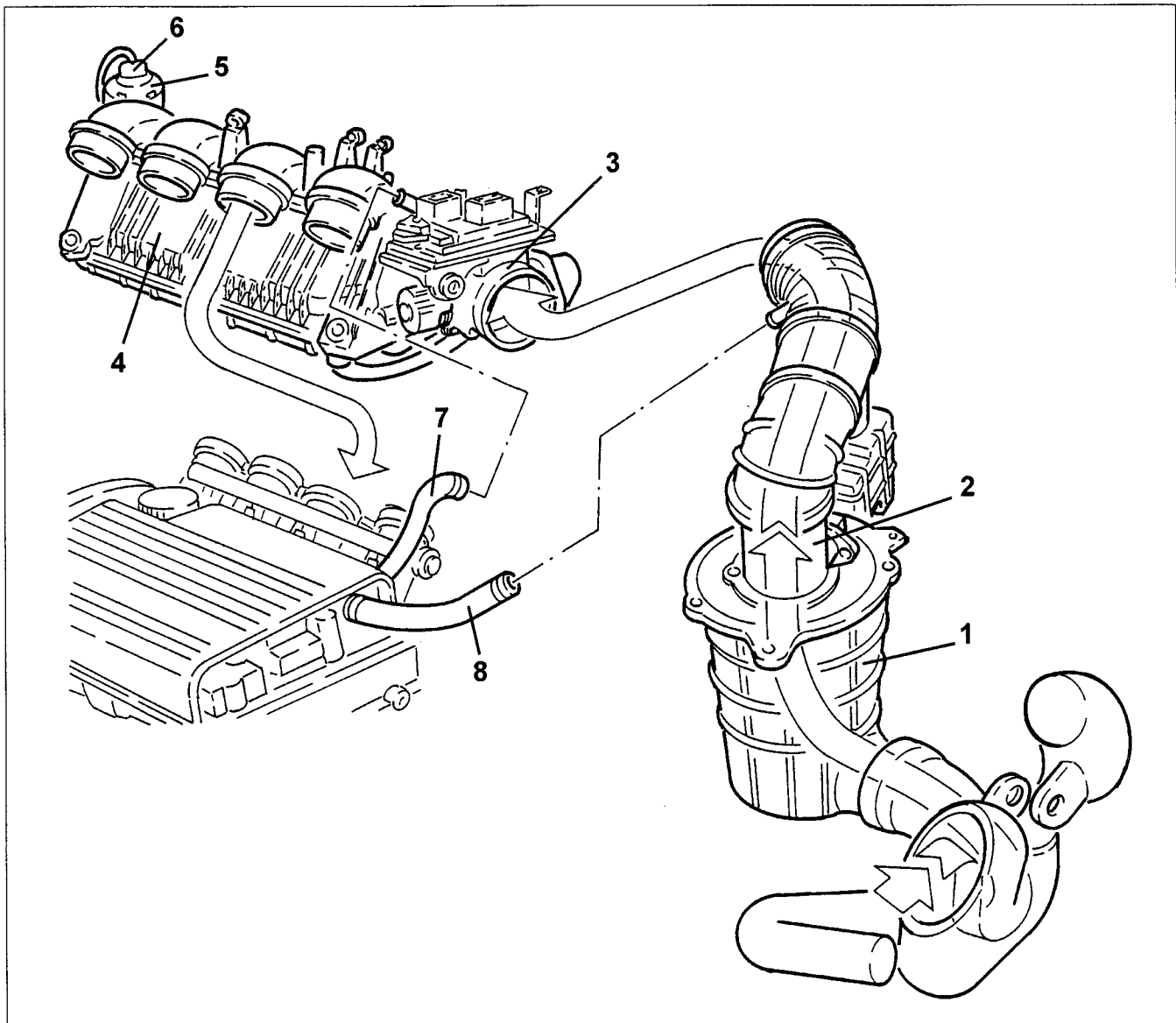


## AIR FEED AND OIL VAPOUR RECOVERY SYSTEM



1. Air cleaner
2. Air flow meter with built-in temperature sensor
3. Idling actuator and throttle position sensor
4. Modular intake manifold

5. Modular intake manifold pneumatic actuator
6. Modular intake manifold solenoid valve
7. Idling oil vapour recirculation pipe
8. Oil vapour recirculation pipe

The air is taken in via a dynamic inlet and filtered by a cartridge element (1). It crosses the hot film flow meter (2) and reaches the throttle casing with built-in MDS (3) via the corrugated sleeve.

The throttle is controlled by the accelerator wire and regulates the amount of air taken into the manifold. The idling actuator and throttle position sensor (MDS) (3) is fitted on one side of throttle and controlled directly by the injection ECU.

The fuel vapours (see specific paragraph) and the oil vapours reach the feed system.

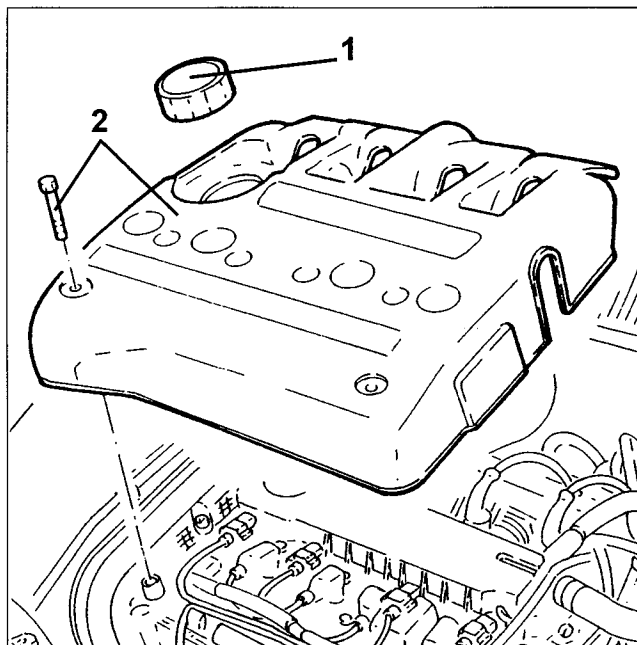
Oil vapours develop during engine operation and are collected in the cylinder head. The condensed oil drips into the crankcase while the remaining vapours are conveyed to the intake manifold via two pipes. During idling, oil vapours are conveyed to the throttle casing via specific pipe (7). At higher loads, the vapours are conveyed upstream with respect to the throttle via a fitting (8) to the corrugated sleeve to be burned in the engine.

### THROTTLE CASING

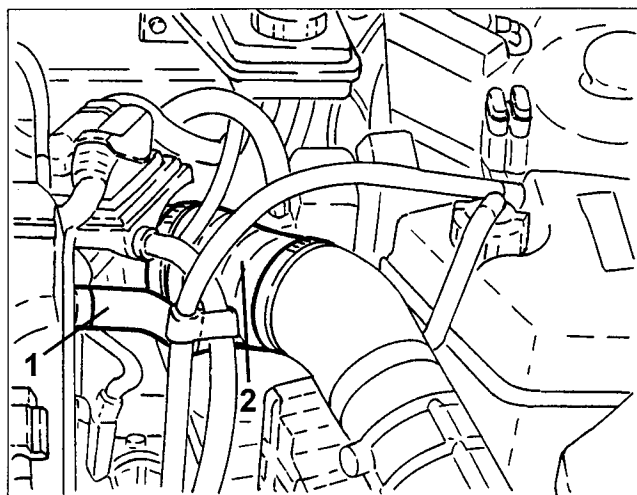
#### REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.

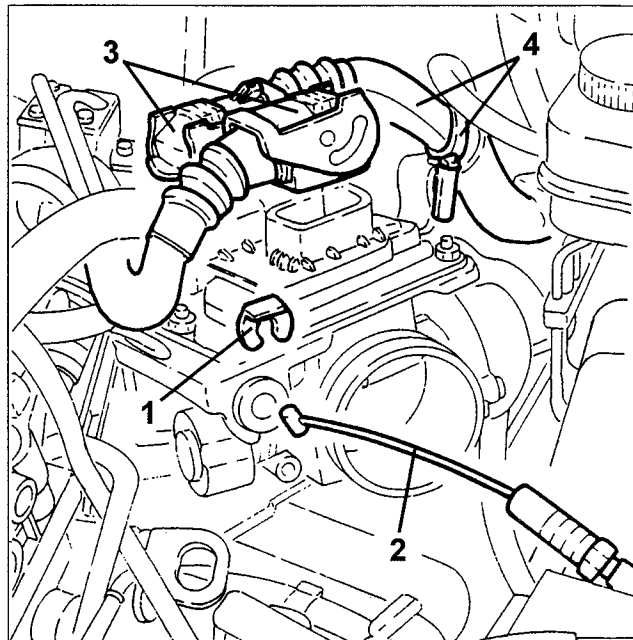
1. Remove the engine oil filler cap.
  2. Loosen the fastening screws and remove the ignition coil cover.
- Refit the engine oil filler cap.



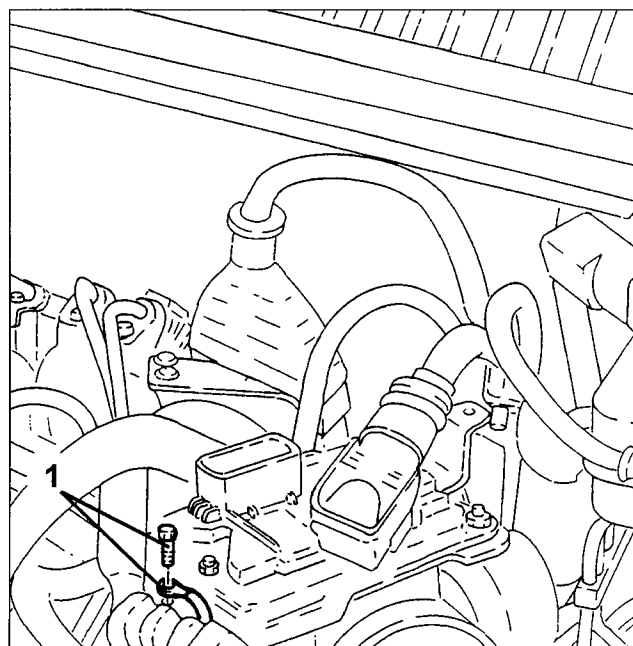
1. Disconnect the oil vapour recovery pipe from the tappet cover.
2. Loosen the fastening clips and remove the throttle casing air intake corrugated sleeve.



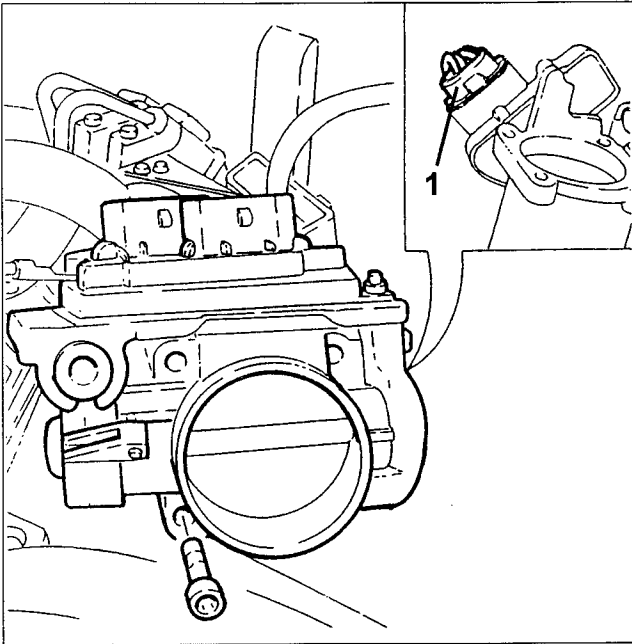
1. Remove the accelerator wire retainer from the bracket.
2. Release the accelerator wire from the throttle casing cam and move it aside.
3. Disconnect the injection-ignition ECU electrical connections.
4. Release the wiring from the clip on the ECU.



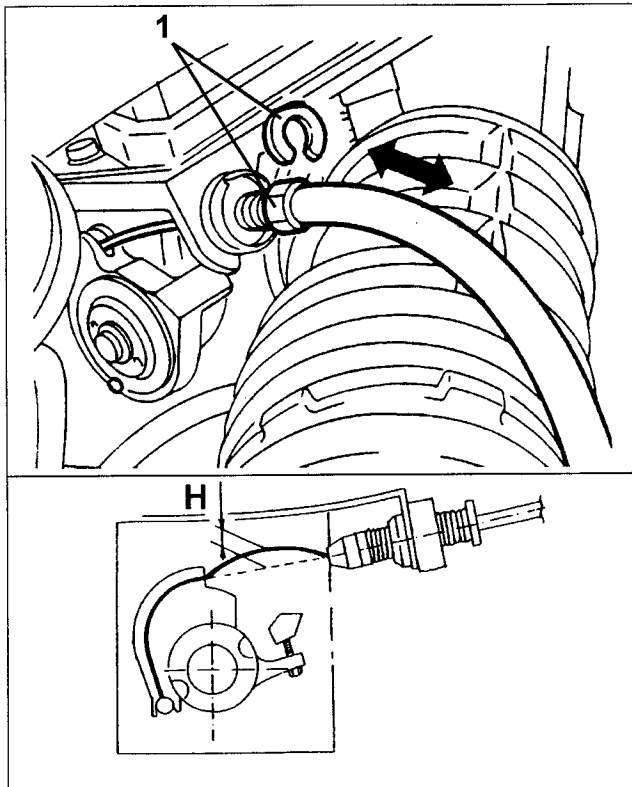
1. Disconnect the earth from the injection-ignition ECU bracket.



1. Loosen the fastening screws and remove the throttle. Disconnect the idling actuator electrical connection and throttle position sensor (MDS).



1. When refitting, calibrate the accelerator wire by means of the retainer so that the throttle is completely closed when the pedal is released and the wire has a play "H" of 5mm.



**IMPORTANT:** After replacing the throttle casing, repeat the throttle casing with built-in MDS self-learning procedure described below.

- Make sure the ignition key is at "STOP".
- Check that the conditioner is off, the accelerator pedal is never pressed and that the accelerator wire is positioned correctly.
- Connect tool no. 1.806.365.000 to the diagnostic socket and turn the knob to position 3.
- Connect Examiner.
- Go to Examiner "ECU Test" environment.
- Turn the ignition key to MAR.
- Go to Examiner "Active diagnosis" environment and select "Reset self-learning parameters" and "Idling actuator".
- Press "Run active diagnosis".
- Turn the ignition key to STOP and wait for 30 seconds.
- Turn the ignition key to MAR and wait for 30 seconds.
- Restore the Examiner-engine control system communication.
- Go to Examiner "Parameter" environment and select "Idling acknowledgement test - done" and "Idling acknowledgement signals - synchronised" in the "Select" menu.

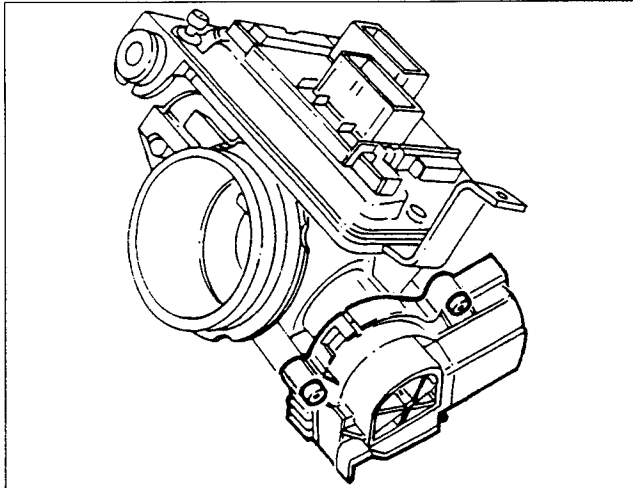
**NOTE:** If one or more parameters are not OK, turn the ignition key to STOP and repeat the procedure. If the problem persists, check the diagnostic wire is connected properly and that the diagnostic tool is working.

- Turn the ignition key to STOP and wait for 30 seconds.
- Start the engine without pressing the accelerator pedal.
- Disconnect the diagnostic tool.
- Run a road test (several kilometres) then when the engine is at running temperature, check correct idling operation.

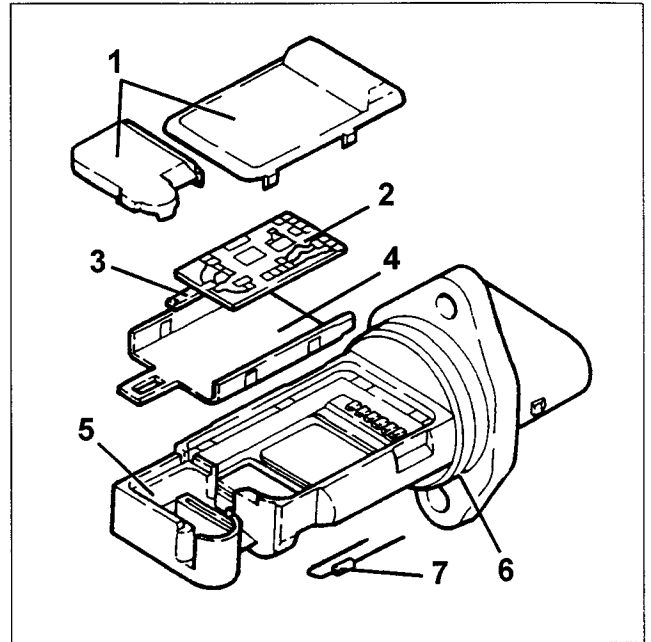


## IDLING ACTUATOR AND THROTTLE POSITION SENSOR (MDS)

The idling actuator/throttle position sensor (MDS) is built into the throttle and controlled by the injection ECU. It consists of a direct current motor which opens the throttle from 0° to 15°. Two potentiometers are built into the actuator. The potentiometers transmit the angle position to the injection ECU:  
- 0° - 15° for idling ratio  
- 0° - 83° for all other engine ratios.



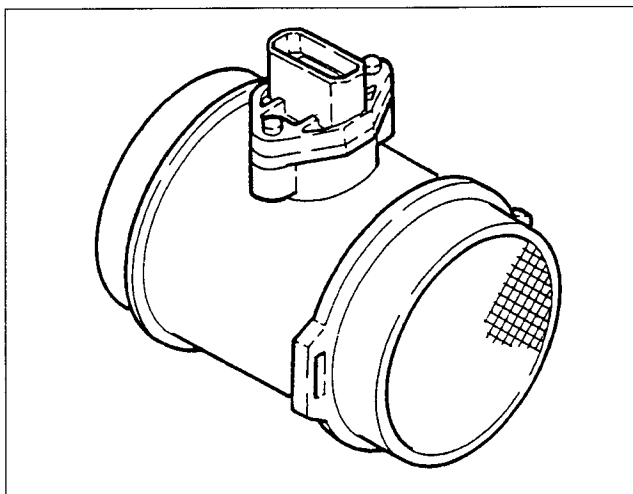
The intake air temperature sensor is built-into the flow meter.



1. Covers
2. Electronic board
3. Sensor
4. Support plate
5. Bracket
6. O-Ring
7. Temperature sensor

## AIR FLOW METER WITH BUILT-IN AIR TEMPERATURE SENSOR

The flow meter is located on the intake air sleeve and is of the "hot film" type.



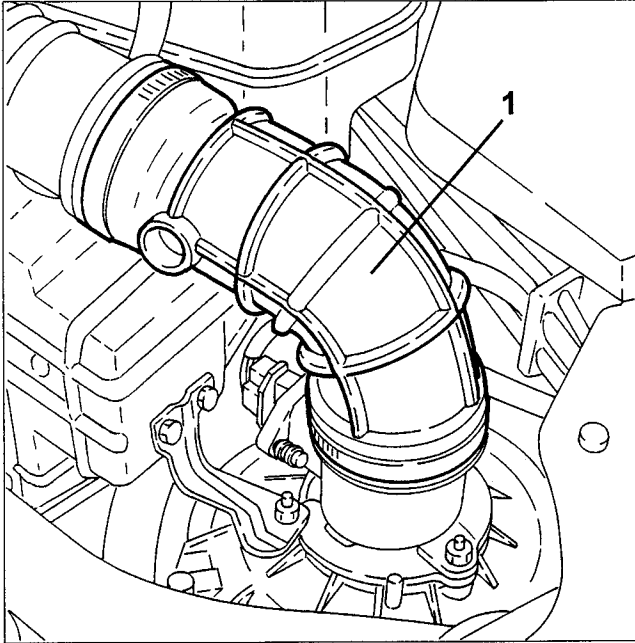
**IMPORTANT:** The flow meter cannot be disassembled.

The operating principle consists of a heated membrane film in a measuring duct through which the engine intake air flows. The film is maintained at constant temperature (approximately 120°C warmer than the intake air temperature) by a resistance. The air flow in the duct tends to take heat from the film. Consequently, a certain current is required by the resistance to keep the temperature. This current is measured by means of a Wheatstone jumper and is proportional to the air flow. This air flow meter directly measures the air mass (and not volume) thus eliminating problems related to temperature, altitude, pressure, etc.

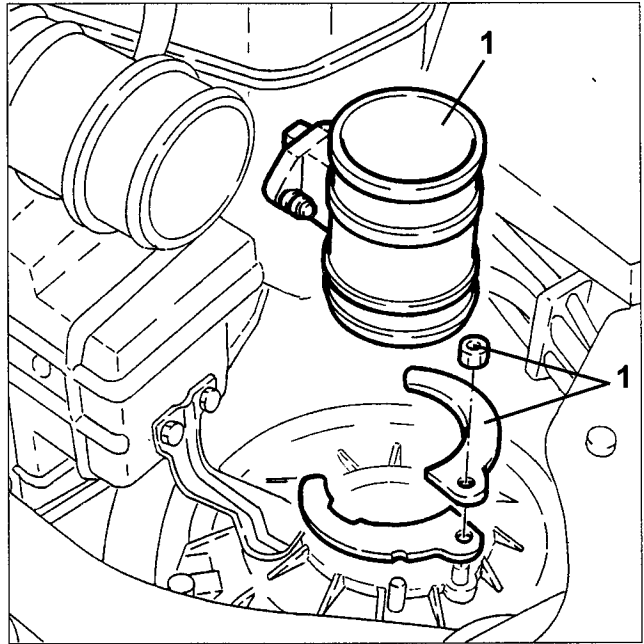
## REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.

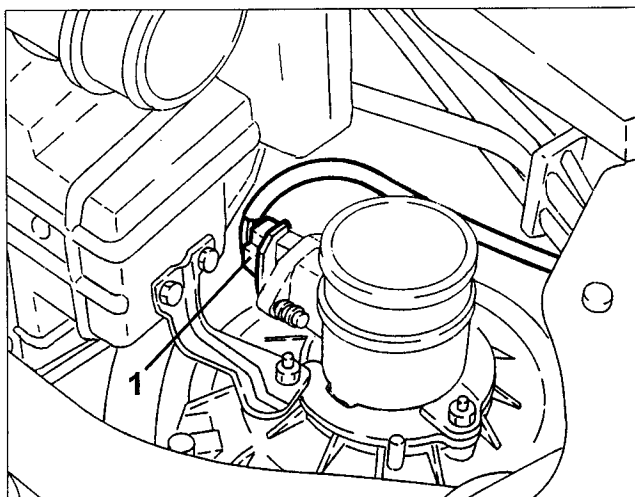
1. Loosen the fastening clips and remove the corrugated sleeve elbow.



1. Loosen the nuts, remove the fastening brackets and remove the air flow meter.



1. Disconnect the air flow meter electrical connection.



## MODULAR INTAKE MANIFOLD

The modular length intake manifold is controlled by the injection-ignition ECU. It allows to increase the volumetric yield and consequently:

- optimise torque output at low/medium ratio
- increase power at high ratio.

The manifold consists of:

- two nylon half casings
- an internal rocking duct
- a vacuum accumulator inside the manifold
- a modular intake device actuator with built-in three-way solenoid valve.

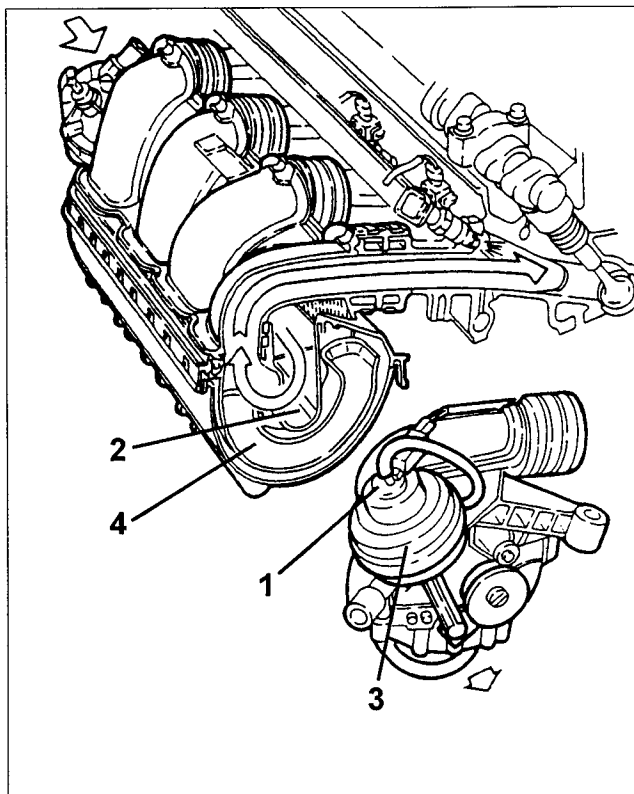
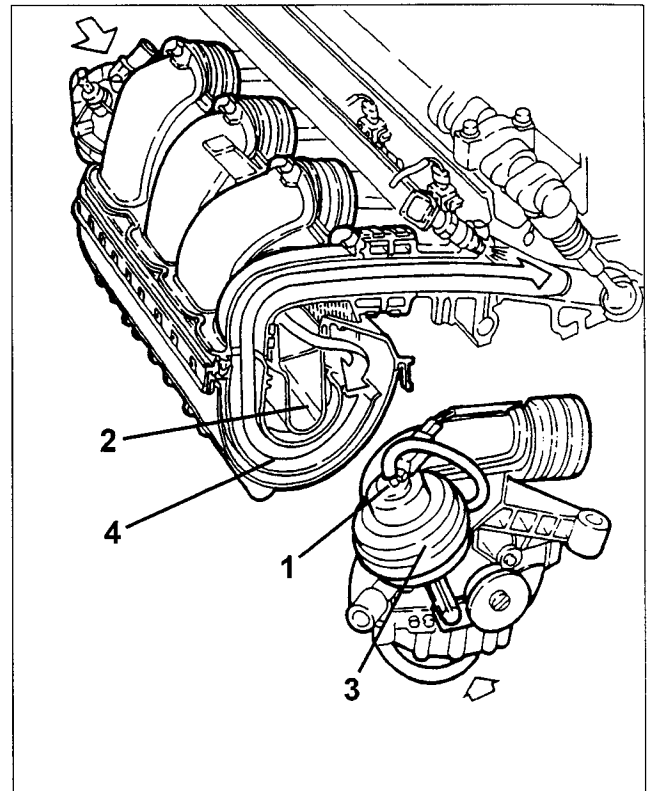
## OPERATION

The injection ECU controls the two-way solenoid valve (1) which connects the vacuum accumulator (2) and the pneumatic actuator (3). This moves the rocking duct (4) by means of linkages.

The rotation of the rocking duct allows the following manifold configurations:

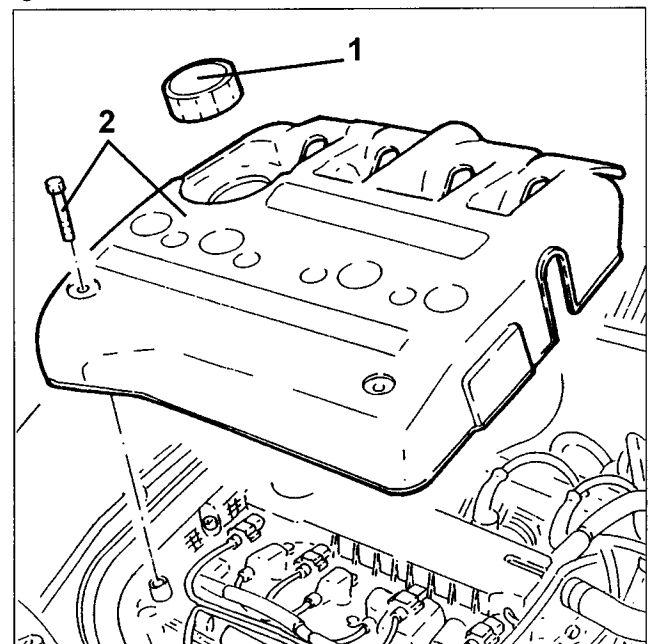
- short power ducts, for ratio over 4900 rpm

- long torque ducts, for ratios from 800 to 4900 rpm.

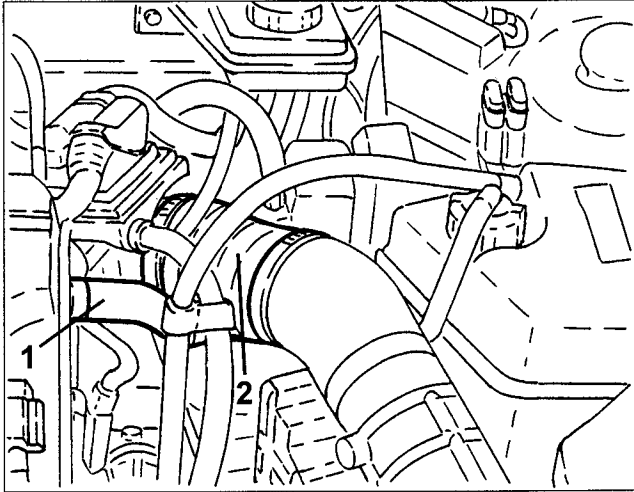


## REMOVAL/REFITTING

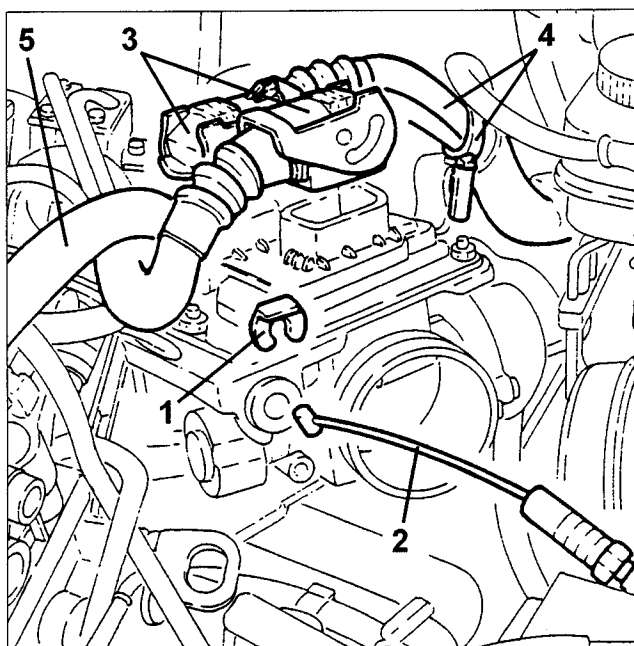
- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- 1. Remove the engine oil filler cap.
- 2. Loosen the fastening screws and remove the ignition coil cover.



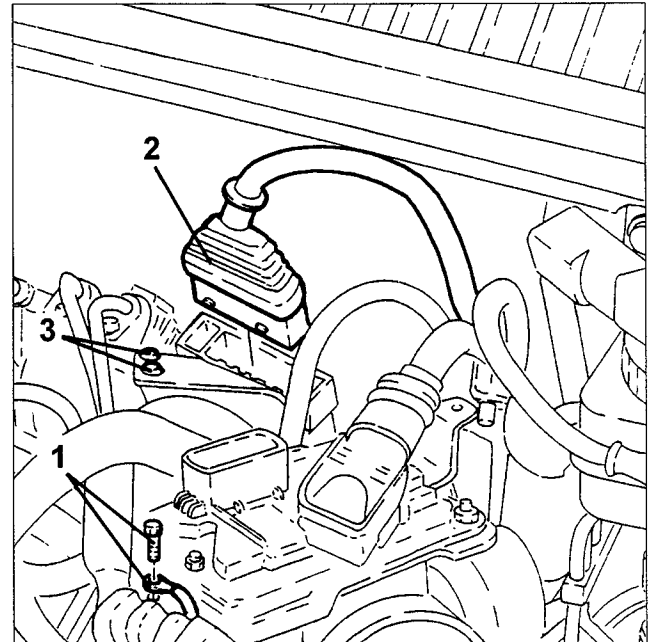
- Refit the engine oil filler cap.
- 1. Disconnect the oil vapour recovery pipe from the tappet cover.
- 2. Loosen the fastening clips and remove the throttle casing air intake corrugated sleeve.



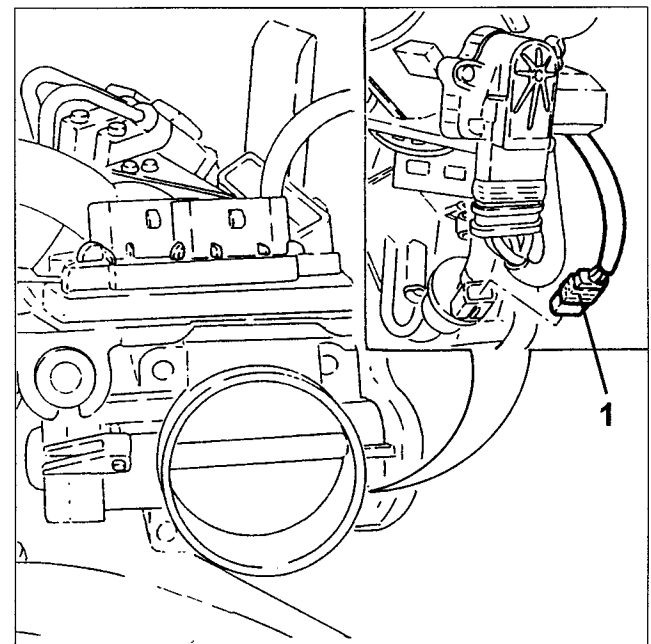
- 1. Remove the accelerator wire retainer from the bracket.
- 2. Release the accelerator wire from the throttle casing cam and move it aside.
- 3. Disconnect the injection-ignition ECU electrical connections.
- 4. Release the wiring from the clip on the ECU.
- 5. Disconnect the oil vapour recirculation pipe from the throttle casing.



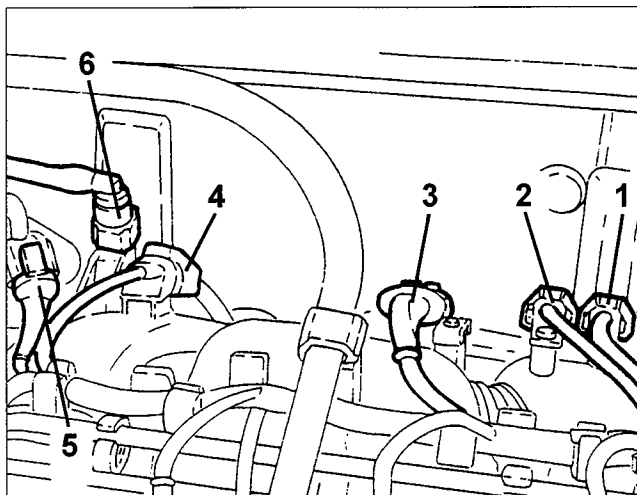
- 1. Disconnect the earth from the injection-ignition ECU bracket.
- 2. Disconnect the front engine joint wiring electrical connection.
- 3. Loosen the module intake manifold front engine joint wiring electrical connection bracket fastening screws.



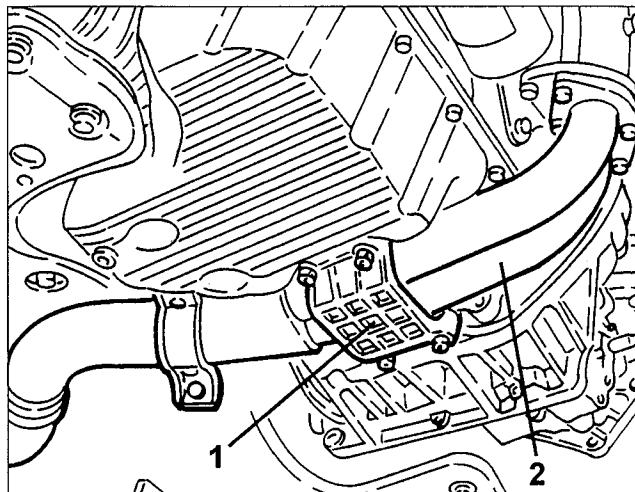
- 1. Disconnect the fuel vapour valve electrical connection.



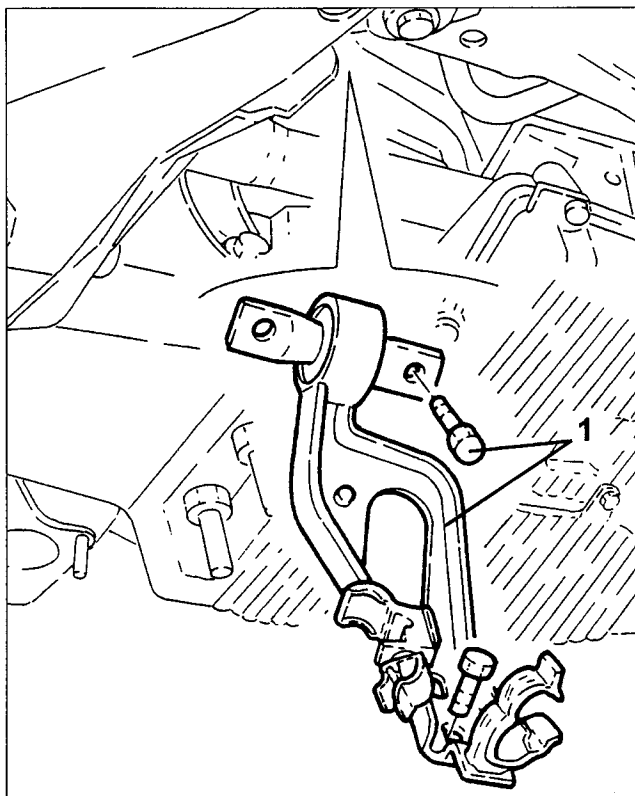
1. Disconnect the rpm and phase sensor electrical connection.
2. Disconnect the knock sensor electrical connection.
3. Disconnect the lambda sensor electrical connection.
4. Disconnect the phase sensor electrical connection.
5. Disconnect the modular intake manifold actuator electrical connection.
6. Disconnect the fuel vapour hose.
  - Release the electrical wiring and the pipes from their respective clips on the modular intake manifold.



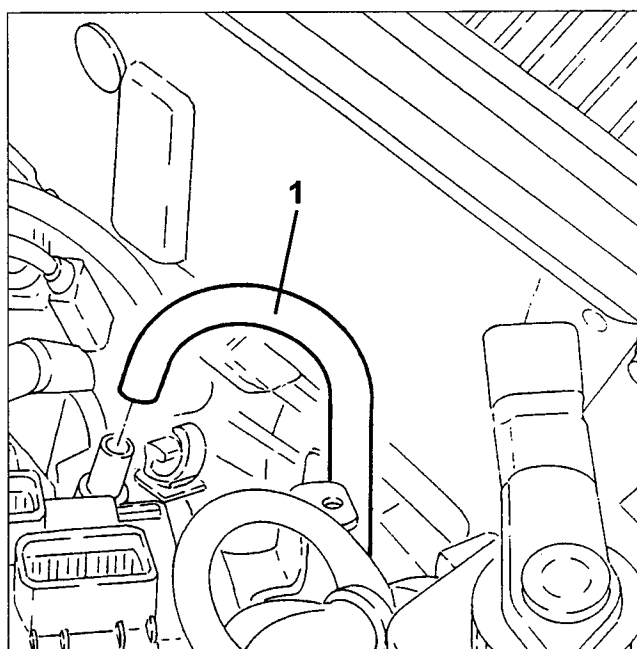
- Release the injector wiring from the fastening clips on the modular intake manifold.
- Release the coolant reservoir return pipe from the fasteners on the modular intake manifold.
- Lift the vehicle and remove the guard under the engine.
  1. Loosen the fastening nuts and remove the exhaust pipe front section bracket.
  2. Loosen the fasteners and remove the front exhaust pipe section with lambda sensor and seals.



1. Loosen the fastening screws and remove the modular intake manifold bracket.
- Loosen the modular intake manifold fastening screw, right-hand side of the vehicle.

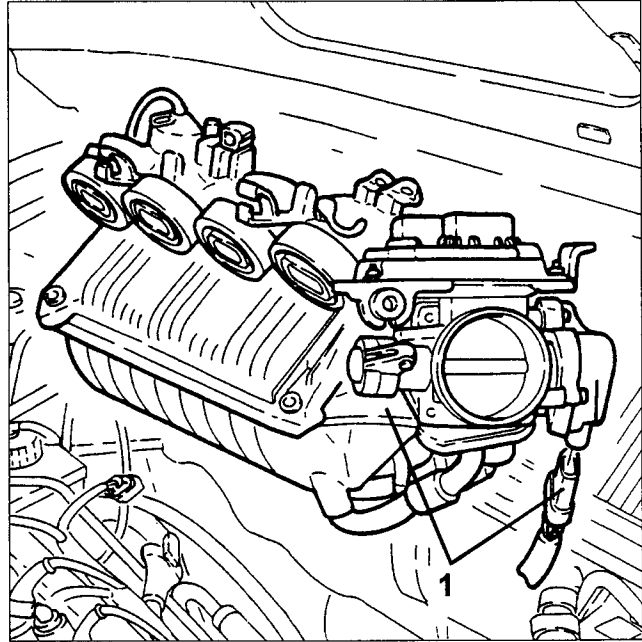
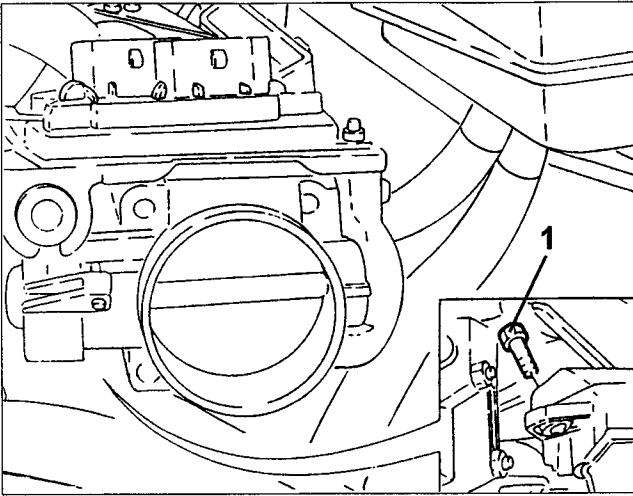


1. Disconnect the brake booster vacuum pipe.



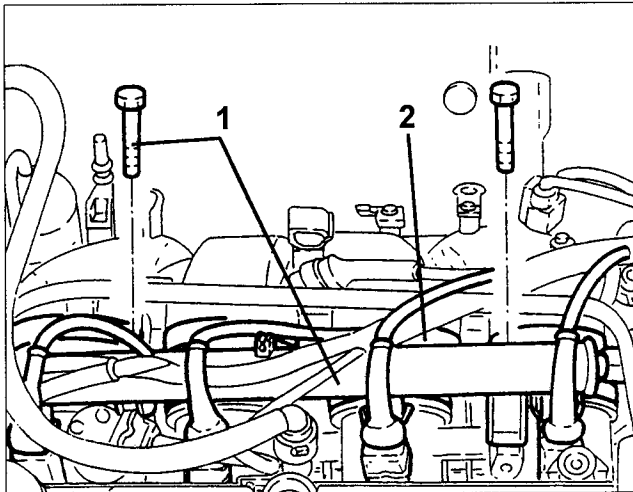


1. Lower the vehicle and loosen the modular intake manifold fastening screw, left-hand side of the vehicle.

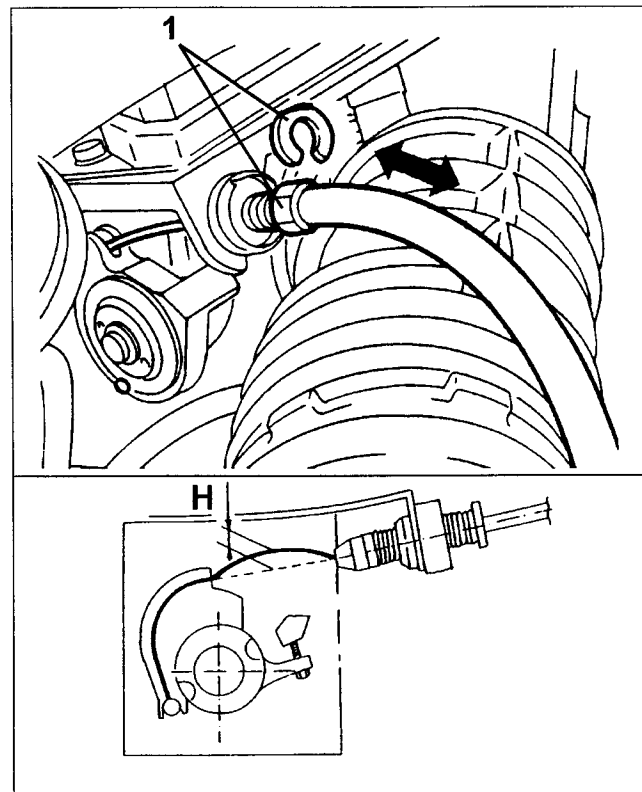


1. Loosen the fuel distribution manifold fastening screws and move it aside just enough to reach the air sleeve clips.

2. Loosen the air sleeve fastening clips and remove them after moving the modular intake manifold aside.



1. When refitting, calibrate the accelerator wire by means of the retainer so that the throttle is completely closed when the pedal is released and the wire has a play "H" of 5mm.



1. Remove the modular intake manifold after disconnecting the constant idling actuator electrical connection.

**IMPORTANT:** After replacing the modular intake manifold, repeat the self-learning procedure described below.

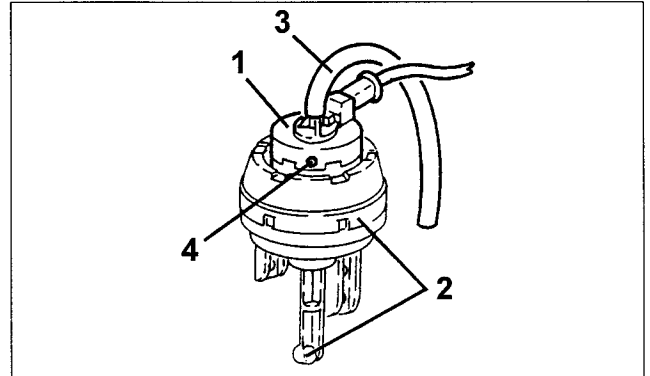
- Make sure the ignition key is at "STOP".
- Check that the conditioner is off, the accelerator pedal is never pressed and that the accelerator wire is positioned correctly.
- Connect tool no. 1.806.365.000 to the diagnostic socket and turn the knob to position 3.
- Connect Examiner.
- Go to Examiner "ECU Test" environment.
- Turn the ignition key to MAR.
- Go to Examiner "Active diagnosis" environment and select "Reset self-learning parameters" and "Idling actuator".
- Press "Run active diagnosis".
- Turn the ignition key to STOP and wait for 30 seconds.
- Turn the ignition key to MAR and wait for 30 seconds.
- Restore the Examiner-engine control system communication.
- Go to Examiner "Parameter" environment and select "Idling acknowledgement test - done" and "Idling acknowledgement signals - synchronised" in the "Select" menu.

**NOTE:** If one or more parameters are not OK, turn the ignition key to STOP and repeat the procedure. If the problem persists, check the diagnostic wire is connected properly and that the diagnostic tool is working.

- Turn the ignition key to STOP and wait for 30 seconds.
- Start the engine without pressing the accelerator pedal.
- Disconnect the diagnostic tool.
- Run a road test (several kilometres) then when the engine is at running temperature, check correct idling operation.

## MODULAR INTAKE MANIFOLD SOLENOID VALVE

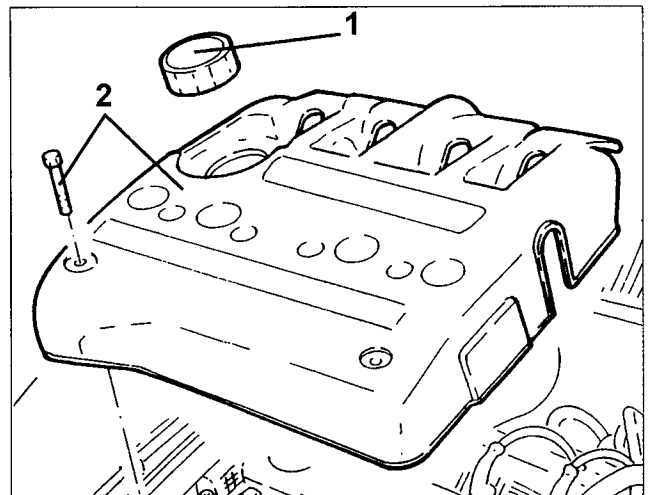
This two way solenoid valve is built-into the variable geometry intake manifold pneumatic actuator and is controlled by the injection ECU. It allows the vacuum in the vacuum accumulator (inside the modular intake manifold) to act on the rocking duct pneumatic control.



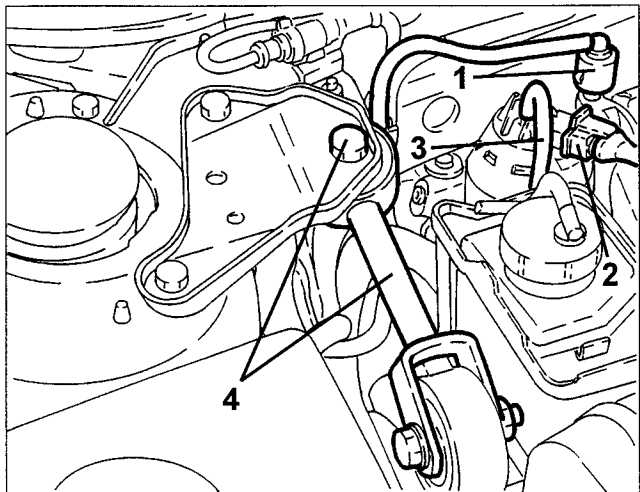
1. Modular intake manifold solenoid valve
2. Modular intake device actuator
3. Vacuum pipe
4. Atmospheric pressure air intake

## REMOVAL/REFITTING

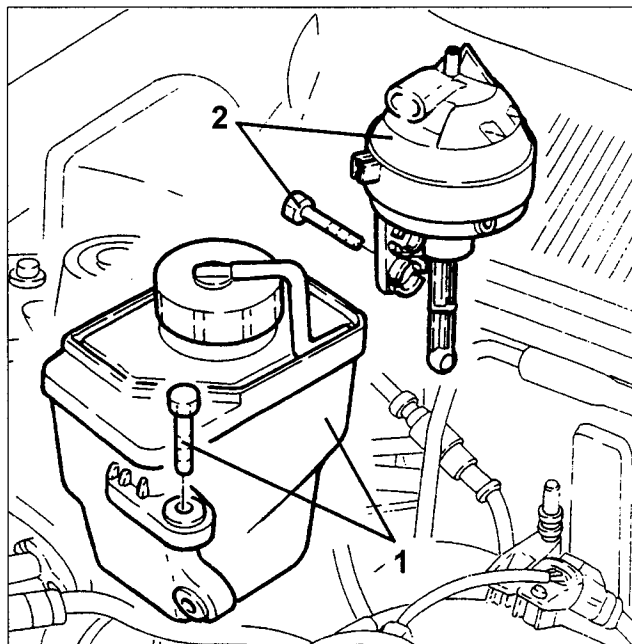
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- 1. Remove the engine oil filler cap.
- 2. Loosen the fastening screws and remove the ignition coil cover.
- Refit the engine oil filler cap.



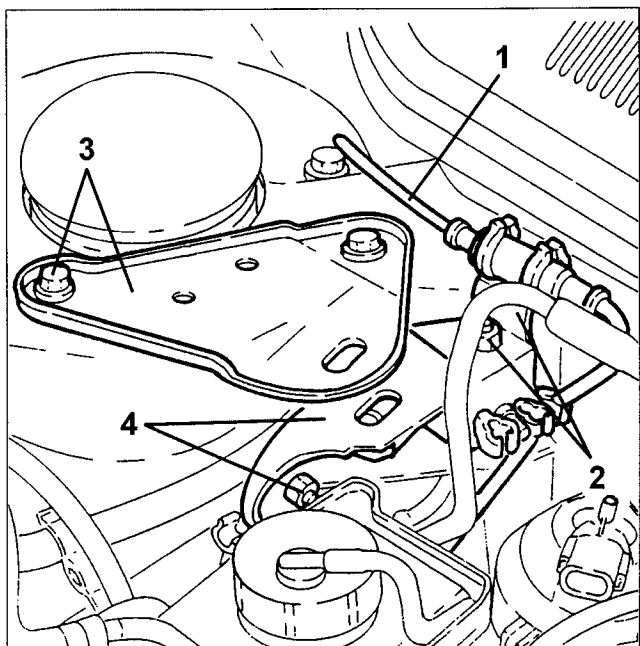
1. Disconnect the fuel vapour pipe quick coupling and release it from the clip on the power steering reservoir.
2. Disconnect the modular intake manifold actuator electrical connection.
3. Disconnect the vacuum pipe from the modular intake manifold actuator.
4. Loosen the fastening screws and remove the engine tie-rod.



1. Loosen the fastening screws and remove the power steering reservoir.
2. Loosen the fastening screws, disconnect the tie-rod from the joint and remove the modular intake manifold actuator.



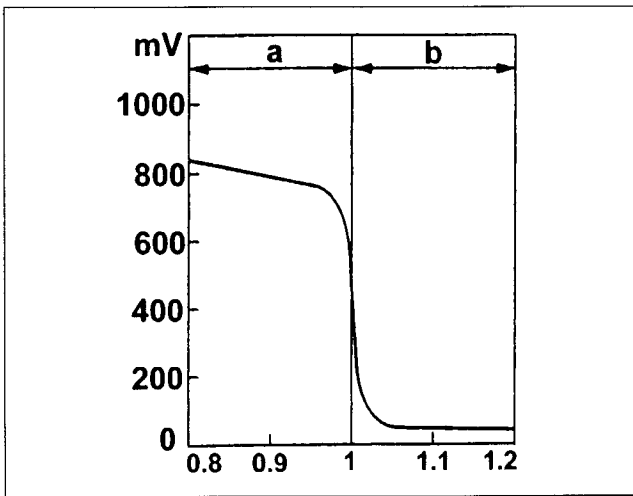
1. Release the right-hand ABS sensor electrical connection from the bracket.
2. Loosen the fastening nut and remove the ABS sensor electrical connection.
3. Loosen the fastening screws and remove the engine tie-rod upper bracket.
4. Loosen the fastening nut and screw. Then remove the engine tie-rod lower bracket.



## LAMBDA SENSOR

This "planar" sensor is fitted on the front section of the exhaust pipe and informs the injection-ignition ECU on the fuel metering (stoichiometric ratio). The injection ECU identifies the mixture compositions (lean or rich) according to the lambda sensor output voltage.

The ECU adjusts the amount of injected fuel to ensure optimal composition of the mixture ( $\lambda = 1$ ), to create ideal conditions for the treatment of exhaust fumes in the catalytic converter. If the mixture is too rich ( $\lambda < 1$ ) the amount of fuel is reduced and if the mixture is too lean ( $\lambda > 1$ ) the amount of fuel is increased.

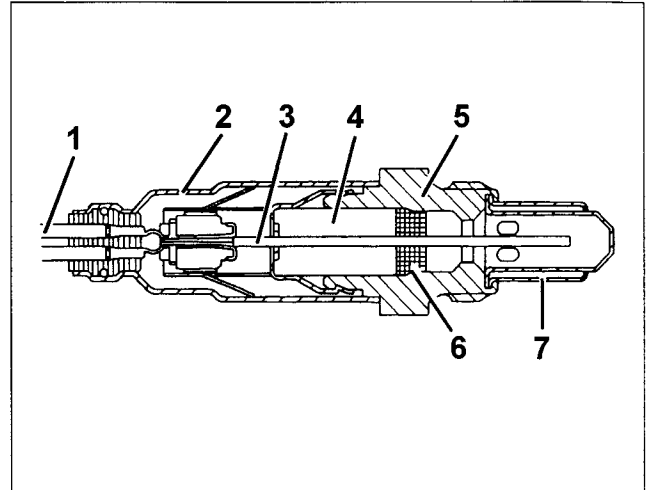


- a. Rich mixture (no air)
- b. Lean mixture (excessive air)

The lambda sensor, in contact with the exhaust fumes, generates an electrical signal with a voltage which varies according to the concentration of oxygen in the fumes. The voltage is characterised by a sudden variation with the composition of the mixture differs from  $\lambda = 1$ .

The lambda sensor heating is governed by the injection ECU proportionally according to exhaust fume temperature. This avoids thermal shocks to the ceramic casing due to the contact with condensed water in the exhaust fumes when the engine is cold.

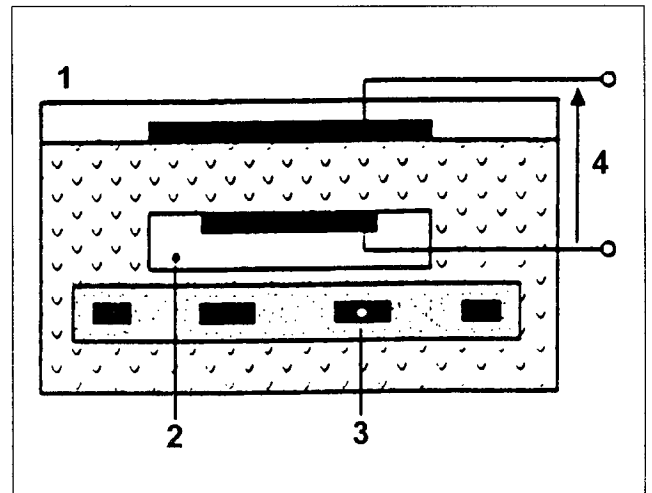
The measuring cell and the heater and built-into the "planar" ceramic element (layered) with the advantage of rapid cell heating to allow a "closed loop" control ( $\lambda = 1$ ) within 10 seconds from when the engine is started.



- 1. Connection wire
- 2. Protective sleeve
- 3. Planar sensor element
- 4. Ceramic supporting tube
- 5. Sensor seat
- 6. Ceramic seal
- 7. Protection pipe

The lambda sensor operation is based on the principle of a oxygen concentration cell and solid electrolyte.

The surfaces of the measuring cells are covered with noble material micro-pore layers.

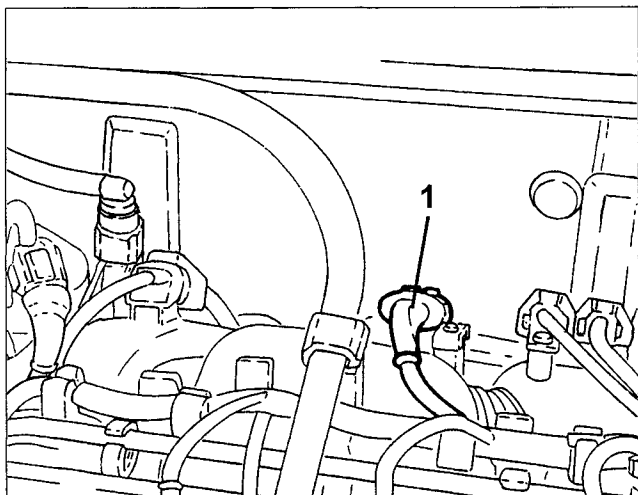


- 1. Exhaust fumes
- 2. Reference air passage
- 3. Heater
- 4. Lambda sensor voltage

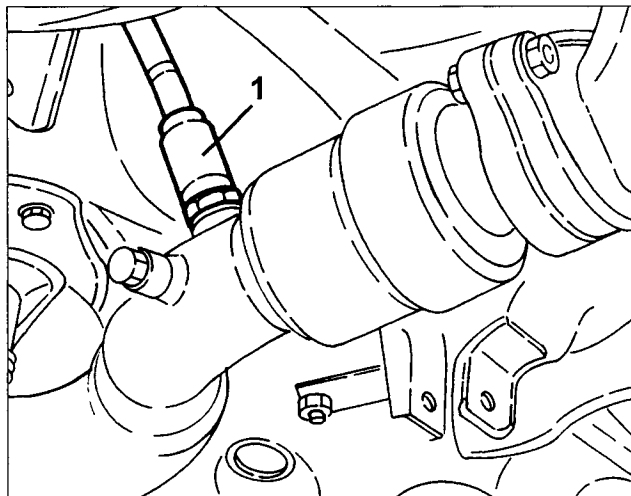
## REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.

1. Disconnect the lambda sensor electrical connection and release the respective electrical wiring from the clips on the modular intake manifold.



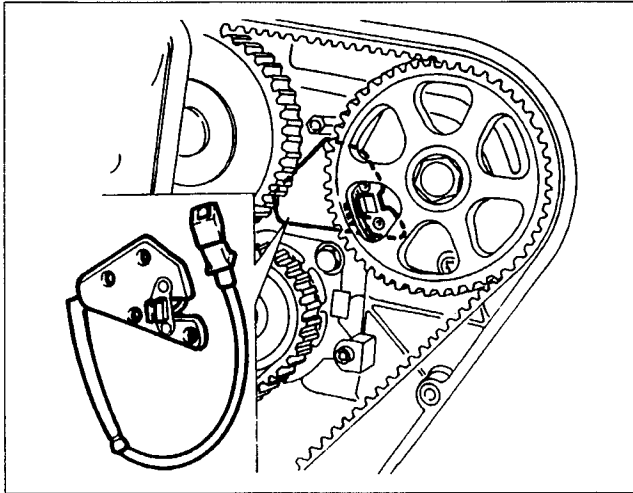
1. Lift the vehicle and remove the lambda sensor with its electrical wiring.



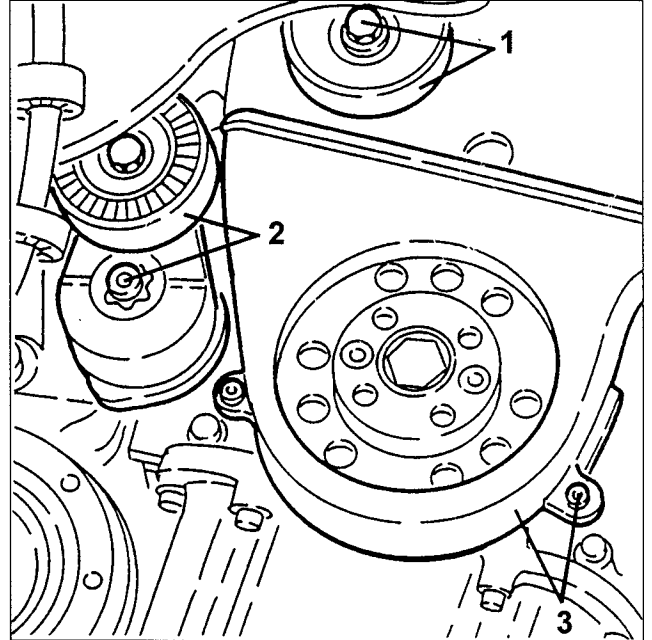
### PHASE SENSOR

This "Hall" effect sensor is fitted on the cylinder head and faces the camshaft drive pulley (exhaust).

Four windows on the pulley allow the phase sensor to rapidly signal the timing position of the engine. The injection-ignition ECU uses the phase sensor signal to acknowledge TDC at the end of compression.



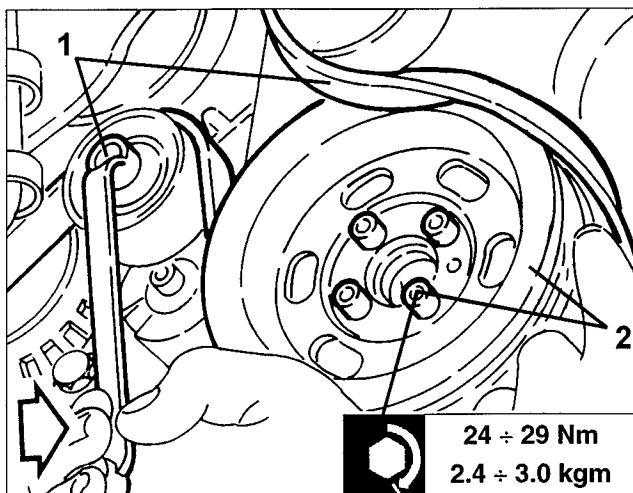
1. Loosen the fastening screw and remove the belt take up.
2. Loosen the fastening screw and remove the engine unit drive belt runner.
3. Loosen the fastening screws and remove the lower timing and counter-rotating shaft belt guard.



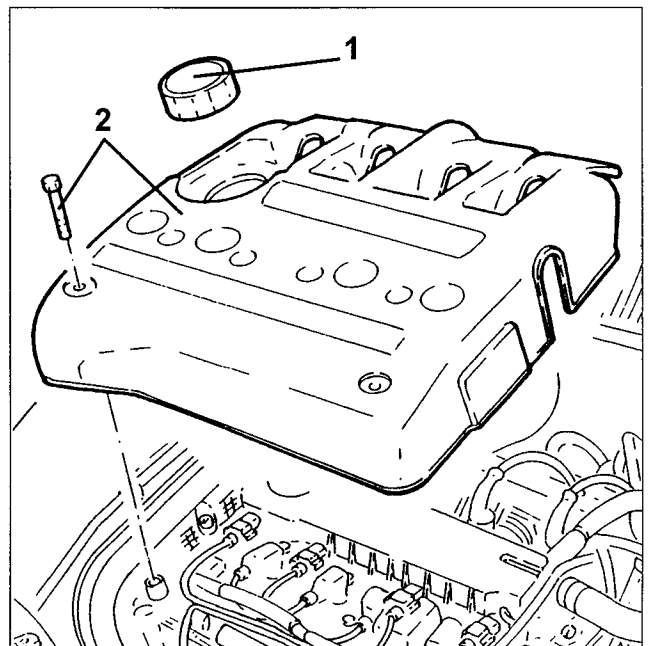
### REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Remove the front right wheel and mudguard.

1. Lift the vehicle. Loosen the engine unit drive belt by means of the belt take-up as shown in the figure and remove the belt.
2. Loosen the four fastening screws and remove the engine pulley.

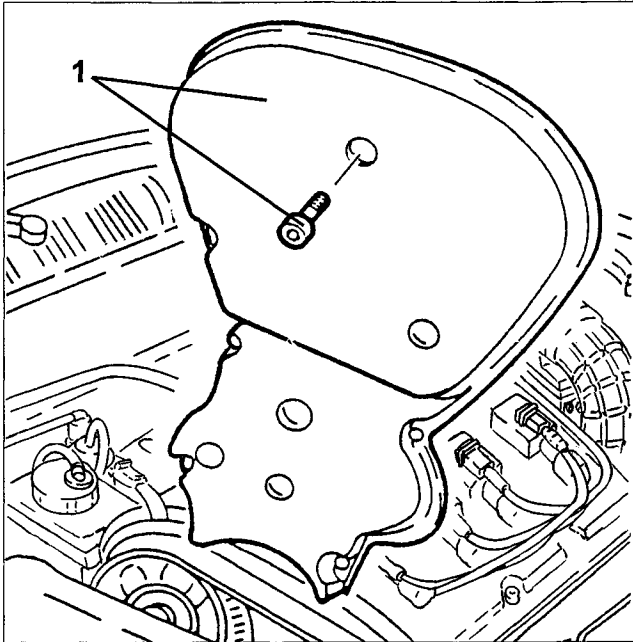


1. Remove the engine oil filler cap.
  2. Loosen the screws and remove the ignition coil cover.
- Refit the engine oil filler cap.



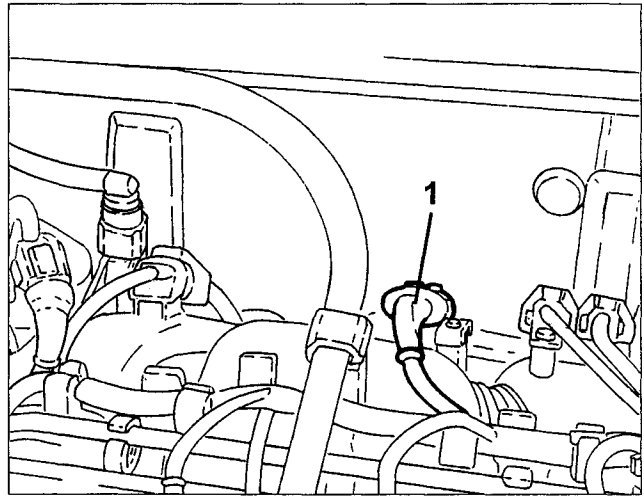
### For 1.8 version

- Loosen the timing belt guard lower screws.
1. Lower the vehicle, loosen the remaining fastening screws and remove the timing belt guard.



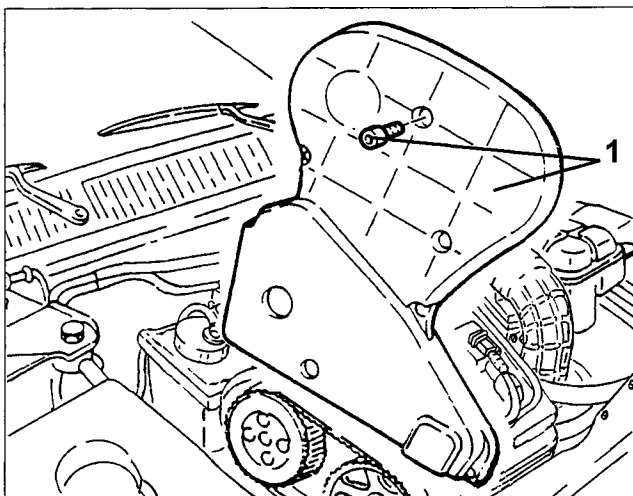
### All types

1. Disconnect the phase sensor electrical connection and release the respective wiring from the clips.



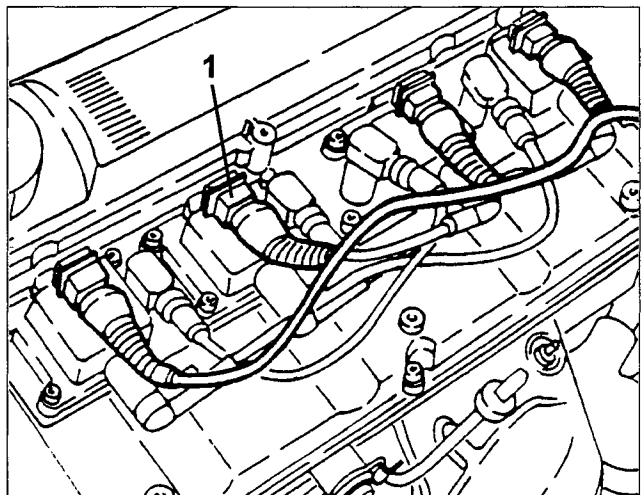
### For 2.0 version

- Loosen the lower timing and counter-rotating shaft belt guard the fastening screws.
1. Lower the vehicle, loosen the remaining fastening screws and remove the upper guard.

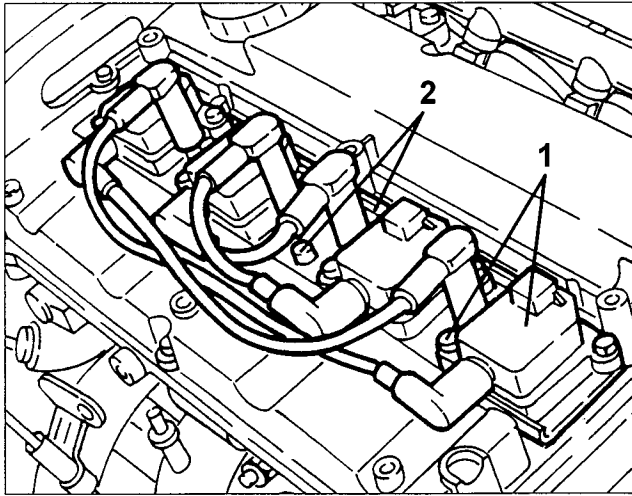


- Disconnect the oil vapour recirculation pipes from the tappet cover.

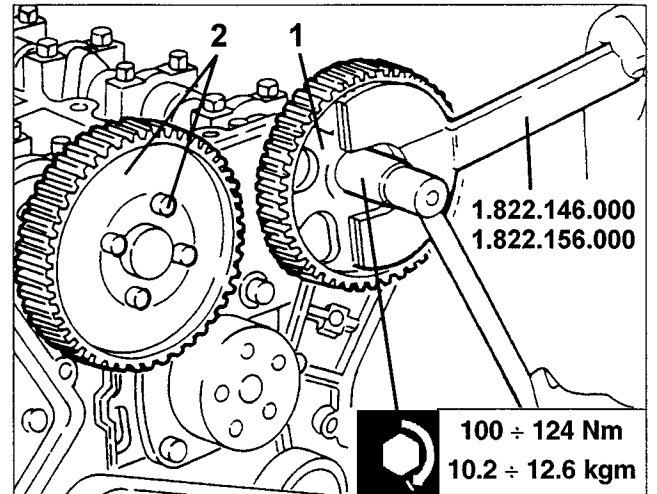
1. Disconnect the ignition coil electrical connections.



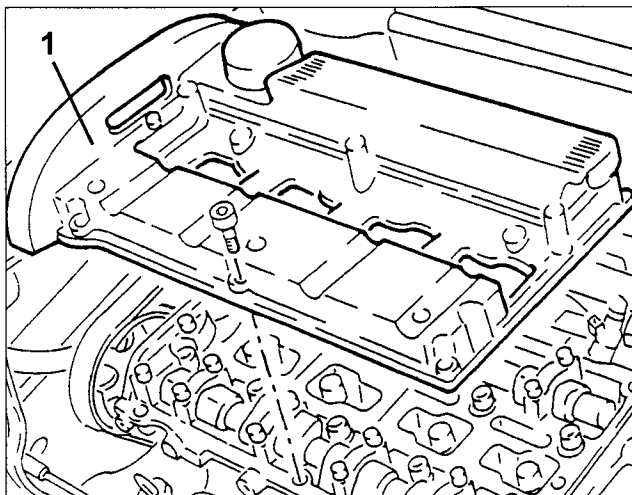
1. Loosen the fastening screws and remove the ignition coils.
2. Loosen the fastening screws and remove the ignition coil bracket.



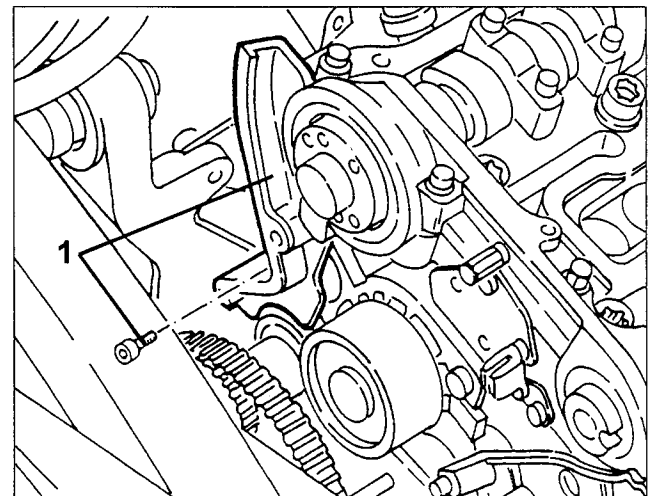
1. Use tools no. 1.822.146.000 and no. 1.822.156.000 to loosen the camshaft drive pulley fastening screws on exhaust side and remove it.
2. Loosen the fastening screws and remove the camshaft drive pulley on intake side.



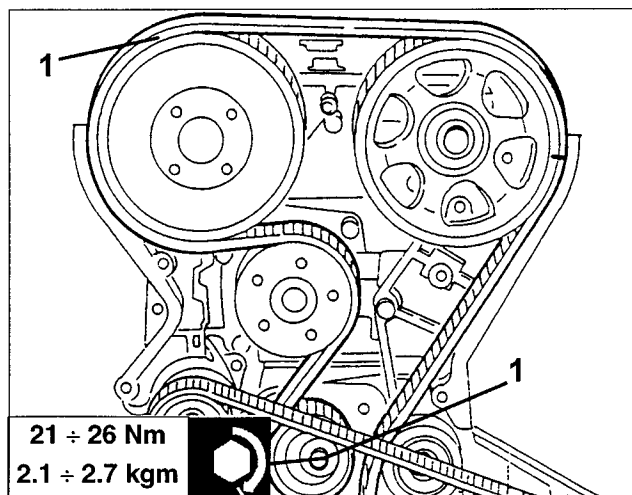
1. Loosen the fastening screws and remove the tappet cover.



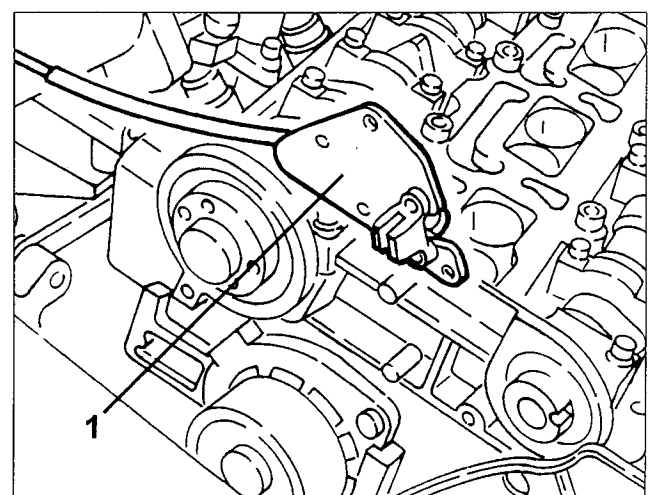
1. Loosen the fastening screws and remove the side guard on intake side.



1. Loosen the belt by means of the belt take-up. Remove it from the camshaft drive pulleys.



1. Loosen the fastening screws and remove the phase sensor.



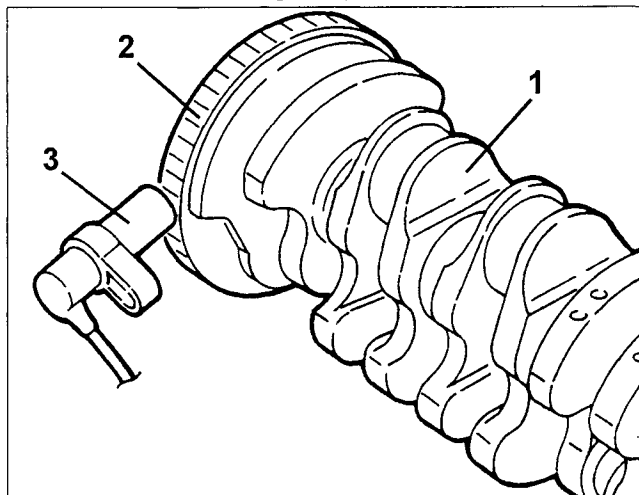


## RPM AND PHASE SENSOR

This sensor is fitted on the crankcase and faces the phonic wheel on the flywheel. It is inductive, i.e. it works by means of the variations in the magnetic field generated by the passage of the phonic wheel teeth (60 - 2 teeth).

The injection ECU uses the rpm sensor signal to:

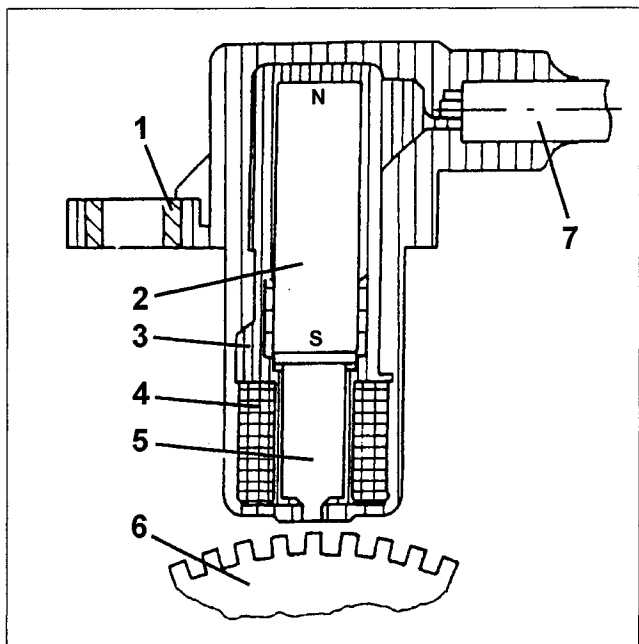
- define revolution speed
- define crankshaft angular position.



1. Crankshaft  
2. Phonic wheel  
3. Rpm and phase sensor

### Operation

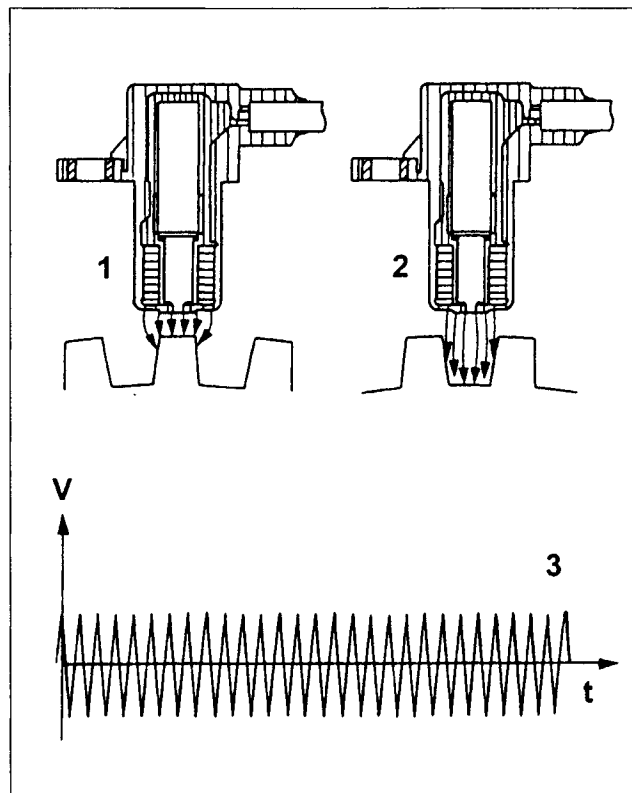
The switchover from full to none, due to the presence or the absence of a tooth, causes magnetic flow variations which generate an induced alternating voltage by counting the teeth on the phonic wheel. The frequency and the width of the voltage sent to the ECU provides the engine angular speed measurement.



1. Brass bushing
2. Permanent magnet
3. Plastic sensor casing
4. Coil winding
5. Pole core
6. Crown or phonic wheel
7. Co-axial double wire or electrical connection

The prescribed gap between the sensor tip and the phonic wheel for correct signals must be between **0.8 and 1.5 mm**.

The gap cannot be adjusted. If the gap is out of tolerance, check intactness of sensor and phonic wheel.

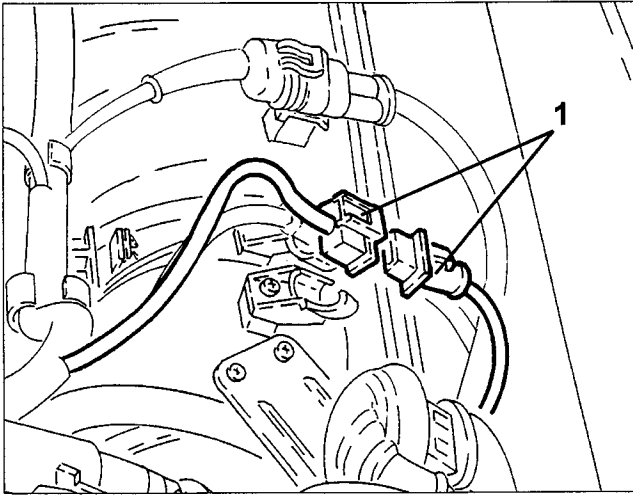


1. Maximum magnetic flow
2. Minimum magnetic flow
3. Induced alternating voltage trend.

### REMOVAL/REFITTING

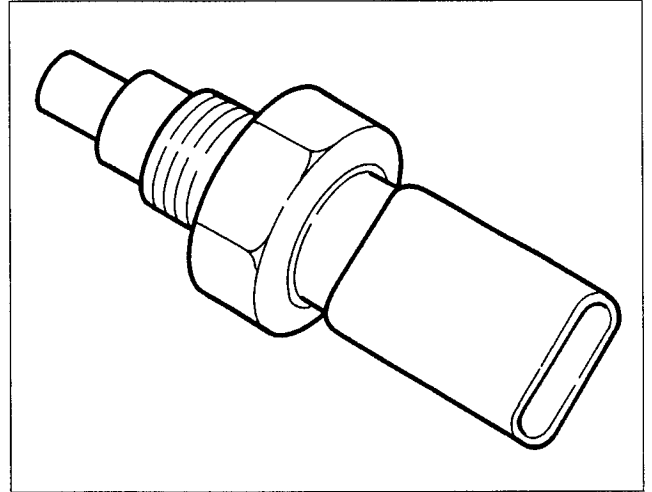
- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.

1. Disconnect the rpm and phase sensor electrical connection and release the respective electrical wiring from the fastening clips.

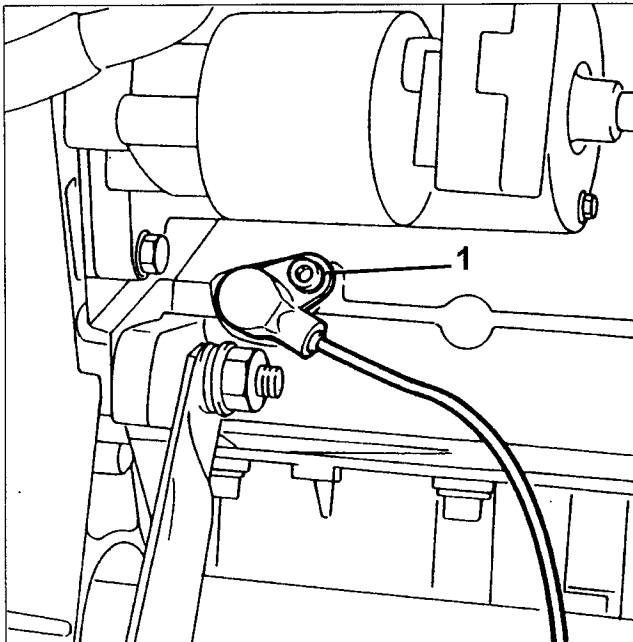


## ENGINE COOLANT TEMPERATURE SENSOR

This sensor is fitted on the thermostat cap and measures the coolant temperature by means of a double NTC thermistor with negative resistance coefficient. One NTC thermistor sends a signal to the injection ECU while the other sends a signal to the instrument panel temperature gauge and warning light.



1. Lift the vehicle. Loosen the fastening screw and remove the rpm and phase sensor.

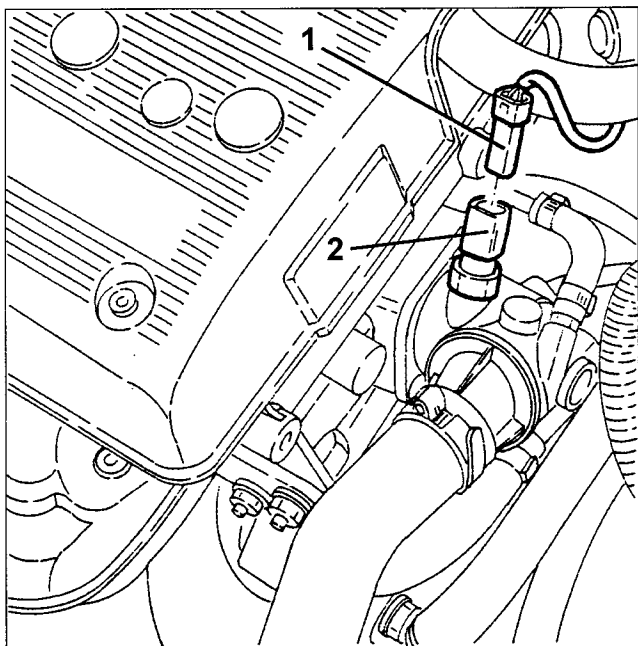


The sensor applies semiconductor technology. Consequently, the resistive value decreases as the sensor temperature increases with the coolant temperature. The resistance variation is not linear: consequently, it is higher at low temperatures with respect to higher temperatures.

## REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and remove the (-) battery terminal.

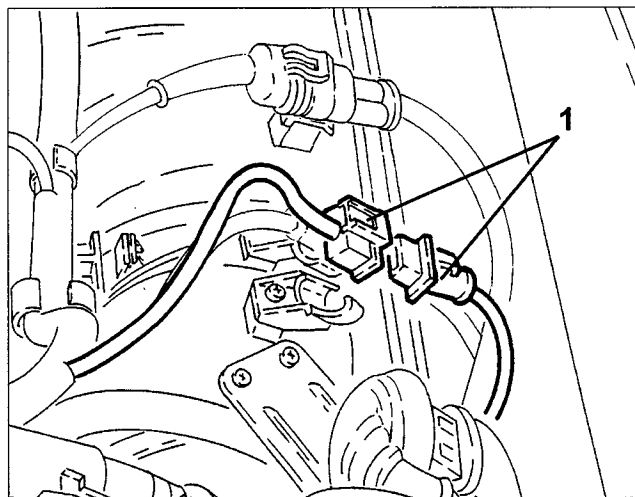
1. Disconnect the engine coolant temperature sensor electrical connection.
2. Loosen and remove the engine coolant temperature sensor from the thermostat cap.



### REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.

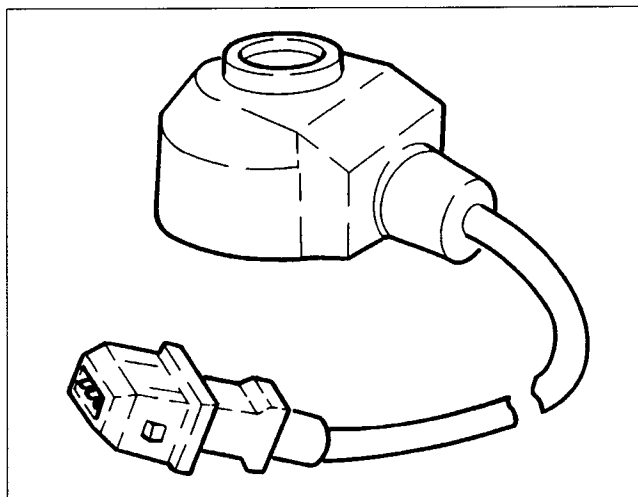
1. Disconnect the knock sensor electrical connection.



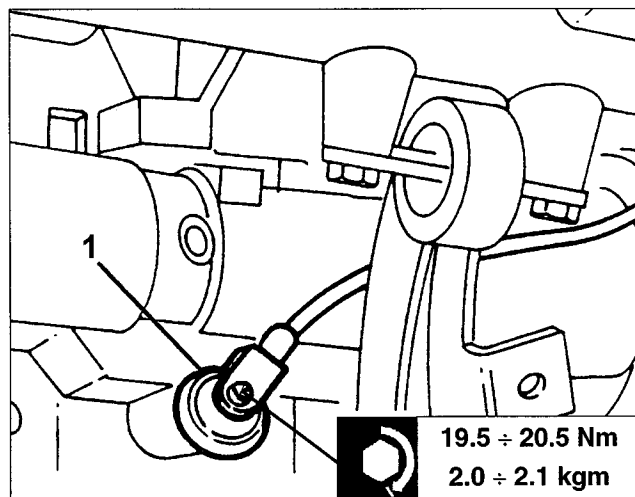
### KNOCK SENSOR

The piezoelectric knock sensor is fitted on the crankcase and detects the intensity of the vibrations caused by the knock in the firing chamber. The sensor piezoelectric crystal detects vibrations generated at frequency included between 12 kHz and 16 kHz and generates electrical signals which are sent to the injection ECU.

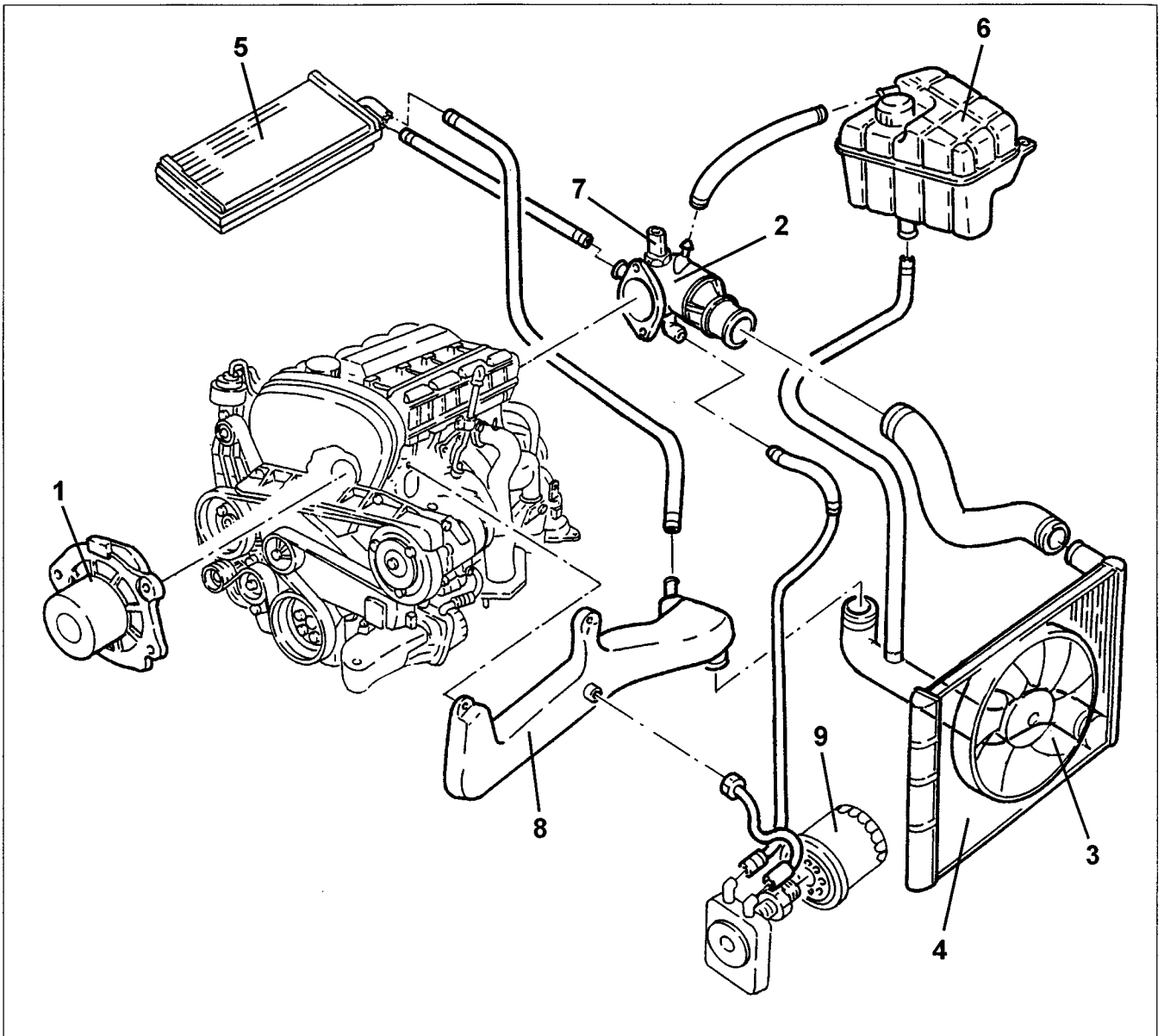
The knock sensor fastening screw torque is 19.5 - 20.5 Nm.



1. Lift the vehicle, loosen the fastening screw and remove the knock sensor.



**ENGINE COOLING SYSTEM**



- 1. Coolant pump
- 2. Thermostat
- 3. Cooling solenoid valve
- 4. Radiator
- 5. Climate control heater

- 6. Expansion reservoir
- 7. Engine coolant temperature sensor
- 8. Longitudinal manifold
- 9. Engine oil/coolant heat exchanger

## DESCRIPTION

The cooling system is sealed and of the forced circulation type. It features a centrifuge pump (1) operated by the crankshaft by the timing belt. A thermostat valve (2) located on the rear of the engine ensures optimal engine temperature. It opens when the coolant reaches a temperature of 83°C. The radiator (3) cools the fluid by means of dynamic air and a fan. The fan is controlled by the injection-ignition ECU according to a specific logic (for greater details see ELECTRIC-ELECTRONIC DIAGNOSTICS - Section 26 for versions with climate control and Section 27 for versions with heater). The expansion reservoir (7) feeds the circuit if the level decreases and absorbs the fluid variations in volume according to the temperature. Furthermore, it acts as a circuit air bleeder. A double NTC thermistor coolant temperature sensor is fitted on the thermostat cup. One NTC thermistor sends a signal to the injection ECU while the other sends a signal to the instrument panel temperature gauge and warning light.

## CIRCUIT OPERATION

The fluid cools the engine as it reaches the thermostat (2) via the cylinder head. If its temperature is lower than 83 °C, the coolant is sucked by the pump (1) via a longitudinal return manifold (11) located on the left-hand side of the cylinder head. If the temperature is higher than this value, the coolant is conveyed to the radiator (4) via the thermostat opening. After being cooled in the radiator, the coolant returns to the thermostat from where it is conveyed to the pump via the longitudinal manifold. Furthermore, from the thermostat cup the coolant is conveyed to:

- the expansion reservoir also for bleeding the circuit;
  - the climate control system to return to the longitudinal manifold;
  - heat exchanger (12) for cooling engine oil. It is then let out and directly conveyed via the coolant return longitudinal manifold to the pump.
- The expansion reservoir feeds the engine cooling circuit via a specific connection pipe on the longitudinal manifold.

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(\*) See  TB

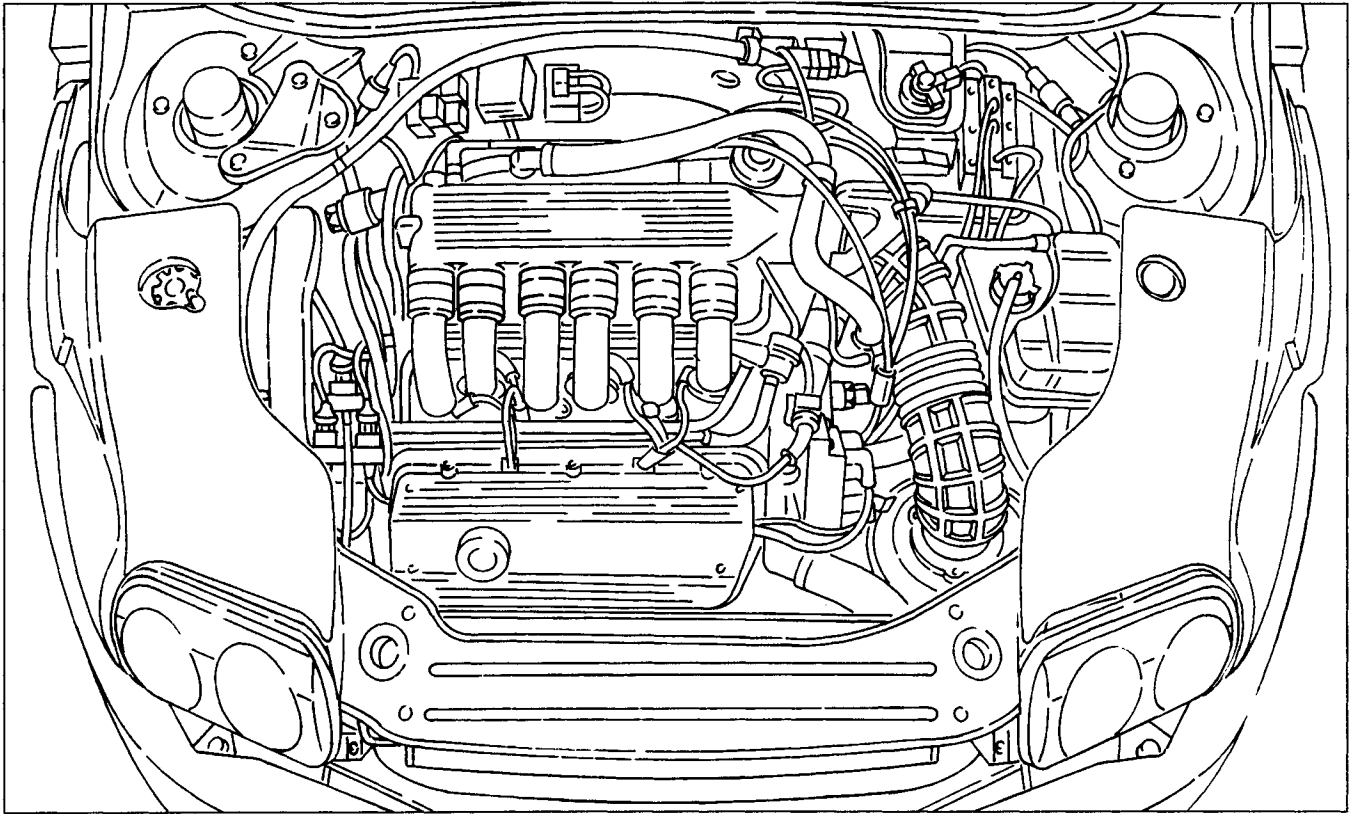
## DESCRIPTION

The information and illustrations given below enable the rapid removal of the power unit from its housing and its subsequent refitting.

Dis-assembly of the single components on the bench is described in the volume "ENGINE OVERHAULING".

The following procedure may be used only in part according to requirements.

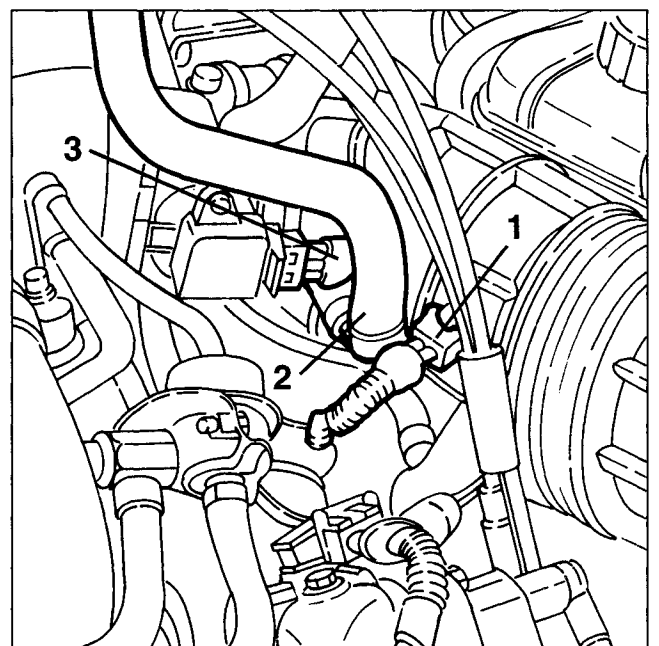
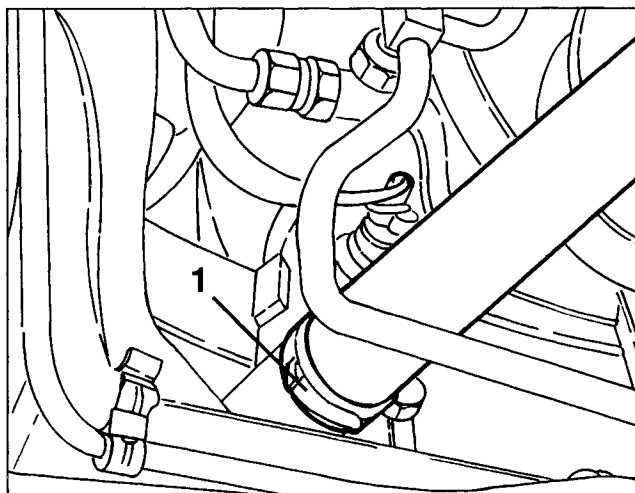
For further information and details, refer to the chapters concerning the components or specific groups.



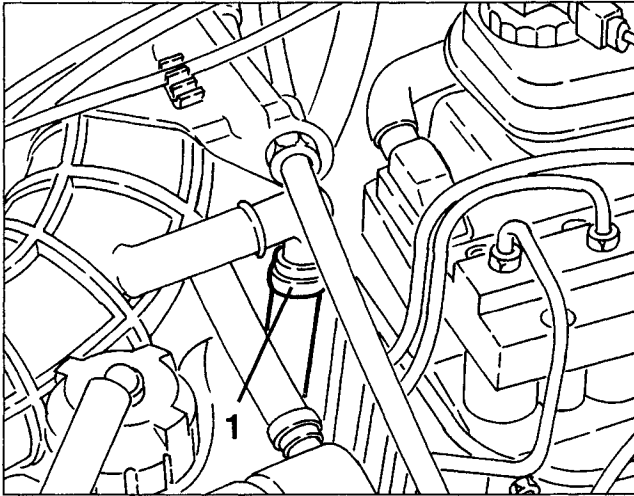
## REMOVAL

- Set the car on a two-column lift.
  - Disconnect the battery (-) terminal.
  - Drain the coolant fluid from the air conditioning system (see specific paragraph).
  - Remove the front wheels and wheel houses.
1. Raise the car and drain the coolant fluid disconnecting the radiator outlet sleeve.

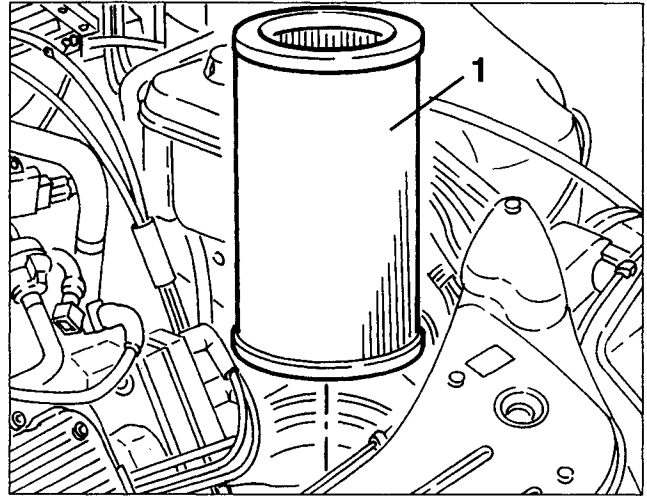
1. Lower the car and disconnect the electrical connection from the intaken air temperature sensor.
2. Disconnect the air inlet pipe for the idle speed actuator from the corrugated sleeve.
3. Disconnect the electrical connection from the throttle potentiometer



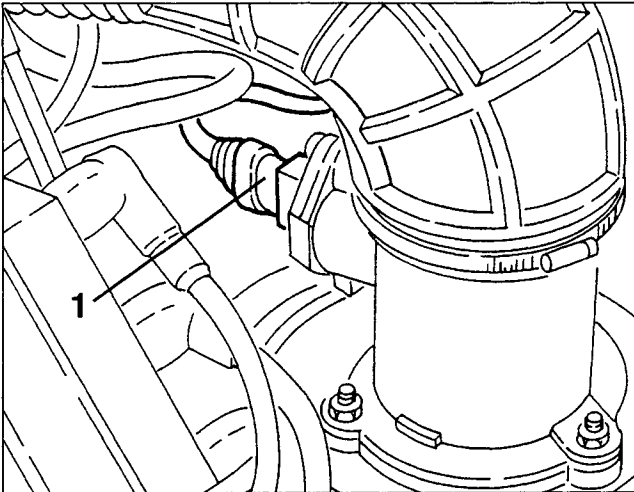
1. Disconnect the oil vapour recirculation pipe from the corrugated sleeve.



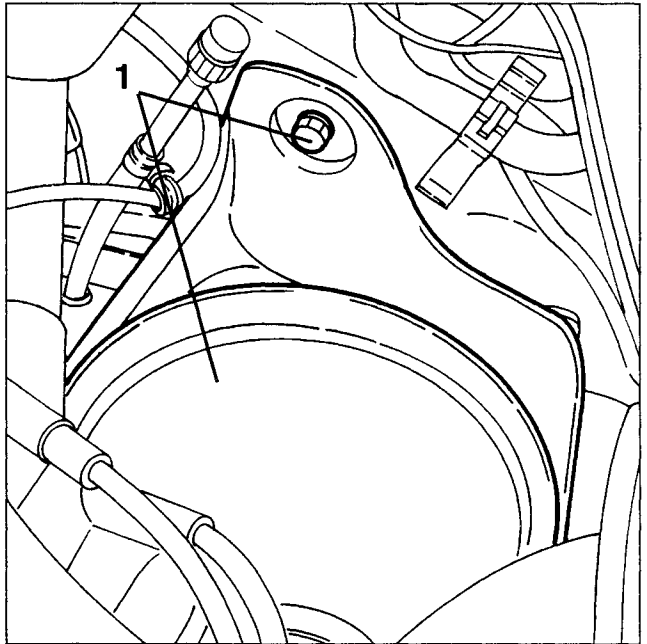
1. Remove the filtering element.



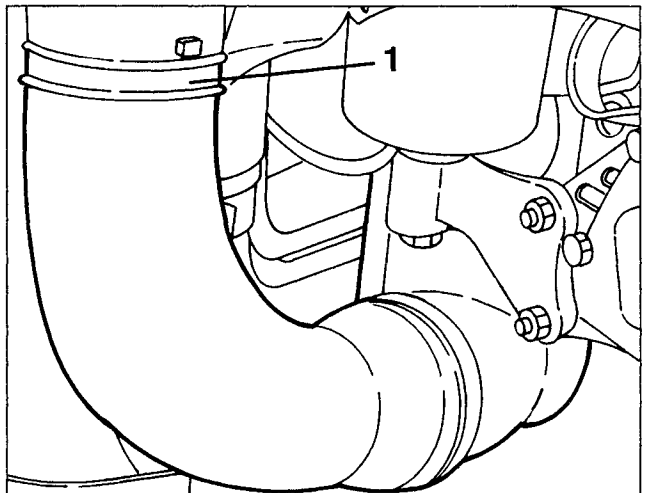
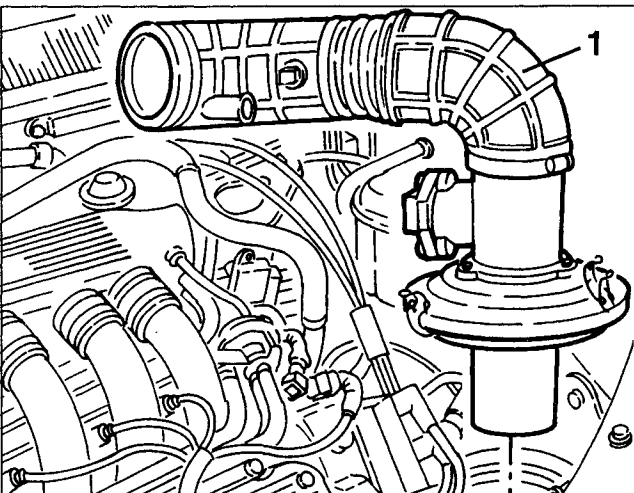
1. Disconnect the electrical connection from the air-flow meter.



1. Slacken the three screws fastening the air cleaner box then remove it complete with elbow after disconnecting same.

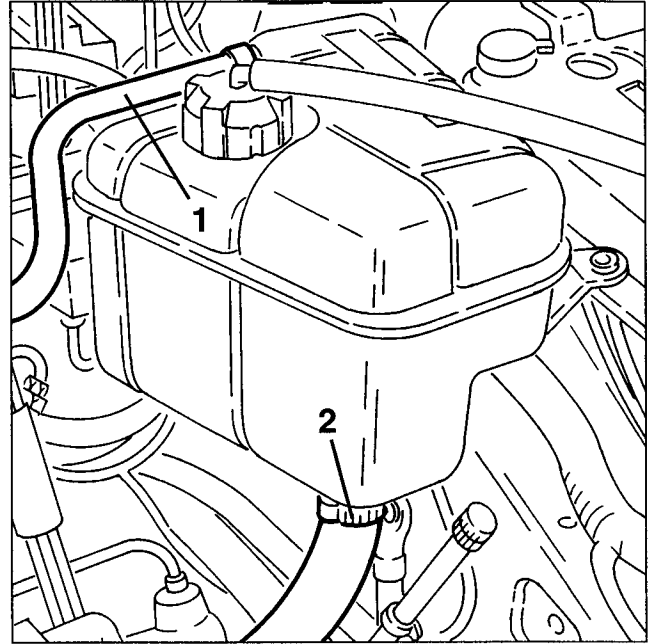
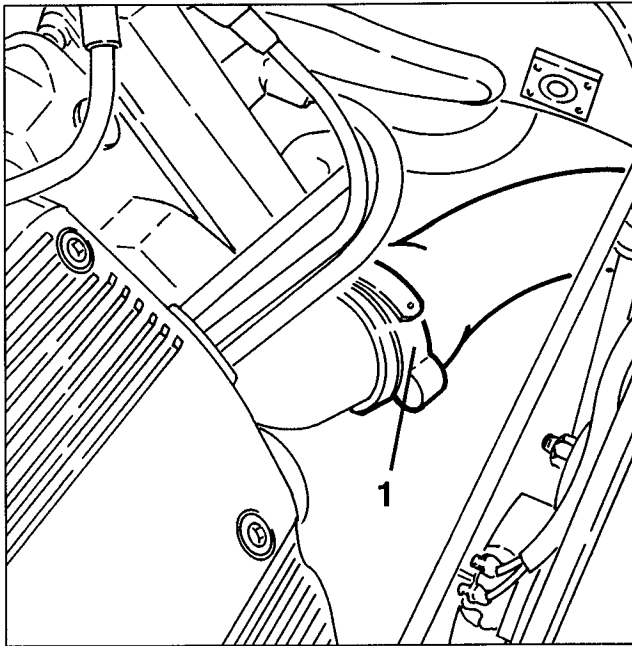


1. Remove the corrugated sleeve complete with air cleaner cover, after slackening the clamps fastening it to the throttle body and the clips fastening it to the air cleaner box.



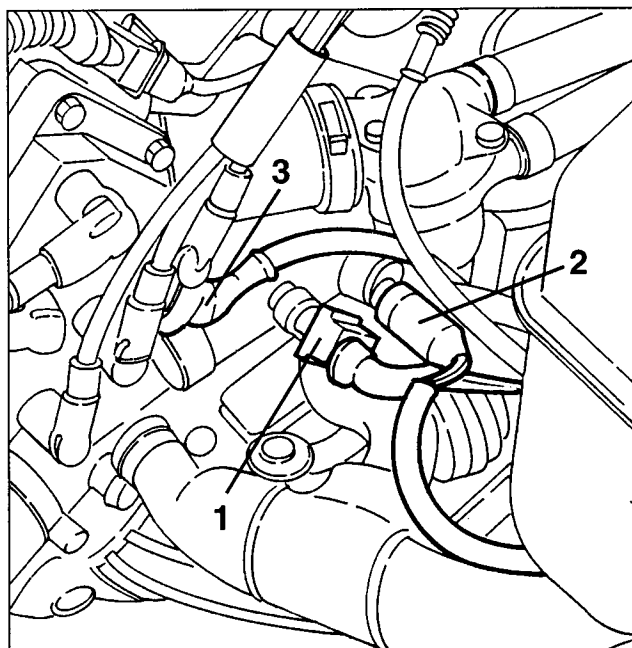
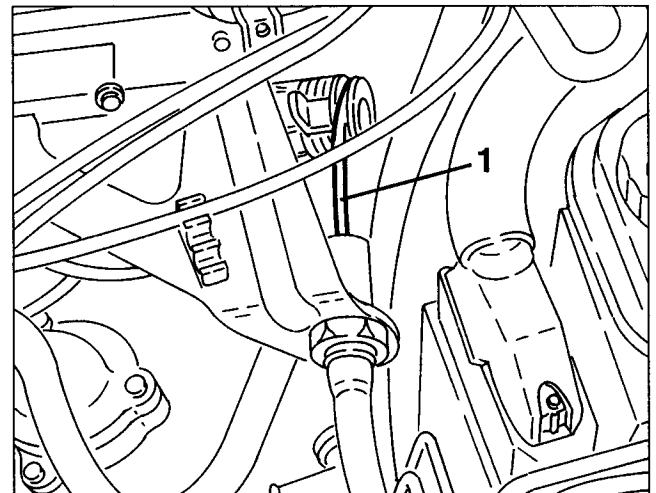


1. From the ignition coil support disconnect the coolant delivery sleeve to the radiator.

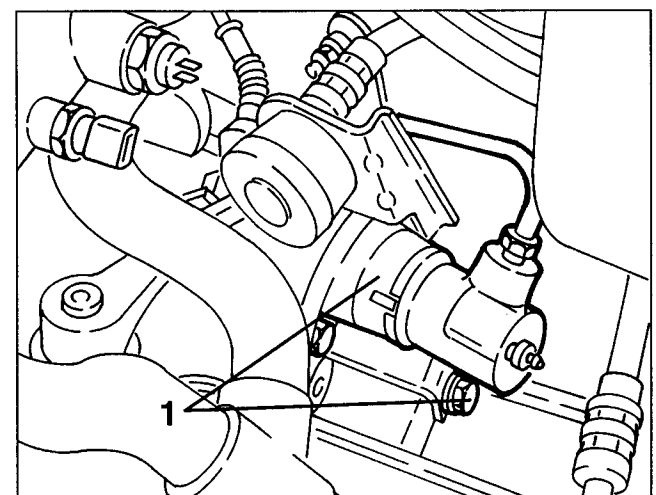


1. Disconnect the accelerator cable from the throttle body.

1. Disconnect the electrical connection from the coolant temperature sensor (NTC).  
 2. Disconnect the electrical connection from the coolant temperature gauge transmitter and max. temperature warning light contact.  
 3. Disconnect the electrical connection from the ignition coils.

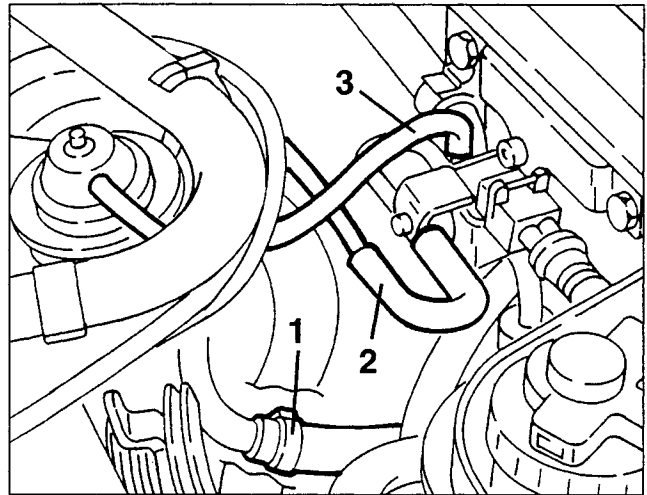
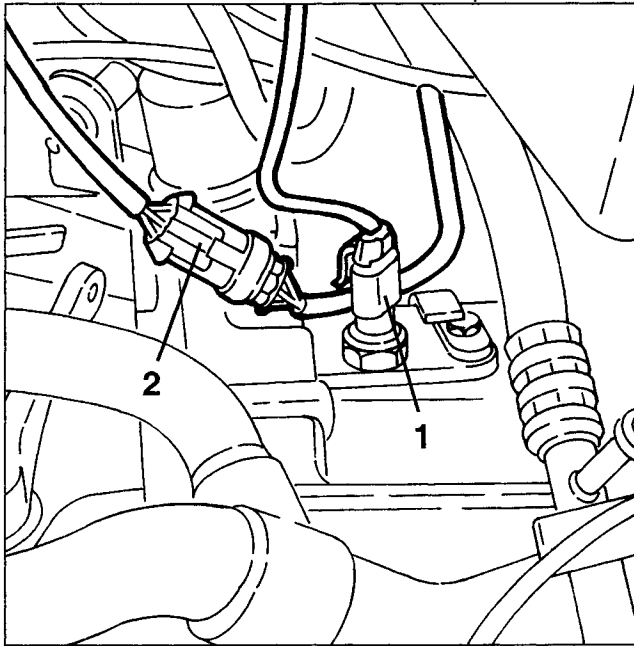


1. Slacken the three screws fastening the clutch control cylinder support bracket, then move the unit aside without disconnecting the piping.

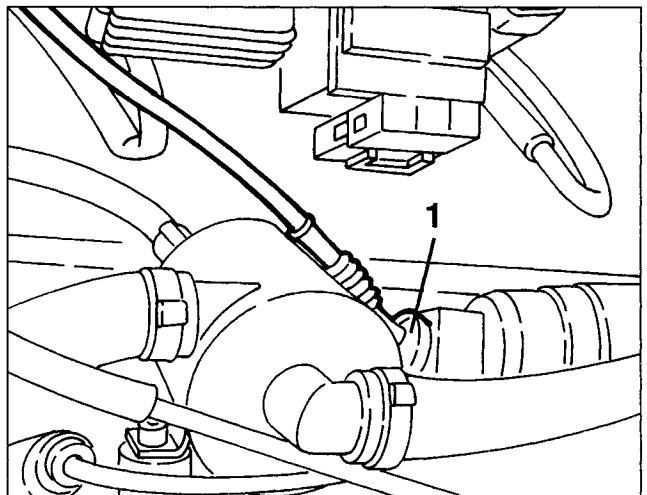


1. Disconnect the coolant return and air relief pipe from the header tank.  
 2. Disconnect the system supply pipe from the header tank.

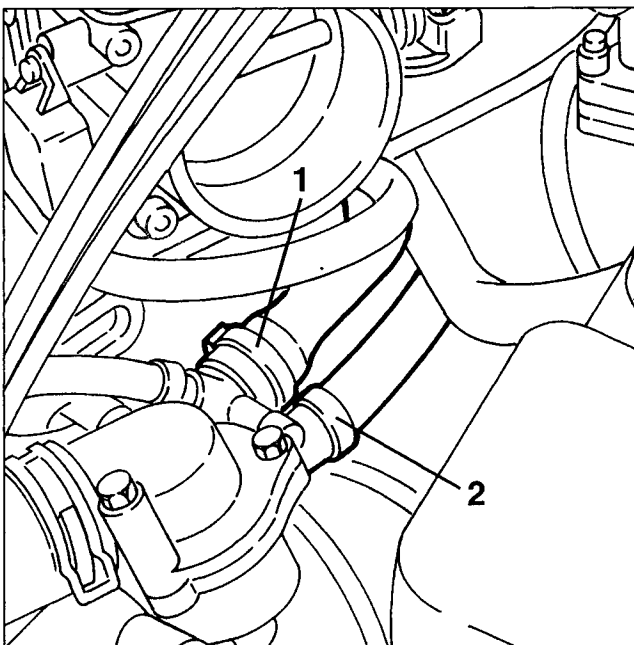
1. Disconnect the electrical connection from the reverse gear switch.
2. Disconnect the electrical connection from the mileage recorder sensor.



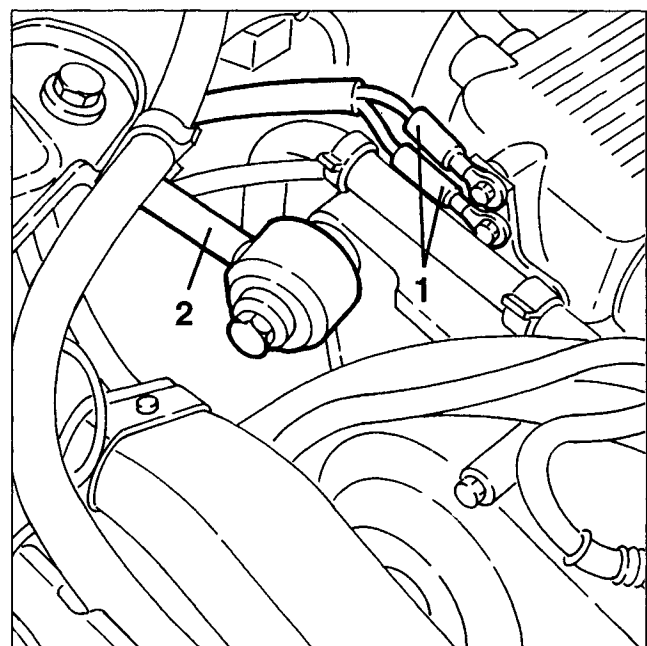
1. Disconnect the electrical connection from the constant idle speed actuator.



1. Disconnect the coolant delivery pipe to the heater.
2. Disconnect the coolant return pipe from the heater.

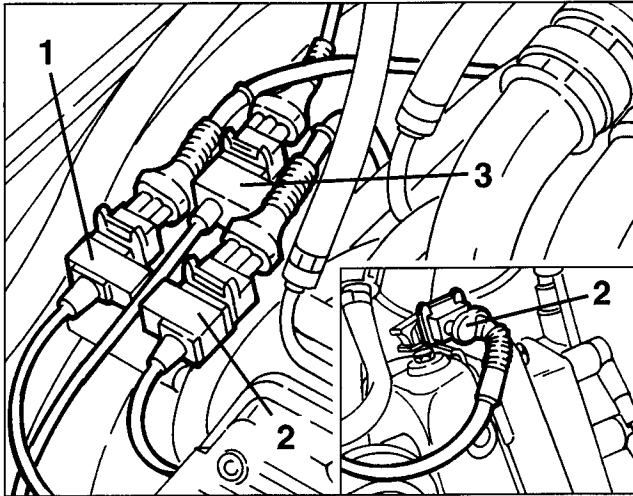


1. Disconnect the earth cables from the intake box.
2. Remove the engine stay connecting rod.

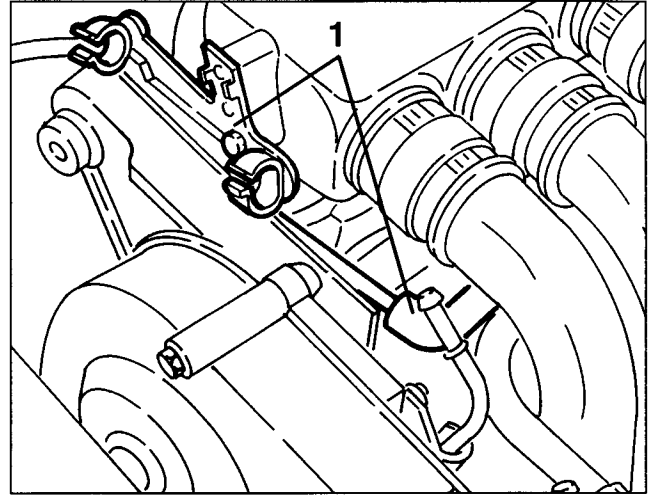


1. Disconnect the servobrake vacuum takeoff pipe.
2. From the pneumatic signal modulation solenoid valve disconnect the vacuum signal delivery pipe to the E.G.R. valve.
3. From the pneumatic signal modulation valve disconnect the vacuum takeoff pipe from the intake box.

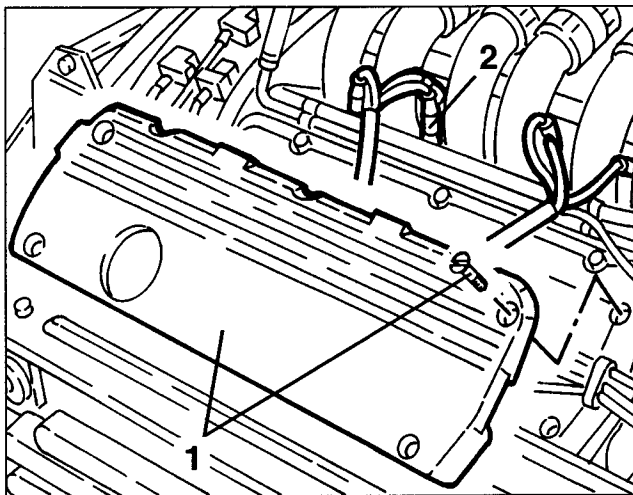
1. Disconnect the timing sensor connection.
2. Disconnect the pinging sensors connections.
3. Disconnect the rpm and timing sensor connection.



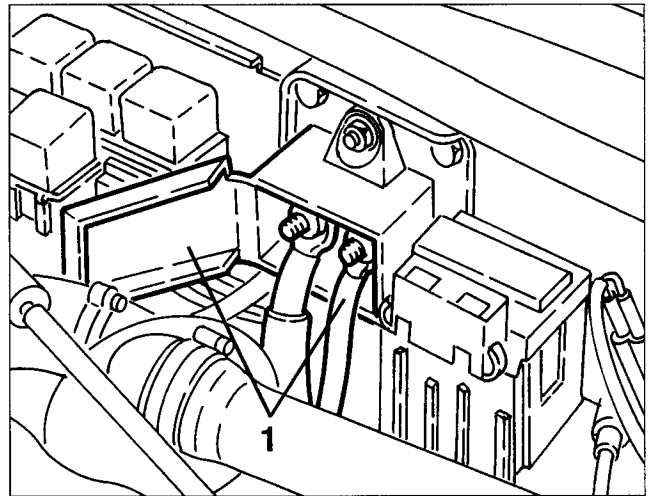
1. Disconnect the fuel vapour recirculation pipe and remove it, after removing the earth cable connection bracket from the box.



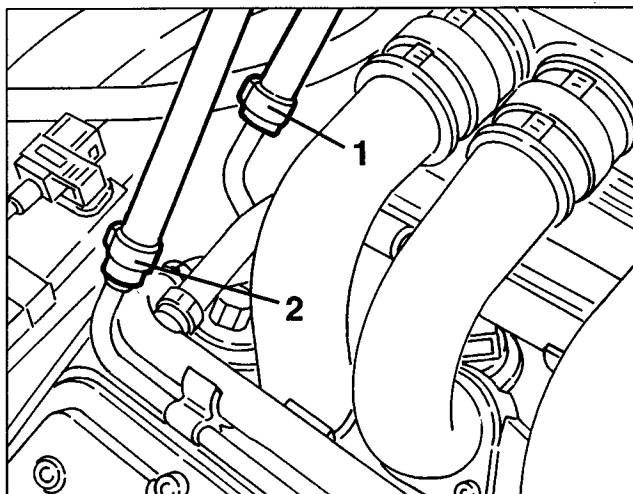
1. Slacken the four screws fastening and remove the left hand cylinder head.
2. Disconnect the connections from the electroinjectors.



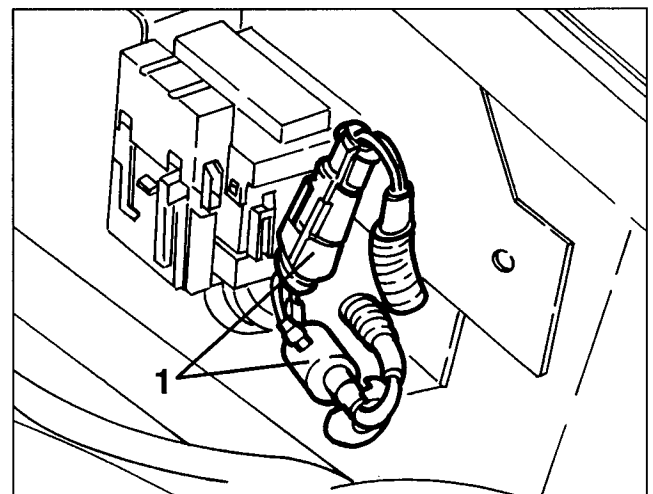
1. Open the cover of the terminal block and disconnect the electrical connections of the starter motor and alternator.



1. Disconnect the fuel inlet pipe from the distributor manifold.
2. Disconnect the fuel return pipe from the distributor manifold.

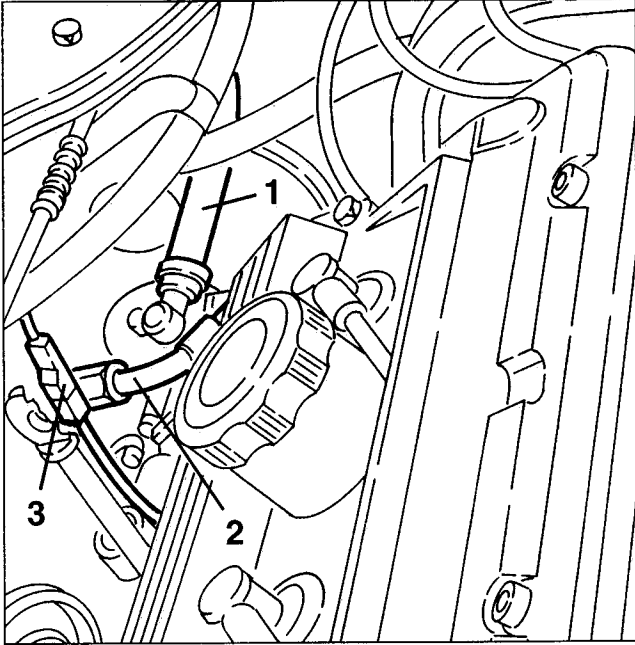


1. Disconnect the two electrical connections of the lambda sensor.

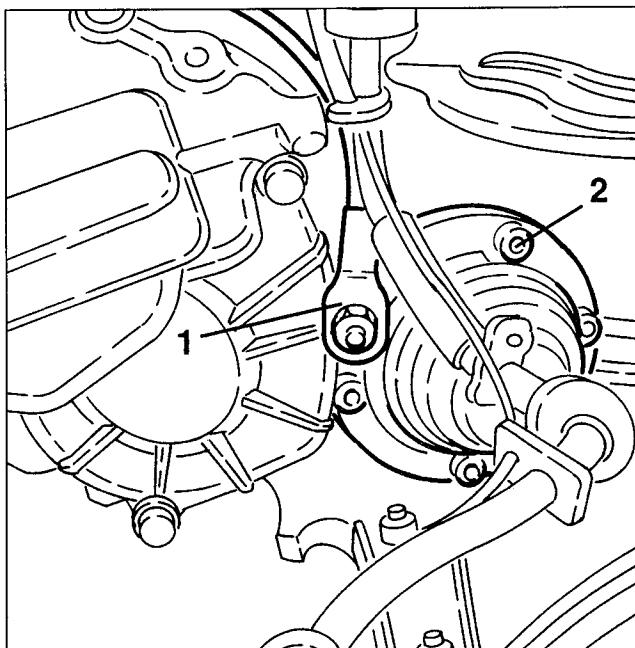


- Empty the power steering tank using a suitable syringe.

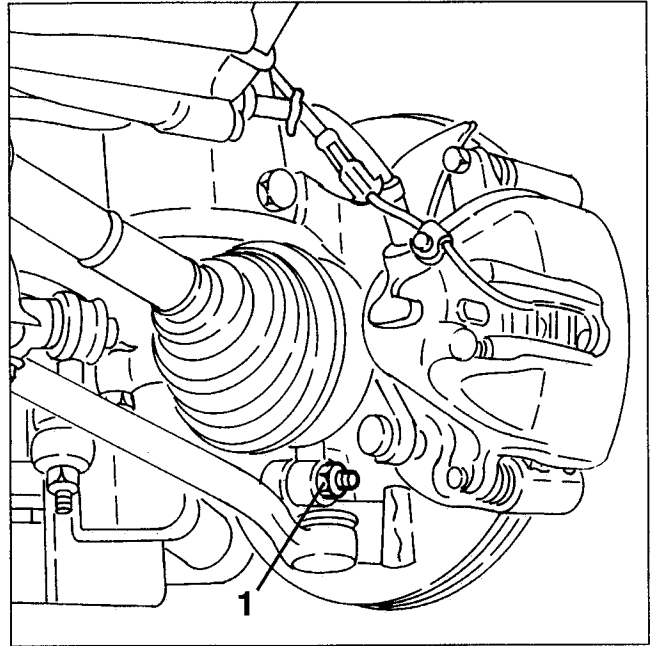
1. Disconnect the oil inlet pipe from the power steering pump.
2. Disconnect the intermediate connection of the oil delivery pipe from the power steering pump.
3. Disconnect the electrical connection from the conditioner compressor.



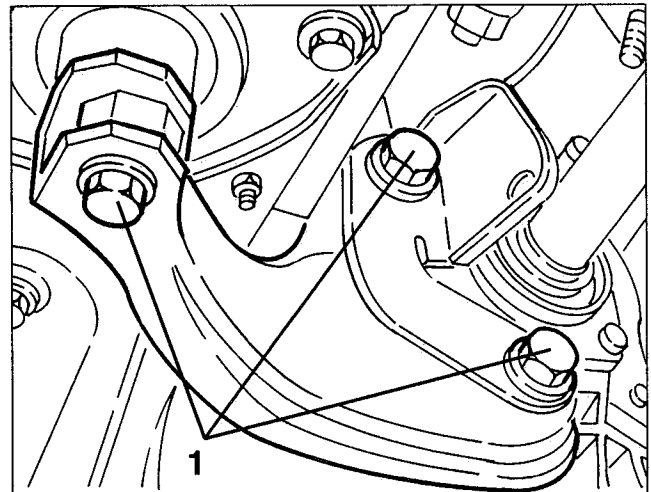
1. Working from the wheel house, disconnect the earth braid from the gearbox rear cover.
2. Slacken the fastening bolts and disconnect the axle shafts.



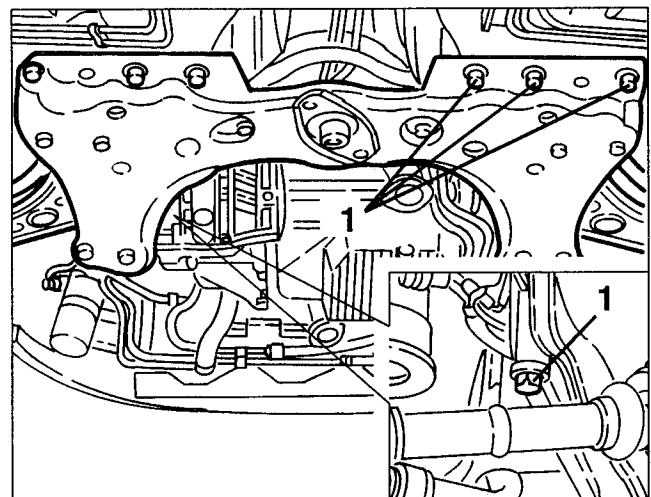
- Raise the car.  
 - Remove the front section of the exhaust pipe.
1. Slacken the bolts fastening the wishbones to the wheel uprights.



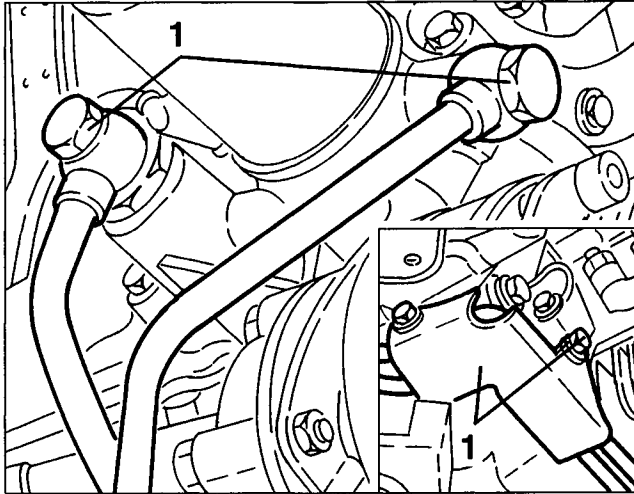
1. Slacken the fastening screws and remove the power unit rear support.



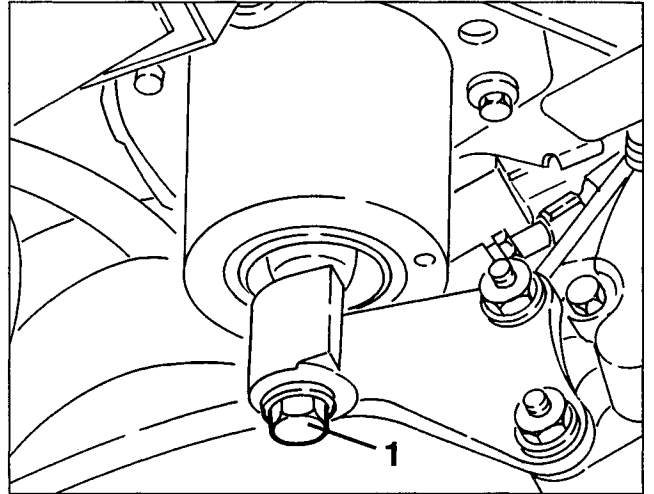
1. Slacken the screws and nuts fastening the cross-member to the body, then, using a hydraulic jack, remove it complete with wishbones and stabilizer bar, after slackening the power steering screws.



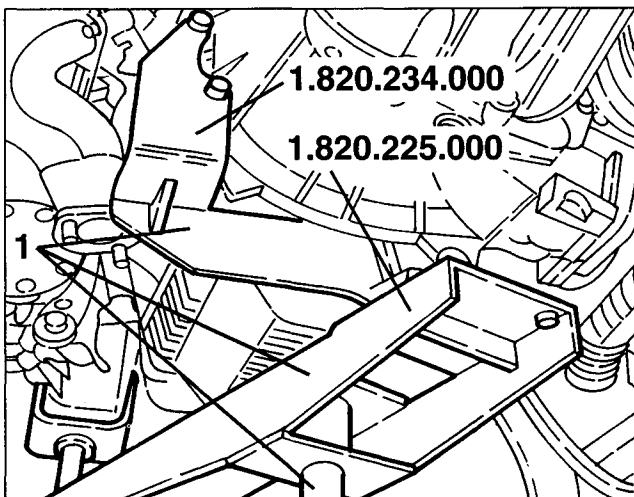
1. Disconnect the radiator oil delivery and return pipes, then move it aside after slackening the support bracket fastening screws.



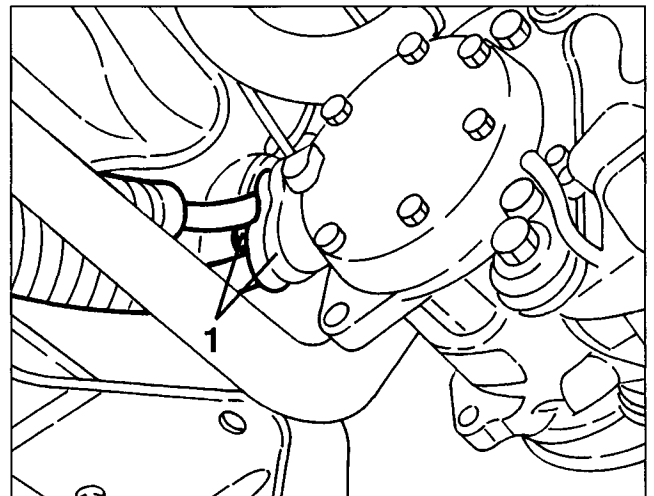
1. Slacken the screw fastening the power unit support on the gearbox side.



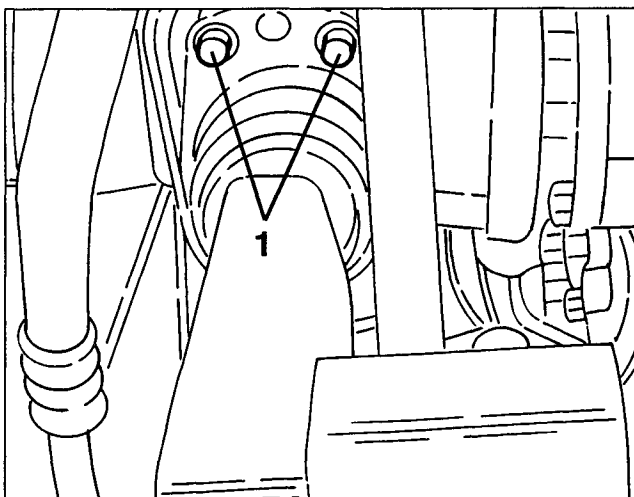
1. Position a hydraulic jack complete with tool no. 1.820.225.000 and no. 1.820.234.000 for supporting the power unit.



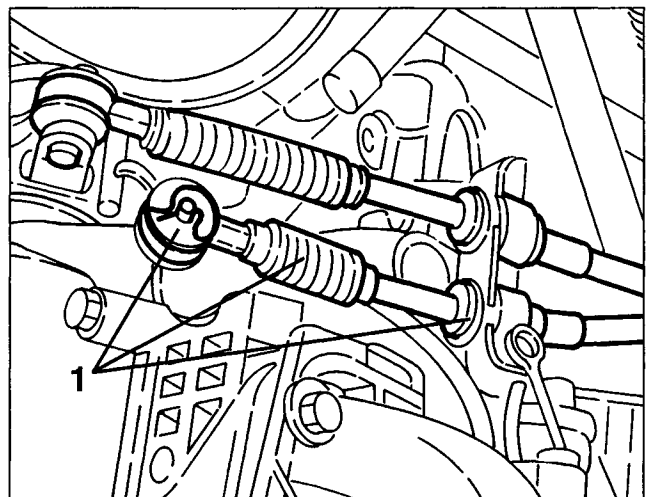
- Slightly lower the power unit with the hydraulic jack.  
1. Slacken the fastening screw and disconnect the coolant inlet and outlet pipe flange from the conditioner compressor.



1. Slacken the three screws fastening the power unit support on the timing gear side.



1. Remove the safety catches and disconnect the gear control cables.

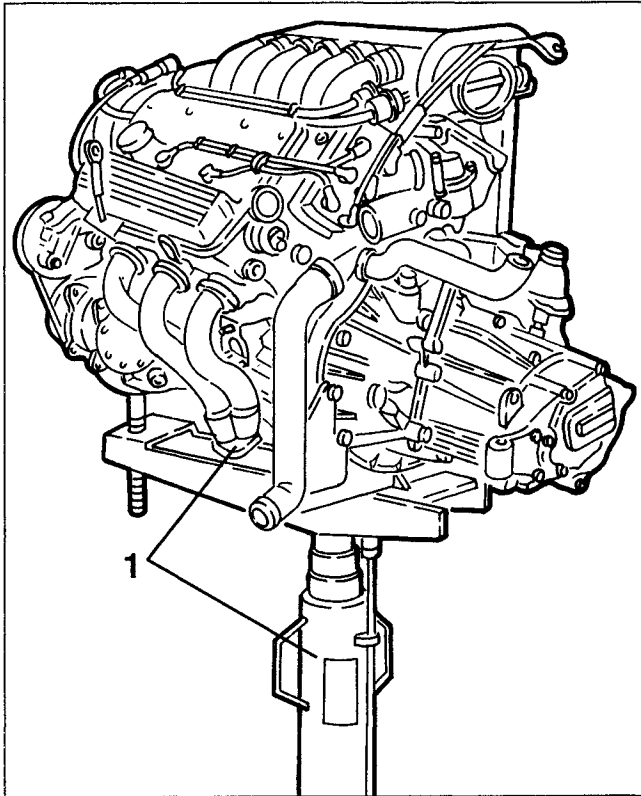


**WARNING:**

The hydraulic jack must have a capacity of at least 1000 kg.

Free the electrical wires from any cable clamps and move them away from the engine to prevent them from getting caught in the engine when it is removed.

1. Lower the hydraulic jack completely and remove the power unit from the engine compartment.



**WARNING:**

When lowering the car make sure that there are no cables or pipes still connected.

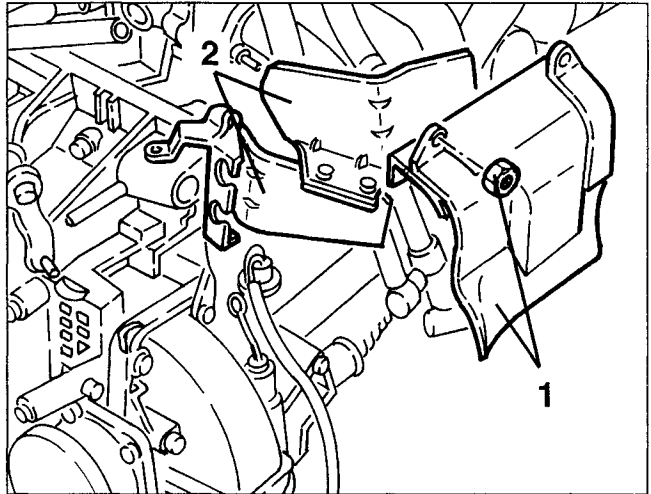
Take due care not to damage any components.

- Support the power unit with a hydraulic hoist as well as with the hydraulic jack used for removal.

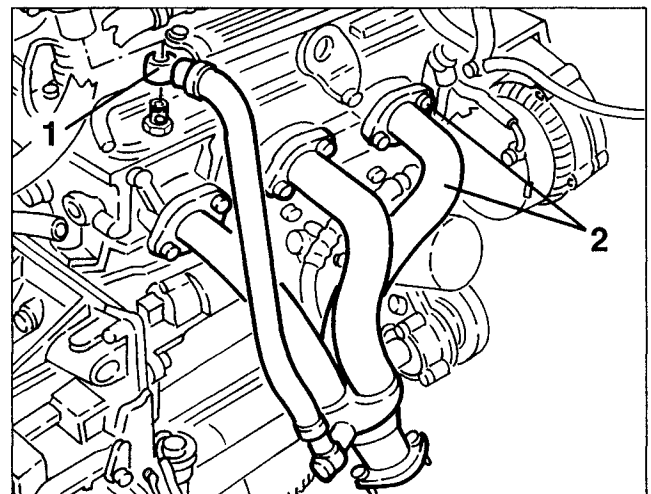
**WARNING:**

For moving the power unit, use a hydraulic hoist after freeing it from the hydraulic jack.

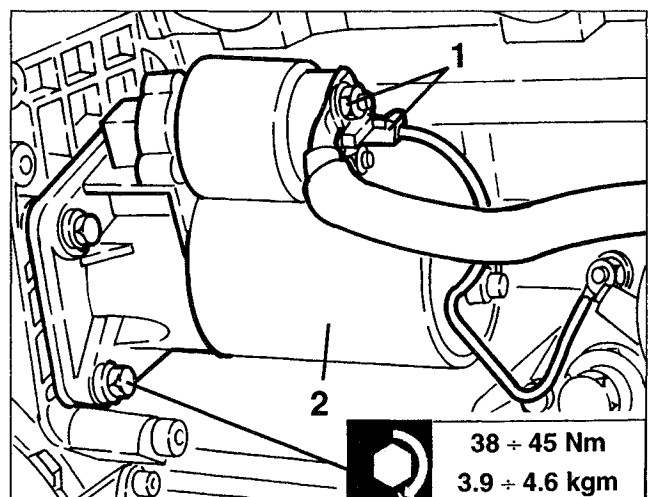
1. Slacken the two fastening nuts and remove the heat shield from the starter motor.
2. Slacken the fastening screws and remove the gearshift control cables support bracket and heat shields.




1. Disconnect the exhaust gas takeoff pipe connection from the E.G.R. valve.
  2. Slacken the fastening nuts and remove the right-hand exhaust manifold.
- Remove the corresponding seals.



1. Disconnect the electrical connections from the starter motor.
2. Slacken the three fastening screws and remove the starter motor.



 38 ÷ 45 Nm  
3.9 ÷ 4.6 kgm

**This page replaces pages 10 - 17/18.  
Therefore page 10 - 18 is annulled.**

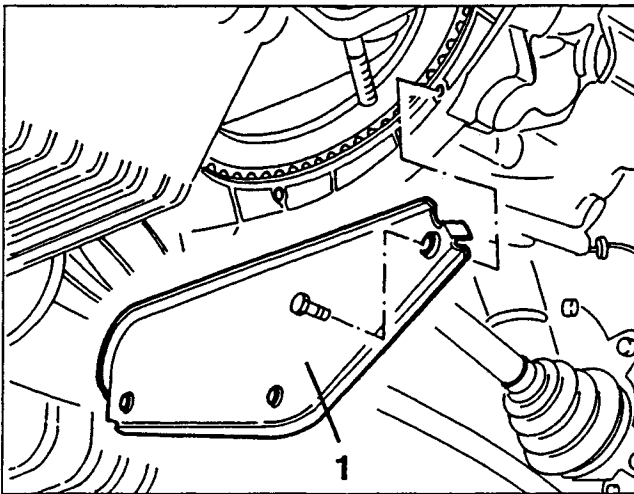
**REMOVAL/REFITTING  
LEFT HAND CYLINDER HEAD**

It is not possible to remove the left-hand cylinder head on the vehicle.  
When needing to carry out any work on the left-hand cylinder head, it is necessary to remove the power unit (see specific paragraph).

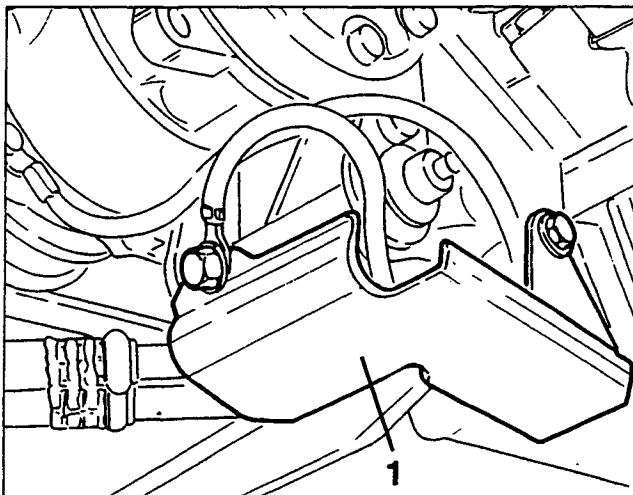
**OIL SUMP**

**REMOVAL/REFITTING**

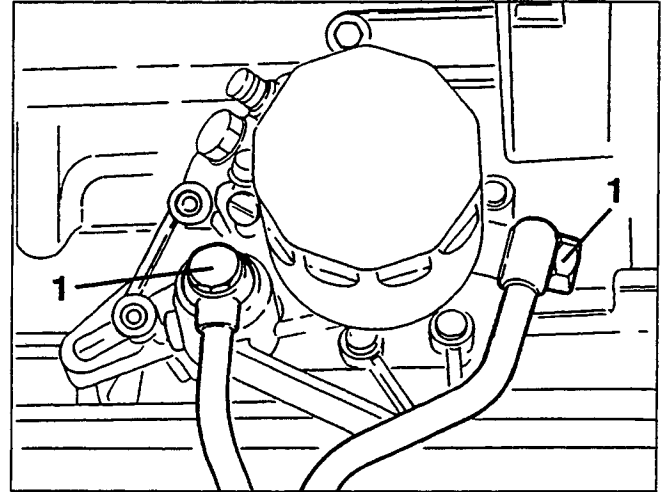
- Set the car on a lift.
  - Disconnect the battery (-) cable.
  - Raise the car and drain the engine oil (see GROUP 00).
  - Remove the front section of the exhaust pipe.
1. Slacken the fastening screws and remove the flywheel cover.



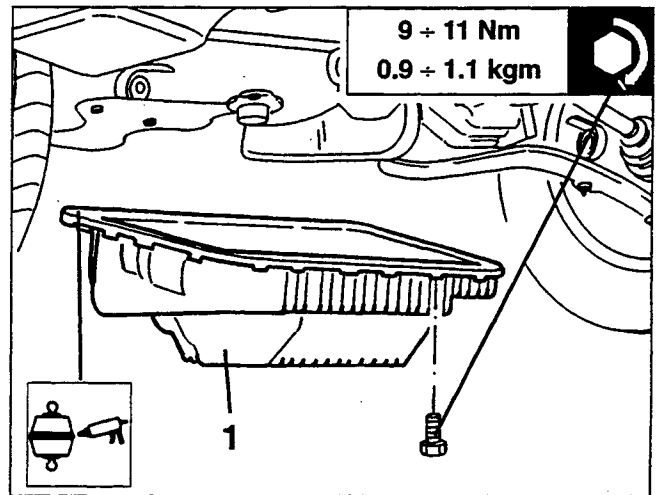
1. Remove the engine oil delivery and return pipes support bracket.



1. Disconnect the two oil delivery and return connections from the oil filter support, then leaving them connected to the radiator, fasten them at the side so that they do not hinder the removal of the oil sump.

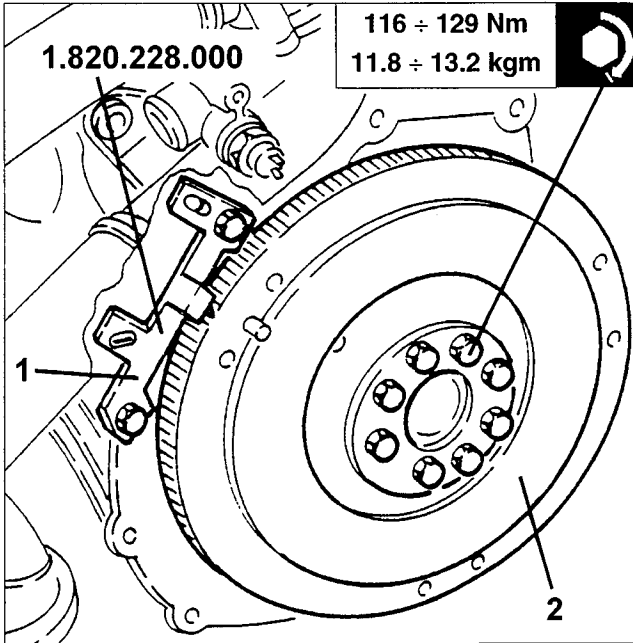


1. Slacken the fastening screws and remove the oil sump.

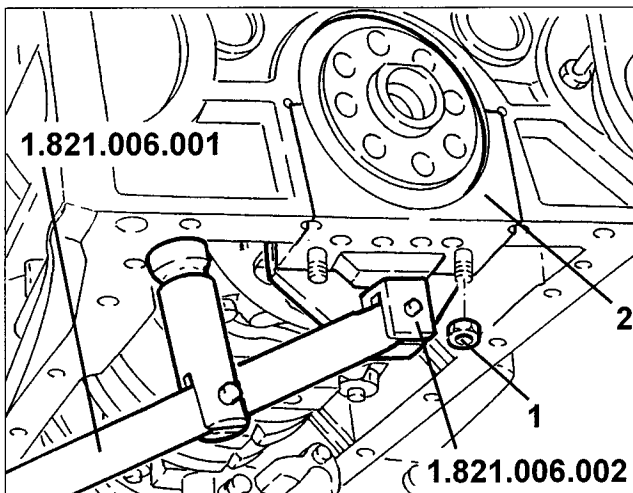


**RESTORING SILICON SEALANT ON REAR CRANKSHAFT JOURNAL SEALING SURFACES**

- Remove the gearbox (see Assembly 21).
- Remove the clutch (see Assembly 18).
- Remove the oil sump (see "Oil pump - Removal/Refitting").
- 1. Fit flywheel retainer no. 1.820.228.000.
- 2. Loosen the fastening screws and remove the flywheel.



1. Loosen the rear main bearing fastening screws.
2. Remove the rear main bearing with tools no. 1.821.006.001 and 1.821.006.002.

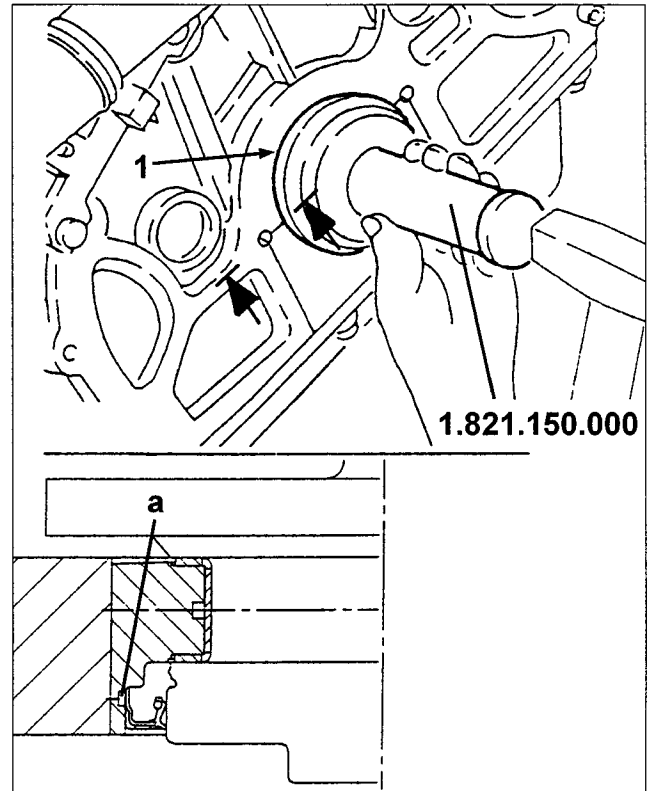


- Remove the main half bearing.
- Remove the seals (only for vehicles to engine no. 00708).
- Remove the engine crankshaft rear seal.
- Accurately remove the sealant residues from the rear main bearing seat, from the oil sump coupling surface and from the holes (only for vehicles to engine no. 00709).
- Accurately remove all traces of engine oil with heptane or similar solvent.
- Fit the rear main bearing with main half bearing (after lubricating it with engine oil) and fasten it with its nuts at a torque of 25 Nm + 79°.

**NOTE:** Use tool no. 1.860.942.000 for angle torque.

1. Fit crankshaft rear oil seal with tool no. 1.821.150.000.

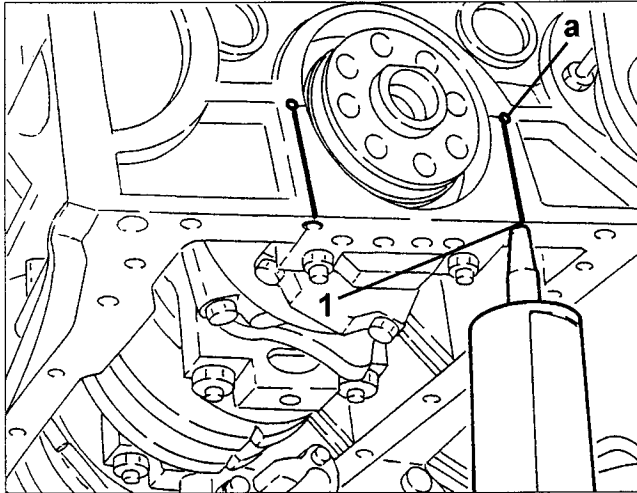
**NOTE:** The oil seal should be fitted in its seat and cover the holes (a).





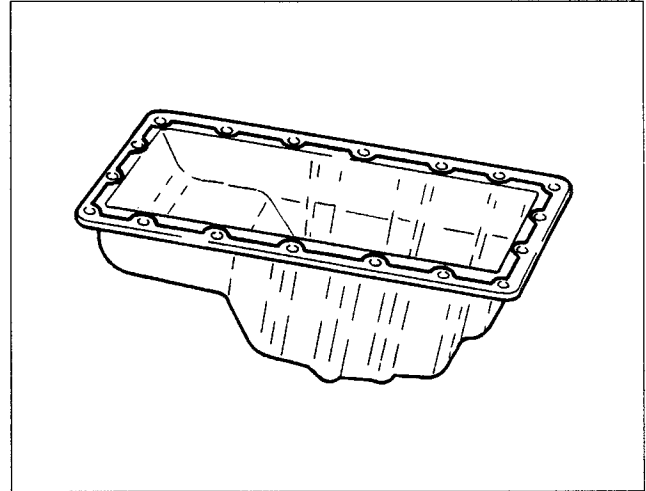
1. Apply "DOW CORNING 7091" silicon sealant with a mechanical gun through the holes shown in the figure.

**NOTE:** Make sure the sealant seeps out along the entire coupling surface of the main bearing with the crankcase and from the holes (a) only for vehicles up to engine no. 00708.



Refit by reversing the removal sequence: Observe the following precautions.

- Apply silicon sealant on the oil sump making sure the sealant strip (maximum diameter approximately 1.5 mm) is outside the oil sump fastening holes (between reservoir and hole).



**IMPORTANT:** Fit the oil sump within 15 minutes from applying the sealant in the crankcase rear journal holes.

## GENERAL DESCRIPTION

An electronic control system supervises and regulates all the parameters of the engine, optimising performance and consumption levels through response in real time to the different operating conditions: this sophisticated latest generation system comprises a single control unit which controls both ignition (static with lost spark) and injection (timed).

This is the M 3.7 version of the proven and reliable BOSCH MOTRONIC.

Compared with the previous versions this new M 3.7 system adopts a control unit - with 88 pins - with advanced design and production technology, it also possesses many possibilities for inserting auxiliary functions.

Owing to the use of new sensors and revision to the control programmes, the system makes it possible to achieve considerable improvements in terms of consumption, emission levels and handling of the vehicle.

Another feature of this system is self-adaptation, i.e. the capability to recognise the changes that take place in the engine and to compensate them, according to functions which mainly correct:

- mixture titration
- the carburetion parameters according to the command of the evaporative solenoid valve
- an adaptive programme for idle speed control.

## FUNCTIONS OF THE SYSTEM

### Sequential and timed injection (S.E.F.I.)

With this control unit injection is sequential and timed for each cylinder: the injection instant (delivery of fuel into the intake manifolds through the opening of the injectors) is not simultaneous for all the cylinders, but takes place for each cylinder in correspondence with the optimal point of injection, calculated by the control unit according to special maps according to the load, speed and temperature of the engine.

NOTE: the instant considered in the design of the maps is that of the start of injection (the cylinder is in the exhaust stroke - intake valve still closed).

### Static ignition

An ignition system has been adopted with "static distribution" (with semi-conductors, without distributor). This solution makes it possible to eliminate rotary components; in addition, it does not produce external sparks thus reducing the risk of interferences; lastly it reduces the number of high voltage cables and connectors; as the power modules for controlling the primary windings of the coil are inside the control unit.

Static ignition takes place through three coils, according to the "lost spark" logic: this solution exploits the different pressures and environments existing contemporaneously in a pair of cylinders: when one of the cylinders approaches the bursting stroke, with a mixture of air and fuel, the corresponding cylinder is at the end of the exhaust stroke in the presence of exhaust gas.

In a V six-cylinder engine, the paired cylinders are 1/5 6/2 and 3/4.

### Metering the air flow rate

The air flow meter adopted is of a more modern design known as the "hot film" type. Outside, the air-flow meter looks like a part of duct between the intake manifold and the air cleaner.

Inside the air-flow meter there is an electronic circuit and a plate that is crossed by the air which passes in the duct.

The film plate is kept at a constant temperature (appr. 120°C above the temperature of the incoming air) by heating resistance placed in contact with it.

The mass of air flowing through the manifold tends to withdraw heat from the plate: therefore, to keep its temperature constant, a certain current needs to flow through the heating resistance: this current, suitably measured, is proportionate with the mass of flowing air.

**N.B.** This air flow meter measures directly the mass of air (and not the volume as in the previous versions with "floating port"), thereby eliminating problems of temperature, altitude, pressure, etc., enabling an optimum ratio between the air and the weight of the fuel.

## Cylinder detection

Following the sequential and timed injection system, a timing sensor has been introduced (cam angle sensor): this makes it possible to detect which cylinder is in the bursting stroke when the engine is started, in order to be able to start the correct injection sequence. The sensor is formed of a Hall-effect device by which the voltage signal sent to the control unit "lowers" suddenly when the tooth machined on the camshaft passes in front of the actual sensor; therefore a signal is sent every two turns of the crankshaft.

Conversely, the rpm sensor sends a reference signal for each turn of the engine and each subsequent tooth of the phonic wheel informs the control unit of an increase of the angular position of the crankshaft, so that injection is sent correctly from the suitable cylinder and the spark to the corresponding pair of cylinders.

## Fuel pump

The control logic of the fuel pump carried out by the control unit which is mainly based on the rpm signal immediately cuts off the supply to the pump as soon as the engine stops.

Moreover, the pump will not operate with the key engaged and the engine not running.

In this car, this logic is integrated - in order to further higher the standards of safety - by the **inertial switch** device: this is an electromechanical switch which, in the event of heavy shocks, opens to cut off the circuit that takes the earth to the fuel pump, which stops instantaneously. This device is particularly important as an integration of the safety guaranteed by the logic of the control unit, especially if the car is hit from behind or in the case of other accidents in which the engine does not stop immediately.

## Percentage of exhaust gas recirculation

Nox (nitric oxide) is developed at high temperatures in the bursting chambers.

To reduce these emissions an E.G.R. (Exhaust Gas Recirculation) system is adopted which by recirculating part of the exhaust gases, lowers the temperature, thus the Nox produced, in the combustion chambers.

In fact, part of the exhaust gas is withdrawn through the special EGR Valve and re-admitted to the intake box where it is mixed with the intaken air and burnt again in the engine. The EGR valve is modulated by a solenoid valve controlled by the injection control unit and, as a result of the type of control, in addition to reducing the amount of Nox, consumption levels are also optimised.

The percentage of exhaust gas to be returned to the engine is established by the control unit taking account of a specific characteristic curve which depends on the load, speed and temperature of the engine.

## OPERATING LOGIC

– **Identification of the "operating point":**

the "point of operation of the engine" is located mainly through two sensors: the rpm sensor informs the control unit of the speed of rotation of the engine; the air flow meter supplies the value of the mass of air actually entering the cylinders, defining the instantaneous volumetric yield of the engine.

– **Adjustment of injection times (quantity of fuel):** the control unit controls the injectors very quickly and precisely, calculating the opening time on the basis of engine load (rpm and air flow), also taking into account the battery voltage and the temperature of the engine. Injection is "sequential", i.e. the injectors are opened in correspondence of the exhaust stroke of the corresponding cylinder.

– **Ignition adjustment (calculation of advances):**

the control unit calculates the advance on the basis of the engine load (rpm and air flow); the value is also corrected according to the temperature of the intaken air and that of the engine: ignition is "static" as described previously.

– **Cold starting control:**

during cold starts the control unit uses special advance values and injection times.

When a determinate temperature/rpm ratio is reached, the control unit resumes normal operating conditions.

– **Control of enrichment during acceleration:**

upon the need for acceleration, the control unit increases injection in order to reach the required rpm as quickly as possible.

This function takes place through the potentiometer located on the throttle which instantaneously informs the control unit of the need to accelerate.

– **Fuel cut-off during deceleration:**

with the throttle closed and an engine speed above a certain threshold, the control unit de-activates fuel injection; this way the rpms decrease rapidly towards idle speed reducing the speed and fuel consumption. The cutoff threshold value varies according to the temperature of the engine and the speed of the car.

– **Control of idle speed:**

the adjustment of the engine idle speed is carried out through the special actuator which acts on the throttle by-pass.

This device acts as a regulator for cutting in the various services (e.g. conditioner compressor): in fact, when the throttle is closed, this valve adjusts the by-pass gap compensating the load required by the services in order to ensure that idle speed is as constant as possible.

– **Maximum Rpm limiting:**

above a certain threshold the control unit automatically stops the injection of fuel preventing the engine from "over-revving".

– **Combustion control -lambda probe-:**

the oxygen sensor (or "lambda" probe) informs the control unit of the amount of oxygen at the exhaust, and therefore the correct air-fuel metering.

The optimum mixture is obtained when the lambda coefficient = 1 (optimum stoichiometric mixture). The electric signal sent by the probe to the control unit changes abruptly when the composition of the mixture departs from lambda = 1. When the mixture is "lean" the control unit increases the amount of fuel, reducing it when the mixture is "rich" so that in this way the engine operates as far as possible around the ideal lambda rating.

The signal from the lambda probe is processed inside the control unit by a special integrator which prevents sudden "oscillations".

The probe is heated by an electrical resistance so that it quickly reaches the correct operating temperature (appr. 300 °C).

Through this probe it is therefore possible to adjust engine carburetion precisely. Among other items, this makes it possible to meet emission limit regulations.

– **Knocking control:**

Through knocking sensors the control unit is informed if any pinging or "knocking" occurs and it corrects the spark advance "delaying" it accordingly; a further correction also takes account of the air temperature, in fact when the temperature of the intake air is high, pinging is more accentuated.

The intaken air temperature, to be found just downstream of the air-flow meter, is not used to calculate the engine load but to control the knocking parameters and spark advances.

– **Fuel vapour recovery:**

the fuel vapours collected from the various points of the supply circuit in a special active carbon canister are ducted to the engine where they are burnt: this takes place through a solenoid valve which is opened by the control unit only when the engine is in a condition that allows correct combustion without adversely affecting the operation of the engine: in fact the control unit compensates this amount of incoming fuel by reducing delivery to the injectors.

– **E.G.R. valve control**

The percentage of exhaust gas to be returned to the engine is determined by the control unit taking account of a specific characteristic curve which depends on the engine load and speed: recirculation is only activated when the engine speed is between 2500 and 4000 rpm., also in relation to the temperature of the engine (higher recirculation percentage with high temperatures).

– **Connection with the air conditioner compressor:**

the control unit is connected with the air conditioner compressor and it cuts in the compressor in relation to operation of the engine. As this service absorbs a considerable amount of power, the control unit:

- adapts the engine idle speed each time the compressor cuts in; if the engine speed falls below 700 rpm, the compressor is turned off;
- when there is the need for power (high throttle opening speed starting from below 3500 rpm, or full load, or high engine temperature - over 117°C), it momentarily cuts out the compressor
- when the engine is being started the compressor is disabled until normal operating conditions have been reached.

– **Connection with the Alfa Romeo CODE system**

on cars fitted with the Alfa Romeo CODE system, as soon as the Motronic control unit receives the signal that the key has been turned to MARCIA, it "asks" the above-mentioned system for consent to start the engine: this consent is given only if the Alfa Romeo CODE control unit recognizes the code of the key engaged in the ignition switch as correct. This dialogue between the control units takes place on diagnosis line K already used for the Alfa Romeo Tester (see specific paragraph).

**N.B.** Before doing any work on the system it is advisable to read the corresponding chapter.

– **Self-diagnosis:**

the control unit possesses a **self-diagnosis system**, which continuously monitors the plausibility of the signals from the various sensors and compares them with the limits allowed: if these limits are exceeded, the system detects a fault and turns on the corresponding warning light on the instrument cluster.

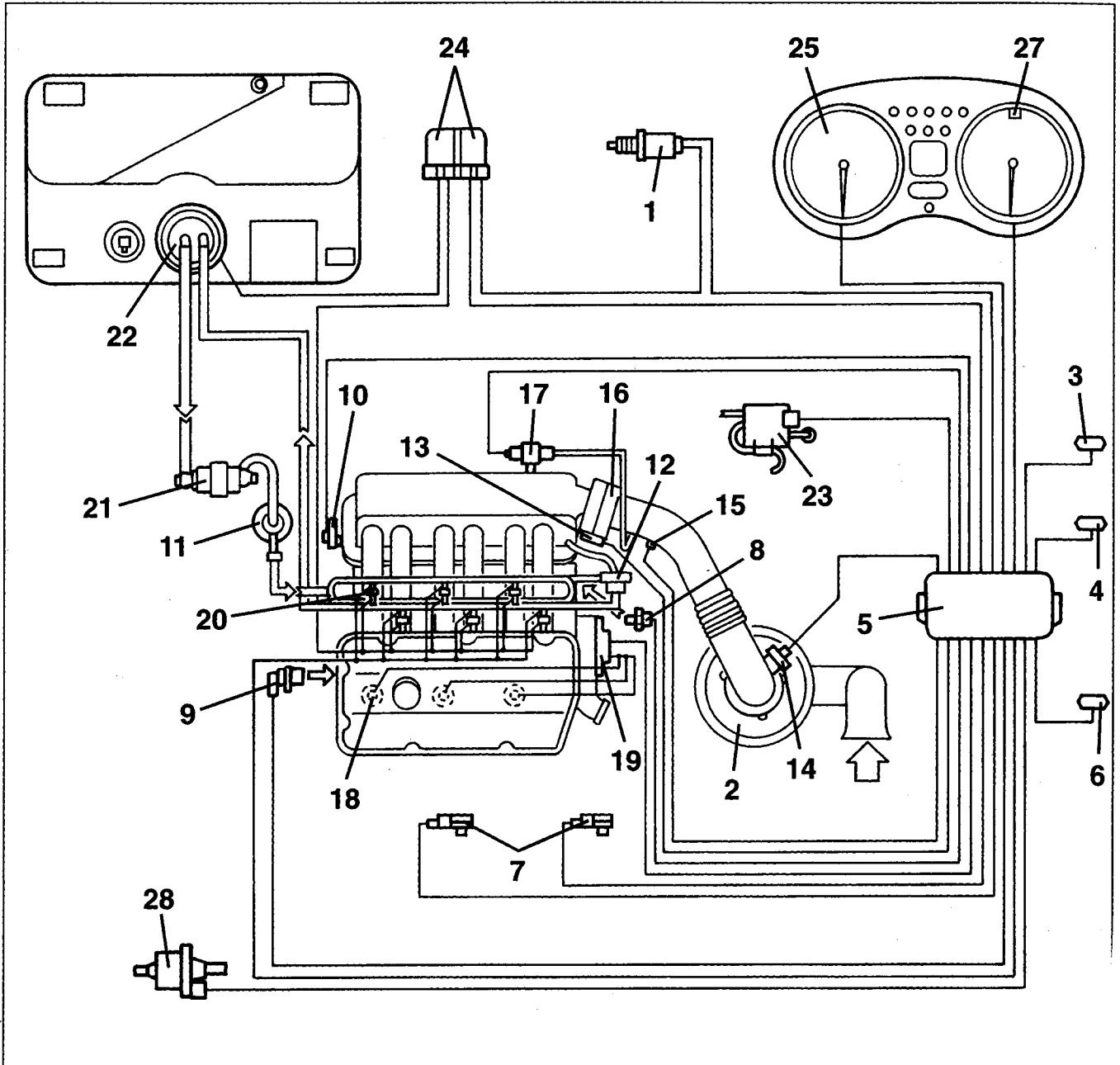
The warning light turns on when the engine is started to indicate the initial test of the entire system (appr. 4 seconds), it then turns off if no errors have been memorised: otherwise it stays on.

For certain parameters, the control unit replaces the abnormal values with suitable mean ones so that the car can "limp" to a point of the Service Network.

These "recovery" values depend on the other correct signals and they are defined individually by the control unit operating logic.

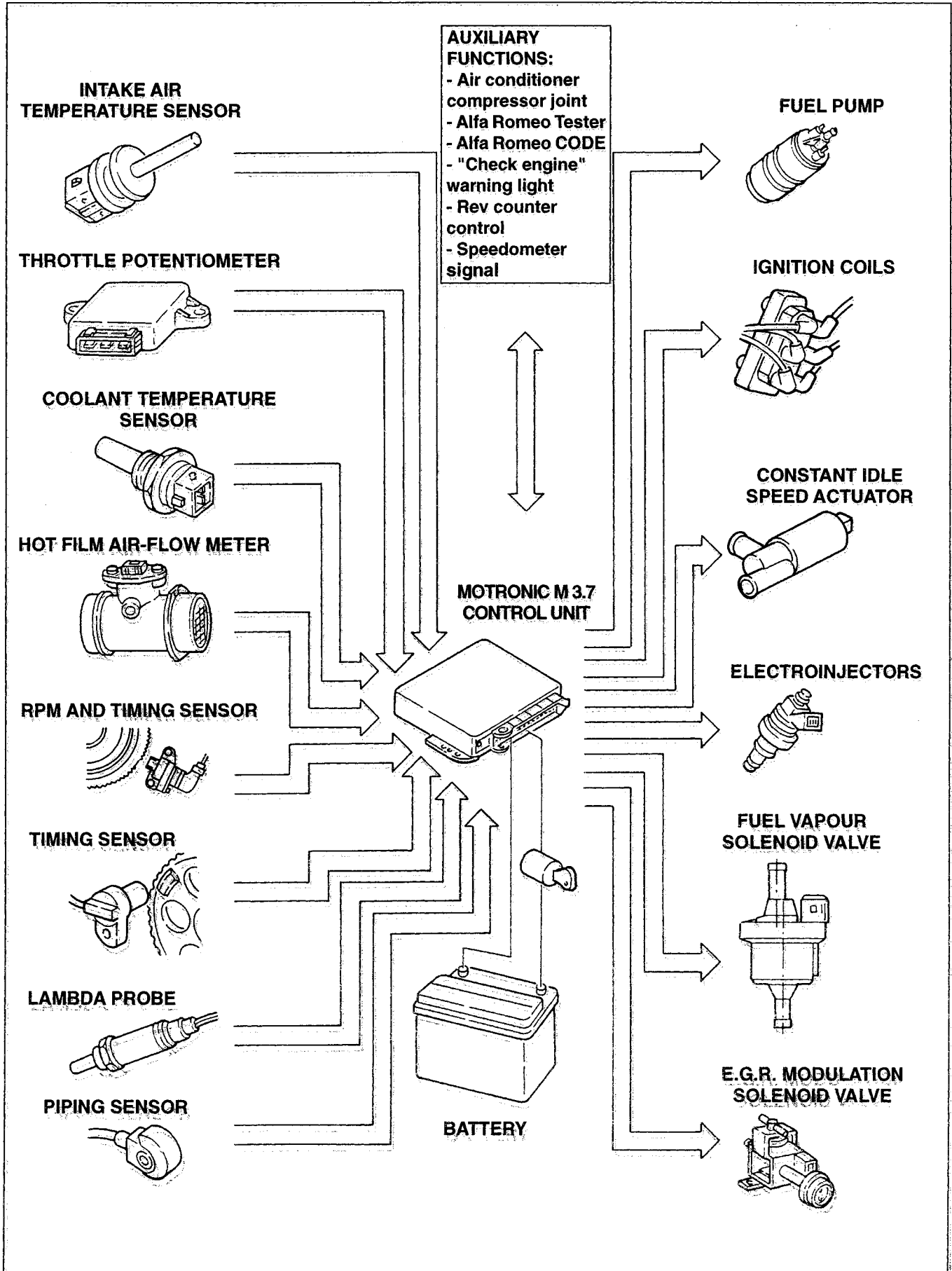
The self-diagnosis system also enables quick and effective location of faults connecting with the ALFA ROMEO Tester (see "Fault-finding), through which all the errors memorised can be displayed. It is also possible to check the operating parameters recorded by the control unit and operate the single actuators to check whether they are working properly.

COMPONENTS OF THE MOTRONIC M3.7 ELECTRONIC INJECTION AND IGNITION SYSTEM

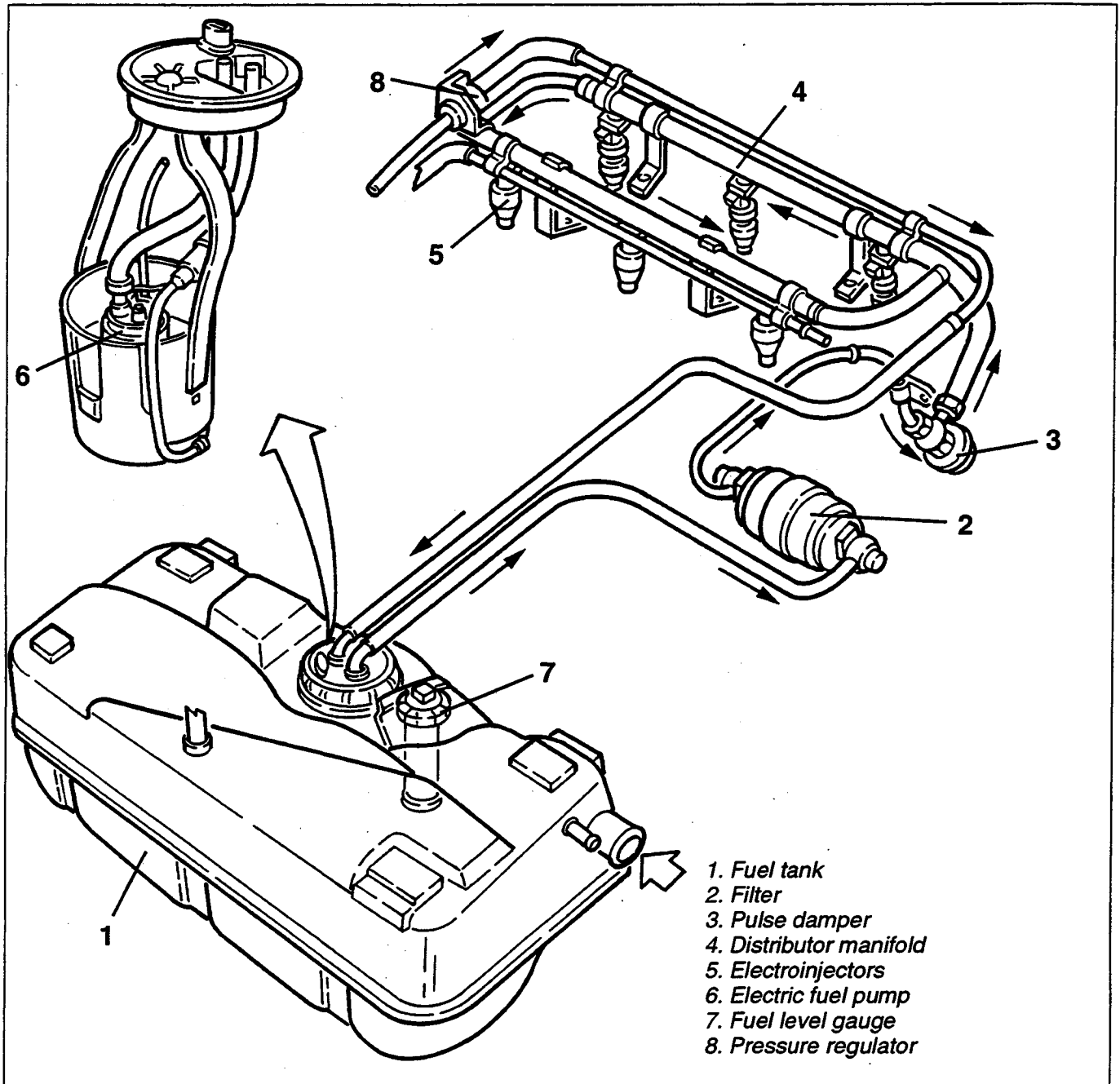


- |   |   |
|---|---|
| 1. Lambda sensor                          | 15. Intake air temperature sensor (NTC) |
| 2. Air cleaner                            | 16. Throttle body                       |
| 3. Climate control system connector       | 17. Constant idle speed actuator        |
| 4. Diagnosis socket (Alfa Romeo Tester)   | 18. Spark plugs                         |
| 5. Injection - ignition control unit      | 19. Ignition coils                      |
| 6. Alfa Romeo CODE control unit connector | 20. Electroinjectors                    |
| 7. Pinging sensors                        | 21. Fuel filter                         |
| 8. Coolant temperature sensor (NTC)       | 22. Electric fuel pump                  |
| 9. Rpm and timing sensor                  | 23. E.G.R. modulation solenoid valve    |
| 10. Timing sensor                         | 24. Set of relays                       |
| 11. Pulse damper                          | 25. Rev counter                         |
| 12. Fuel pressure regulator               | 26. Speedometer                         |
| 13. Throttle potentiometer                | 27. "Check engine" warning light        |
| 14. Air flow meter                        | 28. Fuel vapour solenoid valve          |

**FUNCTIONAL LAYOUT OF MOTRONIC M 3.7 INJECTION - IGNITION SYSTEM**



**DESCRIPTION OF SYSTEM**



- 1. Fuel tank
- 2. Filter
- 3. Pulse damper
- 4. Distributor manifold
- 5. Electroinjectors
- 6. Electric fuel pump
- 7. Fuel level gauge
- 8. Pressure regulator

The fuel supply circuit comprises an electric fuel pump (6) located in the fuel tank (1) which sends the fuel under pressure through a special tube to the filter (2). From here the fuel is sent to the pulse damper (3) and from this to the distributor manifold (4) which distributes it to the electroinjectors (5). The fuel in excess returns to the fuel tank via a special tube, through the pressure regulator (8) controlled by the vacuum withdrawn from the intake box. The amount of fuel injected depends solely on the injection time which is controlled by the control unit.

The different sections of the fuel pipes are connected by special connectors (for their disconnection see specific paragraph). The fuel supply system is fitted with an inertial switch which is triggered in the event of a crash, cutting off the connection to earth of the fuel pump thereby also the injection system supply.

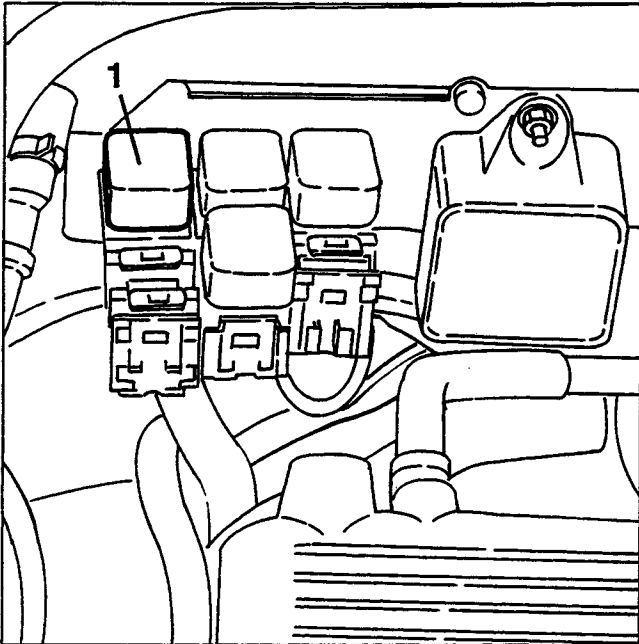
**Notes on serviceable fuels:**  
 correct operation of the engine requires the use of unleaded fuels (95 R.O.N.) as the presence of lead would quickly bring about consumption of the catalytic converter at the exhaust.



**WARNINGS**

Before doing any work on components of the fuel supply system, in order to prevent any dangerous leaks, proceed as follows:

- Disconnect the fuel pump supply relay (1).



- Run the engine until it stops.

**FUEL PIPE CONNECTION FITTINGS ("JOHN GUEST" TYPE)**

**Cleaning for disconnection**

Preferably use one of the following systems described in order of effectiveness.

- Jet of warm water (max. 50°C) on the fitting and drying with jets of compressed air to prevent residual water in the interstices getting into the pipe after disconnection.
- Jet of cold water and drying with compressed air.
- Jet of hot water with neutral soap.
- Jet of cold water with neutral soap.

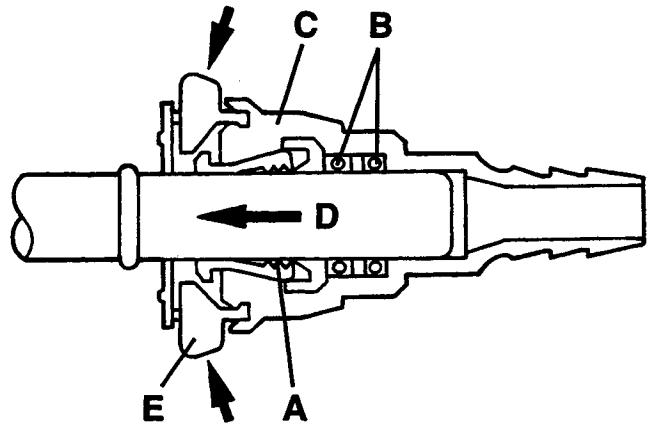
Never use solvents and/or materials that are not compatible with the pipes in general and, for the fitting in particular, not compatible with nylon and acetalic resin.

**Disconnection operations**

When installed, the fitting tends to act as follows for a certain length of time:

- pincer "A" grips the tang with its steel teeth; if they are in plastic the teeth might mark the tang slightly without adversely affecting tightness.

- the seals (O'Rings) "B" tend to stick to the surface of the tang in time whether it is of plastic or metal, as a result of this the coupling seems to be seized and impossible to release by only pressing the fins "E" and pulling the coupling.



Therefore, to disconnect proceed as follows:

- Turn 1/4 - 1/2 of a turn to right and left several times (at least five) body "C" of the fitting in relation to the tang in order to eliminate friction of the seals on the tang and at the same time push the fitting towards the arrow "D" to loosen the grip of the pincers.
- Press with the fingers on the release buttons.
- Pull the fitting to disconnect it.

If disconnecting is still difficult, repeat these operations firstly checking that the pipe fitting is clean and that there is no mud or dirt in the interstices hindering the movement of the release mechanisms.

**NOTE:** Do not use pliers, screwdrivers, etc.. for disconnecting.

If the coupling has not been tampered with and the above operations are correctly carried out, no tools are necessary.

**FUEL PIPE CONNECTION FITTINGS ("HURON" TYPE)**

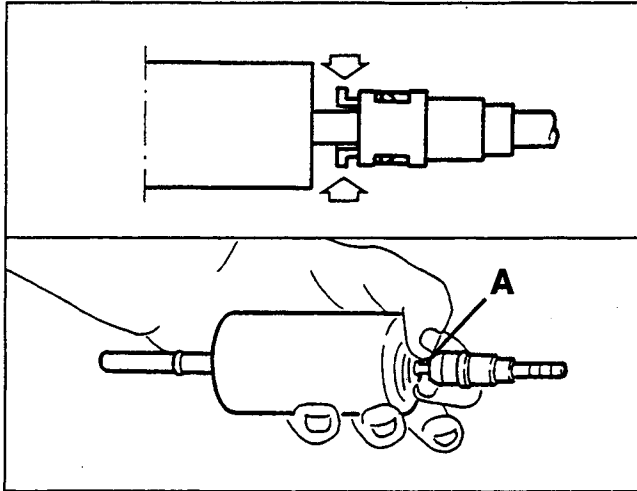
**Operations to be carried out before disconnection**

- Thoroughly clean the connector area with a jet of cold water (or hot, max 50°C) and dry with compressed air.
- A jet of water (hot or cold) may also be used with neutral soap.

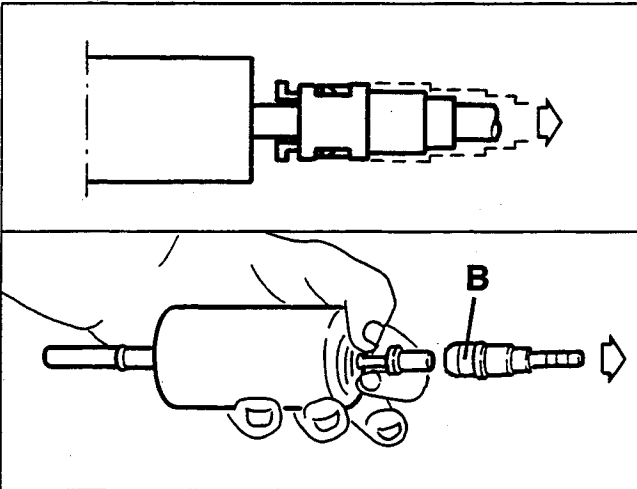
Never use solvents and/or materials that are not compatible with the pipes in general and for the connector in particular, not compatible with nylon and acetalic resin.

**Operations for disconnection/connection**

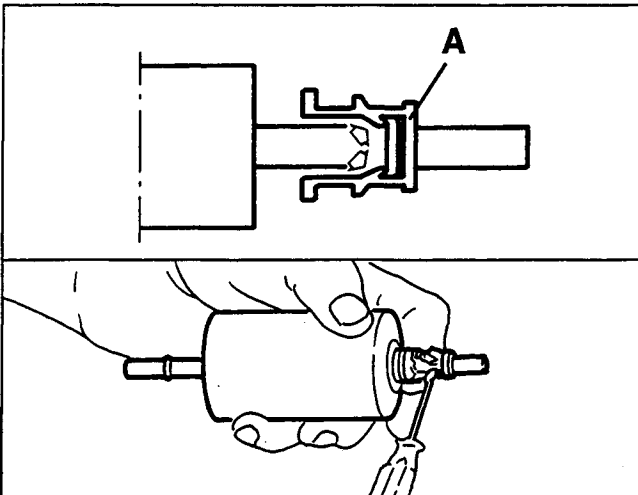
- Pinch the white transparent insert "A" between the thumb and forefinger and keep it pressed.



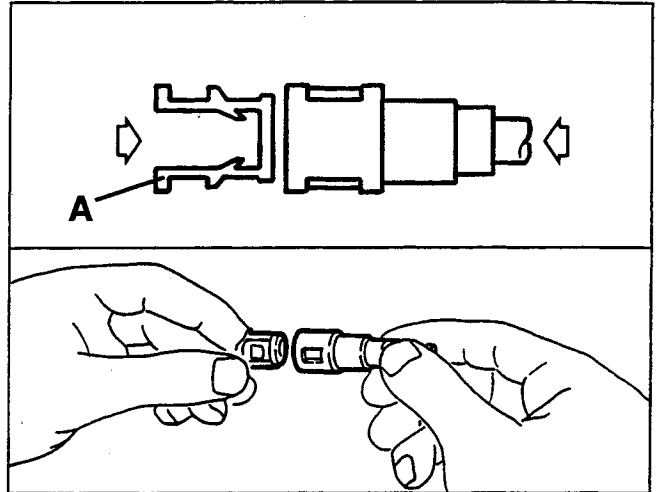
- With the other hand, grip the body "B" of the connector and pull in the direction of release.



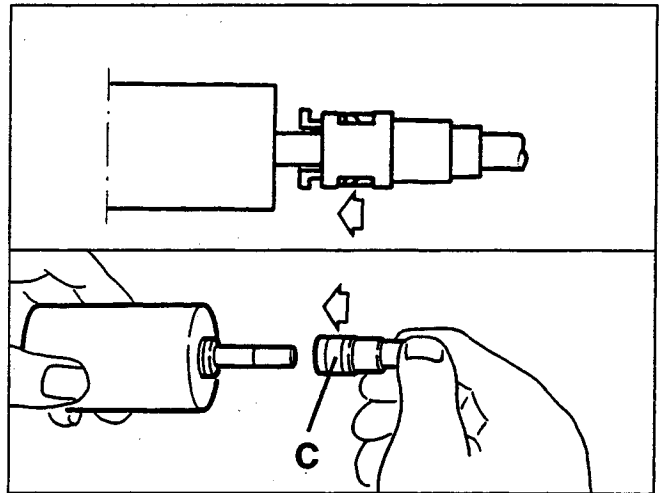
- Using a fine-tipped screwdriver in the points shown by the arrows, remove and retrieve the insert "A" taking care not to damage it.



- Refit insert "A" on the body of the quick coupling, fitted on the pipe, until it clicks meaning that it has been fitted correctly.



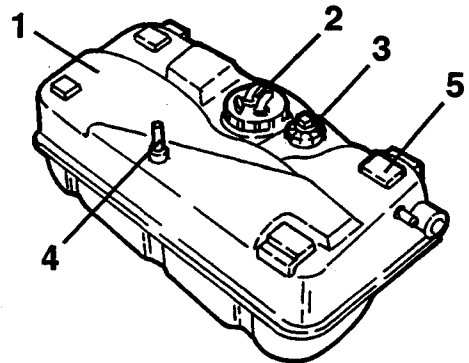
- Then connect the pipe with the quick coupling "C" pushing it until it clicks. Try to remove the coupling to make sure that it has been installed correctly.



**FUEL TANK**

The fuel tank is made from sheet metal and has a capacity of 70 litres including a reserve of appr. 9 litres.

The fuel filler is on the main body and a special opening makes it possible to disconnect it from the tank for removal of the fuel tank itself.



1. Fuel tank

2. Fuel pump

3. Fuel level gauge

4. Vapour breather pipe

5. Antivibration pads

The fuel filler cap has a special device which enables it to be tightened only to the specified torque, this way excessive tightening beyond the specified value is prevented.

The fuel tank located under the top compartment is fastened by two metal straps to the underbody and protected by a special sheet metal partition.

The pipe on the fuel filler acts as a breather.

There is an opening in the upper part of the tank for housing the fuel pump and fuel level gauge.

A special takeoff on the tank allows the fuel vapours to reach the vapour separator via a connection pipe.

## REMOVING/REFITTING

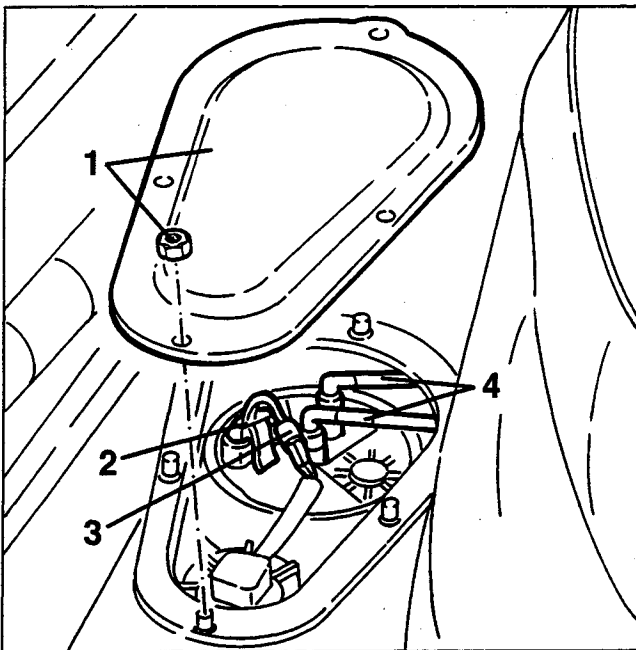
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Empty the tank withdrawing the fuel through the filler using a special pump.
- Raise the rearscreen of the top and open the top upper lid.

1. Move aside the top compartment trim, then slacken the fastening screws and remove the lid to gain access to the pump and to the fuel level gauge.

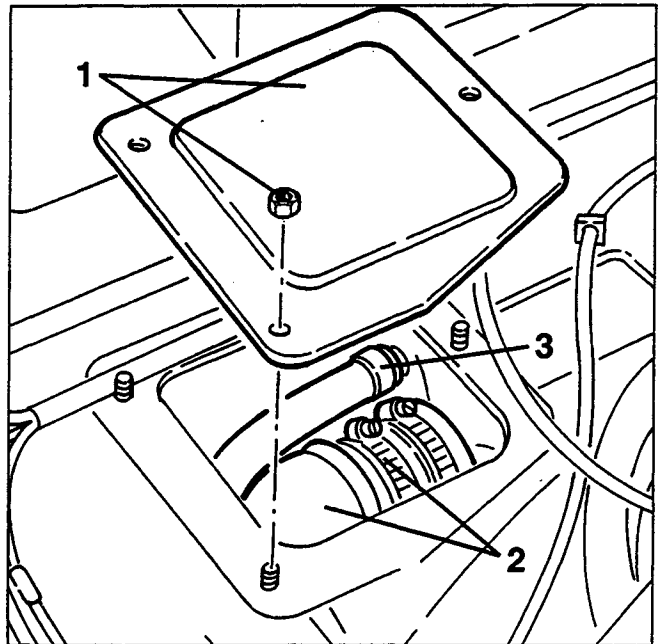
2. Disconnect the electrical connection from the fuel pump.

3. Disconnect the electrical connection from the fuel level gauge.

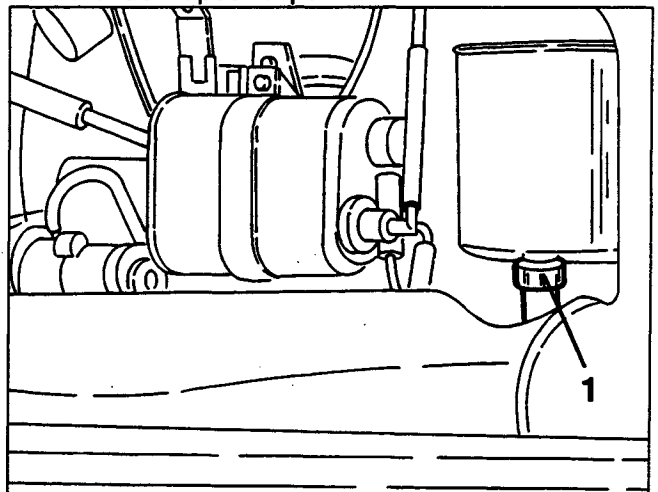
4. Disconnect the fuel delivery and return pipes from the pump.



1. Slacken the fastening nuts and remove the access cover to the fuel filler.
2. Slacken the fastening clamp and disconnect the fuel filler from the tank.
3. Slacken the fastening clamp and disconnect the breather pipe from the fuel tank.

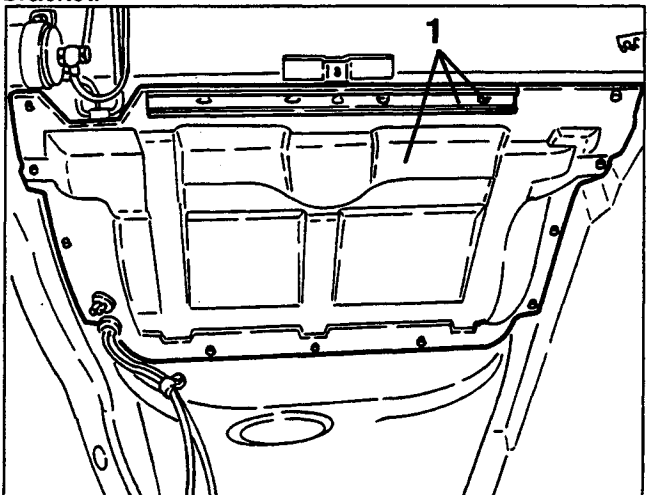


1. Working from the luggage compartment, pull back the trim and disconnect the the fuel vapour inlet pipe from the fuel vapour separator.

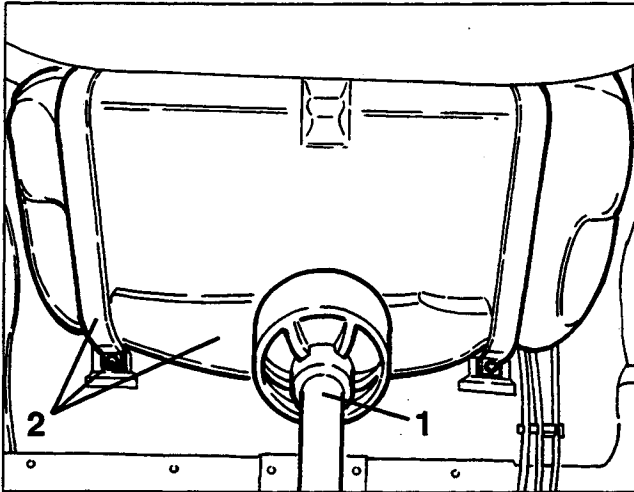


- Raise the car and remove the rear Multilink suspension (see specific paragraph).

1. Slacken the fastening screws and remove the sheet protecting the fuel tank complete with reinforcement bracket.



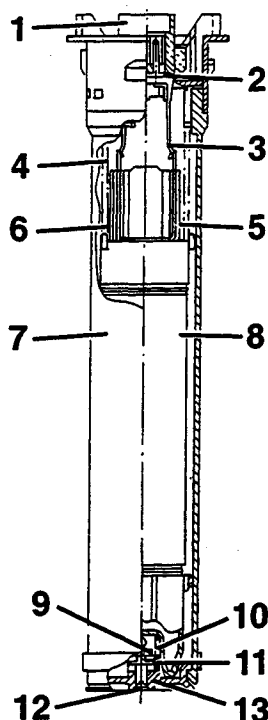
1. Position a hydraulic bracket under the tank.
2. Slacken the fastening screws of the fuel tank metal support straps, then remove the tank lowering the hydraulic jack.



## FUEL LEVEL GAUGE

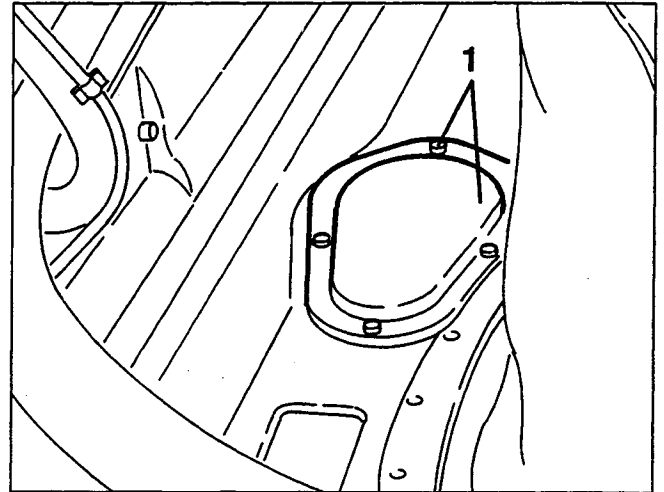
This is of the axial floating type and it is fastened to the tank by a bayonet coupling. Its main feature is that it prevents the gauge pointer from swaying when cornering and on twisting roads. This is because the float that runs inside the tube of the level gauge is submerged in the fuel and is therefore only sensitive to the hydrostatic thrust and not to the differences in level due to swaying of the vehicle.

1. Connector
2. O-Ring
3. Sliding blade
4. Resistance
5. Common blade
6. Upper spring
7. Tube
8. Float
9. Adjustment pin
10. Lower spring
11. Cup
12. Cap
13. Base

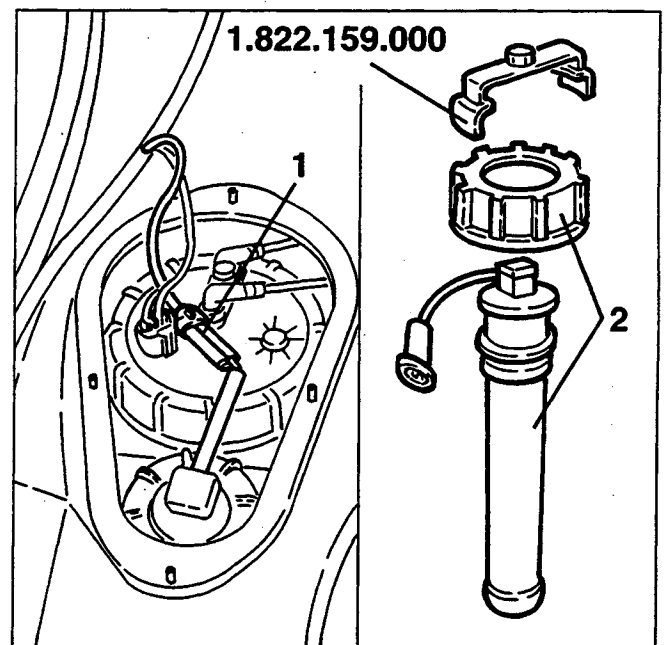


## REMOVING/REFITTING

- Disconnect the battery (-) terminal.
  - Raise the rearscreen of the top and open the top upper lid.
1. Move aside the top compartment trim, then slacken the fastening nuts and remove the lid to gain access to the pump and to the fuel level gauge.



1. Disconnect the electrical connection of the fuel level gauge.
2. Using tool no. 1.822.159.000, slacken the locknut and remove the fuel level gauge complete with seal.



## CHECKS AND INSPECTIONS

For a complete functional check, see GROUP 55 - ELECTRIC SYSTEM DIAGNOSIS.

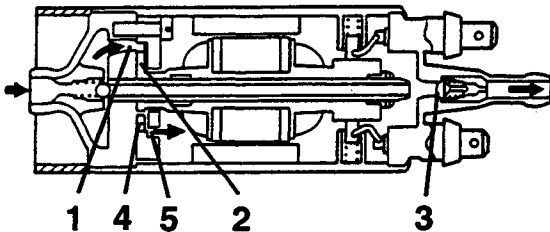
## FUEL PUMP

The electric pump, submerged in the tank is of the volumetric displacement type with rollers (4), with brush motor and excitation by permanent magnets. The impeller (2) turns, pulled by the motor, creating volumes which move from the inlet port (1) to the delivery port (5).

These volumes are delineated by the rollers which during the rotation of the motor adhere to the outer ring.

The pump is fitted with two valves: one is a check valve (3) to prevent the fuel circuit from emptying, when the pump is not operating; the second is an overpressure valve which short circuits the delivery with the inlet when pressures build up above 5 bar, thereby avoiding overheating the electric motor.

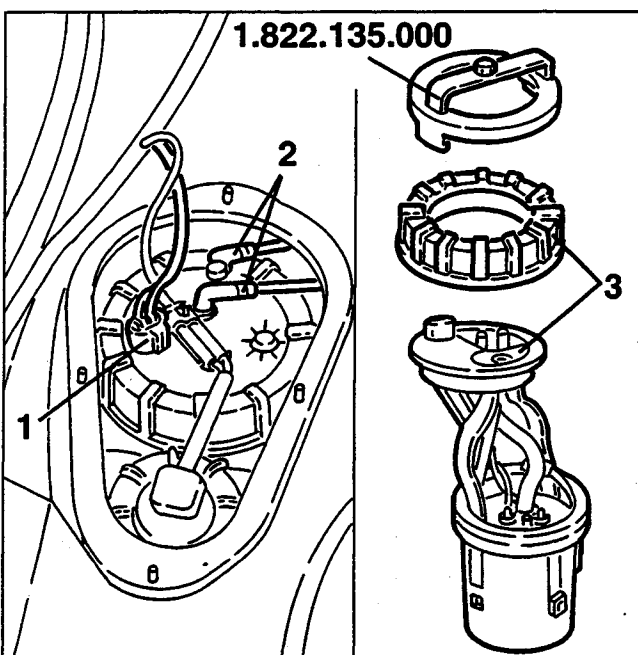
The supply contacts are polarised to prevent the connections from being inverted.



## REMOVING/REFITTING

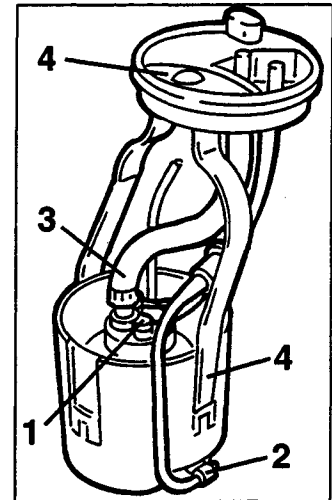
Proceed as described in the first three steps of the procedure "FUEL LEVEL GAUGE - Removing/Refitting".

1. Disconnect the electrical connection of the fuel pump.
2. Disconnect the fuel delivery and return pipes from the pump.
3. Using tool 1.822.135.000, slacken the locknut fastening the fuel pump, then withdraw it from its housing complete with seal.

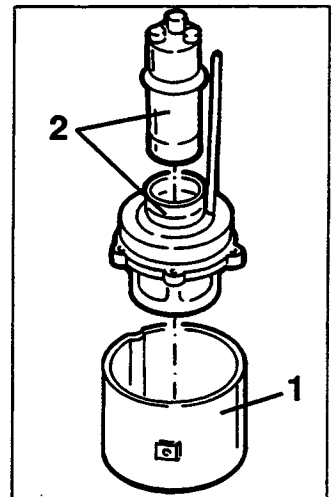


## DIS-ASSEMBLY/RE-ASSEMBLY

1. Disconnect the two electrical connections from the fuel pump.
2. Disconnect the excess fuel return pipe from the pump tray.
3. Disconnect the delivery pipe from the fuel pump.
4. Prise the end of the spring, then separate the cover from the pump.



1. Withdraw the tray from the fuel pump assembly.
2. Slacken the fastening clamp and withdraw the fuel pump from the filtering support.



## CHECKS AND INSPECTIONS

Accurately clean the mesh filter.

The presence of water in the fuel is particularly harmful to the pump as it causes inside rust. Carefully check the operation of the pump if the fuel is contaminated with water.

Also check the efficiency of the supply contacts since any rust would reduce the voltage at their terminals, thereby reducing delivery resulting in the formation of bubbles and reduction of the fuel injected.

**NOTE:** In the event of replacement, remember that the pump is supplied filled with protective oil and with the unions closed by special plugs. When installing on the vehicle, it is not necessary to empty the pump as the oil is burnt in the engine. If the protective oil is emptied from the pump, it is necessary to put it into operation within two weeks to prevent the formation of a film of dry oil on the motor collector which would ruin it due to the lack of electrical continuity.

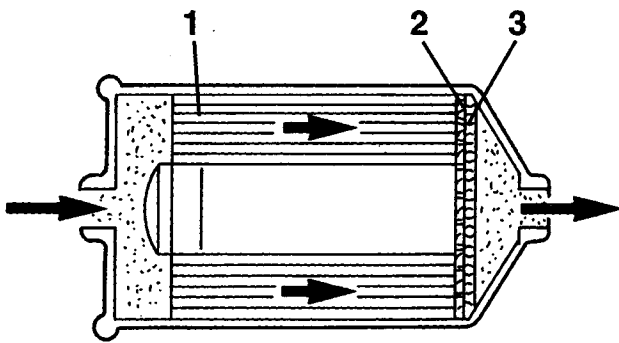
## FUEL FILTER

Inserted in the fuel delivery pipe to the injectors, under the car floor, next to the fuel tank.

It is formed of an outer aluminium cover and an inner polyurethane support which contains a paper element with a high filtering power ( $\sim 5 \mu\text{m}$ ) and a surface of appr.  $1400 \text{ cm}^2$ .

Fuel filtering is indispensable to ensure correct operation of the electroinjectors, given their sensitivity to foreign particles contained in the fuel circuit.

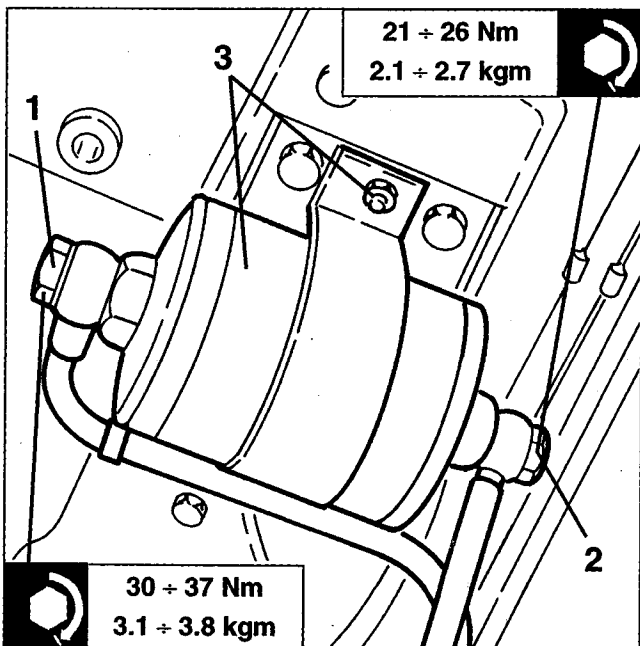
There is an arrow on the outer filter cover which indicates the direction in which the fuel flows and therefore the correct assembly position.



1. Paper filter      2. Fabric filter      3. Mesh

## REPLACEMENT

1. Disconnect the fuel inlet pipe fitting from the filter.
2. Disconnect the fuel outlet pipe fitting from the filter.
3. Slacken the fastening clamp and remove the fuel filter.



## FUEL PRESSURE REGULATOR

The task of the fuel pressure regulator is to keep the difference between the pressure of the fuel and the pressure in the intake manifold constant.

This way it is possible to meter the amount of fuel solely on the basis of the injector opening time.

The pressure regulator is fitted downstream of the fuel distributor manifold.

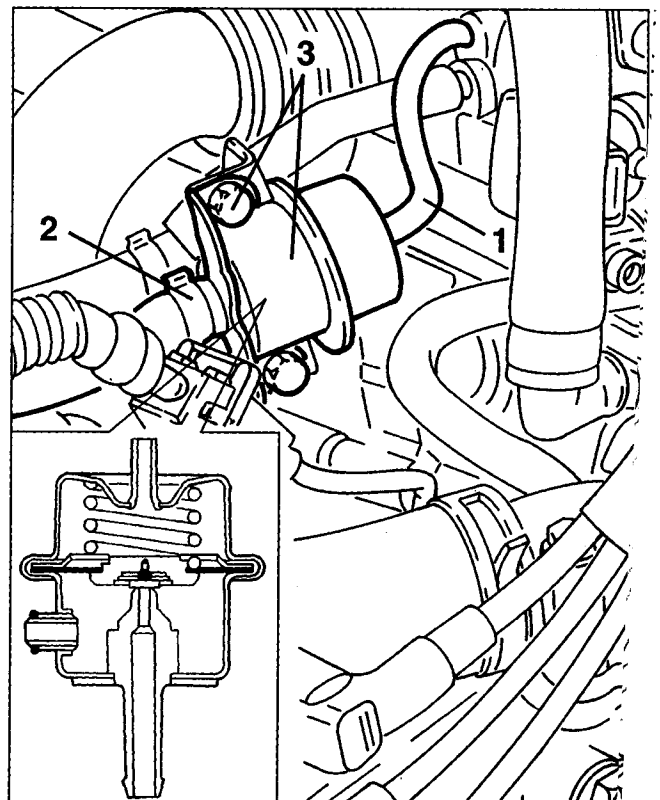
It is a limiting regulator controlled by a diaphragm which regulates the fuel pressure to appr. **3 bar**.

When the fuel pressure exceeds the maximum rating, the diaphragm acts on a valve which opens the return pipe, through which the excess fuel is returned to the fuel tank.

A tube connects the regulator spring chamber to the air intake box. An interdependence is created by this connection between the pressure in the fuel circuit and the pressure in the intake manifold, so that the pressure between the inlet and outlet of the electroinjectors is always the same, when they are open.

## REMOVAL/REFITTING

1. Disconnect the vacuum takeoff pipe from the fuel pressure regulator.
2. Disconnect the fuel return pipe from the pressure regulator.
3. Slacken the two fastening screws and remove the fuel regulator from the fuel distributor manifold and retrieve the O-Ring.



## PULSE DAMPER

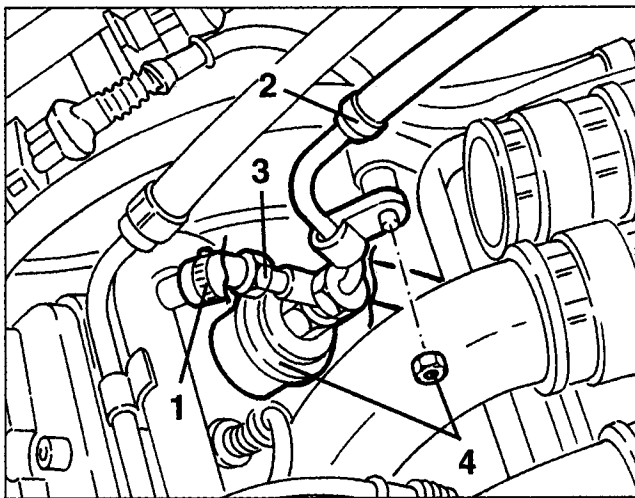
The pulse damper is connected to the inlet of the fuel distributor and it serves to suppress the pulsing noises that can occur especially at low engine rpm.

The pulsing is generated by pressure differences of the fuel deriving from the opening and closing of the electroinjectors or of the pressure regulator.

## REMOVAL/REFITTING

- Remove the intake manifold of cylinder no. 4.

1. Disconnect the fuel distributor manifold connection pipe.
2. Disconnect the fuel inlet pipe from the pulse damper.
3. Disconnect the pulse damper from the fuel distributor manifold slackening its coupling.
4. Slacken the nut of the fastening clamp and remove the pulse damper complete with stiff pipes.



They will let the fuel pass when they are "open" and prevent it from being delivered when they are "closed".

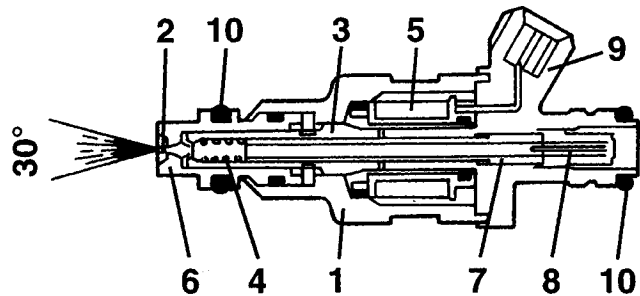
They basically comprise a nozzle controlled by an electromagnet and by a return spring.

In the rest position, the needle, which forms one piece with the core, is pushed by the spring onto the electroinjector nose to close the hole and ensure that unwanted fuel is unable to come out.

As soon as the winding is energized, the core is attracted, it compresses the spring opening the nozzle hole, thereby allowing the fuel to flow out.

Considering the physical characteristics of the fuel (viscosity, density) and the pressure difference (pressure regulator) constant, the amount of fuel injected depends on the injector opening time only.

The winding energizing time is normally called the "injection time".



- |                   |                              |
|-------------------|------------------------------|
| 1. Injector body  | 6. Injector nose             |
| 2. Needle         | 7. Adjustable pressure plate |
| 3. Magnetic core  | 8. Filter                    |
| 4. Helical spring | 9. Electrical connection     |
| 5. Winding        | 10. Seal rings               |

## ELECTROINJECTORS

The injector nozzle is formed so that the jet of fuel atomizes into a 30° cone.

The injectors are locked by the fuel distributor which presses them into their housings machined on the intake ducts.

The injectors are also anchored to the fuel distributor by "safety catches" and sealed by two O-Rings.

The electroinjectors have the task of metering the amount of fuel needed by the engine.

They are "all or nothing" devices i.e. they only have two possible conditions, either open or closed.

## CHECKING FOR CORRECT OPENING OF ELECTROINJECTORS

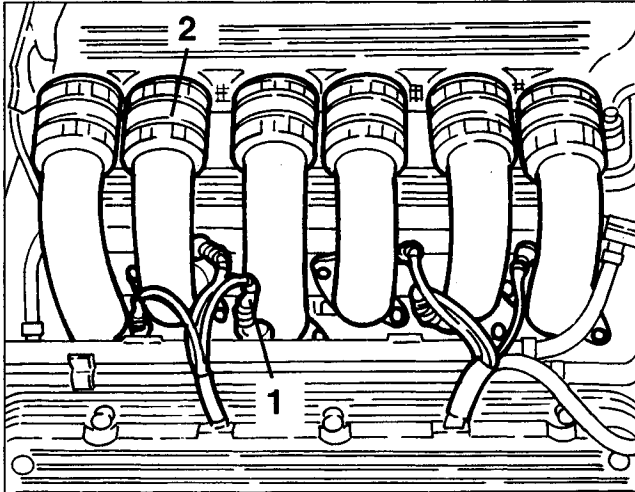
- Measure the quantity of CO at the exhaust.
- Disconnect the electroinjector connectors one by one; each time measure for a reduction of the CO quantity at the exhaust and check that this value remains constant at each check.
- If not, locate and replace the faulty electroinjector; in any case a visual index of the efficiency of the electroinjectors is given by the spark plug electrodes:
  - a mixture which is too rich corresponds to a black colour.
  - a mixture which is too lean corresponds to a light colour.

### CHECKING THE SEALING OF ELECTROINJECTORS

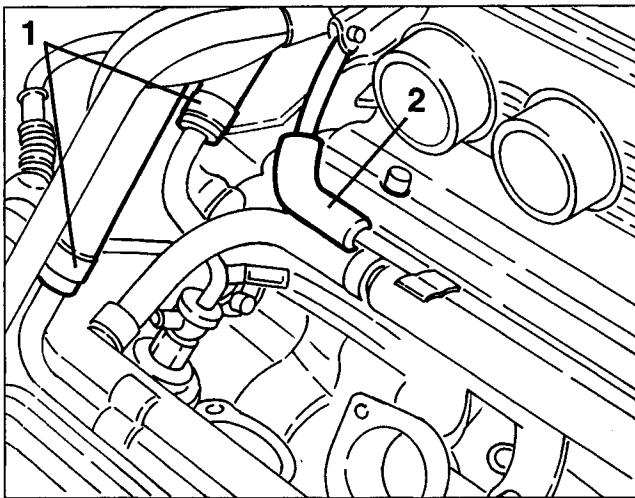
- Remove the electroinjectors complete with fuel distributor manifold, keeping the fuel supply circuit connected.
- Disconnect the electrical connections from the electroinjectors.
- Operate the starter motor and check that there are no leaks of fuel from the electroinjectors; if so replace the faulty injector.

### REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connections from the electroinjectors.
- 2. Remove the intake ducts.

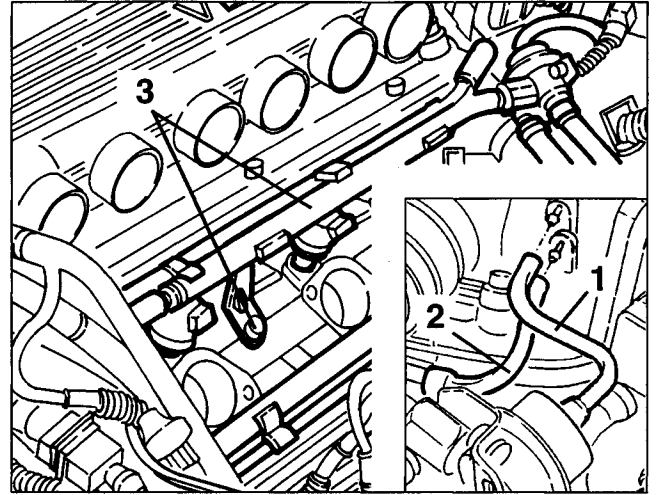


- 1. Disconnect the fuel delivery and return pipes from the fuel distributor manifold.
- 2. Disconnect the fuel vapour recirculation pipe.



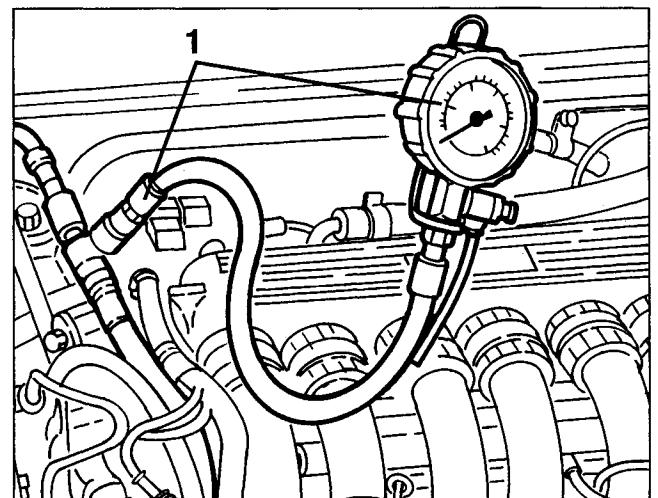
- 1. Disconnect the vacuum takeoff pipe for the fuel pressure regulator from the intake box.
- 2. Disconnect the fuel vapour recirculation pipe from the intake box.

- 3. Slacken the fastening screws and remove the fuel distributor manifold complete with injectors, fuel pressure regulator and pulse damper.
- Working on the bench remove the safety catches and remove the injectors from the fuel distributor manifold.



### CHECKING THE PRESSURE AND TIGHTNESS OF THE FUEL CIRCUIT

- 1. Disconnect the fuel delivery pipe from the pulse damper, then connect a pressure gauge, using a "T" adapter, between the damper and the disconnected pipe.
- Disconnect the fuel pressure regulator vacuum takeoff pipe to avoid any irregularities in the rotation speed from causing abnormal readings.
- Start the engine and at idle speed check that the fuel pressure is within the specified limits.



Fuel pressure at idle speed

2.8 + 3.2 bar

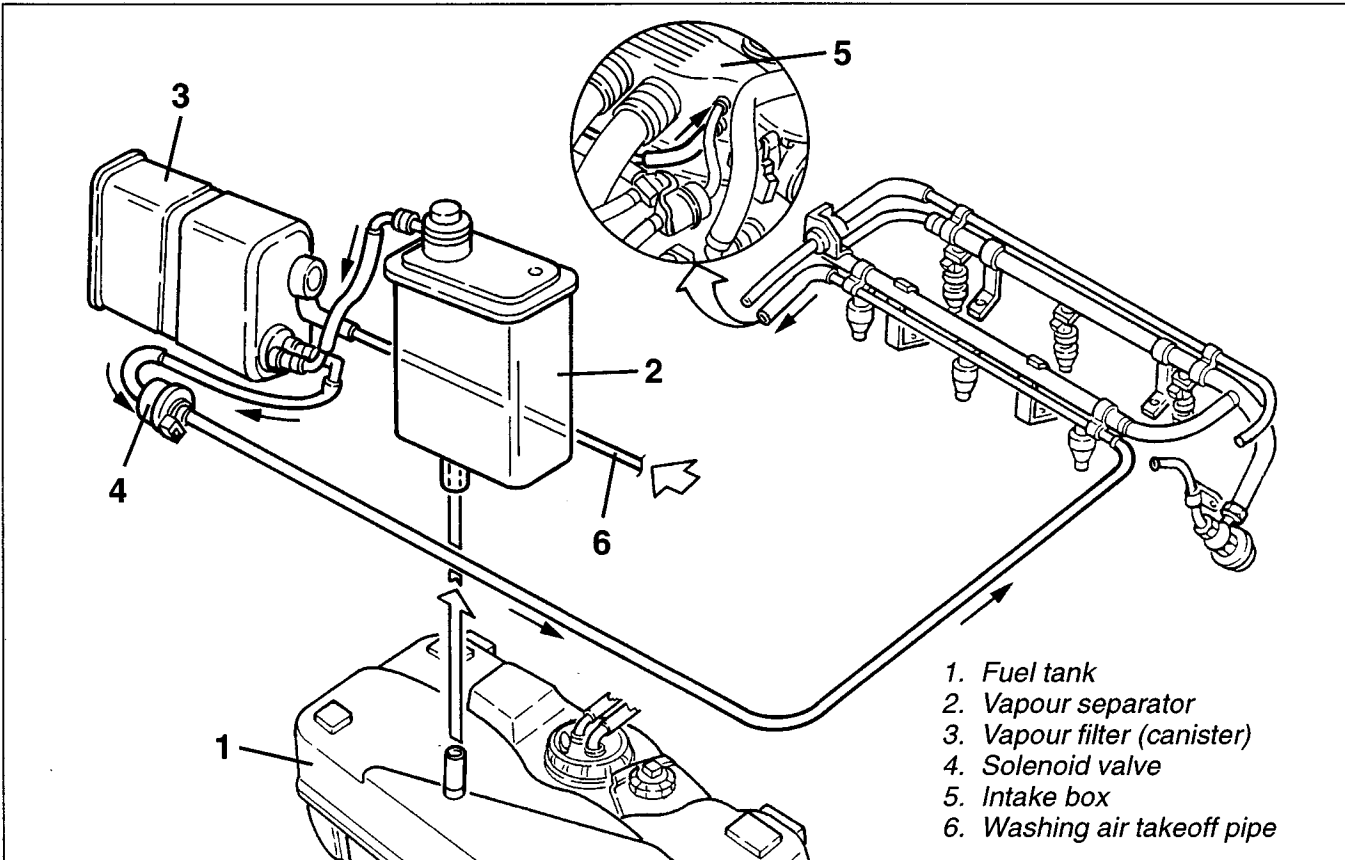


- Reconnect the vacuum takeoff pipe on the regulator and check that the fuel pressure falls by ~ 0.5 bar and then rises again when the throttle valve opens.  
If this fails to occur, look for any leaks in the vacuum takeoff pipe.

- Keeping the vacuum takeoff pipe connected to the regulator and with the engine running at idle speed, choke the regulator fuel outlet pipe noting the increase in pressure up to ~ 4 bar (do not allow the pressure to exceed this rating).

- If the pressure does not reach this rating and no leaks are detected, check the fuel filter and/or that the pump is working properly.

**DESCRIPTION OF THE FUEL VAPOUR RECOVERY SYSTEM**



The fuel contained in the tank produces a considerable amount of vapours, which would pollute the environment if released.

The vapour control and recovery system gathers these vapours and burns them in the engine.

The vapours leading from the fuel tank through a special pipe reach the vapour separator which due to its special shape allows the condensed fuel to return in droplet form to the fuel tank. The remaining vapours are then sent to the fuel vapour filter canister where they are absorbed and stored by the active carbon contained in the filter.

There is a solenoid valve between the fuel vapour filter and the intake box: when the solenoid valve is not activated the connection with the intake is closed and the fuel vapours are collected in the canister in the active carbon.

Under certain load conditions the control unit controls the opening of the solenoid valve allowing any fuel vapours in the canister to be withdrawn. This condition remains even if at the exhaust the lambda sensor detects a reduction of oxygen which, due to the presence of too much fuel in the combustion chamber, is signalled to the control unit which delivers less fuel to the injectors so that the engine is always supplied under optimal conditions.

If there is a lack of fuel vapours in the canister, resulting in withdrawing only air, the lambda sensor detects this and signals the control unit of an increase in the oxygen.

In this case the control unit closes the solenoid valve thus preventing the connection of the canister with the intake box, thereby eliminating the excess air.

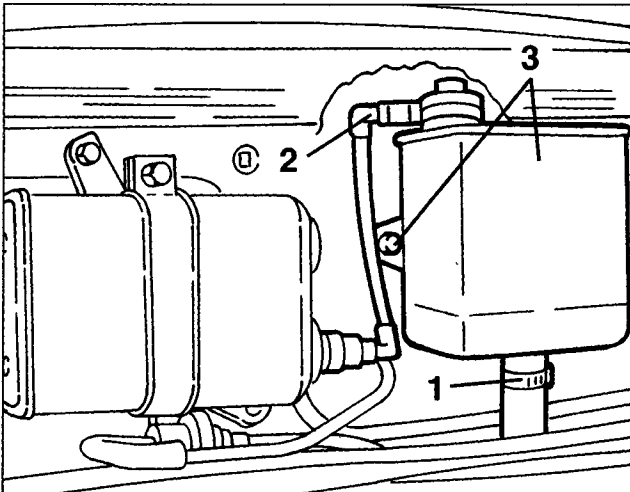
## FUEL VAPOUR SEPARATOR

This is located in the luggage compartment, and its task is to limit the amount of fuel vapours reaching the canister, condensing part of them due to its shape. It is formed of a plastic container with two connections: a lower one for the inlet of fuel vapours and the return of condensed fuel to the tank and an upper one for sending vapours to the canister.

### REMOVAL/REFITTING

- Remove the spare wheel and the luggage compartment front panel.

1. Disconnect the fuel vapour inlet pipe from the separator.
2. Disconnect the fuel vapour delivery pipe to the canister from the separator.
3. Slacken the two fastening screws and remove the fuel vapour separator.



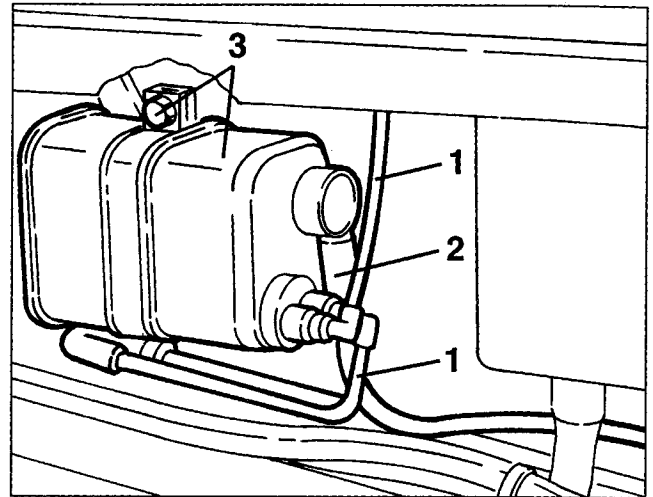
## FUEL VAPOUR FILTER (CANISTER)

The filtering element is formed of active carbons enclosed in a plastic container. Their purpose is to absorb the fuel vapours leading from the separator. A one-way valve, to which a special pipe is connected, admits outside air when the vapours are withdrawn to wash the active carbons.

### REMOVAL/REFITTING

- Remove the spare wheel and the luggage compartment front panel.

1. Disconnect the fuel vapour inlet and outlet pipes from the canister.
2. Disconnect the outside air inlet pipe from the one-way valve on the canister.
3. Slacken the fastening clamp screw and remove the canister.



## FUEL VAPOUR SOLENOID VALVE

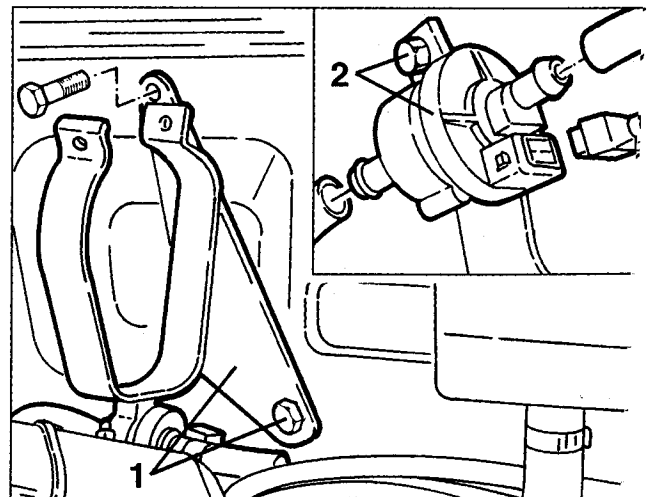
The reason for the use of this valve, controlled by the electronic control unit, is to send the vapours stored in the canister to the engine intake.

This valve enclosed in a casing, comprises a mobile part or shutter, restrained to a plate spring; the fixed part is formed of a metal cylinder, perforated inside, on which the coil is wound.

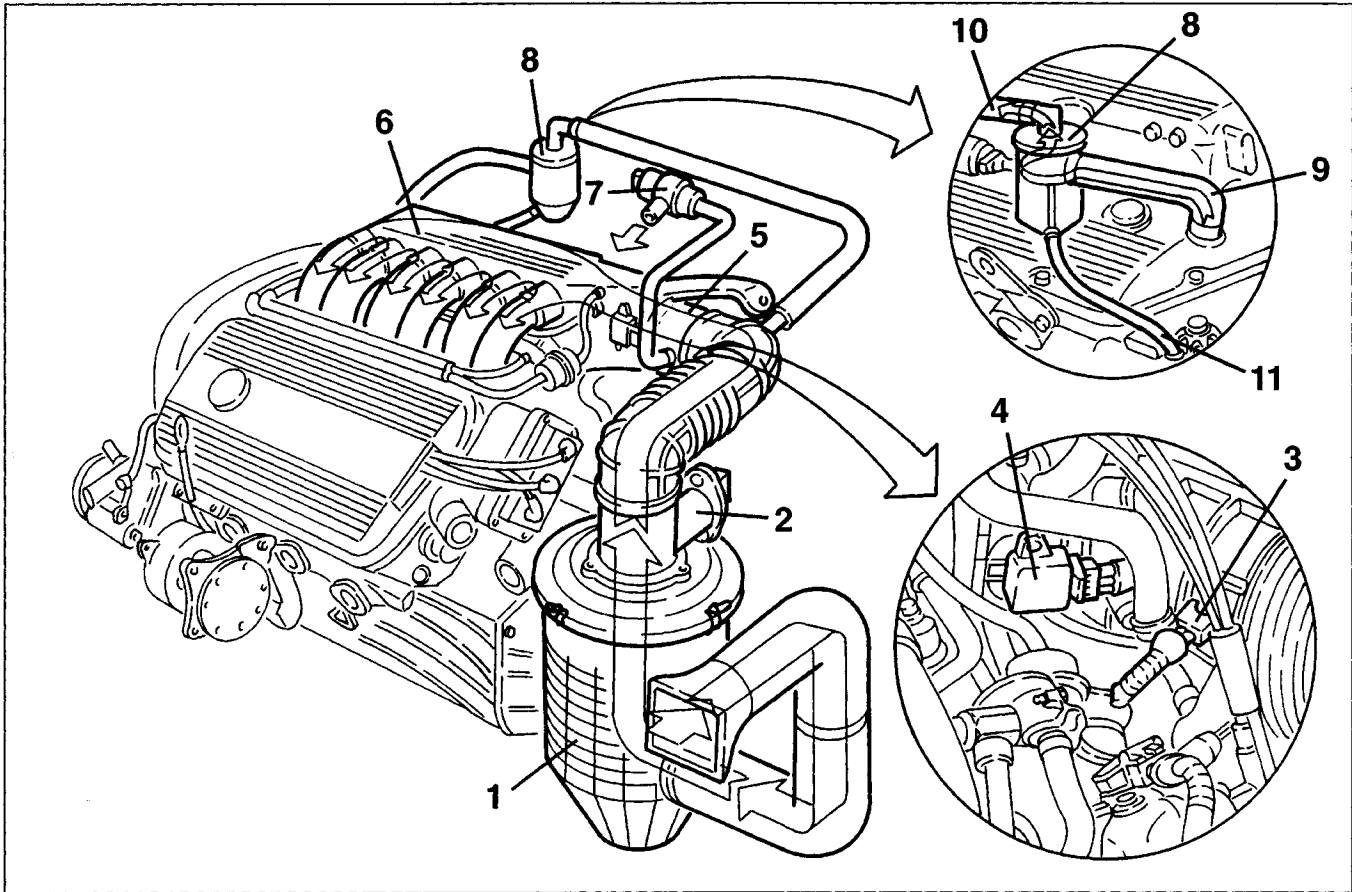
### REMOVAL/REFITTING

- Remove the spare wheel and the luggage compartment front panel.

- Disconnect the battery (-) terminal.
  - Remove the canister without disconnecting it from its pipes.
1. Slacken the two fastening screws and remove the canister support bracket complete with solenoid valve.
  2. Disconnect the electrical connection and the fuel inlet and outlet pipes, then slacken the fastening clamp screw and remove the solenoid valve.



**AIR SUPPLY AND OIL VAPOUR RECOVERY SYSTEM**



- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>1. Air cleaner</li> <li>2. Air flow meter</li> <li>3. Intake air temperature sensor</li> <li>4. Throttle potentiometer</li> <li>5. Throttle body</li> <li>6. Intake box</li> </ul> | <ul style="list-style-type: none"> <li>7. Constant idle speed actuator</li> <li>8. Oil vapour separator</li> <li>9. Oil vapour recovery pipe</li> <li>10. Oil vapour recirculation pipe</li> <li>11. Condensed oil recovery pipe</li> </ul> |
|---|---|

**DESCRIPTION**

The air taken in through a dynamic inlet and filtered by a cartridge element (1), passes through the hot film air-flow meter (2) and from this through the corrugated sleeve, which houses the intake air temperature sensor (3), it reaches the throttle body (5).

The latter, controlled by the accelerator cable, adjusts the amount of air drawn into the box (6). On one side of the throttle body there is the potentiometer (4) fastened to the pivot pin of the throttle itself which informs the control unit of the position of the throttle. An additional air solenoid valve (7) on the intake box by-passes the throttle body through a special pipe to keep the idle rpm constant during particular operating conditions of the engine.

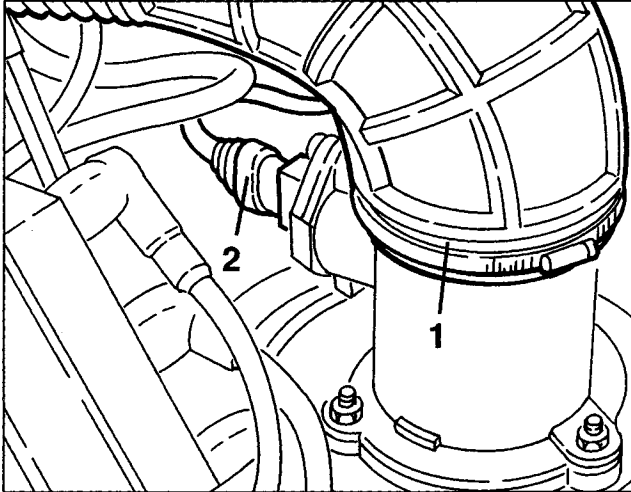
The fuel vapours (see specific paragraph) and the oil vapours flow to the air supply system.

The oil vapours are formed when the engine is running and they are collected in the separator through a pipe (9) leading from the right-hand cylinder head; as the temperature of the separator is lower, part of the oil vapours are condensed.

The condensed oil returns to the engine via a special pipe (11), while the remaining vapours are sent to the corrugated sleeve, upstream of the throttle body and then burnt in the engine.

## CHANGING THE AIR CLEANER CARTRIDGE

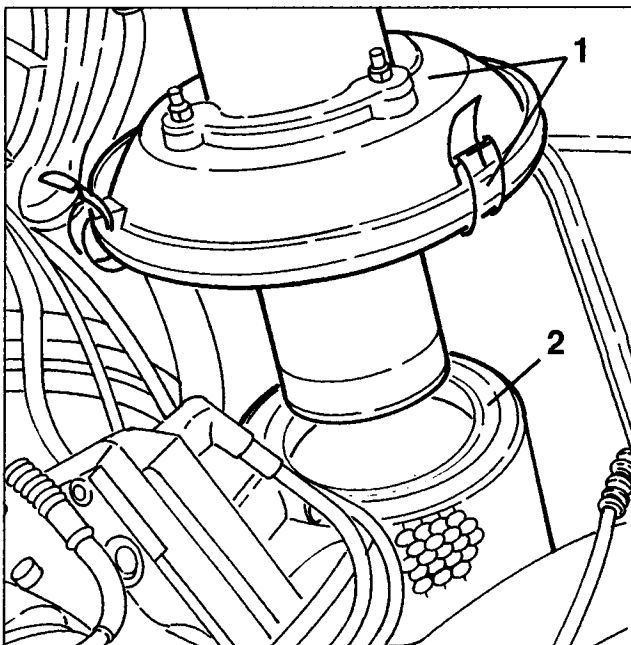
- Disconnect the battery (-) terminal.
- 1. Slacken the fastening clamp and disconnect the corrugated sleeve from the air cleaner cover, then move it to one side.
- 2. Disconnect the electrical connection from the air-flow meter.



1. Release the catches and remove the air cleaner cover complete with air-flow meter.
2. Remove the filtering element.

### WARNING:

Any cleaning operation on the filter can cause damage to it, and might compromise the correct functioning of the engine supply system.



## THROTTLE BODY

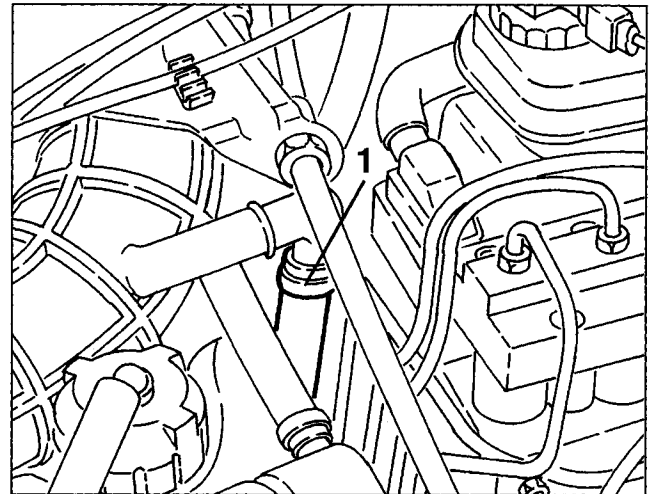
The throttle body adjusts the amount of air sent to the intake box in relation to the position of the accelerator pedal.

In fact, the accelerator acts on a specific sector of pulley locked on the throttle valve pivot pin. A coil spring allows the throttle to return to the closed position.

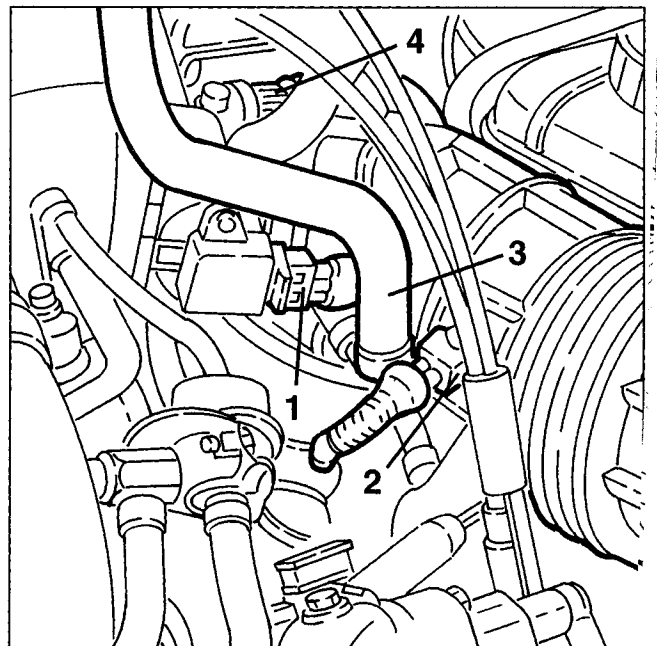
To prevent the formation of ice on the throttle valve which would prevent it from closing, the throttle body is heated by the engine coolant fluid.

## REMOVAL/REFITTING

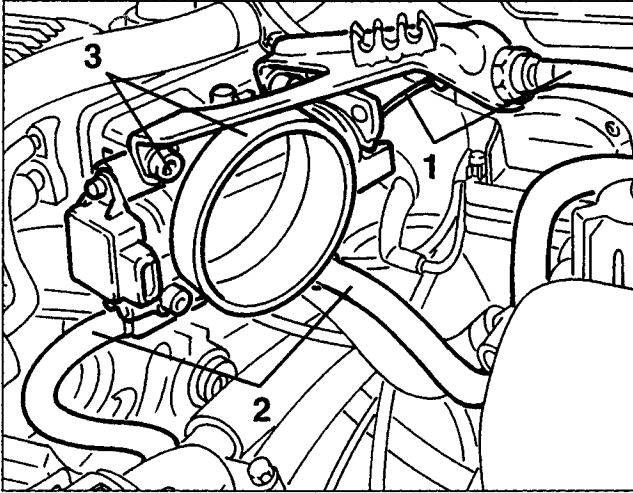
- Disconnect the battery (-) terminal.
- 1. Disconnect the idle speed oil vapour recirculation pipe from the corrugated sleeve.



1. Disconnect the electrical connection from the throttle potentiometer.
2. Disconnect the electrical connection from the intake air temperature sensor.
3. Disconnect the constant idle speed actuator air takeoff pipe from the corrugated sleeve.
4. Slacken the fastening clamp and disconnect the corrugated sleeve from the throttle body.



1. Disconnect the accelerator cable from the throttle.
  2. Disconnect the two coolant inlet and outlet pipes from the throttle body.
  3. Slacken the fastening screws and remove the throttle body complete with potentiometer and accelerator cable support bracket and if necessary, separate them on the bench.
- Remove the throttle body seal.



Its operating principle is based on a heated diaphragm interposed in a measurement duct through which the air admitted to the engine flows.

The hot film diaphragm is kept at a constant temperature (~ 120°C above the temperature of the incoming air) by the heating resistance in contact with it.

The mass of air crossing the measurement duct tends to withdraw heat from the diaphragm, therefore, in order to keep its temperature constant, a certain amount of current must flow through the resistance. This current is measured by a suitable Wheatstone bridge.

Thus, the current is proportionate with the mass of flowing air.

**NOTE:** This air-flow meter measures directly the mass of air and not the volume) thereby eliminating problems of temperature, altitude, pressure, etc.

The correct operation of the air flow meter depends on the condition of the air cleaner, which must therefore be checked often.

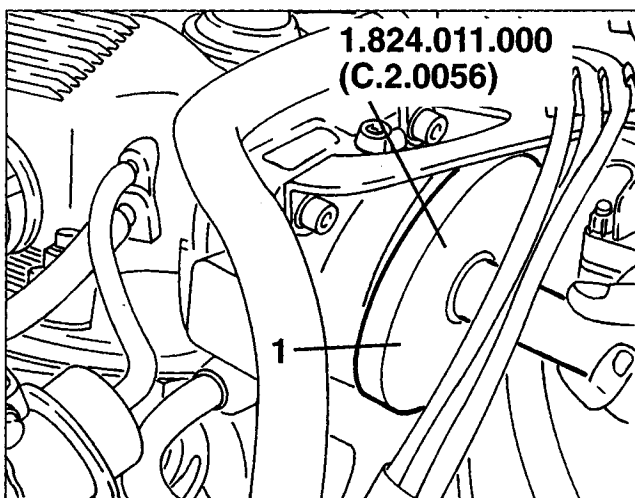
### FLUXING TEST

- Proceed as described in the first four steps of the procedure for "Throttle body - Removal/Refitting".

1. Make sure that the throttle is in the closed position, then using tool no. 1.824.011.000 (C.2.0056) connected to the flow meter, check that the flow is within the specified limits.

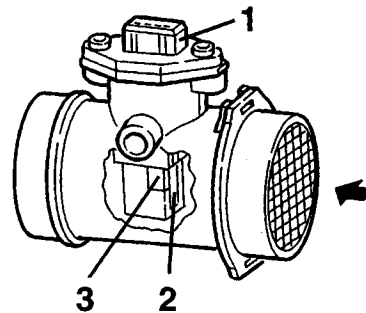
|   |
|---|
| <b>Accelerator throttle blow-by<br/>in closed position (Solex flow meter)</b> |
|---|

|                  |
|------------------|
| 300 ± 10 Scale N |
|------------------|



### AIR-FLOW METER

The air flow meter is of the "heated film" type.

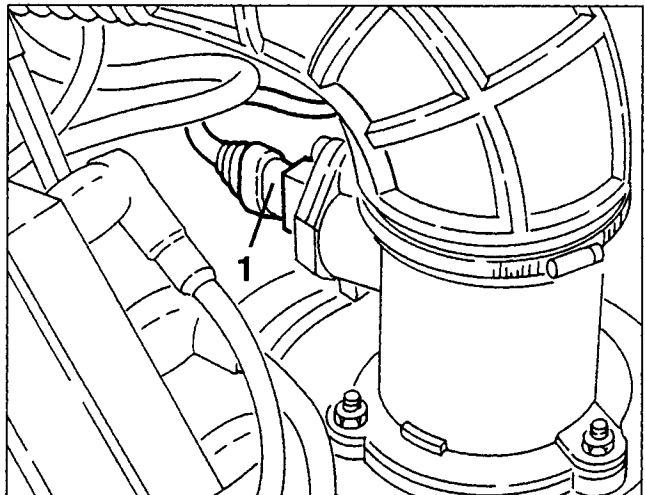


1. Connector
2. Measurement duct
3. Hot film sensor

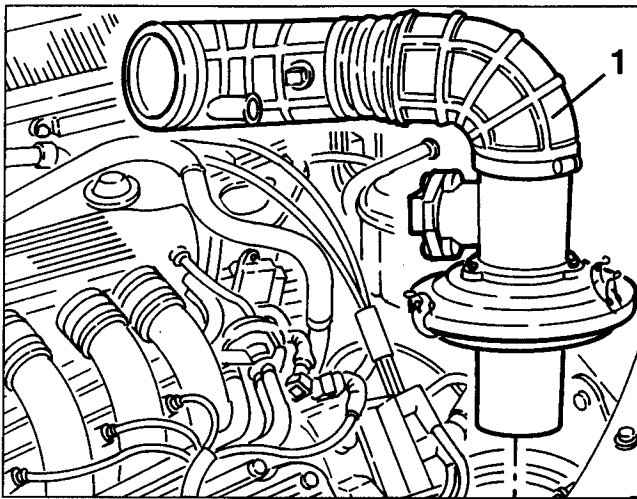
### REMOVAL/REFITTING

- Proceed as described in "Removal/Refitting Throttle body" up to disconnection of the corrugated sleeve.

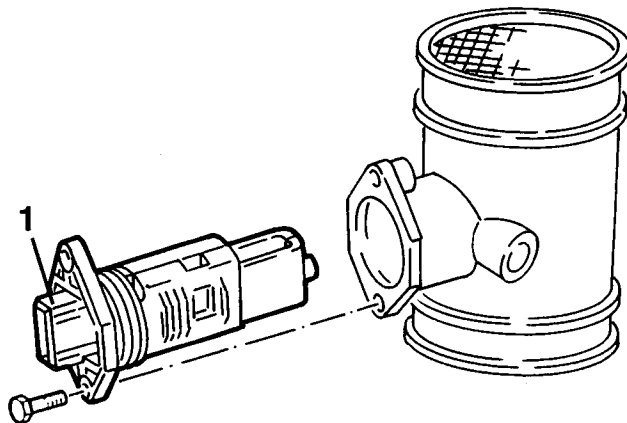
1. Disconnect the electrical connection from the air-flow meter.



1. Release the catches, then remove the air cleaner cover complete with air-flow meter and corrugated sleeve and separate them on the bench.



1. If necessary, slacken the two fastening screws and remove the air-flow meter from its support.

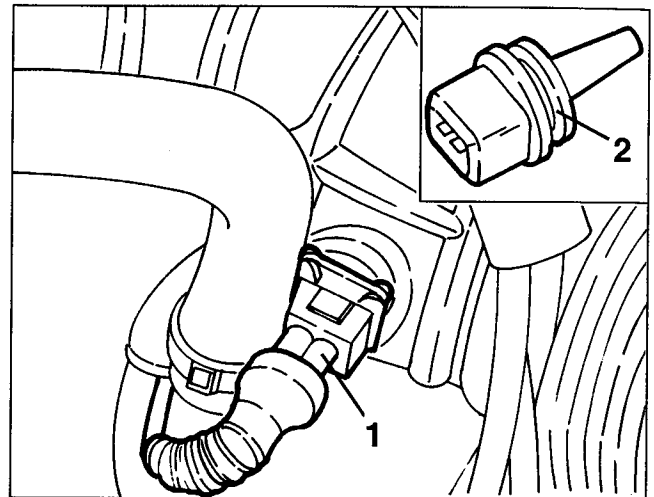


## INTAKE AIR TEMPERATURE SENSOR (NTC)

The intake air temperature sensor is located on the air intake corrugated sleeve and measures the temperature of the air through an NTC thermistor with a negative resistance coefficient, i.e. capable of lowering its resistance as the temperature increases. The electric signal obtained reaches the electronic control unit where it is used to calculate the density of the air.

### REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection from the intake air temperature sensor.
- 2. Withdraw and remove the intake air temperature sensor from the corrugated sleeve.

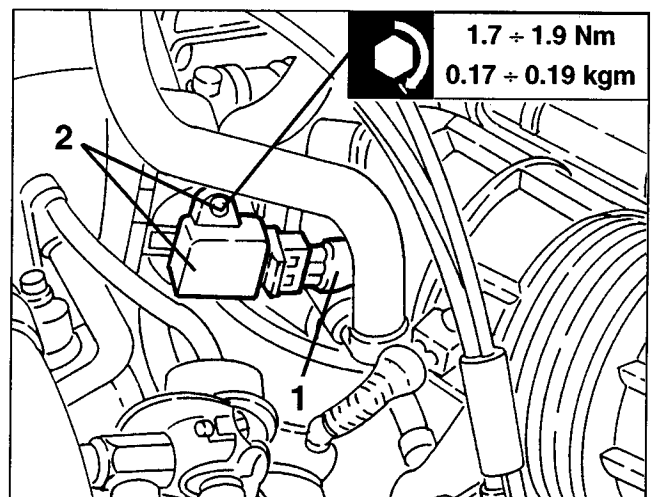


## THROTTLE POTENTIOMETER

This is a potentiometer the mobile part of which is controlled directly by the throttle valve shaft. The potentiometer signals the control unit instantaneously when there is the need for "full power", anticipating the signal from the air-flow meter which records a considerable increase of the flow of air, thereby obtaining a more immediate response. The potentiometer automatically detects the throttle closed position through a "self-adapting" function. This eliminates the need for potentiometer adjustment operations and makes it possible to follow in time any wear occurring on the throttle closing position.

### REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection from the throttle potentiometer.
- 2. Slacken the two fastening screws and remove the throttle potentiometer.

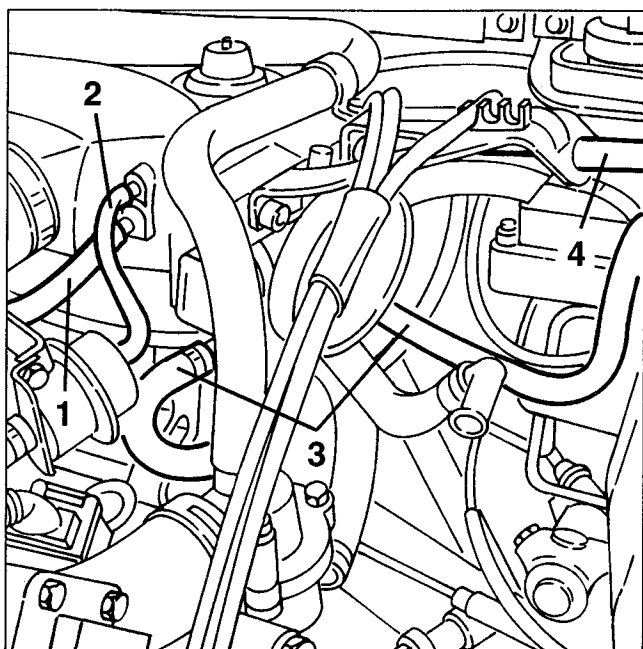


## AIR INTAKE BOX

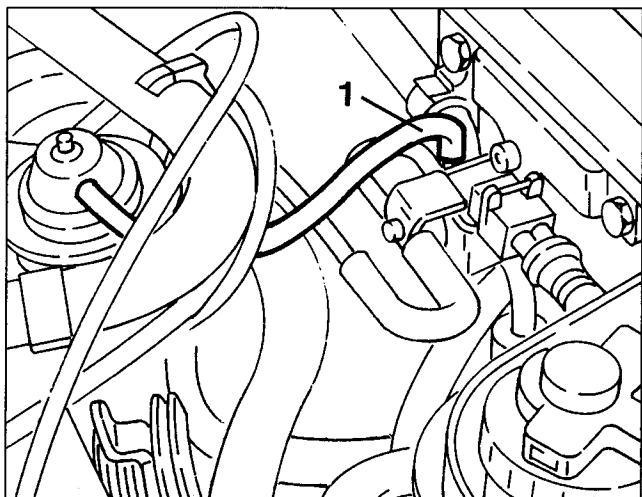
### REMOVAL/REFITTING

- Proceed as described in "Removal/Refitting Throttle body" up to disconnection of the corrugated sleeve.

1. Disconnect the fuel vapour recirculation pipe from the intake box.
  2. Disconnect the fuel pressure regulator vacuum takeoff pipe from the intake box.
  3. Disconnect the coolant inlet and outlet pipes from the throttle body.
  4. Disconnect the accelerator cable from the throttle.
- Free the spark plug cables from the fastenings on the accelerator cable support bracket.

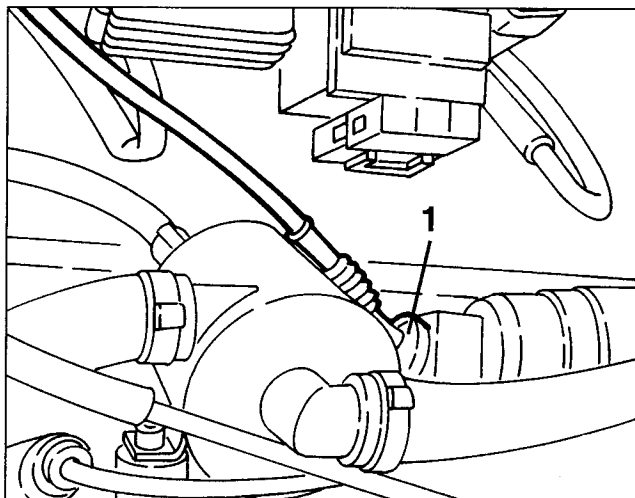


1. Disconnect the pipe that sends the vacuum signal to the E.G.R. valve from the pneumatic signal modulation solenoid valve.

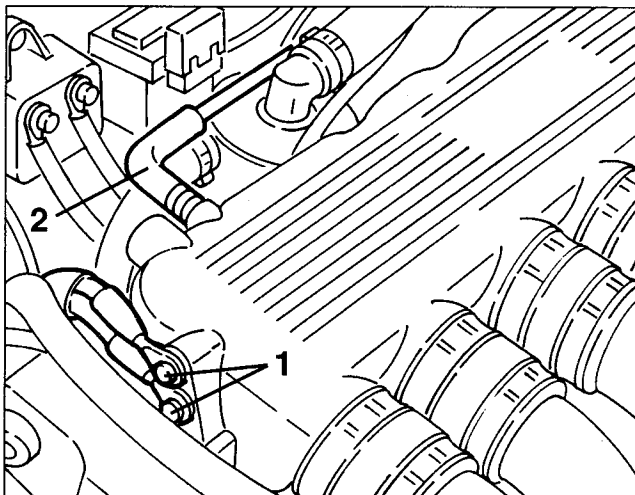


- Disconnect the exhaust gas takeoff pipe from the E.G.R. valve.

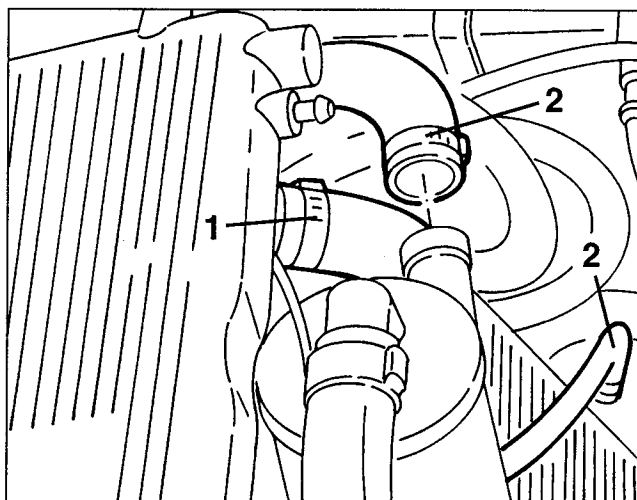
1. Disconnect the electrical connection from the constant idle speed actuator.



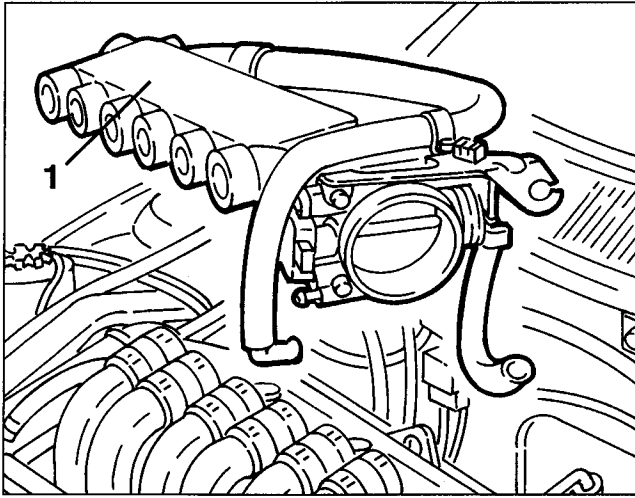
1. Disconnect the earth cables from the box.
2. Disconnect the vacuum takeoff socket for the E.G.R. pneumatic signal modulating solenoid valve from the intake box.



1. Disconnect the servobrake vacuum takeoff pipe from the box.
2. Disconnect the oil vapour recovery pipe and the oil recovery pipe from the separator.



1. Slacken the clamps fastening the intake ducts to the box, then remove the box.



- Working on the bench, separate the E.G.R. valve, constant idle speed actuator, oil vapour separator and throttle body from the intake box.

## CONSTANT IDLE SPEED ACTUATOR

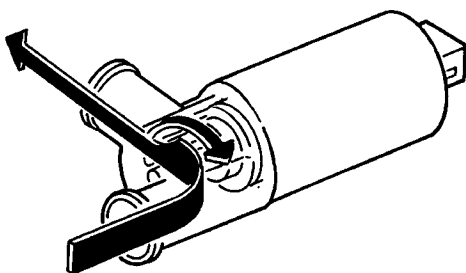
Idle speed rpm is controlled by an actuator which adjusts the amount of air taken in by the engine when the throttle valve is closed.

This makes it possible to compensate the power required by the various services (conditioner compressor, power steering, alternator) so that the engine speed remains unaffected.

The opening and closing controls are independent due to a double electromagnetic circuit with considerable advantages in terms of prompt adjustment.

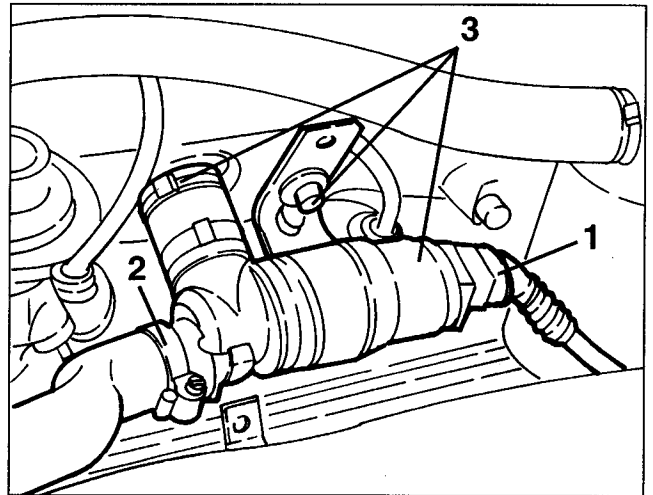
In addition, the control unit is "self-adaptive", i.e. it can follow and "detect" the changes that occur in the engine (different internal frictions at different temperatures, settling of the engine over the course of time etc.) so that idle speed remains constant under all conditions.

Lastly, in the event of a fault, a spring moves the actuator to an intermediate degree of opening to enable the car to reach an authorised service centre.



## REMOVAL/REFITTING

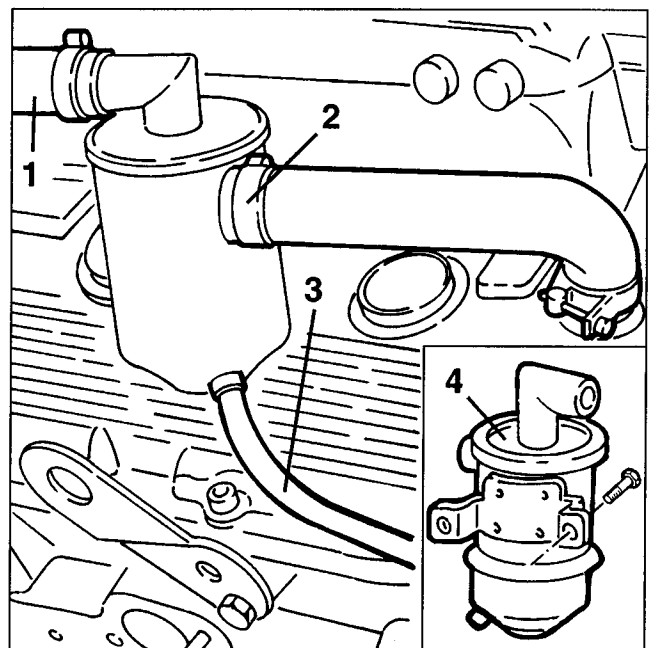
- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the constant idle speed actuator.
  2. Disconnect the air inlet pipe from the constant idle speed actuator.
  3. Slacken the two fastening screws and remove the constant idle speed actuator loosening the clamp and disconnecting the air delivery pipe to the intake box.



## OIL VAPOUR SEPARATOR

### REMOVAL/REFITTING

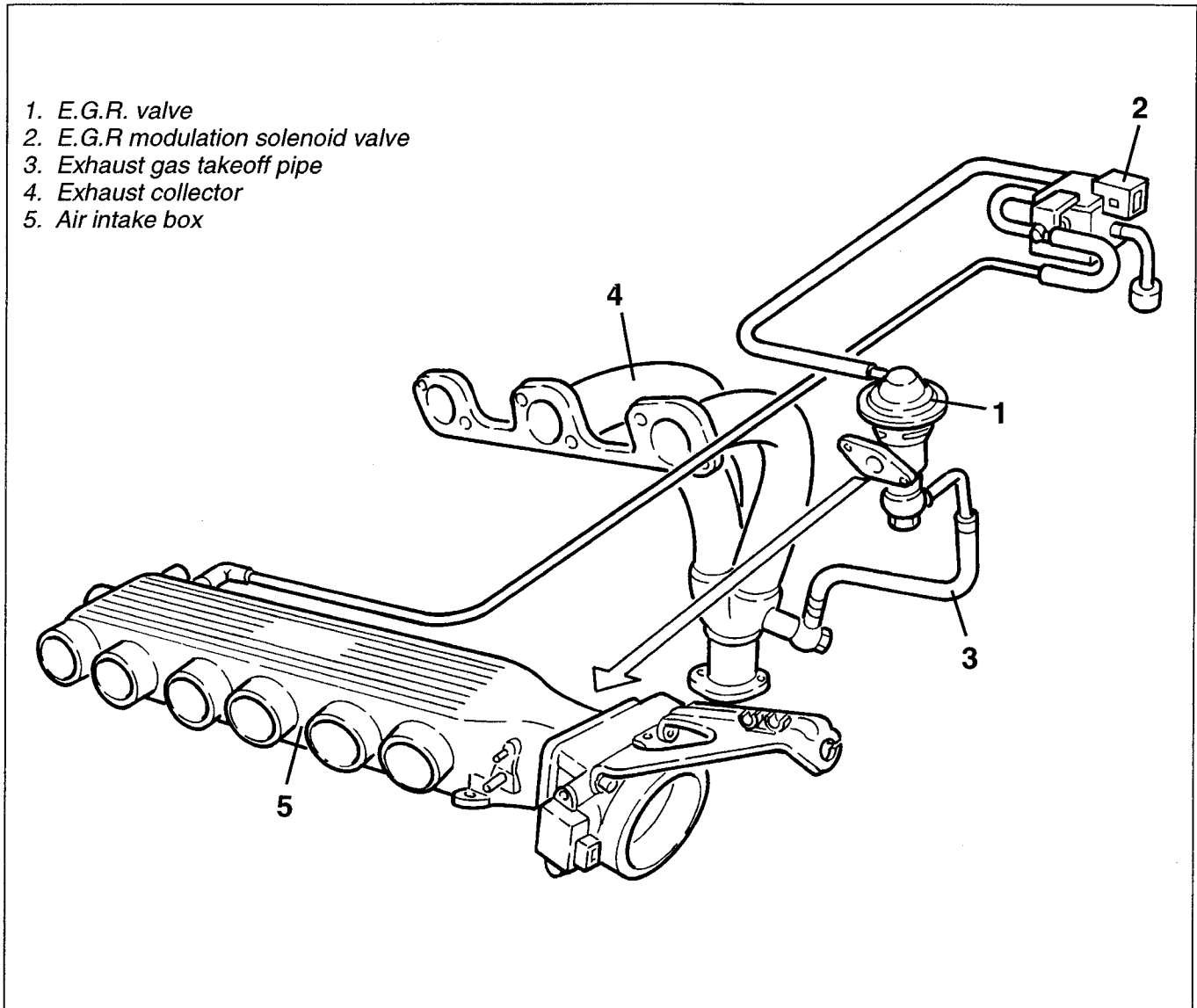
1. Disconnect the oil vapour recirculation pipe from the separator.
2. Disconnect the oil vapour recovery pipe from the separator.
3. Disconnect the oil recovery pipe from the separator.
4. Slacken the two fastening screws and remove the oil vapour separator.





**DESCRIPTION OF SYSTEM**

1. E.G.R. valve
2. E.G.R modulation solenoid valve
3. Exhaust gas takeoff pipe
4. Exhaust collector
5. Air intake box



To further reduce emissions of NOx (nitric oxides) the supply system is fitted with an E.G.R. valve (1). The E.G.R. valve (Exhaust Gas Recirculation) withdraws part of the exhaust gas and returns it to the intake box (5), where it is mixed with the intake air and burnt in the engine.

The E.G.R. valve is operated by the vacuum modulated by the solenoid valve (2) controlled by the MOTRONIC control unit.

The amount of exhaust gas sent to the engine is determined by the MOTRONIC control unit, taking account of the characteristic curve of the E.G.R. control depending on the engine load and speed and on the temperature of the coolant fluid.

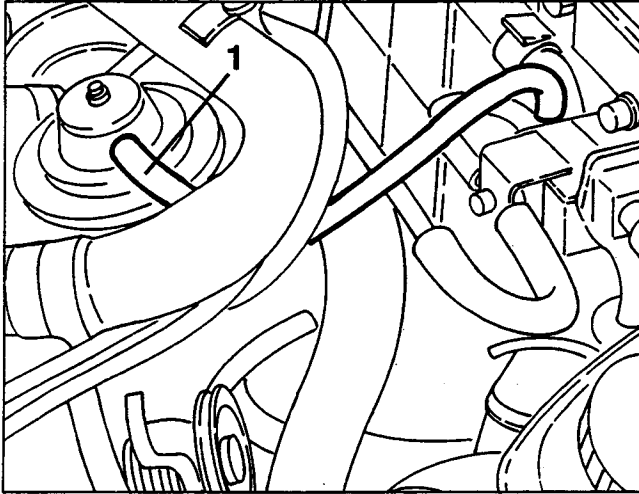
Through the MOTRONIC control unit the solenoid valve modulates the vacuum to be sent to the E.G.R. valve for opening.

The stainless steel exhaust gas takeoff pipe (3), is fitted with an expansion compensation bellows and is covered with a screening braid.

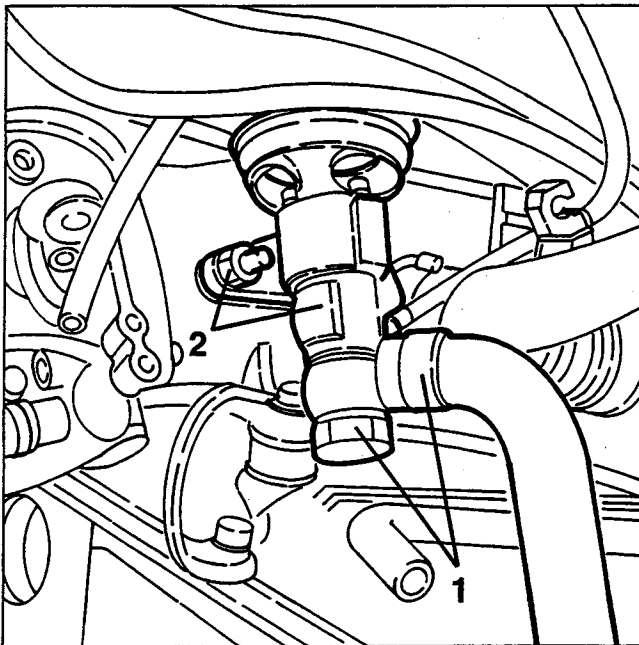
## E.G.R. VALVE

### REMOVAL/REFITTING

1. Disconnect the modulated vacuum pipe leading from the solenoid valve from the E.G.R. valve.



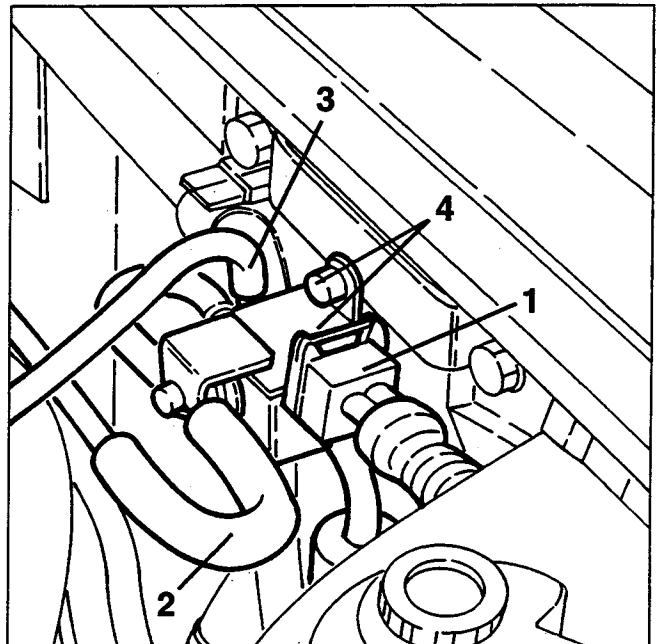
1. Disconnect the exhaust gas takeoff pipe from the E.G.R. valve.
  2. Slacken the two fastening nuts and remove the E.G.R. valve from the intake box.
- Remove the seal.



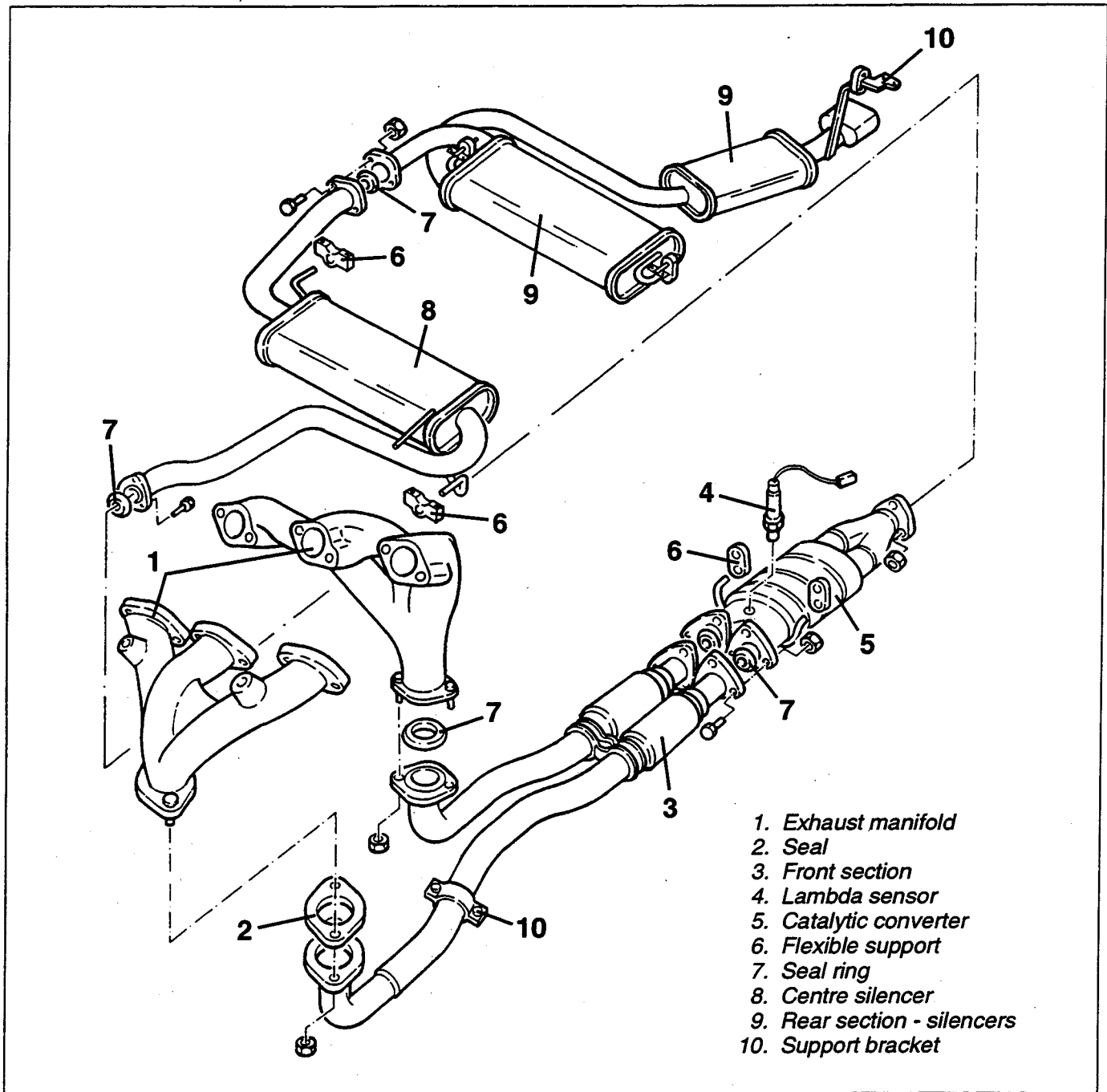
## E.G.R. MODULATING SOLENOID VALVE

### REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the E.G.R. modulating solenoid valve.
  2. Disconnect the vacuum pipe from the intake box from the solenoid valve.
  3. Disconnect the vacuum signal delivery pipe to the E.G.R. valve from the solenoid valve.
  4. Slacken the fastening screw and remove the E.G.R. modulating solenoid valve.



**DESCRIPTION**



The exhaust gas leading from the cylinder head flows through the manifolds (1), to the front section of the exhaust piping (3) on which there are two flexible pieces which enable the limitation of vibrations. From the front section, the exhaust gas reaches the three-way catalytic converter (5) where most of the polluting substances are transformed.

At the beginning of the catalytic converter there is the lambda sensor (4) which informs the control unit of the amount of oxygen contained in the exhaust gas so that the injection time can be adjusted accordingly to keep the stoichiometric ratio (air-fuel) at an optimum level.

The exhaust gas leaves the catalytic converter and crosses three special silencers (8 - 9).

The various sections of the exhaust piping are connected by flanges with interposed seals and support to the underbody is by brackets with flexible supports. The high amount of heat radiated towards the body due to the catalytic converter is limited by a set of heat shields between the exhaust piping and the body itself.

**WARNING:**

When the engine is running all the exhaust pipes and in particular the catalytic converter get very hot.

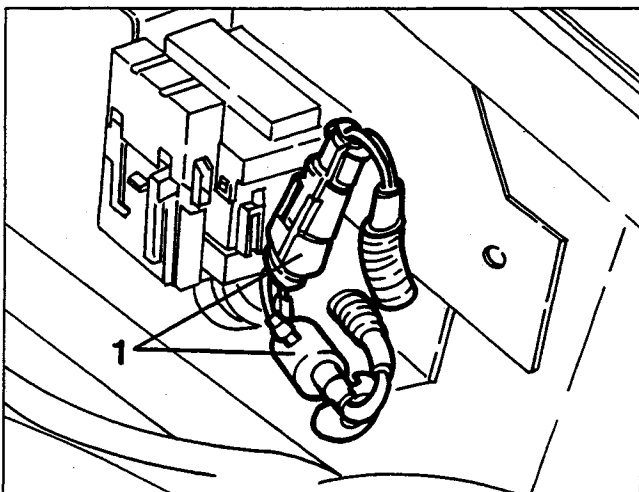
It is therefore necessary to leave the engine off for a suitable length of time before doing any work. Never touch the catalytic converter without suitable protection, such as gloves, etc. Never leave easily inflammable materials near the catalytic converter.

**LAMBDA SENSOR**

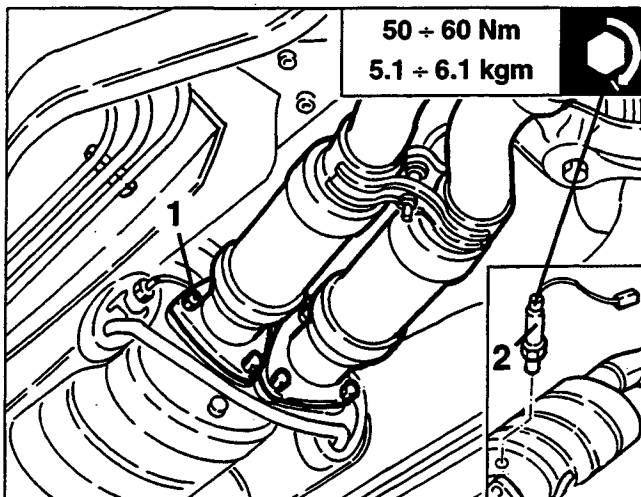
For this description, refer to 1996 TB.

**REMOVING/REFITTING**

- Set the car on a lift.
- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connections from the lambda sensor.



- 1. Slacken the bolts fastening the catalytic converter to the front section of the exhaust piping, then lower the piping just enough to gain access to the lambda sensor.
- 2. Slacken and remove the lambda sensor complete with wiring.



**CHECKING EMISSIONS AT THE EXHAUST**



**WARNING:**

Exhaust emissions must be checked outdoors, or at least in a suitable place equipped according to the regulations in force.

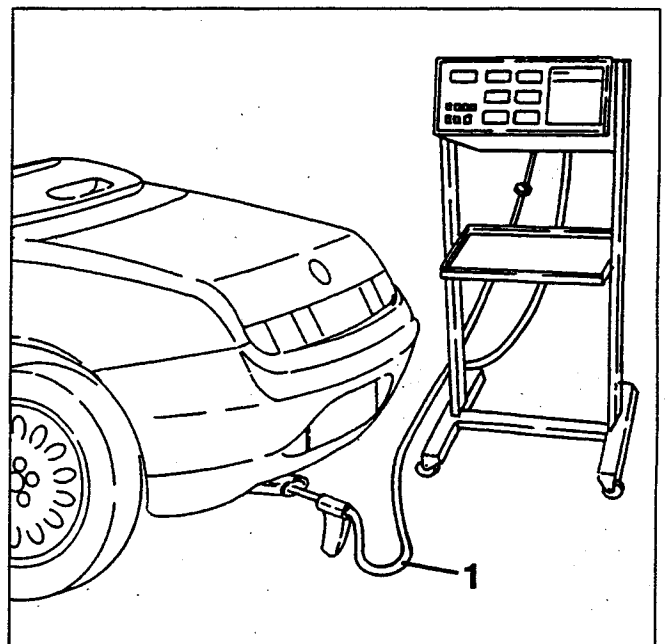
The control should be carried out with the engine at normal operating temperature (i.e. when the fan has turned on and then off) and running at idle speed.

If the idle speed is not within the specified limits, check the constant idle speed actuator.

- Check that the engine oil level is correct and that the air cleaner cartridge is clean.
- Start the engine and keep it at idle speed.

1. Insert the feeler of the analyzer in the end piece of the exhaust pipe and check that the amount of CO and HC are within the specified limits.

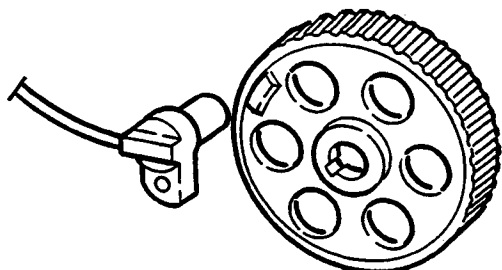
|                         |              |
|-------------------------|--------------|
| CO at the exhaust       | ≤ 2.2 g x km |
| HC + NOx at the exhaust | 0.5 g x km   |



## TIMING SENSOR

The timing sensor (cam angle sensor) comprises a Hall effect device.

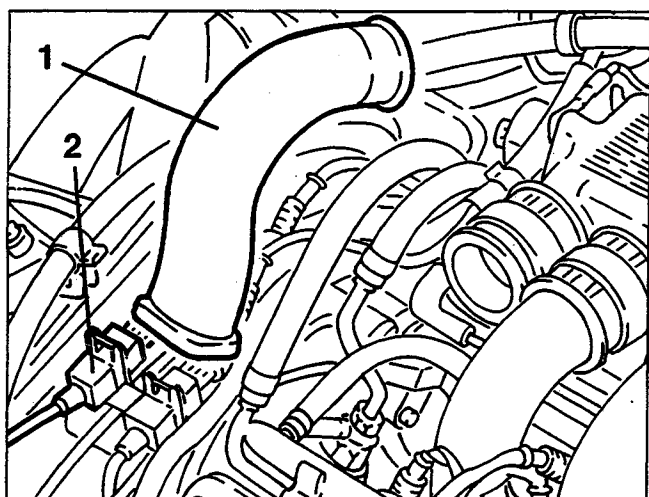
The voltage signal "lowers" sharply when the tooth machined on the camshaft drive pulley opposite the sensor passes in front of it.



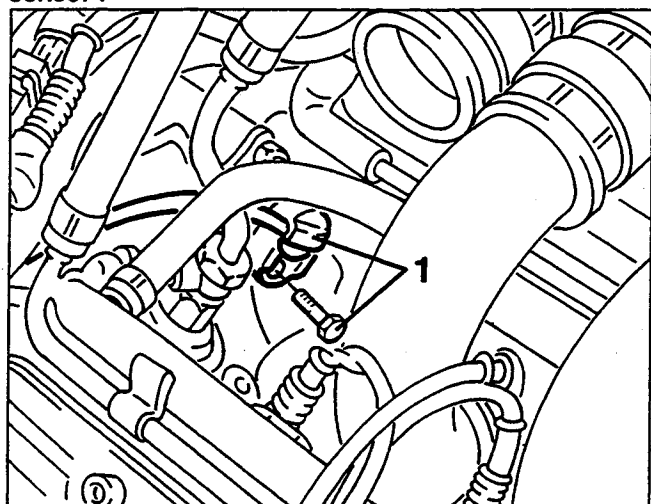
## REMOVAL/REFITTING

- Disconnect the battery (-) terminal.

1. Remove the intake duct of cyl. no. 4.
2. Disconnect the electrical connection of the timing sensor.

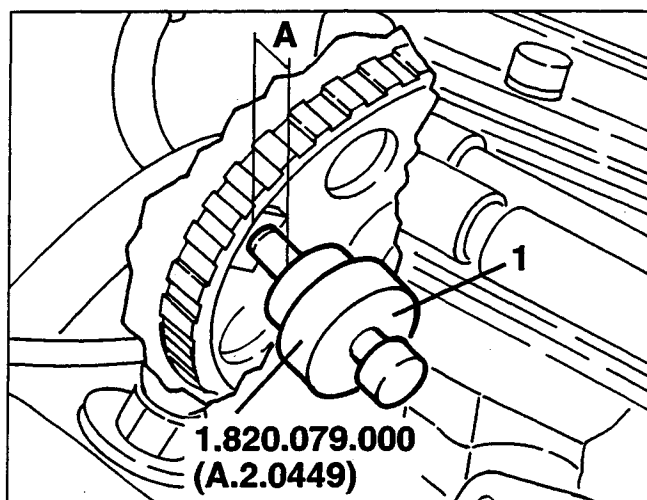


1. Slacken the fastening screw and remove the timing sensor.

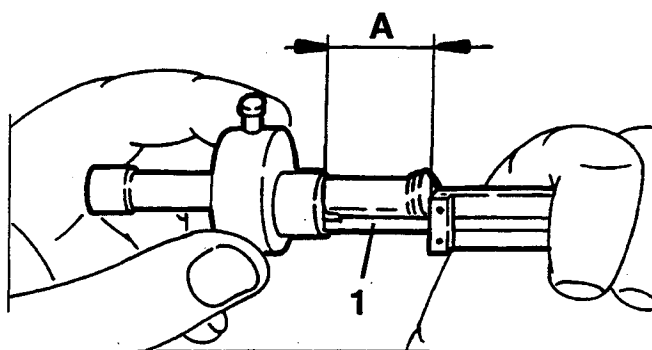


## CHECKING THE GAP

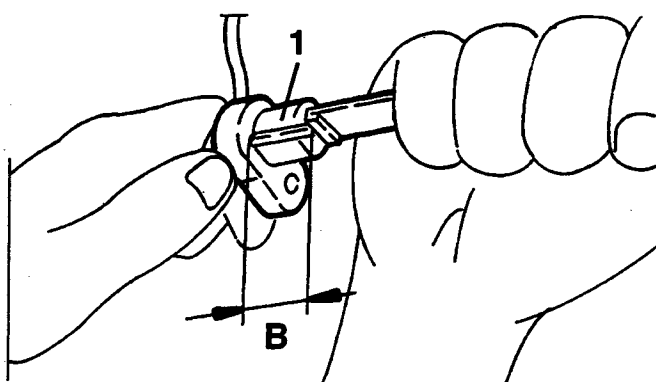
- Remove the timing sensor (see specific procedure).
- 1. Using tool N° 1.820.079.000 (A.2.0449), measure dimension "A".



1. Using a gauge measure dimension "A".



1. Using a gauge measure dimension "B" on the sensor.



- Calculate the timing sensor gap and check that it is within the specified limits.



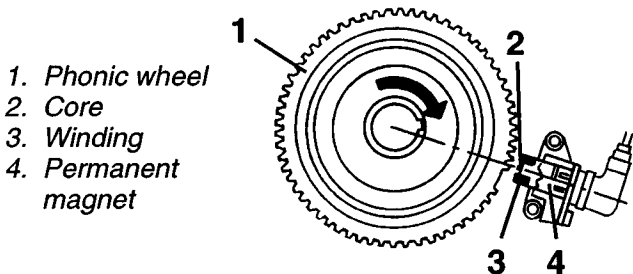
$$A - B = 0.1 \pm 1.5 \text{ mm}$$

## RPM SENSOR AND TIMING SENSOR

The sensor for detecting the rpm and engine timing is of the inductive type which operates through the change of a magnetic field generated by the passage of the teeth of a toothed pulley (phonic wheel) fitted on the flywheel.

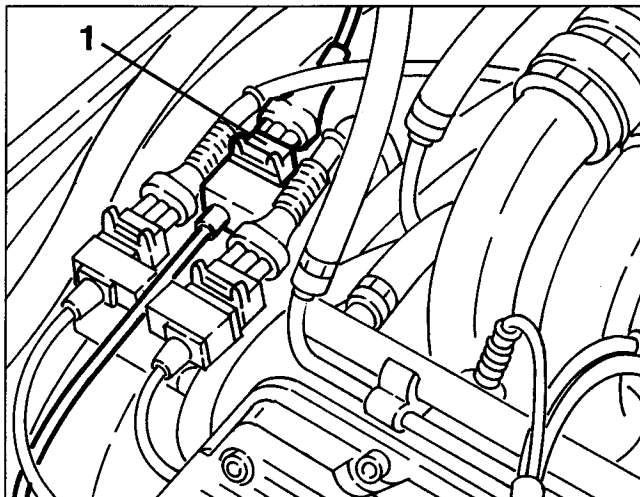
The teeth which pass in front of the magnetic field generator change the gap between the pulley and the sensor; therefore, the dispersed flux, which consequently varies, induces an alternate sinusoidal voltage in the coils of the sensor, the amplitude of which depends on the peripheral speed of the phonic wheel, the gap between the tooth and the sensor, the shape of the teeth, the magnetic characteristics of the sensor and on the support system.

The output signal which varies in relation to the rpm is processed by the control unit to obtain a signal at each passage through zero and a constant rectangular oscillation of amplitude to enable the control of the digital circuits inside the control unit. The interval between the start of one tooth and another is 6° with the exception of the reference mark which is made by eliminating two of the 60 teeth of the pulley. The hollow due to the lack of two teeth gives the control unit a reference point of the crankshaft and each subsequent tooth of the phonic wheel informs the control unit of an increase in its angular position.

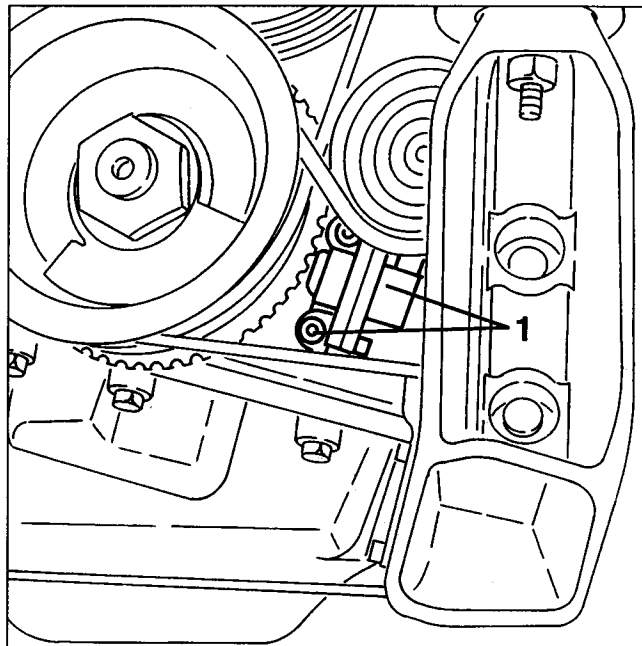


### REMOVAL/REFITTING

1. Disconnect the connection of the rpm and timing sensor.



- Remove the right front wheel and mud flap.
1. Slacken the two fastening screws and remove the rpm and timing sensor complete with support.



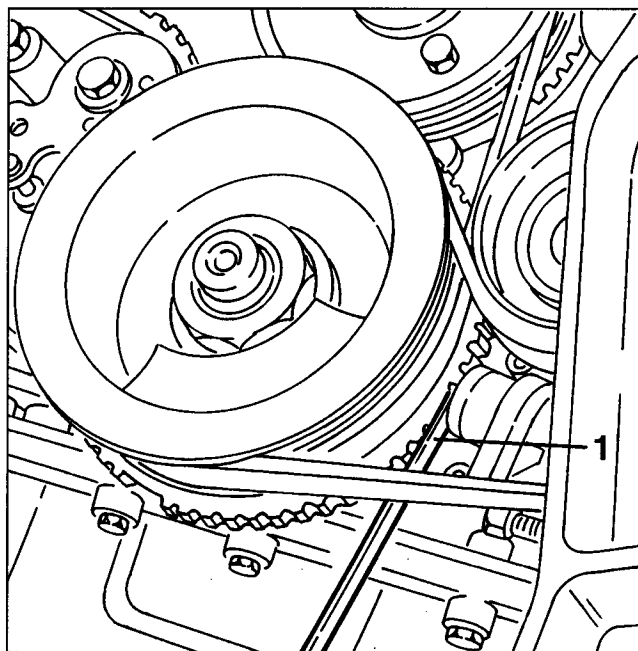
### CHECKING THE GAP

- Remove the right front wheel and dust guard.
1. Using a thickness gauge, check that the gap between the sensor and phonic wheel is between the specified limits.



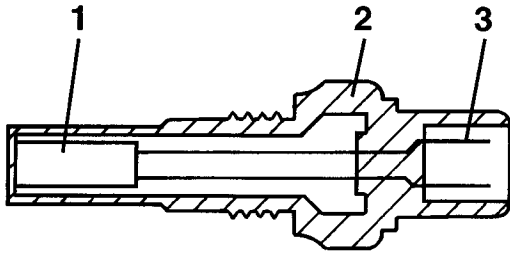
Rpm and timing sensor gap

0.5 + 1.5 mm



## ENGINE COOLANT TEMPERATURE SENSOR (NTC)

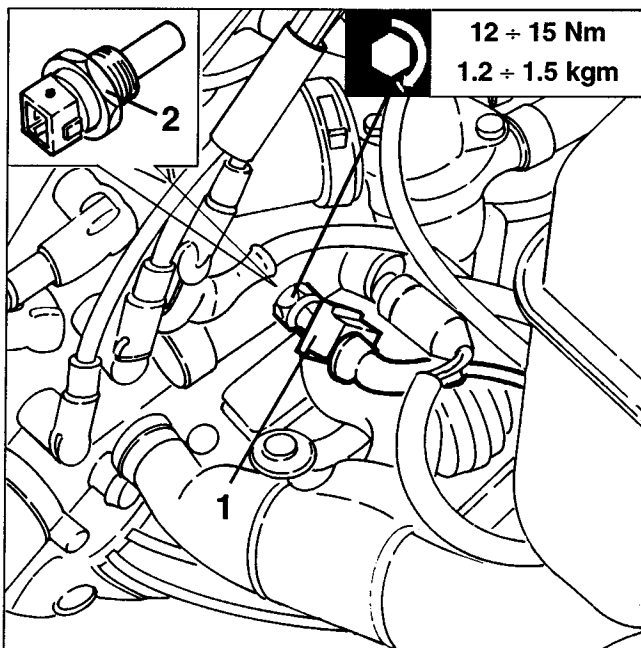
This sensor detects the engine coolant temperature on the thermostatic cup through a thermistor (NTC) with a negative resistance coefficient, i.e. capable of lowering its resistance as the temperature increases. The electric signal obtained reaches the electronic control unit where it is used to correct the air-fuel mixture.



1. NTC resistance
2. Body
3. Connector

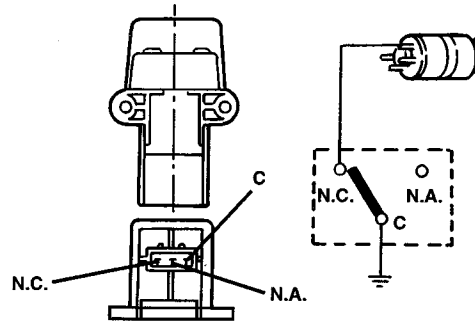
## REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).
- 2. Slacken and remove the engine coolant temperature sensor from the thermostatic cup.



## INERTIAL SWITCH

In the front side of the driver's seat there is a safety switch which is triggered in the case of an impact, cutting off the fuel pump connection to earth, thereby also the supply to the injection system.



A steel ball fitted in a taper housing is normally held in place by the force of attraction of an adjacent magnet.

Under specific acceleration loads the ball releases itself from the magnetic force and gradually moves out of the taper support rising upwards following the angle of the taper.

A quick snap connection is fitted above the ball which forms the normally closed (N.C.) electric circuit.

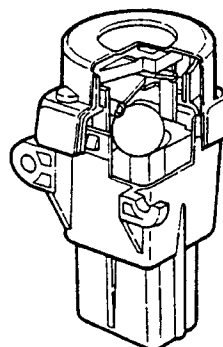
When the mechanism is hit by the ball it changes position, from N.C. circuit to normally open circuit (N.A.), cutting off the fuel pump earth circuit.

In the event of impact in any one of the three orthogonal directions, the switch will be triggered above 12 g peak equivalent to a speed of 25 kph.

The switch can be reset pressing the pushbutton protected by a flexible cover (this also protects against foreign particles which might prevent the switch from operating or reprogramme it).

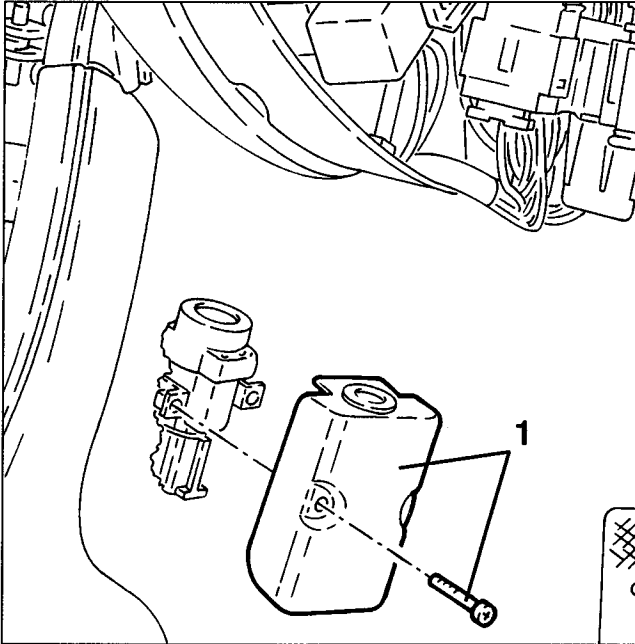
If after even a light crash, there is the smell of petrol or leaks are noted from the fuel supply system, do not reset the switch, but firstly seek the failure and repair it to prevent the hazard of fire.

Conversely, if there are no leaks and the car can be restarted, press the pushbutton to reactivate the fuel pump.

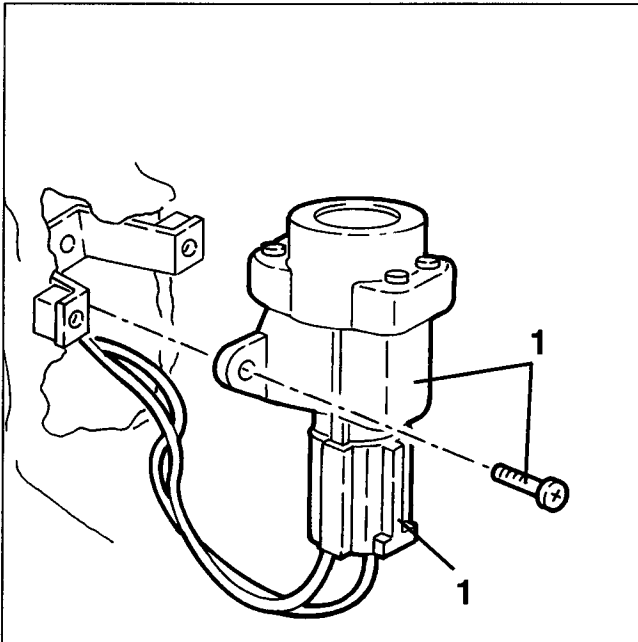


**REMOVAL/REFITTING**

- Disconnect the battery (-) terminal.
- 1. Slacken the two fastening screws and remove the plastic cover protecting the inertial switch.



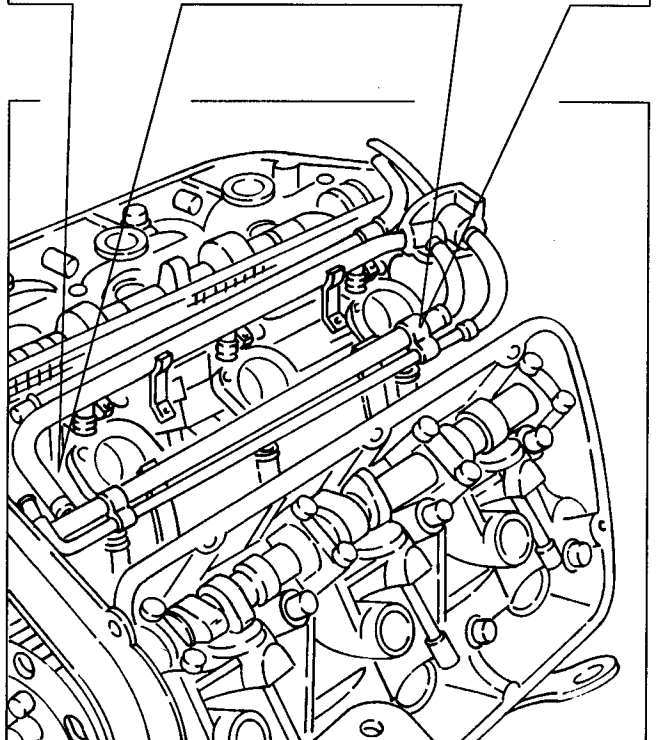
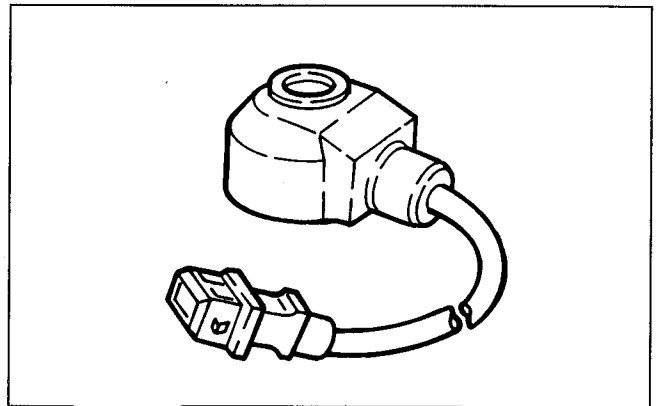
- 1. Slacken the two fastening screws, disconnect the electrical connection and remove the inertial switch.



**KNOCKING SENSORS**

The knocking sensors detect the intensity of the vibrations (pinging) caused by knocking in the combustion chambers.

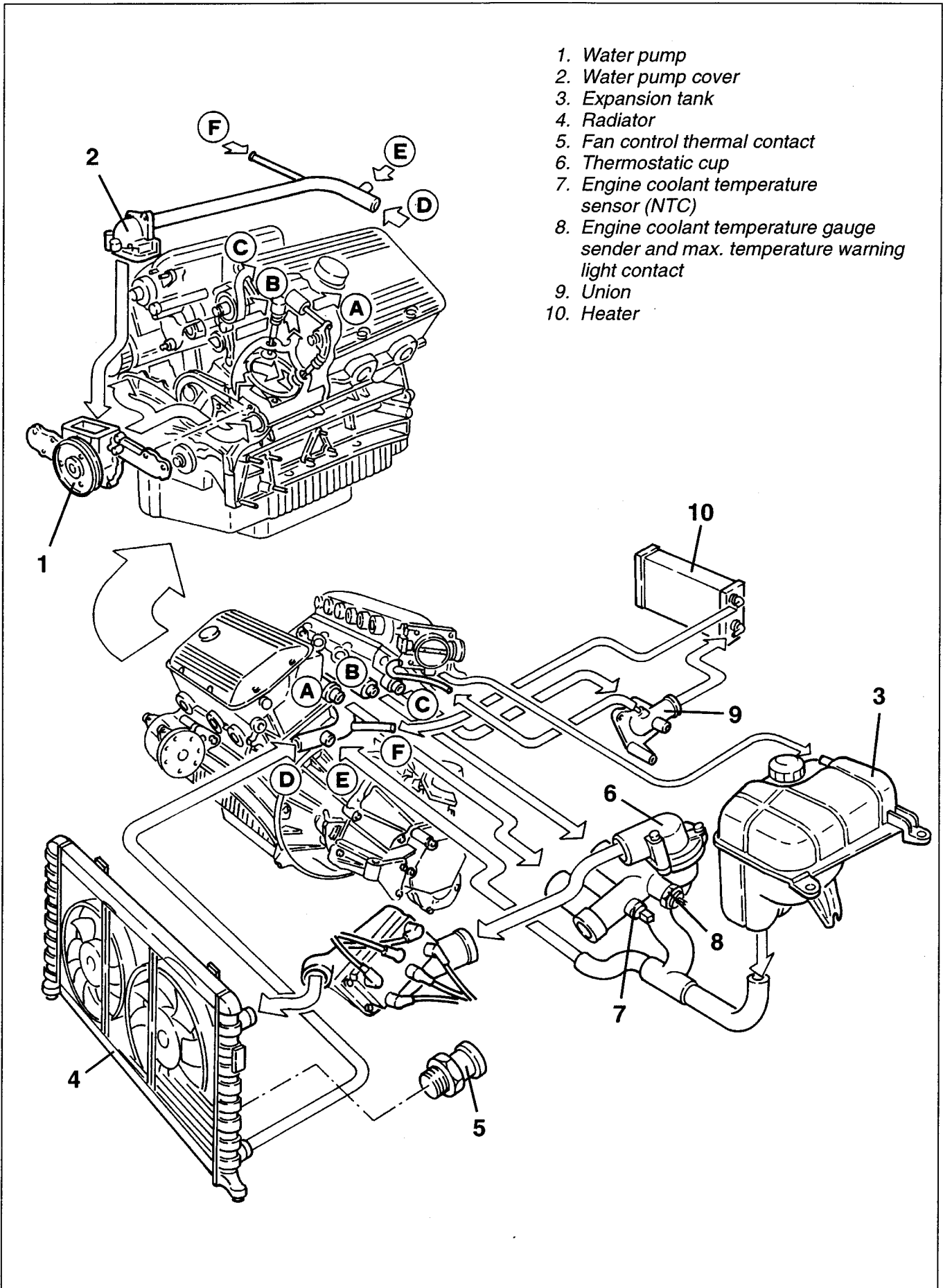
In this condition the control unit increases the amount of fuel and reduces the advance ratings, calculated by a special map, so that pinging is stopped in the shortest time possible: the advance curves are in fact reduced by appr. 2°, then if necessary by another 2° etc., until knocking ceases, after which the normal advance corresponding to the original map is resumed.





## ENGINE COOLING SYSTEM

1. Water pump
2. Water pump cover
3. Expansion tank
4. Radiator
5. Fan control thermal contact
6. Thermostatic cup
7. Engine coolant temperature sensor (NTC)
8. Engine coolant temperature gauge sender and max. temperature warning light contact
9. Union
10. Heater



## DESCRIPTION

The cooling system is of the sealed type with forced circulation by a centrifugal pump (1) operated by the crankshaft through a POLY-V belt.

A thermostatic valve (6) fitted on the rear of the engine keeps the engine temperature at an optimum level: it opens when the coolant reaches a temperature of  $87 \pm 2^\circ\text{C}$ .

The radiator (4) cools the fluid by dynamic air and by two fans with two speeds which are turned on by a thermal contact (5) located on the radiator; two additional resistances and a relay operate the higher fan speed if high temperatures are reached.

The expansion tank (3) tops up the circuit if the level falls and absorbs the changes in the volume of the coolant due to changes in temperature: it also vents air from the circuit.

The circuit also includes a coolant temperature gauge sender (8) and a thermal contact for the maximum temperature warning light which turns on when the coolant temperature exceeds  $115^\circ\text{C}$ .

## OPERATION OF THE CIRCUIT

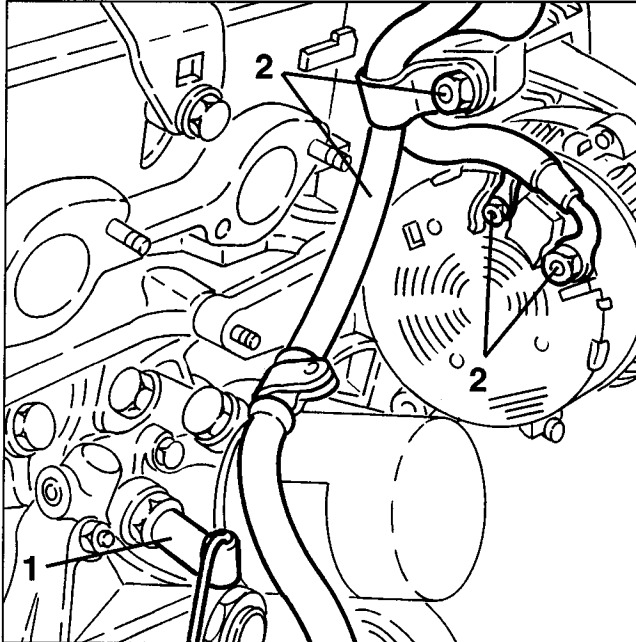
After the fluid has cooled the engine it leaves the cylinder heads and reaches the thermostatic unit (9). From here, if the temperature is below  $87^\circ\text{C}$  it is drawn into the pump (1) through a longitudinal coolant return manifold located between the two cylinder heads. Conversely, if the temperature exceeds this value, the fluid is directed to the radiator (4) through the opening in the thermostat, also heating the ignition coils through a special support.

After being cooled in the radiator, the fluid returns, still through the longitudinal manifold, to the pump which directs it to the engine.

A special union on the right-hand cylinder head receives the coolant from an additional groove on the head and sends it through two special pipes to the heater (10) of the climate control system and to the throttle body to warm it.

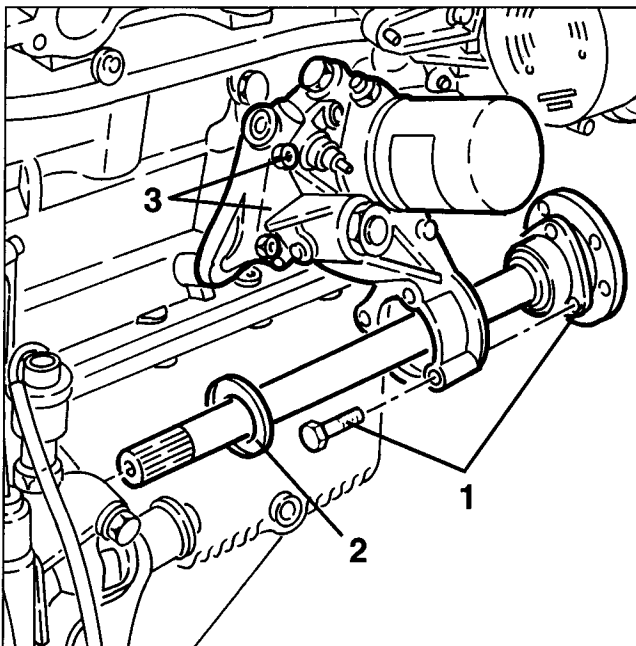
The latter is connected to the expansion tank (3) via a special pipe which in addition to returning the coolant fluid also vents air from the system.

1. Disconnect the electrical connection from the minimum engine oil pressure sensor.
2. Disconnect the electrical connections from the alternator, then remove the electric wiring after freeing from the fasteners.

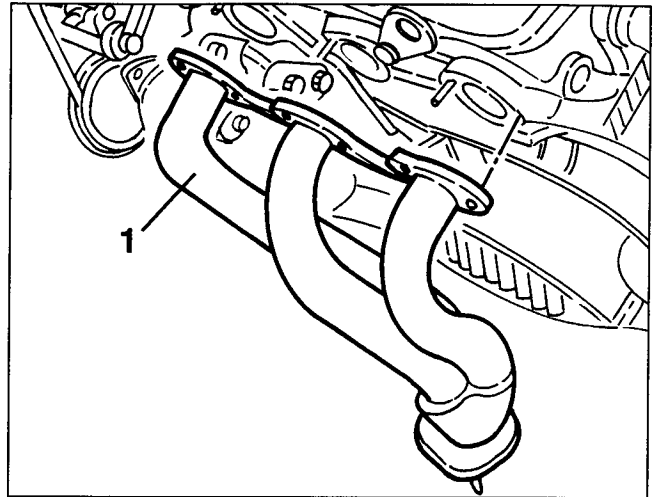


- Drain the gearbox-differential oil.

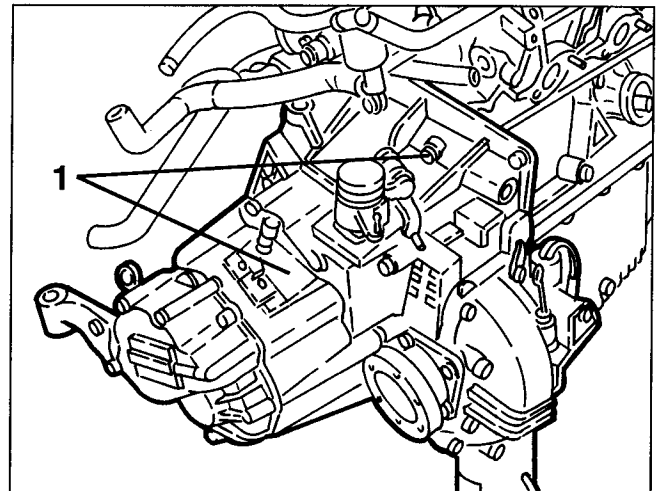
  1. Slacken the three fastening screws and withdraw the intermediate shaft.
  2. Remove the dust guard ring.
  3. Slacken the screws and fastening nuts and remove the oil filter support complete.



1. Slacken the fastening nuts and remove the left-hand exhaust manifold.
- Remove the corresponding seals.



1. Slacken the screws and fastening nuts and, using a hydraulic hoist, remove the gearbox-differential unit.



## REFITTING

- Reverse the sequence followed for removing operations adhering to the following instructions:
- Prepare the engine compartment to receive the power unit assembly, positioning all the electrical cables, pipes, etc. so that they do not interfere with assembly operations.
  - Take due care when refitting the power unit to avoid damaging the single components.

### WARNING:

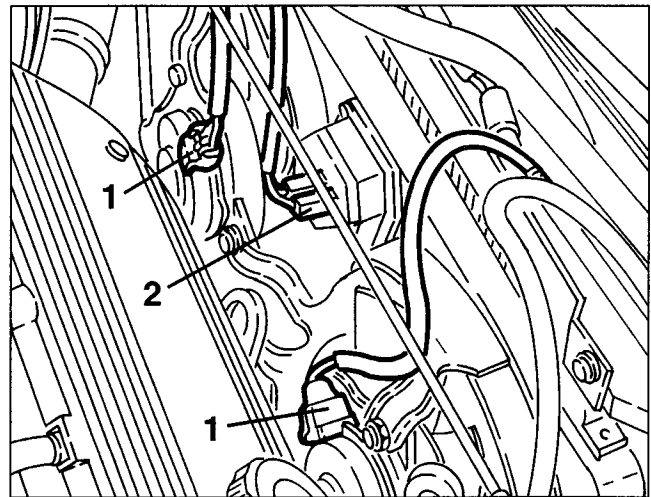
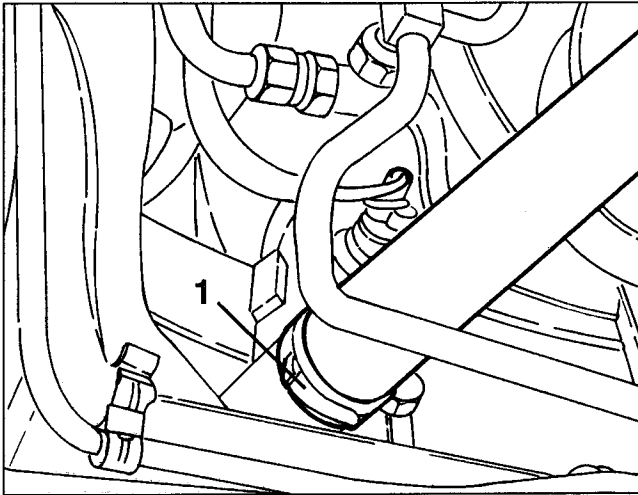
**Make sure that the support points of the power unit have been fastened correctly.**

- Upon completion of assembly operations, check that the belts are tensioned correctly, refill the various systems as specified (see GROUP 00).
- Carry out all the necessary checks and adjustments (see GROUP 00).

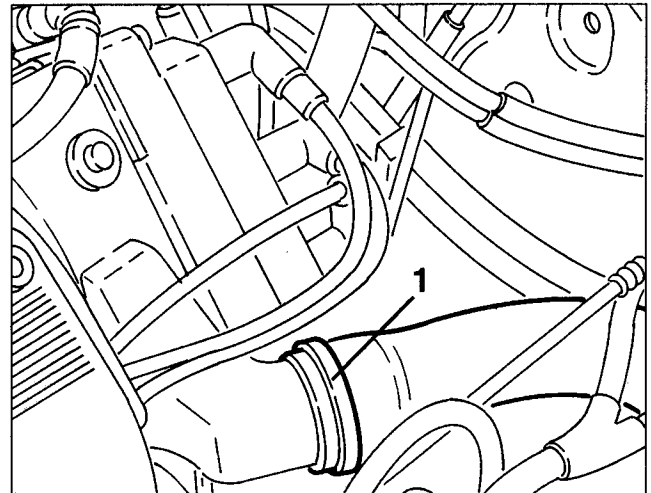
## CYLINDER HEADS

### REMOVAL/REFITTING RIGHT HAND CYLINDER HEAD

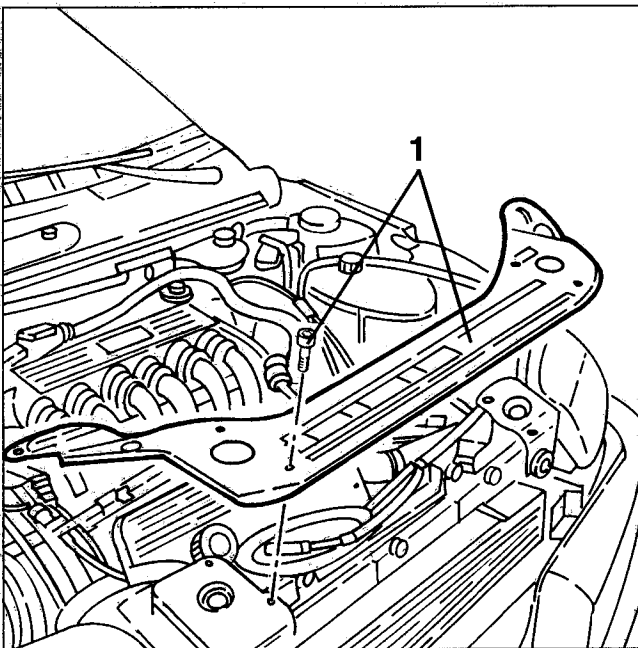
- Set the car on a lift.
  - Disconnect the battery (-) terminal.
  - Remove the right front wheel and mud flaps.
1. Raise the car and drain the coolant fluid disconnecting the radiator outlet sleeve.



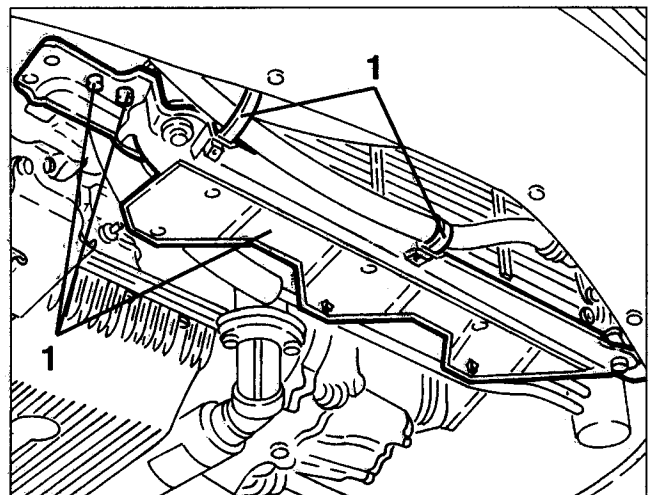
1. Disconnect the coolant delivery sleeve to the radiator from the ignition coils support.



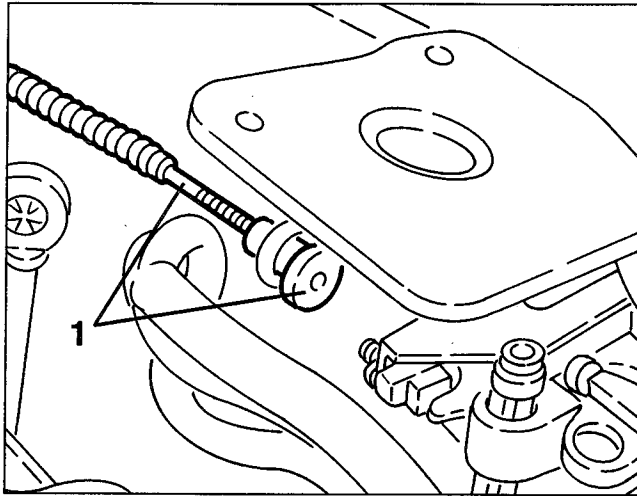
1. Slacken the four fastening screws, lower the lower radiator crossmember just enough to remove the two clamps supporting the engine oil delivery-return pipes to the radiator, then remove it after freeing it from the conditioner pipes.



1. Disconnect the electrical connections from the cooling fans.  
2. Disconnect the electrical connections from the fan speed coil.

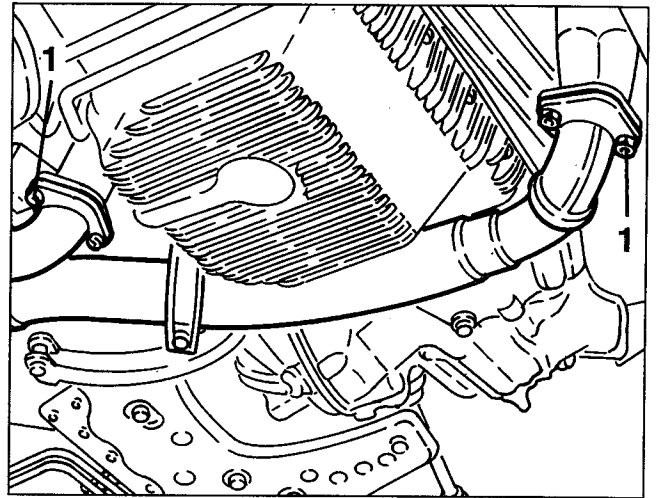


1. Disconnect the bonnet opening cable from the locks.

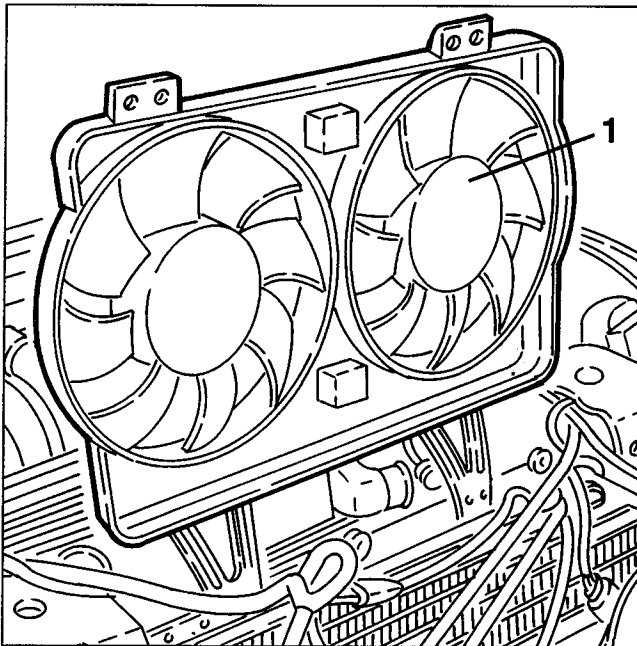


- Working from under the car remove the power steering pump (see GROUP 41).

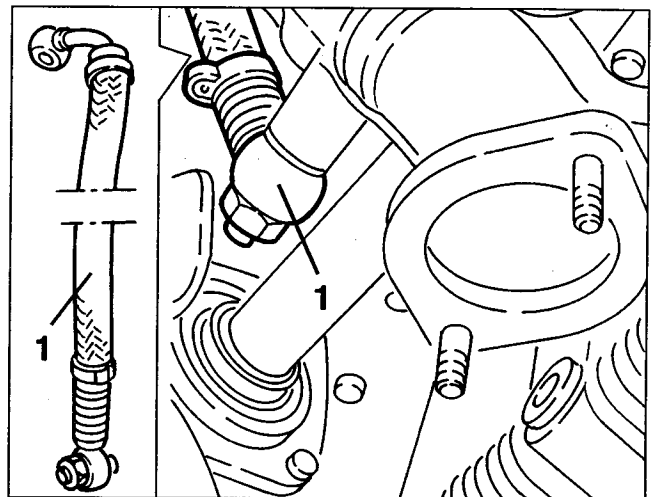
1. Disconnect the front section of the exhaust pipe from the corresponding manifolds.



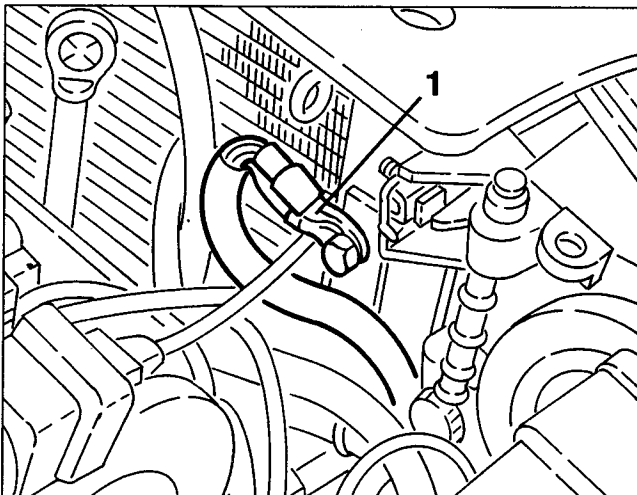
1. Slacken the fastening screws and remove the cooling fans.



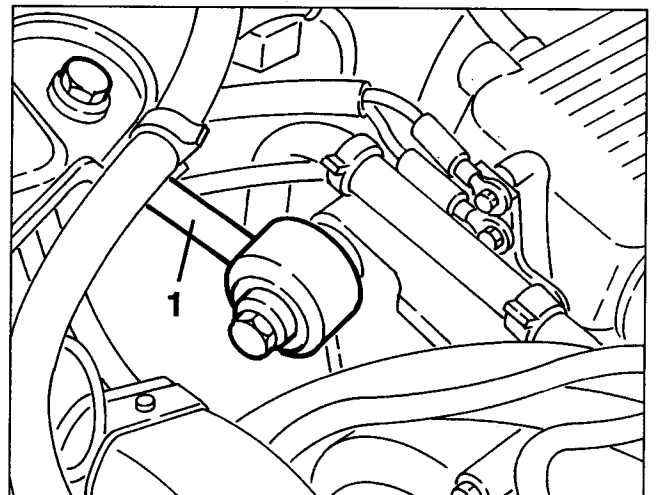
1. Disconnect the connections of the exhaust gas takeoff pipe for the E.G.R. valve, then remove it.



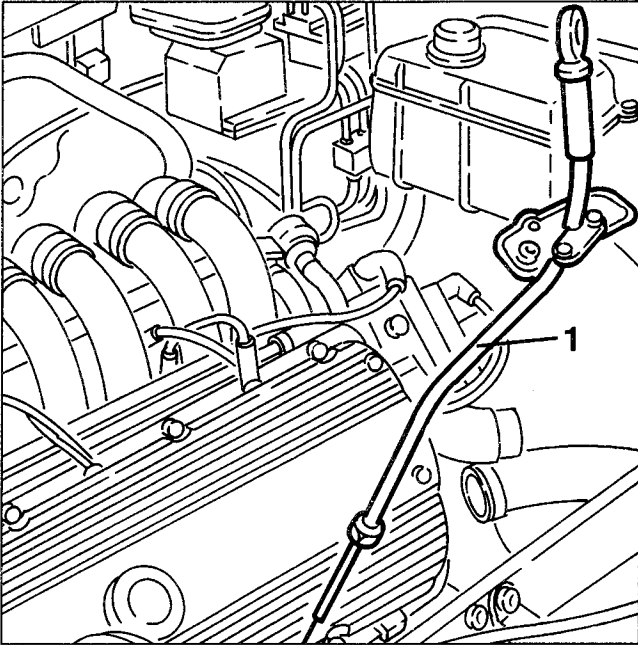
1. Disconnect the earth cables from the body.



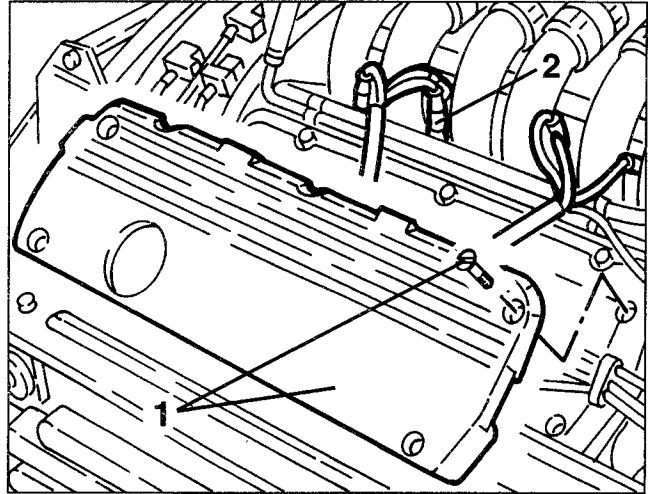
1. Remove the engine stay rod and corresponding support.



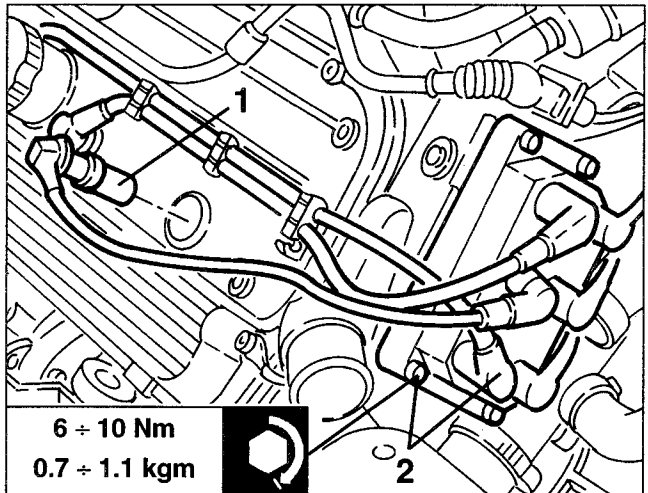
- Remove the corrugated sleeve complete with air cleaner cover proceeding as described in "Removing the Engine".
- Remove the intake box (see specific paragraph).
- 1. Remove the engine oil dipstick complete with guide.



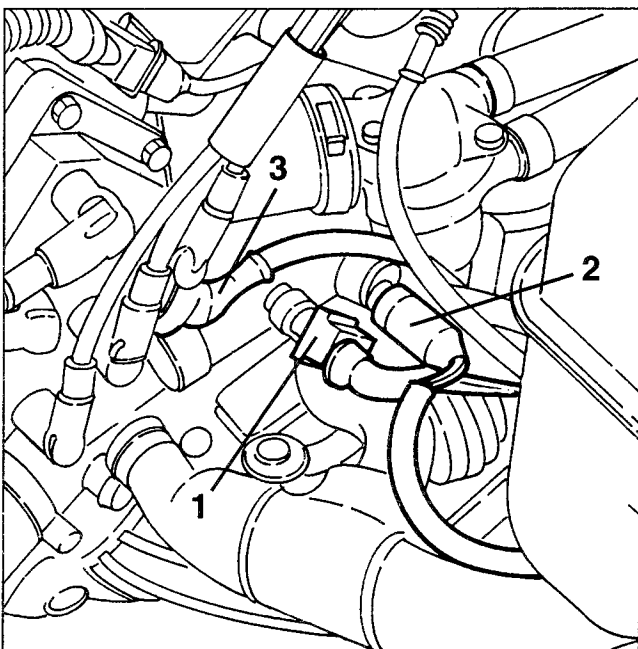
- 2. Disconnect the electrical connections from the electroinjectors.



- 1. Disconnect the high voltage cables from the spark plugs.
- 2. Slacken the fastening screws and remove the ignition coils complete with spark plug cables.

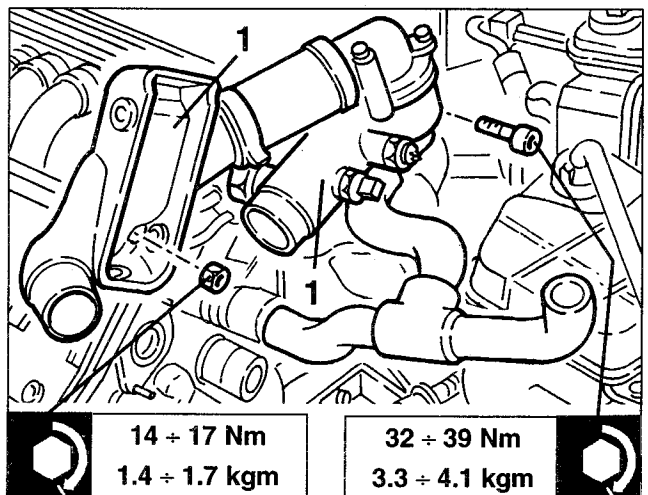


- 1. Disconnect the electrical connection from the coolant fluid temperature sensor (NTC).
- 2. Disconnect the electrical connection from the coolant temperature gauge transmitter and max. temperature warning light contact.
- 3. Disconnect the electrical connection from the ignition coils.

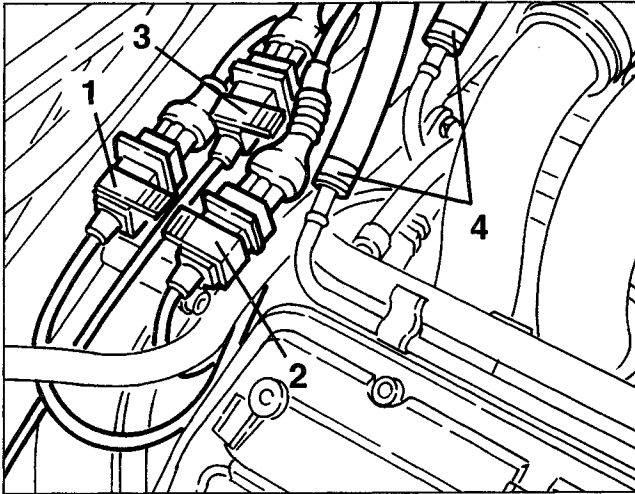


- 1. Slacken the four fastening screws and remove the left hand cylinder head.

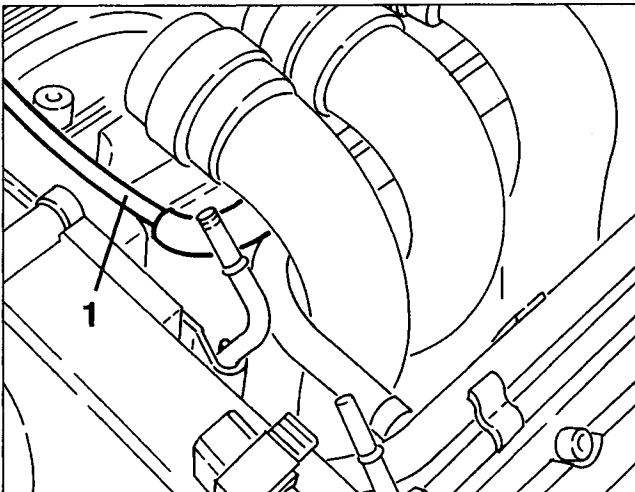
- 1. Disconnect the engine cooling pipes involved, slacken the fastening screws, then remove the thermostat cup complete with ignition coils support and sleeves.



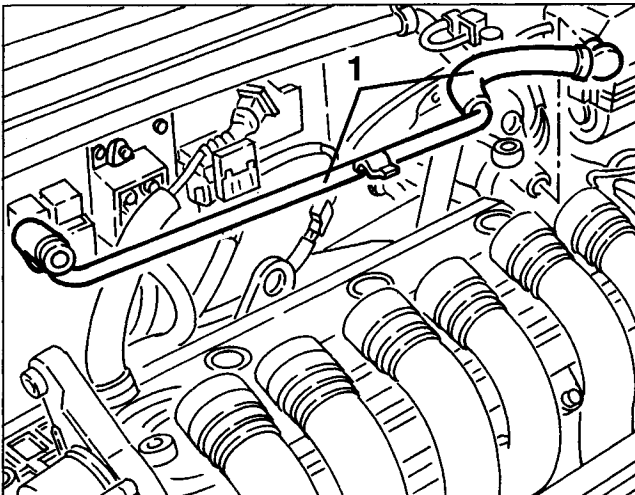
1. Disconnect the timing sensor connection.
2. Disconnect the pinging sensor connection.
3. Disconnect the rpm and timing sensor connection, then move the wiring to one side.
4. Disconnect the fuel delivery and return pipes from the distributor manifold.



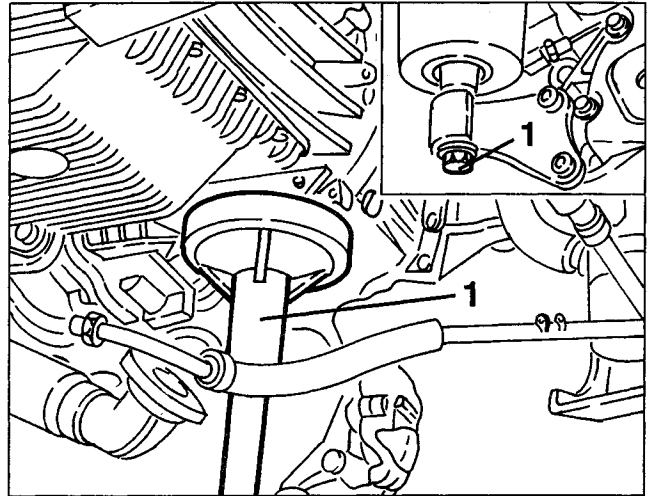
1. Disconnect the fuel vapour recirculation pipe.



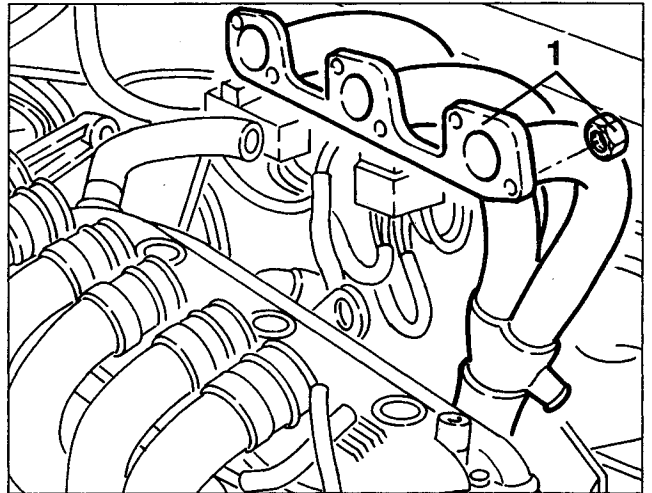
1. Disconnect and remove the servobrake vacuum takeoff pipe.



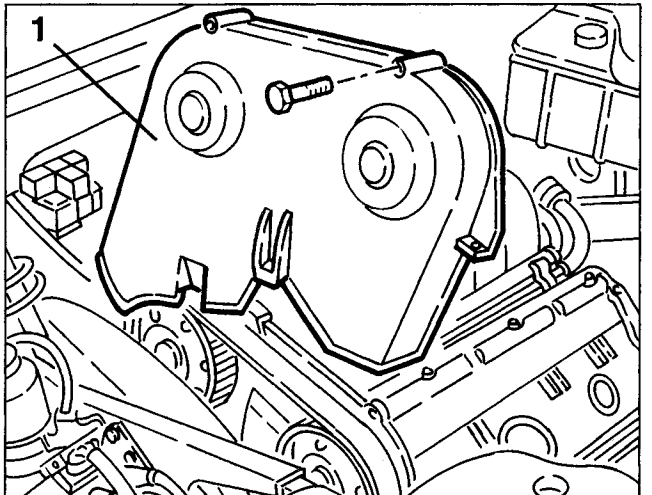
1. Set a hydraulic jack under the gearbox, then slacken the power unit support fastening screw on the gearbox side.



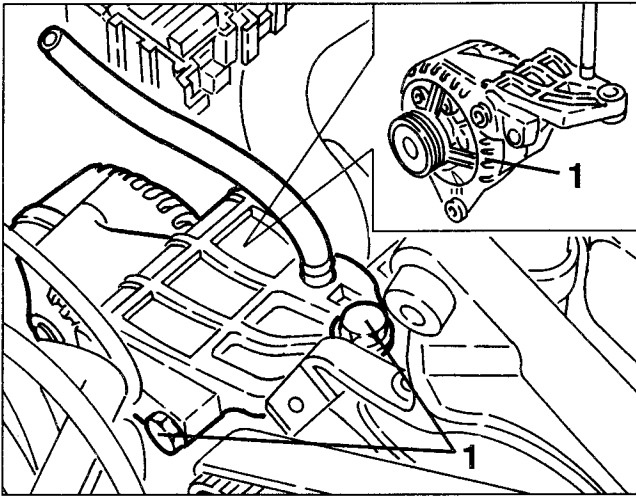
1. Lower the power unit just enough to slacken the fastening nuts and remove the right hand exhaust manifold.
- Retrieve the seals.



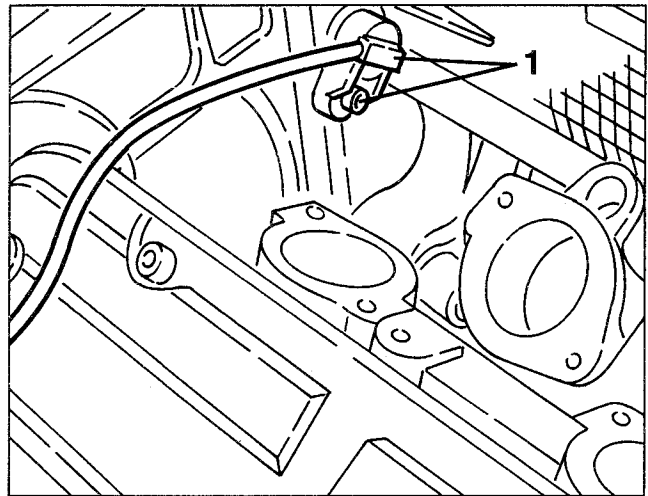
1. Slacken the fastening screws and remove the timing belt cover.



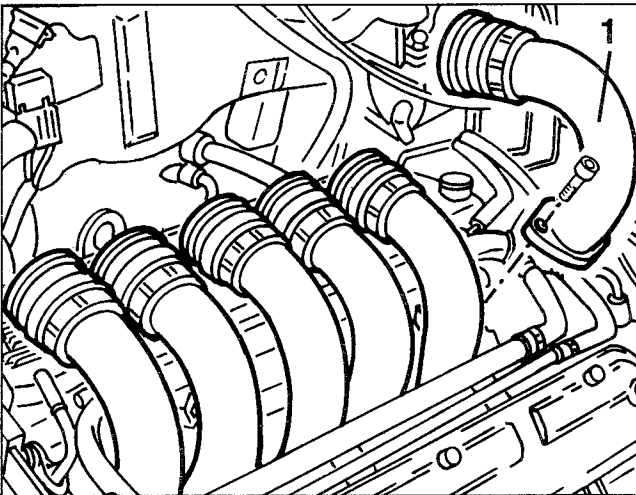
1. Slacken the screws fastening the alternator and upper support bracket, remove the drive belt and from above, remove the alternator complete with bracket.



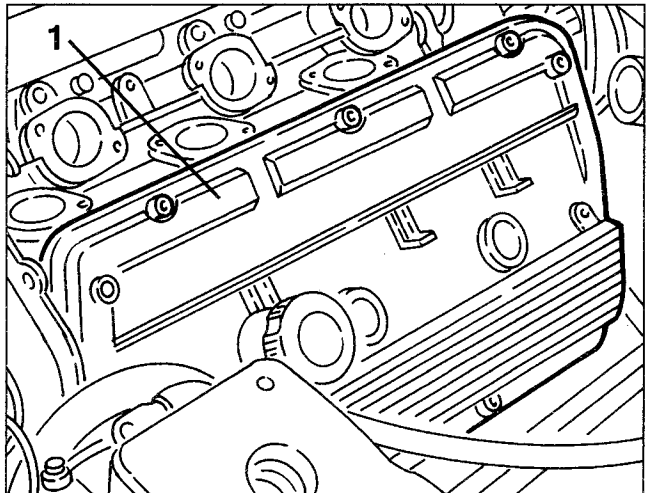
1. Slacken the fastening screw and remove the timing sensor from the right hand cylinder head.



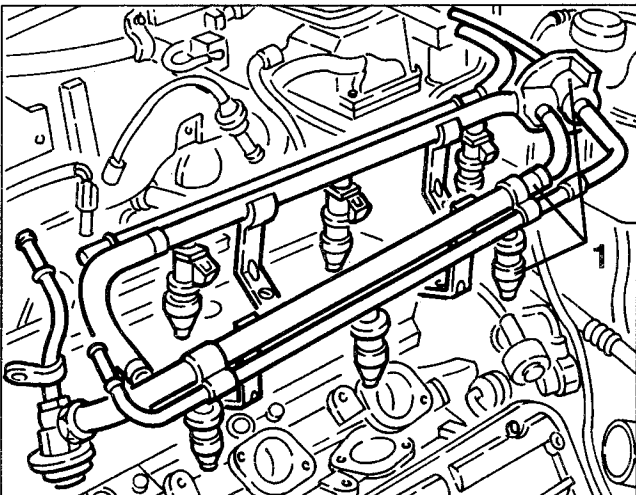
1. Slacken the fastening screws and remove the intake ducts.



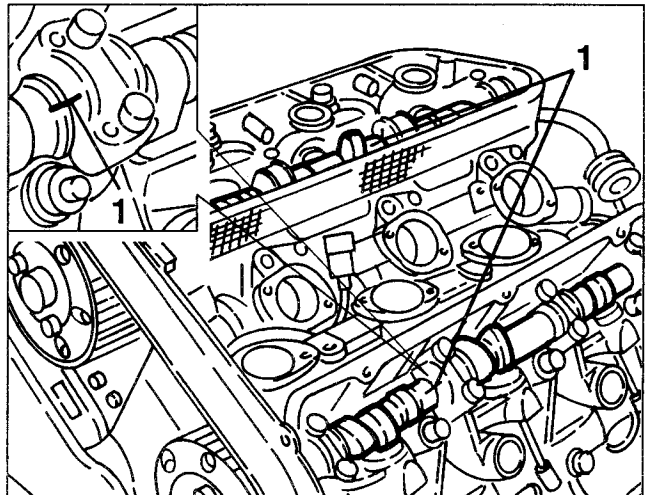
1. Slacken the fastening screws and remove the timing gear covers from the cylinder heads.



1. Slacken the fastening screws and remove the fuel distributor manifold complete with electroinjectors, pressure regulator and pulse damper.

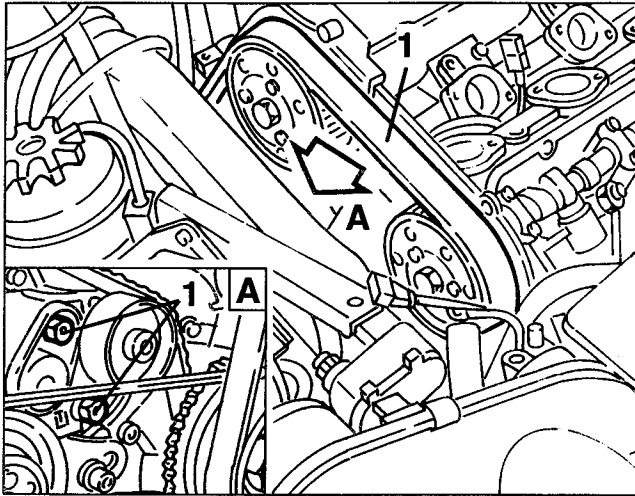


1. Turn the crankshaft until the notches on the camshafts coincide with those on the corresponding caps.

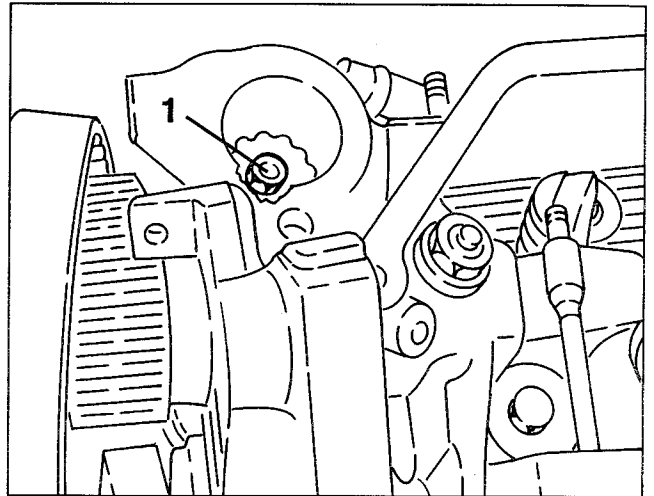




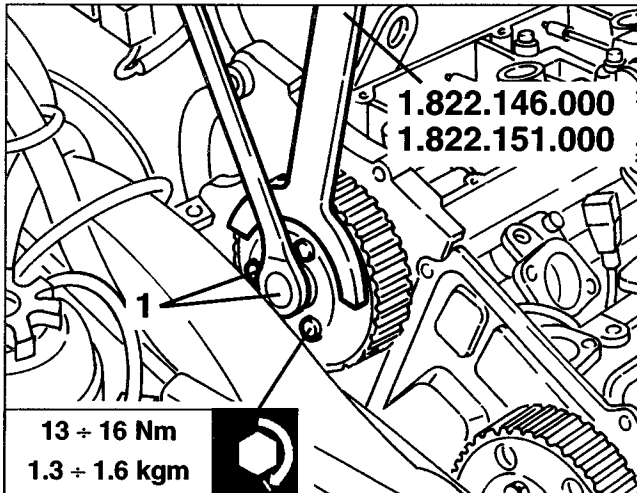
1. Slacken the two nuts fastening the timing belt tensioner, then remove the belt.



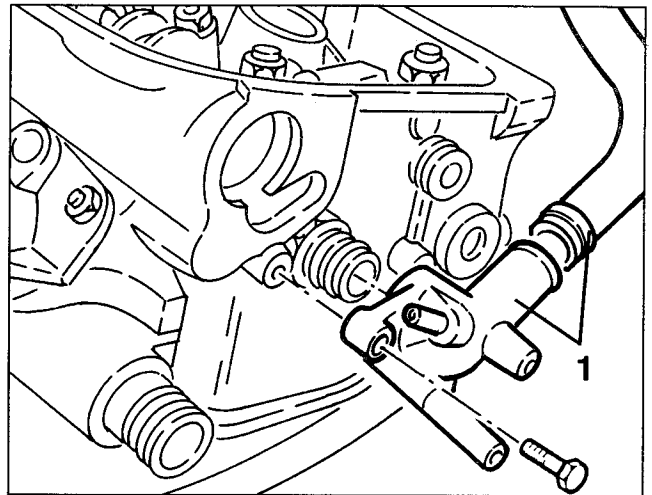
1. Slacken the nut fastening the intermediate oil pump driving gear.



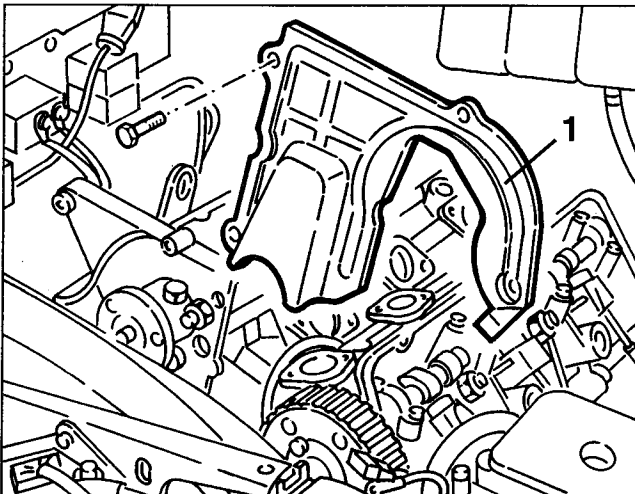
1. Levering with tool no. 1.822.146.000 and no. 1.822.151.000, slacken the nut and the three screws fastening the right-hand timing gear drive pulley, then remove it.



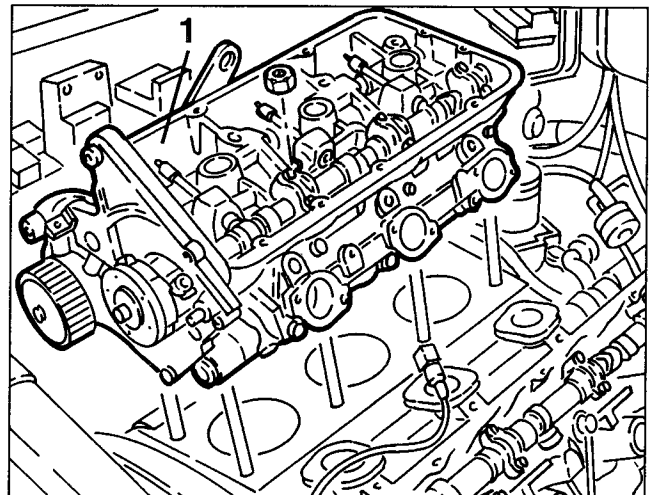
1. Disconnect the coolant delivery pipe to the radiator from the connection on the right hand cylinder head and remove it.



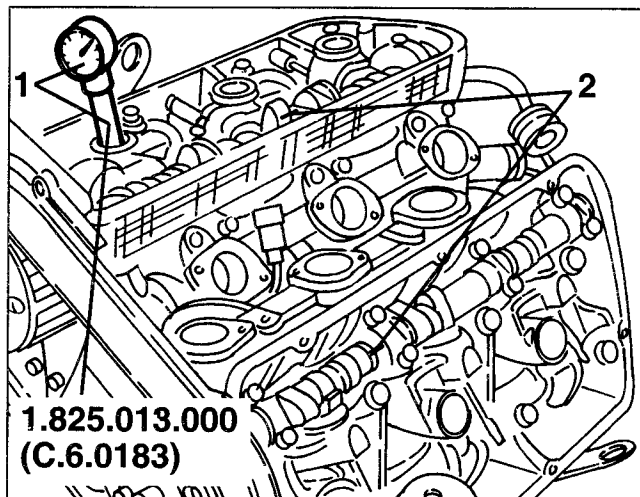
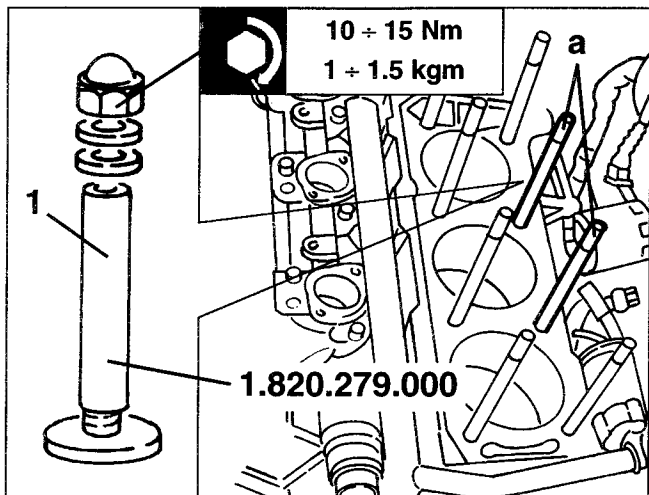
1. Slacken the fastening screws and remove the rear timing belt cover.



1. Slacken the fastening nuts and remove the right hand cylinder head.  
- Remove the corresponding seal.



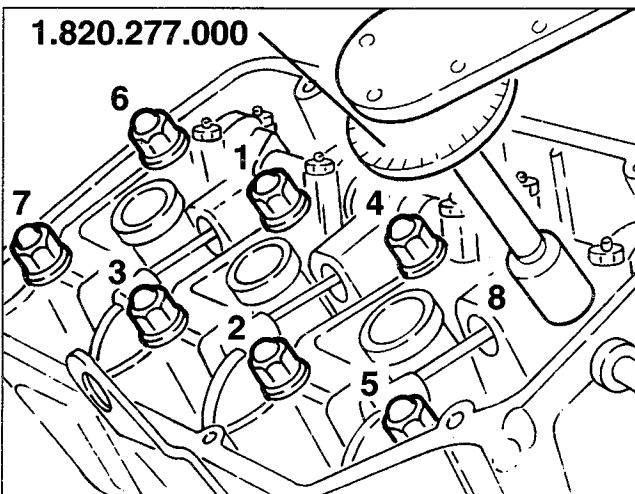
1. Install the cylinder liner stopper tools no. 1.820.279.000 on studs "a".



### PRECAUTIONS FOR REFITTING

Reversing the sequence described for removal, adhere to the following instructions.

- Assemble the right hand cylinder head with the timing references aligned.
- Tighten the cylinder head fastening screws as described below and bearing in mind that, for each step, the tightening sequence is the one illustrated.



| Tightening procedure                         |           |
|--|-----------|
| Set in all the screws to a torque of:        | 25 Nm     |
| Complete tightening with a further angle of: | 230° ± 2° |

- Using tool no. 1.825.013.000 (C.6.0183) fitted with dial gauge turn the crankshaft until the piston of the first cylinder reaches the T.D.C. in the bursting stroke.
- Check that the notches on the camshafts are aligned with those on the corresponding caps.

1. Position the timing belt tensioner so that stud "a" is as illustrated, then completely tighten the two fastening nuts locking them lightly.

- Fit the timing belt on the corresponding pulleys starting from the driving pulley, then continue counter-clockwise.

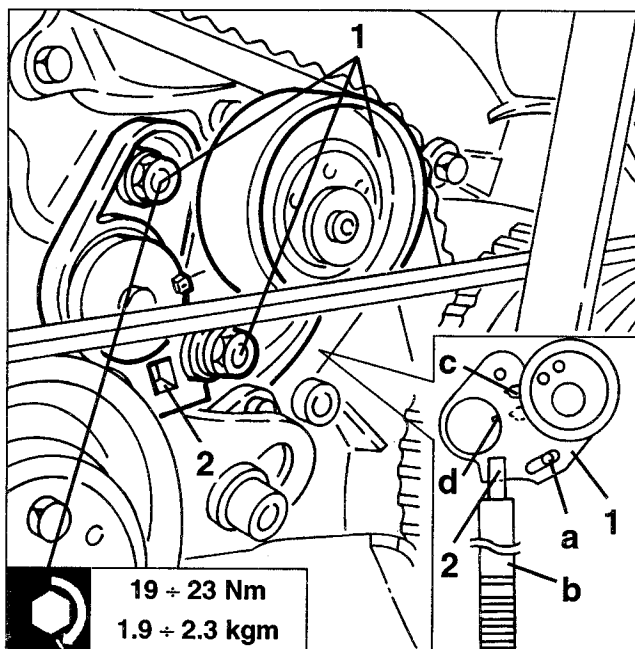
- Slacken the two belt tensioner fastening nuts.

2. Insert the 10mm square of tensioning lever "b" (3/8" ratchet) in the square hole of the belt tensioner, then turn it counter-clockwise so that the dial "c" moves by 2-3 mm with respect to notch "d", then turn clockwise until they coincide; tighten the two belt tensioner fastening nuts without locking them.

- Turn the crankshaft twice until the piston of cylinder no. 1 reaches the T.D.C.

- Check that dial "c" coincides with the centre notch "d" and tighten the two belt tensioner fastening nuts to the specified torque.

- Remove the tensioning lever "b" from the belt tensioner.

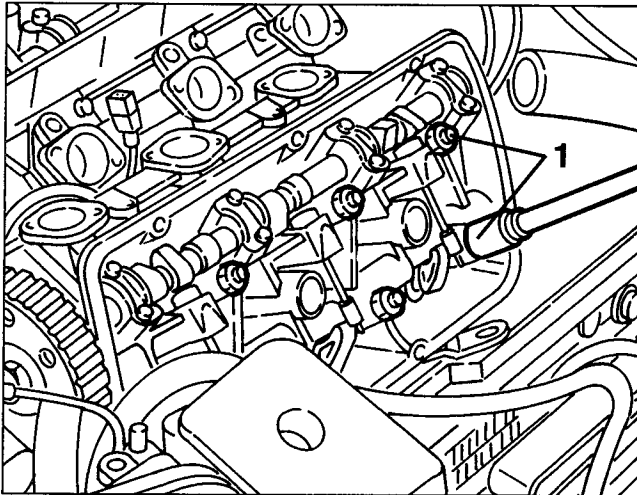


**REMOVAL/REFITTING  
LEFT HAND CYLINDER HEAD**

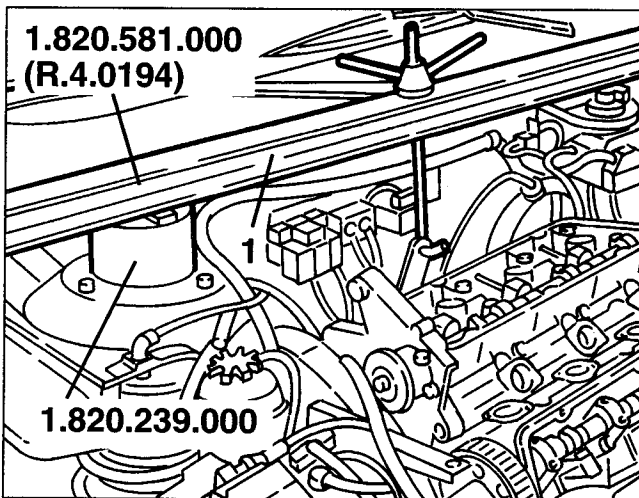
Proceed as described for removing and refitting the right hand head, with the following differences.

- Do not remove the E.G.R. exhaust gas takeoff pipe.
- Do not remove the servobrake vacuum pipe.
- The left hand exhaust manifold is to be removed instead of the right hand one, therefore it is not necessary to lower the power unit.
- Do not remove the alternator.
- Do not remove the timing sensor.
- Do not slacken the intermediate oil pump driving gear fastening nut.
- Do not remove the coolant connection from the right hand cylinder head.

1. Slacken the nuts fastening the left hand cylinder head.



1. Install cross rail no. 1.820.581.000 (R.4.0194) complete with supports no. 1.820.239.000 to support the power unit



- Remove the front suspension crossmember (see GROUP 44).

- Lower the power unit using the centre tie-rod of the support crossrail just enough to withdraw the left hand cylinder head from its studs.
- Install cylinder liner stopper tools no. 1.820.279.000.

**WARNING:**

**While waiting to refit the cylinder head, move the power unit to its initial position restoring the rear fastening.**

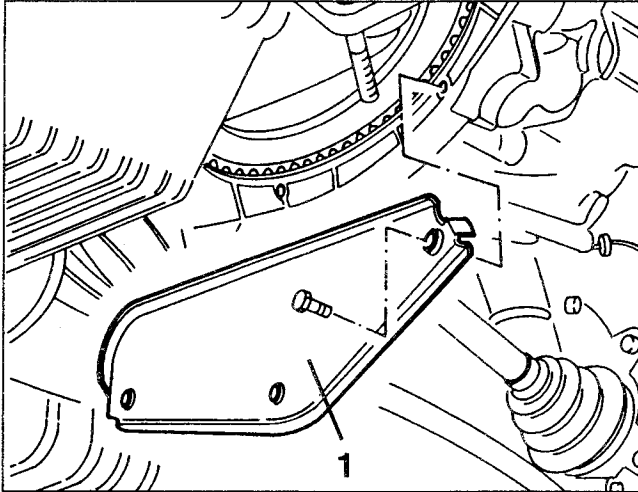
**PRECAUTIONS FOR REFITTING**

Rfit the left hand cylinder head as described for the right hand cylinder head.

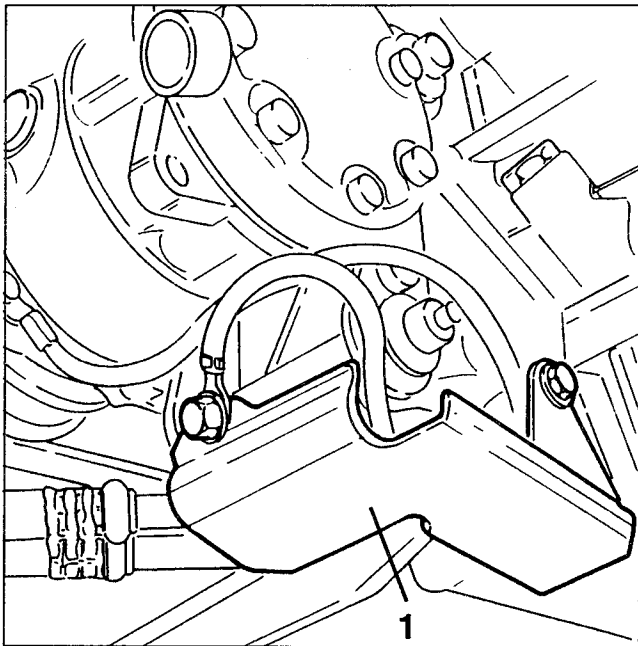
## OIL SUMP

### REMOVAL/REFITTING

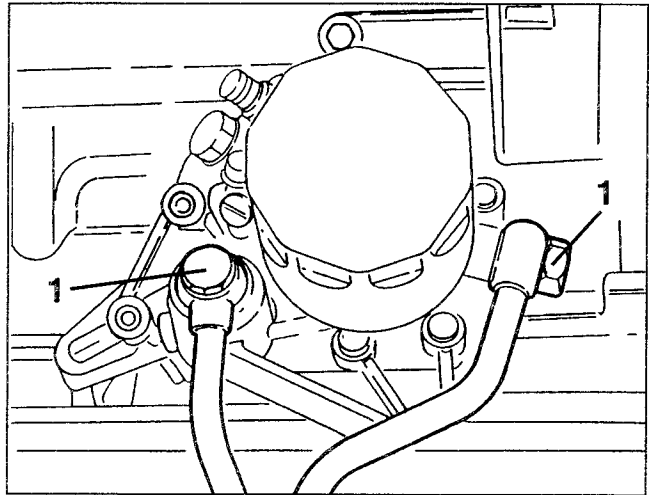
- Set the car on a lift.
  - Disconnect the battery (-) cable.
  - Raise the car and drain the engine oil (see GROUP 00).
  - Remove the front section of the exhaust pipe.
1. Slacken the fastening screws and remove the flywheel cover.



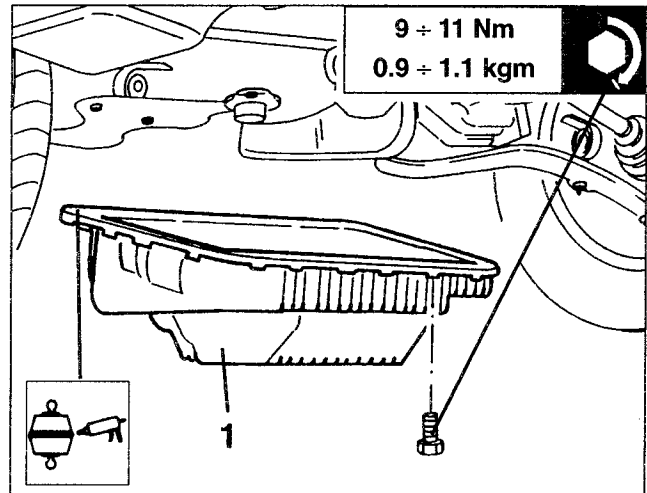
1. Remove the engine oil delivery and return pipes support bracket.



1. Disconnect the two oil delivery and return connections from the oil filter support, then leaving them connected to the radiator, fasten them at the side so that they do not hinder the removal of the oil sump.



1. Slacken the fastening screws and remove the oil sump.



**INDEX****CLUTCH SYSTEM**

- Description . . . . . 1
- Clutch plate and pressure plate . . . . . 2
  - Removal/refitting . . . . . 2
  - Checks and inspections . . . . . 3

**CLUTCH CONTROL**

- Clutch pump . . . . . 4
  - Removal/refitting . . . . . 4
  - Dis-assembly/reassembly . . . . . 4
- Clutch control pedal . . . . . 5
  - Removal/refitting . . . . . 5
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  - Removal / refitting  
(6-cylinder engine) . . . . . 5
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  - Dis-assembly/reassembly . . . . . 6
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- Minimum brake-clutch fluid level sensor . . . . 7
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**CLUTCH SYSTEM****DESCRIPTION**

The clutch adopted is single-plate, dry with diaphragm pressure plate.

The clutch is disengaged by a hydraulic device comprising a reservoir (1) shared with the braking system, a pump (2) fastened to the pedal unit, a control cylinder (3) fastened to the gearbox cover and a thrust bearing (4).

The pump, operated by the pedal, transmits the fluid pressure increase to the control cylinder piston through the special pipe.

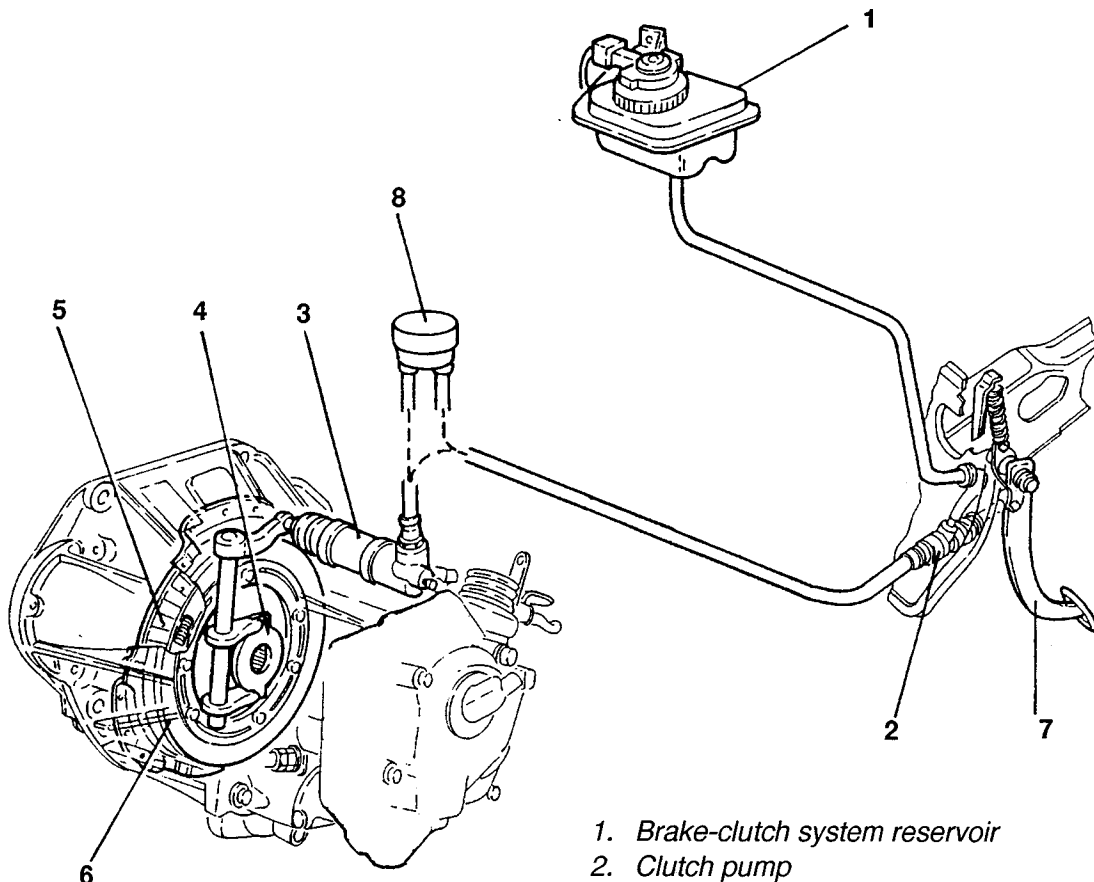
Through a prod, the piston acts on the lever and transmits the control to the fork which moves the thrust bearing overcoming the action of the diaphragm pressure plate.

In addition to reducing the effort required on the pedal, the adoption of the hydraulic clutch release device makes it possible to obtain:

- increased reliability in relation to the conventional, mechanical solution.

- improved smoothness due to the damping of the hydraulic system during disengagement which avoids jerking, particularly when the transmitted torque is high.
- greater operating precision as this device permits constant adjustment of the height of the clutch pedal.
- increased driving comfort as a result of the reduction of the level of vibrations transmitted from the engine, due to the damping effect of the oil.

In order to meet the current laws concerning environmental pollution problems, ecological material (asbestos free) material has been used for the friction linings. For the six cylinder version a damper has been fitted on the hydraulic control circuit to graduate its action.



1. Brake-clutch system reservoir
2. Clutch pump
3. Clutch control cylinder
4. Thrust bearing
5. Clutch plate
6. Pressure plate
7. Clutch pedal
8. Damper

## CLUTCH PLATE AND PRESSURE PLATE

### REMOVAL/REFITTING

– Remove the differential-gearbox unit (see GROUP 21).

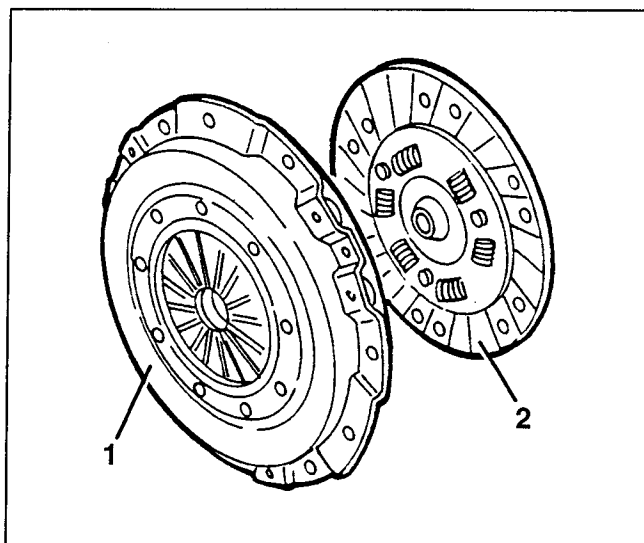
– When replacing only the clutch plate, mark the corresponding positions between the pressure plate and flywheel to simplify refitting operation.

1. Install flywheel stopper tool no. 1.820.228.000.

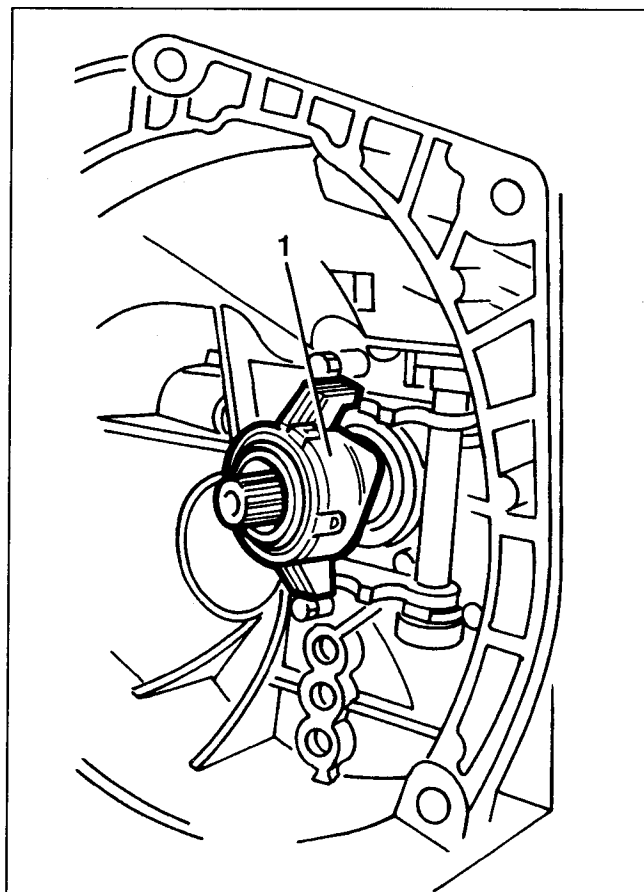
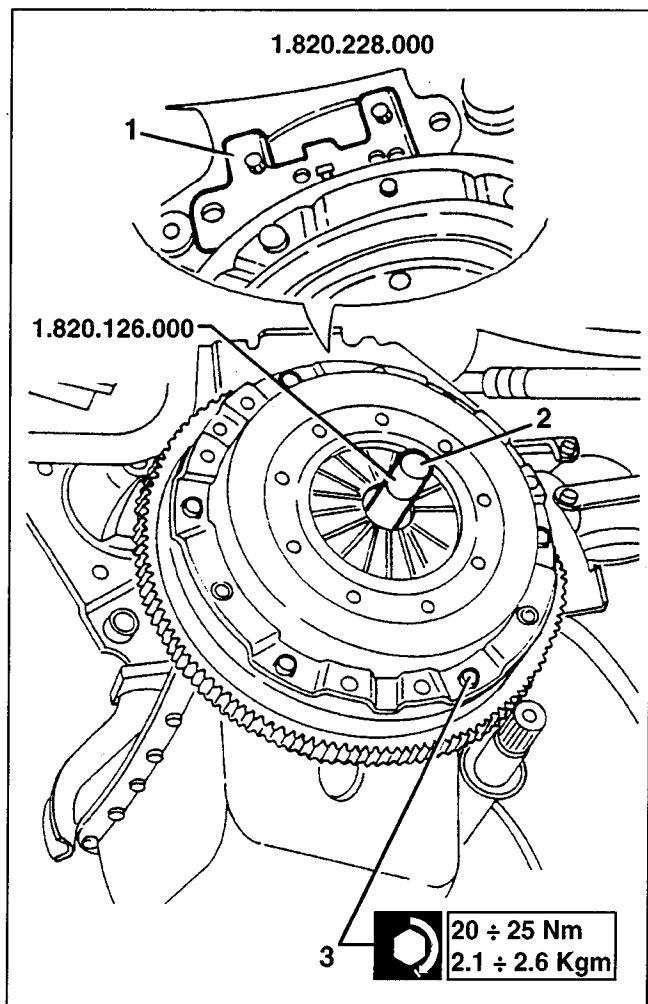
2. Install tool no. 1.820.126.000 in the clutch plate hub.

3. Slacken the screws fastening the pressure plate to the flywheel.

1. Remove the pressure plate.
2. Remove the clutch plate.



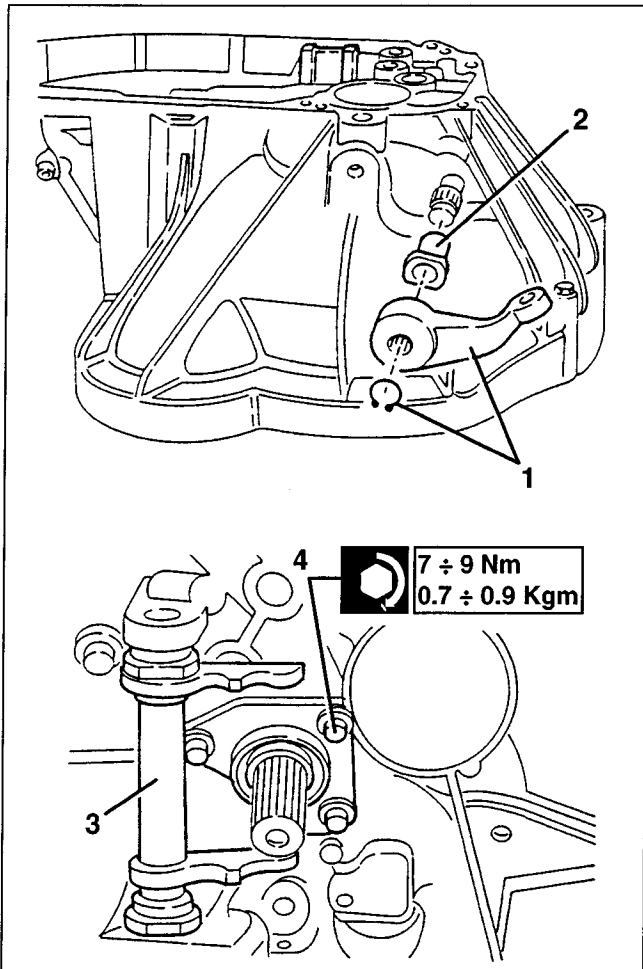
1. Withdraw the thrust bearing from its sleeve in the gearbox cover.



When refitting the bearing it must not stick or turn noisily, otherwise it must be replaced.

– Only if necessary:

1. Remove the seeger locking and withdraw the clutch engagement control lever.
2. Prise and remove the gearbox cover antislip bush.
3. Working from inside the gearbox cover withdraw the clutch engagement sleeve pin and control fork.
4. Slacken the screws fastening the thrust bearing sleeve and remove it.



When refitting install a new antislip bush every time the play of the pin is excessive.

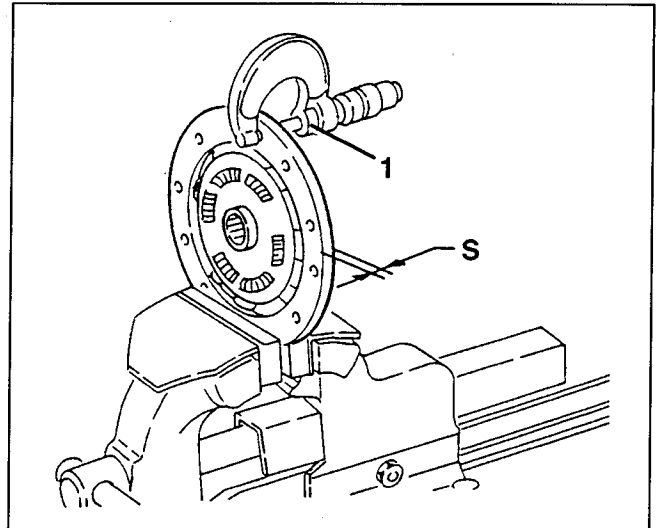
When refitting, grease the bushes and sleeve with the specified product. The sleeve complete with oil seal should be changed each time there are oil leaks.

### CHECKS AND INSPECTIONS

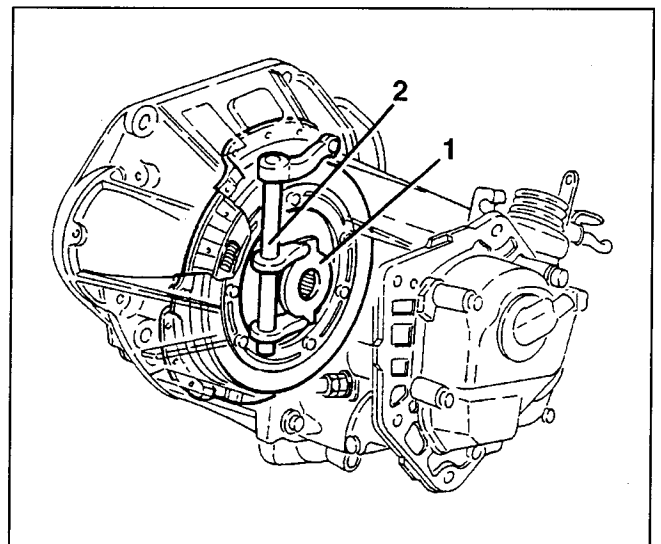
1. Check that the wear of the seals is uniform and that the thickness of the clutch plate is no lower than the minimum allowed limit.



| Clutch plate thickness "S" (mm) |               |
|---------------------------------|---------------|
| New                             | At wear limit |
| 7.1 ÷ 7.7                       | 6.3           |



- Check that there are no burns or signs of vitrification, and that the springs are intact and correctly fastened.
  - Check that the clutch plate hub is intact and runs freely without excessive play on the coupling of the power takeoff shaft.
  - Check the working surfaces of the flywheel and pressure plate for signs of overheating, uneven wear, nicks or missing material.
1. Check the thrust bearing for noise, excessive play and freedom of movement on the guide quill.
  2. Check the fork for cracks, distortion, freedom of movement and excessive wear of the working surfaces.





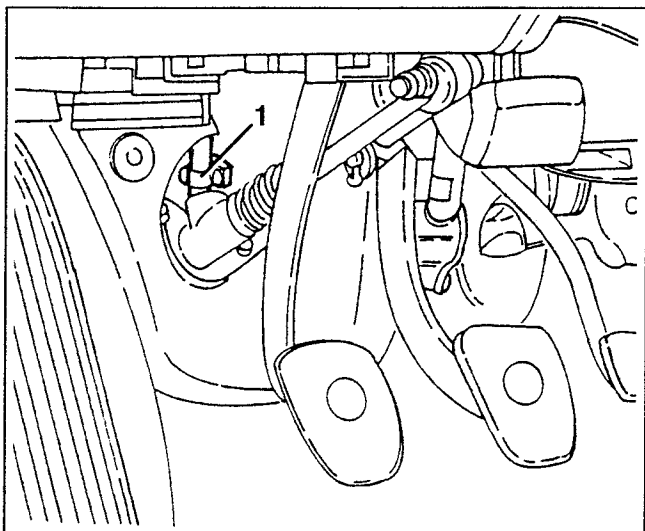
## CLUTCH CONTROL

### CLUTCH PUMP

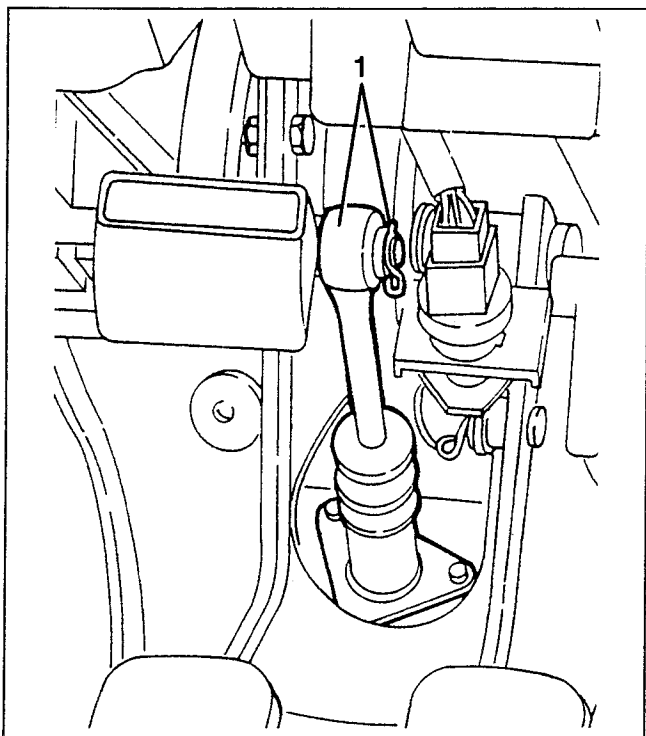
#### REMOVAL/REFITTING

- Empty the brake-clutch fluid reservoir, using a suitable syringe.

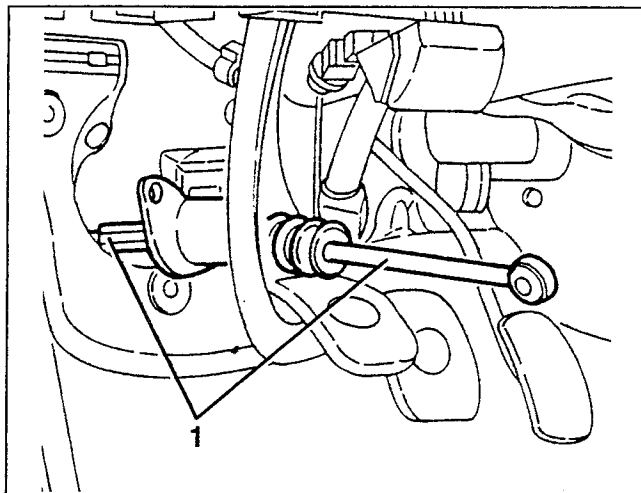
1. Disconnect the reservoir connection pipe from the clutch pump.



1. Remove the safety stopper and disconnect the clutch pump from the pedal.
2. Slacken the two clutch pump fastening nuts.

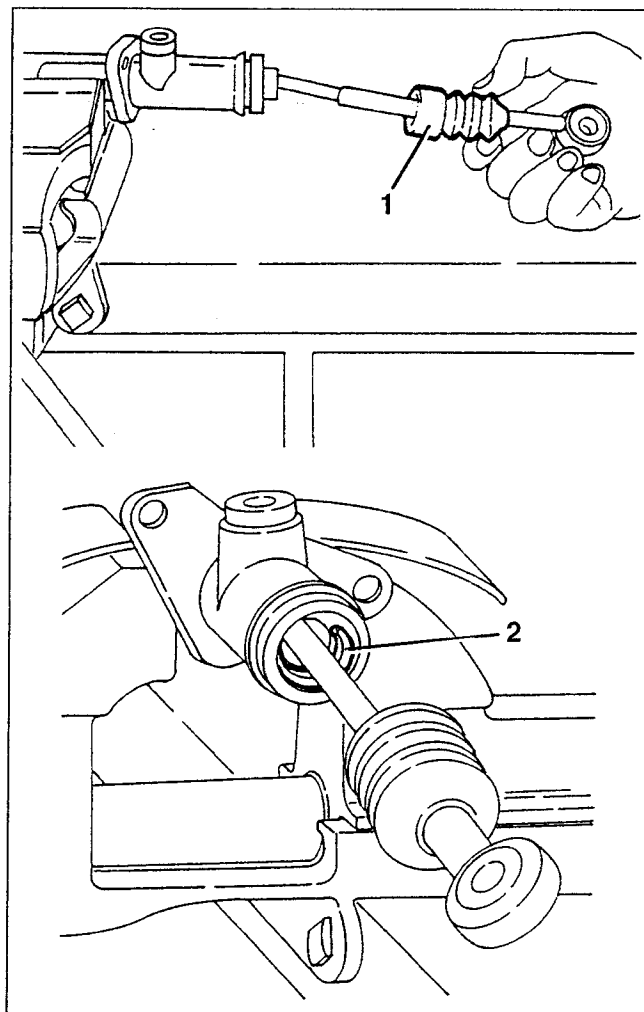


1. Move the clutch pump backwards just enough to disconnect the fitting of the connection pipe to the cylinder, then remove the pump.

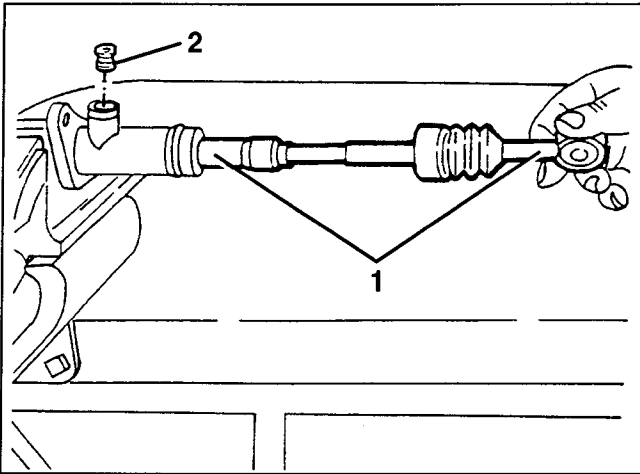


#### DIS-ASSEMBLY/REASSEMBLY

1. Remove the protective boot.
2. Remove the piston retainer ring.



1. Withdraw the piston and operating lever.
2. Remove the seal.

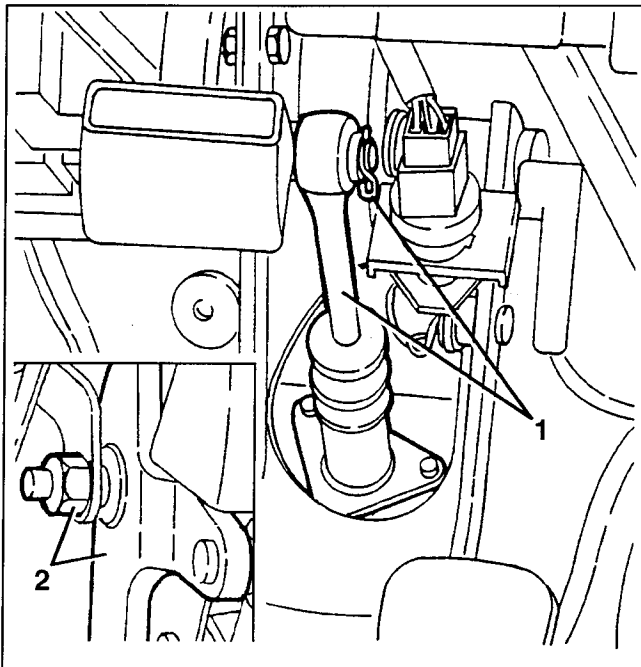


– Check that on the piston and inside the cylinder there are no marks, scores, scrapes or rust, otherwise change the pump assembly.

## CLUTCH CONTROL PEDAL

### REMOVAL/REFITTING

1. Remove the safety stopper and disconnect the clutch pump from the pedal.
2. Slacken the fastening bolt and remove the clutch pedal.

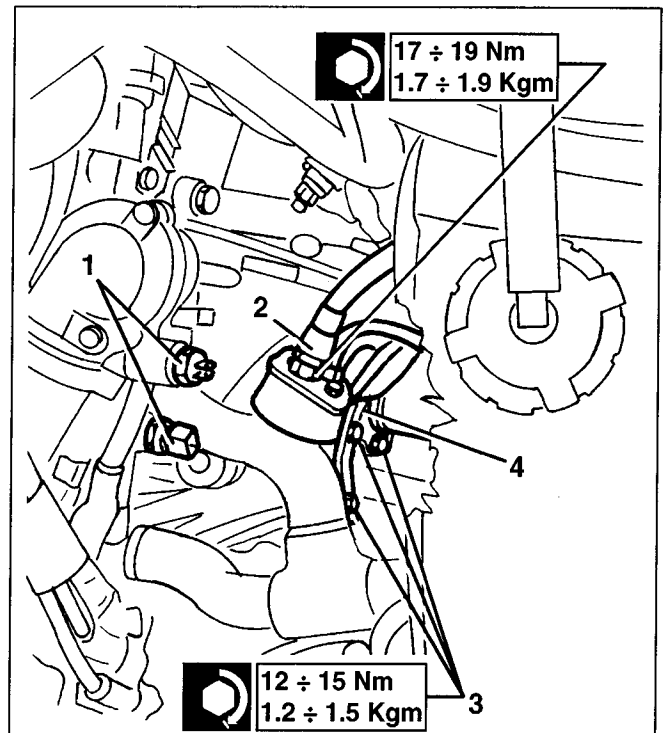


## CLUTCH CONTROL CYLINDER

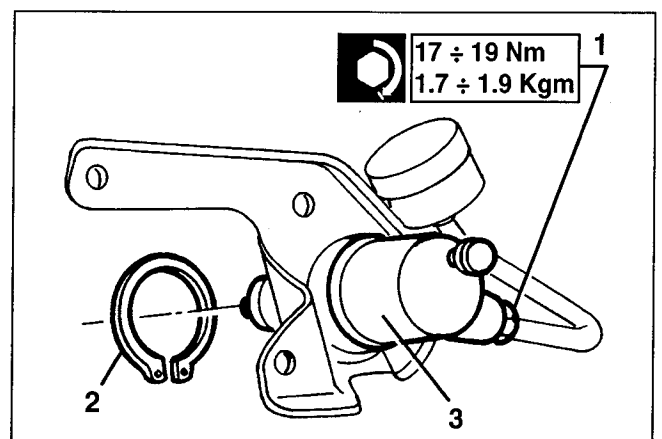
### REMOVAL / REFITTING

#### (6-CYLINDER ENGINE)

- Disconnect the battery.
  - Working from the engine compartment, remove the air cleaner cover complete with sleeve di aspirazione (see GROUP 10).
  - Empty the brake-clutch fluid reservoir, using a suitable syringe.
1. Disconnect the electrical connections of the engine temperature sensor.
  2. Disconnect the hydraulic damper hose.
  3. Slacken the three bracket fastening screws.
  4. Retrieve clutch cylinder support bracket and damper.



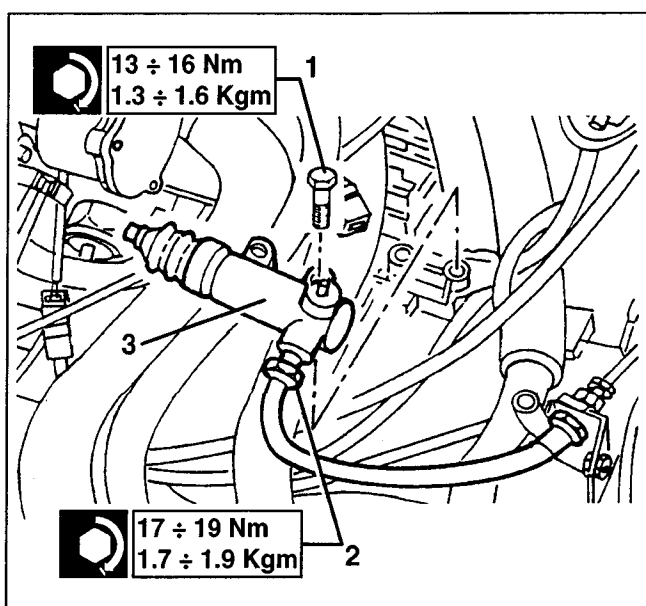
1. Slacken the stiff pipe fitting from the clutch cylinder.
2. Remove the seeger ring.
3. Withdraw the clutch cylinder.



**REMOVAL / REFITTING**

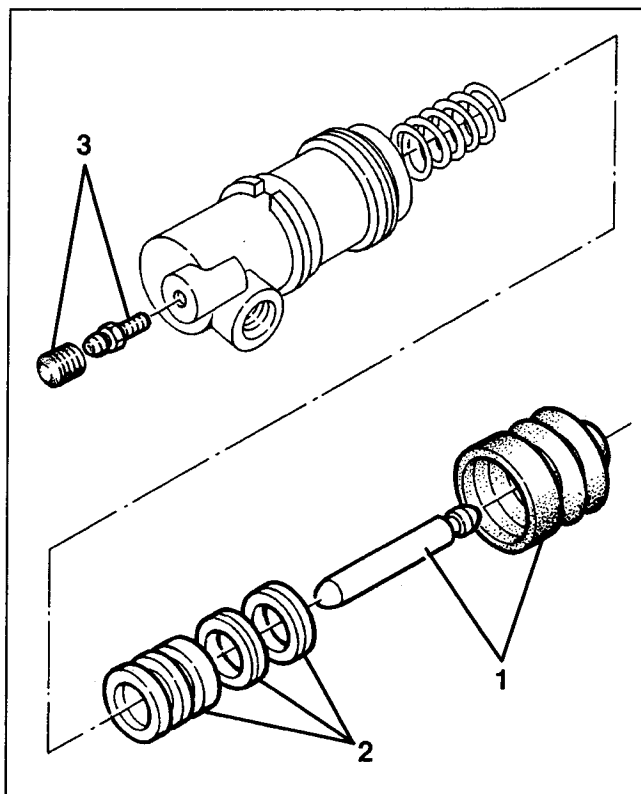
**(4-CYLINDER ENGINE)**

- Working from the engine compartment remove the air cleaner cover complete with intake sleeve (see GROUP 10).
  - Empty the brake-clutch fluid reservoir, using a suitable syringe.
  - Move the injection wiring to gain access to the clutch cylinder.
1. Slacken the two screws fastening the clutch control cylinder.
  2. Disconnect the hose leading from the pump from the clutch control cylinder.
  3. Remove the clutch control cylinder.



**DIS-ASSEMBLY/REASSEMBLY**

1. Withdraw the rubber protective boot and remove it together with the control prod.
2. Withdraw the piston from the cylinder body, with its seals.
3. Remove the spring.
4. Only if necessary, remove the bleed screw.



**WARNING:**  
Always change the seals when refitting.

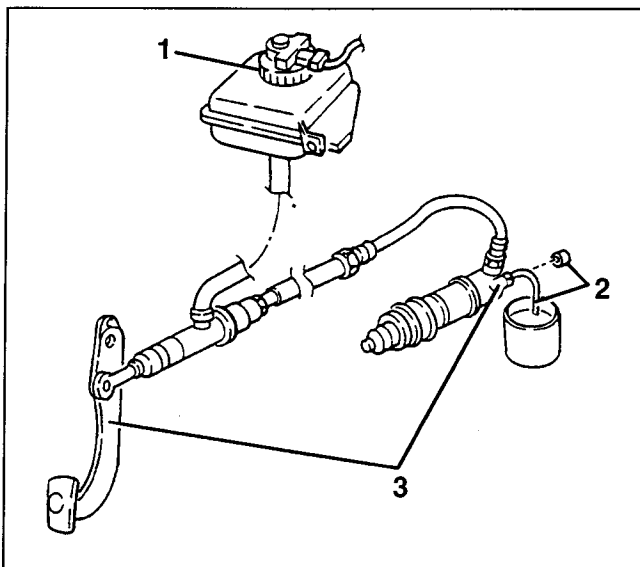
**CHECKS AND INSPECTIONS**

- Check that on the piston and inside the cylinder there are no scores or traces of rust, otherwise replace the cylinder assembly.
- Check that the spring is intact.
- Check that the air relief hole is not clogged.

**RELIEVING THE AIR FROM THE HYDRAULIC SYSTEM**

**WARNING:**  
Never re-use the hydraulic fluid drained during the air relieving procedure.

1. Remove the plug of the brake-clutch hydraulic circuit supply reservoir and, if necessary, top up with the specified fluid.
2. Remove the protection cap of the bleed screw on the cylinder and fit it on a hose with the opposite end dipped in a transparent recipient containing the same fluid as the circuit.
3. Slacken the bleed screw and at the same time press the clutch pedal letting it return slowly; repeat this operation until all the air bubbles have issued.
  - With the pedal fully depressed, tighten the bleed screw, remove the tube and assemble the protective cap.



**During the air relieving operation, keep the level of the fluid in the reservoir above the "MIN" mark.**

- Top up the level of the fluid in the reservoir and install the plug.

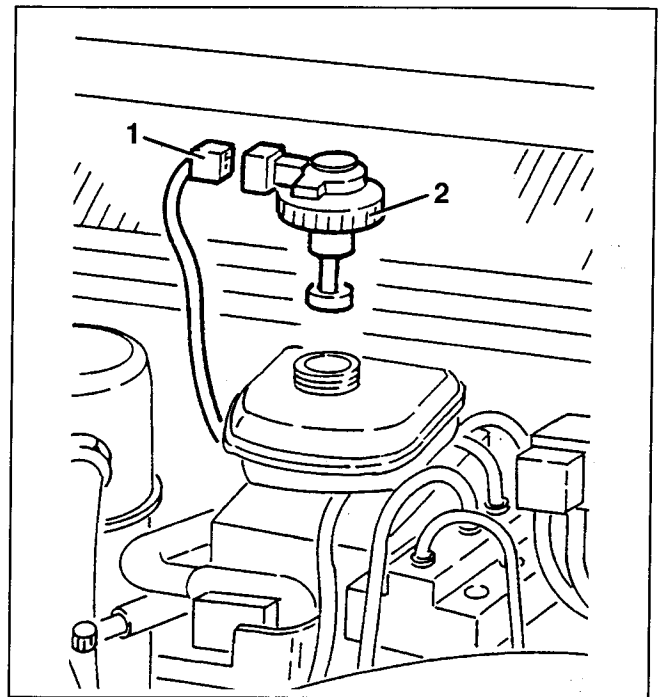
**The brake/clutch fluid can damage the bodywork. Work carefully.**

- After relieving the air, check that the clutch disengages normally and that the gears engage properly.

**MINIMUM BRAKE-CLUTCH FLUID LEVEL SENSOR****REMOVAL / REFITTING**


- Disconnect the battery.

  1. Disconnect the electrical connection of the minimum brake-clutch fluid level sensor.
  2. Slacken the plug incorporating the minimum brake-clutch fluid level sensor and remove it.




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**OUTSIDE GEARBOX CONTROLS**

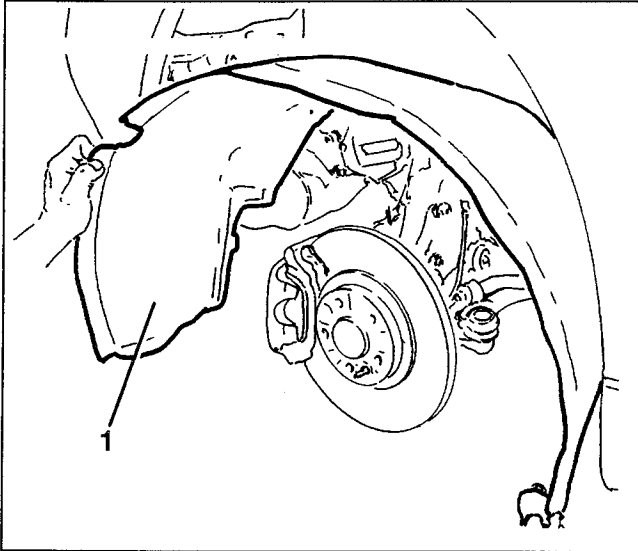
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**GEARBOX UNIT**



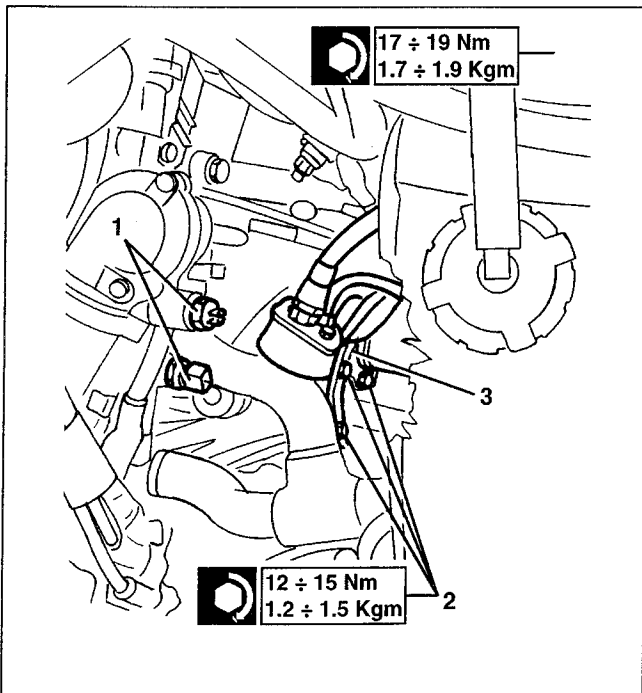
**REMOVING/REFITTING**

- Set the car on a lift.
- Disconnect the battery.
- Remove the front wheels.
- 1. Remove the left gravel guard.

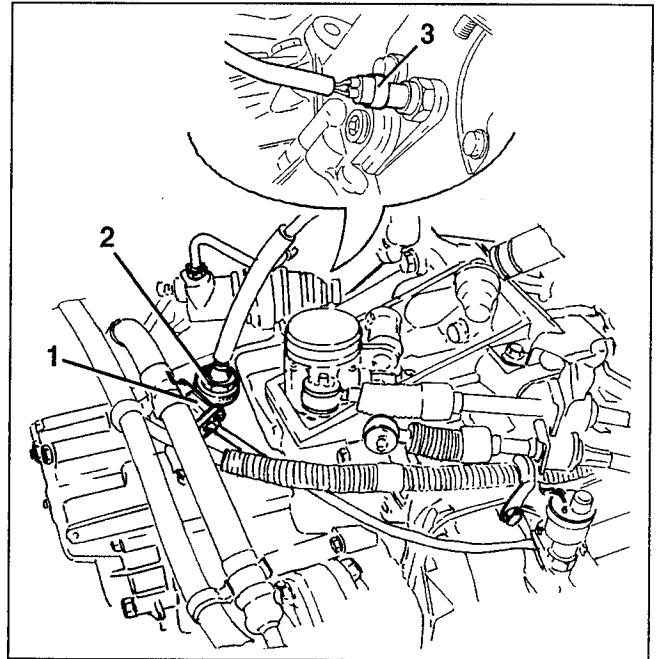


- Remove the engine compartment protection, right-hand side (see GROUP 70).
- Remove the air cleaner unit complete with inlet sleeve and tray with fastening bracket (see GROUP 10).

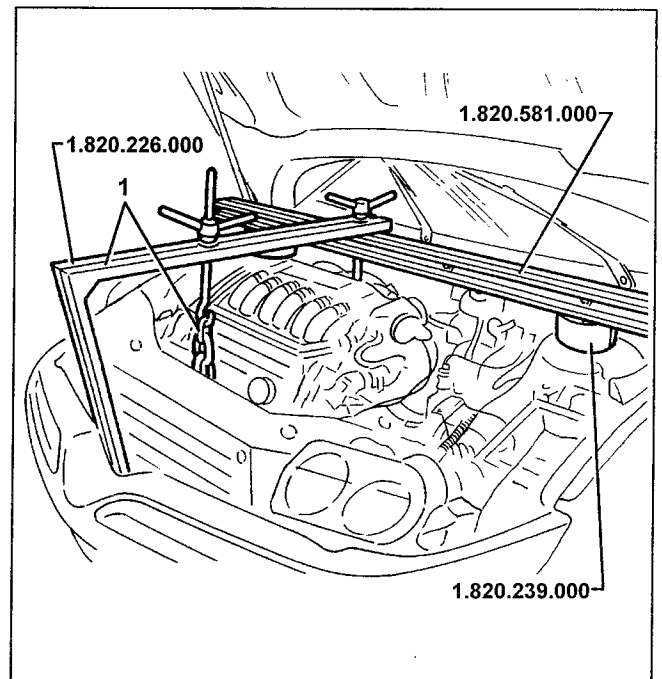
1. Disconnect the electrical connections of the engine temperature sensors
2. Slacken the three screws fastening the clutch cylinder bracket.
3. Move the cylinder aside without disconnecting the pipes.



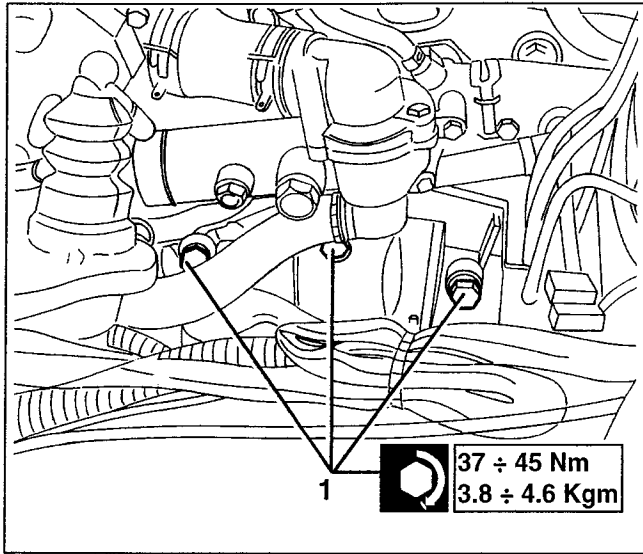
1. Disconnect the electrical connection of the mileage recorder sensor.
2. Disconnect the reverse gear release cable from the gearbox.
3. Disconnect the electrical connection of the reversing switch.



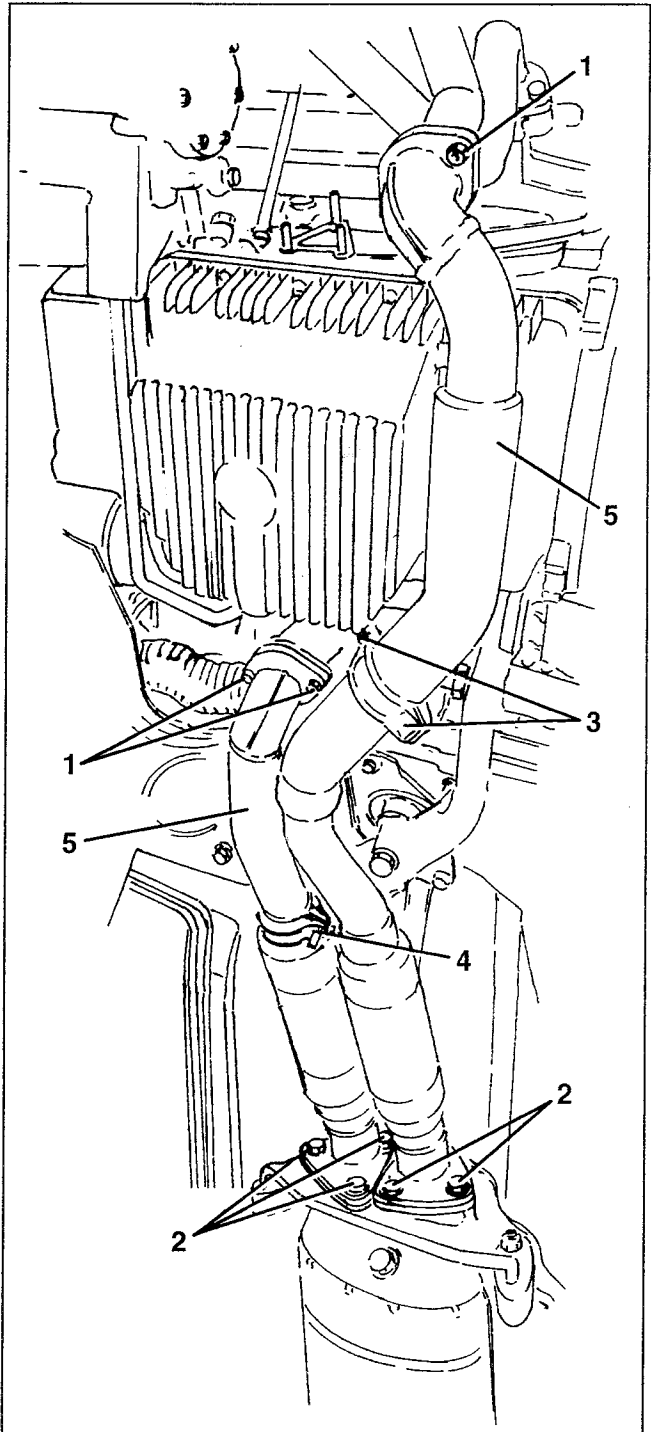
1. Using tools 1.820.239.000, 1.820.581.000 and 1.820.226.000 suitably support the engine with a chain.



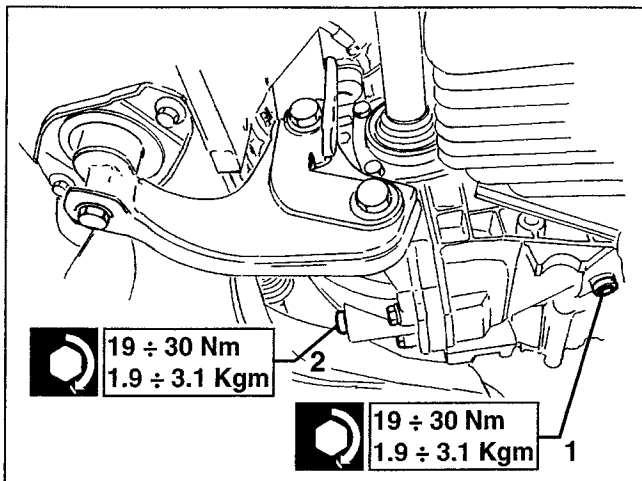
1. Slacken the three upper screws fastening the gearbox cover to the crankcase.
2. Raise the gearbox oil level dipstick.



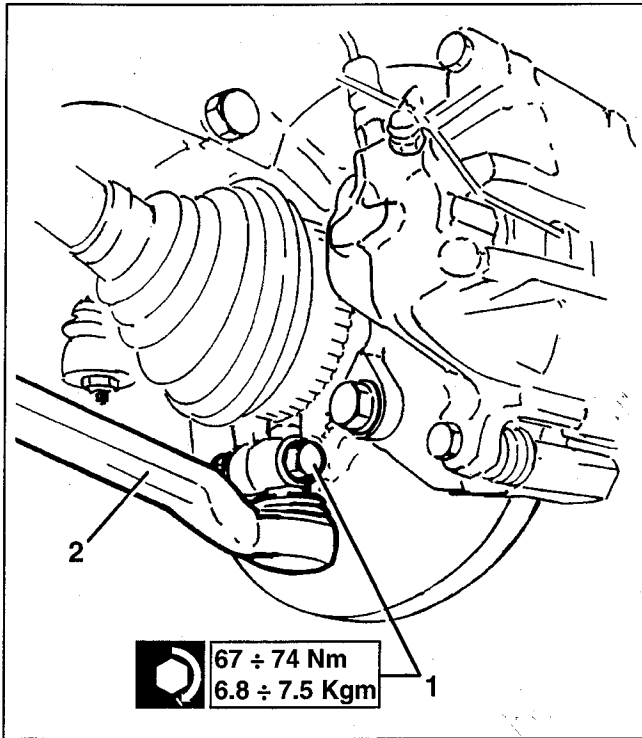
1. Slacken the nuts fastening the front exhaust pipes to the exhaust manifold.
2. Slacken the bolts fastening the pipes to the catalyst.
3. Slacken the bolt and disconnect the collar.
4. Slacken the nut and remove the collar.
5. Remove the front exhaust pipes.



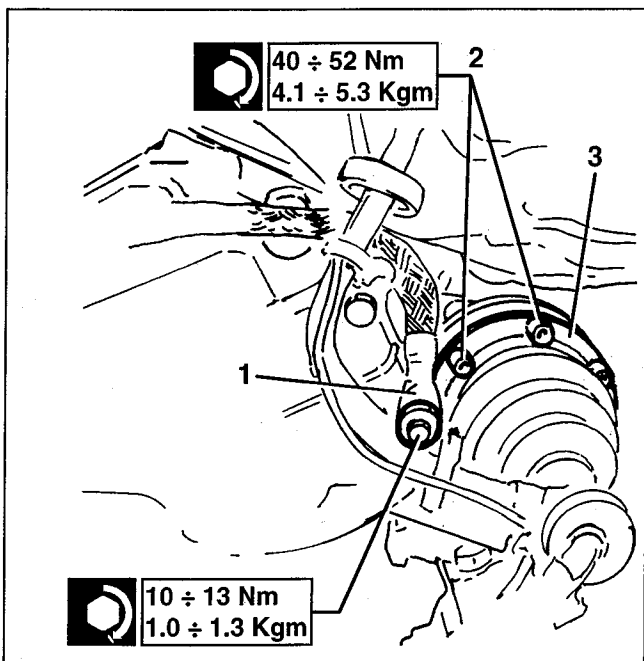
- Raise the car.
  - Set a suitable recipient under the engine compartment.
1. Slacken the plug and drain the gearbox oil.
  2. Slacken the plug and drain the differential oil.



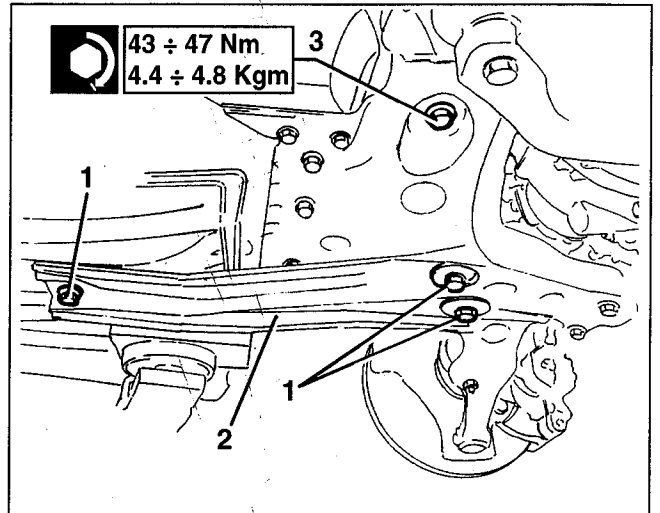
1. Working from both sides of the car, slacken the bolt fastening the suspension wishbone to the wheel hub.
2. Withdraw the ball pin from the suspension wishbone.



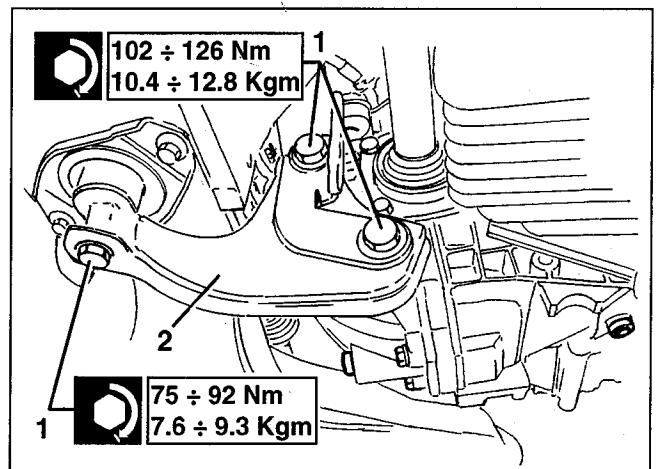
1. Working on the left-hand side of the car, slacken the nut and disconnect the earth braid from the gearbox.
2. Slacken the six bolts and disconnect the axle shaft from the differential.
3. Retrieve the safety plates.



1. Working from under the car, slacken the four screws fastening each of the front crossmember reinforcement struts.
2. Retrieve the reinforcement struts.
3. Slacken the screws fastening the steering box to the crossmember.

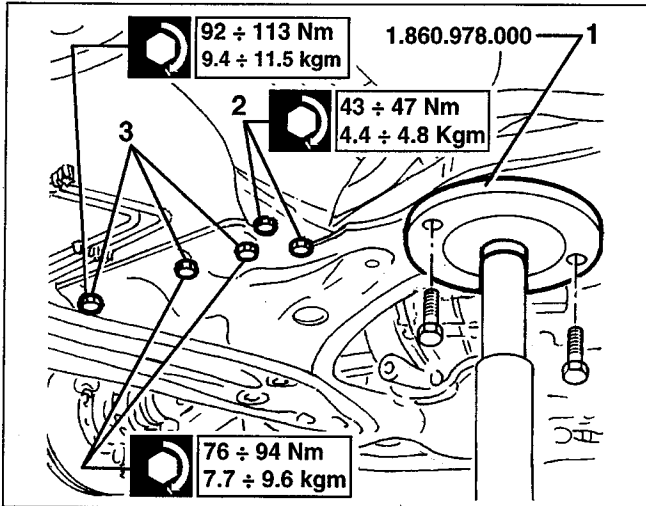


1. Slacken the three fastening screws.
2. Remove the engine rear support.

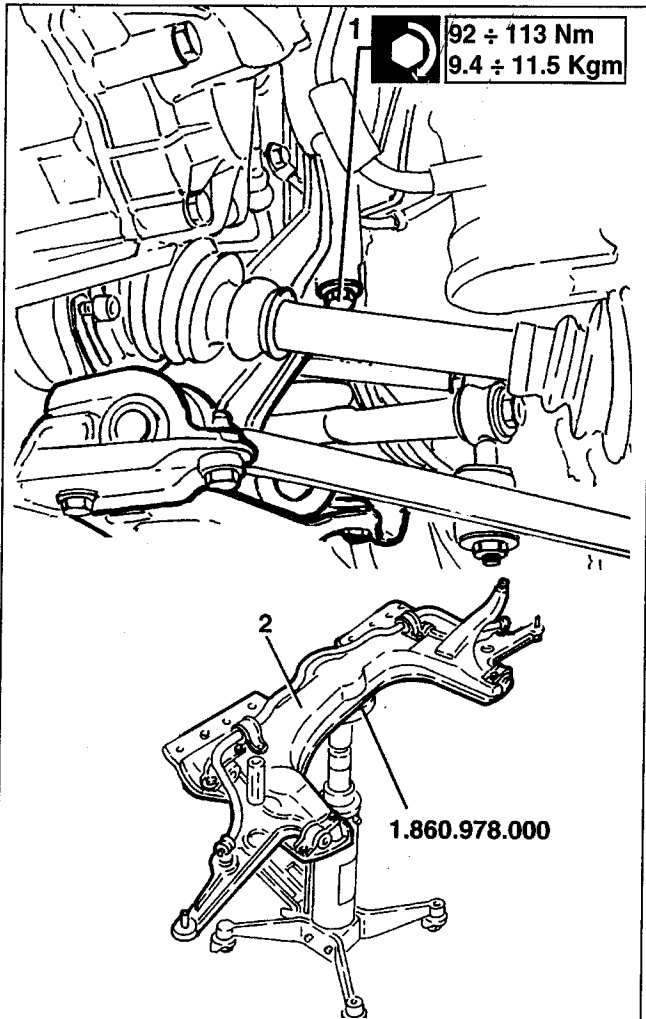




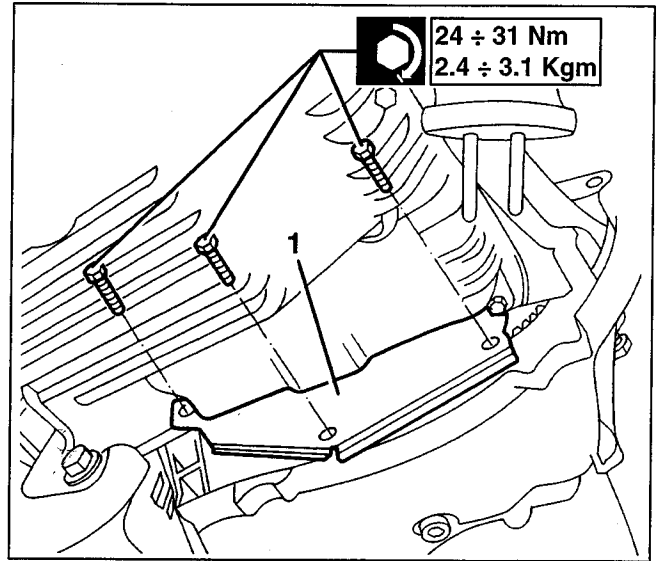
- Install tool 1.860.978.000 on a hydraulic jack.
- 1. Fasten the tool to the centre of the crossmember
- 2. Slacken the nuts fastening the crossmember to the gearbox controls support.
- 3. Slacken the screws fastening the crossmember to the body.



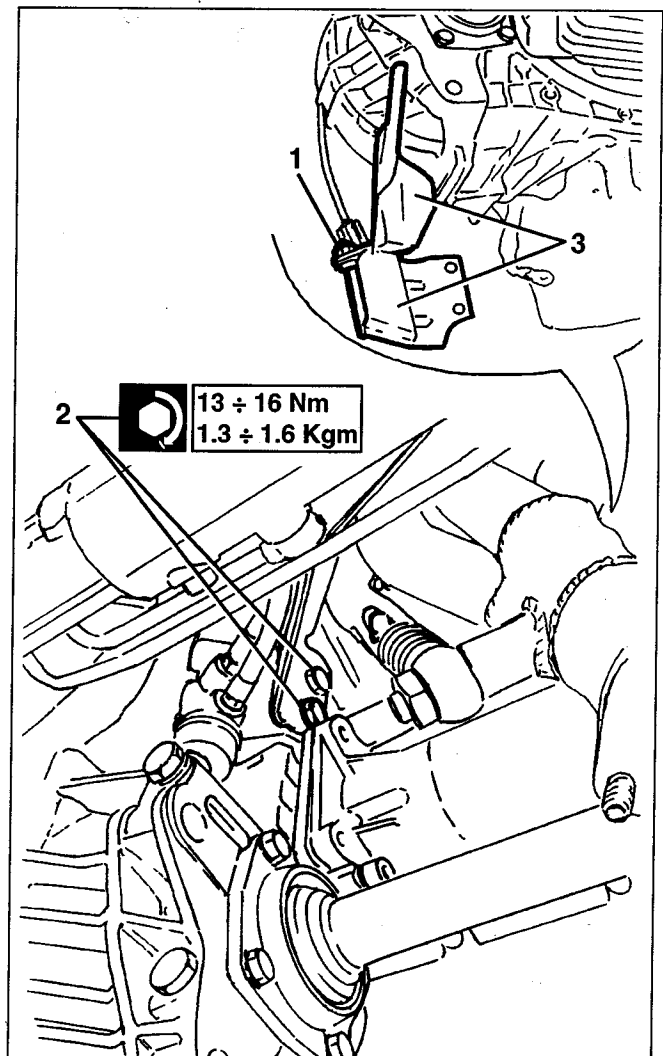
1. Slacken the screw on each side fastening the upper crossmember.
2. Slowly lower the hydraulic jack and remove the crossmember complete with wishbones and stabilizer bar.



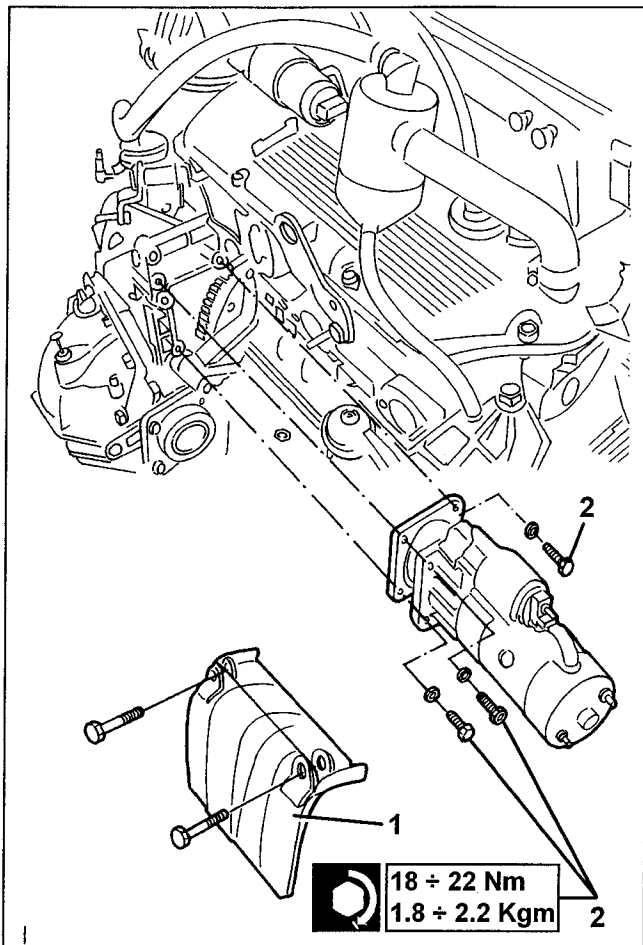
1. Slacken the screws fastening the lower flywheel cover and remove it.



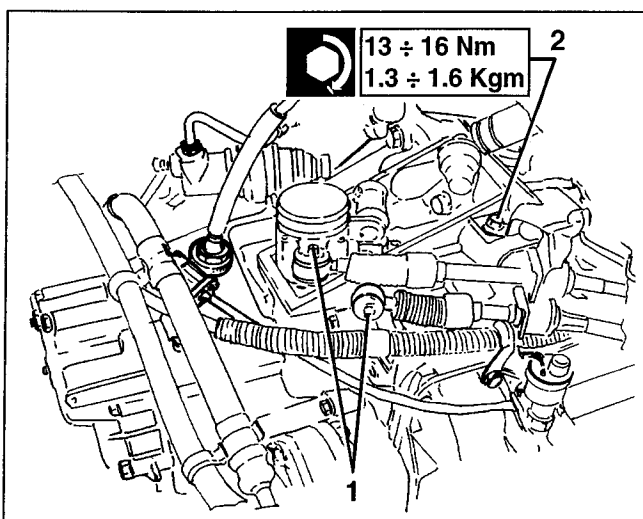
1. Slacken the two nuts fastening the upper cover of the gearbox control cables.
2. Slacken the two screws fastening the lower cover of the gearbox control cables.
3. Retrieve the two covers.



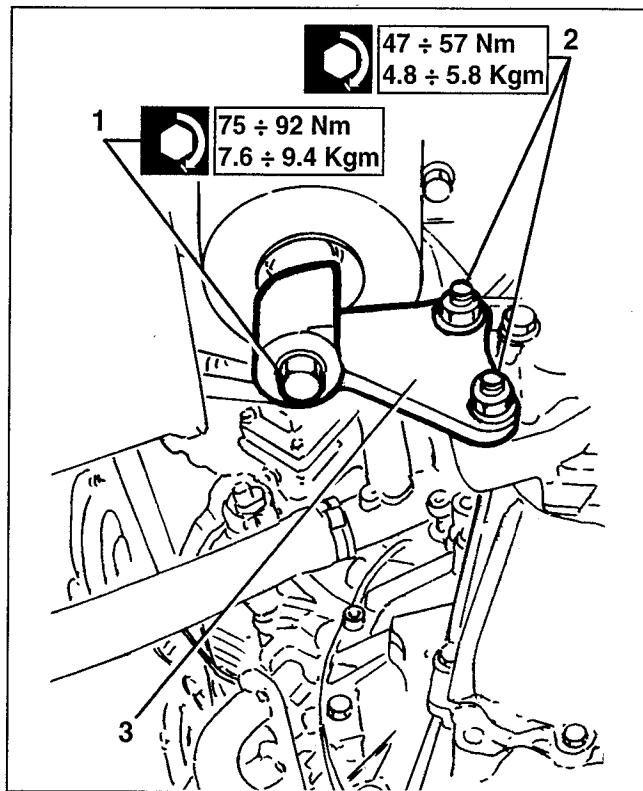
1. Slacken the screws fastening the starter motor heat shield.
2. Slacken the starter motor fastening screws.



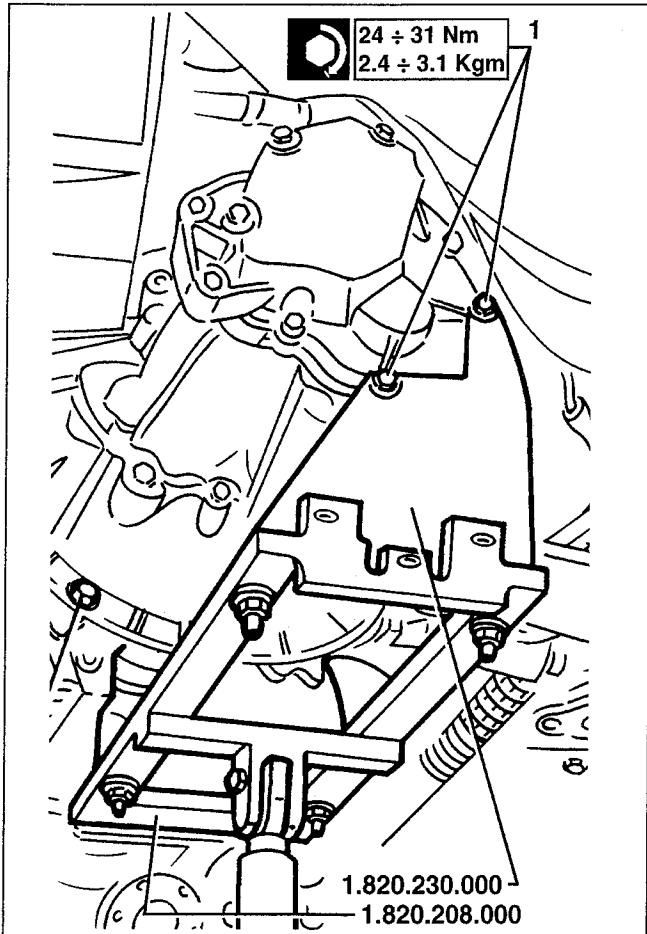
1. Remove the retainer clamps and remove the gearbox control cables from the pins.
2. Slacken the upper screw fastening the gearbox control cables support bracket.



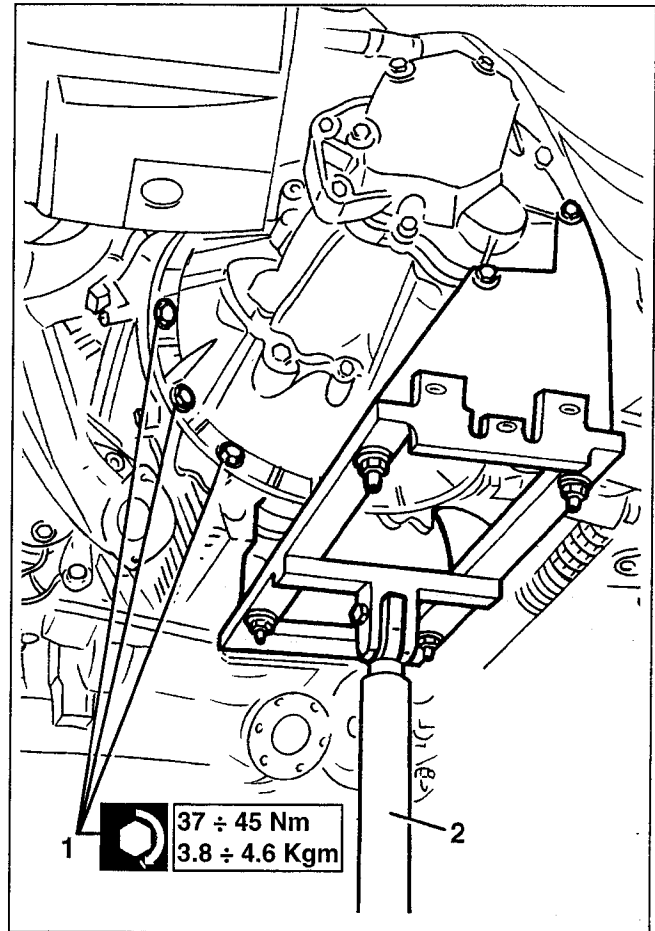
1. Slacken the screw fastening the rear gearbox support.
2. Slacken the nuts fastening the support to the gearbox.
3. Remove the support.



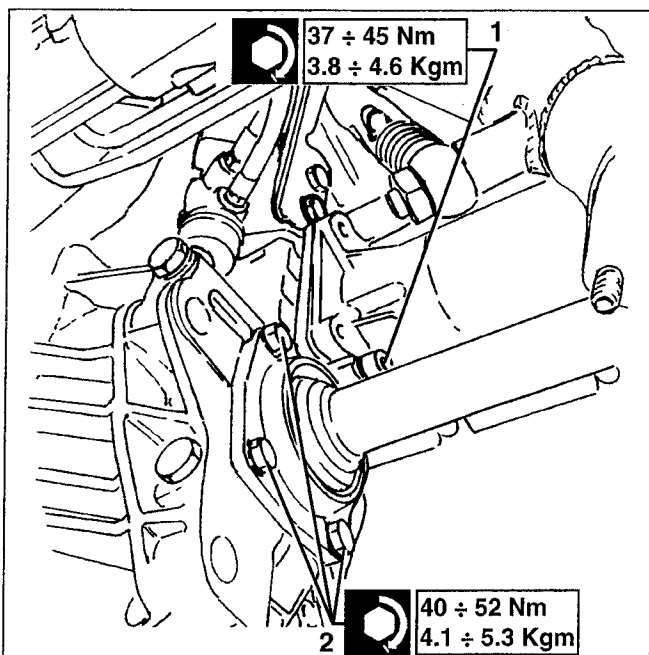
1. Slacken two of the screws fastening the gearbox cover and fasten bracket no. 1.820.230.000 and support no. 1.820.208.000.
2. Using a hydraulic hoist support the gearbox unit.



1. Slacken the three remaining screws fastening the gearbox to the engine.
2. Move the gearbox away from the engine and lower it using the hydraulic jack.



1. Slacken the rear Allen screw fastening the engine to the gearbox.
2. Slacken the four screws fastening the intermediate shaft support to the differential.



## GEARBOX UNIT

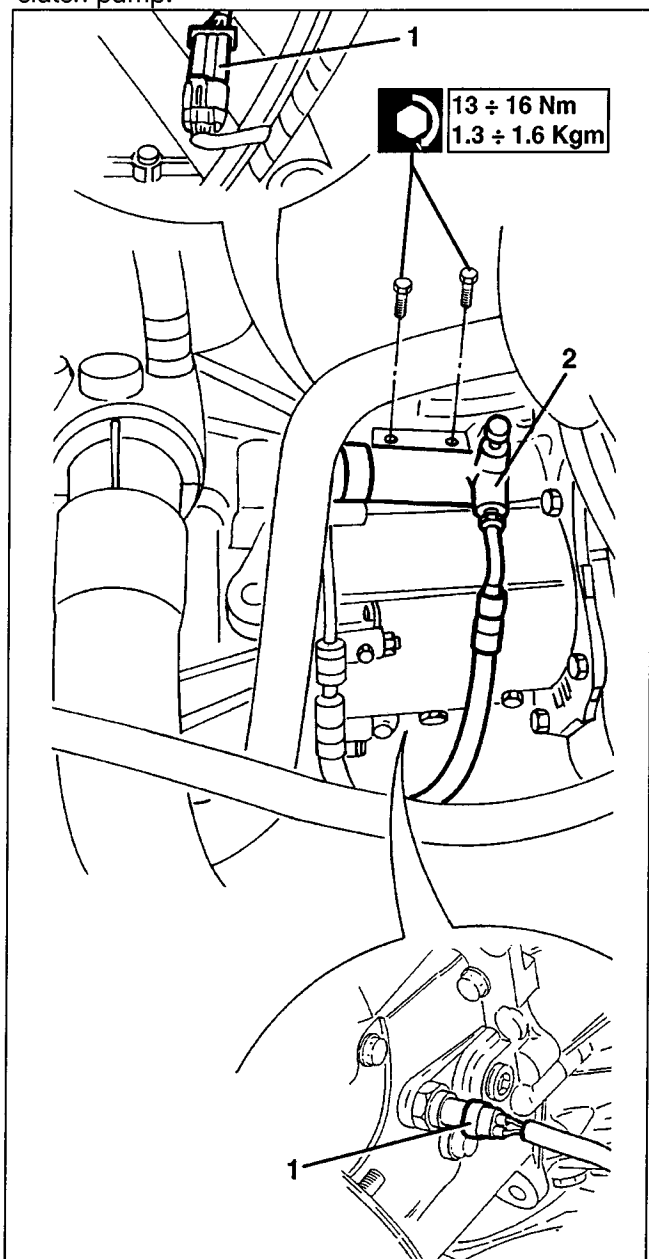


## REMOVING / REFITTING

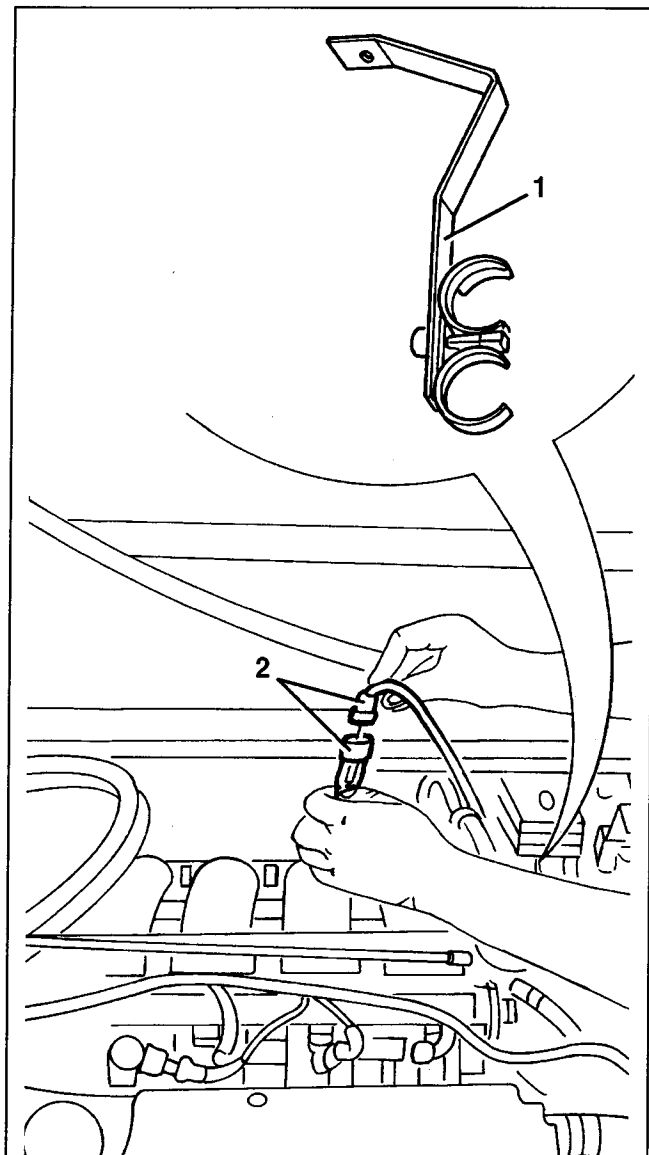
- Set the car on a lift.
- Disconnect the battery.
- Remove the front wheels and gravel guards (see GROUP 70).
- Remove the engine compartment protection, right-hand side (see GROUP 70).
- Remove the air cleaner unit complete with tray and inlet sleeve and bracket (see GROUP 10).
- Move aside the injection wiring, freeing access to the gearbox.

1. Disconnect the connections of the reverse switch and tachometric sensor from the gearbox.

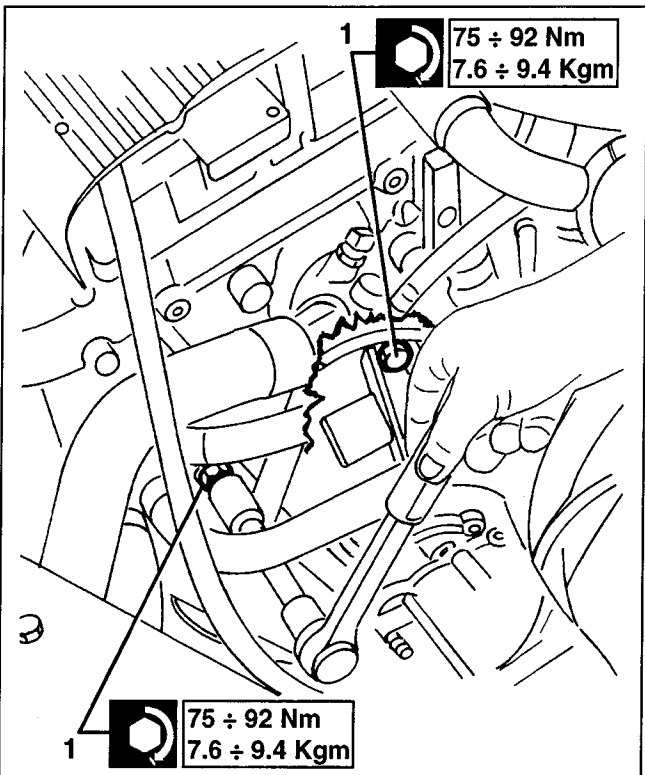
2. Slacken the two screws and remove the clutch cylinder from the gearbox, moving it upwards: in fact the cylinder is restrained by the pipe leading from the clutch pump.



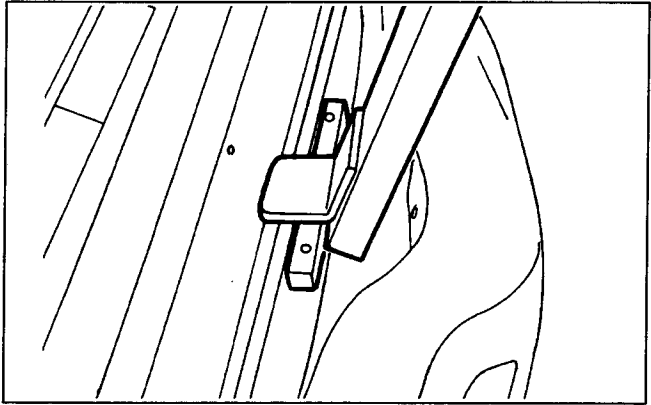
1. Remove the heater pipe fastening clamps from the throttle body.
2. Disconnect the connection of the lambda probe, disconnecting it from the stay clamp.



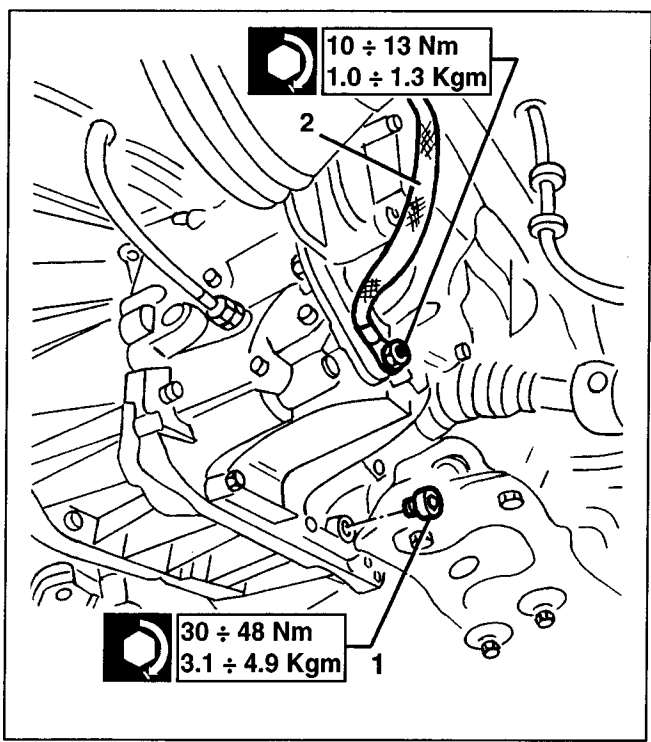
1. Slacken the two upper screws fastening the gearbox to the engine.



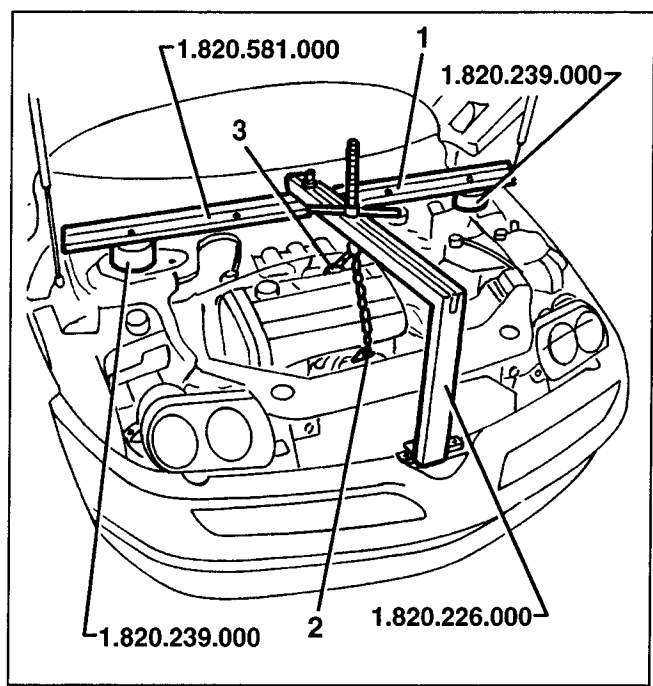
**CAUTION:**  
To avoid damaging the power steering piping housed at the front of the radiator, interpose a suitable thickness between the front connection of the tool and its resting surface.



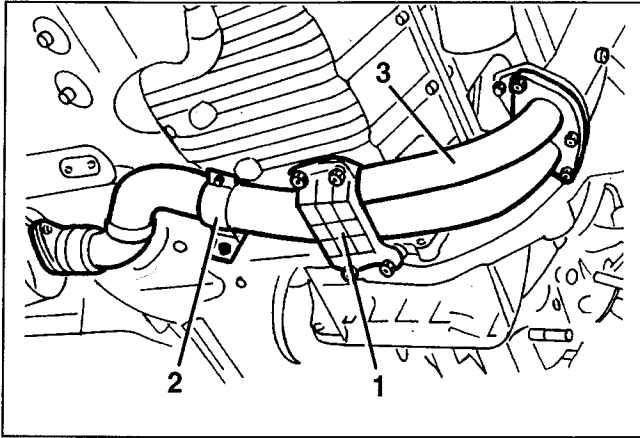
- Raise the car.
- 1. Slacken the plug and drain the gearbox-differential oil recovering it in a suitable recipient.
- 2. Disconnect the earth braid from the gearbox.



1. Position engine support 1.820.226.000, with supports 1.820.239.000 and cross rail 1.820.581.000.
  2. Place a support square on the front of the crankcase.
  3. Place a support square on the rear of the crankcase, between two injectors.
- Set a chain between the two squares and the support, hooking the engine to the support.

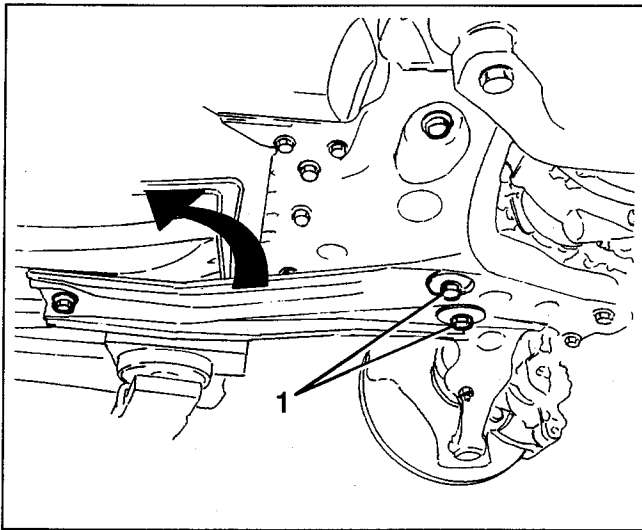


1. Remove the reinforcement under the exhaust pipe.
2. Disconnect the exhaust pipe fastening bracket.
3. Remove the exhaust pipe, front section.

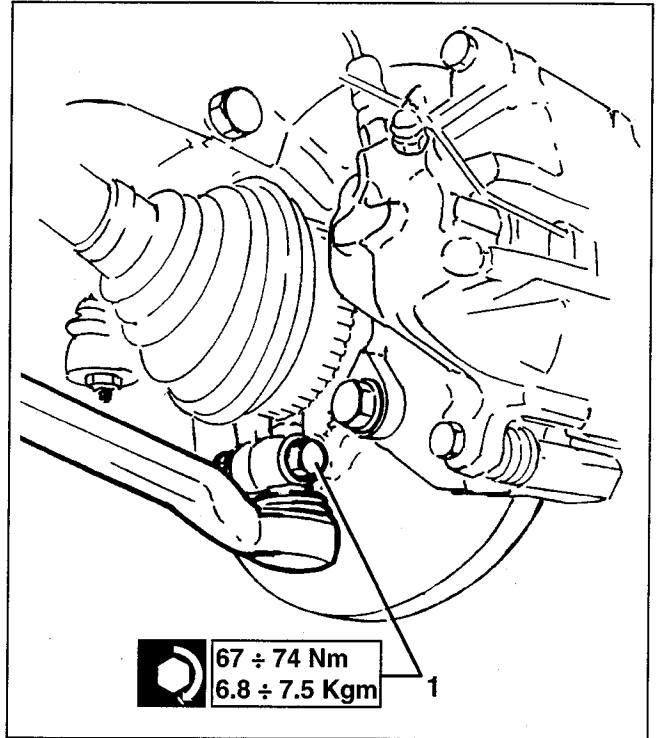


NOTE: retrieve the lambda probe wiring carefully to avoid jerking or damaging it.

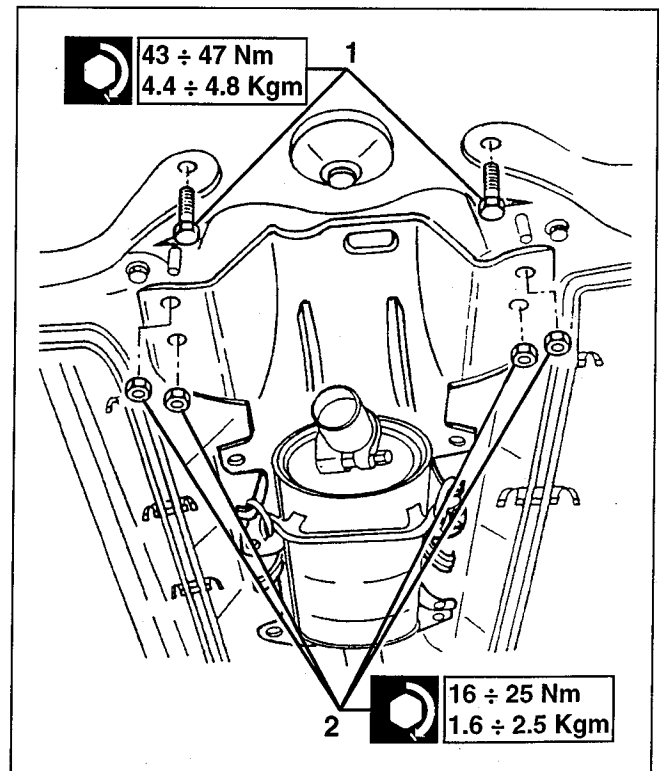
1. Removing the two screws, disconnect the front of the two front crossmember reinforcement struts and turn them rearward removing one of the rear screws.



1. For both sides, slacken the two screws fastening the front crossmember to the wheel hub.

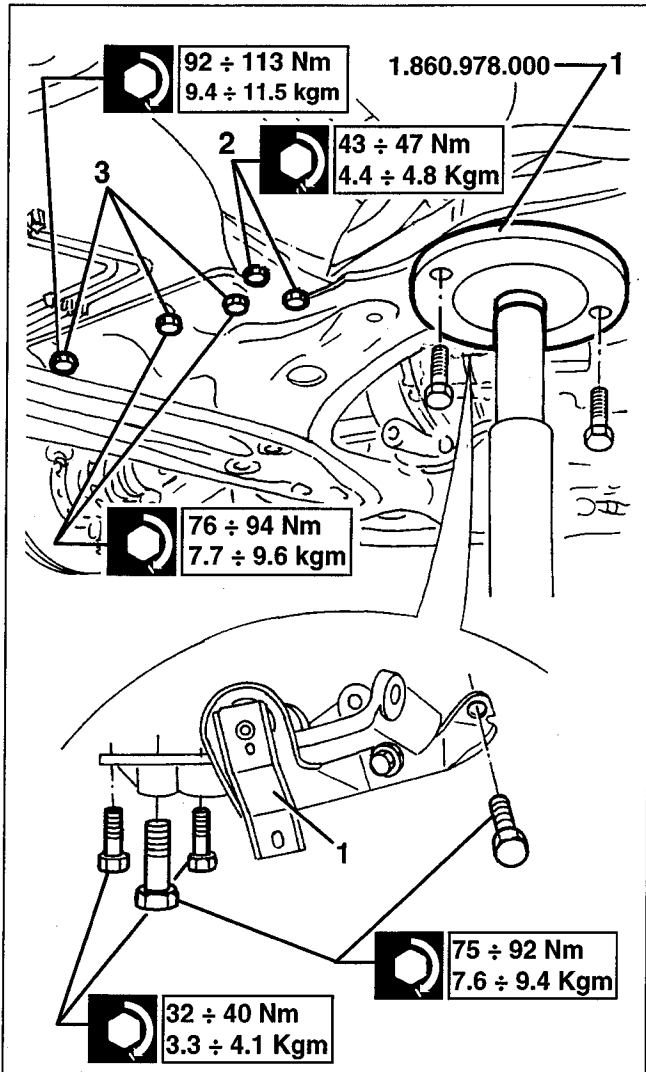


1. Slacken the two screws fastening the power steering to the front crossmember.
2. Slacken the four front nuts and slacken the other fastening screws of the gearbox controls support, which must be slightly lowered to make it possible to free the front crossmember.

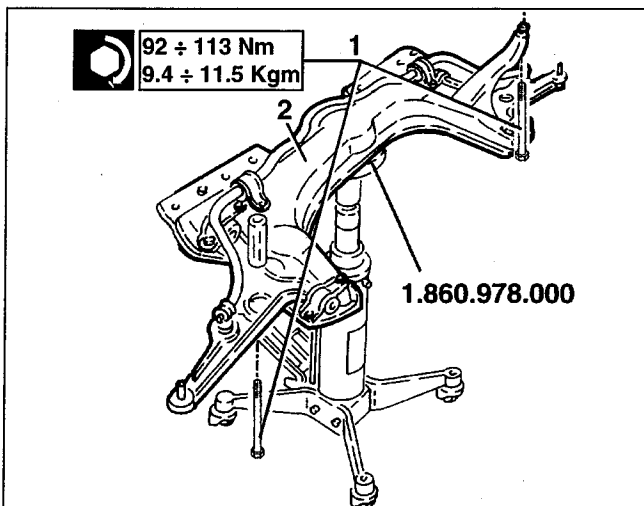
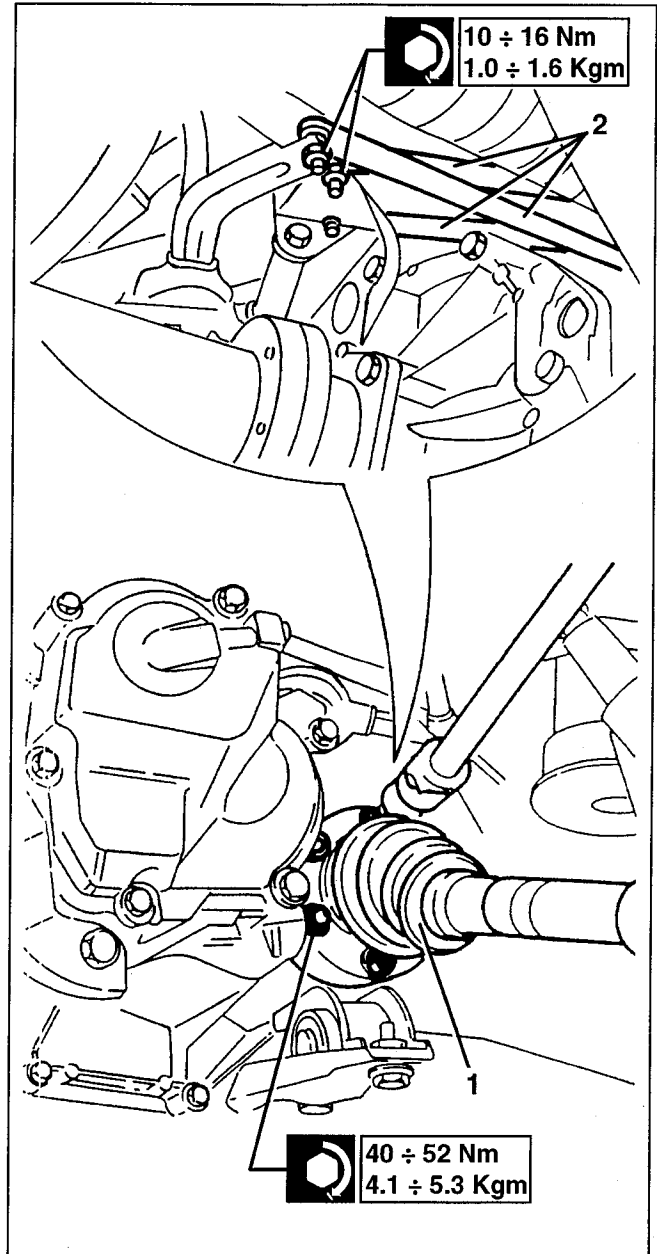


1. Remove the rear engine support.
2. Install tool 1.860.978.000 on a hydraulic jack. Fasten the tool to the centre of the crossmember.
3. Slacken the six rear screws fastening the crossmember to the body.

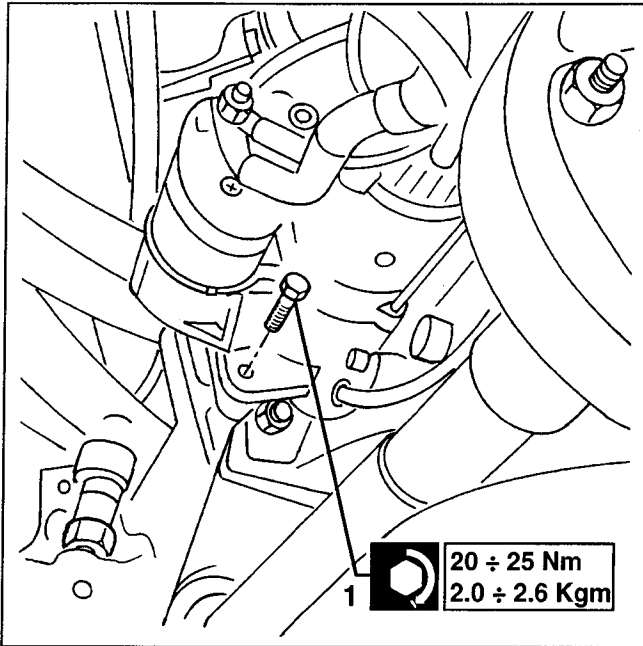
1. Slacken the six fastening bolts and disconnect the left constant velocity joint from the differential side axle shaft.
2. Disconnect the three gearbox control rods.



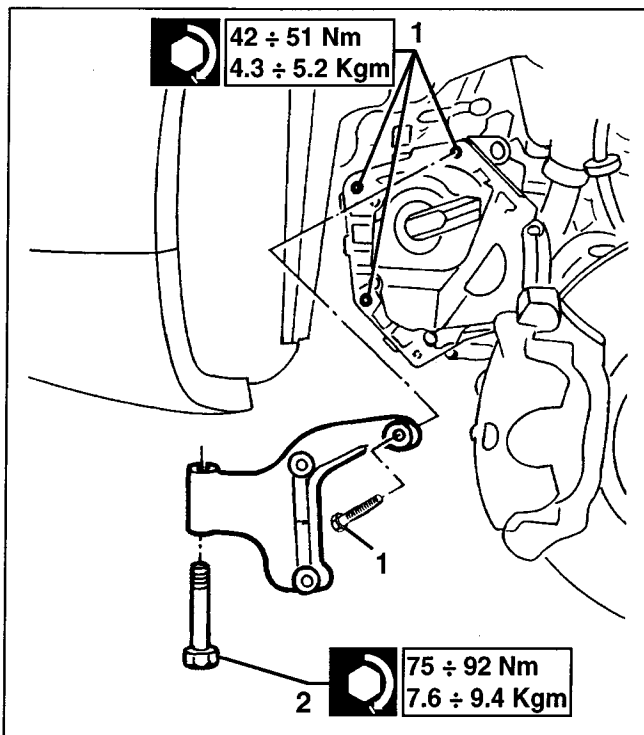
1. Slacken the two front screws fastening the crossmember to the body.
2. Lower the front crossmember and remove it.



1. Slacken the three screws fastening the starter motor to the gearbox.



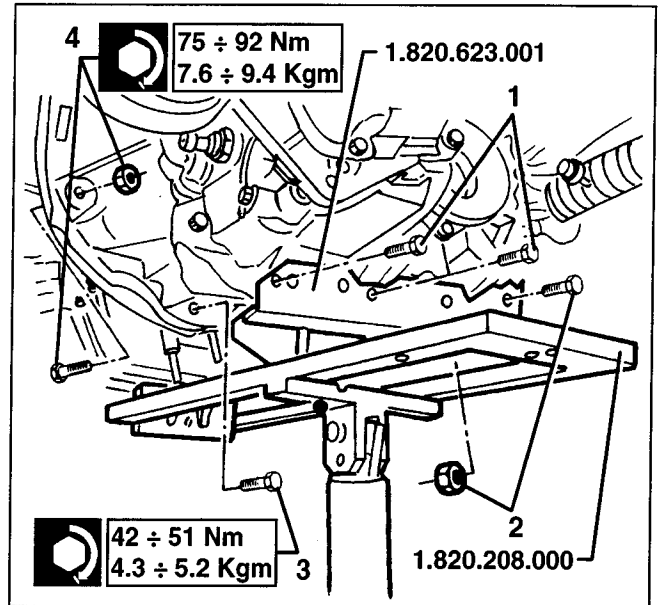
1. Slacken the three screws fastening the rear gearbox support to the gearbox itself.
2. Slacken the bolt fastening the support to the body and remove it.



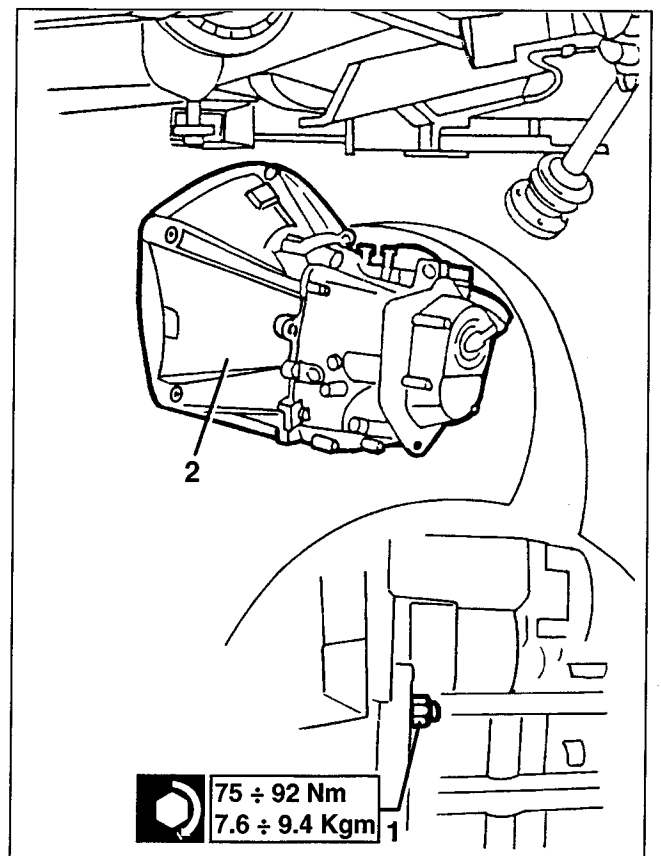
1. Slacken the two lower screws fastening the gearbox cover and in the holes fasten bracket no. 1.820.623.001 with support no. 1.820.208.000.

NOTE: use screws slightly longer than the ones removed.

2. Add a bolt of suitable size in the hole on the right.
3. Slacken the two fastening screws and remove the lower cover.
4. Slacken the bolt fastening the gearbox to the engine.



1. Slacken the nut fastening the gearbox to the engine.
2. Lower the gearbox disconnecting it from the engine.





**GEARBOX UNIT**

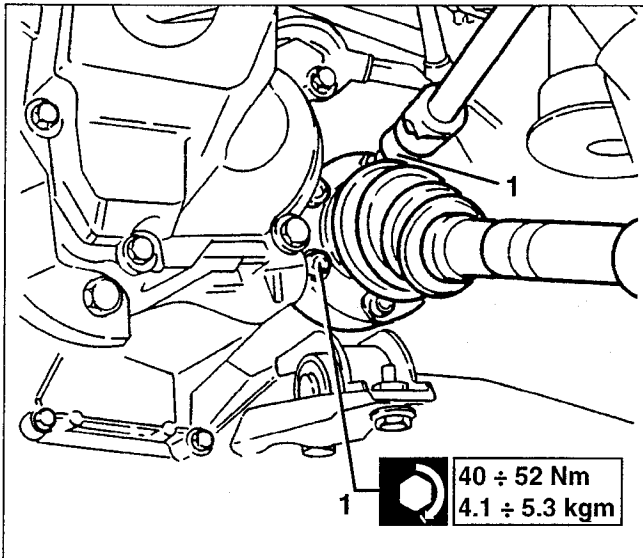
**ON-VEHICLE OPERATIONS**

**DIFFERENTIAL CARRIER OIL SEAL  
GEARBOX SIDE**

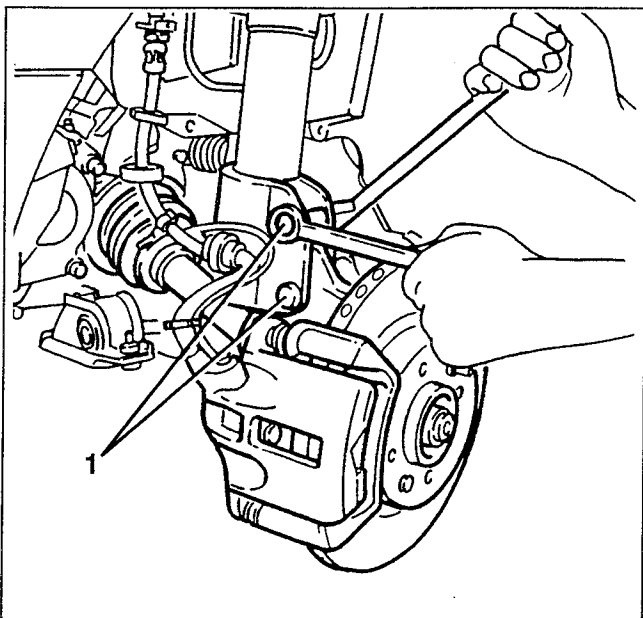
**Replacement**

- Set the car on a lift.
- Disconnect the battery.
- Raise the car.
- Remove the left front wheel and mud flap.
- Working from the left wheelhouse, disconnect the electrical connection of the brake pad wear sensor.
- Release the ABS inductive sensor from the support bracket.

1. Unscrew the left axle shaft fastening screws from the differential.

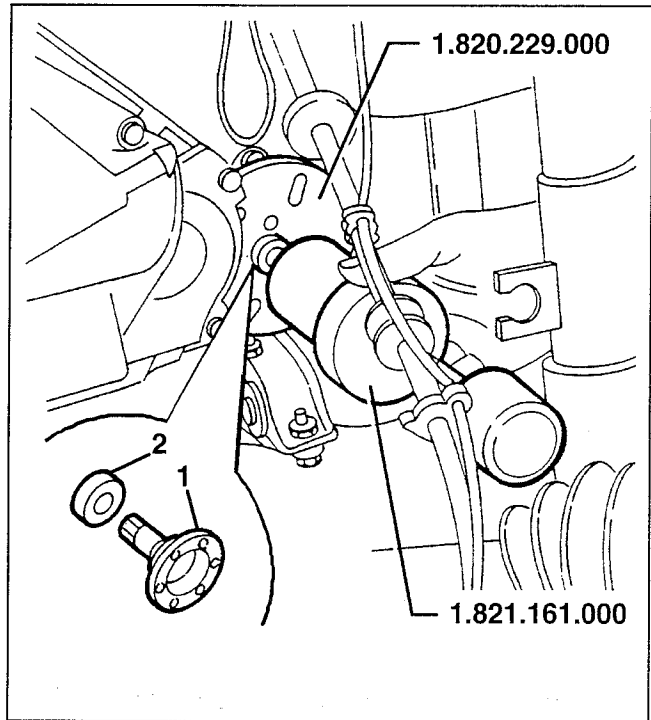


1. Slacken the two bolts fastening the left upright to the shock absorber, then remove only the upper bolt.



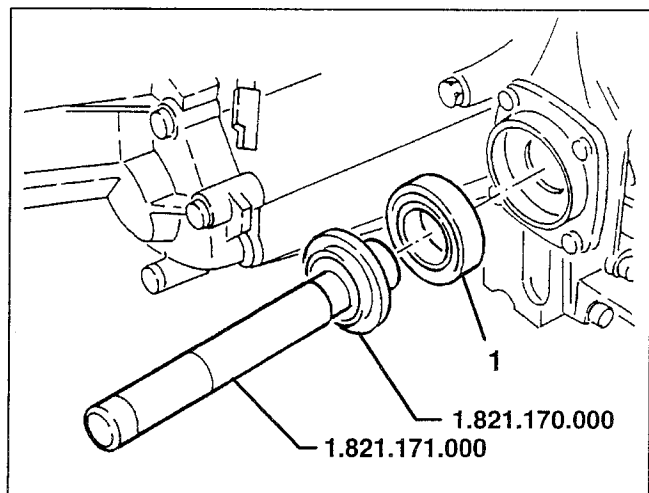
1. Using tools no. 1.820.229.000 and no. 1.821.161.000, remove the flange from the differential.

2. Prise off the seal to be replaced.



1. Using tools no. 1.821.170.000 and no. 1.821.171.000 insert the new oil seal.

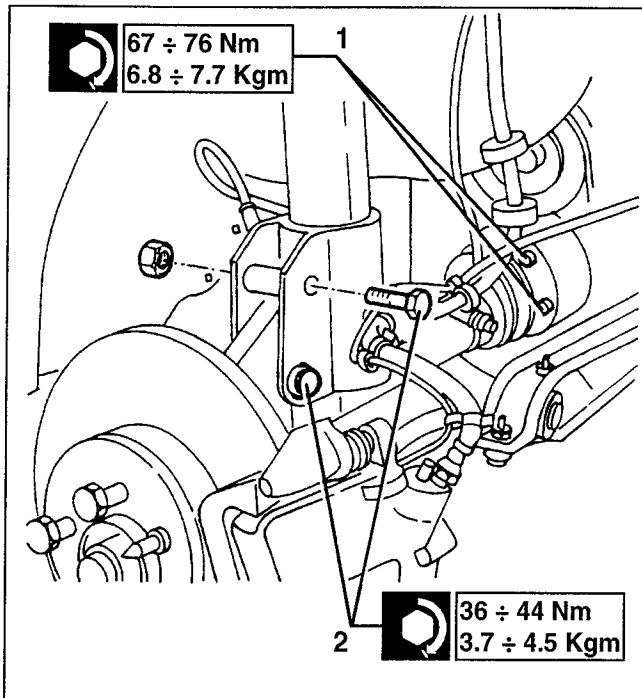
Complete refitting reversing the sequence followed for removal.



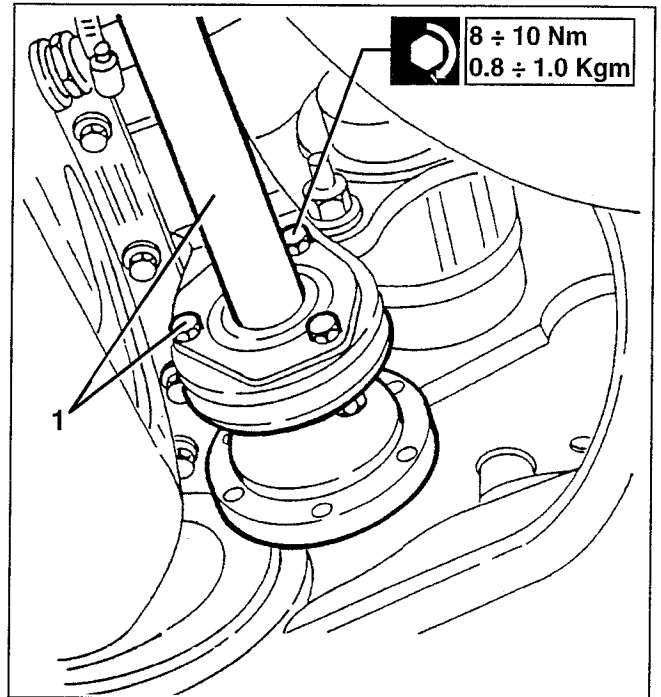
## DIFFERENTIAL CARRIER OIL SEAL ENGINE SIDE

### REPLACEMENT

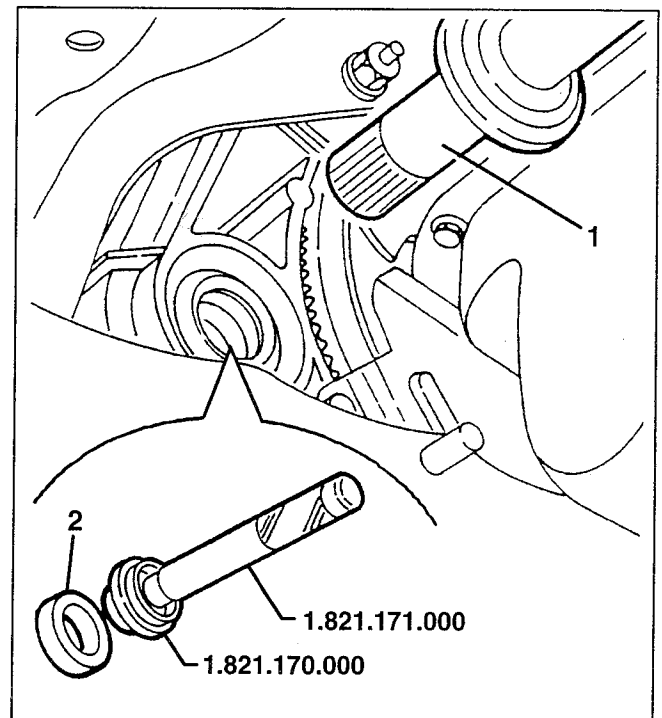
- Set the car on a lift.
  - Disconnect the battery.
  - Raise the car.
  - Remove the left front wheel and mud flap.
  - Working from the left wheelhouse, disconnect the electrical connection of the brake pad wear sensor.
  - Release the ABS inductive sensor from the support bracket.
1. Slacken the screws fastening the right axle shaft from the intermediate shaft.
  2. Slacken the two bolts fastening the right upright, then remove only the upper bolt.
- Move back the axle shaft just enough to disconnect it from the intermediate shaft.



1. Slacken the three bolts fastening the intermediate shaft.



1. Withdraw the intermediate shaft from the differential and withdraw the oil seal to be replaced.
2. Using tools no. 1.821.170.000 and no. 1.821.171.000 insert the new oil seal.



## OUTSIDE GEARBOX CONTROLS

### DESCRIPTION

The set of outside gearshifting controls differs in two types according to the type of gearbox used.

For the 2.0 T.S. 16v engine the traditional solution with rods and tie-rods has been adopted.

For the 3.0 V6 engine, a cable control system has been used which, in addition to improving the maintainability of the system, compared with the conventional system, it enables a considerable reduction of vibrations and the resulting noise, at the same time improving smoothness and precision in gear engagement: also for this version a gearbox control with syn-

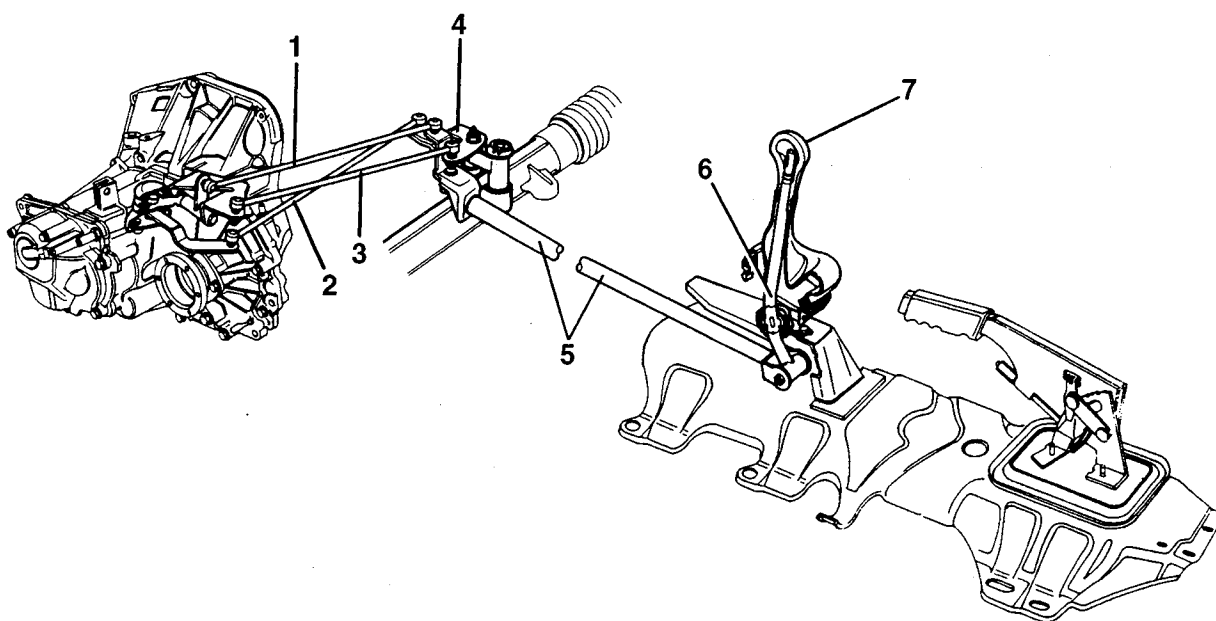
chronized reverse has been adopted: this is an innovative system which improves the engagement of reverse gear and prevents it from being engaged without synchronization.

This type of control is made with the addition of a supplementary cable, in addition to the two normal gear engagement and selection control cables.

The end of the cable, formed of a pin, locks the axial movement of the reverse gear selection fork.

Raising the sleeve under the lever knob, the cable is pulled, therefore also the pin which leaves the movement of the fork free thereby allowing engagement of reverse gear.

### VERSION WITH RODS AND TIE-RODS



1. Gear selection lever control tie-rod
2. Gear engagement lever control tie-rod
3. Reaction rod
4. Tie-rod relay support
5. Gear control rod
6. Gearshift lever
7. Gearshift lever knob

**SYNCHRONIZED REVERSE GEAR**

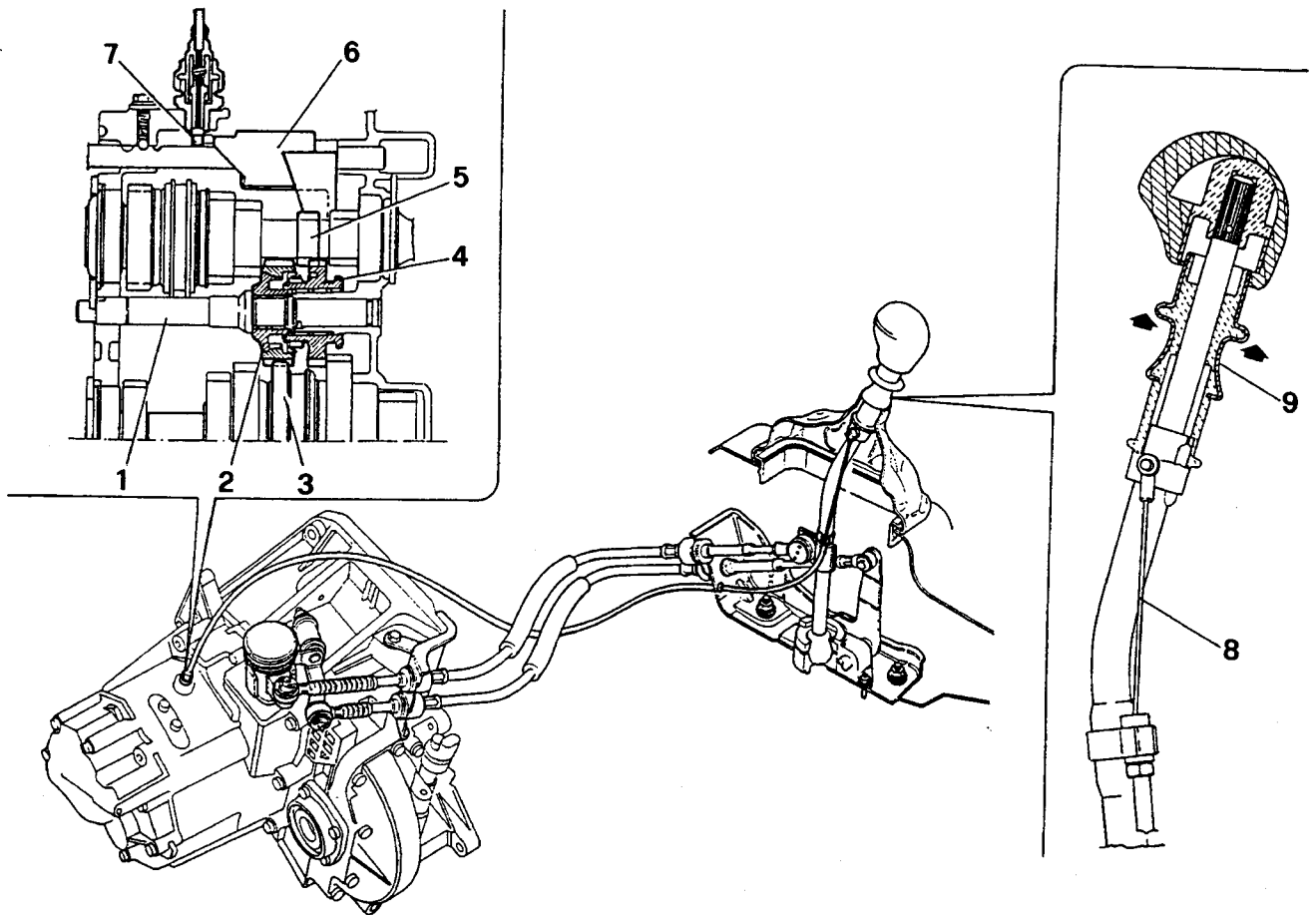
The version for the 6-cylinder engine has a synchronizer for reverse gear, which enables accurate and noiseless engagement.

The motion is reversed by the lay shaft (1) on which the following are to be found:

- a gear (2), with housing for the synchronizer, which constantly meshes with the gear (3) machined on the sleeve for engaging 1st and 2nd speed on the transmission shaft;
- a sliding gear (4) with synchronizer, which constantly meshes with the reverse gear (5) on the main shaft.

Reverse gear is engaged by the movement of the reverse gear selection rod with the corresponding fork (6) and consequently of the sliding gear (4) which becomes integral with the gear (2) through the synchronizer.

A safety device prevents the inadvertent engagement of reverse gear. This device comprises a pin (7) which blocks the axial movement of the reverse gear selection rod; the pin is controlled by a flexible cable (8) operated by a sleeve (9) under the gearshift lever knob. Raising the sleeve (9), the cable (8) releases the pin (7), allowing the rod to move freely thereby enabling the engagement of reverse gear.



1. Reverse gear layshaft
2. Reverse idler gear
3. 1st and 2nd gear engagement sleeve
4. Reverse gear with synchronizer
5. Reverse driving gear

6. Reverse gear selection rod fork
7. Reverse gear selection rod release pin
8. Selection rod release pin control cable
9. Reverse gear selection rod release pin control sliding sleeve