ELITE

COUPÉ SERIES II

WORKSHOP MANUAL

LOTUS CARS LTD.
DELAMARE ROAD, CHESHUNT, HERTFORDSHIRE, ENGLAND
Cables: Lotuscars London *Telephone:* Waltham Cross 26181

53 · 12 · 6

ADDENDA

SECTION A PAGE 4

1. General

Series two cars carry prefix EB on chassis number plate.

SECTION E PAGE 2

12. Removing the Radiator

Drain radiator and remove top and bottom hose connections. Disconnect the two leads to thermostat in header tank of radiator and unscrew radiator mounting set-screws. Withdraw radiator upwards and rearwards from slot in front bulkhead.

SECTION F PAGE 16

20. Removing Engine, Clutch and Gearbox from the Chassis

Disconnect oil pressure line at the engine also fuel lines, tachometer cable, speedometer cable and throttle connections.
Disconnect water thermometer capillary.

SECTION H PAGE 7

10. Slave Cylinder

Removal.
Attach a rubber tube to the bleed screw and open the screw three quarters of a turn. Pump the clutch pedal until all the fluid has been drained into a clean container. Unscrew the pressure pipe union. Withdraw push rod, then remove the two bolts and spring washers securing the cylinder to the clutch housing. The cylinder may now be removed from the vehicle.

SECTION I PAGE 2

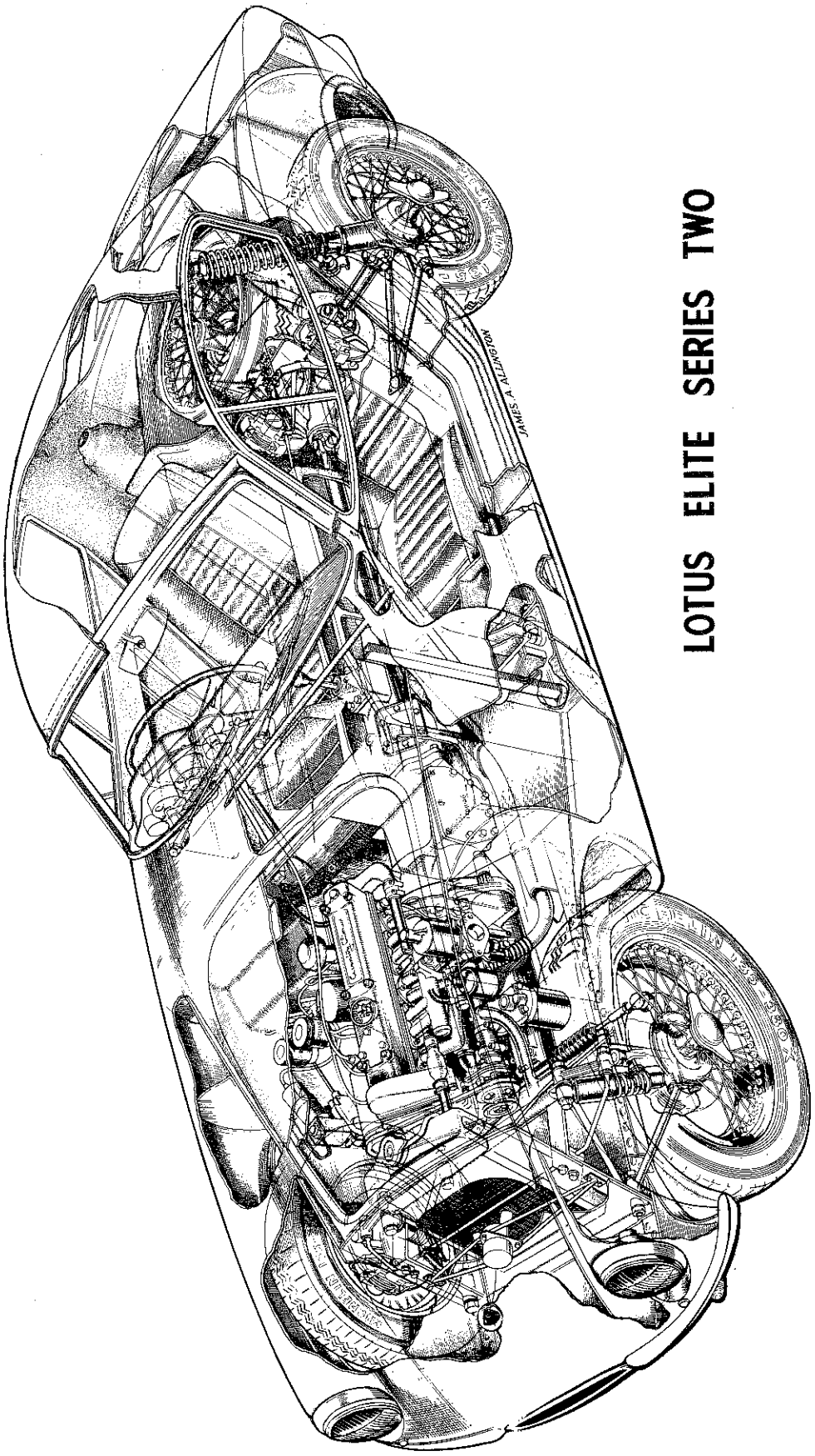
4. Removing the Propeller Shaft

Remove the bolts securing the propeller shaft to the rear axle flange. Remove tank as outlined in Section M7 and differential unit in Section J1. The shaft can now be removed from the car downwards and rearwards.

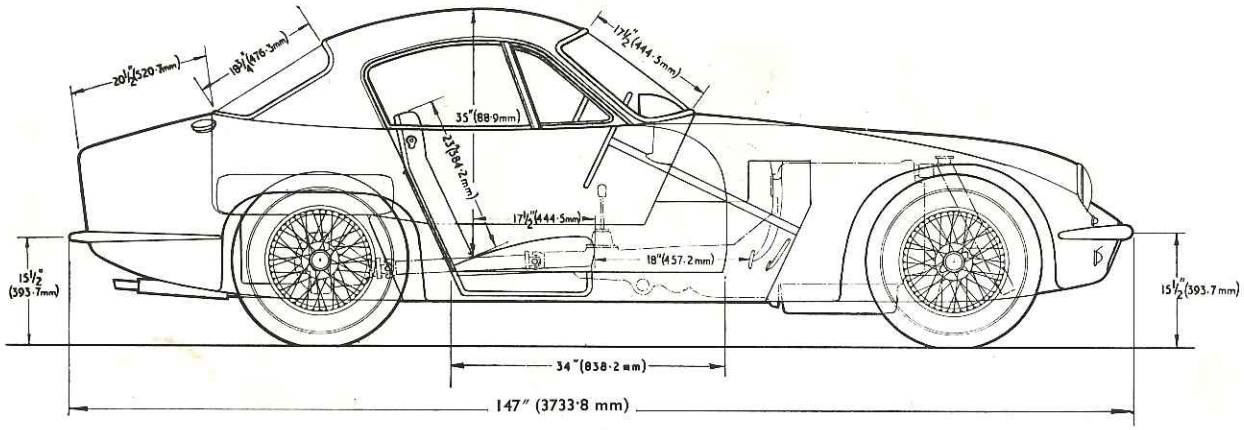
CONTENTS

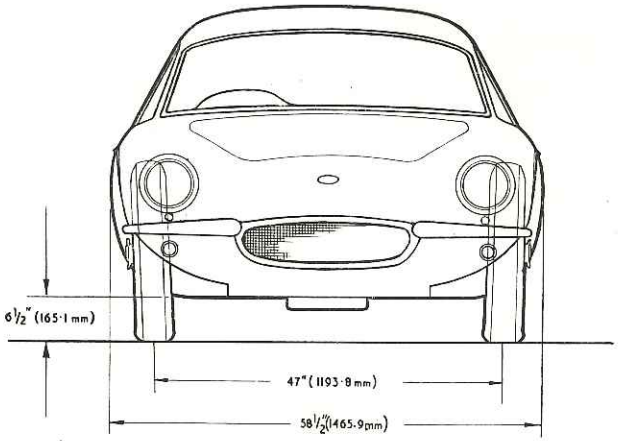
SECTION A

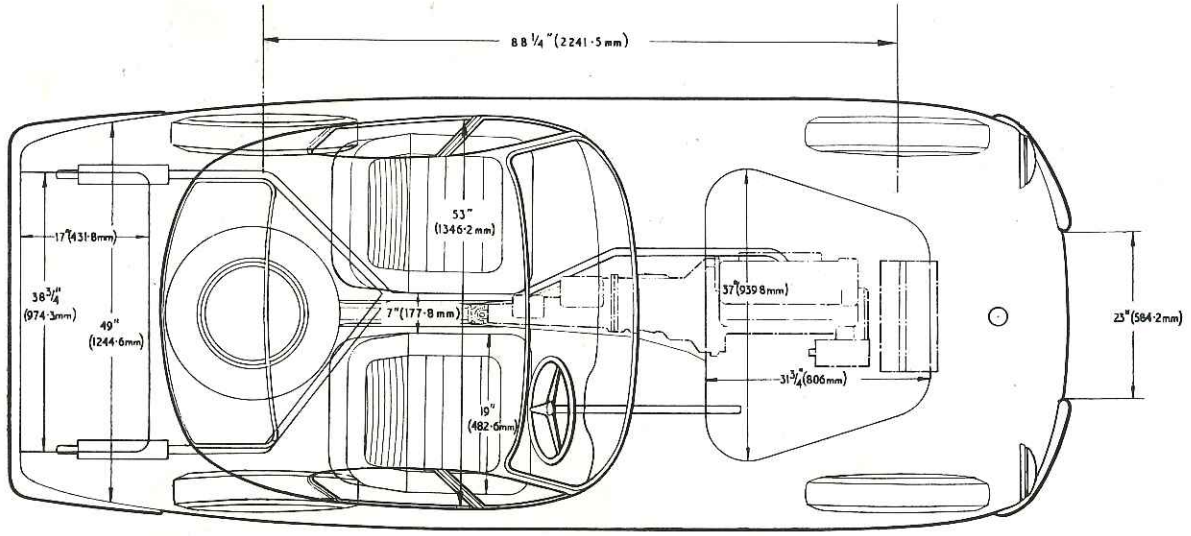
TECHNICAL DATA

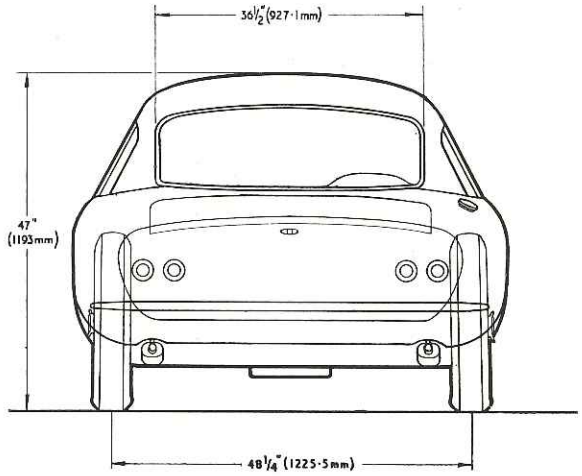


LOTUS ELITE SERIES TWO









LOTUS ELITE SERIES TWO

DIMENSION DRAWING

1. GENERAL

Date of commencement of manufacture series two—May, 1960.
Series two cars carry prefix E on chassis number plate.
It is essential to quote engine and chassis numbers in all enquiries or correspondence concerning the vehicle. Plates secured to bulkhead.
Certain components are the subject of pending patent applications and granted patents in the United Kingdom and Overseas.

2. FRAME

Unitary chassis/body construction. Completely original and extremely strong chassisless structure of glass reinforced Epoxide and Polyester resin; this combines the important advantages of exceptional strength and resistance to corrosion, very good impact resistance, first class sound dampening and good thermal insulation. Two-seat, two-door coachwork offering spacious accommodation for two persons with provision for luggage in separate compartment. Windscreen washers fitted as standard. Wrap round laminated glass windscreen and side windows with hinged quarter lights for ventilation. Large wrap round rear window.

3. FRONT SUSPENSION

Independent front suspension by top arm incorporating anti-roll bar and lower wishbone; springing by combined coil spring damper units reacting through a single attachment point at each end.

4. REAR SUSPENSION

Independent rear suspension by latest Chapman Strut type system, incorporating combined coil spring/damper units, triangulated radius arm and double articulated fixed length drive shaft giving lateral location as developed on Lotus racing cars. This system has been expressly designed to offer a certain amount of camber change with increase in load, to maintain good handling characteristics under all conditions.

5. BRAKES

Hydraulically operated on Girling caliper 9½″ disc brakes, outboard at the front inboard at the rear; scuttle mounted handbrake operating on the rear discs through cables.

6. STEERING

Lightweight rack and pinion steering gear.

7. POWER UNIT

Engine is water cooled and has large steel crankshaft of fully counter-weighted design with a large overlap between crankpins and main journals, carried in 3 × 2⅛″ diameter and 1″ wide main bearings of lead bronze steel backed thin strip type; aluminium pistons are fitted with plated top rings, connecting rods are split diagonally, big-end bearings are renewable, lead-bronze strip type; high mechanical efficiency is provided by a piston speed of 2,500 ft. per min. at 5,750 r.p.m.; cylinder head is heat-treated aluminium; valves of XB steel; shrunk in austentic iron seatings, chain drive from jack-shaft to camshaft, the latter operates the valves direct through piston type cast iron tappets which virtually eliminates wear in the valve guides; tappet clearances are maintained over long periods; a normal spur gear type oil pump with built-in relief valve is used; renewable element type full flow oil filter.

8. ENGINE SPECIFICATION

Number of cylinders	4.
Bore in mm.	76·2.
Bore in inches	3.
Stroke in mm.	66·6.
Stroke in inches	2·625.
Cubic capacity in c.c.	1216 (74·25 cu. ins.)
Type of Valve Gear	O.H.C.
Compression ratio (standard)	10 : 1
Optional Stage 3	11 : 1

9. MECHANICAL SPECIFICATION

Make and type of carburetters	S.U. Model H.4 (single or twin).
Make and type of fuel pump fitted	A.C.
Methods of ignition timing control	Centrifugal Advance and retard
Make and type of engine oil filter	Purolator Full flow.
Maximum Gross (S.A.E.) power developed by engine (B.H.P.)	80.
Maximum NET power as installed in car (B.H.P.)	75.
Corresponding r.p.m.	6,100.
Make, type, and size of clutch	Borg and Beck single 8″ dia. dry plate hydraulically operated.

Mechanical Specification—*continued*

	B.M.C.	Z.F. S4-12
Overall gear ratios		
Top	1 : 1	1 : 1
3rd	1.32 : 1	1·23 : 1
2nd	2·20 : 1	1·71 : 1
1st	3·67 : 1	2·53 : 1
Reverse	3·67 : 1	
Gears with synchromesh	2nd, 3rd, and top	1st, 2nd, 3rd, and top.
Make and type of propeller shaft	Hardy Spicer	
(Standard) type and ratio of final drive gear	4·55 : 1 Hypoid Unit or 4·22 : 1.	
Type of brakes fitted	Disc hydraulically operated $9\frac{1}{2}$″ dia.	
Make and type of shock absorbers Front	Armstrong telescopic.	
Rear	Armstrong telescopic.	
Make and type of steering gear	Alford & Alder lightweight rack and pinion.	
Size of tyres	4·80 × 15 4-ply rating. Firestone high performance nylon cased. 135 × 15 or 155 × 15 Michelin X. 155 × 15 Pirelli Cintura. 500 × 15 Dunlop R5.	

10. COOLING SYSTEM

Tube and gill radiator with integral header tank. Thermostatically controlled cooling fan. Cut in temp. 90—95°C.

11. FUEL SYSTEM

Rear mounted fuel tank, total capacity $6\frac{1}{2}$-gallons. AC fuel pump fitted as standard.

12. ELECTRICAL

Special heavy duty 12-volt 57-amp/hr. battery, weight 24-lbs; belt driven dynamo; fuse box mounted under bonnet. Recessed Lucas 7″ F700 headlamps. Separate side lamps; separate flasher units; twin stop lights; twin rear number illumination lights; twin stop-tail lights; twin high frequency horns. Instrument lighting with brightness control. Two-speed electric screen wiper.

13. EQUIPMENT

Centre point, expanding type jack supplied.

Contents of tool kit	One copper hammer. Pair of pliers. Plug spanner (Box). Screwdriver. Adjustable spanner. 3 spanners ranging from $\frac{9}{16}$″ A.F. down to 4 B.A. One Jack handle.
Circuit-breaker	One circuit-breaker incorporated in the light switch
Fuse-Box	Wipers, Flashers, Fan.
Windscreen wipers used	Lucas twin 2-speed self-parking.
Windscreen washing sprays used	Tex.
Instruments fitted	4″ Tachometer. 0-8,000 r.p.m. 4″ 0-140 m.p.h. Speedometer. Oil pressure gauge, petrol gauge, water temperature gauge and Ammeter.
Warning lights provided	Flashers, High Beam and Ignition.
Ignition keys lock drivers door and boot.	
Glove shelves provided	One.
Map pockets provided	One on inside of each door and rear of each seat.
Parcel shelves provided	One at rear end of car over spare wheel.
Type of interior heater provided	Smiths as optional extra.
Upholstery material used	Leather cloth.
Floor covering material used	Carpet (light grey).
How many exterior colours or colour Combinations are	
(a) standardised	PO31.02300 Metallichrome, I.C.I. PO30.3328, Cirrus White, 3244 Taslaic Red, 3173 Conway or Sunburst Yellow.
(b) available at extra cost	Any colour £50 extra.
Extras approved for this model	Heater and Demister. Masco or Delaney & Gallay type harness seat belts. Smiths Radio.

14. WHEELS AND TYRES

"Knock on" 15″ wire wheels with identical rims front and rear fitted 4·80 × 15 Firestone, 135 × 15 Michelin 'X', 155 × 15 Michelin 'X', 155 × 15 Pirelli Cintura tyres front and rear. Spare wheel mounted at rear of bodywork (provision for two spare wheels to be carried if necessary).

15. WEIGHT

Standard Elite with fuel	12 cwt.

16. MAINTENANCE DATA

	Imperial	*U.S.*
Engine oil sump capacity	8 pints.	9¾ pints.
S.A.E. oil grades (summer and winter recommended)	20/30	20/30.
Gear box oil capacity BMC	4½ pints	6 pints.
S.A.E. oil grade 40/50 ZF	1 pint.	1⅓ pints.
Final Drive gear oil capacity	1⅝ pints.	2½ pints.
S.A.E. oil grades (summer and winter) recommended	90 Expee.	
Steering gear lubricant recommended	Calcium based grease.	
Cooling system water capacity	12 pints.	
Drain taps provided in cooling system	Drain plug on bottom of radiator.	
Chassis lubrication by grease gun	14 nipples greased every 1,500 miles.	
Type of Sparking Plugs recommended	Champion N.3.	
Static ignition timing	2° to 3° B.T.D.C.	
Correct sparking plug gap	·018″.	
Correct contact breaker gap	·014″ to ·016″.	
Correct Tappet Clearances	·004″—·005″ Inlet and Exhaust.	
Tappet valve timing (degrees)	Inlet opens 12° B.T.D.C. Inlet closes 56° A.B.D.C. Exhaust opens 56° B.B.D.C. Exhaust closes 12° A.T.D.C.	
Correct wheel toe-in	⅛″—$\frac{1}{16}$″ Front. 0″—$\frac{1}{16}$″ Rear.	
Front camber angle	1¼° to 1½° at normal ride level.	
Castor angle	7°.	
Swivel pin inclination.	9°.	
Turning Circle	35′	
Rear camber angle	Minus ½°—¾° at normal ride level.	
Tyre pressures		
Michelin 135 × 15		
High Speed	19 lb. per sq. in. Front; 27 lb. per sq. in Rear.	
Low Speed	15 lb. per sq. in. Front; 21 lb. per sq. in. Rear.	
Michelin 155 × 15		
High Speed	18 lb. per sq. in. Front; 26 lb. per sq. in. Rear.	
Low Speed	12 lb. per sq. in. Front; 17 lb. per sq. in. Rear.	
Pirelli Cintura 155 × 15 and Firestone Nylon Sports 480 × 15		
High Speed	21 lb. per sq. in. Front; 25 lb. per sq. in. Rear.	
Low Speed	19 lb. per sq. in. Front; 23 lb. per sq. in. Rear.	
Type of brake fluid	Girling Crimson normal.	
Type of clutch fluid	Girling Crimson normal.	
Type of battery	Lucas special duty 12-volts 57-amp. hour.	
Miscellaneous Servicing Points	Car should only be jacked up by the jacking points provided. The wheels should be checked and balanced at frequent intervals, depending on conditions and nature of use.	

17. DIMENSIONS

Wheel base	7′ 4¼″.
Front track	3′ 11″.
Rear track	4′ 0¼″
Overall length	12′ 3″.
Height to roof	3′ 11″.
Overall width	4′ 10¼″.
Normal ride ground clearance	6½″.

The specification refers to the touring car. When it is intended to race, the section on racing should be studied and closely adherred to.

18. RUNNING IN THE CAR

The following table of speeds in gears will give the owner a guide to the limitations which should be imposed on the car during the first 500 miles of its life.

In order to assist running in, and in particular to assist the bedding-in of piston rings and cylinder bores, fairly high loading on the engine is necessary. Because of the extreme lightness of the car this is best obtained by running in top gear from 2,500 r.p.m. in a series of long periods of acceleration up to 4,500 r.p.m. rather than allowing the car to idle at constant speeds within the r.p.m. range given in the table.

Speeds and loading may be increased gradually over the next 1,000 miles until the full performance of the car is available.

Standard Gearbox—4·55 : 1 Final drive.

	Max. r.p.m.	Max. m.p.h.	Min. r.p.m.	Min. m.p.h.
1st	4,500	18·7	—	—
2nd	4,500	32	1,500	10·7
3rd	4,500	53·3	2,000	23·6
Top	4,500	70	2,500	39·0

SECTION B

SERVICE INFORMATION

SERVICING SCHEDULE

1. Initial Service 500 miles

This is a free service; materials only are chargeable.

Lubrication:
1. Drain engine, gearbox and diff. unit and refill.
2. Grease or oil all lubrication points.
3. Change filter element.

Engine:
4. Check and adjust tappets.
5. Check all water hose connections and radiator level.
6. Check carburetter, slow running, mixture adjustments and oil dash pot, SAE 20.
7. Check all manifold, exhaust system, engine mounting and distributor fitting for security.

Clutch:
8. Check correct operation of clutch.
9. Check clutch fluid reservoir level.

Brakes:
10. Check braking system for operation.
11. Check braking system lines for security.
12. Check brake fluid reservoir level.
13. Check and tighten disc retaining nuts.

Steering:
14. Check all steering connections for security.
15. Check steering rack and pinion mounts for security.

Electrics:
16. Check headlamp adjustment.
17. Check all functions electrical system.
18. Check battery for security, leaks and cleanliness.
19. Check condition of fuse.

Transmission:
20. Check tighten U/J bolts and half shaft bolts.
21. Check rear hub and cross pin bearings.

Suspension:
22. Check all front and rear suspension mounting bolts and units for tightness.

Body:
23. Check door and door lock operation.
24. Check boot and bonnet catch operation.
25. Check seat adjustment operation.
26. Check body condition overall.
27. Check tyre pressures and tightness of wheel nuts.
28. Check body condition generally (for detailed information see Chapter 6).

N.B.—All inconsistancies must be noted and brought to the service manager's notice.

2. "A" Service every 1,500 miles (2,400 km.)

Lubrication:
1. Change engine oil.
2. Grease or oil all lubrication points.
3. Check and top up if necessary diff. and gearbox levels.

Engine:
4. Lubricate throttle linkages.
5. Check radiator level.
6. Add a few drops of oil to carburetter dash pot(s).

Clutch:
7. Check clutch fluid reservoir level.
8. Check clutch operation and lines.

Brakes:
9. Check brake fluid reservoir level.
10. Check brake lines and brake operation.

Steering:
11. Check steering assembly for general condition.

Electrical:
12. Check battery for condition and level.
13. Check operation of all circuits.

General:
14. Check tyre pressure and hub nut tightness.

N.B.—All inconsistencies must be brought to the service manager's notice.

3. "B" Service every 3,000 miles (4,800 km.)

"A" Service plus the following:—

Engine:
1. Check water pump belt.
2. Check all manifold, exhaust system engine mounting and distributor fittings for security.
3. Change oil filter element.

Electrical:
4. Clean and inspect condition of sparking plugs.
5. Check distributor settings and lubricate cam, distributor shaft and counter weights.

Transmission:
6. Check general conditions and tightness of all bolts and mounting parts.

Body:
7. Lubricate door locks and bonnet and boot catch mechanism.
8. Check body condition generally.
9. Change round all road wheels.

Steering:
10. Tighten 4 bolts on bottom rubber coupling.

4. "C" Service every 6,000 miles (9,600 km.)

"A" and "B" Service plus the following:—

Lubrication:

1. Change diff. and gearbox oil.
2. Repack front hubs.

Engine:

3. Lubricate water pump.
4. Check valve clearances.
5. Clean air filter and crankcase breather.
6. Clean carburetter and fuel pump filter.
7. Tighten cylinder head stud nuts.

Clutch:

8. Check clutch operation.

Brakes:

9. Adjust hand brake.
10. Check caliper mounting bolts for security.
11. Check brake pads for wear.

Steering:

12. Check all steering parts and connections for security.

Electrical:

13. Check voltage regulator operation.

Transmission:

14. Check rear hubs and cross pin bearings.
15. Check condition of fluid drive assembly.

Suspension:

16. Check all front and rear suspension mounting bolts for tightness.
17. Check suspension for wear.
18. Check front wheel alignment.

Body:

19. Check seat adjustment operation.
20. Lubricate all boot, bonnet and door hinges.
21. Check condition of side screens and quarter lights

N.B.—All inconsistencies must be brought to the service manager's notice.

5. "D" Service every 12,000 miles (19,200 km.)

"A", "B" and "C" Service plus the following:—

Engine:

1. Remove sump, clean and reassemble.
2. Remove carburetter, strip, clean, fit new gaskets, check condition reassemble.
3. Check condition of distributor for wear.
4. Check condition of all engine components.

Brakes:

5. Check for wear on clutch master cyl. linkage and pedal bearings.
6. Check for condition of calipers and all units including stop light switch.

Steering:

7. Check steering for wear.

Electrical:

8. Fit new sparking plugs.
9. Check battery specific gravity readings.
10. Check head lamp adjustment.
11. Check dynamo and starter brushes.
12. Lubricate dynamo bearing.

General:

13. Inspect body for any damage and condition of windscreen and rear screen seals.
14. Inspect all body units for tightness.

N.B.—All inconsistencies must be brought to the service manager's notice.

6. Body Inspection Schedule (to be conducted at Initial Service and "B" Service)

1. Check differential housing with particular reference to mountings. Remove differential (dipstick) cover and rock car gently forwards and backwards with 2nd gear engaged. Any movement local to the back mounting face or moulded attachment points thereon should be investigated. (For details of the differential repair scheme, see Section O.)

2. Drop front attachment points of rear radius arms and with rear end of car lifted, inspect attachment bobbins and ball/socket housings for fractures or cracks. If there is any movement in the bobbin, or there are any cracks visible on the top of the socket housing, advice should be sought from distributors or manufacturer.

3. A thorough inspection should be made of the exhaust system to make sure that there is no contact between the pipe and bodywork. Scorch marks on the surface of bodywork adjacent to the forward end of exhaust pipe indicate a potential fire risk.

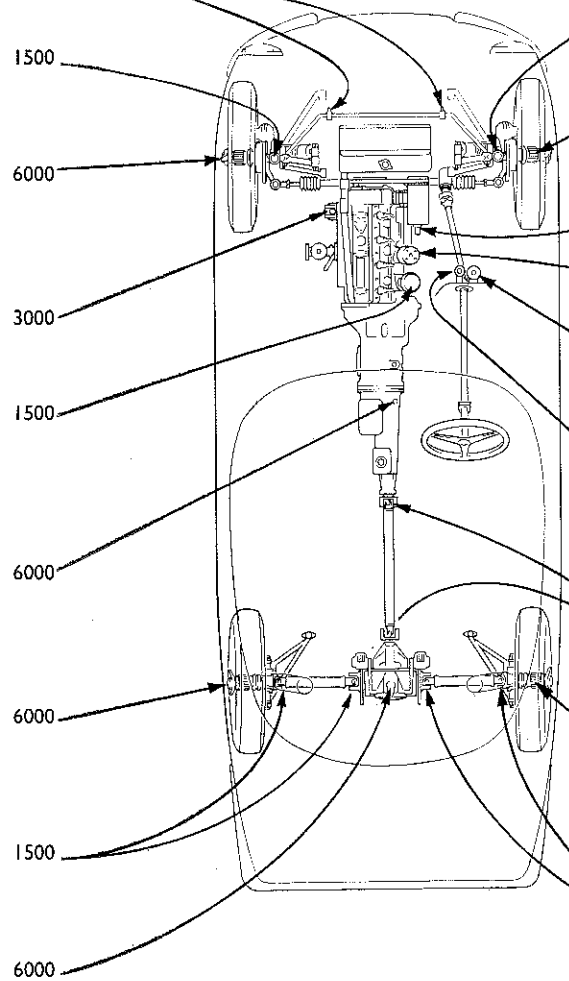
SECTION C

LUBRICATION

1. LUBRICATION CHART

REF.	A		B	C	D
	Engine Summer	**Engine** Winter	**Gearbox**	**Rear Axle**	**Wheel Hubs and Grease Points**
Touring	Esso Extra 40/50	Esso Extra 20W/30	Esso Extra 20W/30	Esso Expee Compound 90	Esso Multi-Purpose Grease H
Racing	Esso Extra 40/50	Esso Extra 40/50	Esso Extra 40/50	Esso Expee Compound 90	Esso Multi-Purpose Grease H
Touring	Castrol XXL	Castrolite	Castrolite	Castrol Hypoy	Castrolease LM
Racing	Castrol XXL	Castrol XXL	Castrol XXL	Castrol Hypoy	Castrolease LM
Touring	Mobil Oil Special	Mobil Oil Special	Mobilube GX90	Mobilube GX90	Mobilgrease MP
Racing	Mobiloil BB	Mobiloil BB	Mobilube GX90	Mobilube GX90	Mobilgrease MP
Touring	Shell X–100–40	Shell X–100–20/20W	Shell X–100–40	Spirax 90EP	Retinax A
Racing	Shell X–100–50	Shell X–100–50	Shell X–100–50	Spirax 90EP	Retinax A
Touring	Energol SAE 40	Energol SAE 20W	Energol SAE 40	Energol SAE90EP	Energrease L2
Racing	Energol SAE 50	Energol SAE 50	Energol SAE 50	Energol SAE 90 EP	Energrease L2

2. LUBRICATION DIAGRAM
for the
LOTUS ELITE



MILES

ANTI-ROLL BAR : 1500
Lubricate with grease (Ref. D)

SWIVEL PIN : 1500
Lubricate nipple with grease (Ref. D)

FRONT HUB BEARINGS : 6000
Remove hub cap and repack with grease (Ref. D)

OIL FILTER : 3000
Fit new element

CRANKCASE : 1500
Check level daily
Drain when hot and refill with fresh engine oil to (Ref. A)

GEARBOX : 6000
Check level every 1,000 miles
Drain when hot and refill every 6,000 miles with oil (Ref. B)

REAR HUB BEARINGS : 6000
Lubricate sparingly every 5,000 miles with grease (Ref. D)

NEARSIDE REAR UNIVERSAL JOINTS : 1500
Lubricate with grease (Ref. D)

REAR AXLE : 6000
Check level with dipstick every 500 miles. Drain when hot and refill every 6,000 miles. Use oil (Ref. C)

MILES

1500 SWIVEL PIN :
Lubricate nipple with grease (Ref. D)

6000 FRONT HUB BEARINGS :
Remove hub cap and repack with grease (Ref. D)

12000 DYNAMO—(OIL) :
Lubricate with engine oil (Ref. A)

3000 DISTRIBUTOR :
Lubricate sparingly with engine oil (Ref. A) (See distributor maintenance—Section D, Chapter 6)

1500 BRAKE RESERVOIR :
Check level every 1,000 miles. Top-up when necessary with brake fluid (see below)

1500 CLUTCH RESERVOIR :
Check level every 1,000 miles. Top-up when necessary with brake fluid (see below)

1500 UNIVERSAL JOINTS :
Lubricate with grease (Ref. D)

6000 REAR HUB BEARINGS :
Lubricate sparingly every 5,000 miles with grease (Ref. D)

1500 OFFSIDE REAR UNIVERSAL JOINTS :
Lubricate every 1,500 miles with grease (Ref. D)

KEY

Engine Oil	Ref. A
Gearbox	Ref. B
Rear Axle	Ref. C
Grease Points and Wheel Hubs	Ref. D

(See page C2 for recommended lubricants)

GENERAL NOTES

Oil Can Lubrication: Lubricate every 1,500 miles the door locks, hinges, bonnet catch, boot handle and throttle linkage.

Radiator Protection: Add 3 pints of any reputable make of Anti-Freeze to the radiator to give winter protection down to 47; Frost (—15;F.).

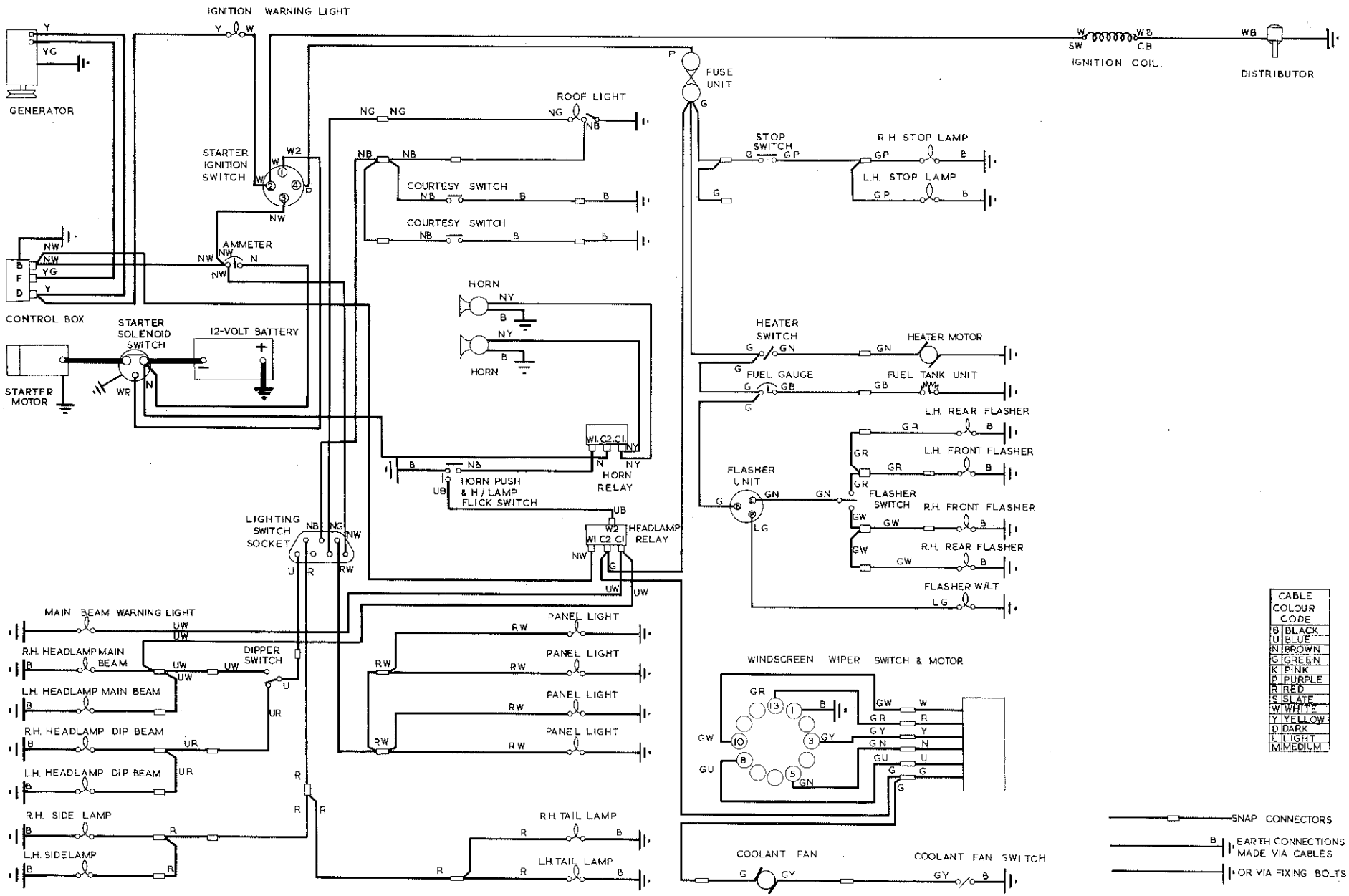
Brake Fluid: Use any reputable make of brake fluid which conforms to SAE 70 R.1.

CAPACITIES (IMPERIAL)

Engine:	8 pints.
Gearbox:	4½ pints.
Rear Axle:	1½ pints plus
Cooling:	12 pints plus 1 pint for Heater.

SECTION D

ELECTRICAL EQUIPMENT


IGNITION WARNING LIGHT
GENERATOR
IGNITION COIL
DISTRIBUTOR
FUSE UNIT
ROOF LIGHT
STOP SWITCH
R H STOP LAMP
L.H. STOP LAMP
STARTER IGNITION SWITCH
COURTESY SWITCH
COURTESY SWITCH
AMMETER
CONTROL BOX
STARTER SOLENOID SWITCH
12-VOLT BATTERY
STARTER MOTOR
HORN
HORN
HEATER SWITCH
HEATER MOTOR
FUEL GAUGE
FUEL TANK UNIT
L.H. REAR FLASHER
L.H. FRONT FLASHER
FLASHER UNIT
FLASHER SWITCH
R.H. FRONT FLASHER
R.H. REAR FLASHER
FLASHER W/LT
HORN PUSH & H/LAMP FLICK SWITCH
HORN RELAY
LIGHTING SWITCH SOCKET
HEADLAMP RELAY
MAIN BEAM WARNING LIGHT
R.H. HEADLAMP MAIN BEAM
DIPPER SWITCH
L.H. HEADLAMP MAIN BEAM
R.H. HEADLAMP DIP BEAM
L.H. HEADLAMP DIP BEAM
R.H. SIDE LAMP
L.H. SIDE LAMP
PANEL LIGHT
PANEL LIGHT
PANEL LIGHT
PANEL LIGHT
WINDSCREEN WIPER SWITCH & MOTOR
R.H. TAIL LAMP
L.H. TAIL LAMP
COOLANT FAN
COOLANT FAN SWITCH
CABLE COLOUR CODE
B BLACK
U BLUE
N BROWN
G GREEN
K PINK
P PURPLE
R RED
S SLATE
W WHITE
Y YELLOW
D DARK
L LIGHT
M MEDIUM
SNAP CONNECTORS
EARTH CONNECTIONS MADE VIA CABLES
OR VIA FIXING BOLTS

W 549 440 32

1. GENERAL DESCRIPTION

The 12-volt electrical equipment incorporates compensated voltage control for the charging circuit. The positive earth system of wiring is employed.

The dynamo is mounted on the right of the cylinder block and driven by endless belt from the crankshaft pulley. A rotatable mounting enables the belt tension to be adjusted.

The voltage control unit adjustment is sealed and should not normally require attention. The fuses are carried in external holders mounted in an accessible position on the engine bulkhead together with spare fuses.

The starter motor is mounted on the flywheel housing on the left-hand side of the engine unit and operates on the flywheel through the usual sliding pinion device.

The headlamps employ the double-filament dipping system. Both lamps are fitted with double-filament bulbs, both dipping either vertically or to the left according to the regulations existing in the country concerned.

2. ELECTRICAL COMPONENT Nos.

Below are listed the main components with their respective part numbers.

	LUCAS	LOTUS
Battery (12v 57 amp FRV9A)	54098357	E8058
Generator (C39PVR-2)	22296	E8049
Distributor (D3AH4)		E8051
Starter Motor (M35G)		E8050
Ignition Coil (HA12)		E8017
Fuse Units (SF5)		E8020
Flasher Unit (FL5)		E8063
Coolant Fan (Smiths 12v FHM5442/01) Motor		E5015
Fan		E5016
Headlamp (RH Drive P700 Le Mans) ..	58500	E8007/A
(LH Drive European) ..	58560	E8007/B
(LH Drive American) ..	58554	E8007/C
(RH Drive (P.L.) Special Equip.)		E8007/D
Side Lamps	52449	E8009
Tail Lamps	53819	E8011
Rear Flasher Lamp (LH Drive)	53861	E8012/L
(RH Drive) ..	52462	E8012/R
Front Flasher Lamp (LH Drive) ..		E8008/L
(RH Drive) ..		E8008/R
Wiring Harness (Basic)	54094122H	E8001
(RH Drive Loom) ..	44946580	E8002/R
(LH Drive Loom) ..	54946581	E8002/L
Number Plate Illuminator	52463A	E8010
Interior Lamp (London Bankside Products)		E8013
Horns (High Tone)	69047	E8014
(Low Tone)	69046	E8015
Screen Wiper Switch (PRS7)	54031941	E8029
Switch Headlamp	33209	E8036
Horn Relay	33188	E8060
Starter Solenoid	76445	E8031
Flasher Switch	5403308	E8062
Stoplight Switch (Girling 398003) ..		E4024
Interior Lamp Switch	5403387	E8032
Ignition and Starter Switch	318467	E8034
Switch Horns Headlamps	31910	E8037
Screen Wiper Motor	37196	E8021

3. BATTERY MAINTENANCE

In order to keep the battery in good condition a periodical inspection must be made: the cell specific gravity should be checked and the electrolyte should be topped up if necessary.

Topping up

Remove the filler plug from each cell and examine the level of the electrolyte. Add distilled water as required to bring the level of the electrolyte in each cell just above the separators.

NOTE.—Do not use tap-water and do not use a naked light when examining the condition of the cells. Wipe away all dirt and moisture from the top of the battery.

Testing the condition of the battery

Every 1,000 miles (1600 km.) examine the condition of the battery by taking hydrometer readings. There is no better way of ascertaining the state of charge of a battery. The hydrometer contains a graduated float on which is indicated the specific gravity of the acid in the cell from which the same is taken.

The specific gravity readings and their indications are as follows:

Climates normally below 90°F. (32°C.)
- 1·270 to 1·290 Cell fully charged.
- 1·190 to 1·210 Cell about half-discharged.
- 1·110 to 1·130 Cell completely discharged.

Climates frequently above 90°F. (32°C).
- 1·210 to 1·230 Cell fully charged.
- 1·130 to 1·150 Cell about half-discharged.
- 1·050 to 1·070 Cell completely discharged.

These figures are given assuming an electrolyte temperature of 60°F. (16°C.). If the temperature of the electrolyte exceeds this ·002 must be added to hydrometer readings for each 5°F. rise to give the true specific gravity. Similarly ·002 must be subtracted from hydrometer readings for every 5°F. below 60°F.

The readings of all the cells should be approximately the same. If one cell gives a reading very different from the rest it may be that the electrolyte has been spilled or has leaked from the cell or there may be an internal fault. In this case it is advisable to have the battery examined by a battery specialist. Should a battery be in a low state of charge, it should be recharged by taking the car for a long daytime run or by charging from an external source of D.C. supply at a current rate of 4 amps. (5 amps. for nine-plate batteries) until the cells are gassing freely.

After examining the battery check the vent plugs, making sure that the air passages are clear, and screw the plugs into position. Wipe the top of the battery to remove all dirt and moisture.

Storage

If a battery is to be our of use for any length of time it should first be fully charged and then given a freshening charge about every fortnight.

A battery must never be allowed to remain in a discharged condition as this will cause the plates to become sulphated.

Initial filling and charging

The specific gravity of the electrolyte necessary to fill a new battery which has been supplied dry and uncharged and the specific gravity at the end of the charge are as follows:

Climate	*S.G. of filling acid (corrected to 60°F. [16°C.])*	*S.G. at end of charge*
Normally below 90°F. (32°C.)	1·270	1·270 to 1·290
Frequently over 90°F. (32°C.)	1·210	1·210 to 1·230

The electrolyte is prepared by mixing distilled water and concentrated sulphuric acid 1·835 S.G. The mixing must be carried out in a lead-lined tank or a suitable glass or earthenware vessel. Steel or iron containers must **not** be used. The acid must be added slowly to the water while the mixture is stirred with a glass rod. **Never add the water to the acid,** as the severity of the resulting chemical reaction may give dangerous consequences.

Heat is produced by the mixture of acid and water, and electrolyte should, therefore, be allowed to cool before it is poured into the battery, otherwise the plates, separators, and moulded container may be damaged.

The temperature of the filling-in acid, battery, and charging room should be above 32°F. (0°C.).

To produce electrolyte of the correct specific gravity:

To obtain specific gravity (corrected to 60°F. [16°C.])	*Add 1 part by volume of 1·835 S.G. acid to distilled water by volume as below*
1·270	2·8 ,,
1·210	4 ,,

Carefully break the seals in the filling holes and half-fill each cell in the battery with dilute sulphuric acid solution of the appropriate specific gravity (according to temperature) (see table). The quantity of electrolyte required to half-fill a two-volt cell is $\frac{3}{8}$ pint (·215 litre) or $\frac{1}{2}$ pint (·28 litre) for nine-plate batteries. Allow to stand for at least six hours, then complete the filling of the cells by the addition of more diluted acid of the same specific gravity as before until the level reaches the bottom of the filling holes, and allow the battery to stand for at least another two hours before commencing the first charge.

Charge at a constant current of 2·5 amps. (3·5 amps. for nine-plate batteries) until the voltage and temperature-corrected specific gravity readings show no increase over five successive hourly readings. This period is dependent upon the length of time the battery has been stored since manufacture, and will be from 40 to 80 hours, but usually not more than 60. not more than 60.

Throughout the charge the acid must be kept level with the tops of the separators in each cell by the addition of acid solution of the same specific gravity as the original filling-in acid.

If, during charge, the temperature of the acid in any cell of the battery reaches the maximum permissible temperature (for climates normally below 90°F. i32°C.i the maximum permissible temperatures i 100°F. i37·7°C.i whilst for climates frequently above 90°F. i32°C.i the maximum permissible temperature is 120°F. i48·8°C.i), the charge must be interrupted and the battery temperature allowed to fall at least 10°F. (5·5°C.) before charging is resumed.

At the end of the first charge, i.e. when specific gravity and voltage measurements remain substantially constant, carefully check the specific gravity in each cell to ensure that it lies within the limits specified. If any cell requires adjustment the electrolyte above the plates must be siphoned off and replaced either with acid of the strength used for the original filling in, or distilled water, according to whether the specific gravity is too low or too high respectively. After such adjustment the gassing charge should be continued for one or two hours to ensure adequate mixing of the electrolyte. Re-check, if necessary, repeating the procedure until the desired result is obtained.

4. STARTING MOTOR MODEL M35G

General

This electric starting motor is a four-pole four-brush machine having an extended shaft which carries the engine engagement gear, or starter drive as it is more usually named. The diameter of the yoke is $3\frac{1}{2}$".

The starting motor is of similar construction to the generator except that heavier gauge conductors are used in the construction of the armature and field coils. The field coils—which are formed from aluminium strip—are parallel-connected between the field terminal and the insulated pair of brushes.

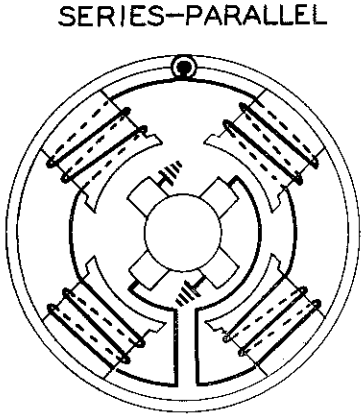


Fig. 1
Internal connections (series-parallel) of the starting motor

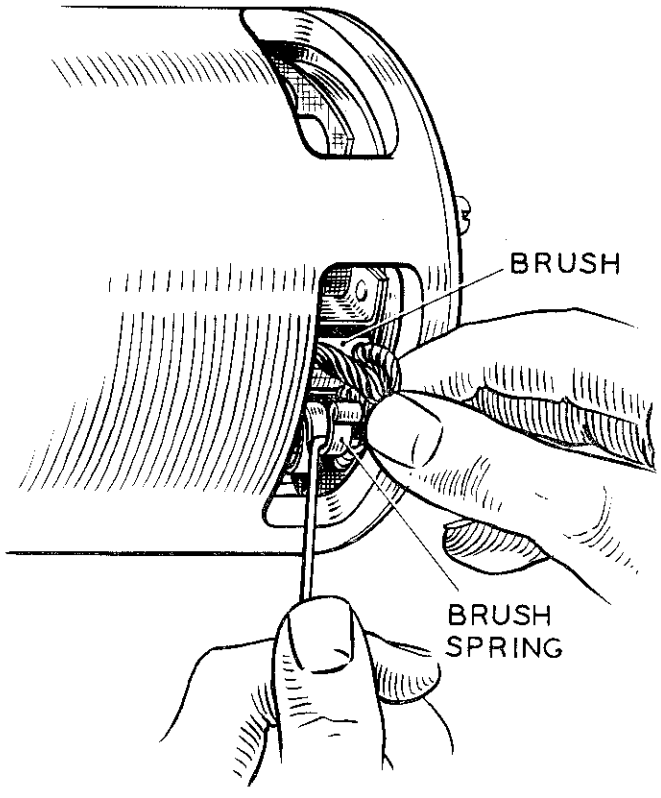


Fig. 2 *Checking brushes*

Routine Maintenance

About every 12,000 miles take the cover band off the starting motor and carry out the following procedure:

(a) Check that the brushes move freely in their holders by holding back the brush springs and pulling gently on the flexible connectors. If movement is sluggish, remove the brush from its holder and clean its sides with a fluffless petrol-moistened cloth. Replace the brush in its original position. Brushes which are worn to less than $\frac{5}{16}$" in length must be renewed.

(b) Check the tension of the brush springs using a spring scale. The correct tension is 30–34 oz. New springs must be fitted if tension is low.

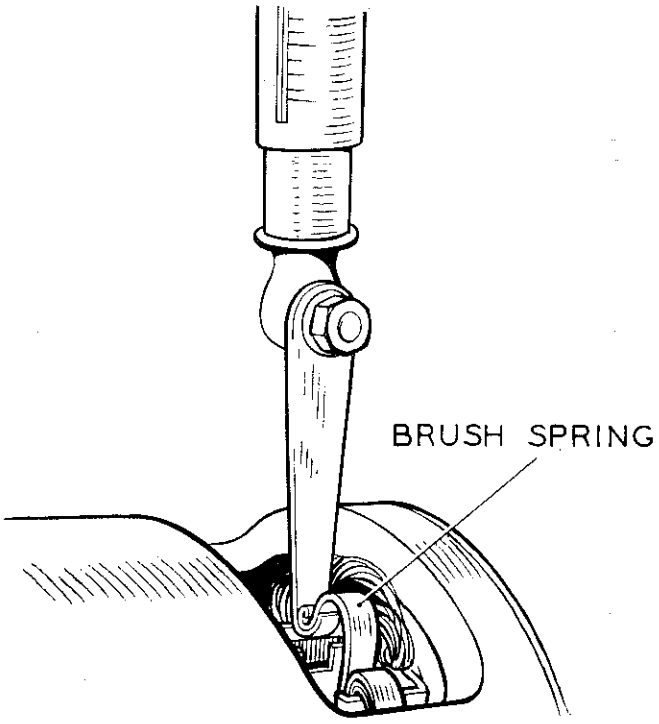


Fig. 3
Checking brush spring tension

(c) The commutator must be clean and have a polished appearance. If necessary, clean it by pressing a fine dry cloth against it while the starter is turned by applying a spanner to the squared extension of the shaft. Access to the squared shaft is gained by removing the thimble-shaped metal cover. If the commutator is very dirty, moisten the cloth with petrol.

(d) Keep all electrical connections clean and tight. Any which may have become dirty must be cleaned and the contacting surfaces lightly smeared with petroleum jelly.

Performance Data

Lock torque:	7·7 lb.-ft. with 330–350 amp. at 7·5–7·1 volts.
Torque at 1,000 r.p.m.:	4·5 lb.-ft. with 215–235 amp. at 9·1–8·7 volts.
Light running current:	45 amps. at 9,500–11,000 r.p.m.

Servicing

(a) *Testing in Position*

If the starting motor does not operate or fails to crank the engine when the starting button is used, switch on the lamps (or connect a moving-coil 0–20 voltmeter between the battery terminals) and again use the starting button.

i. *The lamps dim (or the voltmeter reading falls appreciably) but the motor does not crank the engine.*

This may be caused by the starter drive pinion being jammed in mesh with the engine flywheel. The pinion can usually be freed by removing the cap and applying a spanner to the squared extension of the shaft at the commutator end. It is advisable to remove the starting motor from the engine and inspect the starter drive as described in para. 4 (e).

Sluggish action of the starting motor may be due to a discharged battery. Check by disconnecting the existing cables and reconnecting the motor to a battery known to be fully charged. If the starting motor now gives normal cranking of the engine the vehicle battery must be examined.

If the starting motor still does not operate satisfactorily, it must be removed from the engine and the starting motor and starter drive examined, see para. 4 (b).

ii. *The lamps do not dim (or the voltmeter reading remains unaffected) and the motor does not crank the engine.*

Check by means of a voltmeter or battery-voltage test lamp that the circuit up to the supply terminal on the motor is in order.

If no voltage is indicated (or the test lamp does not light), check the circuit from battery to motor via the starter switch. Ensure that all connections are clean and tight. If the switch is found to be faulty, a replacement must be fitted. A reading of battery voltage (or the test lamp lighting with full brilliance) at the supply terminal indicates that the starting motor has an internal fault and must be removed from the engine for examination.

If the motor operates but does not crank the engine, the starter drive is in needs of cleaning or may have developed some other fault. In either event the motor must be removed from the engine.

(b) *Bench Testing.*

i. *Removing the starting motor from the engine:*

Disconnect the earth terminal on the battery to avoid any danger of short circuits.

Remove the heavy cable from the starting motor.

Remove the mounting bolts and withdraw the starting motor from the engine.

ii. *Measuring the light running current:*

Secure the starting motor in a vice. Connect the starting motor in a series with a starter switch, an ammeter capable of carrying 600 amperes and an appropriate voltage supply. Use

cables of similar size to those in the vehicle starting motor circuit. A fixing lug on the drive end bracket is a suitable earthing point on thestarting motor.

Connect a voltmeter between the terminal and yoke.

Operate the switch and check the speed of armature rotation, nsing a tachometer, and the reading given by the ammeter. The speed should be 9,500–11,000 r.p.m., and the current 45 amp. (approx.).

While the starter motor is running at speed, examine the brushgear and commutator for undue sparking or excessive brush movement.

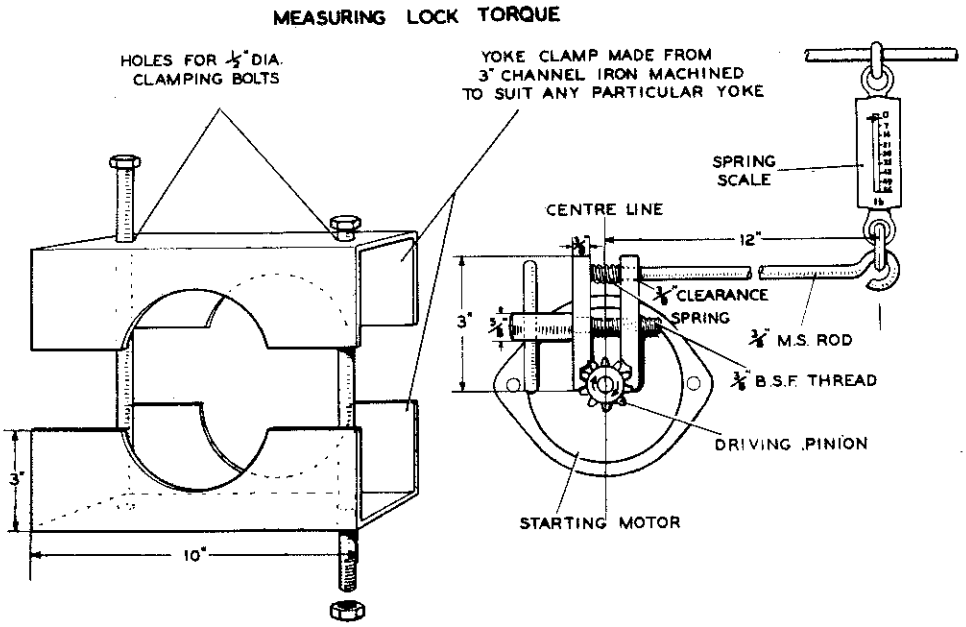


Fig. 4
Measuring lock torque

iii. *Measuring lock torque and lock current:*

With the starting motor firmly clamped in the vice, attach an arm to the driving pinion, see Fig. 4 for details. Connect the free end of this arm to a spring scale.

Operate the switch and note the current consumption, the voltage and the spring scale reading.

The lock torque of the starting motor, calculated from the spring scale reading, should be 7·7 lb.-ft. with a current of 330–350 amp. and a voltage of 7·5–7·1 volts.

The measure of torque can be calculated by multiplying the reading on the spring scale in pounds by the length of the arm in feet.

(c) *Fault Diagnosis.*

An indication of the nature of a fault or faults may be deduced from the results of the no-load and lock torque tests.

Symptom	*Probable Fault*
Speed, torque and current consumption correct.	Assume motor to be in normal operating condition.
Speed, torque and current consumption low.	High resistance in bursh-gear, e.g. faulty connections, dirty or burned commutator causing bad brush contact.
Speed and torque low, current consumption high.	Tight or worn bearings, bent shaft, insufficient end play, armature fouling a pole shoe, or cracked spigot on drive end bracket.
	Short-circuited armature, earthed armature or short-circuited field coils.
Speed and current consumption high, torque low.	Short-circuited field coils.
Armature does not rotate, no current consumption.	Open-circuited armature or field coils. If the commutator is badly burned there may be poor contact between brushes and commutator.
Armature does not rotate, high current consumption.	Earthed field winding, armature prevented mechanically from rotating.
Excessive brush movement.	Low brush spring tension, worn or out-of-round commutator. 'Thrown' or high segments on commutator.
Excessive arcing at the commutator.	Defective armature windings.

If any fault is indicated, the starting motor must be dismantled, and a further check made.

(d) *Dismantling.*

i. Remove the cover band, hold back the brush springs and lift the brushes from their holders.

ii. Remove the nuts from the terminal post which protrudes from the commutator end bracket.

iii. Unscrew the two through bolts from the commutator end bracket and remove the commutator end bracket from the yoke.

iv. Remove the driving end bracket with armature and drive from the starting motor yoke.

v. If it is necessary to remove the drive end bracket from the armature it can be slid off after the drive has been dismantled.

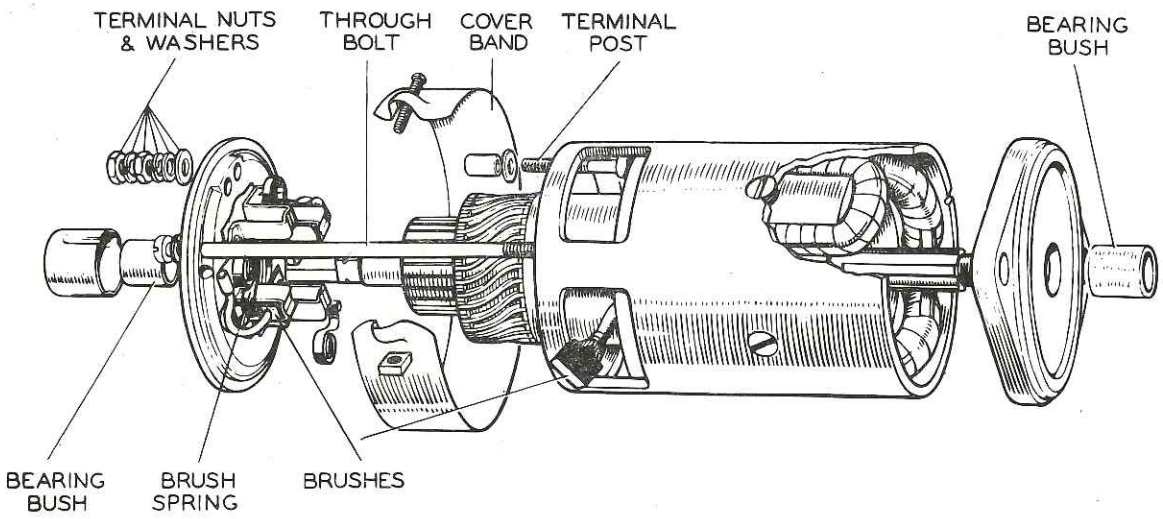


Fig. 5 Starting motor dismantled

(e) *Bench Inspection.*

After the starting motor has been dismantled, individual items must be examined as follows:

Brushgear:

Where necessary, the brushes and brush-holders must be cleaned using a clean fluffless petrol-moistened cloth.

To prevent damage to the commutator, brushes must be replaced when worn to $\frac{5}{16}$" in length.

To replace the brushes, proceed as follows:—

Insulated Brushes:

Cut off the original brush flexible $\frac{1}{8}$" (3 mm. approx.) from the aluminium.

Clean up and tin the original resistance-brazed joint.

Open out the loop of the replacement brush flexible.

Tin the loop, taking great care not to allow any solder to run towards the brush.

Place the original joint within the loop.

Squeeze up and solder.

Note: Providing the necessary equipment is available for refitting and tightening the pole shoes, the above operations will be found easier to carry out if the field coils are removed from the yoke.

Earth Brushes:

Unsolder the brush flexible from the clip located beneath the brush box mounting. Open up the clip, insert the replacement flexible, squeeze up the clip and re-solder.

The brushes are pre-formed so that bedding to the commutator is unnecessary.

Check the brush spring tension using a spring scale (see para. 2 (b)).

Check the tension of any new spring and ensure that it makes contact with the centre of the brush top.

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 and remove the armature from the end bracket.

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:

Check for lifted commutator segments and loose turns in the armature winding. These may be due to the starting motor having remained engaged while the engine is running, thus causing the armature to be rotated at excessive speed. A damaged armature must always be replaced—no attempt should be made to machine the armature core or to true a distorted armature shaft. An indication of a bent shaft or a loose pole shoe may be given by scored armature laminations.

To check armature insulation, use an ohm meter or a 110-volt a.c. test lamp. A high reading should be shown on the meter when connected between the armature shaft and the commutator segments. If a test lamp is used, it must not light when connected as above. Faulty insulation will be indicated by a low ohmic reading or by lighting of the test lamp. If a short circuit is suspected, check the armature on a 'growler'. The motor overheating may cause blobs of solder to short circuit the commutator segments. If an armature fault cannot be located and remedied, a replacement armature must be fitted.

Field Coils:

Continuity test:

Connect a battery and suitable bulb in series with two pointed probes.

If the lamp fails to light in the following test, an open circuit in the field coils is indicated and unless a yoke assembly is available the starting motor must be replaced.

When the probes are placed on the brush tappings, the bulb should light.

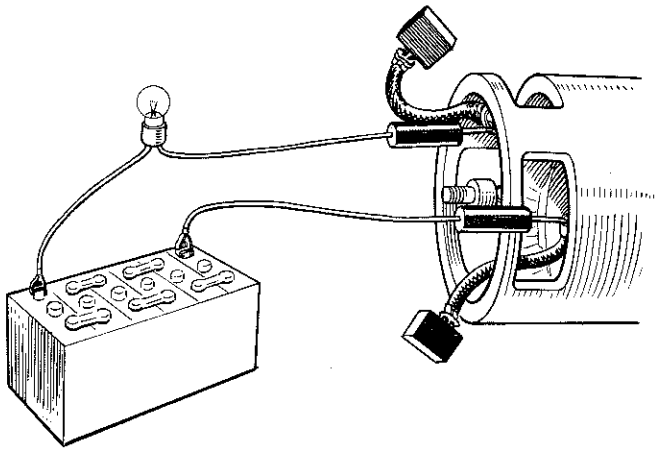


Fig. 6
Testing field coils for continuity

Lighting of the lamp does not necessarily indicate that the field lighting coils are in order. It is possible that a field coil may be earthed to a pole shoe or to the yoke.

Insulation Tests:

Connect an ohm meter or a 110-volt a.c. test lamp between the terminal post and a clean part of the yoke.

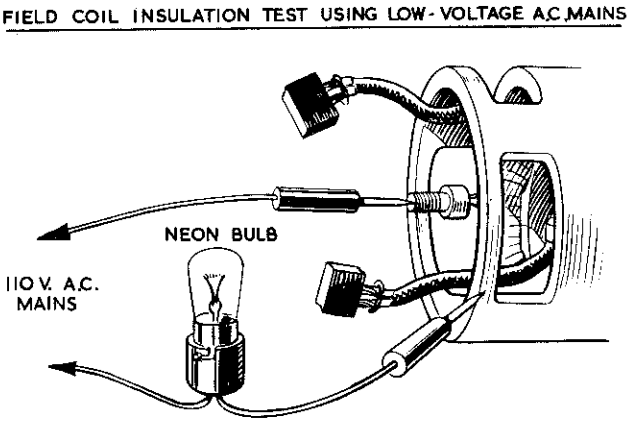


Fig. 7
Testing field coil insulation

Lighting of the test lamp or a low ohmic reading indicates that the field coils are earthed to the yoke and the assembly (or complete unit) must be replaced.

Again using the 110-volt test lamp, check the soundness of the insulation on the two insulated brush boxes, see Fig. 8. Wipe clear from the boxes all dust and dirt before testing in this fashion.

Replacing the field coils:

Unscrew the four pole-shoe retaining screws using a wheel-operated screwdriver.

Remove the insulation piece which is fitted to

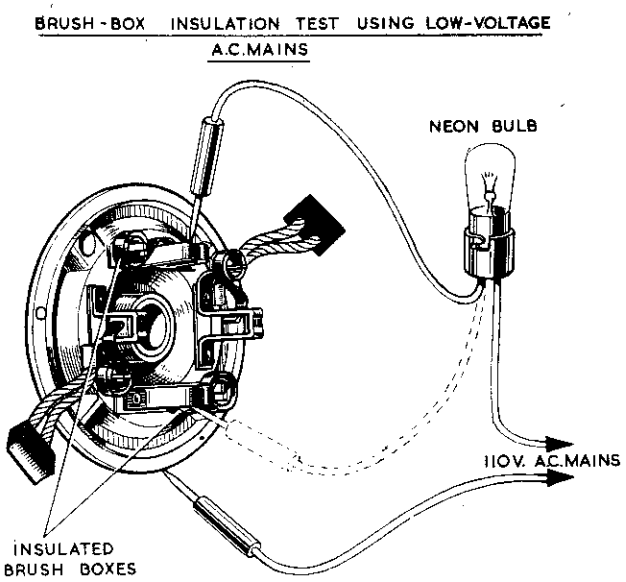


Fig. 8
Testing brush box insulation

prevent the inter-coil connectors from contacting with the yoke.

Mark the yoke and pole shoes in order that they may be refitted in their original positions.

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. Ensure that the tapping of the field coils is not trapped between the pole shoes and the yoke.

Locate the pole shoes and field coils by lightly tightening the fixing screws.

Replace the insulation piece between the field coil connections and the yoke.

Finally, tighten the screws by means of the wheel-operated screwdriver.

Bearings:

Bearings which are worn to such an extent that they will allow excessive side play of the armature shaft must be replaced.

To replace the bearing bushes proceed as follows:

i. Press the bearing bush out of the end bracket.

ii. 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. Porous bronze bushes must not be opened out after fitting, or the porosity of the bush may be impaired.

Before fitting a new porous bronze bearing bush it should be completely immersed for 24 hours in clean thin engine oil. On occasions of urgency this period may be shortened by heating the oil to 100°C. (212°F.) for two hours, then allowing to cool before removing the bearing bush.

Starter Drive:

The pinion must move freely along the splined sleeve. If there is any dirt or foreign matter on the sleeve, the starter drive must be washed in petrol or paraffin and a light film of machine oil smeared on it.

(f) *Reassembling.*

This is, in the main, a reversal of the procedure outlined for dismantling the starter.

5. STARTER DRIVE

"SB" PATTERN (Inboard)

General

The pinion is carried on a barrel type assembly which is mounted on a screwed sleeve. This sleeve is carried on splines on the armature shaft and is arranged so that it can move along the shaft against a compression spring to reduce the shock loading at the moment engagement takes place.

When the starter switch is operated, the armature shaft and screwed sleeve rotate. Owing to the inertia of the 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 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.

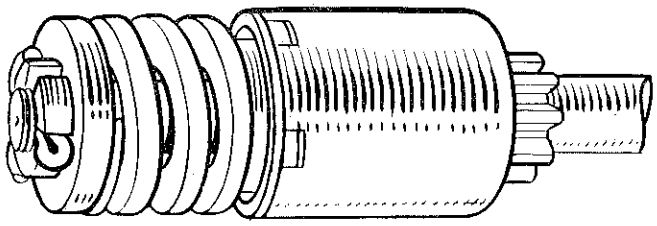


Fig. 9
Drive assembled

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 barrel assembly should move freely on the screwed sleeve; if there is any dirt or other foreign matter on the sleeve it must be washed off with paraffin.

In the event of the pinion becoming jammed in mesh with the flywheel, it can usually be freed by turning the starter motor armature by means of a spanner applied to the shaft extension at the commutator end. This is accessible by removing the cap which is a push fit.

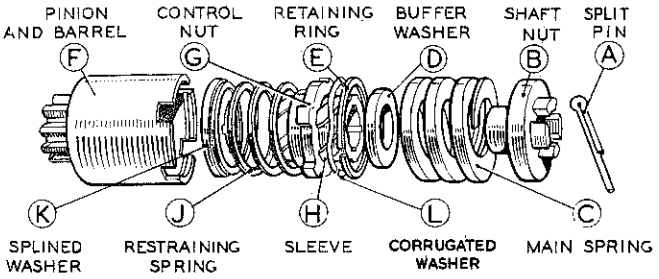


Fig. 10
Drive dismantled

Dismantling and Reassembly

Having removed the armature as described in the section dealing with starting motors, the drive can be dismantled as follows:

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) drive retaining cap 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 reassembly 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.

6. DISTRIBUTOR MODEL D3AH4

General

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 low engine speeds, the spring force maintains the contact breaker 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 advance the cam and thereby the spark, to suit engine conditions at the greater speed.

Specially designed for use where exposure is encountered the D3AH4 distributor incorporates a metal dust-excluding plate, which fits over the cam spindle. In its central hole is a felt sealing ring, thus affording a moisture and dust-proof enclosure for the contact breaker mechanism and automatic timing control.

Routine Maintenance

In general, lubricating and cleaning constitute normal maintenance procedure.

(a) *Lubrication—every* 3,000 *miles or* 100 *hours running.*

Take great care to prevent oil or grease from getting on or near the contacts.

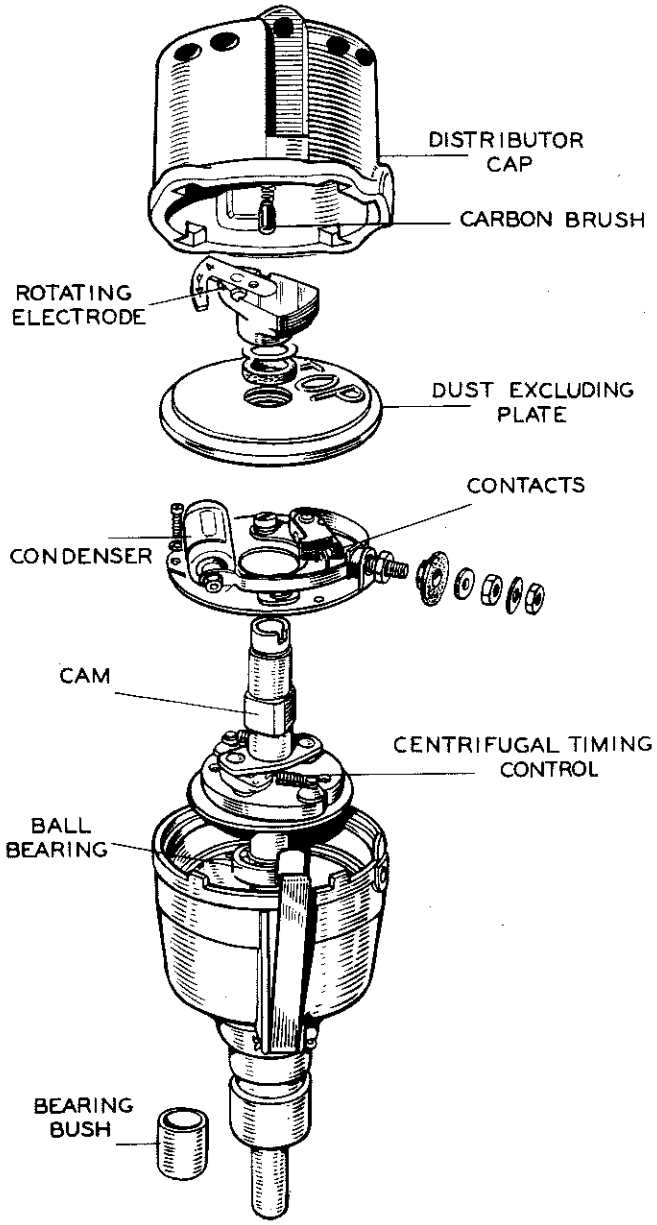


Fig. 11
Distributor, dismantled

Lift off the rotor arm and apply to the spindle a few drops of thin machine oil to lubricate the cam bearing. It is not necessary to remove the exposed screw, since it is either drilled or affords a clearance to permit passage of oil.

Lift off the dust-excluding plate. Lightly smear the cam with a small quantity of Mobilgrease No. 2, or clean engine oil, and apply a drop of oil to the top of the pivot on which the contact-breaker lever works. A few drops of thin machine oil should be applied, through the hole in the contact-breaker base through which the cam passes, to lubricate the automatic timing control mechanism. Replace the dust-excluding plate. 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.

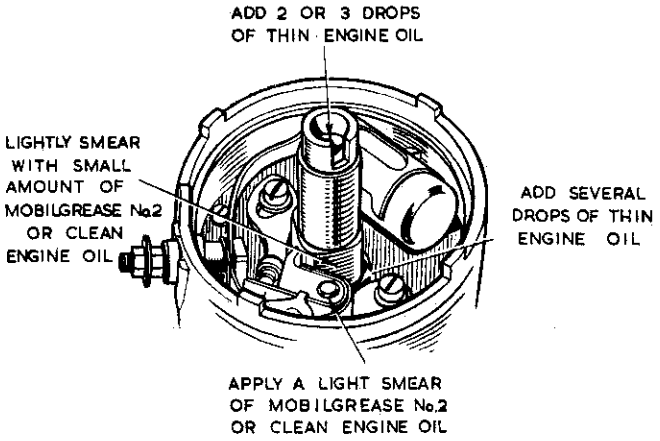


Fig. 12
Lubrication details

(b) *Cleaning—every* 6,000 *miles or* 200 *hours running.*

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 a very fine carborundum stone or emery cloth, then wipe with a petrol-moistened cloth. Cleaning is facilitated by removing the contact-breaker lever. This can be

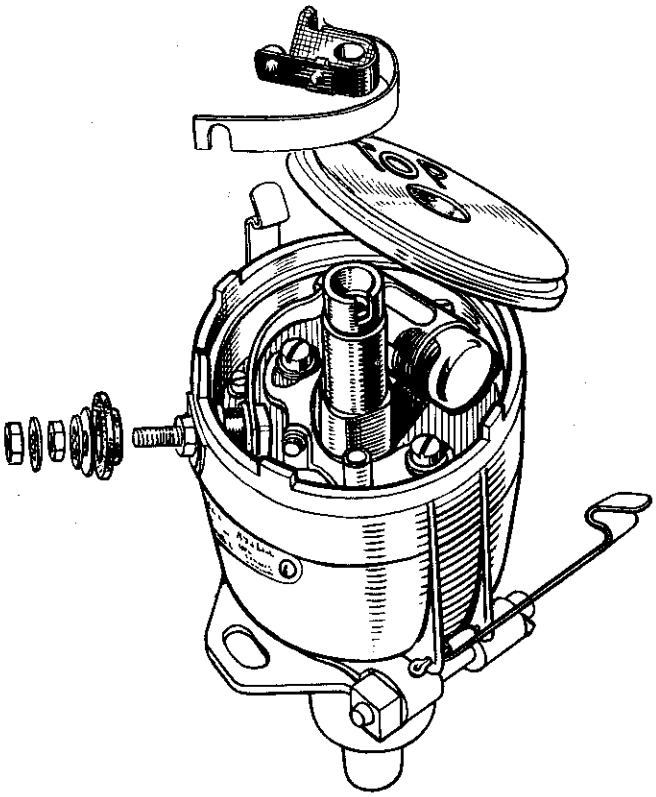


Fig. 13
Contact breaker cleaning

done by removing the two outer nuts on the terminal post, together with the spring washers, plain washer and rubber grommet; a 2 B.A. box spanner can then be used to slacken the third securing nut, and the spring lifted off.

After cleaning, check the contact breaker setting. Turn the engine by hand until the contacts show the maximum opening. This should measure 0·014″ to 0·016″. If the measurement is incorrect, keep the engine in the position giving maximum opening, slacken the two screws securing the fixed contact plate and adjust its position to give the required gap. Tighten the screws. Recheck the setting for other positions of the engine giving maximum opening.

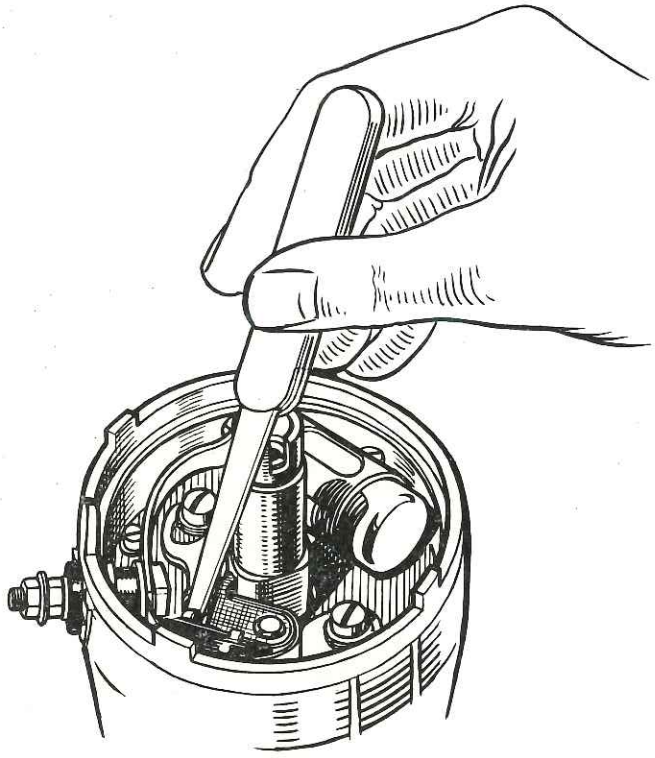


Fig. 14
Contact breaker gap setting

Design Data

(a)	Firing Angles:	0°, 90°, 180°, 270°, ±1°
	Closed Period:	60°, ±3°.
	Open Period:	30°, ±3°.
(b)	Contact breaker gap:	0·014″–0·016″.
(c)	Contact breaker spring tension measured at contacts:	28–34 oz.
(d)	Condenser Capcity:	0·2 microfarad.
(e)	Centrifugal timing control:	

Centrifugal advance commences at 300 R.P.M.
Maximum centrifugal advance: 18°–20° at 1,800 R.P.M.
Check at the following decelerating speeds:
1,150 R.P.M., advance to be 17°–19°.
850 R.P.M., advance to be 14°–16°.
700 R.P.M., advance to be $10\frac{1}{2}$°–$13\frac{1}{2}$°.
450 R.P.M., advance to be 2°–5°.

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.

(a) *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, say, the blade of an insulated screwdriver, or a hammer head, 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 $\frac{3}{16}$″ 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.
Clean and examine the distributor moulded cap for free movement of the carbon brush. If tracking has occurred, indicated by a thin black line, usually between two or more electrodes, a replacement distributor cap must be fitted.

(b) *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. Remove the dust-excluding plate.

(c) *Low tension circuit—fault location.*
Switch on the ignition and, whilst the engine is slowly cranked, observe the reading on the vehicle ammeter or on an ammeter connected in series with the coil supply cable. The reading should rise and fall with the closing and opening of the contacts if the low tension wiring is in order. When a reading is given which does not fluctuate, a short circuit, contacts remaining closed or a faulty capacitor is indicated. No reading indicates an open circuit in the low tension circuit, or badly adjusted or dirty contacts.
Check the contact for cleanliness and correct gap setting. Ensure that the moving arm moves freely on its pivot. If sluggish, remove the arm and polish the pivot pin with a strip of fine emery cloth. Replace the arm and lubricate with a spot of clean engine oil.

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

ii. *Steady reading in ammeter test:*

Check capacitor (either by substitution or on a suitable tester).

Check the ignition coil by substitution.

Examine insulation of contact breaker.

(d) *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 $\frac{3}{16}$" 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 secondary winding of the coil is indicated and the coil must be replaced.

The high tension cables must be carefully examined, and replaced if the rubber insulation is cracked or perished, using a 7 m.m. (p.v.c. or neoprene covered) ignition cable. To replace the cables remove the cover and slacken the screws on the inside of the moulding. Cut the new cables to the length required and push firmly home in the holes in the moulding. Tighten the screws, which will pierce the rubber insulation to make good contact with the cable core. The connection to the centre terminal is made accessible by removing the small carbon brush.

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

(e) *Dismantling.*

Before dismantling, carefully note the positions in which the various components are fitted, in order to ensure their correct replacement on reassembly. If the driving member is offset, or marked in some way for convenience in timing, note the relation between it and the rotor electrode, and maintain this relation when reassembling the distributor.

Spring back the securing clips and remove the moulded cap.

Lift the rotor off the top of the spindle. If tight, carefully lever off with a screwdriver. Remove the dust-excluding plate, together with the felt seal. The contact-breaker base can be lifted out, together with the lever, contact, etc., by proceeding as follows:

i. Remove the washer and two nuts on the low tension terminal.

ii. Remove the insulating grommet.

iii. Slacken and remove the three securing screws, with serrated washers, at the edge of the plate, and lift out the complete contact breaker assembly

iv. Slacken the remaining nut on the low-tension terminal and lift off the contact-breaker lever, its insulating washer and the capacitor. Withdraw the two screws with spring and plain washers, securing the fixed contact plate, and remove the plate.

Remove the driving dog from the shaft.

Remove the cam, automatic timing control and shaft assembly from the distributor. Take out the screw from inside the top of the cam spindle. Lift off the cam, affording access to the automatic timing control.

(f) *Bearing replacement.*

i. *Bearing Bush:*

Remove the bearing bush at the lower end of the shank by using a hand press and mandrel of suitable diameter.

Invert the distributor body and press the new bearing bush into the lower end of the distributor shank, using a shouldered mandrel in the hand press, the mandler being of the same diameter as the distributor shaft.

Before the new bush is fitted it must be completely immersed in thin engine oil for 24 hours. In cases of emergency, this process may be shortened by heating the oil to 100°C., when the period of immersion can be reduced to 2 hours.

Under no circumstances should the bushes be overbored by reamering or any other means, since this will impair the porosity and thereby the effective lubricating quality of the bushes.

ii. *Ball bearing:*

The ball bearing fitted to the distributor shaft can be removed by means of an extractor. The ball bearing can be fitted by means of a sleeve which locates over the distributor shaft and bears on the inner journal of the bearing.

(g) *Reassembly.*

Before reassembly, the automatic advance mechanism distributor shaft and the cam spindle must be lubricated with thin engine oil. Pack the new bearing on the distributor shaft with high-melting-point grease.

Assemble the automatic timing control, taking care that the parts are fitted in their original positions and the control springs not stretched. Two holes are provided in each toggle: the springs must be fitted to the inner hole in each case. Place the cam on the spindle and locate the two pegs on the cam foot in the holes in the toggle levers. Secure the cam by replacing the fixing screw and tightening.

Fit the shaft in its bearings and replace the driving member.

Reassemble the contact-breaker by reversing the appropriate dismantling procedure described above. Adjust the contact-breaker gap to within 0·014" to 0·016" when the contacts are fully opened. Replace the dust-excluding plate, carefully locating the felt seal.

Note: If it is necessary to renew the contacts, a set comprising both fixed and moving contacts must be fitted.

7. GENERATOR MODEL C39PVR-2 (22296)

General

The generator is a shunt-wound two-pole two-brush ventilated machine, arranged to work in conjunction with a Lucas regulator unit.

To render it suitable for racing duties this machine incorporates several features some of which are listed as follows:

Ball race bearing at commutator end.
Field coil assembly "cemented in", i.e. rubber-resin bonded to yoke.
Armature winding slots fitted with laminated plastic wedges.
"Windowed" yoke and cast-iron end brackets.

Routine Maintenance

(a) *Inspection of Brushgear and Commutator.*

Every 12,000 miles inspect the brushgear and commutator. Access to the brushgear is gained by slackening the metal band cover securing screw and sliding the cover back along the yoke.

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 positions in order to retain the "bedding". Brushes which have worn to less than $\frac{11}{32}$" in length 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 with a fine dry cloth. If the commutator is very dirty moisten the cloth with petrol.

(b) *Belt Adjustment.*

Occasionally inspect the generator driving belt. If necessary, adjust to take up any undue slackness by turning the generator on its mounting. The belt should have just sufficient tension to drive without slipping.

See that the machine is properly aligned, otherwise undue strain will be thrown on the generator bearings.

Performance Data

Cutting-in speed, 1,200 (max.) r.p.m. at 13·0 generator volts. Maximum output—19 amps. at 2,150 (max.) r.p.m. at 13·5 generator volts (when connected to a resistance load of 0·71 ohm). Field resistance 6·1 ohms.

Servicing

(a) *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.

i. Inspect the driving belt and adjust if necessary, see Para. 2(b).

ii. Check that the control box is correctly connected to the generator. Control box terminal 'F' must be connected to the small generator terminal, and the large generator terminal to control box terminal 'D'.

iii. Disconnect the cables from terminals of the generator and connect the terminals with a short length of wire.

iv. Start the engine and set to run at normal idling speed.

v. Clip the negative lead of a moving coil type volt-meter, calibrated 0–20 volts, to one of the two linked generator terminals and the other lead to a good earthing point.

vi. Gradually increase the engine speed, when the volt-meter reading should rise rapidly and without fluctuation. Do not allow the volt-meter 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 there is no reading, check the brushgear and commutator as described in para. 2(a). If there is a reading of approximately 6 volts the armature winding may be at fault, see para. 4(d). If there is a low reading of approximately $\frac{1}{2}$–1 volt, the field winding may be at fault, see para. 4(e).

vii. Test the brush spring tension with a spring scale. The tension of the springs when new is 22–25 oz. In service it is permissible for this value to fall (due to ageing and brush wear) to 16 oz., below which figure performance may be affected. Fit new springs if the tension is low. If the commutator is blackened or dirty, clean it with a petrol-moistened cloth. Re-test the generator as in (vi); if there is still no reading on the volt-meter, there is an internal fault and the complete unit, if a spare is available should be replaced. Otherwise the unit must be dismantled (see para. 4(b) for internal examination).

viii. If the generator is in good order, remove the link from between the terminals and restore the original connections as described in para. 4(a)(ii).

(b) *To Dismantle.*

i. Take off the driving pulley.

ii. Unseal, unscrew and withdraw the two through bolts. The commutator end bracket can now be withdrawn from the generator yoke. The driving end bracket together with the armature can now be lifted out of the yoke.

iii. The driving end bracket 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.

(c) *Commutator.*

A commutator in good condition will be smooth and free from pits or burned spots.

Whilst the C39 Generator was designed to accommodate a commutator of fabricated construction, later production also includes machines having commutators of the recently-developed moulded type. Moulded commutators can be recognised by the exposed end being quite smooth unlike that of fabricated commutators from which a metal roll-over and an insulating cone protrude.

A moulded commutator can be re-skimmed during service but care must be exercised to ensure that the finished diameter is not less than 1·450". The process of re-skimming consists of rough

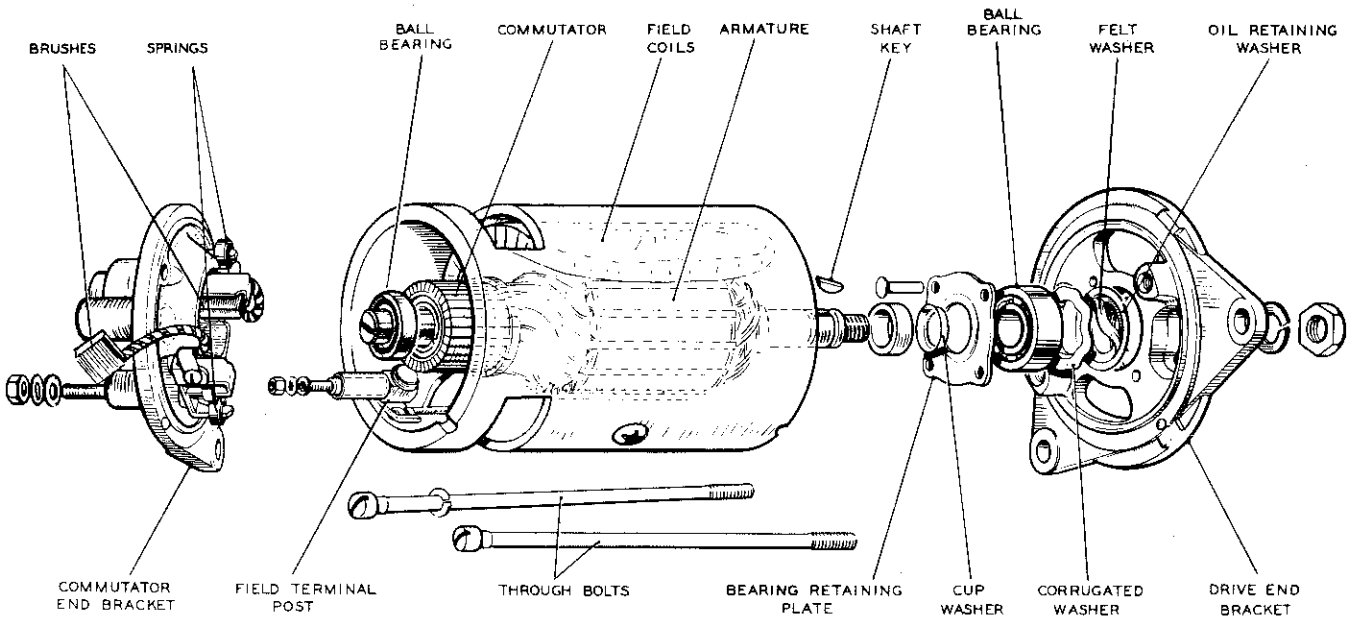


Fig. 15 Generator, dismantled

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 moulded commutator cannot be completely cleaned up without going below the specified diameter the armature should be replaced. The width of the undercut slots must not exceed 0·040″ with a depth of 0·020–″0·035″. It is important to see that the insulating material is cleared from the sides of each slot to a minimum depth of 0·015″.

To remedy a badly-worn fabricated commutator, undercut the insulators between the segments to a depth of $\frac{1}{32}$″, then take a light skim with a very sharp (preferably diamond-tipped) tool. 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.

(d) *Armature.*

The testing of the armature winding requires the use of a volt-drop test and growler. If facilities are not available check the armature by substitution. Do not attempt to machine the armature core or to true a distorted armature shaft.

To remove the armature shaft from the drive end bracket and bearing, support the bearing retaining plate firmly and press the shaft out of the drive end bracket. When fitting the new armature, support the inner journal of the ball bearing whilst pressing the armature shaft firmly home.

(e) *Field Coils.*

Measure the resistance of the field coils by means of an ohm meter connected between the small generator terminal and the yoke of the machine. The ohm meter should read 6·1 ohms. If an ohm meter is not available, connect a 12 volt d.c. supply with an ammeter in series between the same two terminals. The ammeter 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. Current readings of much more than 2 amperes, or ohm meter readings much below 6 ohms, are indications that the insulation of one of the field coils has broken down.

In either case, unless a replacement yoke assembly is available, the generator must be replaced.

(f) *Bearings.*

Bearings which have worn to such an extent that they will allow side movement of the armature shaft must be replaced. The ball bearing at the driving end is replaced as follows:

i. Bend back the tag washers, remove the nuts and withdraw the bolts which secure the bearing retaining plate to the end bracket and remove the plate.

ii. Press the bearing out of the end bracket and remove the corrugated washer, felt ring and retaining cup.

iii. Before fitting the replacement bearing see that it is clean and pack it with high melting point grease.

iv. Place the felt ring retaining cup, felt ring and corrugated washer in the bearing housing in the end bracket.

v. Locate the bearing in the housing and press it home.

vi. Fit the bearing retaining plate in the same manner as hitherto, ensuring that the tag washers are peened over into the end bracket windows.

The commutator end bearing can be withdrawn from the armature shaft by means of a hand press or extractor. The inner race of the replacement bearing must be supported during fitment.

(g) *Reassembly.*

In the main, the reassembly of the generator is a reversal of the operations described in para. 4(b). When reassembling, the commutator end bracket should be refitted to the yoke as described in para. 2(a).

8. IGNITION COIL MODEL HA12

The ignition coil should be kept clean, particular attention being paid to the terminal moulding. Renew the high tension cable if it shows sign of perishing or cracking. To do this, remove the defective cable taking care not to lose the split washer. Thread the new cable through the terminal nut and bare the end of the cable for about $\frac{1}{4}$". Thread the exposed strands through the split washer and bend them back radially. Refit the moulded nut into the terminal moulding.

9. FUSE UNIT MODEL SF5

The fuse unit carries one live and one spare fuse. When changing a blown fuse use only a 35 amp. replacement (Lucas Part No. 188218).

10. SWITCHES, AMMETER, RELAYS

The switches that control the various circuits, the ammeter and the horn and lighting relays, require no maintenance in service.

11. INSTRUCTIONS FOR CHECKING AND SETTING THE ELECTRICAL ADJUSTMENTS OF LUCAS CURRENT-VOLTAGE CONTROL BOX MODEL RB310

General

(a) *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:

i. Check the battery by substitution or with an hydrometer and a heavy discharge tester.

ii. Inspect the generator driving belt. This should be just taut enough to drive without slipping.

iii. Check the generator by substitution or by disconnecting the generator cables and linking large generator terminal 'D' to small terminal 'F' and connecting a volt-meter between this link and earth and running the generator up to about 1,000 r.p.m. when a rising voltage should be shown.

iv. Inspect the wiring of the charging circuit and carry out continuity tests between the generator, control box and, when fitted, the ammeter.

v. Check earth connections, particularly that of the control box.

vi. 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.

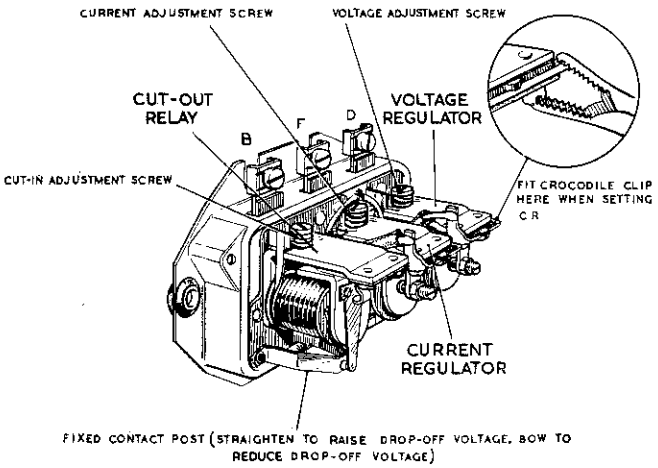


Fig. 16
Control Box, Model RB 310, *with cover removed*

Voltage Regulator

(a) *Open Circuit Settings.*

Ambient Temperature	Voltage Setting
10°C. (50°F.)	15·1–15·7
20°C. (68°F.)	14·9–15·5
30°C. (86°F.)	14·7–15·3
40°C. (104°F.)	14·5–15·1

(b) *Method of Adjustment.*

Checking and adjusting should be completed as rapidly as possible to avoid heating errors.

i. Disconnect control box terminal 'B'.

ii. Connect a first-grade 0–20 moving-coil volt-meter between control box terminal 'D' and a good earthing point.

iii. Start the engine and run the generator at 3,000 r.p.m.

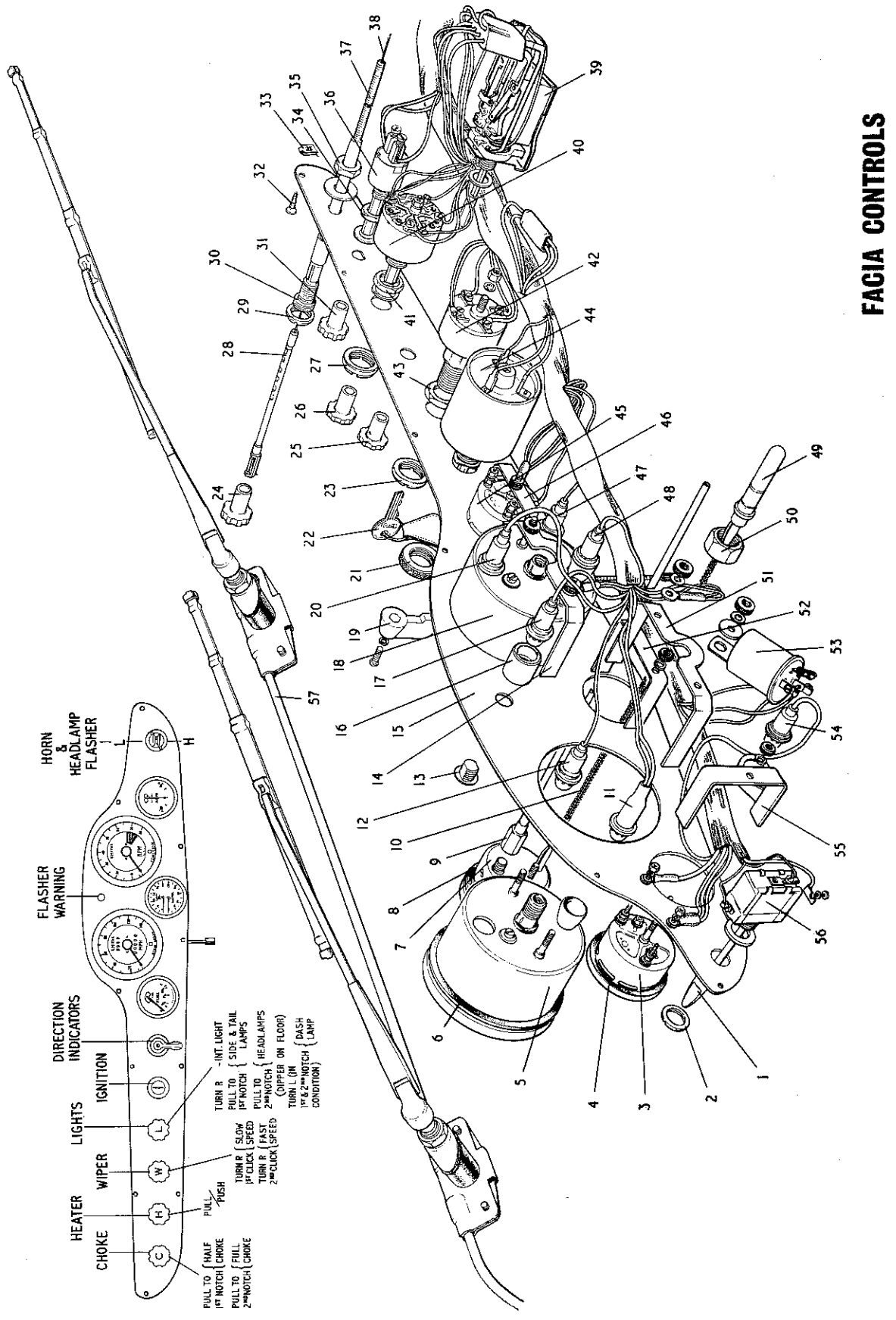
iv. Observe the volt-meter pointer.

The volt-meter reading should be steady and lie between the appropriate limits given in para. 2(a), according to the temperature. An unsteady reading 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:

v. Stop the engine and remove the control box cover.

vi. Re-start the engine and run the generator at 3,000 r.p.m.

vii. Turn the voltage adjustment screw (clockwise to raise the setting or anti-clockwise to lower it) until the correct setting is obtained.


FACIA CONTROLS
HORN & HEADLAMP FLASHER
FLASHER WARNING
DIRECTION INDICATORS
IGNITION
LIGHTS
WIPER
HEATER
CHOKE
PULL TO 1ST NOTCH HALF CHOKE
PULL TO 2ND NOTCH FULL CHOKE
PULL/PUSH
TURN R 1ST CLICK SLOW SPEED
TURN R 2ND CLICK FAST SPEED
TURN R -INT. LIGHT
PULL TO 1ST NOTCH SIDE & TAIL LAMPS
PULL TO 2ND NOTCH HEADLAMPS (DIPPER ON FLOOR)
TURN L (IN 1ST & 2ND NOTCH CONDITION) DASH LAMP

12. KEY TO FACIA CONTROLS

1. Horn and lamp toggle switch.
2. Horn and lamp locking ring.
3. Ammeter.
4. Ammeter sealing ring.
5. Tachometer.
6. Tachometer sealing ring.
7. Water temperature and oil press.
8. Water temperature and oil sealing ring.
9. Oil pipe union nut.
10. Temperature gauge connection
11. Ignition light.
12. Tachometer light.
13. Flasher warning light.
14. Speedometer retaining bracket.
15. Dash pannel.
16. Flasher warning light screen.
17. Flasher light.
18. Speedometer.
19. Flasher indicator switch.
20. Speedometer light.
21. Flasher switch retaining collar.
22. Ignition key.
23. Ignition switch retaining collar.
24. Choke knob.
25. Lights knob.
26. Windscreen wiper knob.
27. Windscreen wiper knob locking ring.
28. Choke stem.
29. Choke knob locking ring.
30. Body of choke control.
31. Heater knob.
32. Dash pannel retaining screw.
33. Steel retaining clip for screw.
34. Heater switch retaining nut.
35. Choke control retaining nut.
36. Heater switch.
37. Choke cable (outer).
38. Choke cable (inner).
39. Lighting switch.
40. Windscreen wiper switch.
41. Windscreen wiper nut.
42. Ignition and starter switch.
43. Ignition and starter nut.
44. Flasher indicator switch.
45. Fuel gauge.
46. Fuel gauge retaining bracket.
47. Fuel gauge panel light.
48. High beam light.
49. Thermometer.
50. Thermometer locking nut.
51. Tachometer retaining bracket.
52. Fuel gauge locating bracket.
53. Flasher unit.
54. Panel light.
55. Ammeter.
56. Horn and lamp switch unit.
57. Windscreen wiper assembly.

viii. Check the setting by stopping the engine and then again raising the generator speed to 3,000 r.p.m.
ix. Restore the original connections and refit the cover.

Current Regulator

(a) *On-Load Setting.*

The current regulator on-load setting is equal to the maximum rated output of the generator.

(b) *Method of Adjustment.*

The generator must be made to develop its maximum rated 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 crocodile clip used in 3(b)(ii) to short out the voltage regulator contacts.

i. Remove the control box cover.
ii. Place a crocodile clip between the insulated fixed contact bracket of the voltage regulator and voltage regulator frame.
iii. Disconnect the cable from control box terminal 'B' and connect a first-grade 0–40 moving-coil ammeter between this cable and terminal 'B'.
iv. Start the engine and run the generator at 4,000 r.p.m.
v. Observe the ammeter pointer.

The ammeter pointer should be steady and indicate a current equal to the maximum rated output of the generator, i.e. 00 amperes. An unsteady reading 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:

vii. Turn the current adjustment screw (clockwise to raise the setting or anti-clockwise to lower it) until the correct setting is obtained.
viii. Switch off and restore the original connections.
ix. Refit the cover.

Cut-out Relay

(a) *Electrical Settings.*

i. Cut-in Voltage: 12·7–13·3.
ii. Drop-off Voltage: 9·5–11·0.

(b) *Method of Cut-in Adjustment.*

Checking and adjusting should be completed as rapidly as possible to avoid heating errors.

i. Connect a first-grade 0–20 moving-coil volt-meter between control box terminal 'D' and a good earthing point.
ii. Switch on an electrical load, such as the headlamps.
iii. Start the engine and slowly increase the engine speed.
iv. Observe the volt-meter pointer.

Closure of the contacts, indicated by a slight drop in the volt-meter reading, should occur between the limits given in para. 4(a)(i). If the cut-in occurs outside these limits, an adjustment must be made. In this event, continue as follows:

v. Remove the control box cover.
vi. Turn the cut-out relay adjustment screw (clockwise to raise the setting or anti-clockwise to lower it) until the correct setting is obtained.
vii. Restore the original connections and refit the cover.

(c) *Method of Drop-off Adjustment.*

i. Disconnect the cable from control box terminal 'B' and connect a first-grade 0–20 moving-coil volt-meter between this terminal and earth.
ii. Start the engine and run up to speed.
iii. Slowly decelerate and observe the volt-meter pointer.

Opening of the contacts, indicated by the volt-meter pointer dropping to zero, should occur between the limits given in para. 4(a)(ii). If the drop-off occurs outside these limits, an adjustment must be made. In this event, continue as follows:

iv. Stop the engine and remove the control box cover.
v. Adjust the height of the fixed contact post by carefully bowing or straightening the legs of the post to reduce or to raise the drop-off voltage, respectively.
vi. Repeat (ii) and (iii) and, if necessary, re-adjust until the correct drop-off setting is obtained.
vii. Restore the original connections and refit the cover.

Cleaning Contacts

(a) *Regulator Contacts.*

To clean the voltage or current regulator contacts, use fine carborundum stone or silicon carbide paper followed by methylated spirits (denatured alcohol).

(b) *Cut-out Relay Contacts.*

To clean the cut-out relay contacts, use a strip of fine glass paper—never carborundum stone or emery cloth.

13. HORN MODEL W.T.618

General Information

Horns are adjusted to give their best performance before being passed out of the Works and are designed to give long periods of service without further attention.

When a horn fails or is unreliable, it does not necessarily follow that the horn itself is defective. The trouble may be due to a discharged battery, loose connection or break in the wiring to the horn. A short-circuit in this wiring will cause the fuse to blow and silence both horns. In this event, the wiring should be examined before the fuse is renewed. If a fault is not due to a blown fuse, the horn and any adjacent fixtures should be checked to see that they are rigidly secured to their mountings.

If the battery, wiring and fixtures are satisfactory the horn may need re-adjusting, although this should not be necessary unless the horn has been in service for a long period.

Adjusting Horns

Adjustment serves to take up wear of moving parts. It does not alter the pitch of the note emitted by the horn.

If adjustment has to be made, the supply to one horn should be disconnected when attending to the other, care being taken to prevent the end of the disconnected cable from contacting any earthed part of the vehicle.

If a horn fails to sound after adjustment, release the horn control at once.

Withdraw the single cover securing screw and remove the domed cover and the cover retaining strap.

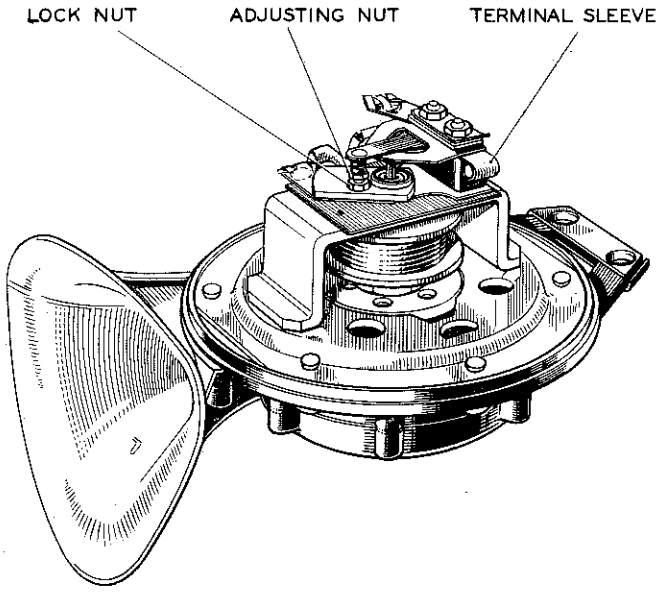


Fig. 17
W.T. 618 *Horn with cover removed*

Slacken the locking nut on the fixed contact stem and rotate the adjusting nut until the contacts just separate (indicated by the horn failing to sound when the horn button or ring is depressed). Rotate the adjusting nut one-half turn in the opposite direction and secure it in this position with the locking nut. Refit the cover.

14. WINDSCREEN WIPER MODEL DR3

General Information

The Lucas windscreen wiper model DR3 is a two-speed, thermostatically protected, self-parking, cable rack unit. The cable rack comprises a flexible inner core of steel wire wound with a wire helix. The rack passes through protective tubing from an underbonnet mounted motor to a pair of scuttle mounted wheelboxes. A reciprocating motion is imparted to the rack by a crank in the wiper gearbox and transmitted to the wiper arm spindles by engagement of the rack with a gear in each wheelbox.

The motor is controlled by a switch giving Park, Normal and High speed operation. The higher speed is intended to be used when driving fast through heavy rain or light snow. It should not be used in heavy snow or with a dry or drying windscreen. If overloaded, the motor windings will over-heat and cause the thermostat to trip and isolate the motor from the supply. Provided the obstruction or other cause of excessive heating is removed, normal working resumes automatically when the temperature falls to a safe value.

Maintenance

Efficient wiping is dependent upon having a clean windscreen and wiper blades in good condition.

Use methylated spirits (denatured alcohol) to remove oil, tar spots and other stains from the windscreen. Silicone and wax-based polishes should not be used for this purpose.

Worn or perished wiper blades are readily removed for replacement.

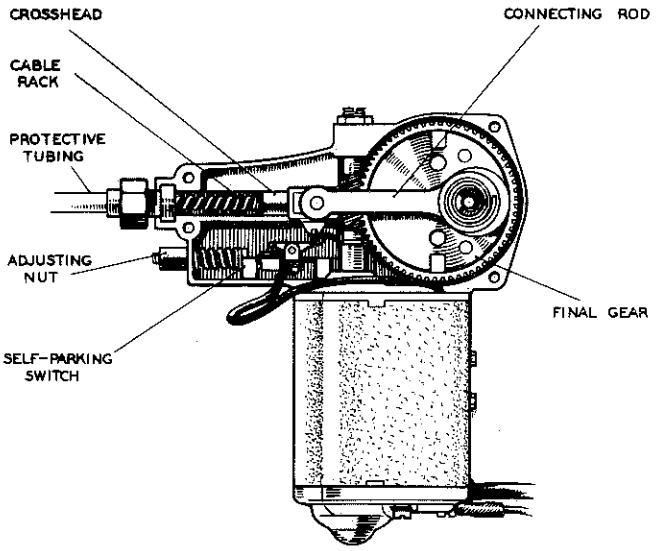


Fig. 18
Motor with gearbox cover removed

When necessary, adjustments to the self-parking mechanism can be made by turning the knurled nut near the cable rack outlet. Turn the nut only one or two serrations at a time and test the effect of each setting before proceeding.

Failure of the motor to stop after the panel switch has been turned "off" indicates an incorrect limit switch setting. This, also, can be corrected by the above adjustment.

Data

Wiping Speed:	
Normal:	45–50 cycles per minute.
High:	60–70 cycles per minute.
Light Running Current:	
Normal Speed:	2·7–3·4 amperes.
High Speed:	2·6 (or less) amperes.
Stall Current (motor hot):	10–11 amperes.
Control Switch:	
Initial Production:	PRS5.
Later Production:	PRS7.
Maximum permissible force to move cable rack in protective tubing with motor, arms and blades disconnected:	6·0 pounds.

Fault Diagnosis

Poor performance can be electrical or mechanical in origin and not necessarily due to a faulty motor, e.g.

i. Low voltage at the motor due to poor connections or to a discharged battery.
ii. Cable rack binding in protective tubing.
iii. Excessive loading on the wiper blades.
iv. Wheelboxes loose, out of alignment or spindles binding in the bearing housing.

Testing:

Unless the origin of the fault is apparent, proceed as follows to determine the cause of failure.

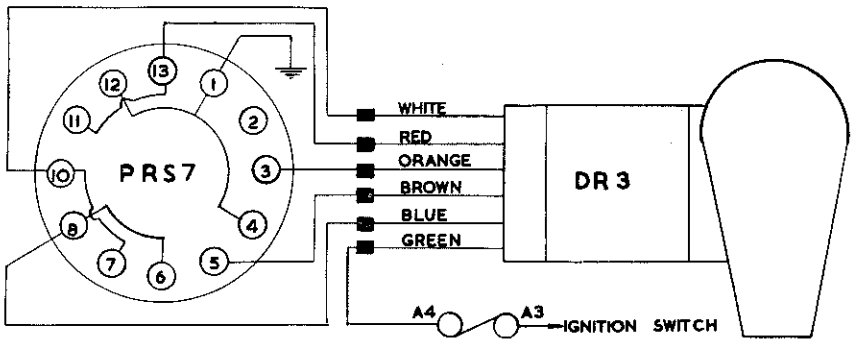


Fig. 19 Motor connections with PRS7 control switch

Measuring Supply Voltage:

Using a first-grade moving-coil voltmeter, measure the voltage between the motor supply terminal (to which the green cable is connected) and a good earthing point. This should be 11·5 volts with the wiper working normally. If the reading is low, check the battery, switch (by substitution), cabling and connections.

Measuring Light Running Current:

If the normal running terminal voltage is correct, disconnect the cable rack at the wiper gearbox and measure the light running current with a first grade moving coil ammeter connected in the supply cable.

As this involves removing the gearbox cover, the opportunity can be taken to observe the speed of operation by counting the revolutions per minute of the final gear.

The light running current must not exceed 3·4 amperes at Normal speed (45–50 c.p.m.). If it does, fit a new windscreen wiper motor.

Checking Cable Rack and Tubing:

The maximum permissible force to move the cable rack in its protective tubing is 6 pounds with the wiper arms, blades and motor disconnected. The measurement can be made by hooking a spring balance in the hole in the cross-head (into which a pin on the connecting rod is normally located) and withdrawing the rack with the balance.

Binding of the rack can be due to kinked or flattened tubing or to faulty installation. Minor faults can be cleared with a suitable test mandrel sold specifically for checking wiper installations. Badly kinked or flattened tubing must be renewed. Any bends of less than 9″ radius must be reformed.

At the wheelboxes the flared ends of the intermediate tubing should be located in the inner wide slots of the wheelbox clamp plates but the end of the main tubing should be located in the outer narrow slot.

The cable rack should be well lubricated with Duckhams HBB grease.

Checking Wheelboxes:

Check the wheelboxes for misalignment or looseness and rectify as required.

Renew seized wheelboxes.

15. FLASHING-LAMP DIRECTION-INDICATORS INCORPORATING FLASHER UNIT MODEL FL.5

General

The Flasher Unit model FL5 is housed in a small cylindrical container. Inside, the alternate heating and cooling of an actuating wire causes the operation of a main armature and associated pair of contacts in the flasher lamp supply circuit. At the same time, a secondary armature operates pilot contacts which cause a warning light to flash in unison with the indicator lamps when the system is functioning correctly. Failure of this warning light to flash will indicate a fault in the system, such as failure of one of the indicator bulb filaments.

Servicing

Flasher Units cannot be dismantled for subsequent reassembly. A defective unit must therefore be replaced, care being taken to reconnect as the original.

(a) *Checking Faulty Operation.*

In the event of trouble occurring with a flashing light direction-indicator system, the following procedure should be followed:

i. Check the bulbs for broken filaments.
ii. Refer to the vehicle wiring diagram and check all flasher circuit connections.
iii. Switch on the ignition.
iv. Check with a volt-meter that Flasher Unit terminal 'B' is at 12 volts with respect to earth.
v. Connect together Flasher Unit terminals 'B' and 'L' and operate the direction-indicator switch. If the indicator lamps now light, the Flasher Unit is defective and must be replaced.

(b) *Replacement of Flasher Unit—Precautionary Note.*

Flasher Units must be handled with care. Factory-made setting, though satisfactory for conditions of normal automobile duty, can be thrown off balance by rough handling.

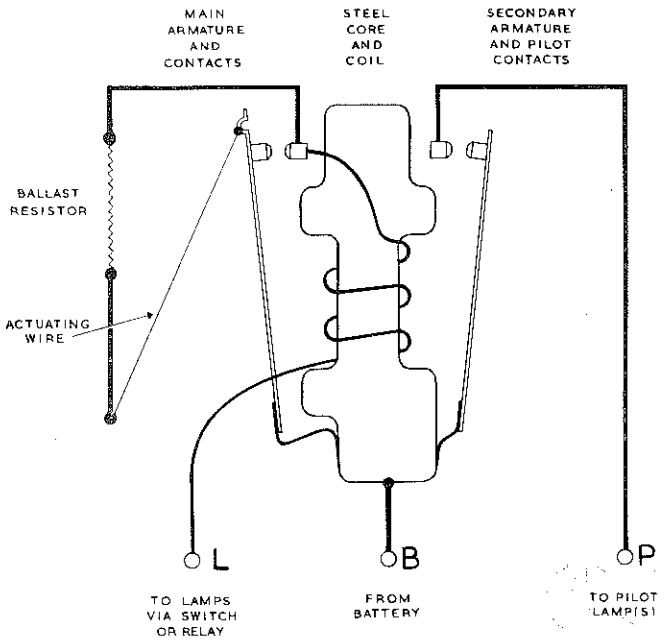


Fig. 20
Symbolic representation of internal connections of Flasher Unit model FL5

16. LIGHTING

When bulb replacement becomes necessary use only bulbs of the correct rating. These are as follows:
Headlamps: 12-volt 50/40-watt. Lucas No. 414.
Sidelamps: 12-volt 6-watt. Lucas No. 989.
Stop Tail Lamps: 12-volt 6/21-Watt. Lucas No. 380.
Rear Flasher: 12-volt 21-Watt. Lucas No. 382.
No. Plate Lamp: 12-volt 6-Watt. Lucas No. 989.
Flasher Warning Light: 12-volt 2·2-Watt. Lucas No. 987.

Headlamps

Beam Setting

Headlamps should be set so that when the car carries its normal load, the driving beams are projected straight ahead, parallel with each other and with the road surface.

Many garages possess a Lucas Beam Setter.

Many garages possess a Lucas Beam Setter. These are scientific instruments enabling accurate beam setting to be effected. The car owner is strongly advised to make use of this service whenever possible. When such facilities are not available, the lamps can be set by marking off a smooth wall or screen and shining the lamps on it from a distance of twenty-five feet.

Remove the clip-on rim by using a screwdriver or similar tool to prise the lower edge of the rim away from the lamp body.

Lift off the rust excluding rubber ring. This is approximately L-shaped in section and is intended to be positioned with the toe of the 'L' facing rearwards.

Cover one lamp while adjusting the other. Vertical trimming is effected by screwing in (or out) the top spring-loaded screw. Horizontal trimming is effected with the two side screws and the top screw.

No focusing is necessary.

Bulb Renewal

Headlamps

Remove the clip-on rims and dust excluding rubber rings as described under Beam Setting. Press the Light Unit inwards against the three spring-loaded adjustment screws and turn it anti-clockwise to disengage it through the keyhole slots.

Release the bayonet-fixed bulb holder (a press-in, anti-clockwise motion) and withdraw the defective bulb. Fit the replacement bulb. Refit the bulb holder and Light Unit, and check the headlamp setting.

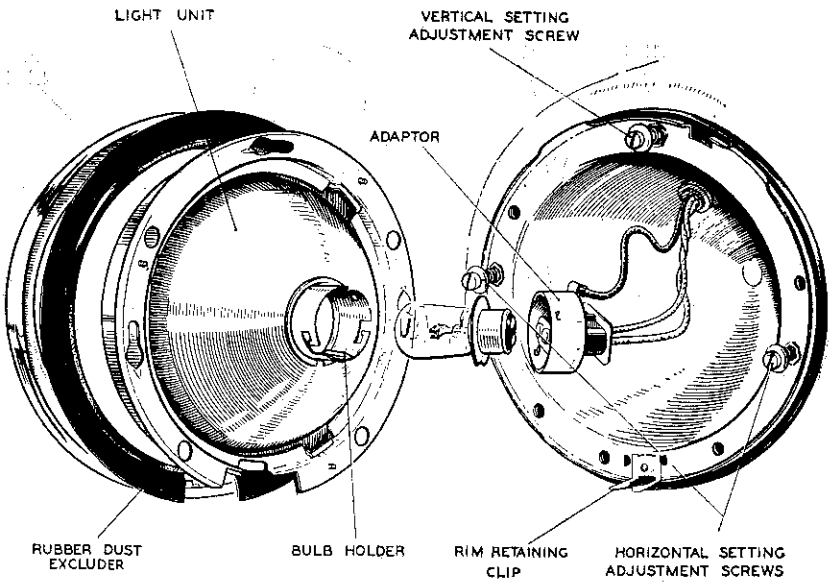


Fig. 21
Headlamp assembly showing method of adjustment

Side Lamps

Remove the screw securing the retaining rim and lift off the rim and lens. The bulb is a bayonet fit in the rubber mounted bulb holder.

Front Flasher Lamps

Peel back the rubber body moulding to release the chromium-plated rim and lens. The bulb is a bayonet fit in the rubber-mounted bulb holder.

Stop Tail Lamps and Rear Flasher Lamps

Press the rim and lens assembly inwards and turn it anti-clockwise to release. The bulb is a bayonet fit in the bulb holder. The double filament stop tail lamp bulb is non-reversible by virtue of offset pins on the cap.

Flasher Warning Light

Withdraw the push-fit bulb holder from the rear of the warning light body.

The bulb is screwed into the bulb holder.

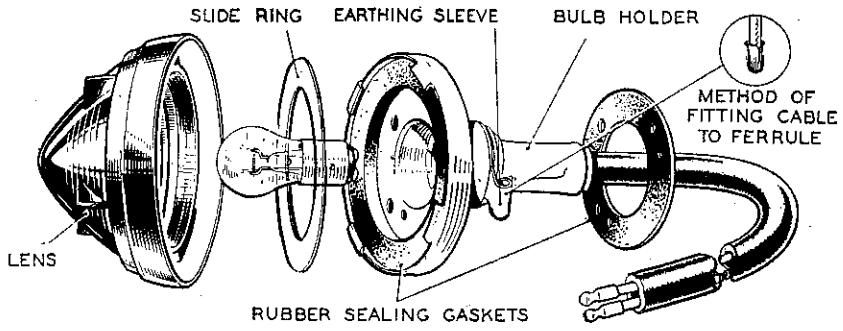


Fig. 22
Components of the front flasher lamp unit

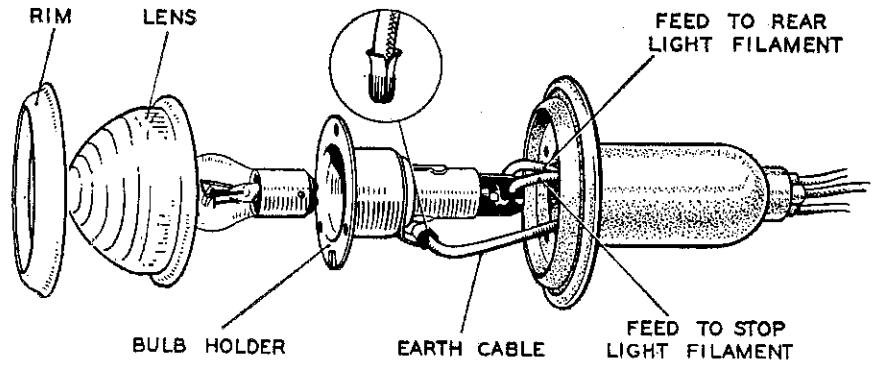


Fig. 23
Components of the stop/tail lamp unit

SECTION E

COOLING SYSTEM

1. General

Circulation of cooling water is assisted by a water pump driven by belt from the engine crankshaft. The pump is bolted to the left hand side of the timing cover and cylinder block. Attachment is by three bolts, the holes for the lower two being elongated to provide means of adjustment for the belt.

Water is drawn from the radiator and supplied via a rubber hose to the top left hand side of the cylinder block. After circulating round the cylinder liners, the water then passes to the cylinder head. It is returned through the outlet elbow situated at the rear right hand side of the cylinder head, through the thermostat to the radiator header tank.

2. Cooling Capacity

Radiator	4½ pints
Engine	7 pints
Total cooling system (including hoses) ...	12 pints
Heater installation	½ pint
Total capacity of cooling system with heater installation (including hoses) ...	12½ pints

3. Thermostat

Engine operating temperature is controlled by a bellows type thermostat contained in a plastic cover inserted into the top hose between the cylinder head and header tank.

The valve is closed when the engine is cold and the water short-circuited round the cylinder head and liners. As the engine heats up the valve opens, permitting a full flow of water to the radiator.

Opening temperature: 80°C. or 176°F.

4. Filler Cap

Great care must be taken in removing the water filler cap when the engine is hot. The cap is fitted with a two stage lock and must be carefully turned anti-clockwise to the first stage to release steam and pressure before fully opening. It is advisable to cover it with a rag to protect the hand whilst removing the cap.

5. Thermostat Switch

The thermostat switch is located in the back face of the header tank. The contacts close at 95°C., operating the fan unit. When the coolant drops to 85°C., the contacts open and the fan ceases to function.

6. Fan

The fan is driven by an electrically controlled motor. The motor is sealed and requires no maintenance, except to check and clean the contacts.

7. Draining the Cooling System

Remove the radiator filler cap.

Open the drain tap at the bottom of the radiator.

Further drain taps are at the bottom of the water pump body and on the cylinder block near the oil filler.

8. Flushing

A certain amount of scaling and sediment will be produced in the radiator. Due to this, it is advisable to flush the radiator periodically with clear running water.

Water should be allowed to flow through the system, until clear water flows out of the taps.

Should serious scaling or "furring up" in the radiator be suspected, remove the radiator and with the radiator inverted, reverse the flow of water from the bottom to top hose connections.

9. Filling the Cooling System

Close the radiator and cylinder block taps.

Check all hose connections for tightness.

Fill up the system with soft water until the level can be seen in the header tank.

Start the engine and run until hot.

Top up the water until the level is within an inch of the bottom of the filler neck.

Screw on the filler cap, ensuring that it is firmly in position.

10. Cold Weather Precautions

It is always advisable to drain and flush the radiator before adding anti-freeze to the coolant. Check all connections for tightness.

Only antifreeze of the ethylene glycol or glycerine type should be used, as manufactured by well-known, reputable, antifreeze solution manufacturers.

A quantity of three pints of antifreeze added to the coolant will give protection down to 47° of frost (–15°F.).

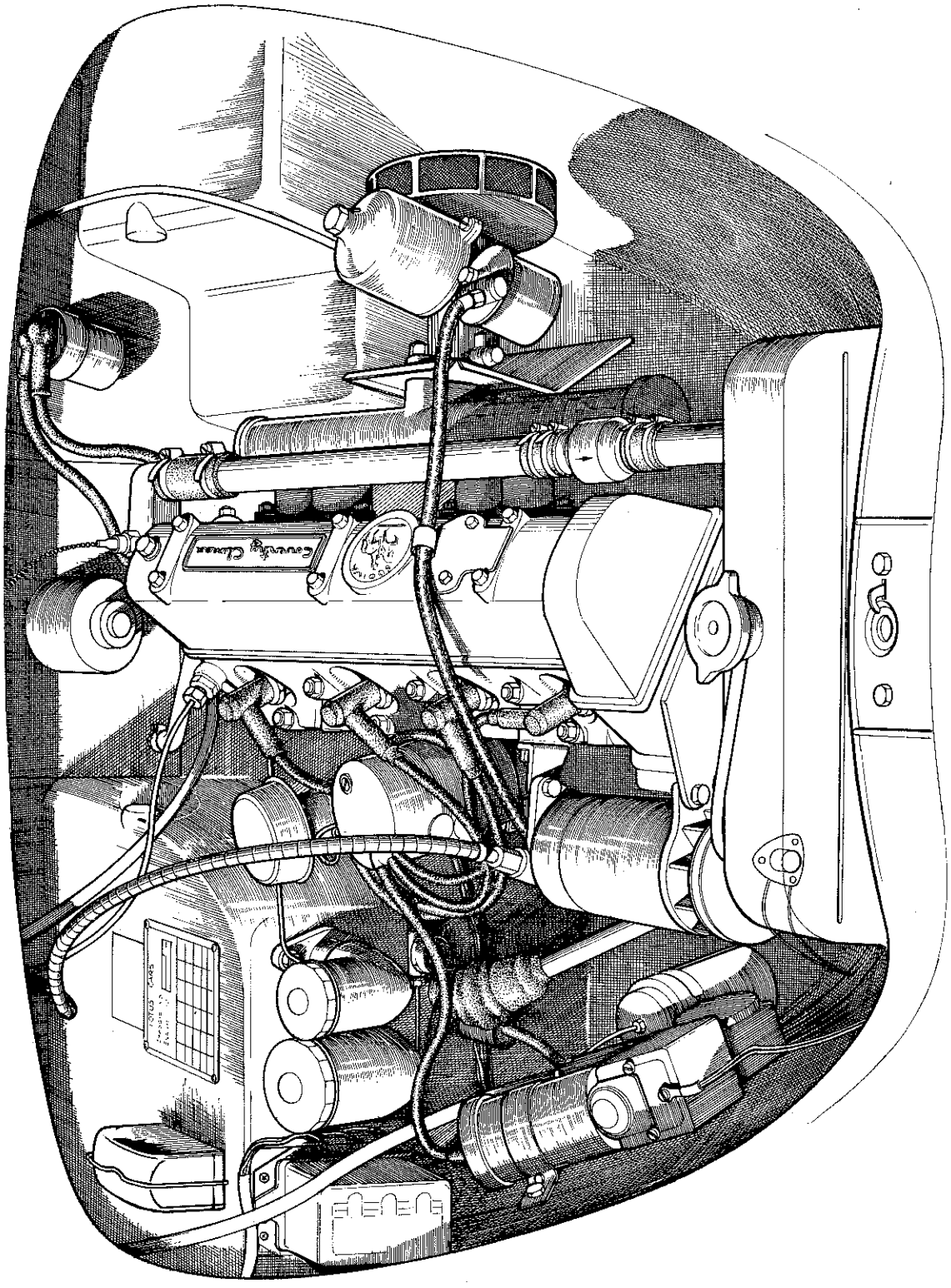
This will prevent freezing under most normal winter conditions and will counteract the artificially induced low temperature created by the ram effect of the cold air on the radiator when the car is at speed on a frosty morning.

11. Removing the Water Pump

See engine section.

SECTION F

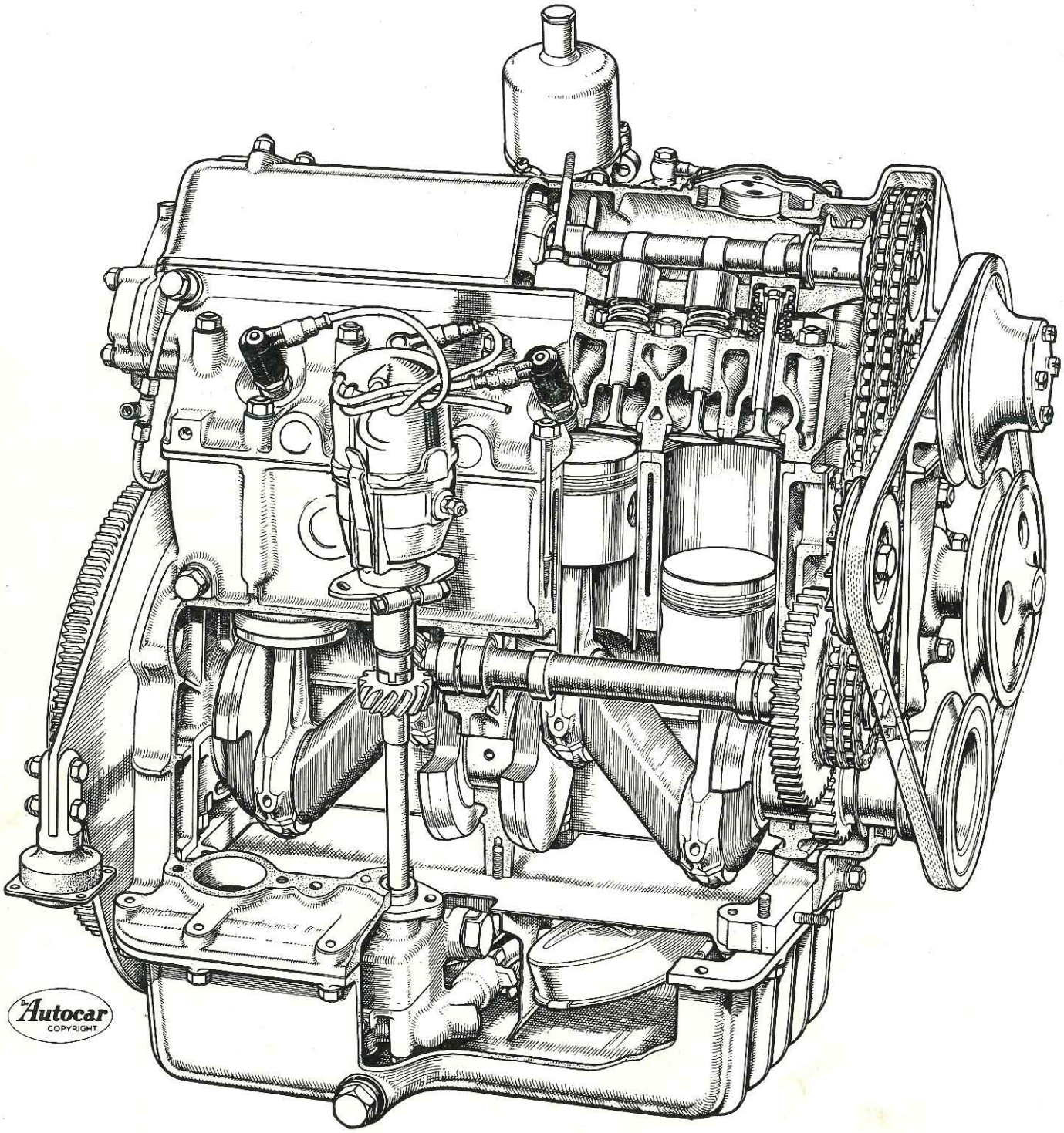
THE ENGINE



THE COVENTRY CLIMAX POWER UNIT LOTUS ELITE SERIES TWO

LEADING PARTICULARS—F.W.E. ENGINE

Engine designation	Type F.W.E.
Type of engine	4 cyl., 4 stroke, single O.H.C.
Firing order	1, 3, 4, 2.
Bore	3·0″.
Stroke	2·625″.
Capacity	1220 c.c. (74·25 cu. in.).
Weight, dry, complete	210 lbs. approx.
Compression Ratio	10 : 1.
Valve clearance, inlet and exhaust, cold	0·006″ (Inlet) and 0·008″ (Exhaust).
Valve timing	
Inlet valve opens	12° B.T.D.C.
Inlet valve closes	56° A.B.D.C.
Exhaust valve opens	56° B.B.D.C.
Exhaust valve closes	12° A.T.D.C.
	Nominal 0·01″ clearance inlet and exhaust (low lift cams).
Ignition timing	2° to 3° B.T.D.C.
Sparking plug type	Champion N-3.
Normal plug gap	0·018″.
Distributor type	Lucas D.3AH 4A.
Distributor contact breaker gap	0·014″ to 0·016″.
Dynamo type	Lucas C.39-PVR2 (Desp. No. 22258).
Starter type	Lucas M.35G (Desp. No. 25022F).
Carburettor type	S.U.H4.
Oil sump capacity	8 pints.



THE COVENTRY CLIMAX TYPE F.W.E. ENGINE

(By kind permission of "The Autocar")

GENERAL DESCRIPTION

Constructional Details

Crankshaft

The steel crankshaft has integral counterweights and is carried in steel-backed, thin strip type bearings.

Connecting Rods.

The steel connecting rods, which are split diagonally for easy removal, have lead-bronze strip type big-end bearings, while the small-ends have Clevite bushes.

Pistons.

The pistons are of aluminium and have two compression rings and one scraper ring, all fitted above the gudgeon pin. The compression rings are of the pressure-locked Dykes type, the top ones being chromium plated for wear reduction. Gudgeon pins of high-tensile steel are a push fit in the pistons and float in the small-end bushes. They are held in position by circlips.

Cylinder block.

The aluminium cylinder block, which incorporates the crankcase, is fitted with dry, renewable, slip-fit liners.

Cylinder head.

The cylinder head is of heat-treated aluminium with efficient wedge-shaped combustion chambers, giving controlled combustion, and easy-flowing ports for high volumetric efficiency.

Jackshaft.

The cast-iron jackshaft is carried in two bi-metal bearings, and is driven by the crankshaft via the crankshaft and jackshaft gears. The jackshaft incorporates a skew-gear driving the shaft operating the oil pump and distributor. In addition, a chain at its forward end is used to drive the overhead camshaft.

Camshaft.

The cast-iron, direct-acting overhead camshaft is driven from the jackshaft via a tensioned duplex chain. The tensioner is of the Weller type, and is fitted on the slack side to damp out vibration. There are three white-metal bearings for the camshaft.

Valve gear.

The steel valves work in renewable guides, and are operated by the action of the camshaft on the valve tappets, which work in guides surmounting the valve springs and are adjusted by means of shims. Austenitic steel valve seat inserts are shrunk into the cylinder head This type of valve operation ensures lack of wear in the valve guides by eliminating all side thrust, and tappet clearances are maintained over very long periods.

Flywheel.

The steel flywheel is accurately balanced and bolted to a flange integral with the crankshaft. The flywheel and rear engine mounting plate are scribed to indicate T.D.C.

Lubrication System

The gear type oil pump is mounted on the bottom of the crankcase and picks up oil from the sump via a floating pick-up filter, passing it to an externally mounted renewable element filter.

A relief valve is built into the body of the pump and passes oil which is surplus to the engine's requirements back to the inlet side of the pump. Thus, oil passes more slowly through the filter and the possibility of aeration is reduced.

From the filter, oil is conveyed by a pipe to a drilling in the crankcase, whence it passes to the oil gallery. Further drillings in the crankcase carry the oil to the three main bearings and to the external pipe which feeds the rear camshaft bearing.

The centre main bearing feeds the crankpins and lubricates the big-ends, splashed oil lubricating the cylinder walls and small-end bushes.

From the rear camshaft bearing, oil passes along the centre of the camshaft to the remaining camshaft bearings. The tappets are lubricated from a trough formed integral with the tappet guides and camshaft bearing block, so that the cams constantly dip into oil spilled from the camshaft bearings.

The oil pressure will normally be in the region of 55 lb. per sq. in., with the engine running at full speed and warmed up.

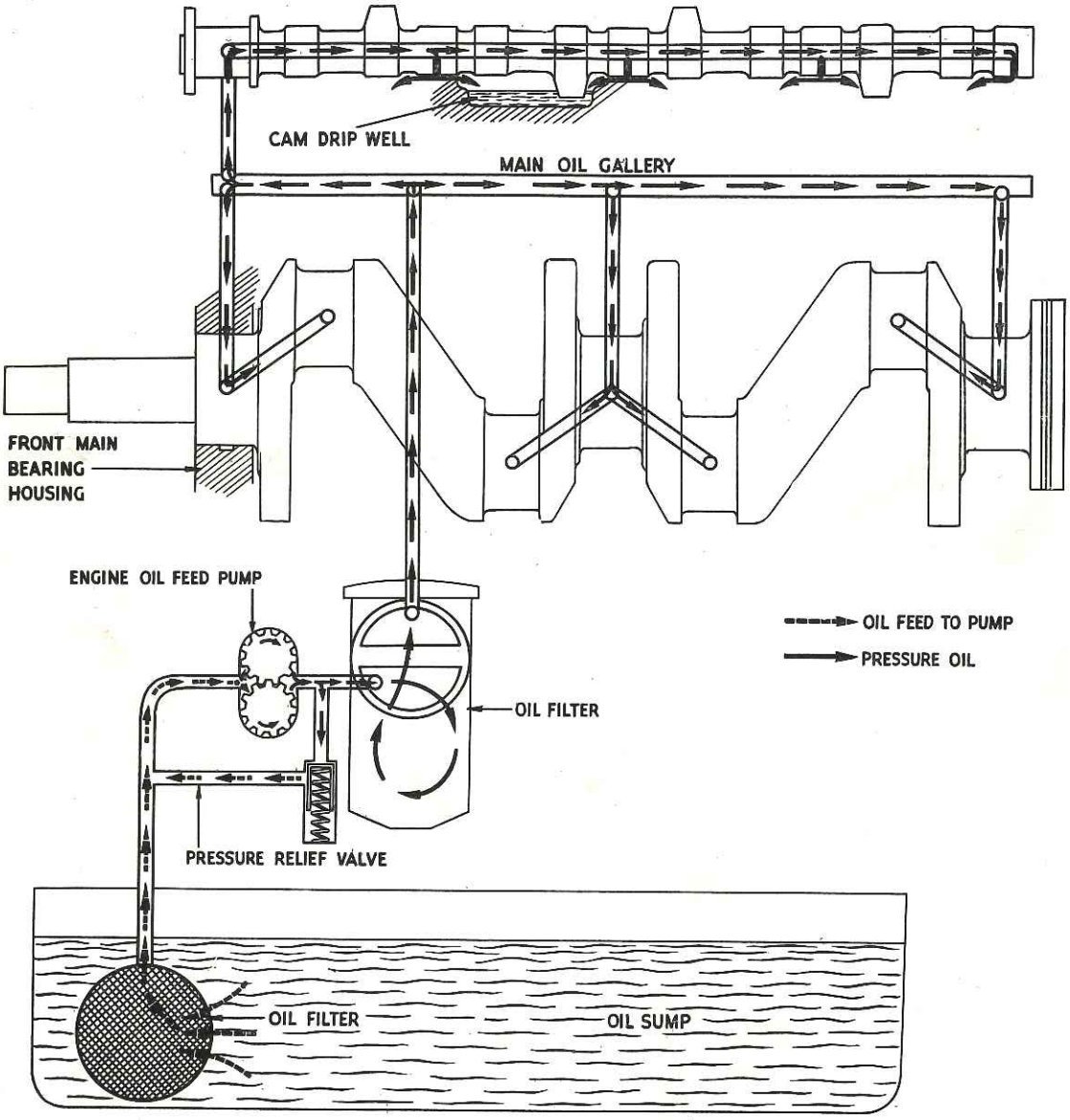
An engine breather is fitted on the oil filler tube on the side of the crankcase.

Induction System

A single $1\frac{1}{2}''$ throttle semi-down draught 'S.U.' H4 carburetter mounted on an aluminium induction pipe, is fitted as standard equipment. Carburetter needle B.F. Carburetter jet ·090″. Twin S.U. H4 carburetters and manifold are fitted to stage 11 models.

Ignition System

Ignition is by coil. A Lucas Type D.3AH 4A distributor is fitted as standard equipment.



ENGINE LUBRICATION DIAGRAM

PERIODICAL ATTENTION

(references to be found in Engine Overhaul Section*)*

1. After the First 500 Miles

Drain the oil from the sump and refill with clean oil. To do this, remove the sump drain plug, preferably with the engine warm, and drain out the old oil. Clean and replace the drain plug. Lift off the breather from either of the two oil fillers (which are situated on the cam box cover and the right-hand side of the cylinder block respectively) and add 8 pints of S.A.E. 30 oil.

Tighten the cylinder head stud nuts (see Chapter 12).

Check the valve clearances (see Chapter 9), and adjust if necessary.

Check the contact breaker gap (see Chapter 7), and adjust if necessary.

2. Every 250 Miles

Check the engine oil level. Remove the dipstick, which is mounted on the right-hand side of the cylinder block, and is marked 'High' and 'Low'. Add S.A.E. 30 oil to bring the level up to the 'High' mark. Never let the level fall below the 'Low' mark.

3. Every 1,500 Miles

Drain the engine sump and refill with fresh oil. (See 'After the first 500 miles' above.)

Purolata and Tecalemit oil filters are fitted as standard equipment.

1 CENTRAL FIXING BOLT
2 PLAIN WASHER
3 RUBBER JOINT WASHER
4 RELIEF VALVE
5 FELT CLEANING ELEMENT
6 BODY
7 CIRCLIP
8 PRESSURE PLATE
9 SPRING
10 STEEL WASHER
11 FELT WASHER
12 CIRCLIP
13 PRESSURE PLATE
14 FELT WASHER
15 RUBBER JOINT RING
16 HEAD

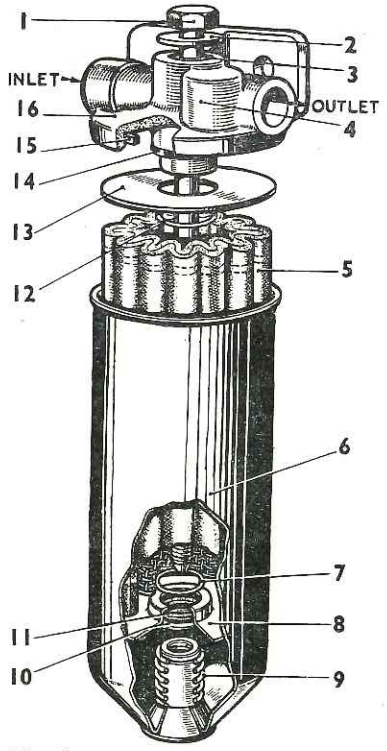


Fig. 1
The Tecalemit external oil filter

4. Every 3,000 Miles

Grease the distributor cam (see Electrical Section).

Oil the distributor shaft (see Electrical Section).

Oil the automatic timing counterweights (see Electrical Section.)

Remove and clean the sparking plugs and re-set the gaps. The normal gap is 0·018″.

Fit a new oil filter element (see Fig. 1). Two alternative types of oil filter are fitted, namely the Purolator and the Tecalemit. Ensure that the correct type of element is used. The Purolator element is No. 26A, and that for the Tecalemit bears the part No. FG. 2344.

5. Every 6,000 Miles

Remove the two breathers, swill them in a shallow bath of paraffin, and allow them to dry. The mesh of the breathers should then be slightly re-oiled with clean engine oil, allowing any surplus oil to drain off before re-fitting them.

Tighten the cylinder head stud nuts (see Chapter 12).

Check the valve clearances (Chapter 9) and adjust if necessary.

Add oil to the carburetter dashpot (see Chapter 1).

Check the contact breaker gap (see Chapter 7), and adjust if necessary.

Clean the distributor cap (see Electrical Section).

Oil the rocker arm pivot (see Electrical Section).

Check the tension of the water pump and dynamo driving belt. There should be $\frac{1}{2}$″ of free movement in the middle of the belt run. Adjustment may be made by slackening the attachment nuts and moving either the dynamo or the water pump.

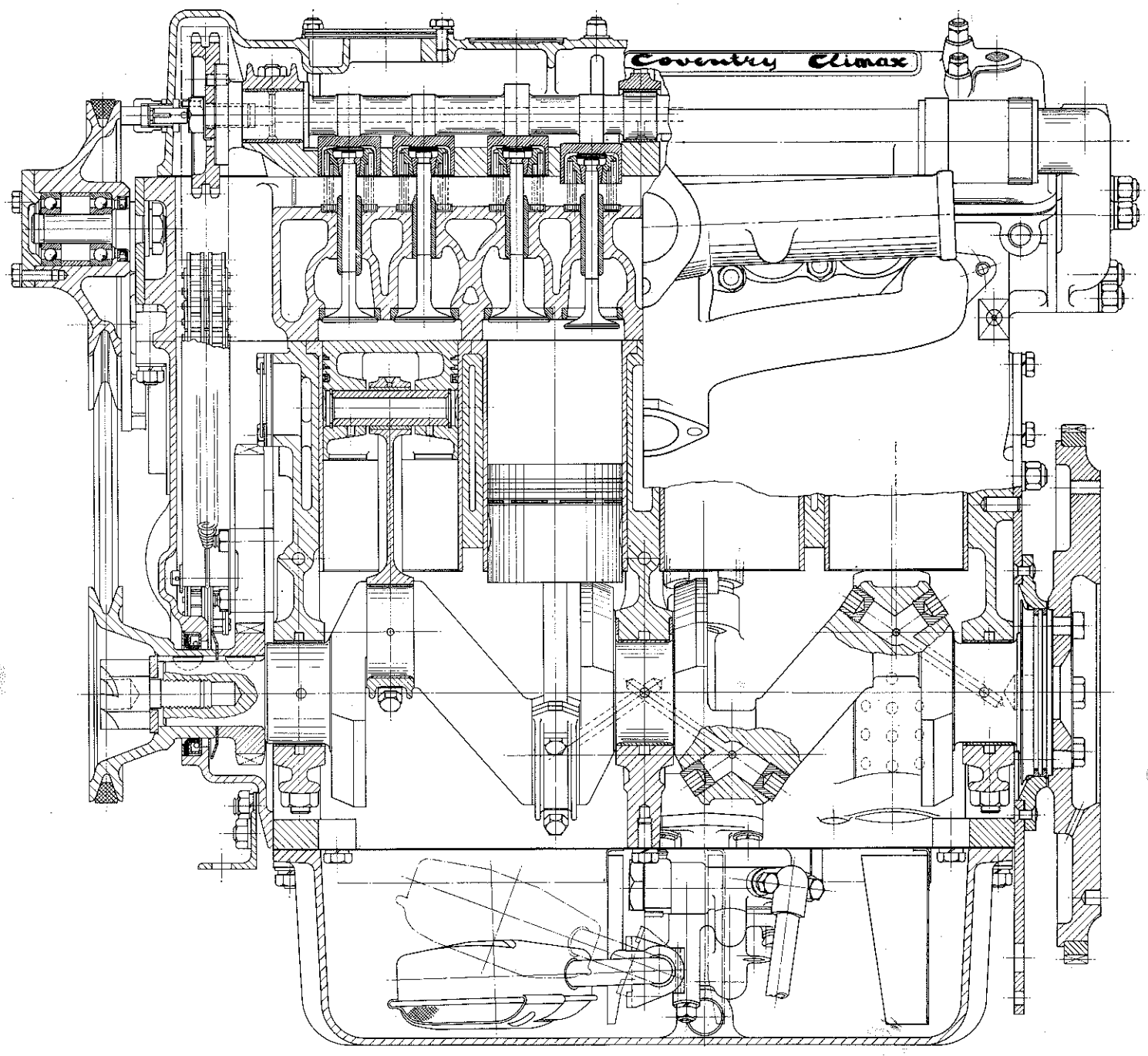
6. Every 12,000 Miles

Lubricate the dynamo bearing (see Electrical Section).

Remove and clean the sump (see Chapter 16).

Check the dynamo and starter brushes (see Electrical Section).

Fit new sparking plugs.



The Coventry Climax Engine in Section

ENGINE OVERHAUL

1. Carburetter—Maintenance Attention

The S.U. carburetter is of the controllable jet type. This carburetter is fitted with a damper, which consists of a plunger and non-return valve attached to the oil cap nut. The damper operates in the hollow piston rod, which is partly filled with oil, and its functions are to give a slightly enriched mixture on acceleration by controlling the rise of the piston, and to prevent piston flutter.

Approximately every 6,000 miles the carburetter oil cap should be unscrewed and a small quantity of light machine oil poured into the dashpot.

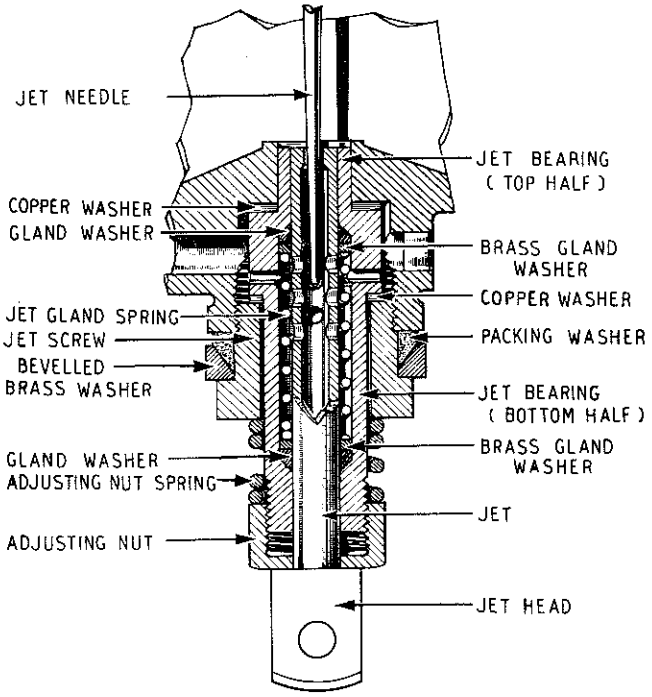


Fig. 1
An enlarged view of the jet assembly

2. Single Carburetter Adjustments

The carburetter should be checked to ensure that the piston is perfectly free and the jet is correctly centred.

Run the engine until it attains its normal working temperature.

Adjust the throttle abutment screw to such a position that the engine idles at a moderate speed.

Adjust the jet to give a richer mixture by screwing the jet adjusting nut upwards, still keeping the jet head in contact with it, until the mixture is obviously too rich, as indicated by "hunting" and a sooty exhaust. Then, screw the adjusting nut upwards, still keeping the jet head in contact with it, until it brings the jet to the position where the engine idles with an even exhaust and runs at the best possible speed for the throttle openning.

Test for correct mixture by lifting the piston with a $\frac{1}{32}$" rod so that it rests on the rod. When this is done the engine should run slightly faster.

If it runs appreciably faster and continues to do so when the piston is further lifted, the mixture is too rich.

If the engine stops when the piston is lifted the mixture is too weak.

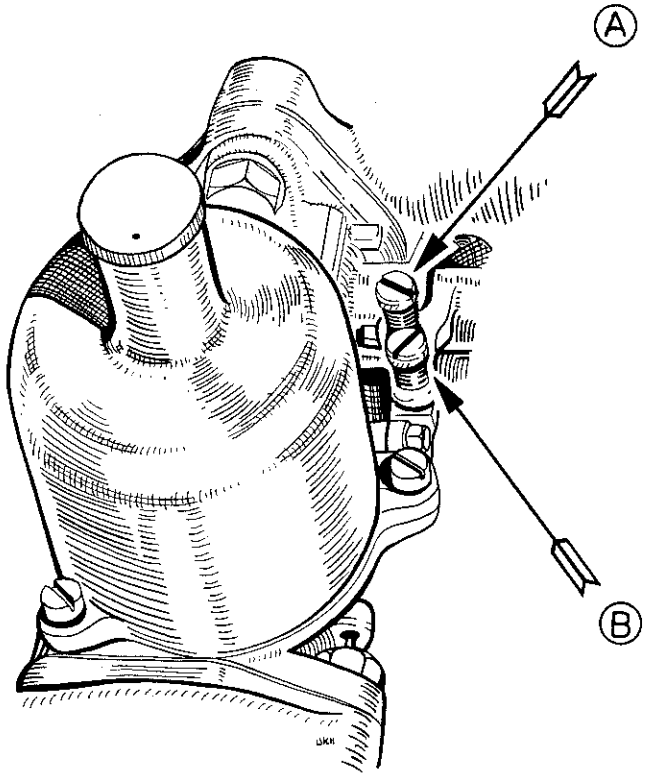


Fig. 2
(A) is the screw which adjusts the degree of interconnection between the mixture control and throttle, and (B) regulates the idling speed

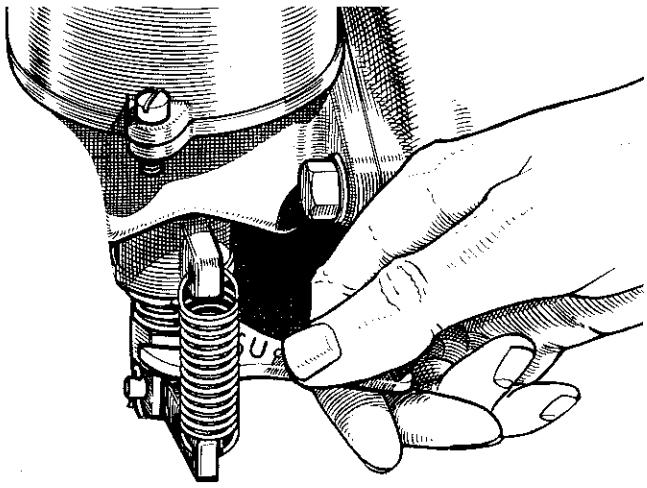


Fig. 3
Adjusting the jet

3. Defects in Operation

In the case of unsatisfactory behaviour of the engine, before carrying out a detailed examination of the carburetter check that the trouble is not due to one of the following points:

i. Ignition fault, such as incorrect contact breaker gap or dirty or pitted points.

ii. Loss of compression on one or more cylinders.
iii. Incorrect plug gaps or dirty or oily plugs.
iv. Sticking valves.
v. Worn inlet valve guides.
vi. Defective fuel pump or choked filter.
vii. Damage at joint between carburetter and manifold or between manifold and cylinder head.

If none of the above defects is present to any great degree the carburetter should be examined for the following possible faults:

(1) *Piston Sticking.*

The piston assembly consists of a suction disc and piston forming the choke, into which is inserted the jet needle. This engages in a bearing in the centre of the suction chamber and in it is inserted the jet needle. The piston rod running in the bearing is the only part which is in actual contact with any other part, the suction disc, piston and needle all having suitable clearances to prevent sticking.

If sticking does occur, the whole assembly should be cleaned carefully and the piston rod lubricated with a drop of thin oil. No oil must be applied to any part other than the piston rod. In order to ascertain whether the piston is sticking, remove the dashpot damper by unscrewing it, insert a finger into the air intake and lift the piston. It should come up quite freely and fall back smartly on to its seating when released. On no account should the piston return spring be stretched or its tension altered in an attempt to improve its rate of return.

(2) *Incorrectly centred jet.*

It is essential for the correct functioning of a carburetter that the jet is correctly centred, *i.e.* that it is not eccentric to the jet aperture in the carburetter body. Eccentricity may cause sticking of the piston.

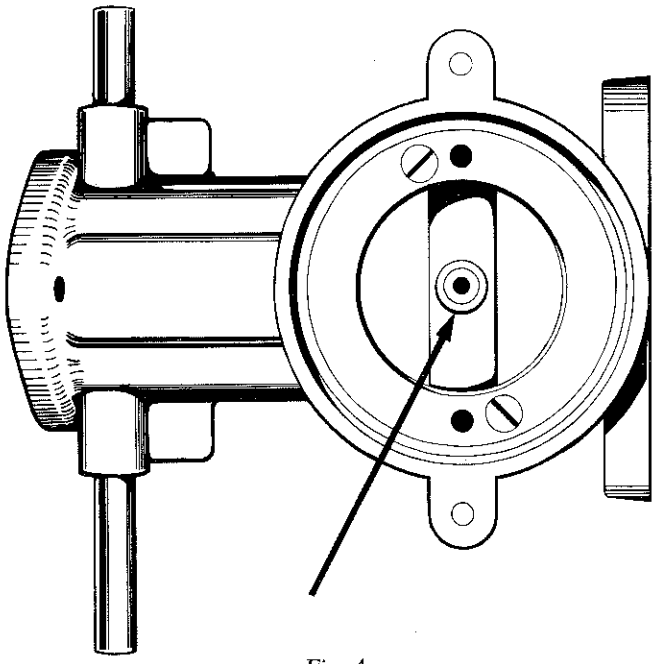


Fig. 4
An incorrectly centred jet

To centre the jet, remove the clevis pin at the base of the jet which attaches the jet head to the jet operating lever. Withdraw the jet completely and remove the adjusting nut and the adjusting nut spring. Replace the adjusting nut without its spring and screw it up to the highest position. Slide the jet into position until the jet head is against the base of the adjusting nut. When this has been done, feel if the piston is perfectly free by lifting it up with the finger, with the dashpot piston removed. If it is not free, slacken the jet holding screw and manipulate the lower half of the assembly, including the projecting part of the lower half jet bearing, adjusting nut and jet head. Make sure that this assembly is now slightly loose. The piston should then rise and fall quite freely, as the needle is now able to move the jet into the required central position. The jet holding screw should now be tightened and a check made to determine that the piston is still quite free. If it is found to be not so, the jet holding screw should be slackened again and the operation repeated.

When complete freedom of the piston is achieved the jet adjusting nut should be removed, together with the jet, and the spring replaced. The adjusting nut should be screwed back to its original position.

(3) *Float chamber flooding.*

If this occurs, petrol flows over the float chamber and drips from the air inlet. It is generally caused by grit between the float chamber needle and its guide. To cure it, remove the float chamber lid and clean the needle and guide.

(4) *Water or dirt in carburetter.*

A blockage due to water or dirt in the carburetter can very often be cured by starting the engine, opening the throttle and blocking up the air inlet momentarily without shutting the throttle, keeping it open until the engine starts to race.

Should the above method not clear it, the only alternative is to remove the jet. This, however, should on no account be done unless it is absolutely necessary, as the jet has to be carefully centred when re-fitting (see (2)).

(5) *Float needle sticking.*

If the engine stops, apparently through lack of fuel, when there is plenty of fuel in the tank and the pump is working properly, the probable cause is a sticking float needle. An easy test for this is to disconnect the pipe from the fuel pump to the float chamber, and to turn the engine over and check if fuel is delivered: if it is, starvation has almost certainly been caused by the float needle sticking to its seating. The float chamber lid should be removed and the needle and its seating cleaned and re-fitted. At the same time it will be advisable to clean out the entire fuel feed system, as this trouble is caused by foreign matter in the fuel, and unless this is removed it is likely to recur.

(6) *Leakage from jet bottom.*

If persistent slow leakage is observed in the neighbourhood of the jet head, it is probable that the jet gland washer and its lower counterpart, together with the

locking screw washer, require renewal. To do this, the jet lever should first be detached from the jet head, the locking screw removed, and the entire jet and jet bush assembly removed. On re-assembly, great care should be taken to ensure that all parts are replaced in their correct positions.

Re-centring the jet will, of course, be necessary after this operation.

(7) *Sticking jet.*

Should the jet and its operating mechanism become unduly resistant to the action of lowering and raising by means of the enrichment mechanism, the jet should be lowered to its fullest extent, and the lower part thus exposed should be smeared with petroleum jelly or similar lubricant. Oil should also be applied to the various linkage pins in the mechanism, and the jet raised and lowered several times in order to promote the passage of the lubricant upwards between the jet and the surrounding parts.

4. Changing a Needle

Should it be necessary to change a needle, this can be done by removing the three screws holding the suction chamber, and lifting off the suction chamber after marking its position to ensure that it is re-fitted in its original position. The piston and return spring can now be removed. At the side of the piston will be found a set-screw. When this is slackened off the needle can be withdrawn, and the new needle fitted. The correct position of the needle is with the shoulder flush with the face of the piston. Figure 5 shows the correct position for the two types of needle which are in use.

When replacing, care should be taken that the key-way at the side of the piston registers with the key in the body, and that the return spring is fitted correctly. Great care should also be taken to see that all machined faces and parts are kept scrupulously clean.

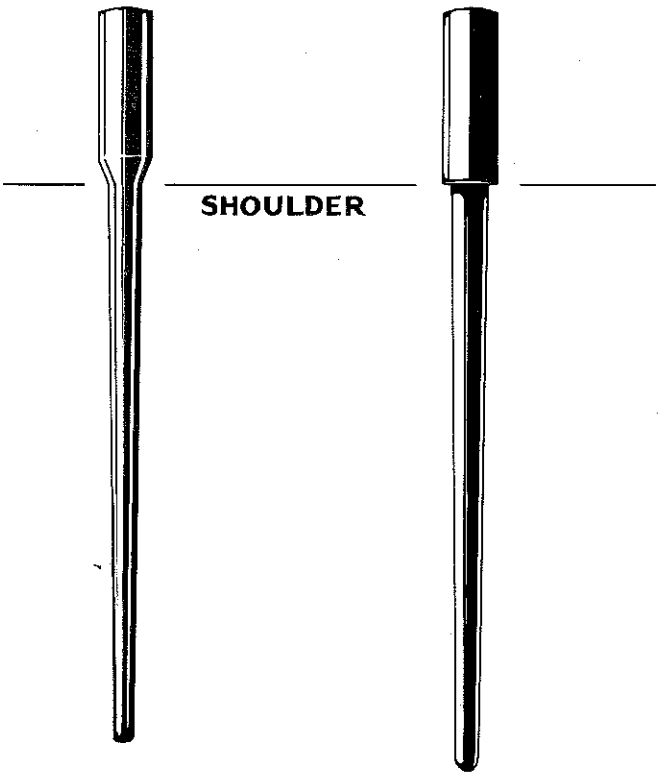


Fig. 5
The shoulder of the needle should be flush with the under face of the piston. Two types of shoulder are in use, and the correct datum point for each is shown

Twin Carburetter Adjustments, etc.

(See Stage Two Tuning).

5. Carburetter—Removing and Replacing

To remove the carburetter, disconnect the throttle and choke cables.

Disconnect the petrol line at the union.

Undo the two nuts securing the carburetter to the manifold and remove carburetter off the studs.

Before re-fitting the carburetter renew the joint washers if they are imperfect.

6. Induction Manifold—Removing and Replacing

To remove the induction manifold, first remove the carburetter (Chapter 5.) Take off the six securing nuts and washers and lift off the induction manifold. This will expose the two joint washers.

When replacing the induction manifold, make sure that the joint washers are in perfect condition, and that air leaks cannot occur.

7. Distributor—Removing and Replacing

To remove the distributor, disconnect the plug leads from the plugs and remove the two nuts, bolts and washers securing the distributor securing plate to the distributor mounting bracket. The distributor may then be lifted out. Note the felt washer in the mounting bracket.

The driving dog on the distributor shaft and the recess for it in the distributor and oil pump drive shaft are off-set so that the distributor can be reconnected to the drive shaft in one way only.

When replacing the distributor, insert the felt washer (fitting a new one if necessary) into the mounting bracket and replace the distributor, which will go into position without difficulty if it is being replaced with the driving dog and its recess in their correct relative positions. Re-fit the attachment nuts, bolts and washers and tighten.

If the distributor securing plate has not been removed or any part of the distributor mechanism disturbed, the ignition timing will still be approximately correct, and the timing may be finalised as follows:

Ensure that the distributor points are set to the correct gap (see Electrical Section) and turn the engine clockwise until the T.D.C. mark on the flywheel is level with the mark on the engine mounting plate. In this position both the T.D.C. mark on the flywheel is level with the mark on the engine mounting plate. In this position both No. 1 and No. 4 pistons are on T.D.C., but one is at the end of its compression stroke and the other at the end of its exhaust stroke. The position required for timing is with No. 1 cylinder on compression, *i.e.* with its valves closed. If necessary, turn the engine 360° to obtain this condition.

Now turn the flywheel clockwise until it is at 6 to 7° before T.D.C., which corresponds to a distance of 0·600″ along the periphery of the flywheel. Slacken the distributor securing plate clamp bolt, remove the distributor cap and turn the distributor body until the points are just about to open with the rotor arm pointing to No. 1 pick-up point. Tighten the clamp bolt. Re-connect the plug leads. Alternatively, this adjustment may be obtained by slackening the screws attaching the securing plate to the mounting bracket. The holes in the securing plate are elongated and allow 7½° of adjustment to be made.

For the maximum power output from the engine, the actual ignition timing required may be anything from 2 to 7° B.T.D.C. The optimum figure may be ascertained on the test bed.

(Contact breaker gap 0·014″ to 0·016″).

For **Routine Maintenance, etc.** see Electrical Section.

8. Cam Box Cover—Removing and Replacing

To remove the cam box cover, undo the six Nyloc nuts, which have plain washers. The cam box cover may then be removed.

When replacing the cover, fit a new joint washer if necessary. Clean the joint surfaces but do not use grease or jointing compound.

The oil filler is secured to the cam box cover by three bolts and spring washers, one of which also secures the breather chain. If the oil filler is removed, a recess in the cover holding a set of grease-packed shims will be revealed (see Chapter 11).

9. Valve Tappet Clearance—Checking

To check the valve tappet clearance, first remove the cam box cover as in Chapter 8.

A feeler gauge may then be inserted between the cams and the valve tappets in order to measure the clearances, which must be 0·006″ for all valves.

When measuring the tappet clearances ensure that the correct gap is obtained by turning the engine until the valve being worked on is at the bottom of its travel, and then turning the engine one complete revolution.

Make a note of the clearance for each valve in turn. Owing to the method of valve operation featured on the engine, it will run for long periods without the need for tappet adjustment, but should adjustment be necessary the procedure outlined in Chapter 11 must be followed.

10. Camshaft and Tappet Block—Removing and Replacing

The camshaft must be removed before the tappet block can be taken off. To remove the camshaft, first take off the cam box cover (Chapter 8), and then knock back the tabwasher on the camshaft sprocket. Remove the bolt attaching the sprocket to the camshaft and move the sprocket clear. Unscrew the six nuts and spring washers and lift off the camshaft bearing caps. The camshaft may now be removed.

All the camshaft bearings are located in position by tags, ensuring that they are assembled correctly.

The tappet block is secured by eight nuts and spring washers and may be lifted off after these have been removed. Leave the valve tappets resting on top of the valve spring assemblies. If they are taken off for any reason, take great care to put them on one side in a particular order so that it is known to which valve each tappet belongs, and so that each tappet retains its own shim.

Note that there is a dowel locating the tappet block, and also a connecting sleeve. The connecting sleeve is hollow to allow the passage of oil, and has a sealing ring.

When replacing the camshaft and tappet block, reverse the above procedure. Do not forget the dowel, connecting sleeve and sealing ring. Fit a new camshaft sprocket bolt tabwasher. Re-tighten the camshaft bearing cap nuts with a torque spanner to 160 to 180 lb. ins., and the tappet block holding down nuts to 130 to 140 lb. ins.

Before re-fitting the cam box cover, check the valve timing as in Chapter 25.

11. Valve Tappet Clearance—Adjusting

The valve tappet clearances are set during manufacture by the fitting of special shims between the valve stems and the valve tappets. If adjustment is necessary during service, different sized shims should be fitted under the appropriate tappets to correct the clearances. For this purpose, a set of shims from 0·096″ to 0·104″ in thickness is supplied packed into a recess in the cam box cover (see Chapter 9).

A typical example of valve adjustment is as follows: When measuring the clearance of a valve it was found to be 0·005″, and the shim fitted to the valve tappet was 0·099″. Therefore, to bring the clearance to its correct value, which is 0·006″ for all valves, the shim must be replaced by one of 0·098″. Thickness of new shim required=Old valve clearance + % Thickness of old shim — Correct valve clearance.

It may be found when calculating the thickness of shim required that a shim thinner than 0·096″ is needed. In this case the correct shim should be obtained from Coventry Climax Engines Limited, who will supply shims in thicknesses down to 0·075″ in steps of 0·001″.

If it is inconvenient to obtain the correct shims from the above source, it is permissible to grind the existing shims down to the required thickness, providing that equipment is available to do so accurately to a finish of 15 to 20 micro inches. It must be noted that in no circumstances must shims be ground to less than 0·075″ in thickness.

In the absence of suitable equipment to carry out the above operation, the valves stems may be ground to give the correct clearances. The end faces of the stems must be square to the axes and of fine ground finish. The valves can be removed for this purpose as in Chapter 13.

12. Cylinder Head—Removing and Replacing

Before removing the cylinder head, ensure that there is no water in the cooling system. There are two drain plugs, one on the cylinder block near the oil filler, and the other at the bottom of the water pump body.

Remove the carburetters (Chapter 5), the induction pipe (Chapter 6) and the cam box cover (Chapter 8). Take off the water outlet pipe, which is secured by nuts, spring washers and plain washers, and the outlet joint washer. No jointing compound or grease is used on this joint. Remove the belt which drives the water pump and dynamo, and take out the three nuts and bolts and remove the dynamo.

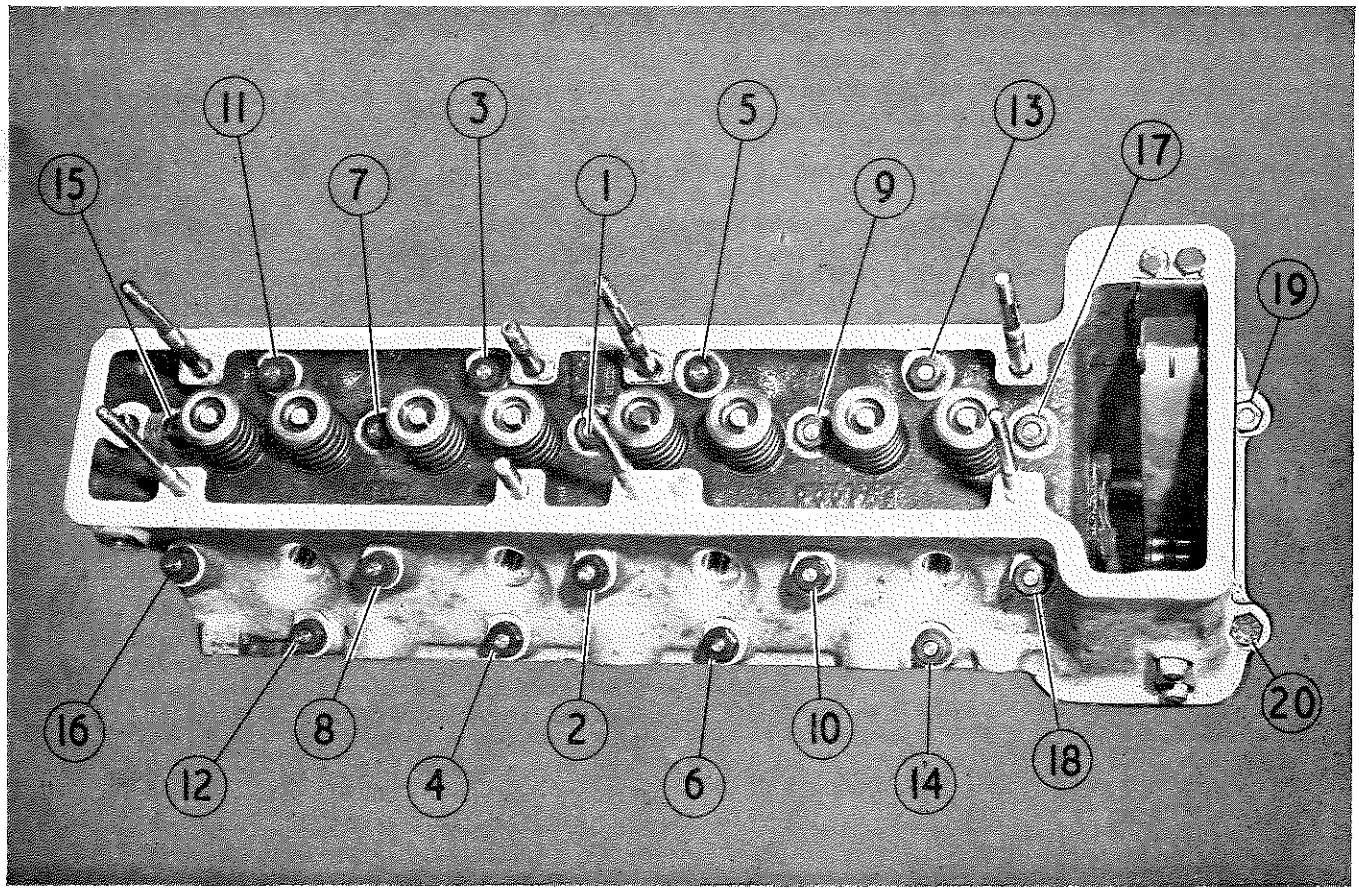


Fig. 6 The order of tightening the cylinder head stud nuts

Unscrew the banjo bolts from the camshaft feed oil pipe and the cylinder head oil drain pipe, and move the pipes clear.

Remove the camshaft and tappet block (Chapter 10). Remove the nuts and spring and plain washers from the two studs attaching the cylinder head to the timing cover. Slacken the eighteen nuts and plain washers on the remaining cylinder head studs, a turn at a time.

Remove the nuts when loose, and gently tap the cylinder head with a mallet to break the joint. When it is loose, lift it off. There is no need to remove the chain tensioner shoe runner or the timing chain damper unless they are to be renewed.

When replacing the cylinder head, reverse the above procedure. Fit a new gasket if the old one is dented, scratched or broken. Clean the jointing surfaces and give a thin coat of jointing compound. Re-tighten the cylinder head nuts in the order shown in Fig. 6, a turn at a time, finishing with a torque spanner giving 240 to 250 lb. ins.

13. Valves—Removing and Replacing

Remove the cylinder head as in Chapter 10. The valves may be removed by means of a valve spring compressor, which should bear on the valve head and the valve spring collar. Compress the valve spring and take off the valve cotters, which will enable the valve, valve spring, valve spring collar and valve spring cup to be removed.

Before replacing the valve springs it is most important to check them for loss of efficiency. This is done by applying varying loads to the springs to ascertain what load is required, in the case of the outer springs, to compress each of them to 0·910″ overall length. If the load required is less than 60 lb., then the valve spring in question must be renewed. In the case of the inner springs, find the load required to compress them to 0·686″ length. If the load required is less than 20 lb., renew the spring in question.

The valves must be fitted into their original guides, and for identification purposes they are numbered 1 to 8 commencing at the timing end. If one of the valves is renewed, stamp the correct number on the new valve before fitting it.

Replacement is a reversal of the method of removal, the valve stems being smeared with grease or oil before re-fitting. A little thick grease placed on the valve stems will be of assistance when the cotters are being replaced.

14. Valve Guides—Renewing

Owing to the fact that the pressure exerted on the valve stems by the valve operating mechanism is devoid of side thrust, it is extremely unlikely that enough wear will take place to necessitate the valve guides being renewed.

In the unlikely event of renewal being necessary, the worn guides should be removed with the aid of a drift, which must be approximately 0·5″ in diameter in order to pass through the valve guide bore in the cylinder head. It is an advantage for the drift to have a spigot 0·3″ in diameter on its end to locate in the valve guide. The guide will come out more easily if the head is heated to about 150°C.

It is also necessary to heat the cylinder head to 150°C. in order to fit the new guides. The inlet guides are shorter than the exhaust guides and their chamfered ends are fitted uppermost. A special location bar, part No. MT.282 may be obtained from Coventry Climax Engines Limited. This is in the form of a shouldered drift which ensures that the guides are inserted into the head with the correct amount of projection, which is 0·350″ above the machined recess in the cylinder head into which the valve spring cup fits.

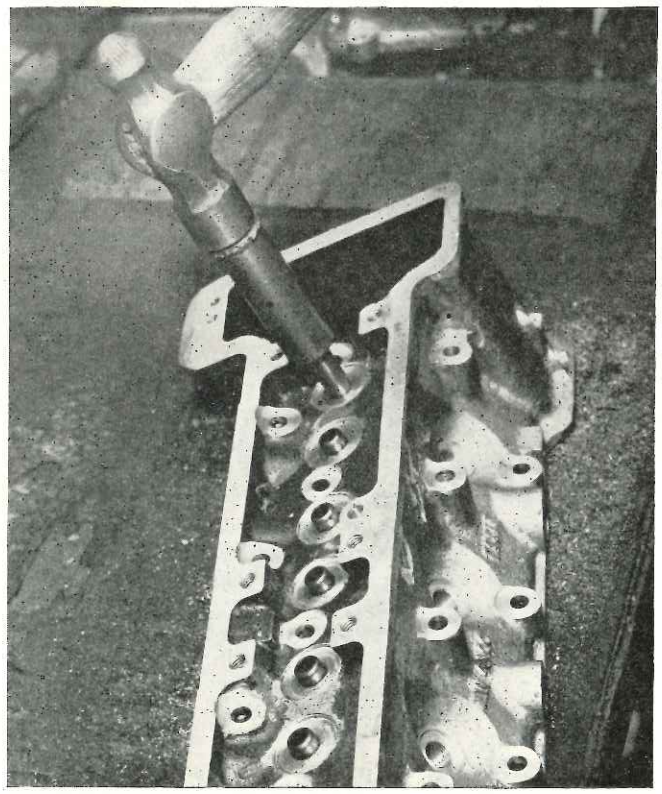


Fig. 7
Fitting the valve guides, using tool No. MT.282

5. Decarbonising

When decarbonising the engine, remove the cylinder head (Chapter 12) and the valves (Chapter 13).

Remove and clean the sparking plugs and set the gaps to 0·018″. Fit new gas-tight copper washers.

Carefully clean the old jointing compound from the joint surfaces.

Scrape away all carbon from the inner side of the cylinder head, using a blunt tool. Do not use emery cloth. Polish the combustion chambers and ports with metal polish.

Turn the engine to bring two of the pistons to the top of their travel and put rag in the other two cylinders and the waterways to keep out carbon dust. Scrape the piston crowns with a blunt tool—do not use emery cloth —and polish with metal polish. Leave a ring of carbon for approximately $\frac{1}{8}$″ round the outside of the piston crowns. An old piston ring placed on top of the piston will facilitate this. Turn the engine half a revolution and repeat this procedure on the other two pistons.

Clean the carbon dust from the valve guides and the cylinder head.

To grind in the valves, smear a little grinding paste on the face of the valves and then rotate them backwards and forwards by means of a suction-type valve-grinding tool. As soon as an even, matt-surfaced appearance is obtained, stop grinding. Any distorted or badly pitted valve must be renewed. After grinding, wash the valves with paraffin and clean out the ports with a rag moistened with paraffin. Great care must be taken not to leave grinding paste or carbon in the ports, valve guides or cylinder head. If the valve seats are very badly pitted, they may be trued by the use of valve seat cutters. A 30° cutter is needed for the inlet valves and a 45° cutter for the exhaust valves, mounted on a $\frac{5}{16}$″ mandrel in both cases.

Fit a new cylinder head gasket, using a little jointing compound.

Replace the vales and cylinder head as described in Chapters 12 and 13, checking and if necessary adjusting the tappet clearances.

When re-starting the engine, it is a good idea to run it at idling speed for about a minute before re-filling the cooling system with water. This will prevent water leaking past the gasket before it has a chance to expand and bed down.

When the engine has run for about 30 minutes, stop it and tighten all cylinder head nuts.

After a few hours running, check the tappet clearances, as the valves have a tendency to bed down after the engine has run for a time.

16. Sump—Removing and Replacing

Before removing the sump, drain the oil system. Take off the fifteen nuts, plain washers and spring washers. The sump may then be removed.

Before replacing the sump, clean the drain plug and wash the sump in paraffin and dry thoroughly. Fit a new joint washer if necessary.

17. Oil Pump—Removing and Replacing

To remove the oil pump, first take off the sump as in Chapter 16.

Remove the two bolts, spring washers and plain washers from the flange at the oil pump end of the pipe which connects the oil pump to a connection on the cylinder block for the external oil filter. Remove the two nuts and spring and plain washers securing the oil pump to the cylinder block, and lift off the pump and floating filter.

To take off the floating filter, remove the split pin.

To remove the oil sump tray, first slacken the nuts and bolts securing the pipe which connects the oil gallery to the connection for the external filter. Take out the five bolts (and spring washers) and remove the tray.

Re-fitting the tray and pump is a reversal of the above procedure, but the floating filter should be cleaned in paraffin and thoroughly dried before replacement.

18. Oil Pump—Maintenance Attention

To dismantle the oil pump, remove the four nuts, spring washers and plain washers, and lift off the pump cover, exposing the driving and driven gears, which may be lifted out.

If the bushes in the pump body and cover are badly worn, push them out and insert new ones. The cover bush must be reamed in position to 0·4724″ to 0·4735″ dia., and the body bush to 0·7188″ to 0·7198″ dia.

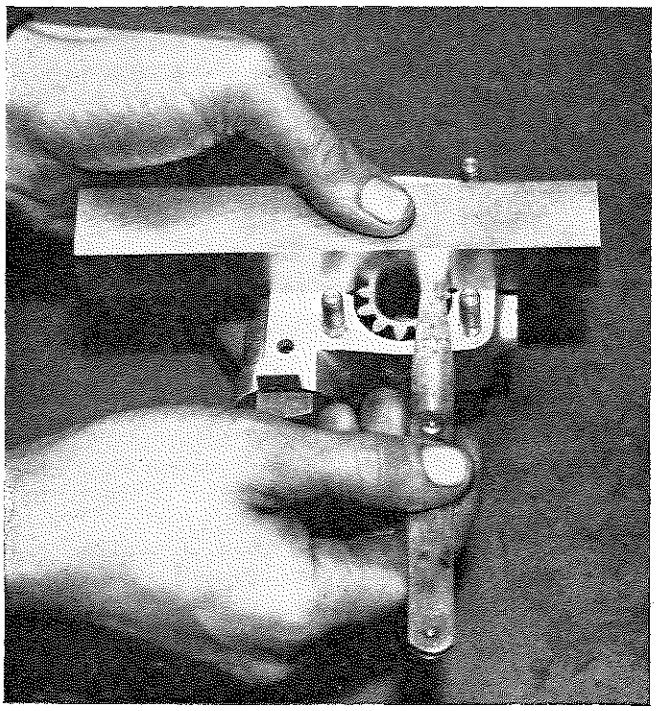


Fig. 8
Checking the oil pump gear end clearance

Measure the clearance between the pump gears and the cover by placing a straight-edge across the body, with the gears in position, and using a feeler gauge. If this clearance exceeds 0·009″, a new pump body must be fitted.

If the gears have worn appreciably into the cover, the cover must be renewed.

Try the fit of the driven gear on the idler shaft, and if it is looser than a normal running fit, examine the idler shaft and driven gear for wear. If the idler shaft is worn, knock out the Mills pin from the pump cover in the direction away from the end of the cover bearing the cover plug. Fit a new shaft and Mills pin, inserting the pin towards the end bearing the cover plug.

The relief valve assembly may be taken out after removing the spring abutment plug. The relief valve plunger should be a free fit in the pump body, and as long as its shoulder is seating correctly it need not be renewed, even if it is a fairly loose fit.

It is extremely unlikely that the relief valve spring will need attention, since it is very lightly loaded, but in the event of failure having taken place, fit a new one.

Before re-assembling the pump, clean all the components.

When tightening the four cover nuts, it will be found helpful if the oil pump and distributor drive shaft is inserted into the driving gear. It may then be used to turn the gears and ensure that they are free to rotate.

19. Water Pump—Maintenance Attention

The water pump may be removed from the engine as described in Chapter 24.

It is unlikely that any attention will have to be given to it, but if after very long periods of service the water pump seal becomes ineffective, water may leak out through the hole in the bottom of the bearing housing. In this case, the pump may be dismantled as follows:

Remove the three nuts, plain and shakeproof washers and separate the pump body from the bearing housing. Note that two of the bolts attaching the body to the bearing housing are dowel bolts, and that the remaining bolt goes into the hole between these two.

Pull off the water pump pulley, which is pressed on to the bearing shaft. This will give access to the bearing locating screw, which must be removed. The bearing unit may then be drifted out from the impeller sufficiently to enable a puller to be put under the impeller to pull it off. This will reveal the seal.

When the pump is dismantled, it is advisable to check the bearing for play. It is pre-packed with grease and does not require further lubrication, but should it be faulty, fit a new complete bearing and shaft unit.

When re-assembling the pump, first clean the casting flanges. Insert the bearing unit into the bearing housing so that the hole in it for the locating screw lines up with the hole in the bearing housing. Fit the seal over the bearing shaft, and press the impeller on. When fitted, the edge of its boss must be level with the end of the shaft. Screw in the locating screw. Press the pulley on so that its end is level with the end of the shaft, and check that the assembly will rotate freely.

Re-fit the bearing housing to the pump body, fitting a new joint washer. Use a little jointing compound. Fit and tighten the three nuts and washers.

20. Removing Engine, Clutch and Gearbox from the Chassis

Engine, clutch and gearbox are removed as one unit from the chassis.

Undo two bolts on each bonnet hinge bracket and remove bonnet from the car.

Disconnect the battery.

Drain water and gearbox oil.

Remove radiator, top and bottom water pipes.

Disconnect exhaust pipe at the manifold.

Remove starter lead from the solenoid, dynamo leads distributor lead and earth wire from the rear of the engine.

Disconnect oil pressure line at the engine and the fuel line at the pump.

Disconnect water thermometer capillary.

Undo the two clutch slave cylinder retaining bolts and move it on to one side.

Remove front engine mounting bolts and gearbox mounting bolts.

Remove gear lever and hoist engine forwards and upwards out of the engine bay.

When engine is clear of the bay disconnect speedometer cable from the gearbox.

21. Separating the Gearbox

With the engine, clutch, gearbox unit on the bench undo 2 × $\frac{3}{8}$″ nuts and bolts holding the starter motor in position and remove starter

Undo 6 bolts holding the gearbox to the engine mounting plate.

Pull tne gearbox straight back. Take care to keep the box in line with the engine until the clutch shaft is free of unit.

centre. Turn the crankshaft 180° and repeat this procedure on the other two big-ends.

The connecting rods and pistons may now be withdrawn upwards through the liners, or alternatively may be taken out complete with the cylinder liners, as follows:

Using a soft metal drift, tap the lower ends of the liners to lift their upper flanges clear of the cylinder block. The liners may now be lifted out, complete with the pistons and connecting rods.

With the aid of a cylinder gauge, check the cylinder liner bores and if the diameter at any point throughout the length of piston travel exceeds 2·858″, a new liner will be required. For details of fitting new pistons, see Chapter 23.

To replace a connecting rod, piston and liner, place the piston and connecting rod in the liner, and insert as

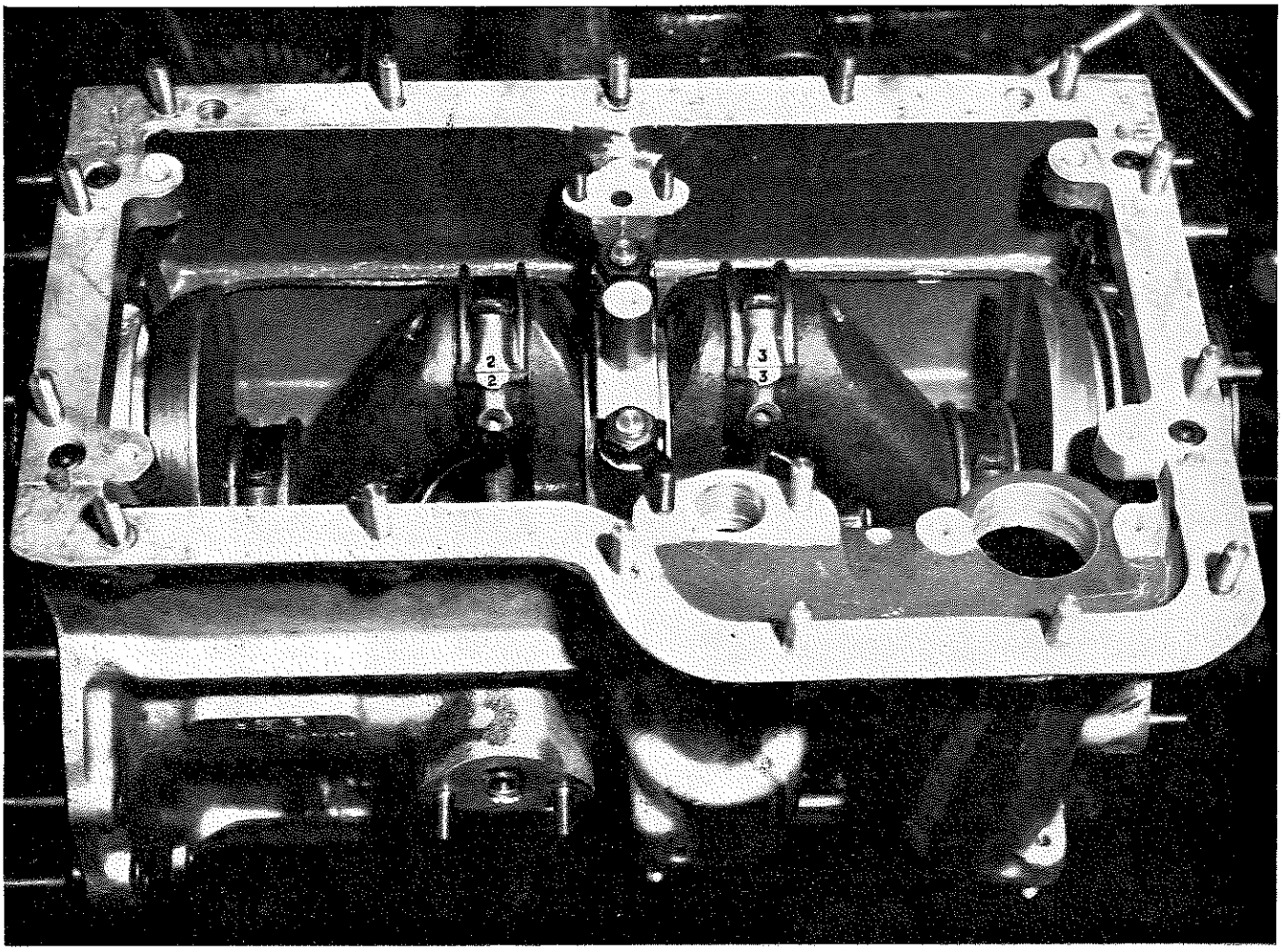


Fig. 9 The crankcase, showing the big-end markings

22. Cylinder Liners, Pistons and Connecting Rods—Removing and Replacing

Take off the cylinder head (Chapter 12), sump (Chapter 16) and oil pump (Chapter 17).

Turn the crankshaft to bottom dead centre on two of the pistons. Knock back the tabwashers and undo the big-end bolts on the two connecting rods at bottom dead

an assembly from the top of the cylinder block. Drive home with a wooden block interposed between the hammer and liner.

If the liners have been left in the block, insert the connecting rod and piston from the top of the block, compressing the rings with a piston ring clamp.

Note that the big-end bearing caps and connecting

rods are each stamped either 1, 2, 3, or 4. When re-assembling these items, the stamped numbers must be towards the right-hand side of the engine, looking from the flywheel end (see Fig. 9). The big-end bearings have a tag on them so that they can only be fitted in the correct way. Fit new tabwashers and tighten the big-end bolts with a torque spanner to 220 to 230 lb. ins.

Details of crankshaft re-grinding and fitting of undersized bearings are given in Chapter 29.

23. Pistons and Connecting Rods—Dismantling and Assembling

To remove the pistons from the connecting rods, take out the gudgeon pin circlips with the aid of a pair of circlip pliers, heat pistons in warm water or oil, and push out the gudgeon pins by hand.

If the small-end bushes are worn, they must be pushed out and new ones fitted. The new bushes must be reamed in position to 0·750″ ± 0·0002″ diameter.

Before re-fitting old pistons, check the side clearance of the rings in the grooves. Note that the two compression rings, the upper one of which is chromium-plated, can only be fitted in one way. The scraper ring may be fitted either way up. The correct clearances are in the Fits and Clearances Schedule. Ensure that the rings are a free fit in the grooves, and clean out any carbon. Old broken rings are useful as scrapers. Check that the gaps of the rings in the bores are correct. If they exceed the figures given in the Fits and Clearances Schedule, fit new rings.

When fitting gudgeon pins, warm the pistons to 80-100°C., which will enable them to be inserted easily.

Owing to the fact that the engine is fitted with renewable cylinder liners, oversize pistons are never required.

When replacing pistons—note that the valve cut-out on piston crowns is always on manifold side.

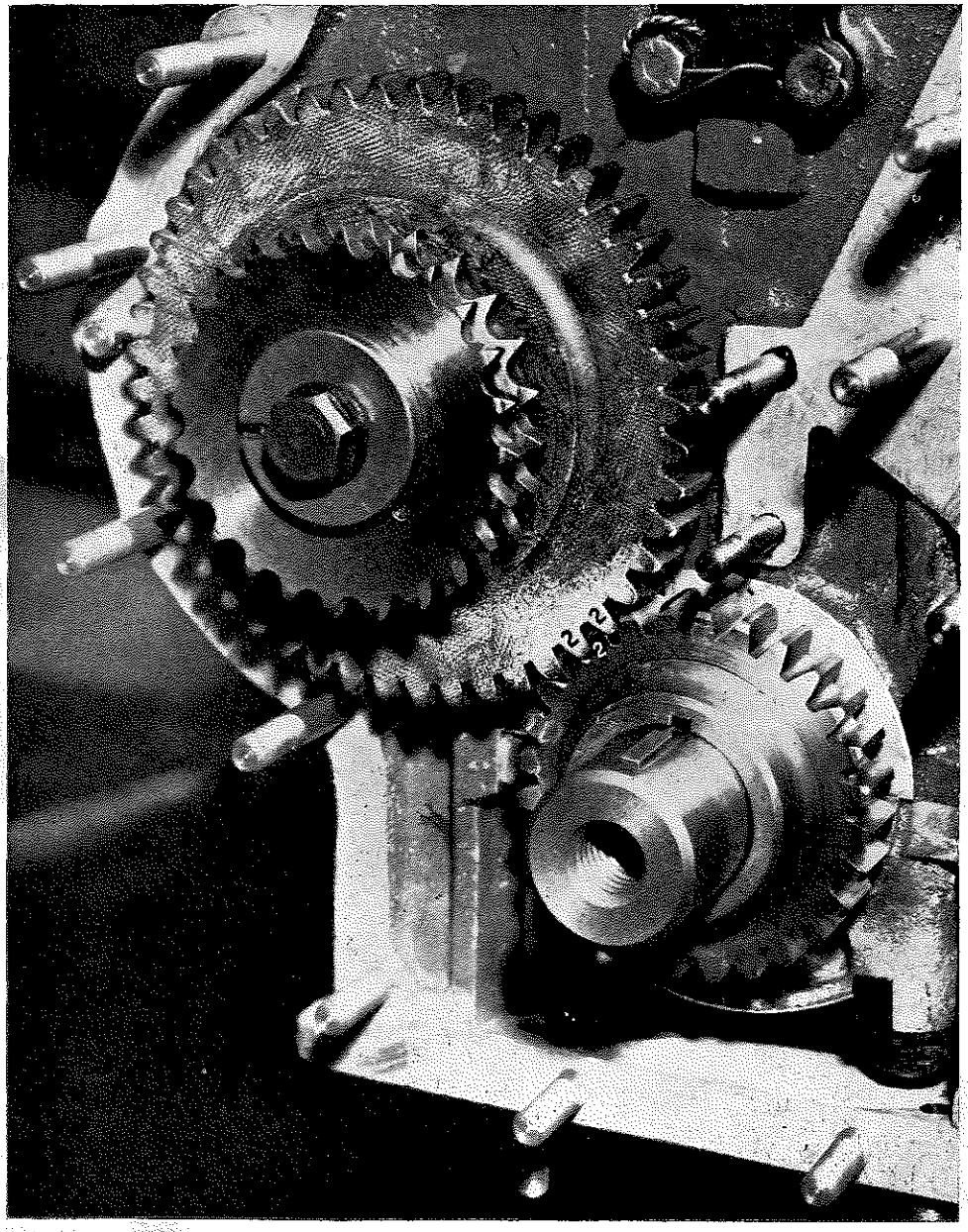


Fig. 10 The crankshaft and jackshaft gears, showing the timing marks

24. Timing Cover—Removing and Replacing

Before removing the timing cover it is essential to remove the camshaft and tappet block (Chapter 10) and slacken the cylinder head stud nuts (as in Chapter 12), so that all strain is taken off the cylinder head studs.

Next, loosen the hose clips on the water pump end of the rubber hoses. Take off the water pump drive belt and remove the three nuts, plain washers and shake-proof washers securing the water pump, which may now be taken off. Unscrew the starting dog and withdraw the crankshaft pulley, which is keyed to the crankshaft.

Take off the nuts from the two studs which attach the timing cover to the cylinder head.

Remove the eleven nuts, plain washers and spring washers and take off the timing cover.

Replacement of the timing cover is a reversal of the above process.

25. Valve Timing

With the timing cover removed (Chapter 24), turn the crankshaft to T.D.C. on Nos. 1 and 4 pistons, and mesh the crankshaft and jackshaft gears so that the markings on them are positioned as shown in Fig. 10. Replace the timing cover, re-tighten the cylinder head stud nuts and re-fit the camshaft and tappet block (Chapter 10). Pull the timing chain up through the front of the cylinder head. Set the camshaft so that the valves of No. 4 cylinder are just rocking. Place the chain over the camshaft sprocket, which must be removed from the camshaft for this purpose, and turn the flywheel slowly a little in each direction to enable the camshaft sprocket to be engaged by its dowel. Secure it by means of the sprocket bolt and tabwasher.

To check the timing, turn the flywheel clockwise a few degrees, and then turn it anit-clockwise (looking from the flywheel end), and see that the inlet valve of No. 4 cylinder just commences to open when the flywheel is coming up to the T.D.C. mark.

26. Distributor and Oil Pump Drive Shaft—Removing and Replacing

To remove the distributor and oil pump drive shaft, take off the distributor as in Chapter 7. Remove the two nuts, plain washers and spring washers and take off the distributor mounting bracket. The drive shaft may then be taken out.

If the drive shaft bush is worn, it should be removed by drifting out from underneath the crankcase, which entails removal of the sump (Chapter 16) and oil pump (Chapter 17). The bush may be inserted from above. No reaming is required.

Replace the distributor and oil pump drive shaft so that when the drive shaft gear is fully meshed with the driving gear on the jackshaft and with the T.D.C. mark on the flywheel in line with the corresponding mark on the mounting plate, the driving dog is positioned as shown in Fig. 11. This will ensure that for correct distributor timing the earth connection on the D3AH4A distributor is clear of the cylinder block.

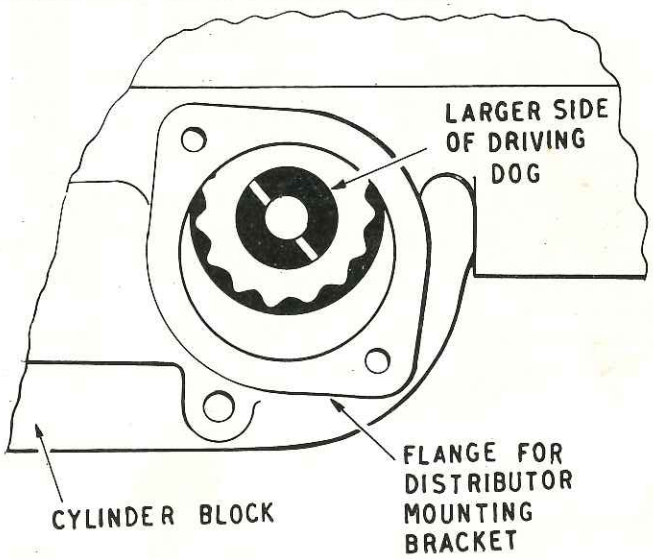


Fig. 11 The distributor driving dog in the correct position for timing (see Chapter 26)

27. Jackshaft—Removing and Replacing

To remove the jackshaft, take off the timing cover (Chapter 24) and remove the distributor and oil pump drive shaft (Chapter 26.)

Disengage the timing chain from the jackshaft chain wheel. Knock back the tabwasher and remove the bolt and shakeproof washer and take off the jackshaft chain wheel. This wheel and the jackshaft gear, which should now be pulled off, both have Woodruff keys. Remove the two bolts and shakeproof washers and take off the jackshaft locating plate. The jackshaft may then be withdrawn from the cylinder block.

If required, remove the oil pump driving gear from the jackshaft. It is secured by a circlip and is located by a Woodruff key.

Replacement of the jackshaft is a reversal of the above process. The valve and ignition timing must be re-set as in Chapters 7, 25 and 26.

28. Crankshaft—Removing and Replacing

When removing the crankshaft, first remove the six bolts and tabwashers and take off the flywheel. Next, take off the thirteen nuts and plain washers securing the mounting plate and remove the plate. Take off the timing cover (Chapter 24) and the sump (Chapter 16) and oil pump (Chapter 17). Disconnect the connecting rods from the crankshaft (Chapter 22). Take off the oil thrower, which is fitted with its dished side towards the engine, and, if required, pull off the crankshaft gear.

Take off the sealing blocks, which are secured by Allen screws.

Knock back the tabwashers from the main bearing cap nuts and unscrew the nuts. Lift off the bearing caps.

The crankshaft may now be lifted out.

Before replacing the crankshaft, clean out all oil passages and put a little engine oil on all bearing surfaces. The centre main bearing has two semi-circular thrust bearings, which are fitted into the crankcase half of the bearing with the oil grooves facing away from the centre main bearing.

Measure the end-float of the crankshaft by inserting a feeler between a thrust bearing and the corresponding crankshaft cheek. The clearance should be 0·002″ to 0·010″. If the clearance exceeds 0·010″, fit new thrust bearings.

The six main bearings halves are identical, but when re-fitting old bearings, replace them in their original positions. They are located by means of tags.

Replacement of the crankshaft is a reversal of its removal. Tighten the main bearing stud nuts with a torque spanner to 440 to 450 lb. ins. Fit new sealing block packings to the sealing blocks. Before fully tightening the sealing block Allen screws, ensure that the outermost edges of the sealing blocks are flush with the end faces of the cylinder block.

29. Crankshaft—Re-grinding

Measure the diameter of the main and big-end journals with a micrometer. If the smallest diameter of any journal is more than 0·004″ undersize according to the diameters given in the accompanying table, the crankshaft should be re-ground and new bearings fitted. The re-grind sizes for all journals are 0·010″, 0·020″, 0·030″

and 0·040″ under standard sizes. All fillet radii are 0·115″ to 0·125″.

New bearings are supplied ready for fitting, and no scraping must be carried out.

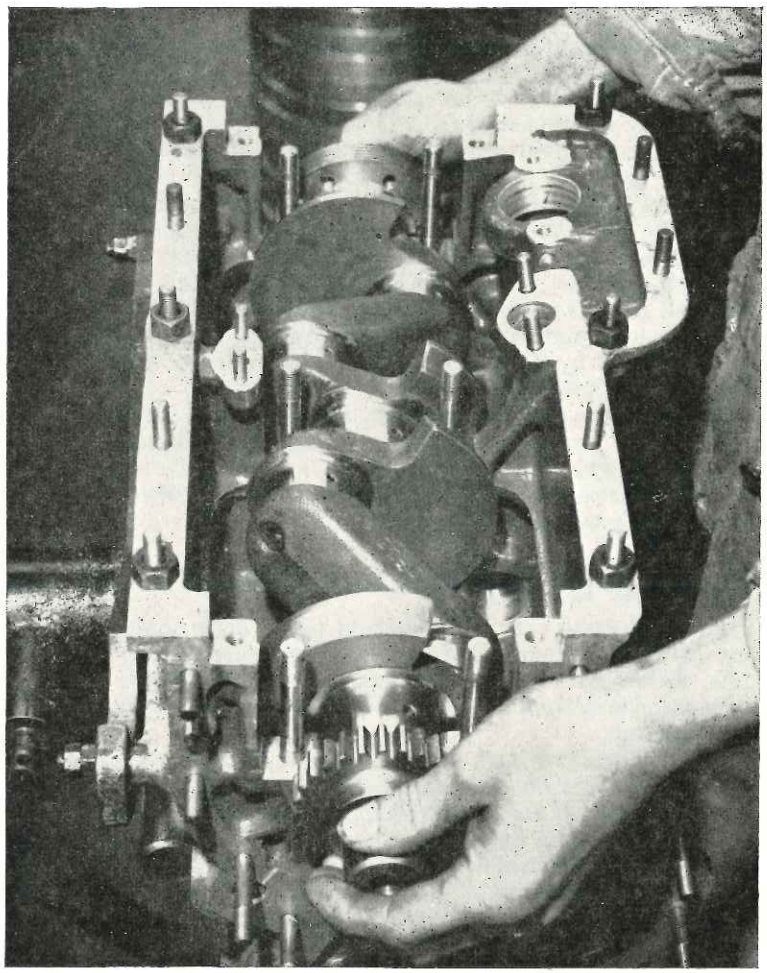


Fig. 12
Lifting out the crankshaft

GRADE	AMOUNT UNDERSIZE	MAIN JOURNAL DIAMETER	MAIN BEARING PART NUMBER	BIG-END JOURNAL DIAMETER	BIG-END BEARING PART NUMBER
Standard	Nil	2·1235″ 2·12425″	FWA. 1014/5	1·8745″ 1·8740″	FW. 1015
1st Re-grind	0·010″	2·1135″ 2·11425″	FWA. 1014/6	1·8645″ 1·8640″	FW. 1015/1
2nd Re-grind	0·020″	2·1035″ 2·10425	FWA. 1014/7	1·8545″ 1·8540″	FW. 1015/2
3rd Re-grind	0·030″	2·0935″ 2·09425″	FWA. 1014/8	1·8445″ 1·8440″	FW. 1015/3
4th Re-grind	0·040″	2·0835″ 2·08425″	FWA. 1014/9	1·8345″ 1·8340″	FW. 1015/4

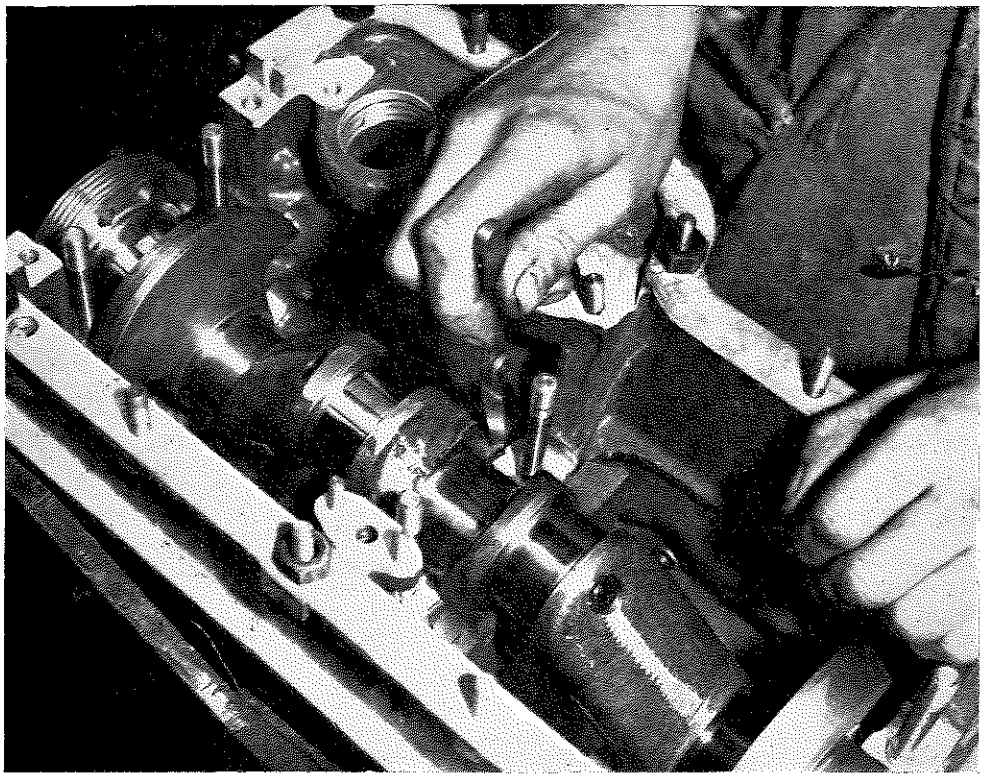


Fig. 13 Checking the crankshaft end-float

30. Replacing Engine, Clutch and Gearbox in the Chassis

Suspend engine above and forward of its chassis position and connect speedometer cable.

If the propeller shaft has not been removed during service the following points must be observed:

i. Lightly grease the gearbox splines.
ii. Put gear lever into fourth gear position.
iii. Remove propeller shaft tunnel inspection plate.
iv. Lower the engine into position in the engine bay.

When gearbox and propeller shaft splines almost meet, place a lever through propeller shaft inspection hole and lever up the end of the gearbox. During this operation, the engine must be as low as possible in the engine bay. When the splines meet, rock the car gently until the splines slide in. Push gearbox mounting bolt through propeller shaft tunnel into mounting bobbins and bolt up.

Thereafter, the reverse process of dismantling may be used.

FITS AND CLEARANCES

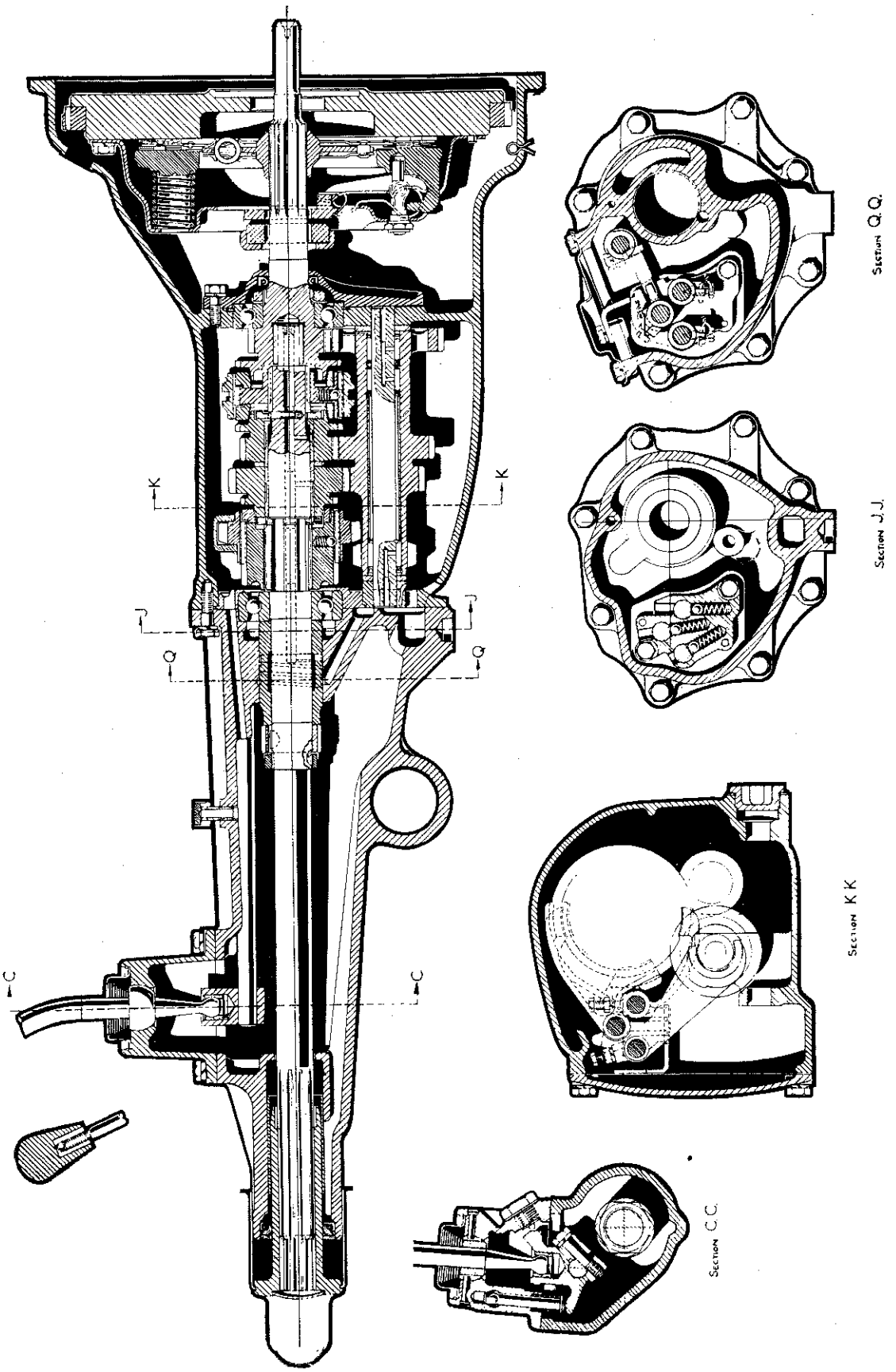
The following table of clearances allowed in the working parts **when new,** is given to facilitate examination for wear.

Description		Minimum	Maximum
Clearance between crankshaft and main bearing		0·001″	0·00275″
Clearance between crankshaft and conn. rod bearing		0·002″	0·0035″
Crankshaft end-float		0·002″	0·010″
Clearance between camshaft and camshaft bearing		0·0005″	0·002″
Clearance between tappet and tappet block		0·0007″	0·0021″
Valve tappet clearance	inlet	0·006″	
	exhaust	0·008″	
Clearance of valves in guides		0·0015″	0·0024″
Piston ring gap (in position in cylinder liner)—			
Compression rings		0·014″	0·019″
Oil ring		0·008″	0·013″
Clearance of piston in cylinder liner—			
Bottom of skirt (thrust face)		0·0033″	0·0053″
Top of skirt (thrust face)		0·0054″	0·0074″
Side clearance of rings in grooves—			
Compression ring (top, plain pattern)		0·0015″	0·0035″
Compression ring (lower, plain pattern)		0·0015″	0·0035″
Oil ring		0·0015″	0·0035″
Clearance of gudgeon pin in piston (obtained by selective assembly)		0·0001″	
Clearance of gudgeon pin in small-end bush		Nil	0·0004″
Clearance of jackshaft in jackshaft bearings		0·0005″	0·003″
Clearance of distributor and oil pump drive shaft—			
In oil pump cover bush		0·0018″	0·003″
In distributor drive bush		0·0018″	0·003″
In oil pump body bush		0·0018″	0·003″
Clearance of oil pump driven gear on idler shaft		0·0015″	0·0032″
Contact breaker gap (fully open)		0·014″	0·016″

SECTION G

THE GEARBOX

THE GEARBOX AND REMOTE CONTROL IN SECTION



1. Description

The gearbox has four forward speeds and one reverse. Top gear is obtained by direct drive, third and second by gears in constant mesh, and first and reverse by sliding spur gears.

A sliding joint of the reverse spline type is fitted to the rear end of the third motion shaft and is lubricated from the gearbox.

2. Separating the Gearbox

With the engine, clutch, gearbox unit on the bench undo 2 × $\frac{3}{8}$" nuts and bolts holding the starter motor in position and remove starter.

Undo 6 bolts holding the gearbox to the engine mounting plate.

Pull the gearbox straight back. Take care to keep the box in line with the engine until the clutch shaft is free of unit.

3. Dismantling the Gearbox

Remove the rear power unit mounting.

Unscrew the speedometer drive, but do not withdraw the pinion from the bush unless absolutely necessary, or damage to the oil seal may result on replacement.

Unscrew the set screws and remove the gear lever tower and joint washer.

Unscrew and remove the six bolts and the rear extension cover and joint washer. Remove the interlock arm and bracket from the aperture in the rear extension.

Unscrew the three countersunk screws and the seven hexagon-headed set screws holding the gearbox cover; remove the cover.

Remove the two nuts and six set screws securing the gearbox extension to the gearbox. Pull the extension from the gearbox, at the same time manoeuvring the remote control shaft selector lever down and out from the selectors.

Cut the locking wire and unscrew the three change speed fork set screws. Release the three locknuts and slacken the fork locating screws.

Unscrew the two set screws and remove the shifter shaft locating block with shifter shafts from the gearbox; note the two dowels in the block. If the rods are withdrawn from the locating block take care to catch the three selector balls and springs.

Withdraw the forks from the box in the following order: reverse, top and third, and first and second.

Unscrew the clutch lever pivot nut; extract the pivot bolt and remove the lever with the thrust bearing.

Unscrew the nuts and remove the gearbox front cover complete with oil seal; note the bearing shims between the cover and the front bearing. Tap out the layshaft, allowing the gear unit to rest in the bottom of the box.

Unscrew the retaining set screw and remove the reverse shaft and gear.

Withdraw the third motion shaft (mainshaft) assembly to the rear.

Withdraw the first motion shaft and drive gear.

Note: Retrieve the 18 spigot needle rollers. Lift out the layshaft gear unit and the two thrust washers.

4. Dismantling the Rear Extension

Remove the rear remote control rod selector arm set screw and withdraw the selector arm and key; unscrew the set screw at the forward end and remove the front remote control selector arm and key.

Withdraw the remote control rod from the rear extension.

To remove the oil seals from the extension use the special tool 18G389 and adaptor 18G389B (see Fig. 1).

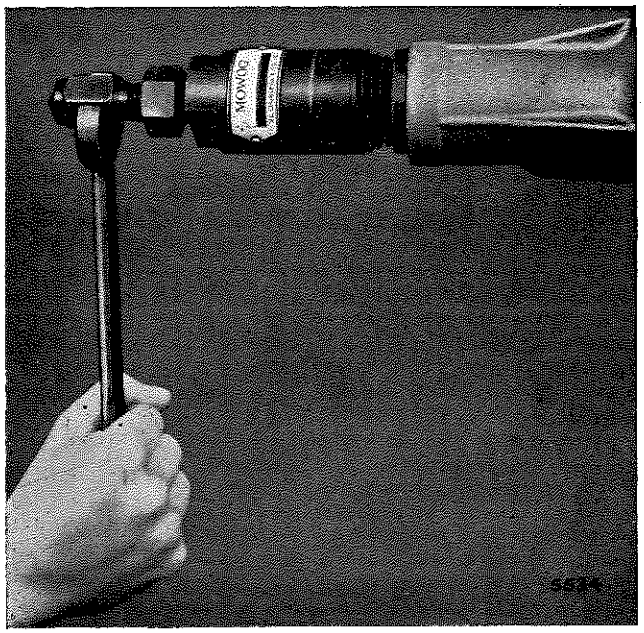


Fig. 1
Removing a rear oil seal assembly with special tools 18G389 *and* 18G389B

Should it be necessary to remove the sliding joint bush, this must be drawn from the extension and not driven inwards.

5. Dismantling the Third Motion Shaft (Mainshaft)

Remove the following items in this order: baulk ring, top and third synchromesh sleeve and hub, second baulk ring. If the synchromesh sleeve is removed from the hub take care not to lose the three locating balls and springs that will be released in consequence.

Press down the third speed cone thrust washer locating plunger; rotate the thrust washer to align its splines with those on the shaft and remove the washer.

Withdraw the third speed gear and its splined bush.

Withdraw the bush interlocking washer to release the second speed gear with its bush and baulk ring.

Remove the rear thrust washer from the splines on the shaft and withdraw the first speed gear and second speed synchronizer; if it is necessary to slide the gear from the synchronizer take care not to lose the three balls and springs.

Tap up the locking washer and unscrew the rear retaining nut; withdraw the washer, speedometer drive gear and key, and the distance sleeve from the shaft.

Press the rear bearing and its housing from the shaft.

6. Assembling the Third Motion Shaft (Mainshaft)

Assemble from the front end.

i. Locate the rear thrust washer on the front end of the splines, ground face to the front.

ii. Push the longer phosphor-bronze bush up to the splines with the dogs towards the front. The bush is a tight fit on the shaft and must be immersed in warm oil to facilitate fitting. The oil hole in the bush must register with the hole in the shaft.

iii. Fit the second speed baulk ring and gear onto the bush with the plain side of the gear towards the front.

iv. Slide on the bush interlocking washer and the shorter-splined bush, locating the dogs of both bushes in the interlocking washer. Immerse the bush in warm oil to facilitate fitting.

v. Insert the spring and plunger into the hole in the shaft.

vi. Fit the third speed gear onto the bush with the cone towards the front.

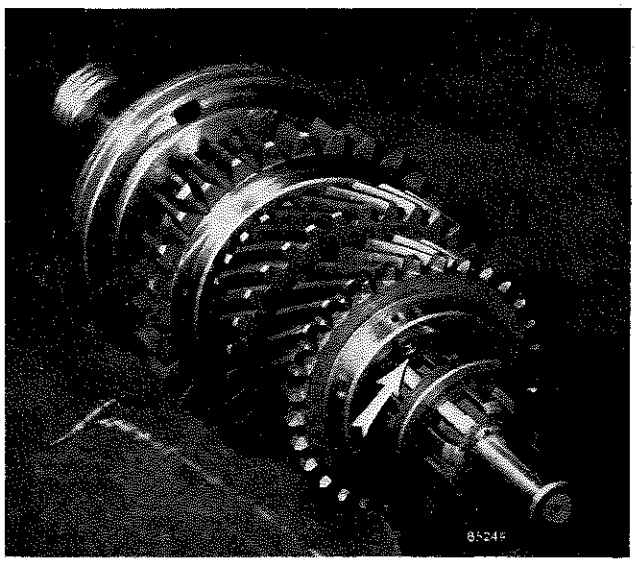


Fig. 2
The arrow indicates the third speed thrust washer and locating peg

vii. Thread on the front thrust washer, machined face towards the gear, while holding down the plunger by means of a thin punch through the hole in the gear cone, and push the washer over it; turn the washer to allow the plunger to engage in one of the splines.

viii. Fit the three springs and balls to the third speed synchronizer and, with the aid of special tool 18G223, push on the synchronizer sleeve (striking dog).

ix. Push on the top and third gear synchromesh assembly hub with its two baulk rings. The plain side of the hub faces the rear.

Assemble the following items from the rear:

i. Insert the three balls and springs in the second gear hub and, with the aid of special tool 18G222, push the synchronizer sleeve (striking dog) into position on the hub.

ii. Fit the first speed gear and synchromesh hub assembly and the baulk ring to the splines on the shaft.

iii. Press the rear bearing into its housing and fit it to the shaft, the flange of the housing to the rear.

iv. Push on the distance sleeve, speedometer drive gear, and key and secure with the lock washer and nut.

7. Dismantling the Layshaft Gear

Extract one of the circlips from the layshaft gear and push out the bearing and distance tube assembly; there are three needle races and one distance tube spaced in the layshaft gear which are retained by a circlip at each end, two races being fitted at the front end and one at the rear.

8. Assembling the Layshaft Gear

The following method for refitting the layshaft gear bearing assemblies is suggested.

Fit a circlip to the innermost groove in the gear.

Hold the shaft vertically in the vice; assemble a roller bearing on the shaft against the vice jaws and then slide the gear over the shaft and the bearing with the large gear downwards.

Remove the shaft from the vice and push the bearing into the gear against the circlip. Fit a circlip, the end roller bearing assembly, and the retaining circlip.

Slide the distance tube into the other end of the gear, followed by the other end bearing and circlip. Remove the gear from the shaft.

9. Dismantling and Assembling the First Motion Shaft

Unlock and remove the securing nut and withdraw the locking washer.

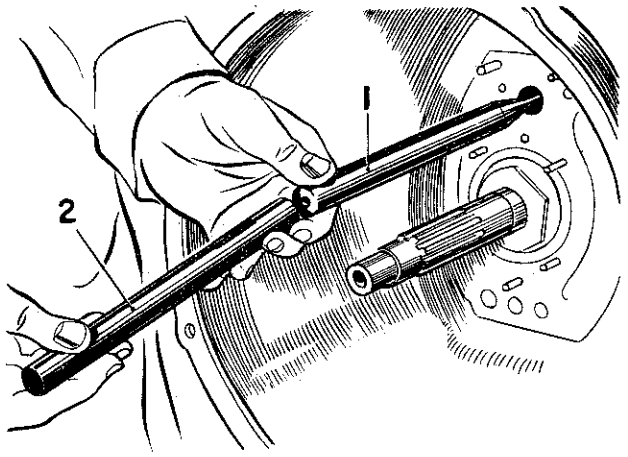
Press the bearing from the shaft and remove the circlip from the bearing.

Re-assembling

Fit the bearing to the shaft with the spring ring away from the gear. Replace the locking washer and tighten the retaining nut; bend over the locking washer to secure the nut.

10. Assembling the Gearbox

Place the layshaft gear in the gearbox complete with the end thrust washer but do not fit the layshaft; use dummy layshaft 18G471 to retain the thrust washers in position. Replace the first motion shaft and insert the 18 needle-roller bearings. Insert the third motion shaft assembly from the rear of the gearbox; enter the spigot in the needle rollers of the first motion shaft. Use the gasket fitted between the gearbox and the rear extension to position the dowel and bearing housing. Push the shaft right home. Fit the layshaft, lining up the cut-away portion of the front end with the locating groove in the front cover.



1. Pilot. 2. Layshaft.

Fig. 3
Using tool 18G471 *as a pilot when installing the layshaft*

Fit the reverse gear and shaft; tighten the set screw and secure with the locking washer.

Refit the front end cover, replacing the bearing shims that were removed on dismantling.

Refit the clutch lever and fork.

Position the gear change forks in the gearbox in the following order: first and second, third and top, reverse.

Bolt the shifter shaft locating block to the rear face of the gearbox; replace the balls and springs and push the shifter shafts through the block into their respective change speed forks. Insert, tighten, and lock the three locating screws.

Position the selectors on the rear end of the shifter shafts; insert, tighten, and wire up the set screws.

11. Assembling the Rear Extension

Fit the rear extention oil seal, using service tool 18G134 with its adaptor 18G134N.

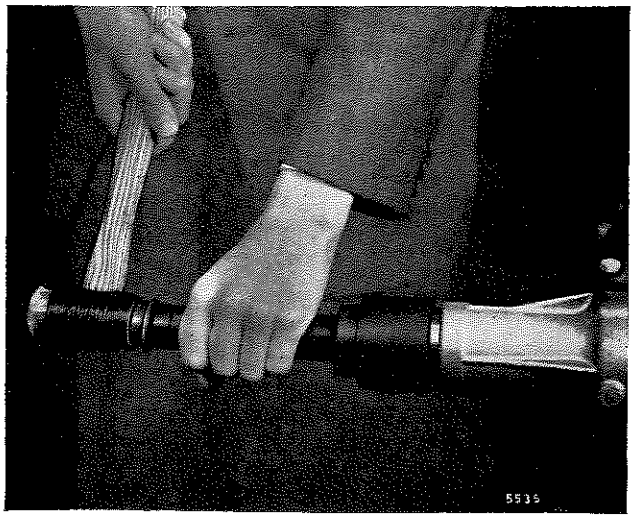


Fig. 4
Installing a new oil seal assembly with special tools 18G134 *and* 18G134N

Locate the remote control rod in the rear extension.

Fit the front and rear selector levers to the remote control rod; note that they are secured and located by keys and set screws.

Fit the rear extension to the gearbox, locating the control rod selector arm in the shifter rod selectors.

Fit the interlock arm to the rear extension and refit the cover.

Bolt the gear lever tower to the rear extension.

Place the two halves of the brass gear lever snug on the lower end of the lever and secure with the circlip. Fit the lever to the tower and secure it with the cover, spring, and circlip.

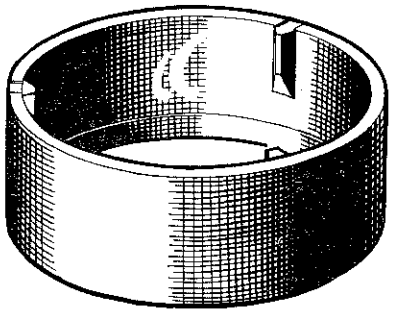
Replace the side cover, using a new joint as necessary. Fit the speedometer drive gear assembly, drain plug, and breather.

Fill with oil to Ref. Section B to the level indicated on the dipstick.

12. Special Tools

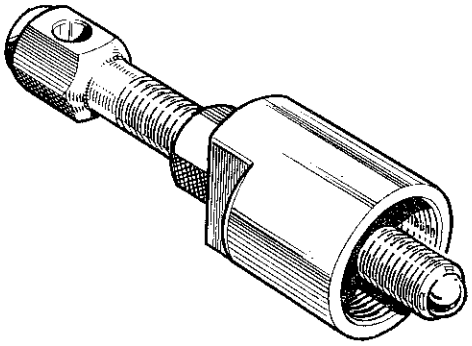
18G222. *Synchromesh Unit Assembly Ring.*
Designed to facilitate the assembly of mated synchronizer and sleeve by enabling the springs and balls to be inserted quickly and easily.

18G223. *Synchromesh Unit Assembly Ring.*



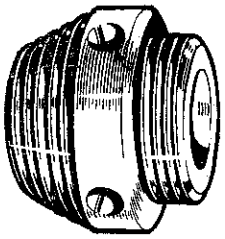
18G222
18G223

18G389. *Gearbox Rear Oil Seal Remover (basic tool)*
This basic tool together with the appropriate adaptor is essential for removing the gearbox extension oil seal easily without damage and without removing the gearbox from the vehicle. The appropriate adaptor for use with the basic tool is supplied separately.



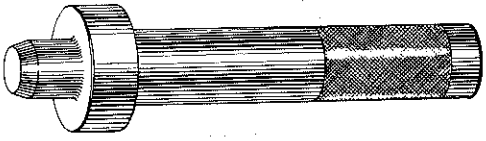
18G389

18G389B. *Gearbox Rear Oil Seal Remover — Adaptor.*
Used in conjunction with basic tool 18G389 it screws into the end of the oil seal and withdraws it without damage to the rear extension.



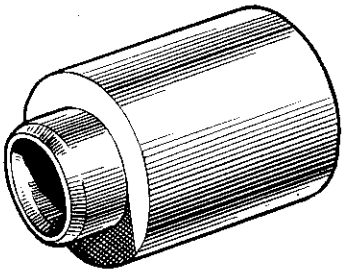
18G389B

18G134. *Bearings and Oil Seal Remover and Replacer (basic tool).*
Used with adaptor 18G134N it enables oil seals to be fitted to the gearbox extension without removal from the vehicle.



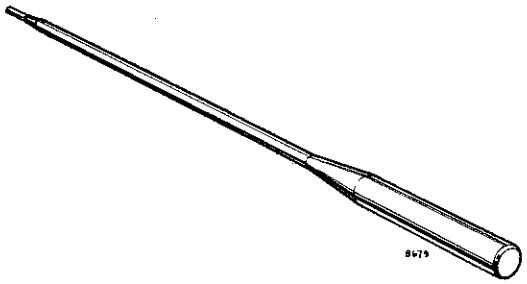
18G134

18G134N. *Gearbox Rear Oil Seal Replacer—Adaptor.*
For the correct and easy replacement of the gearbox extension oil seal. Use in conjunction with 18G134.



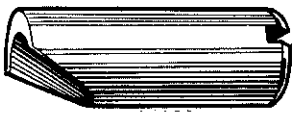
18G134N

18G471. *Dummy Layshaft.*
A pilot for lining up the gears and retaining the thrust washers in position prior to inserting the layshaft proper, it being necessary to drop the laygear for the first motion shaft to be inserted.



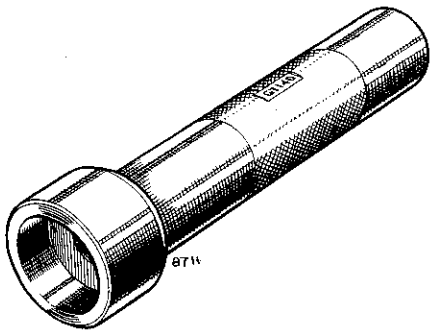
18G471

18G41. *Selector Fork Rod Guide.*
This tool greatly assists the assembly of the selector balls and springs.



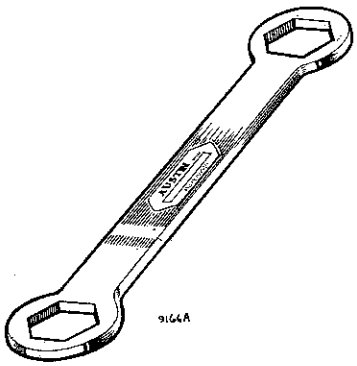
18G41

18G4. *First Motion Shaft Assembly Replacer.*
For the correct and easy replacement of the first motion shaft assembly.

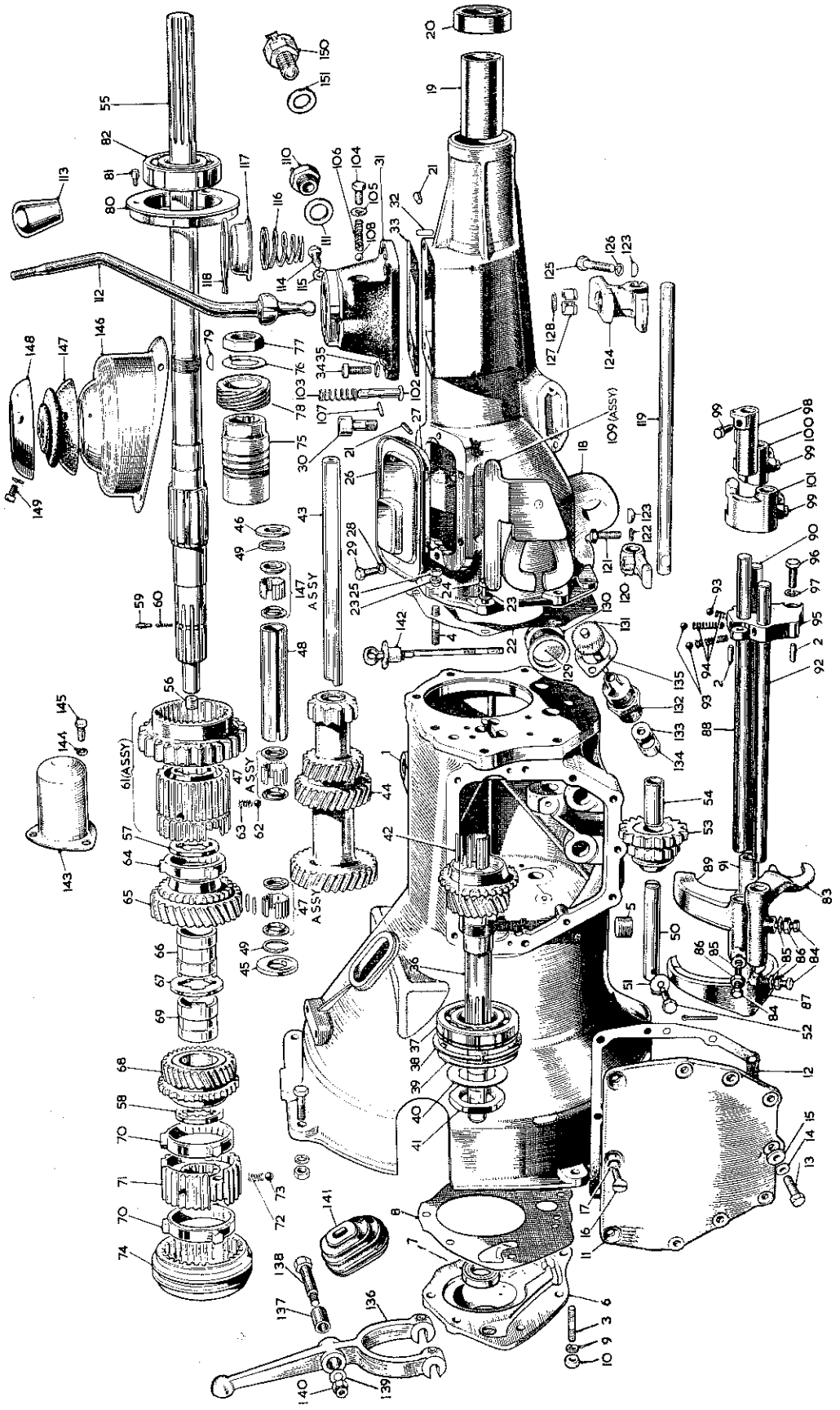


18G4

18G5. *First Motion Shaft Nut Spanner.*
This sturdy spanner provides ample leverage to move the tightest nut.



18G5



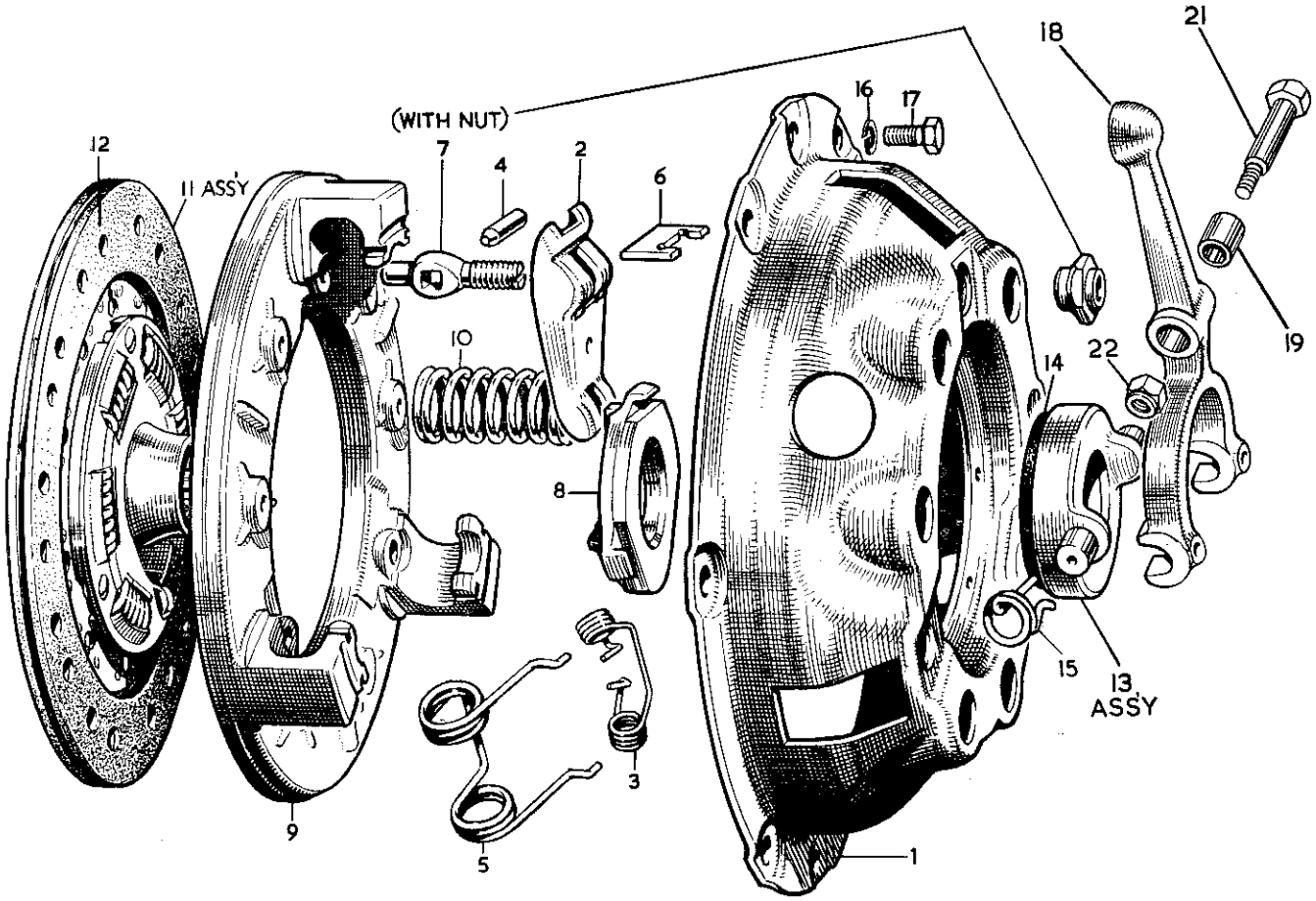
13 KEY TO THE GEARBOX COMPONENTS

No.	Description
1.	Casing assembly.
2.	Dowel locating—block to gearbox.
3.	Stud for front cover.
4.	Stud for rear extension.
5.	Plug—drain.
6.	Cover assembly—front.
7.	Oil seal.
8.	Joint washer—cover to casing.
9.	Washer for stud (spring).
10.	Nut for front cover stud.
11.	Cover—gearbox side.
12.	Joint washer—cover to casing.
13.	Screw—gearbox side cover.
14.	Washer for screw (plain).
15.	Washer for screw (fibre).
16.	Screw—countersunk.
17.	Washer for screw.
18.	Extension—rear.
19.	Bush—rear extension.
20.	Oil seal—rear extension.
21.	Plug—taper.
22.	Joint washer—extension to casing.
23.	Washer for screw and stud (spring).
24.	Screw—extension to casing.
25.	Nut for stud.
26.	Cover—side—rear extension.
27.	Joint washer for side cover.
28.	Washer for screw (spring).
29.	Screw—side cover to extension.
30.	Breather assembly.
31.	Tower—change speed lever.
32.	Dowel for tower.
33.	Joint washer—tower to extension.
34.	Screw—tower to extension.
35.	Washer for screw (spring).
36.	Shaft—first motion.
37.	Bearing.
38.	Spring ring—bearing.
39.	Shim—first motion shaft.
40.	Washer—first motion shaft nut.
41.	Nut for first motion shaft.
42.	Needle rollers.
43.	Layshaft.
44.	Gear unit—layshaft.
45.	Washer—thrust—front.
46.	Washer—thrust—rear.
47.	Rollers—needle bearing.
48.	Tube—distance—laygear bearing.
49.	Ring—spring—laygear.
50.	Shaft—reverse.
51.	Washer for screw—locking.
52.	Screw—reverse shaft locking.
53.	Gear assembly—reverse
54.	Bush—reverse gear.
55.	Shaft—third motion.
56.	Restrictor—oil.
57.	Washer—thrust—rear.
58.	Washer—thrust—front.
59.	Peg for thrust washer—front.
60.	Spring for peg.
61.	Wheel and synchronizer assembly.
62.	Ball for synchronizer.
63.	Spring for synchronizer ball.
64.	Baulk ring for second gear.
65.	GearKsecond speed.
66.	Bush—second speed gear.
67.	Ring—interlocking.
68.	Gear—third speed.
69.	Bush—third speed gear.
70.	Baulk ring—third and fourth gear.
71.	Synchronizer—third and fourth gear.
72.	Spring for synchronizer.
73.	Ball for synchronizer.
74.	Coupling—sliding.
75.	Distance piece—third motion shaft.
76.	Washer—locking.
77.	Nut for third motion shaft.
78.	Gear—speedometer.
79.	Key for speedometer gear.
80.	Housing—rear bearing.
81.	Peg—locating.
82.	Bearing—rear—ball.
83.	Fork—reverse.
84.	Screw—locating—reverse fork.
85.	Washer for screw (shakeproof).
86.	Nut for screw.
87.	Fork—first and second speed.
88.	Rod—first and second speed fork.
89.	Fork—third and fourth speed.
90.	Rod—third and fourth speed fork.
91.	Distance piece.
92.	Rod—reverse fork.
93.	Ball for fork locating.
94.	Spring for locating ball.
95.	Block—sliding shaft locating.
96.	Screw—locating block to casing.
97.	Washer for screw (spring).
98.	Selector—first and second gear.
99.	Screw—selector locating.
100.	Selector—third and fourth gear.
101.	Selector—reverse gear.
102.	Plunger—reverse selector.
103.	Spring—reverse plunger.
104.	Screw—reverse plunger spring.
105.	Washer for screw (spring).
106.	Spring—detent.
107.	Dowel—reverse plunger.
108.	Ball for plunger.
109.	Arm assembly—interlocking.
110.	Plug—reverse light switch.
111.	Washer for plug.
112.	Lever—change speed.
113.	Knob for lever.
114.	Pin—change speed lever.
115.	Washer for pin (spring).
116.	Spring—change speed lever.
117.	Cover for spring.
118.	Circlip for cover.
119.	Shaft—remote control.
120.	Lever—selector—front.
121.	Screw—selector lever.
122.	Washer for screw (shakeproof).
123.	Key—lever to shaft.
124.	Lever—selector—rear.
125.	Screw for selector lever.
126.	Washer for screw (spring).
127.	Bush for change speed lever.
128.	Circlip for bush.
129.	Cap for control shaft boss.
130.	Joint washer for cap.
131.	Pinion—speedometer.
132.	Bush for pinion.
133.	Seal—oil—pinion.
134.	Ring—oil seal retaining.
135.	Joint washer—speedometer bush.
136.	Lever—clutch withdrawal.
137.	Bush—withdrawal lever.
138.	Bolt—clutch withdrawal lever.
139.	Washer for bolt.
140.	Nut for bolt (stiff).
141.	Cover for clutch lever.
142.	Oil level indicator.
143.	Cover—starter pinion.
144.	Washer for screw (spring).
145.	Screw—cover to casing.
146.	Turret—gearbox cover.
147.	Gaiter—gear lever.
148.	Retainer—gaiter.
149.	Screw—gaiter to turret.
150.	Switch—reverse light.
151.	Joint washer.

SECTION H

THE CLUTCH

THE CLUTCH COMPONENTS



No.	*Description*
1.	Cover—clutch.
2.	Lever—release.
3.	Retainer—lever.
4.	Pin—lever.
5.	Spring—anti-rattle.
6.	Strut.
7.	Eyebolt with nut.

No.	*Description*
8.	Plate—bearing thrust.
9.	Plate—pressure.
10.	Spring—pressure plate.
11.	Plate assembly—driven.
12.	Lining.
13.	Ring assembly—thrust.
14.	Ring—carbon.

No.	*Description*
15.	Retainer.
16.	Washer—spring—cover screw.
17.	Screw—cover to flywheel.
18.	Lever—withdrawal.
19.	Bushes.
21.	Bolt for lever.
22.	Nut for bolt.

1. Removing the Clutch

Remove the power unit as detailed in Engine Overhaul Section, Chapter 20.

Remove the clutch housing bolts and withdraw the gearbox from the engine, taking care to support the gearbox until the first motion shaft is clear of the driven plate and release lever plate.

Loosen each of the hexagon bolts securing the clutch to the flywheel by slackening them a turn at a time until spring pressure is released. The clutch cover can now be disengaged from the flywheel dowels and the whole assembly lifted from the flywheel.

2. Refitting the Clutch

Position the driven plate assembly on the flywheel, taking care to place the larger-chamfered spline end of the driven plate hub away from the flywheel.

Centralize the driven plate by means of the alignment bar (special tool 18G279) which fits the splined bore of the driven plate hub and the pilot bearing in the flywheel. As an alternative a spare first motion shaft can be used.

Locate the cover assembly on the flywheel dowels and secure with the bolts, tightening them a turn at a time by diagonal selection. Do not remove the clutch alignment bar until all the bolts are securely tightened.

Remove the clutch alignment bar and refit the gearbox. The weight of the gearbox must be supported during refitting in order to avoid strain on the shaft and distortion or displacement of the release plate or driven plate assembly.

3. Servicing the Clutch

Spring pressure.

A tolerance of not more than 10 to 15 lb. (4·5 to 6·8 kg.) pressure is allowable on the compression load of the operating springs when at their assembled height, and all clutch springs are tested for this before assembly.

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

Tolerances.

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

Driven plates.

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

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

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

Condition of clutch facings in service.

It is natural to assume that a rough surface will give a higher frictional value against slipping than a polished one, but this is not necessarily correct. A roughened surface consists of small hills and dales, only the 'high-spots' of which make contact. As the amount of useful friction for the purpose of taking up the drive is dependent upon the area in actual contact, it is obvious that a perfectly smooth face is required to transmit the maximum amount of power for a given surface area.

Since non-metallic facings of the moulded asbestos type have been introduced in service the polished surface is common, but it must not be confused with the glazed surface which is sometimes encountered due to conditions to be detailed subsequently. The ideally smooth or polished condition will therefore provide proper surface contact, but a glazed surface entirely alters the frictional value of the facing, and will result in excessive clutch slip. These two conditions might be simply illustrated by a comparison between a piece of smoothly finished wood and one with a varnished surface; in the former the contact is made directly by the original material, whereas in the latter instance a film of dry varnish is interposed between the contact surfaces and actual contact is made by the varnish.

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

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

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

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

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

iii. There may be a combination of conditions (i) and (ii) which produces a tendency to 'judder' on such engagement.

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

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

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

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

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

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

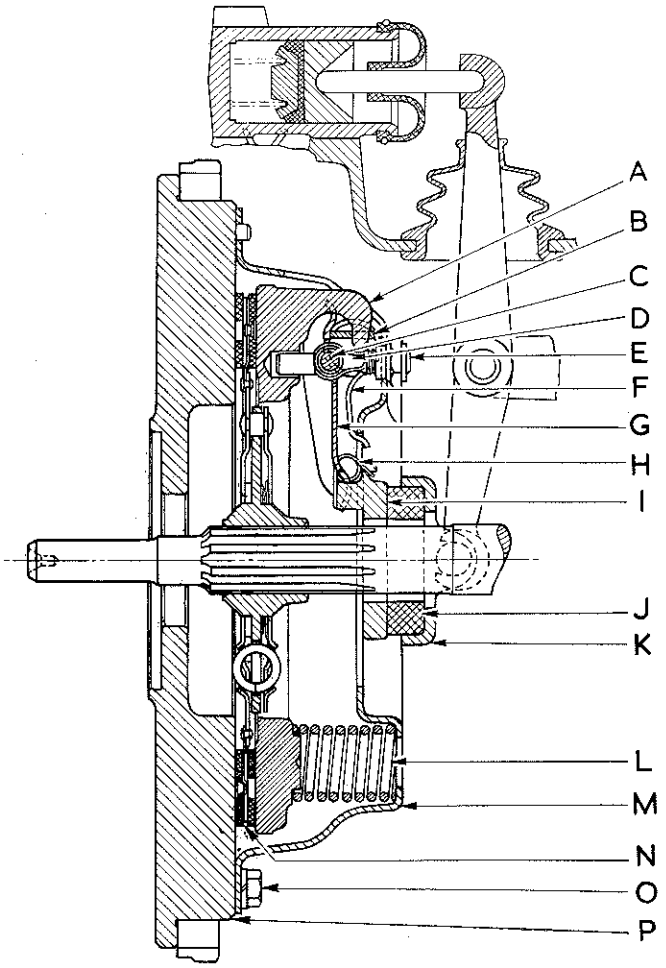


Fig. 1

A. Pressure plate.
B. Struts.
C. Floating pins.
D. Eyebolts.
E. Adjusting nuts.
F. Anti-rattle springs.
G. Release levers.
H. Lever retainer springs.
I. Release plate.
J. Graphite release bearing.
K. Release bearing cup.
L. Thrust coil springs.
M. Clutch cover.
N. Driven plate.
O. Securing bolts.
P. Flywheel.

4. Description

The clutch is of the single-plate dry-disc type operated hydraulically. No adjustment for wear is provided in the clutch itself; individual adjustment is provided for locating each lever during initial assembly. The adjusting nuts are locked in place and must never be disturbed unless the clutch is dismantled.

Driven plate assembly.

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

Withdrawal bearing assembly.

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

Cover assembly.

Each release lever is pivoted on a floating pin (C), which remains stationary in the lever and rolls across a short flat portion of the enlarged hole in the eyebolts (D), (see Fig. 1). The outer ends of the eyebolts extend through holes in the clutch cover and are fitted with adjusting nuts (E) by means of which each lever is located in its correct position. The outer or shorter ends of the release levers engage the pressure plate lugs by means of struts (B) which provide knife-edge contact between the outer ends of the levers and the pressure plate lugs, eliminating friction at this point. Thus the pressure plate (A) is pulled away from the driven plate (N), compressing the six thrust coil springs (L) which are assembled between the pressure plate and the clutch cover (M).

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

Hydraulic operation

A master cylinder is mounted on the engine side of the bulkhead and operated directly by the clutch pedal. Fluid pressure is transmitted to the slave cylinder, moving the piston, push-rod, and clutch lever to disengage the clutch.

Master cylinder.

The clutch master cylinder is of the Girling type C.V. with integral supply tank.

Slave cylinder.

This is bolted to the clutch housing and normally requires no maintenance; its assembly is similar to that of the front wheel brake cylinder. If the system is drained of fluid it will be necessary to bleed the cylinder after reassembly and refilling.

5. Dismantling the Clutch

Two methods are possible in dismantling the clutch: (*a*) using the clutch assembly gauging fixture 18G99A, and (*b*) using a press and blocks of wood.

Using the clutch assembly gauging fixture (*Fig.* 2)

Consult the code card to determine the correct spacers for the particular clutch. Place the spacers on the base plate in the positions indicated on the code card and place the clutch on the spacers. Screw the actuator into the central hole in the base plate and press the handle to clamp the clutch. Screw the set bolts firmly into the base plate. The clutch can now be compressed or released as required.

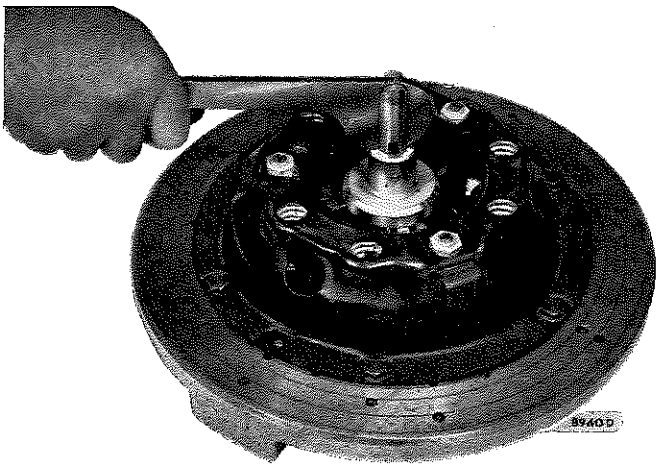


Fig. 2
Using the actuator to compress the clutch springs for dismantling or setting the assembly

Compress the clutch with the actuator and remove the adjusting nuts gradually to relieve the load of the thrust springs. Lift the cover off the clutch and carry out whatever additional dismantling may be necessary.

Using a press and wood blocks (*Fig.* 3)

Place the cover on the bed of a press with the pressure plate resting on wood blocks so arranged that the cover is left free to move downwards. Place a block or bar across the top of the cover, resting it on the spring bosses.

Apply pressure to the cover with the spindle of the press and, holding it under compression, remove the three adjusting nuts. The pressure from the press may now be released gradually until the clutch springs are fully extended.

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

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

To remove the release levers grasp the lever and eyebolt between the thumb and fingers so that the inner end of

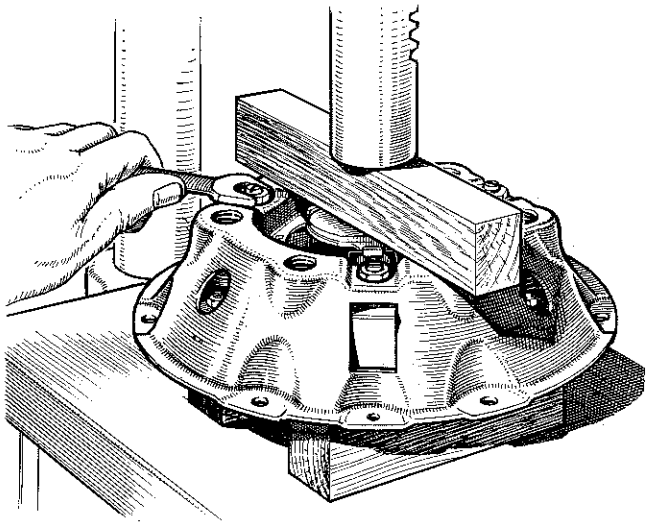


Fig. 3
Compressing the springs with wood blocks and press

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

6. Assembling the Clutch

Lay the pressure plate on the wood block on the bed of the press (or on the base plate of the clutch assembly gauging fixture) and place the springs on it in a vertical position, seating them on their small locating bosses. Clean all parts and renew any which show appreciable wear.

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

Lay the cover over the parts, taking care that the anti-rattle springs are in position as shown in Fig. 1 and that the springs are directly under the seats in the cover. Also make sure, if using the original parts, that the eyebolts, eyebolt nuts, pressure plate lugs, and cover are fitted in their correct relative positions, as marked when dismantling, to ensure correct balance being maintained.

Compress the springs either by the actuator, if the gauging fixture is being used, or by the use of a wooden block across the cover and a press. Take care to guide the eyebolts and the pressure plate lugs through the correct holes in the cover. Make sure also that the thrust springs remain correctly in their seats.

Replace the eyebolt nuts on the eyebolts and release the pressure compressing the cover assembly.

7. Adjusting the Release Levers

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

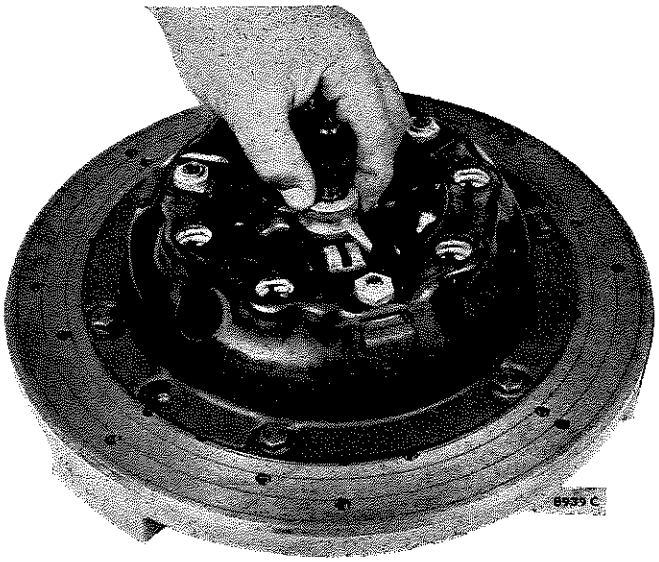


Fig. 4
Checking the setting of the release levers

For an accurate adjustment the universal gauging fixture must be used.

Using the clutch assembly gauging fixture.

After carrying out any necessary servicing reassemble the parts on the clutch pressure plate, and place the cover on it and the whole assembly on the base plate of the gauging fixture. It is essential that the correct spacers be used, as indicated on the code card.

Bolt the cover to the base plate and screw the adjusting nuts onto the bolts until the tops of the nuts are flush with the tops of the bolts. Screw the actuator into the base plate and work the handle a dozen times to settle the mechanism. Remove the actuator. Screw the pillar firmly into the base plate and place the appropriate adaptor (see code card) on the pillar with the recessed side downwards; place the gauge finger in position.

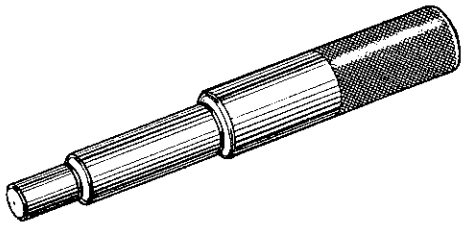
Turn the adjusting nuts until the finger just touches each release lever, pressing downwards on the finger assembly to ensure that it is bearing squarely on the adaptor. Remove the finger and the pillar and replace the actuator; operate the actuator several times. Re-check with the finger assembly and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

Lock the adjusting nuts.

8. Special Tools

18G279. *Clutch Centralizer.*

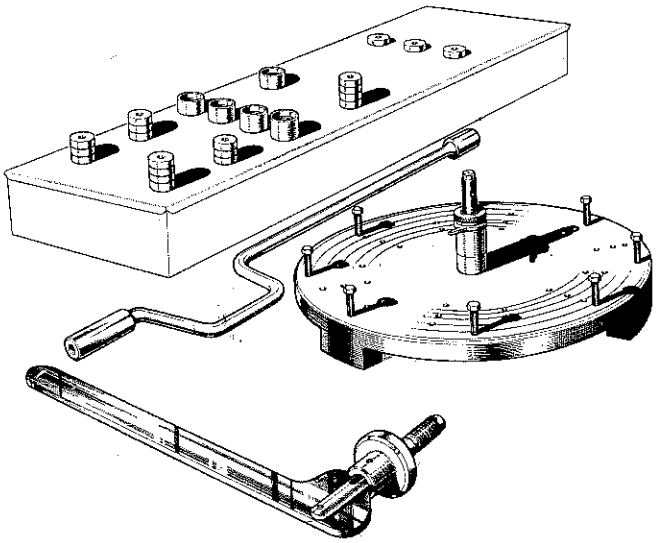
This tool is essential when bolting the clutch cover assembly to the flywheel to centralize the driven plate.



18G279

It ensures that when fitting the gearbox to the engine the first motion shaft passes easily through the clutch driven plate hub and locates in the spigot bearing in the end of the crankshaft.

Alternatively 18G39 may be used.



18G99A

18G99A. *Clutch Assembly Gauging Fixture.*

With the use of this tool a clutch assembly can be quickly dismantled, rebuilt, and finally adjusted with a high degree of accuracy. This is a universal tool for clutch assemblies from $6\frac{1}{4}$" to 11" (159 mm. to 279 mm.) diameter.

9. Master Cylinder

Description.

The inner assembly of the master cylinder is made up of the push-rod, circlip, dished washer, plunger, end seal, plunger seal, spring thimble, plunger return spring, valve spacer, spring washer, valve stem, and valve seal. The open end of the cylinder is protected by a rubber dust seal.

Removal.

Extract the split pin and withdraw the clevis pin from the push-rod yoke. Disconnect the pressure pipe union from the cylinder and remove the two screws and spring washers from the master cylinder mounting flange. The master cylinder may now be withdrawn from the vehicle.

Dismantling.

Remove the retaining circlip with a pair of long-nosed pliers and extract the dished washer and push-rod. When the push-rod has been removed the plunger with seals attached will be exposed; remove the plunger assembly complete. The assembly can be separated by lifting the thimble leaf over the shouldered end of the plunger. Depress the plunger return spring, allowing the valve stem to slide through the elongated hole in the thimble, thus releasing the tension on the spring. Remove the thimble, spring, and valve complete. Detach the valve spacer, taking care of the spacer spring washer which is located under the valve head, and remove the seal from the valve head.

Examine all parts, especially the seals, for wear or distortion and fit new parts where necessary.

Assembly.

Replace the valve seal so that the flat side is correctly seated on the valve head. The spring washer should then be located **with the domed side against the under side 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 centrally on the spacer, insert the thimble into the spring, and depress until the valve stem engages through the elongated hole of the thimble, ensuring that the stem is correctly located in the centre of the thimble. Check that the spring is still central on the spacer. Fit a new plunger seal with the flat face of the seal against the face of the plunger. Refit the plunger end seal using a new seal if necessary.

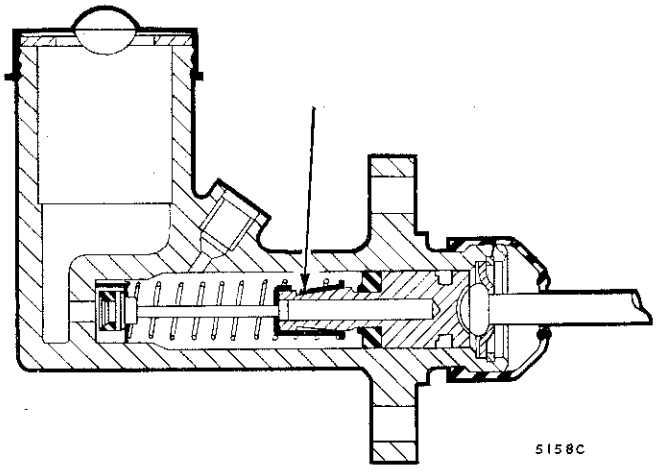


Fig. 5
The master cylinder. The arrow indicates the thimble leaf

Insert the reduced end of the plunger into the thimble until the thimble leaf engages under the shoulder of the plunger. Press home the thimble leaf.

Smear the plunger assembly with the recommended fluid, and insert the assembly into the cylinder bore, valve end first, carefully easing the plunger seal lips into the bore. Replace the push-rod, with the dished side of the washer under the spherical head, into the cylinder, followed by the circlip, which engages in the groove machined in the cylinder body.

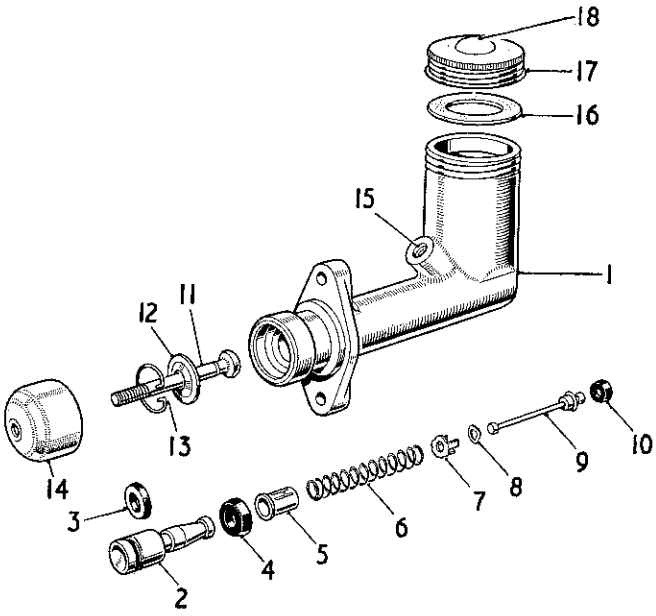


Fig. 6
The clutch mastercylinder components

1.	Master cylinder body.	10.	Valve seal.
2.	Plunger.	11.	Push-rod.
3.	End seal.	12.	Retaining washer.
4.	Plunger seal.	13.	Circlip.
5.	Spring thimble.	14.	Dust cover.
6.	Spring.	15.	Outlet.
7.	Valve spacer.	16.	Cap washer.
8.	Spring washer.	17.	Filler cap.
9.	Valve stem.	18.	Air vent.

Replacement

Locate the master cylinder on the mounting bracket on the bulkhead and fit the bolts, washers, and self-locking nuts. Replace the rubber dust cover. Line up the push-rod fork with the hole in the clutch pedal lever, insert the clevis pin, and secure it with a new split pin. Finally, bleed the system as detailed in Chapter 11.

10. Slave Cylinder

Description.

The slave cylinder is of simple construction, consisting of an alloy body, piston with seal, spring, and bleed screw. The open end is protected by a rubber dust cover. Two bolts with spring washers secure the slave cylinder to the clutch housing.

Removal.

Attach a rubber tube to the bleed screw and open the screw three-quarters of a turn. Pump the clutch pedal until all the fluid has been drained into a clean container. Unscrew the pressure pipe union and remove the two bolts and spring washers securing the cylinder to the clutch housing. The cylinder may now be removed from the vehicle, leaving the push-rod attached to the clutch fork.

Dismantling.

Remove the rubber dust cover, and with an air-line blow out the piston and seal. Extract the spring. Examine all parts, especially the seal, and renew if worn or damaged.

Assembly.

Place the seal on the stem of the piston with the back of the seal against the piston (see Fig. 7). Replace the spring with the small end on the stem, smear well with the recommended fluid, and insert into the cylinder.

Replacement.

Replace the rubber dust cover on the cylinder and locate the cylinder in its correct position on the clutch housing, ensuring that the push-rod enters the hole in the rubber boot. Replace the two mounting bolts and spring washers. Refit the pressure pipe union, taking care to fit the copper washers correctly, and bleed the system.

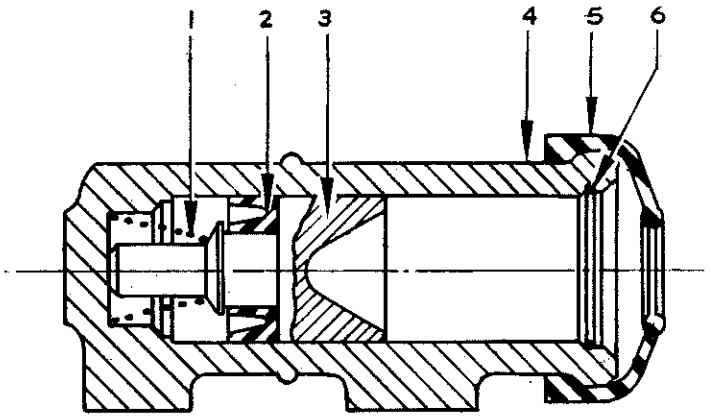


Fig. 7
The clutch slave cylinder components

1. Spring.
2. Seal.
3. Piston.
4. Body.
5. Dust cover.
6. Circlip.

11. Bleeding the Clutch System

Open the bleed screw on the slave cylinder three-quarters of a turn and attach a tube, immersing the open end in a clean receptacle containing a small quantity of the recommended hydraulic fluid. Fill the master cylinder reservoir with fluid. The use of Girling Hydraulic Brake Fluid is recommended, but if this is not available an alternative fluid conforming to Specification S.A.E. 70.R1 should be used. Using slow, full strokes, pump the clutch pedal until the fluid entering the container is completely free from air bubbles. On a downstroke of the pedal tighten the bleed screw and remove the bleed tube.

SECTION I

THE PROPELLER SHAFT

1. Description

The propeller shaft and universal joints are of the Hardy Spicer type with needle-roller bearings.

A single shaft connects the rear axle and the gearbox. To accommodate fore and aft movement of the axle a sliding joint of the reverse spline type is fitted between the gearbox and the front universal joint flange. Each joint consists of a centre spider, four needle-roller bearing assemblies, and two yokes.

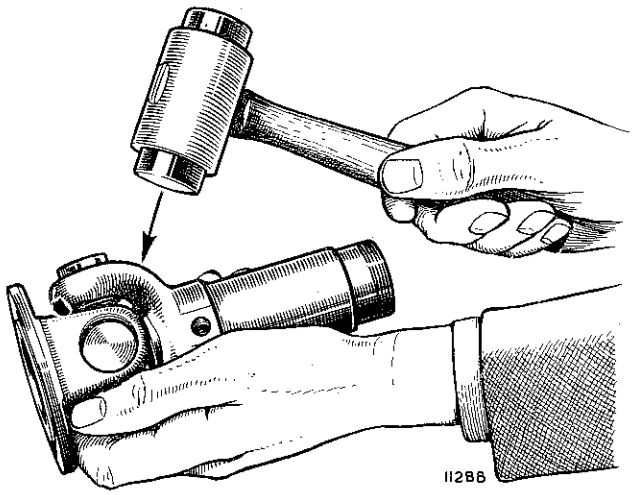


Fig. 1
Where to apply light blows to the yoke after removing the retaining circlip

2. Lubricating the Universal Joints

A lubricator is fitted to each front and rear spider, and should be charged fully after overhauling and subsequently given three or four strokes with the grease gun every 1,000 miles (1600 km.). The correct lubricant is grease to Ref. D (Section C).

If a large amount of grease exudes from the oil seal the joint should be dismantled and new oil seals fitted.

The sliding joint is automatically lubricated from the gearbox.

3. Testing for Wear

Wear on the thrust faces is ascertained by testing the lift in the joint either by hand or with the aid of a length of wood suitably pivoted.

Any circumferential movement of the shaft relative to the flange yokes indicates wear in the needle-roller bearings, or in the splined shaft in the case of the forward joint.

4. Removing the Propeller Shaft

Before removing the bolts and nuts securing the propeller shaft universal joint flange to the rear axle flange carefully mark the flanges to assist in refitting them in their original positions. **This is important.**

Remove the bolts securing the propeller shaft to the rear axle flange. The shaft can now be removed from the car downwards and rearwards.

5. Dismantling the Propeller Shaft

Remove the enamel and dirt from the snap rings and bearing faces. Remove all the snap rings by pinching their ears together with a pair of thin-nosed pliers and prising them out with a screwdriver.

If a ring does not slide out of its groove readily tap the end of the bearing race slightly to relieve the pressure against the ring. Remove the lubricator from the journal and, holding the joint in one hand, tap the radius of the yoke lightly with a copper hammer (Fig. 1). The bearing should begin to emerge; turn the joint over and finally remove with the fingers. If necessary, tap the bearing race from inside with a small-diameter bar (Fig. 2), taking care not to damage the bearing face, or grip the needle bearing race in a vice and tap the flange yoke clear.

Be sure to hold the bearing in a vertical position, and when free remove the race from the bottom side to avoid dropping the needle-rollers.

Repeat this operation for the opposite bearing.

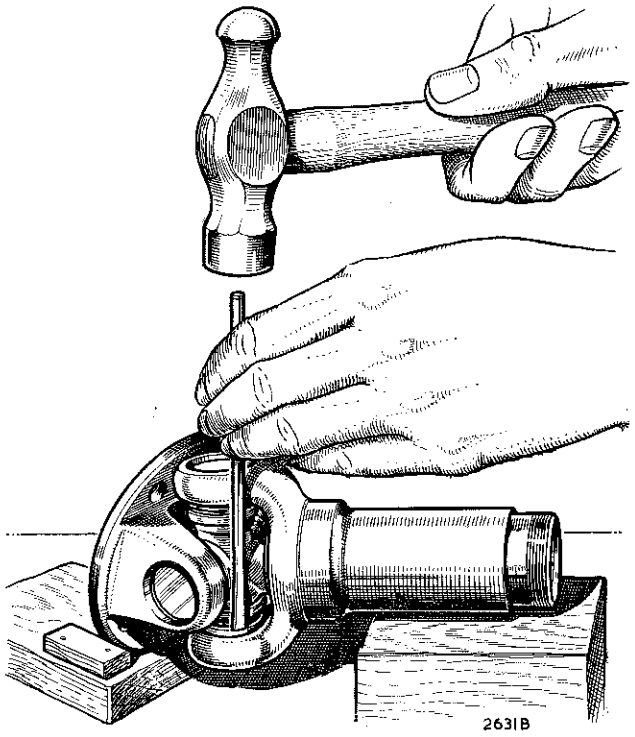


Fig. 2
When dismantling a universal joint the bearings may be tapped out with a small-diameter rod from the inside as shown. Take care not to damage the roller races

Rest the two exposed trunnions on wood or lead blocks to protect their ground surfaces, and tap the top lug of the flange yoke to remove the bearing race.

Turn the yoke over and repeat the operation.

6. To Examine and Check the Wear

The parts most likely to show signs of wear after long usage are the bearing races and the spider journals. Should looseness, load markings, or distortion be

observed, the affected part must be renewed complete; no oversized journals or races are provided.

It is essential that the bearing races are a light drive fit in the yoke trunnions. In the event of wear taking place in the yoke cross-holes, rendering them oval, the yokes must be renewed. In case of wear in the cross-holes in the fixed yoke, which is part of the tubular shaft assembly, it should be replaced by a complete tubular shaft assembly.

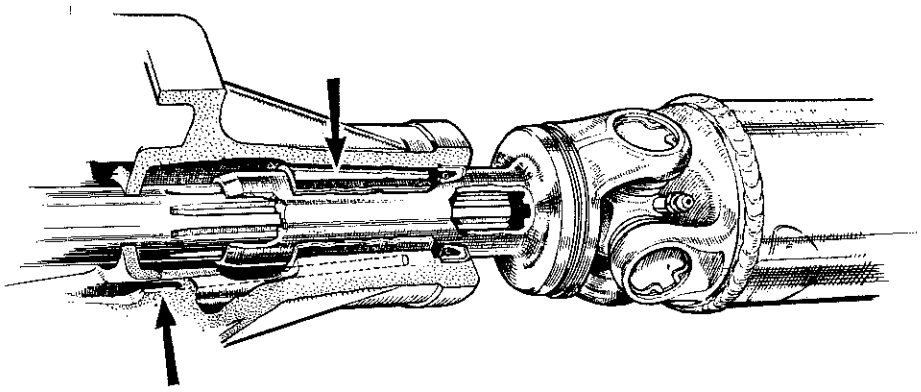


Fig. 4
The sliding joint, showing the oilways which conduct oil from the gearbox

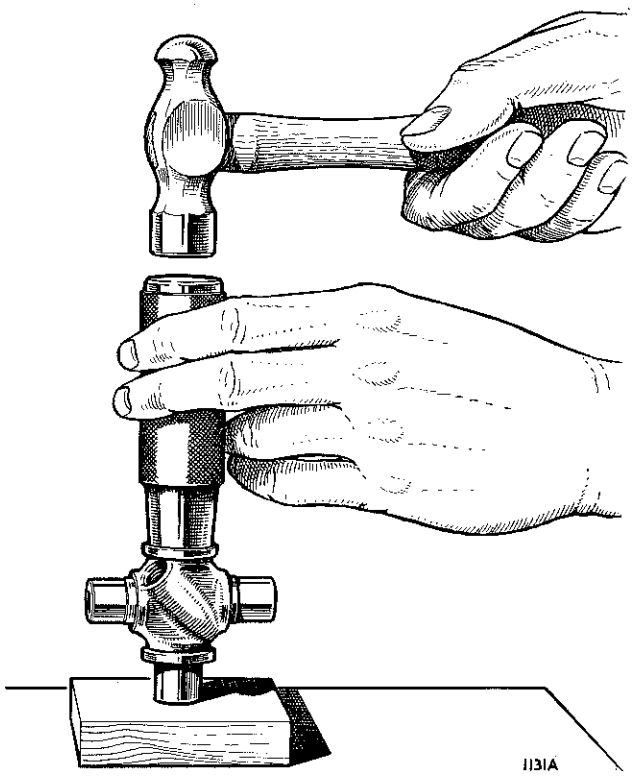


Fig. 3
When replacing the gasket retainer use should be made of a hollow drift to tap it into place without damage

7. Reassembling the Shaft

See that all the drilled holes in the journals are thoroughly cleaned out and free of grease.

Assemble the needle-rollers in the bearing races and fill with grease. Should difficulty be experienced in retaining the rollers under control, smear the walls of the races with grease to Ref. D (Section C) to retain the needle-rollers in position while reassembling.

Insert the spider in the flange yoke, ensuring that **the lubricator boss is fitted away from the yoke.** Using a soft-nosed drift, about $\frac{1}{32}$" (·8 mm.) smaller in diameter than the hole in the yoke, tap the bearing into position. Repeat this operation for the other three bearings. Replace the circlips and be sure that these are firmly located in their grooves. If the joint appears to bind, tap lightly with a wooden mallet: this will relieve any pressure of the bearings on the end of the journals.

It is always advisable to replace the cork gasket and the gasket retainers on the spider journals by means of a tubular drift shown in Fig. 3. The spider journal shoulders should be shellacked prior to fitting the retainers to ensure a good oil seal.

8. Replacing the Propeller Shaft

Wipe the faces of the flanges clean and place the propeller shaft in position on the car. Ensure that the flange resisters engage correctly, that the components are replaced in exactly the same relation as before removal, and that the joint faces bed down even lyall round. Insert the bolts and tighten the self-locking nuts.

SECTION J

REAR SUSPENSION, DIFFERENTIAL AND FINAL DRIVE

1. Removal of Rear Suspension, Differential and Final Drive

Jack up car, remove rear wheels.

To remove the rear suspension, differential and final drive from inside the boot of the car, undo petrol tank straps and remove filler neck and battery cover. Disconnect fuel line at pump. Slide the tank back a few inches and disconnect the fuel line and float unit wires.

Remove the tank (see page M3).

Drain the differential. Disconnect the rear brake hose at the union and disconnect the handbrake cable. Undo the propeller shaft retaining bolts. Undo and remove the four bolts retaining each disc and remove the discs. Undo the 4 differential mounting bolts, leaving the two lower bolts until last; the differential can then be removed.

Remove the locking wire and two bolts retaining the cup on the inboard end of the radius arm. Undo the two nuts holding the radius arm to the strut and withdraw the spindle, at the same time noting the position of the flat washers. Remove radius arm.

Undo the top nut of the damper unit from inside the car and remove the suspension unit.

The suspension unit on the opposite side of the car can be removed in a similar manner.

Replace the hub cap and holding the strut casting, hit the hub cap on the end face with a wooden mallet to loosen hub taper cone. Remove hub cap and the sleeve can be removed and the hub withdrawn from the strut casing. Remove the inner bearing track by use of a parallel drift through the holes provided in the casting. The outer bearing track is removed in a similar manner.

Press the inner race off the stub axle.

Compress the road spring and withdraw the tension pin. Decompress the spring and draw off cap and spring.

Remove the top pick up metacone by undoing the locking wire and the two bolts holding it to the pick up moulding and the mecatone will fall away. *Renewal of damper units can only be done at the factory and must be returned complete with strut casing.*

Remove the inboard drive shaft by extracting the outer circlip and using extractor tool, withdraw the drive shaft complete with bearing.

Remove the inner circlip and pull off the bearing. Remove the O-ring oil seal from the differential casting.

The reverse process may be used for reassembly, remembering that all O-rings and Nylos seals must be renewed.

During re-fitting of the rear radius arm cups take care not to overtighten the retaining bolts which could, in extreme cases, result in loosening the bonded-in metal insert in the body.

No adjustment for track or camber angle is necessary or provided for.

2. Renewing the Pinion Oil Seal

Mark the propeller shaft and pinion shaft driving flanges so that they can be replaced in the same relative positions and disconnect the propeller shaft, carefully supporting it.

Knock back the lock washer and unscrew the nut in the centre of the driving flange. Remove the nut and washer and withdraw the flange and pressed-steel end cover from the pinion shaft.

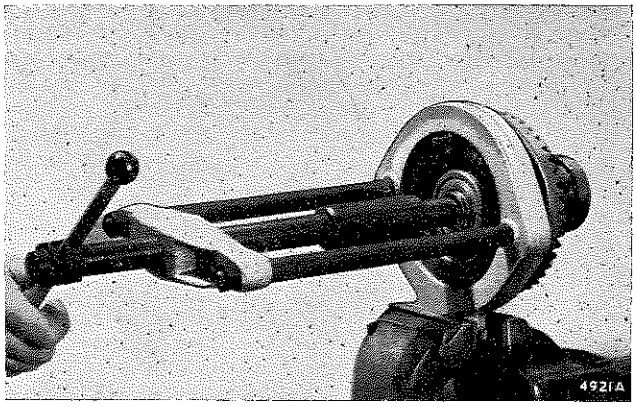


Fig. 1
Using special tool 18G47C *and adaptors* 18G47T *to remove the differential bearings*

Extract the oil seal from the casing.

Press a new seal into the casing with the edge of the sealing ring facing inwards.

Replace the driving flange and end cover, taking care not to damage the edge of the oil seal, and tighten the nut with a torque wrench (special tool 18G372) to a reading of 140 lb. ft. (19·3 kg. m.).

Reconnect the propeller shaft, taking care to fit the two flanges with the locating marks in alignment.

3. Removing the Differential Pinions

Drain the oil from the axle and remove the axle shafts as detailed in Chapter 1.

Mark the propeller shaft and pinion shaft driving flanges so that they can be replaced in the same relative positions; unscrew the self-locking nuts and disconnect the joint.

Unscrew the eight nuts securing the bevle pinion and gear carrier to the axle banjo.

Withdraw the carrier complete with the pinion shaft and differential assembly.

Make sure that the differential bearing housing caps are marked so that they can be replaced in their original positions, then remove the four nuts and spring washers. Withdraw the bearing caps and the differential assembly.

Tap out the dowel pin locating the differential pinion shaft. It must be tapped out from the crown wheel side as the hole into which it fits has a slightly smaller diameter at the crown wheel end to prevent the pin passing right through. It may be necessary to clean out the metal peened over the entry with a $\frac{3}{16}$" drill to facilitate removal of the dowel pin. Drive out the differential pinion shaft when the pinions and thrust washers can be removed from the cage.

4. Replacing the Differential Pinions

Examine the pinions and thrust washers and renew as required.

Replace the pinions, thrust washers, and pinion shaft in the differential cage and insert the dowel pin. Peen over the entry hole.

Reassembly is a versal of the instructions given in Chapter 1.

Refill with fresh oil to Ref. D (Section C).

Note: If it proves necessary to fit any new parts other than those detailed in Chapters 1, 2 and 4 the axle assembly must be set up as in Chapter 6.

5. Dismantling the Crown Wheel and Pinion

Remove the differential assembly as detailed in Chapter 1.

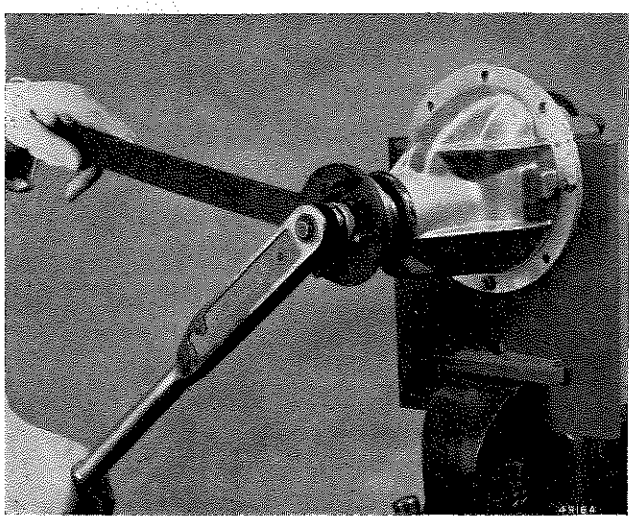


Fig. 2
The bevel pinion flange wrench 18G34A *used to hold the flange against rotation while securing nut is slackened or tightened*

Remove the differential bearings from the differential cage, using the differential bearing remover 18G47C together with the adaptors 18G47T. Note that the thrust face of each bearing is marked with the word 'THRUST' and that shims are fitted between the inner ring of each bearing and the differential cage.

Knock back the tabs of the locking washers, unscrew the nuts from the bolts securing the crown wheel to the differential, and remove the crown wheel from the differential cage.

Unscrew the pinion nut, using a bevel pinion flange wrench (special tool 18G34A) to prevent the flange from turning during this operation.

Remove the driving flange and the pressed-steel end cover.

Drive the bevel pinion rearwards through the carrier, using a soft-metal drift. The pinion will carry with it the inner race and rollers of the rear bearing, distance piece, and shims, leaving the outer race and the complete front bearing in position.

The inner race of the front bearing may be removed with the fingers and the outer race of both the front and rear bearings removed with the special bevel pinion bearing outer race remover (special tool 18G264), together with the adaptors 18G264E and 18G264F (see Fig. 3).

Slide the distance piece and shims from the pinion shaft and withdraw the inner race, using the bevel pinion inner race remover and replacer 18G285 (see Fig. 4).

6. Assembling and Setting the Crown Wheel and Pinion

Apart from the fitting of components as detailed in Chapters 1, 2 and 4 it is not permissible to fit any new parts (e.g. crown wheel and pinion bearings, differential bearings, etc.) to the axle assembly without working through the procedure given in this Section. Furthermore, if a new crown wheel or a new pinion is needed, a mated pair—crown wheel and pinion—must be fitted.

Fitting a new crown wheel and pinion involves four distinct operations:

i. Setting the position of the pinion.
ii. Adjusting the pinion bearing preload.
iii. Setting the crown wheel position.
iv. Adjusting the backlash between the gears.

The following special service tools are required to enable these operations to be carried out correctly:

i. Bevel pinion and differential setting gauge.
ii. Bevel pinion inner race remover and replacer.
iii. Bevel pinion outer race remover and replacer.
iv. Bevel pinion preload gauge.

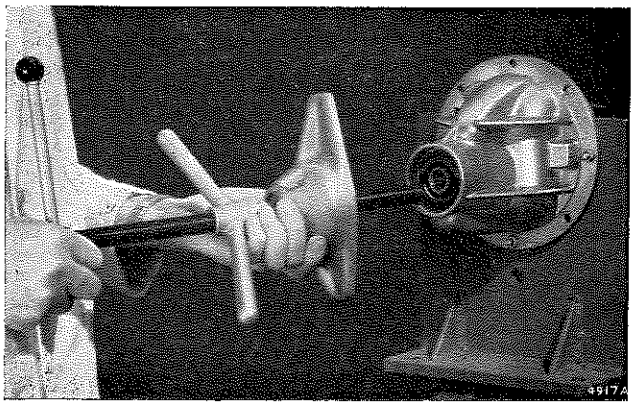


Fig. 3
Both front and rear bearing outer races may be removed, using special tool 18G264 *with adaptors* 18G264E *and* 18G264F

7. Setting the Pinion Position

i. Fit the bearing outer race to the gear carrier, using the special pinion race replacing tool.
ii. Smooth off the pinion head with an oil-stone but do not erase any markings that may be etched on the pinion head.
iii. Assemble the pinion and rear bearing with a washer of known thickness behind the pinion head.
iv. Position the pinion in the gear carrier without the shims, bearing spacer, and oil seal.
v. Fit the inner ring of the front bearing and the universal joint driving flange and tighten the nut gradually until a bearing preload of 10 to 12 lb. in. (·12 to ·14 kg. m.) is obtained.
vi. Remove the keep disc from the base of the magnet. Adjust the dial indicator to zero on the machined step 'B' of the setting block.

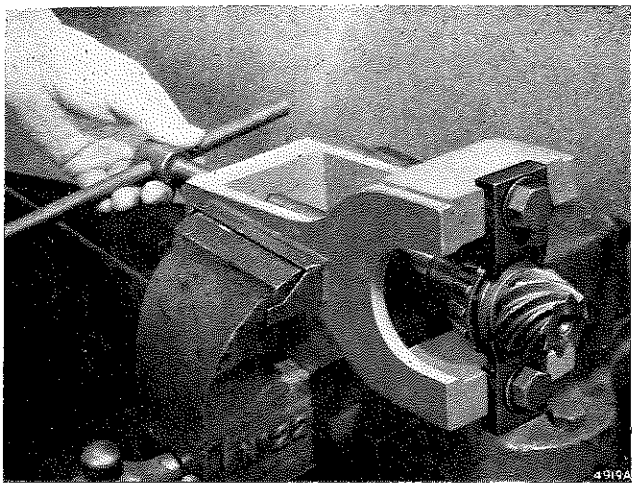


Fig. 4
Using special tool 18G285 *to remove the bevel pinion bearing inner race*

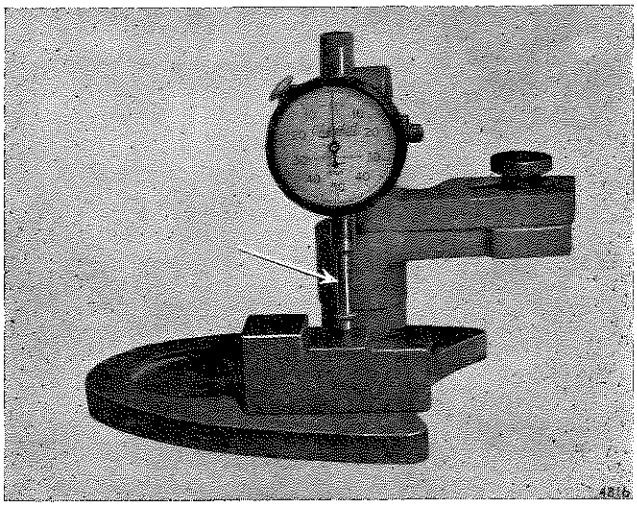


Fig. 5
Setting the gauge to zero on the special block for determination of the pinion position. The arrow indicates the extension of the contact foot

vii. Clean the pinion head and place the magnet and dial indicator in position (Fig. 6). Move the indicator arm until the foot of the gauge rests on the centre of the differential bearing bore at one side and tighten the knurled locking screw.

Obtain the maximum depth reading and note any variation from the zero setting. Repeat the check in the opposite bearing bore. Add the two variations together and divide by two to obtain a mean reading.

viii. Take into consideration any variation in pinion head thickness. This will be shown as an unbracketed figure etched on the pinion head and will always be minus (—). If no unbracketed figure is shown the pinion head is of nominal thickness.

Using the mean clock gauge reading obtained and

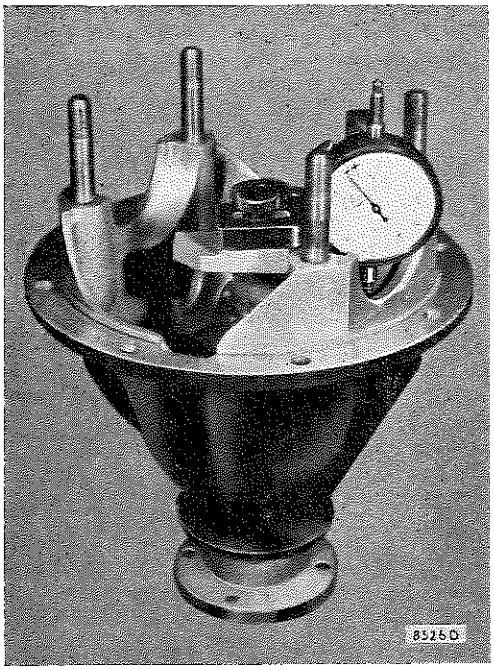


Fig. 6
The special tool in position on the pinion with the dial indicating the variation of the setting from standard

the unbracketed pinion head figure (if any) the following calculation can be made.

(*a*) **If the clock reading is minus** add the clock reading to the pinion head marking, the resulting sum being minus. **Reduce** the washer thickness by this amount.

Example:

Clock reading	... ...	—·002 in.
Pinion marking	... ...	—·005 in.
Variation from nominal	...	—·007 in.

Reduce the washer thickness by this amount.

(*b*) **If the clock reading is plus and numerically less** than the pinion marking, **reduce** the washer thickness by the difference.

Example:

Pinion marking	... ...	—·005 in.
Clock reading	... ...	+·003 in.
Variation from nominal	...	—·002 in.

Reduce the washer thickness by this amount.

(*c*) **If the clock reading is plus and numerically greater** than the pinion marking **increase** the washer thickness by the difference.

Example:

Clock reading	... ...	+·008 in.
Pinion marking	... ...	—·003 in.
Variation from nominal	...	+·005 in.

Increase the washer thickness by this amount.

The only cases where no alterations are required to the washer thickness, are when the clock reading is **plus** and **numerically equal** to the unbracketed pinion marking, or the clock reading is zero and there is no unbracketed marking on the pinion head.

ix. Allowance should then finally be made for the mounting distance marked on the pinion head in a rectangular bracket as follows:

If the marking is a **plus** figure, **reduce** the washer thickness by an equal amount.

If the marking is a **minus** figure, **increase** the washer thickness by an equal amount.

A tolerance of ·001 in. is allowed in the thickness of the washer finally fitted.

8. Adjusting the Pinion Bearing Preload

A washer of the thickness indicated by use of the tool and calculations should now be fitted under the pinion head and the pinion assembled with bearings, pinion bearing distance piece, shims to the value of approximately ·012 in. (·30 mm.), oil seal, and universal joint flange. Prevent the universal joint from turning and tighten the pinion nut gradually to a torque spanner reading of 140 lb. ft. (19·4 kg. m.). Checks should be made during the tightening to ensure that the pinion bearing preload does not exceed 15 lb. in. (·173 kg. m.). When the nut is correctly tightened it should provide a pinion bearing preload of 13 to 15 lb. in. (·149 to ·173 kg. m.). The shim thickness must be increased if the preload is too great or reduced if it is insufficient. When the correct preload is obtained no further attention is needed so far as the pinion is concerned.

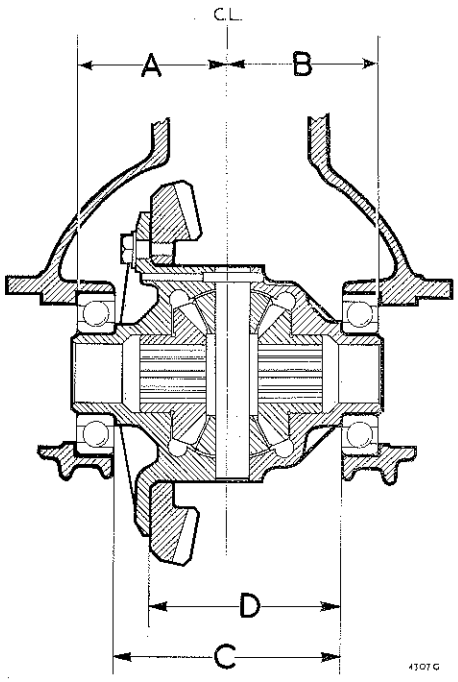


Fig. 7
Variations from the standard dimensions between the registers indicated are stamped on the differential carrier or cage

9. Setting the Crown Wheel Position

Before fitting the crown wheel and differential assembly to the differential carrier it is necessary to calculate the amount of shim thickness. To assist in the calculations of the thickness of shims to be fitted behind each differential cage bearing, variations from the standard dimensions are indicated by stamped numbers on the carrier adjacent to the bearing bores. The variations to be considered are shown in Fig. 7, (A) being the distance from the centre-line to the bearing register of the carrier on the left-hand side and (B) the distance from the centre-line to the bearing register of the carrier on the right-hand side. The (C) dimension is from the bearing register on one side of the cage to the register on the other side, while the (D) dimension is from the rear face of the crown wheel to the bearing register on the opposite side. Any variation from standard on the (A) dimension will be found stamped on the carrier adjacent to the bearing bore, and similarly with the (B) dimension. The (C) and (D) variations are stamped on the machined face of the differential cage.

It is possible to calculate the shim thickness required on the left-hand side by the use of the following formula:

A + D — C + ·007 in.

Substituting the actual variations shown, this formula gives the shim thickness required to compensate for the machining tolerances plus the extra ·002 in. to give the necessary bearing pinch. In addition, allowance must be

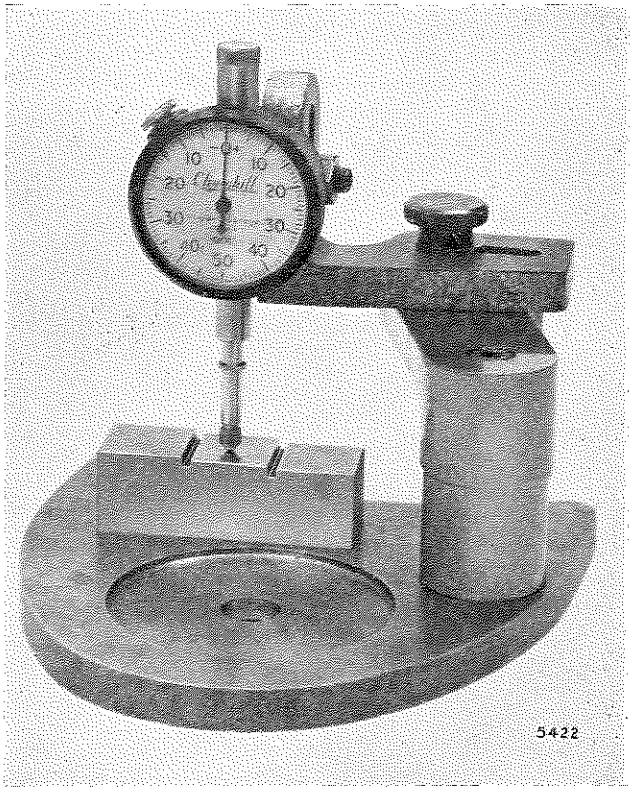


Fig. 8
To measure variations in bearing thickness first zero the gauge on the portion of the gauge block marked 'B'

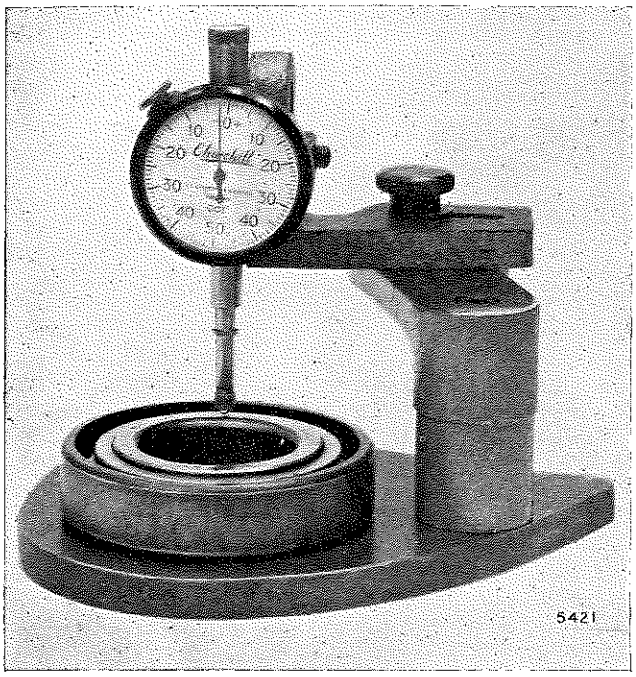


Fig. 9 Checking the variation in bearing thickness

made for variations in bearing thickness in the following manner.

Rest the bearing, with the inner race over the recess and outer ring thrust face downwards, on the small surface plate of the bevel pinion and differential bearing setting gauge. Drop the magnet on the surface plate and zero the clock gauge to the small gauge block on its step marked 'B' (see Fig. 8. This is the thickness of the standard bearing.) Swing over the indicator until it rests on the plain surface of the inner race and, holding the inner race down against the balls, take a reading (Fig. 9). Normally the bearing will be standard to —·003 in., though in some cases variations may be from standard to —·005 in. A negative variation shown by this test indicates the additional thickness of shimming to be added to that side of the differential cage.

The formula for the right-hand side is:

B—D+·006 in.

and here again final allowance must be made for variation in bearing thickness.

When a framed number is marked on the back of the crown wheel, e.g. +2, it must be taken into account before assembling the shims and bearings to the differential cage. This mark assists in relating the crown wheel with the pinion.

If, for example, the mark is +2, then shims to the value of ·002 in. (·05 mm.) must be transferred from the left-hand side (the crown wheel side) to the right-hand side. If the marking is —2, then shims to the value of ·002 in. (·05 mm.) must be moved from the right-hand side to the left-hand side.

10. Adjusting the Backlash

Assemble the bearings (thrust faces outwards) and shims as calculated to the differential cage.

Bolt the crown wheel to the differential cage but do not knock over the locking tabs. Tighten the bolts to a torque wrench reading of 60 lb. ft. (8·3 kg. m.).

Mount the assembly on two 'V' blocks and check the amount of run-out of the crown wheel, as it is rotated, by means of a suitably mounted dial indicator. The maximum permissible run-out is ·002 in. (·05 mm.) and any greater irregularity must be corrected. If there is excessive run-out detach the crown wheel and examine the joint faces on the flange of the differential cage and on the crown wheel for any particles of dirt.

When the parts are thoroughly cleaned it is unlikely that the crown wheel will not run true.

Tighten the bolts to the correct torque wrench reading and knock over the locking washers.

Fit the differential to the gear carrier. Replace the bearing caps and tighten the nuts to a torque wrench reading of 65 lb. ft. (8·99 kg. m.). Bolt the special tool surface plate to the gear carrier flange and mount the clock gauge on the magnet bracket in such a way that an

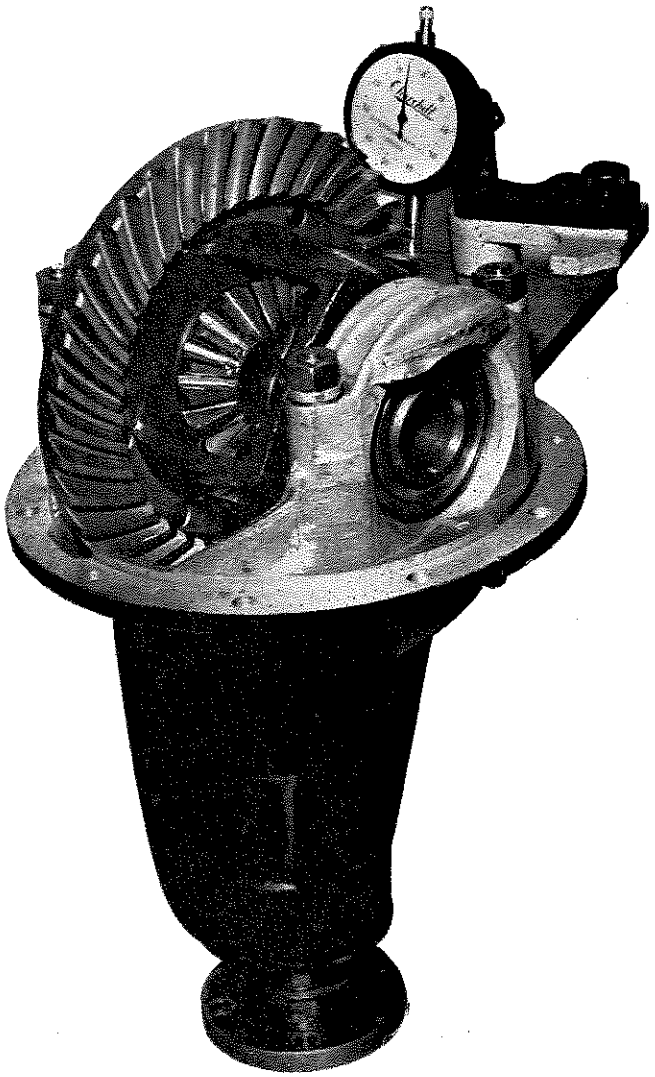


Fig. 10
Measuring the crown wheel backlash with special tool 18G191B

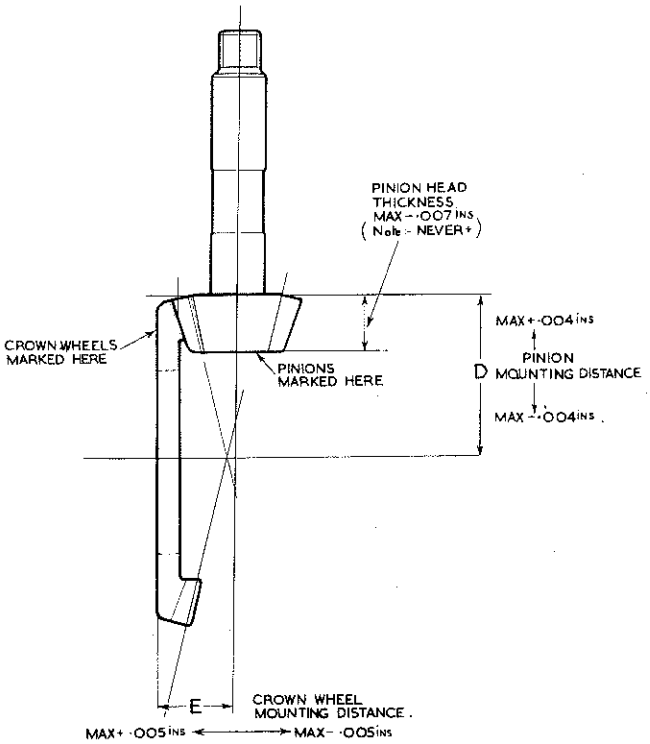


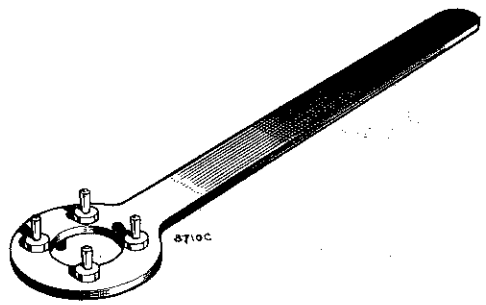
Fig. 11 Crown wheel and pinion markings

accurate backlash figure may be obtained (see Fig. 10). The recommended backlash will be found etched on the rear face of the crown wheel. The minimum backlash allowed in any circumstances is ·005 in. (·127 mm.) and the maximum is ·007 in. (·178 mm.).

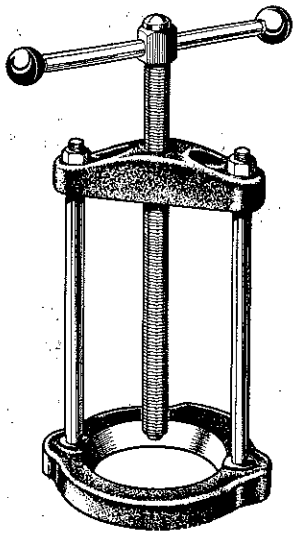
A movement of ·002 in. (·05 mm.) shim thickness from one side of the differential to the other will produce a variation in backlash of approximately ·002 in. (·05 mm.). Thus it should be possible to set up the differential, even though the backlash is incorrect, by removing the bearings on one occasion only.

Great care must be taken to ensure absolute cleanliness during the above operations, as any discrepancies resulting from dirty assembly would affect the setting position of the crown wheel or pinion.

11. Special Tools

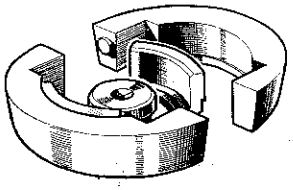


18G34A. *Bevel Pinion Flange Wrench.*
This wrench prevents the rotation of the bevel pinion flange when releasing or tightening the flange securing nut. The pegs of the holding wrench fit into the bolt holes of the flange.



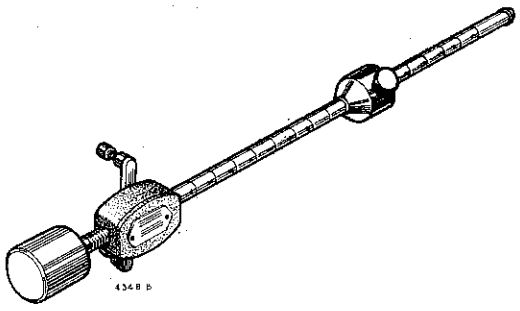
18G47C

18G47C. *Differential Bearing Remover (basic tool).*
This standardized basic tool used in conjunction with adaptors 18G47T permits easy and safe withdrawal of the differential bearings.



18G47T

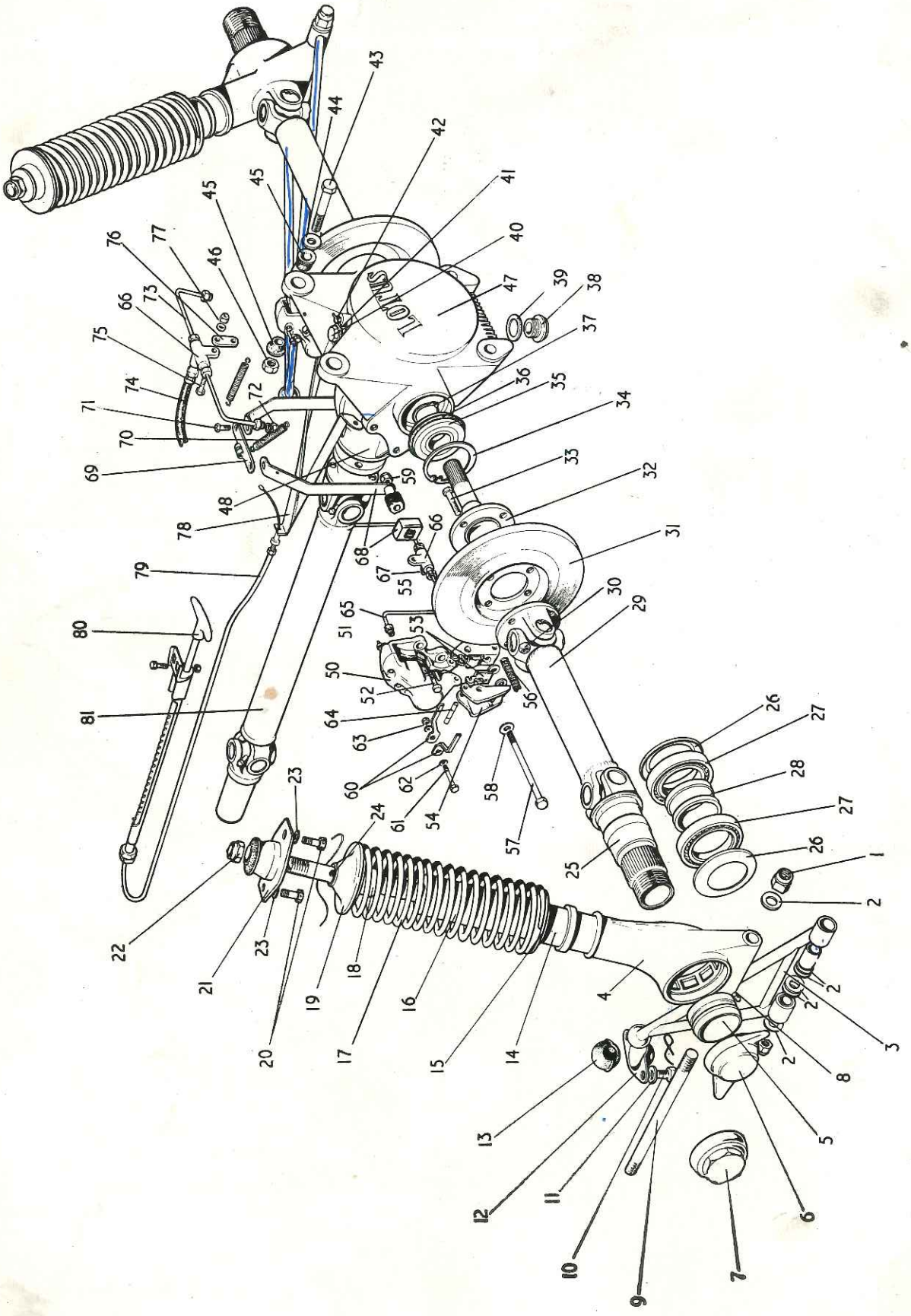
18G47T. *Differential Bearing Remover—Adaptor.*
For use with basic tool 18G47C.



18G207

18G207. *Bevel Pinion Bearing Preload Gauge.*
The movable arms of the tool are located in opposite holes of the bevel pinion flange and the weight moved along the rod to the poundage required.

Special Tools *(continued on* J10*)*

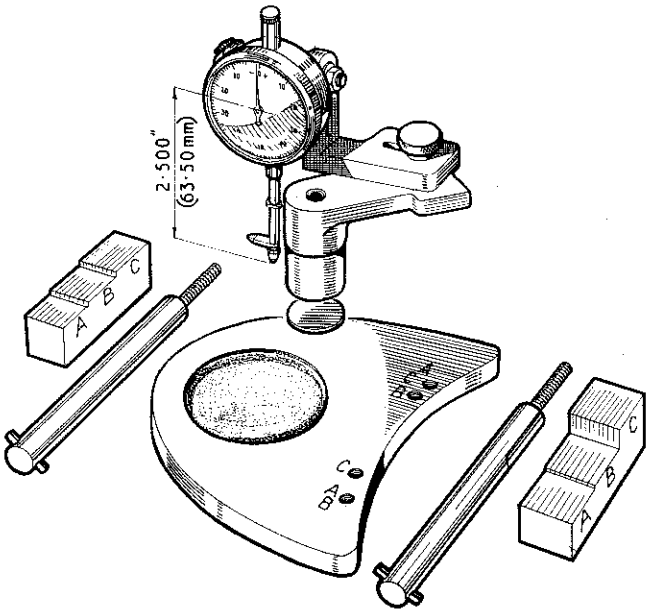


REAR SUSPENSION & DIFFERENTIAL AND FINAL DRIVE COMPONENTS

12 KEY TO REAR SUSPENSION DIFFERENTIAL AND FINAL DRIVE COMPONENTS

No.	Description	Qty.	Lotus Parts No.
1.	7/16″ U.N.F. Nyloc nut	4	B 27
2.	7/16″ Washer, plain	12	B 29
3.	Wishbone	2	E 2006
4.	Rear bearing housing	2	E 2012
5.	Taper collar	2	E 7034/1
6.	Hut nut, standard, right hand	2	E 1024
	Hub nut, standard, left hand	2	E 1025
7.	Hub nut, continental, right hand	2	E 1024/E
	Hub nut, continental, left hand	2	E 1025/E
8.	Grease nipple	2	E 1008
9.	Locating rod	2	E 2009
10.	Bolts 5/16″ U.N.C. × 7/8″ long	4	
11.	Washer 5/16″ plain	4	
12.	Cup radius arm	2	E 2008
13.	Rubber ball	2	E 2007
14.	Suspension arm space, right hand drive	2	E 2002/R
	Suspension arm spacer, left hand drive	1	E 2002/L
	Suspension arm spacer, left hand drive	1	E 2002/R
15.	Bottom abatment	2	E 2004
16.	Damper unit	2	E 2000
17.	Spring	2	E 2001
18.	Aeon rubber, top limit stop	2	E 2005
19.	Top abatment	2	E 2003
20.	3/8″ bolts U.N.C. × 1″ long wirelocking	4	P 7
21.	Bush rubber metacone	2	E 2011
22.	Nut 9/16″ U.N.F. type P	2	G 27
23.	Washers 3/8″ plain	2	D 29
24.	Tension pin 3/13″ D	2	E 2010
25.	Outer drive shaft, left hand	1	E 7034
	Outer drive shaft, right hand	1	E 7035
26.	Nylos seal	4	E 7037
27.	Bearing hub	4	E 7036
28.	Spacer (bearing) (Standard)	2	E 7035/1
	Spacer (bearing) (+ ·0015″)	2	E 7035/2
	Spacer (bearing) (+ ·003″)	2	E 7035/3
29.	Fixed half shaft	2	E 7033
30.	Nut 3/8″ U.N.F. pinnacle	8	C T
31.	Disc rear brake	2	E 4038
32.	Inboard drive shaft	2	E 7030
33.	3/8″ U.N.F. bolt 1″ long	8	C 5
34.	Circlip 72 mm.	2	E 7031
35.	Bearing	2	E 7028
36.	Bearing rubber "O" ring	2	E 7029
37.	Circlip 30 mm.	2	E 7032
38.	Plug drain	1	E 7019
39.	Washer fibre (plug drain)	1	E 7022
40.	Plug filler and breather	1	E 7023
41.	Washer fibre (plug filler and breather)	1	E 7024
42.	Dip stick	1	E 7026
43.	Differential mounting bolt 1/2″ U.N.F. × 3″ long	4	F 16
44.	1/2″ washers	8	
45.	Metalastic half bush	8	E 7018
46.	1/2″ U.N.F. Nyloc P nut	4	F 28
47.	Differential casing	1	E 7017
48.	Nose piece, 4·5 axle	1	E 7039
	Nose piece, 4·2 axle	1	E 7040
49.	Propeller shaft	1	E 7001
50.	Caliper C.I. complete, right hand	1	E 4037
	Caliper C.I. complete, left hand	1	E 4036
51.	Pad assembly rear	2	E 4036
52.	Caliper mounting bolt 3/8″ U.N.F. × 1 1/2″ Lg.	4	E 4057
53.	Hand brake pad assembly	2	
54.	Clamping lever (short)	2	
55.	Clamping lever (long)	2	
56.	Clamping spring	2	
57.	Tie rod	2	
58	Washers, plain (tie rod)	8	
59.	Adjusting nut	2	
60.	Pad retaining fingers	4	
61.	2 B.A. bolt × 1 1/4″ Lg.(finger bolt)	2	
62.	Washers, plain, 2 B.A.	4	
63.	Nut, 2 B.A.	2	
64.	Pivot pin	2	
65.	Bleed pipe	2	
66.	3 way union	2	E 4041
67.	Bleed nipple	1	E 4043
68.	Handbrake nut and screw with nut	2	E 4054
69.	Handbrake balance bar	1	E 4056
70.	Balance bar return spring	2	E 4055
71.	Bolt (balance bar)	2	
72.	Nut (balance bar)	2	
73.	Brake pipe	2	
74.	Rear brake hose assembly	1	
75.	Bolt (union)	2	
76.	Union post	1	E 4042
77.	Nut (union post)	1	
78.	Handbrake cable bracket	1	E 4053
79.	Handbrake cable	1	
80.	Handbrake assembly	1	
81.	Handbrake assembly	1	
	Road wheel (black spot)	5	E 7020
	Road wheel (red spot)	5	E 7020/1

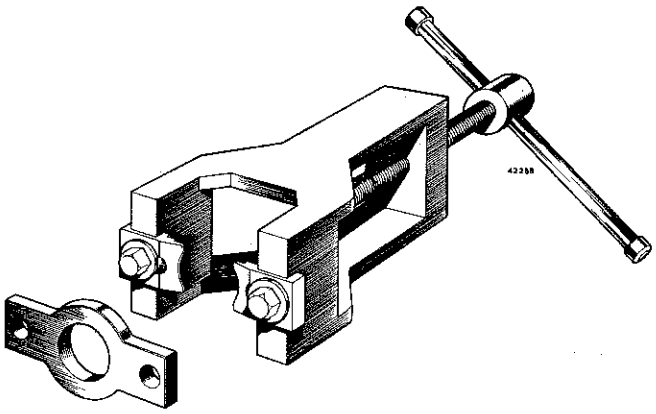
Special Tools *(continued from J7)*



18G191B

18G191B. *Bevel Pinion and Differential Bearing Setting Gauge.*

Correct assembly and adjustment of the pinion and differential gear is impossible without this special tool.
Alternatively 18G191 and 18G191A may be used.



18G285

18G285. *Bevel Pinion Bearing Inner Race Remover and Replacer.*

A tool which is essential when withdrawing or replacing the inner bearing race of the pinion shaft.

SECTION K

FRONT SUSPENSION AND STEERING

1. Dismantling the Front Suspension

Jack the car up. Remove hub nut and wheel. Replace hub nut to protect the thread.

Disconnect the brake hose.

Remove the nut on the end of the steering arm. Separate the track-rod end from the steering arm.

Remove the nut, washer and rubber bush from the end of the anti-roll bar and the nut and washer from the outer end of the suspension arm. Separate the top suspension arm from its taper in the top of the king-post, when the hub and disc assembly will fall away and hang on the lower wishbone.

Remove the securing bolts attaching the lower wishbones to their mounting brackets.

Pull the wishbone and hub assembly away.

Remove the bolt securing the lower end of the spring damper unit to the wishbone.

Remove the spring damper unit.

Remove the bolt securing the lower wishbone to the trunnion.

Unscrew the trunnion from the king-post.

Withdraw the two bolts holding the caliper to the mounting bracket and remove the caliper.

Unscrew the hub cap, remove the grease cap from the end of the hub. Withdraw the cotter pin from the castellated nut enabling the complete hub and disc assembly to be withdrawn from the stub-pin, tap out the bearings.

Undo the six bolts securing the disc to the hub. Part the hub and disc.

Bend back the tab washers on the four bolts securing the caliper mounting bracket, steering arm and disc shield to the kingpost.

Remove the stub pin by slackening off the nyloc nut on the inner end of the stub pin and tap the pin off the taper.

Remove the nut and withdraw the stub pin.

Should the anti-roll bar have to be removed, remove the screws on the forward face of the mounting blocks and pull the bar away, noting that the threaded ends are cranked so that they lie parallel with the ground line of the car.

To dismantle the spring damper unit, compress the road spring.

Remove the slotted spring cap, decompress the spring and draw it from the damper unit.

The suspension is now completely dismantled.

All bearings should be washed and inspected. All parts should be cleaned and inspected for cracks. If the car has suffered any impact, all parts should be electrically crack tested and checked for alignment.

2. Assembling the Front Suspension

Assemble the suspension by reversing the process.

Should the trunnions become mixed, note that the left-hand threaded trunnion fits on to the right-hand king-post and vice versa.

Note: *It should be noted in reassembly that before tightening suspension attachment points the weight of the vehicle should be resting on the front suspension normal assemblies. This will avoid imposing undue torsional stresses on the rubber mounting bushes. That could be possible if units were tightened in their extended positions. Brakes must be bled after re-assembly.*

3. Removing the Steering Column

Remove steering wheel badge.

Remove steering wheel by undoing the six screws round the steering wheel boss.

Remove the two tapers pins securing the boss to the steering column and draw off the boss.

Unscrew the two nuts holding the upper securing brackets to the footwell.

Undo the pinch bolt on the lower rubber joint and draw the joint off the end off the splined shaft of the steering box.

Draw the steering column out through the upper steady bearing and remove the steering column out through the bonnet.

4. Assembling the Steering Column

Assemble in the reverse order.

RACK AND PINION STEERING

5. Removal

Separate the tie rod ball joints from the steering arm taper hole.

Remove the four nyloc nuts from the bottom of the rack and pinion mounting brackets. Withdraw bolts and separate the two halves of the rack and pinion mounting brackets. (Note dowel in top half of bracket nearest pinion box.)

Undo the pinchbolt securing the steering column to the pinion shaft and withdraw the rack and pinion assembly from the engine bay.

6. Dismantling

Slacken the rubber gaiter retaining clips, pull the inner end of each gaiter from between the clip and rack tube, then slide each gaiter towards the outer ball joint.

Slacken the locknuts and unscrew each outer tie rod from the rack. Withdraw a coil spring from each end of the rack.

Turn back taps of tabwashers, then slacken and remove the sleeve nut, tabwasher and thrust pad from each outer tie rod inner ball joint.

Slacken the locknuts and unscrew each outer ball joint assembly from their respective tie rods.

Remove the locknut, rubber, gaiter, clips, and cap nut from each outer tie rod.

Remove the locknuts and clips from each end of the rack.

Slacken and remove the cap nut, shim pack, coil spring and pressure pad.

Slacken and remove pinion retaining nut, shim pack and pinion shaft complete with bush and thrust washer.

Remove and discard the 'O' ring seal from the retaining nut.

Withdraw the rack from the tube.

Remove thrust washer and bush from the pinion housing.

7. Inspection

Thoroughly clean all components.

Examine the bushes in the end of the rack tube for wear and damage. If necessary renew them, pressing the new bushes into the tube, the first with the innermost edge of the bush 1·75 in. (44·45 mm.) in, the second with

the nearest edge of the bush flush with the end face of the tube.

Fit a new 'O' ring seal to the pinion retaining nut.

Examine the rack and pinion for wear or damage. Renew as necessary.

Examine the pinion thrust washers and bushes for wear or damage. Renew as necessary.

Examine the thrust pad and inner ball joint of each outer tie rod for wear or damage. Renew as necessary.

Examine the outer ball joint assemblies for wear or damage. Renew as necessary.

Check each cap nut for wear or damage. Renew as necessary.

Check that the rack tube or outer tie rods are not bent. Renew as necessary.

8. Assembly

Insert bush and thrust washer into the pinion housing.

Insert the rack into the tube.

Insert pinion with thrust washer and bush into the pinion housing.

Adjust pinion end float as follows:

(*a*) Fit the pinion nut with an excessive amount of shims, screwing the nut until the pinion end float is just eliminated.

(*b*) Utilizing feeler gauges, ascertain the clearance between the inner face of the pinion nut head and pinion housing.

(*c*) Remove the pinion nut and remove from the shim pack a number of shims equal in thickness to the pinion nut/pinion body clearance plus ·008 in. (·2 mm.).

(*d*) Leaving the remainder of the shims in position, fit and tighten the pinion nuts. The pinion should now have ·008 in. (·2 mm.) end float. If the float is unsufficient or excessive, remove or add shims as necessary.

Fit the pressure pad and cap nut, screwing down the nut until pressure pad end float is just eliminated.

Utilizing feeler gauges, ascertain the clearance between the inner face of the cap nut head and pinion housing.

Obtain a shim equal in thickness to the cap nut pinion housing clearance plus ·004 in. (·1 mm.).

Remove the cap nut and fit the shim pack to its threaded shank.

Insert the spring into the pinion housing followed by the cap nut, tightening the nut.

Screw a locknut and fit a clip onto each end of the rack.

Smear the inside of each cup nut with grease and fit them to their outer tie rods followed by the rubber gaiters, clips and locknuts.

Screw the outer ball joint assemblies on to the outer tie rods until the distance between the outer ball joint centre and the tie rod ball joint centre on one side is equal to that on the other, then tighten locknuts.

Fit a thrust pad smeared with grease, new tabwasher and sleeve nut to each outer tie rod inner ball joint. Tighten the sleeve nut, then bend over, alternate tab-washer tabs to contact the sleeve nut and cup nut.

Insert a coil spring into each end of the rack. Screw each outer tie rod assembly on to the rack so that the tie rod ball centres are equally spaced on each side from the end of the rack tube. Tighten locknuts.

Note: Maximum lift of ball in cup to be ·002 in. (·05 mm.). Ensure that the ball joint moves freely.

Pull the inner end of each gaiter on to the rack tube and retain in position by tightening the clips. Tighten the clips that hold the gaiters to the outer tie rods.

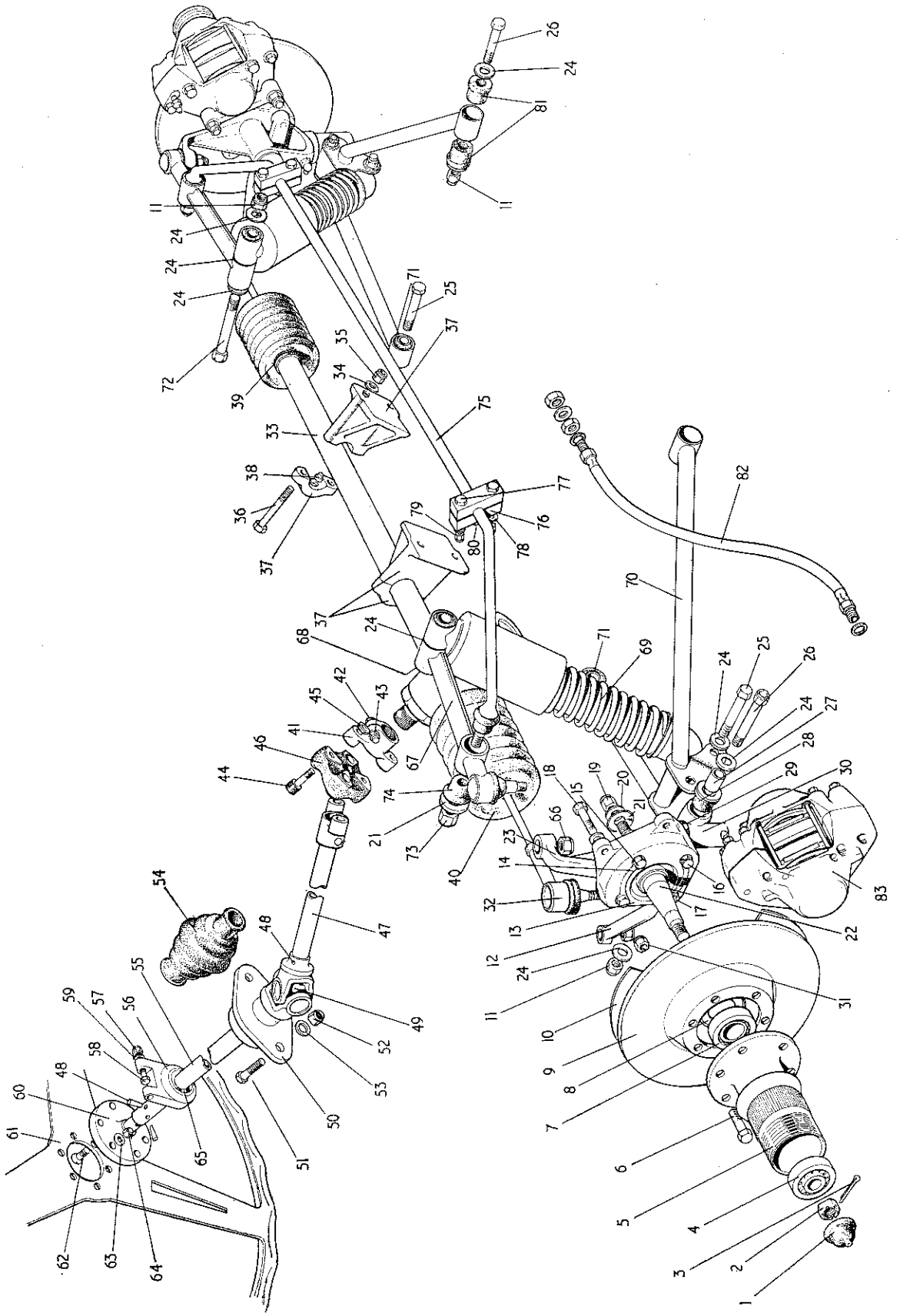
Position the steering wheel in straight ahead position.

Rotate the pinion shaft throughout its whole movement, from stop to stop, counting the number of revolutions. Rotate the pinion from the stop, half the total number of revolutions, thereby centralizing the rack in relation to the pinion.

Fit the steering column, entering the splined pinion shaft into the splined coupling.

Locate the rack and pinion assembly in the engine bay onto the positioned mounting brackets. Place the bracket cap with its locating dowel entered into the corresponding hole in the rack tube. Bolt up.

Connect up the ball joint tapers into the steering arms and lock up with nyloc nuts.



FRONT SUSPENSION AND STEERING COMPONENTS

9 KEY TO THE FRONT SUSPENSION & STEERING COMPONENTS

No.	Description	Qty.	Lotus Parts No.
1.	Grease cap	2	
2.	Stub pin nut ½″ U.N.C. slotted	2	
3.	Split pin $\frac{3}{32}$″ × 1½″	2	
4.	Bearing cone and cup outer	2	E 1022
5.	Hub, right hand	1	E 1023/R
	Hub, left hand	1	E 1023/L
6.	Bolt ⅜″ U.N.F. × 1″ Lg.	12	E 4008
7.	Bearing cone and cup inner	2	E 1021
8.	Nylos seal	2	E 1020
9.	Brake disc front	2	E 4005
10.	Disc dust shield	2	E 4006
11.	½″ U.N.F. Nylock "T" nut	10	F 27
12.	Steering arm, right hand	1	E 1019/R7
	Steering arm, left hand	1	E 1019/L7
13.	Plate caliper mounting, right hand	1	E 4002
	Plate caliper mounting, left hand	1	E 4001
14.	Washer ⅜″ S.P. tab	4	D 30
15.	Bolt $\frac{5}{16}$″ U.N.F. × ⅞″ (top back plate mounting)	4	E 4007
16.	Bolt ⅜″ U.N.F. × 1½″ (bottom front back plate mounting)	2	D 10
17.	Bolt ⅜″ U.N.F. × 1¼″ (bottom rear back plate mounting)	2	E 4009
18.	Bolt ⅜″ U.N.F. × 1¾″ caliper mounting	4	E 4010
19.	Nut $\frac{7}{16}$″ Nylock stub pin	2	E 27
20.	Plain washer (stub pin)	12	
21.	Cup washer (stub pin)	2	
22.	Stub pin	2	1019/5
23.	Vertical link, right hand	1	E 1019 /R
	Vertical link, left hand	1	E 1019/L
24.	Washer plane ½″	10	F 29
25.	Bolt ½″ U.N.F. × 2¾″	4	F 14
26.	Bolt $\frac{7}{16}$″ U.N.F. × 3½″	2	F 19
27.	Distance piece (trunnion) Triumph	2	
28.	Nylon half bush (trunnion) Triumph	4	
29.	Trunnion seal	2	E 1019/4
30.	Trunnion, right hand	1	E 1019/R1
	Trunnion, left hand	1	E 1019/L1
31.	Nut ⅜″ U.N.F. Pinnacle	12	D 27
32.	Track rod ball joint	2	E 3001/2
33.	Rack and pinion assy. complete R.H.D.	1	E 3001/R
	Rack and pinion assy. complete L.H.D.	1	E 3001/L
34.	Washer ¼″ plain	12	B 29
35.	Nut ¼″ U.N.F. Nyloc	4	B 27
36.	Bolt ¼″ U.N.F. × 3¼″ long	4	B 20
37.	Mounting block cap and body complete	2	E 3019
38.	Mounting block locating dowel (pinion box side only)	1	E 3003
39.	Clips (boot to rack)	2	
	Clips (boot to rod)	2	
40.	Boot (rack to track rod)	2	
41.	U/J casting (bottom)	1	E 3005
42.	¼″ U.N.F. 1⅜″ long, clamp bolt	1	B 9
43.	¼″ U.N.F. Nyloc "T" nut	1	B 27
44.	$\frac{5}{16}$″ U.N.F. Allen socket cap screw 1½″ long	4	C 11
45.	$\frac{5}{16}$″ Pal nut	4	E 3017
46.	U/J bottom	1	E 3004
47.	Bottom tube 1′ × 14 S.W.G. ¾″ o.d.	1	E 3008
48.	¼″ taper pin	3	E 3009
49.	U/J centre	1	E 3006
50.	Bottom mounting casting	1	E 3014
51.	Bolt 2 B.A. ½″ hex dead	2	K 3
52.	Nut 2 B.A.	2	
53.	Washer 2 B.A.	2	
54.	Boot steering column	1	
55.	Top tube 3′ × 14 S.W.G. 1″ o.d.	1	E 3007
56.	Top mounting casting	1	E 3016
57.	Nut 2 B.A. Nyloc "T"	2	K 27
58.	Bolt 2 B.A. hex 1″ long	2	K 7
59.	Washer 2 B.A.	4	K 29
60.	Boss (steering wheel)	1	E 3011
61.	Steering wheel	1	E 3010
62.	2 B.A. C.S.K. ⅞″ long screen	6	M 6
63.	Washer 2 B.A. plain	6	K 29
64.	2 B.A. nut nyloc	6	K 28
65.	Sleeve bearing	2	E 3015
66.	Nut ⅜″ U.N.F.	2	
67.	Top arm, right hand	1	E 1002
	Top arm, left hand	1	E 1001
68.	Bush silent block top arm	2	E 1003
69.	Suspension unit complete	2	E 1013
70.	Wishbone, right hand	1	E 1010
	Wishbone, left hand	1	E 1009
71.	Bush silent block lower W/B	2	E 1003
72.	Bolt ½″ U.N.F. × 4½″	2	F 22
73.	Nut $\frac{7}{16}$″ U.N.F. Nyloc "T"	2	E 27
74.	Half bush metalastic	4	E 1004
75.	Anti roll bar	1	E 1005
76.	Mounting block	2	E 1006
77.	Bolt $\frac{5}{16}$″ U.N.F. × 1¾″	4	C 12
78.	Washer plain $\frac{5}{16}$″	4	C 29
79.	Nut $\frac{5}{16}$″ U.N.F. Nyloc	4	C 28
80.	Grease nipple elbow	2	E 1008
81.	Bush half metalastic	4	E 1004
82.	Hose assy. front 12½″ complete	2	E 4013
83.	Caliper C.I. complete, right hand	1	E 4004
	Caliper C.I. complete, left hand	1	E 4003
84.	Spacer, left hand drive only	1	E 1016

SECTION L

THE BRAKES

1. General

All four brakes are Girling Disc Brakes and are operated hydraulically by a master cylinder connected directly to the pendant foot pedal. The two rear brakes, which are fitted each side of the differential housing have additional pads and levers which are operated from the handbrake lever by a single cable.

When the brake pedal is depressed the hydraulic pressure generated in the system moves the pistons and clamps the disc between the pads with equal and opposite force.

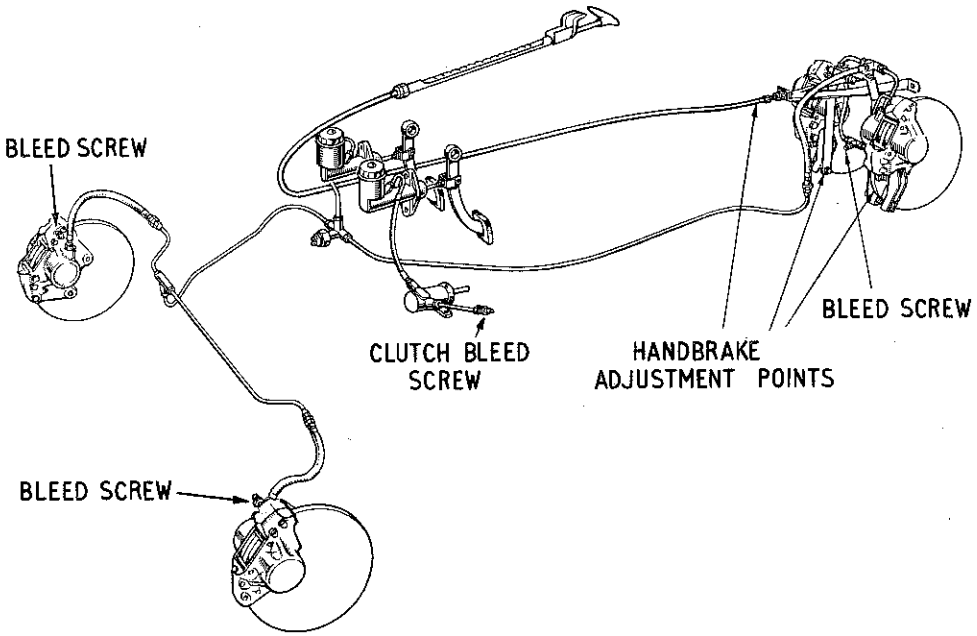


Fig. 1 Lotus Elite Hydraulic System and Brake Layout

When the pressure is released the pads and the pistons remain in a relaxed position with the pads in close proximity to the disc ready for the next application. In this manner adjustment for lining wear is automatic and no manual adjustment is required.

The clutch is also hydraulically operated by a slave cylinder bolted to the clutch housing, which is connected by hose and a pipe to a master cylinder linked to the clutch pedal. The supply tank for the clutch system is cast integrally with the master cylinder, but for the brake system the supply tank is a separate item which screws into the top of the master cylinder. The reservoir of fluid should be maintained to the level marked on the outside of the casting.

The brakes on the front wheels and the main rear brakes are self-compensating for wear and no manual adjustment is needed, but regular inspection is required to ensure that the linings are not worn too thin. The rate of wear can be judged by the thickness of the linings as seen in the caliper "window", and the frequency of future inspection can be estimated.

2. Maintenance Instructions

The pads should be replaced when the lining is worn to within $\frac{1}{8}$ in. thick, and under no circumstances should it be allowed to wear below $\frac{1}{16}$" in thickness. The handbrake pads are not self-adjusting and the movement of the handbrake lever is an indication when adjustment should be made.

The position of the handbrake cable adjusters are shown on the brake layout diagram (Fig. 1) and they should be adjusted so that there is not more than ·003" between the disc and each pad with the brake lever in the "off" position. The foot pedal position can be altered to suit individual requirements by loosening the locknut on the master cylinder push-rod and screwing the jaw end either way to alter the position of the pedal.

Regular inspection of the Brake Supply Tank is needed so that the level of fluid can be maintained to the mark indicated on the outside of the casting. As the brake pads wear the pistons in the cylinders follow up and fluid from the supply tank is drawn into the system. The cylinders are of large capacity and the fluid level could fall dangerously low if the precaution of topping up was neglected. The fluid that should be used is Castrol/Girling Brake and Clutch Fluid, Crimson.

3. Lining Pad Replacement

Jack up the front of the car and remove the road wheels, unscrew the bolts securing the pad retaining plates and swing the plates round to clear the pad window. Remove the wire retaining the pins which hold the pads in position. Lift the worn pads out of the caliper, open the bleed valve one turn, and with an even pressure push the pistons to the bottom of the bores. Some fluid will escape as the pistons are moved. Tighten the bleed screw, place the new pads in position, swing back the pad retaining plates, and tighten the set bolts. Immediately the pads are fitted, and before the car is driven, depress the foot pedal several times until a solid resistance is felt. This ensures that the pistons are against the pads in the correct operating position. Top up the tank with Castrol/Girling Brake and Clutch Fluid and road test.

4. Cylinder Maintenance

The caliper is made of a solid casting with the bores machined from one side and sealed by a threaded plug, disc, and sealing ring, shown in Fig. 2. This plug should not be disturbed, and to avoid damage to the sealing ring the caliper should never be cleaned by a mineral based fluid such as trichloroethylene, petrol or paraffin, etc.

To replace the rubber rings or seals it is necessary to remove the caliper assembly from the vehicle. Drain the fluid from the system by opening a bleed valve and pumping the foot pedal. Disconnect the pipe from the

hose and the hose from the bracket, remove the two caliper fixing bolts and lift the caliper, with the hose attached, from the mounting. Take note of shims between the mounting faces of the caliper and bracket so that they can be replaced in exactly the same manner when refitting.

The brake pads should be removed in the manner described, and instead of pushing the pistons to the

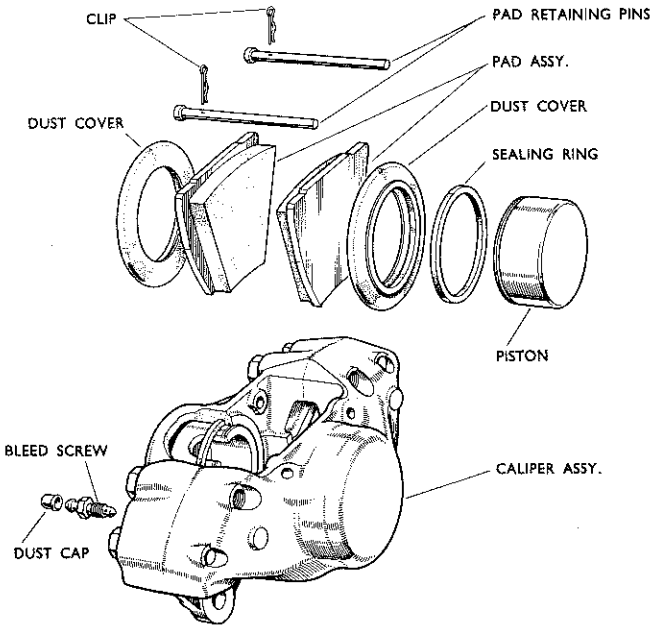


Fig. 2
Wheel cylinder components and caliper

bottom of the bore withdraw them from the caliper body, taking care not to damage the surfaces. The sealing rings may then be lifted out, taking care not to damage the locating grooves. Examine the bores and pistons carefully for any signs of abrasion or 'scuffing'.

It is important that in cleaning the components no petrol, paraffin, trichloroethylene or mineral fluid of any kind should be used. Clean with methylated spirits, allow to vapourise leaving the components clean and dry.

After cleaning and examining lubricate the working surfaces of the bores and pistons with clean genuine Girling Crimson Brake and Clutch Fluid.

5. Assembling

Fit new rubber seals into the grooves of cylinder bore. Locate the rubber dust cover with the projecting lip in the groove provided, the outer one, in the cylinder bore.

Insert the piston, closed end first, into the bore taking great care not to damage the polished surface. Push the piston right home then engage the outer lid of the rubber boot in the groove.

The replacement of the lining pads as described will retain the pistons in position.

Refit the caliper assembly to the support bracket by means of the two securing bolts, confirming that the disc passes between the two pads. If packing shims are assembled between the caliper and the mounting face it is important to replace them as initial assembly.

Re-connect the hose and bleed the brakes.

6. Rear Brakes

The rear brakes are situated each side of the differential housing and carry the handbrake mechanism (see Fig. 3). The replacement of pads and the maintenance of the cylinders is exactly as described for the front brakes, and the handbrake adjustment, which has to be made manually, is done as instructed under the heading "General Maintenance".

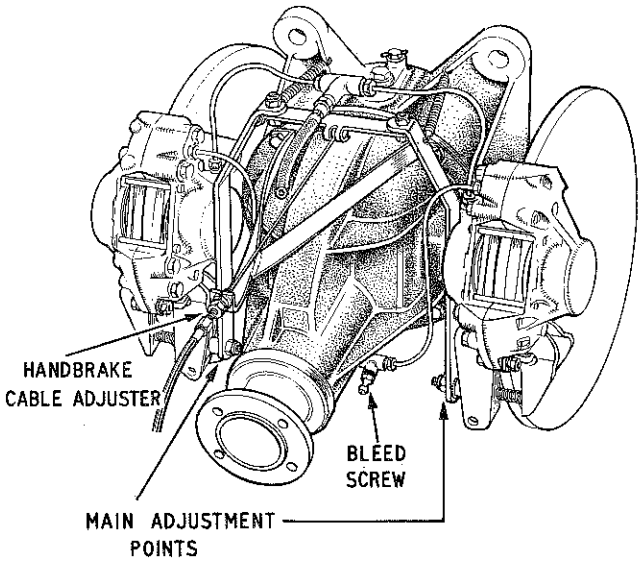


Fig. 3
Rear Handbrake mechanism

7. Fitting New Handbrake Pads

Unscrew the adjustment nuts on the clamping levers and swing the levers outwards. Unscrew the nuts and withdraw the bolts securing the pad positioning arms. Withdraw the arms and the pads can be removed, taking care of the spring and washers, and noting their positions so that they may be replaced correctly. Clean all parts and apply Girling White Brake Grease where necessary, making sure that no grease can touch the lined pads. Lift out the worn pads and place the new ones in position and re-assemble the parts in reverse order to dismantling.

Make sure that the handbreak is fully off and adjust the cable so that there is ·003″ between each pad and the disc face. If it should be necessary to remove the levers from the caliper casting the lever pivot pins have to be removed, and they are retained in position by two pins pressed into the casting. These can be seen in the Fig. 4. On some later models both front and rear calipers have been made by a different manufacturing process, but the maintenance is exactly as described above. On these later models the caliper is made in two halves and bolted together by four bridge bolts. This is done merely for manufacturing reasons and no advantage is gained by separating the two caliper halves. In addition the inner and outer pair of bridge bolts are tightened with a different torque loading to meet the different strain on the casting at these two positions and it is unwise to disturb them.

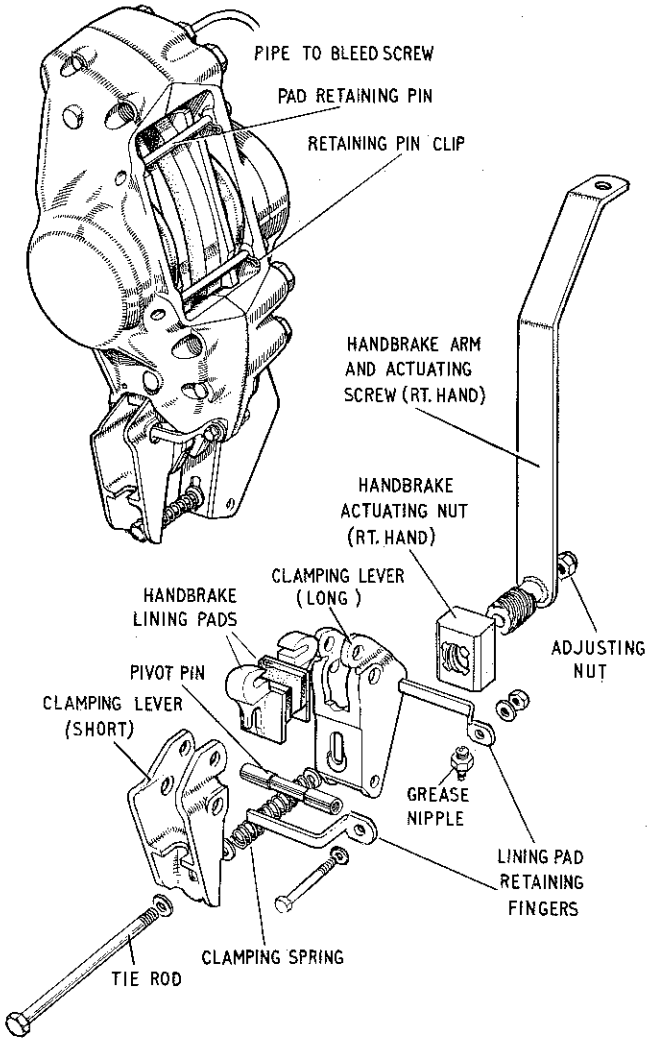


Fig. 4
Rear caliper and handbrake components

8. Discs

To ensure that the brake functions at maximum efficiency a check should be made to see that the disc runs perfectly true between the pads. The maximum run-out permissible on the discs is ·004 in. If e cessive run-out is present it will cause knocking back of the pistons which may create judder and excessive pedal travel. If there is any doubt concerning this condition the disc should be replaced.

9. Bleeding the Hydraulic System

The process of removing air from the pipe line and cylinders is known as "bleeding" and is necessary whenever any part of the system has been disconnected, or the level of fluid in the supply tank has been allowed to fall so low that air has been drawn into the master cylinder.

When seals are worn it is possible for air to enter the wheel cylinders without any sign of leaking fluid, and cause a "spongy" pedal which is the usual indication of bubbles of air in the system.

It is vital that absolute cleanliness is maintained throughout the entire bleeding operation. Never use a rag of linty texture and ensure that no dirt or grit enters the system—especially at the supply tank. All equipment to be used must be entirely free from petrol, paraffin, or any form of mineral oil, as mineral contamination spreads rapidly in the hydraulic system, causing a dangerous deterioration of the rubber seals. Always replace the rubber cap on each bleed screw to prevent dirt entering the bleed tube during any subsequent bleeding operation.

Pressure Bleeding methods are *not* suitable for Girling systems and are not recommended. For pressure bleeding to be successful it must be accompanied by manual bleeding.

10. Bleeding Procedure

Release the parking brake.

Remove the rubber cap from the bleed screw farthest from the master cylinder (i.e. rear, located beneath differential) fit the bleed tube over the bleed nipple, and immerse the free end of the tube in a clean jar containing a little Girling Brake Fluid. Unscrew the bleed nipple about three-quarters of a turn and commence bleeding with a fairly fast full stroke of the pedal. (The floor mat should be removed if it prevents this complete movement.)

As a C.V. master cylinder is fitted to this system the pedal should be allowed to fly back freely.

One or two slightly faster applications may now be made to advantage. Repeat this procedure until it is apparent that all air has been excluded, closing the screw during the last (slow) pedal application.

Repeat with each wheel cylinder in turn, finishing with the cylinder situated nearest the master cylinder (offside front).

It is essential to ensure that at no time during the bleeding operation shall the fluid reservoir level be allowed to fall to a point where air may be admitted.

If the bleeding of any cylinder continues without success for a considerable time it may be that air is being drawn in past the bleed screw threads. In these instances the bleed screw should be tightened at the end of each downward stroke of the pedal and allowing the pedal to return fully before re-opening. Close the bleed screw finally during the last pedal application.

Never use fluid which has just been bled from the system for topping up the supply tank. This fluid will almost certainly be aerated and should be allowed to stand for at least 24 hours before re-use.

11. Detecting the Presence of Air

For all practical considerations the fluid in the hydraulic system is incompressible and movement of the master cylinder plunger is transmitted without loss to the wheel or slave cylinders. If air enters the system part of the plunger movement will be used in compressing the air and causes the "spongy" feel to the pedal movement. This spongyness can be detected more easily by hand pressure than by foot and indicates that "bleeding" is necessary. A more certain test can be applied by the following procedure:

Jack up the car, scotch the wheels, release the parking brake. Slowly apply the foot pedal by hand, whilst an

assistant rotates one of the wheels. When the pedal has travelled approximately $1\frac{1}{4}''$ drag should be felt and the next $\frac{1}{2}''$ to $\frac{3}{4}''$ of pedal travel should lock the wheel. It is an increase in this distance of travel between drag and lock which indicates the existence of air, due to its compressibility.

12. The Brake Master Cylinder

The master cylinder is of the centre valve type and has an alloy body with a polished finished bore, and reservoir. The inner assembly is made up of the push rod, dished washer, circlip, plunger, plunger seal, spring thimble, plunger return spring, valve spacer, spring washer, valve stem and valve seal. The open end of the cylinder is protected by a rubber dust cover.

13. Dismantling

Disconnect the pressure pipe union from the cylinder and remove the securing bolts and clevis pin from jaw end. Remove the filler cap and drain out the fluid.

Pull back the rubber dust cover and remove the circlip with a pair of long-nosed pliers. The push rod and dished washer can then be removed. When the push rod has been removed the plunger with seal attached will then be exposed. Remove the plunger assembly complete. The assembly can then be separated by lifting the thimble leaf over the shouldered end of the plunger. The seal should be eased off the plunger. Depress the plunger return spring allowing the valve stem to slide through elongated hole of thimble, thus releasing tension of spring. Remove thimble, spring and valve complete.

Detach valve spacer taking care of the spacer spring washer which is located under the valve head. Remove the seal from the valve head.

Examine all parts, especially the seals, for wear or distortion and replace with new parts where necessary.

14. Assembling

Replace the valve seal so that the flat side is correctly seated on the valve head. The spring washer should then be located on the under side of valve head, domed side first, being held in position by the valve spacer, the legs of which face towards the valve seal. Replace the plunger return spring centrally on the spacer, insert the thimble into the spring and depress until the valve stem engages through the elongated hole of thimble making sure the stem is correctly located in the centre of thimble. Check that the spring is still central on the spacer. Refit new plunger seal on to the plunger with flat of seal seated against the face of plunger. Insert the reduced end of plunger into the thimble until the thimble leaf engages under the shoulder of the plunger. Press home thimble leaf.

Smear the assembly well with Girling Brake Fluid, and insert the assembly into the bore of cylinder valve end first, easing the plunger seal lips in the bore. Replace the push rod with the dished side of washer under the spherical head into the cylinder followed by the circlip which engages into groove machined in cylinder body.

Replace the rubber dust cover and refit the cylinder to the chassis.

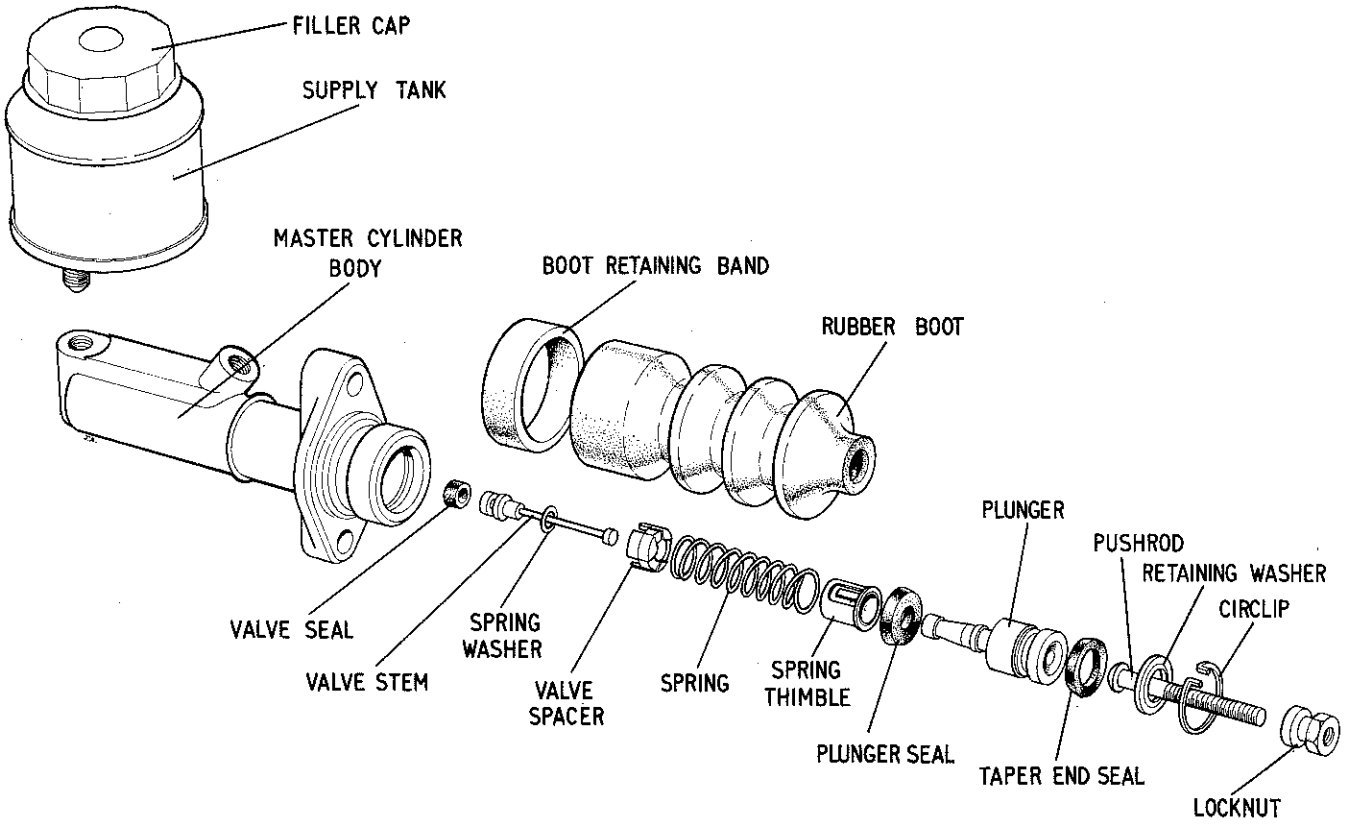


Fig. 5 The brake master cylinder components

SECTION M

FUEL SYSTEM

1. Description

Fuel is drawn from the fuel tank by the AC Fuel Lift Pump which is secured to the engine block and is driven by an eccentric on the camshaft.

The AC pump consists of two main bodies which clamp a diaphragm between their outer flanges.

The lower assembly comprises a rocker arm and body link, both of which pivot on a pin located in the body, attached to the link is the pull rod incorporated in the diaphragm assembly. To protect the diaphragm from crankcase oil splash, an oil seal is located at the point in the lower body where the push rod passes through. A return spring is interposed between the underside of the diaphragm and the lower body, this spring determining the pump output pressure. A further spring is fitted between the rocker arm and the body for the purpose of ensuring that the rocker arm is in constant contact with the eccentric on the camshaft. Also incorporated in the AC fuel lift pump lower body is the hand priming mechanism.

Assembled in the upper body are two valve assemblies, one being opened by suction, and the other by pressure, both valves held in position by a common retaining plate secured inside the upper body by two screws.

Both inlet and outlet valve assemblies are identical in construction and are renewable and interchangeable.

Also incorporated in the upper body is a filter gauze which is held in position with a domed metal top cover and gasket, which in turn is held by a centre screw through the cover into the upper body.

2. To Test in Position

With the engine stopped and switched off, the pipe to the carburetter should be disconnected at the carburetter end, leaving a free outlet from the pump. The engine can then be turned over by hand, when there should be a well defined spurt of petrol at every working stroke of the pump, namely, once every two revolutions of the engine.

3. To Remove Fuel Pump

i. Disconnect the pipes from the inlet and outlet bosses of the fuel pump. Seal off the ends of the pipes to prevent the ingress of foreign matter.

ii. Remove the two fuel pump retaining nuts or bolts and lockwashers, and withdraw fuel pump and engine pad gasket from engine block.

4. To Dismantle

i. Before commencing to dismantle, clean exterior of the pump and scribe a line across the lower and upper body flanges of the pump for location purposes during re-assembly.

ii. Remove domed top cover of pump also gasket and filter gauze.

iii. Remove the five screws and spring washers securing the lower and upper bodies together and separate the two bodies, where an extension primer is fitted to the pump, the priming lever bracket is held by one of the five screws which hold the bodies together.

iv. Remove the two valve plate retainer screws and remove retainer plate, valve assemblies, and gasket from upper body.

v. From the lower body, remove the diaphragm and pull rod assembly, first turning the assembly through an angle of 90° in order to free the rod from the link in the rocket arm assembly.

Note: The diaphragm and pull rod are a permanent assembly and no attempt should be made to separate the two parts.

vi. Lift out the diaphragm return spring and where fitted, remove oil seal retaining washer and oil seal.

vii. Providing that the rocker arm pin is held firmly in the lower body it should not be necessary to remove the rocker arm pin or associated parts unless undue wear is in evidence.

Should it be necessary to remove rocker arm from body, the following procedure should be adopted:

viii. With the earlier type AC fuel pump, the rocker arm pin passes straight through the lower body of the pump and is retained by a spring clip at each end of the pin. Remove one clip and with suitable punch, drive the rocker arm pin through the lower body and withdraw rocker arm, link assembly, rocker arm return spring and spacing washer; with the later type lower body assembly, the rocker arm and associate parts are retained by two retainers which are fitted into slots at engine face of casting, the retainers in turn being held by punch indentations at each end of retaining pins.

To remove the later type of rocker arm assembly, hold rocker arm firmly in suitable vice, leaving a gap between casting and vice, and with two flat bars, approximately 12″ long, insert one in the gap each side of the casting and vice; lever the body away from the rocker arm and pin.

Note: Care should be taken that the type of removing bars used are flat to ensure that the body machined face is not damaged.

ix. On AC fuel pumps where priming levers are fitted, the priming lever should only be removed if known to be defective, when a complete new hand priming assembly should be fitted on re-assembly.

To remove, it is necessary to file off the riveted head of the pivot pin and tap it through the body.

5. Inspection and Overhaul

i. Thoroughly wash all parts in clean paraffin, ensuring that valves are cleaned separately if being used again.

ii. Check the diaphragm for hardening or cracking and examine the lower extremity of the pull rod, where it connects with the rocker arm link, for wear. Renew the diaphragm assembly if any of these signs are in evidence.

iii. Check diaphragm return spring, if coroded or damaged, it should be replaced.

iv. Visually check valve assemblies; if any doubt exists, replacement valves should be fitted. The two valves are identical and can be used for either application by inverting their positions.

v. Examine the rocker arm pad face for wear. Slight wear is permissable but should not exceed a depth of ·010 in. (·254 mm.).

Check rocker arm pin and link holes for wear, also underside of link where diaphragm pull rod engages for wear.

Badly worn or damaged parts should be renewed. Check rocker arm return spring.

vi. Discard old oil seal and gaskets.

vii. Examine upper and lower bodies for cracks or damage. If either the diaphragm or engine mounting flanges are distorted, these should be lapped to restore their flatness.

Renew either if distortion is excessive.

viii. The upper and lower bodies can now be fitted together as follows:

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

Place the upper half of the pump body into its correct position by aligning the scribed lines made on the two flanges prior to dismantling.

Replace the five securing screw and spring washers and tighten only until the heads of the screws just engage the washers.

Release and push rocker arm away from the pump so as to hold the diaphragm at the top of the stroke, and while so held, tighten the body screws diagonally and securely.

Important: After assembling in the manner described above, the edges of the diaphragm should be about flush with its two clamping flanges.

Any appreciable protrusion of the diaphragm indicates incorrect fitting in which case, special care should be taken in maintaining downward pressure on the rocker arm while the diaphragm screws are finally tightened.

Note: Where priming lever extension is fitted, one of the flange screws also holds the priming lever extension bracket.

6. To Reassemble

i. Where the hand primer mechanism has been removed, replace with new assembly, inserting pin through the lower body together with the priming lever. With the return spring in position, rivet over exposed end of pin.

ii. The re-assembly of the rocker arm into the old type body is as follows:

Assemble link, packing washers, rocker arm and rocker arm spring into lower body, at the same time engaging the packing washers, link and rocker arm. Then refit retaining clips into grooves at the ends of rocker arm pin.

The rocker arm should be a tap fit in the body.

Note: The fitting of the rocker arm and associate parts into the body can be simplified by using a piece of ·240″ rod which, being a loose fit in the body, would enable easier assembly. The rocker arm pin can then be pushed through, removing the temporary rod as the pin takes up the proper position.

Assembly of the rocker arm in respect to the new type body assembly:

Assemble rocker arm, link and spacing washers onto rocker arm pin, place rocker arm return spring into body and insert rocker arm assembly into body of pump ensuring that the rocker arm return spring is properly engaged between locating "pips" on casting and rocker arm. Tap two new pin retainers into slots in the body and while holding the retainers hard against the rocker arm, pin punch over the end of the slots with a $\frac{1}{8}$″ pin punch to prevent retainers working loose.

Note: When refitting rocker arm pins, always use new service replacement retainers (coloured copper for identification). These are slightly shorter than the production type to allow for new staking.

iii. Fit a new oil seal washer and steel retaining washer into the lower body, if required on the model fuel pump being repaired.

iv. Place the diaphragm return spring in position over oil seal retaining washer.

v. Place the diaphragm assembly over the spring, with the pull rod downwards, and with the locating tab on the diaphragm at the twelve o'clock position. Press down on the diaphragm at the same time turning the assembly to the left in such a manner that the slot on the pull rod will engage the fork in the link, ultimately turning the assembly a complete quarter of a turn to the left, which will place the pull rod in its correct working position in the link. This will also permit the matching up of the holes in the diaphragm with those on the pump body flange and the tab will now be at nine o'clock position.

vi. Place the new valve gasket in the upper body round the valve ports. Place valve assembly in inlet port with spring facing outwards. Fit other valve in the outlet port position with spring inside the port.

Refit the valve retainer plate and tighten screws until the tension in the retaining plate is taken up.

vii. Refit filter gauze in top of upper body, also domed top cover with new cover gasket. Fit central holding screw ensuring that fibre sealing washer is between screw and cover.

7. To Remove Petrol Tank

i. Disconnect hose clips from inside of boot of car and remove petrol filler cap.

ii. Unscrew the bolts on top of each retaining bracket.

iii. Unscrew the nuts on the underside of the boot holding the lower ends of the retaining bracket withdraw the bolts.

iv. Draw rubber hose off tank.

v. Disconnet petrol line at pump. Draw tank back a few inches.

vi. Disconnect petrol line at tank.

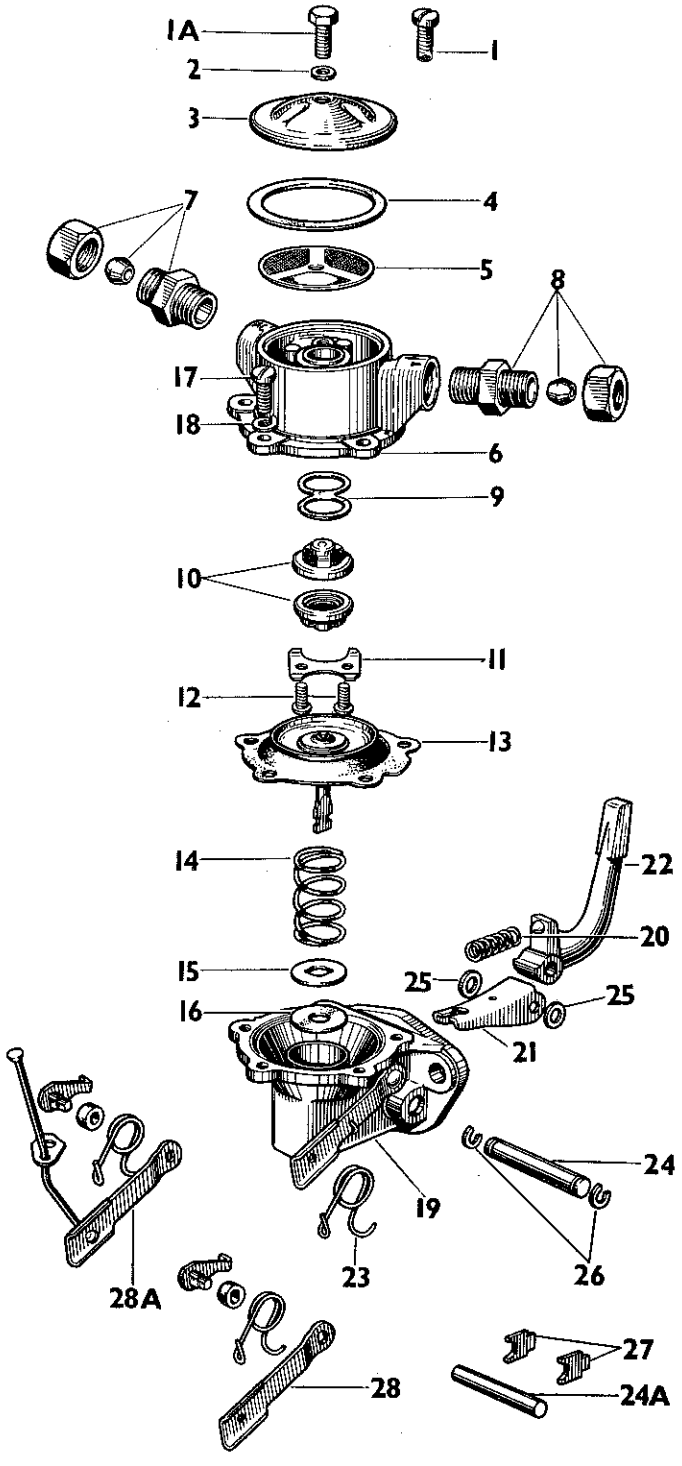
vii. Disconnect the green lead from the top terminal and the black lead from the lower terminal of the gauge unit.

viii. Lift the tank backwards and outwards from boot of car.

Replace the tank by lowering it into the boot. Connect up the hose and gauge leads. Push the tank into position and bolt up the brackets. Place the hose clips over the filler neck. Push the hose into position on this filler neck and the filler cap through the hole in the outer skin of the body. Pull the hose clips up into position and tighten up.

Note: When pushing tank forward into position after connecting petrol pipe, it is important that the petrol pipe at the engine end is gently pulled forward with the tank. Failure to do this can result in a kink in the pipe and subsequent petrol starvation.

AC FUEL PUMP (YD SERIES) STANDARD PARTS



8. Renewing the Petrol Pipe

Disconnect the pipe line at both ends. Draw off the olives and pull the pipe out from the tank end.

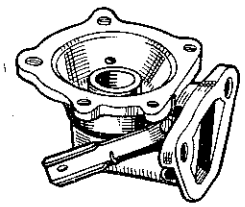
Replace the line by guiding it up through the propeller Shaft Tunnel. Slip the connector and olive on each end and tighten up.

9. Throttle Controls

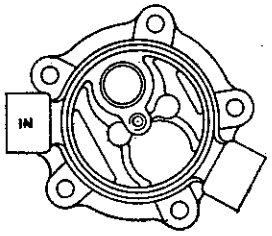
The accelerator pedal is pivoted on a bracket mounted on the inner face of the footwell, which is secured by two nuts and bolts.

The nipple of the inner cable fits into a slot and recess in the top end of the pedal. The forward end of the outer cable locates against a bracket adjacent to the carburetter and the inner cable is locked to the throttle lever.

No.	*Description*	*Qty.*	*A.C. Parts No.*
1.	Head Screw	1	855493
1a.	Head Screw	1	856824
2.	Head Screw Gasket	1	851297
3.	Filter Cover	1	856820
4.	Filter Gasket	1	7950272
5.	Filter Screen	1	856850
6.	Upper Casting	1	7950096
7.	Outlet Connection $\frac{7}{16}$" × $\frac{1}{2}$" elbow union	1	
8.	Inlet Connection $\frac{7}{16}$" × $\frac{1}{2}$" straight union	1	
9.	Valve Gasket	1	1537404
10.	Valve Assembly	2	5591860
11.	Valve Retaining Plate	1	1521956
12.	Valve Retaining Screw	2	132696
13.	Diaphragm Assembly	1	1524631
14.	Diaphragm Spring (Grey)	1	856829
15.	Oil Seal Washer—metal	1	7950105
16.	Oil Seal Washer—fabric	1	7950064
17.	Cover Screw	5	132117
18.	Cover Screw Washer	5	114648
19.	Body	1	856895
20.	Rocker Arm Spring	1	856830
21.	Link	1	856817
21.	Link and leaf spring Assembly	1	856902
22.	Rocker Arm	1	1524214
23.	Spring Priming Lever	1	1524217
24.	Rocker Arm Pin (Circlip Type)	1	856035
25.	Rocker Arm Pin Washer	2	856828
26.	Rocker Arm Pin Clip (used with 24)	2	1524112
28.	Primer Parts Set	1	1524223
	Engine Pad Gasket	1	856794



Primer Type Pump Body (Previous Ref. No. 7950076) — 1 — 856895



Upper Casting — 1 — 7950096

SECTION N

BODY EQUIPMENT

BODY ADJUSTMENTS

1. Removing the Door Lock

Remove inner door and grab handle (where fitted).

Undo five 4 BA screws holding the trim to the inside door panel and remove trim.

Undo the three screws securing the remote control unit to the door and pull forward sufficiently to allow the split pin holding the operating arm onto the remote control arm to be removed. Withdraw the remote control unit.

Undo three screws securing the door lock and withdraw door lock and remote control arm out from the rear face of the door.

The door lock is located by a five toothed rotor engaging in a triple toothed rack and a stud on the upper portion of the lock locating in a female slide in which is incorporated a spring-loaded laterally sliding sintered iron wedge.

The rack can be adjusted laterally by loosening the two screws holding it to the door frame and sliding it in the required direction.

It may be necessary to remove the rack and elongate the existing holes in the glass fibre.

Similarly the female slide is adjustable for up and down movement.

FRONT AND REAR SCREENS

2. Removal and Replacement

The joint of the brightwork strip surrounding the windscreen will be found in the centre of the lower half of the rubber shock pad in which the screen is encased. The strip is of Tee-shaped section, fitting into a groove in the rubber shock pad. Insert a suitable tool into the joint and lever outwards until the end can be grasped. Pull the strip out of the rubber pad and press the screen and pad outwards over the bonnet of the car. It is advisable to put a protective cover over the paint work on the scuttle to prevent damage.

To replace the windscreen, locate the rubber shock pad round the screen and press it into position on the car. Ensure that the rubber lips are correctly positioned both on the screen and on the flange provided for location on the body of the car, and that the slot in the pad faces the outside of the car as shown in the section.

Place the brightwork strip into the Special Tool (see Fig. 1) so that the face side goes under the roller from the handle side, up through the loop of the tool, with the end of the strip directly below the roller.

Insert the loop of the tool into the slot in the shock pad at the lower centre of the windscreen and push the tool and strip along the slot. The slot will be separated by the loop of the tool to allow the rib of the brightwork strip to enter the slot and the roller will press the strip into place.

Continue round the full periphery of the windscreen until the tool butts up against the end of the located strip. Skilful manipulation is required around the four corner radii of the screen, and to prevent the flexible strips from buckling it may be necessary to "run" the section backwards and forwards a few times, or even to soften it slightly by heating gently.

Remove the tool from the slot and press the remaining inch or so of the strip into place.

The procedure is similar for both front and rear screens.

BODY FITTINGS

KEY TO COMPONENTS (*opposite*)

1. Bonnet release mechanism.
2. Suspension sub frame.
3. Foot pedal control bracket.
4. Accelerator pedal.
5. Clutch pedal.
6. Brake pedal.
7. Body frame hoop.
8. Windscreen brightwork strip.
9. Windscreen moulding.
10. Door handles (2).
11. Rear view mirror.
12. Boot hinges (2).
13. Rear bumper.
14. Door locks (2).
15. Door lock remote control units (2).
16. Body jacking points (2).
17. Bonnet hinge assembly (2).
18. Front bumpers (left and right hand).
19. Silencers (2).
20. Screen washers (2).
21. Windscreen wipers (2).
22. Electric radiator fan unit.
23. Exhaust pipe.
24. Filler cap.
25. Filler neck extension hose.
26. Filler neck extension clips (2).
27. Fuel tank.
28. Fuel tank straps (2).
29. Courtesy light limit switches (2).

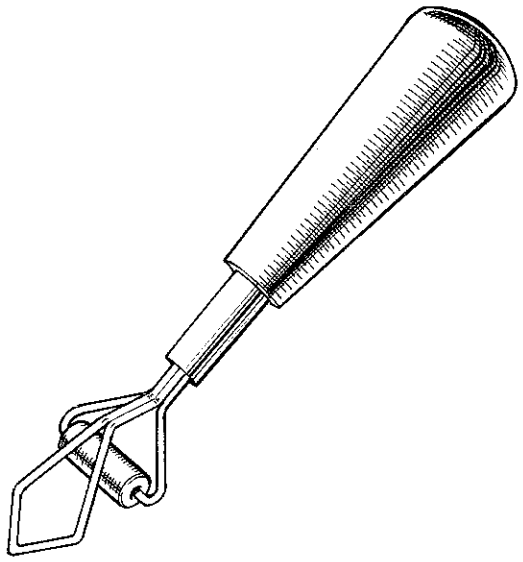
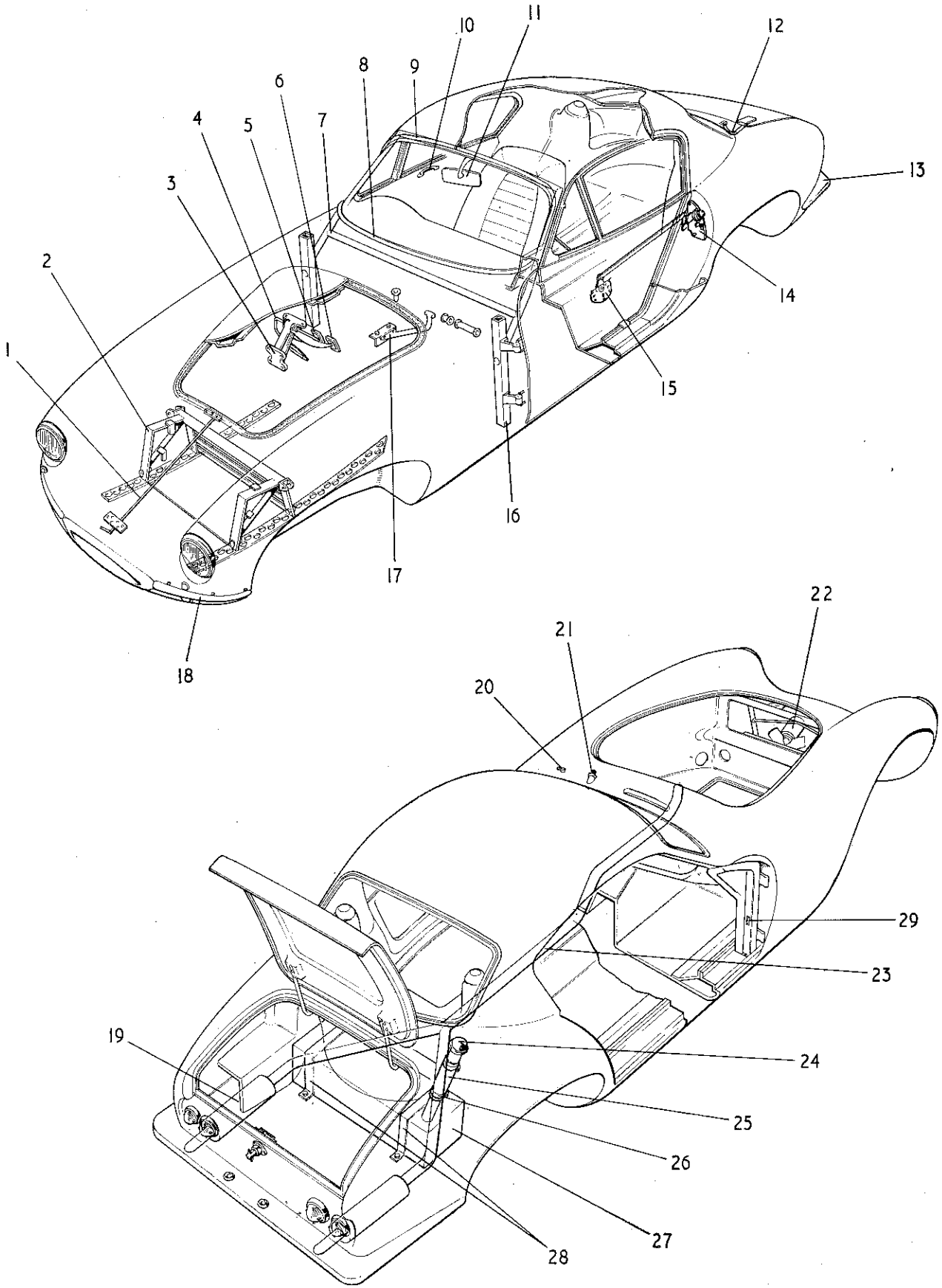
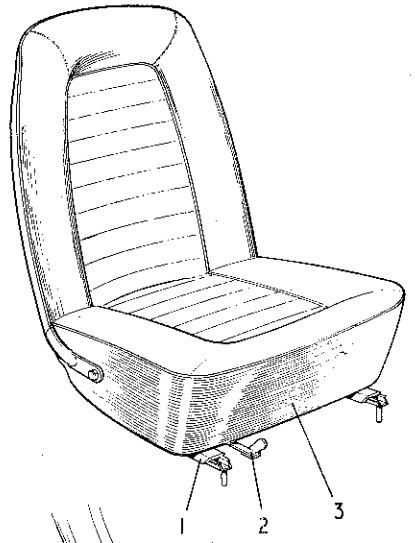
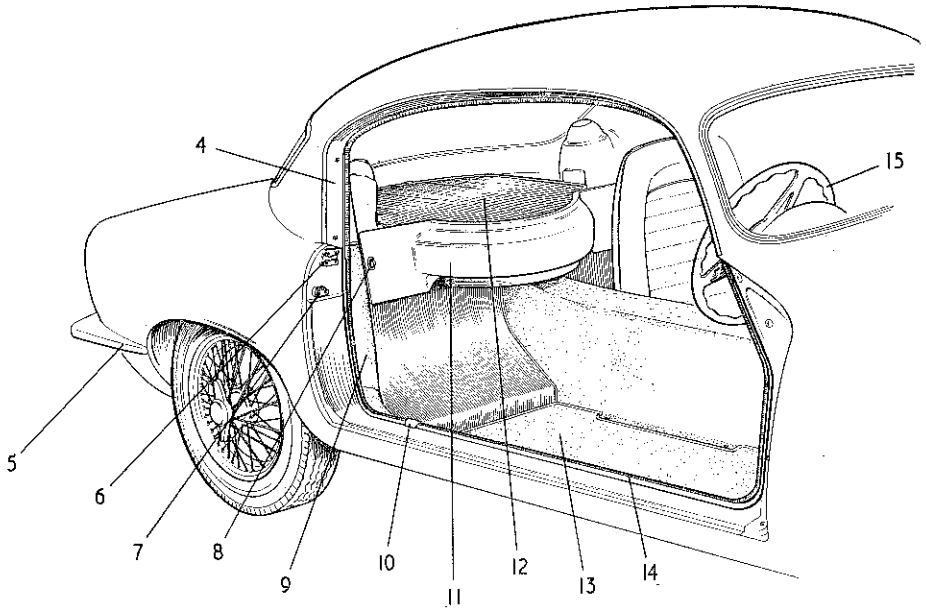


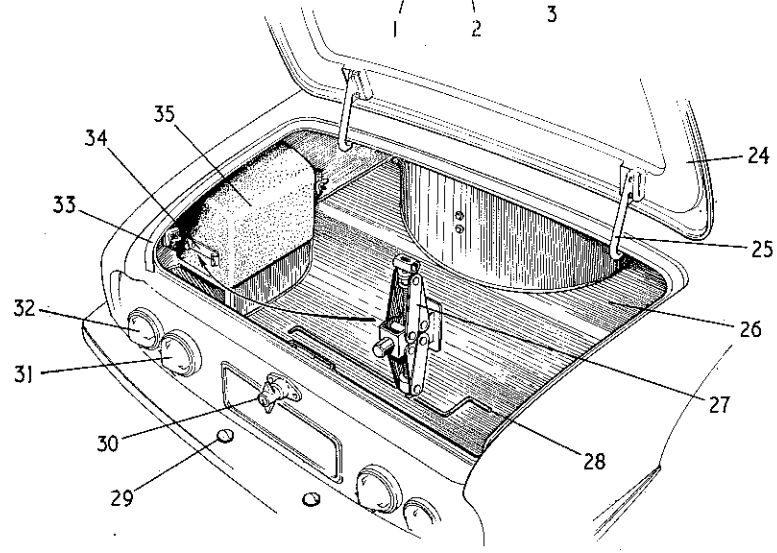
Fig. 1
Windscreen Surround Tool

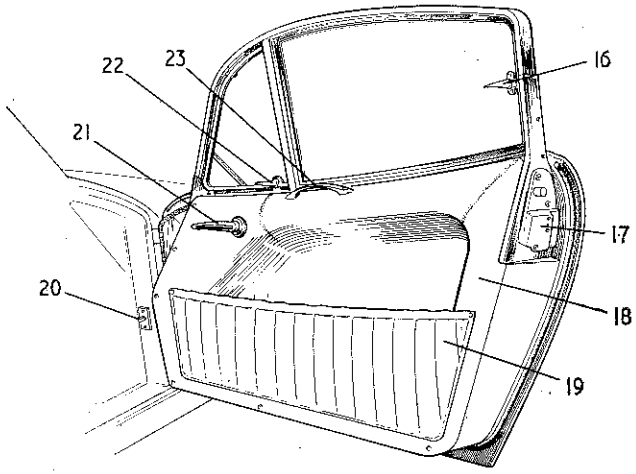


BODY FITTINGS









BODY TRIM DETAILS

1. Seat slide.
2. Seat adjustment lever.
3. Seat.
4. Door frame trim.
5. Rear bumber
6. Lock Dovetail.
7. Triple tooth rack.
8. Fastener.
9. Interior wall trim.
10. Trim clip.
11. Spare wheel front cover.
12. Spare wheel cover.
13. Floor carpet.
14. Draught excluding strip.
15. Steering wheel.
16. Removable side window handle.
17. Door lock.
18. Door trim.
19. Map pocket.
20. Courtesy light switch.
21. Remote control door handle.
22. Ventilator handle.
23. Grab handle.
24. Boot lid.
25. Boot lid hinge.
26. Petrol tank cover and boot floor carpet.
27. Jack.
28. Jack handle.
29. Rear number plate light.
30. Boot lock.
31. Stop light.
32. Rear light.
33. Boot sealing strip.
34. Jack securing bracket.
35. Battery box.

EXTRAS

3. Heater Installation

All parts are supplied by Smiths Motor Accessories except:

i. Heater unit mounting brackets (L/H and R/H).
ii. Water valve control mounting bracket.
iii. Heater outlet duct.
iv. Thermostat installation.
v. Hose and hose clips.
vi. Water valve mounting bracket.

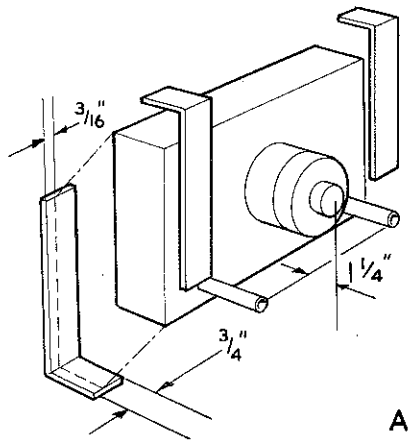
A 45° Union must be obtained in addition to the above.

Fitting instructions:

i. Heater unit in engine bay.

Using Bostik adhesive, glue 22″ polyurathene strip round the heater air inlet hole in the chassis bulkhead.

Glue four 10″ × ¾″ polyurathene strips round the edge of the heater unit as shown in sketch A, leaving $\frac{3}{16}$″ overlap at the edge.



A

Cut away soundproofing felt over the reactangular heater side holes in the bulkhead.

It is next advisable to fit the valve control mounting bracket onto the bulkhead mounting (i.e. gearbox right-hand side) before installing the heater unit in the engine bay—as accessibility is restricted afterwards.

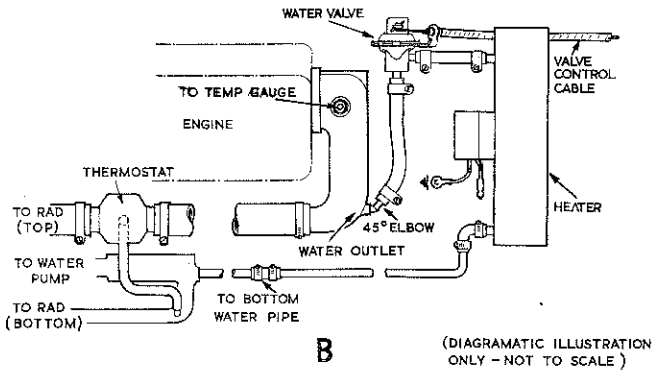
Fit heater unit using the brackets provided, the top bolt to be used as the top bolt for the parcels tray (passenger's side) and the heater outlet duct (driver's side).

ii. Water valve.

A ½″ rubber hose is taken from the boss on the L/H side rear of the water manifold across the back of the engine and forward of the R/H water outlet of the heater and connected to the underside of the water valve provided (see sketch B).

Ensure that the operating arm of the water valve is at right angles to the line of the car when the valve is open.

The water mounting valve is secured to the bulkhead by drilling two holes in the bulkhead and locking the valve in place with two 2 B.A. nuts and bolts.

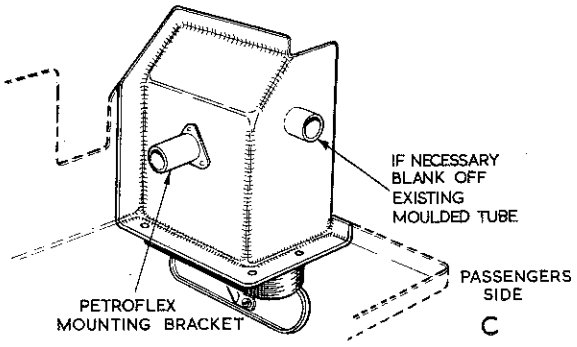


B (DIAGRAMATIC ILLUSTRATION ONLY – NOT TO SCALE)

A further length of hose is connected between the other outlet on the water valve and the R/H pipe on the heater with hose clips.

iii. Attachment of Petroflex mounting brackets to parcel trays and valve control mounting bracket to bulkhead.

The Petroflex mounting brackets are fitted over holes bored in the heater outlet ducts (L/H and R/H) as shown in sketch C.



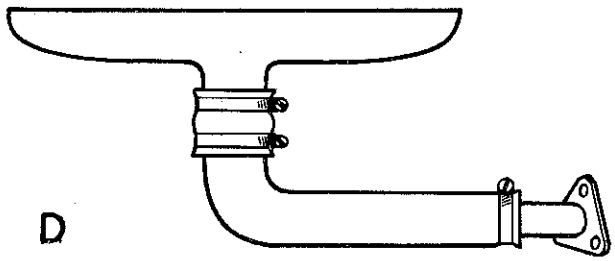
C

The valve control mounting bracket is bolted to the L/H side of the bulkhead under the parcel tray with a ¼″ UNF bolt 1″ long and a Nyloc nut. Drill hole in line with and horizontal to the car to allow the cable to pass through. A continuation of the hole needs to be taken through the trim.

The valve control cable is fitted to the mounting bracket as shown and passes through the hole drilled in the bulkhead into the engine bay and connects to the water control valve.

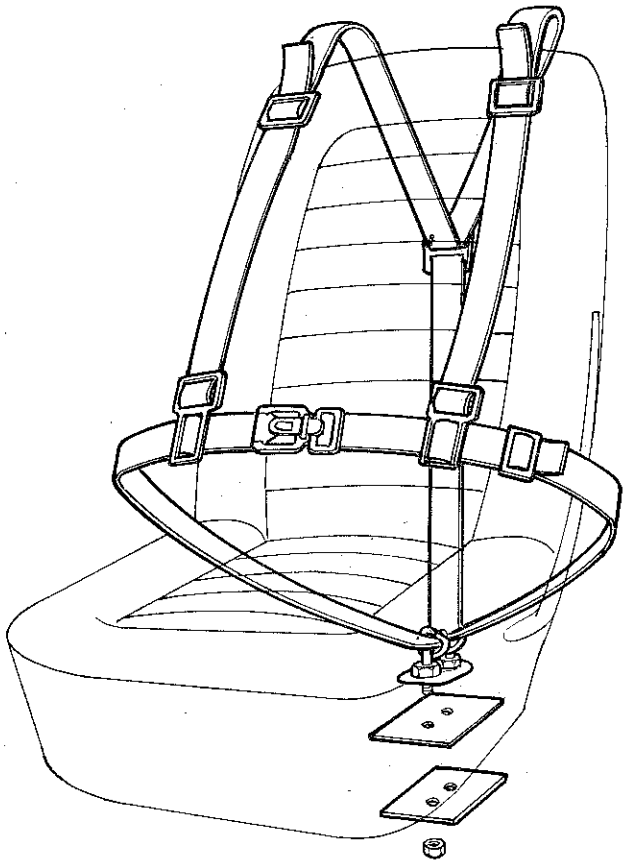
iv. De-mister piping (L/H and R/H).

Petroflex hose is taken from the mounting bracket up to the de-mister housing as shown in sketch D.


D

v. Final air sealing.
Check air sealing when the heater is installed with the fan running. Seal any leaks behind the parcel tray using pieces of trim felt, Bostik glue or Dum Dum.
Any cable holes in the bulkhead should be sealed with Dum Dum.

vi. Thermostat installation.
The thermostat is inserted in the top water hose behind the radiator. It is secured by two pieces of rubber hose and four hose clips, as shown in sketch F. The top water pipe will require shortening to suit.
A length of $\frac{1}{2}$" i/d rubber hose is attached to the bypass pipe on the thermostat and taken down down to the bottom hose as shown in the sketch.



4. Delaney Gallay Safety Belt

Two floor buckles are provided with the kit of parts. One only is used and both the back strap and belt strap are attached to it. Both large plated are used.

Drill the floor as far back as possible centrally behind the seat to accommodate the two threaded ends of the floor buckle and cut the carpet to suit.

Attach both straps to the floor buckles as shown in the illustration and place one of the large plates under the carpet.

Push the threaded ends of the floor buckles through the carpet, plate and floor holes. Locate the second large plate on the threaded ends where they appear on the underside of the car and bolt up.

SECTION O

CHASSIS-BODY UNIT

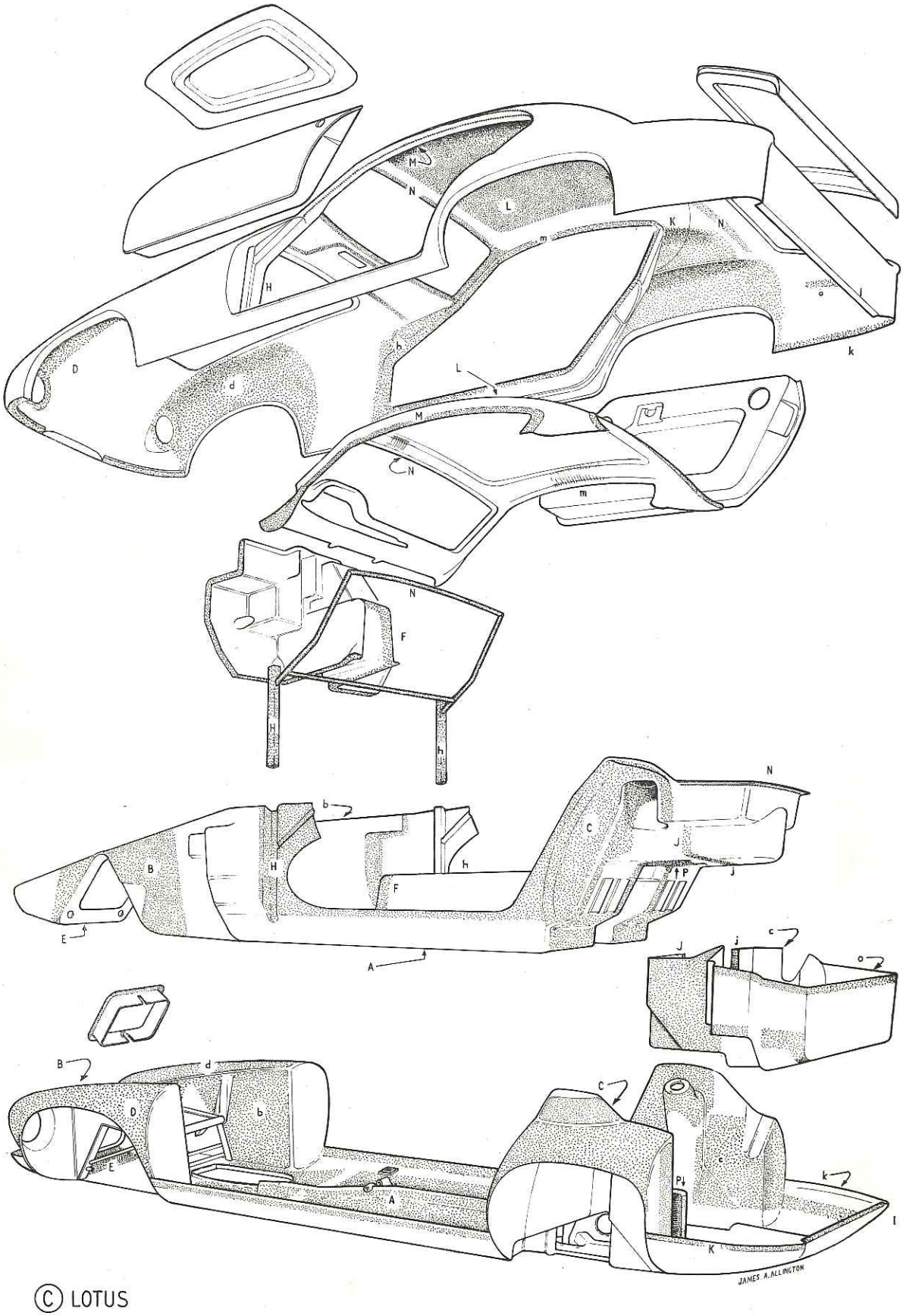


Fig. 1 *The chassis-body unit basic components*

CHASSIS-BODY CONSTRUCTION: RECTIFICATION AND REPAIR INSTRUCTIONS

1. Notes on Construction

The Lotus Elite is unique in using glass-fibre reinforced plastics structurally, and this fact must never be overlooked when effecting repairs or assessing damage.

The basic principal employed is to make the car in six major mouldings (and two minor ones) with two reinforcing metal frames, as shown in Fig. 1. Each moulding in itself is very thin and light, but when they are all bonded together to form numerous "box" sections, the result is a light and rigid yet resilient structure. It is non-corrosive and free from drumming or rattling and has the advantage over steel structures of suffering only localised damage in minor or medium accidents, thereby keeping repair costs to a minimum.

However, this radical design demands an equally radical approach for the repair of structural damage. The key throughout is:—"It is not good enough for the repair to just look good; it must be structurally sound as well". In fact, it is almost true to say that a good repair *cannot* be made invisible on both sides of a panel.

Although every attempt has been made in the following notes to give clear and comprehensive instructions for dealing with damage, etc., it is essential that structural repairs can be undertaken only under the supervision of experienced glass-fibre technicians.

2. Manufacturing Process

A high quality polyester resin is used for the hand-layup of all components except the doors (and in some cases the boot and bonnet lids), where epoxides are used. For replacement laminates or repairs, any high quality commercial grade polyester can be used, although it should be of a type having a reasonably high heat distortion point, particularly if the repair concerns an area near the exhaust or the differential housing. The average weight of most panels is $2\frac{1}{2}$ oz. chopped-strand-mat but in places (i.e. large single-skinned areas of top body, door sills, wheel arch lips, etc.) it is approximately 4 ozs. In a few more highly-stressed areas (e.g. areas around engine, transmission and suspension mounting points—and even door locks) the layup is increased to 6 or 9 ozs. It should further be noted that local build-ups of considerable weight sometimes occur around the various threaded metal inserts (this is more fully described in Chapter 16) and that woven materials are used in certain highly-stressed areas.

After curing, the polyester panels are abraded (sanded or roughed up), swabbed with acetone to remove dust, and bonded together using slate-filled polyester or epoxide resin. As a general rule epoxide is used on the reverse sides of all panels which are paint finished, in order to avoid the distortion which would result from the use of thick buildups of polyester. In some cases, particularly the double-skinned wheel arches, where the bonding materials also acts as a filler, Phenolic Micro-Balloons are added to give bulk without weight. They also give tensile strength far superior to chalk, vermiculite or cork fillers.

It should be remembered that the bond is, in all cases, provided by an adhesive or "glueing" action, and for this reason the efficiency of the bond will depend on the following factors:

i. *Surface preparation:*

Polyester laminates (notably the "rough" side) cure with a "greasy" surface, usually caused by air-inhibition of the resin. This is best removed by light sanding of the *greatest possible area*, and thereafter swabbing off the dust with acetone. It is of no advantage to rough up with a toothed tool, leaving the surface covered with fibre stubs as these will have no tensile strength at all and combined with loose dust can actually act as a barrier between the bonding resin and the laminate.

When bonding to a moulded surface great care must be taken to remove all parting agents, e.g. wax or P.V.A. (Poly-vinyl-alcohol).

ii. *Surface coverage:*

As stated in the preceding paragraph, it is essential to concentrate on preparing the greatest possible area, but in point of fact it is vertually impossible to achieve a 100% bond, particularly when bonding two rough surfaces of laminates together, as the high-spots and build-ups vary considerably. For this reason, the practice is to mix the bonding resin to a "toothpaste" consistency, apply fairly thickly (approximately $\frac{1}{8}$" in most cases), and apply sufficient clamping pressure to squeeze as much resin as possible out.

At the edges of box sections (see fig. 1) it is best to lay an extra thick "wall" of resin to ensure closure and maximum strength of the box section.

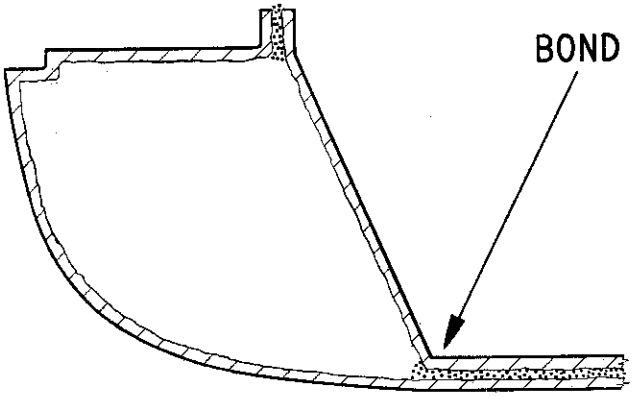


Fig. 2
Box section showing resin bonds

iii. *Correctness of bonding mix:*

Particularly with epoxides, great care has to be taken to see that the percentages of curing agents or hardeners are very carefully calculated. If this is not done, the bonding material may remain elastic or become too brittle, resulting in an inferior bond.

Clamping pressure has to be maintained until the material has set properly. The various types of bond employed in the Lotus Elite are described in the following section.

3. Bonding Methods Used in Manufacture

i. *Highly stressed bonds:*

These are invariably in the form of flanged joints, and therefore highly-stressed in the sense that one or both of the bonding surfaces are only 1″ or 2″ wide. It therefore follows that these require more critical attention.

Fig. 3 shows the type of bond used on the tops of the front and rear bulk-heads; Fig. 4 the type used around the door aperture flanges; and Fig. 5 the type used for the main joint across the back panel of the car.

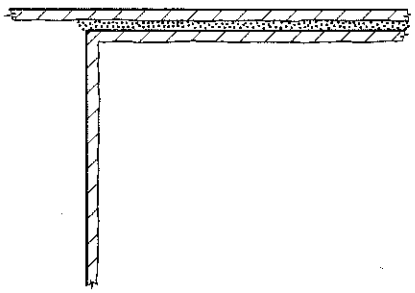


Fig. 3
Bulkhead bond

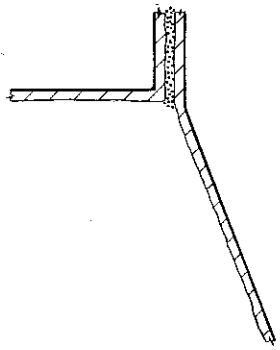


Fig. 4
Door flange joint

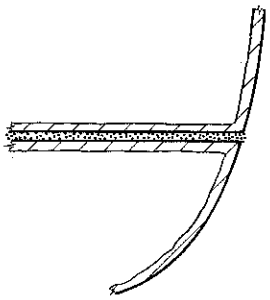


Fig. 5
Back panel joint

Another form of highly-stressed bond is known as a *lap joint*. Fig. 6 shows this as used for the main joint which runs from front to rear wheel arches under the door apertures and Fig. 7 as used for the main joint behind front and rear bumpers.

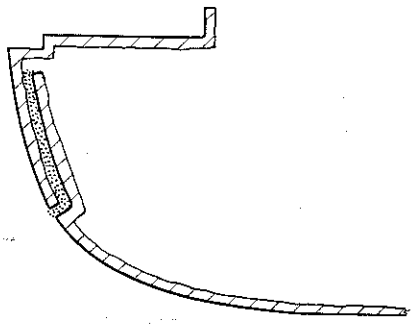


Fig. 6
Main lap joint

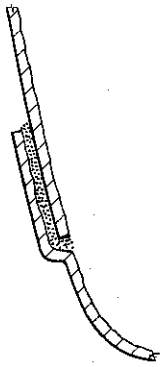


Fig. 7
Joint behind bumpers

ii. *Lowly stressed bonds:*

These usually take the form of double-skinned areas, and Fig. 8 shows a section incorporating "box" reinforcement as found in the bonnet lid.

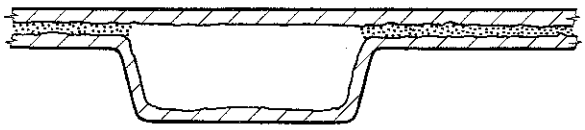


Fig. 8 Bonnet lid

iii. *Taped joints:*

In this type of joint successive layers of woven tape are laminated into the angle where the two panels intersect. Fig. 9 shows this as used along the engine-bay side-walls.

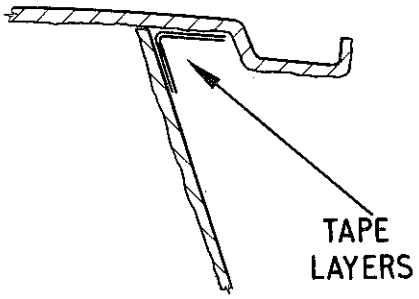


Fig. 9 Engine bay side panel joint

iv. *Semi-wet bonded joints:*

In this system, a cured moulding is pressed against the wet layup of another moulding, so that the bond is formed as the wet layup cures. Fig. 10 shows this system, which has been used experimentally on a number of boot and bonnet lids, when a cured polyester inner moulding has been bonded to a wet epoxide outer moulding.

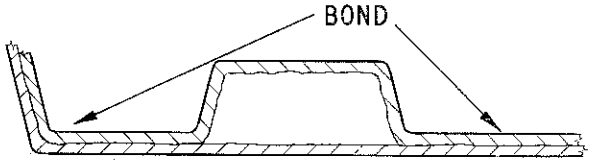


Fig. 10 Boot/bonnet joint semi-wet

v. *Wet-bonded joints:*

This system is employed only on the doors using epoxide resins. Fig. 11 shows how the flanges around the door are clamped together when both laminates are still wet.

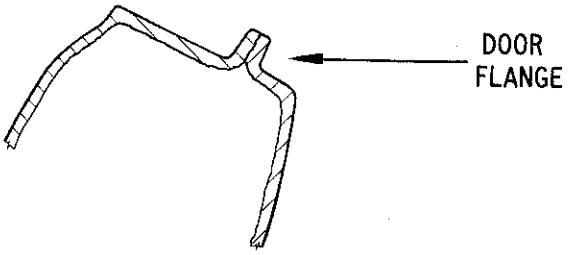


Fig. 11 Door flange wet-bonded joint

4. Rectification of Minor Surface Defects

i. *Pin-holes or air voids:*

These are unfortunately quite inseparable from the hand-layup system but provided the gel-coat is thick enough they should cause little difficulty. When they do, the only solution is to "dig them out" and fill the holes with a polyester stopper or filler. Fig. 12 below shows two commonly used methods of filling these small holes. Generally speaking, method A in which the holes are drilled or routed out so as to leave a larger hole with near vertical walls, will be found more satisfactory than method B where the hole is enlarged by gouging or "picking out", as the latter procedure allows feathering and flaking of the edges of the filler.

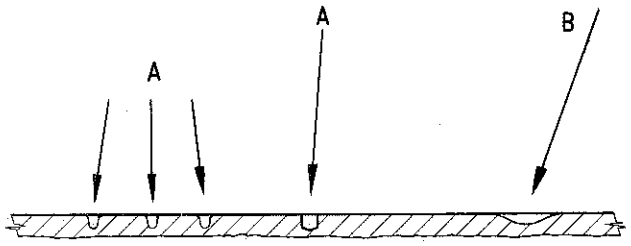


Fig. 12
Pin-hole rectification

A common problem of repaired pin-holes is the sinking of the paint surface some time after the repair has been completed. This may result from the use of a cellulose paint stopper which has a higher rate of shrinkage, or in the case of a polyester stopper is usually caused by painting too soon after effecting the repair, or in other words before the filler is properly cured. Furthermore, the filled areas should, on no account, be rubbed down until the filler has fully cured, or sinking will obviously result.

As a general rule epoxide panels, i.e. doors and in some cases boot and bonnet lids should be repaired only with a suitable epoxide filler, unless cautious experimentation has shown that the type of polyester filler being used adheres satisfactorily. Epoxide filling should definitely be cured in warm conditions and should definitely not be painted on in less than 48 hours after application.

ii. *Gel-coat crazing:*

There are various causes of gel-coat crazing, but practically all are caused by flexing the laminate beyond the point of resistance of the unsupported gel-coat. Typical causes are sharp impacts or accident damage. During an accident some panels may flex sufficiently to cause the gel-coat to craze, without causing immediately apparent damage to the paint surface. This crazing may not work its way through the paint surface for some weeks, so that it is necessary when assessing accident damage to carefully examine all panels, particularly near cracked or split bonds, and in cases of doubt it may be possible to promote the appearance of the crazing by applying gentle heat.

Crazing generally stops at the first layer of glass-fibre and is consequently not in itself structurally serious, but extensive crazing near damaged areas should be taken as an indication of over-stressing, and the panel should be reinforced or replaced.

It has not been found possible to cure crazing by simply resurfacing with a further layer of resin. The only solution is to rout out the crazed areas and fill with a polyester filler as described in Chapter 4(i) above, or of course to completely replace the laminate concerned.

iii. *Wrinkling or distortion:*

This phenomenon sometimes appears on panels which were previously "perfect", and it is usually caused by exposure to severe heat. This can cause the resin to soften slightly and in doing so give way to any inbuilt or associated stresses. Similarly, excessive heat can cause further curing and consequent distortion. In all such cases technical advice should be sought from the manufacturers.

iv. *Split bonds:*

Small splits occur quite frequently, being caused mainly by flexing of the panels or by vibration, and they should be arrested before they can extend and become serious. The split should be peeled open slightly further, the inside flange surfaces should be roughed up with a hacksaw blade, and the appropriate type of bonding resin should be inserted before clamping up. Clamping pressure should always be applied evenly using small strips of wood or metal, if dimpling of the panel surface is to be avoided.

5. Accident Repairs—General

i. *Assessing accident damage:*

(*a*) As stated previously, all body damage must be considered as structural, apart perhaps from minor damage to the front and rear extremities, doors, etc.

(*b*) In order to assess damage it is obviously necessary to study the basic form of construction, nature and position of bonds, and for this reason an exploded view of the body is provided in Fig. 1 with the mating bonded areas indicated. As a general rule however there should be a bond wherever two panels touch or wherever they enclose either the front sub-frame or the body jacking hoop, and it is usually possible to check these bonds both visually and physically for fractures or breaks. If necessary, small inspection panels should be cut in box sections or small holes drilled through bonds for examination purposes.

(*c*) Ascertain the cause of damage and the direction of impact and examine all panels or bonds which may have been effected. A front end impact, for example, may easily cause the bond on top of the bulk-head to split without the defect being normally visible, and so on. Similarly, the front frame should be checked for distortion (see further notes on this in Chapter 6) and if the shock of the accident was sufficient to move the engine, the gearbox mounting parts should be carefully examined for fracture.

(*d*) If necessary metal or other components should be removed to facilitate examination.

(*e*) Before the assessment can be completed it is essential to decide on the repair method to be followed, the sizes of replacement panels to be ordered, etc., and the detailed instructions provided hereafter should be carefully studied.

(*f*) The extent of damage (and size of replacement panels) should take into account the gel-coat crazing mentioned in Chapter 4(ii).

(*g*) Fire damage is one of the most difficult to assess, but generally speaking the damaged panels should be cut back much further than would otherwise be the case, as the excessive heat will most probably have had a permanently damaging effect on the resin content.

ii. *Obtaining replacement panels:*

(*a*) *Replacement components:*

Replacement doors, lids and other loose components are available from the manufacturers or distributor. These are generally provided with base-paint finish only, as it may be necessary to hand fit and trim the edges, etc.

(*b*) *Standard repair moulds:*

Standard sectional moulds cater for the repair of damage to the most vulnerable areas of the top body and undertray (see Fig. 18). These are so designed that they can be used individually or connected together for the manufacture of the required section of the body, or they can be used for locating new sections correctly relative to the existing panels.

These moulds are deliberately left unframed so as to accommodate slight discrepancies, and have been made on a standard painted body shell to allow for average paint thickness.

When laying up sections in these repair moulds, it should be noted that the general layup weight is $2\frac{1}{2}$ oz. chopped strand mat, increased to $4\frac{1}{2}$ oz. chopped strand mat, at the following points:

*Single-skinned area of front panel between radiator intake and bonnet aperture.

*Entire scuttle area in front of windscreen and sides of body from back of front wheel arch to door apertures.

*Area between boot lid aperture and rear windscreen.

*Upper section (approximately 6″ wide) of rear panel below boot lid aperture.

*All wheel arch lips and other flanges.

(*c*) *Replacement Sections:*

Where the repair of a damaged section calls for a replacement panel not catered for under headings (*a*) and (*b*) above, replacement sections are available from the manufacturer. In the case of any severe damage to such highly-stressed or important areas as the rear differential mountings, front suspension frame, gearbox mountings, etc., it is definitely advisable to have these replaced with properly manufactured sections as detailed in the following paragraphs.

iii. *Basic bonds and joints for repair work:*

(*a*) *Simple fracture, or insertion of new sectional laminates:*

The ideal way to repair a fracture is shown in Fig. 13. The old laminates are tapered off for 3-4″ on each side of the fracture line, a reinforcing layup comprising alternative layers of chopped strand mat and fine woven cloth is

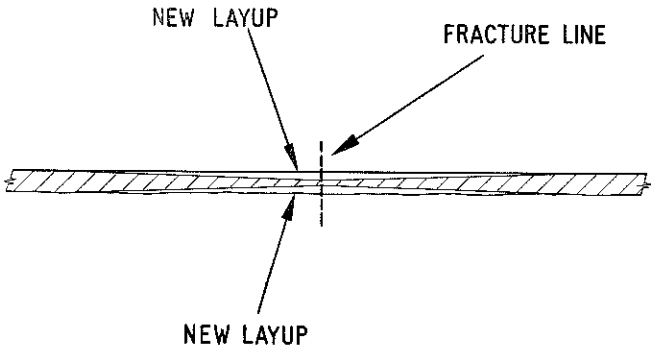


Fig. 13

applied on both sides of the panel, providing a "symetrical" repair of great strength. In most cases it is naturally advisable to make the reinforcing layup on the back side of the panel considerably stronger than that on the outside.

Alternatively: When it is difficult to taper both sides of the laminate, an almost equally effective joint can be obtained as shown in Fig. 14, in which the reinforcing layer is done on the back side of the panel only.

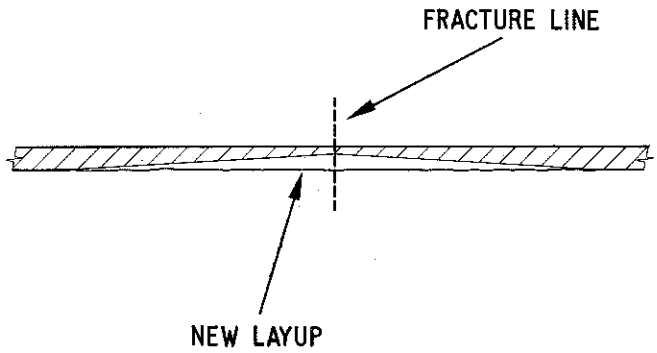


Fig. 14

Alternatively: The method shown in Fig. 15 is also possible, but not very satisfactory as it leaves a latent weakness on the old fracture line. In this system the reinforcing layer is added only on the back side, but with no tapering of the old panels and with the crack line of the old panel merely filled in.

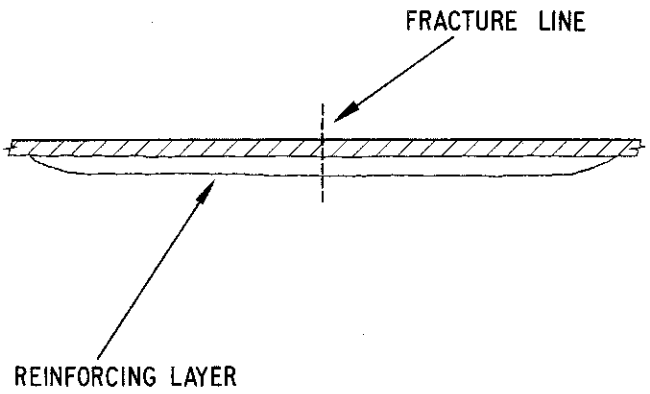


Fig. 15

(*b*) *Double-skinned area—single fracture:*

This type of fracture usually occurs near the perimeter of a double-skinned area (as shown in Fig. 16) but the scheme should only be used if the "bonding platform" available is at least

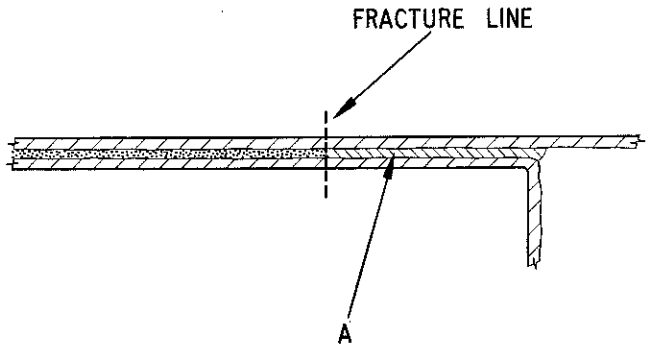


Fig. 16

2″ wide. If the remaining skin "A" is very thin as in the wheel arches, it should be reinforced by an additional layer (on either side) before the bonding operation is effected.

(*c*) *Double-skinned area—double fracture:*

Where both skins are fractured a way must be found to stagger the joint lines as shown in Fig. 17. These joints should be staggered a minimum of 4″-6″ if possible, and it will consequently be necessary to obtained or make up at least one replacement section to provide the overlap as indicated in the sketch.

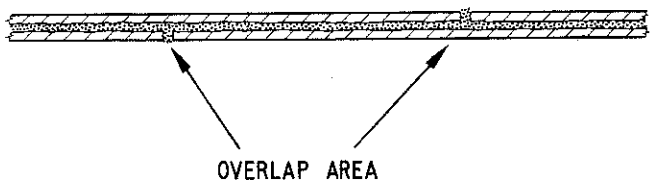


Fig. 17

6. Front End Damage

The most critical requirement here naturally concerns the front suspension frame.

Where the front ends of the "skids" of the front suspension sub-frame have been bent without disturbing the portions of the frame which contain the lower wishbone pickups, they can usually be cold-bent to their original profile after the surrounding fibre glass has been cut away.

Generally speaking, severe distortion of the front frame will be of an obvious nature, and it should be noted that it has been found far more practical and economical to straighten or even rebuild the damaged frame in situ whenever possible. In many instances parts can be cold-bent to their original shapes, but it is possible to electrically weld damaged areas provided the fibreglass is removed for some inches around, and that the metal where it disappears into the fibreglass panel is kept cool by wet rags. It is always advisable to have a fire extinguisher handy as well.

One point of distortion which it is important to check and correct, and which is also sometimes difficult to detect in cases of slight impact, occurs when the impact has been localised to one side. In this case the "trapezoid" on one side of the frame may have been distorted, usually thereby pushing the lower front wishbone pickup upwards.

In case of any doubt, remove the entire sprung assembly of both front wheels and check the alignment of the lower pickups from one side to the other. This can quite effectively be done by devising a simple pair of checking rods which should be say $\frac{1}{2}$″ diameter and approximately 18″ long. Rest one of these rods between the pickups on each side of the car and sight through visually or by any more accurate method available to ensure that these pickups are in line.

(It should be noted at this stage that an impact severe enough to have moved the engine or badly distorted the front frame has also quite likely caused damage to the rear engine mounts under the gearbox. In this connection see Chapter 10.)

If the damage has been severe enough to destroy virtually the whole front end of the car, it is possible to graft on a complete new section, an in this case it will be necessary to obtain from the manufacturer the following replacement sections indicated in Fig. 18.

(*x*) Undertray front section from rear edge of sump hole to front extremity .

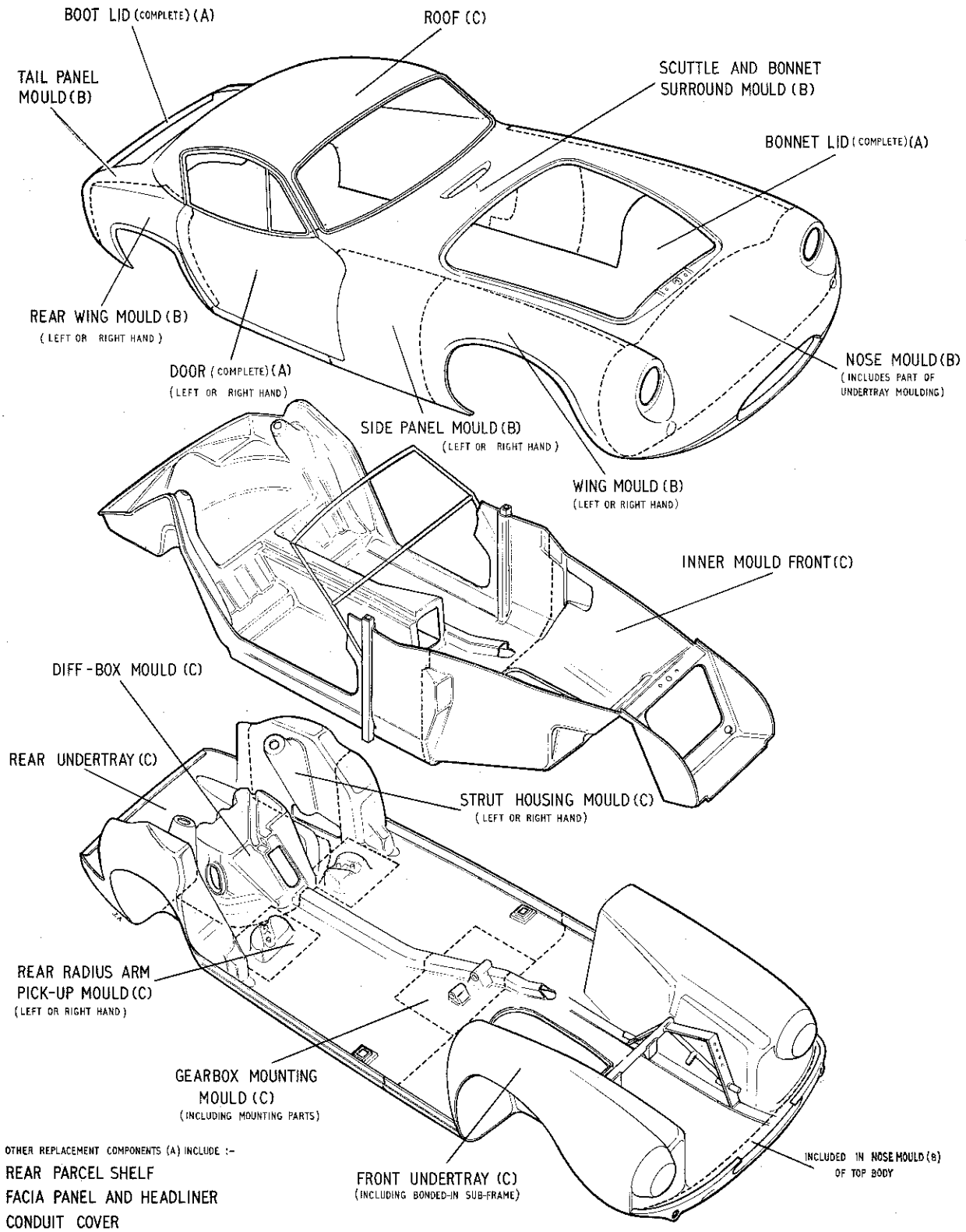
(*y*) Inner Mould front section from base of engine-bay bulkhead to front extremity.

(*z*) Top body sections (usually obtainable from standard repair moulds).

In view of the fact that in no two cases will damage be exactly the same, it is only possible here to lay down a few general rules, and for the remainder it is necessary to follow the basic principles already laid down.

i. Before cutting away the damaged parts or ordering replacement sections, work out the proposed method of repair, positioning of joint lines, overlaps, etc.

ii. Remember the need to determine a method for the correct positioning of replacement sections, and before cutting away damaged parts check on any prominent features from which measurements can



OTHER REPLACEMENT COMPONENTS (A) INCLUDE :-

REAR PARCEL SHELF
FACIA PANEL AND HEADLINER
CONDUIT COVER
DOOR HINGE COVERS (LEFT OR RIGHT HAND)
PASSENGERS PARCEL SHELF (LEFT OR RIGHT HAND)
HEATER DUCT (DRIVERS SIDE ONLY. LEFT OR RIGHT HAND)
RADIATOR DUCT (SEE FIG.1)
BATTERY COVER

(A) REPLACEMENT COMPONENTS
(B) STANDARD REPAIR MOULDS
(C) REPLACEMENT SECTIONS

Fig. 18 Moulded repair sections

be made and scribe these clearly on to the panels which are to be left intact.

iii. Use masking tape or chalk to define the lines on which you propose to cut the panels away and study these lines thoroughly to see that:

(*a*) You will not be removing an undamaged or slightly damaged panel which would be useful in the aligning of another major panel, e.g. it is sometimes possible to replace the undertray area containing a new front frame, and the surrounding areas of the inner mould, whilst leaving the top body almost intact.

(*b*) On single-skinned areas in particular, the proposed cut line traverses longitudinal, lateral and horizontal definition points to assist easy lining up of the new panel in all three planes. (A study of the differential box repair scheme will make this requirement somewhat clearer.)

(*c*) The proposed cut lines on doubled-skinned panels, overlap by 6″ where possible, to enable the repair joint to be made as shown in Fig. 17.

In making cut lines of this type one is faced with the problem of cutting through only one of the skins, and this is best achieved by the careful use of an oscillating saw of the type used by surgeons for either bone or plaster cutting, or by the careful use of a portable grinder.

(*d*) One or both sides of the join line will be readily accessible for doing the necessary reinforcing layups. (Where this appears to be impossible, for example on the side body panel behind the front wheel arch, it may be necessary to cut an access hole on an adjacent or opposite panel. This should preferably be done on a flat surface, in this case on the rear bulkhead of the front wheel arch, by cutting a hole approximately 8″ × 6″.)

After completing the necessary repair, this access panel can be replaced by bonding one or more strips of laminate approximately 2″ wide on the inside surface of the panel around the access hole, so as to provide a seating for the access panel which can then be secured permanently in place with resin, P.K. screws, etc., as shown in Fig. 19.

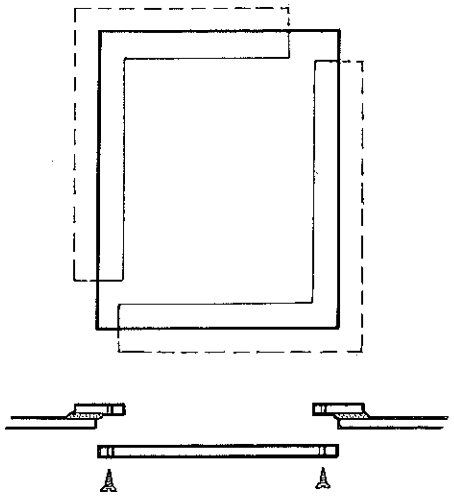


Fig. 19

(*e*) Split bonds have been taken into account. For example if a front wing has been damaged to the extent of parting the top body from the wheel arch area of the undertray completely, it will be impossible to re-bond this satisfactorily without completely removing the top panel by cutting it on a line through the centre of the cavity behind the wheel arch, chipping away the old bonding resin, and thereafter re-bonding the wing panel or a replacement panel into place.

Some bonded joints such as simple lap or flange joints can easily be made good by adding a reinforcing layer of the type shown in Fig. 20.

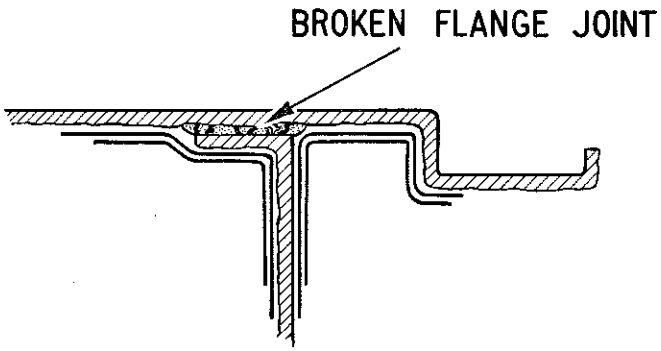


Fig. 20
Split bond repair

iv. *Positioning replacement panels:*

Considerable care should of course be taken to see that the replacement panels are trimmed exactly to the line of those removed, or vice versa, and in the absence of special repair jigs to hold replacement panels in their correct positions, particularly around the door and lid apertures, it is advisable to fix the door or lid *firmly* in position and make sure that the aperture concerned is being correctly made up. The same applies where areas surrounding other major components, e.g. windscreens or bumbers are being replaced.

In addition, all replacement panels should be offered up and held in place as follows before commencement of laminating. This is because it is invariably better to properly align major surfaces even if it means the filling in at a later stage of numerous bolt holes, etc.

(*a*) Line up flat surfaces (e.g. undertray or floor area) using long wooden beams bolted to undamaged area.

(*b*) Line up main contours (e.g. wing sections) using splines and bolt in position with flat or curved steel straps.

(*c*) Line up minor or inside surfaces with small aluminium plates screwed in place.

7. Damage Around Front Bulkhead

It is extremely difficult to replace the front bulkhead completely, and comprising as it does mainly flat surfaces

it is best repaired in situ using sheet metal "moulds" if necessary. In front end impacts the bonds along the top of the bulkhead flanges frequently part, and in view of their inaccessability, they should be repaired by removing the felt from the inside of the car, roughing up and cleaning the surfaces on both sides of the bulkhead, and doing a reinforcing layup on both sides as shown in Fig. 20.

8. Damage to Side Box-Sections

Where damage to the outside skin immediately behind the front wheel arch or under the door apertures is too serious to be repaired working from the outside, it is necessary to follow the procedure detailed in Chapter 6. iii(*d*) above.

Where the damage involves only or primarily a split bond along the main join which runs along the body under the doors, this can sometimes be repaired by removing existing bonding material and roughing up with a hacksaw blade, injecting fresh bonding material (preferably epoxide) drawing the two skins together with pop rivets or P.K. screws, and later reinforcing the bond with two layers of 6 oz. woven cloth and 1 oz. of chopped strand mat "capping" the joint by several inches, and later fairing in.

9. Damage to Body Jacking Hoop

Since it is impossible to bodily replace the body jacking hoop, welding or straightening must be effected in situ taking the same precautions as advised for the front sub-frame, and thereafter rebuilding the surrounding areas of fibreglass.

10. Gearbox (Rear Engine) Mounts

Damage to the gearbox mounting parts is usually caused when the engine has moved back during an impact. The mounting is comprised of two tubular collars laminated in during manufacture of the undertray and although damage, i.e. cracks can usually be detected from underneath the car, it is necessary to remove the engine for a proper examination.

If this area has been damaged it has to be replaced completely, using a replacement laminate obtainable from the manufacturers, which embodies the mounting collars properly located and laminated in place. The recommended procedure is as follows:

i. Remove engine, battery, bonnet lid, drain fuel and differential, and turn the vehicle bodily onto one side, resting it full length on a well padded floor and leaning it against a wall. Care should be taken during lifting and resting to keep the loads well spread and in particular to avoid concentrating loads around the wheel arch lip areas which could easily lead to cracked gel-coats or laminates.

ii. Before removing the damaged area, carefully mark scribe lines on surrounding areas of the undertray which will not be cut away, to enable accurate fore-and-aft positioning of the replacement section. (vertical positioning will be obvious, and lateral positioning will be provided by exhaust trough.)

iii. Remove an area measuring approximately (see Fig. 21) the size and shape of the replacement laminate, cutting right through the double skin of the floor area, but taking care to cut no higher than is necessary into the centre tunnel section of the inner mould.

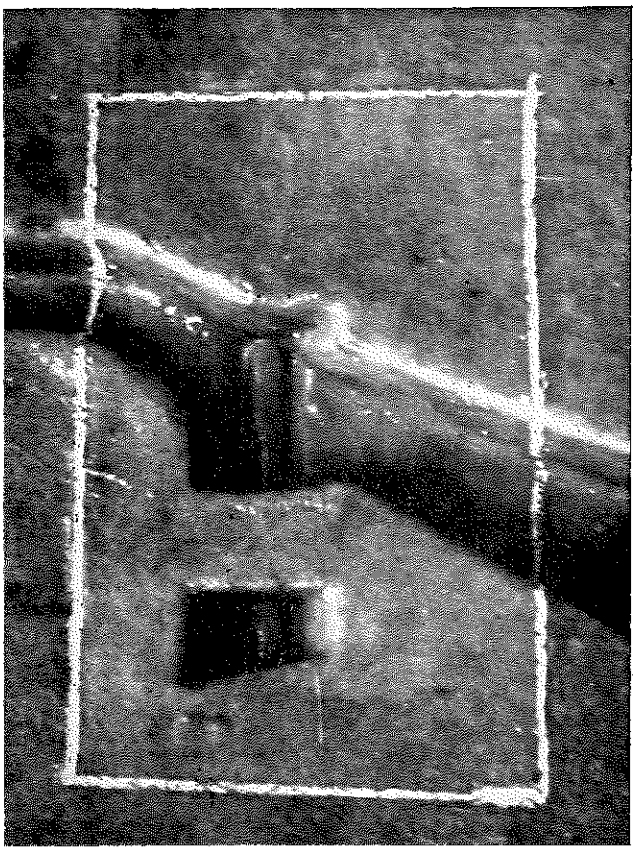


Fig. 21
Marking out the damaged area

iv. Clean off as much oil as possible inside the tunnel and on the undertray using acetone, etc., and rough up both inside of the tunnel and top and bottom surfaces of the undertray floor. It is also advisable to prepare the surrounding surfaces to give a good mechanical key for the reinforcing laminate on the underside by drilling a number of shallow $\frac{1}{4}$" holes at random every 1" or so.

v. It has to be remembered that this mounting carries a considerable "weight load" and must accordingly be well bonded in. To prevent it from dropping out it is necessary to do a substantial layup on the top as well as underneath, and a layup comprising approximately four layers of woven rovings and two of chopped strand mat is recommended on both sides, with the best possible layup on to all presenting faces inside the tunnel, working through from the engine bay, gear lever hole, etc.

vi. During laminating it will probably be advisable to hold the section in place with metal straps, and it is also advisable to bolt the gearbox mounting bush and a washer approximately $\frac{1}{16}$" thick in place (using the standard bolt) between the collars to ensure that they are not compressed out of their correct position during assembly and laminating.

As an extra safeguard, the metal straps referred to above can simply be left in place and laminated in.

vii. Finally, ensure that the area around the collars has been made gas-tight to exclude engine fumes from the passenger compartment.

11. Rear Radius Arm Pickups

Slight damage to the boxes containing the rear radius arm pickups can be repaired by cutting and peeling away the double skin of the inner moulding above the pickups, reinforcing as required and finally replacing the "access" panel and laminating over the whole from inside.

If this area has been severely damaged it will be necessary to obtain a new sectional laminate (left or right hand side) embracing the box and the surrounding area from the manufacturer, and having taken the necessary precautions regarding location of the new section to fix it in place in the same manner as has been described for the gearbox mounts.

12. Differential Mountings of Diff. Box Area

This is one of the most highly stressed areas on the entire structure, and failure of or damage to any area near the pickups can only be rectified by replacing an area large enough to ensure that where the joins are made the loads are fairly well dispersed.

In cases where the actual diff. mountings or the back face of the diff. box only have been broken, it is possible to replace the rear half of the box only.

However, where the damage extends in a serious form to the front half of the box or to the rear end of the undertray where the propeller shaft emerges, it is possible to insert a larger area.

In either case it is essential to use a replacement laminate obtained from the manufacturer or distributor. This is so because a special inter-laminating technique is used for the construction of this area.

Only the former scheme will be described in detail here, the latter being merely an "extended" version using identical principles.

i. It is advisable, if not essential, to turn the car on its side as described in Chapter 10 above, after removing the differential, rear suspension, fuel tank, battery, spare wheel and boot lid, and draining the engine completely. The fuel and hydraulic brake lines and preferably also the battery and electric leads running through the conduit housing on top of the diff. box should also be withdrawn.

ii. The replacement laminate is provided slightly oversize and after cleaning off all oil from the relevant area the proposed cut-line should be carefully marked with tape or chalk as shown in Fig. 22.

As this shows, the line runs across the undertray, behind the diff. mounting face approximately in line with the leading edge of the rear silencer recesses, forward along the inside walls of the exhaust housings on each side, vertically up the sides of the box through the centres of the half-shaft holes, and finally on a line behind the centre of the top face of the box. It is at this point, and where it cuts through the diagonal conduit, that care should be taken to see that all the electric wires in the conduit are not severed and also that the top skin, i.e. the inner mould skin under the spare wheel bowl, is not penetrated.

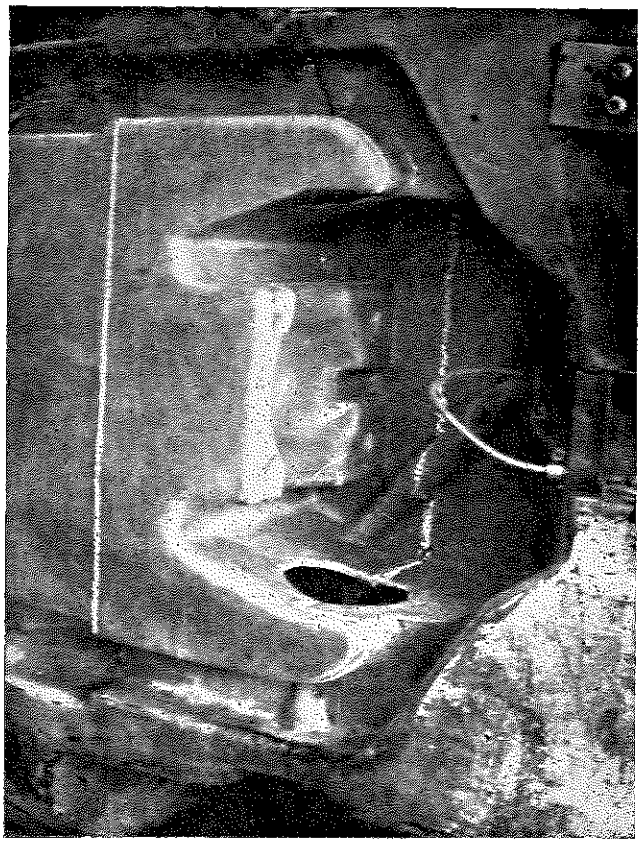


Fig. 22
Marking out the damaged area

For guidance, the diff. box skin at this point is approximately $\frac{1}{8}$" to $\frac{3}{16}$" thick, and there is between $\frac{1}{16}$" and $\frac{3}{16}$" bonding material sandwiched between it and the inner mould skin.

In this connection, reference should be made to the instructions contained in Chapter 6, paragraph iii.(*c*).

iii. Before the defective diff. box can be prised away from the body, it is necessary to cut away a certain amount of the boot liner as illustrated in Fig. 23, both to release the diff. box bonds and to provide access for doing the reinforcing laminate at a later stage.

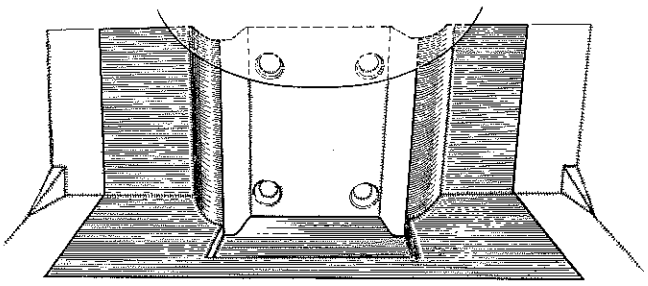


Fig. 23

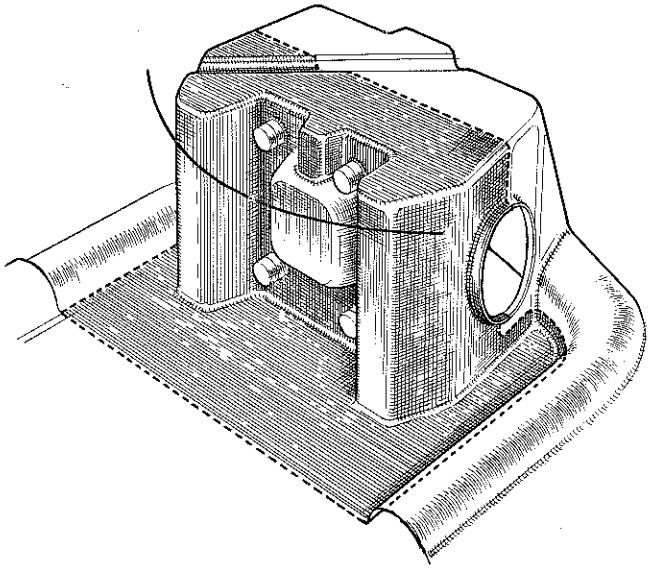


Fig. 24
The damaged diff. box marking out from above

This cut line runs straight across the car approximately "from the front vertical walls", forward approximately "from the outside vertical walls", i.e. on the centre line of the exhaust recesses, up the front vertical walls as far as the horizontal "ledge or suage", stopping where it reaches the spare wheel bowl.

The cut line should also be continued down the centre lines of the disc brake housing and acrosss the base of the vertical liner panel below the diff. bolt conical access holes.

iv. It should now be possible to prise the diff. box and two separate sections of the boot liner away from the body (the one which is the aforementioned cover panel containing all four diff. bolt access holes can be discarded as it serves no structural purpose). Proceed to offer the replacement section into place, trimming the edges as necessary. If the cut line has been correctly made, location in all three planes will be "automatically" provided by various planes and recesses, and when the new laminate fits readily into place, preparation can be made to do the reinforcing layup.

v. This is done by chamfering and roughing up approximately 3″ to 6″ of the perimeter strip adjacent to the join line on both the body and the replacement laminate (as described in Chapter 5, paragraph iii.). Small metal plates or strips should be employed to screw the new box firmly into place.

vi. The new box having now received its final fitting is ready for bonding into place. The metal plates and box are accordingly removed and a mix of epoxide or polyester resin filled with slate or other suitable filler to a fairly thick consistency should be liberally applied to the top surface of the box and to the mating area of the inner mould, using pop rivets or P.K. screws to provide temporary clamping pressure if necessary.

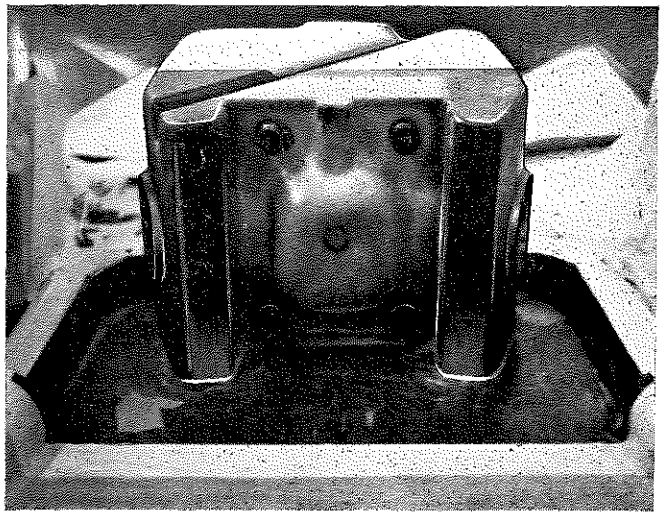


Fig. 25
The new diff. box in position

vii. The remainder of the join should now be reinforced, by doing a layup on both sides of the single-skinned panels wherever possible, using several alternate layers of heavy woven rovings and chopped strand mat on each side.

viii. In order to thoroughly rigidify the rear joint line, it is recommended that two wood sections approximately 1″ × 1″ × 12″ long be laminated in at right angles to and symetrically across the join line so as to provide two rigid "top hat" sections running fore and aft.

ix. Finally, the larger section of the boot liner should be replaced, once again employing a reinforcing laminate on either side of the panel wherever possible, and using metal tags, etc., to ensure that the rear join line across the floor of the boot will be strong enough to support the fuel tank. Owing to the extra thickness of the undertray laminate directly behind the lower diff. pickups it may be found necessary to amputate the lower portion of the recess on the boot liner which normally mates up at this point.

x. If there is any likelihood that the inner mould under the spare wheel bowl has been cut or weakened it is advisable to remove the interior trim and effect a reinforcing layup over the entire area.

xi. The necessary holes should now be cut for brake and fuel lines, etc., before proceeding with normal re-assembly.

13. Top Strut Pickups

These seldom suffer extensive accident damage, and when they do, require individual attention. In extreme cases replacement sections could be obtained provided the requirements could be specifically enough defined, but generally speaking, it will be found more satisfactory to rebuild the damaged area in situ.

In cases of severe impact, the horizontal joint between the headliner and inner moulds which runs approximately 3″ above the bridge near the strut housings inside the

passenger compartment may split open. This should be rectified by normal procedure but since this area is accessible from one side only the repair must be solidly reinforced by laminating over it. The same applies to any other cracks or fractures around this area.

14. Roof Damage

The severest damage to the roof structure usually occurs when the vehicle has been rolled over. This can impose a tremendous impact/shear load which frequently results in a fractured bond, perhaps over a large area. In many cases, the inner and outer panels return to their original shape, but loose lumps of the fractured bonding material may jam in place as shown in Fig. 26 causing unsightly bulges on the interior headliner.

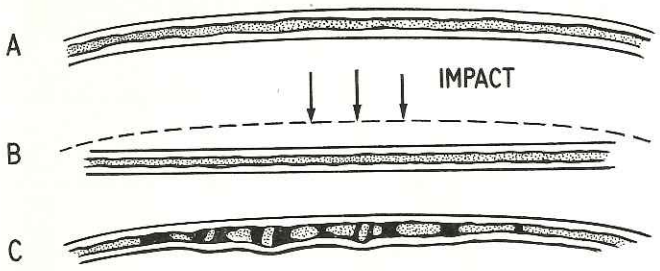


Fig. 26
Roof damage

This type of damage is best repaired by cutting one or more small holes through the roof opposite the area concerned, removing the lumps, and injecting a fresh quantity of bonding material wherever the bond has been broken.

This can best be achieved by using a fairly thin polyester or epoxide mix in a steel syringe and injecting it into a number of appropriately small holes drilled through the top roof skin only. It is sometimes necessary to drill blow-holes at the extermities of the damaged area to allow air to excape and the resin to penetrate.

Great care must of course be taken to wash the syringe out immediately it has served its purpose.

15. Rear End Damage

Damage to the top and under body surfaces can usually be repaired using the repair moulds, or in other cases sectional laminates can be obtained.

It should be noted that in cases of damage to the back panel or the join across same at bumper level, access can be gained to the inside surface of the area but splitting the bond across the top of the panel (if this has not already happened), cutting away the tape or cloth laminate which secures the vertical joins between the inside back panel and the rear wings, and flapping the entire inside back panel forward.

In case of accident damage near the wheel arches, ensure that the repair is made waterproof to exclude water from the boot and in particular from the tool box inside the left side rear wheel arch.

16. Metal Inserts

Throughout the Elite use is made of threaded metal inserts, commonly known as "bobbins" because of their shape, which provide strong and accurate attachment points for a variety of components. (Some, such as those providing the bonnet lid hinge pivots, are unthreaded.)

The three sizes of bobbins employed are $\frac{1}{4}$", $\frac{5}{16}$" and $\frac{3}{8}$" UNF respectively. The first are a generally used type, the second are used solely for door hinge mounting points and the latter solely for rear radius arm pickups on Series Two cars.

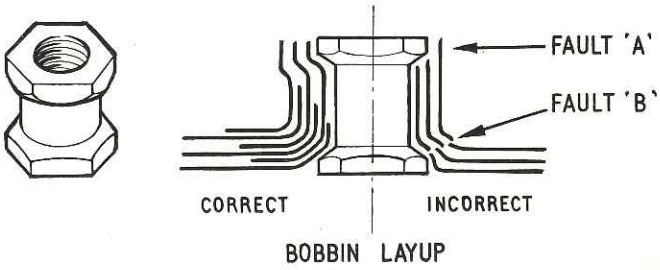


Fig. 27
Bobbin lay-up

Fig. 27 shows a typical hexagonal ended bobbin, and indicates graphically the requirements for a well laminated bobbin. Firstly, the laminates from the basic mounting surface must overlap and interleave with the laminates around the bobbin. Secondly, the laminate must be well built up under the shoulder of the bobbin to prevent the bobbin from pulling out in a downwards direction. Thirdly, one or two layers of tape or cloth should be wound around the "barrel" of the bobbin to prevent the laminate around the bobbin from spreading if any diagonal loads are applied. Finally, plasticine or similar "plugs" should be used during laminating to keep resin out of the bobbin threads.

The following advice is offered on dealing with bobbin failures:

i. *Bobbins pulling out:*

This could be caused either by faulty laying up (see Fig. 27 above) or by overloading, e.g. accident damage. Where the bobbin and its surrounding area is accessible from the rough side of the laminate either naturally (e.g. door hinge bobbins) or by cutting of non-weakening access holes (e.g. rear radius arm pickups on Series Two cars) the remedy is to improvise a local mould in plaster or glass-fibre of the area surrounding the "finished" side of the bobbin. This is done by removing the component which attaches to the bobbin, filling the bobbin hole with plasticine or clay but leaving sufficient of the hole definition for positioning purposes, and thereafter proceeding to take a cast or mould of the surrounding area.

The bobbin should then be removed together with the surrounding few inches of laminate, recovered (unless a new bobbin is available) and accurately positioned on the improvised mould surface which is then located against the body panel. The bobbin can then be directly laminated on to the old moulding using the techniques already described, and overlapping the new laminate on to the old by several inches wherever possible.

The only cases where the "back" of the bobbin is

not thus accessible, is in the boot and bonnet lids, where a whole portion of the inner skin box section must be removed, the bobbin layups repaired and the section then "floated back" into place using bonding resin and finally an external reinforcing layup.

ii. *Stripped threads:*

Whilst their hexagonal ends will prevent these bobbins from turning in normal usage, they may start to turn and loosen if too much tightening pressure is applied, or when an attempt is made to tap them out to a larger diameter. If a thread is damaged or stripped an attempt should therefore be made to drill the thread clear and use a bolt and lock-nut where possible to avoid the need for replacing the bobbin completely.

iii. *Turning:*

This is often the outcome of using too much force when the bobbin threads are blocked with resin, or as described in the preceding paragraph, of an attempt to tap out a stripped thread. In many instances it is due simply to overtightening.

Generally speaking, and particularly if the application is a critical structural one, the bobbin should be replaced in the manner already described. However, in a few instances, e.g. rear radius arm pickups, it has been found possible to cut fairly large access holes on the inner mould panel, electrically weld tags to the top hexagonal end of the bobbins and effect a very strong layup over same. This procedure is naturally recommended only where no tendency has developed for sideways or vertical movement of the bobbin.

SECTION P

COMPETITION TUNING

INTRODUCTION

It is not possible to give comprehensive general instructions for preparing the Lotus Elite for competitive events. What is suitable for one meeting may not answer the requirements for another, and in any case, it is assumed that owners who wish to improve the performance of their vehicles already possess some knowledge on this subject. Considerations to be born in mind are the amount one wishes to spend in time, parts, and extra fittings, as well as the exact purpose the owner has in mind. In this connection, it has been found that a number of owners are anxious to enhance the performance of their Elites for road work only, but whatever the object may be, it must be understood that any increase in the power output of the engine must inevitably carry with it a tendancy to reduce reliability. Specific handling characteristics may also be enhanced at the cost of sacrificing others. The standard specification is a compromise giving a good balance between such factors as performance, longevity, comfort and fuel economy. It is advisable for the owner therefore to fully consider the main purpose of his vehicle and select the appropriate stage he wishes to carry his modification to.

The Lotus Elite is produced in two versions:—The Standard Series Two and the Series Two Special Equipment model.

The Standard Series Two model can be modified to two stages: The twin carburetter or Special Equipment conversion or to Stage Three.

The twin carburetter conversion, a mild form of tune only, has been specifically introduced for the owner who desires a little extra road performance consistant with complete reliability.

The Special Equipment conversion is an extention of this. It provides a specification for ultimate road performance compatible with tractability, whilst at the same time the equipment gives it a useful track performance.

Stage Three conversion is a full racing specification and it should be noted that this conversion almost precludes its use on the road.

The equipment listed in this section can be fitted before customer takes delivery. Alternatively, conversion can be carried out at the 500 miles service. However, the information provided here will enable the owner with reasonable facilities and technical experience to modify his standard model.

TWIN CARBURETTER CONVERSION

1. General

This conversion comprises twin S.U.H4 carburetters (see Fig. 1) on special manifold with a four-branch specially tuned exhaust system which raises the standard B.H.P. from 75 at 6,100 r.p.m. to 85 at 6,500 r.p.m. The factory strongly recommend fitting 4·2 : 1 rear axle ratio when this conversion is incorporated on the car. If the rear axle ratio is changed from the standard 4·55 : 1, the appropriate [redacted] speedometer head must be fitted.

List of additional parts required.

1 H4 S.U. carburetter.
1 Twin inlet manifold set with balance pipe.
4 Manifold rubber O rings.
2 Balance pipe rubber O rings.
2 Carburetter flange gaskets.
1 Carburetter flange heat insulators.
2 Throttle W clips.
1 Throttle connection rod.
6 Long inlet manifold studs $\frac{5}{16}$" dia.
12 Double spring washers $\frac{5}{16}$" dia.
18 Flat washers.
1 Carburetter heat shield.
1 Four branch exhaust manifold with gaskets.
1 Double outlet banjo union.
1 18" length of flexible petrol hose.
2 Petrol pipe stems.
2 Petrol pipe nuts.
2 O clips.

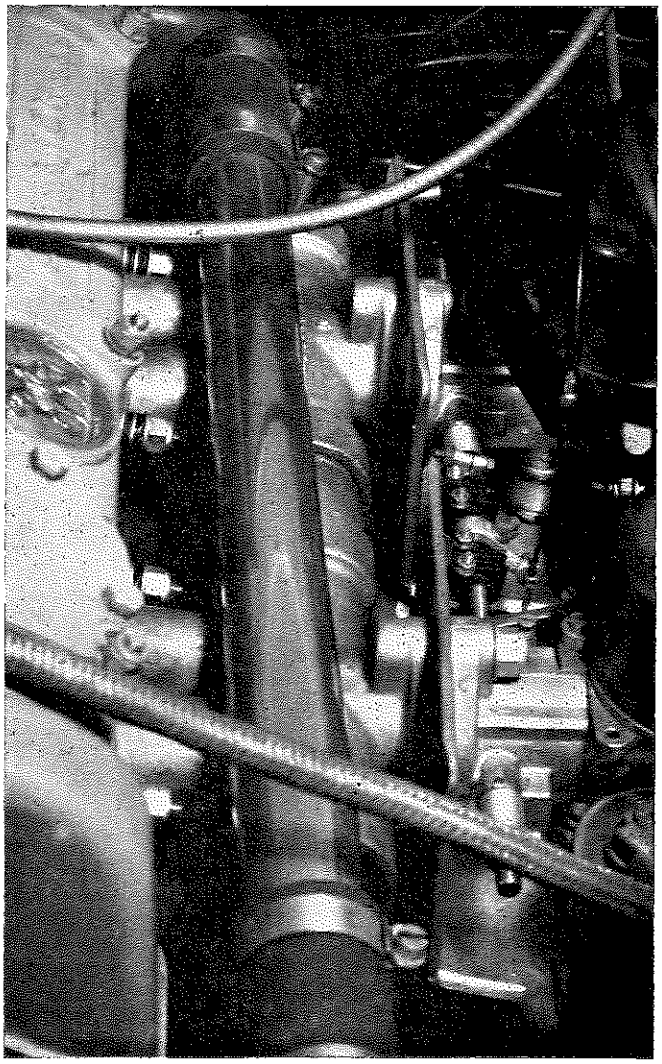


Fig. 1
Twin carburetter installation

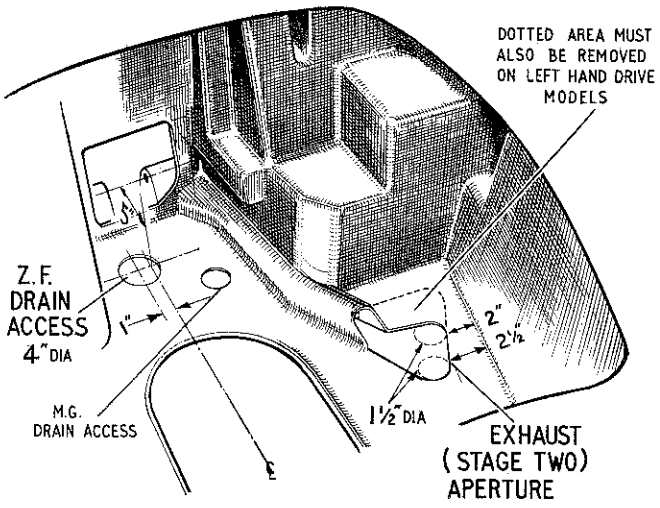


Fig. 2
Cutting hole for exhaust manifold

Open up the exhaust hole in the bottom of the engine bay to comply with the specification given in Fig. 2.

Fit the four branch exhaust manifold to the engine.

Remove inlet manifold studs and replace with the long ones provided.

Fit O rings to the manifolds and balance pipe and place in position on the studs.

Place washers and spring washers over the studs in compliance with the accompanying Fig. 3.

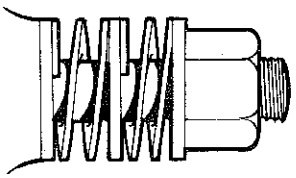


Fig. 3
Manifold stud set-up

Screw up the nuts until $\frac{1}{8}$" movement up and down can still be felt on the end of the manifold.

Before placing the carburetters in position, remove the float chambers and choke from one carburetter and replace it so that both carburetters are on the outside and both chokes towards the centre.

Connect up the throttle together with W clips and rod.

Connect the choke cable up to the front carburetter.

2. Tuning the twin carburetters

Before attempting to tune the carburetters it is advisable to check all engine details which affect performance, such as tappet clearances, plug gaps and distributor gap, and to ensure that these are all correct. The carburetters should then be checked (see Engine Section) in order to ensure that the pistons are perfectly free and that the jets are correctly centred. While the suction chambers are off, see that the needles are located in the same position in both of the pistons and that the jets are the same distance below the bridges of the carburetters when they are pushed down hard against their adjusting nuts.

Now slacken the clamping bolts on the universally jointed connections between the throttle spindles so that the throttles can be set independently, and disconnect the choke control by removing the fork swivel pin.

Undo the throttle adjusting screws and screw back until they will just hold a thin piece of paper inserted between the adjusting screws and the stop lug, with the screw on the throttle and mixture interconnection cam slackened off. Next screw the two throttle adjusting screws equal amounts in either direction, depending on whether a higher or lower speed is required. To check for exact synchronisation of the throttle openings listen to the intake by holding one end of a piece of rubber tubing against the ear and the other end near the intake of each of the carburetters in turn. If the hiss of one of them is louder than the other, unscrew the throttle adjusting screw until the intensity of the hiss is equal. When this is achieved, the mixture should be adjusted by screwing the adjusting nuts for the jets up or down to exactly the same extent, pushing the jets hard up against the nuts, until satisfactory running is obtained. As these nuts are adjusted the engine will probably run faster, and it will be necessary to unscrew the throttle adjusting screws, each by the same amount, in order to reduce the speed. When the mixture is correct on both carburetters, adjust the throttle and mixture control interconnecting screw so that it is just out of contact with the interconnecting cam when the jet has been rasied to its normal running position and the throttle is shut back to its normal idling position, as determined by the throttle stop screw.

With a correct mixture on both carburetters, lifting the piston on one of them with the aid of the plunger mounted on the side of the carburetter body should make the engine beat become irregular from excessive weakness the engine beat become irregular from excessive weakness. If lifting the piston on one carburetter stops the engine and lifting that of the other does not, this indicates that the mixture on the first carburetter is weaker than that on the second. When the mixture is correct from both carburetters, the exhaust beat should be regular and even. If it is irregular, with a splashy type of misfire and a colourless exhaust ,the mixture is too weak. If it is too rich, there will be a rhythmical or regular type of misfire together with a blackish exhaust.

Before re-connecting the choke control, make sure that the jets are hard up against the adjusting nuts. The throttle spindle interconnection clamping bolts may now be tightened.

3. The Float Chambers

Two remote float chambers are normally used to supply the fuel to the carburetters and are connected to them by short flexible pipes. This arrangement is used primarily to prevent engine vibration from causing fuel aeration, which has been found to provoke serious weakening-off of the mixture at high speeds.

The following point should be noted when installing the float chamber :

The float chambers must be adjusted in a vertical direction so that the level of fuel in the carburetters is $\frac{1}{16}$" below the top of the jet. In order to inspect the fuel level in the carburetters, take off the suction chamber, piston and jet needle.

4. Twin carburetter installation—removing and replacing

To remove the carburetters, first disconnect the throttle mechanism. Disconnect the choke cable from the front carburetter. Remove the split pin from the clevis pin at the fork end of the choke control and take out the clevis pin. Disconnect the fuel pipe unions at their carburetter ends. Slacken the nuts on the four bolts attaching the heat shields to the heat shield supports. Remove the two nuts attaching the heat shields to the induction manifold. Remove the two nuts securing each carburetter and take off the carburetters and heat shields.

Do not forget to re-fit the spacing washers between the shields.

SPECIAL EQUIPMENT SPECIFICATION

1. General

In addition to the modifications carried out in the twin carburetter conversion, the Special Equipment model comprises the following specification.

Engine—modifications as outlined in Chapter 2, bringing the B.H.P. output to 83 at 6,500 r.p.m.

Gearbox—4 speed gearbox with syncromesh in all gears with the following ratios:

First	2·53 : 1
Second	1·71 : 1
Third	1·23 : 1
Fourth	1·00 : 1
Reverse	2·59 : 1

(used in conjunction with standard 4·22 : 1 rear axle ratio.)

Heater/de-mister Unit.

Screen washers.

Headlamps	F700—7".
Filler Cap	Monza alloy type.
Interior Trim	The special Royalite trim is available in a variety of colours. (ashtrays are included.)
Exterior Finish	An attractive range of single or two-tone colour schemes is available.

2. Engine

Dynamo Speed Reduction

Due to the regular use of speeds in excess of 6,000 r.p.m. it has been found necessary to introduce a larger dynamo pulley in order to reduce the dynamo speed to ·9 engine speed. This entails modification to the dynamo adjusting bracket and the use of a 40" drive belt in place of the previous 39" belt used on engines not fitted with a fan. All belts supplied on future spares orders for engines not fitted with a fan will be 40", as the adjustment provided will allow the use of the larger belt even if the original pulley is retained.

Where a fan is fitted the original belt can be used in conjunction with the new pulley, providing the new type bracket is fitted.

The following new parts are required:—

Part No.	*Description*	*No. off*
FWA.2066	New dynamo pulley	1
FWA.1098 (issue 3)	Modified adjusting bracket	1
FWA.1231 (issue 1)	Dynamo link	1
FWA.1231 (issue 1)	Dynamo link	1
FWA.1200 (issue 2)	Dynamo link spacer	1
FWA.2016/2	Belt (A.40) (Engines not fitted with Fan)	

It should be noted that this modification will alter the ratio of the tachometer drive taken from the back of the dynamo and will necessitate a gearbox having a ratio to suit the ·9 engine speed dynamo ratio.

Fitting Oversize Valve Seat Inserts

Valve seat inserts 0·010" oversize are now available, and may be fitted as follows:—

Remove the cylinder head and take off the camshaft and valves, etc. To remove an old valve seat insert, drill two holes in the insert 108° apart, not exceeding the width of the insert in depth, using a drill slightly less than the radial thickness of the insert. A small chisel may then be used to cut the small sections of metal between the holes and the edges of the insert, which will then be in two pieces and may easily be prised out. When drilling and cutting care must be taken not to damage the sides or bottom of the recesses in the head.

The cylinder head must be machined as shown in Fig. 4, and then heated to 150°C. in order to fit the new inserts, which are parts No. FWA.1005/3 (exhaust) and FWA.1006/3 (inlet). Make sure that the inserts are inserted fully into the recesses in the cylinder head. The inserts should then be skimmed with valve seat cutters as described in Engine Section, until the larger diameters of the valve seating faces of the inserts are 1·200" (exhaust) and 1·350" (inlet). Next, grind the valves with grinding paste as described in Engine Section.

Re-assemble the cylinder head in the normal way, checking the valve tappet clearances and fitting the necessary shims to give the correct tappet clearances.

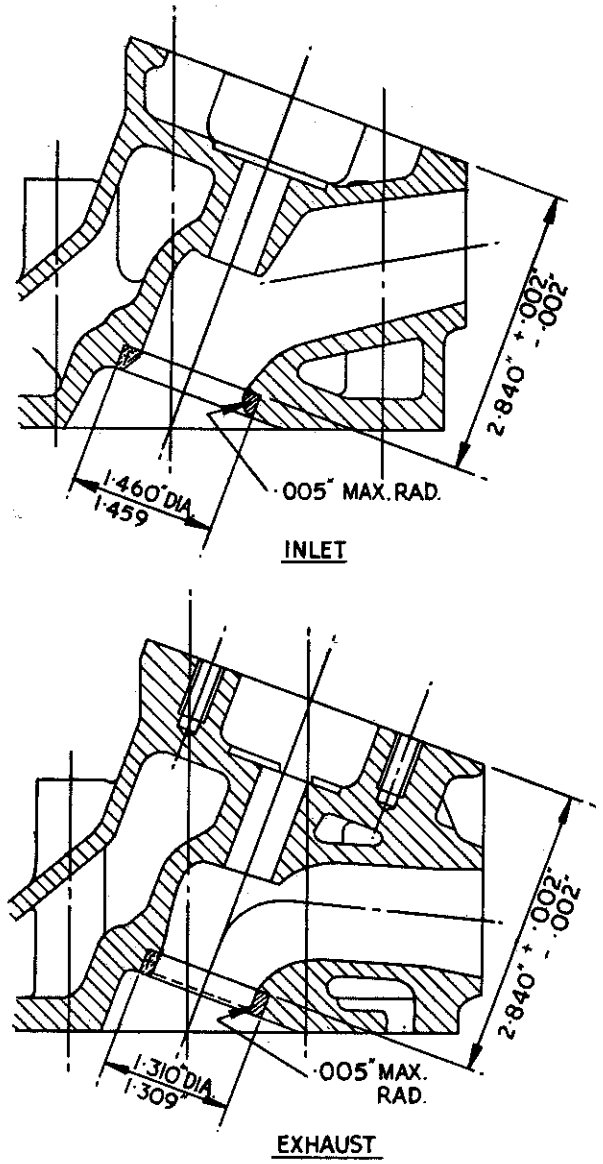
Oversize Valve Guides

Valve guides $\frac{1}{32}$" oversize are now available. To fit these it is necessary to bore out the valve guide holes in the cylinder head and then ream to 0·5327" to 0·5320" (17/32").

The oversize guides, which are parts No. FWA.1023/3 (inlet) and FWA.1024/2 (exhaust), may be fitted as described in Engine Section.

Valve Springs

It is important to ensure that the valve springs are up to strength. The total load required to compress them to their fitted length must not be less than 50 lb. (see fig. 6, Stage III tuning).



Fifg. 4
Fitting oversize valve seat inserts

*Camshaft FWA.*3021/1

This camshaft gives increased lift from 0·310″ to 0·360″, and increased opening period of 22°.

The timing with 0·010″ tappet clearance is:—

Inlet opens	30° B.T.D.C.	Note: The 0·010″ clearance called for is for timing purposes only, ensuring timing from the start of the flank. For each thou. below 0·010″ allow 4° at flywheel.
Inlet closes	60° A.B.D.C.	
Exhaust opens	60° B.B.D.C.	
Exhaust closes	30° A.T.D.C.	

If the same dowel hole in the chain sprocket is matched to the dowel hole in the camshaft it will be found to give approximately the above timing, and no other change is necessary except to adjust the tappet shims to give:—

0·006″ inlet
0·008″ exhaust

*Induction Pipes FWA.*3007/1

These induction pipes comprise two similar castings in which the port extensions converge at the carburetter entry, so giving a more direct line of flow from carburetter to inlet port.

Carburetters

These are the S.U. H4 type as previous lyused, but size B.F. needles are now required to give the correct mixture.

3. Gearbox

The four-speed Z.F. gearbox with ratios outlined in General (Chapter 1) may be fitted at this stage. Owners may, however, wish to retain the B.M.C. gearbox replacing the standard gears with close ratio items. The box may be removed and stripped in accordance with the instruction given in the gearbox section, and replaced with the B.M.C. components tabulated below.

Alternative available ratios B.M.C. gearbox.

Gear	Ratio	No. of Teeth	Input/ Layshaft Ratio
Top	1 : 1		
3rd	1·37 : 1	26/25	
2nd	2·22 : 1	20/31	×21/30
1st	3·64 : 1	11/28	
Top	1 : 1		
3rd	1·27 : 1	22/29	
2nd	2·22 : 1	19/32	×26/25
1st	2·45 : 1	11/28	

4. Other items

The Heater/de-mister unit may be fitted to instructions outlined in Section N (Body Equipment).

STAGE III SPECIFICATION

1. General

This conversion is for owners desiring the Series II Lotus Elite in full racing trim. The brake horsepower output has been raised to 103 and the specification includes Z.F. close ratio gearbox, competition clutch, light alloy brake calipers and S.U. high pressure fuel pump system. As there is a most comprehensive range of components available for this conversion, the Development Dept. of Lotus Cars Ltd. recommend the following specification.

Engine: 103 b.h.p. modifications as outlined in Chapter 2. Fitted with 2 twin choke Weber 40 DCOE carburetters and necessary fuel piping. Man jet No. 125 or 2 SU.H4 carburetters.

4 *Branch Exhaust:* As per established pattern.

Heat Shields: (a) Over starter motor.
(b) Attached to side of engine by exhaust pipe.

Fuel pump: S.U. Electric high pressure fuel pump, No. AUA 56 to be fitted in boot with necessary piping.

Fuel tank: 10½ gallon tank to be fitted in the boot and/or 7 gallon alluminium tank inside of front wing.

Fuel Filler: Monza filler No. M.775-D and M.775-18 collar type, or Le Mans M.1539 Cap and M.1539 16B neck (Bush type).

Wheels: Dunlop "Red Spot" (Borani wheels may be used as an alternative.

Gearbox: 4-speed Z.F. S4-12 all syncromesh close-ratio.

Gear	Ratio	No. of Teeth	Input/ layshaft Ratio
1st	2·53 : 1	14/33	
2nd	1·71 : 1	20/32	
3rd	1·23 : 1	27/31	× 28/30
4th	1·00 : 1		
Reverse	2·59 : 1		

Clutch: Competition type. Pressure assembly Part No. 45688/39; Plate assembly Part No. 48831/39.

Front Suspension: Early wishbone 112/3/55. Issue No. 4. Damper Unit AT 7 1485/5. Shock Absorber settings as earlier Mk. I model. Spring: Total coils 13¾″; Wire dia.: ·348″; Mean dia.: 2¼″; Free length 10$\frac{11}{16}$″. Rate 154 lb./in. Lower Alford 2nd Alder 02203 R.H., Trunnion 02209 L.H.

Rear Suspension: Damper unit AS 1501 (open and closed length to be as Standard item (AS 1506). Spring: Total Coils 11, wire dia. ·406″, mean dia. 3½″, free length 12¼″, rate 96 lb./in.

Ground Clearance: Adjusted to 6½″ by modifying spacer-tube length.

N.A.C.A. Duct: One in bonnet over carburetters.

Front Brakes: Type AR (no dust shields).

Rear Brakes: Type NR (used in conjunction with Series I differential housing and handbrake. Type 10H (used in conjunction with Series II differential housing and handbrake (umbrella).)

Amber brake fluid.

Tyres: According to contract (Dunlop R5PD9 500 × 15 recommended all round).

Back Axle: 4·55 : 1 recommend for racing in U.K. Alternative ratios tabulated below.

Ratio	No. of Teeth
3·7 : 1	11/41
3·9 : 1	10/39
4·2 : 1	9/38
4·6 : 1	8/37
4·9 : 1	8/39
5·4 : 1	8/43

Z.F. Limited slip differential is also available as alternative.

Screen Washers: large capacity.

Oil Cooler: fitted in front of water radiator. Cov. Rad. No. M.6738 ·090 0148 or Scerck No. C.94470 with air duct.

Oil Filter: may be removed from side of engine and blanking plate fitted. Fit with Telcalemit external type.

Starter Motor: Fit Lucas end 3347 or 25081

2. Engine

For this stage, engine and bonnet top must be returned to the factory, the engine for the 103 b.h.p. modifications and the bonnet top for the fitting of the cold air duct. The standard clutch must be removed and replaced with the competition component to withstand the subsequent increase in power output. By various modifications, detailed below, engines in the Stage II state of tuning may be converted to stage III. The parts needed for the modifications are listed in five separate sections so that the owner may incorporate them at his convenience.

Stage III tuning is to increase the power output of the engine by raising the compression ratio. This is effected by machining 0·040″ from the underside of the cylinder head. To retain the tension in the camshaft driving chain, the tappet block must be raised in relation to the cylinder head, by the use of tappet block packing washers. 100 octane fuel may be used to full advantage with the new compression ratio (10·5 : 1). Section 'A' of the attached parts list gives the parts necessary for this compression ratio modification.

In order to counteract the increased load on various parts of the engine, four other modifications should follow the above:

Section 'B' lists parts to be used when the three bearing camshaft is replaced by the five bearing camshaft. Stronger valve springs are fitted with the five bearing camshaft and the head must be machined as shown in Fig. 5, to accommodate the outer springs. See Engine Section (Section F).

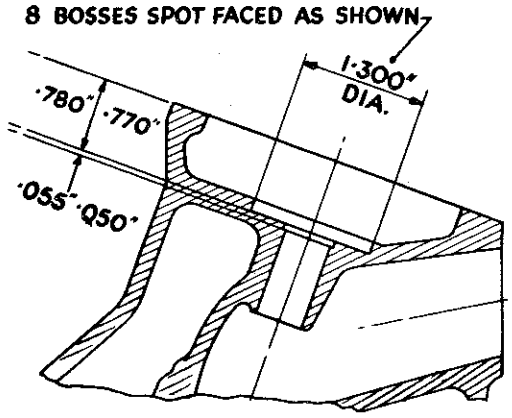


Fig. 5
Modifying the cylinder head

Section 'C' lists connecting rod assemblies and 9 mm. connecting rod bolts. The original connecting rod assembly may be modified to include the new 9 mm. bolt and tabwasher listed. Details of the necessary drilling and tapping are shown in Fig. 6.

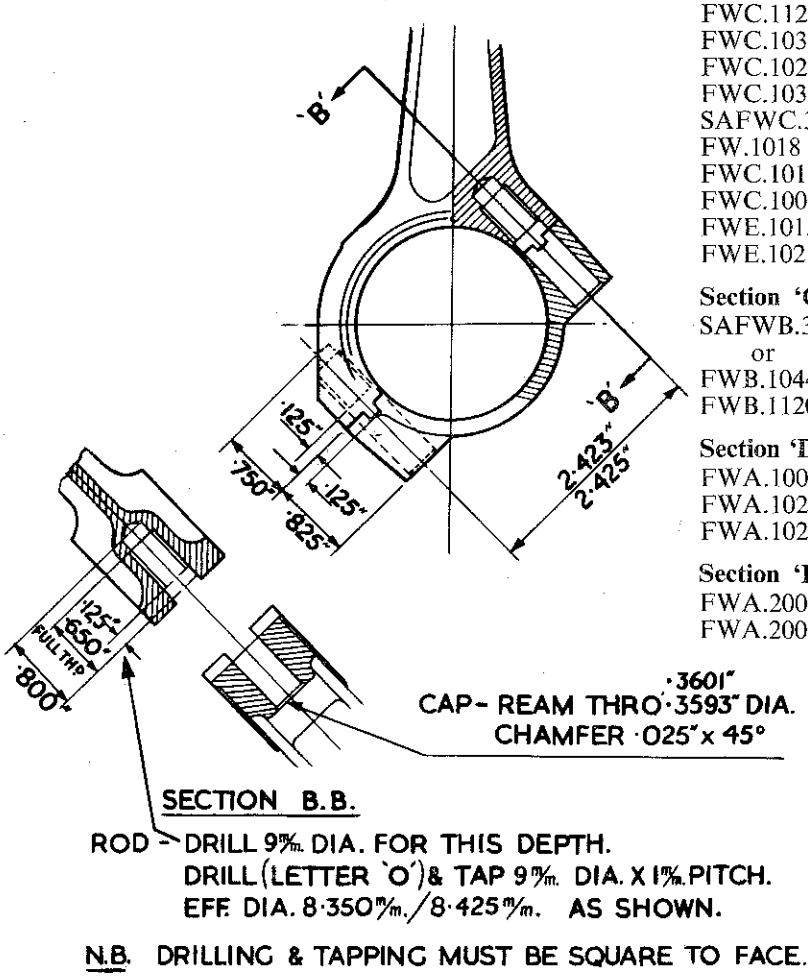


Fig. 6
Modifying the connecting rod

		Qty per engine
Section 'A'		
FWA.1548	Tappet Block Packing Washers ...	9
SAFWA.2128	Piston Assembly	4
Section 'B'		
SAFWA.3060	Camshaft Assembly	1
FWC.1121/3	Inner Valve Spring	8
FWC.1032/3	Outer Valve Spring	8
FWC.1022/4	Valve Spring Collar	8
FWC.1031/3	Valve Spring Cup	8
SAFWC.3052	Tappet Block Assembly	1
FW.1018	Camshaft Bearing (Front and Rear)	4
FWC.1019/5	Camshaft Bearing (Centre) ...	6
FWC.1007/3	Tappet	8
FWE.1013/7	Inlet Valve	4
FWE.1021/7	Exhaust Valve	4
Section 'C'		
SAFWB.3061	Connecting Rod Assembly ...	4
or		
FWB.1044/1U	Connecting Rod Bolt (9 mm.) ...	8
FWB.1120/2	Connecting Rod Bolt Tabwasher	8
Section 'D'		
FWA.1005/7	Exhaust Valve Seat Insert ...	4
FWA.1024/4	Exhaust Valve Guide	4
FWA.1023/6	Inlet Valve Guide	4
Section 'E'		
FWA.2006/5	Bearing Cap (Front and Rear) ...	2
FWA.2007/5	Bearing Cap (Centre)	1

Section 'D' lists three parts which have a longer life than those which they replace. Details of the fitting of guides and seats are dealt with in the Special Equipment Section.

When the oversize exhaust valve seat inserts have been fitted it will not be possible to fit the new inserts FWA. 1005/7. In this case it will be necessary to fit a new cylinder head.

Section 'E' lists new main bearing caps. The new bearing caps must be assembled on the cylinder block and line bored as shown in Fig. 7. The front and rear main bearing caps are different from the centre cap. They may be recognised by the width from front to rear of the cap: front and rear caps are 1·1″ in width, the centre cap is 1·23″ in width.

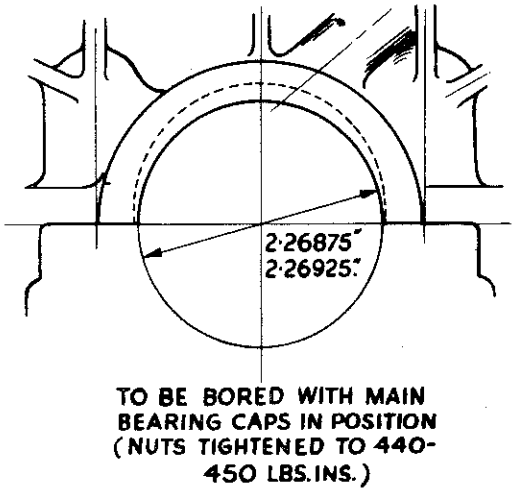


Fig. 7
Line bore dimensions for the bearing cap

Cylinder Head

In order to realise the potential improved performance from the modifications it is necessary to carry out certain extra fettling, notably:—

Inlet Port. The metal around the valve guide must be cut away so that the boss is thinned away very considerably, as shown in Fig. 8.

Combustion Chamber. The cut-away round the inlet valve requires blending in to the parallel side of the chamber, as shown in Fig. 8.

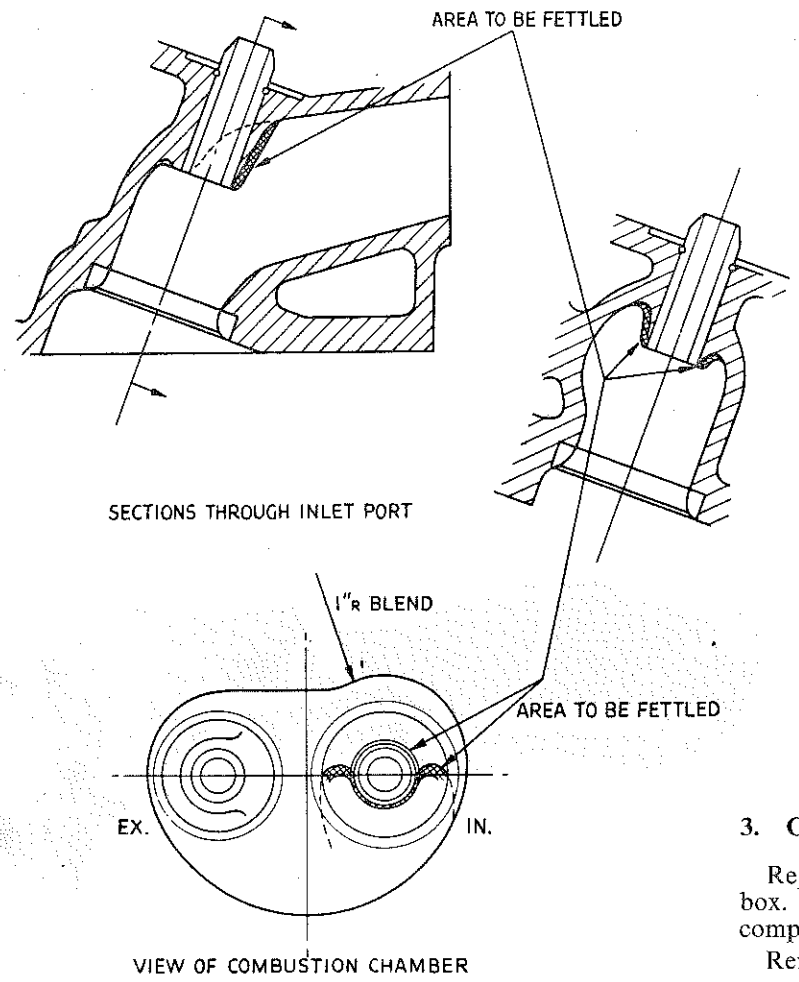


Fig. 8
Inlet port and combustion chamber fettling

Valve Springs

It is important to ensure that the valve springs are up to strength. The total load required to compress them to their fitted length must not be less than 50 lb. (see Fig. 9).

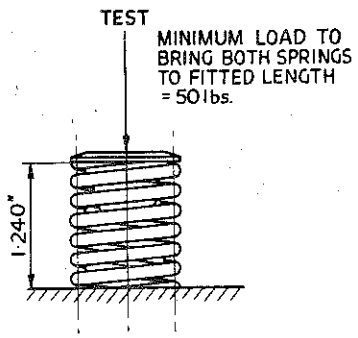


Fig. 9
Valve spring checking

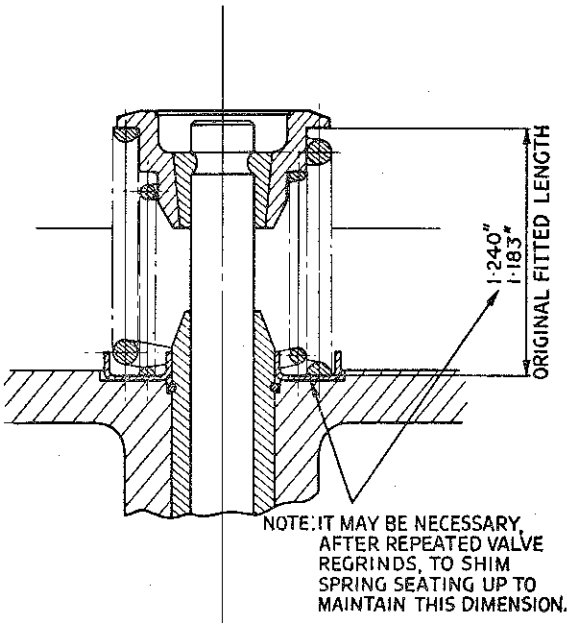


Fig. 10
Valve spring lengths

3. Other Components

Replace B.M.C. gearbox unit with Z.F. close ratio box. Replace the existing clutch with the competition component.

Remove the petrol filler cap and tank.

Replace the tank with the long range fuel tank. Increase the size of the filler cap hole in the body shell and fit the Monza fuel cap.

Fit the high pressure S.U. electric fuel pump in the boot of the car on the right hand side of the boot at the lowest possible level, facing fore and aft. Mounting instructions are printed on the pump. Connect up the fuel lines. A plain green lead is provided on the wiring loom for connecting to the pump. Connect the black earth lead from the pump to the earth connection on the petrol gauge installation situated on the tank top.

Remove the standard cast iron brake calipers and fit light alloy calipers types AR and NR.

Empty the hydraulic system and refill with Girling heavy duty Amber brake fluid.

If any modifications are made to the exhaust pipes, it is essential that they clear the bodywork and undertray of the car. Hot exhaust pipes, it is essential they that clear the bodywork and undertray of the car. Hot exhaust gases played directly onto the glass fibre can have a disastrous effect.

Replace the radiator filler cap with the 7 lbs. per square inch, pressure cap, or on the older type radiator, the 10 lbs. per square inch pressure cap is suitable.

Fit Champion N58R sparking plugs.

Re-spray to own racing colours.

Spring/Damper units. Details of the normal ride settings are tabulated below. These are suitable for most conditions, but will serve as a basic 'standard' from which owners may wish to deviate. To suit these varying track conditions, a range of Spring Damper units with alternative ratings are available.

	Series I Front	Series II Front	Series I Rear	Series II Rear
Normal Rate	150lb/in	112lb/in	96 lb/in	69 lb/in
Normal Ride Load	516 lb	532 lb	468 lb	483 lb
Normal Ride Length	$7\frac{1}{4}$"	$8\frac{5}{8}$"	$7\frac{3}{8}$"	$10\frac{3}{4}$"
Spring:				
No. total coils	$13\frac{3}{4}$	$18\frac{1}{2}$	11	$12\frac{1}{8}$
Wire dia.	·348	·348	·406	·406
Mean dia.	$2\frac{1}{4}$"	$2\frac{1}{4}$"	$3\frac{1}{2}$"	$3\frac{3}{4}$"
Free length	$10\frac{11}{16}$"	$13\frac{3}{8}$"	$12\frac{1}{4}$"	$17\frac{3}{4}$"

Speedometer heads are available to suit alternative differential ratios.

Tyre pressures. Tyre pressures should under normal conditions be 20 p.s.i. Front and Rear but should be adjusted to suit varying conditions.

Wheel Balancing as constant velocity universal joints are not fitted, tyre wear under racing conditions may be uneven. Apart from the normal practice of changing wheels over, it is advisable to balance wheels at every available opportunity as an additional precaution.

Oil. It is recommended that a heavier engine oil should be used (approx. SAE40). Advice on this should be obtained from the company contracted.

Filter. Element should be replaced regularly (approx. every 500 racing miles).

Prepared by James Allington and printed by the Saffron Press Ltd., Saffron Walden, Essex, England