



## DESCRIPTION

The diesel engine fitted to New Range Rover is a 2.5 litre, liquid cooled, 6 cylinder, in-line unit. It has an electronically regulated fuel injection system and is turbocharged. Power output is increased by the turbocharger which delivers compressed air to the combustion chambers via an intercooler.

The engine develops 100 kW (134 hp) at 4400 RPM.

Engine performance is managed by a Digital Diesel Electronics (DDE) system. This system monitors and controls all engine functions such as the injection timing, delivery volume and charge-air intercooling. For full description of the DDE system, **See FUEL SYSTEM, Description and operation.**

The flywheel is a dual-mass unit and is hydraulically damped to prevent transmission rattle in all operating conditions. Attached to the flywheel, around its circumference at 60 degree intervals, are six position pins. These are used by the DDE system to determine engine speed and crankshaft position.

The engine comprises the following main systems and components:

- Crankcase
- Cylinder head
- Air intake system
- Forced aspiration system
- Injection system - **See FUEL SYSTEM, Description and operation.**
- Lubrication system
- Cooling system - **See COOLING SYSTEM, Description and operation.**
- Auxiliary driven assemblies

### Crankcase

The cast steel crankcase, which incorporates a cooling water jacket, is machined and bored to form a cylinder block (cylinder bore 80 mm) and a crankshaft housing. These contain the pistons, connecting rods and the crankshaft. Bolted to the underside of the crankcase is an aluminium reinforcement plate with an integrated oil deflector. The reinforcement plate increases crankcase stability and prevents oil foaming and ventilation losses.

### Pistons

Each piston is manufactured from aluminium and has three grooves to accommodate piston rings. The top ring is a 15°keystone ring, the centre ring is a tapered compression ring and the lower ring is spring-loaded oil ring. The piston skirt is phosphated and graphited while the piston crown has a V-patterned groove machined into it. The V-patterned groove forms part of the combustion chamber, which is designed on a swirl chamber principle. This reduces fuel consumption, exhaust emission and smoke produced at full load. Piston cooling is by oil which is directed to the underside of each piston through crankcase-mounted spray jets; drillings in the piston allow oil to circulate thoroughly.

Pistons have a stroke of 82.8 mm and are attached to the connecting rods by 27 mm diameter gudgeon pins

### Connecting rods

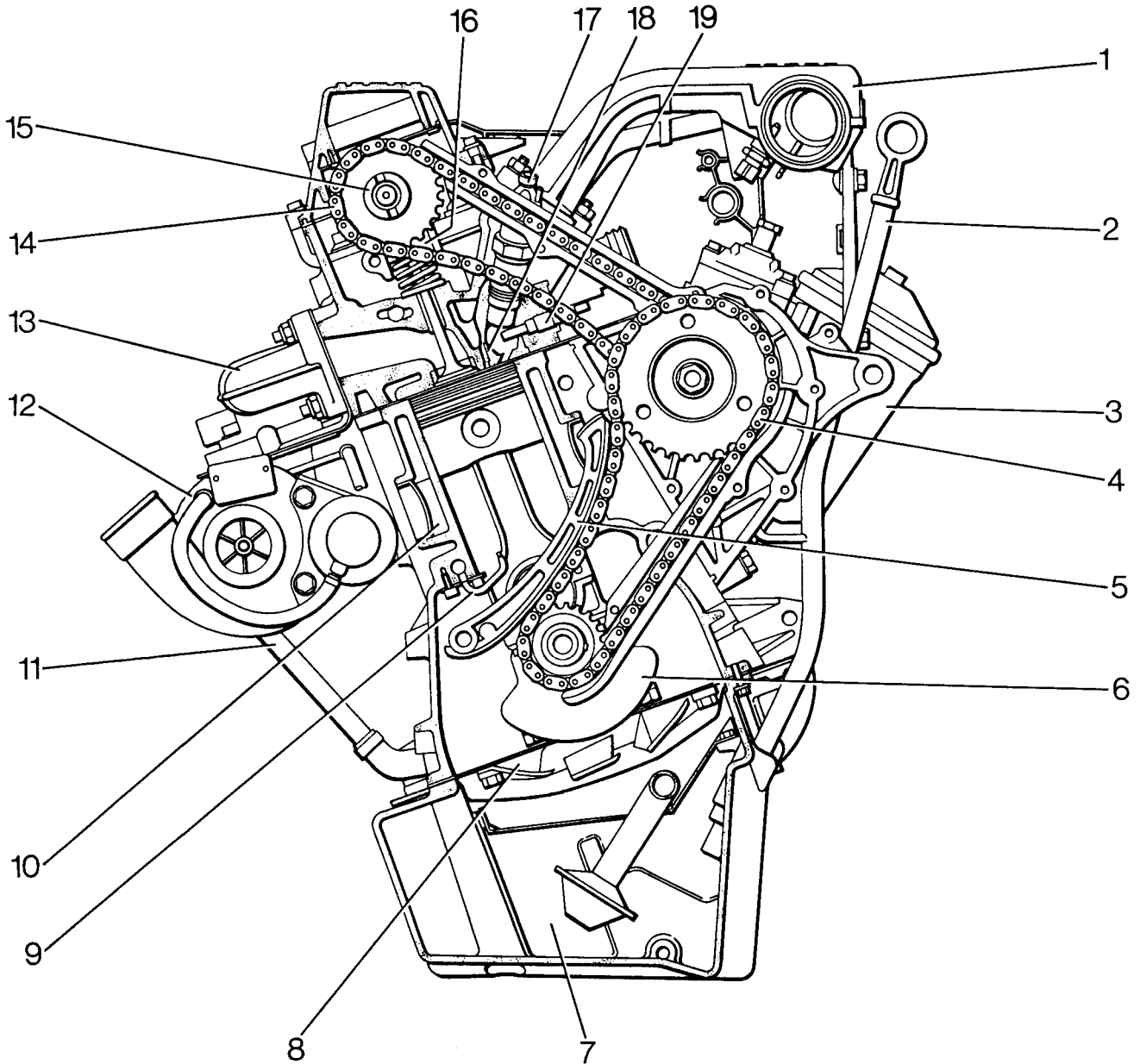
Power is transmitted to the crankshaft through the forged steel connecting rods.

### Crankshaft

The crankshaft is forged from high-tensile steel and has seven main bearing journals. Journals are supported in bearing shells fitted to the crankcase; dynamic balancing of the crankshaft is achieved by the use of 12 balance weights. An axially decoupled torsional vibration damper suppresses longitudinal vibration of the crankshaft to reduce noise.

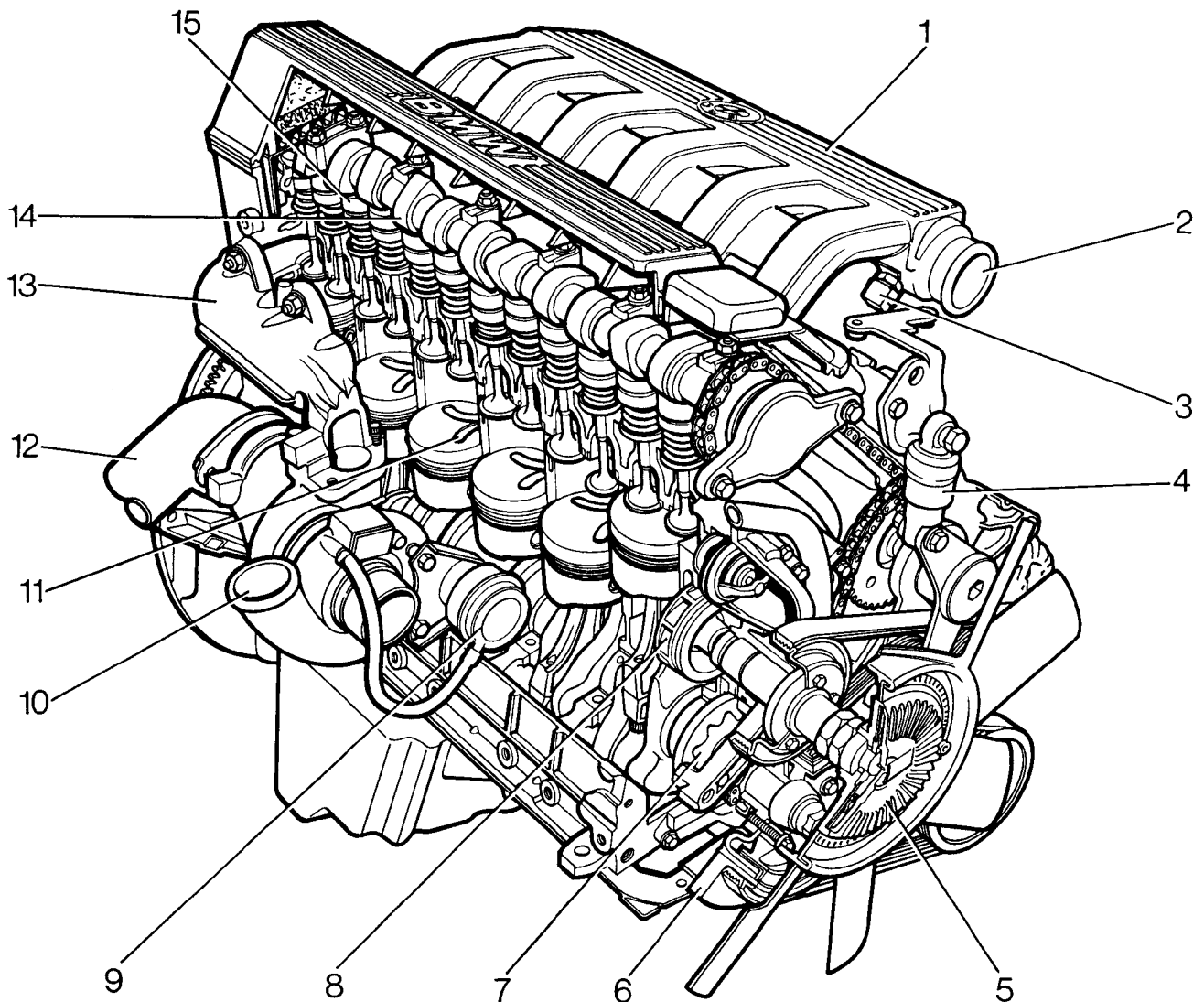
Crankshafts are available in three sizes which have different journal sizes - standard size, undersize 1 and undersize 2. A colour code, yellow, green or white denotes the actual size of the journals.

At its front end, the crankshaft drives a close coupled oil pump for the engine lubrication system and the fuel injection pump timing chain. The timing chain connects the crankshaft mounted sprocket and injector pump drive sprocket. A second timing chain takes drive from the injector pump sprocket to the overhead camshaft in the cylinder head.



12M7135

- |                                    |                                  |
|------------------------------------|----------------------------------|
| 1. Charge air collector            | 11. Oil return from turbocharger |
| 2. Oil dipstick                    | 12. Turbocharger                 |
| 3. Oil filter                      | 13. Exhaust manifold             |
| 4. Fuel injection pump chain drive | 14. Camshaft drive chain         |
| 5. Tensioner rail - chain drive    | 15. Camshaft                     |
| 6. Crankshaft                      | 16. Hydraulic tappet             |
| 7. Oil sump                        | 17. Fuel injector                |
| 8. Reinforcement plate             | 18. Swirl chamber                |
| 9. Piston cooling jet              | 19. Glow plug                    |
| 10. Cooling water jacket           |                                  |



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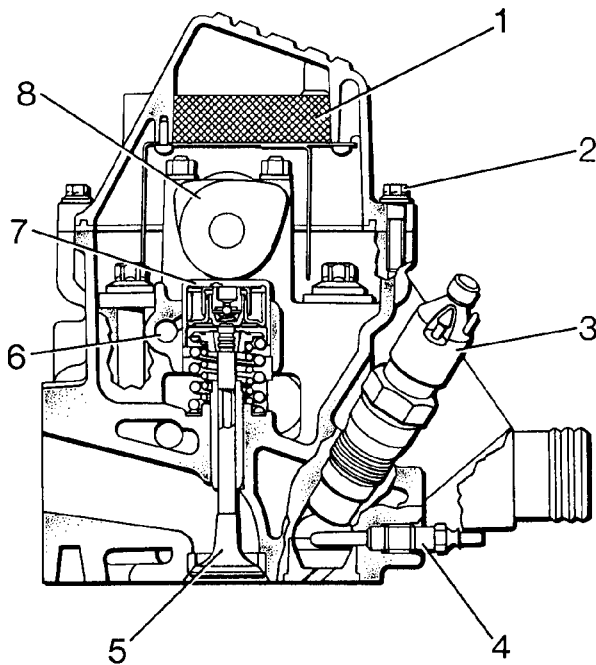
- |   |                                    |
|---|------------------------------------|
| 1. Charge air collector                 | 9. Vacuum cell for turbocharger    |
| 2. Connection from intercooler          | 10. Turbocharger air intake        |
| 3. Intake air temperature sensor groove | 11. Piston crown, V-pattern        |
| 4. Hydraulic damper - tensioner roller  | 12. Exhaust pipe from turbocharger |
| 5. Radiator fan and viscous coupling    | 13. Exhaust manifold               |
| 6. Torsional vibration damper           | 14. Overhead camshaft              |
| 7. Oil pump                             | 15. Hydraulic tappet               |
| 8. Water pump                           |                                    |

## Cylinder head

The aluminium cylinder head houses the chain driven overhead camshaft, the valve gear and fuel injectors.

Coolant enters the cylinder head from the crankcase. The coolant flow is across the cylinder head and out to the heater matrix and radiator.

An oil separator with wire mesh filter is installed in the camshaft cover.

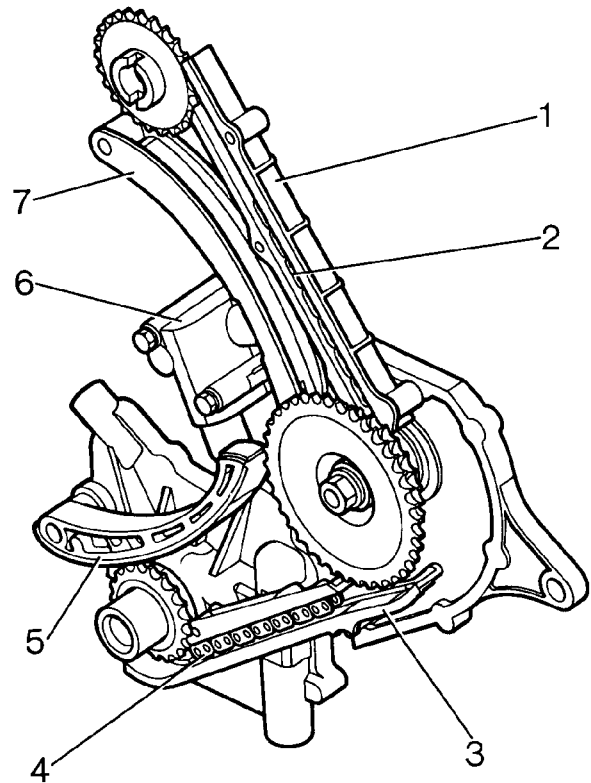


12M7137

1. Oil separator
2. Camshaft cover bolts
3. Fuel injector
4. Glow plug
5. Outlet valve
6. Oil supply duct
7. Hydraulic tappet
8. Camshaft

## Camshaft

Seven bearings support the camshaft in the cylinder head. The camshaft is chain driven from the fuel injection pump drive sprocket, which itself is chain driven from the crankshaft. Both the injection pump timing chain and the camshaft timing chain run within guide rails and are tensioned automatically by tension rails and a chain adjuster mechanism.



12M7138

1. Guide rail
2. Camshaft drive chain
3. Guide rail
4. Injection pump drive chain
5. Tension rail
6. Chain adjuster
7. Tension rail

## Valve gear

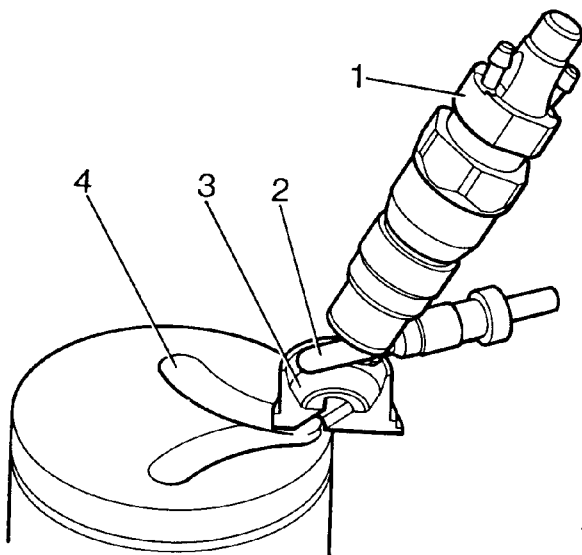
The camshaft operates the inlet and exhaust valves through bucket-type tappets with hydraulic valve clearance adjustment. The hydraulic tappets are leakproof, eliminating rattle during the first few revolutions of the engine. Valves are available in standard size or oversize and are identified by a number stamped on the stem. Valves are coated during manufacture and DO NOT need to be lapped when they are renewed.



**Fuel injectors**

Fuel is delivered to each cylinder through fuel injector nozzles. An injector is screwed into a pre-combustion chamber (swirl chamber) at each cylinder position.

The precombustion chambers are also fitted with glow plugs. Each injector comprises a nozzle holder and contains a spring-loaded needle valve; the nozzle holder of cylinder No 4 incorporates a sender which senses the time of fuel ejection by recognising needle movement. This information is utilised by the DDE system - **See ENGINE MANAGEMENT, Description.**



12M7139

- 1. Fuel injector
- 2. Glow plug
- 3. Pre-combustion chamber
- 4. Piston crown, V-patterned groove

**Air intake**

Fresh air is drawn in through an air cleaner assembly secured to the left hand inner wing of the vehicle. The air cleaner assembly comprises a housing which contains a paper filter element. The rectangular, two-part housing is constructed from moulded plastic and incorporates an air inlet and an air outlet.

The air cleaner delivers filtered air to the turbocharger.

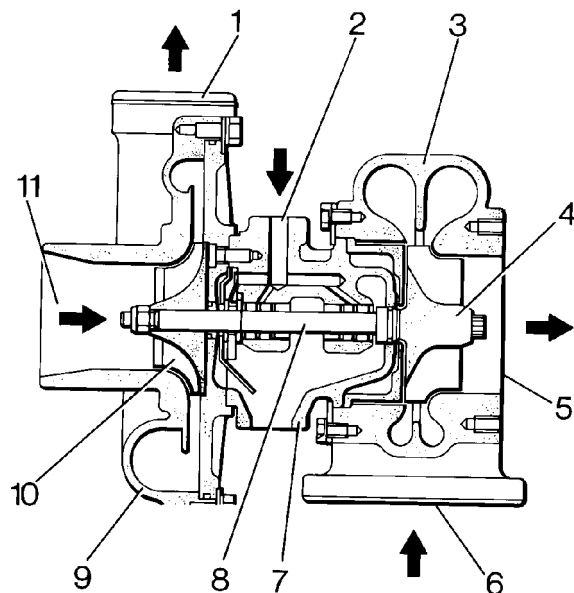
**Forced aspiration system**

Forced aspiration is by an exhaust driven turbocharger. Compressed air, from the turbocharger, passes through an intercooler to the charge air collector mounted on the cylinder head.

**Turbocharger**

The turbocharger consists of a compressor housing and a turbine housing bolted to the exhaust manifold. The compressor housing has an ambient air inlet and a compressed air outlet. The turbine housing has an exhaust gas inlet and an exhaust gas outlet. Both compressor and turbine housings are bolted to a central bearing housing. The bearing housing contains two pressure lubricated bearings which provide support for the rotor shaft. An exhaust-gas driven turbine mounted at one end of the rotor shaft, drives a centrifugal compressor mounted at the other.

To regulate charge air pressure, a by-pass plate is installed on the exhaust side of the turbocharger. The by-pass plate is connected to a pneumatic pressure actuator.



12M7140

- 1. Charge air outlet
- 2. Pressurised oil from engine
- 3. Turbine housing
- 4. Turbine
- 5. Exhaust gas outlet
- 6. Exhaust gas inlet
- 7. Bearing housing
- 8. Rotor shaft
- 9. Compressor housing
- 10. Compressor
- 11. Air intake

## Intercooler

To lower the temperature of the charge air, and therefore increase its density, an intercooler is fitted between the turbocharger and the charge air collector.

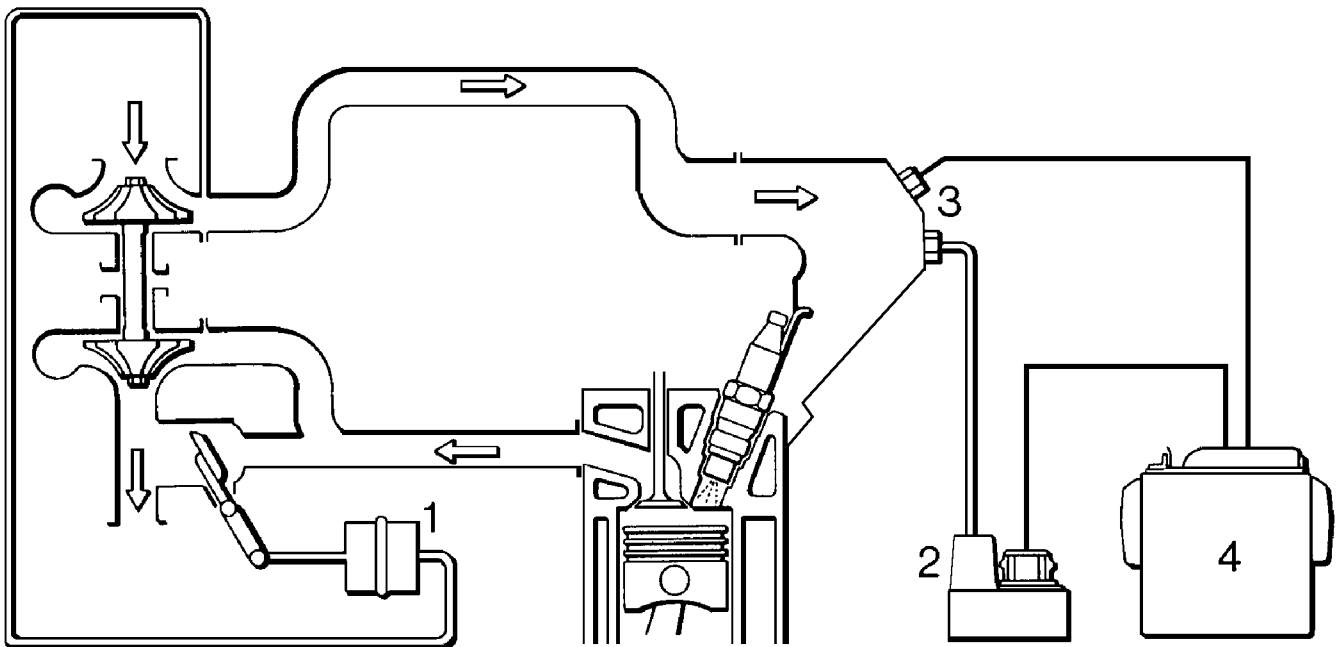
## Charge air collector

The charge air collector is bolted to the cylinder head and consists of a manifold having a single inlet and six individual outlets, one to each cylinder. Intake charge air pressure and charge air temperature sensors mounted on the collector are linked to the control unit of the DDE system. The air temperature sensor has a black connector and is fitted at the front of the air collector. The pressure sensor is a small, black plastic sensor mounted on the fuel filter bracket. It is connected to the air collector through a tube.

## Operation

When the engine is running, exhaust gas impinges on the turbine vanes of the turbocharger causing the turbine to rotate. The rotor shaft transmits drive from the turbine to the inlet centrifugal compressor. Air is drawn into the compressor from the air cleaner and compressed air is discharged to the charge air collector via the intercooler.

Charge air pressure is regulated by operation of the by-pass plate.



12M7141

1. By-pass plate actuator
2. Charge air pressure sensor
3. Intake air (charge air) temperature sensor
4. DDE system control unit



**Lubrication system**

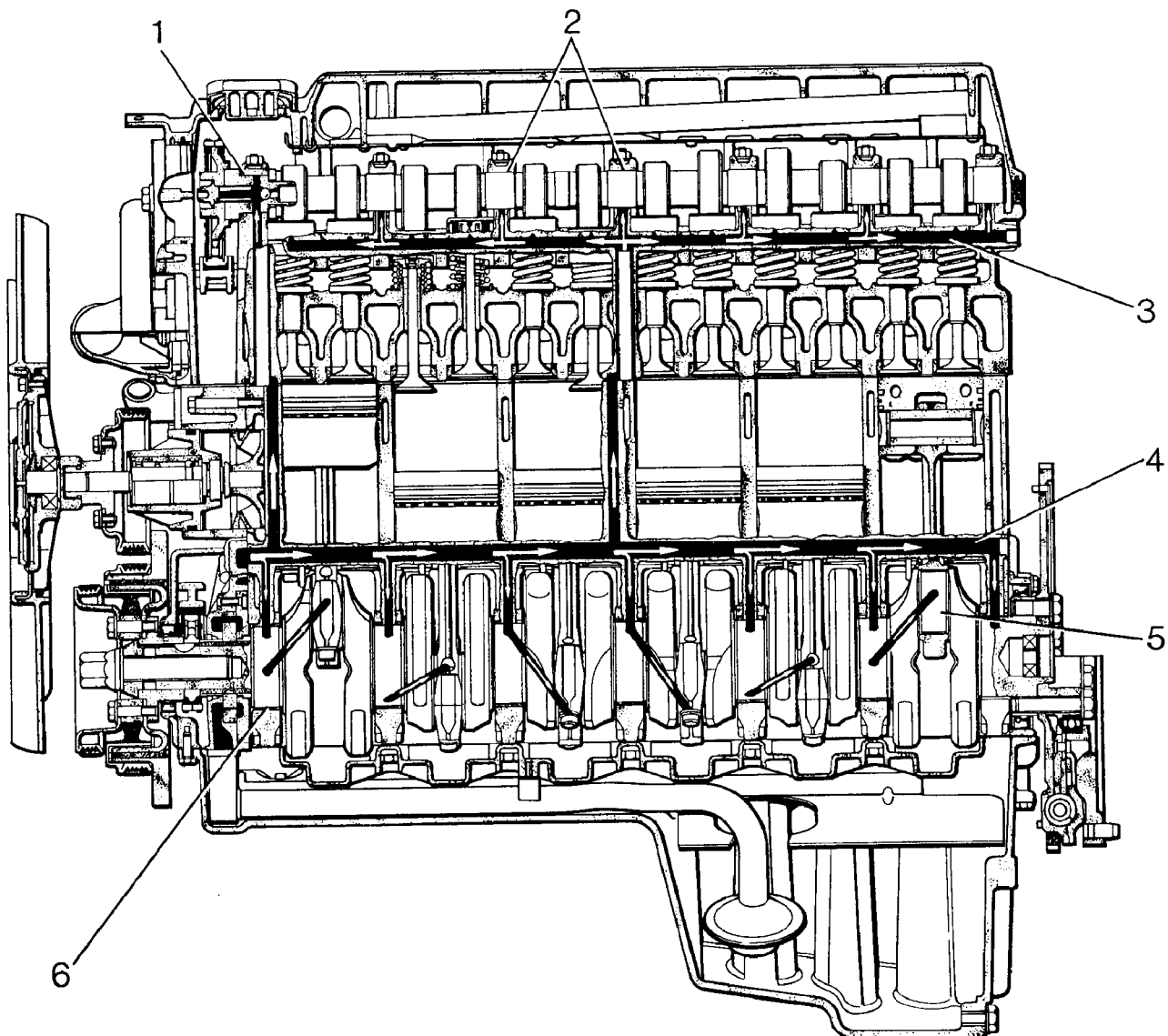
The lubrication system comprises the sump, pump, oil filter and oil ducts.

**Sump**

This is a one-piece, rigid, aluminium, die-cast unit bolted to underside of the crankcase. An oil deflector plate is attached to the crankcase reinforcing shell above the sump. The sump incorporates a drain plug and a dip-stick guide pipe.

**Oil pump**

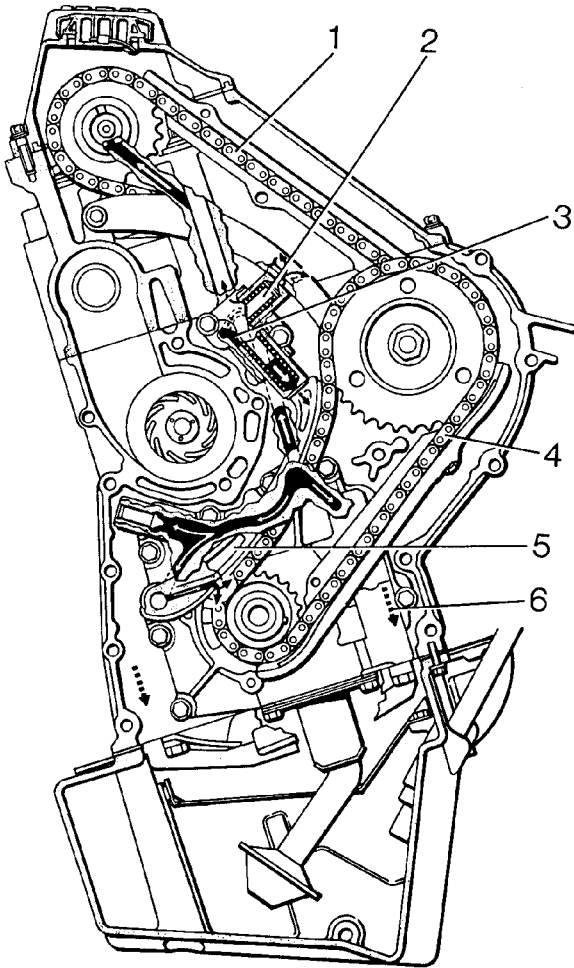
An internal gear-type pump is mounted on the front end of the crankshaft. It is directly driven by the crankshaft. The pump consists of a body which houses a driven rotor and a stator. Pump pressure is regulated by a piston operated pressure relief valve housed within the body of the pump.



12M7142

- 1. Camshaft bearing
- 2. Camshaft bearings
- 3. Oil duct

- 4. Main oil duct
- 5. Big end bearing
- 6. Main crankshaft bearing



12M7143

1. Camshaft timing chain drive
2. Upper tension rail
3. Chain adjuster
4. Injection timing
5. Lower tension rail
6. Oil return

### Oil filter

The oil filter is vertically-mounted below the charge air collector. It consists of a filter element contained within a housing which is screwed to a filter head. A filter by-pass valve is installed in the housing, while the filter head holds a thermostat. The thermostat promotes quick warm up of the engine by preventing oil circulating through the oil cooler when the oil temperature is low. The thermostat operates at 80°C.

### Oil ducts

Oil circulates around the engine, and is delivered to the turbocharger bearings, through ducts and oilways. A longitudinal main oil duct allows oil to be delivered to the crankshaft bearings. Vertical ducts from the main duct allow oil to the piston cooling jets and to the camshaft bearings.

### Operation

Refer to the lubrication system circuit diagrams for lubrication system operating details.

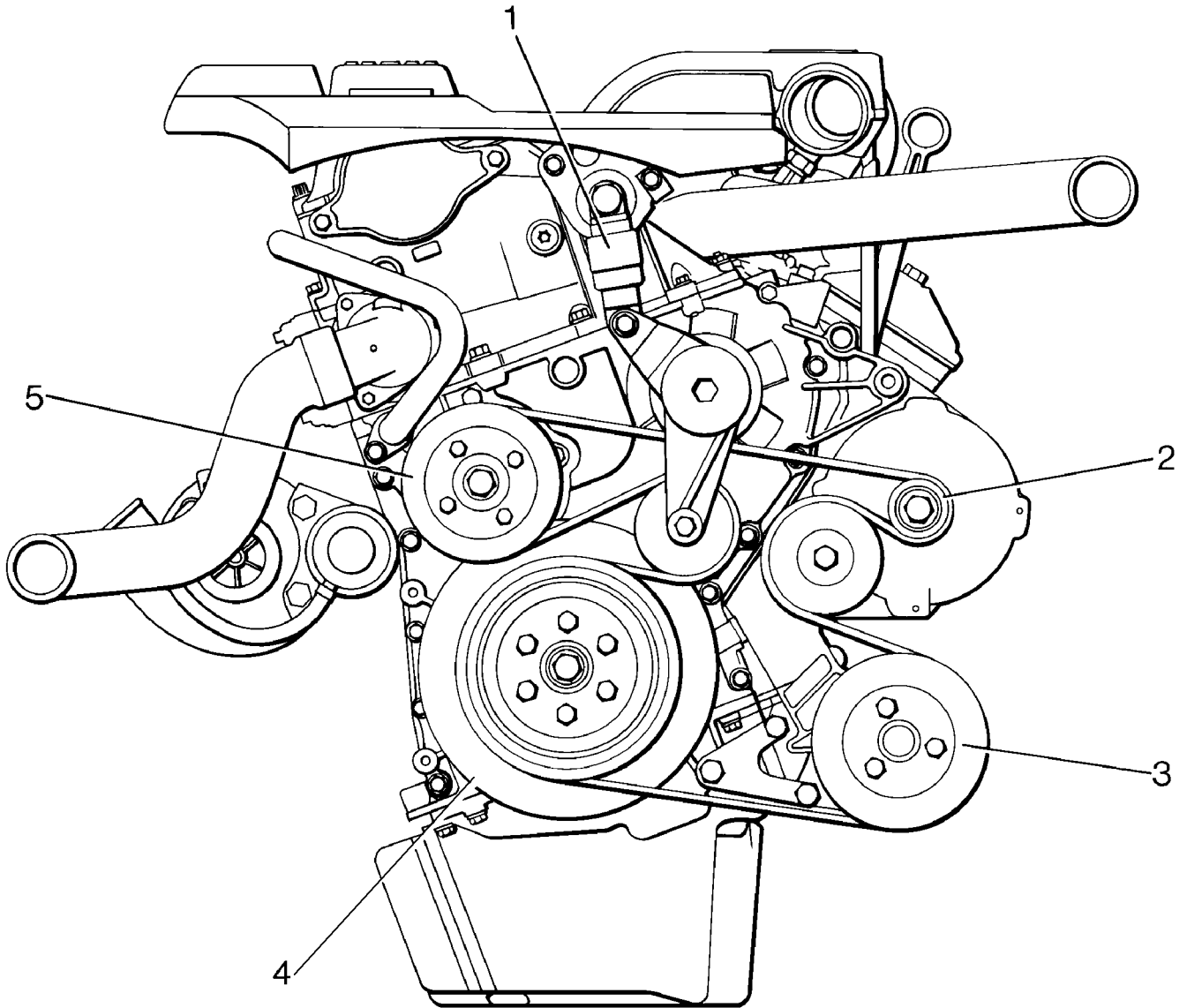
### Auxiliary driven assemblies

The auxiliary driven assemblies consist of the following:

Water pump  
Power steering pump  
Alternator

The water pump, alternator and power steering pump are driven from the crankshaft by means of a decoupled pulley and a 5-rib, automatically tensioned, V-belt.





12M7144

1. Belt tensioning element
2. Alternator drive
3. Power steering pump drive
4. Torsional vibration damper with decoupled pulley
5. Water pump drive





## CYLINDER PRESSURE CHECK - DIESEL

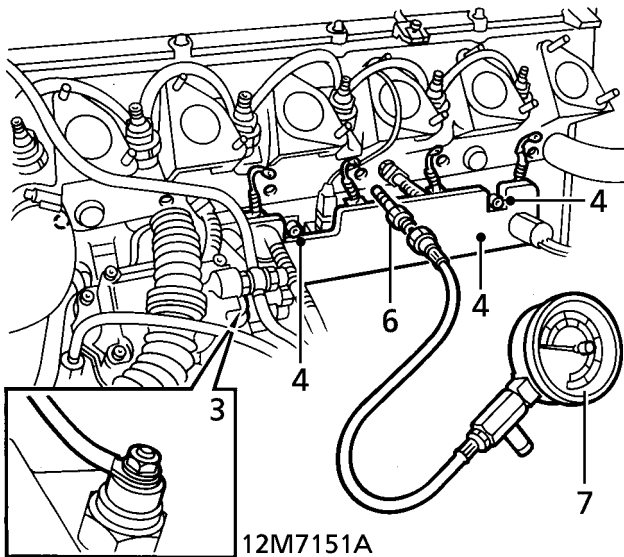
Service repair no - 19.60.31



**NOTE:** Test must only be carried out with battery in good condition. Compression tests should not be used as the sole means of assessing the state of an engine. They must only be used to support other symptoms or the results of other tests.

1. Disconnect battery negative lead.
2. Remove glow plugs. *See FUEL SYSTEM, Repair.*
3. Release cover and disconnect lead from stop solenoid.
4. Remove 2 screws securing harness trunking to cylinder block and position trunking aside.
5. Reconnect battery negative lead.
6. Using kit LRT-19-007 fit adaptor DA 102-85 to number 1 glow plug location. Tighten to **20 Nm (15 lbf.ft)**.
7. Connect gauge to adaptor and tighten securely.

9. Repeat operations 6 to 8 on remaining cylinders.
10. All readings should be at least 20 bar and within approximately 3 bar of each other.
11. If any reading is low, inject 4 shots of clean engine oil into glowplug hole and repeat test. Low readings on both wet and dry tests indicate a badly seating valve or leaking cylinder head gasket. Low readings on a dry test and satisfactory wet test results indicate piston ring and/or cylinder bore problems.
12. Disconnect battery negative lead.
13. Remove test equipment.
14. Connect stop solenoid.
15. Align harness trunking and secure with screws.
16. Fit glow plugs, *See FUEL SYSTEM, Repair.*
17. Reconnect battery negative lead.



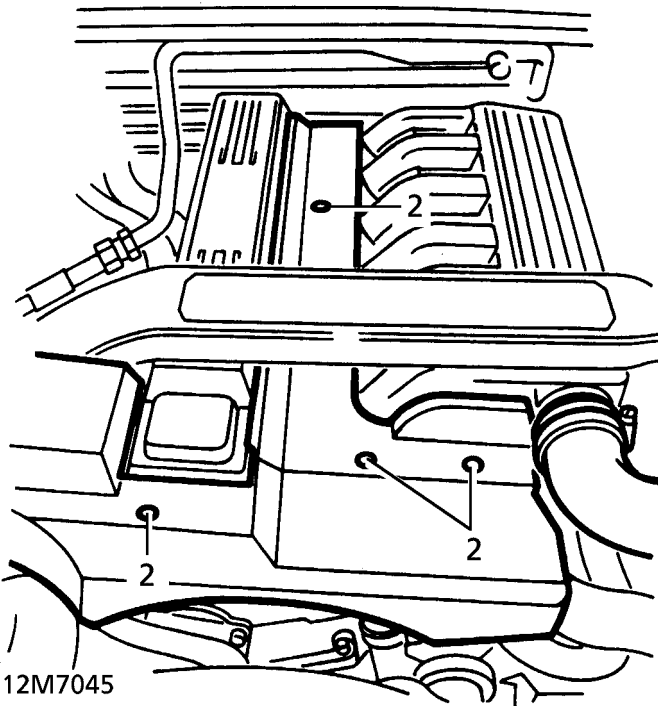
8. Operate the starter motor until the gauge needle reaches its highest reading and mark with the pointer.

## CAMSHAFT COVER GASKET - NON EGR

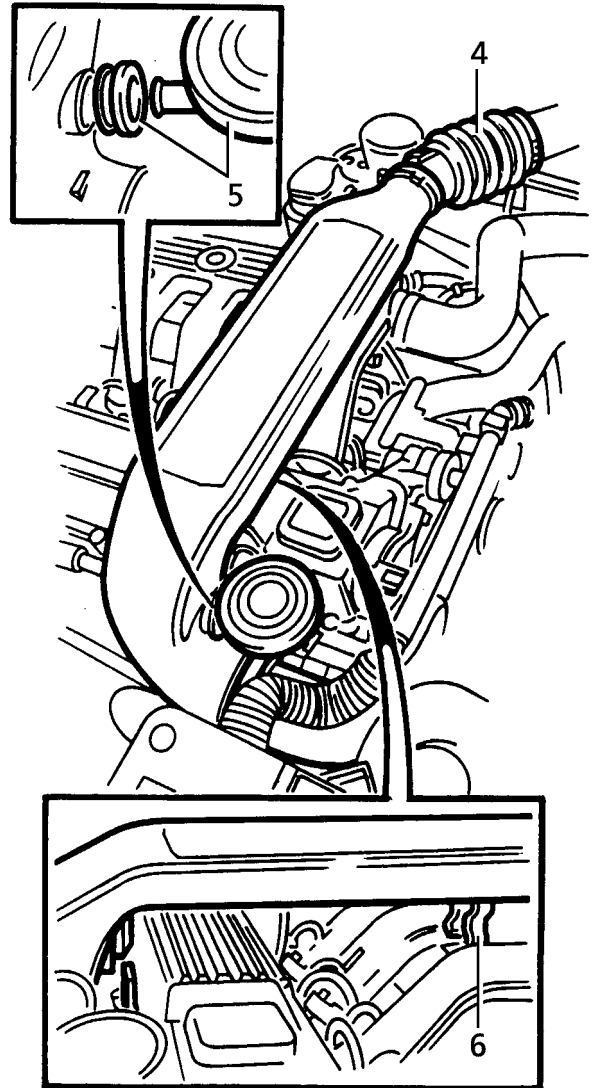
Service repair no - 12.29.40

### Remove

1. Disconnect battery negative lead.
2. Remove 4 screws securing injector covers. Remove covers.



3. Release intake hose from ducting.
4. Release turbocharger intake hose from ducting.

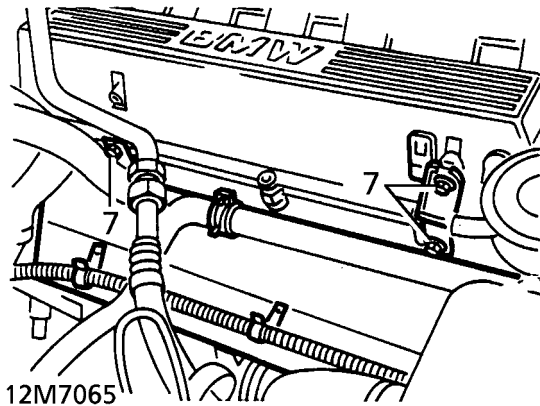


5. Release breather valve from intake ducting grommet.



**NOTE: Collect grommet. Refit to ducting.**

6. Disengage 2 clips. Remove intake ducting.
7. Remove 3 bolts securing intake ducting bracket and exhaust manifold heat shield to camshaft cover. Collect bracket.



8. Remove 10 bolts securing camshaft cover to cylinder head.
9. Remove camshaft cover. Collect gasket and discard.

#### Refit

10. Ensure mating faces are clean.
11. Fit gasket to camshaft cover.
12. Position camshaft cover on cylinder head. Ensure gasket is correctly seated.



**NOTE: Protrusion on rear of gasket can snag on bearing cap during positioning of cover.**

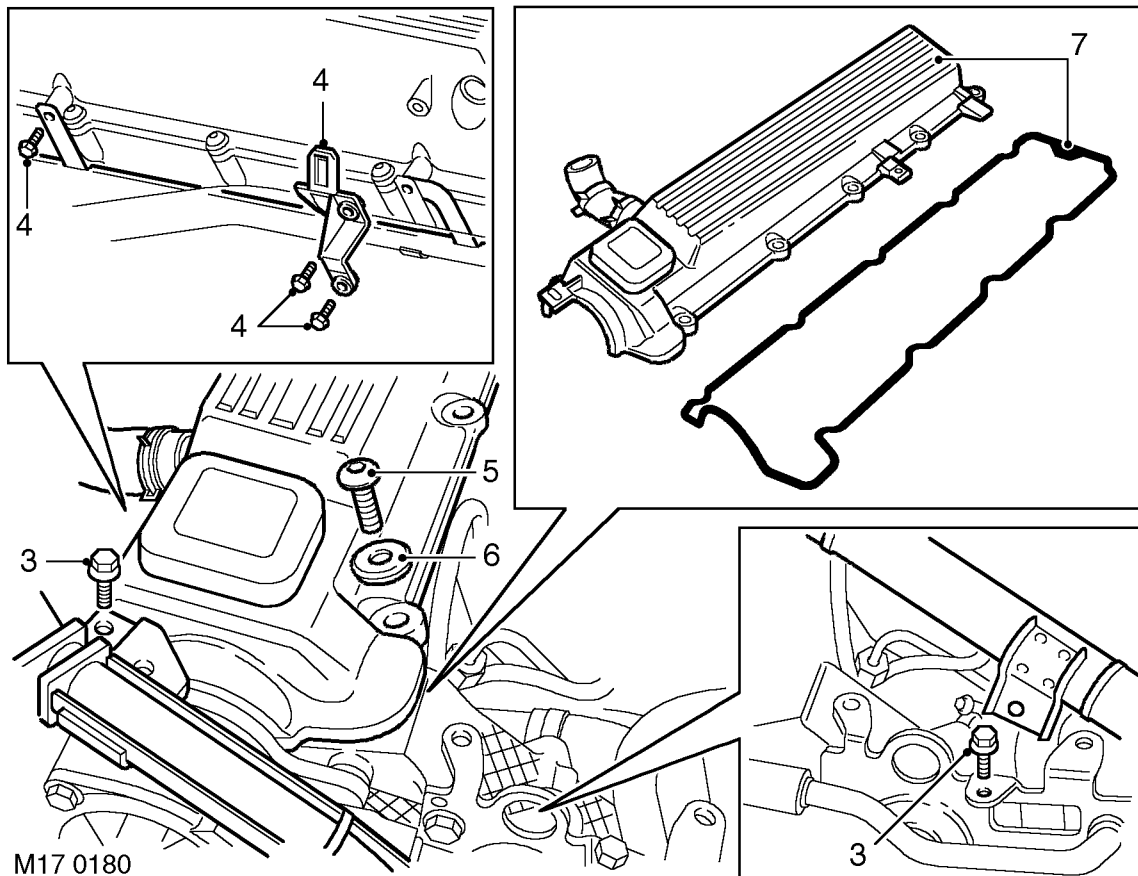
13. Fit camshaft cover bolts. Tighten in diagonal sequence, working from centre outwards to **15 Nm (11 lbf.ft)**
14. Align exhaust manifold heat shield. Position intake ducting bracket.
15. Secure ducting bracket and heat shield with bolts.
16. Position intake ducting. Engage clips.
17. Engage breather valve into ducting grommet.
18. Connect ducting to turbocharger intake hose. Secure clip.
19. Connect intake hose to ducting. Secure clip.
20. Fit injector covers. Secure with screws.
21. Reconnect battery negative lead.

## CAMSHAFT COVER GASKET - WITH EGR

Service repair no - 12.29.40

### Remove

1. Disconnect battery negative terminal.
2. Remove air intake ducting. **See FUEL SYSTEM, Repair.**
3. Remove 2 bolts securing harness trunking and position trunking aside.
4. Remove 3 bolts securing intake ducting bracket and exhaust manifold heat shield to camshaft cover. Collect bracket.
5. Remove 10 bolts securing camshaft cover to cylinder head.
6. Collect sealing washers.
7. Remove camshaft cover. Collect gasket and discard.



### Refit

8. Inspect sealing washers, renew as necessary.
9. Ensure mating faces are clean.
10. Fit gasket to camshaft cover.
11. Position camshaft cover on cylinder head. Ensure gasket is correctly seated.
12. Fit camshaft cover bolts. Tighten in diagonal sequence, working from centre outwards to **15 Nm (11 lbf.ft)**.
13. Align exhaust manifold heat shield. Position intake ducting bracket.
14. Secure ducting bracket and heat shield with bolts.
15. Fit air intake ducting. **See FUEL SYSTEM, Repair.**
16. Connect battery negative terminal.



**NOTE: Protrusion on rear of gasket can snag on bearing cap during positioning of cover.**

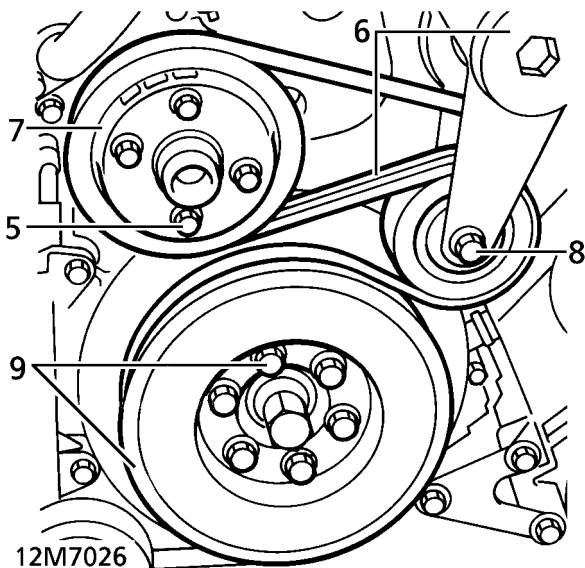


## CRANKSHAFT PULLEY AND FRONT COVER OIL SEAL

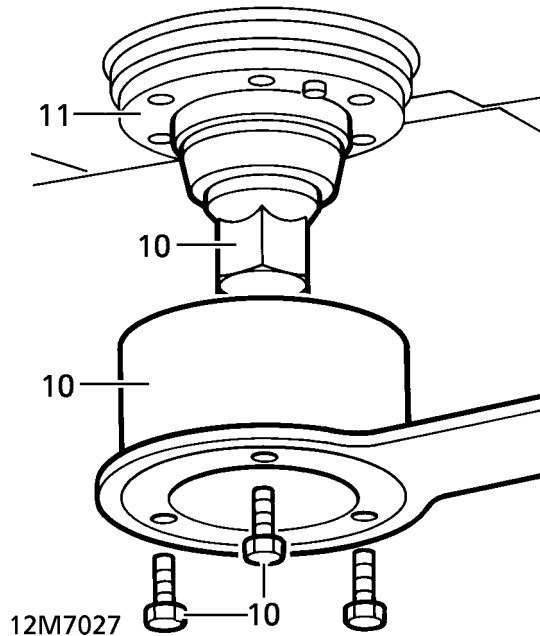
Service repair no - 12.21.01 - Crankshaft Pulley  
Service repair no - 12.65.05 - Timing Gear Cover Oil Seal

### Remove

1. Disconnect battery negative lead.
2. Remove radiator. **See COOLING SYSTEM, Repair.**
3. Remove cover from air conditioning drive belt tensioner.
4. Release drive belt tension. Remove drive belt.
5. Slacken 4 water pump pulley bolts.



6. Release auxiliary drive belt tension. Remove belt.
7. Remove water pump pulley bolts. Remove pulley.
8. Remove bolt from auxiliary drive belt tensioner pulley. Remove pulley.
9. Remove 6 bolts securing vibration damper and air conditioning pulley to vibration damper hub. Remove damper and pulley.



10. Secure LRT-12-105 to hub with 3 bolts. Remove and discard hub retaining bolt.
11. Note orientation of shouldered washer. Remove hub and tool.
12. Remove seal from front cover.

### Refit

13. Ensure mating faces are clean.
14. Lubricate outer face of seal.
15. Locate seal in timing cover.
16. Using LRT-12-111, push seal home until flush with face of timing cover.
17. Lubricate lip of oil seal. Fit crankshaft pulley hub.
18. Hold hub using LRT-12-105. Secure with new bolt and tighten to **100 Nm (74 lbf.ft) plus 150 ° torque angle.**
19. Fit damper and pulley to hub. Secure with bolts. Tighten to **23 Nm (17 lbf.ft)**
20. Fit auxiliary belt tensioner pulley. Secure with bolt.
21. Fit pulley to water pump. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
22. Rotate auxiliary drive belt tensioner. Fit drive belt.
23. Fit and tension air conditioning drive belt. **See AIR CONDITIONING, Repair.**
24. Fit radiator. **See COOLING SYSTEM, Repair.**
25. Reconnect battery negative lead.

## CRANKSHAFT REAR OIL SEAL

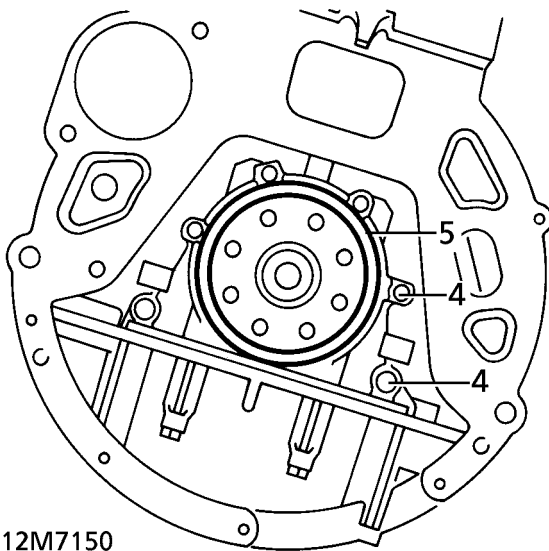
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**NOTE:** Seal and carrier are supplied as an assembly.

### Remove

1. Disconnect battery negative lead.
2. Remove flywheel. **See this section.**
3. Remove sump. **See this section.**
4. Remove 6 bolts securing seal carrier to cylinder block.



12M7150

5. Remove seal carrier from location dowels.
6. Collect gasket and discard.

### Refit

7. Ensure mating faces are clean.
8. Position new gasket.
9. Lubricate seal guide LRT-12-107 with engine oil. Position over crankshaft boss.
10. Lubricate oil seal lip. Position seal carrier squarely over guide. Locate carrier onto dowels.
11. Remove guide.
12. Secure carrier with bolts.  
M6, Tighten to **10 Nm (7 lbf.ft)**  
M8, Tighten to **22 Nm (16 lbf.ft)**
13. Fit sump. **See this section.**
14. Fit flywheel. **See this section.**
15. Reconnect battery negative lead.

## ENGINE AND GEARBOX

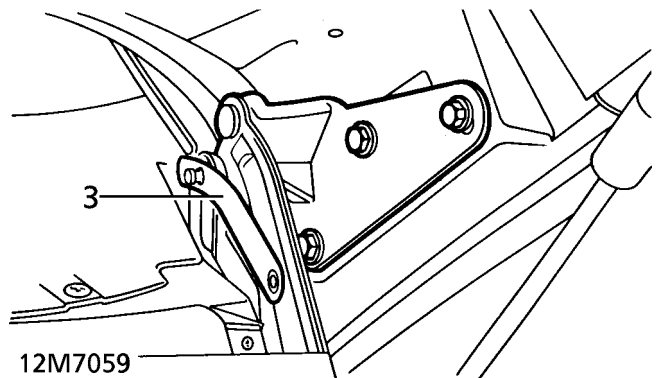
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### Remove

1. Position vehicle on four post lift.
2. Remove battery. **See ELECTRICAL, Repair.**
3. With assistance, release bonnet struts from body locations. Retain bonnet in vertical position using stay clips.

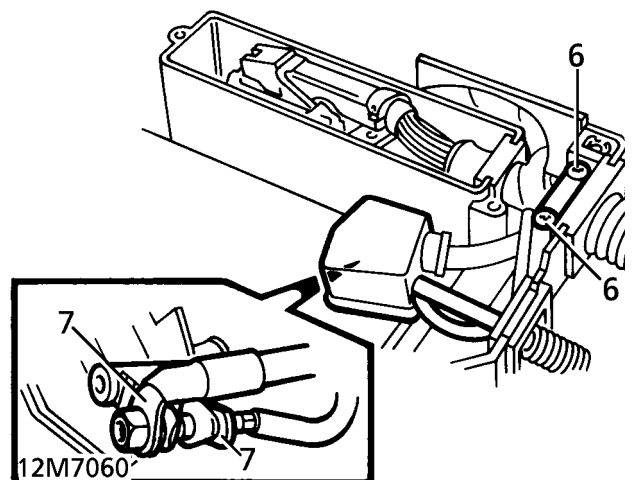


**WARNING:** Only open the bonnet to the vertical position with the vehicle on a horizontal surface in the workshop. This position is not intended to be used outdoors where the bonnet could be affected by winds.



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4. Remove inlet manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
5. Remove ECM. **See FUEL SYSTEM, Repair.**
6. Remove 2 screws securing engine harness clamp to battery tray. Collect harness clamp.

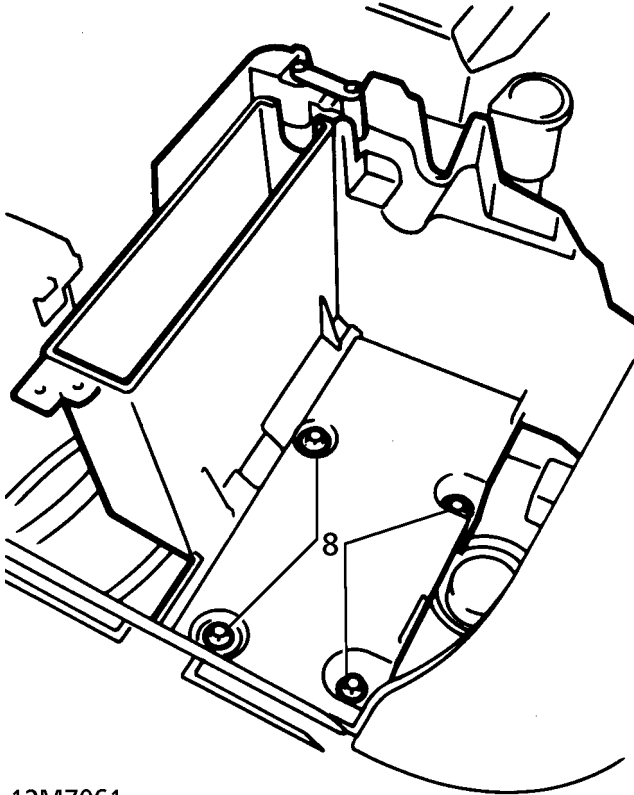


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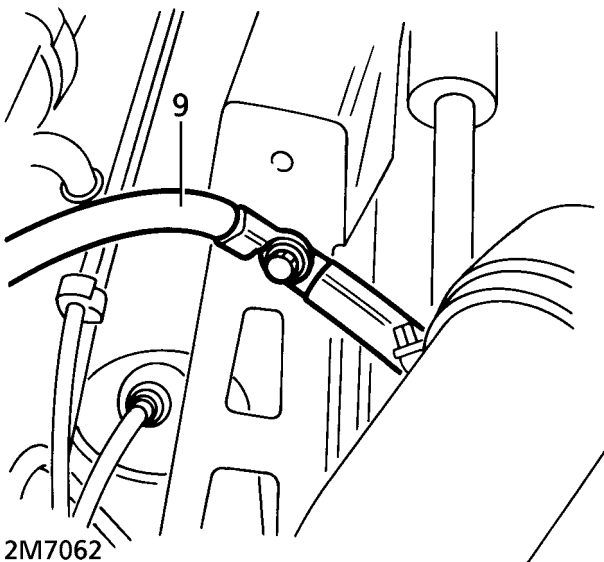


7. Release starter feed wire and glow plug relay feed from battery terminal clamp.
8. Remove 4 bolts securing battery tray. Remove battery tray.



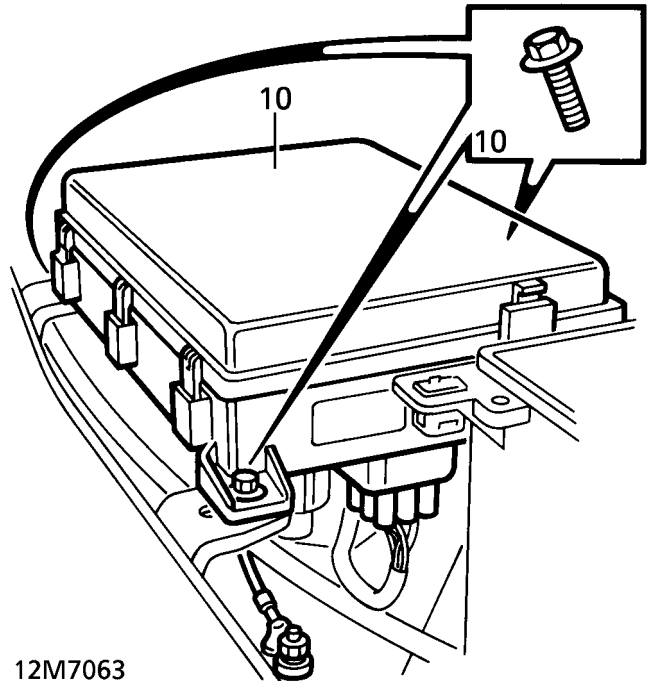
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9. Release earth lead from shock absorber turret.



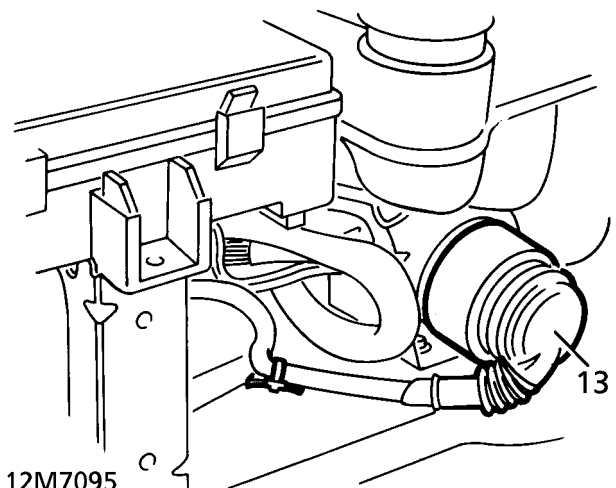
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10. Remove 3 bolts securing fuse box. Lift fuse box for access.



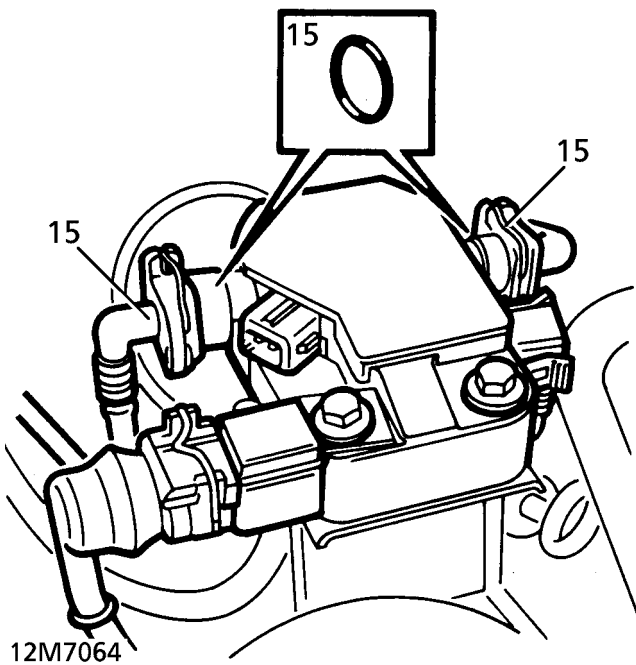
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11. Disconnect engine harness multiplug from base of fuse box.
12. Release earth wire from valance stud.
13. Disconnect engine harness multiplug from main harness.



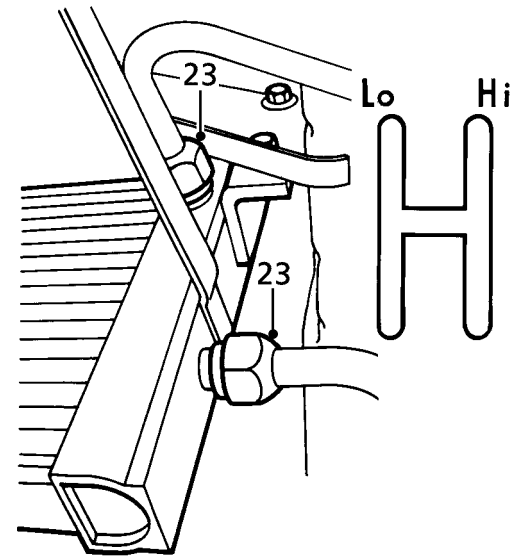
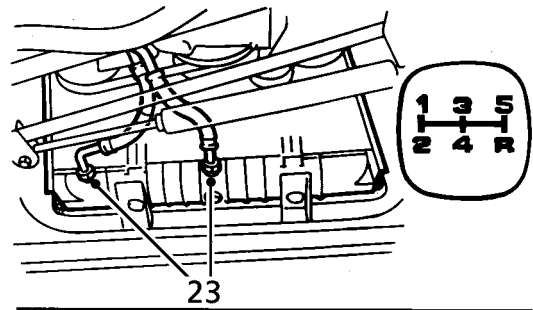
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14. Release engine harness clip from valance. Tie harness aside over engine.
15. Disconnect fuel feed line from fuel heater/filter head. Remove 'O' rings and discard.



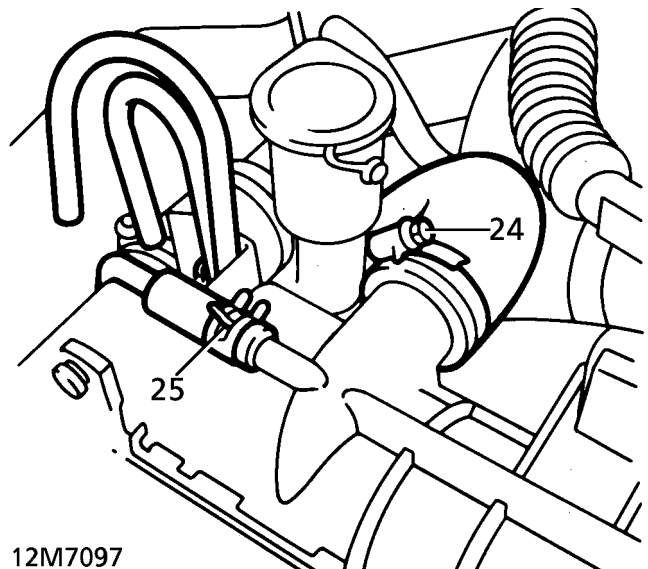
- 16. Release clip. Disconnect fuel return hose from Fuel Injection Pump (FIP).
- 17. Disconnect multiplugs from fuel heater and turbo boost sensor.
- 18. Position harness aside over engine.
- 19. Drain cooling system. **See COOLING SYSTEM, Repair.**
- 20. Discharge air conditioning system. **See AIR CONDITIONING, Adjustment.**
- 21. Remove cooling fan. **See COOLING SYSTEM, Repair.**
- 22. Remove engine oil cooler. **See this section.**

- 23. Disconnect gearbox oil cooler. Remove 'O' rings and discard. Tie pipes aside on engine.



**CAUTION:** Where pipes are disconnected, plug pipes and ports to prevent ingress of dirt.

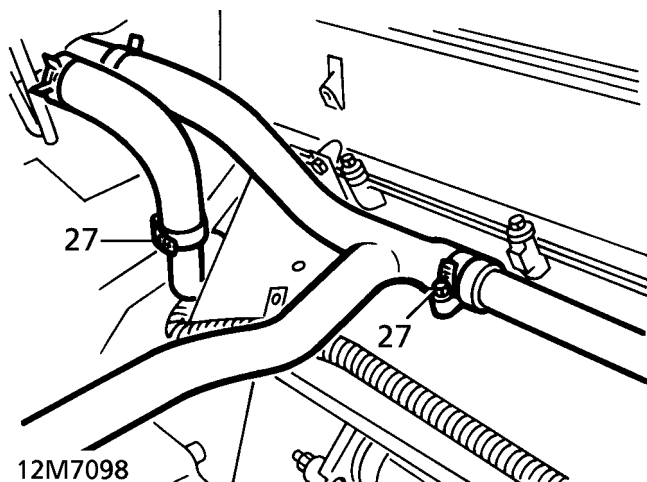
- 24. Disconnect bottom hose from radiator.



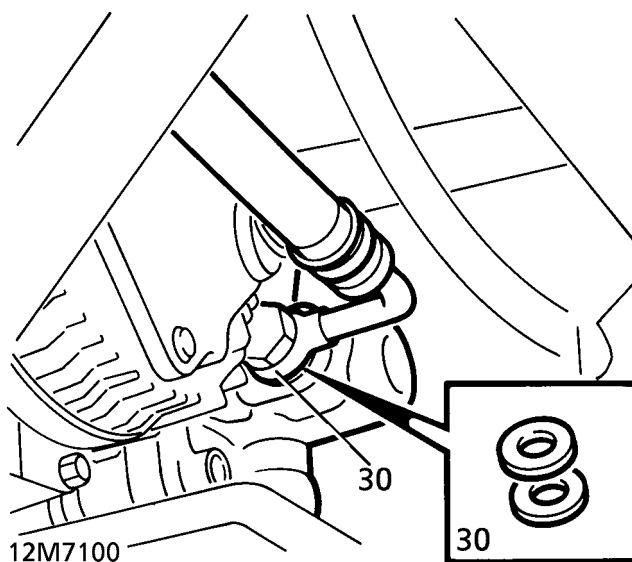
- 25. Disconnect coolant bleed hose from radiator.



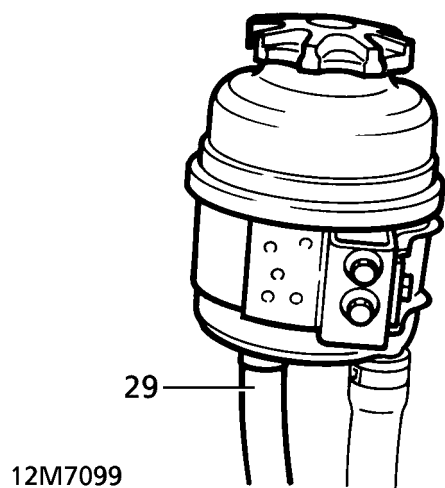
- 26. Release 2 fog lamp breather hoses from clips on either side of radiator.
- 27. Disconnect 2 heater hoses from engine coolant pipes.



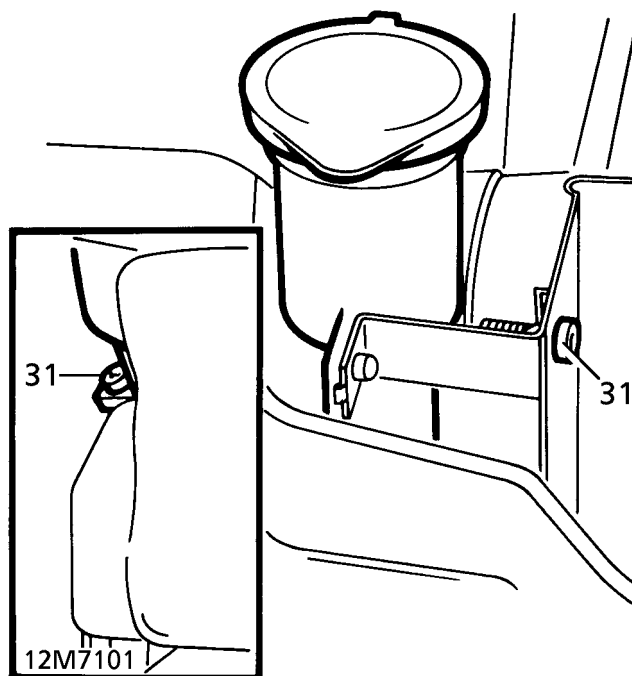
- 30. Disconnect feed pipe from power steering pump. Remove sealing washers and discard. Tie pipe aside to chassis.



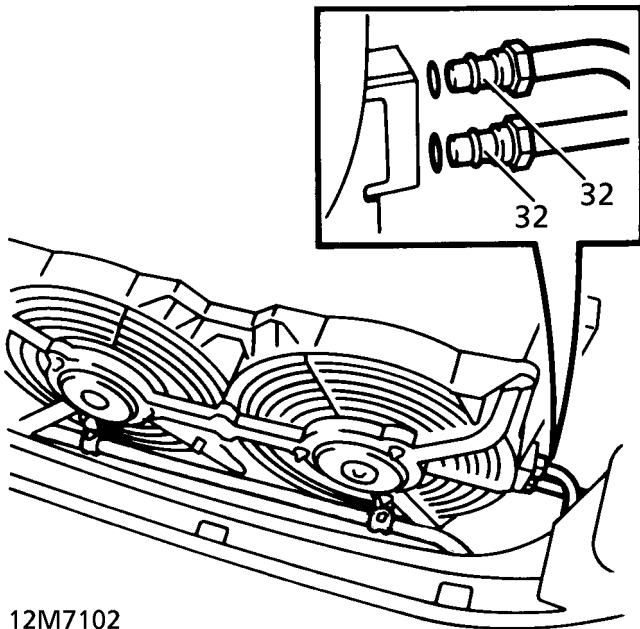
- 28. Position container beneath power steering reservoir to catch spillage.
- 29. Disconnect return pipe from reservoir. Tie reservoir aside to engine.



- 31. Remove bolt and screw securing washer bottle filler neck. Remove filler neck.

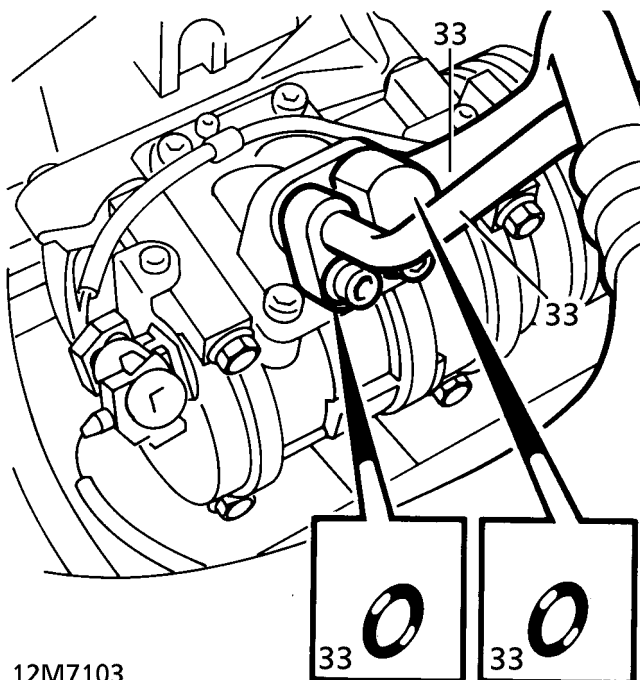


32. Disconnect 2 pipes from air conditioning condenser. Remove 'O' rings and discard.



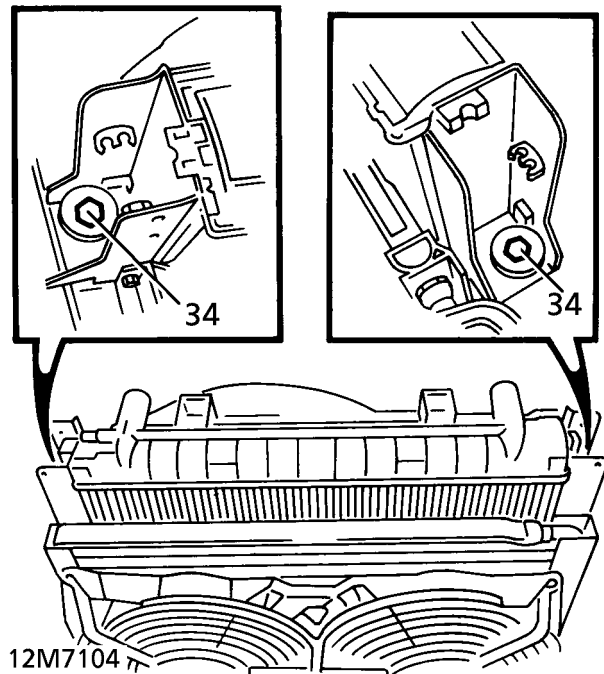
12M7102

33. Disconnect 2 pipes from air conditioning compressor. Remove 'O' rings and discard. Place pipes aside.



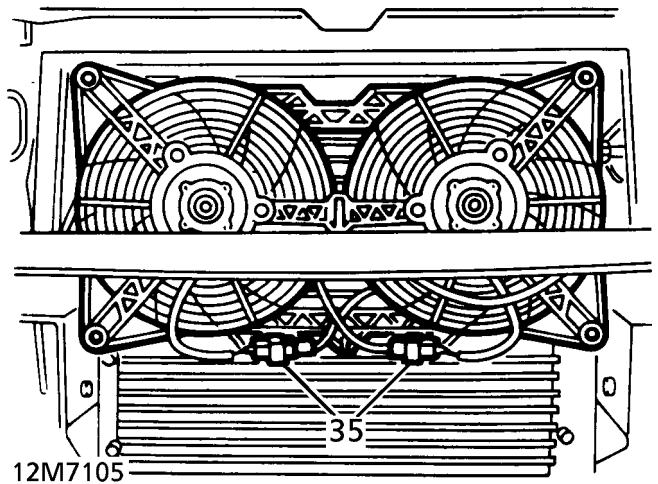
12M7103

34. Remove 2 nuts and bolts securing radiator mountings to chassis.



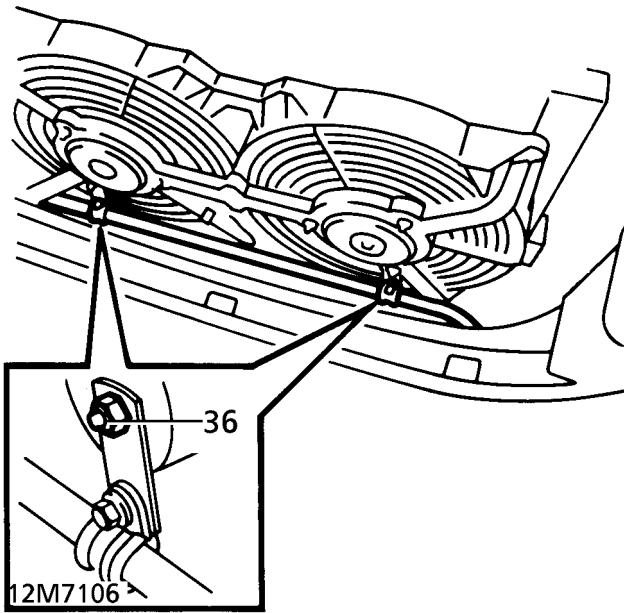
12M7104

35. Disconnect 2 condenser cooling fan multiplugs.



12M7105

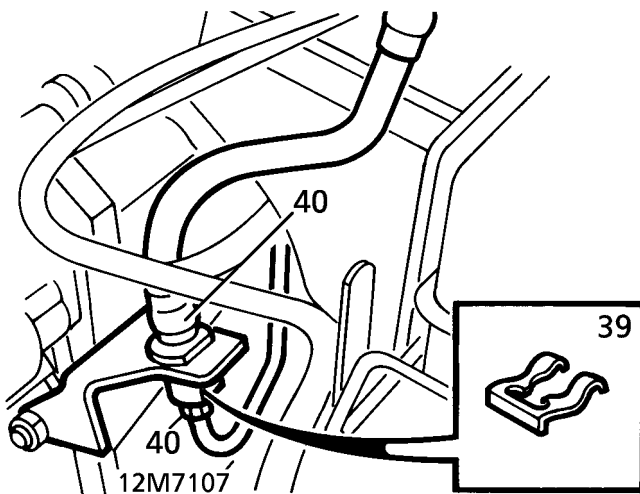
36. Remove 2 nuts securing air conditioning pipe to condenser fans. Release pipe.



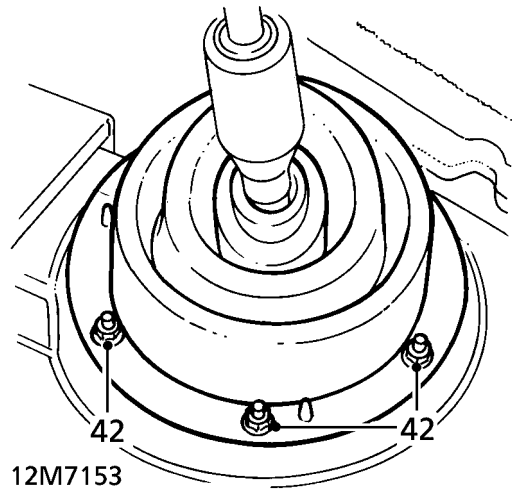
37. With assistance, remove radiator/condenser assembly.

**Manual Vehicles:**

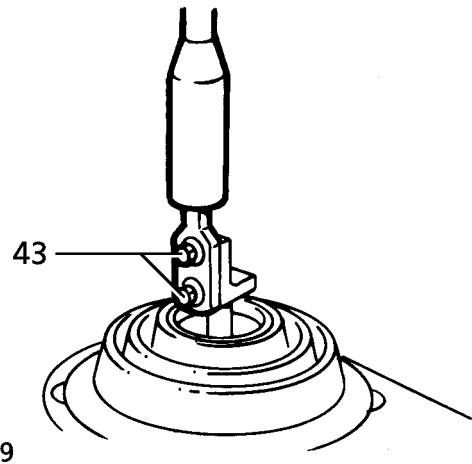
38. Clamp clutch flexible hose using approved brake hose clamp.



- 39. Remove clip securing flexible hose to gearbox bracket.
- 40. Disconnect clutch flexible hose at gearbox pipe. Position hose aside.
- 41. Remove centre console. **See CHASSIS AND BODY, Repair.**
- 42. Remove 6 nuts securing gaiter ring. Remove ring and gaiter.



43. Remove 2 bolts securing gear lever. Remove lever.

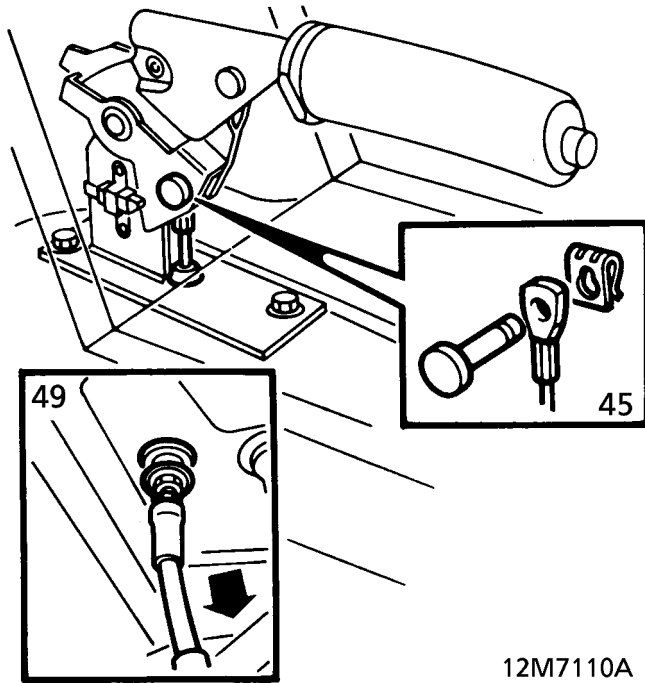


**Automatic Vehicles:**

44. Remove window switch pack. **See ELECTRICAL, Repair.**

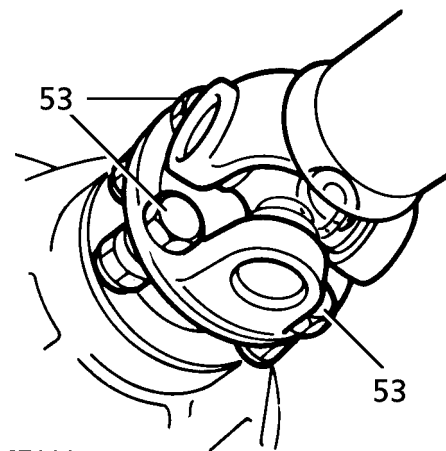
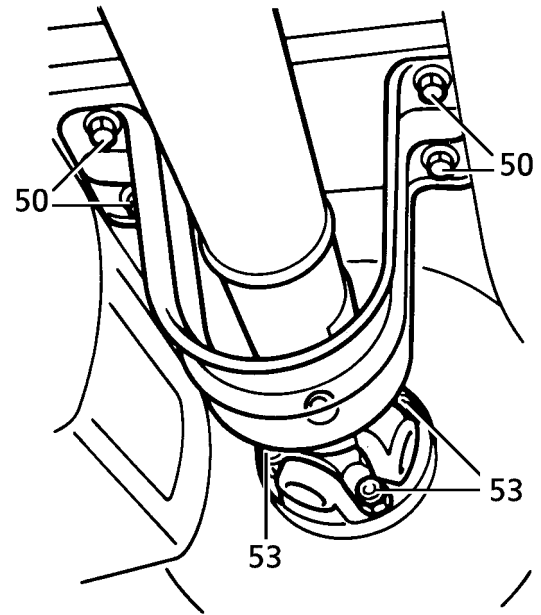
**All Vehicles:**

45. Release handbrake. Remove handbrake cable clevis pin.



12M7110A

46. Raise lift. Drain gearbox, transfer box and engine fluids. **See SECTION 10, Maintenance.**
47. Using a transmission jack, support transmission under brake drum.
48. Remove chassis cross member. **See CHASSIS AND BODY, Repair.**  
Remove exhaust front pipe. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
49. Release hand brake cable from grommet in tunnel.
50. Remove 4 bolts securing rear propeller shaft guard. Remove guard.



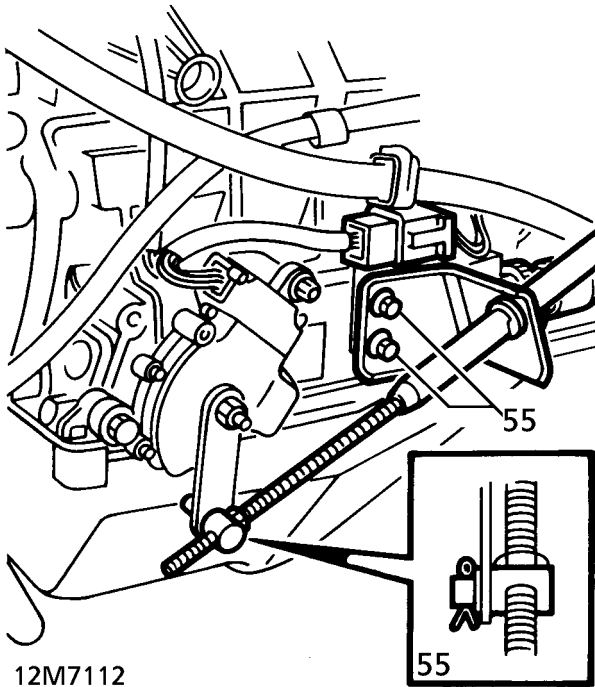
12M7111

51. Mark positions of propeller shafts and transfer box flanges to aid reassembly.
52. Raise one wheel on each axle to allow rotation of propeller shafts.
53. Remove 4 nuts from rear flange and 4 nuts and bolts from front flange. Disconnect propeller shafts. Tie aside.
54. Lower gearbox for access.



**Automatic Vehicles:**

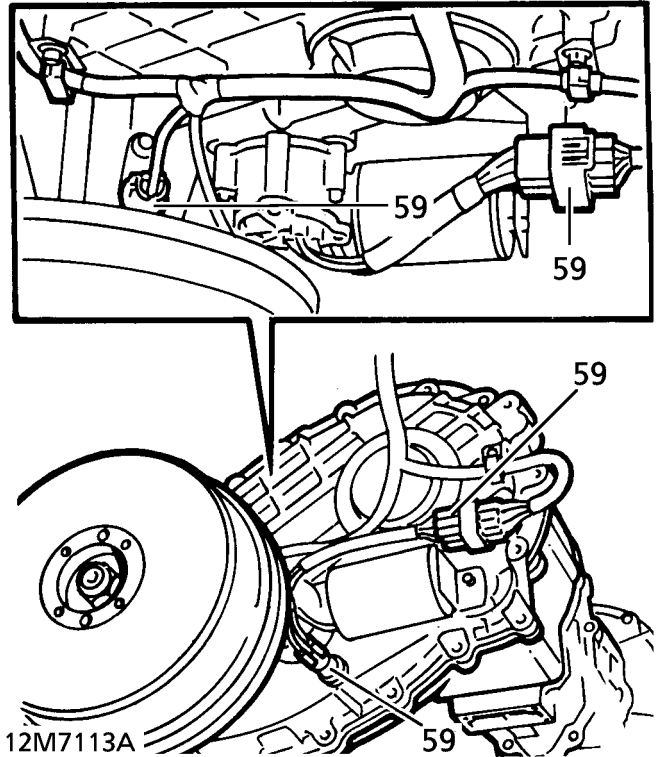
- 55. Disconnect gear selector cable trunnion from gearbox lever. Remove 2 bolts securing selector cable abutment bracket to gearbox.
- 56. Place selector cable aside.



- 57. Disconnect multiplugs from gear selection position switch and gearbox speed sensor.

**All Vehicles:**

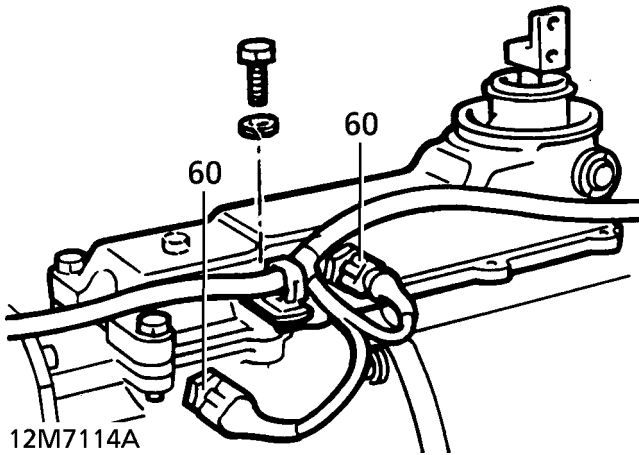
- 58. Disconnect 2 Lucars from transfer box fluid temperature sensor.



- 59. Disconnect multiplugs from High/Low motor and output shaft speed sensor.

### Manual Vehicles:

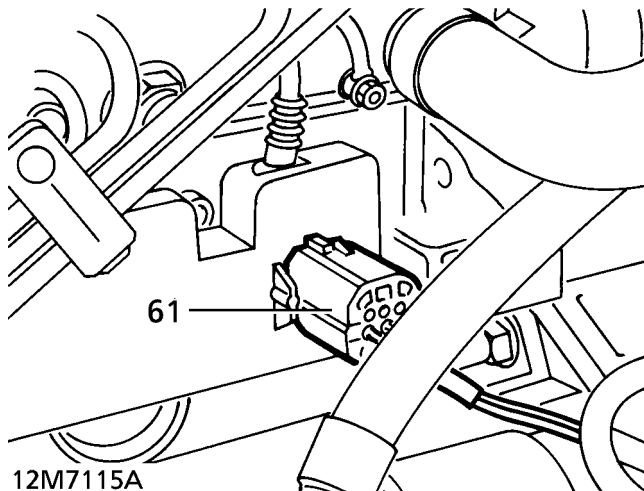
- 60. Disconnect multiplugs from reverse and neutral switches. Remove bolt securing harness bracket to gearbox. Release harness from clips on gearbox brackets.



12M7114A

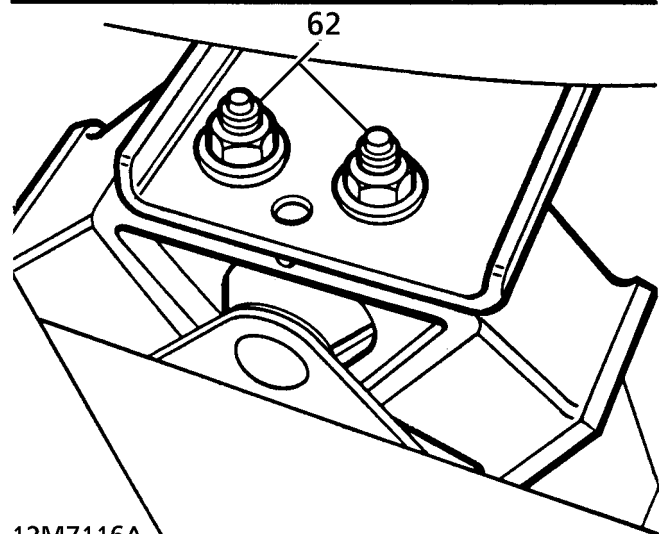
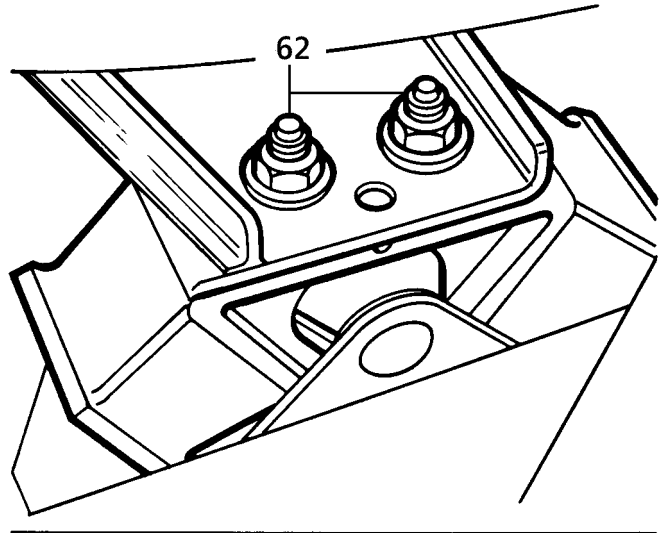
### All Vehicles:

- 61. Disconnect engine harness to gearbox harness multiplug. Position harness aside.



12M7115A

- 62. Remove 4 nuts securing each engine mount to engine bracket.

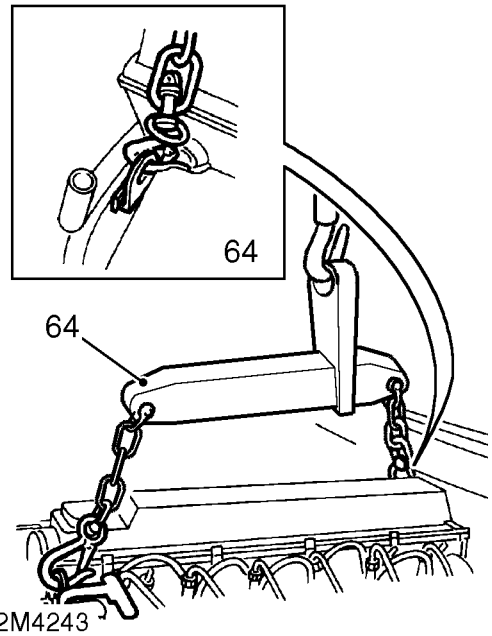
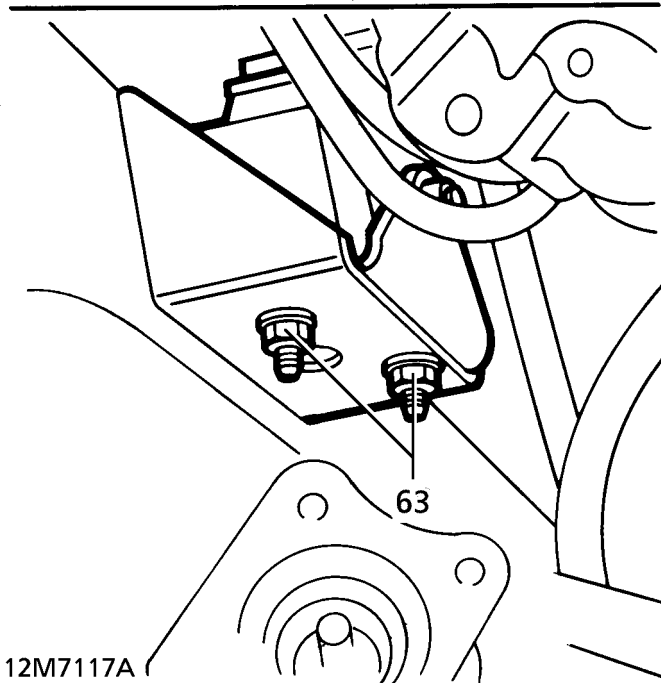
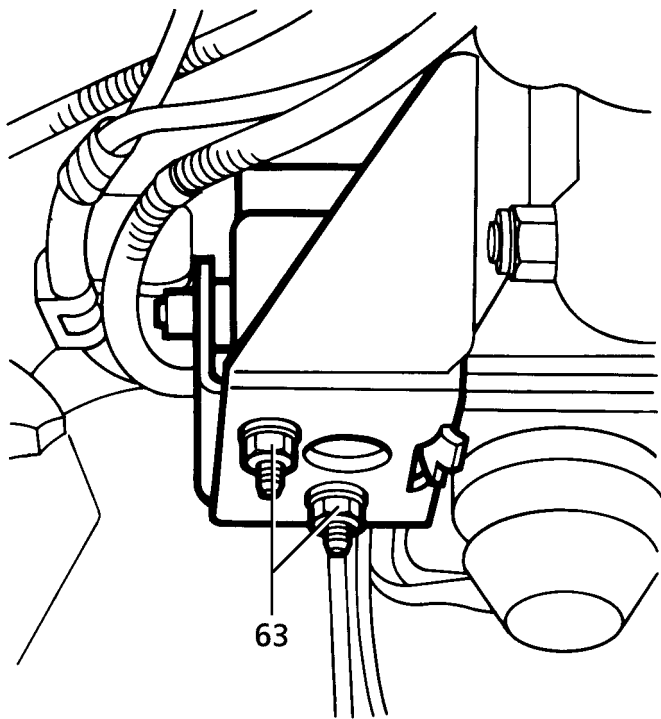


12M7116A





63. Remove 4 nuts securing each engine mount to chassis. Discard nuts.



- 64. Fit lifting bracket to engine lifting eyes. Attach suitable hoist.
- 65. Raise engine slightly. Ensure that lifting bracket does not foul bulkhead. Remove both engine mountings.

△ **NOTE:** It may be necessary to lower gearbox support slightly during above operation.

- 66. Raise power unit and draw forward.
- 67. Lower support from transmission.

△ **NOTE:** Power unit must be tilted at an angle of approximately 45 degrees before it can be withdrawn from engine compartment.

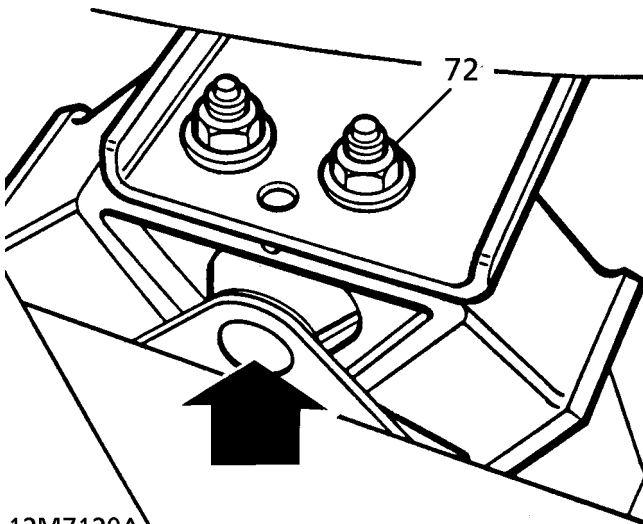
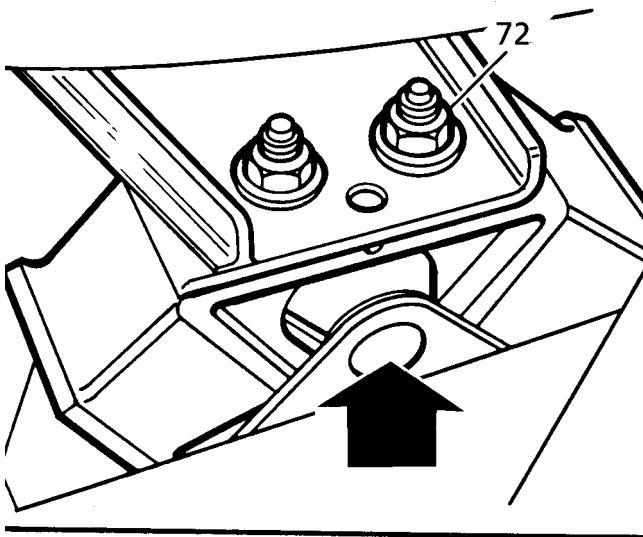
- 68. Remove engine/transmission assembly.

## Refit

69. Raise power unit. Guide into engine bay.
70. Position transmission jack beneath transmission brake drum.
71. With assistance, raise transmission and lower engine until engine mountings can be fitted.
72. Attach mountings to chassis with new flange nuts. Do not tighten at this stage.



**CAUTION: Engine mountings must be fitted with centre bolt head facing outboard as shown.**



12M7120A

73. Lower and guide engine onto mounting studs.

74. Attach engine to mountings with new flange nuts. Do not tighten at this stage.
75. Release lifting bracket from engine lifting eyes. Remove hoist.
76. Route gearbox harness. Secure with clips.
77. Connect multiplug to engine harness
78. Connect multiplugs to High/Low motor and output shaft speed sensor.

## Manual Vehicles:

79. Secure gearbox harness bracket with bolt. Tighten to **6 Nm (4 lbf.ft)**.
80. Connect multiplugs to reverse and neutral switches.
81. Secure harness to gearbox bracket with clips.
82. Connect Lucars to transfer box fluid temperature sensor.
83. Raise transmission on jack.
84. Align harness bracket to gearbox.

## Automatic Vehicles:

85. Connect multiplugs to gear selection position switch and gearbox speed sensor.
86. Position selector cable abutment bracket to gearbox. Secure with bolts.
87. Adjust gear selector cable. **See AUTOMATIC GEARBOX, Adjustment.**

## All Vehicles:

88. Raise one wheel on each axle to allow rotation of propeller shafts.
89. Position shafts to transfer box flanges. Align marks.
90. Secure propeller shaft flanges with nuts and bolts. Tighten to **48 Nm (35 lbf.ft)**
91. Fit propeller shaft guard. Tighten bolts.
92. Guide hand brake cable through grommet in transmission tunnel.
93. Fit exhaust front pipe. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
94. Fit chassis cross member. **See CHASSIS AND BODY, Repair.**
95. Remove support from under transmission.
96. Tighten engine mounting nuts to **45 Nm (33 lbf.ft)**
97. Lower lift.
98. Connect handbrake cable to lever, secure with clevis pin and clip.

**Manual Vehicles:**

- 99. Fit seal around gearbox remote housing to transmission tunnel aperture.
- 100. Fit gear lever bolts. Tighten to **25 Nm (18 lbf.ft)**
- 101. Fit gaiter and ring. Secure with nuts.
- 102. Fit centre console. **See CHASSIS AND BODY, Repair.**

**Automatic Vehicles:**

- 103. Fit window switch pack. **See ELECTRICAL, Repair.**

**Manual Vehicles:**

- 104. Connect clutch flexible hose. Remove hose clamp.
- 105. Secure flexible hose union to gearbox bracket with clip.
- 106. Bleed clutch hydraulic system. **See CLUTCH, Repair.**

**All Vehicles:**

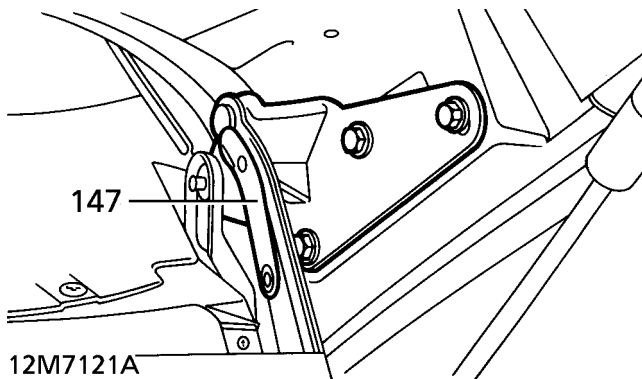
- 107. With assistance, position radiator/condenser assembly.
- 108. Connect multiplugs to condenser cooling fans.
- 109. Engage radiator in lower mounting rubbers. Secure with nuts and bolts.
- 110. Align air conditioning pipe to condenser fans. Secure with nuts.
- 111. Remove plugs from air conditioning compressor and pipes.
- 112. Fit new 'O' rings to compressor pipes. Lubricate 'O' rings with compressor oil. Connect to compressor.
- 113. Fit compressor connection bolts. Tighten to **23 Nm (17 lbs.ft)**
- 114. Remove plugs from air conditioning condenser and pipes.
- 115. Fit new 'O' rings to condenser pipes. Lubricate 'O' rings with compressor oil. Secure pipes to condenser. Tighten to **15 Nm (11 lbf.ft)**
- 116. Fit washer bottle filler neck. Secure with bolt and screw.
- 117. Remove plugs from power steering pump and pipes.
- 118. Using new sealing washers, secure feed pipe to power steering pump. Tighten to **30 Nm (22 lbf.ft)**

- 119. Untie power steering reservoir from engine. Remove plugs. Connect return pipe. Secure return pipe to reservoir with clip.
- 120. Secure fog lamp breather hoses to clips on either side of radiator.
- 121. Connect heater hoses to engine coolant pipes. Secure with clips.
- 122. Connect coolant bleed hose to radiator. Secure with clip.
- 123. Connect bottom hose to radiator. Secure with clip.
- 124. Remove plugs from transmission oil cooler and pipes.
- 125. Lubricate pipes with transmission fluid, fit new 'O' rings. Connect to oil cooler. Tighten to **30 Nm (22 lbf.ft)**
- 126. Replenish transmission fluids. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
- 127. Fit engine oil cooler. **See this section.**
- 128. Fit cooling fan. **See COOLING SYSTEM, Repair.**
- 129. Evacuate and recharge air conditioning system. **See AIR CONDITIONING, Adjustment.**
- 130. Refill cooling system. **See COOLING SYSTEM, Repair.**
- 131. Refill engine oil. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
- 132. Connect multiplugs to fuel heater and turbo boost sensor.
- 133. Connect fuel return hose to FIP. Secure with clip.
- 134. Using new 'O' rings, connect fuel feed hose to fuel heater/filter head.
- 135. Route engine harness along valance. Secure clip.
- 136. Connect engine harness multiplug to main harness. Secure earth terminal to valance stud.
- 137. Connect engine harness multiplug to base of fuse box.
- 138. Position fuse box. Secure with bolts.
- 139. Position earth lead to shock absorber turret. Secure with bolt.
- 140. Fit battery tray. Secure with bolts.
- 141. Fit starter feed wire to battery positive terminal clamp. Secure with nut.
- 142. Position engine harness to battery tray. Secure harness grommets.
- 143. Secure harness clamp to battery tray with screws.

- 144. Fit ECM. *See FUEL SYSTEM, Repair.*
- 145. Fit inlet manifold. *See MANIFOLD AND EXHAUST SYSTEM, Repair.*
- 146. Refit battery. *See ELECTRICAL, Repair.*
- 147. With assistance, release bonnet stay clips. Engage bonnet struts.



**CAUTION:** Ensure bonnet stay clips are returned to their original positions as shown.



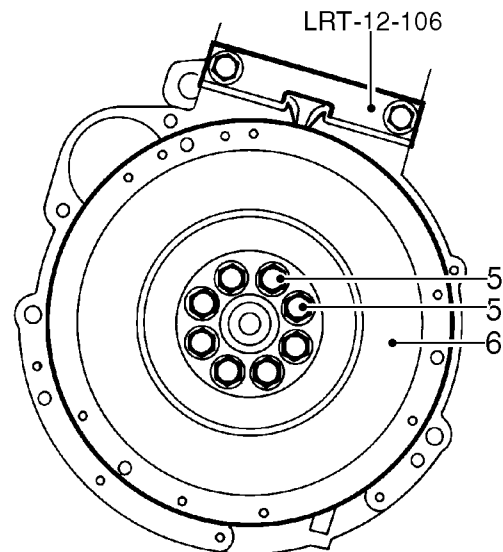
- 148. Start engine. Check for fuel, coolant and oil leaks.

## FLYWHEEL/DRIVE PLATE

Service repair no - 12.53.07

### Remove

1. Disconnect battery negative lead.
2. *Manual gearbox:* Remove clutch assembly. *See CLUTCH, Repair.*
3. *Automatic gearbox:* Remove gearbox. *See AUTOMATIC GEARBOX, Repair.*
4. Lock flywheel/drive plate using LRT-12-106.
5. Remove and discard 8 bolts securing flywheel/drive plate.
6. Remove flywheel/drive plate.



**NOTE:** Flywheel illustrated

### Inspection

7. Inspect flywheel clutch face/drive plate for cracks, scores or overheating.
8. Inspect ring gear for worn, chipped or broken teeth.
9. Replace defective parts as necessary.



## Refit

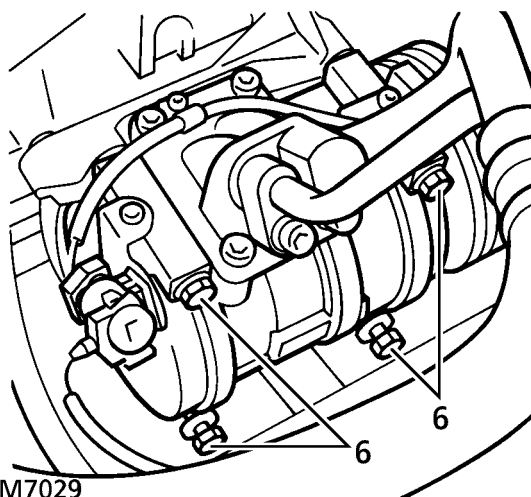
10. Ensure mating faces, dowel and dowel locations are clean.
11. Position flywheel/drive plate to crankshaft, locate dowel.
12. Secure flywheel/drive plate with new bolts. Tighten bolts to:  
Flywheel - **105 Nm (77 lbf.ft)**  
Drive plate - **120 Nm (88 lbf.ft)**
13. Manual gearbox: Fit clutch assembly. **See CLUTCH, Repair.**
14. Automatic gearbox: Fit gearbox. **See AUTOMATIC GEARBOX, Repair.**
15. Reconnect battery negative lead.

## FRONT COVER GASKET

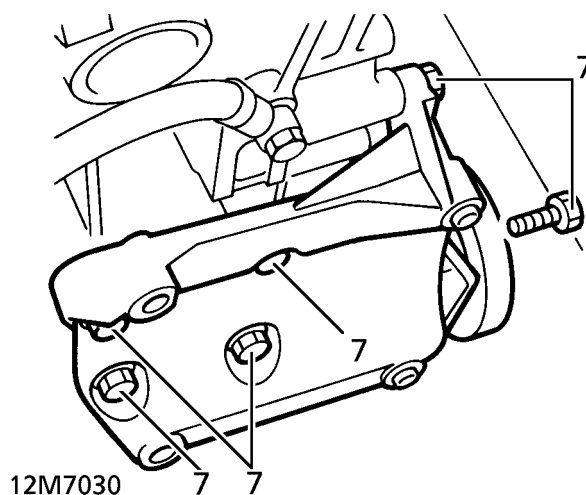
Service repair no - 12.65.04

### Remove

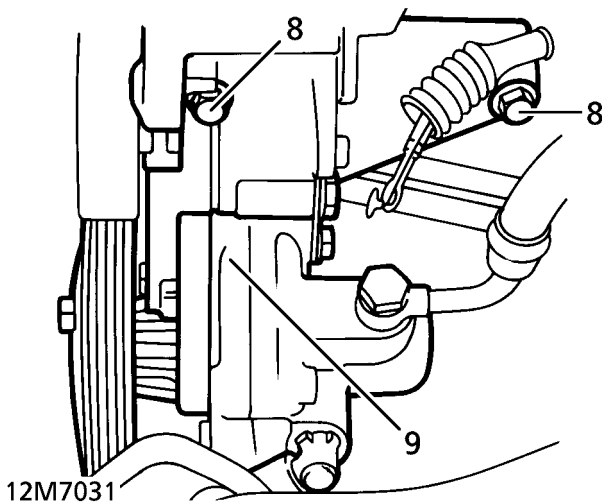
1. Disconnect battery negative lead.
2. Remove cylinder head gasket. **See this section.**
3. Remove sump. **See this section.**
4. Remove alternator. **See ELECTRICAL, Repair.**
5. Remove crankshaft pulley. **See this section.**



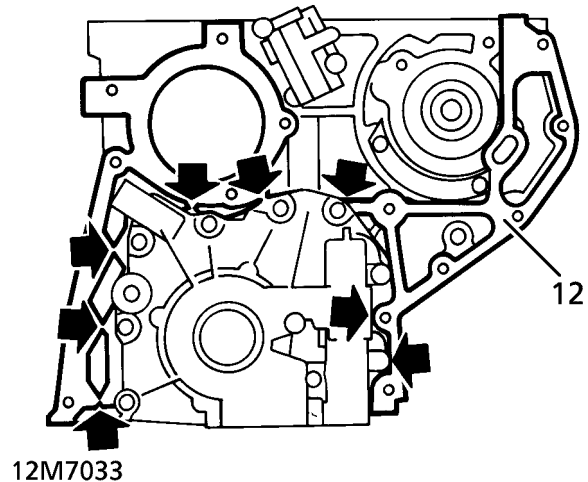
6. Remove 4 bolts securing air conditioning compressor to bracket. Tie compressor aside.



7. Remove 6 bolts securing compressor bracket to cylinder block and front cover. Remove compressor bracket.



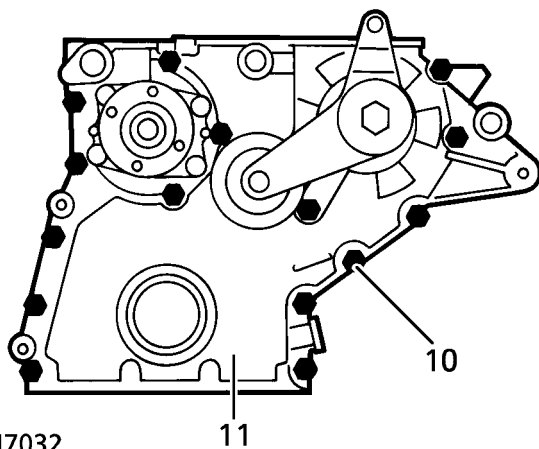
- 8. Remove 2 bolts securing power steering pump bracket to front cover and cylinder block.
- 9. Release bracket/pump assembly. Tie aside.



- 12. Remove and discard gasket.



**NOTE:** Front cover gasket is integral with oil pump gasket. When removing front cover only, separate gaskets by cutting at points shown.



- 10. Remove 15 bolts securing front cover to cylinder block.
- 11. Remove front cover from 2 cylinder block ring dowels.

### Refit

- 13. Ensure mating faces are clean.
- 14. Position new gasket on cylinder block.
- 15. Align front cover to cylinder block dowels. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
- 16. Position power steering pump on cylinder block dowel.
- 17. Secure steering pump bracket to front cover and cylinder block with bolts. Tighten to **22 Nm (16 lbf.ft)**
- 18. Position air conditioning compressor bracket to cylinder block. Secure with bolts.
- 19. Position compressor on mounting bracket ring dowels. Secure with bolts.
- 20. Fit crankshaft pulley. **See this section.**
- 21. Fit alternator. **See ELECTRICAL, Repair.**
- 22. Fit sump. **See this section.**
- 23. Fit cylinder head gasket. **See this section.**
- 24. Reconnect battery negative lead.

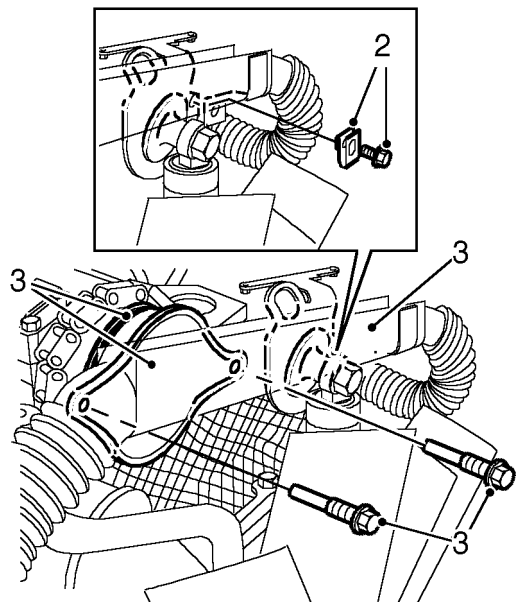


**CAMSHAFT**

Service repair no - 12.13.02

**Remove**

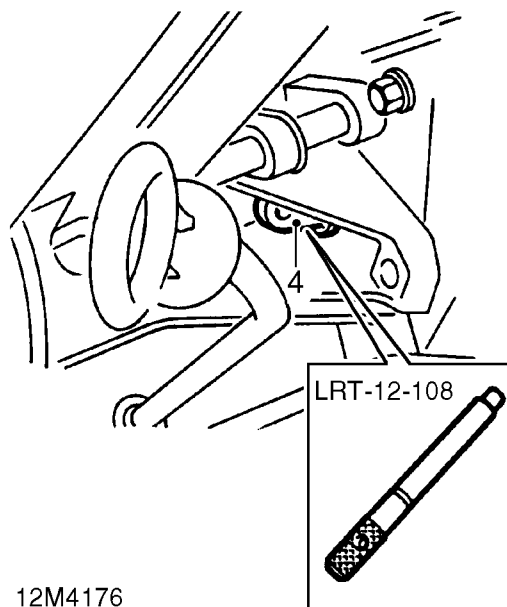
1. Remove camshaft cover. **See this section.**  
*Vehicles with EGR:* Remove EGR vacuum pump. **See EMISSION CONTROL, Repair.**



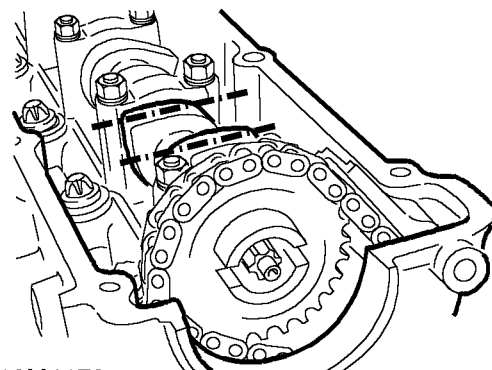
12M4175A

2. Remove bolt securing harness trunking, recover nut plate.
3. *Vehicles without EGR:* Remove 2 bolts securing camshaft front cover plate, remove cover plate; remove and discard 'O' ring. Lay harness trunking aside.

4. Remove plastic plug from flywheel/drive plate timing pin access hole.



12M4176

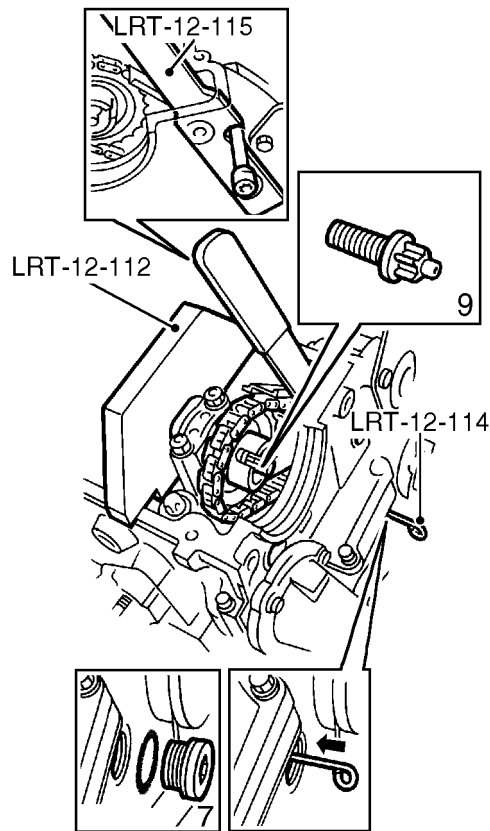


12M4179

5. Rotate crankshaft clockwise until No.1 piston is at top dead centre (TDC) on its compression stroke. Insert timing pin LRT-12-108 into hole in flywheel/drive plate.



**NOTE:** TDC No. 1 is indicated when camshaft lobes of No. 1 cylinder are positioned as shown.



12M4177

6. Fit camshaft holding tool LRT-12-112.
7. Remove timing chain tensioner access plug, remove and discard sealing washer.
8. Using tool LRT-12-115, retract timing chain tensioner and insert tensioner pin LRT-12-114 to retain tensioner plunger.



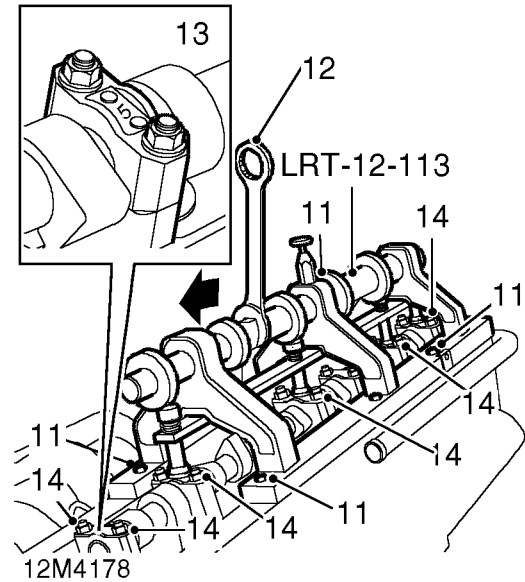
**CAUTION:** Ensure eye of tensioner pin LRT-12-114 is vertical not horizontal.

9. Remove bolt securing camshaft sprocket, remove sprocket.



**NOTE:** Do not discard bolt at this stage.

10. Remove camshaft holding tool LRT-12-112.



11. Locate tool LRT-12-113 on cylinder head, secure with tool with camshaft cover bolts.
12. Rotate shaft of tool LRT-12-113 to load camshaft bearing caps.
13. Ensure camshaft bearing caps are suitably identified to their fitted positions.



**NOTE:** Caps should be numbered from 1 to 7 and are read from the front of the engine.

14. Remove nuts securing camshaft bearing caps.
15. Rotate shaft of tool LRT-12-113 until loading is removed from camshaft bearing caps, remove tool.
16. Remove camshaft bearing caps.
17. Remove camshaft.

### Inspection

18. Clean camshaft, bearing caps and journals in cylinder head.
19. Check cam lobes for signs of wear, pitting or scoring.
20. Check journals on camshaft, bearing caps and cylinder head for signs of wear, overheating and scoring.
21. Lubricate cam followers, camshaft bearing caps and journals with engine oil.
22. Clean sealant from threads of front cover plate bolt and bolt hole.



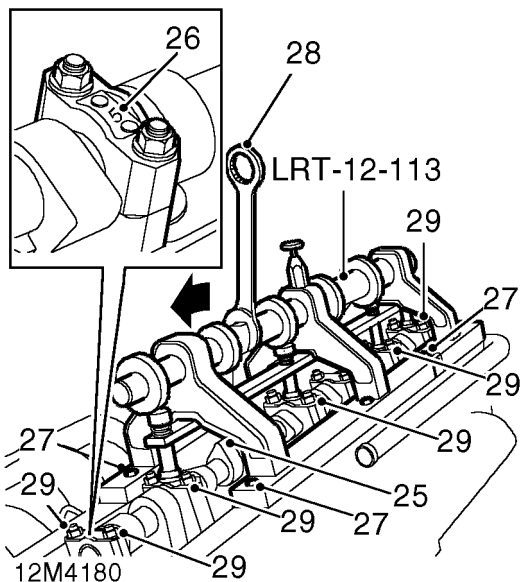
**CAUTION:** Do not use a tap.





**Refit**

- 23. Remove timing pin LRT-12-108 from flywheel/drive plate.
- 24. Rotate crankshaft **anti-clockwise** approximately 30° .



- 25. Fit camshaft with lobes of No.1 cylinder facing upwards.
- 26. Fit camshaft bearing caps ensuring No.1 cap is at front of engine and cap identification marks are on exhaust manifold side.
- 27. Locate tool LRT-12-113 on cylinder head, secure tool with camshaft cover bolts.
- 28. Rotate shaft of tool LRT-12-113 to load camshaft bearing caps.
- 29. Fit camshaft bearing cap nuts and tighten to:  
 M6 - **10 Nm (7 lbf.ft)**  
 M7 - **15 Nm (11 lbf/ft)**  
 M8 - **20 Nm (15 lbf/ft)**
- 30. Rotate shaft of tool LRT-12-113 until loading is removed from camshaft bearing caps, remove tool.



**CAUTION:** The tappets expand when camshaft is removed. To avoid pistons contacting valves, observe the following

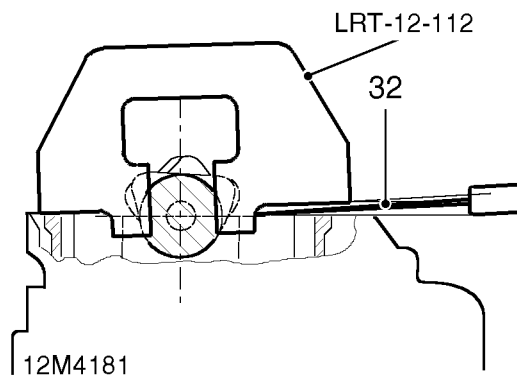
wait times before rotating pistons back to top dead centre (TDC).

- Above 20° C - 4 minutes
- 10° C to 20° C - 11 minutes
- 0° C to 10° C - 30 minutes
- Below 0° C - 75 minutes

- 31. Rotate crankshaft clockwise until No.1 piston is at top dead centre (TDC) and timing pin LRT-12-108 can be inserted in flywheel/drive plate; fit camshaft holding tool LRT-12-112.



**NOTE:** If camshaft is not positioned correctly, rotate camshaft using spanner on cast hexagon until tool can be fitted.



- 32. *Engines with recorded mileage in excess of 20,000 km (12,500 miles):* Insert a 4.61 mm (0.18 in) thickness of feeler gauges between camshaft holding tool LRT-12-112 and inlet manifold side of cylinder head.
- 33. *All engines:* Fit camshaft sprocket.
- 34. Fit new camshaft sprocket bolt and tighten to:  
 Stage 1 - **20 Nm (15 lbf.ft)**  
 Stage 2 - Further 35°



**NOTE:** Use angular torque wrench.

- 35. Using tool LRT-12-115, retract timing chain tensioner rail slightly and remove tensioner pin LRT-12-114.
- 36. Fit new sealing washer to timing chain tensioner access plug, fit plug and tighten to **20 Nm (15 lbf.ft)** .
- 37. Remove timing pin LRT-12-108 from flywheel/drive plate.
- 38. Fit plastic plug in timing pin access hole.

39. Apply STC 3373 sealant to camshaft front cover plate dowel bolt.
40. Lubricate new 'O' ring with engine oil.
41. Position harness trunking.
42. *Vehicles without EGR*: Fit 'O' ring and camshaft front cover plate, fit bolts and tighten to **22 Nm (16 lbf.ft)**.



**CAUTION:** Ensure dowel bolt passes through timing chain guide rail.

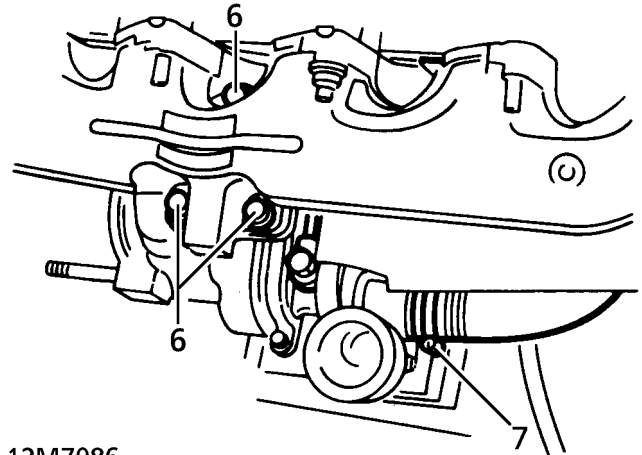
43. Position nut plate to bracket, fit and tighten harness trunking bolt.
44. Fit camshaft cover. **See this section.**
45. *Vehicles with EGR*: Fit EGR vacuum pump. **See EMISSION CONTROL, Repair.**

## CYLINDER HEAD GASKET

Service repair no - 12.29.02

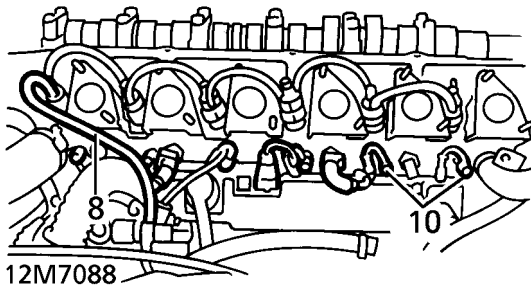
### Remove

1. Disconnect battery negative lead.
2. Remove fan cowl. **See COOLING SYSTEM, Repair.**
3. Remove high pressure fuel pipe assembly. **See FUEL SYSTEM, Repair.**
4. Remove camshaft cover. **See this section.**
5. *Vehicles with EGR*: Remove EGR vacuum pump. **See EMISSION CONTROL, Repair.**
6. Remove exhaust manifold heat shield. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
7. Remove 3 bolts securing turbocharger to exhaust manifold. Collect gasket and discard.



12M7086

8. Remove turbocharger intake hose. Plug turbocharger intake.

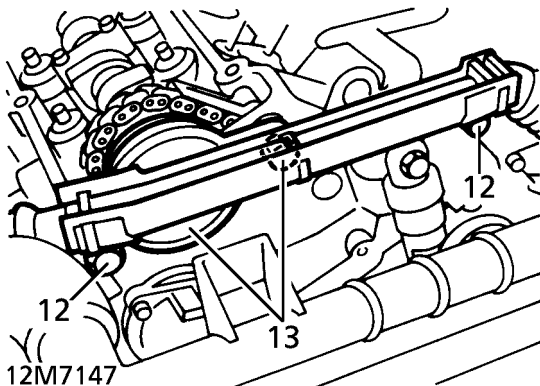


12M7088

- 9. Disconnect leak-off pipe from No. 1 injector. Plug injector and pipe.
- 10. Disconnect engine coolant temperature sensor (ECT) Sensor and temperature gauge sensor.
- 11. Disconnect leads from 6 glowplugs.
- 12. Disconnect No. 4 injector needle lift sensor.

**Vehicles without EGR**

- 13. Remove 2 bolts securing harness trunking to cylinder head. Tie trunking aside.



12M7147

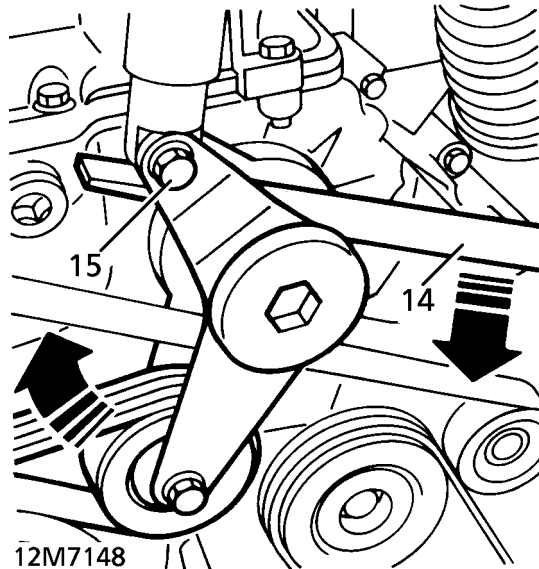
- 14. Remove remaining bolt securing camshaft end cover. Remove cover. Discard 'O' ring.



**NOTE:** LH cover bolt also serves as retaining pin for timing chain guide rail.

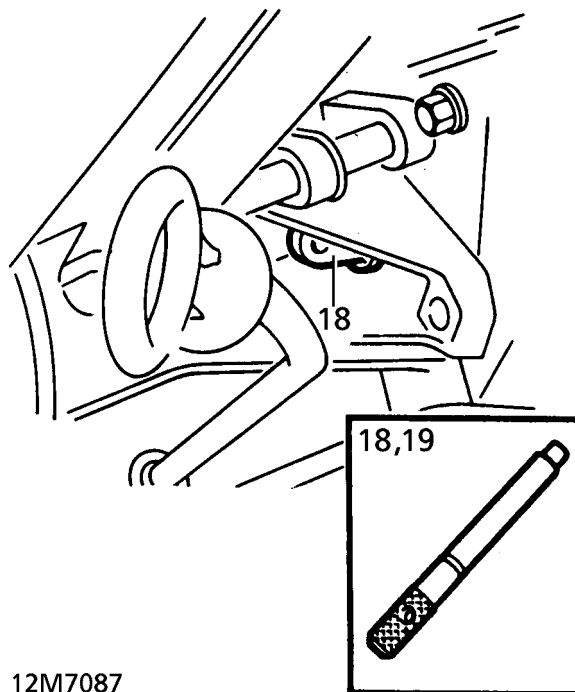
**All vehicles**

- 15. Release alternator belt tension using a suitable lever beneath tensioner damper as shown. Release drive belt from alternator pulley.




12M7148

- 16. Remove bolt securing damper to drive belt tensioner.
- 17. Release hoses from thermostat housing and cylinder head.
- 18. Disconnect heater hose from cylinder head.
- 19. Remove plastic plug from flywheel timing pin access hole. Insert timing pin LRT-12-108.

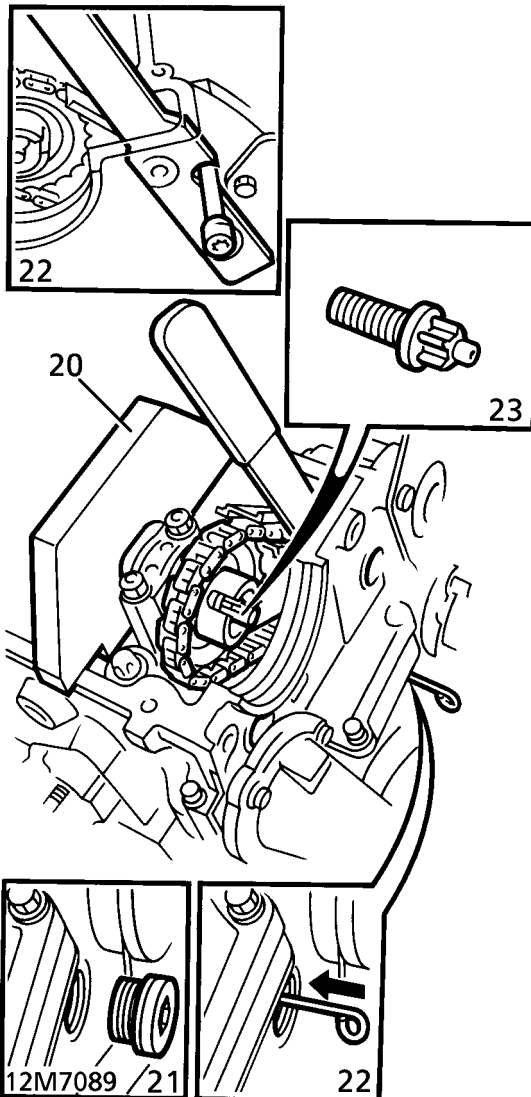


12M7087

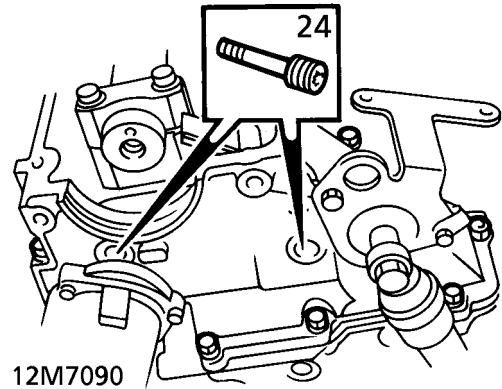
20. Turn crankshaft clockwise until No. 1 piston is at Top Dead Centre (TDC) on its compression stroke. Locate timing pin into flywheel.

 **NOTE: TDC No. 1 indicated by camshaft lobes of No. 1 cylinder pointing upwards.**


21. Fit camshaft holding tool LRT-12-112.
22. Remove timing chain tensioner access plug. Collect sealing washer and discard.
23. Using tool LRT-12-115, lever timing chain tensioner rail to slack position. Insert tool LRT-12-114 to retain tensioner plunger.



24. Remove bolt securing camshaft sprocket. Remove sprocket.

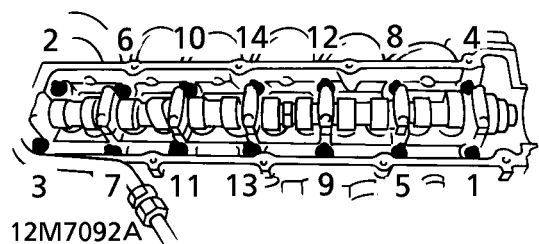


25. Remove timing chain tensioner and guide rail pins. Remove 'O' rings and discard.
26. Remove timing chain tensioner rail.
27. Remove 5 bolts and 1 nut securing cylinder head to timing cover.
28. Remove camshaft holding tool.

 **CAUTION: Do not rotate camshaft.**

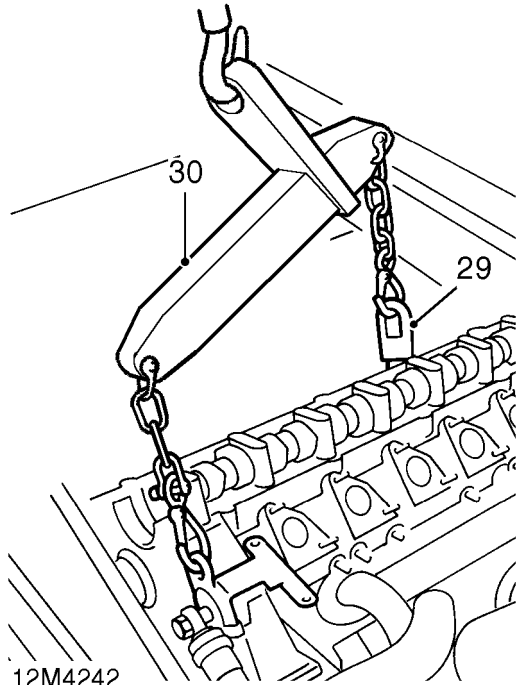
29. Using sequence shown, progressively slacken and remove 14 cylinder head bolts. Discard bolts.

 **NOTE: LH rear bolt cannot be removed due to proximity of bulkhead.**

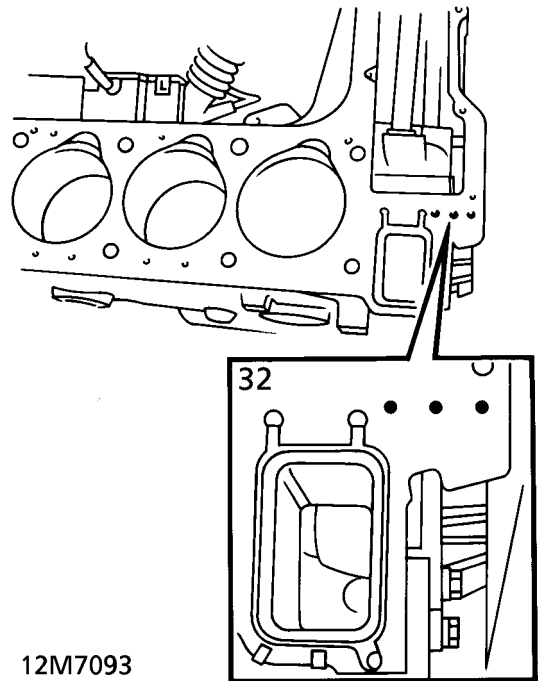




30. Attach suitable lifting eye to upper rear inlet manifold stud.



32. Remove cylinder head gasket.  
33. Check number of thickness identification holes before discarding gasket.



31. Attach hoist to lifting eyes. Remove cylinder head, remove and discard LH rear cylinder head bolt.



**NOTE:** 2 ring dowels locate cylinder head to block.



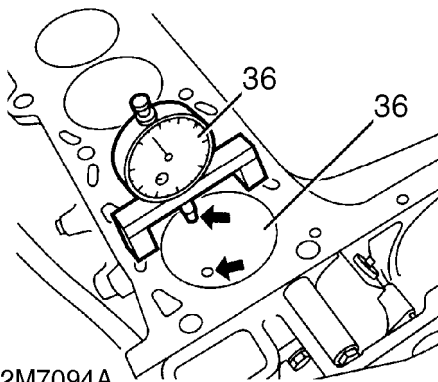
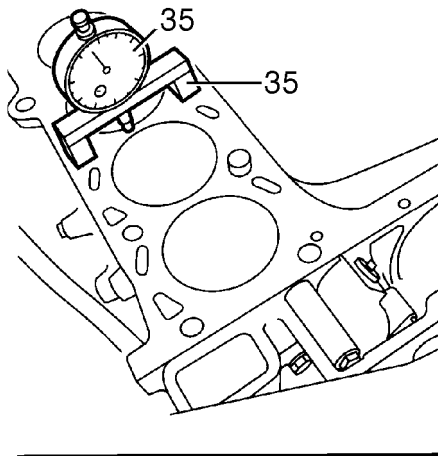
**CAUTION:** To avoid damaging timing chain guide, ensure cylinder head is lifted as squarely as possible.



**CAUTION:** Check cylinder head for warping, see Cylinder head warp check. If crankshaft, pistons or connecting rods have been renewed, new cylinder head gasket thickness must be determined using the following Piston Protrusion Check procedure. If above items have not been disturbed, continue at Refit using gasket with same thickness identification as original.

## Piston Protrusion - Check

34. Ensure cylinder block face and piston crowns are clean.
35. Position a dial gauge with suitable base to cylinder block.



12M7094A

36. Preload and zero gauge on cylinder block face.
37. Move gauge onto piston crown. Measure protrusion of No. 1 piston in two positions as shown. Take average of readings. Record results.
38. Repeat protrusion check on piston No. 6.
39. Remove timing pin LRT-12-108 from flywheel.
40. Record protrusion of remaining pistons. Ensure that readings are taken at **exactly** TDC.



**NOTE: Top Dead Centre must be located using dial gauge.**

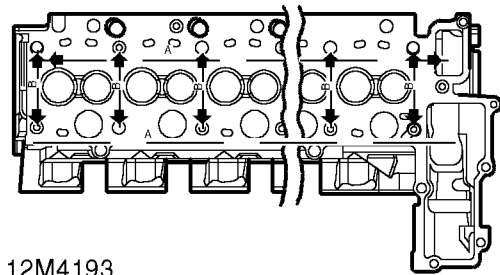
41. Calculate average piston protrusion to determine required gasket thickness:  
Up to 0.76 mm = 2 identification holes  
Over 0.76 mm = 3 identification holes



**NOTE: If any piston protrudes more than 0.81 mm, a gasket with 3 identification holes must be fitted.**

## Cylinder head warp - check

42. Remove all traces of carbon and gasket material from cylinder head.



12M4193

43. Using a straight edge and feeler gauges, check cylinder head for distortion along lines shown in illustration and compare with figures given:  
Longitudinal warp **A** = 0.1 mm (0.004 in)  
Lateral warp **B** = 0.05 mm (0.002 in)
44. Replace cylinder head if figures obtained exceed those given.



**NOTE: Cylinder heads may not be refaced.**



## Refit



**CAUTION:** If crankshaft timing pin LRT-12-108 has been removed, ensure that FIP is on correct stroke, with dimple on FIP sprocket visible, before refitting pin.

45. Ensure all mating faces are clean.
46. Check cylinder block ring dowels for condition and correct location.
47. Apply 1.5mm bead of Unipart sealant STC 3373 to joint lines of cylinder block and timing cover.
48. Fit cylinder head gasket of correct thickness.
49. Fit tool LRT-12-112 to ensure camshaft is in correct position. If necessary, turn camshaft using spanner on cast hexagon.



**CAUTION:** Do not turn camshaft if cylinder head is fitted to cylinder block.

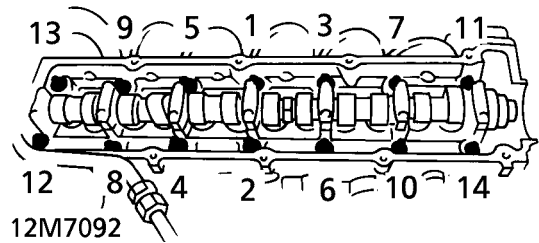


**NOTE:** Fit a lightly oiled, new cylinder head bolt in LH rear location.

50. Position cylinder head on cylinder block. Ensure timing chain guide is not fouled and rear LH bolt enters bolt hole in cylinder block. Locate cylinder head on ring dowels.
51. Disconnect lifting chains. Remove lifting eye.
52. Lightly lubricate new cylinder head bolts. Fit bolts. Tighten, in sequence shown, in the following stages.
  - Stage 1 = 80 Nm (59 lbf.ft)
  - Stage 2 = Loosen by 180°
  - Stage 3 = 50 Nm (37 lbf.ft)
  - Stage 4 = Tighten 90°
  - Stage 5 = Tighten 90°
  - Stage 6 = Run engine for 25 minutes
  - Stage 7 = Stop engine, allow to cool
  - Stage 8 = Tighten 90°



**NOTE:** Tighten using angular torque wrench.



53. Secure cylinder head to timing cover with bolts and nut.
  - M7 - **15 Nm (11 lbf.ft)**
  - M8 - **20 Nm (15 lbf.ft)**
54. Fit camshaft timing chain tensioner rail.
55. Using new 'O' rings, fit tensioner and guide rail pins.
56. Engage timing chain with camshaft sprocket. Position sprocket on camshaft.
57. Fit NEW camshaft sprocket bolt.



**NOTE: Important; if engine has covered more than 20,000 km (12,500 miles), insert a feeler gauge of 4.61 mm (0.18 in) thickness between cylinder head face and inlet manifold side of LRT-12-112 prior to tightening bolt.**

58. With LRT-12-112 fitted to camshaft, tighten camshaft sprocket bolt to **20 Nm (15 lbf.ft)**.
59. Using a suitable torque angle gauge, further tighten bolt by 35°.
60. Remove LRT-12-112.
61. Using tool LRT-12-115, lever tensioner rail to slack position. Remove LRT-12-114 from tensioner plunger.
62. Using a new sealing washer, refit access plug.

63. Remove LRT-12-108 from flywheel. Fit plastic plug.
64. Connect cooling hoses. Secure with clips.
65. Align damper to tensioner. Secure with bolt.
66. Lever tensioner to slack position. Engage drive belt over alternator pulley.

### Vehicles without EGR

67. Using a new 'O' ring, fit camshaft end cover.



**NOTE: Apply Loctite 577 sealant to threads of LH camshaft end cover bolt.**

68. Align harness trunking to cylinder head. Secure camshaft end cover and harness trunking with bolts.

### All Vehicles

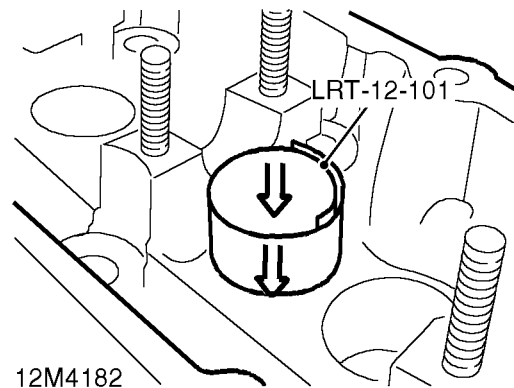
69. Connect No. 4 injector needle lift sensor.
70. Connect leads to glowplugs.
71. Connect ECT sensor and temperature gauge sensor.
72. Remove plugs. Connect leak-off pipe to No. 1 injector.
73. Remove plug, fit intake hose to turbocharger. Secure with clip.
74. Position new gasket on exhaust manifold. Fit turbocharger.
75. Secure with bolts. **45 Nm (33 lbf.ft)**
76. Fit exhaust manifold heat shield. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
77. Fit camshaft cover. **See this section.**
78. *Vehicles with EGR:* Fit EGR vacuum pump. **See EMISSION CONTROL, Repair.**
79. Fit high pressure fuel pipes. **See FUEL SYSTEM, Repair.**
80. Fit fan cowl. **See COOLING SYSTEM, Repair.**
81. Reconnect battery negative lead.

## VALVES AND TAPPETS

Service repair no - 12.29.59

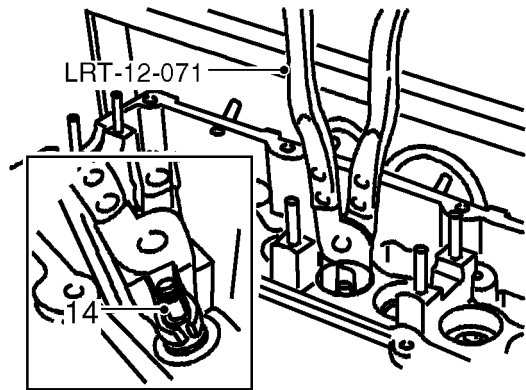
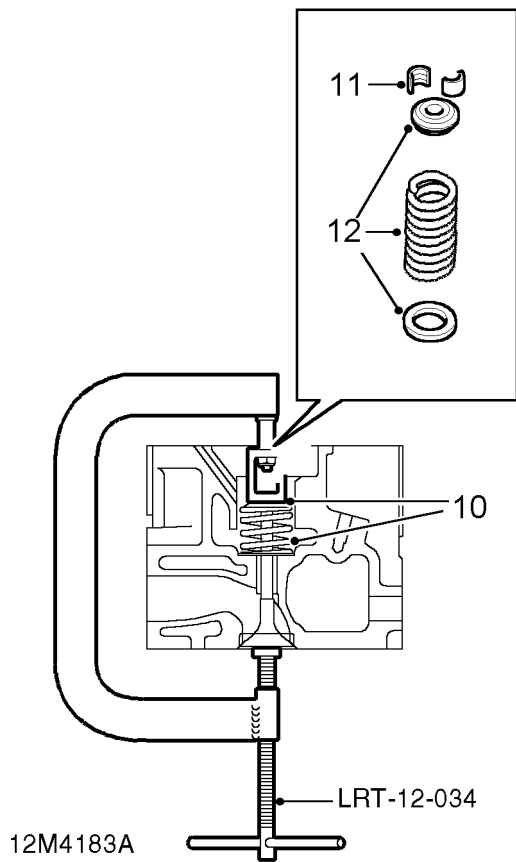
### Remove

1. Remove camshaft. **See this section.**
2. Remove inlet manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
3. Remove exhaust manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
4. Remove injectors. **See FUEL SYSTEM, Repair.**
5. Remove glow plugs. **See FUEL SYSTEM, Repair.**
6. Remove cylinder head. **See this section.**
7. Remove tappets and store in their fitted order.



8. Insert protective sleeve LRT-12-101 in tappet bore.





12M4184

9. Position tool LRT-12-034 on valve.
10. Compress valve spring.
11. Remove 2 collets using a stick magnet.
12. Release tool LRT-12-034, collect valve spring cup, valve spring and spring seat, discard valve spring.

13. Remove valve stem oil seal using LRT-12-071, discard seal.
14. Remove valve.



**CAUTION: Store valve components in their fitted order.**

15. Repeat above procedures for remaining valves.
16. Clean all components.

## Inspection

### Valves

17. Remove carbon from valves, valve guides and seats.
18. Check valves for signs of burning, cracking and pitting of valve seats.
19. Check head diameter of each valve:  
Inlet = 36.0 mm (1.42 in)  
Exhaust = 31.0 mm (1.22 in)
20. Check stem diameter of each valve, half-way along stem and compare diameters with dimensions given to determine stem sizes of valves fitted and valve stem wear.

#### Standard:

- Inlet = 6.97 mm (0.274 in)  
Service limit = 6.95 mm (0.273 in)  
Exhaust = 6.95 mm (0.273 in)  
Service limit = 6.93 mm (0.272 in)

#### 1st oversize:

- Inlet = 7.07 mm (0.28 in)  
Service limit = 7.05 mm (0.277 in)  
Exhaust = 7.06 mm (0.278 in)  
Service limit = 7.04 mm (0.27 in)

#### 2nd oversize:

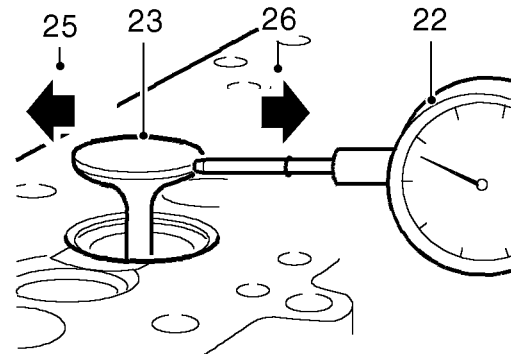
- Inlet = 7.17 mm (0.282 in)  
Service limit = 7.15 mm (0.28 in)  
Exhaust = 7.16 mm (0.281 in)  
Service limit = 7.14 mm (0.279 in)

21. If valve stems are worn in excess of service limits, valves with next oversize stems must be fitted and valve guides reamed to correct size.

### Valve guides



**CAUTION:** Prior to checking/reaming valve guides, check cylinder head for warping. See *Cylinder head gasket*.

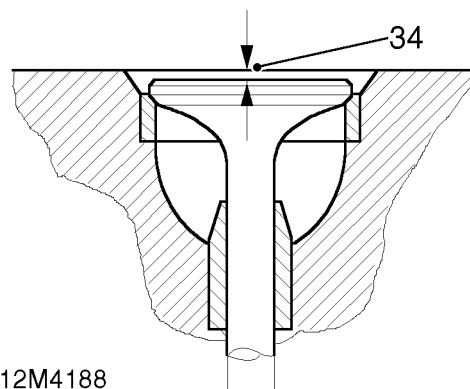
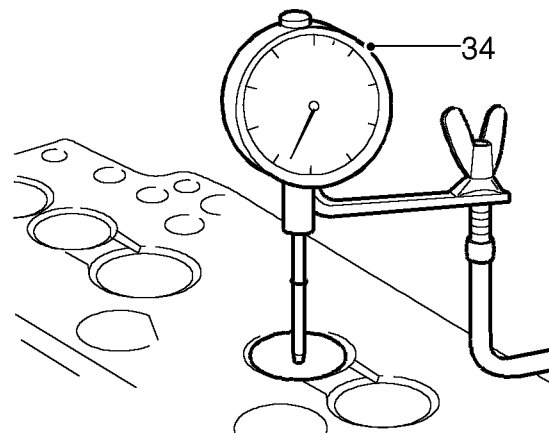
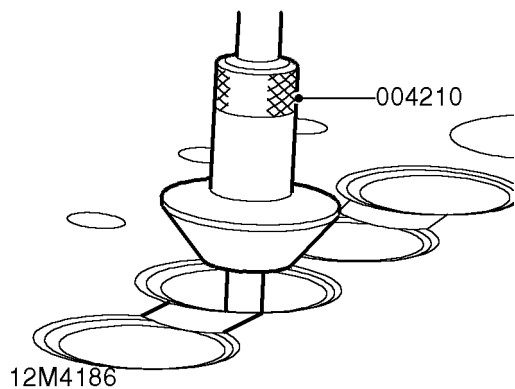


12M4185

22. Position a suitable DTI to cylinder head adjacent to No.1 valve seat.
23. Insert a new valve with same stem diameter as the original in the valve guide.
24. Position end of valve stem flush with spring end of guide.
25. Move valve away from DTI, pre-load gauge and note pre-load reading.
26. Move valve towards DTI, note gauge reading and subtract pre-load from this figure. Compare final figure obtained with tilt figure:  
Valve tilt - inlet and exhaust = 0.5 mm (0.02 in).
27. If tilt figure exceeds above dimension, original valve must be replaced with next oversize valve and valve guide reamed to next oversize.  
Valve guide inside diameter - inlet and exhaust:  
Standard = 7.0 mm (0.275 in)  
For 1st oversize valve stem = 7.1 mm (0.28 in)  
For 2nd oversize valve stem = 7.2 mm (0.283 in)



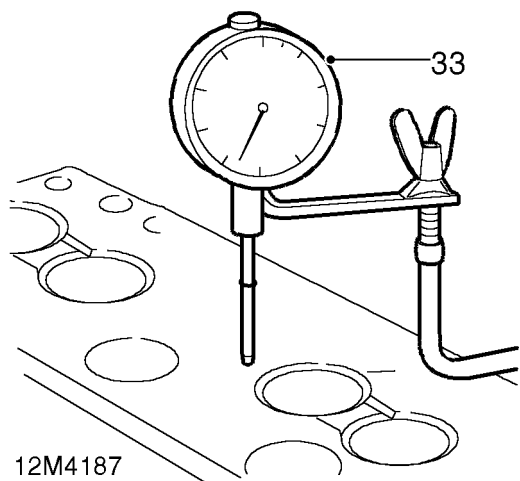
**NOTE:** Valve guides may not be replaced.



- 28. Dry ream valve guides using BMW tool 004210 and appropriate size reamer from those supplied with tool.
- 29. Ream valve guide from combustion chamber side, rotate tool once only in a downwards direction; remove all traces of swarf on completion.

**Check valve head stand-down**

- 30. *Original valves:* Lap valves to their seats, remove all traces of grinding paste on completion.
- 31. *Replacement valves:* Do not lap valves to their seats.
- 32. Insert No.1 valve into its guide.



- 34. Position DTI to centre of valve, measure valve head stand-down and compare with figures given:  
 Inlet = 0.65 to 0.85 mm (0.02 to 0.03 in)  
 Exhaust = 0.85 to 1.05 mm (0.03 to 0.04 in)
- 35. Replace any valve having stand-down in excess of figures given with a valve having an increased head thickness.
- 36. Refer to the following to determine thickness of valve head required ensuring that valves with correct size stem diameter are obtained.



**NOTE:** It will be necessary to re-cut valve seats when fitting valves with increased head thickness.

**Standard valve stem diameter:**

Head thickness increase - 0.25 mm (0.01 in)  
 Identification marks - RO

- 33. Position suitable DTI to cylinder head, pre-load then zero gauge.

### 1st oversize valve stem:

Head thickness increase - 0.25 mm (0.01 in)

Identification marks - R1

Head thickness increase - 0.50 mm (0.02 in)

Identification marks - R2

### 2nd oversize stem:

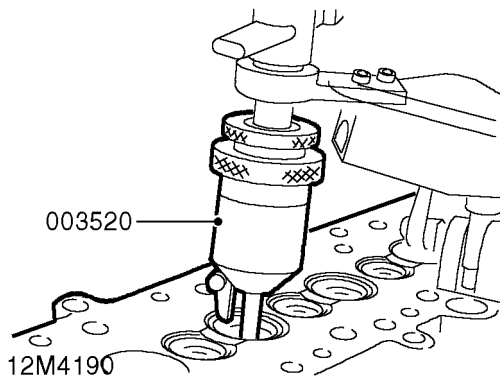
Head thickness increase - 0.50 mm (0.02 in)

Identification marks - R3



**NOTE:** Identification marks will be found adjacent to cotter grooves.

### Valve seat - recut

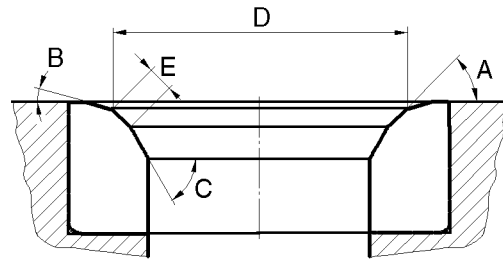


### 37. Recut valve seats using BMW tool 003520.

Head thickness:

0.25 mm (0.01 in) - Increase depth by 0.25 mm (0.01 in)

0.50 mm (0.02 in) - Increase depth by 0.50 mm (0.02 in)



12M4191

### 38. Use BMW tool 003580 to obtain specified valve seat dimensions:

Valve seat angle **A** =  $45^\circ \pm 10'$

Correction angle - outside **B** =  $15^\circ$

Correction angle - inside **C** =  $60^\circ$

Seat face outside diameter **D**:

Inlet valve = 35.5 mm (1.4 in)

Exhaust valve = 30.6 mm (1.2 in)

Valve seat width **E**:

Inlet valve = 1.75 to 2.25 mm (0.07 to 0.09 in)

Exhaust valve = 2.60 to 2.90 mm (0.10 to 0.11 in)

### 39. Remove all traces of swarf on completion.

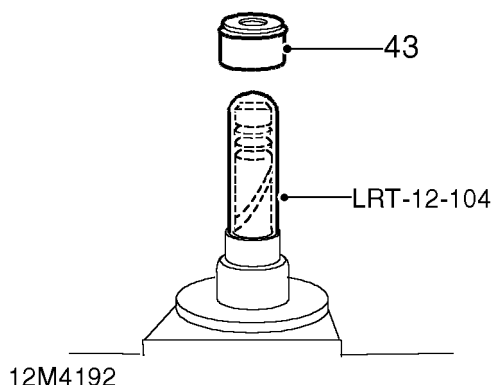


**CAUTION:** Do not lap replacement valves to their seats.

### Refit

### 40. Lubricate all components including valve guides and new valve stem oil seals with engine oil.

### 41. Insert protective sleeve LRT-12-101 in tappet bore.



- 42. Fit protection sleeve LRT-12-104 on valve stem.
- 43. Fit new valve stem oil seal.



**NOTE: Inlet valve stem oil seals are coloured RED whilst exhaust valve stem oil seals are coloured GREEN.**

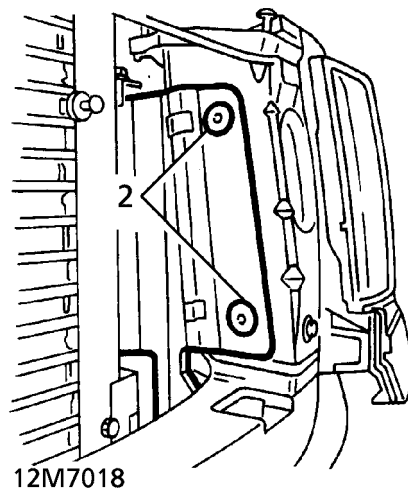
- 44. Press valve stem oil seal into position using tool LRT-12-071, remove protection sleeve LRT-12-104.
- 45. Fit valve spring seat, new valve spring and spring cup.
- 46. Compress valve spring using tool LRT-12-034, fit 2 collets.
- 47. Remove protection sleeve LRT-12-101.
- 48. Repeat procedures for remaining valves.
- 49. Lubricate tappet bores and tappets with engine oil, fit tappets to their original locations.
- 50. Fit cylinder head. **See this section.**
- 51. Fit exhaust manifolds. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
- 52. Fit glow plugs. **See FUEL SYSTEM, Repair.**
- 53. Fit injectors. **See FUEL SYSTEM, Repair.**
- 54. Fit inlet manifolds. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
- 55. Fit camshaft. **See this section.**

**OIL COOLER**

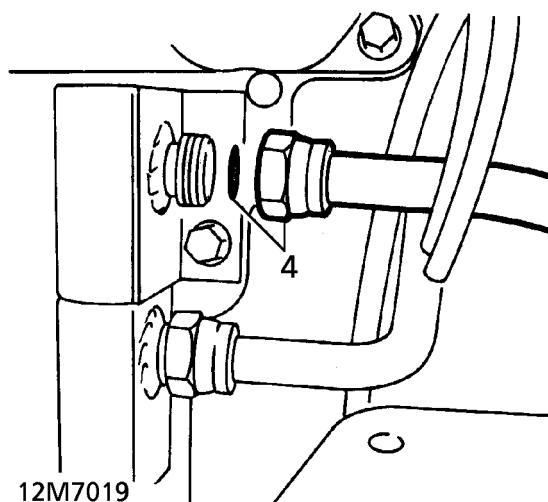
Service repair no - 12.60.68

**Remove**

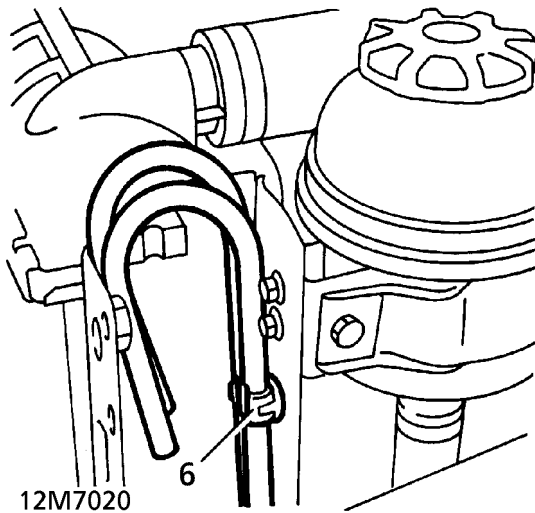
- 1. Remove intercooler. **See FUEL SYSTEM, Repair.**
- 2. Remove 2 trim fixing studs securing LH deflector panel. Remove panel.



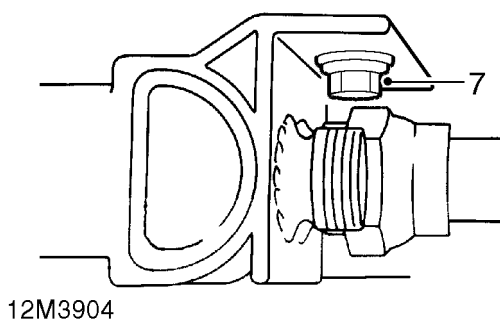
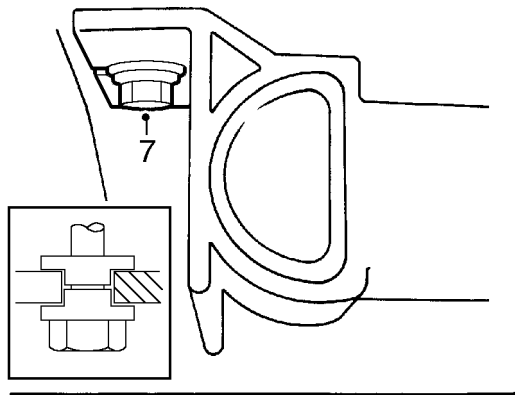
- 3. Position container to catch oil spillage.
- 4. Disconnect oil cooler upper hose. Remove 'O' ring and discard.



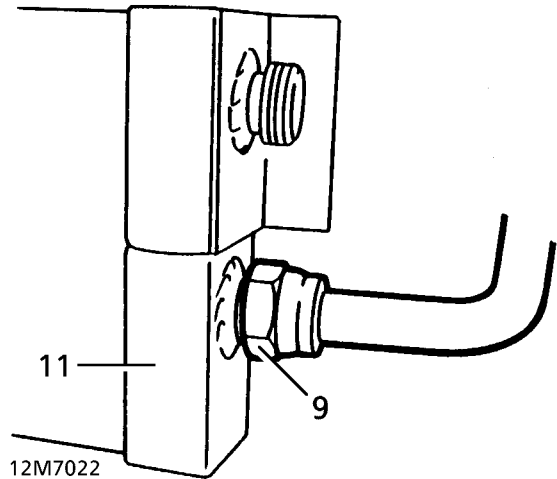
- 5. Plug hose and cooler.
- 6. Release left hand fog lamp breather tubes from radiator bracket clips.



7. Remove 2 bolts securing oil cooler to radiator bracket.



8. Raise oil cooler for access.
9. Disconnect lower hose. Remove 'O' ring and discard.



10. Plug hose and cooler.
11. Remove oil cooler.

### Refit

12. Position oil cooler. Remove plugs.
13. Using new 'O' ring, connect lower hose to oil cooler. Tighten to **30 Nm (22 lbf.ft)**.
14. Lower cooler to radiator bracket.
15. Apply Loctite 270 Stud Lock to threads of RH fixing.
16. Assemble spacers to fixing and secure fixing to radiator bracket, finger tight.
17. Engage slot in RH side of cooler to spacers.
18. RH fixing Tighten to **5 Nm (4 lbf.ft)**.  
LH fixing Tighten to **25 Nm (19 lbf.ft)**.
19. Using new 'O' ring, connect upper pipe to oil cooler. Tighten to **30 Nm (22 lbf.ft)**
20. Remove container.
21. Secure fog lamp breather tubes to radiator bracket clips.
22. Fit deflector panel. Secure with studs.
23. Fit intercooler. **See FUEL SYSTEM, Repair.**
24. Check engine oil level. Top-up if necessary.



**CAUTION:** The RH side of the oil cooler has a sliding mount which allows the cooler to expand and contact with changes in temperature. Incorrect tightening torque of the RH fixing will lead to cooler damage.

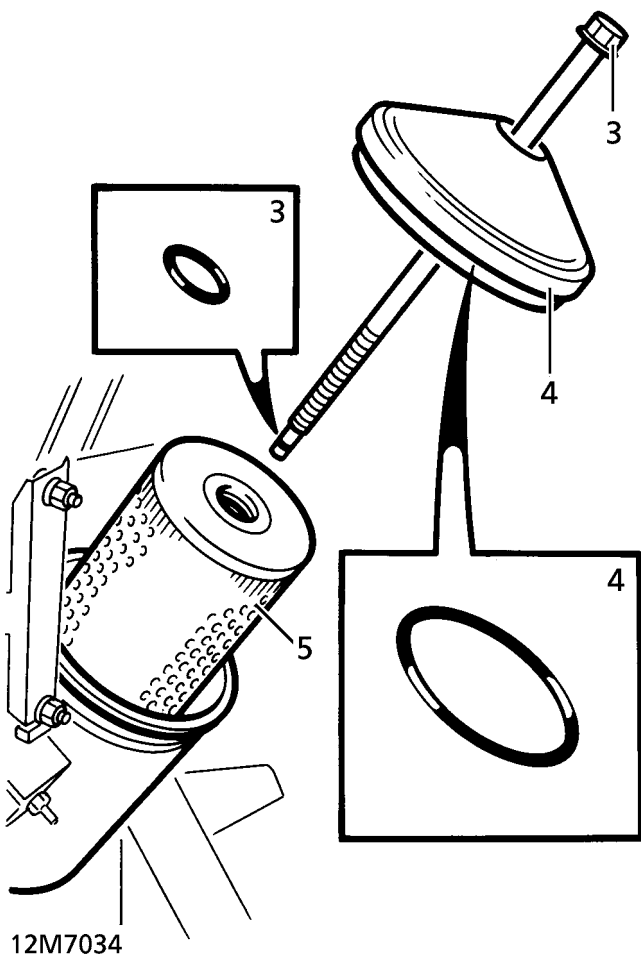


## OIL FILTER - UP TO 1998MY

Service repair no - 12.60.02

### Remove

1. Drain engine oil. **See SECTION 10, Maintenance.**
2. Position cloth beneath oil filter casing to catch spillage.
3. Remove bolt securing cover to filter casing. Collect 'O' ring and discard.
4. Remove cap. Collect 'O' ring and discard.
5. Remove filter element and discard.



**NOTE:** Oil in filter casing will run back into sump once cover is removed.

### Refit

6. Clean filter casing and cap.
7. Fit filter element.
8. Using new 'O' rings, position cap. Secure with bolt. Tighten to **33 Nm (24 lbf.ft)**
9. Replenish engine oil. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
10. Start engine. Run at 2500 rev/min until oil pressure warning light extinguishes.



**NOTE:** Oil pressure warning light will extinguish after approximately 5 seconds.

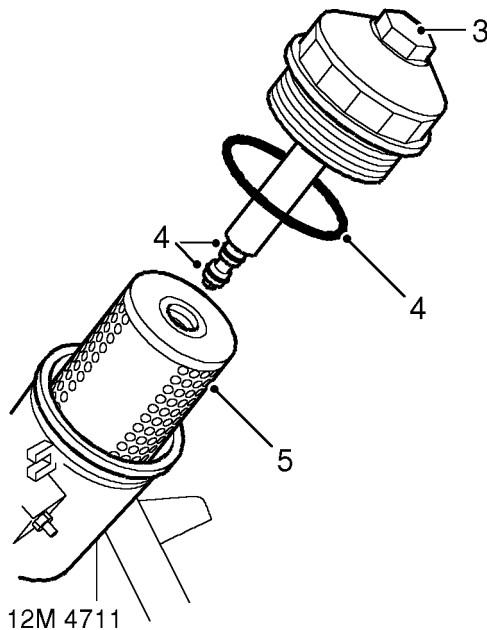
11. Stop engine. Recheck oil level.

## OIL FILTER 1998MY ONWARDS

Service repair no - 12.60.02

### Remove

1. Drain engine oil. **See SECTION 10, Maintenance.**
2. Position cloth beneath oil filter casing to catch spillage.
3. Using a socket wrench, carefully loosen cap and allow oil to drain back into sump.
4. Remove cap and collect 3 'O' ring seals. Discard seals.
5. Remove filter element and discard.



### Refit

6. Clean filter casing and cap.
7. Fit filter element.
8. Lubricate new 'O' ring seals using engine oil.
9. Fit cap and tighten to **25 Nm (18 lbf.ft)**
10. Replenish engine oil. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
11. Start engine. Run at 2500 rev/min until oil pressure warning light extinguishes.



**NOTE: Oil pressure warning light will extinguish after approximately 5 seconds.**

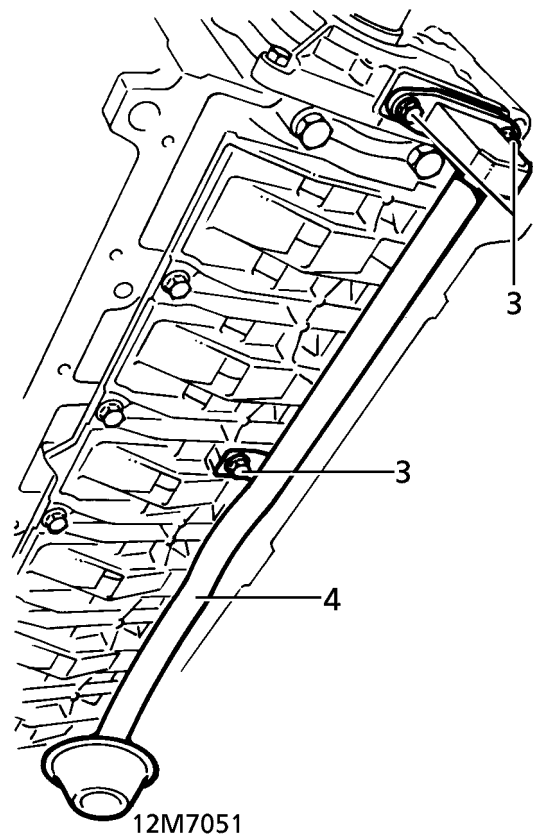
12. Stop engine. Recheck oil level.

## OIL PUMP

Service repair no - 12.60.26

### Remove

1. Remove timing chains and sprockets. **See this section.**
2. Remove sump. **See this section.**
3. Remove 3 bolts securing oil pick-up strainer to oil pump and deflector plate.

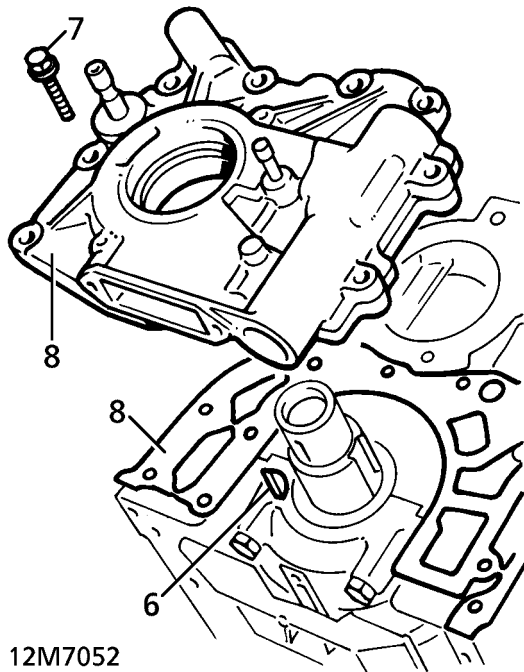


4. Remove pick-up strainer. Collect gasket.





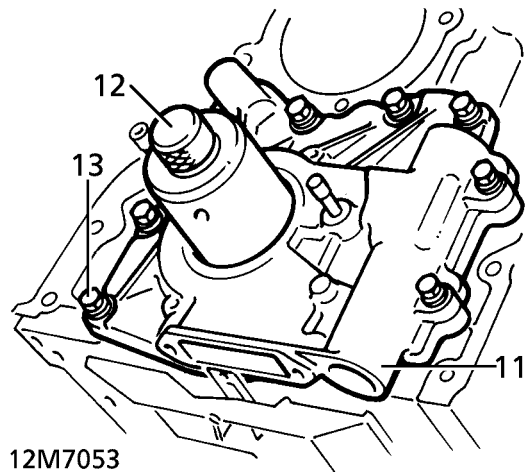
5. Remove lower chain guide.
6. Remove Woodruff key from crankshaft.



7. Remove 8 bolts securing oil pump to cylinder block.
8. Remove pump. Collect gasket.

### Refit

9. Ensure mating faces are clean.
10. Position new oil pump/front cover gasket to cylinder block.
11. Refit oil pump. Fit bolts, finger tight.
12. Fit tool LRT-12-116 over crankshaft. Tighten centre screw by hand to centralise oil pump.



13. Tighten oil pump bolts to **22 Nm (16 lbf.ft)**
14. Remove tool from crankshaft.
15. Fit woodruff key to crankshaft.
16. Fit lower chain guide.
17. Using a new gasket, position oil pick-up strainer. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
18. Fit timing chains and sprockets. **See this section.**
19. Reconnect battery negative lead.

## OIL PUMP AND OIL PRESSURE RELIEF VALVE - OVERHAUL

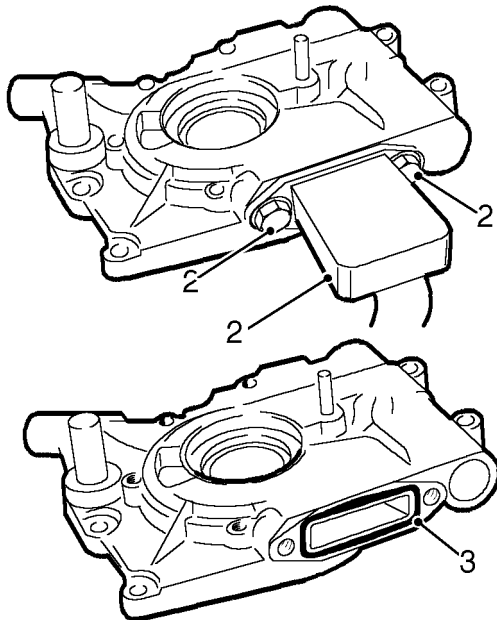
Service repair no - 12.60.32

1. Remove oil pump. *See this section.*

### Oil pump

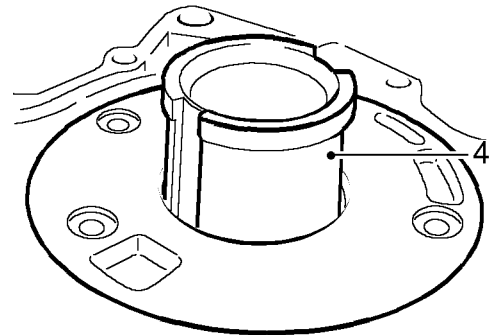


**NOTE:** Oil pump is only supplied as an assembly but the following dimensional checks checks may be carried out to determine serviceability.



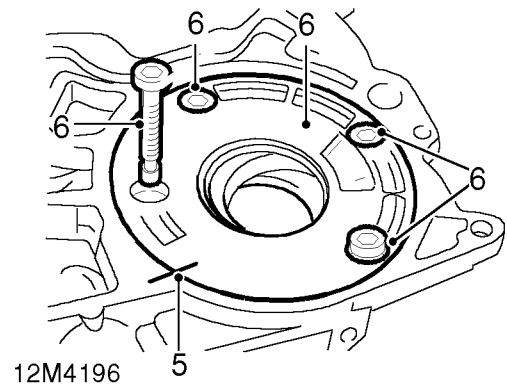
12M4194

2. *If fitted* : Remove 2 bolts securing oil pick-up pipe, remove pipe.
3. Remove and discard seal.



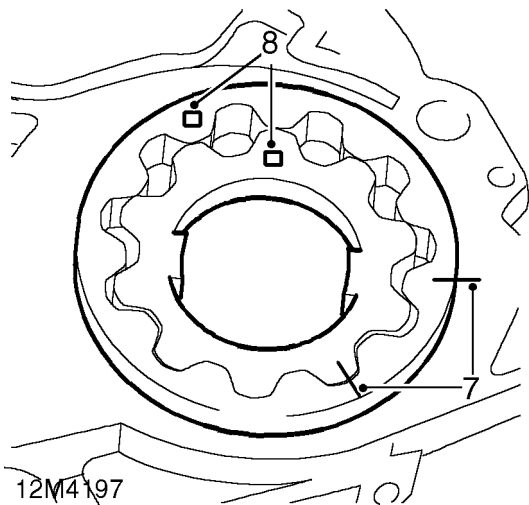
12M4195

4. Press flanged bush out from front of oil pump.

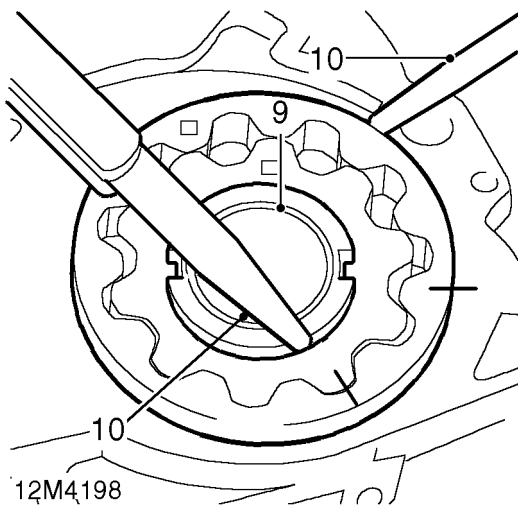


12M4196

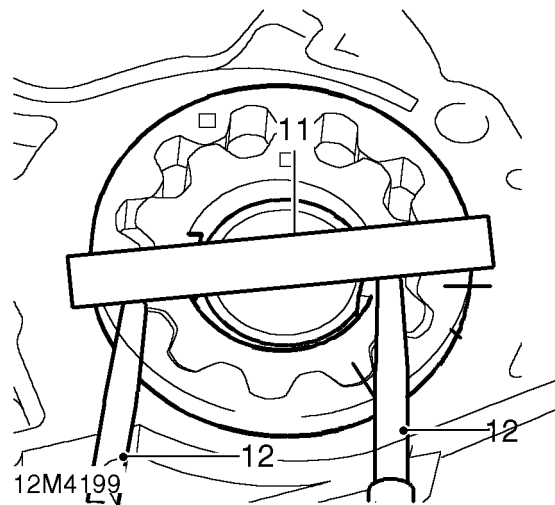
5. Make suitable alignment marks between cover plate and pump housing.
6. Noting fitted position of special screw, remove 4 screws securing cover plate, remove plate.



7. Make suitable alignment marks between inner and outer rotors and pump housing.
8. Clean rotors and recess in pump housing, fit rotors ensuring square identification marks face towards cover plate and reference marks are aligned.

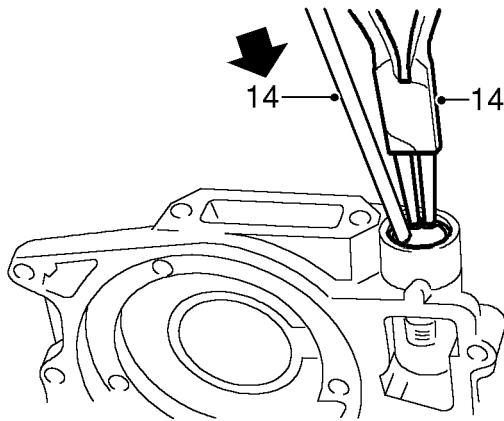


9. Insert flanged bush into inner rotor with flange on rotor side of pump.
10. Using feeler gauges, check clearance between outer rotor to pump body and inner rotor to flanged bush and compare with figures given:  
Outer rotor to pump housing = 0.4 mm (0.02 in) - maximum  
Inner rotor to flanged bush = 0.065 mm (0.003 in) - maximum



11. Remove flanged bush, position a straight edge across both rotors and the pump body.
12. Using feeler gauges inserted between straight edge and on each side of inner and outer rotors, measure axial clearance between rotors and pump body and compare with figures given:  
Outer rotor to pump body axial clearance = 0.070 mm (0.004 in) - maximum  
Inner rotor to pump body axial clearance = 0.065 mm (0.003 in) - maximum
13. If any of the clearances obtained exceed figures given, pump assembly must be replaced.

## Oil pressure relief valve

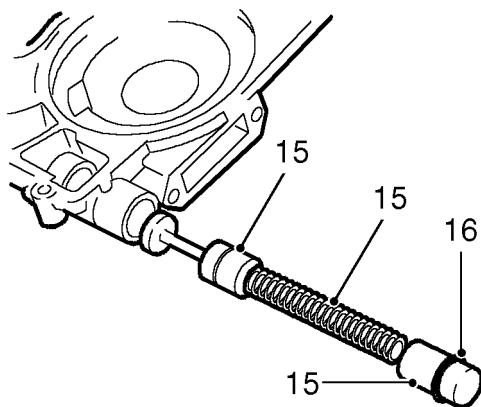


12M4200

14. Using a suitable mandrel, depress sleeve and remove circlip.



**WARNING: Sleeve is under strong spring pressure, suitable eye protection must be worn.**



12M4201

15. Gradually release spring pressure, remove sleeve, spring and piston.
16. Remove and discard 'O' ring.
17. Clean all components, check piston, sleeve and relief valve bore for damage, scoring and signs of wear.
18. Check relief valve spring free length:  
Free length = 84.1 mm (3.3 in)
19. Renew relief valve as an assembly.

## Oil pump and oil pressure relief valve - assembling

20. Lubricate all components with engine oil.
21. Fit a new 'O' ring to sleeve.
22. Insert piston, spring and sleeve into relief valve bore, depress sleeve and fit circlip.



**WARNING: Suitable eye protection must be worn.**

23. Check that circlip is correctly seated in groove.
24. Insert rotors into pump ensuring that square identification marks are toward cover.
25. Fit cover plate ensuring reference marks are aligned.
26. Fit 4 screws ensuring special screw is in its original location, tighten screws to **20 Nm (15 lbf.ft)**.
27. Fit flanged bush ensuring that flange is on cover plate side of pump.
28. Position new seal to oil pick-up pipe, fit pipe.
29. Fit 2 bolts and tighten to **10 Nm (7 lbf.ft)**.
30. Fit oil pump. **See this section.**

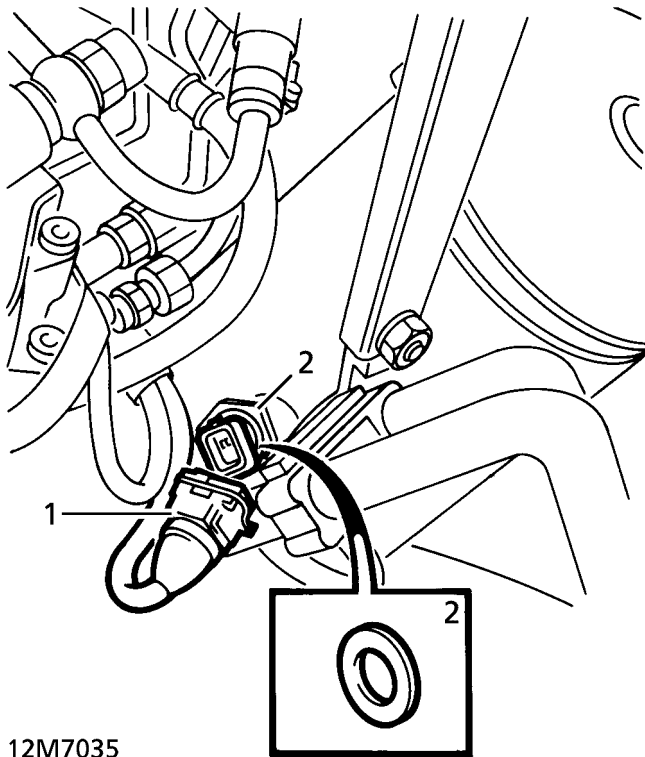


## OIL PRESSURE SWITCH

Service repair no - 12.60.50

### Remove

1. Disconnect switch multiplug.
2. Remove switch. Collect sealing washer and discard.



12M7035

### Refit

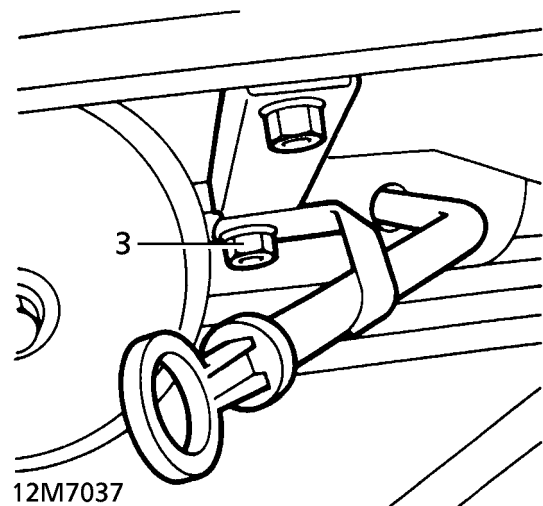
3. Ensure mating faces are clean.
4. Fit a new sealing washer, oil threads of switch and fit switch. Tighten to **40 Nm (30 lbf.ft)**
5. Connect multiplug.

## SUMP

Service repair no - 12.60.44

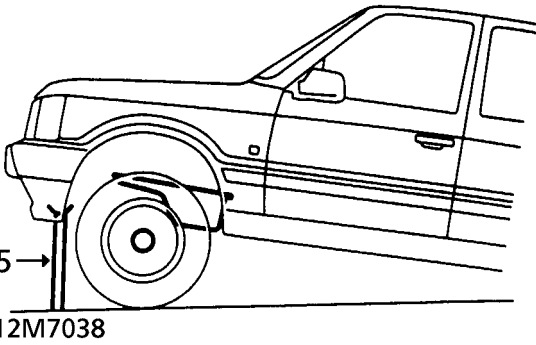
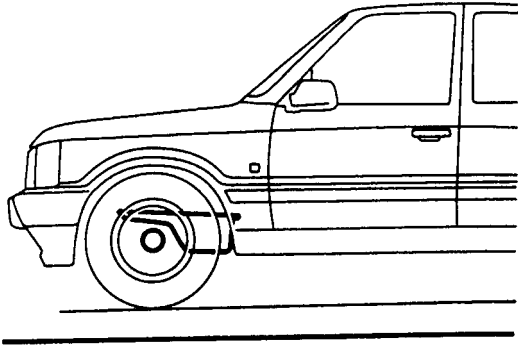
### Remove

1. Raise vehicle on four post lift.
2. Disconnect battery negative lead.
3. Remove nut and bolt securing dipstick tube. Remove tube. Remove and discard 'O' ring.



12M7037

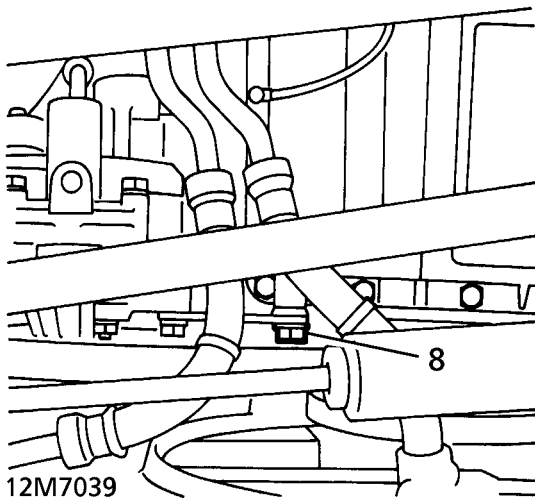
4. Raise lift.
5. Position support under chassis front cross member.



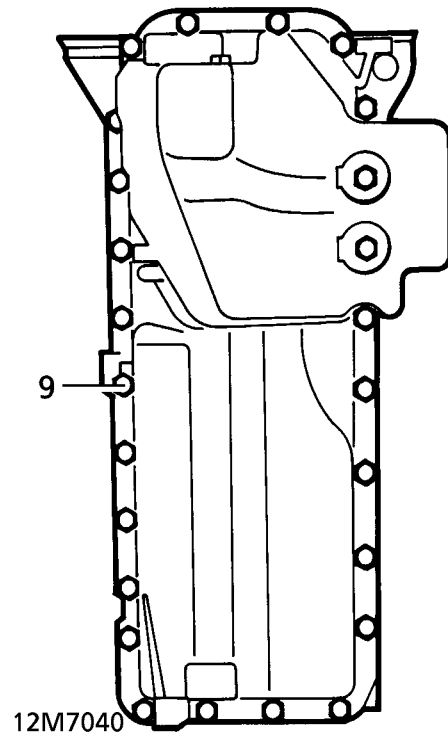
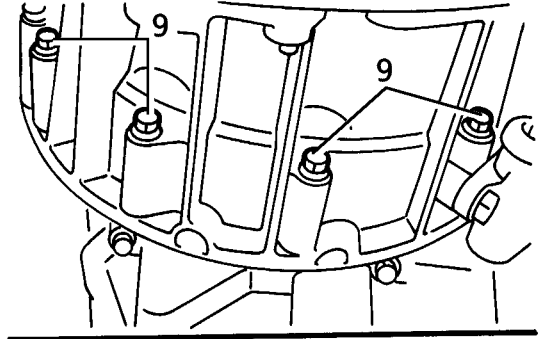
- 6. Lower lift to give clearance between front axle and sump.

**CAUTION:** Do not lower axle from chassis if front shock absorbers are disconnected.

- 7. Drain oil from sump. Refit sump plug.
- 8. Remove bolt securing power steering pump bracket to sump.



- 9. Remove 29 bolts securing sump. Remove sump and gasket.





## Refit

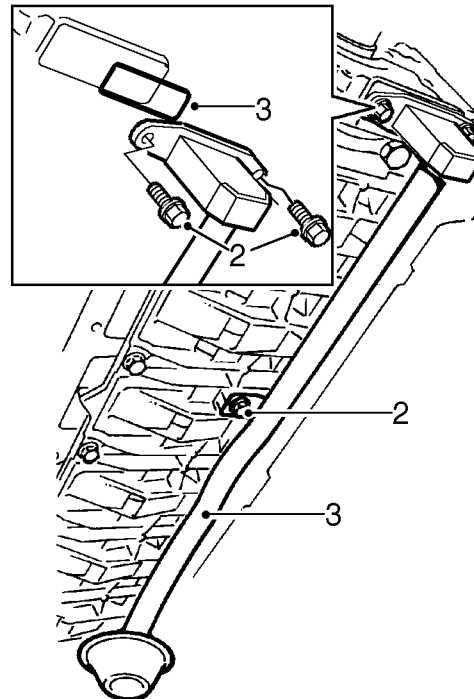
10. Ensure mating faces are clean.
11. Clean sump.
12. Fit gasket to sump. Fill front and rear openings in gasket with STC 3373 sealant.
13. Position sump to cylinder block.
14. Secure sump with bolts.  
M6 - **10 Nm (7 lbf.ft)**  
M6 - **12 Nm (9 lbf.ft)**  
M8 - **20 Nm (15 lbf.ft)**
15. Tighten sump plug to:-  
M12 - **25 Nm (18 lbf.ft)**  
M22 - **60 Nm (44 lbf.ft)**
16. Position power steering pump bracket on sump. Secure with bolt.
17. Raise lift. Remove chassis support.
18. Lower lift.
19. Lubricate new dipstick tube 'O' ring with clean engine oil.
20. Fit 'O' ring to dipstick tube. Fit tube. Secure with nut and bolt.
21. Refill engine oil. **See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
22. Reconnect battery negative lead.

## BIG-END BEARINGS

Service repair no - 12.17.16

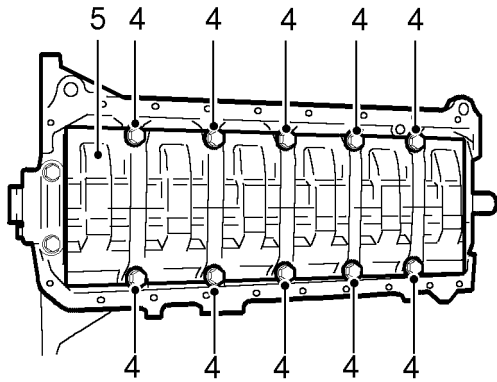
### Remove

1. Remove sump. **See this section.**



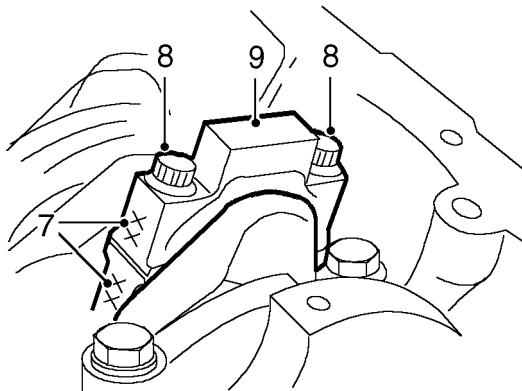
12M4202

2. Remove 3 bolts securing oil pick-up pipe.
3. Remove oil pick-up pipe, remove and discard seal.



12M4203

4. Progressively slacken then remove and discard 10 bolts securing reinforcing plate,
5. Remove reinforcing plate.
6. Carefully rotate crankshaft to gain access to connecting rod bolts.



12M4204

7. Ensure that connecting rods and big-end bearing caps are suitably identified to each other.
8. Remove big-end bearing cap bolts.



**NOTE: Do not discard bolts at this stage.**

9. Remove big-end bearing caps, remove and discard big-end bearing shells.



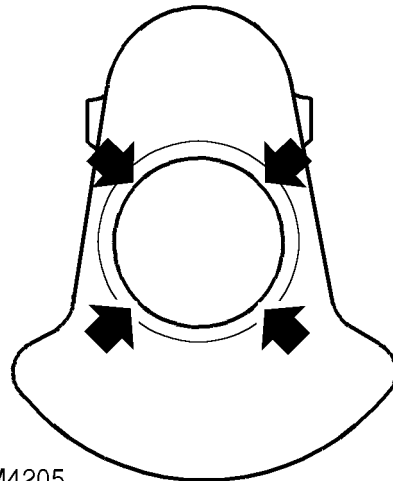
**CAUTION: Dowel located, do not tap bearing caps sideways.**

10. Remove and discard big-end bearing shells from connecting rods.



**CAUTION: Take care when carrying out above operation that piston does not contact valves. Keep big-end bearing caps and bolts in their fitted order.**

### Inspection



12M4205

11. Measure and record crankshaft big-end journal diameter, take 4 measurements at 90° intervals.



**NOTE: There are 3 sizes of crankshaft big-end journals, Standard, Size 1 and Size 2. Crankshafts with either Standard or Size 1 journals may be ground to the next undersize and the appropriate oversize big-end bearing shells fitted.**

**Standard = 44.975 to 45.00 mm (1.770 to 1.771 in)**

**Size 1 - 0.25 (0.01 in) undersize = 44.725 to 44.75 mm (1.761 to 1.762 in)**

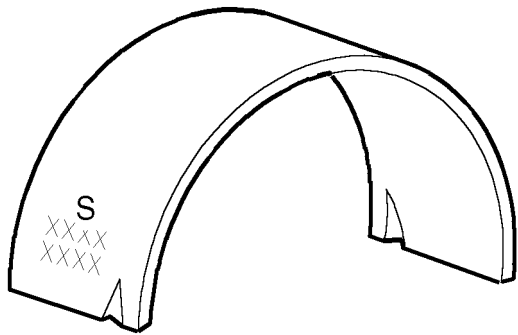
**Size 2 - 0.50 mm (0.02 in) undersize = 44.475 to 44.50 mm (1.751 to 1.752 in)**

12. Repeat above procedures for remaining big-end journals.



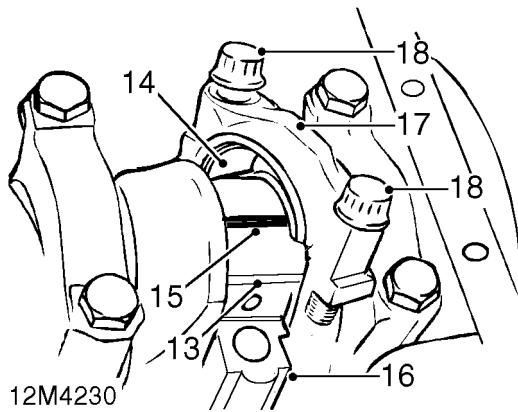


**Check big-end bearing clearances**



12M4229

**NOTE:** Big-end bearing shells are available in 3 sizes - Standard, 0.25 (0.01 in) and 0.50 (0.02 in) oversize and are colour coded RED or BLUE. Additionally, the connecting rod bearing shell is of the 'sputter' type and can be identified by a letter S or a series of XXX on the outside of the shell. Sputter bearings must be fitted to the connecting rod.



12M4230

13. Fit a new RED colour coded big-end bearing shell of the appropriate size in connecting rod.

**CAUTION:** Ensure bearing shell is of the 'sputter' type.

14. Fit a new BLUE colour coded big-end bearing shell of the appropriate size in the big-end bearing cap.



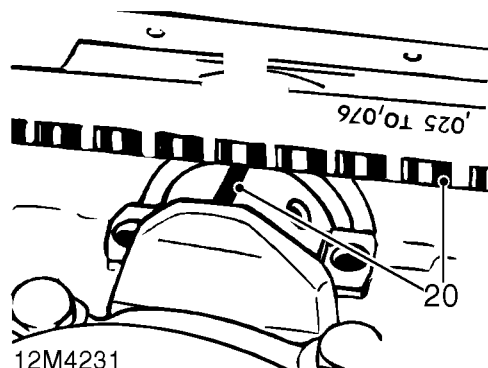
**CAUTION:** Do not fit a 'sputter' bearing to bearing cap.

15. Place a strip of Plastigage across crankshaft big-end journal.
16. Pull connecting rod on to journal.
17. Fit big-end bearing cap ensuring reference marks on connecting rod and cap are aligned.
18. Fit original big-end bearing cap bolts and tighten to:
  - Stage 1 - **5 Nm (4 lbf.ft)**
  - Stage 2 - **20 Nm (15 lbf.ft)**
  - Stage 3 - Use angular torque wrench and tighten further 70°



**CAUTION:** Do not rotate crankshaft.

19. Remove big-end bearing cap.



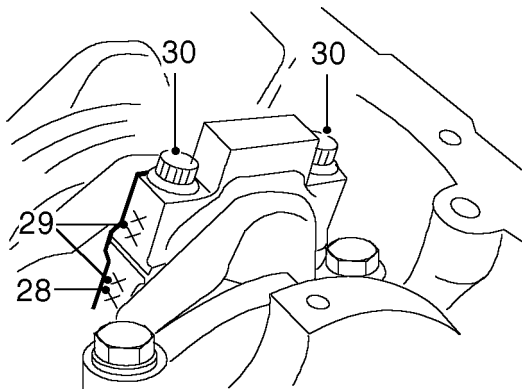
12M4231

20. Using scale provided, measure width of Plastigage on bearing journal and compare with bearing clearance:  
Big-end bearing clearance = 0.010 to 0.055 mm (0.0004 to 0.002 in)
21. If correct clearance cannot be obtained with bearing shells available, crankshaft journals must be ground to next undersize and the appropriate oversize big-end bearing shells fitted.

22. Retain selected bearing shell with connecting rod and bearing cap.
23. Remove all traces of Plastigage using an oily rag.
24. Repeat above procedures for remaining big-end bearings.
25. Discard original big-end bearing cap bolts.

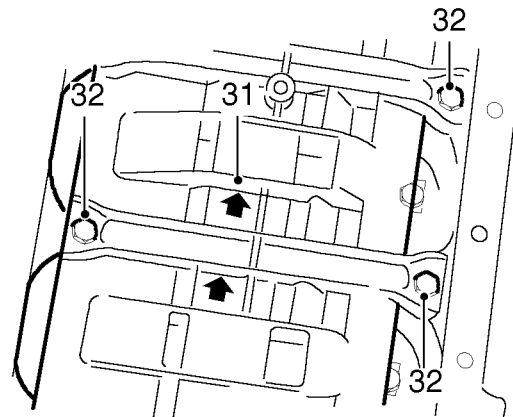
### Refit

26. Lubricate crankshaft journals and selected big-end bearing shells with engine oil.
27. Fit selected big-end bearing shells to connecting rod and big-end bearing cap ensuring that 'sputter' bearing is fitted to connecting rod.



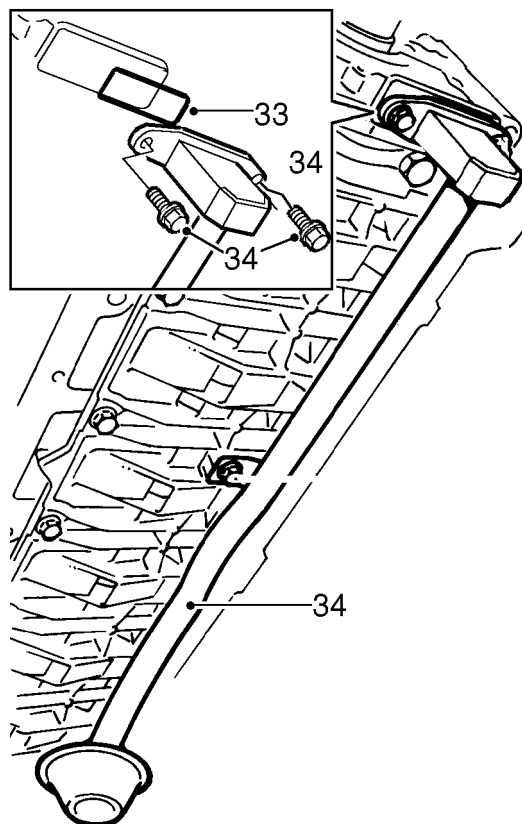
12M4232

28. Pull connecting rod down on to crankshaft journal.
29. Fit big-end bearing cap ensuring that reference marks on cap and rod are aligned.
30. Fit new big-end bearing cap bolts and tighten to:
  - Stage 1 - **5 Nm (4 lbf.ft)**
  - Stage 2 - **20 Nm (15 lbf.ft)**
  - Stage 3 - Use angular torque wrench and tighten further 70°.



12M4233

31. Position reinforcing plate to crankcase ensuring that arrows on plate are pointing towards front of engine.
32. Fit 10 new bolts and tighten from centre outwards to :
  - M4 - **22 Nm (16 lbf.ft)**
  - M10 - **43 Nm (32 lbf.ft)**



12M4234

33. Position new seal to oil pump.
34. Fit oil pick-up pipe, fit 3 bolts and tighten to **10 Nm (7 lbf.ft)**
35. Fit sump. **See this section.**

## PISTONS, CONNECTING RODS AND CYLINDER BORES

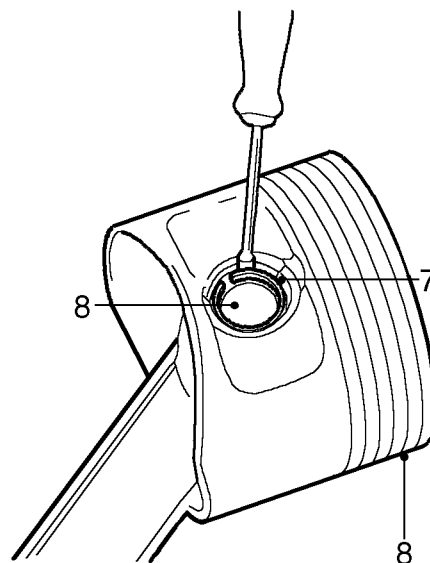
Service repair no - 12.17.03

### Remove

1. Remove cylinder head. **See this section.**
2. Remove big-end bearings. **See this section.**
3. Push piston and connecting rod to top of cylinder bore, remove piston and connecting rod.
4. Suitably identify piston and connecting rod to its cylinder bore.
5. Repeat above procedure for remaining pistons and connecting rods.

### Pistons and connecting rods - dismantling

6. Remove and discard piston rings.



12M4207

7. Remove and discard snap rings retaining gudgeon pin.
8. Remove gudgeon pin, remove piston from connecting rod.



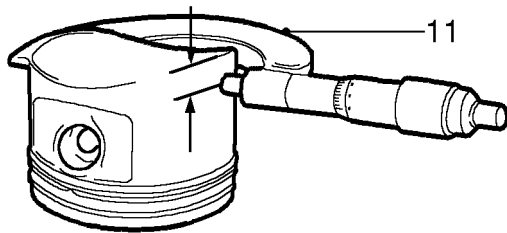
**CAUTION:** Keep each piston, gudgeon pin and connecting rod together as a set.

- Remove carbon from piston crowns, and piston ring grooves.

**CAUTION:** Do not attempt to remove carbon or deposits from piston skirts as graphite coating will be destroyed.

### Pistons - inspection

- Check piston for signs of burning and skirt for scoring or damage.



12M4208

- Measure and record piston diameter at a point 7.0 mm (0.27 in) from bottom of skirt and at right angles to gudgeon pin holes.

**NOTE:** Three sizes of piston may be fitted:  
**Standard = 79.96 ± 0.009 mm (3.14 ± 0.0004 in)**

**Intermediate = 80.04 ± 0.009 mm (3.15 ± 0.0004 in)**

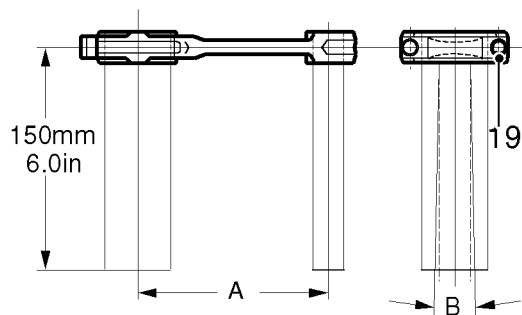
**1st oversize = 80.21 ± 0.009 mm (3.16 ± 0.0004 in)**

- Check gudgeon pin holes in piston for signs of ovality.
- Repeat above procedures for remaining pistons.

### Connecting rods - inspection

- Check that oil feed passages are clear.
- Check dowels in connecting rods and big-end bearing caps for security, replace as necessary.
- Check gudgeon pin bush in connecting rod for wear:  
 Gudgeon pin bush bore = 28.995 to 29.021 mm (1.142 to 1.143 in)
- Replace worn bushes as necessary.

**CAUTION:** When fitting new bushes, ensure oil holes in bush and connecting rod are aligned.

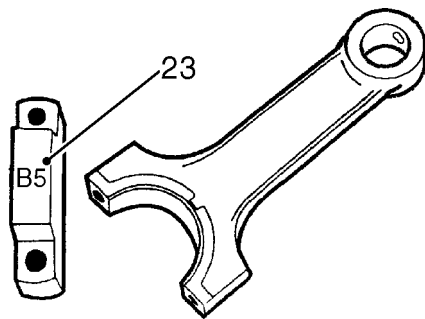


12M4210

- Check connecting rods for distortion, fit a new BLUE colour coded 'sputter' big-end bearing shell to the connecting rod and a new RED colour coded shell to the big-end bearing cap.
- Fit original big-end bearing cap bolts and tighten to **5 Nm (4 lbf.ft)**.
- Check parallelism of connecting rods on both sides of rod.  
 Maximum deviation **A** = 0.05 mm (0.002 in)

**NOTE:** Measurement must be taken approximately 150 mm (6.0 in) from centre line of rod:

- Check for distortion on both sides of connecting rod:  
 Maximum distortion **B** = 0.5 mm (0.02 in)
- Repeat above procedures for remaining connecting rods.



12M4235

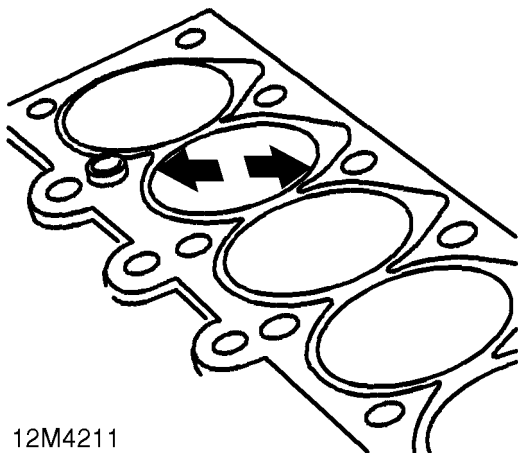
23. Replace connecting rods as necessary, do not attempt to straighten distorted rods.



**CAUTION:** replacement connecting rods must be of the same weight classification, the classification is embossed on the main bearing caps.

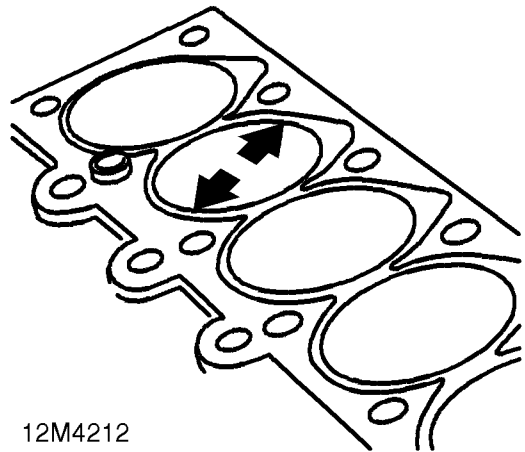
#### Cylinder bores - inspection

24. De-glaze cylinder bores, check bores for scoring.  
25. Remove all traces of cylinder head gasket and carbon deposits from cylinder block.



12M4211

26. Check and record cylinder bore diameter at bottom, centre and top of bore ensuring that measurements are taken at the angle shown.  
27. Compare figures obtained with the following and determine cylinder bore size:  
Standard = 80.00 to 80.04 mm (3.150 to 3.151 in)  
Intermediate = 80.08 to 80.12 mm (3.153 to 3.154 in)  
1st oversize = 80.25 to 80.29 mm (3.20 to 3.21 in)



12M4212

28. Repeat procedure at angle shown and from the 2 sets of measurements obtained, calculate cylinder bore ovality and taper:  
Maximum ovality = 0.04 mm (0.002 in)  
Maximum taper = 0.04 mm (0.002 in)  
29. Compare piston diameter with cylinder bore size and determine piston to bore clearance:  
Piston to bore clearance = 0.031 to 0.063 mm (0.0012 to 0.002 in)



**NOTE:** For engines which have been 'run in,' the above clearance may be increased to 0.213 mm (0.008 in).

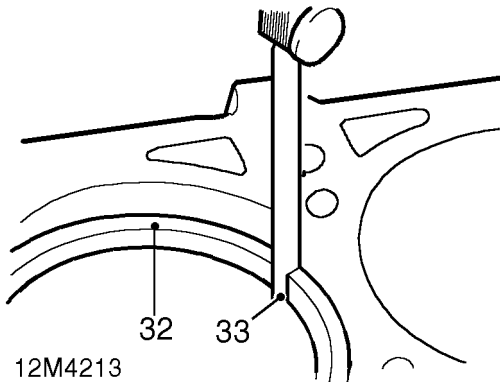
30. Standard and intermediate size cylinder bores which are worn in excess of limits given may be rebored to next oversize and the appropriate oversize pistons fitted.

## Piston rings - check



**CAUTION:** Ensure that replacement piston rings are the correct size for the pistons to be fitted.

31. Lubricate cylinder bores and new piston rings with engine oil.



12M4213

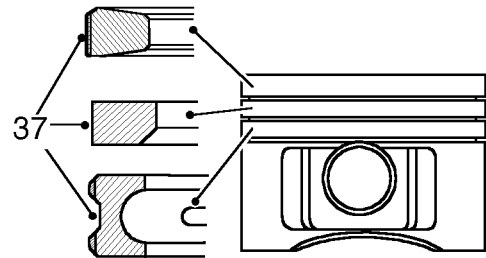
32. Insert 1 set of piston rings in turn into No. 1 cylinder bore.
33. Check piston ring gaps using feeler gauges: Piston ring gap - 1st, 2nd and oil control rings = 0.2 to 0.4 mm (0.008 to 0.020 in)



**CAUTION:** If ring gaps are too wide, it will be necessary to rebores cylinder(s) to next size and fit appropriate size pistons and rings.

rings.

34. Suitably identify the piston rings with No.1 cylinder and retain with the piston and connecting rod for that cylinder.
35. Repeat above procedures for remaining cylinders.
36. Lubricate pistons and ring grooves with engine oil.

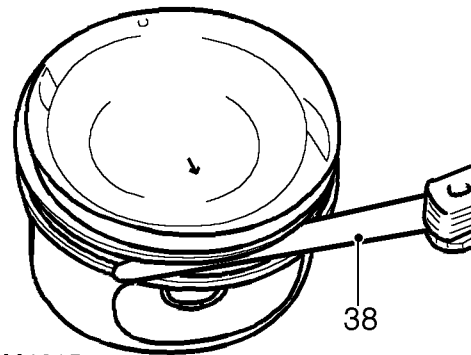


12M4214

37. Fit oil control, 2nd and 1st compression rings to piston.



**NOTE:** 1st and 2nd rings are marked TOP.

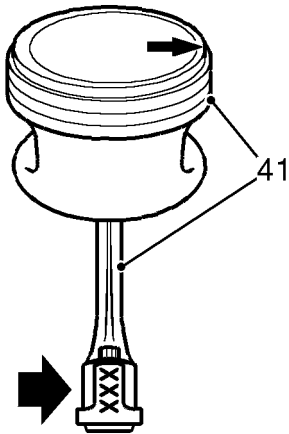


12M4215

38. Using feeler gauges, measure clearance between piston ring groove and 2nd compression and oil control rings.  
Ring to groove clearance:  
1st compression - not checked  
2nd compression = 0.040 to 0.072 mm ( 0.002 to 0.004 in)  
Oil control = 0.030 to 0.065 mm (0.001 to 0.003 in)
39. Check that 1st compression ring is free to move in groove.
40. Repeat above procedures for remaining pistons and rings.

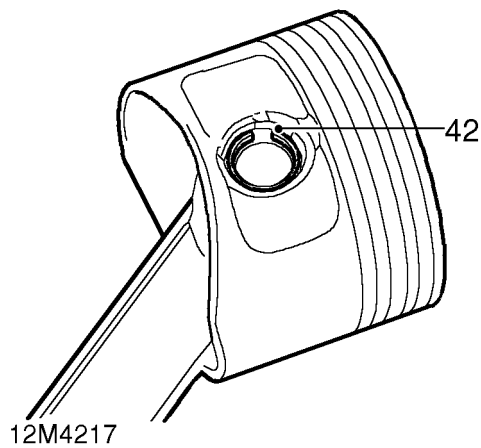


**Pistons and connecting rods - assembling**



12M4216

41. Assemble each piston to its connecting rod ensuring that the number on the rod is positioned relative to the arrow on the piston crown as shown.



12M4217

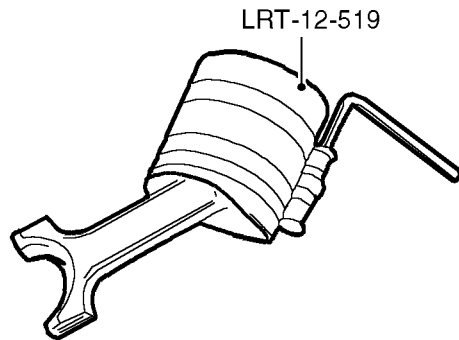
42. Lubricate gudgeon pins and bushes with engine oil, fit pins and retain with new snap rings.



**NOTE:** Position snap ring gaps opposite recess in piston.

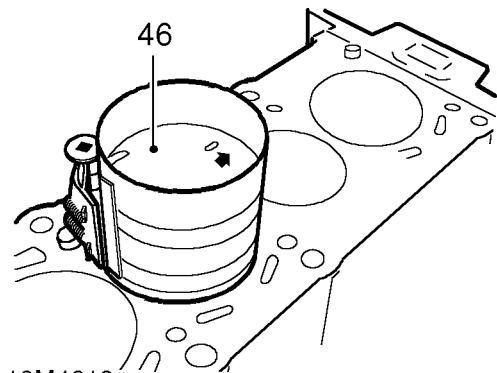
**Pistons and connecting rods - refit**

43. Lubricate pistons, rings and cylinder bores with engine oil.  
 44. Position piston ring gaps at 120° to each other ensuring that they are not over gudgeon pin.



12M4218

45. Compress piston rings using LRT-12-519.



12M4219

46. Fit each piston and connecting rod to its respective cylinder in turn ensuring that arrow on piston crown is pointing towards front of engine.



**CAUTION:** Fit pistons using hand pressure only.

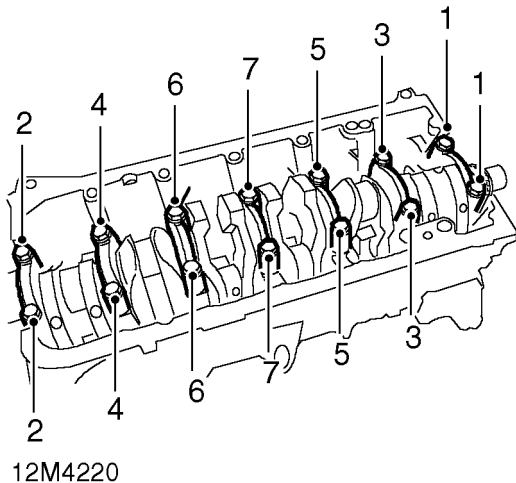
47. Fit big-end bearings. *See this section.*  
 48. Fit cylinder head. *See this section.*

## CRANKSHAFT AND MAIN BEARINGS

Service repair no - 12.21.33/01

### Remove

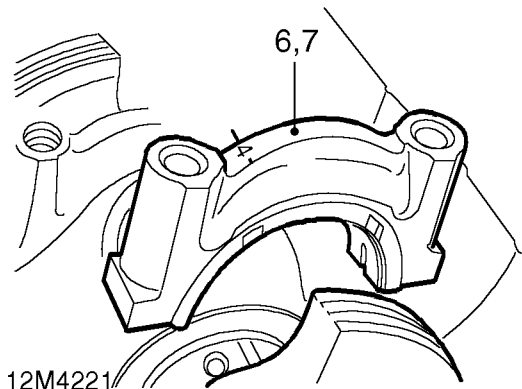
1. Remove engine and gearbox. **See this section.**
2. Remove oil pump. **See this section.**
3. Remove crankshaft rear oil seal. **See this section.**
4. Remove pistons and connecting rods. **See this section.**



5. Using sequence shown, progressively slacken then remove main bearing cap bolts.



**NOTE: Do not discard bolts at this stage.**



6. Ensure that main bearing caps 1 to 5 are suitably identified on the exhaust manifold side of the engine.



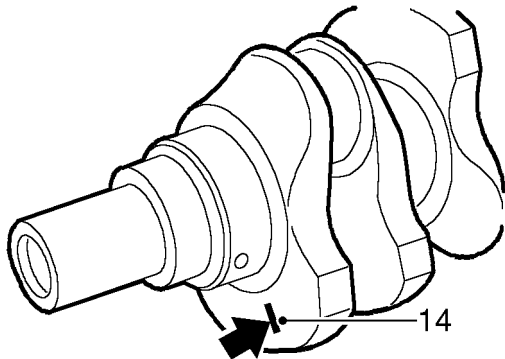
**NOTE: Main bearing caps 6 and 7 are not marked on production, ensure that they are suitably identified to their fitted positions. Bearing cap 6 carries the integral thrust/main bearing shell.**

7. Remove main bearing caps.
8. Remove and discard main bearing shells from caps.
9. Lift out crankshaft.
10. Remove and discard main bearing shells from cylinder block.
11. Clean crankshaft, ensure all oilways are clear.
12. Clean main bearing caps and bearing shell locations in cylinder block; ensure bearing cap bolt holes are clean and dry.
13. Clean original bearing cap bolts and lightly oil threads.





## Inspection



12M4222

- 14.** Check front web of crankshaft to determine if main bearing journals have been ground undersize.
- No paint mark - Standard journals  
 1 paint mark - Journals are 0.25 mm (0.01 in) undersize  
 2 paint marks - Journals are 0.50 mm (0.02 in) undersize



**NOTE:** Each of the three main journal sizes has a triple colour classification which corresponds to the colour code of the main bearing cap shells, a colour code on the edge of the balance webs will indicate the actual size.

- 15.** Measure and record main journal diameters and compare with the sizes given below. Take 4 measurements of each journal at 90° intervals to check for appropriate specified size and ovality.

**Standard:**

Yellow = 59.984 to 59.990 mm (2.3616 to 2.3618 in)

Green = 59.977 to 59.983 mm (2.3612 to 2.3615 in)

White = 59.971 to 59.976 mm (2.3610 to 2.3611 in)

**Undersize 1 - 0.25 mm (0.01 in):**

Yellow = 59.734 to 59.740 mm (3.3522 to 2.3526 in)

Green = 59.727 to 59.733 mm (2.3514 to 2.3520 in)

White = 59.721 to 50.726 mm (2.3512 to 2.3514 in)

**Undersize 2 - 0.50 mm (0.02 in):**

Yellow = 59.484 to 59.490 mm (2.3418 to 2.3420 in)

Green = 59.477 to 59.483 mm (2.3414 to 2.3417 in)

White = 59.471 to 59.476 mm (2.3413 to 2.3415 in)

- 16.** If standard or undersize 1 journals are found to be oval, the crankshaft may be ground to the next undersize.
- 17.** If journals are worn below the original colour code size but ovality is within limits, then the next size main bearing shells should be fitted in the main bearing caps and cylinder block when carrying out the Plastigage check.



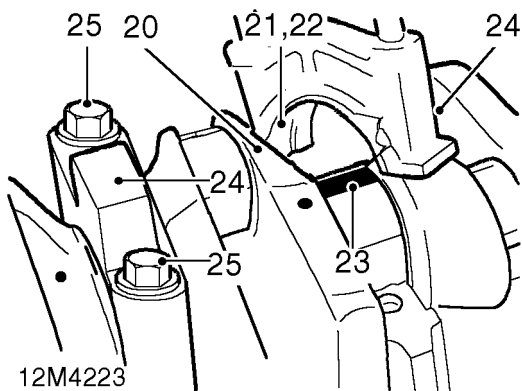
**NOTE:** If journals are worn below the lowest colour size for standard or undersize 1 journals, crankshaft may be ground to the next undersize. Ensure that paint stripe(s) to denote that grinding has been carried out are marked on the crankshaft front web.

## Check crankshaft main bearing clearances

18. Fit new, appropriate size yellow main bearing shells in cylinder block at positions 1 to 5 and 7.
19. Fit new, appropriate yellow thrust/main bearing shell in cylinder block at position 6.

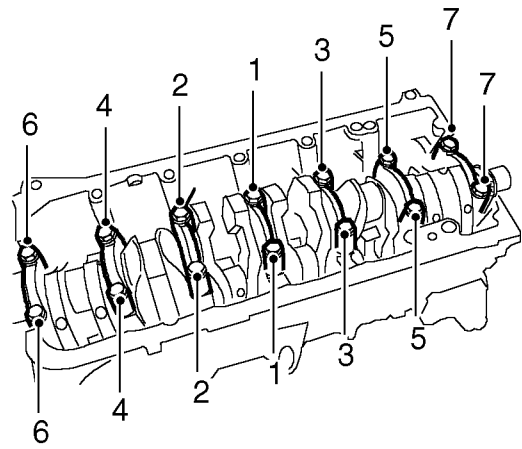


**NOTE:** Thrust portion of bearing shells fitted in cylinder block and main bearing cap should be the thinnest of the range available - See *crankshaft end-float - check*.



12M4223

20. Position crankshaft in cylinder block.
21. Check colour coding on crankshaft webs and fit new, appropriate size main bearing shells of the same colour coding in main bearing caps numbers 1 to 5 and 7.
22. Fit new, appropriate size thrust/main bearing shell of the same colour coding in number 6 main bearing cap.
23. Place a strip of Plastigage across each main bearing journal.
24. Fit main bearing caps ensuring that identification marks are on exhaust manifold side of engine.
25. Fit original main bearing cap bolts.
26. Align main bearing caps to crankcase.

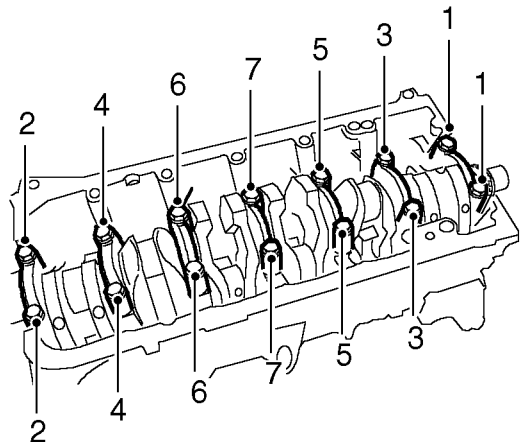


12M4224

27. Using sequence shown, tighten main bearing cap bolts to **20 Nm (15 lbf.ft)**.
28. Using a suitable angular torque wrench, tighten bolts in sequence a further 50°

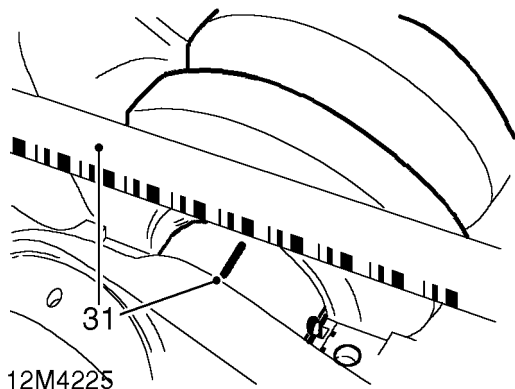


**CAUTION:** Do not rotate crankshaft.



12M4220

29. Using sequence shown, progressively slacken then remove main bearing cap bolts.
30. Remove main bearing caps and shells.



12M4225

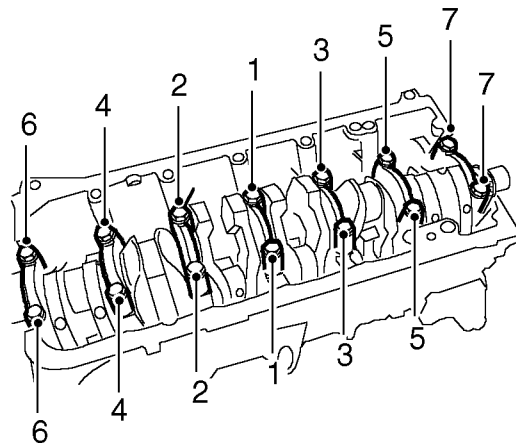
- 31. Using scale provided, measure width of Plastigage on each main bearing journal and compare with specified bearing clearances: Main bearing clearance = 0.020 to 0.058 mm (0.001 to 0.002 in)
- 32. If clearances are incorrect, select alternative main bearing cap shell(s) from the range available and repeat check.

**NOTE:** If colour coding of selected bearing shell(s) differs from colour marked on adjacent crankshaft web, ensure correct colour is marked on web on completion.

- 33. Remove all traces of Plastigage using an oily rag.
- 34. Fit selected main bearing shells to main bearing caps.
- 35. Remove crankshaft, lubricate journals and main bearing shells with engine oil.

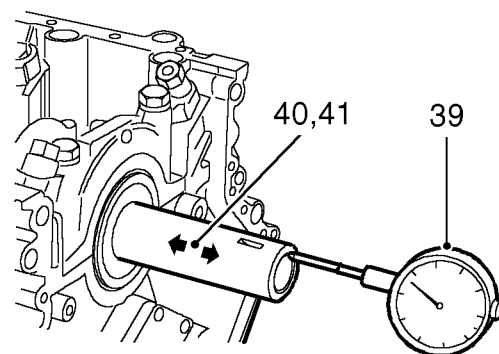
**Crankshaft end float - check**

- 36. Fit crankshaft, fit main bearing caps ensuring that reference marks are on exhaust manifold side of engine.
- 37. Align main bearing caps to crankcase.



12M4224

- 38. Fit original main bearing cap bolts and tighten in sequence shown to **20 Nm (15 lbf.ft)** then using an angular torque wrench, tighten in sequence a further 50° .



12M4226

- 39. Position a suitable DTI to front of crankshaft.
- 40. Move crankshaft fully rearwards and zero gauge.
- 41. Move crankshaft fully forwards and note end-float reading on gauge.  
Crankshaft end-float = 0.080 to 0.163 mm (0.003 to 0.006 in)

### Crankshaft end-float incorrect:

42. Remove crankshaft.
43. Select combined thrust/main bearing shells from the range available to give correct end-float ensuring that correct colour coding/size of bearing shell is maintained.



**NOTE:** Each of the thrust/main bearing shell sizes has three widths of shell available:

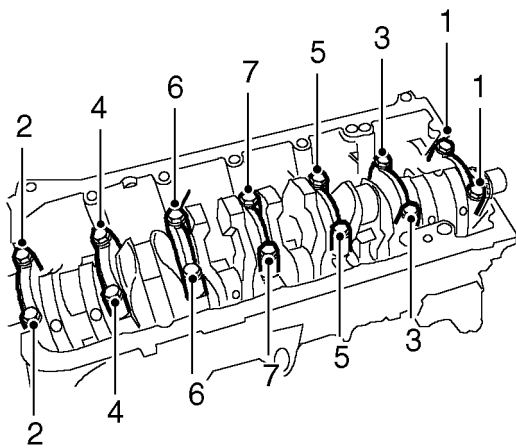
Standard = 25.0 mm (0.94 in)

Size 1 = 25.2 mm (0.992 in)

Size 2 = 25.4 mm (1.00 in)

44. Fit selected thrust/main bearing shells in cylinder block and main bearing caps.
45. Fit crankshaft and main bearing caps ensuring that identification marks are on exhaust manifold side of engine and repeat check as necessary until end-float is correct.
46. Discard original main bearing cap bolts on completion.

### Crankshaft end-float correct:

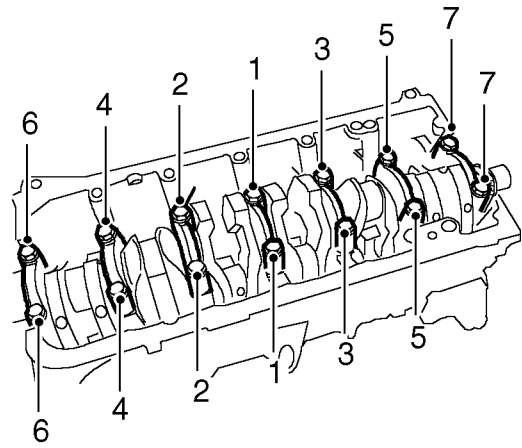


12M4220

47. Using sequence shown, progressively slacken then remove main bearing cap bolts; discard bolts.

### Refit

48. Lightly oil threads of new main bearing cap bolts.
49. Fit main bearing cap bolts, align main bearing caps to crankcase.



12M4224

50. Tighten main bearing cap bolts in sequence shown using the following procedure:
  - Stage 1 - Tighten in sequence shown to **20 Nm (15 lbf.ft)**.
  - Stage 2 - Slacken bolts on number 6 main bearing cap.
  - Stage 3 - Using a hide mallet, strike each end of crankshaft to centralise thrust/main bearing shells.
  - Stage 4 - Tighten number 6 main bearing cap bolts to **20 Nm (15 lbf.ft)**
  - Stage 5 - Using an angular torque wrench, tighten all main bearing cap bolts in sequence a further 50° .
51. Fit pistons and connecting rods. **See this section.**
52. Fit crankshaft rear oil seal. **See this section.**
53. Fit oil pump. **See this section.**
54. Fit engine and gearbox. **See this section.**

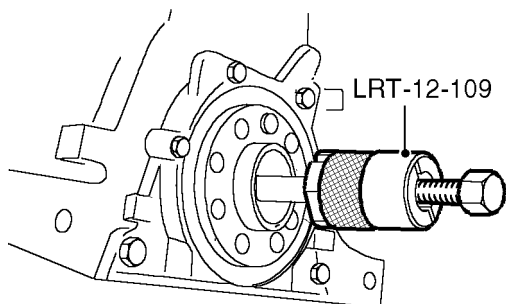


## CRANKSHAFT SPIGOT BEARING

Service repair no - 12.21.45/01

### Remove

1. Remove flywheel/drive plate. **See this section.**

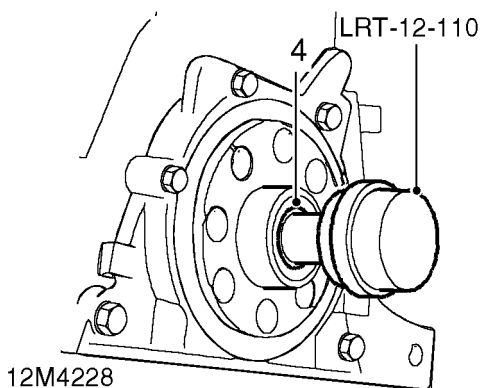


12M4227

2. Remove spigot bearing using LRT-12-109, discard bearing.

### Refit

3. Clean spigot bearing recess in crankshaft.



12M4228

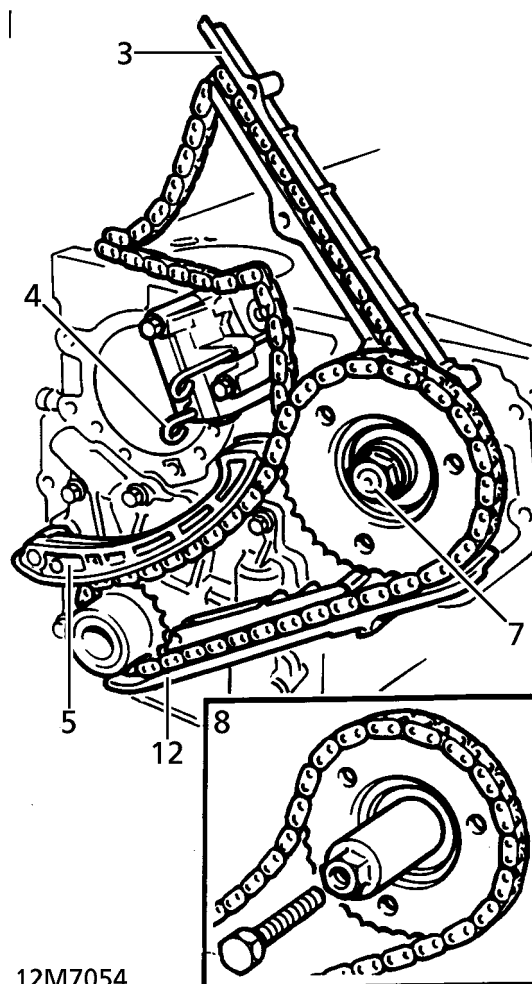
4. Position new spigot bearing to crankshaft.
5. Drift bearing fully into crankshaft using LRT-12-110.
6. Fit flywheel/drive plate. **See this section.**

## TIMING CHAINS AND SPROCKETS

Service repair no - 12.65.12

### Remove

1. Disconnect battery negative lead.
2. Remove front cover. **See this section.**
3. Remove upper timing chain guide rail.



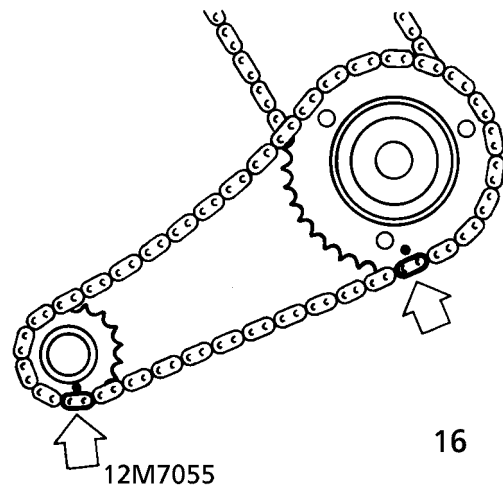
12M7054

4. Using a suitable lever, retract lower chain tensioner plunger. Insert retaining pin LRT-12-114.
5. Remove lower timing chain tensioner rail.
6. Ensure timing pin LRT-12-108 is still located in flywheel.

7. Remove nut from Fuel Injection Pump (FIP) sprocket.
8. Remove centre bolt from tool LRT-12-119. Screw body of tool onto FIP sprocket.
9. Fit centre bolt to tool. Pull sprocket from FIP.
10. Withdraw sprockets and chains as an assembly.
11. Remove tool from FIP sprocket.
12. Remove lower timing chain guide rail.

### Refit

13. Ensure mating faces are clean.
14. Lubricate timing chains with clean engine oil.
15. Fit lower chain guide.
16. Assemble sprockets to lower timing chain. Ensure dimples on sprockets align with chain 'bright' links.



17. Engage upper timing chain over rear sprocket.
18. Engage sprockets over crankshaft and FIP shaft. Ensure sprockets/bright links remain aligned.



**NOTE: Align FIP shaft to sprocket keyways using tool LRT-12-118 prior to fully engaging sprockets.**

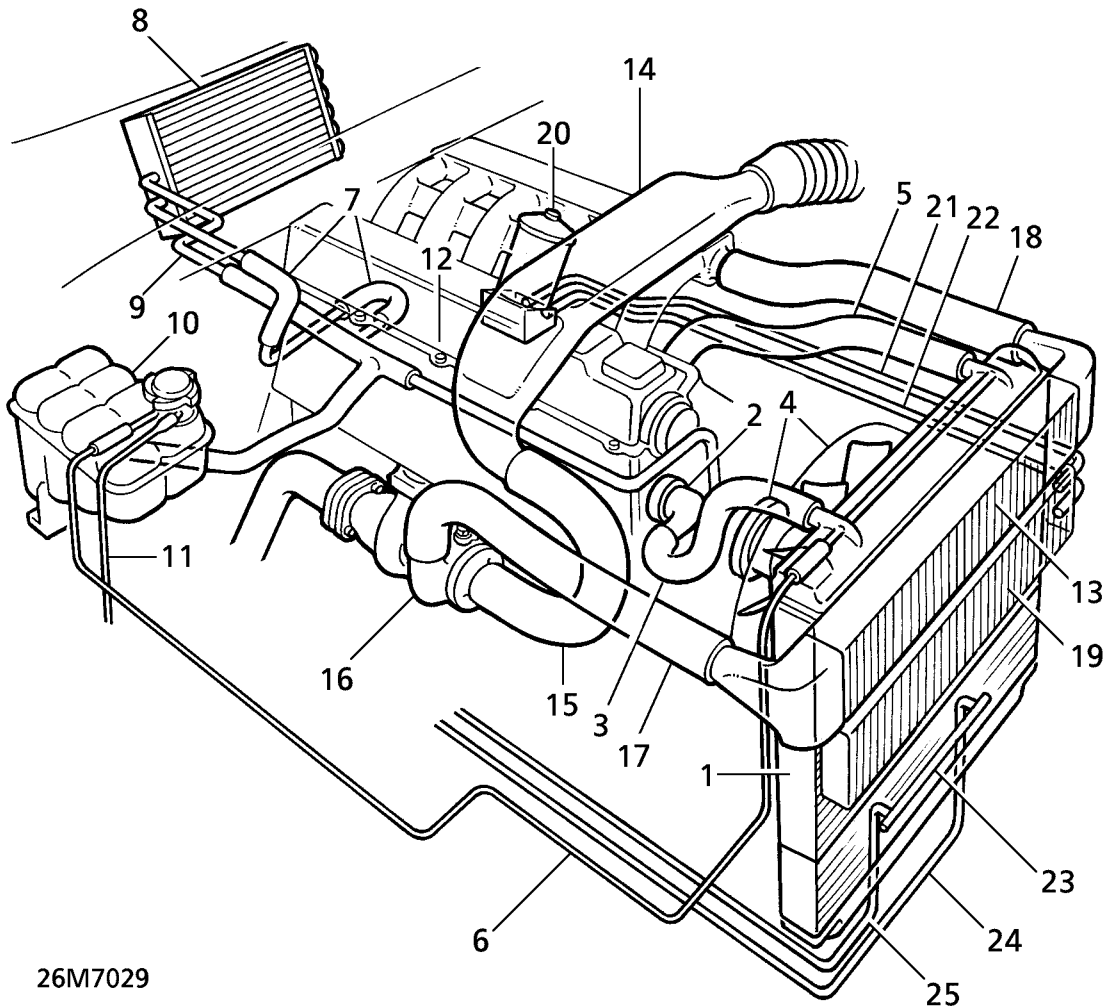
19. Secure FIP sprocket with nut. Tighten to **50 Nm (37 lbf.ft)**
20. Fit lower timing chain tensioner rail.
21. Depress tensioner plunger using a suitable lever. Remove retaining pin LRT-12-114.
22. Fit upper timing chain guide rail.
23. Refit front cover. **See this section.**
24. Check and adjust fuel injection pump timing. **See FUEL SYSTEM, Adjustment.**
25. Reconnect battery negative lead.



**DIESEL COOLING SYSTEM**

The complete cooling system installed in vehicles with diesel engines incorporates four independent cooling functions:- Engine (coolant) cooling; Turbo (charge air) intercooling; Engine oil cooling; Gearbox oil cooling.

Both intercooler and engine oil cooler are mounted in front of the radiator while the gearbox oil cooler on manual vehicles is an integral part of the radiator. Pre-formed pipes/hoses are used to link the components within the separate systems, as shown in 26M7029.



26M7029

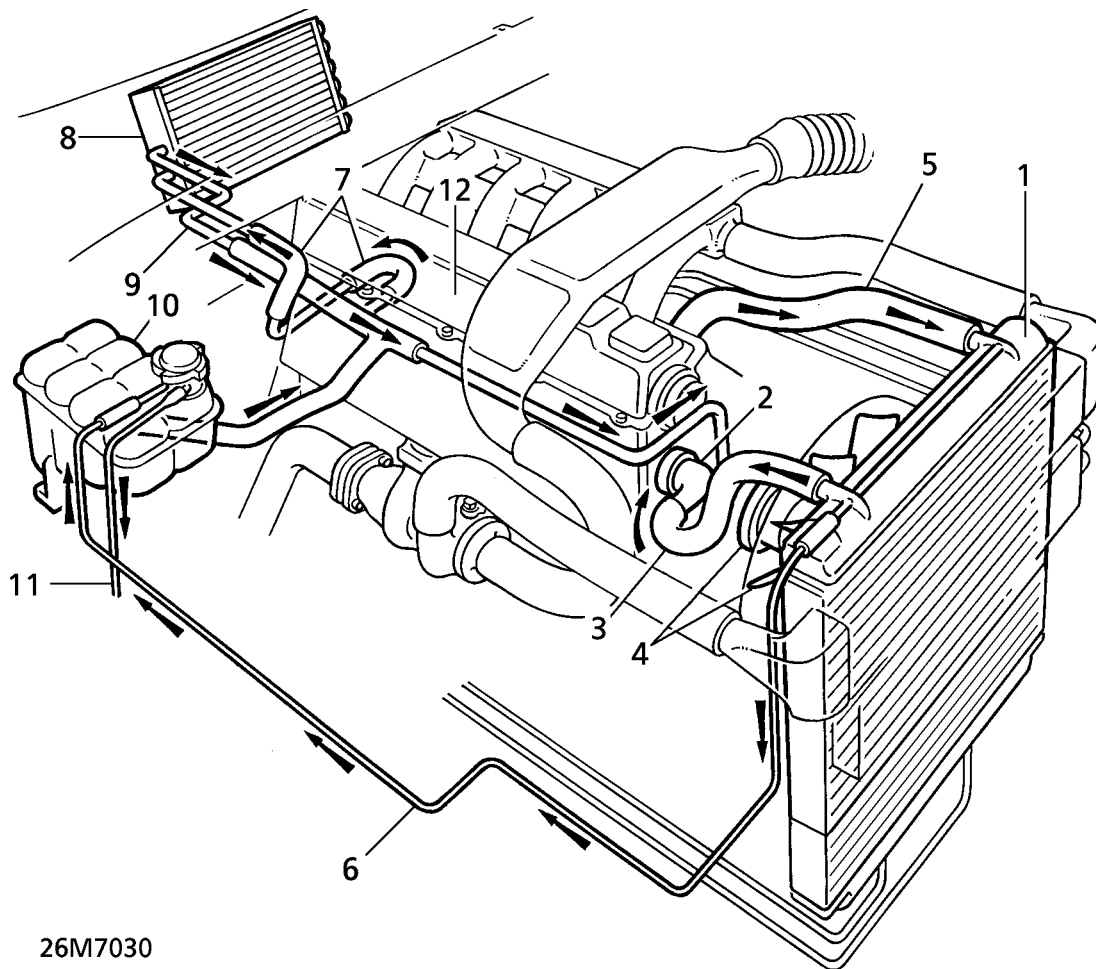
**Engine cooling system**

- |                               |                            |   |
|-------------------------------|----------------------------|---|
| 1. Radiator                   | 10. Expansion tank         | 19. Engine oil cooler                                     |
| 2. Thermostat housing         | 11. Overflow/breather pipe | 20. Oil filter  |
| 3. Radiator return hose       | 12. Crankcase              | 21. Feed pipe, engine oil cooler                          |
| 4. Viscous fan and water pump | 13. Intercooler            | 22. Return pipe, engine oil cooler                        |
| 5. Radiator top hose          | 14. Cross-over duct        | 23. Gearbox oil cooler (manual gearbox, oil cooler shown) |
| 6. Radiator bleed pipe        | 15. Link hose              | 24. Feed pipe, gearbox oil cooler                         |
| 7. Heater feed pipe           | 16. Turbocharger           | 25. Return pipe, gearbox oil cooler                       |
| 8. Heater matrix              | 17. Inlet pipe             |   |
| 9. Heater return pipe         | 18. Feed hose              |   |

**ENGINE COOLING****Description**

The 2.5 litre diesel engine uses a pressurized cooling system and a vertical flow, two row matrix radiator. An expansion tank, mounted on the RH side of the engine compartment, provides a fluid reservoir for the coolant system.

A belt driven centrifugal water pump, complete with viscous fan, is fitted to the engine front timing cover and pumps coolant to the engine crankcase and cylinder head. The thermostat housing, located at the front of the crankcase, is fitted with a separate vent valve.



26M7030

**Engine cooling system**

- |                               |                            |
|-------------------------------|----------------------------|
| 1. Radiator                   | 7. Heater feed pipe        |
| 2. Thermostat/housing         | 8. Heater matrix           |
| 3. Radiator return hose       | 9. Heater return pipe      |
| 4. Viscous fan and water pump | 10. Expansion tank         |
| 5. Radiator top hose          | 11. Overflow/breather pipe |
| 6. Radiator bleed pipe        | 12. Crankcase              |





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## COOLANT CIRCULATION

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### Operation

When the engine is started from cold, the thermostat, integral in the housing (2), prevents any coolant circulation through the radiator by closing off the supply from the radiator. During the engine warm up, the water pump (4) pumps coolant around the cylinders in the crankcase (12) and through separate galleries to the cylinder head. At the rear LH side of the cylinder head, a proportion of the flow is diverted through a heater feed pipe (7). The heater feed pipe is connected to the heater matrix (8), which is housed in the distribution unit of the heating and ventilation system. This coolant is then carried, via the heater return pipe (9) back to the water pump. The remaining coolant flows through a bypass port at the front of the cylinder head back to the water pump to complete the cycle.

When normal engine running temperature is reached, the thermostat opens and a secondary valve closes the bypass port. With the thermostat open, coolant is circulated through the top hose (5) to the radiator. Coolant is drawn from the base of the radiator by the water pump. Coolant circulation through the crankcase and cylinder head to the heater matrix remains the same.

An integral bleed pipe (6), connects the top of the radiator to the expansion tank and aids bleeding of air from the coolant system. The expansion tank cap contains a pressure valve which allows excessive pressure and coolant to vent to the overflow pipe (11) if the system has been overfilled.

### VISCOUS FAN

The viscous drive unit for the cooling fan on diesel engines work on the same principal as that fitted on V8 engines but is of slightly different size. **See this section.**

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**INTERCOOLER**

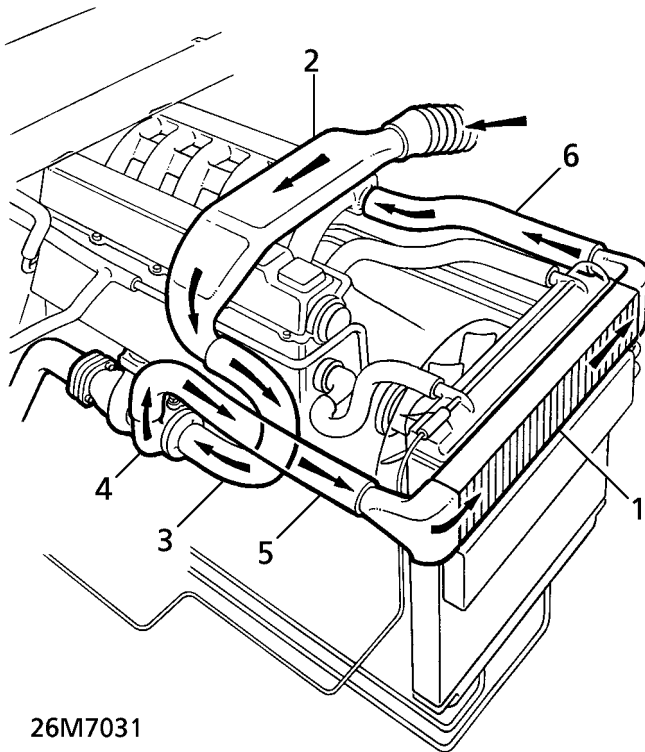
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**Description**

The intercooler (1) is an aluminium heat exchanger, with integral side tanks, comprising a single row matrix incorporating fifteen internal cooling tubes. A cross-over duct (2) directs air from the air cleaner, through a link hose (3) to the turbocharger (4). Air is directed under pressure from the turbocharger to the intercooler via the pre-formed inlet pipe (5). The cooled air is fed to the inlet manifold through the feed hose (6), see 26M 7031.

**Operation**

The 2.5 litre diesel has a high power output and is subject to high running temperatures. Compression in the turbocharger heats the air considerably, so that it expands. As a result the air charge mass per cylinder is reduced, having a negative effect on power output. The charge-air intercooler cools the air before it reaches the cylinders, thus increasing its density. This increases power output through increased mass of oxygen in the combustion process as well as maximising engine durability through maintaining lower piston and head temperatures.



26M7031

**Intercooler**

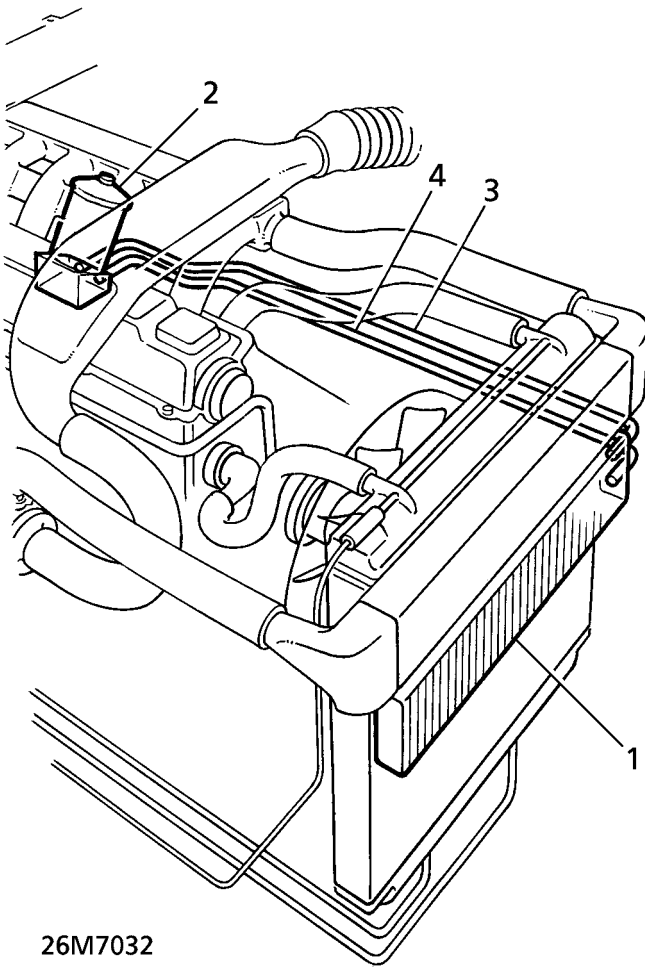
1. Intercooler
2. Cross-over duct
3. Link hose
4. Turbocharger
5. Inlet pipe
6. Feed hose



## ENGINE OIL COOLER

### Description

The engine oil cooler is located in front of the radiator, below the intercooler, and comprises a two pass, single row matrix with twelve internal cooling tubes. Pre-formed feed and return pipes/hoses are used to link the oil filter housing and oil cooler, as shown in 26M7032.



### Operation

When the engine reaches its normal operating temperature, oil, drawn through a steel strainer in the sump, is pumped under pressure from the filter housing (2) to the oil cooler (1) via the feed pipe (3). Ambient air, forced through the front grille of the vehicle and assisted by the pull of the viscous fan, is dispersed across the oil cooler. The cooled oil then passes through a return pipe (4) to the filter housing before being distributed by the oil pump to the various internal engine components.

### Engine oil cooler

1. Engine oil cooler
2. Oil filter
3. Feed pipe
4. Return pipe

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**GEARBOX OIL COOLER - MANUAL**

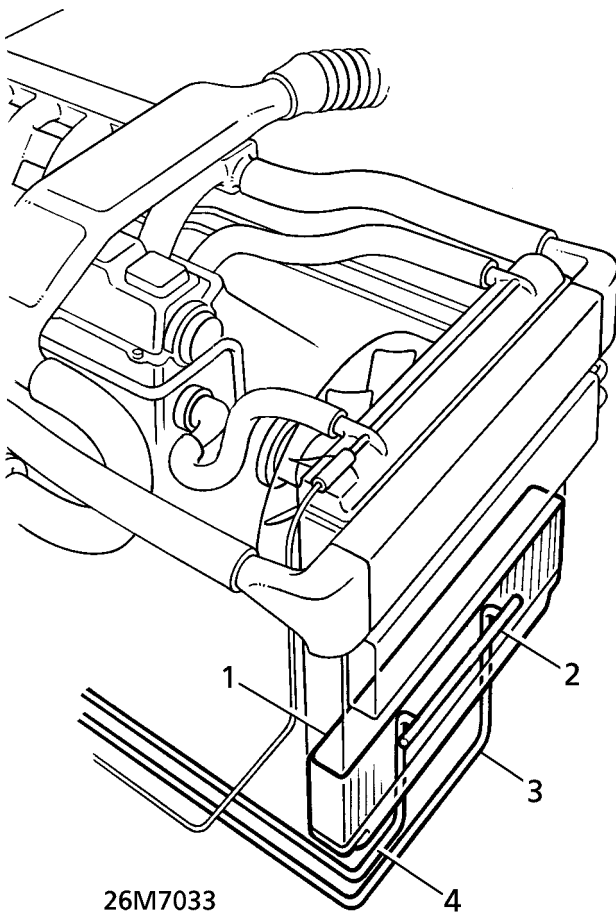
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**Description**

The gearbox oil cooler on manual vehicles is an integral part of the radiator and is a brass concentric tube type. The cooler is immersed in a separate water tank at the base of the radiator. The inner core, which has its own water jacket within the cooling tube, carries the transmission oil via feed and return pipes, see 26M7033.

**Operation**

Oil is pumped under pressure from the gearbox through the feed pipe (3) into the tube (2) of the oil cooler tank. With a combination of water and ram air cooling, through the front grille of the vehicle and assisted by the pull of the viscous fan, the cooled transmission oil is routed back to the gearbox via the return pipe (4), to repeat the cycle.

**Gearbox oil cooler, manual transmission**

1. Gearbox oil cooler tank
2. Coolant tube
3. Feed pipe, oil cooler
4. Return pipe, oil cooler



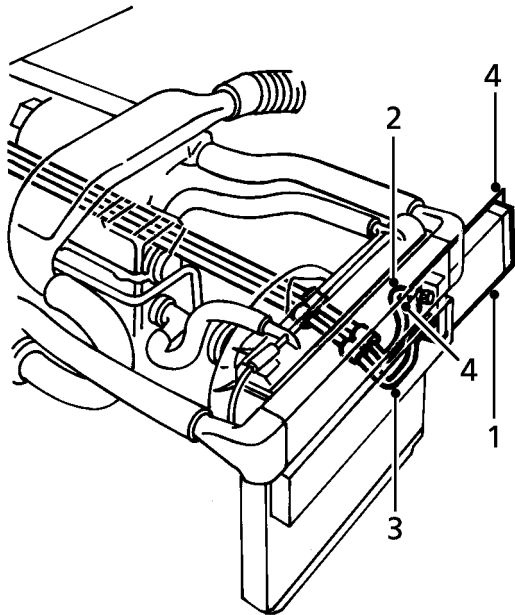
## GEARBOX OIL COOLER - AUTOMATIC

### Description

On diesel models with automatic transmission an independent oil cooler is used and is mounted on the LH side of the vehicle behind the front bumper. The oil cooler comprises a cast aluminium radiator, two pass, single row matrix with sixteen internal cooling tubes. Pre-formed feed and return pipes/hoses are used to link the automatic transmission and oil cooler.

### Operation

On automatic vehicles the coolant process relies on ram air only through an aperture in the LH side of the bumper moulding. Air is dispersed over the oil cooler, the cooled oil then being fed back, via the return pipe (3), to run parallel with the feed pipe to the LH side of the transmission.



26M7043

### Gearbox oil cooler, automatic transmission

1. Gearbox oil cooler
2. Feed pipe, oil cooler
3. Return pipe, oil cooler
4. Mounting brackets





## COOLING SYSTEM FAULTS

This section covers mechanical faults that could occur in the complete cooling system :- 1 Engine (coolant) cooling; 2 Turbo intercooling; 3. Engine oil cooling; 4. Gearbox oil cooling.

Before conducting any visual checks within the separate systems and undertaking detailed diagnosis procedures. **See Description and operation.**

### 1. ENGINE (COOLANT) COOLING SYSTEM

#### Symptom - Engine Overheating

POSSIBLE CAUSE	REMEDY
1. Engine coolant low.	1. Allow engine to cool. Top up expansion tank to correct level, with engine running at idle. Check cooling system for leaks and rectify if necessary.
2. Loose drive belt.	2. Check/renew drive belt tensioner or renew drive belt. <b>See ELECTRICAL, Repair.</b>
3. Coolant in radiator frozen.	3. Slowly thaw and drain cooling system. <b>See Repair.</b>
4. Air flow through radiator restricted or blocked.	4. Apply air pressure to engine side of radiator to clear obstruction. If mud or dirt is evident, carefully use a hose.
5. External leaks from water pump, engine gaskets, thermostat housing or pipe/hoses.	5. Check for visual causes and rectify.
6. Viscous fan not operating correctly or inoperative.	6. Renew viscous fan unit. <b>See Repair.</b>
7. Thermostat seized in closed position.	7. Check radiator bottom hose for coolant flow through radiator. If cold a faulty thermostat is confirmed. Renew thermostat. <b>See Repair.</b>

**Symptom - Engine Overheating Continued**

POSSIBLE CAUSE	REMEDY
8. Air in cooling system.	8. Check coolant level. Run engine at fast idle (approximately 2,000 rpm) with expansion tank cap off. Top up coolant level with engine at idle and refit expansion tank cap.
9. Air conditioning condenser fans not operating correctly or inoperative.	9. <b>See AIR CONDITIONING, Fault diagnosis.</b>
10. Temperature gauge or sender unit giving inaccurate readings.	10. Refer to <b>TestBook</b> .
11. Coolant leakage across cylinder head gasket.	11. Carry out cylinder pressure test to determine if pressure is leaking into cooling system, causing over pressurising and loss of coolant. Renew cylinder head gasket.
12. Engine oil contamination of cooling system due to leaking.	12. Renew cylinder head gasket. <b>See ENGINE, Repair.</b>
13. Coolant contamination of lubrication system.	13. Renew inlet manifold or front cover gaskets. <b>See MANIFOLD AND EXHAUST SYSTEM, Repair.</b> or <b>See ENGINE, Repair.</b>

**Symptom - Engine Runs Cold**

POSSIBLE CAUSE	REMEDY
1. Thermostat seized in open or partially open position.	1. Remove thermostat housing and check operation of thermostat. Renew, if necessary. <b>See Repair.</b>
2. Temperature gauge or sender unit giving inaccurate readings.	2. Refer to <b>TestBook</b> .
3. Viscous fan not operating correctly.	3. Renew viscous fan unit. <b>See Repair.</b>
4. Air conditioning condenser fans operating continuously.	4. Refer to <b>TestBook</b> .





## 2. TURBO INTERCOOLING SYSTEM

### Symptom - Loss of Performance

POSSIBLE CAUSE	REMEDY
1. Cooling air flow through intercooler matrix restricted or blocked.	1. Apply air pressure to engine side of radiator to clear obstruction. If mud or dirt is evident, carefully use a hose.
2. Charge-air flow through intercooler matrix restricted.	2. Check for blocked air cleaner element and renew, if necessary. <b>See SECTION 10, Maintenance.</b>
3. Blocked air cleaner.	3. Renew air cleaner element. <b>See SECTION 10, Maintenance.</b>
4. Pipe/hose leaks in intercooler system.	4. Tighten all joint connections or renew components as necessary.
5. Turbocharger not operating correctly or inoperative.	5. Substitute parts and recheck. <b>See FUEL SYSTEM, Repair.</b>
6. Customer fitted grille blind restricting cooling air flow.	6. Remove blind or advise accordingly.

## 3. ENGINE OIL COOLING SYSTEM

### Symptom - Engine Oil Overheating

POSSIBLE CAUSE	REMEDY
1. Air flow through oil cooler matrix restricted or blocked.	1. Apply air pressure to engine side of radiator to clear obstruction. If mud or dirt is evident carefully use a hose.
2. Blocked or damaged oil cooler or pipe/hoses, restricting engine oil flow.	2. Check for visual damage and renew components where necessary.
3. Oil cooler relief valve seized in closed position.	3. Remove and check relief valve. Renew if necessary.

#### 4. GEARBOX OIL COOLING SYSTEM

##### Symptom - Gearbox Oil Overheating

POSSIBLE CAUSE	REMEDY
1. Blocked or damaged oil cooler or pipe/hoses restricting gearbox oil flow.	1. Check for visual damage and renew components where necessary.
2. Leaking coolant from oil cooler water tank.	2. Remove radiator, inspect for source of leak and repair. <b>See Repair.</b>
3. Vehicle being driven in wrong gear.	3. Advise owner/driver accordingly.



**NOTE:** Critical warning messages relating to the complete cooling system are displayed on the message centre of the instrument pack, should a fault occur in any of the separate systems.



## COOLANT - DRAIN AND REFILL

Service repair no - 26.10.01

### Drain



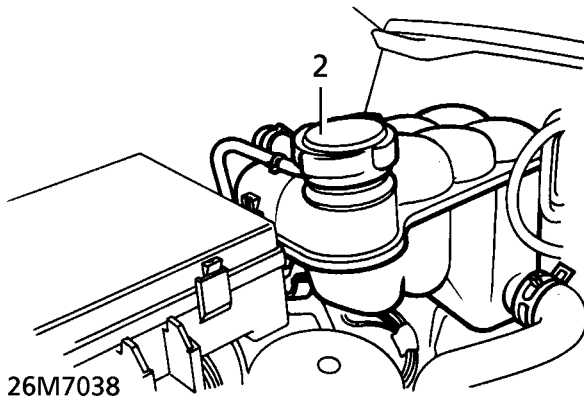
**WARNING:** Do not remove expansion tank filler cap when engine is hot. The cooling system is pressurised. Personal scalding could result.

1. Raise the vehicle.

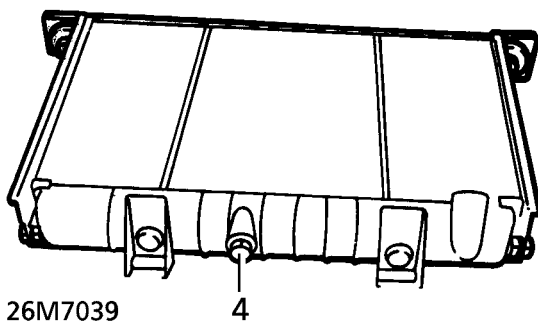


**WARNING:** Support on safety stands.

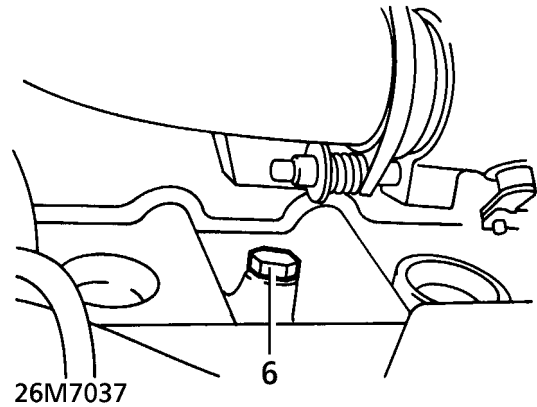
2. Remove expansion tank filler cap to assist draining.



3. Position container beneath radiator.
4. Remove plug from base of radiator. Allow coolant to drain.



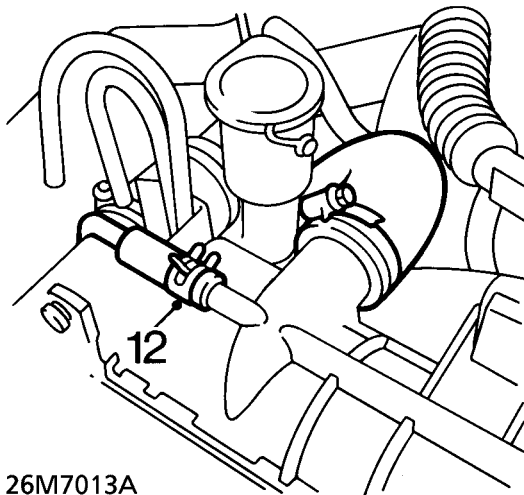
5. If system is only being partially drained, continue at **Refill**.
6. Reposition container. Remove cylinder block drain plug. Allow coolant to drain.



7. Clean drain plug threads. Apply a coating of 'Loctite 577'. Refit plug to block. Tighten securely.

## Refill

8. Ensure sufficient coolant solution is available.  
**See LUBRICANTS, FLUIDS AND CAPACITIES, Information.**
9. Inspect radiator drain plug 'O' ring, renew if required.
10. Fit drain plug to radiator. Tighten to **Max 6 Nm (4 lbf.ft)**
11. Remove safety stands. Lower vehicle.
12. Disconnect radiator bleed hose at the radiator.
13. Blow through hose to clear any residual coolant. Reconnect hose.
14. Fill expansion tank until coolant is level with base of neck.
15. Start engine, continue filling at expansion tank until coolant level stabilises at the 'COLD LEVEL' marking.
16. Run the engine until the thermostat opens (top hose becomes warm).
17. Stop engine, allow to cool.
18. Check coolant level, top-up as necessary.
19. Refit expansion tank filler cap.



26M7013A

## RADIATOR

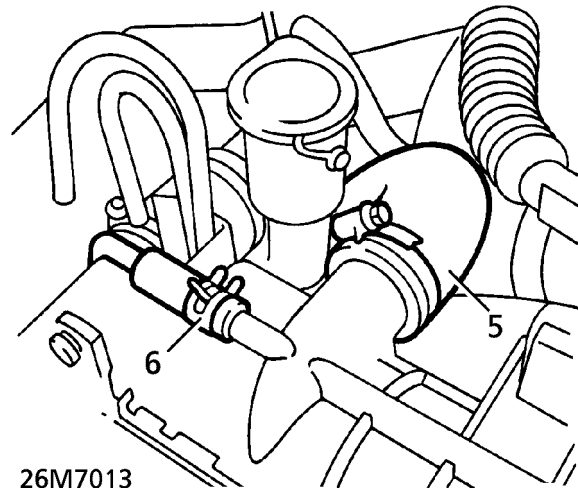
Service repair no - 26.40.04

## Remove

1. Disconnect battery negative lead.
2. Raise the vehicle.

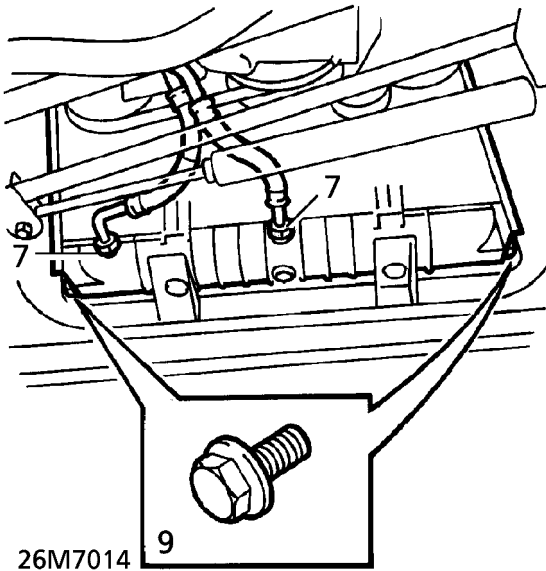
**WARNING: Support on safety stands.**

3. Drain cooling system. **See this section.**
4. Remove viscous coupling. **See this section.**
5. Release bottom hose from radiator.
6. Release expansion tank hose from radiator.



26M7013

7. **Manual Vehicles:** Disconnect gearbox oil cooler pipes from radiator. Remove 'O' rings and discard.
8. **Manual Vehicles:** Plug oil cooler pipes and connections.
9. Remove 2 bolts securing radiator to bracket. Remove radiator assembly.

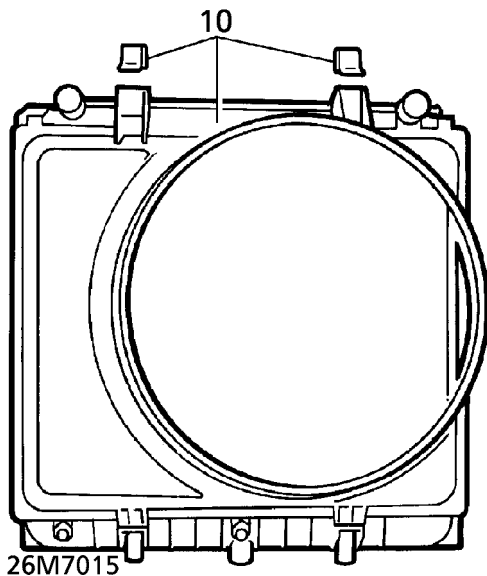


26M7014

### Refit

11. Ensure that lower mounting rubbers are positioned.
12. With assistance, position radiator. Engage mountings. Secure with bolts.
13. **Manual Vehicles:** Remove plugs from oil cooler pipes and connections.
14. **Manual Vehicles:** Using new 'O' rings, connect gearbox oil cooler pipes. Tighten to **30 Nm (22 lbf.ft)**
15. Fit viscous coupling. **See this section.**
16. Connect cooling hoses to radiator. Secure with clips.
17. Refill cooling system. **See this section.**
18. Remove safety stands. Lower vehicle.
19. Reconnect battery negative lead.
20. **Manual Vehicles:** Top-up gearbox fluid. **See SECTION 10, Maintenance.**

10. If necessary, remove 2 clips securing cowl to radiator. Remove cowl.



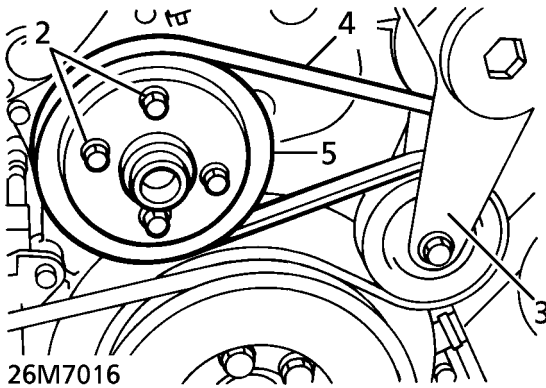
26M7015

**WATER PUMP**

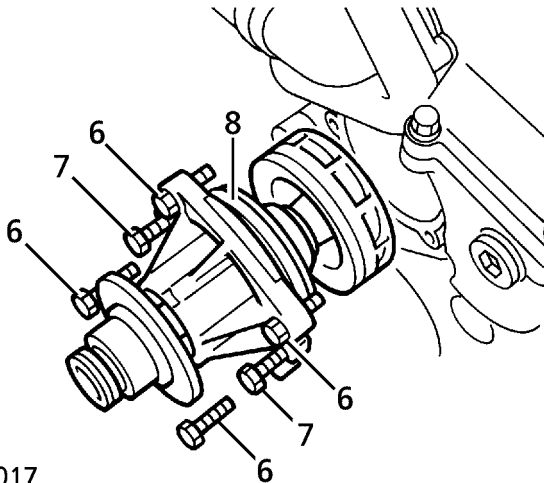
Service repair no - 26.50.01

**Remove**

1. Remove radiator assembly. **See this section.**
2. Slacken 4 water pump pulley bolts.



3. Release tension from auxiliary drive belt.
4. Release belt from water pump pulley.
5. Remove pulley bolts. Remove pulley.
6. Remove 4 bolts securing water pump.



7. Fit 2 M6 bolts into tapped holes of water pump. Extract pump.
8. Remove 'O' ring and extraction bolts.

**Refit**

9. Ensure mating faces are clean.
10. Lubricate 'O' ring with petroleum jelly. Fit to water pump.
11. Fit water pump. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
12. Fit water pump pulley. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
13. Rotate tensioner. Fit auxiliary drive belt.
14. Fit radiator assembly. **See this section.**



## VISCOUS COUPLING AND FAN ASSEMBLY

Service repair no - 26.25.19

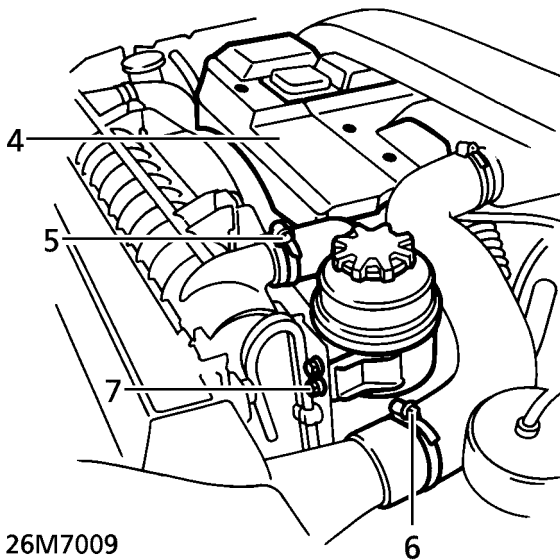
### Remove

1. Disconnect battery negative lead.
2. Raise the vehicle.



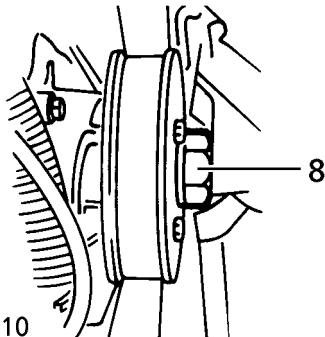
**WARNING: Support on safety stands.**

3. Drain cooling system. **See this section.**
4. Remove 3 bolts securing upper fan cowl. Remove cowl.



26M7009

5. Release top hose from radiator. Position hose aside.
6. Release outlet hose from intercooler. Position hose aside.
7. Remove 2 bolts securing power steering reservoir to radiator bracket. Position reservoir aside.
8. Using special tools LRT-12-093 and LRT-12-094 unscrew viscous coupling.

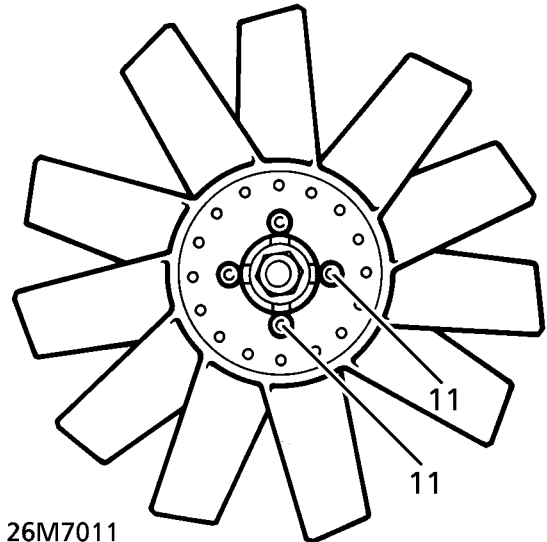


26M7010



**NOTE: Viscous coupling is fitted with a LH thread.**

9. Remove viscous coupling assembly from LH side of radiator.
10. **Do not carry out further dismantling if component is removed for access only.**
11. Remove 4 bolts securing fan to coupling. Remove coupling.



26M7011

### Refit

12. Ensure mating faces are clean.
13. Fit fan to coupling. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
14. Position viscous coupling assembly.
15. Engage to pump. Using special tools LRT-12-093 and LRT-12-094. Tighten to **40 Nm (29 lbf.ft)**
16. Connect hoses to intercooler and radiator. Secure with clips.
17. Position power steering fluid reservoir to radiator bracket. Secure with bolts.
18. Position upper fan cowl. Secure with bolts.
19. Refill cooling system. **See this section.**
20. Remove safety stands. Lower vehicle.
21. Reconnect battery negative lead.

## THERMOSTAT

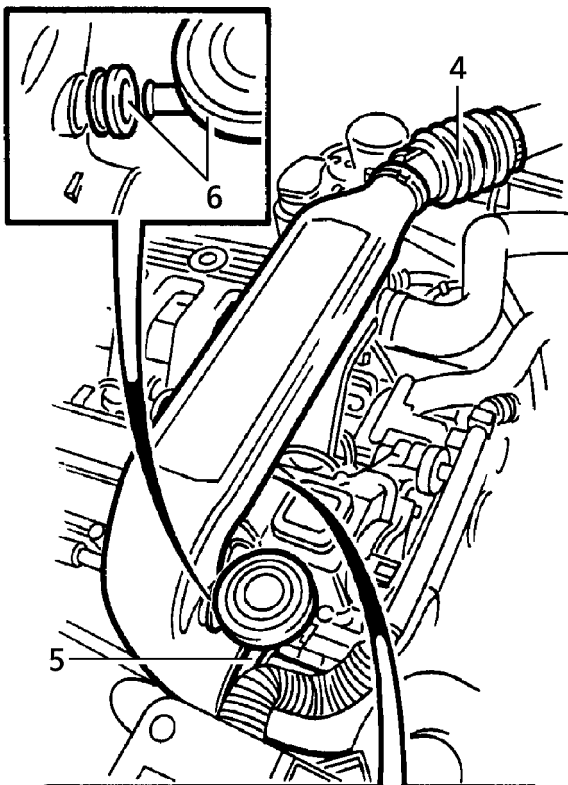
Service repair no - 26.45.01

## Remove

1. Disconnect battery negative lead.
2. Raise the vehicle.

**WARNING: Support on safety stands.**

3. Remove cooling fan cowl. *See this section.*
4. Release intake hose from ducting.

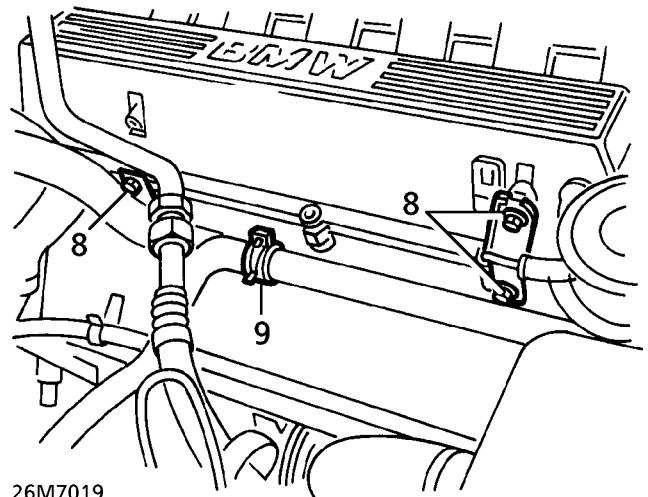


26M7018

5. Release turbocharger intake hose from ducting.
6. Release breather valve from intake ducting grommet.

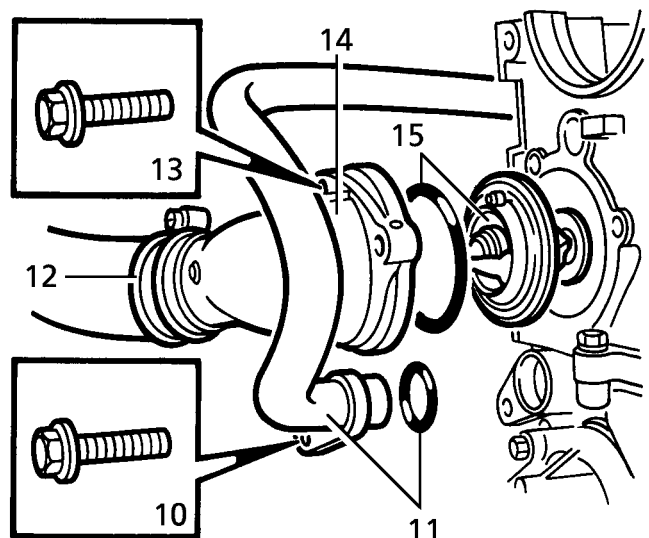
**NOTE: Collect grommet. Refit to ducting.**

7. Disengage 2 clips securing intake ducting. Remove ducting.
8. Remove 3 bolts securing intake ducting bracket and exhaust manifold heat shield to camshaft cover. Collect bracket.



26M7019

9. Disconnect heater hose from coolant connecting pipe.
10. Remove bolt securing coolant connecting pipe to engine front cover.



26M7020

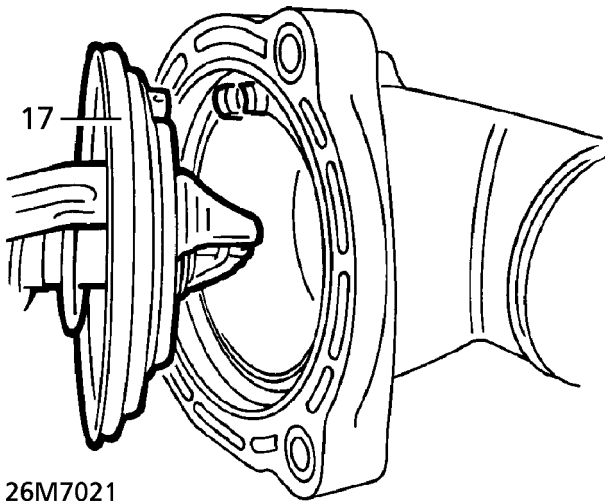




11. Remove coolant pipe. Remove 'O' ring and discard.
12. Remove top hose from thermostat housing.
13. Remove 3 bolts securing thermostat housing to engine front cover.
14. Remove thermostat housing.
15. Collect thermostat. Remove 'O' ring and discard.

#### Refit

16. Lubricate new 'O' ring with clean coolant solution. Fit to thermostat.
17. Locate thermostat in housing.



26M7021



**CAUTION:** Ensure that ball valve is correctly located.

18. Position thermostat and housing assembly. Secure with bolts. Tighten to **10 Nm (7 lbf.ft)**
19. Fit top hose to thermostat. Secure with clip.
20. Using a new 'O' ring, position coolant pipe. Engage to engine front cover.
21. Secure connecting pipe to front cover with bolt. Tighten to **10 Nm (7 lbf.ft)**
22. Connect heater hose. Secure with clip.
23. Align exhaust manifold heat shield. Position intake ducting bracket.
24. Secure ducting bracket and heat shield with bolts.
25. Position intake ducting. Engage clips.
26. Engage breather valve into ducting grommet.
27. Connect ducting to turbocharger intake hose. Secure with clip.
28. Connect intake hose to ducting. Secure with clip.
29. Fit cooling fan cowl. **See this section.**
30. Remove safety stands. Lower vehicle.
31. Reconnect battery negative lead.

#### COOLING FAN COWL

Service repair no - 26.25.11

#### Remove

1. Disconnect battery negative lead.
2. Raise the vehicle.



**WARNING:** Support on safety stands.

3. Remove viscous coupling and fan assembly. **See this section.**
4. Disconnect bottom hose from radiator.
5. Remove 2 clips securing cowl to radiator.
6. Remove cooling fan cowl from radiator.

#### Refit

7. Reverse removal procedure.



## 26 - COOLING SYSTEM

### CONTENTS

Page

## LAND ROVER V8

### DESCRIPTION AND OPERATION

ENGINE COOLING - DESCRIPTION .....	3
ENGINE COOLING - OPERATION .....	9

### FAULT DIAGNOSIS

COOLING SYSTEM FAULTS .....	1
-----------------------------	---

### REPAIR

COOLANT - DRAIN AND REFILL .....	1
RADIATOR .....	2
VISCOUS COUPLING AND FAN ASSEMBLY - UP TO 99MY .....	4
VISCOUS COUPLING AND FAN ASSEMBLY - FROM 99MY .....	5
WATER PUMP - UP TO 99MY .....	6
WATER PUMP - FROM 99MY .....	7
THERMOSTAT - UP TO 99MY .....	8
THERMOSTAT - FROM 99MY .....	8
EXPANSION TANK .....	9







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## DESCRIPTION

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Operation of the engine is monitored and controlled by a Digital Diesel Electronics (DDE) system. The DDE system electronically regulates injection timing and fuel delivery rate under all operating conditions.

The system comprises:

- An engine control module
- Output devices
- Input devices
- An injection pump

### Engine Control Module (ECM)

The 55-pin engine control module (ECM) is located under the bonnet, in a compartment of the battery tray. It consists of an input section, two microprocessors, No. 1 and No. 2, and an output section. The microprocessors receive input signals from the various input devices and calculate the necessary response to the output devices. Calculations are based on fixed, pre-programmed data. Data is manipulated within function blocks:

#### Microprocessor function blocks

The following function blocks are provided in microprocessor 1:

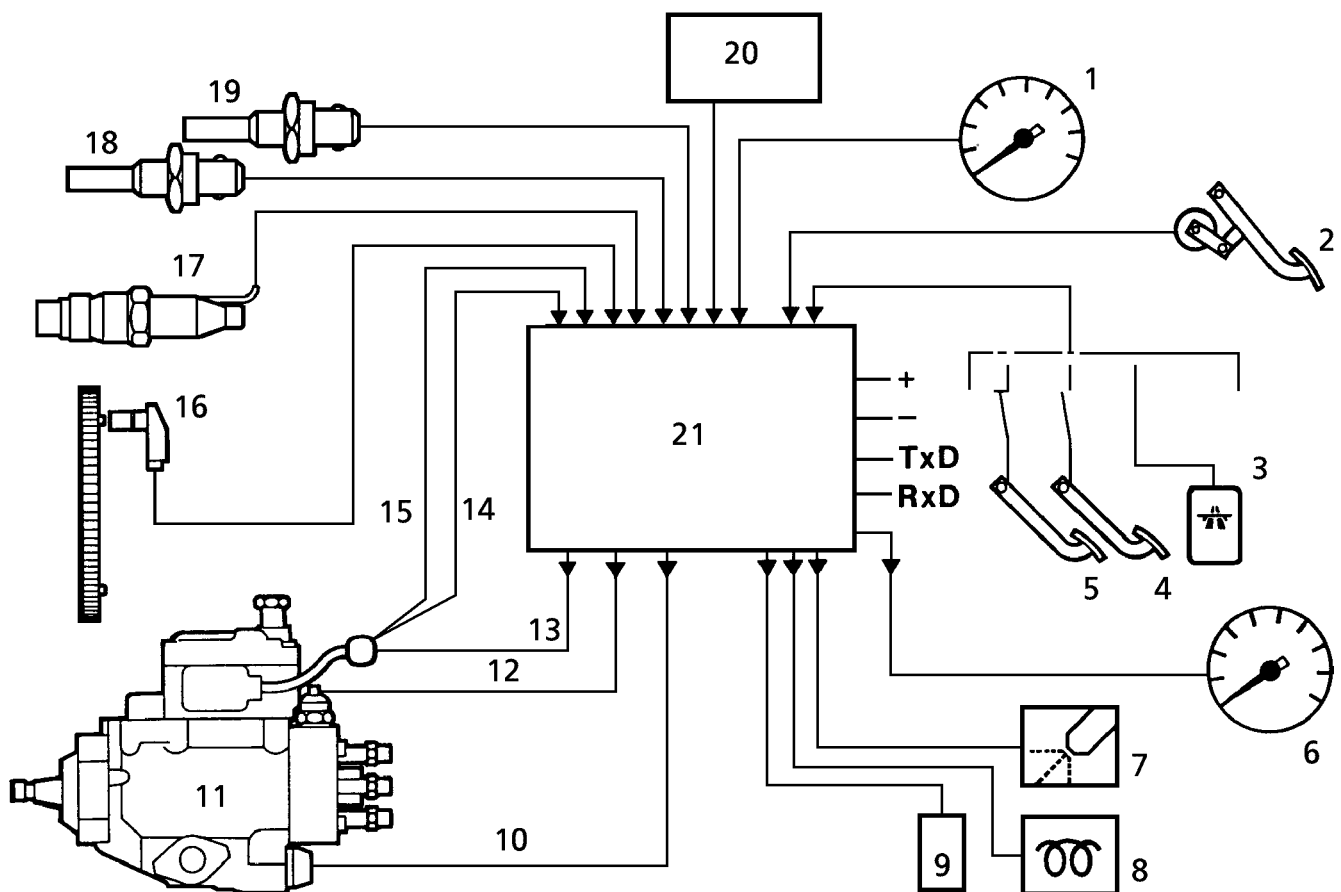
- Injection timing (start of injection) control
- Output of self-diagnosis results

The following function blocks are provided in microprocessor 2:

- Injection quantity control with special start quantity control and full load quantity limitation
- Engine speed control
- Running stability control and vibration damping
- Exhaust emission limitation and overheating protection
- Cruise control

### Fault diagnosis

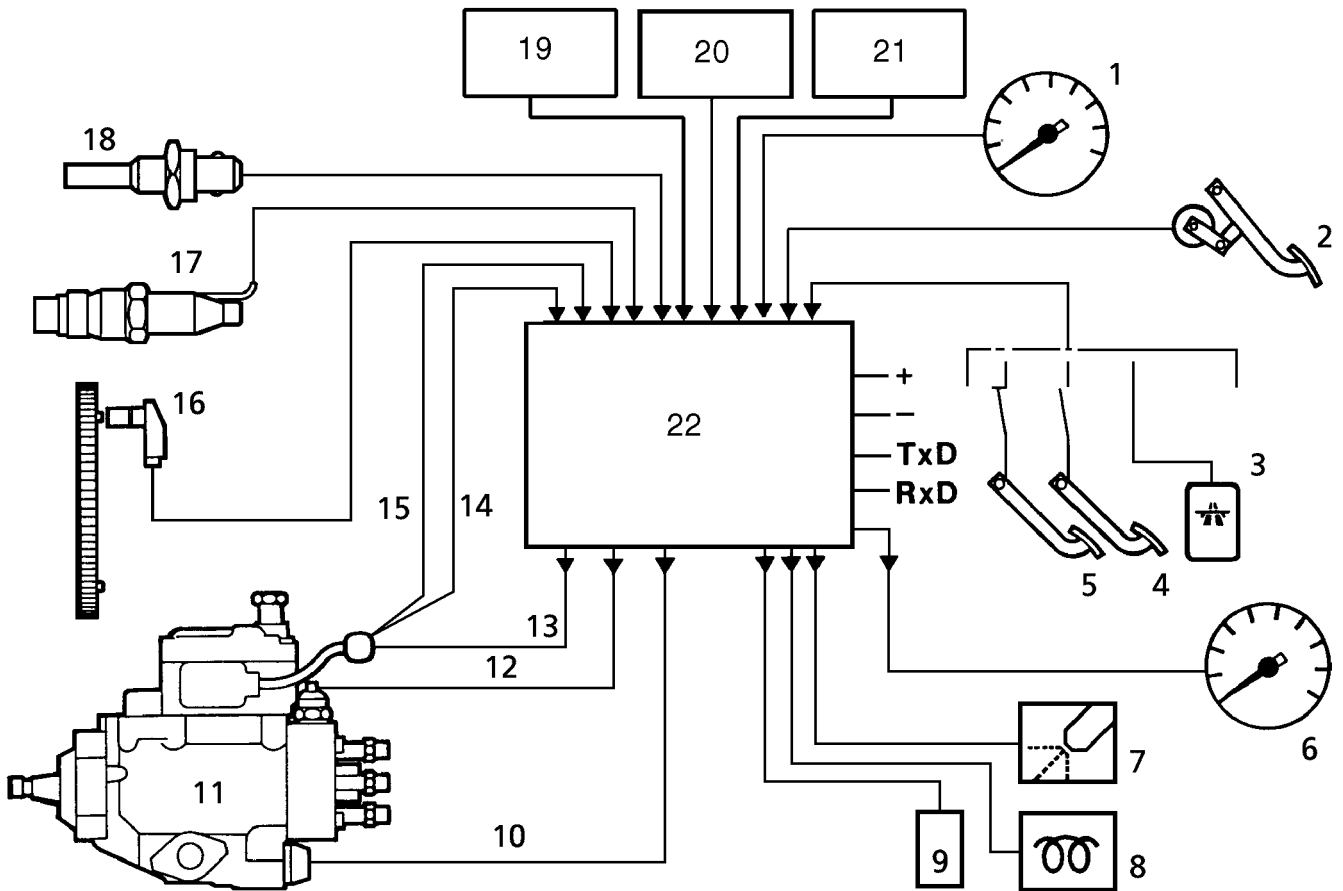
Operating faults are registered by the ECM and held within a defect code memory. TestBook connected into the diagnostic socket beneath the fascia, can be used to interrogate the ECM for stored faults and perform diagnostic routines. The ECM is also connected to a warning lamp on the instrument panel.



18M7013A

### Fuel system inputs/outputs - Vehicles without EGR

- |   |   |
|---|---|
| 1. Vehicle speed signal                                   | 11. Fuel injection pump                       |
| 2. Throttle position sensor - linked to accelerator pedal | 12. Stop solenoid                             |
| 3. Cruise control selector (optional)                     | 13. Quantity servo control unit               |
| 4. Brake switch   | 14. Quantity servo control unit potentiometer |
| 5. Clutch switch  | 15. Fuel temperature sensor                   |
| 6. Engine speed signal                                    | 16. Crankshaft position sensor                |
| 7. Diagnostic lamp  | 17. Start of injection sensor                 |
| 8. Glow plug lamp   | 18. Coolant temperature sensor                |
| 9. Heater time relay                                      | 19. Intake air temperature sensor             |
| 10. Injection timing device                               | 20. Manifold absolute pressure sensor         |
|   | 21. Engine Control Module (ECM)               |



M18 0286

**Fuel system inputs/outputs - Vehicles with EGR**

- |   |   |
|---|---|
| 1. Vehicle speed signal                                   | 12. Stop solenoid                             |
| 2. Throttle position sensor - linked to accelerator pedal | 13. Quantity servo control unit               |
| 3. Cruise control selector (optional)                     | 14. Quantity servo control unit potentiometer |
| 4. Brake switch   | 15. Fuel temperature sensor                   |
| 5. Clutch switch  | 16. Crankshaft position sensor                |
| 6. Engine speed signal                                    | 17. Start of injection sensor                 |
| 7. Diagnostic lamp  | 18. Coolant temperature sensor                |
| 8. Glow plug lamp   | 19. Manifold Absolute Pressure (MAP) sensor   |
| 9. Heater time relay                                      | 20. Mass Air Flow (MAF) sensor                |
| 10. Injection timing device                               | 21. EGR Modulator valve                       |
| 11. Fuel injection pump                                   | 22. Engine Control Module (ECM)               |

### Input devices

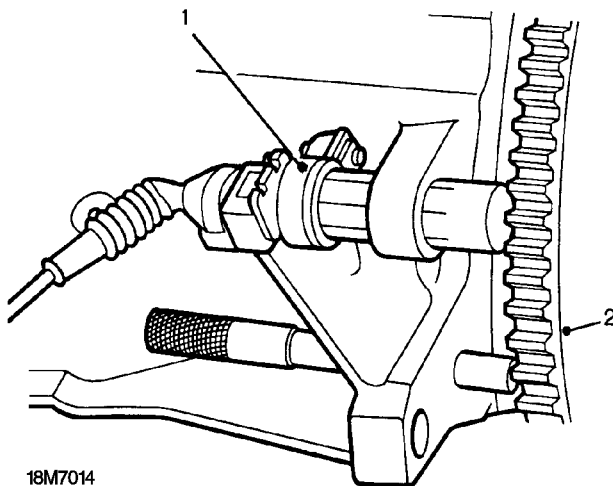
Input devices of the DDE system comprise the following:

- Crankshaft position sensor
- Start of injection sensor
- Fuel temperature sensor
- Coolant temperature sensor
- Intake air temperature sensor
- Manifold absolute pressure sensor
- Vehicle speed signal
- Throttle position sensor
- Servo unit potentiometer (drive potentiometer) on quantity servo control unit
- Clutch switch
- Brake switches
- Cruise control selector (if fitted)

### Crankshaft position sensor (CKP sensor)

Attached to the flywheel of the engine are six position pins. These are equally spaced around the crankshaft circumference at 60 degree intervals.

To determine engine speed and crankshaft position, an inductive CKP sensor is mounted on the crankcase adjacent to the flywheel. The CKP sensor consists of a body containing a coil and a permanent magnet which provides a magnetic field. The CKP sensor is situated so that an air gap exists between it and the position pins. Air gap distance is critical for correct operation.

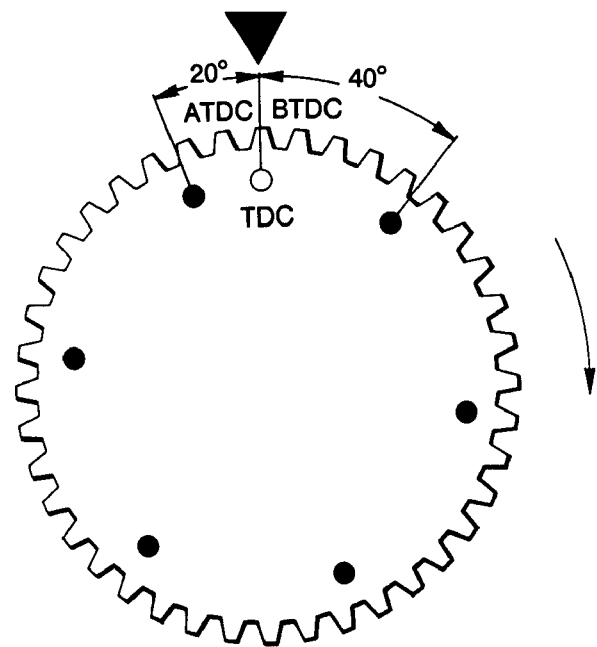


18M7014

1. Sensor
2. Flywheel

As the flywheel rotates, position pins pass the CKP sensor and disturb the magnetic field, inducing voltage pulses in the coil. The pulses are transmitted to the ECM.

When the flywheel rotates one complete revolution, six pulses are transmitted to the ECM. The ECM determines engine speed by calculating how many pulses occur within a given time. The output from the CKP sensor is also used, in conjunction with the start of injection sensor, to determine and control ignition timing.



18M7015A

The flywheel position pins are spaced so that at TDC, one pin is 40 degrees before TDC while the other is 20 degrees after TDC as shown. To determine which pulse represents 40 degrees before, or 20 degrees after TDC, the control unit requires additional information from the start of injection sensor.



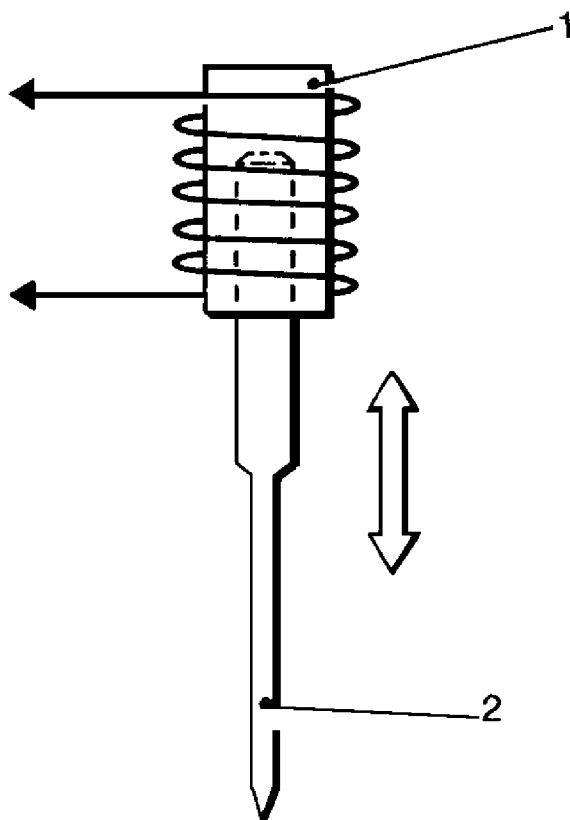


### Start of injection sensor

The start of fuel injection is registered by this sensor which is incorporated in No 4 injector.

The sensor consists of a coil which surrounds the shaft of an extended injection needle. The coil is fed a DC supply from the ECM which produces a magnetic field.

When the needle is moved under the influence of fuel pressure, the magnetic field is disturbed which induces an AC voltage in the coil. The induced voltage is registered in the ECM as a reference point for the start of injection.



1. Coil
2. Injector needle

The ECM uses the input signals from the start of injection sensor, together with signals from the crankshaft position sensor, to detect the actual start of injection angle. The detected actual value is adjusted by the ECM to a nominal value via the injection timing solenoid.

### Fuel temperature sensor

Fuel temperature is monitored by a sensor located in the fuel injection pump. This sensor is of the negative temperature coefficient (NTC) type, designed to reduce its resistance with increasing temperature.

When the system is operating, the ECM regularly checks the sensor resistance. As fuel density varies with temperature, the information received is used to calculate the correct quantity of fuel to inject.

### Engine coolant temperature sensor (ECT sensor)

The temperature of the engine coolant is monitored by a ECT sensor located on the cylinder head.

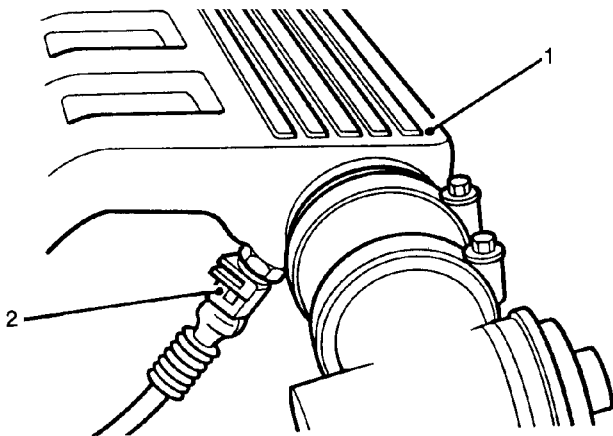
The ECT sensor is of the NTC type and is similar in operation to the fuel temperature sensor previously described.

The ECM uses this information to adjust the basic injection timing and quantity values for all operating conditions.

### Intake air temperature sensor (IAT sensor) - Vehicles without EGR

Intake air temperature is monitored by a IAT sensor in the intake manifold. The IAT sensor is of the NTC type and is similar in operation to the fuel temperature sensor previously described.

The ECM uses the information received from the IAT sensor, in conjunction with the manifold absolute pressure sensor, to determine the volume of air being drawn in to the engine.



18M7017

1. Intake manifold
2. IAT sensor

### EGR Modulator valve - Vehicles with EGR

The EGR modulator valve is located in the engine compartment on the left inner wing near the bulkhead. The EGR modulator valve is used to control the EGR valve and is controlled by the ECM. **See EMISSION CONTROL, Description and operation.**

### Manifold absolute pressure sensor (MAP sensor)

Inlet air pressure is monitored by a silicon diaphragm type sensor mounted on top of the fuel filter and connected, via a pressure tube to the intake manifold. The MAP sensor is connected electrically to the ECM.

When inlet air pressure changes, pressure in the detection chamber causes the diaphragms to deflect. This alters the length of each resistor, changing their resistance value. The change is detected by electronics within the MAP sensor which varies the output voltage. This is converted to a pressure reading in the ECM.

Manifold absolute pressure, when linked to inlet air temperature, gives an accurate measurement of the charge volume. The ECM adjusts fuelling as necessary.

### Mass air flow sensor (MAF sensor) - Vehicles with EGR

The MAF sensor is located in the air inlet pipe from the air cleaner and is connected electrically to the ECM. The sensor replaces the Air Intake Temperature (IAT) sensor previously used on Pre-EGR vehicles.

The MAF sensor comprises a hot film sensor which has a heated surface maintained by an electrical current at a constant temperature. With cool air flowing past the sensor, the volume of air drawn into the intake manifold is measured by the electrical current required to keep the temperature of the hot film sensor constant.

The MAF sensor records the amount of incoming air being drawn into the engine. The ECM uses this information to control the Exhaust Gas Recirculation (EGR) process. **See EMISSION CONTROL, Description and operation.**



### Vehicle speed signal

Vehicle speed is monitored by the ECM from the ABS ECU.

The ECM uses vehicle speed data when adjusting idle stabilisation, cruise control and fuel delivery.

### Throttle position sensor (TP sensor)

The position, selected by the driver, of the accelerator pedal is signalled to the ECM by the TP sensor. This is linked, mechanically to the pedal and electrically to the ECM.

The sender consists of a thick film TP sensor together with a sender switch (9 degree switch). With the accelerator pedal at rest the switch is open. When the pedal is moved past the 9 degree position the switch closes.

When the ignition is switched ON, pedal position is signalled to the ECM. Pedal movement causes voltage through the TP sensor to vary and the ECM uses this to measure:

- Required engine speed
- Rate of acceleration
- Rate of deceleration

The ECM calculates the rate of change of the voltage signal in a positive (accelerate) or negative (decelerate) direction. From this, acceleration enrichment, deceleration fuel metering or overrun fuel cut-off can be carried out by the system.

The sender switch is used together with the voltage from the TP sensor to check the operation of the circuit. When the pedal is moved, the switch signals a logic input to the ECM. The ECM then checks the voltage signal from the TP sensor. This voltage is compared with a pre-programmed value to check that the TP sensor is working correctly.

### Servo unit potentiometer (drive potentiometer) on quantity servo control unit

This potentiometer signals a voltage to the ECM. The voltage value is used to calculate the position of the control spool in the injection pump quantity servo control unit - See description of this item.

### Clutch switch

A switch fitted at the clutch pedal position is connected to the ECM.

The switch detects when the clutch is depressed. This input is used to deactivate the cruise control and various driveability strategies.

### Brake switch

The brake pedal is fitted with a twin contact switch which provides two outputs. Both outputs send signals to the ECM. Both signals are used by the system to test the operation of the brake circuit, and to deactivate the cruise control.

### Output devices

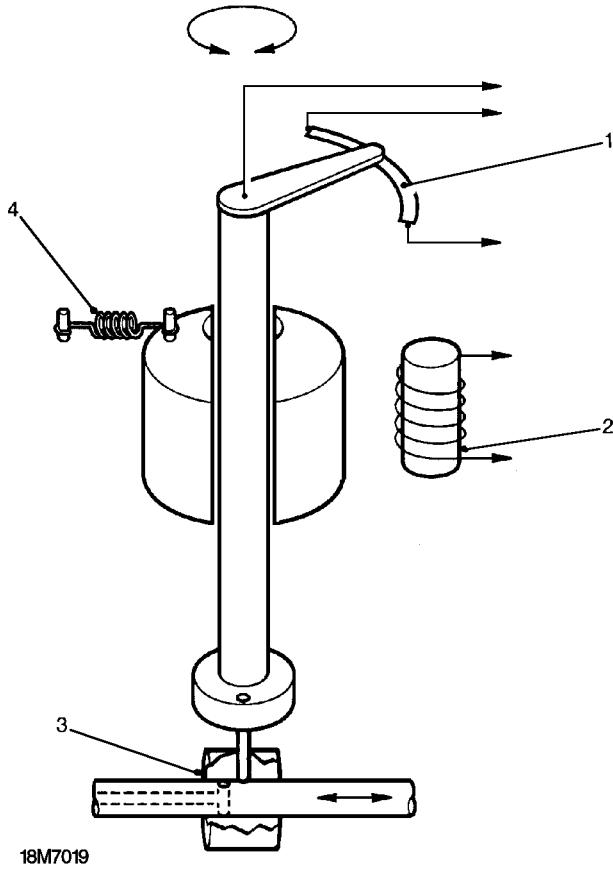
Output devices of the DDE system comprise the following:

- Quantity servo control unit
- Stop solenoid
- Injection timing device
- Heater time relay
- Diagnosis and preheater lamps
- Fuel consumption indicator in instrument pack

### Quantity servo control unit

The servo is used to accurately control the amount of fuel delivered to the injectors. It is housed within the fuel injection pump. **See Injection pump.**

The unit consists of a rotary magnet mounted on an eccentric shaft; the shaft engages with the control spool of the pump. The rotary magnet is fitted with a return spring and moves under the influence of a control coil. The magnet rotates through an arc of about 60 degrees which moves the control spool from zero to maximum fuel delivery position. The eccentric shaft engages with the control spool at one end, while the opposite end operates a rotary potentiometer.



- 1. Rotary potentiometer
- 2. Control coil
- 3. Control spool
- 4. Return spring

When the control coil is energised the rotary magnet and eccentric shaft move against spring pressure. Rotary movement of the eccentric shaft is converted into linear movement of the control spool. This allows more fuel to be delivered to the injectors.

When the control coil is de-energised the return spring causes the rotary magnet and eccentric shaft to resume their original position. The control spool is moved to the zero position.

The control unit accurately controls the position of the control spool to achieve the desired engine performance.

**Stop solenoid**

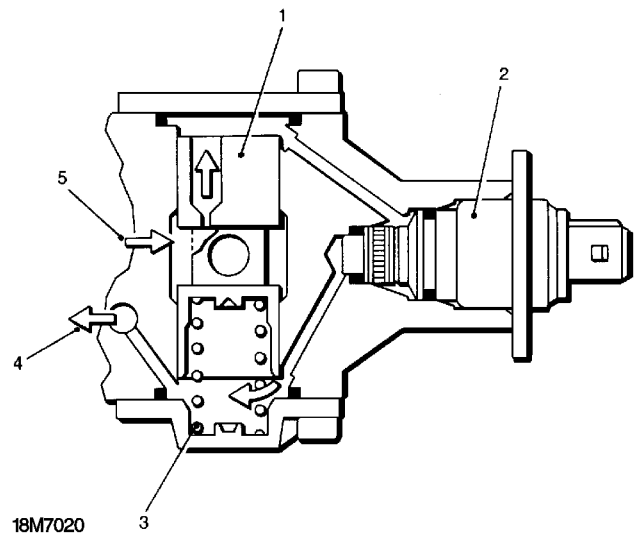
This is a solenoid operated valve located on the high pressure section of the injection pump. When the ignition is switched ON it receives voltage supply and the valve opens allowing fuel to flow.

When the ignition is switched OFF the valve closes and the fuel supply is cut.

**Injection timing device**

This injection timing device is housed within the fuel injection pump. It consists of a spring-loaded plunger and a solenoid. The spring loaded plunger moves under the influence of pump working pressure. The solenoid is controlled by a pulsed frequency signal from the control unit.

When the pump is operating the solenoid regulates the speed dependent, internal pump pressure into working pressure. This moves the plunger against spring tension.



- 1. Plunger
- 2. Solenoid
- 3. Spring
- 4. Pump feed pressure
- 5. Pump internal pressure

Injection is retarded with an energised solenoid and the resultant pressure drop. The beginning of injection is advanced with a de-energised solenoid and the resultant pressure rise.

**Heater time relay**

Glow plug preheating time is regulated by the heater timer relay in the heating time control unit. This connects to the glow plugs in the cylinder head and to the ECM.

The control unit monitors and operates the glow plugs; operating time for the glow plugs is dependent on engine temperature.



**Fuel injection pump (FIP)**

The FIP is of the vane-type and is chain driven from the front end of the crankshaft. Fuel delivery from the FIP to the injectors is regulated by the movement of a control spool. Movement of the control spool increases or decreases the fuel delivery rate to meet engine operating requirements.

The FIP houses the following items that either send signals to the ECM, or responds to signals sent from the ECM:

**Fuel quantity servo unit**

Moves the control spool to regulate the amount of fuel delivered to injectors.

**Servo unit potentiometer**

Used by the control unit to calculate the position of the control spool.

**Injection timing device**

Regulates pump speed dependent on internal pump pressure.

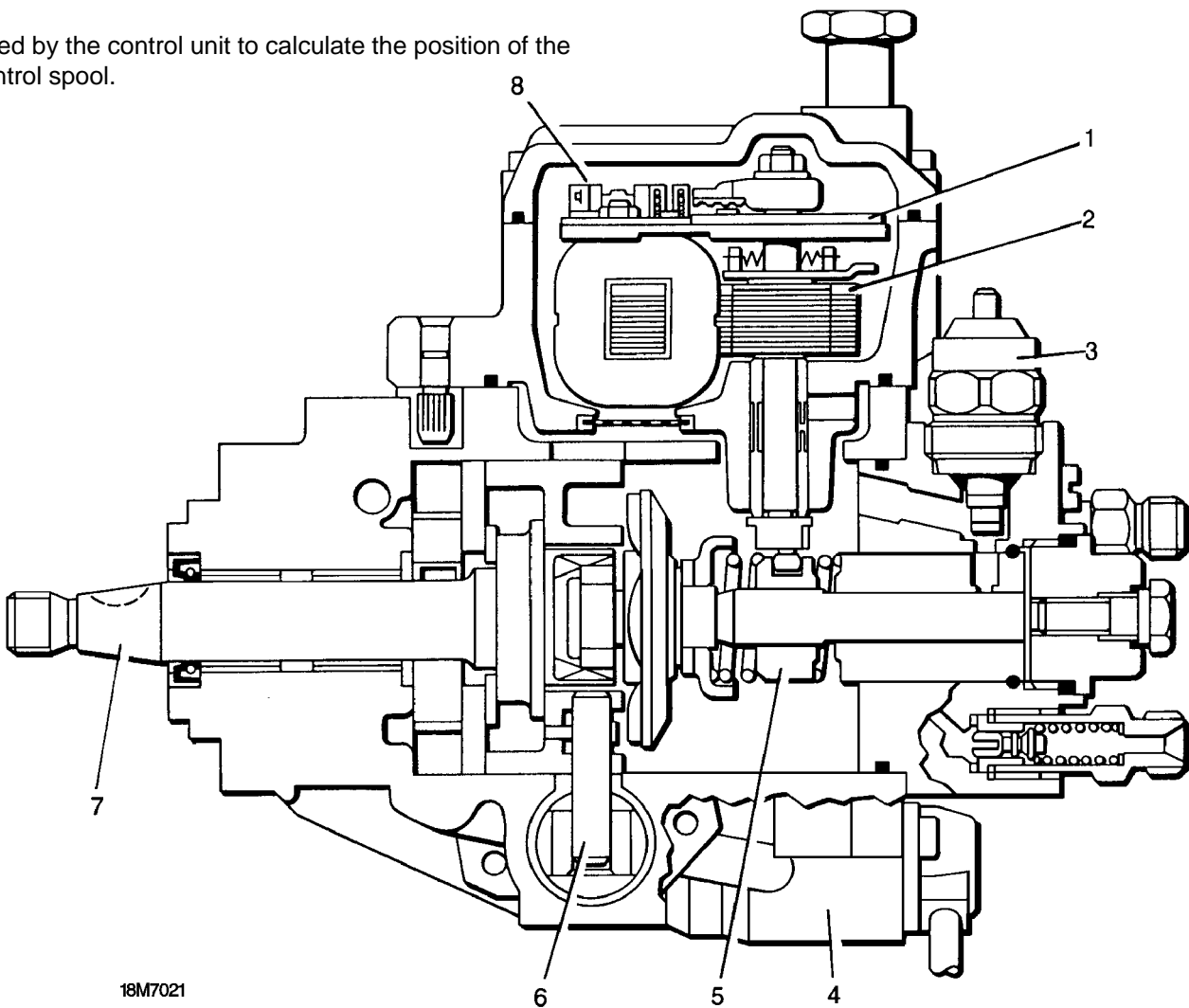
**Fuel temperature sensor**

Monitors fuel temperature.

**Stop solenoid**

Cuts fuel delivery to the injectors when de-energised.

These items have been previously described in this section - **See Input devices or Output devices** as applicable.



18M7021

- |   |                            |
|---|----------------------------|
| 1. Rotary potentiometer                   | 5. Control spool           |
| 2. Quantity control servo unit            | 6. Timing device plunger   |
| 3. Stop solenoid                          | 7. Drive shaft             |
| 4. Injection timing device solenoid valve | 8. Fuel temperature sensor |

---

**OPERATION**

---

**General**

The digital diesel electronics system (DDE) facilitates exact control of injection quantity and injection timing under all operating conditions. As a result, fuel consumption and exhaust emissions are kept to a minimum.

**Malfunctions**

If a fault occurs in any of the following circuits: manifold absolute pressure sensor, fuel temperature sensor or coolant temperature sensor, the ECM will provide substitute values. In the case of a faulty throttle position sensor, start of injection sensor or injection timing device, the engine will run at a reduced performance level.

If the servo unit potentiometer or servo unit fails, the injection system is deactivated. The engine shuts down as a result.

**Injection timing (Start of Injection) control**

The start of injection is controlled by the injection timing device in the injection pump. A solenoid valve modulates the internal pump pressure on one side of the system so that a defined start of injection is set. When no power is applied, the solenoid valve is closed, resulting in advanced injection timing (start of injection).

**Injection quantity control**

Injection quantity control is achieved by the quantity servo control unit in the injection pump. The servo acts on the pump control spool to vary the effective stroke of the pump piston (injection quantity). The position of the control spool is signalled back via the servo potentiometer to the ECM. The ECM compares the actual value with the nominal value and, if necessary, adjustment is carried out until the nominal injection quantity value is achieved. The servo control unit is set to zero delivery when no power is applied.

**Start control**

To determine the quantity of fuel to inject during starting, the ECM uses signals from the coolant temperature sensor, fuel temperature sensor, crankshaft position sensor and throttle position sensor.

**Engine speed control**

After starting, an idle speed control function cuts in after a certain engine speed threshold has been exceeded. This is calculated by the ECM dependent on the coolant temperature and the active loads. The idle speed can be adjusted by means of TestBook.

The maximum engine speed is limited by the ECM by reducing the injection quantity.

**Running stability control and jolt damping**

The running stability control system is used for engine speed stabilization when idling. Controlled injection quantity correction counteracts the irregularities which occur in the individual cylinders as the result of dispersion of the injected fuel quantity.

In the case of spontaneous change in the position of the accelerator pedal or a sudden change in the driving resistance, vibrations occur which, in conjunction with the control frequency of the injection hydraulics, can result in jolts and jerks.

On the basis of segment-by-segment angle evaluation in the input sequence, the engine speed signals provide the information which is used for corrective control (rotation irregularities) in the quantity servo control unit. The prerequisite for this function is the input of the vehicle speed signal.

**Exhaust emission limitation and overheating protection**

At high ambient air temperatures and at increasing altitude, the full load quantity is reduced in order to limit exhaust emission. The full load fuel quantity is also reduced when the permissible water temperature is exceeded in the high speed range.



### **Cruise control**

The required driving statuses: acceleration or resume driving speed can be set or selected using the steering wheel switches. These functions are active with a vehicle speed of more than 40 km/h (25 mph).

### **Air conditioning compressor cut-out**

The ECM switches off the air conditioning compressor during driving conditions demanding high torque requirements (starting off, accelerating). The compressor is also cut-out at high water temperatures (more than 110°C) in order to protect the engine.

### **Self-diagnosis**

The task of the self-diagnosis function is to detect malfunctions in the DDE system and to make available substitute values and emergency programs. The ECM stores a record of faults, including intermittent faults which can be interrogated using TestBook.





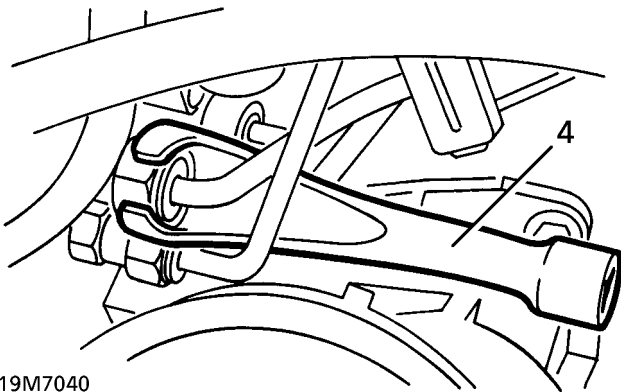


**FUEL INJECTION PUMP TIMING - CHECK AND ADJUST**

Service repair no - 19.30.01

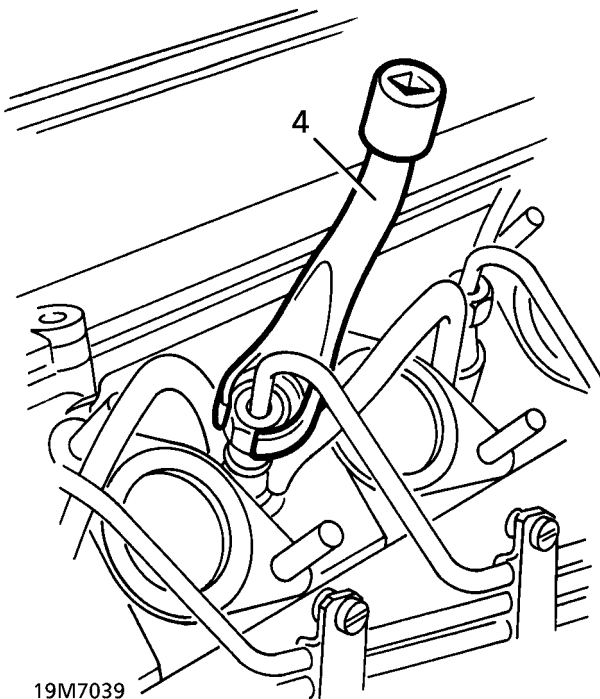
**Check**

1. Disconnect battery negative lead.
2. Remove intake manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
3. Remove cooling fan cowl. **See COOLING SYSTEM, Repair.**



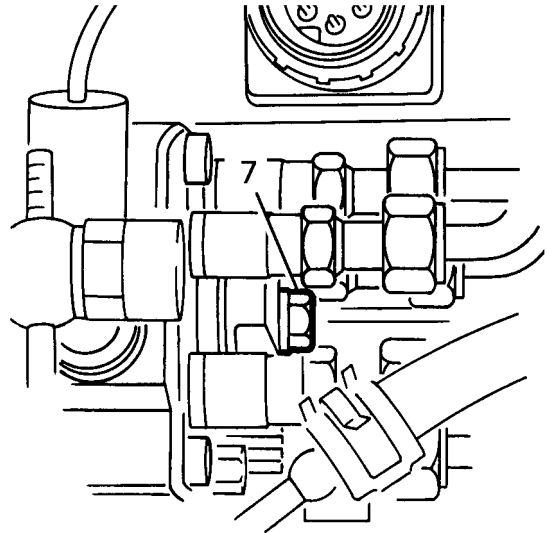
19M7040

4. Loosen high pressure pipe unions at injectors and Fuel Injection Pump (FIP) using LRT-12-117.

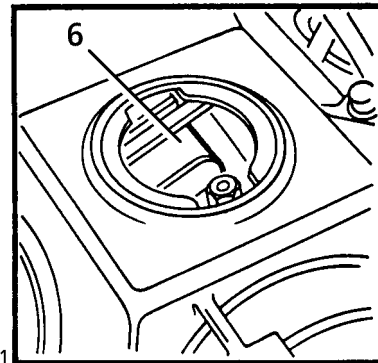


19M7039

5. Remove oil filler cap.
6. Observe No. 1 camshaft lobe. Turn engine clockwise until lobe points vertically upwards.



19M7041

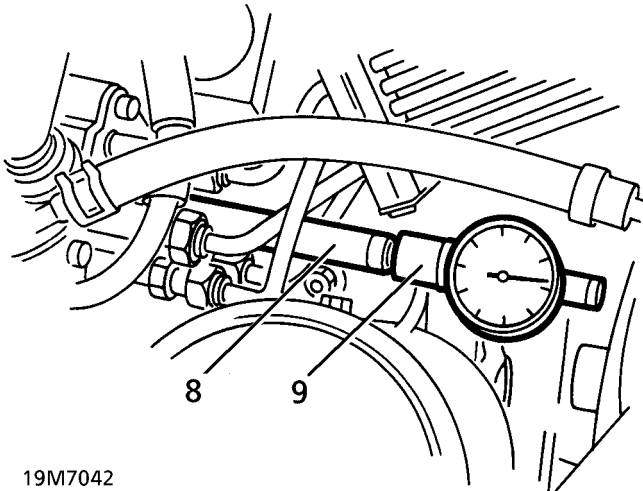


**NOTE:** This indicates that the engine is approximately 90° Before Top Dead Centre (BTDC) with No. 1 cylinder on its compression stroke.

7. Remove bolt from timing access hole in FIP. Collect sealing washer.

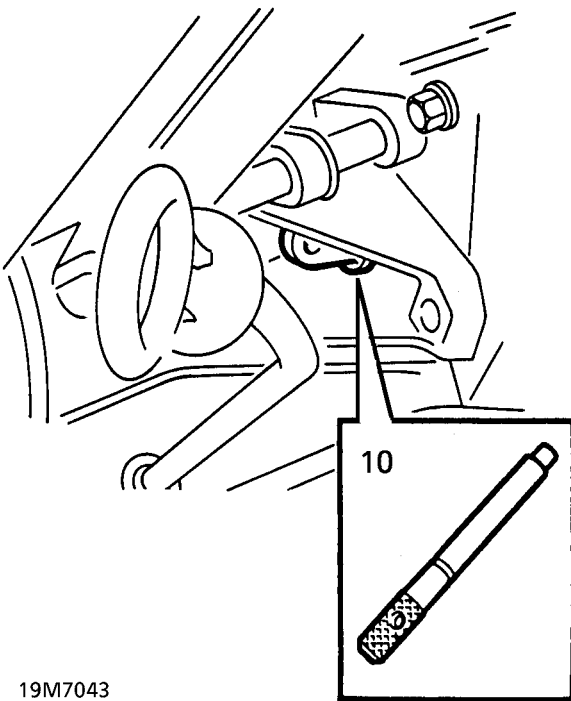


**CAUTION:** Hold delivery valves against rotation as pipe unions are loosened.



19M7042

8. Fit injection pump timing gauge holder LRT-12-121 into access hole.
9. Fit dial gauge and preload by approximately 2 mm. Secure dial gauge in holder.



19M7043

10. Remove plastic plug from flywheel timing pin access hole. Insert timing pin LRT-12-108.

11. Rotate engine slowly clockwise until dial gauge needle reaches its lowest point. Zero gauge.
12. Continue turning crankshaft in a clockwise direction until timing pin locates into flywheel.

**Check reading:**

- Engines with less than  
20,000 km = 0.95 mm  $\pm$  0.02 mm (0.4  $\pm$  0.001 in)
- Engines with more than  
20,000 km = 0.90 mm  $\pm$  0.02 mm (0.035  $\pm$  0.001 in)

If in tolerance, continue at **Assemble**.

If out of tolerance, carry out adjustment as follows:

**Adjust**

13. Slacken 2 flange nuts and 1 support bolt securing FIP.



**CAUTION: Slacken flange nuts by minimum amount. Timing chain tension will deflect pump if bolts are over loose, leading to false readings.**

14. Rotate pump on mounting until correct reading is achieved.



**NOTE: Ensure final movement of pump head is made towards the engine.**



**CAUTION: If final movement of pump head is away from engine, backlash will be left in pump mechanism, leading to false readings.**

15. Tighten pump flange nuts to **22 Nm (16 lbf.ft)**
16. Remove flywheel timing pin.
17. Repeat from operation 6 to verify timing.
18. Refit plastic plug to flywheel timing pin hole.
19. Tighten rear support bolt to **22 Nm (16 lbf.ft)**



## Assemble

20. Remove dial gauge and holder.
21. Fit bolt to FIP timing access hole, use a new sealing washer if necessary. Tighten to **25 Nm (18 lbf.ft)**
22. Using LRT-12-117, tighten high pressure pipe unions on injection pump to **20 Nm (15 lbf.ft)**.  
**Do not tighten pipes at injectors.**



**CAUTION:** Hold delivery valves against rotation as pipe unions are tightened.

23. Fit oil filler cap.
24. Fit cooling fan cowl. **See COOLING SYSTEM, Repair.**
25. Fit intake manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
26. Reconnect battery negative lead.
27. With assistance, crank engine. As fuel emerges at injector connections, secure each pipe union using tool LRT-12-117. Tighten to **20 Nm (15 lbf.ft)**



**WARNING:** Engine will start during high pressure pipe bleeding procedure.



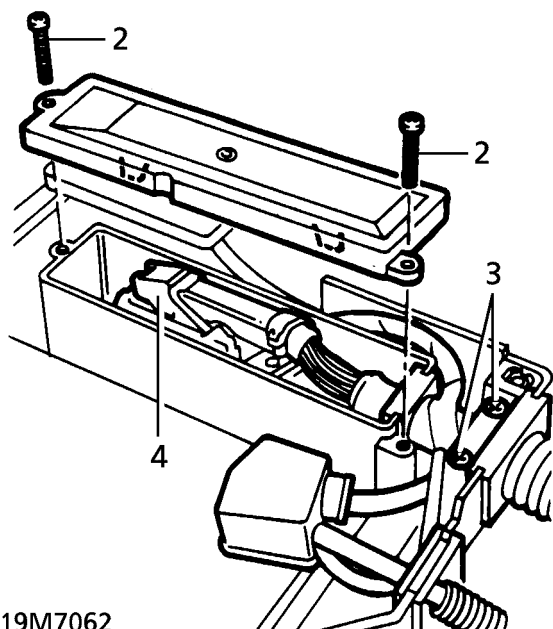


## GLOW PLUG CONTROL UNIT

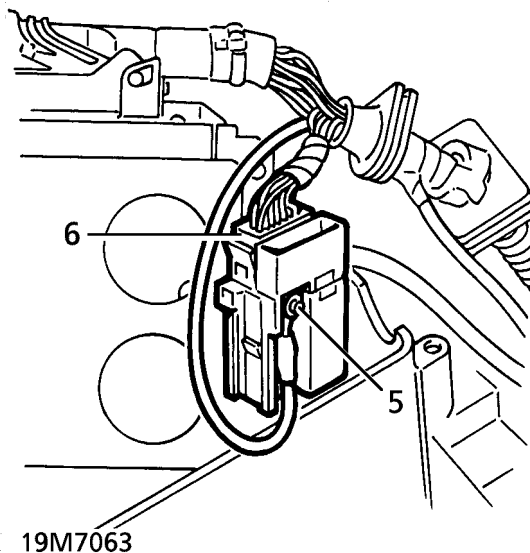
Service repair no - 19.60.33

### Remove

1. Disconnect battery negative lead.
2. Remove 2 screws securing ECM housing cover. Remove cover.



3. Remove 2 harness clamp screws. Remove harness clamp.
4. Lift ECM and control unit from housing.
5. Remove nut securing battery cable to control unit. Release cable.



6. Disconnect multiplug. Remove control unit.

### Refit

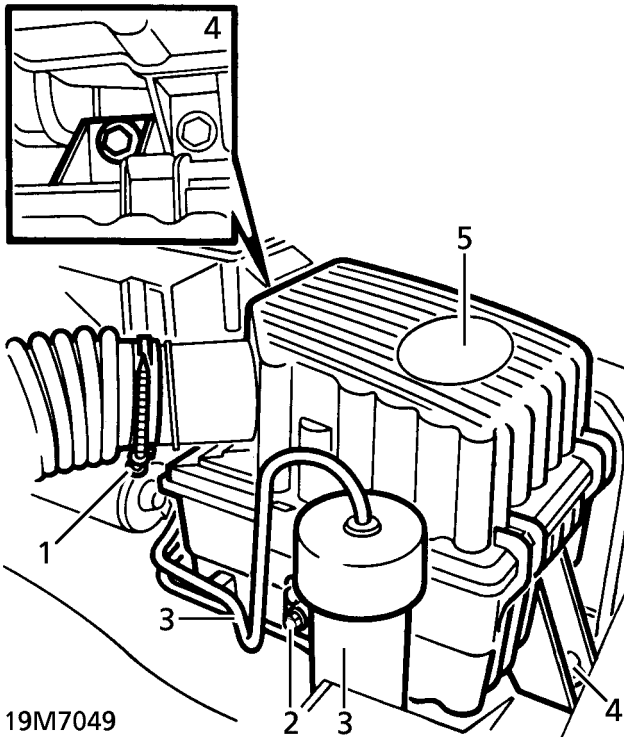
7. Reverse removal procedure.

## AIR CLEANER ASSEMBLY

Service repair no - 19.10.01

### Remove

1. Release intake hose from air cleaner.



2. Remove bolt securing air suspension dryer to air cleaner.
3. Release dryer pipes from air cleaner. Position dryer aside.
4. Remove 2 bolts securing air cleaner to valance.
5. Release air cleaner lug from valance grommet. Remove air cleaner.
6. If necessary, remove seal.

### Refit

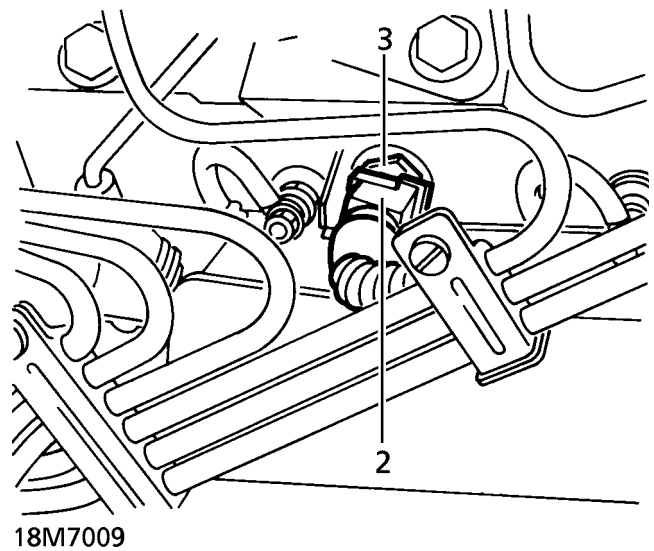
7. If removed, refit seal to air cleaner.
8. Position air cleaner assembly. Engage lug to valance grommet. Secure with bolts.
9. Position air suspension dryer to air cleaner. Secure with bolt. Tighten to **8 Nm (6 lbf.ft)**
10. Engage dryer pipes to clips.
11. Connect intake hose to air cleaner. Secure with clip.

## ENGINE COOLANT TEMPERATURE SENSOR (ECT SENSOR)

Service repair no - 18.30.10

### Remove

1. Partially drain cooling system. **See COOLING SYSTEM, Repair.**
2. Disconnect ECT sensor multiplug.
3. Remove ECT sensor. Collect sealing washer and discard.



### Refit

4. Ensure mating faces are clean.
5. Using a new sealing washer, fit ECT sensor. Tighten to **18 Nm (13 lbf.ft)**
6. Connect multiplug to ECT sensor.
7. Refill cooling system. **See COOLING SYSTEM, Repair.**
8. Run engine to normal operating temperature. Check for leaks around ECT sensor.



## CRANKSHAFT POSITION SENSOR (CKP SENSOR)

Service repair no - 18.30.12

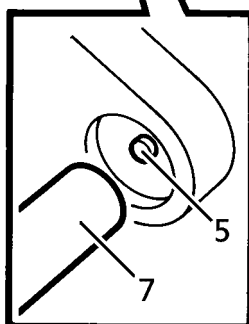
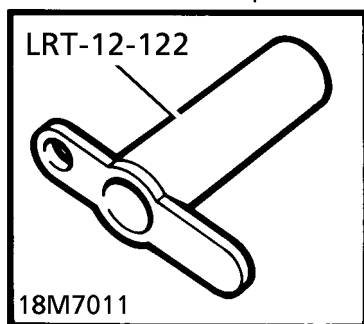
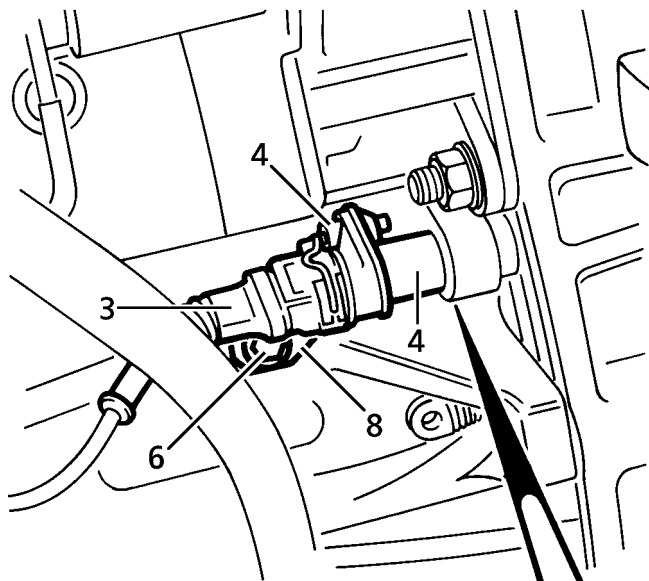
### Remove

1. Disconnect battery negative lead.
2. Remove cooling fan cowl. **See COOLING SYSTEM, Repair.**



**NOTE:** Cowl removed to give access to crankshaft pulley for manual cranking of engine.

3. Disconnect CKP sensor multiplug.



4. Remove bolt securing CKP sensor to bracket. Remove CKP sensor.

### CKP Sensor Bracket - Adjust



**CAUTION:** CKP Sensor bracket must be correctly positioned. CKP sensor damage or failure will result from mis-aligned bracket.

5. Rotate crankshaft until flywheel TDC pole is central to CKP sensor aperture.



**NOTE:** Use mirror and lamp to view flywheel poles.

6. Slacken bolt securing CKP sensor bracket to cylinder block.
7. Position LRT-12-122 to CKP sensor bracket. Secure with bolt.
8. Push CKP sensor bracket rearwards until tool contacts flywheel pole.



**NOTE:** Tool positions bracket allowing for correct air gap between CKP sensor nose and flywheel poles.

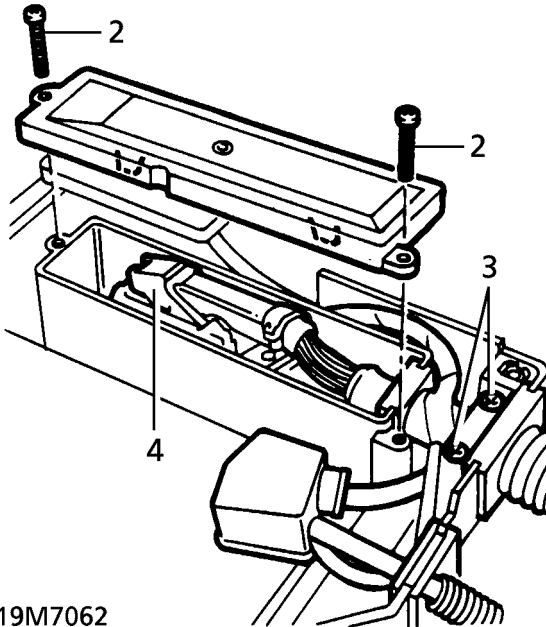
9. Tighten bolt securing bracket to cylinder block.
10. Remove bolt securing tool to bracket. Remove tool.

### Refit

11. Fit CKP sensor to bracket. Secure with bolt. Tighten to **Max 8 Nm (6 lbf.ft)**
12. Connect CKP sensor multiplug.
13. Fit cooling fan cowl. **See COOLING SYSTEM, Repair.**
14. Reconnect battery negative lead.

**ENGINE CONTROL MODULE (ECM)****Service repair no - 18.30.03****Remove**

1. Disconnect battery negative lead.
2. Remove 2 screws securing ECM housing cover.  
Remove cover



3. Slacken 2 harness clamp screws.
4. Lift ECM slightly for access. Disconnect multiplug.
5. Remove ECM from housing.
6. Remove carrier plate from ECM.

**Refit**

7. Reverse removal procedure.



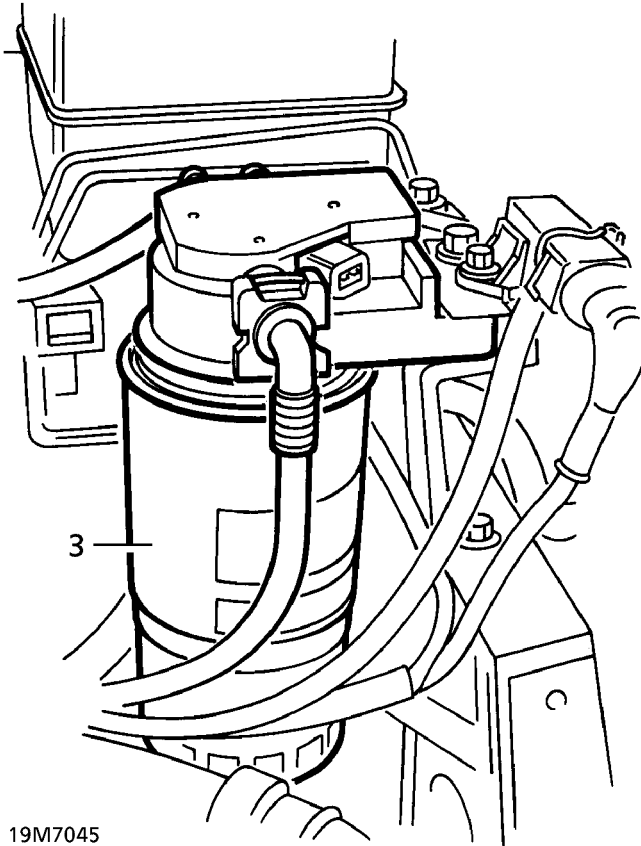


## FUEL FILTER

Service repair no - 19.25.07

### Remove

1. Disconnect battery negative lead.
2. Position container beneath fuel filter to catch spillage.



19M7045

3. Remove filter using strap wrench.

### Refit

4. Ensure mating faces are clean.
5. Lubricate seal on new filter with clean diesel fuel.
6. Fit filter to filter head. Tighten securely by hand.
7. Remove container.
8. Slacken fuel feed union at fuel injection pump using LRT-12-117.



**NOTE: Position cloth over feed union to catch any fuel spillage.**

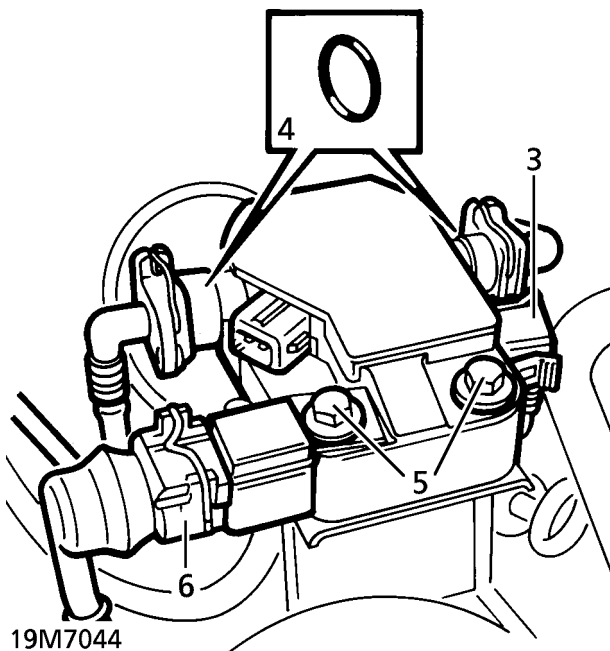
9. Reconnect battery negative lead.
10. With assistance, turn on ignition switch to operate fuel lift pump.
11. When all air is bled from filter, secure feed pipe at injection pump. Tighten to **14 Nm (10 lbf.ft)**

**FUEL HEATER/FILTER HEAD**

Service repair no - 19.25.20

**Remove**

1. Disconnect battery negative lead.
2. Remove fuel filter. **See this section.**



3. Disconnect multiplug from fuel heater.
4. Disconnect fuel lines from filter head. Remove 2 'O' rings from each connection and discard.



**NOTE: Fuel line connections are of quick release type. Press retainer, pull fuel line to remove.**

5. Remove 2 bolts securing fuel heater to bracket.
6. Position Manifold Absolute Pressure (MAP) sensor aside. Remove fuel heater.

**Refit**

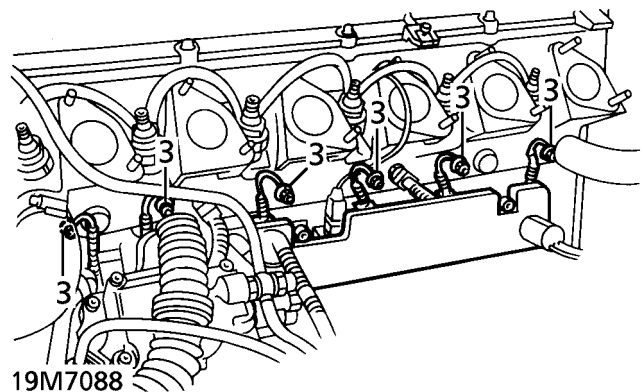
7. Align fuel heater to bracket. Position MAP sensor.
8. Secure fuel heater and MAP sensor to bracket with bolts.
9. Fit new 'O' rings to fuel connections. Lubricate with diesel fuel.
10. Connect fuel lines and multiplug to fuel heater.
11. Fit fuel filter. **See this section.**
12. Reconnect battery negative lead.

**GLOW PLUGS**

Service repair no - 19.60.31

**Remove**

1. Disconnect battery negative lead.
2. Remove injector high pressure pipe assembly. **See this section.**
3. Remove nuts and disconnect feed wires from glow plugs.
4. Using a deep 12 mm socket, remove glow plugs.

**Refit**

5. Ensure glow plug threads and locations in cylinder head are clean.
6. Fit glow plugs. Tighten to **20Nm (15lbf.ft)**.
7. Connect feed wires and tighten nuts to **4Nm (3lbf.ft)**.
8. Fit injector pipe assembly. **See this section.**
9. Reconnect battery negative lead.



**FUEL INJECTION PUMP (FIP)**

Service repair no - 19.30.07

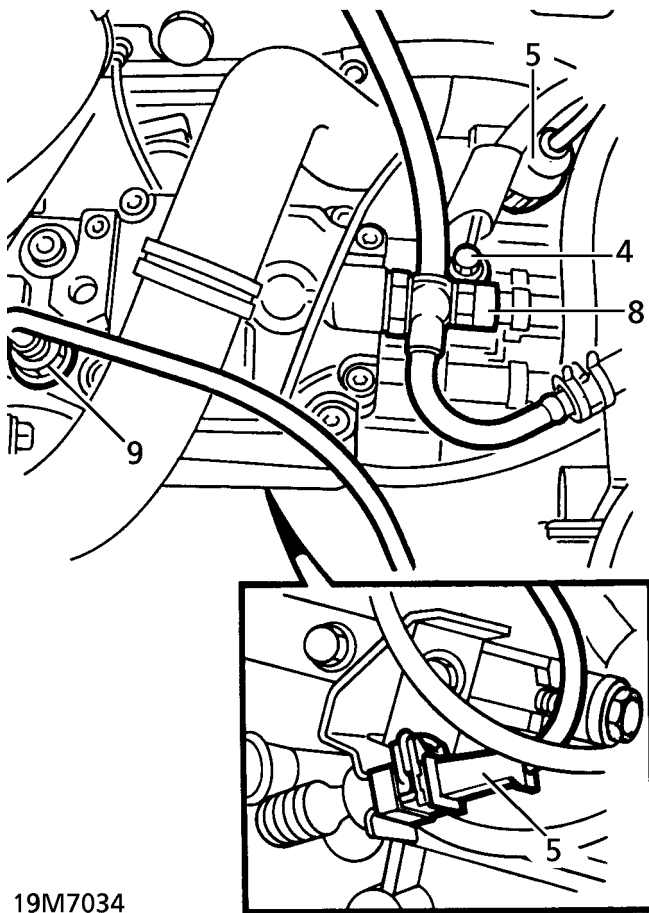
**Remove**

1. Disconnect battery negative lead.
2. Remove high pressure pipes. **See this section.**
3. Remove cooling fan cowl. **See COOLING SYSTEM, Repair.**
4. Disconnect lead from stop solenoid terminal.



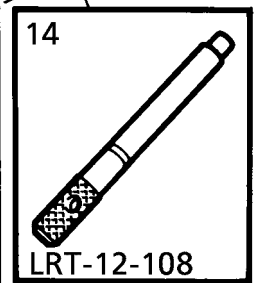
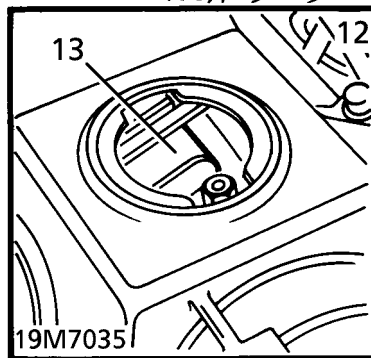
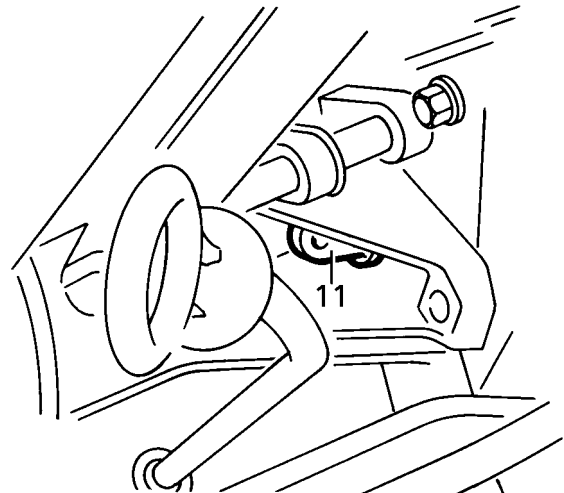
**NOTE: Position cloth beneath FIP to catch fuel spillage.**

8. Disconnect fuel return pipe. Collect sealing washers.
9. Using tool LRT-12-117, disconnect fuel feed pipe at FIP.
10. Plug pipes and connections.
11. Remove plastic plug from flywheel timing pin access hole.



19M7034

5. Disconnect FIP harness multiplug.
6. Disconnect oil pressure switch.
7. Disconnect FIP cycle valve multiplug.

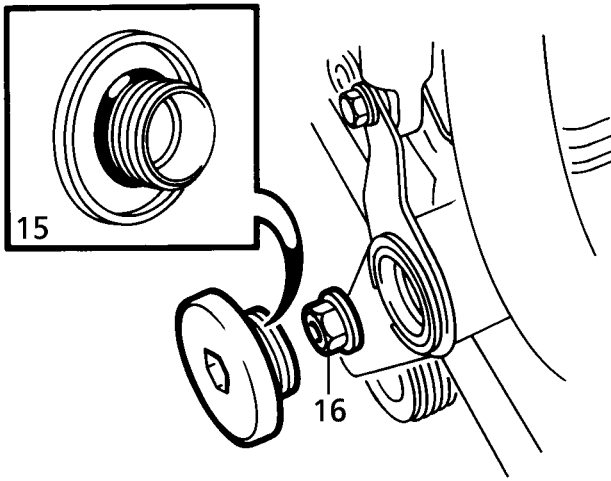


12. Remove oil filler cap. Observe No. 1 camshaft lobe.
13. Rotate crankshaft clockwise until camshaft lobe points towards inlet side of engine.
14. Insert timing pin LRT-12-108 into access hole. Locate into flywheel timing hole.



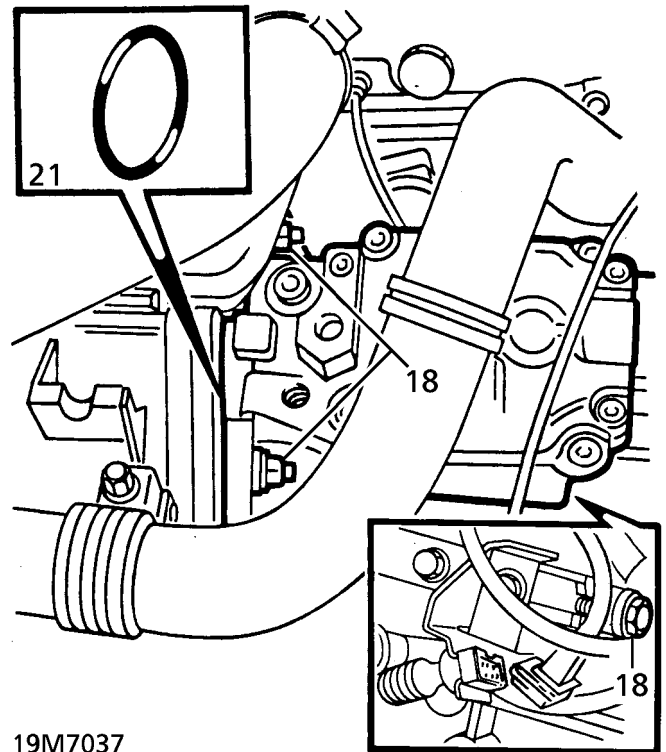
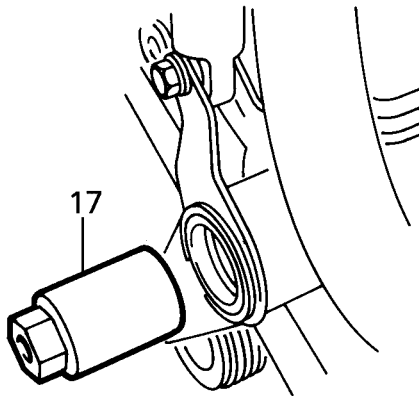
**NOTE: No. 1 Piston is now at Top Dead Centre (TDC) on its compression stroke.**

15. Remove end cap from auxiliary belt tensioner fulcrum. Collect 'O' ring and discard.



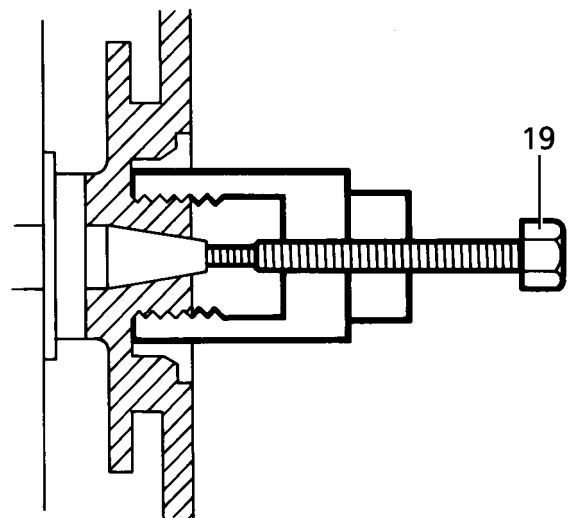
19M7036

16. Remove nut from FIP sprocket.  
 17. Remove centre bolt from LRT-12-119. Screw body of tool onto FIP sprocket to retain sprocket in position when pump is removed.  
 18. Remove 2 flange nuts and 1 support bolt securing FIP to timing case.



19M7037

19. Fit centre bolt to LRT-12-119. Press FIP from sprocket.



19M7038



20. Remove FIP from timing case.
21. Remove FIP. Collect 'O' ring and discard.
22. Remove centre bolt from LRT-12-119.



**CAUTION: If body of tool is removed, FIP sprocket will drop into timing case.**

#### Refit

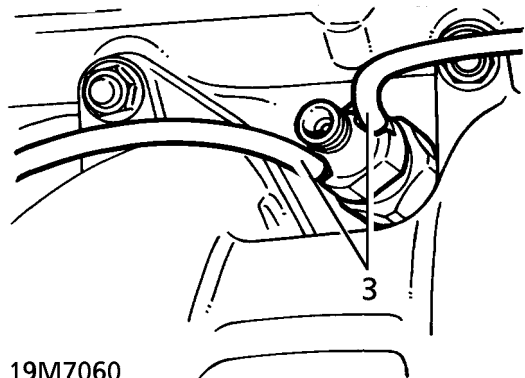
23. Ensure mating faces are clean.
24. Ensure Woodruff key on FIP drive shaft aligns with sprocket keyway. If necessary, turn pump shaft using tool LRT-12-118.
25. Fit new 'O' ring. Position pump to timing case.
26. Secure pump to timing case with nuts and bolts. Do not tighten at this stage.
27. Remove body of LRT-12-119 from injection pump sprocket.
28. Fit nut to injection pump shaft. Tighten to **50 Nm (37 lbf.ft)**
29. Using a new 'O' ring, fit end cap to auxiliary belt tensioner fulcrum.
30. Adjust injection timing. **See Adjustment.**
31. Remove plugs from FIP connections and pipes.
32. Connect fuel feed pipe to FIP using LRT-12-117. Tighten to **14 Nm (10 lbf.ft)**
33. Using new sealing washers, connect fuel return pipe. Tighten to **25 Nm (18 lbf.ft)**
34. Connect FIP harness and cycle valve multiplugs.
35. Connect oil pressure switch.
36. Connect lead to stop solenoid terminal.
37. Fit cooling fan cowl. **See COOLING SYSTEM, Repair.**
38. Fit high pressure pipes. **See this section.**
39. Reconnect battery negative lead.

#### FUEL INJECTORS

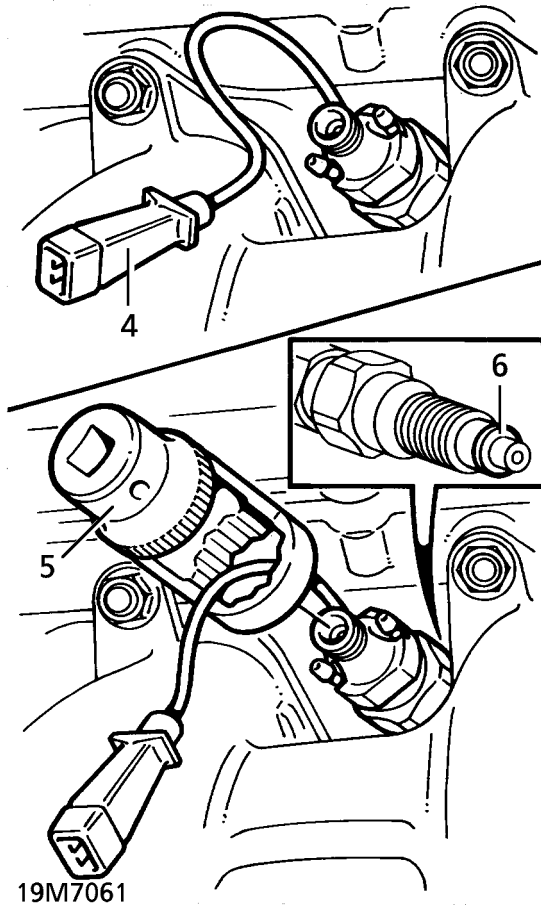
**Service repair no - 19.60.10 - Injectors - each**  
**Service repair no - 19.60.12 - Injectors - set**

#### Remove

1. Disconnect battery negative lead.
2. Remove high pressure pipes. **See this section.**
3. Disconnect leak-off pipes from injector. Plug connections.



4. **No. 4 injector only:** Disconnect needle lift sensor multiplug.



5. Remove injector using tool LRT-12-120.



**NOTE:** Special tool has cut-out for needle lift sensor multiplug. Thread flylead through tool. Ensure lead and connector are not damaged during injector removal or refitting.

6. Collect sealing washer and discard.

#### Refit

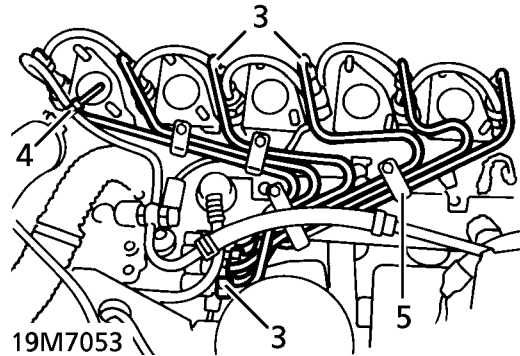
7. Ensure injector nozzle and cylinder head bore are clean.
8. Apply anti-seize compound to injector threads.
9. Position injector with new sealing washer to cylinder head. Using LRT-12-120. Tighten to **65 Nm (48 lbf.ft)**
10. **No. 4 injector only:** Connect needle lift sensor multiplug.
11. Remove plugs. Connect leak-off pipes.
12. Fit high pressure pipe assembly. **See this section.**
13. Reconnect battery negative lead.

#### HIGH PRESSURE PIPES

Service repair no - 19.60.14

#### Remove

1. Disconnect battery negative lead.
2. Remove inlet manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
3. Using LRT-12-117, disconnect high pressure pipes at Fuel Injection Pump (FIP) and injectors.



**CAUTION:** Hold delivery valves against rotation as pipe unions are loosened.

4. Remove clip securing leak-off pipe to No. 1 high pressure pipe.
5. Remove high pressure pipe assembly.
6. Plug high pressure pipes and connections.

#### Refit

7. Ensure all pipes and connections are clean.
8. Remove plugs. Position pipe assembly.
9. Using LRT-12-117, secure high pressure pipes to injection pump. Tighten to **22 Nm (16 lbf.ft)**



**CAUTION:** Hold delivery valves against rotation as pipe unions are tightened.

10. Connect pipes to injectors. Do not tighten.
11. Secure leak-off pipe to No. 1 high pressure pipe with clip.
12. Fit inlet manifold. **See MANIFOLD AND EXHAUST SYSTEM, Repair.**
13. Reconnect battery negative lead.
14. With assistance, crank engine. As fuel emerges at injector connections, secure each pipe union using tool LRT-12-117. Tighten to **22 Nm (16 lbf.ft)**



**CAUTION:** Engine will start during high pressure pipe bleeding procedure.

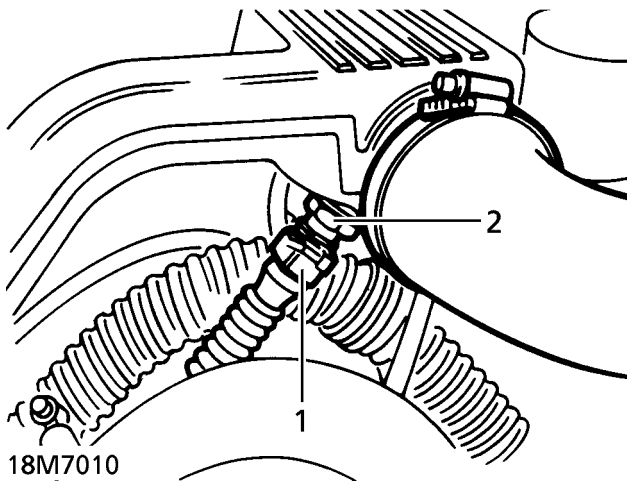


## INTAKE AIR TEMPERATURE SENSOR (IAT SENSOR) - VEHICLES WITHOUT EGR

Service repair no - 18.30.09

### Remove

1. Disconnect multiplug.
2. Remove sensor from intake manifold. Discard sealing washer.



### Refit

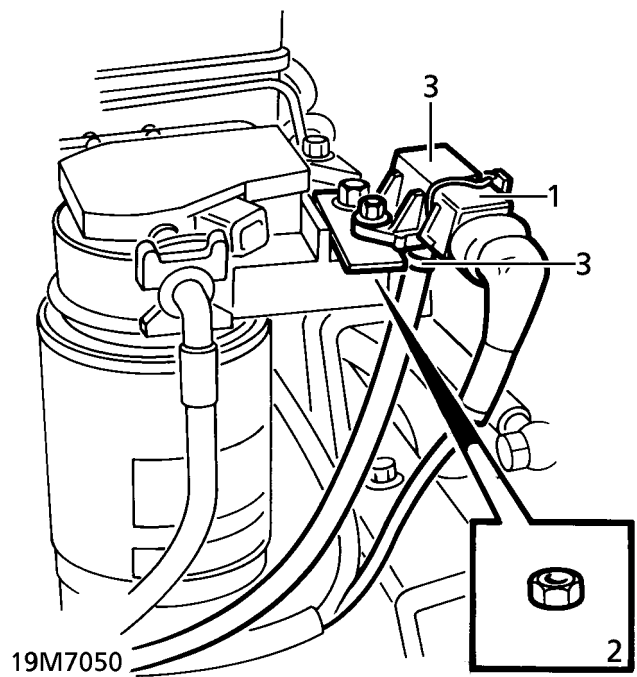
3. Ensure mating faces are clean.
4. Using a new sealing washer, fit sensor to intake manifold. Tighten to **14 Nm (10 lbf.ft)**
5. Connect multiplug.

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Service repair no - 19.42.34

### Remove

1. Disconnect multiplug from sensor.
2. Remove nut and bolt. Release sensor from bracket.
3. Release clip. Remove sensor from hose.



### Refit

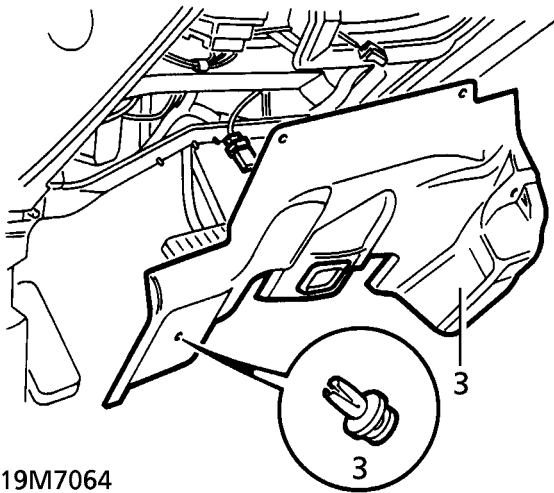
4. Reverse removal procedure.

**THROTTLE POSITION SENSOR (TP SENSOR)**

Service repair no - 19.22.49

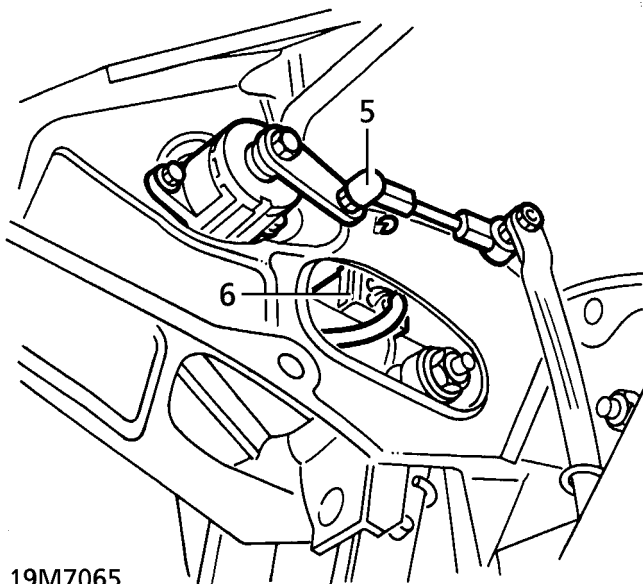
**Remove**

1. Disconnect battery negative lead.
2. Remove drivers side fascia closing panel. **See CHASSIS AND BODY, Repair.**
3. Remove 3 scrivet fasteners securing lower closing panel. Release panel to gain access to blower motor ducting.



19M7064

4. Release ducting from blower motor housing and heater. Remove blower motor ducting.
5. Release linkage from ball joint on TP sensor lever.



19M7065

6. Disconnect multiplug.

7. Remove 2 bolts securing TP sensor to pedal box.
8. Release TP sensor harness from pedal box. Remove TP sensor.

**Refit**

9. Position TP sensor. Route harness correctly over pedal box.
10. Secure TP sensor with bolts. Tighten to **5 Nm (4 lbf.ft)**
11. Connect linkage to TP sensor lever ball joint.
12. Connect multiplug.
13. Fit blower ducting. Engage to heater and blower motor housing.
14. Align lower closing panel. Secure with scrivet fasteners.
15. Fit drivers side fascia closing panel. **See CHASSIS AND BODY, Repair.**
16. Reconnect battery negative lead.





## TURBOCHARGER

Service repair no - 19.42.01

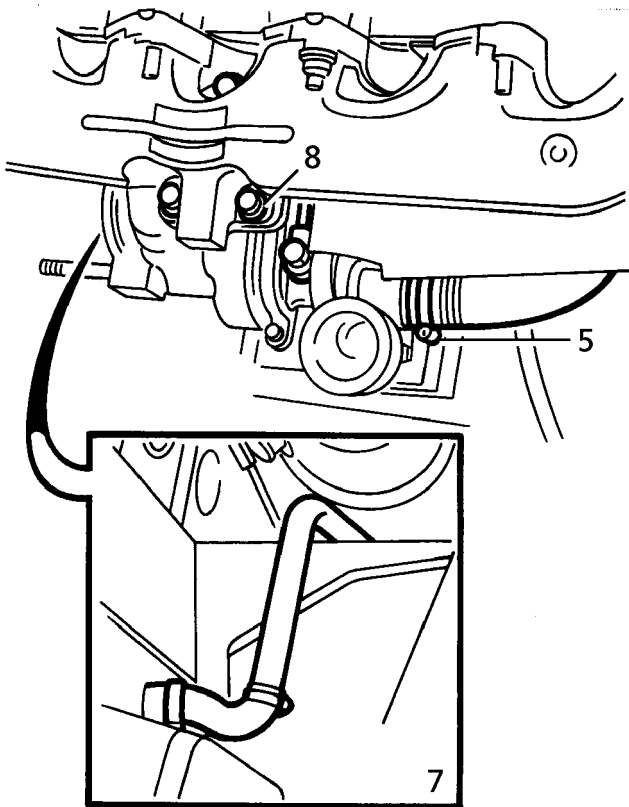
### Remove

1. Disconnect battery negative lead.
2. Raise the vehicle.



**WARNING: Support on safety stands.**

3. Remove exhaust system front pipe. *See MANIFOLD AND EXHAUST SYSTEM, Repair.*
4. Remove heat shield. *See MANIFOLD AND EXHAUST SYSTEM, Repair.*
5. Disconnect intake hose from turbocharger.



19M7046

6. Disconnect oil feed pipe from turbocharger. Collect sealing washers and discard.
7. Disconnect oil drain hose from turbocharger.
8. Remove 3 bolts securing turbocharger to exhaust manifold.
9. Remove turbocharger. Collect gasket and discard.



**NOTE: Plug all connections to prevent ingress of dirt.**

### Refit

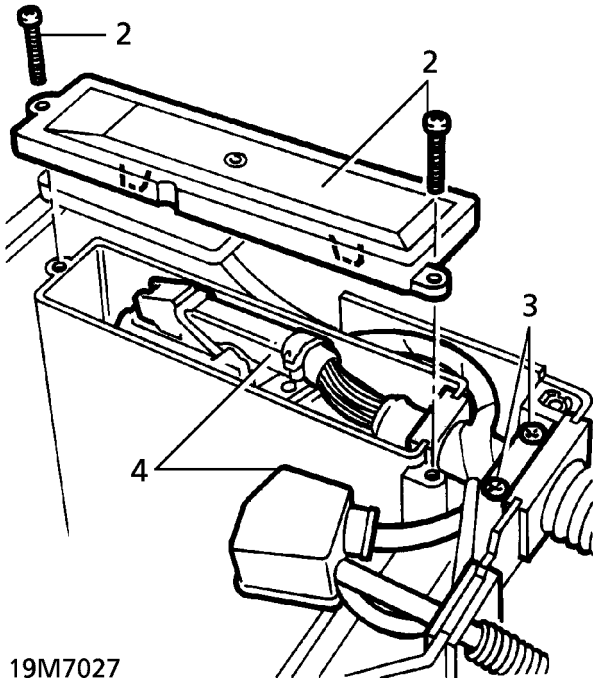
10. Ensure all mating faces are clean.
11. Remove plugs. Position new gasket on manifold. Position turbocharger.
12. Secure turbocharger with bolts. Tighten to **45 Nm (33 lbf.ft)**
13. Connect oil drain hose to turbocharger. Secure with clip.
14. Position oil feed pipe with new washers. Secure with banjo bolt. Tighten to **25 Nm (18 lbf.ft)**
15. Connect intake hose to turbocharger. Secure with clip.
16. Fit exhaust system front pipe. *See MANIFOLD AND EXHAUST SYSTEM, Repair.*
17. Fit heat shield. *See MANIFOLD AND EXHAUST SYSTEM, Repair.*
18. Remove safety stands. Lower vehicle.
19. Reconnect battery negative lead.

## INTERCOOLER

Service repair no - 19.42.15

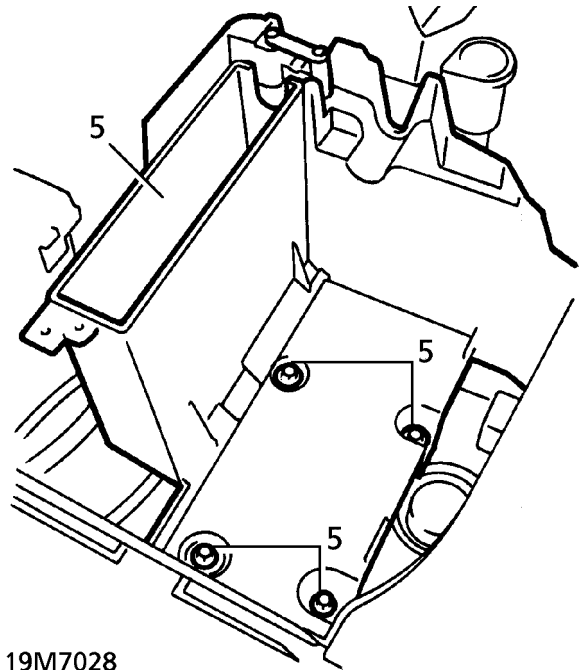
## Remove

1. Remove battery. *See ELECTRICAL, Repair.*



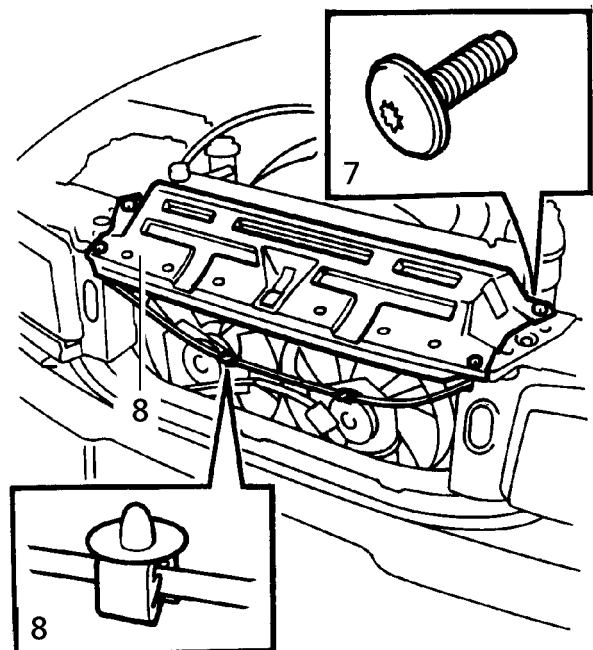
19M7027

2. Remove 2 screws securing fuel ECM cover. Remove cover.
3. Remove 2 screws securing ECM harness clamp. Remove clamp.
4. Remove ECM from battery box. Position ECM and battery harness aside.



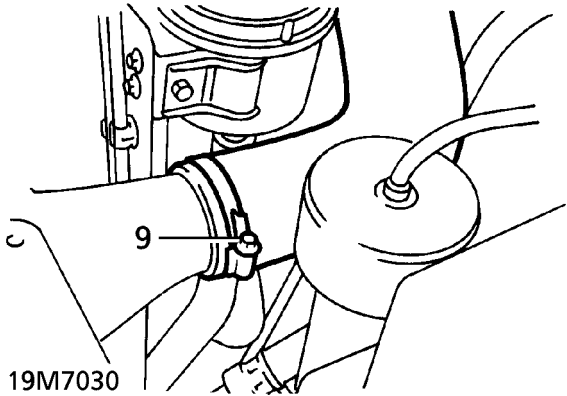
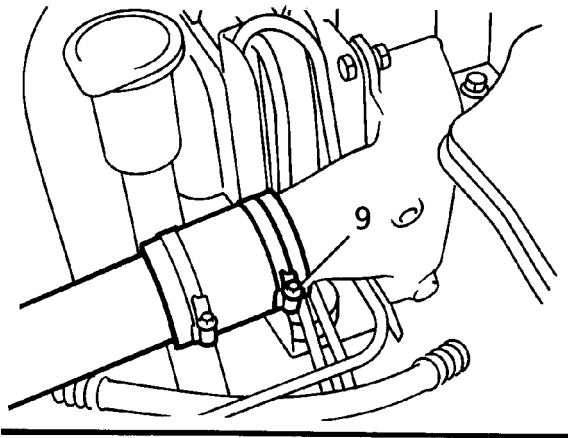
19M7028

5. Remove 4 bolts securing battery box. Remove battery box.
6. Remove front grille. *See CHASSIS AND BODY, Repair.*
7. Remove 4 bolts securing bonnet platform.



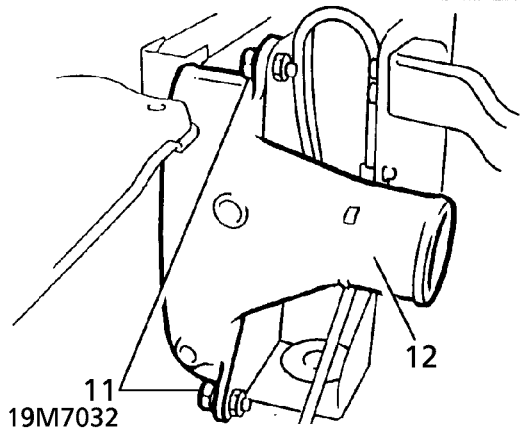
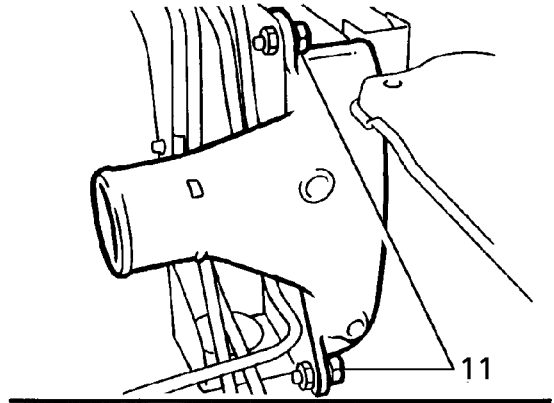
19M7029

8. Release bonnet release cable clips from platform. Remove platform.



9. Disconnect hoses from intercooler.

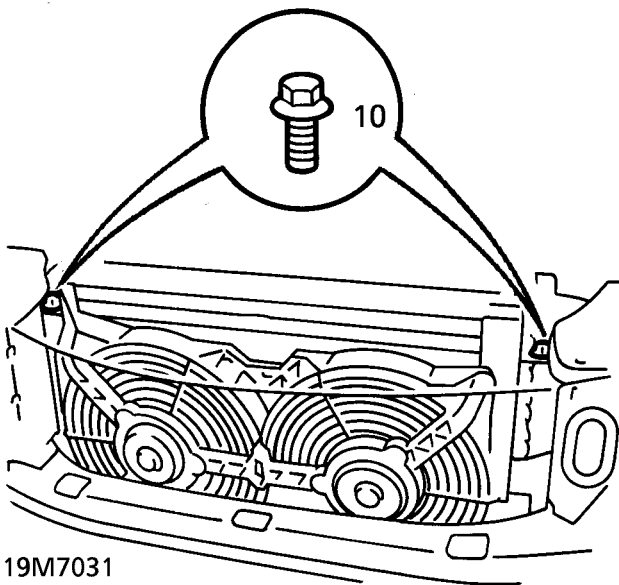
- 10. Remove 2 bolts securing intercooler to air conditioning condenser.
- 11. Remove 4 bolts securing intercooler to radiator bracket.



12. Remove intercooler.

**Refit**

- 13. Reverse removal procedure.



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**FILLER NECK ASSEMBLY**


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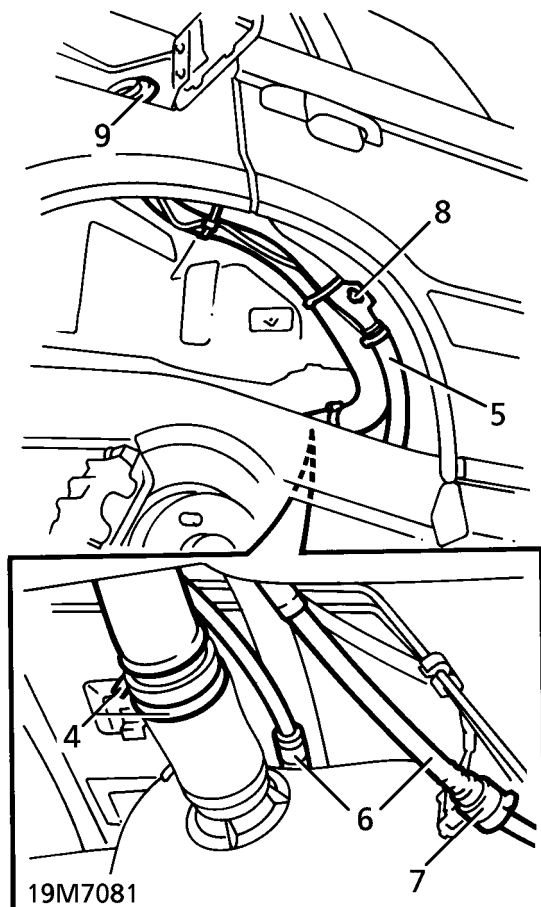
Service repair no - 19.55.07



**WARNING:** If fuel tank is full, fuel level will be above filler neck aperture in the tank. If gauge indicates over 75%, drain a minimum 10 litres of fuel from tank.

**Remove**

1. Disconnect battery negative lead.
2. Remove rear wheel arch liner. **See CHASSIS AND BODY, Repair.**
3. Remove fuel filler cap.
4. Slacken clips securing hoses to filler neck.



5. Release fill breather hose from filler neck.
6. **Petrol Models Only:** Disconnect fuel tank and charcoal canister hoses from vapour separator.
7. **Diesel Models Only:** Release cap from quick release connector. Disconnect breather hose.
8. Remove nut securing filler neck to wheel arch.

9. Release filler neck from fuel tank hose and grommet in body aperture.
10. Remove filler neck assembly.

**Refit**

11. Apply liquid soap to grommet and mating surface of filler neck.
12. Reverse removal procedure.

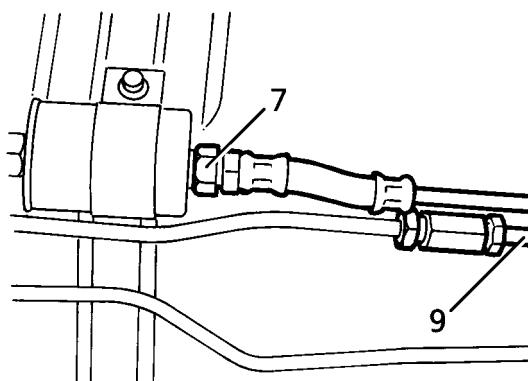


**FUEL TANK, PUMP AND GAUGE SENDER UNIT**

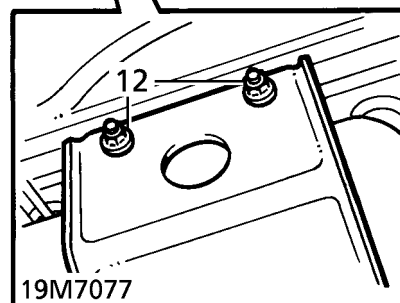
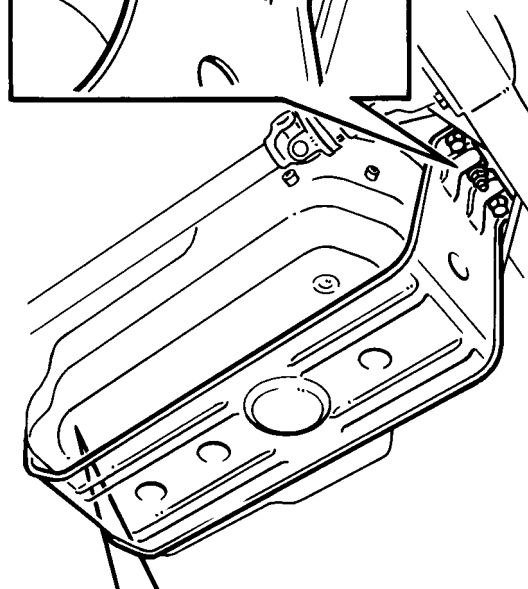
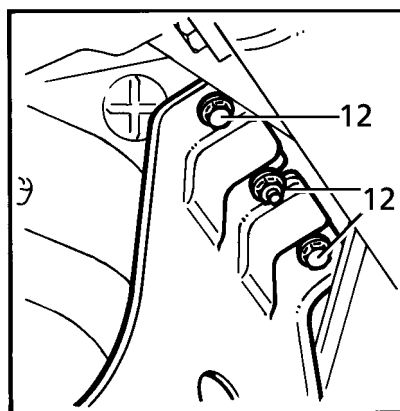
Service repair no - 19.55.01 - Fuel Tank  
 Service repair no - 19.45.08 - Fuel Pump  
 Service repair no - 88.25.32 - Fuel gauge Tank Unit

**Remove**

1. Disconnect battery negative lead.
2. **Petrol Models Only:** Depressurise fuel system. *See this section.*
3. Remove contents of fuel tank into an approved closed container.
4. Remove fuel filler neck. *See this section.*
5. Raise vehicle on four post lift.
6. Position container beneath fuel filter to catch spillage.
7. **Petrol Models Only:** Disconnect feed pipe from fuel filter.
8. **Diesel Models Only:** Disconnect feed pipe at connection, forward of fuel tank.



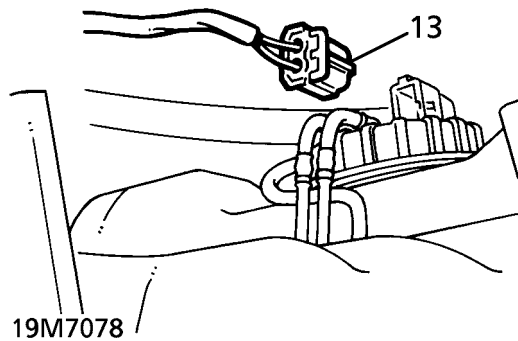
19M7076



19M7077

9. Disconnect return pipe, forward of tank.
10. Plug pipes and connections.
11. Support tank with jack.
12. Remove 3 nuts and 2 bolts securing tank cradle to floor pan.

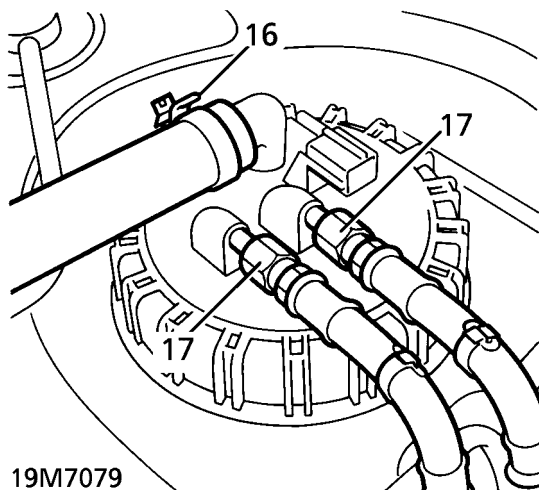
13. Lower tank by 150mm. Disconnect multiplug from fuel tank unit.



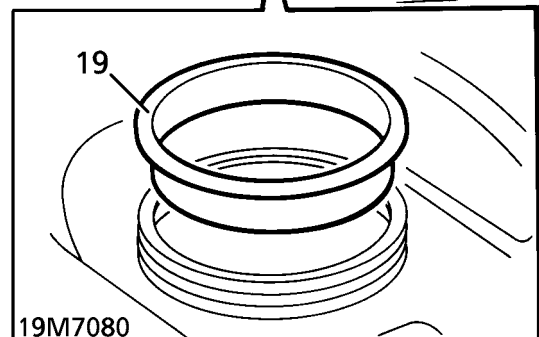
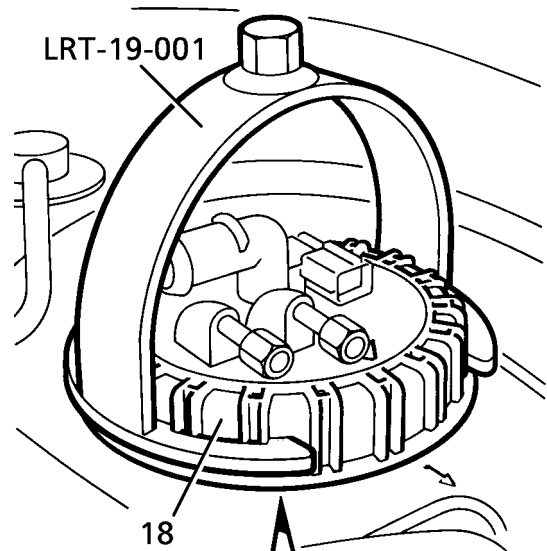
14. Lower tank assembly. Remove from jack.  
**Do not carry out further dismantling if component is removed for access only.**

### Disassemble

15. Remove tank from cradle.  
16. Slacken clip. Remove fill breather pipe from tank unit.



17. Disconnect feed and return pipes from tank unit. Remove each pipe from 2 fuel tank clips.  
18. Remove tank unit retaining ring using LRT-19-001. Remove assembly from tank.



**WARNING: A quantity of fuel will be retained in the unit, care must be taken to avoid excessive spillage during removal.**

19. Remove tank unit sealing rubber and discard.

### Reassemble

20. Fit new sealing rubber.  
21. Fit tank unit. Align location marks.  
22. Fit retaining ring using LRT-19-001.  
23. Connect fuel feed and return pipes to tank unit. Tighten to **16 Nm (12 lbf.ft)**  
24. Secure pipes to fuel tank clips.  
25. Position fill breather pipe to tank unit. Secure with clip.  
26. Position tank in cradle.



## Refit

27. Raise fuel tank assembly on jack until multiplug can be connected to tank unit.
28. Raise tank. Align cradle mounting points. Secure with nuts and bolts.
29. Remove plugs from pipes and connections.
30. **Petrol Models Only:** Using new 'O' ring, connect fuel spill return pipe. Tighten to **16 Nm (12 lbf.ft)**
31. **Petrol Models Only:** Using new 'O' ring, connect fuel feed pipe to filter. Tighten to **20 Nm (15 lbf.ft)**
32. **Diesel Models Only:** Connect fuel feed and return pipes.
33. Lower vehicle.
34. Refit fuel filler neck. **See this section.**
35. Refill fuel tank.
36. Reconnect battery negative lead.

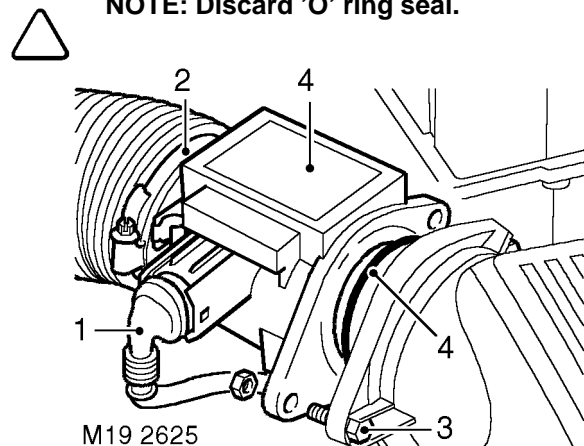
## MASS AIR FLOW (MAF) SENSOR - DIESEL WITH EGR

Service repair no - 19.22.25

### Remove

1. Disconnect multiplug from MAF sensor.
2. Slacken clip and disconnect intake hose from MAF sensor.
3. Remove 2 bolts securing MAF sensor to air cleaner.
4. Remove MAF sensor and collect 'O' ring seal.

**NOTE: Discard 'O' ring seal.**



### Refit

5. Position new 'O' ring seal to MAF sensor.
6. Engage MAF sensor to air cleaner and secure with bolts. Tighten bolts to **10Nm (7 lbf.in)**.
7. Connect intake hose and secure with clip.
8. Connect multiplug to MAF sensor.

**DUCTING - AIR INTAKE - DIESEL WITH EGR**

Service repair no - 19.10.27

**Remove**

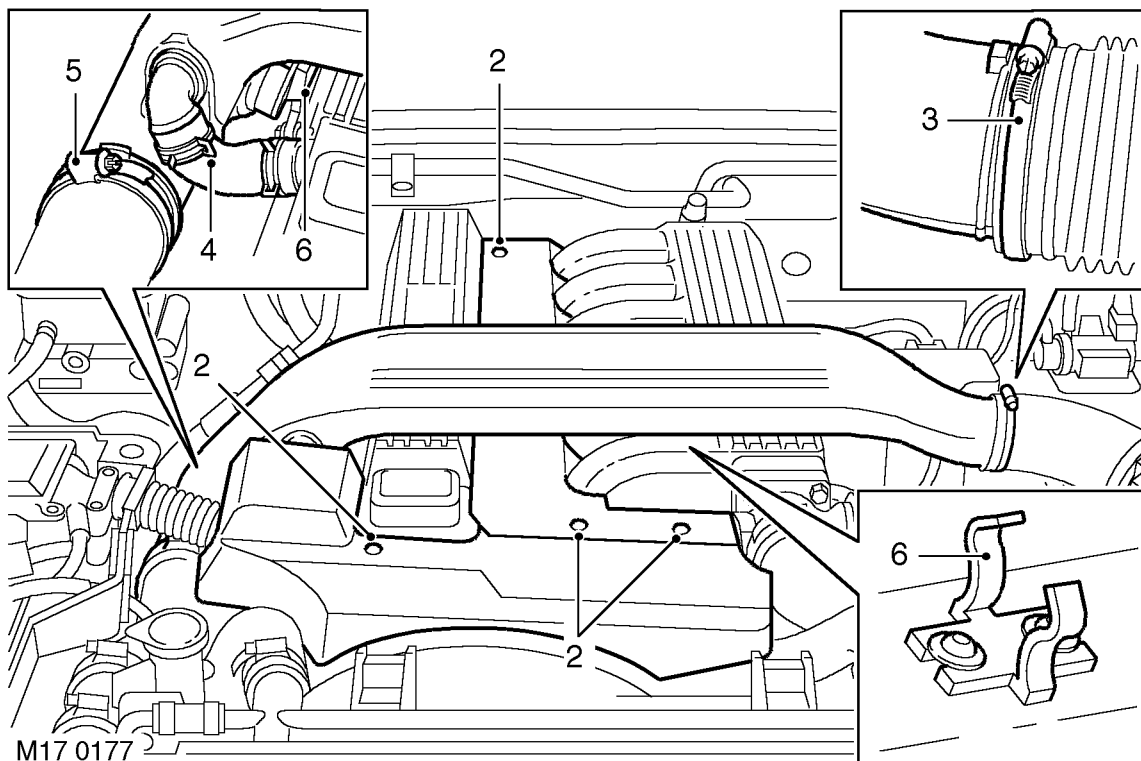
1. Disconnect battery negative terminal.
2. Remove 4 bolts securing injector cover and remove cover.
3. Slacken clip securing intake hose to intake ducting and disconnect hose.

4. Release clip securing breather hose to intake ducting.
5. Slacken clip securing intake duct to turbo duct.
6. Carefully release intake duct from clips on intake manifold and camshaft cover.



**CAUTION: Care must be taken to ensure clips do not become damaged.**

7. Disengage duct from breather hose and turbo duct. Remove intake duct assembly.

**Refit**

8. Position intake duct. Engage turbo duct and breather hose.
9. Carefully engage intake duct clips to camshaft cover and inlet manifold locations.

10. Connect intake hose to intake duct.
11. Secure clips on intake turbo duct, intake hose and breather hose.
12. Position injector cover and secure with bolts. Tighten bolts to **10 Nm (7 lbf.in)**.
13. Connect battery negative terminal.



**CAUTION: Ensure that manifold clips are correctly engaged before pushing duct downwards or clips may be damaged.**



# 19 - FUEL SYSTEM

## CONTENTS

Page

### LAND ROVER V8

#### DESCRIPTION AND OPERATION

ENGINE MANAGEMENT SYSTEM - up to 99MY .....	1
ENGINE MANAGEMENT SYSTEM COMPONENT LOCATION - up to 99MY .....	2
ENGINE MANAGEMENT SYSTEM SCHEMATIC - up to 99MY .....	4
ENGINE MANAGEMENT SYSTEM - from 99MY .....	7
ENGINE MANAGEMENT SYSTEM COMPONENT LOCATION - from 99MY .....	8
ENGINE MANAGEMENT SYSTEM COMPONENT LOCATION - from 99MY (Continued) .....	10
ENGINE MANAGEMENT SYSTEM SCHEMATIC - from 99MY .....	12
COMPONENT DESCRIPTIONS - up to 99MY .....	14
COMPONENT DESCRIPTIONS - from 99MY .....	31

#### ADJUSTMENT

FUEL TANK - DRAIN .....	1
THROTTLE CABLE - up to 99MY .....	2
THROTTLE CABLE - from 99MY .....	2
ENGINE TUNING - up to 99MY .....	3

#### REPAIR

AIR CLEANER ASSEMBLY - up to 97MY .....	1
AIR CLEANER ASSEMBLY - from 97MY .....	2
ELEMENT - AIR CLEANER - from 99MY .....	3
AIR INTAKE HOSE - up to 99MY .....	3
CAMSHAFT POSITION (CMP) SENSOR - up to 99MY .....	4
CAMSHAFT POSITION (CMP) SENSOR - from 99MY .....	5
ENGINE COOLANT TEMPERATURE (ECT) SENSOR - up to 99MY .....	5
ENGINE COOLANT TEMPERATURE (ECT) SENSOR - from 99MY .....	6
CRANKSHAFT POSITION (CKP) SENSOR - up to 97MY .....	7
CRANKSHAFT POSITION (CKP) SENSOR - 97MY to 99MY .....	8
CRANKSHAFT POSITION (CKP) SENSOR - from 99MY .....	9
FUEL SYSTEM - DEPRESSURISE .....	10
ENGINE CONTROL MODULE (ECM) - up to 99MY .....	10
ENGINE CONTROL MODULE (ECM) - from 99MY .....	11
FAN - ECM COOLING - from 99MY .....	12
MASS AIR FLOW (MAF) SENSOR - up to 99MY .....	13
MASS AIR FLOW (MAF) SENSOR - from 99MY .....	13
FUEL RAIL AND INJECTORS - up to 99MY .....	14
FUEL RAIL AND INJECTORS - from 99MY .....	16



# 19 - FUEL SYSTEM

## CONTENTS

	Page
ENGINE FUEL TEMPERATURE (EFT) SENSOR .....	18
HEATED OXYGEN SENSOR (HO2S) - FRONT (up to 99MY) AND REAR .....	18
HEATED OXYGEN SENSOR (HO2S) - FRONT - from 99MY .....	19
SPARK PLUGS .....	20
H.T. LEADS .....	21
IGNITION COILS - up to 99MY .....	22
IGNITION COILS - from 99MY .....	23
INERTIA FUEL SHUT OFF (IFS) SWITCH .....	24
INTAKE AIR TEMPERATURE (IAT) SENSOR .....	25
THROTTLE POSITION (TP) SENSOR - up to 99MY .....	26
THROTTLE POSITION (TP) SENSOR - from 99MY .....	26
KNOCK SENSOR (KS) - up to 99MY .....	27
KNOCK SENSOR (KS) - from 99MY .....	28
FUEL PRESSURE REGULATOR .....	28
IDLE AIR CONTROL (IAC) VALVE - up to 99MY .....	30
IDLE AIR CONTROL (IAC) VALVE - from 99MY .....	30
PLENUM CHAMBER - up to 97MY .....	31
PLENUM CHAMBER - 97MY to 99MY .....	33
PLENUM CHAMBER - from 99MY .....	35
FUEL FILTER .....	36
THROTTLE CABLE - up to 99MY .....	37
THROTTLE CABLE - from 99MY .....	38
FILLER NECK ASSEMBLY - PRE-ADVANCED EVAPS .....	40
FUEL FILLER NECK - ADVANCED EVAPS .....	41
ANTI-TRICKLE FILL VALVE - ADVANCED EVAPS .....	42
FUEL TANK, PUMP AND GAUGE SENDER UNIT - PRE-ADVANCED EVAPS .....	43
FUEL TANK, PUMP AND GAUGE SENDER UNIT - ADVANCED EVAPS .....	46
FUEL TANK FILLER CAP - ADVANCED EVAPS .....	48
THROTTLE BODY - from 99MY .....	49