

12 - ENGINE

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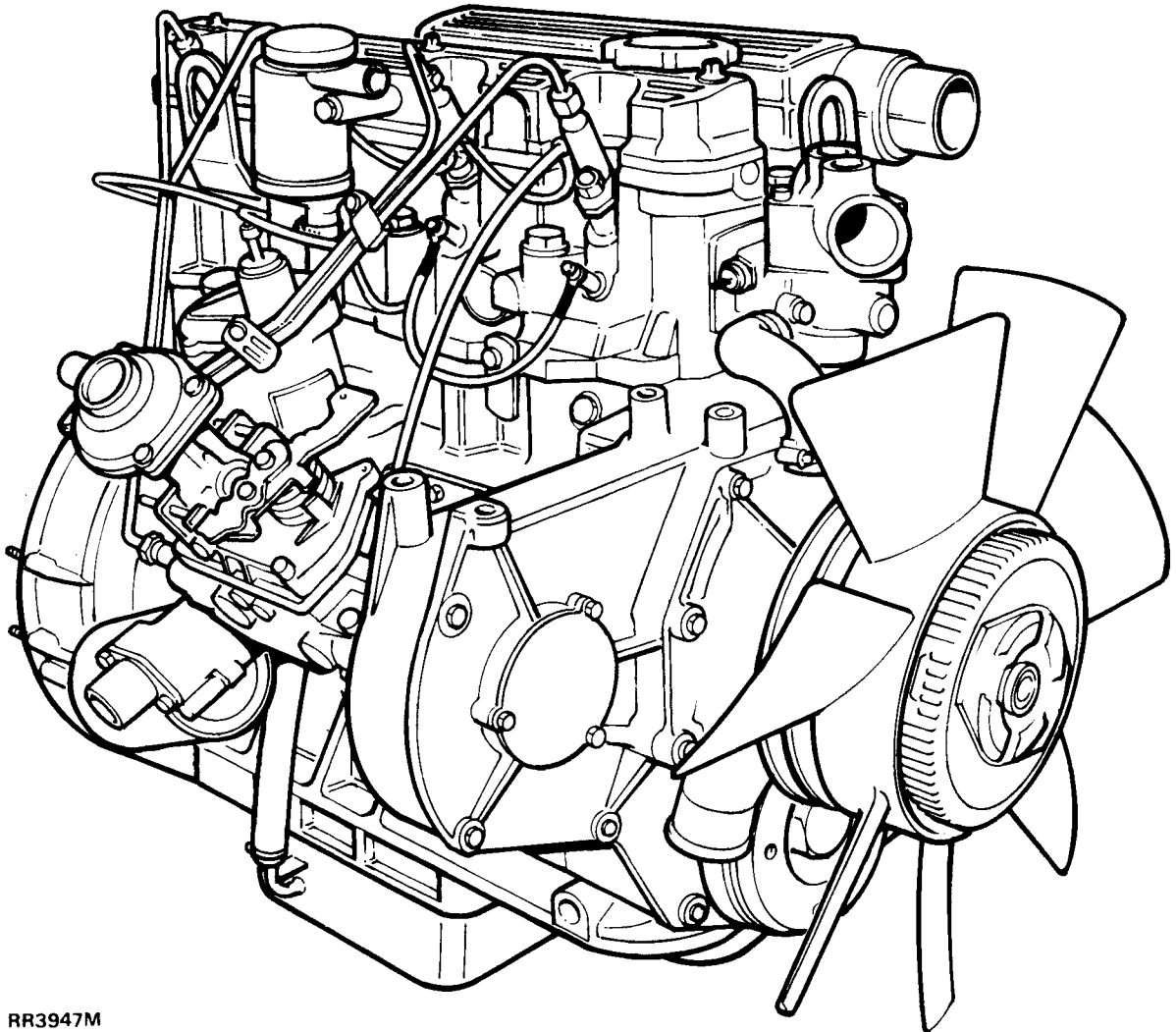
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DESCRIPTION



RR3947M

The four cylinder turbocharged direct injection engine is an optional power unit for both Range Rover and Discovery.

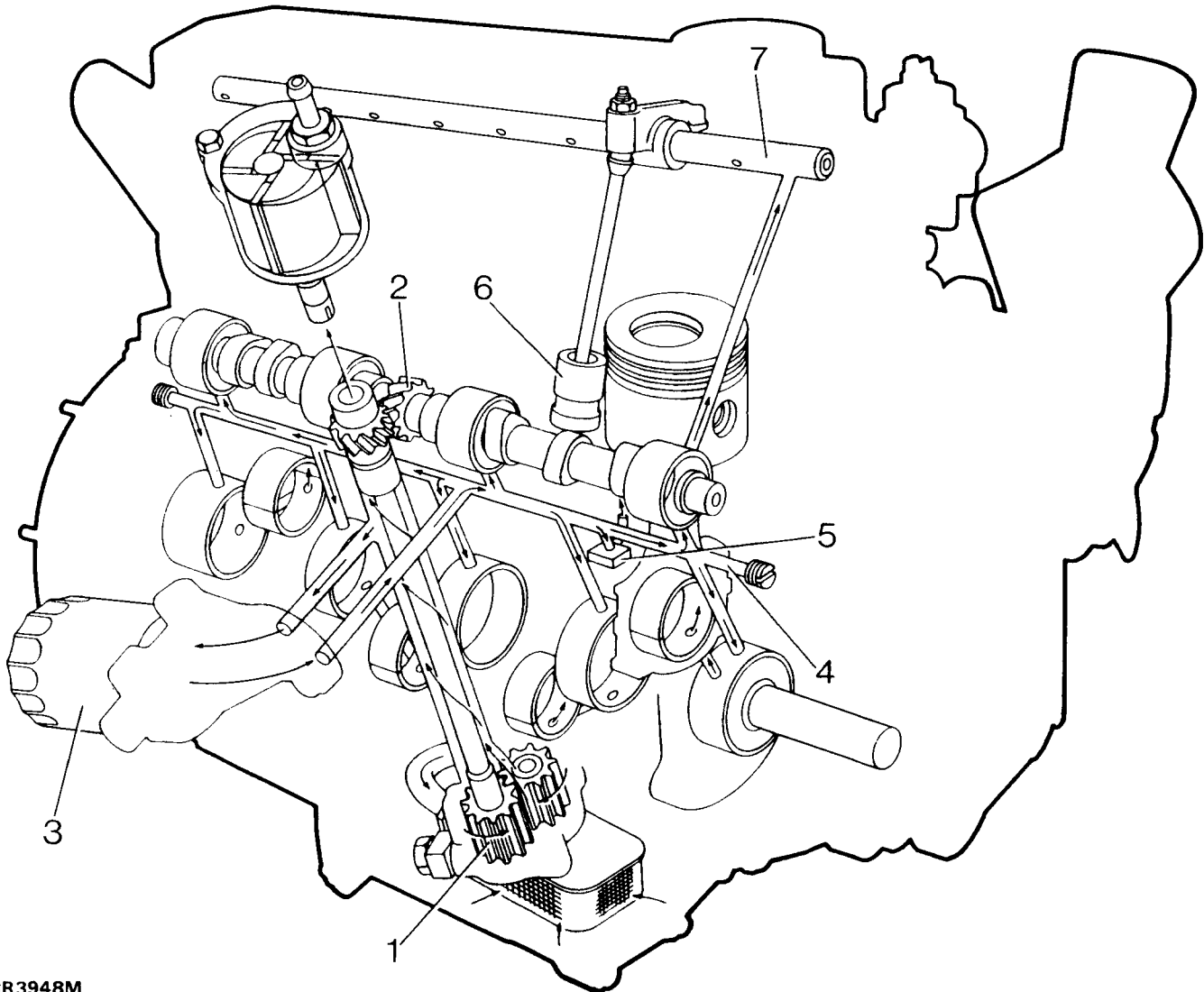
The engine consists of three main castings, cylinder block, ladder frame and cylinder head. The cast iron cylinder block includes the integral cylinders, line bored main bearing locations and caps and bearing locations for support of the camshaft. The cast aluminium ladder frame is bolted to the bottom face of the cylinder block, providing additional rigidity and noise suppression.

The cast aluminium cylinder head is secured to the cylinder block with eighteen bolts. The head gasket is selected from three different thicknesses to ensure optimum combustion efficiency and performance.

Crankshaft end float is controlled by two selective half thrust washers, one each side of the centre main bearing.

The roller tappet camshaft and fuel injection pump are driven off the front of the crankshaft by a totally enclosed toothed rubber timing belt.

Lubrication system - RR3948M



RR3948M

The lubrication system employs a submerged gear type oil pump (1) driven by the camshaft and skew gear (2). Oil drawn into the gears through the steel gauze filter is pumped up the cavity between the pump body and the vertical drive shaft to the external oil filter (3).

After passing through the filter, the oil flows through the distribution oil gallery (4) and drillings in the cylinder block to lubricate the crankshaft main and big end bearings and the camshaft bearings. The thrust side of each cylinder is lubricated direct from the distribution gallery by separate oil jet tubes (5).



Lubrication to the front camshaft bearing continues through more drillings in the cylinder block to lubricate the roller tappets (6). The rocker shaft (7) is lubricated via a vertical drilling in the cylinder head. The clearance around the pushrods and large ports in the camshaft chamber allows oil drainage to lubricate the skew gear and return to the sump.

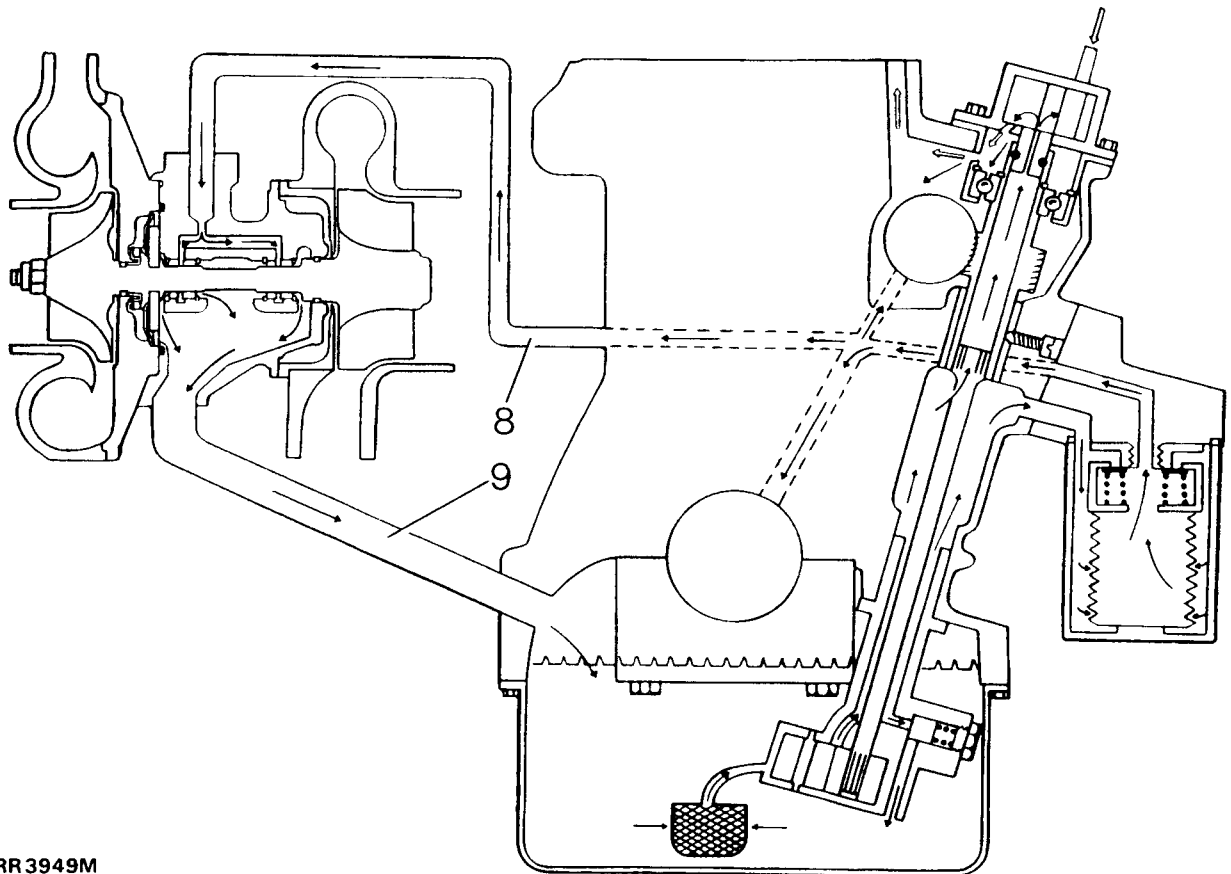
Three of the four camshaft bearing lubrication drillings in the cylinder block are drilled externally. These drillings which are visible on the right hand side of the block are blanked off by each bearing and sealed using an aluminium plug and silicon sealant.

The oil which is pumped up between the vertical drive shaft and pump body is unfiltered. This oil lubricates the skew gear bush and passes through the centre of the skew gear to lubricate the brake servo vacuum pump.

System pressure is controlled by a non adjustable pressure relief valve located in the pump body.

Turbocharger lubrication - RR3949M

The turbocharger bearings are lubricated with filtered oil from the gallery in the cylinder block (8) at pump pressure. After lubricating the bearings the oil returns to the sump via a large diameter drain hose (9). As the turbocharger bearings are subject to extremely high speeds and temperatures, it is essential that they are well sealed, cooled and lubricated.

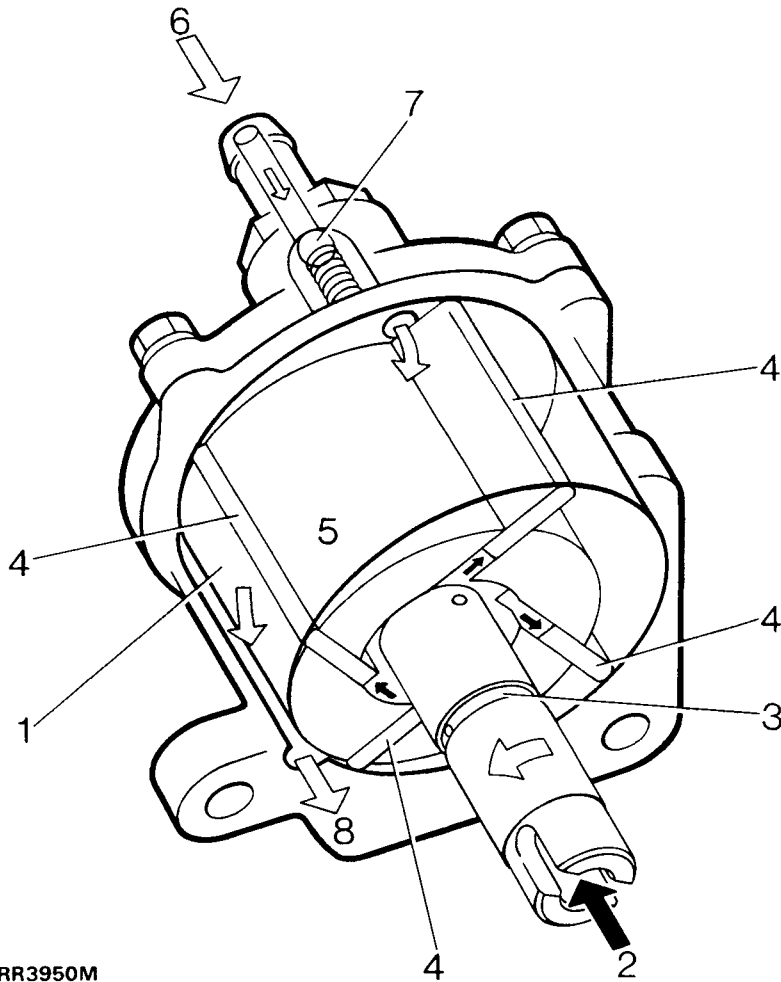


RR 3949M

Brake servo vacuum pump - RR3950M**Lubrication**

The brake servo vacuum pump rotor (1) is lubricated with unfiltered oil direct from the engine oil pump. Oil is supplied via the centre of the skew gear (2), where it lubricates the vacuum pump shaft (3) and is fed into slots behind each of the four carbon vanes (4).

Oil pressure behind the vanes exerts a force which ensures that they follow the contours of the pump chamber (5) to form a good seal. An 'O' ring is fitted inside the hollow skew gear to form a seal with the pump shaft to prevent pressure leakage. The condition of this 'O' ring should be checked if low oil pressure occurs, before continuing with any further diagnosis.



RR3950M



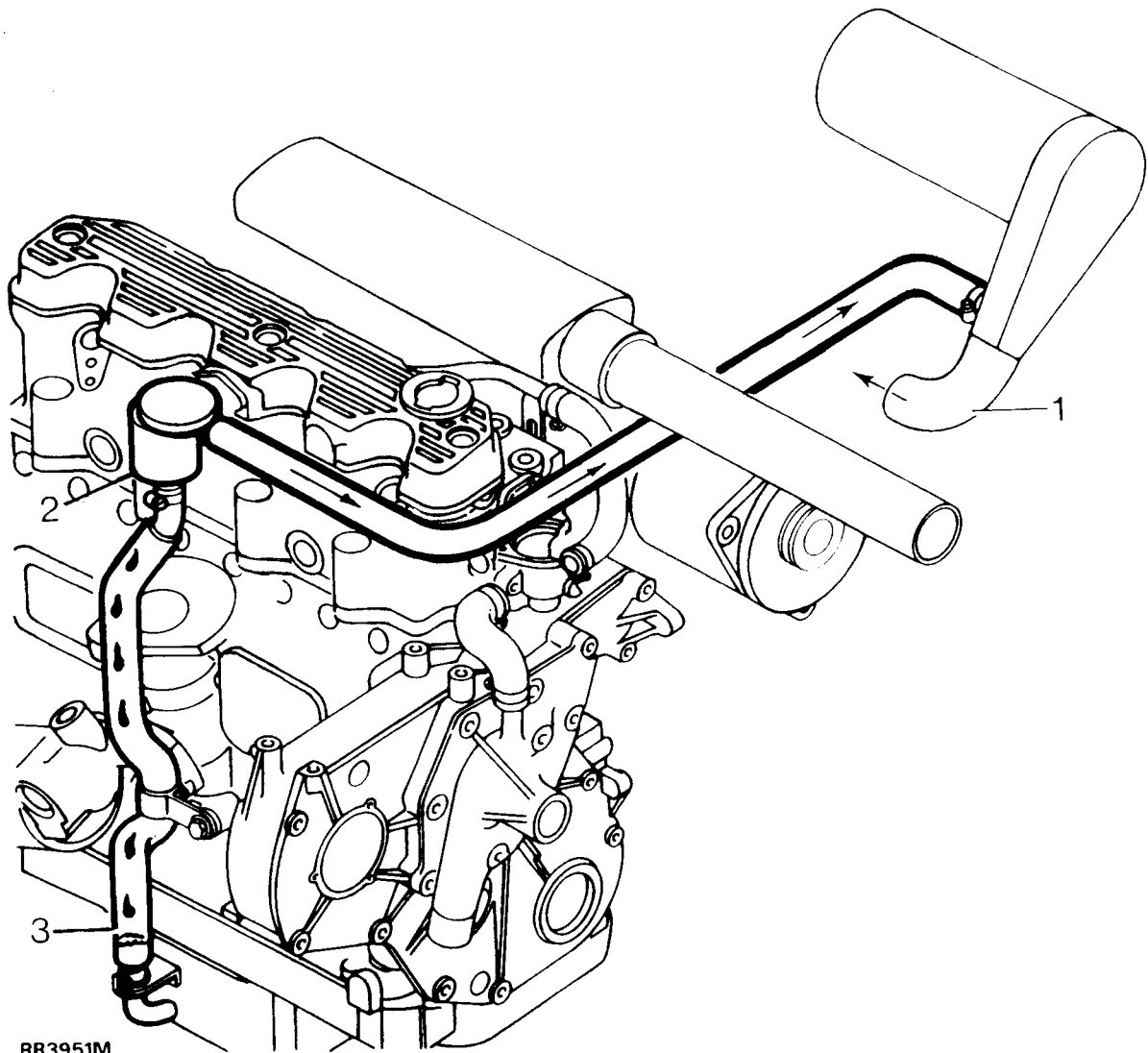
Operation

With the brake servo hose connected and the vacuum pump operating, the pump will be producing a depression ready to operate the brakes. Each time the brakes are applied and released the pump will draw a small volume of air (6) from the servo chamber past valve (7) and discharge it through the pump outlet (8) into the cylinder block. Provided the vacuum pump is not pumping an excessive volume of air, the crankcase ventilation system will not be affected. However, if the engine is operated with a faulty brake servo, damaged or disconnected vacuum hose, the pump can force an uncontrolled volume of air into the crankcase ventilation system causing pressure build up.

Crankcase ventilation system - RR3951M

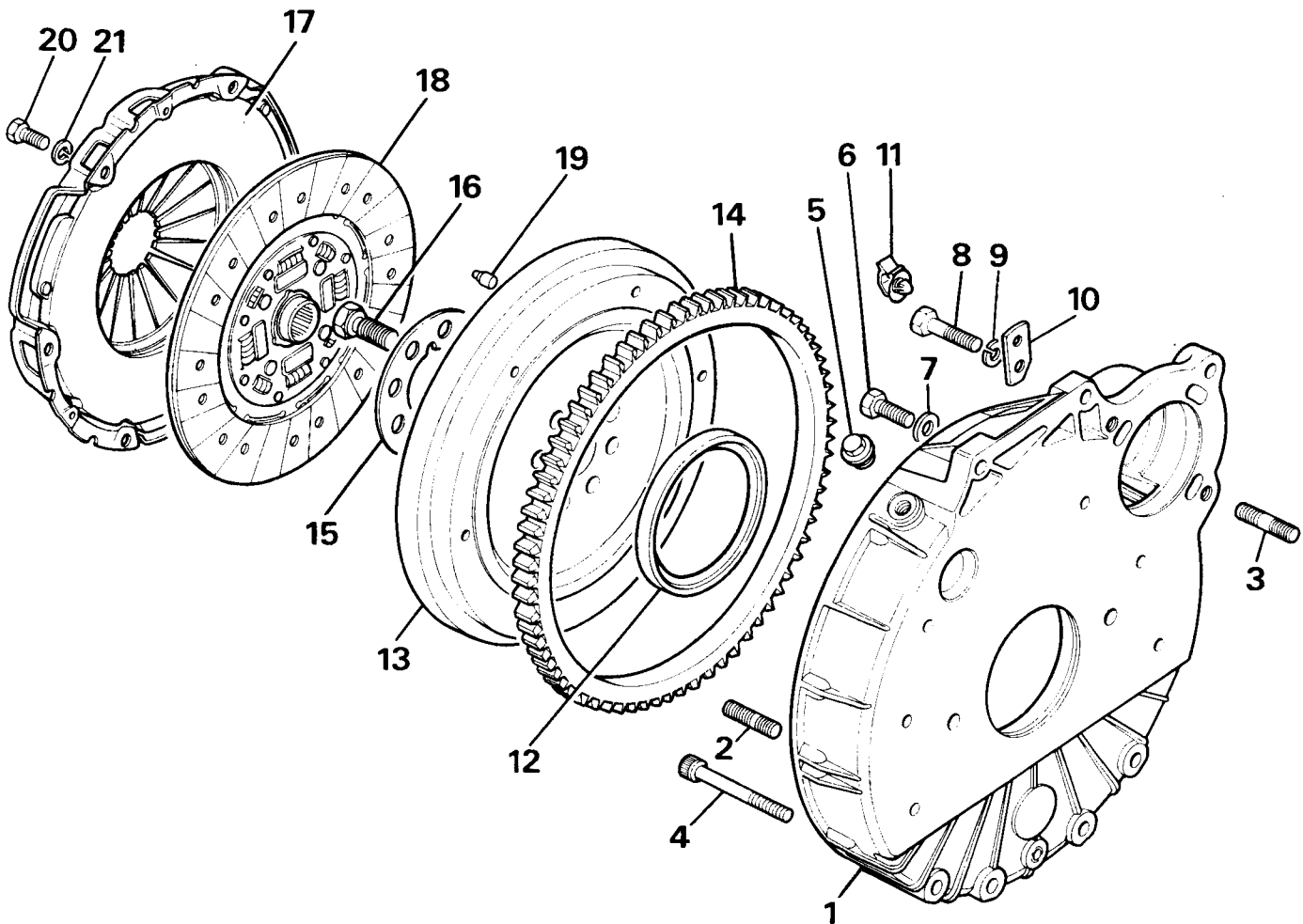
The crankcase ventilation system is associated with drainage of lubricant to the sump and is designed to separate the oil from the gaseous atmosphere before the residue is fed into the inlet system and burned in the combustion chamber.

Oil laden air in the engine is drawn from the rocker cover by depression created in the air intake (1). The breather cyclone (2), fitted to the rocker cover, acts as an oil separator. It controls the rate at which air is purged from the sump and extracts the oil. The oil extracted drains back down hose (3) to the sump. The remaining air is controlled by a diaphragm valve in (2), before passing, via the turbocharger, into the engine where it is burned.



CLUTCH AND FLYWHEEL HOUSING COMPONENTS

- | | |
|-------------------------------|---------------------------------|
| 1. Clutch housing | 12. Oil seal |
| 2. Clutch housing stud (9) | 13. Flywheel |
| 3. Starter motor stud (1) | 14. Starter ring |
| 4. Allen bolts (4) | 15. Reinforcing plate |
| 5. Plug (2) | 16. Bolt flywheel to crankshaft |
| 6. Screw housing to block (6) | 17. Clutch cover |
| 7. Washer (6) | 18. Clutch plate |
| 8. Bolt housing to block (2) | 19. Dowel |
| 9. Spring washer (2) | 20. Screw |
| 10. Bracket (2) | 21. Spring washer |
| 11. Harness clip (2) | |

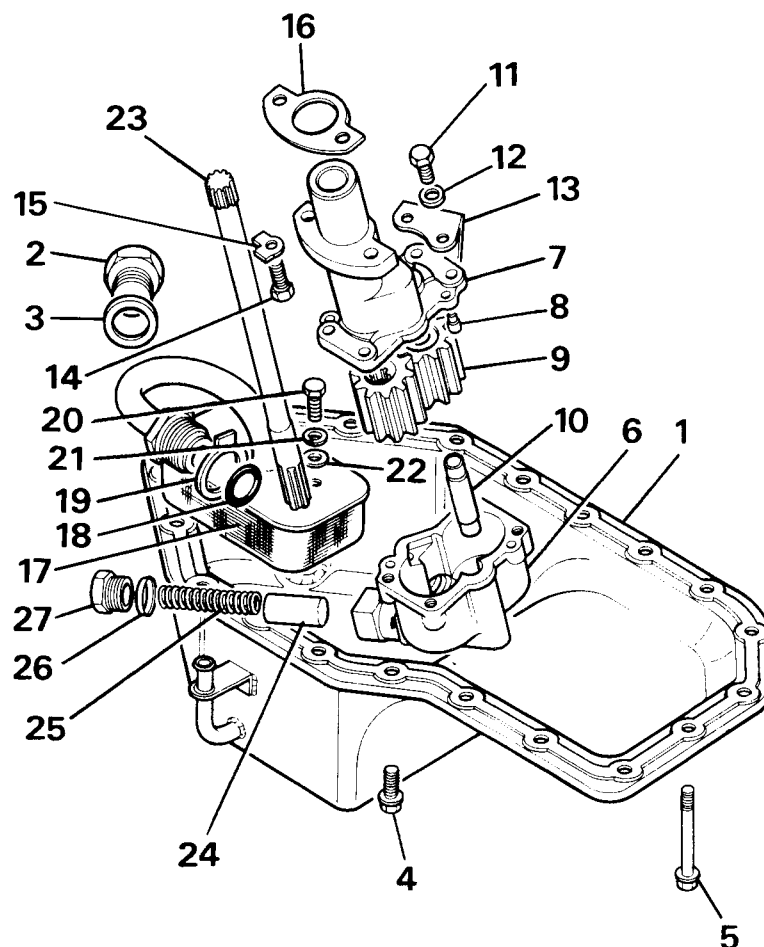


ST3066M



SUMP AND OIL PUMP COMPONENTS

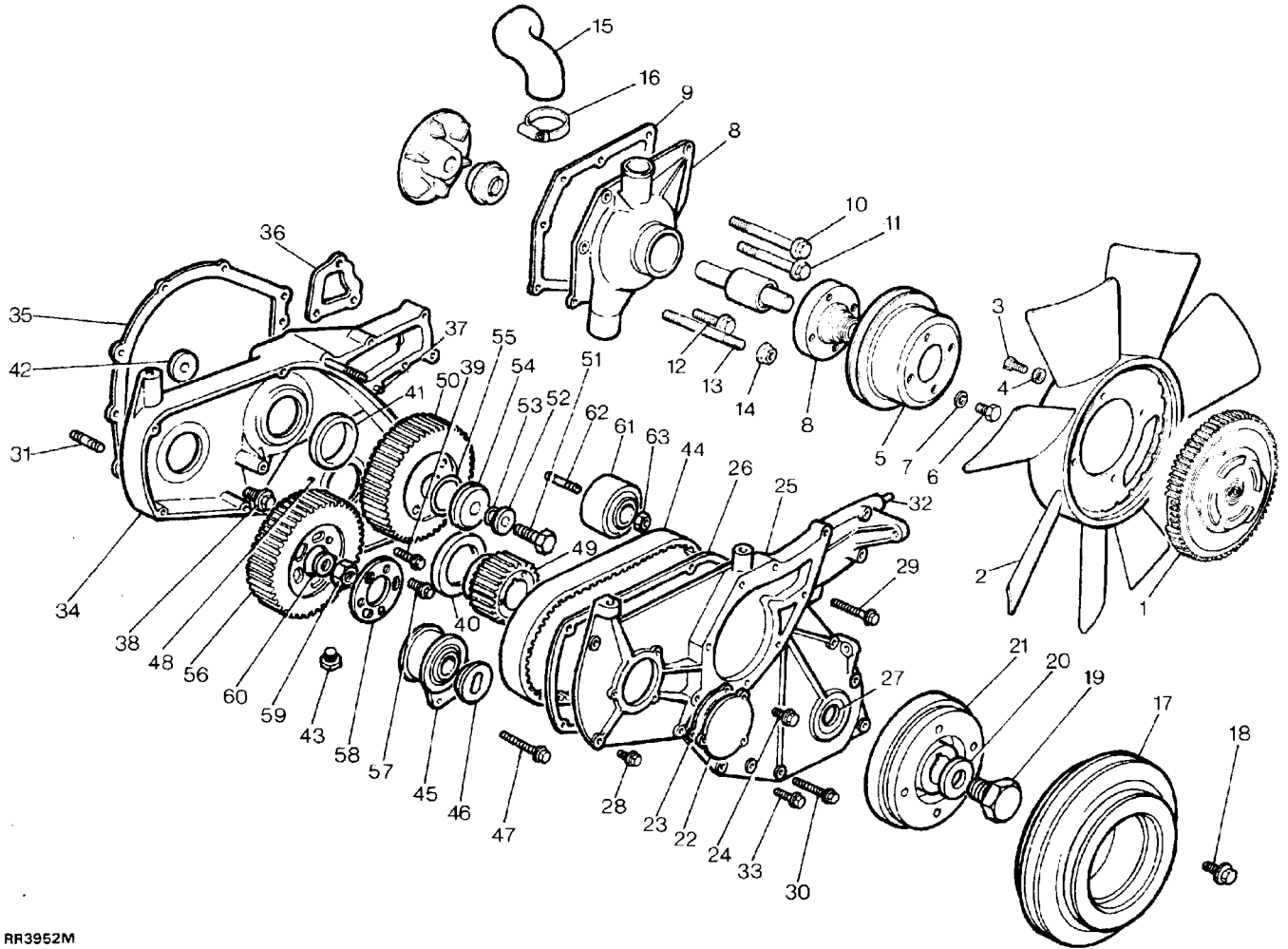
- | | |
|---------------------------|------------------------|
| 1. Sump | 15. Lock washer |
| 2. Drain plug | 16. Gasket |
| 3. Joint washer | 17. Filter |
| 4. Flange bolt M8x20 (8) | 18. 'O' ring |
| 5. Flange bolt M8x60 (12) | 19. Lock washer |
| 6. Oil pump housing lower | 20. Screw |
| 7. Oil pump housing upper | 21. Spring washer |
| 8. Dowel | 22. Plain washer |
| 9. Oil pump gears | 23. Drive shaft |
| 10. Spindle | 24. Oil relief plunger |
| 11. Screw | 25. Spring |
| 12. Spring washer | 26. Joint washer |
| 13. Support bracket | 27. Oil relief plug |
| 14. Screw | |



ST3065M

FRONT COVER COMPONENTS

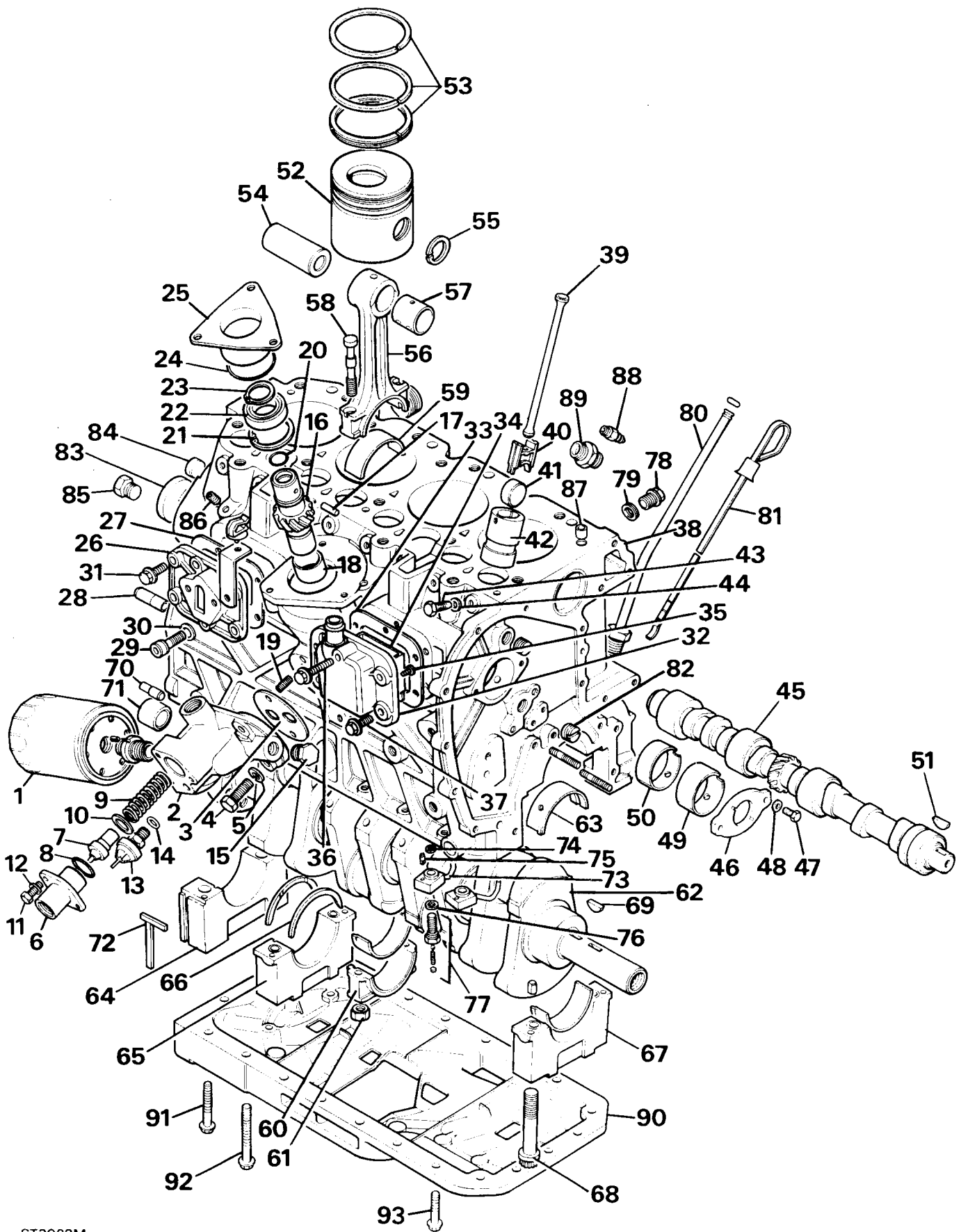
1. Viscous unit
2. Fan assembly
3. Bolt (4)
4. Plain washer (4)
5. Pulley
6. Screw (3)
7. Spring washer (3)
8. Water pump assembly
9. Gasket
10. Flange bolt M8x55 (2)
11. Flange bolt M8x110 (1)
12. Flange screw M8x25 (3)
13. Stud M8x110
14. Flange nut M8
15. By-pass hose
16. Hose clip
17. Crankshaft pulley
18. Flange bolts M8x20 (4)
19. Crankshaft pulley bolt
20. Washer
21. Torsional vibration damper
22. Inspection plate
23. Gasket
24. Flange screw M6x20 (3)
25. Front cover plate
26. Gasket
27. Cover plate seal
28. Flange screw M8x25 (3)
29. Flange bolt M8x90 (2)
30. Flange bolt M8x80 (4)
31. Stud injection pump to front cover M8x92 (3)
32. Stud M8x35 (1)
33. Flange bolt M8x35
34. Front cover
35. Front cover gasket
36. Front cover/water inlet gasket
37. Front cover dowel
38. Flange screw M8x25 (1)
39. Flange bolt M8x70 (1)
40. Crankshaft oil seal
41. Camshaft oil seal
42. Gasket block front face
43. Wading plug
44. Timing belt
45. Timing belt tensioner assembly
46. Slotted washer
47. Flange bolt M10x70
48. Tensioner pivot pin
49. Crankshaft gear wheel
50. Camshaft gear wheel
51. Bolt
52. Washer
53. 'O' ring
54. Retaining plate
55. 'O' ring
56. Injection pump timing gear
57. Flange screw (3)
58. Retaining plate
59. Nut
60. Spring washer (3)
61. Idler pulley
62. Stud
63. Nut



RR3952M

CYLINDER BLOCK COMPONENTS

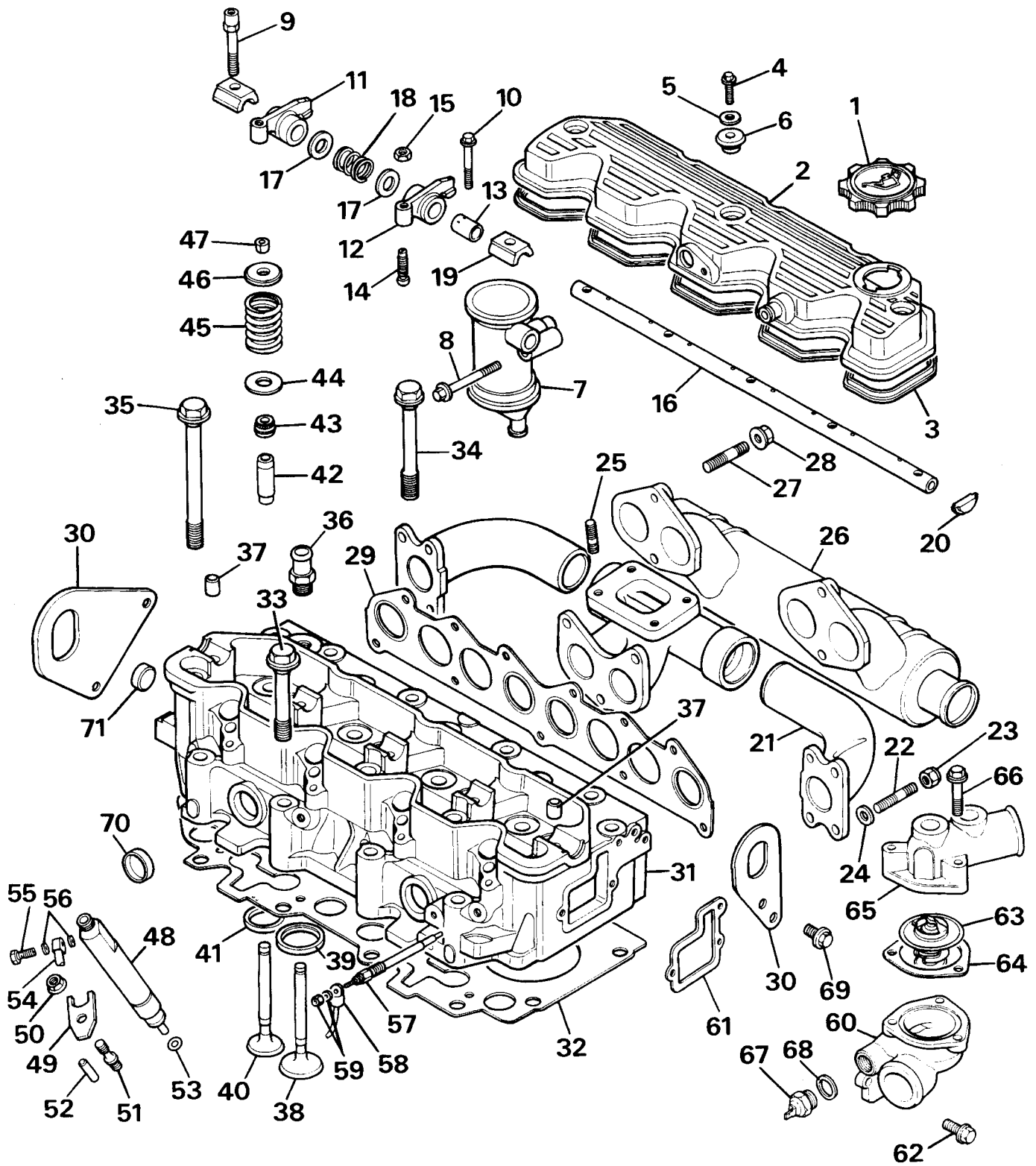
1. Oil filter element
2. Oil filter adaptor
3. Gasket
4. Screw (2)
5. Spring washer (2)
6. Oil cooler adaptor
7. Thermostat bulb
8. 'O' ring
9. Spring
10. Washer
11. Screw (2)
12. Washer (2)
13. Oil pressure switch
14. Copper washer
15. Blanking plug
16. Skew gear
17. Dowel pin
18. Bush
19. Locking screw
20. 'O' ring
21. Snap ring external
22. Deep groove bearing
23. Snap ring internal
24. 'O' ring bearing housing
25. Bearing housing
26. Rear side cover
27. Gasket
28. Dowel flywheel housing (2)
29. Socket screw (2)
30. Washer (2)
31. Flange bolts (6)
32. Front side cover breather
33. Gasket
34. Baffle plate
35. Screw No.6 (2)
36. Flange bolt M8x40(1)
37. Flange screw M8x25 (5)
38. Cylinder block
39. Pushrod
40. Tappet slide
41. Roller follower
42. Tappet guide
43. Set bolt
44. Washer
45. Camshaft
46. Locking plate
47. Screw (2)
48. Spring washer (2)
49. Camshaft bearing - front
50. Camshaft bearing - inter/rear (3)
51. Camshaft key
52. Piston
53. Piston rings
54. Gudgeon pin
55. Circlip (8)
56. Connecting rod
57. Gudgeon pin bush
58. Connecting rod bolt
59. Big end bearing
60. Big end bearing cap
61. Connecting rod nut
62. Crankshaft
63. Crankshaft main bearing
64. Main bearing cap - rear
65. Main bearing cap - centre
66. Thrust washers
67. Main bearing cap (3)
68. Main bearing cap bolt
69. Crankshaft key
70. Crankshaft dowel
71. Crankshaft bush
72. Packing strip
73. Jet adaptor
74. Joint washer
75. Dowel
76. Joint washer
77. Relief valve assembly
78. Drain plug
79. Joint washer
80. Dipstick tube
81. Dipstick
82. Oil gallery plug
83. Cup plug (5)
84. Cup plug
85. Oil gallery plug
86. Camshaft oil feed plug (3)
87. Ring dowel (2)
88. Oil feed adaptor
89. Oil drain adaptor
90. Ladder frame
91. Flange bolt M8x125 (3)
92. Flange bolt M8x60 (4)
93. Flange screw M8x30 (3)



ST3063M

CYLINDER HEAD COMPONENTS

1. Oil filler cap
2. Rocker cover
3. Rocker cover gasket
4. Flange headed bolt
5. Washer
6. Sealing washer
7. Breather cyclone
8. Flange headed screw
9. Rocker shaft bolt (3)
10. Rocker shaft bolt (2)
11. Rocker arm RH
12. Rocker arm LH
13. Rocker arm bush
14. Tappet adjuster screw
15. Locknut
16. Rocker shaft
17. Rocker shaft spacer
18. Rocker shaft spring
19. Rocker shaft clamp
20. Rocker shaft seal
21. Exhaust manifold
22. Manifold stud exhaust
23. Self locking nut
24. Plain washer
25. Stud turbocharger mounting
26. Inlet manifold
27. Manifold stud inlet
28. Flange nut
29. Manifold gasket
30. Engine lifting brackets
31. Cylinder head
32. Cylinder head gasket
33. Head bolts M12 short (4)
34. Head bolts M12 long (10)
35. Head bolts M10 (4)
36. Adaptor cooling system
37. Ring dowel
38. Valve inlet
39. Valve seat insert
40. Valve exhaust
41. Valve seat insert
42. Valve guide
43. Valve steam seal
44. Valve spring seat
45. Valve spring
46. Valve spring cup
47. Split cotters
48. Injector
49. Injector clamp
50. Injector clamp nut
51. Injector clamp stud
52. Injector clamp dowel
53. Injector sealing washer
54. Spill return pipe
55. Banjo bolt 6mm
56. Copper washer
57. Glow plug
58. Glow plug cable
59. Nut and washer
60. Thermostat housing
61. Gasket
62. Flange screw (3)
63. Thermostat
64. Gasket
65. Thermostat housing cover
66. Flange bolt M6x40 (3)
67. Thermal transmitter
68. Joint washer
69. Flange bolt
70. Cup plug (1)
71. Cup plug (2)



ST3062M



ENGINE OVERHAUL

Engine data

For engine general specification data See **GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**

Remove engine from vehicle and clean. See **Repair Engine.**

To overhaul the engine requires the use of service tools. See **Service tools Tdi engine.**

The use of a purpose designed engine stand is recommended. Secure engine to stand. Drain the sump oil.



NOTE: The position of brackets, clips, harness, pipes, and hoses, and any non standard items, for assembly.

Remove the following components where applicable:-

Air conditioning compressor.

Power steering pump and alternator.

Starter motor.

Engine electrical harness.

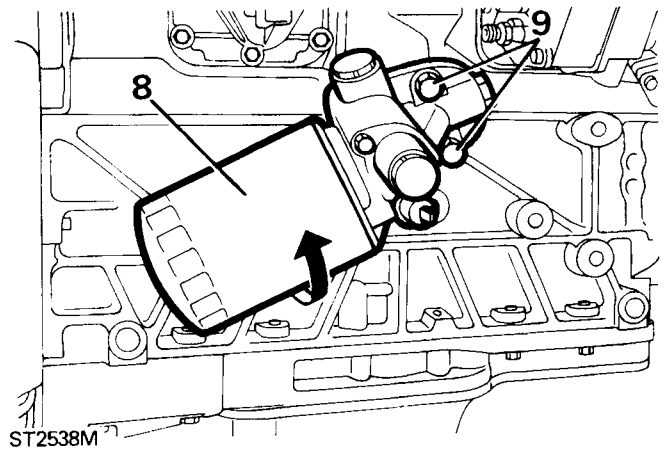
Air inlet manifold

Exhaust manifold and turbocharger

Water pump

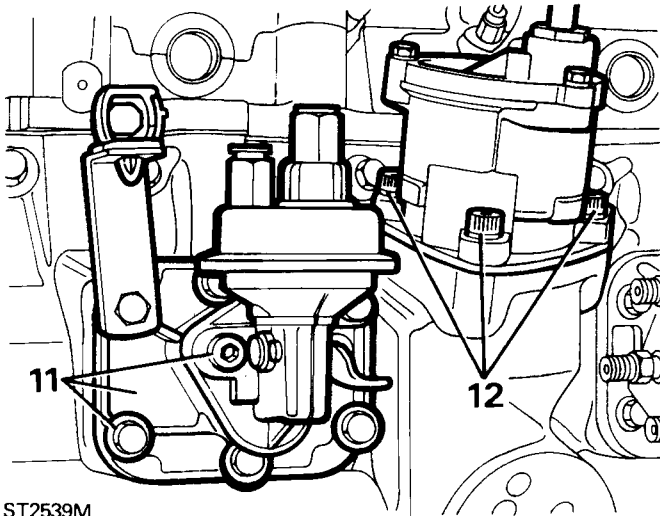
Clutch

1. Loosen all the union nuts at the injectors and injection pump and then remove the pipes from the engine.
2. Remove the spill return pipes from the injectors and injection pump and retrieve the washers.
3. Disconnect the electrical lead from the fuel cut-off switch at the rear of the injector pump.
4. Disconnect the lead from the oil pressure switch.
5. Disconnect the electrical leads from the heater plugs.
6. Remove the lead from the engine coolant temperature switch.
7. Check that all the electrical leads have been disconnected. Release the harness from the retaining clips and remove from the engine.
8. Unscrew the oil filter cartridge, anti-clockwise, using a strap wrench if necessary. Dispose of the oil safely.
9. Release the two bolts and remove the oil filter adaptor and gasket from the engine.



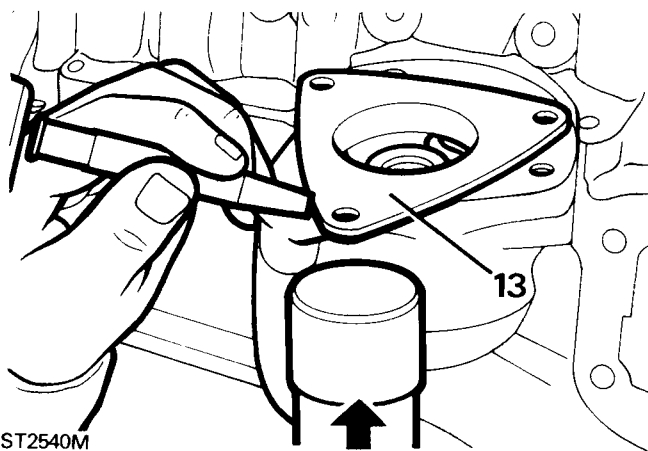
10. Remove the single bolt and pull the engine breather canister from the rocker cover. Also release the breather hose from the sump connection and remove from the engine.

11. If the fuel lift pump is suspected of being faulty it can be removed from the rear cover by releasing the two retaining screws using a 6 mm Allen key. Alternatively, it can be removed still attached to the rear cover, by removing the six bolts.
12. Mark the position of the brake servo vacuum pump with relation to the cylinder block. Using a 6 mm Allen key remove the three screws and lift out the pump.

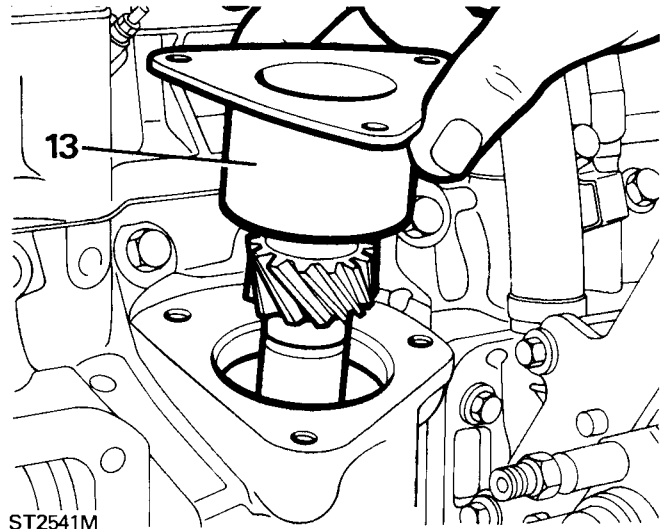


ST2539M

13. Similarly, mark the relationship of the skew gear flange with the cylinder block and the skew gear teeth with the camshaft gear teeth. To remove the skew gear assembly, tap the flange round so that the edges overlap the cylinder block. Tap the flange upwards sufficiently to enable the skew gear assembly to be lifted out.



ST2540M

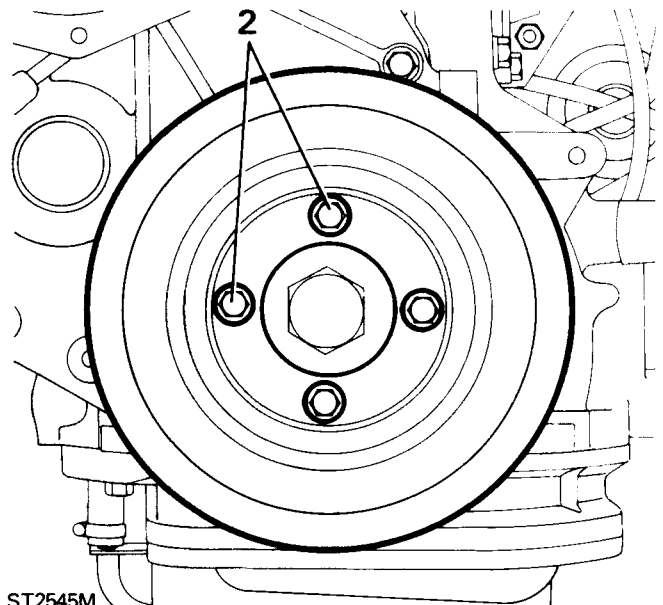


ST2541M

14. Using a length of wire or long nosed pliers withdraw the oil pump drive shaft.

CHECK INJECTION PUMP TIMING

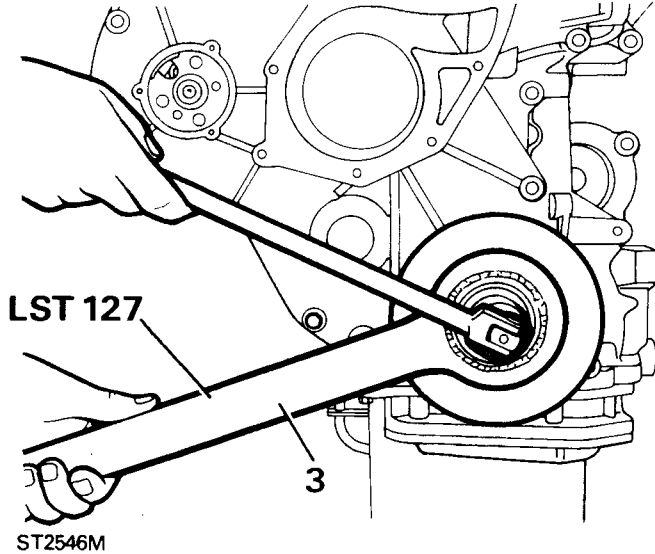
1. Evenly loosen and remove the three rocker shaft cover retaining bolts and remove the cover so that the position of the valves in relation to the crankshaft and pistons may be seen.
2. Release the four bolts and remove the crankshaft pulley from the damper.



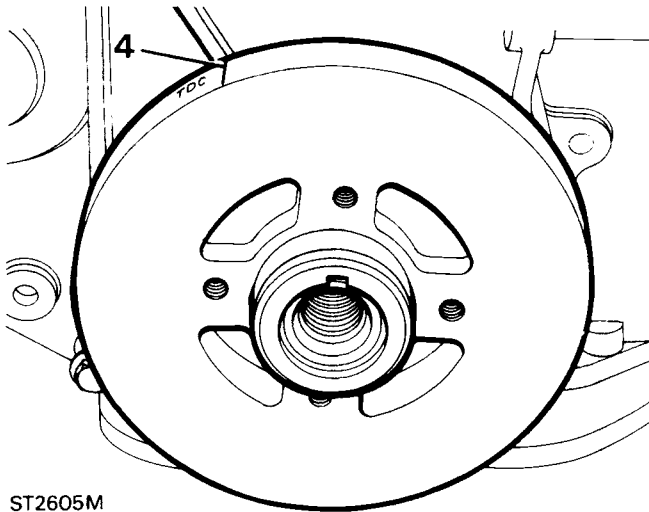
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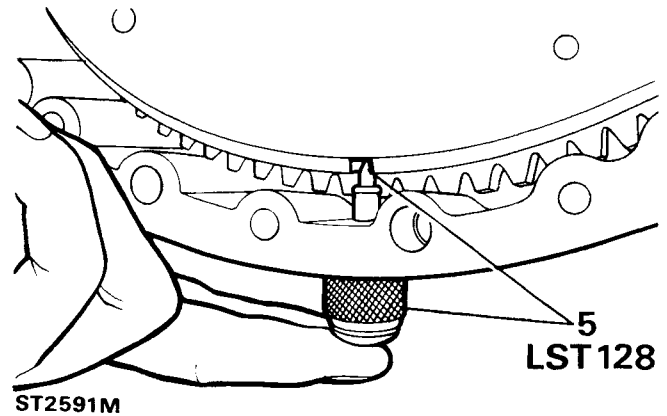
3. To remove the crankshaft damper retaining bolt use special service tool LST127 to restrain the damper and a 30 mm socket to remove the special bolt. Leave the damper in position on the crankshaft.



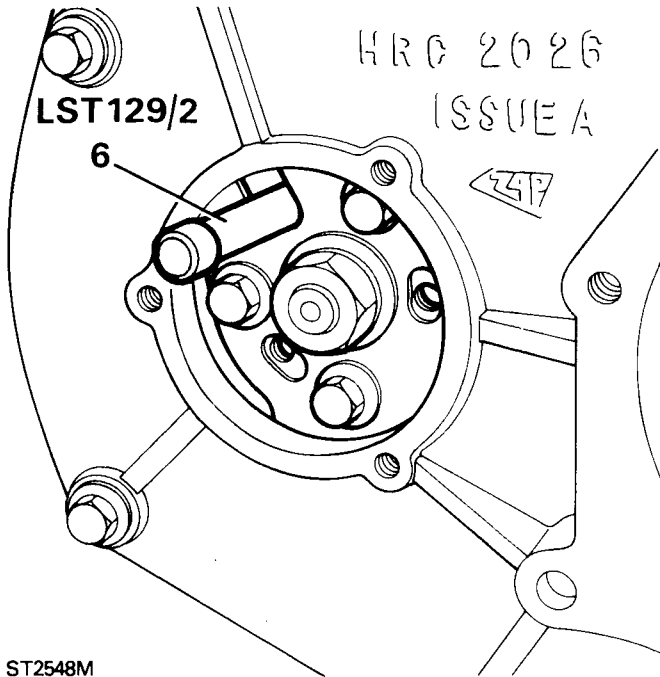
4. Use the restraining tool to turn the crankshaft in a clockwise direction to T.D.C. so that the mark on the damper is in line with the cover plate web as illustrated. The valves of number one cylinder should be closed with number four cylinder valves on the "rock". If the crankshaft is turned beyond T.D.C. continue on round until the above conditions are achieved.



5. Screw the body of the timing pin tool LST128 into the flywheel housing and check the pin can be inserted into the slot in the flywheel. Note that there are two slots in the flywheel. The narrowest slot determines T.D.C. for this direct injection engine and it is therefore important that the correct slot is used.

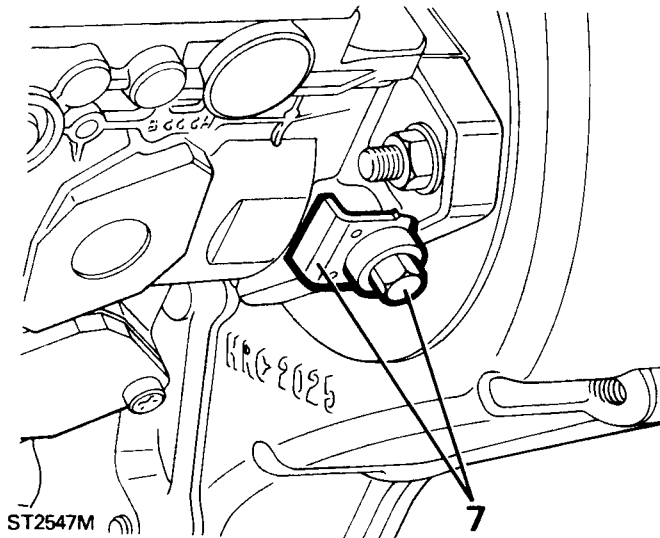


6. Remove the injection pump access cover and check the service tool timing pin can be inserted through the "U" shaped cut-out in the pump hub and into the hole in the pump-body. Also the dot on the camshaft gear should align with the web on the front cover. This will confirm that the injection pump is correctly timed in relation to the valves and crankshaft and can be locked ready for removing. Leave the bolt in position in the pump.



ST2548M

7. To lock the pump, loosen the locking screw and remove the inhibiting plate. Tighten the screw to lock the pump shaft. Remove the timing pin from the flywheel housing.



ST2547M



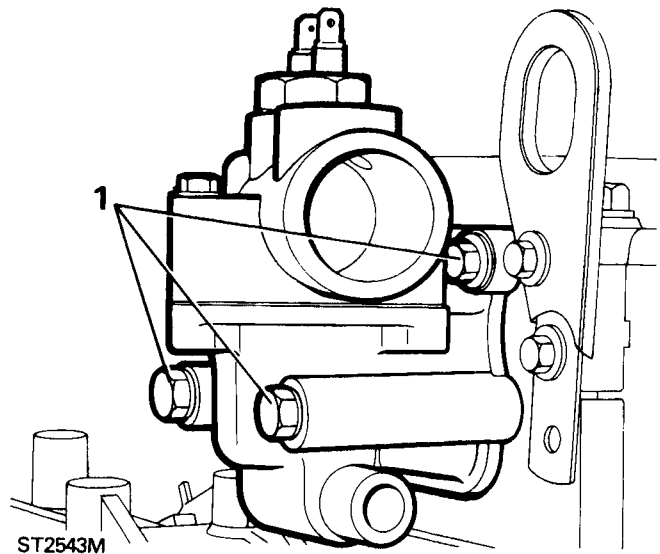
CAUTION: It is important to ensure that once the injection pump has been locked no attempt must be made to rotate it.

Therefore do not allow the crankshaft to be turned until the pump has been removed.

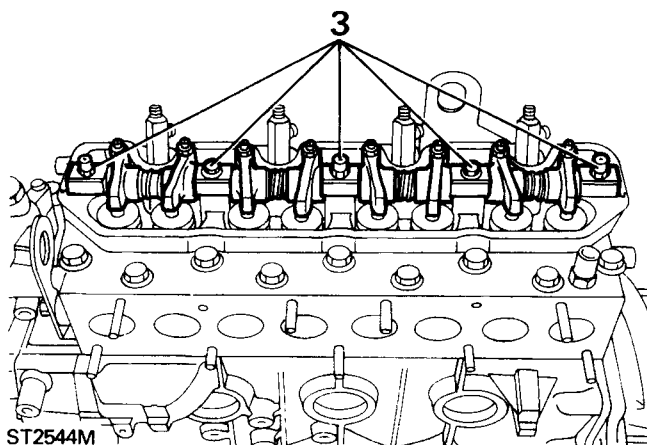
8. Before dismantling the timing components, the cylinder head should be removed to avoid the possibility of damage being caused to the valves and pistons should the camshaft be inadvertently turned once the timing belt has been removed.

REMOVE CYLINDER HEAD

1. Remove the three bolts and remove the thermostat housing.



2. Evenly release the five rocker shaft retaining bolts but do not remove the bolts from the shaft, especially the two end ones, to prevent the assembly from falling apart when removed from the cylinder head.



3. Having removed the rocker shaft, lift-out the push rods and insert them through holes in a piece of card marked from 1 to 8 to ensure assembly to their original locations.

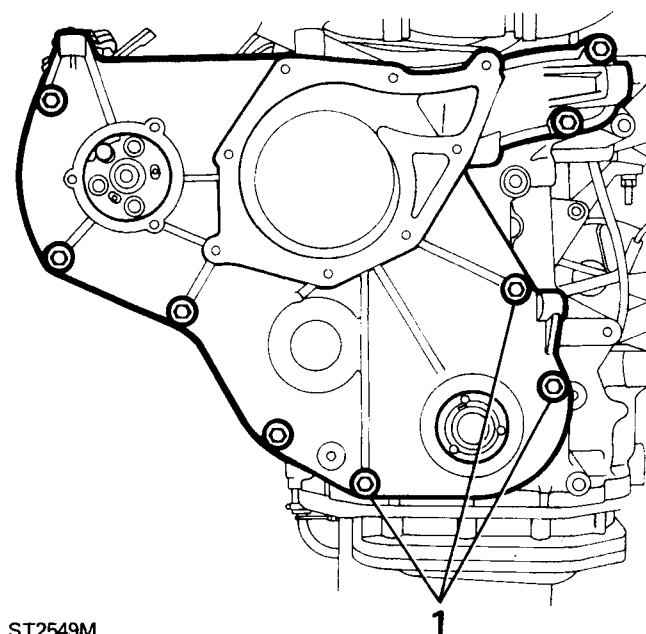
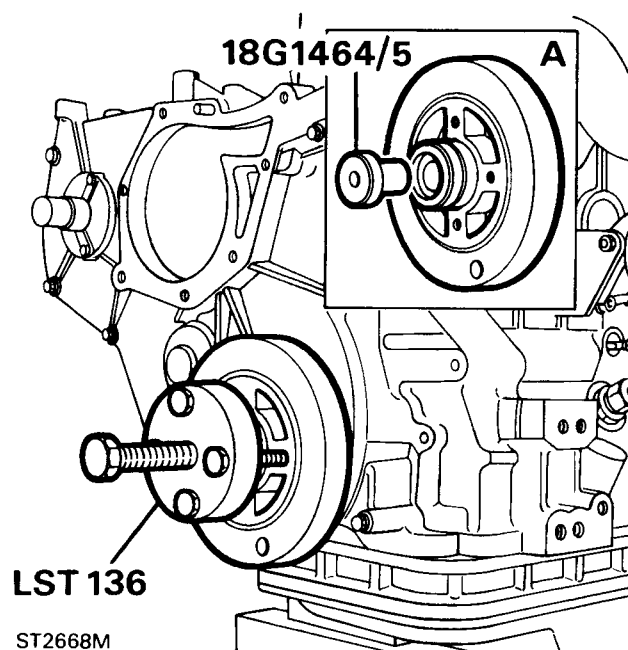


CAUTION: Since the injectors and heater plugs protrude below the combustion face of the cylinder head, it is important that they are removed before removing the cylinder head to avoid the possibility of damage to the injectors, heater plugs and pistons.

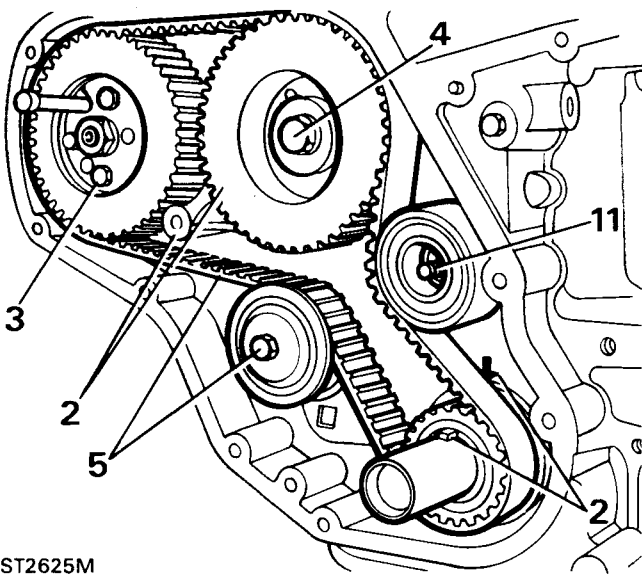
4. Remove the valve stem caps.
5. Mark each injector with the number of the cylinder to which it is fitted. Remove the injector clamp nut and carefully remove the injectors. Store in a bag to prevent contamination and damage.
6. Remove the glow plugs and sealing washers and store in a safe place.
7. Evenly loosen and remove the eighteen bolts retaining the cylinder head and lift the cylinder head from the cylinder block and remove the gasket. Discard the cylinder head bolts.

REMOVE TIMING GEAR AND INJECTION PUMP

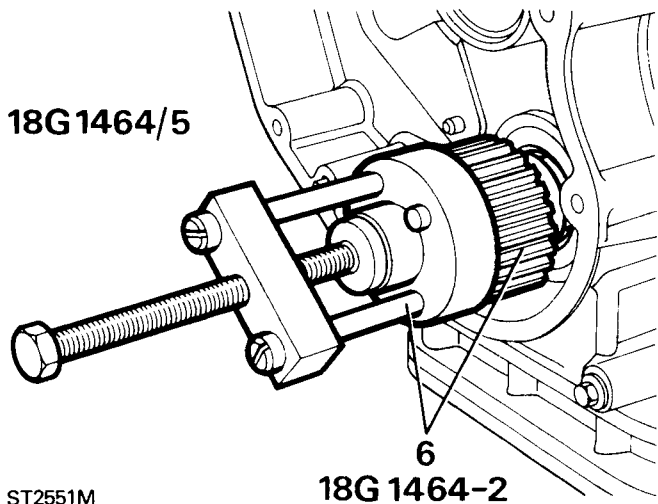
1. Remove the crankshaft damper using service tool LST136. The damper is secured to the crankshaft with Loctite. Fit the pressure button A from tool 18G1464/5 and assemble the tool LST136 to the damper as illustrated. Remove the nine bolts securing the cover plate to the front cover.



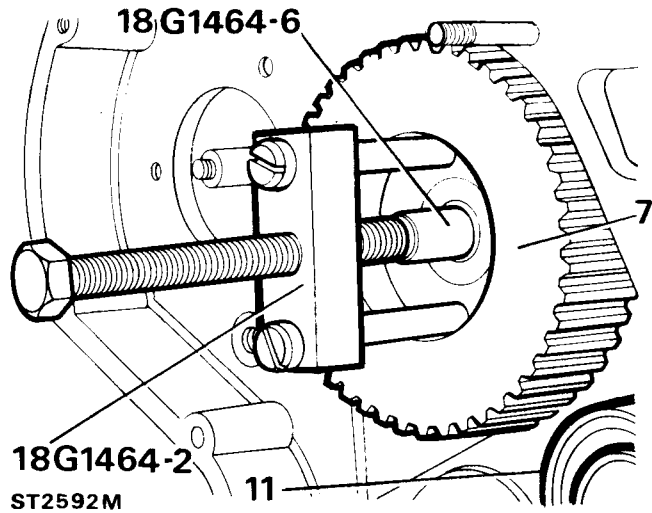
2. Check that the timing marks inside the front cover line-up with the gear wheels, ie. the arrow on the front cover aligns with the crankshaft key and the dot on the camshaft gear aligns with the front cover web.
3. Loosen the three screws securing the pump timing gear to the pump hub.
4. Temporarily fit the damper and restrain the crankshaft with service tool FR101 while the camshaft gear wheel retaining bolt is being loosened.
5. Remove the single bolt and special washer and remove the tensioner and drive belt.



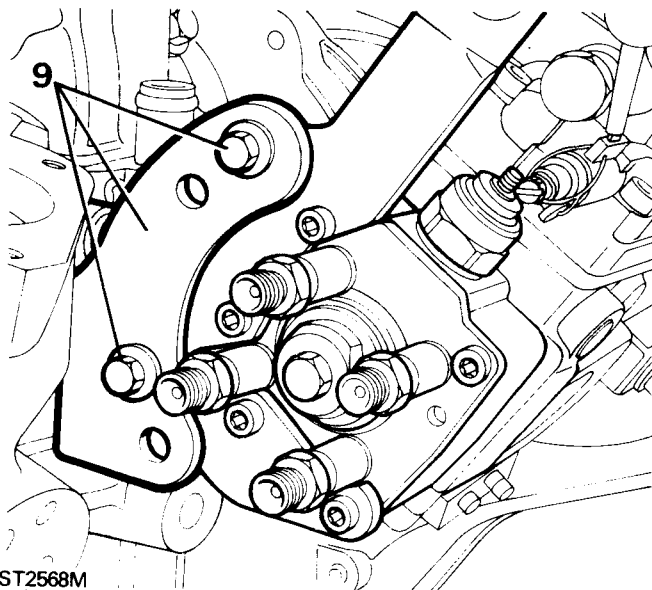
6. If the crankshaft gear wheel cannot be removed by hand, use special service tool 18G1462-2 and pressure button 18G1464/5. Assemble the tool as illustrated and withdraw the gear wheel.



7. Remove the camshaft gear wheel retaining bolt. Remove gear using service tool 18G1462-2 and button 18G1464-6.

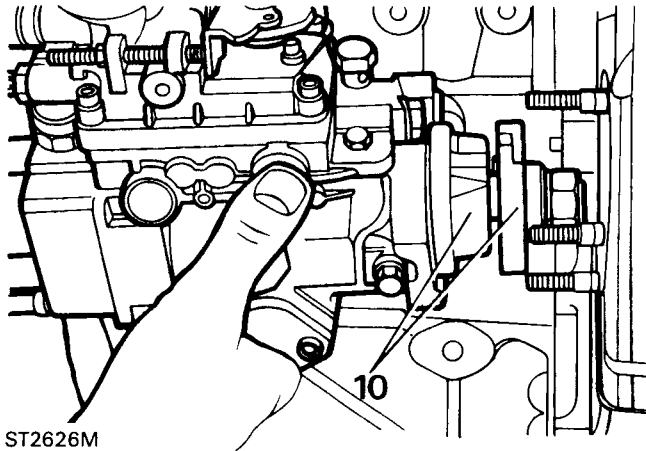


8. The timing bolt can now be withdrawn from the pump together with the three previously loosened screws and the gear removed.
9. Release the pump from the rear support bracket.



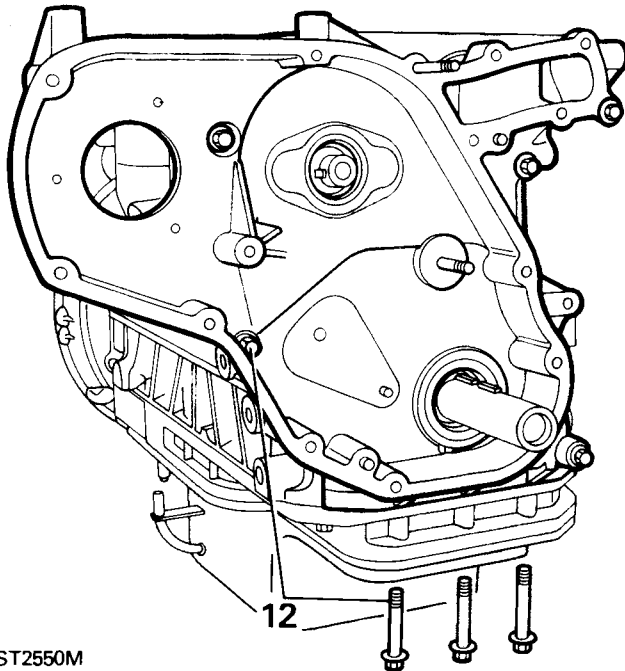


10. Remove the three nuts securing the pump flange to the front cover and withdraw the pump and gasket complete with hub.



ST2626M

11. Remove the single nut to release the static jockey pulley.
12. To remove the front cover, release the five bolts securing it to the cylinder block front face and the three bolts that pass up through the sump and ladder frame into lower face of the cover.



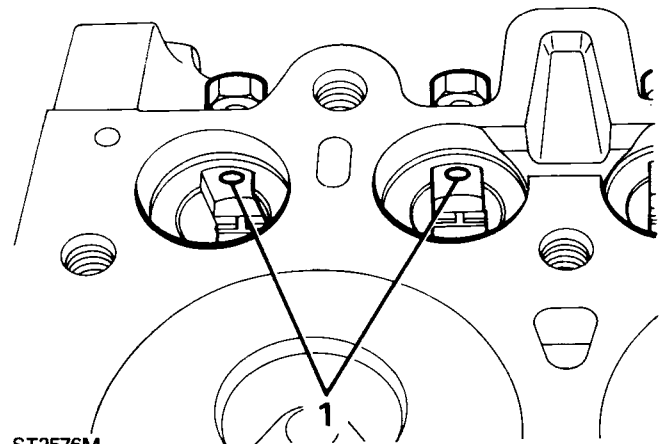
ST2550M

REMOVING CAM FOLLOWER ASSEMBLIES



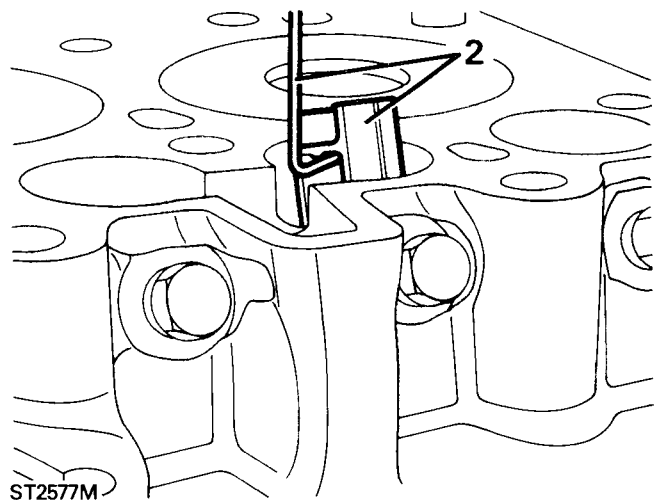
CAUTION: The cam followers are solid rollers held in position against the cam by a slide inside a fixed guide. If the guide is removed before the roller, the roller can fall and jam behind the camshaft. Also the roller could slip past the cam into the crankcase. It is important to follow this procedure for removal:-

1. Loosen back the guide locating screw so that the end is below the bore of the guide.



ST2576M

2. Using a length of thin wire with a hooked end lift-out the slide.



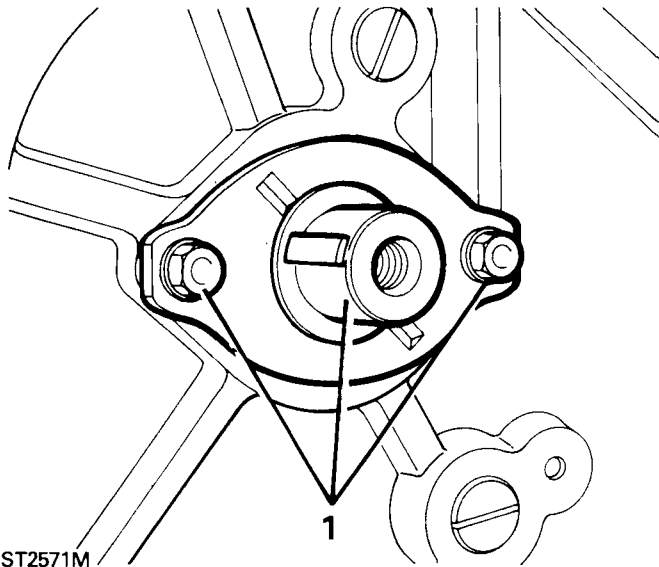
ST2577M

3. With the same piece of wire remove the roller.

4. Remove the guide locating screw and lift-out the guide.
5. As each assembly is removed, number it from one to eight, for refitting to its original location.

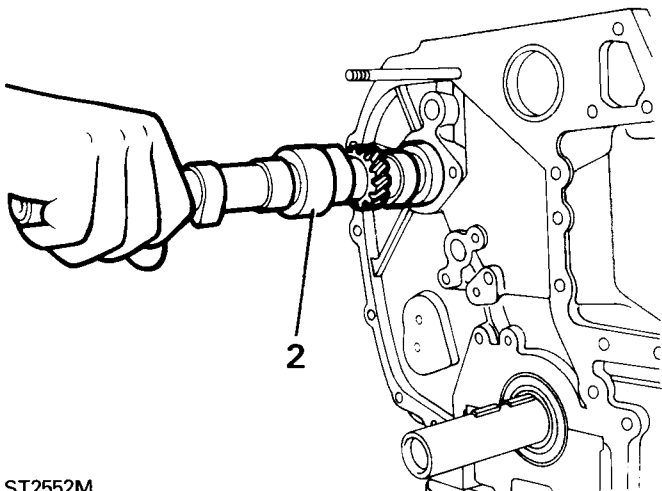
REMOVING THE CAMSHAFT

1. Release the two screws and remove the camshaft thrust plate.



ST2571M

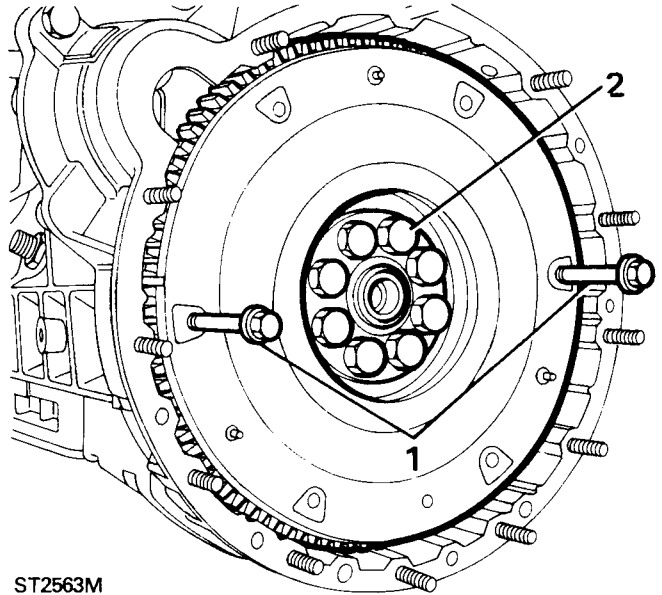
2. Carefully withdraw the camshaft taking care not to allow the end of the shaft to drop on to the bearings as it is removed.



ST2552M

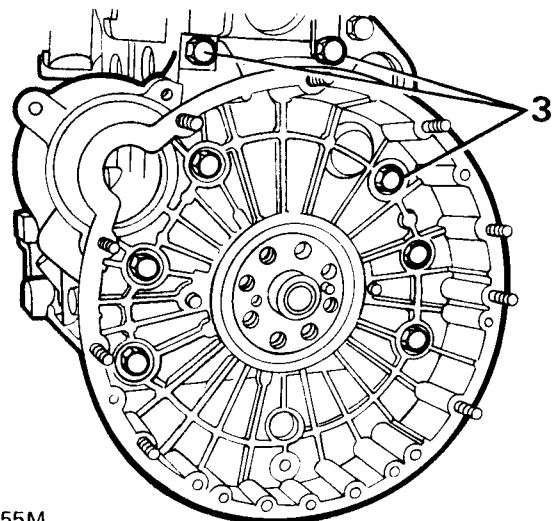
REMOVE FLYWHEEL AND HOUSING

1. In the interests of safety, fit two long 8 mm bolts into the clutch bolt holes, diametrically opposite, to use as handles for lifting the flywheel off the crankshaft.
2. Temporarily fit the crankshaft damper and use service tool FR101 to restrain the crankshaft while loosening the flywheel eight retaining bolts. Remove the bolts and reinforcing plate and lift-off the flywheel.



ST2563M

3. Remove the six internal and two external bolts and ease the flywheel housing from the two locating dowels and crankshaft. Discard the rear main oil seal, avoid damaging the seal housing.

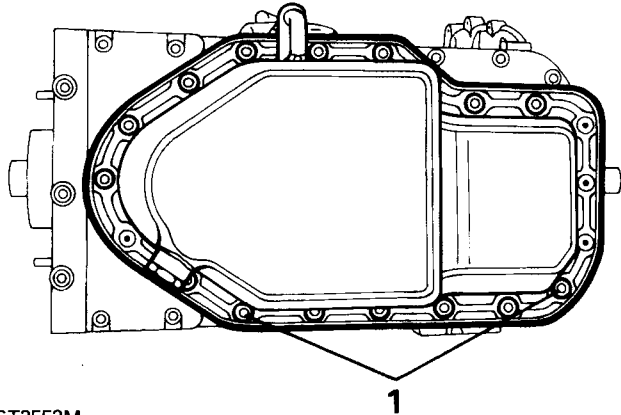


ST2655M



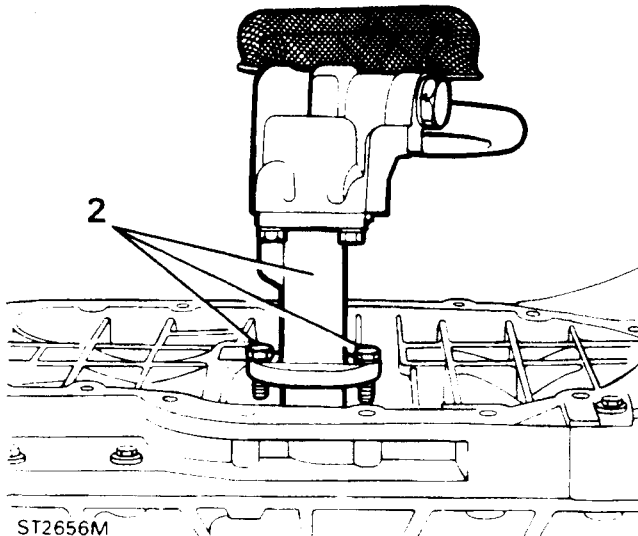
REMOVE SUMP, OIL PUMP AND LADDER FRAME

1. Invert the cylinder block so that the sump is uppermost. Remove the remaining seventeen screws and ease the sump from the ladder frame to reveal the oil pump.



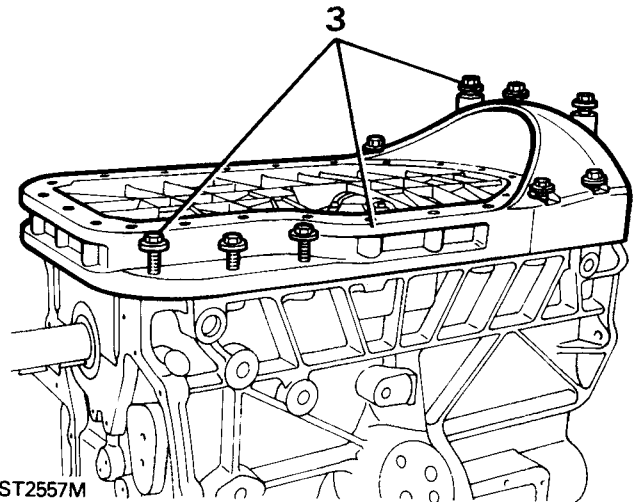
ST2553M

2. Two bolts secure the oil pump to the crankcase. Access to the right hand bolt may require the use of a socket with a universal joint. Removal of the bolts will enable the pump to be withdrawn.



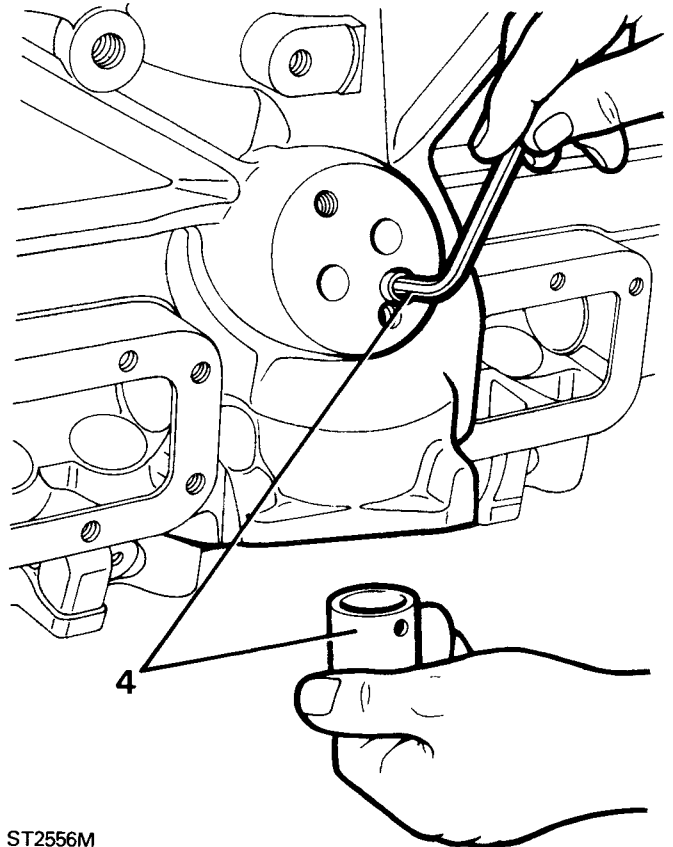
ST2656M

3. Remove the ten bolts and separate the ladder frame from the crankcase by gently tapping to break the seal.



ST2557M

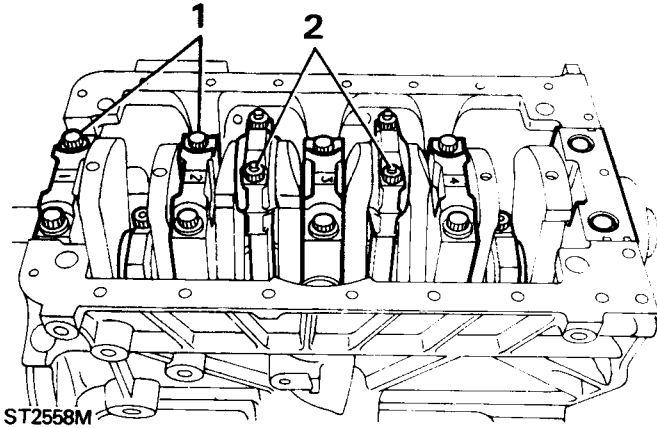
4. Using a 6 mm Allen key remove the socket headed screw retaining the skew gear bush and withdraw the bush.



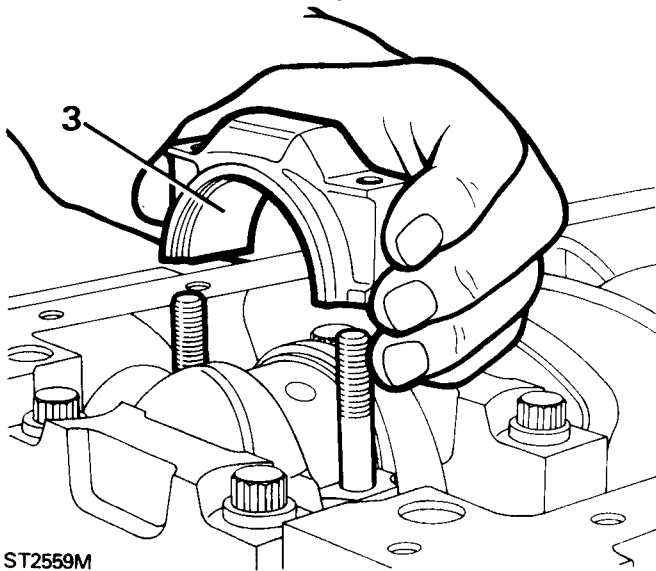
ST2556M

REMOVE CRANKSHAFT

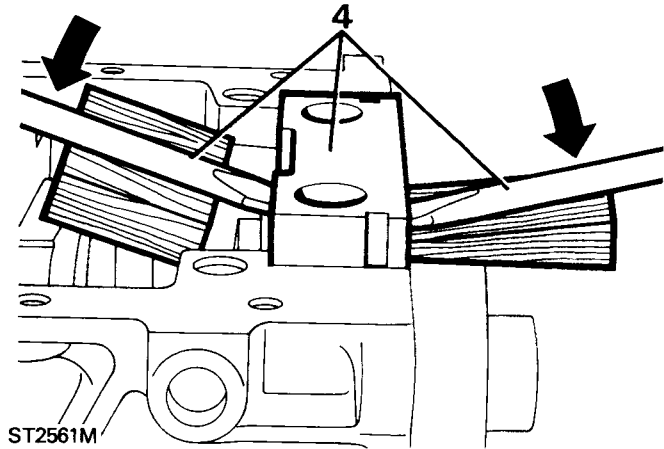
1. Loosen the ten main bearing bolts with a 14 mm socket.
2. Turn the crankshaft to bring all the connecting rod caps to an accessible position and loosen the nuts using a 15 mm socket.



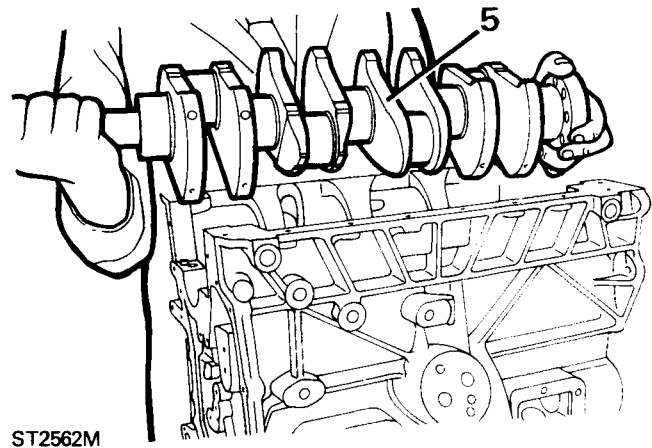
3. Remove the connecting rod nuts and remove the caps and lower bearing shells.



4. The rear main bearing cap has a "T" shaped neoprene seal each side of the main bearing cap. Difficulty may be experienced removing the cap. If so lever the cap from both sides, as illustrated. Insert a suitable bar in the hole in the inside face of the cap and lever against the crankshaft journal on the outside face. **Ensure that timber blocks are used under the levers to protect the crankshaft.**

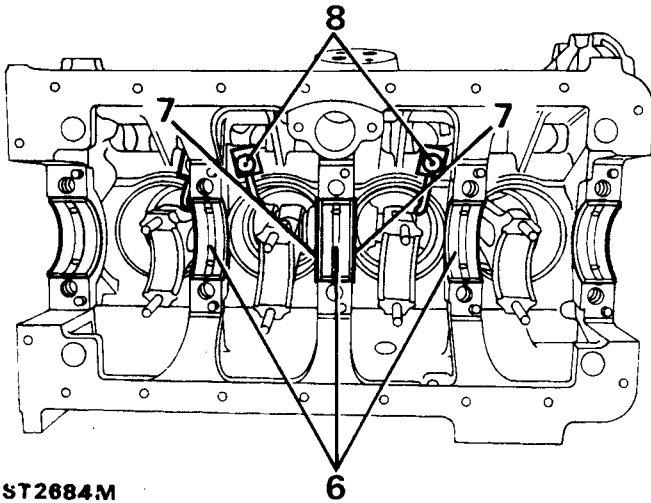


5. Lift-out the crankshaft either by hand or hoist. If a hoist is used be sure to insert adequate protection between the sling and journals to avoid damage.





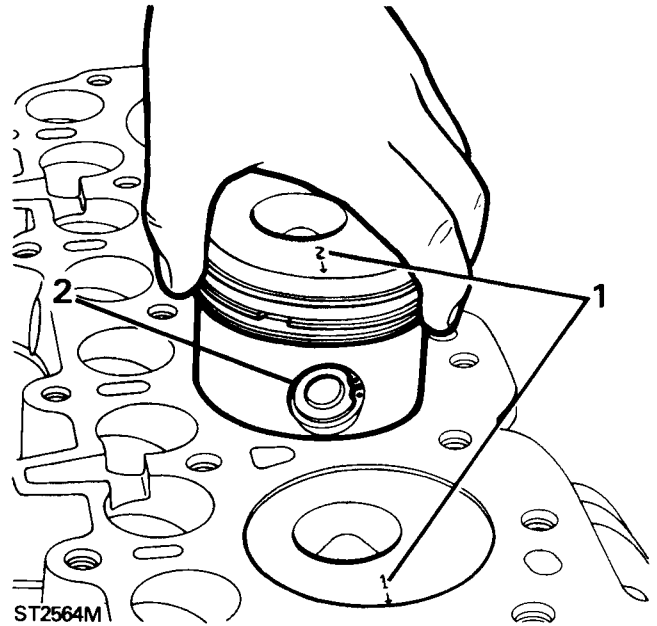
6. Remove the main bearing upper shells from the bearing saddles.
7. Remove the two thrust washers from each side of the centre saddle.
8. Remove the four jet tubes.



ST2684.M

REMOVE PISTONS AND CONNECTING RODS

1. Before removing the piston assemblies, number each piston from one to four so that it can be identified with the bore from which it was removed.
2. Push each connecting rod and piston up the bore until it can be withdrawn from the cylinder block. As each piston assembly is removed fit the corresponding cap and bearing shell to the connecting rod noting that the shell locating tags are together on the same side as the connecting rod number.

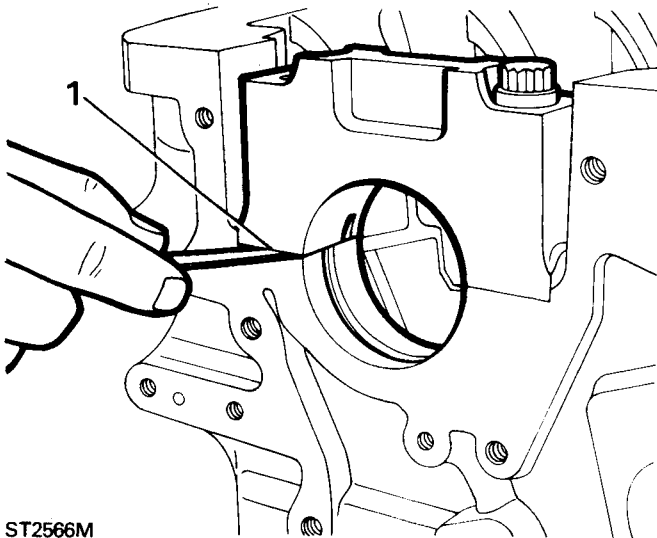


ST2564.M

OVERHAUL CYLINDER BLOCK

1. Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage. To check the main bearing caps and saddles for distortion, fit the main bearing caps without bearing shells and tighten to **133 Nm**.

Loosen and remove the bolt on one side of each bearing cap and check no clearance exists at the joint face between the cap and saddle. A clearance indicates either a bent bolt, distortion of the caps, or block or that the cap has been filed or machined in an attempt to reduce the clearance due to wear in the bearings. Main bearing caps are not available separately from the cylinder block and if clearance exists the block must be renewed.



ST2566M

Inspect cylinder bores

2. Measure the cylinder bores for ovality, taper and general wear, using any suitable equipment. However, an inside micrometer is best for checking ovality and a cylinder gauge for taper.

3. Check the ovality of each bore by taking measurements at the top of the cylinder just below the ridge at two points diametrically opposite. The difference between the two figures is the ovality of the top of the bore. Similar measurements should be made approximately 50 mm up from the bottom of the bore so that the overall ovality may be determined.
4. The taper of each cylinder is determined by taking measurements at the top and bottom of each bore at right angles to the gudgeon pin line. The difference between the two measurements is the taper.
5. To establish maximum overall bore wear, take measurements at as many points as possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared with the original diameter of the cylinder bore.

Maximum permissible ovality - 0,127 mm.

Maximum permissible taper - 0,254 mm.

Maximum permissible overall wear - 0,177 mm.

If these figures are exceeded the cylinders may be rebored, depending upon the condition of the bores and the amount of wear. If the overall wear, taper and ovality are well within the acceptable limits and the original pistons are serviceable new piston rings may be fitted. Deglaze the bores to give a cross-hatched finish to provide a seating for new rings. Wash the bores afterwards to remove all traces of abrasive material.

Inspect camshaft bearings

6. Measure the internal diameter of each camshaft bearing at several points using an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The bearings should be renewed if the clearance exceeds 0,0508 mm or, if scored or pitted.



Check crankcase main bearings

7. Discard scored, pitted, cracked and worn bearing shells.
8. To determine the maximum wear, assemble the main bearing shells and caps to the crankcase and tighten the bolts to **133 Nm**.
9. Using an inside micrometer, measure each bearing at several points and note the greatest figure. The maximum wear is the difference between this figure and the smallest diameter of the corresponding crankshaft journal. The main bearing running clearance is in the data section **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**
10. The bearing clearances may also be determined by using 'Plastigauge'. Since this method requires the crankshaft to be fitted to the crankcase, the procedure is described under engine assembly.

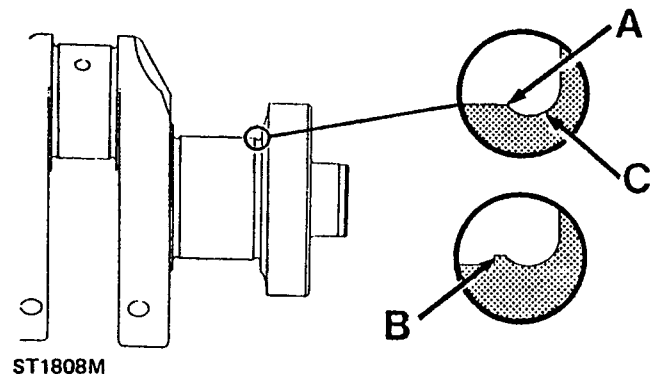
CRANKSHAFT

1. Degrease the crankshaft and clear out the oil ways which can become clogged after long service. Examine visually, the crankpins and main bearing journals for obvious wear, scores, grooves and overheating.
2. With a micrometer, measure and note the ovality and taper of each main bearing journal and crankpin as follows.
3. **Ovality** - Take two readings at right angles to each other at various intervals. The maximum ovality must not exceed 0,040 mm
4. **Taper** - Take two readings parallel to each other at both ends of the main bearing journal and crankpin. The maximum permissible taper must not exceed 0,025 mm

5. To check for straightness, support the front and rear main bearing journals in 'V' blocks and position a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0,076 mm taking into account any ovality in the centre journal. The overall wear limit should not exceed 0,114 mm for main bearing journals and 0,088 mm for crankpins.
6. A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground to 0,25 mm under size.



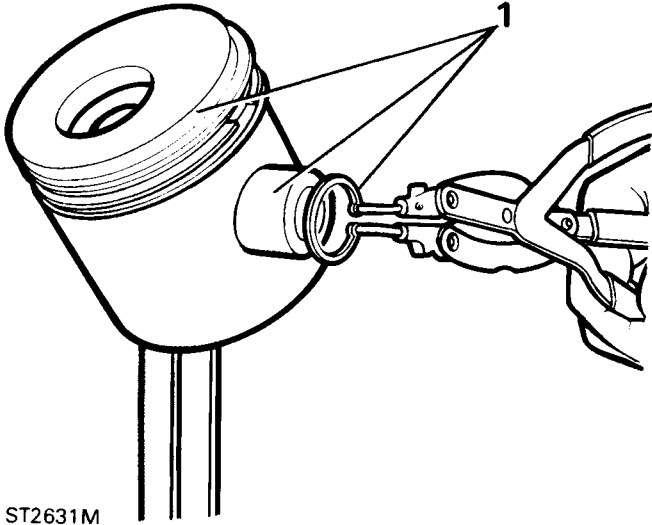
CAUTION: When grinding the crankshaft main bearing and crankpin journals, rotation of the grinding wheel and crankshaft must be in the same direction, anti-clockwise, viewed from the flywheel end of the crankshaft. Final finishing of the journals should be achieved by using a static lapping stone with the crankshaft rotating in a clockwise direction viewed from the flywheel end of the crankshaft. It is important to ensure that, when grinding, the stone travels beyond the edge of the journal 'A' to avoid formation of a step 'B' as illustrated. Also care must be taken not to machine or damage the fillet radii 'C'.



PISTONS AND CONNECTING RODS

The following checks relating to pistons and rings must also be carried out prior to fitting new pistons to rebored and sleeved cylinder blocks. Until it is decided if new components are required all parts must be kept in their related sets and the position of each piston to its connecting rod should be noted.

1. Remove the piston rings and gudgeon pin from each piston and detach the connecting rod.

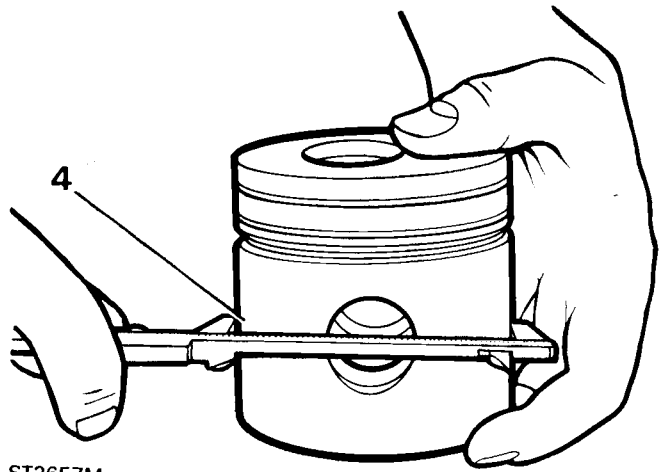


ST2631M

2. **Original pistons** - Decarbonise and degrease all components and carry out a visual examination of the piston and rings and discard any which are unserviceable. Pistons which appear serviceable should be subjected to a more detailed examination described under 'New pistons'.
3. **New pistons** - Original pistons fitted to new engines at the factory are specially graded to facilitate assembly. The grade letter on the piston crown should be ignored when ordering new pistons. Genuine Land Rover service standard size pistons are supplied 0,025 mm oversize to allow for production tolerance on new engines. When fitting new pistons to a standard size cylinder block the bores must be honed to accommodate the pistons with the correct clearances. In addition Land Rover pistons are available 0,50 and 1,01 mm oversize for fitting to rebored cylinder blocks.

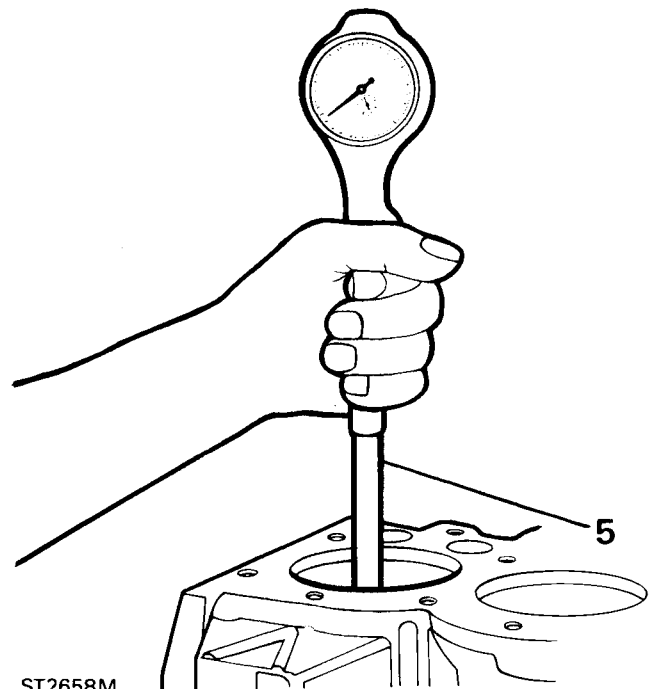
Clearance limits for new standard size pistons in a standard cylinder bore measured at right angles to the gudgeon pin are in the data section. **See GENERAL SPECIFICATION DATA, Information 200 Tdi engine.**

4. Using a suitable micrometer or vernier measure the pistons at the bottom of the skirt at right angles to the gudgeon pin.



ST2657M

5. With an inside micrometer or cylinder gauge measure the diameter of the bore at approximately half-way down and note the reading.
6. The clearance is determined by subtracting the piston diameter from the bore diameter.



ST2658M

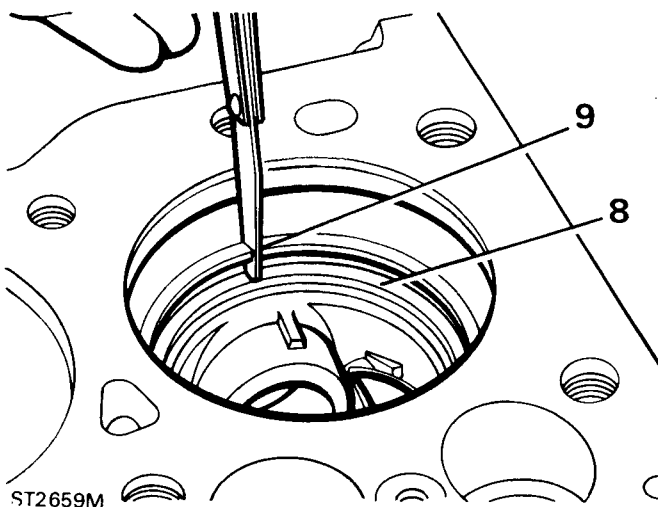


7. If gauge equipment is not available the clearance can be assessed by placing a long, suitably sized, feeler gauge down the thrust side of the bore and inserting the appropriate piston, 'upside down', in the bore and position it with the gudgeon pin parallel to the crankshaft axis. Push the piston down the bore and stop at the tightest point and whilst holding the piston still, slowly withdraw the feeler gauge. If a steady resistance of approximately 2,5 kg is felt, the clearance is satisfactory.

Inspect piston rings

Normally when an engine is being overhauled the piston rings are discarded unless the pistons have been removed for a different purpose and the engine has only completed a small mileage. Before refitting the piston the rings should be examined for wear and damage. In addition the rings must be checked for side clearance in the pistons and gap in the bores. The latter two checks must be made when fitting new rings to new and used pistons.

8. **Check gap** - When checking the ring gap in worn bores, which are within the acceptable taper and ovality limits, the ring must be inserted squarely into the bottom of the bore at the lowest point of the piston travel. To ensure squareness of the ring push the ring down into the bore to the correct position with a piston. With newly machined bores, the ring may be inserted squarely into any position in the bore.



ST2659M

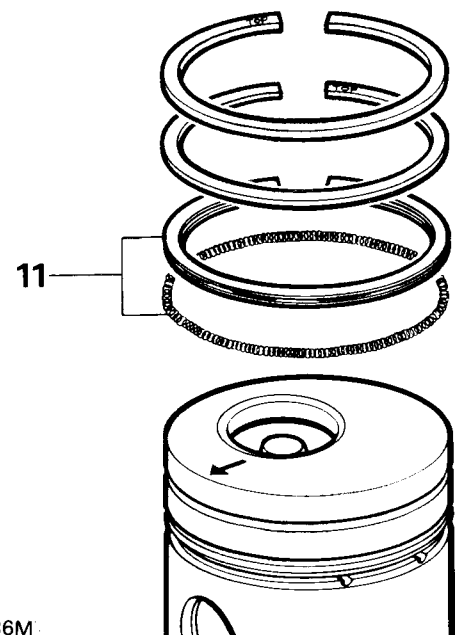
9. Measure the gaps of all the rings, in turn, including the oil control ring assembly.

The correct gaps are listed in the data section **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**

If any gap is less than that specified, remove the ring, and file the ends square, whilst holding the ring in a filing jig or vice. Should any gap be excessively wide and not likely to close up to within the specified limits when hot, an oversize ring should be fitted.

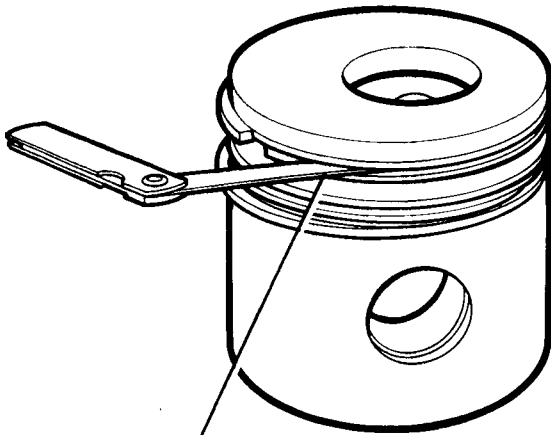
Check piston side ring clearance

10. It is important that clearances are correct. Rings that are too tight will bind when hot, impairing the radial pressure causing possible loss of compression. Excessive clearance will allow the rings to rock in the grooves and the resulting pumping action could cause excessive oil consumption and eventually broken rings.
11. Fit the oil control ring expander to the bottom groove, then fit the oil control ring ensuring that it fits over the expander. Fit the second, narrow, compression ring with the word "TOP" uppermost. Likewise fit the first compression ring to the top groove, word "TOP" uppermost.
12. After fitting each ring, roll it around the piston groove to ensure that it is free and does not bind.



ST2636M

13. Measure the clearance between the rings and piston grooves. Clearances in excess of the figures given in data section are unacceptable and the rings or the pistons should be renewed.



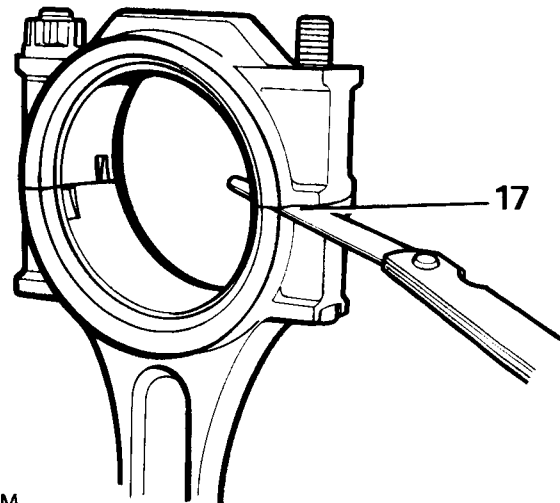
ST2632M

Inspect gudgeon pins

14. Check the gudgeon pins for wear, cracks, scores and overheating.
15. The gudgeon pin fit into the piston must be tight push fit at a temperature of 20°C. Check the gudgeon pin for ovality and taper using a micrometer.

Connecting rod inspection

16. Check the connecting rods and caps for distortion as follows; fit the correct cap, less the bearing shells, to each connecting rod as denoted by the number stamped near the joint faces. This number also indicates the crankshaft journal to which it must be fitted.
17. Tighten the nuts to **59 Nm** and release the nut on one side only. Check that no clearance exists between the joint faces. If there is a gap the connecting rod is distorted and should be renewed.



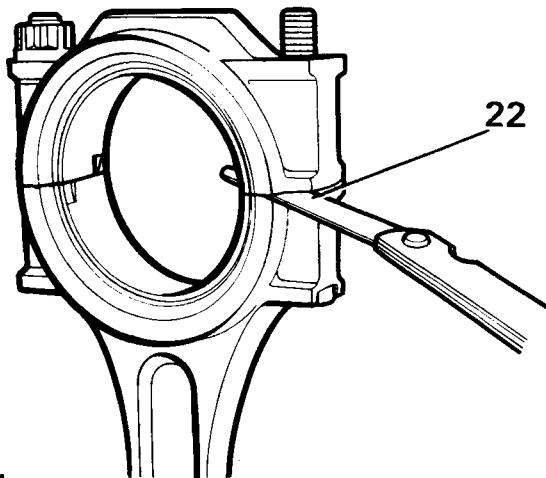
ST2633M

18. Use a connecting rod alignment gauge to check the rods for bend and twist. The maximum allowable for both conditions must not exceed 0,127 mm
19. Examine and check the small-end bush for wear. If necessary renew the bush. The correct clearance of the gudgeon pin in the small-end bush is given in the data section. **See GENERAL SPECIFICATION DATA, Information 200 Tdi engine.**
20. When renewing a bush, ensure that the oil hole in the bush lines up with the hole in the connecting rod. Finish the bush to the correct size and clearance.
21. Connecting rod bearings that are worn, pitted, scored and show signs of overheating must be discarded. If more than one of the bearings show these signs they must all be renewed. When fitting new or used bearings to serviceable crankpins the clearances must be checked.

Connecting rod bearing nip and clearance

New bearing halves are supplied with a protective coating and must be degreased before fitting.

22. Fit the bearing halves to the connecting rod and cap and secure the assembly to **59 Nm**. Loosen the nut on one side only and check the clearance between the joint faces with a feeler gauge.



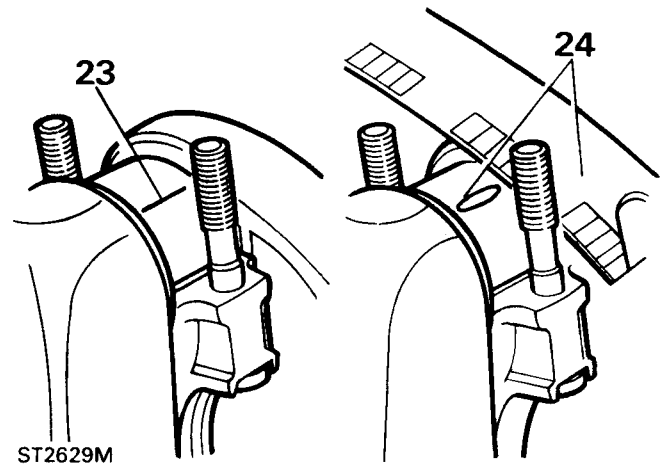
ST2630M

The clearance should be 0,10 to 0,20 mm The bearing nip can be adjusted by the selective assembly of the bearing shells which are available in slightly varying thicknesses. Do not file or machine the rods to vary the bearing nip.

Make a final check to prove the clearance by inserting a 0,063 mm shim paper between the crankpin and one half of the bearing and tighten. The connecting rod should resist rotation and move freely with the shim paper removed. Alternatively, the bearing clearances can be determined by using 'Plastigauge'. This consists of a thin piece of plastic material. When this material is squeezed between the bearing and crankpin the width of the plastic is measured by a scale gauge which indicates clearance.

23. Wipe any oil from the crankpins and place a piece of 'Plastigauge' across the centre of the bearing in the connecting rod cap. Assemble the rod to the appropriate crankpin and tighten to the correct torque. Do not rotate the connecting rod or the crankshaft during this operation.

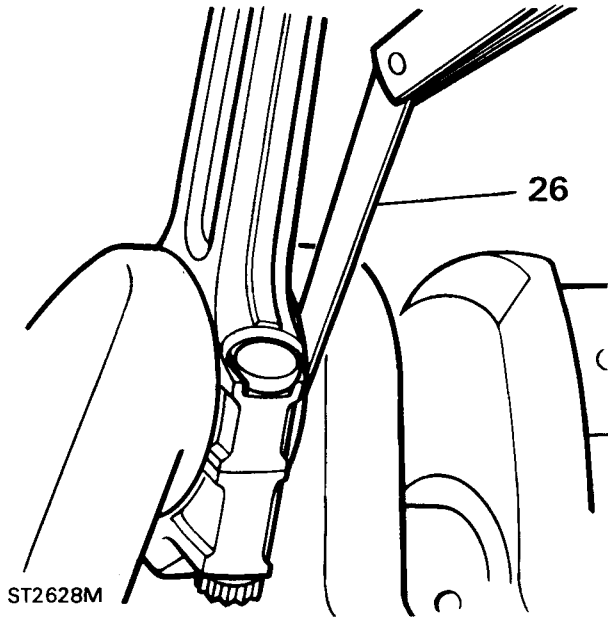
24. Remove the connecting rod cap and bearing shell and using the scale supplied measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds to the width of the 'Plastigauge' indicates the bearing clearance. The correct clearance with new or overhauled components is given in the data section. **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**
25. Wipe off the 'Plastigauge' with an oily rag. Do not scrape it off otherwise it may damage the crankpins.



ST2629M

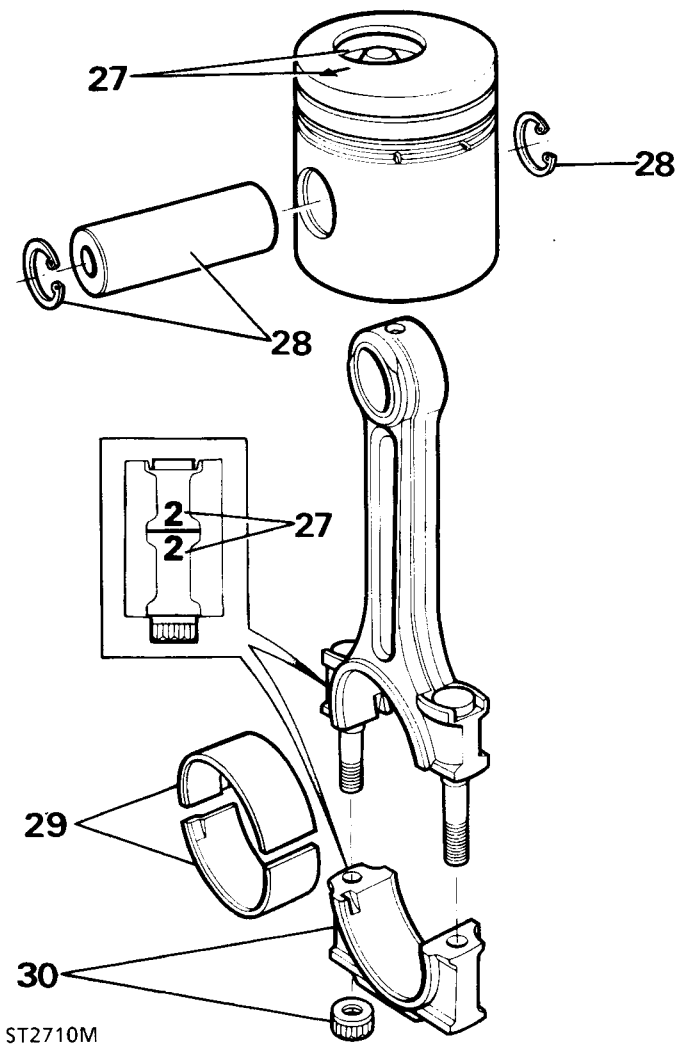
Connecting rod end-float

26. Fit the connecting rods complete with bearings to their respective crankpins. Move the connecting rod to one side and check the clearance, with a feeler gauge, on the opposite side. The correct clearance is given in the data section **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**



Assembling pistons to connecting rods

27. The piston must be assembled to the connecting rod so that the arrow on the piston crown points to the front of the engine and the off-set combustion chamber bearing shell tags and connecting rod number are all on the same, right hand side of the cylinder block viewed from the rear of the engine (camshaft side).
28. Insert a circlip in one side of the gudgeon pin boss and assemble the piston to the connecting rod with the gudgeon pin. Secure the assembly with a circlip on the opposite side of the piston.
29. Fit the bearing shells to the connecting rod and cap. Ensure that the tags locate correctly in the cut-outs.
30. Assemble the cap to the rod and secure temporarily with the two nuts until ready for fitting to the cylinder block.



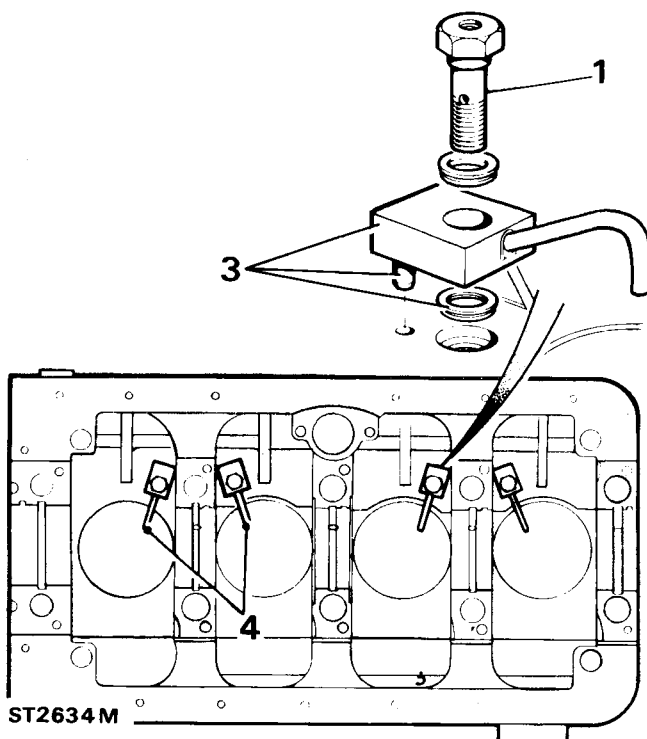


FIT JET TUBES TO CYLINDER BLOCK

Oil jet tubes are fitted to lubricate the pistons and bores directly from the main oil gallery.

1. The jet tubes are 'handed' and can only be fitted one way. It is important to note that the jet retaining bolt contains a non-return valve and therefore on no account must an ordinary bolt be used.
2. Clean the recess in the cylinder block using an air line, if available, to remove any swarf.
3. Assemble and fit the jet tube assemblies ensuring that the pegs locate in the holes in the cylinder block, and that the larger diameter washer fits under the bolt head. Tap the jet blocks down to ensure that the locating dowel is fully home. Fit and tighten the retaining bolts to **17 Nm**.

When the crankshaft and pistons have been fitted, slowly turn the crankshaft and check that no fouling occurs.



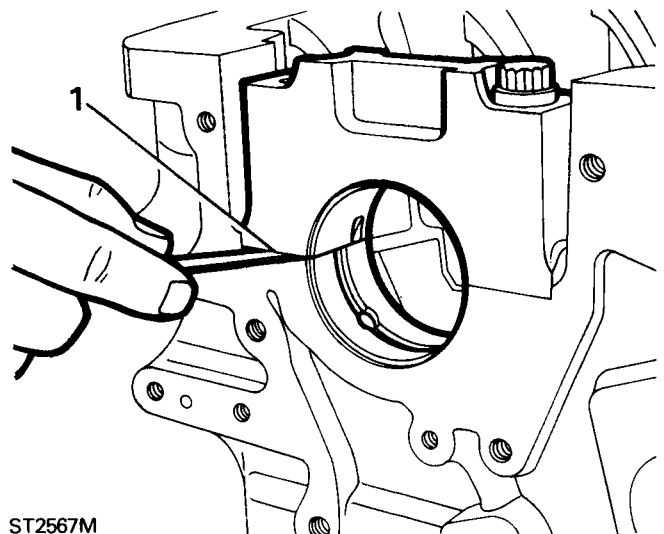
FIT CRANKSHAFT

Main bearing nip and clearance

New main bearing halves are supplied with a protective coating and must be degreased before fitting.

1. Fit the bearing halves in the crankcase saddles and caps and secure the caps to the crankcase and tighten to **133 Nm**.

Loosen the bolts on one side of the caps only and, with a feeler gauge, check the gap between the joint faces. The clearance or nip must be within 0,10 to 0,15 mm. The bearing nip can be adjusted by selective assembly of the bearing halves available in varying thicknesses. Do not file or machine the caps or saddles to achieve the correct clearance. Note that the rear main bearings are wider than the remaining four.

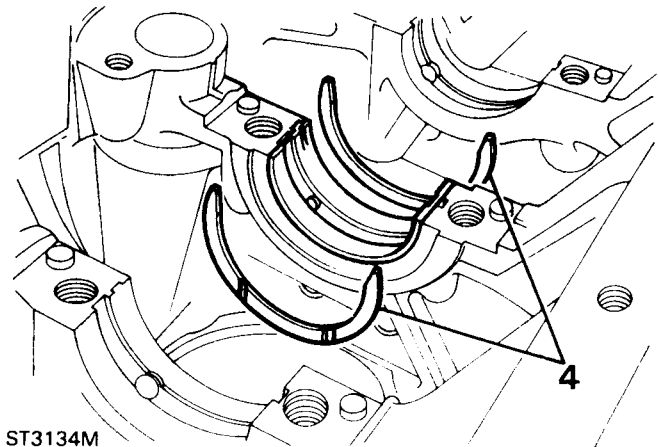


2. To make a final check that the clearance is correct, leave the bearing halves in the crankcase saddles and carefully lower the crankshaft into position. Check each bearing in turn by inserting a 0,063 mm shim paper between the bearing cap and crankshaft journal and tighten the bolts to **133 Nm**. If the clearance is correct, there should be a slight increase in the resistance to the rotation of the crankshaft. As an alternative 'Plastigauge' may be used to check the clearance in the same manner as with the connecting rod bearings. This material may also be used to determine the amount of wear in used bearings and journals.

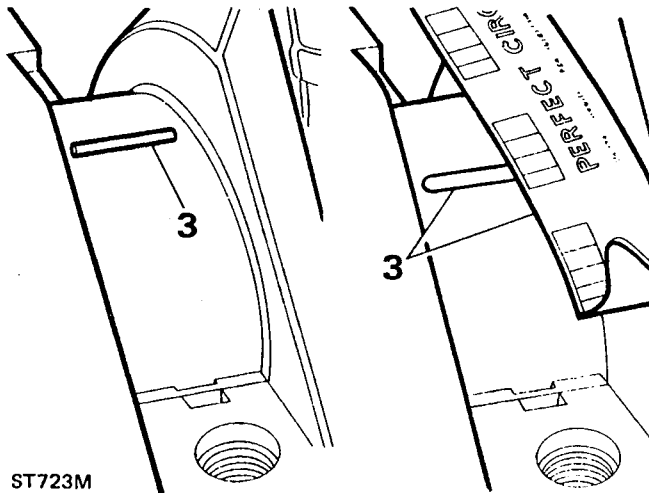
3. Locate the crankshaft in position on the upper bearing halves in the crankcase and wipe any oil from the journals since 'Plastigauge' is soluble in oil. Place a piece of 'Plastigauge' across the lower half of each crankshaft journal or lower bearing cap shell. Fit the cap and tighten to the correct torque. Remove the cap and bearing and using the scale supplied with the 'Plastigauge' measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds with the width of the 'Plastigauge' indicates the bearing clearance.

The correct clearance with new or overhauled components is included in the data section **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**

If fitting new bearings use selective assembly to obtain the correct clearance. Wipe off, not scrape the 'Plastigauge' with an oily rag from the journals or bearings.



ST3134M



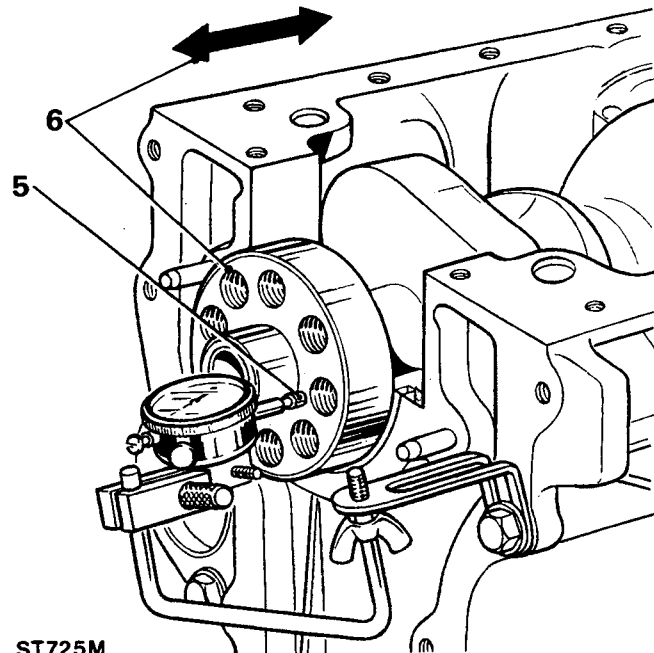
ST723M

Adjust crankshaft end-float

4. Lift out the crankshaft and insert a standard size thrust washer both sides of the centre main bearing saddle with the grooves towards the crankshaft.

5. Place the crankshaft in position in the crankcase and mount a dial test indicator to read-off the end of the crankshaft. A feeler gauge may be used instead of an indicator.

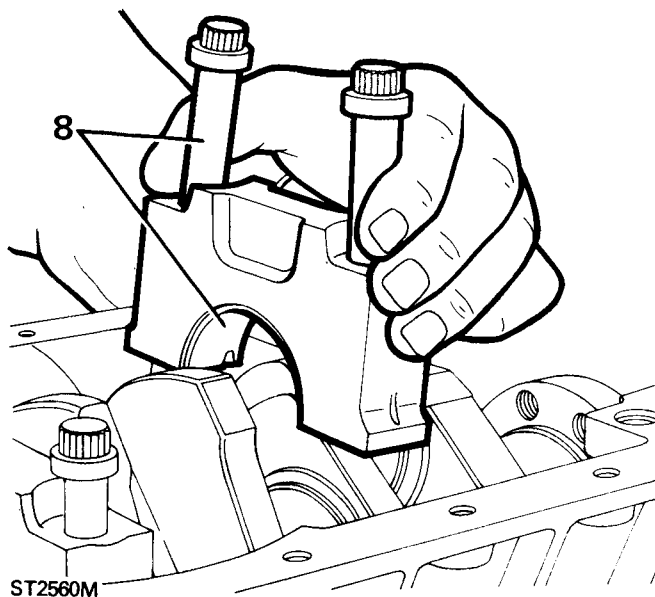
6. Determine the end-float by moving the crankshaft away from the indicator and zero the dial. Move the crankshaft in the opposite direction and note the indicator reading. Alternatively measure the clearance with a feeler gauge. The end-float should be 0,05 to 0,15 mm.



ST725M



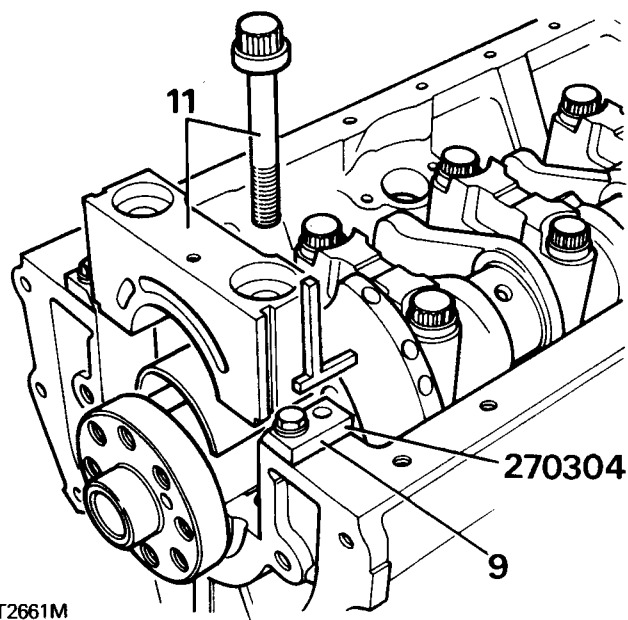
7. If adjustment is required substitute with oversize thrust washers. Variation of thrust washer thicknesses at each side of the crankshaft journal must not exceed 0,08 mm to ensure that the crankshaft remains centralised.
8. Lubricate the crankshaft main journals with clean engine oil and fit the appropriate bearing caps and lower shells to the crankcase with the exception of number five bearing. Ensure that the caps locate properly over the dowels. Using new bolts evenly tighten to **133 Nm**.



ST2560M

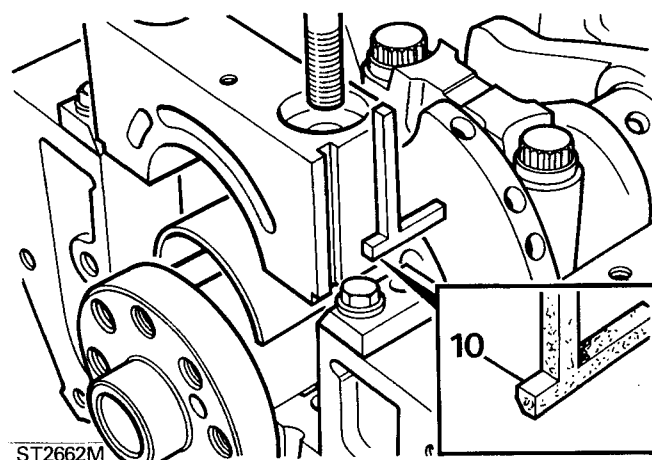
Fit rear main bearing cap

9. Ensure that number five main bearing cap is clean and free from old seal material. Attach the seal guides number 270304 to the crankcase, as illustrated, and ensure that they are parallel to the crankcase edge.



ST2661M

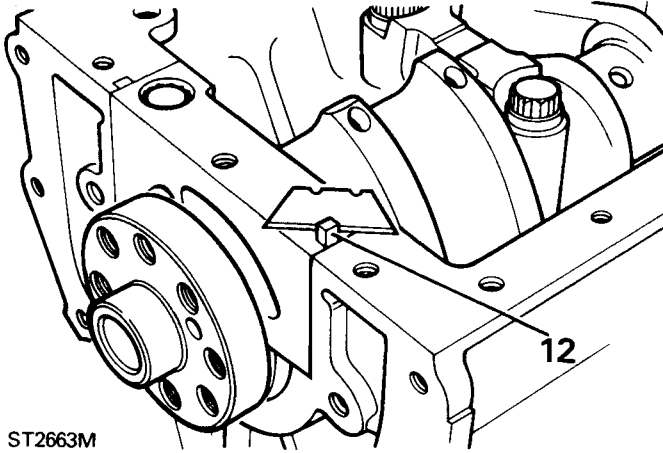
10. To prevent any seal material becoming trapped between the bearing cap and crankcase, chamfer the inner edge of the seal 0,40 to 0,80 mm wide as illustrated. Smear the seals with engine oil and fit them to the bearing cap.



ST2662M

11. Fit the bearing cap and lower shell to the crankcase and secure with new bolts and tighten to **133 Nm**. Remove seal guides.

12. To allow for shrinkage after fitting leave the seals standing proud of the crankcase face then using a sharp blade, trim the seals off to approximately 0,80 mm above the crankcase face.

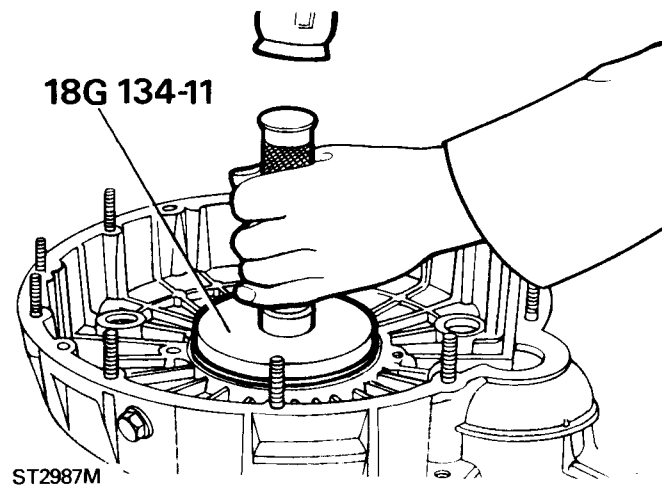


FITTING REAR MAIN OIL SEAL TO FLYWHEEL HOUSING



NOTE: The oil seal is manufactured from PTFE and is supplied with a former to maintain the correct shape which must not be removed until the seal is to be fitted.

1. Make sure the seal housing is clean and dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry.
2. Using seal replacer 18G134-11 and with the lip side leading fit the seal. Fit the seal to the bottom of the housing.

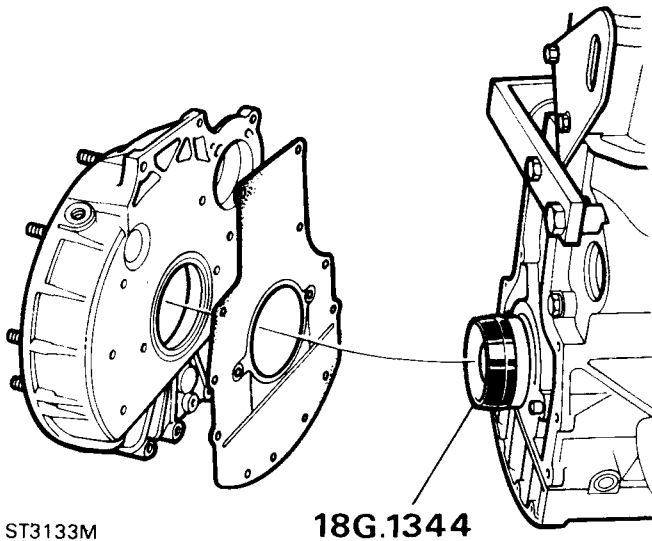


Fitting flywheel housing

3. Examine the seal guide, number 18G1344 ensuring that it is perfectly smooth and not damaged or scratched. Also check that the crankshaft oil seal journal is smooth and clean.

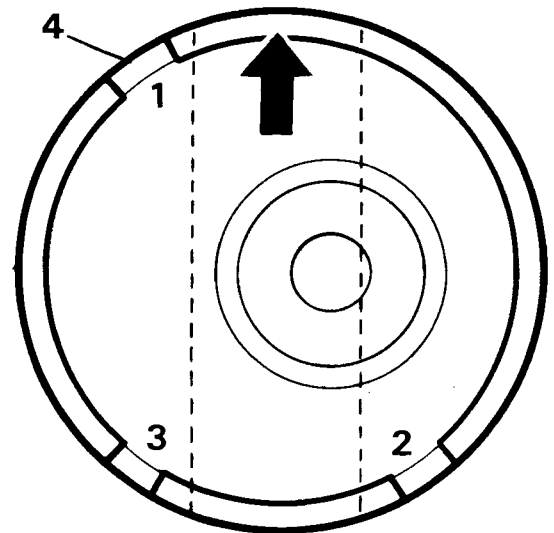


4. Locate the seal guide on to the crankshaft and lubricate the seal, guide and journal.
5. Position the gasket on the cylinder block over the two dowels. The gasket will only fit one way round.
6. Fill the annular groove with RTV sealant.
7. Place the seal guide over the crankshaft flange and using the two dowels as a guide to ensure initial squareness, fit the flywheel housing and remove the seal guide.
8. Secure the housing with the retaining bolts and tighten evenly to **45 Nm**.

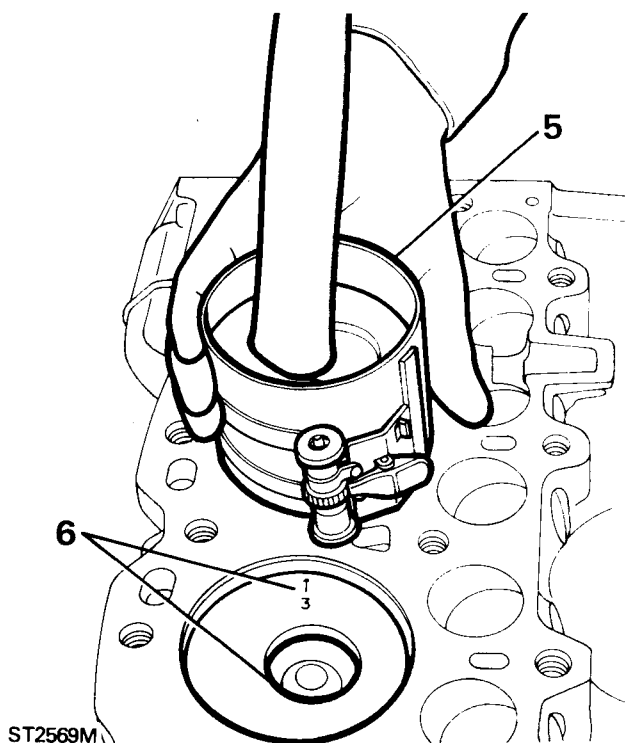


FIT THE CONNECTING RODS AND PISTONS

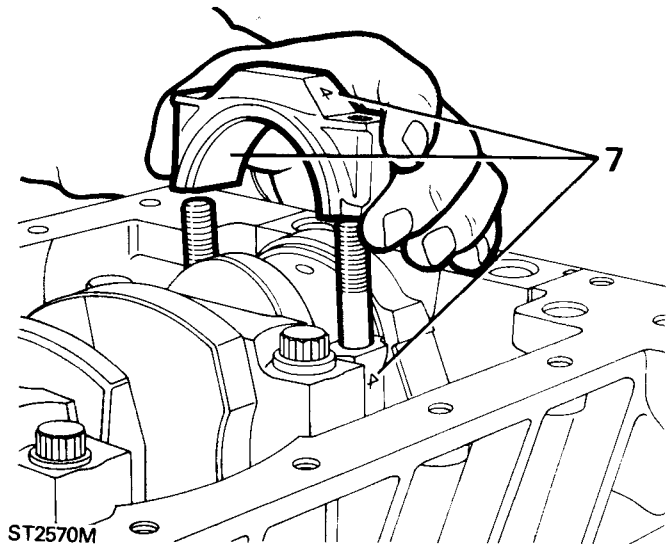
1. Invert the cylinder block so that the combustion face is uppermost. Turn the crankshaft to position numbers one and four crankpins at bottom dead centre to facilitate fitting the connecting rods.
2. When fitting the connecting rods and pistons ensure that bolts do not foul and damage the crankpins. It is recommended that rubber or soft plastic sleeves are placed over the threads.
3. The connecting rod bolts have eccentric heads which locate in a recess in the connecting rod. It is essential that the head of each new bolt is properly located before tightening.
4. Stagger the compression rings so that the gaps are equidistantly spaced around the piston but, arranged so, that no gap is positioned on the thrust side of the piston i.e. opposite the camshaft. Turn the oil control ring so that the gap is to the left of the gudgeon pin.



5. Lubricate the cylinder walls, piston rings and crankpins. Compress the piston rings with a suitable compressor tool and carefully lower the connecting rod into the bore ensuring that the piston is assembled in accordance with instruction 27 under "Assemble pistons to connecting rods".
6. The arrow must point to the front of the engine and the offset combustion chamber in the piston crown must be towards the camshaft side of the cylinder block, with the bearing tag also on the camshaft side. Sharply tap the piston into the bore so that the whole of the piston is just below the surface of the cylinder block.

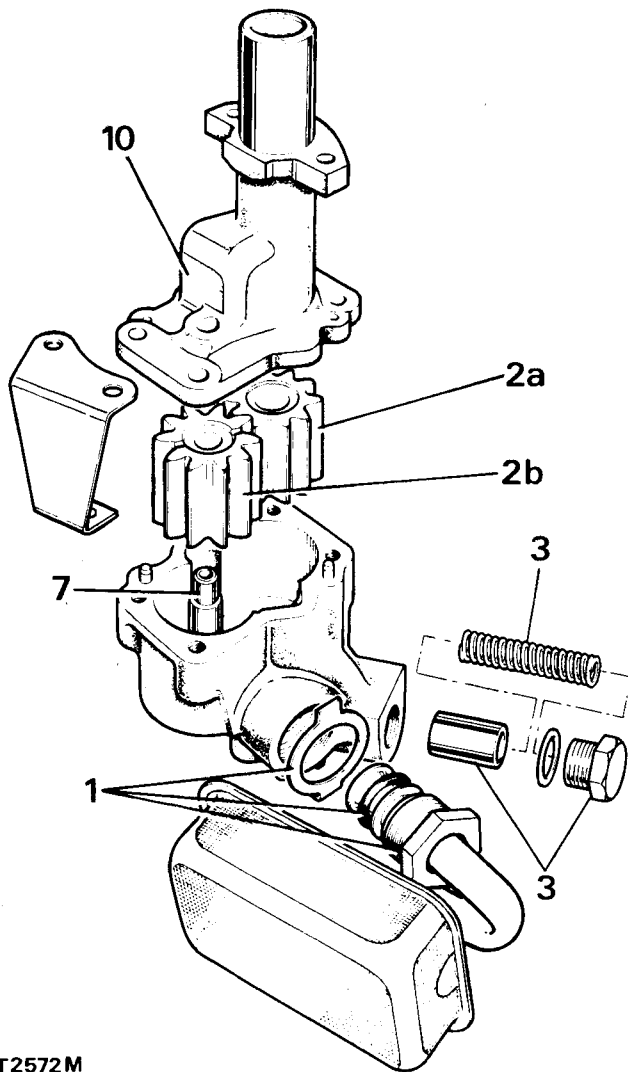


7. Check that the bearing shell is properly located in the connecting rod and pull the rod onto the crankpin. Locate the bearing shell correctly and fit the cap so that the identification numbers are together on the camshaft side of the engine. Fit and tighten new nuts to the correct torque **59 Nm**. Repeat the foregoing instructions for fitting the remaining piston and connecting rod assemblies.



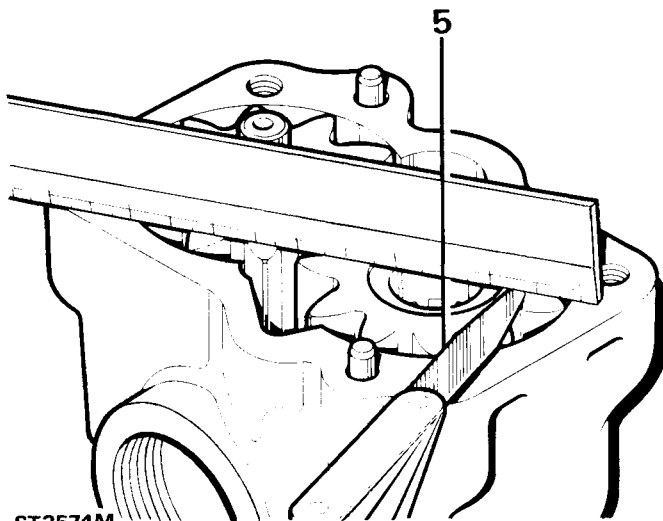
OVERHAUL THE OIL PUMP

1. Bend back the lock washer and release the nut securing the strainer to the oil pump body and remove the strainer and sealing ring.
2. Remove four bolts and washers and lift off the oil pump cover and lift out the driven and idler gears.
 - (a) driven gear
 - (b) idler gear
3. Remove the oil pressure relief valve plug and sealing washer. Withdraw the relief valve spring and plunger and examine for wear and scores.
4. Examine the gears for wear, scores and pits. If the gears appear serviceable check for end-float as follows:
5. Clean the pump body and assemble the gears. Place a straight edge across the pump body face, as illustrated, and using a feeler gauge, measure the clearance between the body and gears. Check also the backlash between the gears. The correct clearances are given in the data section. **See GENERAL SPECIFICATION DATA, Information 200 Tdi Engine.**



ST2572M

6. A worn, but serviceable gear, must not be matched with a new one, always renew gears in pairs.

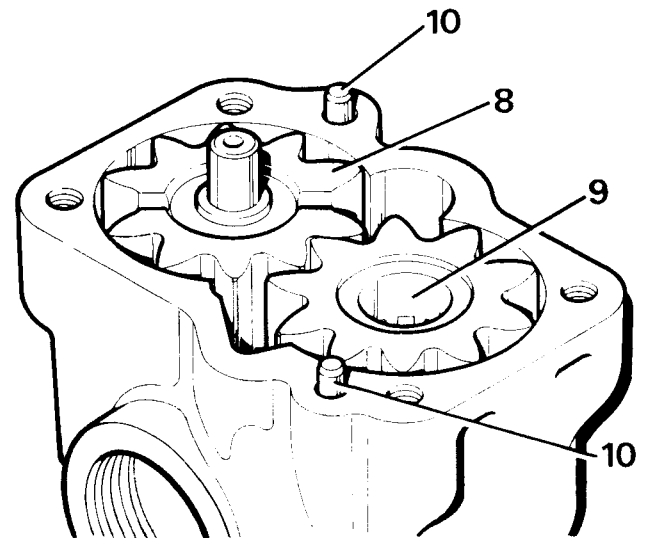


ST2574M

7. If necessary renew idler gear spindle by driving-out the spindle from the pump body and driving or pressing-in a new spindle up to the shoulder of the spindle.

Assemble the oil pump

8. Fit the idler gear to the spindle.
 9. Fit the driven gear with the plain part of the bore uppermost.
 10. Check the pump cover for wear and scores, and if necessary fit a replacement, locating it over the two pegs. Loosely secure with the four bolts until the strainer is fitted.



ST2573M

11. Hold relief valve bore vertically and insert the plunger with the solid end first. Fit the spring, sealing washer and plug.
 12. Fit a new 'O' ring to the oil strainer pipe and insert into the pump body and loosely secure with the lock washer and nut.
 13. Secure the strainer bracket to the pump body and tighten the four screws.
 14. Tighten the strainer pipe nut and secure with the lock tab.

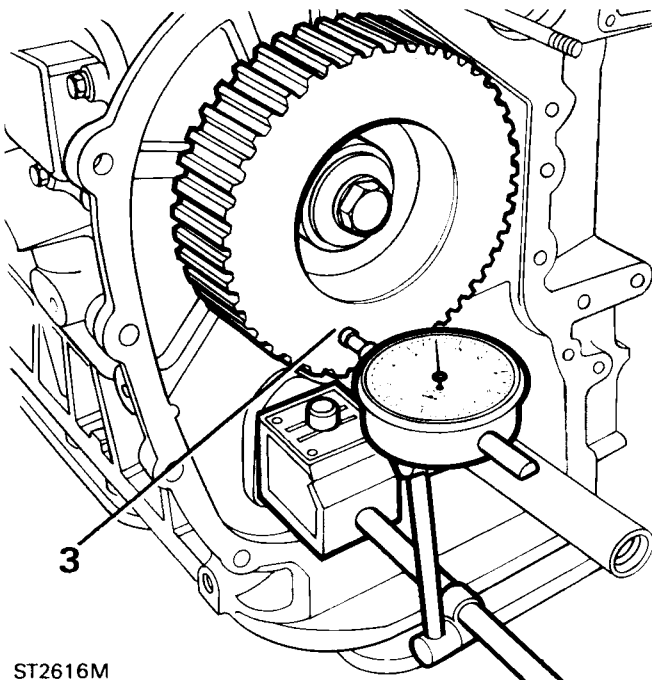
EXAMINE AND FIT THE CAMSHAFT

1. Mount the camshaft on "V" blocks on a surface plate and examine the cams for wear, scores, pitting and chipped edges. Examine the journals for obvious wear and scores and signs of overheating, in particular, check the thrust face of the front journal and the thrust plate. If the journals are visibly serviceable, check with a dial indicator or micrometer for overall wear, ovality, taper and run-out.



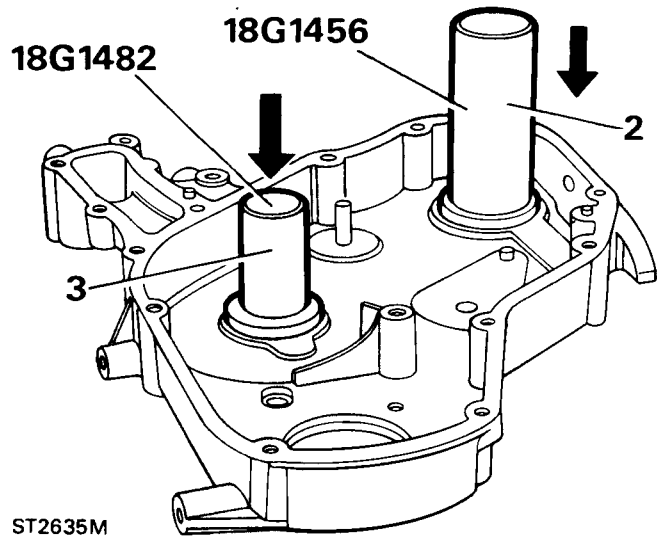
CAUTION: If the skew gear is worn and requires renewal, the camshaft must also be renewed even though the camshaft gear may appear satisfactory. Once the two gears have run together they become a matched pair.

2. Lubricate the camshaft bearings and journals with clean engine oil and carefully insert the camshaft into the cylinder block. Fit the thrust plate and secure with the two bolts and tighten to **9 Nm**.
3. To check the camshaft end-float, temporarily fit the camshaft gear and mount a dial test indicator so that the stylus rests in a loaded condition upon the machined face of the gear. Zero the dial and move the camshaft back and forward and note the reading. The end-float should be within 0,06 to 0,13 mm. If the end-float is outside these limits, fit different thrust plates until the correct tolerance is achieved.



FIT THE FRONT COVER

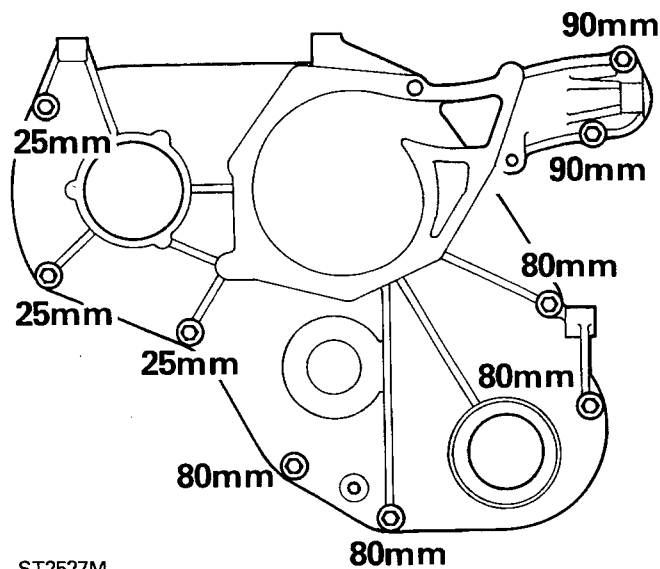
1. Clean the front cover and remove the crankshaft and camshaft oil seals taking care not to damage the seal housings. Examine the cover for damage, cracks and distortion. Check the mating face of the cylinder block and the cover plate for burrs.
2. Place the front cover, cylinder block face downwards on a flat surface and lubricate a new crankshaft oil seal. With the lip side leading, drive-in the seal, squarely, using service tool 18G1456. The back of the seal should be approximately 0,5 mm below the inner face of the cover.
3. Similarly, lubricate and drive-in a new camshaft oil seal, lip side leading using special service tool 18G1482. The seal should be approximately 1,0 mm below the inner face of the cover.



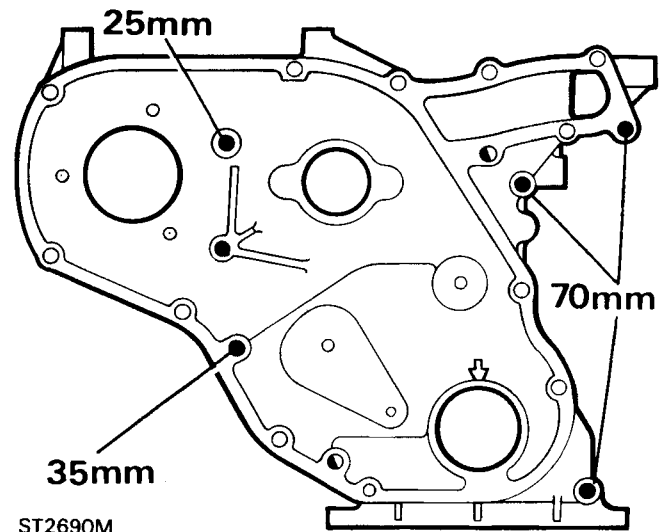
4. Clean the front face of the cylinder block and use a little grease to hold in position a new joint washer.
5. Also fit a new joint washer to the coolant aperture and to the tapped hole for the jockey pulley clamp bolt.



6. Taking care not to damage the oil seals fit the front cover locating it over the single stud. Secure with the five retaining bolts tightening evenly to the correct torque. The correct bolt length for each hole is given in the following chart.



ST2527M

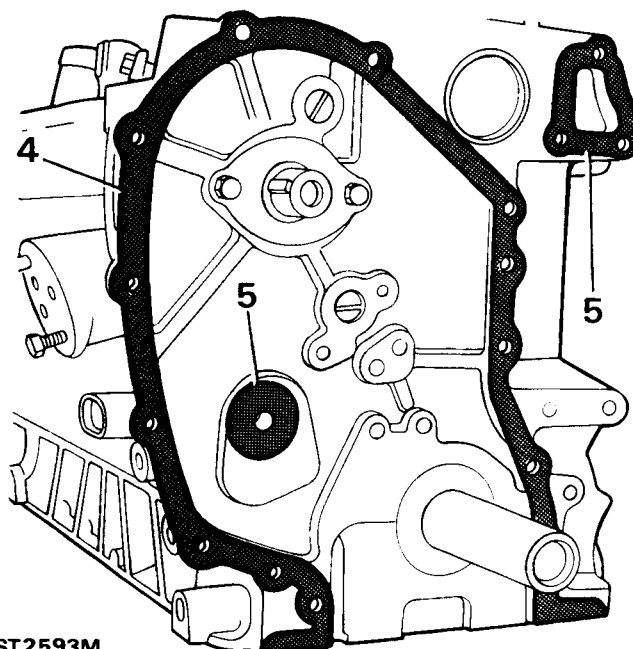


ST2690M

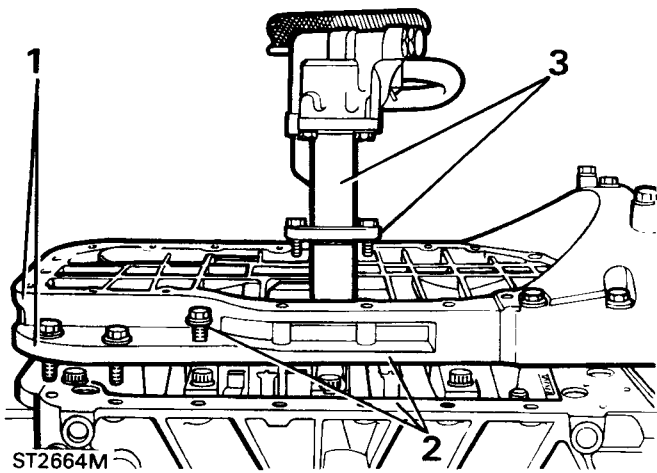
FIT LADDER FRAME, OIL PUMP AND SUMP

The sealant used cures within 15 minutes and as some of the retaining bolts are common to the sump it is important that the ladder frame, oil pump and sump are fitted together without delay. Before applying sealant coat both faces with Hylogrip Primer to clean and hasten curing.

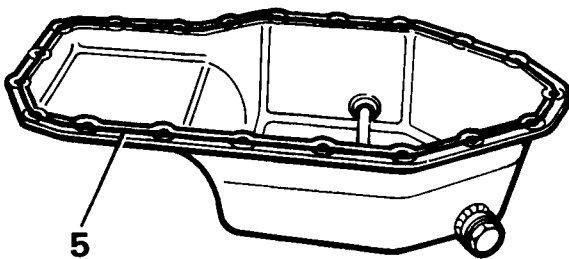
1. Clean both sides of the ladder frame and remove all traces of old sealant. Check the frame is not distorted and is free from burrs and damage on the mating faces that could cause oil or bypass gas to leak.
2. Apply 'Hylogrip 2000' to the mating face with crankcase. Apply 'Hylosil RTV' to joint line of crankcase to flywheel housing. Loosely fit the ladder frame. Fit 4 bolts securing flywheel housing to ladder frame tighten to **45 Nm**. Tighten 10 ladder frame to crankcase bolts to **25 Nm**.
3. Fit the oil pump and strainer assembly to the crankcase location and tighten the two bolts to **25 Nm**.



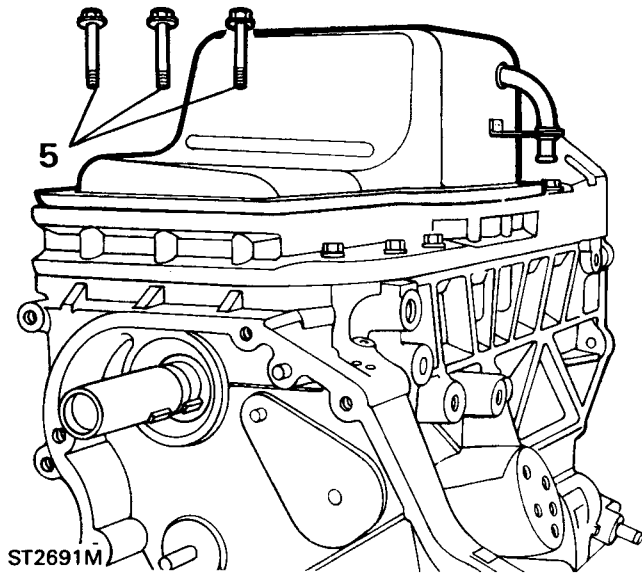
ST2593M



4. Clean the sump and remove all traces of old sealant. Examine the sump for damage, such as dents, and distortion. Check that the drain plug threads in the sump are not stripped or damaged so that an oil leak could occur.
5. Apply 'Hylosil RTV' to the sump mating face with the ladder frame. Fit the 20 bolts and tighten to **25 Nm**. Note that the three long bolts pass through the sump and ladder frame into the front cover.



ST2665M



ST2691M

OVERHAUL AND FIT FLYWHEEL

1. Normal wear and scores on the flywheel clutch face can be repaired by machining provided that the overall width of the flywheel is not reduced below 36,96 mm. Examine the ring gear and if the teeth are chipped and worn the gear can be renewed.

Reface the flywheel

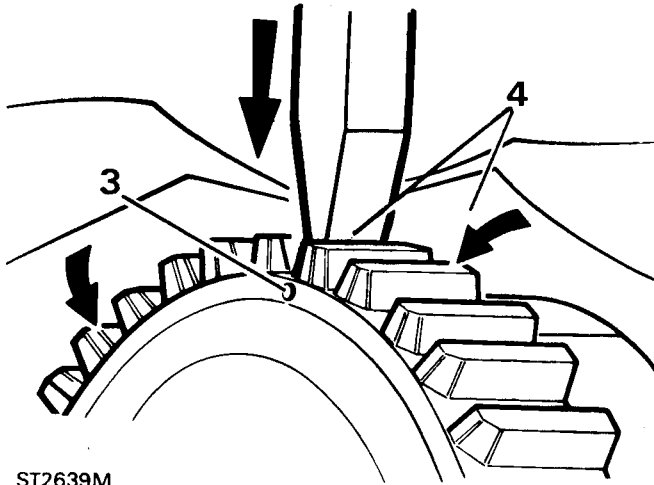
2. Remove the clutch cover locating dowels. Machine the flywheel over the entire clutch face removing only the minimum of material necessary to achieve a smooth surface parallel with the crankshaft mating face and within the above dimensions.
3. To renew the ring gear, drill a 8 mm hole between the root of any two teeth and the inner diameter of the ring gear deep enough to weaken the gear. Take care not to allow the drill to enter the flywheel.



WARNING: Wear industrial goggles to protect the eyes from flying fragments.

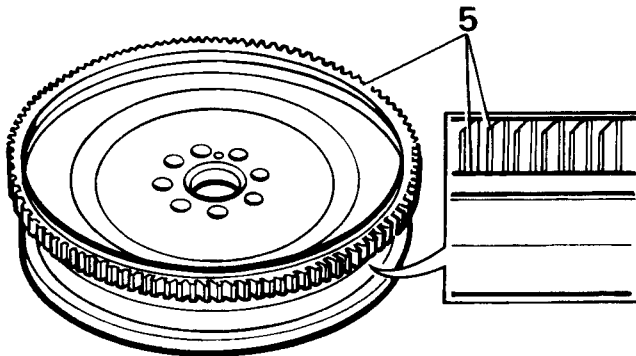


- Secure the flywheel in a soft jawed vice and cover it with a cloth to avoid personal injury. Place a cold chisel above the drilled hole and strike it sharply to split the ring gear.



ST2639M

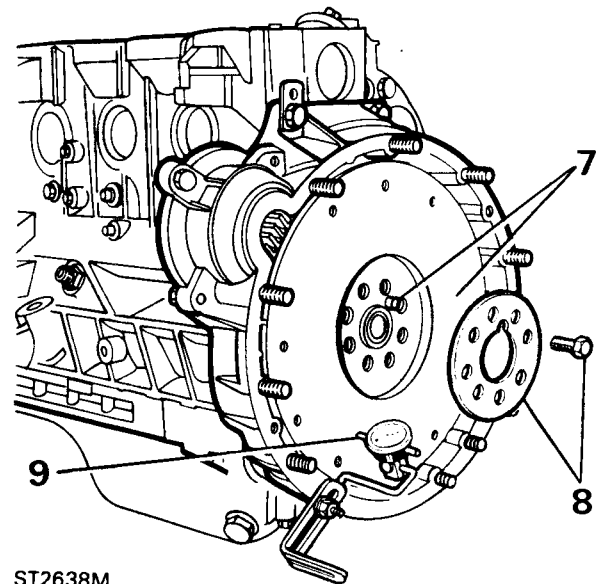
- Heat the new ring uniformly to between 225°C and 250°C but do not exceed the higher figure. Place the flywheel, clutch face down, on a flat surface and locate the heated ring gear with the square edge of teeth downwards towards the flywheel clutch face and chamfered edge of the teeth uppermost.
- Press the starter ring firmly against the flange until the ring contracts sufficiently to grip the flywheel. Allow the ring to cool naturally. Do not hasten cooling in anyway otherwise distortion may occur.



ST2640M

Fitting flywheel

- Make sure the crankshaft and flywheel mating faces are clean and free from burrs and imperfections that could prevent the flywheel running true. Check that the dowel is in position in the crankshaft and that it is undamaged.
- Offer up the flywheel to the crankshaft and secure with the reinforcing plate and retaining bolts. Temporarily fit the damper to front of crankshaft and use special service tool FR101 or LST127 to restrain the crankshaft whilst the eight retaining bolts are being tightened to **146 Nm**.
- To check the flywheel for possible run-out, mount a dial test indicator so that the stylus rests, in a loaded condition, on the clutch pressure face at a radius of 114 mm from the centre of the flywheel. Turn the flywheel, and check that run-out does not exceed 0,05 to 0,07 mm. Should any run-out be excessive, remove the flywheel, and check again for irregularities on flywheel and crankshaft mating faces and dowel. Should excessive run-out persist the flywheel should be checked on independent equipment in case the flywheel is at fault.



ST2638M

VALVE AND INJECTION PUMP TIMING

1. Examine the gear wheels for wear and damage. Cleanliness and accuracy are vital when carrying out the following instructions. The gear wheels must be free from oil and grease. Drive belts which have not been stored and treated in the following manner should not be used.

Drive belts must be stored on edge on a clean flat surface and in such a manner that bends are not less than 50 mm radius.

When a belt is handled, it must not be bent at an acute angle or an arc of less than 25 mm in diameter, as damage may be caused to the glass fibre reinforcement and premature failure could result.

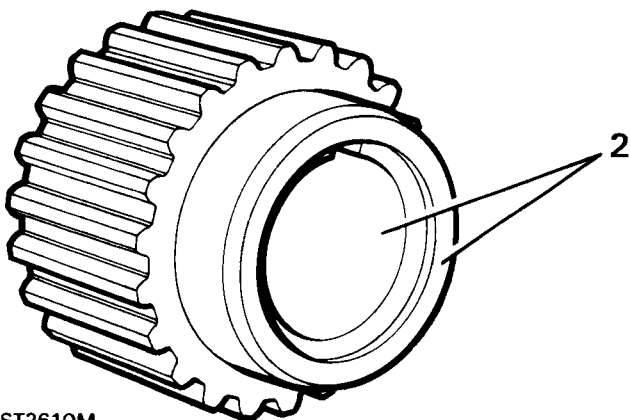
During use, a belt develops a wear pattern, therefore, if it has to be re-used, before removal, mark the direction of rotation, using soft chalk or a similar marker, and refit the belt so that it runs in the original direction.

Belts must be dry and **FREE FROM ANY OIL OR OTHER CONTAMINATION.**

Do not turn the crankshaft by applying leverage to the camshaft pulley or its retaining bolt.

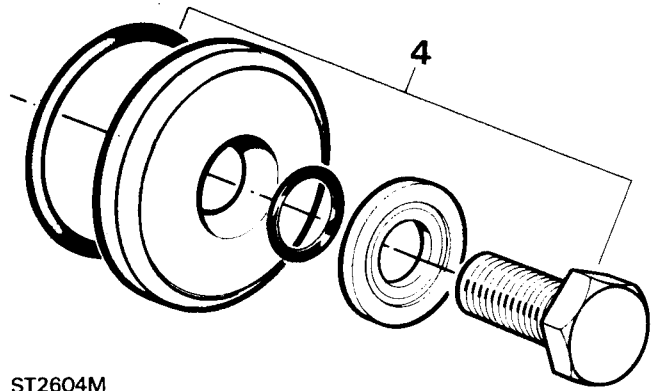
To remove a belt always use clean hands, or a recommended tool - **NEVER** use a lever.

2. Fit the gearwheel to the crankshaft.



ST2610M

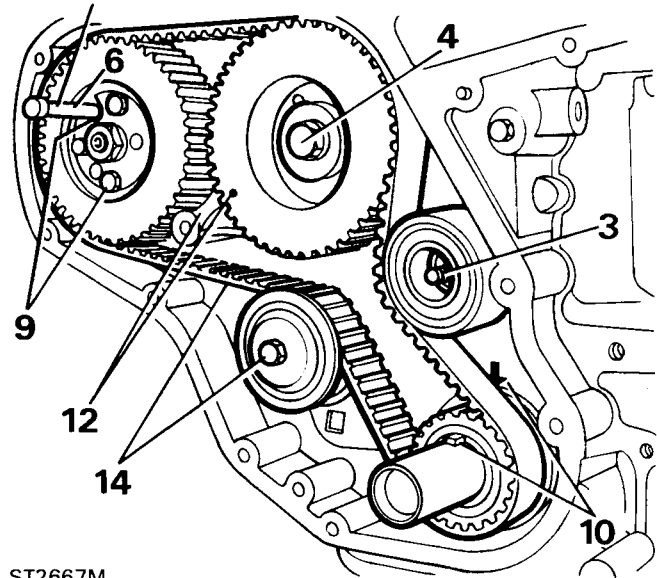
3. Fit the static tensioner and secure with the single nut and tighten to **45 Nm**.
4. Fit the camshaft gear and secure with the special bolt, washer and 'O' rings.



ST2604M

5. Fit the front side cover.
6. Insert timing pin in the pump hub and body.
7. Fit the injection pump and secure with the three nuts and tighten evenly to **25 Nm**.
8. Fit the pump rear support bracket to the front side cover and secure to the pump with two bolts and nuts.
9. Fit the gear to the injection pump hub with the reinforcing plate and three bolts so that the 'U' shaped slot lines up with the timing pin. Do not fully tighten the three bolts at this stage.
10. Turn the crankshaft so that numbers one and four pistons are at T.D.C. and the woodruff key is aligned with the cast on arrow inside the front cover.

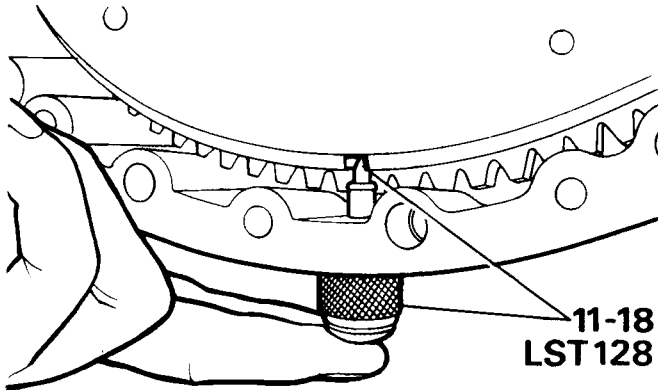
LST 129



ST2667M

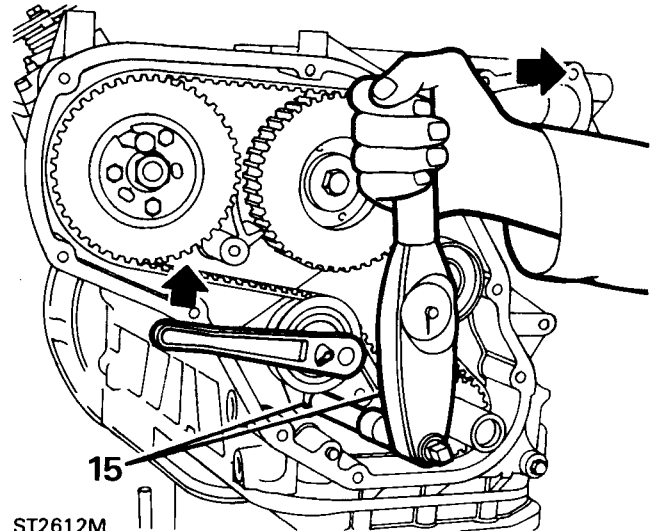


11. Screw the body of timing pin LST128 into the bottom of the flywheel housing and check that the pin will locate into the flywheel slot. It is important to note that there are two slots in the flywheel and that the narrowest is the one that must be used for this direct injection engine.



ST2641M

12. Rotate the camshaft so that the cams are positioned with number one cylinder valves closed and number four cylinder valves on the "rock". The centre dot on the camshaft gear should now be aligned with the front cover web as shown.
13. Feed the drive belt over the gears keeping it tight on the drive side without moving the gears.
14. Fit the belt tensioner with the special washer and single bolt.
15. Insert a 13 mm square drive extension into the hole in the tensioner support plate and with a dial type torque wrench held vertically, tension the belt to 18 to 20 Nm whilst tightening the tensioner clamp bolt to **25 Nm**. Do not use a "break" type torque wrench.



ST2612M

16. Tighten the three bolts that secure the pump gear and reinforcing plate to the pump hub to **25 Nm** and remove the timing pin.



CAUTION: Unlock the injection pump and fit the keeper plate before attempting to turn the crankshaft. Also ensure that the flywheel timing pin LST128 is clear of the flywheel slot.

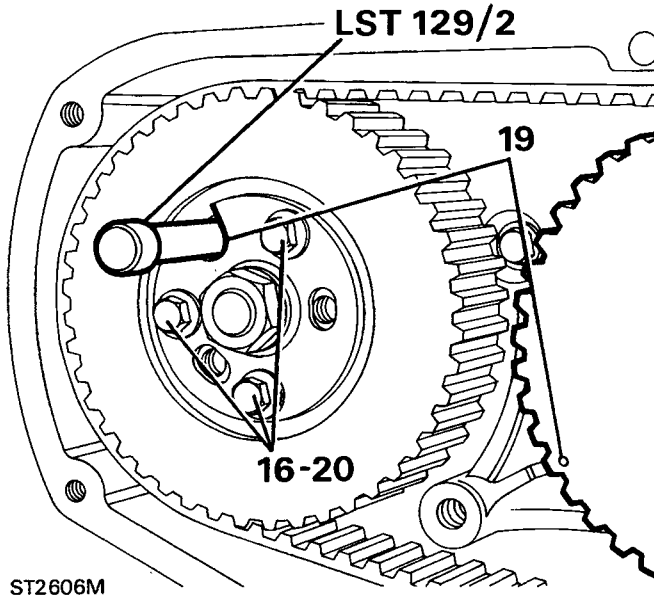
17. Rotate the crankshaft two complete revolutions and loosen the tensioner clamp bolt and tension the belt again, as previously described.



CAUTION: The double tensioning procedure is vital otherwise the belt could fail resulting in serious damage to the engine. If a new belt is not available and it is necessary to fit the old one, it should only be torqued to 16 to 18 Nm.

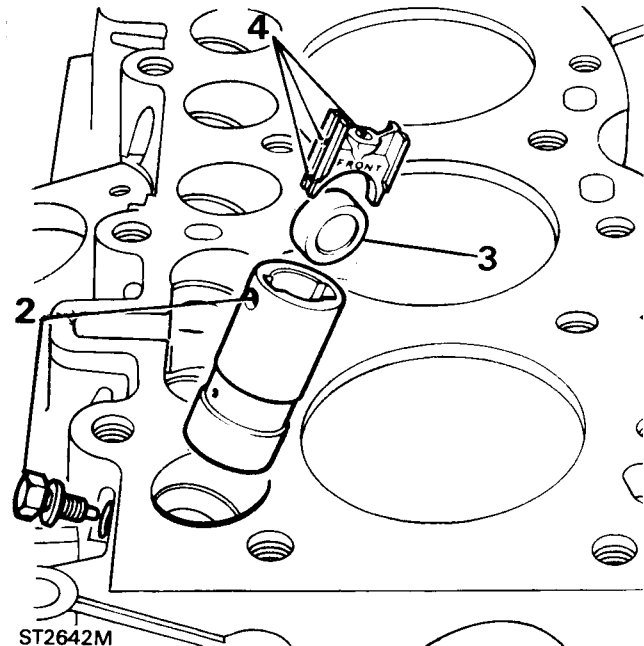
18. Turn the crankshaft again in a clockwise direction until the flywheel timing pin locates in the T.D.C. slot.

19. Insert the timing pin in the pump hub and check that the crankshaft key aligns with the arrow on the front cover. Also check that the dot on the camshaft gear aligns with the front cover web.
20. If the timing pin cannot be inserted fully into the pump hub slot, it is necessary to loosen the three pump gear retaining bolts and slightly turn the hub, in the appropriate direction, to allow the pin to locate. Retighten the bolts.



FIT CAM FOLLOWER ASSEMBLIES

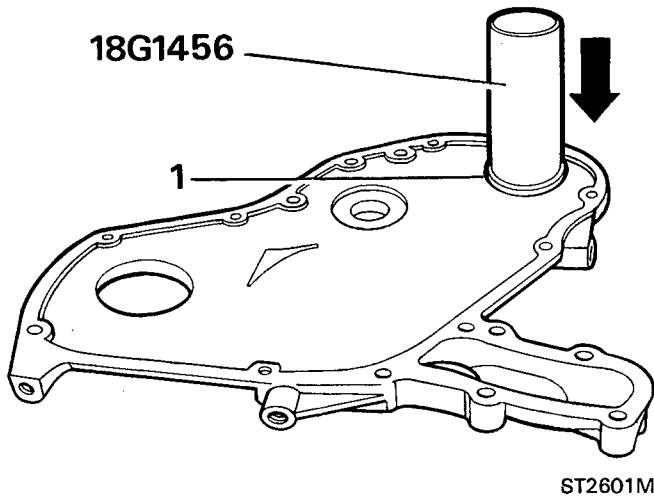
1. Examine all the components for wear and damage, particularly the rollers. Renew any component that is worn. Ensure that the tappet slides move freely in the guides. If the same parts are being refitted, ensure that they are returned to their original positions.
2. Insert the tappet guides into the cylinder block and align the locating screw holes and fit new micro encapsulated screws but do not allow the ends of the screws to protrude into the bore of the guide until the slides and rollers are fitted.
3. Fit the tappet rollers ensuring that they are fitted in accordance with the marks made during removal. New rollers, however, may be fitted either way around.
4. Before fitting the tappet slides make sure the oilways are clear to the tappet bearing surface, the cross drilling and the oil feed to the push rod. Insert the tappet slides with the word 'FRONT' or 'F' towards the front of the engine.
5. Finally tighten the screws securing the guides to **14 Nm**.



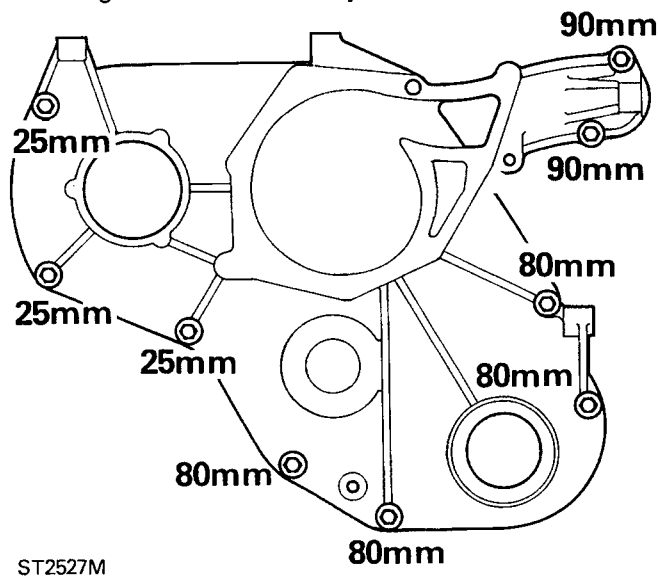


FITTING FRONT COVER PLATE AND DAMPER

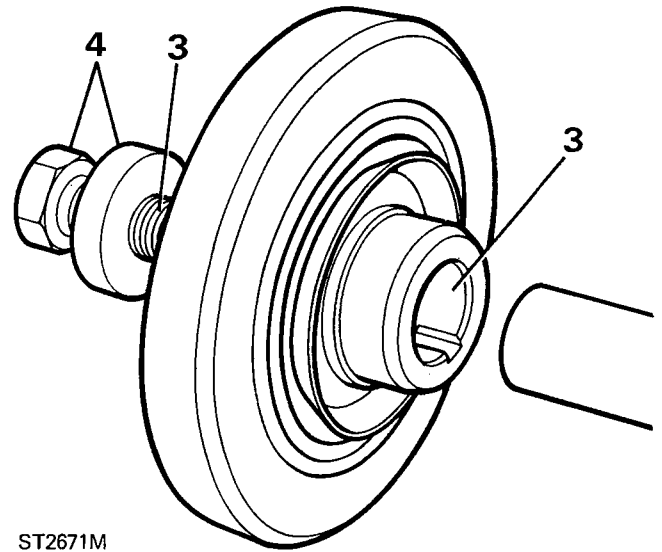
1. Remove the old ingress seal from the front cover plate and clean the seal housing. With the inside of the cover uppermost use special service tool 18G1456 to drive-in a new seal, lip side leading, so that when fitted the lip faces away from the crankshaft.



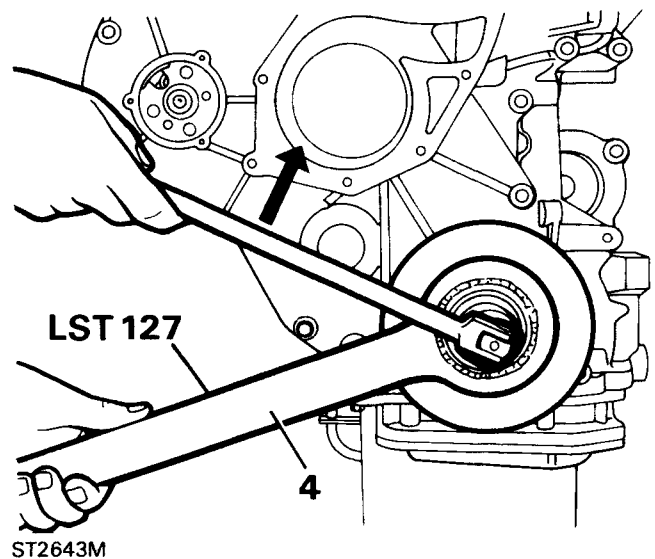
2. Clean the front cover and cover plate mating faces and apply Hylogrip Primer to both faces. The primer acts as a cleaner and a curing agent for the sealant. Apply a bead of Hylogrip 2000 to the cover plate and fit the plate to the front cover. Secure the cover with the nine retaining bolts. Since the bolts are of varying lengths, the following chart shows the correct positions. Tighten the bolts evenly to **25 Nm**.



3. Clean off the old Loctite and smear the in-board half of the inside diameter of the damper with Loctite 242.



4. Fit the damper to the crankshaft with the distance piece and special bolt. Using service tool LST127 restrain the damper whilst pulling the damper into position with the bolt. Remove the bolt, apply Loctite 242 to threads and fit and tighten to **341 Nm**.



OVERHAUL AND FIT CYLINDER HEAD



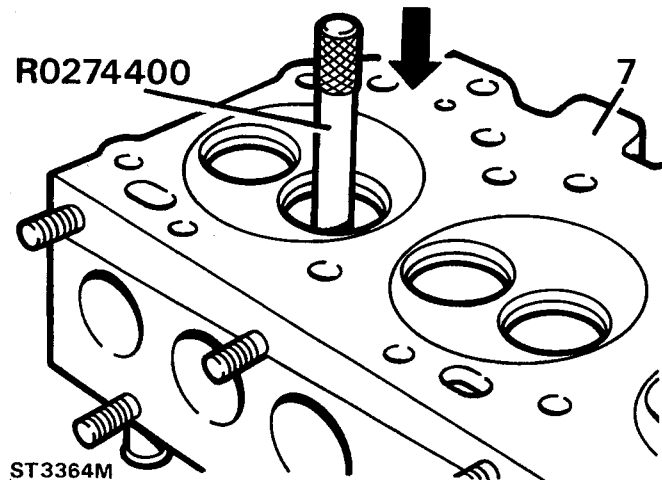
CAUTION: Since the cylinder head is manufactured from an aluminium alloy care must be taken to ensure that the combustion face, in particular, is not damaged or scratched by resting it on a hard or abrasive surface while carrying out the overhaul operations.

1. Using valve spring compressor MS1519A or a suitable alternative, remove the valve and spring assemblies keeping them identified with their original locations for possible refitting.
2. Discard the valve springs and valve guide oil seals. Remove carbon deposits from the valves and combustion chambers and degrease all parts ready for examination.
3. Examine the cylinder head for damage and distortion. Inspect the valve seat inserts for damage. Seat inserts that are beyond repair and require renewal should only be attempted by skilled specialists in this work. However, refacing of the seats can be carried out using valve seat cutting equipment as described later.
4. Examine the valve guides for wear and damage. Check for stem wear by inserting a new valve, in each guide in turn, approximately 8 mm above the seat and if movement across the head exceeds 0,15 mm, the guide should be renewed.

5. Inspect the valves for wear and damage. Valve heads that are burnt and cracked should be renewed. Valves which are bent and distorted should also be renewed. Check the stems for wear by inserting in a new guide and checking the movement across the valve head when held approximately 8 mm above the seat. If movement exceeds 0,15 mm the valve should be discarded.

Renew valve guides

6. Support the cylinder head, to enable valve guides to be driven out.
7. Using service tool RO274400, drive out the inlet and exhaust valve guides.



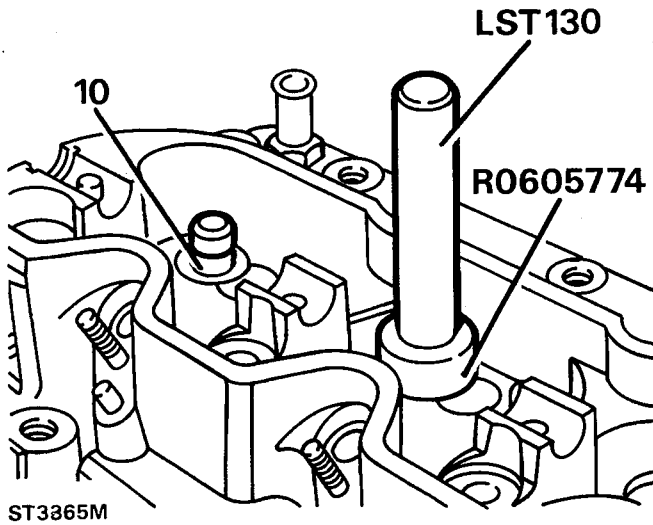
8. Clean the bores from which the guides were removed.
9. Heat the cylinder head to a temperature of 120°C.



NOTE: Only service valve guides must be used for this operation, standard valve guides are not suitable.



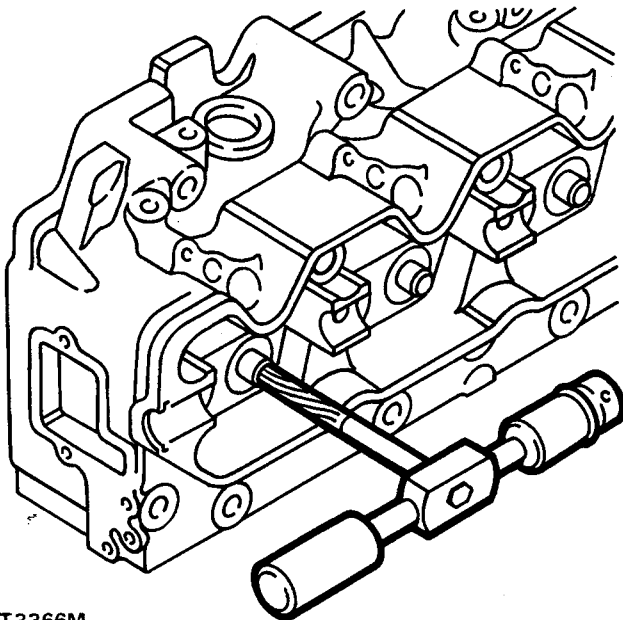
10. Lubricate then fit valve guides using service tools LST130, height gauge RO605774 and a press.



11. To ensure a uniform internal diameter for the total length of the guide, hand ream the guides with 18G 1636.



CAUTION: After the cutting edges of the reamer have passed through the guide detach the wrench and withdraw reamer from combustion side of head. Under no circumstances should the reamer be withdrawn back through the guide.



Reface valve seat inserts

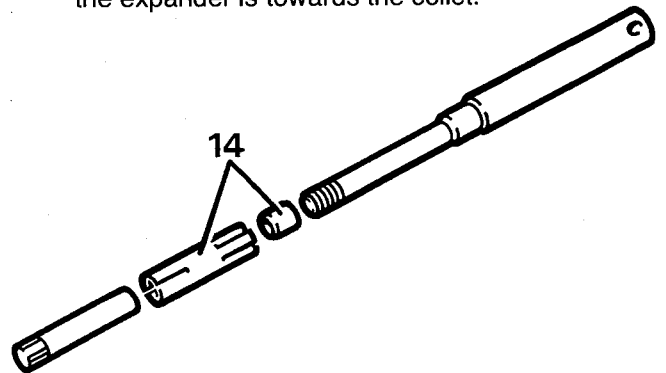
Exhaust valve seat faces should be recut to 45°. Inlet valve seat faces should be recut to 60°.

12. The special set of hand tools recommended for refacing valve seat inserts comprise expandable pilots, MS150-8, that fit tightly into new or worn guides to ensure that the valve seat is concentric with the valve guide.
13. The refacing tool, MS621 has 45° cutters for use on exhaust valve seats, and MS627 has 60° cutters for use on the inlet valve seats. The handle set MS76B is common to both cutting heads.



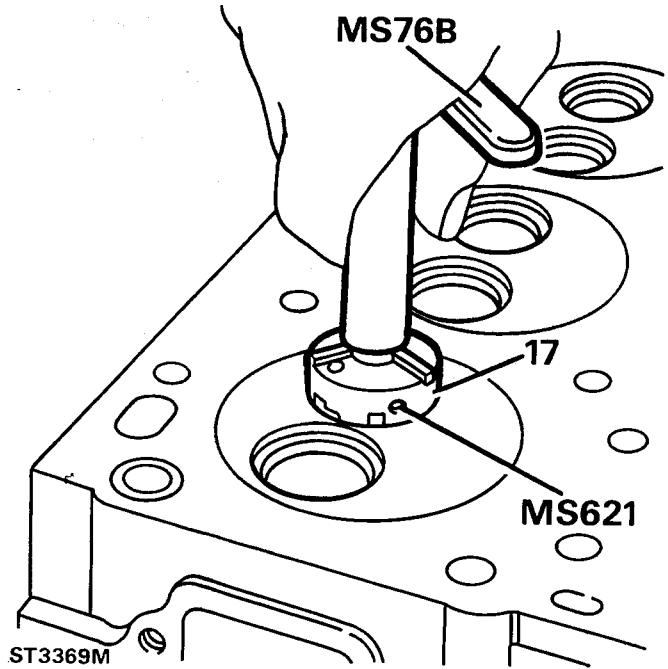
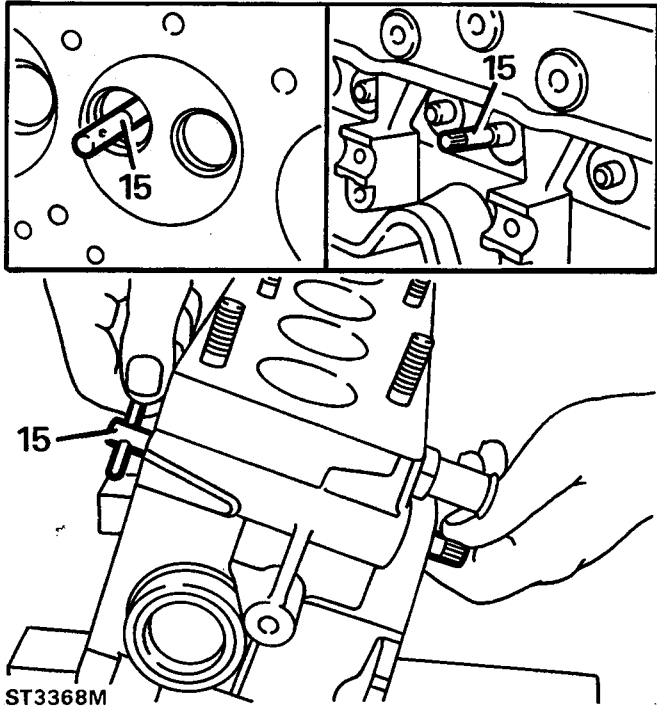
NOTE: Cutter MS621 is a double ended tool having cutters of 30° and 45°. Ensure that the 45° cutter is used in this application.

14. Loosely assemble the pilot in the sequence illustrated, ensuring that the chamfered end of the expander is towards the collet.



ST3367M

15. Insert the assembled pilot into the valve guide, from the combustion face side of the cylinder head, until the shoulder contacts the valve guide and the whole of the collet is inside the valve guide. Expand the collet in the guide by turning the tommy bar clockwise whilst holding the knurled knob.



Reface valve head faces

Exhaust valve head faces should be reground to an angle of $45^{\circ} 00'$ - $44^{\circ} 30'$ to give an included angle of 90° .

Inlet valve head faces should be reground to an angle of $60^{\circ} 30'$ - $60^{\circ} 00'$ to give an included angle of 120° .

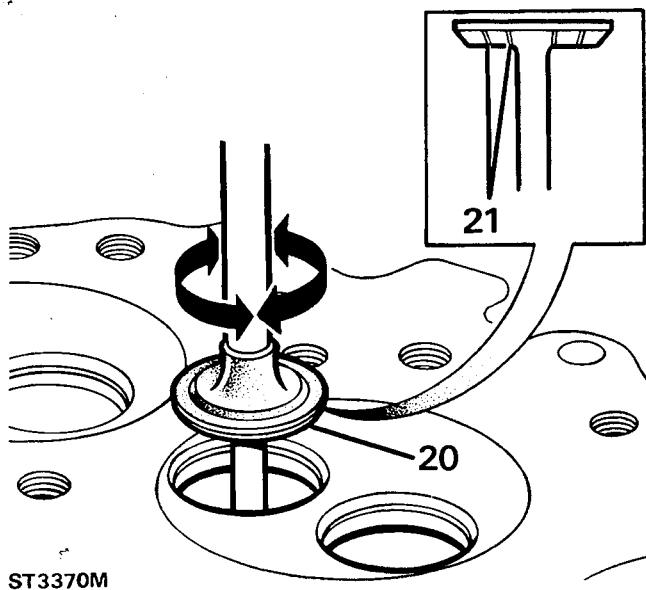
16. Using the appropriate cutter for the valve seat being refaced, ensure that the cutter blades are correctly fitted to the head with the angled end of the blade downwards facing the work. Check that the blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided to make any adjustments.
17. Fit the wrench to the cutter head and turn clockwise using only very light pressure. Continue cutting to approximately the centre of the existing seat.
18. To check the effectiveness of the cutting operation use engineers blue. Smear a small quantity of 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.

19. Valves that are satisfactory for further service can be refaced. This operation should be carried out using a valve grinding machine. Only the minimum of material should be removed from the valve face to avoid thinning of the valve edge. The valve is refaced correctly when all pits are removed and the face concentric with the stem.



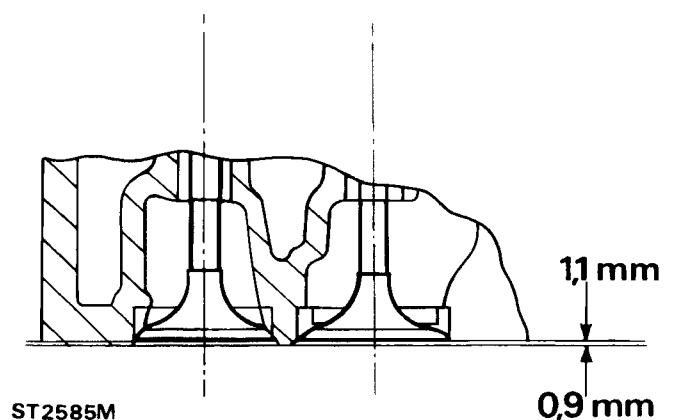
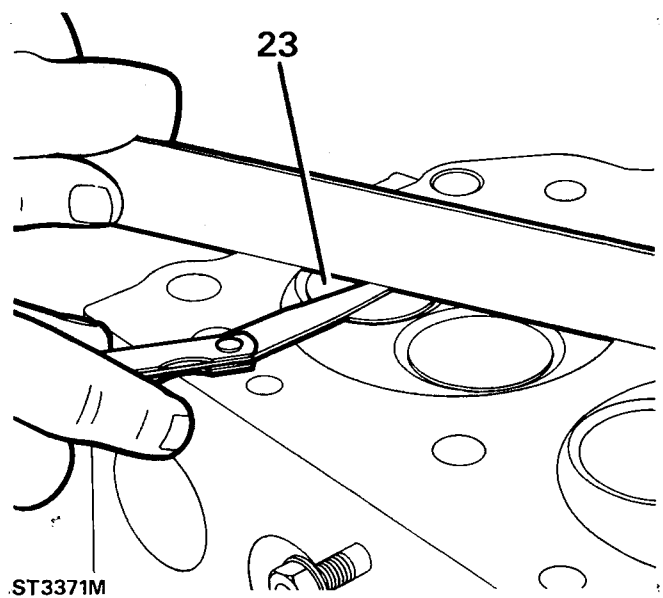
Lap-in valves

20. To ensure a gas tight seal between the valve face and valve seat it is necessary to lap-in the appropriate valve to its seat. It is essential to keep the valve identified with its seat once the lapping-in operation has been completed. Unless the faces to be lapped are in poor condition it should only be necessary to use fine valve lapping paste. Smear a small quantity of paste on the valve face and lubricate the valve stem with engine oil. Insert the valve in the appropriate guide and using a suction type valve lapping tool employ a light reciprocating action while occasionally lifting the valve off its seat and turning it so that the valve returns to a different position on the seat.



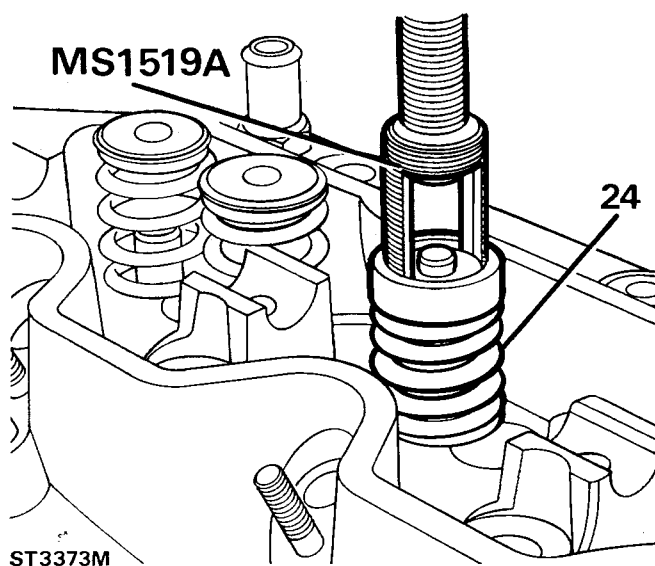
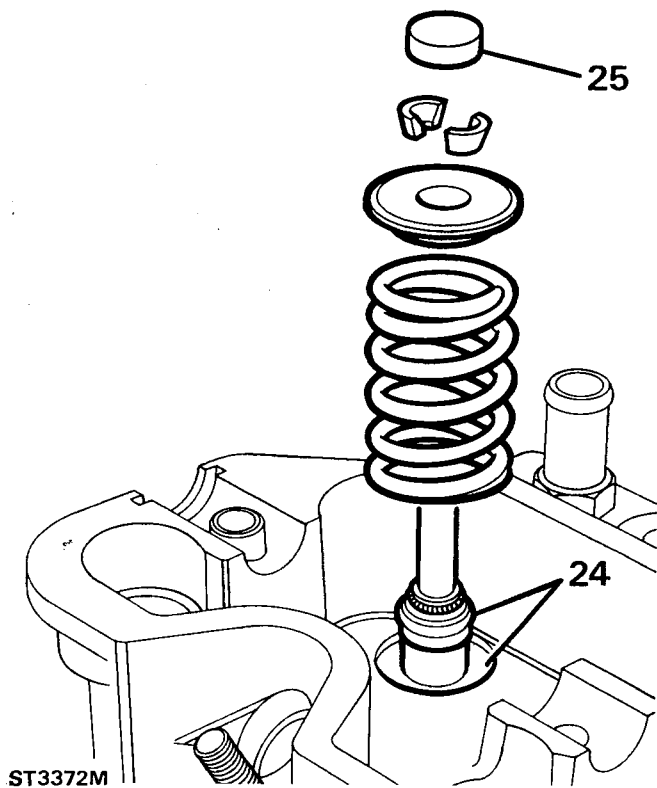
21. Continue the operation until a continuous matt grey band round the valve face is obtained. To check that the lapping operation is successful, wipe off the valve paste from the valve and seat and make a series of pencil lines across the valve face.
22. Insert the valve into the guide and while pressing the valve onto the seat revolve the valve a quarter of a turn a few times. If all the pencil lines are cut through no further lapping is required. Wash all traces of grinding paste from the valves and cylinder head.

23. Position the cylinder head with the combustion face uppermost and insert the valves into their respective guides. To check the valve head stand-down or the correct dimension of the valve head below the combustion face, use either a dial test indicator or a straight edge and feeler gauge. Hold the straight edge across the centre of each valve in turn and measure the gap between the valve head and straight edge. The correct dimension should be 1,1 to 0,9 mm. Using a dial gauge zero the gauge on the combustion face then move the stylus across to the valve head and note the reading.



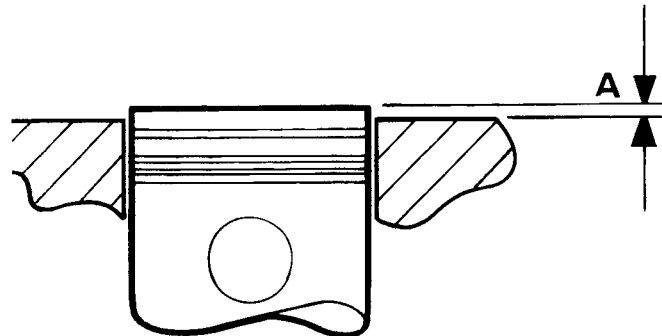
Assemble valves to cylinder head

24. Insert the valves into their respective guides. Place the steel spring plate over the valve guide, followed by the oil seal with the garter spring uppermost. Ensure that the seal fits over the valve guide. Fit the spring and cup and secure with the multi-groove butting cotters whilst compressing the assembly with the special service tool MS1519A or a suitable alternative.
25. Fit new caps to the valve tips.



Fitting cylinder head

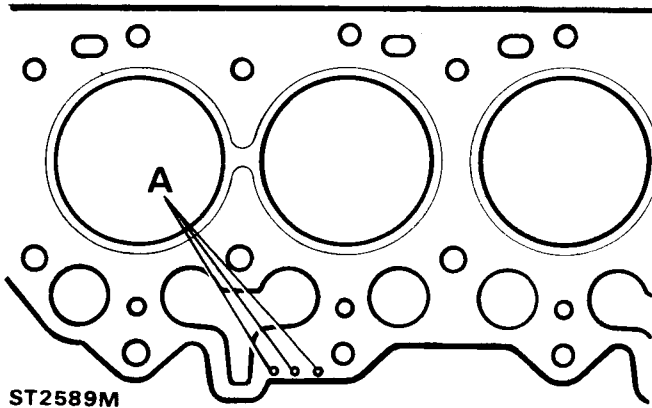
When the pistons are at T.D.C. they protrude above the top of the cylinder block. The amount of protrusion determines the thickness of cylinder head gasket that must be fitted. The height of all the pistons above the cylinder block must be measured and the thickness of the gasket selected is based upon the largest value of dimension 'A'. This dimension, however, must not exceed 0,8 mm



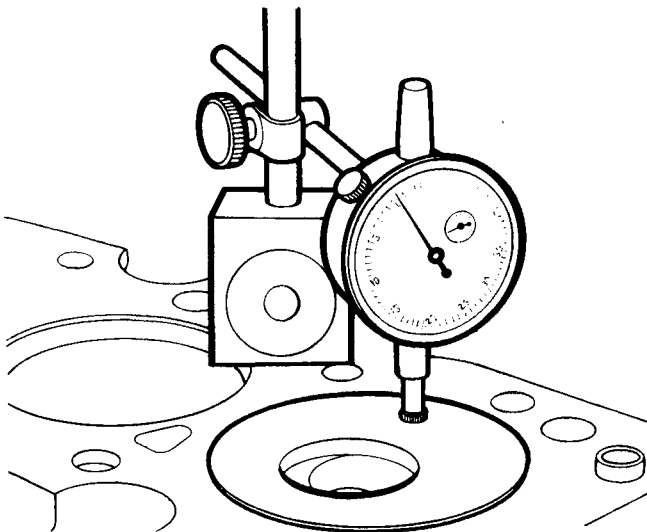
ST2646M

Three thicknesses of gasket are available and each size can be recognised by the number of identification holes punched in the side of the gasket as illustrated. The table below gives the details of the gaskets available. The thickness of gasket fitted can be seen when the cylinder head is fitted since the identification holes can be seen protruding from the right hand side of the engine towards the rear.

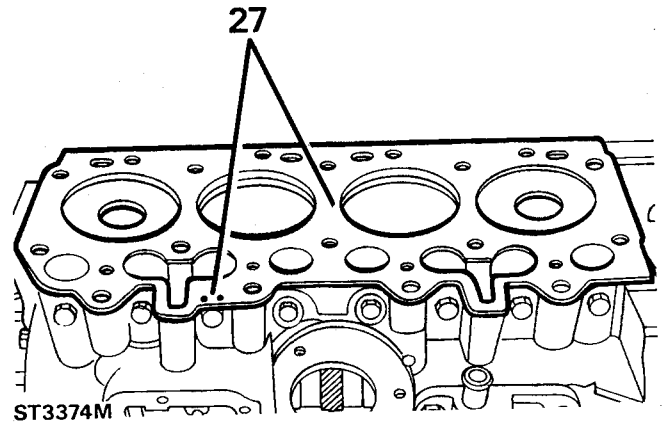
No. of holes	Metric	Imperial	Gasket
1	0,60 / 0,50	0.0196 / 0.0236	ERR 0382
2	0,70 / 0,61	0.024 / 0.0275	ERR 0383
3	0,80 / 0,71	0.0279 / 0.0314	ERR 0384



26. Clean the cylinder block combustion face and turn the crankshaft so that number one and number four pistons are at T.D.C. Use a dial test indicator to determine the highest travel of the piston then zero the gauge and move the stylus over to the cylinder block and note the reading. Repeat the procedure on the remaining pistons. The highest figure obtained will determine the gasket to fit.



27. Place the cylinder head gasket in position on the cylinder block so that the identification holes are towards the rear on the right-hand side.
28. Clean the cylinder head face and if preferred, guide studs may be fitted to the cylinder block to facilitate the lowering of the head into position. Locate the head over the two dowels.

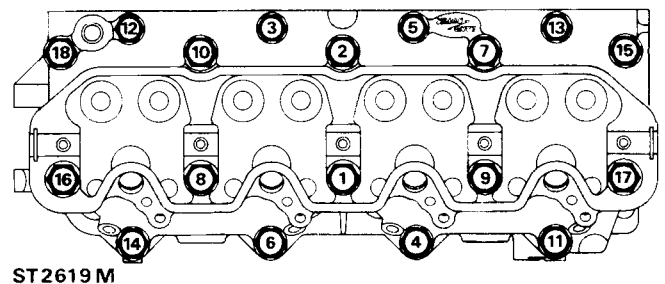


29. Lubricate the new bolt threads and fit loosely into their location.



NOTE: Always fit new cylinder head bolts.

30. Tighten all the bolts down in the sequence shown to Tighten to **40 Nm**.



Bolt sizes:

M10 locations - 3, 5, 12 and 13

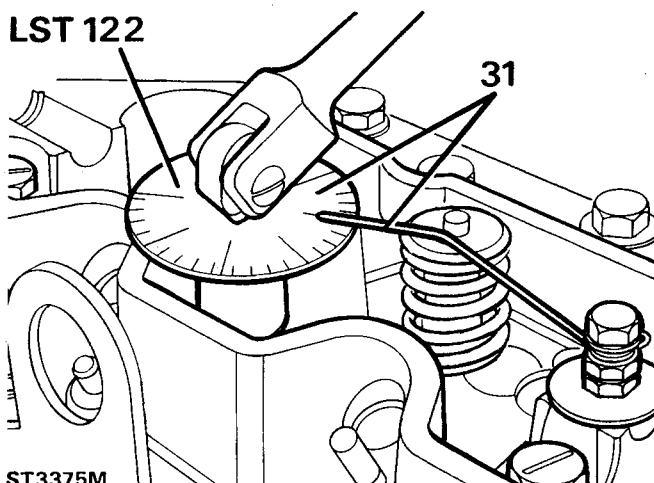
M12 locations - 1, 2, 4, 6, 7, 8, 9, 10, 11, 14, 15, 16, 17 and 18

31. Attach the service tool degree disc LST122 to a power bar. Make a suitable pointer from welding rod and attach it to a bolt screwed into a rocker shaft securing bolt hole. Tighten all the bolts down through an angle of 60° strictly in the sequence illustrated. As each bolt is tightened scribe a line across the head with a piece of chalk or crayon to identify which bolts have been tightened. Again, in the correct sequence, tighten the bolts a further 60° and scribe another line across each bolt head as it is tightened. Re-positioning of the pointer will, be necessary to reach all bolts.



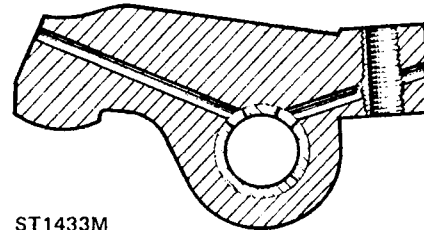
CAUTION: It is important that the double torquing procedure is observed and that on no account should the total angle of 120° be performed in one operation otherwise damage and distortion of the cylinder head may occur.

LST 122

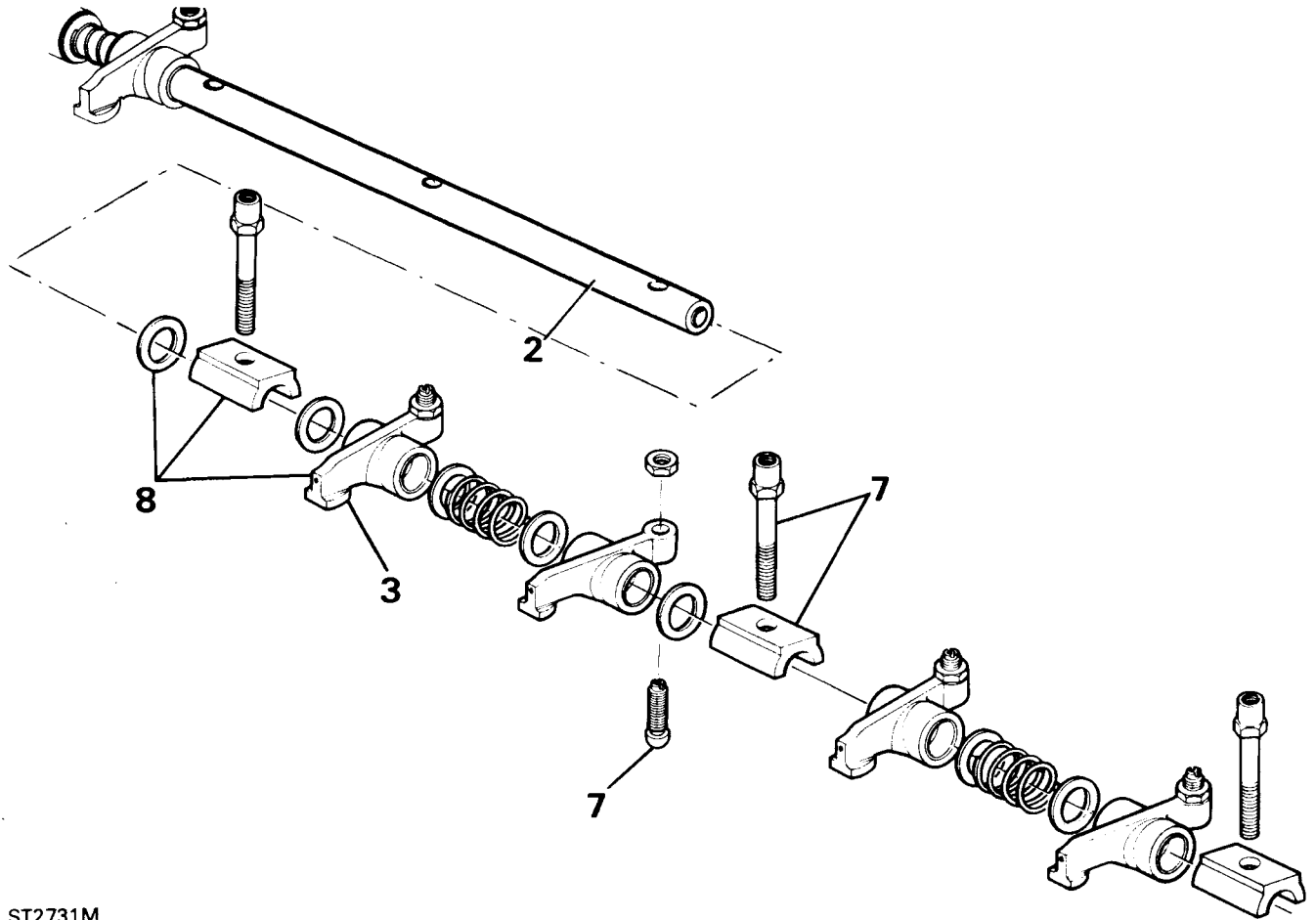


OVERHAUL AND FIT ROCKER SHAFT

1. Remove the five rocker shaft retaining bolts and withdraw the bearing caps, rockers, washers and springs from the shaft.
2. Examine the rocker shaft for wear and discard it if the bearing surface is worn, scored or pitted. Check also that the oilways are clear.
3. Inspect the rockers and discard if the pads are worn. It is not permissible to grind pads in an attempt to reclaim rockers.
4. Renew bushes if the clearance between shaft and bush is in excess of 0,101 to 0,127 mm. Press in replacements ensuring that the pre-drilled oil holes coincide with the holes in the rockers.
5. The following cross section of a rocker shows the oil drillings.



6. Finish the bushes to 18,018 to 18,00 mm after fitting.
7. Examine the tappet adjustment screws and check that the ball end is not worn or pitted and that the lubrication hole is clear.



ST2731M

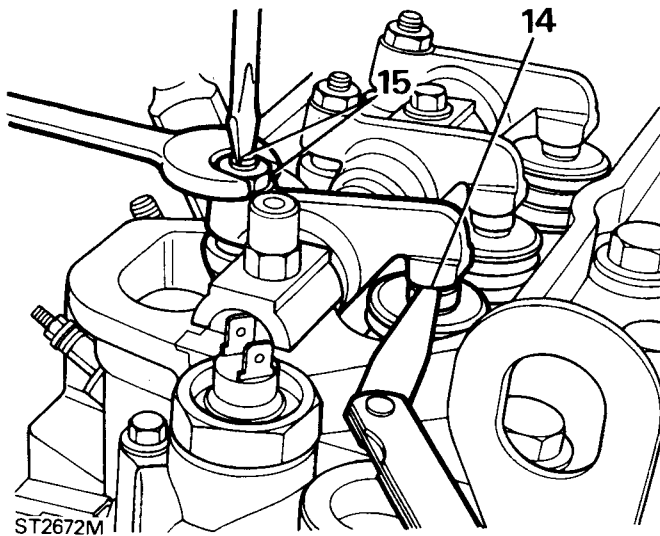
8. Assemble the rockers, bearing caps, new springs and washers to the shaft noting where the washers are fitted. Hold the assembly together with the five rocker shaft retaining bolts.

Fitting rocker shaft assembly

9. Examine the push rods and renew any that are bent or where the ball or cup ends are worn or pitted.
10. Fit the push rods to the engine ensuring that the ball-end locates properly in each camfollower slide.
11. Fit the rocker shaft assembly to the cylinder head and secure in position with the five retaining bolts. Ensure that the tappet adjusting screws locate in the cup ends of the push rods. Evenly tighten the securing bolts to **30 Nm**.

Adjust tappet clearances

12. If the crankshaft is rotated with excessive valve clearances, it is possible that the push rods may become dislodged from the tappet seating and fracture the tappet slide. To prevent damage, eliminate all clearance from any loose rockers before turning the crankshaft to adjust clearances.
13. Turn the engine over until number eight valve (counting from front of engine) is fully open.
14. Using a 0,20 mm feeler gauge check the clearance between the valve tip and rocker pad of number one valve.

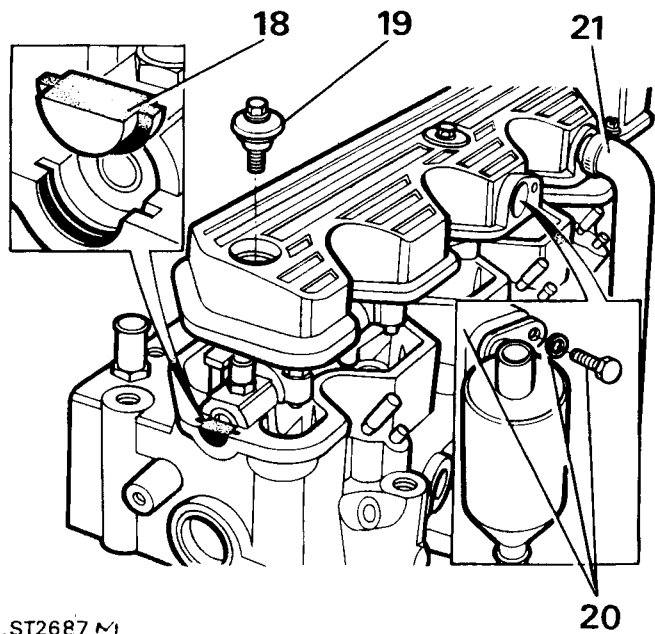


15. Adjust the clearance by loosening the lock nut and turning the tappet adjusting screw clockwise to reduce clearance and anti-clockwise to increase clearance. Recheck the clearance after tightening the lock nut.
16. Continue to check and adjust the remaining tappets in the following sequence:

Set No. 3 tappet with No. 6 valve fully open.
 Set No. 5 tappet with No. 4 valve fully open.
 Set No. 2 tappet with No. 7 valve fully open.
 Set No. 8 tappet with No. 1 valve fully open.
 Set No. 6 tappet with No. 3 valve fully open.
 Set No. 4 tappet with No. 5 valve fully open.
 Set No. 7 tappet with No. 2 valve fully open.

Fitting rocker cover

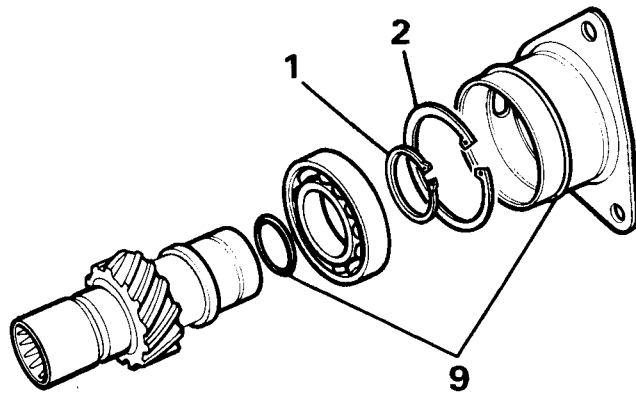
17. Fit existing seal to the rocker cover, renew if damaged or leaks were evident.
18. Apply superglue to the half-moon groove both ends of the cylinder head and then fit the rubber seal.
19. Fit the rocker cover and secure with the three bolts and special conical washers and tighten evenly to **4 Nm**.
20. If removed, fit the cyclone engine breather to the rocker cover with a new seal and secure with the single bolt.
21. Fit the breather hose that runs between the rocker cover and front side cover.





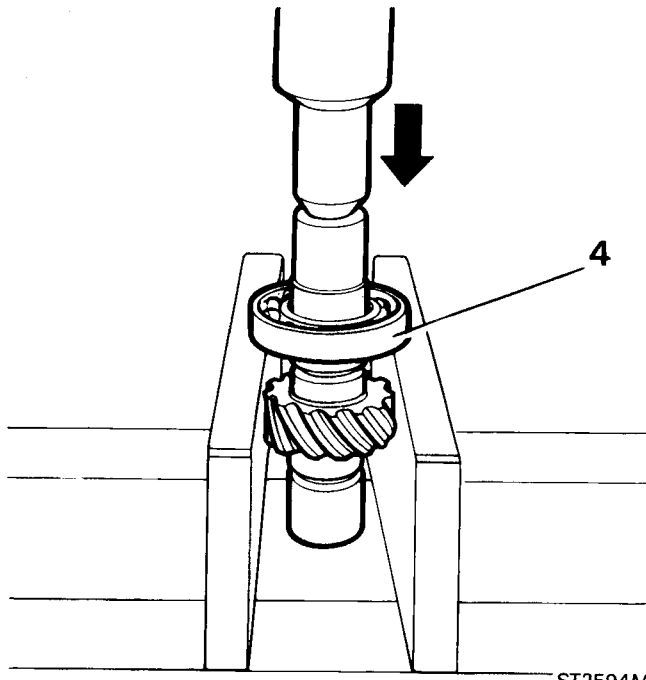
OVERHAUL AND FIT SKEW GEAR ASSEMBLY

1. Remove the circlip from the skew gear shaft.
2. Remove the circlip retaining the bearing in the housing. Remove bearing only if necessary.



ST2584M

3. Press the bearing and shaft assembly from the housing.
4. Press the bearing from the shaft.



ST2594M

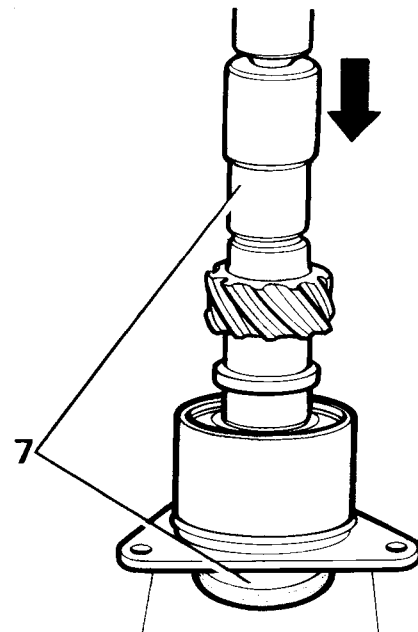
5. Examine all components especially the bearing and skew gear for wear and damage and renew if necessary.



CAUTION: If the skew gear is to be refitted, the teeth must mesh with the same teeth on the camshaft. If either the skew gear or the camshaft are renewed, the mating component must also be renewed.

Assemble

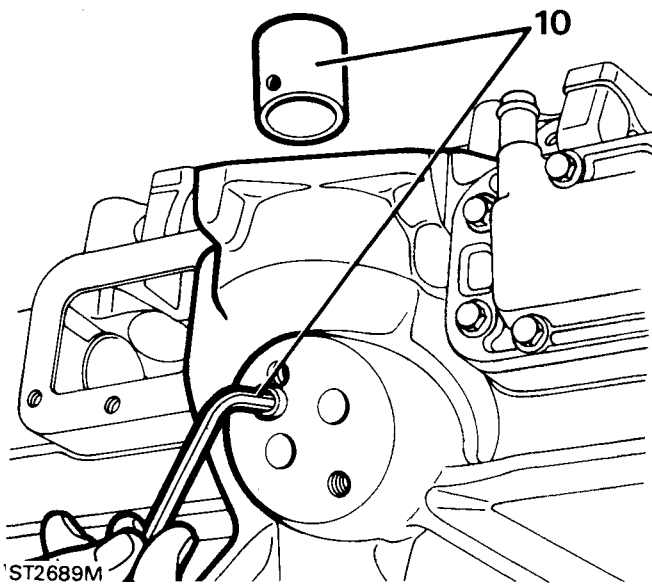
6. Press the bearing into the housing up to the shoulder.
7. Support the outside diameter of the bearing with a suitable tube and press the skew gear shaft on to the bearing.



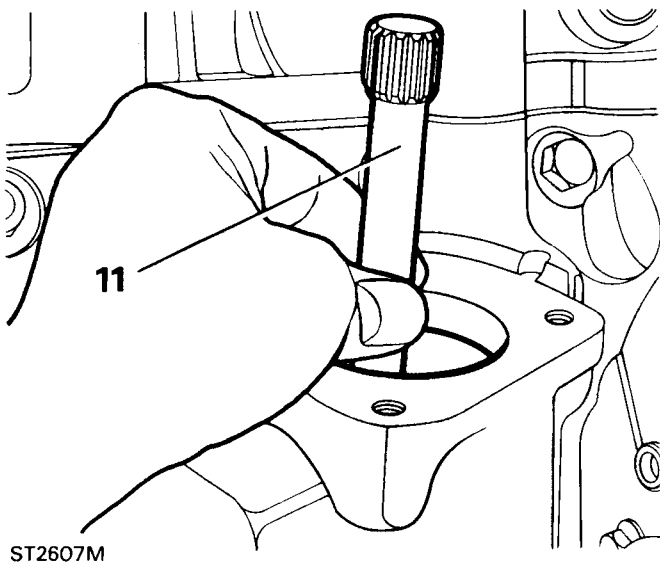
ST2595M

8. Secure the assembly with the two circlips.
9. Fit new 'O' rings to the inside diameter of the skew gear shaft and the outside diameter of the housing.

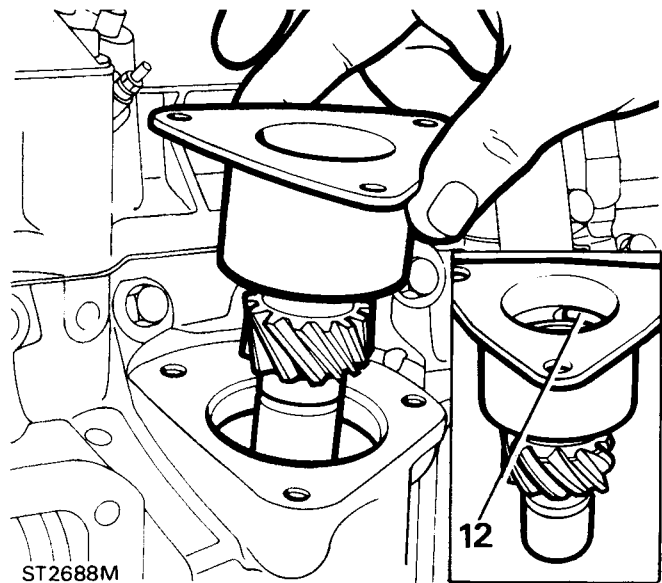
10. Fit a new skew gear bush to the cylinder block and secure with the socket headed screw. Ensure that the screw locates correctly into the hole in the bush.



11. Fit the oil pump drive shaft, long-spline end into the pump.



12. Fit the skew gear assembly so that the slot is towards the front of the engine.



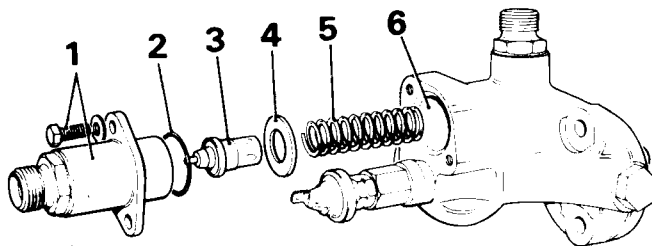
13. Using a new gasket fit the vacuum pump so that the outlet is towards the front of the engine. Ensure that the cross-pin in the skew gear shaft locates in the end of the groove in the end of the pump shaft. Secure with the three screws and tighten evenly.



OVERHAUL AND FIT OIL FILTER ADAPTOR

Renew oil temperature thermostat

1. Remove the two bolts and carefully withdraw the thermostat extension housing.
2. Remove the 'O' ring.
3. Withdraw the thermostat.
4. Remove the washer.
5. Remove the spring.
6. Clean the adaptor housing with lint-free cloth.

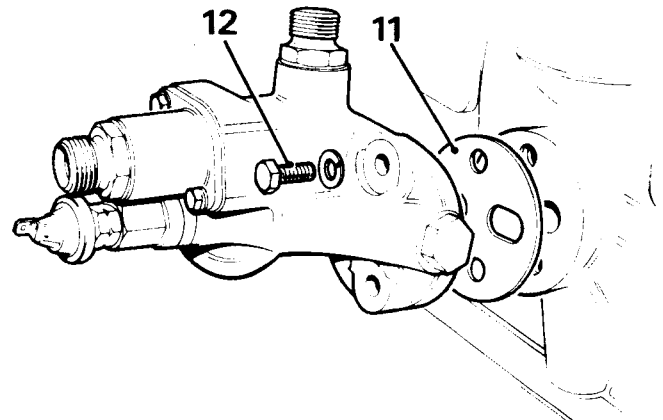


ST2596M

7. Fit the spring and washer.
8. Fit a new thermostat with the pin uppermost.
9. Fit the extension housing using a new 'O' ring. Ensure that the pin protruding from the thermostat locates in the hole in the extension housing.
10. Secure the housing with the two bolts and washers.

Fit oil filter adaptor

11. Using a new joint washer fit the oil filter adaptor. Ensure that the retaining bolts pass through the two small holes in the joint washer.
12. Tighten the two retaining bolts evenly to **45 Nm**.

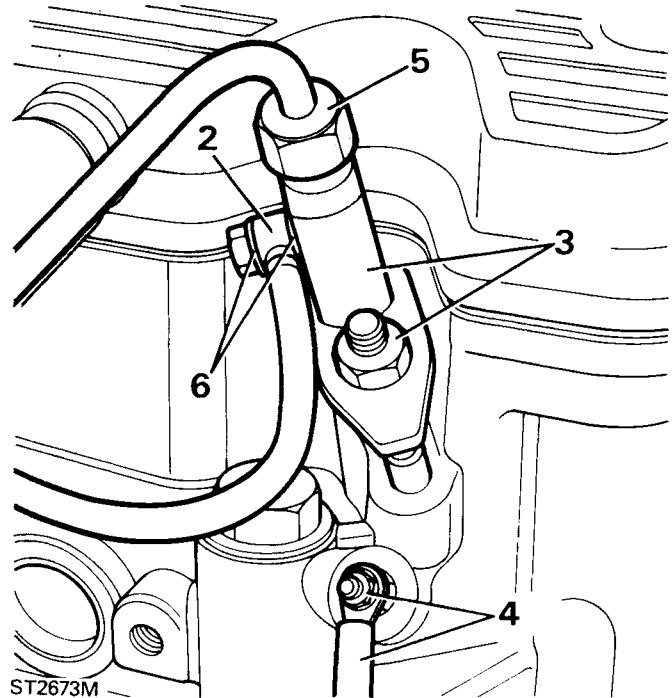


ST2597M

13. Smear a little clean engine oil on the rubber washer of the new filter, then screw the filter on clockwise until the rubber sealing ring touches the machined face, then tighten a further half turn by hand only.
14. Do not overtighten.

FIT FUEL LIFT PUMP AND REAR SIDE COVER

1. If the fuel lift pump was separated from the side cover, fit the pump to the cover first using a new joint washer between the pump flange and rear cover, evenly tighten the nuts.
2. Place a new cover plate joint washer in position and fit the cover and pump assembly to the cylinder block.
3. Ensure that the pump actuating lever rides on top of the camshaft.
4. Secure the cover, evenly tighten the retaining bolts.

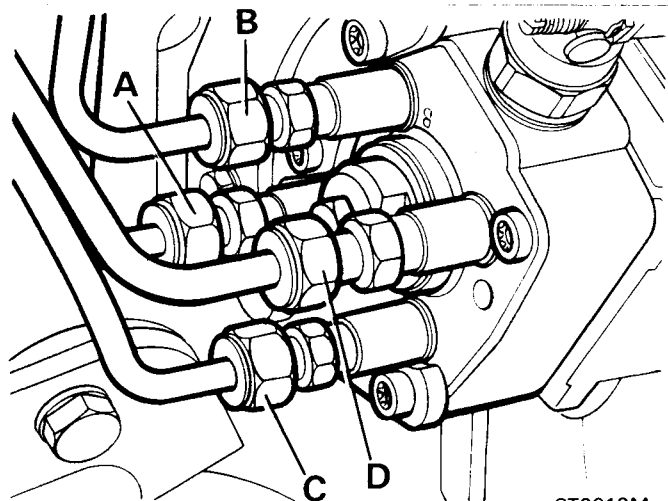


FIT INJECTORS, PIPES AND HEATER PLUGS

1. Ensure injector locations are clean. Grease a new copper washer to hold it in position on the injector.
2. Fit injectors with spill return outlet facing to rear of engine.
3. Secure injector with a clamp and nut. Fit clamps with convex side fitted uppermost. Tighten the nuts to **20 Nm**.
4. Fit the four glow plugs and tighten to **23 Nm**. Fit electrical connections to glow plugs and secure with single nut and washer. Tighten to **2 Nm**. Ensure the terminal and the insulation clears the cylinder head and breather cyclone.

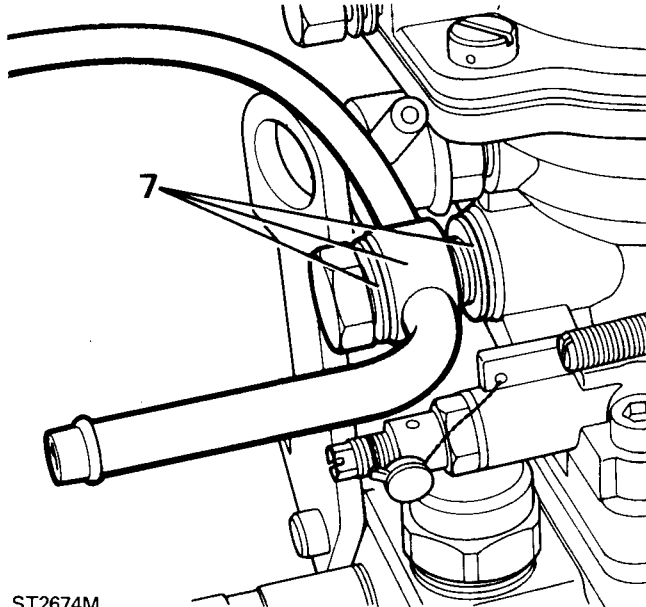
5. Fit loosely all injector fuel supply pipes, then tighten evenly to **24 Nm**. From the front of the engine connect the pipes as follows:

- A. To number 1 injector.
- B. To number 2 injector.
- C. To number 3 injector.
- D. To number 4 injector.





6. Fit the spill return rail to the injectors, with copper washers fitted each side of the retaining union screw. The inner washer locates in a recess in the injector.
7. Fit the spill return rail to the rear of the injector pump and secure with a copper washer each side of the banjo and the union bolt.



ST2674M

Fit clutch. *See CLUTCH, Repair Clutch assembly.*

Fit the starter motor

Fit air inlet manifold

Fit exhaust manifold and turbocharger

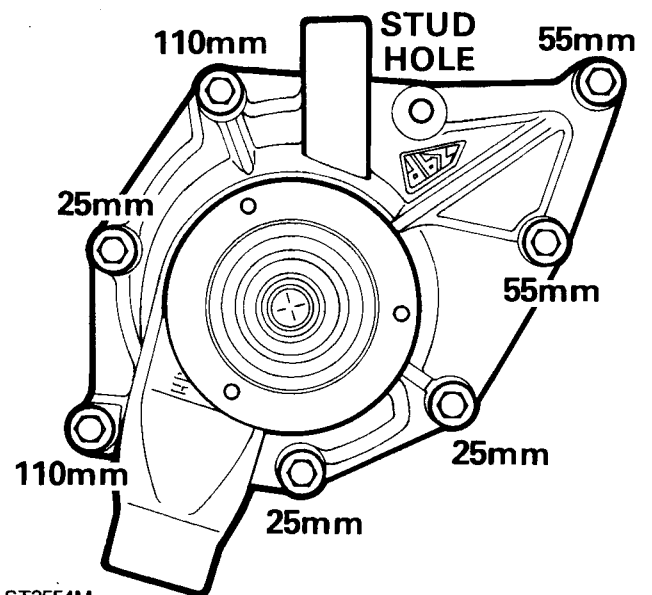
Fit thermostat and housing

Fit alternator

Fit power steering pump

FIT WATER PUMP

1. The water pump is not serviceable. Check condition of the bearings.
2. Check the pump body for signs of coolant or oil leaks. If there is any evidence of leakage, the pump should be renewed.
3. Grease and position a new joint washer on the timing cover.
4. Apply Loctite 572 thread lubricant sealant to the long bolts which penetrate into cylinder block.
5. Fit the pump and secure with the 7 bolts as shown. Tighten the bolts to **27 Nm**.



ST2554M

6. Connect hose to water pump and thermostat housing and secure with clips.
7. Fit the fan blades to the viscous coupling with the four screws.
8. Fit viscous coupling assembly to water pump spindle. Note it is a left-hand thread.

Fit air conditioning compressor.

Fit and tension drive belts. *See SECTION 10, Maintenance, Under Bonnet maintenance.*

Fit engine to vehicle. *See Repair Engine.*

Before starting engine

1. Check sump and cylinder block drain plugs are fitted.
2. Add correct lubricant to high mark on the dipstick. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information , Recommended lubricants and fluids.**
3. Check that all pipes and hoses are secure and that all electrical connections are made.
4. Fill the cooling system with correct mixture of coolant. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information , Anti-Freeze.**
5. Start and run the engine for up to ten minutes. Check for oil, fuel and coolant leaks. Stop engine and allow to cool. Recheck the oil and coolant levels.
6. Recheck the tension of the drive belts.



ENGINE

Service repair no - 12.41.01

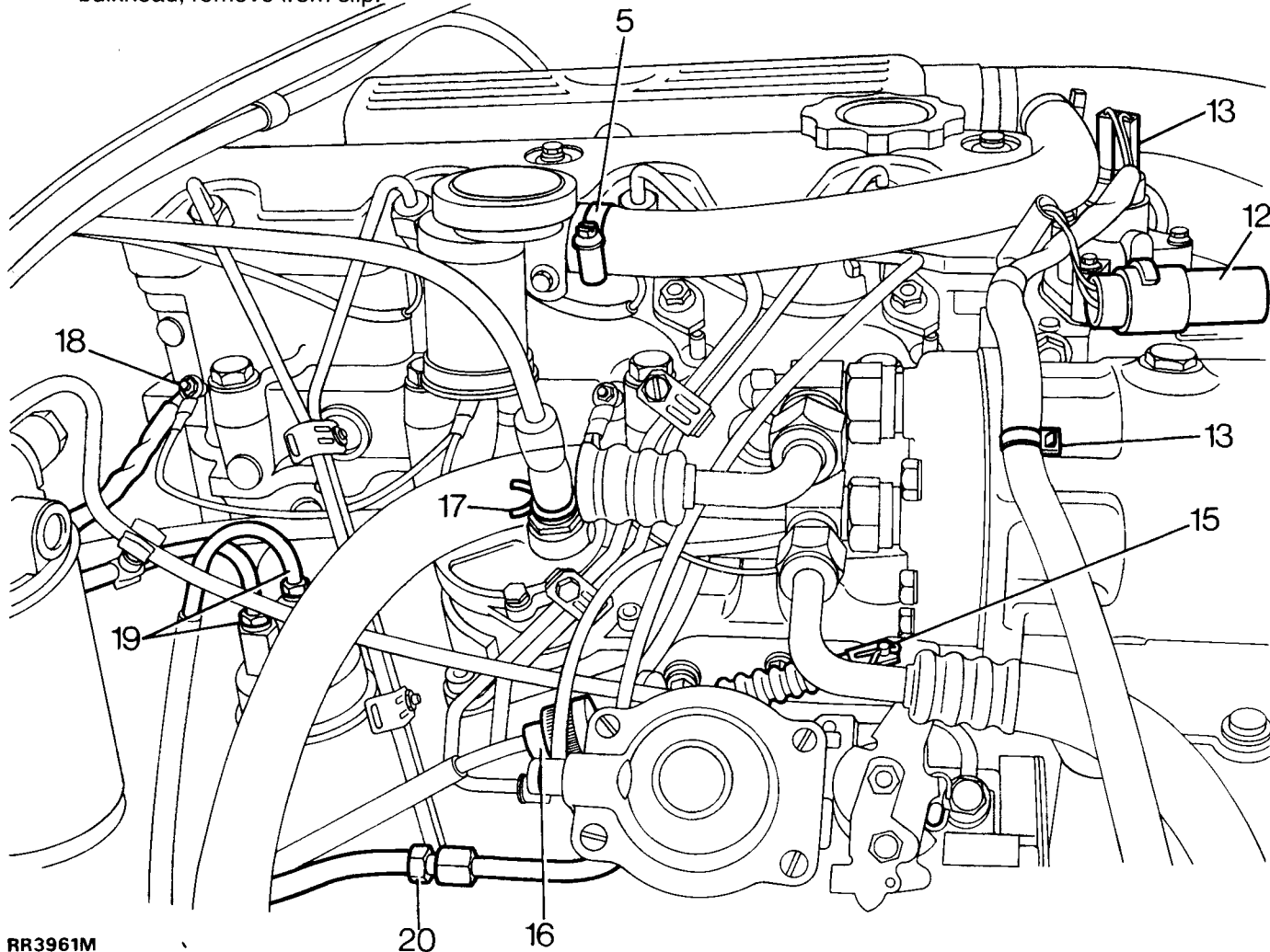
Remove



CAUTION: Seal all exposed pipe ends against ingress of dirt after disconnection.

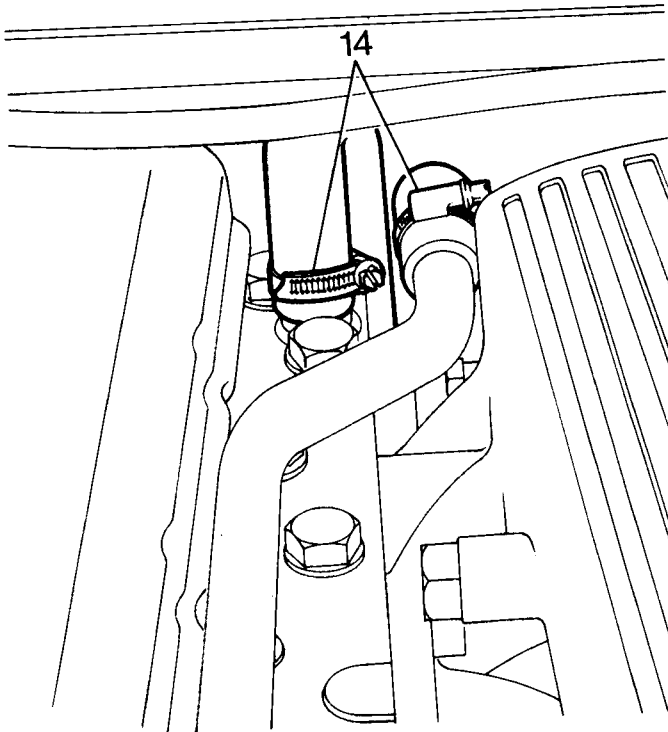
1. Park vehicle on level ground, apply park brake.
2. Remove bonnet. *See CHASSIS AND BODY, Repair, Bonnet.*
3. Remove radiator assembly. *See COOLING SYSTEM, Repair, Radiator.*
4. Remove air cleaner hose from turbocharger.
5. Remove air cleaner hose from breather cyclone.
6. Remove power steering pump inlet and outlet hoses.
7. Disconnect engine electrical harness at bulkhead, remove from clip.

8. Disconnect positive battery lead, remove from chassis clips.
9. Discharge air conditioning system. *See AIR CONDITIONING, Repair, Discharging system.*
10. Remove high and low pressure hoses from compressor.
11. Remove hose from receiver drier unit.
12. Disconnect compressor clutch multi-plug.
13. Disconnect temperature sensor connection. Remove wiring clip from compressor.

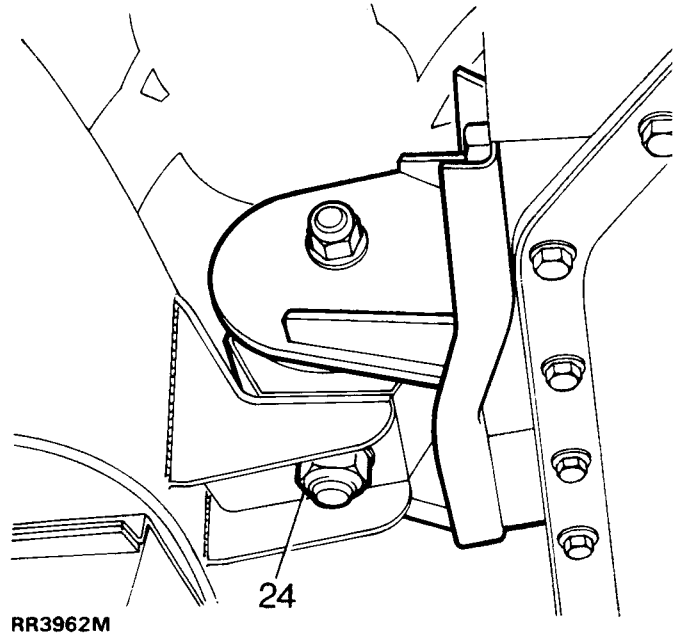


RR3961M

14. Disconnect both heater hoses at rear of engine.



15. Remove split pin securing inner throttle cable to injection pump.
16. Depress tags on outer cable adjusting nut, remove cable from bracket.
17. Disconnect pipe from vacuum pump.
18. Disconnect heater plug feed wire.
19. Remove both pipes from fuel lift pump.
20. Remove spill return pipe from injection pump.
21. Loosen clip, disconnect exhaust down pipe.
22. Remove clip securing transmission breather pipes to rear of cylinder head.
23. Remove starter motor heat shield, disconnect starter earth lead.



24. Remove nuts and plain washers securing front engine mountings to chassis.
25. Support gearbox.
26. Remove bell housing insulation.
27. Remove engine to bell housing fixings, leaving starter motor attached to engine.
28. Fit lifting chains to engine. Carefully raise engine to pull it away from transmission.
29. Ensure all connections to engine have been removed.
30. Remove engine.

Refit

31. Clean bell housing.
32. Apply hylomar to bell housing mating face.
33. Lubricate splines of gearbox primary pinion using Rocol MV 3.
34. Raise vehicle.
35. Lower engine into position. Locate primary pinion into clutch, engage bell housing dowels.
36. Fit engine to bell housing fixings, tighten to **40 Nm**.
37. Raise engine, refit front engine mountings to chassis.
38. Remove gearbox support, lower engine.
39. Tighten front engine mounting nuts.
40. Reverse removal procedure 1 to 24.

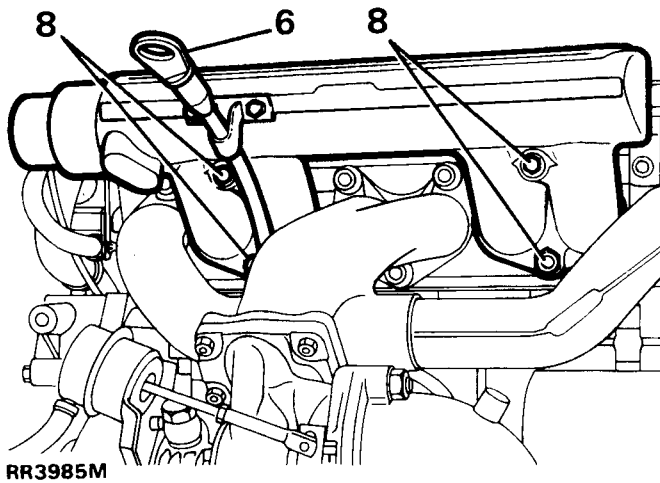


CYLINDER HEAD GASKET

Service repair no - 12.29.02

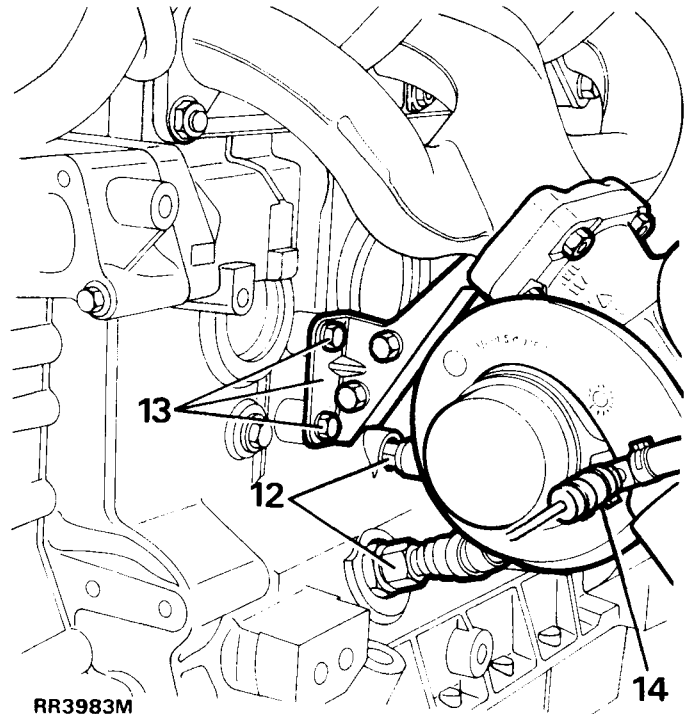
Remove

1. Disconnect battery negative lead.
2. Drain cooling system.
3. Remove radiator top hose.
4. Remove intercooler hose from inlet manifold.
5. Remove turbocharger intake hose.
6. Remove dipstick.



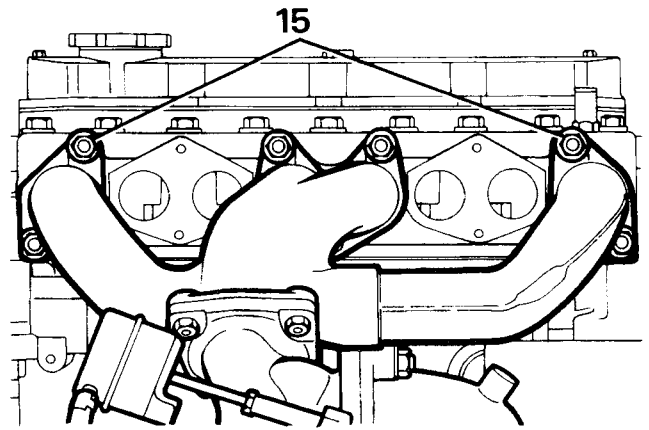
RR3985M

7. Release dipstick tube securing nut from cylinder block.
8. Remove two bolts and two nuts and remove inlet manifold with dipstick tube.
9. Disconnect heater hose and by-pass hose from thermostat housing.
10. Disconnect heater hoses from rear of cylinder head.
11. Remove two nuts securing heater rail to exhaust manifold studs.
12. Disconnect turbocharger lubrication hoses from block.



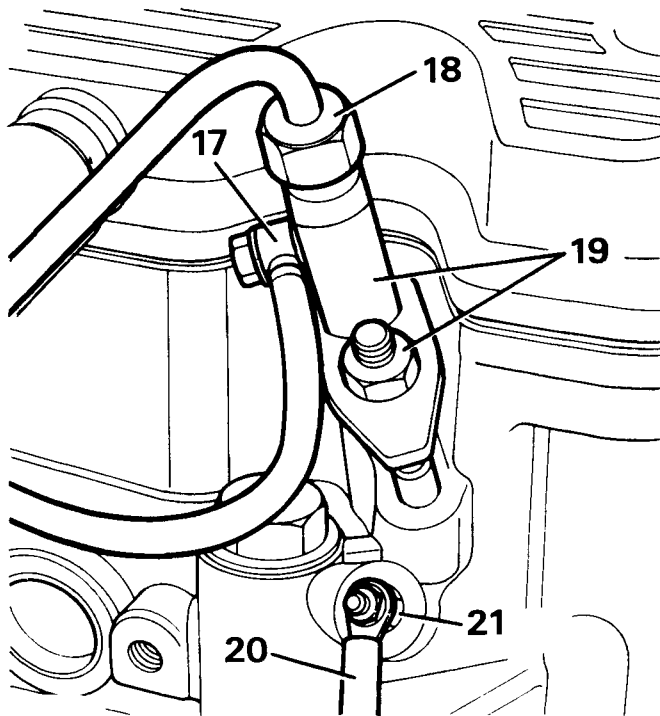
RR3983M

13. Remove two bolts securing support bracket to block.
14. Disconnect pipe to injection pump.



RR3984M

15. Disconnect exhaust front pipe from manifold.
16. Evenly loosen and remove seven nuts and washers. Remove exhaust manifold complete with turbocharger.
17. Disconnect spill return pipe.



RR3986M

18. Remove injector pipes.
19. Mark each injector to ensure they are reassembled in original position. Remove injectors. Retain injectors in separate plastic bags to avoid damage.
20. Disconnect glow plug wiring.
21. Remove glow plugs and sealing washers.
22. Remove rocker cover. **See rocker cover.**
23. Evenly release five rocker shaft retaining bolts. Remove rocker shaft keeping bolts in place. Remove valve stem caps.
24. Remove pushrods, retain in original order.
25. Remove clip securing engine breather hose to lifting eye.
26. Disconnect water temperature sensor.
27. Remove clip securing transmission breather pipes to back of cylinder head
28. Evenly loosen eighteen cylinder head bolts. Remove bolts leaving two at rear in position.
29. With assistance remove cylinder head.



NOTE: If cylinder head overhaul is required. **See Overhaul , Overhaul and fit cylinder head.**

Refit

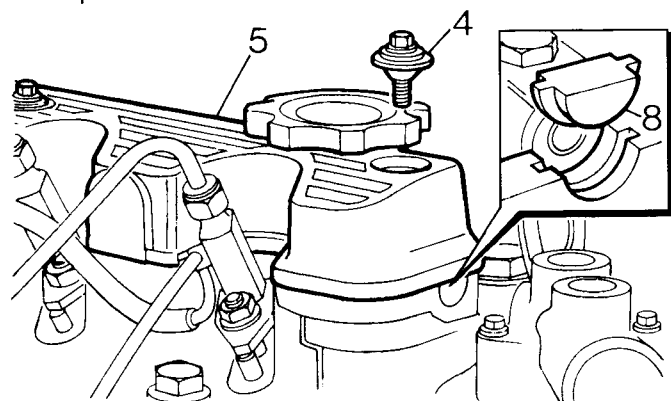
30. Clean mating faces of cylinder head and block.
31. Fit cylinder head. **See Overhaul , Overhaul and fit cylinder head.**
32. Fit rocker shaft. **See rocker shaft.**
33. Fit rocker cover. **See rocker cover.**
34. Fit injectors, pipes and heater plugs. **See Overhaul , injectors, pipes and heater plugs.**
35. Fit manifolds. Tighten fixings to **23 Nm**.
36. Reverse removal procedure.

ROCKER COVER

Service repair no - 12.29.40

Remove

1. Disconnect battery negative lead.
2. Disconnect air cleaner hose from breather canister.
3. Disconnect oil drain hose from bottom of canister.
4. Remove three rocker cover bolts, washers and sealing washers.
5. Remove rocker cover.
6. Inspect rocker cover gasket. Unless there is evidence of damage or leaks this may be refitted.
7. Clean mating faces of rocker cover and cylinder head.
8. Examine half moon seals. If fitting new ones, clean grooves in cylinder head. Glue seals in place.



RR3987M

Refit

9. Fit gasket to rocker cover.
10. Fit rocker cover. Secure with bolts, washers and sealing washers. Tighten bolts to **4 Nm**.
11. Connect hoses and tighten clips.



ROCKER SHAFT

Service repair no - 12.29.54

Remove

1. Remove rocker cover. **See rocker cover.**
2. Loosen five rocker shaft retaining bolts.
3. Remove rocker shaft. Do not remove retaining bolts at this stage, especially two end bolts, to keep assembly together when it is removed.

Refit

4. Overhaul rocker shaft and refit. **See Overhaul , overhaul and fit rocker shaft.**
5. Refit rocker cover.

FLYWHEEL

Service repair no - 12.53.07

Remove

1. Remove clutch assembly. **See CLUTCH, Repair clutch assembly.**
2. Remove flywheel. **See Overhaul , remove flywheel and housing.**

Refit

3. Examine flywheel, overhaul as necessary and refit. **See Overhaul , Overhaul and fit flywheel.**
4. Refit clutch assembly. **See CLUTCH, Repair clutch assembly.**

REAR MAIN OIL SEAL

Service repair no - 12.21.90

Remove

1. Remove clutch assembly. **See CLUTCH, Repair clutch assembly.**
2. Remove flywheel and housing. **See flywheel.**
3. Remove rear main oil seal.

Refit

4. Fit new oil seal. **See Overhaul , Fitting rear main oil seal to Flywheel Housing.**
5. Fit flywheel housing. **See Overhaul , Overhaul and fit Flywheel.**
6. Refit flywheel. **See Overhaul , Overhaul and fit Flywheel.**
7. Refit clutch assembly. **See CLUTCH, Repair clutch assembly.**

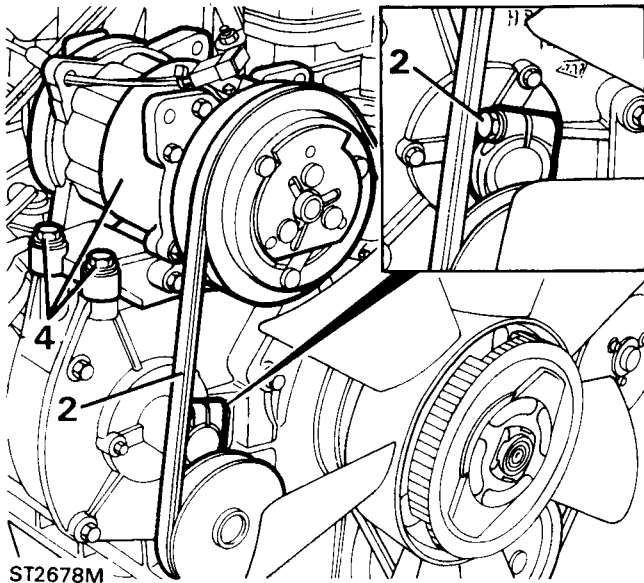
FRONT COVER OIL SEALS

Service repair no - 12.65.05 - Cover plate oil seal
 Service repair no - 12.65.10 - Front cover gasket

Remove

Air conditioning models - to gain access.

1. Disconnect battery negative lead.
2. Release compressor drive belt tensioning pulley. Remove belt from compressor pulley.
3. Disconnect the two electrical leads from thermostat housing sensor.
4. Remove the four bolts securing compressor to engine and move compressor aside taking care not to strain hoses.

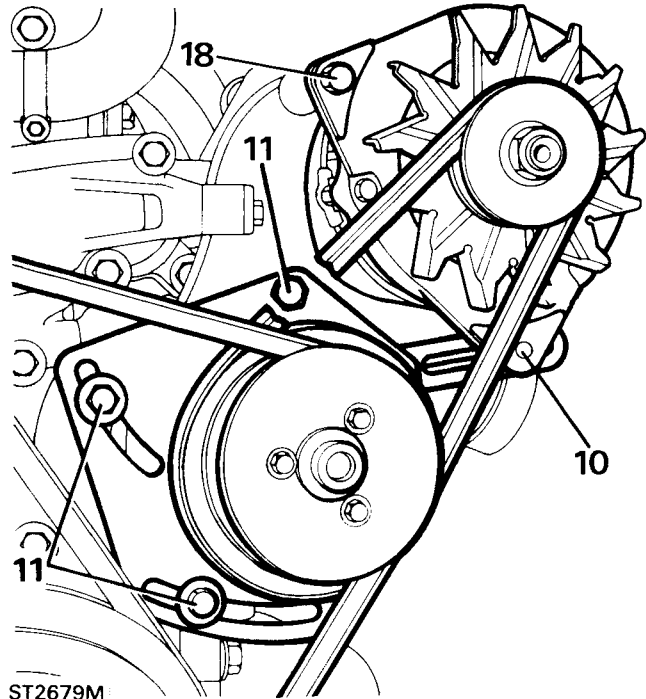


ST2678M

All models - to gain access

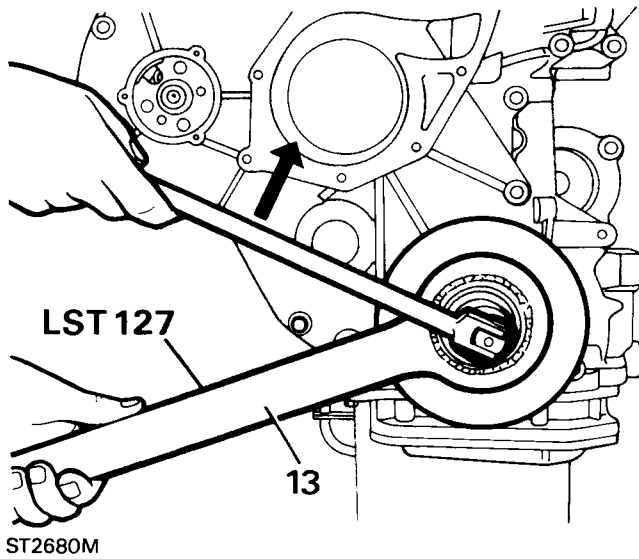
5. Disconnect battery and drain cooling system by removing bottom hose from radiator and allowing coolant to drain into a suitable container.
6. Remove viscous coupling and fan assembly, noting that coupling is secured to water pump shaft with a left hand thread.

7. Disconnect intercooler to manifold hose at the manifold.
8. Remove top hose.
9. Remove two nuts securing fan cowl to top of radiator and lift-out cowl.
10. Loosen alternator belt adjustment bolt.
11. Loosen PAS pump belt adjustment bolts and remove both belts.

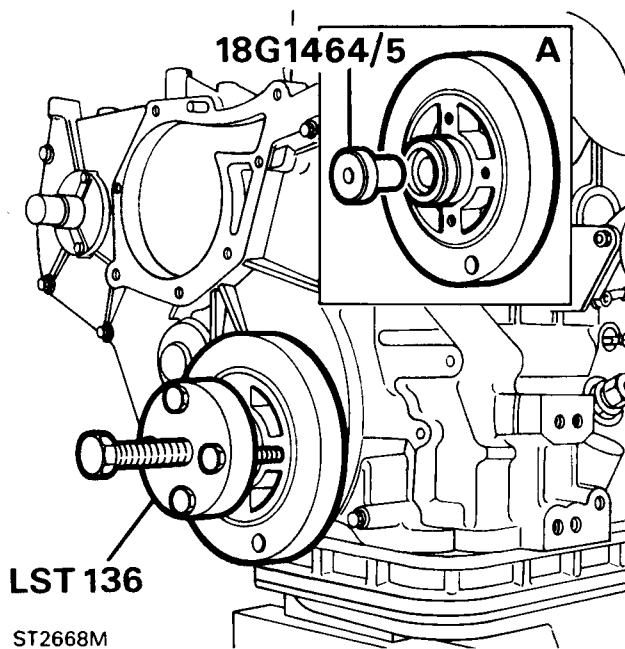


ST2679M

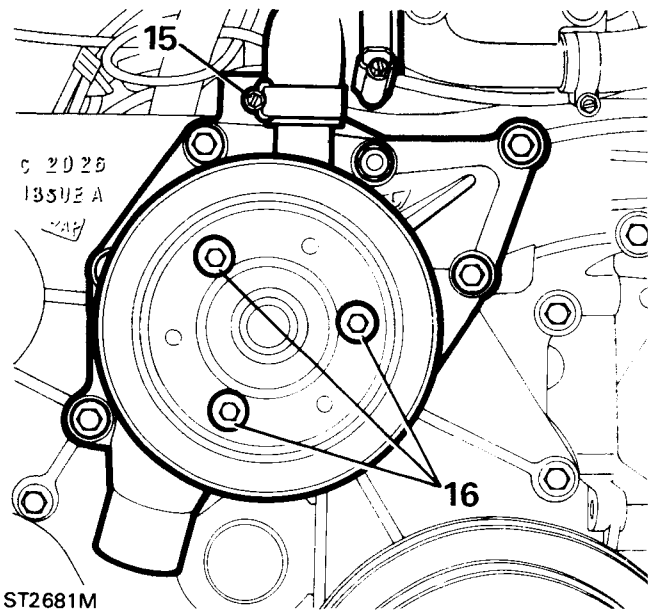
12. Remove four screws. Remove the crankshaft pulley from damper.
13. Restrain damper with special tool LST 127. Using a 30 mm socket, remove damper retaining bolt and spacer. Since this bolt is retained with Loctite and tightened to a very high torque considerable effort will be required to release it.



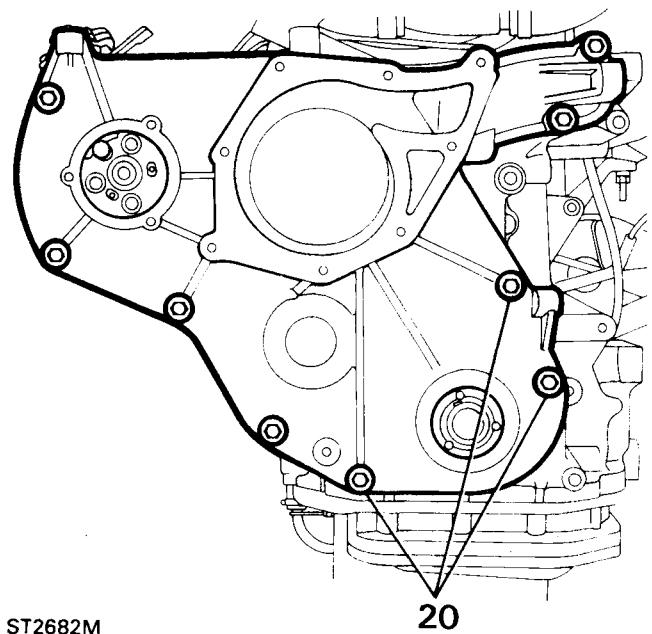
14. Since damper is also retained with Loctite, use special tool LST 136 and pressure button A from 18G 1464/5 to withdraw it from the crankshaft.



15. Disconnect bottom and by-pass hoses from water pump.
16. Remove three screws to remove water pump pulley. Remove seven bolts to remove water pump.
17. Remove air cleaner to turbo charger hose.
18. Withdraw pivot bolt, and remove the alternator. Similarly, remove PAS pump.



19. Remove five bolts to release common bracket.
20. Remove nine bolts and carefully remove cover plate from front cover.



21. Remove front cover. **See Overhaul , Remove timing gear and injection pump.**

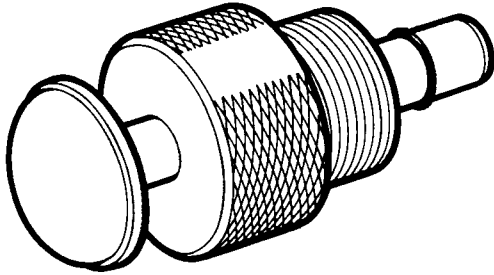
Refit

22. Fit front cover. **See Overhaul , fit the front cover.**
23. Fit camshaft drive belt. **See Overhaul , valve and injection pump timing.**
24. Fit front cover plate and damper. **See Overhaul , Fitting front cover plate and damper.**
25. Reverse removal procedure.



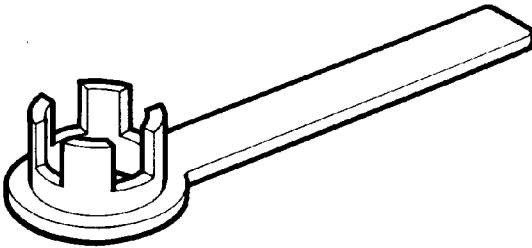
Tdi ENGINE

LRT-12-044 Flywheel timing pin
LST 128



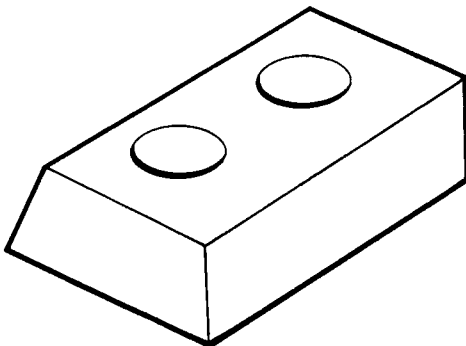
LST128

LRT-12-043 Crankshaft damper restraining tool
LST 127



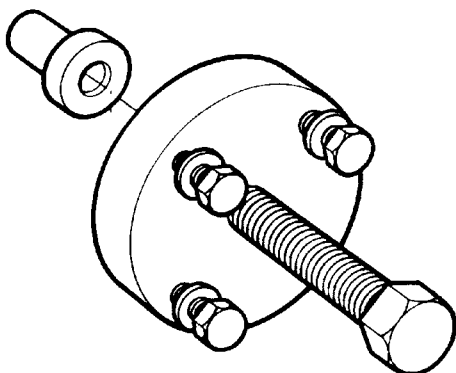
LST127

LRT-12-035 Rear main cap seal guide
RO 270304A

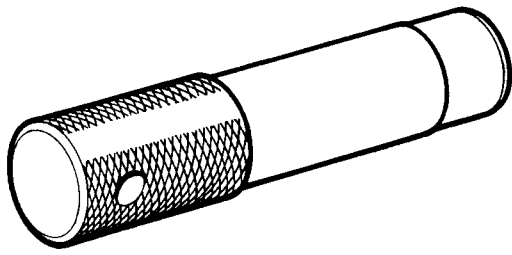


RO270304

LRT-12-049 Crankshaft damper tool
LST 136

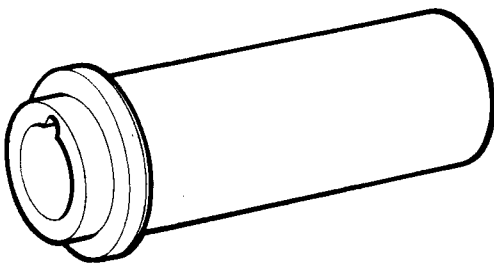


LST136



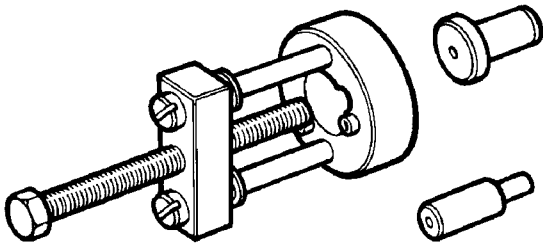
RO605022

LRT-12-040 Mandrel, clutch plate
RO 605022



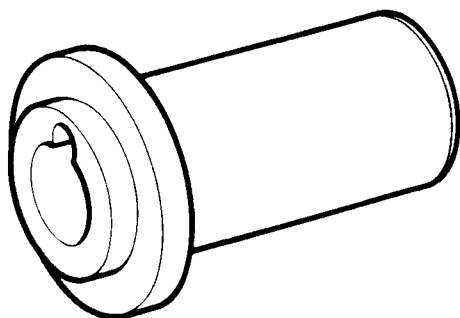
18G1456

LRT-12-028 Replacer, crankshaft front seal
18G 1456



18G1464

LRT-12-031 Remover, crankshaft/camshaft gear
18G 1464

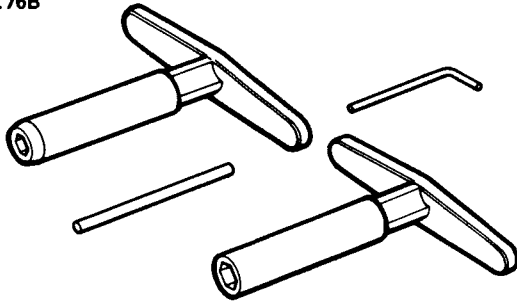


18G1482

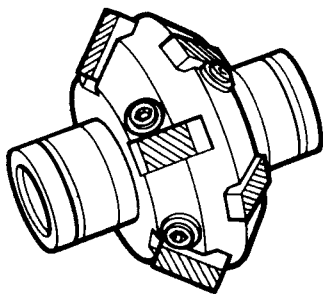
LRT-12-032 Replacer, camshaft oil seal
18G 1482



MS.76B

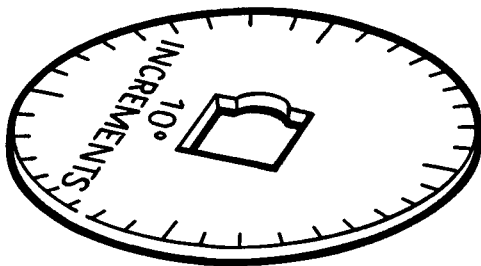


LRT-12-501 Handle set, seat cutter MS 76B



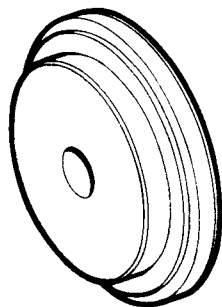
LRT-12-504 Valve seat cutter MS 621

MS621



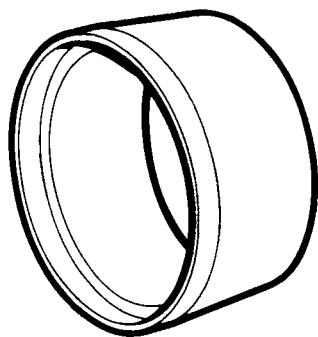
LRT-12-007 Degree plate LST 122

LST122



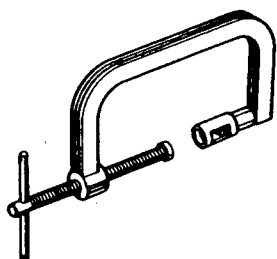
LRT-12-008 Adaptor, crankshaft rear seal 18G134-11

18G13411



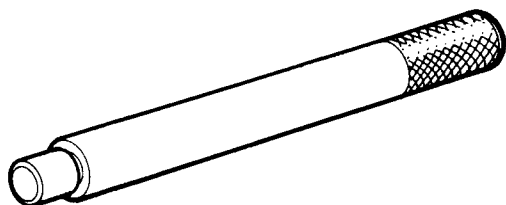
RO1014

LRT-12-015 Crankshaft rear seal saver
18G 1344



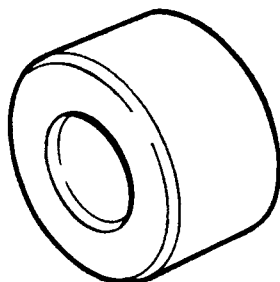
MS1519A

LRT-12-034 Valve spring compressor
MS 1519A



RO274400

LRT-12-036 Drift, valve guide removal
RO 274400

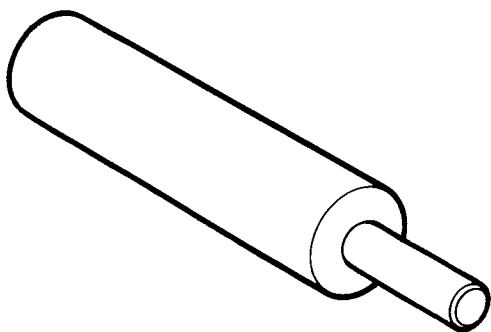


605774A

LRT-12-515 Distance piece, valve guide fitting
RO 605774A
LST 130

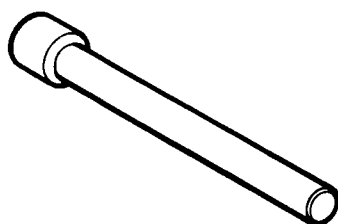


LRT-12-046 Valve guide drift



LST130

LRT-12-045 Retainer injection pump & timing pin
LST 129



LST129



TORQUE VALUES



NOTE: Torque wrenches should be regularly checked for accuracy to ensure that all fixings are tightened to the correct torque.

	Nm
ENGINE	
Bearing cap to cylinder block.....	133
Camshaft thrust plate to cylinder block.....	9
Clutch cover plate to flywheel.....	34
Connecting rod to cap	59
Dipstick tube assembly to cylinder block	25
Dipstick mounting bracket to inlet manifold	9
Engine mounting foot to cylinder block M10	45
Engine mounting foot to cylinder block M12	85
Housing flywheel to cylinder block.....	45
Flywheel to crankshaft	146
Ladder frame to cylinder block	25
Oil filter adaptor to cylinder block	45
Oil pressure switch	17
Oil pump cover to pump body.....	24
Oil pump relief valve plug	30
Oil pump to cylinder block	25
Oil pump strainer to oil pump.....	45
Oil jet assembly to cylinder block	17
Oil strainer to mounting bracket.....	25
Plug - blanking oil gallery.....	37
Plug - drain oil sump	45
Plug - drain cylinder block	25
Plug - drain flywheel housing.....	12
Plug - inlet manifold (boost take-off)	25
Side cover to cylinder block.....	27
Starter motor to flywheel housing	45
Sump to ladder frame	25
Sump to ladder frame/cylinder block	25
Sump to cylinder block/front cover	22
Brackets - exhaust manifold to cylinder block	25
Vacuum pump to cylinder block.....	25
Vertical drive shaft gear to cylinder block	25
Alternator and heat shield to mounting bracket	25
Adjusting link to alternator	25
Adjusting link to PAS pump plate	25
Breather cyclone to rocker cover	9
Engine lifting bracket to cylinder head.....	25
Electrical harness clip to cylinder head	25
Exhaust manifold to cylinder head.....	23
Glow plug terminal nut.....	2
Glow plug to cylinder head	23
Heater stud (water) to cylinder head	23
Injector clamp stud to cylinder head	8
Injector clamp to injector nut.....	20
Inlet manifold to cylinder head.....	23
Rocker cover to cylinder head	4
Rocker shaft to cylinder head	30

Tappet adjusting nut	24
Thermostat housing to cylinder head	25
Water outlet to thermostat housing	9
Water temperature switch to thermostat housing	17
Cowl mounting bracket to front cover	25
Fan assembly to water pump hub	25
Front cover plate to cylinder block	25
Front cover plate to front cover	25
Front cover to cylinder block	25
Injector pump to front cover	25
Injector pump stud to front cover	8
Injector pump to support bracket	25
Tensioner (timing belt) to cylinder block	45
Timing pulley to camshaft	45
Timing pulley to injector pump hub	25
TV damper pulley to crankshaft	347
Water pump to cylinder block	27
Water pump to cylinder block - stud	27
Water pump to front cover	25
Oil drain adaptor to cylinder block - Turbocharger	25
Oil drain pipe to turbo	40
Oil feed pipe adaptor to cylinder block - Turbocharger	25
Oil feed pipe to turbo	19
Outlet elbow to turbocharger - nut	24
Outlet elbow to turbocharger - stud	25
Turbocharger to exhaust manifold	24
Belt tensioner assembly to front cover plate compressor	15
Compressor to mounting bracket	45
Compressor mounting bracket to front cover and plate	45
Banjo bolt - fuel pump	12
Banjo bolt - boost pipe	12
Banjo bolt - spill rail	25
Banjo bolt - fuel filter	17
Banjo bolt - injector spill rail	2
Fuel lift pump to fuel filler unions	12
Fuel lift pump to cylinder block	25
Injector pipes to injectors and injector pump	24
P.A.S. pump to mounting plate	15
P.A.S. pump mounting plate to front cover	25
P.A.S. pump pulley to hub	15
Tappet guide retaining screw	14