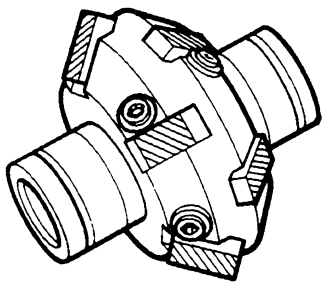
DISMANTLE, OVERHAUL AND ASSEMBLE

Special service tools

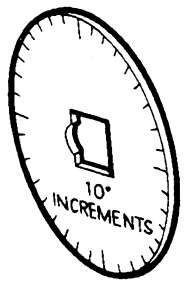
Handle set, seat cutter	MS76B
Pilot, seat cutter	MS150-8
Valve seat cutter	MS621
Cylinder head bolt degree plate	LST122
Adaptor, crankshaft rear seal	18G134-11
Crankshaft rear seal saver	18G1344
Valve spring compressor	MS1519A
Drift, valve guide removal	RO274400
Distance piece, valve guide fitting	RO605774A
Drift, valve guide fitting	LST130
Mandrel, clutch plate	RO605022
Replacer, crankshaft front seal	18G1456
Remover, crankshaft/camshaft gear	18G1464
Replacer, camshaft oil seal	18G1482
Flywheel timing pin	LST128
Crankshaft damper restraining tool	LST127
Rear main cap seal guide	270304
Crankshaft damper tool	LST136
Injection pump timing pin - part of LST129 pump remover tool	LST129/2

NOTE: 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.

MS.621

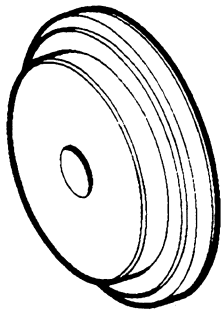


LST. 122

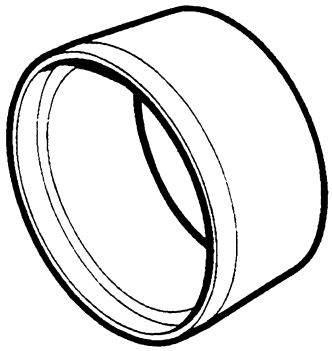


Dia. Range 28.5 mm - 44 mm 15 & 45

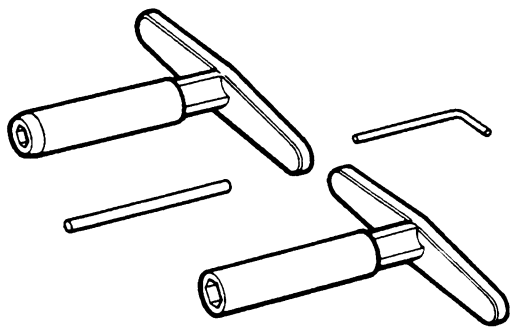
18G.134-11



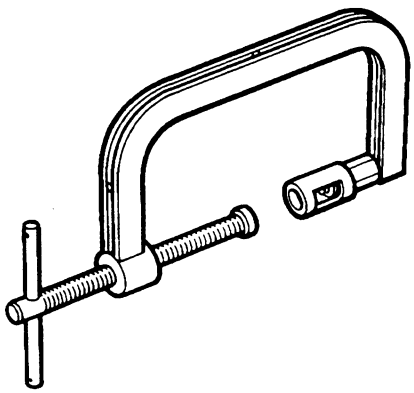
18G.1344



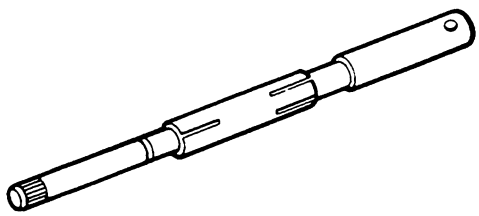
MS.76B



MS. 1519A



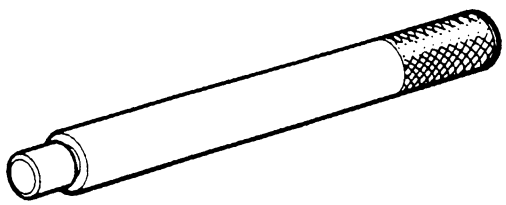
MS.150-8



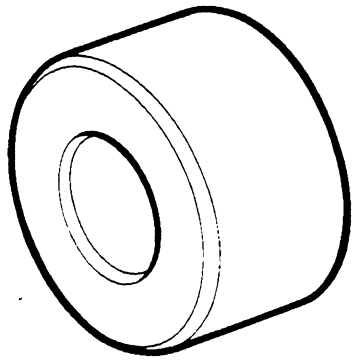
Dia 7.9 mm - 8.5 mm

ST2675M

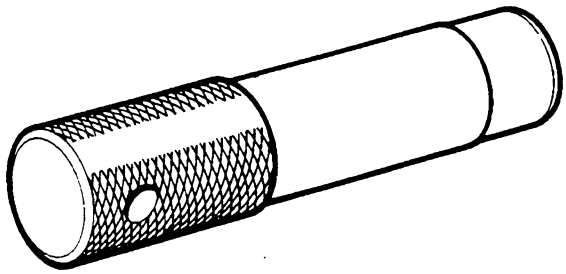
RO.274400



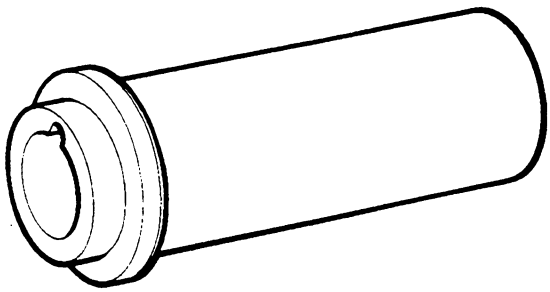
RO.605774A



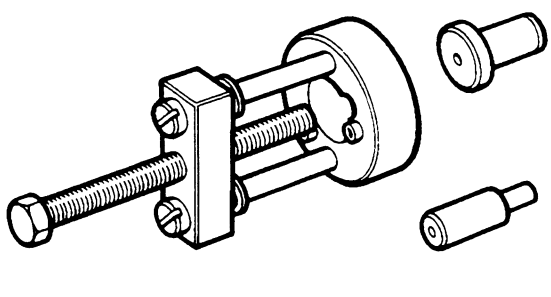
RO.605022



18G.1456

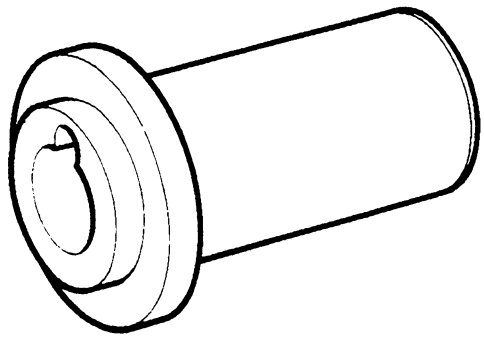


18G.1464

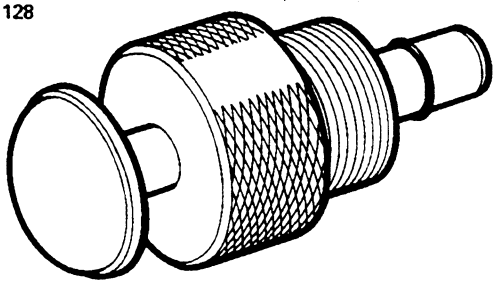


ST2944M

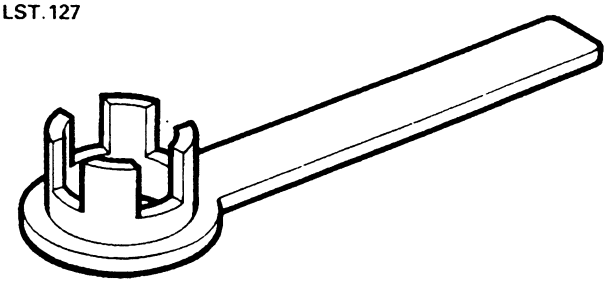
18G.1482



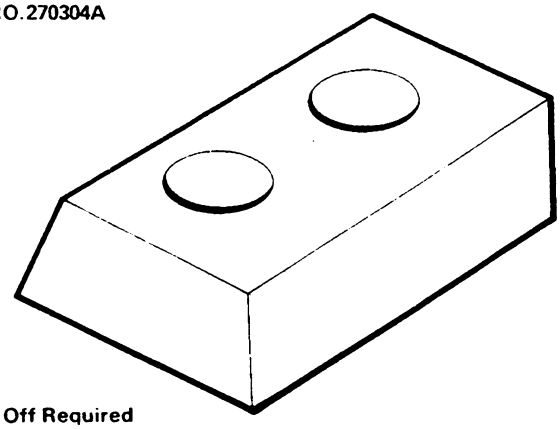
LST.128



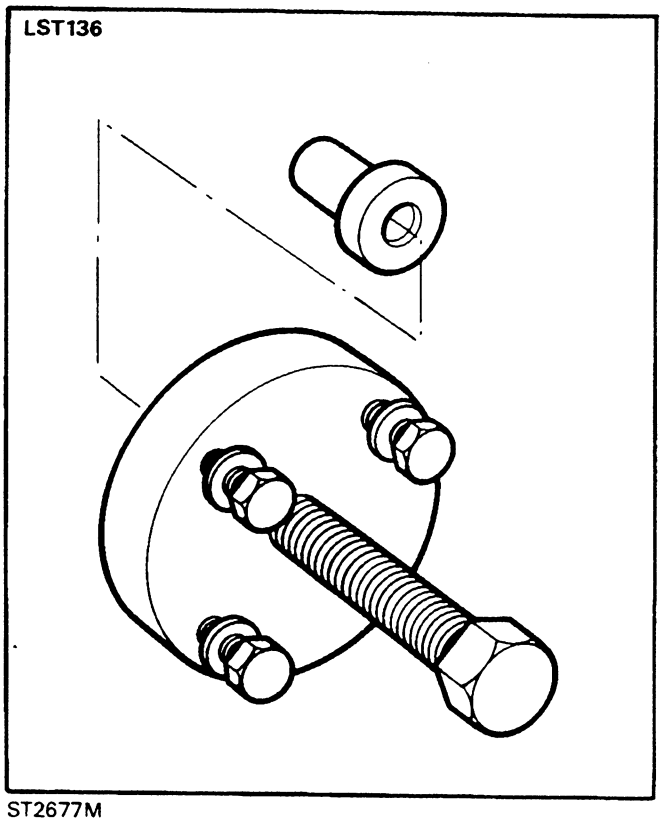
LST.127



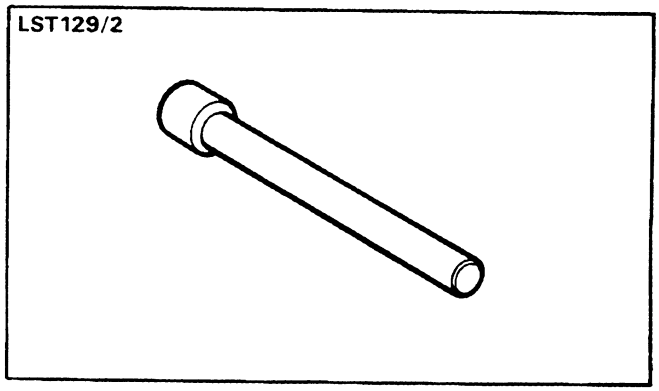
RO.270304A

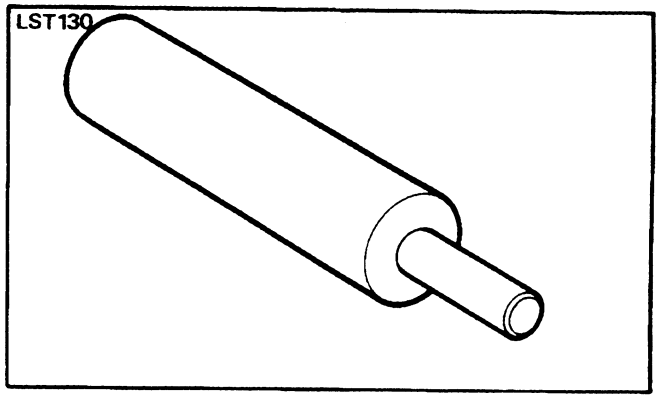


2 Off Required



ST2677M





DATA

Crankshaft

Main bearing journal diameter	63,475 - 63,487 mm (2.499 - 2.4993 in)
Regrind dimensions	63,2333 - 63,246 mm (2.4895 - 2.490 in) Use 0.010 in U/S bearings
Crankpin journal diameter	58,725 - 58,744 mm (2.312 - 2.31275 in)
Regrind dimensions	58,4708 - 58,48985 mm (2.30200 - 2.30275 in) Use 0.010 in U/S bearings
Crankshaft end thrust	Taken on thrust washers at centre main bearing
Crankshaft end float	0,05 - 0,15 mm (0.002 - 0.006 in)

Main bearings

Number and type	5 halved shells with oil grooves
Diametrical clearance	0,0792 - 0,0307 mm (0.0031 - 0.0012 in)

Connecting rods

Length between centres	175,38 - 175,43 mm (6.905 - 6.907 in)
Diametrical clearance (big-end bearings)	0,025 - 0,075 mm (0.001 - 0.003 in)
End float on crankpin	0,15 - 0,356 mm (0.006 - 0.014 in)

Pistons

Type	Aluminium alloy, combustion chamber in crown
Skirt diametrical clearance (at right angle to gudgeon pin)	0,025 - 0,05 mm (0.001 - 0.002 in)
Maximum height above combustion face	0,8 mm (0.031 in)

Gudgeon pins

Type	Floating
Fit in piston	Hand push fit
Diameter	30,1564 - 30,1625 mm (1.18726 - 1.18750 in)
Clearance in connecting rod	0,0036 - 0,0196 mm (0.00014 - 0.00077 in)

Piston rings

Type:	
- Top	Chamfered friction edge, chrome plated
- Second	Taper faced
- Oil control	Expander and rails
Gap in bore:	
- Top	0,40 - 0,65 mm (0.0157 - 0.0255 in)
- Second	0,30 - 0,50 mm (0.0118 - 0.0196 in)
- Oil control	0,3 - 0,6 mm (0.011 - 0.023 in)
Clearance in piston grooves:	
- Top	0,167 - 0,232 mm (0.0065 - 0.0091 in)
- Second	0,05 - 0,08 mm (0.0019 - 0.0031 in)
- Oil control	0,05 - 0,08 mm (0.0019 - 0.0031 in)

Camshaft

Drive	30 mm (1.2 in) wide dry toothed belt
Location	Right hand side (thrust side)
End float	0,1 - 0,2 mm (0.004 - 0.008 in)
Number of bearings	4
Material	Steel shell, white metal lined

Valves

Tappet clearance:	
- Inlet and exhaust	0,20 mm (0.008 in)
Seat angle:	
- Inlet	30°
- Exhaust	45°
Head diameter:	
- Inlet	39,35 - 39,65 mm (1.549 - 1.560 in)
- Exhaust	36,35 - 36,65 mm (1.431 - 1.443 in)
Stem diameter:	
- Inlet	7,960 - 7,975 mm (0.313 - 0.314 in)
- Exhaust	7,940 - 7,960 mm (0.212 - 0.313 in)
Valve lift:	
- Inlet	9,93 mm (0.401 in)
- Exhaust	10,26 mm (0.404 in)
Cam lift:	
- Inlet	6,81 mm (0.268 in)
- Exhaust	7,06 mm (0.278 in)
Valve head stand down	
- Inlet and exhaust	0,9 - 1,1 mm (0.035 - 0.040 in)

Valve springs

Type	Single coil
Length, free	46,28 mm (1.822 in)
Length, under 21 kg (46 lb) load	40,30 mm (1.587 in)

Lubrication

System	Wet sump, pressure fed
Pressure, engine warm at normal operating speeds	25 - 55 p.s.i. (1.76 - 3.86 kgf/cm^2)
Oil pump:	
- Type	Double gear 10 teeth, sintered iron gears
- Drive	Splined shaft from camshaft skew gear
- End float of both gears	0,026 - 0,135 mm (0.0009 - 0.0045 in)
- Radial clearance of gears	0,025 - 0,075 mm (0.0008 - 0.0025 in)
- Backlash of gears	0,1 - 0,2 mm (0.0034 - 0.0067 in)
Oil pressure relief valve	Non-adjustable
Relief valve spring:	
- Full length	67,82 mm (2.670 in)
- Compressed length at 2.58 kg (5.7 lb) load	61,23 mm (2.450 in)
Oil filter	Screw-on disposable canister
Engine oil cooler	Combined with coolant radiator and intercooler

Fuel system

Injection pump type	Bosch rotary VE4/11F (see section 05)
Injection pump timing	1.54 mm lift at T.D.C.
Injectors	(see section 05)
Heater plugs	(see section 05)
Fuel lift pump type	Mechanical with hand primer
Fuel lift pump pressure	42 - 55 kpa at 1800 rpm
Fuel filter	Paper element in disposable canister
Air cleaner	Paper element type
Turbo charger	Garrett T25 (see section 05)

TORQUE WRENCH SETTINGS	Nm
Bearing cap to cylinder block	130 - 136
Camshaft thrust plate to cylinder block	7 - 10
Clutch cover plate to flywheel	30 - 38
Connecting rod to cap	56 - 62
Dipstick tube assembly to cylinder block	22 - 28
Dipstick mounting bracket to inlet manifold	7 - 10
Engine mounting foot to cylinder block M10	42 - 48
Engine mounting foot to cylinder block M12	80 - 90
Housing flywheel to cylinder block	40 - 50
Flywheel to crankshaft	139 - 153
Ladderframe to cylinder block	22 - 28
Oil filter adaptor to cylinder block	40 - 50
Oil pressure switch	15 - 19
Oil pump cover to pump body	20 - 28
Oil pump relief valve plug	27 - 33
Oil pump to cylinder block	22 - 28
Oil pump strainer to oil pump	40 - 50
Oil squirt jet assembly to cylinder block	14 - 20
Oil strainer to mounting bracket	22 - 28
Plug - blanking oil gallery	32 - 42
Plug - drain oil sump	40 - 50
Plug - drain cylinder block	25
Plug - drain flywheel housing	10 - 14
Plug - inlet manifold (boost take-off)	23 - 27
Side cover to cylinder block	23 - 30
Starter motor to flywheel housing	40 - 50
Sump to ladderframe	22 - 28
Sump to ladderframe/cylinder block	22 - 28
Sump to cylinder block/front cover	20 - 24
Brackets - exhaust manifold to cylinder block	22 - 28

TORQUE WRENCH SETTINGS (continued)	Nm
Vacuum pump to cylinder block	22 - 28
Vertical drive shaft gear to cylinder block	22 - 28
Alternator and heat shield to mounting bracket	22 - 28
Adjusting link to alternator	22 - 28
Adjusting link to pas pump plate	22 - 28
Cylinder head to cylinder block	See page 44
Breather cyclone to rocker cover	7 - 10
Engine lifting bracket to cylinder head	22 - 28
Electrical harness clip to cylinder head	22 - 28
Exhaust manifold to cylinder head	20 - 26
Glow plug terminal nut	3 - 5
Glow plug to cylinder head	15 - 30
Heater stud (water) to cylinder head	15 - 30
Injector clamp stud to cylinder head	6 - 10
Injector clamp to injector nut	18 - 22
Inlet manifold to cylinder head	20 - 26
Rocker cover to cylinder head	3,5 - 4,5
Rocker shaft to cylinder head	28 - 32
Tappet adjusting nut	22 - 26
Thermostat housing to cylinder head	22 - 28
Water outlet to thermostat housing	7 - 10
Water temperature switch to thermostat housing	15 - 19
Cowl mounting bracket to front cover	22 - 28
Fan assembly to water pump hub	22 - 28
Front cover plate to cylinder block	22 - 28
Front cover plate to front cover	22 - 28
Front cover to cylinder block	22 - 28
Injector pump to front cover	22 - 28
Injector pump stud to front cover	6 - 10
Injector pump to support bracket	22 - 28
Tensioner (timing belt) to cylinder block	40 - 50
Timing pulley to camshaft	40 - 50
Timing pulley to injector pump hub	22 - 28
TV damper pulley to crankshaft	333 - 350
Water pump to cylinder block	23 - 30
Water pump to cylinder block - stud	23 - 30
Water pump to front cover	22 - 28
Oil drain adaptor to cylinder block - Turbo	22 - 28
Oil drain pipe to turbo	32 - 48
Oil feed pipe adaptor to cylinder block - Turbo	22 - 28
Oil feed pipe to turbo	15 - 22
Outlet elbow to turbo - nut	21 - 26
Outlet elbow to turbo - stud	22 - 28
Turbocharger to exhaust manifold	21 - 26
Belt tensioner assembly to front cover plate compressor	14 - 16
Compressor to mounting bracket	40 - 50
Compressor mounting bracket to front cover and plate	40 - 50
Banjo bolt - fuel pump	10 - 14
Banjo bolt - boost pipe	8 - 12
Banjo bolt - spill rail	20 - 30
Banjo bolt - fuel filter	14 - 20
Banjo bolt - injector spill rail	2
Fuel lift pump to fuel filler unions	10 - 14
Fuel lift pump to cylinder block	22 - 28
Injector pipes to injectors and injector pump	22 - 25
P.A.S. pump to mounting plate	14 - 16
P.A.S. pump mounting plate to front cover	
P.A.S. pump pulley to hub	14 - 16
Tappet guide retaining screw	13 -15

DISMANTLE

Remove the engine from the vehicle and clean the exterior. 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.

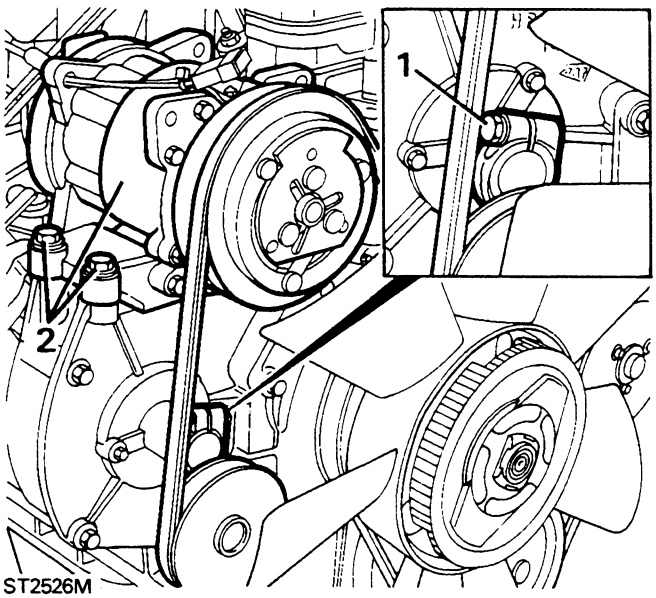
WARNING: Where the use of an engine stand is recommended, it is absolutely essential to follow the stand manufacturers instructions to ensure safe and effective use of the equipment.

Remove ancilliary equipment

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.

Air conditioning compressor - where fitted

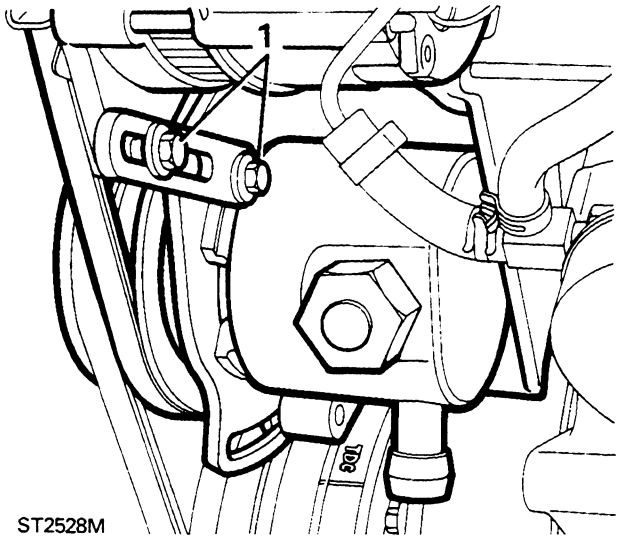
1. Release the drive belt tensioner pinch bolt and slip the belt from the pulleys and remove the tensioner. It will be noted that at this stage the belt cannot be removed from the engine until the water pump and power steering pump belt is removed.
2. Remove the four bolts, two each side of the compressor, and lift the compressor, complete with its mounting bracket from the engine.



ST2526M

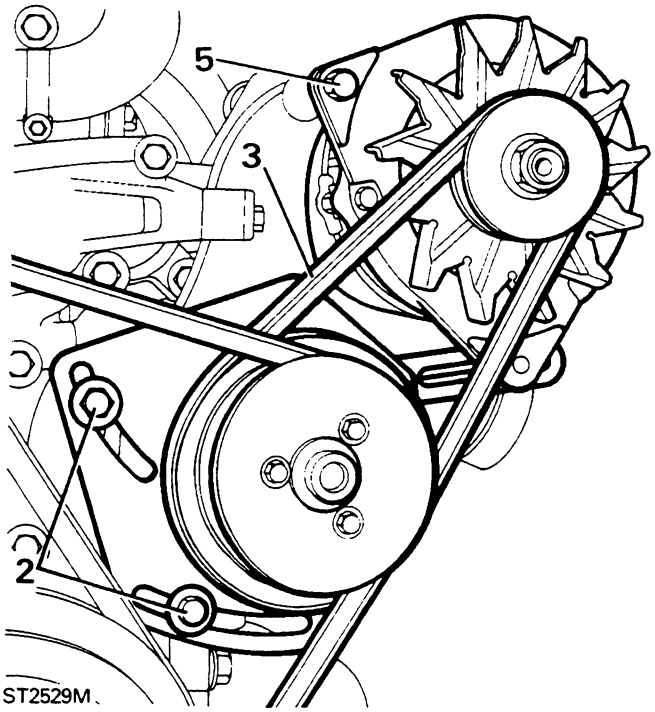
Power steering pump and alternator

1. Note that the power steering pump and alternator share a common bracket. Since the alternator adjustment link is attached to the power steering pump bracket it is easier to slacken the link pivot bolt and remove the clamp bolt from the alternator.



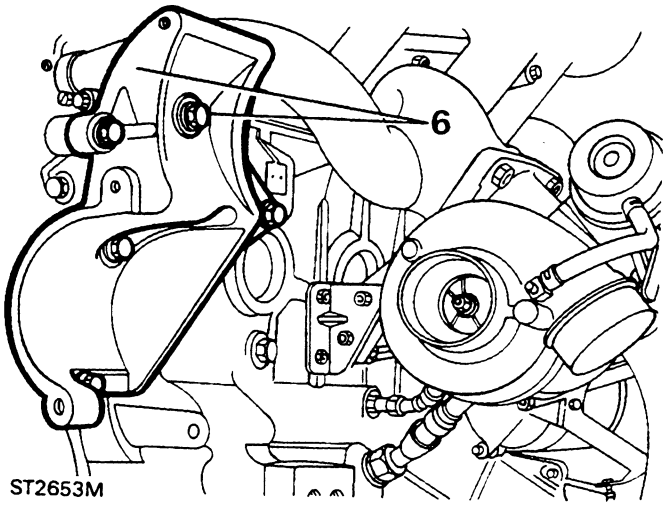
ST2528M

2. Slacken and remove the two steering pump adjustment bolts.
3. Slacken the pump pivot bolt to enable the water pump and power steering pump drive belts to be removed.



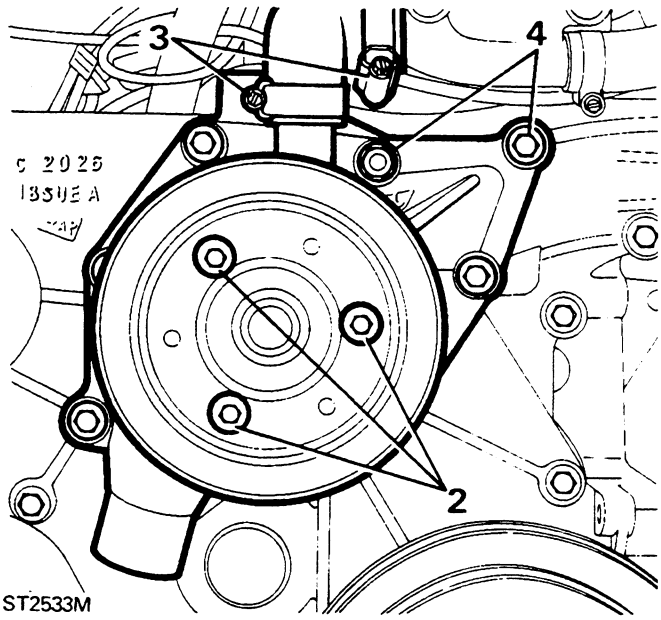
ST2529M

4. Finally remove the pivot bolt and two adjustment bolts and remove the pump from the common bracket.
5. Disconnect the electrical leads and remove the alternator pivot bolt. Since the adjustment link has already been disconnected, the alternator can now be removed from the common bracket.
6. Remove the five bolts to release the bracket from the cylinder block.



Water pump

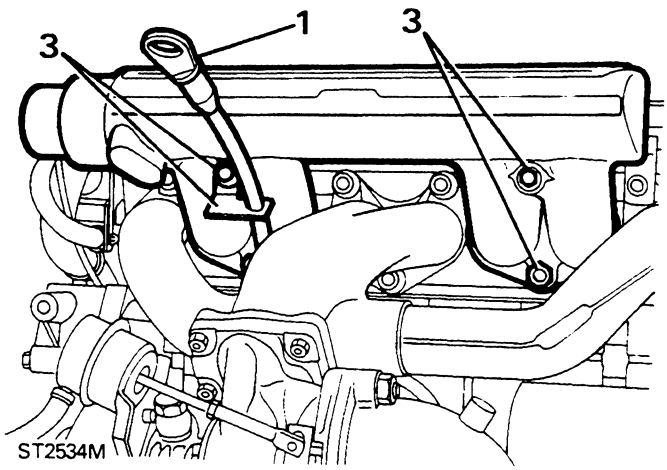
1. Using a cranked open-ended spanner, remove the viscous coupling complete with the fan, from the water pump spindle, noting that it has a left-handed thread.
2. Remove the three screws, to release the pulley from the water pump hub.

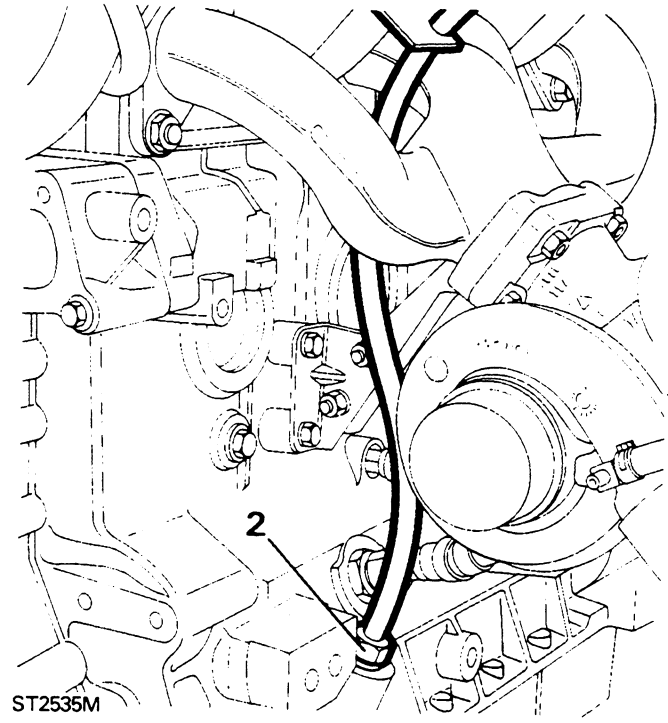


3. Release the two Jubilee clips and remove the bypass hose from the water pump and thermostat housing.
4. Evenly release and remove the seven bolts and one nut to remove the water pump from the front cover plate.

Air intake manifold

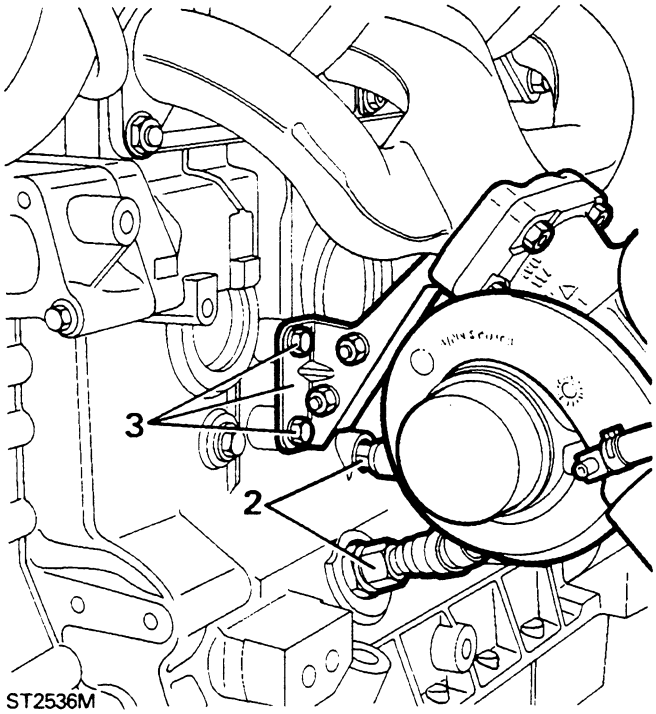
1. Remove the dipstick from the tube.
2. Release the dipstick tube union nut from the cylinder block.
3. Remove the two bolts and two nuts and release the air inlet manifold from the cylinder head together with the dipstick tube and bracket. On later engines the dipstick bracket is attached by two bolts.





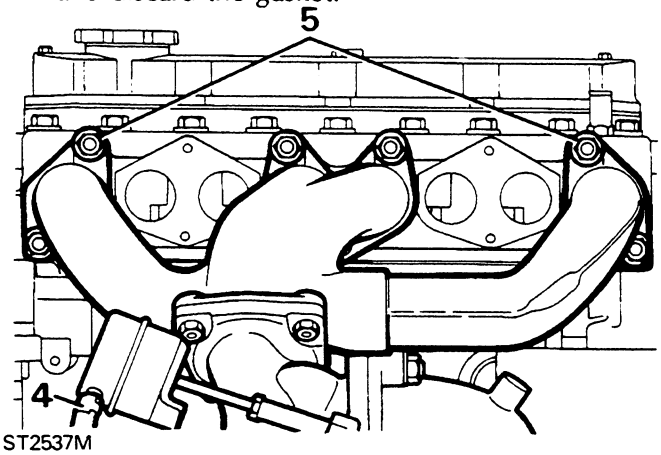
Exhaust manifold and turbo charger

1. Disconnect the heater hose from the thermostat housing and remove the two nuts securing the heater rail to the exhaust manifold studs and remove the rail.
2. Disconnect, from the cylinder block, the turbo charger lubrication inlet and return hoses.
3. Remove the two bolts securing the exhaust manifold lower support bracket to cylinder block.
4. Disconnect the turbo charger boost pipe from the actuator.



ST2536M

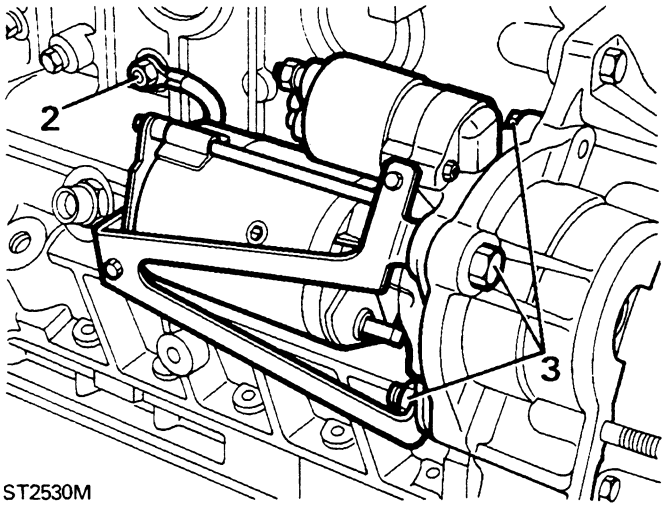
5. Evenly slacken and remove the seven nuts and washers retaining the exhaust manifold to the cylinder head. The manifold complete with turbo charger can now be withdrawn. Remove and discard the gasket.



ST2537M

Starter motor

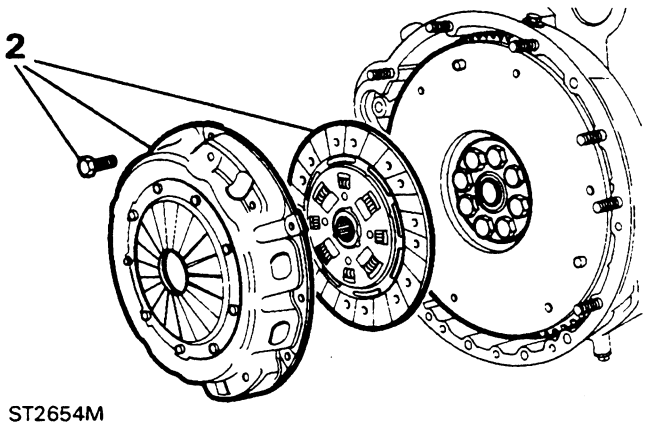
1. Remove the starter motor heat shield.
2. Disconnect the starter motor earth lead from the cylinder block.
3. Remove the two bolts and one nut and withdraw the starter motor complete with its bracket.



ST2530M

Clutch assembly

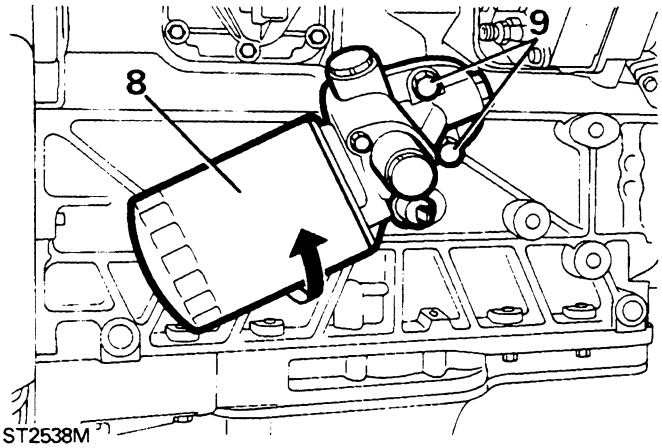
1. If, after inspection, the same clutch cover and flywheel are to be refitted, mark the relationship of the cover to the flywheel.
2. Evenly slacken and remove the six clutch retaining bolts and washers and release the clutch cover from the flywheel locating dowels together with the centre plate.



ST2654M

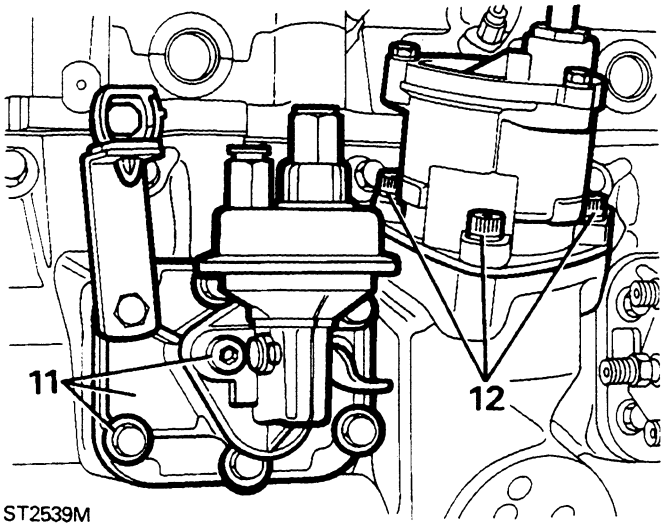
Dismantling left hand side of engine

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



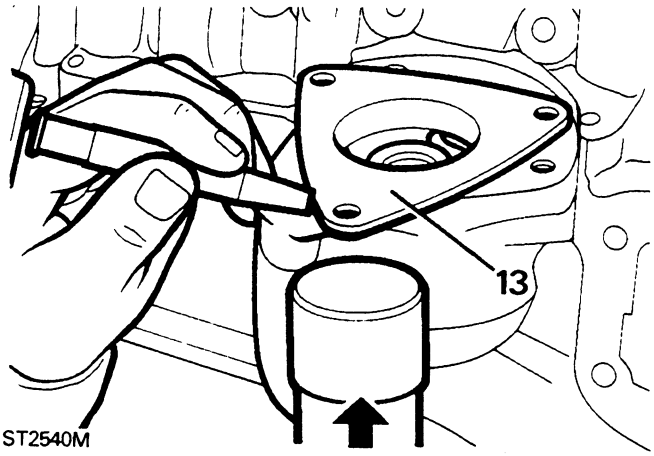
ST2538M

10. Remove the single bolt and pull the engine breather canister fom the rocker cover. Also release the breather hose from the sump connection and remove from the engine.
11. If the fuel lift pump is suspected of being faulty it can be removed from the rear cover by releasing the two retaining screws using a 6 mm Allen key. Alternatively, it can be removed still attached to the rear cover, by removing the six bolts.
12. Mark the position of the brake servo vacuum pump with relation to the cylinder block. Using a 6 mm Allen key remove the three screws and lift out the pump.

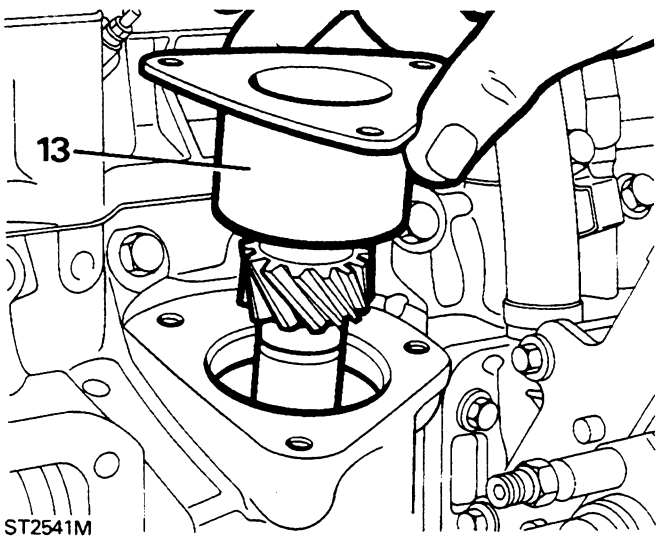


ST2539M

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



ST2540M

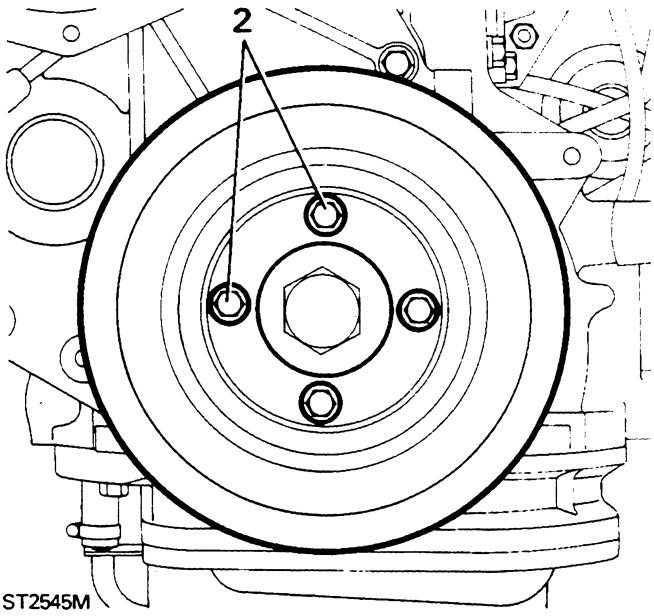


ST2541M

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

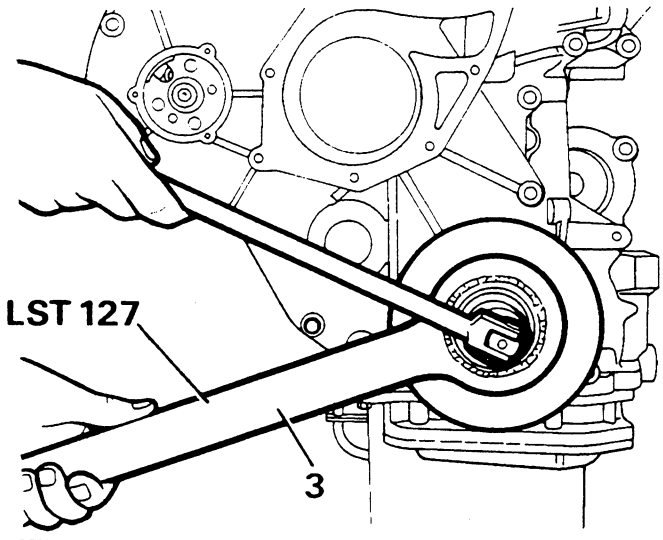
Checking injection pump timing

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



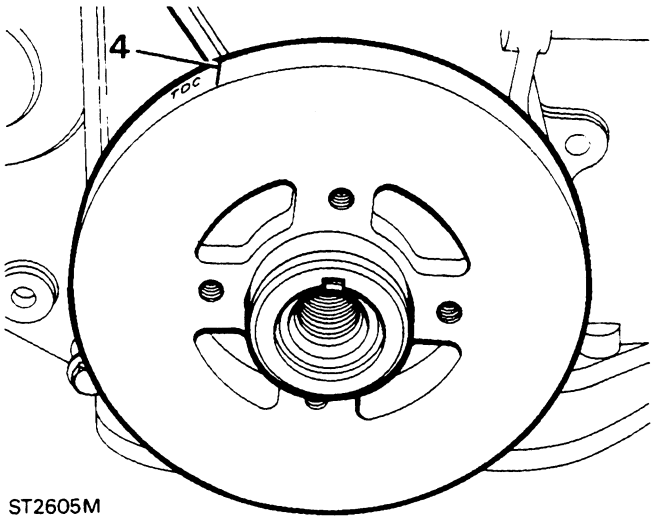
ST2545M

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



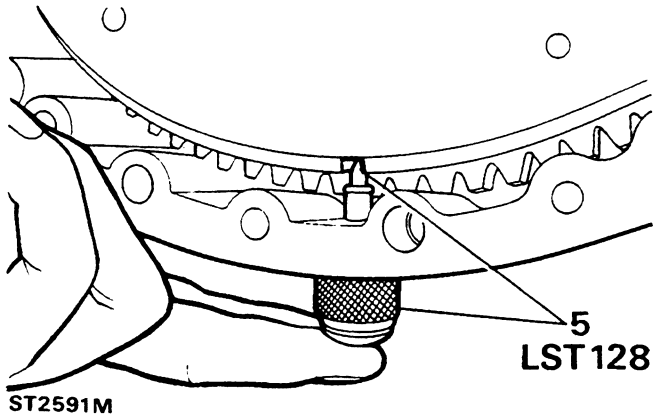
ST2546M

4. Use the restraining tool to turn the crankshaft in a clockwise direction to T.D.C. so that the mark on the damper is in line with the cover plate web as illustrated. The valves of number one cylinder should be closed with number four cylinder valves on the "rock". If the crankshaft is inadvertently turned beyond T.D.C. do not turn it back but continue on round until the above conditions are achieved.



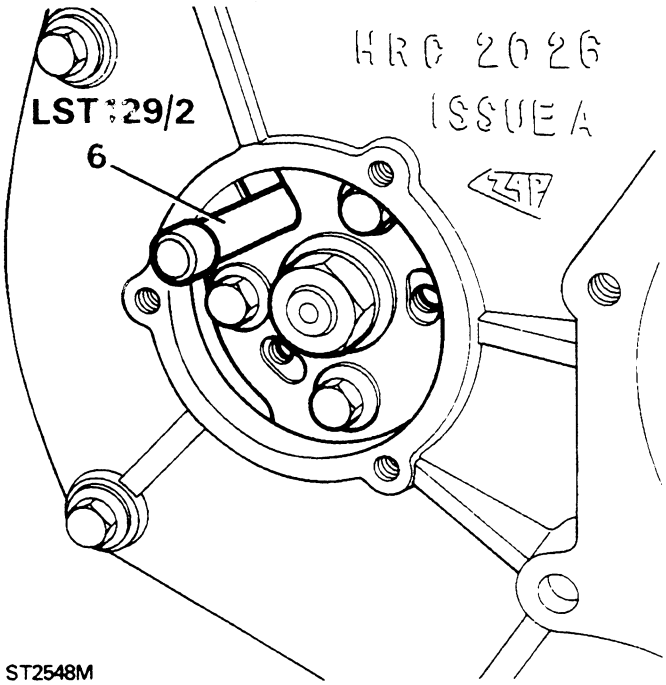
ST2605M

5. Now screw the body of the timing pin tool LST128 into the flywheel housing and check that the pin can be inserted into 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 T.D.C. for this direct injection engine and it is therefore important that the correct slot is used.

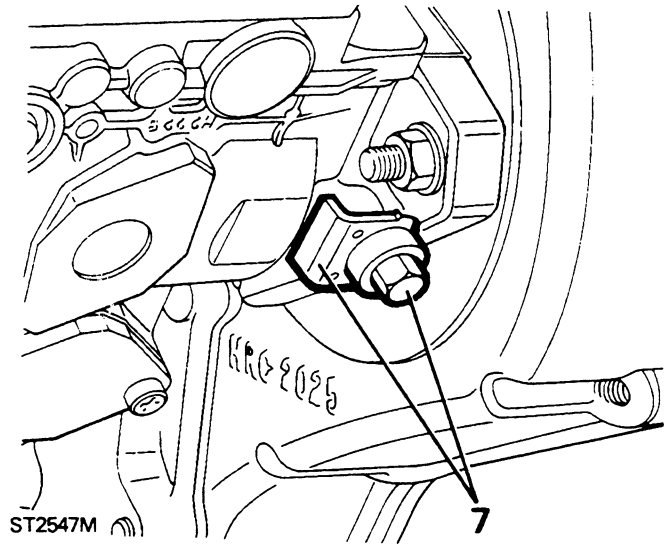


ST2591M

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



7. 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.

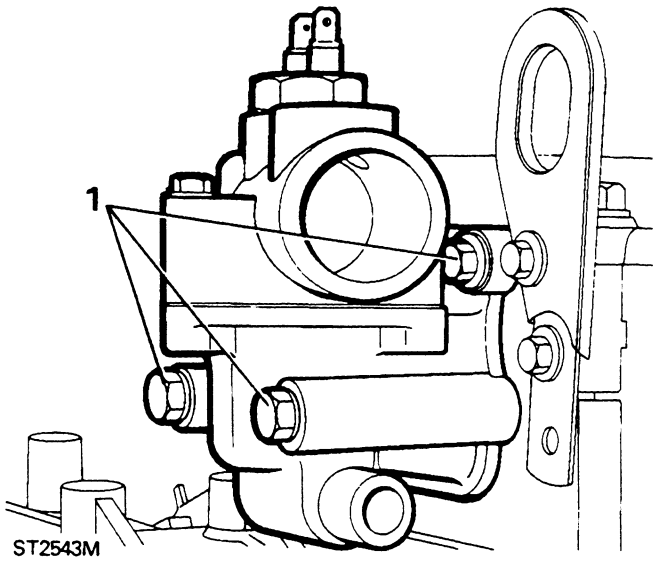


CAUTION: It is important to ensure that once the injection pump has been locked no attempt must be made to rotate it. Therefore take care not to allow the crankshaft to be turned until the pump has been removed.

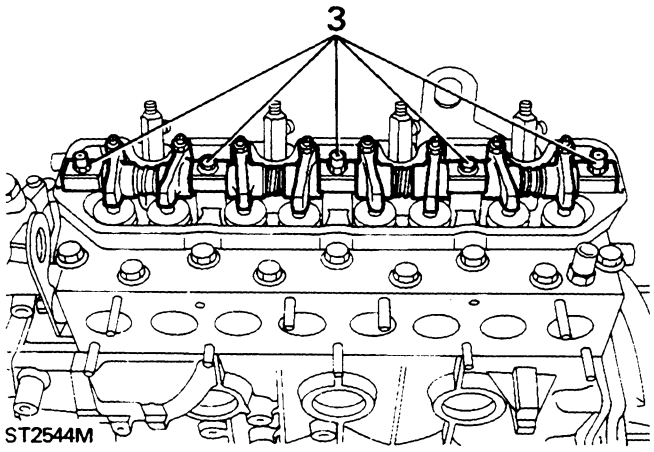
8. Before dismantling the timing components, the cylinder head should be removed to avoid the possibility of damage being caused to the valves and pistons should the camshaft be inadvertently turned once the timing belt has been removed.

Remove cylinder head

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



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



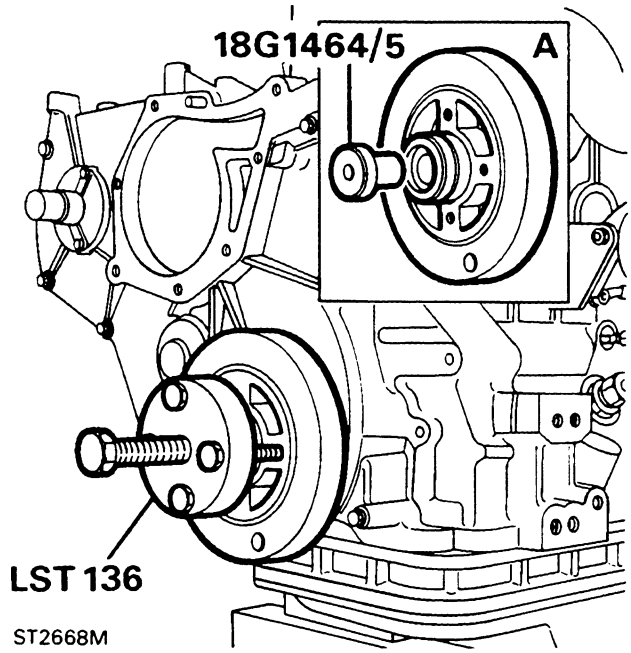
3. Having removed the rocker shaft, lift-out the push rods and insert them through holes in a piece of card marked from 1 to 8 to ensure assembly to their original locations.

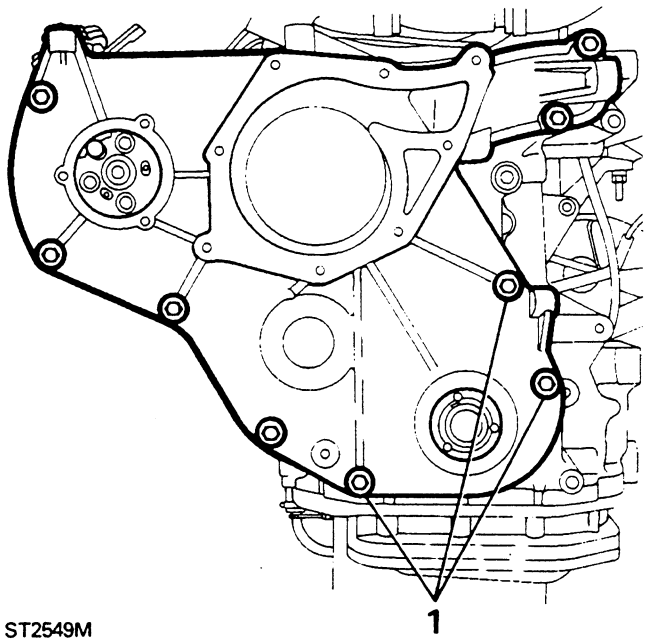
   CAUTION: Since the injectors and heater plugs protrude below the combustion face of the cylinder head, it is important that they are removed before removing the cylinder head to avoid the possibility of damage to the injectors, heater plugs and pistons.

4. Remove the valve stem caps.
5. Mark each injector with the number of the cylinder to which it is fitted. Remove the injector clamp nut and carefully remove the injectors 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.
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.

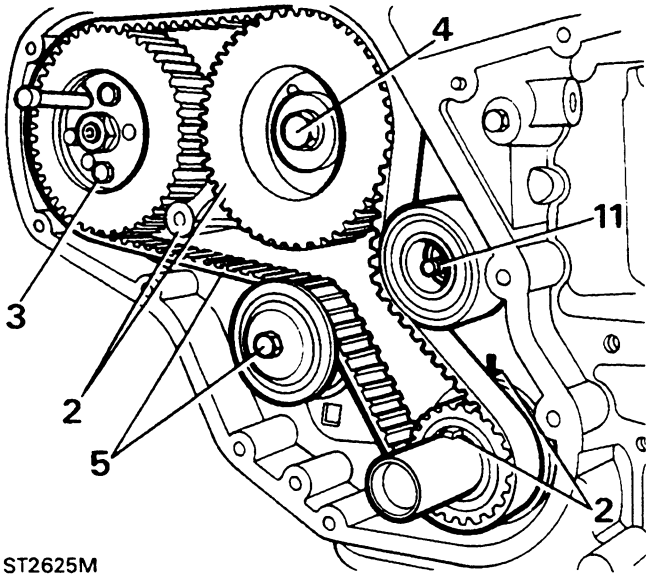
Remove timing gear and injection pump

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



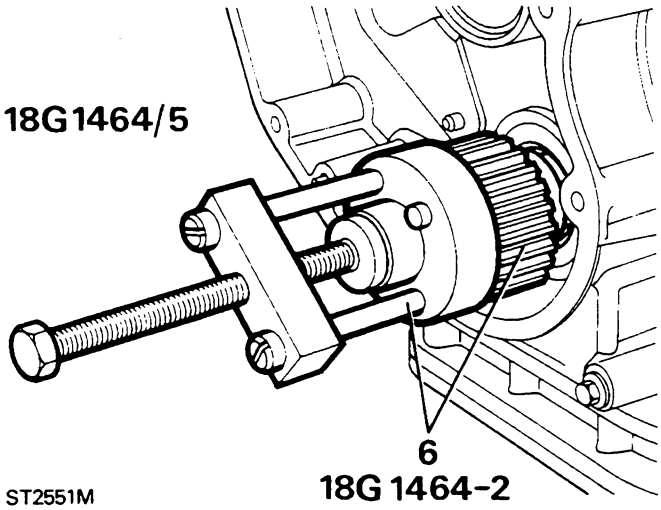


2. Check that the timing marks inside the front cover line-up with the gear wheels, ie. the arrow on the front cover aligns with the crankshaft key and the dot on the camshaft gear aligns with the front cover web.
3. Slacken the three screws securing the pump timing gear to the pump hub.
4. Temporarily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



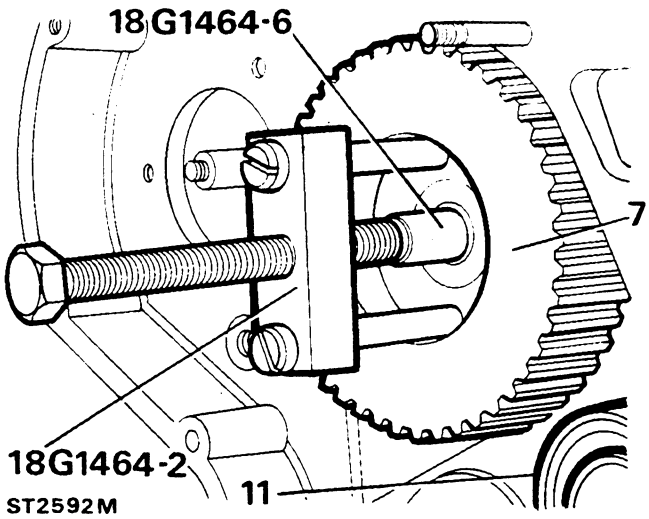
ST2625M

6. If the crankshaft gear wheel connot be removed by hand, use special service tool 18G1462-2 and pressure button 18G1464-5. Assemble the tool as illustrated and withdraw the gear wheel.



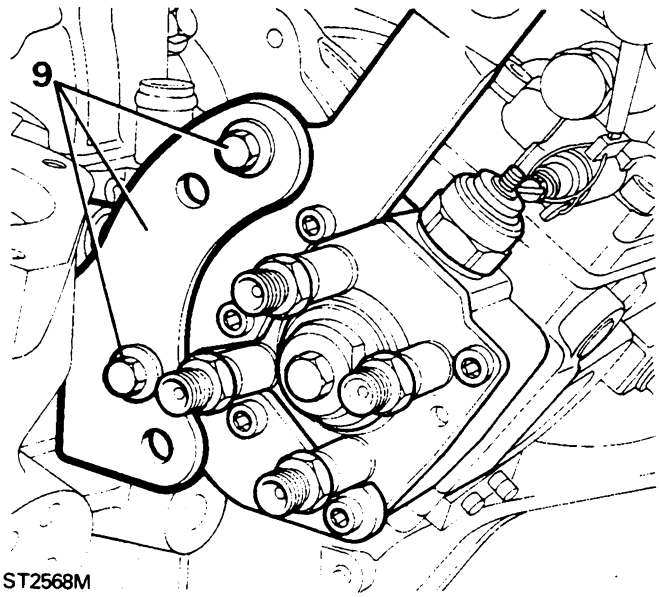
ST2551M

7. Remove the camshaft gear wheel reataining bolt assembly to enable the gear to be removed. Use special service tool 18G1462-2 and button 18G1464-4. Assemble as shown and withdraw the gear.



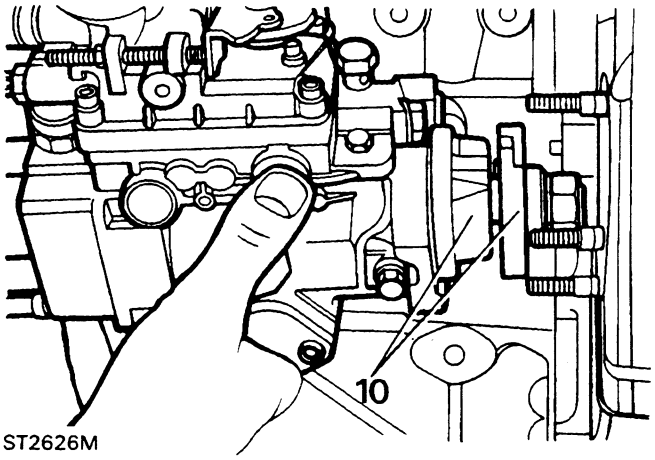
ST2592M

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



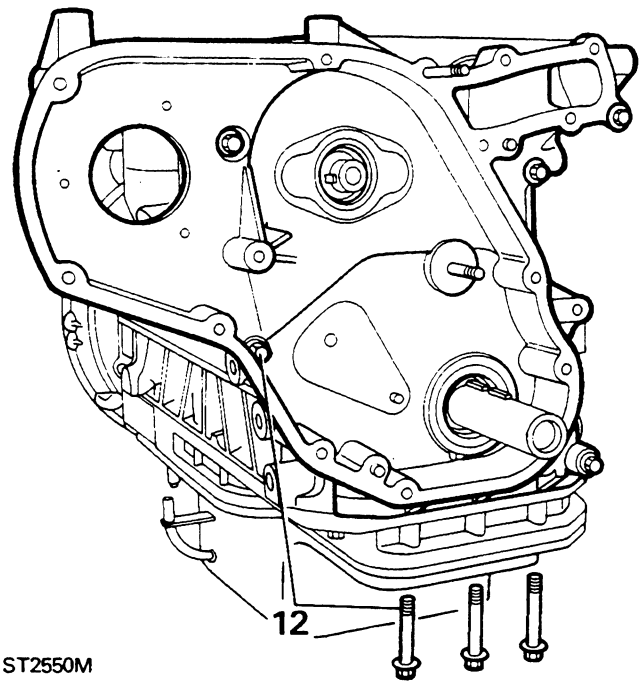
ST2568M

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



ST2626M

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

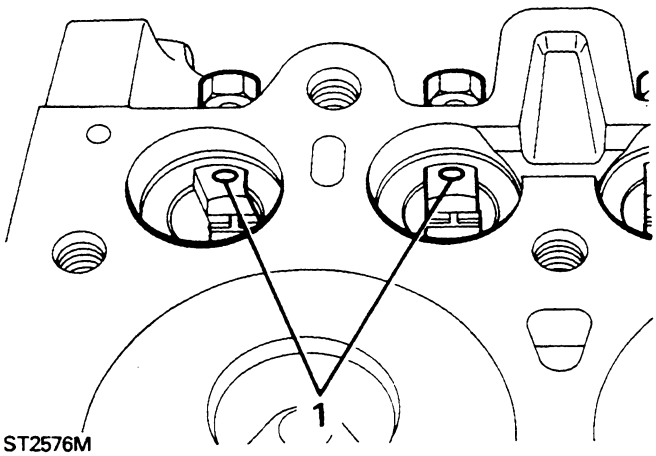


ST2550M

Removing camfollower assemblies

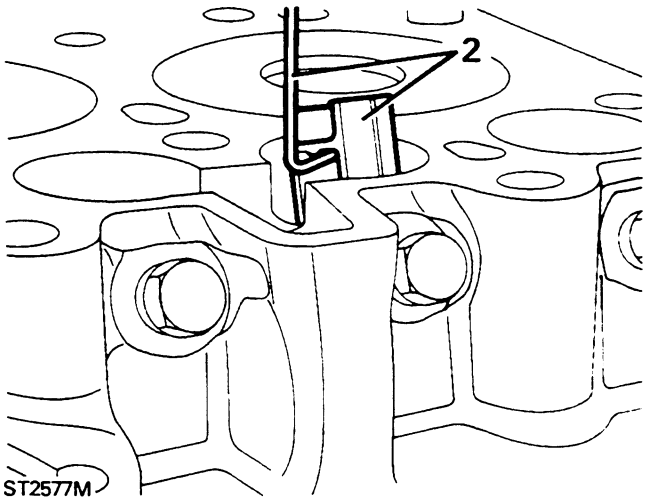
CAUTION: The camfollowers are solid rollers held in position against the cam by a slide inside a fixed guide. If the guide is removed before the roller, it is possible that the roller can fall behind the camshaft and become jammed. Furthermore the roller could slip past the cam and fall into the crankcase. 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.

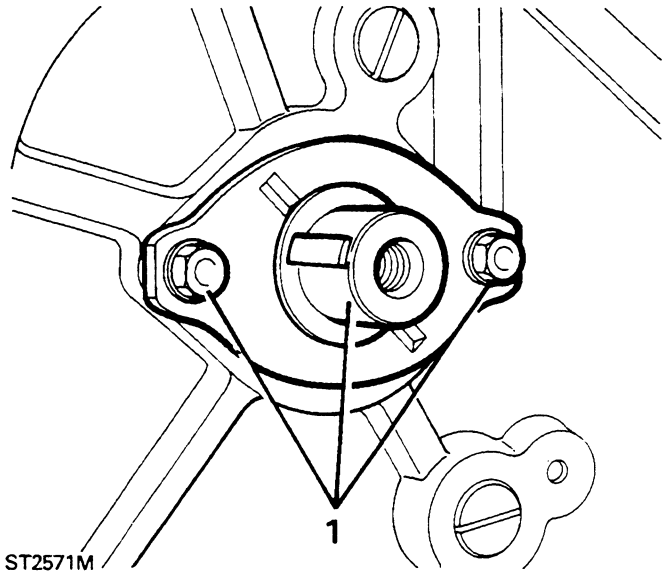


ST2577M

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

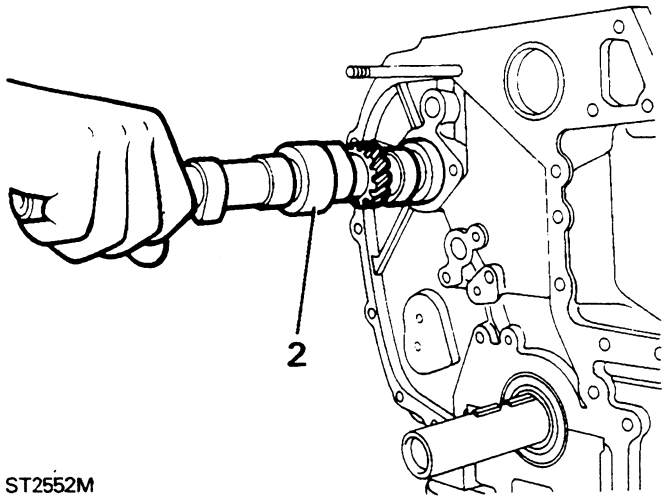
Removing the camshaft

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



ST2571M

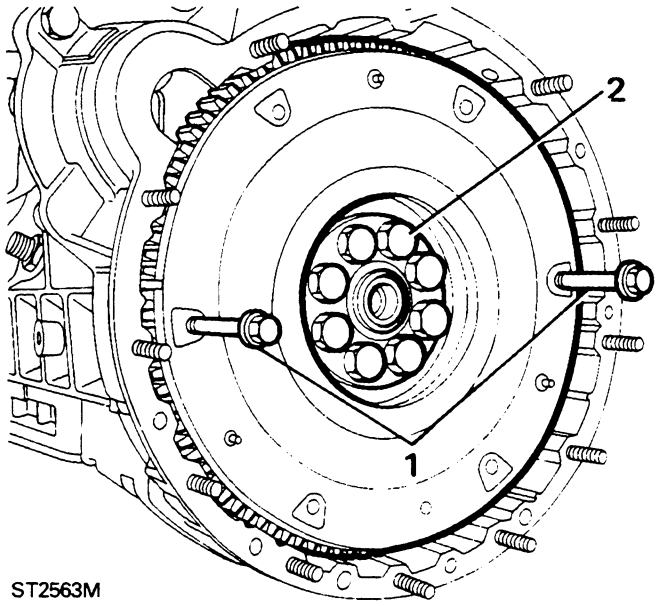
2. Carefully withdraw the camshaft taking care not to allow the end of the shaft to drop on to the bearings as it is removed.



ST2552M

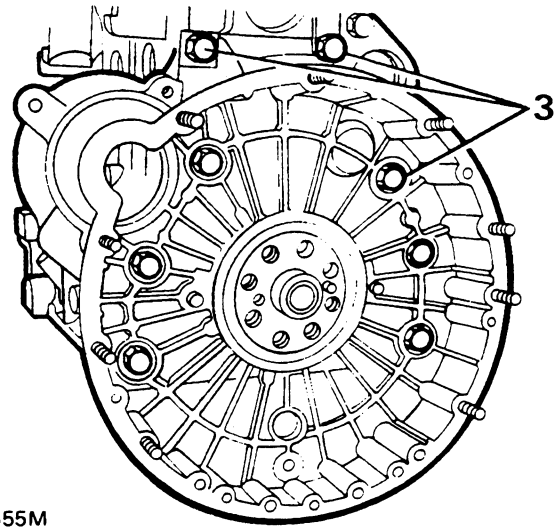
Remove flywheel and housing

1. In the interests of safety, fit two long 8 mm bolts into the clutch bolt holes, diametrically opposite, to use as handles for lifting the flywheel off the crankshaft.
2. Temporarily fit the crankshaft damper and use 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

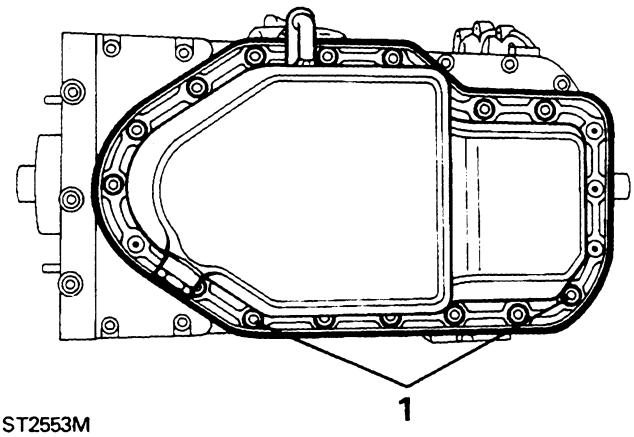
3. Remove the six internal and two external bolts and ease the flywheel housing from the two locating dowels and crankshaft. Remove and discard the rear main oil seal taking care not to damage the seal housing.



ST2655M

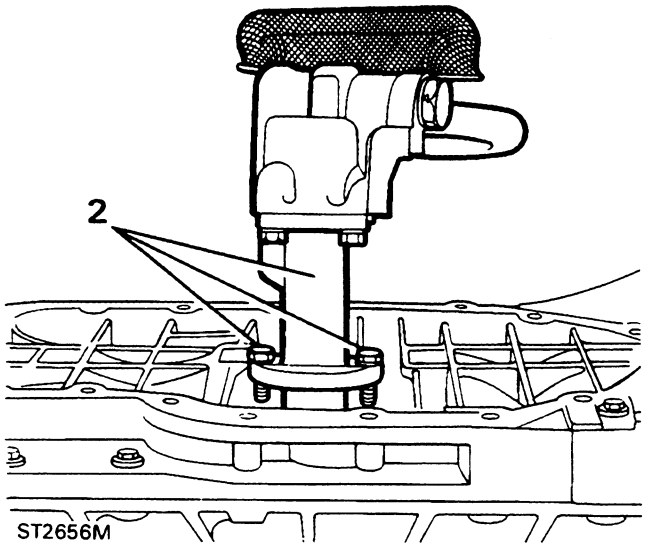
Removing sump, oil pump and ladder frame

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



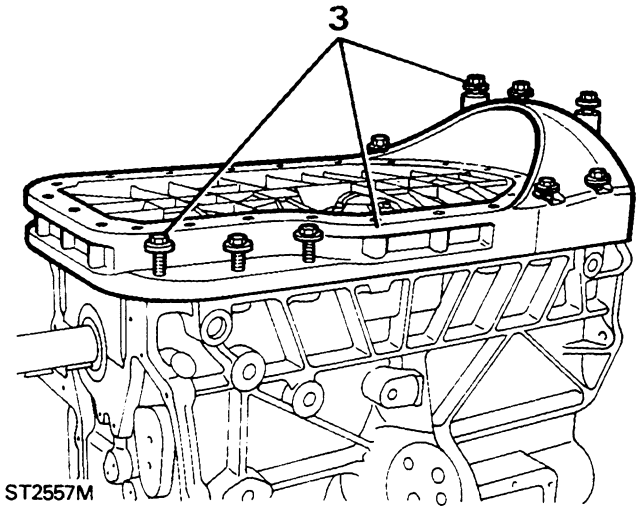
ST2553M

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



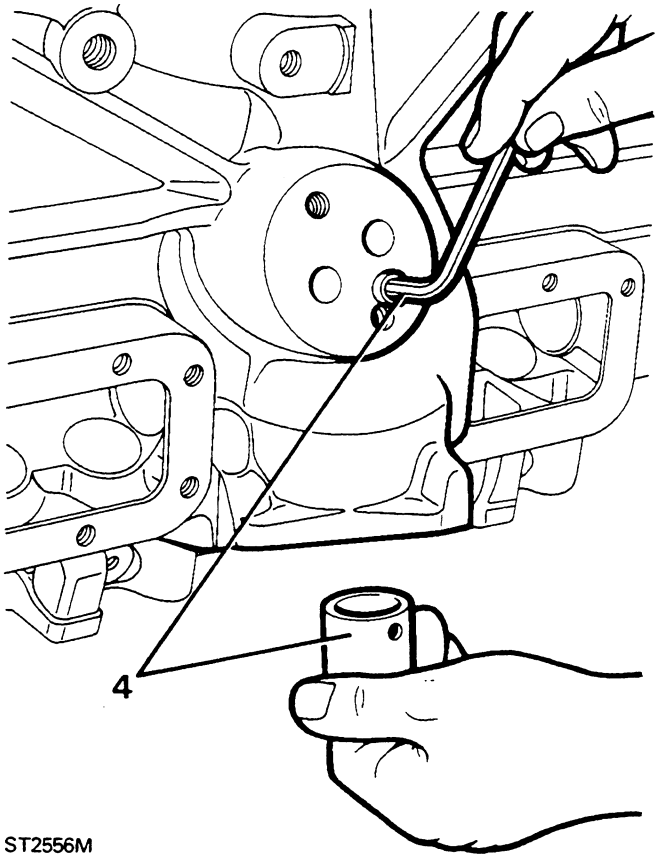
ST2656M

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



ST2557M

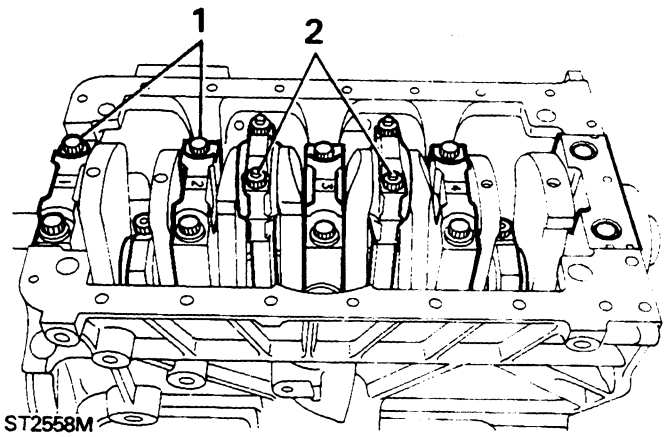
4. Using a 6 mm Allen key remove the socket headed screw retaining the skew gear bush and withdraw the bush.



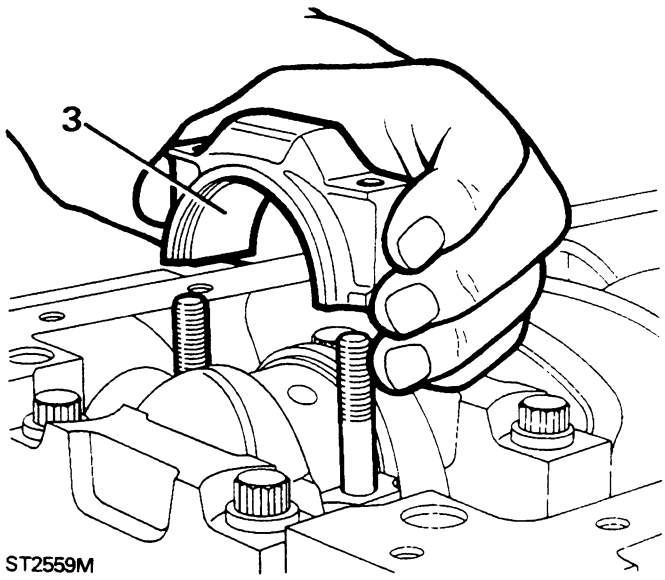
ST2556M

Removing crankshaft

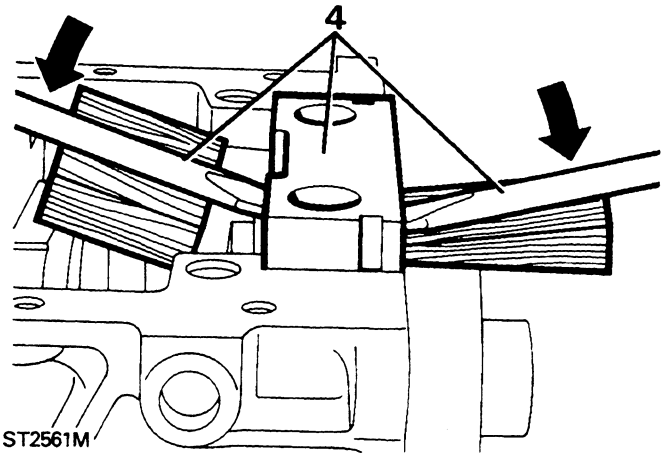
1. Slacken the ten main bearing bolts with a 14 mm socket.
2. Turn the crankshaft to bring all the connecting rod caps to an accessable position and slacken the nuts using a 15 mm socket.



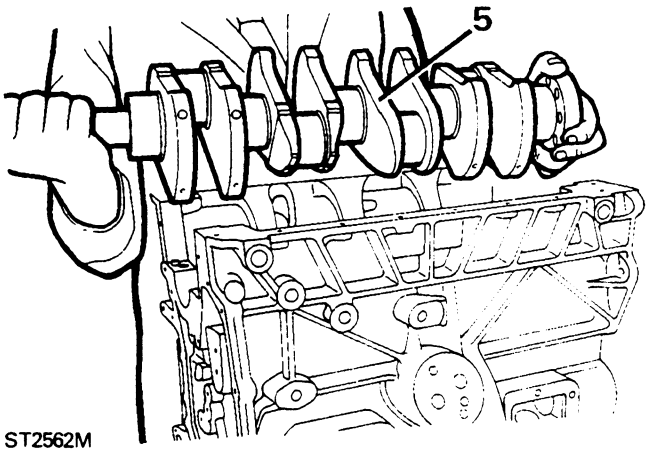
3. Remove the connecting rod nuts and remove the caps and lower bearing shells.



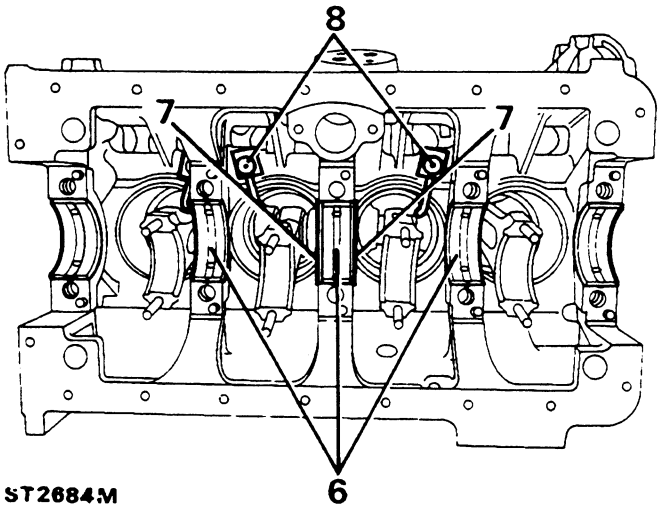
4. Since the rear main bearing cap is sealed with a "T" shaped neoprene seal each side of the main bearing cap and because these seats swell, in service, difficulty may be experienced removing the cap. A suggested method is to lever the cap from both sides, as illustrated. Insert a suitable bar in the hole in the inside face of the cap and lever against the crankshaft journal on the outside face. **Ensure that blocks of timber are used under the levers particularly to protect the crankshaft.**



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

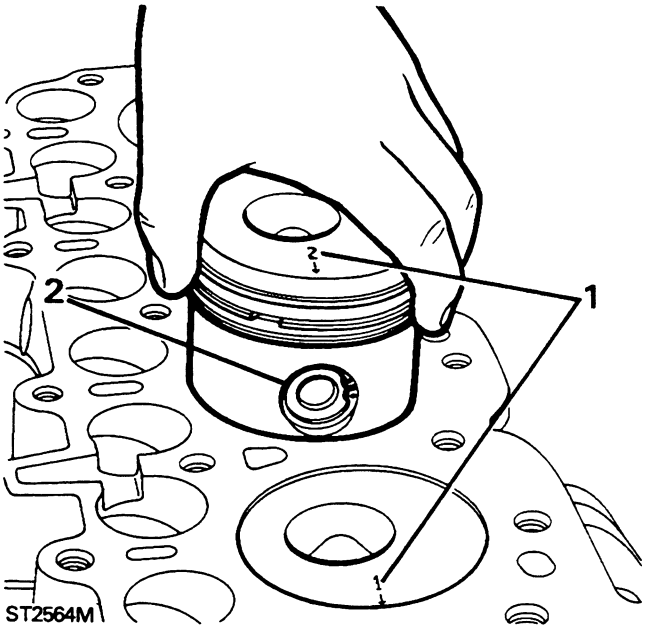


6. Remove the main bearing upper shells from the bearing saddles.
7. Remove the two thrust washers from each side of the centre saddle.
8. Remove the four jet tubes.



Removing pistons and connecting rods

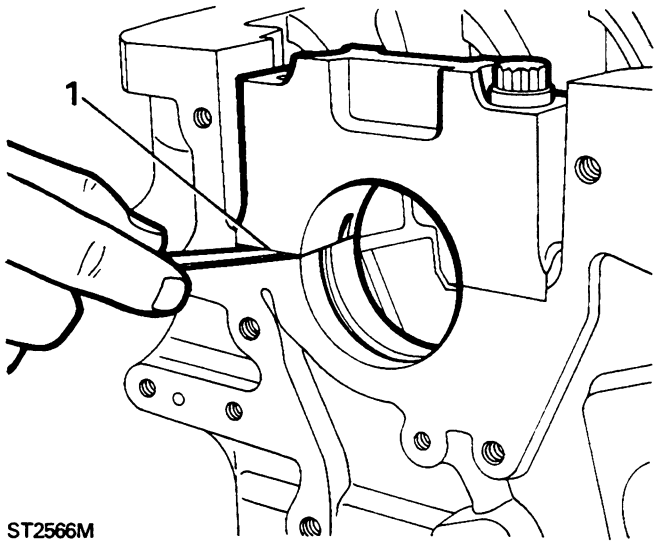
1. Before removing the piston assemblies, number each piston from one to four so that it can be identified with the bore from which it was removed.
2. Taking care not to damage the bores, push each connecting rod and piston, in turn, up the bore until it can be withdrawn from the cylinder block combustion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



OVERHAUL AND ASSEMBLE

CYLINDER BLOCK

1. Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage. To check the main bearing caps and saddles for distortion, fit the main bearing caps without bearing shells and tighten to the correct torque. Slacken and remove the bolt on one side of each bearing cap and check with a feeler gauge that no clearance exists at the joint face between the cap and saddle. A clearance indicates either a bent bolt, distortion of the caps, or block or that the cap has been filed or machined in an attempt to reduce the clearance due to wear in the bearings. Main bearing caps are not available separately from the cylinder block and if clearance exists the block must be renewed.



Inspect cylinder bores

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

3. Check the ovality of each bore by taking measurement at the top of the cylinder just below the ridge at two points diametrically opposite. The difference between the two figures is the ovality of the top of the bore. Similar measurements should be made approximately 50 mm (2.0 ins) up from the bottom of the bore so that the overall ovality may be determined.
4. The taper of each cylinder is determined by taking measurements at the top and bottom of each bore at right angles to the gudgeon pin line, The difference between the two measurements is the taper.
5. To establish maximum overall bore wear, take measurements at as many points as possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared with the original diameter of the cylinder bore.

Maximum permissible ovality
- 0,127 mm (0.005 in).
Maximum permissible taper
- 0,254 mm (0.010 in).
Maximum permissible overall wear
- 0,177 mm (0.007 in).

If the above figures are exceeded the cylinders may be rebored, 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 rings. It is vital to thoroughly wash the bores afterwards to remove all traces of abrasive material.

Inspect camshaft bearings

6. Measure the internal diameter of each camshaft bearing at several points using an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The bearings should be renewed if the clearance exceeds 0,0508 mm (0.002 in). Or, in any event, if they are scored or pitted. This work should only be entrusted to line boring specialists.

Check crankcase main bearings

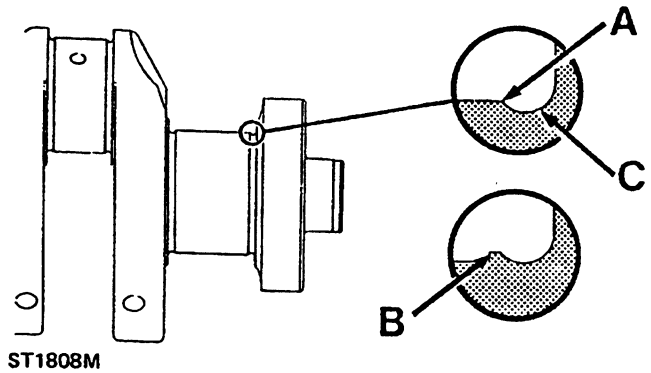
7. Discard scored, pitted, cracked and worn bearing shells.
8. To determine the maximum wear, assemble the main bearing shells and caps to the crankcase and tighten the bolts to the correct torque figure.
9. Using an inside micrometer, measure each bearing at several points and note the greatest figure.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

CRANKSHAFT

1. Degrease the crankshaft and clear out the oil ways which can become clogged after long service. Examine visually, the crankpins and main bearing journals for obvious wear, scores, grooves and overheating. A decision at this stage should be made as to whether the condition of the shaft is worth continuing with a more detailed examination.
2. With a micrometer, measure and note the ovality and taper of each main bearing journal and crankpin as follows.
3. **Ovality** - Take two readings at right angles to each other at various intervals.
   The maximum ovality must not exceed 0,040 mm (0.0015 in).
4. **Taper** - Take two readings parallel to each other at both ends of the main bearing journal and crankpin.
   The maximum permissible taper must not exceed 0,025 mm (0.001 in).

5. To check for straightness, support the front and rear main bearing journals in 'V' blocks and postion a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0,076 mm (0.003 in) taking into account any ovality in the centre journal.
   The overall wear limit should not exceed 0,114 mm (0.0045 in) for main bearing journals and 0,088 mm (0.0035 in) for crankpins.
6. A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground to 0,25 mm (0.010 in) under size.

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'.

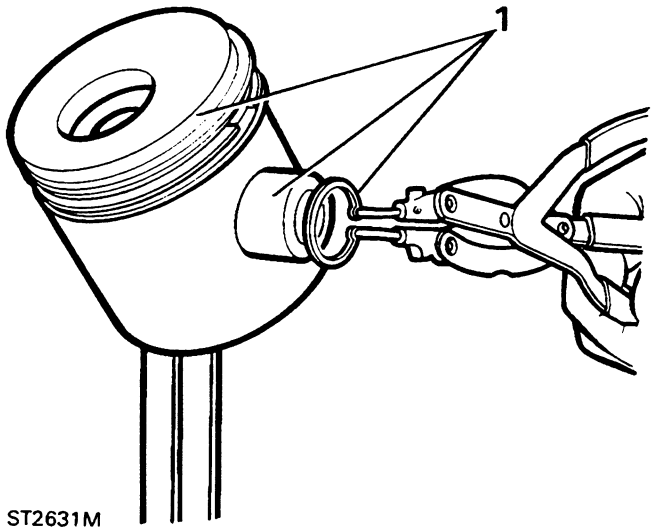


ST1808M

PISTONS AND CONNECTING RODS

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

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



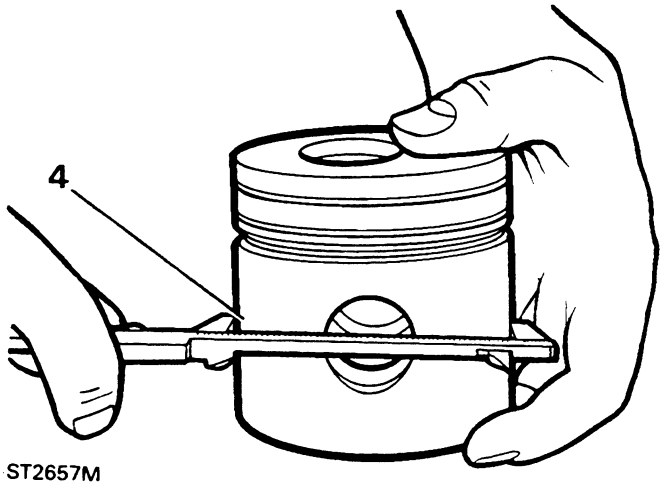
ST2631M

2. **Original pistons** - Decarbonise and degrease all components and carry out a visual examination of the piston and rings and discard any which are unserviceable. Pistons which appear serviceable should be subjected to a more detailed examination described under 'New pistons'.
3. **New pistons** - Original pistons fitted to new engines at the factory are specially graded to facilitate assembly. The grade letter on the piston crown should be ignored when ordering new pistons. Genuine Land Rover service standard size pistons are supplied 0,025 mm (0.001 in) oversize to allow for production tolerance on new engines. When fitting new pistons to a standard size cylinder block the bores must be honed to accomodate the pistons with the correct clearances. In addition Land Rover pistons are available 0,50 and 1,01 mm (0.020 and 0.040 in) oversize for fitting to rebored cylinder blocks.

Clearance limits for new standard size pistons in a standard cylinder bore measured at right angles to the gudgeon pin are in the data section.

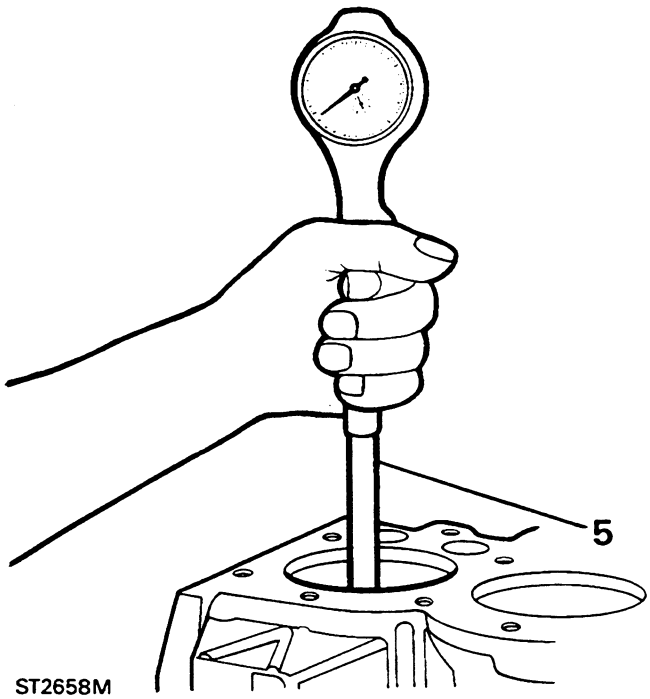
When taking the following measurements the cylinder block and pistons must be the same temperature to ensure accuracy.

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.
6. The clearance is determined by subtracting the piston diameter from the bore diameter.



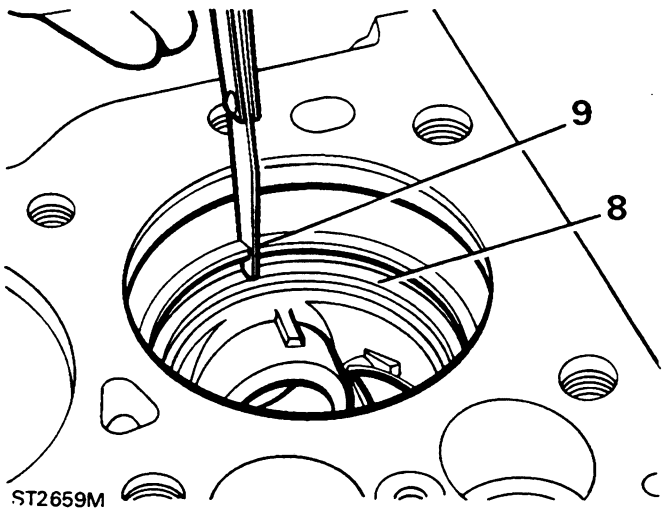
ST2658M

7. If gauge equipment is not available the clearance can be assessed by placing a long, suitably sized, feeler gauge down the thrust side of the bore and inserting the appropriate piston, 'upside down', in the bore and position it with the gudgeon pin parallel to the crankshaft axis. Push the piston down the bore and stop at the tightest point and whilst holding the piston still, slowly withdraw the feeler gauge. If a steady resistance of approximately 2,5 kg (6 lbs) is felt, the clearance is satisfactory.

Inspect piston rings

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

8. **Check gap** - When checking the ring gap in worn bores, which are within the acceptable taper and ovality limits, the ring must be inserted squarely into the bottom of the bore at the lowest point of the piston travel. To ensure squareness of the ring push the ring down into the bore to the correct position with a piston. With newly machined bores, the ring may be inserted squarely into any position in the bore.
9. Using an appropriate feeler gauge check the gaps of all the rings, in turn, including the oil control ring assembly.

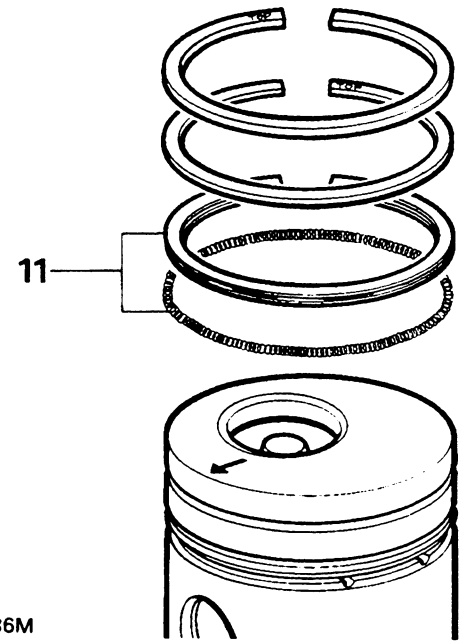


ST2659M

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

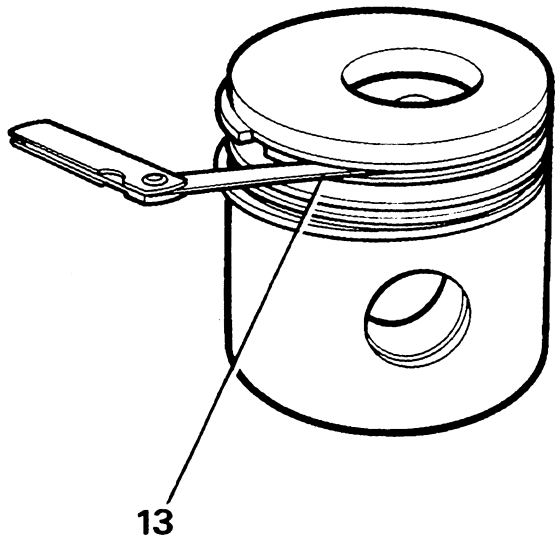
Check piston side ring clearance

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



ST2636M

13. Using an appropriate feeler gauge check the clearance between the rings and piston grooves. Clearances in excess of the figures given in data section are unnaceptable and the rings or the pistons should be renewed.



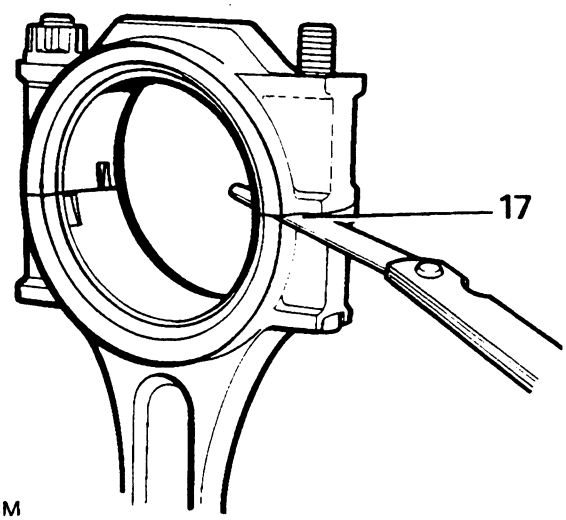
ST2632M

Inspect gudgeon rings

14. Check the gudgeon pins for wear, cracks, scores and overheating.
15. The gudgeon pin fit into the piston must be tight push fit at a tempertaure of 20°C (68°F). Check the gudgeon pin for ovality and taper using a micrometer.

Connecting rod inspection

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



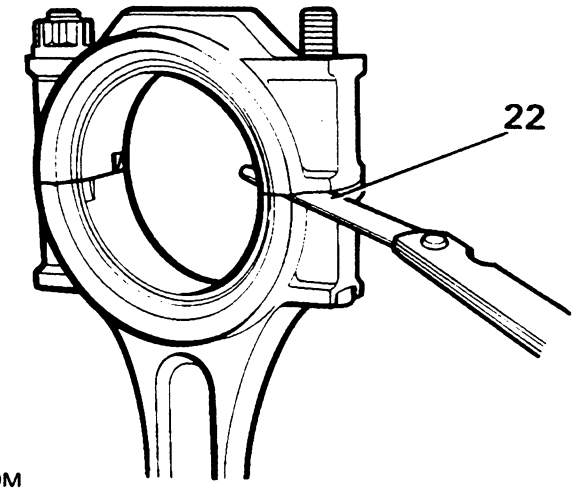
ST2633M

18. Use 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 (0.005 in).
19. Examine and check the small-end bush for wear. If necessary renew the bush. The correct clearance of the gudgeon pin in the small-end bush is given in the data section.
20. When renewing a bush ensure that the oil hole in the bush lines up with the hole in the connecting rod. Finish the bush to the correcty size and clearance.
21. Connecting rod bearings that are worn, pitted, scored and show signs of overheating must be discarded. If more than one of the bearings show these signs they must all be renewed. When fitting new or used bearings to serviceable crankpins the clearances must be checked.

Connecting rod bearing nip and clearance

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

22. Fit the bearing halves to the connecting rod and cap and secure the assembly to the correct torque. Slacken the nut on one side only and check the clearance between the joint faces with a feeler gauge.

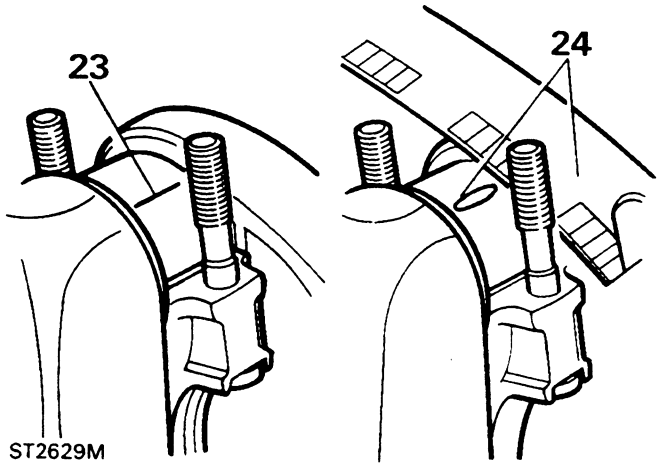


ST2630M

The clearance should be between 0,10 and 0,20 mm (0.004 and 0.008 in). The bearing nip can be adjusted by the selective assembly of the bearing shells which are available in slightly varying thicknesses. Do not file or machine the rods to vary the bearing nip.

Make a final check to prove the clearance by inserting a 0,063 (0.0025 in) shim paper between the crankpin and one half of the bearing and tightening to the correct torque. The connecting rod should resist rotation and move freely with the shim paper removed.
As an alternative, the bearing clearances can be determined by using 'Plastigauge' which consists of a thin piece of plastic material a few hundreds of a millimeter or thousands of an inch in diameter. When the material is flattened by being squeezed between the bearing and crankpin the width of the plastic is measured by a scale gauge which indicates clearance.

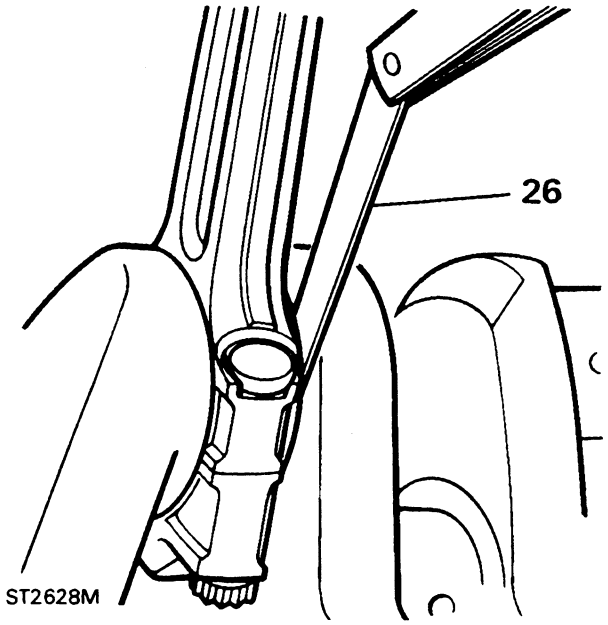
23. Wipe any oil from the crankpins and place a piece of 'Plastigauge' across the centre of the bearing in the connecting rod cap. Assemble the rod to the appropriate crankpin and tighten to the correct torque. Do not rotate the connecting rod or the crankshaft during this operation.
24. Remove the connecting rod cap and bearing shell and using the scale supplied measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds to the width of the 'Plastigauge' indicates the bearing clearance. The correct clearance with new or overhauled components is given in the data section.
25. Wipe of the 'Plastigauge' with an oily rag. Do not scrape it off otherwise it may damage the crankpins.



ST2629M

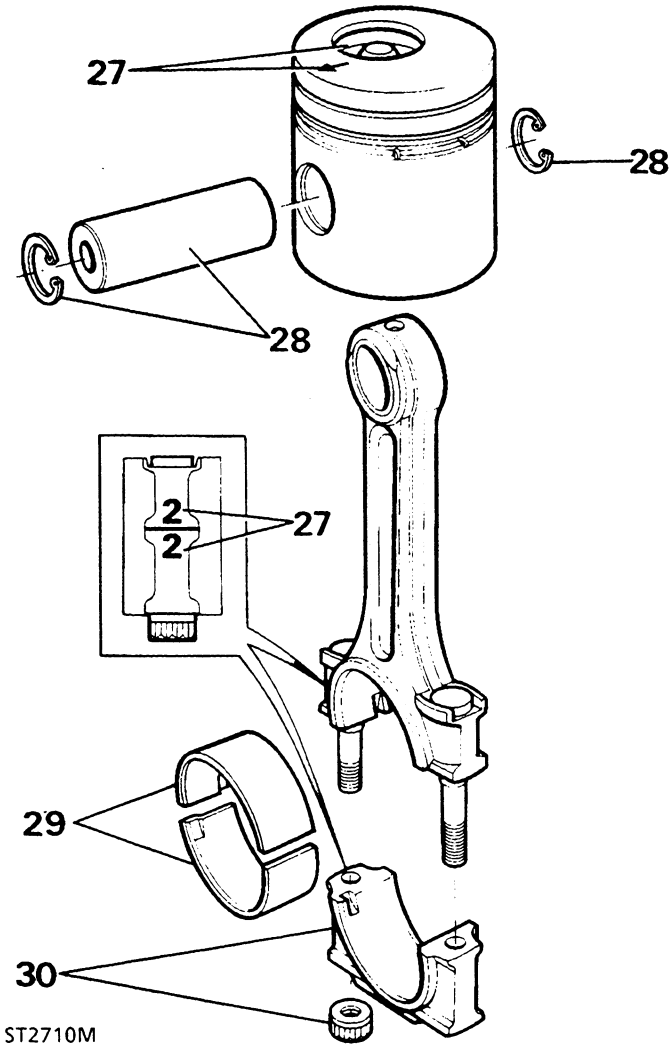
Connecting rod end-float

26. Fit the connecting rods complete with bearings to their respective crankpins. Move the connecting rod to one side and check the clearance, with a feeler, on the opposite side. The correct clearance is given in the data section.



Assembling pistons to connecting rods

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

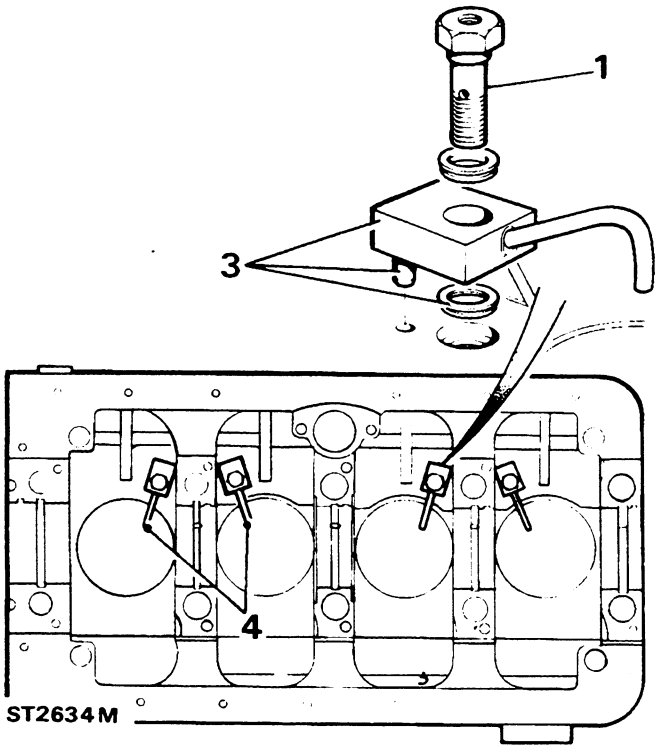


ASSEMBLE ENGINE

ASSEMBLE JET TUBES TO CYLINDER BLOCK

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

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



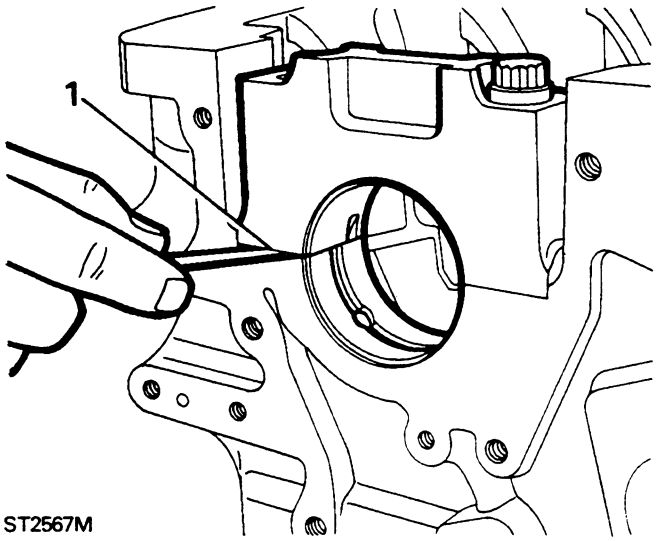
ST2634M

FIT CRANKSHAFT

Main bearing nip and clearance

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

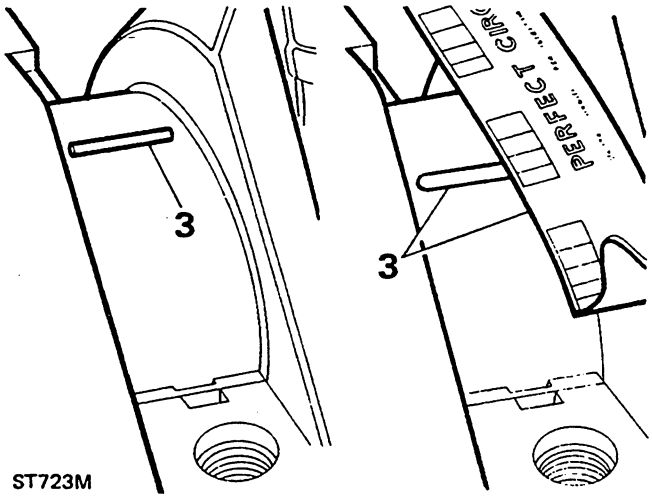
1. Fit the bearing halves in the crankcase saddles and caps and secure the caps to the crankcase and tighten to the correct torque. Slacken the bolts on one side of the caps only and, with a feeler gauge, check the gap between the joint faces. The clearance or nip must be within 0,10 to 0,15 mm (0.004 to 0.006 in). The bearing nip can be adjusted by selective assembly of the bearing halves available in varying thicknesses. Do not file or machine the caps or saddles to achieve the correct clearance. Note that the rear main bearings are wider than the remaining four.



ST2567M

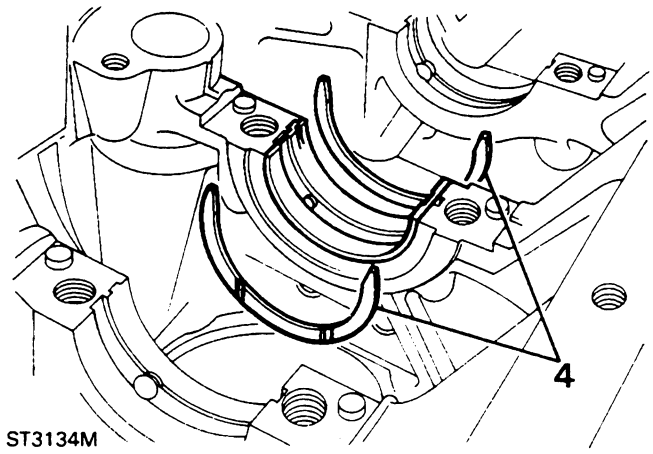
2. To make a final check that the clearance is correct, leave the bearing halves in the crankcase saddles and carefully lower the crankshaft into position. Check each bearing in turn by inserting a 0,063 mm (0.0025 in) shim paper between the bearing cap and crankshaft journal and tighten the bolts to the correct torque. If the clearance is correct, there should be a slight increase in the resistance to the rotation of the crankshaft.
   As an alternative 'Plastigauge' may be used to check the clearance in the same manner as with the connecting rod bearings. This material may also be used to determine the amount of wear in used bearings and journals.

3. Locate the crankshaft in position on the upper bearing halves in the crankcase and wipe any oil from the journals since 'Plastigauge' is soluble in oil. Place a piece of 'Plastigauge' across the lower half of each crankshaft journal or lower bearing cap shell. Fit the cap and tighten to the correct troque. Remove the cap and bearing and using the scale supplied with the 'Plastigauge' measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds with the width of the 'Plastigauge' indicates the bearing clearance.
   The correct clearance with new or overhauled components is included in the data section. If new bearings are being fitted use selective assembly to obtain the correct clearance. Wipe off, not scrape the 'Plastigauge' with an oily rag from the journals or bearings.

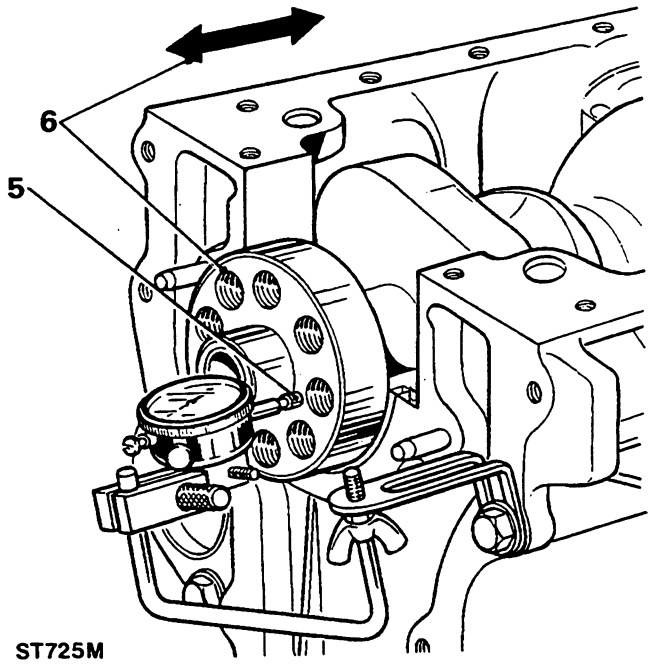


Adjust crankshaft end-float

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

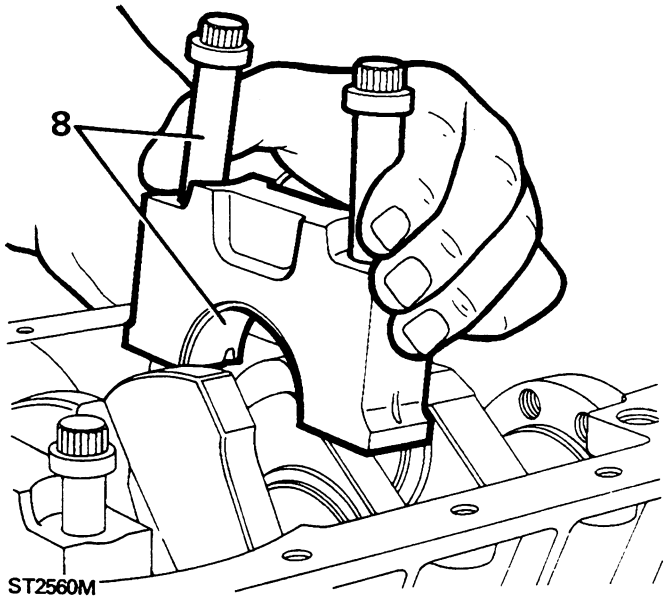


5. Place the crankshaft in position in the crankcase and mount a dial test indicator to read-off the end of the crankshaft. A feeler gauge may be used instead of an indicator.
6. Determine the end-float by moving the crankshaft away from the indicator and zero the dial. Move the crankshaft in the opposite direction and note the indicator reading. Alternatively measure the clearance with a feeler gauge. The end-float should be 0,05 to 0,15 mm (0.002 to 0.006 in).



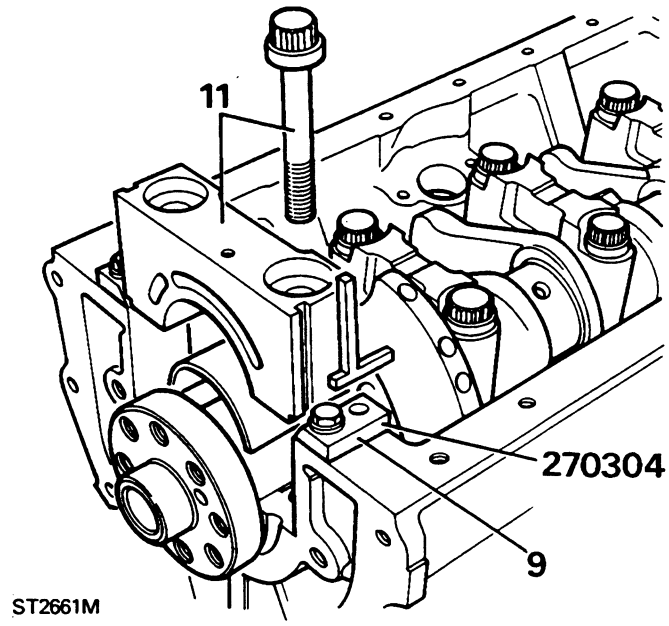
7. If adjustment is required substitute with oversize thrust washers. Variation of thrust washer thicknesses at each side of the crankshaft journal must not exceed 0,08 mm (0.003 in) to ensure that the crankshaft remains centralised.

8. Lubricate the crankshaft main jounals with clean engine oil and fit the appropriate bearing caps and lower shells to the crankcase with the exception of number five bearing. Ensure that the caps locate properly over the dowels. Using new bolts evenly tighten to the correct torque figure.

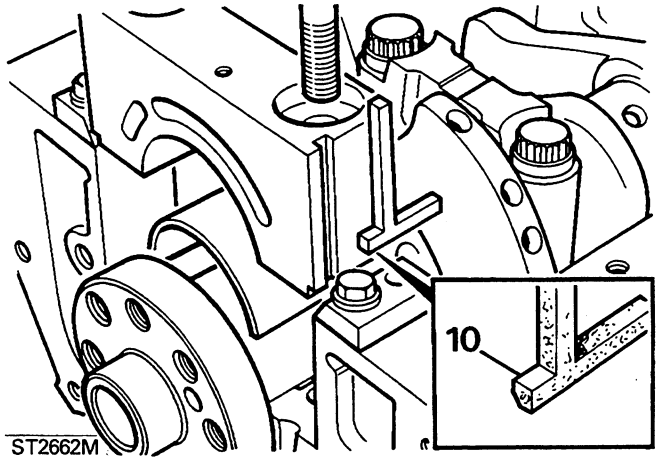


Fit rear main bearing cap

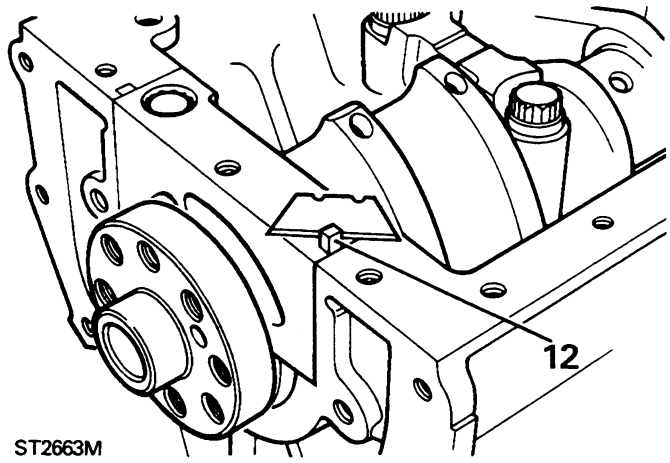
9. Ensure that number five main bearing cap is clean and free from old seal material. Attach the seal guides number 270304 to the crankcase, as illustrated, and ensure that they are parallel to the crankcase edge.



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



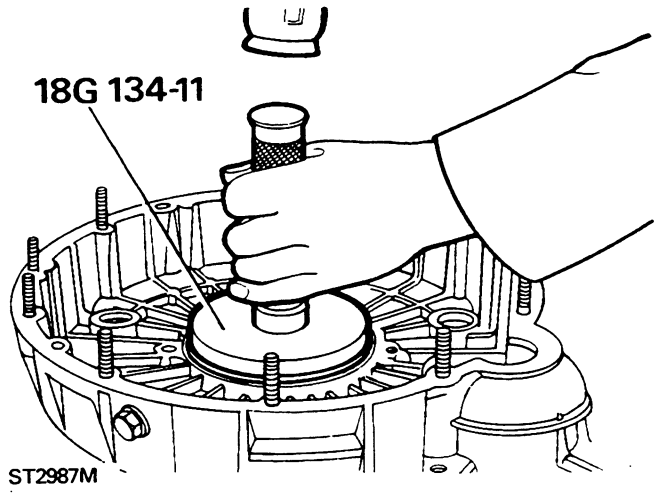
11. Fit the bearing cap and lower shell to the crankcase and secure with new bolts and tighten to the appropriate torque. Remove seal guides.
12. To allow for shrinkage after fitting leave the seals standing proud of the crankcase face then using a sharp blade, trim the seals off to approximately 0,80 mm above the crankcase face.



Fitting rear main oil seal to flywheel housing

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

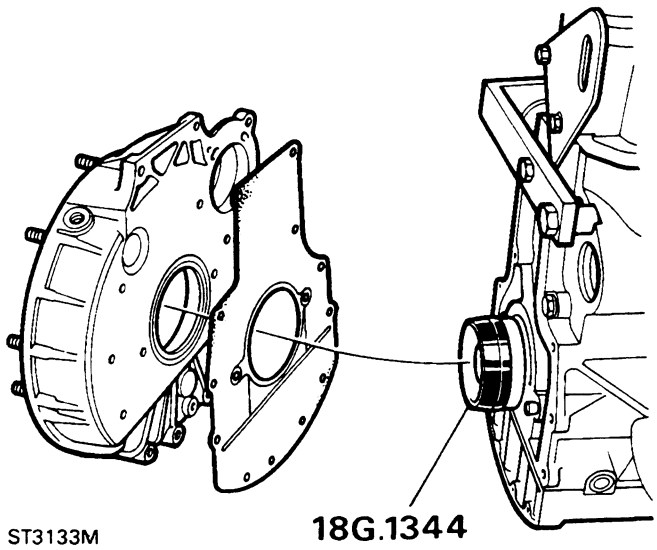
1 Make sure the seal housing is clean and dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry.
2. Using the special seal replacer 18G134-11 and with the lip side leading drive in the seal as far as the tool allows. If the tool is not available fit the seal to the bottom of the housing to ensure squareness.



Fitting flywheel housing

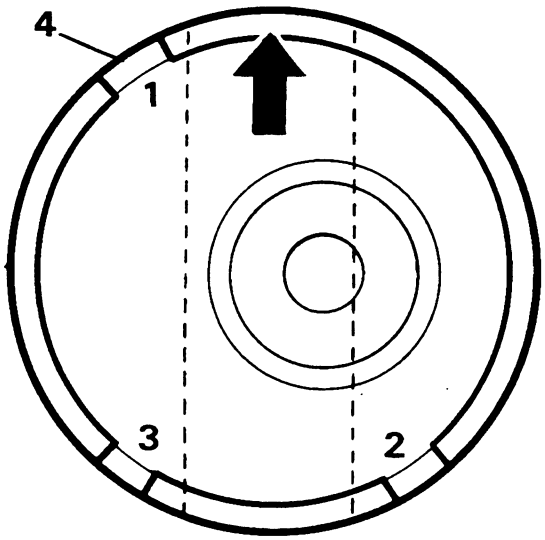
NOTE: Earlier Tdi engines were fitted with a flywheel housing having a shallow annular groove round the seal housing and was sealed by a bead of sealant fitted to a precise configuration. Later type flywheel housings have a flat joint face with the cylinder block and are sealed with a large special gasket. The new gasket 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.

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



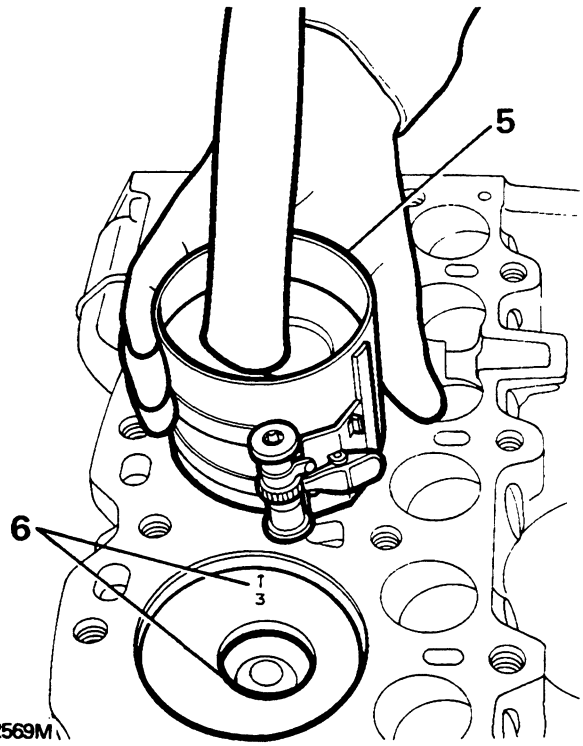
FIT THE CONNECTING RODS AND PISTONS

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



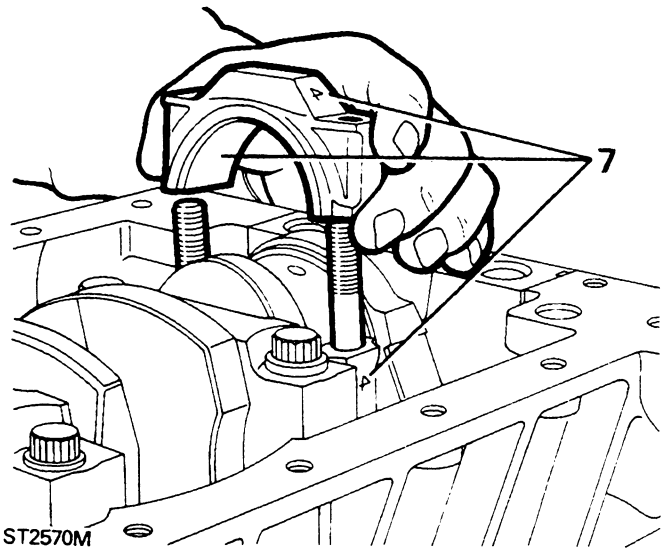
ST2669M

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



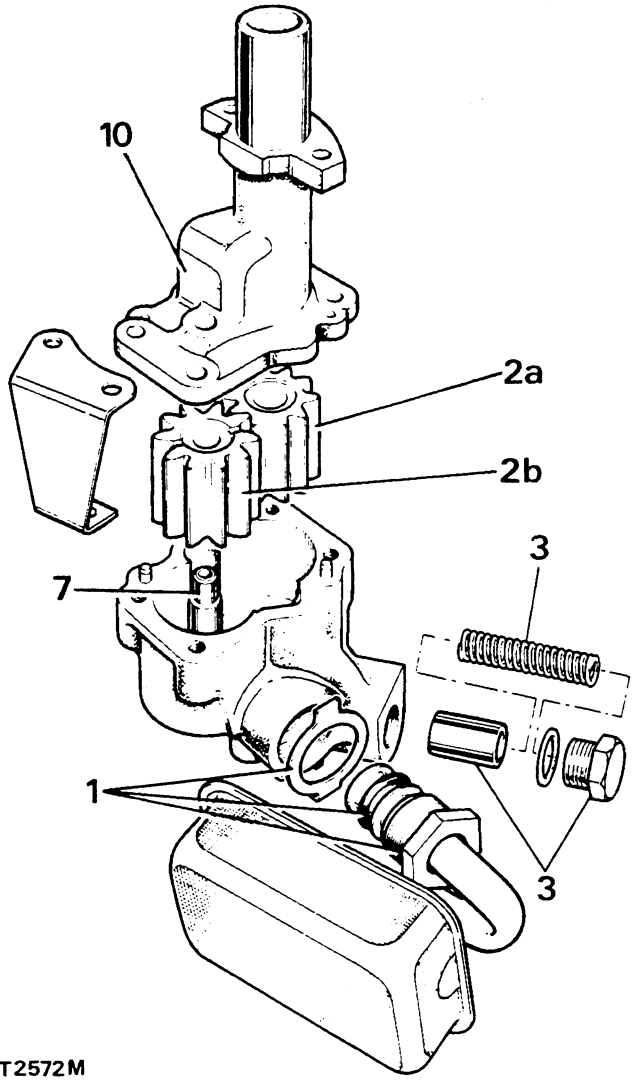
ST2569M

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

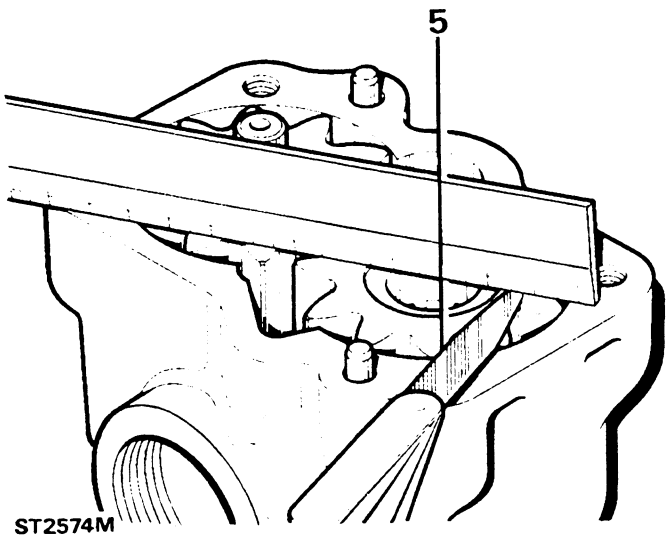


OVERHAUL THE OIL PUMP

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



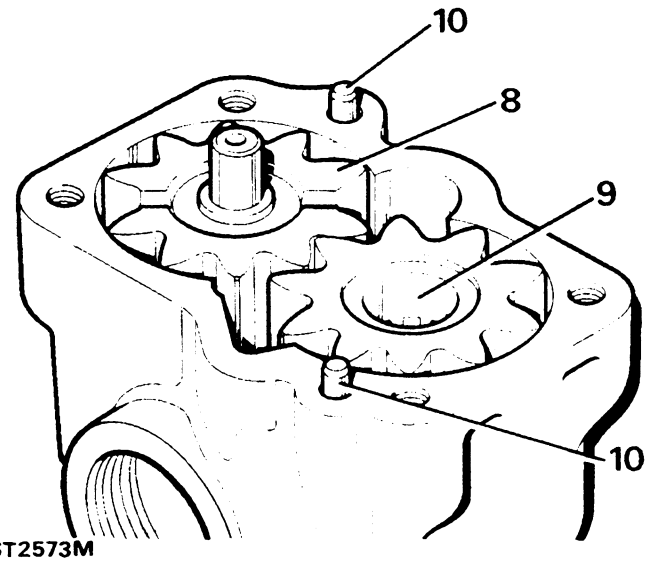
6. A worn, but serviceable gear, must not be matched with a new one.



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

Assemble the oil pump

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



ST2573M

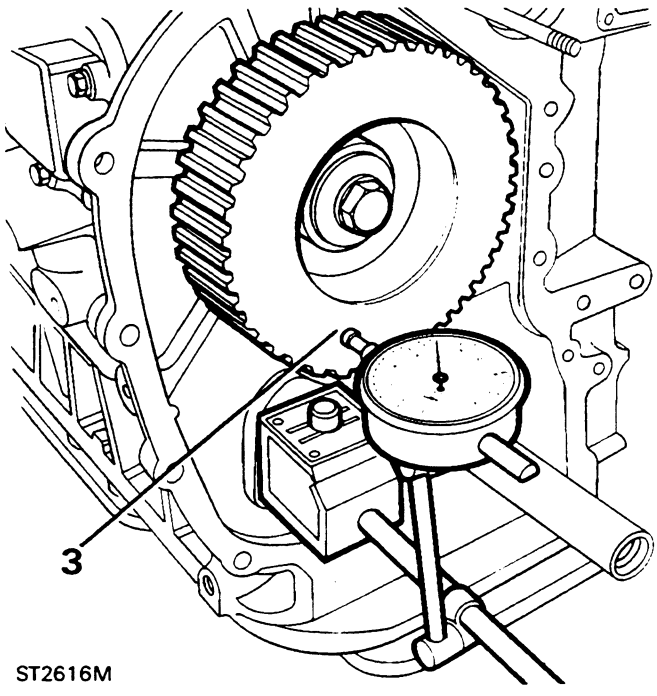
11. Hold relief valve bore vertically and insert the plunger with the solid end first. Fit the spring, sealing washer and plug.
12. Fit a new 'O' ring to the oil strainer pipe and insert into the pump body and loosely secure with the lock washer and nut.
13. Secure the strainer bracket to the pump body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

EXAMINE AND FIT THE CAMSHAFT

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

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

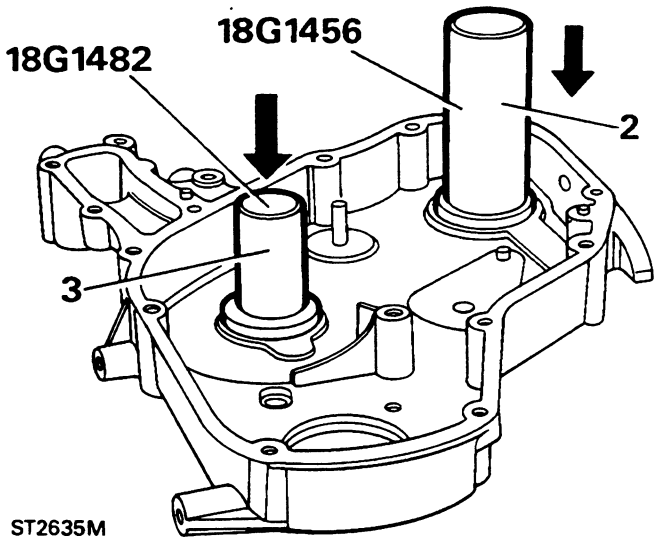
2. Lubricate the camshaft bearings and journals with clean engine oil and carefully insert the camshaft into the cylinder block. Fit the thrust plate and secure with the two bolts and tighten to the correct torque.
3. To check the camshaft end-float, temporarily fit the camshaft gear and mount a dial test indicator so that the stylus rests in a loaded condition upon the machined face of the gear. Zero the dial and move the camshaft back and forward and note the reading. The end-float should be within 0,06 to 0,13 mm (0.0025 to 0.0055 in). If the end-float is outside these limits, fit different thrust plates until the correct tolerance is achieved.



ST2616M

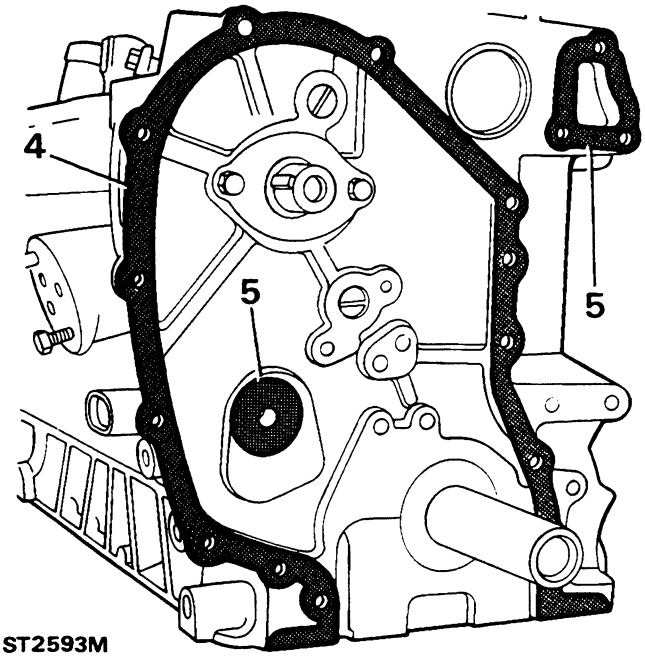
FIT THE FRONT COVER

1. Clean the front cover and remove the crankshaft and camshaft oil seals taking care not to damage the seal housings. Examine the cover for damage, cracks and distortion. Check the mating face of the cylinder block and the cover plate for burrs.
2. Place the front cover, cylinder block face downwards on a flat surface and lubricate a new crankshaft oil seal. With the lip side leading, drive-in the seal, squarely, using special service tool 18G1456. The back of the seal should be approximately 0,5 mm (0.002 in) below the innner face of the cover.
3. Similarly, lubricate and drive-in a new camshaft oil seal, lip side leading using special service tool 18G1482. The seal should be approximately 1,0 mm (0.004 in) below the inner face of the cover.

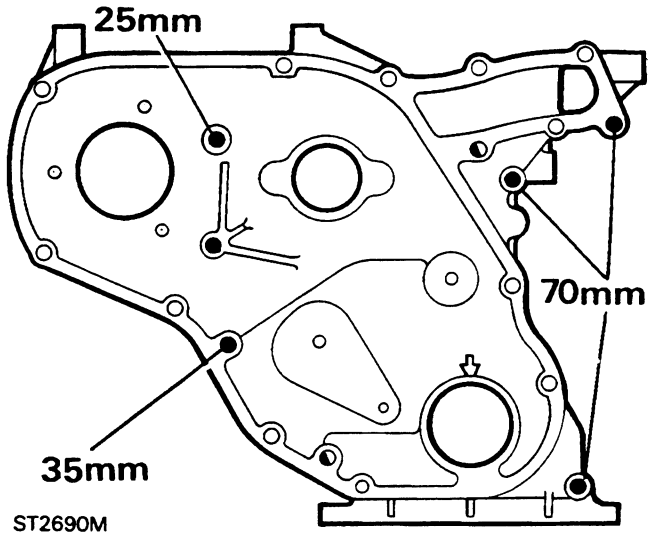


ST2635M

4. Clean the front face of the cylinder block and use a little grease to hold in position a new joint washer.
5. Also fit a new joint washer to the coolant aperture and to the tapped hole for the jockey pulley clamp bolt.
6. Taking care not to damage the oil seals fit the front cover locating it over the single stud. Secure with the five retaining bolts tightening evenly to the correct torque. The correct bolt length for each hole is given in the following chart.



ST2593M

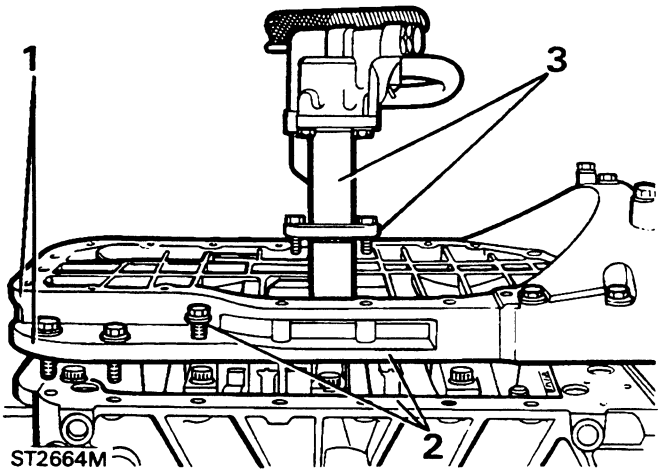


ST2690M

FIT LADDER FRAME, OIL PUMP AND SUMP

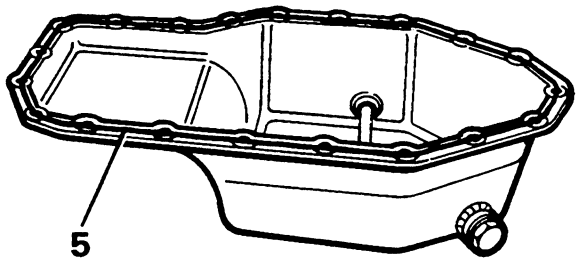
Since the sealant specified to seal the ladder frame to the crankcase and the sump to the ladder frame cures within fifteen minutes and some of the retaining bolts are common to the sump it is important that the ladder frame, oil pump and sump are fitted together without undue delay. Before applying sealant coat both faces with Hylogrip Primer to clean and hasten curing.

1. Clean both sides of the ladder frame and remove all traces of old sealant. Check 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. Apply Hylogrip 2000 to the mating face with the crankcase. Also apply Hylosil RTV where the crankcase meets the flywheel housing. Loosely fit the ladder frame. Fit 4 bolts securing flywheel housing to ladder frame. Tighten ladder frame to crankcase bolts to 25 Nm.
3. Fit the oil pump and strainer assembly to the crankcase location and tighten the two bolts to the correct torque.

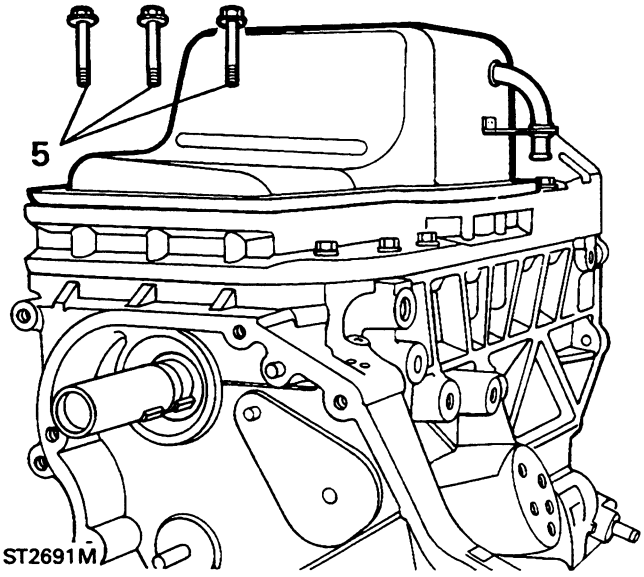


ST2664M

4. Clean the sump and remove all traces of old sealant. Examine the sump for damage, such as dents, and distortion. Check that the drain plug threads in the sump are not stripped or damaged so that an oil leak could occur.
5. Apply a 2,0 mm wide bead of "Hylosil" RTV102 black to the sump mating face with the ladder frame. Fit 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.



ST2665M



ST2691M

EXAMINE, OVERHAUL AND FIT FLYWHEEL

1. Normal wear and scores on the flywheel clutch face can be repaired by machining provided that the overall width of the flywheel is not reduced below 36,96 mm (1.453 in) therefore check that the flywheel has not been previously machined before proceding further. Examine the ring gear and if the teeth are chipped and worn the gear can be renewed.

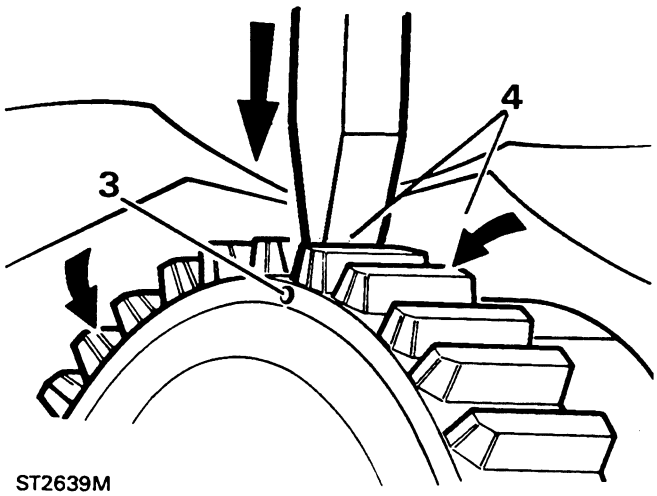
Reface the flywheel

2. Remove the clutch cover locating dowels. Machine the flywheel over the entire clutch face removing only the minimum of material necessary to achieve a smooth surface parallel with the crankshaft mating face and within the above dimensions.

3. To renew the ring gear, drill a 8 mm hole between the root of any two teeth and the inner diameter of the ring gear deep enough to weaken the gear. Take care not to allow the drill to enter the flywheel.

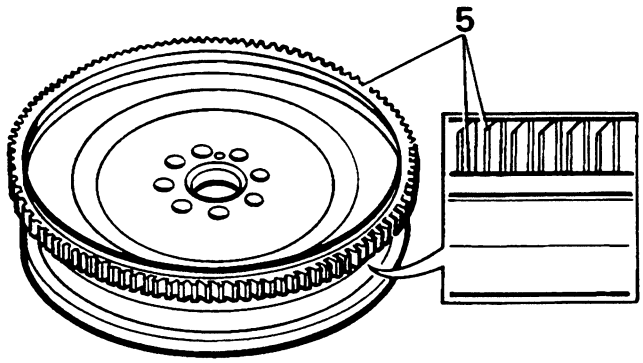
WARNING: Wear industrial goggles to protect the eyes from flying fragments.

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



ST2639M

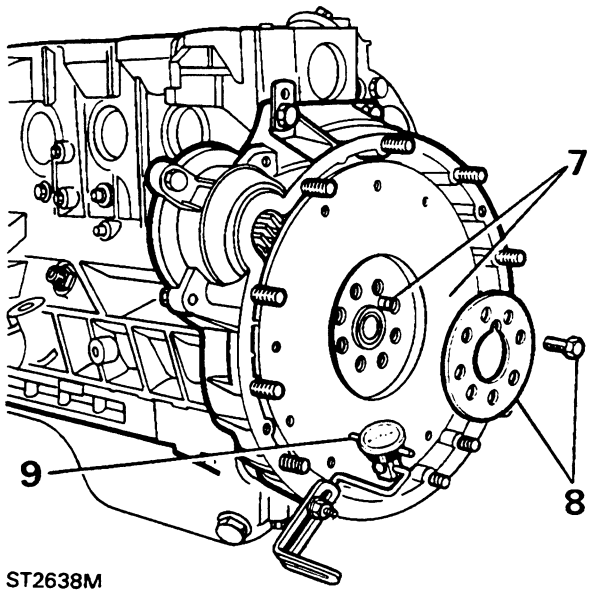
5. Heat the new ring uniformally to between 225°C and 250°C but do not exceed the higher figure. Place the flywheel, clutch face down, on a flat surface and locate the heated ring gear with the square edge of teeth downwards towards the flywheel clutch face and chamfered edge of the teeth uppermost.
6. 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

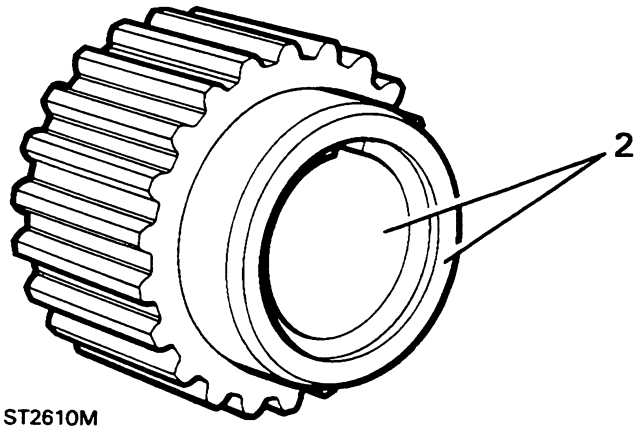
7. Make sure the crankshaft and flywheel mating faces are clean and free from burrs and imperfections that could prevent the flywheel running true. Check that the dowel is in position in the crankshaft and that it is undamaged.
8. Offer up the flywheel to the crankshaft and secure with the reinforcing plate and retaining bolts. Temporarily fit the damper to front of crankshaft and use special service tool FR101 or LST127 to restrain the crankshaft whilst the eight retaining bolts are being tightened to the correct torque.
9. 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 (4.5 in) from the centre of the flywheel. Turn the flywheel, and check that run-out does not exceed 0,05 to 0,07 mm (0.002 to 0.003 in). Should any run-out be excessive, remove the flywheel, and check again for irregularities on flywheel and crankshaft mating faces and dowel. Should excessive run-out persist the flywheel should be checked on independant equipment in case the flywheel is at fault.



ST2638M

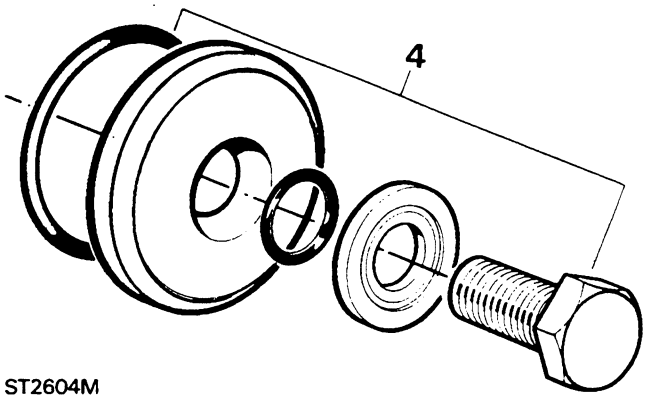
VALVE AND INJECTION PUMP TIMING

1. Examine the gear wheels for wear and damage. Cleanliness and accuracy are vital when carrying out the following instructions. The gear wheels must be free from oil and grease. Drive belts which have not been stored and treated in the following manner should not be used.
   Drive belts must be stored on edge on a clean flat surface and in such a manner that bends are not less than 50 mm (2 in) radius.
   When a belt is handled, it must not be bent at an acute angle or an arc of less than 25 mm (1 in) in diameter, as damage may be caused to the glass fibre reinforcement and premature failure could result.
   During use, a belt develops a wear pattern, therefore, if it has to be re-used, before removal, mark the direction of rotation, using soft chalk or a similar marker, and refit the belt so that it runs in the original direction.
   Belts must be dry and FREE FROM ANY OIL OR OTHER CONTAMINATION.
   Do not turn the crankshaft by applying leverage to the camshaft pulley or its retaining bolt.
   To remove a belt always use clean hands, or a recommended tool - NEVER use a lever.
2. Fit the gearwheel to the crankshaft.



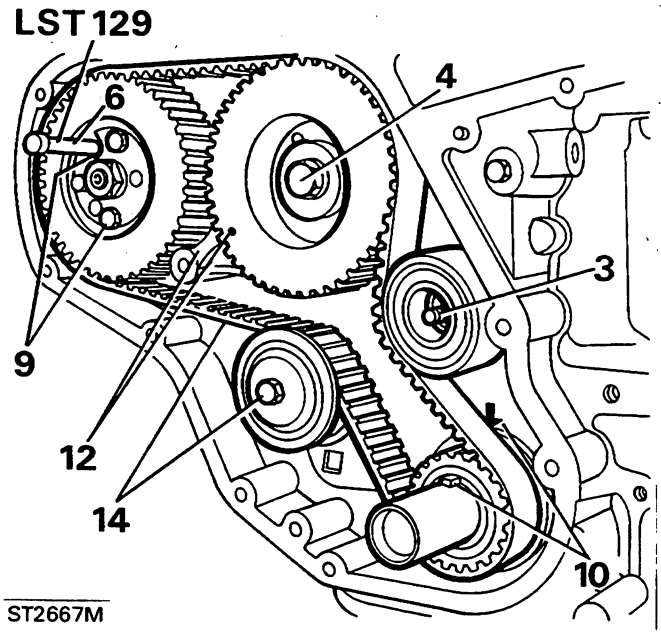
ST2610M

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



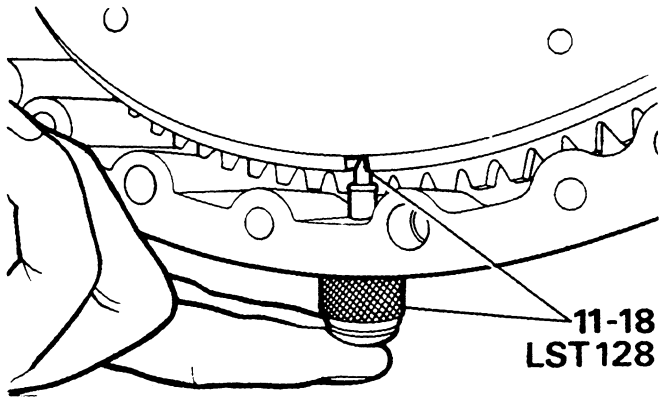
ST2604M

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



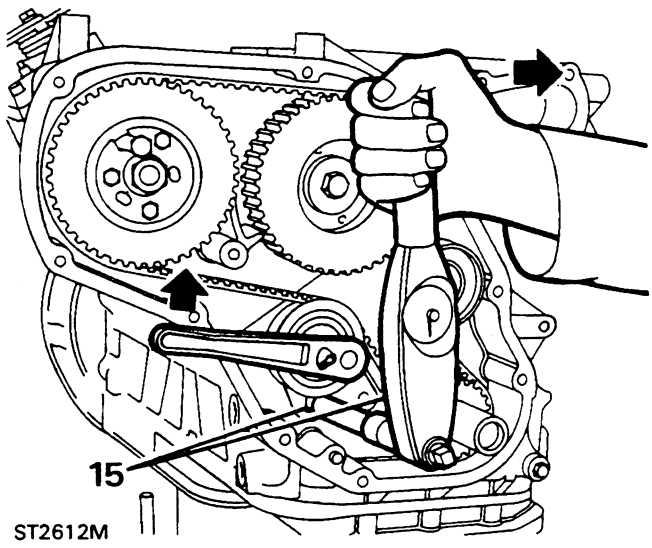
ST2667M

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



ST2641M

12. Rotate the camshaft so that the cams are positioned with number one cylinder valves closed and number four cylinder valves on the "rock". The centre dot on the camshaft gear should now be aligned with the front cover web as shown.
13. Feed the drive belt over the gears keeping it tight on the drive side without moving the gears.
14. Fit the belt tensioner with the special washer and single bolt.
15. Insert a 13 mm (0.5 in) square drive extension into the hole in the tensioner support plate and with a dial type torque wrench held vertically, tension the belt to 18 to 20 Nm (13 to 15 lbf ft) whilst tightening the tensioner clamp bolt to the correct torque. Do not use a "break" type torque wrench.



ST2612M

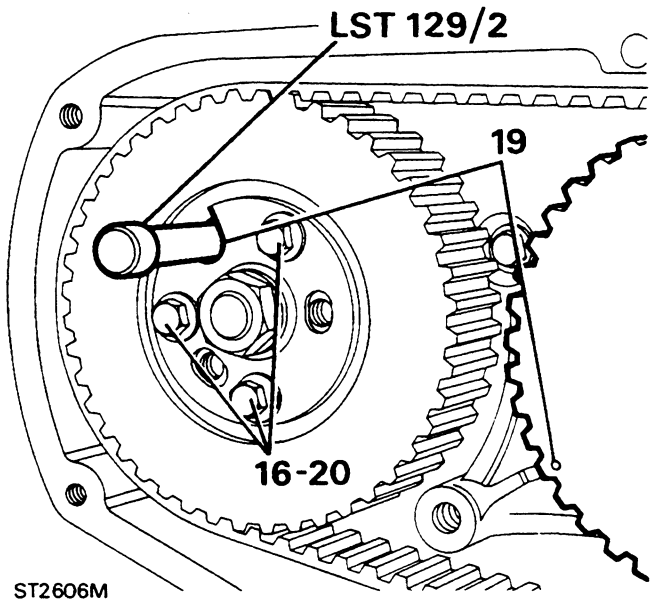
16. Tighten the three bolts that secure the pump gear and reinforcing plate to the pump hub to the correct torque and remove the timing pin.

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

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

CAUTION: The double tensioning procedure is vital otherwise the belt could fail resulting in serious damage to the engine. If a new belt is not available and it is necessary to fit the old one, it should only be torqued to 16 to 18 Nm (12 to 13 lbf ft).

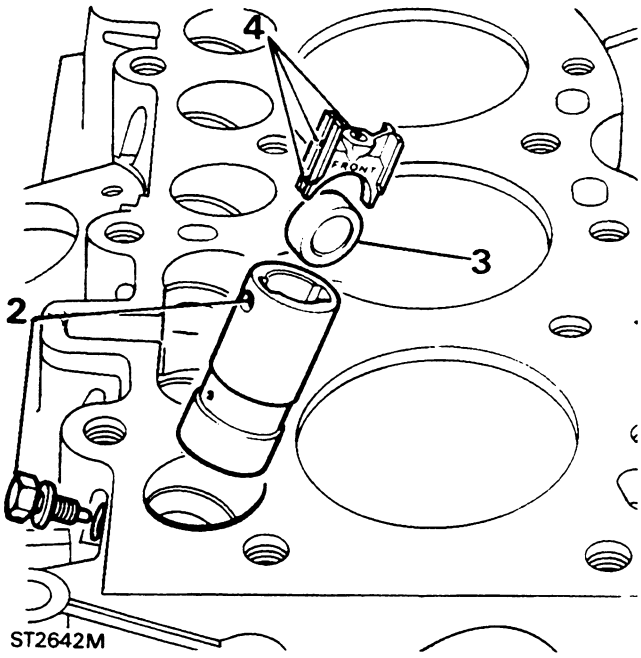
18. Turn the crankshaft again in a clockwise direction until the flywheel timing pin locates in the T.D.C. slot.
19. Insert the timing pin in the pump hub and check that the crankshaft key aligns with the arrow on the front cover. Also check that the dot on the camshaft gear aligns with the front cover web.
20. If the timing pin cannot be inserted fully into the pump hub slot, it is necessary to slacken the three pump gear retaining bolts and slightly turn the hub, in the appropriate direction, to allow the pin to locate. Retighten the bolts to the correct torque.



ST2606M

FIT CAM FOLLOWER ASSEMBLIES

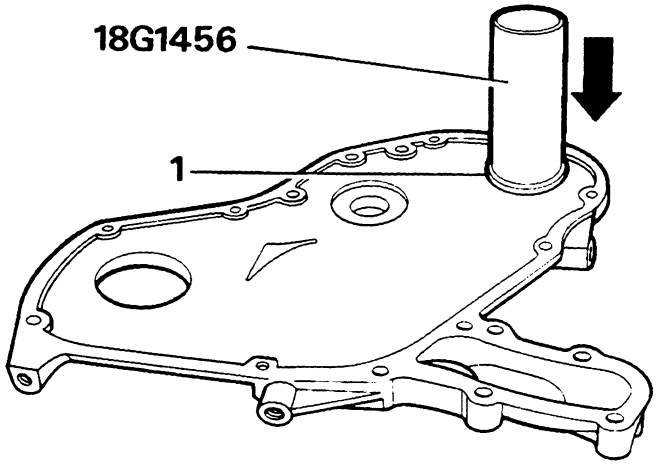
1. Examine all the components for wear and damage, particularly the rollers. Renew any component that is worn. Ensure that the tappet slides move freely in the guides. If the same parts are being refitted, ensure that they are returned to their original positions.
2. Insert the tappet guides into the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



ST2642M

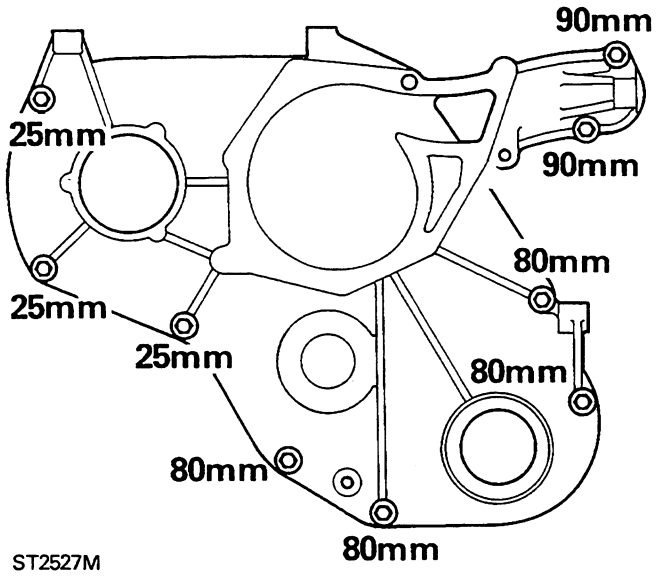
FITTING FRONT COVER PLATE AND DAMPER

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



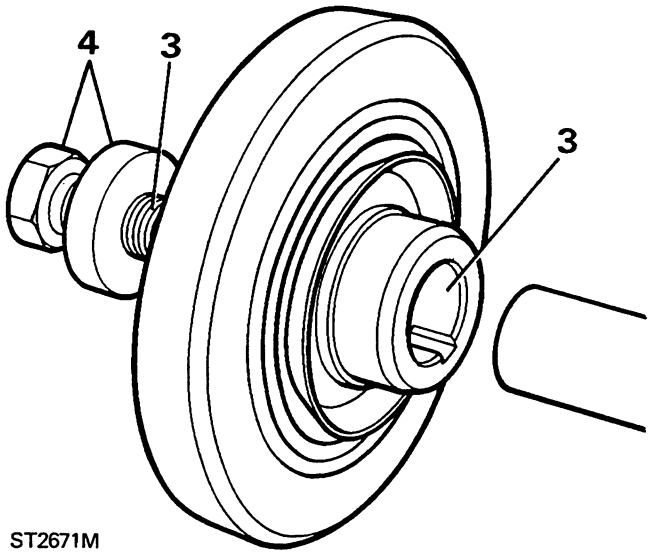
ST2601M

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



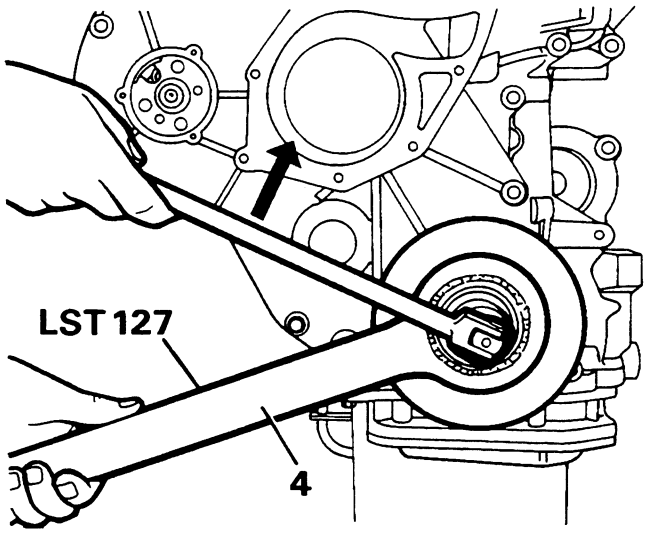
ST2527M

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



ST2671M

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



ST2643M

OVERHAUL AND FIT CYLINDER HEAD

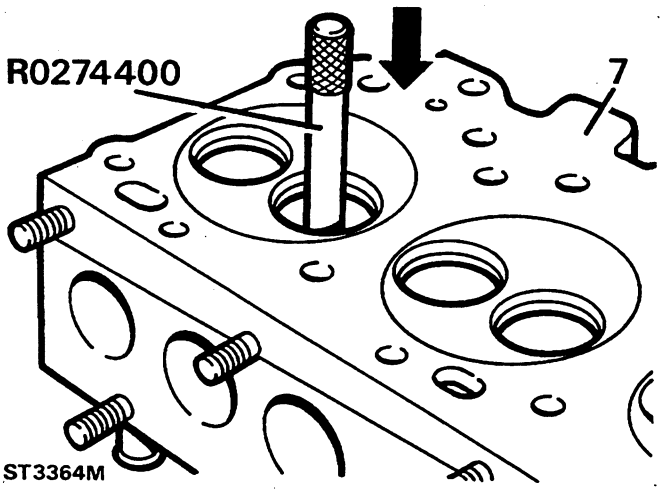
CAUTION: Since the cylinder head is manufactured from an aluminium alloy care must be taken to ensure that the combustion face, in particular, is not damaged or scratched by resting it on a hard or abrasive surface while carrying out the overhaul operations.

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

4. Examine the valve guides for wear and damage. Check for stem wear by inserting a new valve, in each guide in turn, approximately 8 mm above the seat and if movement across the head axceeds 0,15 mm (0.006 in) 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. Check the stems for wear by inserting in a new guide and checking the movement across the valve head when held approximately 8 mm above the seat. If movement exceeds 0,15 mm (0.006 in) the valve should be discarded.

Renew valve guides

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



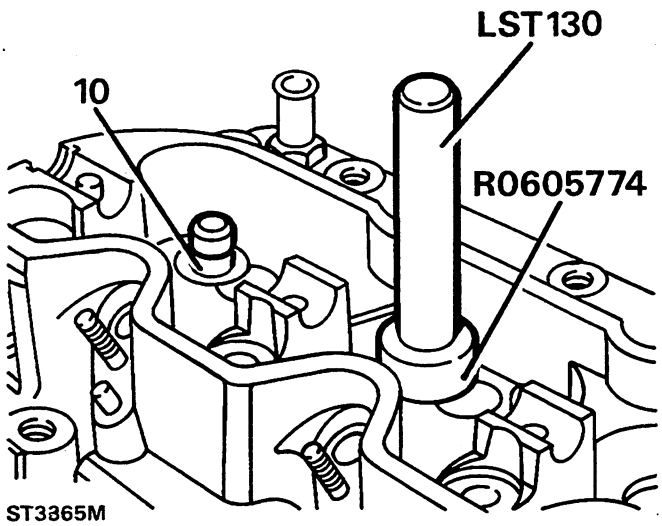
ST3364M

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

CAUTION: Local heating using a welding torch or other similar means must not be used.

NOTE: Only service valve guides Part Number SFR0035 must be used for this operation, standard valve guides are not suitable.

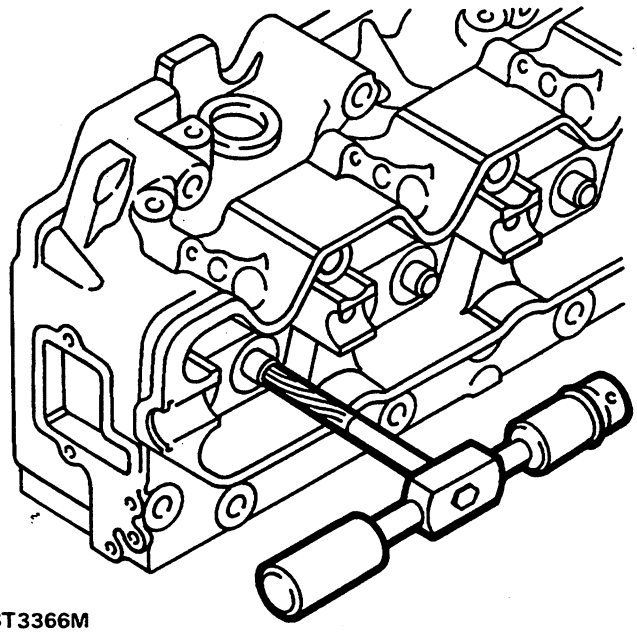
10. Lubricate then fit valve guides using service tools LST130, height gauge RO605774 and a press.



ST3365M

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

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


ST3366M

Reface valve seat inserts

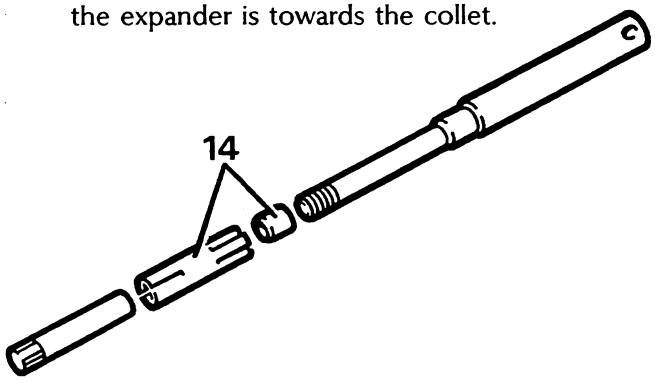
Exhaust valve seat faces should be recut to 45°.
Inlet valve seat faces should be recut to 60°.

12. The special set of hand tools recommended for refacing valve seat inserts comprise expandable pilots, MS150-8, that fit tightly into new or worn guides to ensure that the valve seat is concentric with the valve guide.

13. The refacing 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.

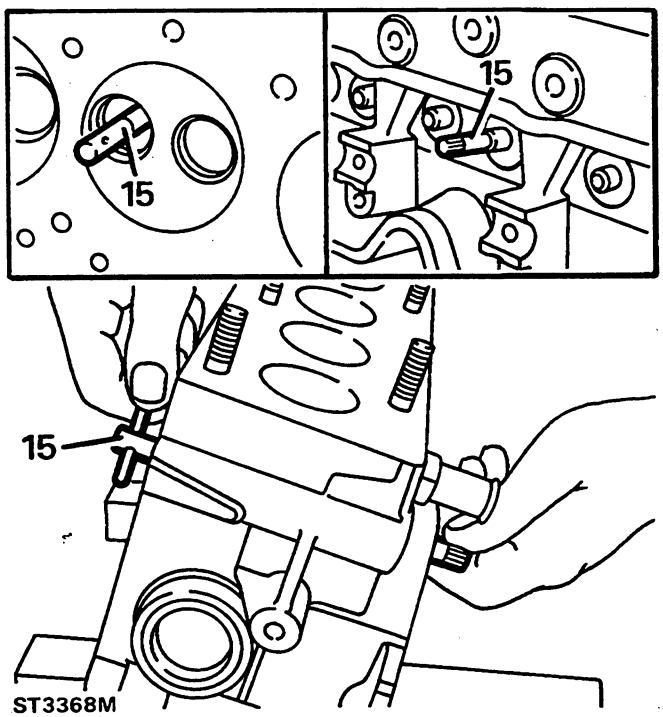
NOTE: Cutter MS621 is a double ended tool having cutters of 30° and 45°. Ensure that the 45° cutter is used in this application.

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



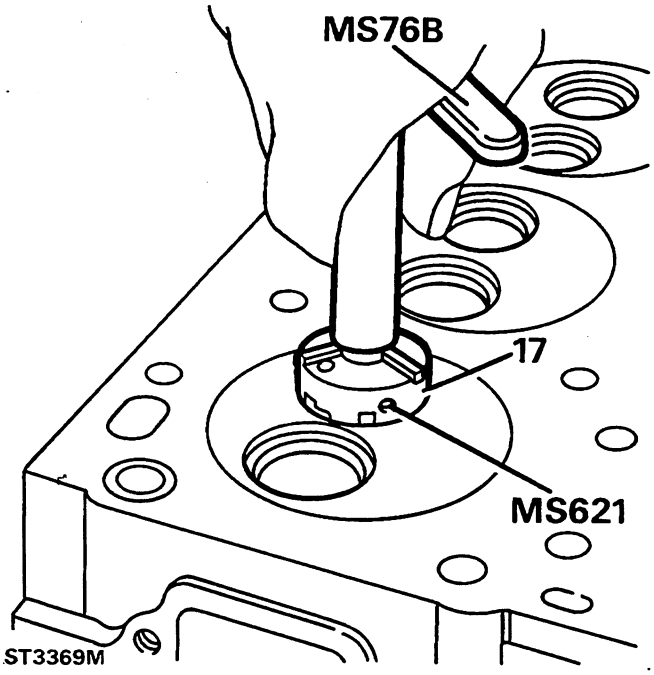
ST3367M

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



ST3368M

16. Using the appropriate cutter for the valve seat being refaced, ensure that the cutter blades are correctly fitted to the head with the angled end of the blade downwards facing the work. Check that the blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided to make any adjustments.
17. Fit the wrench to the cutter head and turn clockwise using only very light pressure. Continue cutting to approximately the centre of the existing seat.
18. To check the effectiveness of the cutting operation use engineers blue. Smear a small quantity of blue round the vale seat and revolve a properly ground valve against the seat. A continuous fine line should appear round the valve. If there is a gap of not more than 12 mm it can be corrected by lapping.



ST3369M

Reface valve head faces

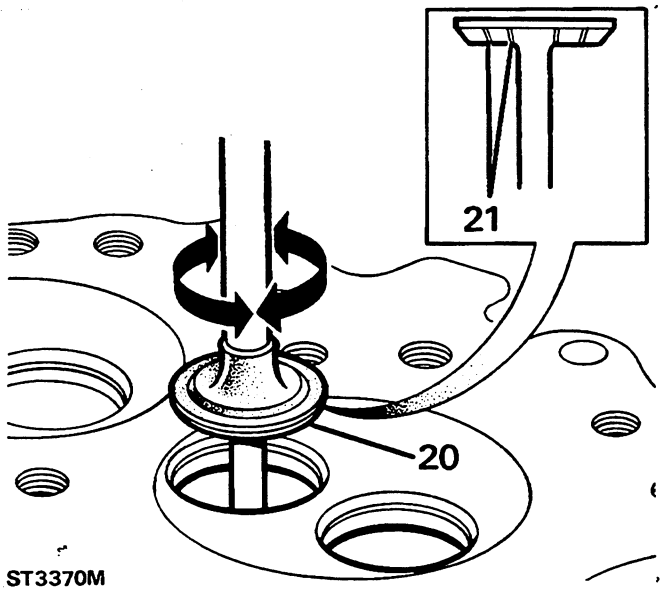
Exhaust valve head faces should be reground to an angle of 45° 00′ - 44° 30′ to give an included angle of 90°.

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

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

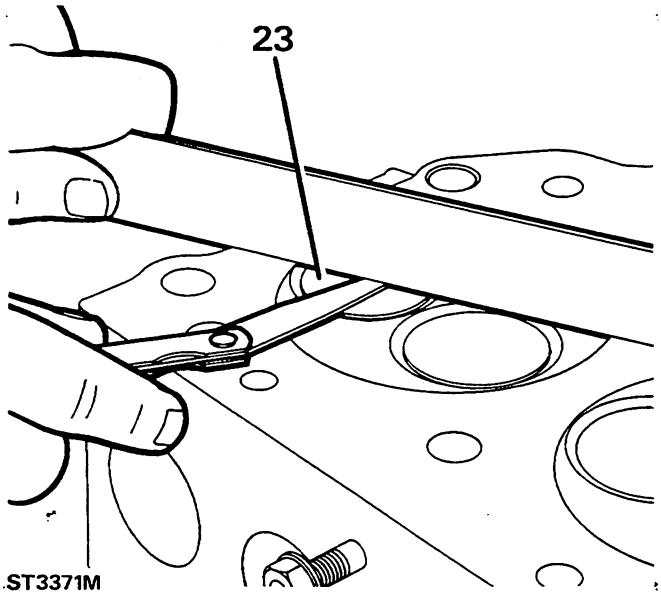
Lap-in valves

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

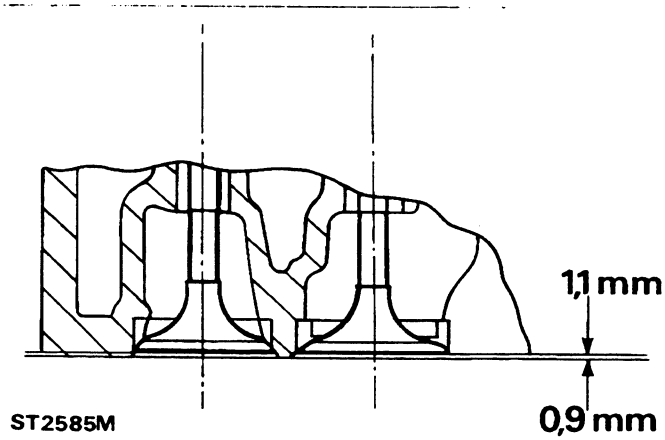


ST3370M

21. Continue the operation until a continuous matt grey band round the valve face is obtained. To check that the lapping operation is sucessful, wipe off the valve paste from the valve and seat and make a series of pencil lines across the valve face.
22. Insert the valve into the guide and while pressing the valve onto the seat revolve the valve a quarter of turn a few times. If all the pencil lines are cut through no further lapping is required. Wash all traces of grinding paste from the valves and cylinder head.
23. Position the cylinder head with the combustion face uppermost and insert the valves into their respective guides. To check the valve head stand-down or the correct dimension of the valve head below the combustion face, use either a dial test indicator or a straight edge and feeler gauge. Hold the straight edge across the centre of each valve in turn and measure the gap between the valve head and straight edge. The correct dimension should be 1,1 to 0,9 mm (0.040 to 0.035 in). Using a dial gauge zero the gauge on the combustion face then move the stylus across to the valve head and note the reading.



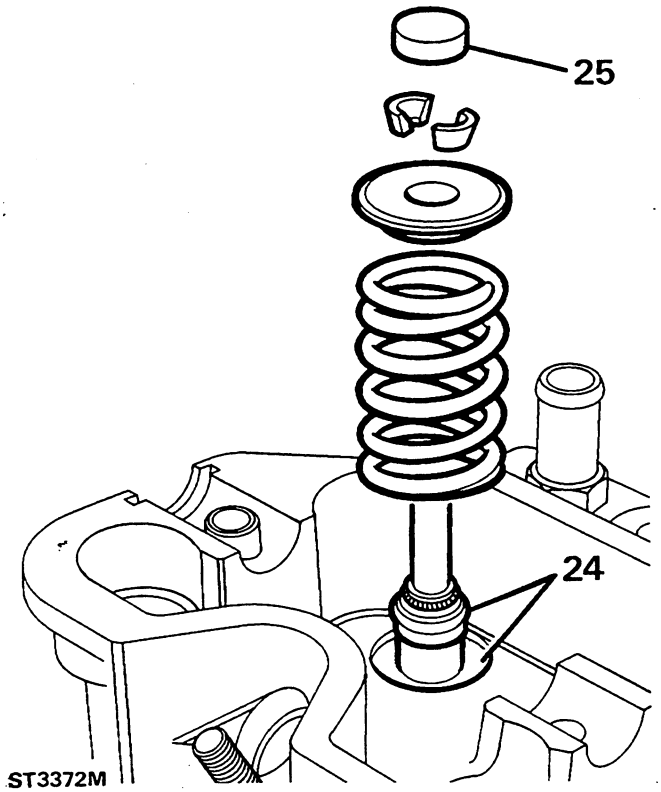
ST3371M



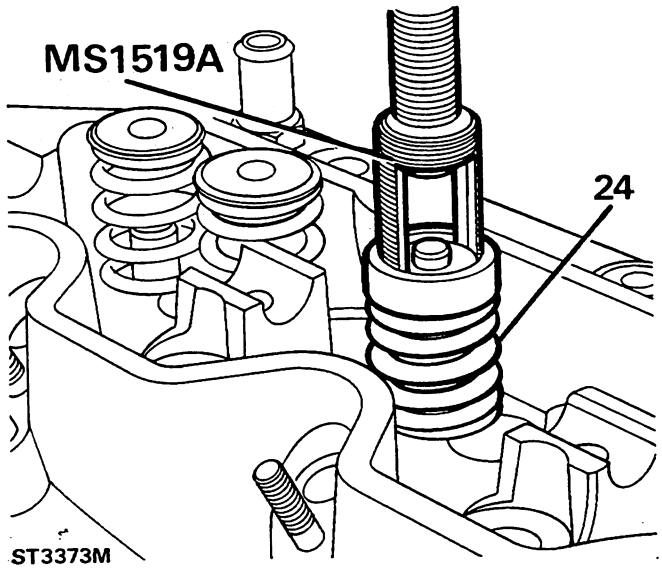
ST2585M

Assemble valves to cylinder head

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



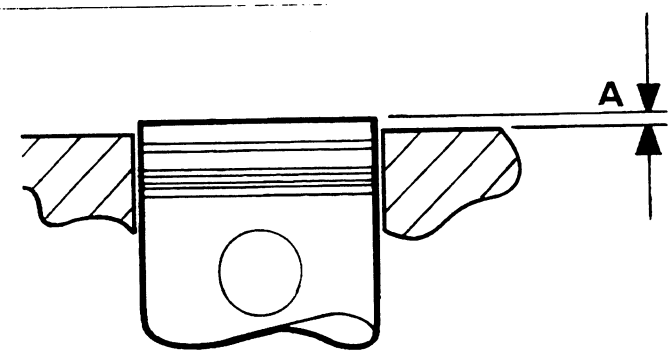
ST3372M



ST3373M

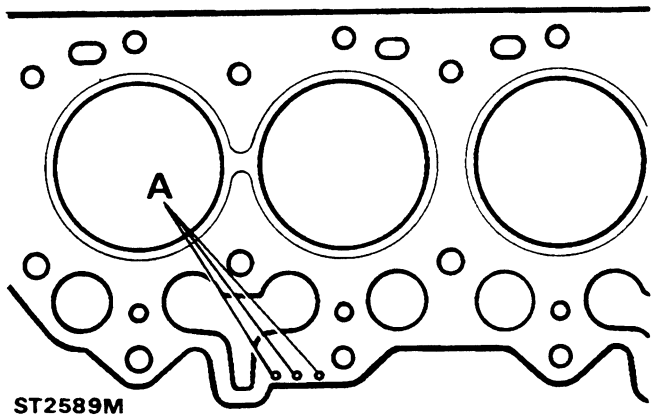
Fitting cylinder head

When the pistons are at T.D.C. they protrude above the top of the cylinder block. The amount of protrusion determines the thickness of cylinder head gasket that must be fitted. The height of all the pistons above the cylinder block must be measured and the thickness of the gasket selected is based upon the largest value of dimension 'A'. This dimension, however, must not exceed 0,8 mm (0.032 in).



ST2646M

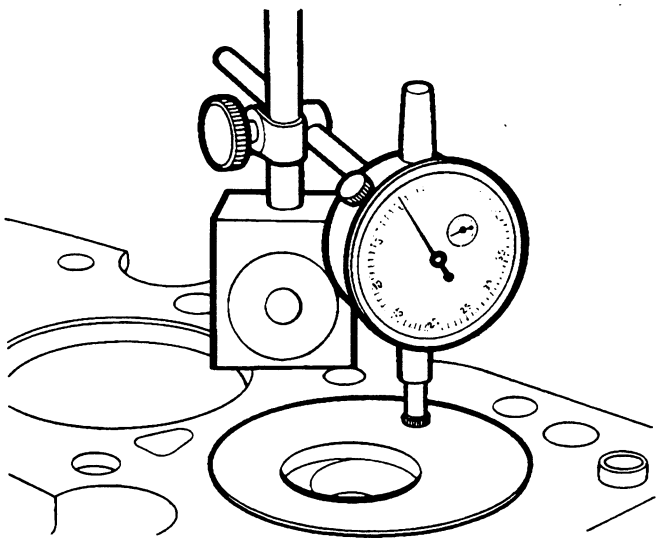
Three thicknesses of gasket are available and each size can be recognised by the number of identification holes punched in the side of the gasket as illustrated. The table below gives the details of the gaskets available. The thickness of gasket fitted can be seen when the cylinder head is fitted since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



ST2589M

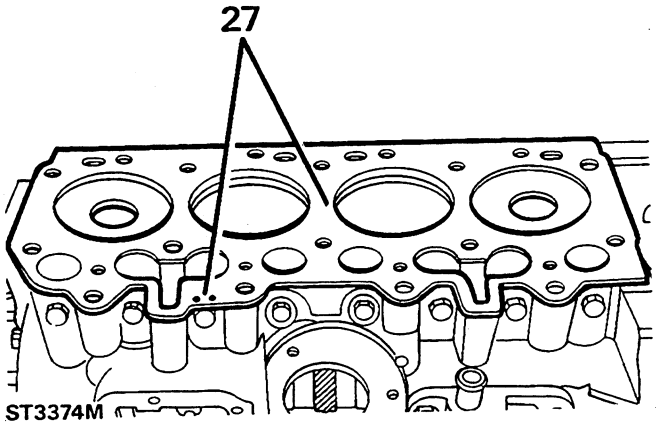
No. of holes	Metric	Imperial	Gasket
1	0,60 / 0,50	0.0196 / 0.0236	ERR 0382
2	0,70 / 0,61	0.024 / 0.0275	ERR 0383
3	0,80 / 0,71	0.0279 / 0.0314	ERR 0384

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



ST2581M

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

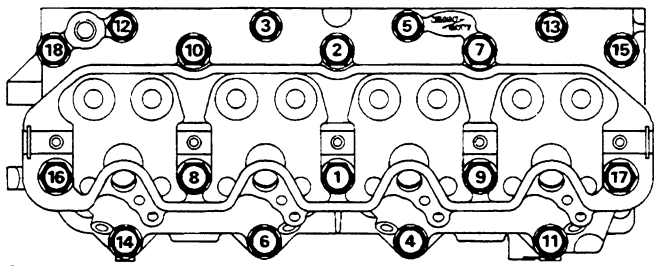


ST3374M

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

NOTE: Cylinder head bolts may be re-used a maximum of five times, unless damaged.

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



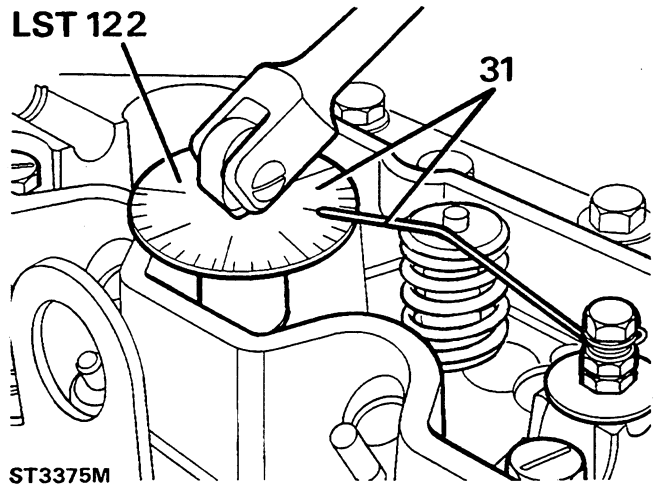
ST2619M

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

31. Attach 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. Tighten all the bolts down through an angle of 60° strictly in the sequence illustrated. As each bolt is tightened scribe a line across the head with a piece of chalk or crayon to identify which bolts have been tightened. Again, in the correct sequence, tighten the bolts a further 60° and scribe another line across each bolt head as it is tightened. Re-positioning of the pointer will, no doubt, be necessary to reach all bolts.



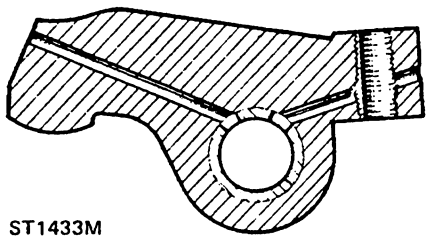
ST3375M

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.

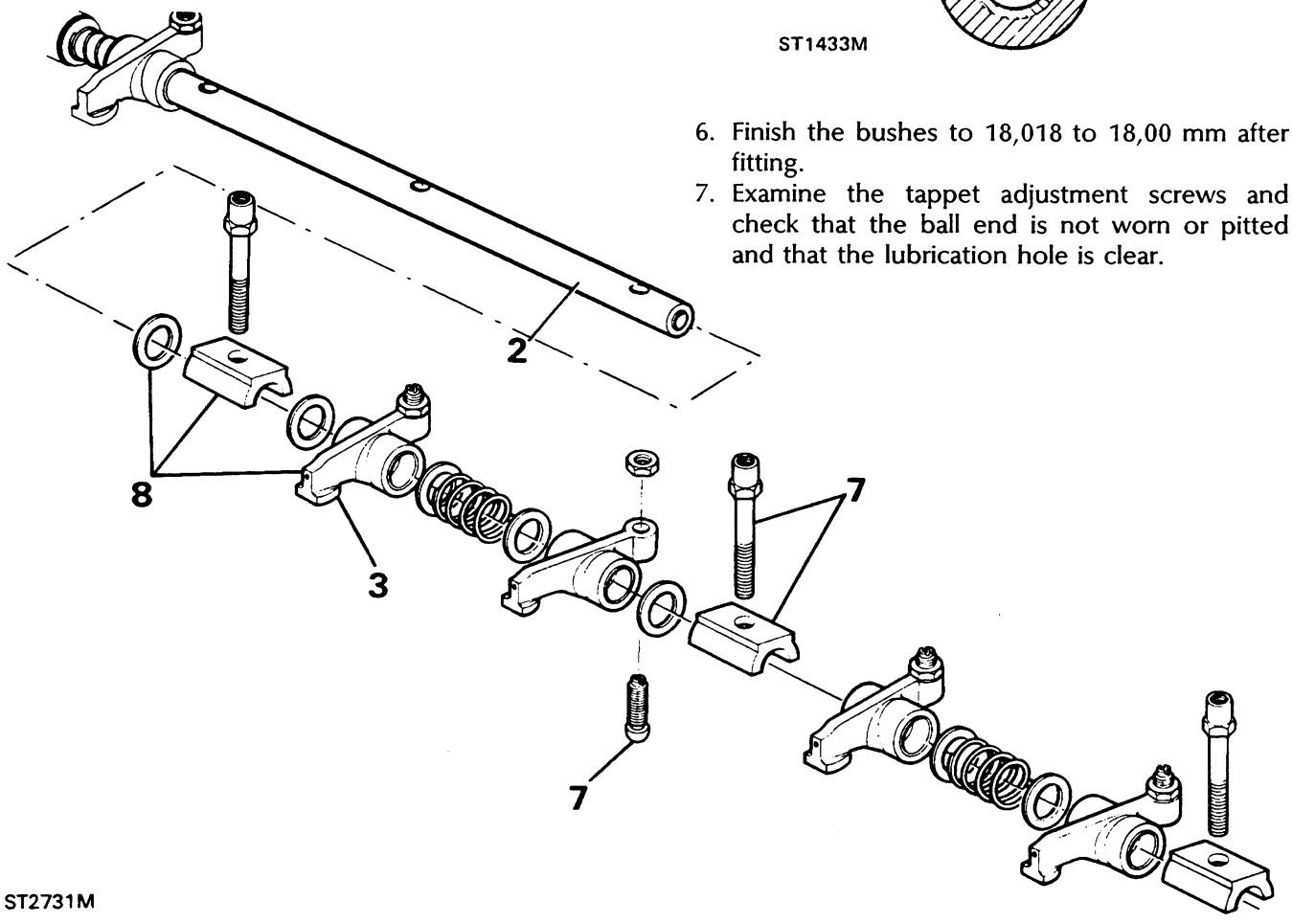
OVERHAUL AND FIT ROCKER SHAFT

Overhauling

1. Remove the five rocker shaft retaining bolts and withdraw the bearing caps, rockers, washers and springs from the shaft.
2. Examine the rocker shaft for wear and discard it if the bearing surface is worn, scored or pitted. Check also that the oilways are clear.
3. Inspect the rockers and discard if the pads are worn. It is not permissible to grind pads in an attempt to reclaim rockers.
4. Renew bushes if the clearance between shaft and bush is in excess of 0,101 to 0,127 mm (0.004 to 0.005 in). Press in replacements ensuring that the pre-drilled oil holes coincide with the holes in the rockers.
5. The following cross section of a rocker shows the oil drillings.


ST1433M

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



ST2731M

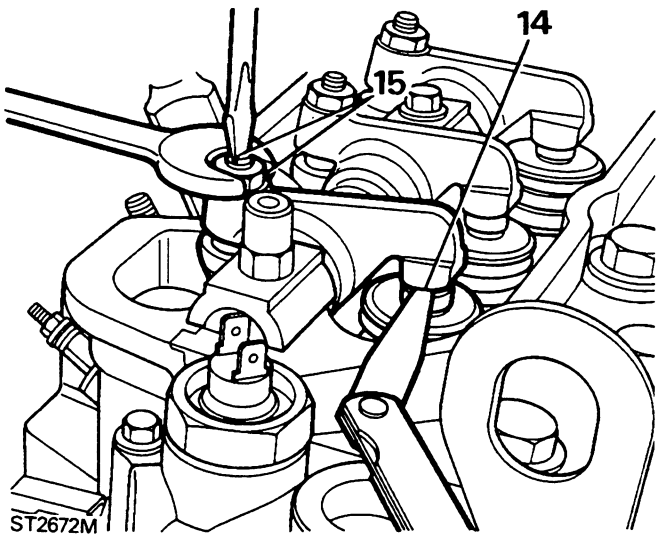
8. Assemble the rockers, bearing caps, new springs and washers to the shaft noting where the washers are fitted. Hold the assembly together with the five rocker shaft retaining bolts.

Fitting rocker shaft assembly

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

Adjust tappet clearances

12. If the crankshaft is rotated with excessive valve clearances, it is possible that the push rods may become dislodged from the tappet seating and fracture the tappet slide. To prevent damage, eliminate all clearance from any loose rockers before turning the crankshaft to adjust clearances.
13. Turn the engine over until number eight valve (counting from front of engine) is fully open.
14. Using a 0,20 mm (0.008 in) feeler gauge check the clearance between the valve tip and rocker pad of number one valve.

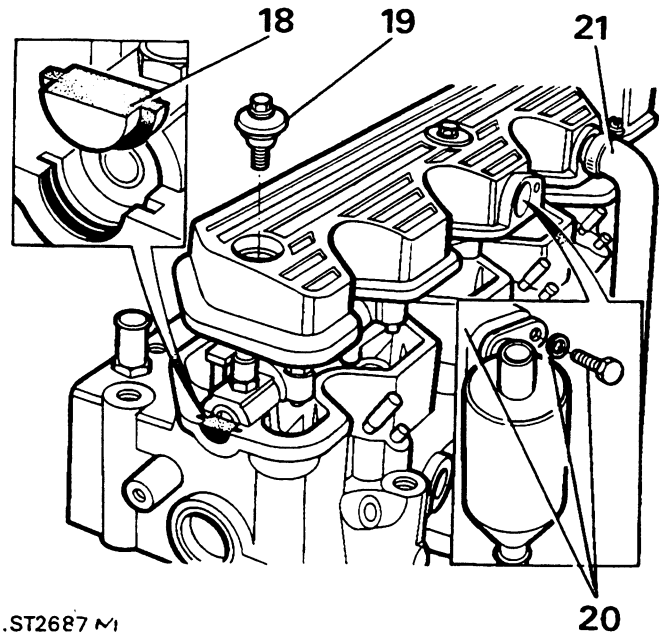


15. Adjust the clearance by slackening the lock nut and turning the tappet adjusting screw clockwise to reduce clearance and anti-clockwise to increase clearance. Recheck the clearance after tightening the lock nut.
16. Continue to check and adjust the remaining tappets in the following sequence:

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

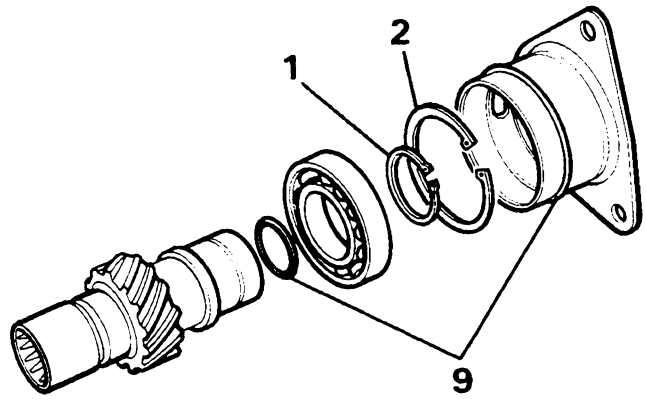
Fitting rocker cover

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



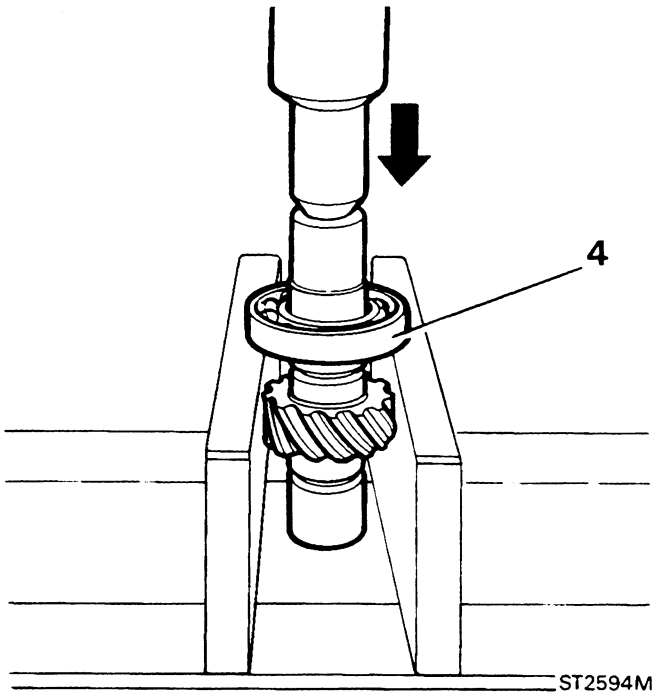
OVERHAUL AND FIT SKEW GEAR ASSEMBLY

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



ST2584M

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



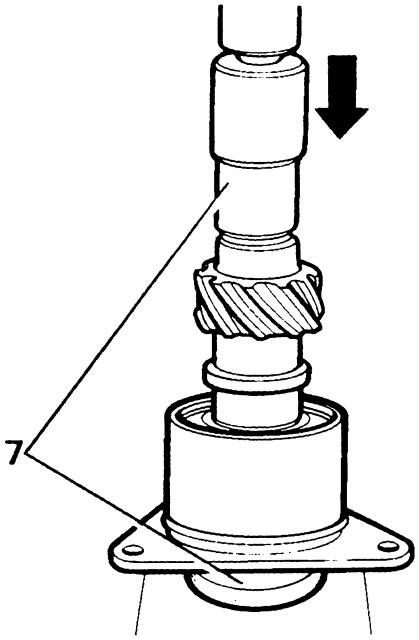
ST2594M

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

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

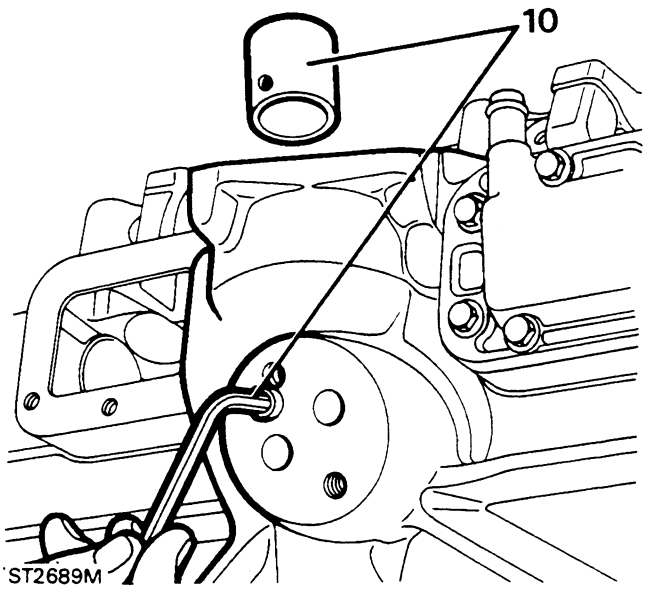
Assembling

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



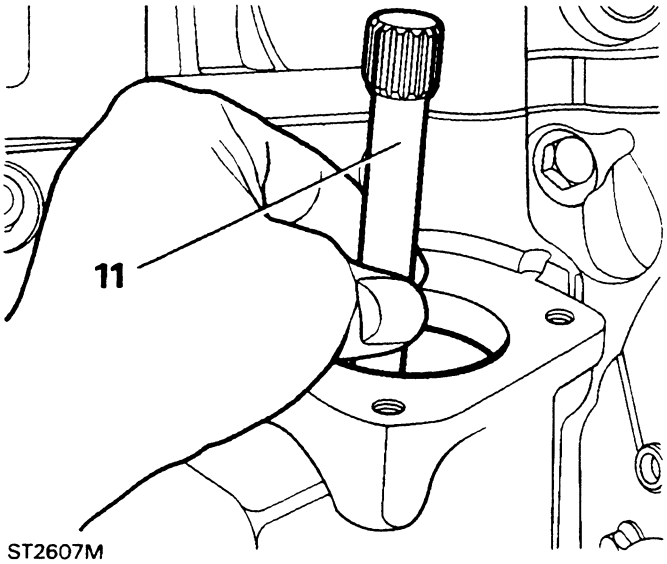
ST2595M

8. Secure the assembly with the two circlips.
9. Fit new 'O' seals to the inside diameter of the skew gear shaft and the outside diameter of the housing.
10. Fit a new skew gear bush to the cylinder block and secure with the socket headed screw. Ensure that the screw locates correctly into the hole in the bush.



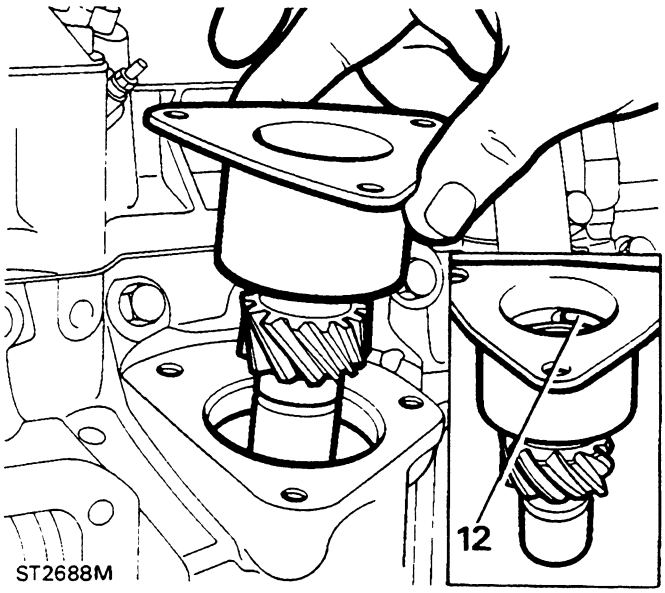
ST2689M

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



ST2607M

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



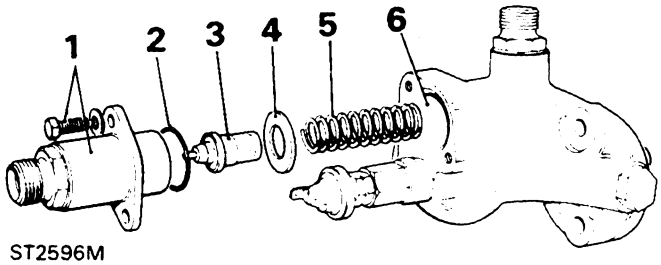
ST2688M

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

OVERHAUL AND FIT OIL FILTER ADAPTOR

Renew oil temperature thermostat

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

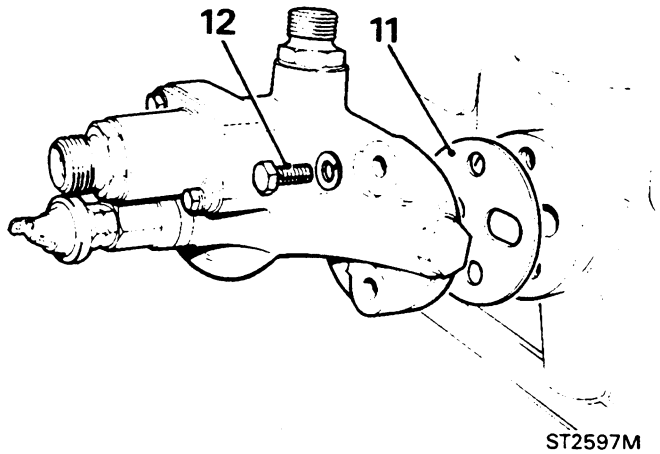


ST2596M

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

Fit oil adaptor

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



ST2597M

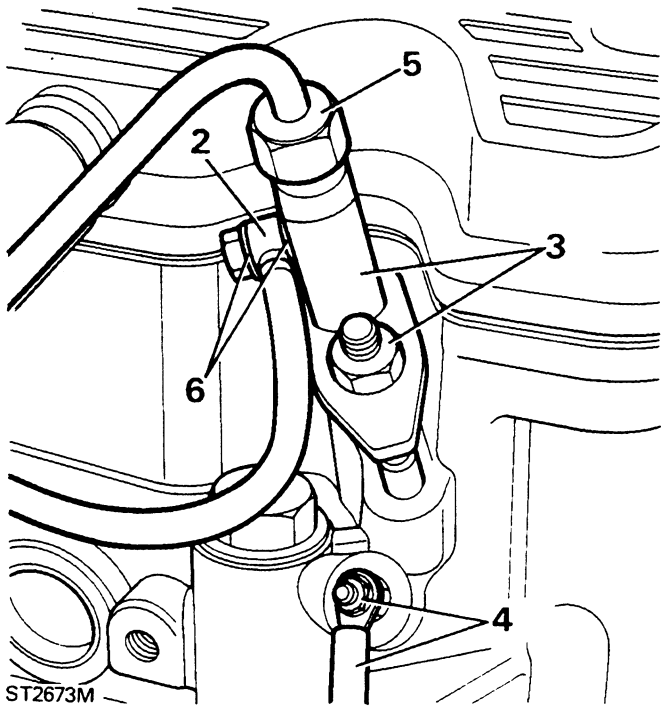
13. Smear a little clean engine oil on the rubber washer of the new filter, then screw the filter on clockwise until the rubber sealing ring touches the machined face, then tighten a further half turn by hand only.
14. Do not overtighten. See Maintenance Operations, section 10.

FIT FUEL LIFT PUMP AND REARSIDE COVER

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

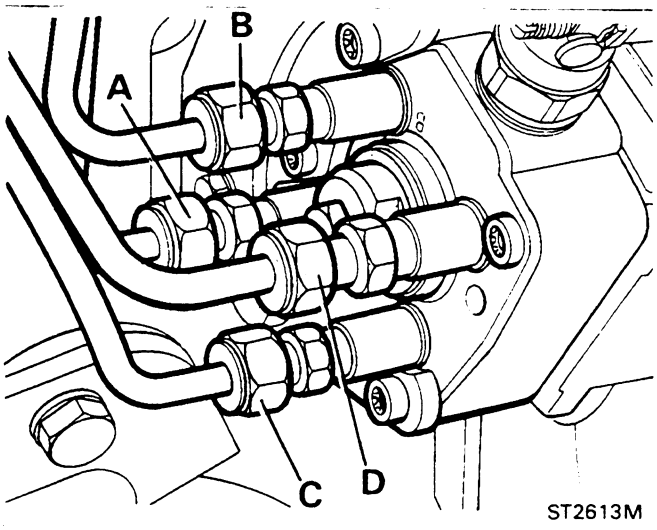
FITTING INJECTORS, PIPES AND HEATER PLUGS

1. Ensure that the injector location in the cylinder head is clean. Lightly grease a new copper washer to hold it in position on the injector while being fitted.
2. Fit the injectors noting that the spill return outlet faces towards the rear of the engine.
3. Secure each injector 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.
4. Fit the four heater plugs and tighten to the correct torque. Do not over-tighten. 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 breather cyclone.

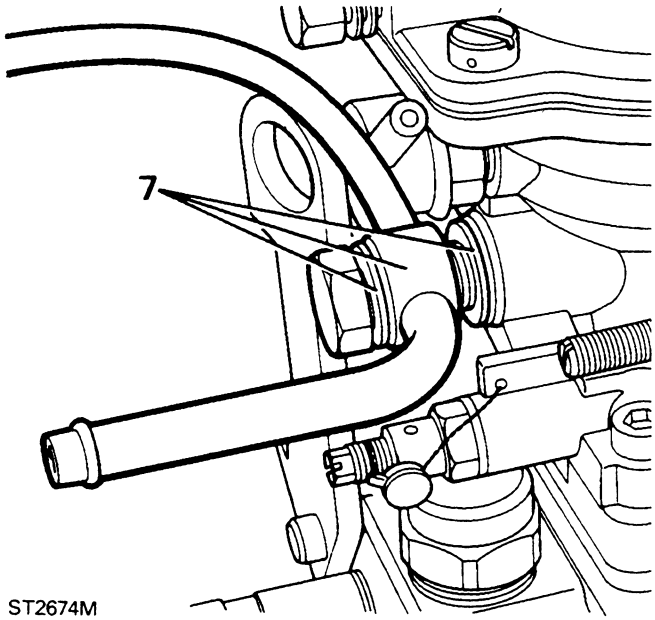


5. Fit the injector fuel supply pipes securing each end of the pipes to their respective locations loosely, then tighten evenly. Do not, however, over-tighten. Commencing at the front of the engine connect the pipes as follows:

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



6. 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.
7. 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.

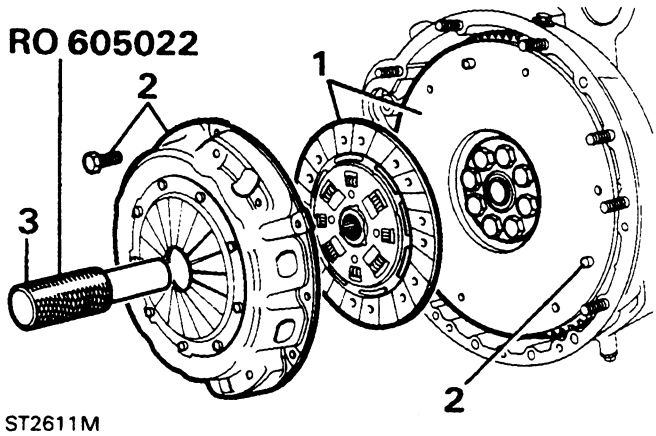


ST2674M

FIT THE CLUTCH

Unless the clutch has only been recently renewed, it is recommended that a new clutch pressure plate assembly and friction plate are fitted.

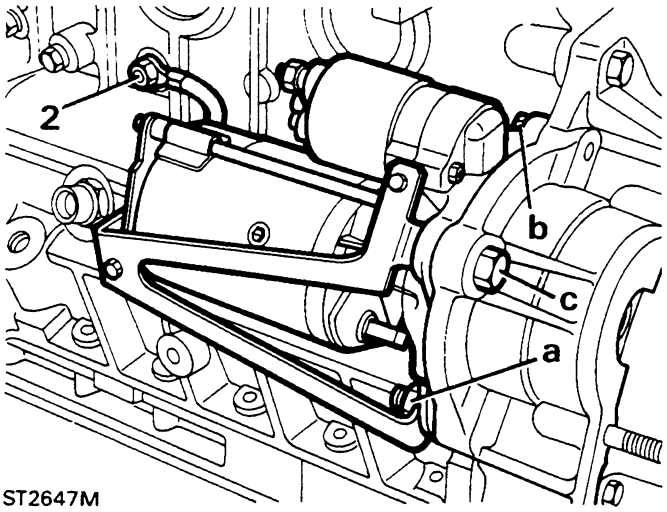
1. Clean the flywheel and place the friction plate with the raised centre section outwards away from the flywheel.
2. Fit the clutch assembly locating it over the three dowels and loosely secure with the six bolts.
3. Centralise the centre plate using special tool RO605022 or a spare primary shaft and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



ST2611M

FIT THE STARTER MOTOR

1. Fit the starter motor to the flywheel housing and secure with:
   a) one stud and nut
   b) one single bolt
   c) one nut and bolt.
   Evenly tighten to the correct torque.
2. Connect the starter motor earth lead to the cylinder block with a single washer and nut.

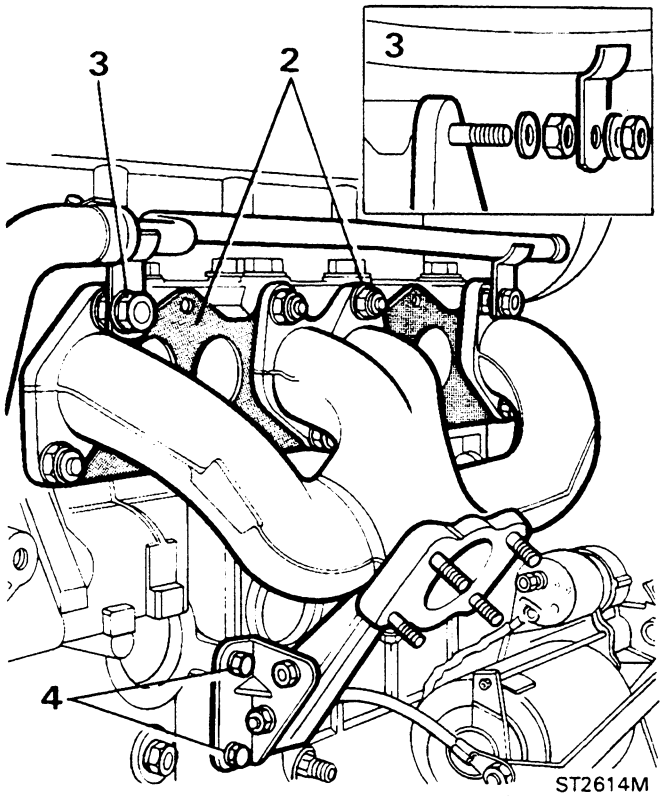


ST2647M

FITTING EXHAUST AND AIR INLET MANIFOLDS AND TURBO CHARGER

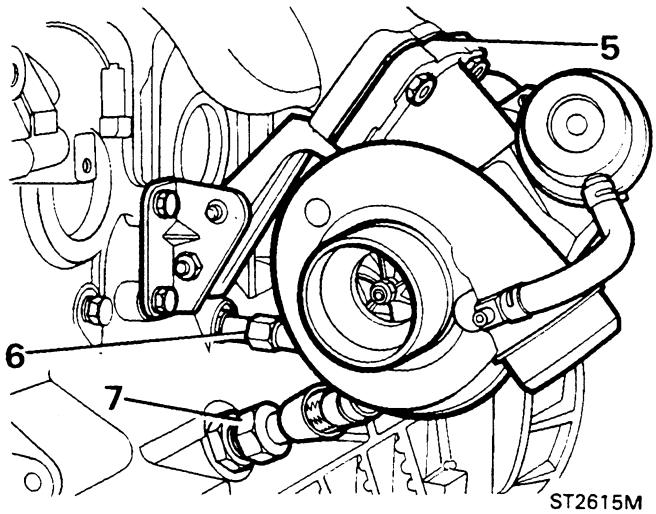
Exhaust manifold

1. Examine the manifold for damage, cracks and distortion and renew if necessary.
2. Clean the cylinder head mating face and fit a new manifold gasket. Fit the manifold complete with the lower support bracket. Secure the manifold with the seven nuts and plain washers and tighten evenly to the correct torque.
3. Attach the heater rail to the two end manifold studs and secure with a plain washer and locknut.
4. Secure the manifold support bracket to the cylinder block with the two bolts and plain washers.



ST2614M

5. If removed, fit the turbo charger to the exhaust manifold, using if necessary a new steel gasket between the manifold and turbo housing. The raised bead side of the gasket should be fitted towards the turbo charger. Tighten the four nuts, evenly, to the correct torque.
6. Connect the oil feed pipe to the cylinder block supply union.
7. Connect the oil drain hose to the cylinder block large connection.

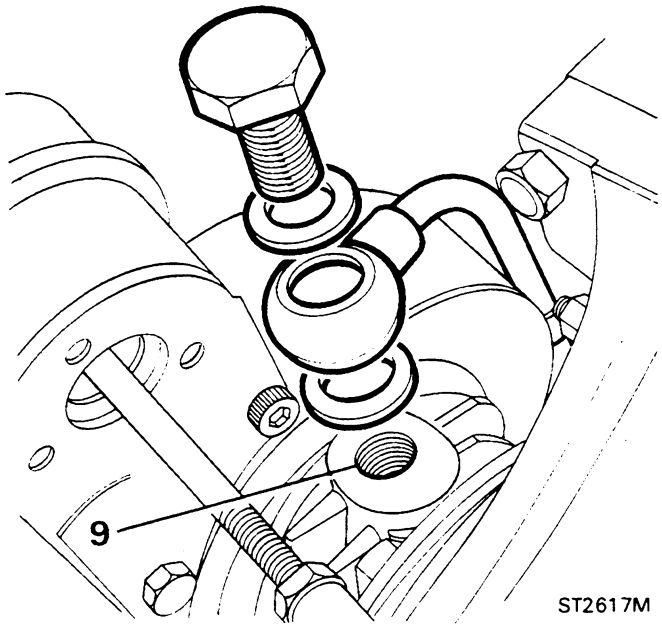


ST2615M

8. If removed, fit the exhaust elbow to the turbo charger, if necessary using a new steel gasket with the raised bead side towards the elbow. Fit and tighten the three retaining nuts and plain washers to the specified torque.
9. Connect the turbo charger boost pipe to the actuator.

CAUTION: In order to ensure an instantaneous supply of oil to the turbo charger when the engine is first started the system must be primed immediately prior to the engine being started as follows:

10. Remove the banjo bolt from the centre housing of the turbo charger and fill the housing with clean, new oil of the correct make and grade from a sealed container.

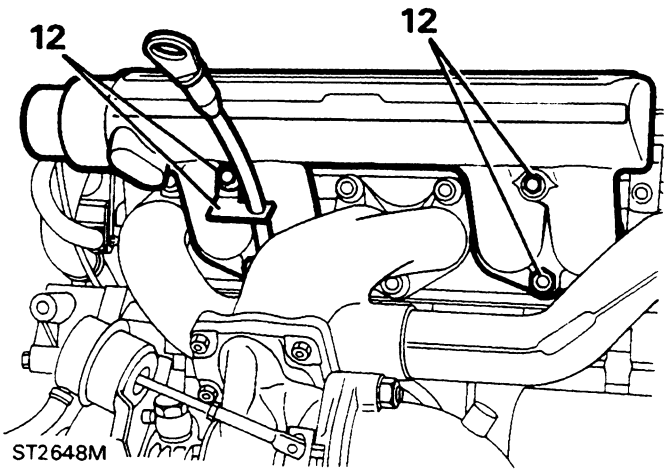


ST2617M

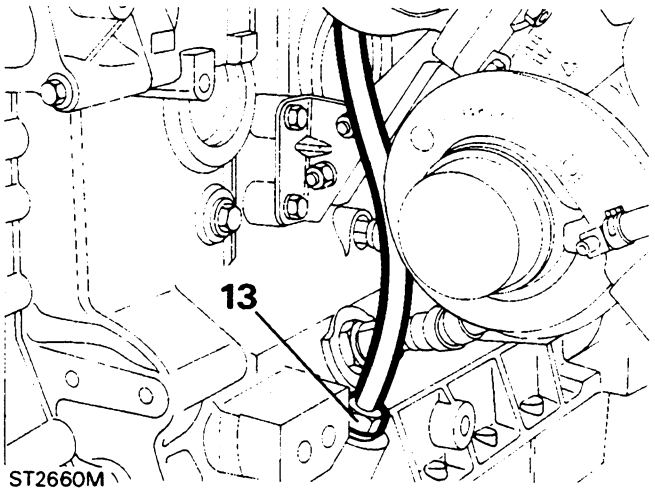
Refit the bolt ensuring that the copper washers are positioned one each side of the banjo connection and tightened to the correct torque.

Air inlet manifold

11. Examine the manifold for damage, cracks and distortion of the machined face.
12. Locate the manifold on the cylinder head over the two lower studs. secure with the two nuts and two bolts noting that the forward bolt also secures the dipstick bracket. Tighten the fixings evenly to the correct torque. On later engines the dipstick bracket is attached by two bolts.

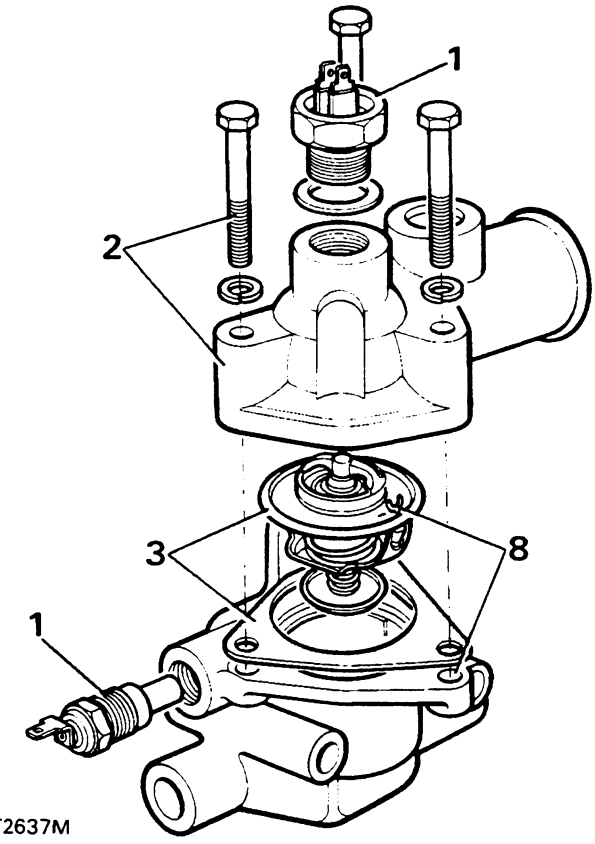


13. Fit the lower end of the dipstick tube to the crankcase connection and tighten the union nut.



OVERHAUL AND FIT THERMOSTAT HOUSING

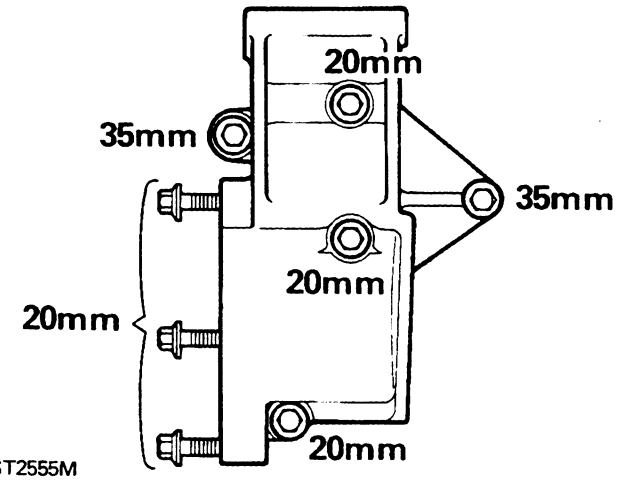
1. Secure the thermostat housing in a vice and remove the temperature sensor from the housing cover and the sensor from the body.
2. Remove the three screws and lift-off the housing cover.
3. Remove the cover gasket and lift-out the thermostat.
4. Clean and examine the housing and cover. Renew if damaged, cracked, pitted or corroded.
5. To test the thermostat, note the temperature stamped on the thermostat at which it should be fully open.
6. Place the thermostat and a Centigrade thermometer in a laboratory beaker, or suitable alternative, half full of water. Heat the water and observe the temperature at which the thermostat opens. If faulty discard the thermostat.
7. Apply Hylomar to the threads of the coolant temperature indicator sensor and fit to the body.
8. Fit the thermostat to the housing, noting that the "jiggle pin" must be positioned adjacent to the threaded hole furthest from the cylinder head.



9. Fit a new gasket and fit the cover and secure with the three screws.
10. Fit the temperature sensor and copper washer to the thermostat cover.
11. Clean the cylinder head and thermostat mating faces. Coat the threads of the fixing bolts with hylomar and fit the thermostat housing, with a new gasket, to the cylinder head. Tighten the bolts evenly to the correct torque.
12. Connect the heater rail hose to the thermostat housing and tighten the retaining clips.

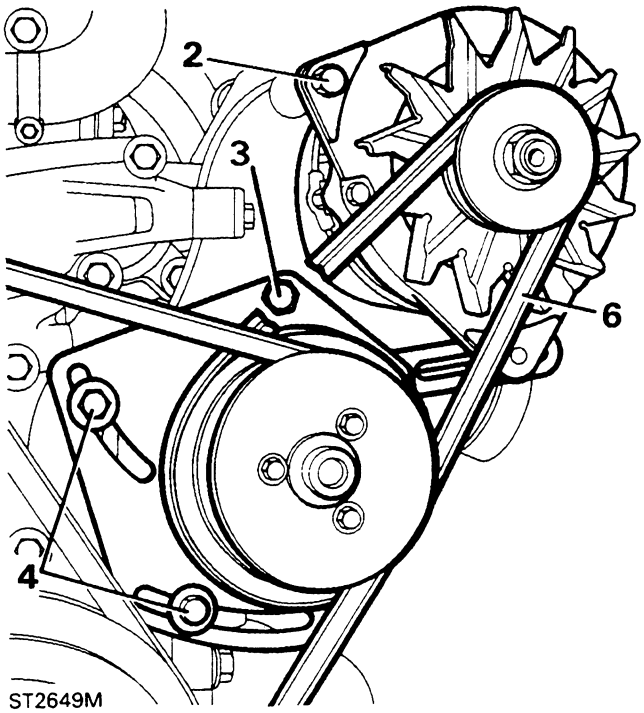
FIT THE ALTERNATOR AND POWER STEERING PUMP

1. Fit the common mounting bracket to the cylinder block and the front cover and secure with the five various length bolts as shown in the illustration below.



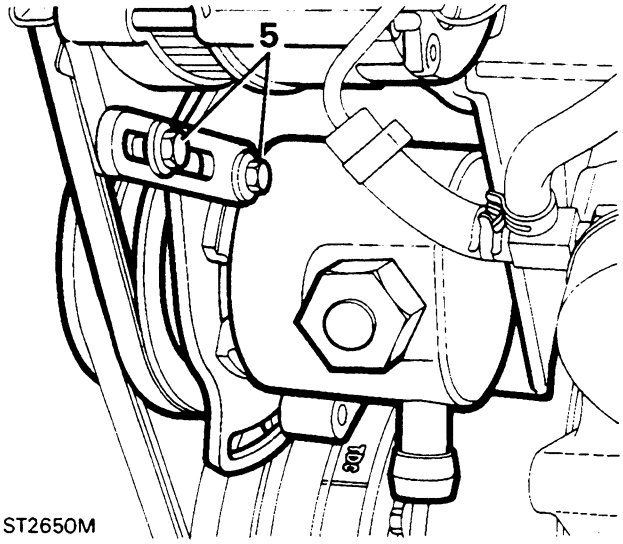
ST2555M

2. Fit the alternator loosely to the top half of the bracket with the pivot bolt and nut.
3. Offer up the power steering pump to the common mounting bracket and secure it loosely with the pivot bolt into the top threaded hole.
4. Fit the two adjacent clamp bolts for the power steering pump to the two lower threaded holes, through the slots in the pump bracket.



ST2649M

5. Attach the alternator adjustment link to the alternator threaded lower hole and secure loosely with the single bolt and washer.
6. Fit the alternator/power steering pump drive belt and leave slack until all belts are fitted.



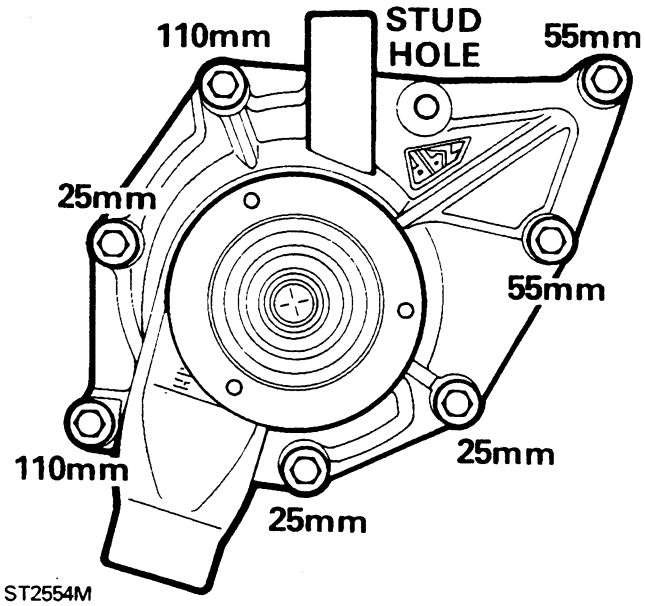
ST2650M

WATER PUMP INSPECTION AND FITTING

1. The water pump is not a reconditionable unit but its condition can be determined by the following checks.
2. Spin the pump spindle and listen for noise. Push and pull the spindle and check for sideways movement. The condition of the bearings can be judged from these checks.
3. During the above checks the clearance between the impeller and the pump body should not vary.
4. Inspect the vent hole in the pump body for signs of coolant or oil leaks. If there is any evidence of leakage, the pump should be renewed.

Fitting water pump

5. Lightly grease a new joint washer and place it in position on the timing cover.
6. 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.
7. Fit the pump to the cylinder block and secure with the seven bolts in accordance with the chart below. Tighten the bolts evenly to the correct torque.

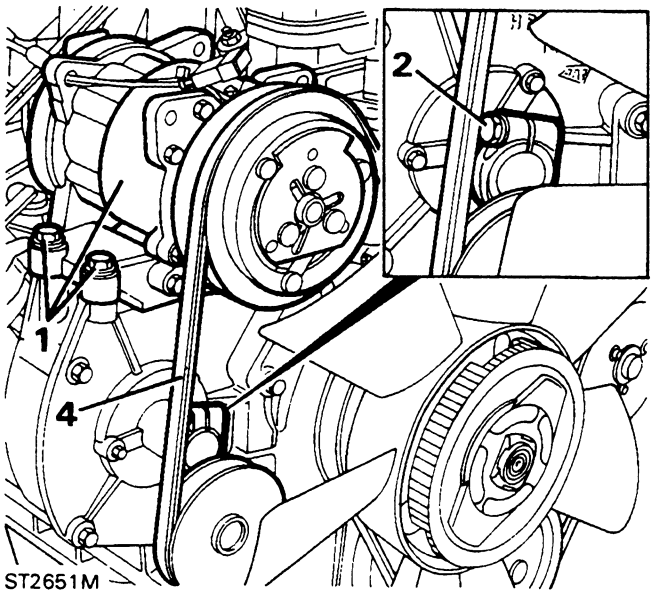


ST2554M

8. Connect the bypass hose to the water pump and thermostat housing and secure with hose clips.
9. If separated, fit the fan blades to the viscous coupling with the four screws.
10. Fit the fan and viscous coupling assembly to tha 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 AIR CONDITIONING COMPRESSOR

1. Mount the compressor on the engine and secure with the four bolts and tighten evenly to the correct torque.
2. Fit the drive belt tensioning jockey pulley to the front cover plate and loosely secure with the pinch bolt.



ST2651M

3. Fit the double drive belt pulley to the crankshaft damper and secure with the four bolts.
4. Fit the drive belt, but leave slack at this stage.

TENSIONING DRIVE BELTS

Fan - Power steering pump belt

1. Move the power steering pump to the right and tighten the two clamp bolts and the pivot bolt.

   CAUTION: Do not lever against the power steering pump body to tension the belt since it will damage the pump beyond repair.

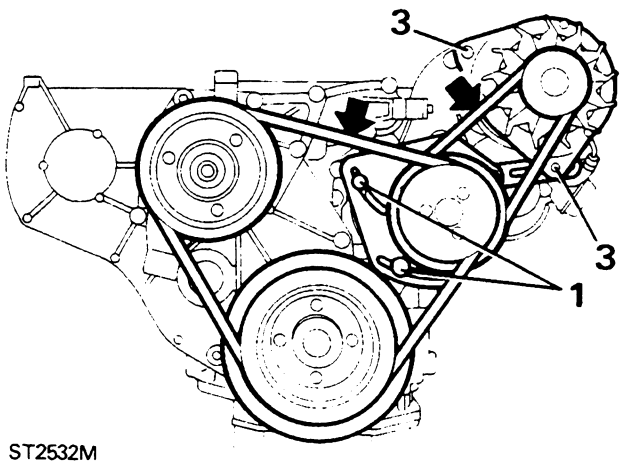
2. Check the tension of the belt which should deflect, by thumb pressure, 5 mm at the mid-point of the run between the water pump and power steering pump.

Alternator drive belt

3. Swing the alternator to the right to tension the belt and tighten the adjustment link clamp bolt, the link pivot bolt and the alternator top pivot bolt.

   CAUTION: Do not lever against the slip ring end or stator to tension the belt otherwise damage to the alternator may result.

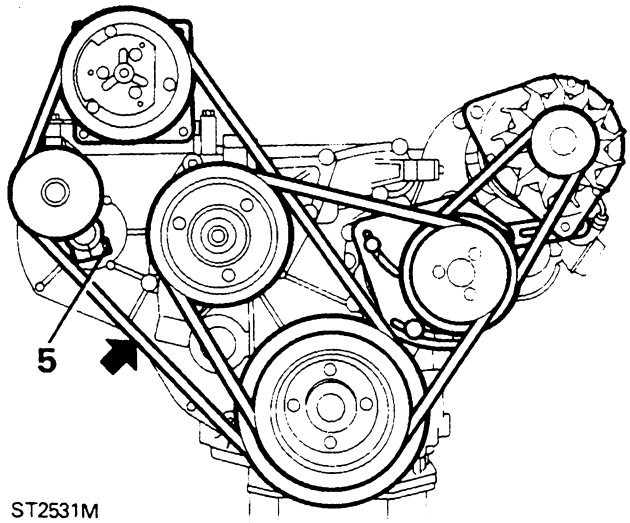
4. The tension of the belt is correct when it can be deflected, by thumb pressure, approximately 4 mm at the mid-point of the run between the power steering pump and alternator pulleys.



ST2532M

Compressor drive belt

5. Move the jockey pulley to the left and tighten the pinch bolt. The tension is correct when the belt can be deflected by thumb pressure, approximately 8 mm at the mid-point of the run between the compressor and crankshaft pulleys.



ST2531M

Once the engine has been fitted to the vehicle, the tension of all the drive belts must be checked and if necessary adjusted after the engine has been run for at least three to five minutes. See Maintenance section 10 for full information. The above deflection figures are approximate to enable the engine to be run.

PRIOR TO STARTING ENGINE

When the engine has been refitted to the vehicle the following checks should be made:

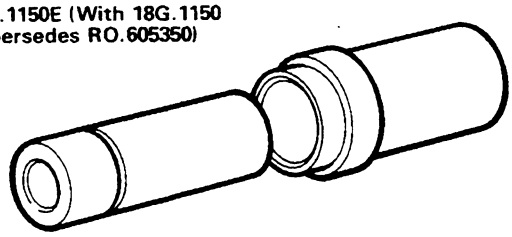
1. Check that the sump and cylinder block drain plugs are tight.
2. Fill the sump with new oil of the correct make and grade from a sealed container to the high mark on the dipstick.
3. Check that all pipes and hoses are secure and that all electrical connections are made.
4. Fill the cooling system with a 50 - 50 mixture of water and anti-freeze.
5. Connect the battery and start the engine. Run for approximately five to ten minutes whilst checking for oil, fuel and coolant leaks. Stop the engine, disconnect the battery and allow to cool. Check the oil and coolant levels and top-up if necessary. Check the tension of the drive belts as described in the Maintenance section 10 and adjust if required.

DISMANTLE OVERHAUL AND ASSEMBLE

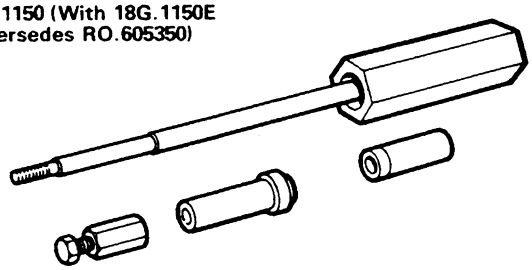
Special tools:
Guide bolts - 605351
Clutch centralising tool - 18G79
Gudgeon pin remover/replacer - basic tool - 18G1150
Adaptor remover/replacer - gudgeon pin - 18G1150E or 605350
Spring compressor - 18G106A or RO276102 or MS1519A
Valve guide drift exhaust and inlet - 600959
Valve cutter handle set - MS76B
8.5 Adjustable pilot - MS150-8.5
Valve seat cutter - MS621
Drift for guide removal - inlet and exhaust - RO274401
Crankshaft rear seal sleeve - RO1014

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.

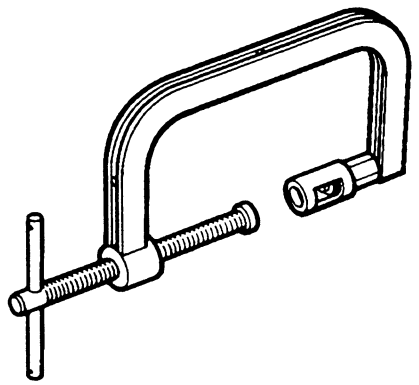
18G.1150E (With 18G.1150 Supersedes RO.605350)



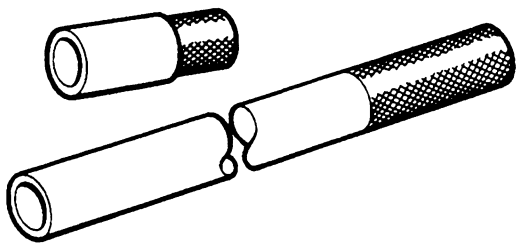
18G.1150 (With 18G.1150E Supersedes RO.605350)



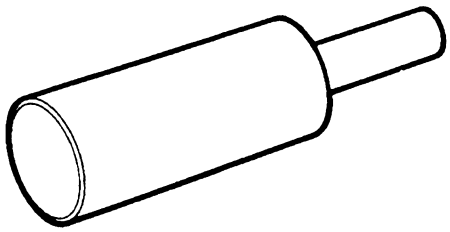
MS1519A



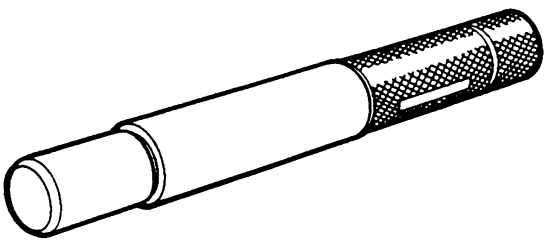
RO.605351



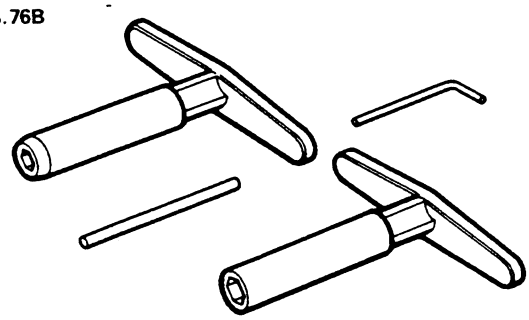
RO.600959



18G.79

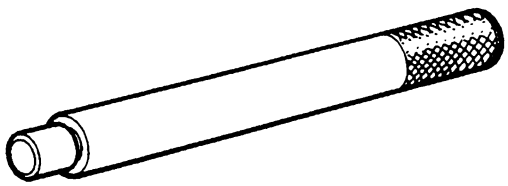


MS.76B



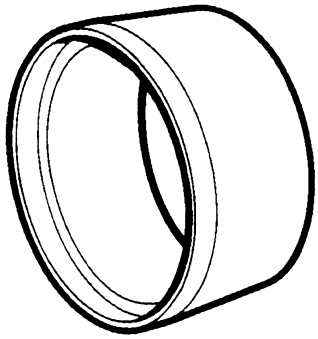
ST2397M

RO.274401

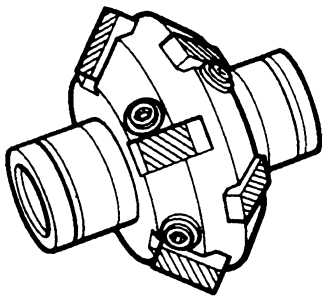


Dia. 8.4mm - 9.0mm

RO.1014

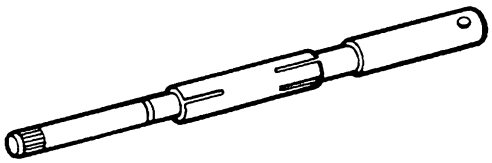


MS.621



Dia. Range 28.5mm - 44mm 15° & 45°

MS.150-8.5



ST2398M

DATA

Crankshaft

Main journal diameter	58,409 - 58,422 mm (2.2996 - 2.3001 in)
Minimum regrind diameter	57,393 - 57,406 mm (2.2596 - 2.2601 in)
Crankpin journal diameter	50,800 - 50,812 mm (2.0000 - 2.0005 in)
Minimum regrind diameter	49,784 - 49,797 mm (1.9600 - 1.9605 in)
Crankshaft end thrust	Taken on thrust washers of centre main bearing
Crankshaft end-float	0,10 - 0,20 mm (0.004 - 0.008 in)

Main bearings

Diametrical clearance	0,010 - 0,048 mm (0.0004 - 0.0019 in)
Undersizes	0,254 mm, 0,508 mm (0.010 in, 0.020 in)

Big-end bearings

Diametrical clearance	0,015 - 0,055 mm (0.0006 - 0.0022 in)
End-float on crankpin	0,15 - 0,36 mm (0.006 - 0.014 in)
Undersizes	0,254 mm 0,508 (0.010 in 0.020 in)

Gudgeon pins

Length	72,67 - 72,79 mm (2.861 - 2.866 in)
Diameter	22,215 - 22,22 mm (0.8746 - 0.8749 in)
Fit-in connecting rod	Press fit
Clearance in piston	0,002 - 0,007 mm (0.0001 - 0.0003 in)

Pistons

Clearance in bore measured at bottom of skirt at right angles to gudgeon pin	0,018 - 0,040 mm (0.0007 - 0.0016 in)

Piston rings

Number of compression	2
Number of oil	1
No.1 compression ring	Chrome parallel faced
No.2 compression ring	Stepped to 'L' shape and marked 'T' or 'TOP'
Width of compression	1,56 - 1,59 mm (0.0615 - 0.0625 in)
Compression ring gap	0,44 - 0,57 mm 0.017 - 0.022 in)
Oil ring type	Perfect circle, type 98-6
Oil ring width	4.811 mm (0.1894 in) max

Camshaft

Location	Central
Bearings	Non-serviceable
Number of bearings	5
Drive	Chain 9,52 mm (0.375 in) pitch x 54 pitches

Valves

Length:	
Inlet	116,59 - 117,35 mm (4.590 - 4,620 in)
Exhaust	116,59 - 117,35 mm (4.590 - 4.620 in)
Seat angle:	
Inlet	45° - 45,5°
Exhaust	45° - 45,5°
Head diameter:	
Inlet	39,75 - 40,00 mm (1.565 - 1,575 in)
Exhaust	34,226 - 34,480 mm (1.3475 - 1.3575 in)
Stem diameter:	
Inlet	8,664 - 8,679 mm (0.3411 - 0.3417 in)
Exhaust	8,651 - 8,666 mm (0.3406 - 0.3412 in)
Stem to guide clearance:	
Inlet	0,025 - 0,066 mm (0.0010 - 0.0010 - 0.0026 in)
Exhaust	0,038 - 0,078 mm (0.0015 - 0.0031 in)
Valve lift (inlet and exhaust)	9,93 mm (0.390 in)
Valve spring length fitted	40,4 mm (1.590 in) at pressure of 29,5 kg (65 lbs)

Oil pressure relief valve

Type	Non-adjustable
Relief valve spring:	
Free length	81,2 mm (3.200 in)
Compressed length at 4,2 kg (9.3 lb) load	45.7 mm (1.800 in)

TORQUE WRENCH SETTINGS	Nm	lbf ft
Air intake adaptor to carbs	24	17
Alternator mounting bracket to cylinder head	34	25
Alternator to mounting bracket	24	17
Alternator to adjusting link	24	17
Chainwheel to camshaft	54 - 61	40 - 45
Connecting rod bolt	47 - 54	35 - 40
Clutch attachment to flywheel	24 - 30	18 - 22
Cylinder head:		
Outer row	54 -61	40 - 45
Centre row	88 - 95	65 - 70
Inner row	88 - 95	65 - 70
Distributor clamp nut	19 - 22	14 - 16
Exhaust manifold to cylinder head	19 - 22	14 - 16
Fan attachment	11,5	
Flywheel to crankshaft	74 - 81	55 - 60
Inlet manifold to cylinder heads	47 - 54	35 - 40
Lifting eye to cylinder heads	24	17
Main bearing cap bolts	68 - 75	50 - 55
Main bearing cap rear bolts	88 - 95	65 - 70
Manifold gasket clamp bolt	13,5 - 20	10 - 15
Oil pump cover to timing cover	11 - 14	8 - 10
Oil plug	25 - 30	18 - 22
Oil relief valve cap	61	45
Oil sump drain plug	40,6 - 47	30 - 35
Oil sump to cylinder block	8 - 11	5 - 8
Oil sump to cylinder block - rear	17,6 - 20,3	13 - 15
Rocker cover to cylinder head	7	5
Rocker shaft bracket to cylinder head	34 - 40	25 - 30
Spark plug	19 - 21	14 - 16
Starter motor attachment	40,6 - 47,4	30 - 35
Damper to crankshaft	257 - 285	190 - 210
Timing cover to cylinder block	24 - 30	18 - 22
Tempatrol unit to water pump	36 - 40	27 - 30
Water pump pulley to water pump hub	23	17
Water pump and timing cover to cylinder block	24 - 30	18 - 22

DISMANTLE

Remove the engine from the vehicle and clean the exterior. In the interests of safety and efficient working secure the engine to a recognised engine stand. Drain and discard the sump oil. Observe the precautions concerning used engine oil in the 'introduction' section 01.

WARNING: Where the use of an engine stand is necessary, it is absolutely essential to follow the stand manufacturer's instructions to ensure safe and effective use of the equipment.

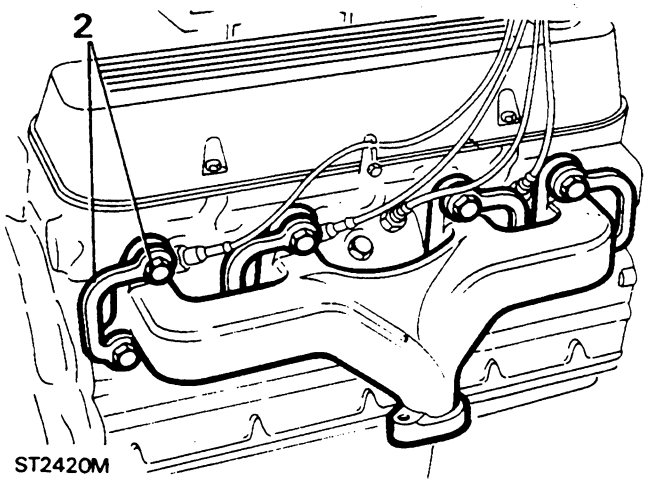
REMOVE ANCILLARY EQUIPMENT

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

1. Remove the following items of equipment:
   Starter motor.
   Alternator and mounting bracket.
   Power steering pump.
   Disconnect spark plug H.T. leads and remove the disributor cap.
   Clutch
   Fan blades, pulley and drive belt.
   Dipstick and engine mounting brackets.

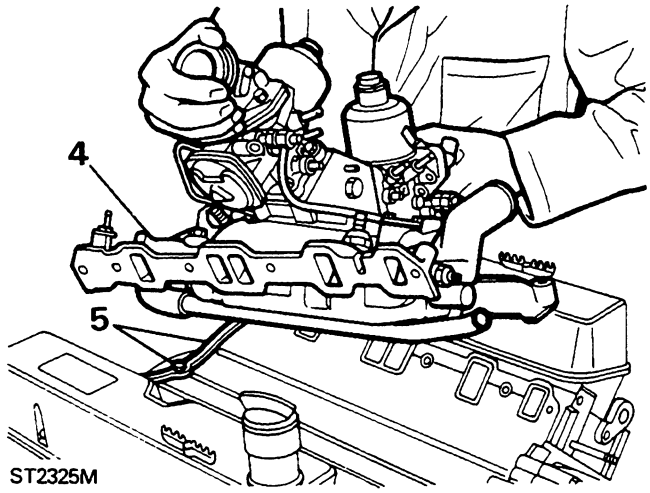
Remove exhaust manifolds

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

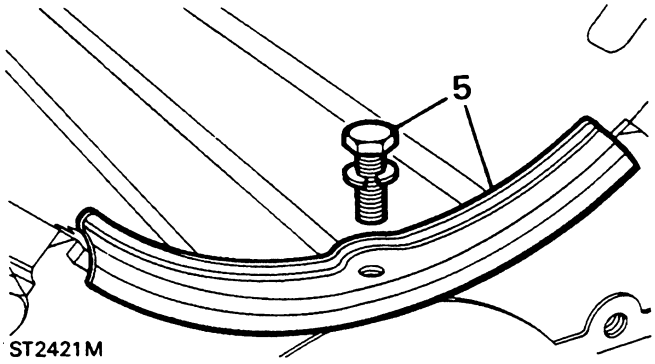


Remove induction manifold

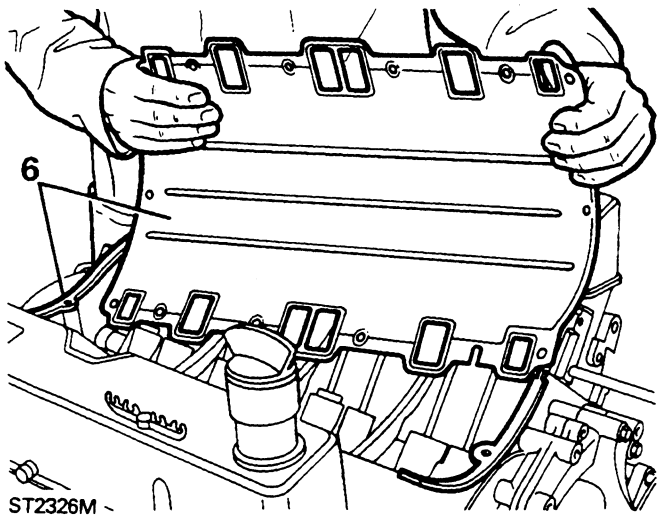
3. Disconnect miscellaneous pipes and hoses from the induction manifold and the carburetters.
4. Evenly slacken and remove the twelve bolts and lift off the induction manifold complete with carburetters.



5. Wipe away any surplus coolant lying on the manifold gasket and remove the gasket clamp bolts and remove the clamps.



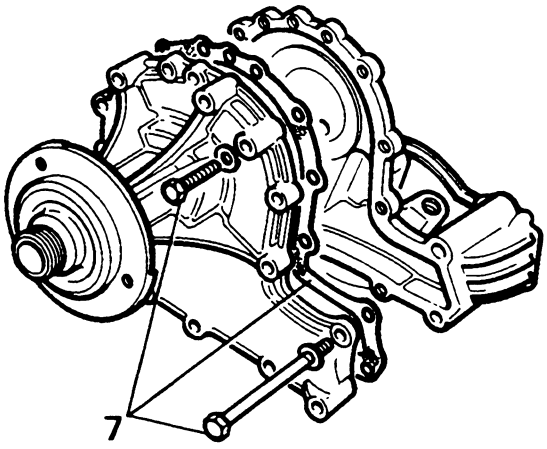
6. Lift off the manifold gasket and seals to reveal the tappets and push rods.



Remove water pump

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

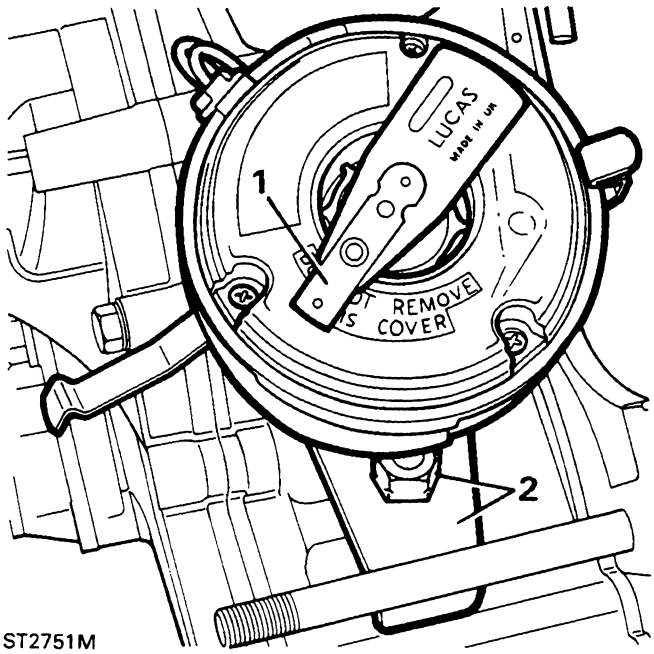
NOTE: The water pump is not a serviceable item, in the event of bearing failure or severe corrosion to the pump impeller vanes. Fit a new water pump assembly.



ST2452M

REMOVE THE DISTRIBUTOR

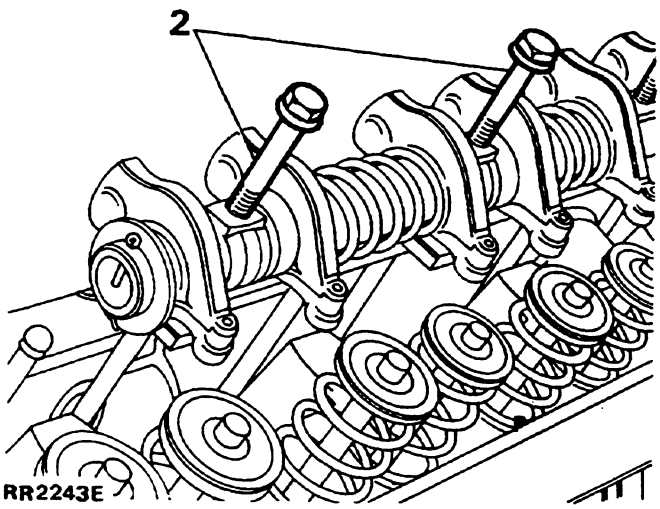
1. Remove the distributor cap and turn the crankshaft until the rotor arm is pointing to number one plug lead in the distributor cap.
2. Remove the nut securing the distributor clamp and lift-off the distributor.



ST2751M

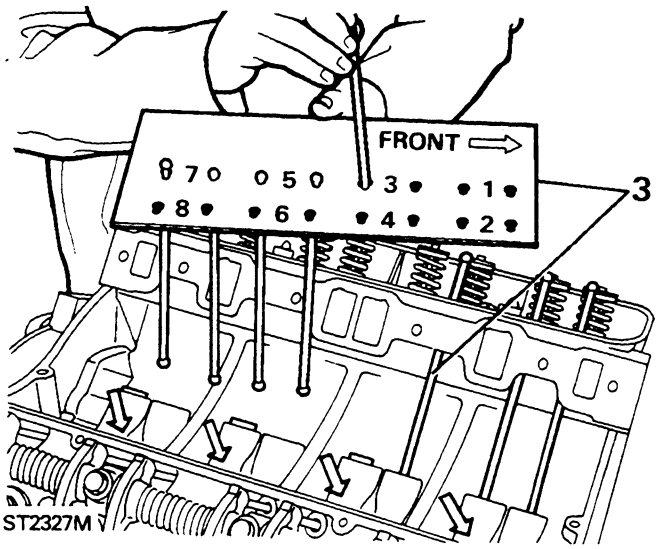
REMOVE ROCKER SHAFTS AND VALVE GEAR

1. Remove the screws and lift-off the rocker covers. Before removing the rocker shaft and valve gear, mark each shaft with the cylinder head from which it was removed, ie. left-hand or right-hand.
2. Remove the four rocker shaft retaining bolts and lift-off the assembly.



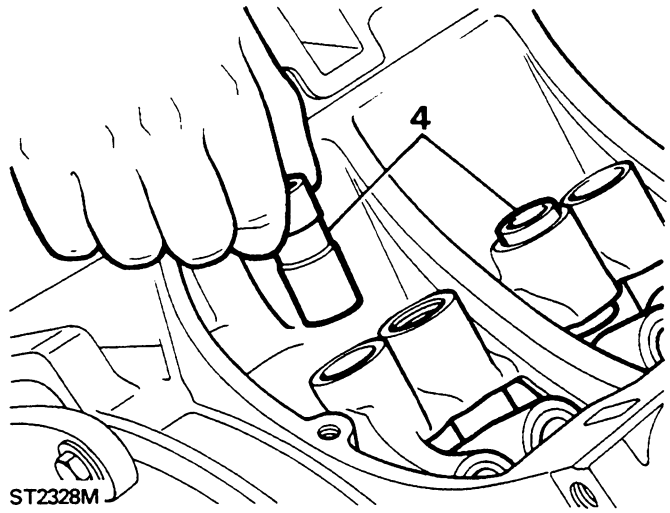
RR2243E

3. Withdraw the pushrods and retain in the sequence removed by inserting each rod in a suitable numbered piece of card as illustrated. Take care not to allow the rods to become dislodged and fall into the crankcase through the oil drain holes as shown by the arrows.



ST2327M

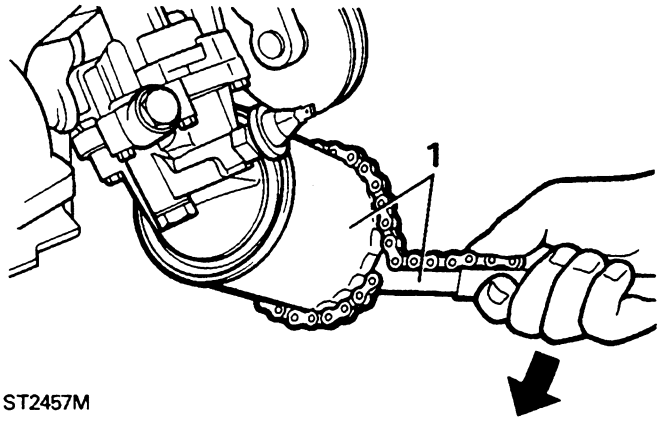
4. Remove the hydraulic tappets and immerse in clean engine oil and place to one side.
5. If a tappet cannot be removed due to damage and enlargement of the cam face, no attempt should be made to remove the tappet at this stage, but leave in position until the camshaft is removed. Any attempt to force a tappet out will damage the tappet bore in the cylinder block.



ST2328M

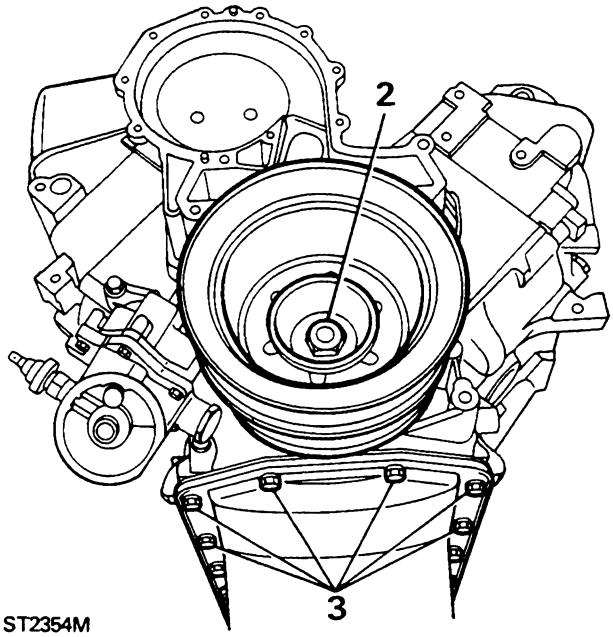
REMOVE TIMING GEAR COVER AND OIL PUMP

1. Place an oil drip tray beneath the timing cover and remove the oil filter cartridge by turning anti-clockwise using, if necessary, a strap wrench to overcome the initial torque.



ST2457M

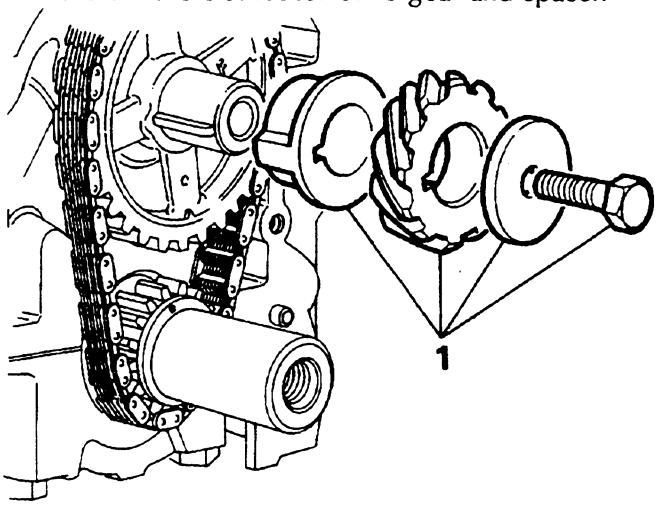
2. Remove the crankshaft pulley bolt and special washer and withdraw the pulley.
3. Remove the two bolts securing the sump to the bottom of the timing cover and slacken the four front side bolts.
4. Remove the remaining timing cover retaining bolts and withdraw the cover complete with oil pump.



ST2354M

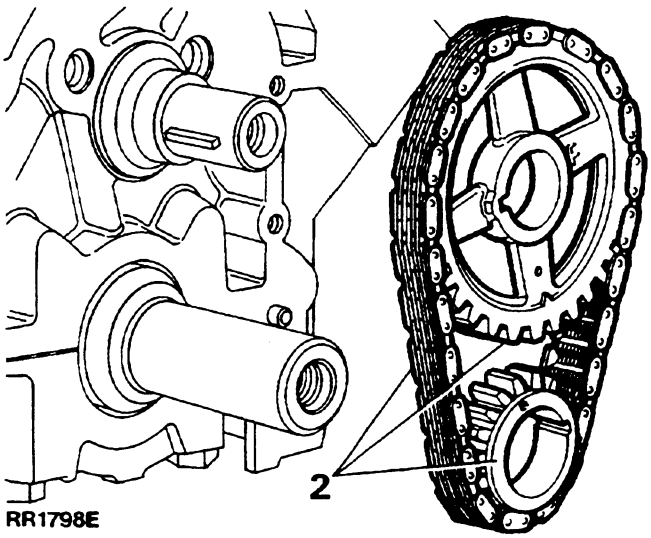
REMOVE TIMING CHAIN AND SPROCKETS

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



RR1797E

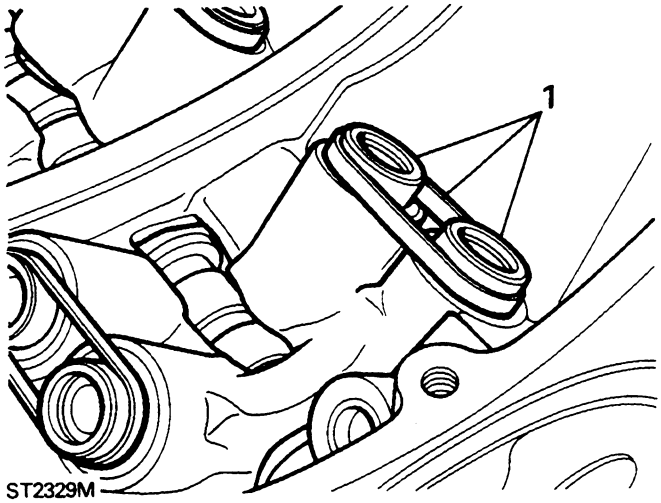
2. Withdraw the camshaft and crankshaft sprockets complete with the timing chain.



RR1798E

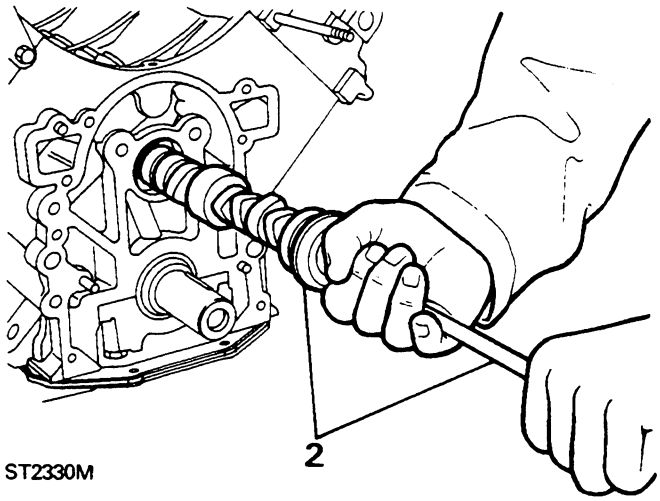
REMOVE THE CAMSHAFT

1. If there are any tappets that could not be removed earlier due to enlarged cam faces, insert the tappet next to the damaged one and lift them both clear of the camshaft and secure together with a rubber band.



ST2329M

2. Withdraw the camshaft whilst taking care not to damage the bearings in the cylinder block. To assist in keeping the camshaft horizontal whilst withdrawing it from the cylinder block, insert a screw driver or suitable bar into the threaded hole in the end of the shaft to enable it to be supported by both hands to prevent the shaft falling on the bearings as it is released from the rear bearing.

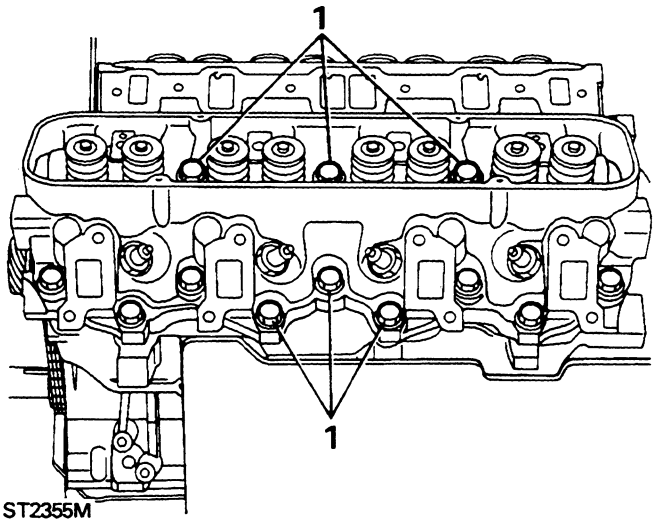


ST2330M

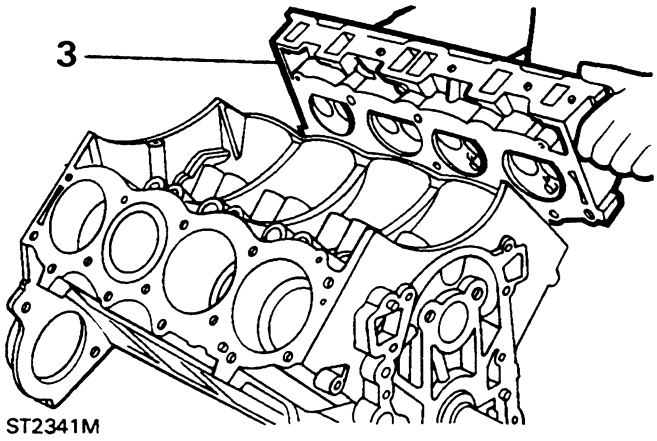
3. Remove the sump and retrieve the damaged tappets from the crankcase.

REMOVE THE CYLINDER HEADS

1. Evenly slacken and remove the fourteen cylinder head bolts reversing the tightening order to prevent distortion (nine side bolts and five top bolts.

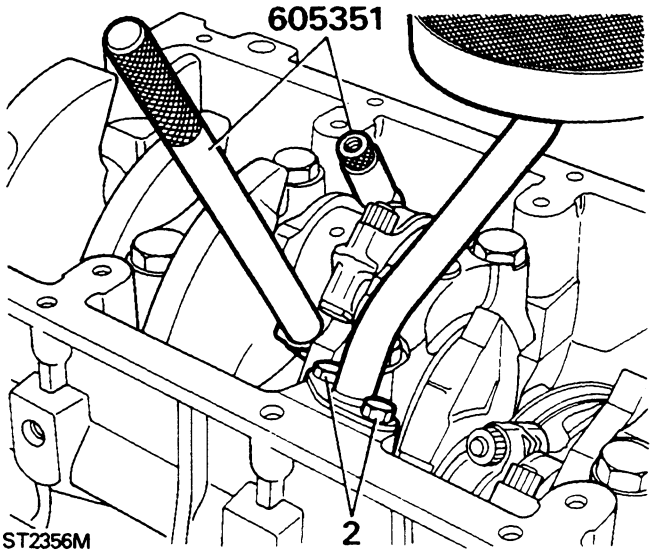


2. Before removing the heads mark them relative to the L.H. and R.H. side of the engine.
3. Lift off the cylinder heads and discard the gasket.

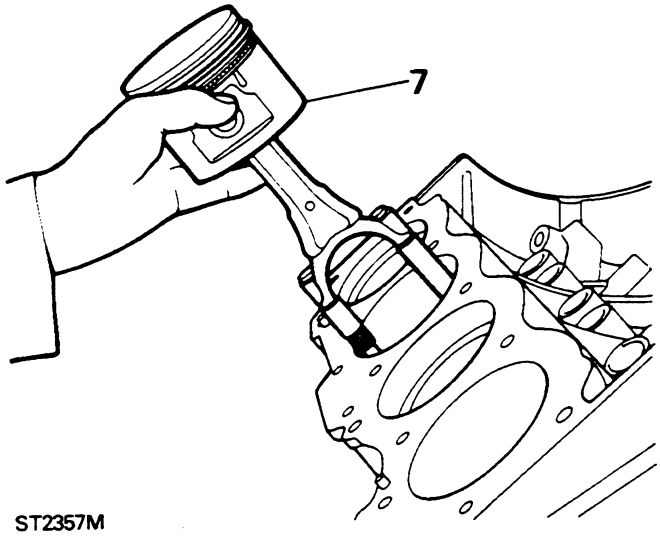


REMOVE CONNECTING-RODS AND PISTONS

1. Turn the engine over and withdraw the remaining bolts and remove the sump, if not already removed.
2. Remove the sump bolts and oil strainer.
3. Mark each piston assembly with the number of the bore from which it will be removed.
4. Turn the crankshaft so that the first piston to be removed is at bottom dead centre.
5. Remove the connecting-rod caps and retain them in sequence for reassembly.
6. Screw the guide bolts 605351 on to each the connecting-rod in turn. Fit the longer guide bolt to the lowest connecting rod bolt.



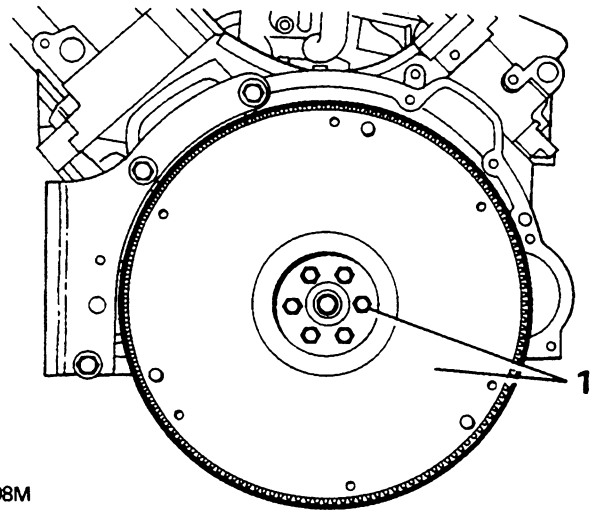
7. Check that the connecting rod big-end is aligned exactly with the bore and push the connecting-rod and piston assembly up the cylinder bore and withdraw it from the top. Retain the connecting-rod and piston assemblies in sequence with their respective caps and bearing shells.
8. Remove the guide bolts from the connecting-rod and repeat the above instructions on the remaining connecting rods and pistons.



REMOVE THE FLYWHEEL

1. Prevent the cranshaft from turning and remove the retaining bolts and withdraw the flywheel from the crankshaft.

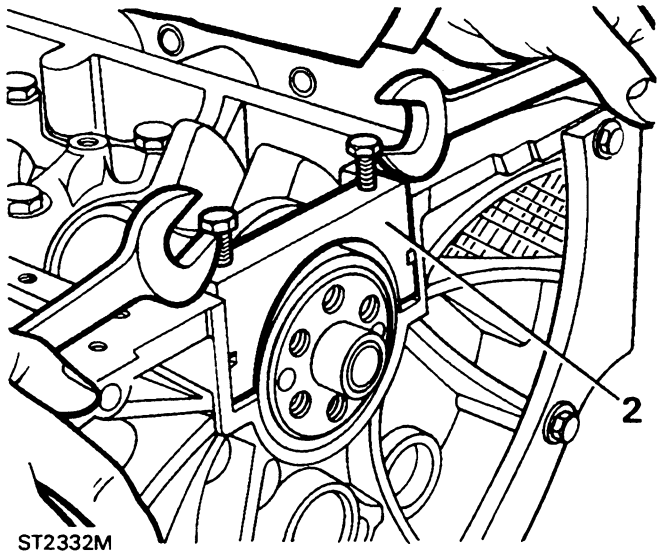
   WARNING: Hold the flywheel firmly while the last bolt is being removed to prevent the flywheel falling and causing personal injury.



ST2408M

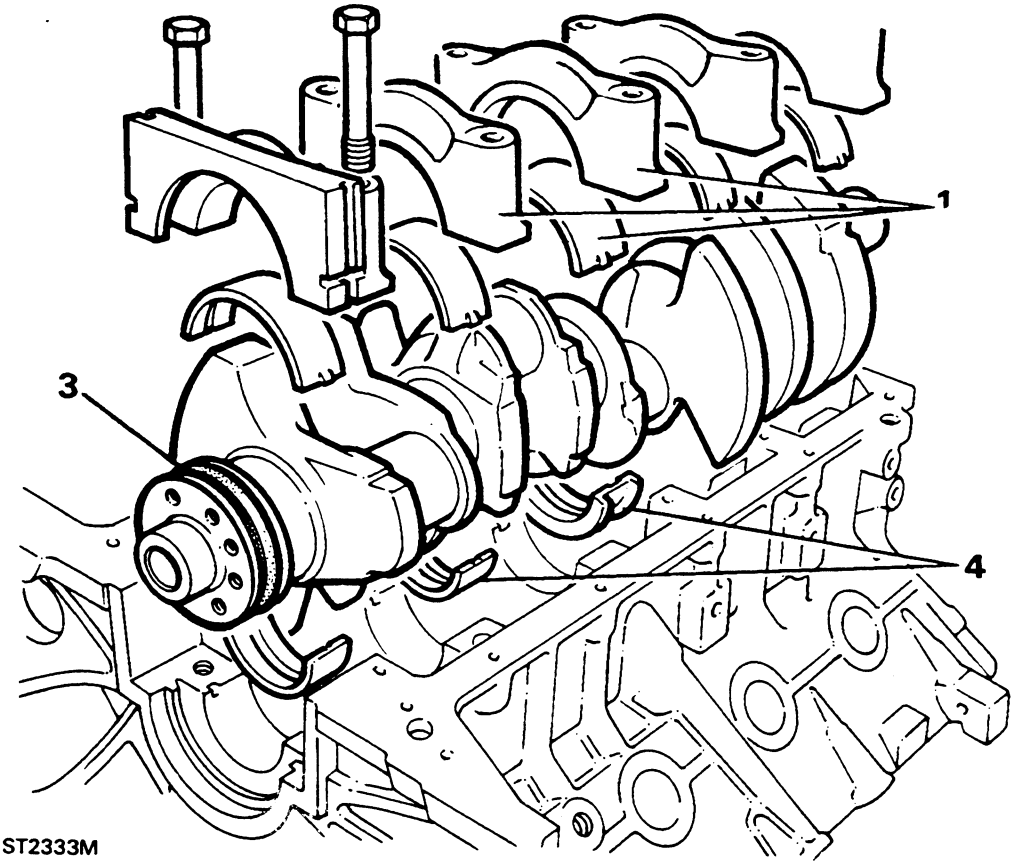
REMOVE THE CRANKSHAFT

1. Remove the main bearing caps and lower bearing shells and retain in sequence. It is important to keep them in pairs and mark them with the number of the respective journal until it is decided if the bearing shells are to be refitted.
2. Remove the rear main bearing cap using two spanners as illustrated below, taking care not to damage the cylinder block face.



ST2332M

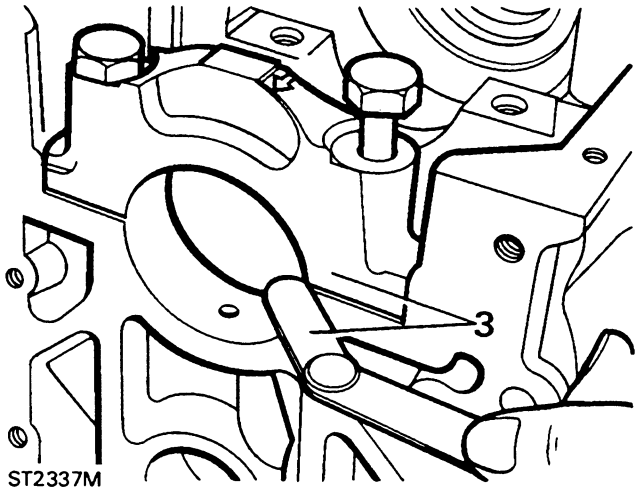
3. Lift out the crankshaft and rear oil seal.
4. Remove the upper bearing shells from the cylinder block.



ST2333M

EXAMINE AND OVERHAUL CYLINDER BLOCK

1. Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage.
2. The cylinder bores are cast iron lined and are shrunk into the bores. The liners must not be bored out more than 0,508 mm and if they have been bored already beyond this oversize the cylinder block must be renewed.
3. Assuming that, so far, the cylinder block is satisfactory for reconditioning, proceed to the next stage of the examination. To check the main bearing caps and saddles for distortion, fit the main bearing caps without bearing shells and tighten to the correct torque. Slacken and remove the bolt on one side of each bearing cap and check with a feeler gauge that no clearance exists at the joint face between the cap and saddle. A clearance indicates either a bent bolt, distortion of the caps, or block or that the cap has been filed or machined in an attempt to reduce the clearance due to wear in the bearings. Main bearing caps are not available separately from the cylinder block and if a clearance exists the block must be renewed.

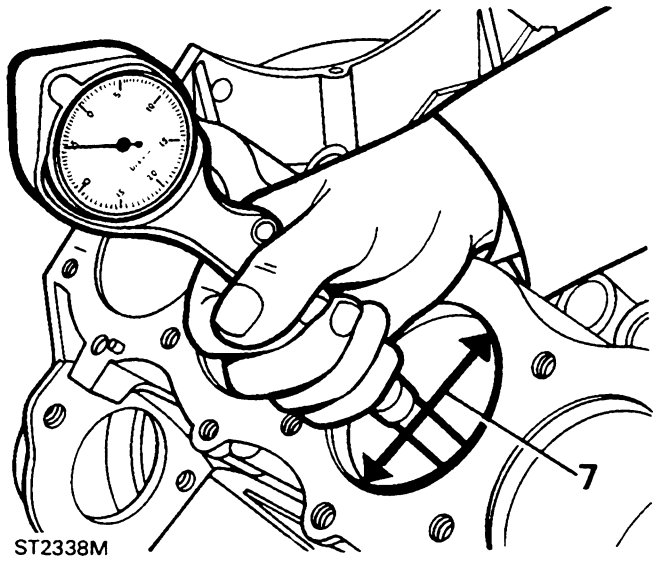


Camshaft bearings

4. Each of the five camshaft bearings is a different diameter, with the smallest at the rear and the largest at the front. If the bearings are excessively worn, pitted, or scored the cylinder block must be renewed since the bearings are not available as replacement parts.

Inspect cylinder bores

5. 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.
6. Check the ovality of each bore by taking measurements at the top of the cylinder 40 to 50 mm (1.5 to 2.0 ins) from the top of the cylinder at two points diametrically opposite. The difference between the two figures is the ovality of the bore. Similar measurements should be made approximately 50 mm (2.0 ins) up from the bottom of the bore so that the overall ovality may be determined.
7. The taper of the bore 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.



8. To establish maximum overall bore wear, take measurements at as many points as possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared to the original diameter of the cylinder bore.

   Maximum permissible ovality 0,127 mm (0.005 in).
   Maximum permissible taper 0,254 mm (0.010 in).
   Maximum permissible overall wear 0,177 mm (0.007 in).

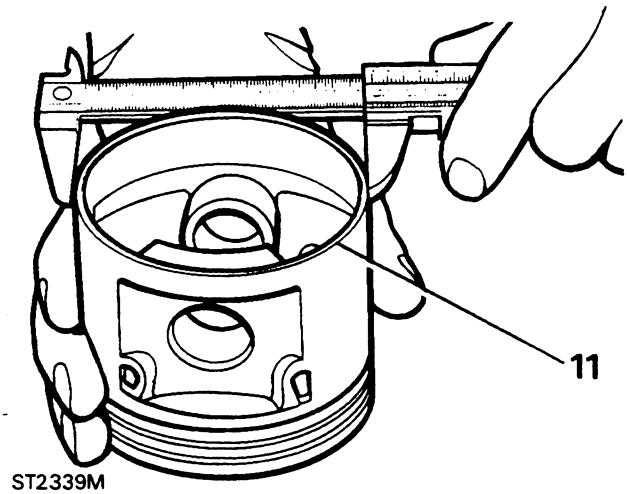
9. If the measurements taken are greater than the above figures the cylinders may be bored to a suitable oversize provided that the maximum oversize of 0,508 mm is not exceeded.

10. When the cylinders are being rebored it is essential to fit the bearing caps and tighten the bolts to the correct torque to prevent distortion during the machining operation.

    NOTE: Pistons are available in service standard size and in oversizes of 0,25 mm (0.010 in) and 0,50 mm (0.020 in). Service standard size pistons are supplied 0,0254 mm (0.001 in) oversize. When fitting new service standard size pistons to a cylinder block, check for correct piston to bore clearance, honing the bore if necessary. Bottom of piston skirt-bore clearance should be 0,018 to 0,040 mm (0.0007 to 0.0016 in).

    NOTE: The temperature of the piston and cylinder block must be the same to ensure accurate measurement.

11. Mark each new piston with the number of the bore to which it will be fitted. Measure each piston at the bottom of the skirt at right angles to the gudgeon pin and bore the cylinder concerned to provide a running clearance of 0,018 to 0,040 mm (0.0007 to 0.0016 in). Be sure to keep each piston hereafter identified with its cylinder bore.

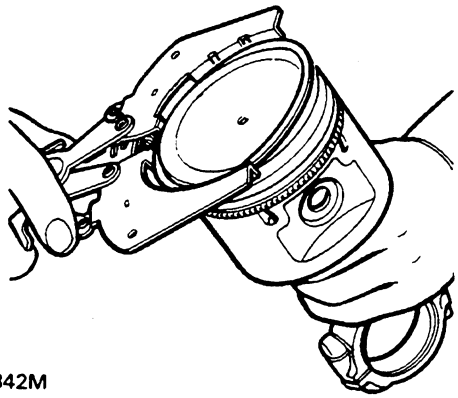


ST2339M

12. 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 rings. It is vital to thoroughly wash the bores afterwards to remove all traces of abrasive material.
13. After reboring or honing, check the bore-to-piston clearance at the bottom of the bore at right angles to the gudgeon pin in the normal running position of the piston.

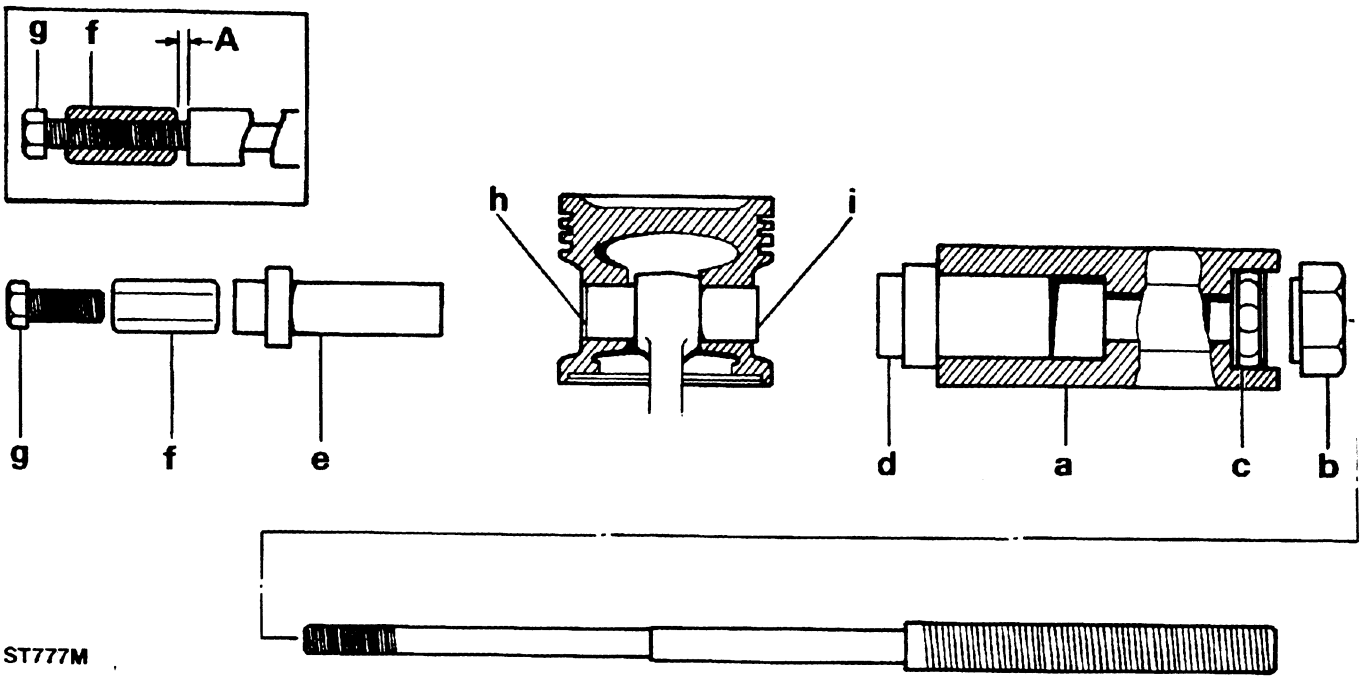
DISMANTLING CONNECTING RODS AND PISTONS

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

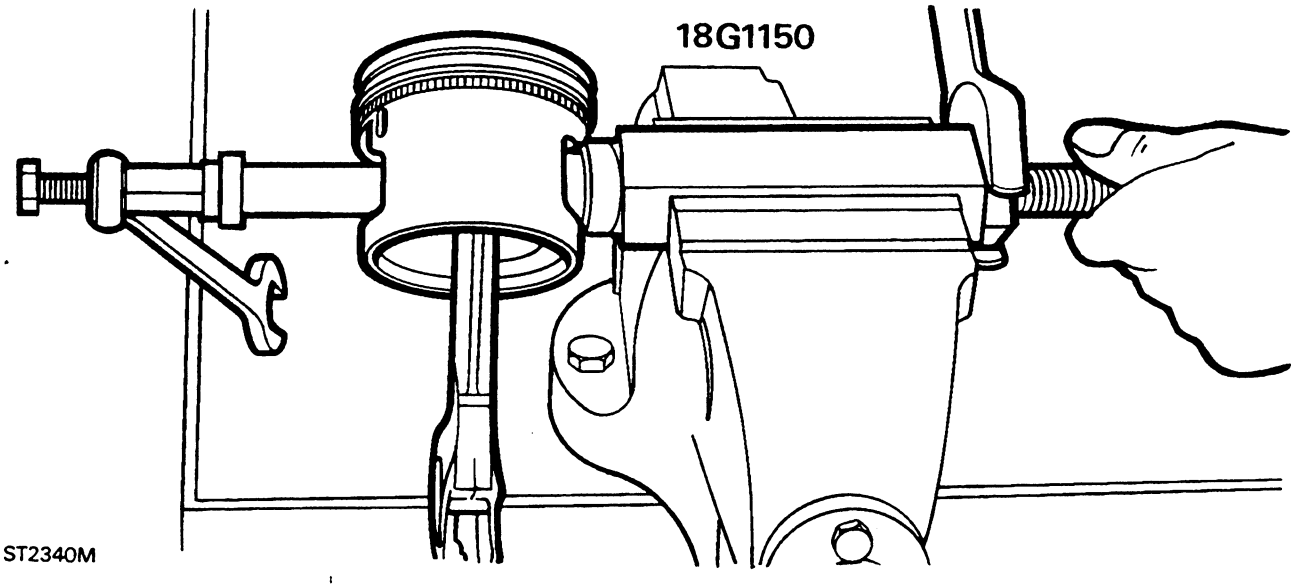


ST2342M

1. Withdraw the gudgeon pin from the connecting-rod small end using tool 18G1150 as follows:
   a. Clamp the hexagon body of 18G1150 in a vice.
   b. Position the large nut flush with the end of the centre screw.
   c. Push the screw forward until the nut contacts the thrust race.
   d. Locate the piston adaptor 18G1150E with its long spigot inside the bore of the hexagon body.
   e. Fit the remover/replacer bush of 18G1150 on the centre screw with the flanged end away from the gudgeon pin.
   f. Screw the stop-nut about halfway onto the smaller threaded end of the centre screw, leaving a gap 'A' of 3,0 mm (0.125 in) between this nut and the remover/replacer bush.
   g. Lock the stop-nut securely with the lock screw.
   h. Check that the remover/replacer bush is correctly positioned in the bore of the piston.
   i. Push the connecting-rod to the right to expose the end of the gudgeon pin, which must be located in the end of the adaptor 'd'.
   j. Screw the large nut up to the thrust race.
   k. Hold the lock screw and turn the large nut until the gudgeon pin has been withdrawn from the piston. Dismantle the tool.

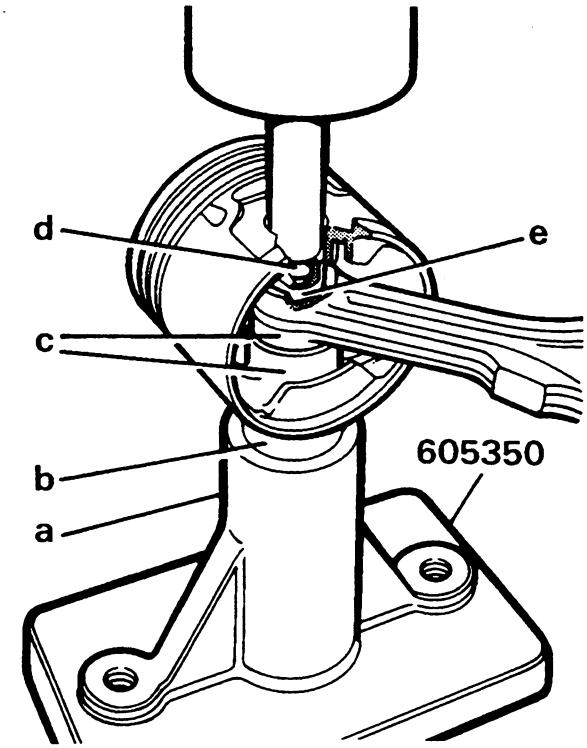


ST777M



ST2340M

2. As an alternative to tool 18G1150, press the gudgeon pin from the piston using an hydraulic press and the components which comprise tool 605350 as follows:
a. Place the base of the tool 605350 on the bed of an hydraulic press which has the capacity of 8 tons (8 tonnes).
b. Fit the guide tube into the bore of the base with its countersunk face uppermost.
c. Push the piston to one side so as to expose one end of the gudgeon pin and locate this end in the guide tube.
d. Fit the spigot end of the small diameter mandrel into the gudgeon pin.
e. Press out the gudgeon pin, using the hydraulic press.



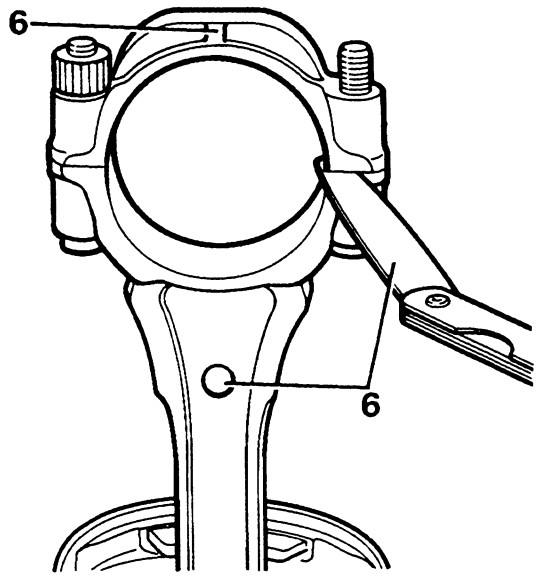
ST2422M

Examining pistons

3. If the intention is to refit the original pistons with new rings, degrease and decarbonise the pistons removing all traces of carbon particularly from the piston grooves. Check for excessive wear, scores, burning and cracks especially around the gudgeon pin boss. Check that the gudgeon pin is a push fit in the pistons at a temperature of 68°F (20°C).
4. Having visually examined check that the clearance between the bore and piston skirt at right angles to the gudgeon pin is between 0,018 to 0,040 mm (0.0007 to 0.0016 in) at 50 mm (2.0 in) from the bottom at the bore.
5. If it is necessary to fit a new piston to any bore or bores, the above check must also be made. Remember that if the bores are standard size, the bores to which the new pistons are to be fitted must be honed to provide the correct clearance since new standard pistons are supplied 0,0254 mm (0.001 in) oversize.

Checking the connecting-rods

6. Remove the bearing shells and refit the cap tightening the nuts to the correct torque, and ensure that the dome on the cap and rod are aligned Slacken the nut on one side and with a feeler gauge, check for clearance between the rod and cap on the side slackened off. A rod in good condition should have no gap.

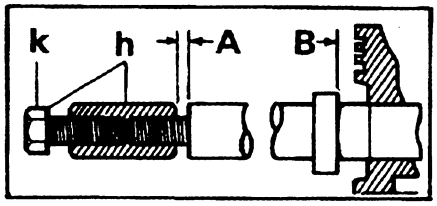


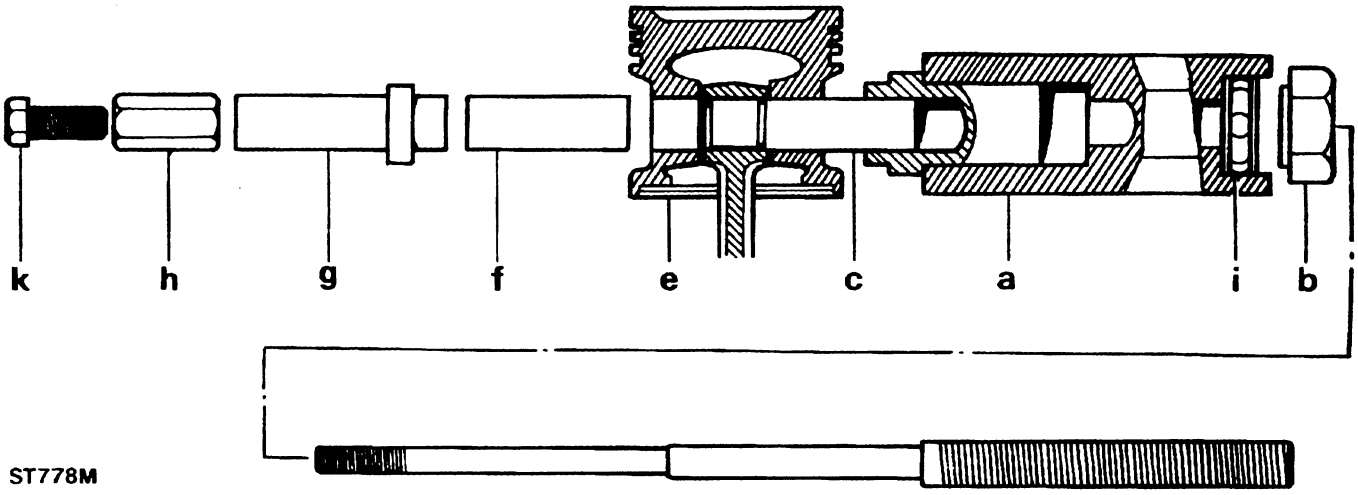
ST2409M

7. If the necessary equipment is available the rods should be checked for bend and twist, especially on high mileage engines and ones which show evidence of overheating.

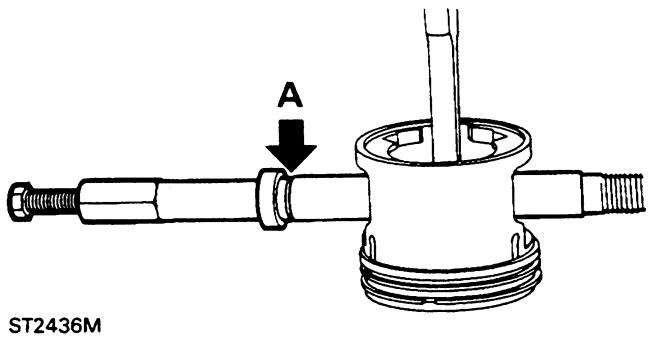
Fitting pistons to connecting-rods

8. If tool 18G1150 was used for dismantling, refit each piston to its connecting-rod as follows:
a. Clamp the hexagon body of 18G1150 in a vice, with the adaptor 18G1150E positioned as for piston removal.
b. Remove the large nut of 18G1150 and push the centre screw approximately 50 mm (2.0 ins) into the body until the shoulder is exposed.
c. Slide the parallel guide sleeve, grooved end last, onto the centre screw and up to the shoulder.
d. Lubricate the gudgeon pin and bores of the connecting-rod and piston with graphited oil (Acheson's Colloids 'Oildag'). Also lubricate the ball race and centre screw of 18G1150.
e. Fit the connecting-rod and piston together onto the tool with the markings together if the original pair are being used and with the connecting-rod around the sleeve up to the groove.
f. Fit the gudgeon pin into the piston bore up to the connecting-rod.
g. Fit the remover/replacer bush 18G1150/3 with its flanged end towards the gudgeon pin.
h. Screw the stop-nut on to the centre screw and adjust this nut to obtain a 1 mm (0.03125 in) end-float 'A' on the whole assembly, and lock the nut securely with the screw.
i. Slide the assembly back into the hexagon body and screw on the large nut up to the thrust race.





ST778M



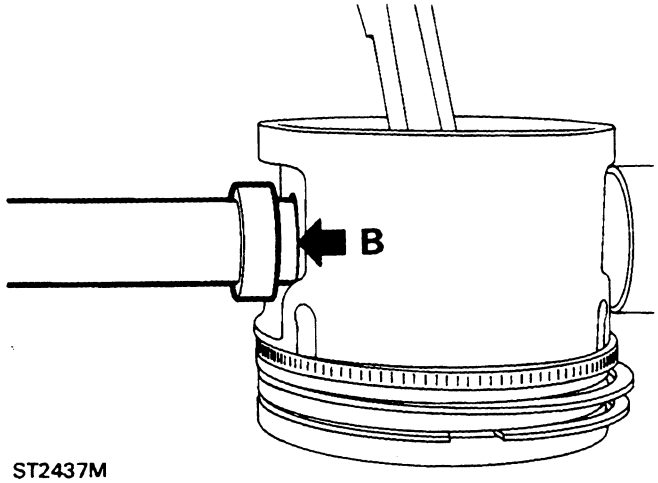
ST2436M

j. Set the torque wrench to 12 lbf ft. This represents the minumum load for an acceptable interference fit of the gudgeon pin in the connecting-rod.

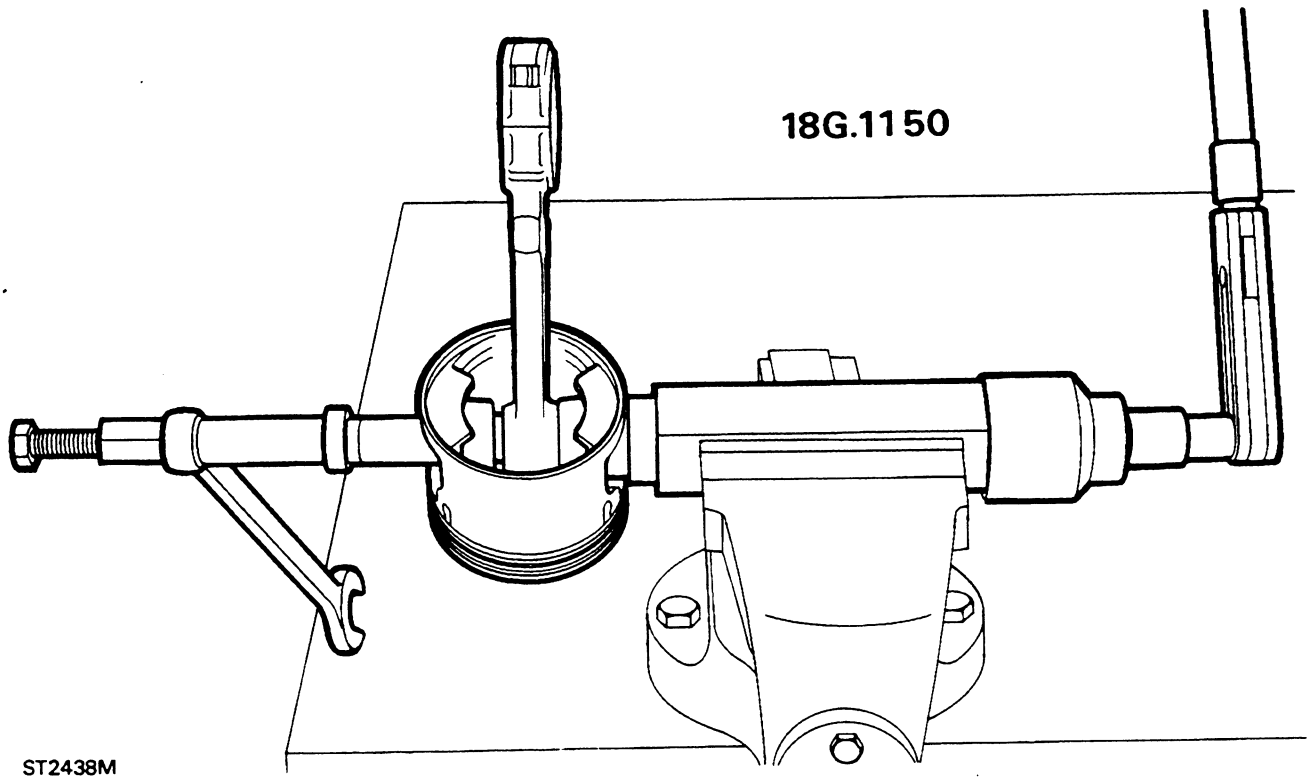
k. Using the torque wrench and socket on the large nut, and holding the lock screw, pull the gudgeon pin in until the flange of the remover/replacer bush is 4 mm (0.16 in) 'B' from the face of the piston. Under no circumstances must this flange be allowed to contact the piston.

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

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



ST2437M

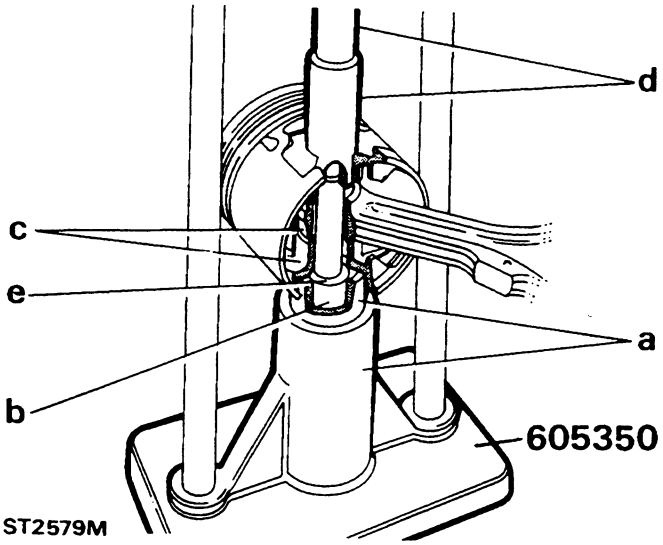


ST2438M

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

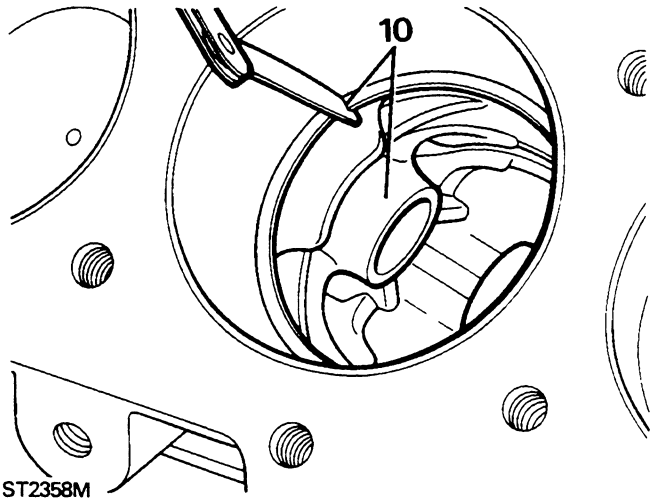
a. Place the base of tool 605350 on the bed of an hydraulic press which has a capacity of 8 tons (8 tonnes).
   Fit the guide tube into the bore of the base with its countersunk face uppermost.
b. Fit the long mandrel inside the guide tube.
c. Fit the connecting-rod into the piston with the markings together if the original pair are being used, then place the piston and connecting-rod assembly over the long mandrel until the gudgeon pin boss rests on the guide tube.
d. Fit the gudgeon pin into the piston up to the connecting-rod, and the spigot end of the small diameter manderal into the gudgeon pin.
e. Press in the gudgeon pin until it abuts the shoulder of the long mandrel.

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

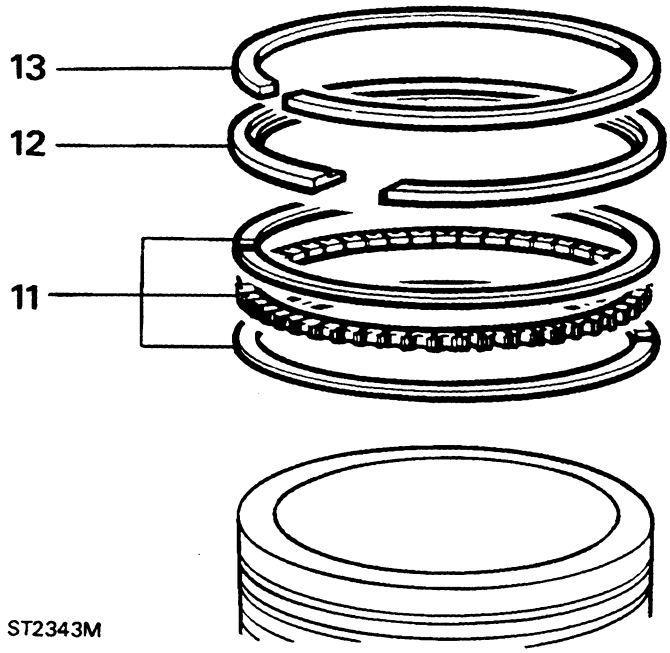


Fitting piston rings - checking compression ring gaps

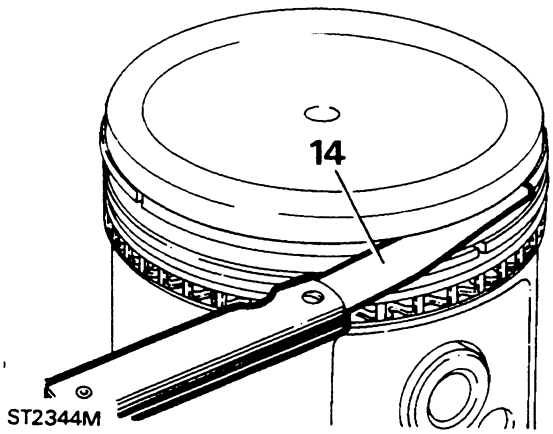
10. Check the compression ring gaps in the applicable cylinder, held square to the bore with the piston. The gaps must be checked with the ring at the bottom of the piston stroke, about 82 mm (3.25 ins) down the cylinder. The gap should be within 0,44 to 0,56 mm (0.017 to 0.022 in). To increase the gap use a fine-cut file preferably with the ring held in a filing rig.



11. Once the ring gaps are correct fit the rings to the pistons starting with the oil control ring assembly. Fit the expander ring into the bottom groove making sure that the ends butt and do not overlap. Fit two ring rails to the bottom groove, one above and one below the expander ring. The rail gaps must be 180° distant from each other in such a position that the gaps do not align with the expander joint.
12. Preferably, using a piston ring expander tool, fit the stepped second compression ring with the word 'TOP' uppermost.
13. The top compression ring can be fitted either way around.



14. Check the top and second compression ring clearance in the piston grooves with a feeler gauge. The clearance for both rings is 0,05 to 0,10 mm (0.002 to 0.004 in).

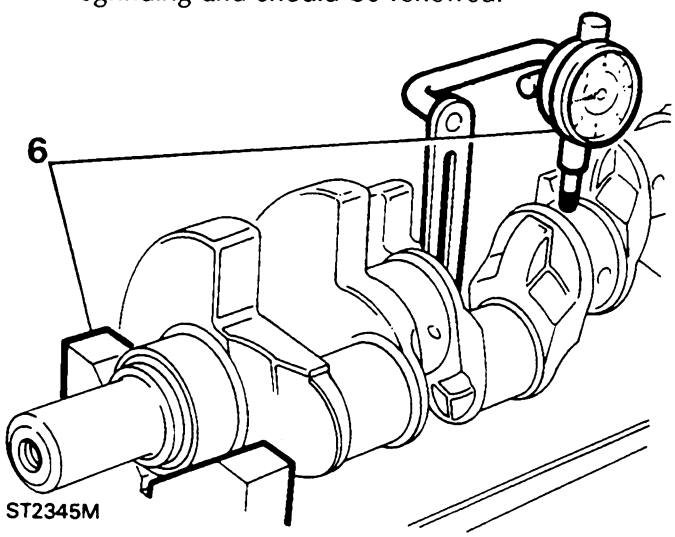


15. Lubricate the piston rings with clean engine oil and place the piston and connecting-rod assemblies aside and cover with clean cloth ready for assembly to the cylinder block.

EXAMINE AND OVERHAUL 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 (0.0015 in).
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 (0.001 in).

6. To check for straightness, support the front and rear main bearing journals in 'V' blocks and postion a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0,076 mm (0.003 in) taking into account any ovality in the centre journal.
   The overall wear limit should not exceed 0,114 mm (0.0045 in) for main bearing journals and 0,088 mm (0.0035 in) for crankpins.
   A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground to 0,254 mm (0.010 in) or 0,508 mm (0.020 in).
   A crankshaft that is bent is not suitable for regrinding and should be renewed.



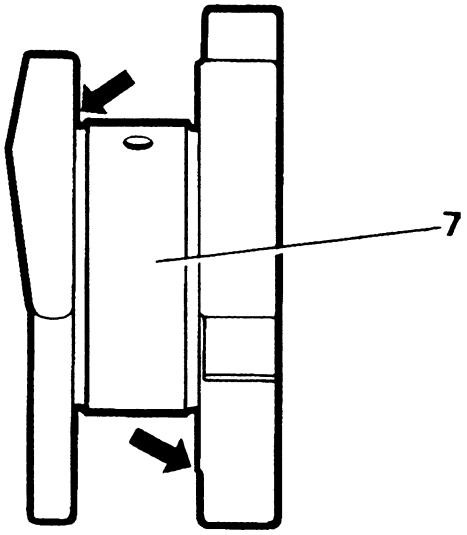
7. When regrinding the crankshaft, care should be taken not to remove too much material from the thrust faces of the centre main bearing journal. This is because oversize bearings of 0,25 mm are the same width across the thrust face as the standard bearing, whereas the 0,508 mm oversize bearing is 0,25 mm wider. When regrinding the crankshaft, the journals and thrust faces on either side of the centre main journal must be machined in accordance with the dimensions in the following charts.

   For example: If a 0,50 mm (0.020 in) undersize bearing is to be fitted, then 0,12 mm (0.005 in) must be machined off each thrust face of the centre journal, maintaining the correct radius.

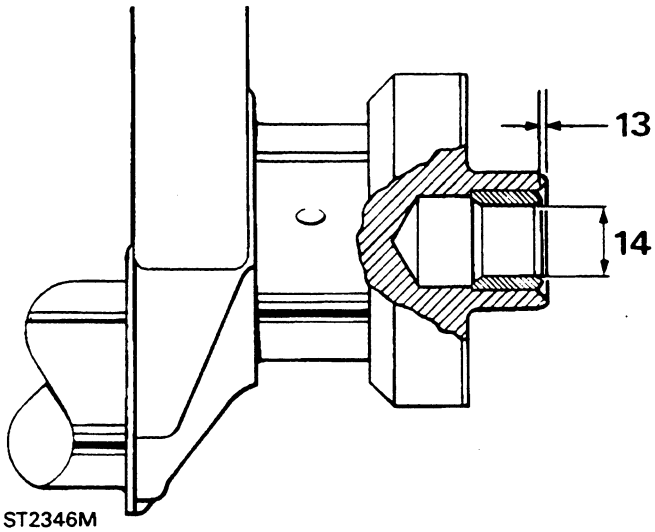
8. The radius for all journals except the rear main bearing is 1,90 to 2,28 mm (0.075 to .090 in).
9. The radius for the rear main bearing journal is 3,04 mm (0.120 in).
10. Main bearing journal diameter, see the chart below.
11. Thrust face width, and connecting-rod journal diameter, see the chart below.

Renew spigot bearing

12. Carefully remove the old bearing.
13. Fit the spigot bearing flush with, or to a maximum of 1,6 mm (0.063 in) below the end face of the crankshaft.
14. Ream the spigot bearing to 19,177 + 0,025 mm (0.7504 + 0.001 in) inside diameter. Ensure all swarf is removed.



ST2320M



ST2346M

CRANKSHAFT DIMENSIONS-MILLIMETRES

Crankshaft	Diameter	Width	Diameter
Standard	58,400-58,413	26,975-27,-26	50,800-50,812
0,254 U/S	58,146-58,158	26,975-27,026	50,546-50,559
0,508 U/S	57,892-57,904	27,229-27,280	50,292-50,305

CRANKSHAFT DIMENSIONS-INCHES

Crankshaft	Diameter	Width	Diameter
Standard	2,2992-2,2997	1,062-1,064	2,0000-2,0005
0.010 U/S	2,2892-2,2897	1,062-1,064	1,9900-1,9905
0.020 U/S	2,2792-2,2797	1,072-1,074	1,9800-1,9805

Main bearing journal size	Thrust face width
Standard	Standard
0,25mm (0.010 in) undersize	Standard
0,50mm (0.020 in) undersize	0,25mm (0.010 in) oversize

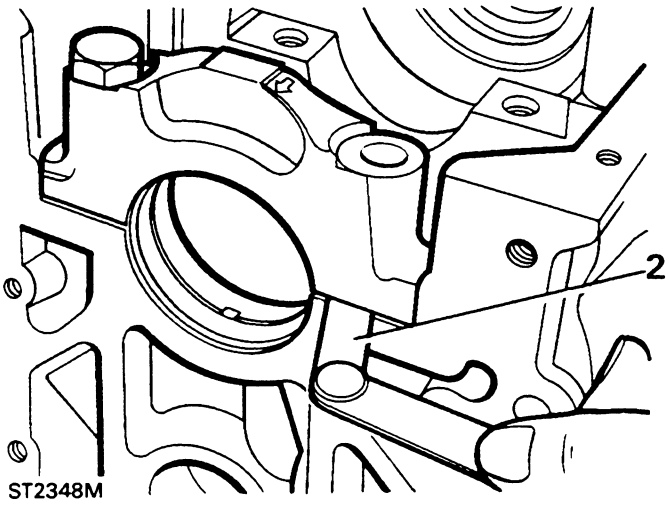
ST2347M

ASSEMBLING ENGINE

FITTING CRANKSHAFT AND MAIN BEARINGS

Checking main bearing clearance

1. To check the correct fit of the main bearing shells, they should first be installed into the cylinder block and into the main bearing cap locations. Note that the shell bearing with a groove and oil hole must be located in the cylinder block whilst the plain bearing is located in the cap.
2. Fit and secure the main bearing caps, observing the numerical sequence and the arrow stamped on each, tightening the bolts to the recommended torque. Then slacken one bolt on each of the main bearing caps and check the clearance between the cylinder block and cap face on the side that the bolt is slackened. This clearance should be between 0,10 mm and 0,15 mm. Clearances in excess of this tolerance may be corrected either by selective assembly of the shell bearings or by rubbing down the face edge of one half of the shell using very fine emery cloth on a flat surface. It is very unusual to find a clearance less than 0,10 mm but should this be the case the bearing will not be securely clamped in position and is therefore likely to turn during normal engine running. It is therefore important that the correct bearing nip is achieved.

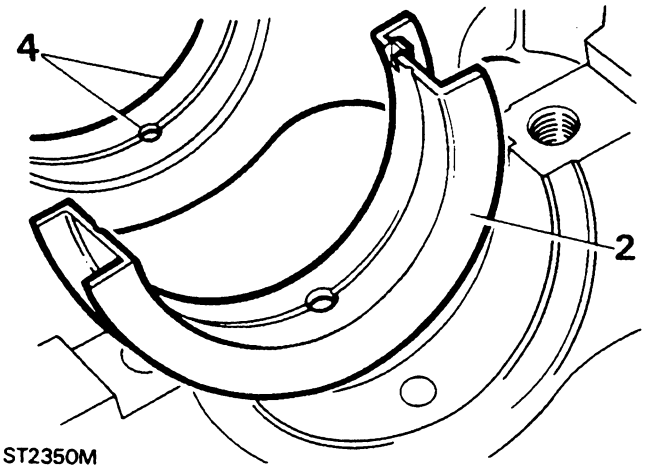


3. If the diameter of the shell bearings is too large for its location the edges may be reduced by gently rubbing on fine emery on a flat surface, but if they are too small and therefore likely to turn in operation, one or both halves of the shell bearing are faulty and should be renewed.

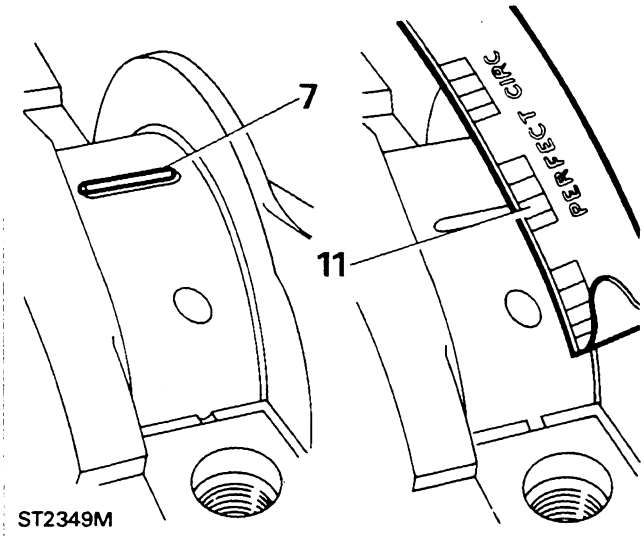
Checking main bearing clearances using Plastigauge.

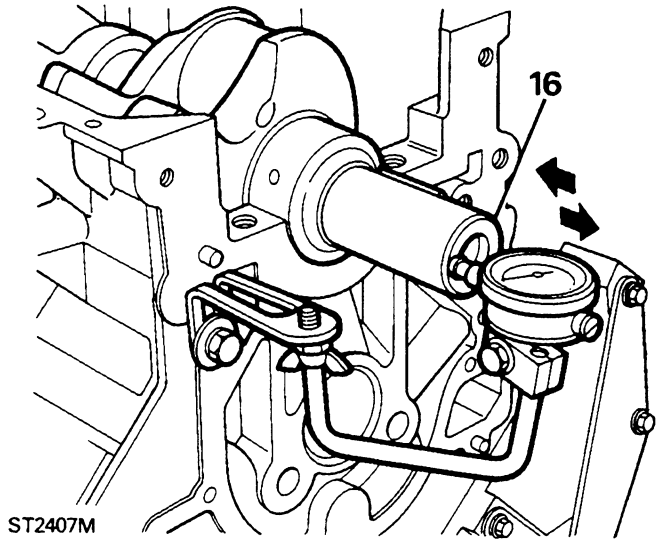
This method may be used instead of the above or as a check, particularly if an incorrect clearance is suspected.

4. Locate the upper main bearing shells into the cylinder block. These must be the shells with the oil drilling and oil grooves.
5. Locate the flanged upper main bearing shell in the centre poisition.
6. Lower the crankshaft into position on the bearings.



7. Place a piece of Plastigauge across the centre of the crankshaft main bearing journals.
8. Locate the bearing lower shell into the main bearing cap.
9. Fit numbers one to four main bearing caps and shells and tighten to the correct torque.
10. Fit the rear main bearing cap and shell and tighten to the correct torque. **Do not allow the crankshaft to be rotated while the Plastigauge is in use.**
11. Remove the main bearing caps and shells and using the scale printed on the Plastigauge packet, measure the flattened Plastigauge at its widest point. The graduation that most closely corresponds to the width of the Plastigauge indicates the bearing clearance.
12. The correct bearing clearance with new or overhauled components is 0,010 to 0,048 mm (0.0004 to 0.0019 in). If the correct clearance is not obtained initially, use selective bearing assembly.

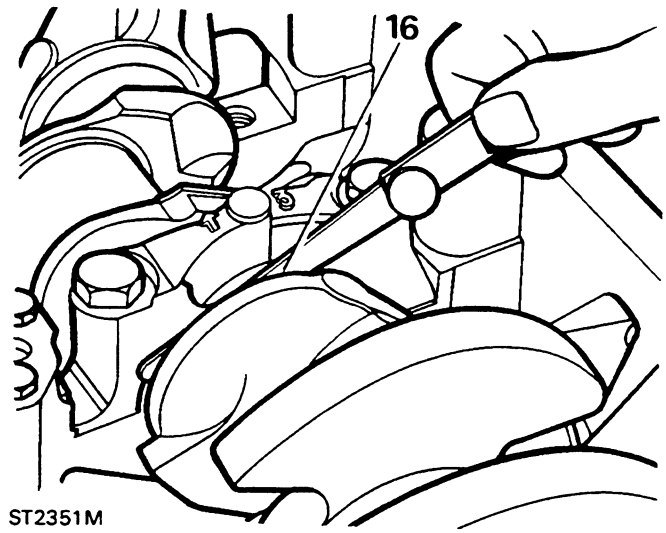




13. Wipe off the Plastigauge with an oily rag. Do NOT scrape it off.
14. Lift out the crankshaft and lubricate the main bearing journals and bearing shells with clean engine oil and lower the crankshaft into position again.

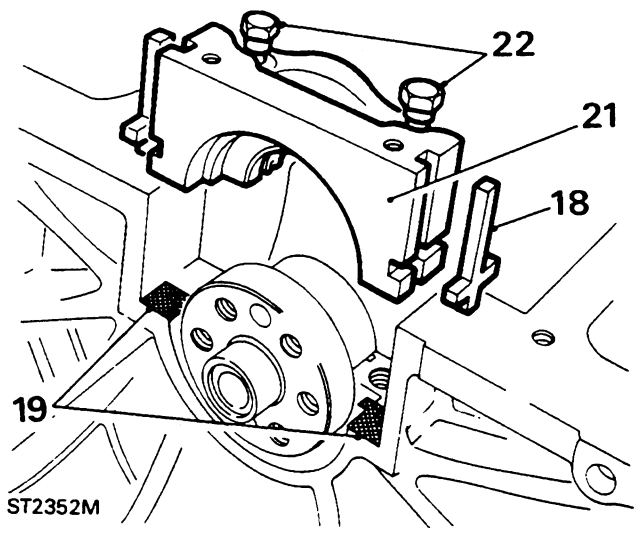
Checking crankshaft end-float

15. The end-float can be checked with either a dial test indicator or a feeler gauge.
16. Mount a dial test indicator on the cylinder block with the indicator stylus resting on the end of the crankshaft. Push the crankshaft back and zero the gauge. Move the crankshaft forward and note the gauge reading. Similarly, using a feeler gauge, push the crankshaft back and measure the clearance between the bearing flange and crankshaft thrust face. The correct end float is between 0,10 to 0,20 mm (0.004 to 0.008 in).



Fitting main bearing caps and rear oil seal

17. Lubricate the lower main bearing shells and fit numbers one to four main bearing caps and shells only, leaving the fixing bolts finger tight at this stage.
18. Fit the cruciform side seals to the grooves each side of the rear main bearing cap. Do not cut the side seals to length, they must protrude 1,5 mm (0.062 in) approximately above the bearing cap parting face.
19. Apply Hylomar PL32M jointing compound to the rearmost half of the rear main bearing cap parting face or, if preferred, to the equivalent area on the cylinder block as illustrated.
20. Lubricate the bearing half and bearing cap side seals with clean engine oil.
21. Fit the bearing cap assembly to the engine. Do not tighten the fixings at this stage but ensure that the cap is fully home and squarely seated on the cylinder block.



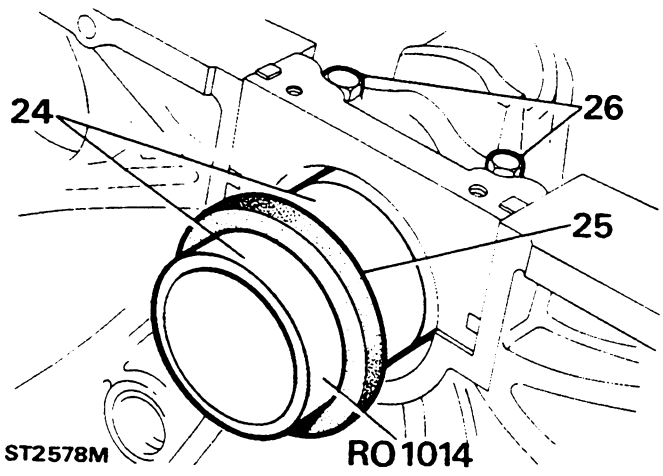
22. Tension the cap bolts equally by one-quarter turn approximately, then back off one complete turn on each fixing bolt.

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

23. Position the seal guide RO1014 on the crankshaft flange.
24. Ensure that the oil seal guide and the crankshaft journal are scrupulously clean, then coat the seal guide and oil seal journal with clean engine oil.

    NOTE: The lubricant coating must cover the seal guide outer surface completely to ensure that the oil seal lip is not turned back during assembly. Position the oil seal, lipped side towards the engine, on to the seal guide. The seal outside diameter must be clean and dry.

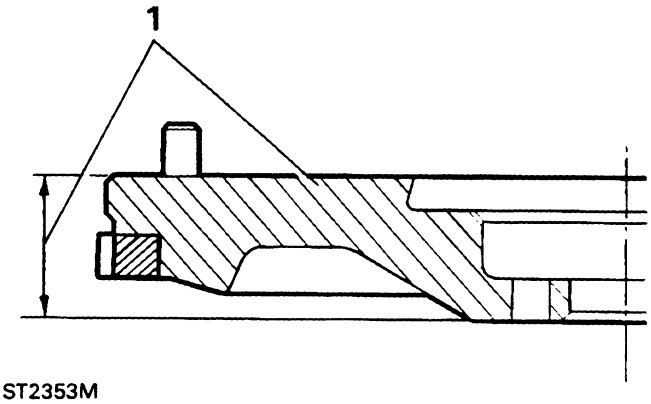
25. Push home the oil seal fully and squarely by hand into the recess formed in the cap and block until it abuts against the machined step in the recess. Withdraw the seal guide.
26. Tighten the main bearing cap bolts to the correct torque noting that the bolts for numbers one to four bearings have a different torque to number five bearing cap bolts.
27. Turn the crankshaft to ensure that it turns freely.



ST2578M

OVERHAUL AND FIT FLYWHEEL

1. Examine the flywheel clutch face for cracks, scores and overheating. If the overall thickness of the flywheel is is excess of the minimum thickness i.e. 39,93 mm (1.572 in) it can be refaced provided that after machining it will not be below the minimum thickness. Remove the three dowels before machining.

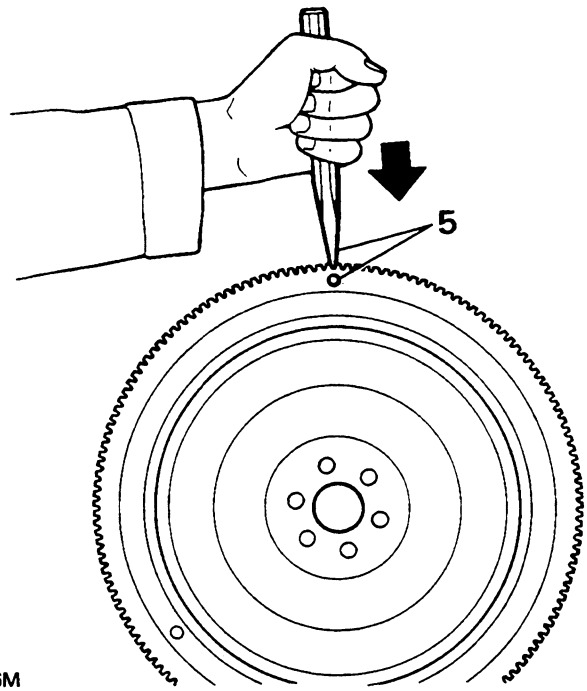


ST2353M

2. Examine the ring gear and if worn or the teeth are chipped and broken it can be renewed as folllows.
3. Drill a 10 mm (0.375 in) diameter hole axially between the root of any tooth and the inner diameter of the starter ring sufficiently deep to weaken the ring. Do NOT allow the drill to enter the flywheel.
4. Secure the flywheel in a vice fitted with soft jaws and place a cloth over the flywheel to protect the operator from flying fragments.

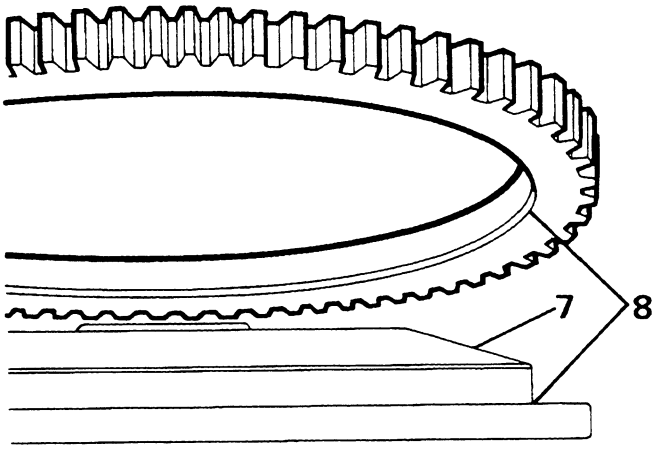
   WARNING: Take adequate precautions against flying fragments when splitting the ring gear. Wear protective industrial goggles.

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



ST2406M

6. Heat the new ring gear uniformly to between 170 to 175°C (338 to 347°F) but do not exceed the higher temperature.
7. Place the flywheel, clutch side down, on a flat surface.
8. Locate the heated starter ring in position on the flywheel, with the chamfered inner diameter towards the flywheel flange. If the starter gear ring is chamfered both sides, it can be fitted either way round.
9. Press the starter ring gear firmly against the flange until the ring contracts sufficiently to grip the flywheel.



ST2359M

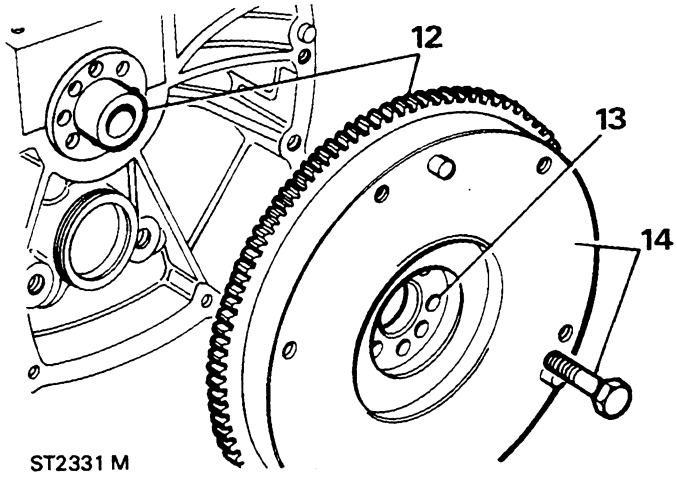
10. Allow the flywheel to cool gradually. Do NOT hasten cooling in any way or distorting may occur.
11. Fit new clutch assembly location dowels to the flywheel.

Fitting flywheel

12. Locate the flywheel in position on the crankshaft spigot, with the ring gear towards the engine.

    WARNING: Hold the flywheel in position until the first retaining bolt is fitted to prevent the flywheel falling and causing personal injury.

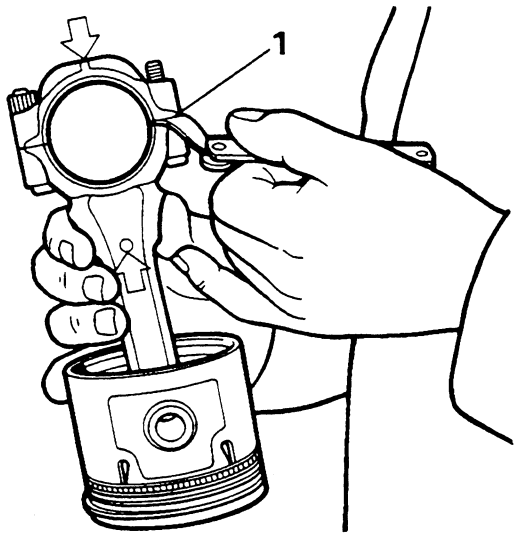
13. Align the flywheel fixing bolt holes which are off-set to prevent incorrect assembly.
14. Fit the flywheel fixing bolts and before finally tightening, take up any clearance by rotating the flywheel against the direction of engine rotation. Tighten the bolts evenly to the correct torque using a suitable torque wrench.



ST2331 M

CHECKING CONNECTING-ROD BEARING RUNNING CLEARANCE

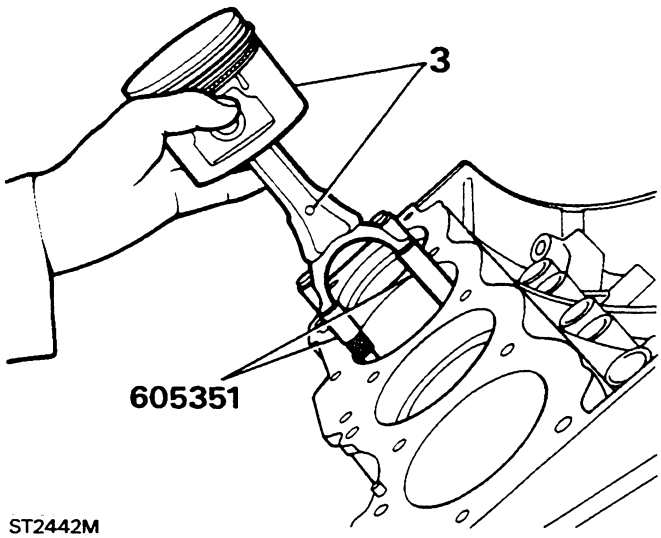
1. Fit the new bearing shells to each connecting-rod and tighten both nuts to the correct torque. Slacken one nut on each rod and with a feeler gauge, measure the clearance between the parting face of the rod and the cap. This clearance should be between 0,1 and 0,2 mm (0.003 and 0.007 in). To overcome a clearance in excess of 0,25 mm (0.010 in), rub down the edge of the shell with fine emery cloth on a flat surface. Refit the bearing, tighten the nuts, slacken one nut as previously described and check the clearance again. Repeat this procedure if necessary, until satisfied the clearance is correct. Ensure that the dome on the connecting-rod and cap are aligned.



ST2371M

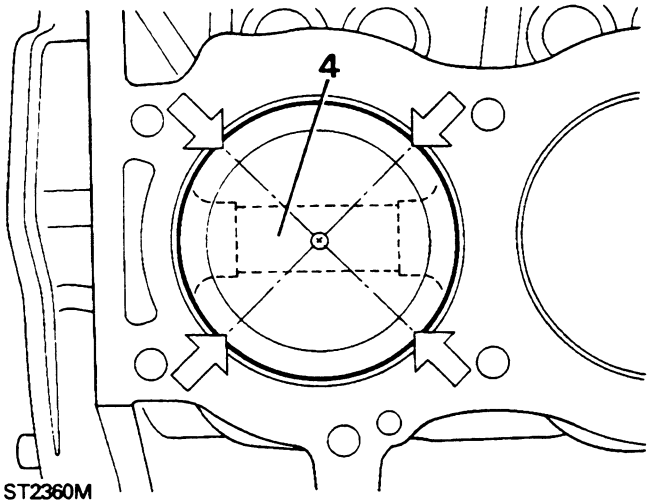
FITTING CONNECTING-RODS AND PISTONS

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



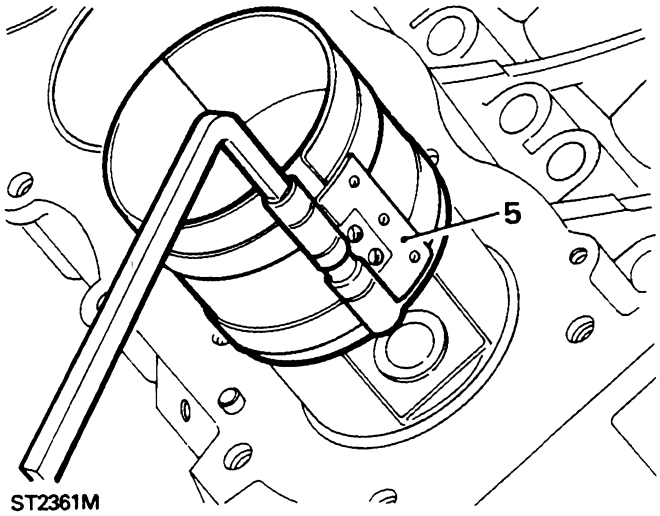
ST2442M

4. Space the piston ring gaps at intervals of 45° avoiding gaps at 90° to the gudgeon pin, see illustration below which shows the correct position of the ring caps in relation to piston in the bore.



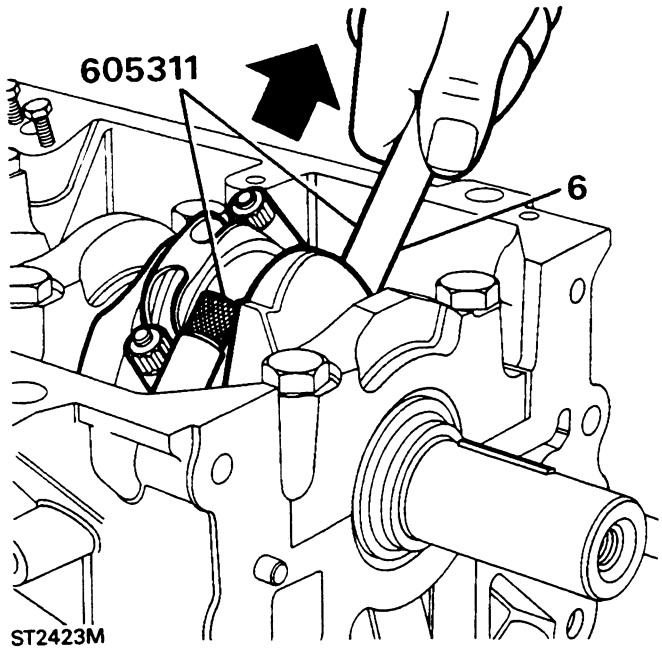
ST2360M

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



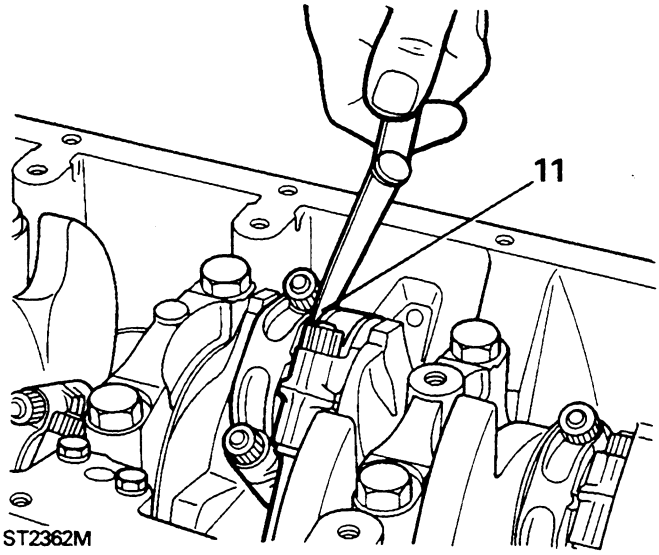
ST2361M

6. Pull the connecting-rod on to the crankpin using the guide rods having first lubricated the bearings.
7. Locate the bearing lower shell in the connecting-rod cap and lubricate.
8. Fit the cap and shell on to the connecting-rod, noticing that the dome on the edge of the cap must be towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank, pointing in the same direction as the dome on the connecting-rod.
9. Fit and tighten the connecting-rod nuts to the correct torque.
10. Repeat the above procedure for the remaining connecting-rods and pistons.



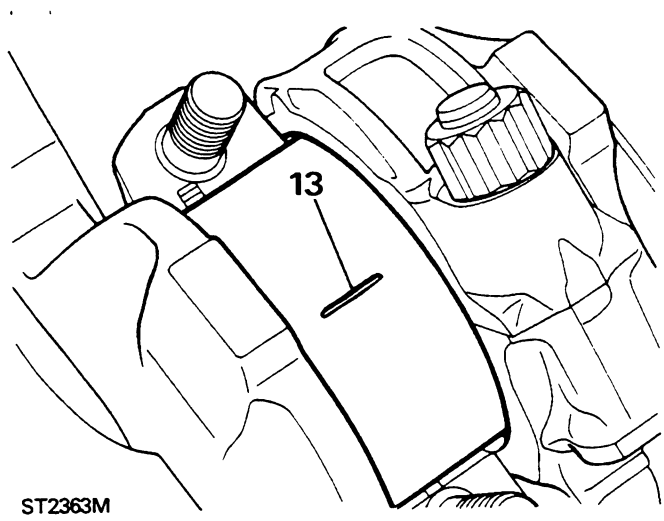
ST2423M

11. Finally, with a feeler gauge, check that the side-play clearance between each pair of connecting-rods on the crankpins is 0,15 to 0,37 mm (0.006 to 0.014 in).



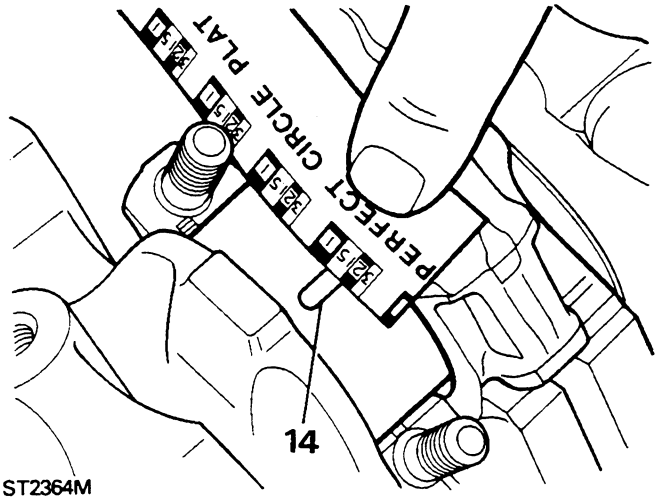
ST2362M

12. Lubricate the cylinder bores and turn the crankshaft to check that there are no tight spots, and that the connecting-rods move freely sideways on the crankshaft.
13. Should any doubt exist about a running clearance between the bearings and crankpin on any connecting-rod being too tight, these may be checked as follows by using Plastigauge type PG1. Release the bearing cap which is suspected of binding and place a small piece of Plastigauge on the journal in-line with its axis as illustrated. Refit the cap and bearing, tighten both the nuts to the correct torque then release and remove the cap and shell once again. Do not allow the crankshaft to be turned while making this check.



ST2363M

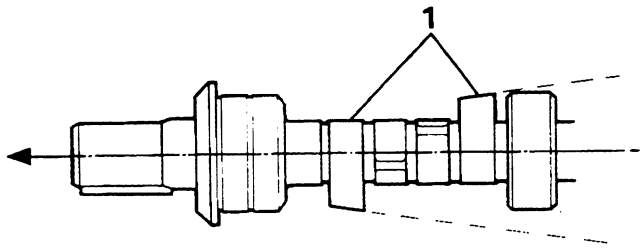
14. The Plastigauge will have been flattened on to the journal. Now compare the width of the Plastigauge with the scale printed on the packet which is shown in inches and mm. To determine the running clearance of the bearing, the graduation that most closely corresponds to the width of the flattened Plastigauge indicates the bearing to crankpin running clearance.



ST2364M

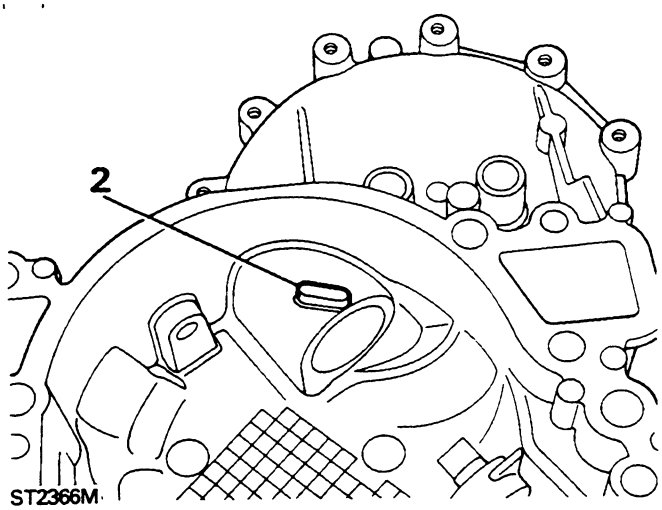
CAMSHAFT INSPECTION

1. Examine each cam lobe for wear or damage. The cam lobes are in fact manufactured with a slight taper with the highest point at the rear as the exaggerated illustration shows. This taper ensures that the tappet rotates in operation thus reducing wear and causes the shaft to be thrust onto the cylinder block.



ST2365M

2. This arrangement also obviates the need for a camshaft thrust plate or retainer. In the event of the camshaft being thrust forward during heavy braking, in an emergency stop for example, the movement of the camshaft is limited by an abutment pad cast into the front cover. If this pad is worn, serious end float of the cam shaft has occured.



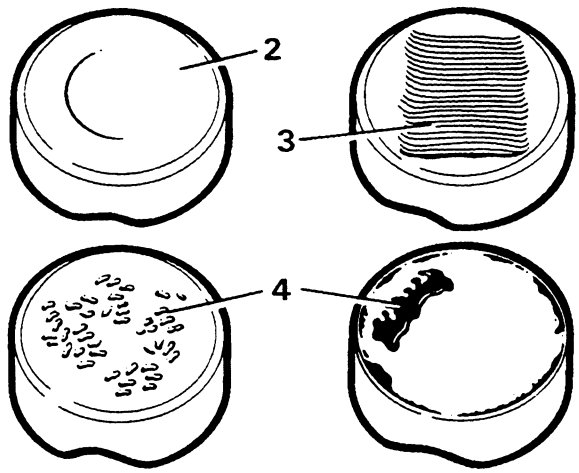
3. Measure the camshaft journals for overall wear, ovality and taper. The diameters of the five journals are as follows commencing from the front of the shaft.

   Number 1 journal 1.786 to 1.785 ins
   Number 2 journal 1.750 to 1.755 ins
   Number 3 journal 1.726 to 1.725 ins
   Number 4 journal 1.696 to 1.695 ins
   Number 5 journal 1.666 to 1.665 ins

4. To check the camshaft for bow, rest the two end journals i.e. numbers 1 and 5 on 'V' blocks and mount a dial gauge on the centre journal. Rotate the shaft and note the reading. If the run out is more than 0,05 mm (0.002 in) it should be renewed.

INSPECTION OF TAPPETS

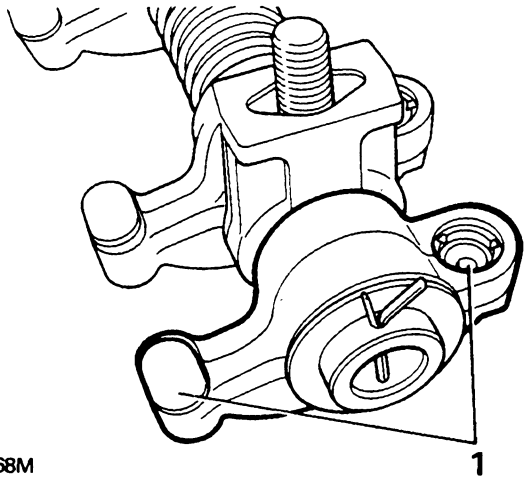
1. Examine the face of each tappet and compare with the wear patterns illustrated below.
2. Only the top left illustration shows a tappet that has been rotating correctly and is visibly serviceable, the other three should be renewed.
3. The tappet shown at the top right is an indication that it has not been rotating, which could mean that the corresponding cam lobe is worn and should be closely examined.
4. The remaining two tappets show examples of general wear and damage and must be renewed.



5. The hydraulic performance of the tappets, however, can only be judged when the engine is running so if there is the slightest doubt the tappets should be renewed.

ROCKER SHAFT ASSEMBLY AND PUSH ROD INSPECTION

1. Examine the rockers for wear at the push rod and valve pad ends. Rockers that have worn, pitted or scored pads and ball seatings must be renewed.



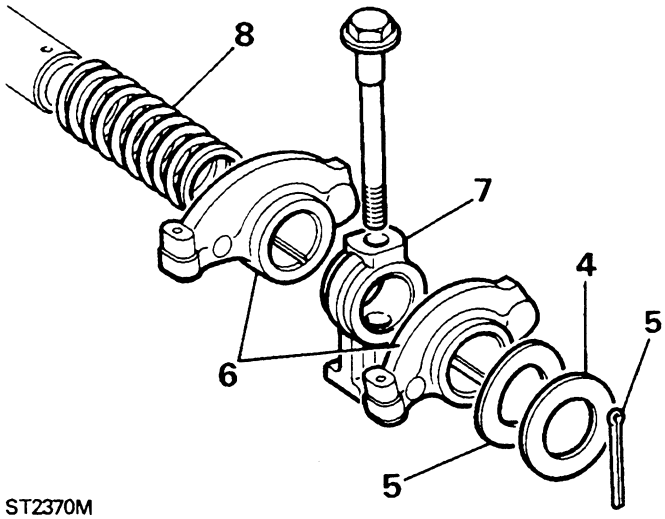
ST2368M

Dismantle rocker shaft assembly

2. Remove the split pin from the end of the rocker shaft that has the identification groove.
3. Withdraw the following components and retain them in the correct sequence for reassembly.
4. A plain washer.
5. A wave washer.
6. Rocker arms.
7. Brackets.
8. Springs.
9. Examine the shafts for wear, scores and pitting. Check that the lubrication drillings are clear.
10. A broken spring should be renewed and if possible sound springs should be checked for tension against a new one.

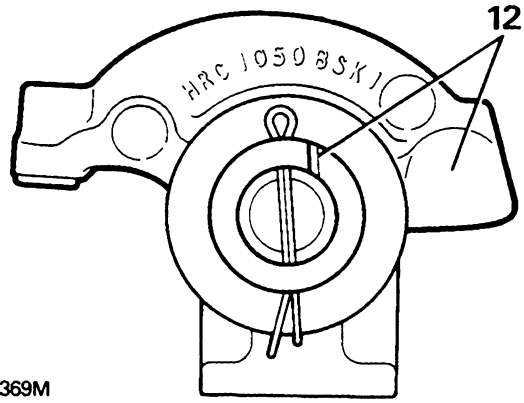
Assemble rocker shafts

11. Fit a new split pin to the opposite end of the shaft to the identification groove.
    Slide a plain washer over the long end of the shaft to abut the split pin.
    Fit a wave washer to abut the plain washer.
    Assemble the rocker arms, brackets and springs to the rocker shaft in the sequence illustrated.
    Compress the springs, brackets and rockers, and fit a wave washer, plain washer and split pin to the end of the rocker shaft.



ST2370M

12. Both shafts must be assembled so that the identification groove is at the one-o'clock position with the push rod end of the rockers to the right.



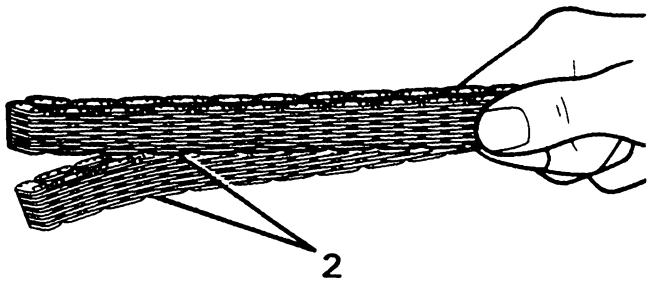
ST2369M

CAUTION: If the shafts and rockers are incorrectly assembled and fitted to the engine, the oil supply to the rocker shafts will be restricted.

13. Examine the push rods and renew any that are bent or have scored, pitted or worn ball ends.

INSPECTION OF TIMING CHAIN AND GEARS

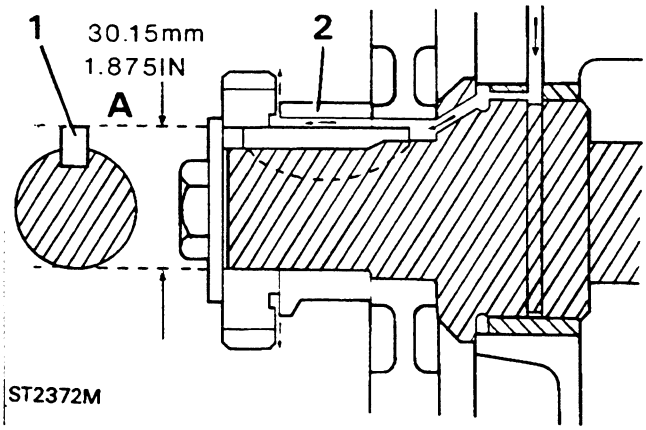
1. Examine the camshaft and crankshaft sprockets for wear and damage and discard if necessary. Also check the condition of the distributor and oil pump drive gears. Do not mate a worn gear with a new one.
2. Inspect the timing chain and if possible compare it with a new one. Alternatively squeeze the chain together and hold it at one end horizontally and if there is a considerable bend, the link pins of the chain are worn and the chain should be renewed.



ST2424M

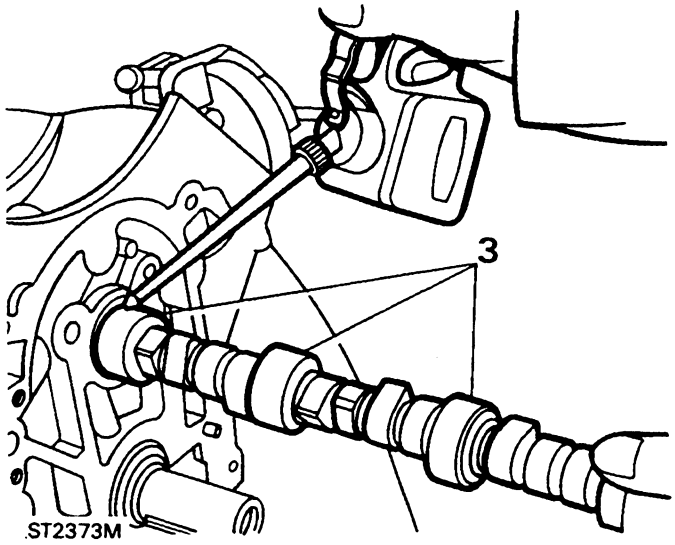
FITTING CAMSHAFT

1. It is very important that the sprocket key in the front of the camshaft is fitted parallel to the shaft and that the overall dimension does not exceed 30.15 mm (1.187 in) dimension 'A'.
2. Lubrication for the timing chain and gears is supplied by the front camshaft bearing through a channel along the top of the keyway to an annular groove in the rear face of the oil pump distributor drive gear. Lubrication to the timing chain will be severely restricted if the key is loose enough to be affected by centrifugal force, or is fitted inclined into its groove in the shaft. The key must be securely fitted parallel to the shaft.



ST2372M

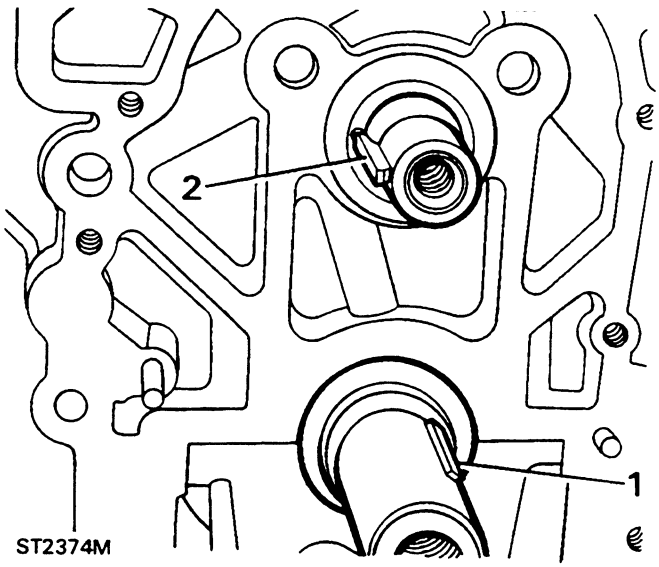
3. Lubricate the camshaft journals and carefully insert the camshaft into the cylinder block.



ST2373M

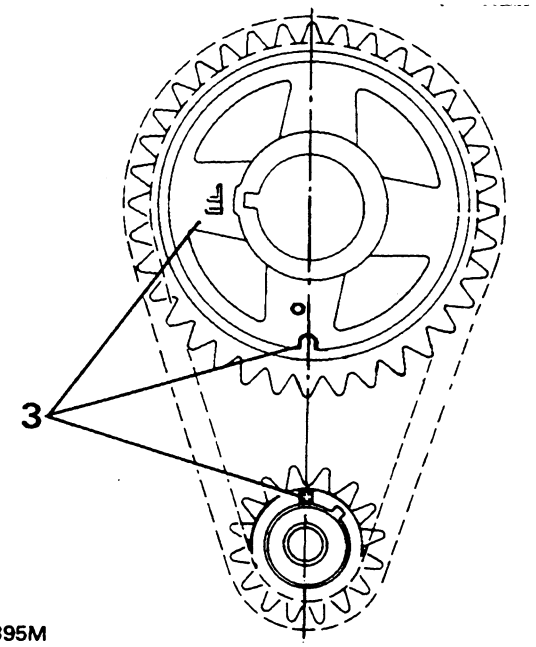
VALVE TIMING

1. Turn the crankshaft to bring number one piston to T.D.C. Looking at the engine from the front, number one piston is the first one in the right-hand bank. The crankshaft key will be at the one-o'clock position.
2. Turn the camshaft until the sprocket key is at the nine-o'clock position.



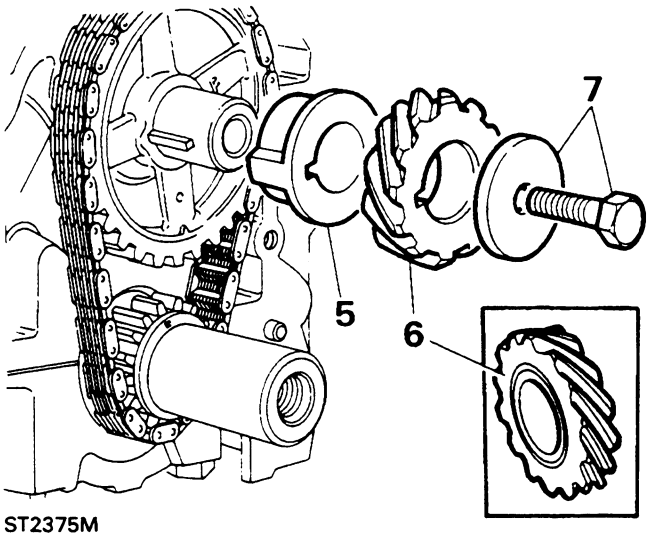
ST2374M

3. Encircle the camshaft and crankshaft sprockets with the chain so that the timing marks on the two sprockets are aligned as illustrated. Ensure that letter 'F' is at the front on the cam shaft sprocket.



ST2395M

4. Fit the two sprockets and chain as an assembly to the camshaft and crankshaft respectively. Check that the camshaft key is parallel to the shaft and that the two timing marks are still aligned.
5. Fit the spacer with the flange side outwards.
6. Fit the distributor drive gear ensuring that the annular grooved side is fitted towards the spacer.
7. Secure the drive gear and camshaft chain wheel assembly with the bolt and washer and tighten to the correct torque.

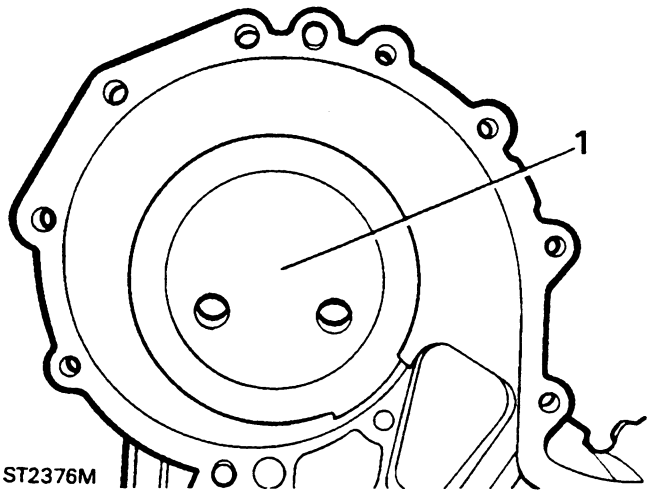


ST2375M

OIL PUMP/TIMING COVER OVERHAUL

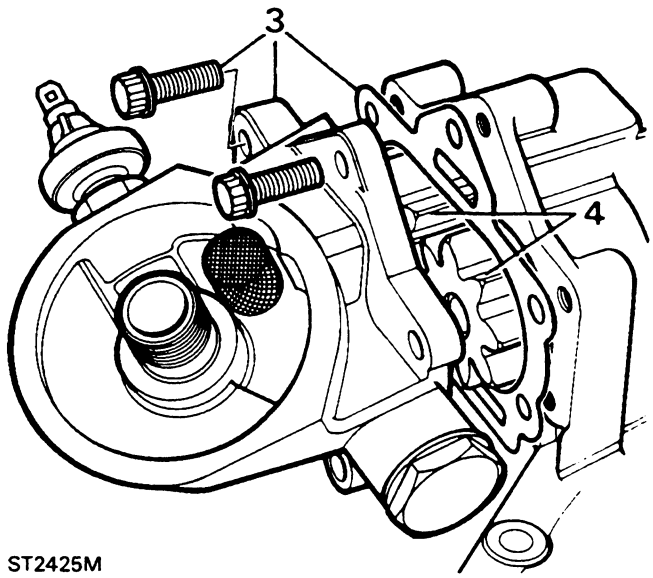
Serviceability of the front cover depends upon the condition of the water pump and oil pump recesses.

1. Examine the water pump recess for damage and corrosion.



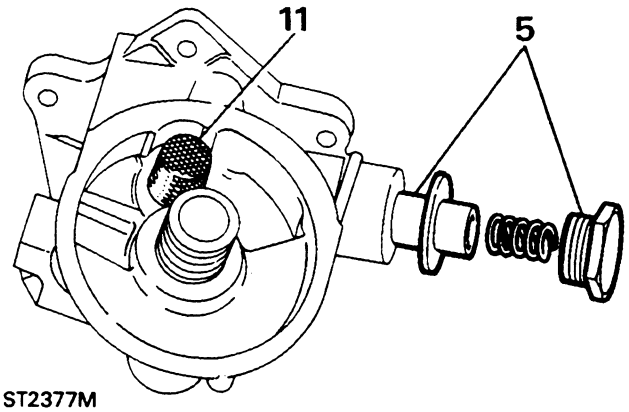
ST2376M

2. Check the camshaft abutment mentioned in "camshaft inspection" for damage and cracks in this area.
3. Remove the screws and withdraw the oil pump cover and gasket.
4. Remove the oil pump gears.



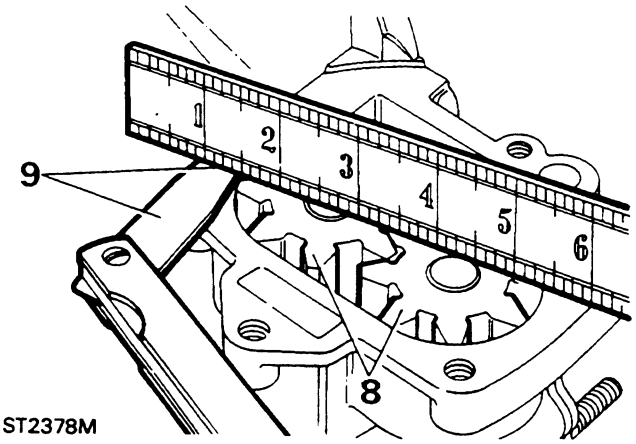
ST2425M

5. Remove the pressure relief valve plug and release the spring, relief valve and plug washer.



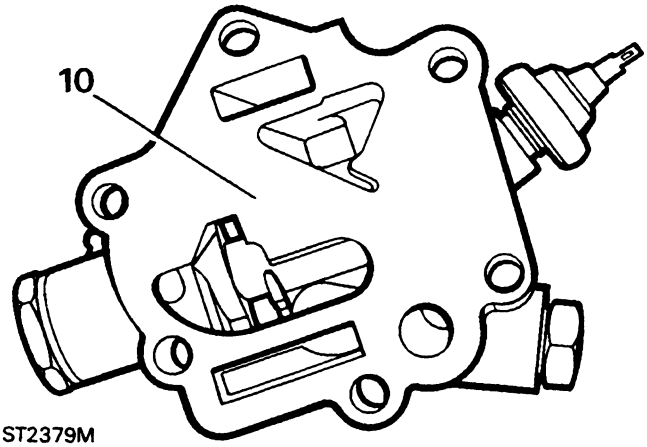
ST2377M

6. Clean all components including the recess in the front cover.
7. Check the oil pump gears for wear or scores.
8. Fit the oil pump gears and shaft into the front cover.
9. Place a straight-edge across the gears and check the clearance between the straight-edge and the front cover. If less than 0,05 mm (0.0018 in), it indicates that the gear recess is worn and that the cover should be renewed.



ST2378M

10. Check the pump gear cover thrust face for wear. If scored it may be restored by careful refacing.



ST2379M

11. Check the oil pressure relief valve for wear and scores.
    Check the relief valve spring for wear at the sides or signs of collapse.
    Clean the gauze filter for the relief valve.
    Check the fit of the relief valve in its bore. The valve must be an easy slide fit with no perceptible side movement.
12. Renew any parts if their condition is doubtful.

Assemble pump

13. Insert the relief valve spring.
14. Locate the sealing washer on to the relief valve plug.
15. Fit the relief valve plug and tighten to 61 Nm (45 lbs ft).
16. Fully pack the oil pump gear housing with petroleum jelly.

    CAUTION: Grease must not be used since most greases contain additives which do not dissolve in engine oil and may cause malfunction of the hydraulic tappets, and or block the oil pick-up strainer, unless the pump is fully packed with petroleum jelly it may not prime itself when the engine is started.

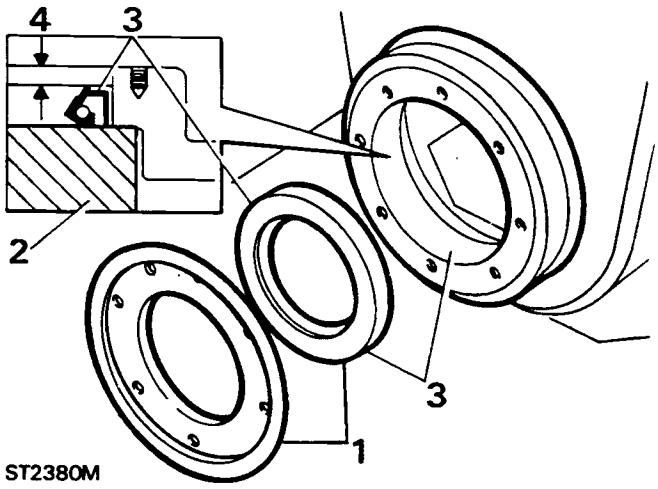
17. Fit the oil pump gears so that the petroleum jelly is forced into every cavity between the teeth of the gears.
18. Place a new gasket on the oil pump cover.

    CAUTION: Since it is the thickness of the gasket which determines the clearance of the gears it is vital that only a genuine Land Rover replacement part is used otherwise the end clearance may be reduced sufficiently to cause the pump to seize.

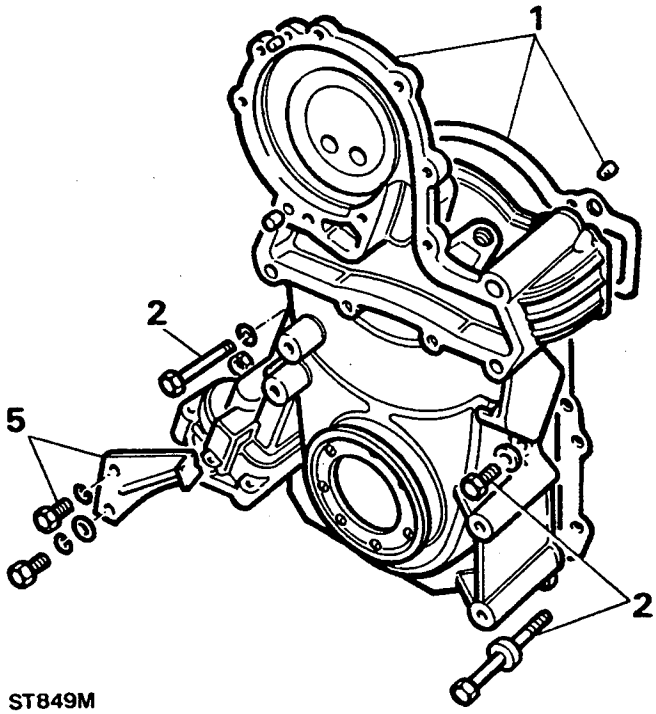
19. Locate the oil pump cover in position and fit the special fixing bolts and tighten alternately and evenly to the correct torque.

TIMING COVER OIL SEAL - renew

1. Remove the seven drive screws and withdraw the mud shield and the oil seal.
2. Position the gear cover with the front face uppermost and the underside supported across the oil seal housing bore on a suitable wooden block.
3. Enter the oil seal, lip side leading, into the housing bore.
4. Press in the oil seal until the plain face is 1,5 mm (0.062 in) approximately below the gear cover face.
5. Fit the mud shield and secure with the screws and a smear of sealing compound.



ST2380M



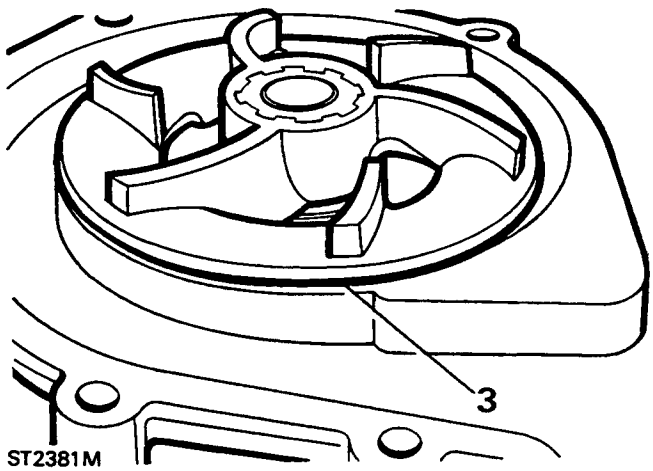
ST849M

WATER PUMP INSPECTION AND FITTING

1. The water pump is not a reconditionable unit but its condition can be determined by the following checks.
2. Spin the pump spindle and listen for noise. Push and pull the spindle and check for sideways movement. The condition of the bearings can be judged from these checks.
3. During the above checks the clearance between the impeller and the pump body should not vary.

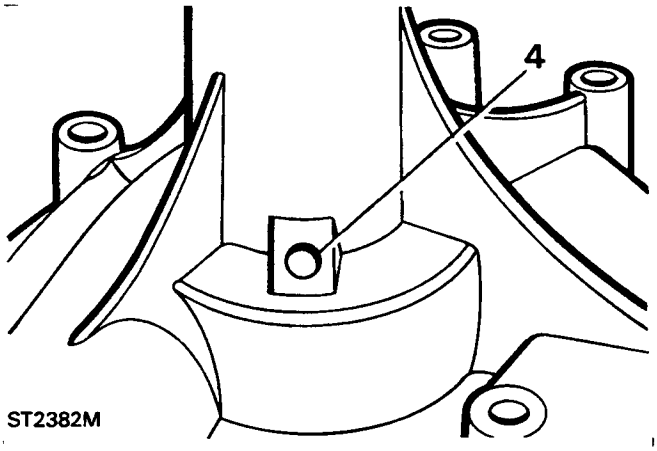
FIT THE TIMING COVER AND CRANKSHAFT PULLY

1. Place a new timing cover joint washer in position and fit the timing cover locating it on the two dowels.
2. Clean the threads of the timing cover securing bolts, then coat them with Thread Lubricant-Sealant Loctite 572.
3. Fit the timing cover bolts but do not fully tighten until the water pump is fitted.
4. Fit the crankshaft pulley and tighten the retaining bolt to the correct torque.
5. Fit the timing pointer.



ST2381M

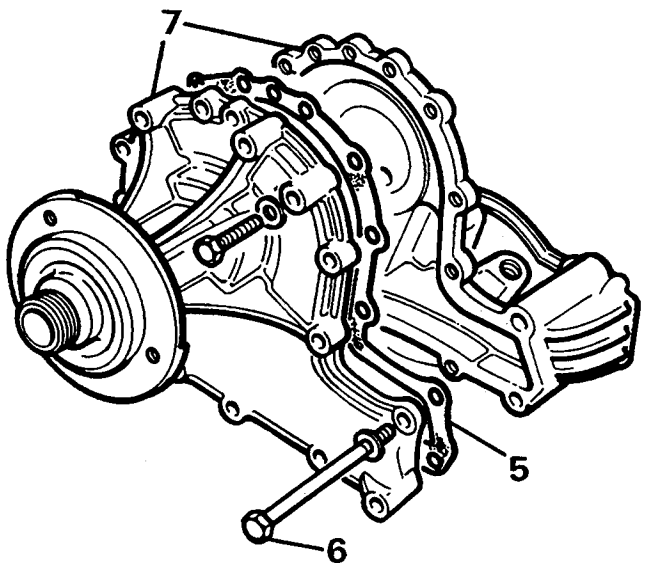
4. Inspect the vent hole in the pump body for signs of coolant or oil leaks. If there is any evidence of leakage, the pump should be renewed.



ST2382M

Fitting water pump

5. Lightly grease a new joint washer and place it in position on the timing cover.
6. Clean the threads of the four long bolts and smear them with Loctite 572 thread lubricant-sealant.
7. Locate the water pump in position and fit any ancillary brackets. Tighten the securing bolts including the timing cover bolts evenly to the correct torque.

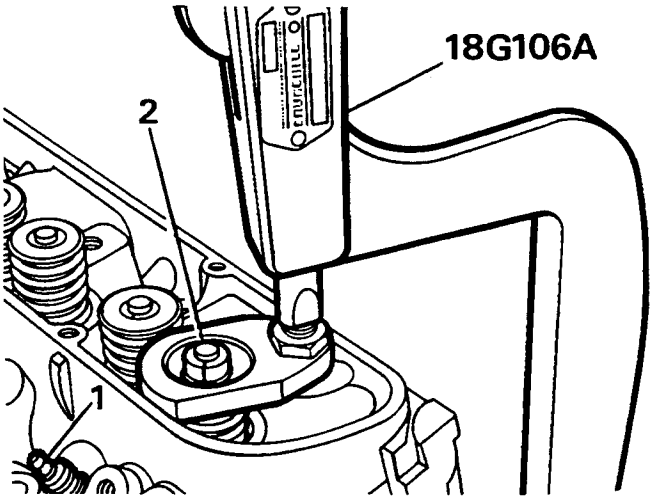


ST3165M

CYLINDER HEAD OVERHAUL

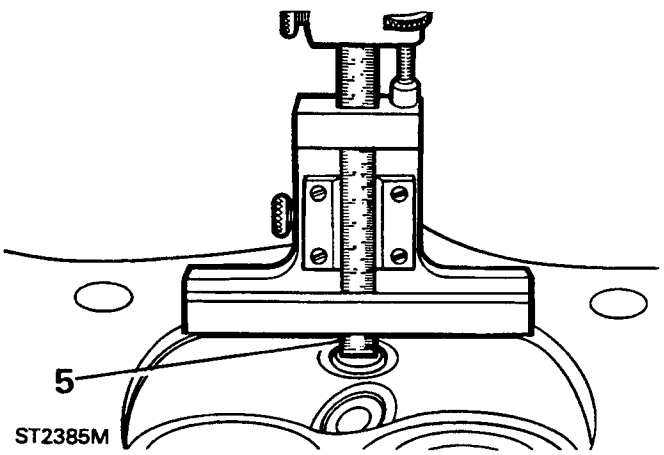
Dismantle cylinder heads

1. Remove the spark plugs.
2. Using the valve spring compressor 276102, or 18G106A or MS1519A or a suitable alternative, remove the valves and springs and retain valves in sequence for possible refitting. The springs should be discarded.



ST2384M

3. Clean and degrease the cylinder heads and remove carbon from the combustion face and chambers with a soft wire brush. Wear protective goggles.
4. Examine both heads for damage, cracks and overheating.
5. Using a depth gauge measure the distance between the combustion face and the boss in each combustion chamber. A reading of less than 6,35 mm (0.250 in) indicates that the combustion face has previously been machined. It is very important that the measurement is the same on both cylinder heads since any variation will cause misalignment of the inlet manifold and possible leakage at the manifold gasket.



ST2385M

6. Examine the condition of all threaded holes and any holes which are stripped and damaged can be salvaged by fitting Helicoils.

Reclaiming cylinder head threads

Holes A - These three holes may be drilled 0.3906 in dia. x 0.937 + 0.040 in deep. Tapped with helicoil Tap No. 6CPB or 6CS x 0.875 in (min.) deep (3/8 UNC 1 1/2D insert).

Holes B - These eight holes may be drilled 0.3906 in dia. x 0.812 + 0.040 in deep. Tapped with helicoil Tap No. 6CBB 0.749 in (min.) deep (3/8 UNC 1 1/2D insert).

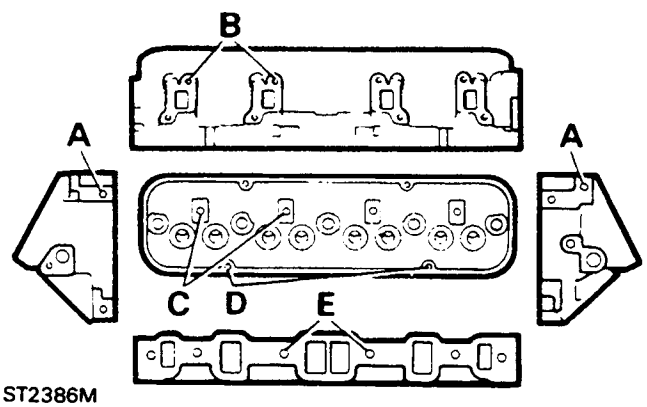
Holes C - These four holes may be drilled 0.3906 in dia. x 0.937 + 0.040 in deep. Tapped with helicoil Tap No. 6CPB or 6CS x 0.875 in (min.) deep (3/8 UNC 1 1/2D insert).

Holes D - These four holes may be drilled 0.261 in dia. x 0.675 + 0.040 in deep. Tapped with helicoil Tap No. 4CPB or 4CS x 0.625 in (min.) deep (1/2 UNC 1 1/2D insert).

Holes E - These six holes may be drilled 0.3906 in dia. x 0.937 + 0.040 in deep. Tapped with helicoil Tap No. 6CPB or 6CS x 0.875 in (min.) deep (3/8 UNC 1 1/2D insert).

NOTE: Right-hand cylinder head illustrated. American projection

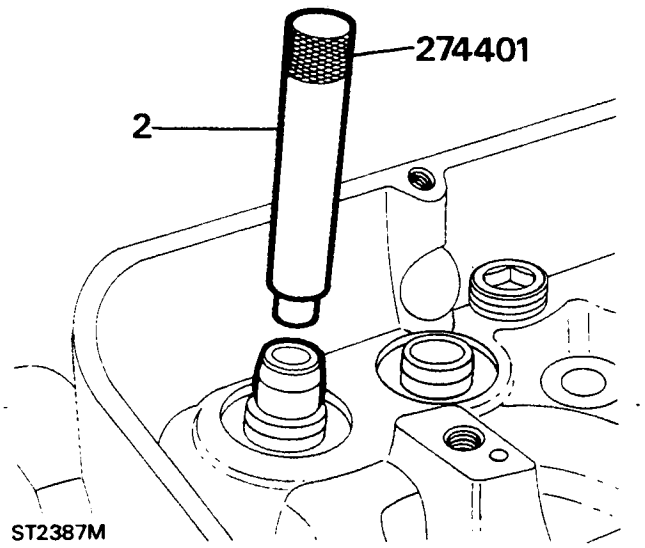
F Exhaust manifold face
G Inlet manifold face
H Front face
I Rear face
J Front of engine



ST2386M

Examine and renew valve guides

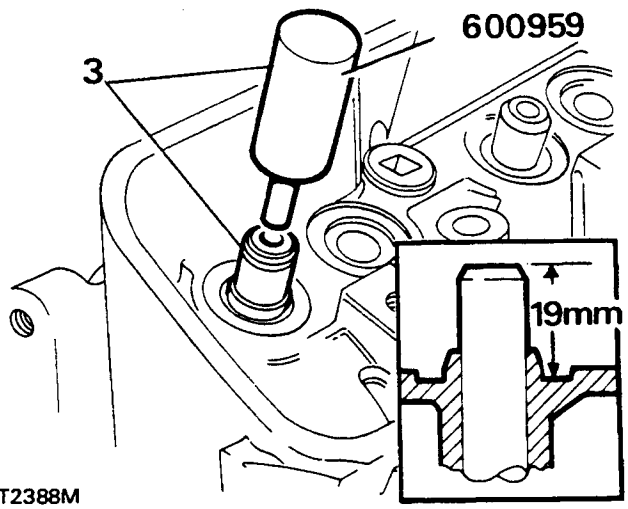
1. Check the valve guides for wear by inserting a new valve in the guide and holding it 8 mm from the seat. If sideways movement of the valve head exceeds 0,15 mm (0.006 in) the guide should be renewed.
2. To remove worn guides, use guide removing tool 274401 and drive-out the guides from the rocker shaft side of the cylinder head through the valve port. Clean away any carbon deposits from the port that were not accessible before the guides were removed.



ST2387M

3. Lubricate the new valve guide and place in position. Using guide drift 600959 and if available, height gauge RO605774A, drive the guide into the cylinder head until it protrudes 19 mm above the valve spring recess in the head or flush with the height gauge.

NOTE: Service valve guides are 0,02 mm (0.001 in) larger on the outside diameter than the original equipment to ensure interference fit.

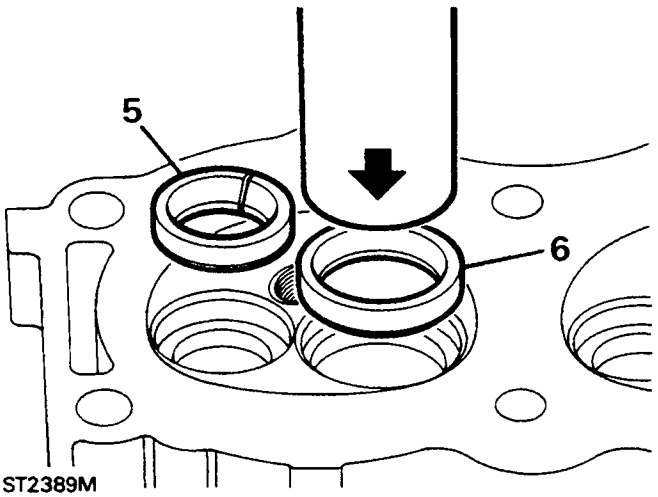


ST2388M

Examine and renew valve seat inserts

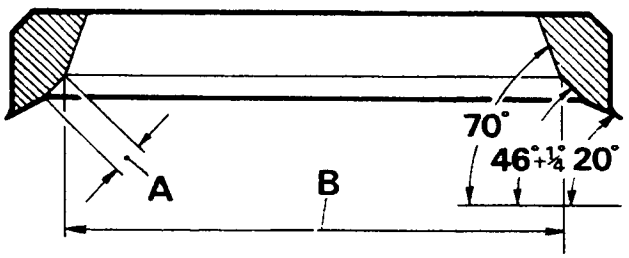
4. Check the valve seats for wear, pits and burning or pocketing due to repeated refacing and renew the inserts if necessary.
5. Remove the old seat inserts by grinding them away until they are thin enough to be cracked and prised out. WEAR GOGGLES.
6. Heat the cylinder head evenly to approximately 65°C (150°F) and press the new insert into the recess in the cylinder head and allow the cylinder head to cool naturally.

NOTE: Service valve seats are available in two oversizes: 0,25 and 0,50 mm (0.010 and 0.020 in) larger on the outside diameter to ensure interference fit.



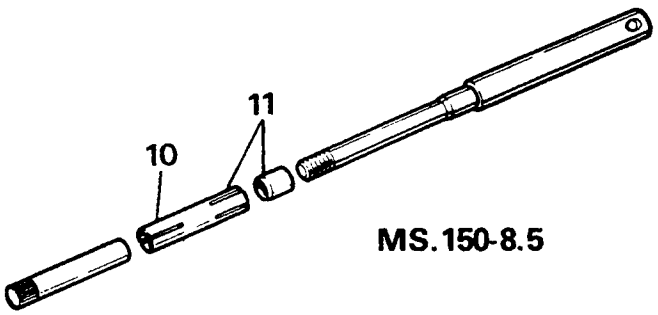
ST2389M

7. If necessary, cut the valve seats to 46.25°. The nominal seat width 'A' is 1,5 mm (0.031 in). If the seat exceeds 2,0 mm (0.078 in) it should be reduced to the specified width by the use of 20 and 70° cutters.
8. The inlet valve seat diameter, B is 37,03 mm (1.458 in) and the exhaust valve seat is 31,50 mm (1.240 in) diameter.



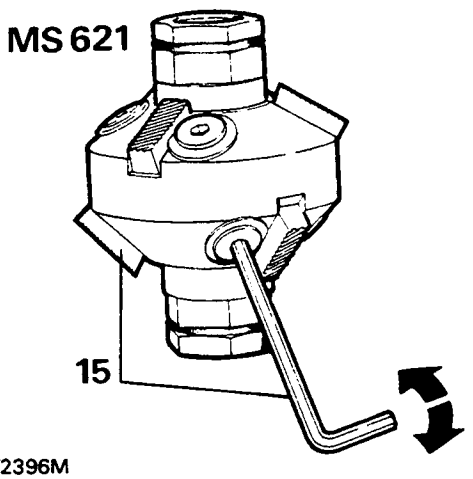
ST2392M

9. The special set of hand tools recommended for refacing include expandable pilots that fit tightly into new or worn guides to ensure that the valve seat is concentric with valve guide. The refacing tool has tungsten carbide cutters and can be used to cut a seat in a new exhaust seat insert.
10. Select the correct expandable collet for the valve.
11. Ensure that the chamfered end of the expander is towards the collet.
12. Insert the assembled pilot into the valve guide from the combustion face side of the cylinder head until the shoulder contacts the valve guide and the whole of the collet is inside the valve guide. Tommy bar hole combustion face side.
13. Expand the collet in the guide by turning the tommy bar clockwise whilst holding the knurled nut.



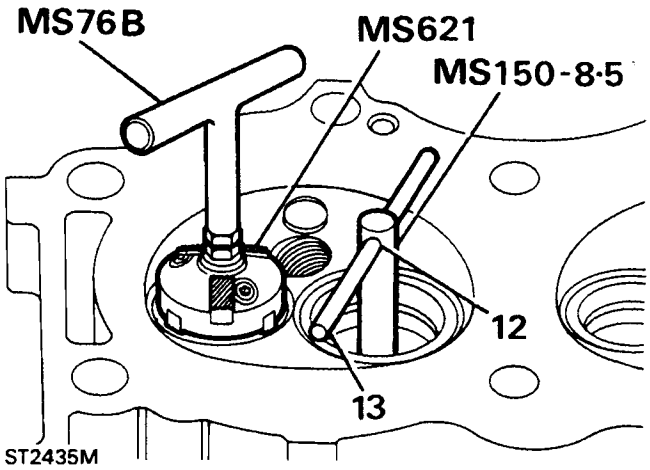
ST2410M

14. Select the appropriate angled cutter for the seats to be cut.
15. Ensure that the cutter blades are correctly fitted to the cutter head with the angled end of the blade downwards facing the work as illustrated.



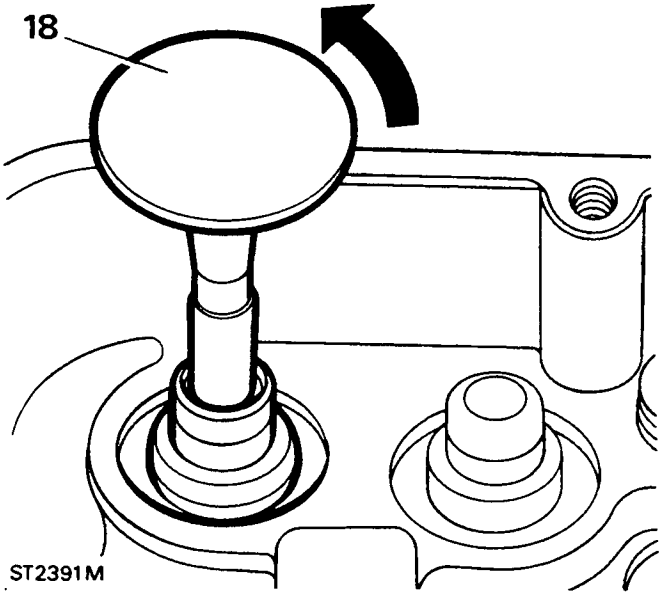
ST2396M

16. Check that the cutter blades are adjusted so that the middle of the blade contacts the area of of material to be cut. Use the key provided in the hand set MS76 to adjust the cutters so that they all contact the seating simultaneously. Use light pressure and remove only the minimum material necessary.

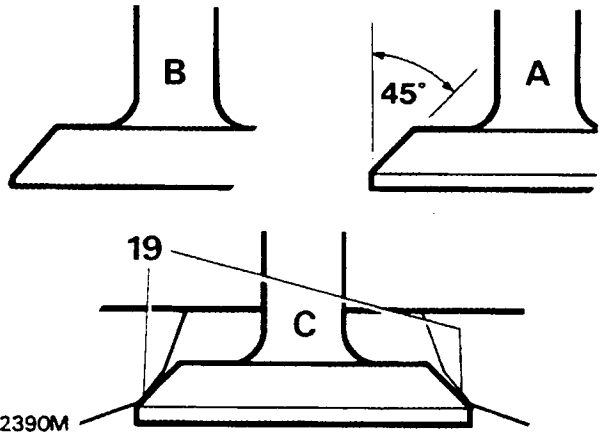


Examine and reface valves

17. Examine the valves and discard any which are burnt, cracked or where the head is dished. Also renew valves if the stems are scored, show signs of overheating and seizure. Valves that appear satisfactory should be checked in the guides, using the same method as for checking the valve guides, for stem wear.
18. Revolve valves in the guides to check for bend.



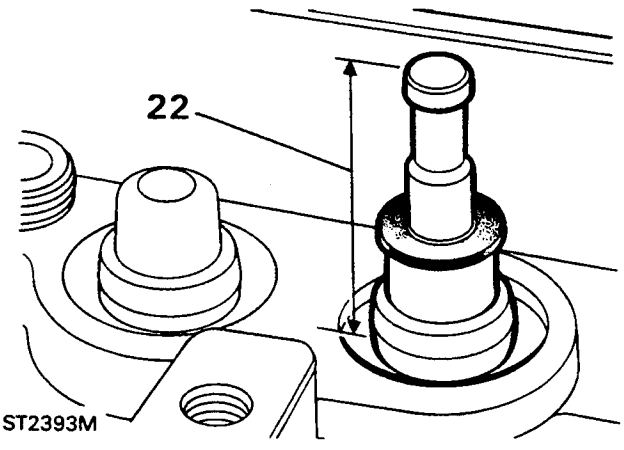
19. Reface serviceable valves to an axle of 45°, example 'A'. Any valve which after refacing resembles 'B' must be renewed.



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

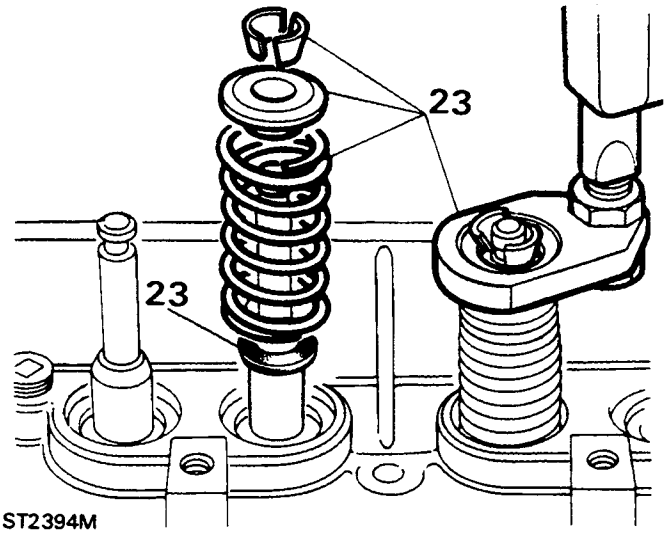
Valve clearance and assembly to head

22. Before fitting the valves and springs the height of each valve above the head must be checked. Insert each valve in turn in its guide and whilst holding the head firmly agaianst its seat, measure the height of the stem above the valve spring seat surface. This dimension must not exceed 47,63 mm (1.875 in). If necessary renew the valve or grind the end of the valve stem.



Fitting valves and springs

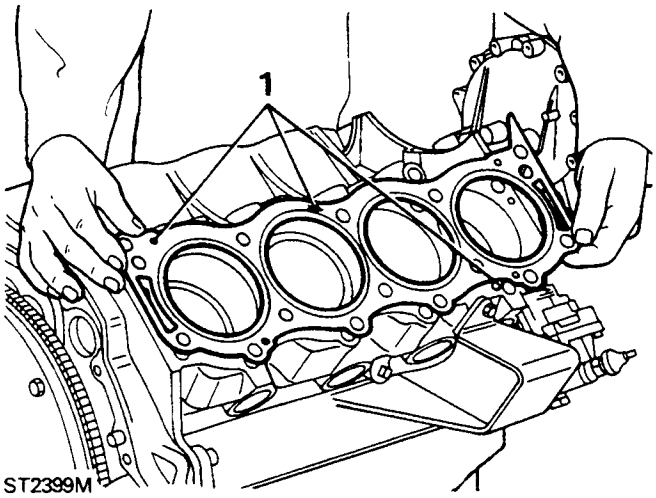
23. Insert each valve in its guide, lubricate with clean oil and place a new seal over the stem of the INLET valves only. Fit a new spring and using spring compressor 18G106A or 276102, secure the valve with the cap and collets.



ST2394M

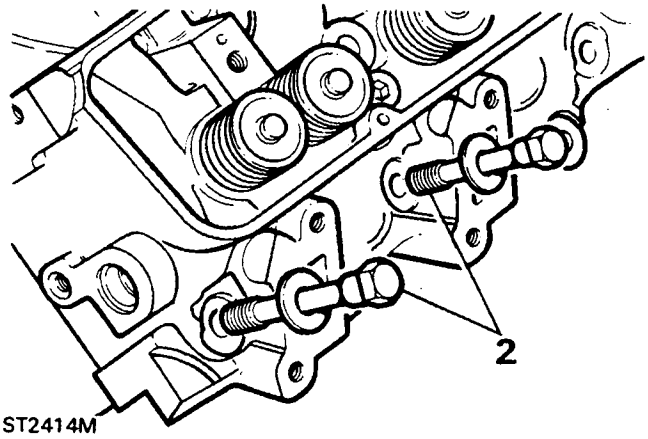
FITTING CYLINDER HEADS

1. Place new genuine Land Rover cylinder head gaskets in position over the dowel pins, on the cylinder block, with the word 'TOP' uppermost. DO NOT use any sealant.



ST2399M

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



ST2414M

3. Locate the cylinder head bolts in the positions as illustrated below.

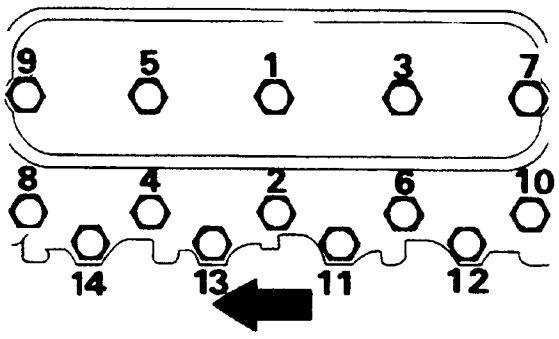
Long bolts - 1, 3 and 5.
Medium bolts - 2, 4, 6, 7, 8, 9 and 10.
Short bolts - 11, 12, 13 and 14.

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

Tighten the cylinder head bolts a little at a time in the sequence shown below to the following figures:

Bolts 1 to 10 - 65 to 70 lbf ft (88 to 95 Nm).
Bolts 11 to 14 - 40 to 45 lbf ft (54 to 61 Nm).

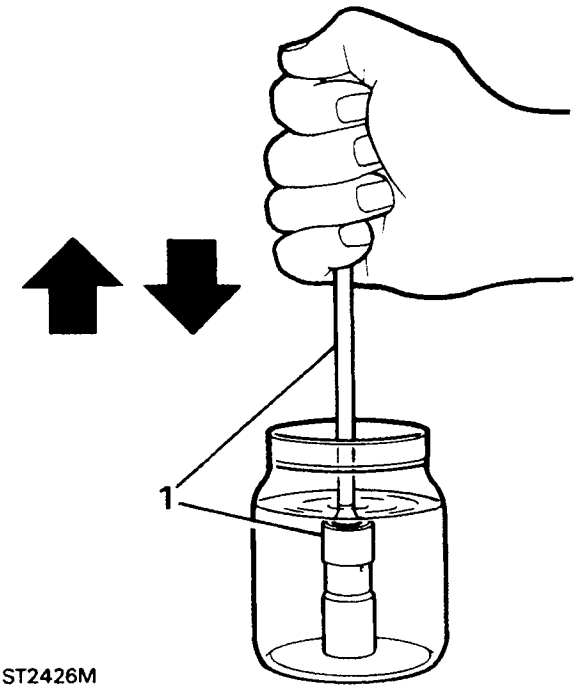
When all bolts have been tightened, recheck the torque settings



ST845M

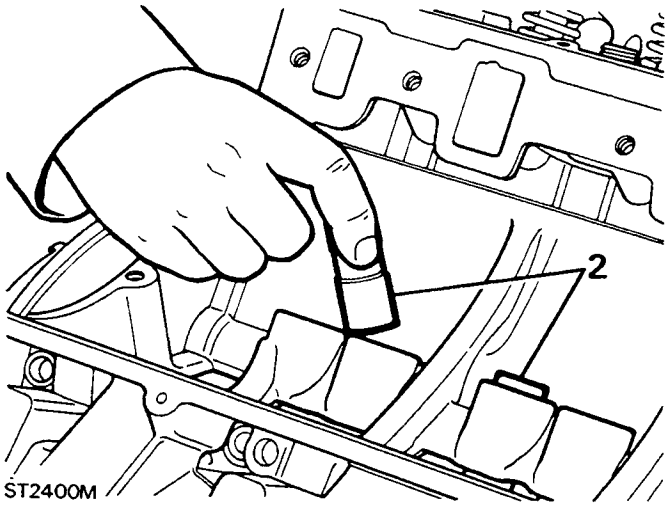
FITTING TAPPETS

1. Place all the tappets into a metal container of clean engine oil and operate the inner member using a push rod to fill each tappet with oil. This will reduce tappet noise when the engine is first started.



ST2426M

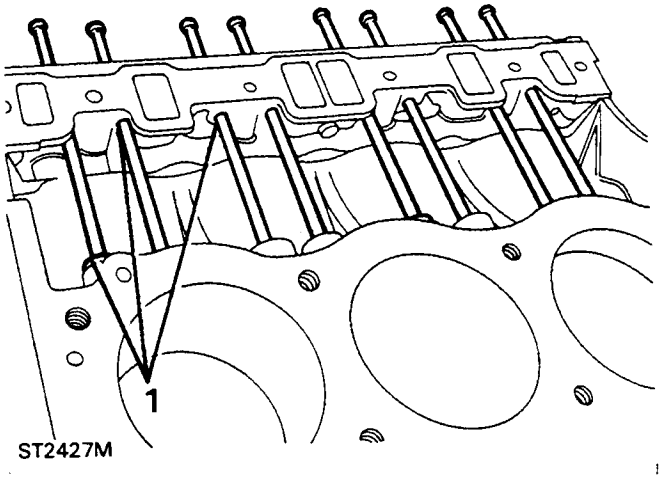
2. Refit any used tappets into their original locations and ensure that they all rotate freely in the bores.



ST2400M

FITTING ROCKER SHAFTS AND PUSH RODS

1. Fit the push rods through the guide holes in the cylinder head ensuring that any used ones are returned to their original locations and that all the rods locate properly in the tappets.

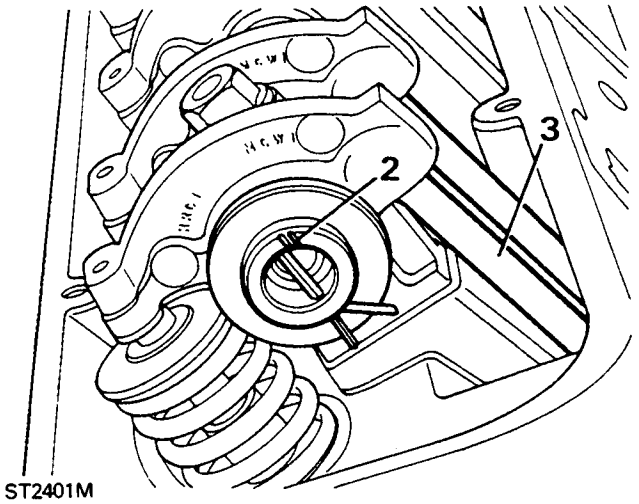


ST2427M

2. The rocker shafts are handed and must be fitted correctly to align the oilways. Each rocker shaft is notched at one end and on one side only. If they are correctly assembled then when fitted the notch in the end of each shaft will be at one-o'clock position and towards the front on the right bank and to the rear on the left bank, viewing the engine from the flywheel end.

CAUTION: Incorrectly assembled and fitted rocker shafts will prevent lubrication reaching the shafts and rockers.

3. When fitting the rocker shaft assembly to the cylinder head ensure that the push rods locate correctly in the rocker seats. Tighten the retaining bolts evenly to the correct torque.



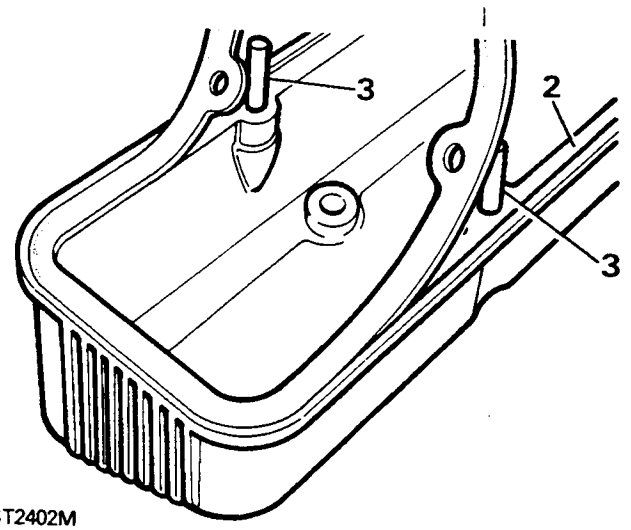
ST2401M

FITTING ROCKER COVERS

1. An oil baffle is fitted inside each rocker cover and is secured by self tapping screws to enable the baffle to be removed for cleaning if necessary.
2. Remove all traces of old gasket on the covers and cylinder heads. Clean and dry the gasket mounting surface, using Bostik cleaner 6001. Apply Bostik 1777 impact adhesive to the seal face and the gasket, using a brush to ensure an even film. Allow the adhesive to become touch-dry, approximately fifteen minutes.

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

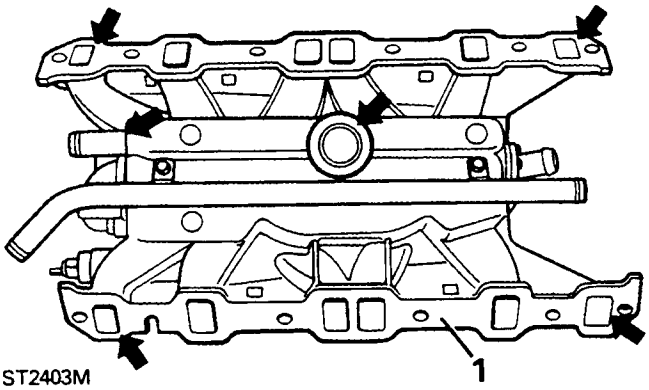
3. Fit pilot studs in the rocker cover fixing holes to guide the gasket on to the cover and into the recess. Press the gasket into position ensuring that the outer edge firmly adheres to the recess wall. Remove the pilot studs when the gasket is finally positioned.
4. Allow the covers to stand for thirty minutes before fitting them to the engine, then secure the rocker covers to the engine with the retaining screws.



ST2402M

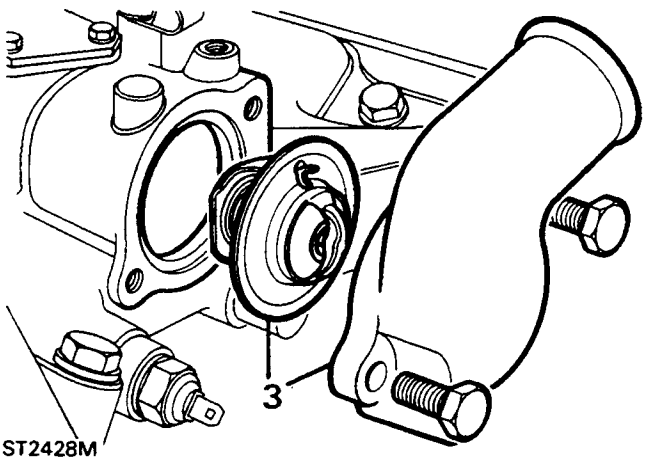
INLET MANIFOLD INSPECTION

1. Examine the manifold for cracks and damage. Check the threaded holes and joint faces.
2. Since the manifold is water heated, a thorough check should be made for signs of coolant leaks from pipes and plugs particularly on the underside of the casting.



ST2403M

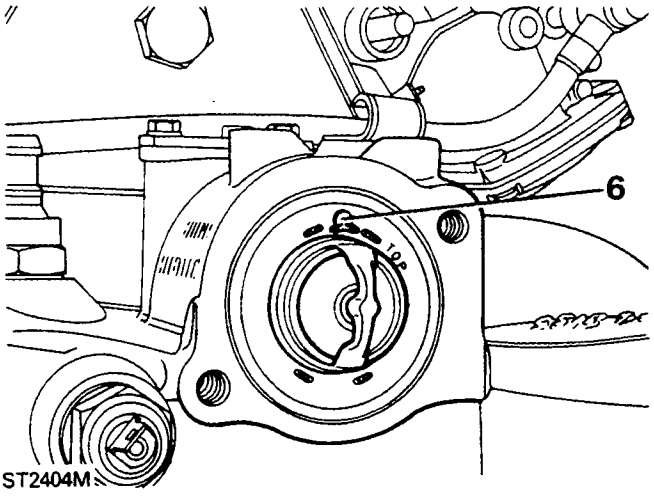
3. Remove the thermostat cover and withdraw the thermostat. Clean any deposits from the housing and the cover.



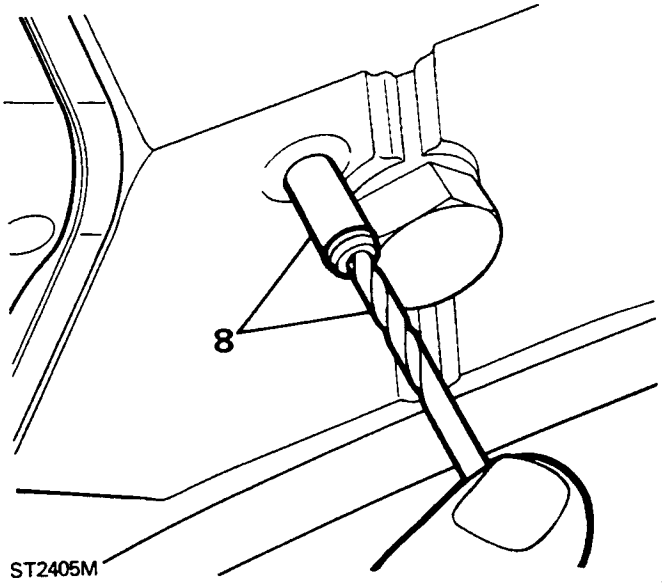
ST2428M

4. The temperature at which the thermostat should be fully open is stamped on the forward end of the thermostat. The following method can be used to determine if the thermostat is satisfactory and suitable for refitting.
5. Place the thermostat and a Centigrade thermometer in a laboratory beaker, or a suitable alternative, half full of water. Heat the water and observe the temperature at which the thermostat opens. If faulty, discard the thermostat.

6. The thermostat has a small vent hole in which is fitted a 'jiggle' pin to keep the hole clear. Fit the thermostat to the housing ensuring that this vent is uppermost at the 12 o'clock position. If fitted in any other way, an air lock could result in the water passages causing overheating and coolant loss from the system.

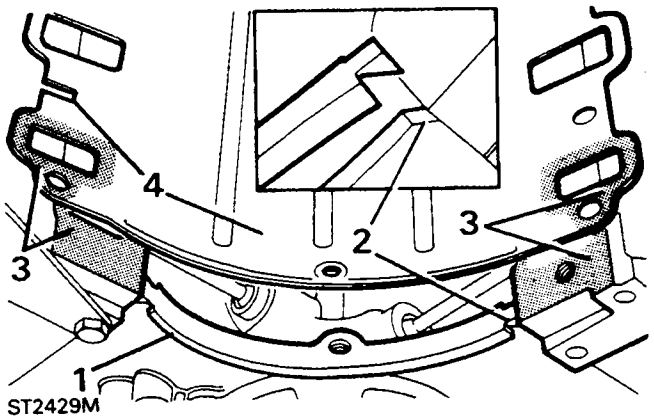


7. Fit the thermostat cover using a new gasket. Coat the threads of the retaining screws with Loctite 572 and tighten the screws evenly to the correct torque.
8. A small diameter vent pipe is located at the side of the manifold penthouse. Disconnect the hose and insert a 2 mm drill and turn it by hand to ensure that the vent is clear. Any blockage at this point will cause overheating and loss of coolant. Check that the hose is also clear.

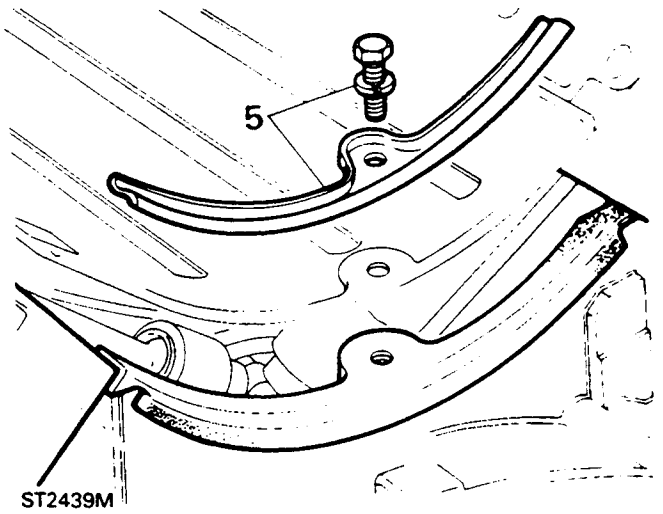


FITTING INLET MANIFOLD

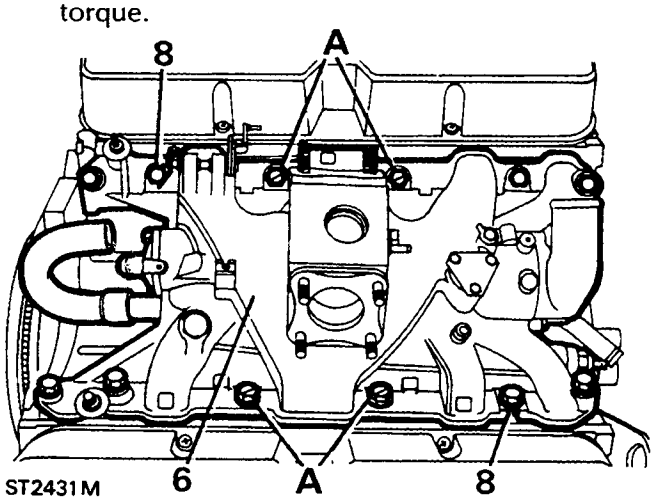
1. Coat both sides of the new manifold gasket seals with silicon grease.
2. Apply a 6 mm (6.25 in) diameter globule of loctite super flex in the four notches formed between the cylinder head and block. Locate the seals in position with their ends engaged in the notches formed between the cylinder head and block.
3. Apply 'Hylomar' sealing compound SQ32M on the corners of the cylinder head, manifold gasket and manifold, around the water passage joints.
4. Fit the manifold gasket with the word 'FRONT' to the front and the open bolt hole at the front R.H. side.



5. Fit the gasket clamps but do not fully tighten at this stage.



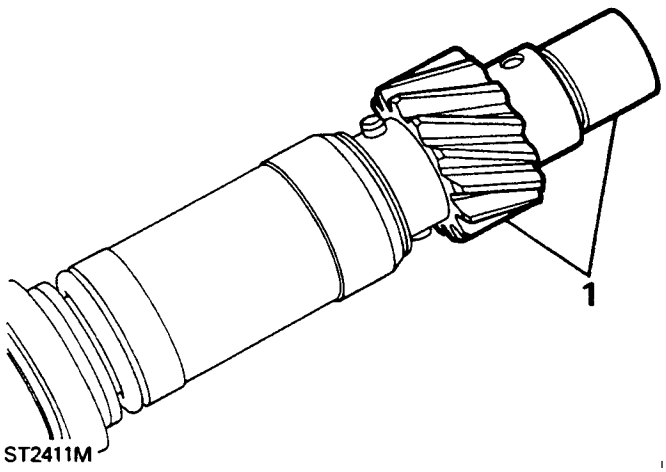
6. Locate the manifold on to the cylinder head.
7. Clean the threads of the twelve manifold securing bolts and apply Loctite 572 to the threads.
8. Fit all the manifold bolts and tighten them a little at a time, evenly, alternate sides working from the centre to each end and finally tighten to the correct torque. Note that the four slotted headed bolts are fitted at the locations 'A'.
9. Tighten the gasket clamp bolts to the correct torque.



ST2431M

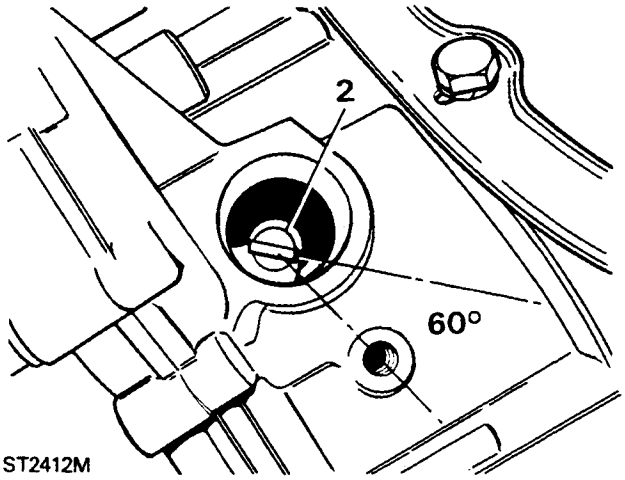
FITTING THE DISTRIBUTOR

1. Examine the distributor drive gear and swivel coupling and renew if necessary.



ST2411M

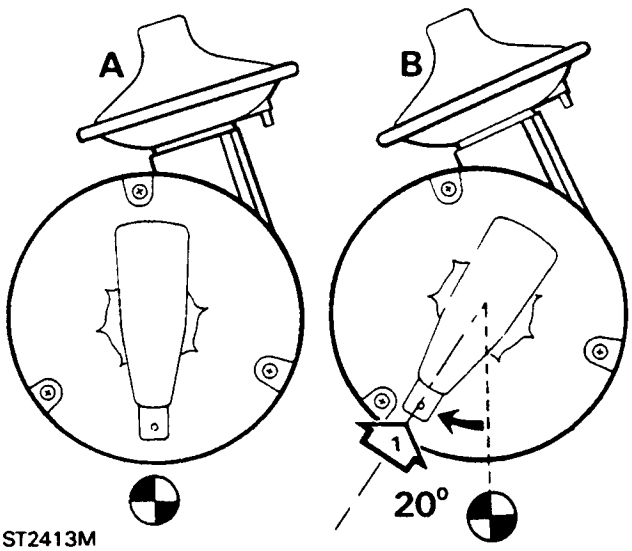
2. Turn the crankshaft to bring number one cylinder piston to T.D.C. with number six cylinder valves on overlap. Turn the oil pump drive shaft so that the tongue is at an angle of 60° to the distributor clamp bolt hole. Insert the distributor into the front cover with the vacuum unit pointing in the direction illustrated and the rotor arm aligned with the clamp hole.



ST2412M

3. Insert the distributor into the front cover with the vacuum unit pointing in the direction illustrated and the rotor arm aligned with the clamp hole, illustration A.

4. When the distributor drive engages with the camshaft gear the distributor shaft and rotor arm will turn clockwise approximately 20° and should seat fully into its location with the rotor arm inline with number one cyclinder plug lead. If the oil pump drive does not engage with the distributor coupling the distributor can not be pushed fully home. Therefore remove the distributor and reposition the oil pump drive a few degrees and try again. Do not however, use any force to locate the distributor.
5. Fit the clamp and nut but do not fully tighten at this stage.

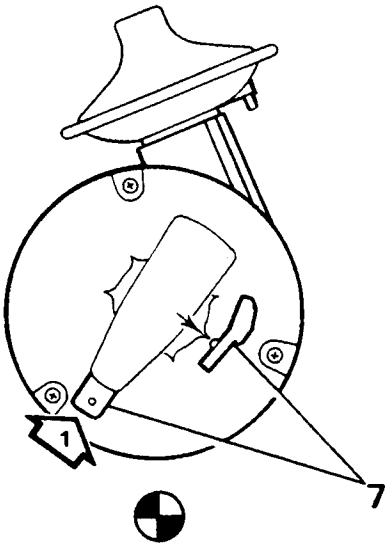


ST2413M

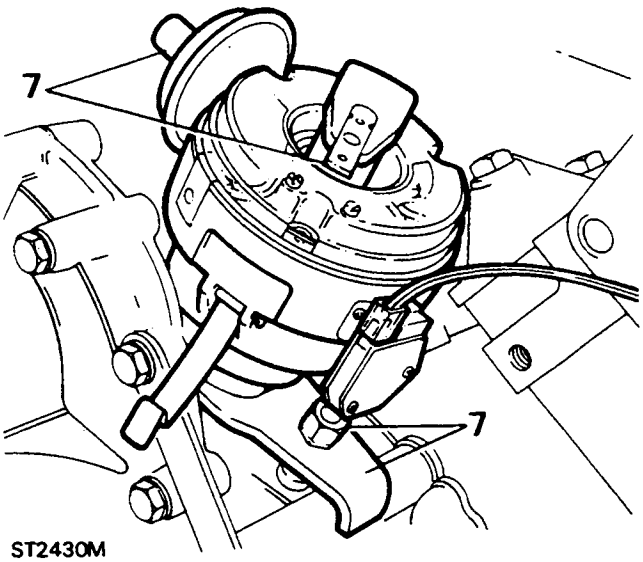
Static ignition timing

6. Ensure that number one cylinder piston is at T.D.C. with both valves closed.
7. Turn the distributor body so that the rotor arm is pointing to number one cylinder plug lead, in the distributor cap, and the reluctor is aligned with the pick-up. Finally tighten the clamp nut.

NOTE: The above distributor setting is only provisional to enable the engine to be started. When the engine is refitted to the vehicle the ignition timing must be set using electronic equipment in accordance with the information in ENGINE TUNING DATA Section 05.

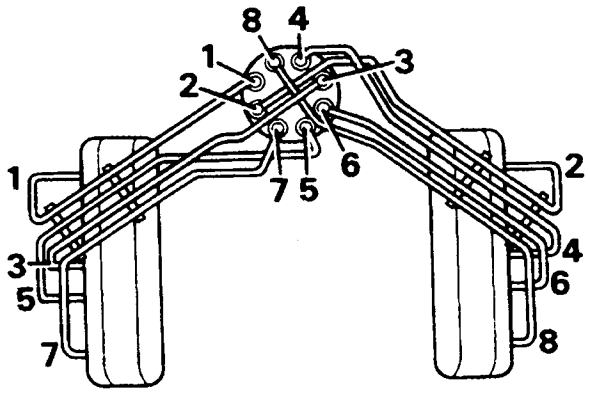


ST2415M



ST2430M

8. Fit the distributor cap and spark plugs and connect the distributor leads exactly in accordance with the illustration.

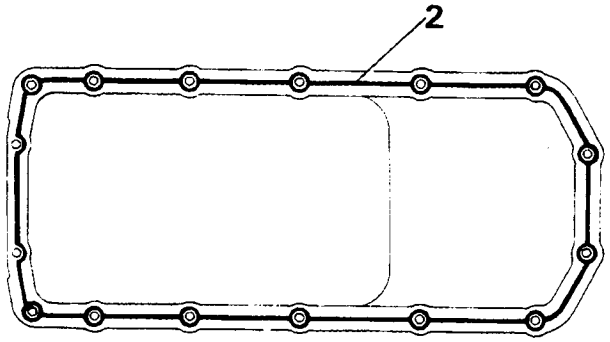


ST2416M

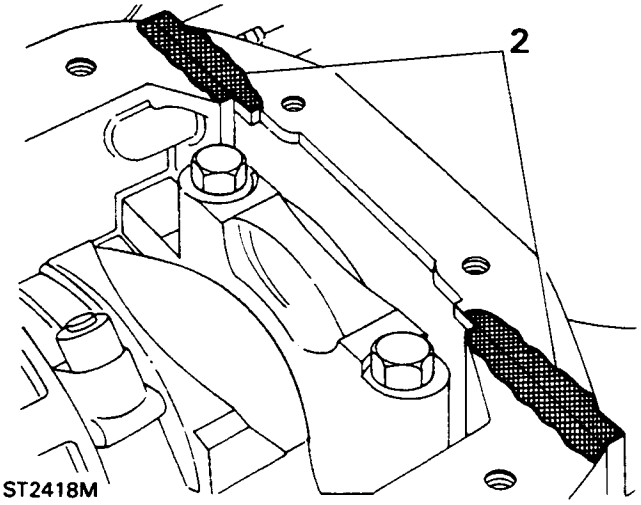
CAUTION: Failure to route the leads correctly, as shown, can cause cross firing between cylinders five and seven, as can be seen by the firing order 18436572. When cylinder 5 is at T.D.C. on the power stroke, cylinder 7 is at 90° before T.D.C. on the compression stroke ready for ignition. If the plug leads for these two cylinders are routed parallel in adjacent clips, HT current to number 5 plug will also be induced in number 7 causing combustion of the mixture in number 7 cylinder to occur 90° B.T.D.C. and again at T.D.C. It is for this reason that the correct clipping of the plug leads is observed to avoid the possibility of severe damage to the engine.

FITTING THE SUMP

1. Fit the oil strainer.
2. Remove all traces of gasket material or sealant from the joint faces, then apply a 2 mm wide bead of silicone rubber sealant Hylosil 102 to the joint face of the sump. Also smear a coating of the above sealant about 13 to 19 mm wide at the joint between the timing cover and crankcase in the area illustrated.



ST2417M



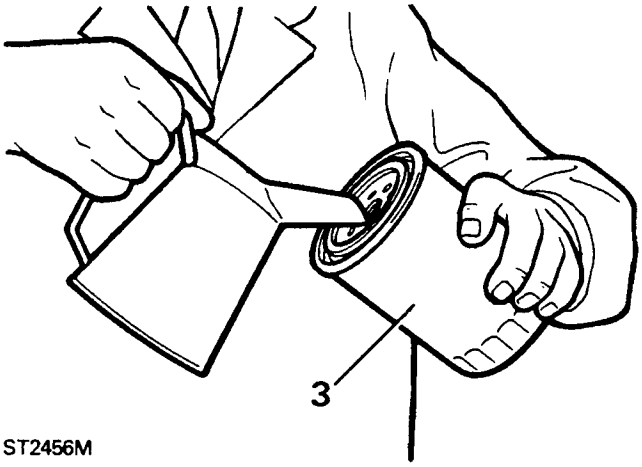
ST2418M

3. Fit the sump and secure with the retaining screws tightening evenly to the correct torque. Allow thirty minutes drying time before starting the engine.

FIT ENGINE OIL FILTER

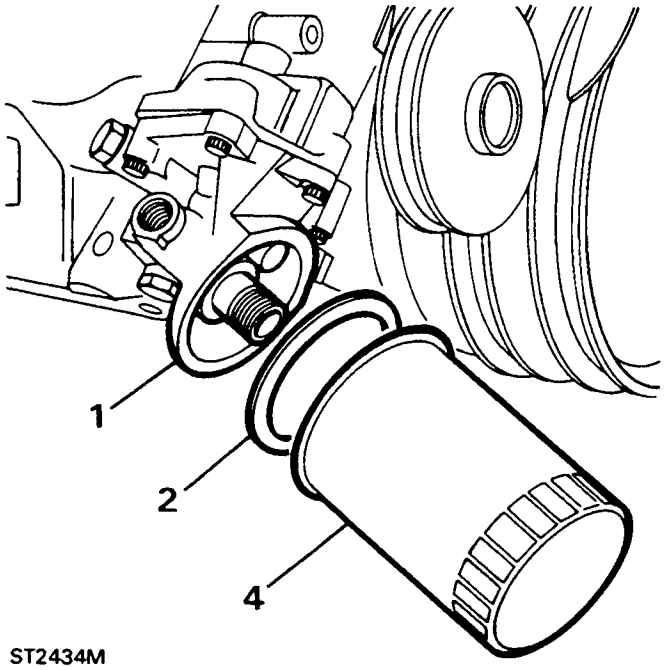
CAUTION: Use only a genuine Land Rover replacement filter.

1. Clean oil pump cover mating face with filter.
2. Smear clean engine oil on the rubber washer of the new filter.
3. Fill the filter with new oil as far as possible, noting the angle at which the filter is to be fitted.



ST2456M

4. Screw on the filter until the sealing ring touches the oil pump cover face, then tighten it a further half turn by hand only. **Do not overtighten.**
5. Fit the oil pressure and oil temperature transmitters to the oil pump cover.

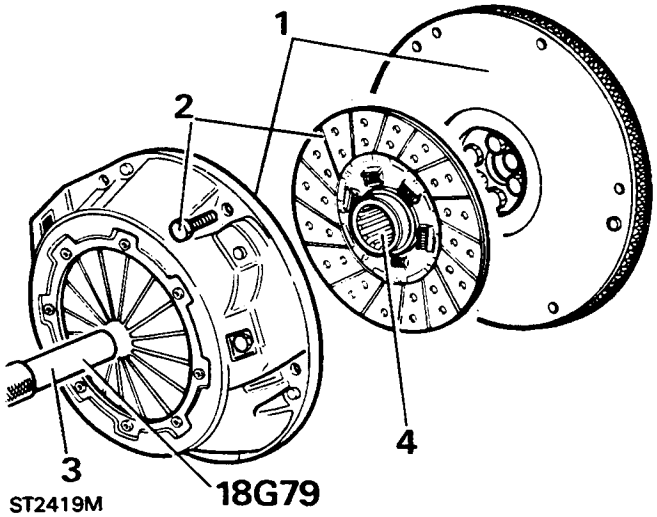


ST2434M

FIT THE CLUTCH

Fit a new clutch assembly complete

1. Clean the flywheel and protective grease from the clutch assembly pressure plate.
2. Fit the centre plate and the clutch assembly, locating on the dowels, and loosely secure to the flywheel with the retaining bolts.
3. Insert clutch centralising tool 18G79 or a spare primary shaft through the clutch assembly into the flywheel. Finally tighten the clutch assembly retaining bolts in a diagonal sequence, to the correct torque.
4. Smear the centre plate spines with Rocol MV3 or Rocol MTS 1000 grease.

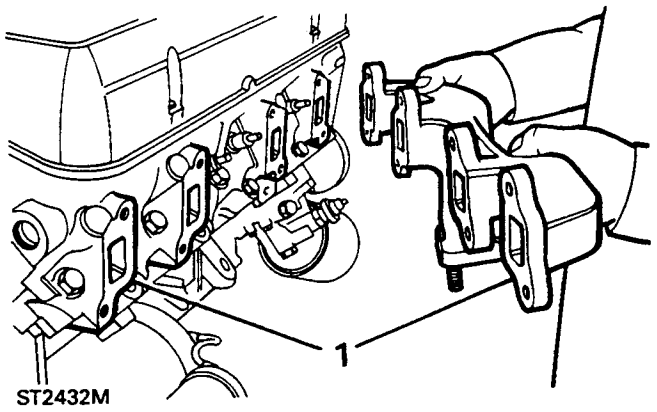


FIT THE FAN PULLEY, VISCOUS COUPLING AND FAN

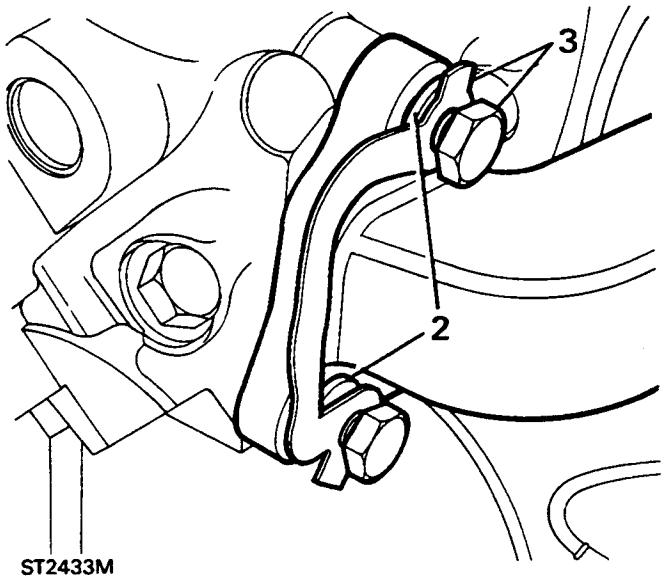
1. Secure the fan to the viscous coupling with the four screws and tighten evenly.
2. If removed, fit the pulley to the water pump and secure with the three screws.
3. Screw the viscous coupling onto the adaptor thread. Note that the adaptor and viscous coupling have a left-hand thread.
4. Fit the fan and any other drive belts.

FIT EXHAUST MANIFOLD

1. Ensure that the mating faces of the cylinder head and exhaust manifold are clean and smooth and coat the faces with 'Foliac J 166' or 'Moly Paul' anti-seize compound. 'Foliac J 166' is manufactured by Rocol Ltd., Rocol House, Swillington, Leeds, England. 'Moly Paul' is manufactured by K.S. Paul Products Ltd., Nobel Road, London N18.



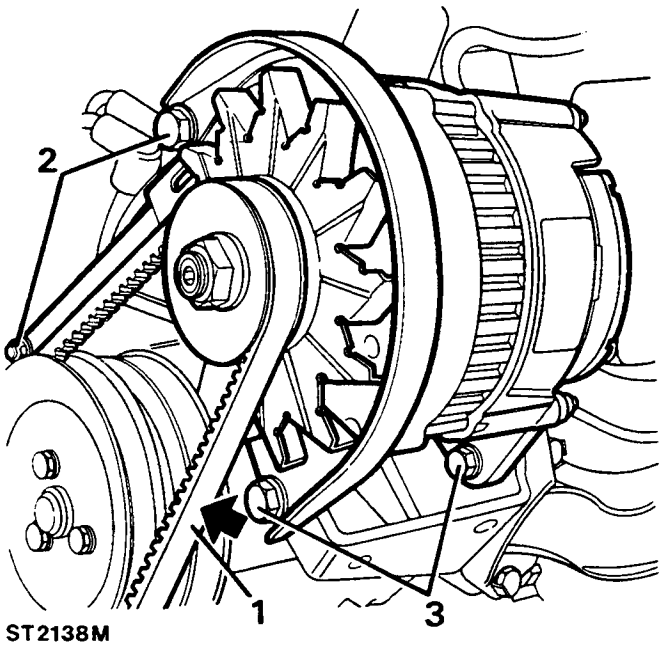
2. Place the manifold in position on the cylinder head and fit the securing bolts, lockplates and plain washers. The plain washers are fitted between the manifold and lockplates.
3. Evenly tighten the manifold bolts to the correct torque figure and bend over the lock tabs.



DRIVE BELT TENSIONING

Alternator drive belt driven from power steering pump.

1. Check the drive belt tension using thumb pressure at the mid point of the run between the power steering pump and alternator pulleys. If the deflection is greater or less than 4 mm to 6 mm adjustment is required as follows:-
2. Slacken the adjustment link pivot and clamp bolts.
3. Slacken the alternator two pivot nuts and bolts.



ST2138M

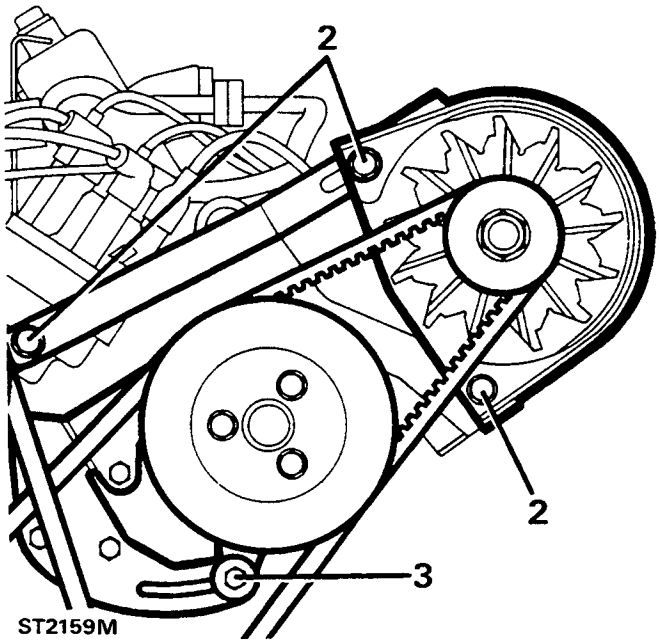
4. Move the alternator towards or away from the engine as necessary until the correct tension is achieved. Tighten the adjustment link bolts and the two pivot nuts and bolts.

CAUTION: To avoid damage to the alternator do not lever or apply pressure to the stator or slip ring end bracket.

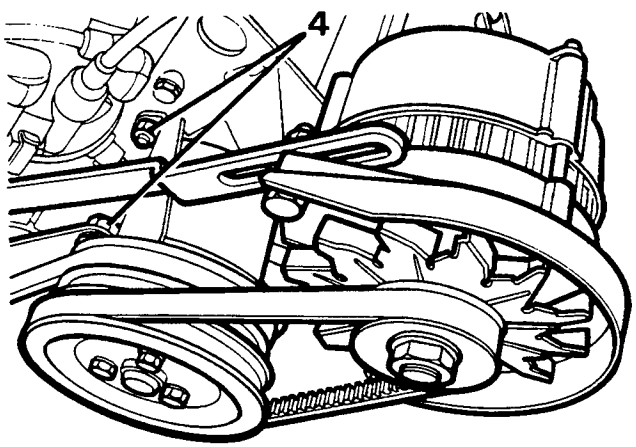
5. When the engine is refitted to the vehicle connect the battery, run the engine for the three to five minutes at a fast idle, switch-off and check the belt tension.

Power steering pump drive belt

1. Check, with thumb pressure, the tension of the drive belt at the mid point between the crankshaft and steering pump pulleys. If the deflection is less or in excess of 4 mm to 6 mm the belt requires adjustment as follows:-
2. Disconnect the battery and slacken the alternator adjustment-link clamp and pivot bolts and the alternator two pivot nuts and bolts.
3. Slacken the power steering pump adjustment clamp bolt.
4. Slacken the steering pump two pivot nuts and bolts.



ST2159M



ST2165M

5. Move the steering pump in the required direction to achieve the correct tension. Tighten the link clamp and pivot bolts and the two pivot nuts and bolts.

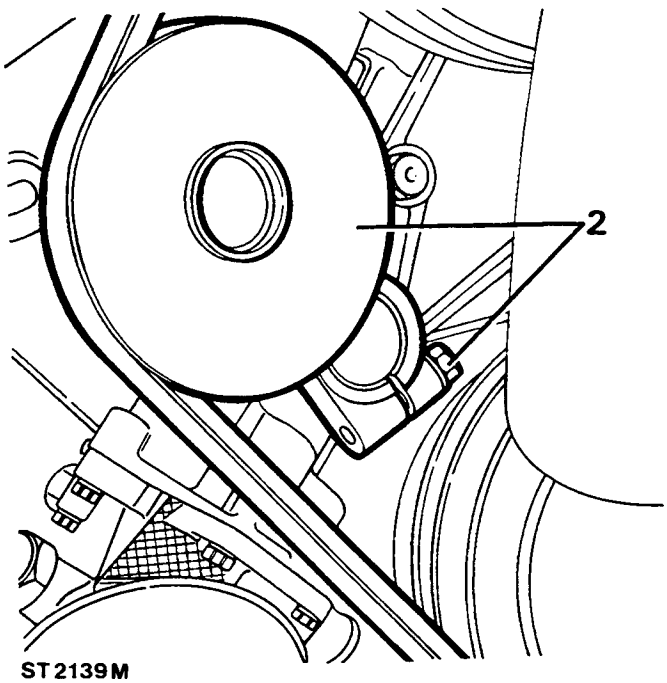
CAUTION: Do not use a lever or apply pressure to the pump body since this will cause permanent damage to the pump.

6. Adjust the alternator drive belt.
7. When the engine is refitted to the vehicle connect the battery , run the engine for three to five minutes at a fast idle, switch-off and check both the steering pump and alternator drive belt tension.

NOTE: A positive drive tensioner is fitted to later vehicles to provide greater accuracy when setting power steering and alternator drive belts. The tensioner eliminates the need to lever both power steering pump and alternator when adjusting belt tension. See Section 10 Maintenance for details.

Fan drive belt (with Air Conditioning)

1. With thumb pressure, check the fan belt tension at the mid point of the run between the fan and crankshaft pulleys on the side opposite the tensioning pulley. If the deflection is less or greater than 4 mm to 6 mm adjustment is nescessary as follows.



ST2139M

2. Disconnect the battery and slacken the tensioning pulley pinch bolt. Move the pulley to the left or right as required to achieved the correct tension and tighten the pinch bolt.
3. When the engine is refitted to the vehicle connect the battery, run the engine for three to five minutes at a fast idle, switch-off and check the tension.

RUNNING ENGINE FOLLOWING OVERHAUL

CAUTION: If the rear crankshaft seal is new do not exceed 1,000 engine rev/min when first starting the engine, otherwise the seal will be damaged.

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

Checking cylinder pressures

1. Run the engine until normal operating temperature is attained.
2. Remove the spark plugs from all the cylinders.
3. Secure the throttle in the fully open position and check and note the pressure of each cylinder in turn as follows: Insert a suitable pressure gauge, designed for the purpose, into a spark plug hole. Crank the engine with the starter motor for several revolutions and make a note of the highest figure recorded on the gauge. Repeat this procedure for the remaining cylinders. If the compression figures are within 10% of each other the engine is satisfactory. However, should the figures vary considerably more than 10% it indicates that the pistons and or valves are at fault. Low pressure in adjoining cylinders could be due to a leaking cylinder head gasket.

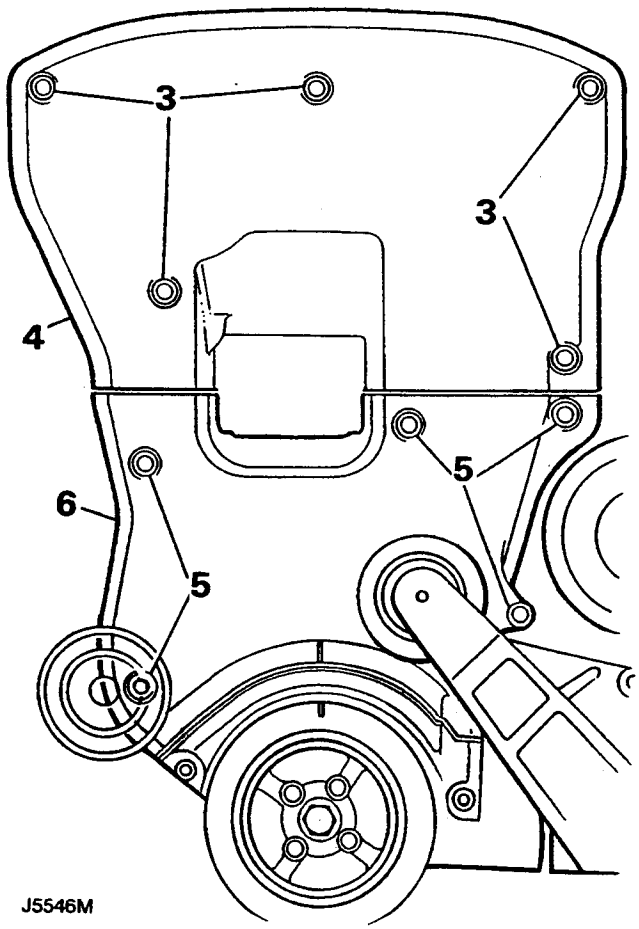
TOOL NUMBERS

LRT-12-056	Engine Lifting Bracket
LRT-12-058	Location Pin Valve Timing
LRT-12-059	Crankshaft Pulley Locking Tool
LRT-12-060	Locking Tool Camshaft Gear
LRT-12-061	Protector sleeve crankshaft rear oil seal
LRT-12-063	Remover camshaft oil seals
LRT-12-064	Replacer pilot camshaft front
LRT-12-069	Replacer crankshaft front oil seal
LRT-12-070	Sleeve crankshaft front oil seal
LRT-12-072	Replacer drift camshaft front oil seals
LRT-12-073	Remover crankshaft front oil seal
LRT-12-074	Remover adaptor kit
LRT-12-076	Replacer needle crankshaft bearing

CAMSHAFT FRONT OIL SEAL

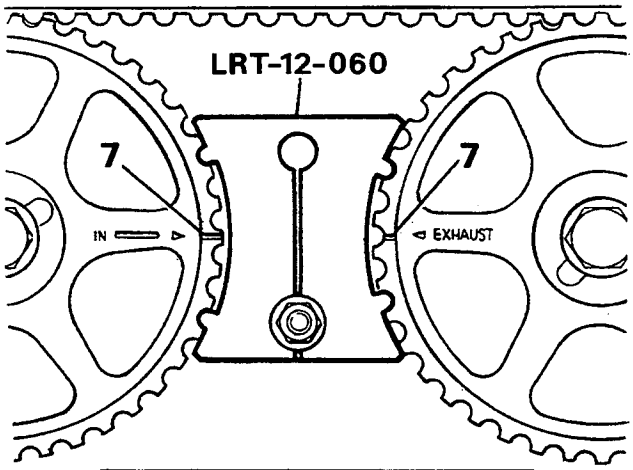
Remove

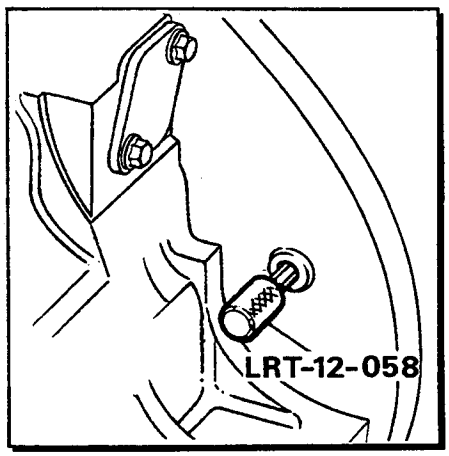
1. Disconnect battery earth lead.
2. Remove drive belt see maintenance section 10.
3. Remove 5 bolts, timing belt upper cover.
4. Remove timing belt upper cover.
5. Remove 5 bolts, timing belt centre cover.
6. Remove timing belt centre cover.



J5546M

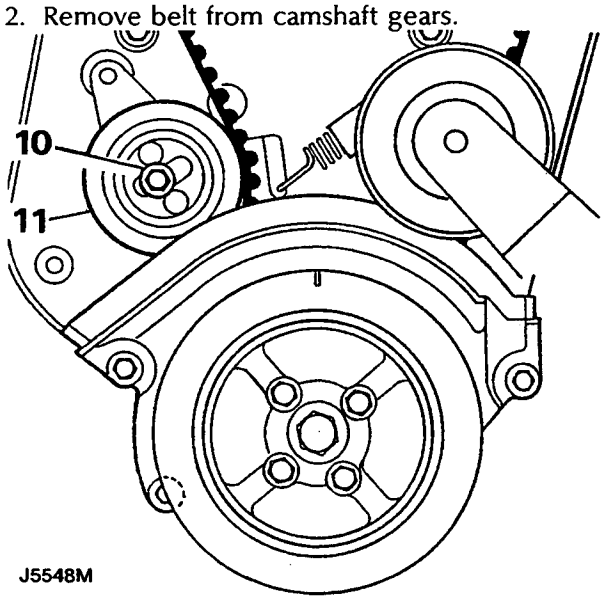
7. Rotate crankshaft to align camshaft gear timing marks - 90° B.T.D.C.
8. Fit tool LRT-12-058 to lock flywheel.
9. Fit tool LRT-12-060 to lock camshaft gears.





J5547M

10. Slacken camshaft belt tensioner bolt.
11. Move tensioner away from belt and tighten tensioner bolt.
12. Remove belt from camshaft gears.

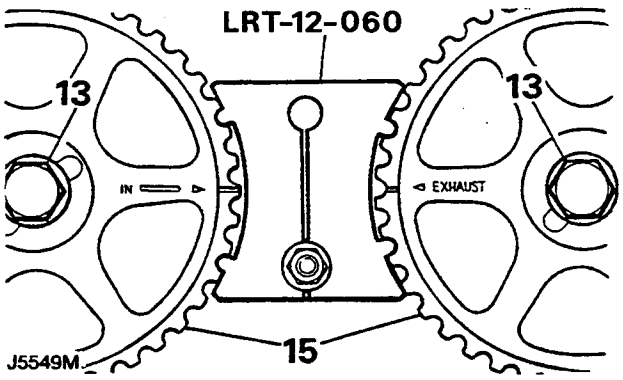


J5548M

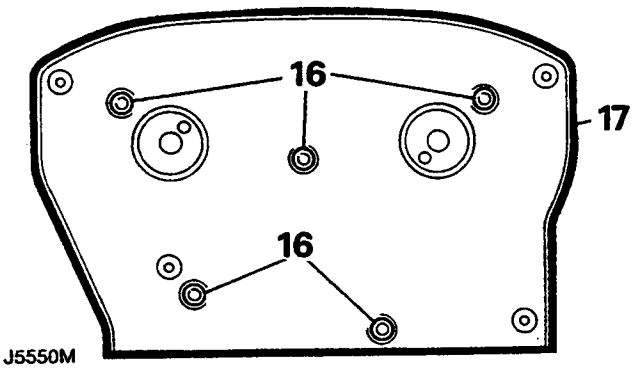
13. Remove 2 bolts securing camshaft gears to camshafts.
14. Remove tool LRT-12-060.

CAUTION: Do not rotate camshafts.

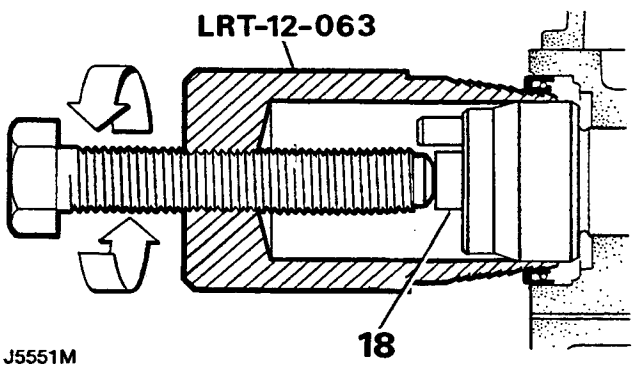
15. Remove gears noting the 'IN' and 'EXHAUST' identifying marks.



16. Remove 5 bolts securing timing belt upper backplate.
17. Remove belt upper backplate.



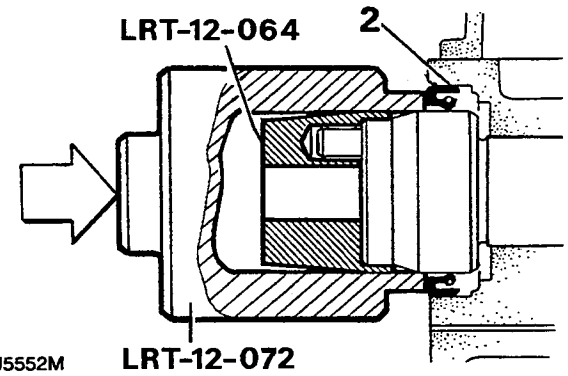
18. Remove seals using tool LRT-12-063 fit thrustpad as shown.



Refit

1. Clean sealing area of cylinder head and camshaft, ensure all traces of rubber are removed - do not scrape.
2. Using tool LRT-12-064 and LRT-12-072 fit new camshaft oil seals.

CAUTION: Ensure sealing lip of seal is not distorted.

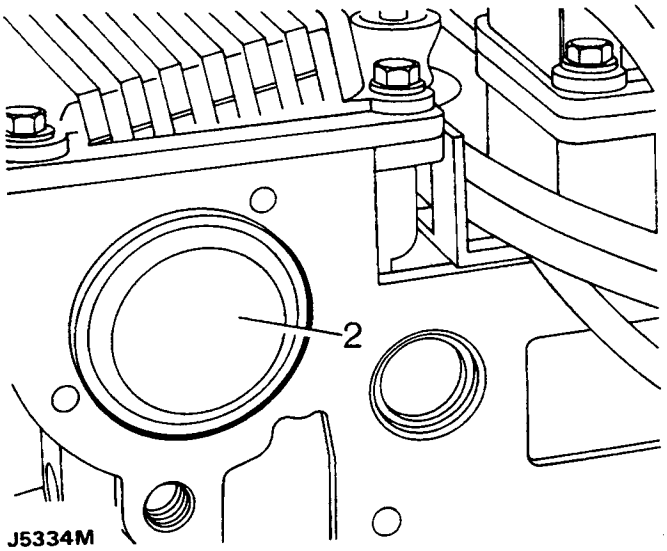


3. Fit timing belt upper backplate and tighten bolts to the correct torque.
4. Fit camshaft gears noting the 'IN' and 'EXHAUST' identifying marks.
5. Fit, but do not tighten, camshaft gear centre bolts.
6. Ensure timing marks are aligned.
7. Fit camshaft locking tool LRT-12-060.
8. Tighten camshaft gear bolts to the correct torque.
9. Fit timing belt, see maintenance section 10.
10. Adjust timing belt tension, see maintenance section 10.
11. Remove tool LRT-12-058 from flywheel.
12. Fit timing belt centre cover and tighten bolts to correct torque.
13. Fit timing belt upper cover and tighten bolts to correct torque.
14. Fit drive belt, see maintenance section 10.
15. Connect battery earth lead.

INLET - EXHAUST CAMSHAFT REAR OIL PLUG

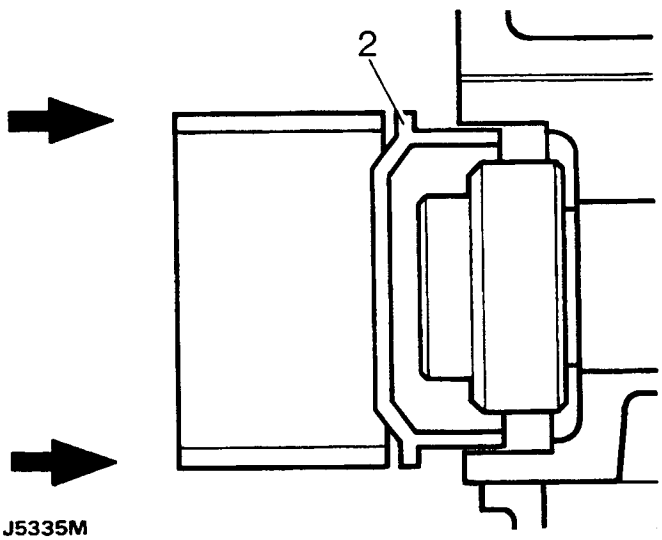
Remove

1. Remove cylinder head.
2. Lever out, camshaft rear oil seal plug.



Refit

1. Clean plug housing.
2. Fit new plug applying force to outer edge only.

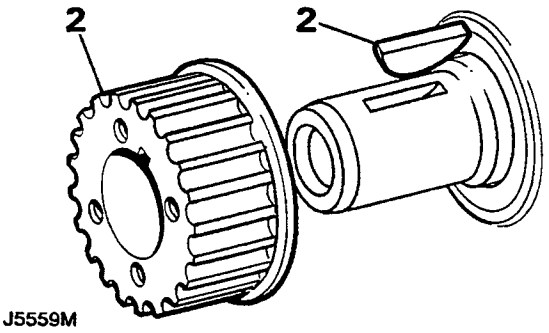


3. Refit cylinder head.

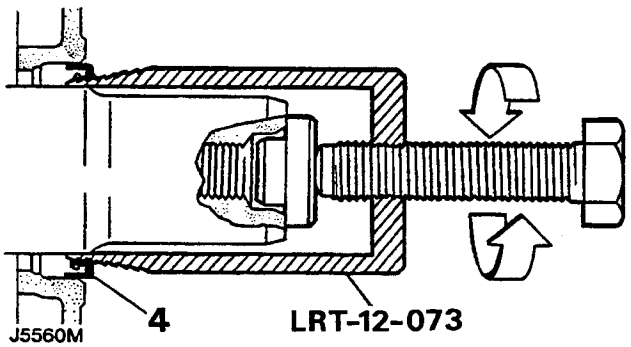
CRANKSHAFT FRONT OIL SEAL

Remove

1. Remove timing belt see maintenance section 10.
2. Slide timing gear off crankshaft and remove drive key.



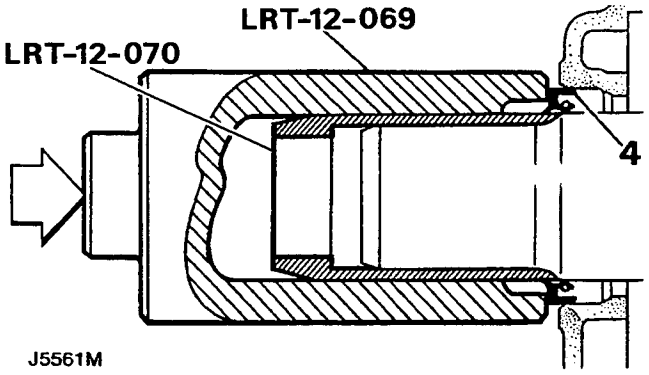
3. Ensure bore of tool is burr free, fit and tighten tool LRT-12-073 into crankshaft front oil seal.
4. Using thrustpad, tighten centre screw of tool to remove oil seal.
5. Remove thrust button from crankshaft.



Refit

1. Use lint free cloth and thoroughly clean seal recess and running surface on crankshaft. Clean crankshaft gear and pulley.
2. Lubricate oil seal sealing surfaces with engine oil.
3. Fit tool LRT-12-070 onto crankshaft.

4. Position new oil seal on crankshaft, drift into place using LRT-12-069 and remove protector.

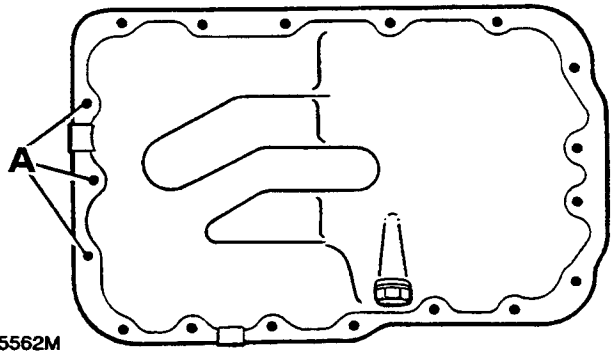


5. Fit drive key to crankshaft and slide timing gear onto crankshaft.
6. Fit and tension timing belt see maintenance section 10.

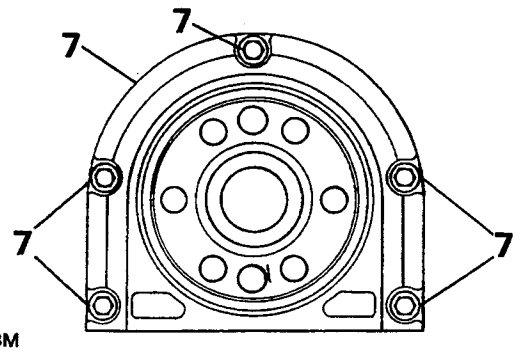
CRANKSHAFT REAR OIL SEAL

Remove

1. Remove gearbox.
2. Remove clutch assembly.
3. Remove flywheel.
4. Drain engine oil.
5. Fit sump plug, replacing sealing washer if damaged and tighten to the correct torque.
6. Slacken 15 sump bolts by approximately 3 turns, allowing sump to drop away from rear oil seal housing. Do not slacken 3 bolts **A** around oil pump housing.

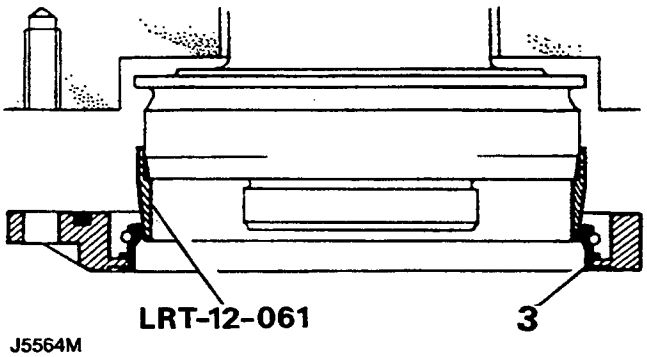


7. Remove bolts securing oil seal housing, remove seal and housing assembly.

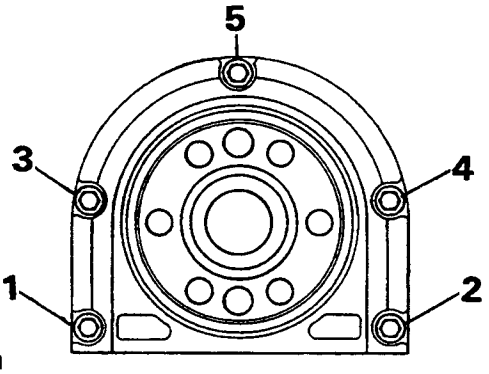


Refit

1. Clean seal seating area of block and accessible area of sump gasket. Sump gasket must be replaced if damaged.
2. Lubricate oil seal sealing surfaces with engine oil.
3. Fit tool LRT-12-061 over crankshaft boss and fit oil seal and housing assembly.
4. Remove tool.



5. Fit and tighten seal housing bolts to correct torque in sequence shown.



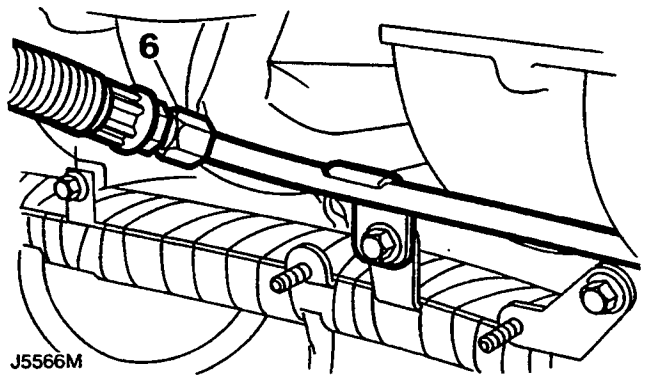
6. Tighten sump bolts to correct torque and in the correct sequence, see engine sump gasket.
7. Fit flywheel.
8. Fit clutch assembly.
9. Fit gearbox.

ENGINE

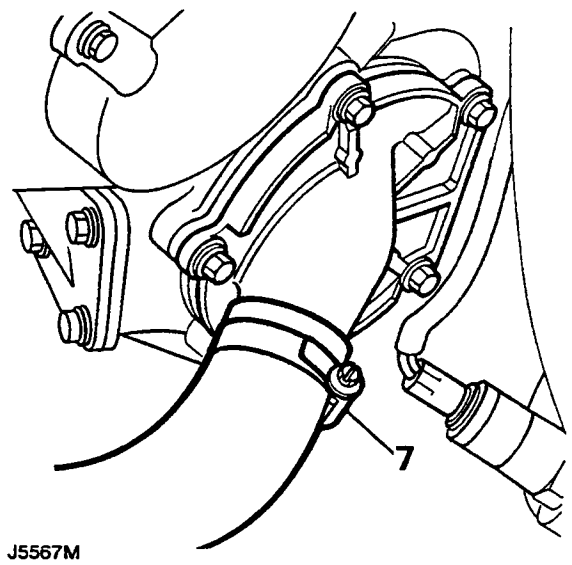
Remove

1. Drive vehicle onto 4 post lift.
2. Remove the drive belt, see Maintenance section 10
3. Remove radiator, see Cooling section 26
4. Remove bonnet, see Chassis and body section 76
5. Drain engine oil.
6. Position absorbent cloth around fuel pipe to fuel rail union.
   Unscrew union to relieve pressure.

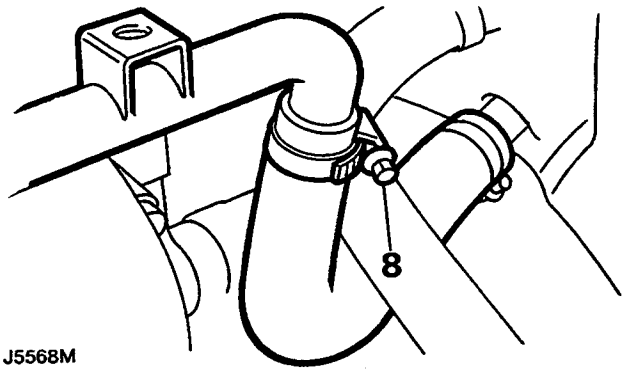
CAUTION: Plug the connections



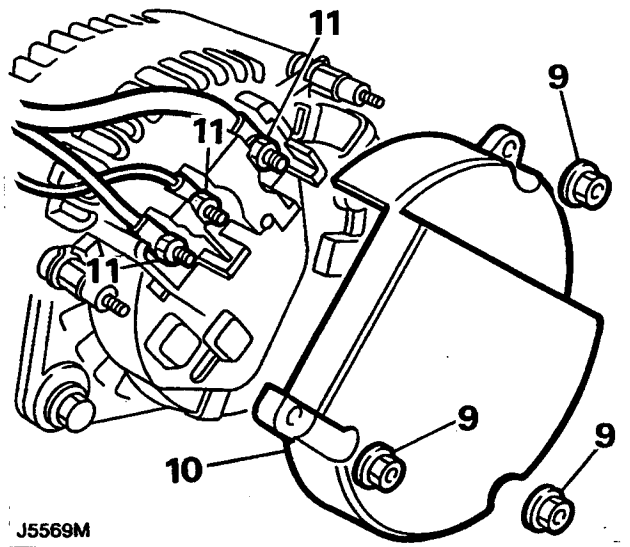
7. Release clip and disconnect hose from coolant pump.



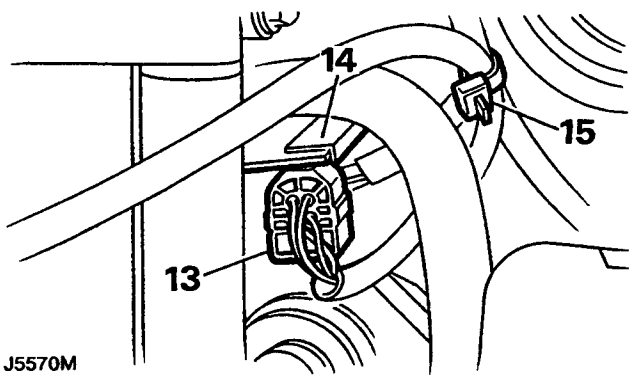
8. Release clip and disconnect hose from heater rail.



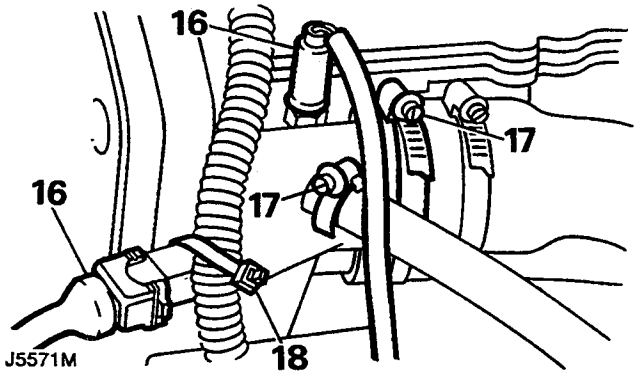
9. Remove 3 nuts securing alternator rear cover.
10. Remove rear cover.
11. Remove 3 nuts securing harness to alternator.
12. Remove harness.



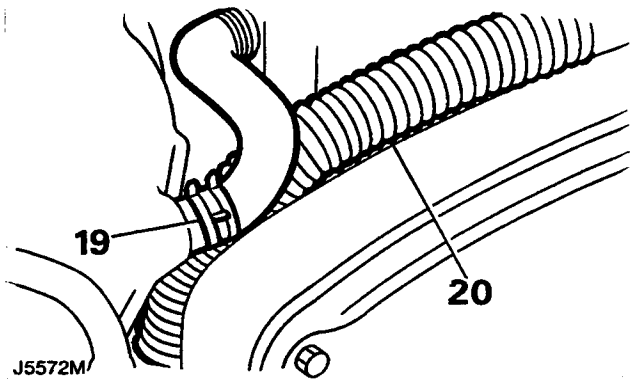
13. Disconnect oxygen sensor multiplug.
14. Release multiplug from bracket.
15. Release harness from cable tie.



16. Disconnect 2 coolant temperature sensor multiplugs.
17. Release clips and disconnect the bypass and top hose.
18. Release harness lead from cable tie.

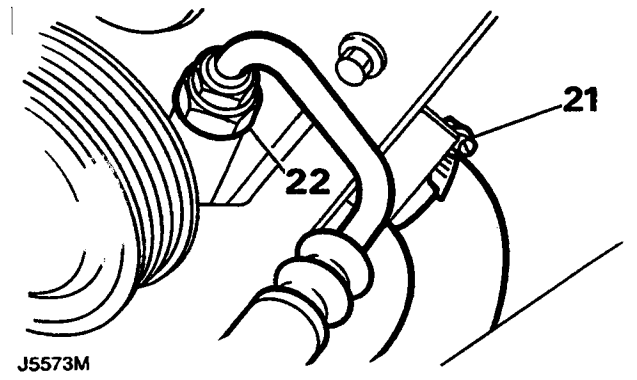


19. Release clip and disconnect breather hose from inlet manifold.
20. Feed harness between inlet manifold and cam cover.

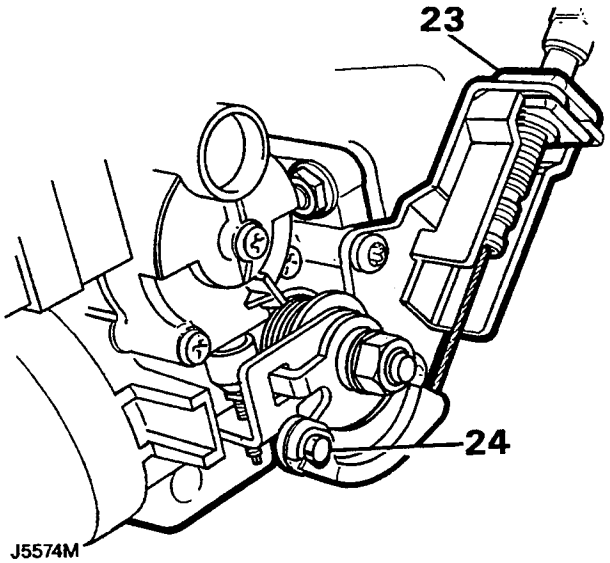


21. Release clip and disconnect inlet hose from power steering pump.
22. Disconnect outlet pipe union at power steering pump, discard 'O' ring.

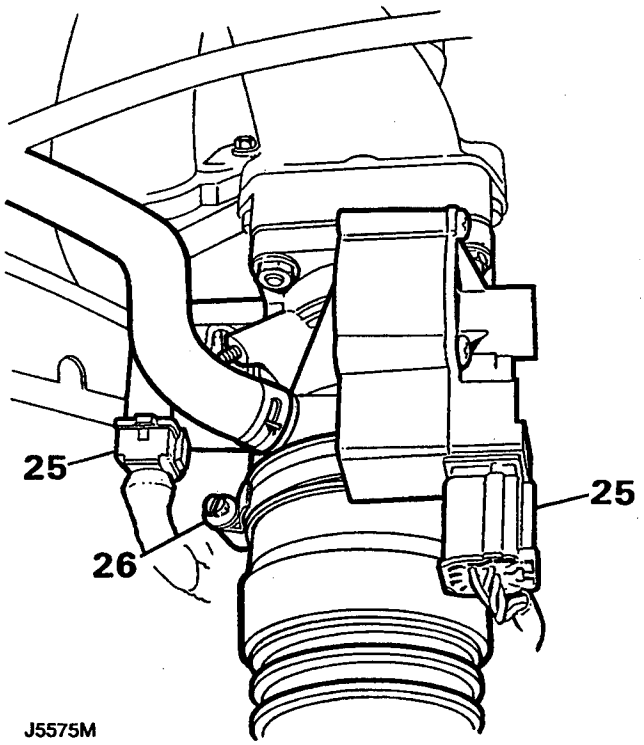
CAUTION: Plug the connections



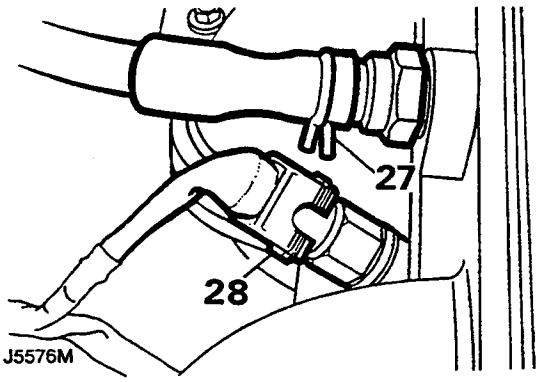
23. Release throttle cable from abutment bracket.
24. Release throttle cable from cam and place aside.



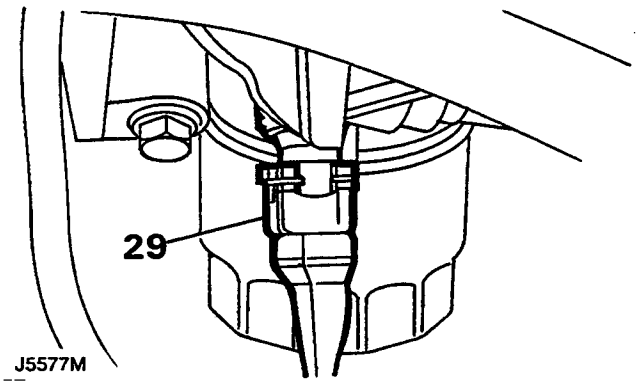
25. Disconnect stepper motor and throttle potentiometer multiplugs.
26. Release clip and disconnect hose, air cleaner to throttle housing.



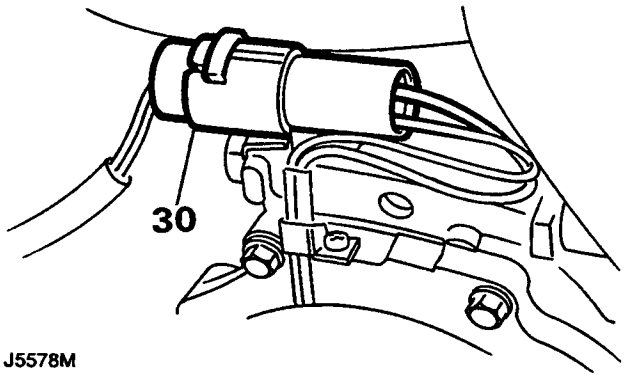
27. Release clip and disconnect brake servo hose from manifold.
28. Disconnect fuel temperature sensor multiplug.



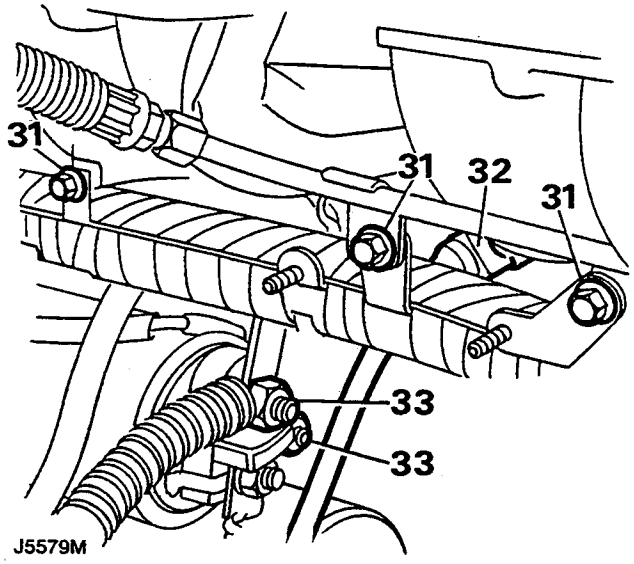
29. Disconnect oil pressure switch multiplug.



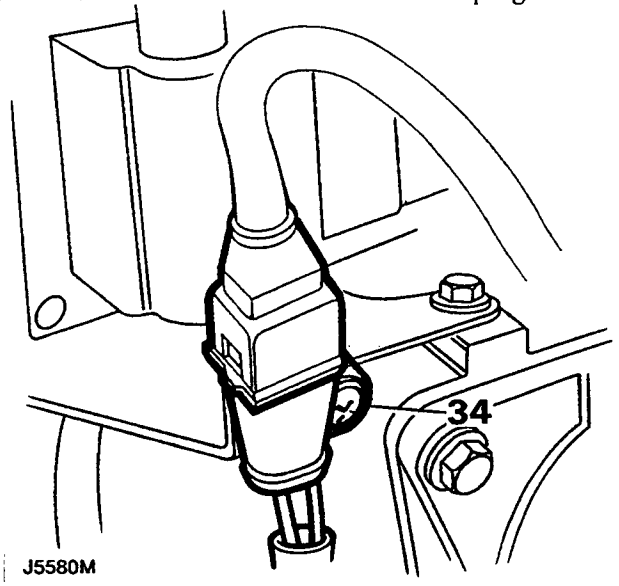
30. Disconnect air conditioning compressor multiplug.



31. Remove 3 bolts securing engine harness to manifold and fuel pipe.
32. Disconnect knock sensor multiplug.
33. Remove 2 nuts securing harness to starter motor solenoid, remove harness.

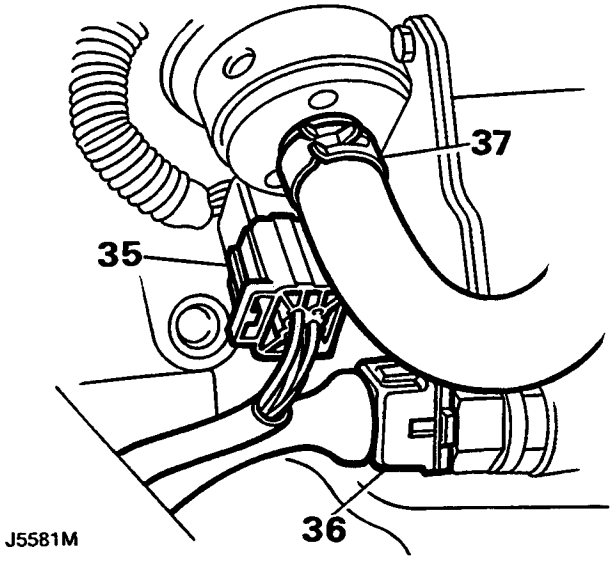


34. Disconnect crankshaft sensor multiplug.

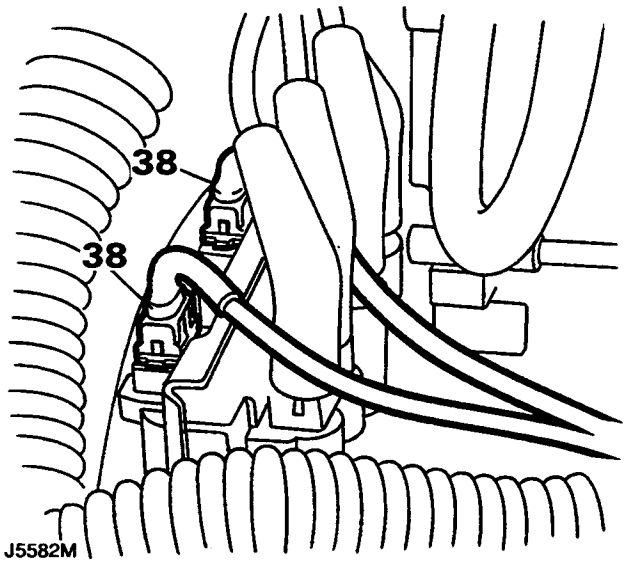


35. Disconnect fuel injection harness multiplug.
36. Disconnect inlet manifold air temperature sensor multiplug.
37. Release clip and disconnect fuel hose from pressure regulator.

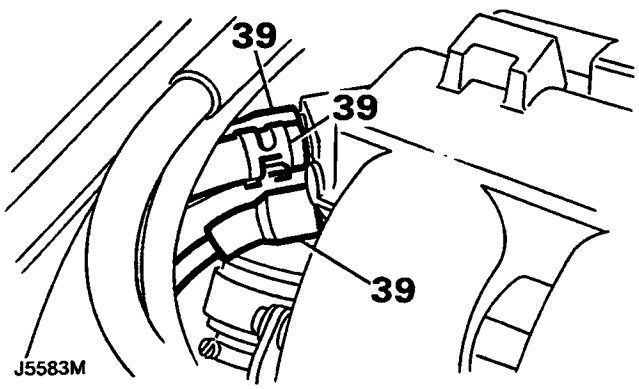
CAUTION: Plug the connections.



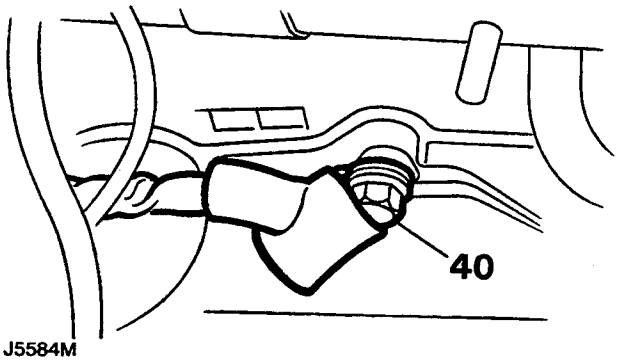
38. Disconnect 2 ignition coil multiplugs.



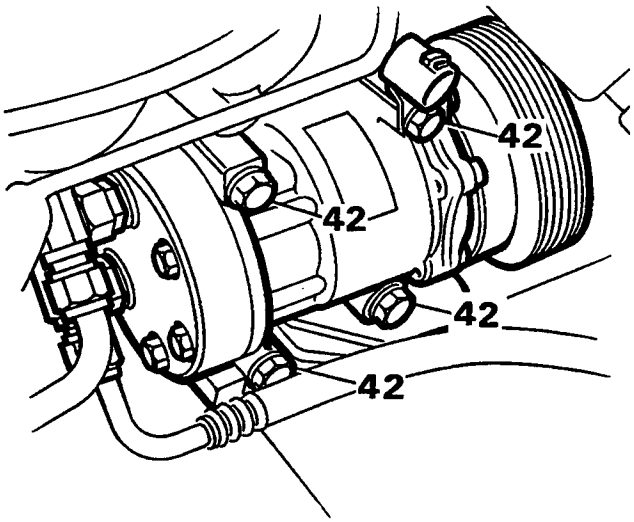
39. Disconnect 3 vacuum hoses from manifold.



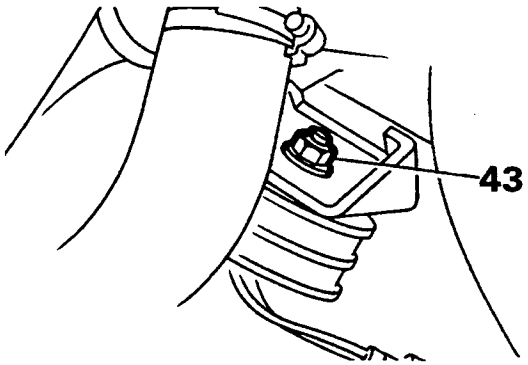
40. Release cover and remove bolt securing earth lead to cylinder block.
41. Move earth lead aside.

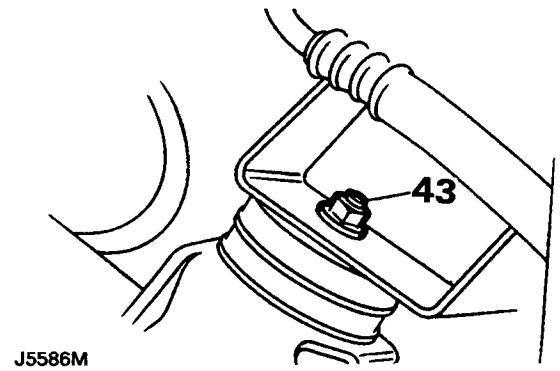


42. Remove 4 bolts securing air conditioning compressor, move compressor aside.

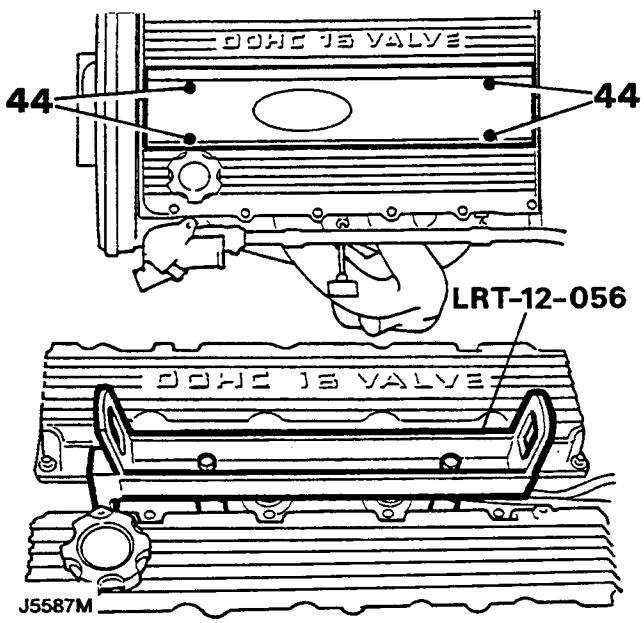


43. Remove upper nuts from engine L.H. and R.H. mountings.

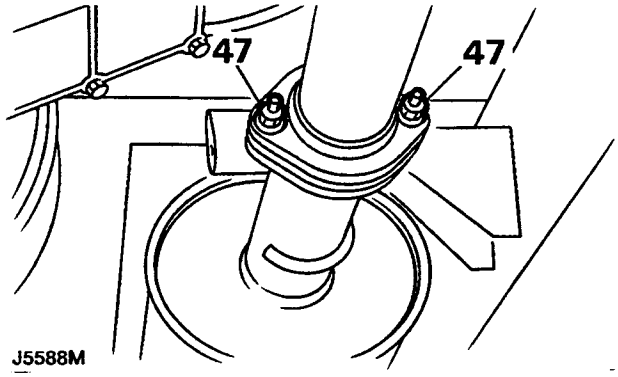




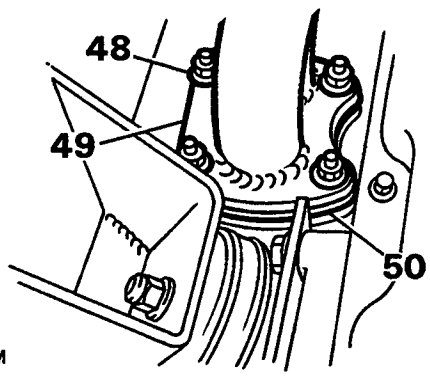
44. Release 4 screws and remove spark plug cover.
45. Fit tool LRT-12-056, support engine using suitable hoist.



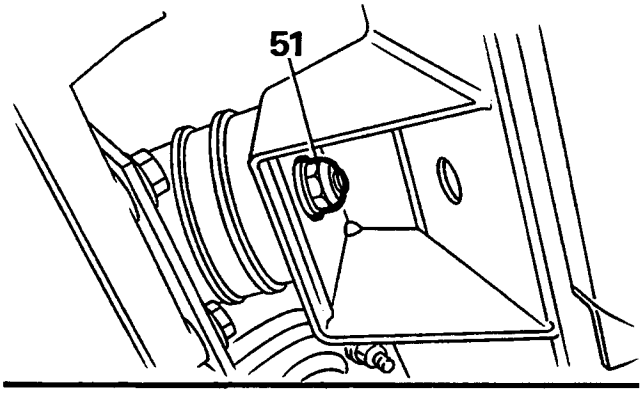
46. Raise vehicle.
47. Slacken 2 nuts securing downpipe to silencer.

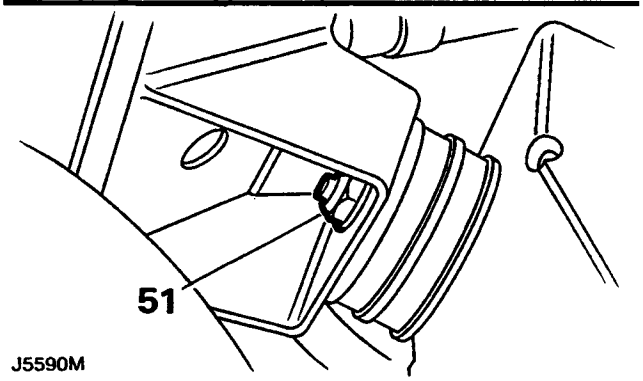


48. Remove 4 nuts securing downpipe to exhaust manifold.
49. Release downpipe from exhaust manifold.
50. Collect gasket.

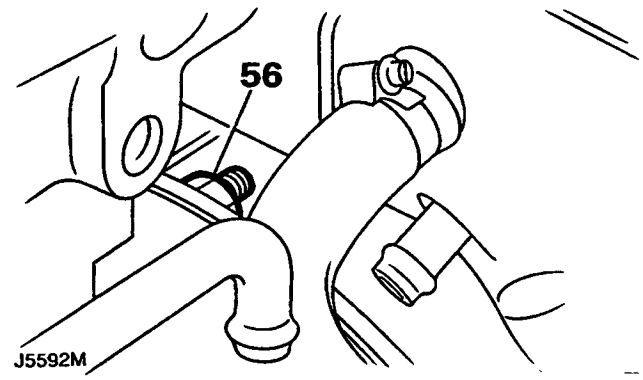


51. Remove engine L.H. and R.H. mounting lower nuts.



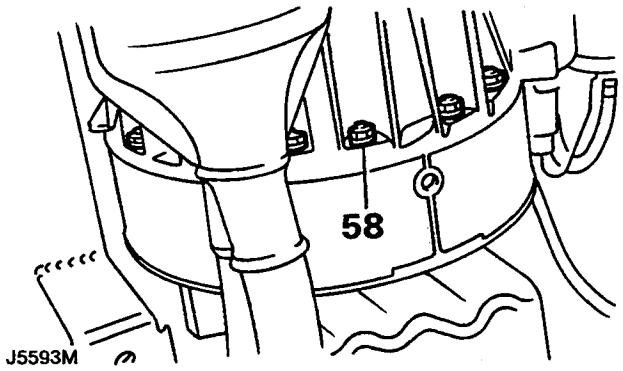


52. Lower vehicle.
53. Raise engine.
54. Remove engine mountings.
55. Lower engine.
56. Remove bell housing top nut.



57. Raise engine and support gearbox.

58. Remove 12 remaining bell housing nuts.



59. Remove engine.

Refit

1. Using assistance, lower engine into position.
2. Fit bell housing nuts, tighten to the correct torque.
3. Remove gearbox support.
4. Lower engine.
5. Fit bell housing top nut, tighten to the correct torque.
6. Raise engine.
7. Position engine mountings, partially tighten nuts.
8. Lower engine.
9. Remove hoist and chains.
10. Tighten L.H. and R.H. mounting nuts to the correct torque.
11. Fit new gasket to exhaust downpipe.
12. Fit exhaust manifold to downpipe nuts and tighten to the correct torque.
13. Tighten exhaust downpipe to silencer box nuts to the correct torque.
14. Position air conditioning compressor and secure with bolts. Tighten to the correct torque.
15. Connect coil multiplugs.
16. Connect harness to starter solenoid and secure with nuts.

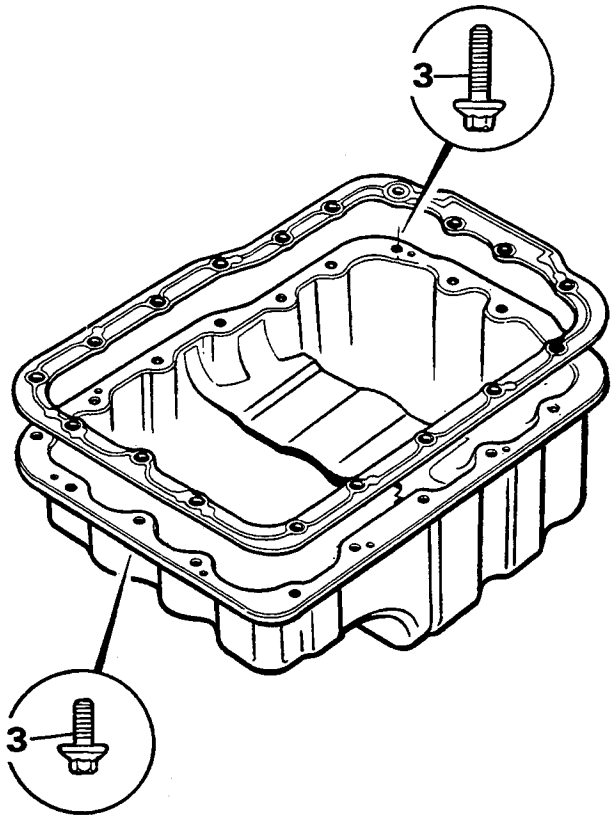
17. Connect earth lead to cylinder block and secure with nut.
18. Position engine harness to manifold, secure with bolts.
19. Connect crankshaft sensor, knock sensor, air conditioning compressor, fuel injector harness, inlet manifold air temperature and fuel temperature sensor multiplugs.
20. Connect fuel hose to pressure regulator and secure with clip.
21. Fit and tighten fuel pipe to fuel rail union.
22. Connect multiplugs to throttle housing.
23. Connect vacuum hose to manifold.
24. Connect oil pressure switch multiplug.
25. Connect brake servo hose to manifold, secure with clip.
26. Connect throttle cable to cam.
27. Position engine harness and connect breather hose to inlet manifold, secure with clip.
28. Connect coolant temperature sensor multiplugs, secure harness with cable tie.
29. Connect oxygen sensor multiplug, secure harness with cable tie.
30. Connect alternator harness.
31. Position alternator rear cover and secure with nuts.
32. Connect heater hose to heater rail and secure with clip.
33. Connect hose to coolant pump and secure with clip.
34. Connect inlet hose to power steering pump and secure with clip.
35. Fit and tighten outlet pipe union to power steering pump.
36. Connect bypass and top hose, secure with clip.
37. Connect air cleaner to throttle housing hose and secure with clip.
38. Remove engine lifting bracket.
39. Position spark plug cover and secure with screws.
40. Fill engine with oil.
41. Fit bonnet, see Chassis and Body section 76.
42. Fit radiator, see Cooling section 26.
43. Adjust throttle cable, see Modular Engine Management System section 19.

ENGINE SUMP GASKET

Remove

1. Drain engine oil.
2. Refit drain plug, use new sealing washer if necessary, tighten to the correct torque.
3. Remove 18 bolts securing sump.

NOTE: 25mm long bolt is fitted at rear L.H. corner of sump.

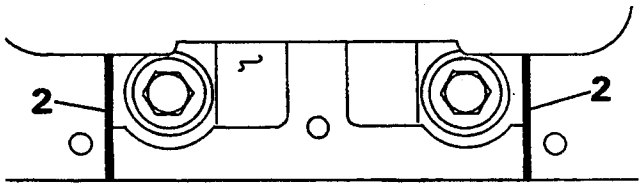


J5594M

4. Release sump from cylinder block.
5. Discard gasket.

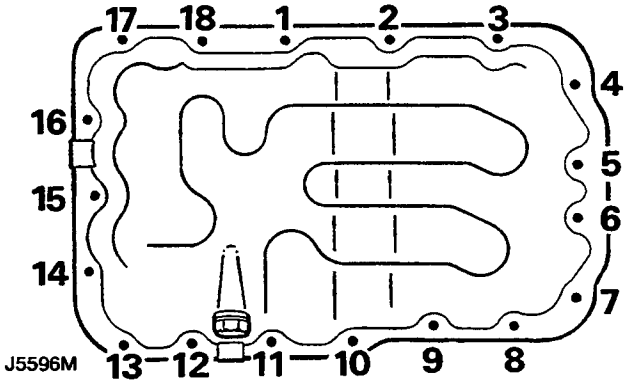
Refit

1. Clean sump, remove all traces of gasket from mating faces of sump and cylinder block. Visually check sump for damage.
2. Apply beads of RTV sealant to front main bearing cap.



J5595M

3. Position new gasket to sump, ensuring that location pips on gasket are located in sump. Check gasket lays flat on sump flange.
4. Fit sump. Fit bolts, ensuring that longest bolt is inserted at position 7.
5. Working around the sump in the sequence illustrated, tighten the bolts to the stage 1 torque figure. Then, in the same sequence, tighten the bolts to the stage 2 torque figure.



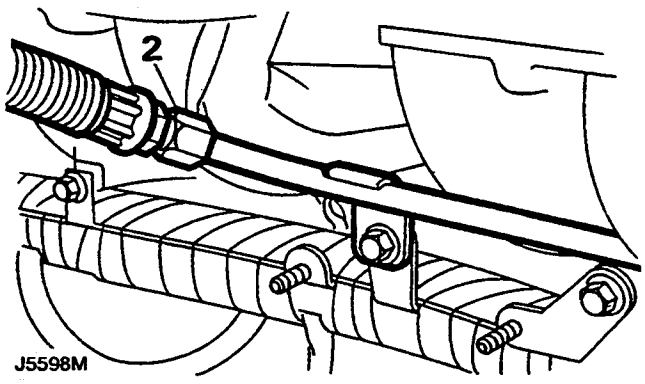
6. Fill engine with oil.

CYLINDER HEAD GASKET

Remove

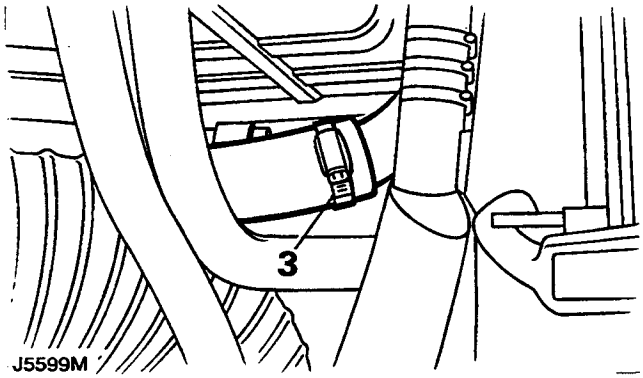
1. Disconnect the battery negative lead.
2. Position absorbent cloth around fuel pipe to fuel rail union. Unscrew union to relieve pressure.

CAUTION: Plug the connections.

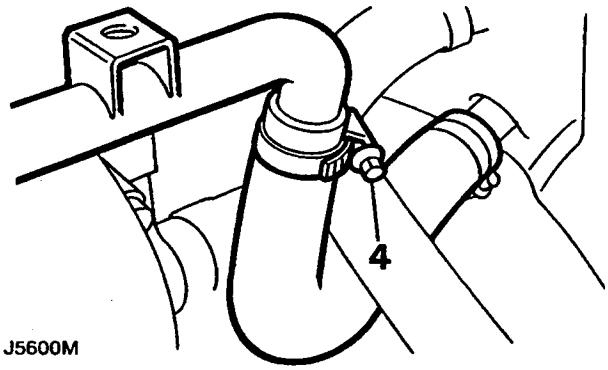


WARNING: Do not carry out the next instruction until the coolant is cool to avoid personal injury from scalding.

3. Release clip and disconnect radiator bottom hose, allowing coolant to drain into a suitable container.

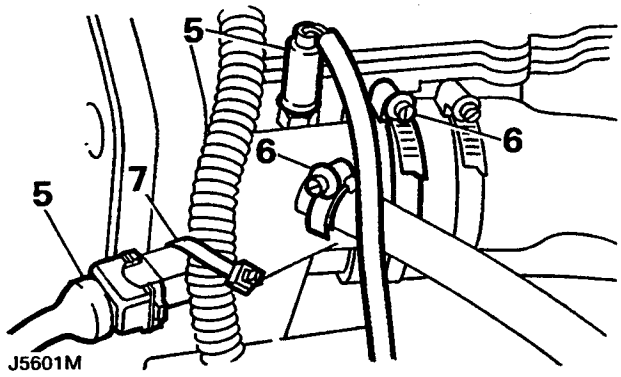


4. Release clip and disconnect hose from heater rail.

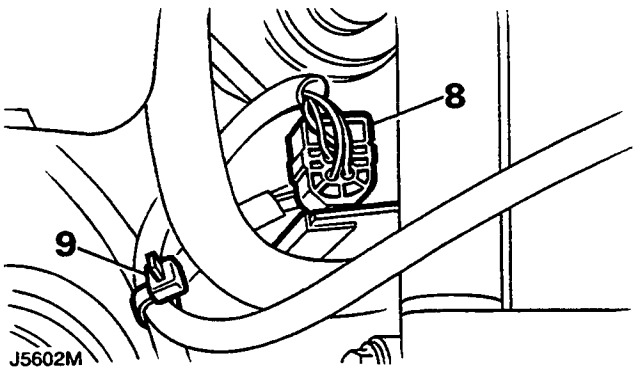


5. Disconnect 2 coolant temperature sensor multiplugs.
6. Release clips and disconnect the bypass hose and top hose.

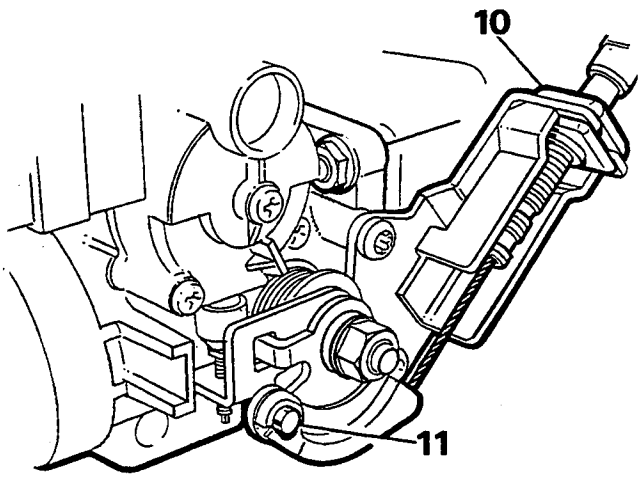
7. Release harness from cable tie.



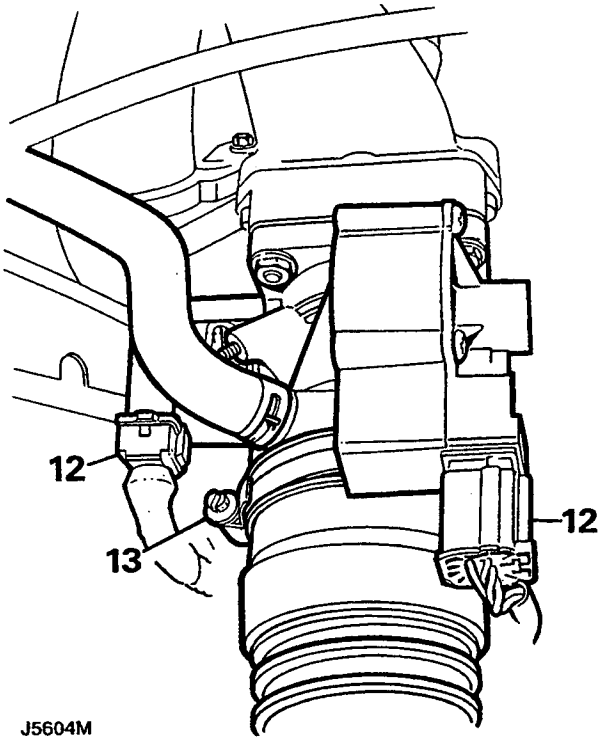
8. Disconnect oxygen sensor multiplug.
9. Release harness lead from cable tie.



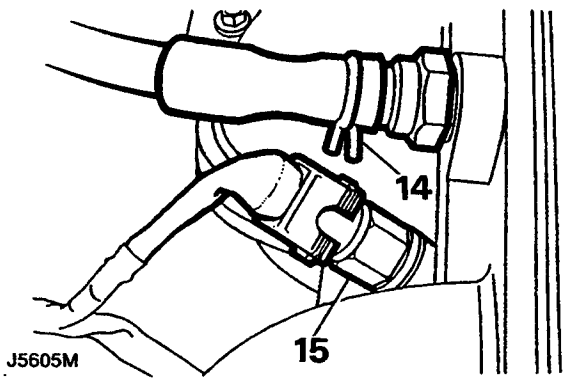
10. Release throttle cable from abutment bracket.
11. Release throttle cable from cam and place aside.



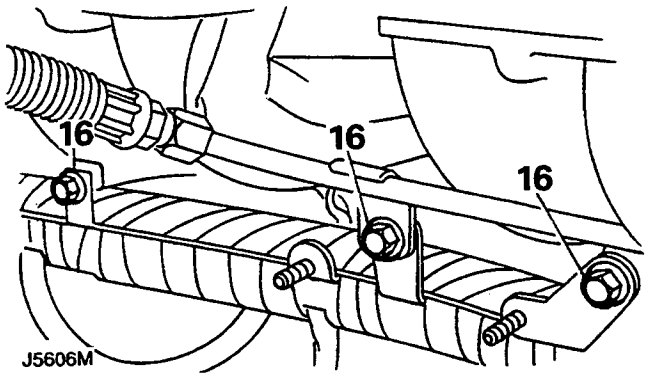
12. Disconnect stepper motor and throttle potentiometer multiplugs.
13. Release clip and disconnect hose, air cleaner to throttle housing.



14. Release clip and disconnect brake servo hose from manifold.
15. Disconnect fuel temperature sensor multiplug.

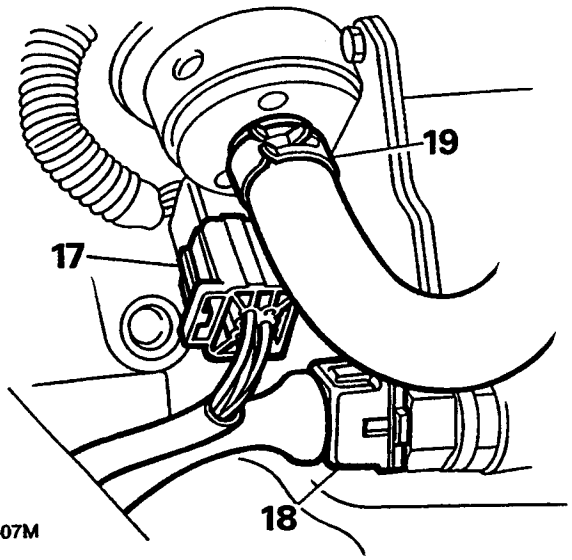


16. Remove 3 bolts securing engine harness to manifold.

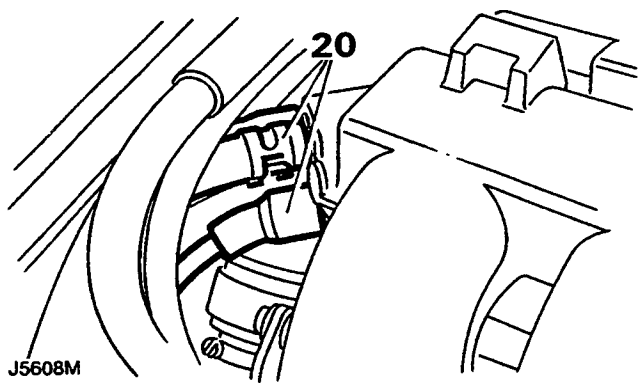


17. Disconnect fuel injection harness multiplug.
18. Disconnect inlet manifold air temperature sensor multiplug.
19. Release clip and disconnect fuel hose from pressure regulator.

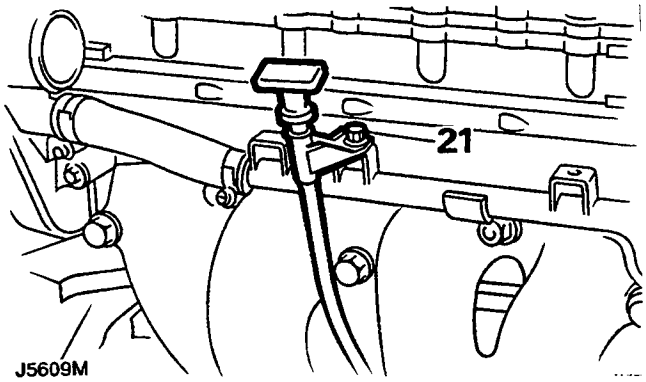
CAUTION: Plug the connections



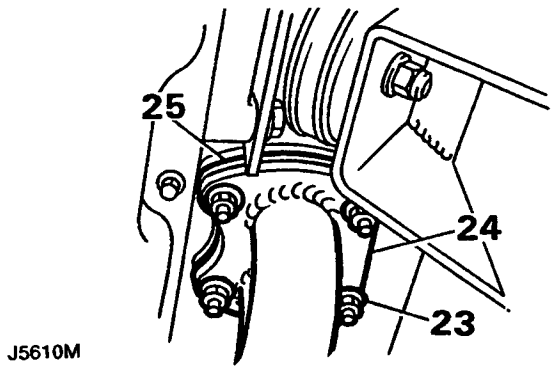
20. Release clips and disconnect 3 hoses from manifold.



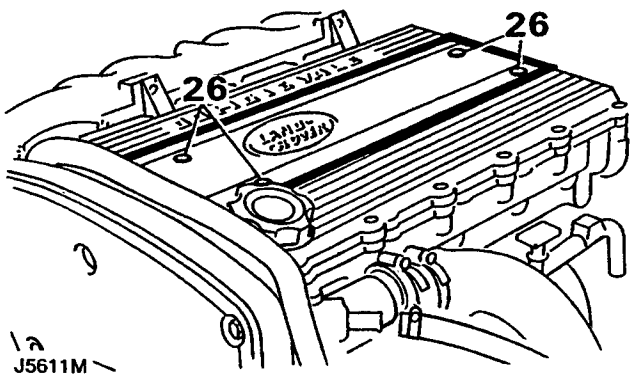
21. Remove bolt securing dipstick tube to coolant rail.



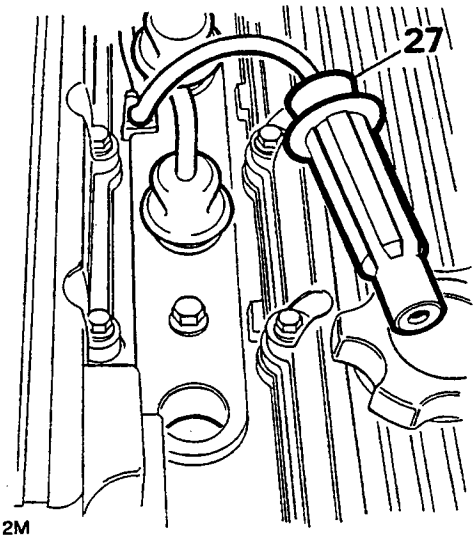
22. Raise vehicle
23. Remove 4 nuts securing downpipe to exhaust manifold.
24. Release downpipe from exhaust manifold.
25. Collect gasket.



26. Release 4 screws and remove spark plug cover.

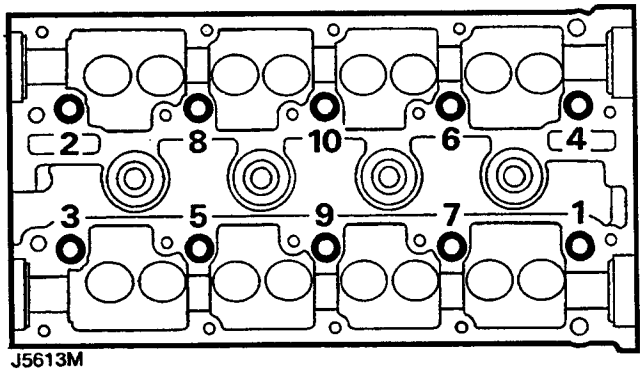


27. Release spark plug leads from spark plugs and release from clips. Place aside.



J5612M

28. Remove camshaft covers.
29. Remove timing belt, see camshaft front oil seal.
30. Progressively slacken and remove 10 cylinder head bolts in sequence shown.

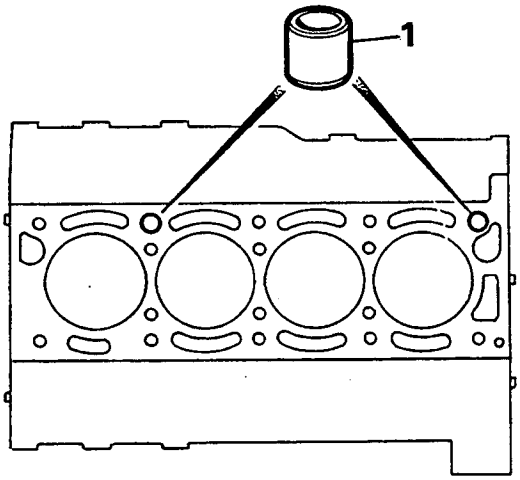


J5613M

31. Remove cylinder head complete with manifold, place on blocks to prevent damage.
32. Remove and discard cylinder head gasket.
33. Remove location dowels from cylinder block.
34. Inspect cylinder head for damage, cracks and burning.
35. Inspect cylinder block. Ensure that the oil restrictor is clear and fitted below the block face.
36. Clean all traces of gasket material from head and block mating faces, using release agent and plastic scraper.
37. Check cylinder head and block faces for warpage:
    Longitudinal warp = 0.1 mm max.
    Transverse warp = 0.1 mm max.
    Diagonal warp = 0.1 mm max.
38. Decarbonize cylinder head and pistons if necessary.
39. Clean cylinder head bolt threads with a wire brush, check for damage, replace if necessary.
40. Check cylinder block threads by running bolts into threads using fingers only. Clean any tight threads using M11 x 1.5 mm tap. Remove all traces of oil from bolt holes.

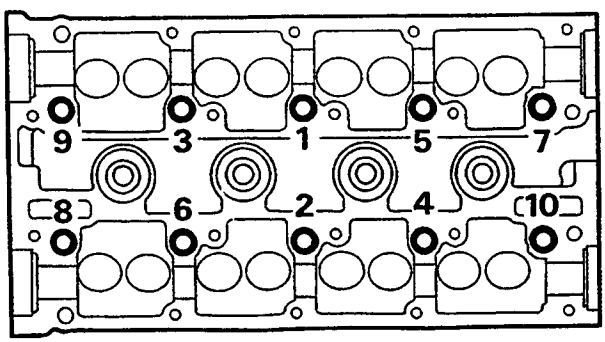
Refit

1. Fit location dowels to cylinder head.



J5614M

2. Fit cylinder head gasket to cylinder block.
3. Using assistance fit cylinder head to cylinder block.
4. Lubricate cylinder head bolts.
5. Fit and tighten cylinder head bolts to the correct torque and in the correct sequence.



J5615M

6. Fit timing belt.
7. Fit camshaft covers.
8. Fit spark plug leads to spark plugs and secure to clips.
9. Fit spark plug cover and secure with screws.
10. Fit new gasket and secure downpipe to exhaust manifold with nuts.
11. Fit bolt securing dipstick tube to coolant rail.
12. Connect 3 vacuum hoses to inlet manifold.
13. Connect fuel to pressure regulator, secure with clip.
14. Connect fuel injection harness, inlet manifold air temperature sensor and fuel temperature sensor multiplugs.
15. Secure engine harness to manifold with bolts.
16. Connect brake servo hose to manifold, secure with clip.
17. Connect air cleaner hose to throttle housing, secure with clip.
18. Connect stepper motor and throttle potentiometer multiplugs.
19. Fit and adjust throttle cable.
20. Connect oxygen sensor multiplug, secure with cable tie.
21. Connect the bypass and top hose, secure with clips.
22. Connect coolant temperature sensor multiplugs, secure with cable tie.
23. Connect hose to heater rail and secure with clip.
24. Connect radiator bottom hose and secure with clip.
25. Tighten fuel pipe to fuel rail union.
26. Connect battery earth lead.

CAMSHAFT COVER GASKET

Remove

1. Release 4 screws from spark plug cover.
2. Remove spark plug cover.

Inlet only

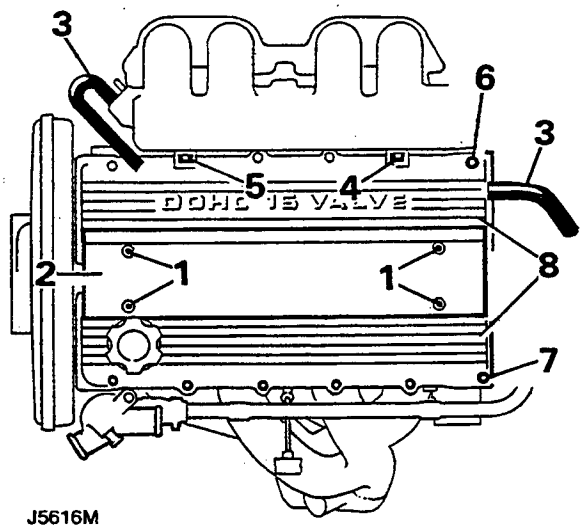
3. Release clips and disconnect 2 breather hoses from camshaft cover.
4. Remove 4 bolts securing support brackets to manifold and cover.
5. Remove support brackets.
6. Remove 12 bolts from camshaft cover.

Exhaust only

7. Remove 13 bolts from camshaft cover.

Inlet and exhaust

8. Remove camshaft cover assemblies.
9. Remove and discard baffle/gasket plate(s).



J5616M

Refit

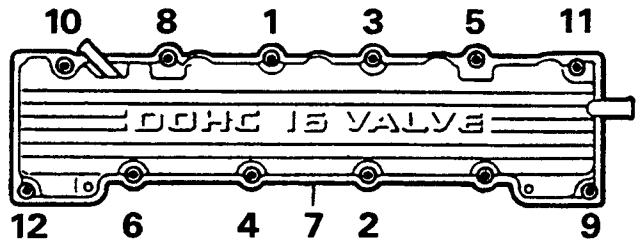
1. Place protective cloth over tappets.
2. Using an M8 x 1.25 mm tap, remove all traces of sealing compound from camshaft housing bolt holes.
3. Blow out bolt holes using an airline.
4. Ensure all traces of oil are removed from bolt holes, remove protective cloth.
5. Clean camshaft cover(s) and mating face of camshaft housing(s).
6. Position new baffle/gasket plate to camshaft housing(s).

NOTE: Fit baffle/gasket dry.

7. Fit camshaft cover(s).

Inlet only

8. Position spacers and manifold support brackets.
9. Fit bolts finger tight.
10. Working from the centre outwards, progressively tighten bolts to the correct torque.

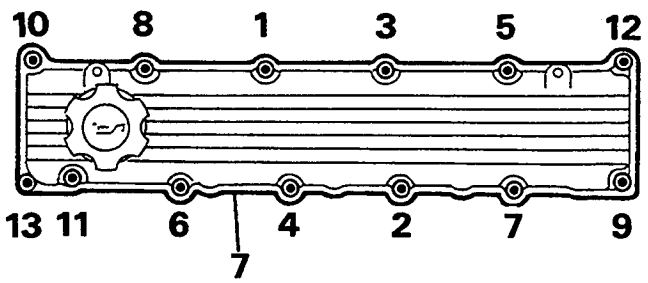


J5617M

11. Tighten support bracket to inlet manifold bolts to the correct torque.
12. Connect breather hoses to camshaft cover.

Exhaust only

13. Fit bolts finger tight.
14. Working from the centre outwards, progressively tighten bolts to the correct torque.



J5618M

Inlet and exhaust

15. Fit spark plug cover to camshaft cover, tighten screws.