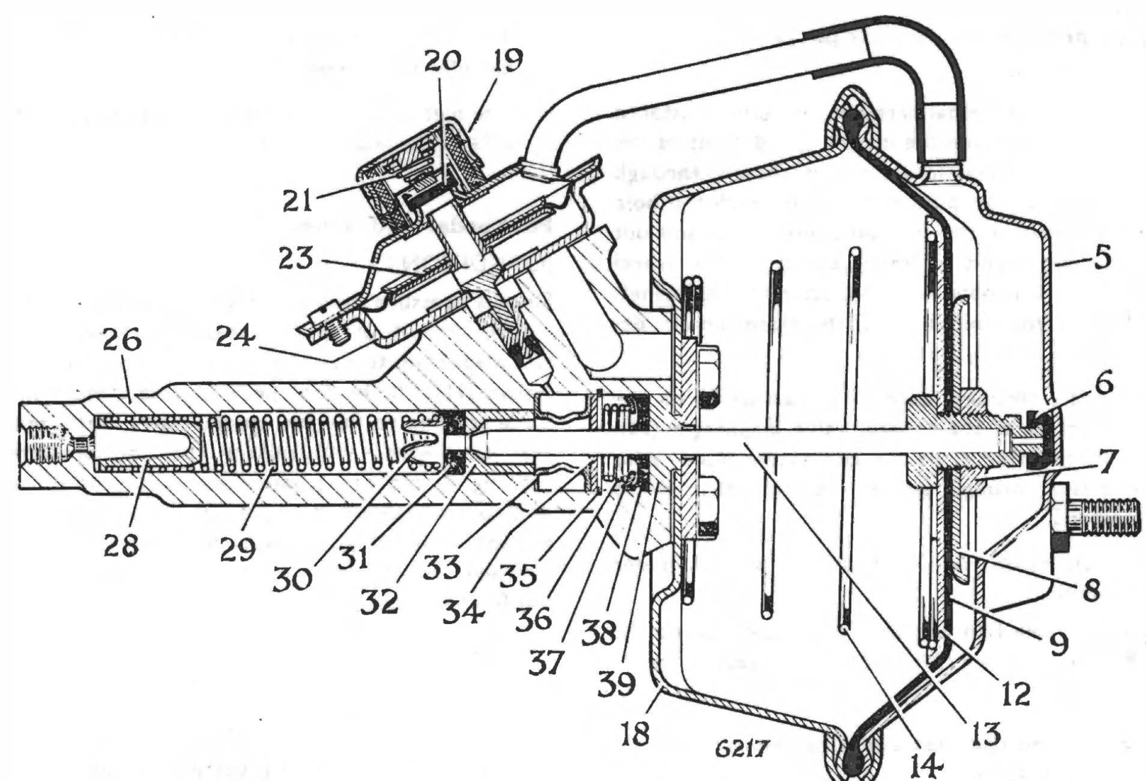


Fig. 23. *Sectional view of the servo unit*

Annotation for Figs. 22 and 23

1. RUBBER ELBOW
2. CLAMPING RING
3. CLAMPING SCREW
4. NUT
5. END COVER
6. RUBBER BUFFER
7. NUT
8. SMALL PLATE
9. BOOSTER DIAPHRAM
10. SEAL
11. VALVE PISTON
12. LARGE PLATE
13. PUSH ROD
14. RETURN SPRING
15. BOLT
16. LOCKING PLATE
17. ABUTMENT PLATE
18. VACUUM SHELL
19. AIR VALVE COVER ASSEMBLY
20. AIR VALVE
21. AIR VALVE SPRING
22. SCREW
23. CONTROL VALVE DIAPHRAM ASSEMBLY
24. VALVE HOUSING
25. GASKET
26. SLAVE CYLINDER BODY
27. GASKET
28. SPRING RETAINER
29. SPRING
30. SPRING GUIDE
31. MAIN CUP
32. HYDRAULIC PISTON
33. DISTANCE PIECE
34. WASHER
35. CIRCLIP
36. SPRING
37. CUP SPREADER
38. SECONDARY CUP
39. GUIDE PIECE

Light pressure on the foot pedal

CONDITION A

With very light pedal pressure, no servo assistance is given. Fluid from the master cylinder enters the servo unit hydraulic inlet and travels through cavity V, past the push rod (13), through the hole in the centre of the hydraulic piston (32) and out of the servo unit hydraulic outlet to the wheel cylinders. Chamber W is connected to the engine's induction manifold and is therefore under depression.

There is a through passage to chamber X via the hollow stem of the control valve diaphragm (23), and to chamber Y via the connecting pipe. Also there is a through passage from chamber W to chamber Z.

Thus chambers W, X, Y and Z are all under depression.

The air valve (20) remains on its seat due to the influence of spring (21), and the air pressure on its outer face.

Pressure on the foot pedal increased

(CONDITION B)

This results in an increase of hydraulic pressure on the bottom face of the valve piston (11) which causes it to move upwards taking with it the control valve diaphragm (23), the stem of which butts against the air valve (20) thus isolating chambers X and Y from the vacuum source. If the increase in hydraulic pressure is great enough, the air valve (20) is lifted off its seat causing air (at atmospheric pressure) to be admitted to chamber X and thence chamber Y.

The difference in pressure thus created across the booster diaphragm (9) induces it to flex towards the slave cylinder, taking with it the push rod (13).

The end of the push rod engages with the hydraulic piston (32), blocking off the hole in its centre and moving it down the slave cylinder bore, thereby increasing the hydraulic line pressure to the wheel cylinders. There now exists, therefore, two hydraulic line pressures:—

(*a*) The lower pressure line from the master cylinder to chamber V.

(*b*) The high pressure line beyond hydraulic piston (32) to the wheel cylinders.

Foot pedal held steady

(CONDITION C)

Since a pressure differential also exists across the control valve diaphram (23), there is a tendency for this diaphragm to flex in the direction of the valve piston (11). If the foot pedal is held steady, the force tending to flex the control valve diaphragm (23) downwards will balance the line pressure tending to move the valve piston (11) upwards. The control valve diaphragm (23) has at this point already moved slightly downwards, permitting the air valve (20) to return to its seat thus cutting off any further supply of air.

The condition at this stage, therefore, is that cavity Z is under depression, whilst cavity Y is cut off from any further air supply. The booster diaphragm (9) will remain stationary, the force due to the pressure of air in cavity Y being balanced by the spring (14) and fluid pressure behind hydraulic piston (32) and no further servo assistance will be given.

Pressure on the foot pedal further increased

(CONDITION B)

Increase in pressure from the master cylinder will increase the force on the bottom of the valve piston (11), re-opening the air valve (20) and increasing the servo assistance in the manner previously described.

When the opposing forces on the control valve diaphragm (23) are once more in balance, the air valve (20) will again close on its seat. It will be apparent, therefore, that the control valve diaphragm (23) acts as a balancing device so that for a given foot pedal pressure, a certain amount of servo assistance is supplied, which is proportional to the pedal pressure.

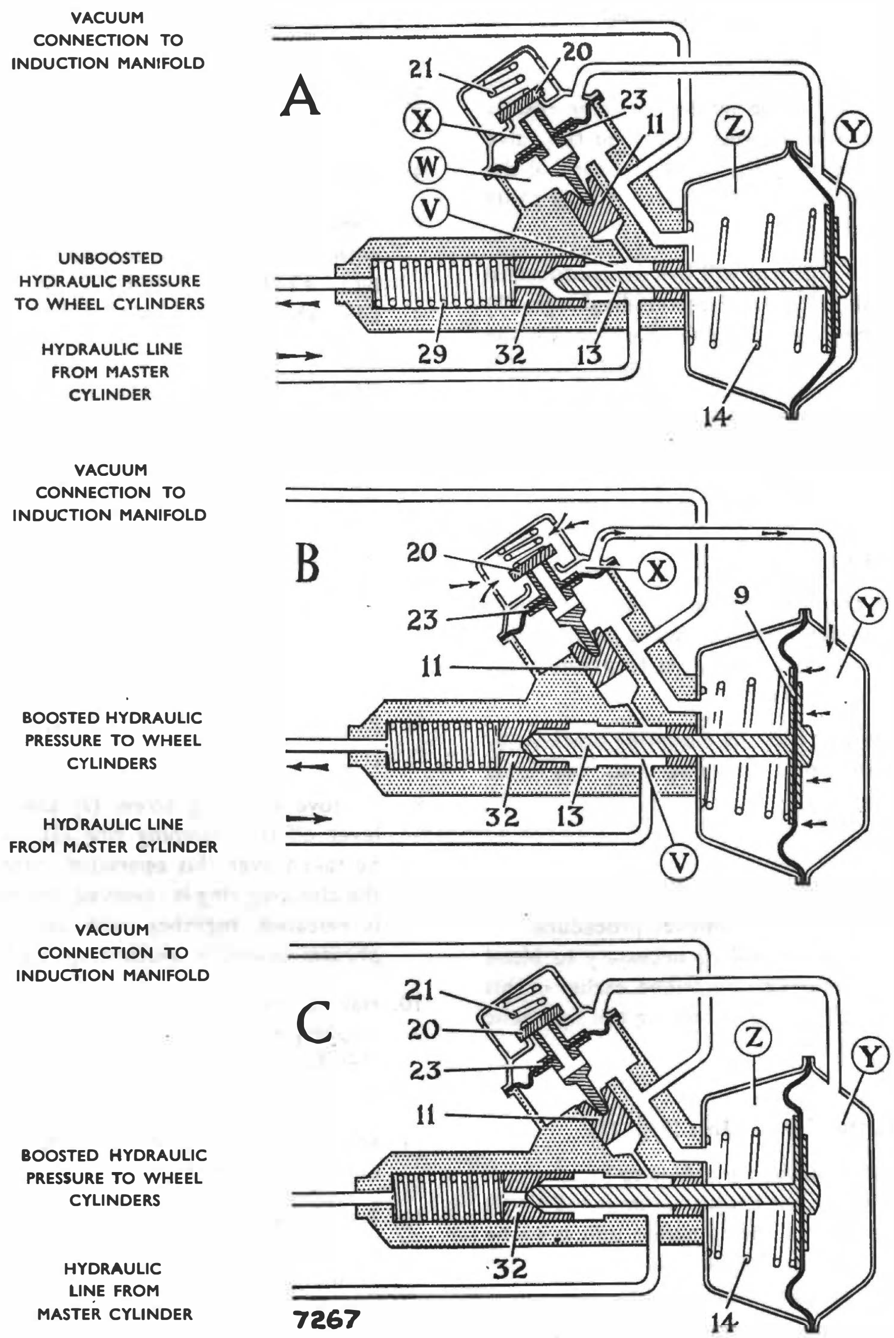


Fig. 24. *Diagram of the operating principles*

Pressure on the foot pedal released

(CONDITION A)

The pressure drop at the master cylinder results in a sudden decrease in pressure behind the valve piston (11) causing air pressure on the back of the control valve diaphragm (23) to force it back to its original position.

As a result of this, vacuum will be re-introduced in chambers X and Y and the booster diaphragm (9) will be returned to its original position by the action of spring (14), taking the push rod (13) with it. The hydraulic piston (32) will be returned to its seat by spring (29). A through passage is then available for hydraulic fluid from master cylinder to wheel cylinders.

Servo Unit—to remove

1. Disconnect the vacuum pipe and hydraulic inlet and outlet pipes from the servo body. Plug the ends of the hydraulic pipes to prevent loss of fluid and entry of dirt.
2. Remove the unit from its mounting brackets by removing two nuts and two nuts and bolts respectively.

To refit

This is a reversal of the removal procedure. It should be noted that it will be necessary to bleed the brakes after refittingas described earlier in this section under the heading "Bleeding the hydraulic system".

To dismantle the Servo Unit (Fig. 22)

If the control valve assembly only is to be serviced, the Control Valve Repair Kit (part number 5040185) should be obtained. If the complete unit is to be overhauled, the Major Repair Kit (part number 5040184) should also be obtained.

The dismantling of the control valve assembly only is covered by operations 1—5.

1. Remove the servo unit from the car as previously described.
2. Hold the unit in a vice by the slave cylinder body (26), taking care not to over-tighten.
3. Remove the rubber elbow (1).
4. Remove the air valve cover assembly (19) by withdrawing the five securing screws (22). NO ATTEMPT SHOULD BE MADE TO DISMANTLE THIS ASSEMBLY ANY FURTHER.
5. Lift off the control valve diaphragm assembly (23). This item should not be taken apart.
6. Remove the valve housing (24) by withdrawing the four securing screws.
7. Remove the valve piston (11). The simplest way to carry this out is to place a clean rag over the piston bore, then apply LOW air pressure to the hydraulic inlet whilst placing a thumb over the hydraulic outlet.
8. Remove the seal (10) from the valve piston (11).
9. Remove clamping screw (3) and nut (4) and lever off the clamping ring (2). Care should be taken over this operation since as soon as the clamping ring is removed, the end cover (5) is released, together with the booster diaphragm assembly which is spring-loaded.
10. Having removed the end cover and booster diaphragm assembly, release the return spring (14) from the locking plates (16) inside the vacuum shell (18).
11. Remove rubber buffer (6) from the outer end of the push rod (13).
12. To separate the various parts of the booster diaphragm assembly, hold the hexagon of the push rod (13), taking care not to damage the high surface finish of the rod, and unscrew the nut (7) from the other side of the diaphragm (9).

13. Bend back the tabs of the locking plates (16) and remove the four bolts (15) securing the vacuum shell (18) and abutment plate (17) to the slave cylinder (26). Note the gasket (27).
14. Extract the guide piece (39) and secondary cup (38) from the slave cylinder using a suitable hooked tool; also the cup spreader (37) and spring (36).
15. Depress the hydraulic piston (32) against the spring pressure by using the push rod (13) or a suitable piece of $\frac{5}{16}$ in. (7.9 mm.) diameter brass rod, and release the circlip (35). Removal of the circlip will then release the washer (34), distance piece (33), hydraulic piston (32), main cup (31) and spring (29) complete with spring guide (30) and spring retainer (28).

To inspect

If the air-valve, air-valve cover, pipe, or filter are faulty a new air-valve cover assembly must be fitted.

Examine all metal parts for damage or wear, particularly those listed below, and renew as necessary.

(*a*) valve piston (11)
(*b*) valve piston bore
(*c*) slave cylinder main bore
(*d*) push rod (13)
(*e*) distance piece (33).

To reassemble

Discard those parts for which replacements are supplied in the repair kit. The remaining original parts, apart from the air valve cover assembly *, should be washed in industrial methylated spirit and allowed to dry.

Just before assembling, the rubber cups and seals should be dipped in Lockheed brake fluid of the specified grade (see Section "P").

In order to fit the main cup (31) it will be necessary to make up a fitting sleeve, the ideal dimensions for which are as follows:

Inside diameter	...	0·688—0·690 in. (17·48—17·53 mm.)
Outside diameter	...	0·9735—0·9745 in. (23·73—23·75 mm.)
Length	... ...	1·37—1·38 in. (34·8—35·1 mm.)

1. Position the slave cylinder (26) in the vice with the hydraulic outlet facing downwards, taking care not to overtighten the clamp.
2. Fit the spring retainer (28) into one end of the spring (29) and the spring guide (30) into the other end. Insert the spring assembly into the slave cylinder bore, retainer end first.
3. Fit the main cup (31) by positioning the fitting sleeve, previously made up, at the mouth of the slave cylinder bore and passing the main cup through it (lip foremost). Take particular care not to turn back or buckle the lip.
4. Fit the hydraulic piston (32), flat face leading, into the bore and holding the piston against the spring pressure, fit the distance piece (33), washer (34) and circlip (35). Use the push rod (13), or a $\frac{5}{16}$ in. (7·9 mm.) diameter brass rod to depress the piston when fitting the circlip. Take care not to score the slave cylinder bore with the circlip and after fitting check that it is properly seated in its groove.
5. Insert spring (36) into the slave cylinder bore followed by the cup spreader (37), dished side facing inwards. Next, insert the secondary cup (38), hollow side facing inwards, ensuring that it locates properly on the cup spreader (see Fig. 23).
6. Fit the guide piece (39) in the end of the bore with the flat side facing inwards.
7. Place the gasket (27) in position.
8. Offer up the vacuum shell (18) to the slave cylinder (26), locating its base on the projecting portion of the guide piece (39).

*Refer to "Maintenance" for method of cleaning the filter in the air valve cover assembly

9. Place the abutment plate (17) in position inside the vacuum shell (18) and secure, using two locking plates (16) and four bolts (15). The four bolts should be tightened to a torque reading of 150—170 lb. in. (175—195 kg. cm.).

10. To build up the booster diaphragm assembly proceed as follows:—

    (*a*) Hold the hexagon of the push rod (13) in a vice with the push rod facing downwards.

    (*b*) Slide the large plate (12) over the threaded spigot with the lip side facing downwards.

    (*c*) Similarly, slide the rubber diaphragm (9) over the push rod with the hollow side facing the large plate (12).

    (*d*) Slide the small plate (8) over the spigot, lip side upwards, and secure by fitting the nut (7).

    (*e*) Lock the nut by punching the thread in two separate places.

    (*f*) Fit the rubber buffer (6).

11. Engage the small end of the return spring (14) under the locking plate tabs (16).

12. Engage the booster diaphragm assembly on the large end of the return spring and enter the end of the push rod (13) into the slave cylinder bore by compressing the spring. Whilst holding the assembly in this position, fit the end cover (5) and secure, using the clamping ring (2), bolt, nut and washer. Do not fully tighten the nut and bolt at this stage.

13. Fit the seal (10) on to the valve piston (11) with the lip facing away from the piston, and insert the piston, seal end first, into the bore in the inclined face of the slave cylinder.

14. Place the gasket (25) in position on the inclined face of the slave cylinder, followed by the valve housing (24), and secure by fitting the four screws.

15. Place the control valve diaphragm assembly (23) on the valve housing (24), with the narrow stem inserted into the piston (11) and the screw holes in the periphery of the diaphragm in line with the holes in the flange of the valve housing.

16. Fit the air valve cover assembly (19) complete with rubber elbow (1) and secure, using five screws (22).

17. Reposition the end cover (5) so that the connecting pipe is in line with the rubber elbow (1) then fully tighten the nut and bolt securing the clamping ring (2).

18. Fit the rubber elbow over the connecting pipe.

19. Refit the servo unit to the car as previously described, and test for correct operation.

Vacuum non-return valve

The vacuum non-return valve is fitted to the engine's induction manifold.

Its purpose is to preserve vacuum in the servo and to prevent damage to the servo unit in the event of backfire. It consists of a spring-loaded valve which, under normal conditions, will be open due to suction from the manifold. Should the suction from the manifold become insufficient to preserve the vacuum in the servo unit, the valve will close on its seat due to the action of the spring.

Since it is not possible to service the non-return valve, in the event of trouble it should be renewed.

To remove, pump the footbrake several times to destroy any vacuum in the servo and vacuum hose pipe, then remove pipe from the non-return valve.

Unscrew non-return valve from engine manifold.

When refitting use a new copper washer between the non-return valve and manifold.

HANDBRAKE CABLE

Alpine Series III and Rapier Series IV Models onwards

The long handbrake cable from the driver's hand-brake lever to the compensating lever mounted on the rear axle is nylon lined and requires no periodical lubrication, thus no greaser is provided.

HANDBRAKE COMPENSATING LEVER

Alpine Series III and Early Rapier Series IV Models (Fig. 25)

A new type handbrake compensating lever is mounted on the rear axle in a central position.

The compensating lever consists of a downward pointing lever pivoting in a bracket welded onto the rear face of the differential casing.

The lower end of the compensating lever accommodates the end of the outer casing from the driver's handbrake lever, while the inner cable passes through the compensating lever and runs parallel with the axle casing to one brake assembly. The compensating lever also accommodates the inner end of a short cable from the opposite rear brake assembly.

When the handbrake is correctly adjusted and fully released the compensating lever should be inclined 5° towards the short cable side, i.e., the driver's side of the car.

Adjusting handbrake (Fig. 25)

Adjustment of the rear brake shoes will automatically adjust the handbrake and when the handbrake operation is correct there is four to six clicks of handbrake lever travel before the rear wheels are fully locked.

If, with the rear brakes in correct adjustment, excessive handbrake lever travel is still experienced, adjust the length of the long and short handbrake cables as follows:—

1. Chock the front wheels, release the handbrake and jack up the rear of the car.

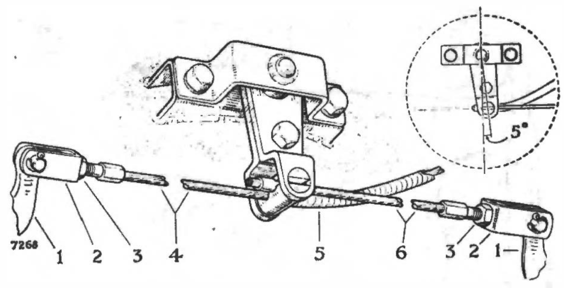


Fig. 25. *Compensating lever assembly mounted on the rear axle; note the 5° inclination of the compensating lever towards the side having the short cable. Right-hand drive shown, left-hand drive symmetrically opposite*

In some instances an extension lever (Fig. 26) may be fitted between the lever (1) and the handbrake cable forkend (2).

WHEEL CYLINDER LEVER	4. INNER CABLE
2. FORK END	5. OUTER CASING
3. LOCKNUT	6. SHORT CABLE

2. Lock both rear wheels by rotating the rear brake shoe adjusters fully clockwise.

3. Detach the inner cable (4) of the long handbrake cable from the wheel cylinder lever (1) by discarding the split pin, removing the plain and spring washers and withdrawing the clevis pin from the cable fork-end (2).

4. Apply light pressure to the compensating lever to tighten the short cable (6); when it is observed that the compensating lever is not inclined 5° towards the short cable side, detach the short cable (6) from the wheel cylinder lever (1) by discarding the split pin, removing the plain and spring washers and withdrawing the clevis pin from the cable fork-end (2). Adjust the length of the short cable (6) by slackening off the locknut (3) and screwing the cable fork-end in or out to shorten or lengthen the cable respectively and retighten the locknut. Refit the cable fork-end (2) to the wheel cylinder lever (1) by reversing the removal sequence and using a new split pin.

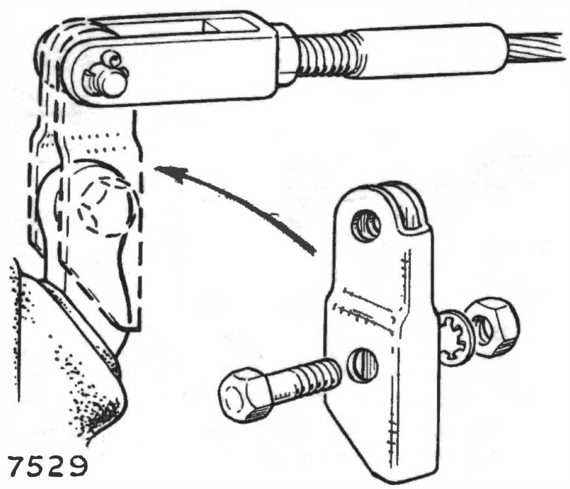


Fig. 26. *The lever extension fitted between the wheel cylinder lever and the handbrake cable forkend; note the position of the "fold" in the lever extension relative to the wheel cylinder lever.*

5. Adjust the length of the long handbrake cable (4), detached during a previous operation, to remove all slackness from itself and the short cable. Refit the cable fork-end (2) to the wheel cylinder lever (1) by reversing the removal sequence and using a new split pin.

6. Re-adjust the rear brake shoes, see under "Brake Adjustments".

7. Lower the car to the ground, apply the hand-brake and remove the chocks.

Handbrake operation (Fig. 26)

Early Rapier Series IV Models

To improve handbrake operation on early Rapier Series IV Cars an extension is fitted to the wheel cylinder levers and the forkends of the handbrake cables are attached to these lever extensions.

The lever extensions can be fitted retrospectively to very early cars of the same Series should the need arise.

To remove and refit (Fig. 26)

The removal of the lever extension will be necessary only when the wheel cylinder is being removed from the back plate, by withdrawing a bolt, nut and washer.

When refitting the lever extension ensure that the fold of the pressing is towards the centre of the car.

SELF ADJUSTING REAR BRAKES

DESCRIPTION (Fig. 27)

Later Rapier Series IV Cars and onwards are equipped with self adjusting rear brakes which will maintain a specific brake shoe clearance. The self adjusting action is effected as the brakes are released whether foot or hand operated.

The previous "micram" adjusters have been replaced by screwed tappets and adjuster wheels with a pawl linkage mounted on the outer piston and wheel cylinder body. Self adjustment is effected by movement of the outer piston.

Adjustment—foot operated

Periodical adjustment is unnecessary and will only be required after thebrakeshoes havebeen refitted.

1. Pump the foot pedal a number of times, when each pump will be of a lesser depth than the previous pump while brake shoe clearance is being reduced.
2. Stop, when the pedal reaches a constant depth.

Adjustment—hand operated (Fig. 28)

The handbrake mechanism is set during initial assembly and will only require attention when replacement parts have been fitted or the length of the cable inadvertantly altered.

1. Chock the front wheels, release the handbrake and jack up the rear of the car.
2. Remove all slackness from the handbrake cable by slackening off the locknut and rotating the threaded sleeve, retighten the locknut.

   Correct adjustment can be ascertained by counting the clicks of hand lever travel, when five or six clicks will be heard.
3. Ensure that the brakes do not bind by rotating the rear wheels by hand.
4. Apply the handbrake, remove the jack and the chocks.

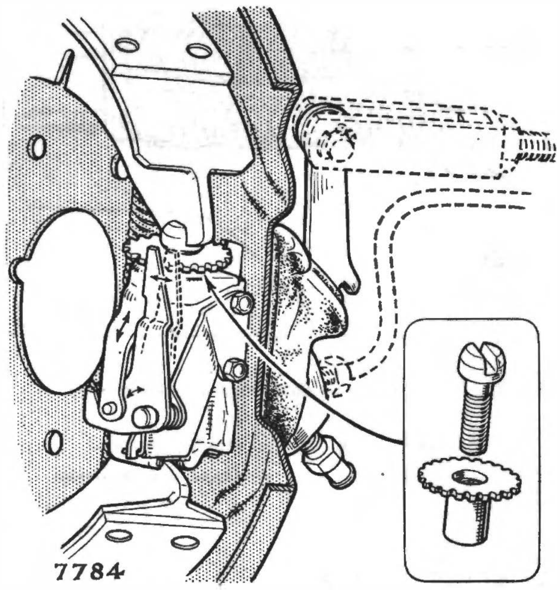


Fig. 27. *A left hand self adjusting wheel cylinder with arrows on the pawl linkage indicating the direction of travel as the brake is applied and released. The insert shows the screwed tappet and adjuster wheel.*

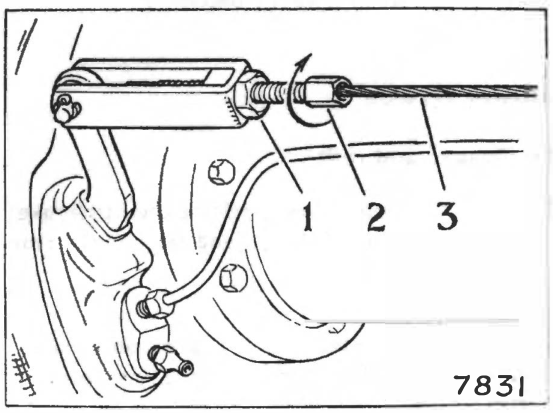


Fig. 28. *The handbrake cable adjuster, the arrow indicates the direction of rotation to shorten the cable.*

1. LOCKNUT. 2. THREADED SLEEVE.
3 INNER CABLE

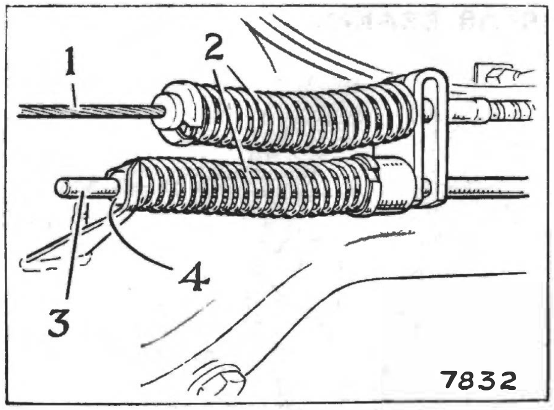


Fig. 29. *Return springs on the handbrake cable and rod.*

1. INNER CABLE. 2. RETURN SPRINGS.
3. BRAKE ROD. 4. BRAKE ROD BEARINGS.

LUBRICATION (Fig. 29)

At regular intervals, clean off and coat the pull off springs on the handbrake cable and rod together with the rod bearing on the rear axle differential casing with the recommended grease see under "Recommended Lubricants, Section P".

BRAKE SHOES

To remove and refit

1. Chock the front wheels, release the handbrake, Jack up the rear of the car and remove the rear wheel.

2. Remove the brake drum and distance piece, when fitted, by withdrawing a countersunk screw.

3. Withdraw the two brake shoe steady posts from the back plate by holding the head of the steady post and rotating the dished washer 90°.

4. Apply a rubber band to the wheel cylinder to retain the tappet and adjuster wheel in the head of the piston; identify the four holes in the brake shoe webs accommodating the two pull off springs.

5. Remove the heel ends of both brake shoes from the abutment opposite the wheel cylinder followed by the toe end of the trailing shoe from the wheel cylinder body; the tension of the pull off springs is released and the leading shoe can now be removed from the slot in the tappet.

6. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

   i. Ensure that the wheel cylinder moves freely within the back plate slot, when this condition is not evident determine and eliminate the cause of the stiffness.

   ii. Smear the slots in the fixed abutment, tappet and wheel cylinder body also the underside of the adjuster wheel sparingly with high melting point grease; screw, the tappet into the adjuster wheel to its fullest extent, the round headed tappet has a right hand thread and the hexagon headed tappet a left hand thread.

   iii. When fitting new brake shoes also fit new pull off springs and position the springs between the brake shoe webs and the back plate. The double coil spring is fitted adjacent to the wheel cylinder and using the outer large hole in the leading shoe and the outer hole of the two in the trailing shoe. The single coil spring is fitted adjacent to the abutment so that coil faces inward using the inner hole of the two in the leading shoe and the outer large hole in the trailing shoe.

   iv. Adjust the brakes by pumping the foot pedal.

WHEEL CYLINDERS

To remove and refit

1. Remove the brake shoes from the back plate, see under "Brake shoes—To remove and refit".

2. Detach the handbrake cable or rod from the wheel cylinder lever by withdrawing the spring clip from the clevis pin, removing the plain and spring washers and the clevis pin from the cable forkend or by releasing the spring clip from the upturned end of the brake rod.

3. Withdraw the hydraulic pressure pipe(s) from the wheel cylinder by releasing the union nut(s), trapping any escaping fluid in a drip tray.

4. Remove the wheel cylinder from the back plate by detaching the rubber dust cover and sliding the wheel cylinder in the back plate slot towards the piston end, then manoeuvring the opposite end out of the slot.

5. Refitting is the reverse of the removal sequence but particular attention must be given to the following:—

   i. Grease the back plate slot sparingly with high melting point grease, ensure that the wheel cylinder moves freely within the slot both before and after the rubber dust cover is fitted.

   ii. The brake shoes are fitted, see under "Brake shoes—To remove and refit".

   iii. When a new wheel cylinder is fitted, check the operation of the handbrake.

To dismantle and reassemble

1. Clean off all road dirt and when working on two wheel cylinders, identify them left or right hand.
2. Remove the tappet and adjuster wheel from the outer piston by removing the rubber band.
3. Withdraw the outer piston and pressing from the wheel cylinder; it will be necessary to rotate the piston a short distance to disengage the pin in the end of the pressing from the adjuster pawl.
4. Remove the adjuster pawl, tension spring and mounting plate from the wheel cylinder by withdrawing two bolts. Remove the lever by ejecting the pivot pin.
5. Eject the inner piston from the wheel cylinder by applying low pressure air to pressure pipe or bleed screw tappings.
6. Remove the rubber seals from the inner and outer pistons.
7. Reassembly is the reverse of the dismantling sequence but particular attention must be given to the following:—
   i. All parts must be meticulously clean and reassembled under equally clean conditions.
   ii. The tapered seal is fitted to the inner piston using a liberal coating of brake fluid and with the wider end of the taper away from the slotted end of the piston.
   iii. Smear the inner piston and seal with brake fluid and feed the piston, seal end first, into the body exercising care not to damage the fine edge of the seal and so the longest side of the slot in the piston aligns with the slot in the wheel cylinder body.
   iv. The rectangular seal is fitted to the outer piston using a liberal coating of brake fluid and fed into the wheel cylinder body, engage the pin at the end of the pressing in the groove in the adjuster pawl.
   v. The hexagon and round headed tappets have left and right hand threads respectively and are fitted to the right and left hand wheel cylinders respectively.

TYRES AND WHEELS

CONTENTS

TYRES AND WHEELS

TYRE EXAMINATION

Tyres should be examined regularly for:—

- Inflation pressures.
- Small objects embedded in the treads, such as flints and nails.
- Degree and regularity of tread wear.
- Misalignment.
- Cuts and penetrations.
- Damage due to impacts with kerbs, etc.
- Oil and grease.

Oil and grease should be removed by using petrol sparingly. If oil or grease on the tyres results from over-lubrication or defective oil sealing, suitable corrective action should be taken.

TYRE AND WHEEL BALANCE

In the interests of smooth riding, precise steering and high speed stability all tyres are balance checked to predetermined limits. Coloured spots may be found on one bead indicating the lightest part of the tyre, and should be fitted near the valve or, where inner tubes are fitted, in line with the coloured spots on the tube.

Some tyres may be found to have small balance correction patches affixed internally, which should on no account be disturbed.

Where balance weights have been fitted to the wheel rims, it is advisable to detach them before tyre removal to avoid the possibility of their inadvertently falling inside the tyre. If the same tyre is subsequently to be refitted, the positions and amounts of these balance weights as well as the position of the tyre on the wheel should be marked with chalk on the rim, so that subsequent replacement may restore the original balance as far as possible.

The original degree of balance is not necessarily maintained in service, as it may be affected by uneven tread wear, by cover or tube repairs or by tyre removal and replacement. Normal wear of moving parts may even render the car more sensitive to unbalance.

Rebalancing of tyre and wheel assemblies should be carried out with the aid of approved equipment capable of measuring both static and dynamic balance. It is important to note that this does not constitute a remedy for wheel distortion.

PRESSED STEEL WHEELS

Distortion.

Wheel lift and wobble. On a truly mounted and revolving wheel the difference between the high and low points measured at any location on either tyre seat (Fig. 1 at "A") should not exceed 0·070 in. (1·8 mm.). The lateral variation measured on the vertical inside face of the flange (Fig. 1 at "B" should not exceed 0·070 in. (1·8 mm.). The positions " C and D" may be used when the tyre is mounted on the rim.

Radial eccentricity greater than this figure may give rise to static unbalance and irregular tyre wear, while excessive lateral variation will affect dynamic balance.

It is impracticable to true distorted pressed steel wheels, and they should be replaced.

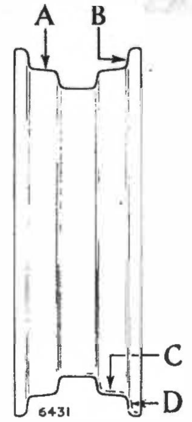


Fig. 1. *Check for wheel distortion at "A" and "B" but "C" and "D" when tyre is mounted*

Tightening. Wheel nuts should be free on their studs. When fitting a wheel all the nuts should initially be screwed up lightly, ensuring that their conical faces engage in the seatings in the wheel.

Final tightening should be done progressively by short turns of diagonally opposite nuts to obtain centralization and avoid distortion.

Wheels with damaged or elongated stud holes, resulting from slack nuts, should be replaced.

WIRE WHEELS

Occasionally the wheels should be removed and cleaned for the examination.

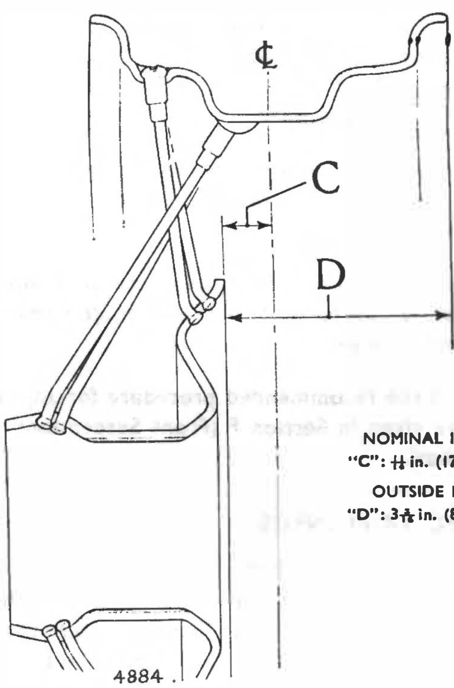


Fig. 2. *Wire wheel alignment—rim to hub*

The wire wheels fit on splined hubs and are secured by a nut. On earlier cars, lug–type hub nuts were fitted, whilst from chassis number B9101257, cars were fitted with octagonal hub nuts. When the latter type of nut is fitted, a spanner is provided in the tool kit for removal purposes.

Hub nuts on the right-hand side of the car are removed by turning them **clockwise**, those on the left-hand side by turning them **anti-clockwise**. The nuts should be loosened slightly before the car is jacked up, and finally tightened with the car on the ground. If possible the car should be run a short distance to settle the wheels on the splines and the nuts re–tightened.

Extreme care must be taken to ensure that the 'O' ring on the conical seat of the hub is not damaged in any way when removing or refitting the wheels.

On removing the wheels, the following items should be examined:—

Spokes. Wire wheels are built with a predetermined spoke tension, which provides a very slight amount of flexibility under running conditions; it is important that this tension is maintained in service and should be checked at regular intervals.

Looseness can be corrected and damaged spokes replaced, but care must be taken not to affect the alignment of the rim relative to the hub shell (See Fig. 2). Spoke tensioning should be carried out with the tyre and tube removed so that any protruding spoke heads may be filed off flush to the nipple.

If the condition of the wheel is in doubt, or if extensive trueing or re-spoking is required, it is strongly recommended that a wheel specialist be consulted.

Hub tapers and serrations. Any surface corrosion should be cleaned off, and the extent of wear noted. Wear at the serrations can be minimised by regularly ensuring that the hub caps are fully tightened. A light coating of grease should be applied to the serrations both to protect them from corrosion and to facilitate the removal and replacement of the wheel.

It is very important to ensure that the tapers are clean before the wheel is fitted. If necessary, the tapers should be emeried and polished to remove all dirt and rust; all mating faces should then be well greased.

CHANGING POSITION OF TYRES

Road and traffic conditions and driving methods may produce a tendency to irregular tread wear or different rates of wear between one tyre and another.

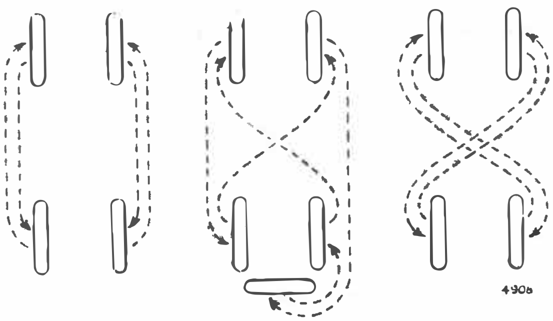


Fig. 3. *Methods of interchanging wheels and tyres*

Steeply cambered roads, for instance, tend to cause more rapid wear of the near-side front tyre than of the others.

To minimise such effects, it is recommended that front tyres be interchanged with rear tyres at regular intervals. Diagonal interchanging provides the most satisfactory first change because it reverses the directions of rotation.

Subsequent interchanging of front and rear tyres should be as indicated by their appearance, with the object of keeping the wear of all treads even and uniform. Change tyres round without removing from wheels.

Methods of interchanging tyres and wheels are illustrated in Fig. 3. It should be noted that where wire wheels are fitted, the offside hub should never be fitted to the nearside and vica versa. The offside hubs are marked RHS and the nearside LHS.

NYLON TYRES

Nylon tyres may develop temporary flatting after standing for some time and cooling off, following a long run during which high temperatures have been reached.

These flat spots can be run out quite quickly but it may be necessary to approach the speeds and temperatures which have led to the flatting. For example, flats on tyres which have developed after a long fast run may be difficult to remove if the car is then used for local "pottering" especially if the weather has become colder and wetter.

Before balancing nylon tyres it is desirable to ensure that the flats have been fully run out, otherwise a false reading may be obtained.

WHEEL ALIGNMENT

Tyre wearing qualities are dependent to a large extent on the maintenance of correct wheel alignment and steering geometry.

A regular check should be made of the dimensions involved. *This is particularly important after repairs to accident damage.*

Details of the recommended procedure for adjustment are given in Section F (Front Suspension) of this manual.

WHEEL TRIM DISCS

A wheel trim disc is fitted to each of the four roadwheels and therefore must be removed from the wheel before the spare is fitted. The disc has a hole for the tyre valve and is held in position by the nave plate.

To remove and refit

1. Remove the nave plate from the roadwheel.
2. Ease the wheel trim disc from three nave plate studs.
3. Refitting is the reverse of the removal.

ELECTRICAL EQUIPMENT

CONTENTS

ELECTRICAL SYSTEM

Years of experience have proved Lucas electrical equipment to be very realiable and efficient. Periodical maintenance, however, must not be neglected if the best results are to be obtained from the system.

If trouble is experienced with any of the electrical equipment it is important that the exact source is quickly located by following an orderly course of investigation. Random probing among units of the system is useless and often incurs much unwarranted expense without locating the true source of trouble.

Trouble in the system can generally be immediately localised to a particular unit of the system by its very nature. Further localisation, in order to trace its exact source within the faulty unit, should then be carried out by following the series of testing operations laid down under the appropriate section.

It is important to note, however, that these **tests cannot be satisfactorily carried out unless the equipment recommended is available.** Further, it will be seen that special equipment is needed for dismantling and reassembling some units of the system and **should this equipment not be available dismantling must not be attempted.**

It is recommended that the fullest use is made of the very extensive Lucas Service System. New units and reconditioned exchange units are always available at these Service Depots.

The electrical system is a 12 volt earth return type. It can be broken down into the following units:—

1. Battery.
2. Generator, control box and fuse unit.
3. Starter and starter switch.
4. Ignition system (coil, distributor and plugs).
5. Lamps, switches, direction indicators, windscreen wipers, etc.

BATTERY

GENERAL

The battery is of the "clean-top" pattern, having submerged intercell connectors to minimise the risk of corrosion. Diecast cable connectors are fitted, retained with screws.

The battery fitted to the Alpine is positioned in a well under the floor behind the right-hand seat, and is accessible for topping up and testing after the cover plate has been removed.

The battery fitted to the Rapier is positioned in the engine compartment.

Batteries are supplied either filled and charged, unfilled and uncharged, or "dry-charged", that is with the cells in a charged condition but sealed and without electrolyte. Details of preparing unfilled, uncharged and "dry-charged" batteries are given in later paragraphs.

MAINTENANCE

Battery maintenance consists mainly of regular inspection and servicing.

1. Keep the battery and its surroundings clean and dry. Give particular attention to the top of the battery to prevent electrical leakage between the cell terminals.
2. Remove the vent plugs, and see that the vent holes are clear.
3. Check the electrolyte level and top up, when necessary. The correct level is just to the perforated splash guard. Do not over-fill or acid will escape through the vent holes with detrimental effect to the connections and adjacent parts of the car.

   The use of a Lucas Battery Filler will be found helpful in this topping-up process, as it ensures that the correct electrolyte level is automatically obtained and also prevents distilled water from being spilled over the top of the battery.

Distilled water should always be used for topping-up. In an emergency, however, drinking water, clean rainwater or melted snow may be used. The following waters must not be used: salt water, chlorinated water, chemically softened water or stagnant water.

Caution.—Never use a naked light when examining a battery, as the mixture of oxygen and hydrogen given off by the battery when on charge, and to a lesser extent when standing idle, can be dangerously explosive.

If a battery is found to need an excessive amount of topping-up, the cause should be sought. If an excessive charge is suspected, check the regulator setting. If one cell in particular is at fault, examine the container for cracks.

Note.—Never transfer electrolyte from one cell to another.

4. With the diecast type of connector no corrosion difficulties arise. When fitting the connectors to the battery, first smear the inside of the tapered hole of the connector with silicone grease and push on the connector by hand.

   Insert the self-tapping screw and tighten with medium pressure only; fill in the recess around the screw head with more silicone grease. If the connectors are fitted dry, and driven home with too much force, they may be difficult to remove at a later date.

5. Examine the earth connection to ensure that it is clean and free from rust or corrosion.

6. Measure the specific gravity of the electrolyte in each cell in turn, with a hydrometer. The reading given by each cell should be approximately the same; if one cell differs appreciably from the others, an internal fault in the cell is indicated. This will probably be confirmed by the heavy discharge test described later.

   The appearance of the electrolyte drawn into the hydrometer when taking a reading gives a useful indication of the state of the plates; if it is very dirty, or contains small particles in suspension, it is possible that the plates are in a bad condition.

   Check the specific gravity of the electrolyte (Refer to Fig. I) as an indication of the state of charge of the battery using a hydrometer.

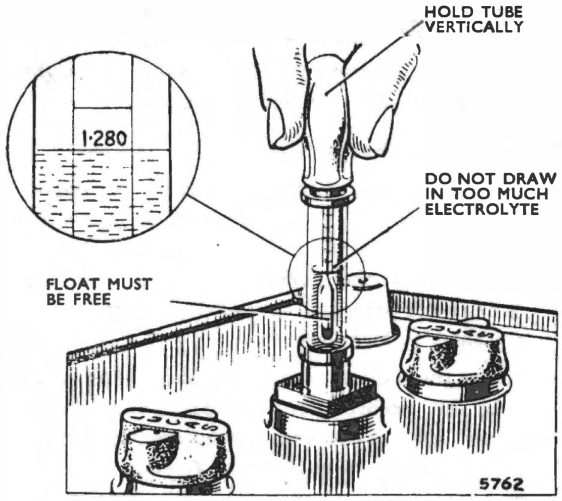


Fig. I. *Taking hydrometer readings. Take readings at eye level*

The specific gravities and their indications are as follows:

Climate ordinarily below	80°F. (26·7°C).
Cell fully charged	1·270 — 1·290
Cell half charged	1·190 — 1·210
Cell fully discharged	1·110 — 1·130
Climate ordinarily above	80°F. (26·7°C).
Cell fully charged	1·210 — 1·230
Cell half charged	1·130 — 1.150
Cell fully discharged	1·050 — 1·070

The specific gravity of electrolyte varies with its temperature. The figures quoted above are for an electrolyte temperature of 60°F. (15·6°C). If the electrolyte tempreture is above 60°F. (15·6C.) add 0·002 to the hydrometer reading for each 5°F. (2·8°C.) rise to obtain true specific gravity. Similarly 0·002 must be deducted from the hydrometer reading for each 5°F. (2·8°C.) below 60°F. (15·6°C.).

If the level of the electrolyte is so low that a hydrometer reading cannot be taken, no attempt should be made to take a reading after adding distilled water until the battery has been on charge for at least thirty minutes.

Note.—If the car 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 recharged about every fortnight from an independent electric supply.

7. **Heavy Discharge Test**

A heavy discharge tester consists of a centre-zero voltmeter, 2 or 3 volts full scale, across which is connected a shunt resistance capable of carrying the current involved. Pointed prongs are provided for making contact with the inter-cell connectors.

Pierce the indentations in the battery top with a heated, pointed tool and press the contact prongs against the exposed positive and negative terminals of each cell. A good cell will maintain a reading of 1·2-1·5 volts, depending on the state of charge, for at least 6 seconds. If, however, the reading rapidly falls, the cell is probably faulty and a new plate assembly may have to be fitted.

Remember that if the battery is subjected to heavy loads (i.e., long periods of night parking with lights on) without suitable opportunities for recharging, a low state of charge is only to be expected. A fault in the dynamo or regulator, or neglect during a period out of commission, may also be responsible for any trouble.

RECHARGING FROM AN EXTERNAL SUPPLY

If tests indicate that the battery is discharged, but is otherwise in good condition, it should be re-charged, either on the vehicle by a period of daytime running or on the bench from an external supply. If the latter, the battery should be charged at 5 amperes until the specific gravity and voltage show no increase over three successive hourly readings. During the charge the electrolyte must be kept level with the tops of the separator guard by the addition of distilled water. Re-charge rates are as follows:—

BT 7A Batteries (43 ampere-hour) 4 amps.
BV 9-11A Batteries (67 ampere-hour) 6 amps.

Do not allow the temperature of the electrolyte to exceed the maximum permissable temperature during charging, *i.e.*,

Climates below 80°F. (26·7°C.)	100°F. (37·8°C.)
Climates above 80°F. (26·7°C.)	120°F. (48·9°C.)

A battery in which all cells show a general falling off in efficiency will often respond to the process known as "cycling". This process consists of fully charging the battery as described above, and then discharging it by connecting to a lamp board, or other load, at the same rate. The battery should be capable of providing this current for at least 7 hours before it is fully discharged, as indicated by the voltage of each cell falling to 1·8. If the battery discharges in a shorter time, repeat the "cycle" of charge and discharge.

PREPARING NEW BATTERIES FOR SERVICE

Batteries for the home market are normally supplied dry and uncharged; in this event the instruction in para. (*a*) should be followed.

Batteries for export markets are supplied "dry-charged". Before fitting to the vehicle the battery must be filled with acid as described in paragraph (*b*); no initial charging is necessary, although, if time permits a short freshening charge is advantageous.

Preparation of Electrolyte

Electrolyte of the specific gravity given below is prepared by mixing distilled water and concentrated sulphuric acid, usually of 1·835 S.G. The mixing must be carried out either in a lead-lined tank or in suitable glass or earthenware vessels. Slowly add the acid to the water, stirring with a glass rod. Never add the water to the acid as the resulting chemical reaction causes violent and dangerous spurting of the concentrated acid. The approximate proportions of acid and water are indicated in the table.

To obtain specific gravity (corrected to 60°F. (1·56°C.) of:	*Add 1 vol. of acid of 1·835 S.G. (corrected to 60°F. (1·56°C.) to:*
1·260 (Climates below 80°F. (26·7°C.)	3·0 volumes of water
1·210 (Climates above 80°F. (26·7°C.)	4·0 volumes of water

Heat is produced by the mixture of acid and water, and the electrolyte should be allowed to cool before taking hydrometer readings—unless a thermometer is used to measure the actual temperature, and a correction applied to the reading as previously described—and before pouring the electrolyte into the battery. The total volume of electrolyte required is 4½ pints (2·66 litres) for BT 7A batteries and 7½ pints (4·3 litres) for BV 11A batteries.

(*a*) UNCHARGED BATTERIES

Filling the Cells

The temperature of the acid, battery and filling-in room must be not below 32°F. (0°C.). Carefully break the seals in the filling holes and half fill each cell with electrolyte of the appropriate specific gravity. Allow the battery to stand for at least six hours, in order to dissipate the heat generated by the chemical action of the acid on the plates and separators, and then add sufficient electrolyte to fill each cell to the top of the separator guard. Allow to stand for a further two hours and then proceed with the initial charge.

Initial Charge

The initial charging rate is 2·5 amperes for BT 7A batteries and 3·5 amperes for BV9-11A batteries. Charge at this rate until the voltage and specific gravity readings show no increase over five successive hourly readings. This will take from 40 to 80 hours, depending on the length of time the battery has been stored before charging.

Keep the current constant by varying the series resistance of the circuit, or the generator output. This charge should not be broken by long rest periods. If, however, the temperature of any cell rises above maximum quoted:

Climate below 90°F. (32°C).	100°F· (38°C).
Climate above 90°F. (32°C).	120°F. (49°C).

The charge must be interrupted until the temperature has fallen at least 10°F. (6°C.) below that figure. Throughout the charge the electrolyte must be kept level with the top of the separator guard by the addition of more electrolyte as required.

At the end of the charge carefully check the specific gravity in each cell to ensure that, when corrected to 60°F. (15·6°C.), it lies within the specific limits. If any cell requires adjustment, some of the electrolyte must be syphoned off and replaced either by distilled water or by acid of the strength originally used for filling-in, depending on whether the specific gravity is too high or too low. Continue the charge for an hour or so to ensure adequate mixing of the electrolyte and again check the specfic gravity readings. If necessary, repeat the adjustment process until the desired reading is obtained in each cell. Finally, allow the battery to cool and syphon off any electrolyte above the tops of the separators.

(*b*) "DRY-CHARGED" BATTERIES

Electrolyte of the appropriate specific gravity, either 1·270 or 1·210, is prepared as previously described.

Filling the Cells

Carefully break the seals or remove the tape (as applicable) and fill each with electrolyte to the tops of the separators, **in one operation.** The temperature of the filling room, battery and electrolyte should be maintained between 60°F. (15·6°C.) and 100°F. (38°C.). If the battery has been stored in a cool place it should be allowed to warm up to room temperature before filling.

Batteries filled in this way are 90 per cent. charged and may be used after a standing period of one hour. When time permits, however, a short freshening charge will ensure that the battery is fully charged. Such a freshening charge should last for no more than 4 hours, at the normal recharge rate of the battery. During the charge the electrolyte must be kept level with the top edge of the separators by the addition of distilled water. Check the specific gravity of the acid at the end of the charge; if 1·260 acid was used to fill the battery, the specific gravity should now be between 1·270 and 1·290; if 1·210, between 1·210 and 1·230.

GENERATOR

GENERAL

The generator is a shunt-wound, two-pole, two-brush machine, arranged to work in conjunction with a Lucas regulator unit. A fan, integral with the driving pulley, draws cooling air through the generator, inlet and outlet holes being provided in the end brackets of the unit. The armature is supported at the drive-end in a ball race bearing and at the commutator-end in a porous bronze bush.

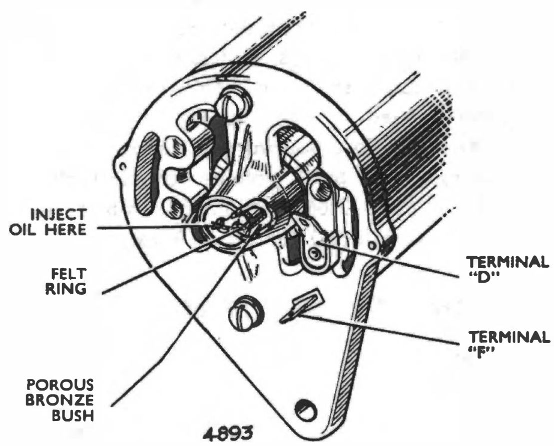


Fig. 2. *Generator lubrication*

ROUTINE MAINTENANCE

Lubrication

Inject a few drops of engine oil into hole marked "OIL" at the end of the C.E. bearing housing (See Fig. 2). The felt ring acts as a reservoir.

Inspection of Brushgear

The brushgear should be inspected periodically (See page 7).

Belt Adjustment

See Section "B" of this manual.

PERFORMANCE DATA

(See General Data).

SERVICING

Testing in Position to Locate Fault in Charging Circuit

In the event of a fault in the charging circuit, adopt the following procedure to locate the cause of trouble.

1. Inspect the driving belt and adjust if necessary (see Section B).

2. Check the Lucar connections on the commutator-end bracket. The larger connector carries the main generator output, the smaller connector the field current (see Fig. 2).

3. Switch off all lights and accessories, pull off the connectors from the terminals of the generator and connect the two terminal blades with a short length of wire.

4. Start the engine and set to run at normal idling speed.

5. Clip the negative lead of a moving coil type voltmeter, calibrated 0-20 volts, to one generator terminal and the positive lead to a good earthing point on the yoke.
6. Gradually increase the engine speed, when the voltmeter reading should rise rapidly and without fluctuation. Do not allow the voltmeter reading to reach 20 volts, and do not race the engine in an attempt to increase the voltage. It is sufficient to run the generator up to a speed of 1,000 r.p.m. If the voltage does not rise rapidly and without fluctuation the unit must be dismantled for internal examination.

   Excessive sparking at the commutator in the above test indicates a defective armature which must be renewed.

Note.—If a radio suppression capacitor is fitted between the output terminal and earth, disconnect this capacitor and re-test the generator before dismantling. If a reading is now given on the voltmeter, the capacitor is defective and must be renewed.

If the generator is in good order, remove the link from between the terminals and restore the original connections.

To Dismantle (See Fig. 3)

1. Take off the driving pulley and Woodruff key.
2. Unscrew and withdraw the two through bolts (11).
3. Withdraw the commutator-end bracket (1) from the yoke (6).
4. Lift the driving-end bracket and armature assembly from the yoke. Take care not to lose the fibre thrust washer (5) from the commutator end of the shaft.
5. The driving-end bracket, which on removal from the yoke has withdrawn with it the armature and armature shaft ball-bearing, need not be separated from the shaft unless the bearing is suspected and requires examination, or the armature is to be replaced; in this event the armature should be removed from the end bracket by means of a hand press.

Brushgear (Checking with yoke removed)

1. Lift the brushes up into the brush boxes and secure them in that position by positioning the brush springs at the sides of the brushes (see Fig. 4)(A).
2. Fit the commutator-end bracket over the commutator and release the brushes.
3. Hold back each of the brush springs and move the brush by pulling gently on its flexible connector. If the movement is sluggish, remove the brush from its holder and ease the sides by lightly polishing on a smooth file. Always refit brushes in their original positions. If the

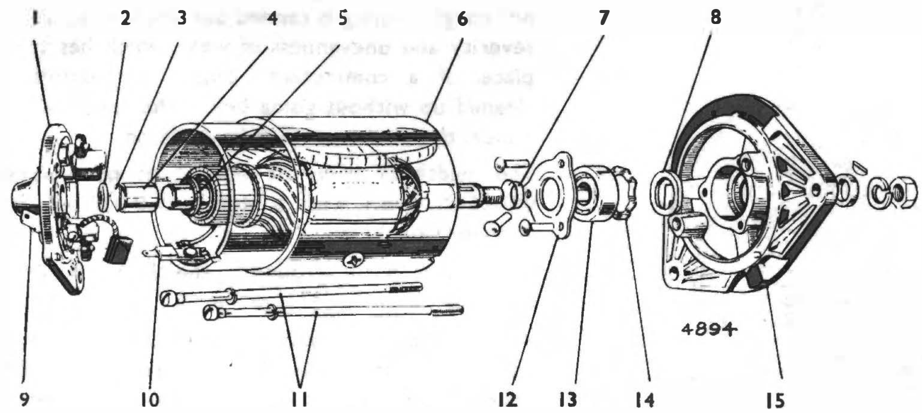


Fig. 3 *Exploded view of generator*

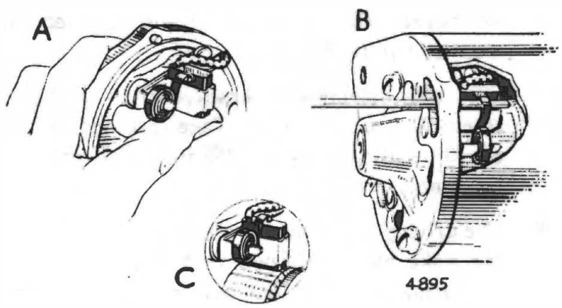


Fig. 4. *Assembling end bracket and brushes to generator*

brushes are badly worn, new brushes must be fitted and bedded to the commutator. The minimum permissible length of brush is $\frac{1}{4}''$. (6 mm.).

4. Test the brush spring tension using a spring scale (See Fig. 5). The tension of the spring when new is 15/25 oz. (·42/·71 kgs.) when exerted on a new brush. Fit new springs if the tension is low.

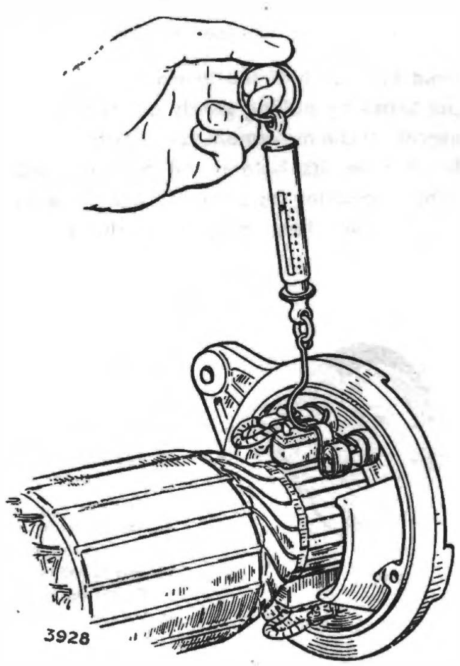
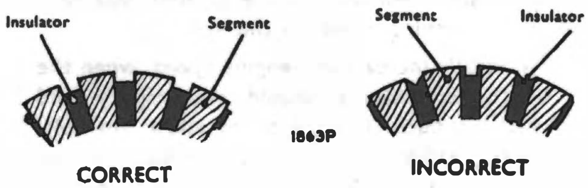


Fig. 5. *Testing brush spring tension*

Commutator

A commutator in good condition will be smooth and free from pits or burned spots.



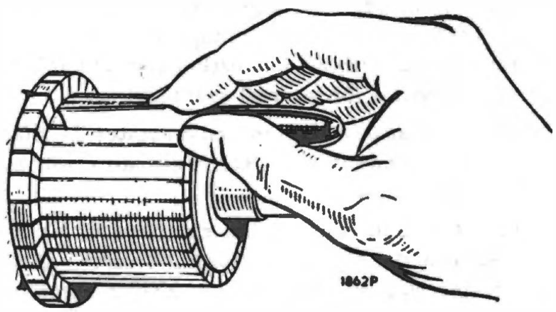


Fig. 6 *Undercutting commutator insulation*

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.

The commutator is of moulded construction and can be re-skimmed during service, but care must be exercised to ensure that the finished diameter is not less than 1·450" (36·8 mm.). The process of re-skimming consists of rough turning, undercutting and diamond turning—in that order. Whether or not rough turning is carried out depends upon the severity and unevenness of wear which has taken place. If a commutator cannot be completely cleaned up without going below the specified diameter, the armature must be replaced.

The width of undercut slots must not exceed 0·040" (1 mm.) with a depth of 0·020"—0·035" (0·5— 0·9 mm.).

A hacksaw blade ground to the thickness of the insulator can be used. (See Fig. 6).

If a non-diamond-tipped tool is used for machining, the commutator should afterwards be lightly polished with a very fine glass-paper—**never emery cloth.**

Armature

Indication of an open-circuited armature winding will be given by burnt commutator segments. If armature testing facilities are not available, an armature can be checked by substitution.

To separate the armature shaft from the drive-end bracket, press the shaft out of the drive-end bracket bearing. When fitting the new armature, support the inner journal of the ball bearing, using a mild steel tube of suitable diameter, whilst pressing the armature shaft firmly home (See also "To re-assemble", page 10).

Field Coils

Measure the resistance of the field coils, without removing them from the generator yoke, by means of an ohm meter connected between the field terminal and the yoke.

Field resistance is 5·9 ohms.

If an ohm meter is not available, connect a 12-volt d.c. supply between the field terminal and generator yoke with an ammeter in series. The reading should be approximately 2 amperes. Zero reading on the ammeter or an "Infinity" ohm meter reading indicates an open circuit in the field winding.

If the current reading is much more than 2 amperes, or the ohm meter reading much below 5·9 ohms, it is an indication that the insulation of one of the field coils has broken down.

In either event, unless a replacement generator is available, the field coils must be replaced. To do this, carry out the procedure outlined below:—

1. Drill out the rivet securing the field coil terminal assembly to the yoke, and remove the insulated sleeve from the terminal blade to protect it from the heat of soldering.
2. Unsolder the terminal blade and earthing eyelet.
3. Remove the insulation piece which is provided to prevent the junction of the field coils from contacting with the yoke.
4. Mark the yoke and pole shoes so that the latter can be fitted in their original positions.
5. Unscrew the two pole shoe retaining screws by means of a wheel-operated screwdriver (See Fig. 7).
6. Draw the pole shoes and coils out of the yoke and lift off the coils.

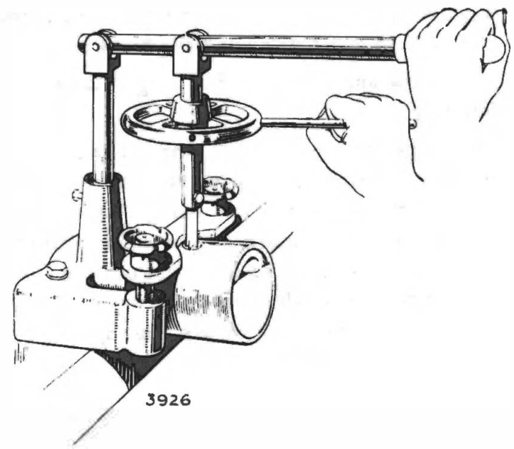


Fig. 7. *Unscrewing pole retaining screws*

7. Fit the new field coils over the pole shoes and place them in position inside the yoke. Take care to ensure that the taping 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 fixing screws.
9. Fully tighten the screws by means of the wheel-operated screwdriver.
10. Solder the terminal blade and earthing eyelet to the appropriate coil ends.
11. Refit the insulating sleeve and re-rivet the terminal assembly to the yoke.
12. Refit the insulation piece behind the junction of the two coils.

Bearings

Bearings which are worn to such an extent that they will allow side movement of the armature shaft, must be renewed.

To replace the bearing bush in the commutator-end bracket, proceed as follows:—

1. Remove the old bearing bush from the end bracket. The bearing can be withdrawn with a suitable extractor or by screwing a $\frac{5}{8}$" tap into the bush for a few turns and pulling out the bush with the tap. Screw the tap squarely into the bush to avoid damaging the bracket.
2. Withdraw and clean the felt ring retainer and felt ring.
3. Insert the felt ring and felt ring retainer in the bearing housing, then 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, until the visible end of the bearing is flush with the inner face of the bracket (See. Fig. 8).

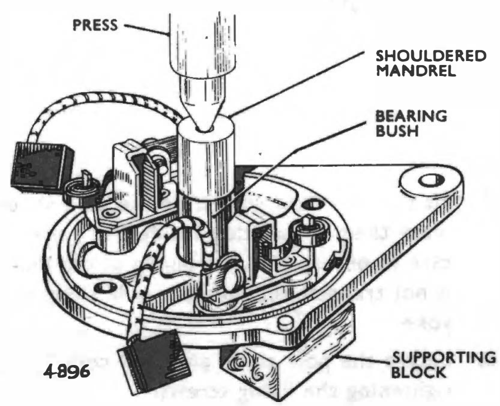


Fig. 8. *Fitting commutator end brush*

Porous bronze bushes must not be opened out after fitting, or the porosity of the bush may be impaired.

Note.—Before fitting the new bearing bush, it should be allowed to stand for 24 hours completely immersed in engine oil; this will allow the pores of the bush to be filled with lubricant.

The ball bearing at the driving end is renewed as follows (See Fig. 3):—

1. Drill out the rivets which secure the bearing retaining plate (12) to the end bracket and remove the plate.
2. Press the bearing (13) out of the end bracket and remove the corrugated washer (14), and felt ring (8).
3. Before fitting the replacement bearing, see that it is clean and pack it with high melting point grease.
4. Place the felt ring and corrugated washer in the bearing housing in the end bracket.
5. Locate the bearing in the housing and press it home.
6. Fit the bearing retaining plate.
7. Insert new rivets from the pulley side of the end bracket and open the rivets over the plate by means of a punch to secure the rigidly in position.

To Reassemble

1. Fit the drive end bracket to the armature shaft The inner journal of the bearing must be supported by a tube, approximately 4" (10·16 cm.) long, $\frac{1}{8}$" (3 mm.) thick and internal diameter $\frac{5}{8}$" (1·6 cm.). **Do not use the drive end bracket as a support for the bearing whilst fitting an armature.**
2. Fit the yoke to the drive-end bracket.
3. Push the brushes up into the brush boxes and secure them in that position by positioning each brush spring at the side of its brush (See Fig. 4, (A).
4. Fit the fibre thrust washer(s) and commutator-end bracket to the yoke so that the dowel on the bracket locates with the groove in the yoke. Take care not to trap the brush connectors.
5. Insert a thin screwdriver through the ventilator holes adjacent to the brush boxes and gently lever up the spring arms until the brushes correctly locate with the commutator (See Fig. 4,) (A) and (B).
6. Refit the two through bolts.
7. After reassembly lubricate the commutator-end bearing (see page 6).

CONTROL BOX

Equipment and General

We have tested and recommend the Avo Model 12 (obtainable from Avo Ltd., 92-96 Vauxhall Bridge Road, London S.W.1.) which has been designed specially for automotive use and enables a very wide range of checking operations to be carried out with a single instrument.

The control box houses the generator voltage regulator unit and the cut-out.

Although combined structurally, the regulator and cut-out are electrically separate. Both are accurately adjusted during manufacture, and the cover protecting them should not be removed unnecessarily.

The Regulator

The regulator unit is arranged to work in conjunction with the shunt-wound generator. The regulator is set to maintain a predetermined generator voltage at all speeds above the regulating point, the field strength being controlled by the automatic insertion of a resistance in the generator field circuit. When the generator voltage reaches a predetermined value, the magnetic field due to the shunt or voltage winding becomes sufficiently strong to attract the armature. This causes the contacts to open, thereby inserting the resistance in the field circuit.

The consequent reduction in field current lowers the generator voltage and this, in turn, weakens the magnetic field due to the voltage coil. The armature is allowed to return to its original position, thus closing the contacts, so that the voltage returns to the predetermined maximum. The cycle is then repeated and the armature is set into vibration.

As the speed of the generator rises above that at which the regulator comes into operation the amplitude of vibration increases and the periods of interruption increase in length, with the result that the mean value of the generator voltage undergoes practically no increase once the operating speed has been attained.

The series or current winding provides a compensation on this system of control, for if the control were arranged entirely on the basis of voltage there would be a risk of very seriously overloading the generator when the battery was in a low state of charge, particularly if the lamps were simultaneously in use. Under these conditions, with a battery of low internal resistance, the generator would be forced to give an output to bring the voltage of the system up to the same value as if the battery were fully charged. This would necessitate an extremely heavy current, far beyond the normal capacity of the machine. The series winding assists the voltage coil so that when the generator is delivering a heavy current into a discharged battery the regulator comes into operation at a somewhat reduced voltage, thus limiting the output accordingly. A split series winding is used, the centre tapping carrying the battery charging current while the complete winding carries lighting and ignition loads.

By means of a temperature compensation device the voltage characteristic of the generator is caused to conform more closely to that of the battery under

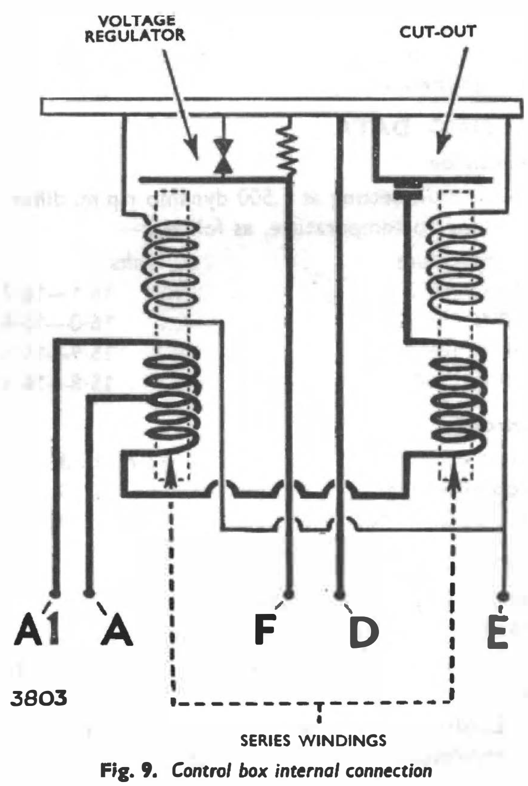


Fig. 9. *Control box internal connection*

all climatic conditions. In cold weather the voltage required to charge the battery increases, whilst in warm weather the voltage of the battery is lower. The method of compensation takes the form of a bi-metallic spring suspension for the armature of the regulator which causes the operating voltage of the regulator to be increased in cold weather and reduced in hot weather, and thereby to compensate for the variations in charging current which would otherwise occur due to the changing characteristics of the battery.

The Cut-out

The cut-out is an automatic switch connected between generator and battery. It consists of a pair of contacts held open by a spring and closed magnetically when the engine is running fast enough to cause the generator voltage to exceed that of the battery. The battery will then be charged by the generator. On the other hand, when the speed is low or the engine is stationary the contacts open, thus disconnecting the generator from the battery and preventing current flowing from the battery through the windings.

SETTING DATA

Regulator

Open circuit setting at 1,500 dynamo r.p.m. differs according to temperature, as follows:—

Temperature	*Volts*
10°C. (50°F.)	16·1—16·7
20°C. (68°F.)	16·0—16·6
30°C. (86°F.)	15·9—16·5
40°C. (104°F.)	15·8—16·4

Cut-out

Cut-in voltage	12·7—13·3
Drop-off voltage	8·5—11·0
Reverse Current	3·5— 5·0 amp

SERVICING

Testing in position to locate fault in charging circuit

If the generator and battery are in order, check as follows:—

1. Ensure that the wiring between battery and regulator is in order. To do this, disconnect the

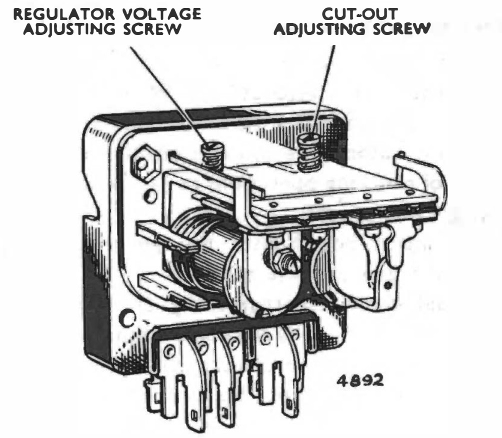


Fig. 10. *Cut-out and regulator assembly*

wire from control box terminal "A" and connect the end of the wire removed to the negative terminal of voltmeter.

   Connect the positive voltmeter terminal to an earthing point on the chassis. If a voltmeter reading is given, the wiring is in order and the regulator must be examined.

2. If there is no reading, examine tne wiring between battery and control box for defective cables or loose connections.
3. Re-connect the wire to terminal "A".

Regulator Adjustment

The regulator is carefully set during manufacture and, in general, it should not be necessary to make further adjustments. If, however, the battery does not keep in a charged condition, or if the generator output does not fall when the battery is fully charged, the setting should be checked and, if necessary, corrected.

It is important before altering the regulator setting to check that the low state of charge of the battery is not due to a battery defect or to slipping of the generator belt.

(1) *Electrical Setting*

It is important that only a good quality MOVING COIL VOLTMETER (0-20 volts) is used when checking the regulator. The electrical setting can be checked without removing the cover from the control box.

Withdraw the cables from control box terminals "A" and "A1" and connect these cables together.

Connect the negative lead of the voltmeter to control box terminal "D" and connect the other lead to terminal "E".

Slowly increase the speed of the engine until the voltmeter needle "flicks" and then steadies. This should occur at a voltmeter reading between the appropriate limits given according tothe ambient temperature.

If the voltage at which the reading becomes steady occurs outside these limits, the regulator must be adjusted.

Stop the engine and remove the control box cover. Turn the voltage adjusting screw in a clockwise direction to raise the setting or an anti-clockwise direction to lower the setting. Turn the screw only a fraction of a turn at a time. Repeat as above until the correct setting is obtained.

Adjustment of regulator open-circuit voltage should be completed within 30 seconds, otherwise heating of the shunt winding will cause false settings to be made.

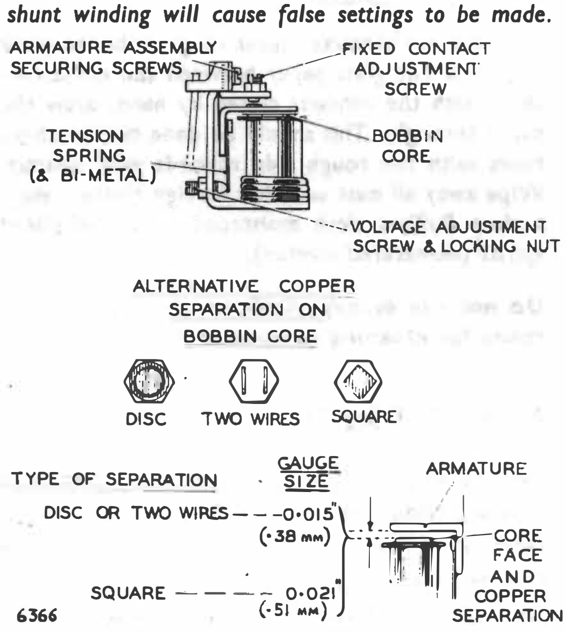


Fig. 11. *Setting of regulator*

Remake the original connections.

A generator run at high speed on open circuit will build up a high voltage. Therefore, when adjusting the regulator do not run the engine up to more than half speed or a false setting will be made.

(2) *Mechanical Setting*

The mechanical or air-gap settings of the regulator, shown in Fig. 11, are accurately adjusted before leaving the works and, provided that the armature carrying the moving contact is not removed, these settings should not be tampered with. If, however, the armature has been removed, the regulator will have to be reset. To do this proceed as follows:—

Slacken the fixed contact locking nut and unscrew the contact screw until it is well clear of the armature moving contact.

Slacken the voltage adjusting screw until it is well clear of the armature tension spring.

Slacken the two armature assembly securing screws.

Insert a gauge of appropriate thickness (Refer to Fig. 11) between the armature and the copper separation. The gauge must be wide enough to cover the core face completely. Take care not to turn up or damage the copper disc, wires or square.

(3) *Cleaning Contacts*

After long periods of service it may be found necessary to clean the regulator contacts. Clean the contacts by means of fine carborundum stone or fine emery cloth.

Carefully wipe away all traces of dust or other foreign matter with methylated spirit (de-natured alcohol).

Cut-out Adjustment (Fig. 12)

(1) *Electrical Settings*

If the regulator is correctly set but the battery is still not being charged, the cut-out may be out of adjustment. To check the voltage at which the cut-out operates, remove the control box cover and connect the voltmeter between terminals "D" and "E". Start the engine and slowly increase its speed until the cut-out contacts are seen to close,

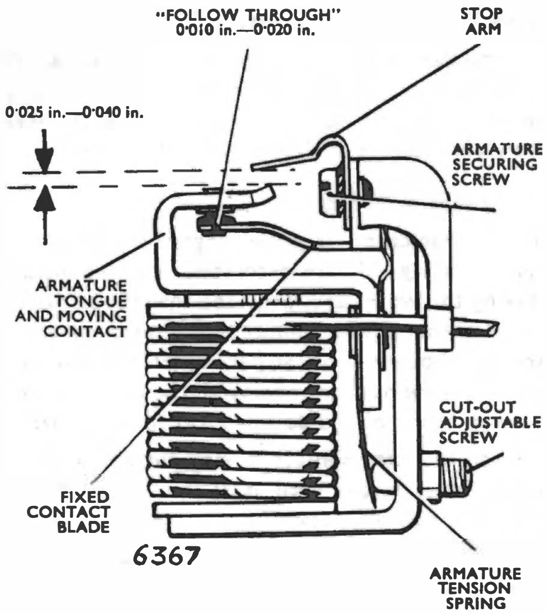


Fig. 12. *Mechanical setting of cut-out*

noting the voltage at which this occurs. This should be 12·7—13·3 volts.

If operation of the cut-out takes place outside these limits, it will be necessary to adjust. To do this, turn the cut-out adjusting screw (see Fig. 12) in a clockwise direction to raise the voltage setting or in an anti-clockwise direction to reduce the setting. Turn the screw only a fraction of a turn at a time. Test after each adjustment by increasing the engine speed and noting the voltmeter readings at the instant of contact closure. Electrical settings of the cut-out, like the regulator, must be made as quickly as possible because of temperature-rise effects. If the cut-out does not operate, there may be an open circuit in the wiring of the cut-out and regulator unit, in which case the unit should be removed for examination or renewal.

(2) *Mechanical Setting*

If for any reason the cut-out armature has to be removed from the frame, care must be taken to obtain the correct air-gap settings on reassembly. These can be obtained as follows:—

Unscrew the cut-out adjusting screw until it is well clear of the armature tension spring.

Slacken the two armature securing screws.

Press the armature **squarely** down against the copper-sprayed core face and re-tighten the armature securing screws. No gauge is necessary.

Press the armature **squarely** down against the core face and, using a pair of snipe-nosed pliers, adjust the gap between the armature stop arm and the tongue to between 0·025 in. and 0·040 in. by carefully bending the stop arm.

Adjust the fixed contact blade to give a "follow through", or blade deflection, of between 0·010. in. (0·254 mm.) and 0·020 in. (0·508 mm.) when the armature is pressed **squarely** down against the core face.

Re-set the cut-out adjusting screw as described under Para. (1).

(3) *Cleaning Contacts*

If the cut-out contacts appear rough or burnt, place a strip of fine glass paper between the contacts—then, with the contacts closed by hand, draw the paper through. This should be done two or three times with the rough side towards each contact. Wipe away all dust or other foreign matter, using a clean fluffless cloth moistened with methylated spirits (de-natured alcohol).

Do not use emery cloth or a carborundum stone for cleaning cut-out contacts.

FUSE UNIT (Fig. 13)

Two 35 amp. fuses with spares are carried by a separate fuse unit. The fuse which bridges terminal blocks 1—2 is to protect auxiliary circuits independent of the ignition switch. The fuse bridging terminals 3—4 protects those circuits controlled by the ignition switch.

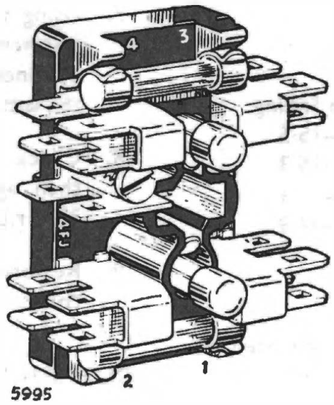


Fig. 13. *Fuse unit*

CONTROL BOX

MODEL R.B. 340

GENERAL

Equipment

We have tested and recommend the Avo Model 12 (obtainable from Avo Ltd., 92–96 Vauxhall Bridge Road, London, S.W.1) which has been specially designed for automotive use and enables a very wide range of checking operations to be carried out with a single instrument.

Preliminary Checking of Charging Circuit

Before disturbing any electrical adjustments, examine as under to ensure that the fault does not lie outside the control box:—

1. Check the battery by substitution or with an hydrometer and a heavy discharge tester.

2. Inspect the generator driving belt. This should be just taut enough to drive without slipping.

3. Check the generator by substitution or by disconnecting the generator cables and linking the larger generator terminal "D" to the smaller terminal "F" and connecting a first grade moving coil 0—20 voltmeter between this link and earth and running the generator up to about 1000 r.p.m. when a rising voltage should be shown.

4. Inspect the wiring of the charging circuit and carry out continuity tests between the generator, control box and the ammeter.

5. Check earth connections, particularly that of the control box.

6. In the event of reported undercharging, ascertain that this is not due to low mileage.
Note—Should the control box fail to respond correctly to any adjustment given in the following instructions, it should be examined at a Lucas Service Depot or by an official Lucas Agent.

VOLTAGE REGULATOR

Open Circuit Settings

Ambient Temperature	*Voltage Setting*
10°C. (50°F.)	14·9—15·5
20°C. (68°F.)	14·7—15·3
30°C. (86°F.)	14·5—15·1
40°C. (104°F.)	14·3—14·9

Method of Adjustment

Checking and adjusting should be completed as rapidly as possible to avoid heating errors.

1. Withdraw both cables from control box terminals "B" and join them together with a suitable "jumper lead".

2. Connect the voltmeter between control box terminal "D" and a good earthing point. A convenient method of making this connection to terminal "D" is to withdraw the ignition warning light feed from control box terminal "WL" and to clip the voltmeter lead to the small terminal blade thus exposed—this terminal being electrically common with terminal "D".

3. Start the engine and run the generator at 3000 r.p.m.

4. Observe the voltmeter pointer.

The voltmeter reading should be steady and lie between the appropriate limits given, according to the temperature. An unsteady reading, i.e., one that fluctuates more than $\pm 0{\cdot}3$ volts, may be due to unclean contacts. If the reading occurs outside the appropriate limits, an adjustment must be made. In this event, continue as follows:—

5. Stop the engine and remove the control box cover.

6. Re-start the engine and run the generator at 3000 r.p.m.

7. Using the correct tool, turn the voltage adjustment cam until the correct setting is obtained—turning the tool clockwise to raise the setting or anti-clockwise to lower it.

8. Check the setting by stopping the engine and then again raising the generator speed to 3000 r.p.m.

9. Restore the original connections and refit the cover.

CURRENT REGULATOR

On-Load Setting

The current regulator on-load setting is equal to the maximum rated output of the generator, which is 25 amperes.

Method of Adjustment (Refer to Fig. 13A)

The generator must be made to develop its maximum output, whatever the state of charge of the battery might be at the time of setting. The voltage regulator must therefore be rendered inoperative, and this is the function of the bulldog clip used in keeping the voltage regulator contacts together.

1. Remove the control box cover.

2. Using a bulldog clip, short out the voltage regulator contacts.

3. Disconnect the cables from control box terminals "B" and connect a first-grade 0–40 moving-coil ammeter between these cables and terminal "B". (Both cables must be connected to the same ammeter terminal).

4. Switch on all lights.

5. Start the engine and run the generator at 500 r.p.m.

6. Observe the ammeter pointer.

The ammeter pointer should be steady and indicate a current of 24—26 amps. An unsteady reading, i.e., one that fluctuates more than ± 1 ampere, may be due to unclean contacts. If the reading is too high or too low, an adjustment must be made. In this event, continue as follows:—

7. Using the correct tool, turn the current adjustment cam (clockwise to raise the setting or anti-clockwise to lower it) until the correct setting is obtained.

8. Switch off and restore the original connections.

9. Refit the cover.

CUT-OUT RELAY

Electrical Settings

1. Cut-in Voltage: 12·6—13·4

2. Drop-off Voltage: 9·3—11·2

Method of Cut-in Adjustment

Checking and adjusting should be completed as rapidly as possible to avoid heating errors.

1. Connect a first-grade 0–20 moving coil voltmeter between control box terminal "D" and a good earthing point. A convenient method of making this connection to terminal "D" is to withdraw the ignition warning light feed from control box terminal "WL" and to clip the voltmeter lead to the small terminal blade thus exposed—this terminal being electrically common with terminal "D".

2. Switch on an electrical load, such as the headlamps.

3. Start the engine and slowly increase the engine speed.

4. Observe the voltmeter pointer. The voltage should rise steadily and then drop slightly at the instant of contact closure. The cut-in voltage is that indicated immediately before the pointer drops back. If the cut-in occurs outside the correct limits, an adjustment must be made. In this event reduce the engine speed to below cut-in value and continue as follows:—

5. Remove the control box cover.

6. Using the correct tool, turn the cut-out relay adjustment cam until the correct setting is obtained—turning the tool clockwise to raise the setting or anti-clockwise to lower it.

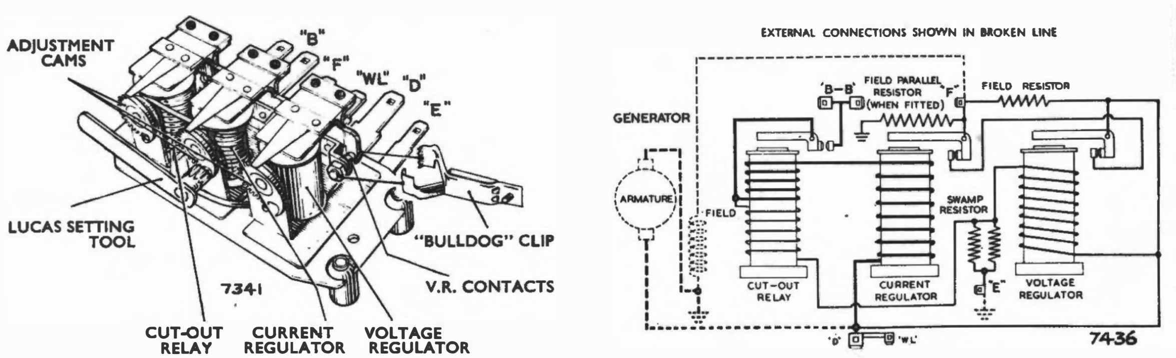


Fig. 13A. *Current-voltage control box and internal wiring diagram*

7. Repeat the above checking procedure until the correct setting is obtained.

8. Switch off, restore the original connections and refit the cover.

Method of Drop-off Adjustment

1. Disconnect the cables from control box terminal "B" and connect a first-grade 0–20 moving-coil voltmeter between this terminal and earth. Join the cables removed from "B", using a suitable "jumper lead".

2. Start the engine and run up to approximately 3000 r.p.m.

3. Slowly decelerate and observe the voltmeter pointer.

Opening of the contacts, indicated by the voltmeter pointer dropping to zero, should occur between 9·3—11·2 volts. If the drop-off occurs outside these limits, an adjustment must be made. In this event, continue as follows:—

4. Stop the engine and remove the control box cover.

5. Adjust by carefully bending the fixed contact bracket. Closing the contact gap will raise the drop-off voltage. Opening the gap will reduce the drop-off voltage.

6. Repeat 2 and 3 and, if necessary, re-adjust until the correct drop-off setting is obtained.

7. Restore the original connections and refit the cover.

CLEANING CONTACTS

Regulator Contacts

To clean the voltage or current regulator contacts, use fine carborundum stone or silicon carbide paper followed by methylated spirits (denatured alcohol).

Cut-out Relay Contacts

To clean the cut-out relay contacts, use a strip of fine glasspaper—never carborundum stone or emery cloth.

STARTER MOTOR

GENERAL

The starter motor is a four-pole, four-brush machine having an extended shaft to carry the engine engagement gear or starter drive. This motor is controlled by a solenoid switch mounted on the battery carrier and operated by the ignition key on the instrument panel. In an emergency or for testing purposes, the solenoid can be operated by hand by pressing the rubber cap covering the plunger.

ROUTINE MAINTENANCE

The starter motor fixing bolts should be checked for tightness periodically.

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" qualities. Brushes 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.

SERVICING

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, an 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.

Bench Testing and Examination of Brushgear and Commutator

1. If it is necessary to remove the motor from the engine first proceed as follows:—

   Disconnect the cable from the positive battery terminal to avoid any danger of causing short circuits.

   Disconnect the heavy cable from the starter motor.

2. After removing the starter motor from the engine, secure the 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 body or end bracket. Under these light load conditions, the starter should run a very high speed—approximately 10,000 r.p.m.

3. 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 on a smooth file. Always replace brushes in their original positions. If the brushes are badly 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.

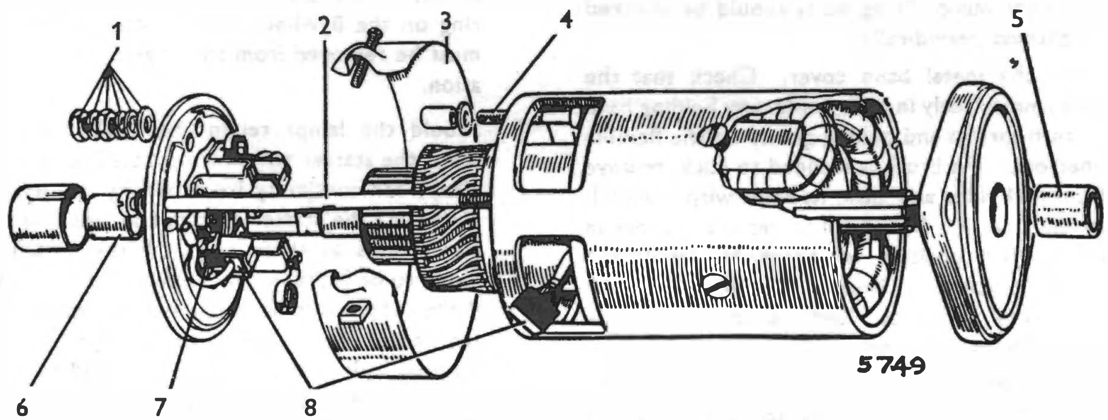
   Check the tension of the brush springs with a spring scale. The correct tension is 15 to 25 ozs. (·42/·71 kg.). A new spring should be fitted if the tension is low.

   If the commutator is blackened or dirty, clean it by holding a petrol-moistened cloth against it while the armature is rotated.

4. Re-test the starter as described under (2). If the operation is still unsatisfactory, the unit must be dismantled for detailed inspection and testing.

To Dismantle (See Fig. 13)

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.



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 SPRINGS
8. BRUSHES

Fig. 13. *Exploded view of starter motor*

3. Remove the two through bolts from the commutator-end bracket, and take off the commutator-end bracket from the yoke.
4. Remove the drive-end bracket complete with armature and drive from the starter motor yoke. If it is necessary to remove the armature from the drive-end bracket it can be done by means of a hand press after the drive has been dismantled.

Replacement of Brushes

If the brushes are worn to $\frac{5}{16}$" in. length, they must be renewed.

Two of the brushes are connected to terminal eyelets attached to the brush boxes on the commutator-end bracket and two are connected to tappings on the field coils (see Figs. 14 and 15). 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, dismantle the starter drive (as described under "Starter Drive") and remove the armature from the end bracket. Now

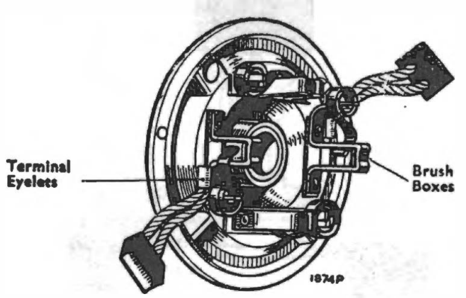


Fig. 14. *Commutator end bracket brush connections*

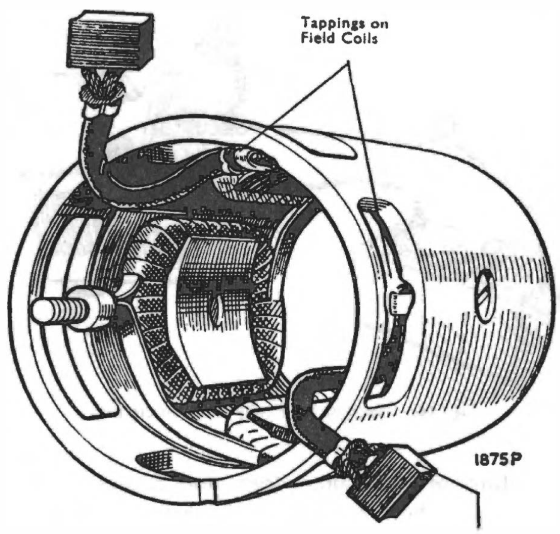


Fig. 15. *Brush connections to field coil tappings*

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 renewed—no attempt should be made to machine the armature core or to true a distorted armature shaft.

Field Coils

1. 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. (Fig. 16).

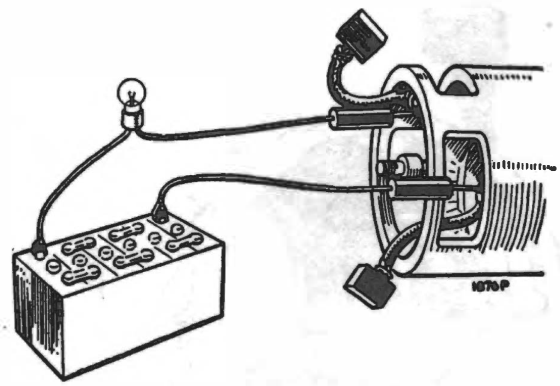


Fig. 16. *Checking field coils for open circuit*

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.

In either case, unless a replacement starter motor is available, the field coils must be replaced. To do this, carry out the procedure outlined below, using a pole shoe expander and a wheel-operated screw-driver.

Remove the insulation piece which is provided to prevent the intercoil connectors from contacting with the yoke.

Mark the yoke and pole shoes in order that they can be fitted in their original positions.

Unscrew the four pole shoe retaining screws by means of the wheel-operated screwdriver.

Draw the pole shoes and coils out of the yoke and lift off the coils.

Fit the new field coils over the pole shoes and place them in position inside the yoke. Take care to ensure that the taping of the field coils is not trapped between the pole shoes and the yoke.

Locate the pole shoes and field coils by lightly tightening the fixing screws.

Insert the pole expander, open it to the fullest extent and tighten the screws.

Finally tighten the screws by means of the wheel-operated screwdriver.

Replace the insulation piece between the field connections and the yoke.

Bearings

Bearings which are worn to such an extent that they will allow excessive side play of the armature shaft must be replaced. 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 18) Porous bronze bushes must not be opened out after fitting, or the porosity of the bush may be impaired.

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. when the time of immersion may be reduced to 2 hours.

Reassembly

The reassembly of the starter motor is a reversal of the dismantling procedure.

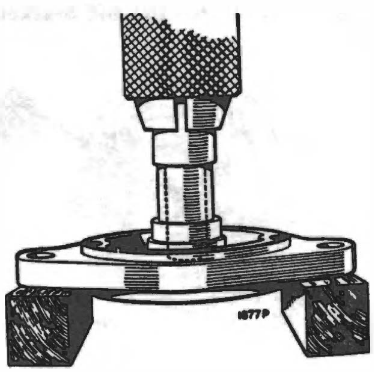


Fig. 17. *Fitting bearing bush*

STARTER DRIVE

GENERAL

The pinion and barrel assembly 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 engagement takes place.

When the starter switch is operated the armature shaft and screwed sleeve rotate. Owing to the inertia of the pinion and barrel assembly the latter is caused to move along the sleeve until the pinion comes into engagement with the flywheel ring. The starter will then turn the engine.

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 pinion and barrel assembly 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.

ROUTINE MAINTENANCE

If any difficulty is experienced with the starting motor not meshing correctly with the flywheel, it may be that the drive requires cleaning. The pinion and 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.

DISMANTLING AND REASSEMBLY

Having removed the armature as described in the section dealing with starting motors, the drive can be dismantled as follows (see Fig. 18):—

Remove the split pin (A) from the shaft nut (B) at the end of the starter drive. Hold the squared starter shaft extension at the commutator end by means of a spanner and unscrew the shaft nut (B). Lift off the main spring (C) and buffer washer (D) and remove the retaining ring (E) from inside the end of the pinion and barrel assembly (F). Corrugated washer (L), control nut (G), sleeve (H) and restraining spring (J) will now slide off. Withdraw the splined washer (K) from the armature shaft and remove the pinion and barrel.

The assembly of the drive is a reversal of the dismantling procedure.

Note.—Should either the control nut or screwed sleeve be damaged, then a replacement assembly of screwed sleeve and control nut must be fitted. These components must not be renewed individually.

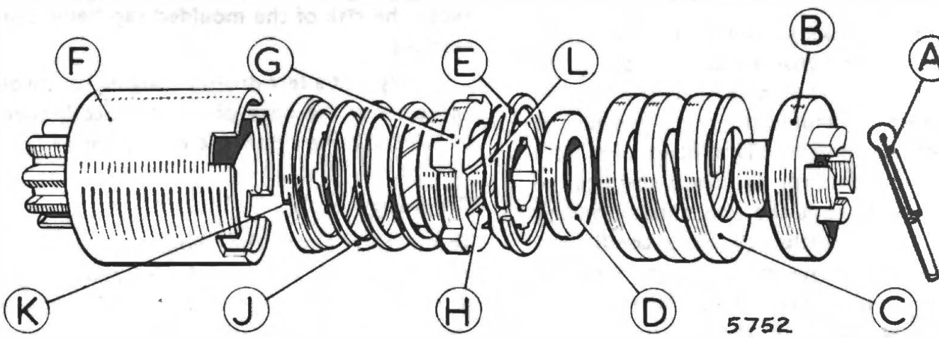


Fig. 18. *Exploded view of starter drive*

DISTRIBUTOR

GENERAL

The coil ignition equipment comprises a high tension induction coil and a combined distributor, contact breaker and automatic timing control assembly driven at half engine speed *via* the cam-shaft. 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 a cam-operated contact breaker, driven from the engine, 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, a rotor arm in the distributor connects the secondary winding of the coil with one of four metral electrodes, from which cables lead to the sparking plugs in the engine cylinders.

Thus, a spark is produced in the cylinder under compression at the optimum moment for combustion of the mixture.

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 out against the spring pressure, to move the contact breaker cam and thereby advance the spark, to suit engine conditions at the greater speed.

A vacuum-operated timing control is also fitted, designed to give additional advance under part-throttle conditions. 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 operating 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.

Special ignition for cold climate countries.

The ignition coil is a 7-volt unit, and during normal running the excess voltage is dropped across a ballast resistor in series with the coil primary winding. For starting, an additional contact on the solenoid starter switch shorts out the ballast resistor, thus ensuring that the terminal voltage, and hence the performance, of the coil at this time remains practically unaffected by the drop in battery voltage. As soon as the engine starts, and the solenoid switch is opened, the ballast resistor is automatically reconnected into the primary circuit.

ROUTINE MAINTENANCE (See Fig. 20)

In general, lubrication and cleaning constitute normal maintenance procedure.

Lubrication

Take great care to prevent oil or grease from getting on or near the contacts.

Lightly smear the cam and the pivot on which the contact breaker works with lubricant as specified.

Lift off the rotor arm by pulling vertically and apply to the spindle a few drops of engine oil to lubricate the cam bearing. It is not necessary to remove the exposed screw, since it affords a clearance to permit passage of oil.

Replace the rotor arm carefully, locating its moulded projection in the keyway in the spindle and pushing it on as far as it will go, in order to avoid the risk of the moulded cap being burned or tracked.

Carefully add a few drops of engine oil through the aperture at the edge of the contact breaker plate to lubricate the automatic timing control.

Cleaning

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.

Examine the contact breaker. The contacts must be quite free from grease or oil. If they are burned or blackened, clean them with very fine carborundum stone or emery cloth, then wipe 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 by hand until the contacts show the maximum opening. This should measure ·015 in. (·38 mm.) If the 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 (Fig. 19). Tighten the screw. Re-check the setting for other positions of the engine giving maximum opening.

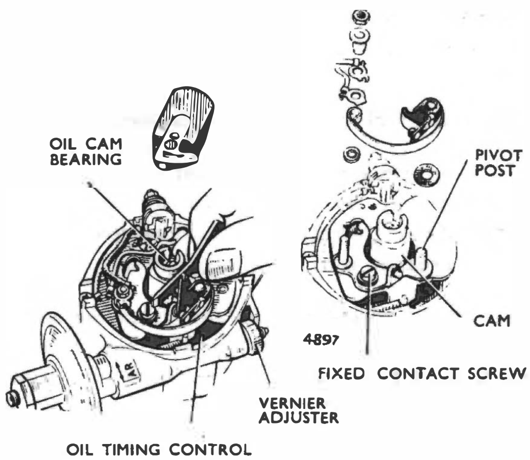


Fig. 19. *Distributor maintenance*

SERVICING

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.

Testing in position to locate cause of uneven firing

Run the engine at a fairly fast idling speed.

Short circuit each plug in turn with the blade of an insulated screwdriver placed across the terminal to contact the cylinder head.

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.

Having thus located the defective cylinder, stop the engine and remove the cable from the sparking plug terminal.

Restart the engine and hold the cable end about $\frac{3}{16}$" (5 mm.) from the cylinder head. If sparking is strong and regular, the fault lies with the sparking plug, and it should be removed, cleaned and adjusted, or a replacement fitted.

If however, there is no spark, or only weak irregular sparking, examine the cable from the plug to the distributor for deterioration of the insulation, renewing the cable if the rubber is cracked or perished.

If the cable is fitted with radio or television suppressor, this should also be checked for damage or open circuit.

Clean and examine the moulded distributor cap for free movement of the carbon brush. If tracking has occurred, indicated by a thin line, usually between two or more electrodes, a replacement distributor cap must be fitted.

Testing in position to locate cause of ignition failure

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

Check the contacts for cleanliness and correct gap setting as described previously.

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 opening of the contacts if the low tension wiring is in order. When the reading does not fluctuate, a short circuit, or contacts remaining closed, is indicated. No reading indicates a broken or loose connection in the low tension wiring or badly adjusted or dirty contacts.

Low tension circuit—Fault location

If it is determined that the fault lies in the low tension circuit, by the eliminating check above, switch on the ignition and turn the engine until the contact breaker points are fully opened.

Refer to the wiring diagram and check the circuit with a voltmeter (0-20 volts) between the following points and a good earth. If the circuit is in order, the voltage reading should be approximately 12 volts. No reading indicates a damaged cable or loose connections, or a break- down in the section under test.

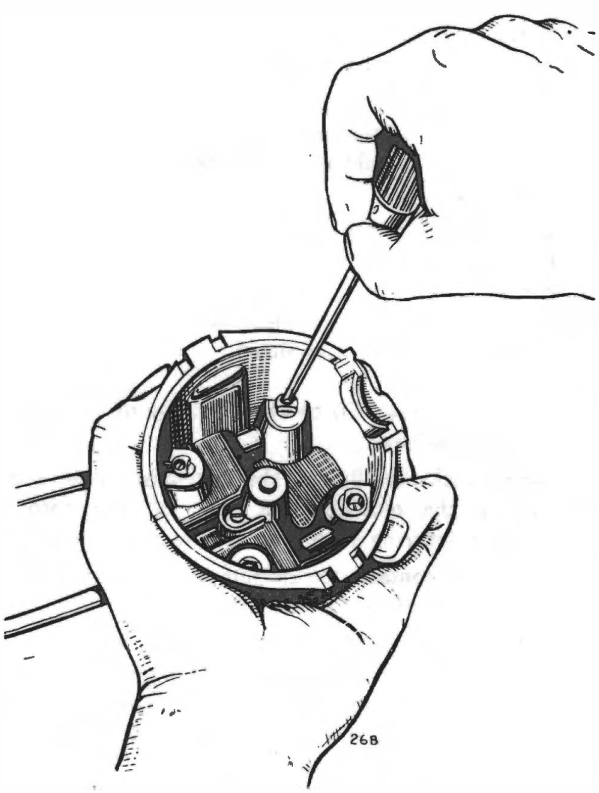


Fig. 20. *Ignition coil high tension cable*

(1) *Battery to control box*

Connect the voltmeter between the control box terminal "A" and earth. No reading indicates a faulty lead or loose connection.

(2) *Control box*

Check the voltage to earth at the control box terminal "A1". No reading indicates a broken connection in the series winding.

(3) *Control box to ignition switch*

Connect the voltmeter between the ignition switch terminal, to which the lead from the control box is connected, and a good earth. No reading indicates a faulty lead or loose connections.

(4) *Ignition switch*

Check the voltage between the other terminal of the ignition switch and earth. No reading indicates a fault in the switch.

(5) *Ignition switch to ignition coil*

Remove the lead from the ignition coil "SW" terminal, and connect the voltmeter between the free end of the cable and earth.

This portion of the circuit is made by way of the control box or fuse unit "3" terminal and a voltage check should be made at this point also.

Remake the connection to the coil.

(6) *Ignition coil*

Disconnect the lead from the "CB" terminal of the coil and connect the voltmeter between the "CB" terminal and a good earth. No reading indicates a fault in the primary winding of the coil, necessitating coil replacement. If, however, the correct reading is obtained, remake the cable connection to the coil terminal.

(7) *Ignition coil to distributor*

Disconnect the low tension cable to the distributor and connect the voltmeter between the end of the cable removed and earth. No reading indicates a faulty lead or loose connection. Reconnect the cable to the distributor.

(8) *Contact breaker and condenser*
Connect the voltmeter across the contact points. If no reading is obtained, re-check with the condenser removed. If a reading is now given, the condenser is faulty and must be renewed.

(9) Measure the contact breaker spring tension. This should be 18-24 oz., (·51-·68 kg.) measured at the contacts.

High tension circuit

If, after carrying out these tests, the fault has not been located, remove the high tension lead from the centre terminal of the distributor. Switch on the ignition and turn the engine until the contacts close. Flick open the contact breaker lever while the high tension lead from the coil is held about $\frac{3}{16}$ in. (5 mm) from the cylinder block. If the ignition equipment is in good order, a strong spark will be obtained. If no spark occurs, a fault in the circuit of the secondary winding of the coil is indicated and the coil must be replaced.

The high tension cables must be carefully examined, and renewed if the rubber insulation is cracked or perished, using 7 mm. rubber covered ignition cable. To connect a new cable to the ignition coil, pass the cable through the knurled moulded nut, bare about $\frac{1}{4}$ in. (6 mm.) of the end of the cable, thread the wire throught he brass washer (removed

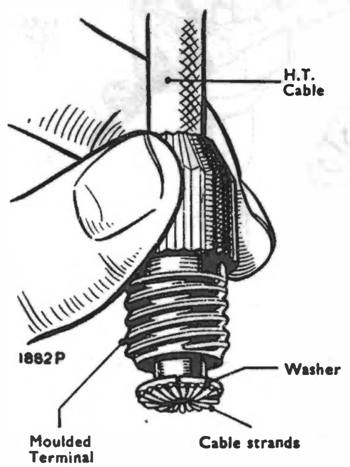


Fig. 21. *Distributor high tension cable terminal*

from the original cable) and bend back the strands. Finally screw the nut into its terminal (Fig. 20).

To make the connections to the terminals in the distributor cap, remove the cap and slacken the screws on the inside of the moulding. Cut the cables to the length required and push firmly home into the holes in the moulding. Tighten the screws, which will pierce the rubber insulation to make good contact with the cable core (Fig. 21).

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

Contact breaker mechanism

Check and adjust as described above.

Ensure that the moving arm moves freely on the pivot. If sluggish, remove the arm and polish the pivot pin with a strip of very fine emery cloth. Replace the arm and lubricate with a spot of clean engine oil.

Dismantling

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. Note the relationship between the driving dog and the rotor electrode and maintain this relation when reassembling the distributor. The amount of dismantling necessary will obviously depend on the repair required.

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

Disconnect the vacuum unit link to the moving contact breaker plate, and remove the two screws at the edge of the contact breaker base. The contact breaker assembly, complete with external terminal, can now be lifted off (see (1) below). Remove the circlip on the end of the micrometer timing screw, and turn the micrometer nut until the screw and the vacuum unit assembly are freed. Take care not to lose the ratchet and coil type springs located under the micrometer nut.

The complete shaft assembly, with centrifugal timing control and cam foot can now be removed from the distributor body (see (2) below).

(1) *Contact breaker*

To dismantle the assembly further, remove the nut, insulating piece and connections from the pillar on which the contact breaker spring is anchored. Slide out the terminal moulding. Lift off the contact breaker lever and the insulating washers beneath it. Remove the screw securing the fixed contact plate, together with the spring and plain steel washers, and take off the plate. Withdraw the single screw securing the capacitor and contact breaker earthing lead. Dismantle the contact breaker base assembly by turning the base plate clockwise and pulling to release it from the moving contact breaker plate.

(2) *Shaft and action plate*

To dismantle the assembly further, take out the screw inside the cam and remove the cam and cam foot. The weights and springs of the centrifugal timing control can now be lifted off the action plate.

Bearing renewal

The single long bearing bush used in this distributor can be pressed out of the shank by means of a shouldered mandrel. If the bearing has been removed the distributor must be assembled with a new bush fitted. The bush should be prepared for fitting by allowing it to stand completely immersed in engine oil for at least 24 hours. Press the bearing into the shank, using a shouldered polished mandrel of the same diameter as the shaft. Under no circumstances should the bush be overbored by reaming or any other means, since this will impair the porosity and thereby the effective lubricating quality of the bush.

Reassembly (Refer to Fig. 22)

The following instructions assume that *complete* dismantling has been undertaken.

1. Place the distance collar over the shaft, smear the shaft with clean engine oil, and fit it into its bearing.

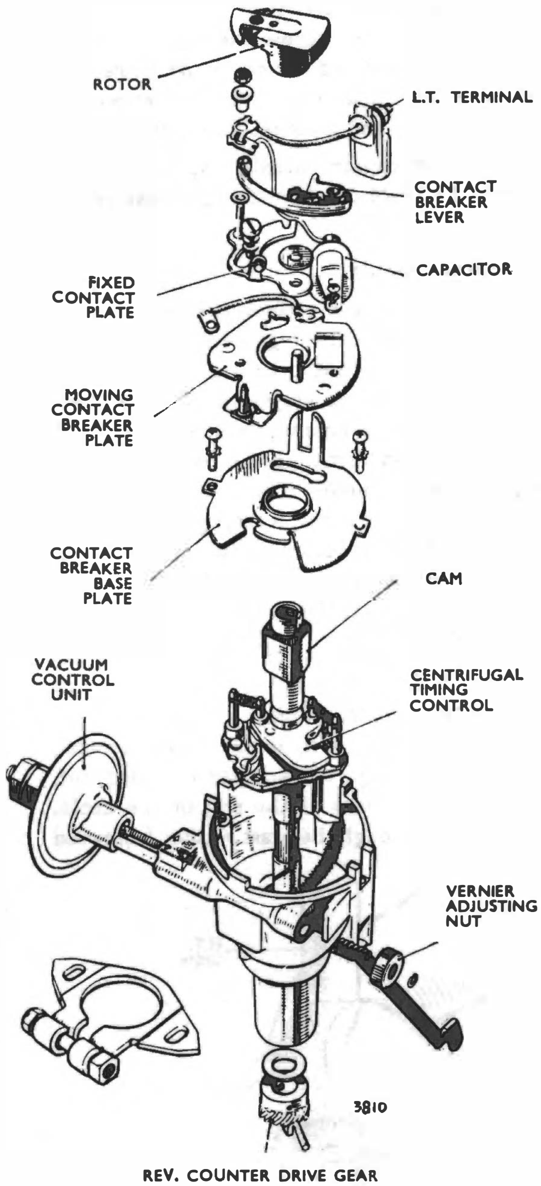


Fig. 22. *Exploded view of distributor*

2. Refit the vacuum unit into its housing and replace the springs, milled adjusting nut and securing circlip.

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

4. Before reassembling the contact breaker base assembly, lightly smear the base plate with clean engine oil.

   Fit the moving contact breaker plate to the contact breaker base plate and secure using a reversal of the dismantling procedure. Refit the contact breaker base into the distributor body. Engage the link from the vacuum unit. Insert the two base plate securing screws, one of which also secures one end of the contact breaker earthing cable.

5. Fit the capacitor into position. Place the fixed contact plate in position and secure lightly. One plain and one spring washer must be fitted under the securing screw.

6. 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. Refit the contact breaker lever and spring.

7. Slide the terminal block into its slot.

8. 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.*

9. Set the contact gap to 0·015 in. (·38 mm.) and tighten the fixed contact securing screw.

10. Refit the rotor arm, locating the moulded projection in the rotor arm with the keyway in the shaft, and pushing fully home. Refit the moulded cover.

Renewal of contacts

If the contacts are so badly worn that renewal is necessary, they must be renewed as a pair and not individually. The contact gap must be set to 0·015 in. (·38 mm.); after the first 500 miles (800 kg.) running with new contacts fitted, the setting should be checked and if required the gap should be reset to 0·015 in. (·38 mm.). This procedure allows for the initial "bedding-in" of the heel. Ensure that the L.T. eyelets do not foul the H.T. cover and prevent the vacuum advance mechanism from functioning.

LAMPS

HEADLAMPS

Early Models

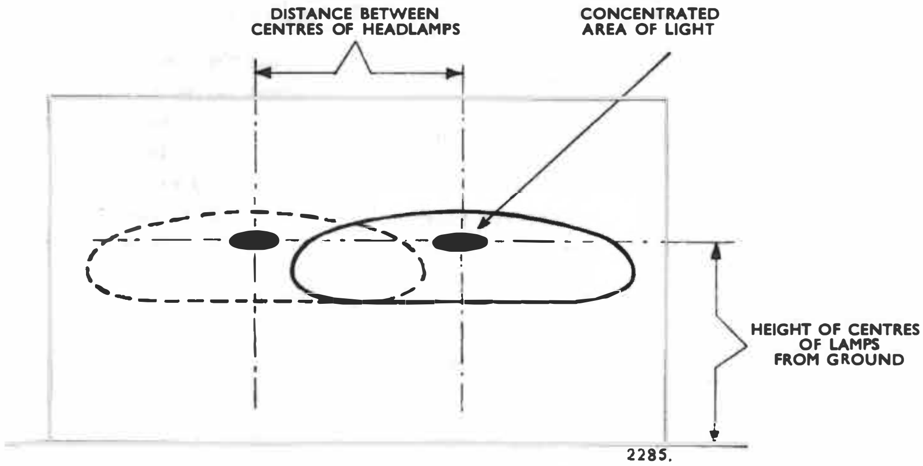
The headlamps are of the flush fitting type, incorporating Lucas Light Units, or combined reflector and front lens assemblies. "Pre-focus" bulbs are used, so that the bulb filament is always correctly located with regard to the reflector and lens and no adjustment of focusing is required. All lamps incorporate "block pattern" lenses. These lenses provide great accuracy of beam control, with a resultant improvement in road illumination and decrease in the dazzle caused to other road-users.

Anti-dazzle arrangements

Dipping of the headlamp beams for anti-dazzle purposes is achieved by the use of double-filament bulbs in both of the headlamps. The exact arrangement depends on the legal requirements of the country in which the car is to be used.

Beam adjustment (Refer to Fig. 23).

The headlamps are to be adjusted so that when the car is normally laden the main beams will be parallel with the road as well as with each other. This adjustment gives the best driving light and also ensures that the "dipped" beam complies with the appropriate British Ministry of Transport Lighting Regulations, so that they are incapable of dazzling any person who is standing on the same horizontal plane as the vehicle, at a greater distance than 25 feet (7·62 m.) from the lamp.



(A) FRONT OF CAR TO BE SQUARE WITH SCREEN
(B) CAR TO BE LOADED AND STANDING ON LEVEL GROUND
(C) RECOMMENDED DISTANCE FOR SETTING IS AT LEAST 25 FT.
(D) FOR EASE OF SETTING ONE HEADLAMP SHOULD BE COVERED

Fig. 23. *Headlight Alignment*

Whenever possible, the beams of headlamps are to be set using an optical-type beam setter, but when this is not possible, the headlamps can be set and a fair degree of accuracy attained by use of an aiming board (Refer to Fig. 23). When adjusting the headlamps, regardless of which method is employed, mask one lamp whilst carrying out adjustment on the other.

Adjustment of Setting (Refer to Fig. 24)

Slacken the screw securing the front rim and lift off the rim and dust-excluding rubber. Three spring-loaded adjustment screws are now exposed, by which the setting can be adjusted as required.

Check on the road and if necessary carry out further adjustment.

To remove glass and reflector assembly
(Refer to Fig. 24)

Take out the screw at the bottom of the rim with screwdriver. The lamp front can then be pulled off by hand. Grasp glass and reflector assembly with both hands, press rearwards and turn slightly in an anti-clockwise direction, which will release the three "key hole" apertures in its rear edge from the three spring-loaded screws. Do not turn or remove these screws, as this would upset the alignment of the lamp. Reverse procedure to reassemble. *The glass and reflector assembly is a sealed unit and no attempt is to be made to separate it.*

To renew bulbs (Refer to Fig. 24)

Remove lamp front and glass and reflector assembly as described above. Press the adaptor towards the rear of the reflector, meanwhile turning slightly to line up the two arrows marked on the adaptor and reflector. The adaptor can now be withdrawn and the bulb taken out. To reassemble adaptor to reflector, press on with arrows in line and turn to the right.

In territories where bulbs can be renewed, compress the two ends of the bulb retaining spring to clear the bulb flange. The bulb can now be removed.

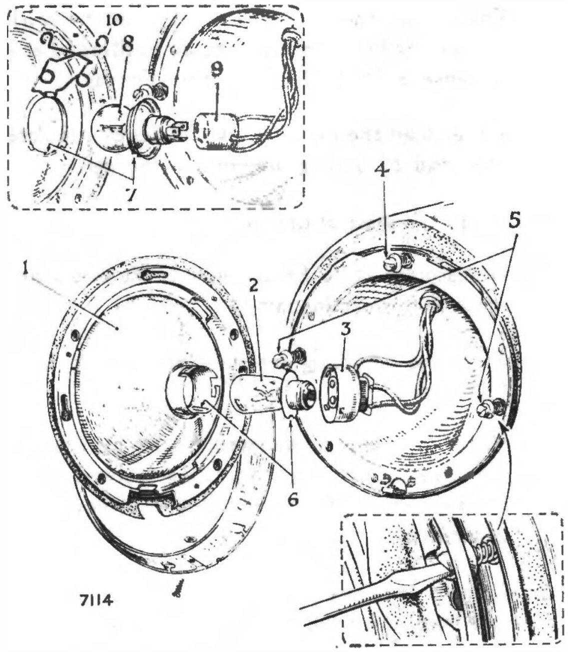


Fig. 24 *Headlamp Assembly (Early Models)*

KEY TO FIG. 24

1. REFLECTOR
2. BULB
3. BULB ADAPTER
4. VERTICAL ADJUSTMENT SCREW
5. LATERAL ADJUSTMENT SCREW
6. BULB LOCATION
7. BULB LOCATION
8. BULB } EUROPEAN TYPE
9. BULB ADAPTER } EUROPEAN TYPE
10. BULB RETAINER } EUROPEAN TYPE

HEADLAMPS

Later Models

The two headlamps employed incorporate the Sealed Beam light unit each of which is 7 in. (177.8 mm.) in diameter. The light unit is of "all glass" construction with an internally aluminised glass reflector which is fused to the front lens.

The two filaments, one for "main" beam and the other for "dipped" beam, are installed with absolute care and precision before they are finally sealed in the gas-filled chamber which comprises the light unit. The fact that the light unit is completely sealed, ensures that the reflecting surface is protected to the extent of producing continual reflective efficiency without deterioration.

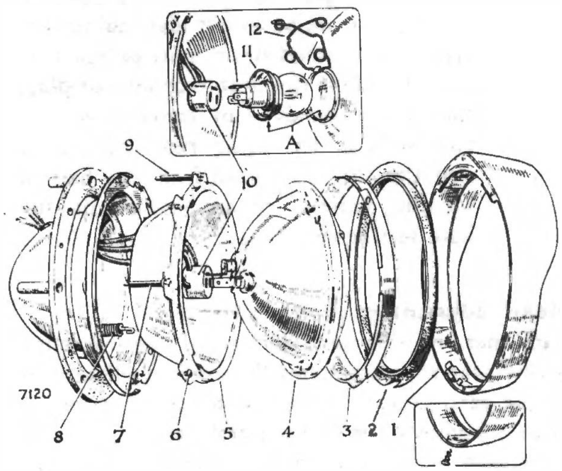


Fig. 24A *Headlamp Assembly (Later Models)*

KEY TO FIG. 25

1. FRONT RIM
2. SEALING RING
3. RETAINING RIM
4. SEALED BEAM LIGHT UNIT
5. SEATING RIM
6. RETAINING RIM SCREW
7. LATERAL ADJUSTING SCREW
8. TENSIONING SPRING
9. VERTICAL ADJUSTING SCREW
10. SLOTTED CONNECTOR-PLUG
11. BULB } EUROPEAN TYPE
12. BULB RETAINER } EUROPEAN TYPE

A LOCATION FOR BULB

In the event of headlamp failure and should the cause not be traced to loose and/or broken connections, the fault will lie in the lamp unit itself, in which case the light unit will require renewal.

To remove the Sealed Beam light unit (Refer to Fig. 25).

Remove the front (painted) rim which is secured either by one screw at the base or a concealed clip; in the case of the later, prise-off the rim from the base.

Remove the three cross-head screws securing the retaining rim, which are accessible on removal of the dust excluding rubber; the Sealed Beam unit can then be withdrawn and detached from the slotted connector-plug.

Note: In certain countries where ordinary filament bulbs are retained, the procedure for removal will be almost identical to that given for a Sealed Beam unit, except that after detaching the slotted connector-plug, the bulb is removed by compressing the two ends of its spring retaining-clip so that the clip is released from the pair of securing tabs which are formed on the bulb seating-ring.

Beam adjustment (Refer to Fig. 25).

Each headlamp is provided with two adjusting screws, the adjusting screw (9) provides adjustment in the vertical plane whilst the adjusting screw (7) provides adjustment in the lateral plane.

This type of sealed headlamp is so designed that adjustment can be accurately undertaken using a spirit-level type beam setter. Three glass " aiming pads " take the form of projections moulded integrally around the outer front edge of the lamp glass, where their purpose is to provide a reference plane for beam aiming.

It is desirable to use a reputable brand of spirit-level type beam setter if the best standards of accuracy and speed are to be obtained. Advice is available on application to the Rootes Group Development Section at Coventry, in respect of all Factory approved equipment.

Should a spirit-level type beam setter not be available, the use of an optical-type beam setter can be employed, providing it is of the type (Lucas No. 571119).

If the use of neither type of beam setter is available, a fair degree of accuracy can be attained by use of an aiming board (Refer to Fig. 23).

BEAM SETTING USING THE AIMING BOARD

Proceed as follows:—

1. Ensure that the car is parked (handbrake on) on level ground.
2. Ensure that the front of the car is parallel with the aiming board which is to be positioned at a distance of 25 ft. (7.62 m.) from the car.
3. Either load the car with two adults or simulate this load by adding weights to the car.
4. Clean the glass of one lamp.
5. Adjustment is to be commenced at one lamp; mask the remaining lamp.
6. Turn the adjusting screws clockwise to their full extent.
7. With the lamp illuminated in the main beam condition, turn the adjusting screws anti-clockwise as necessary until the required setting is achieved.
8. Remove the mask from the remaining lamp and mask the lamp which has been set.
9. Clean the glass of the lamp.
10. Turn the lamp adjusting screws clockwise to their full extent.
11. With the lamp illuminated in the main beam condition turn the adjusting screws anti-clockwise as necessary until the required setting is achieved.
12. Recheck the setting of both lamps.

SIDE LAMPS—(Rapier—early models)

(See Fig. 26)

To renew bulbs, turn the lens anti-clockwise approximately 20° and lift off the rim and glass. When refitting, line up the flanges on glass and lamp body and turn clockwise.

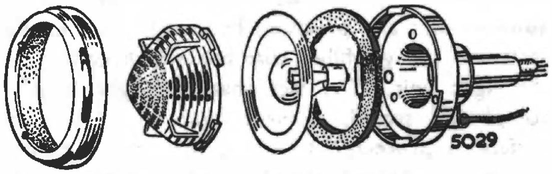


Fig. 26. *Side lamp details (Rapier)*

SIDE LAMPS AND FRONT FLASHER BULBS *Rapier IV models*

(Refer to Fig. 27)

To renew a defective bulb, remove the two screws and detach the white and amber lenses. Renew the defective bulb(s) and refit the lenses, making sure that the rubber seat is correctly located; secure the lenses with the two screws.

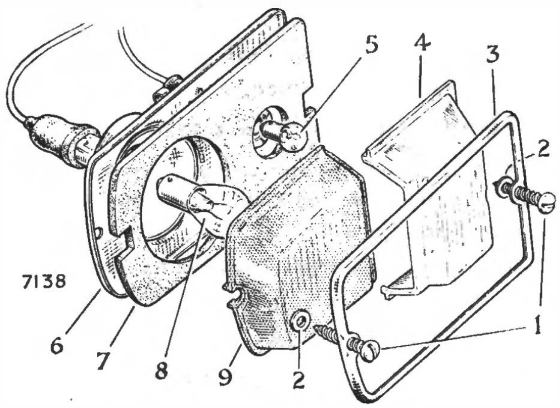


Fig. 27. *Side lamps and front flasher bulbs*

KEY TO Fig. 27

1. RETAINING RIM SCREWS
2. RUBBER WASHER
3. RETAINING RIM
4. CLEAR LENS
5. SIDE LAMP BULB
6. LAMP BODY
7. LENS SEATING
8. FLASHER BULB
9. AMBER LENS

SIDE LAMPS—(Alpine I, II and III models)

(See Fig. 28)

The rim and glass are retained by shaped lips formed in the rubber body. To renew bulbs, first remove the rim by easing back the rubber lip and then remove the glass by the same method. The lips can be carefully eased back by means of a screwdriver.

Reassembly is a reversal of the above instructions.

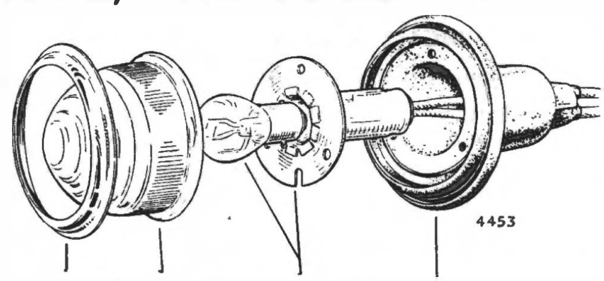


Fig. 28. *Side lamp details (Alpine I, II and III)*

SIDE LAMPS AND FRONT FLASHER BULBS *Alpine IV models*

(Refer to Fig. 29)

To renew a defective bulb, remove the three screws and detach the white and amber lenses. Renew the defective bulb(s) and refit the lenses, making sure that rubber seat is correctly located; secure the lenses with the two screws.

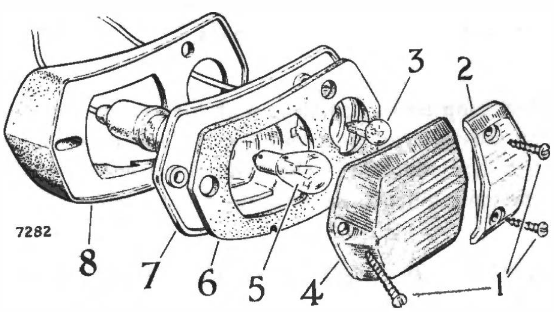


Fig. 29. *Side lamps and front flashers bulbs*

KEY TO Fig. 29

1. RETAINING SCREWS
2. CLEAR LENS
3. CAPLESS SIDE LAMP BULB
4. AMBER LENS
5. FLASHER BULB
6. LENS SEATING
7. LAMP BODY
8. RUBBER PLINTH

STOP/TAIL AND FLASHER LAMPS (Rapier)

Access for bulb renewal is available from within the boot. The detachable bulbholder assembly is retained by a single, central screw.

To renew lenses, remove bulbholder assembly from lamp body. Remove two nuts and washers and withdraw lamp unit outwards. Remove four self-tapping screws which retain lenses.

During reassembly, care must be taken to correctly position the rubber sealing washers.

STOP/TAIL AND FLASHER LAMPS (Alpine I & II)

Bulbs can be renewed after removal of the trim pad at the side of the boot (retained by spring clips) to gain access to the bulbholders, which are a push fit in the lamp bodies.

(Alpine III)

To gain access to defective tail lamp bulbs on this model, an aperture is formed in the trim which conceals two separate fuel tanks.

The lamp units, complete with lenses, are retained by stirrup-type clips and nuts. Removal of these and disconnection of the bulbholders then permits the lamp units to be withdrawn rearwards.

STOP/TAIL AND REAR FLASHER LAMPS (Alpine IV Models)

To renew the bulbs, pull the clip type bulb holder from the rear of the lamp unit (in the luggage compartment).

To remove the lamp units, remove the two securing screws from the rear of the unit. The lenses may be removed after removal of the lamp unit by unscrewing the four cross-headed screws. When reassembling, ensure that the rubber gaskets are correctly positioned (see Fig. 30).

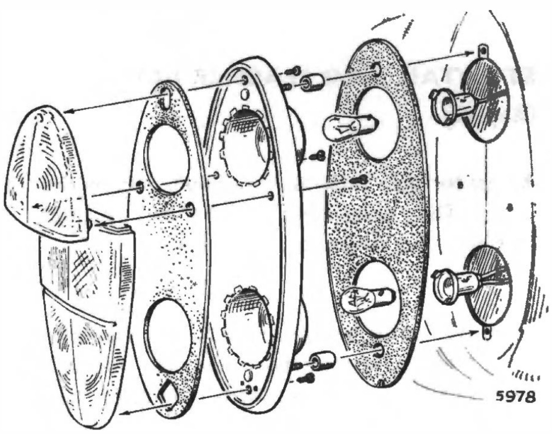


Fig. 30. *Exploded view of stop/tail and rear flasher lamps*

REAR NUMBER PLATE ILLUMINATING LAMP

Release the dome-shaped glass by sliding the retaining clip to one side. Take off the glass and renew the bulb. Refit the glass and move the retaining clip into position.

STOP LAMP SWITCH UNIT

The stop lamps are automatically controlled by a hydraulically operated switch incorporated in the brake fluid pipe line.

The switch is accessible when the bonnet is raised.

It is located in the branch union which is forward of the brake master cylinder.

INSTRUMENT PANEL AND WARNING LAMPS

The bulbholders are a push fit in the backs of the instruments and access is obtained from behind the facia panel. To remove a warning lamp bulb holder, push out the holder from the rear of the facia.

INTERIOR LAMP (Rapier and Alpine G.T.)

Firmly press one side of the plastic lamp cover inwards so that the retaining flanges of the cover are clear of the slots in the lamp housing and take away the cover. Renew the bulb.

When refitting the cover first enter the flanges in the slots on one side and then press it into position.

MAP LIGHT (Alpine)

Immediately above the cubby box is a map light, the switch for its operation being positioned at one end of the body. Renewal of the festoon type bulb is occasioned by detaching the lens from the two brass retaining pegs by simply pulling the lens from the body.

DIRECTION INDICATOR SIGNALS AND HEADLAMP FLASHER

Direction Indicators

The correct operation of direction signals requires that the bright filament in the parking and tail lamp bulbs (depending on the position of the switch) flash intermittently whether or not the headlamps, parking lamps, tail lamps or stop lamps are "on". A correctly operating direction signal will be indicated by a regular intermittent flashing of the green pilot lamp located on facia panel 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 can be readily checked by plugging in a known substitute.

The inoperative parking or rear flasher lamp bulbs should be checked for a burned-out bright filament. Where it is found that neither lamp has a burned-out filament the wiring between the defective lamp and indicator switch must be checked.

If the direction signal is entirely inoperative, check the fuse (A.4 on fuse box), flasher unit and circuit from the fuse box up through the steering column switch in the order named.

The flasher unit is located inside the car and is plugged into a socket on the underside of the facia. No servicing of the flasher is required, and where this unit breaks down in service it must be renewed.

It is important to note that the twin filament bulbs used in the side and tail lamps (Lucas 380 12 v. 21/6w.) are the same type. These bulbs have offset pins and cannot be fitted incorrectly.

Operation of Flasher Unit (See Fig. 31)

This 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 expanding and contracting 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:—

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 (B) are also closed completing the pilot lamp circuit.

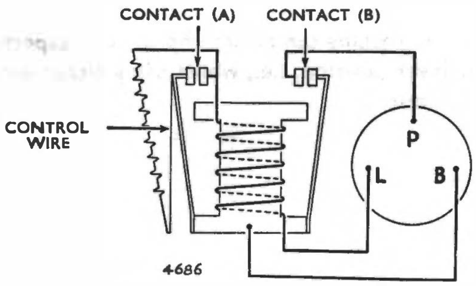


Fig. 31. *Showing internal connections of flasher unit*

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 (parking) lamp and rear flasher lamp is passing through the windings of the electro-magnet to close contacts (B). The flashing pilot lamp, therefore, gives the driver a clear indication that the direction signals 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.

Headlamp Flasher Switch

(*Later Models*)

The direction indicator switch also incorporates the switch for flashing the headlamps, this is achieved by moving the lever stalk towards the steering wheel and in so doing an insulated spring-loaded plunger, operated by the inner end of the lever, is depressed to make switch contact so that both headlamps illuminate and will remain so until upward pressure on the lever is released. When the lever is released the switch will return to the OFF position under the influence of its spring and the headlamps will extinguish.

Headlamp flashing can be accomplished irrespective of the lever position, i.e., whilst using either direction indicator.

CAUTION

In countries where the headlamp flasher operates on the main beam, it is inadvisable to use the flasher continuously when the headlamps are already in the "dipped" condition, as the excess heat generated by both filaments will greatly lessen the life of either the bulbs or lamp units, which ever is appropriate.

When the headlamp flasher system is functioning correctly, each application of the switch lever in the upward direction will illuminate both headlamps.

Should either headlamp fail to illuminate a check is to be made to ensure that the connections to the headlamp are secure, if on inspection the connections are found to be satisfactory the bulb or lamp unit is to be changed for one which is known to be serviceable.

In the event of both headlamps failing to illuminate when the switch is operated, for the Alpine III and IV, the circuit from the switch to terminal 1 on the fuse unit is to be checked. For the Rapier IV, the circuit from the switch to the starter solenoid, via the ammeter, is to be checked. If after test the switch is found to be defective, it must be renewed as the switch is irreparable.

HORNS

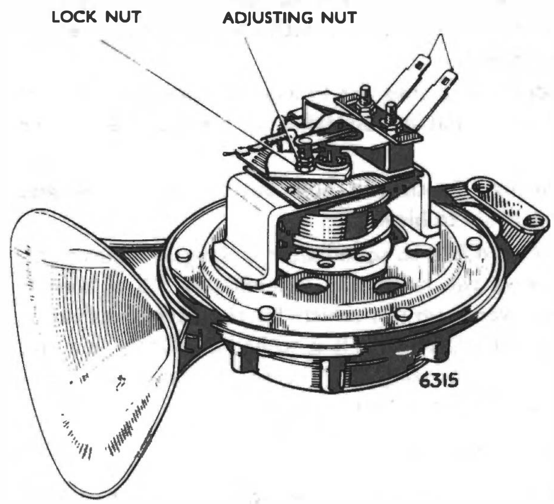
Lucas Windtone Horns (Fig. 32) Models WT 618 and 9H:

The horns operate on the principle of a resonating air column vibrated by means of a diaphragm which is actuated electro-magnetically by a self-interruptory circuit. The tonal quality of each horn is adjusted to give its best performance before leaving the manufacturers, consequently, it should require no further attention until it has given a long period of service. However, in the event of a single or both horns failing to sound satisfactorily, the cause can be diagnosed and rectified as follows:—

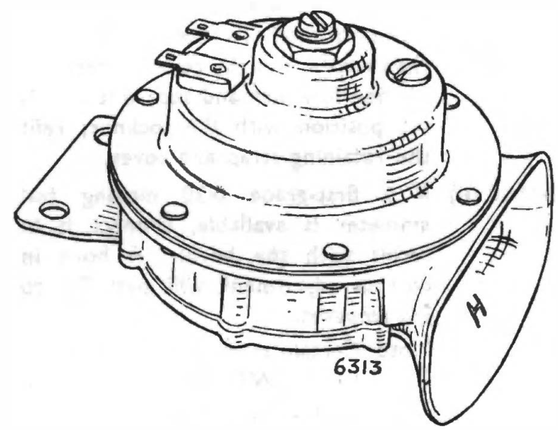
WARNING: Do not dismantle the horn(s) beyond the instructions given in the following paragraphs and on no account is the central locknut or slotted stem to be disturbed on the 9H model horn(s).

Maintenance

If the horns suddenly fail to sound after operating normally the cause is unlikely to be in the horns themselves. First ensure that the cause is not due to such defects as a loose or broken connection in the horn wiring circuit. A short circuit in the horn wiring will cause the fuse to blow. In this event, examine the wiring to locate the fault and rectify accordingly before renewing the fuse. Failure of the horns to perform correctly can be attributed to either a discharged battery, faulty or loose connections or loose mounting bolts; check and remedy as found necessary. If on inspection these points are found to be in order, it is possible that the horns require adjustment.



The model WT 618 horn with cover removed



The model 9H horn

Fig. 32. *Lucas Windtone Horns*

Adjustment

Where twin horns are fitted disconnect one whilst carrying out adjustment on the other, at the same time ensuring that the current supply cable does not come into contact with any part of the vehicle metalwork.

Adjustment does not in any way alter the pitch of the note but merely takes up wear of the moving parts.

During adjustment, short out the fuse, otherwise it is liable to blow.

If a horn fails to sound after making an adjustment, release the horn ring immediately. If a horn is removed from the vehicle for the purpose of carrying out adjustment, it is to be held firmly in a vice by the mounting bracket so that the best results in sound are obtained.

Model WT 618

Method (i) Remove the cover securing screw, take-off the domed cover and remove the cover retaining strap and rotate the adjusting nut in a clockwise direction until the horn just fails to sound, then rotate it in the reverse direction for one half turn and secure it in this set position with the locknut; refit the retaining strap and cover.

Method (ii) If a first-grade 0-20 moving coil ammeter is available, connect it in series with the horn. A horn in correct adjustment will pass 7·5 to 8·5 amperes.

Note: Certain models have the designation WT 618 U, these are uprated for greater output and their current consumption is 13·5 to 15·5 amperes. In order to recognise the WT 618 U model horn, a printed label bearing a number is affixed either in the horn flare or on one end of the bridge which mounts the contact and coil assembly. These are No. 69087, 69090, 69127, 69128, 69131 and 69132.

Remove the cover securing screw, take-off the domed cover and remove the cover retaining strap. Slacken the locknut on the fixed contact stem and rotate the adjusting nut a few degrees at a time in a clockwise direction to reduce the current or in the reverse direction to increase it; this adjustment is quite critical.

Before testing the horn, retighten the locknut and ensure to do this after each trial adjustment, repeating the exact process until the best performance is achieved within the stated current range.

When the horns are operating satisfactorily, refit the cover retaining strap, the domed cover and secure the whole with the screw.

Model 9H

Method (i) Adjustment is provided by either a plain or a serrated screw which is located adjacent to the horn terminals. Rotate this screw in an anticlockwise direction until the horn just fails to sound, then rotate it in the reverse direction for one quarter turn.

Method (ii) If a first grade 0-10 moving coil ammeter is available, connect it in series with the horn. A 9H model horn in correct adjustment will pass 3·0 to 3·5 amperes. Rotate the adjusting screw in a clockwise direction in order to increase the current and in the reverse direction to reduce it until the best performance is obtained within the stated current range.

Clear Hooter Horns (Fig. 33): The tonal quality of horns and their correct current consumption is accurately set before each unit leaves the manufacturers, therefore, the need for further adjustment after the horns have been fitted to the vehicle should not normally be necessary. However, in an instance where a single or both horns fail to operate satisfactorily the exact cause can be quickly diagnosed and rectified as follows:—

NOTE: Early model horns can be dismantled for the purpose of examining the internal connections and contacts only, further dismantling beyond this is not to be attempted. Later model horns are a riveted assembly and, therefore, cannot be dismantled. If the horns are removed from the vehicle for the purpose of tonal adjustment, they are to be held firmly in a vice by the mounting bracket so that the best results in sound are obtained.

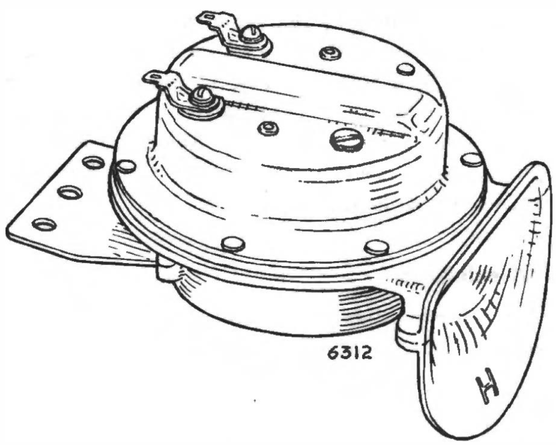


Fig. 33. *The Clear Hooter horn*

Sound—loss of volume

Normally this condition is caused by insufficient current being drawn by the defective horn in which case the adjusting screw is to be rotated slowly clockwise until the volume of sound is restored, then rotate the adjusting screw slowly anti-clockwise to the point where the volume of sound is just maintained. At no time should the operating current exceed 3·5 amperes.

Intermittent operation

Usually this cause can be attributed to that of mal-adjustment or the presence of foreign matter between the contact points. In this instance the adjusting screw is to be rotated slowly in a clockwise direction for almost one half turn. Should the horn fail to sound after carrying out this adjustment the screw is to be rotated in the reverse direction until the horn operates at the correct volume, which should occur within 180 degrees either side of the original setting.

Complete failure of sound

In the event of a complete failure, examine the appropriate fuse and the electrical connections in the horn circuit for security and carry out a voltage check to establish whether the correct voltage is available at the horn terminals. If it was observed that a gradual deterioration in volume was apparent before the failure then the instructions outlined under the heading " Sound—loss of volume " are to be carried out. Should the horns have been operating satisfactorily prior to a sudden failure, the horn circuit is to be checked in order to establish the current capacity, should this be in excess of 3·5 amperes, the adjusting screw is to be rotated slowly in an anti-clockwise direction until the horns are restored to their correct volume of sound. If the current capacity is less than that specified the adjusting screw is to be rotated slowly in the reverse direction until the correct volume is obtained.

WINDSCREEN WIPER

GENERAL

The motor and gearbox are mounted on pillars cast as part of the gearbox. The rotary motion of the motor armature is converted to the reciprocating motion of a cable rack by means of a single-stage worm and nylon-gear reduction drive. A connecting rod and cross-head in the gearbox actuate the cable rack.

The flexible cable rack comprises an inner steel core carrying a wire helix, the whole being run within rigid connecting tubes between the gearbox and two wheelboxes. These wheelboxes, house a toothed wheel pressed on the wiper arm spindles. The toothed wheel engages with the cable rack, thus giving an oscillatory motion to the spindle.

A limit switch in the gearbox is connected in parallel with a control switch mounted on the instrument panel. The contacts of this limit switch are opened once per revolution of the final gear.

When the wiper control switch is switched to the "OFF" position the motor continues to drive until the limit switch contacts are opened. The switch is adjustable and can be set to alter the position of the limit switch and this determines the position at which the wiper blades park.

MAINTENANCE

The gearbox, rack and wheelboxes are packed with grease during manufacture, and require no periodic lubrication.

Worn or perished wiper blades should be renewed. To ensure correct operation under all conditions, it is essential that parts of identical pattern to the original equipment be fitted.

Oil, tar and other stains on the windscreen may be removed by the judicious use of methylated spirits (de-natured alcohol). Do not allow silicon or wax-based polishes on the glass.

SERVICING

Poor performance may be due to either mechanical or electrical faults, not necessarily connected with the motor itself. Checks should first be made for a binding rack, faulty wheelboxes, excessive blade loading and low supply voltage.

Cable rack and tube

Check for binding by removing the wiper arms and blades, disconnecting the rack from the motor and affixing a light spring balance to the motor end of the rack. A steady pull should give a reading of not more than 6 lbs. (2·75 kg.). Remove any slight kinks in the tube and check that it is not bent to a radius of less than 9 in. (23 cm.).

Wheelboxes

Check for misalignment, looseness or seizure, and rectify or renew as necessary.

Blade loading

Windscreen contamination can cause poor performance due to excessive friction. Clean, and renew blades if necessary.

Supply voltage

With the motor operating, use a high-quality moving coil voltmeter to check the voltage at the motor. If below 11·5 volts check the battery, switch (by substitution), wiring and connections. Rectify as necessary.

Motor—Light running current

Connect a high-quality moving-coil ammeter in series with the motor supply. With the cable rack disconnected, switch on the motor and observe the current and speed of operation. Current should be 2·7—3·4 amps. after running for one minute.

*Two types of limit (parking) switch (Refer to Fig. 34).

Limit (parking) switch—to adjust (Refer to Figs. 34 and 35).

DR3 wiper motor

With the wiper arms positioned on their serrated spindles so as to provide the best arc of wipe, the blades should be parked at the lower edge of the screen. If the blades fail to park in this position, adjustments can be made by rotating the knurled nut which projects from the cable rack outlet-end of the gearbox.

The knurled nut is to be rotated a little at a time until the correct parking position is obtained; **during this adjustment the windscreen is to be maintained in a wet condition.**

DR2 wiper motor

The switch portion of the gearbox cover is adjustable and can be set to alter the position of the limit switch with respect to the crank pin and this determines the position at which the wiper blades park.

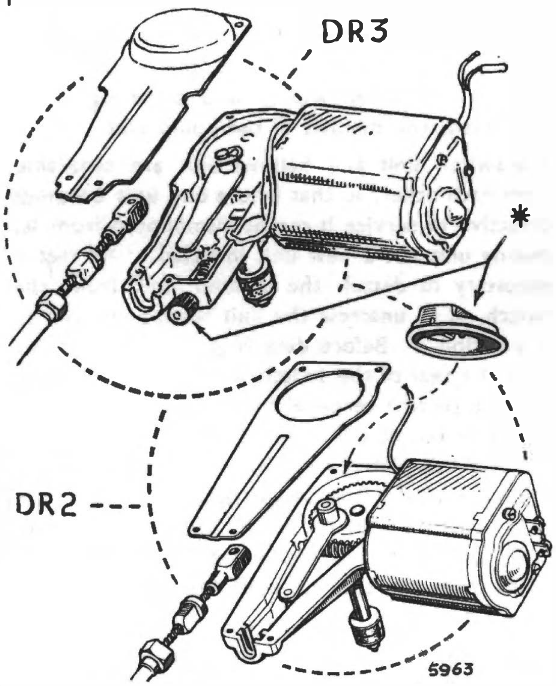


Fig. 34. *Limit (parking) switch adjustment*

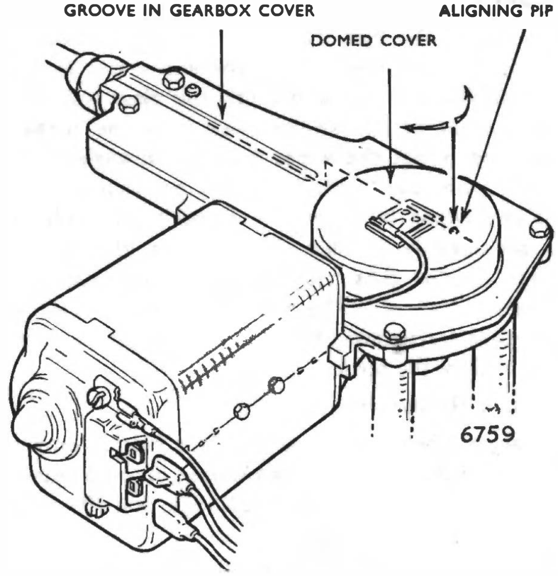


Fig. 35. *DR3A wiper motor*

DR3A wiper motor (Later models)

With the wiper arms positioned on their serrated spindles so as to provide the best arc of wipe, the blades should be parked at the lower edge of the screen. If the blades fail to park in this position, slacken the four gearbox cover-securing screws and rotate the domed cover until the setting pip, formed in the top of the cover, is aligned with the control groove in the gearbox cover.

The aligning pip must be on that side of the cover nearest the cable rack outlet in order to obtain parking with the crosshead away from the worm gear, or rotated through 180° to obtain parking with the crosshead towards the worm gear. **During this adjustment, the windscreen is to be maintained in a wet condition.**

Any attempt to obtain a parked position with the wiper blades against the screen moulding will result in noisy operation and a reduced arc of wipe. Slight adjustments to the parked position of the wiper blades may be carried out as described above.

Alpine I

To obtain the best operating sweep, the recommended procedure is to fit the wiper arm to the serrated spindle so that, with the glass wet, the full extent of the sweep away from the parked position brings the wiper arms to an angle of 41 degs. from the vertical; in this position the tip of the wiper blade on the driver's side will be approximately 3 inches (75 mm) from the outside edge of the glass. It should be observed that when the wiper blades are in the parked position they are a little away from, and at a slight angle to, the base of the screen.

Alpine II onwards

A larger wheel-box fitted to wiper motors on the driver's side of the car has resulted in an increased arc of wipe on that side to 122 degs., and 103 degs. on the passengers side.
This improvement has been introduced from Chassis Number B.9104616 R.H.D. B.9104783 L.H.D. (U.S.A. and Canada only) and B.9108012 L.H.D. (Remaining countries taking L.H.D. cars).
To ensure the correct position of wiper arms on this model, proceed as follows:—

Remove both wiper arms and blade assemblies.

Switch ON the ignition and with the screen wet operate the windscreen wiper switch ON and OFF to position the serrated spindles in the parked condition.

Fit the wiper arms, complete with blades, on to the serrated spindles with the lower edge of the wiper blade positioned approximately ¼ inch (6 mm) away from the base of the screen.

Any attempt to obtain a parked position with the wiper blades against the screen moulding will result in noisy operation and a reduced arc of wipe.

Slight adjustments to the parked position of the wiper blades may be carried out as described above.

Wiper arms—to remove and refit

(See Fig. 36)

Lift spring retaining clip and slide arm from spindle.

Serratious provide 5° adjustment steps for the arm.

Refit arm and check sweep of operation as described on Pages 37 and 38.

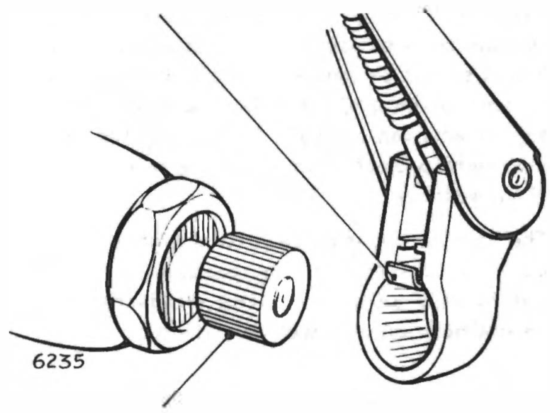


Fig. 36. *Wiper arm and spindle*

Combined Windscreen Wiper Switch and Washer Control (Later Models)

Integral with the switch on later models is a windscreen washer pump unit, the control knob for the windscreen wipers also actuating, when depressed, the bellows of the pump unit.

The switch unit and bellows unit are separable from each other, so that where one unit becomes defective in service it can be dismounted from its mating unit and a new unit installed. All that is necessary to detach the bellows unit from the switch, is to unscrew the unit leaving the switch in position. Before detaching Lucar connectors from the rear of the switch, always disconnect the positive (earth) terminal from the battery. The complete assemble is retained to the facia panel by a chromium plated ring-nut which is situated at the front of the facia immediately in front of the facia control knob; to detach the control knob, first depress the spring-loaded catch which extends from the control shaft into the shank of the knob.

Do not attempt further disassembly as no provision is made for the repair of defective units.

INSTRUMENTS AND CONTROLS

Instruments—to remove and refit

Always disconnect the battery positive lead before carrying out any work behind the instrument panel to avoid the risk of short circuits.

Each instrument is retained by a stirrup and knurled nuts, which are accessible from behind the panel. Disconnect wires, drive cable or pipe, remove bulbholder(s) and withdraw instrument forwards.

Refer to wiring diagram when refitting.

Horn Ring Assembly—To remove

Remove the three screws which secure the horn ring assembly in the hub of the steering wheel.

These screws are equally spaced around the hub and located in line with the lower edge of the spokes of the steering wheel. The complete assembly is now free to be withdrawn from the hub of the wheel.

It will be noted that a short cable which supplies the current to the ring has a snap connector end, and is plugged into the connector on the steering wheel.

To refit, reverse the above instructions.

Care should be taken to ensure that the plug of the snap connector is fully home before the horn ring assembly is replaced and secured.

Horn Ring Assembly—To dismantle

Remove horn ring assembly from steering column (see above).

Turn the assembly over and remove three 4 B.A. self-locking nuts with washers securing the lower horn contact plate and springs.

Take off contact plate and springs.

Remove three screws securing the hub mouldings to the horn rings.

To reassemble, reverse the above instructions. It is important, however, to ensure that the air gap between the contacts is maintained at ·020″ (·5 mm.).

Adjustment of the gap is effected by means of the three 4 B.A. self-locking nuts.

Direction Indicator Switch—To remove

No servicing of the direction indicator switch is required and if this unit breaks down in service a replacement unit should be fitted.

Remove two screws securing steering column cover.

Disconnect the battery at the positive (earth) terminal.

Disconnect the leads to the switch at the snap connectors located under the facia and in line with the steering column.

Remove two screws with washer securing the switch assembly to the steering column.

Refitting is a reversal of the above.

Care must be taken to ensure that the switch is fitted centrally with the self-cancelling stop, with the steering wheel in the straight ahead position. Reference must be made to the wiring diagram when reconnecting the leads.

ELECTRIC IMPULSE TACHOMETER

(Refer to Fig. 37)

Later Models

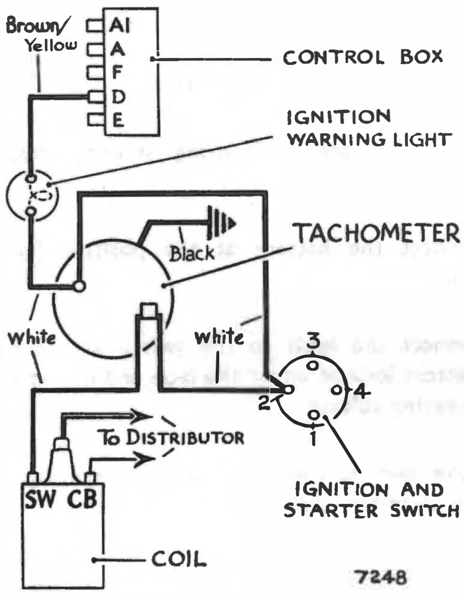
Fitted as standard equipment on later models is the electric impulse tachometer, this instrument is an advanced engine-speed indicator which measures revolutions per minute by "counting" electrical impulses called for by the ignition coil.

The tachometer has no mechanical take-off and operates in the following manner:—

The tachometer "counts" low-tension current impulses demanded by the ignition coil by means of a transistorised printed circuit unit contained within the instrument head. This in turn influences a D.C. voltmeter movement to which a pointer is attached, so that when the engine is running this moves round the instrument dial which is calibrated from 0-6,000 r.p.m. The accuracy of this instrument is not affected by variations in ignition timing, or gap settings of either the distributor or the plugs.

No servicing is required of the tachometer, therefore, where the instrument becomes faulty, a new instrument must be fitted as the unit can only be repaired by the manufacturers or their appointed agents.

Should the instrument cease to function, a check is to be made of the electrical connections to see if they are in order. If the connections prove to be correct, then the tachometer must be removed and replaced by a new unit.



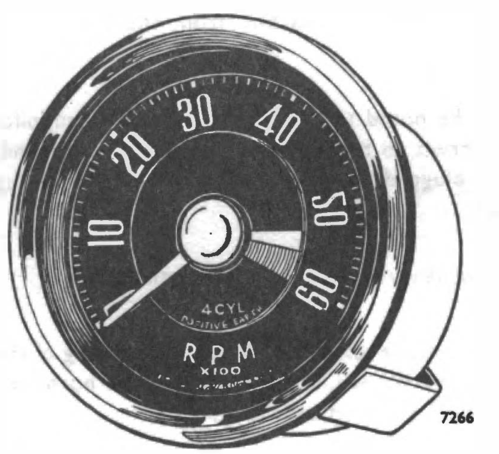


Fig. 37. *Tachometer and circuit diagram. (Earth wire on tachometer head for Rapier only.)*

Fuel and temperature indicators

(Refer to Fig. 38)

(Later Models)

The bimetal resistance equipment for fuel contents and temperature indication consists, in each case, of an indicator head and transmitter unit connected to a common voltage regulator. In both applications the indicator head operates on a thermal principle, using a bimetal strip surrounded by a heater winding and the transmitter unit is of a resistance type.

The system by which the equipment functions is voltage sensitive and the voltage regulator which serves both indicators is necessary to ensure a constant supply of a predetermined voltage to the equipment. The regulator is situated behind the instrument panel.

The mean voltage between terminal "I" and earth should be 10 volts. (See wiring diagram). Renew if faulty.

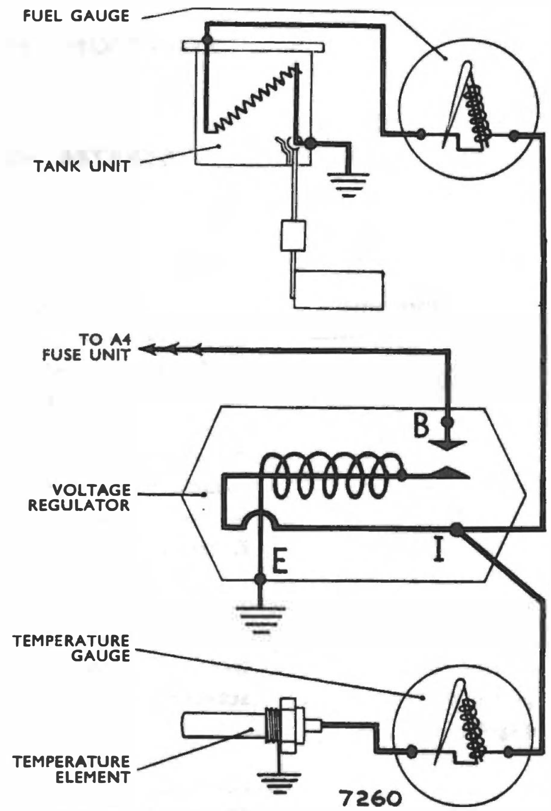


Fig. 38. *Fuel and temperature indicators and voltage regulator*

LOCATION AND REMEDY OF FAULTS

STARTER MOTOR TROUBLE

Symptoms	Possible Causes	Remedy
	Stiff engine, indicated by inability to turn by hand.	Locate and remedy cause of stiffness.
	If engine can be turned by hand then trouble may be due to:—	
	Battery discharged.	Start by hand. Charge battery either by a long period of day-time running or from independent electrical supply.
Starter motor lacks power or fails to turn engine.	**Broken or loose connection in starter circuit.**	See that connections to battery, starter and starter switch are tight, and that cables connecting these units are not damaged.
	Starter commutator or brushes dirty.	Clean.
	Brushes worn, or not fitted correctly.	Replace worn brushes. See that brushes "bed" correctly.
	Starter pinion jammed in mesh with flywheel.	Rotate squared end of starter shaft with spanner.
Starter operates, but does not crank engine.	**Pinion of starter drive does not engage with flywheel, due to dirt on screwed sleeve.**	Clean sleeve with paraffin.
Starter pinion will not disengage from flywheel when engine is running	Starter pinion jammed in mesh with flywheel.	Rotate squared end of starter shaft with spanner.

VOLTAGE CONTROL—GENERATOR TROUBLE

Symptoms	Possible Causes	Remedy
Battery in low state of charge, shown by lack of power when starting. (Hydrometer reading less than 1·200).	**Generator not charging when running at about 20 m.p.h. with no lights in use.** Due to:—	
	Broken or loose connection in generator circuit, or regulator not functioning correctly.	Examine charging and field circuit wiring Tighten loose connection or replace broken lead. Particularly examine battery connections. Return regulator to Lucas Service Depot for attention.
	Commutator greasy or dirty.	Clean with soft rag moistened in petrol.
	Giving low or intermittent output, when car is running steadily in top gear. Due to:—	
	Generator belt slipping.	Adjust belt (see Section B).
	Loose or broken connections in generator circuit.	Examine charging and field circuits wiring. Tighten loose connections or replace broken lead. Particularly examine battery connections.
	Brushes greasy or dirty.	Clean with soft rag moistened in petrol.
	Brushes worn or not fitted correctly.	Replace worn brushes. See that brushes "bed" correctly.
	Regulator not functioning correctly.	Have equipment examined by a Lucas Service Depot.
Battery overcharged, shown by burnt-out bulbs and very frequent need for "topping up". Hydrometer readings high.	**Giving high output,** Due to:—	
	Regulator not functioning correctly.	Return regulator to Lucas Service Depot for attention.

IGNITION TROUBLE

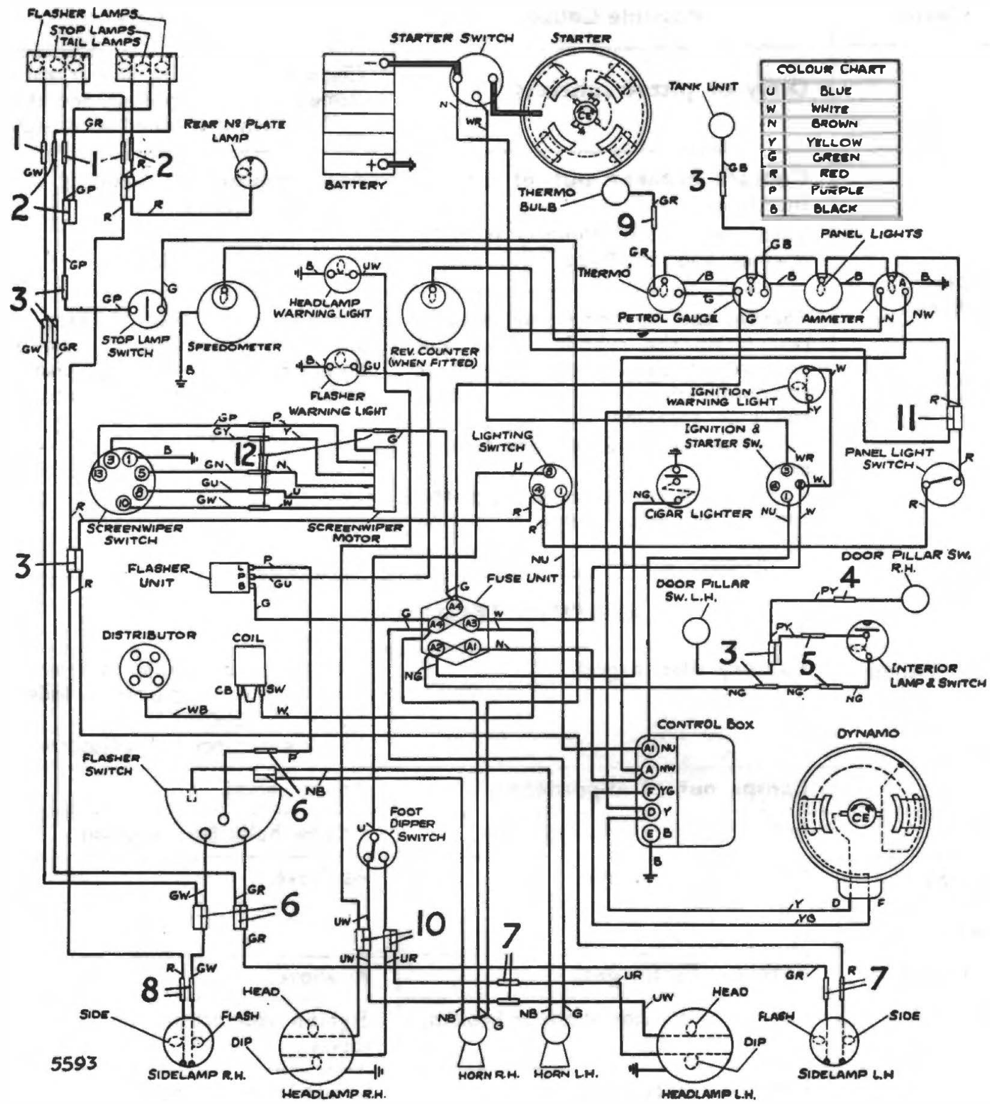
Symptoms	Possible Causes	Remedy
Engine will not fire.	**Battery discharged.** Starter will not turn engine and lamps do not give good light.	Battery should be recharged by running car for a long period during daytime. Alternatively, recharge from an independent electrical supply.
	Controls not set correctly for starting.	See that (1) ignition is switched on (2) there is petrol in the tank, and (3) everything is in order for starting.
	Test if coil sparks by removing lead from centre distributor terminal and hold it about $\frac{3}{16}$" away from some metal part of the chassis while engine is turned over. If sparks jump gap regularly the coil and distributor are functioning correctly.	Examine the sparking plugs, and if these are clean and the gaps are correct, the trouble is due to carburettor petrol supply, etc.
	If the coil does not spark, the trouble may be due to any of the following causes:— **Fault in low tension wiring.** Indicated by (1) No ammeter reading when engine is slowly turned and ignition switch is on; or (2) No spark occurs between the contacts when quickly separated by the fingers when the ignition switch is on.	Examine all cables in ignition circuit and see that all connections are tight. See that battery terminals are secure.
	Dirty or pitted contacts.	Clean contacts with fine carborundum stone or fine emery cloth and afterwards with a cloth moistened with petrol.
	Contact breaker out of adjustment. Turn engine until contacts are fully opened and test gap with gauge.	Adjust gap to correct setting.

Symptoms	Possible Causes	Remedy
Engine misfires	**Dirty or pitted contacts**	Clean contacts with fine carborundum stone or fine emery cloth and afterwards with a cloth moistened with petrol.
	Contact breaker out of adjustment. Turn engine until contacts are fully opened and test gap with gauge.	Adjust gap to correct setting.
	Remove each sparking plug in turn, rest it on the cylinder head, and observe whether a spark occurs at the points when the engine is turned. Irregular sparking may be due to dirty plugs or defective high tension cable. If sparking is regular at all plugs, the trouble is probably due to engine defects.	Clean plugs and adjust the gaps. Replace any lead if the insulation shows signs of deterioration or cracking. Examine the carburettor, petrol supply, etc.

LIGHTING TROUBLE

Lamps give insufficient illumination.	**Battery discharged.**	Charge battery either by a long period of daytime running or from independent electrical supply. Check generator belt adjustment.
	Lamps out of alignment.	Adjust Lamps.
	Bulbs discoloured through use.	Fit new bulbs (see page 26).
Lamps light when switched on, but gradually fade out.	**Battery discharged.**	As above.
Brilliance varies with speed of car.	**Battery discharged.**	As above.
	Battery connection loose or broken.	Tighten connections or replace faulty cables.
Lights flicker.	**Loose connection.**	Locate loose connection and tighten.
Failure of lights.	Faulty cable, connection or fuse blown (where applicable).	Examine wiring for faulty cables or connections and remedy. Fit replacement fuse. (see page 14A).
	Battery discharged.	Recharge battery.
	Loose or broken connection.	Locate and tighten loose connection, or remake broken connection.

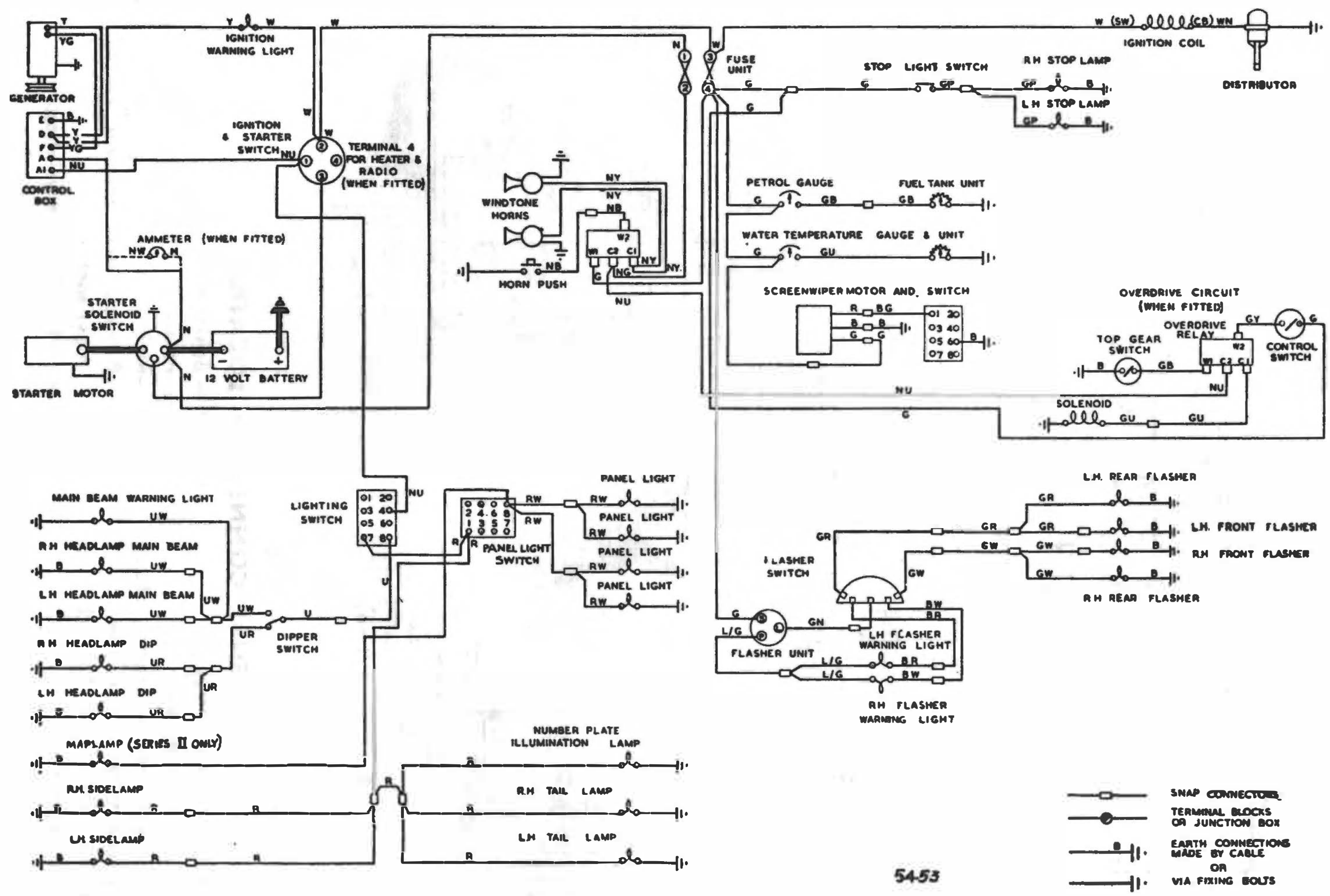
RAPIER SERIES III and IIIA
WIRING DIAGRAM



SNAP CONNECTOR LOCATIONS

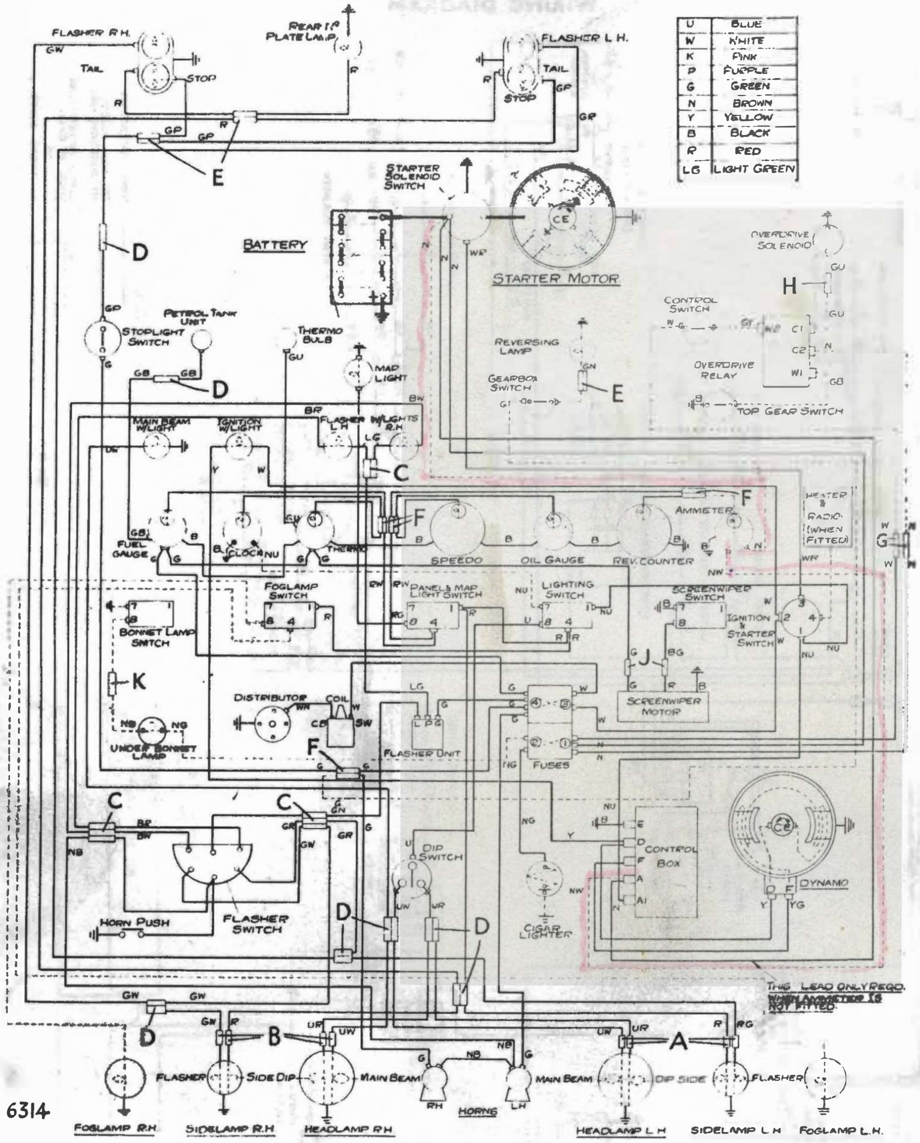
1 Top right-hand corner of boot.
2 Top left-hand corner of boot.
3 Under left-hand side of facia.
4 Under right-hand side of facia.
5 Behind left-hand quarter trim pad.
6 Under facia in line with steering column.
7 On left-hand front wing valance.
8 On right-hand front wing valance.
9 Near thermometer element on water pump.
10 L.H.D. at left-hand front wing valance.
R.H.D. at right-hand front wing valance.
11 Behind facia near instruments.
12 Near windscreen wiper motor.

ALPINE SERIES I
WIRING DIAGRAM



For cable colours refer to chart on page 48.

ALPINE SERIES II
WIRING DIAGRAM



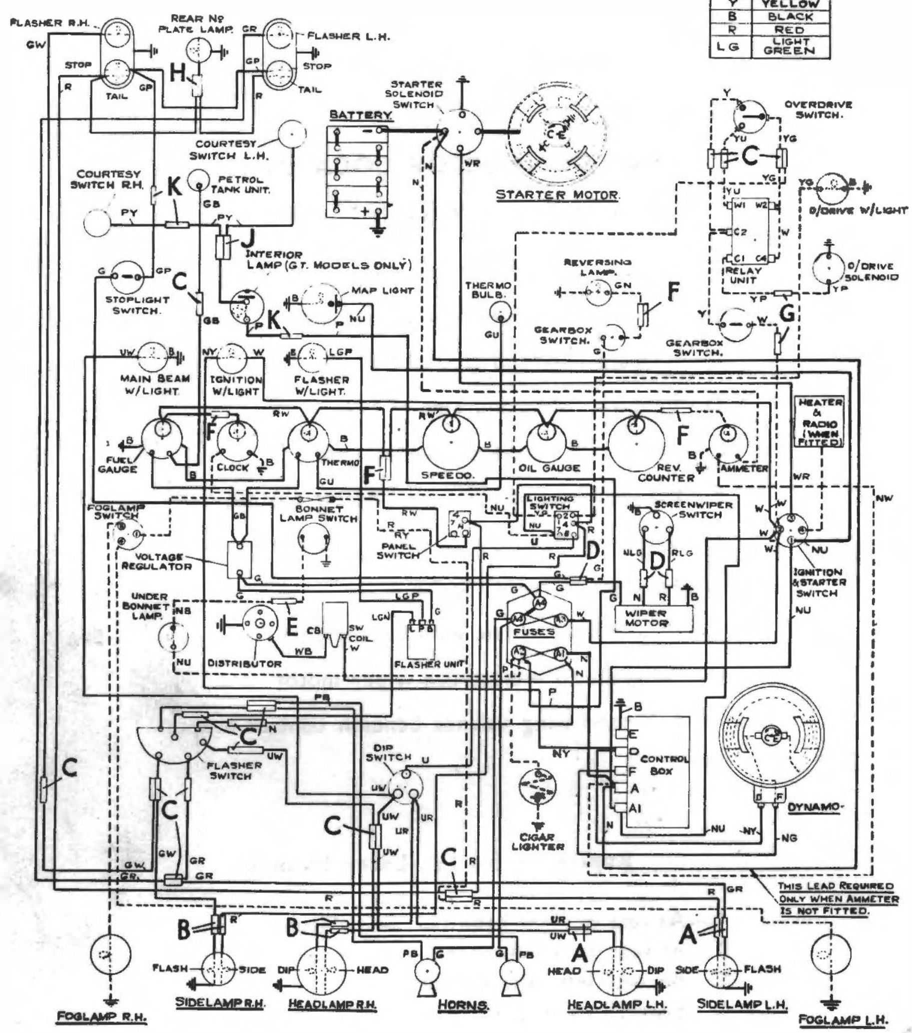
U	BLUE
W	WHITE
K	PINK
P	PURPLE
G	GREEN
N	BROWN
Y	YELLOW
B	BLACK
R	RED
LG	LIGHT GREEN

SNAP CONNECTOR LOCATIONS

A—Left-hand front wing valance.
B—Right-hand front wing valance.
C—Beneath facia adjacent to steering column.
D—On bulkhead below control box.
E—At extreme rear of car beneath spare wheel compartment.
F—Behind facia at rear of main instruments.
G—Attached to bulkhead on right-hand side.
H—Right-hand side of gearbox assembly.
J—Beneath facia adjacent to windscreen wiper motor.
K—Centre of engine bulkhead.

ALPINE SERIES III STANDARD AND G.T. MODELS WIRING DIAGRAM

COLOUR CHART	
U	BLUE
W	WHITE
K	PINK
P	PURPLE
G	GREEN
N	BROWN
Y	YELLOW
B	BLACK
R	RED
LG	LIGHT GREEN



7014 OPTIONAL EXTRAS SHOWN THUS :- ----------

LOCATIONS OF SNAP CONNECTORS

A—Left-hand front wing valance
B—Right-hand front wing valance
C—Beneath facia adjacent to steering column
D—Beneath facia adjacent to windscreen wiper motor
E—Centre of engine bulkhead
F—At rear of facia adjacent to instruments
G—At left-hand side of gearbox
H—At rear of car behind the boot lock
J—Beneath facia on left-hand side
K—Beneath facia on right-hand side

SNAP CONNECTOR LOCATIONS

Rapier Series IV (Early Models)

A—At rear of right-hand tail lamp cluster

B—At rear of left-hand tail lamp cluster

C—Beneath left-hand side of facia

D—Beneath right-hand side of facia

E—At rear of left-hand quarter trim

F—Beneath facia adjacent to steering column

J—Upper left-hand corner of luggage compartment

K—Adjacent to reversing lamp

L—Behind facia in line with instruments

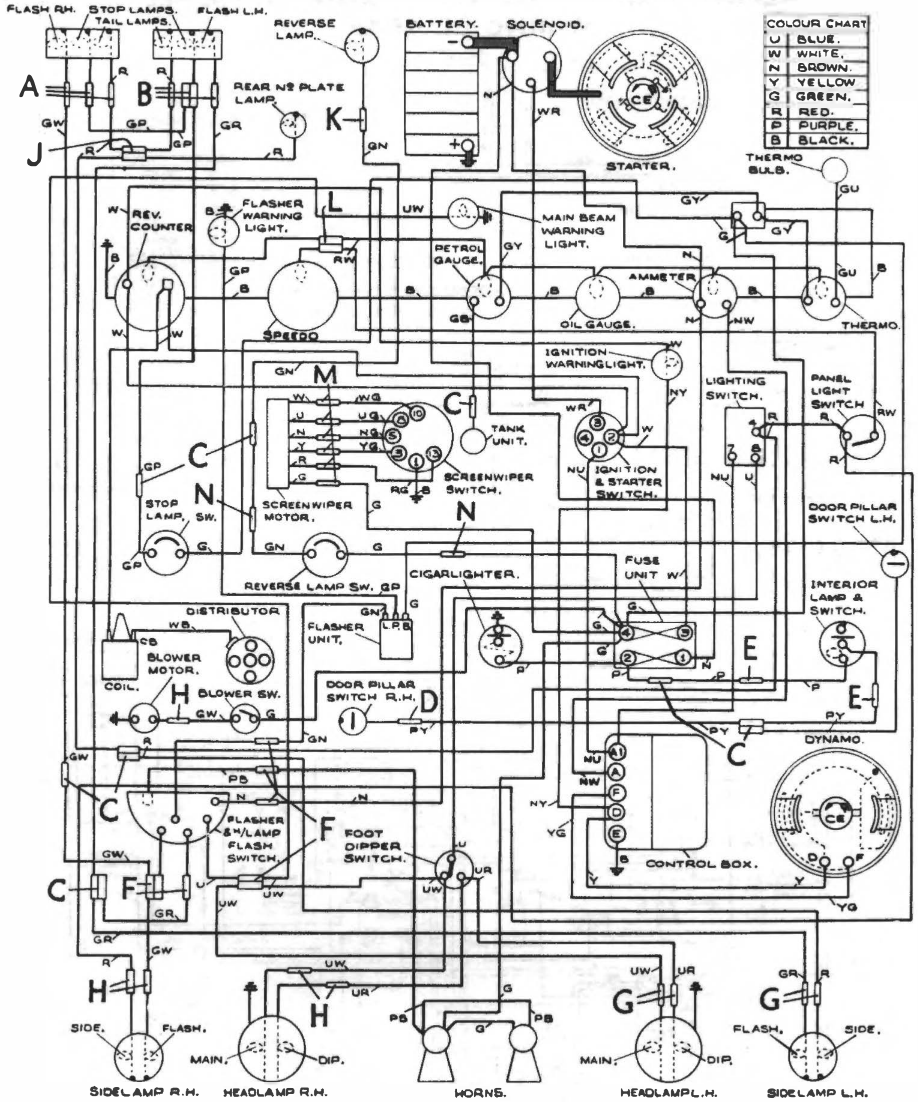
M—Adjacent to windscreen wiper motor

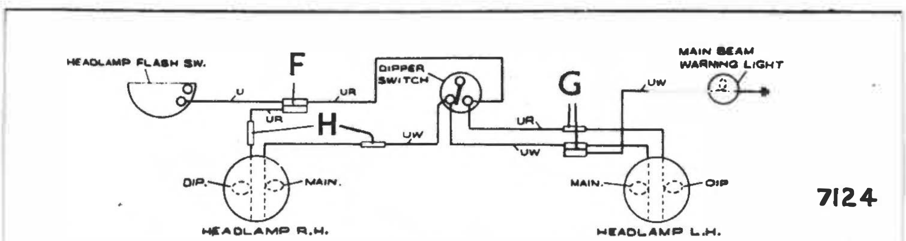
N—Left-hand wing valance beneath control box

Rapier Series IV (Later Models)

A—At rear of right-hand tail lamp cluster
B—At rear of left-hand tail lamp cluster
C—Beneath left-hand side of facia
D—Beneath right-hand side of facia
E—At rear of left-hand quarter trim
F—Beneath facia adjacent to steering column
G—On front wing valance at left-hand side
H—On front wing valance at right-hand side
J—Upper left-hand corner of luggage compartment
K—Adjacent to reversing lamp
L—Beneath facia in line with instrument
M—Adjacent to windscreen wiper motor
N—On front wing valance at left-hand side beneath control box

RAPIER SERIES IV (EARLY MODELS) — WIRING DIAGRAM

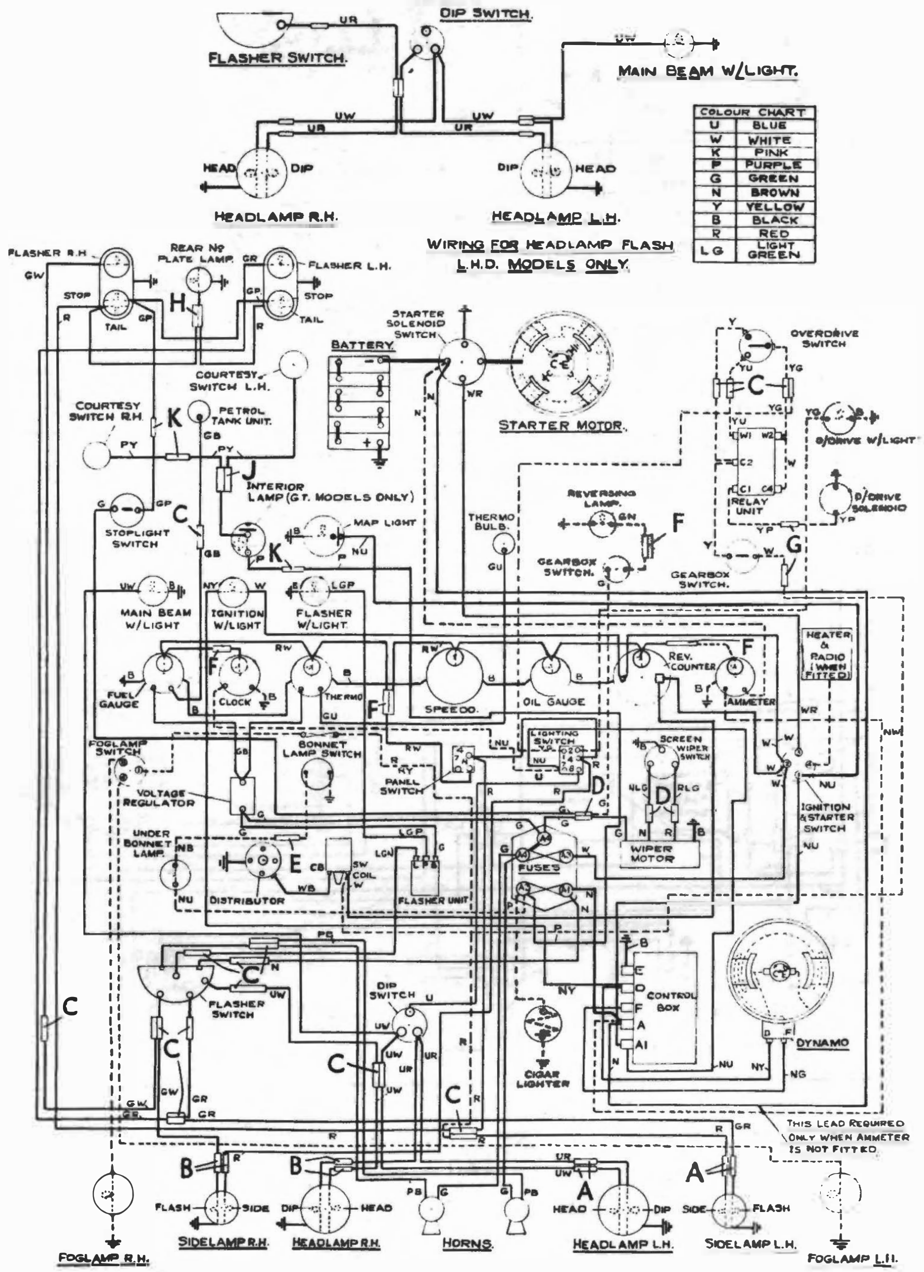




WIRING OF HEADLAMPS. W/LIGHT & FLASH SWITCH FOR L.H.D.

For location of snap connectors see Page 50

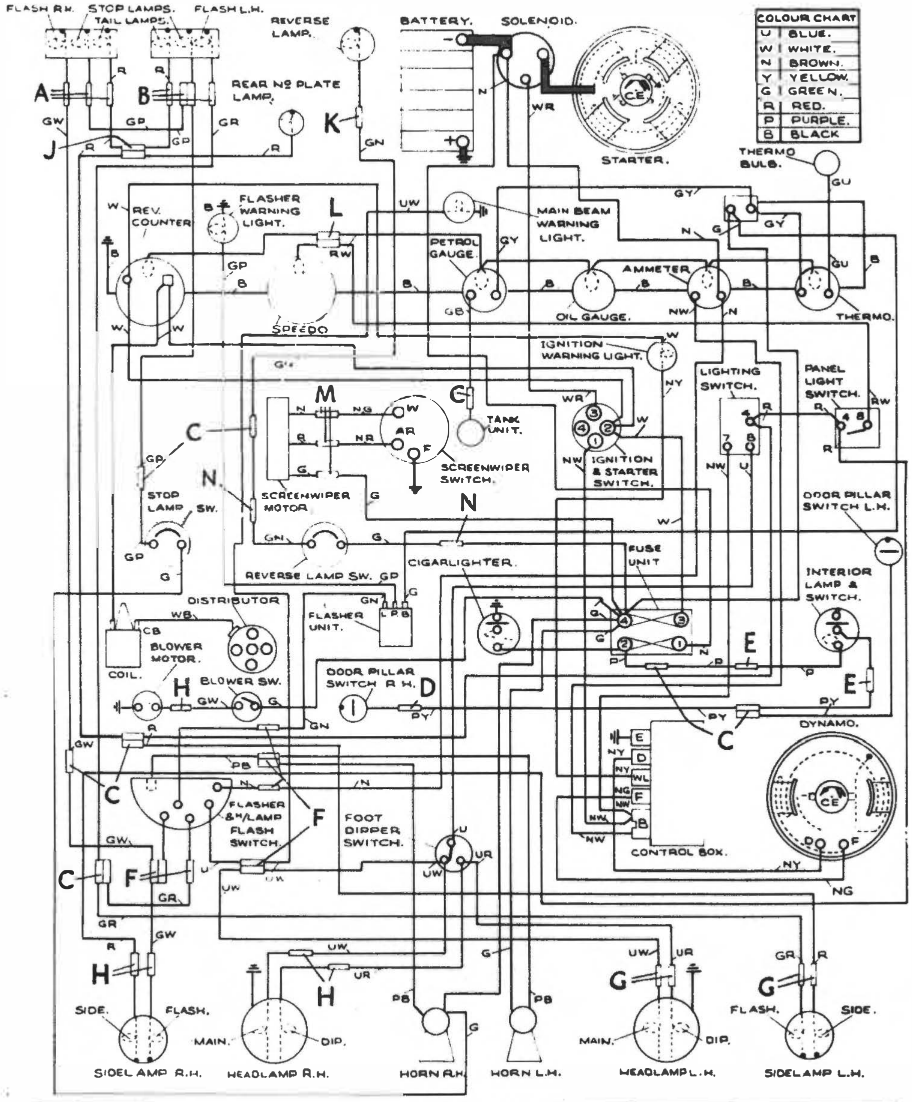
ALPINE SERIES IV STANDARD AND G.T. MODELS
WIRING DIAGRAM

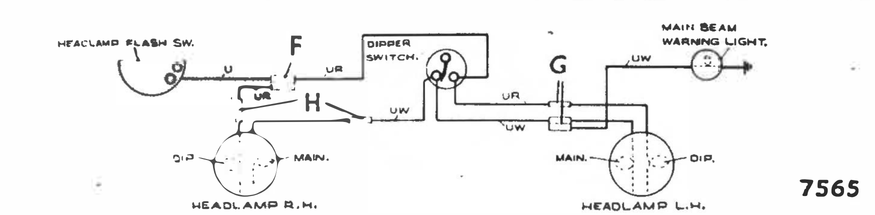


7252 OPTIONAL EXTRAS SHOWN THUS :- - - - - - - - - - -

For location of snap connectors see Page 49

RAPIER SERIES IV (LATER MODELS) — WIRING DIAGRAM





7565

WIRING OF HEADLAMPS, W/LIGHT & FLASH SWITCH FOR L.H.D.

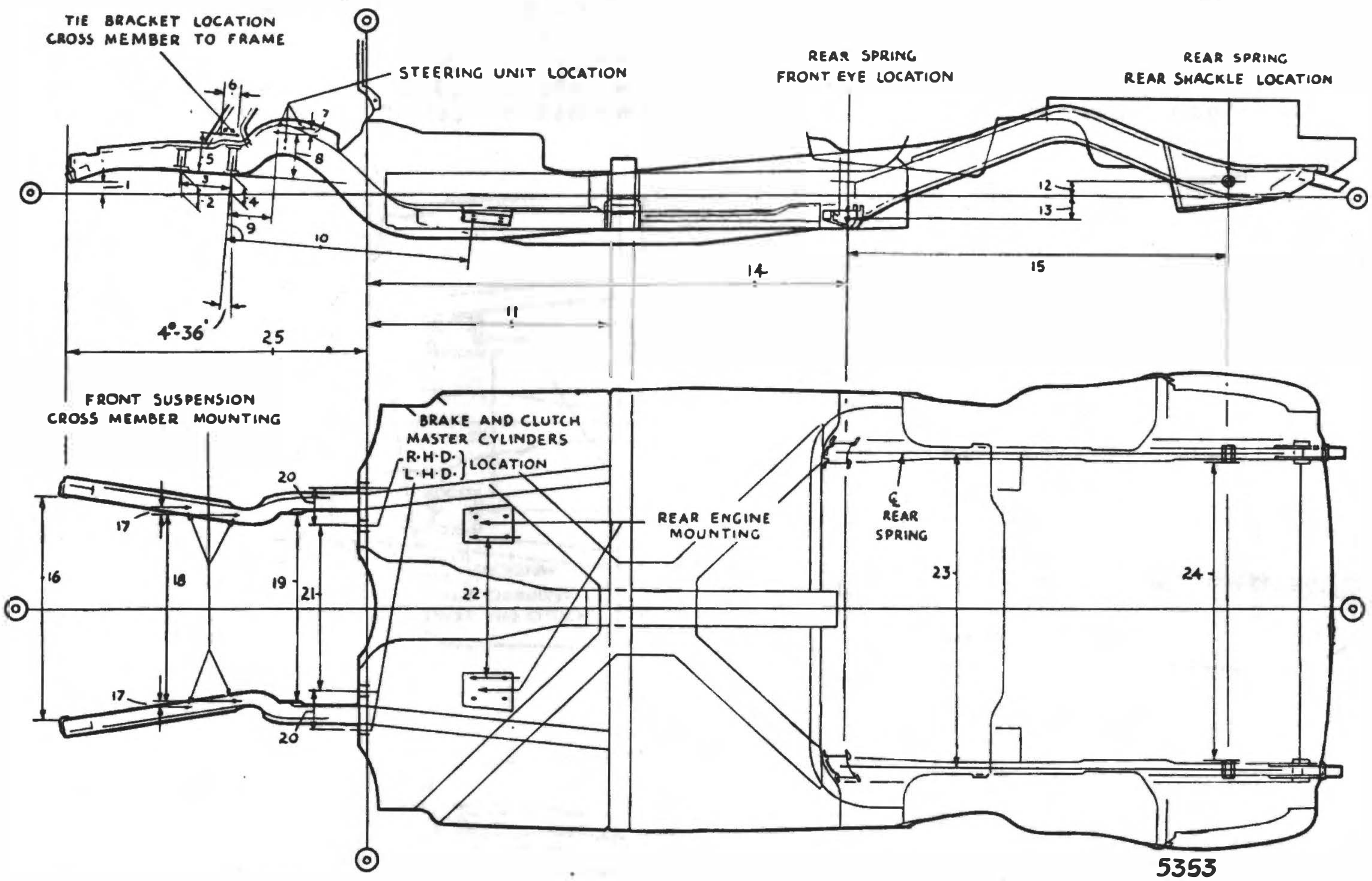
For location of snap connectors see Page 50

BODY

CONTENTS

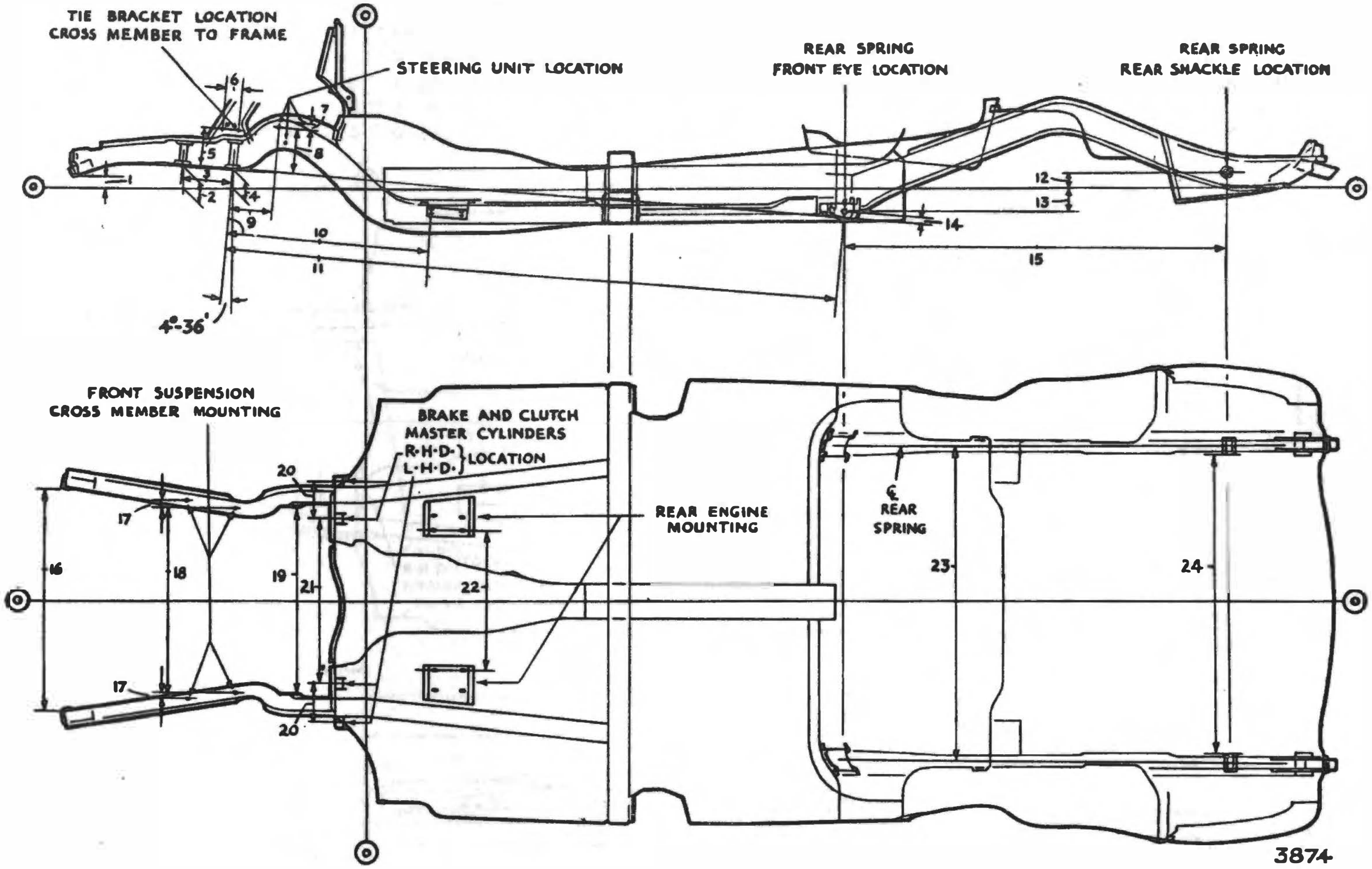
Pages 1—27

PRINCIPAL UNDERFRAME DIMENSIONS — ALPINE Series I & II



1.— 1·66" (4·216 c.m.)
2.— 3·12" (7·925 c.m.)
3.— 6·00" (15·240 c.m.)
4.— 2·64" (6 706 c.m.)
5.— 4·50" (11 430 c.m.)
6.— 2 18" (5·537 c.m.)
7.— 0·53" (1·350 c.m.)
8.— 5·15" (13·081 c.m.)
9.— 5·56" (14·122 c.m.)
10.— 27·78" (70·55 c.m.)
11.— 29·44" (74·77 c.m.)
12.— 0·25" (0·635 c.m.)
13.— 3·97" (10·08 c.m.)
14.— 49·14" (124·82 c.m.)
15.— 43·42" (110·29 c.m.)
16.— 27·12" (69·364 c.m.)
17 — 0·88" (2·235 c.m.)
18.— 22·56" (57·302 c.m.)
19 — 22·34" (56·743 c.m.)
20 — 5·00" (12·70 c.m.)
21.— 18 25" (46·355 c.m.)
22.— 16·50" (41 91 c.m.)
23.— 37·50" (95·25 c.m.)
24.— 35·84" (91·034 c.m.)
25 — 37·12" (94·28 c.m.)

PRINCIPAL UNDERFRAME DIMENSIONS — RAPIER



1.—1·66" (4·216 c.m.)	7.—0·53" (1·350 c.m.)	13.—2·96" (7·518 c.m.)	19.—22·34" (56·743 c.m.)
2.—3·12" (7·925 c.m.)	8.—5·15" (13·081 c.m.)	14.—0·34" (0·863 c.m.)	20.—5·00" (12·70 c.m.)
3.—6·00" (15·240 c.m)	9.—5·56" (14·122 c.m.)	15.—46·44" (117·96 c.m.)	21.—19·64" (49·90 c.m.)
4.—2·64" (6·706 c.m.)	10.—24·36" (61·874 c.m.)	16.—27·12" (69·364 c.m.)	22.—16·50" (41·91 c.m.)
5.—4·50" (11·430 c.m.)	11.—74·16" (188·36 c.m.)	17.—0·88" (2·235 c.m.)	23.—37·50" (95·25 c.m.)
6.—2·18" (5·537 c.m.)	12.—1·38" (3·505 c.m.)	18.—22·56" (57·302 c.m.)	24.—35·84" (91·034 c.m.)

SUPPLY OF REPLACEMENT BODY COMPONENTS

Body components are not supplied as service replacements in finished trim condition. When it is necessary to carry out repairs to trimmed parts, arrangements should be made for the supply of trim materials, which can then be applied locally.

WEATHERSTRIPS

"Bostik" Adhesive No. 1261

Bostik 1261 Adhesive is obtainable from most Factors or from the "B.B." Chemical Co., Ulverscroft Road, Leicester, England.

It is absolutely imperative that the tin containing the adhesive should be thoroughly stirred before use and stirred again at intervals until the operation concerned has been completed. If this is not done certain constituents will sink to the bottom of the tin and unsatisfactory results may be obtained.

'Bostik" 1261 is recommended for attaching all rubber components to metal panels, door flanges, etc.

Preparation of surfaces

(*a*) The porous unskinned surface of the weatherstrip should be cleaned with a wire brush or file carding. Care must be taken to ensure that any deposits of chalk and mica-dust are removed.

(*b*) Clean the surface of the panel to which the rubber is to be fixed. Petrol or white spirit may be used for this purpose.

If old seals are being reapplied, remove all traces of the old adhesive.

(*c*) Apply the adhesive to the porous surface of the rubber and the metal panel. It is important that sufficient adhesive is applied to ensure a continuous film over the whole of the contacting surfaces of the rubber and panel.

Bonding

A period of 15 minutes should be allowed for the adhesive to become tacky before the rubbers are mounted in position. The actual time to be allowed for drying may vary between 10 and 20 minutes according to temperature and humidity, but in no instance must the maximum period of 20 minutes be exceeded.

IMPORTANT

Great care must be taken to ensure that the rubbers are placed in the correct positions on the panels as the surfaces are brought together. On no account must rubbers be stretched during the operation, particularly where panel contours change abruptly. In all cases the rubbers must lie naturally and free from tension.

When bringing the surfaces together the rubbers must be pressed firmly on to the panel surfaces.

The greatest possible amount of time should be allowed to elapse before the vehicle is used.

Cleaning off

When the bonding is completed, any surplus adhesive must be cleaned off the surface of the panels. This is best effected by means of a rag treated with a small quantity of petrol or white spirit. Do not saturate the rag otherwise any excess of liquid may seep into and destroy the bond.

"Seelastik" compound

"Seelastik" is a proprietary sealing compound recommended for sealing rubber weatherstrip to glass and to metal body panels, as in the case of the windscreen and backlight. Its use is recommended also for crack-sealing joints between body panels, to prevent the entry of dust and/or water. "Sealastik" is obtainable from:- Expandite Products Ltd., Cunard Road Works, London, N.W.10. England.

WINDSCREEN—To remove and refit

Rapier

The services of two operators are necessary to carry out the removal and refitting operations, one working from inside the car and one from the outside. The windscreen is located and retained in position by means of the glazing rubber around its periphery. No other form of fixing is used, but the contacting surfaces are treated with "Seelastik" sealing compound during assembly.

To remove

Remove wiper arms.

Remove interior rear view driving mirror and sun visors where fitted.

Remove chromium-plated beading. The beading is retained in position by lips formed in the rubber.

To release the glazing rubber from the inner and outer contacting surfaces of the body, the "Seelastik" seal formed during the original assembly must be broken. The use of a small screwdriver from which all the sharp edges have been removed is recommended. Care should be taken when drawing this tool around and under the rubber to keep the tip firmly under the lip, otherwise damage to paintwork may result.

Apply hand pressure to one of the lower corners and force the windscreen outwards. The second operator (outside the car) can then support the glass as it is released.

Remove the glazing rubber from the glass.

To refit

Remove all traces of old sealing compound from the glass and glazing rubber.

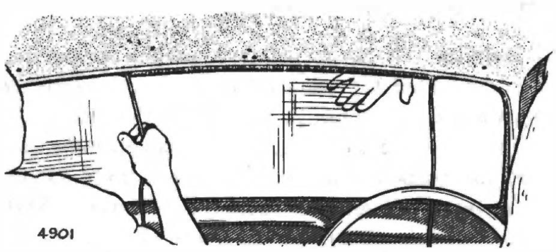


Fig. 1. *Windscreen refitting (Rapier)*

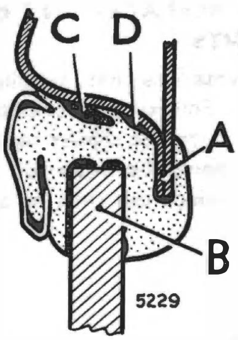


Fig. 2. *Cross-section of weatherstrip (Rapier)*

Apply a coating of "Seelastik" to the face of the rubber which is in contact with the outside face of the glass.

For this operation a special gun is available from Messrs. Expandite Ltd., Cunard Road Works, London, N.W.10, England, who also supply full instructions for operating the gun. In the absence of such a gun it is suggested that an adaptor in the form of a piece of piping with a flattened end could be fitted to a lubrication gun which has a screw-type plunger.

Fit the rubber to the glass (Item B, Fig. 2).

Cut a piece of strong cord of a length considerably greater than the periphery of the glass. The use of thin string should be avoided as this will cut the rubber.

Insert the cord into the inner channel of the rubber (Fig. 5) with the aid of a piece of small diameter pipe through which the cord passes, so that loose ends are near to the centre of the upper edge.

Ensure that the flange of the aperture in the body is clean and free from grease.

Apply a coating of "Seelastik" to the outer channel of the glazing rubber which is to be in contact with the flange of the aperture in the body. Press the windscreen assembly into the aperture from the outside of the car after passing the ends of the cord from the inner channel into the inside of the car. Work the lip of the rubber over the

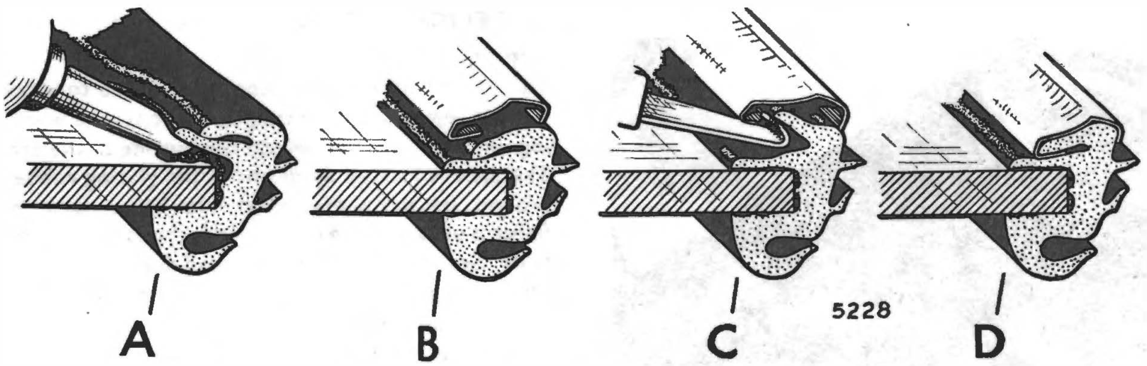


Fig. 3. Method of fitting the chrome beading (Rapier)

flange by pulling the ends of the cord. Pull out this cord completely.

If the outer lip of the glazing rubber becomes folded under itself, work it free with a small screwdriver. Fit the chromium-plated beading.

It may be found easier to fit the beading to the rubber by making up a special tool, as illustrated in Fig. 4, before fitting the windscreen assembly. Smear the rubber with a soap solution before fitting the beading.

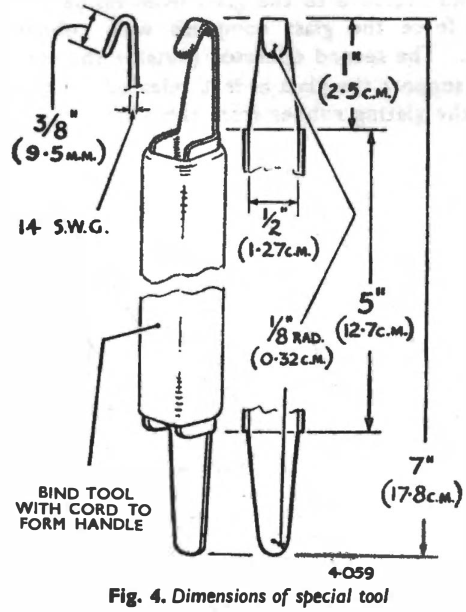


Fig. 4. Dimensions of special tool

Carefully remove any surplus sealing compound with a rag slightly dampened with petrol or white spirit.

WINDSCREEN—To remove and refit
Alpine

It is recommended that if the windscreen has to be removed for any reason, the complete assembly is taken off the car, and the windscreen removed from its frame on a bench.

Fig. 5. Inserting cord into weatherstrip (All models)

To remove

If a hardtop is fitted, this must be removed.
Remove wiper arms.

From below the scuttle, take off the nuts and washers which retain the assembly in position. (Fig. 6). These are located, two at each side, and three across the front. With the assembly removed from the car, take off the top and bottom channels and the side pillars by removing the retaining screws. Remove the glazing rubber from the glass.

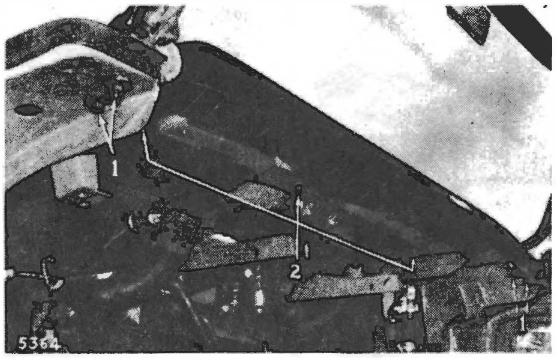


Fig. 6. *Location of Alpine windscreen assembly retaining nuts. (Facia removed for clarity).*

To refit

Remove all traces of old sealing compound from the glass and glazing rubber.

Reference should now be made to Fig. 7 which shows the correct way to fit the glazing rubber to the glass. (A and B shows early and later cars respectively.) It should be noted at this juncture, that the wide notches in the rubber are at the top. Apply a coating of "Seelastik" to the area of the rubber which is in contact with the outside face of the glass, and refit rubber to glass.

Replace top and bottom channels and the side pillars and refit the retaining screws. Before fitting the screen assembly to the car, apply "Seelastik" to the inner forward edge of the screen to scuttle weatherstrip.

It should be noted, when fitting the screen assembly to the car, that the mounting holes are elongated to enable a perfect mating contact to be made between the body and the windscreen assembly.

Refit the hardtop (if fitted) and test for water leaks. Finally, replace the wiper arms in their correct positions.

BACKLIGHT—To remove and refit

Rapier

The services of two operators are needed to carry out the removal and refitting operations, one working on the inside and one on the outside of the car. The glass is located by means of the glazing rubber around its periphery only. No other form of fixing is used, but the contacting surfaces are treated with "Seelastik" sealing compound during assembly. The backlight is removed by pressing it outwards from the interior of the car. In order to do this it will be necessary to break the seal of the "Seelastik" compound between the rubber weatherstrip and the backlight aperture.

To remove

Remove the rear seat cushion and squab.
Remove rear parcel tray.
Release lower ends of headlining at the rear quarters to gain access to the nuts retaining the beading corner pieces. Remove the corner pieces after taking off the nuts.
To release the lip of the rubber from the surface of the rear panel, the "Seelastik" seal formed during original assembly must be broken. This is done by inserting the point of a wedge, and drawing it all round the outer edge of the backlight. Apply hand pressure to the glass from inside the car, and force the glass complete with rubber outwards. The second operator (outside the car) can then support the glass as it is released.
Remove the glazing rubber from the glass.

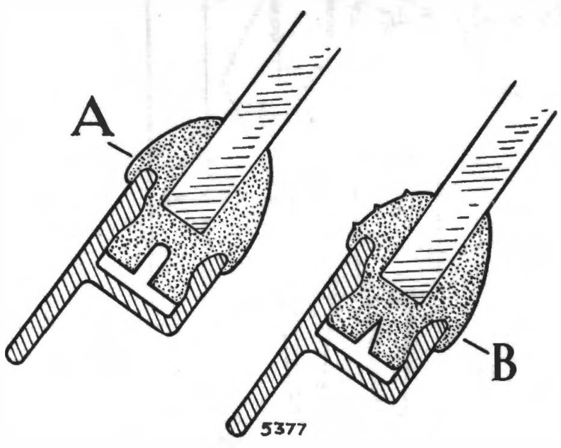


Fig. 7. *Correct fitting of glazing rubber (Alpine)*

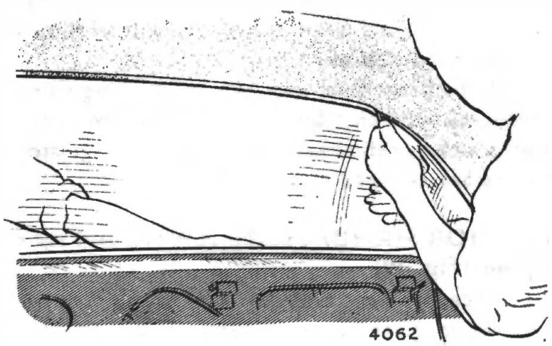


Fig. 8 *Backlight refitting (All models)*

To refit Fig. 8

Remove all traces of old sealing compound from the glass and glazing rubber. Fit the rubber to the glass, followed by the upper and lower beading. Apply a coating of "Seelastik" to the face of the rubber which is in contact with the outside face of the glass.

Cut a piece of strong cord of length considerably greater than the periphery of the glass. The use of thin string should be avoided, as this will cut the rubber.

Insert the cord into the inner channel of the glazing rubber (Fig. 5) so that the loose ends are near to the middle of the upper edge.

Ensure that the aperture in the body is clean and free from grease.

Apply a coating of "Seelastik" to the outer channel of the glazing rubber which is to be in contact with the flange of the aperture in the body. Allow the two ends of the cord to hang on the inner side of the glass.

Press the assembly into the aperture from outside the car, after first making sure that the two retaining clips are in position at the upper edge of the aperture. Work the inner lip of the rubber over the flange of the aperture by pulling the ends of the cord.

Pull out cord completely.

If the outer lip of the rubber becomes folded under itself, work it free with a small screwdriver.

Replace the corner piece beadings and their retaining nuts.

Re-attach the lower ends of the headlining, and replace the parcel tray followed by the rear seat squab and cushion.

BACKLIGHT—To remove and refit

Alpine

The backlight is located by means of the glazing-rubber around its periphery only. No other fixing is used, but the contacting surfaces are treated with "Seelastik" during assembly.

To remove

Take off the two corner cover plates from the upper and lower chrome mouldings.

Starting at the ends, remove the upper and lower mouldings.

From inside the car, remove the filler strips from the upper and lower rubbers.

Starting from the centre of the top rubber, gently push out the backlight. In all probability the rubbers will remain in the hardtop aperture.

To refit

When refitting the backlight, the refitting procedure is not a complete reversal from the removal, due to the fact that the light is made from perspex, and is, therefore, more flexible than if made of glass.

Apply a coating of "Seelastik" to the contacting surfaces of the rubber. Fit the rubber to the glass, followed by the upper, lower, and corner mouldings.

Cut a piece of strong cord of length considerably longer than the periphery of the light. Thin string will cut the rubber.

Insert the cord into the inner channel of the weatherstrip in a similar manner to that shown in Fig. 5, so that the loose ends are near to the middle upper edge.

Press the assembly into the car from the outside with the two ends of the cord on the inner side of the light.

Work the lip of the rubber over the flange in the aperture by pulling the ends of the cord.

Pull out the cord completely.

Finally, refit the filler strips into the glazing rubbers, starting at the ends and pushing into place with the thumbs.

Remove any surplus sealing compound with a rag slightly dampened with petrol or white spirit.

Note

Care should be taken not to scratch the surface of the light.

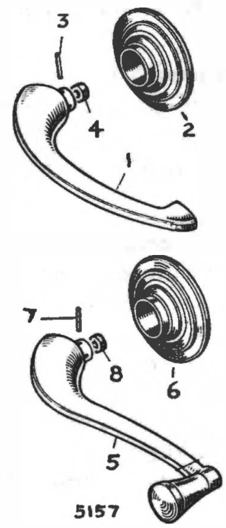


Fig. 9. *Interior door handles (Rapier)*

1. HANDLE, DOOR LOCK
2. ESCUTCHEON
3. PIN
4. RUBBER PAD
5. HANDLE, WINDOW REGULATOR
6. ESCUTCHEON
7. PIN
8. RUBBER PAD

INTERIOR HANDLES—To remove and refit Rapier (Fig. 9)

Turn the escutcheon so that the radial groove in its face is parallel with the dowel hole in the handle. Press the escutcheon against the trim panel.
This will also expose the retaining pin.
With an awl, tap out the pin securing the handle to its spindle. Remove the handle and its escutcheon from the spindle.
This operation is facilitated by a forked wedge inserted between the handle and escutcheon from the underside
Repeat this procedure with the window regulator handle.

To refit

Slide the remote control handle escutcheon on to its spindle.
Slip the handle on to its spindle, matching its position with the handle on the opposite door.
Insert the pin into the hole in the handle shank, line up with the pin the groove on the escutcheon, and push the handle in towards the trim pad When the pin locates with the hole in the spindle, force it home, and allow the escutcheon to return over the handle shank.
Repeat the procedure with the window regulator handle, ensuring that both the windows are in the same positions before the positions of the regulator handles are matched.

INTERIOR HANDLES—To remove and refit Alpine (Fig. 10)

The procedure for removing and refitting is the same as is given under "Rapier", except that between the handle and the escutcheon is a cup and spring.

To remove

Push the cup towards the trim pad, turning while still pushed in until the end of the handle retaining pin is exposed.
Tap out the pin, and take off the handle, cup and spring, followed by the escutcheon.

To refit

Reverse the above procedure.

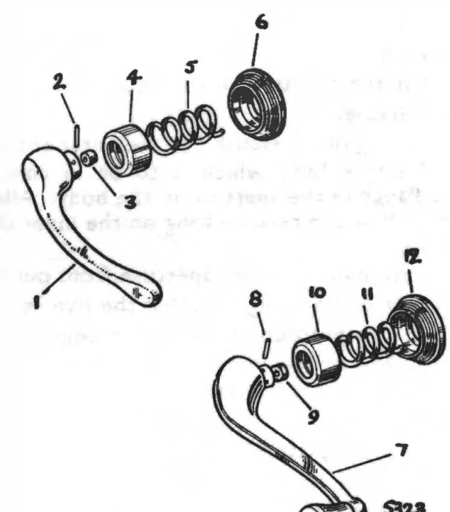


Fig. 10. *Interior door handles (Alpine)*

1. HANDLE, DOOR LOCK
2. PIN
3. RUBBER PAD
4. CROWN (CUP
5. SPRING
6. ESCUTCHEON
7. HANDLE, WINDOW REGULATOR
8. PIN
9. RUBBER PAD
10. CROWN (CUP)
11. SPRING
12. ESCUTCHEON

DOOR PULL—To remove

All models

These are retained by two self-tapping screws, the removal of which frees them from their locations on the door.

TRIM PAD—To remove and refit

All models

Remove interior door handles.

The trim pads are attached to the door panel by spring-in clips which are concealed.

Insert a broad-bladed knife or screwdriver under the edges of the trim pad at any convenient point around its edges. Ease the trim pad away from the door panel, working progressively around the edges, and keeping the tool close to each clip as it is prised out.

Pull the trim pad downwards until the upper edge is clear of the retaining flange on the door at its upper edge.

The pad is now free.

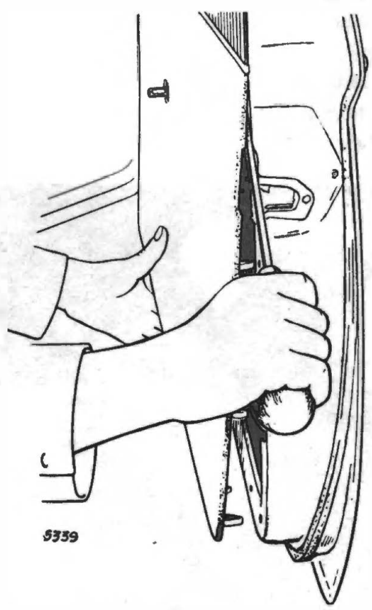


Fig. 11. *Removing a trim pad (Rapier illustrated)*

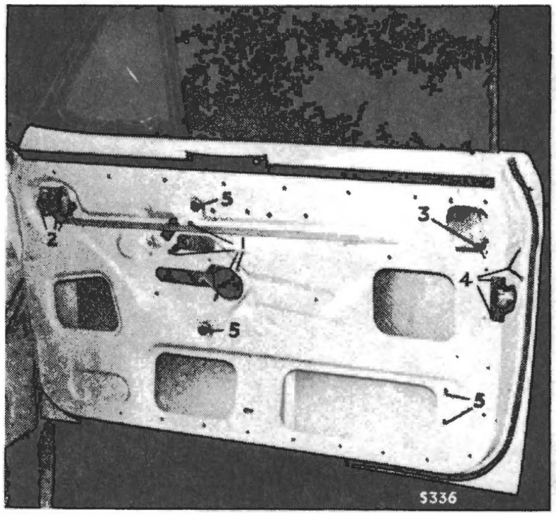


Fig. 12. *General view of door with trim pad removed (Rapier)*

To refit

Enter the upper edge of the trim pad into the retaining flange and fit the spring clips on the trim pad into the holes around the door panel. Press the trim pad firmly home and refit interior handles.

WINDING WINDOW, DOOR—To remove and refit

Rapier

Remove interior handles and trim pad.

Remove bottom stop.

Replace window winding handle temporarily and lower window to the bottom of the door and clear of its operating arms.

Remove screw, nut and washer from the rear end of the guide channel (camplate) in which the arms operate.

Remove top stop.

Lift the glass up the channel in which it normally operates, and out of the top of the door.

Replacement is a reversal of the above procedure.

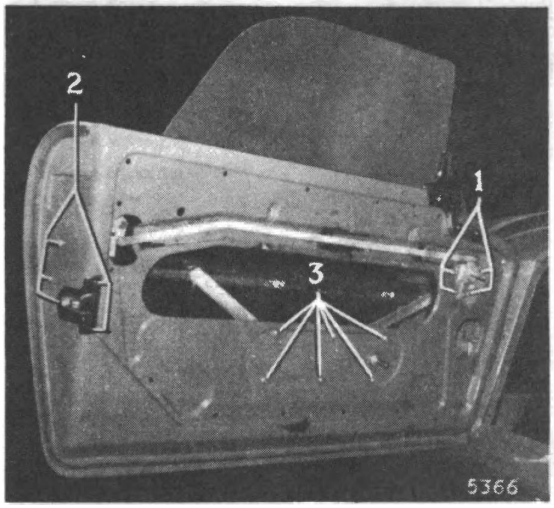


Fig. 13. General view of door with trim pad removed (Alpine)

WINDING WINDOW, DOOR—To remove and refit

Alpine

Remove interior handles and trim pad.

Replace window winding handle temporarily and lower window until the regulator guide channel (camplate) is visible through the aperture in the inner door panel.

Spring out the regulator operating arms from their locations.

Remove the furflex anti-rattle strips by easing them down with a screwdriver.

Release the front and rear glass channels.

Turn the window (Fig. 14) and lift up and out through the aperture in the door.

When refitting, replace the anti-rattle strips first, but leave the rear ends free.

After replacing the window, fit the rear ends of the anti-rattle strips.

QUARTER-LIGHT GLASS—To remove and refit

Rapier (Fig. 15)

Remove window winding handle.

Remove rear seat cushion and squab. The retaining screws for the squab are accessible from inside the boot.

Remove the trim panel from below the window aperture.

Remove the cotter pin and large nut from the quarter-light pivot.

Temporarily replace window winding handle and lower window to approximately the half-way position.

Release operating arm from its guide channel.

Pull the glass assembly by grasping the upper forward edge, clear of its pivot, and up and out of the body side.

NOTE: When removing the left hand light it is advisable to remove the interior lamp. In which case refer to Section N.

NO DRAUGHT VENTILATOR—To remove and refit

Rapier

Remove winding window.

Remove four screws securing ventilator and frame to the door, located as follows:—

Two at the upper and forward edge of the door.
One immediately above the winding window regulator, and one above the bottom stop.

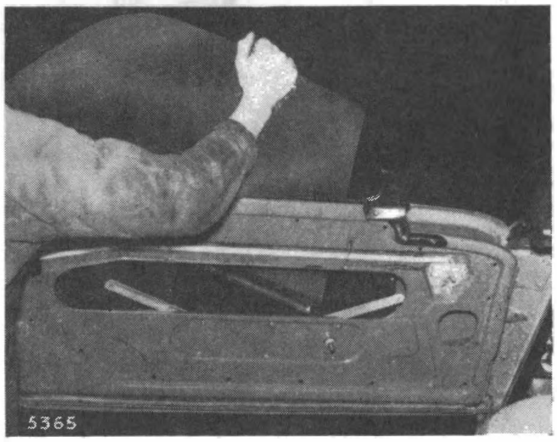


Fig. 14. Refitting winding glass (Alpine)

Fig. 15. *Quarter-light removal (Rapier)*

Slightly lift the ventilator and withdraw complete with its outer frame towards the rear and out of the door.

To dismantle the ventilator from its frame, carefully ease the weatherstrip from the outer frame and with a steady hand pressure, push the inner frame complete with glass out.

After easing the weatherstrip from the inner frame, the glass may be freed by pulling straight out.

To assemble the ventilator to its frame, commence by applying a coat of "Seelastik" to the inner channel of the inner weatherstrip which is in contact with the glass.

Assemble the glass and weatherstrip to the inner frame, not forgetting to apply "Seelastik" to the channel of the inner frame which the glass weatherstrip fits into.

For the remainder of the refitting instructions, reverse the removal procedure.

FRONT SEAT—To remove
Rapier

Upon removal of the seat runner bolts (each corner of the seat), the assembly is free and can be removed from the car.

Slide the seat forwards and rearwards on its runners to gain access to the bolts.

To refit

Reverse the above instructions.

FRONT SEAT—To remove
Alpine

Slide the seat backwards to expose the forward retaining screws, and forwards for the rear screws. Upon removal of these, the seat assembly is free to be removed from the car.

Refitting is a reversal of the above instructions.

FRONT SEAT—Removal of trim
All models

The trim, which is secured to the seat spring case with ring clips, is retained in position on the seat frame with bifurcated rivets. The rivets, at each side, are concealed by the lower ends of the side panels of the seat squab.

Before the trim can be removed from the seat spring case, it is necessary to remove the cushion assembly from the seat frame as a complete unit. First remove the pivot arms by extracting the pin from below the seat frame, then turn the seat upside down and release the lower end of the side panels of the squab trimming. Each side is secured to the underside of the seat frame and conceals the bifurcated rivets retaining the seat cushion in position. Remove the rivets from each side and lift the complete cushion assembly from the seat frame.

Lay the cushion down with the underside uppermost and release the ring clips securing the trim to the spring case. The trimming of the seat cushion is now free to take away.

To refit, reverse the above instructions.

NOTE: Pivot arms are only fitted to the "Rapier" models.

FRONT SEAT SQUAB (Removal of trim)
All models

Remove seat cushion.

Release the ring clips securing the lower end at the front of the squab trim to the seat frame.

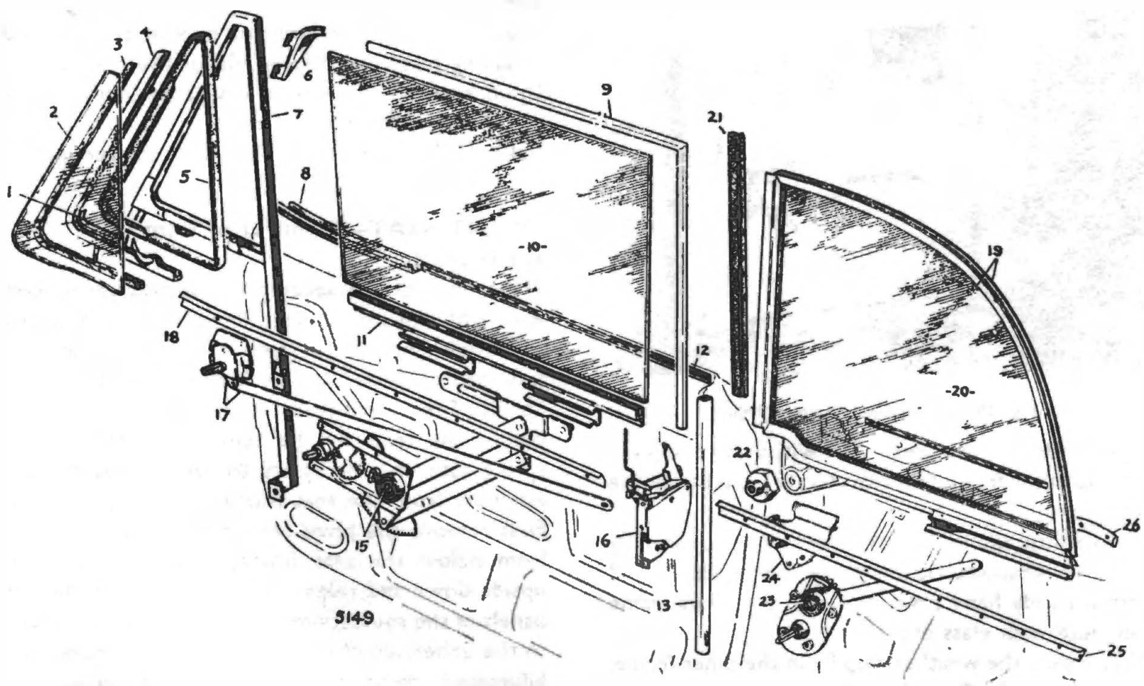


Fig. 16. *Door glasses and mechanism (Rapier Coupe)*

1. DRAIN CHANNEL
2. GLASS
3. GLAZING RUBBER
4. INNER FRAME
5. WEATHERSTRIP
6. RAIN DEFLECTOR

9. WINDING WINDOW FRAME
10. WINDING WINDOW
11. GLASS CHANNEL AND CAMPLATE
12. SEAL
13. GLASS RUN CHANNEL

19. QUARTER LIGHT FRAME
20. GLASS
21. WEATHERSTRIP
22. SPECIAL NUT
24. MOUNTING BRACKET
25. RETAINER (TRIM PAD)
26. GUIDE BUFFER

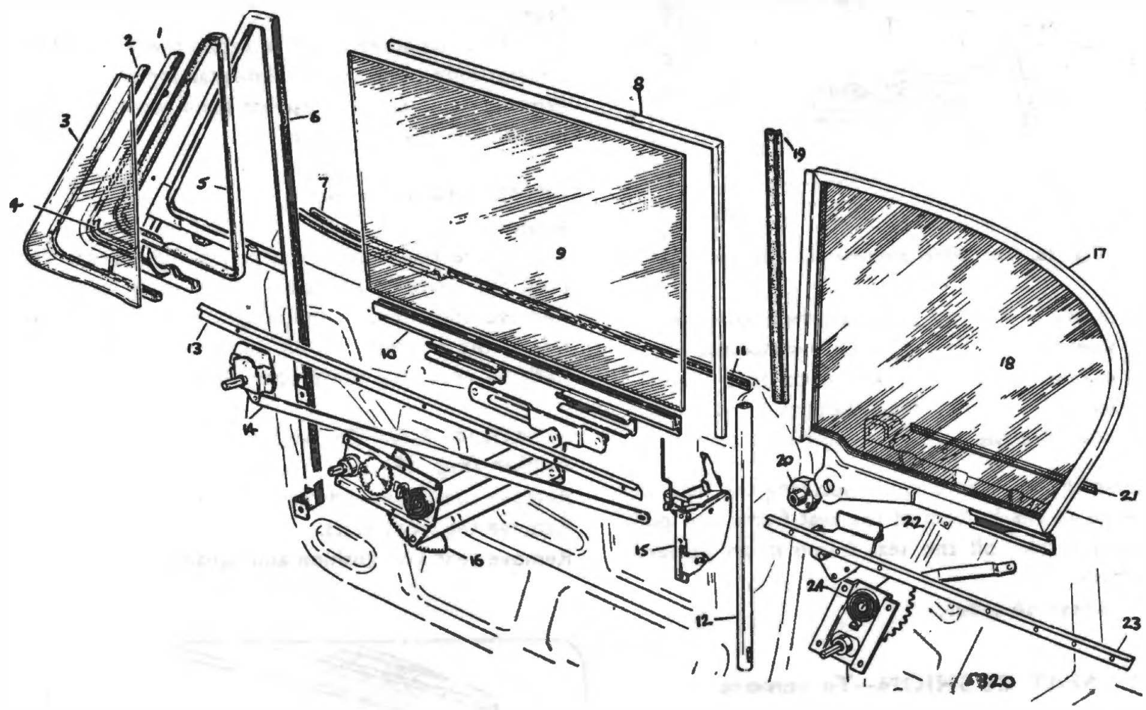


Fig. 17. *Door glasses and mechanism (Rapier Hardtop)*

1. INNER FRAME
2. GLAZING RUBBER
3. GLASS
4. DRAIN CHANNEL
5. WEATHERSTRIP
6. OUTER FRAME
7. WEATHERSTRIP
8. LIFTING GLASS FRAME
9. LIFTING GLASS
10. GLASS CHANNEL AND CAMPLATE
11. SEAL
12. GLASS RUN CHANNEL
13. RETAINER (DOOR TRIM PAD)
14. REMOTE CONTROL
15. DOOR LOCK
16. WINDOW REGULATOR
17. QUARTERLIGHT FRAME
18. GLASS
19. WEATHERSTRIP
20. NUT
21. SEAL
22. MOUNTING BRACKET
23. RETAINER (TRIM PAD)
24. QUARTERLIGHT REGULATOR

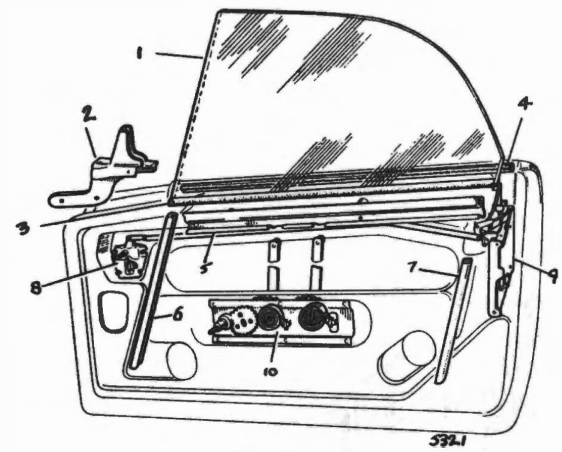


Fig. 18. *Door glasses and mechanism (Alpine)*

1. GLASS	6. GLASS RUN CHANNEL (F)
2. SUPPORT	7. GLASS RUN CHANNEL (R)
3. GLAZING RUBBER	8. REMOTE CONTROL
4. SEAL	9. DOOR LOCK
5. GLASS CHANNEL	10. WINDOW REGULATOR

Remove the bifurcated rivets securing the back of the trim to the bottom of the seat frame and pull the squab trim off the seat frame in an upward direction.
Refit in reverse order.

REAR SEAT CUSHION—To remove
Rapier
Simply lift up the forward edge of the cushion from its front retaining valance, whereupon the cushion can be removed.
Refit by reversing this operation.

REAR SEAT—To remove
Alpine
Release the press fasteners and remove seat pad.

REAR SQUAB—To remove
Rapier
Pull the lower edge of the squab forward, lift the squab upwards to release its retaining clips and remove it from the car.

To refit
Enter the clips at the top edge of the squab and push the lower edge of the squab into position.

ARMREST—To remove
Rapier
From below the armrest remove the outer screws and take off the armrest.
Note
The two inner screws help to retain the trim of the armrest only. The other trim-retaining screws are exposed when the armrest has been removed.
Refit in the reverse order.

ARMREST—To remove
Alpine
To remove the combined armrest and locker, tip both the driver's and passenger's seats forward. Remove the three self-tapping screws from each side of the armrest, and lift off.
Refit by reversing these operations.

HEADLINING—To remove
Rapier (Fig. 19)
Remove sun visors and rear view mirror.
Remove the front seats.
Remove rear seat cushion and squab.

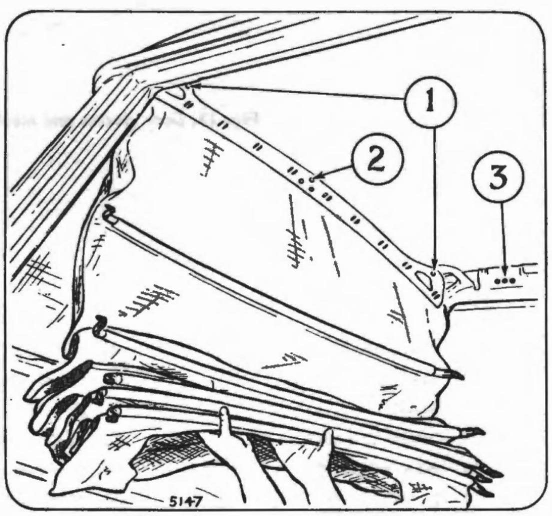


Fig. 19. *Headlining refitting showing retention of header pad (Rapier)*

Release the draught welt from above the doors, and down as far as the striker.
Remove the rear quarter trim panels.
Remove backlight glass.
Remove the clips securing the edges of the roof lining to the flanges of the door and backlight, and release the roof lining. All edges are secured to the flanges in production with adhesive solution.
The lining is now supported by the listing rails and the header pad only. Remove the rearmost listing rail first.
Continue to release the remaining rails in turn by springing the lower edges inwards to release from the locating holes in the cantrails.
Remove the screws securing the header pad to the top of the screen and remove pad.

To refit

The services of two people are required to refit the lining. In order that the lining will conform to the shape of the inside of the roof, listing rails of different contours are used, the ends of which are coloured to aid identification, the position of which MUST be observed when removing the lining.
It will be noted that there are three alternative locating holes (3) in the cantrail for the ends of each listing rail. These holes accommodate any variations which may occur during the original making up of the lining.
Clean off all traces of old adhesive from the flanges of the doors and backlight aperture. Before fitting the new headlining, apply a suitable adhesive to the door flanges and backlight aperture and allow it to become nearly dry.
To refit the lining, reverse the removal procedure. The lining when fitted must be free from creases with no sagging occurring anywhere.

Note

After fitting the header pad, and BEFORE fitting the remainder of the lining, secure the header pad by temporarily replacing the sun visor (1) and rear view mirror (2) retaining screws, otherwise, when pulling on the lining to remove the creases which occur while fitting, the header pad will be pulled out of position, necessitating starting again.

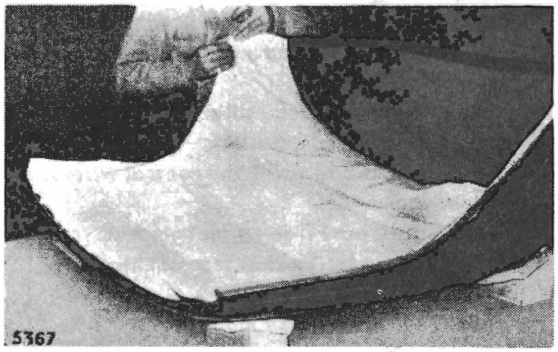


Fig. 20. *Fitting headlining (Alpine)*

HEADLINING—To remove
Alpine (Fig. 20)

Remove the hardtop.
Remove the backlight.
Remove the finishing strips from the forward, side and rear flanges.
Remove the clips securing the edges of the headlining to the flanges of the hardtop, and release the lining.
All edges are secured to the flanges in production with an adhesive solution.
Remove the self-tapping screws securing the listing rods, and remove the lining.

To refit

Unlike the Rapier, the headlining listing rails on the Alpine can only be fitted in one position. Secondly, attach the lining at the rear corners, taking the tension before sticking down to remove wrinkles.
Stick down the front edges working from centre outwards, following with the side edges last.

Note

Before sticking the edges down, all wrinkles and creases must be eliminated and no sagging should occur when finally fitted.
Replace the clips securing the edges of the lining to the flanges of the hardtop, following with the finishing strips at forward, rear and side flanges.
Replace the backlight.
Refit the hardtop.

DOORS All models

Lubrication

It is essential that the hinge pins and door locks are lubricated at regular intervals.

On Rapier cars an oil hole is provided in the shut face of the door approximately on a line with the operating push-button of the exterior handle When not in use, the oil hole is sealed by a polythene grommet.

When oiling the door locking mechanism the windows should be fully wound up, and after oiling, the doors should be left open for as long as possible, otherwise, since some oil is bound to be wasted, it may flow out of the drain holes and possibly into the interior of the car.

The wards of the lock should be lubricated by applying oil to the key, which is then inserted into the lock in the normal manner.

The push-button of the exterior handle is lubricated from the outside.

To adjust hang of doors

Remove hinge cover plates where fitted. Free the door weatherstrip around the vicinity of the door hinges.

Note: If hinges are adjusted, then the door lock striker plates must also be adjusted.

Adjustment of the doors is carried out by loosening off the bolts securing the hinges to the body, and moving the doors in the required direction, after which the securing bolts must be re-tightened.

In order to raise or lower the door diagonally, packing pieces of the required thickness may be fitted between the hinges and their respective attachment points.

Refit weatherstrip and hinge cover plates.

If damage to the locks, the door components, and trim is to be avoided, the following dismantling instructions should be adhered to.

DOOR LOCKS—To remove

All models

Remove the interior trim.

Remove the securing screws which hold the remote control to the door and swing the unit and connecting link vertically downwards (Fig. 21). In this position, the unit can be detached from its dowel on the operating lever.

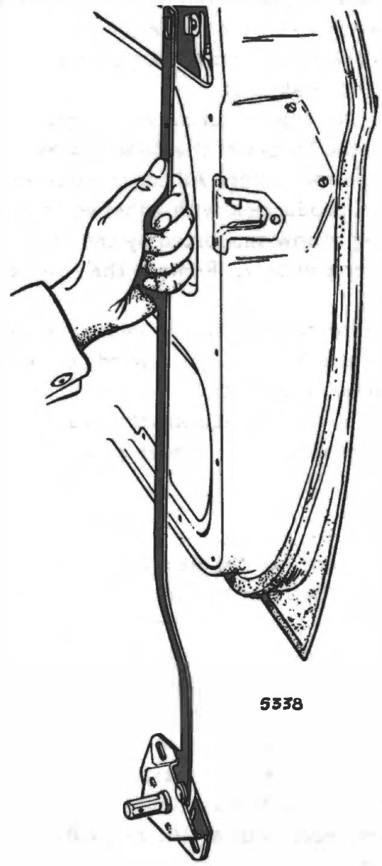


Fig. 21 *Removing lock remote control (Rapier)*

Remove the securing screws in the shut face of the door and the screws securing the dovetail on the inner door panel.

On Rapier doors, press the sill control knob downwards into the locked position.

Unscrew the knob and swing the control wire down against the lock.

The lock unit is now free to be removed through the lock aperture in the shut face of the door.

To refit

Reverse the above instructions, except that when the remote control unit is fitted, slide the unit

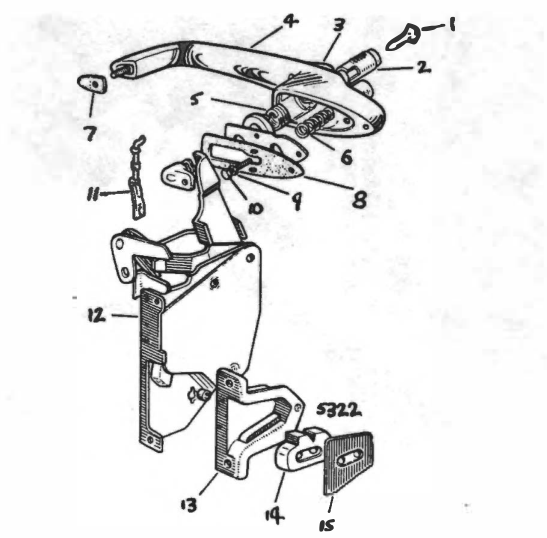


Fig. 22. *Components of the lock mechanism*

1. KEY	9. NUT
2. LOCK	10. CONTACT SCREW
3. WEATHERSHIELD	11. LINK
4. OUTSIDE HANDLE	12. DOOR LOCK
5. SPRING	13. DOVETAIL
6. SPRING (PUSH-BUTTON)	14. STRIKER
7. WASHER	15. BACKPLATE
8. WASHER	

away from the lock until approximately $\frac{1}{32}$" (·8 mm.) free movement is obtained. A small working clearance is essential for the correct functioning of the lock mechanism.

After successfully refitting the door locks and remote control, the safety catch controls (Rapier only) should also be adjusted, the procedure of which is as follows.

Check that the catch wires do not foul their respective apertures, bending them if necessary. Press the control knob downwards into the locked position, screw the knob home, leaving a small clearance between the knob head and the door sill to ensure that the full travel of the control is not restricted.

EXTERIOR DOOR HANDLE—To remove
All models

Remove door trim.

From inside the door casing remove nut at front and screw at rear. Both are fitted with plain and shakeproof washers.

To adjust

On the reverse side of the push-button is a plunger held by a locknut. The correct clearance between the plunger head and the lock contactor should be $\frac{1}{32}$" (·8 mm.) and must be checked when the handle is attached to the door, through the large aperture in the inner door.

When adjusting, simply release the locknut and rotate the plunger bolt in or out as required, finally tightening the locknut.

To refit

Reverse the removal instructions, not forgetting the seating washers between the handle and the door panel.

STRIKER UNIT—To remove
All models (Fig. 23)

It is not necessary to disturb this component other than to fit a replacement or to make adjustments. In this case, remove the securing screws (B). Screws (A) retain the lock in the shut face of the door.

To refit

Attach the striker unit loosely to the door pillar, moving to the desired position before finally tightening the securing screws.

When fitted the unit should be at right angles to the door hinges.

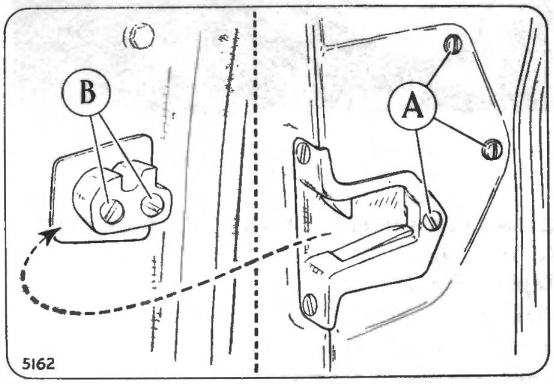


Fig. 23. *Striker and dovetail*

WINDOW REGULATOR—To remove
All models

Remove interior trim.

Temporarily replace window winding handle and lower window to approximately halfway down and support the glass.

Release the lower ends of the glass run channels.

Remove the screws securing the regulator to the inner door panel. Spring the operating arms from the location in the guide channel (camplate) of the glass and remove regulator from the door.

Reference can be made to Figs. 12 and 13 for the location of the various items.

To refit

Reverse the above procedure.

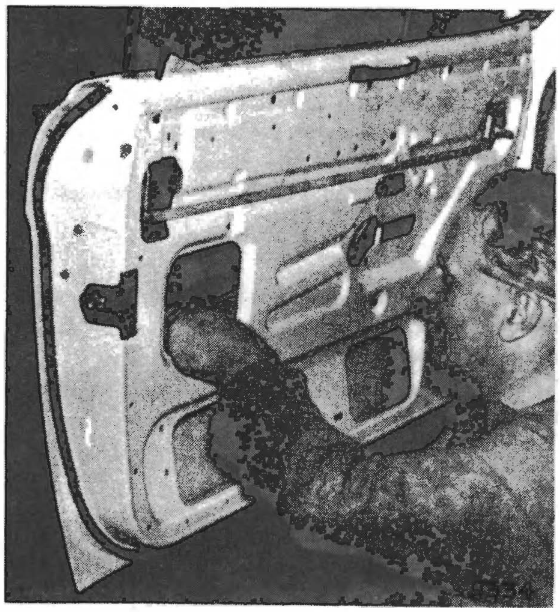


Fig. 24. *Removing retaining screws from window regulator (Rapier)*

QUARTER-LIGHT GLASS REGULATOR—To remove
Rapier (Fig. 25)

Remove interior trim.

Temporarily replace window winding handle and lower window to approximately halfway.

Release the operating arm from its location and

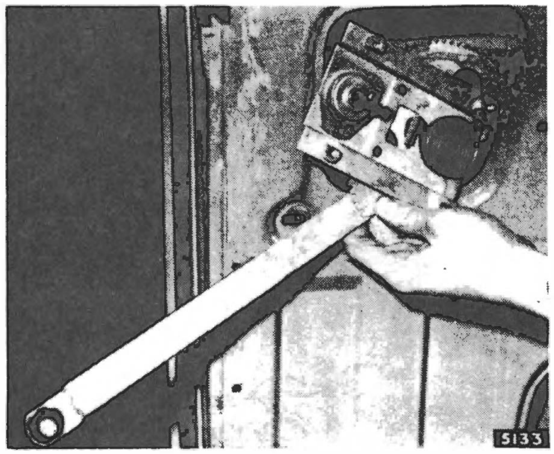


Fig. 25. *Removing quarter-light regulator (Rapier)*

the screws securing the regulator to the inner body panel.

To refit, reverse the above instructions.

BONNET—To remove
Rapier (Fig. 26)

Support the bonnet lid with a suitable sling in the open position.

Remove the two setscrews with their respective washers (2) from each bonnet hinge, whereupon the bonnet is free to be removed.

Replacement is a reversal of the above instructions.

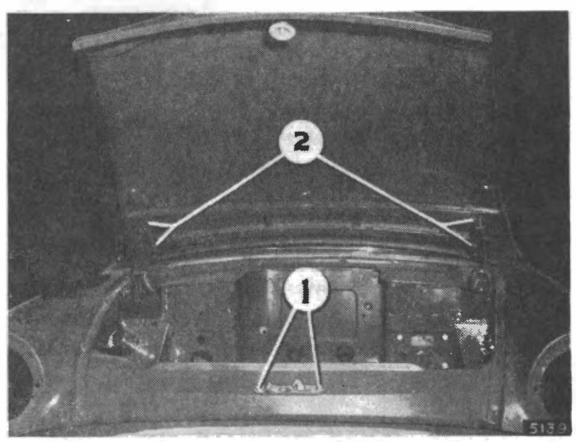


Fig. 26. *Bonnet and lock attachment points (Rapier)*

BONNET—To remove
Alpine (Fig. 27)

Support the bonnet lid with a suitable sling in the open position.

Remove the four setscrews with their washers from each hinge. (1)

The bonnet lid is now free to be removed.

To refit, reverse the above instructions.

BONNET LOCK—To remove (Fig. 28)
Rapier

Take out the two bolts with their spring and flat washers (1), (Fig. 26).

Gently ease the lock out of its aperture and release the operating cable.

With the cable released from (A) pull slightly up on the lock to gain access to (7). Remove this to free lever (8) and take out lock.

To remove striker, undo the locknut from above the baffle into which the unit fits, and turn in an anti-clockwise direction by the screwdriver slot provided.

Replace both striker unit and lock by reversing the above procedure.

Adjustment of the striker is carried out by screwing in or out of the striker pin, finally locking up with the locknut.

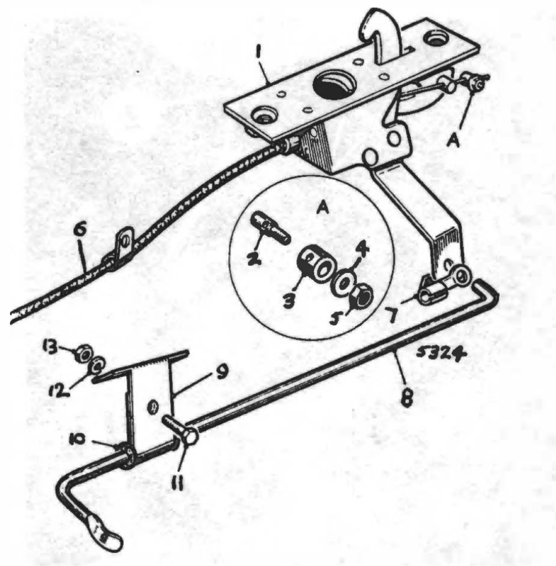


Fig. 28. *Components of the bonnet lock (Rapier)*

1. CATCH
2. PIN
3. BUSH
4. WASHER
5. NUT
6. CONTROL CABLE
7. CLIP
8. LEVER
9. BRACKET
10. BUSH
11. BOLT
12. WASHER
13. NUT

When correctly adjusted, a slight movement is perceptible in the bonnet top when it is in the closed position.

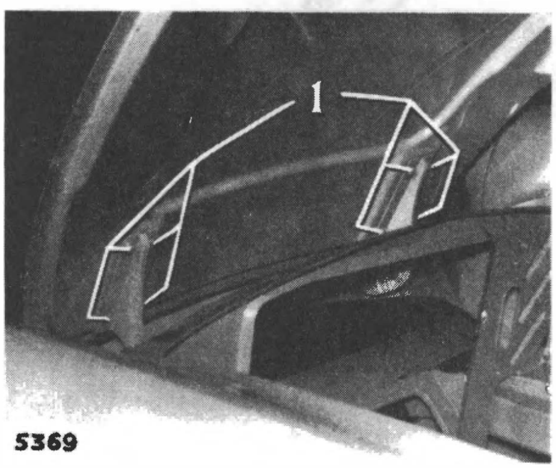


Fig. 27 *Bonnet and lock attachment points (Alpine)*

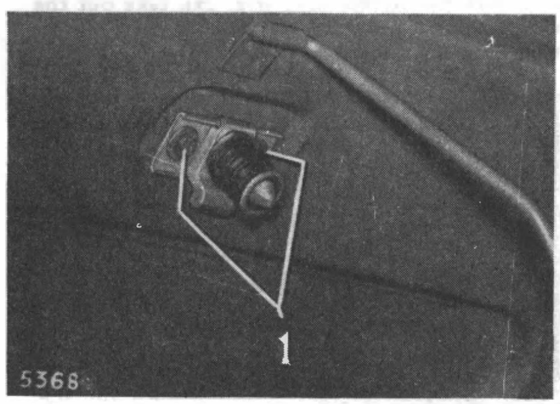


Fig. 29. *Bonnet lock striker (Alpine)*

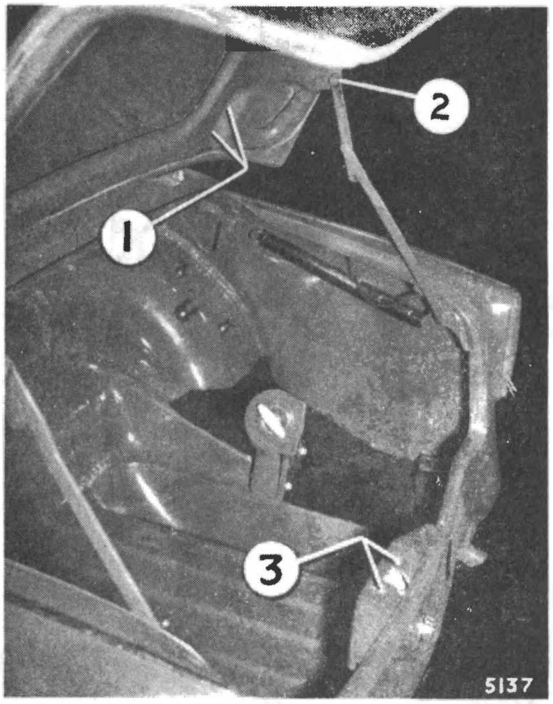


Fig. 30. *Boot lid and lock attachment points (Rapier)*

BONNET LOCK—To remove

Alpine

Remove the cotter pin and flat washer retaining the control rod slide and lift off slide.
Take out the three setscrews with their washers and lift off lock.

To remove the striker unit (Fig. 29), take out the two setscrews (1) with their flat and spring washers.

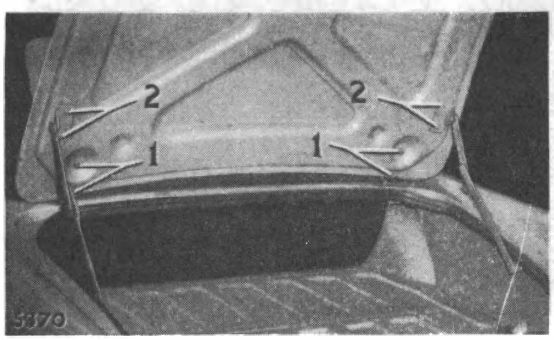


Fig. 31. *Boot lid attachment points (Alpine)*

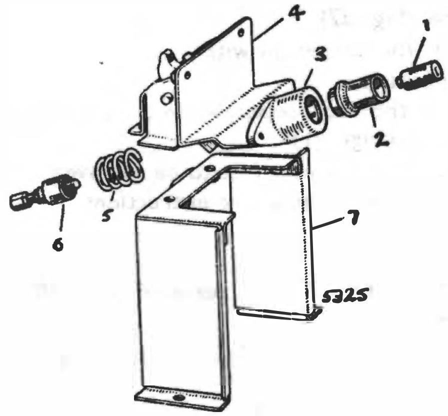


Fig. 32. *Components of the boot lid lock (Rapier)*

1. LOCKING BARREL
2. PUSH-BUTTON
3. HOUSING
4. LOCK
5. SPRING
6. PUSH-BUTTON ASSEMBLY
7. BRACKET

Replace both striker unit and lock by reversing the above procedure.
Adjustment of the striker is carried out by screwing in or out of the striker pin, finally locking up with the locknut.

BOOT LID—To remove

Rapier (Fig. 30)

Disconnect the battery from the positive terminal

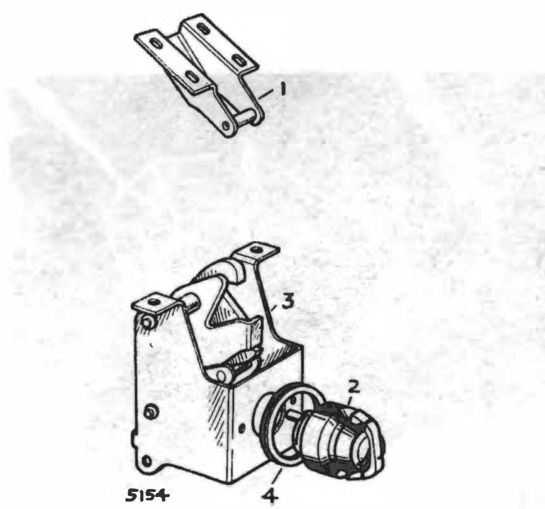


Fig. 33. *Components of the boot lid lock (Alpine)*

1. STRIKER PLATE
2. OPERATING KNOB
3. LOCK
4. SEAL

Open the boot lid, and from the underside pull out the number plate lamp wire from its snap connector.
Support the lid with a suitable sling and remove the retaining bolts from the prop at each side (2).
Finally, remove two nuts and washers (1) from each hinge and take off the boot lid.
Reverse these instructions when refitting.

BOOT LID—To remove
Alpine (Fig. 31)

Support the boot lid with a suitable sling in the open position.
Remove both the nuts, screws and washers from each hinge (1), and the setscrews with their washers (2) from each support prop.
Reverse these instructions when refitting.

BOOT LID LOCK—To remove
Rapier

Remove two screws with their washers (3), (Fig. 30).
The lock can now be removed by pulling out from the inside of the boot.
The striker plate is removed by taking out the four securing screws with their washers. The mounting holes in the plate are elongated to provide a means of adjustment.

To refit

Reverse the above procedure.

BOOT LID LOCK—To remove
Alpine

From below the outer edge of the boot weatherstrip remove the two self-tapping screws.
Remove the two screws from the rear of the top face of the lock, and remove lock from inside the boot.
The striker plate is removed by taking out the four securing screws with their washers.
The mounting holes in the plate are elongated to provide a means of adjustment.

To refit

Reverse the above procedure.

FRONT GRILLE ASSEMBLY—To remove

Rapier

Disconnect the battery.

Pull out snap connectors for side lamps and dismantle the lamps. (See Section N.)
Remove three self-tapping screws (each side) retaining the lamp body to the side grilles.
Remove the self-tapping screws securing the grille and take off grille.

Remove nuts from the reverse side of each side grille and remove grille.

To refit

Reverse the above instructions, but when refitting the side grilles, ensure that the seals are correctly positioned, otherwise damage may well ensure with the final tightening of the retaining nuts.

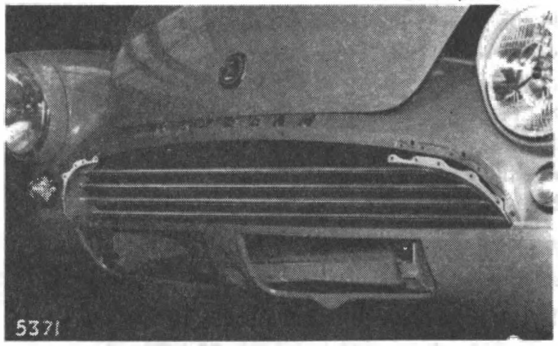


Fig. 34. *Front grille assembly (Alpine) I, II, III.*

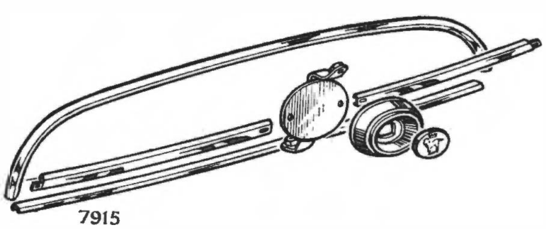


Fig. 34a. *Front grille assembly (Alpine IV)*

FRONT GRILLE ASSEMBLY—To remove
Alpine I, II and III (Fig. 34)

From the reverse side of the grille, take off the clips which retain the finisher to the body.
Pull off the finisher, starting at one end.
Remove the retaining screws now exposed at each end of the grille.
On some models there are three retaining nuts along the bottom edge of the grille, access to which is gained from below the front apron.

Alpine IV (Fig. 34a)

Remove retaining screws from behind the griddle.
Reverse the above instructions when refitting.

FRONT AND REAR BUMPERS—To remove
Rapier

The bumpers can either be removed complete with their mounting back bars, or without.
In the first case, remove four nuts (two each side) with their washers.
In the latter case, remove two (one each side) large bolts with their respective washers and distance pieces.
If overriders are fitted, they are retained by nuts and washers screwed onto a bolt in the overrider itself. This bolt passes through the bumper back bar.

FRONT AND REAR BUMPERS—To remove
Alpine

The bumpers can either be removed complete with their mounting brackets, or without.
In the first case, remove two bolts (one each side) with their washers for both the front and rear bumpers.
In the latter case, remove the nuts and washers from the outer sides, and the bolts and washers (which also retain the overriders) from the inner mountings on both the front and rear bumpers.

BODY MOULDINGS—To remove
Rapier

The mouldings are retained in position by screws or nuts at their ends, and clips along their length.
After the removal of the screws or nuts, the mouldings should be eased up from their lower edges with a piece of sharpened wood, and then pulled away from their clips.
The upper tonneau moulding has nuts along its entire length ; so, too, has the bead below the rear lamps.
The end capping above the rear lamps is retained by screws.
The names "Sunbeam" and "Rapier" use for their retention either spire nuts or friction bushes.
When refitting enter the top edges of the mouldings first, pushing down the lower edges until the clips are fully engaged.

NAME BADGES—To remove
Alpine

Friction bushes are used in the retention of the badge on the bonnet, the name "Sunbeam" on the bonnet surround, and the "Alpine" plaque on the rear end of the front wings.
The name "Sunbeam" on the boot lid is retained by spire nuts.
If it is necessary to remove the name plates for any reason, simply pull off their respective retainers.
When refitting, new friction bushes or spire nuts should be used.

RECOMMENDED LUBRICANTS

CONTENTS

RECOMENDED LUBRICANTS

ENGINE

Where prevailing climatic temperature is:—

SUMP (OIL PAN)	Above 70°F. (21°C.)	Shell X-100 30 or Shell X-100 Multigrade 20W/40.
	80°F. to 20°F. (27° to —7°C.) ...	Shell X-100 20/20W or Shell X-100 Multigrade 10W/30.
	32°F. to 0°F. (0° to —18°C.) ...	Shell X-100 10W or Shell X-100 Multigrade 5W/20.
	Below 5°F. (—15°C.)	Shell X-100 Multigrade 5W/20.

Upper Cylinder Lubricant ... ... Shell Donax U or Shell Upper Cylinder Lubricant

AIR CLEANER AND SILENCER ... ... Engine Oil

DISTRIBUTOR

Shaft and Cam bearing. Contact breaker pivot. Automatic timing (Spark) control ... ... Engine Oil

Cam Profile and shaft greaser ... ... Shell Retinax A

GENERATOR ... ... Engine Oil

BATTERY TERMINALS ... ... Petroleum Jelly

STEERING UNIT ... ... Shell Spirax 90 E.P.

FRONT SUSPENSION (where necessary)

King Pins, Idler Pivot, Steering Joints and front suspension links ... ... Shell Retinax A

ACCELERATOR CONTROL LINKAGE ... ... Engine Oil

GEARBOX	*Above*, minus 10°F. (minus 23°C.) ...	Shell X-100 Motor Oil 30
(and overdrive, if fitted)	*Below*, minus 10°F. (minus 23°C.) ...	Shell X-100 Motor Oil 20/20W
From Chassis Nos B33100001 (Rapier) B94100001 (Alpine)	All temperatures	Shell X-100 Multigrade 10W/30

PROPELLER SHAFT

Needle Roller Bearings ... ... Shell Spirax 140 E.P. or Shell Retinax A.

REAR AXLE

*HYPOID	*Above*, minus 10°F. (minus 23°C.)	Shell Spirax 90 E.P.
	Below, minus 10°F. (minus 23°C.)	Shell Spirax 80 E.P.
SPIRAL	*Above*, 32°F. (0°C.)	Shell Spirax 140 E.P.
BEVEL	32°F. (0°C.) to minus 10°F. (minus 23°C.)	Shell Spirax 90 E.P.
	Below, minus 10°F. (minus 23°C.)	Shell Spirax 80 E.P.

FRONT WHEEL HUB BEARINGS ... ... Shell Retinax A

REAR WHEEL HUB BEARINGS ... ... No attention required

HANDBRAKE

Cable ... ... Shell Retinax A

Linkage ... ... Engine Oil

BRAKE AND CLUTCH PEDAL PIVOTS ... ... Engine Oil

BRAKE AND CLUTCH MASTER CYLINDERS

ALPINE (All temperatures) ... ... Girling Fluid S.A.E. Spec. 70 R.3

RAPIER (All temperatures) ... ... Lockheed Super Heavy Duty Brake Fluid to S.A.E. Spec. 70 R.3

SHOCK ABSORBERS

Alpine (Front)	No attention required
Alpine (Rear)	Armstrong Shock Absorber Fluid No. 624
Rapier (Front and Rear)	No attention required

BODY

Hinges, Locks, Catches ... ... Engine Oil

Notes

Any addition to the above lubricants, which may alter their characteristics sufficiently to affect mechanical efficiency, should not be used. Additives should not be used in the gearbox of cars fitted with overdrive. For continuous high speed driving Shell X-100 Multigrade 20W/40 should be used. This is particularly important during the hot weather.

**Hypoid axles may be identified by white marking around the filler plug. For further details reference should be made to Section G*

OIL SEALS AND TAPER-ROLLER BEARINGS

CONTENTS

(3 Pages)

OIL SEALS

1. Before fitting, carefully examine the seal and remove all traces of dirt or 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 in the housing recess, **with the lip and the 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 lie 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. ·005″—·015″ (·13—·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. ·005″—·015″ 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 "cocked" 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 ·002" (·051 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 (Stub axles)

(*a*) The cones must be a "creep" fit on the shaft, the ideal being ·0002"/·0013" (·005/·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 inner race must always be smeared with grease before the bearings are fitted.

(*b*) Hub bearings should be adjusted in the manner described in Section F of this manual.
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.

HEATING AND VENTILATION

CONTENTS

HEATING AND VENTILATION

These instructions apply only to the Rapier Series III and IV heater.

(Sunbeam Rapier Series III, IIIA, and Series IV—*These kits are not suitable for Series II or earlier vehicles. The adjustments given below apply to Series III, IIIA and Series IV only. No adjustments were provided for on the earlier heaters*).

GENERAL DESCRIPTION

The new 4 kw. heater embodies a number of improvements, one advantage being that the "Car" control lever does not pass through the "Hot" position when moving from "Cold" to "Off".

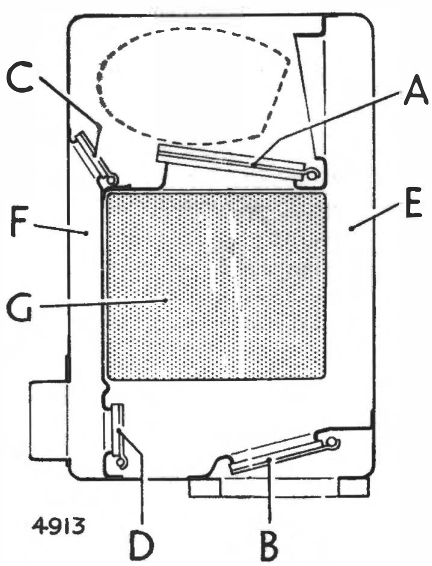
The heater casing is made in two halves to facilitate assembly. However, it is not necessary to open up the heater in order to carry out adjustments.

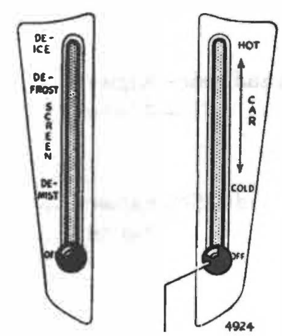
Fresh air enters the heater by ram effect via the blower-ventilator air hose and is boosted by the action of the blower (if fitted) when required.

There are four flap-valves within the heater as follows:— (See Fig. 1)

A. Air Mixing Valve.
B. Air Outlet Valve.
C. Cold Demist Valve.
D. Hot Demist Valve.

These valves are controlled by interconnected rods, cams and levers actuated by the dashboard "Car" and "Screen" controls which are connected by means of flexible cables to the water control valve lever (H) and the flap-valve (J) Figs. 6 and 7 respectively.



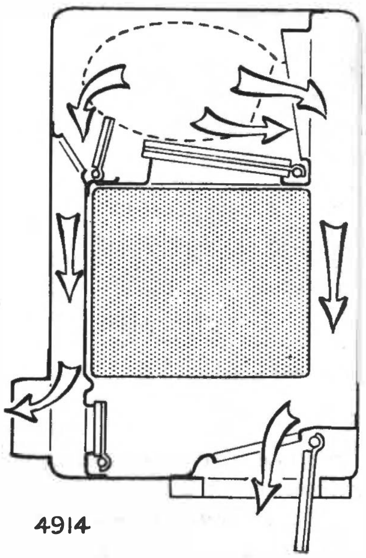


Blower Switch
Pull—"ON"
Push—"OFF"

(Series I-III, IIIA.
Separate blower switch on Series IV.)

Fig. 1. *Schematic internal view*

A. Air mixing valve
B. Air outlet valve
C. Cold demist valve
D. Hot demist valve
E. Car cold air passage
F. Demist cold air passage
G. Heater matrix



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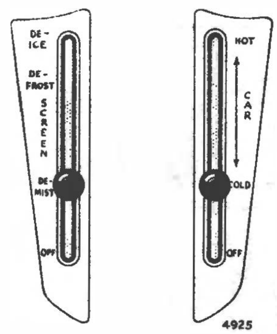
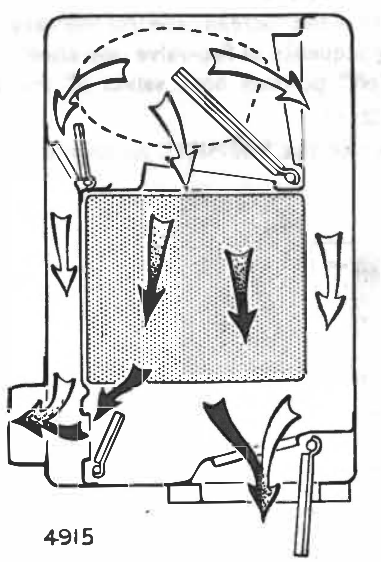


Fig. 2. *Ventilation*

The "Air Mixing Valve" (A, Fig. 1) controls the mixing of the hot and cold air. When this valve is in the horizontal position all the air by-passes the heater matrix through the "Cold Air Passages" (Fig. 1) and the "Water Control Valve" is closed. (See also Fig. 2).

"Car" Control

When the "Car" control lever is moved from the "Cold" positon towards "Hot" the "Air Mixing Valve" (A) progressively approaches the vertical position, (See Fig. 3). First the hot water commences to flow through the heater matrix, and secondly an increasing air flow passes through the heater matrix until the valve is vertical when the "Cold Air Passage" is closed off. Full heating is then obtained. (See Fig. 4).



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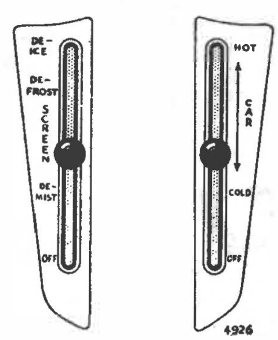
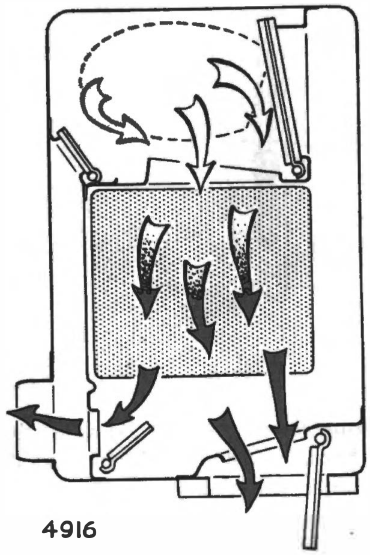


Fig. 3. *General heating to car and screen*



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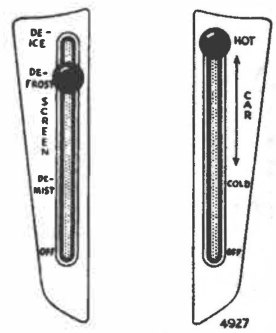


Fig. 4. *Increased heating to car and screen*

The "Air Outlet Valve" (B, Fig. 1) controls air flow into the car interior. It is closed when the "Car" lever is at "off" and is restricted when the "Screen" lever is moved to "DE-ICE", otherwise this valve remains fully open.

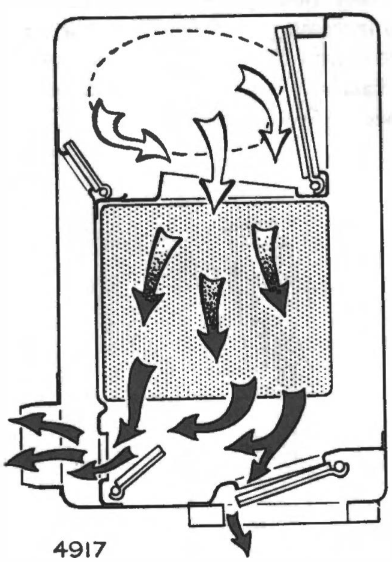
The "Cold Demist Valve" (C, Fig. 1) controls the amount of cold air entering the "Demist" Cold Air Passage (F, Fig. 1) and is interconnected with the "Hot" Demist Valve (D, Fig. 1) which controls the warmed air directed to the windscreen.

"Screen" Control

Movement of the "Screen" control will result in the following sequence of flap-valve operation:—

In the "off" position both valves (C and D) are closed (Fig. 1).

Movement to the "DEMIST" position opens valve



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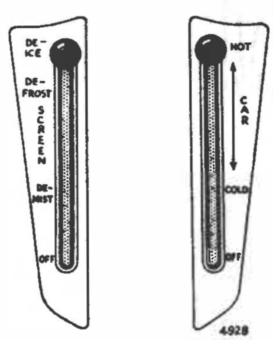

Fig. 5. *Maximum air flow to screen*

(C) and cold air only is directed to the windscreen. (Fig. 2).

Further movement towards the "DEFROST" position gradually closes valve (C) and opens valve (D) allowing warmed air to enter the Demist Chamber (Fig. 3) until at the "DEFROST" position valve (C) is fully closed and valve (D) is fully open (Fig. 4). The demist air temperature is now the same as that entering the car.

Movement of the "Screen" lever to the "DE-ICE" position restricts the "Car" air outlet and so increases the "SCREEN" air flow to maximum (See Fig. 5).

N.B.—The water control valve is not interconnected between the "Car" and "Screen" controls. Therefore, it is necessary to set the "Car" control lever between the "Cold" and "Hot" positions to obtain heated air at the windscreen.

ADJUSTMENTS

All the interconnected mechanism is outside the heater, therefore, all the adjustments are made externally.

In the event of malfunction it is imperative that a check be made to ensure that the cable run, fitting and adjustment of the control cables is normal, and that full movement is achieved without slack. Adjust the cables at the heater unit end.

If normal function is not restored or derangement of the linkages has inadvertently occurred, proceed as follows:—

1. **"CAR" Control** (See Fig. 6)

(a) Move the "Car" lever to the "off" position, the water control valve lever should now be in its fully anti-clockwise position (valve closed). If this is not so, slacken screw "K", set the lever fully anti-clockwise and re-tighten screw "K".

(b) The water valve lever is interconnected with the air mixing valve and the air outlet valve. When the water valve lever is fully anti-clockwise the air mixing valve should be at rest in the horizontal position; to check this slacken screw (L) (this will allow the valve to drop should it be out of position) and now retighten screw (L).

(c) If the air outlet valve is not fully closed, move the "Car" lever away from the "off" position until the water valve lever (H) ⅛" is (3·2 mm.) from the end of its slot (as shown in Fig. 6).

Slacken screw (M), fully close the air outlet valve by finger pressure on cam (X) and retighten screw (M).

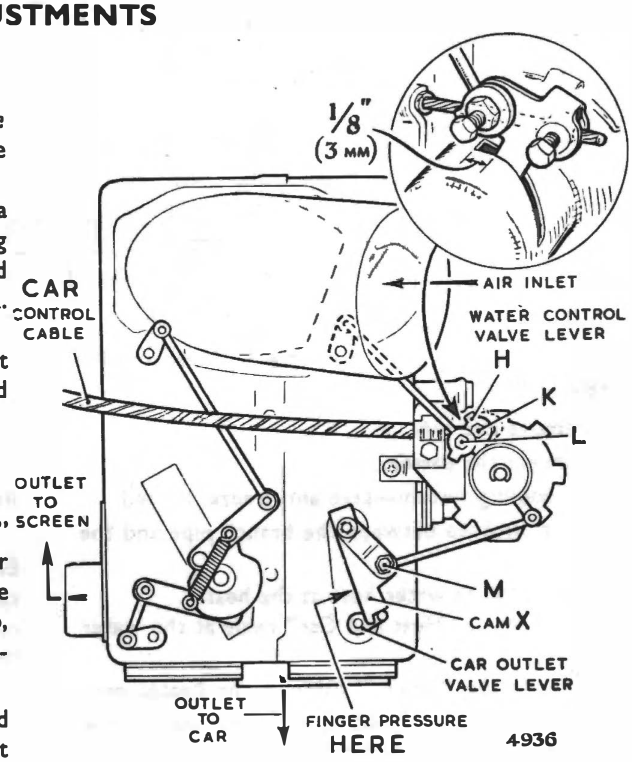

Fig. 6. *Car control, water valve, air mixing valve and air outlet valve adjustment details*

2. **"SCREEN" Control** (See Fig. 7)

It is also necessary to ensure that the air outlet valve is in its correct position when the "Screen" control lever is in the "DE-ICE" position, proceed as follows:—

Move the screen lever to the "DE-ICE" position.

Slacken screw (N), fully close the air outlet valve by finger pressure on cam (Y) and re-tighten screw (N).

Check to ensure that both controls have full movement without slack.

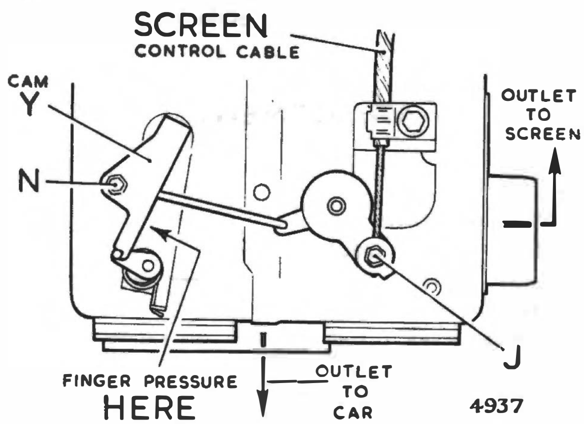

Fig. 7. *Screen control and air outlet valve adjustment details*

HEATER

To remove and refit.

Disconnect the battery.

Drain cooling system—save anti-freeze, if used.

Remove air hose between the branch pipe and the heater.

Disconnect each water hose at the heater.

Disconnect the "Heat and Car" cable at the water valve.

Disconnect the "Screen" cable at the heater end.

Loosen the rear throttle bracket securing screw and remove the forward one.

Remove the right-hand heater securing screw and the two upper screws which anchor the heater to the bulkhead.

Fully close the water valve and wire the lever in this position (to prevent damage to the car air outlet valve).

Note: This wire must not be removed until the heater is re-positioned and finally tightened down.

Carefully ease the heater away from the bulkhead and remove from the car.

Refitting is a reversal of the above operations.

Ensure that the car air outlet seal and both the sponge collars are in good condition and properly positioned. Enter the left-hand lug under the throttle bracket, push the heater firmly towards the bulkhead securely tighten all fixings.

Release the wired up water valve lever and check to ensure that the car air outlet valve has unobstructed movement.

Re-couple the control cables, water and air hoses (See also "ADJUSTMENTS").

Re-connect battery start clock (if fitted) and test equipment.

BLOWER—To remove and refit.

Disconnect the battery.

Release the branch pipe at the wing valance and remove air hose between branch pipe and blower.

Disconnect blower cable at the snap tube connector.

Remove blower securing screws and withdraw blower complete with the rubber elbow.

Refitting is a reversal of the above operations, reconnect battery, start clock (if fitted) and test blower.

CONTROLS—To remove and refit (see Sections "N and O").

Disconnect battery.

Remove control lever knobs (screw off).

Remove console and filler panel (Series IV only).

Release the lower facia panel.

Release control, disconnect cable and withdraw control. On those models with the blower switch incorporated in the control, disconnect the cables at the snap connector and the in-line fuse.

Refitting is a reversal of the above operations. It is important when refitting the cable that the outer cable end is flush with its clamp and that the inner cable protrudes $\frac{1}{8}$ in. (3 mm.) through its trunnion.

(See also "ADJUSTMENTS".)

Re-connect battery and start clock (if fitted).

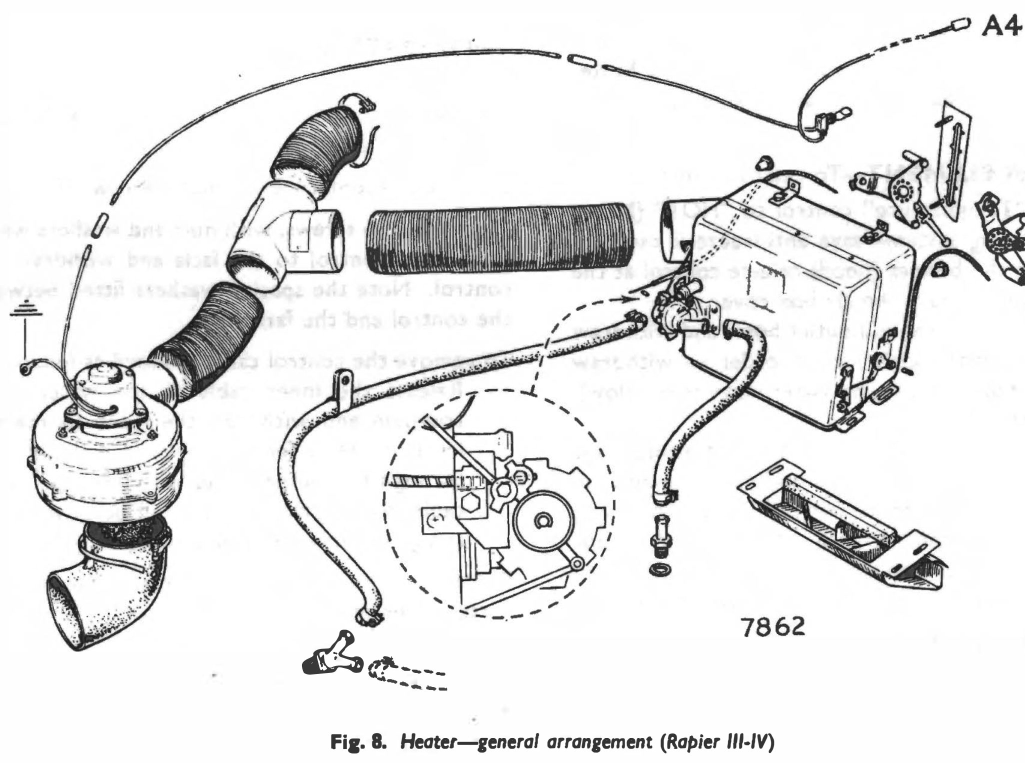

Fig. 8. *Heater—general arrangement (Rapier III-IV)*

ALPINE

(Series I-IV)

GENERAL DESCRIPTION

The heater element and its associated control, supplement the fresh air system built into the car. The temperature of the fresh air, directed to either car or screen, is regulated by means of the "Temperature" control. Use of the blower increases the volume of air.

On Series I-III a single-speed blower is fitted, and the switch is incorporated in the air control lever—pull to switch "ON" and push to switch "OFF". The switch supply cable has an "in-line" fuse (10 amp) "B" in Fig 9.

On Series IV a two-speed blower of increased power is fitted. A three-position switch "C" in Fig. 9, is fitted at the outer end of the facia panel:

UP ...	...	OFF
CENTRE	...	SLOW
DOWN	...	FAST

Hot water from the engine cooling system circulates through the heater element and is returned to the inlet side of the water pump. The heater element is fitted into the air box built into the scuttle.

HEATER ELEMENT—To remove and refit.

Set the "Temperature" control to "HOT" (Max.).

Drain cooling system—save anti-freeze if used.

Uncouple the bonnet (hood) release control at the air box and remove the air box cover.

Disconnect the inlet and outlet hoses and withdraw each clear of the element. In order to withdraw the inlet hose remove the water valve (see below).

Lift out the element.

Refitting is a reversal of the above operations, care must be taken to ensure that each felt strip and the rubber drain trough is correctly positioned and also that the adhesive strip ('A' in Fig. 9) is not disturbed. After refilling it may be necessary to bleed the heater—See "TO BLEED THE HEATER".

WATER VALVE—To remove and refit.

Set the "Temperature" control to "HOT" (Max.) and drain the cooling system—save anti-freeze if used.

Release the control cable.

Disconnect each hose at the water valve.

Undo the retaining screws and remove the water valve complete with bracket.

Refitting is a reversal of the above operations.

After refilling it may be necessary to bleed the heater—See "TO BLEED THE HEATER".

TO BLEED THE HEATER

As the heater element is above the level of the radiator it may be necessary to bleed the heater after refilling the cooling system:

> Release the inlet hose (between the water valve and the element) at the highest point and, with the engine idling, dispel the air and re-secure hose. Top up cooling system as required.

TEMPERATURE CONTROL—To remove and refit.

Release the outer cable clamp and remove the inner cable from the peg on the control lever.

Remove the control lever knob—screw off.

Undo the two screws, with nuts and washers which secure the control to the facia and withdraw the control. Note the spacing washers fitted between the control and the facia lugs.

To remove the control cable proceed as follows:—

> Release the inner cable at the water valve trunnion and withdraw the cable to the car interior. Now feed a length of welding wire through the outer cable, withdraw the outer cable leaving the slave wire in position to act as a guide when refitting or renewing the cable.

Refitting of both the control and the cable is a reversal of the instructions.

Note: When refitting the cable, each end of the outer cable should be flush with its clamp. Full movement of the control lever should be obtained without slack.

BLOWER—To remove and refit.

Disconnect the battery.

Disconnect the blower:—

(a) Single-speed unit at the snap connector.

(b) Two-speed unit at the switch and release the cable where taped to facia harness.

Remove the air deflector housing secured to the tunnel by four screws, and release the left-hand de-mist hose.

Remove the four nuts and washers, one of which also secures the blower earth lead and carefully withdraw the blower.

Refitting is a reversal of the above operations.

When refitting the blower ensure that the upper sponge collar is in position and also that the blower outlet enters the rubber at the air box inlet.

When reconnecting the two-speed blower, connect the green cable to terminal 6 on the switch and the brown cable to terminal 8. (See "C" in Fig. 9.)

Re-connect the battery, start clock (if fitted) and test the blower.

ANTI-FREEZE AND FROST PRECAUTIONS
—See Section "A".

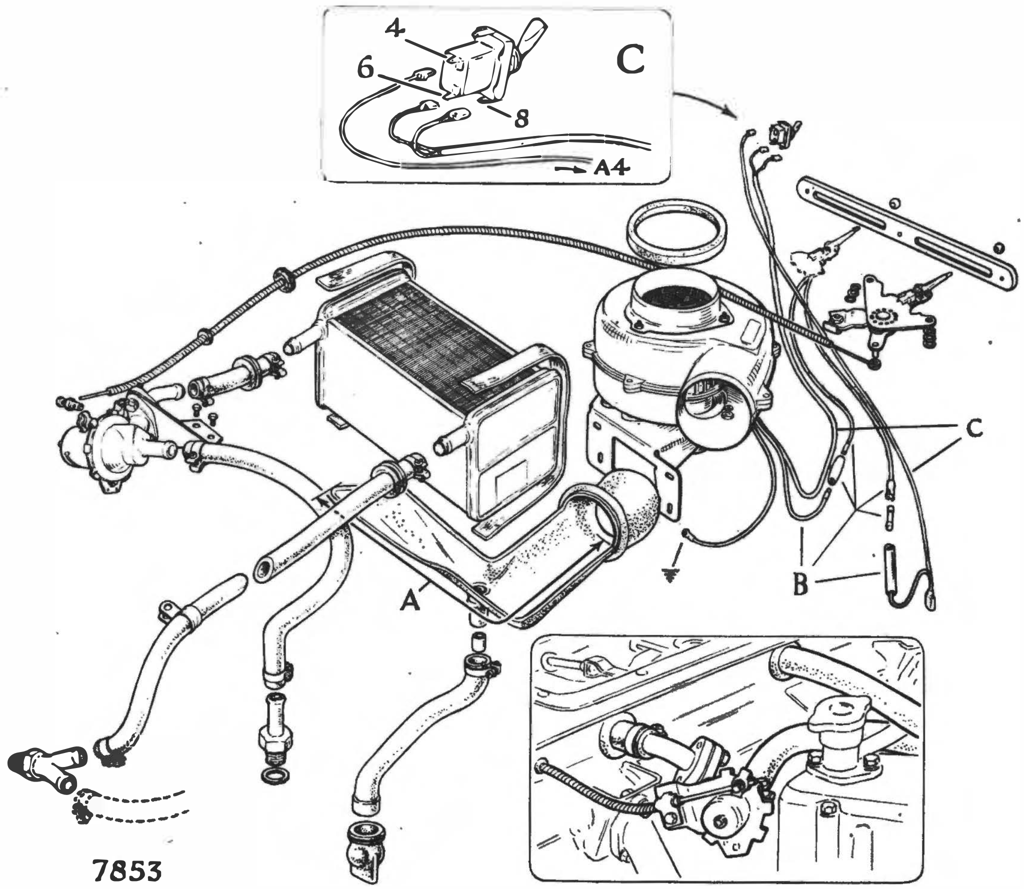

Fig. 9. *Heater—Alpine (Series I-IV)*

SPECIAL TOOLS

Obtainable from:

V. L. CHURCHILL & CO. LTD.
Great South West Road
Bedfont
Feltham
Middlesex, England

Engine

RG.10A-7	Adaptor Set. Use with RG.10A Valve Guide Remover/Replacer.
RG.32-2	Adaptor Set. Use with Camshaft Bush Remover/Replacer 32.
RG.89A	Timing Cover Centraliser.
RG.90A	Distributor Clamping Nut Wrench.
RG.155-1	Adaptor } Use with small adjustable two-legged Puller 155.
RG.155-4	Adaptor (Crankshaft Pulley, using Parts of RG.155-1). } Use with small adjustable two-legged Puller 155.
RG.172A	Piston ring compressor. (79mm. bore engine)
RG.186	Sump Drain Plug Socket (For ½" drive).
RG.209	Camshaft wheel remover
RG.225	Cylinder Head Nut Crowfoot Wrench (For ½" drive extension).
RG.290	Starter dog wrench.
RG.336-1	Adaptor. Use with Con. Rod Jig 335 & Master Arbor 336. (79mm. bore engine)
RG.7600-2	Adaptor Collelts (2). Use with Flywheel Spigot Bearing Remover 7600.
RG.306	Piston ring compressor (81·5mm. bore engine).
RG.336-3	Adaptor. Use with Con. Rod Jig 335 & Master Arbor 336 (81.5 mm. bore engine).
————	Ring gauges for checking bore measuring gauge are obtainable from Coventry Gauge and Tool Co. Ltd. Coventry. (3·21"—1592c.c. engine, 3·11"—1494cc. engine)

Clutch, Gearbox and overdrive

RG.41	Clutch Plate Centraliser.
RG.62	Selector Shaft Loading Adaptor.
RG.200	Group of Overdrive tools.
L.212	Rear Cover Oil Seal Replacer—Adaptor. (Use with No. 550 Handle).
7065C	Circlip Pliers (Type C points).

Rear Axle

RG.16A-4	Axle shaft remover adaptor. Used with main tool RG.16A.
RG.16A-5	Axle shaft remover adaptors (4 legs). Used with main tool RG.16A. (centre lock hubs).
RG.48	Bevel pinion flange holding wrench.
RG.188A-1	Rear hub bearing remover plate and bush. Used with 4 legs RG.16A-5 and RG.188A.
RG.188A	Rear hub remover and securing plate. Used with 4 legs RG.16A-5 for centre lock hubs.

RG.188A-2	...	Rear hub thrust block and bolts (centre lock hubs).
RG.292	....	Differential bearing replacer. Use with 550 handle.
RG.1105-1	....	Bevel pinion bearing outer race remover/replacer. Used with RG.1105.
RG.295A	....	Differential assembly jig.
RG.4221 B-20	....	Differential bearing remover adaptor. Used with RG.4221B.
RG.4221B-21	....	Bevel pinion bearing inner race remover/replacer. used with RG.4221B.
RG.300 ...	...	Bevel pinion bearing pre-load gauge.
RG.300-1	...	Bevel pinion bearing pre-load gauge adaptor.

Steering and Suspension

RG.50D-2....	....	Adaptor for coil spring compressor. (Use with RG.50D main tool).
RG.187	....	Steering idler lever bush remover and replacer adaptor. (Use with shackle pin bush remover/replacer RG.3034).
RG.191A	....	Upper ball joint remover.
RG.192	....	Stub axle swivel pin replacer.
RG.193	....	Stub axle swivel pin remover.
RG.194	....	Swivel pin bush remover, replacer and broaching equipment.
RG.196A-1	....	Fulcrum pin brush remover/replacer—adaptor. (Use with RG.196A main tool).
RG.198A ...	....	Drop arm remover.

General Equipment

No. 1	....	Tension wrench 5-20 lb. ft. (·6–2·7 kg.m) [3/8" sq. drive]
No. 2	....	Tension wrench 16-100 lb. ft. (2·2–13·8 kg.m.) [1/2" sq. drive].
No. 3	....	Tension wrench 25–170 lb. ft. (3·5–23·5 kg.m.). [1/2" sq. drive].
RG.6201	....	Small end bush remover/replacer.
RG.6513	....	Valve spring compressor.
6312A	....	Universal puller (for crankshaft sprocket).

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