Chapter E
ENGINE

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Chapter E
ENGINE

Introduction

The engine *(see Figs. E1 and E2)* is an eight - cylinder over square 90°Vee form, four stroke, cooled by an approved anti-freeze mixture.

The engine is mounted onto the front sub-frame by rubber mounts. The aluminium crankcase incorporates detachable wet cylinder liners of centrifugally spun cast iron. The aluminium alloy pistons have three compression rings and one oil control ring on the 9,14 cm. (3.600 in.) stroke engine and two compression rings and one oil control ring on the 9,90 cm. (3.900 in.) stroke engine.

All piston rings are fitted above the gudgeon pin which is offset to the vertical axis of the piston.

The engine has two aluminium alloy cylinder heads each having four separate inlet and exhaust ports. The cylinder heads are fitted with phosphor bronze exhaust valve guides, cast iron inlet valve guides and austenitic steel valve seat inserts. The valves are austenitic steel with a stellite tip and valve seat face. The overhead valve mechanism is operated from a single camshaft by push rods and self adjusting hydraulic tappets.

The five journal crankshaft is forged from chrome molybdenum steel, nitride hardened and dynamically balanced. Location is by steel backed, lead bronze thrust washers at the centre bearing. The crankshaft is drilled for pressure lubrication of all bearings and the crankpins incorporate sludge traps with removable sealing plugs.

The main and big end bearing shells are lined with reticular aluminium-tin.

The engine is lubricated by oil from the sump, circulated by a gear driven pump mounted on the front of the crankcase. High pressure oil from the full flow filter is delivered to the crankshaft, connecting rods, camshaft bearings, timing gears, tappets, push rods and rocker ball end seatings. Low pressure oil is fed intermittently through the front camshaft bearing to the rocker shafts, rocker arms and valve tips. The connecting rod small ends, gudgeon pins and cylinder walls are splash fed with oil from the crankcase.

Identification

The cylinder banks are referred to as the 'A' and 'B' bank sides of the engine.

Viewed from the driving position 'A' bank is on the right and 'B' bank on the left-hand side of the engine compartment.

Long and short stroke engines

There are two basic engine types, a short stroke engine and a long stroke engine. Identification can be made by reference to either the car serial number or the engine serial number.

Car serial number

Cars produced prior to serial number SRH 8742 have engines fitted with cylinder dimensions of 10,41 cm. x 9,14 cm. (4.100 in. x 3.600 in.).

Cars produced from serial number SRH 8742 and onwards have engines fitted with cylinder dimensions of 10,41 cm. x 9,90 cm. (4.100 in. x 3.900 in.).

Engine number

Engines can be identified by the prefix of the engine serial number. This number is stamped on a small crankcase boss situated directly under the thermostat housing.

The prefix letters 'SY' refer to the short stroke engine; the prefix letters 'SYL' refer to the long stroke engine.

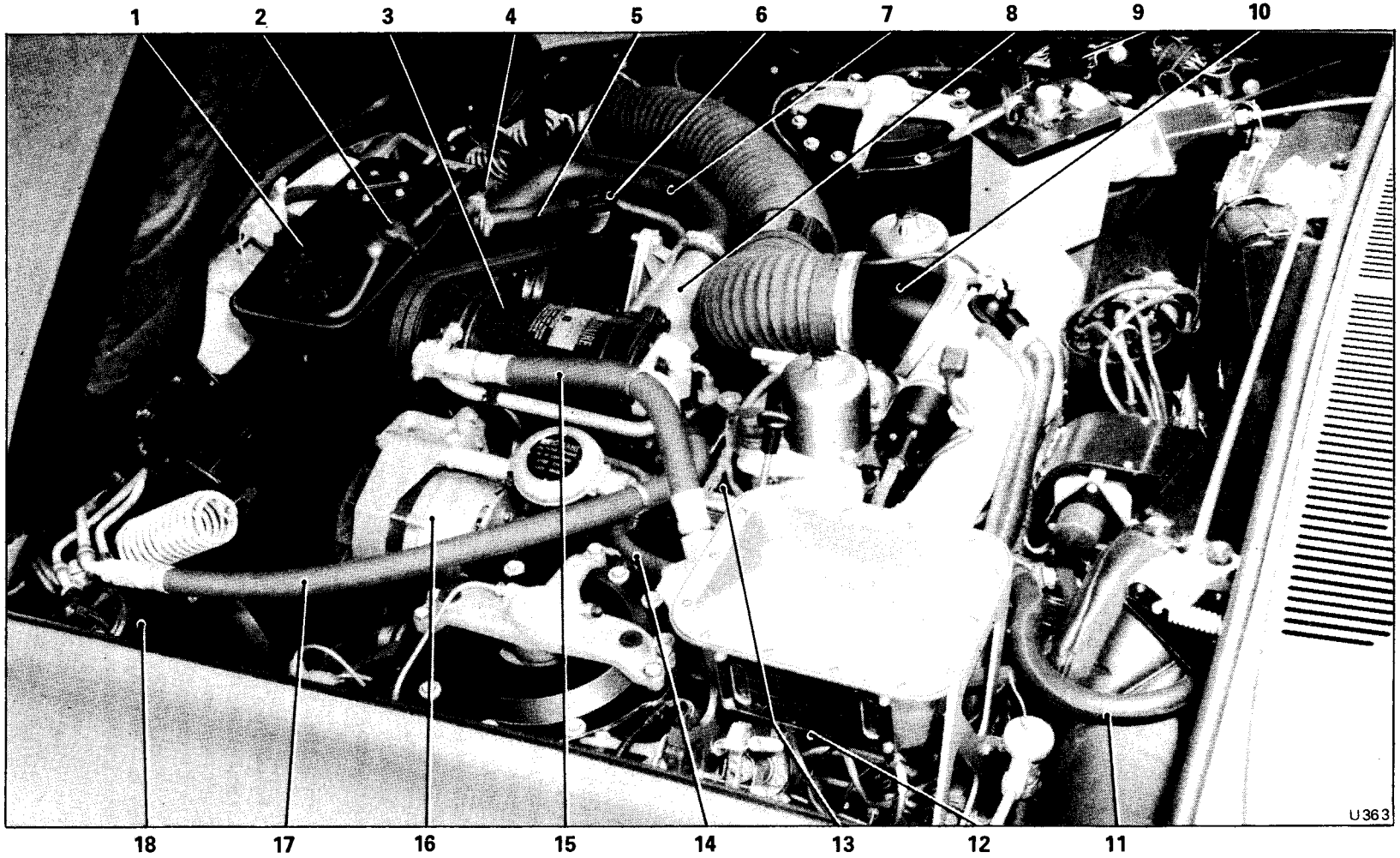

Fig. E1 General view of engine compartment - Early cars

1 Radiator header tank
2 Coolant level probe
3 Refrigeration compressor
4 Coolant overflow hose
5 Coolant hose
6 Steering pump reservoir filler cap
7 Coolant hose
8 Thermostat elbow
9 Engine wiring loom connections
10 Air intake
11 Heating system hose
12 Wiring loom connector (hidden)
13 Brake pump (hidden)
14 Low pressure hose
15 Low pressure refrigeration pipe
16 Alternator
17 High pressure refrigeration
18 Refrigeration receiver/drier unit

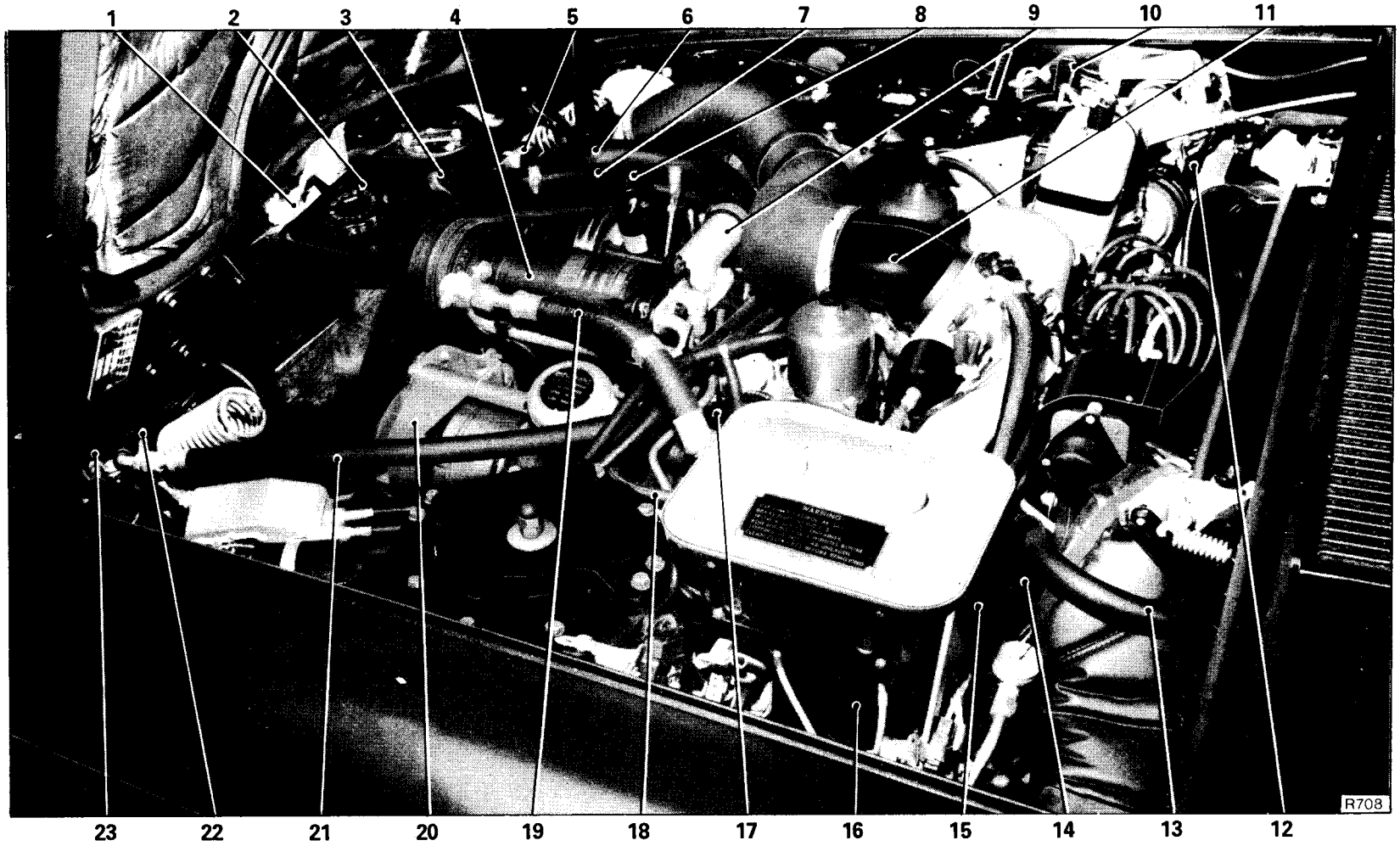

Fig. E2 General view of engine compartment - Late cars

1 Bonding strip
2 Radiator header tank
3 Coolant level probe leads
4 Refrigeration compressor
5 Coolant overflow hose
6 Coolant hose
7 Coolant hose
8 Steering pump reservoir filler cap
9 Thermostat elbow
10 Engine wiring loom connections
11 Air intake
12 Wiring loom connector block (hidden)
13 Heating system hose
14 Heating system hose (hidden)
15 Low pressure hose
16 Wiring loom connector (hidden)
17 Front brake pump (hidden)
18 Low pressure hose
19 Low pressure refrigeration pipe
20 Alternator
21 High pressure refrigeration pipe
22 Pipe - Refrigeration condenser
23 Pipe - Refrigeration condenser

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Section E1
ENGINE REMOVAL AND FITTING

Information

Before attempting engine removal reference should be made to Chapter G - Special Precautions. This section should be read and fully understood so that depressurising the hydraulic systems and disconnecting the hydraulic pipe work affecting the engine are carried out correctly.

Dependent upon the specification of a particular car, it is suggested that the operator also familiarises himself with the details contained in the chapter listed below, before commencing any work on the engine.

Air Conditioning - Chapter C
Fuel System and Carburetters - Chapter K
Exhaust Emission Control System - Chapter U
Transmission - Chapter T Parts 1 and 2

The following pages describe the best method of engine removal, which is by lifting the engine out through the bonnet aperture. However, should it be necessary to remove the sub-frame, the engine may be removed complete with gearbox (transmission) and sub-frame from underneath the car. This method of engine removal is fully described in Chapter H.

To remove the engine through the bonnet aperture, proceed as follows.

Engine - To remove

1. Drive the car onto a ramp or over a pit.
2. Chock both front wheels and one of the rear wheels to prevent the car from moving. To protect the paintwork on the wings from accidental damage while working in the engine compartment, it is recommended to fit a wing cover set RH 2684 and liners RH 2685.
3. Drain the cooling system as described in Chapter L.
4. Depressurise the hydraulic systems as described in Chapter G.
5. Disconnect the battery leads.
6. Remove any dirt surrounding the engine oil drain plug then remove the plug together with the aluminium sealing washer. Drain the oil into a container of suitable capacity *(see Fig. E5)*. Inspect the aluminium sealing washer; renew if necessary and then fit the sealing washer and the drain plug.
7. If refrigeration is fitted, discharge the system as described in Chapter C - Part 2.
8. If the exhaust emission control and evaporative emission control systems are fitted, refer to Chapter U for information relating to the removal of the various components.
9. Scribe location lines around the profile of the engine mounting brackets *(see Fig E4)*; this is necessary to ensure correct engine alignment when the engine is replaced.
10. Remove the torque converter transmission or four speed automatic gearbox as applicable.

    Chapter T Part 1 gives the correct procedure for removal of the four speed automatic gearbox.

    Chapter T Part 2 gives the correct procedure for removal of the torque converter transmission.

    A plate attached to the right-hand side of each transmission (as viewed from the driver's seat) serves to determine the type of transmission fitted; the plate for the torque converter transmission is rectangular and the plate for the four speed automatic gearbox is oval.
11. After removal of the transmission, the jack taking the weight of the engine *(see Fig. E5)* should be left in position and the following work carried out *(refer to Fig. E1 and E2)*.
12. Disconnect the bonnet lamp leads at the switch snap connectors and connector block; these are situated just below the right-hand bonnet hinge *(see Fig. E6)*. Detach the leads and clips from the body.
13. Disconnect the bonding strip from the front of the bonnet (*see Figs. E1 and E2 item 1*).
14. Remove the eight setscrews securing the bonnet to its two hinges. Remove the bonnet.
15. Slacken the worm drive clips securing the air silencer tube to the carburetter air intake; detach the tube from the intake together with the bonding strip (if fitted).
16. Slacken the worm drive clip at the intake end of the air silencer tube then detach the tube.
17. Slacken the two screws from the air silencer clamp, then withdraw the tube through the clamp and

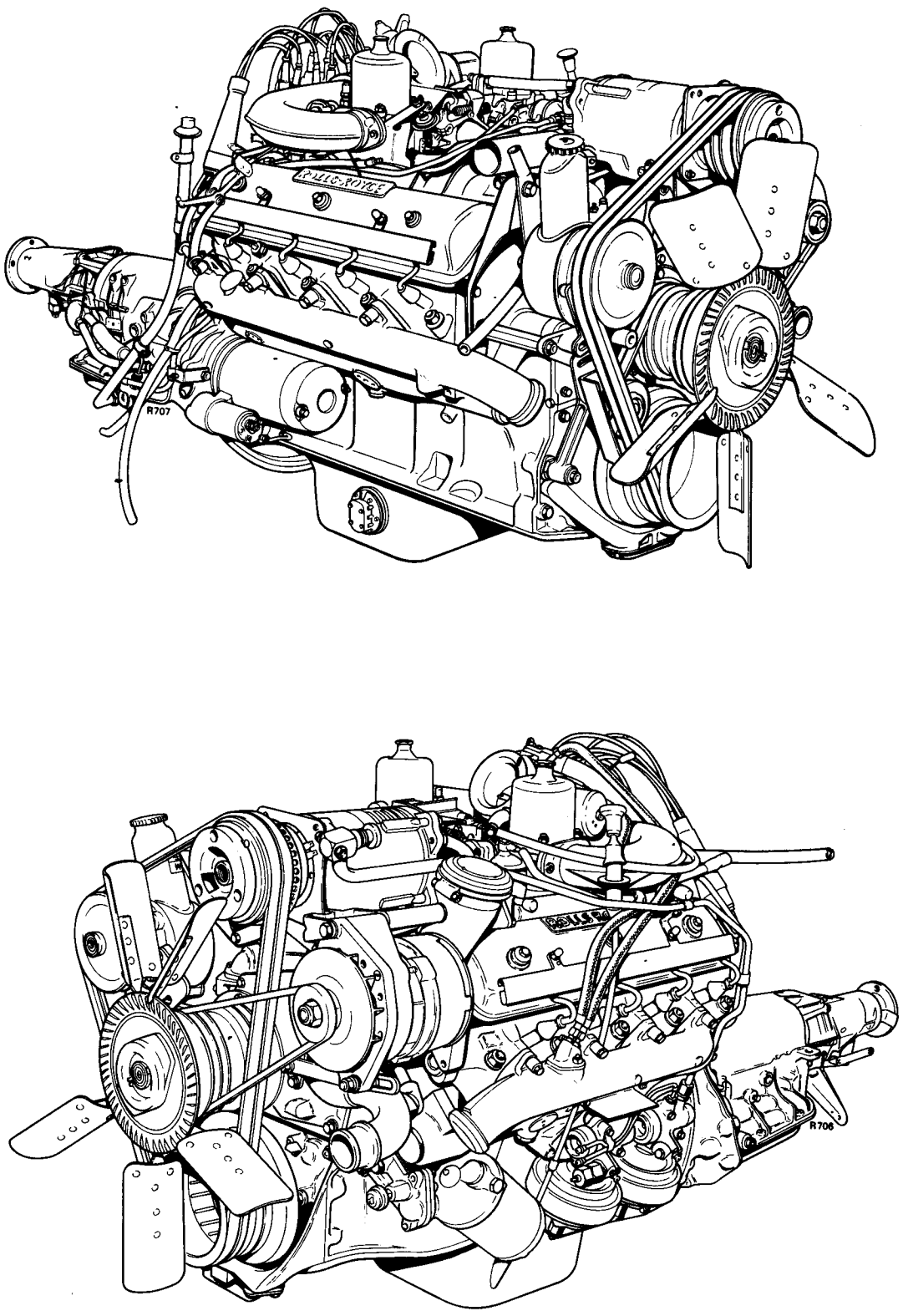

FIG. E3 GENERAL VIEWS OF 6,75 LITRE ENGINE UNIT

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remove from the engine compartment.

18. To prevent the ingress of dirt, blank off both the carburetter air intake and the air silencer outlet apertures.

19. Disconnect the coolant level probe leads from the header tank (*see Figs. E1 and E2 item 3*); detach the leads from the header tank.

20. Slacken the worm drive clips securing the coolant hose and coolant overflow hose to the rear of the header tank; detach the hoses.

21. Slacken the worm drive clip securing the coolant hose to the radiator upper connection; detach the hose.

22. Slacken the worm drive clip securing the coolant hose to the radiator lower connection; detach the hose.

23. On cars fitted with a fan cowl of either metal or plastic, the procedure for removing the radiator assembly is as follows:

a. Place a piece of sheet foam rubber inside the cowl, ensure that it covers the radiator matrix, thus providing protection against accidental damage during removal.
b. Unscrew the four setscrews securing the fan extension to the coolant pump pulley.
c. Carefully ease the fan assembly from the pulley and place inside the cowl onto the sheet of foam rubber.
d. By using a metal support strap or similar arrangement, secure the fan assembly so that it cannot move during removal of the radiator, as illustrated on Figure E11.

24. Remove the four setscrews securing the radiator in position, two of these setscrews are shown on Figure E6 the other two are located on the opposite side of the radiator; remove the radiator together with the header tank.

25. Remove the four setscrews securing the fan in position then remove the fan together with its extension.

26. Disconnect the two pipes to the refrigeration compressor (if fitted); refer to Figures E1 and E3, items 19 and 21.

27. To prevent the ingress of dirt, fit blanks to the ends of the pipes.

28. Remove the steering pump reservoir filler cap.

29. Using a syringe, transfer as much fluid as possible from the steering pump reservoir into a container and discard the fluid; approximately 0,5 litre (0.75 pint) of fluid can be removed in this way *(see Fig. E7)*.

30. Disconnect the two steering pump hoses from the pump, simultaneously placing a container beneath the exposed tubes to prevent any fluid spilling onto the floor. To prevent ingress of dirt and further oil spillage, fit blanks to the open ends of the tubes and hoses and leave them supported in a vertical position.

31. Slacken the worm drive clips from the two heating system hoses then detach the hoses. These

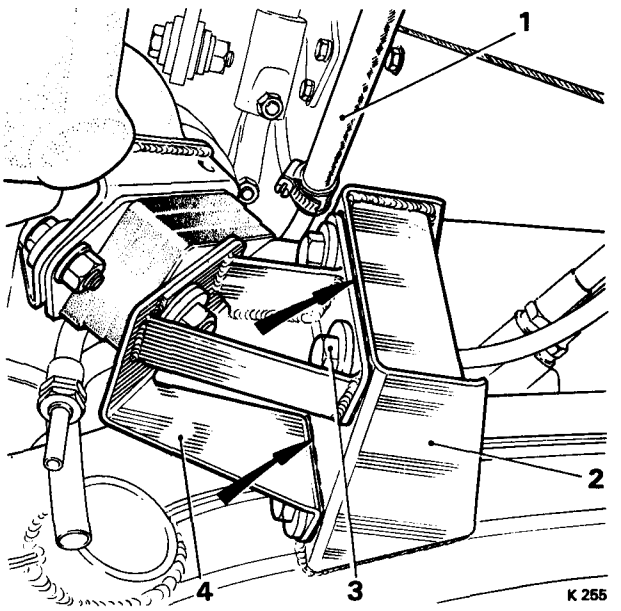

FIG. E4 POSITIONS FOR SCRIBING ENGINE MOUNTING PROFILE

1 Petrol pipe
2 Front sub-frame
3 Mounting setscrew
4 Mounting bracket

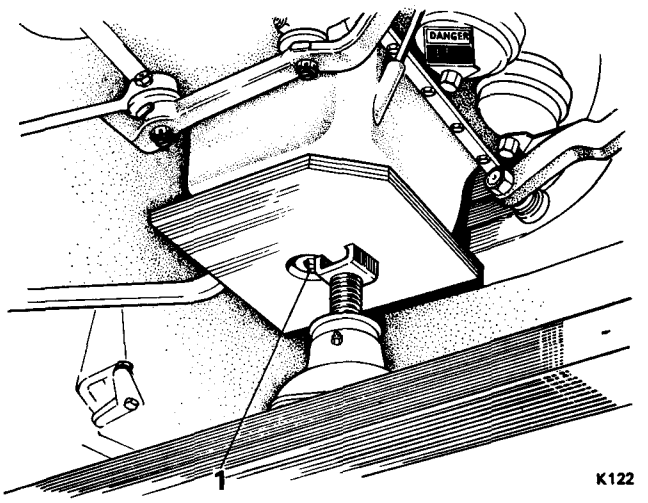

FIG. E5 JACK IN POSITION

1 Sump drain plug

hoses are situated immediately below the upper heating system actuators (*see Figs. E1 and E2 items 13 and 14*).

32. Slacken the worm drive clips securing the two low pressure hydraulic brake pump hoses. One of the clips is situated below the upper heating system actuators (*see Figs. E1 and E2 item 15*) and the other clip is situated adjacent to the engine oil filler cap (*see Figs. E1 and E2 item 18*). Blank off the ends of the hoses to prevent ingress of dirt and fluid drainage from the reservoir.

33. Slacken the two worm drive clips securing the

accumulator to reservoir low pressure return hoses, then disconnect the hoses *(see Fig. E8 item 1).* Blank off the hose ends to prevent ingress of dirt also drainage from the reservoir. On some later cars the accumulators are situated one on each side of the engine.

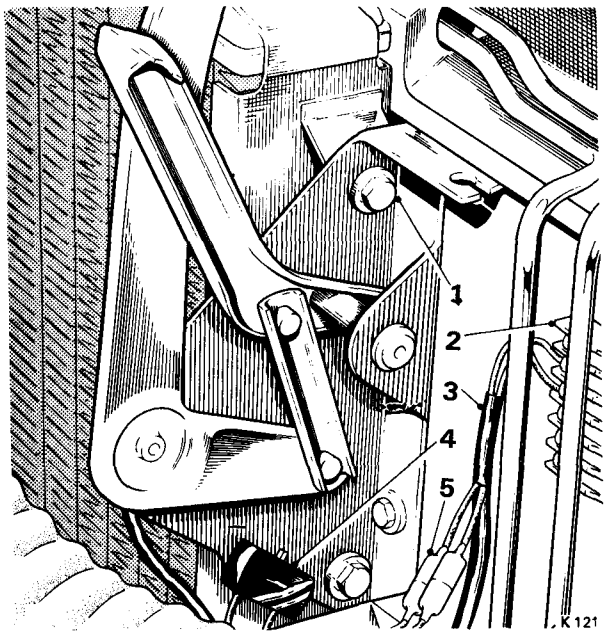

FIG. E6 RADIATOR MOUNTING

1 Setscrew - radiator (4 off)
2 Connector block
3 Wiring loom
4 Bonnet lamp switch
5 Snap connectors

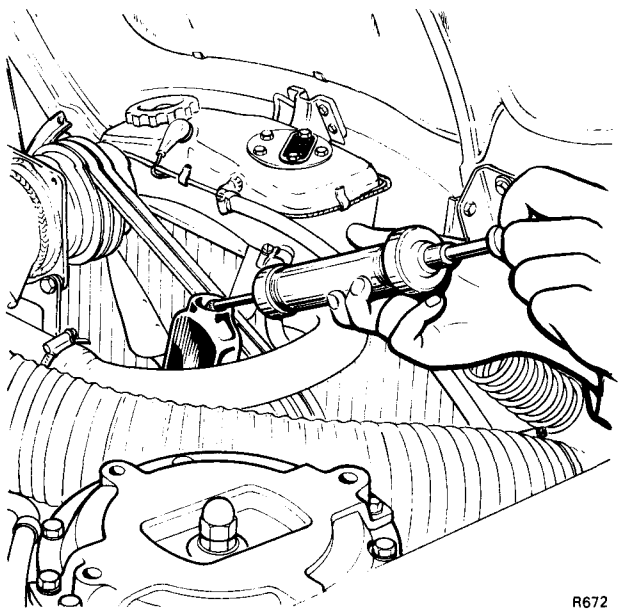

FIG. E7 REMOVING FLUID FROM STEERING PUMP RESERVOIR

34. Disconnect the two high pressure hoses which run between the accumulator and body connection *(see Fig. E8 item 2).* Blank off the pipe ends to prevent the ingress of dirt.

35. Slacken the worm drive clip fitted to the petrol supply pipe then disconnect the pipe. The worm drive clip is situated just above the combined engine and gearbox (transmission) flexible mounting on the 'A' bank side of the car refer to Figure E4.

36. Disconnect the oil filter electrical leads *(see Fig. E8).*

37. Remove the three exhaust downtake pipe clamps adacent to the engine then detach the 'A' bank pipe from the engine and remove the short 'B' bank downtake pipe.

38. Disconnect the engine wiring looms at their socket and blade connections, there are three blocks of these connections which are situated as follows.

Block 1 Immediately below the right-hand blower motor (when viewed from the driver's seat). *(see Fig. E10 item 2).* Two connections only of this block apertain to the engine, however for practical reasons it is better to disconnect all the connections. When the windscreen wiper motor is fitted adjacent to the blower motor, access to these connections will be simplified if the windscreen wiper motor and the blower motor are removed.

Block 2 On the cast arm of the oil filter *(see Fig. E9 item 1).*

Block 3 Adjacent to the heating system water tap *(see Figs. E1 and E2 item 16).*

39. Disconnect the leads to the remote starter switch *(see Fig. E11).*

40. Disconnect the control rod which is fitted between the pedal linkage and compensator linkage *(see Fig. E11 item 2).*

41. Remove the long bolt and nut securing the compensator linkage to the mounting bracket adjacent to the rear end of the 'A' bank cylinder head *(see Fig. E11 item 1);* attach the compensator linkage to the engine.

42. Remove the starter motor if it has not been removed previously.

43. Disconnect the leads to the ignition coil then remove the two setscrews securing the coil clamping bracket to the induction manifold; remove the coil.

Note The coil must be removed from the engine before engine removal, otherwise it will foul the upper heating actuator mounting as the engine is lifted clear of the engine compartment.

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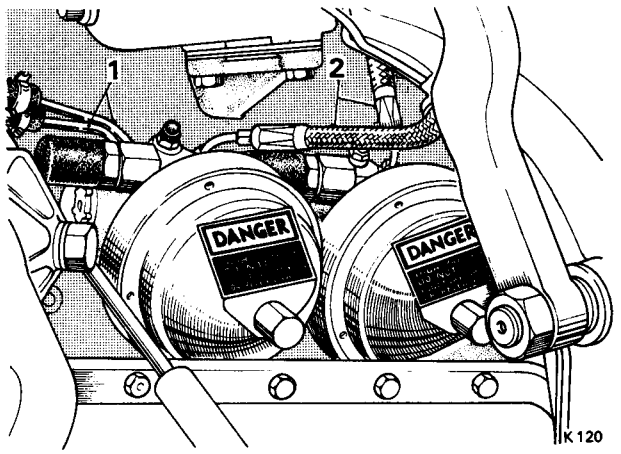

FIG. E8 POSITION OF HYDRAULIC ACCUMULATOR

1 Low pressure hoses 2 High pressure hoses

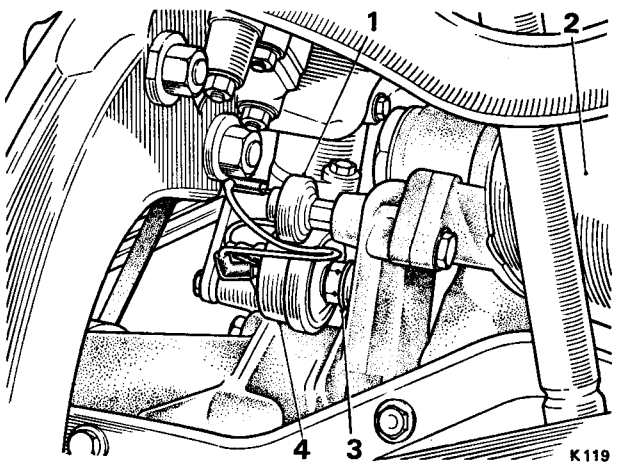

FIG. E9 OIL PRESSURE TRANSMITTER LEADS

1 Oil pressure warning lamp switch
2 Filter Bowl
3 Copper washer
4 Oil pressure transmitter (if fitted)

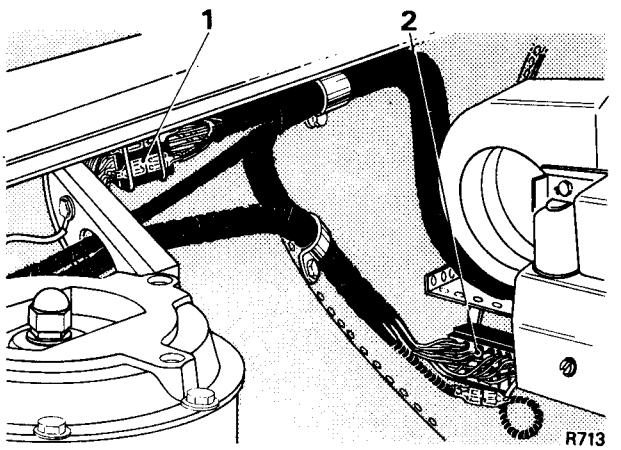

FIG. E10 POSITION OF ENGINE LOOM SOCKET

1 Connector block 2 Connector block

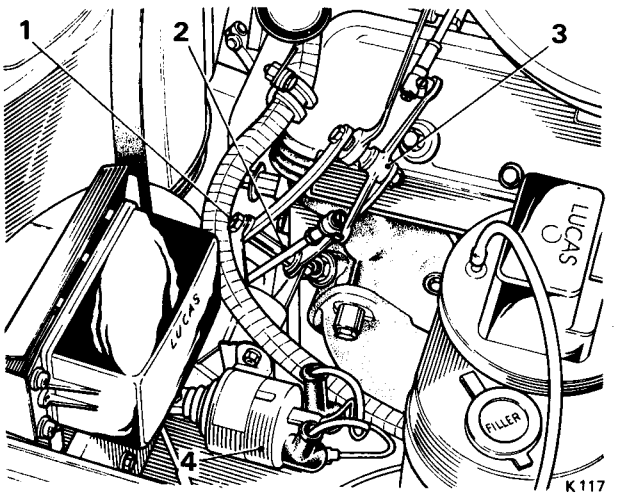

FIG. E11 COMPENSATOR LINKAGE AND REMOTE STARTER MOTOR SWITCH (Early Cars)

1 Long bolt and nut
2 Control rod
3 Compensator linkage
4 Remote starter switch

44. Using a crane and slings capable of lifting 10 cwt. take the weight of the engine.
45. Disconnect the engine front mounting.
46. Check to ensure that the engine is completely disconnected from any pipes, wiring etc.
47. Carefully lift the engine out of the engine compartment simultaneously checking to ensure that the engine does not foul any point of the engine compartment.

Engine - To replace

To fit the engine into position reverse the procedure given for its removal noting the following points.

1. When lowering the engine into position, ensure that the flywheel and rear of the engine do not get trapped against the rear crossmember of the front sub-frame, otherwise damage to these parts will result.
2. Position the engine on its rear mounts, so that the scribed lines on the sub-frame align with the profile of the mounts *(see Fig. E4)*.
3. With the engine front mounting setscrews slack, adjust the position of the engine mounting stop plate so that there is a 1,27 mm. (0.050 in.) gap between the bonded rubber strip on the stop plate and the crossmember stop bracket *(see Fig. E13)*. The engine stop plate has elongated holes to allow it to be moved fore and aft as required.

After the 1,27 mm. (0.050 in.) gap has been set, tighten the engine front mounting setscrews.

4. To avoid damage to the conical seats (where fitted), care should be taken not to overtighten the pipes at the unions on the power assisted steering pump reservoir.

5. Any hoses showing signs of deterioration should be renewed.
6. Fill the engine with fresh approved oil to the level marked on the dipstick.
7. Fill the coolant system with the approved anti-freeze.
8. Fill the power steering reservoir with fresh approved fluid.
9. Fill the hydraulic fluid reservoir.
10. Connect the battery leads.
11. Fill the transmission with fresh approved fluid as described in Chapter T.
12. Bleed the hydraulic systems as described in Chapter G.
13. Bleed the power steering system as described in Chapter N.
14. Charge the refrigeration system as described in Chapter C.
15. Tighten all nuts, bolts, setscrews etc., to the torque figures specified in Chapter P.
16. With the engine running, check all pipes, hoses and joints for leaks.
17. After a short period of engine operation, check all oil and fluid levels and top-up to the correct levels if necessary.

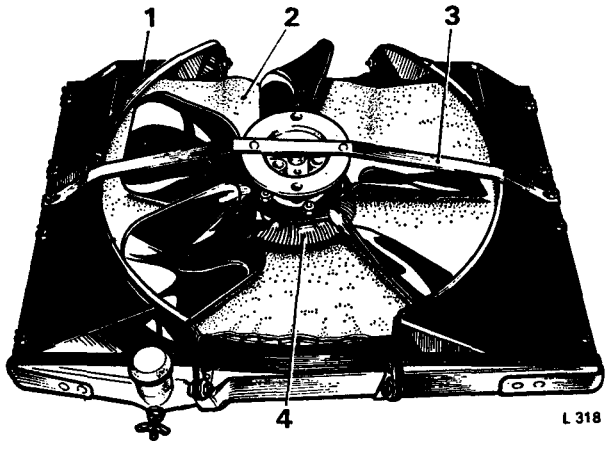

FIG. E12 METHOD OF RETAINING FAN ASSEMBLY FOR RADIATOR/ENGINE REMOVAL

1 Fan cowl
2 Sheet of rubber
3 Support strap
4 Viscous fan assembly

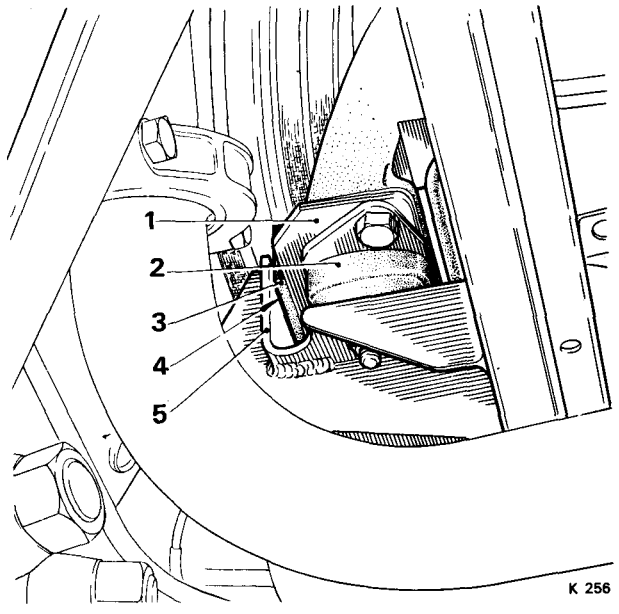

FIG. E13 ENGINE MOUNTING - Front Stop Plate Gap

1 Engine stop plate
2 Front engine mounting
3 Rubber strip
4 Gap 1,27 mm. (0.150 in.)
5 Front crossmember stop bracket

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Section E2
CYLINDER HEADS

Cylinder heads - To remove

1. To remove the heads with the engine in the car. fit front wing cover sets number (RH 2684) and cover liner set number (RH 2685) over each wing to protect paintwork.
2. Disconnect the battery.
3. Depressurise the hydraulic systems (*see Chapter G - Special Precautions*).
4. Drain the cooling system as described in Chapter L.
5. If refrigeration is fitted, discharge the system (*see Chapter C - Part 2*).
6. Remove the engine oil dipstick.
7. Disconnect the vacuum advance pipe (if fitted) between the distributor and 'B' bank carburetter.
8. Remove the carburetters and air horns assembly (*see Chapter K or Chapter U*).
9. Remove the refrigeration compressor (if fitted) (*see Chapter C - Part 2*); blank off all open ended pipes to prevent the ingress of dirt.
10. Detach the alternator (if fitted) from the cylinder head (*see Chapter M*).
11. Remove the generator (*see Chapter M*).
12. Disconnect the hydraulic pipes from the brake pumps; blank off the open ends of the pipes to prevent the ingress of dirt.
13. Detach the gearbox (transmission) dipstick tube from the 'A' bank cylinder head.
14. Remove the long control rod fitted between the compensator linkage and the pedal linkage (*see Fig. E11*).
15. Remove the long bolt securing the compensator linkage to the mounting bracket (*see Fig. E11*).
16. If a four speed automatic gearbox is fitted, disconnect the throttle valve control rod from the manifold shaft lever. This rod is situated adjacent to the distributor.
17. Disconnect the engine wiring looms (*see Section E1 - Engine - To remove - Operation 38*).
18. Remove as much fluid as possible from the steering pump then disconnect the hoses (*see Section E1 - Engine - To remove - Operations 28,29 and 30*).
19. Remove the steering pump.
20. Remove the rubber coolant hose from the thermostat elbow.
21. Detach the clip from the thermostat housing.
22. Disconnect the heating system hoses, these hoses are situated adjacent to the upper heating system actuators (*see Figs. E1 and E2*).
23. Remove the two rigid heater pipes from their connections at the front of the engine.
24. Remove the ignition coil.
25. Remove the distributor head together with the ignition harness.
26. Remove the rocker covers.
27. Remove the induction manifold.
28. Remove the exhaust pipes from the exhaust manifolds; remove the manifolds (*see Chapter Q - Exhaust System*).
29. Remove the sparking plugs.
30. Progressively unscrew the five setscrews securing the rocker pedestals to the cylinder head and remove the rocker shaft assembly. Withdraw the push rods.
31. Using box spanner RH 7126 progressively unscrew the 20 cylinder head retaining nuts for each cylinder head. Commencing with those at each end and working inwards.
32. Lift off the cylinder heads and gaskets taking care that the cylinder head studs do not damage the face of the heads, check also, that the stud threads are not damaged.

Valve removal

1. To remove the valves, special tool number RH 7094 and the wooden base RH 7200 are required.
2. Fit a valve tool pedestal at each end of the cylinder head. The pedestals locate in the recesses used for the rocker pedestals and are secured by two nuts and bolts.
3. Place the head on the wooden base (RH 7200) ensuring that the four raised blocks fit into the combustion chambers to support the valves whilst the springs are being compressed.
4. Insert the fulcrum bar through the holes in the pedestals.
5. Fit the hook of the valve spring compression tool under the fulcrum bar and fit the stirrup over the valve top washers (*see Fig. E14*). Compress the valve spring and remove the two collets, followed by the valve spring top washer, valve spring, grommet

housing, grommet, grommet spring and bottom washer.

6. The cylinder head may then be turned over and the valves removed.

Valve replacement

To fit the valves reverse the procedure given for their removal, noting the following points.

1. Ensure that each valve is fitted to the guide from which it was removed.

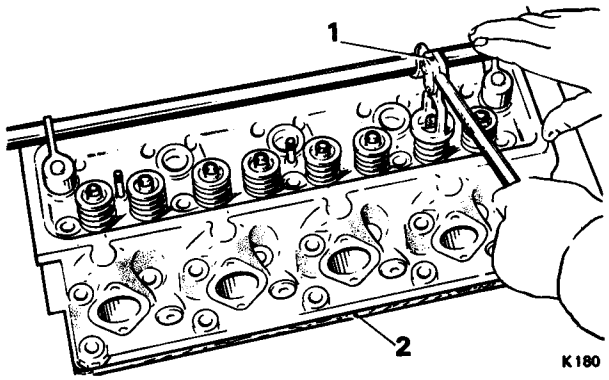

FIG. E14 REMOVAL OF VALVE COLLETS

1 Valve compressing tool (RH 7094)
2 Block of wood (RH 7200)

2. Check that the valves operate smoothly in their respective guides and that they are seating correctly.

3. Thinly coat the valve stems with 'Molykote G Rapid' grease or its equivalent and liberally lubricate the valve guide bores with engine oil before fitting the valves.

Assemble the valve collets in pairs on a clean dry surface. Apply a coat of 'Silastic' 732 sealant along one edge of each collet so that when assembled a coated edge opposes an un-coated edge. Allow approximately ten minutes before assembly. After assembly wipe off the excess sealant. Allow a period of at least 12 hours from applying the sealant before running the engine.

4, To fit collets that do not have a rubber strip bonded to one edge proceed as follows.

Ensure that the top washer and collets are degreased and the valve stem taper is wiped clean.

5. When fitting the valve springs, it should be noted that engines with the 9,14 cm. (3.600 in.) stroke (i.e. those with an engine number prefix of 'SY'), have interchangeable exhaust and inlet valve springs. The engines with the longer 9,90 cm. (3.900 in.) stroke (i.e. those with an engine number prefix of 'SYL'), have a stronger exhaust valve spring and therefore, inlet and exhaust valve springs from these later engines *must not be interchanged.*

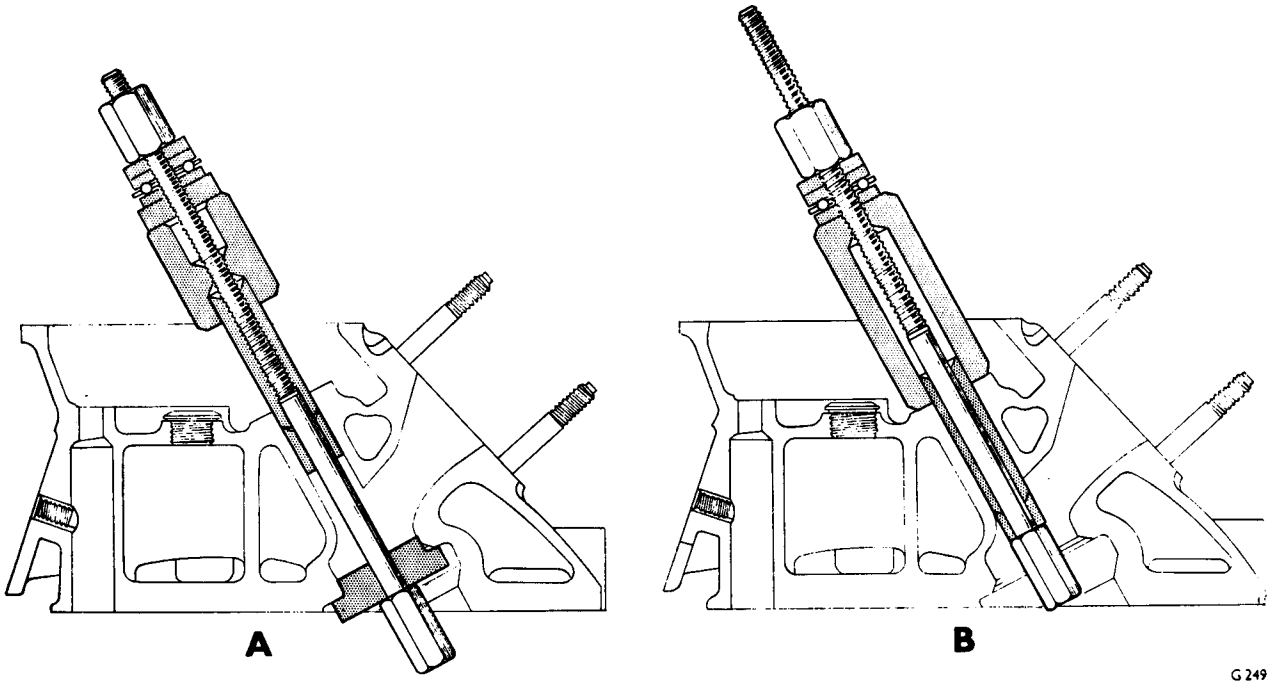

FIG. E15 VALVE GUIDE RENEWAL

A Insertion **B** Extraction

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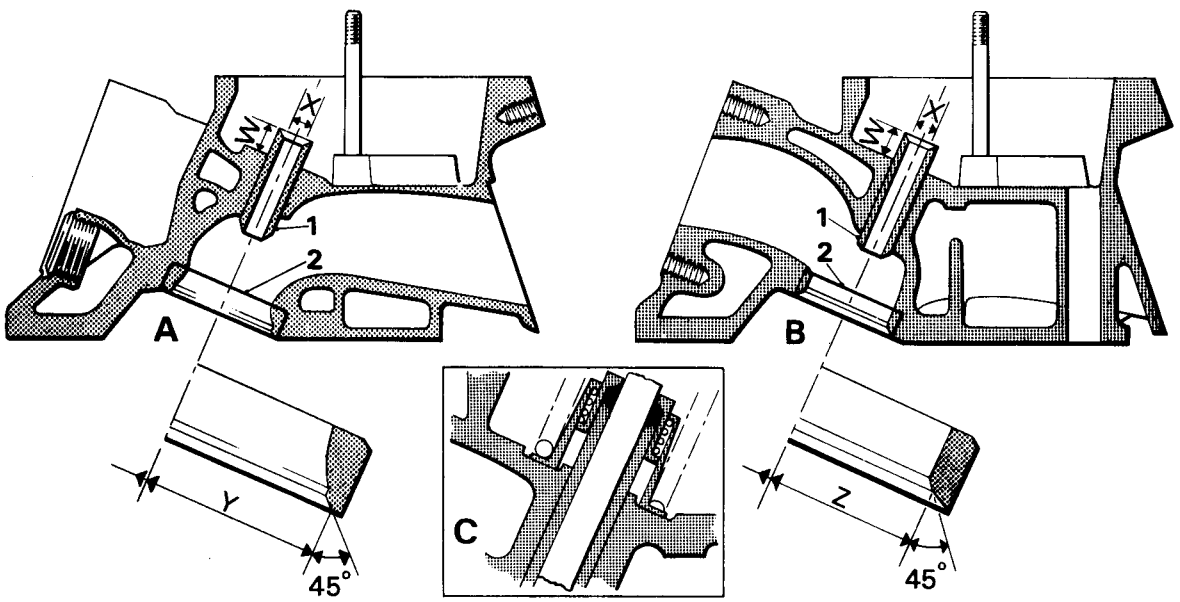

FIG. E16 INLET AND EXHAUST VALVE GUIDE AND SEAT DIMENSIONS

1 Valve guide **2** Valve seat insert **A** Inlet **B** Exhaust **C** Long stroke engine exhaust boss

W = 18,796 mm. to 19,050 mm. (0.740 in. to 0.750 in.)

X = 9,525 mm. to 9,5377 mm. (0.375 in. to 0.3755 in.)

Y = 4,826 cm. to 4,851 cm. (1.900 in. to 1.910 in. dia.)

Z = 3,899 cm. to 3,924 cm. (1.535 in. to 1.545 in. dia.)

Valve guides - To remove

Remove the valve guides from the cylinder head using tools RH 7207 and RH 7272; draw the guides out from the rocker side of the head *(see Fig. E15B).*

Note Inset shows the narrow type of exhaust valve guide boss, fitted to the 'long stroke' type of engines.

Valve guides - To fit

1. Thoroughly clean the valve guide bores in the cylinder heads and measure the diameters of the bores.
2. Select a new set of oversize guides that will give the correct interference fit when fitted in the heads *(see Section E11 - Dimensional Data).*
3. Using the special tools RH 7207 and RH 7272 draw the valve guides into the heads from the rocker side until they stand the correct distance proud of the cylinder head face *(see Fig. E16 - Dimension W).*
4. Using special reamer RH 7825 or the tungsten carbide tipped version RH 7827, ream the inlet and exhaust valve guides to finished size.

Valve seat inserts - To remove

1. Remove the inserts from the head by machining leaving a thin skin of metal of approximately 0,25 mm. (0.010 in.) thick.
2. After machining, carefully lift the insert shell from the bore in the head.

Valve seat inserts - To fit

1. Compare the sizes of the bore in the head from which the valve seat inserts have been removed with the standard figures given in Section E11 - Dimension Data.
2. If the bores do not conform to these sizes, it will be necessary to machine them to a larger diameter and to fit oversize seat inserts *(see Parts List).*
3. Ensure that when new inserts are fitted into the head, the correct interference is maintained *(see Section E11 - Dimensional Data).*

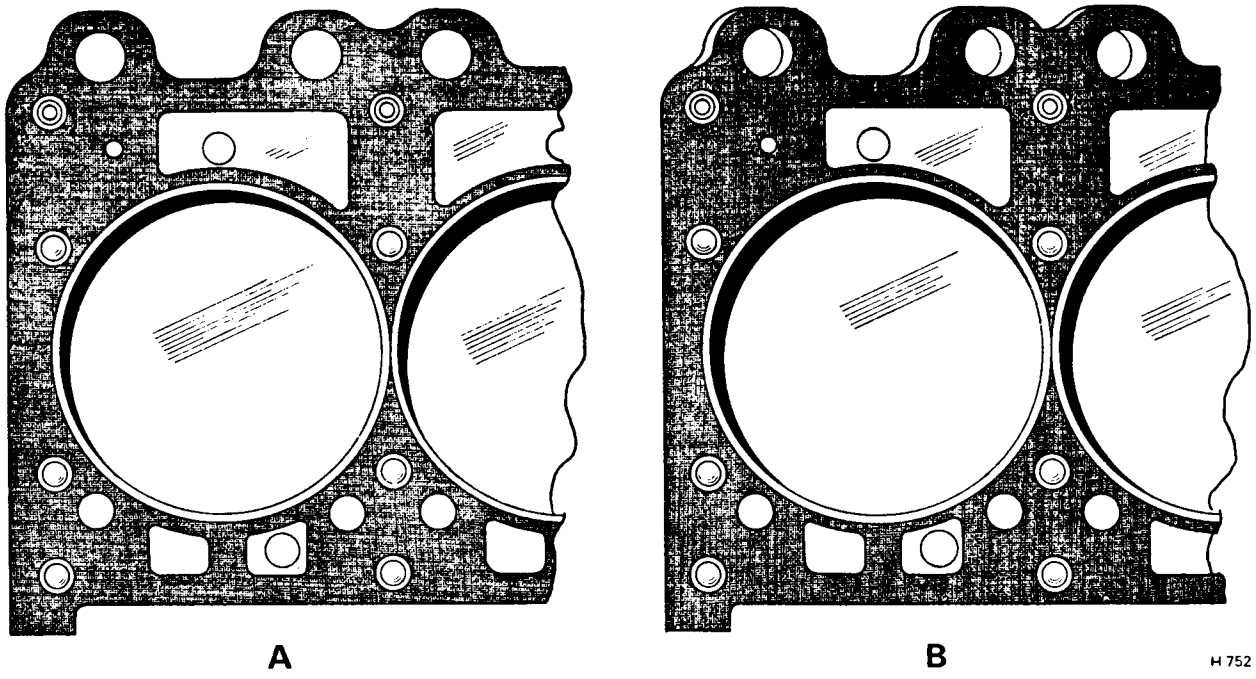

FIG. E17 POSITIONING THE CYLINDER HEAD GASKET (Early Cars)

A Correct **B** Incorrect

4. To fit the seats it is necessary to heat the head in an oven to a temperature of 151.5°C (305°F) for a period of one hour. The head should then be quickly removed and the inserts driven into their bores in the head using a soft drift. Do not finish machine the valve seats until after the valve guides have been reamed (*see Fig. E16 for machining dimensions*).

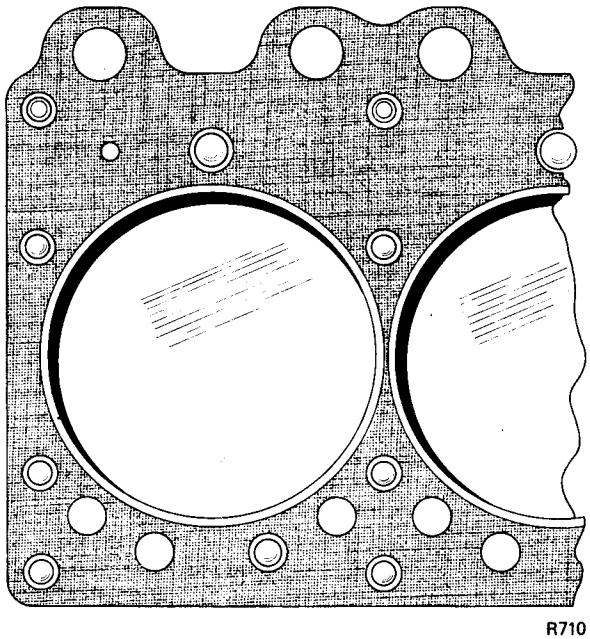

FIG. E18 CYLINDER HEAD GASKET (Late Cars)

5. If the necessary service facilities are not available it is recommended that the cylinder heads be returned to the Rolls-Royce Service Stations, at Pym's Lane, Crewe, or Hythe Road, London.

Cylinder heads - To fit

Fit the cylinder heads by reversing the procedure given for removal, noting the following points.

1. Fit the cylinder head gasket so that the face marked 'TOP' is uppermost. If the gasket is not marked 'TOP' it should be fitted so that the holes line up with the coolant holes in the crankcase. If incorrect alignment occures the gasket should be turned over end to end. *(see Figs. E17 and E18).*
2. Progressively torque tighten the cylinder head nuts in two stages, to the figures given in Chapter P. The correct tightening sequence is shown in Figure E19. Ensure that the remainder of the setscrews, nuts and bolts are torque tightened to the figures quoted in Chapter P.
3. Clean the flame traps in the crankcase breather tube by washing them in petrol and drying them with a high pressure air line (*see Section E9*).
4. Ensure that brake and steering pump pipes are not overtightened otherwise damage to conical seatings may occur.
5. All hoses showing signs of deterioration should be renewed.
6. Renew all joints and rubber 'O' rings.

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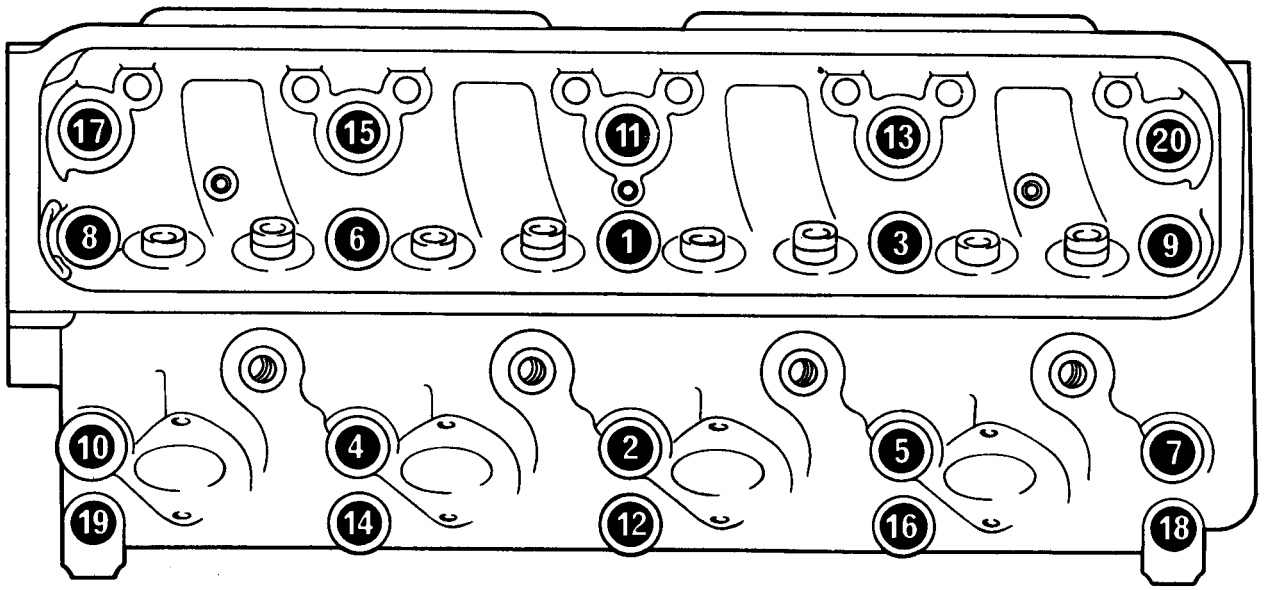

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FIG. E19 CYLINDER HEAD UNIT TIGHTENING SEQUENCES

7. When replacing the compressor on cars fitted with a refrigeration unit the air must be purged from the system *(see Chapter C - Part 2)*.

8. Ensure that the driving belts are adjusted to the correct tension *(see Chapter L)*.

9. Fill the power-assisted steering pump reservoir to the correct level *(see Chapter N)*.

10. Ensure that the cooling system is replenished with the correct anti-freeze mixture *(see Chapter L)*.

11. Connect the battery leads.

12. Bleed the hydraulic systems *(see Chapter G)*.

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Section E3

CRANKCASE AND CYLINDER LINERS

Introduction

The cylinder bore dimensions should be checked only when all the liners from any one bank are in position, any deviation from this rule could result in false readings.

If the readings taken show that the bore is worn in excess of 0,1016 mm. (0.004 in.) or ovality exceeds 0,076 mm. (0.003) *(see Section E11 Dimensional Data)* the liner should be withdrawn and a new liner, sealing rings and piston fitted.

Cylinder liner seal leakage can be detected by 'tell-tale' holes in the side of the crankcase. Coolant or oil will issue from these holes depending upon which of the two bottom sealing rings is leaking. The upper of the two bottom rings leaks coolant and the lower one leaks oil, in either case the appropriate liner should be removed and new seals fitted to the crankcase *(see Fig. E20)*.

When renewing liners, it is important that as one liner is removed it is replaced by a new liner, before any other liners are removed.

If this procedure is not adopted and a liner is extracted from a bore adjacent to bores without liners, it is possible for the crankcase bridge piece to sustain damage. This is caused by a hard crust of corrosion which forms on the liner immediately below the upper of the two lower sealing rings *(see Fig. E20)*. As the liner is withdrawn, the deposit has to pass under the sealing ring thus exerting an abnormally high bursting pressure which, if the crust of corrosion is thick enough will cause the rubber ring to twist and the bridge piece to fracture.

Cylinder liner - To remove

1. Using extraction tool (RH 7095) as shown in Figure E21, remove the liner from the crankcase; note that the liners can be removed from the top face only.

Cylinder liner - To fit

1. Ensure that the coolant drain hole in the crankcase wall is clean and unobstructed.
2. Ensure that the seal leakage 'tell-tale' holes in the crankcase wall are clean and unobstructed.
3. Remove any burrs then clean the crankcase cylinder liner, crankcase liner location bore and seating face in the crankcase counterbore with

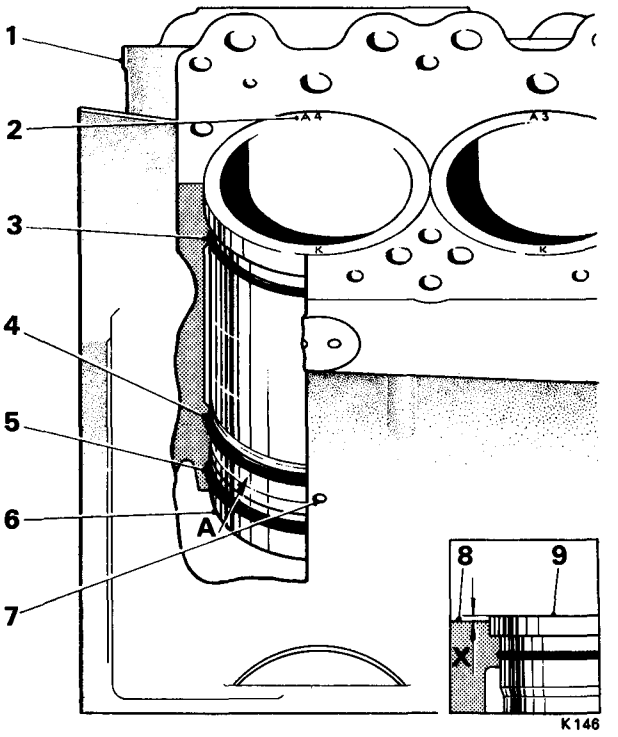

FIG. E20 CYLINDER LINER IN CRANKCASE

A Position of corrosion build up on cylinder liner and crankcase
X 0,051 mm. to 0,076 mm. (0.002 in. to 0.003 in.)

1 Crankcase	6 Cylinder liner
2 Bore reference number	7 Tell tale hole (8 off)
3 Rubber 'O' ring	8 Crankcase
4 Upper sealing ring	9 Cylinder liner
5 Lower sealing ring	

'Genklene' or a similar alternative.

Note Meticulous care should be exercised when carrying out these operations as any dirt or burrs allowed to remain will have an adverse affect on the fit of the liner in the crankcase and may in fact distort the liner bore.

4. A liner when fitted into the crankcase should stand between 0,051 mm. and 0,076 mm. (0.002 in. and 0.003 in.) proud of the crankcase top face, this is to provide a 'nip' when the cylinder head and gasket are fitted. To obtain the correct amount of 'nip' proceed as described in operations 5 and 6 (*see Fig. E20*).

5. Measure the width of the liner collar and the depth of the counterbore in the crankcase.

Subtract the measurement taken for the depth of the counterbore from the width of the collar. Compare this figure with the 'nip' required (*see Operation 4*).

6. If the amount of 'nip' does not correspond with the amount required, either another liner should be tried or if the figure allows more than 0,076 mm. (0.003 in.) 'nip', the excess should be ground off the top face of the liner; after grinding, again thoroughly clean the liner.

7. A liner is identified with the corresponding bore reference etched onto its top face. Any new liner which is being fitted should also have the appropriate bore reference etched onto its top face before being fitted (e.g. No. 1 bore 'A' bank to be etched A1. Certain cars fitted with service reconditioned engines have oversize liners (outside diameter). These engines are identified by an SR number suffixed by the letters O/L stamped on a small boss situated at the front of the crankcase

The liner is identified by the marking of the letter O/L on the top face of the liner adjacent to the piston grade information.

A liner is also graded and if not already done so, the grade should be etched onto the top face of the liner so that the grade can be seen when the liner is fitted into the crankcase.

8. Fit three new rubber sealing rings to the crankcase, then thinly smear the rings and location diameters with Palmolive grease or its equivalent.

9. To enable a liner to be fitted which can be up to 0,032 mm. (0.00125 in.) interference fit in the crankcase bore, the crankcase should be placed in an oven which has controlled heat of approximately 150° C (302° F). The crankcase should be allowed to remain in the oven until it has reached oven temperature.

Important Do not attempt to fit a liner into a cold crankcase.

10. Remove the crankcase from the oven then quickly push the liner into the crankcase bore until it is felt to seat on the seating face of the counterbore. Bear in mind that the bore reference etched onto the top face of the liner should be positioned at its nearest point to the camshaft location i.e. innermost part of the engine.

11. Allow the crankcase to return to its cold condition.

12. Using a depth micrometer, measure the amount that the liner stands proud above the crankcase face. As stated previously this figure should be between 0,051 mm. and 0,076 mm. (0.002 in. and 0.003 in.).

13. If the liner stands more than 0,076 mm. (0.003 in.) proud, an even tap with a plastic-headed mallet about the top face of the liner is permissible. If this does not move the liner below the 0,076 mm. (0.003 in.) limit or if the liner is below the 0,051 mm. (0.002 in.) limit, the liner should be withdrawn and the cause of the trouble investigated.

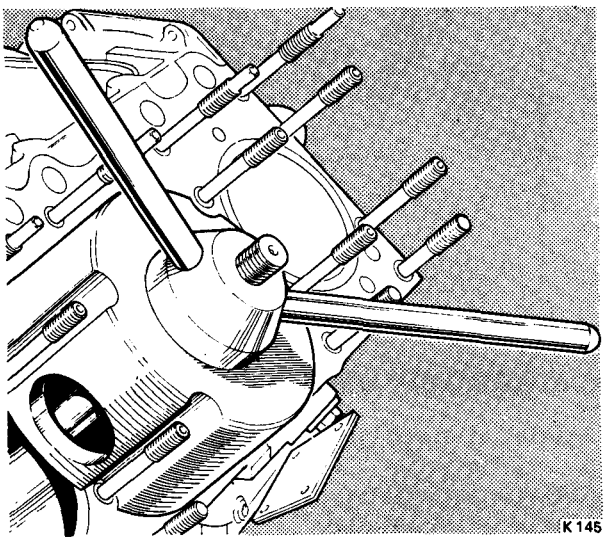

FIG. E21 METHOD OF REMOVING CYLINDER LINERS

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Section E4
CRANKSHAFT AND MAIN BEARINGS

Crankshaft - To remove

1. Remove the engine from the car (*see Section E1*).
2. Fit the engine into a turnover stand.
3. Remove the sump.
4. Remove the oil pedestal and strainer.
5. Remove the front cover, oil pump etc. (*see Section E10 - Oil Pump - To remove*).
6. Remove the flywheel.
7. Withdraw the rear adapter, incorporating the balance weight (if fitted).
8. Remove the engine backplate, this component is dowelled to the crankcase.
9. Unscrew the nuts from the connecting rod bolts, remove the connecting rod caps and the shell bearings from both the caps and the rods.
10. Fit a piece of rubber tubing over the connecting rod bolts to prevent damage to the shaft, then push the pistons to the top of their bores.
11. Remove the main bearing caps and bearings using extractor tool RH 7208 and attachment RH 7498 (*see Fig. E22*).
12. Remove the thrust washers from the centre main bearing.
13. Fit a piece of rubber tubing over the main bearing cap studs to prevent damage to the crankshaft.
14. Carefully lift the crankshaft from the crankcase.

Crankshaft - To dismantle

1. Using spanner RH 7110, remove the serrated nut and washer from the crankshaft.
2. Remove the oil flingers.
3. Remove the oil pump gear.
4. Using a soft thin punch, remove the Woodruff key.
5. Remove the spacer.
6. Remove the timing gear.
7. To dismantle the sludge traps, remove the circlips and withdraw the oil sealing plugs. These plugs can be removed with the aid of a setscrew or stud screwed into the tapped extraction holes; discard the rubber sealing rings.

Bolted on crankshaft balance weights are fitted to long stroke engines

It is not envisaged that these weights will require attention in service but if the crankshaft requires a regrind they will have to be removed to allow access to the various crankshaft journals and pins.

It is essential that if the balance weights are removed, they be returned to their original positions, otherwise, not only will the balance of the crankshaft be severely impaired but there will also be a danger of the balance weights striking the pistons when the engine is running.

The crankshaft web number is stamped on each balance weight together with the word 'Front' which must be facing the front of the engine when that particular weight is fitted.

It is also necessary to ensure that all sludge deposits be removed from the threads of the bolts and tapped holes in the crankshaft, so that when the bolts securing the balance weights are tightened to the torque figures quoted in Chapter P, a false reading is not registered on the torque spanner.

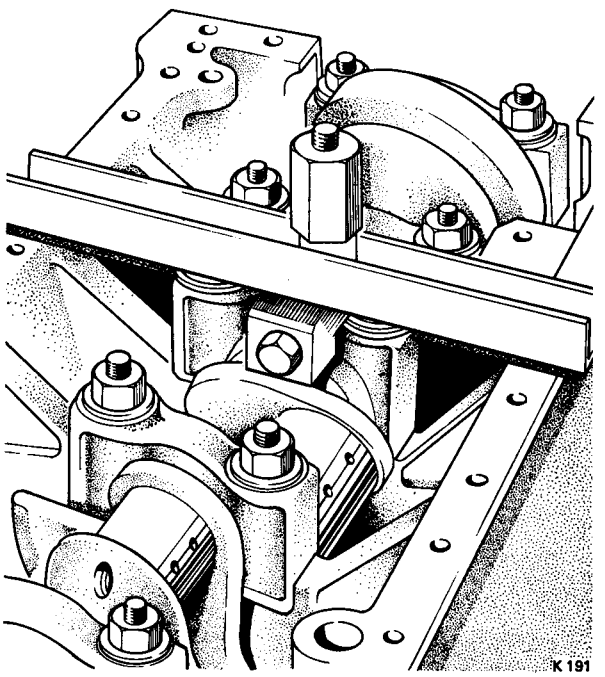

FIG. E22 REMOVAL OF MAIN BEARING CAP

Main bearings

1. Shell bearings removed from an engine during maintenance or overhaul must always be fitted back into their original positions. On initial assembly each pair of shell bearings are marked with their appropriate position in the crankcase. They are not however, marked top and bottom and care should be taken that they are not interchanged. When fitting the shells check that the locating tangs are correctly located in their recesses.

On short stroke 9,14 cm. (3.600 in.) engines it is necessary to remove the oil pump assembly before the front main bearing cap can be withdrawn. On the long stroke 9,90 cm. (3.900 in.) engines the outer surface of the oil pump casing has been machined to allow the front main bearing cap to be withdrawn with the oil pump in position.

Crankshaft - To inspect

1. Mount the crankshaft in a pair of Vee-blocks on an inspection table.
2. Using a micrometer check the journals and crankpins for wear and ovality; regrind the shaft if wear exceeds the figure quoted in Section E11 - Dimensional Data.
3. Remove the crankshaft then position the Vee-blocks so that the crankshaft when fitted will rest on journals Nos. 1 and 5.
4. Fit a test bar onto the Vee-blocks and check that the Vee-blocks are parallel to the table. If necessary, correct any errors by fitting packing pieces under the feet of the Vee-blocks.
5. Fit the crankshaft onto the Vee-blocks and ensure that it is free to rotate.
6. Place the arm of a dial test indicator onto the centre journal then set the indicator to zero.
7. Rotate the crankshaft until the difference between the maximum and minimum reading on the indicator is recorded. Halve this reading to give the amount of bow in the crankshaft (*see Fig. E24);* ensure that any ovality in the two end and centre journals is taken into account.

The maximum permissible bow is 0,25 mm. (0.010 in.), if this figure is exceeded, the crankshaft must be reground.

8. Turn the shaft so that the webs of each crankpin are first at 45° then at 135° to the table. Check the journals and crankpins in each position for parallelism; regrind the shaft if wear exceeds the figure given in Section E11 - Dimensional Data.

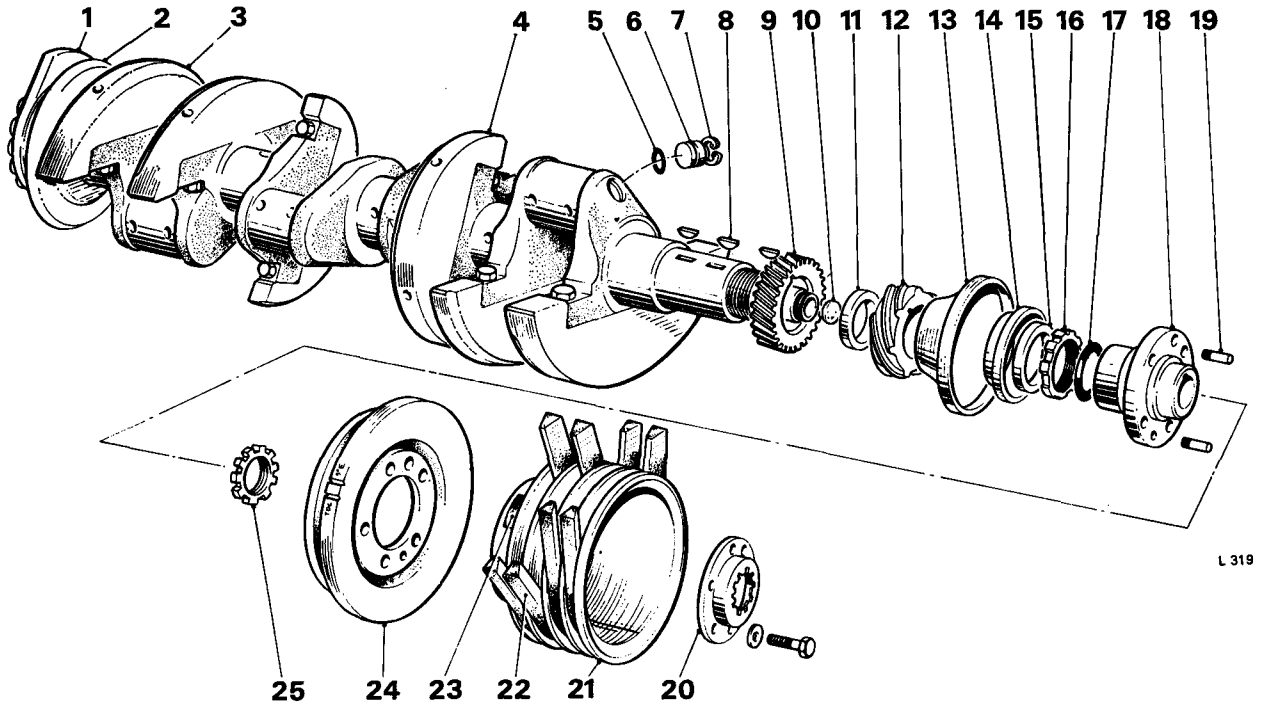

FIG E23 EXPLODED VIEW OF CRANKSHAFT 9,90 cm. (3.900 ins.) STROKE ENGINE

1	Rear adapter	6	Plug	11	Washer	16	Nut
2	Flinger	7	Circlip	12	Oil pump driving gear	17	Rubber 'O' ring
3	Bolted-on balance weight	8	Woodruff key	13	Flinger	18	Driving flange
4	Bolted-on balance weight	9	Timing gear	14	Flinger	19	Dowel
5	'O' ring	10	Disc	15	Washer	20	Lockplate
21	Pulley						
22	Belt						
23	Balance weight						
24	Damper						
25	Nut						

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Crankshaft - To regrind

1. The crankshaft should be reground when wear or ovality exceeds 0,025 mm. (0.001 in.) or when the crankpins and journals are heavily scored or when the bow in the crankshaft exceeds 0,25 mm. (0.010 in.).
2. Replacement bearings are available in the following sizes, standard, minus 0,25 mm. (0.010 in.) and minus 0,50 mm. (0.020 in.).
3. The crankpins and journals should be ground and lapped to suit the nearest undersize bearing. (*see Section E11 - Dimensional Data*).
4. When grinding, use a stone having a grit and grade equivalent to a NORTON A 46 NV or one grade softer. **A harder stone must not be used.**
5. For 'plunge' grinding, the width of the stone must be 0,51 mm. (0.020 in.) less than the dimension between the journal or crankpin end faces and the machine must be fitted with hydraulic stops. For traverse grinding a suitable width of stone should be selected (*see Fig.E25*).
6. Care must be taken to ensure that no sharp ridges are left in the radii where the grinding wheel traverse ends and the radii of the grinding wheel must be carefully controlled to ensure that the grinding fades out not more than half way up the radius on the crankshaft.

On no account must the grinding wheel touch the side faces of the crankpin or journal.

7. Lubrication must be continuous during re-grinding and the lubricant should be fed liberally onto the ingoing side of the grinding wheel. The grinding wheel must not be allowed to contact the journal or crankpin until the shaft is thoroughly wet. Any approved lubricant can be used.
8. Grind the crankpins and journals until they are 0,025 mm. (0.001 in.) larger than the required finished size. This will allow for lapping and polishing.
9. Crankshafts must be re-hardened by the nitriding process after each re-grind.
10. After hardening, test the hardness of the journals and crankpins. The minimum acceptance figure for the hardened crankshaft is 570 VPN/30 kg. using a Vickers Diamond Pyramid Machine.
11. After grinding, and, if the necessary equipment is available, the shaft should be magnetically crack tested. It should then be lapped and polished to the finished size.

Crankshaft - To lap

1. The crankshaft journals and crankpins should be lapped to produce a perfectly smooth finish after grinding and hardening.
2. Cast iron laps should be used and the machine set to run at between 220 r.p.m. and 250 r.p.m.
3. The lapping compound should consist of a mixture of grade M.303½ grit and vegetable oil in proportion of 1,134 kg. (2.5 lb.) of grit to 4,546 litres (1 gallon) of the oil. The compound must be mixed to a smooth consistency and injected into the laps at frequent intervals.
4. The crankpins and journals must be lapped parallel to within 0,025 mm. (0.001 in.). Whilst lapping, the size of the crankpins and journals should be checked frequently; allowances must be made for the slight contraction which will take place as the shaft cools.
5. After lapping, wash the shaft thoroughly in a high pressure paraffin wash; blow off any surplus paraffin with compressed air and dry the shaft with a soft lint-free cloth.

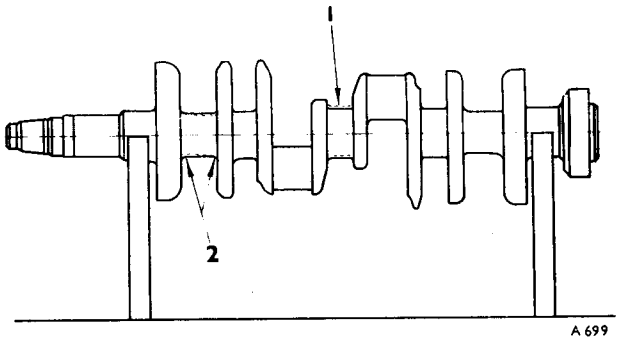

FIG. E24 CRANKSHAFT CHECKING

1 Bow check 2 Parallelism

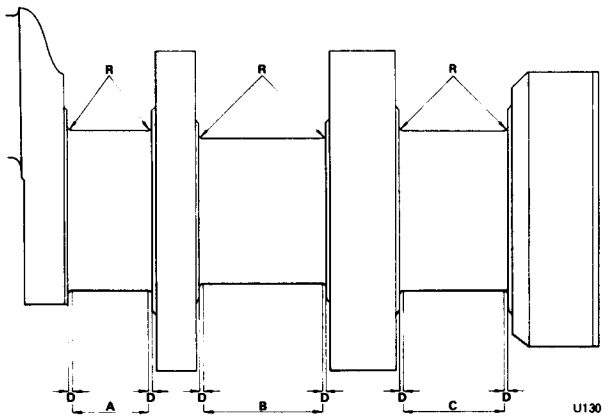

FIG. E25 CRANKPIN AND JOURNAL GRINDING DIMENSIONS

- **A** 3,297 mm. (1.298 in.) Grinding wheel travel - Journals 2,3 and 4.
- **B** 5,029 mm. (1.980 in.) Grinding wheel travel - Crankpins.
- **C** 4,267 mm. (1.680 in.) Grinding wheel travel - Journal 5.
- **D** 0,254 mm. (0.010 in.) Minimum distance - Side face to grinding wheel.
- **R** 2,362 mm. to 2,108 mm (0.093 in. to 0.083 in.) Radius.

6. When the shaft is dry, polish the crankpins and journals with Corolite 320 grade abrasive tape 2,5 cm. 1 in.) wide liberally lubricated with vegetable oil.
7. After polishing, again wash the shaft and repeat the cleaning procedure.

Crankshaft - To assemble

1. On long stroke engines, fit the 'bolted on' balance weights, refer to the sub-section Crankshaft - To dismantle, for the procedure that should be adopted.
2. Fit the Woodruff key to the crankshaft then fit the timing gear; ensure that the timing gear locates correctly on the Woodruff key.
3. Fit the spacer.
4. Fit the Woodruff key to the crankshaft, then fit the oil pump drive gear, ensuring that the oil pump gear locates correctly on the Woodruff key.
5. Fit the oil flingers.
6. Fit the washer and serrated nut.

Note Always use a new serrated nut *(see item 16, Fig. E23).*

7. Using special box spanner RH 7110, torque tighten the serrated nut to the figures quoted in Chapter P.

The crankshaft should be held firm whilst tightening the serrated nut. This can be accomplished by fitting two long setscrews in the rear end of the crankshaft and inserting a bar between them, offset the force needed to tighten the serrated nut.

8. Fit new rubber sealing rings to the sludge trap plugs, then smear engine oil onto the rings.
9. Push the plug firmly home and fit the circlip into its groove; pull the plug outwards to meet the circlip face.

Before fitting a timing gear to the crankshaft, ensure that it is the correct component *(see Fig. E28).*

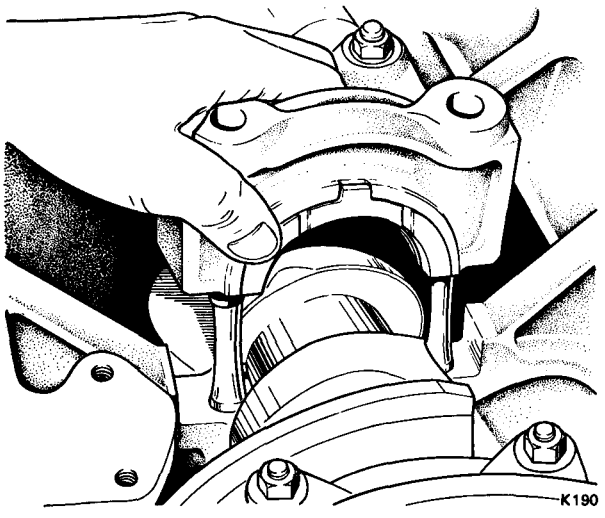

FIG. E26 FITTING THE CENTRE MAIN BEARING CAP

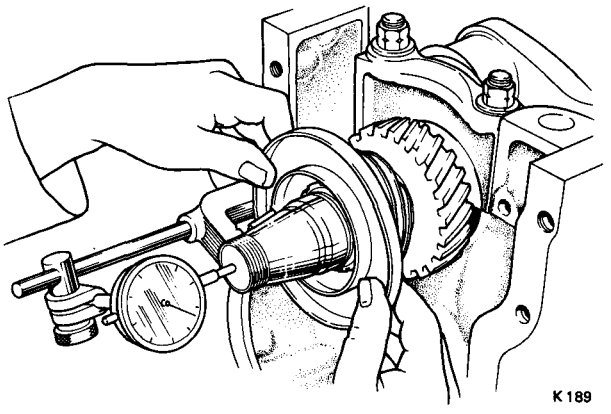

FIG. E27 CHECKING THE CRANKSHAFT END-FLOAT

Crankshaft - To fit

1. Ensure that the bearing shells are the correct size for the journals and crankpins.
2. Ensure that all parts are clean. A lint-free cloth should be used for wiping all parts.
3. Position the upper bearing shells in the crankcase and slightly smear them with clean engine oil.
4. Place the crankshaft in position and fit the upper halves of the thrust washer to the centre main bearing.
5. Fit the main bearing caps and shells together with the two lower thrust washers for the centre main bearing *(see Fig. E26).* When fitting the bearing caps it may be necessary to tap them lightly into position. If this is done ensure that the bearing shells are not dislodged. The cap nuts should be torque tightened to the figure quoted in Chapter P.
6. Check that the crankshaft rotates freely.
7. Check the crankshaft end - float *(see Fig. E27 and Section E11 - Engine Dimensional Data).*
8. Fit the bearing shells to the connecting rods and caps, then lightly smear the shells with clean oil. Fit the caps to the rods and torque tighten the nuts to the figures quoted in Chapter P to give a bolt stretch of 0,152 to 0,203 mm. (0.006 to 0.008 in.) *(see Fig. E29).*
9. Re-set the valve timing as described in Section E7 and fit the camshaft timing wheel.
10. Fit the oil pump and oil filter delivery pipe using new rubber 'O' sealing rings. Fit the oil strainer pick-up and pedestal *(see Fig. E29).*
11. Connect a pressurised supply of clean oil to the oil supply hole in the crankcase and pump oil

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into the crankcase at a pressure of 5,62 kg/sq.cm. (80 lb/sq.in.). Check the oil flow to the main and big-end bearings. Prime the oil pump by filling the strainer with clean oil and at the same time turning the crankshaft.

12. Assemble the front end of the engine, fitting the lower front cover, the damper, the driving pulley, the coolant pump, the generator or alternator, the refrigeration compressor (if fitted), and the belts. A new Neoprene seal must be fitted between the lower front cover and the coolant pump.

13. Fit new rubber 'O' rings then fit the driving flange.

14. Using special spanner RH 7131, torque tighten the serrated nut securing the driving flange to the crankshaft *(see Chapter P)*.

15. Check that the lockplate aligns with the five setscrew holes. If it does not, carefully tighten the serrated nut until the five setscrews can be inserted easily without binding.

16. Fit the engine back-plate, flywheel, and rear adapter (if fitted).

17. Using new joints, fit the sump and the dipstick assembly.

18. Fit the engine into the engine compartment by following the procedure given in Section E1.

Crankshaft damper - To remove

1. Disconnect the battery leads.
2. Remove the radiator intake grille and matrix.
3. Slacken off the generator or alternator, the power assisted steering pump and remove the driving belts.
4. Remove the five setscrews and the locking

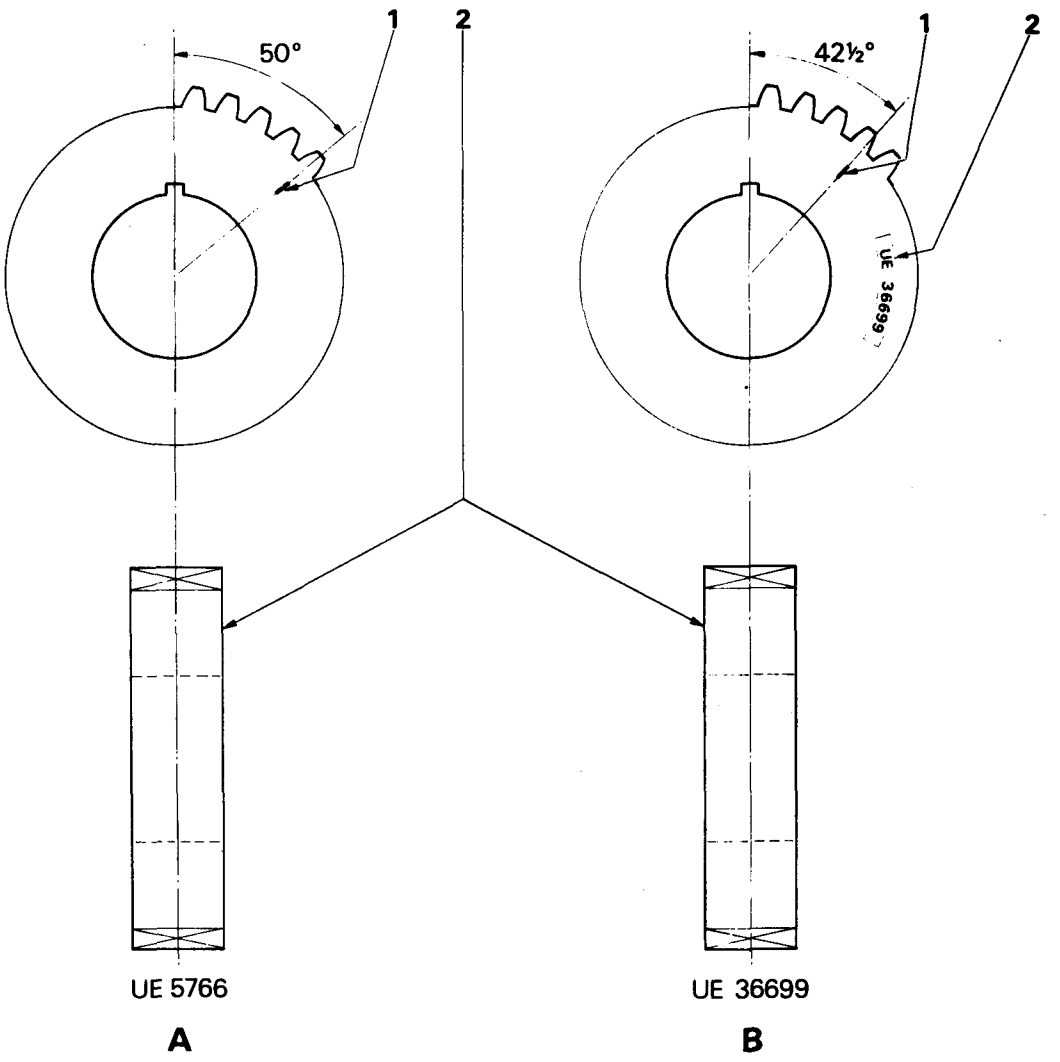

FIG. E28 IDENTIFICATION OF TIMING GEARS

A Silver Shadow T Series
Corniche (U.S.A. and Canada)
B Corniche (other than U.S.A. and Canada)

1 Timing mark
2 Position of part number

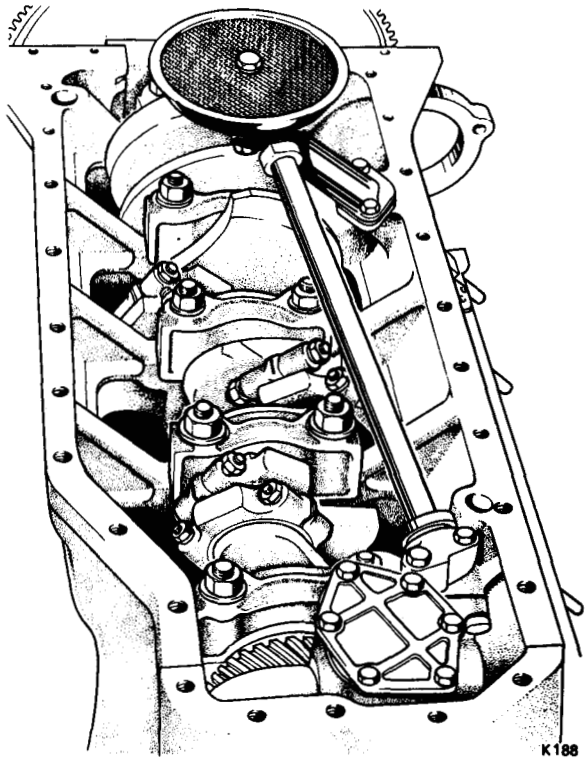

FIG. E29 VIEW OF MAIN BEARING CAPS

plate securing the crankshaft pulley and damper to the driving flange. Both the pulley and damper are located by dowel pins which are pressed into the driving flange.

5. It should be noted that the long stroke 9,90 cm. (3.900 in.) engines have a crankshaft pulley with an additional balance weight incorporated in the rear flange.

Crankshaft damper - To fit

To fit the damper, reverse the procedure given for its removal, noting the following points.

1. The damper and crankshaft pulley can only be fitted one way due to the positioning of the locating dowels.
2. Torque tighten the setscrews to the figures quoted in Chapter P.
3. Ensure that the generator or alternator (if fitted), and the power assisted steering pump driving belts are adjusted to the correct tension (*see Chapter L*).
4. Connect the battery leads.

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Section E5
CONNECTING RODS AND PISTONS

Connecting rod bearings - To remove

1. The big-end bearings may be renewed whilst the engine is in position in the car by adopting the following procedure.
2. Place the car on a ramp beneath an overhead pulley.
3. Disconnect the battery leads.
4. Drain the engine oil into a container.
5. Remove the exhaust pipe section which fits adjacent to the sump.
6. Place a sling beneath the crankshaft pulley, take the weight of the engine and detach the front engine mount; slightly raise the engine front end.
7. Remove the four nuts and bolts securing the crossmember to the steering and idle boxes; remove the crossmember.
8. Disconnect and remove the steering cross-beam at the ball joints (*see Chapter N*).
9. Disconnect the lead to the sump oil level gauge.
10. If necessary, dependent upon the type of transmission, remove the transmission front adapter cover to gain access to the setscrews at the rear of the sump.
11. Remove the sump securing setscrews and remove the sump.
12. Remove the oil pedestal and fine mesh strainer.
13. To facilitate rotation of the crankshaft, remove the sparking plugs.
14. The crankshaft can be rotated manually when the static timing inspection cover has been removed from the base of the flywheel ring (torus).
15. Rotate the crankshaft until one pair of connecting rod caps are at bottom dead centre and then remove the nuts from the connecting rod caps. Ease off the caps and the bearing shells, then fit rubber tubing over the connecting rod bolts to prevent damage to the crankshaft. Push the rods up sufficiently to allow the bolts to clear the crankshaft; remove the shell from the rod.

Repeat this operation with the remaining connecting rods ensuring that the bolts do not foul the crankshaft when it is being rotated.

Do not remove the connecting rod bolts.

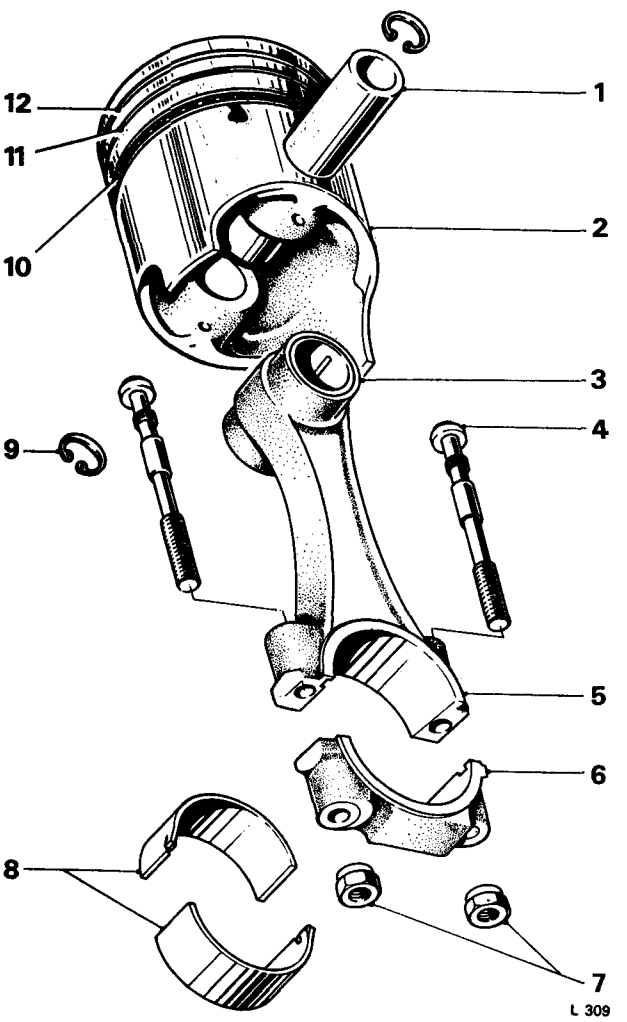

FIG. E30 EXPLODED VIEW OF PISTON AND CONNECTING ROD ASSEMBLY

1	Gudgeon pin	7	Connecting rod nuts
2	Piston	8	Connecting rod bearing
3	Connecting rod small-end	9	Circlip
4	Connecting rod bolt	10	Scraper ring
5	Connecting rod	11	2nd compression ring
6	Connecting rod cap	12	1st compression ring

Note It is important that, with the long stroke 9,90 cm. (3.900 in.) engine which has the 'bolted-on' crankshaft balance weights, only one pair of big-end bearings are dismantled at any one time. The big-end bearings must be assembled or the connecting rod assembly withdrawn from the top of the engine before the crankshaft is rotated, otherwise the crankshaft balance weights will foul the big-ends.

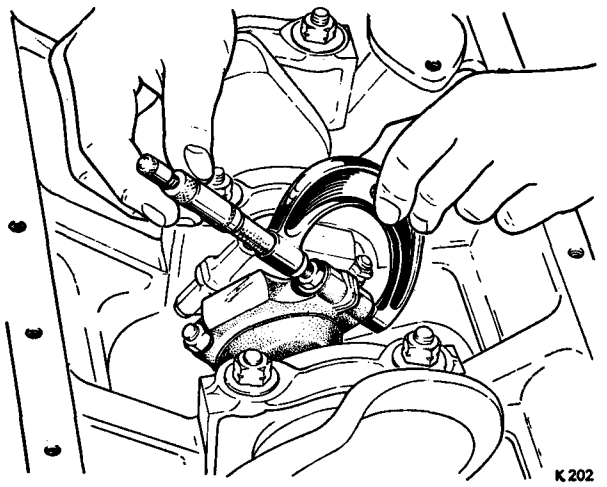

FIG. E31 CHECKING CONNECTING ROD BOLT STRETCH

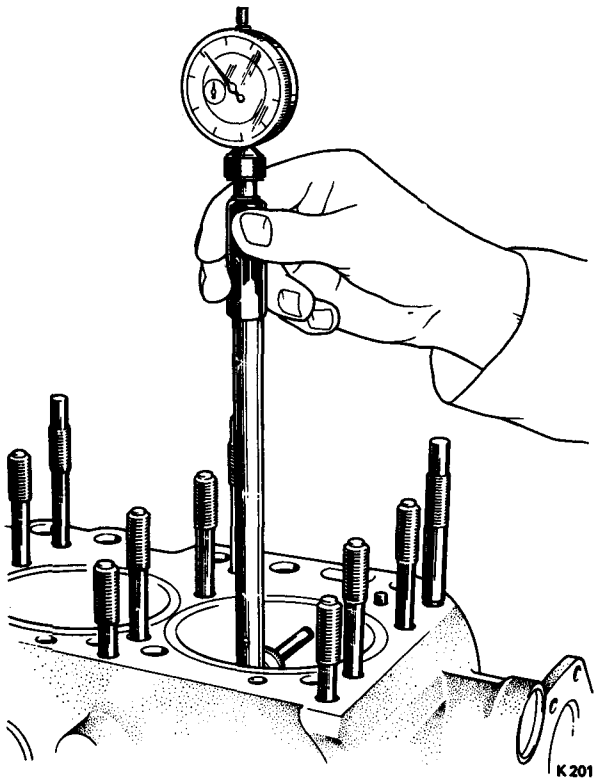

FIG. E32 CHECKING CYLINDER BORE DIAMETER

Crankpins and bearings - To inspect

1. Thoroughly clean each crankpin with a lint-free cloth and measure the diameters for wear and ovality (*see Section E4 - Crankshaft - To regrind).*
2. The running clearance between the connecting rod big-end bearing and the crankpin is 0,032 mm. to 0,076 mm. (0.0015 in. to 0.003 in.) measured in the plane of the rod centre line. The maximum permissible wear should not exceed 0,089 mm. (0.0035 in.).
3. The bearing shells used for the big-ends are of the conventional design, having a lead-tin, lead-indium or aluminium-tin lining and a steel back. New bearing shells should be fitted if the specified limits of the originals are exceeded or if they are scored.
4. The 'nip' between the bore of the rod and the outer diameter of the bearing shells, i.e. the amount by which the bearing shell is larger than the connecting rod bore, should be 0,038 mm. to 0,076 mm. (0.0015 in. to 0.003 in.). This 'nip' is necessary to ensure that the bearing shells are firmly located in the connecting rod and cap, and this prevents the bearing shells from rocking or fretting in the rod.

Connecting rod bearings - To fit

1. The upper and lower bearing shells are interchangeable but not with shells from another connecting rod. After inspection shells can be used again if they are considered serviceable.
2. Before fitting new bearings to the connecting rods and caps, etch the number of the bore on the locating tang. Thoroughly clean the shells and the crankpin, checking that there is no sludge or dirt in the feed holes from the main bearings.
3. Lightly smear the bearing with oil and fit it into the connecting rod.
4. Pull the rod down onto the crankpin ensuring that the bolts do not damage the crankpin. Remove the protective rubber tubing from the bolts.
5. Fit the second shell into the connecting rod cap and lightly smear it with clean oil.
6. Place the cap on the rod ensuring that the two tangs are both on the same side of the crankpin. The cap may require a certain amount of gentle tapping before it is fully 'home' and care should be taken that the bearing shell is not dislodged. Fit the nuts to the bolts and torque tighten to the figure quoted in Chapter P. This torque figure should give a bolt stretch of approximately 0,152 mm. to 0,205 mm. (0.006 in. to 0.008 in.) (*see Fig. E31).* If necessary, further tighten the bolt until the correct extension is obtained.

The connecting rod bolts are an interference fit in the rods and should not be removed unless absolutely necessary.

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7. Repeat Operations 3 to 6 inclusive for the remaining bearings, taking care that when the crankshaft is rotated the connecting rod bolts do not damage the crankpins.
8. Fit the oil strainer and pedestal using new 'O' rings.
9. Fit the sump using a new joint and fill the engine with clean oil.
10. Fit the crossmember to the steering and idler boxes.
11. When fitting the steering cross-beam it should be noted that the cross-beam ends have a 29° 'set' and care should be taken to replace the cross-beam in its correct position, i.e. with the 'set' pointing towards the rear of the car (*see Chapter N*).
12. Before tightening the front engine mount ensure that the engine is lined up correctly. Set the front engine mount stop plate to a 1,27 mm. (0.050 in.) gap. this procedure is fully described in Section E1 - Engine - To fit.
13. Fit the sparking plugs, connect the battery leads and torque tighten all setscrews, nuts and bolts to the figures specified in Chapter P.

Connecting rods and pistons - To remove

1. Remove the cylinder heads (*see Section E2 - Cylinder Heads*).
2. Remove the connecting rod caps and bearings as described previously in this Section.
3. Remove the pistons from the top face of the engine crankcase.
4. If a three ring piston is removed from an engine for any reason and is to be used again, a new second compression ring (centre piston ring) must be fitted.

Connecting rod and piston - To dismantle

1. Remove the circlip from each end of the gudgeon pin.
2. The four ring piston of the 9,14 cm. (3.600 in.) stroke engine, should be immersed in a hot bath of oil or placed on a hot plate until the piston is thoroughly warmed.
3. The gudgeon pin of the three ring piston which is fitted to the 9,90 cm. (3.900 in.) stroke engine is a clearance fit in the piston, therefore, heating the piston assembly is unnecessary.
4. Using a suitable guide push the gudgeon pin out of the piston bore.

Piston and cylinder bores - To inspect

1. Before checking the cylinder bore dimensions it is essential to ensure that **all** the cylinder liners of a particular 'bank' are correctly in position.

If one liner has been removed, **do not** check

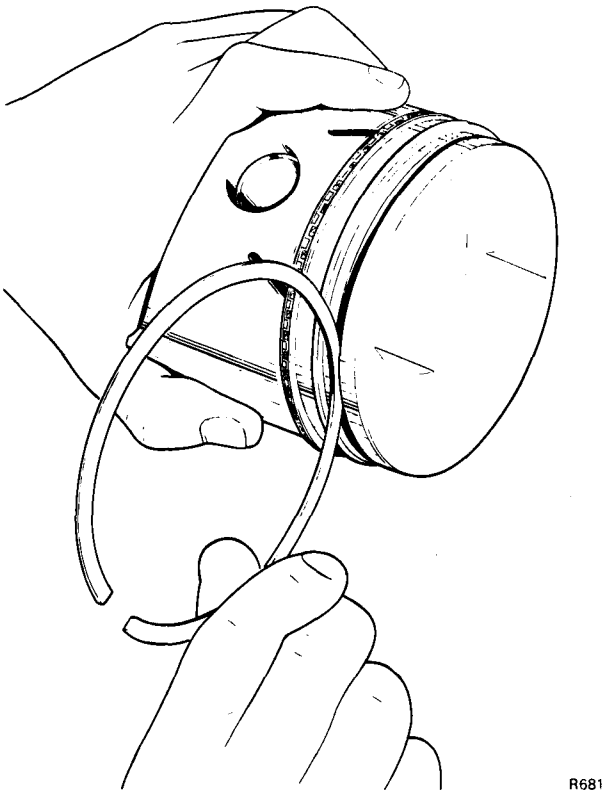

FIG. E33 CHECKING PISTON RING CLEARANCE

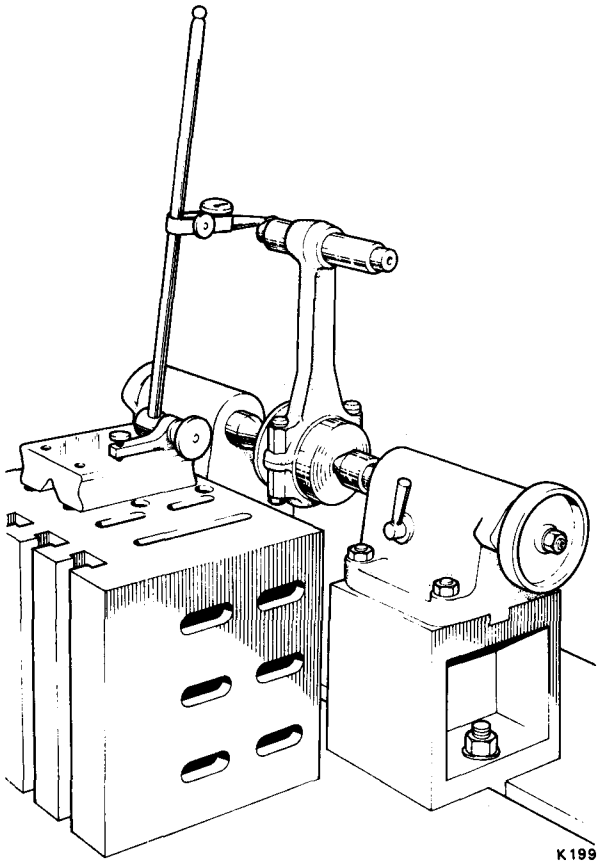

FIG. E34 CHECKING CONNECTING ROD ALIGNMENT

the bore dimension of an adjacent liner until the first liner has been replaced. Otherwise false readings could be obtained.

2. Clean the cylinder bores.

3. Using a dial test indicator, check the diameters of each cylinder bore. If the liners are worn more than 0,1016 mm (0.004 in) or if the ovality exceeds 0,076 mm. (0.003 in.) it is necessary to fit new liners and pistons.

Do not fit new pistons to liners which are worn beyond the permissible limit.

4. Using a piston ring expander tool, remove the rings from the piston.

5. Remove the carbon from the rings, the grooves and pistons.

6. Check the clearance of the rings in the grooves (*see Fig. E33 and Section E11 - Dimensional Data*).

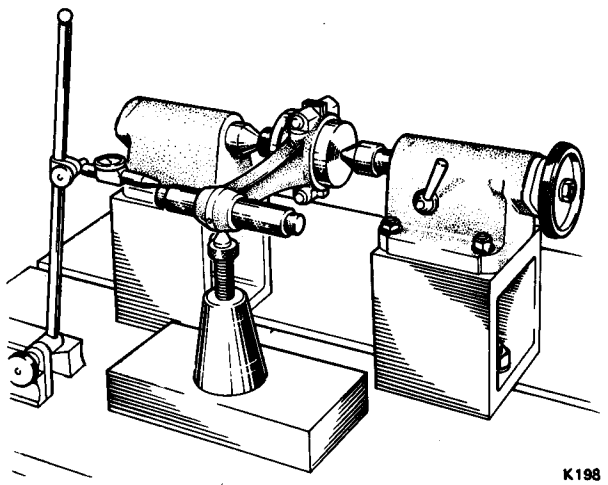

FIG. E35 CHECKING CONNECTING ROD FOR TWIST

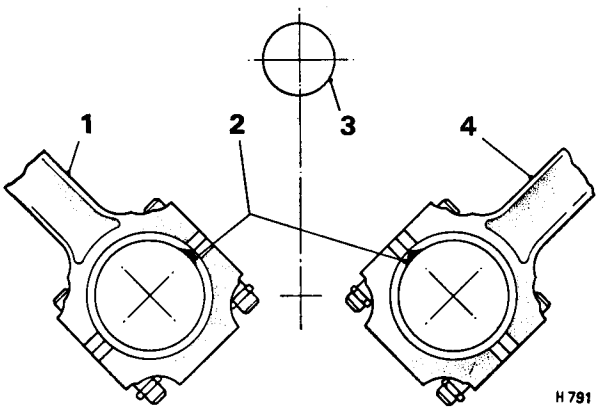

FIG. E36 POSITION OF CONNECTING ROD TANGS

1 'A' bank connecting rod
2 Position of tangs
3 Camshaft
4 'B' bank connecting rod

7. Check the compression rings in a 10,414 cm. (4.100 in.) diameter gauge; if the rings are in good condition there should be no light shown around the circumference of the rings.

8. Check the closed ring gap when fitted to the gauge; this should be between 0,38 mm. to 0,51 mm. (0.015 in. to 0.020 in.). The free gap should be 13,21 mm. (0.520 in.) nominal.

9. Check the dimensions of the pistons across the thrust axis. The measurements should be taken at the piston grading point which is 2,3 cm. (0.906 in.) above the bottom of the skirt.

The grading and the part number are stamped on the piston crown; the pistons are graded in five sizes (*see Section E11 - Dimensional Data*).

Small end bush - To renew

1. Check the diameters of the gudgeon pin and the small-end bush and if the total clearance exceeds 0.013 mm. (0.0005 in.) renew the bush.

2. Using a suitable drift, remove the small-end bush. Before fitting the new bush, check that the interference between the bush and the connecting rod is 0,051 mm. to 0,089 mm. (0.002 in. to 0.0035 in.).

3. Press the bush into the connecting rod ensuring that the split in the bush is positioned so that it is 45° away from the central axis of the rod and on the same side of the rod as the locating recess for the big-end bearing shell. In this position the oil hole in the bush should line up with the oil hole in the small-end boss.

4. Check the grade of the piston gudgeon pin which is to be used, then bore or ream the bush to whichever of the finished bore sizes given below is appropriate,in order to match the grade of the gudgeon pin. The gudgeon pin has its grade etched onto one of its end faces. The corresponding grade is also stamped onto the inside of the piston.

Grade 'A' - 2,5407 cm. to 2,5409 cm.
(1.0003 in. to 1.00037 in.)
Grade 'B' - 2,54096 cm. to 2,54114 cm.
(1.00038 in. to 1.00048 in.)

Connecting rods - To check alignment and twist

1. Correct alignment of the connecting rods is of the utmost importance, and all connecting rods after rebushing and boring should be checked for alignment in a reliable alignment indicator.

2. Connecting rods that are bent will produce slight knocking noises when under acceleration or loading, and will also cause uneven or premature wear between the cylinder walls and pistons.

3. Alignment of the rods may be checked in the following manner if a suitable alignment fixture is not available.

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4. Fit the gudgeon pin to the small-end of the rod and a mandrel in the big-end, then set up the connecting rod on a surface block, with the mandrel resting in either Vee-blocks or between centres and with the rod in a vertical plane (*see Fig. E34*).
5. Using a dial indicator gauge, take readings at both ends of the gudgeon pin. The difference between the two readings must not exceed 0,025 mm. (0.001 in.) per 25,4 mm. (1.00 in.) length of the gudgeon pin.
6. Check the connecting rod for 'twist' in a similar manner to the procedure adopted for checking the alignment but with the axis of the rod in a horizontal plane (*see Fig. E35*).
7. The difference in the readings at each end of the gudgeon pin should not exceed 0,076 mm. (0.003 in.) per 25,4 mm. (1.00 in.) length of gudgeon pin.
8. Connecting rods can be corrected when the inaccuracies are small, but where greater errors exist, new connecting rods must be fitted.

Connecting rod and piston - To assemble

1. Ensure that the piston grade matches the bore grade into which it is to be fitted and that the gudgeon pin grade suits the connecting rod small-end bush.
2. Pistons and gudgeon pins are supplied as an assembly, the gudgeon pin being grade 'A' or 'B' to provide a selective fit to suit the piston bore size. On no account must gudgeon pins and pistons be interchanged.
3. Check the size of the small-end bush, then select a piston having a gudgeon pin of the corresponding size. For graded bore sizes, refer to Small-end bush - To renew. The selected gudgeon pin should be a push fit into the small-end bush.
4. It is possible that service personnel will encounter three different types of piston assembly and therefore, if replacement of these items is contemplated it is essential that the car serial number and engine compression ratio be considered, when the appropriate section of the Parts Catalogue is consulted.
5. The pistons should be assembled as follows, noting that the piston rings are fitted from the piston crown to avoid damaging the skirt and that a new second compression ring must always be fitted when assembling the three ring piston.

Pistons - four rings

Scraper ring

Fit the expander ring.
Fit the bottom steel rail.
Fit the spacer.
Fit the top steel rail.

Two Intermediate taper rings

Fit the rings so that their side marked 'TOP' is uppermost.

Top ring

Fit the top chromium plated ring; this ring can be fitted either way up.

Pistons - three rings

Scraper ring

Fit the expander ring.
Fit the bottom steel rail.
Fit the spacer.
Fit the top steel rail.

Two Compression rings

Fit the two compression rings so that their side marked 'TOP' is uppermost. The top compression ring is chromium plated on the outside diameter and has the additional letters 'AE' adjacent to the word 'TOP'.

6. Pistons with four rings should be warmed in a hot oil bath or on a hot plate. This operation is not essential with the three ring piston as they can be assembled in the cold condition due to the gudgeon pin having clearance in the bore of the piston.
7. Fit the connecting rod to the piston as described under 'Connecting rods and pistons - To fit' noting that the word 'Front' which is stamped onto the piston crown should be towards the front of the engine and the tangs on the connecting rod and cap are adjacent to the camshaft (*see Fig. E36*).
8. Remove the four ring piston from the oil/hot plate.
9. To assemble either the three or four ring pistons to the connecting rods, hold the connecting rod in its correct position inside and fit a suitable guide through the piston and the small-end bush.

Using a hide mallet and a guide pin to facilitate connecting rod and piston small-end alignment, tap the gudgeon pin into position in the piston and connecting rod.

Fit the circlip to each end of the gudgeon pin, thus securing it in the piston.

Connecting rods and pistons - To fit

1. Liberally cover the pistons with 'Molykote G Rapid' grease or its equivalent and fit a ring compressor over the piston rings.
2. Fit the bearing shells to the connecting rod and cap. The shells should have the number of the bore etched on them and should be in pairs.
3. Place rubbers on the end of the connecting rod bolts to prevent damage to the crankpins when fitting the rods.

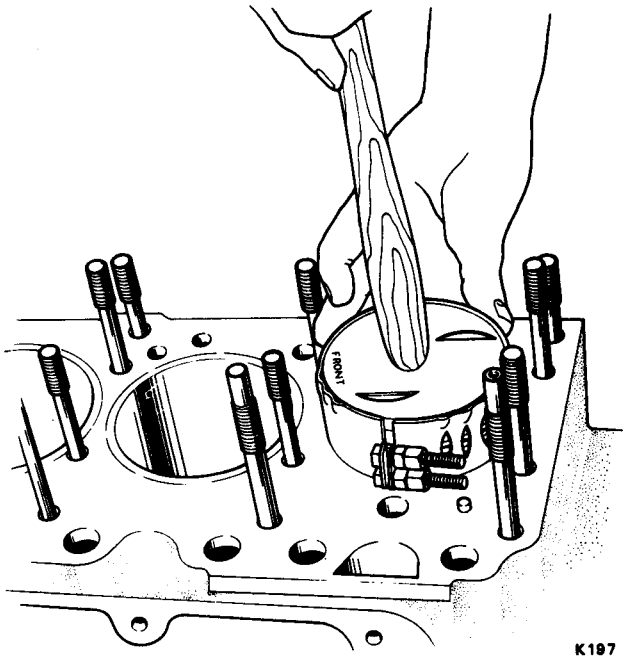

FIG. E37 METHOD OF FITTING PISTONS

4. Fit the piston into the bore from the top ensuring that the piston is in the right bore and that the 'FRONT' of the piston is to the front of the engine and the tang on the connecting rod is nearest to the camshaft.
5. Tighten the ring compressor and hold it against the liner, then push the piston into the bore (*see Fig. E37*).
6. Ensure that the connecting rod is correctly positioned around the crankshaft.
7. Remove the rubber from the connecting rod bolts and fit the connecting rod cap to the rod. The tang on the cap should be on the same side of the journal as the tang on the rod.
8. Fit the nuts to the bolts and torque tighten them to the figure quoted in Chapter P. This reading should give a 0,152 mm. to 0,205 mm. (0.006 in. to 0.008 in.) bolt stretch (*see Fig. E31*). If necessary, further tighten the bolt until the correct extension is obtained.
9. Fit the sump by reversing the procedure adopted for removal noting the following points.
10. Fit a new sump joint.
11. The steering cross-beam ends have a 29° 'set' and care should be taken to replace the cross-beam in its correct position, i.e. with the 'set' pointing towards the rear of the car (*see Chapter N*).
12. Ensure that the engine front mount stop plate is set correctly with a gap of 1,27 mm. (0.050 in.); this procedure is fully described in Section E1 - Engine - To replace - Operation 3.
13. Remove the sling from beneath the crankshaft pulley.

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Section E6
VALVE GEAR AND HYDRAULIC TAPPETS

Hydraulic tappets

A tappet which is found to be defective in service should be replaced by a complete assembly and not by renewing any individual components.

Where a tappet is noisy but otherwise appears to be serviceable and replacement tappets are not readily available, it may be worthwhile dismantling the tappet and thoroughly washing it in clean paraffin. After cleaning, the tappet should be assembled and fitted back into the engine and tested. If the noise still persists, the tappet should be renewed.

Tappet noise

A defective tappet makes a noise like a 'rifle crack' and is usually caused by one or more tappets collapsing, it can be heard with each revolution of the camshaft. This could be caused by dirt which has infiltrated into the tappet(s) in which case the tappet(s) should be dismantled and cleaned. If cleaning the tappet does not cure the fault, the tappet should be renewed.

The tappet can be isolated by the fact that the noise changes as the rocker arm is depressed manually to take up any 'sponge' while the engine is running.

If the noise is not caused by a collapsed tappet(s) one of the following causes should be suspected.

(i) Sometimes air is drawn into the tappets after standing overnight and one of the tappets may be reluctant to clear itself even after 30 minutes hot running.
(ii) Very occasionally a tappet leaks down too quickly at high temperatures causing a knock. This tappet is really a milder case of the 'rifle crack failure' and should be renewed.
(iii) Very occasionally a tappet will stick in the bore of the tappet block at high temperatures causing a knock. This will show itself by being consistently noisy when the engine is very hot and always quiet at other times. Should this situation be encountered and all other tappet rectification measures failed to effect a cure, the suspect tappet block should be checked for incorrect crankcase bedding by lightly smearing the seating face with engineers blue and trying it in the crankcase. If the check proves conclusively that the tappet block bedding in the crankcase if faulty, the crankcase can be scraped to improve the situation.

Important Extreme care must be exercised when carrying out this operation and the minimum amount of metal removed from the crankcase.

Tappet wear

There is very seldom a just cause for rejecting tappets due to wear of the bottom face unless the cam peak on the camshaft is also badly worn. This type of excessive mutual wear would cause a loud noise at the valve and is termed a 'catastrophic' failure. It is very rare and has never been known after the first 10,000 miles. A badly worn tappet which would indicate camshaft wear is illustrated in Figure E38.

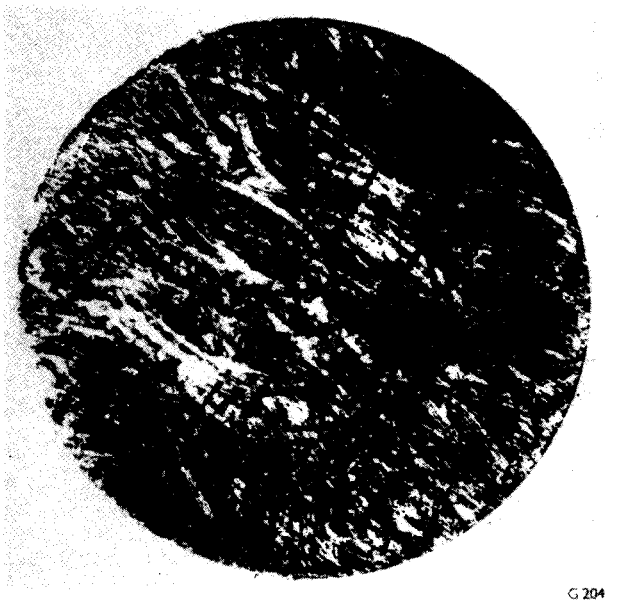

FIG. E38 SEVERELY SCUFFED TAPPET BASE

All other cases of seemingly bad surface wear on the tappet bottom e.g. pitting, scuffing, etc., are not yet known to be harmful (after many 100,000 miles experience with experimental engines). It is known however that it may be harmful to replace a mildly worn tappet with a new one unless the camshaft is also changed. For this reason, if not for economy, only the tappets which actually cause a noise should be changed. If it is found necessary to fit a new camshaft to an engine, (sixteen) one complete set of new tappets must also be fitted.

Hydraulic tappets - To remove

1. Remove the carburetters and induction manifold etc. (*see Section E2 - Cylinder heads - To remove - Operations 1 to 27 inclusive*).
2. Progressively unscrew the setscrews securing the tappet chest cover to the crankcase. The setscrews must be removed progressively. If the brake pump operating cam happens to be on its peak, distortion could occur to the tappet chest cover.
3. Remove the rocker covers.
4. Progressively unscrew the five setscrews securing the rocker pedestals to each cylinder head, then remove the rocker shaft assemblies.
5. Remove the push rods.
6. Withdraw the hydraulic tappets from the tappet blocks.

Hydraulic tappets - To dismantle

1. Press down the spherical cap situated in the top of the tappet and remove the circlip holding the cap in place. After gradually releasing the pressure from the spherical cap the tappet can be dismantled (*see Fig. E43*).
2. Remove the plunger and valve from the tappet barrel. The tappet barrel should be examined for any signs of wear on the base.

Hydraulic tappets - To assemble and prime

In order to obtain the high degree of accuracy necessary for efficient operation of the hydraulic tappets, it is essential that extreme precautions are taken to ensure complete cleanliness on assembly.

It is therefore most important that particular attention is given to the following points.

(i) Due to the highly critical surfaces and dimensions of the hydraulic tappets, great care and cleanliness are of the utmost importance when handling tappet components.
If a cloth is to be used ensure that it is lint free.

(ii) Ensure that the assembly tank is perfectly clean before adding paraffin; only clean fresh paraffin must be used.

(iii) Wash all the tappet components in clean paraffin, taking care that the components of each tappet are retained as an assembly and are not interchanged with parts of another tappet.

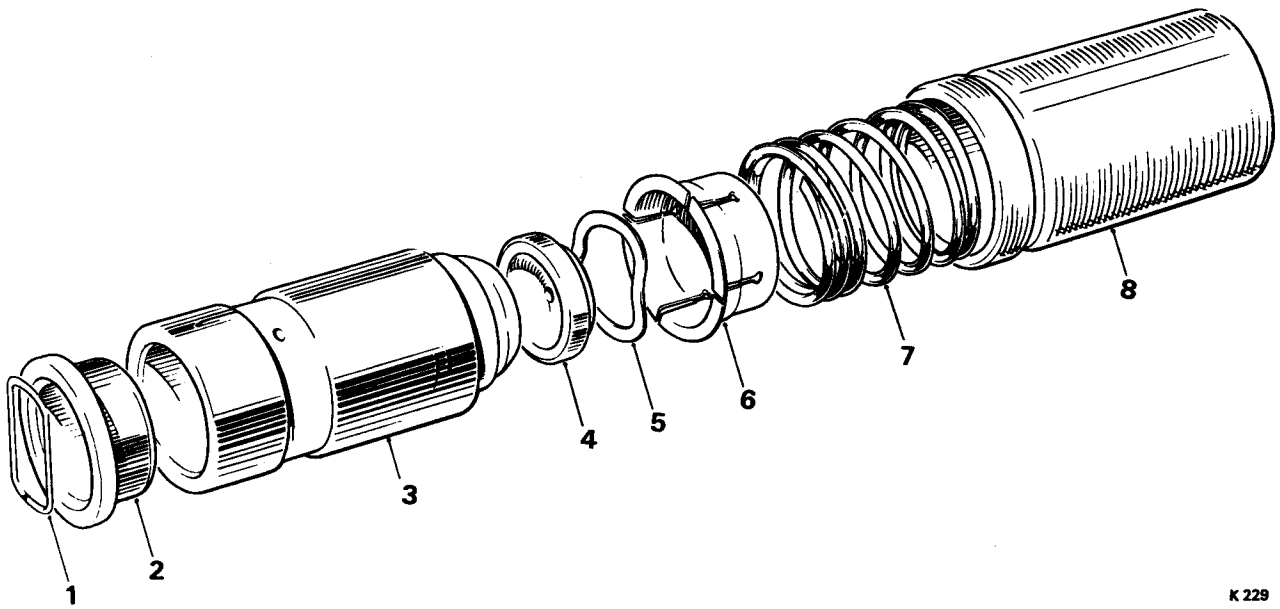

FIG. E39 EXPLODED VIEW OF HYDRAULIC TAPPET

1 Circlip	3 Plunger	5 Wave washer	7 Spring
2 Cap	4 Valve	6 Retainer	8 Tappet barrel

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1. Commence assembly of the tappet by fitting the wave washer (*see Fig. E39*) and valve into the retainer.
2. Using 'finger' pressure, carefully press the retainer assembly onto the spigot of the plunger.
3. Fit the spring onto the retainer assembly.
4. Fit the valve assembly (plunger, valve, wave washer, retainer and spring), into the tappet barrel.
5. Fit the cap into the top of the plunger.
6. Using an old push rod press the cap downward until it is possible to fit the retaining circlip into the groove located inside the top of the tappet barrel.
7. Release the pressure.
8. Submerge the tappet assembly in clean Esso T.S.D. 1047 rust inhibiting paraffin.
9. Using a small probe push the valve off its seat; the probe should be carefully positioned through the small hole in the tappet cap and pushed down into the tappet until it contacts the valve. A slight increase in pressure will then be required to overcome the wave washer loading and open the valve.
10. Continue to hold the valve open and place a small screwdriver into the cap adjacent to the probe.
11. Apply pressure to both the probe and screwdriver. Press the cap downwards in the tappet barrel, compressing the spring. Note the air bubbles that are expelled from the tappet barrel oil inlet hole.
12. When the air bubbles cease, release the pressure from the cap and valve.
13. Repeat operations 9 to 12 continuously, until the air bubbles have ceased to appear throughout the cycle of operations.
14. Withdraw the probe from the small hole in the centre of the cap.
15. Again apply pressure to the cap with a small screwdriver. If the assembly feels solid it can be assumed that it is operating satisfactorily, therefore it can be removed from the paraffin and fitted to the engine.

Hydraulic tappets - To fit

1. Oil the bores of the tappet blocks.
2. Check that if new tappets are being fitted, the grade of each tappet corresponds with the bore of the tappet block into which it is to be fitted. The tappet barrel grading marks are etched onto the top lip of the barrel.
3. Fit the tappets.
4. Fit the push rods to the engine, into the same position from which they were removed.
5. Fit the rocker shafts then progressively tighten the securing nuts.
6. Rotate the camshaft until the brake pump eccentrics are at B.D.C.
7. To prevent the possibility of hydraulic lock, ensure that the brake pumps are drained of fluid.
8. To check that the position of the brake pump push rods are set correctly, carry out Operations 9 to 27 inclusive.

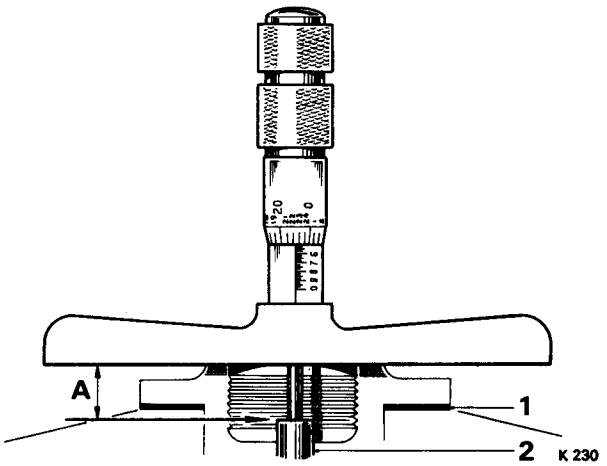

FIG. E40 CHECKING THE POSITION OF THE BRAKE PUMP PUSH ROD

1 Shims
2 Push rod
A 13,26 mm. to 13,33 mm. (0.522 in. to 0.525 in.)

9. Temporarily fit the tappet cover together with the brake pumps; tighten the tappet cover setscrews.
10. Using spanner RH 7856, unscrew the serrated nut securing the front brake pump to its push rod housing.
11. Rotate the engine to find the lowest position of the front brake pump push rod, then using a depth micrometer, check the dimension (A) from the top face of the mounting flange to the top of the push rod (*see Fig. E40*).
12. If this dimension A is incorrect, the total thickness of the shim washers fitted between the brake pump and the tappet cover should be altered as necessary.

The shims are available in two sizes 0,076 mm. and 0,178 mm. (0.003 in. and 0.007 in.) and can be obtained from the Parts Department, Rolls-Royce Motors Limited.

13. To alter the number of shims carry out Operations 14 and 21 inclusive.
14. Remove the tappet cover together with the push rod housing.
15. Unscrew the two setscrews which secure the push rod housing to the mounting flange and remove the housing and flange together with the shim washers.
16. Care should be taken to ensure that dirt or any other foreign matter is not allowed to come into contact with the eccentrics or the cam face of the follower.
17. Either add or subtract the necessary shim washers.
18. Secure the push rod housing and mounting flange to the tappet cover, then fit the tappet cover to the engine and tighten the securing setscrews.
19. Again using a depth micrometer, check the

dimension (A) in Figure E40 from the top face of the mounting flange to the tappet cover.
20. Fit the front brake pump to its push rod housing then rotate the pump casing so that the position of its inlet port is relative to the feed pipe run from the reservoir.
21. Using spanner RH 7856, torque tighten the serrated nut (*see Chapter P*).
22. Repeat Operations 11 to 21 inclusive for the rear brake pump.
23. Remove the tappet cover together with the brake pumps.
24. Wellseal the crankcase tappet cover joint face, then fit a new length of sealing thread to the face. Fit the thread so that its two ends overlay and it surrounds all the tapped holes in the crankcase. (*see Fig. E41*).
25. Wellseal the joint face of the tappet cover.
26. Check that the brake pump operating eccentrics are at B.D.C. and that all fluid is drained from the brake pumps.
27. Fit the tappet cover to the crankcase then fit and tighten the setscrews.
28. Complete the engine build by reversing the procedure given for its dismantling, noting the following points.
29. Fit new joints and sealing rings.
30. Refer to Chapter P for torque tightening figures.
31. Ensure that brake pipes are not over-tightened otherwise damage to the conical seating may occur.
32. Any hoses showing signs of deterioration should be renewed.
33. Ensure that the driving belts are adjusted to the correct tension.
34. Refill the cooling system with the correct anti-freeze mixture.
35. Connect the battery leads.
36. Bleed the hydraulic systems (*see Chapter G*).
37. Charge the refrigeration system (*see Chapter C - Part 2*).

Rocker shaft assembly - To remove

1. Remove the rocker assembly by unscrewing the pedestal setscrews and lifting the assembly away from the base but not above the rim of the rocker box.
2. Replace setscrews into the end pedestals otherwise the spacing springs will force the rocker arms and pedestals off the shaft.
3. Lift the rocker assembly to a bench and remove one of the restraining setscrews.
4. Withdraw the rocker arms, pedestals and springs to a clean container, keeping the components in their correct order for assembly.

Rocker arms - To inspect

1. Examine the pads on the rocker arms for wear and renew them if they are badly worn. Slight 'scuffing' or pitting on the pad may be removed with a smooth stone.
2. Rocker pads are case hardened to a depth of between 0,635 mm. and 0,762 mm. (0.025 in. and 0.030 in.) and the Rockwell hardness value should be between C57 and C65.
3. If, after refacing or stoning the rocker pads, the hardness value is below these figures, the rocker arms should be renewed.

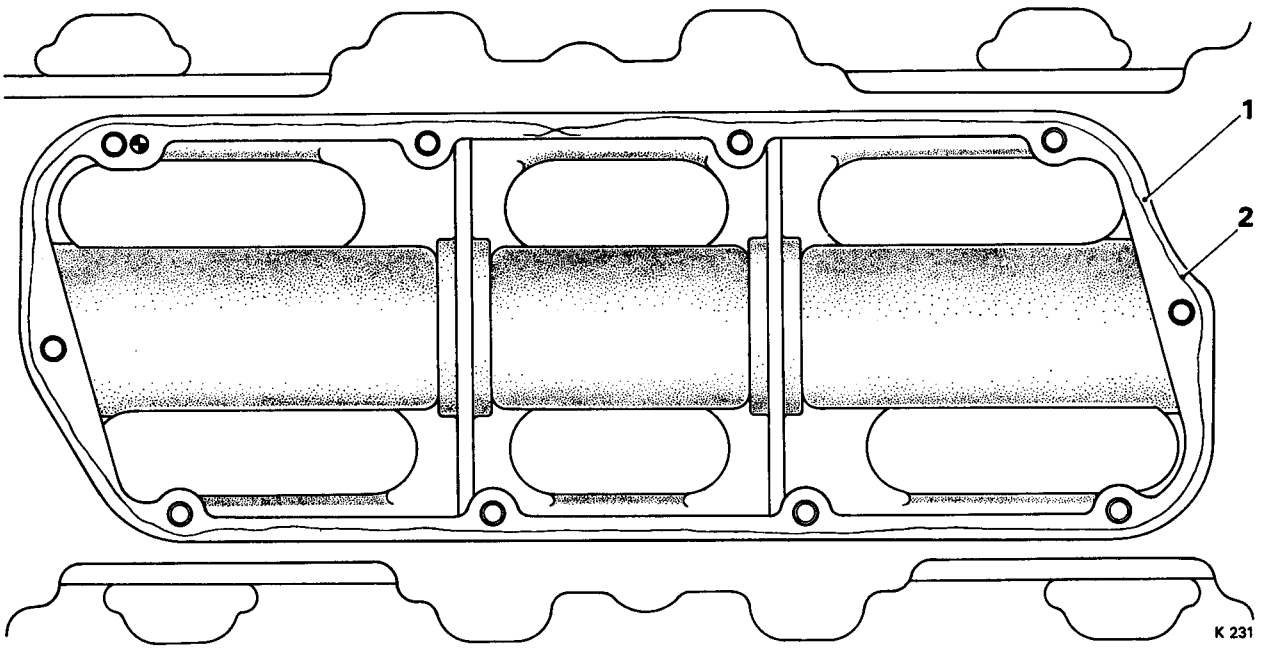

FIG. E41 SILK SEALING THREAD IN POSITION ON THE CRANKCASE FACE

1 Crankcase tappet cover face
2 Silk sealing thread

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Rocker shaft - To assemble

1. Fit the rocker pedestals, spacing springs and rockers to the rocker shaft.
2. When building up the shaft fit a setscrew through the end pedestal and shaft before the remaining pedestals and springs are fitted. The rockers are handed and should be fitted in pairs so that the arms point inward over the cylinder bore when the rocker shaft is fitted to the rocker box. *(see Fig. E42).*

Rocker shaft assembly - To fit

Fit the rocker shafts to the cylinder heads, noting the following points.

1. The cylinder heads are fitted with dowel pins, these pins ensure that the rocker shaft is fitted correctly and the oil feed holes align.
2. When tightening the five setscrews and washers that hold the shaft, ensure that the ball-ends of the push rods are correctly seated in the tappet and rocker arms.
3. Tighten the shaft down progressively to the torque figure quoted in Chapter P.

Push rods

1. Check the push rods for bow, any that are bowed more than 0,51 mm. (0.020 in.) total indicator reading should be renewed.
2. Before fitting the push rods, check that the ball-ends are not blocked by dirt.

Valve spring - To renew (Cylinder head fitted)

1. Remove the rocker gear as already described then proceed as follows.
2. Using valve spring compressing tool RH 7094, press down the valve spring which is to be replaced *(see Fig. E43).*
3. Very carefully, rotate the engine crankshaft by hand until the corresponding piston is felt to touch the head of the valve.
4. Continue to carefully rotate the crankshaft, until the piston reaches T.D.C.

Whilst the piston is being moved toward T.D.C. with the valve head touching it, the pressure should be progressively released from the compressing tool so that a minimum amount of pressure is exerted onto the valve.

If the operation is not carried out in this manner, the valve could sustain damage.

5. Temporarily remove the valve spring compressing lever then using a soft headed mallet, tap the top washer until the collets are disturbed in their seat.
6. Compress the valve spring then remove the collets, top washer and spring.

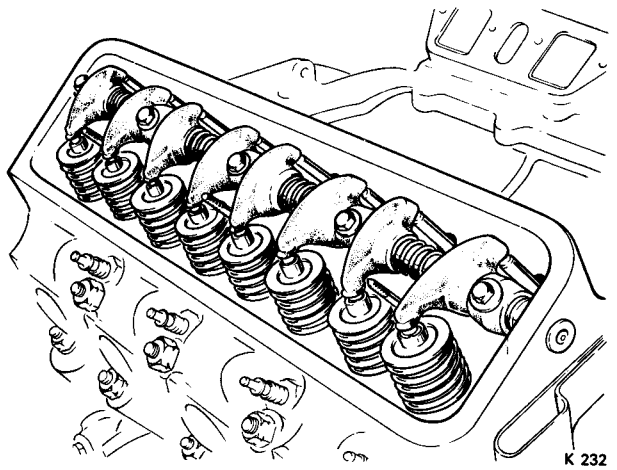

FIG. E42 ROCKER SHAFT ASSEMBLY IN POSITION

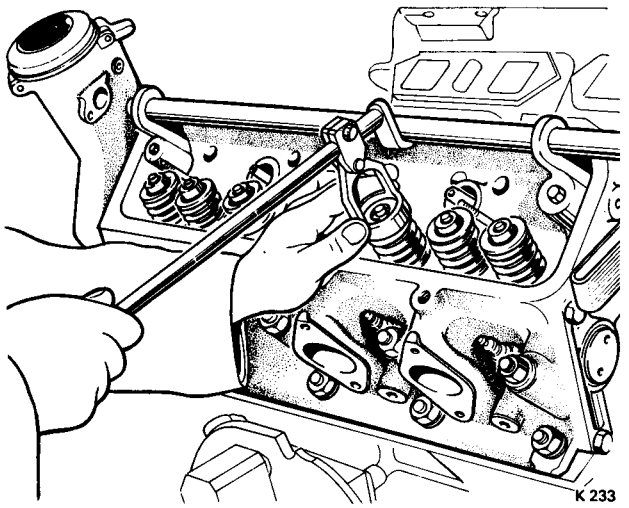

FIG. E43 REMOVAL OF VALVE COLLETS - CYLINDER HEADS MOUNTED ON ENGINE

7. Fit a new spring; then fit the top washer, collets and valve gear by reversing the procedure given for dismantling.

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Section E7
CAMSHAFT

Camshaft - To remove

1. Remove the engine from the car *(see Section E1)*, blanking off all pipes and ports immediately after being disconnected or uncovered.
2. Place the engine in a stand.
3. Remove the hydraulic tappets *(see Section E6)*.
4. Remove the flywheel.
5. Remove the distributor together with its pedestal *(see Chapter M)*.
6. Remove the pressed steel cover from the rear end of the crankcase to expose the distributor driving gears *(see Fig. E44)*.
7. Withdraw the distributor driving shaft together with the locating plug and 'O' ring.
8. Withdraw the distributor driving spindle and integral gear together with the thrust washer.
9. Remove the skew gear from the rear end of the camshaft.
10. Remove the front cover from the front of the camshaft and withdraw the cam gear.
11. Remove the camshaft thrust plate together with the timing gear lubricating oil pipe assembly then withdraw the camshaft through the front end of the crankcase. Take care that the bearing bores are not damaged by the cam lobes.

Camshaft - To inspect

1. Inspect the cams for wear and pitting. The cam lift is 6,43 mm. (0.253 in.) but a minimum lift of 5,97 mm. (0.235 in.) is permissible.
2. If wear is in excess of this figure, the camshaft must be renewed.

Camshaft - To fit

1. Lightly smear the camshaft bearings with clean engine oil. Lubricate the camshaft lobes with EP (extreme pressure) oil such as Castrol Hipress SC 140. Fit the camshaft through the front end of the crankcase, taking care that the cam lobes do not damage the camshaft bearing bores.
2. Fit the timing gear lubricating jet to the thrust plate and secure it with two setscrews and tabwashers.
3. Fit and secure the camshaft thrust plate to the crankcase; use new tabwashers. Torque tighten the setscrews to the figure quoted in Chapter P; lock the tab washers.

Camshaft end float - To check (see Fig. E45)

1. Fit a dial test indicator to the crankcase and set the scale to zero.
2. Fit the two setscrews to the end of the camshaft.
3. Grip the setscrews then move the camshaft backward and forward and note the reading on the dial test indicator.
4. The camshaft end-float should be between 0,05 mm. and 0,15 mm. (0.002 in. and 0.006 in.).

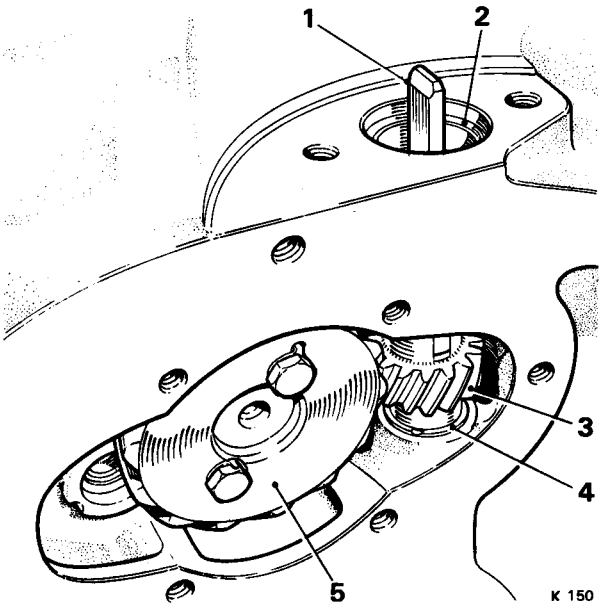

FIG. E44 VIEW OF DISTRIBUTOR DRIVING GEARS

1 Distributor driving shaft
2 Locating plug
3 Driving spindle and integral gear
4 Thrust washer
5 Skew gear

Valve gear - To time (see Fig. E46)

1. Rotate the crankshaft until the mark on the crankshaft timing gear is vertical and toward the top of the crankcase.

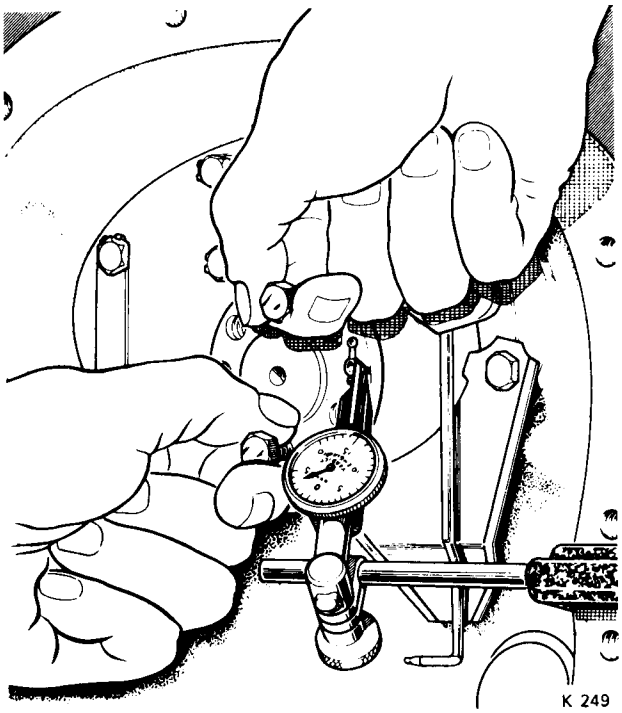

FIG. E45 CHECKING CAMSHAFT END FLOAT

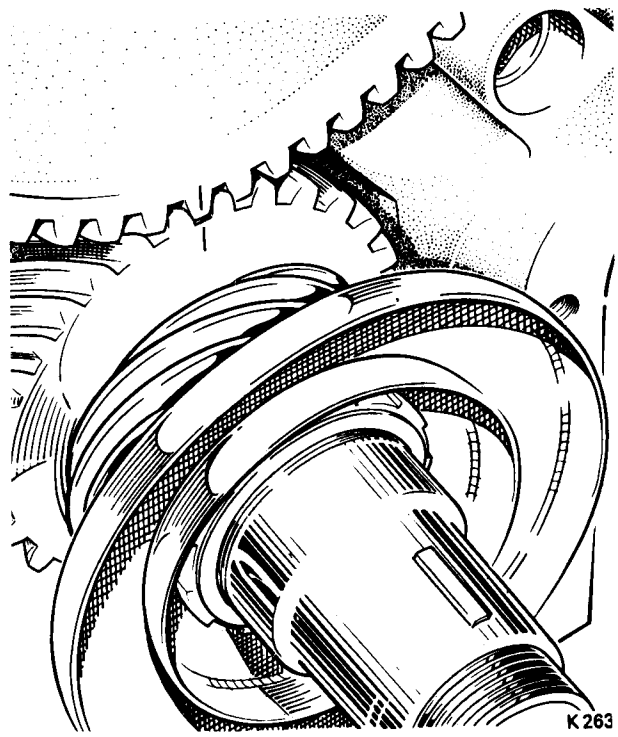

FIG. E46 VALVE TIMING MARKS

2. Fit the camshaft timing gear to the camshaft, so that the mark on the camshaft timing gear is aligned with the mark on the crankshaft timing gear; do not fit any setscrews at this stage.
3. Carefully rotate the camshaft until the holes in the camshaft timing gear align exactly with the threaded holes in the camshaft.
4. Fit the end plate cover and secure the timing gear and the cover to the camshaft with eight set-screws. Torque tighten the setscrews to the figure quoted in Chapter P.

Camshaft timing gear backlash and run-out - To check

1. Fit a dial test indicator to the crankcase and set the scale to zero as shown in Figure E47.
2. Rock the cam gear and check the backlash. The backlash should be between 0,025 mm. and 0,10 mm. (0.001 in. and 0.004 in.).
3. Check the backlash on various teeth around the circumference of the gear.
4. Check the timing gear run-out as follows (*see Fig. E48).*
5. Move the indicator pointer so that it touches the front face of the cam gear.
6. Rotate the crankshaft and check the run-out shown on the indicator dial. The run-out should not exceed 0,05 mm. (0.002 in.).

Distributor driving gear - To fit

1. Fit the camshaft distributor driving gear.
2. Rotate the crankshaft until the timing marks on the camshaft and crankshaft gears are in line.
3. Fit the thrust washer to the distributor driving gear spindle then fit the gear into the recess in the crankcase. It will help in fitting this gear if the washer is held to the gear with a light smear of grease.
4. When the gear is fitted, the slot in the top of the gear spindle should be in line with the camshaft (*see Fig. E44).*

On no account should the setting of crankshaft and camshaft be disturbed whilst fitting this gear.

5. Fit the distributor driving shaft to the driving spindle then fit the locating plug.
6. If necessary, renew the rubber 'O' ring on the locating plug.
7. Using a dial test indicator in a similar manner to that shown in Figure E47, check the backlash of the distributor driving gear. This should be between 0,05 mm. and 0,10 mm. (0.002 in. and 0.004 in.).
8. Fit the camshaft rear cover using a new paper joint.

Engine assembly - To complete

Complete the engine assembly by reversing the procedure given for camshaft removal, noting the following points.

1. All setscrews, nuts and bolts must be torque tightened to the figures quoted in Chapter P.
2. Renew all joints.
3. Fit a new Neoprene oil seal between the lower front casing and the coolant pump.
4. Ensure that the tappet cover is fitted correctly (*see Section E6*).
5. Fit the distributor and time the ignition as described in Chapter M.
6. If new camshaft is fitted to an engine, one complete set (sixteen) new tappets must also be fitted.

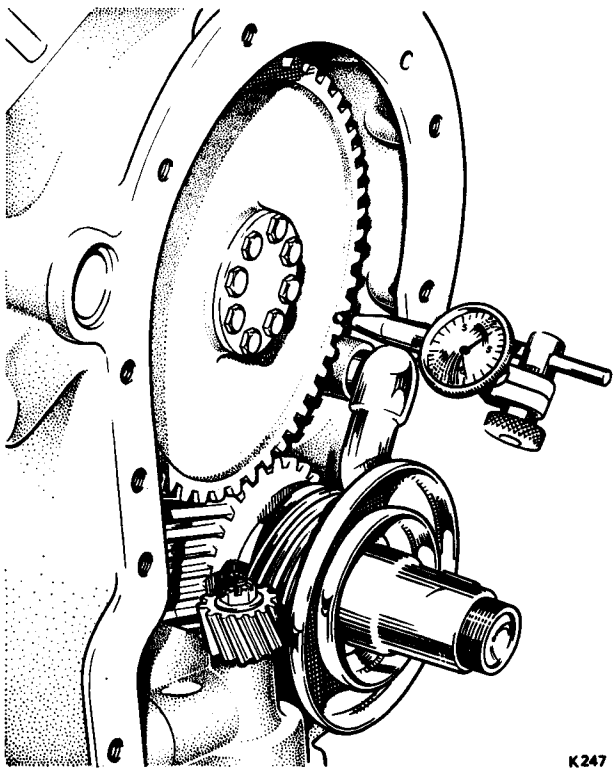

FIG. E48 CHECKING TIMING GEAR RUN-OUT

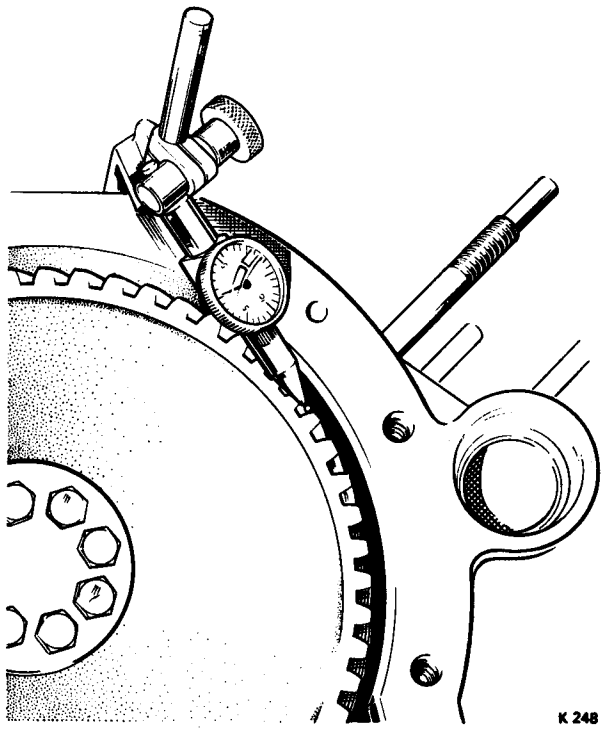

FIG. E47 CHECKING TIMING GEAR BACKLASH

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Section E8
CRANKCASE BREATHER PIPE

Maintenance

1. Periodically clean the flame trap fitted to the breather pipe in the following manner.
2. Unscrew the setscrew securing the breather pipe connection to the oil filler pedestal; withdraw the connection from the pedestal (slight resistance may be felt due to the rubber 'O' ring connections).
3. Withdraw the connection from the pipe flange.
4 Wash the flame trap assembly in clean petrol, then dry with a high pressure air line. The flame trap assembly consists of either 6 separate gauzes or 3 gauzes crimped together as shown in Figure E49.
5. To clean the adapter fitted to the choke housing, remove the single setscrew from the breather pipe end connection and detach the pipe.
6. Clean the adapter fitted to the choke housing and ensure that the holes in the adapter are clear.
7. Assemble the flame trap and breather pipe in the reverse order, ensuring that the 'O' rings are in good condition.

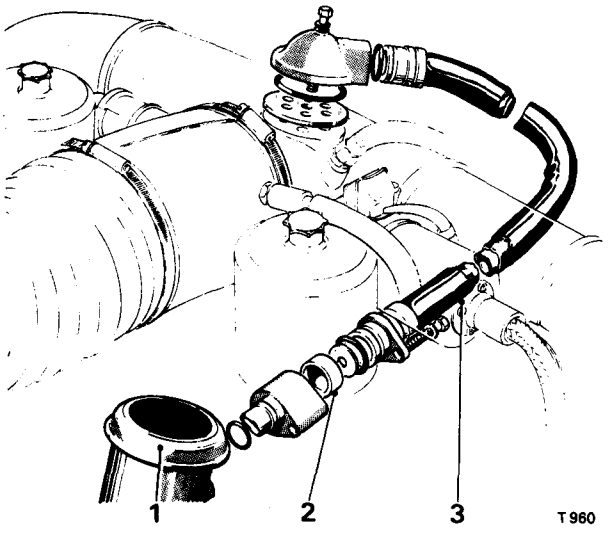

FIG. E49 EXPLODED VIEW OF CRANKCASE BREATHER PIPE

1 Oil filler housing
2 Flame trap
3 Breather tube

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Section E9
DECARBONIZING

Engine - To decarbonize

1. Remove the cylinder heads and the valves *(see Section E2 - Cylinder Heads).*
2. The valve spring, washer, split collets, valve gland, housing and gland pressure spring from each valve assembly should be retained as a separate assembly in order that they can be readily assembled in the head in their original positions.
3. Using a blunt tool or wire brush, remove the carbon deposit from the cylinder heads, the piston crowns and the top faces of the cylinder liners; care should be taken not to damage the valve seats or to make heavy score marks in the piston crowns and cylinder heads. Heavy score marks will quickly accumulate carbon and seriously impair the performance of the engine.
4. Wash the cylinder heads in paraffin then blow off the surplus paraffin with compressed air.
5. Remove all traces of carbon from the cylinder bores and the crankcase top faces, ensuring that carbon does not get into the coolant or oil drain holes.
6. Clean all the carbon off the valves.

Valve guides - To inspect

1. Using a new valve as a gauge, examine the valve guides for wear.
2. The maximum permissible wear on both the inlet and exhaust guides is 0,051 mm. (0.002 in.). If this figure is exceeded, the guides should be renewed as described in Section E2. 'Bell mouthing' at the lower ends of the valve guides is permissible up to 0,15 mm. (0.006 in.) for a depth of 9,52 mm. (0.375 in.).
3. The maximum permissible clearance in the bore between each valve and its bore is 0,132 mm. (0.0052 in.).

Valve and valve seat inserts - To reface

1. Reface the valve seats and seat inserts using valve reconditioning equipment to give a seat angle of 45°.

When refacing the valve seats, remove the minimum amount of material possible to give a 'clean' seating, whilst maintaining the two dimensions shown in Figure E50.

2. If necessary, the valve seat inserts may be crowned with a 30° cutter to prevent 'pocketing'.
3. Renew the valve seat inserts if they are badly worn *(see Section E2).*
4. Using a fine, good quality lapping paste, lightly lap each valve to its seating. Check the seating using Prussian blue.
5. Wash the head and the valves in paraffin to remove all grinding dust and lapping paste. Blow off the surplus paraffin with compressed air.
6. If new valve guides and valve seat inserts are fitted, the valve guides should be reamed before the valve seat inserts are faced.

Valve springs - To test

1. Visually examine the valve springs for defects and check the poundage of the springs on a valve spring tester.
2. Data for this test can be found in Section E11 - Engine dimensional data.
3. Engines with a 9,14 cm. (3.600 in.) stroke have identical inlet and exhaust valve springs.

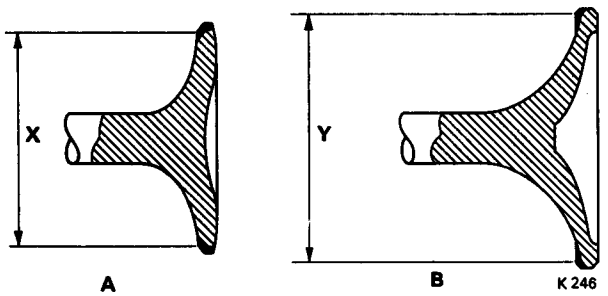

FIG. E50 VALVE SEAT DIMENSIONS

A Exhaust
B Inlet
X 3,576 cm. to 3,58 cm. (1.408 in. to 1.412 in.)
Y 4,56 cm. to 4,58 cm. (1.775 in. to 1.805 in.)

However, on later engines with the 9,90 cm. (3.900 in.) stroke, having an engine number prefix 'SYL', the inlet valve spring remains unchanged but both the dimensions and rating of the exhaust valve spring are increased. Assemble and fit the cylinder heads as described in Section E2, noting the following points.

Cylinder heads - To assemble

1. Ensure that the valves are fitted in their correct position and that the valve guide bores are perfectly clean.
2. Fit new cylinder head gaskets.
3. Tune the carburetters *(see Chapter K).*
4. Ensure all setscrews, nuts and bolts are torque tightened to the figures quoted in Chapter P.

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Section E10
ENGINE LUBRICATION

Oil pump - To remove

1. Drive the car onto a ramp then chock the road wheels to prevent the car from moving.
2. Drain the coolant as described in Chapter L.
3. Disconnect the battery leads.
4. Drain the engine oil as described in Section E1.
5. Remove the bonnet as described in Section E1.
6. Remove the eight nuts and bolts securing the radiator grille; remove the grille.
7. If refrigeration is fitted, discharge the system as described in Chapter C - Part 2.
8. Disconnect the two high pressure pipes located at the top of the condenser (*see Figs. E1 and E2 items 22 and 23*).
9. Remove the coolant fan, viscous coupling assembly (if fitted), radiator and header tank as described in Section E1.
10. Remove the four setscrews securing the condenser to the body; remove the condenser. The condenser is fitted between the radiator and the grille.
11. Remove the three exhaust downtake pipe clamps adjacent to the engine then detach the right-hand pipe from the engine and remove the short left-hand downtake pipe. *(Left-hand and right-hand description applies when viewed from the driver's seat).*
12. Using a jack, support the weight of the engine as shown in Figure E2 .
13. Remove the nuts and washers securing the front engine mounting to the cross-member.
14. Remove the drive belts from the crankshaft pulley; refer to Chapter L.
15. Disconnect the electrical wiring to the generator or alternator, taking a careful note of the connections to ensure correct assembly.
16. Remove the nut, bolt and distance washer from the generator or alternator adjusting strap.
17. Detach the generator or alternator from its front and rear mounting points; remove the generator or alternator.
18. Remove the refrigerant compressor (if fitted) as described in Chapter C - Part 2; blank the ends of open pipes to prevent the ingress of dirt.
19. Disconnect the generator or alternator adjusting strut.
20. Disconnect the heater pipes from the coolant pump.
21. Disconnect the thermostat by-pass pipe at the coolant pump.
22. On cars fitted with an oil pressure gauge, remove the capacitor from the front lower casing.
23. Remove the setscrews securing the coolant pump to the crankcase; remove the coolant pump.
24. Discard the Neoprene seal which fits between the coolant pump and front lower casing.
25. Remove the lockplate and setscrews securing the pulley and Metalastik damper to the pulley drive flange; remove the pulley and Metalastik damper.
26. Using spanner RH 7131, remove the serrated nut from the crankshaft.
27. Using withdrawal tool RH 7097, remove the pulley driving flange (*see Fig. E53*).

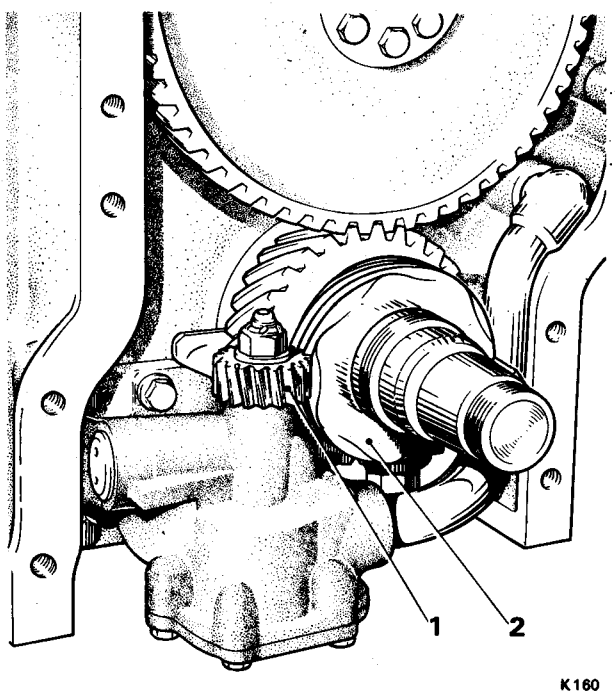

FIG. E51 VIEW OF OIL PUMP FITTED TO THE ENGINE

1 Oil pump gear
2 Oil pump gear drive

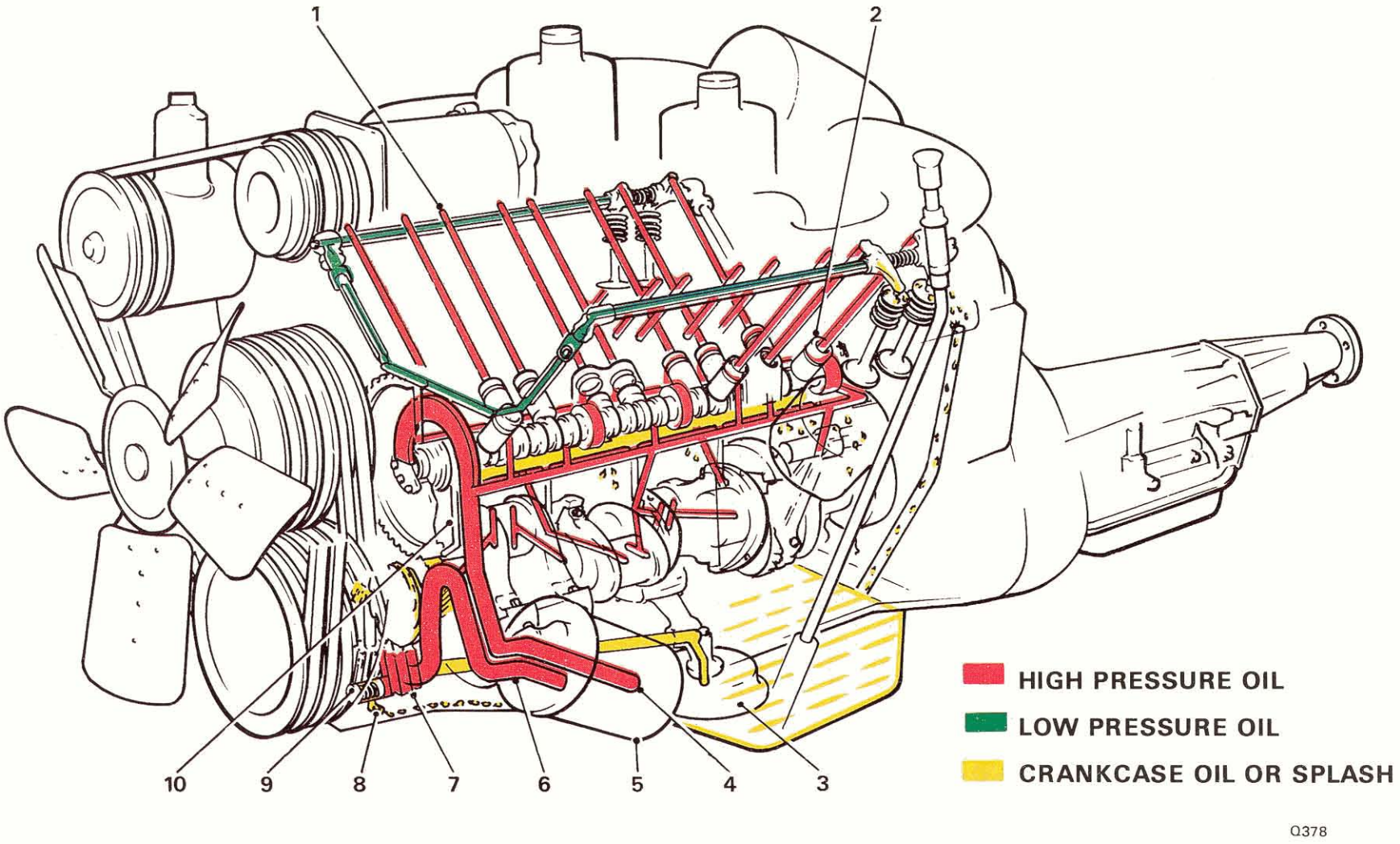

FIG. E52 ENGINE LUBRICATION DIAGRAM

1 Push rods
2 Hydraulic tappets
3 Oil pick-up and strainer
4 Full flow oil filter
5 Filter to oil gallery
6 Filter intake
7 Oil pump
8 Return to intake side of sump
9 Relief valve
10 Oil jet to camshaft gear

28. Remove the setscrews securing the front lower casing to the crankcase then remove the casing; note that this casing is dowelled to the crankcase.
29. Detach the oil pipe connecting the pump to the filter intake ensuring that the rubber 'O' ring, fitted at the filter end of the pipe is also removed.
30. Remove the three setscrews securing the pump to the crankcase, then remove the pump together with the dowel inserts.

A little difficulty may be experienced when withdrawing the oil pump and it may be necessary to turn the unit from side to side as it is removed.

Crankshaft oil pump driving gear - To remove

1. With the front engine cover removed from the crankcase use special spanner RH 7110 to remove the serrated nut from the crankshaft.
2. Remove the washer and the two oil flingers.
3. The oil pump driving gear can now be withdrawn.

Oil pump - To test

The pump must be tested on a rig which has a variable orifice so that the oil delivery pressure from the pump can be restricted. The rig should also be able to drive the pump at a controlled speed and be capable of maintaining a constant temperature of 80° C (176° F) for the duration of the test. If these facilities are available, the pump should be tested as follows.

1. Drive the pump at 200 r.p.m. then adjust the variable orifice until the pump is delivering oil at 1,055 kg/sq.cm. (15 lb/sq.in.); with the orifice at this setting, the pump oil delivery should be 4,55 litres/min. (1 gal/min.).
2. Maintain the orifice at this setting then increase the pump speed to 1 500 r.p.m. At this speed, the pump oil delivery should be at least 9,00 litres/min. (2 gal/min.) at 2,95 kg/sq.cm. (42 lb/sq.in.). The oil pump relief valve should blow at approximately 2,95 kg/sq.cm. (42 lb/sq.in.).

If the performance of the pump does not conform to these figures, proceed as follows;

3. Examine the working face of the pump cover and if necessary, remove light wear marks by machining.
4. Compare the pump clearance with the figures given in Section E11 - Dimensional Data. If necessary renew the pump casing and fit a new matched set of gears.
5. If the condition of the pump is poor, the complete pump should be renewed.

Oil pump - To dismantle (see Fig. E54)

1. Hold the external driving gear in a suitable fixture, taking care that sufficient protection is provided to ensure that the teeth of the gear are not damaged.
2. Remove the split pin, nut and washer securing the driving gear to the driving shaft then carefully withdraw the gear; remove the Woodruff key from the shaft.

Unscrew the six setscrews from the end cover; remove the cover together with the two gears from the casing.

Oil pump - To assemble

Assemble the oil pump by reversing the procedure given for dismantling noting the following points.

1. Examine all working parts for wear and inspect the end cover and casing for distortion; renew if necessary. If the end cover is lightly scored by the pump gears, the score marks may be removed by machining.
2. Assemble the oil pump then check that the end-float in the gears and backlash between the pump driving gear and the driven gear is correct *(see Section E11 - Dimensional Data).*
3. Torque tighten the setscrews, nuts and bolts to the figure specified in Chapter P.

Oil pump - To fit

Fit the oil pump by reversing the procedure given for removal, noting the following points.

1. Ensure that all setscrews, nuts and bolts are torque tightened to the figures specified in Chapter P.

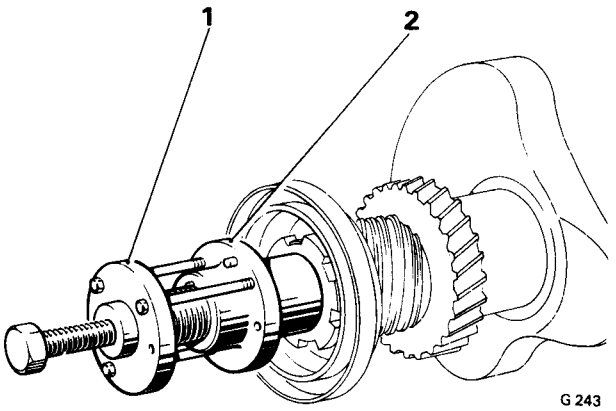

FIG. E53 WITHDRAWING THE CRANKSHAFT FRONT FLANGE

1 Withdrawal tool
2 Driving flange

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2. Ensure that the backlash between the driving gear on the crankshaft and the gear on the pump is correct (*see Section E11 - Dimensional Data: refer to Fig. E55).*

3. When fitting the setscrews securing the pump to the engine, ensure that the dowel inserts are fitted to the holes from which they were removed.

4. The filter delivery pipe is held in position by means of a rubber pad attached to the front cover; ensure that this pad is in position before fitting the cover. Renew the delivery pipe 'O' rings.

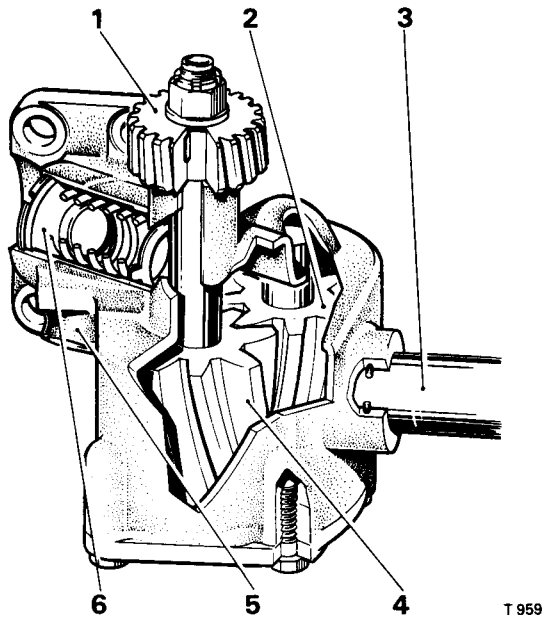

FIG. E54 CUT-AWAY VIEW OF OIL PUMP

1 Crankshaft driven gear
2 Oil pump driven gear
3 Oil filter delivery pipe
4 Oil pump driving gear
5 Relief valve
6 Oil pump body

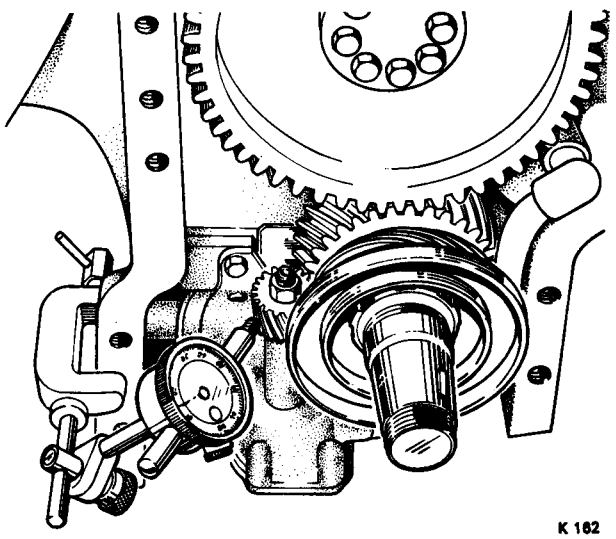

FIG. E55 CHECKING GEARING BACKLASH ON THE OIL PUMP

5. Fit new joints to the lower front cover and the oil pump facing. If the front cover to sump joint is damaged or in a poor condition it will be necessary to remove the sump to enable a new joint to be fitted (*see Section E5 - Connecting rod bearings - To remove, Operations 6 to 11 inclusive).*

6. Set the engine mounting stop plates to a 1,27 mm. (0.050 in.) gap; this procedure is fully described in Section E1 - Engine - To fit.

7. Renew the Neoprene seal between the coolant pump casing and the lower front cover and also the coolant pump 'O' rings.

8. Examine all coolant hoses for deterioration; replace any that are unserviceable.

9. Ensure that the driving belts are adjusted to the correct tension (*see Chapter L*).

10. Replenish the cooling system with the correct anti-freeze mixture.

11. If refrigeration is fitted, charge the system as described in Chapter C - Part 2.

12. Fill the engine with an approved oil to the 'Max.' level mark on the dipstick.

Oil filter element - To renew (see Fig. E56)

The sump should be drained when the oil is warm, preferably after the car has completed a run.

1. Place car on a ramp.

2. Position a container of suitable capacity beneath the sump plug.

3. Drain engine oil into container by unscrewing and removing, the drain plug and aluminium sealing washer.

4. Clean the drain plug, washer and small area of sump around the drain hole.

5. Inspect the condition of the aluminium sealing washer and renew if necessary.

6. Fit the sealing washer and drain plug to the sump and tighten.

7. Position the container beneath the oil filter.

8. Support the filter bowl and unscrew the retaining bolt. Remove the bowl and pour away the old oil.

9. Remove the rubber ring from the filter head.

10. Remove and discard the filter element.

11. Remove the conical cork washer, the spring and the rubber washer from inside the bowl and withdraw the retaining bolt and Dowty seal.

12. Thoroughly wash the bowl in clean paraffin and wipe it dry with a clean cloth ensuring that the rim and the bottom of the bowl are free from any foreign matter.

13. Inspect the Dowty seal, the conical cork washer and the rubber sealing washer for signs of deterioration or damage, and renew them if necessary.

14. Fit a new element, together with the retaining

bolt, sealing washers and spring in the filter bowl.

The element should be installed over the retaining bolt so that the drilled centre piece is to the top and the recessed portion of the lower sleeve seats against the spring loaded cork washer.

15. Ensure that the conical cork sealing washer and cup washer are fitted correctly. Failure to fit either one or both of these washers will allow unfiltered oil to pass up the centre of the filter, and this can result in serious damage to the engine bearings.

16. Pour a quantity of clean oil into the filter bowl and fit the bowl together with a new rubber ring to the filter head.

17. Ensure that the corners of the element are not trapped between the bowl and the head; as a precaution to prevent this, it is permissible to turn the corners over. Check also, that the bowl and the ring are seating correctly. Torque tighten the centre retaining bolt to the figure quoted in Chapter P.

Filter head - To fit

Fit the filter head by reversing the procedure given for removal, noting the following points.

1. Fit a new joint between the head and the crankcase adapter.
2. Tighten the setscrews to the figure quoted in Chapter P.
3. The filter head must be in position before the filter and bowl can be replaced.

Filter head - To remove

1. If it is necessary to remove the filter head from the crankcase adapter, the bowl must first be removed as previously described.
2. Unscrew the two setscrews securing the head to the crankcase adapter, remove the head and discard the joint.
3. Scrape the faces to remove all old joint material.

Oil pressure transmitter (if fitted) - To assemble

To obtain an accurate oil pressure reading, it is essential that the oil pressure transmitter is correctly assembled to the crankcase oil filter adapter.

The transmitter should be fitted so that the raised portion of the cover is towards the top and within 60° either side of the vertical datum.

The correct position of the transmitter can be achieved by fitting an additional copper washer to the threaded union *(see Fig. E9)*.

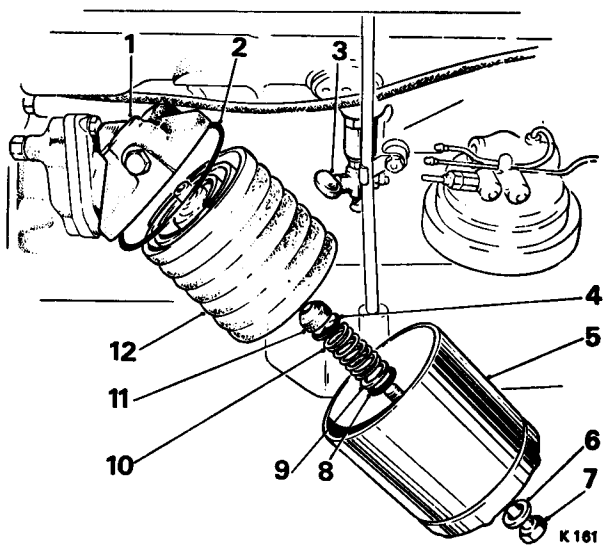

FIG. E56 EXPLODED VIEW OF FILTER ASSEMBLY (Early Cars)

1	Filter head	7	Retaining bolt
2	Rubber sealing ring	8	Rubber washer
3	Coolant drain tap	9	Plain washer
4	Cup washer	10	Spring
5	Filter bowl	11	Cork washer
6	Dowty seal	12	Element

Oil level sender unit - To replace

1. Disconnect the battery.
2. Before removing the unit which is fitted into the side of the sump, drain the sump oil *(see Oil filter element - To renew)*.
3. Disconnect the electrical leads from the unit and remove.
4. Fit a new joint between the sender and the sump face before replacing an existing unit or fitting a new one.
5. Ensure that the spring washers are fitted to the securing setscrews.
6. Fill the sump with approved clean oil to the 'Max.' mark on the dipstick. See Chapter A for capacities.

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Section E11
ENGINE DIMENSIONAL DATA

Description	Dimension	Permissible Worn Dimensions	Remarks
Crankcase and Cylinders			
Cylinder liner bore grading	H. 10,414 cm. to 10,41476 cm. (4·100 in. to 4·1003 in.) J. 10,41502 cm. to 10,41578 cm. (4·1004 in. to 4·1007 in.) K. 10,41603 cm. to 10,41679 cm. (4·1008 in. to 4·1011 in.) L. 10,41705 cm. to 10,41781 cm. (4·1012 in. to 4·1015 in.) M. 10,41806 cm. to 10,41908 cm. (4·1016 in. to 4·102 in.)	0,1016 mm. (0·004 in.) wear	If these measurements are exceeded a new assembly of liner and piston must be fitted
Cylinder liner 'nip'	0,051 mm. to 0,076 mm. (0·002 in. to 0·003 in.)		New liners must be selectively fitted or ground on the end to give this dimension
Pistons			
Piston grading	H. 10,41019 cm. to 10,41095 cm. (4·0985 in. to 4·0988 in.) J. 10,41121 cm. to 10,41197 cm. (4·0989 in. to 4·0992 in.) K. 10,41222 cm. to 10,41298 cm. (4·0993 in. to 4·0996 in.) L. 10,41324 cm. to 10,4140 cm. (4·0997 in. to 4·100 in.) M. 10,41425 cm. to 10,41502 cm. (4·1001 in. to 4·1004 in.)		Piston clearance in the bore 0,0305 mm. to 0,0457 mm. (0 0012 in. to 0 0018 in.) measured 23,012 mm. (0 906 in.) from the bottom of the skirt across the thrust axis
Compression ring groove widths	2,049 mm. to 2,075 mm. (0·0807 in. to 0·0817 in.)		

Description	Dimension	Permissible Worn Dimensions	Remarks
Pistons - continued			
Compression ring widths	1,973 mm. to 1,998 mm. (0·0777 in. to 0·0787 in.)		The rings should be assembled with staggered gaps
Clearance	0,051 mm. to 1,1016 mm. (0·002 in. to 0·004 in.)	0,127 mm. (0·005 in.)	
Compression ring closed	0,38 mm. to 0,051 mm. (0·015 in. to 0·020 in.)	0,64 mm. (0·025 in.)	Engine No. Prefix 'SY'
Compression ring closed	0,33 mm. to 0,64 mm. (0·013 in. to 0·025 in.)		Engine No. Prefix 'SYL'
Open gap, (nominal)	13,21 mm. (0 520 in.)		
Scraper ring groove width	4,521 mm. to 4,547 mm. (0·178 in. to 0·179 in.)	4,597 mm. (0·181 in.)	
Scraper ring width	4,458 mm. to 4,470 mm. (0·1755 in. to 0·1760 in.)		Neglecting spring
Clearance	Nil		Clearance taken up by spring load
Closed gap	0,38 mm. to 0,51 mm. (0·015 in. to 0·020 in.)	0,64 mm. (0.025 in.)	
Open gap, (nominal)	13,21 mm. (0·520 in.)		
Gudgeon Pins			
Bore diameter in piston	2,5397 cm. to 2,5402 cm. (0·9999 in. to 1·0001 in.)		Engine No. Prefix 'SY'
Gudgeon pin diameter	2,5402 cm. to 2,5407 cm. (1·0001 in. to 1·0003 in.)		
Interference in boss	0,0051 mm. (0·0002 in.)		By selective assembly at room temp. 20°C to 22.2°C (68°F to 72°F)
Bore diameter in piston	2,5408 cm. to 2,5413 cm. (1·0003 in. to 1·0005 in.)		Engine No. Prefix 'SYL'
Gudgeon pin diameter	2,5402 cm. to 2,5407 cm. (1·0001 in. to 1·0003 in.)		
Clearance in boss	0,0025 mm. to 0,0076 mm. (0·0001 in. to 0·0003 in.)		

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Description	Dimension	Permissible Worn Dimensions	Remarks
Crankshaft and Connecting Rods			
Connecting rod small-end bush internal diameter	2,5408 cm. to 2,5413 cm. (1·0003 in. to 1·0005 in.)		
Gudgeon pin clearance	0,002 mm. to 0,0068 mm. (0·00008 in. to 0·00027 in.)	0,0127 mm. (0·0005 in.)	At room temp. 20° C to 22.2° C (68° F to 72° F)
Big-end bearing housing, internal diameter	6,0833 cm. to 6,0846 cm. (2·395 in. to 2·3955 in.)		This diameter should be checked with the big-end bolts in position and the nuts torque tightened to 4,147 kgf.m. (30 lbf.ft.)
Big-end bearing shell, internal diameter	5,71627 cm. to 5,71881 cm. (2·2505 in. to 2·2515 in.)		
Crankpin diameter	5,71119 cm. to 5,71246 cm. (2·2485 in. to 2·249 in.)	5,70865 cm. (2·2475 in.)	
Clearance	0,0381 mm. to 0,0762 mm. (0·0015 in. to 0·003 in.)	0,1016 mm. (0·004 in.)	Clearance measured vertically. Renew bearings if lead plating is worn through
Small-end bush housing, internal diameter	2,8956 cm. to 2,89687 cm. (1·140 in. to 1·1405 in.)		
Small-end bush external diameter	2,902 cm. to 2,9058 cm. (1·1425 in. to 1·144 in.)		Handpush fit in ring gauge.
Interference	0,051 mm. to 0,1016 mm. (0·002 in. to 0·004 in.)		
Connecting rod and cap bolt holes diameter for location	9,525 mm. to 9,538 mm. (0·375 in. to 0·3755 in.)		On location diameter
Connecting rod bolt diameter for location	9,512 mm. to 9,525 mm. (0·3745 in. to 0·375 in.)		On location diameter
Clearance	Size to 0,0254 mm. (0·001 in.)		
Connecting rod bolt			
Interference on knurled diameter	0,081 mm. to 0,183 mm. (0·0032 in. to 0·0072 in.)		Bolts should not be removed from rods unless they are to be renewed
Theoretical nip on connecting rod bearing shells	0,076 mm. to 0,203 mm. (0·003 in. to 0·008 in.)		Controlled by clearance between rods and crankpin end faces
Connecting rod end - float	0,203 mm. to 0,432 mm. (0·008 in. to 0·017 in.)		

Description	Dimension	Permissible Worn Dimensions	Remarks
Crankshaft and Connecting Rods - continued			
Main bearing shell internal diameter: Theoretical	6,3525 cm. to 6,3551 cm. (2·501 in. to 2·502 in.)		
Crankshaft journal diameter	6,3487 cm. to 6,35 cm. (2·4995 in. to 2·500 in.)	6,3462 cm. (2·4985 in.)	
Diametral clearance	0,025 mm. to 0,063 mm. (0·001 in. to 0·0025 in.)	0,0889 mm. (0·0035 in.)	Renew bearings if lead plating is worn through
Crankshaft end - float	0,1016 mm. to 0,25 mm. (0·004 in. to 0·010 in.)	0,31 mm. (0·012 in.)	
Connecting rod bolt stretch	From 0,152 mm. to 0,203 mm. (0·006 in. to 0·008 in.) bolt stretch Torque load - 4,84 kgf.m. to 5,53 kgf.m. (35 lbf.ft. to 40 lbf.ft.)		

Crankshaft Size	Crankshaft Journal	Main Shell Bearing
Crankcase grinding dimensions		
Standard	6,35 cm. −0,0127 mm. (2·500 in. −0·0005 in.)	6,35254 cm. + 0,0254 mm. (2·501 in. + 0·001 in.)
0,254 mm. undersize	6,3246 cm. − 0,0127 mm.	6,32714 cm. + 0,0254 mm.
(0 010 in. undersize)	(2·490 in. − 0·0005 in.)	(2·491 in. + 0·001 in.)
0,508 mm. undersize	6,299 cm. − 0,0127 mm.	6,30174 cm. + 0,0254 mm.
(0 020 in. undersize)	(2·480 in. − 0·0005 in.)	(2·481 in. + 0·001 in.)

Crankshaft Size	Crankpin	Big-end Bearing
Standard	5,7125 cm. − 0,0127 mm. (2·249 in. − 0·0005 in.)	5,7163 cm. + 0,0254 mm. (2·2505 in. + 0·001 in.)
0,254 mm. undersize	5,6871 cm. − 0,0127 mm.	5,6909 cm. + 0,0254 mm.
(0 010 in. undersize)	(2·239 in. − 0·0005 in.)	(2·2405 in. + 0·001 in.)
0,508 mm. undersize	5,6617 cm. − 0,0127 mm.	5,6655 cm. + 0,0254 mm.
(0 020 in. undersize)	(2·229 in. − 0·0005 in.)	(2·2305 in. + 0·001 in.)

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Description	Dimension	Permissible Worn Dimensions	Remarks
Main Bearing Housings			
Bore diameter	6,7704 cm. to 6,77164 cm. (2·6655 in. to 2·6660 in.)		This diameter should be checked with the main bearing cap nuts in position and torque loaded to 4,839 kgf.m. (35 lbf.ft.)
Main Bearing Cap			
Width of cap	12,955 cm. to 12,957 cm. (5·1005 in. to 5·1010 in.)		
Crankcase location gap	12,954 cm. to 12,957 cm. (5·1000 in. to 5·1010 in.)		
Fit - Interference	0,0254 mm. (0·001 in.)		
Clearance	0,0127 mm. (0·0005 in.)		
Valve Gear			
Camshaft timing gear backlash	0,0254 mm. to 0,1143 mm. (0·001 in. to 0·0045 in.)	0,152 mm. (0·006 in.)	
Camshaft gear face run-out	0,000 mm. to 0,051 mm. (0·000 in. to 0·002 in.)		
Camshaft end - float	0,051 mm. to 0,152 mm. (0·002 in. to 0·006 in.)		
Camshaft journal diameter	5,0737 cm. to 5,0749 cm. (1·9975 in. to 1·998 in.)	5,07111 cm. (1·9965 in.)	
Camshaft bearing, internal diameter	5,08 cm. to 5,0813 cm. (2·000 in. to 2·0005 in.)	5,0851 cm. (2·002 in.)	
Camshaft journal clearance	0,0508 mm. to 0,0762 mm. (0·002 in. to 0·003 in.)	0,1016 mm. (0·004 in.)	
Inlet cam and base circle - overall dimension	3,727 cm. to 3,739 cm. (1·467 in. to 1·472 in.)	3,701 cm. (1·457 in.)	Max. cam lift is 6,44 mm. (0·25355 in.). Minimum permissible lift is 5,969 mm. (0·235 in.)
Exhaust cam and base circle - overall dimension	3,727 cm. to 3,739 cm. (1·467 in. to 1·472 in.)	3,701 cm. (1·457 in.)	Max. cam lift is 6,44 mm. (0·25355 in.). Minimum permissible lift is 5,969 mm. (0·235 in.)
Tappet block bore diameter			
Colour code white (grade Y)	22,981 mm. to 22,987 mm. (0·90475 in. to 0·9050 in.)		Groove(s) etched onto the top face of tappet barrel. Tappets marked with one groove should be used with tappet block bores colour coded white and tappets marked with two grooves should be used with tappet block bores colour coded red
Colour code red (grade Z)	22,987 mm. to 22,993 mm. (0·9050 in. to 0·90525 in.)		
Tappet external diameter			
One groove	22,962 mm. to 22,968 mm. (0·9040 in. to 0·90425 in.)		

Description	Dimension	Permissible Worn Dimensions	Remarks
Valve Gear - continued			
Two grooves	22,968 mm. to 22,974 mm. (0·90425 in. to 0·9045 in.)		
Clearance	0,0127 mm. to 0,0254 mm. (0·0005 in. to 0·001 in.)	0,0381 mm. (0·0015 in.)	
Exhaust valve guide - external diameter	15,9385 mm. to 15,9512 mm. (0·6275 in. to 0·628 in.)		
Cylinder head bore diameter for exhaust valve guide	15,875 mm. to 15,9004 mm. (0·625 in. to 0·626 in.)		
Interference in head	0,0381 mm. to 0,0762 mm. (0·0015 in. to 0·003 in.)		
Exhaust valve guide - internal diameter	9,525 mm. to 9,54 mm. (0·375 in. to 0·3755 in.)	9,588 mm. (0·3775 in.)	'Bellmouth' at the lower end is permissible up to 0,1524 mm. (0 006 in.) for a depth of 9,4615 mm. (0·3725 in.)
Exhaust valve stem diameter	9,492 mm. to 9,499 mm. (0·37375 in. to 0·374 in.)	9,468 mm. (0·37275 in.)	
Clearance	0,025 mm. to 0,044 mm. (0·001 in. to 0·00175 in.)	0,089 mm. (0·0035 in.)	
Exhaust valve spring compressed to 4,064 cm. (1 600 in.)	37,195 kg. to 39,009 kg. (82 lb. to 86 lb.)	32,205 kg. (71 lb.)	Engine No. Prefix 'SY'
Exhaust valve spring compressed to 4,470 cm. (1 725 in.)	39,009 kg. to 40,823 kg. (86 lb. to 90 lb.)	36,287 kg. (80 lb.)	Engine No. Prefix 'SYL'
Exhaust and inlet valve seat angle	45°		'Crown' with 30°cutter to avoid pocketing after re-grinding seat
Exhaust valve seat insert - external diameter	4,4552 cm. to 4,4564 cm. (1·7540 in. to 1·7545 in.)		Standard size
Cylinder head bore diameter for exhaust seat insert	4,445 cm. to 4,4475 cm. (1·750 in. to 1·751 in.)		
Interference	0,0762 mm. to 0,1143 mm. (0·003 in. to 0·0045 in.)		
Inlet valve seat insert - external diameter	5,1536 cm. to 5,1549 cm. (2·0290 in. to 2·0295 in.)		Standard size

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Description	Dimension	Permissible Worn Dimensions	Remarks
Valve Gear continued			
Cylinder head bore diameter for inlet seat insert	5,1435 cm. to 5,1460 cm. (2·025 in. to 2·026 in.)		
Interference	0,0762 mm. to 0,1143 mm. (0·003 in. to 0·0045 in.)		
Inlet valve guide - external diameter	15,9385 mm. to 15,9512 mm. (0·6275 in. to 0·628 in.)		
Cylinder head bore diameter for inlet valve guide	15,875 mm. to 15,90 mm. (0·625 in. to 0·626 in.)		
Interference in head	0,0381 mm. to 0,0762 mm. (0·0015 in. to 0·003 in.)		
Inlet valve guide - internal diameter	9,525 mm. to 9,54 mm. (0·375 in. to 0·3755 in.)	9,588 mm. (0·3775 in.)	
Inlet valve stem diameter	9,492 mm. to 9,499 mm. (0·37375 in. to 0·374 in.)	9,468 mm. (0·37275 in.)	
Clearance	0,025 mm. to 0,044 mm. (0·001 in. to 0·00175 in.)	0,089 mm. (0·0035 in.)	
Inlet valve spring compressed to 4,064 cm. (1 600 in.)	37,195 kg. to 39,009 kg. (82 lb. to 86 lb.)	32,205 kg. (71 lb.)	
Exhaust valve - overall length	12,42 cm. (4·891 in.)		
Inlet valve - overall length	12,509 cm. (4·925 in.)		
Distributor gear backlash	0,0254 mm. to 0,1524 mm. (0·001 in. to 0·006 in.)	0,2286 mm. (0·009 in.)	
Rocker bore diameter	19,031 mm. to 19,044 mm. (0·74925 in. to 0·74975 in.)	19,075 mm. (0·751 in.)	
Rocker shaft diameter	19,006 mm. to 19,012 mm. (0·74825 in. to 0·7485 in.)		
Clearance	0,0191 mm. to 0,0331 mm. (0·00075 in. to 0·0015 in.)	0,089 mm. (0·0035 in.)	
Hydraulic brake pump push rod lift	13,26 mm. to 13,33 mm. (0·522 in. to 0·525 in.)		This measurement is taken from the top face of the mounting flange to the top of the push rod (see Fig. E40)

Description	Dimension	Permissible Worn Dimensions	Remarks
Oil Pump			
Driving shaft diameter	12,675 mm. to 12,687 mm. (0·4990 in. to 0·4995 in.)	12,624 mm. (0·4970 in.)	
Shaft bore diameter	12,70 mm. to 12,713 mm. (0·500 in. to 0·5005 in.)		
Shaft clearance in casing bore	0,0127 mm. to 0,038 mm. (0·0005 in. to 0·0015 in.)	0,0762 mm.	
Stationary spindle diameter	12,675 mm. to 12,687 mm. (0·499 in. to 0·4995 in.)	12,637 mm. (0·4975 in.)	
Driven gear internal diameter	12,70 mm. to 12,713 mm. (0·500 in. to 0·5005 in.)	12,738 mm. (0·5015 in.)	
Clearance on spindle	0,0127 mm. to 0,038 mm. (0·0005 in. to 0·0015 in.)	0,076 mm. (0·003 in.)	Permissible only when the radial clearance of the gears in the case exceeds this figure
Diametrical clearance between gears and side of chamber	0,0508 mm. to 0,089 mm. (0·002 in. to 0·0035 in.)	0,152 mm. (0·006 in.)	
Pump gears - backlash	0,0762 mm. to 0,1778 mm. (0·003 in. to 0·007 in.)	0,2159 mm.	
Pump gears - end float	0,0254 mm. to 0,1016 mm. (0·001 in. to 0·004 in.)	0,127 mm. (0·005 in.)	
Drive gear backlash	0,0254 mm. to 0,1524 mm. (0·001 in. to 0·006 in.)	0,305 mm. (0·012 in.)	
Cylinder Head Studs			
Stud diameter	Yellow 10,287 mm. to 10,262 mm. (0·405 in. to 0·404 in.) Red 10,262 mm. to 10,236 mm. (0·404 in. to 0·403 in.) Blue 10,236 mm. to 10,208 mm. (0·403 in. to 0·4019 in.)		Studs must be matched to hole, colour for colour
Threaded hole diameter	Yellow 10,262 mm. to 10,236 mm. (0·404 in. to 0·403 in.) Red 10,236 mm. to 10,211 mm. (0·403 in. to 0·402 in.) Blue 10,211 mm. to 10,185 mm. (0·402 in. to 0·401 in.)		
Interference	0,000 mm. to 0,0508 mm. (0·000 in. to 0·002 in.)		

Description	Dimension	Permissible Worn Dimensions	Remarks
Main Bearing Housing Studs			
Stud diameter	Yellow 11,874 mm. to 11,849 mm. (0·4675 in. to 0·4665 in.) Red 11,849 mm. to 11,824 mm. (0·4665 in. to 0·4655 in.) Blue 11,824 mm. to 11,793 mm. (0·4655 in. to 0·4643 in.)		Studs must be matched to hole, colour for colour
Threaded hole diameter	Yellow 11,849 mm. to 11,824 mm. (0·4665 in. to 0·4655 in.) Red 11,824 mm. to 11,798 mm. (0·4655 in. to 0·4645 in.) Blue 11,798 mm. to 11,758 mm. (0·4645 in. to 0·4635 in.)		
Interference	0,000 mm. to 0,0508 mm. (0·000 in. to 0·002 in.)		

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Section E12

FAULT DIAGNOSIS

(For cars fitted with Exhaust Emission Control and Evaporative Emission Control Systems, see also Chapter U)

Symptom	Possible Cause	Action
1 Engine fails to start; starter motor inoperative	1(a) Gearchange selector out of neutral position or neutral or park position on cars fitted with torque converter transmission	1(a) Move gear lever into neutral position or neutral or park position on cars fitted with the torque converter transmission
	(b) Parking lamp switch in park position (early cars only)	(b) Return switch to central position
	(c) Ignition fuse blown	(c) Fit new fuse (see Chapter M)
	(d) Battery discharged	(d) Charge battery and check specific gravity (see Chapter M)
	(e) Break or high resistance in battery connections and starter relay connections	(e) Clean all terminals and repair any broken connections (see Chapter M)
	(f) Auxiliary starter relay faulty	(f) Fit new relay (see Chapter M)
	(g) Starter motor commutator or brushes in poor condition	(g) Clean or machine commutator as necessary and renew brushes (see Chapter M). If the overall condition of the starter motor is poor, a new or re-conditioned starter motor should be fitted
	(h) Defective starter motor	(h) Remove and examine the starter motor (see Chapter M)
2 Engine fails to start; starter motor operates but fails to turn engine	2(a) Discharged battery	2(a) Check voltage supply across terminals with battery under equivalent starter motor load (see Chapter M)
	(b) Fault in starter circuit	(b) Examine starter circuit connections and starter switch (see Chapter M)

Symptom	Possible Cause	Action
	(c) Defective starter motor	(c) Remove and examine the starter motor (see Chapter M)
	(d) Starter motor spinning but not engaging	(d) Check solenoid for correct operation (see Chapter M)
3 Engine fails to fire	3(a) No fuel at carburetters	3(a) Check fuel level in fuel tank. Check operation of fuel pumps and examine fuel pipes for blockage or excessive leakage (see Chapter K)
	(b) Defective ignition	(b) Examine leads and connections to ignition switch, battery, coil, distributor contact breaker gap. (if fitted) Check operation and condition of contact breaker points (burnt points may indicate a faulty condenser). Test condenser and coil. Examine distributor cap for tracking. Remove, clean and adjust sparking plugs. Check ignition timing (see Chapter M)
	(c) Excess fuel in combustion chamber	(c) Remove, clean and dry sparking plugs. Turn engine with sparking plugs removed, to blow out excess fuel. Check carburetters and controls for correct operation (see Chapter K)
	(d) Incorrect metering of fuel by carburetters	(d) Check level of floats. Examine jets for blockage. Examine needles for distortion. Examine filters in the float chamber caps. Examine float chamber needles for freedom of movement and wear. Examine jets for wear and correct settings. Refer to Chapter K
4 Engine fails to fire (hot engine only)	4(a) Incorrect choke operation	4(a) Ensure that the choke is not on the fast-idle step of the cam (trigger choke by depressing accelerator pedal with engine stationary). Examine the choke controls for freedom of movement. Examine the bi-metal coils to ensure that they are correctly operating the choke (see Chapter K)

Symptom	Possible Cause	Action
5 Poor engine idling	5(a) Throttle butterfly valves not synchronised	5(a) Correctly adjust throttle butterfly valves (see Chapter K)
	(b) Incorrect mixture	(b) Tune the carburetters (see Chapter K)
	(c) Sticking carburetter piston caused by a bent damper rod	(c) Carry out the check given in Chapter K
	(d) Incorrect ignition timing	(d) Check the ignition timing and correct if necessary (see Chapter M)
	(e) Air leaks in induction system	(e) Examine the induction manifold joints, carburetter joints and manifold vacuum connections (see Chapter K and Section E4)
6 Incorrect engine idle speed	6(a) Carburetters incorrectly set	6(a) Tune carburetters (see Chapter K)
	(b) Choke controls incorrectly adjusted or sticking	(b) Ensure correct operation and freedom of movement of choke controls (see Chapter K)
7 Poor engine idling (black smoke from exhaust)	7(a) Flooding of the float chamber or the jet	7(a) Examine floats and needle valves in the float chambers. Check the float height (see Chapter K)
8 Irregular running; engine misfiring	8(a) Dirty or defective sparking plugs	8(a) Clean and examine sparking plugs. Examine insulators. Check gaps. Renew plugs if necessary (see Chapter M)
	(b) Defective ignition circuit	(b) Examine all leads for security. Examine the L.T. and earth leads in the distributor for damage to the braiding. Ensure that the wires are not trapped by the distributor cap. Examine the contact breaker spring connections and the lubricating pad spring connection for security (if fitted). Examine the rotor for signs of tracking. Check the contact breaker gap. Examine the condition of the points. Check the operation of the coil. Check the carbon brush for freedom of movement in the distributor cap (see Chapter M)

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Symptom	Possible Cause	Action
	(c) Air leaks in induction system	(c) Examine the induction manifold joints, carburetter joints and manifold vacuum connections (see Chapter K and Section E4)
	(d) Valves not seating correctly	(d) Examine the valves for freedom of movement, also examine valve seats and valve springs
	(e) Defective cylinder head gasket(s)	(e) Remove the cylinder head(s) and examine the gasket(s). Refer to Section E4
9 Loss of power	9(a) Dirty or defective sparking plugs	9(a) Clean and examine the sparking plugs. Check the gaps. Renew the sparking plugs if necessary (see Chapter M)
	(b) Defective ignition circuit	(b) Examine all electrical leads in circuit. Check operation and condition of distributor points and ignition timing
	(c) Air leaks in induction system	(c) Examine induction manifold joints, carburetter joints and manifold vacuum connections (see Chapter K and Section E4)
	(d) Blocked air cleaner	(d) Clean or renew air filter element (see Chapter K)
	(e) Faulty carburetter, insufficient fuel supply or sticking carburetter air valve piston	(e) Examine jets and filters for foreign matter. Examine float chamber needle valves. Check operation of fuel pumps. Examine fuel pipes for leakage or obstruction. Examine air valves pistons and dampers (see Chapter K)
	(f) Throttle linkage incorrectly adjusted or sticking	(f) Correctly adjust the throttle linkage (see Chapter K)
	(g) Worn or burnt valves. Broken or weak valve springs	(g) Examine the condition of the valves and springs (see Section E4)
	(h) Defective cylinder head gasket(s)	(h) Examine the condition of the gasket(s). Refer to Section E4

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Symptom	Possible Cause	Action
10 Engine spits back through carburetters	10(a) Insufficient fuel supply or weak mixture	10(a) Examine jets and filters for foreign matter. Examine the float chamber needle valves. Check the operation of the fuel pumps. Examine the fuel pipes for leakage or obstruction (see Chapter K)
	(b) Inlet valve not seating	(b) Examine the valves for correct operation (see Section E4)
	(c) Detonation or incorrect timing	(c) Ensure that the fuel grade is correct. Check that the distributor octane selector setting is correct (if fitted). Check for correct advance and retard operation. Examine the condition and setting of the distributor points (if fitted). Examine the condition of the sparking plugs (see Chapter M)
	(d) Heavily carboned engine	(d) Decarbonise engine (see Section E9)
11 Detonations in silencer	11(a) Incorrect mixture	11(a) Examine the carburetter jets, filters, floats, float chamber needles and adjust mixture (see Chapter K)
	(b) Incorrect ignition timing or intermittent 'short' in ignition circuit	(b) Check the distributor for correct ignition timing, and correct contact breaker gaps. Examine connections for security and leads for damage to the braiding (see Chapter M)
	(c) Exhaust valves sticking	(c) Examine exhaust valves for freedom of movement (see Section E2)
12 Overheating	12(a) Loss of coolant	12(a) Check level of coolant in header tank. Examine the coolant system for leaks
	(b) Faulty thermostat	(b) Check the thermostat for correct operation (see Chapter L)
	(c) Broken or slipping fan belts	(c) Examine the condition of the fan belts. Renew or adjust (see Chapter L)

Symptom	Possible Cause	Action
Overheating (continued)	(d) Faulty coolant pump	(d) Drain the coolant system then remove and check the operation of the pump (see Chapter L)
	(e) Faulty cylinder head gasket or gasket fitted incorrectly	(e) Examine the cylinder head gasket(s). Check the torque tightness of the cylinder head securing nuts (see Chapter P)
	(f) Weak/fuel/air mixture	(f) Examine jets, filters, floats and needle valves (see Chapter K)
	(g) Inadequate lubrication	(g) Check the level of oil in the sump. Examine the oil filter element. Check operation of the relief valve
	(h) Incorrect ignition timing	(h) Check the ignition timing and for correct operation of the advance and retard mechanism (see Chapter M)
	(i) Blocked coolant system	(i) Drain and reverse flush coolant system. Examine matrix face for flies, leaves, paper etc., which would restrict air flow (see Chapter L)
13 Low oil pressure	13(a) Inadequate oil supply	13(a) Check level of oil in sump. Examine oil pipes, joints, seals and connections for leaks
	(b) Engine overheating	(b) See 'Overheating'
	(c) Defective oil pressure relief valve	(c) Examine and clean relief valve (see Section E10)
	(d) Defective oil pressure transmitter	(d) Check transmitter (see Section E10)
	(e) Defective oil pressure gauge	(e) Fit new oil pressure gauge (see Chapter M)
	(f) Blocked oil filter	(f) Change filter
14 Excessive fuel consumption	14(a) Fuel leakage	14(a) Examine all fuel connections for leaks
	(b) Incorrect choke operation	(b) Correctly adjust choke controls and check for freedom of operation (see Chapter K)

Symptom	Possible Cause	Action
Excessive fuel consumption (continued)	(c) Worn or maladjusted carburetters Piston air valve damper sticking	(c) Examine the carburetter for excessive wear. Check for correct adjustment (see Chapter K)
	(d) Blocked air cleaner	(d) Clean or renew air filter element (see Chapter K)
	(e) Incorrect ignition timing	(e) Check the distributor for correct ignition timing and correct contact breaker gaps (see Chapter M)
	(f) Loss of compression	(f) Examine valves, valve spring and piston rings (see Sections E2 and E5)
	(g) Decarbonize engine (see Section E9)	(g) Heavily carboned engine

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Section E13
WORKSHOP TOOLS

Tool Number	*Description*
RH 2684	Wing Cover Set
RH 2685	Wing Cover Liners
RH 7094	Valve Spring Compressor
RH 7095	Extraction Tool - Cylinder Liner
RH 7097	Withdrawal Tool - Front Pulley Driving Flange
RH 7110	Serrated Nut (small) Spanner - Crankshaft
RH 7126	Box Spanner - Cylinder Head Nuts
RH 7131	Serrated Nut (large) Spanner - Crankshaft
RH 7200	Base - Valve Spring Compressor
RH 7207	Extraction and Insertion Tool - Inlet and Exhaust Valve Guides
RH 7208	Extractor - Main Bearing Caps
RH 7498	Attachment - Extractor - Main Bearing Caps
RH 7272	Guide Block
RH 7825	Reamer - Inlet and Exhaust Valve Guides
RH 7827	Reamer - (tipped) - Inlet and Exhaust Valve Guides
RH 7856	Serrated Nut Spanner - Hydraulic Brake Pumps