

V8 CYLINDER ENGINE

The following V8 Engine overhaul is applicable to all Range Rovers.

Before removing the fuel injection engine from the vehicle, the following equipment and bracketry must be disconnected or removed.

Air conditioning compressor (if fitted, do not evacuate or disconnect any hoses. Release the compressor from its mounting and lay to one side)

Alternator

Radiator

Power steering pump (disconnect pipes and hoses)

Fan blades

Automatic transmission fluid pipes (from side of block)

Any electrical wiring or harnesses

For the removal procedure of the following items see the 'Fuel Injection' section of manual.

Air cleaner

Air flow meter

Throttle lever bracketry

Plenum chamber

Ram housing

Any electrical wiring or harnesses

DISMANTLE AND OVERHAUL

Remove the engine from the vehicle and clean the exterior. In the interests of safety and efficient working secure the engine to a recognised engine stand. Drain and discard the sump oil.

Special tools:

RO605351—Guide bolts

18G 537—Torque wrench

18G 79—Clutch centralising tool

18G 1150—Gudgeon pin remover/replacer—Basic tool

18G 1150E—Adaptor remover/replacer—gudgeon pin.

18G106A—Spring compressor

600959—Valve guide drift exhaust

MS76—Valve cutter handle set

MS150—8.5 Adjustable pilot

MS621—Valve seat cutter

RO605774—Distance piece for valve guide

RO274401—Drift for guide removal—inlet and exhaust

RO1014—Camshaft rear seal sleeve

REMOVE ANCILLARY EQUIPMENT

Before commencing, and whilst dismantling, make a careful note of the position of brackets, clips, harnesses, pipes, hoses, filters and other miscellaneous and non-standard items to facilitate reassembly.

1. Remove the following items of equipment:

Starter motor.

Alternator and mounting bracket.

Power steering pump.

Disconnect spark plug H.T. leads and remove the distributor.

Clutch.

Fan blades, pulley and drive belt.

Remove pulse air rails from cylinder heads.

Dipstick and engine mounting brackets.

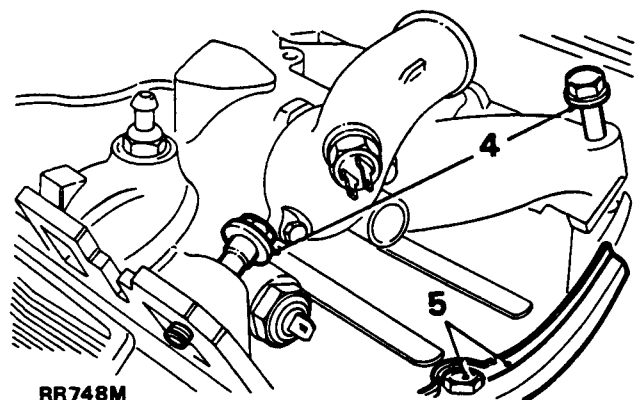
Remove exhaust manifolds

2. Bend back the lock tabs, and remove the eight bolts securing each manifold, and withdraw the manifolds.

Remove intake manifold—Carburettor versions only

NOTE: The removal procedure for the intake manifold on fuel injection models is incorporated in the 'Fuel Injection' section of the manual.

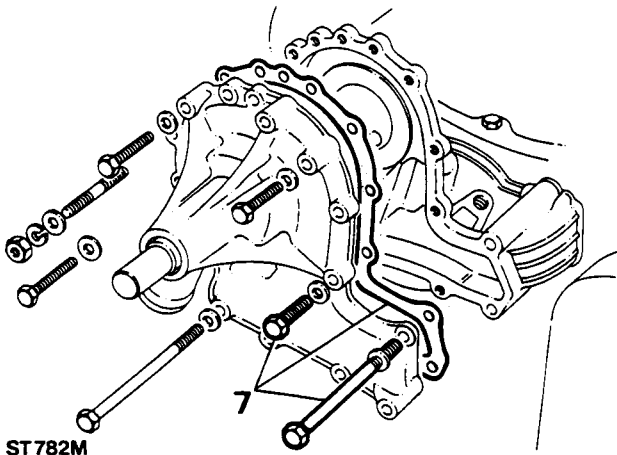
3. Disconnect miscellaneous pipes and hoses from the intake manifold and the carburetters.
4. Evenly slacken and remove the twelve bolts and lift off the intake manifold complete with carburetters.
5. Wipe away any surplus coolant lying on the manifold gasket and remove the gasket clamp bolts and remove the clamps.
6. Lift off the manifold gasket and seals.



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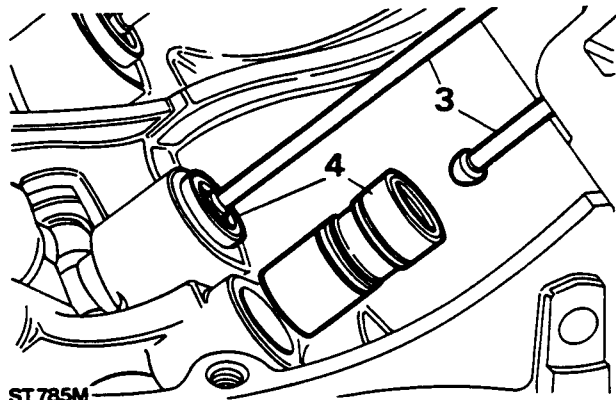
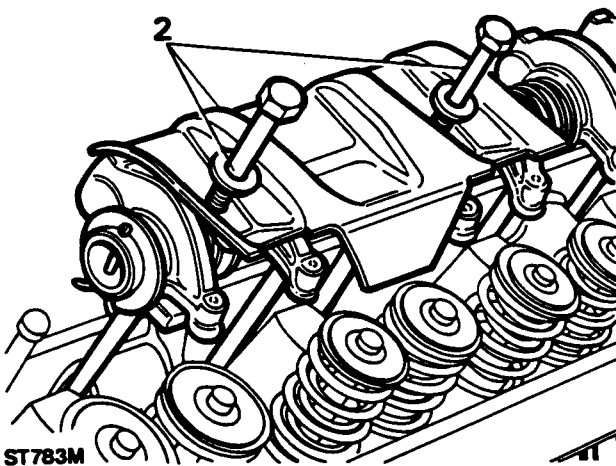
Remove water pump

7. Remove the fifteen bolts and withdraw the water pump and joint washer.



REMOVE AND OVERHAUL ROCKER SHAFTS AND VALVE GEAR

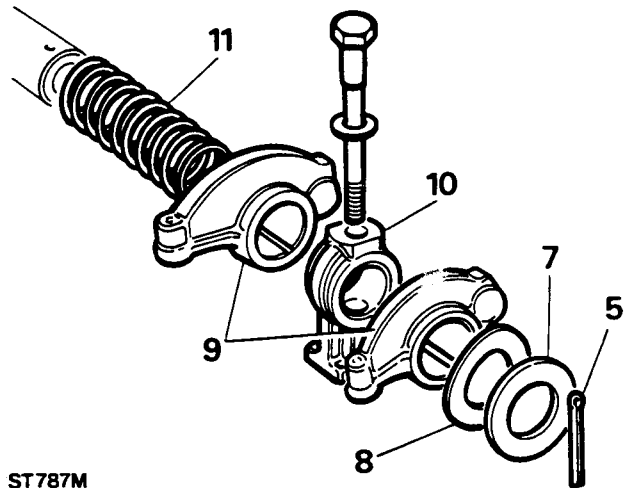
1. Remove the four screws and lift off the rocker covers.
2. Remove the four rocker shaft retaining bolts and lift off the assembly complete with baffle plate.



3. Withdraw the pushrods and retain in the sequence removed.
4. Remove the hydraulic tappets and place to one side with their respective pushrods. If a tappet cannot be removed leave in position until the camshaft is removed.

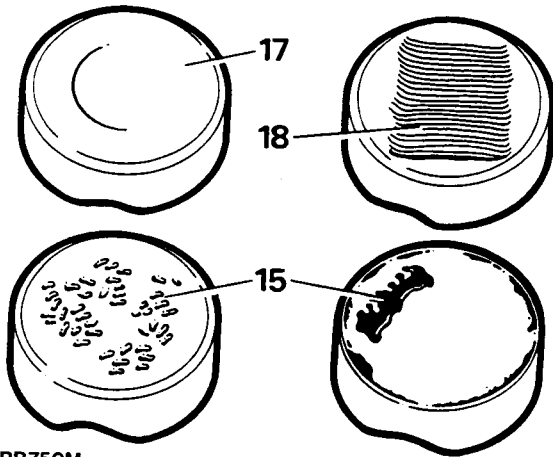
Dismantle rocker shafts

5. Remove the split pin from one end of the rocker shaft.
6. Withdraw the following components and retain them in the correct sequence for reassembly:
 7. A plain washer.
 8. A wave washer.
 9. Rocker arms.
 10. Brackets.
 11. Springs.
12. Examine each component for wear, in particular the rockers and shafts. Discard weak or broken springs.



Inspect tappets and pushrods

13. Hydraulic tappet: inspect inner and outer surfaces of body for blow holes and scoring. Replace hydraulic tappet if body is roughly scored or grooved, or has a blow hole extending through the wall in a position to permit oil leakage from lower chamber.
14. The prominent wear pattern just above lower end of body should not be considered a defect unless it is definitely grooved or scored. It is caused by side thrust of the cam against the body while the tappet is moving vertically in its guide.
15. Inspect the cam contact surface of the tappets. Fit new tappets if the surface is excessively worn or damaged.
16. A hydraulic tappet body that has been rotating will have a round wear pattern and a non-rotating tappet body will have a square wear pattern with a very slight depression near the centre.
17. Tappets **MUST** rotate and a circular wear condition is normal. Tappets with this wear pattern can be refitted provided there are no other defects.
18. In the case of a non-rotating tappet, fit a new replacement and check camshaft lobes for wear; also ensure the new tappet rotates freely in the cylinder block.



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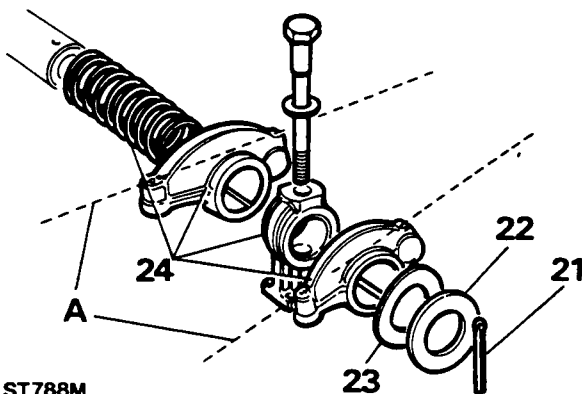
19. Fit a new hydraulic tappet if the area where the pushrod contacts is rough or otherwise damaged.
20. Renew any pushrod having a rough or damaged ball end or seat. Also bent rods must be renewed.

Assemble rocker shafts

21. Fit a split pin to one end of the rocker shaft.
22. Slide a plain washer over the long end of the shaft to abut the split pin.
23. Fit a wave washer to abut the plain washer.

NOTE: Two different rocker arms are used and must be fitted so that the valve ends of the arms slope away from the brackets, as indicated by the dotted lines 'A' on the illustration.

24. Assemble the rocker arms, brackets and springs to the rocker shaft.

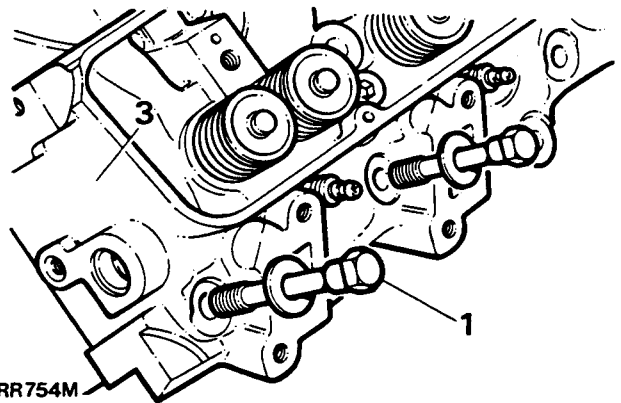


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25. Compress the springs, brackets and rockers, and fit a wave washer, plain washer and split pin to the end of the rocker shaft.
26. Locate the oil baffle plate in place over the rockers furthest from the notched end of the rocker shaft and fit the bolts through the brackets and place the assemblies to one side.

REMOVE AND OVERHAUL THE CYLINDER HEADS

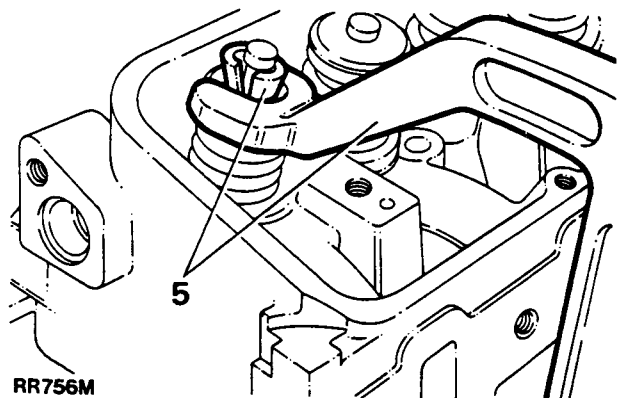
1. Evenly slacken the fourteen cylinder head bolts reversing the tightening order.
2. Before removing the heads mark them relative to the LH and RH side of the engine.
3. Lift off the cylinder heads and discard the gasket.



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Dismantle cylinder heads

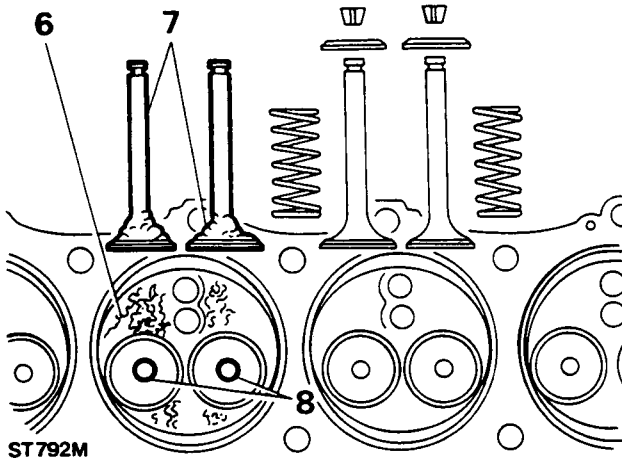
4. Remove the spark plugs.
5. Using the valve spring compressor 18G 106A or a suitable alternative, remove the valves and springs and retain in sequence for refitting.



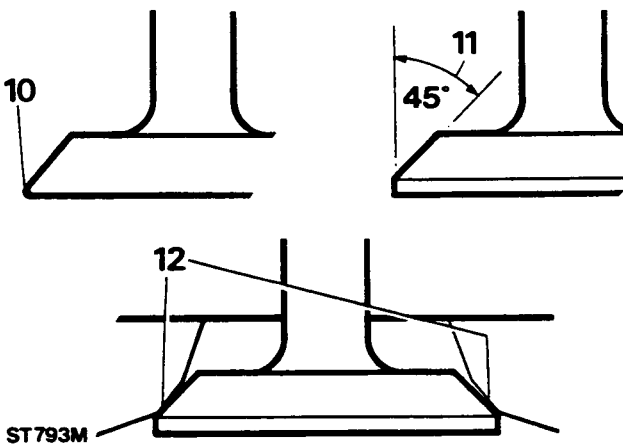
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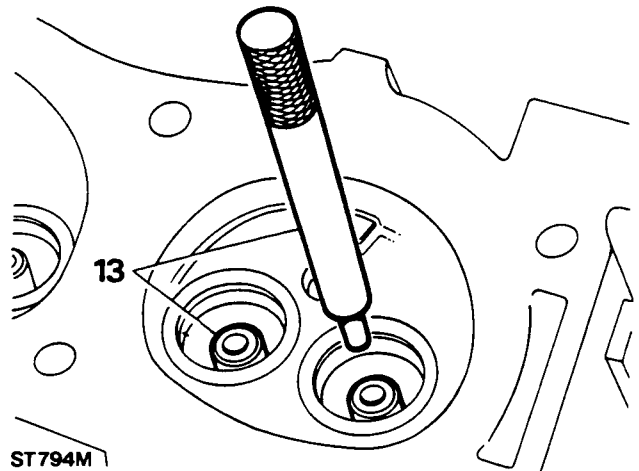
6. Clean the combustion chambers with a soft wire brush.
7. Clean the valves.
8. Clean the valve guide bores.



9. Regrind or fit new valves as necessary.
10. If a valve must be ground to a knife-edge to obtain a true seat, fit a new valve.
11. The correct angle for the valve face is 45 degrees.
12. The correct angle for the seat is $46 \pm \frac{1}{4}$ degrees and the seat witness should be towards the outer edge.



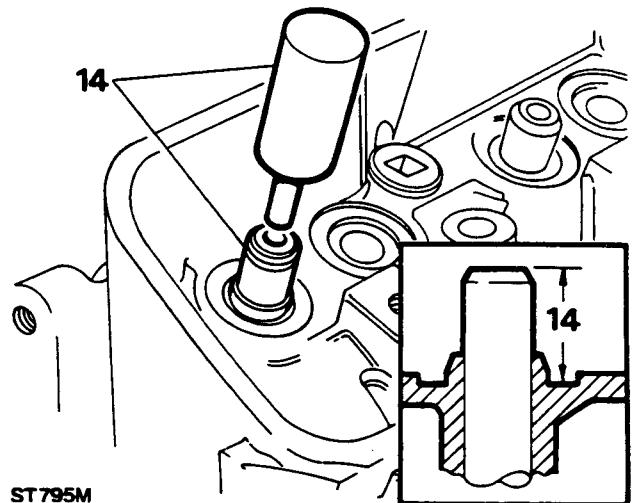
13. Check the valve guides and fit replacements as necessary. Using the valve guide remover 274401, drive out the old guides from the combustion chamber side.



Fit new valve guides

14. Lubricate the new valve guide and place in position. Using guide drift 600959 drive the guide into the cylinder head until it protrudes 19 mm ($\frac{3}{4}$ in) above the valve spring recess in the head.

NOTE: Service valve guides are 0.02 mm (0.001 in) larger on the outside diameter than the original equipment to ensure interference fit.



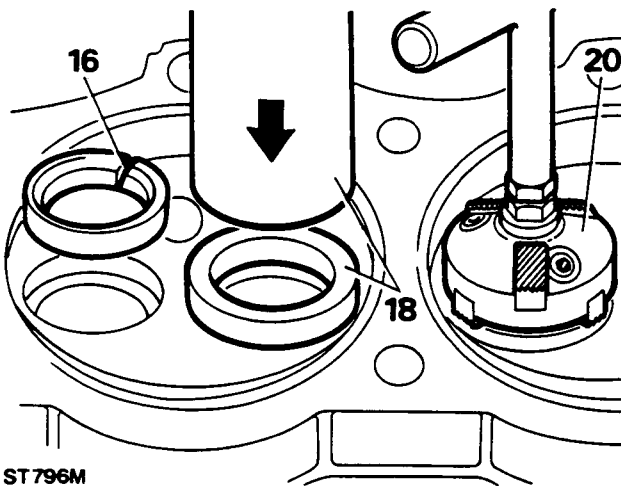
Examine and fit new valve seats

15. Check the valve seats for wear, pits and burning and renew the inserts if necessary.

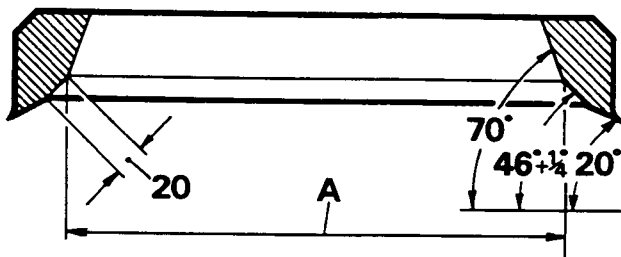
16. Remove the old seat inserts by grinding them away until they are thin enough to be cracked and prised out.
17. Heat the cylinder head evenly to approximately 65° C (150° F).
18. Press the new insert into the recess in the cylinder head.

NOTE: Service valve seat inserts are available in two over-sizes 0.25 and 0.50 mm (0.010 and 0.020 in) larger on the outside diameter to ensure interference fit.

19. If necessary, cut the valve seats to $46 \pm \frac{1}{4}$ degrees.
20. The nominal seat width is 1.5 mm (0.031 in). If the seat exceeds 2.0 mm (0.078 in) it should be reduced to the specified width by the use of 20° and 70° cutters.
21. The inlet valve seat diameter: 'A' is 37.03 mm (1.458 in) and the exhaust valve seat is 31.50 mm (1.240 in).

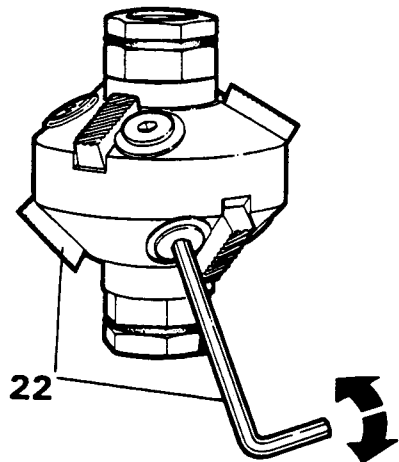


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22. Ensure that the cutter blades are correctly fitted to the cutter head with the angled end of the blade downwards facing the work, as illustrated. Check that the cutter blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided in the hand set MS76. Use light pressure and remove only the minimum material necessary.

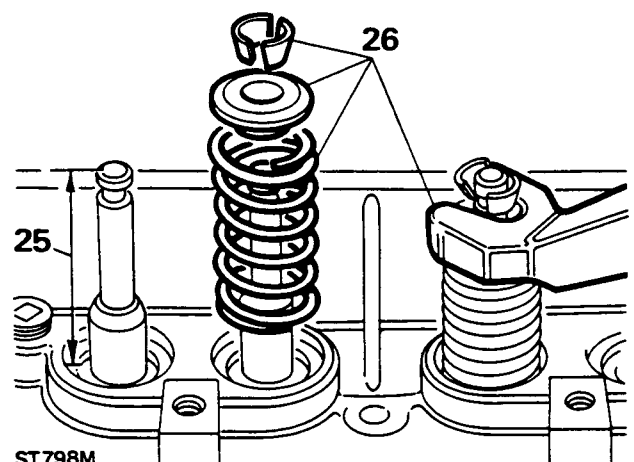


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23. Smear a small quantity of engineers' blue round the valve seat and revolve a properly ground valve against the seat. A continuous fine line should appear round the valve. If there is a gap of not more than 12 mm it can be corrected by lapping.
24. Alternatively, insert a strip of cellophane between the valve and seat, hold the valve down by the stem and slowly pull out the cellophane. If there is a drag the seal is satisfactory in that spot. Repeat this in at least eight places. Lapping-in will correct a small open spot.

Assemble valves to cylinder head

25. Before fitting the valves and springs the height of each valve above the head must be checked. Insert each valve in turn in its guide and whilst holding the head firmly against the seat, measure the height of the stem above the valve spring seat surface. This dimension must not exceed 47.63 mm (1.875 in). If necessary renew the valve or grind the end of the valve stem.
26. Lubricate the valve stems and assemble the valves, springs and caps and secure with the collets using valve spring compressor 18G 106A.



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Reclaiming cylinder head threads

Damaged or stripped threads in the cylinder head can be salvaged by fitting Helicoils as follows:

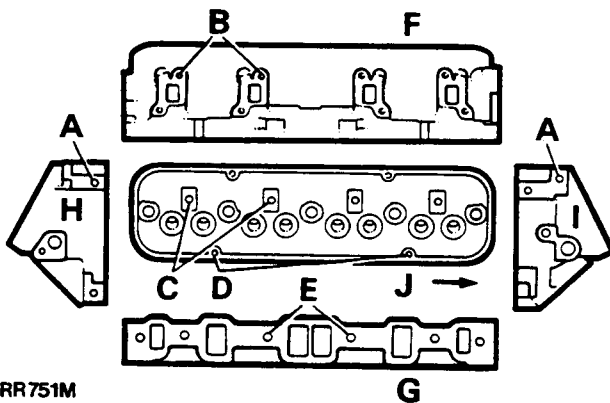
Holes A — These three holes may be drilled 0.3906 in dia. \times 0.937 + 0.040 in deep. Tapped with Helicoil Tap No. 6 CPB or 6CS \times 0.875 in (min) deep ($\frac{3}{8}$ UNC 1 $\frac{1}{2}$ D insert).

Holes B — These eight holes may be drilled 0.3906 in dia. \times 0.812 + 0.040 in deep. Tapped with Helicoil Tap No. 6 CBB 0.749 in (min) deep ($\frac{3}{8}$ UNC 1 $\frac{1}{2}$ D insert).

Holes C — These four holes may be drilled 0.3906 in dia. \times 0.937 + 0.040 in deep. Tapped with Helicoil Tap No. 6 CPB or 6CS \times 0.875 in (min) deep ($\frac{3}{8}$ UNC 1 $\frac{1}{2}$ D insert).

Holes D — These four holes may be drilled 0.261 in dia. \times 0.675 + 0.040 in deep. Tapped with Helicoil Tap No. 4 CPB or 4CS \times 0.625 in (min) deep ($\frac{1}{4}$ UNC 1 $\frac{1}{2}$ D insert).

Holes E — These six holes may be drilled 0.3906 in dia. \times 0.937 + 0.040 in deep. Tapped with Helicoil Tap No. 6 CPB or 6CS \times 0.875 in (min) deep ($\frac{3}{8}$ UNC 1 $\frac{1}{2}$ D insert).



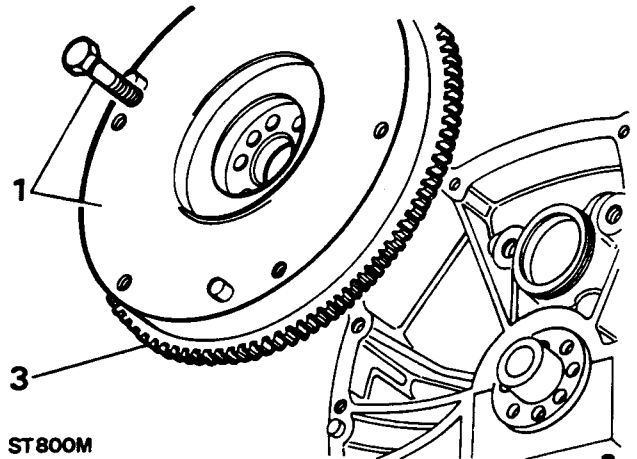
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NOTE: Right-hand cylinder head illustrated. American projection.

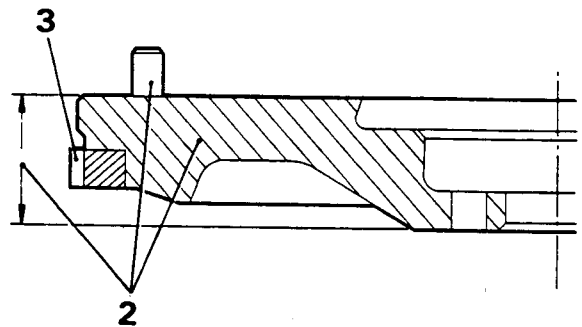
- F Exhaust manifold face
- G Inlet manifold face
- H Front face
- I Rear face
- J Front of engine

REMOVE AND OVERHAUL FLYWHEEL

1. Remove the retaining bolts and withdraw the flywheel from the crankshaft.



2. Examine the flywheel clutch face for cracks, scores and overheating. If the overall thickness of the flywheel is in excess of the minimum thickness i.e. 39.93 mm (1.572 in) it can be refaced provided that after machining it will not be below the minimum thickness. Remove the three dowels before machining.
3. Examine the ring gear and if worn or the teeth are chipped and broken it can be renewed as follows:

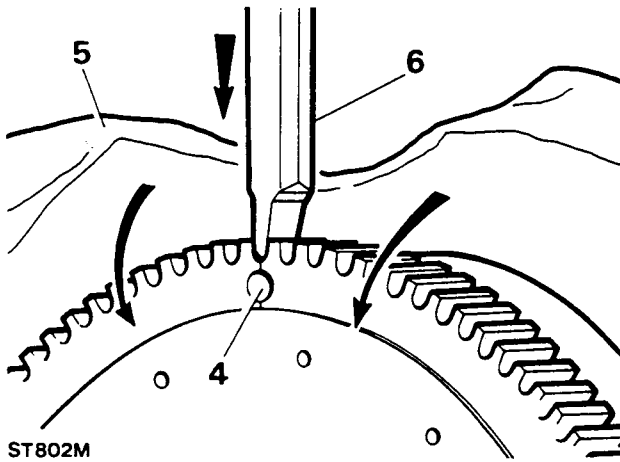


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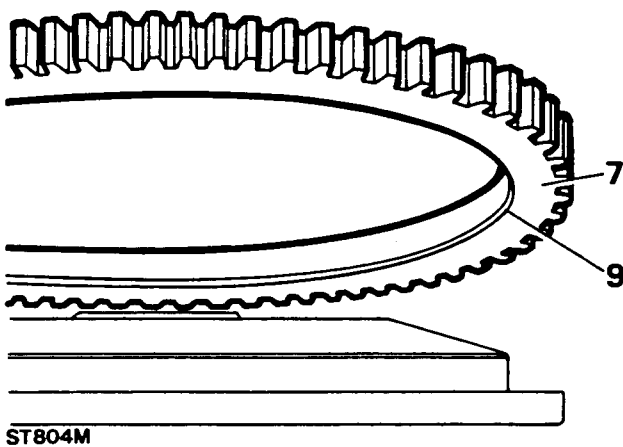
4. Drill a 10 mm (0.393 in) diameter hole axially between the root of any tooth and the inner diameter of the starter ring sufficiently deep to weaken the ring. Do NOT allow the drill to enter the flywheel.
5. Secure the flywheel in a vice fitted with soft jaws and place a cloth over the flywheel to protect the operator from flying fragments.

WARNING: Take adequate precautions against flying fragments when splitting the ring gear.

- Place a chisel immediately above the drilled hole and strike it sharply to split the starter ring gear.

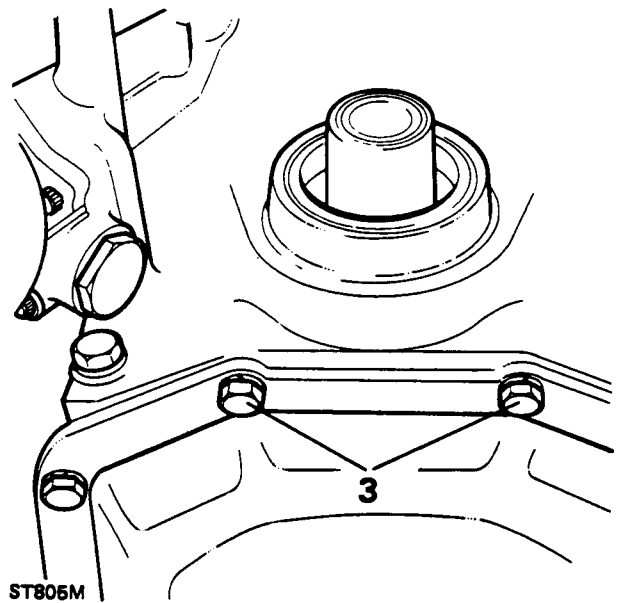


- Heat the new ring gear uniformly to between 170° and 175° C (338° to 347° F) but do not exceed the higher temperature.
- Place the flywheel, clutch side down, on a flat surface.
- Locate the heated starter ring gear in position on the flywheel, with the chamfered inner diameter towards the flywheel flange. If the starter ring gear is chamfered both sides, it can be fitted either way round.
- Press the starter ring gear firmly against the flange until the ring contracts sufficiently to grip the flywheel.
- Allow the flywheel to cool gradually. Do NOT hasten cooling in any way or distorting may occur.
- Fit new clutch assembly location dowels to the flywheel.

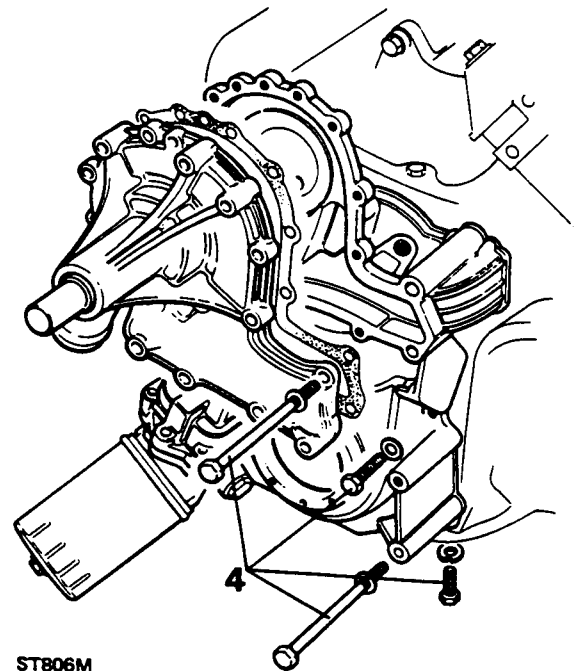


REMOVE TIMING GEAR COVER AND WATER PUMP

- Place an oil drip-tray beneath the timing cover and remove the oil filter element.
- Remove the crankshaft pulley bolt and special washer and withdraw the pulley.
- Remove the two bolts securing the sump to the bottom of the timing cover.



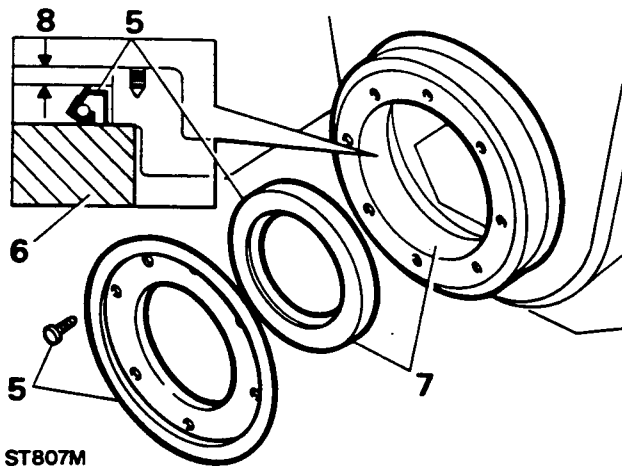
- Remove the remaining timing cover retaining bolts and withdraw the cover complete with oil pump.



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Renewing timing cover oil seal

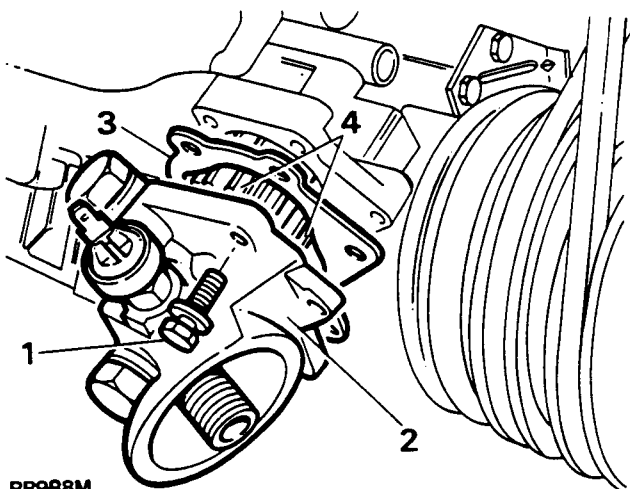
5. Remove the seven drive screws and withdraw the mud shield and the oil seal.
6. Position the gear cover with the front face uppermost and the underside supported across the oil seal housing bore on a suitable wooden block.
7. Enter the oil seal, lip side leading, into the housing bore.
8. Press in the oil seal until the plain face is 1.5 mm (0.062 in) approximately below the gear cover face.
9. Fit the mud shield and secure with the screws.



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REMOVE AND OVERHAUL THE OIL PUMP

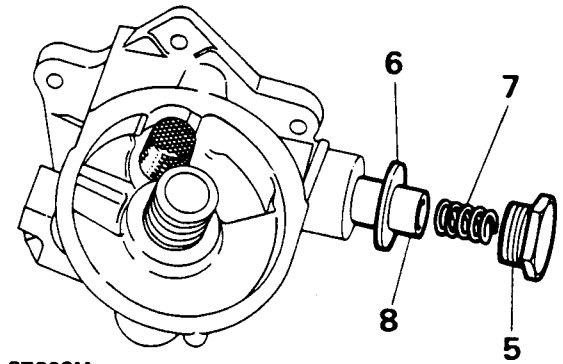
1. Remove the bolts from the oil pump cover.
2. Withdraw the oil pump cover.
3. Lift off the cover gasket.
4. Withdraw the oil pump gears.



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Dismantle pump

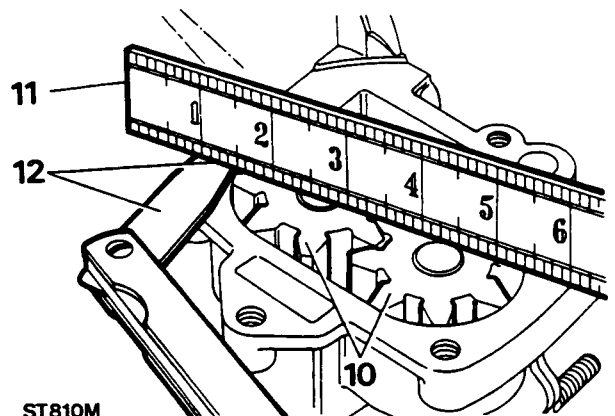
5. Unscrew the plug from the pressure relief valve.
6. Lift off the joint washer for the plug.
7. Withdraw the spring from the relief valve.
8. Withdraw the pressure relief valve.



ST809M

Examine pump

9. Check the oil pump gears for wear or scores.
10. Fit the oil pump gears and shaft into the front cover.
11. Place a straight-edge across the gears.
12. Check the clearance between the straight-edge and the front cover. If less than 0.05 mm (0.0018 in), check the front cover gear pocket for wear.



ST810M

13. Check the oil pressure relief valve for wear or scores.
14. Check the relief valve spring for wear at the sides or signs of collapse.
15. Clean the gauze filter for the relief valve.
16. Check the fit of the relief valve in its bore. The valve must be an easy slide fit with no perceptible side movement.

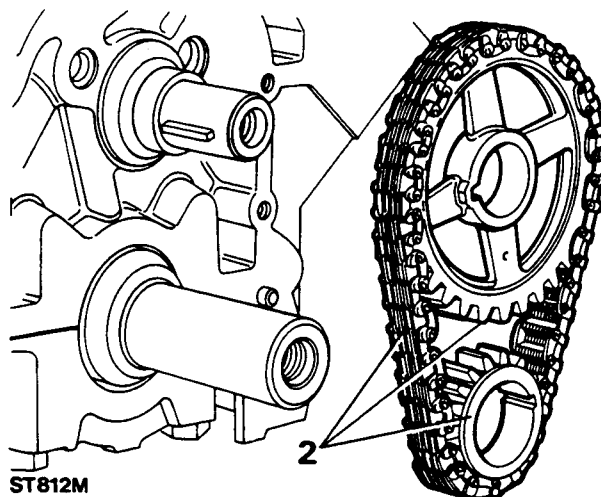
Assemble pump

17. Insert the relief valve spring.
18. Locate the sealing washer on to the relief valve plug.
19. Fit the relief valve plug and tighten to correct torque —see data section.
20. Fully pack the oil pump gear housing with petroleum jelly. Use only petroleum jelly; no other grease is suitable.
21. Fit the oil pump gears so that the petroleum jelly is forced into every cavity between the teeth of the gears.

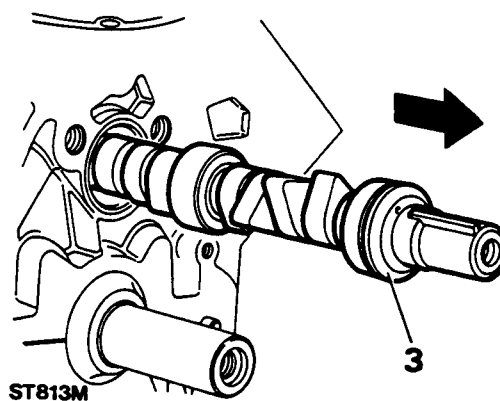
IMPORTANT: Unless the pump is fully packed with petroleum jelly it may not prime itself when the engine is started.

22. Place a new gasket on the oil pump cover.
23. Locate the oil pump cover in position.
24. Fit the special fixing bolts and tighten alternately and evenly to the correct torque.

2. Withdraw the chain wheels complete with timing chain.

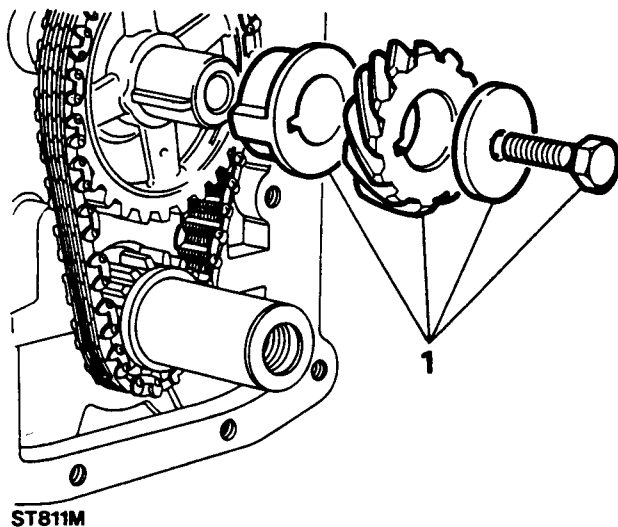


3. Withdraw the camshaft whilst taking particular care not to damage the bearings in the cylinder block.

**REMOVE TIMING CHAIN GEARS AND CAMSHAFT**

CAUTION: If this operation is carried out with cylinder heads and rocker shafts in position the engine must NOT be rotated once the timing chain has been removed otherwise the pistons and valves will be damaged.

1. Remove the retaining bolt and washer and withdraw the distributor drive gear and spacer.

**Examine components**

4. Visually examine all parts for wear. Check the camshaft bearing journals and cams for wear, pits, scores and overheating. Should any of these conditions be present the shaft should be renewed.
5. Examine the links and pins of the timing chain for wear and compare its condition with that of a new chain. Similarly the teeth of the chain wheels should be inspected and if necessary the wheels should be renewed.

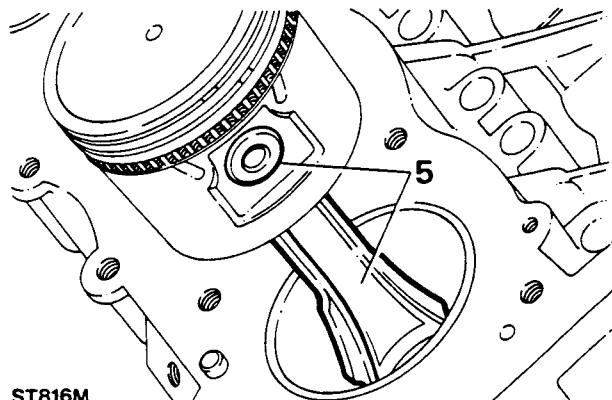
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6. Measure the camshaft journals for overall wear, ovality and taper. The diameters of the five journals are as follows commencing from the front of the shaft:

Number 1 journal 1.786 to 1.785 in
 Number 2 journal 1.750 to 1.755 in
 Number 3 journal 1.726 to 1.725 in
 Number 4 journal 1.696 to 1.095 in
 Number 5 journal 1.666 to 1.665 in.

7. To check the camshaft for bow, rest the two end journals i.e. numbers 1 and 5 on 'V' blocks and mount a dial gauge on the centre journal. Rotate the shaft and note the reading. If the run out is more than 0.05 mm (0.002 in) it should be renewed.

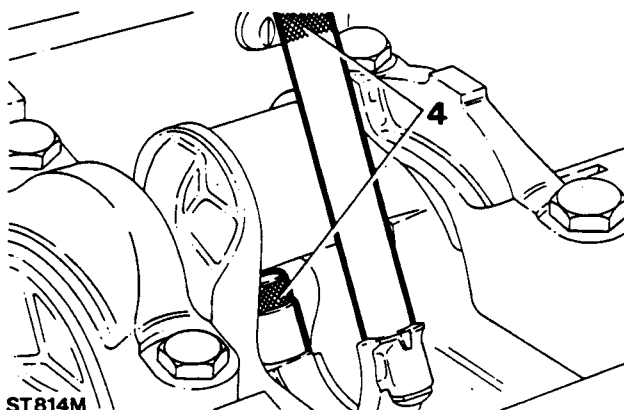
5. Push the connecting-rod and piston assembly up the cylinder bore and withdraw it from the top. Retain the connecting-rod and piston assemblies in sequence with their respective caps.
6. Remove the guide bolts 605351 from the connecting-rod.



ST816M

REMOVE AND OVERHAUL CONNECTING-RODS AND PISTONS

1. Withdraw the remaining bolts and remove the sump.
2. Remove the sump oil strainer.
3. Remove the connecting-rod caps and retain them in sequence for reassembly.
4. Screw the guide bolts 605351 onto the connecting-rods.

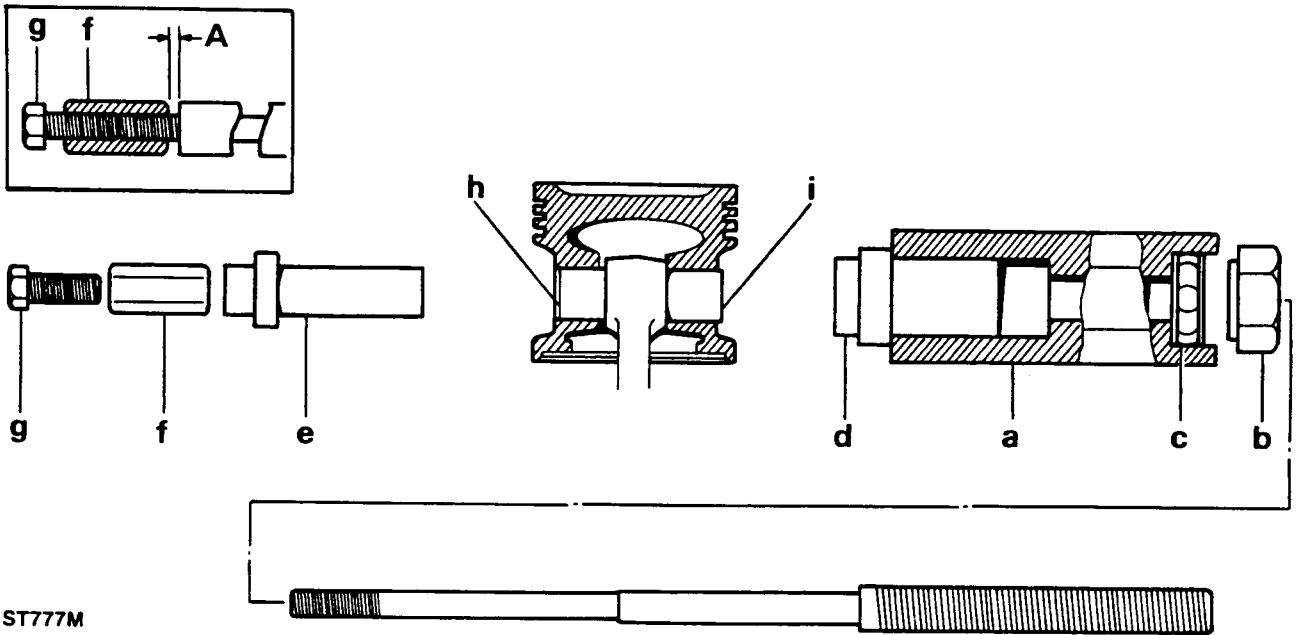


ST814M

Overhaul

NOTE: The connecting-rods, caps and bearing shells must be retained in sets, and in the correct sequence. Remove the piston rings over the crown of the piston. If the same piston is to be refitted, mark it relative to its connecting-rod to ensure that the original assembly is maintained.

7. Withdraw the gudgeon pin, using tool 18G 1150 as follows:
 - a. Clamp the hexagon body of 18G 1150 in a vice.
 - b. Position the large nut flush with the end of the centre screw.
 - c. Push the screw forward until the nut contacts the thrust race.
 - d. Locate the piston adaptor 18G 1150 E with its long spigot inside the bore of the hexagon body.
 - e. Fit the remover/replacer bush of 18G 1150 on the centre screw with the flanged end away from the gudgeon pin.
 - f. Screw the stop-nut about half-way onto the smaller threaded end of the centre screw, leaving a gap 'A' of 3 mm (1/8 in) between this nut and the remover/replacer bush.
 - g. Lock the stop-nut securely with the lock screw.
 - h. Check that the remover/replacer bush is correctly positioned in the bore of the piston.
 - i. Push the connecting-rod to the right to expose the end of the gudgeon pin, which must be located in the end of the adaptor 'd'.
 - j. Screw the large nut up to the thrust race.
 - k. Hold the lock screw and turn the large nut until the gudgeon pin has been withdrawn from the piston. Dismantle the tool.



ST777M

8. As an alternative to tool 18G 1150, press the gudgeon pin from the piston using an hydraulic press and the components which comprise tool 605350 as follows:
 - A. Place the base of tool 605350 on the bed of an hydraulic press which has a capacity of 8 tons (8 tonnes).
 - B. Fit the guide tube into the bore of the base with its countersunk face uppermost.
 - C. Push the piston to one side so as to expose one end of the gudgeon pin and locate this end in the guide tube.
 - D. Fit the spigot end of the small diameter mandrel into the gudgeon pin.
 - E. Press out the gudgeon pin, using the hydraulic press.

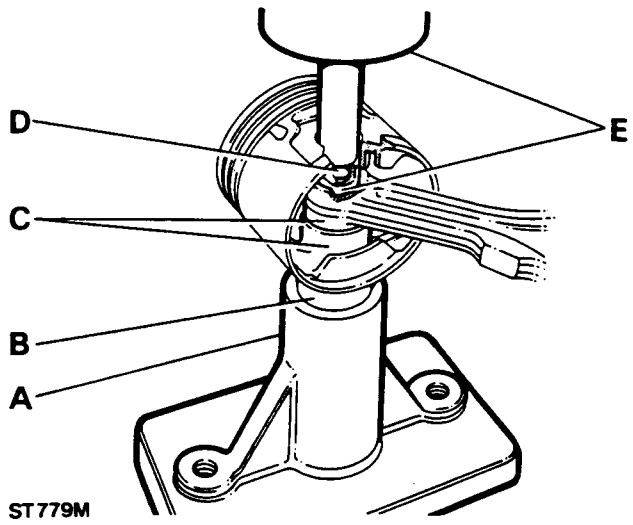
Original pistons

Remove the carbon deposits, particularly from the ring grooves. Examine the pistons for signs of damage or excessive wear; refer to 'new pistons' for the method of checking the running clearance. Fit new pistons if necessary.

New pistons

Pistons are available in service standard size and in oversizes of 0.25 mm (0.010 in) and 0.50 mm (0.020 in). Service standard size pistons are supplied 0.0254 mm (0.001 in) oversize. When fitting new service standard size pistons to a cylinder block, check for correct piston to bore clearance, honing the bore if necessary. Bottom of piston skirt/bore clearance should be 0.018 to 0.033 mm (0.0007 to 0.0013 in).

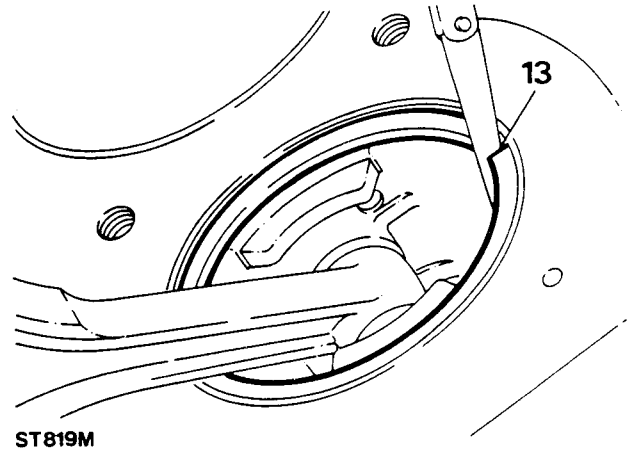
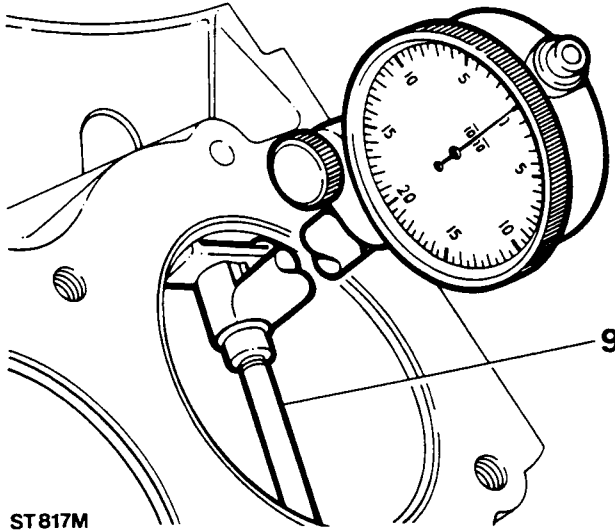
NOTE: The temperature of the piston and cylinder block must be the same to ensure accurate measurement. When reboring the cylinder block, the crankshaft main bearing caps must be fitted and tightened to the correct torque.



ST779M

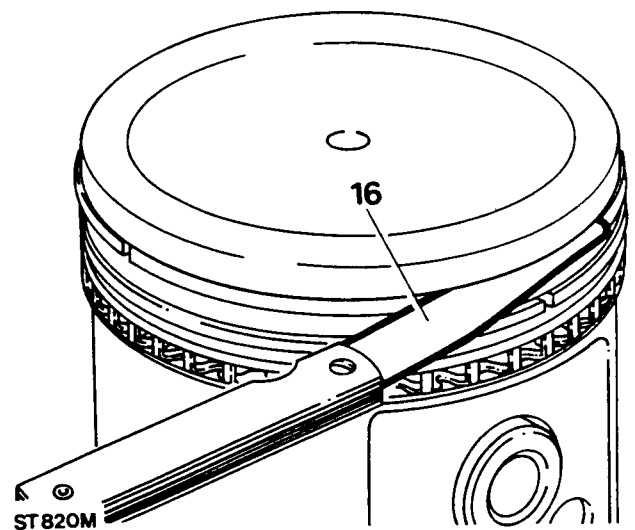
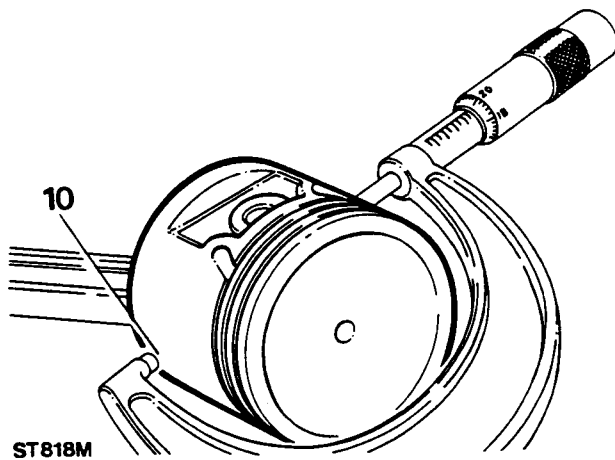
9. Check the cylinder bore dimension at right angles to the gudgeon pin, 40 to 50 mm (1½ to 2 in) from the top.

Continued



10. Check the piston dimension at right angles to the gudgeon pin, at the bottom of the skirt.
11. The piston dimension must be 0.018 to 0.033 mm (0.0007 to 0.0013 in) smaller than the cylinder.
12. If new piston rings are to be fitted without reboring, deglaze the cylinder walls with a hone, without increasing the bore diameter to provide a cross-hatch finish.

14. Temporarily fit the compression rings to the piston.
15. The ring marked 'TOP' must be fitted with the marking uppermost and into the second groove. The chrome ring is for the top groove and can be fitted either way round.
16. Check the compression ring clearance in the piston groove. Clearance limits: 0.05 to 0.10 mm (0.002 to 0.004 in).

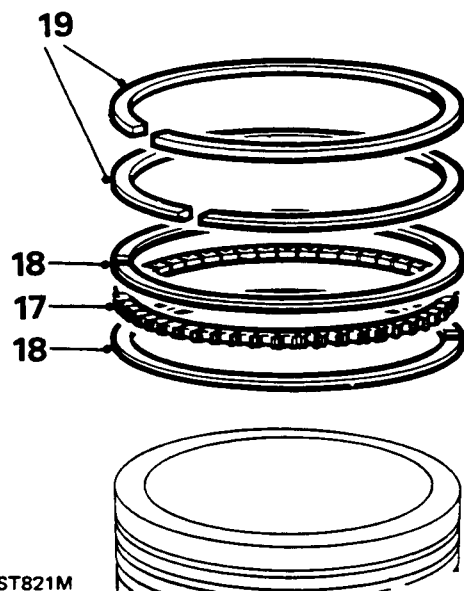


13. Check the compression ring gaps in the applicable cylinder, held square to the bore with the piston. Gap limits: 0.44 to 0.56 mm (0.017 to 0.022 in). Use a fine-cut flat file to increase the gap if required. Select a new piston ring if the gap exceeds the limit.

NOTE: Gapping does not apply to oil control rings.

Fit piston rings

17. Fit the expander ring into the bottom groove making sure that the ends butt and do not overlap.
18. Fit two ring rails to the bottom groove, one above and one below the expander ring.
19. Fit the second compression ring with the marking 'TOP' uppermost and the chrome compression ring in the top groove, either way round.



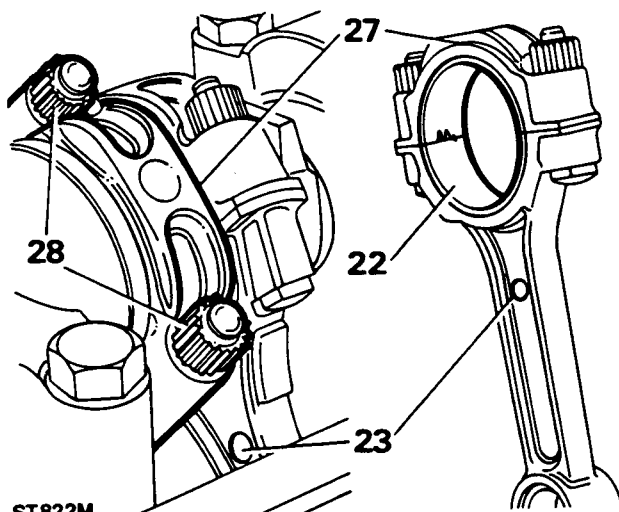
ST821M

Examine connecting-rods

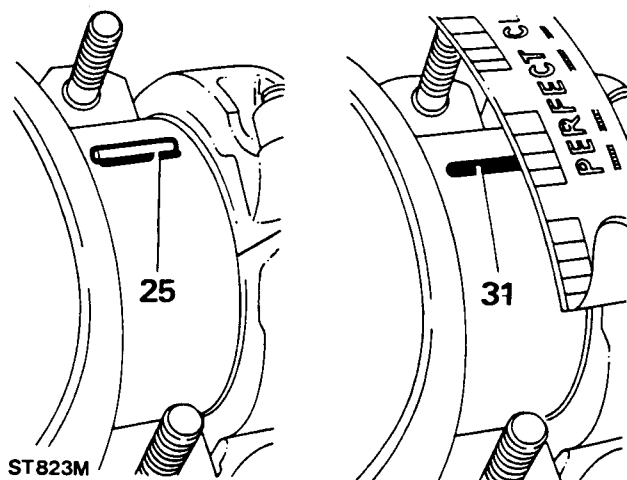
20. Check the alignment of the connecting-rod.
21. Check the connecting-rod small end, the gudgeon pin must be a press fit.

Check crankshaft bearings

22. Locate the bearing upper shell into the connecting-rod.
23. Locate the connecting-rod and bearing onto the applicable crankshaft journal, noting that the domed shape boss on the connecting-rod must face towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank.
24. When both connecting-rods are fitted, the bosses will face inwards towards each other.



ST822M



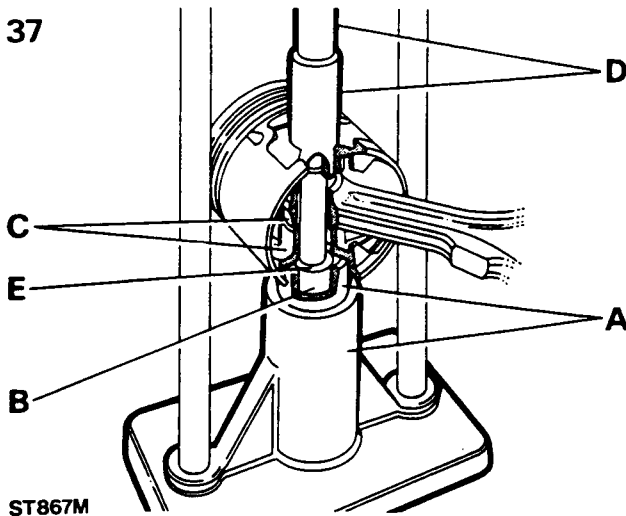
ST823M

25. Place a piece of Plastigauge across the centre of the lower half of the crankshaft journal.
26. Locate the bearing lower shell into the connecting-rod cap.
27. Locate the cap and shell onto the connecting-rod. Note that the rib on the edge of the cap must be the same side as the domed shape boss on the connecting-rod.
28. Secure the connecting-rod cap. Tighten to the correct torque, see data section.
29. Do not rotate the crankshaft or connecting rod while the Plastigauge is in use.
30. Remove the connecting-rod cap and shell.
31. Using the scale printed on the Plastigauge packet, measure the flattened Plastigauge at its widest point.
32. The graduation that most closely corresponds to the width of the Plastigauge indicates the bearing clearance.
33. The correct bearing clearance with new or overhauled components is 0.013 to 0.06 mm (0.0006 to 0.0022 in).
34. If a bearing has been in service, it is advisable to fit a new bearing if the clearance exceeds 0.08 mm (0.003 in).
35. If a new bearing is being fitted, use selective assembly to obtain the correct clearance.
36. Wipe off the Plastigauge with an oily rag. DO NOT scrape it off.

IMPORTANT: The connecting-rods, caps and bearing shells must be retained in sets, and in the correct sequence.

Continued

37



ST867M

Assembling pistons to connecting-rods

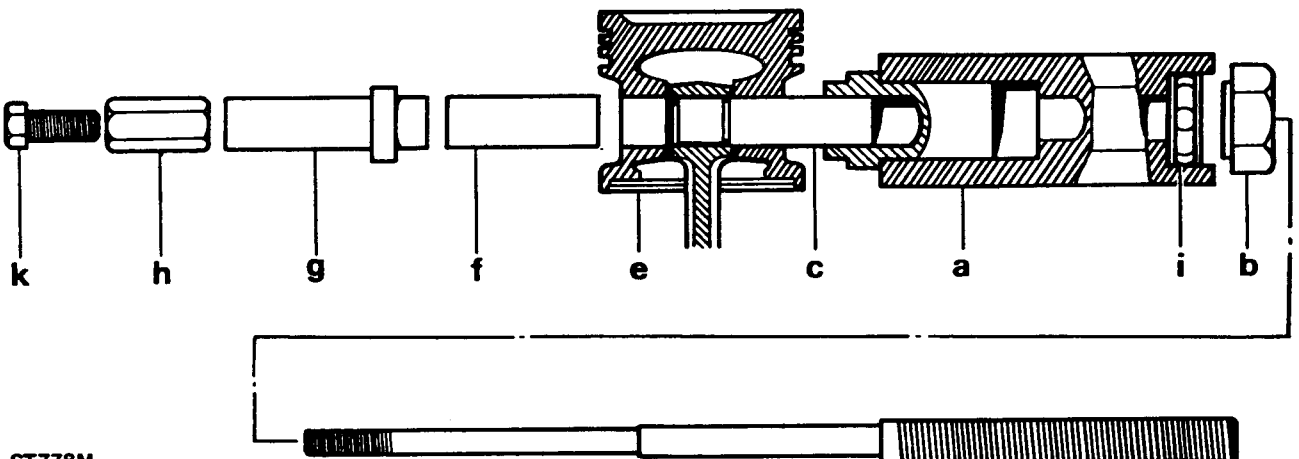
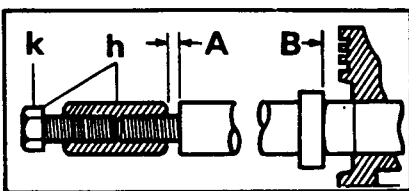
37. If an hydraulic press and tool 605350 was used for dismantling, refit each piston to its connecting-rod as follows:

- A. Check that the base of tool 605350 and the guide tube are fitted as follows:
Place the base of tool 605350 on the bed of an hydraulic press which has a capacity of 8 tons (8 tonnes).
Fit the guide tube into the bore of the base with its countersunk face uppermost.
- B. Fit the long mandrel inside the guide tube.
- C. Fit the connecting-rod into the piston with the markings together if the original pair are being used, then place the piston and connecting rod assembly over the long mandrel until the gudgeon pin boss rests on the guide tube.

- D. Fit the gudgeon pin into the piston up to the connecting-rod, and the spigot end of the small diameter mandrel into the gudgeon pin.
- E. Press in the gudgeon pin until it abuts the shoulder of the long mandrel.

38. If tool 18G 1150 was used for dismantling, refit each piston to its connecting-rod as follows:

- a. Clamp the hexagon body of 18G 1150 in a vice, with the adaptor 18G 1150 E positioned as in 7d.
- b. Remove the large nut of 18G 1150 and push the centre screw approximately 50 mm (2 in) into the body until the shoulder is exposed.
- c. Slide the parallel guide sleeve, grooved end last, onto the centre screw and up to the shoulder.
- d. Lubricate the gudgeon pin and bores of the connecting-rod and piston with graphited oil (Acheson's Colloids 'Oildag'). Also lubricate the ball race and centre screw of 18G 1150.
- e. Fit the connecting-rod and the piston together onto the tool with the markings together if the original pair are being used and with the connecting-rod around the sleeve up to the groove.
- f. Fit the gudgeon pin into the piston bore up to the connecting-rod.
- g. Fit the remover/replacer bush 18G 1150/3 with its flanged end towards the gudgeon pin.
- h. Screw the stop-nut onto the centre screw and adjust this nut to obtain a 1 mm ($\frac{1}{32}$ in) end-float 'A' on the whole assembly, and lock the nut securely with the screw.
- i. Slide the assembly back into the hexagon body and screw on the large nut up to the thrust race.



ST778M

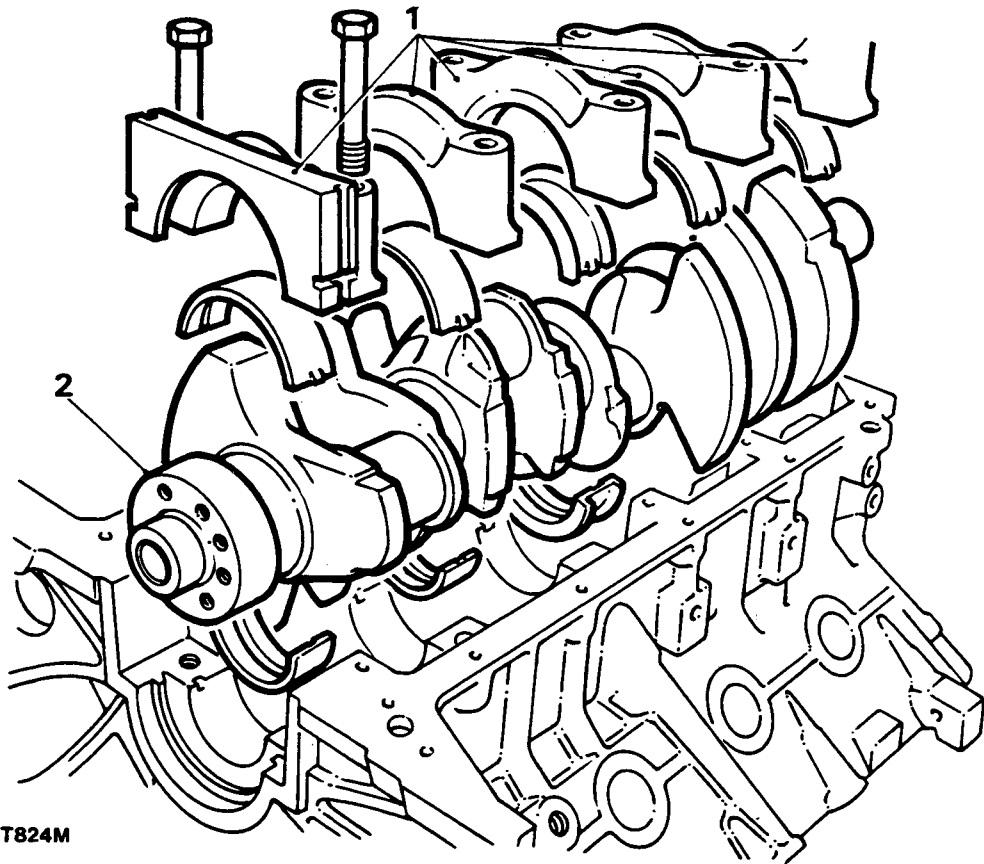
-
- j. Set the torque wrench 18G 537 to 12 lbf/ft. This represents the minimum load for an acceptable interference fit of the gudgeon pin in the connecting-rod.
 - k. Using the torque wrench and socket 18G 587 on the large nut, and holding the lock screw, pull the gudgeon pin in until the flange of the remover/replacer bush is 4 mm (0.160 in) 'B' from the face of the piston. Under no circumstances must this flange be allowed to contact the piston.

CAUTION: If the torque wrench has not broken throughout the pull, the fit of the gudgeon pin to the connecting-pin is not acceptable and necessitates the renewal of components. The large nut and centre screw of the tool must be kept well-oiled.

- 39. Remove the tool and check that the piston moves freely on the gudgeon pin and that no damage has occurred during pressing.
-

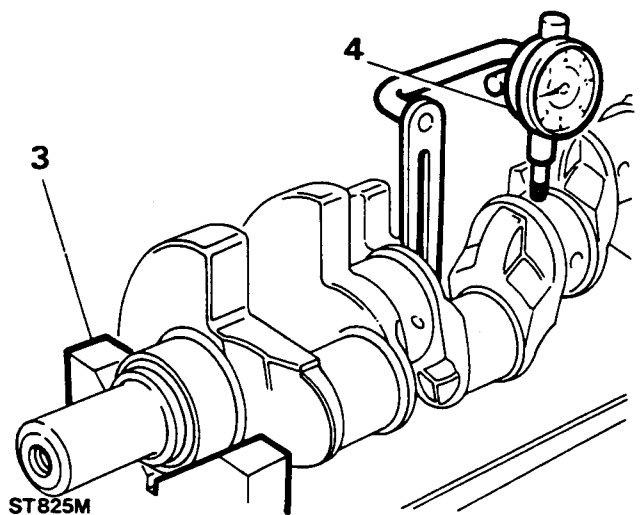
REMOVE AND OVERHAUL CRANKSHAFT

1. Remove the main bearing caps and lower bearing shells and retain in sequence. It is important to keep them in pairs and mark them with the number of the respective journal until it is decided if the bearing shells are to be refitted.
2. Lift out the crankshaft and rear oil seal.

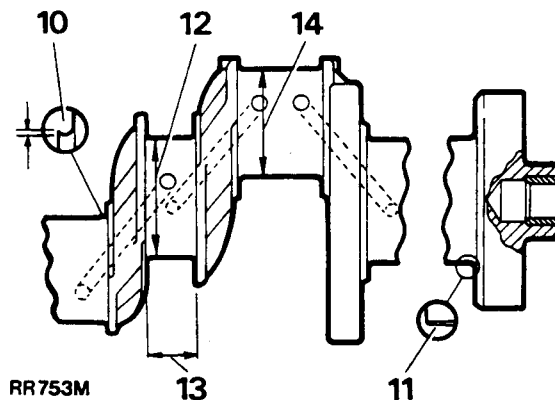
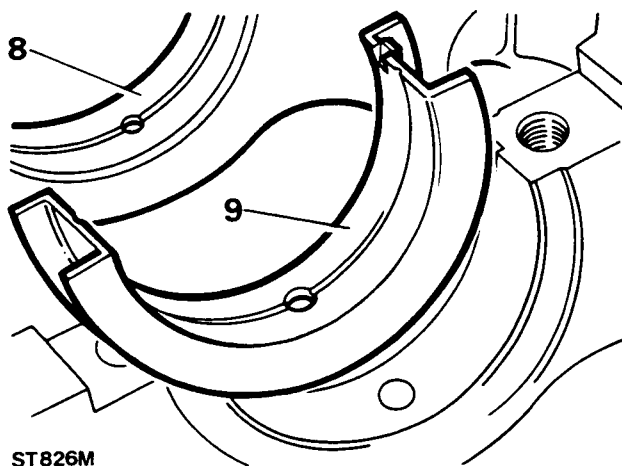


Inspect and overhaul crankshaft

3. Rest the crankshaft on vee-blocks at numbers one and five main bearing journals.
4. Using a dial test indicator, check the run-out at numbers two, three and four main bearing journals. The total indicator readings at each journal should not exceed 0.08 mm (0.003 in).
5. While checking the run-out at each journal, note the relation of maximum eccentricity on each journal to the others. The maximum on all journals should come at very near the same angular location.
6. If the crankshaft fails to meet the foregoing checks it is bent and is unsatisfactory for service.
7. Check each crankshaft journal for ovality. If ovality exceeds 0.040 mm (0.0015 in), a reground or new crankshaft should be fitted.



8. Bearings for the crankshaft main journals and the connecting-rod journals are available in the following undersizes:
0.25 mm (0.010 in)
0.50 mm (0.020 in)
9. The centre main bearing shell, which controls crankshaft thrust, has the thrust faces increased in thickness when more than 0.25 mm (0.010 in) undersize, as shown on the following chart.



Crankshaft dimensions—millimetres

Crankshaft Grade	Diameter '12'	Width '13'	Diameter '14'
Standard	58.400–58.413	26.975–27.026	50.800–50.812
0.254 U/S	58.146–58.158	26.975–27.026	50.546–50.559
0.508 U/S	57.892–57.904	27.229–27.280	50.292–50.305

Crankshaft dimensions—inches

Crankshaft Grade	Diameter '12'	Width '13'	Diameter '14'
Standard	2.2992–2.2997	1.062–1.064	2.0000–2.0005
0.010 U/S	2.2892–2.2897	1.062–1.064	1.9900–1.9905
0.020 U/S	2.2792–2.2797	1.072–1.074	1.9800–1.9805

Check main bearing clearance

10. When a crankshaft is to be reground, the thrust faces on either side of the centre main journal must be machined in accordance with the dimensions on the following charts.

Main bearing journal size	Thrust face width
Standard	Standard
0.25 mm (0.010 in) undersize	Standard
0.50 mm (0.020 in) undersize	0.25 mm (0.010 in) oversize

11. For example: If a 0.50 mm (0.020 in) undersize bearing is to be fitted, then 0.12 mm (0.005 in) must be machined off each thrust face of the centre journal, maintaining the correct radius.

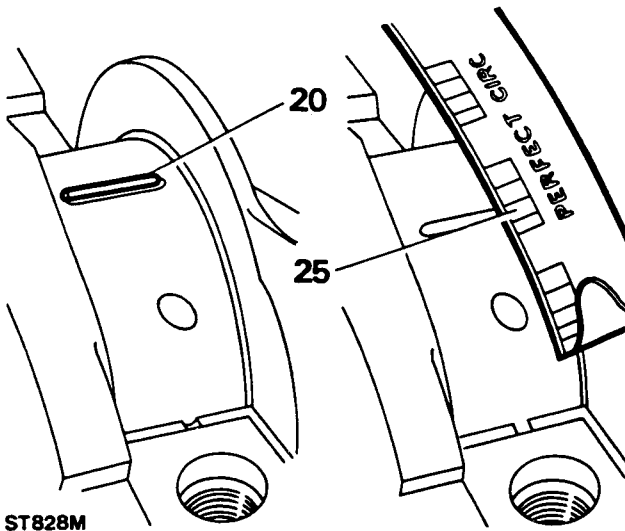
16. Remove the oil seals from the cylinder block and the rear main bearing cap.
17. Locate the upper main bearing shells into the cylinder block. These must be the shells with the oil drilling and oil grooves.
18. Locate the flanged upper main bearing shell in the centre position.
19. Place the crankshaft in position on the bearings.

Continued

Crankshaft dimensions

12. The radius for all journals except the rear main bearing is 1.90 to 2.28 mm (0.075 to 0.090 in).
13. The radius for the rear main bearing journal is 3.04 mm (0.120 in).
14. Main bearing journal diameter, see the following charts.
15. Thrust face width, and connecting-rod journal diameter, see the following charts.

20. Place a piece of Plastigauge across the centre of the crankshaft main bearing journals.
21. Locate the bearing lower shell into the main bearing cap.
22. Fit numbers one to four main bearing caps and shells, tighten to the correct torque, see data section.
23. Fit the rear main bearing cap and shell and tighten to the correct torque, see data section. Do not allow the crankshaft to be rotated while the Plastigauge is in use.
24. Remove the main bearing caps and shells.
25. Using the scale printed on the Plastigauge packet, measure the flattened Plastigauge at its widest point.

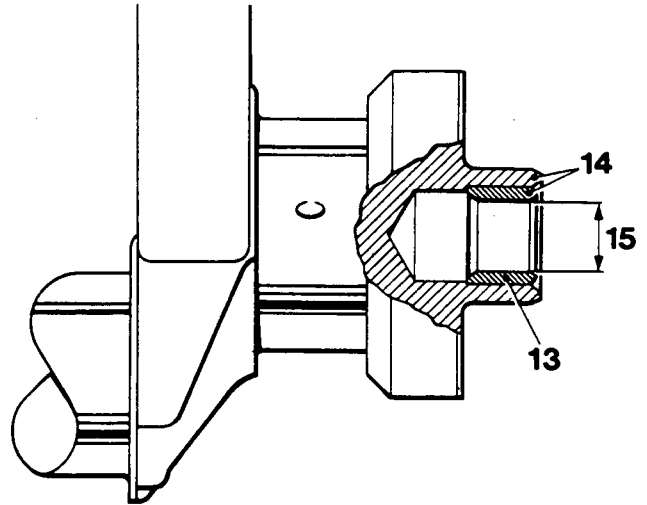


ST828M

26. The graduation that most closely corresponds to the width of the Plastigauge indicates the bearing clearance.
27. The correct bearing clearance with new or overhauled components is 0.023 to 0.065 mm (0.0009 to 0.0025 in).
28. If the correct clearance is not obtained initially, use selective bearing assembly.
29. Wipe off the Plastigauge with an oily rag. Do NOT scrape it off.
30. Maintain the bearing shells and caps in sets and in the correct sequence.

Renew spigot bearing

31. Carefully remove the old bearing.
32. Fit the spigot bearing flush with, or to a maximum of 1.6 mm (0.063 in) below the end face of the crankshaft.
33. Ream the spigot bearing to $19.177 + 0.025$ mm ($0.7504 + 0.001$ in) inside diameter. Ensure all swarf is removed.

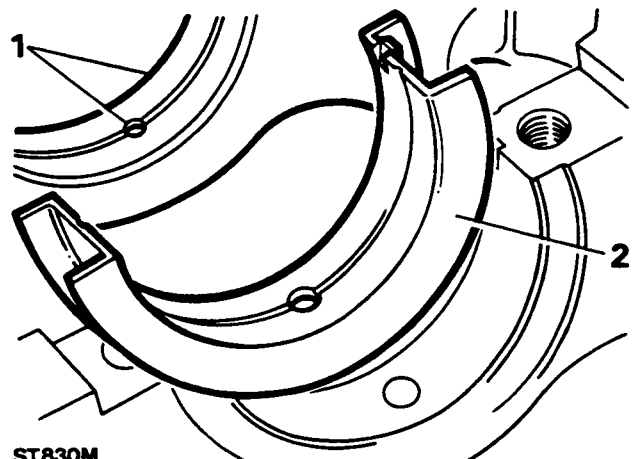


ST 829M

ASSEMBLING ENGINE

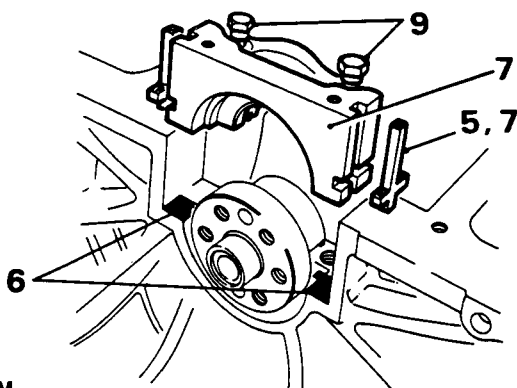
FIT CRANKSHAFT AND MAIN BEARINGS

1. Locate the upper main bearing shells into the cylinder block; these must be the shells with the oil drilling and oil grooves.
2. Locate the flanged upper main bearing shell in the centre position.
3. Lubricate the crankshaft main bearing journals and bearing shells with clean engine oil and lower the crankshaft into position.



ST830M

4. Lubricate the lower main bearing shells and fit numbers one to four main bearing caps and shells only, leaving the fixing bolts finger-tight at this stage.
5. Fit the cruciform side seals to the grooves each side of the rear main bearing cap. Do not cut the side seals to length, they must protrude 1.5 mm (0.062 in) approximately above the bearing cap parting face.
6. Apply Hylomar PL32M jointing compound to the rearmost half of the rear main bearing cap parting face or, if preferred, to the equivalent area on the cylinder block as illustrated.
7. Lubricate the bearing half and bearing cap side seals with clean engine oil.
8. Fit the bearing cap assembly to the engine. Do not tighten the fixings at this stage but ensure that the cap is fully home and squarely seated on the cylinder block.
9. Tension the cap bolts equally by one-quarter turn approximately, then back off one complete turn on each fixing bolt.



ST831M

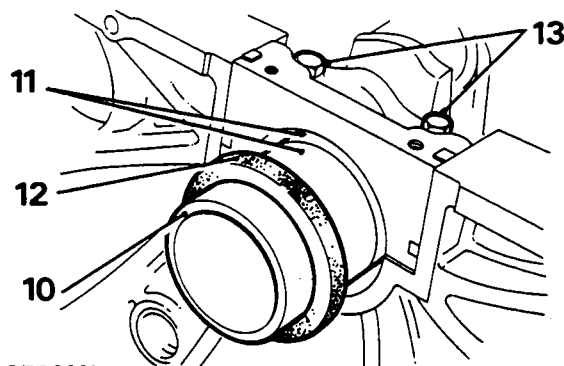
CAUTION: Do not handle the seal lip, visually check that it is not damaged and ensure that the outside diameter remains clean and dry.

10. Position the seal guide RO 1014 on the crankshaft flange.
11. Ensure that the oil seal guide and the crankshaft journal are scrupulously clean, then coat the seal guide and oil seal journal with clean engine oil.

NOTE: The lubricant coating must cover the seal guide outer surface completely to ensure that the oil seal lip is not turned back during assembly.

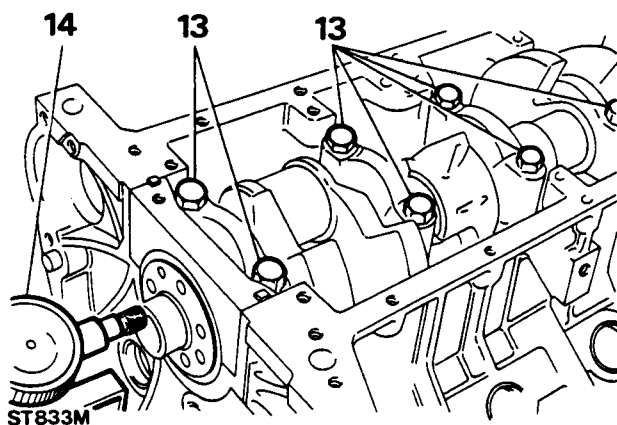
Position the oil seal, lipped side towards the engine, onto the seal guide. The seal outside diameter must be clean and dry.

12. Push home the oil seal fully and squarely by hand into the recess formed in the cap and block until it abuts against the machined step in the recess. Withdraw the seal guide.



ST832M

13. Tighten the main bearing cap bolts to the correct torque noting that the bolts for numbers one to four bearings have a different torque to number five bearing cap bolts.
14. Using a feeler gauge or a dial indicator check the crankshaft end-float, 0.10 to 0.20 mm (0.004 to 0.008 in).

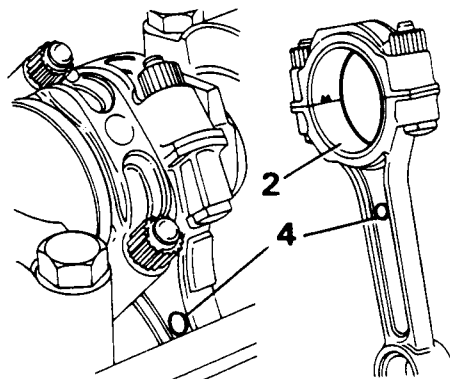


ST833M

CAUTION: Do not exceed 1,000 engine rev/min when first starting the engine, otherwise the crankshaft rear oil seal will be damaged.

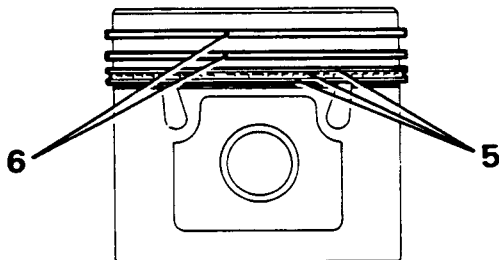
FIT CONNECTING-RODS AND PISTONS

1. Locate the applicable crankshaft journal at BDC.
2. Place the bearing upper shell in the connecting-rod.
3. Retain the upper shell by screwing the guide bolts 605351 onto the connecting-rods.
4. Insert the connecting-rod and piston assembly into its respective bore, noting that the domed shape boss on the connecting-rod must face towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank. When both connecting-rods are fitted, the bosses will face inwards towards each other.



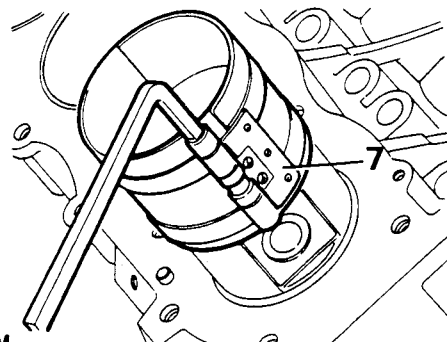
ST834M

5. Position the oil control piston rings so that the ring gaps are all at one side, between the gudgeon pin and piston thrust face. Space the gaps in the ring rails approximately 25 mm (1 in) each side of the expander ring joint.
6. Position the compression rings so that their gaps are on opposite sides of the piston between the gudgeon pin and piston thrust face.



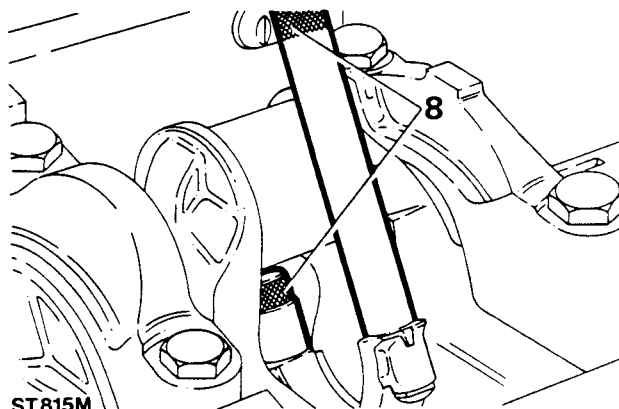
ST835M

7. Using a piston ring compressor, locate the piston into the cylinder bore, until the piston crown is just below the cylinder block top face.



ST836M

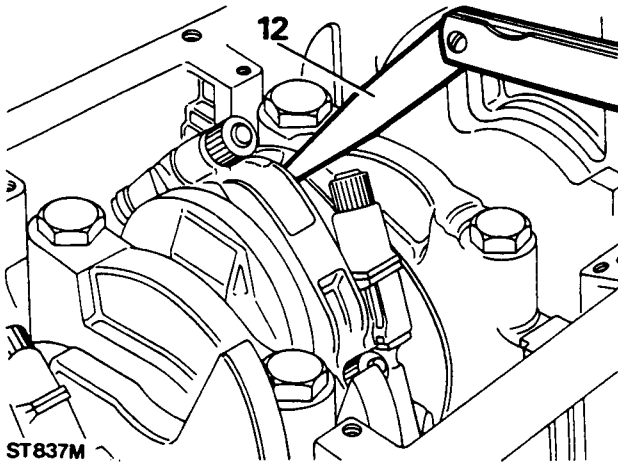
8. Pull the connecting rods on to the crankpins using the guide rods.



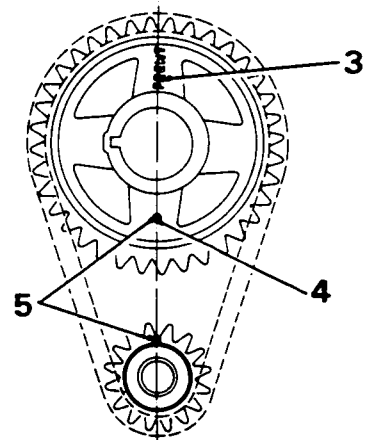
ST815M

9. Place the bearing lower shell in the connecting-rod cap.
10. Locate the cap and shell onto the connecting-rod, noting that the rib on the edge of the cap must be towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank.
11. Check that the connecting-rods move freely sideways on the crankshaft. Tightness indicates insufficient bearing clearance or a misaligned connecting-rod.

12. Check the end-float between the connecting-rods on each crankshaft journal. Clearance limits: 0.15 to 0.37 mm (0.006 to 0.014 in).
13. Tighten the connecting-rod nuts to the correct torque. Fit the oil strainer and joint washer.



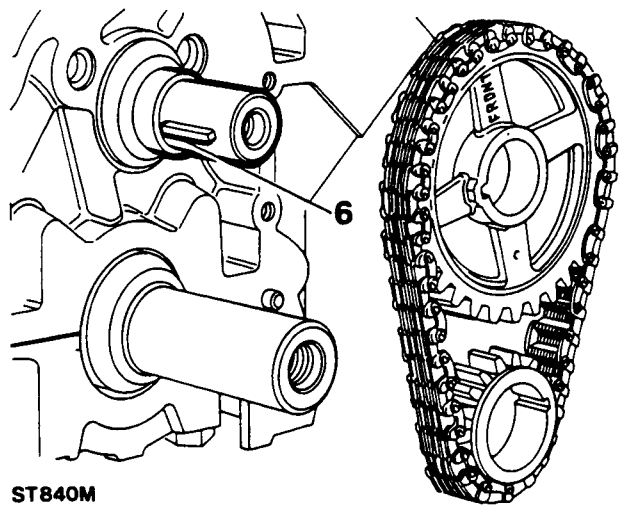
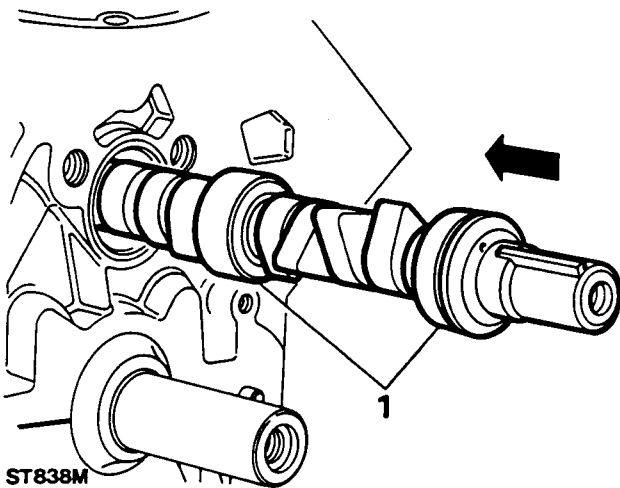
3. Temporarily fit the camshaft chain wheel with the marking 'FRONT' outward.
4. Turn the camshaft until the mark on the camshaft chain wheel is at the six o'clock position, then remove the chain wheel without disturbing the camshaft.
5. Encircle the chain wheels with the chain keeping the timing marks aligned.



6. Engage the chain wheel assembly on the camshaft and crankshaft key locations and check that the camshaft key is parallel to the shaft axis to ensure adequate lubrication of the distributor drive gear.

FIT CAMSHAFT TIMING GEARS AND CHAIN

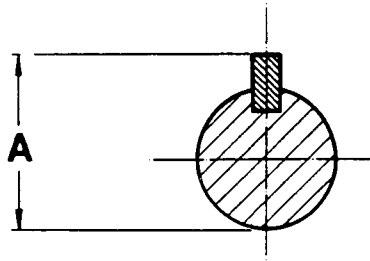
1. Lubricate the camshaft journals and carefully insert the camshaft into the cylinder block.



Continued

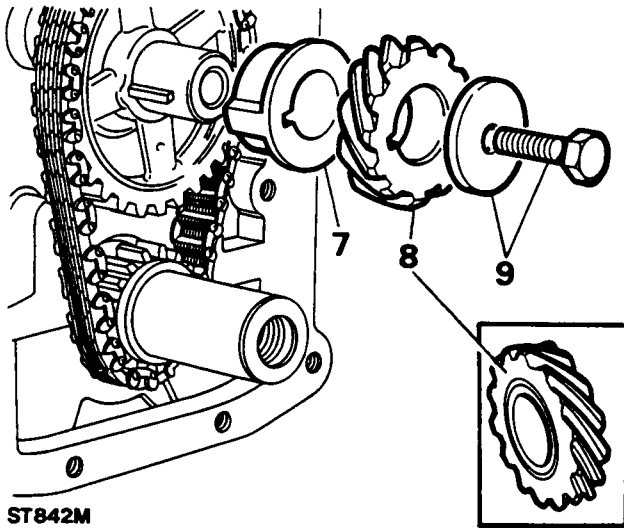
2. Turn the crankshaft to bring number one piston to TDC.

CAUTION: The space between the key and keyway acts as an oilway for lubrication of the drive gear. Ensure that the key is seated to the full depth of the keyway. The overall dimension of shaft and key must not exceed 30.15 mm (1.187 in). Dimension A below.



ST841M

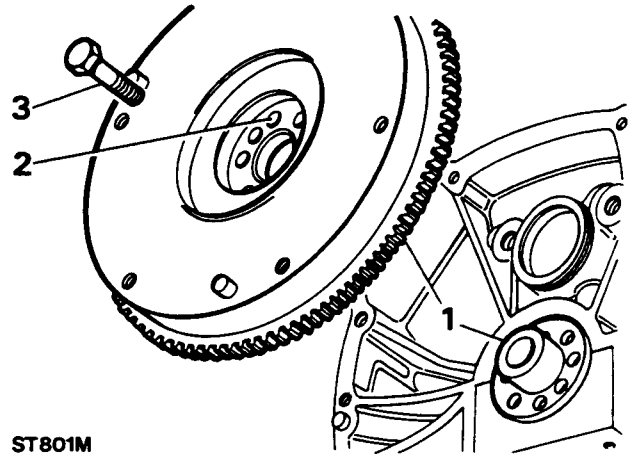
7. Check that the timing marks line-up and fit the spacer with the flange to the front.
8. Fit the distributor drive gear ensuring that the annular grooved side is fitted to the rear, that is towards the spacer.
9. Secure the drive gear and camshaft chain wheel assembly with the bolt and washer and tighten to the correct torque.



ST842M

FIT THE FLYWHEEL

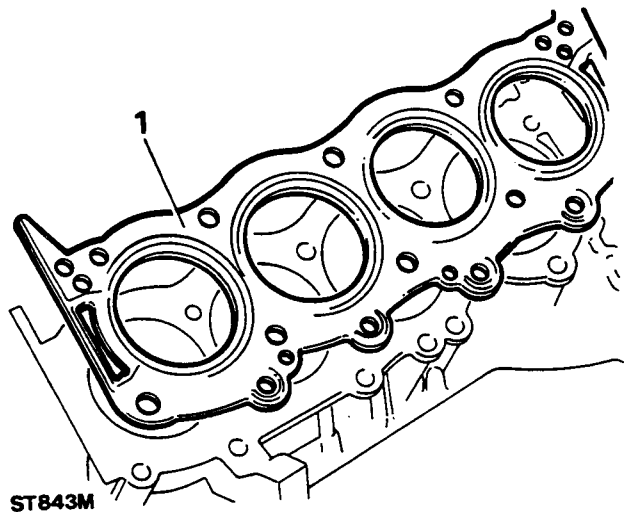
1. Locate the flywheel in position on the crankshaft spigot, with the ring gear towards the engine.
2. Align the flywheel fixing bolt holes which are off-set to prevent incorrect assembly.
3. Fit the flywheel fixing bolts and before finally tightening, take up any clearance by rotating the flywheel against the direction of engine rotation. Tighten the bolts evenly to the correct torque.



ST801M

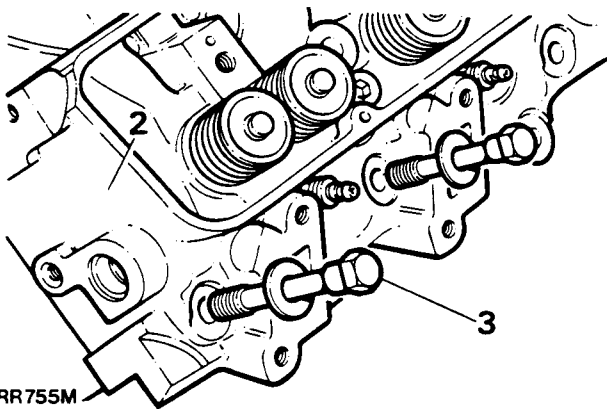
FIT CYLINDER HEADS

1. Fit new cylinder head gaskets with the word 'TOP' uppermost. Do NOT use sealant.



ST843M

2. Locate the cylinder heads on the block dowel pins.
3. Clean the threads of the cylinder head bolts then coat them with Thread Lubricant-Sealant Loctite 572.



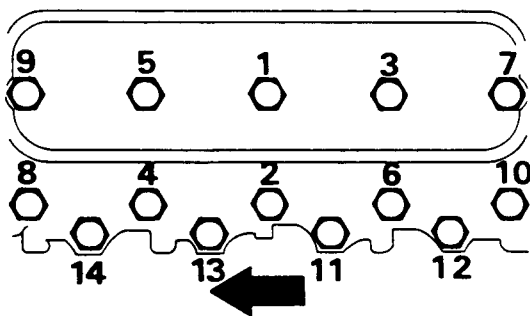
4. Locate the cylinder head bolts in position as illustrated and fit dipstick tube.

Long bolts—1, 3 and 5.

Medium bolts—2, 4, 6, 7, 8, 9 and 10.

Short bolts—11, 12, 13 and 14.

5. Tighten the cylinder head bolts a little at a time in the sequence shown. See data for correct tightening torque.
6. When all bolts have been tightened, re-check the torque settings.



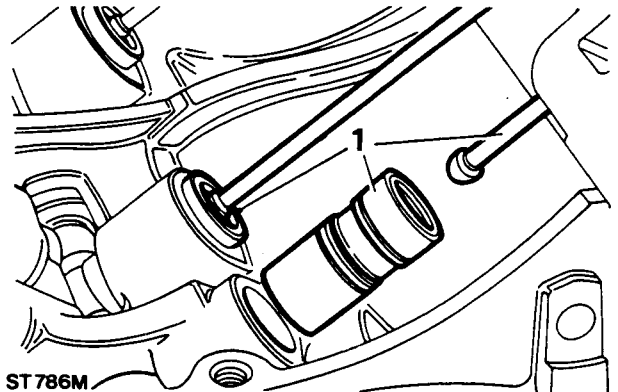
ST845M

Note: Left-hand cylinder head illustrated.
Arrow points to front of vehicle.

FIT TAPPETS, PUSH RODS AND ROCKER ASSEMBLIES

Fit tappets and push rods

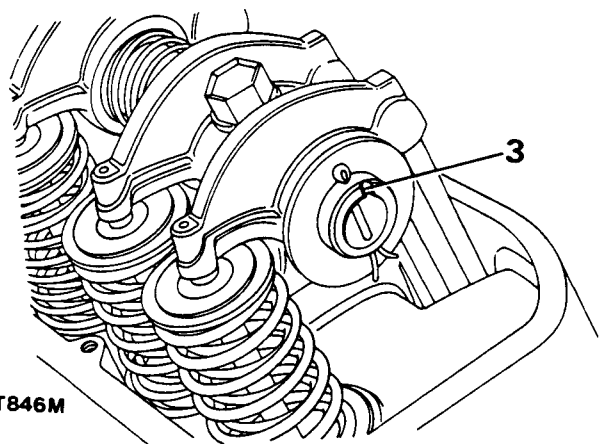
1. Fit the tappets and push rods to their original locations. Ensure that the tappets move freely in their respective bores. Before fitting the tappets immerse them in clean engine oil to reduce tappet noise when the engine is first started after the overhaul.



ST786M

Fit the rocker assemblies

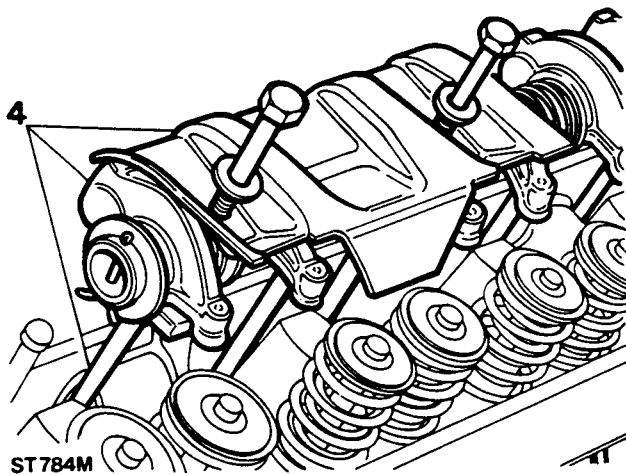
2. The rocker shafts are handed and must be fitted correctly to align the oilways.
3. Each rocker shaft is notched at one end and on one side only. The notch must be uppermost and towards the front of the engine on the right-hand side, and towards the rear on the left-hand side.



ST846M

Continued

4. Fit the rocker shaft assemblies. Ensure that the push-rods engage the rocker cups and that the baffle plates are fitted to the front on the left-hand side, and to the rear on the right-hand side. Tighten the bolts.

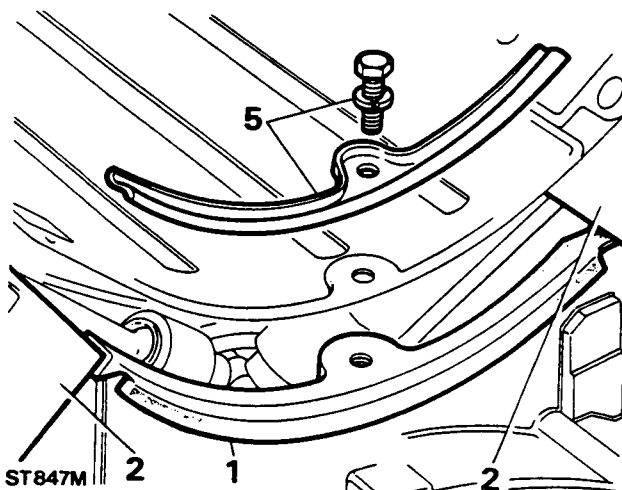


It should be noted that tappet noise can be expected on initial starting-up after an overhaul due to oil drainage from the tappet assemblies or indeed if the vehicle has been standing over a very long period. If excessive noise should be apparent after an overhaul, the engine should be run at approximately 2,500 rev/min for a few minutes (subject to the following caution), when the noise should be eliminated.

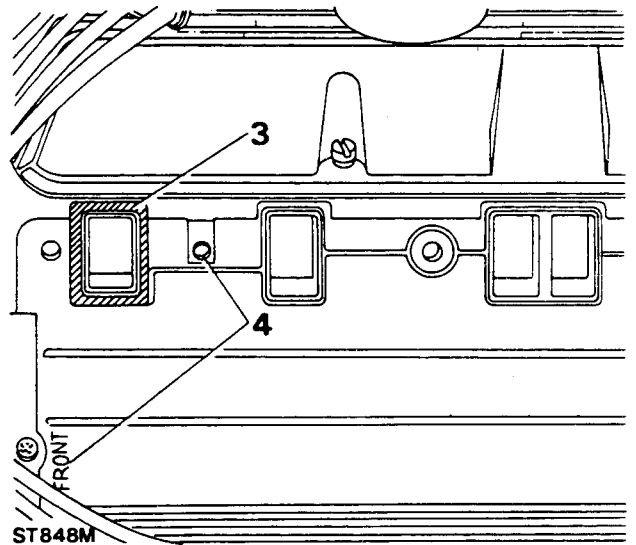
CAUTION: Do not exceed 1,000 engine rev/min when first starting the engine, otherwise the crankshaft rear oil seal will be damaged.

FIT THE INTAKE MANIFOLD

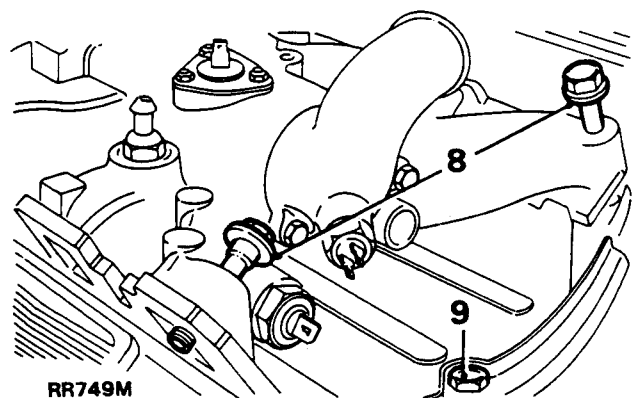
1. Coat both sides of new manifold gasket seals with silicon grease.
2. Locate the seals in position with their ends engaged in the notches formed between the cylinder head and block.



3. Apply 'Hylomar' sealing compound SQ32M on the corners of the cylinder head, manifold gasket and manifold, around the water passage joints.
4. Fit the manifold gasket with the word 'FRONT' to the front and the open bolt hole at the front R.H. side.
5. Fit the gasket clamps but do not fully tighten the bolts at this stage.

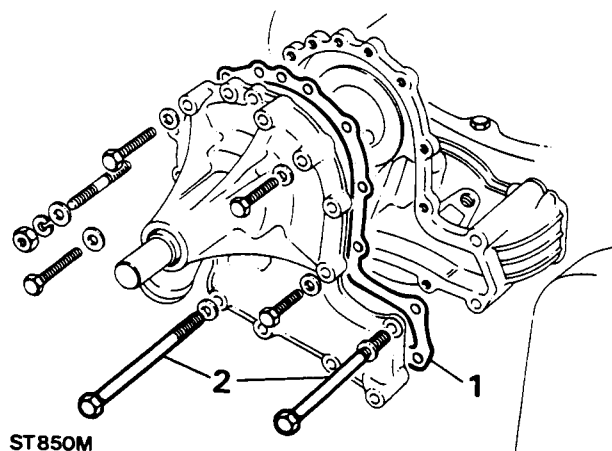
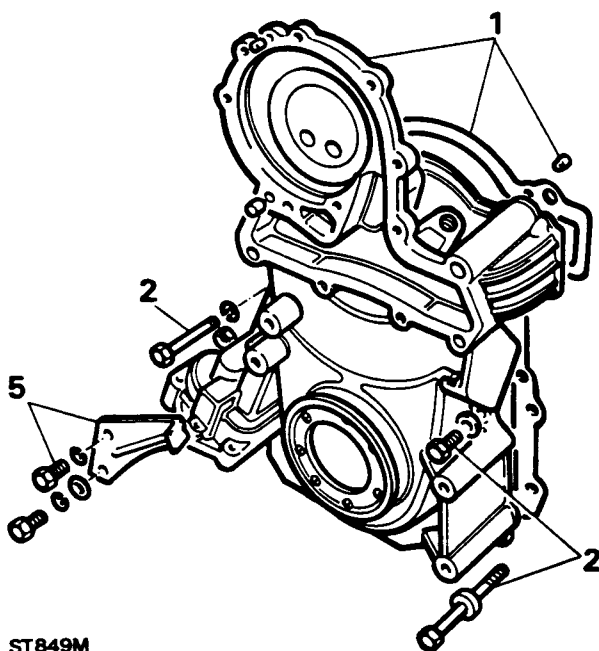


6. Locate the manifold onto the cylinder head.
7. Clean the threads of the manifold securing bolts.
8. Fit all the manifold bolts and tighten them a little at a time, evenly, alternate sides working from the centre to each end and finally tighten to the correct torque.
9. Tighten the gasket clamp bolts to the correct torque.



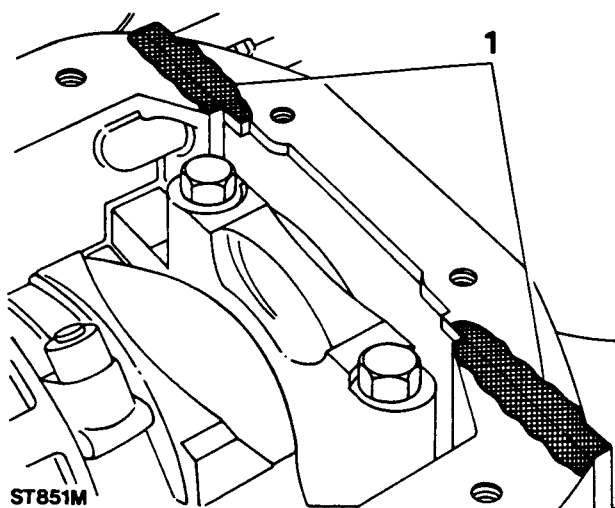
FIT THE TIMING COVER AND CRANKSHAFT PULLEY

1. Place a new timing cover joint washer in position and fit the timing cover locating it on the two dowels.
2. Clean the threads of the timing cover securing bolts, then coat them with Thread Lubricant-Sealant Loctite 572.
3. Fit and evenly tighten the timing cover bolts to the correct torque figure.
4. Fit the crankshaft pulley and tighten the retaining bolt to the correct torque.
5. Fit timing pointer.



FIT THE SUMP

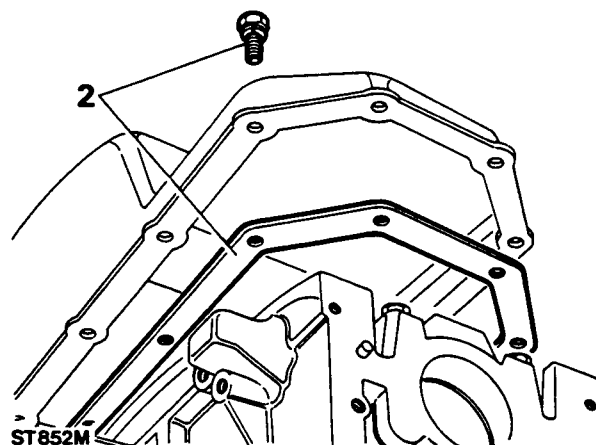
1. Clean the sump mating faces and at the joint between the timing cover and crankcase apply a coating of a universal jointing compound about 13 to 19 mm ($\frac{1}{2}$ to $\frac{3}{4}$ in) wide in the area illustrated.



2. Place the sump gasket in position, fit the sump and evenly tighten the retaining bolts to the correct torque.

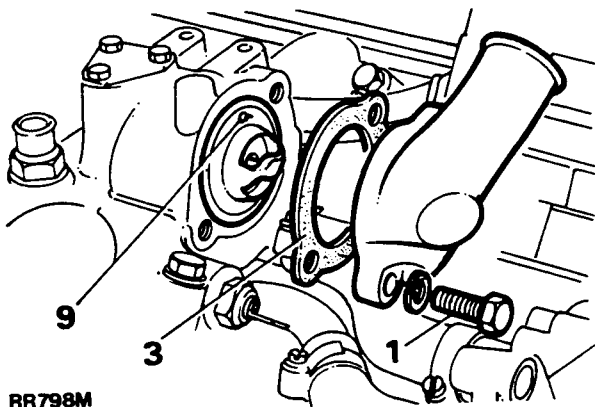
FIT THE WATER PUMP

1. Lightly grease a new joint washer and place it in position on the timing cover.
2. Clean the threads of the four long bolts and smear them with Loctite 572 thread lubricant sealant. Locate the water pump in position.
3. Locate the alternator adjusting link on the water pump.
4. Leave the alternator adjusting link loose and tighten the remaining water pump housing bolts evenly and to the correct torque.

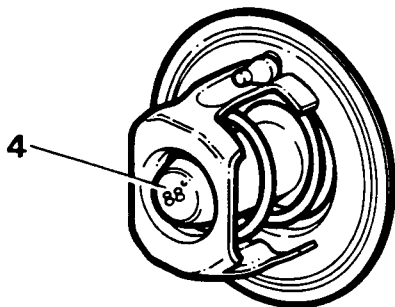


TEST AND FIT THERMOSTAT

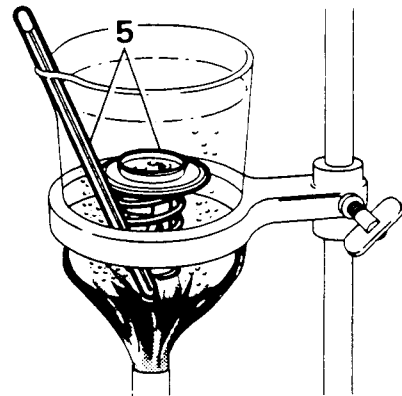
1. Remove the two bolts securing the thermostat housing to the intake manifold.
2. Remove the housing gasket.
3. Withdraw the thermostat.



4. Note the temperature stamped on the thermostat at which it should be fully open.



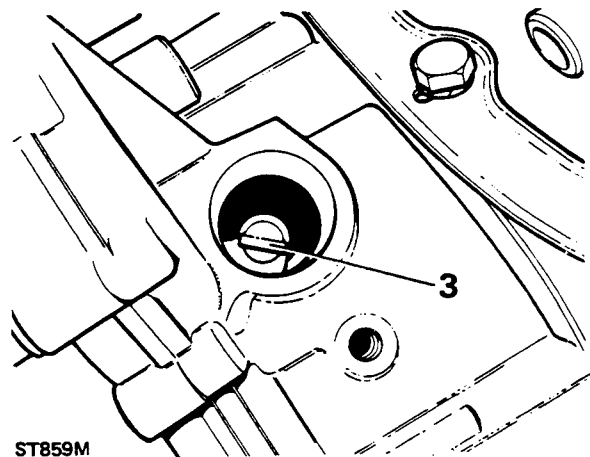
5. Place the thermostat and a Centigrade thermometer in a laboratory beaker, or a suitable alternative, half full of water.
6. Heat the water and observe the temperature at which the thermostat opens.
7. If faulty discard the thermostat.



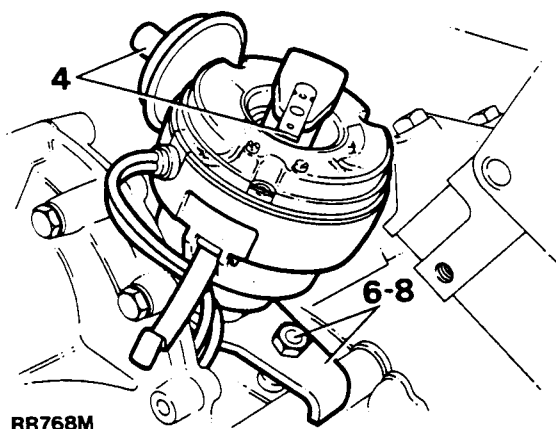
8. Clean the intake manifold and thermostat housing mating faces.
9. Fit the thermostat with the jiggle pin uppermost at 12 o'clock.
10. Fit the housing using a new gasket, and tighten the two bolts to the correct torque, see 'data section'.

FIT THE DISTRIBUTOR

1. Turn the crankshaft to bring number one piston to TDC on the compression stroke (both valves closed number one cylinder).
2. Turn distributor drive until rotor arm is approximately 30° anti-clockwise from number one sparking plug lead position on cap.
3. Turn the oil pump and distributor common drive shaft so that the tongue is in the approximate position as illustrated.



4. Fit distributor to engine and check that centre line of rotor arm is now in line with number one sparking plug lead in cap. Reposition distributor if necessary. The vacuum capsule should be at 90° to the camshaft.
5. If distributor does not seat correctly in front cover, oil pump drive is not engaged. Engage by lightly pressing down distributor while turning engine.
6. Fit clamp and bolt leaving both loose at this stage.



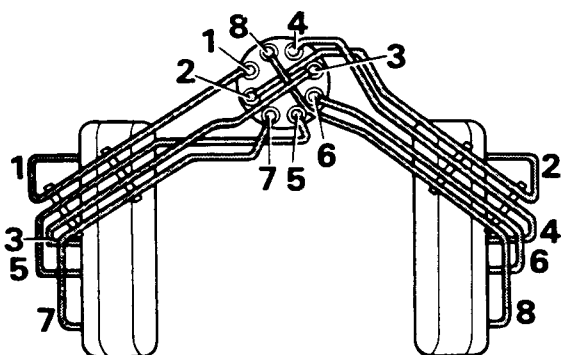
RR768M

7. Rotate distributor until the static timing is within 2–3° of TDC.

CAUTION: On no account must the engine be started before this operation is carried out.

8. Secure distributor in this position by tightening clamp bolt.
9. Fit the distributor cap and spark plugs and connect the H.T. leads in accordance with the illustration below.

NOTE: The above distributor setting is to enable the engine to be run so that the correct setting given in 'Engine Tuning Data' can be achieved once the engine is refitted to the vehicle.



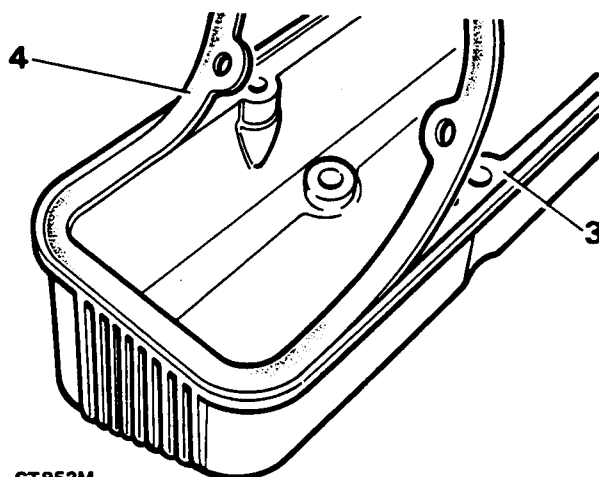
ST098

FIT ROCKER COVERS

1. Remove all traces of old gasket on the covers and cylinder heads.
2. Clean and dry the gasket mounting surface, using Bostik cleaner 6001.
3. Apply Bostik 1775 impact adhesive to the seal face and the gasket, using a brush to ensure an even film. Allow the adhesive to become touch-dry, approximately fifteen minutes.

NOTE: The gasket fits one way round only and must be fitted accurately first time; any subsequent movement would destroy the bond.

4. Place one end of the gasket into the cover recess with the edge firmly against the recess wall: at the same time hold the remainder of the gasket clear; then work around the cover, pressing the gasket into place ensuring that the outer edge firmly abuts the recess wall.

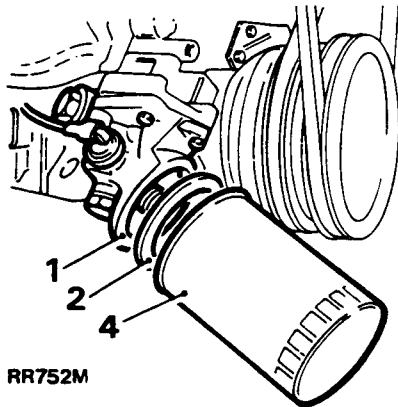


ST853M

5. Allow the cover to stand for thirty minutes before fitting it to the engine.
6. Secure the rocker covers to the engine with the four screws. Short screws—in board, long screws—out board.

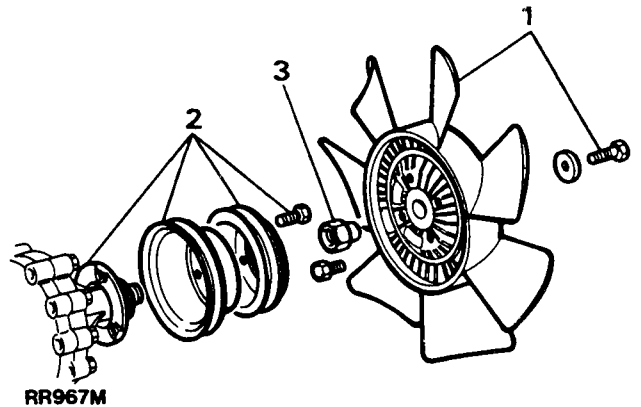
FIT ENGINE OIL FILTER

1. Clean oil pump mating face with filter.
2. Smear clean engine oil on the rubber washer of the new filter.
3. Fill the filter with new oil as far as possible, noting the angle at which the filter is to be fitted.
4. Screw on the filter until the sealing ring touches the oil pump cover face, then tighten it a further half turn by hand only. **Do not overtighten.**



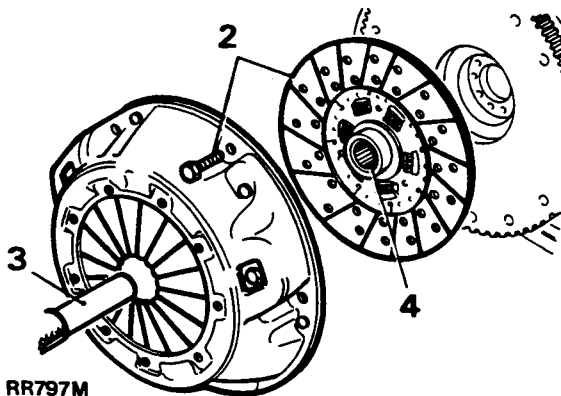
FIT THE FAN PULLEY, VISCOUS COUPLING AND FAN

1. Secure the fan to the viscous coupling with the four bolts and tighten evenly.
2. If removed, fit the pulley to hub assembly adaptor and secure with the three bolts and tighten to the correct torque.
3. Screw the viscous coupling onto the adaptor thread tighten to the correct torque—see data section.
4. Fit the fan belt and compressor belt if fitted.



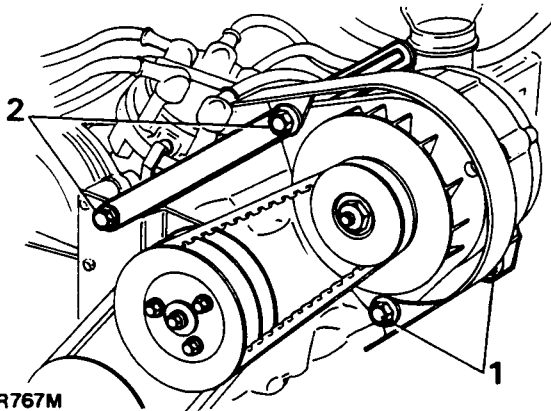
FIT THE CLUTCH

1. Clean the flywheel and clutch assembly pressure plate.
2. Fit the centre plate and the clutch assembly and loosely secure to the flywheel with the retaining bolts.
3. Insert centralising tool 18G 79 or a slave primary shaft and finally tighten the clutch assembly retaining bolts in a diagonal sequence, to the correct torque.
4. Smear the centre plate splines with Rocol MV3 or Rocol MTS 1000 grease.



FIT THE ALTERNATOR

1. Offer up the alternator to the mounting bracket and locate the pivot nuts and bolts noting that the fan guard is attached to the front nut and bolts.
2. Slacken the alternator adjustment bracket and attach alternator bracket. Note that the fan guard is attached to the adjustment bracket bolt.
3. Fit and tension the fan belt as follows:
Pivot the alternator away from the engine but in doing so, do not apply any pressure to the slip ring end bracket. Tighten the pivot nuts and bolts and adjustment bolt. The tension is correct when, with thumb pressure, the belt deflection is approximately 11 to 14 mm (0.437 to 0.562 in) between alternator and the power steering pulley. Finally, tighten the fixings and connect the wiring plug to the alternator.



RR767M

FIT THE CARBURETTERS

If removed, fit the carburetters to the induction manifold, using new joint washers in the correct sequence as illustrated.

Illustration A

1. Fit the liner.
2. Fit the two joint washers.
3. In between the washers fit the insulator.

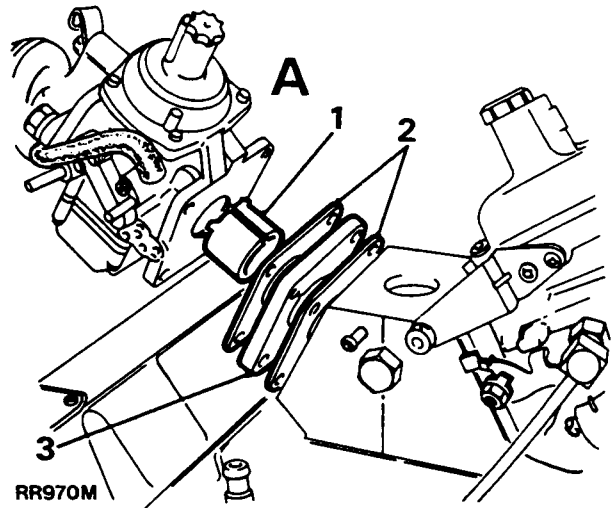
Illustration B

NOTE: Ensure the teeth are pointing towards the manifold penthouse when the deflector is refitted.

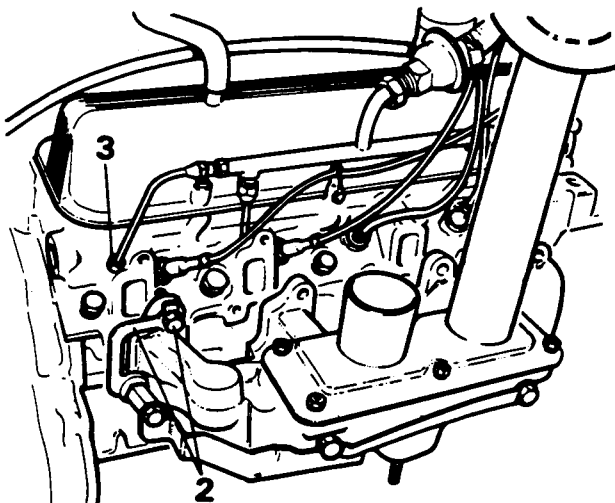
4. Fit the three joint washers.
5. Fit the saw toothed deflector.
6. Fit the insulator.

FIT EXHAUST MANIFOLD AND AIR RAILS

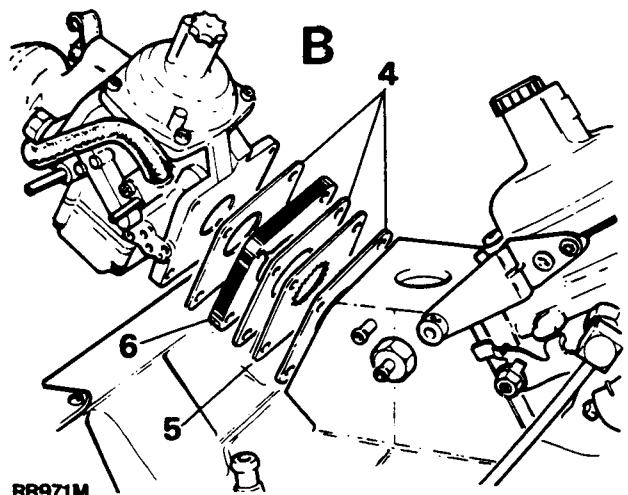
1. Ensure that the mating surfaces of the cylinder head and exhaust manifold are clean and smooth and coat the faces with 'Foliac J 166' or 'Moly Paul' anti-seize compound. 'Foliac J 166' is manufactured by Rocol Ltd., Rocol House, Swillington, Leed, England. 'Moly Paul' is manufactured by K.S. Paul Products Ltd., Nobel Road, London N18.
2. Place the manifold in position on the cylinder head and fit the securing bolts, lockplates and plain washers. The plain washers are fitted between the manifold and lockplates. Evenly tighten the manifold bolts to the correct torque figure and bend over the lock tabs.
3. Fit pulse-air rails to cylinder heads.



RR970M



RR972M



RR971M

MISCELLANEOUS AND NON-STANDARD ITEMS

Fit any other items of equipment and miscellaneous hoses, pipes, filters, clips and brackets to the positions noted during dismantling.

FAULT DIAGNOSIS

SYMPTOM	POSSIBLE CAUSE	CURE
ENGINE FAILS TO START	<ol style="list-style-type: none"> 1. Incorrect starting procedure 2. Starter motor speed too slow 3. Faulty ignition system 4. Water or dirt in fuel system 5. Carburetter(s) flooding 6. Defective fuel pump 7. Defective starter motor 8. Starter pinion not engaging 	See owners handbook Check battery and connections Check each component in system Flush out system with clean fuel Check float chamber needle valve Remove, overhaul or renew Overhaul or renew Remove starter motor and overhaul
ENGINE STALLS	<ol style="list-style-type: none"> 1. Low idling speed 2. Faulty sparking plugs 3. Faulty coil 4. Faulty reluctor 5. Incorrect mixture 6. Foreign matter in fuel system 	Adjust carburetter(s) Clean and test; renew if necessary Renew Renew Adjust carburetter(s) Investigate source of foreign matter and clean as necessary
LACK OF POWER	<ol style="list-style-type: none"> 1. Poor compression 2. Badly seating valves 3. Faulty exhaust silencer 4. Incorrect ignition timing 5. Leaks or restriction in fuel system 6. Faulty sparking plugs 7. Excessive carbon deposit 8. Brakes binding 9. Faulty coil or battery 	If the compression is appreciably less than the correct figure, the piston rings or valves are faulty. Low pressure in adjoining cylinders indicates a faulty cylinder head gasket Overhaul cylinder head(s) Renew Check and adjust using electronic equipment Check through system Clean, test and renew if necessary Decarbonize Adjust brakes or overhaul Determine which component and renew
ENGINE RUNS ERRATICALLY	<ol style="list-style-type: none"> 1. Faulty electrical connections 2. Defective sparking plugs 3. Low battery charge 4. Defective distributor 5. Foreign matter in fuel system 6. Faulty fuel pump 7. Sticking valves 8. Defective valve springs 9. Incorrect ignition timing 10. Worn valve guides or valves 11. Faulty cylinder head gaskets 12. Damaged exhaust system 13. Vacuum pipes, disconnected at inlet manifold, distributor or gearbox 	Check security of all ignition connections Clean, test and renew if necessary Recharge battery and test for condition Remove and overhaul Determine source of dirt and clean system Remove and overhaul or renew Overhaul cylinder head(s) Overhaul cylinder head(s) Check timing with electronic equipment, if possible Overhaul cylinder head(s) Renew gaskets Rectify or renew Refit pipes
ENGINE STARTS, BUT STOPS IMMEDIATELY	<ol style="list-style-type: none"> 1. Faulty electrical connections 2. Foreign matter in fuel system 3. Faulty fuel pump 4. Low fuel level in tank 	Check HT leads for cracked insulation, check low tension circuit Determine source of matter and clean system Remove, overhaul or renew Replenish
ENGINE FAILS TO IDLE	<ol style="list-style-type: none"> 1. Incorrect carburetter setting 2. Faulty fuel pump 3. Sticking valves 4. Faulty cylinder head gasket(s) 	Adjust as necessary Remove, overhaul or renew Overhaul cylinder head(s) Renew
ENGINE MISFIRES ON ACCELERATION	<ol style="list-style-type: none"> 1. Distributor incorrectly set 2. Faulty coil 3. Faulty sparking plugs 4. Faulty carburetter(s) 5. Vacuum pipes disconnected at inlet manifold 	Adjust Renew Clean, test or renew Overhaul Check all vacuum connections. Renew faulty pipes
ENGINE KNOCKS	<ol style="list-style-type: none"> 1. Ignition timing advanced 2. Excessive carbon deposit 3. Incorrect carburetter setting 4. Unsuited fuel 5. Worn pistons or bearings 6. Distributor advance mechanism faulty 7. Defective sparking plugs 	Adjust using electronic equipment Decarbonise Adjust Adjust ignition timing to suit octane rating Overhaul engine Renew capsule and re-check Clean, test and renew if necessary
ENGINE BACKFIRES	<ol style="list-style-type: none"> 1. Ignition defect 2. Carburetter defect 3. Sticking valve 4. Weak valve springs 5. Badly seating valves 6. Excessively worn valve stems and guides 7. Excessive carbon deposit 8. Incorrect sparking plug gap 9. Air leak in induction or exhaust systems 	Check all ignition components and timing Overhaul carburetter(s) } Overhaul cylinder head Clean and reset Renew faulty gaskets or components

FAULT DIAGNOSIS

SYMPTOM	POSSIBLE CAUSE	CURE
BURNED VALVES	<ol style="list-style-type: none"> 1. Sticking valves 2. Weak valve springs 3. Excessive deposit on valve seats 4. Distorted valves 5. Excessive mileage between overhauls 	<p>} Overhaul cylinder head</p>
NOISY VALVE MECHANISM	<ol style="list-style-type: none"> 1. Excessive oil in sump, causing air bubbles in hydraulic tappets 2. Worn or scored parts in valve operating mechanism 3. Valves and seats cut down excessively, raising end of valve stem, 1.27 mm (0.050 in) above normal position 4. Sticking valves 5. Weak valve springs 6. Worn timing chain or chain wheels 	<p>Drain and refill to correct level on dipstick</p> <p>Replace faulty parts</p> <p>Grind off end of valve stem or replace parts</p> <p>} Overhaul cylinder head</p> <p>Renew worn parts</p>
<p>NOISE FROM HYDRAULIC TAPPETS</p> <ol style="list-style-type: none"> 1. Rapping noise only when engine is started 2. Intermittent rapping noise 3. Noise on idle and low speed 4. General noise at all speeds <p>5. Loud noise at normal operating temperature only</p>	<ol style="list-style-type: none"> 1. Oil too heavy for prevailing temperature Excessive varnish in tappet 2. Leakage at check ball 3. Excessive leak-down 4. High oil level in sump Leakage at check ball Worn tappet body Worn camshaft 5. Excessive leak-down rate or scored lifter plunger 	<p>Drain and refill with correct grade</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Drain and refill to correct level on dipstick</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Replace camshaft</p> <p>Replace tappet</p>
MAIN BEARING RATTLE	<ol style="list-style-type: none"> 1. Low oil level in sump 2. Low oil pressure 3. Excessive bearing clearance 4. Burnt-out bearings 5. Loose bearing caps 	<p>Replenish as necessary to high mark on dipstick</p> <p>Worn bearings</p> <p>Renew bearings; grind crankshaft</p> <p>Renew and investigate reason for failure</p> <p>Tighten to correct torque</p>
<p>LOW OIL PRESSURE WARNING LIGHT REMAINS ON, ENGINE RUNNING</p> <p>ON, ENGINE RUNNING</p>	<ol style="list-style-type: none"> 1. Thin or diluted oil 2. Low oil level 3. Choked pump strainer 4. Faulty release valve 5. Excessive bearing clearance 6. Oil pressure switch unserviceable 7. Electrical fault 8. Relief valve plunger sticking 9. Weak relief valve spring 10. Pump rotors excessively worn 11. Excessively worn bearings; main connecting rod, big end, camshaft, etc 	<p>Drain and refill with correct oil and renew filter</p> <p>Replenish to high mark on dipstick</p> <p>Clean</p> <p>Rectify</p> <p>Rectify</p> <p>Renew</p> <p>Check circuit</p> <p>Remove and ascertain cause</p> <p>Renew</p> <p>Overhaul oil pump</p> <p>Ascertain which bearings and rectify</p>
RATTLE IN LUBRICATION SYSTEM	<ol style="list-style-type: none"> 1. Oil pressure relief valve plunger sticking 	<p>Remove and clean</p>
ENGINE OVERHEATING	<ol style="list-style-type: none"> 1. Low coolant level 2. Faulty cooling system 3. Faulty thermostat 4. Incorrect timing 5. Defective lubrication system 	<p>Check for leaks. Check expansion tank level</p> <p>Check fan and belt, pump, radiator fins not blocked</p> <p>Test and renew if necessary</p> <p>Check and adjust using electronic equipment</p> <p>Renew filter. Check pump. Clean strainer.</p> <p>Check oil circulation</p>
<p>MECHANICAL NOISES:</p> <p>Medium low pitch knock</p> <p>Low pitch thud</p> <p>High pitch tap</p> <p>Intermittent thuds</p> <p>Continual slapping</p>	<p>Big end bearing slack or run</p> <p>Main bearing slack or run</p> <p>Worn gudgeon pins</p> <p>Loose flywheel or excessive crankshaft end-float</p> <p>Piston clearance excessive—more apparent when engine cold, may disappear when engine hot</p>	

