Workshop Manual

Ninety
One Ten

Including Workshop Manual
Supplements for Defender
Model up to 1993

LAND ROVER

DEFENDER

WORKSHOP MANUAL

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This Workshop Manual covers petrol and diesel powered Defender models from 1993 up to the end of the 1995 model year. Engines covered include the 2.25, 2.5, 3.5 V8 petrol and 2.25, 2.5, 2.5 Turbo and 200 Tdi diesel.

Separate Overhaul manuals are available to compliment this workshop manual

V8 petrol engine - LZBOMENV8A
300 Tdi diesel engine - LRL 0070
R380 Manual gearbox - LRL 0003
LT230T Transfer gearbox - LRL 0081

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INTRODUCTION

This Workshop Manual covers the Defender 90 • 110 • 130 range of vehicles. It is primarily designed to assist skilled technicians in the efficient repair and maintenance of Land Rover vehicles.

Individuals who undertake their own repairs should have some skill and training, and limit repairs to components which could not affect the safety of the vehicle or its passengers. Any repairs required to safety critical items such as steering, brakes, or suspension should be carried out by a Land Rover Dealer. Repairs to such items should NEVER be attempted by untrained individuals.

WARNINGS and **CAUTIONS** are given throughout this Manual in the following form:

WARNING: Procedures which must be followed precisely to avoid the possibility of personal injury.

CAUTION: This calls attention to procedures which must be followed to avoid damage to components.

NOTE: This calls attention to methods which make a job easier to perform.

REFERENCES

References to the left- or right-hand side in the manual are made when viewing the vehicle from the rear. With the engine and gearbox assembly removed, the water pump end of the engine is referred to as the front.
To reduce repetition, operations covered in this manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and tested after completion and if necessary a road test of the vehicle is carried out particularly where safety related items are concerned.

DIMENSIONS

The dimensions quoted are to design engineering specification. Alternative unit equivalents, shown in brackets following the dimensions, have been converted from the original specification.
During the period of running-in from new, certain adjustments may vary from the specification figures given in this Manual. These adjustments will be re-set by the Distributor or Dealer at the After Sales Service, and thereafter should be maintained at the figures specified in the Manual.

REPAIRS AND REPLACEMENTS

When replacement parts are required it is essential that only Land Rover parts are used.
Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories:

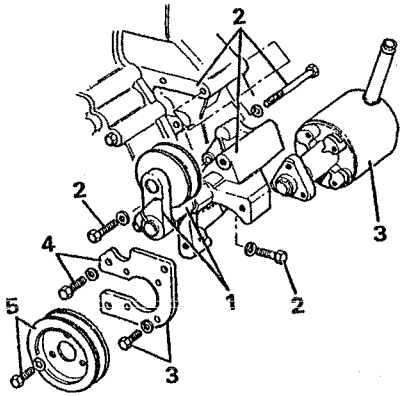
Safety features embodied in the vehicle may be impaired if other than Land Rover parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the vehicle manufacturer's specification. Torque wrench setting figures given in the Repair Operation Manual must be strictly adhered to. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal it must be renewed. Owners purchasing accessories while travelling abroad should ensure that the accessory and its fitted location on the vehicle conform to mandatory requirements existing in their country of origin. The terms of the Owners Service Statement may be invalidated by the fitting of other than Land Rover parts.
All Land Rover parts have the full backing of the Owners Service Statement.
Land Rover Distributors and Dealers are obliged to supply only Land Rover service parts.

FUEL HANDLING PRECAUTIONS

The following information provides basic precautions which must be observed if fuel is to be handled safely. It also outlines the other areas of risk which must not be ignored.
This information is issued for basic guidance only, and in any case of doubt appropriate enquiries should be made of your local Fire Officer.
Fuel vapour is highly flammable and in confined spaces is also very explosive and toxic.
When fuel evaporates it produces 150 times its own volume in vapour, which when diluted with air becomes a readily ignitable mixture. The vapour is heavier than air and will always fall to the lowest level. It can readily be distributed throughout a workshop by air current, consequently, even a small spillage of fuel is very dangerous.

FIT POWER STEERING PUMP

1. If removed, fit the jockey pulley to the spindle.
2. Fit the bracket and jockey pulley assembly to the engine with the three bolts.
3. Fit the power steering pump to the bracket and secure the plate to the pump with four bolts.
4. Secure the plate to the bracket with the three bolts.
5. Fit the drive pulley to the pump with the three bolts.
6. Fit the drive belt.



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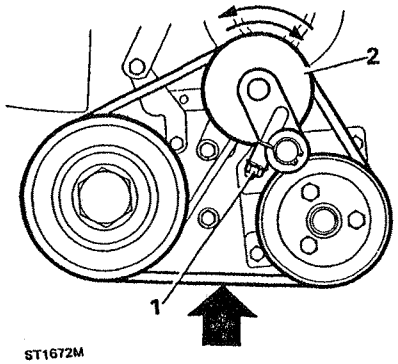
ADJUST POWER STEERING PUMP DRIVE BELT

1. Slacken the jockey pulley pinch bolt.
2. Move the jockey pulley to the left or right as necessary to achieve a deflection, by thumb pressure, of 12 mm at the mid-point of the belt run between the crankshaft and power steering pump pulley.
3. Tighten the pinch bolt.



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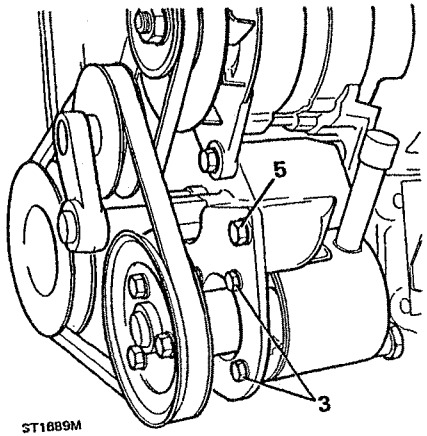
NOTE: Drive belt tensions covering all engine variants and models is included in the MAINTENANCE SECTION.

TURBO - CHARGED ENGINES

1. Connect pipe union 'A' to turbo charger 'T' piece hose.
2. Connect pipe union 'B' to injector spill rail.



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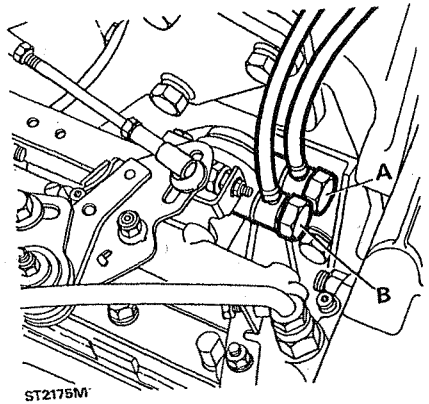

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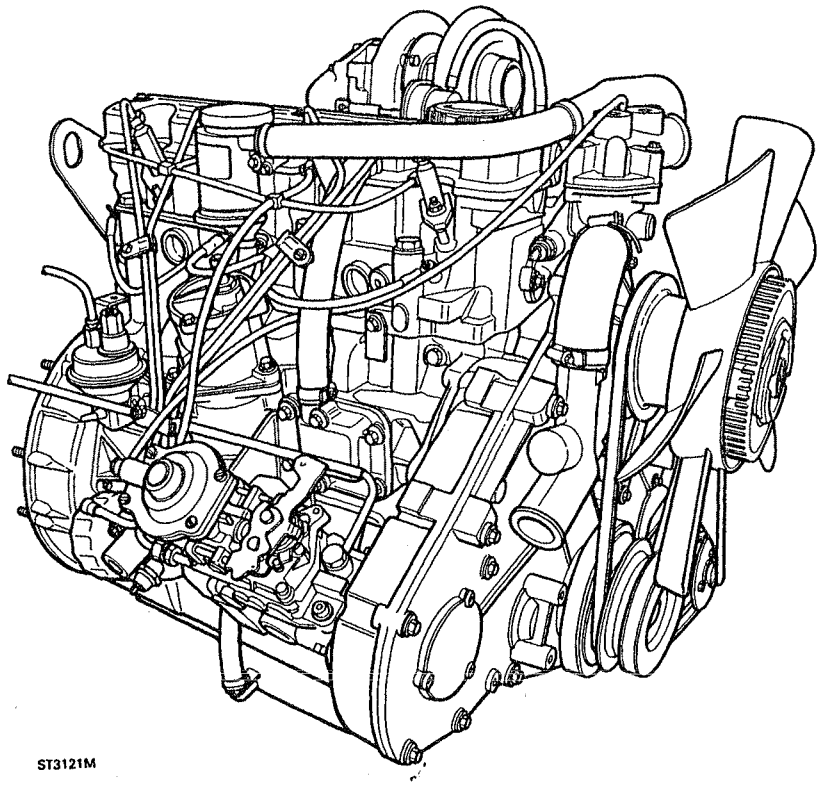
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DESCRIPTION AND OPERATION

200 Tdi engine

The four cylinder Tdi Diesel engine which is an optional power unit for the Land Rover Defender is a derivative of the 200 TDi unit installed in Discovery. Only minor modifications to the injection pump location, drive belt arrangement, inlet and exhaust systems was necessary to facilitate installation of the engine in the under bonnet space of Defender.

The power, performance and economy of the engine, is a blend of up to the minute computer technology and well proven Land Rover design features. The retention of design features such as the roller tappet camshaft, ensures continued interchangeability of parts with earlier models, while the aluminium cylinder head is completely new.

The engine is constructed from three main castings. The largest casting is the cylinder block which is made from cast iron and includes the integral cylinders, line bored crankshaft main bearing locations and caps and the bearing locations for support of the camshaft. The ladder frame which is cast from aluminium is bolted to the bottom face of the cylinder block after fitting the crankshaft and pistons to provide extra rigidity and noise suppression.

The direct injection cast aluminium cylinder head is secured to the cylinder block with eighteen bolts. The head gasket is selective from a range of three different thicknesses to ensure optimum combustion efficiency and performance.

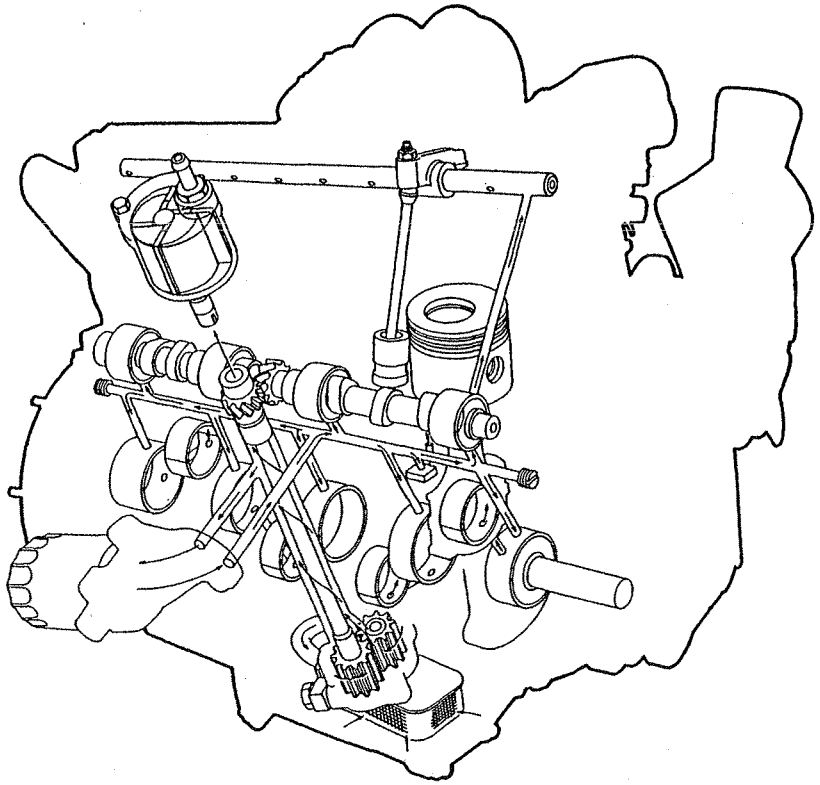
The crankshaft end float is controlled by selective half thrust washers, one each side of the centre main bearing.

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

Lubrication system

The lubrication system is similar to previous four cylinder units and employs a submerged gear pump which is driven by the camshaft and skew gear. 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 filter.

After filtering, the oil continues via the distribution oil gallery and drillings in the cylinder block to lubricate the crankshaft main and big end bearings and camshaft bearings. The thrust side of the cylinders is lubricated direct from the distribution gallery via separate jet turbos.



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Lubrication to the front camshaft bearing continues through more drillings in the cylinder block to lubricate the roller tappets and rocker shaft 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.

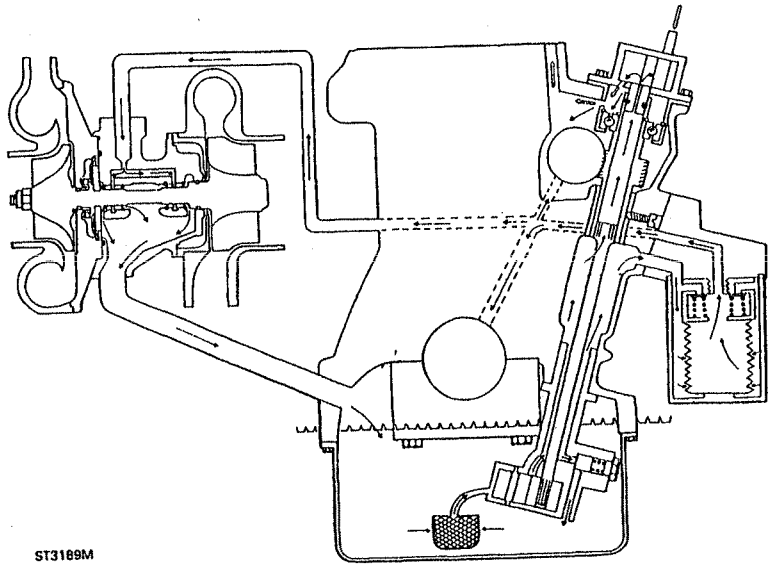
Three of the four camshaft bearing lubrication drillings in the cylinder block are drilled externally. These ports which are visible on the right side of the cylinder block are blanked off by each bearing and sealed with a black silicon sealant.

The oil which is pumped up the cavity between the vertical drive shaft and pump body is unfiltered. This unfiltered oil will not only lubricate the skew gear bush but also passes up the centre of the skew gear to lubricate the brake servo vacuum pump.

The system pressure is controlled by the pressure relief valve which is located in the pump body and is non adjustable.

Turbo Charger Lubrication

The turbo charger bearings are lubricated with filtered oil from the oil gallery in the cylinder block at pump pressure. After lubricating the bearings the oil returns to the sump via a large diameter drain hose. Obviously the turbo bearings which are operating at very high speeds and in a very hot environment need to be well sealed, cooled and lubricated.



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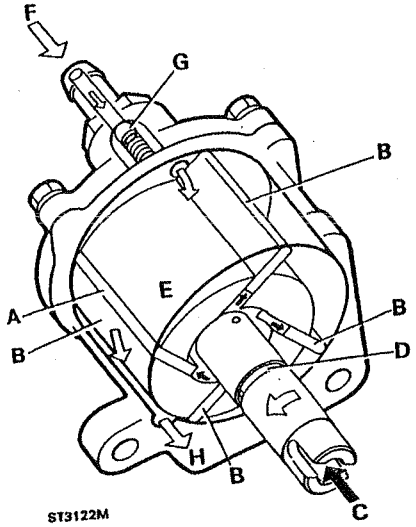
Brake servo Vacuum Pump lubrication

The brake servo vacuum pump rotor A is lubricated with unfiltered oil direct from the engine oil pump. Oil is supplied via the hole up the centre of the skew gear and the vacuum pump shaft C where, it not only lubricates the pump shaft D but is also fed into slots behind each of the four carbon vanes B.

The oil pressure behind the vanes exerts a force which ensures that they follow the contours of the pumping chamber E and form a good seal. An O' ring is fitted inside the hollow skew gear to form a seal between the skew gear and the vacuum pump shaft to prevent pressure leakage. In the event of low oil pressure the condition of this 'O' ring should be checked before continuing with further diagnosis.

With the brake servo vacuum 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 F from the servo chamber past valve G and discharge it through the pump outlet H into the camshaft/skew gear chamber and engine crankshaft atmosphere.

Provided the vacuum pump is not pumping an excessive volume of air, the crankcase ventilation system will not be affected. If however the engine is operated with a faulty brake servo, damaged vacuum hose or with the hose disconnected, the pump can force an uncontrolled volume of air into the crankcase ventilation system causing pressure to build up.



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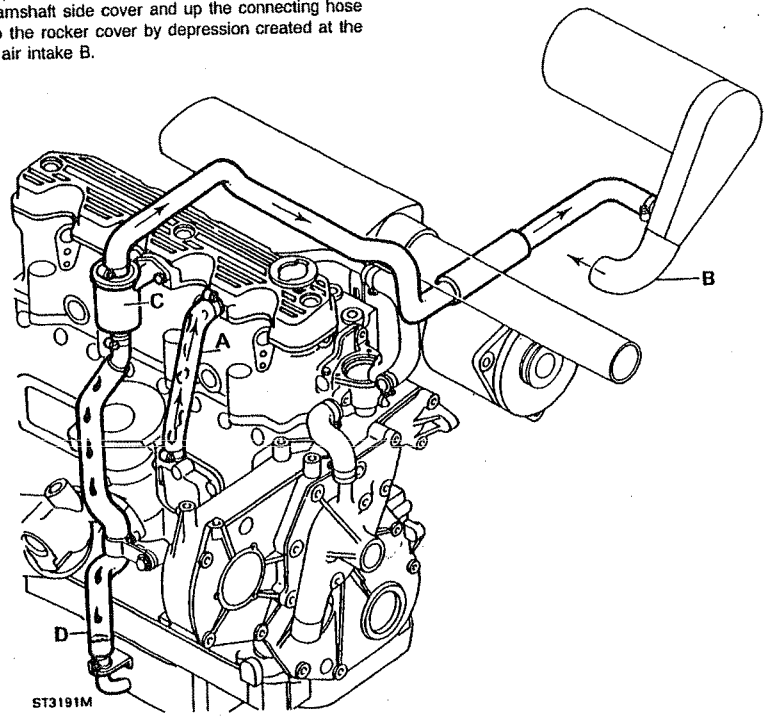
Crankcase Ventilation system

The crankcase ventilation system is of course associated with drainage of lubrication 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.

As can be seen in the illustration, oil laden atmosphere in the engine crankcase is drawn from the camshaft side cover and up the connecting hose A into the rocker cover by depression created at the turbo air intake B.

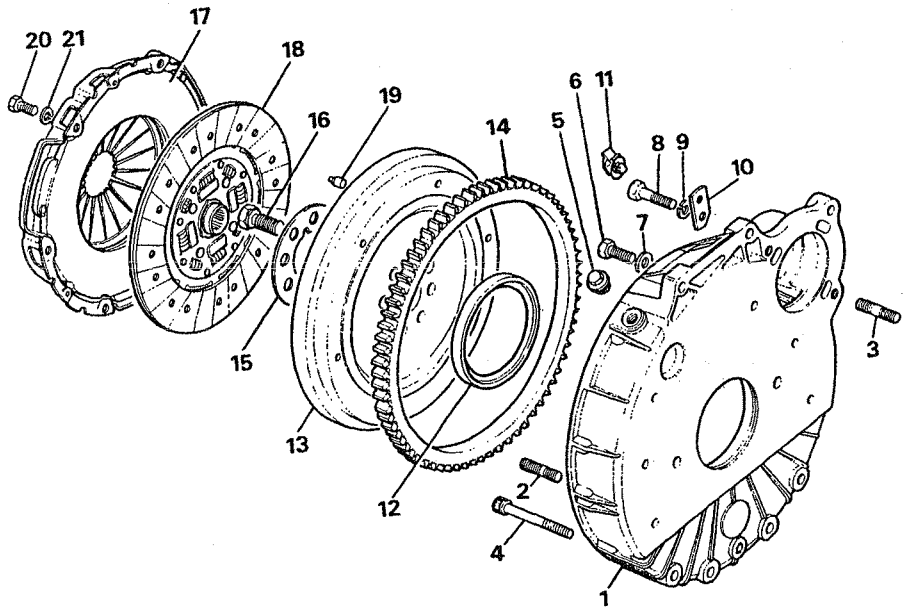
The oil separator C fitted to the rocker cover is designed to control the rate at which the air is purged from the sump and extracts the oil. The oil when extracted, drains back down hose D to the sump and the remaining atmosphere is controlled by a diaphragm valve in C before passing into the engine via the turbo charger, where it is burned.



ST3191M

CLUTCH AND FLYWHEEL HOUSING COMPONENTS - Tdi engine

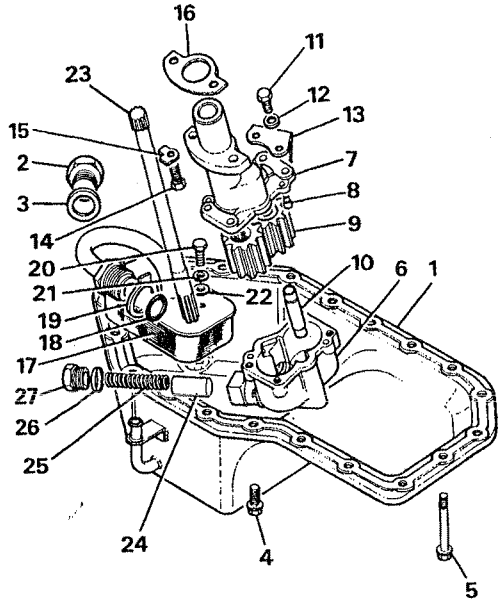
1. Clutch housing
2. Bell housing stud (9)
3. Starter motor stud (1)
4. Allen bolts (4)
5. Plug (2)
6. Screw housing to block (6)
7. Washer (6)
8. Bolt housing to block (2)
9. Spring washer (2)
10. Bracket (2)
11. Harness clip (2)
12. Oil seal
13. Flywheel
14. Starter ring
15. Reinforcing plate
16. Bolt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



ST3066M

SUMP AND OIL PUMP COMPONENTS - Tdi engine

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



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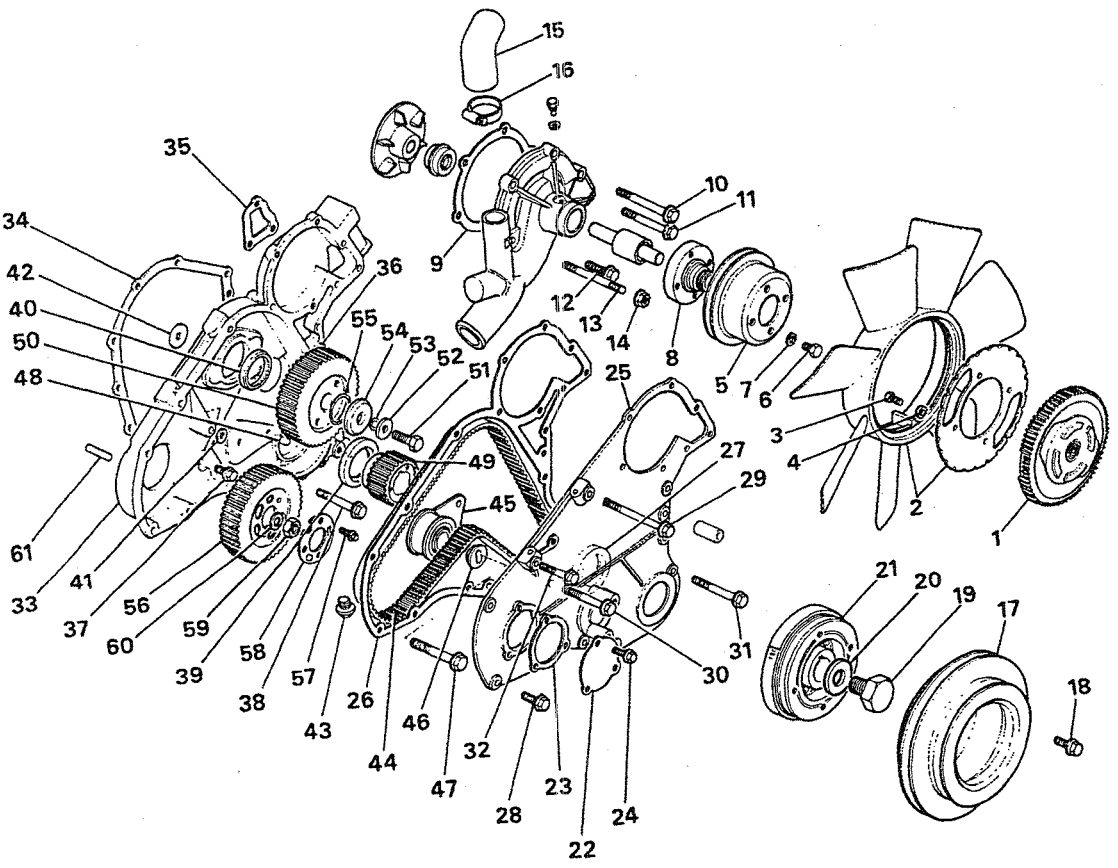
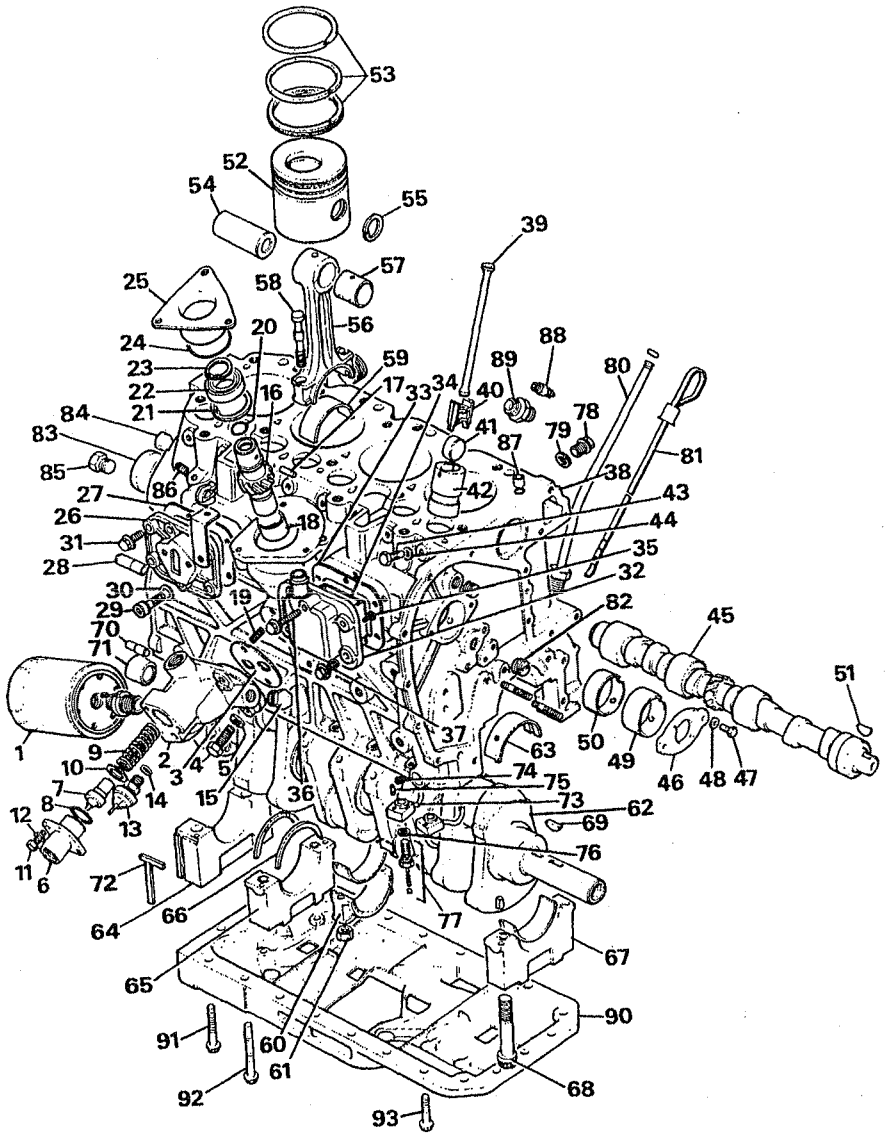


ST3064M

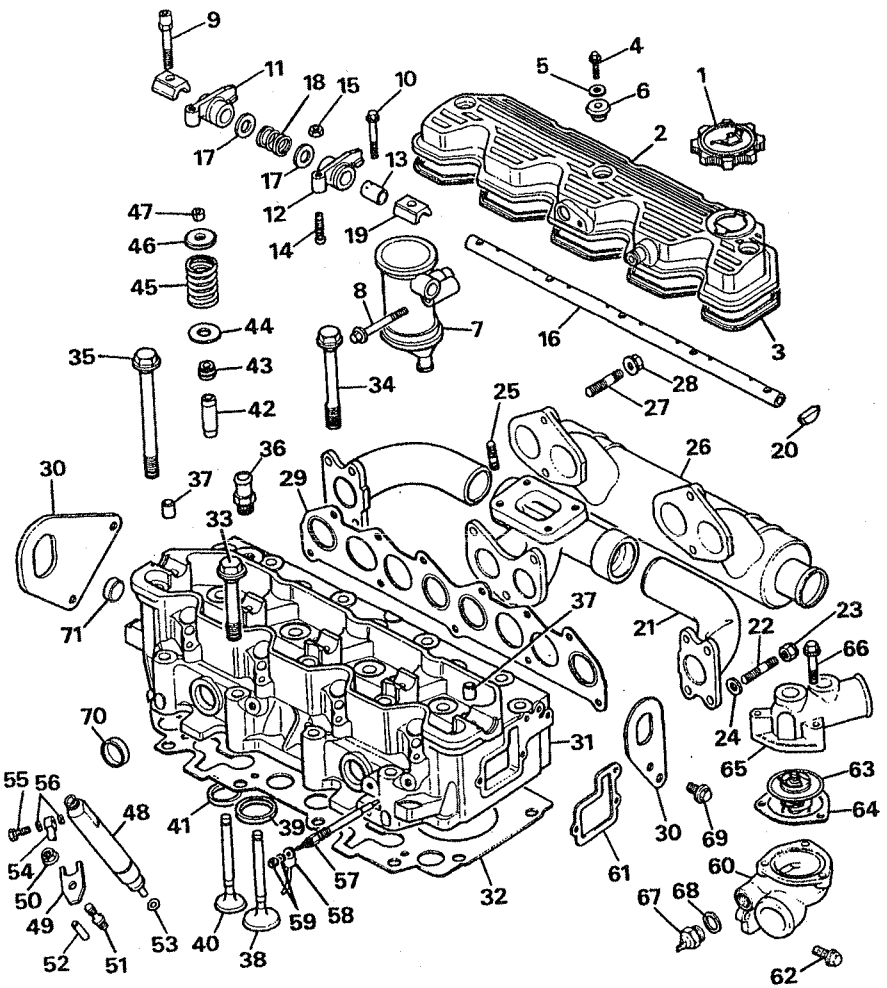
FRONT COVER COMPONENTS - Tdi engine (ST3064M)

1. Viscous unit
2. Fan assembly
3. Bolt (4)
4. Plain washer (4)
5. Pulley
6. Screw (4)
7. Spring washer (4)
8. Water pump assembly
9. Gasket
10. Flange bolt M8x85 (2)
11. Flange bolt M8x75 (1)
12. Flange screw M8x35 (3)
13. Stud M8
14. Flange nut M8
15. By pass hose
16. Hose clip
17. Crank pulley
18. Flange bolts (4)
19. Crank 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 M8x100 (2)
30. Flange bolt M8x70 (2)
31. Flange bolt M8x75 (3)
32. Flange bolt M8x50 (1)
33. Front cover
34. Front cover gasket
35. Front cover/water inlet gasket
36. Front cover dowel
37. Flange screw M8x20 (2)
38. Flange bolt M8x65
39. Crankshaft oil seal
40. Camshaft oil seal
41. Gasket centre bolt
42. Gasket block front face
43. 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. Stud injection pump to front cover (3)



CYLINDER BLOCK COMPONENTS - Tdi engine (ST3063M)

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)



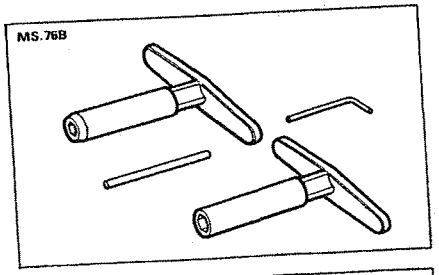
CYLINDER HEAD COMPONENTS - Tdi engine (ST3062M)

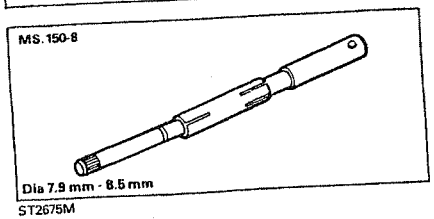
1. Oil filler cap
2. Rocker cover
3. Rocker cover gasket
4. Flange headed bolt
5. Washer
6. Sealing washer
7. Breather cyclone
8. Flange headed screw
9. Rocker shaft bolt (3)
10. Rocker shaft bolt (2)
11. Rocker arm RH
12. Rocker arm LH
13. Rocker arm bush
14. Tappet adjuster screw
15. Locknut
16. Rocker 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. Splint 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)

ENGINE OVERHAUL

Service Repair No.12.41.05

Special service tools
Handle set, seat cutter - LRT-12-501/MS76B
Pilot, seat cutter - LRT-12-502/MS150-8
Valve seat cutter - LRT-12-504/MS621
Cylinder head bolt degree plate - LRT-12-007/LST122
Adaptor, crankshaft rear seal - LRT-12-008/18G134-11
Crankshaft rear seal saver - LRT-12-015/18G1344
Valve spring compressor - LRT-12-034/MS1519A
Drift, valve guide removal - LRT-12-036/RO274400
Distance piece, valve guide fitting - LRT-12-515/RO605774A
Drift, valve guide fitting - LRT-12-046/LST130
Mandrel, clutch plate - LRT-12-040 - RO605022
Replace, crankshaft front seal - LRT-12-028/18G1456
Remover, crankshaft/camshaft gear - LRT-12-031/18G1464
Replace, camshaft oil seal - LRT-12-032/18G1482
Flywheel timing pin - LRT-12-044/LST128
Crankshaft damper restraining tool - LRT-12-043/LST127
Rear main cap seal guide - LRT-12-035/RO270304
Crankshaft damper tool - LRT-12-049/LST136
Injection pump timing pin - part of LST129 pump remover tool - LST129/2





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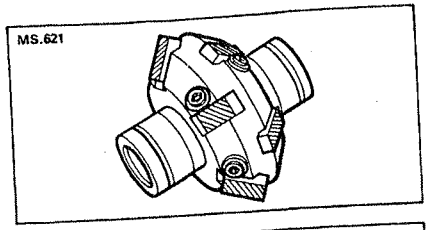
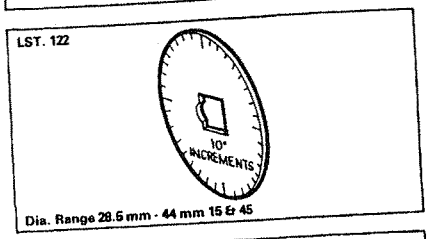
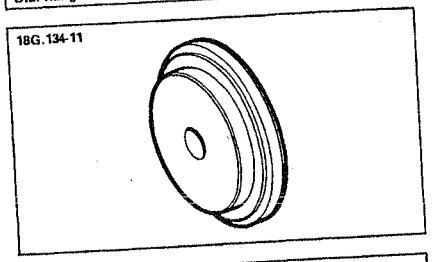
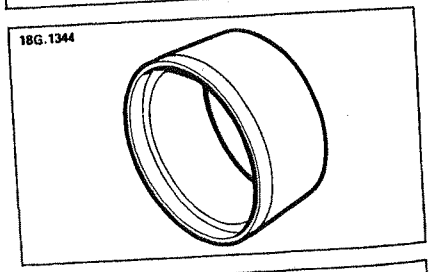
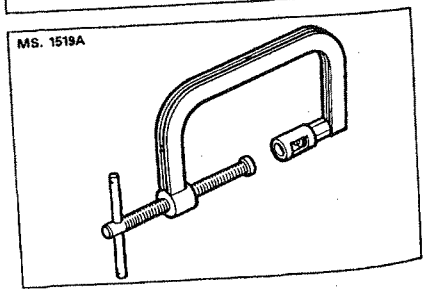
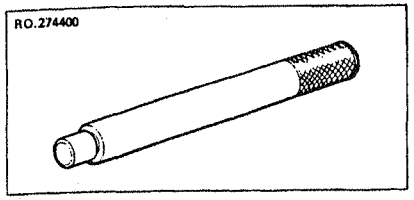


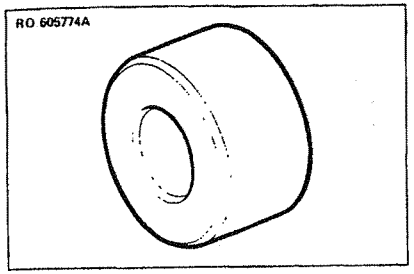


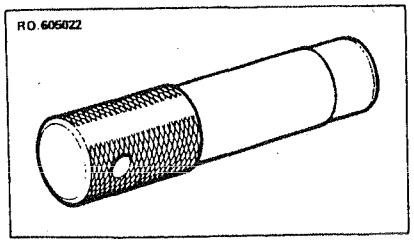


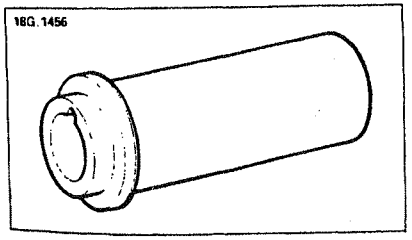


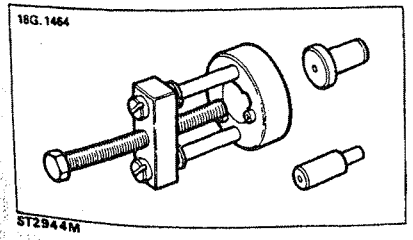




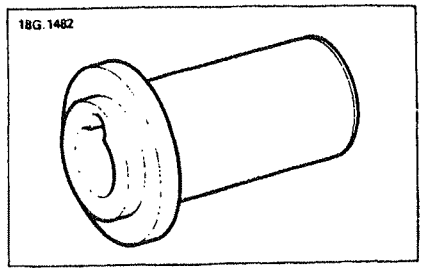


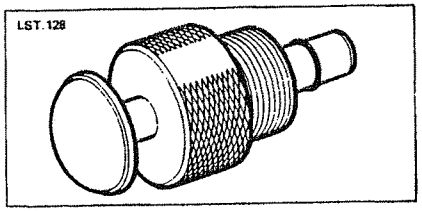


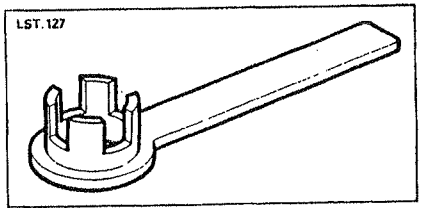


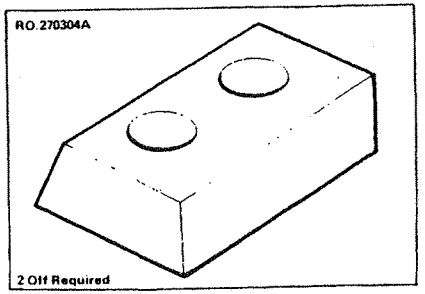


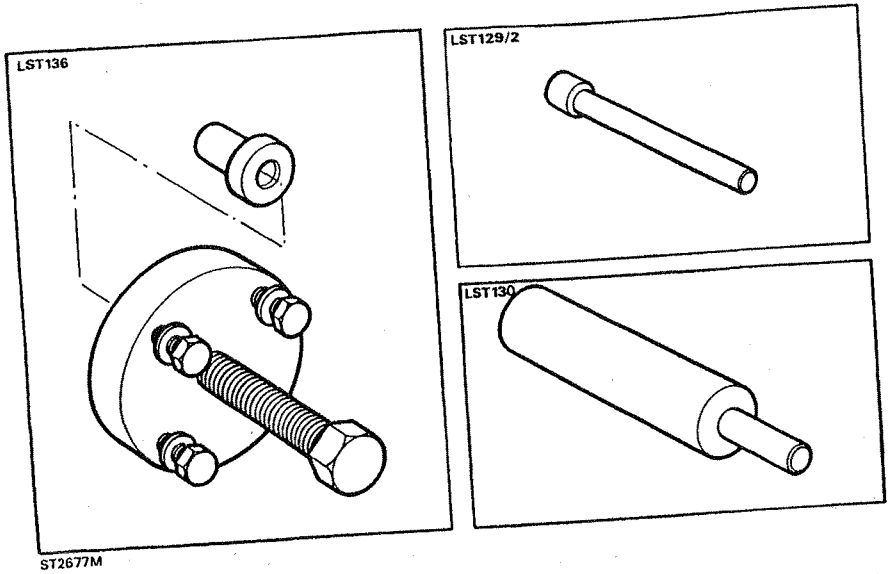
ST2944M











ST2677M

WARNING: Where the use of special service tools is specified, only these tools should be used to avoid the possibility of personal injury and or damage to components.

WARNING: Where the use of an engine stand is recommended, it is absolutely essential to follow the stand manufacturers instructions to ensure safe and effective use of the equipment. In the interests of safety and efficient working, secure the engine to an engine stand recognised by the garage repair trade. Drain and discard the sump oil whilst strictly observing the handling and disposal instructions in the introduction SECTION 01.

Remove the following ancillary equipment prior to dismantling the engine.

Air conditioning compressor - where fitted

Power steering pump and alternator.

Starter motor.

Engine electrical harness.

Air inlet manifold.

Exhaust manifold and turbo charger.

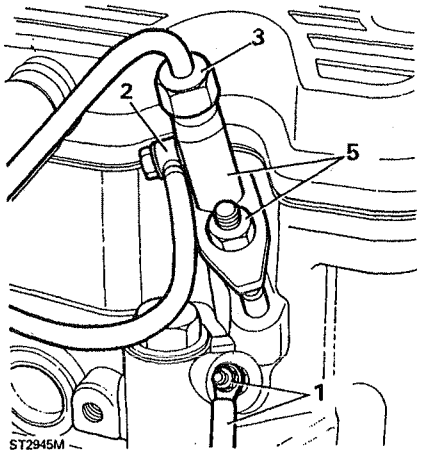
Whilst dismantling, make a note of the position of miscellaneous brackets, clips, harness, pipes, and hoses, that are removed at the same time, and any non standard items, to facilitate assembly.

CYLINDER HEAD REMOVE AND DISMANTLE

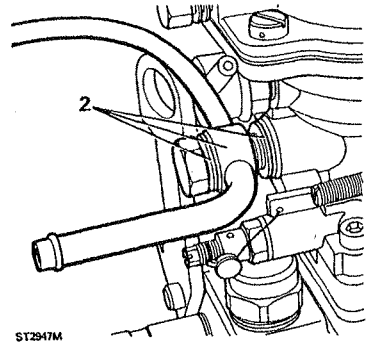
CAUTION: Since the injectors and heater plugs protrude below the combustion face of the cylinder head, it is important that they are removed before removing the cylinder head to avoid the possibility of damage to the injectors, heater plugs and pistons.

Heater plugs remove

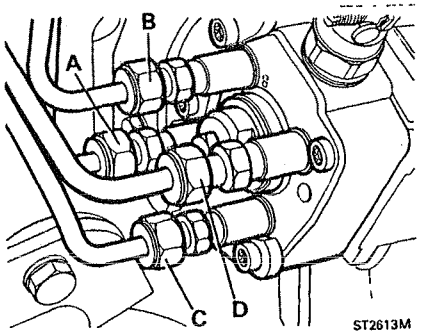
1. Disconnect the wiring, remove the heater plugs and store in a safe place to avoid damage.



ST2945M



ST2947M



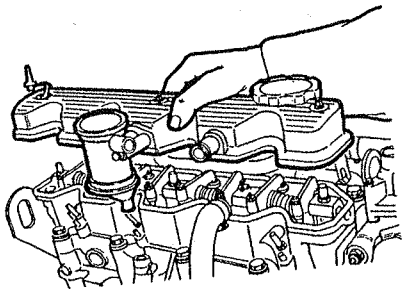
ST2613M

Injectors remove

2. Disconnect the spill return at the pump and injectors.
3. Release the pipes at the injectors and at the pump A-B-C and D as illustrated.
4. Remove the pipes and store in a clean plastic bag.
5. Release the injector clamp nuts, remove the injectors and store in separate plastic bags to prevent contamination and damage. Retrieve the sealing washers from the injector seating in the cylinder head.

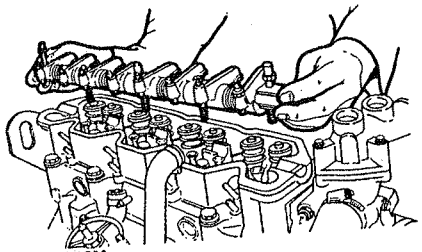
Rocker cover remove.

1. Release the crankcase ventilation hose connections, evenly slacken and remove the three bolts then lift-off the rocker cover.

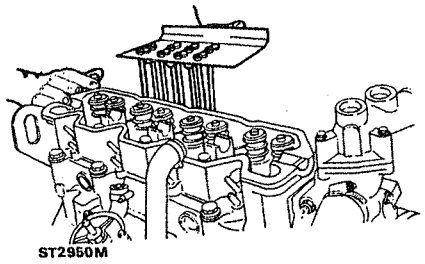

ST2948M

Rocker shaft remove

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.


ST2949M

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.

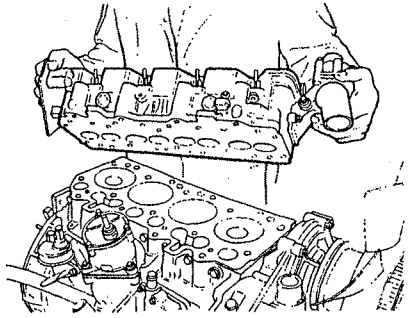

ST2950M

CAUTION: Since the injectors and heater plugs protude 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 and place each in a separate plastic bag to prevent contamination and damage.
6. Remove the heater plugs and sealing washers and store in a safe place to avoid damage.

Removing cylinder head

7. Evenly slacken and remove the eighteen bolts retaining the cylinder head and lift the cylinder head from the cylinder block and remove the gasket.

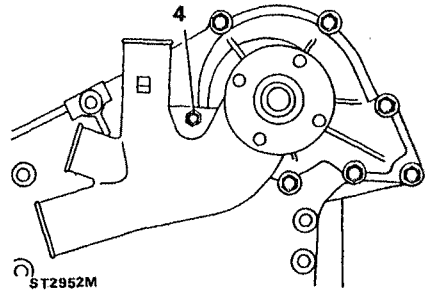

ST2951M

NOTE: If necessary, at this stage the cam followers may be removed for inspection. See Cam follower removal.

FRONT COVER OIL SEALS/TIMING BELT/CAMSHAFT

Water pump remove

1. If necessary remove the viscous coupling complete, with the fan, from the water pump spindle, using a cranked open-ended spanner, noting that it has a left-handed thread.
2. Remove the four screws, to release the pulley from the water pump hub.
3. If necessary release the two jubilee clips and remove the by-pass hose.
4. Evenly release and remove the six bolts and one nut to remove the water pump from the front cover plate.

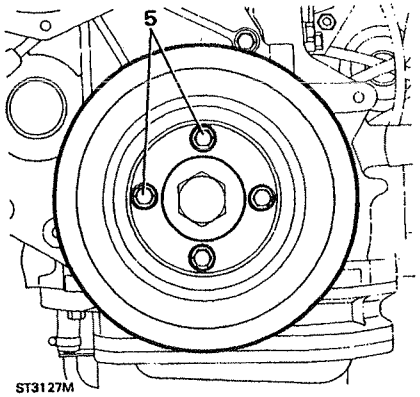


ST2952M

Front cover plate or seal remove

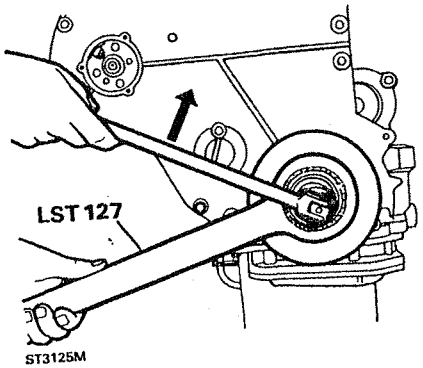
Front pulley and damper

5. Release the four bolts and remove the crankshaft pulley from the damper.



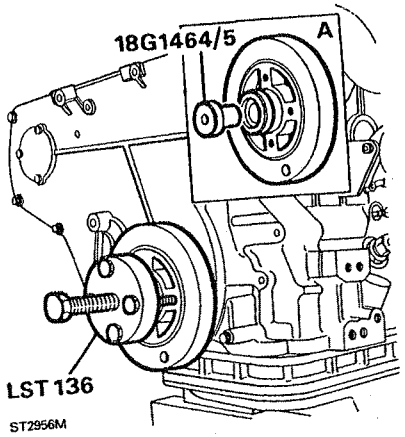
ST3127M

6. To remove the crankshaft damper retaining bolt use Special service tool FR101 or LST127 to restrain the damper and a 30mm socket to remove the special bolt.



ST3125M

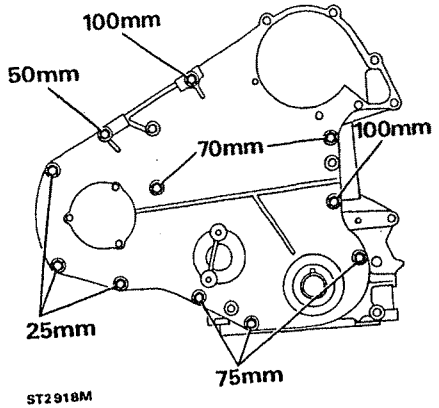
7. Fit the pressure button 18G1464/5 to the end of the crankshaft and using service tool LST136, extract the damper as illustrated.



ST2956M

Removing front cover plate

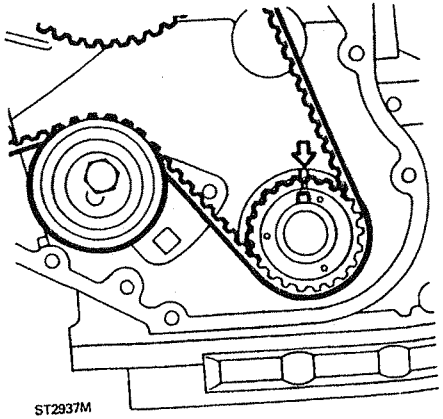
8. Unscrew the 11 bolts and one nut to release the cover plate.



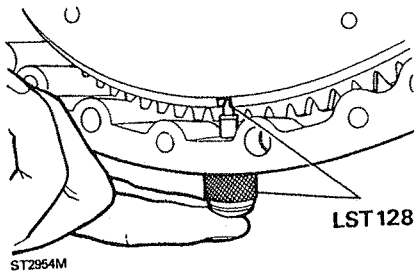
ST2918M

Removing timing belt

1. Use the restraining tool LST127 to turn the crankshaft in a clockwise direction to TDC so that the valves of number one cylinder are closed and number four cylinder valves on the rock' and the crankshaft key aligned with the arrow cast into the front cover as illustrated. If the crankshaft is turned inadvertently beyond TDC do not turn back but continue on round until the above conditions are achieved.

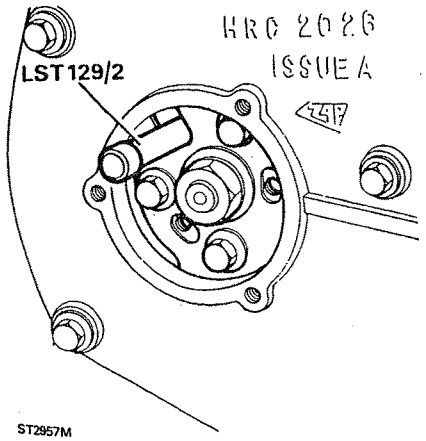

ST2937M

2. Now screw the body of the timing pin tool LST128 into the flywheel housing and check that the pin can be inserted in to the appropriate slot in the flywheel periphery. Note that there are two slots in the flywheel one being wider than the other. The narrowest slot determines TDC for this engine and it is therefore important that the correct slot is used.



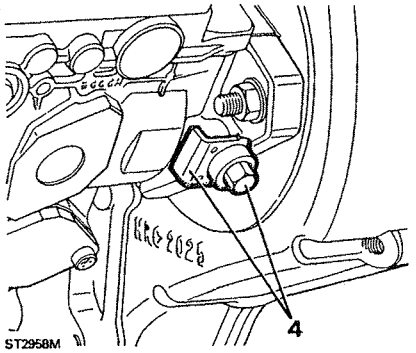
ST2954M

3. Remove the three screws to release the injection pump access cover from the front cover plate and insert the locking pin LST129/2 through the 'U' shaped cut-out in the pump hub and into the hole in the pump body. 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 pin in position in the pump.



ST2957M

4. To lock the pump, slacken the locking screw anti-clockwise and remove the inhibiting plate. Turn the screw clockwise to lock the pump shaft. Remove the timing pin from the flywheel housing.

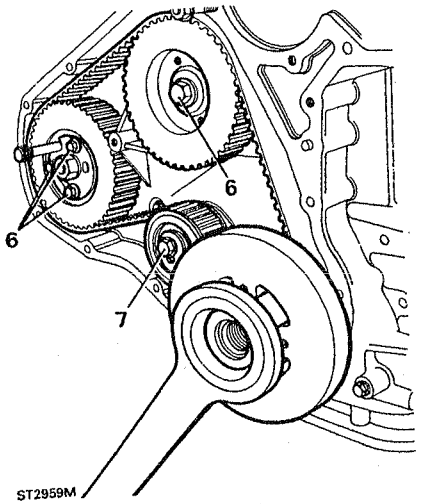


ST2958M

CAUTION: It is important to ensure that once the injection pump has been locked no attempt must be made to rotate it. Therefore take care not to allow the crankshaft to be turned until the pump has been removed.

NOTE: If renewing the timing belt, oil seals or gears (with the cylinder head fitted) and there is any possibility that the crankshaft will need to be rotated after removal of the timing belt, it would be advisable to remove the rocker shaft. This will prevent the pistons contacting the valves as the crankshaft is turned. If necessary, See rocker shaft removal.

5. To verify any timing error, check that the timing marks inside the front cover line-up with the gear wheels.
6. If necesary temporarily fit the damper and restrain the crankshaft with service tool FR101 while the three screws securing the pump timing gear to the pump hub and the camshaft gear wheel retaining bolt is being slackened.
7. Remove the single bolt, special washer and remove the tensioner.
8. If the original belt is to be re-fitted, mark its direction of rotation with soft chalk before removing it.

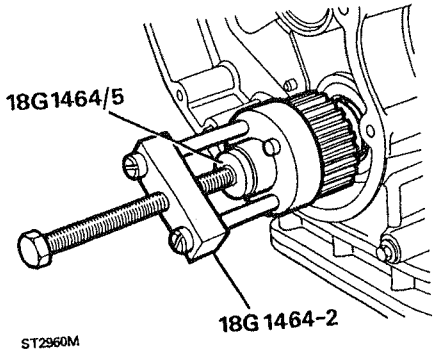


ST2959M

NOTE: A used drive belt develops a wear pattern relative to the driving loads and its direction of rotation. If the belt is to be re-used it must be refitted so that it continues to operate in the original direction.

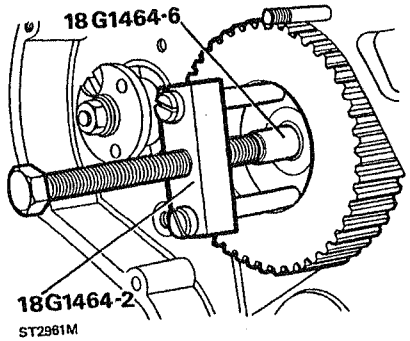
Removing timing belt gears

9. If the crankshaft gear wheel cannot be removed by hand, use special service tool 18G1462-2 and pressure button 18G 1464-5. Assemble the tool and withdraw the gear wheel as illustrated.



ST2960M

10. Remove the camshaft gear wheel retai ning bolt assembly to enable the gear to be removed. Use special service tool 18G 1462-2 and button 18G 1464-6. Assemble as shown and withdraw the gear.

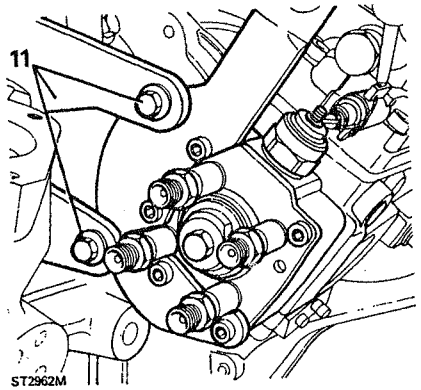


ST2961M

NOTE: The camshaft and crankshaft oil seals may be renewed at this stage with the engine in the vehicle without removing the front cover, See fitting front cover seals.

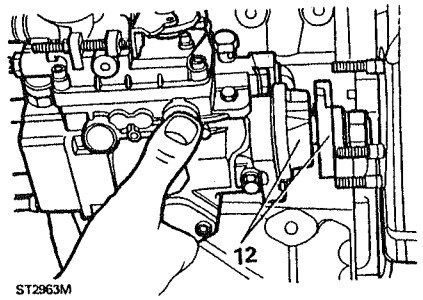
Removing injection pump

11. Release the injection pump from the rear support bracket.



ST2962M

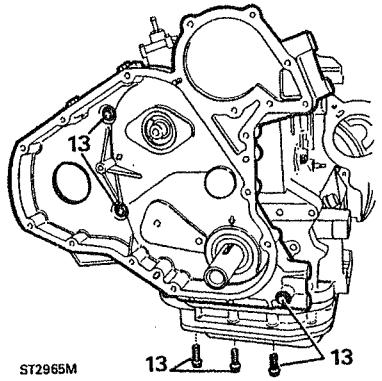
12. Remove the three nuts securing the pump flange to the front cover and withdraw the pump and gasket complete with hub and timing pin.



ST2963M

Removing front cover

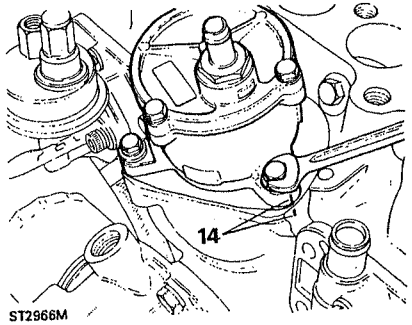
13. To remove the front cover, release the three bolts securing it to the cylinder block front face and the three bolts that pass up through the sump and ladder frame into lower face of the cover.



ST2965M

Removing vacuum pump

14. Mark the position of the brake servo vacuum pump with relation to the cylinder block. Using a 6mm Allen key remove the three screws and lift-out the pump.

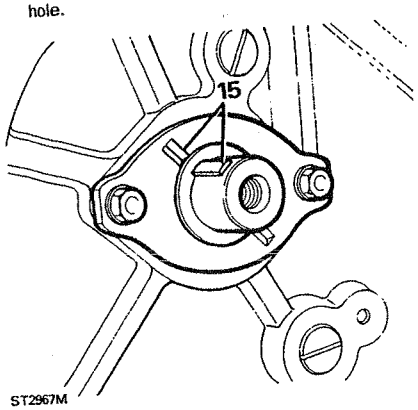


ST2966M

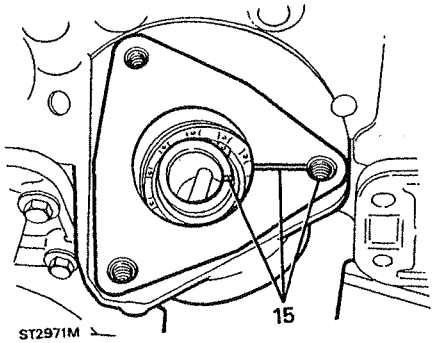
Removing skew gear

During normal operation of the engine the camshaft and skew gear teeth develop a mated and wear pattern. It is therefore important that if the skew gear is to be re-used it should be fitted so that the teeth on the gear and the camshaft engage in the original running position.

15. To ensure original re-engagement of the gears turn the camshaft so that the camshaft key is aligned with the oil groove in the thrust plate and mark the position of the skew gear in relation to the one of the three bolt holes for securing the vacuum pump. Also mark the skew gear housing flange to the same bolt hole.



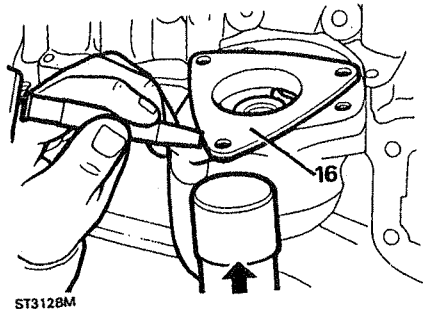
ST2967M



ST2971M

16. To remove the skew gear assembly, tap the flange round so that the edge overlaps the cylinder block, then tap the flange upwards to enable the skew gear assembly to be lifted out.

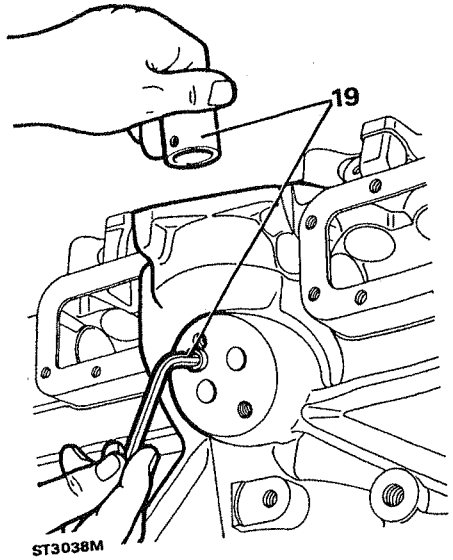
If necessary the oil pump drive shaft may be removed at this stage.



ST3128M

Removing skew gear bush

17. Unscrew the oil filter cartridge, anti-clockwise, using a strap wrench. Dispose of the oil safely.
18. Release the two bolts and remove the oil filter adaptor and gasket from the engine.
19. Using a 6mm allen key remove the retaining screw and bush.



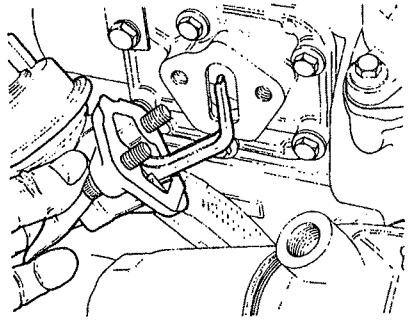
ST3038M

Removing fuel pump and side cover

20. Use a 6mm allen key to release the fuel lift pump to gain access to the side cover retaining bolts.
21. Release the six bolts and remove the cover plate.

Remove front side cover plate

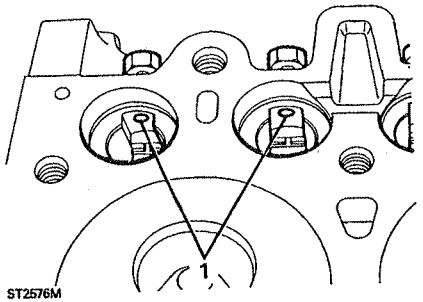
22. Release the six bolts and remove the front side cover plate complete with the crankcase ventilation pipe.


ST3003M

Remove cam followers

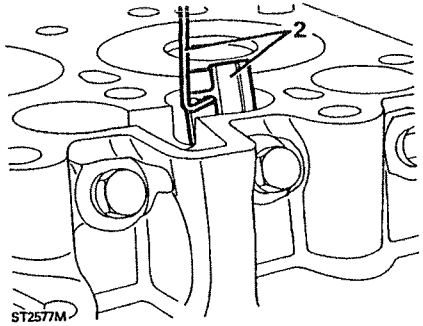
CAUTION: The cam followers are solid rollers held in position against the cam by a slide inside a fixed guide. If the guide is removed before the roller, it is possible that the roller can fall behind the camshaft and become jammed. Furthermore the roller could slip past the cam and fall into the crankcase. It is therefore important to adopt the following procedure for removal.

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



ST2576M

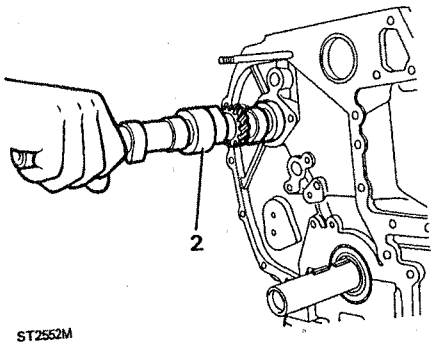
2. Using a length of thin wire with a hooked end lift-out the slide.
3. With the same piece of wire remove the roller .
4. Remove the guide locating screw and lift-out the guide.
5. As each assembly is removed number it, from one to eight, for refitting to its original location.



ST2577M

Removing the camshaft

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



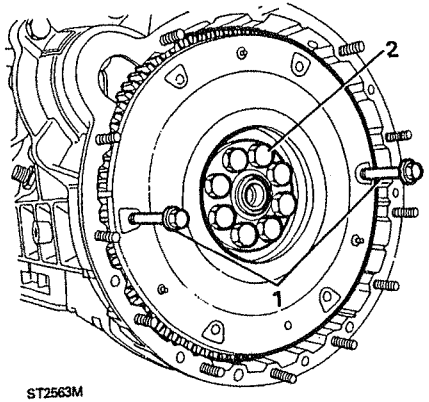
ST2552M

Removing Clutch

1. Mark the relationship of the cover to the flywheel to ensure original balance is maintained.
2. Evenly slacken and remove the six retaining bolts and washers and remove the assembly complete with the friction plate.

Removing flywheel

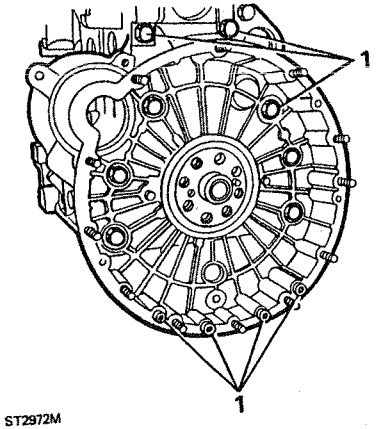
1. In the interests of safety, fit two long 8mm bolts into the clutch bolt holes, diametrically opposite, to use as handles for lifting the flywheel off the crankshaft.
2. Temporarily fit the crankshaft damper and use special service tool FR101 to restrain the crankshaft while slackening the flywheel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



ST2563M

Removing flywheel housing

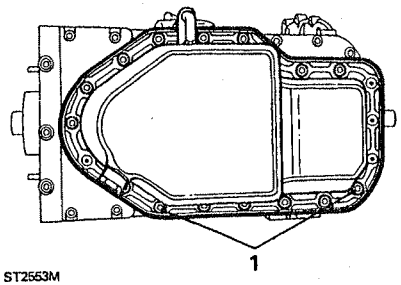
1. Remove the eight internal and two external and five ladder frame securing bolts, then ease the flywheel housing from the two locating dowels and crankshaft.



ST2972M

Removing sump and oil pump

1. If necessary drain the engine oil. When working with the engine on a work stand, invert the cylinder block so that the sump is uppermost. Remove the screws and ease the sump from the ladder frame to reveal the oil pump.

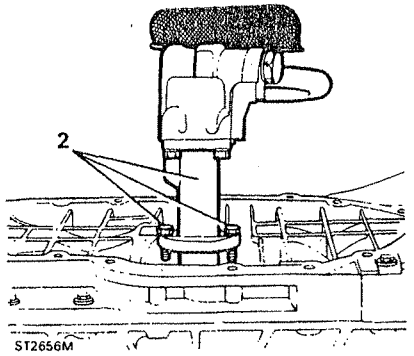


ST2553M

NOTE: After removing the oil sump when the engine is in the vehicle, refit and tighten two of the retaining bolts to the left side of the cylinder block to maintain pressure on the ladder frame cylinder block joint seal.

Removing oil pump

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 two bolts will enable the pump to be withdrawn.

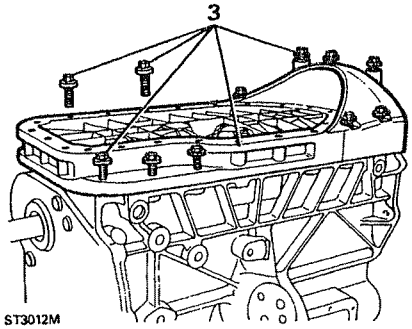


ST2656M

Removing ladder frame

NOTE: The ladder frame and flywheel housing are secured by five bolts which are inaccessable with the gearbox bell housing fitted. Therefore it is not possible to remove the ladder frame when the engine is in the vehicle without first removing the gearbox or engine unit, flywheel, flywheel housing, engine sump and oil pump.

3. With the engine removed, release the remaining ten bolts and separate the ladder frame from the crankcase by gently tapping to break the seal.

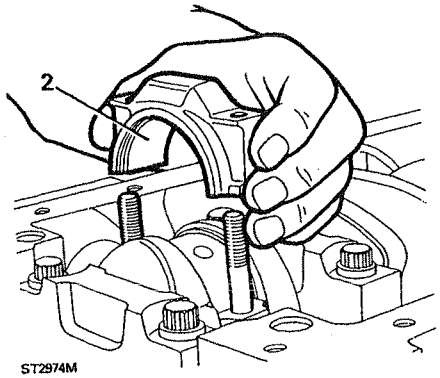


ST3012M

Removing pistons and connecting rods

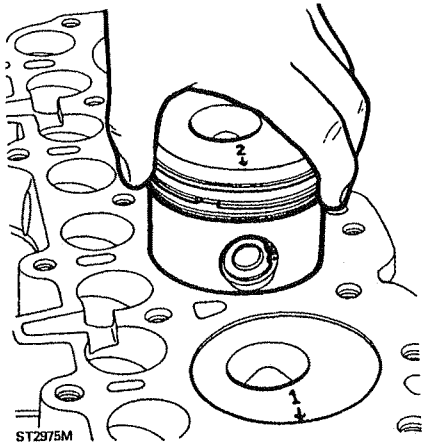
NOTE: On this version of the Tdi engine, it is not possible to remove the connecting rods or pistons with the engine in the vehicle because of the method by which the ladder frame is secured. See note under Ladder frame removal.

1. Turn the crankshaft to bring all the connecting rod cap nuts to an accessible position and slacken the nuts using a 15mm socket.
2. Remove the connecting rod nuts and remove the caps complete with the lower bearing halves.



ST2974M

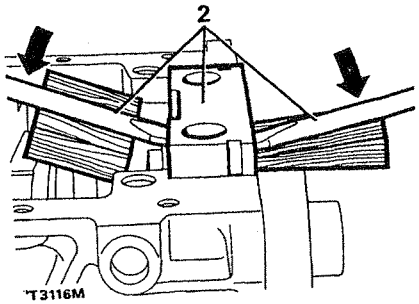
3. Before removing the piston assemblies, number each piston from one to four so that it can be identified with the bore from which it was removed.
4. Taking care not to damage the bores, push each connecting rod and piston, in turn, up the bore until it can be withdrawn from the cylinder block combustion face. 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.



ST2975M

Removing crankshaft

1. Slacken the ten main bearing bolts with a 14mm socket.
2. If difficulty is experienced removing the cap a suggested method is to lever the cap from both sides, as illustrated.
3. 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 blocks of timber are used under the levers particularly to protect the crankshaft.
4. Release the remaining bolts and remove the main bearing caps complete with the lower bearing shells.



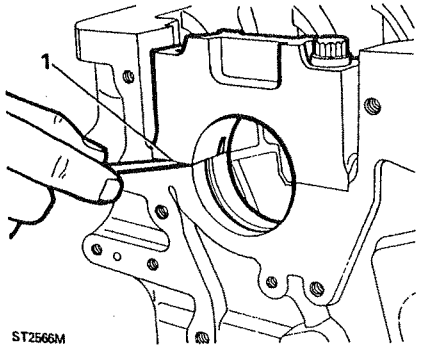
T3116M

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 cylinder block.
7. Remove the two thrust washers frome each side of the centre bearing location.
8. Remove the four cylinder lubrication, jet tubes.

CYLINDER BLOCK INSPECTiON AND OVERHAUL

Inspection

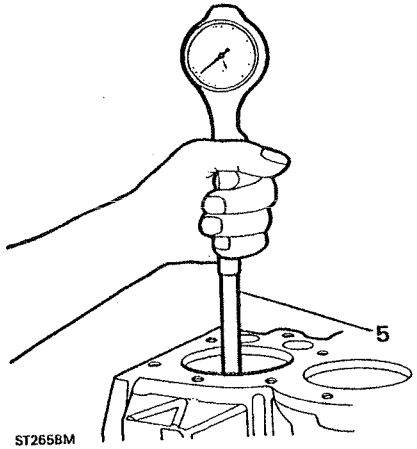
1. Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage.To check each main bearing cap and its location on the cylinder block, fit the bearing caps without the bearing shells.
2. Fit the bolts and tighten to the correct torque, then remove one bolt from each bearing cap and check with a feeler gauge that no clearance exists at the joint face as illustrated.
3. A clearance indicates either a bent bolt, damaged dowl, distortion of the caps or block, or that the cap has been filed or machined in an attempt to reduce any clearance due to wear in the bearings. Main bearing caps are not available separately from the cylinder block therefore any clearance should be investigated and rectified or the block renewed.



ST2566M

Cylinder bores

4. 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.Check the ovality of each bore by taking measurement at the top of the cylinder just below the ridge at two points diametrically opposite.
5. The difference between the two figures is the ovality at 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.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.



ST2658M

6. To establish maximum overall bore wear, take measurements at as many points as possible down the bore 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.

7. If the above figures are exceeded the cylinders can be rebored to a maximum of 0,50 mm depending upon the condition of the bores and the amount of wear. Alternatively, 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. It is important however, that the bores are deglazed, with a hone, to give a cross-hatched finish to provide a seating for the new ring. It is not permissible to reclaim a cylinder block by fitting cylinder liners to the Tdi engine.

Camshaft bearings

8. 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, in any event, if they are scored or pitted.This work should only be entrusted to line boring specialists.

It is vital to thoroughly wash the cylinder block after machining to remove all traces of abrasive material, ensuring that all oil galleries are clean.

Check crankcase main bearings

Discard scored, pitted, cracked and worn bearing shells.To determine the maximum wear, assemble the main bearing shells and caps to the crankcase and tighten the bolts to the correct torque figure. 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 given in the **GENERAL SPECIFICATION DATA.**

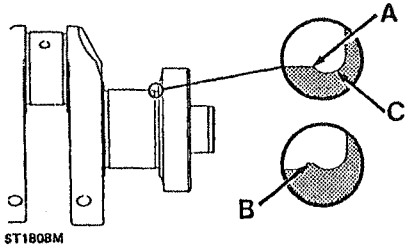
CRANKSHAFT

1. Degrease the crankshaft and clear out the oil ways which can become clogged after long service.
2. Examine visually, the crankpins and main bearing journals for obvious wear, scores, grooves and overheating. A decision at this stage should be made as to whether the condition of the shaft is worth continuing with a more detailed examination.
3. With a micrometer, measure and note the ovality and taper of each main bearing journal and crankpin as follows.
4. Ovality - Take two readings at right angles to each other at various intervals.The maximum ovality must not exceed 0,040 mm.
5. 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.
6. 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.
7. A crankshaft worn beyond the limits of maximum taper, ovality and overall wear, can be ground to 0,25 mm.

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'.
It is vital to thoroughly wash the crankshaft after machining to remove all traces of abrasive material, ensuring that all oil galleries are clean.

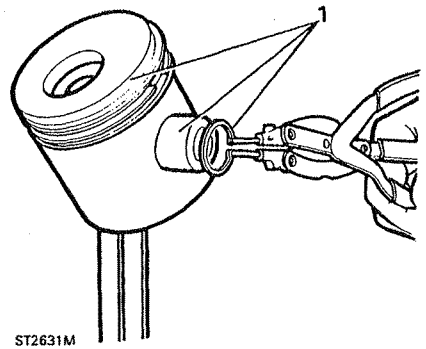


ST1808M

Pistons and connecting rods

The following checks relating to pistons and rings must also be carried out prior to fitting new pistons to rebored 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.
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.

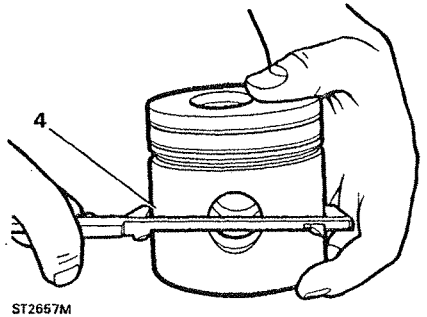


ST2631M

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, the bores must be honed to accommodate the pistons with the correct clearances.

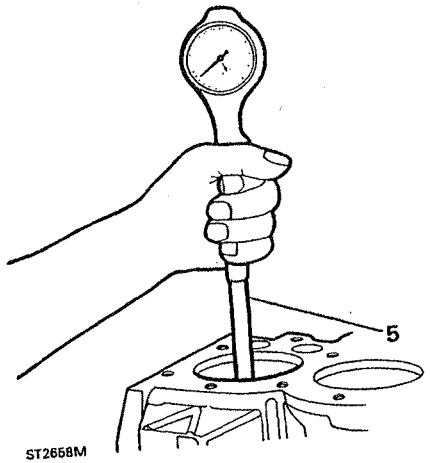
Clearance limits for new standard size pistons in a standard cylinder bore measured at right angles to the gudgoen pin are in the data section. When taking the following measurements the cylinder block and pistons must be the same temperature to ensure accuracy.

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

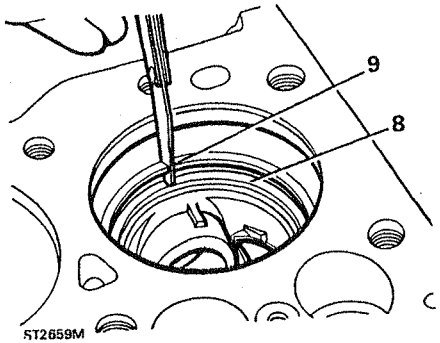


ST2657M

5. With an inside micrometer or cylinder gauge measure the diameter of the bore at approximately half-way down and note the reading.



ST2658M



ST2659M

6. The clearance is determined by subtracting the piston diameter from the bore diameter.
7. If gauge equipment is not available the clearance can be assessed by placed 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.

Piston ring gaps

8. When checking the piston 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 cylinder at the lowest point of the piston travel. To ensure squareness push the ring to the correct position using a piston.
9. With the appropriate feeler gauge check all the ring gaps in turn, including the oil control rings.

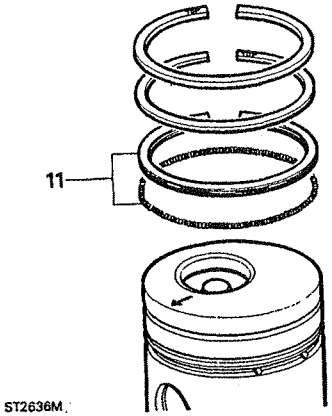
The correct gaps are listed in the **GENERAL SPECIFICATION DATA.** If any gap is less than that specified, remove the ring, and file the ends square, whilst holding the ring in a filing jig or vice.Should any gap be excessively wide and not likely to close up to within the specified limits when hot,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

Once the rings have been selected for a particular cylinder and piston ensure that they are not again mixed up.

Piston ring groove clearance

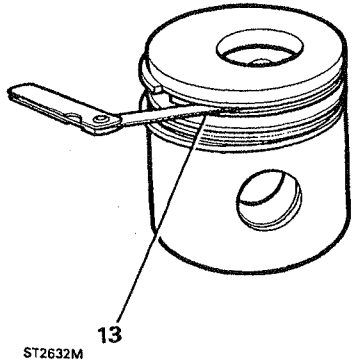
10. It is important that the groove clearances are correct. Rings that are too tight may bind or fracture when hot and cause loss of compression. Excessive clearance allows the rings to rock in the groove and may result in a pumping action and excessive oil consumption.

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.



ST2636M

12. After fitting slide each ring around the groove to ensure that it is free and does not bind.
13. Using an appropriate feeler gauge check the groove clearance between the rings and piston. If the clearances in excess of the figures given in data section the rings or the pistons should be renewed.



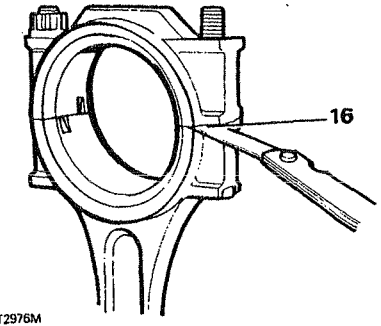
ST2632M

Gudgeon pins

14. Examine the gudgeon pin for obvious wear, cracks, scores, or overheating and ovality and taper using a micrometer.

Connecting rods

15. 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 piston/cylinder/crankshaft journal to which it must be fitted.
16. Tighten both nuts to the correct torque, then release one nut on each cap, now check that no clearance exists at the joint face as illustrated. A clearance may indicate a bent bolt or that either of the joint faces has been filed or machined previously, in attempt to rectify excessive bearing wear.



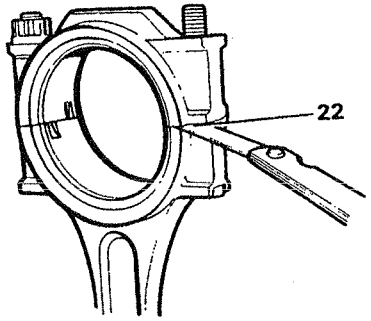
ST2976M

17. Use an accurate connecting rod alignment gauge to check the rods for bend and twist. The maximum allowable for both conditions must not exceed 0,127 mm.
18. 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.
19. 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.

20. Connecting rod bearings that are worn, pitted, scored and show signs or 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.

Big end bearing nip and clearance

21. Clean the protective coating from new bearings before fitting.
22. Fit the bearing shells to each connecting rod and cap ensuring that the location tags are correctly seated and aligned.Fit and tighten both bolts to the correct torque, next release one nut on each cap then check for a nip clearance of between 0,10 to 0,20 mm.



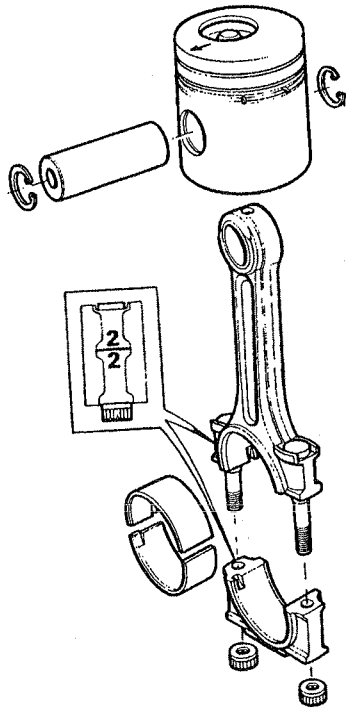
ST2977M

23. Check the joint face of faces of both cap rod and bearing shells if the nip clearance is excessive. Too little nip clearance will allow the shell bearings to move (possibly rotate) inside the connecting rod when the engine is running. After satisfactory fitting of the bearings temporary retain the shells and caps to the appropriate connecting rod.

Assembling pistons to connecting rods

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).

24. 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.



ST2979M

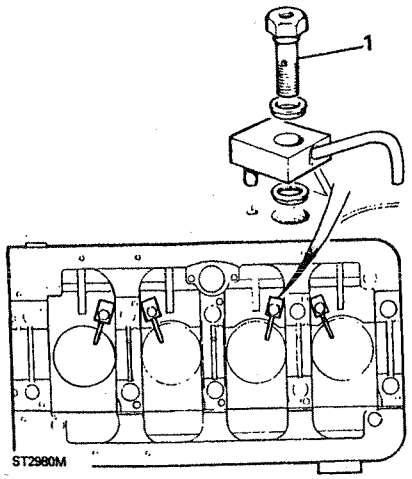
ASSEMBLE ENGINE

Ensure that the cylinder block and all oilways are thoroughly clean using an air line, if available, prior to assembly.

Refitting cylinder lubrication jet tubes

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

1. Assemble and fit the jet tube as illustrated ensuring that the dowels 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 the correct torque.



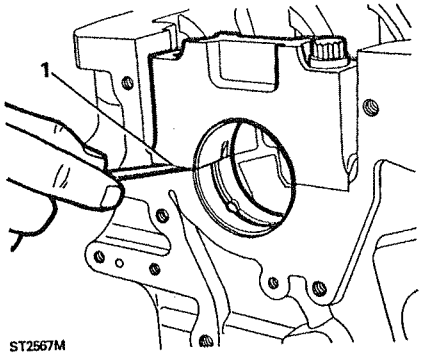
ST2980M

Crankshaft bearings

Main bearing nip clearance

Clean the protective coating from new bearings before fitting.

1. Fit the bearing halves to the cylinder block ensuring full engagement of the location tags.
2. Install the other half shells into the main bearing caps, again ensuring that the tags locate correctly.
3. Fit all the main bearing caps to their original locations tightening the bolts to the correct torque, then release one bolt on each cap.
4. Check the clearance between the cap and the block as illustrated.

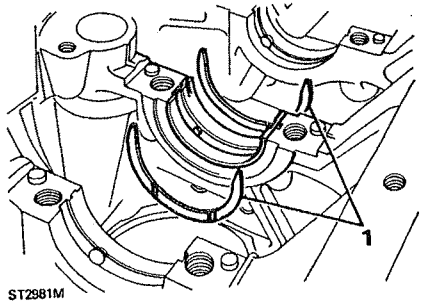


ST2567M

The nip clearance which ensures that the bearings are correctly clamped, must be within 0,10 to 0,15 mm. Investigate and correct any nip clearance errors before removing the main bearing caps prior to fitting the crankshaft.

Fitting crankshaft

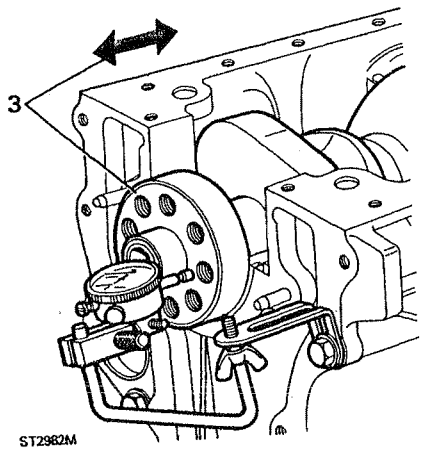
1. Insert two standard thickness thrust washers each side of the centre main bearing location with the oil grooves towards the crank thrust faces.
2. Lubricate the cylinder block bearing shells and carefully install the crankshaft.



ST2981M

Crankshaft end-float

3. To determine the crankshaft end-float mount a dial test indicator to read-off the end of the crankshaft. Move the crankshaft away from the indicator and zero the dial, then move the crankshaft in the opposite direction and note the indicator reading. The end-float should be 0,05 to 0,15 mm.

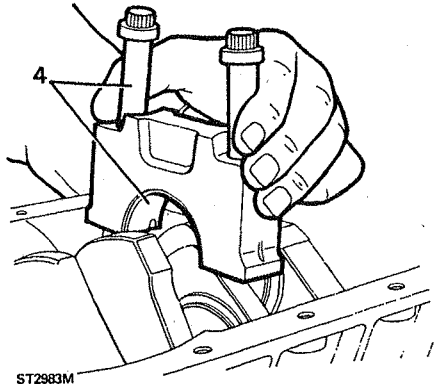


ST2982M

Alternatively measure the clearance with a feeler gauge.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.

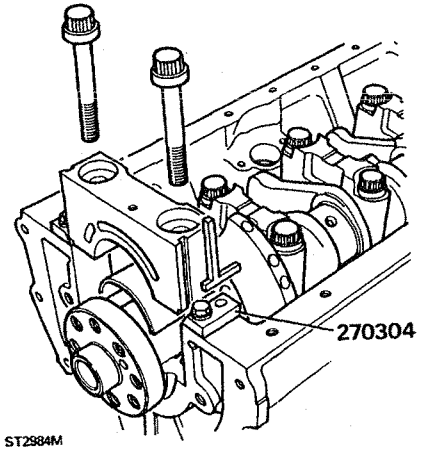
Main bearing caps

4. Lubricate and fit the centre main bearing cap, tighten both bolts to the correct torque and ensure that the shaft is free to rotate before fitting the next bearing cap.
5. Lubricate and fit 1-2 and 4 main bearing caps checking that the shaft is free to rotate after tightening the bolts for each.



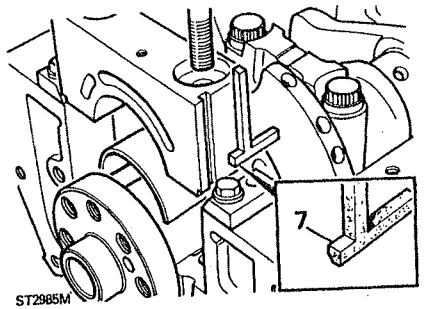
ST2983M

6. Ensure that number five main bearing cap is clean and free from old seal material. Attach the seal guides number RO270304 to the crankcase, as illustrated, and ensure that they are parallel to the crankcase edge.



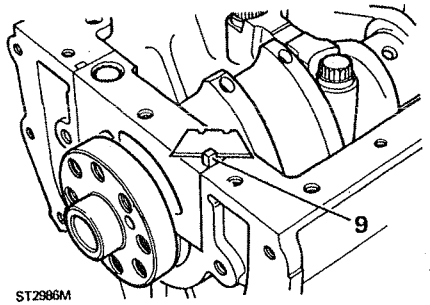
ST2984M

7. 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.
8. Fit the bearing cap complete with shell bearing to the crankcase and secure with new bolts and tighten to the appropriate torque. Remove seal guides and check that the shaft is free to rotate.



ST2985M

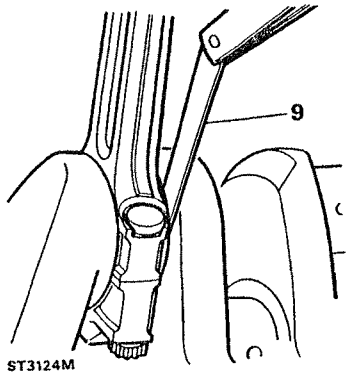
9. To allow for shrinkage after fitting leave the seals standing proud of the crankcase face then using a sharp blade, trim the seals off to approximately 0,80 mm above the crankcase face.



ST2986M

Fitting connecting rods and pistons

1. Ensure that the essentric headed big end bolts and shell bearings are correctly located in the connecting rods and as a precaution against possible damage to the crankshaft journals during installation of the pistons, cover the bolt threads with a layer of adhesive tape. Check that the number on the connecting rod is the same as the piston and cylinder and that they are correctly orientated.
2. With the cylinder block vertical, and 2 and 3 crankshaft journals at BDC lubricate and install 2 and 3 piston connecting rod assemblies so that the piston rings are resting on the block face.
3. Stagger the piston rings on both pistons as illustrated, then using a suitable tool compress the piston rings and gently push each piston into the cylinder bore.
4. Pull both connecting rod big ends on to the journals and fit the caps ensuring the numbers match and orientation is correct. Retain the caps with new nuts but do not tighten at this stage.
5. Turn the crankshaft so that 1 and 4 journals are at BDC and install the pistons and connecting rods as previously described.
6. Tighten both nuts on one connecting rod to the correct torque and check that the crankshaft is free to rotate before securing the next connecting rod cap nuts.
7. Investigate and rectify any big end bearing which when tightened restricts the freedom of the crankshaft.
8. Check that each big end is free to move sideways on its journal and if necessary check the actual side clearance using a feeler gauge.The correct clearance is given in **GENERAL SPECIFICATION DATA.**

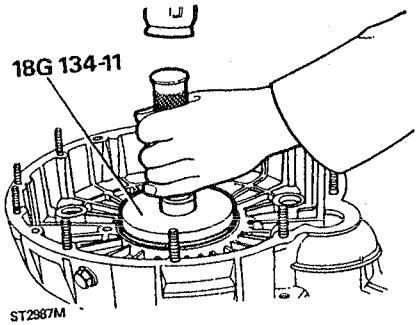


ST3124M

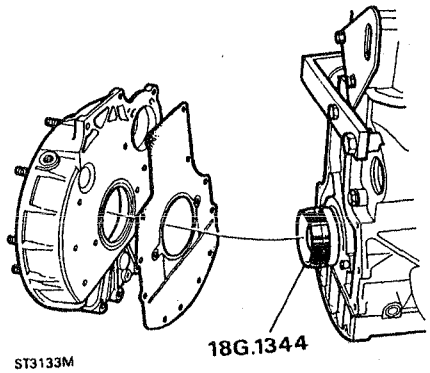
Fitting rear main oil seal to flywheel housing

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 special seal replacer 18G134-11 and with the lip side leading drive-in the seal as far as the tool allows.If the tool is not available fit the seal to the bottom of the housing to ensure squareness.
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 clear.
4. Locate the seal guide on to the crankshaft and lubricate the seal, guide and journal with concentrated Oildag' in a 25% solution with clean engine oil.
5. Position the gasket on the cylinder block over the two dowels.The gasket will only fit one way round.
6. Where applicable, 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 the correct torque.



ST2987M



ST3133M

Fitting flywheel housing

NOTE: Later Tdi engines are fitted with a flywheel housing that has a flat joint face with the cylinder block instead of a shallow annular groove round the seal housing. The method of sealing the housing to the cylinder block has also changed. Instead of a bead of sealant to a precise configuration, a large special gasket is used. The new gasket is interchangeable and should be used to seal the flywheel housing to the cylinder block on earlier engines but the annular groove must be filled with RTV sealant.

OVERHAUL AND FITTING FLYWHEEL

Inspection

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 therefore check that the flywheel has not been previously machined before proceding further. The ring gear may be renewed if the teeth are chipped or damaged.

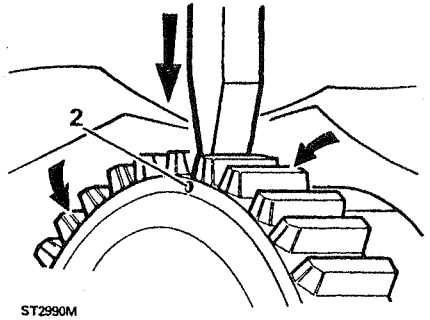
Reface the flywheel

1. 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 within the dimensions given above.

Renew ring gear

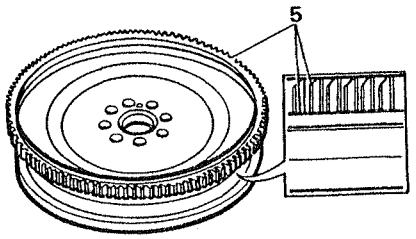
WARNING: Wear industrial goggles to protect the eyes from flying fragments.

2. 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.



ST2990M

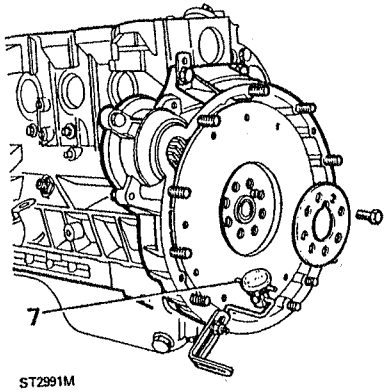
3. Secure the flywheel in a soft jawed vice and cover it with a cloth to avoid personal injury. Place a cold chisel above the drilled hole and strike it sharply to split the ring gear.
4. Heat the new ring uniformly to between 225°C and 250°C but do not exceed the higher figure.
5. Place the flywheel, clutch face down, on a flat surface and 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

6. Locate the flywheel on 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 the correct torque.
7. 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.
8. 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 irregularites on flywheel and crankshaft mating faces and dowel.

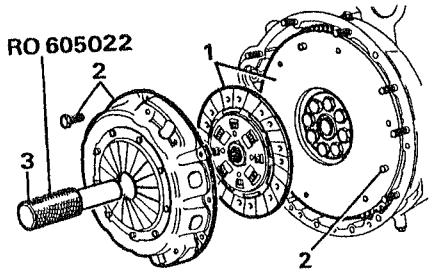


ST2991M

Fitting clutch

If the original clutch cover is being refitted, ensure any marks made during dismantling are aligned to maintain original balance.

1. Clean the flywheel and place the friction plate with the raised centre section outwards away from the flywheel.
2. Fit the clutch assembly locating it over the three dowels and loosely secure with the six bolts.
3. Centralise the centre plate using special tool RO605022 or a spare primary shaft and tighten the six bolts evenly to the correct torque.
4. Remove the tool and smear the splines of the centre plate with Molybdenum disulphide grease, such as Rocol MTS1000.



ST2611M

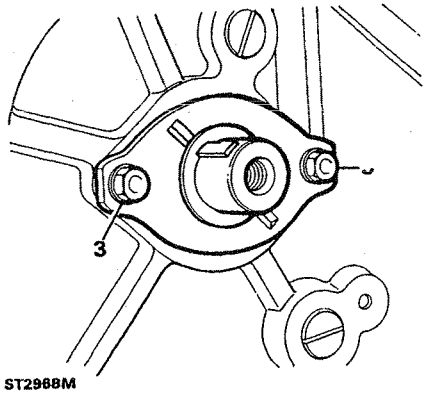
Fitting camshaft

Inspection

1. Mount the camshaft on 'V' blocks on a surface plate for convenience and examine the cams for wear, scores, pitting and chipped edges.
2. Examine the journals for obvious wear and scores and signs of overheating, in particular, check the thrust plate. If the journals are visibly serviceable, check with a dial gauge or micrometer for overall wear, ovality, taper and runout.

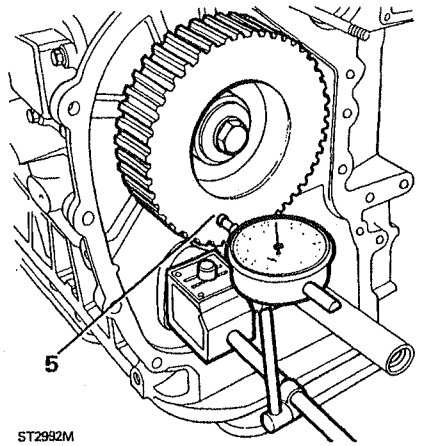
CAUTION: If the skew gear is worn and requires renewal, the camshaft must also be renewed even though the camshaft gear may appear satisfactory. Once the two gears have run together they become a matched pair.

3. 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 the correct torque.



ST2988M

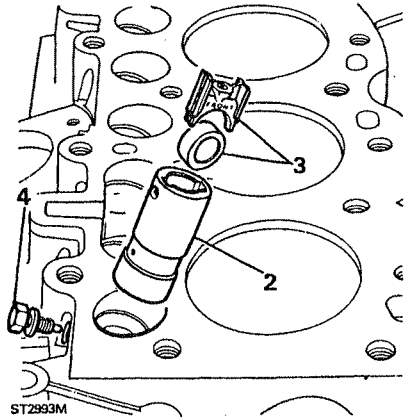
4. To check the camshaft end-float, temporarily fit the camshaft gear and mount a dial test indicator so that the stylus rests in a loaded condition upon the machined face of the gear.
5. Zero the dial and move the camshaft back and forward and note the reading.The end-float should be within 0,06 to 0,13 mm. If necessary fit another thrust plate to achieve the correct end-float.



ST2992M

Fitting cam followers

1. Examine all the components for wear and damage particularly the rollers and pushrod seating in the slides and 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.



ST2993M

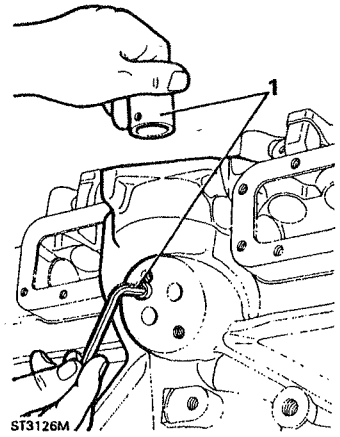
NOTE: The tappet retaining screws have a micro encapsulated locking compound applied to the threads to ensure that they do not become loose.Once the screw has been used the locking ability is lost.

2. Insert the tappet guides into the cylinder block, retaining each with a new screw which should be screwed in sufficiently to allow the rollers and slides to be installed. Ensure the rollers are fitted in accordance with any marks made during removal. New rollers, however, may be fitted either way around.
3. Before fitting the tappet slides make sure the oilways are clear to the running surface of the roller and the pushrod seating.Insert the tappet slides with the word FRONT' or F' to the front of the engine.
4. Finally tighten the screws to the correct torque to secure the guides.

Fitting skew gear bush

Inspect the skew gear bush for wear and renew if necessary.

1. Insert the bush into the cylinder block and secure with a new screw to the correct torque. Do not over tighten as this may damage the bush.



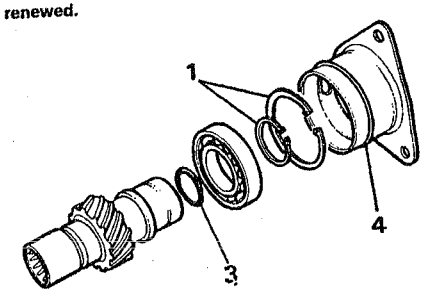
ST3126M

Overhaul and fitting skew gear

1. Remove the circlips retaining the skew gear shaft to the bearing and the bearing in the housing.
2. Press the bearing and shaft assembly from the housing and the shaft from the bearing.

Discard both rubber 'O' rings, examine all components especially the bearing and skew gear for wear and damage and renew if necessary.

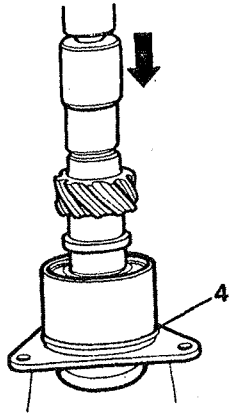
CAUTION: If the original skew gear and camshaft are to be re-used, they must be fitted so that the teeth on each, mesh in the original position. If either the skew gear or the camshaft are renewed, the mating component must also be renewed.



ST2995M

Assembling

3. Press the bearing into the housing and secure with the circlip.Support the housing and press the shaft into position and secure with the circlip.
4. Fit a new rubber 'O' ring to the outside of the housing and to the internal annular groove in the shaft ready for installation.

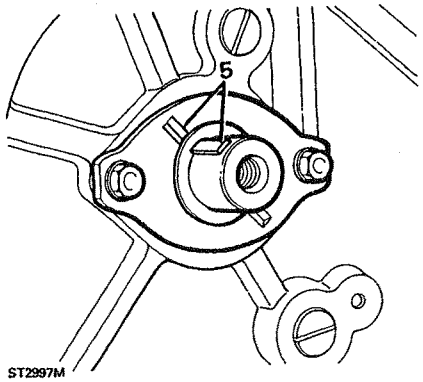


ST2999M

Fitting skew gear

If the original skew gear and camshaft are being re-used it is important that the gear teeth mesh in the original position as follows:

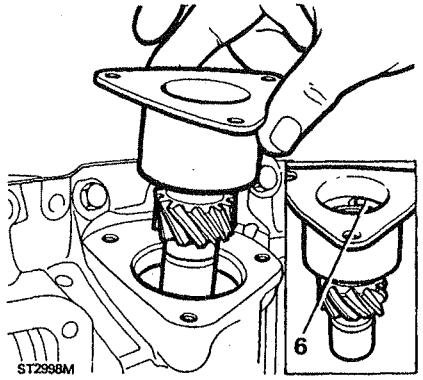
5. Turn the camshaft so that the key aligns with the oil groove as illustrated.



ST2997M

6. Fit the skew gear assembly so that the ventilation slot in the gear housing is towards the front of the engine as illustrated and ensuring that any alignment marks made during dismantling are realigned.

If both components are new it is only necessary to correctly align the ventilation slot as described above.

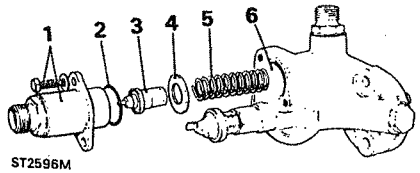


ST2998M

OVERHAUL AND FITTING OIL FILTER ADAPTOR

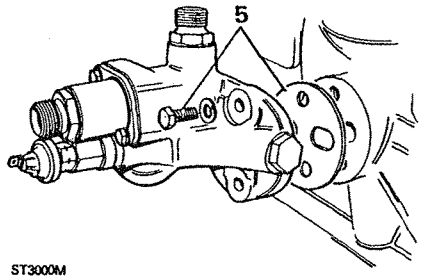
Oil temperature thermostat

1. Remove the two bolts and carefully withdraw the thermostat extension housing complete with the 'O' ring (2), thermostat (3), washer (4), and spring (5).
2. Clean the adaptor housing (6) with lint-free cloth. Inspect all the parts and renew as necessary
3. Fit the spring, washer and thermostat with the pin uppermost.
4. 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 and secure with the two bolts and washers.



ST2596M

5. 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. Tighten the two retaining bolts evenly to the correct torque.



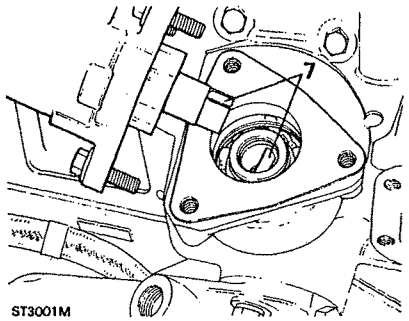
ST3000M

Oil filter

6. Smear the filter sealing ring with oil and screw the filter clockwise until the seal touches the machined face, then tighten the filter a further half turn only. Do not over tighten. See Maintenance operations, section 10.

Fitting vacuum pump

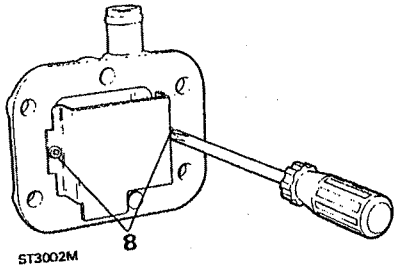
7. Using a new gasket fit the vacuum pump so that the brake servo connection is towards the front of the engine, ensuring that the cross-pin in the skew gear locates in the pump drive shaft then secure with three screws tightened to the correct torque.



ST3001M

Fitting front and rear side covers and fuel lift pump

8. Check that the front side cover baffle plate is secure and fit the cover using a new gasket securing with only four of the six fixing bolts at this stage, leaving out the two which secure the injection pump support bracket as illustrated.



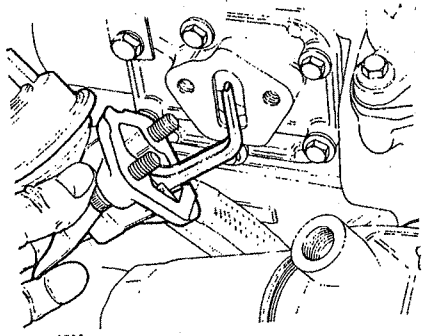
ST3002M

Fitting rear cover

9. Fit the rear cover also using a new gasket and secure with six bolts tightened to the correct torque.

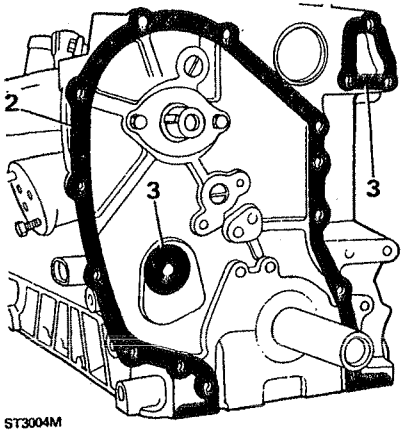
Fitting fuel lift pump

10. Check that the lift pump is serviceable and refit using a new gasket, ensuring that the pump actuating lever locates correctly onto the camshaft.


ST3003M

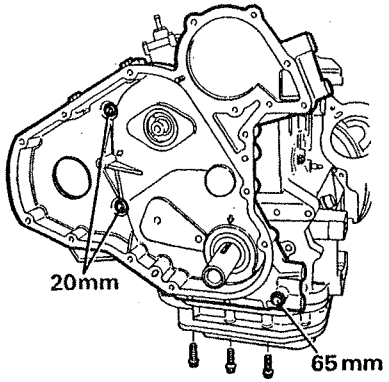
FITTING FRONT COVER TIMING BELT AND GEARS

1. Clean the front cover and remove the crankshaft and camshaft oil seals taking care not to damage the seal housing. Examine the cover for damage, cracks and distortion.Check the mating face of the cylinder block and the cover plate for burrs.
2. Clean the front face of the cylinder block and use a little grease to hold in position a new joint washer.

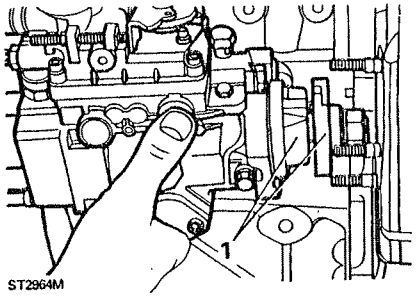


ST3004M

3. Also fit a new joint washer to the coolant aperture and to the tapped hole for the jockey pulley clamp bolt.
4. Fit the front cover locating it over the single stud and secure with the three retaining bolts tightening evenly to the correct torque. The correct bolt length for each hole is given in the following illustration.



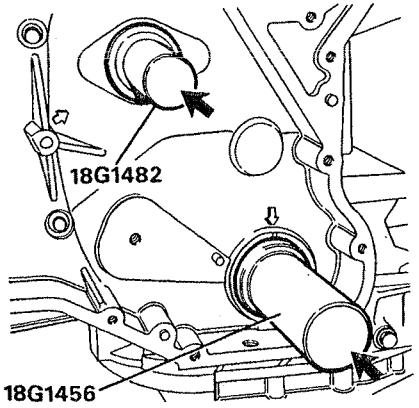
ST3005M



ST2964M

Front cover seals

5. Lubricate a new crankshaft oil seal. With the lip side leading, drive-in the seal, squarely, using special service tool 18G1456.
6. Similarly, lubricate and drive-in a new camshaft oil seal, lip side leading, using special service tool 18G1482.



ST3006M

Fitting injection pump

1. Insert the timing pin in the pump hub and body. Fit the injection pump and secure with the three nuts and tighten evenly to the correct torque.
2. Fit the pump rear support bracket to the front side cover and secure to the pump with two bolts and nuts.
3. Inspect the pump drive gear for wear and damage, ensure it is thoroughly clean and dry before fitting to the pump. Retain the gear with three bolts and reinforcing plate. Do not overtighten the bolts at this stage.

Injection pump, valve timing and drive belt

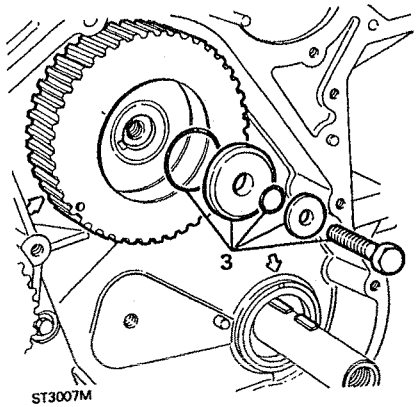
Drive belt

During use, a belt develops a wear pattern relative to its running direction, therefore, if the original belt is to be re-used it must be fitted so that it continues to rotate in the original direction, otherwise the belt must be renewed.

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. Do not bend the belt at an acute angle or radius less than 50 mm otherwise premature failure of the fibre reinforcement could result.

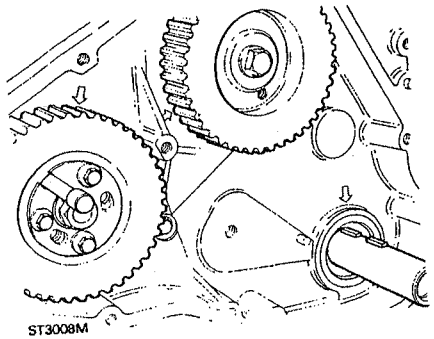
Cleanliness and accuracy are vital when carrying out the timing operations and fitting the drive belt.

1. Check the gear wheels are not damaged or scratched and that they are thoroughly clean and dry.
2. Ensure that the belt adjustment idler bearing is sound and not leaking lubricant.
3. Fit the crankshaft and camshaft gears ensuring that the camshaft gear is retained with the special bolt, washer and new 'O' ring but do not tighten at this stage.

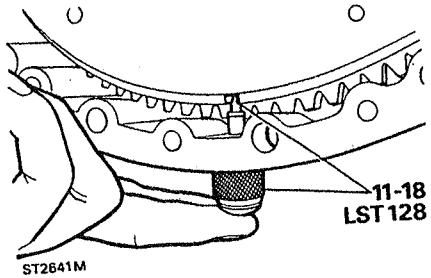


ST3007M

4. Rotate the camshaft so that the centre dot on the camshaft gear is aligned with the arrow in the front cover.
5. Temporarily refit the crankshaft pulley and turn the crankshaft so that one and four pistons are at TDC and the crankshaft key is aligned with the arrow in the front cover.


ST3008M

6. 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

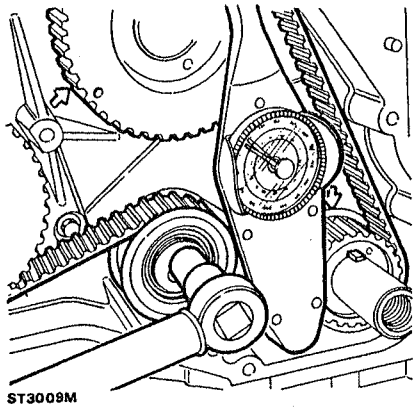
Belt fitting and tensioning

NOTE: It is vitally important that the following belt tensioning procedure is carried out carefully and accurately. The procedure which ensures that the belt is equally tensioned between each of the gears involves tensioning the belt twice. New and original belts are tensioned to different figures.

7. Ensure that the crankshaft, camshaft and the injection pump are correctly aligned with the timing marks as per previous instructions, then carefully fit the belt observing any rotational marks made during removal. Feed the belt over the gears keeping it tight on the drive side.
8. Fit the belt tensioner with the special washer and single bolt screwed in finger tight. Insert a 13 mm (0.5 in) square drive extension into the tensioner plate and with a dial type torque meter with a range not exceeding 60 Nm, apply a tension of 19 Nm for a new belt, or 17 Nm for an original belt. When the tension is correct and the meter is in the vertical position, tighten the clamp bolt.

NOTE: To ensure correct belt tension it is very important that the tensioner is clamped when torque meter is in the vertical position and the applied tension is correct.

9. Tighten the camshaft drive gear retaining bolt and the three bolts that secure the pump gear and reinforcing plate to the pump hub to the correct torque and remove the timing pin LST129/2.


ST3009M

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.

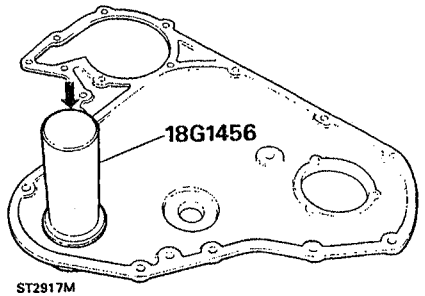
10. Rotate the crankshaft one and three quarter revolutions, then continue to turn the crankshaft slowly in the normal running direction until the injection pump timing peg will slide into position.

CAUTION: To ensure the accuracy of the timing and tensioning of the drive belt, the injection pump hub and crankshaft must only be turned in the normal running direction when carrying out the timing and belt tensioning procedure.

11. Check that the crankshaft and camshaft timing marks are correctly aligned, then slacken the three injection pump pulley bolts and the tensioner clamp bolt. Re-adjust the belt tension, again ensuring that the tension is correct when the torque meter is vertical and the tensioner clamp bolt is tightened.
12. Finally tighten, the tensioner clamp bolt and the three injection pump pulley bolts to the correct torque and remove the timing pin.

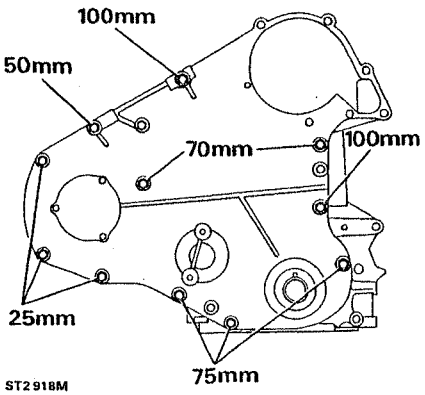
Fitting front cover plate

13. Remove the worn seal from the cover and clean the recess. Support the cover on a flat surface and using service tool 18G1456 press in the new seal into the location, lip side leading, so that when fitted the lip faces away from the crankshaft.



ST2917M

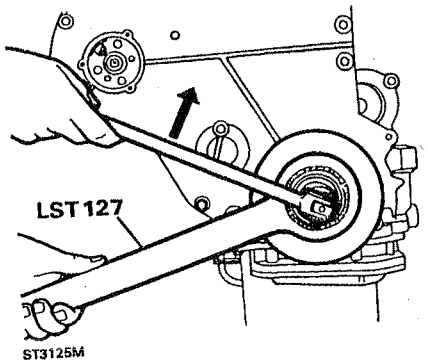
14. Ensure that the front cover and plate joint faces are clean and fit a new gasket to the front cover using a little grease.
15. Fit a new gasket to the centre hole in the cover plate and locate in position by inserting a bolt. Then fit the plate to the cover securing with the eleven retaining bolts using the location chart showing the various lengths. Tighten the bolts evenly to the correct torque.



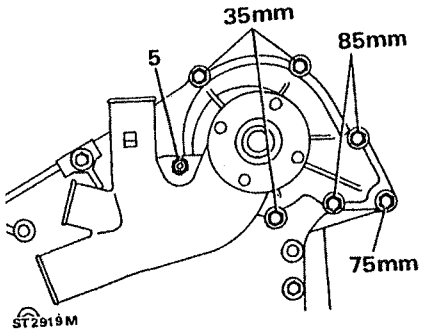
ST2918M

Fitting front damper and pulley

16. Check that the damper rubber is in good condition then locate the unit on the crankshaft key and secure with the distance piece and special bolt. Apply a little Loctite 242 to the bolt threads and tighten to the correct torque using service tool LST127 to restrain the crankshaft, as illustrated.
17. Refit the pulley securing with the four bolts and tighten to the correct torque.



ST3125M



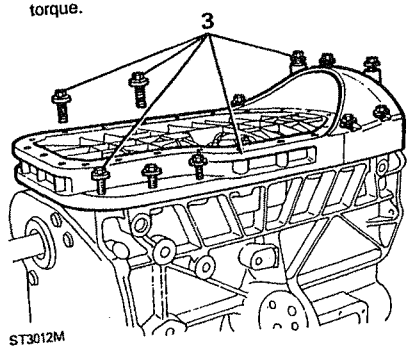
ST2919M

6. If separated, fit the fan blades to the viscous coupling with the four screws. Fit the fan and viscous coupling assembly to the water pump spindle noting that it is secured with a left-hand thread. If air conditioning is fitted do not at this stage fit the drive belt until the compressor belt is fitted.

Fitting ladder frame

Since the sealant specified to seal the ladder frame to the crankcase cures within fifteen minutes it is important to fit sufficient bolts to ensure adequate compression while the sealant cures.

1. Clean both sides of the ladder frame and remove all traces of old sealant. Check that 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. Coat both faces with Hylogrip Primer to clean and hasten curing then apply a bead of 'Hylogrip 2000' 3,0 mm wide to the mating face with the crankcase.
3. Fit ten securing bolts through the ladder frame flange and two more through the sump face as illustrated. Tighten all bolts evenly to the correct torque.



ST3012M

WATER PUMP INSPECTION AND FITTING

The water pump is not a reconditionable unit but its condition can be determined by the following checks.

1. Spin the pump spindle and listen for bearing noise, also push and pull the spindle and check for sideways movement. If the bearing is in good condition the clearance between the impeller and the pump body should not vary.
2. Inspect the vent hole in the pump body for signs of coolant or lubricant leaks. If there is any evidence of leakage, the pump should be renewed.

Fitting water pump

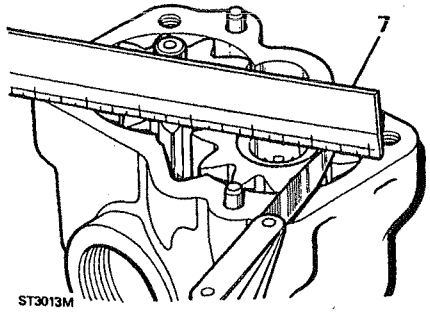
3. Lightly grease a new joint washer and place it in position on the timing cover.
4. Clean the threads of the water pump retaining bolts and apply Loctite 572 thread lubricant sealant to the threads of the long bolts which penetrate into the cylinder block.
5. Fit the pump to the cylinder block and secure in accordance with the bolt chart. Tighten the six bolts and one nut evenly to the correct torque.

OIL PUMP OVERHAUL

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 the four bolts and washers, lift off the oil pump cover and remove the driving and driven 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 pitting and renew if necessary.

NOTE: Gears must be renewed in pairs only.

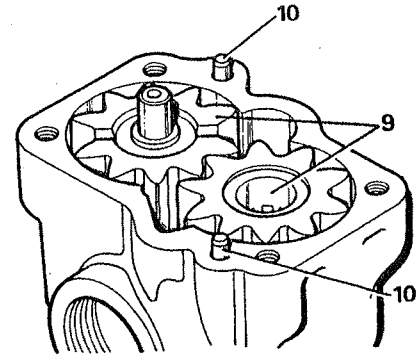
5. If showing signs of wear the driven gear spindle may be renewed.
6. Clean all the components then install both gears into the body ensuring that the recessed end of the driving gear is uppermost.
7. Place a straight edge across both gears as illustrated to measure the end-float of each using a feeler gauge. Also check the gear backlash and the clearance between the gears and pump body. The correct clearances are given in the data section.
8. Examine the gear thrust face on the pump cover, any slight scratches may be erased by rubbing on fine emery cloth on a flat surface.



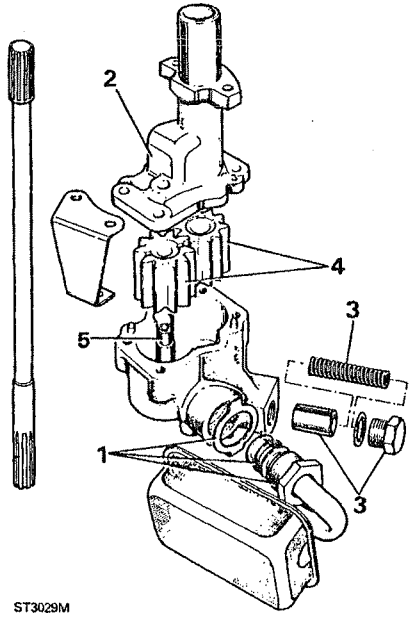
ST3013M

Pump assembly

9. With gear tolerances correct, lubricate and fit the driven gear to the spindle and install the driving gear with the counter bored splined end of the gear uppermost in the pump housing.
10. Fit the cover locating it over the two dowels and loosely secure with the four bolts until the strainer is fitted.
11. Install the spring into the relief valve then lubricate and insert the valve into the relief valve bore retaining with the 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. Tighten the strainer pipe nut and secure with the lock tab.
14. Insert the pump drive shaft and check that the gears are free to operate before refitting to the engine.



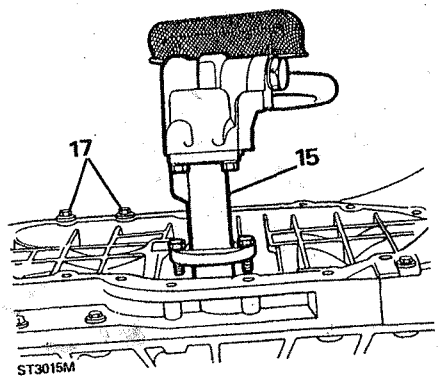
ST3014M



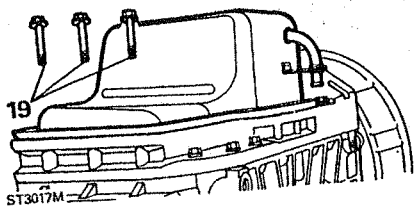
ST3029M

Fitting oil pump

15. Ensure that the oil pump drive shaft is located in the appropriate splines and fit the oil pump and strainer assembly into the cylinder block using a new gasket, tighten the two bolts to the correct torque.



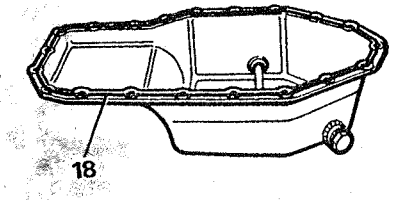
ST3015M



ST3017M

Fitting the sump

16. Ensure that all traces of old sealant are removed from the sump joint face and that the sump is thoroughly clean inside and out.
17. Remove the two bolts securing the ladder frame to the cylinder block to allow fitting of the sump.
18. Apply a 2,0 mm wide bead of 'Hylosil' RTV102 black to the sump face and fit the sump.
19. Install and tighten the twenty remaining bolts to the correct torque. Note that the three long bolts pass through the sump and ladder frame into the front cover.

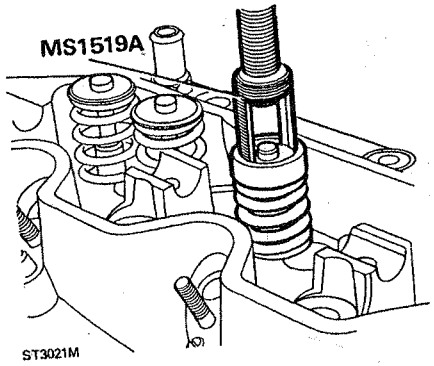


ST3016M

CYLINDER HEAD OVERHAUL

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 placing it on a hard or abrasive surface while carrying out the overhaul operations.

1. Using valve spring compressor MS 1519A or a suitable alternative, remove the valve and spring assemblies identified to their original locations.

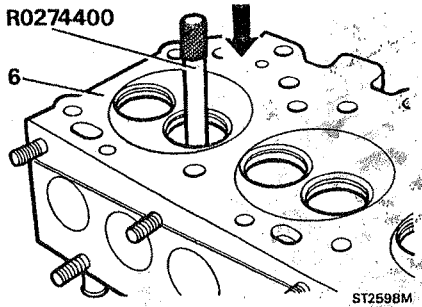


ST3021M

2. Discard the valve springs and valve guide oil seal. 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 be replaced by a skilled specialist in this type of work.
4. Examine each valve guide and valve stem for wear and damage. Suspect guides should be checked by inserting a new valve into the guide and with the valve lifted approximately - mm clear of the seat the valve head should not rock more than 0,15 mm . If the valve head movement 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. So should valves which are bent and distorted. Insert the valve into a new guide and check the side movement as described above to determine the wear on the valve stem.

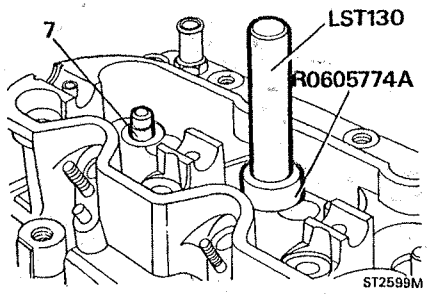
Renew valve guides

6. Support the cylinder head, combustion chamber uppermost on pieces of timber of sufficient thickness to allow clearance for the inlet or exhaust for the valve guides to be driven out using special tool RO27440



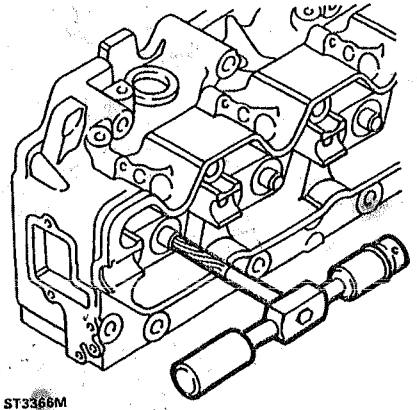
ST2598M

7. Clean the bores and heat cylinder head to a temperature of 120°C. Lubricate the new valve guides and using special tools LST130, height gauge RO605774 and a suitable press, insert them into the cylinder head from the top. To ensure that a uniform internal diameter is maintained for the total length of the guide, ream the bores from the top of the head using hand reamer 18G1636.



ST2599M

NOTE: Only service valve guides Part No. SFR0035 are to be used for this operation. Standard valve guides are not suitable.


ST3366M

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

Reface valve seat inserts

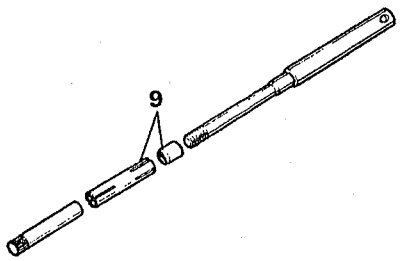
Exhaust valve seat faces should be recut to 45°

Inlet valve seat faces should be recut to 60°

8. 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.
   The refacing tools, 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

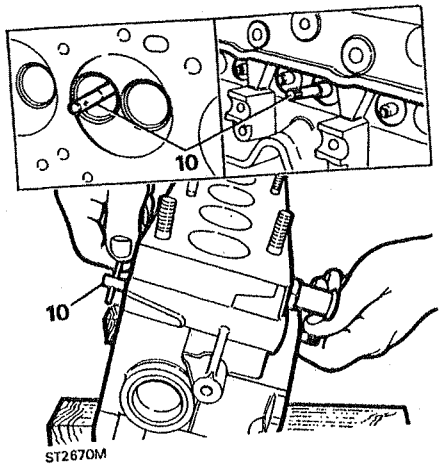
NOTE: Cutter MS621 is a double ended tool having cutters of 30° and 45°. Ensure that the 45° cutter is used in this application.

9. Loosely assemble the pilot in the sequence illustrated. Ensure that the chamfered end of the expander is towards the collet.



ST2644M

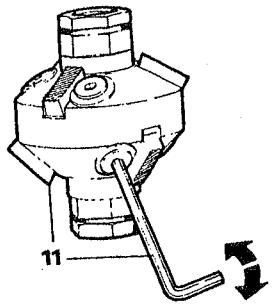
10. Insert the assembled pilot into the valve guide from the combustion chamber side of the cylinder head until the shoulder contacts the valve guide and the whole of the collet is inside the guide. To lock the pilot in the guide turn the tommy bar clockwise whilst holding the knurled knob.



ST2670M

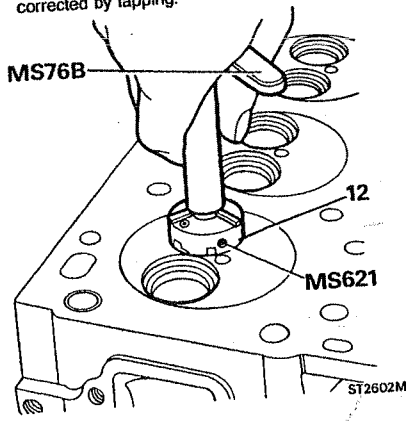
11. Using the appropriate cutter for the valve seat being refaced, ensure that the cutter blades are correctly fitted to the head with the angled end of the blade downwards facing the work. Check that the blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided to make any adjustments.

12. 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.



ST2645M

13. To check the effectiveness of the cutting operation smear a small quantity of engineers' blue round the valve seat and revolve a correctly ground valve against the seat. A good seating will produce a continuous fine polished line around the valve face. A slight gap of not more than 12 mm in the polished line, can be corrected by lapping.



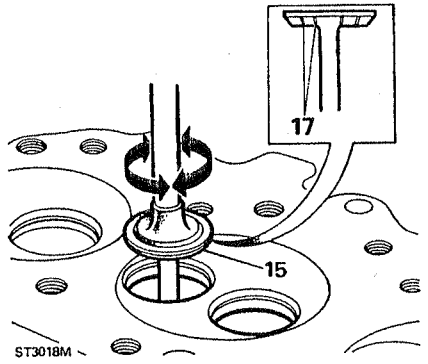
ST2602M

Reface valve head faces

Exhaust valve head faces should be reground to an angle of 45° 00' - 44° 30' to give an included angle of 90°.

Inlet valve head faces should be reground to an angle of 60 30' - 60° 00' to give an included angle of 120°

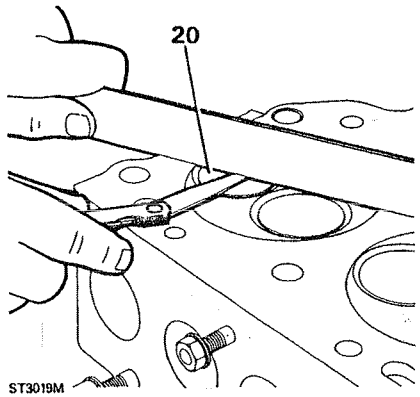
14. Valves that are satisfactory for further service can be refaced. This operation should be carried out using a valve grinding machine. Only the minimum of material should be removed from the valve face to avoid thinning of the valve edge. The valve is refaced correctly when all pits are removed and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



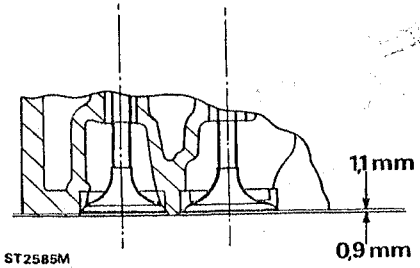
ST3018M

Lapping valves

15. 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.
16. 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.
17. 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.
18. 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 necessary. Thoroughly wash the cylinder head ensuring no lapping paste remains before fitting the valves.
19. Position the cylinder head with the combustion face uppermost, lubricate 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 as follows.
20. 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.



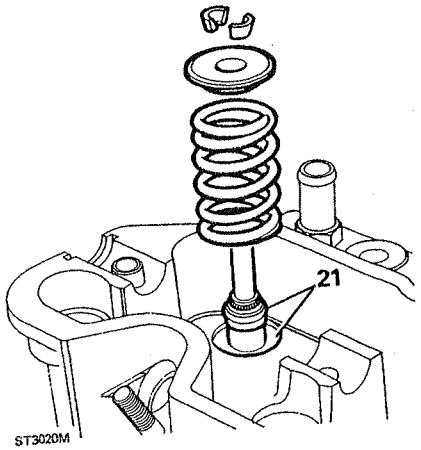
ST3019M



ST2585M

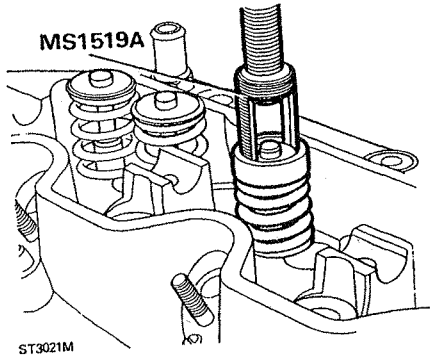
Assembling valves to cylinder head

21. Insert the valves to their respective guides and locate a spring protection washer over each guide. Fit new oil seals to all the valve guides with the garter spring uppermost. Ensure that the seals fully locate on valve guides.



ST3020M

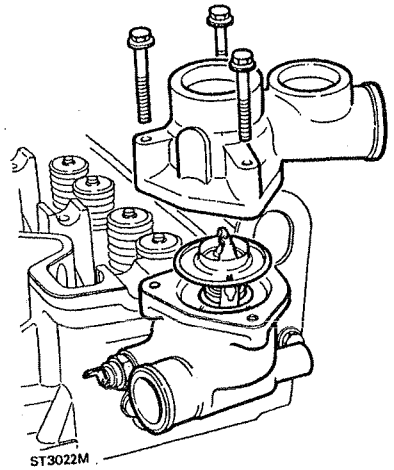
22. Fit a spring and cup to each valve and compress with special service tool MS1519A or a suitable alternative. Retain with the multi-groove cotters ensuring that they are fully located in the valve stem and cup.



ST3021M

Thermostat and housing

23. If necessary remove the temperature transmitter and temperature sensor from the housing.
24. Release the three bolts securing the thermostat cover and lift out the thermostat. The thermostat may be tested by immersing it in hot water of a known temperature and comparing its operation with the temperature range stamped on the flange. Any leakage of wax (which is the colour of copper) from around the centre pin of the thermostat, indicates that it is faulty and should be renewed.

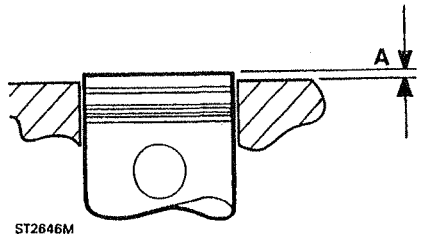

ST3022M

25. The thermostat housing may be removed from the cylinder head at this stage and if necessary the gasket renewed.
26. The 'jiggle pin' which allows any air to escape from below the thermostat, may be fitted in any position. Renew the gasket when fitting the thermostat and apply a little Hylomar sealant to the threads of temperature sensor and transmitter before screwing into position.

FITTING CYLINDER HEAD

Piston protrusion and gasket selection

Before fitting the cylinder head, the protrusion of the pistons above the block face must be checked in order that the correct thickness gasket may be selected from the range of three. 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', as illustrated. This dimension, however, must not exceed 0,8 mm.

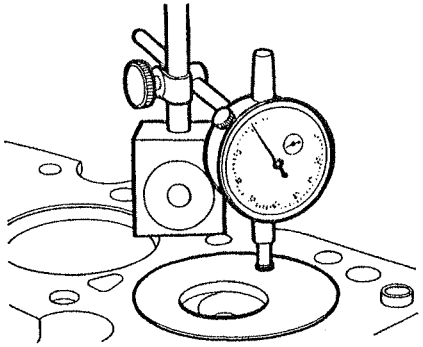


ST2646M

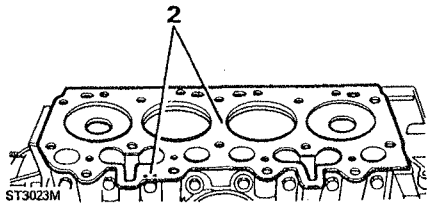
Three thicknesses of gasket are available and each size can be recognised by the number of identification holes punched in the side of the gasket as illustrated. The table below gives the details of the gaskets available. The thickness of gasket fitted can be seen when the cylinder head is fitted since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

Number of holes	Metric	Gasket
1	0,50 to 0,60	ERR0382
2	0,61 to 0,70	ERR038
3	0,71 to 0,80	ERR0384

1. Clean the cylinder block combustion face and turn the crankshaft so that number one and number four pistons are at DC. 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 selected.


ST2581M

2. Place the selected head gasket in position on the cylinder block so that the identification holes are towards the rear on the right-hand side.



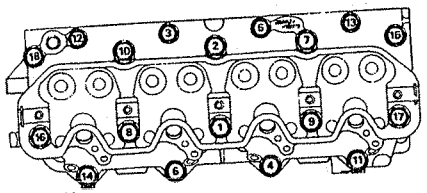
ST3023M

3. 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.
4. Lubricate the threads of new bolts, with light oil, and fit to the positions illustrated according to length and diameter. Tighten the bolts down so that the heads just make contact with the cylinder head. Now, in the sequence shown, tighten all the bolts down to 40 Nm with a suitable torque wrench.

Bolt sizes:

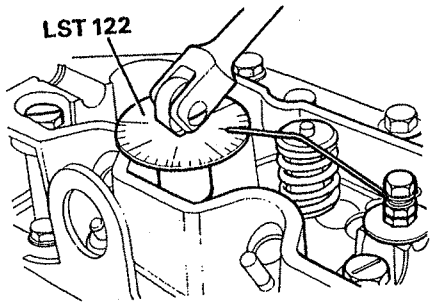
M10 locations 3, 5, 12 and 13

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



ST2619M

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.



ST3024M

5. Attached the special 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.
6. 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, then tighten each bolt a further 60° again in the correct sequence to complete the tightening procedure. Re-positioning of the pointer will, no doubt, be necessary to reach all bolts.

OVERHAUL ROCKER SHAFT

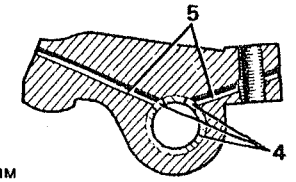
1. Remove the five rocker shaft retaining bolts and withdraw the bearing caps, rockers, washers and springs from the shaft.
2. Examine the rocker shaft for wear and discard if the bearing surface is worn, scored or pitted. Check also that the oilways are clear.
3. Inspect the rockers and discard if the pads are worn. It is not permissible to grind pads in an attempt to reclaim rockers.
4. Renew the bushes if the clearance exceeds 0,127 mm. Press in replacements ensuring that the pre-drilled holes align with those in the rockers and machine the inside bore of the bushes to 18,018 mm. The rocker arm and bush oil drillings are shown in the cross section illustration.
5. Examine the tappet adjustment screws and check that the ball end is not worn or pitted and that the lubrication hole is clear.
6. 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.

Push rods

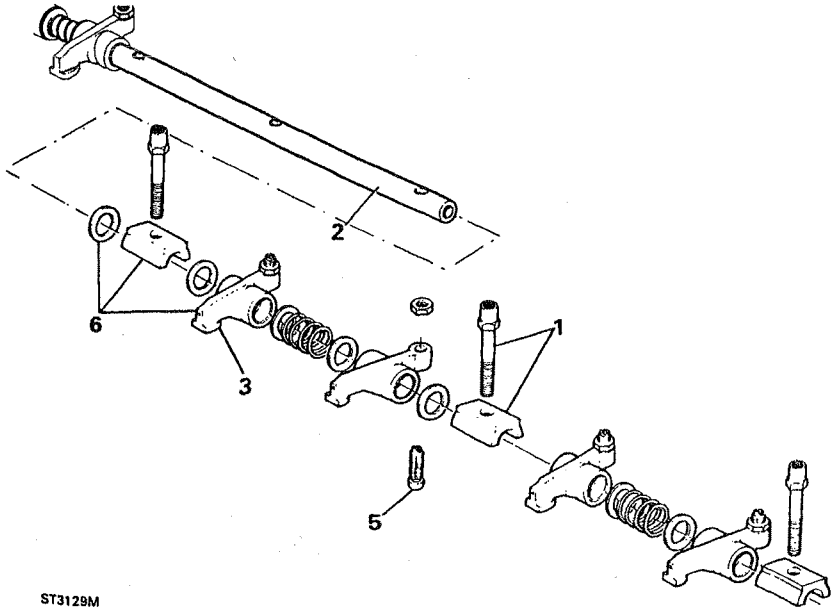
1. Examine the push rods and renew any that are bent or where the ball or cup ends are worn or pitted.
2. Fit the push rods to the engine ensuring that the ball-end locates properly in each camfollower slide.

FITTING ROCKER SHAFT

1. Ensure that a new cap is fitted to each valve stem before fitting the rocker shaft.
2. Fit the rocker shaft to the cylinder head ensuring that the retaining bolts and push rods are correctly located then evenly tighten the bolts to correct torque.



ST3131M



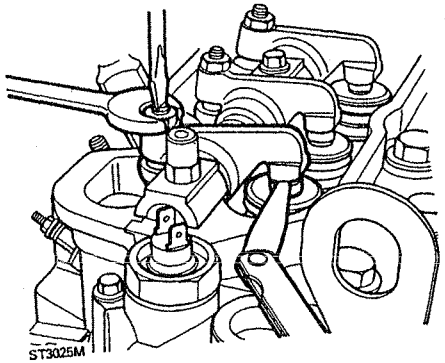
ST3129M

Adjust tappet clearances

WARNING: 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.

1. Turn the engine over until number eight valve (counting from front of engine) is fully open.
2. Using a 0,20 mm feeler gauge adjust the clearance of number one valve.


ST3025M

Continue to 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 .

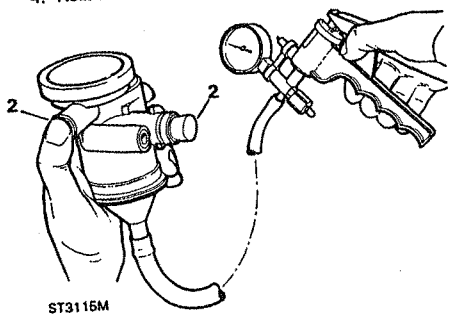
Rocker cover and crankcase ventilator

1. If necessary release the single bolt and remove the oil separator ventilation valve unit, from the side of the rocker cover and thoroughly clean.

Its function is to separate the oil from the crankcase ventilation atmosphere, allowing the oil to return to the sump and the residues to be drawn into the combustion chamber where they are burned. The unit also contains a diaphragm valve which controls the purge rate of the crankcase fumes. The operation of the valve may be tested as follows.

Test procedure crankcase ventilator

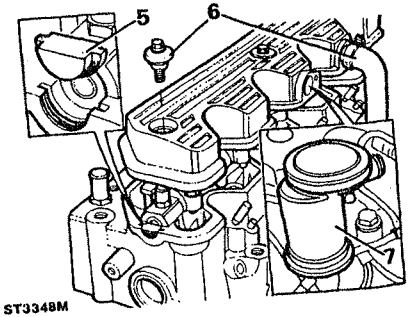
2. With the unit removed from the rocker cover seal off the two ports illustrated and apply a vacuum to the third port. As the vacuum pump is operated the diaphragm valve will be heard to seat. While holding the vacuum unseal either of the other two ports and the diaphragm valve will release.
3. Failure of the diaphragm valve to seat during test, indicates that the diaphragm is punctured and the unit should be renewed.
4. Refit the unit using a new rubber 'O' ring .



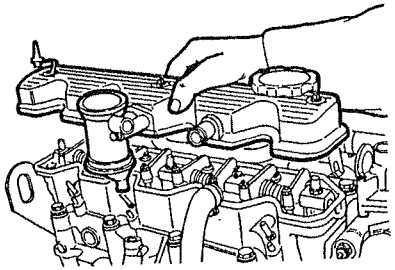
ST3115M

Fitting rocker cover

5. Apply a small blob of RTV sealant in the base of the half-moon groove at both ends of cylinder head and fit seals
6. Locate a new surround seal on the rocker cover and fit the cover to the cylinder head securing with the three special bolts and conical washers. Tighten the bolts evenly to the correct torque. and connect ventilator hose.
7. Fit the crankcase ventilator and connect the hose.



ST3348M

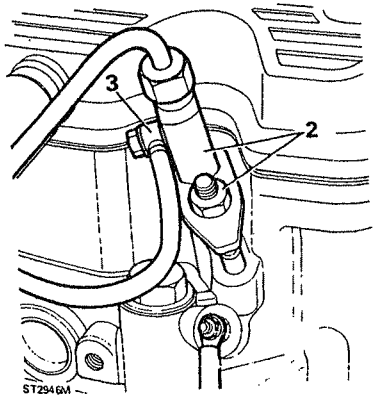

ST2948M

FITTING HEATER PLUGS

1. If necessary check the operation of each heater plug before fitting and tighten to the correct torque, do not over-tighten.
2. Connect the electrical harness to the plugs and secure with the single nut and washer. Ensure that each spade terminal is fitted so that neither the terminal nor the insulation touches the cylinder head, or oil separator.

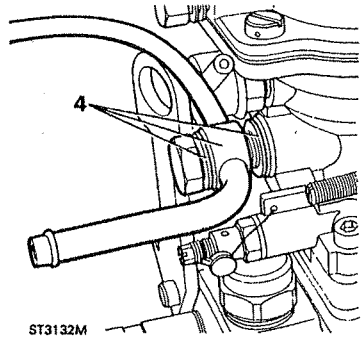
FITTING INJECTORS AND PIPES

1. Ensure that the injector and seating in the cylinder head is clean then lightly grease a new copper washer in position on the injector.
2. Fit the injectors with the spill return outlet facing towards the rear of the engine and secure each with a clamp and nut. The clamps are slightly curved and the convex side should be fitted uppermost. Tighten the nuts to the correct torque.
3. Fit the spill return rail to the injectors, noting that there are two copper washers and one must be fitted each side of the retaining union screw. The in-board washer locates in a recess in the injector. Do not over-tighten the screws.



ST2946M

4. Fit the banjo-union end of 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.



ST3132M

5. Fit the injector fuel supply pipes securing each end of the pipes to their respective locations loosely, then tighten evenly. Do not, however, over-tighten.

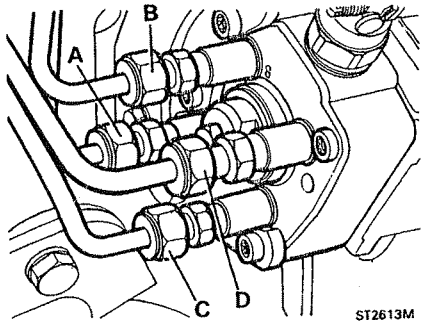
Commencing at the front of the engine connect the pipes as follows:

A. To number 1 injector.

B. To number 2 injector.

C. To number 3 injector.

D. To number 4 injector.



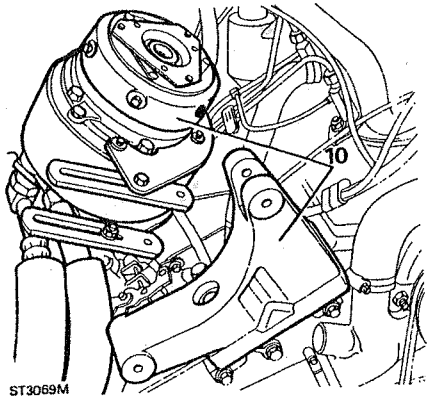
ST2613M

CAMSHAFT - remove with engine in vehicle

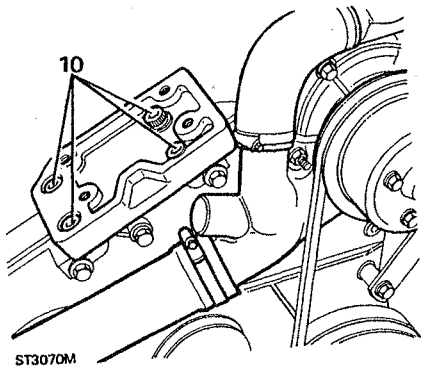
Service Repair No. 12. 13. 02

Remove and refit

1. Remove the bonnet and disconnect the battery.
2. Disconnect the radiator bottom hose and allow the coolant to drain and reconnect the hose.
3. Remove the radiator top coolant hose.
4. Remove the fan and viscous coupling assembly, see operation 26.25.19 instructions 4 to 7.
5. Remove the fan cowl.
6. Remove the radiator, see operation 26.40.01 instructions 3 to 5 and 7 to 8.
7. Remove the air cleaner, see operation 19.10.01 instructions 1 to 5.
8. Remove the alternator, see operation 86.10.02 instructions 5 to 9.
9. Remove the power assisted steering pump bracket, see operation 12.25.22 instructions 4 to 9.
10. Remove the air conditioning compressor, where fitted, and the mounting bracket together with the platform secured by four socket headed bolts. Note that the hoses must not be removed from the compressor but it should be carefully secured to one side.



ST3069M

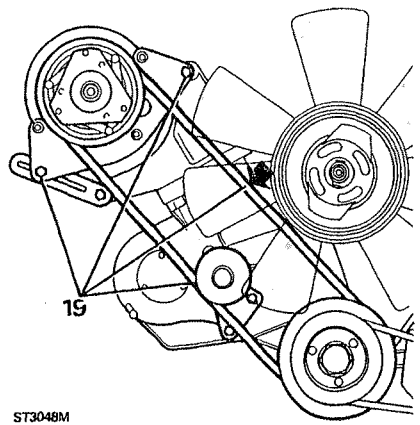


ST3070M

11. Remove the exhaust and inlet manifolds, see operation 30.15.01 instructions 4 to 15.
12. Remove the cylinder head, see operation 12.29. 02 instructions 6 to 7 and 9 to 17.
13. Now follow the instructions in **ENGINE OVERHAUL.**

Refitting

14. Follow the instructions for fitting the camshaft and assembly of the engine up to the fitting of the rocker cover, crankshaft damper and pulley.
15. Fit the inlet and exhaust manifolds see operation 30.15.01 instructions 16 to 24 and 27.
16. Fit the power assisted steering pump bracket and secure and the four bolts.
17. Fit the power steering pump to the bracket with the single pivot bolt and clamp bolts. Leave the bolts slack at this stage.
18. Fit the alternator to the common bracket, see operation 86.10.02 instructions 10 to 15.
19. Where applicable, fit the air conditioning compressor and tension the drive belt as follows: Move the compressor clockwise about the pivot bolts (do not use a lever against the pump) until the belt deflects 12 mm at the mid point of the run between the compressor and crankshaft pulleys. Tighten the pivot and clamp bolts. Move the drive belt damper so that it is just in contact with the belt or 1,0 mm clear of belt and tighten the damper bolts.



ST3048M

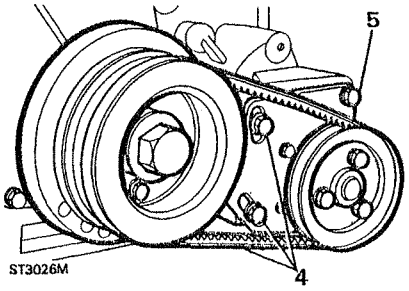
20. Fit and tension the power steering pump drive belt, see operation 57.20.14 instruction 10. Take note of the **CAUTION** when tensioning the belt.
21. Fit the air cleaner, see operation 19.10.01 instructions 12 to 14.
22. Fit the radiator, see operation 26.40.01 instructions 9 to 15.
23. Fit the fan cowl in position but do not secure to the radiator.
24. Fit the fan and coupling assembly, see operation 26.25.19 instructions 8 to 11.
25. Fill the cooling system, see operation 26.10. 01 instructions 5 to 8.

POWER STEERING PUMP BRACKET - with engine in vehicle

Service Repair No. 12.25.22

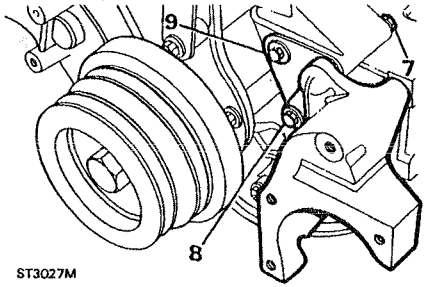
Remove and refit

1. Disconnect the battery.
2. Remove the air cleaner, see operation 19.10.01.
3. Remove the alternator, instructions 2 to 9 operation 86.10.02.
4. Remove the steering pump two adjustment clamp bolts and remove the drive belt.
5. Remove the single pivot bolt.



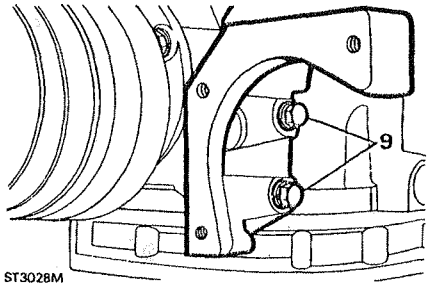
ST3026M

6. Move the pump aside with the two hoses still attached to gain access to the bracket four retaining bolts.
7. Remove the single long bolt through the cylinder block into the bracket.
8. Remove the single bolt from the front into the cylinder block.



ST3027M

9. Remove the two bolts inside the bracket into the front cover and remove the bracket and triangle shaped packing plate.



ST3028M

Refitting

10. Fit the bracket to the cylinder block with the four bolts, reversing instructions 7 to 9.
11. Loosely secure the pump to the bracket with the three bolts.
12. Fit and tension the drive belt.

CAUTION: Do not apply any pressure against the pump casing when tensioning the drive belt since it will damage the casing, permanently, beyond repair.

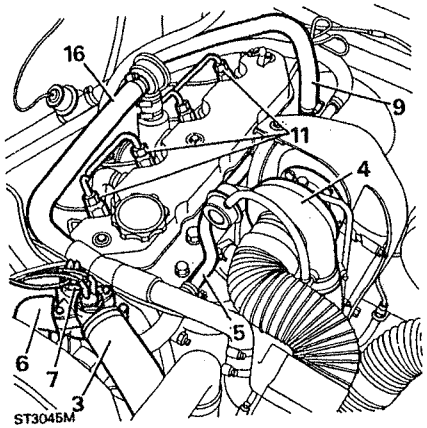
13. Tighten the two clamp bolts and single pivot bolt. The belt is correctly tensioned when the belt can be deflected by thumb pressure 12 mm.
14. Fit the alternator and tension the drive belt, see operation 86.10.02.
15. Fit the air cleaner.
16. Connect the battery, run the engine at a fast idle for approximately three to five minutes. Stop the engine and check the drive belt tensions.

CYLINDER HEAD - remove with engine in vehicle

Service Repair No. 12.29.02

Remove and refit

1. Remove the bonnet and disconnect the battery
2. Drain the coolant.
3. Remove the radiator top hose.
4. Remove the exhaust and inlet manifolds, complete with turbo charger see operation 30.29.02.
5. Remove the heater rail.
6. Remove the thermostat to water pump hose.
7. Disconnect the electrical leads from the thermostat housing sensors.
8. Disconnect the harness from the alternator
9. Remove the heater hose from the cylinder head
10. Remove the axle breather pipe from the rear of the cylinder head.
11. Remove the fuel pipes from the injectors and injector pump.
12. Remove the spill return pipes from the injectors.
13. Remove the injectors and washers and place in a clean, sealable container, for safe keeping.
14. Remove the electrical leads from the heater plugs.
15. Remove the heater plugs and store in a safe place.
16. Remove the hose from the breather valve.
17. Follow the instructions in the **ENGINE OVERHAUL.**



ST3045M

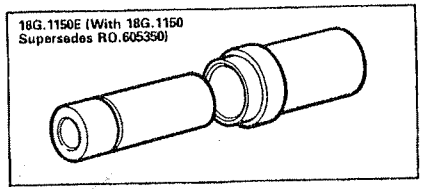
Refitting

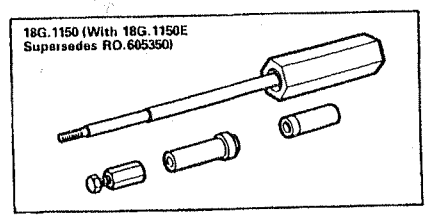
18. Follow the instructions in **ENGINE OVERHAUL** from 'fitting cylinder head' and continue until the rocker cover is fitted.
19. Fit the heater plugs and connect the electrical leads. Do no allow any part of the lead or insulation to touch the cylinder head when fitted.
20. Fit the injectors - see **ENGINE OVERHAUL.**
21. Fit the spill return pipes to the injectors.
22. Fit the supply pipes to the injectors and pump.
23. Fit the hose to the breather valve.
24. Fit the axle breather bracket.
25. Fit the heater hose to cylinder head.
26. Connect the harness to the alternator.
27. Fit the water pump to thermostat hose.
28. Connect the leads to the thermostat sensors .
29. Fit the inlet and exhause manifolds and heater rail.
30. Fit the radiator top hose.
31. Fill the cooling system, see operation 26.10.01.
32. Fit the bonnet.

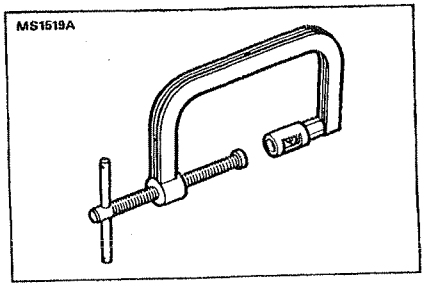
DISMANTLE, OVERHAUL AND ASSEMBLE

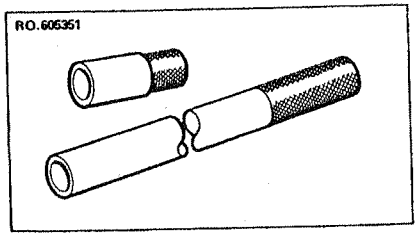
Special tools:
Guide bolts - RO605351-LRT-12-041
Clutch centralising tool - 18G79-LRT-12-001
Gudgeon pin remover/replacer - basic tool - 18G1150-LRT-12-013
Adaptor remover/replacer - gudgeon pin - 18G1150E or RO605350-LRT-12-013
Valve spring compressor - 18G106A or RO276102 or MS1519A-LRT-12-034
Valve guide drift exhaust and inlet RO600959-LRT-12-038
Valve cutter handle set - MS76B-LRT-12-501
8.5 Adjustable pilot - MS150-8.5-LRT-12-503
Valve seat cutter - MS621-LRT-12-504
Drift for guide removal - inlet and exhaust - RO274401-LRT-12-037
Crankshaft rear seal sleeve - RO1014-LRT-12-010

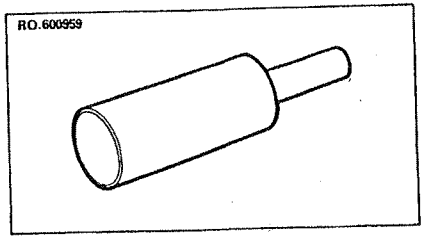
NOTE: Where the use of special service tools is specified, only these tools should be used to avoid the possibility of personal injury or damage to components.

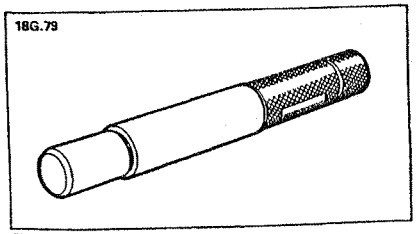












ST2397M