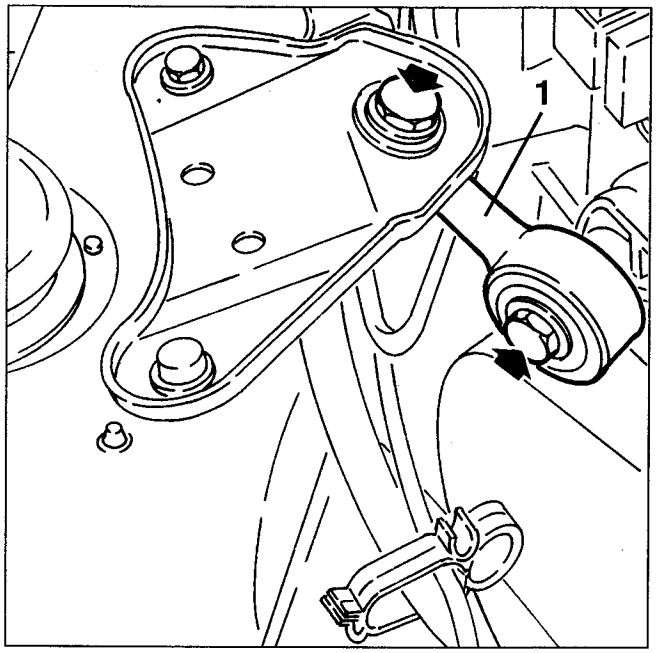
CHANGING THE CAMSHAFT OIL SEALS

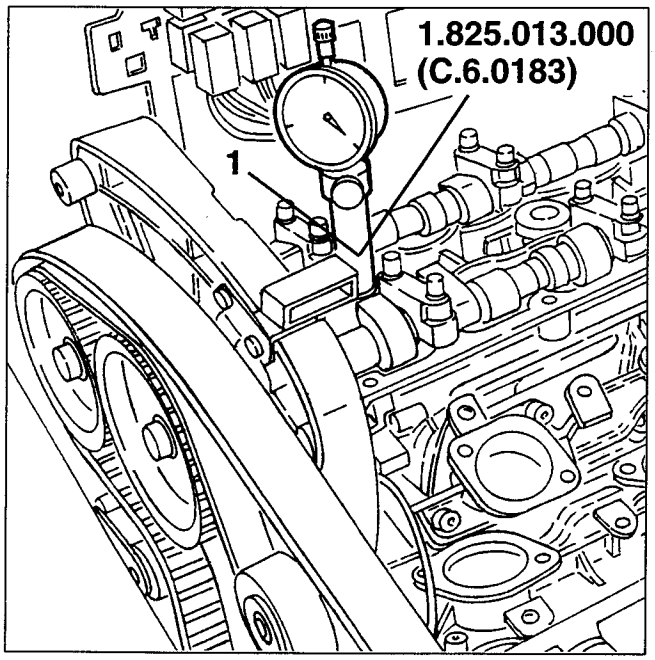
Proceed as described in Group 00 in the procedure "Changing the timing gear belt" up to removing the cylinder head covers.

1. Slacken the fastening screws and remove the engine stay rod.

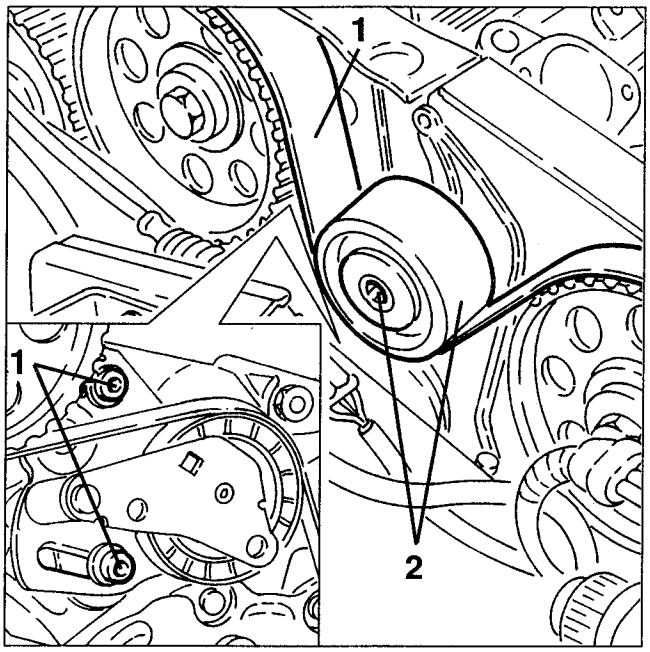


1. Install tool no. 1.825.013.000 (C.6.0183) complete with dial gauge in the seat of the 1st cylinder spark plug.
- Working on the fastening nut of the auxiliary components drive pulley turn the crankshaft slightly (both ways) until the piston of the 1st cylinder reaches T.D.C. in the bursting stroke.

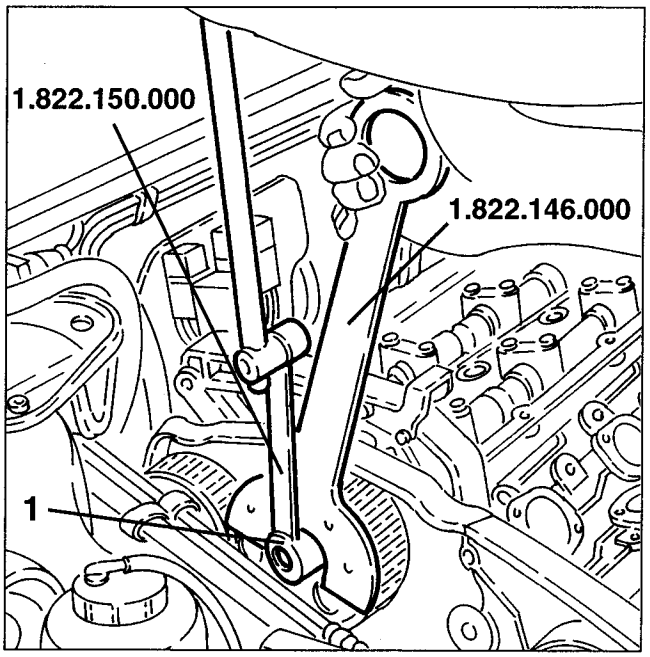
NOTE: Make sure that the last turn of the crankshaft is in the operating direction.



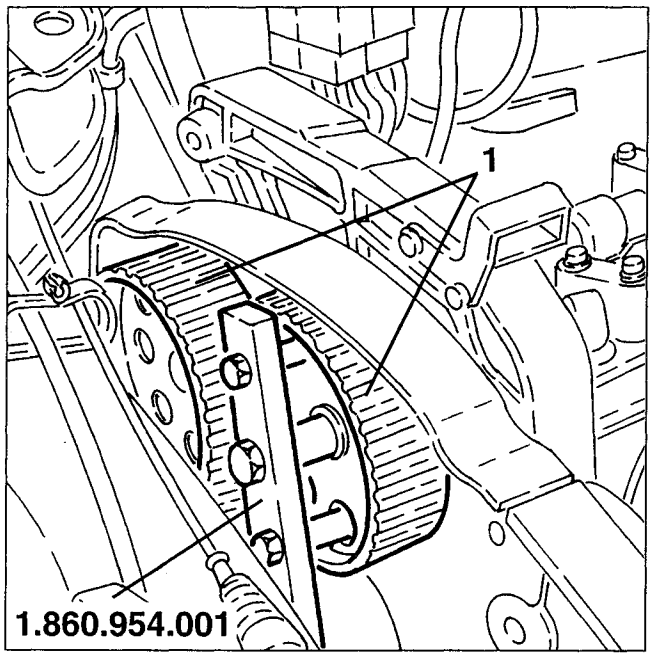
1. Slacken the two screws fastening the timing gear drive belt tensioner and remove the belt from the camshaft drive pulleys.
2. Slacken the fastening screw and remove the timing gear drive belt guide pulley.



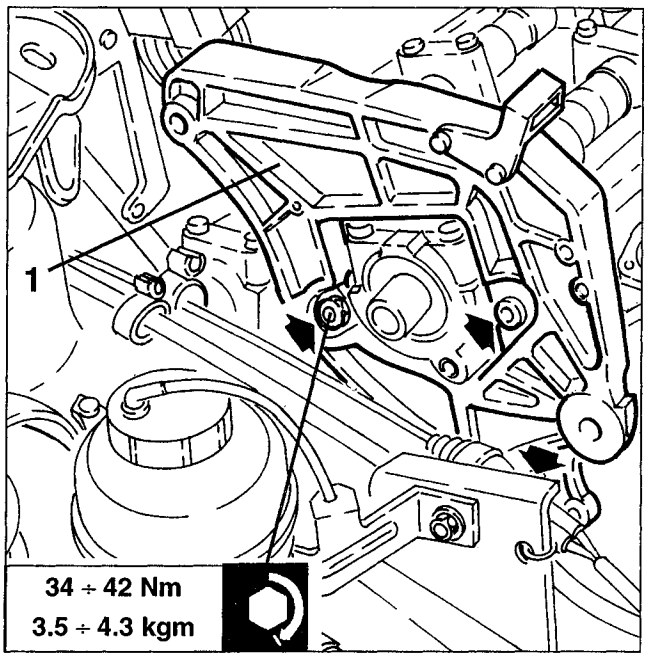
1. Using extension no. 1.822.150.000 and tool no. 1.822.146.000 as counter torque, slacken the screws fastening the camshaft drive pulleys.



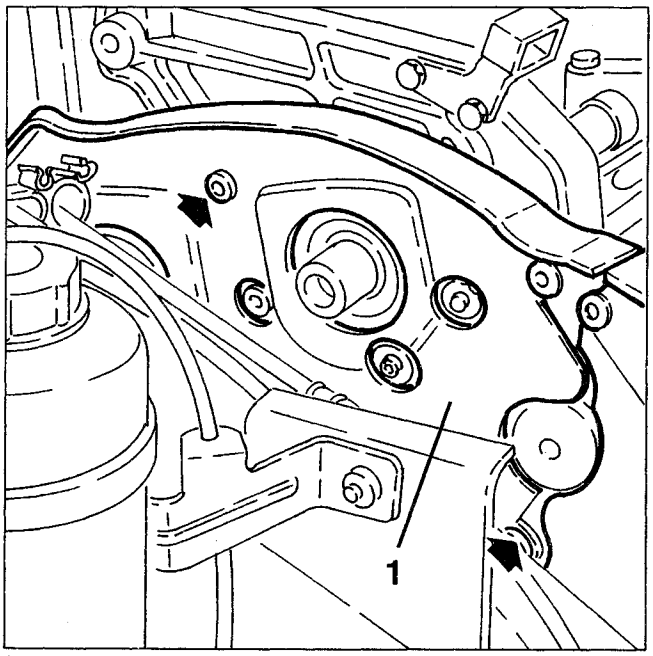
1. Using tool no. 1.860.954.001 pull remove the drive pulleys from the camshafts.



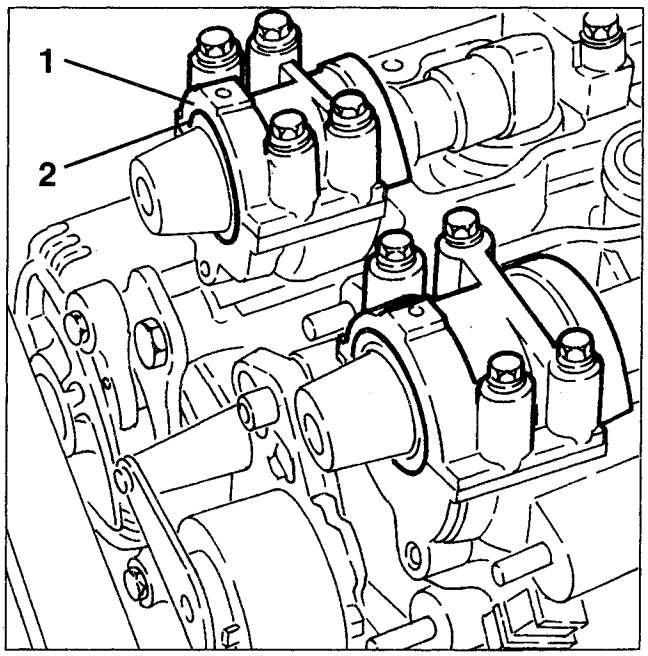
1. Slacken the fastening nuts and remove the engine stay rod support bracket.



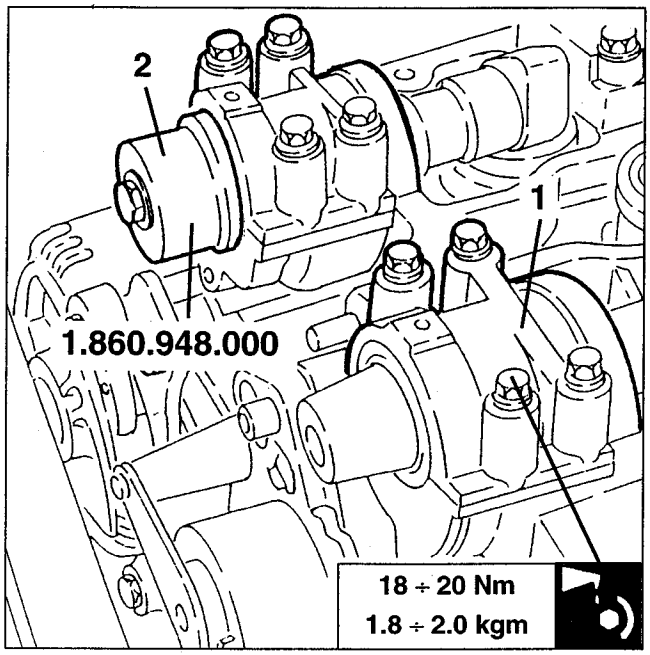
1. Slacken the fastening screws and remove the inner timing gear belt guard.



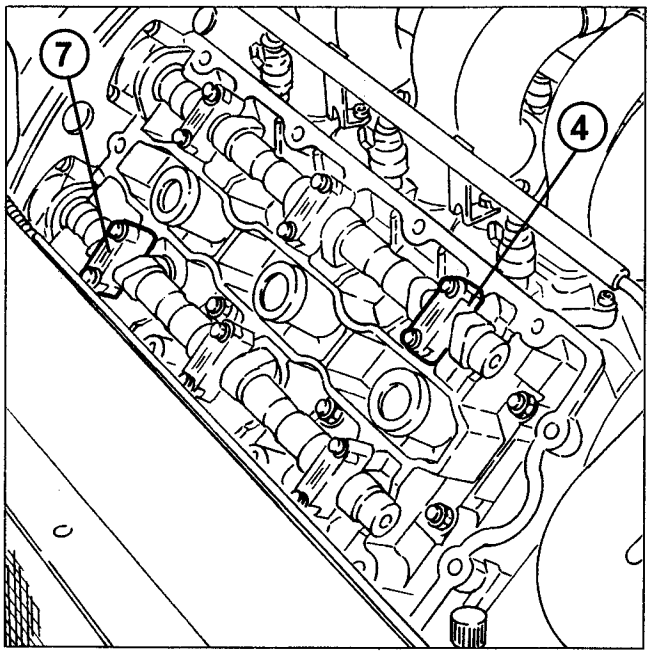
1. Slacken the fastening screws and remove the camshaft front caps.
2. Remove the oil seal rings.



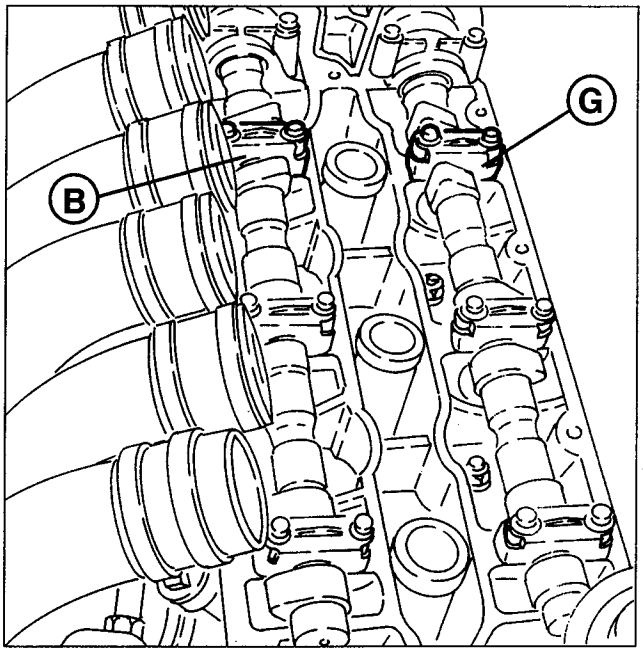
1. Refit the camshaft front caps and tighten the fastening screws to the specified torque.
2. Using tool no. 1.860.948.000, insert new camshaft oil seals.



- Refit the engine stay rod support bracket and the timing gear belt inner guard.
- Remove camshaft caps **4** and **7** for the left cylinder head.

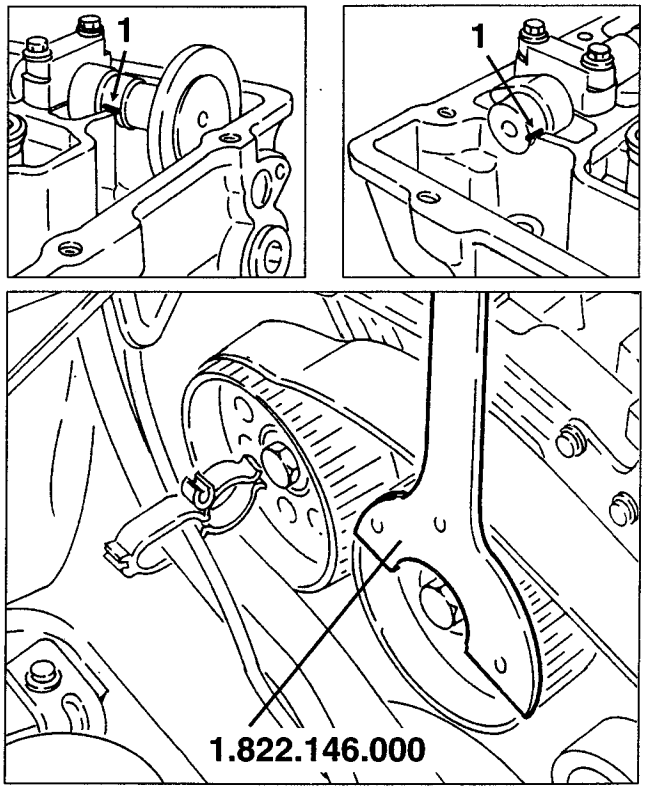


- Remove camshaft caps **B** and **G** for the right cylinder head.

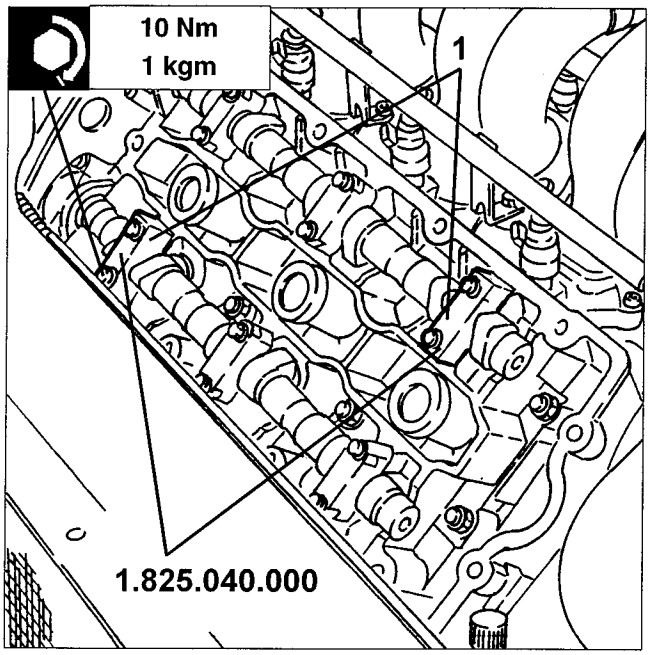


- Refit the camshaft drive pulleys tightening the fastening screws by hand.
1. Using tool no. 1.822.146.000, turn each camshaft until the reference notches on the shafts coincide with the upper surface of the cylinder head.

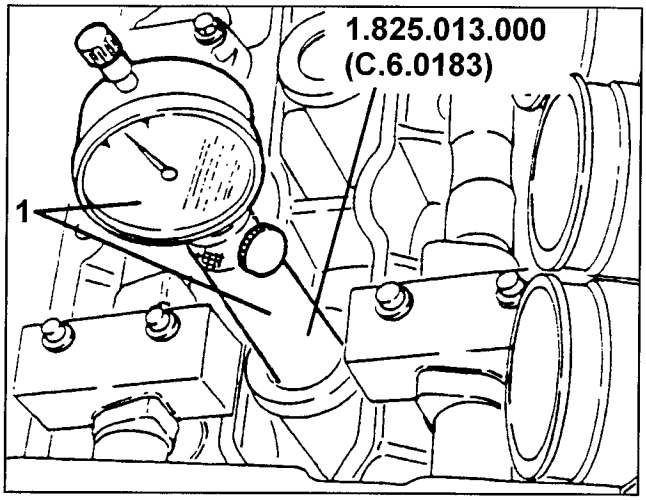
NOTE: The reference marks should face towards the centre of each head.



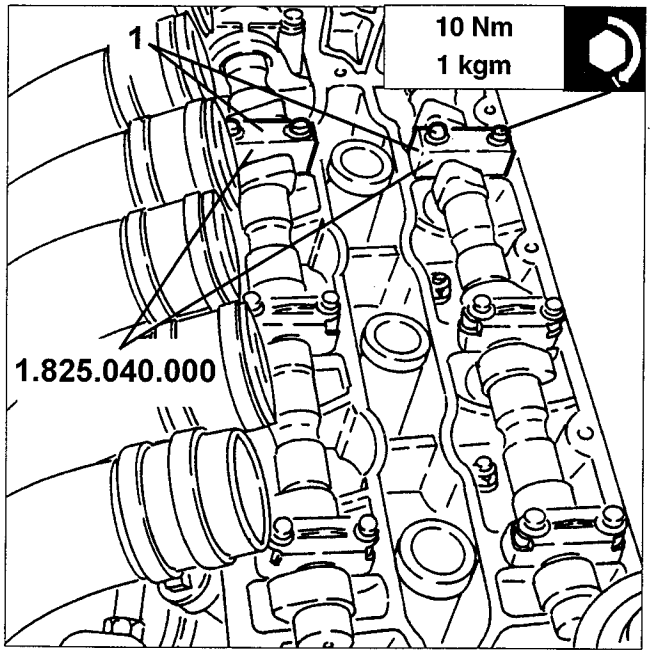
1. Fit templates no. 1.825.040.000 in the position printed on the templates in the place of camshaft bearings **4** and **7**.



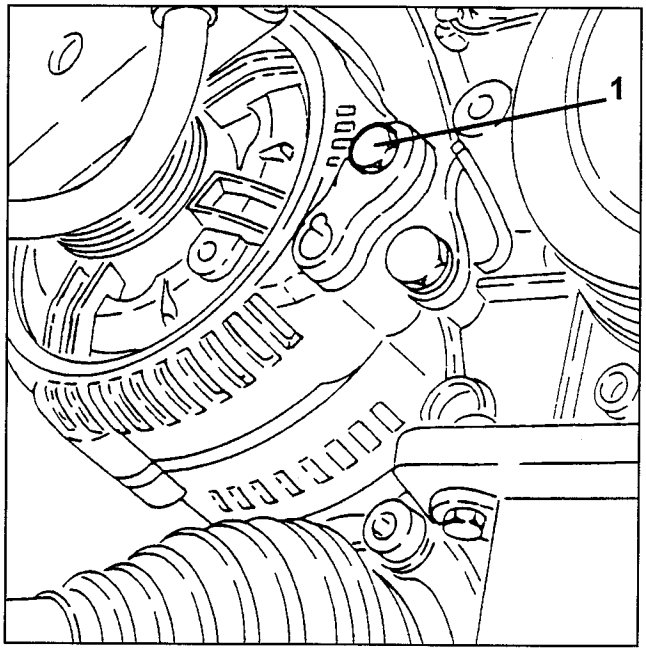
1. Check whether the 1st cylinder piston is at TDC, firing stroke. If not, move it to this position by slightly turning in both directions the auxiliary unit drive pulley fastening nut.
NOTE: Make sure the last revolution of the crankshaft is in the direction of operation.



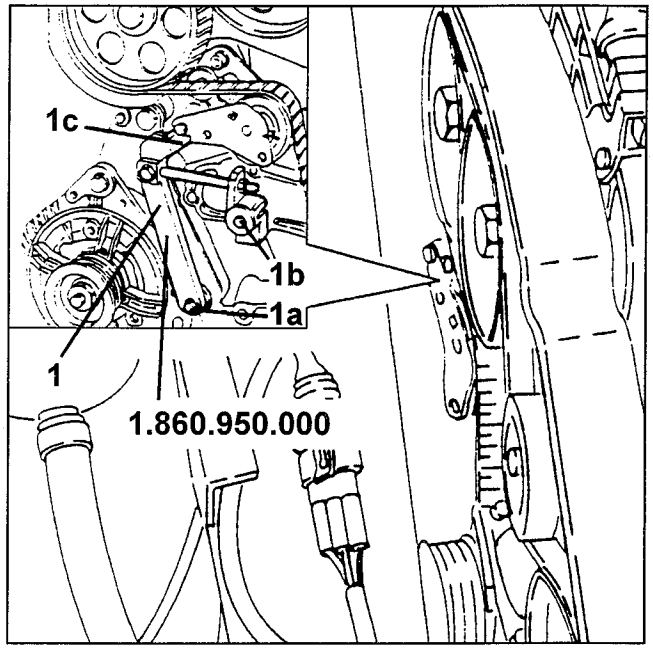
1. Fit templates no. 1.825.040.000 in the position printed on the templates in the place of camshaft bearings **B** and **G**.



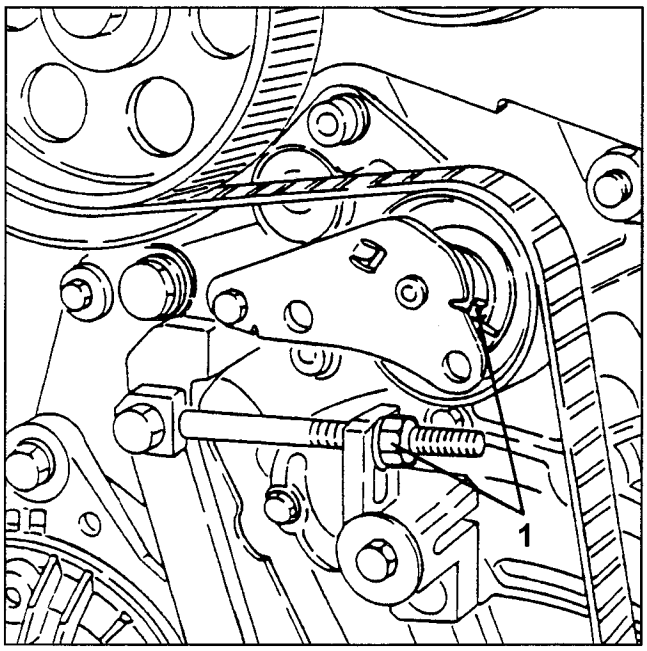
1. Loosen the lower alternator fastening screw to fit the timing belt tension tool.



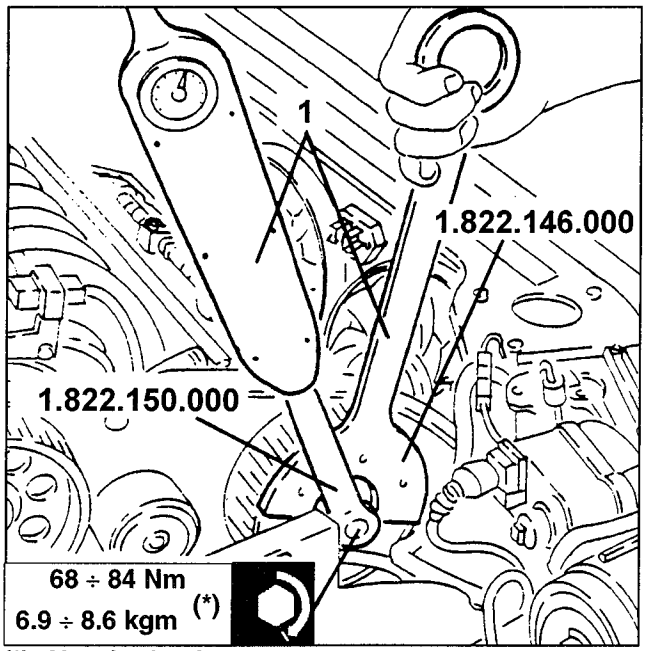
1. Fit timing belt tension tool no. 1.860.950.000 and fasten the previously loosened screw (1a) to the alternator and screw (1b) to the coolant pump; tool pin (1c) should contrast the belt take-up device mobile part.



1. Take the mobile notch under the belt take-up fixed notch as shown in the figure.

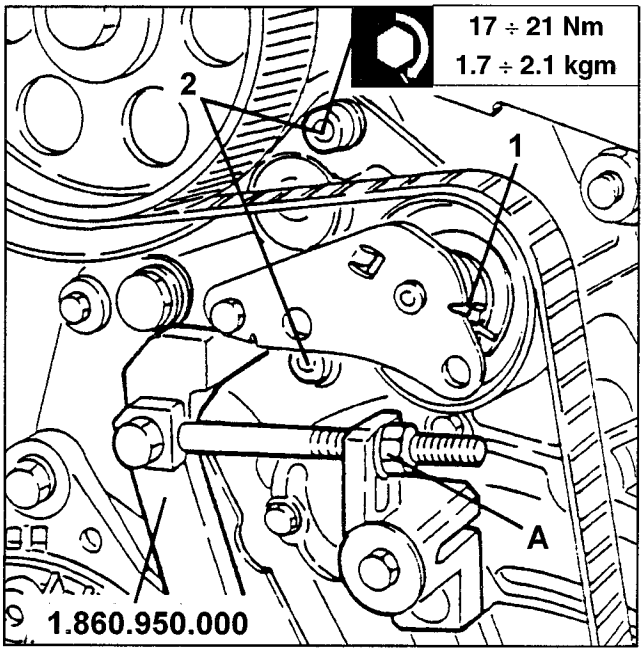


1. Use extension no. 1.822.150.000 and tool no. 1.822.146.000 to contrast torque. Fasten the camshaft drive pulley screws at the prescribed torque.



(*): Nominal value

- Remove the previously fitted templates no. 1.825.040.000. Fit the previously fitted bearings in their place and fasten the screws at the prescribed torque.
- Turn the crankshaft twice in the direction of revolution to fit the timing belt well.
1. Check whether the fixed notch on the belt take-up coincides with the mobile notch. If not, loosen the belt take-up tension by turning nut (A) until the notches meet.
2. Torque the belt take-up fastening nuts as prescribed and remove belt tension tool no. 1.860.950.000.

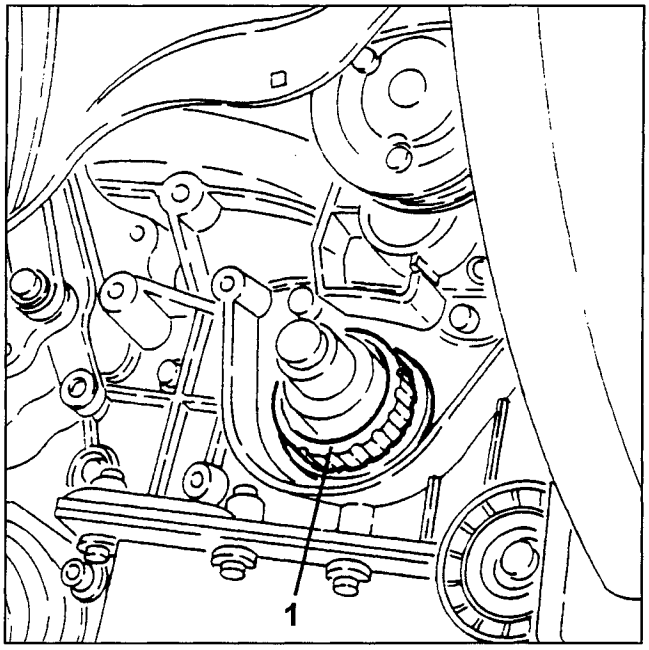


- Complete refitting by reversing the removal sequence.

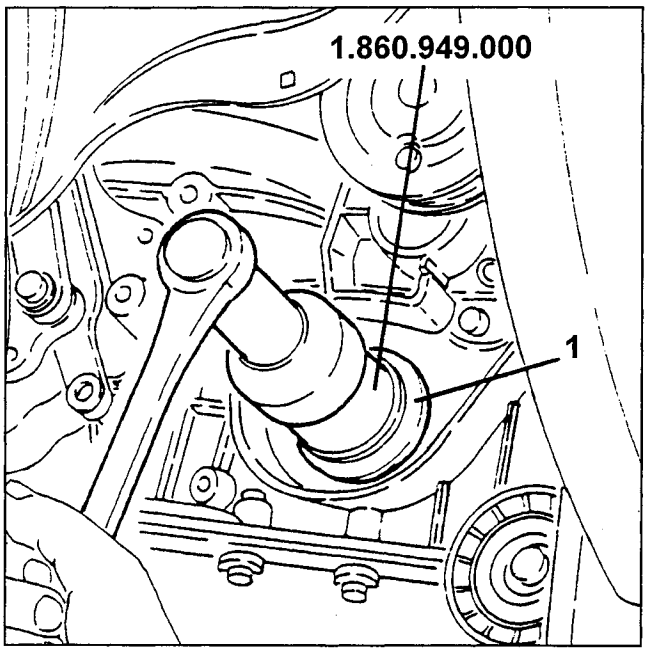
FRONT CRANKSHAFT OIL SEAL REPLACEMENT

Proceed as shown in Assembly 00, procedure "Replacing the timing belt" to remove the timing belt.

1. Remove the timing belt and thrust ring.



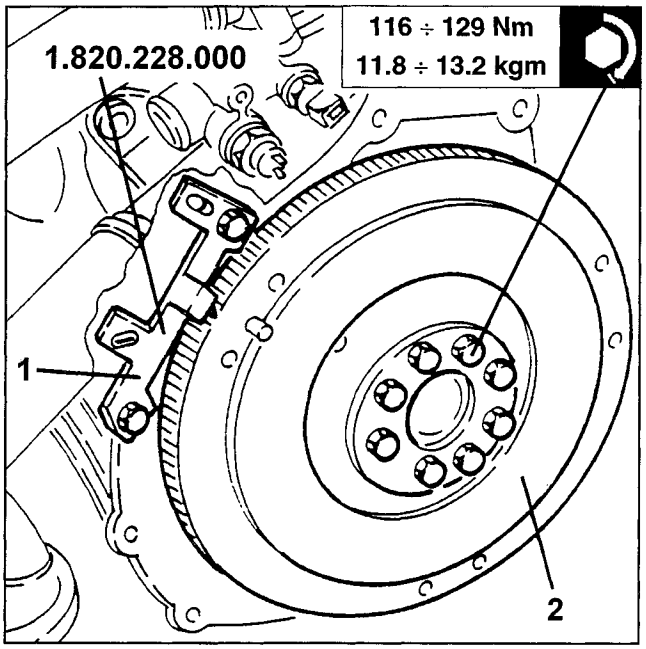
- Remove the crankshaft front oil seal.
1. Use tool no. 1.860.949.000 to introduce a new oil seal on the crankcase front cover.



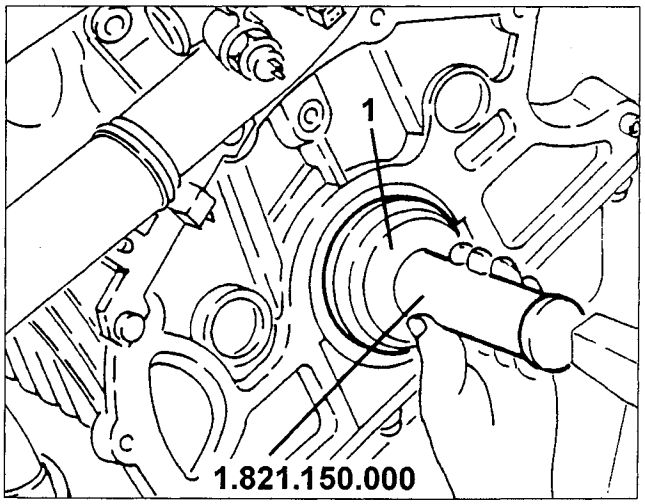
- Reposition the thrust ring. Make sure the convex surface is facing the front crankcase cover. Then refit the timing belt pulley.
Complete the refitting operation as described in the "Timing belt replacement" procedure from where it was interrupted.

REAR CRANKSHAFT OIL SEAL REPLACEMENT

- Remove the gearbox (see ASSEMBLY 21).
- Remove the clutch (see ASSEMBLY 18).
1. Fit the flywheel retainer no. 1.820.228.000.
2. Loosen the fastening screws and remove the flywheel.

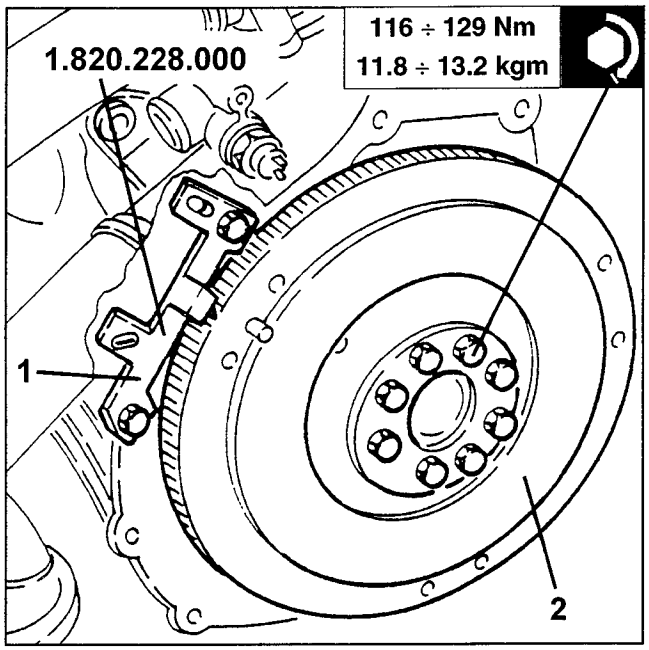


- Remove the rear crankshaft oil seal.
1. Use tool no. 1.821.150.000 to introduce a new rear crankshaft oil seal.

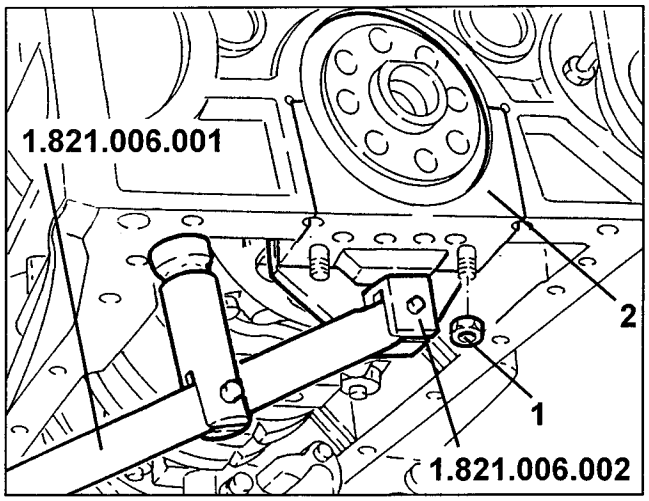


REAR CRANKSHAFT JOURNAL SILICON SEAL RESTORING

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



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

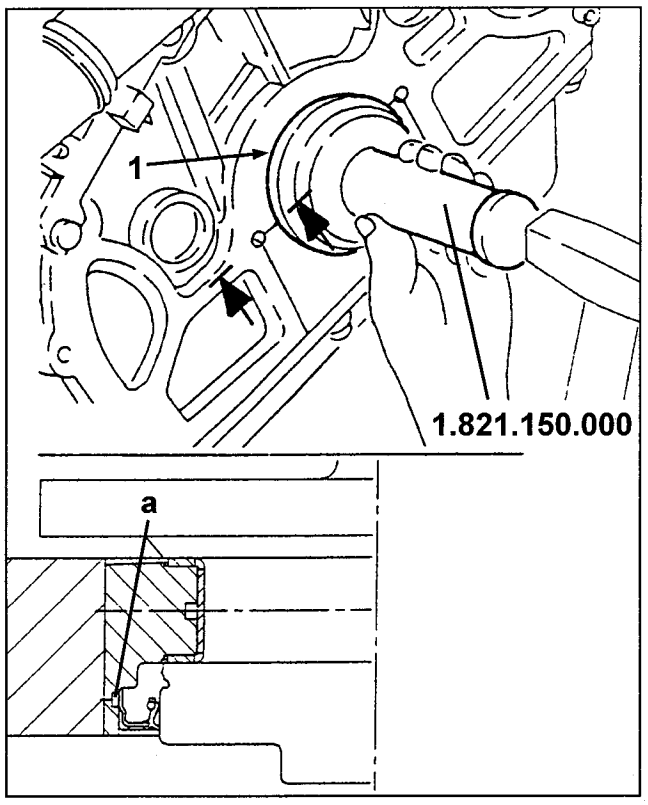


- Remove the main half-bearings.
- Remove the rubber seals (for vehicles up to engine no. 00708 only).
- Remove the engine rear crankshaft seal.
- Carefully remove sealant residues from the rear bearing seats, oil sump coupling surfaces and sealant drain holes (for vehicles from engine no. 00709 only).
- Carefully remove all traces of engine oil with heptane or similar solvent.
- Refit the rear main bearing with main half-bearing (after lubricating with engine oil) and torque the nuts at **25 Nm + 79°**.

NOTE: Use tool no. 1.860.942.000 for angle torque.

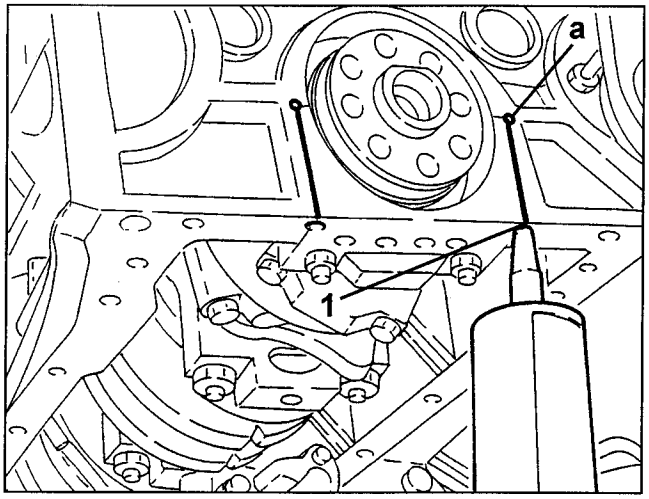
1. Refit crankshaft rear oil seal with tool no. 1.821.150.000.

NOTE: Fit the oil seal so that it covers holes (a).



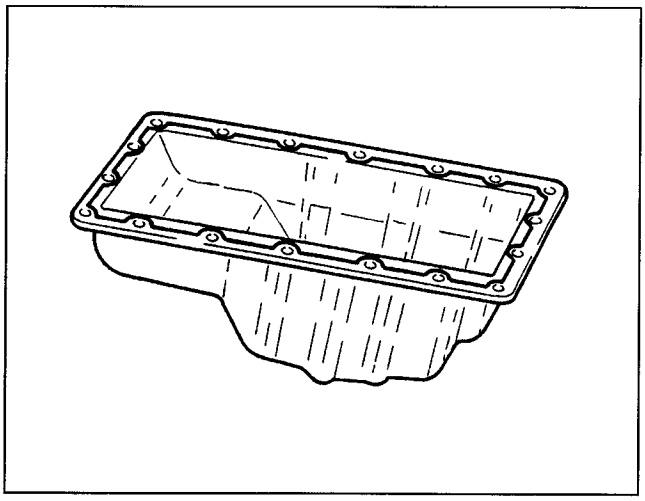
1. Apply "**DOW CORNING 7091**" silicon sealant with a mechanical gun through the holes shown in the figure.

NOTE: Check that the sealant seeps out from the rear crankcase-main bearing coupling along the entire length from holes (a) (for vehicles from engine no. 00708 only).



Refit by reversing the removal sequence attaining to the following precautions.

- Apply sealant to the oil sump. Make sure the strip of sealant (not wider than approximately 1.5 mm in diameter) is within the oil sump fastening holes (between reservoir and hole).



IMPORTANT: Fit the oil sump within 15 minutes from applying the sealant in the crankshaft rear seal holes.

GENERAL DESCRIPTION

Engines are governed by an electronic control system which manages and adjusts parameters, optimising performance and consumption by real time response to the various operating conditions.
This last generation, sophisticated system consists of a tested and reliable BOSCH MOTRONIC M 3.7.1 ECU which controls both ignition and injection.

SYSTEM OPERATION

Sequential, phased injection (S.E.F.I.)

Fuel injection governed by this ECU is sequential and phased for each cylinder.
The injection instant (when fuel is conveyed in the intake manifolds by opening the injectors) is not simultaneous in all cylinders but corresponds to the optimal injection point computed by the ECU according to specific maps on the basis of engine load, ratio and temperature.

Static ignition

An electronic "static distribution" ignition system is adopted (with semiconductors and without distributor). This solution eliminates rotating components.
Furthermore, the risk of interference is reduced.
Finally, high voltage wires and connections are reduced, as the power modules controlling the coil primary windings are inside the ECU.
The static ignition is ensured by six coils located on the cylinder heads.
Each coil directly powers a spark plug without intermediate wires.

Air intake flow meter

A modern "hot film" system is used to measure the intake air flow.
The flow meter is a duct located between the intake manifold and the air cleaner.
An electronic circuit and film are contained in the flow meter and are crossed by the air flowing in the duct.
The film is maintained at constant temperature (approximately 120°C warmer than the intake air temperature) by a resistance in contact with it.
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 and is proportional to the air flow.
N.B. This air flow meter directly measures the air mass (and not volume, as in the previous "floating flap" meters) thus eliminating problems related to temperature, altitude, pressure, etc. and ensuring optimal air and petrol mixture ratio.

Cylinder acknowledgement

A phase sensor has been introduced with the sequential, phase injection system (cam sensor angle).
This allows the system to acknowledge which cylinder is in firing stroke to start the correct injection sequence.
This sensor is a Hall effect device: the voltage signal sent to the ECU goes down suddenly when the pin on the right-hand cylinder head exhaust shaft crosses the sensor.
Consequently, the signal is sent each two crankshaft revolutions.
The rpm sensor, on the other hand, sends a reference signal at each engine revolution.
Each tooth step on the phonic wheel informs the ECU of the increased crankshaft angular position so to send injection to the suitable cylinder and to ignite the respective 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.

– **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 load 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.

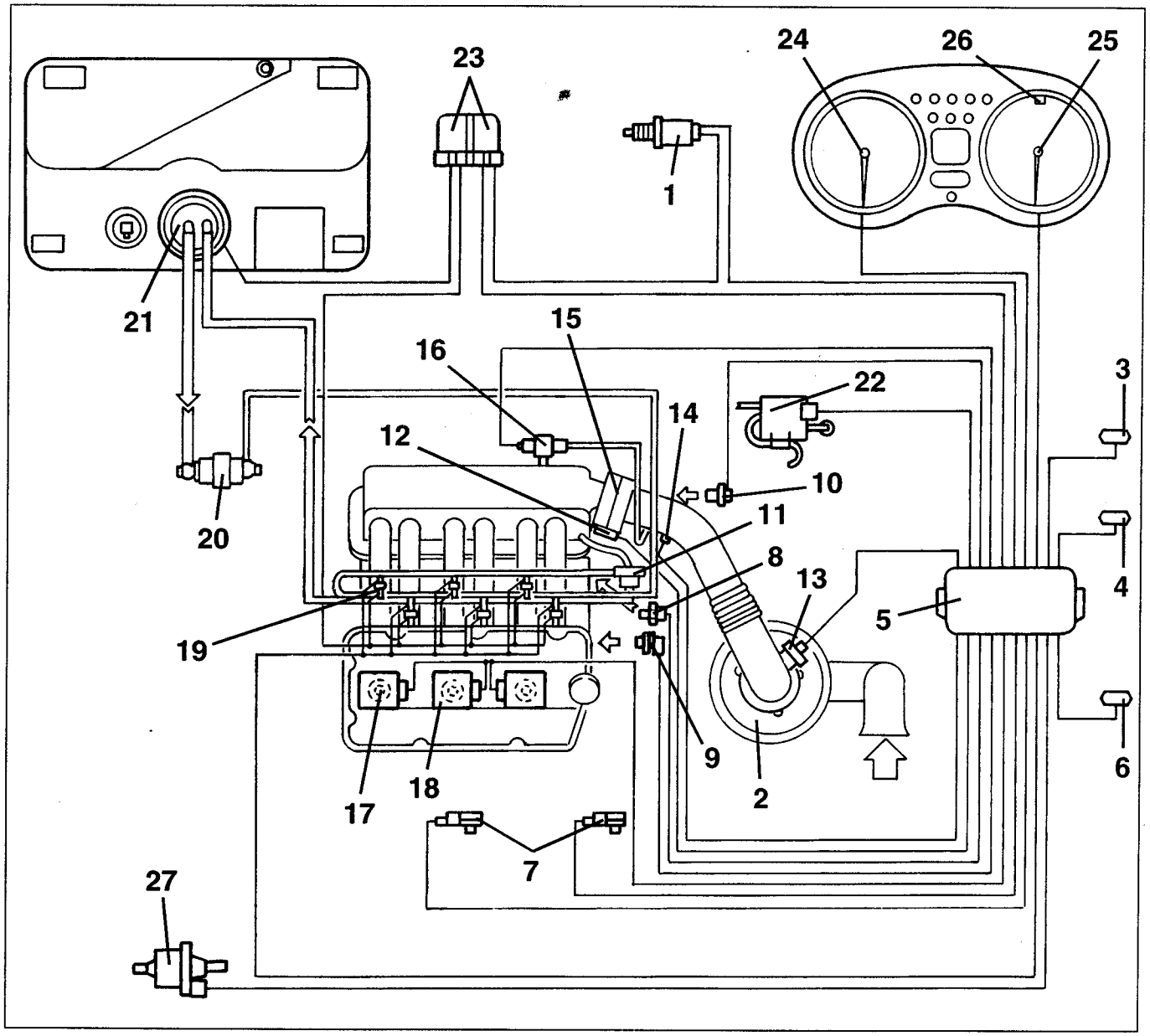
– **E.G.R. valve control**
The percentage of exhaust gas to be returned to the engine is determined by the control unit taking account of a specific characteristic curve which depends on the engine load and speed: recirculation is only activated when the engine speed is between 2500 and 4000 rpm., also 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 momentaneously 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**
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.

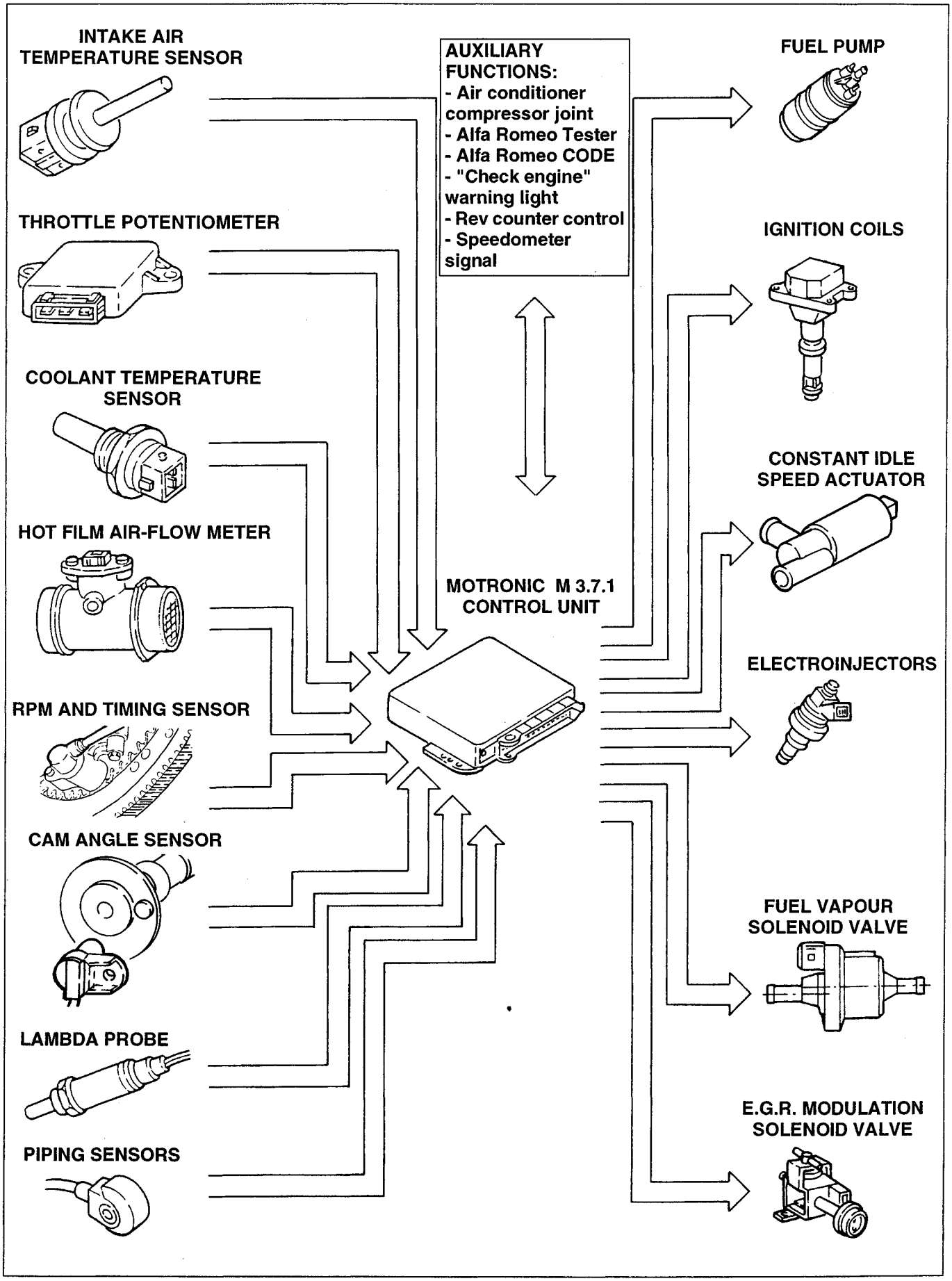
– **Self-diagnosis:**
the control unit possesses a **self-diagnosis system**, which continuously monitors the plausibility of the signals from the various sensors and compares them with the limits allowed: if these limits are exceeded, the system detects a fault and turns on the corresponding warning 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 M 3.7.1 INJECTION-IGNITION SYSTEM

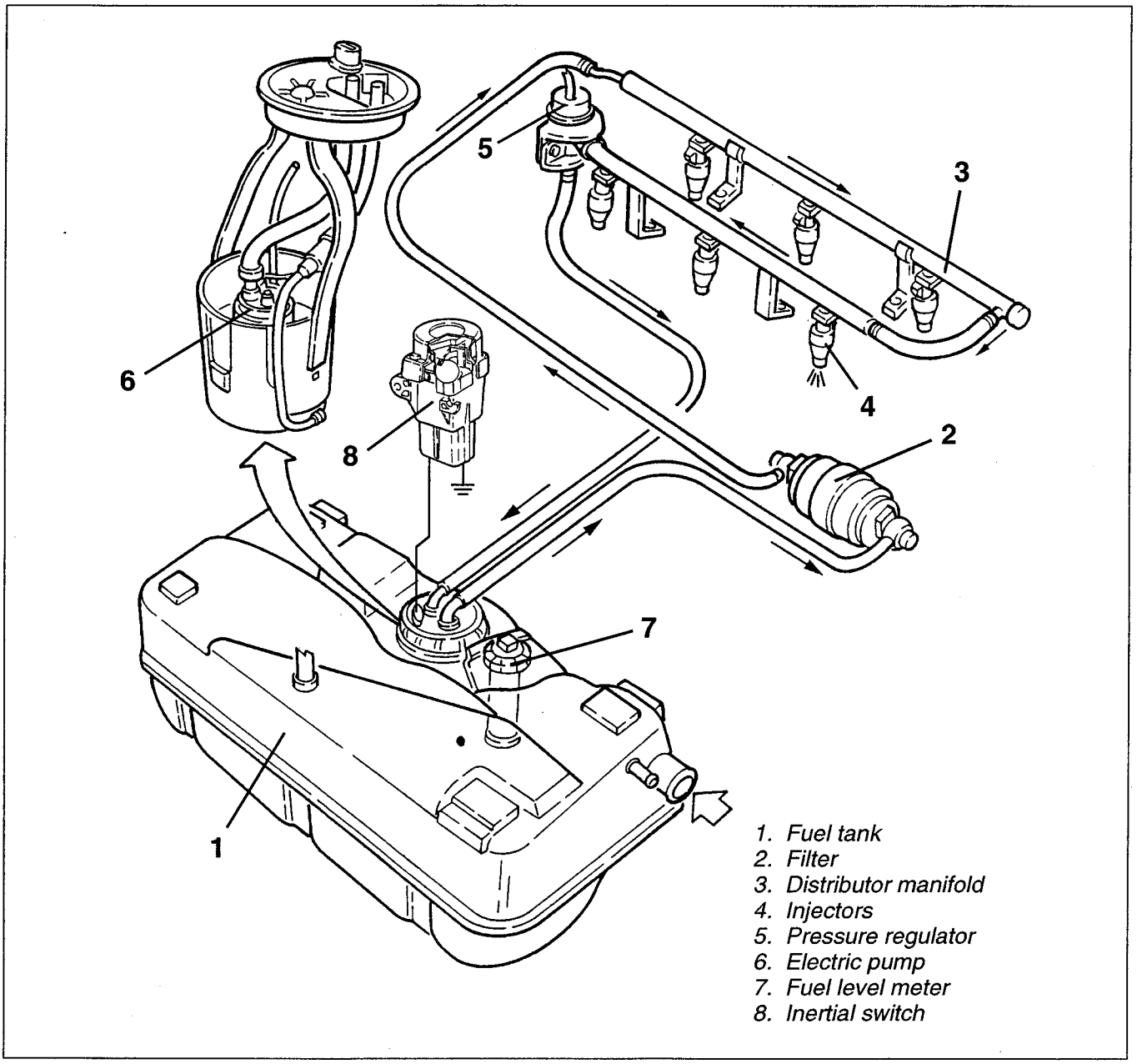


1. *Lambda sensor*
2. *Air cleaner*
3. *Climate control unit connector*
4. *Diagnosis socket (Alfa Romeo Tester)*
5. *Injection-ignition control unit*
6. *Alfa Romeo CODE control unit connector*
7. *Pinging sensors*
8. *Coolant fluid temperature sensor (NTC)*
9. *Rpm and timing sensor*
10. *Timing sensor*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

OPERATING LAYOUT OF MOTRONIC M 3.7.1 INJECTION-IGNITION SYSTEM



DESCRIPTION OF THE FUEL SUPPLY SYSTEM



1. *Fuel tank*
2. *Filter*
3. *Distributor manifold*
4. *Injectors*
5. *Pressure regulator*
6. *Electric pump*
7. *Fuel level meter*
8. *Inertial switch*

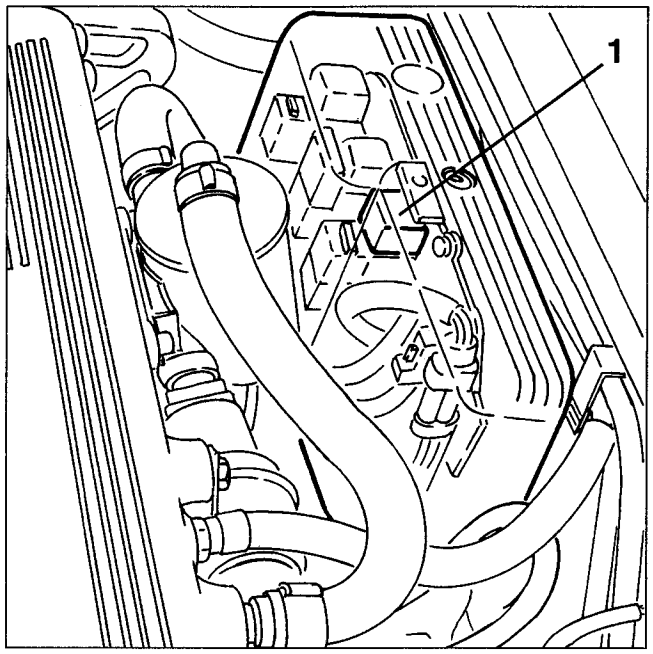
The fuel supply circuit comprises an electric pump (6) located in the fuel tank (1) which sends the fuel under pressure to the filter (2) through a special pipe.
From here the fuel is sent to the distributor manifold (3) which distributes it to the injectors (4).
Through the pressure regulator (5) controlled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

The fuel supply system is fitted with an inertial switch which is triggered in the event of a crash, cutting off the fuel pump connection to earth and thereby the supply to the injection system.

Notes on utilisable fuels:
in order to work properly, the engine requires the use of unleaded petrol (95 R.O.N.) as the presence of lead would quickly wear out the catalytic converter of the exhaust system.

WARNINGS

Before working on components of the fuel supply system, to prevent dangerous fuel spilling, proceed as follows:
- Disconnect the fuel pump supply relay (1).

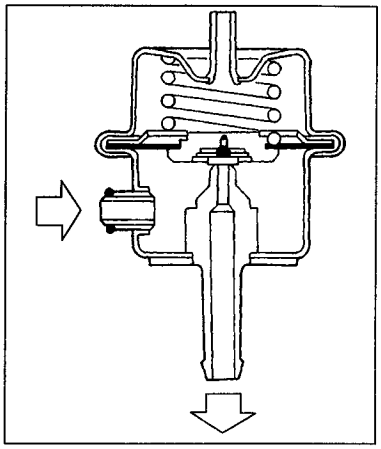


- Run the engine until it stops.

FUEL PRESSURE REGULATOR

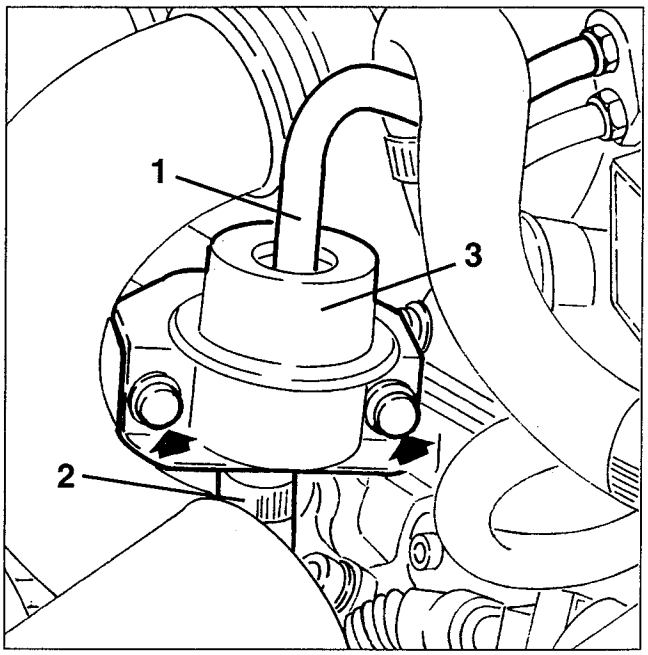
The task of the fuel pressure regulator is to keep a constant difference between the pressure of the fuel and the pressure in the intake manifold.
This way it is possible to meter the quantity of fuel solely on the basis of the injector opening time.
The pressure regulator is fitted downstream of the fuel distributor manifold.
It is a regulating-limiting device controlled by a diaphragm which adjusts the fuel pressure at 3 bar.
When the fuel pressure exceeds the maximum rating, the diaphragm operates a valve which opens the return pipe, through which the excess fuel retruns to the tank.

A tube connects the regulator spring chamber with the intake box.
Through this connection an interdependence is created between the pressure of the fuel circuit and pressure in the intake box, so that the pressure between the injector inlet and outlet is always the same when they are open.



REMOVING/REFITTING

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

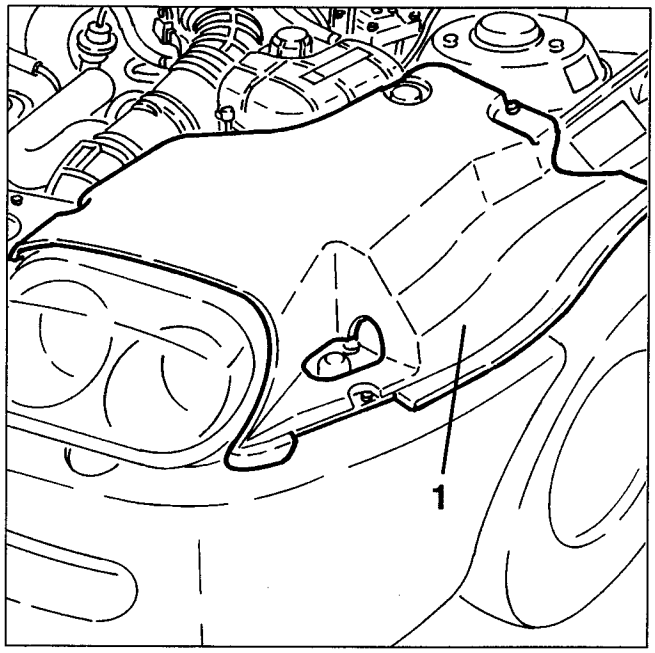


INJECTORS

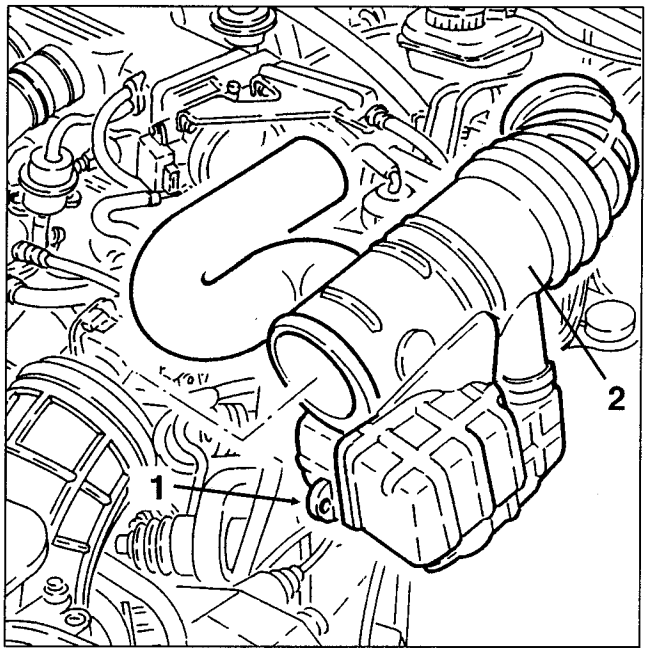
REMOVING/REFITTING

- Set the car on a lift.
- Disconnect the battery (-) terminal.

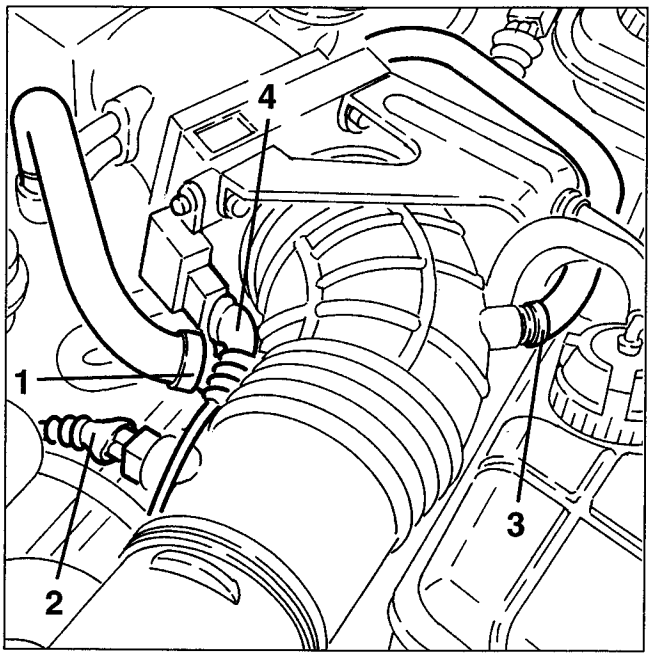
1. Remove the left hand engine compartment trim.



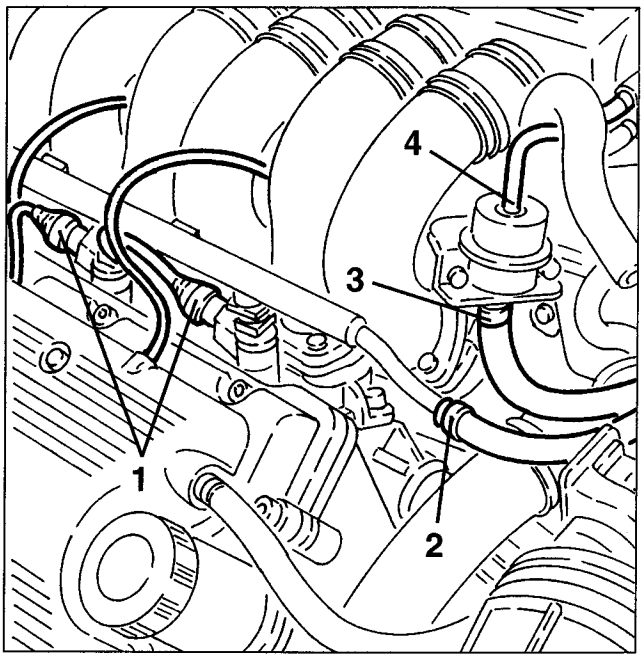
1. Remove the button fastening the first section of the corrugated sleeve to the resounder.
2. Slacken the two fastening clamps and remove the second section of the corrugated sleeve complete with resounders.



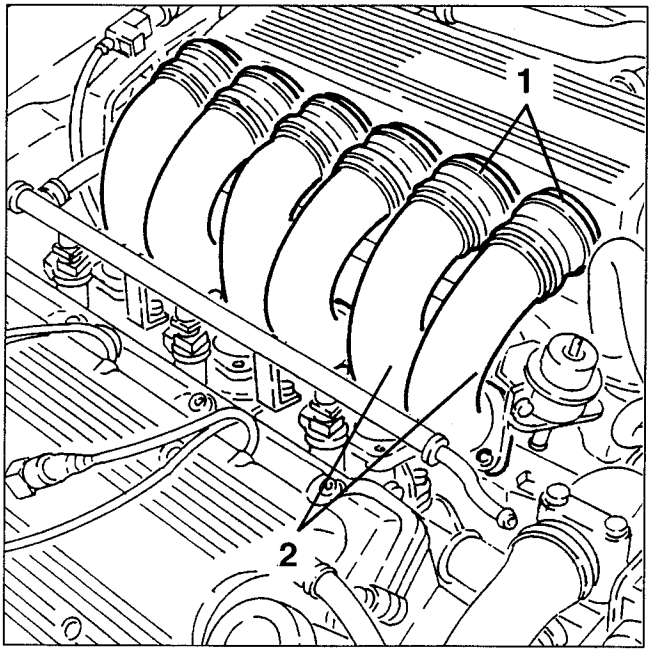
1. Disconnect the fuel vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.
2. Disconnect the electrical connection from the intake air temperature sensor.
3. Disconnect the air takeoff pipe for the constant idle speed device from the corrugated sleeve.
4. Disconnect the electrical connection from the throttle potentiometer.



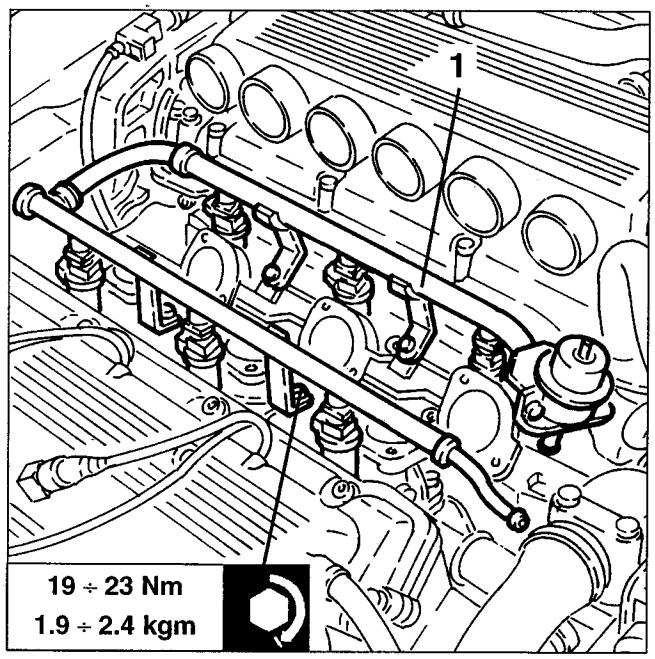
1. Disconnect the electrical connections from the injectors
2. Disconnect the fuel delivery pipe from the distributor manifold.
3. Disconnect the excess fuel return pipe from the pressure regulator.
4. Disconnect the vacuum takeoff pipe from the pressure regulator.



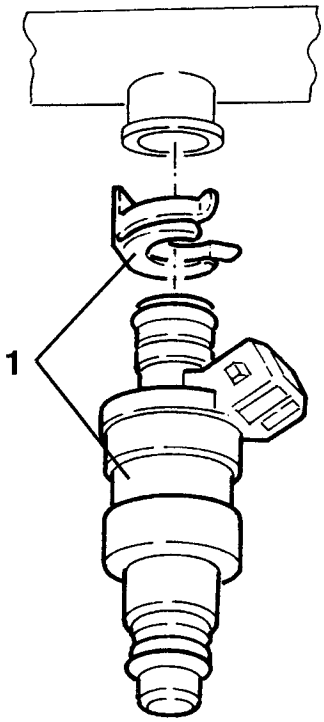
1. Slacken the clamps fastening the supply ducts to the intake box.
2. Slacken the fastening screws and remove the supply ducts.



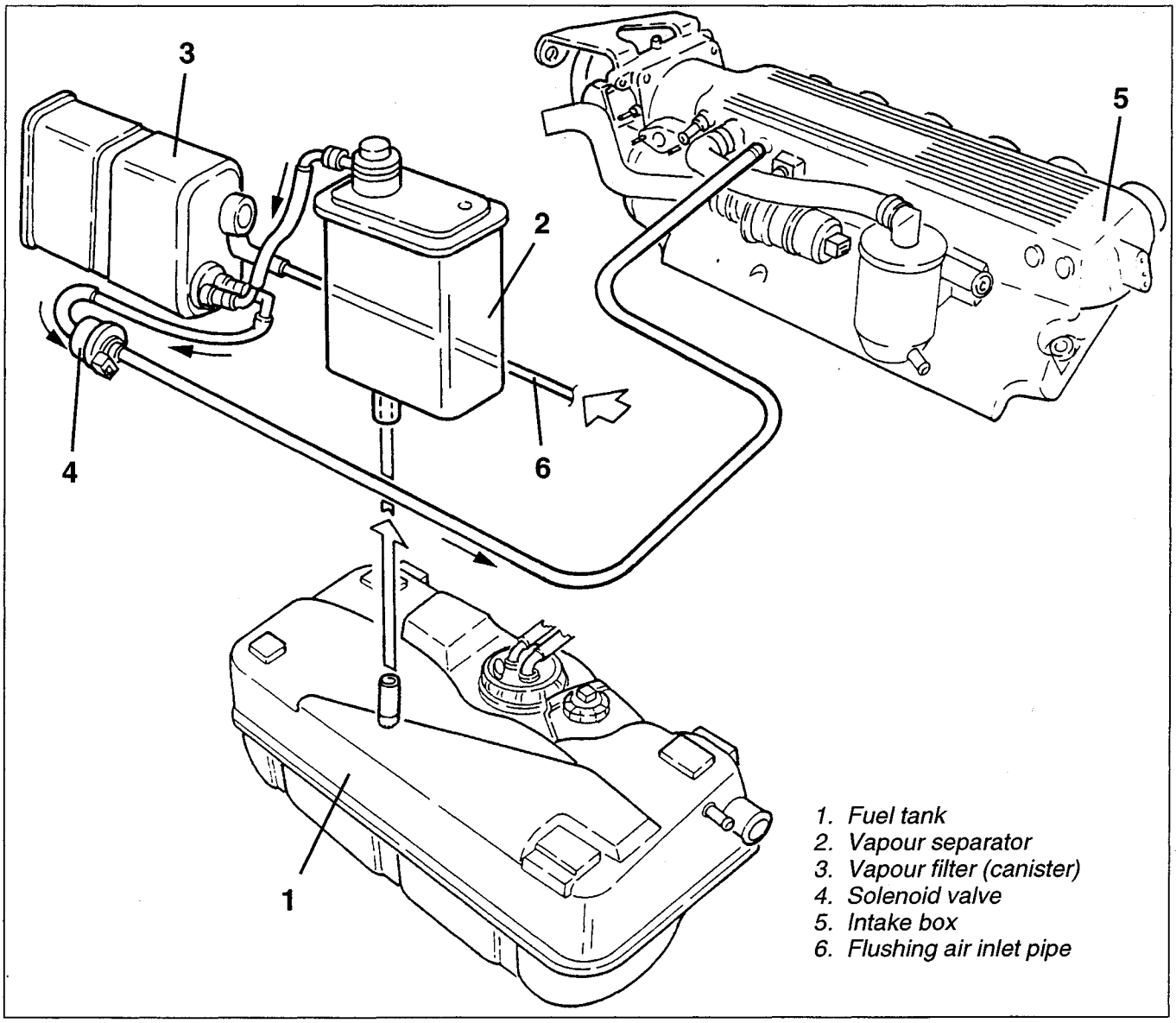
1. Slacken the fastening screws and remove the distributor manifold complete with pressure regulator and injectors.



1. Working on the bench, remove the safety catches and remove the injectors from the distributor manifold.



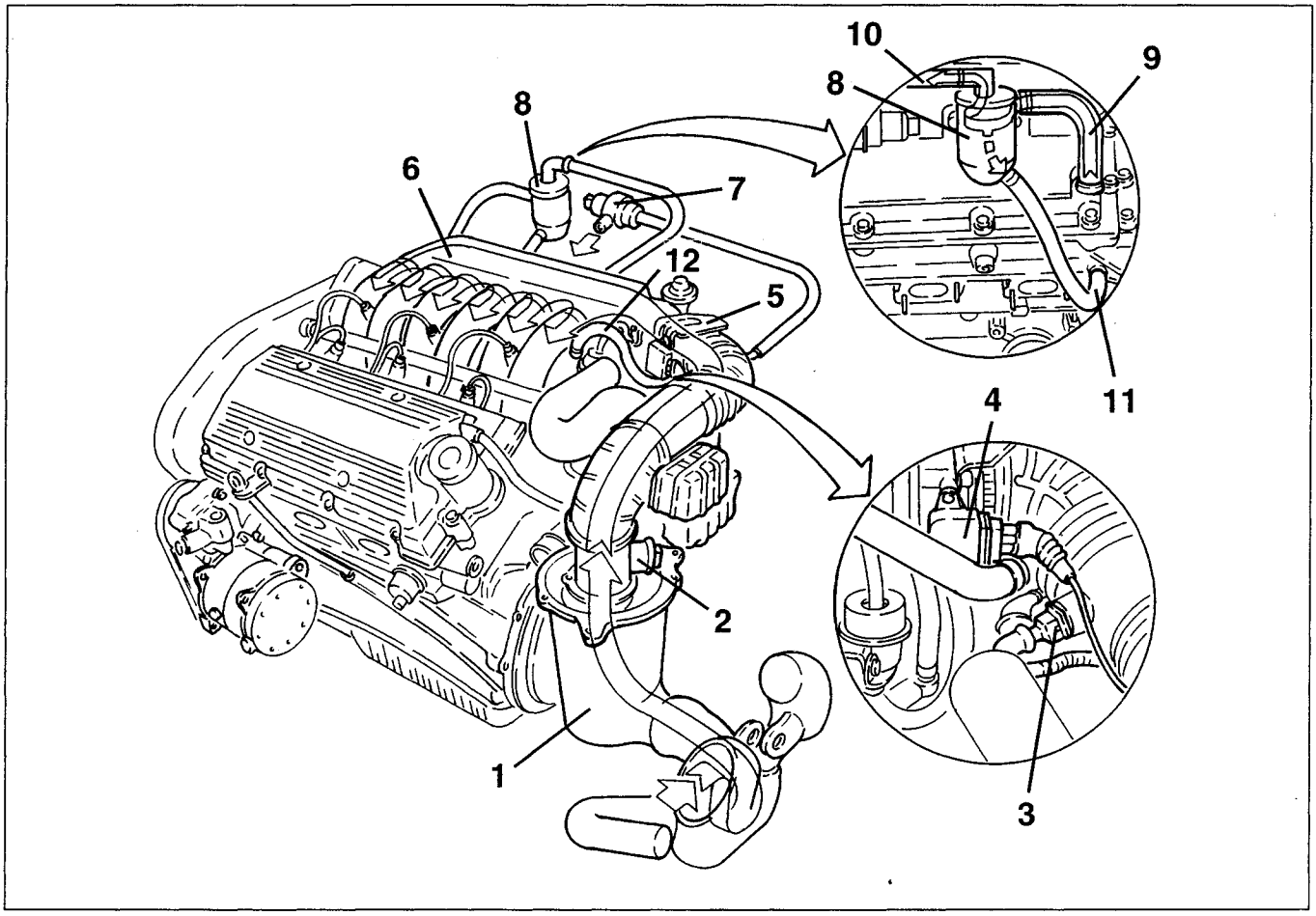
DESCRIPTION OF THE FUEL VAPOUR RECOVERY SYSTEM



1. *Fuel tank*
2. *Vapour separator*
3. *Vapour filter (canister)*
4. *Solenoid valve*
5. *Intake box*
6. *Flushing air inlet pipe*

The fuel contained in the fuel tank produces a considerable amount of vapours which would pollute if released to the environment.
The system for controlling and recovering these vapours makes it possible to recover them and burn them in the engine.
The vapours leading from the fuel tank (1) through a special tube reach the vapour separator (2) which, due to its shape, allows the condensed fuel to return to the tank in droplet form.
The remaining vapours are then sent to the fuel vapour filter "canister" (3) where they are absorbed and stored by the activated carbon it contains.
There is a solenoid valve (4) between the fuel vapour filter and the engine intake; when the solenoid valve is not activated, the connection with the intake box is closed and the vapours are gathered inside the canister by the activated carbon.
Under certain load conditions, the control unit opens the solenoid valve allowing any vapours in the canister to be taken in.
This condition remains even if the lambda sensor detects a lowering of the oxygen at the exhaust which, due to excess presence of fuel in the combustion chamber, is signalled to the control unit which lowers the delivery rate of the injectors so that the engine is always supplied under optimum conditions.
In the event of a lack of fuel vapours in the canister, resulting in only air being withdrawn, the lambda sensor detects this and signals an increase of oxygen to the control unit.
In this case, the control unit shuts the solenoid valve, preventing connection of the canister with the intake box, thereby eliminating the excess air.

DESCRIPTION OF THE AIR SUPPLY AND OIL VAPOUR RECOVERY SYSTEM

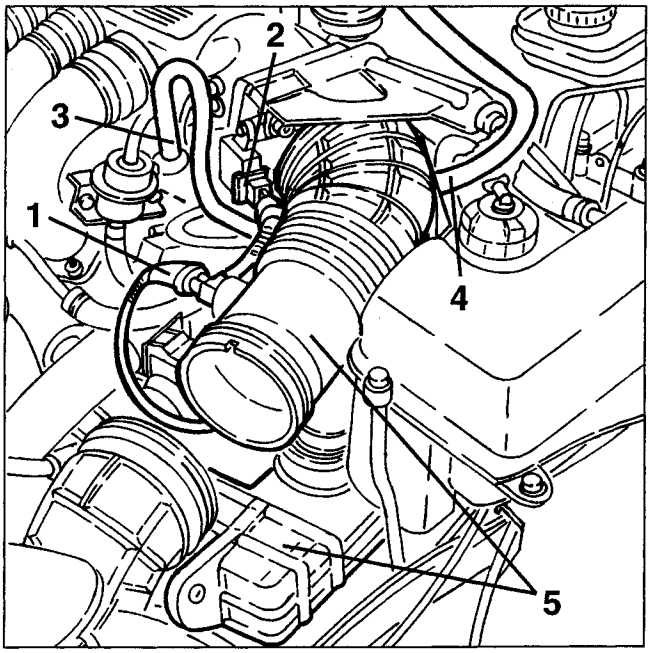


1. *Air cleaner*
2. *Air flow meter*
3. *Intake air temperature sensor*
4. *Throttle potentiometer*
5. *Throttle body*
6. *Intake box*
7. *Constant idle speed actuator*
8. *Oil vapour separator*
9. *Oil vapour recovery pipe*
10. *Oil vapour recirculation pipe*
11. *Condensed oil recovery pipe*
12. *Oil vapour recovery pipe*

The air, taken in through a dynamic inlet and filtered by a cartridge element (1), flows through the hot film flow meter (2) and from here, through the corrugated sleeve, on which the intake air temperature sensor (3) is fitted, it reaches the throttle body (5). Along the intake duct, "resounders" are installed, some of which are machined directly on the pipes and others are separable.
The throttle body, controlled by the accelerator cable, adjusts the quantity of air taken in by the box (6).
On one side of the throttle body there is the potentiometer (4) fastened to the throttle rotation spindle which informs the control unit of the position of the throttle. On the intake box there is an additional electromagnetic valve (7) which, through a special tube, by-passes the throttle body making it possible to keep idle speed constant under particular engine operating conditions.

The fuel vapours and oil vapours converge at the air supply system.
The latter are developed while the engine is running and are collected in the special separator via a pipe (9) leading from the right cylinder head; as the separator temperature is lower, the oil vapours are partially condensed.
The condensed oil returns to the engine via a special pipe (11), while the remaining vapours are sent directly to the intake box through a pipe (10) and then burnt in the engine.
An additional pipe (12) collects the oil vapours from the right cylinder head and sends them to the intake corrugated sleeve.

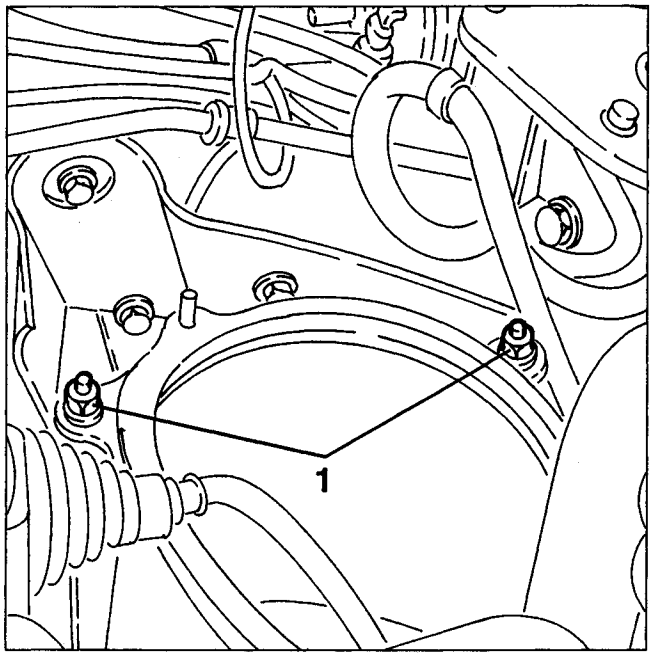
1. Disconnect the electrical connection from the intake air temperature sensor.
2. Disconnect the electrical connection from the throttle potentiometer.
3. Disconnect the oil vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.
4. Disconnect the air takeoff pipe for the constant idle speed device from the corrugated sleeve.
5. Slacken the clamp fastening to the throttle body, then remove the intermediate resounder complete with corrugated sleeve and separate them on the bench.



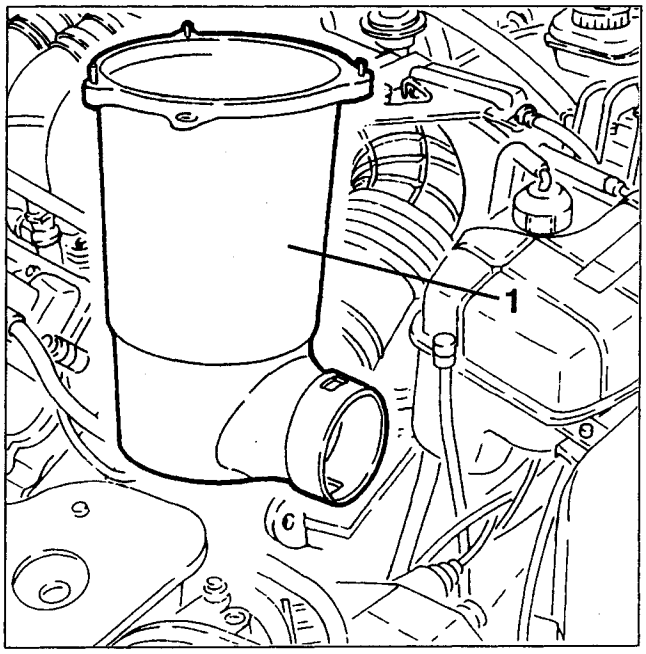
AIR CLEANER BOX

REMOVING/REFITTING

- Remove the air cleaner cartridge (see specific paragraph).
1. Slacken the two nuts fastening the air cleaner box.



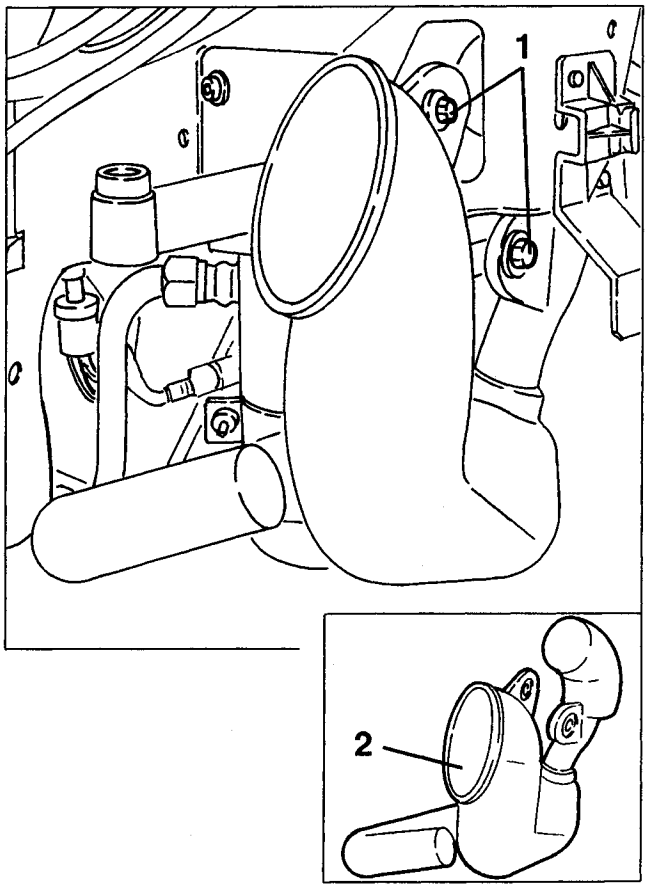
1. Remove the the air cleaner box releasing it from the lower resounder.



LOWER RESOUNDER

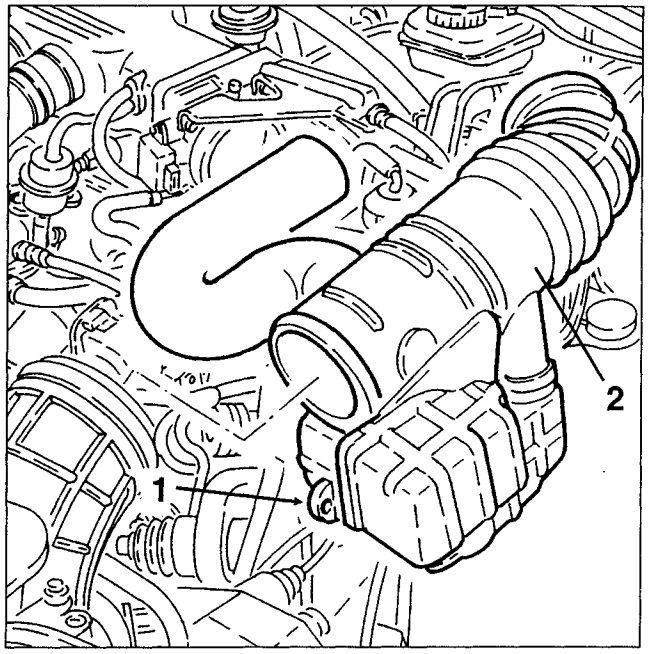
REMOVING/REFITTING

- Remove the front bumper (see GROUP 70).
1. Slacken the two screws fastening the lower resounder.
2. Remove the lower resounder releasing it from the air cleaner box.



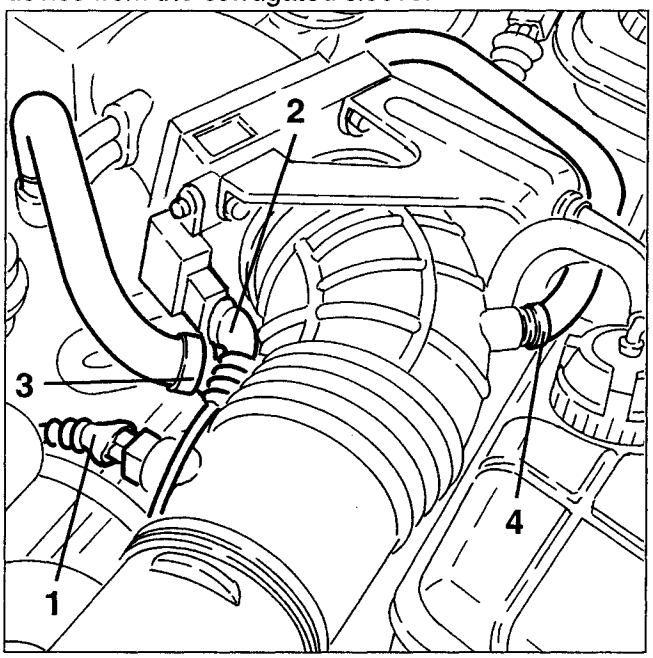
THROTTLE BODY

The throttle body adjusts the amount of air sent to the intake box depending on the accelerator pedal position.
The accelerator cable acts on a special 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 returning to the closed position, the throttle body is heated by the engine coolant fluid.



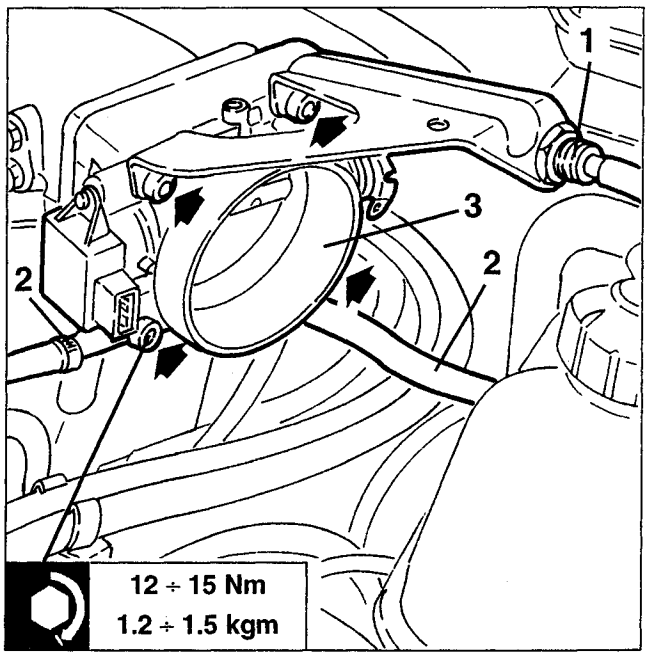
REMOVING/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the intake air temperature sensor.
2. Disconnect the electrical connection from the throttle potentiometer.
3. Disconnect the oil vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.
4. Disconnect the air takeoff tube for the constant idle device from the corrugated sleeve.



1. Prise of the button fastening the first section of the corrugated sleeve to the intermediate resounder.
2. Slacken the two fastening clamps and remove the second section of the corrugated sleeve complete with resounders.

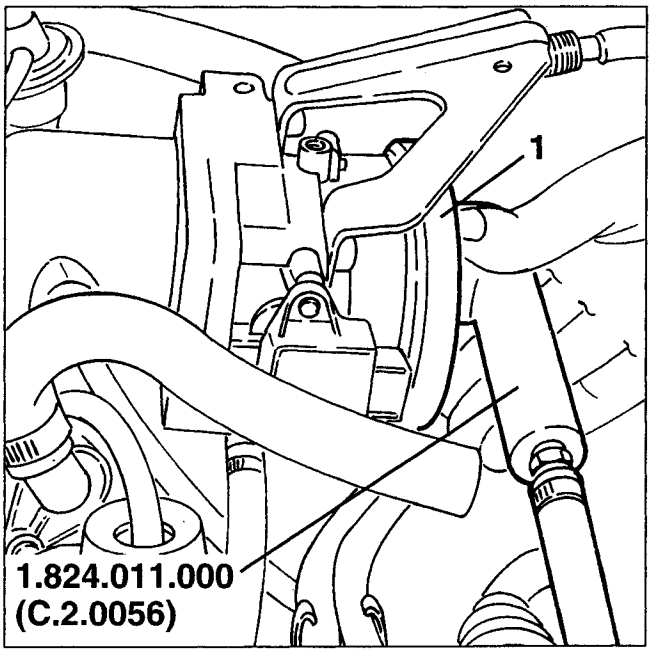
1. Disconnect the accelerator cable from the throttle.
2. Disconnect the engine coolant inlet and outlet pipes from the throttle body.
3. Slacken the fastening screws and remove the throttle body complete with potentiometer, and, if necessary separate them on the bench.
- Retrieve the accelerator cable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



FLUX TEST

Proceed as described for the first steps of the procedure "Throttle body - Removing/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 flux meter, check that leakage is within the specified limits.

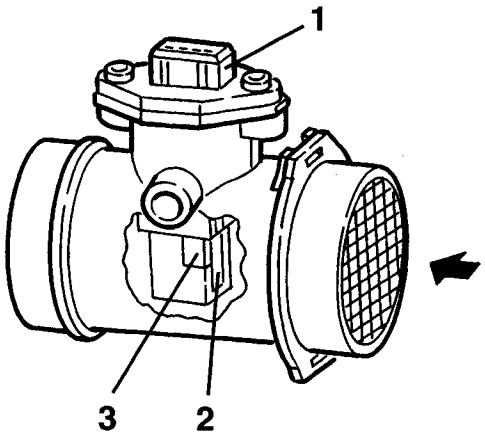
Air leakage with throttle in the closed position
280 ± 10 Scale N



AIR FLOW METER

The air flow meter is of the "heated film" type.
Its operating principle is based on a heated diaphragm in a measurement channel through which the intake 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 placed in contact with it.
The air crossing the measurement channel tends to withdraw heat from the diaphragm, therefore in order to keep it at a constant temperature, a certain amount of current must flow to the resistance.
This current is measured by an appropriate Wheatstone bridge.
Therefore the current is proportionate with the flow of air.

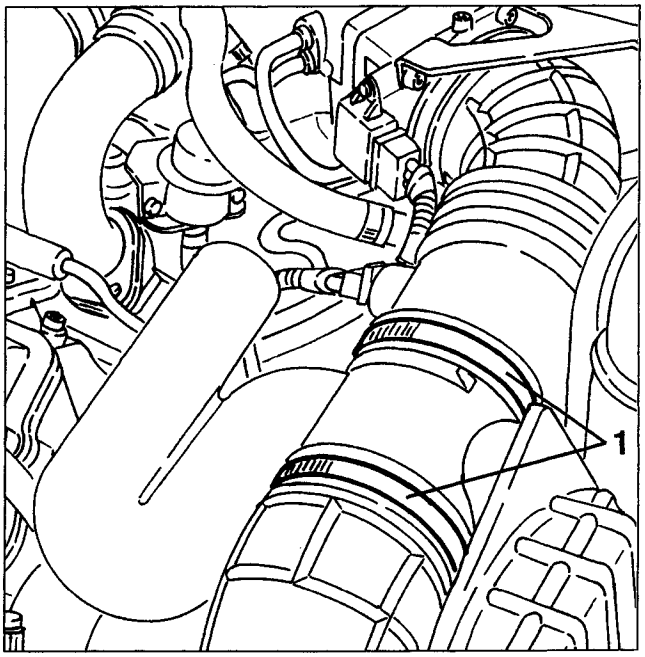
NOTE: This air flow meter measures directly the mass of air (and not the volume) thereby eliminating problems of temperature, altitude, pressure, etc.
Correct operation of the flow meter depends on the condition of the air cleaner, which must therefore be checked often.



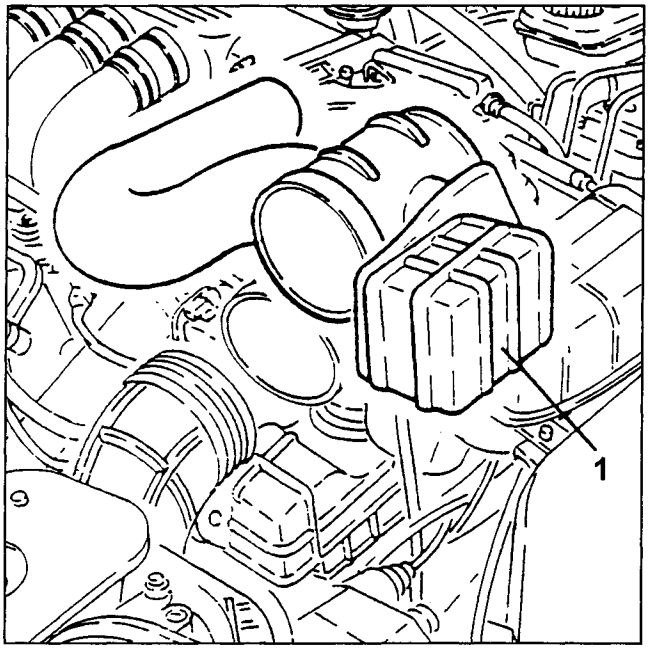
1. Connector
2. Measurement channel
3. Hot film sensor

REMOVING/REFITTING

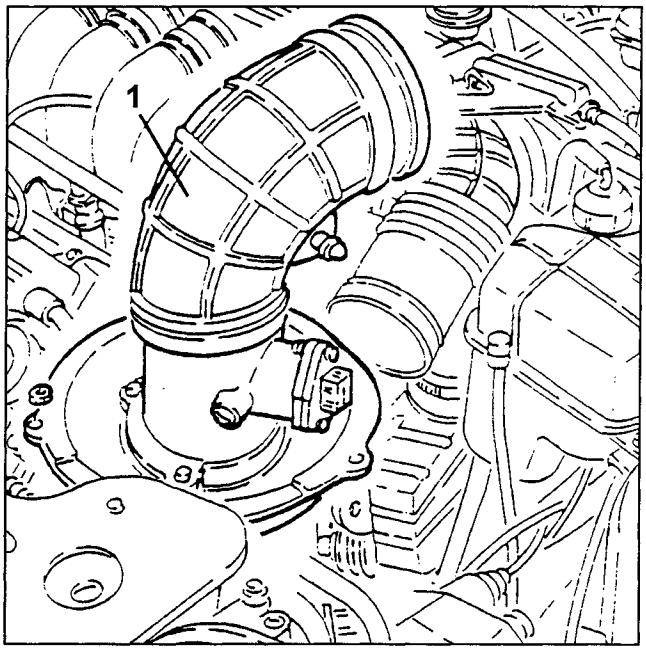
- Disconnect the battery (-) terminal.
- Remove the left hand engine compartment trim.
1. Slacken the two clamps fastening the upper resounder to the corrugated sleeve.



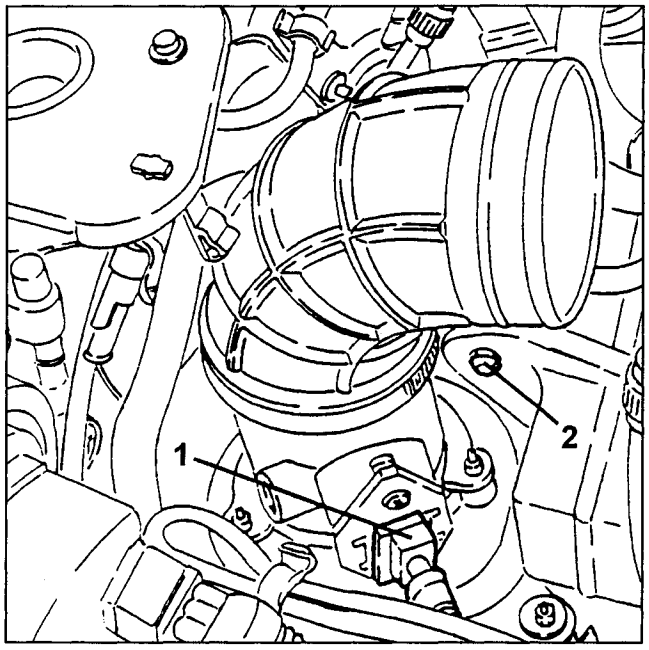
1. Remove the upper resonator.



1. Loosen the three fastening screws and remove the air cleaner with hot film flow meter and corrugated sleeve elbow. Separate at the bench.



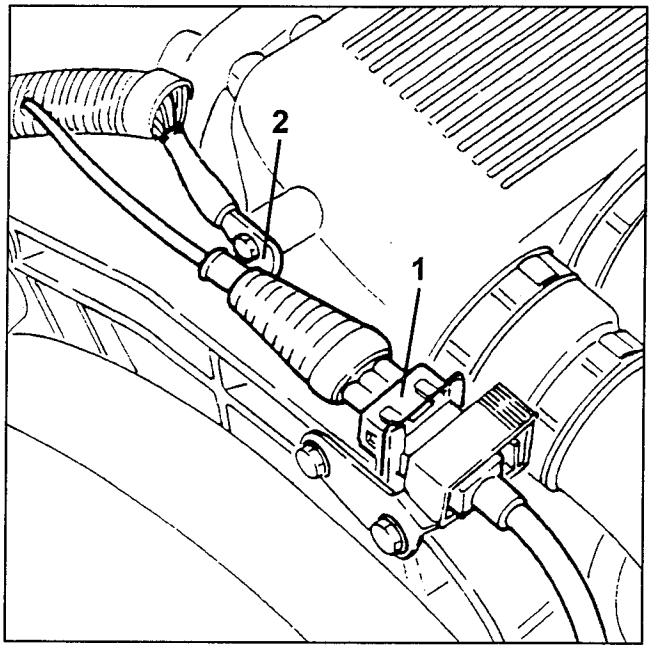
1. Disconnect the hot film flow meter electrical connection.
2. Remove the corrugated sleeve elbow fastening button from the intermediate resonator.



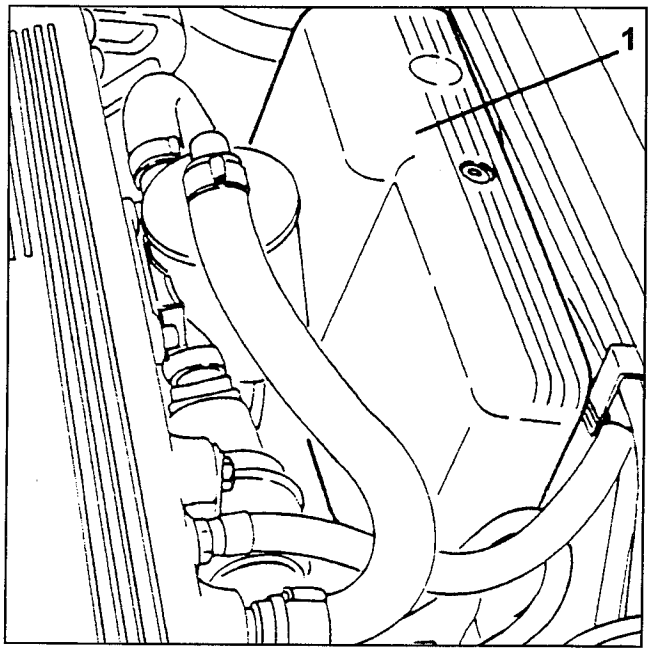
INTAKE MANIFOLD

REMOVAL/REFITTING

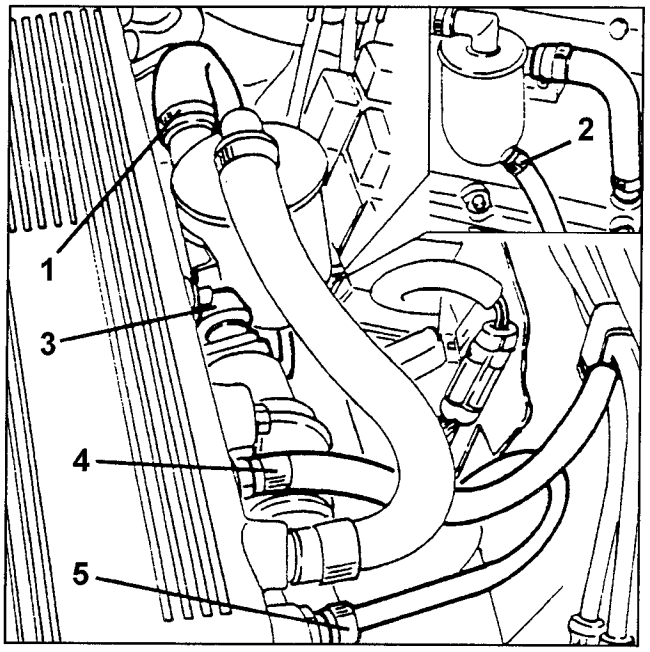
- Disconnect the (-) battery terminal.
1. Disconnect the front knock sensor electrical connection.
2. Disconnect the intake manifold earth wire (front).



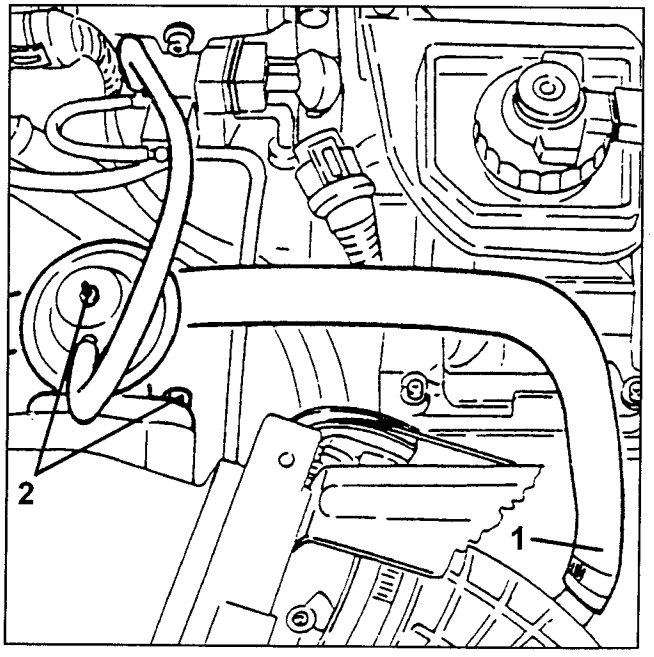
1. Remove the plastic relay, fuse and electrical connection guard.



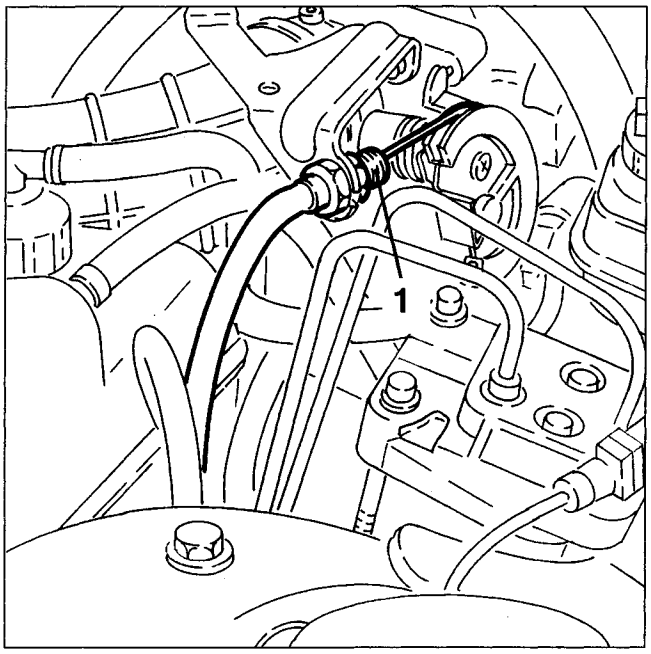
1. Disconnect the oil vapour recovery pipe from the separator.
2. Disconnect the condensed oil recovery pipe from the separator.
3. Disconnect the constant idling actuator electrical connection.
4. Disconnect the fuel vapour recovery pipe from the intake manifold.
5. Disconnect the brake booster vacuum pipe from the intake manifold.



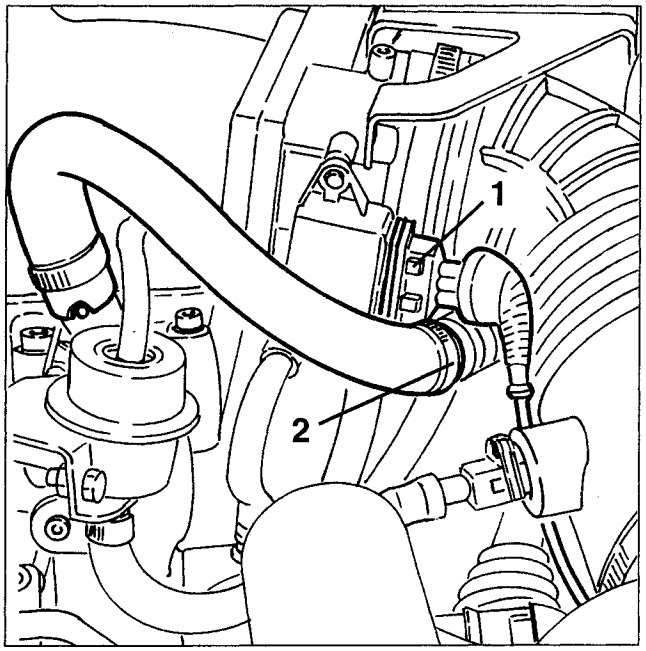
1. Disconnect the constant idling actuator air intake pipe from the corrugated sleeve.
2. Loosen the two fastening nuts and remove the EGR valve from the intake manifold.



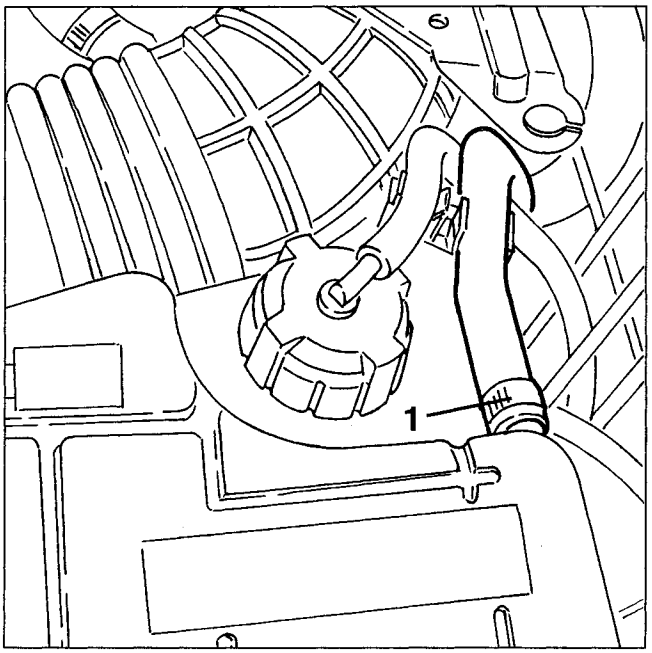
1. Disconnect the accelerator cable from the throttle cam.



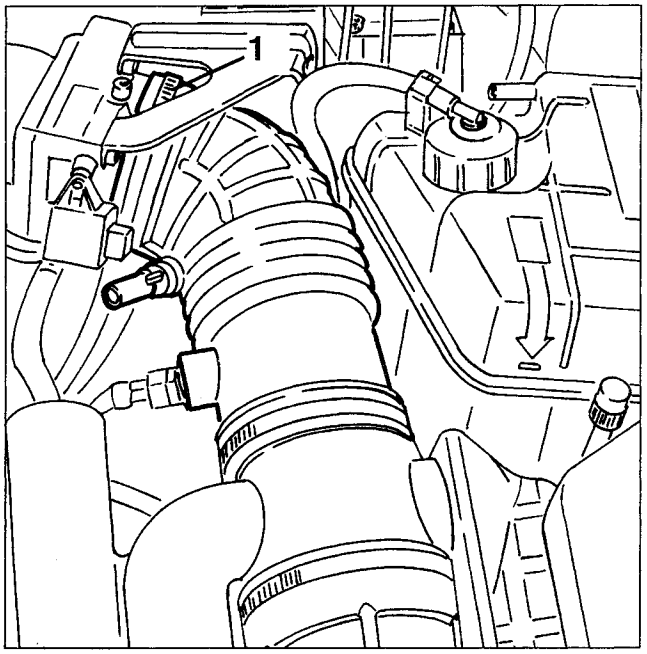
1. Disconnect the electrical connection from the throttle potentiometer.
2. Disconnect the oil vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.



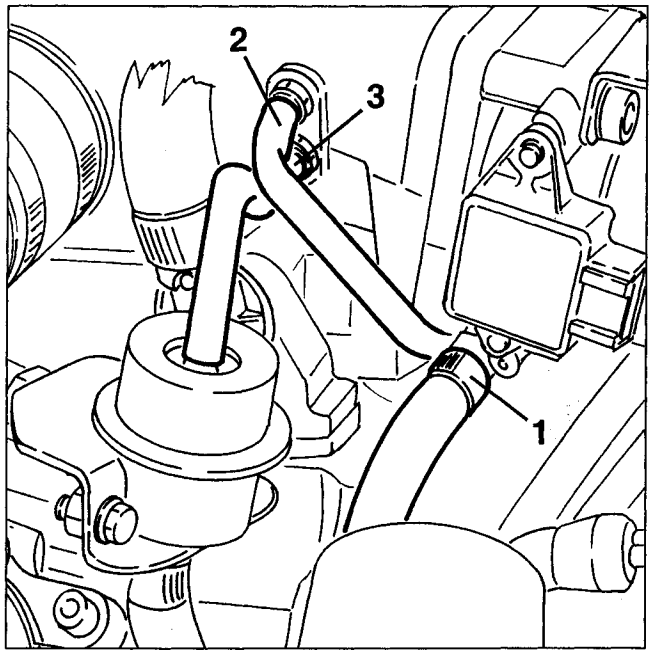
1. Disconnect the throttle body coolant return pipe from the expansion tank.



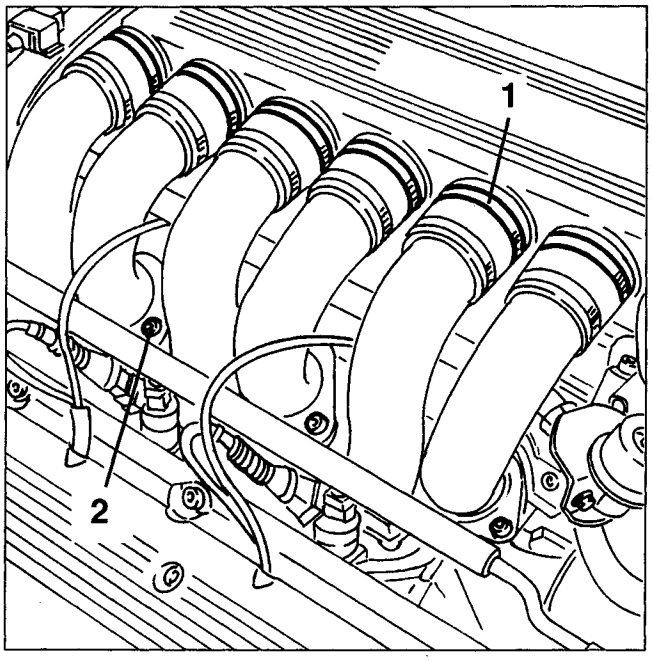
1. Slacken the fastening clamp and disconnect the corrugated sleeve from the throttle body.



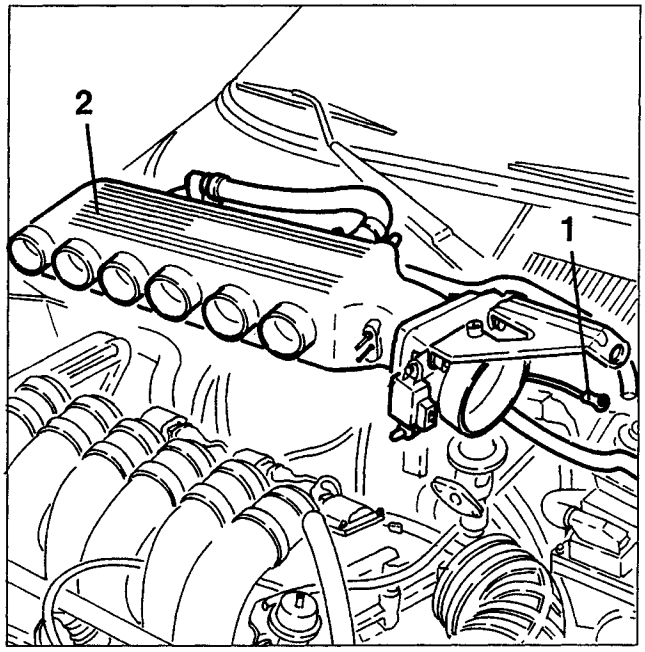
1. Disconnect the coolant inlet pipe from the throttle body.
2. Disconnect the vacuum takeoff pipe for the E.G.R. modulation solenoid valve from the intake box.
3. Disconnect the fuel pressure regulator vacuum takeoff pipe from the intake box.



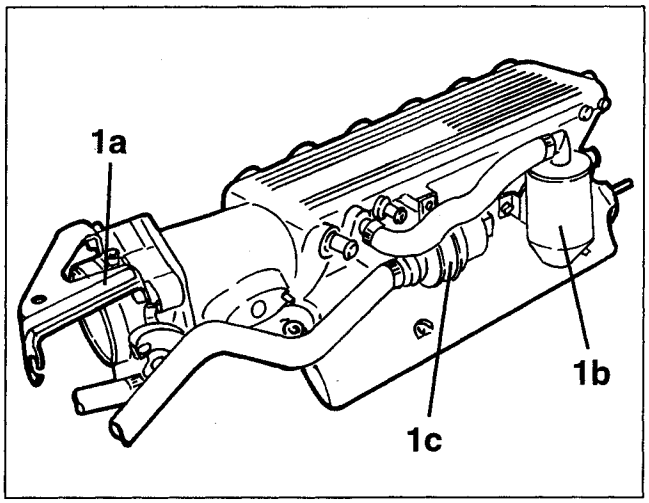
1. Slacken the clamps fastening the air supply ducts to the intake box.
2. Slacken the screws fastening the supply ducts to the cylinder heads.



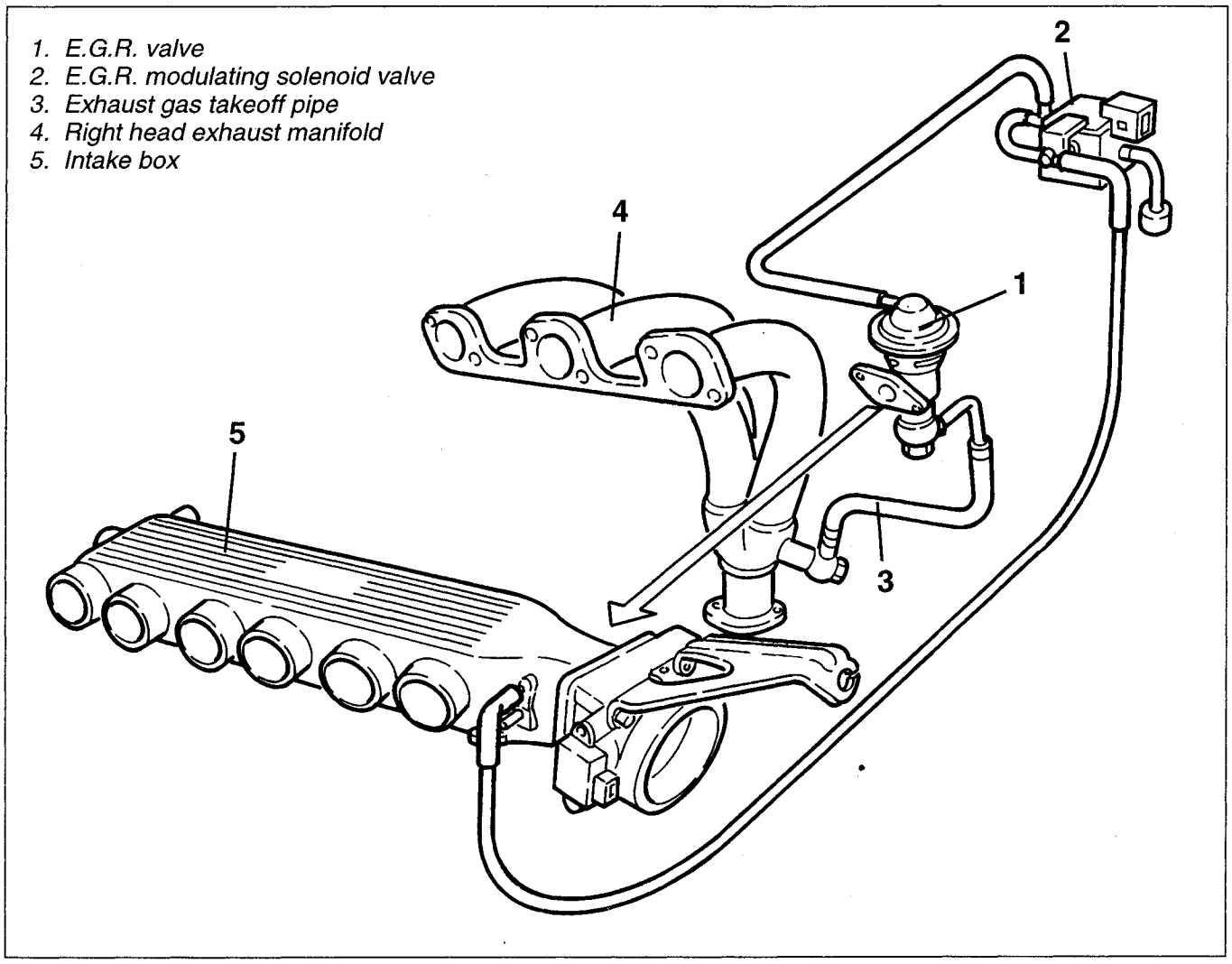
1. Disconnect the earth cable (rear) from the intake box.
2. Slacken the two fastening screws and remove the intake box complete.



1. If necessary on the bench separate the throttle body (1a), oil vapour separator (1b) and the constant idle speed device (1c) from the intake box.

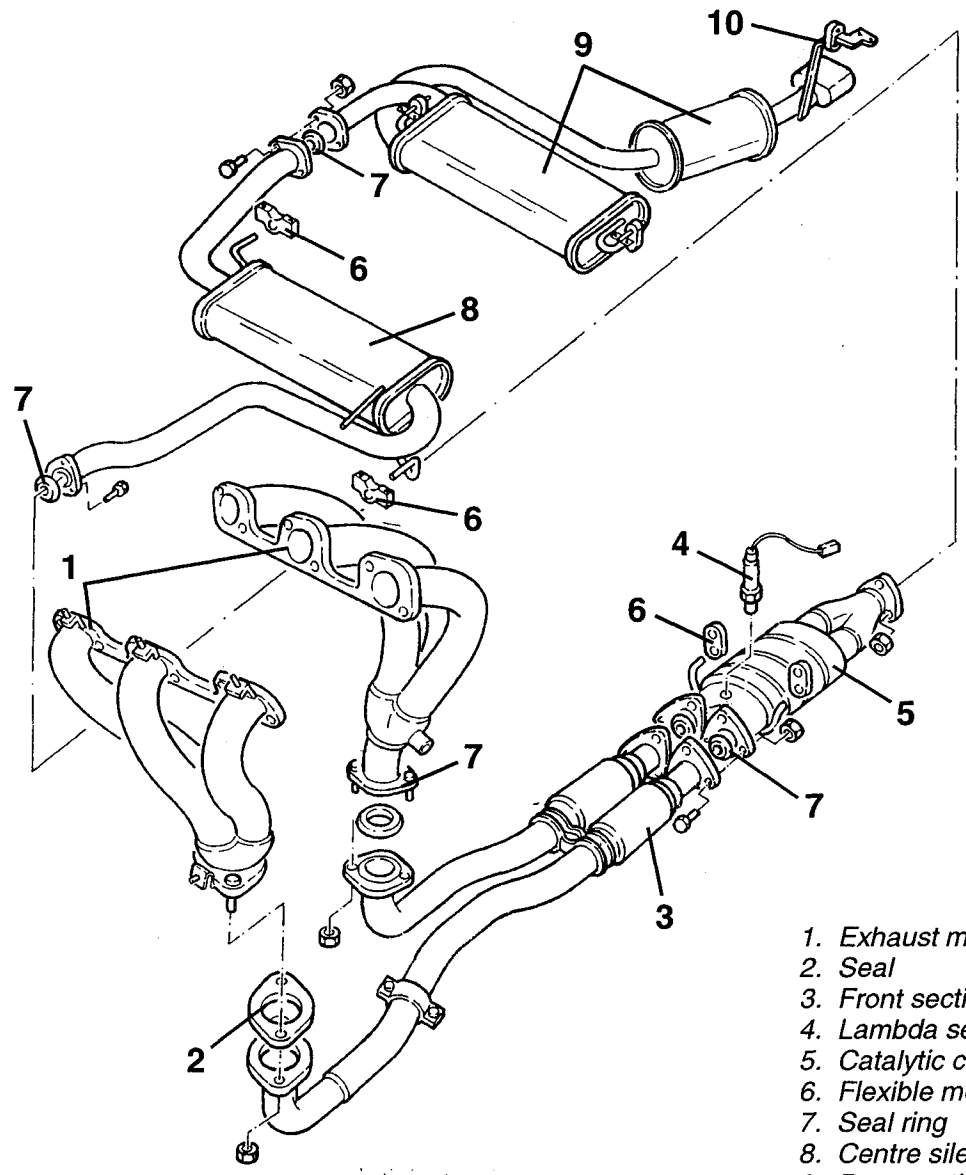


DESCRIPTION



In order to further reduce NOx (nitric oxide) emissions, 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 sends it back into 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 modulated vacuum of the electromagnetic valve (2) controlled by the MOTRONIC control unit.
The amount of exhaust gas sent to the engine is defined by the MOTRONIC control unit, taking account of the characteristic curve of the E.G.R. command depending on the engine load and speed and on the coolant fluid temperature.
Through the MOTRONIC control unit, the electromagnetic 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 covered with thermal insulation.

DESCRIPTION



1. *Exhaust manifolds*
2. *Seal*
3. *Front section*
4. *Lambda sensor*
5. *Catalytic converter*
6. *Flexible mount*
7. *Seal ring*
8. *Centre silencer*
9. *Rear section - silencers*
10. *Support brackets*

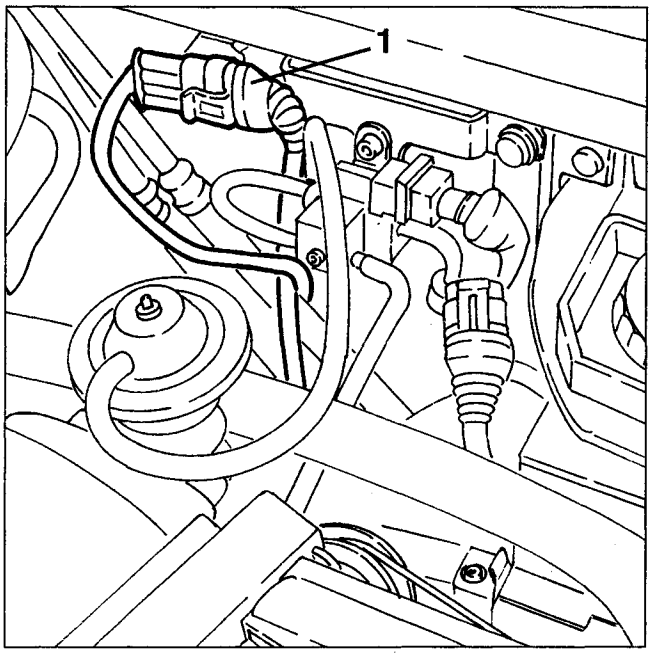
The exhaust gas leading from the cylinder heads converges through the manifolds (1) in the first section of the exhaust piping (3) on which there are two flexible pieces which restrict the transmission of vibration. From the front section, the exhaust gas reaches the three-way catalytic converter (5) 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 injection time can be adjusted 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 connection between the various sections of exhaust pipe is by flanges with seals in between and connection to the body is by brackets with flexible mounts.
The very high amount of heat radiated towards the body owing to the presence of the catalytic converter is limited by a series of heat guards between the exhaust pipe and the body.

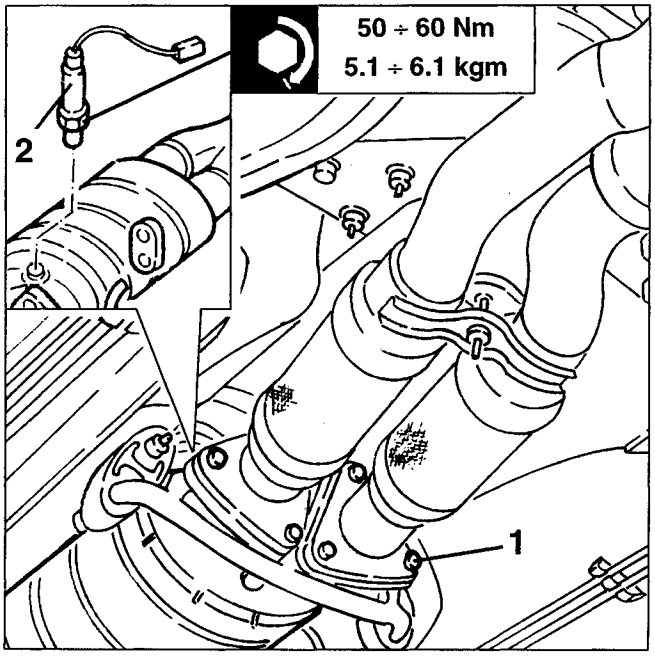
LAMBDA SENSOR

REMOVING/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection of the lambda sensor.



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



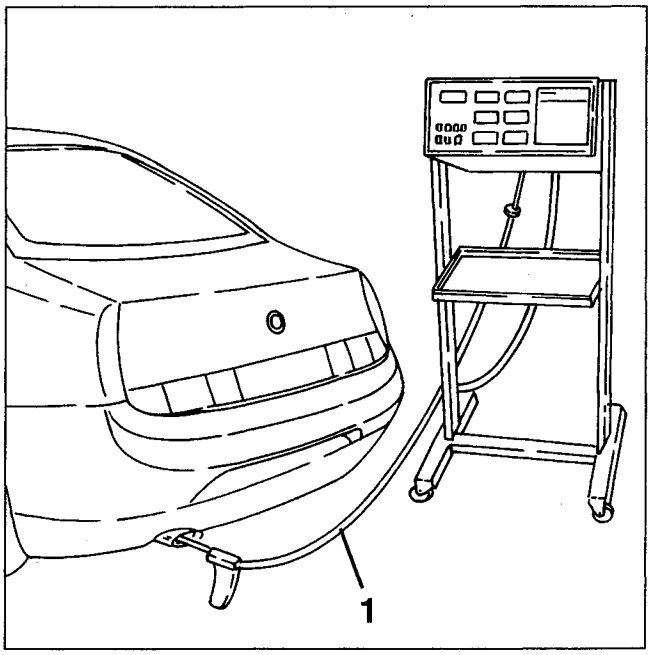
CHECKING EXHAUST EMISSION

WARNING:
Emission levels at the exhaust should be checked outdoors, or at least in a suitably equipped place according to current laws.

The test should be carried out with the engine at normal operating temperature (i.e. when the fan has come on and then turned off) and at idle speed.
If idle speed is not within the specified limits, check that the constant idle speeddevice is working properly.

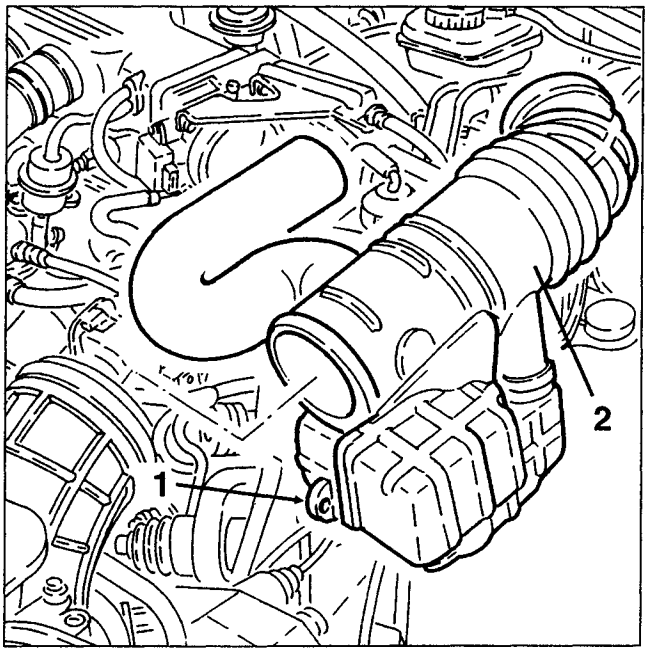
- Check that the engine oil level is correct and that the air cleaner cartridge is clean.
- Start the engine and run it at idle speed.
1. Insert the analyser feeler in the end of the exhaust pipe and check that the quantity of CO and HC is within the specified limits.

CO at the exhaust	**% vol.**	< 0.2
HC at the exhaust	**p.p.m.**	≤ 50



RPM AND TIMING SENSOR

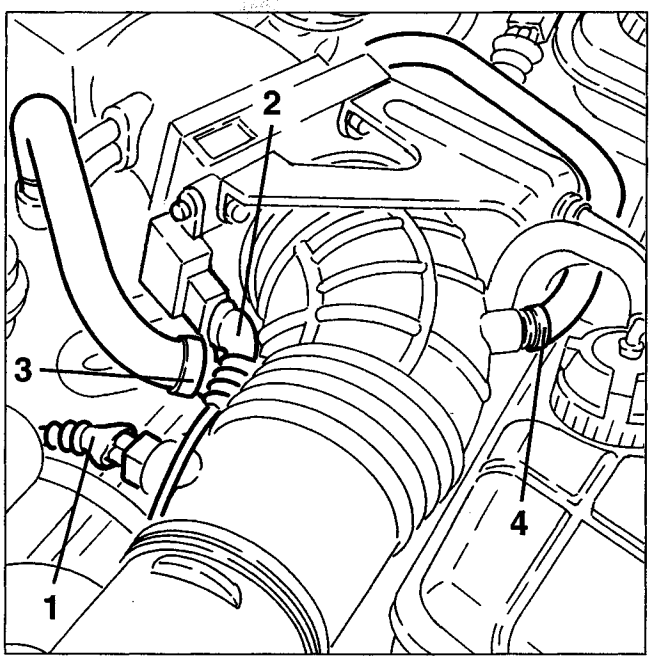
The rpm and timing sensor used on this car do not differ from the previous versions; but it faces a phonic wheel on the flywheel instead of on the auxiliary components drive pulley.
This is to eliminate the effect of torsional oscillation improving angular speed sensitivity thus better location of any misfiring.



REMOVING/REFITTING

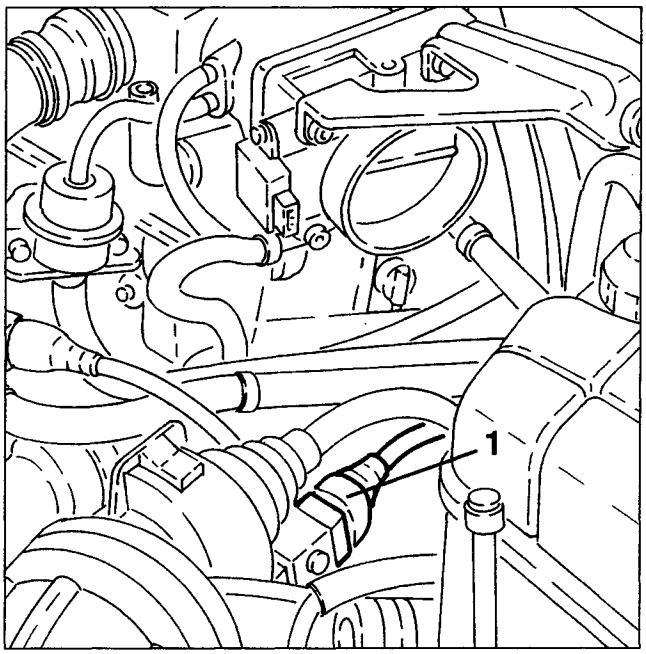
- Set the car on a lift.
- Disconnect the battery (-) terminal.

1. Disconnect the electrical connection from the intake air temperature sensor.
2. Disconnect the electrical connection from the throttle potentiometer.
3. Disconnect the oil vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.
4. Disconnect the air takeoff pipe for the constant idle device from the corrugated sleeve.

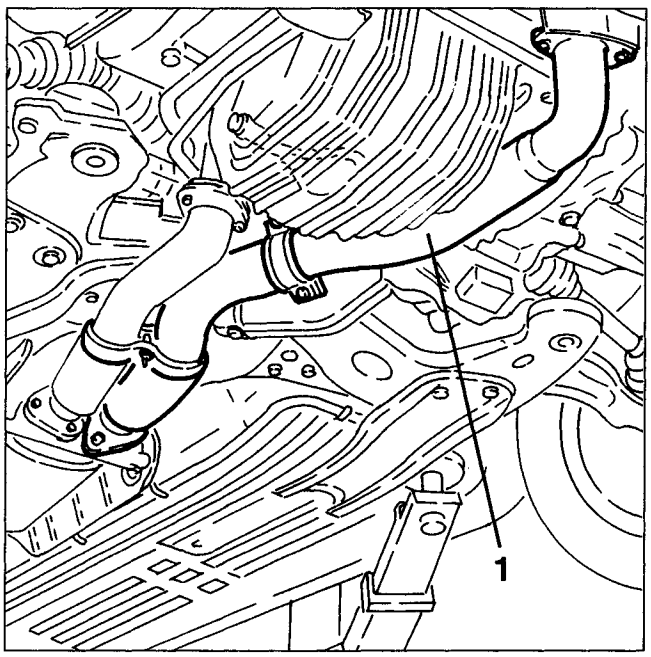


1. Prise off the fastening button of the first section of the corrugated sleeve to the intermediate resounder.
2. Slacken the two fastening clamps and remove the second section of corrugated sleeve complete with resounder.

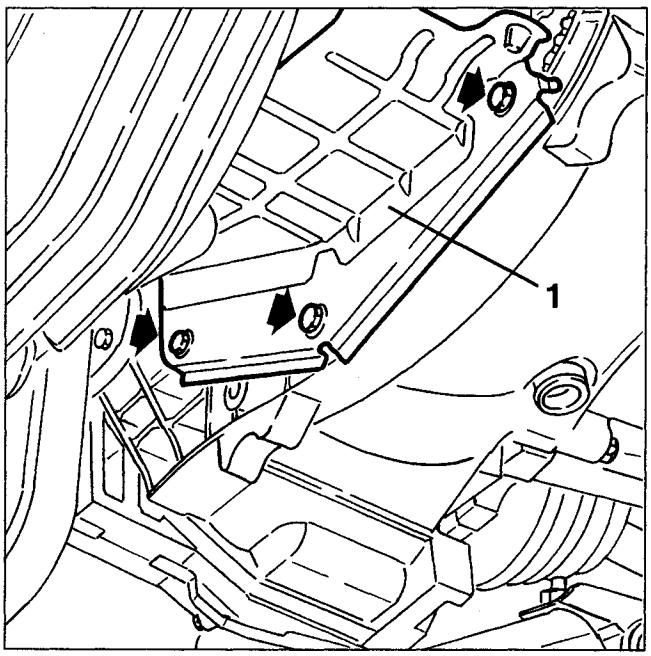
1. Disconnect the electrical connection of the rpm and timing sensor and release the wiring of any fastening clamps.



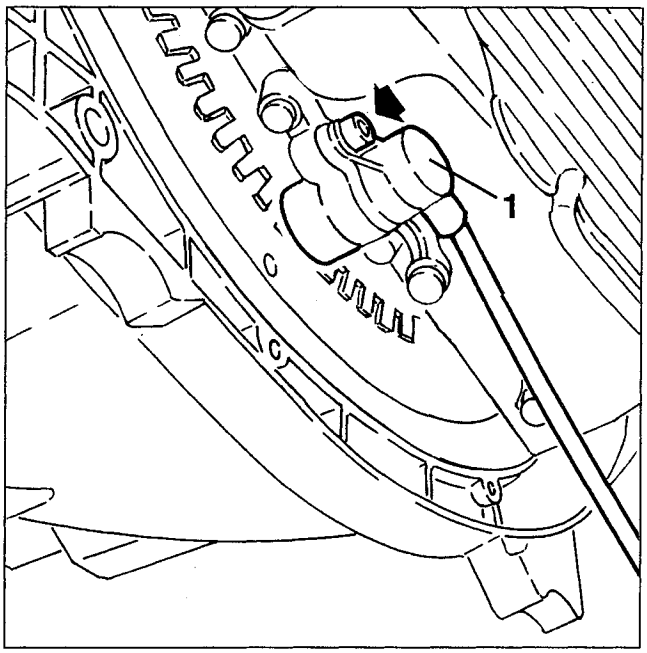
1. Raise the car, then slacken the fastenings and disconnect the front section of the exhaust pipe from the left cylinder head.



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



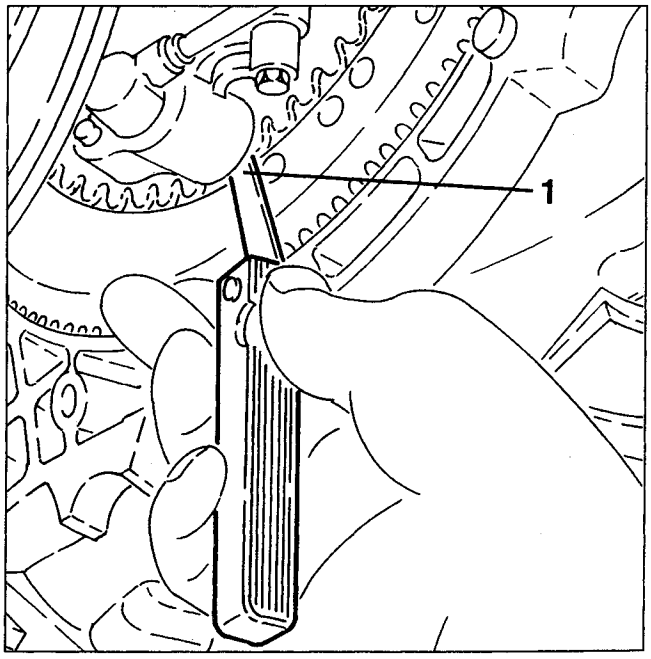
1. Slacken the fastening screw and remove the rpm and timing sensor.
- If necessary, slacken the two fastening screws and remove the support of the rpm and timing sensor.



CHECKING THE GAP

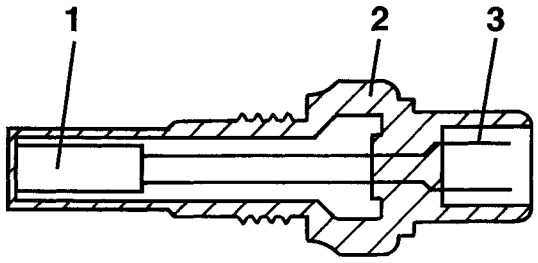
- Proceed as described in removing/refitting to gain access to the rpm and timing sensor.
1. Using a thickness gauge, check that the gap between the sensor and phonic wheel is within the specified limits.

Rpm and timing sensor gap
0.8 ÷ 1.5 mm



ENGINE COOLANT TEMPERATURE SENSOR (NTC)

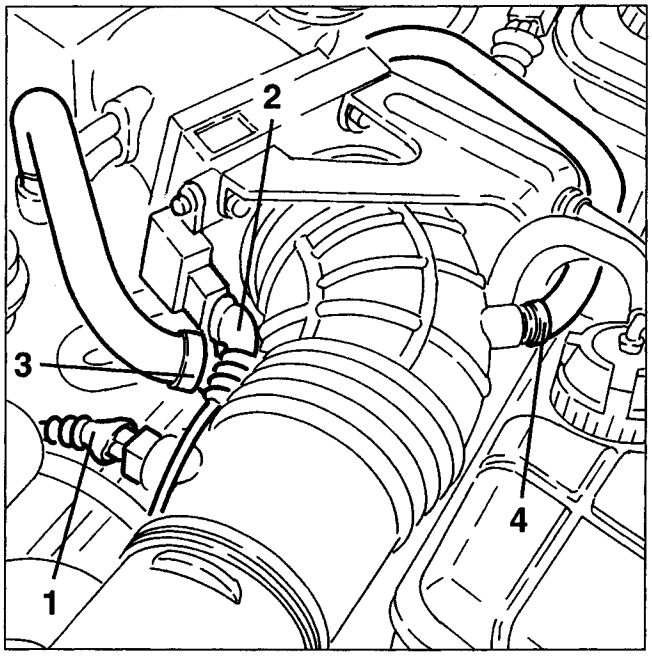
This sensor detects the temperature of the engine coolant on the thermostatic cup by a thermistor (NTC) with negative resistance coefficient, i.e. capable of lowering its resistance as the temperature increases. The electrical signal obtained reaches the electronic control unit and is used to correct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



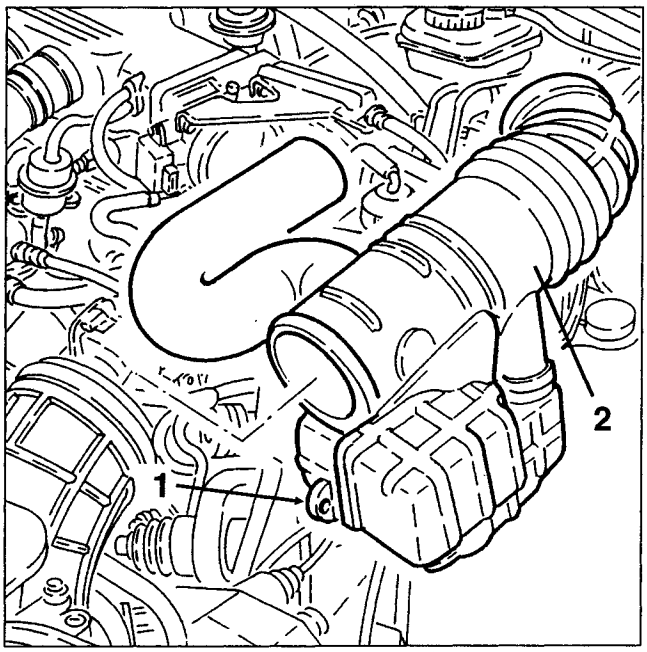
1. NTC resistance
2. Body
3. Connector

REMOVING/REFITTING

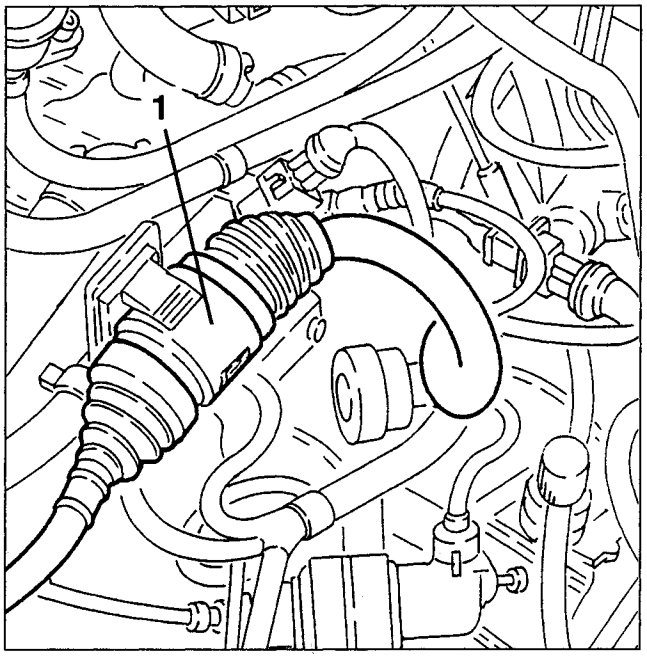
- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the intake air temperature sensor.
2. Disconnect the electrical connection from the throttle potentiometer.
3. Disconnect the oil vapour recovery pipe leading from the right cylinder head from the corrugated sleeve.
4. Disconnect the air takeoff pipe for the constant idle device from the corrugated sleeve.



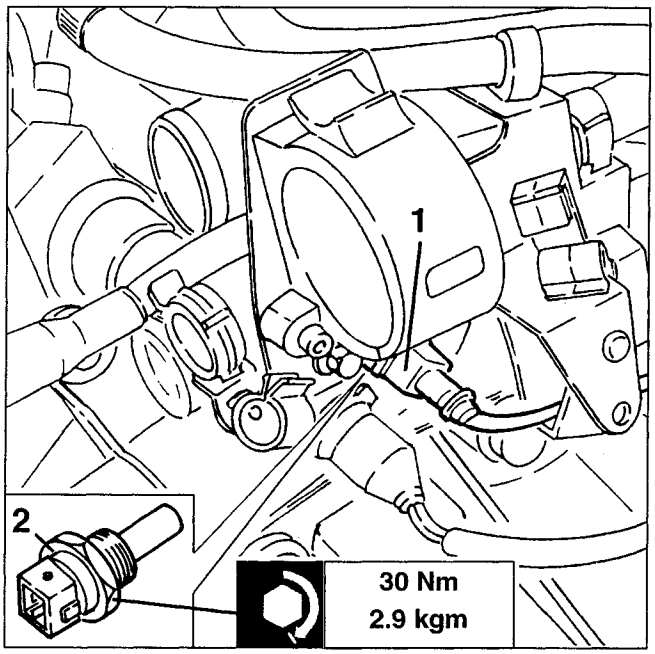
1. Prise off the fastening button of the first section of corrugated sleeve to the intermediate resounder.
2. Slacken the two fastening clamps and remove the second section of corrugated sleeve complete with resounders.



1. Release the injection wiring connector from the support bracket.

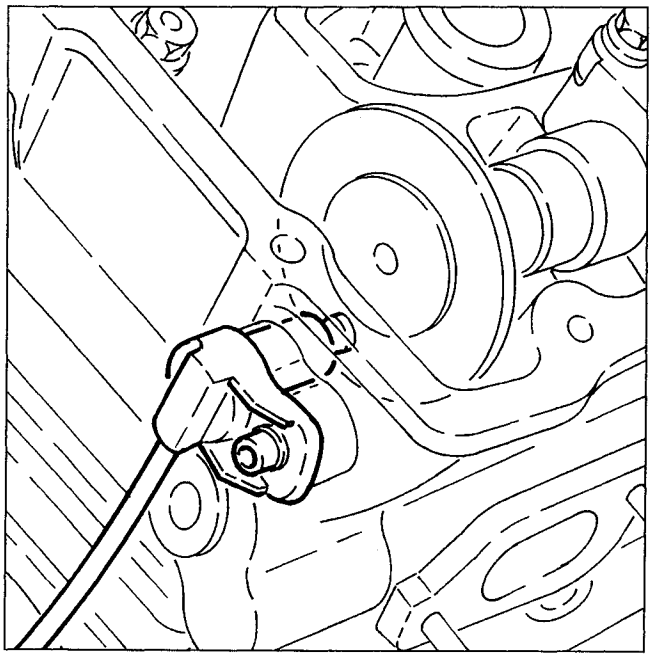


1. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).
2. Slacken and remove the engine coolant temperature sensor (NTC) from the thermostatic cup.



CAM ANGLE SENSOR

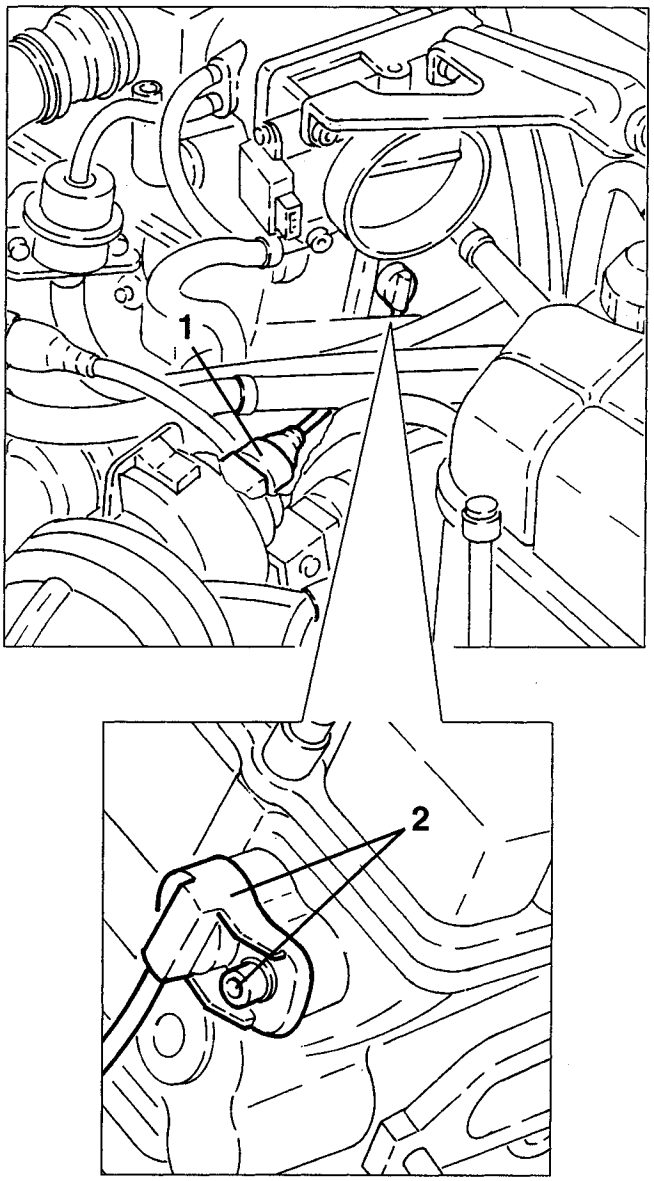
The cam angle sensor comprises a Hall effect device. The voltage signal "lowers" sharply" when the peg machined on the exhaust camshaft of the right cylinder head facing the sensor passes in front of the sensor itself.



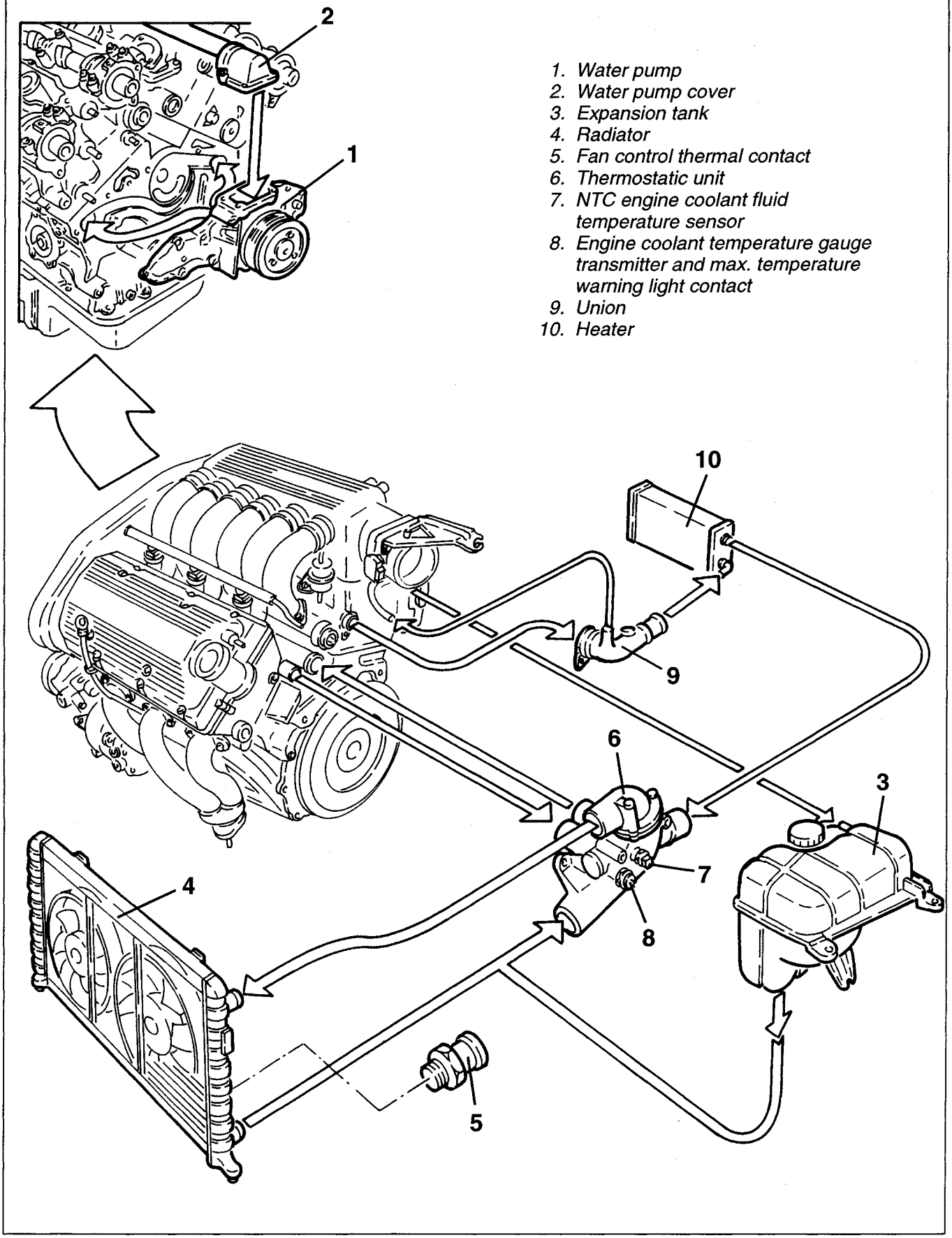
REMOVING/REFITTING

- Proceed as described in the first seven steps of the procedure "Engine coolant temperature sensor (NTC) - REmoving/Refitting".

1. Disconnect the electrical connection of the cam angle sensor.
2. Slacken the fastening screw and remove the cam angle sensor complete with wiring from the right cylinder head.



ENGINE COOLING SYSTEM



1. *Water pump*
2. *Water pump cover*
3. *Expansion tank*
4. *Radiator*
5. *Fan control thermal contact*
6. *Thermostatic unit*
7. *NTC engine coolant fluid temperature sensor*
8. *Engine coolant temperature gauge transmitter and max. temperature warning light contact*
9. *Union*
10. *Heater*

DESCRIPTION

The cooling system is sealed and of the forced circulatio type. It features a centrifuge pump (1) operated by the crankshaft by means of a Poly-V belt.
A thermostat valve (6) located on the rear of the engine ensures optimal engine temperature. It opens when the coolant reaches a temperature of 87 ± 2°C.
The radiator (4) cools the fluid by means of dynamic air and a two double speed fans. The fans are controlled by a thermal contact (5) located on the radiator. An additional resistance and a relay operate the fans at higher speed when the temperature is high.
The expansion reservoir (3) 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.
The circuit is equipped with an engine coolant temperature sensor (8) for the gauge and a maximum temperature thermal contact for the warning light up when the coolant temperature exceeds 115°C.

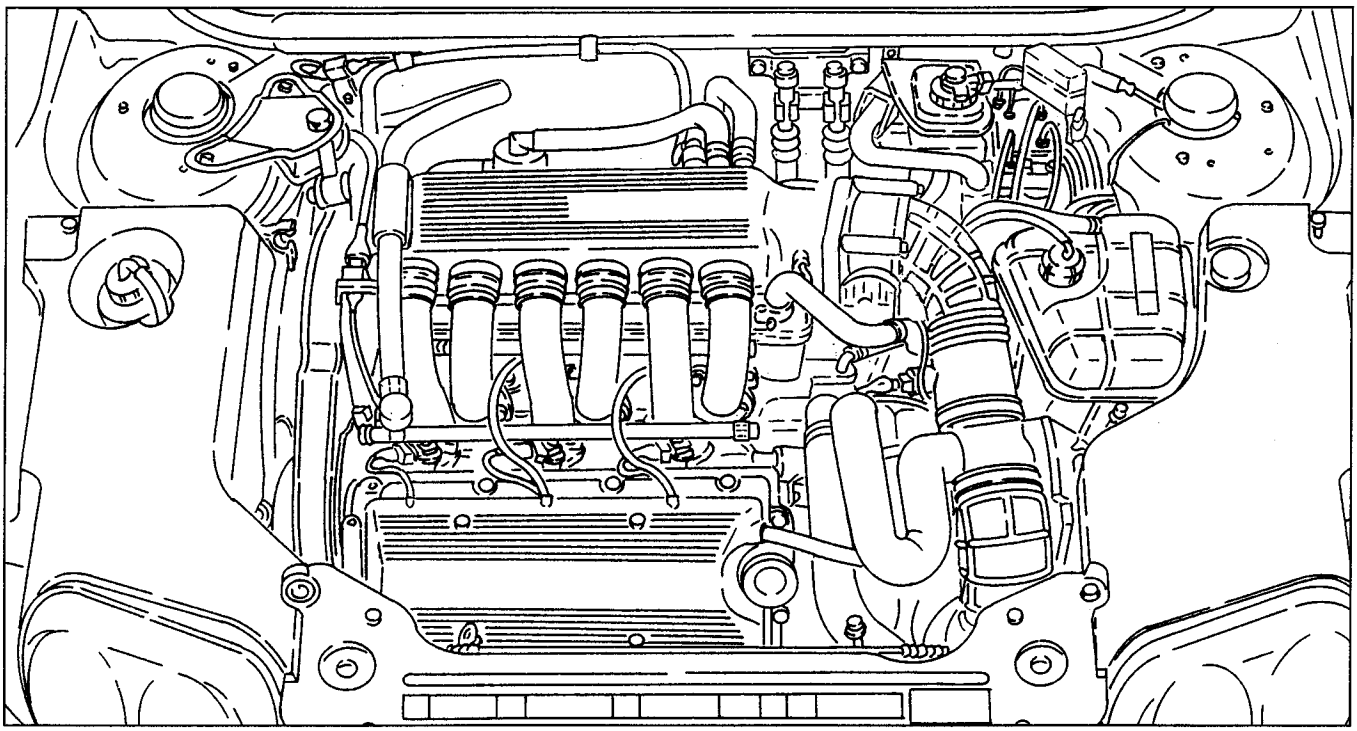
CIRCUIT OPERATION

The fluid cools the engine and reaches the thermostat (5) via the cylinder head. If its temperature is lower than 87°C the coolant is sucked by the pump (1) via a longitudinal return manifold located between the two cylinder heads.
If the temperature is higher than this values, the coolant is conveyed to the radiator (4) via the thermostat opening.
After being cooled in the radiator, the coolant returned to the thermostat from where it is conveyed to the pump via the longitudinal manifold.
A specific fitting (9) on the right-hand cylinder head receives the coolant from a suppelementary duct on the head and sends it via two specific pipes to the climate control system heater (10) and to the throttle casing for heating it.
The throttle is connected to the expansion reservoir (3) by means of a specific pipe which ensures fluid return and also bleeds the system.

DESCRIPTION

The following information and illustrations allow quick engine removal and refitting.

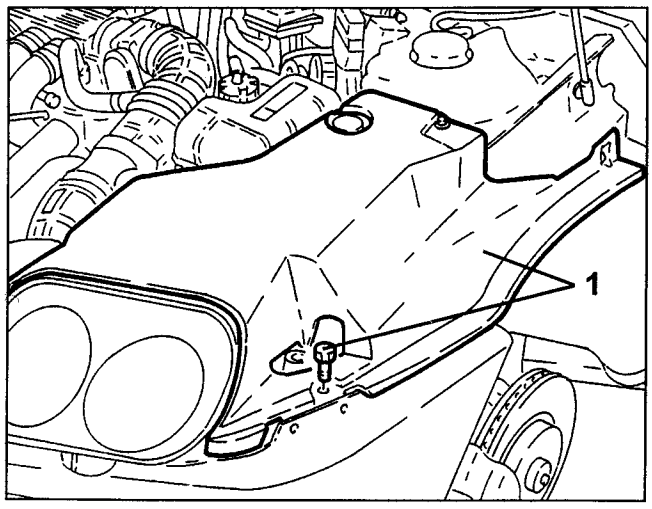
Bench disassembly instructions for single components are contained in the "ENGINE OVERHAUL" volume.
The following procedures may be used only in part, according to requirements.
For additional information and details, refer to the specific component and assembly chapters.



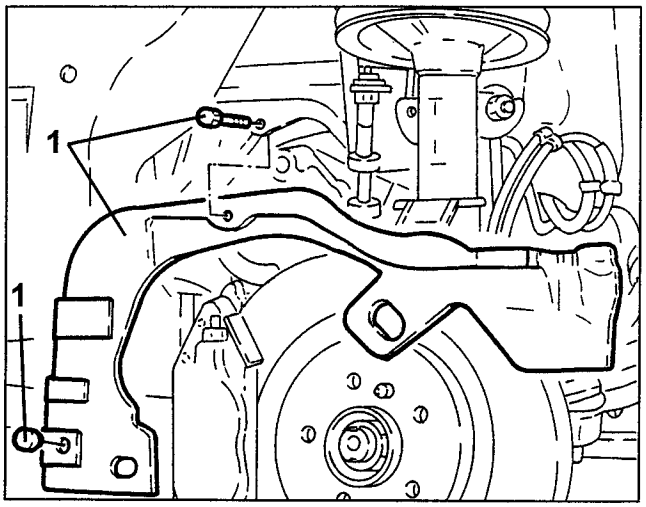
REMOVAL

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

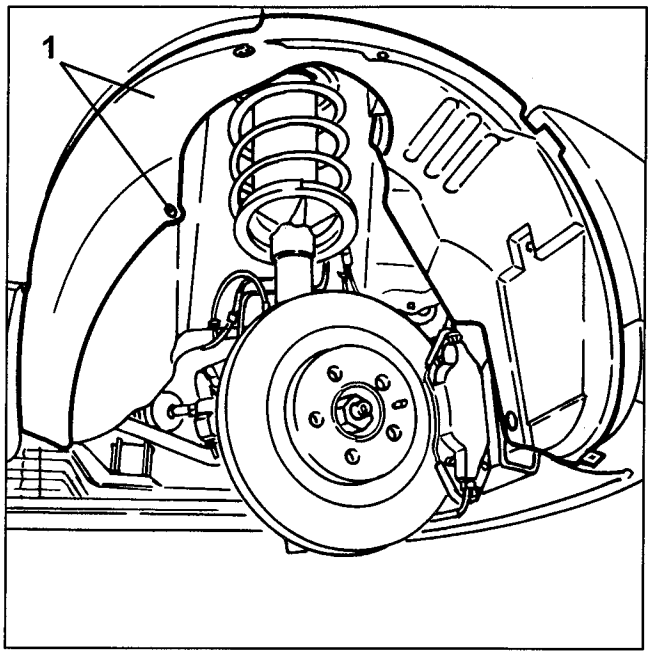
1. Loosen the screws and remove the two side engine guards.



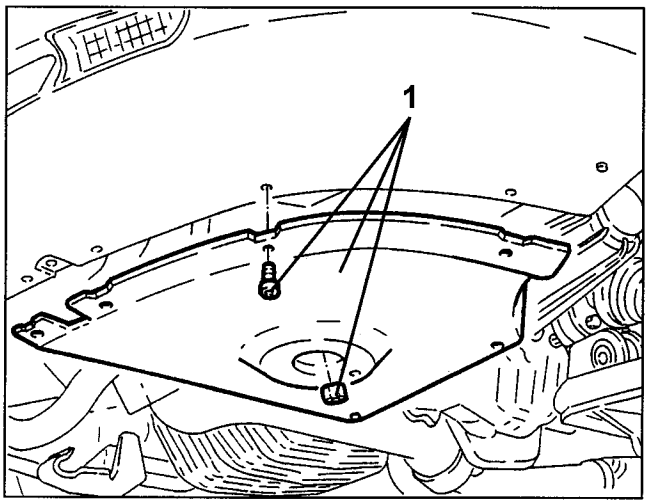
1. Release the buttons, loosen the screws and remove the front wheel compartment dust guards.



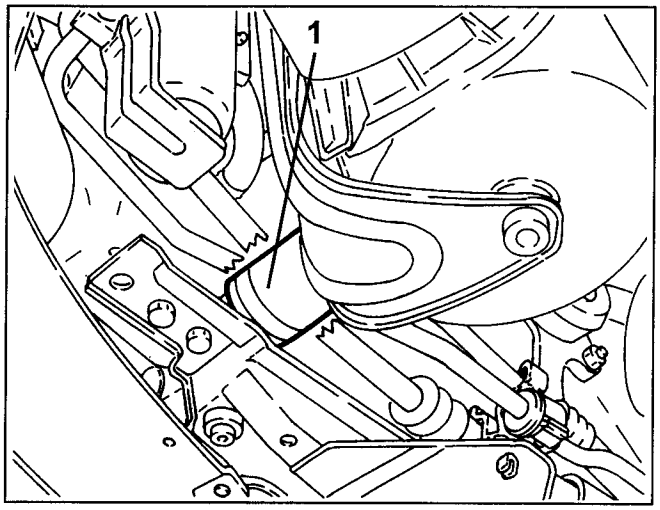
1. Loosen the fasteners and remove the right-hand front wheelhouse.



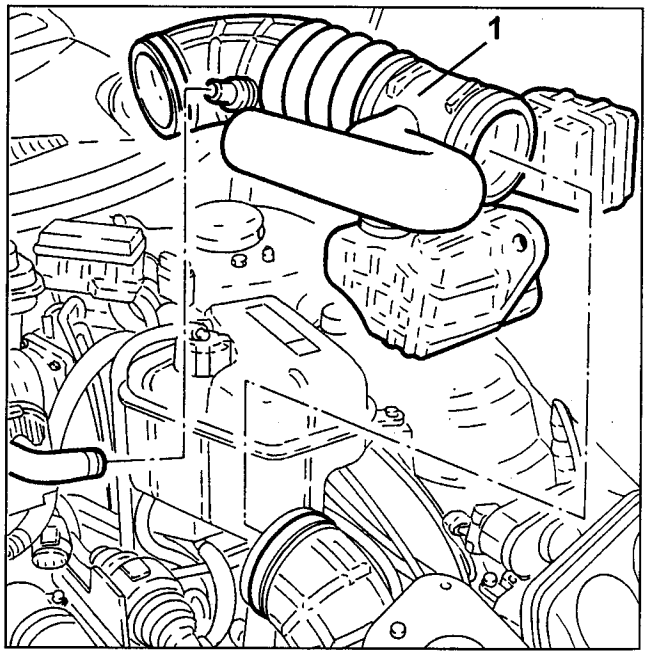
- Lift the vehicle.
1. Loosen the nut and the screws and remove the lower air cleaner guard.



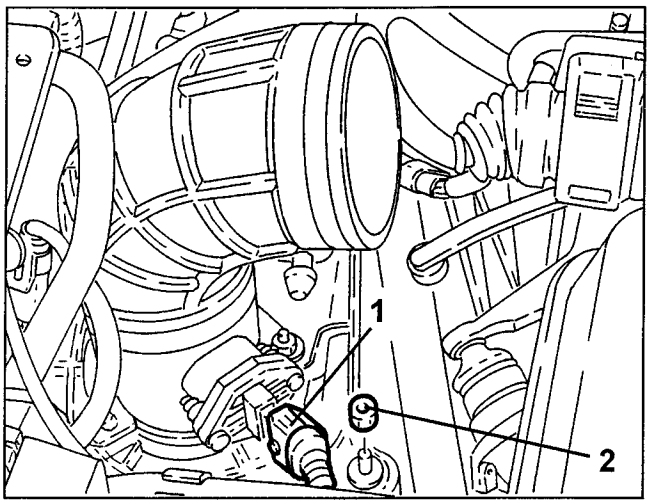
1. Drain the engine coolant by disconnecting the radiator fluid output sleeve and collect the coolant in a suitable container.



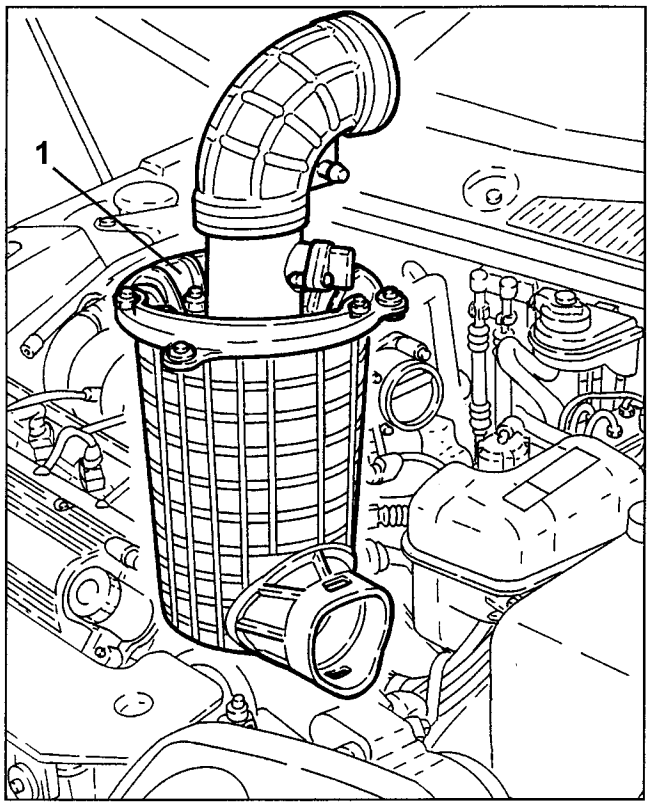
- Lower the vehicle.
1. Loosen the clips and remove the corrugated sleeve and resonators after releasing the intermediate resonator from the fastening pin.



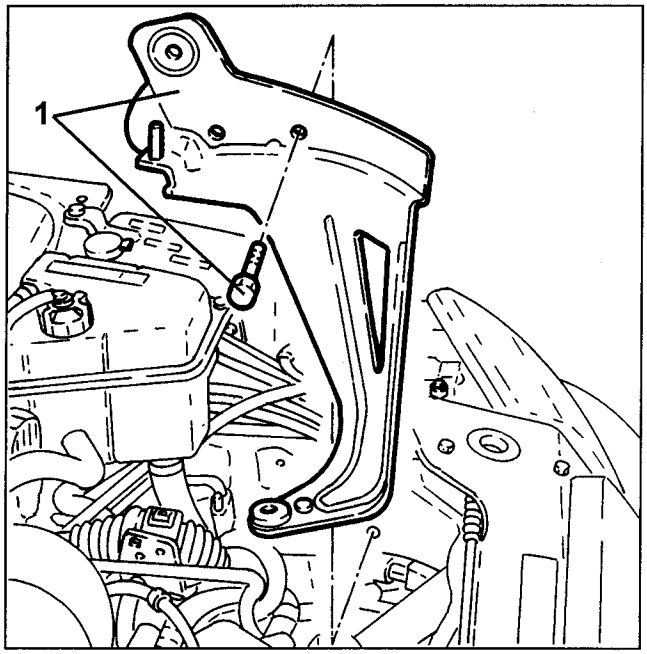
1. Disconnect the hot film air flow meter electrical connection.
2. Loosen the air cleaner fastening nuts.



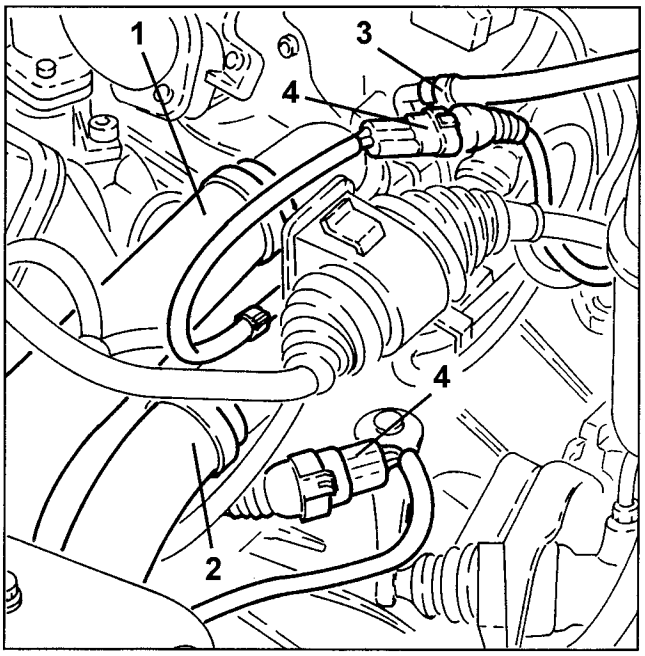
- Release the air cleaner from the lower resonator sleeve.
1. Remove the air cleaner and hot film air flow meter.



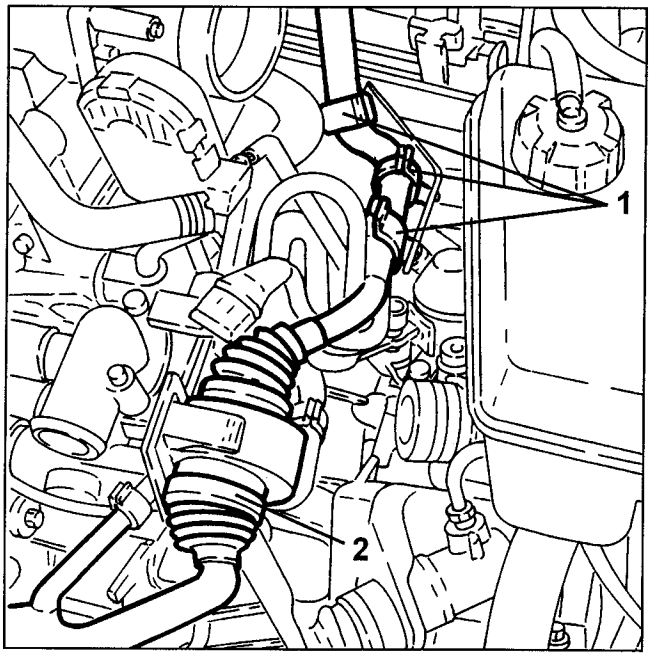
1. Loosen the screws and remove the air cleaner bracket.



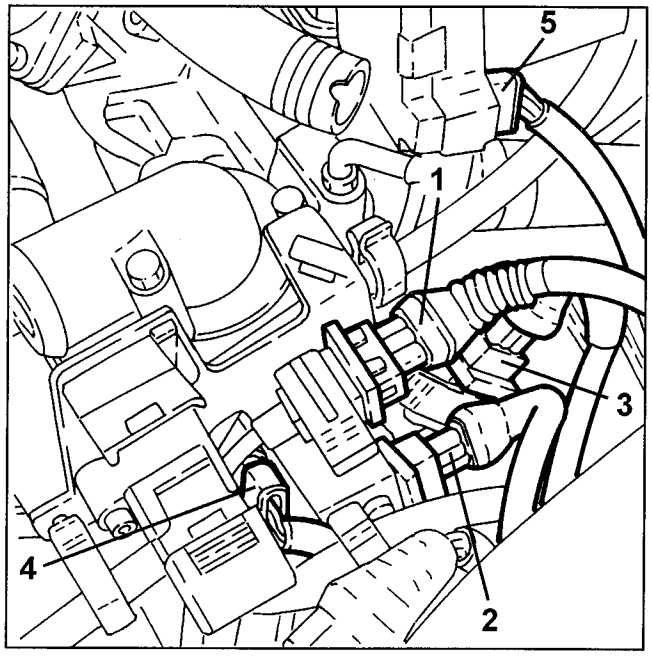
1. Disconnect the radiator coolant delivery sleeve from the thermostat.
2. Disconnect the radiator return coolant sleeve from the thermostat and move it aside.
3. Disconnect the expansion reservoir coolant return pipe from the right-hand cylinder head fitting.
4. Disconnect the lambda sensor electrical connections and release the respective wiring from the fastening clips.



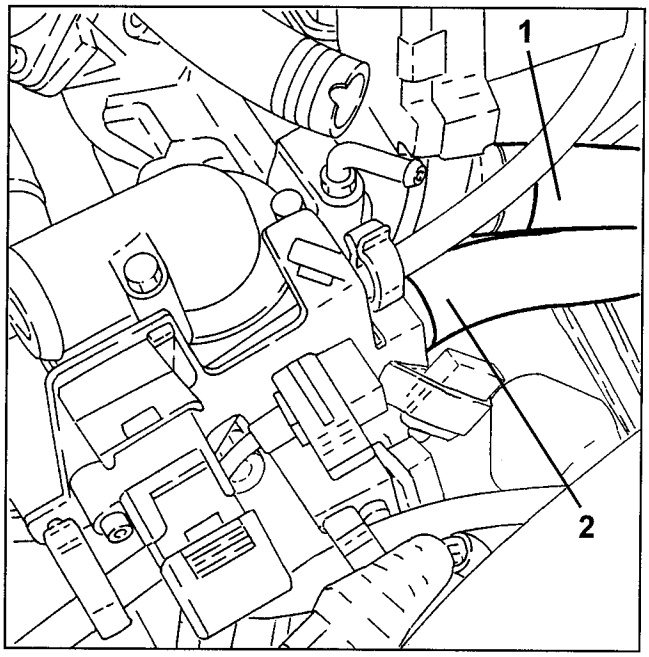
1. Release the injection wiring from the fastening clips.
2. Disconnect the injection wiring joint.



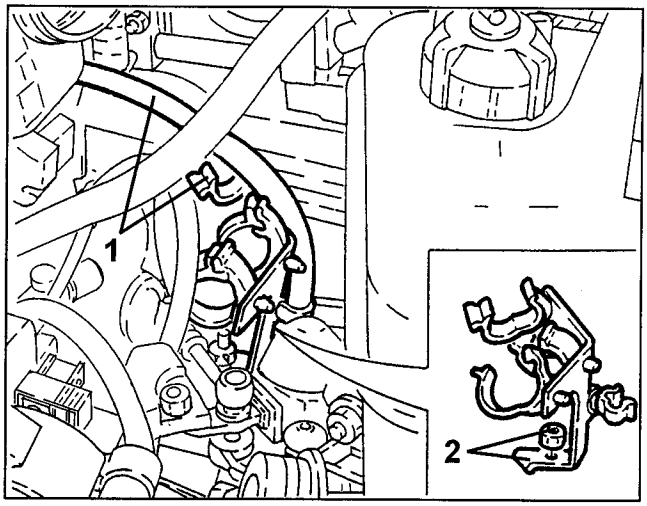
1. Disconnect the rpm and phase sensor electrical connection.
2. Disconnect the rear knock sensor electrical connection.
3. Disconnect the cam angle sensor electrical connection.
4. Disconnect the engine coolant temperature sensor electrical connection.
5. Disconnect the throttle casing with built-in DVL electrical connection.



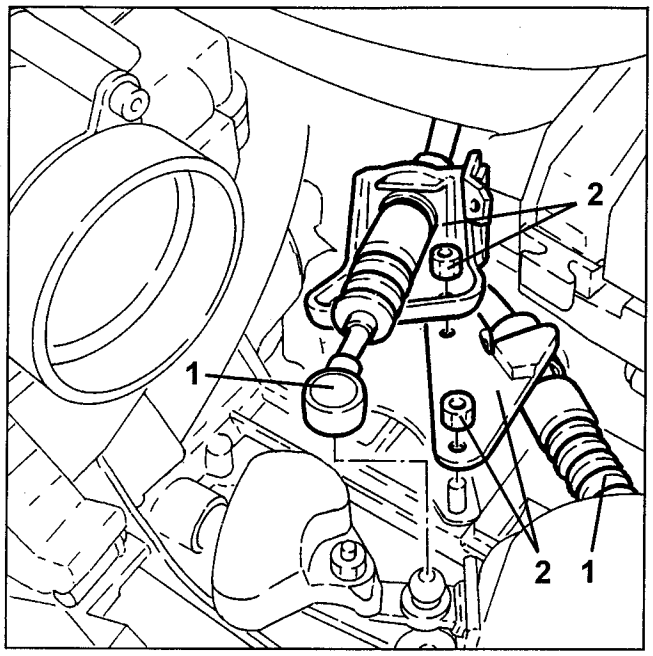
1. Disconnect the climate control system heater coolant delivery pipe from the right-hand cylinder head fitting.
2. Disconnect the climate control system coolant return sleeve from the thermostat.



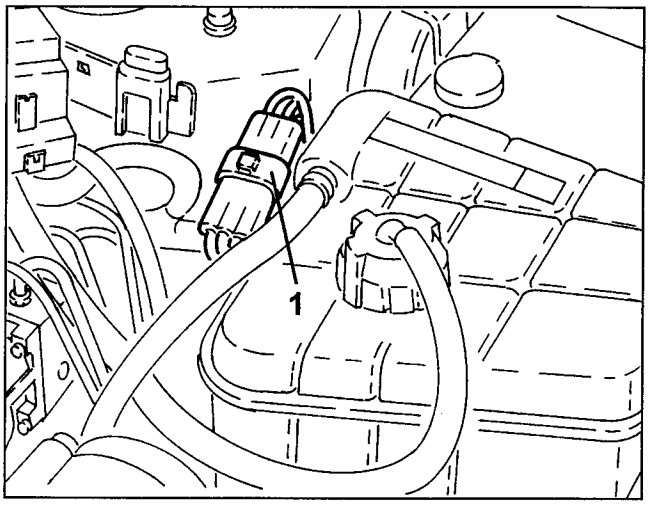
1. Release the lambda sensor wiring from the injection wiring bracket.
2. Loosen the nut and remove the injection wiring bracket.



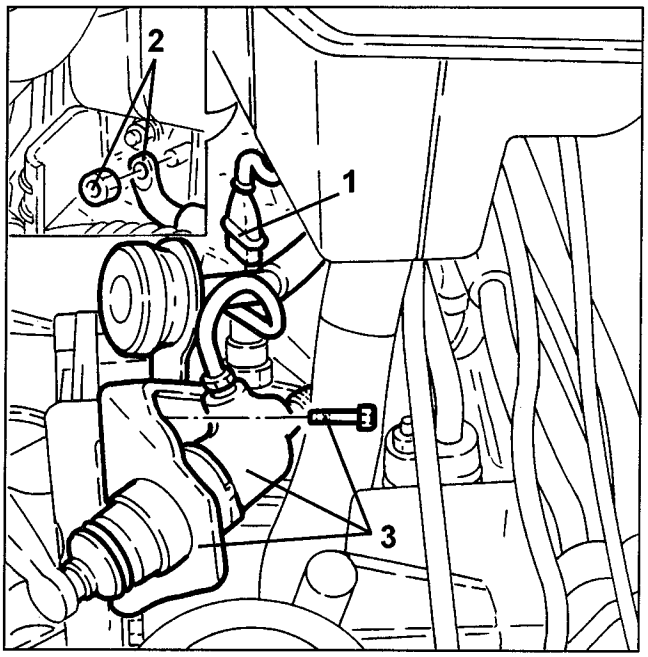
1. Disconnect the gear engagement and selection wires.
2. Loosen the nuts and move the brackets and gear engagement and selection wires aside.



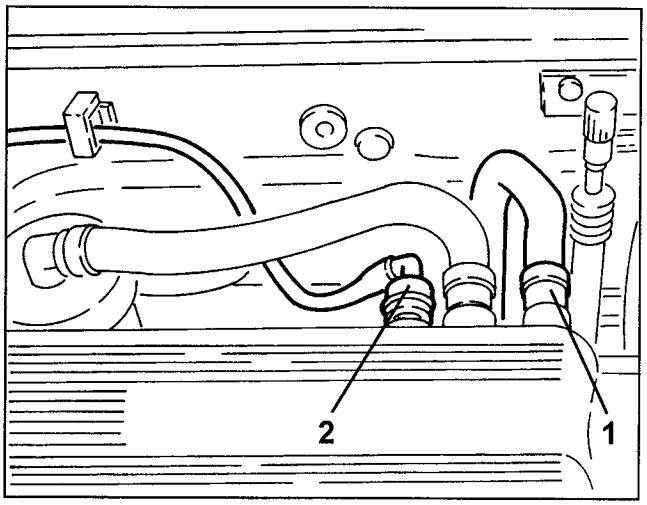
1. Disconnect the starter motor wiring electrical connection.



1. Disconnect the reversing light switch electrical connection.
2. Open the junction unit and disconnect the starter motor and alternator power wire.
3. Loosen the fastening screws and move the bracket with clutch cylinder and vibration damper aside without disconnecting the respective pipes.



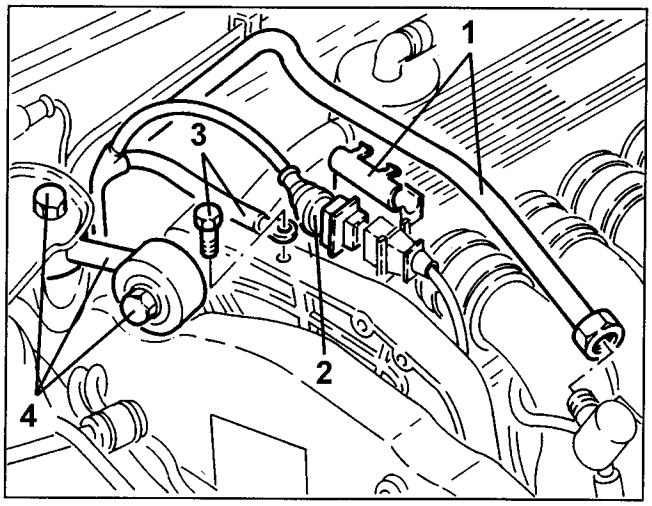
1. Disconnect the brake booster vacuum pipe from the intake manifold.
2. Disconnect the fuel vapour pipe quick coupling from the intake manifold.



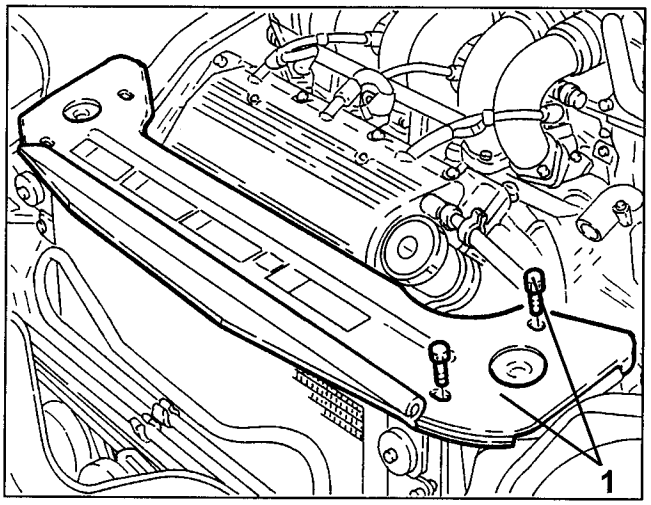
- Drain the fuel pressure by removing the specific caps on the distribution manifold and operating the valves underneath.

NOTE: Collect the fuel in a suitable container.

1. Disconnect the fuel delivery pipe from the distribution manifold and release it from the fastening bracket.
2. Disconnect the front knock sensor electrical connection.
3. Disconnect the earth wire from the engine tie-rod.
4. Loosen the screws and remove the engine tie-rod.

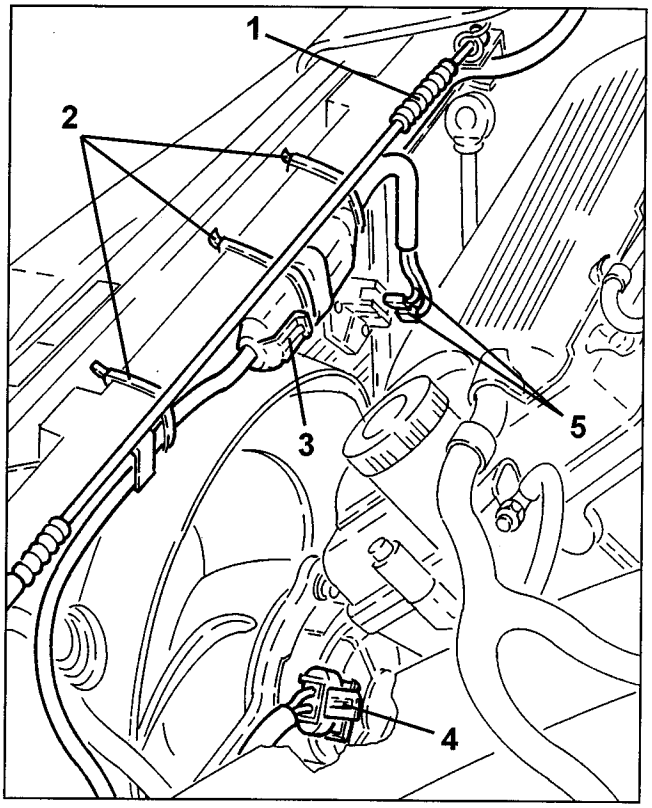


1. Loosen the screws and remove the upper radiator crossmember.

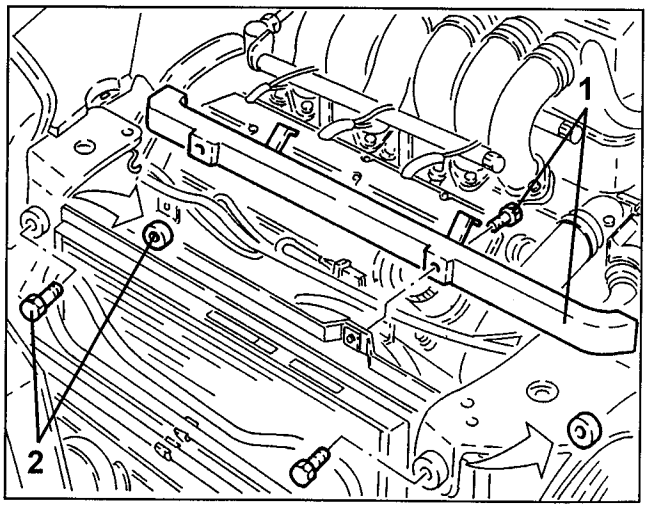


1. Disconnect the bonnet lock wire and move it aside.
2. Release the electrical wiring from the fastening clips and the duct.
3. Disconnect the electrical connection.
4. Disconnect the engine cooling fan electrical connection.

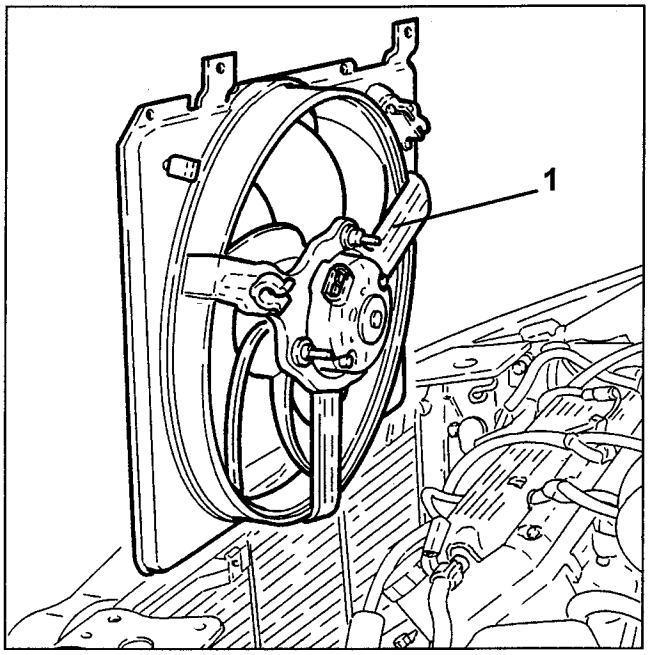
5. Disconnect the engine cooling fan resistor electrical connection and move the electrical wiring aside.



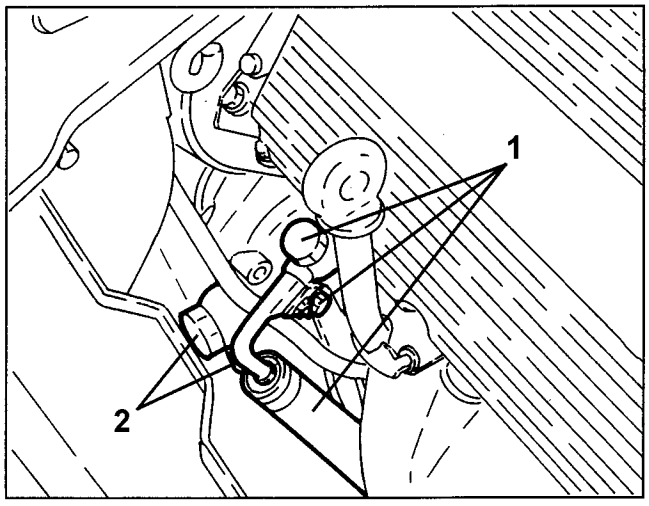
1. Loosen the screws and remove the electrical wiring duct.
2. Loosen the upper radiator fastening screws and take the respective shims.



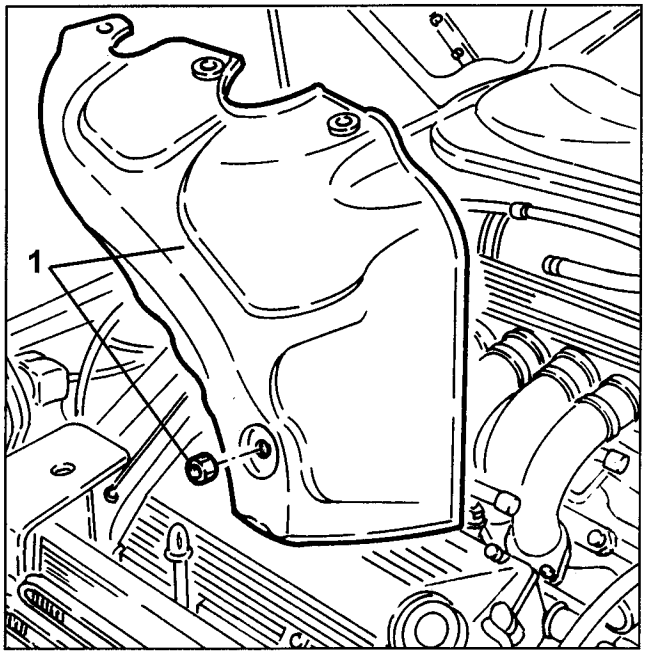
1. Move the radiator aside just enough to remove the engine cooling fan.
- Provisionally refit the engine cooling radiator upper screws.



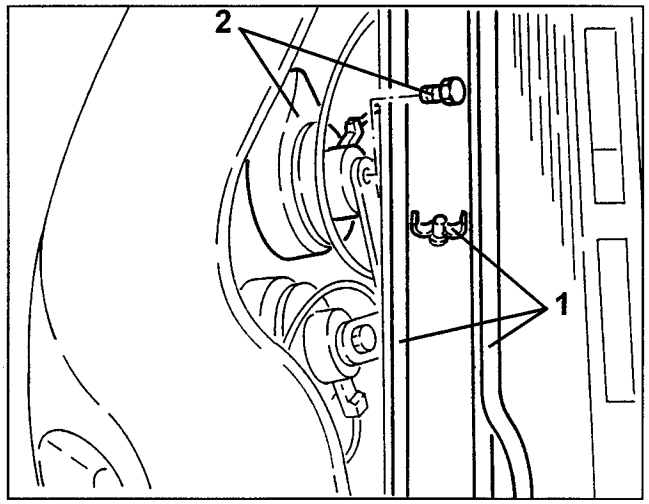
- Empty the power steering oil reservoir with a suitable syringe.
1. Loosen the screw and the fitting. Then disconnect the power steering pump oil delivery pipe.
2. Loosen the fitting and disconnect the power steering pump oil intake pipe.



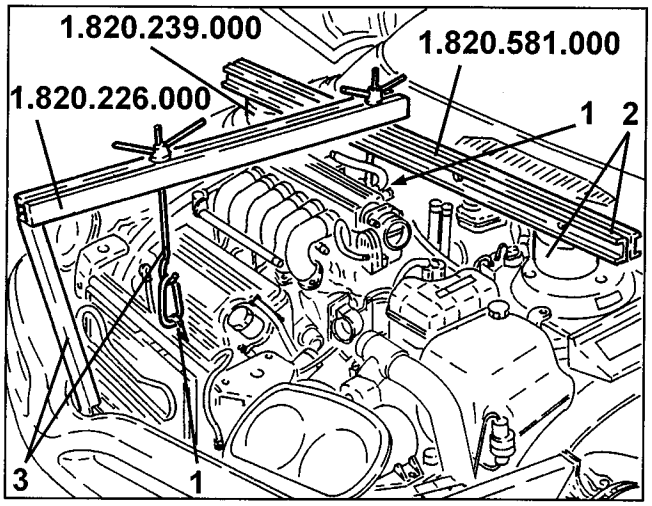
1. Loosen the nuts and remove the firewall from the left-hand exhaust manifold.



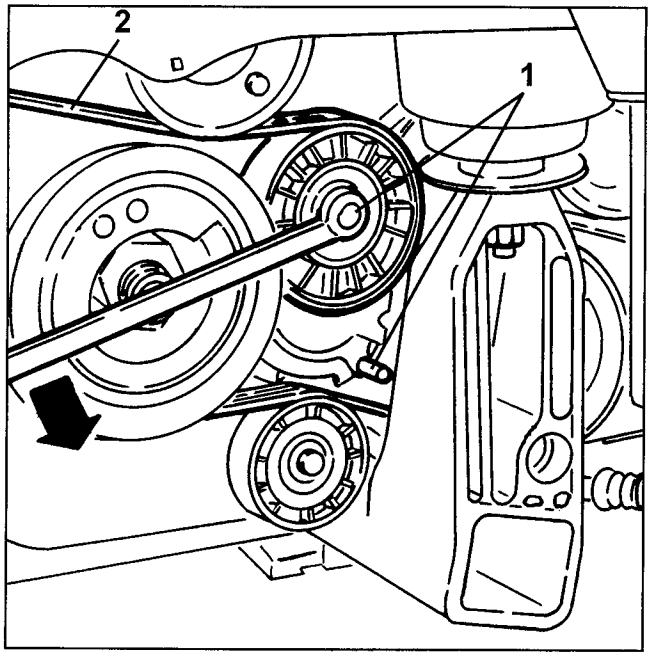
1. Loosen the power steering cooling serpentine from the retainers on the front underbody crossmember.
2. Loosen the fastening screw and move the right-hand horn aside.



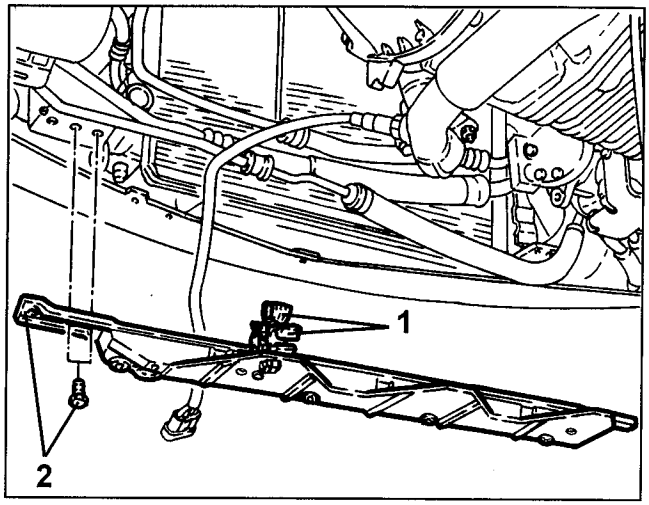
1. Fit the two engine mount rods on the cylinder heads.
2. Fit the crossmember no. 1.820.581.000 with mounts no. 1.820.239.000.
3. Fit mount no. 1.820.226.000 and connect the respective tie-rods on the brackets previously fitted on the cylinder heads.



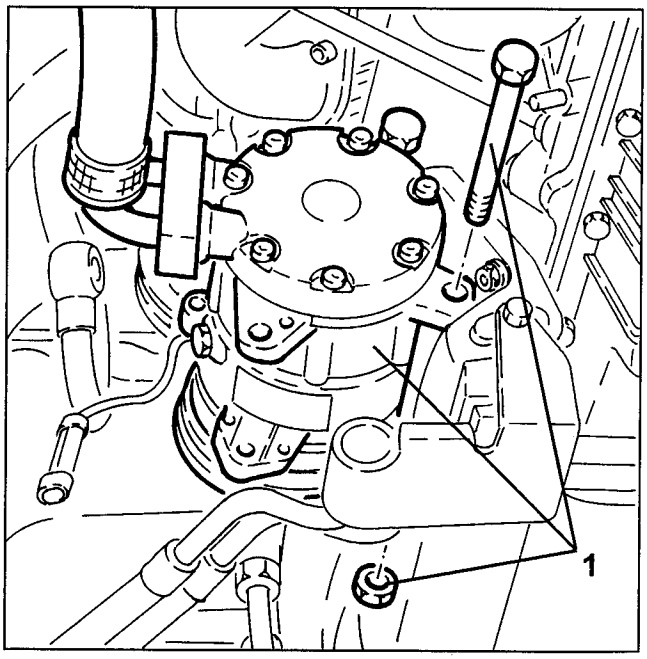
- Lift the vehicle.
1. With a wrench on the belt take-up pulley fastening screw, overcome the automatic take-up force and lock it in this position (belt loose) with a pin as shown in the figure.
2. Remove the engine unit drive belt.



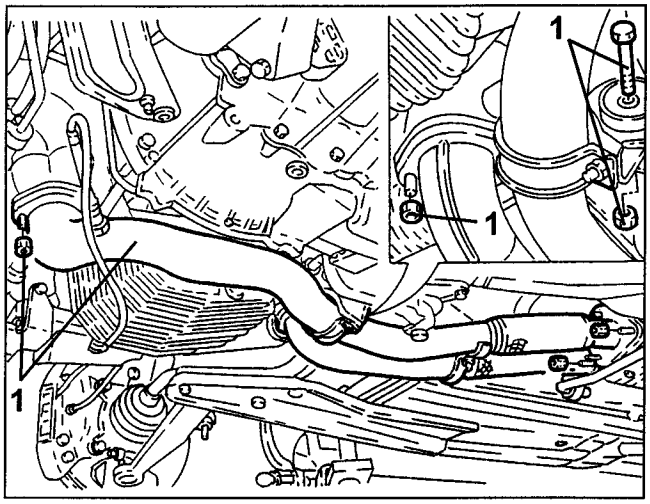
1. Release the power steering and climate control pipes from the clips on the lower radiator crossmember.
2. Loosen the screws and remove the lower engine cooling crossmember.

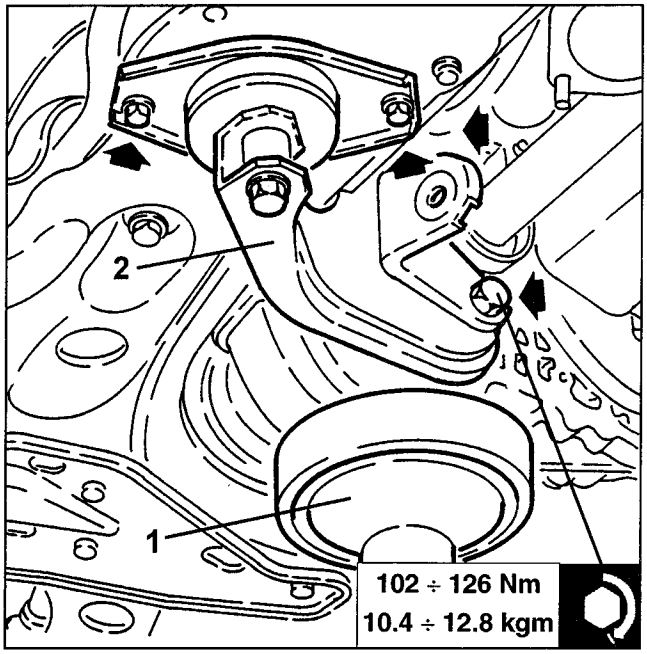


1. Loosen the conditioner compressor fastening screws. Move it aside and fasten it to the underbody.

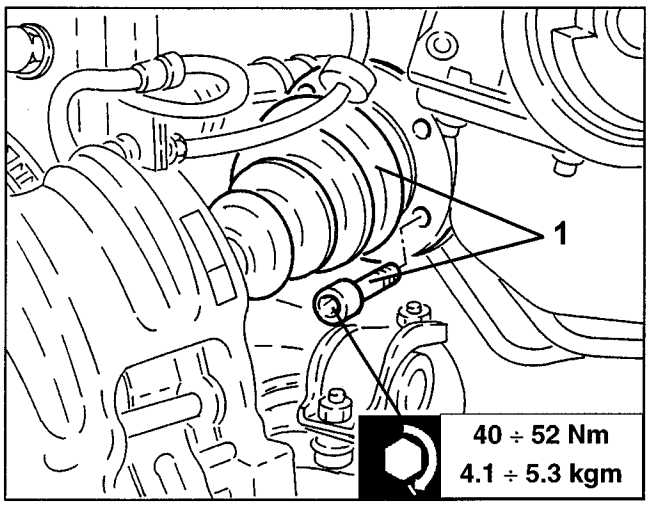


1. Loosen the fasteners and remove the front exhaust pipe section.

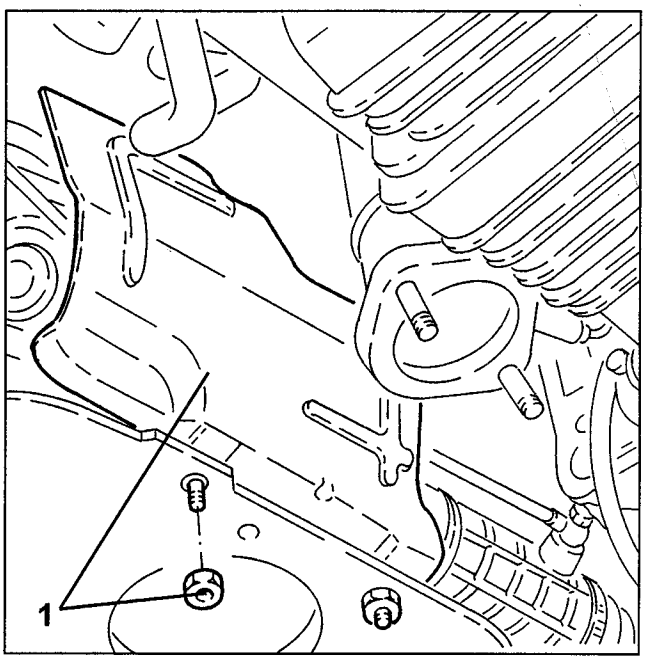




1. Loosen the fastening bolts and disconnect the drive shafts.

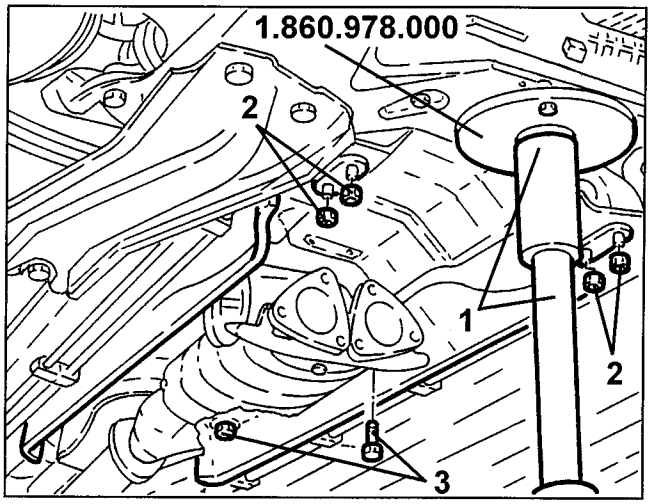


1. Loosen the nuts and remove the power steering unit firewall.

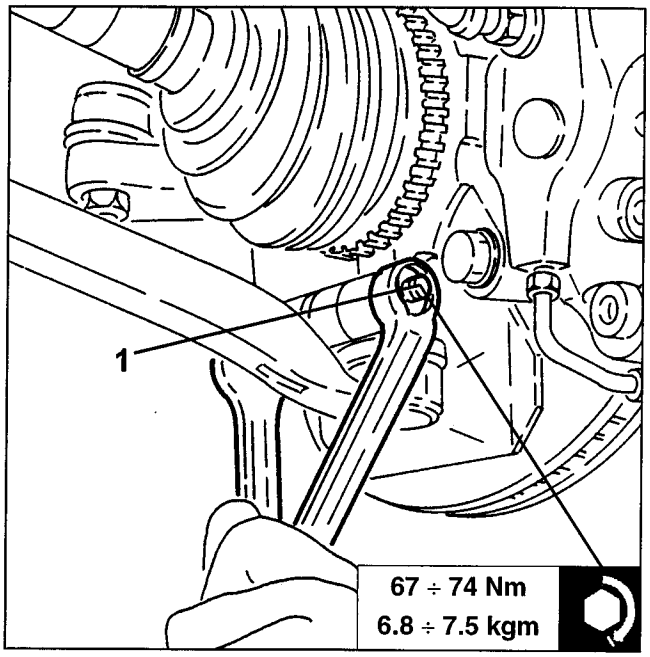


1. Position a hydraulic jack under the differential.
2. Loosen the fastening screws and remove the rear engine mount.
- Remove the hydraulic jack from under the differential.

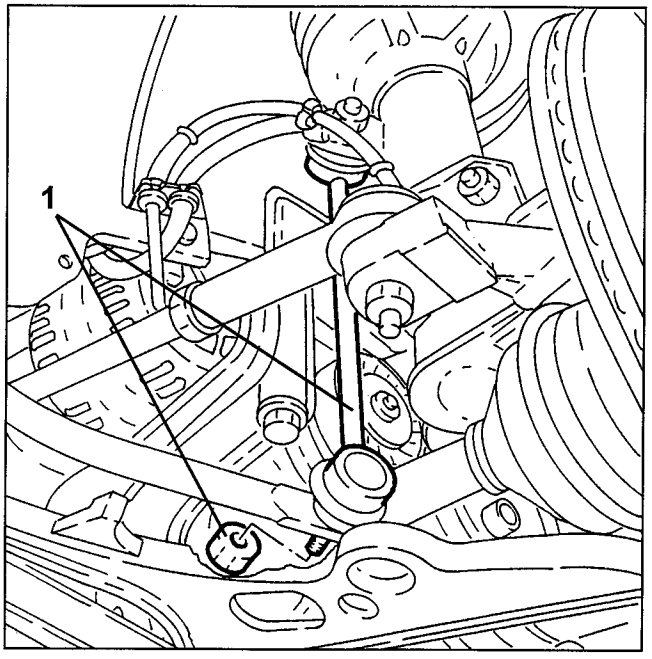
1. Use a hydraulic jack to support the crossmember by means of tool no. 1.860.978.000.
2. Loosen the gear lever bracket front fastening nuts.
3. Loosen the gear lever bracket rear screws and the remaining screws.



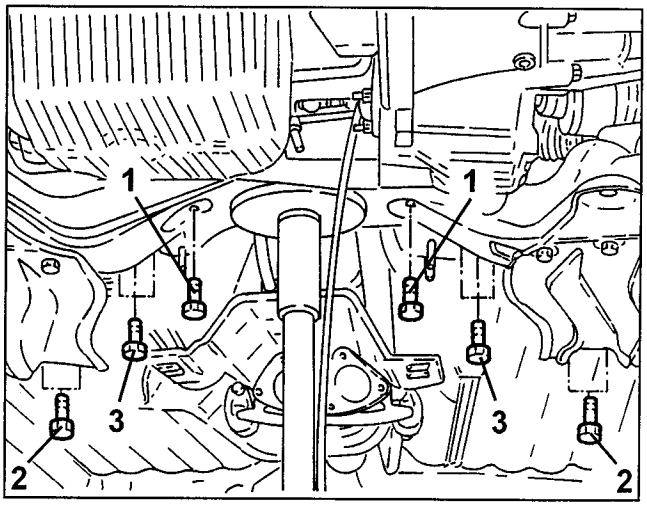
1. Loosen the bolts fastening the wishbones to the wheel risers.



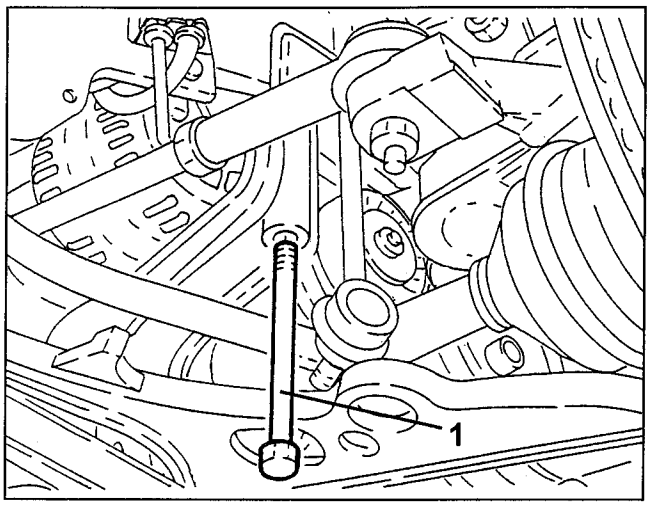
1. Loosen the nuts and disconnect the stabiliser bar tie-rods.



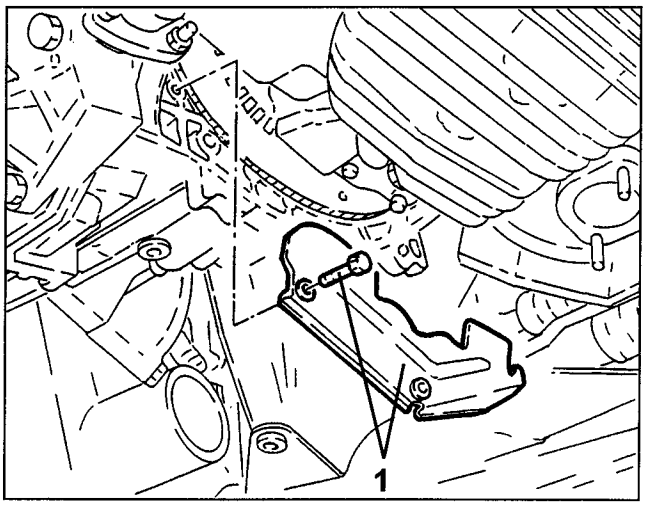
1. Loosen the screws fastening the power steering unit to the crossmember.
2. Loosen the rear screws fastening the crossmember reinforcement to the underbody.
3. Loosen the central screws fastening the crossmember to the underbody.



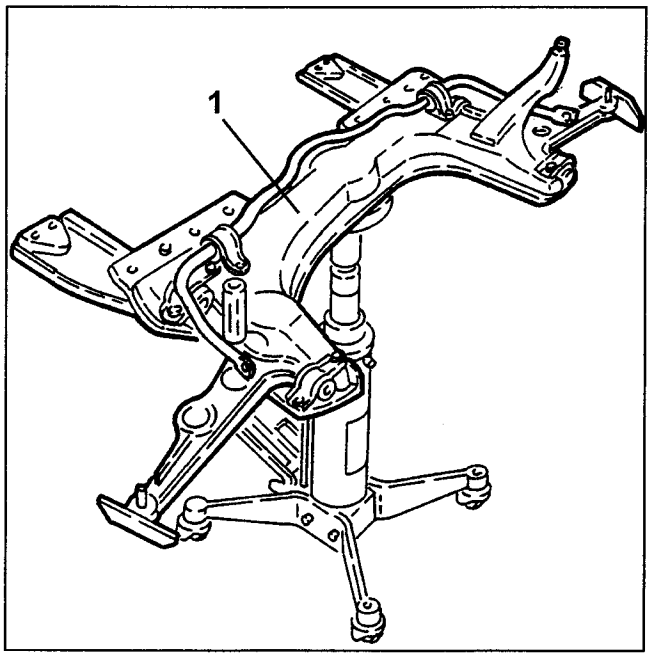
1. Loosen the side screws fastening the crossmember to the underbody.



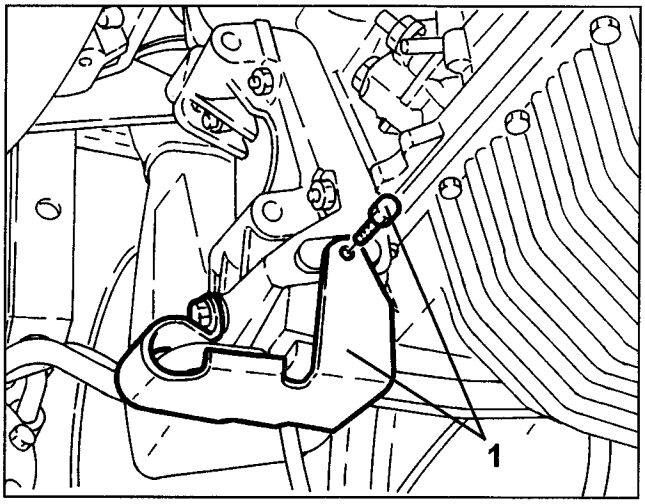
1. Loosen the fastening screws and remove the flywheel guard.



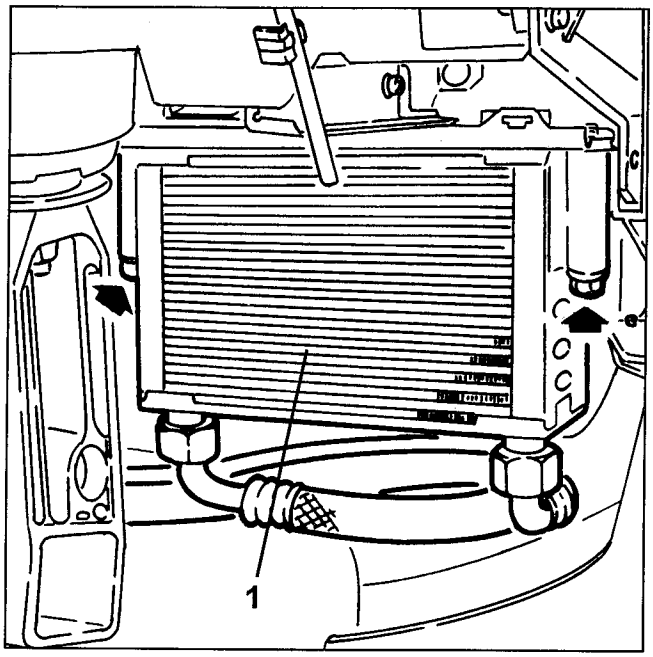
1. Lower the hydraulic jack and remove the crossmember with wishbones, stabiliser and reinforcements.



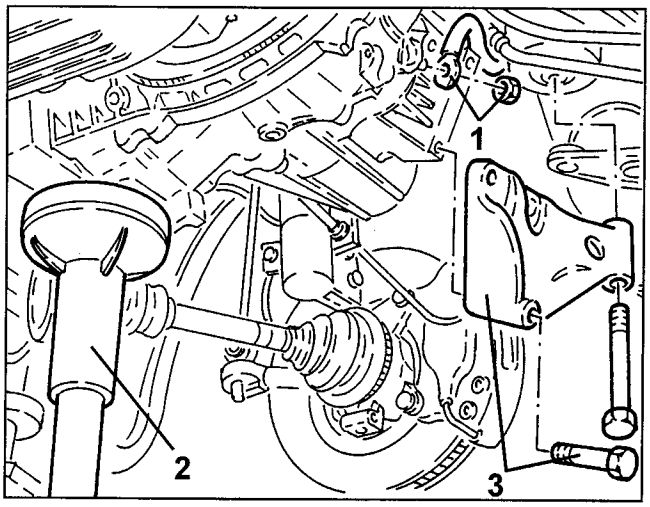
1. Loosen the fastening screws and remove the cooling radiator engine oil delivery and return pipe bracket.



1. Loosen the fastening screws and remove the engine oil radiator from the bracket. Then fasten it to the engine as not to obstruct the following operations without disconnecting it.



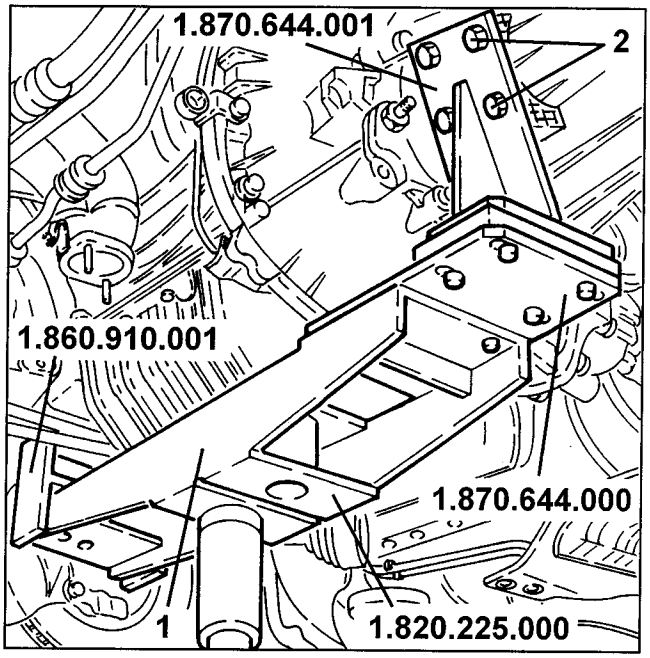
1. Disconnect the gearbox earth braid.
2. Position a hydraulic jack under the differential.
3. Loosen the screws and remove the gearbox bracket on engine side.
- Remove the hydraulic jack from under the differential.



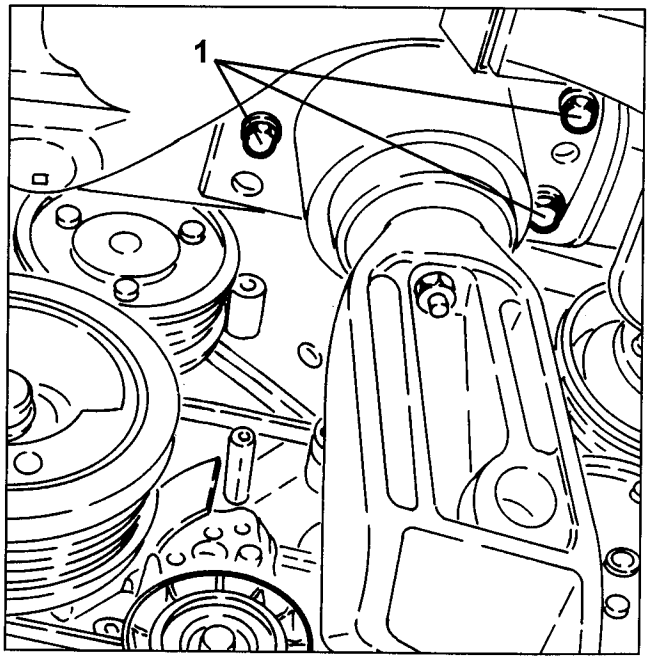
1. Position tool no. 1.820.225.000 with tools no. 1.870.644.000, no. 1.870.644.001 and no. 1.860.910.001 on the hydraulic jack.

NOTE: Position the hydraulic jack in the central hole in tool 1.820.225.000 to ensure the engine is balanced correctly on the fixture.

2. Fasten the fixture to the engine.



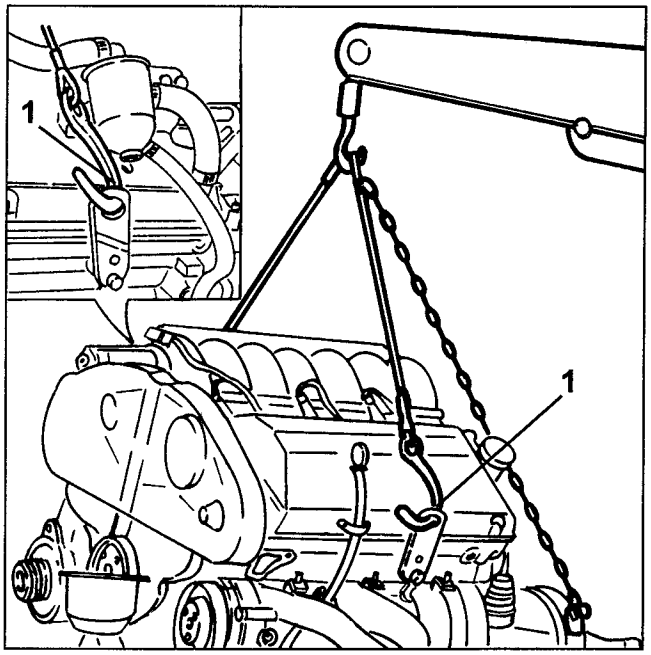
- Release the engine safety fixture tie-rods from the cylinder head brackets.
1. Loosen the engine stiff rubber mount fastening screws, timing side.



- Release the electrical wires from any clips and move them away from the engine so that they will not get caught when the engine is removed.
- Lower the hydraulic jack completely and remove the engine from the engine compartment.

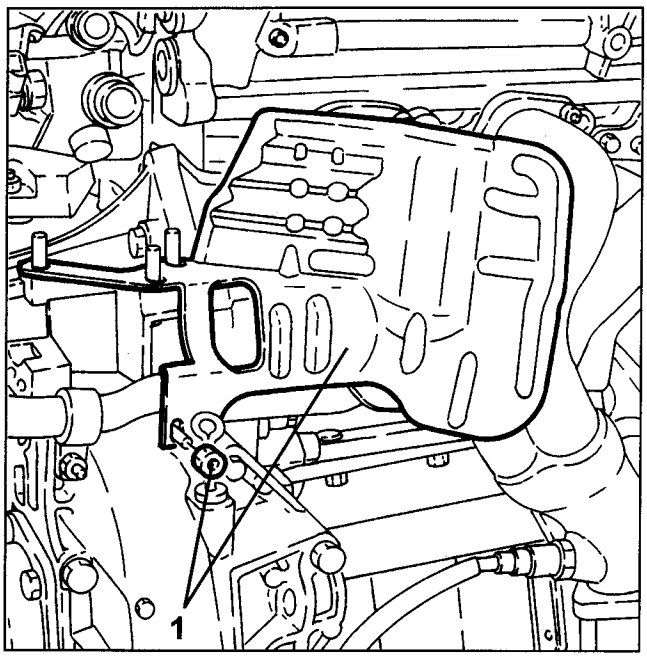
IMPORTANT: The hydraulic jack must have a payload of at least 1000 kg.
When lowering the engine, make sure no wires or pipes are still connected.
Be careful not to damage any components.

1. Support the engine with the hydraulic jack used for removal and with a hydraulic crane as shown in the figure.

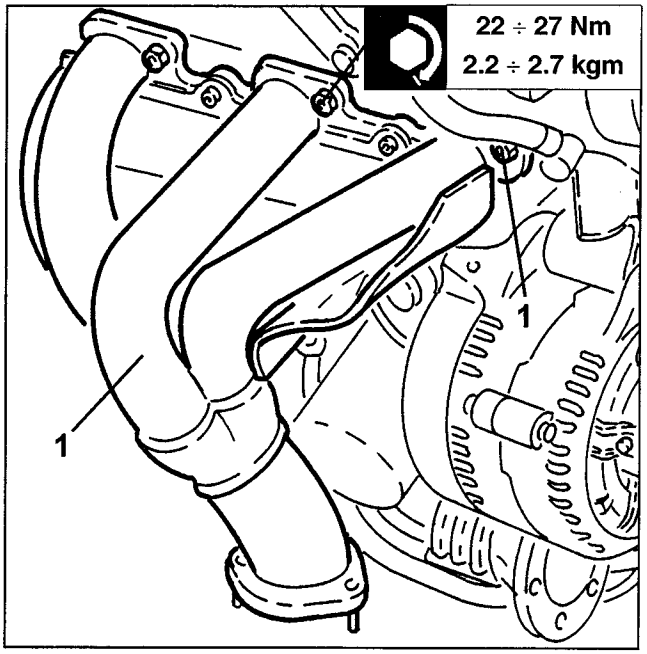


IMPORTANT: Use a hydraulic crane to move the engine after releasing it from the hydraulic jack.

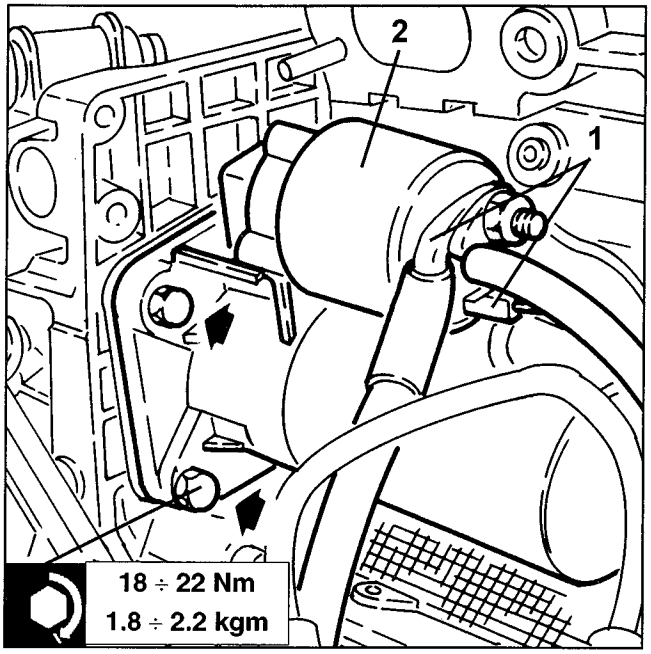
- Lower the hydraulic crane and position the engine on a specific engine stand.
1. Loosen the fastening nut and remove the upper firewall from the right-hand exhaust manifold.



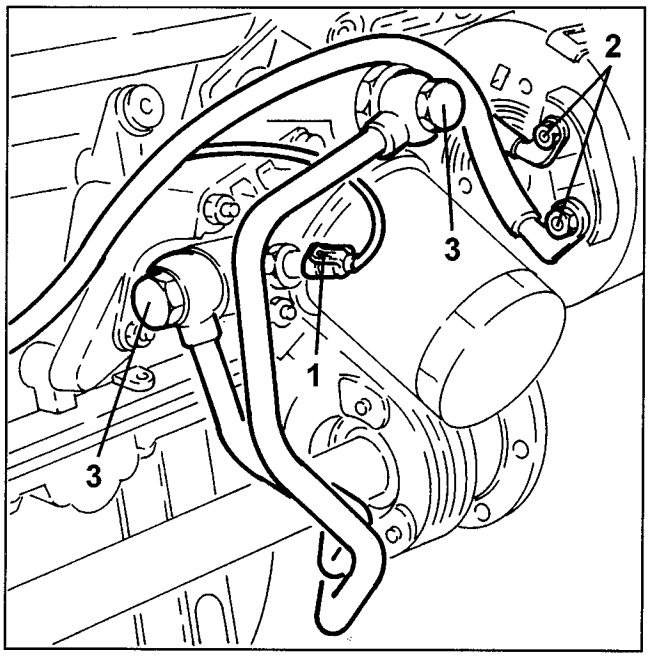
1. Loosen the fasteners and remove the right-hand exhaust manifold and starter motor firewall.
- Remove the respective seals.



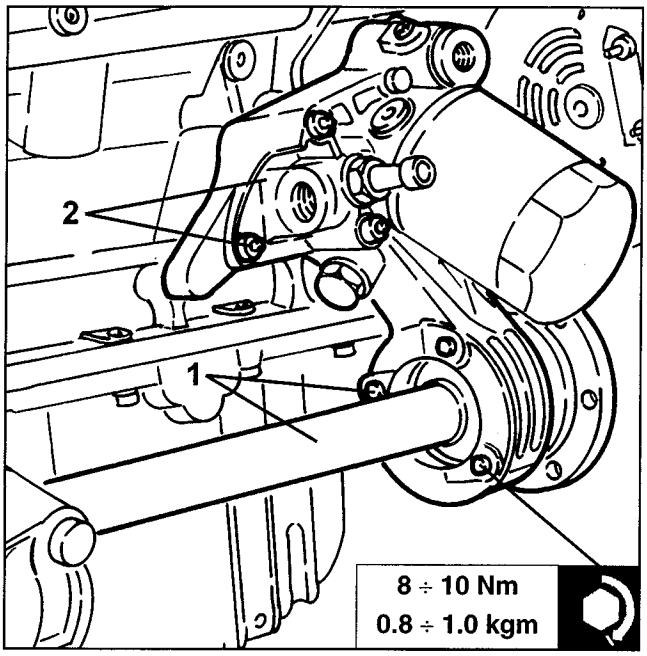
1. Disconnect the starter motor electrical connections.
2. Loosen the three fastening screws and remove the starter motor.



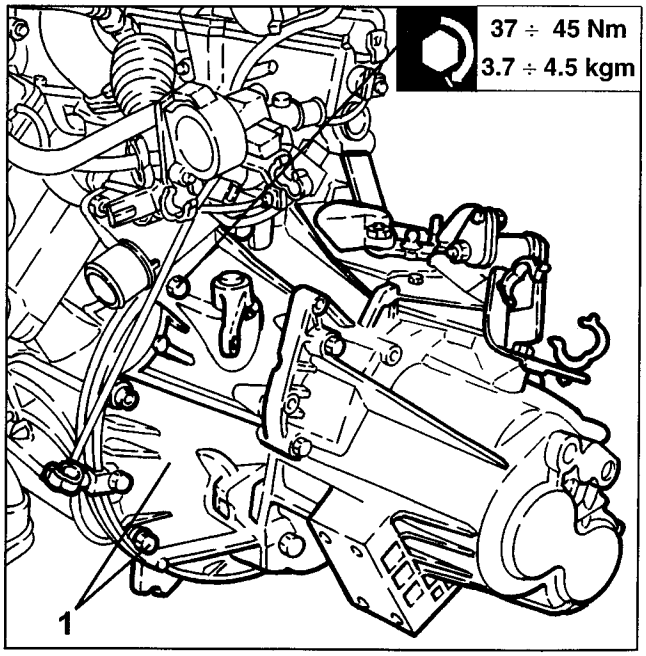
1. Disconnect the engine oil minimum pressure sensor electrical connection.
2. Disconnect the alternator electrical connections. Then remove the electrical wiring by releasing it from the fasteners.
3. Disconnect the radiator engine oil delivery and return pipe fittings from the oil filter bracket. Then remove them with the bracket.



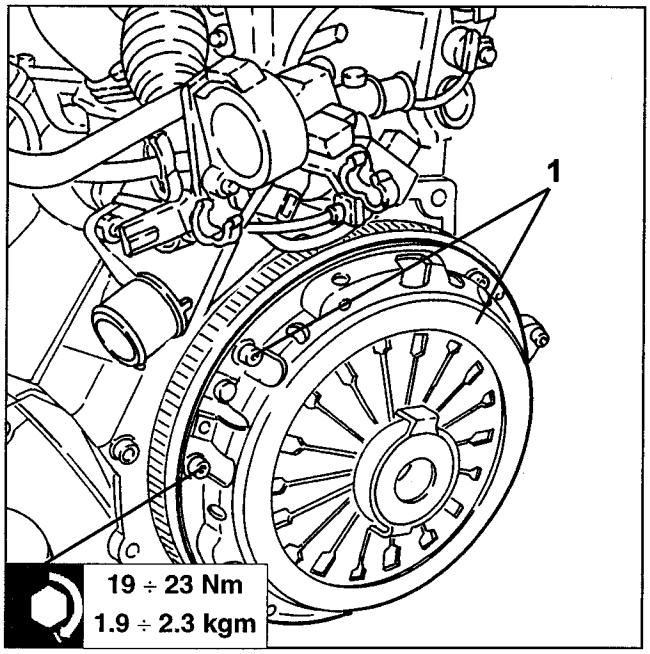
- Drain the gearbox-differential oil.
1. Loosen the fastening screws and release the intermediate shaft.
- Remove the dust guard ring.
2. Loosen the fastening nuts and remove the oil filter bracket.



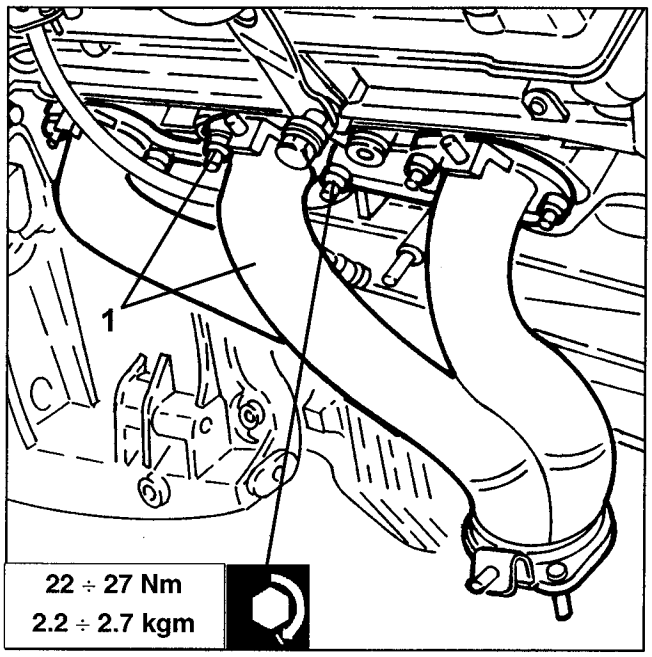
1. Loosen the fastening screws and remove the gearbox-differential with a hydraulic crane.



1. Loosen the fastening screws and remove the thrust plate with thrust bearing and clutch plate.



1. Loosen the fastening nuts and remove the exhaust manifold, left-hand side.
- Remove the respective seals.



REFITTING

Reverse the removal sequence and observe the following warnings:
- Prepare the engine compartment to insert the engine assembly by positioning all the electrical wires, pipes, etc. so that they do not interfere with the refitting operations.
- Be careful not to damage the single components when refitting the engine.

IMPORTANT: Make sure the engine assembly mounts are correctly fastened.

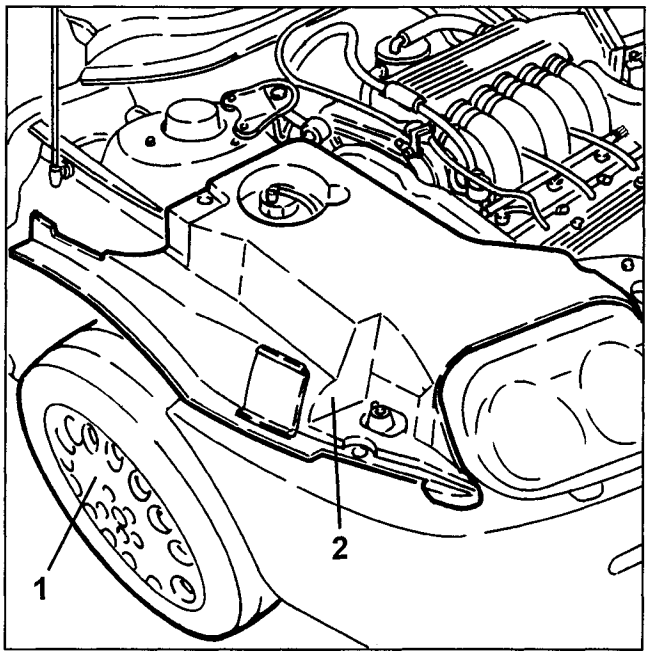
- After refitting, top the various systems up as required (see Assembly 00).
- Perform all the checks and interventions required (see Assembly 00).

CYLINDER HEAD

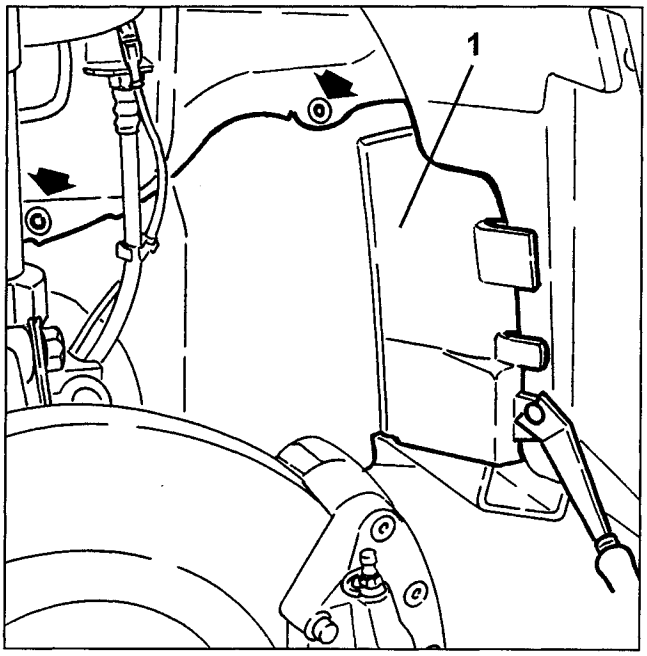
NOTE: Only the right-hand cylinder head can be removed in the vehicle as shown below. Remove the engine assembly to remove the left-hand cylinder head (see specific paragraph).

REMOVAL/REFITTING RIGHT-HAND CYLINDER HEAD

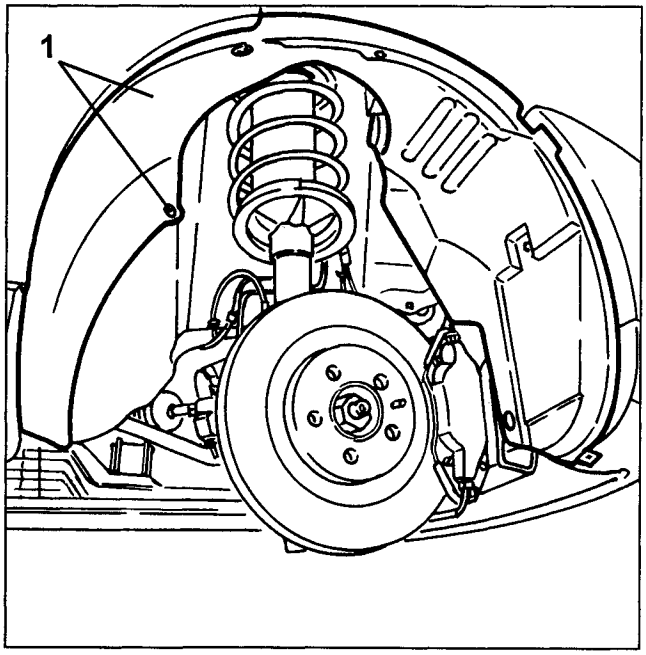
- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Remove the front right-hand wheel.
2. Loosen the screws and remove the two engine compartment side guards.



1. Loosen the two fastening screws, remove the plastic button and remove the dust guard from the front right-hand wheel compartment.

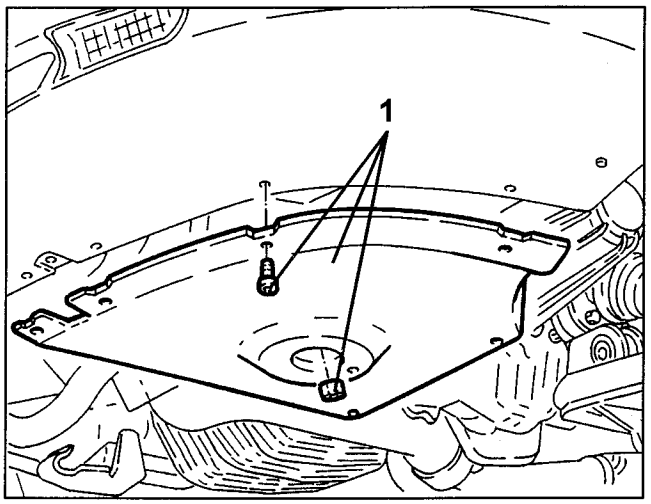


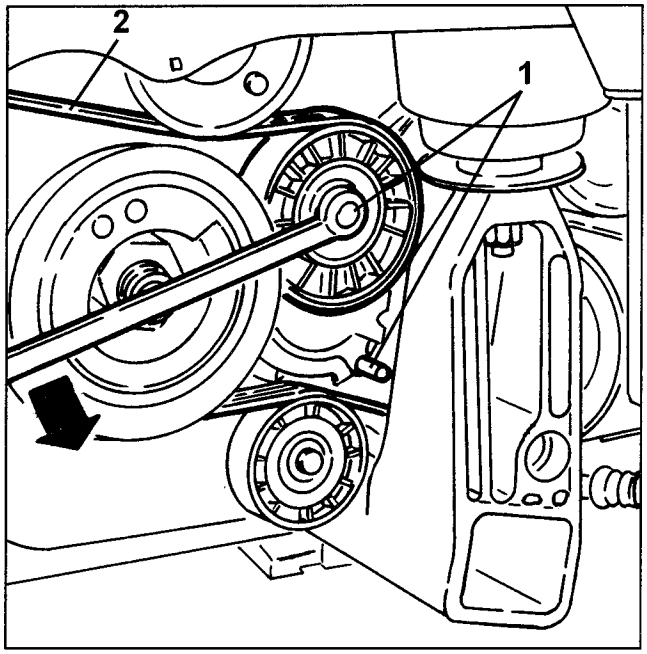
1. Loosen the fasteners and remove the front right-hand wheelhouse.



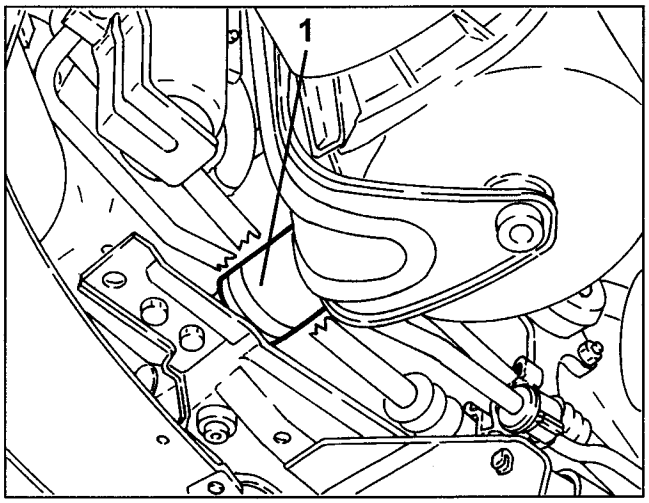
- Lift the vehicle.

1. Loosen the nut and the screws. Then remove the lower air cleaner guard.



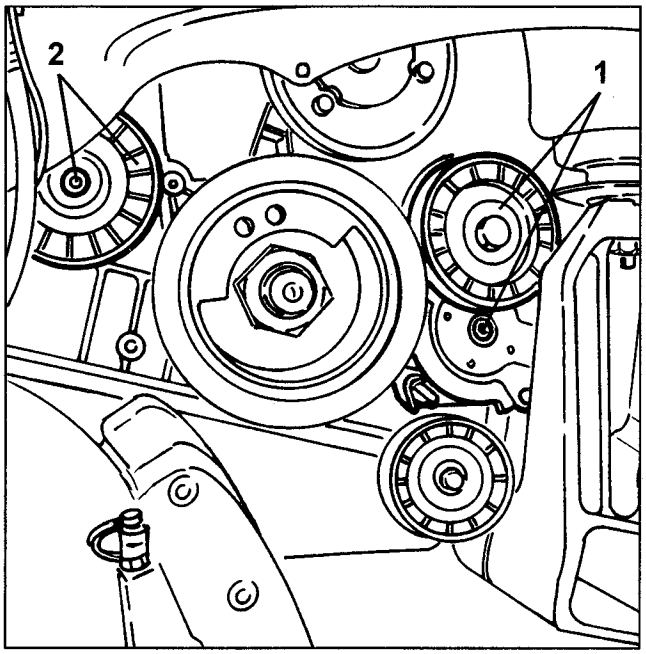


1. Drain the engine coolant by disconnecting the radiator outlet sleeve and collect the coolant in a suitable container.

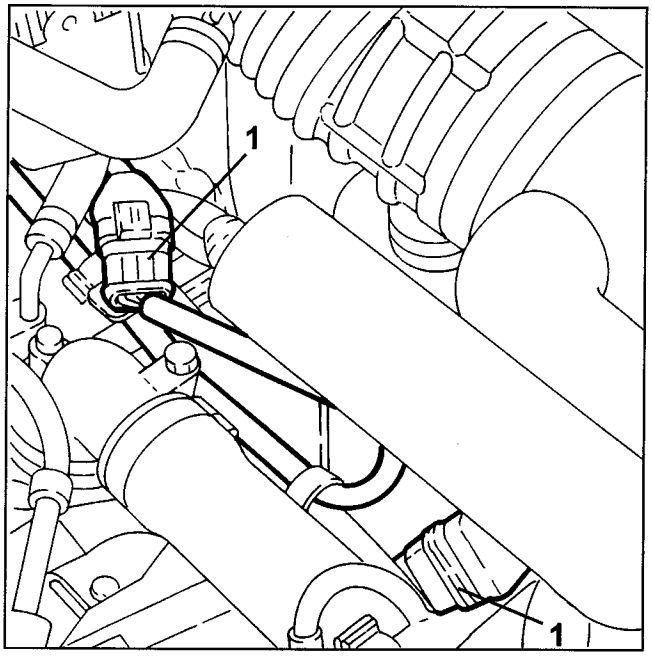


1. With a wrench on the belt take-up pulley fastening screw, overcome the automatic take-up force and lock it in this position (belt loose) with a pin as shown in the figure.
2. Remove the auxiliary unit drive belt.

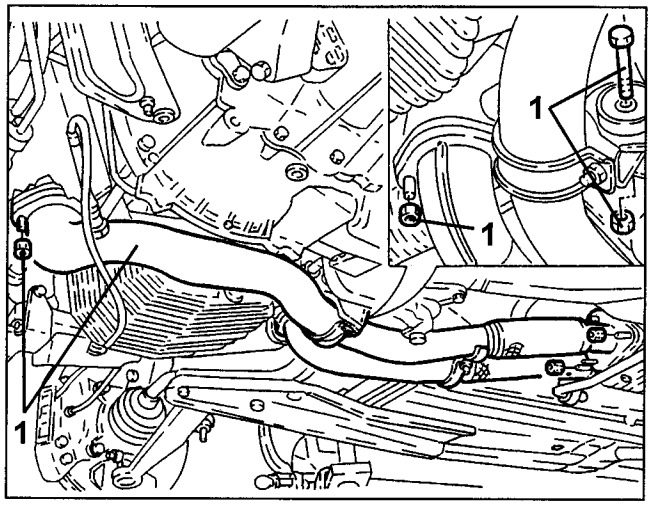
1. Loosen the fastening screw and remove the engine unit drive belt take-up.
2. Loosen the fastening screw and remove the auxiliary unit drive belt runner.



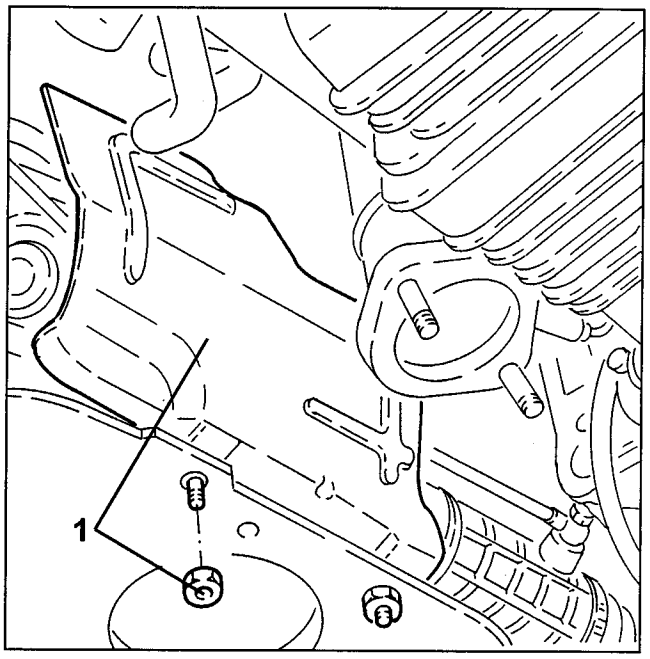
- Lower the vehicle.
1. Disconnect the lambda sensor electrical connections.



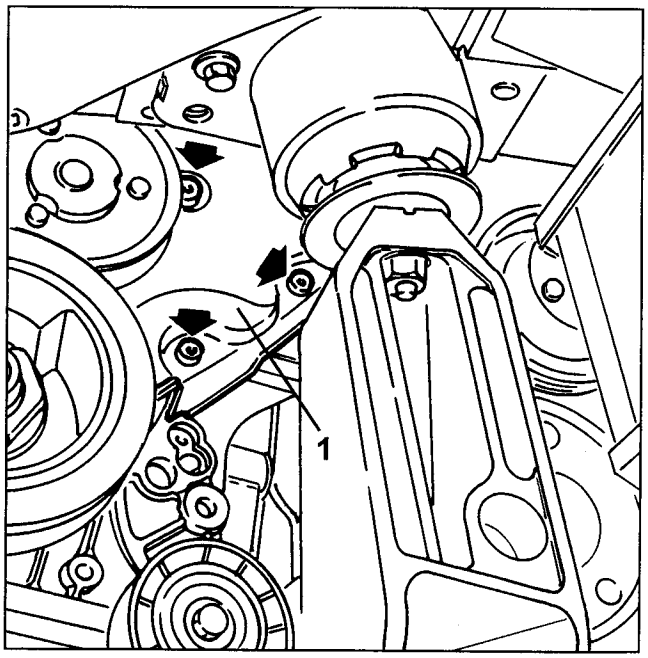
- Lift the vehicle.
1. Loosen the fasteners and remove the front exhaust pipe section.



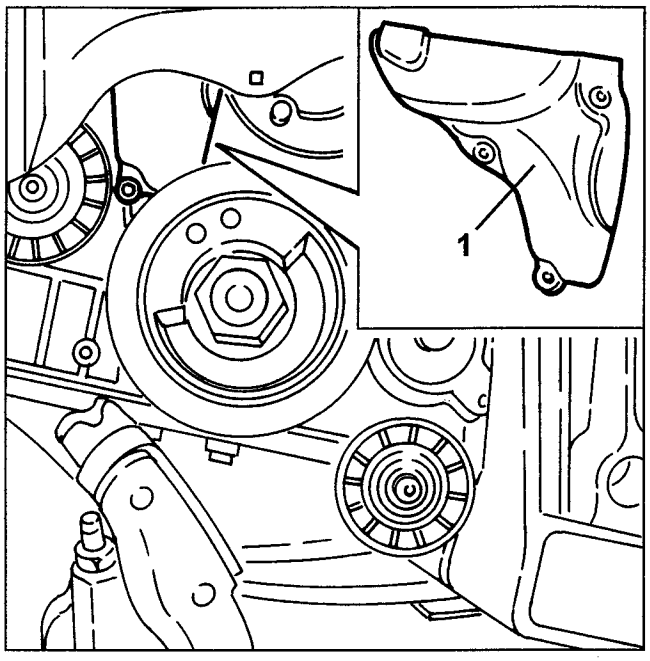
1. Loosen the nuts and remove the power steering unit firewall.



1. Loosen the fastening screws and remove the lower left-hand timing belt guard.

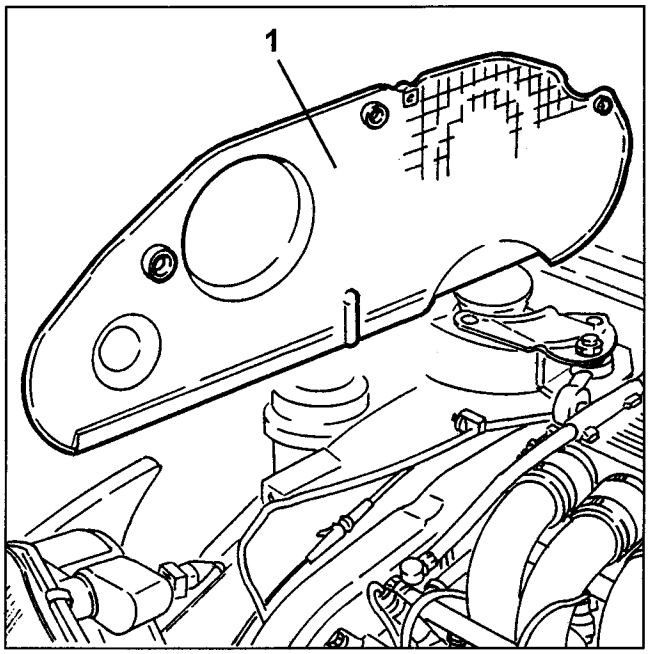


1. Loosen the fastening screws and remove the lower right-hand timing belt guard.

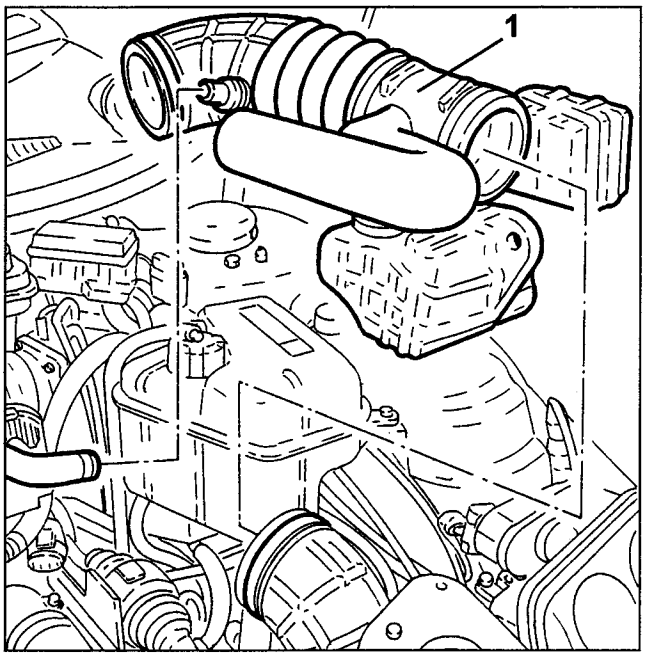


- Lower the vehicle.

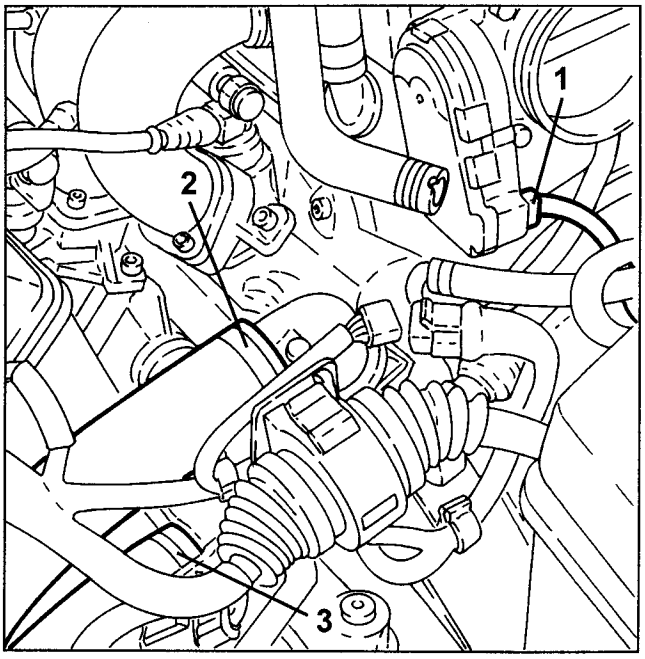
1. Loosen the fastening screws and remove the upper timing belt guard.



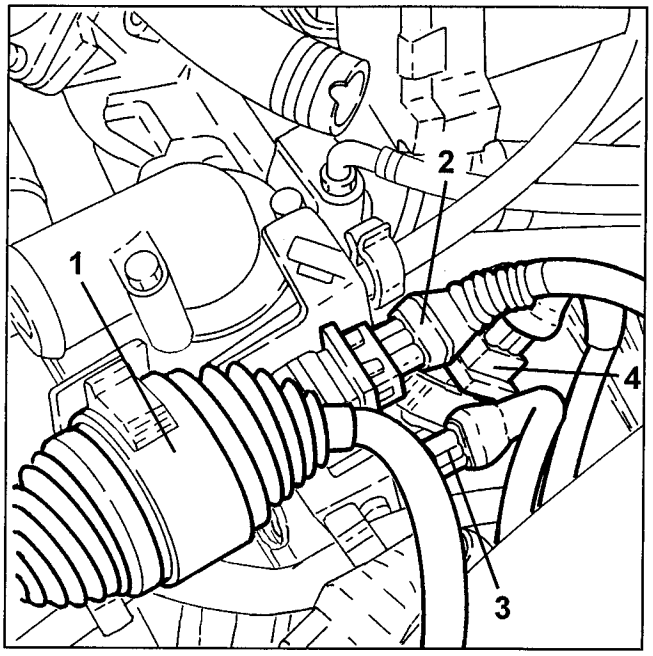
1. Loosen the clips and remove the corrugated sleeve with resonators after releasing the intermediate resonator from the fastening pin.



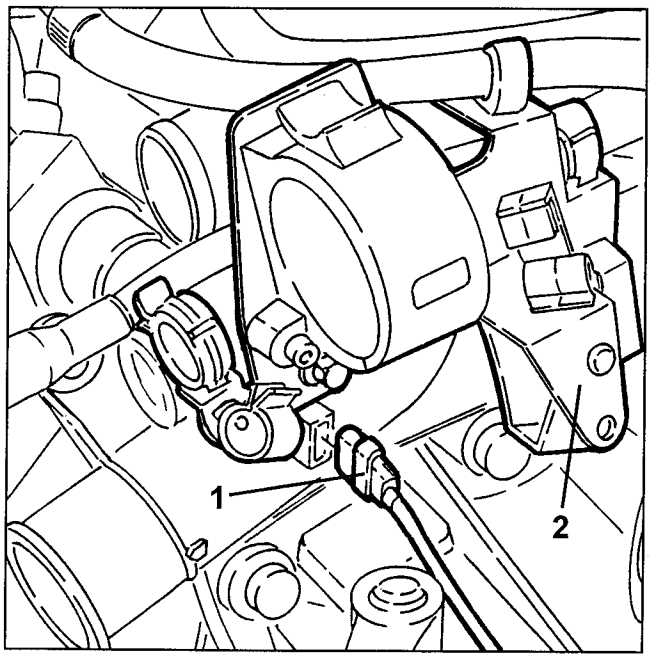
1. Disconnect the electrical connection from the throttle casing with built-in DVL.
2. Disconnect the radiator coolant delivery sleeve from the thermostat.
3. Disconnect the radiator coolant return sleeve from the thermostat.



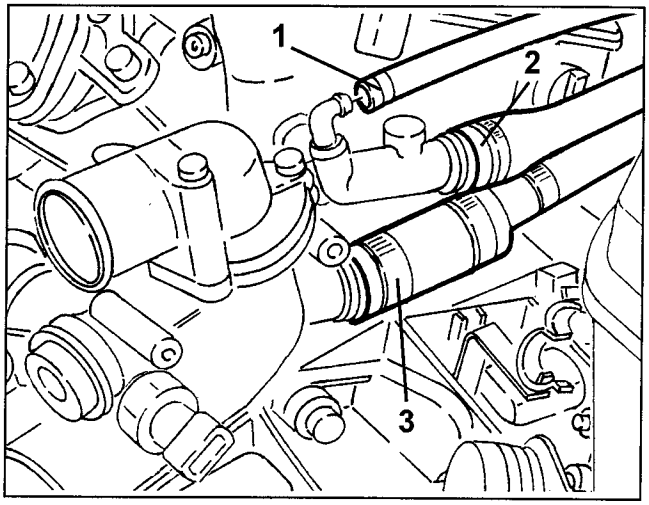
1. Disconnect the injection wiring joint from the bracket.
2. Disconnect the rpm and phase sensor electrical connection.
3. Disconnect the rear knock sensor electrical connection.
4. Disconnect the cam angle sensor electrical connection.



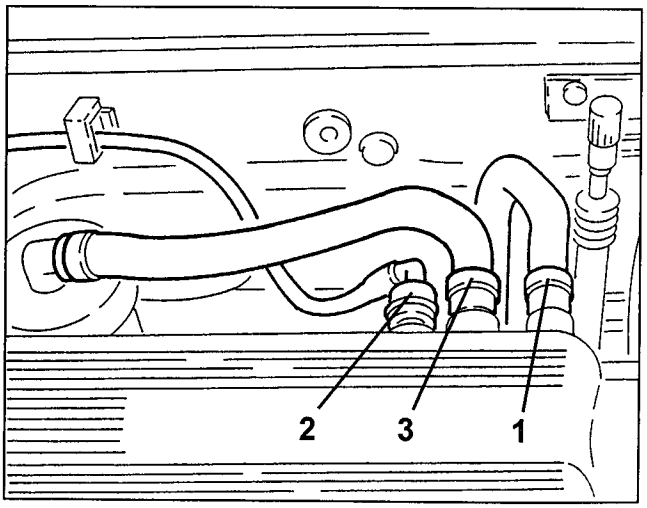
1. Disconnect the engine coolant temperature sensor electrical connection.
2. Loosen the fastening screws and remove the electrical connection bracket and pipes.



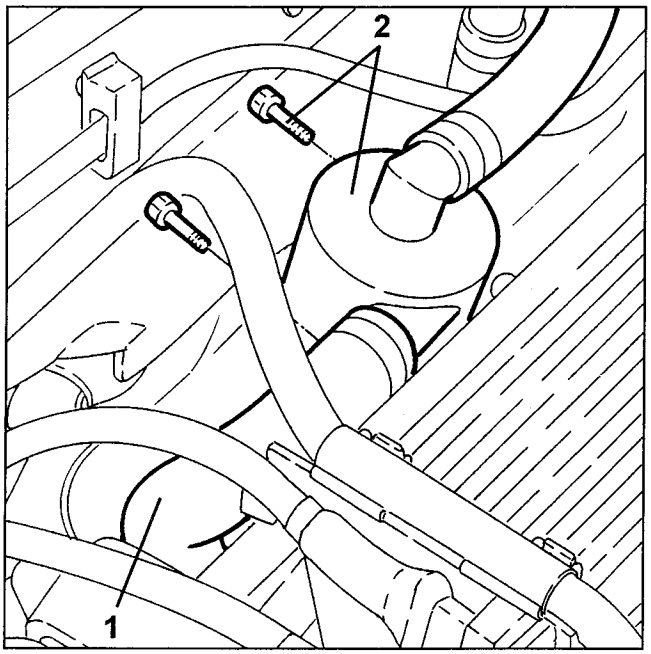
1. Disconnect the coolant return pipe to the expansion reservoir from the right-hand cylinder head.
2. Disconnect the coolant delivery pipe to the climate control system from the right-hand cylinder head fitting.
3. Disconnect the climate control system coolant return sleeve from the thermostat.



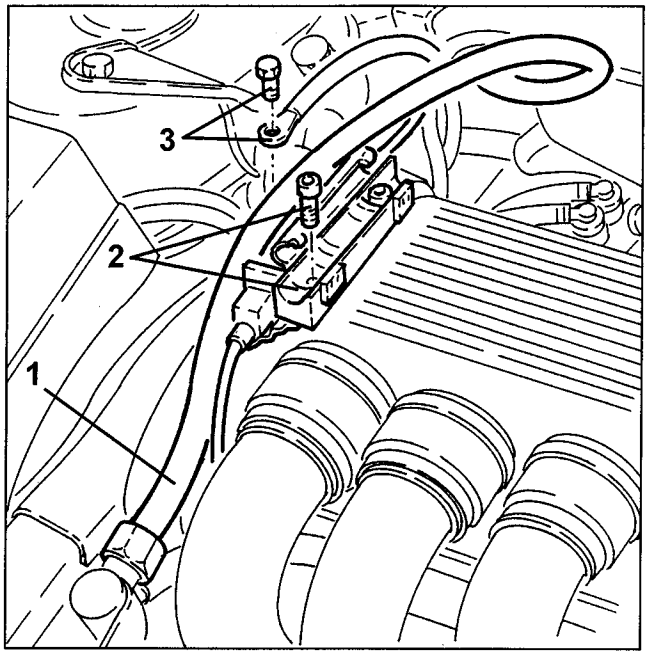
1. Disconnect the brake booster vacuum pipe from the intake manifold.
2. Disconnect the fuel vapour pipe quick coupling fitting from the intake manifold.
3. Disconnect the oil vapour recirculation pipe from the intake manifold.



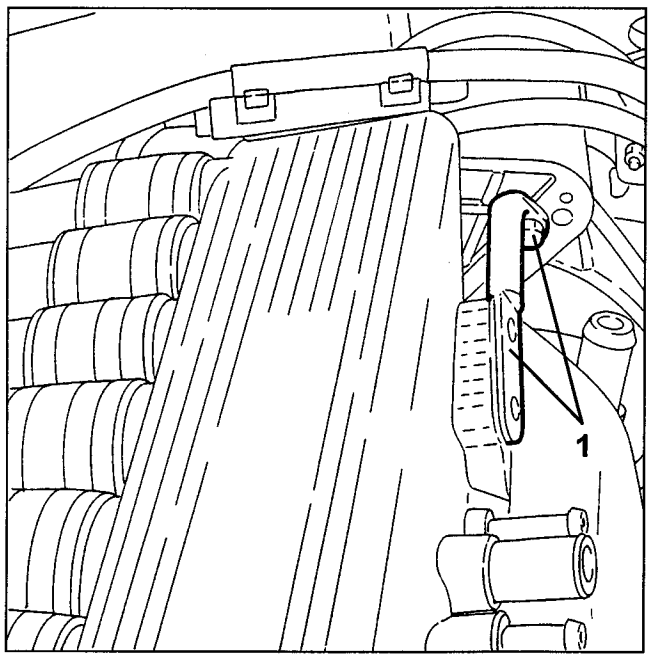
1. Disconnect the oil vapour recovery pipe from the right-hand cylinder head tappet cover.
2. Loosen the fastening screws and move the oil vapour separator from the intake manifold.



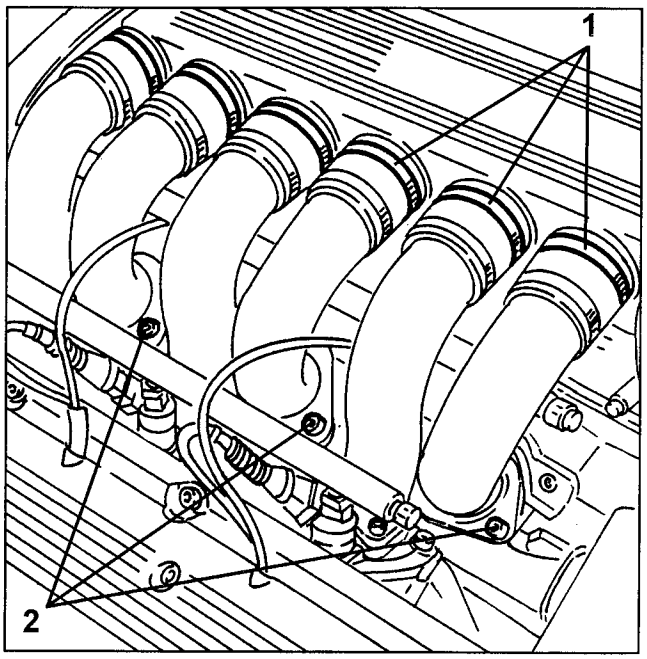
1. Release the fuel delivery pipe from the bracket.
2. Loosen the screws and remove the fuel delivery pipe bracket.
3. Disconnect the engine tie-rod earth wire.



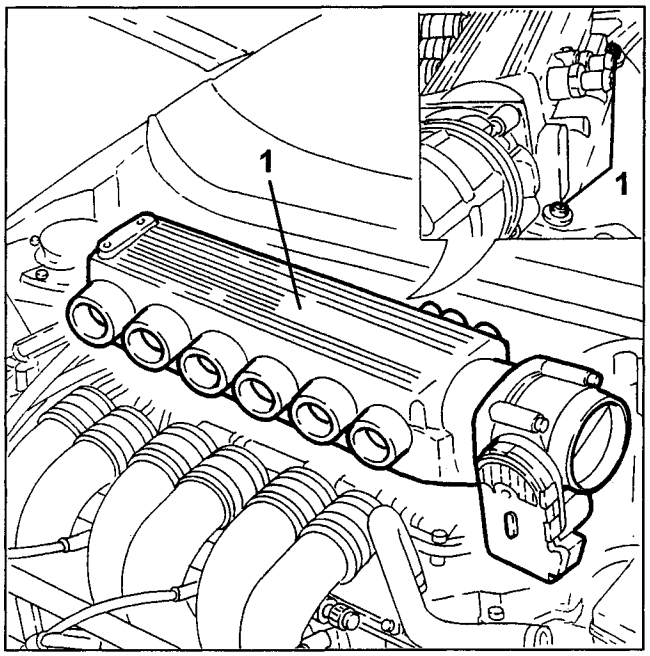
1. Loosen the screw and remove the intake manifold connection to engine tie-rod bracket.



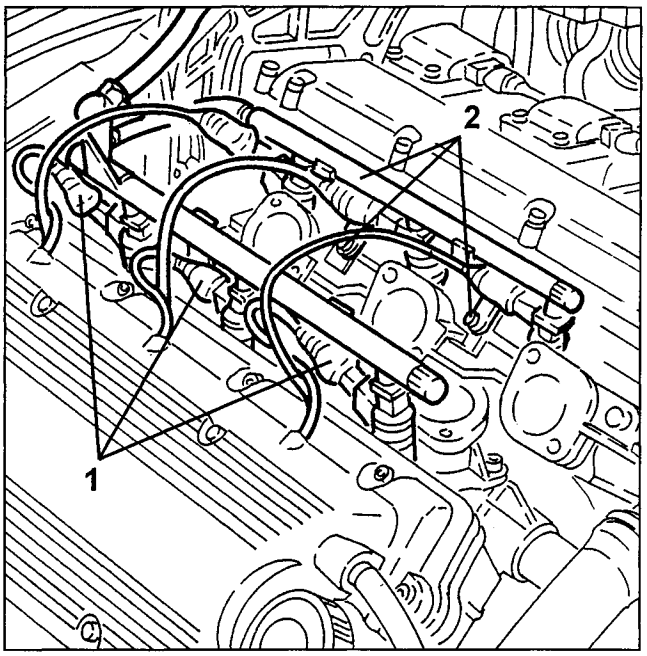
1. Loosen the intake manifold duct clips.
2. Loosen the air intake duct fastening screws on the cylinder head.



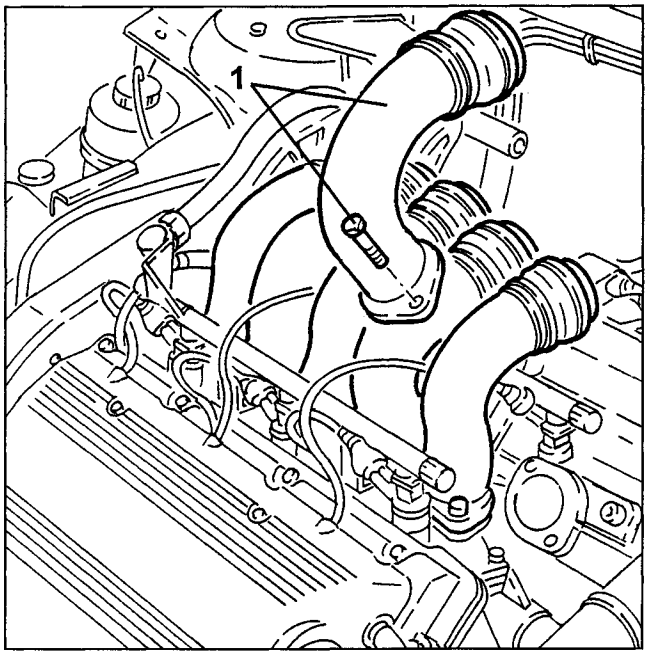
1. Loosen the fastening screws and remove the intake manifold.



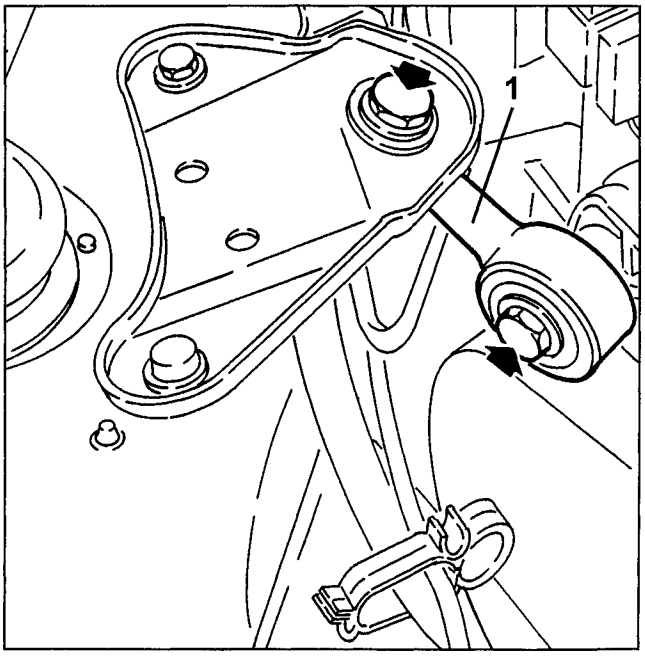
1. Disconnect the injector electrical connections.
2. Loosen the fastening screws and move the fuel distribution manifold with injectors aside.



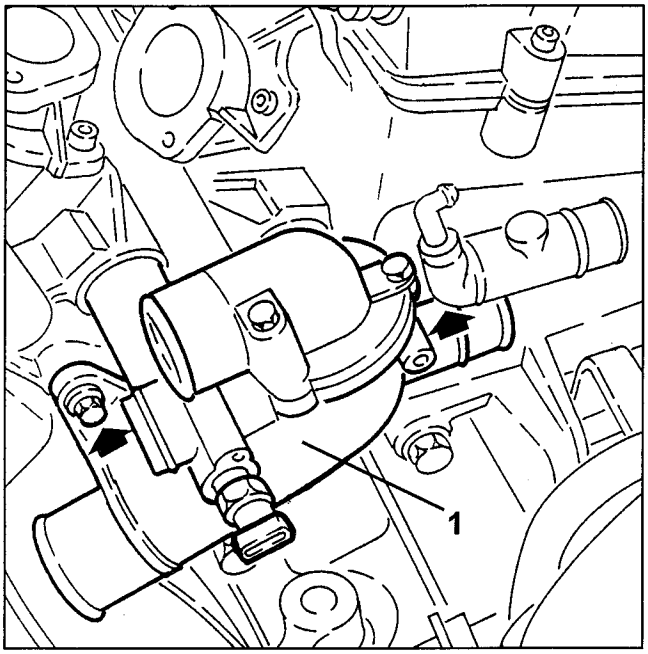
1. Remove the previously loosen screws and remove the intake ducts.
- Refit the respective seals.



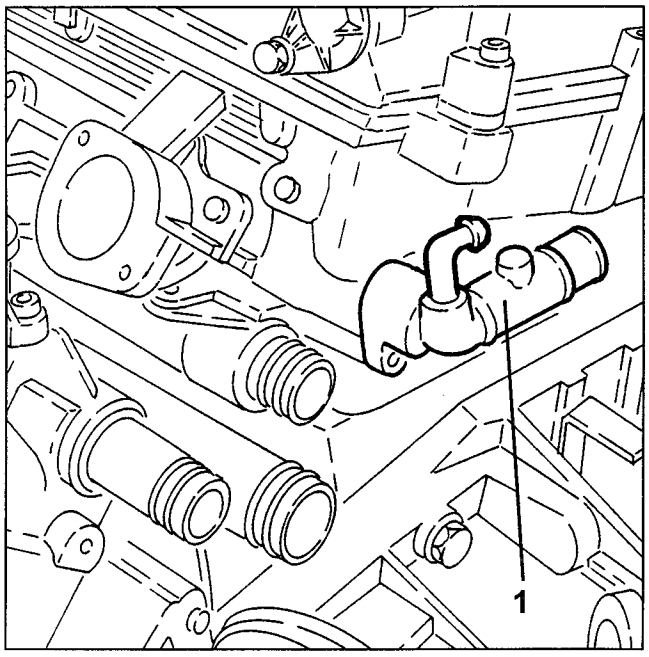
1. Loosen the fastening screws and remove the engine assembly tie-rod.



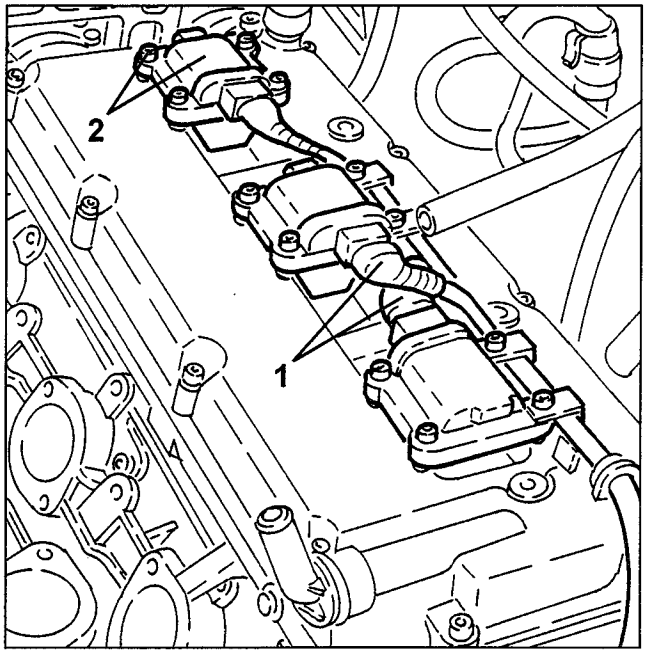
1. Loosen the fastening screws and remove the thermostat.



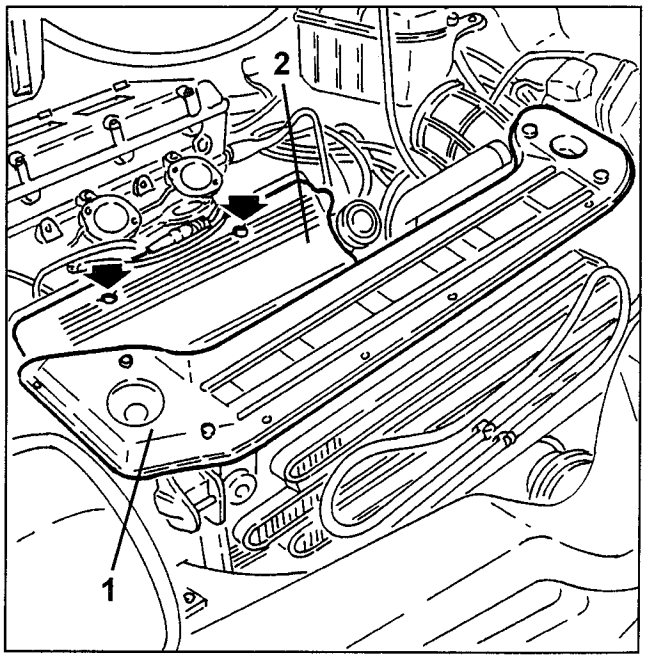
1. Loosen and remove the right-hand cylinder head coolant outlet fitting.



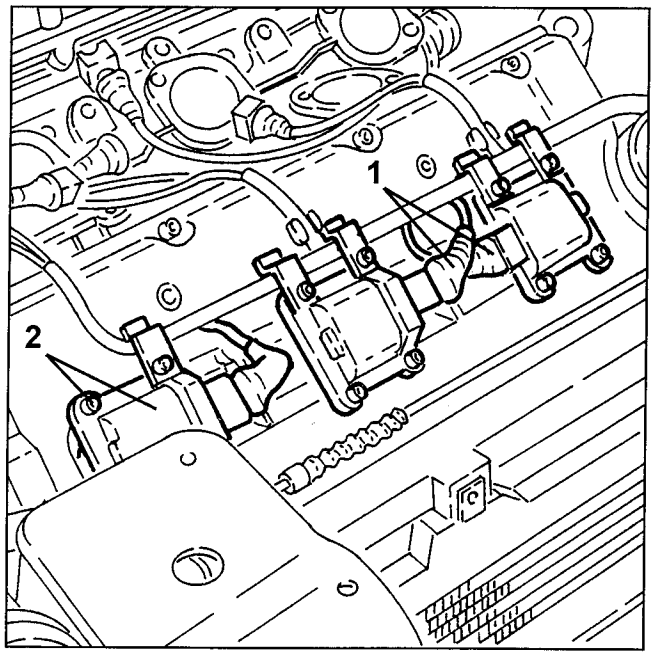
1. Disconnect the electrical connections from the right-hand side cylinder head ignition coils and move the respective wiring aside.
2. Loosen the fastening screws and remove the right-hand cylinder head ignition coils.



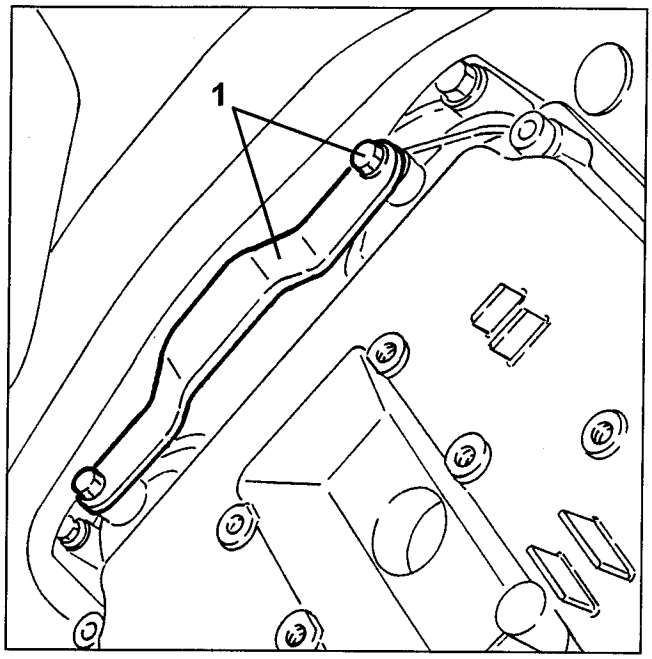
- Release the engine cooling fan wiring from the fasteners on the front crossmember.
1. Loosen the fastening screws and remove the upper radiator crossmember.
2. Loosen the fastening screws and remove the left-hand cylinder head ignition coils.



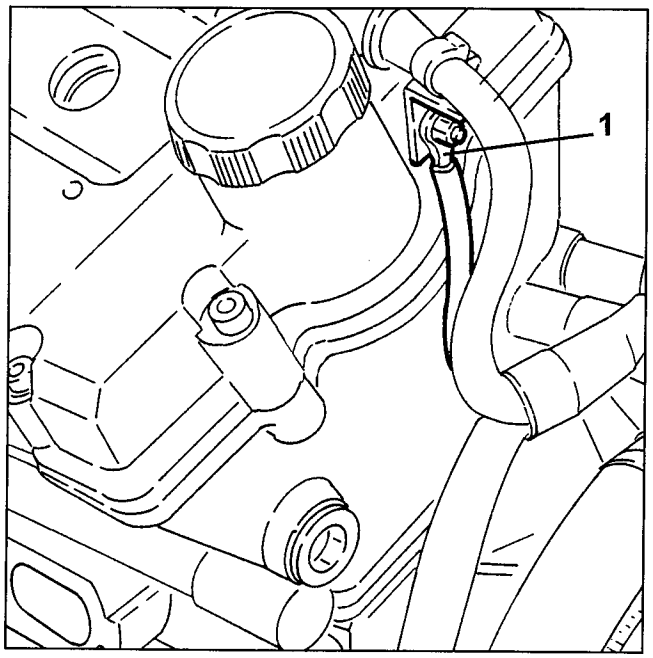
1. Disconnect the electrical connections from the left-hand cylinder head ignition coils.
2. Loosen the fastening screws and remove the left-hand cylinder head ignition coils.



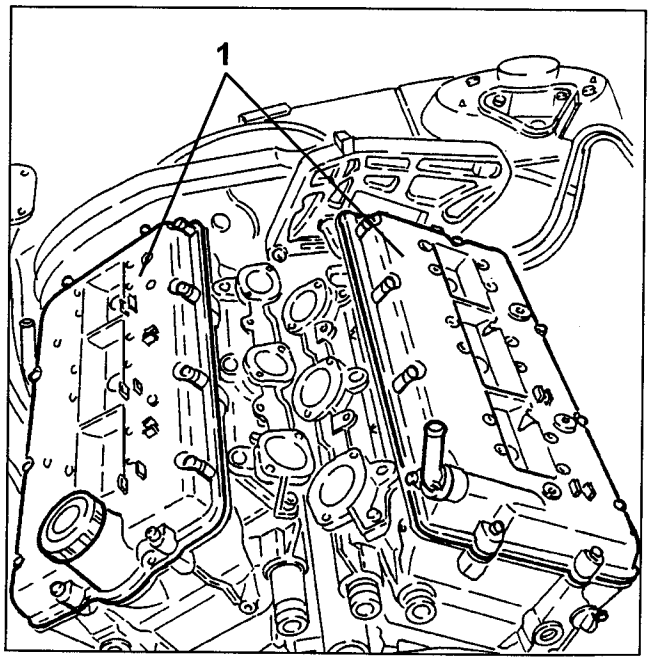
1. Loosen the fastening screws and remove the bracket and threaded nut fastening the upper timing belt guard from the left-hand cylinder head.



1. Disconnect the earth wire from the left-hand cylinder head and move the respective wiring aside.

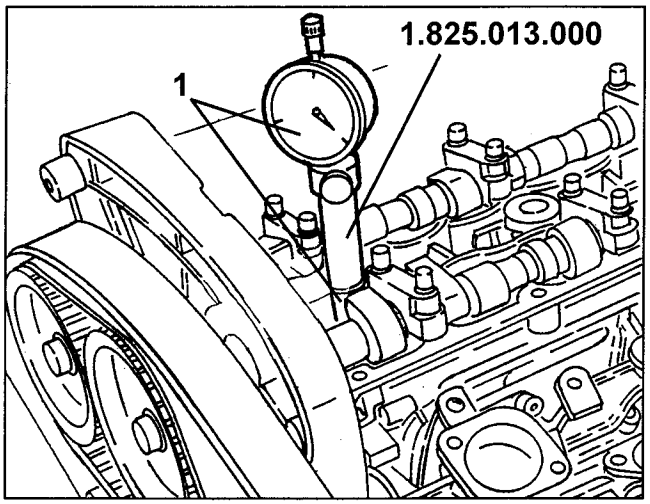


1. Loosen the fastening screws and remove the cylinder head covers and respective seals.

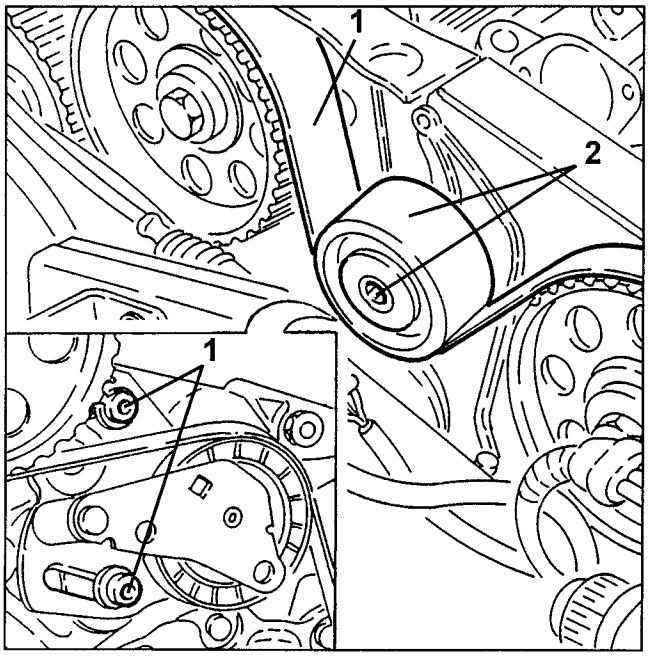


- Loosen the exhaust manifold fastening nuts from the right-hand cylinder head and leave it on the power steering unit.
1. Fit tool no. 1.825.013.000 in cylinder 1 spark plug seat.
- Move the auxiliary unit drive pulley nut and slightly turn the crankshaft in both directions to take cylinder 1 piston to TDC, firing stroke.

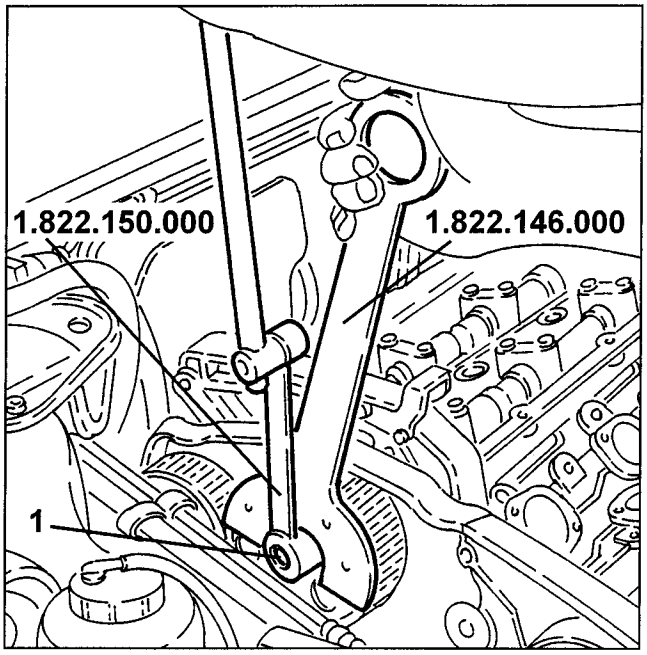
NOTE: Make sure the last rotation of the crankshaft is in the direction of operation.



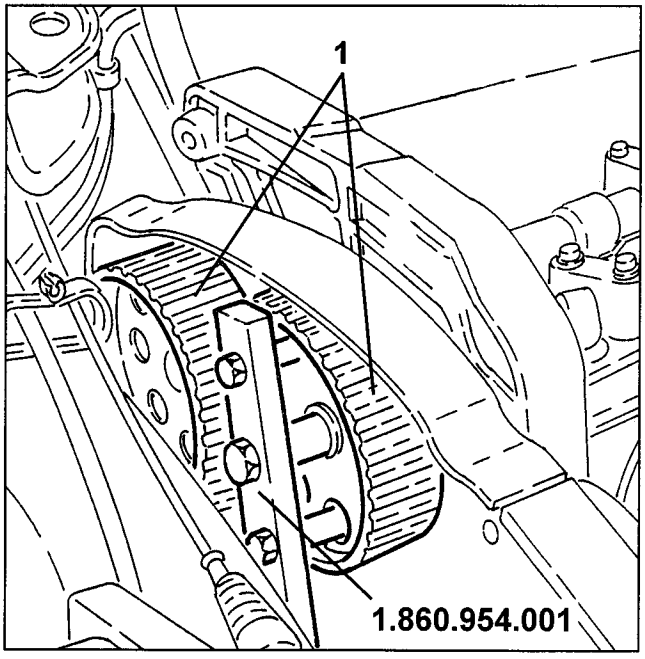
1. Loosen the two timing belt take-up fastening screws and remove the belt from the camshaft pulleys.
2. Loosen the fastening screw and remove the timing belt runner.



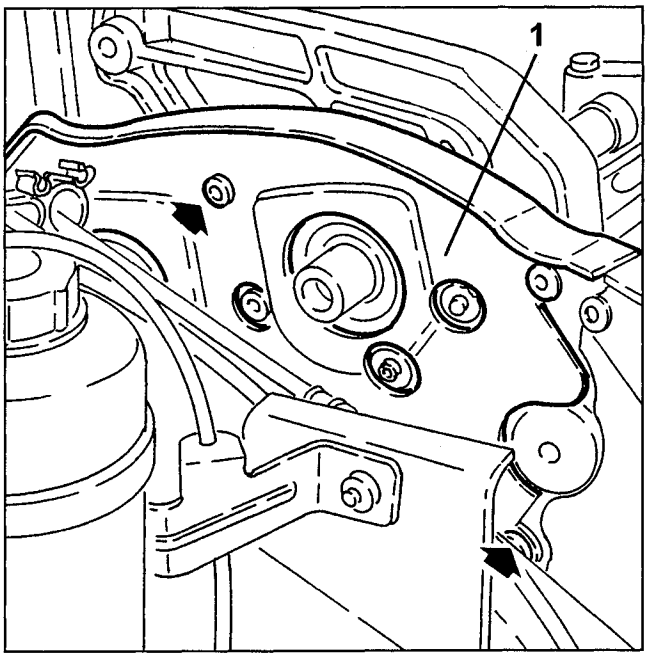
1. Use extension no. 1.822.150.000 and tools no. 1.822.146.000 to contrast torque. Loosen the camshaft drive pulley fastening screws from the right-hand cylinder head.



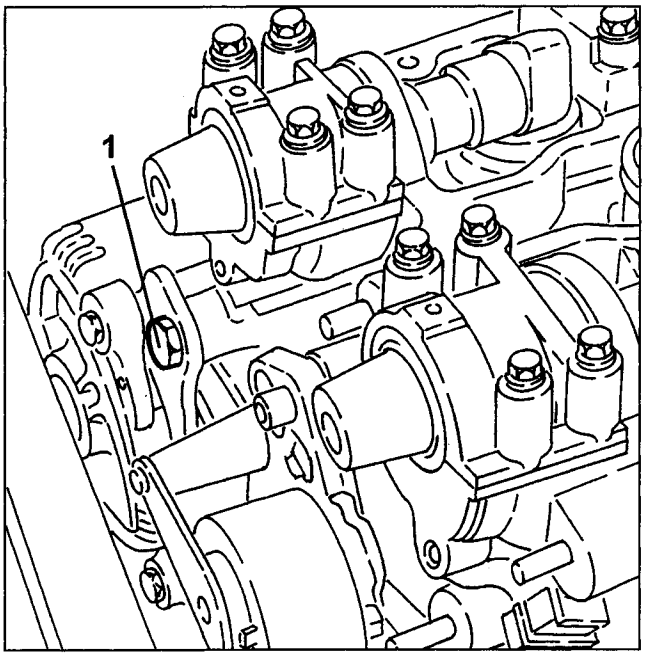
1. Use tool no. 1.860.954.001 and remove the camshaft drive pulleys from the right-hand cylinder head.



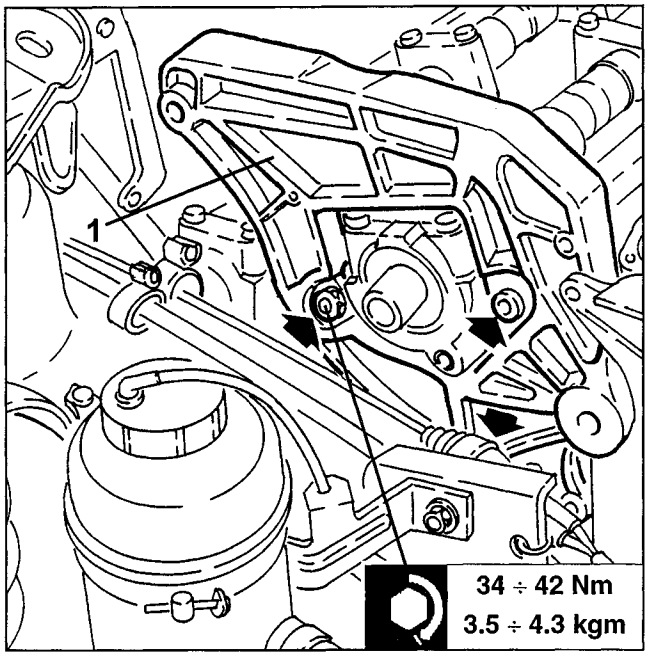
1. Loosen the fastening screws and remove the rear timing belt guard from the right-hand cylinder head.



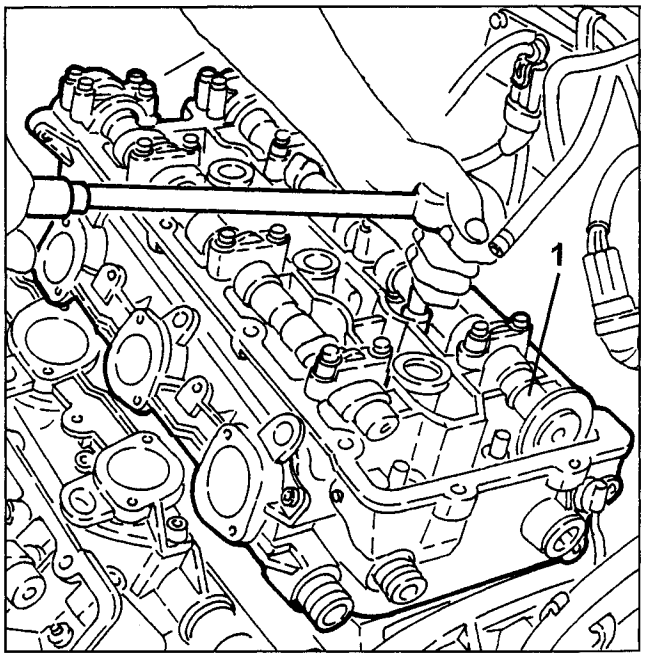
1. Loosen the upper alternator bracket fastening nut.



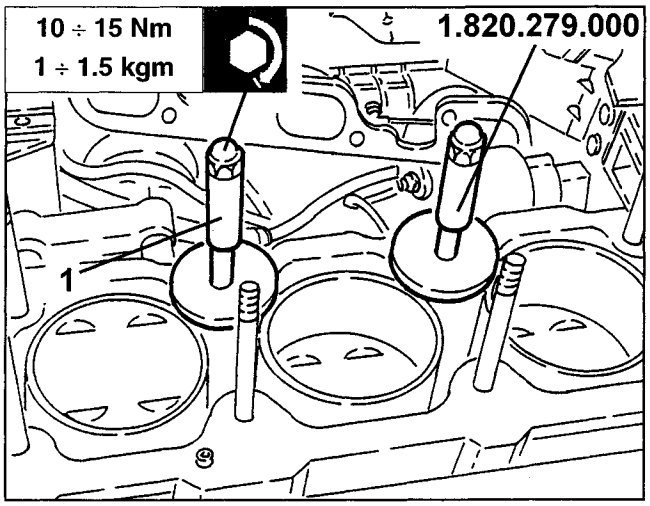
1. Loosen the fastening nuts and remove the engine tie-rod bracket.

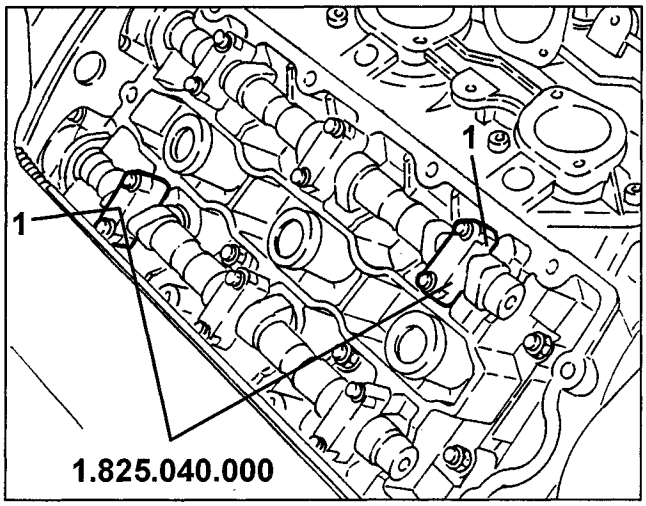


1. Loosen the fastening nuts and remove the right-hand cylinder head.
- Remove the respective seal.



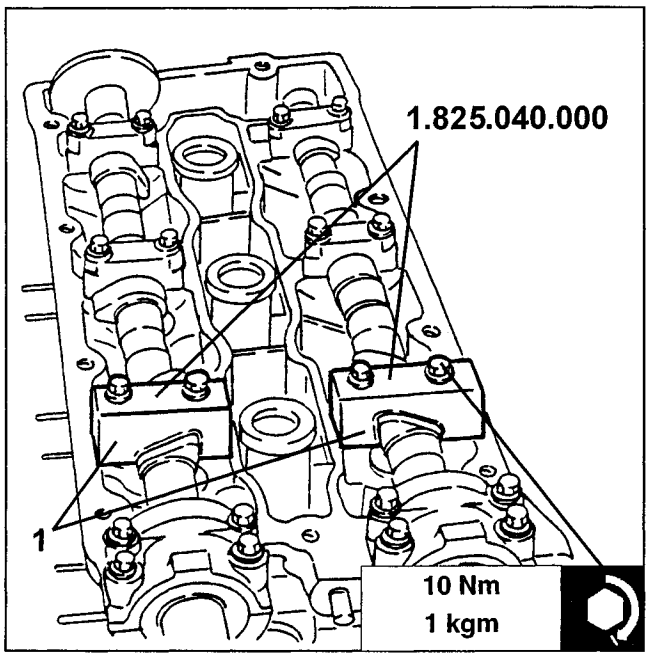
1. Fit cylinder liner retainer tools no. 1.820.279.000 as shown in the figure.





REFITTING PRECAUTIONS

Reverse the removal sequence and attain to the following precautions.
1. Fit templates no. 1.825.040.000 in the position printed on the templates in the place of camshaft bearings **B** and **G** after overhauling the right-hand cylinder head and before refitting it on the engine.

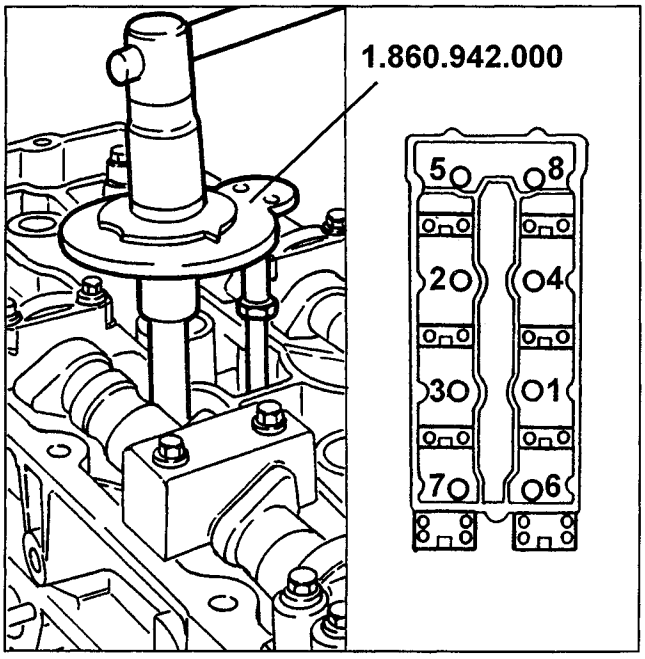


1. Fit templates no. 1.825.040.000 in the position printed on the templates in the place of left-hand cylinder head camshaft bearings **7** and **4**.

- Remove the previously fitted cylinder liner retainers no. 1.820.279.000.
- Refit the right-hand cylinder head with a new seal.
- Lubricate threading, nuts and washers with engine oil and torque as shown below in the order shown in the figure.

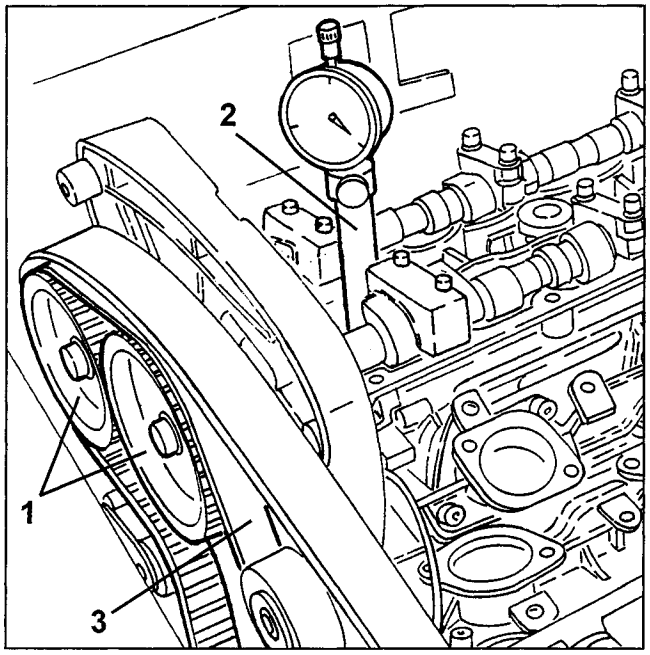
NOTE: Use the tool and gauge no. 1.860.942.000 for angle torque.

Tightening procedure	
Tighten all nuts at:	24 ÷ 26 Nm 2.5 ÷ 2.7 kgm
Complete torque with additional:	240° ± 2°

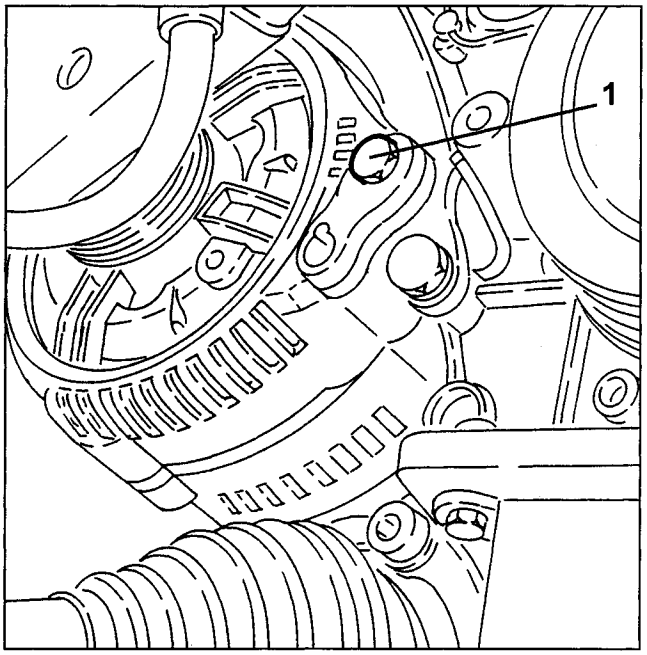


NOTE: ASTADUR cylinder head seals are used. The special material the seals are made of polymerises during engine operation and consequently becomes very hard.
The following precautions are required to ensure cylinder head seal polymerisation:
- keep the seals closed in their nylon bags;
- take them out of the packaging just before fitting;
- do not lubricate or soil the seals with oil. Make sure the cylinder head and crankcase surface are clean.

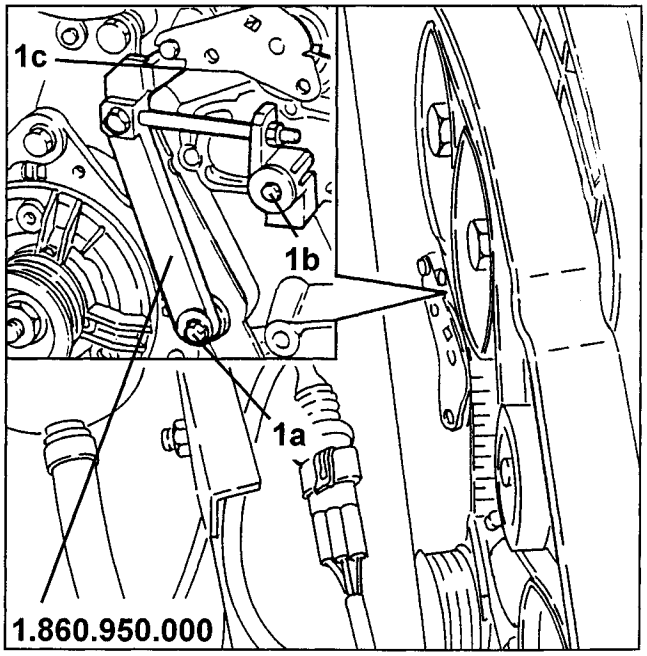
1. Reverse the removal sequence and refit the right-hand cylinder head camshaft drive pulleys, fastening the screws by hand.
- Use extension no. 1.822.150.000 and tool no. 1.822.146.000 to contrast torque. Loosen the left-hand cylinder head camshaft drive pulley fastening screws.
- Use tool no. 1.860.954.001. Extract the left-hand cylinder head camshaft drive pulleys are reposition them fastening the screws by hand.
2. Check whether the 1st cylinder piston is at TDC, firing stroke. If not, move it to this position by slightly turning in both directions the auxiliary unit drive pulley fastening nut.
NOTE: Make sure the last revolution of the crankshaft is in the direction of operation.
3. Fit the camshaft drive pulley drive belt.



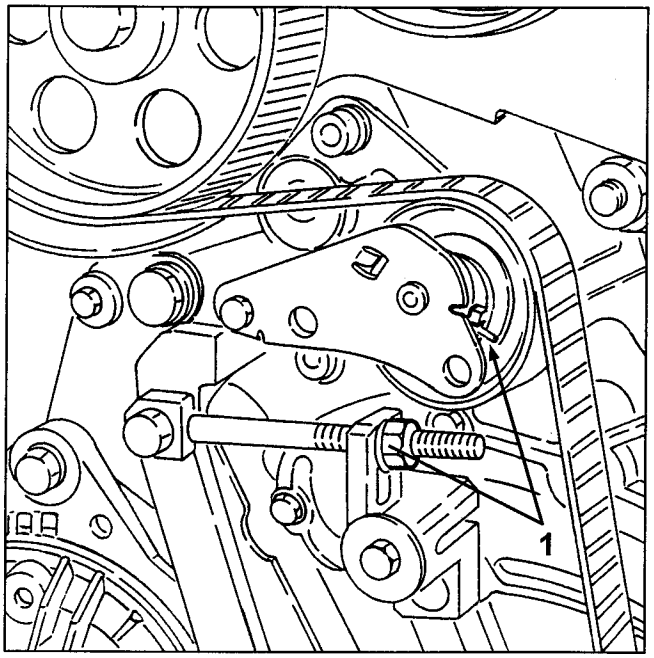
- Remove the cylinder head alternator bracket upper screw.
1. Loosen the lower alternator fastening screw to fit the timing belt tension tool.



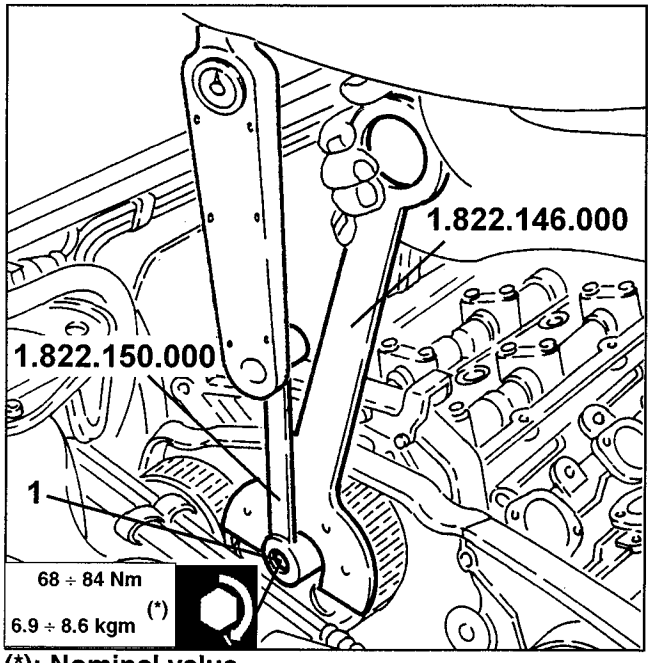
1. Fit timing belt tension tool no. 1.860.950.000 and fasten the previously loosened screw to the alternator (1a) and screw (1b) to the coolant pump; tool pin (1c) should contrast the belt take-up device mobile part.



1. Take the mobile notch under the belt take-up fixed notch as shown in the figure.

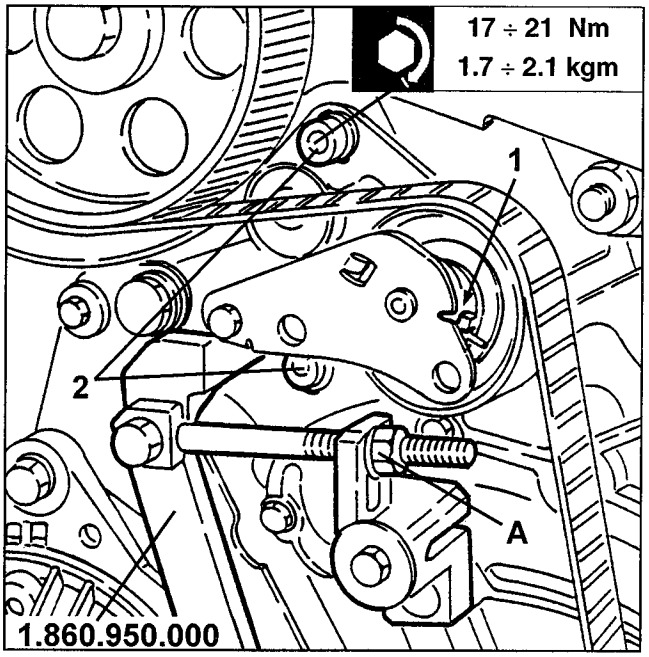


1. Use extension no. 1.822.150.000 and tool no. 1.822.146.000 to contrast torque. Fasten the camshaft drive pulley screws at the prescribed torque.



(*): Nominal value

- Remove the previously fitted templates no. 1.825.040.000. Fit the previously fitted bearings in their place and fasten the screws at the prescribed torque.
- Turn the crankshaft twice in the direction of revolution to fit the timing belt well.
1. Check whether the fixed notch on the belt take-up coincides with the mobile notch. If not, loosen the belt take-up tension by turning nut (A) until the notches meet.
2. Torque the belt take-up fastening nuts as prescribed and remove belt tension tool no. 1.860.950.000.

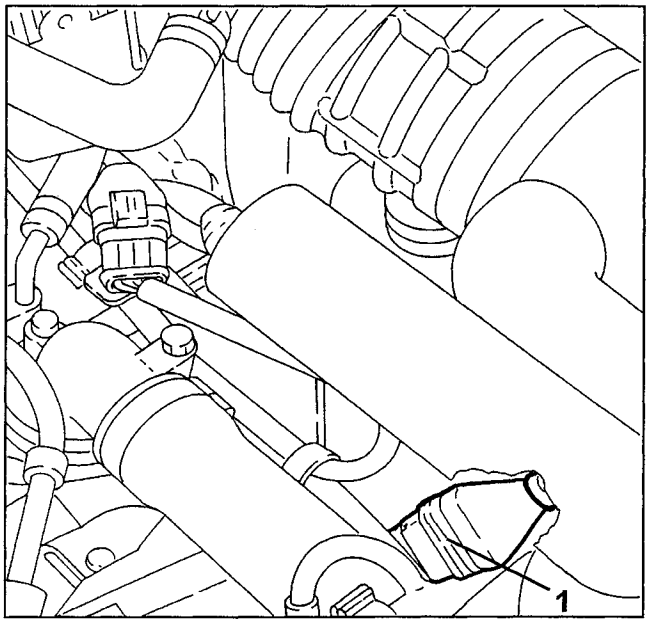


- Complete refitting by reversing the removal sequence.

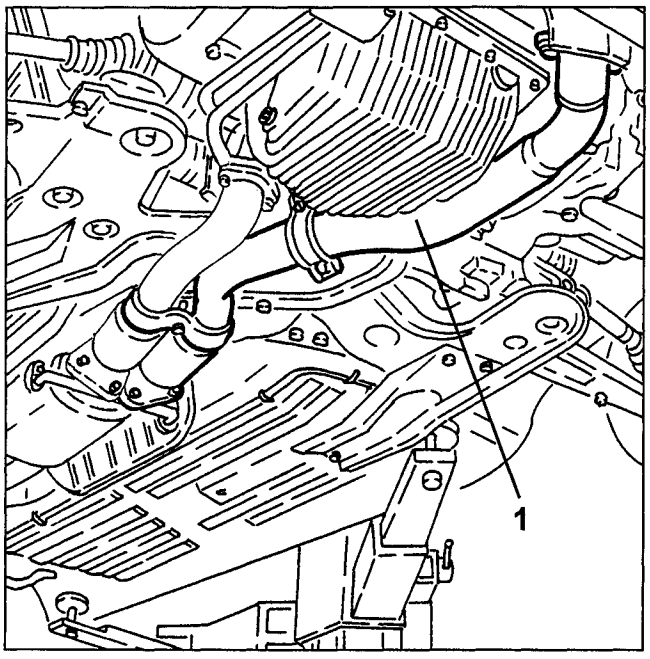
OIL PUMP

REMOVAL/REFITTING

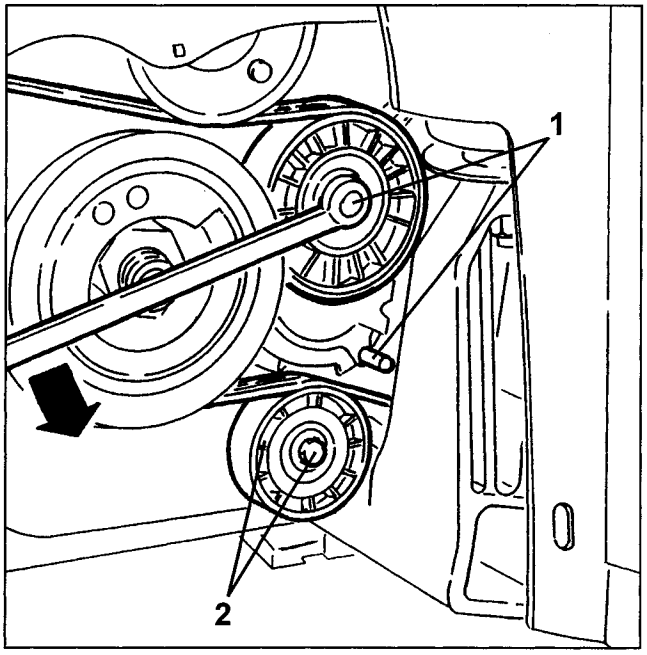
- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Disconnect the lambda sensor electrical connection from the left-hand exhaust manifold and release the respective wiring from the fastening clips.



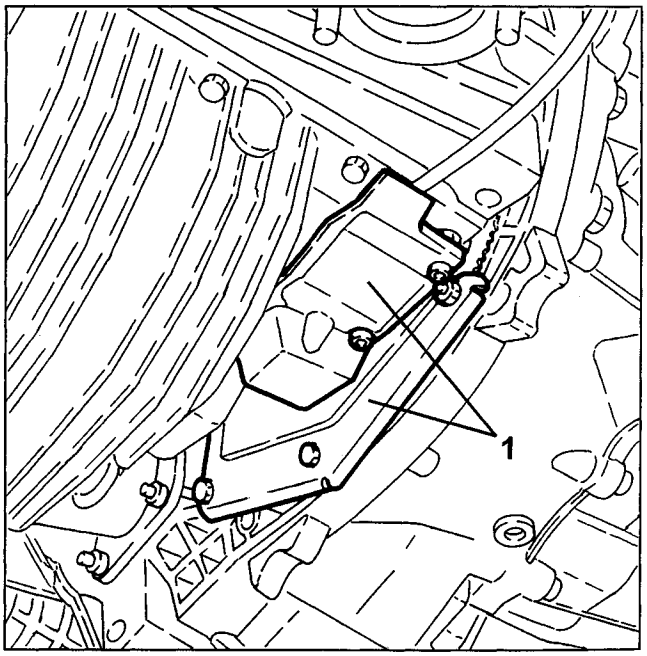
- Remove the front right-hand wheel and the respective dust guard.
- Drain engine oil (see assembly 00).
1. Loosen the fasteners and remove the front left-hand exhaust pipe section and lambda sensor.



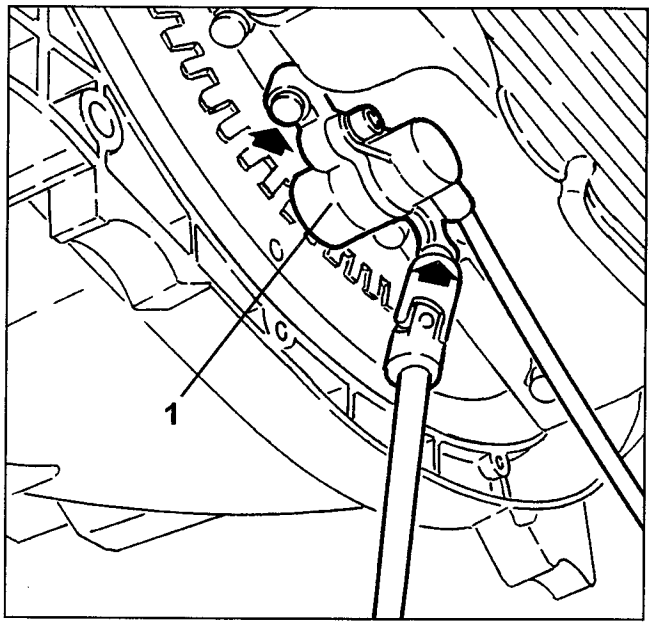
1. With a wrench on the belt take-up pulley fastening screw, overcome the automatic take-up force and lock it in this position (belt loose) with a pin as shown in the figure.
2. Loosen the fastening screw and remove the lower engine drive belt runner.



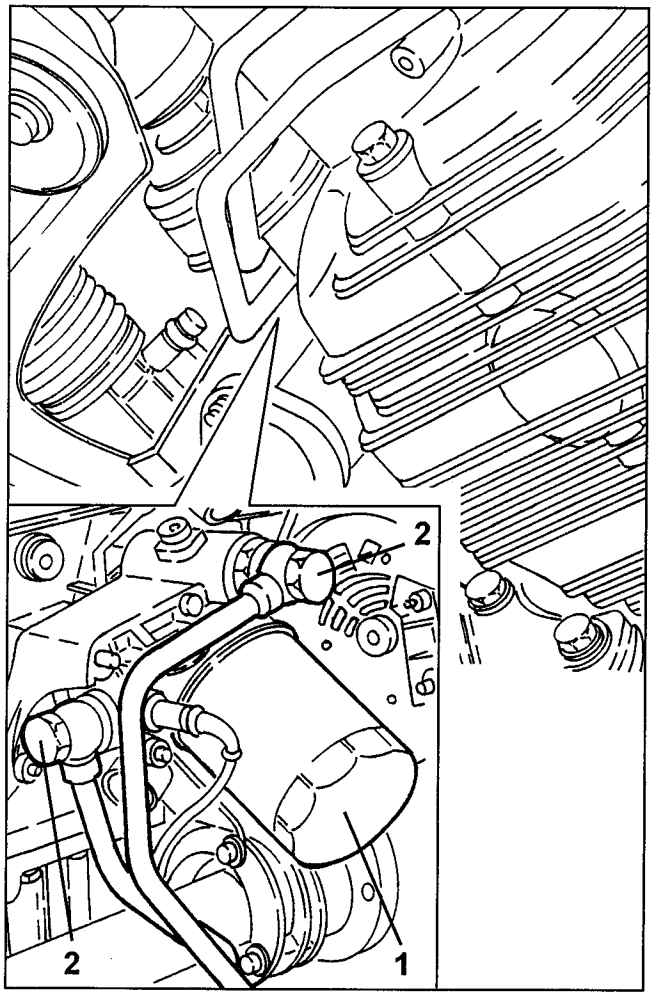
1. Loosen the fasteners and remove the lower flywheel and rpm and phase sensor guards.



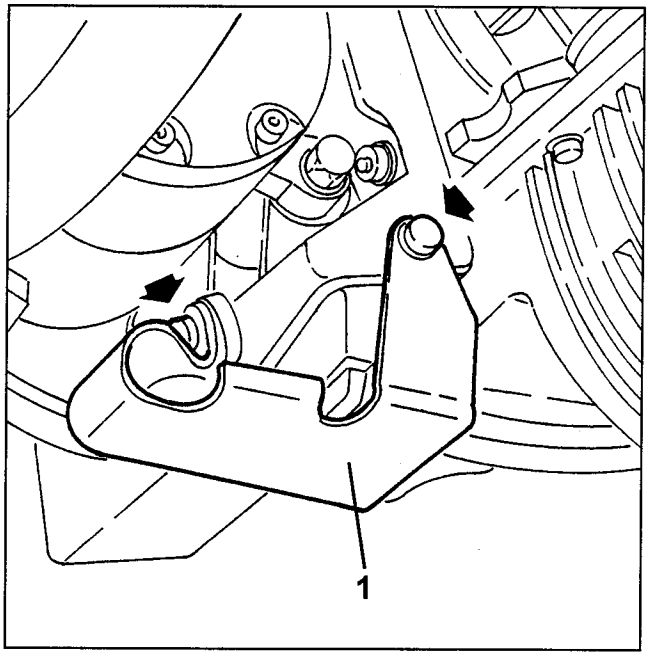
1. Loosen the fastening screws and move the rpm and phase sensor aside.



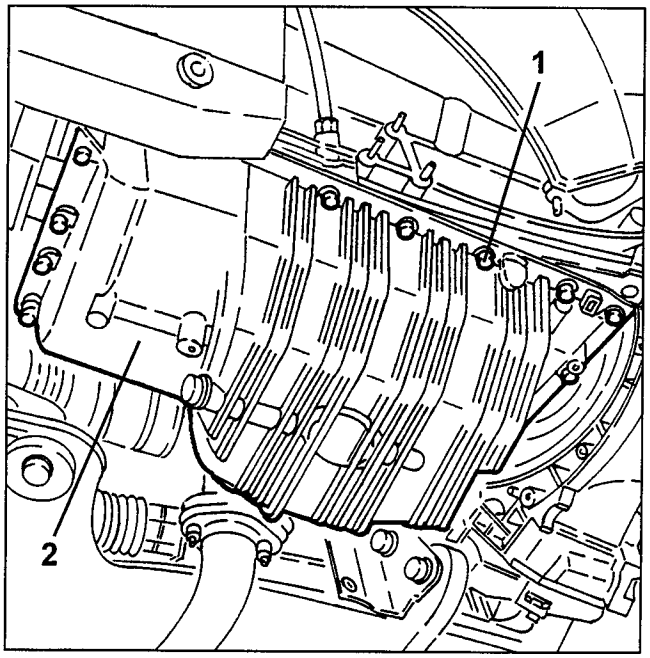
1. Remove the engine oil filter with a suitable wrench.
2. Loosen the fittings and disconnect the coolant radiator delivery and return pipes from the oil filter bracket.



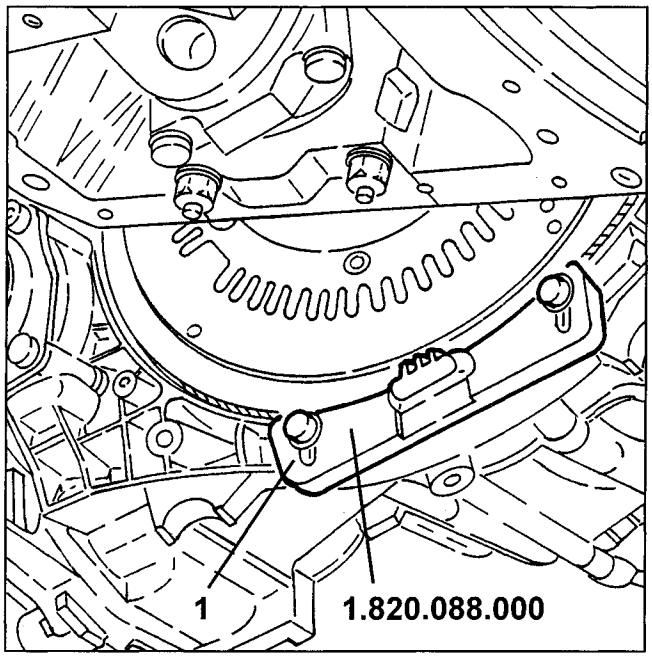
1. Loosen the fastening screws and remove the coolant radiator engine oil delivery and return pipe bracket.
- Move the coolant radiator engine oil delivery and return pipes aside provisionally as not to interfere with the following operations.



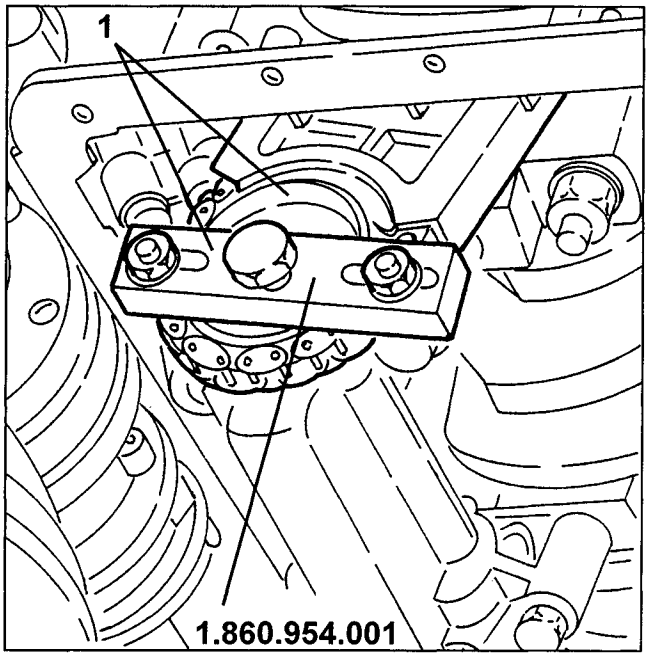
1. Loosen the screws fastening the sump to the crankcase.
- Heat the crankcase sump coupling area and cut the sealant.
2. Remove the sump from the crankcase.



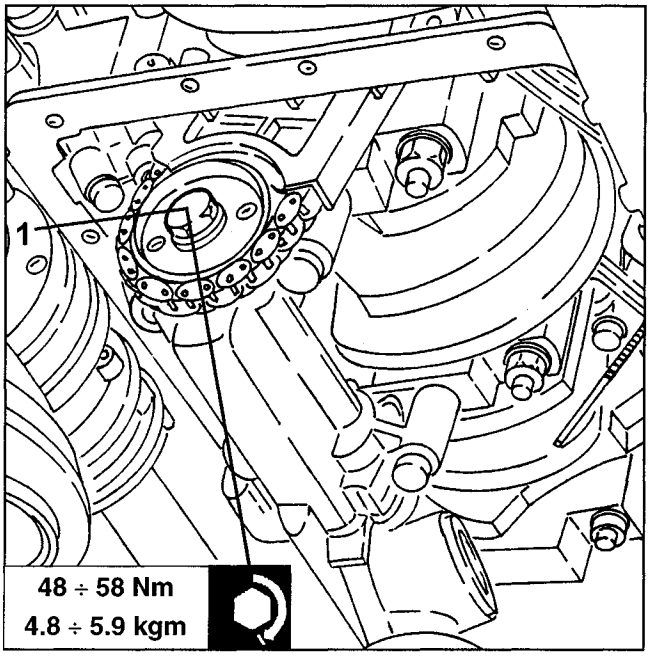
1. Fit flywheel retainer tool no. 1.820.088.000.



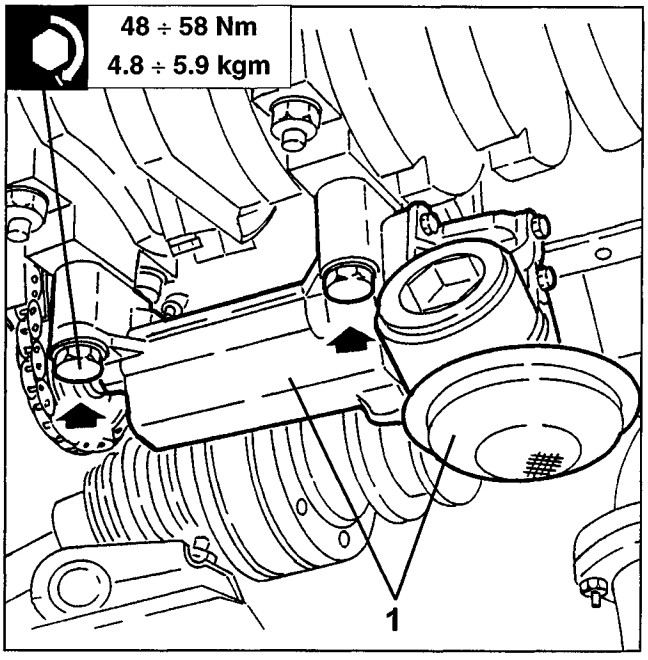
1. Use tool no. 1.860.954.001 to remove the drive gear from the oil pump shaft.



1. Loosen the oil pump drive gear fastening screw.



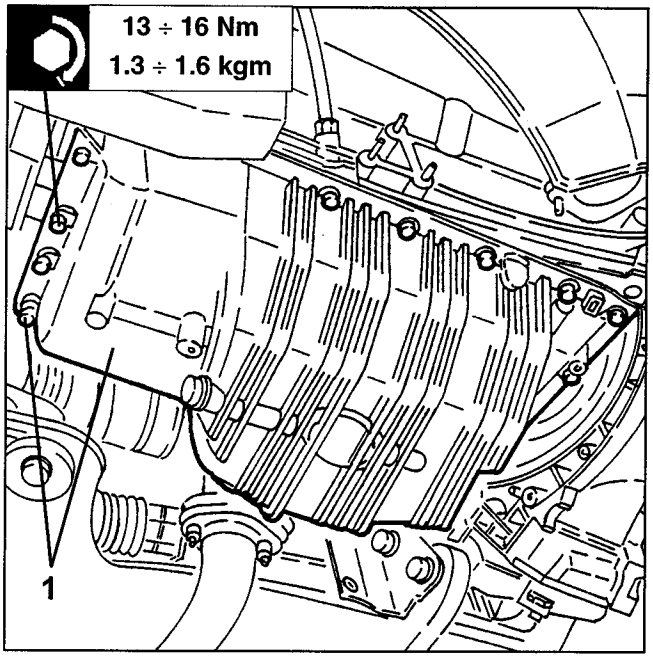
1. Loosen the fastening screws and remove the complete oil pump.



Refit by reversing the removal operation sequence. Attain to the following precautions.
- Clean the oil sump and engine crankcase coupling surfaces.

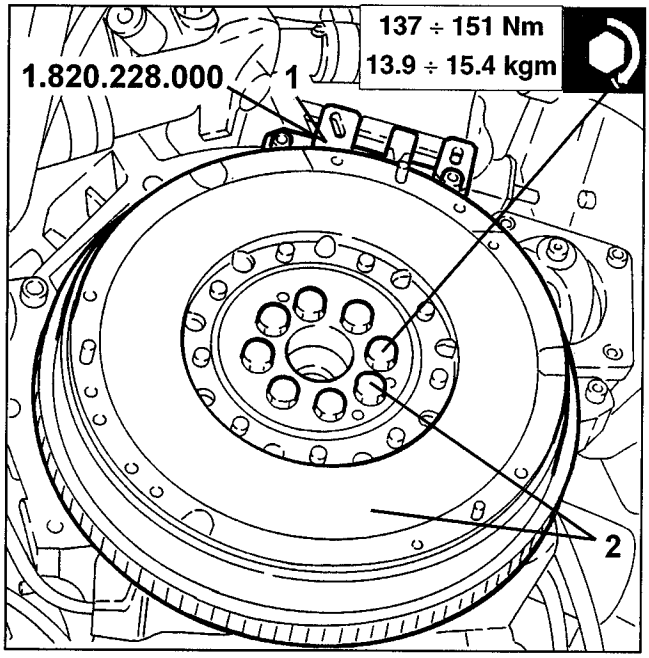
IMPORTANT: Check intactness of rear main bearing seal; if this is not so, restore it.

- Apply "Dow Corning 7091" silicon sealant on the entire oil sump perimeter.
1. Position the oil sump avoiding movements which could remove the sealant. Then torque the fastening screws as prescribed.

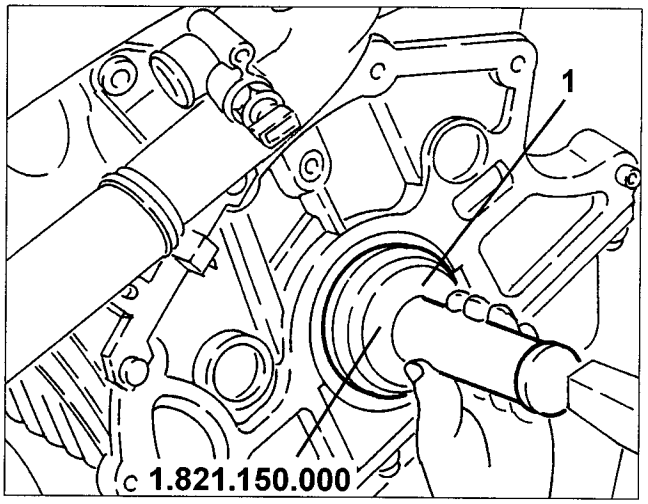


REAR CRANKSHAFT OIL SEAL REPLACEMENT

- Remove the gearbox (see Assembly 21).
- Remove the clutch (see Assembly18).
1. Fit flywheel retainer tool no. 1.820.228.000
2. Loosen the fastening screws and remove the flywheel.



- Remove the crankshaft rear oil seal.
1. Introduce a new crankshaft rear oil seal with tool no. 1.821.150.000.



- Complete refitting by reversing the removal sequence.

GENERAL DESCRIPTION

The Bosch Motronic ME2.1 driven throttle system a belongs to the category of integrated electronic sequential, phased ignition and injection systems.
The ECU controls the idling ratio air intake by means of the electronic throttle.
The ECU controls spark advance to adjust the engine to changes in environmental parameters and applied loads.
The ECU controls and manages injection so that the stoichiometric ratio (air-to-fuel ratio) is constantly optimal.
Essentially, the main functions of the system are:
- self-learning;
- system self-adapting;
- self-test;
- Alfa Romeo CODE (Immobilizer) ECU acknowledgement;
- cold start control;
- fuel-lambda sensor control;
- knock control;
- acceleration enrichment control;
- fuel cut-off upon accelerator pedal release;
- fuel vapour recovery;
- engine rpm limitation;
- fuel pump control;
- connection to climate control system;
- cylinder position acknowledgement;
- optional cylinder injection time control;
- spark advance;
- idling ratio management (also according to battery voltage);
- fan control;
- connection to instrument panel.

INJECTION SYSTEM

The essential conditions which should always be fulfilled in preparing the air-to-fuel mixture for the good operation of controlled ignition engines are mainly:
- "metering": the air-to-fuel ratio should be kept as close as possible to the stoichiometric value to ensure maximum catalytic converter efficiency.
- the mixture should be homogenous, i.e. consist of petrol diffused as finely and uniformly as possible.

The information processed by the ECU for controlling optimal metering is received in the form of electrical signals emitted by the:
- air flow meter and temperature sensor, for the exact quantity of intake air
- rpm sensor which produces an alternating single phase signal indicating the engine rpm
- throttle potentiometer, to acknowledge the required accelerator conditions
- coolant temperature sensor on the thermostat
- lambda sensor to determine the oxygen content in exhaust gases.

IGNITION SYSTEM

The ignition system is the static advance induced discharge type (i.e. without high voltage distributor) with power modules inside the injection ECU.
The system has a single coil for each spark plug (MONOCOIL).
The advantages of this solution are:
- less electrical overload;
- guarantee of constant discharge at each spark plug.

A map containing the entire set of optimal spark advance values (for each cylinder at power stroke) which the engine can adopt according to the ratio and the engine load is stored in the ECU.
The ECU corrects spark advance mainly according to:
- air coolant temperature
- air intake temperature
- knock.

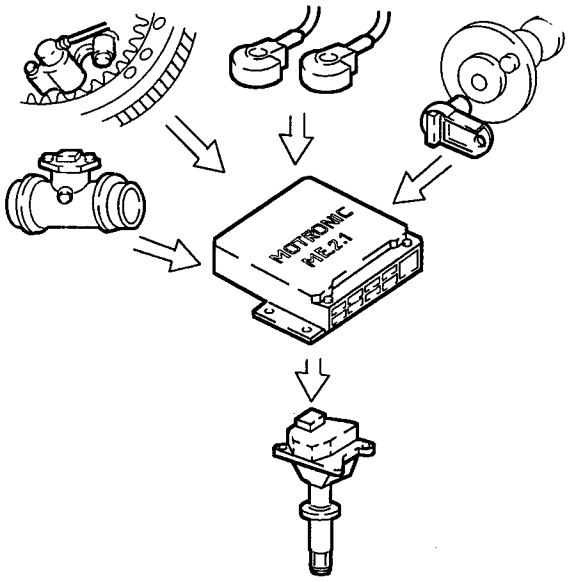
The information that the ECU processes to pilot the monocoils is received in the form of electrical signals emitted by:
- air flow meter and temperature sensor, for the exact quantity of intake air
- rpm sensor which produces an alternating single phase signal indicating the engine rpm
- knock sensors (on the upper part of the crankcase between the two heads) to acknowledge the cylinder where detonation is occurring and to correct spark advance
- throttle potentiometer to acknowledge load conditions (idling, partial and full)
- phase sensor.

Knock control

The ECU can delay ignition selectively on each cylinder as required according to the combination of values received from the knock and phase sensors. It:
- reduces spark advance by 3° steps to reach a maximum of 9°
- updates the threshold considering:
  - basic noise
  - engine ageing.

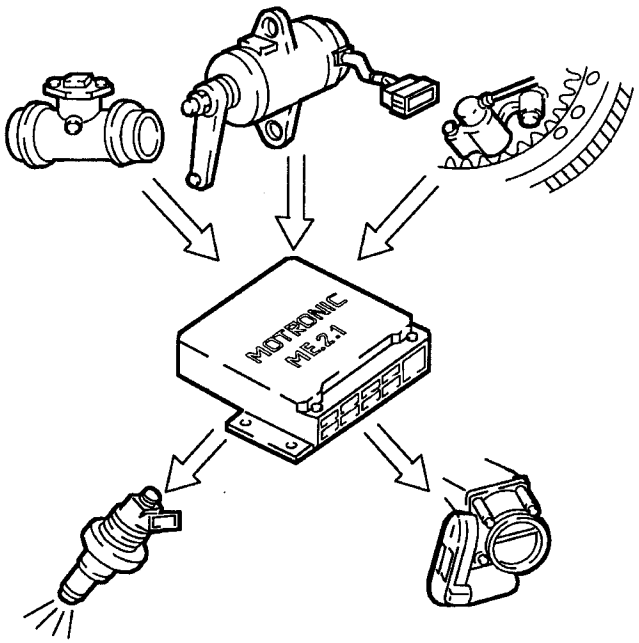
During acceleration, the ECU employs a higher threshold to adapt to increased engine noise. When knock disappears, the ECU decreases spark advance in 0.75° steps to complete recovery.
The self-adapting feature of the ECU:
- stores the continuous, repeated spark advance reductions
- updates the map to the various conditions in which the engine is working.

Recovery:
- in the event of failures to either the phase sensor, the knock sensor or the injection ECU, a spark delay - which is variable according to the rpm and the engine temperature - is implemented. Maximum spark delay is always lower than 9° engine.



Acceleration enrichment control

Upon considerable demand for acceleration, the ECU adjusts the injection time and the throttle position.
Recovery
- the ECU replaces the signal from the faulty air flow meter with the signal from the potentiometer built-into the throttle and DVL.

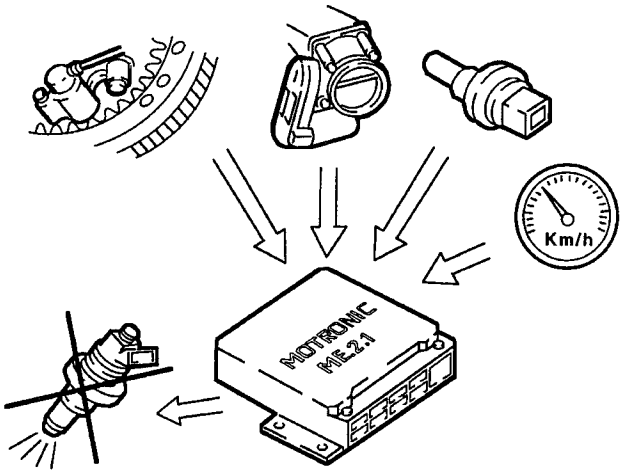


Fuel cut-off upon accelerator pedal release

In the following conditions:
- acknowledge idling ratio
- rpm exceeding a certain threshold

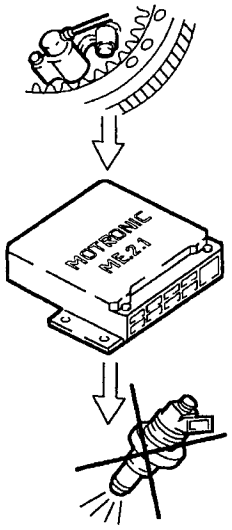
the ECU deactivates injection according to:
- rpm
- engine temperature
- vehicle speed.

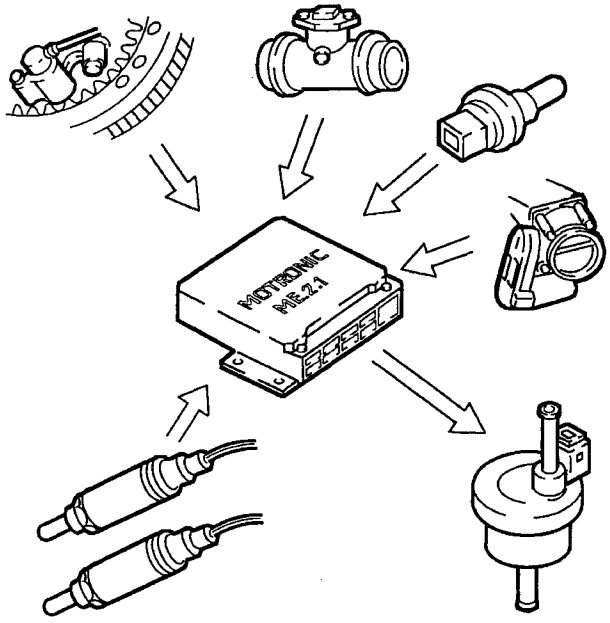
Before reaching idling speed, the rpm decrease dynamics is checked.
If this is higher than a certain value, fuel injection is partially reactivated according to a logic to take the engine to idling speed smoothly. Once idling conditions are reached, the normal functions are reactivated.
Fuel cut off is active only 20 seconds after engine start-up.



Fuel vapour recovery

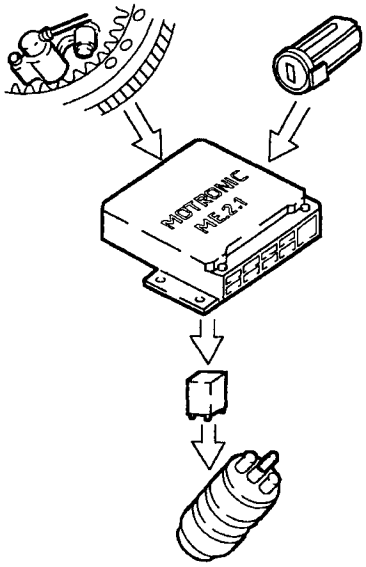
Fuel vapours (pollutants) are collected in an active carbon canister and are conveyed to the intake ducts to be burnt.
This is ensured by means of a solenoid valve controlled by the ECU.
The valve is closed for 60 seconds after start-up and opened for 90 seconds.
During this time (90 seconds) the lambda sensors meter carburation and the values are compared against the basic ECU maps.
If there are no variations, the ECU closes the solenoid valve, otherwise it is kept open for other 90 seconds to allow canister wash-out.
The canister wash-out is nominally limited to a small percentage of intake air detected by the flow meter to ensure balance and disrupt driveability as little as possible.





Fuel pump control

The ECU:
- powers the fuel pump in the following conditions:
  - key at MAR (for 5 sec.)
  - key at AVV and rpm > 25.
- cuts off fuel pump power in the following conditions:
  - key at STOP
  - rpm < 25.

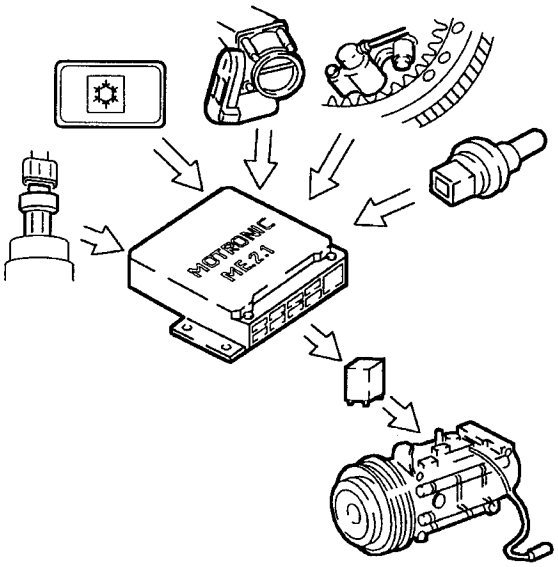


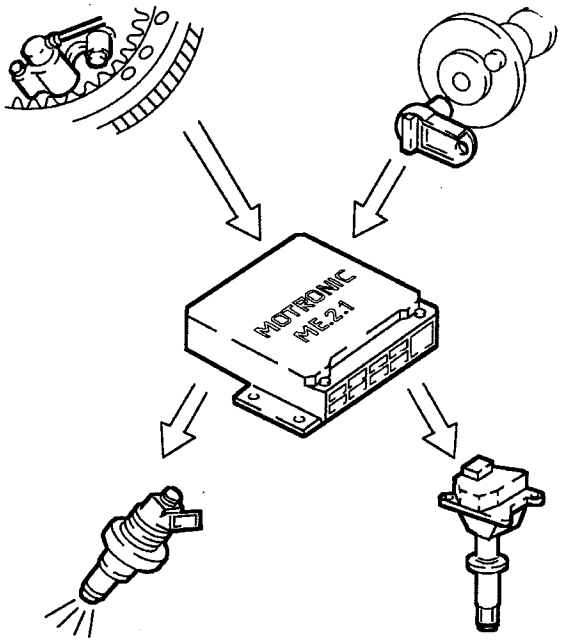
Engine rpm limitation

According to the engine rpm, the ECU:
- stops feed to the injectors over 6800 rpm (a maximum of 7000 rpm is allowed for less than 5 sec.).
- start piloting the injectors again under 6600 rpm.

Connection to climate control system

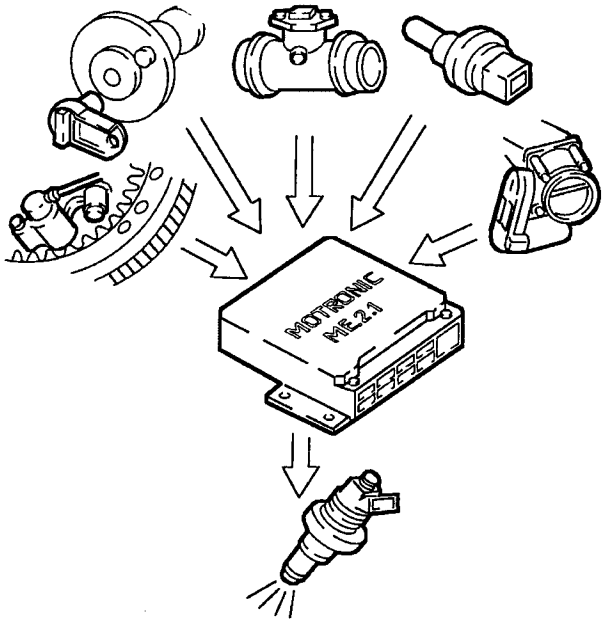
The climate control system compressor intakes engine power. When idling, the ECU suits the new air intake requirement to the required power to ensure optimal driveability.
The ECU excludes the compressor in the following conditions:
- over 6500 rpm;
- over a certain engine coolant temperature threshold (117°C);
- at start up.





Optimal cylinder injection time

The ECU compute optimal injection time for each cylinder according to specific maps:
- it changes the injector opening instant
- it keeps the injector closing instant planned in the maps according to engine rpm
- the fuel injection is sequential and phased in each cylinder (S.E.F.I.).

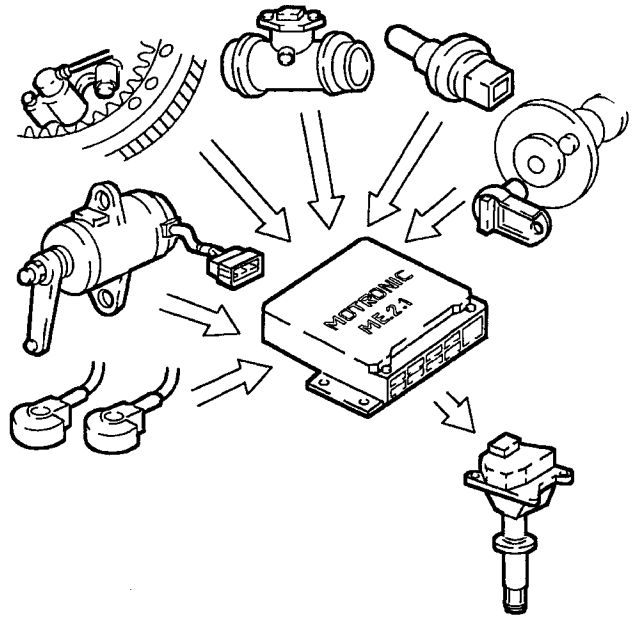


Cylinder position acknowledgement

At each engine revolution the ECU acknowledges which cylinder is firing and:
- controls the injection and ignition sequence to the suitable cylinder.
If the phase sensor is faulty, the ECU cannot acknowledge whether cylinder 1 or 5 is at firing stroke; consequently it adopts the following strategies:
- engine running: the engine runs normally on the basis of the stored cylinder firing sequence
- engine stopped and re-started: coil pair ignition is started and a fixed delay is applied to all cylinders.

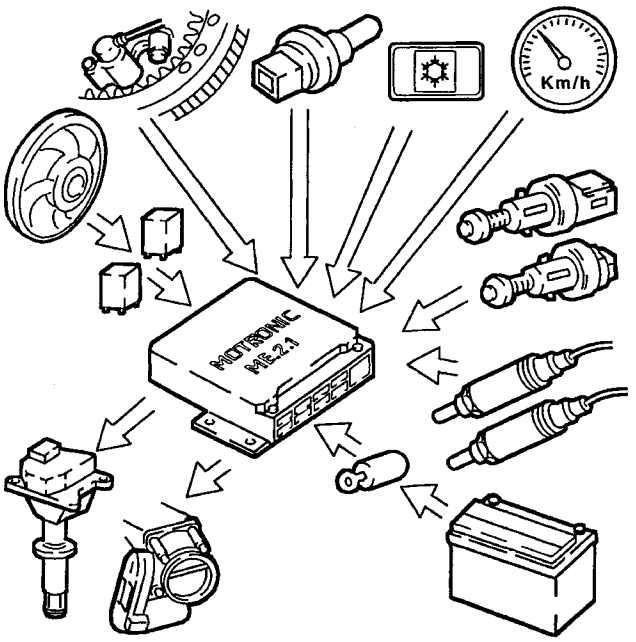
Spark advance

The ECU processes the signals from the sensors and defines:
- spark advance for each cylinder
- spark delay for the required cylinder (according to knock).



Idling ratio management

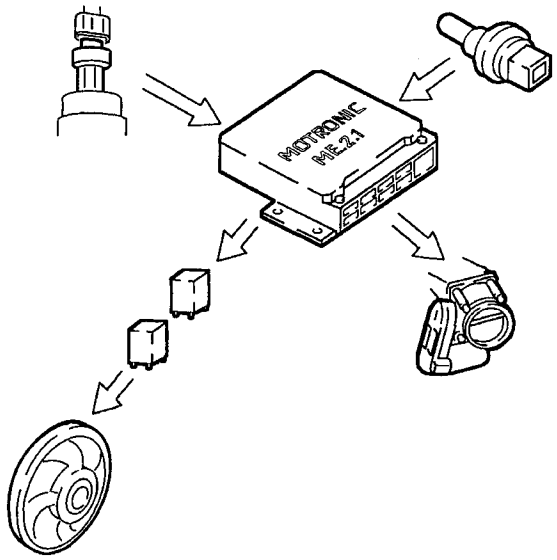
The ECU acknowledges idling condition when the accelerator pedal is released. The ECU controls idling speed by piloting the driven throttle according to the devices which are on and the signals from the brake-clutch pedals. When the fans are running at second speed, idling ratio goes from 700 to 750 rpm.



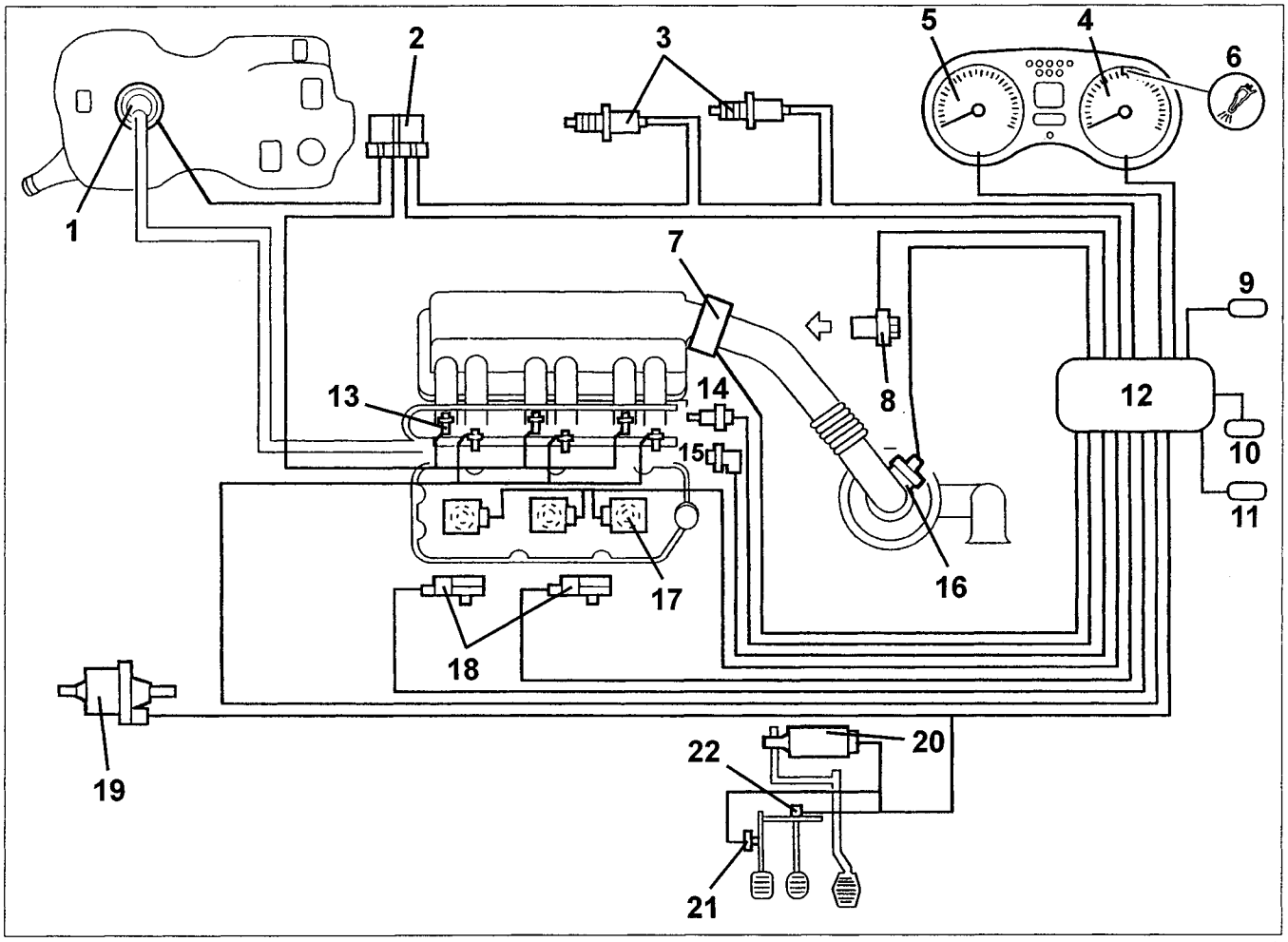
Fan control

According to the coolant temperature, the ECU controls fan operation as follows:
- 1st speed at 95°C
- 2nd speed at 102°C.

If the climate control system is on, the ECU controls the fan at 1st speed.
Without the coolant temperature signal the ECU implements a recovery function by controlling the fan at 2nd speed until the error is removed.
Before starting the fans, the idling ratio is adapted by increasing the air delivery according to the fan to be started.

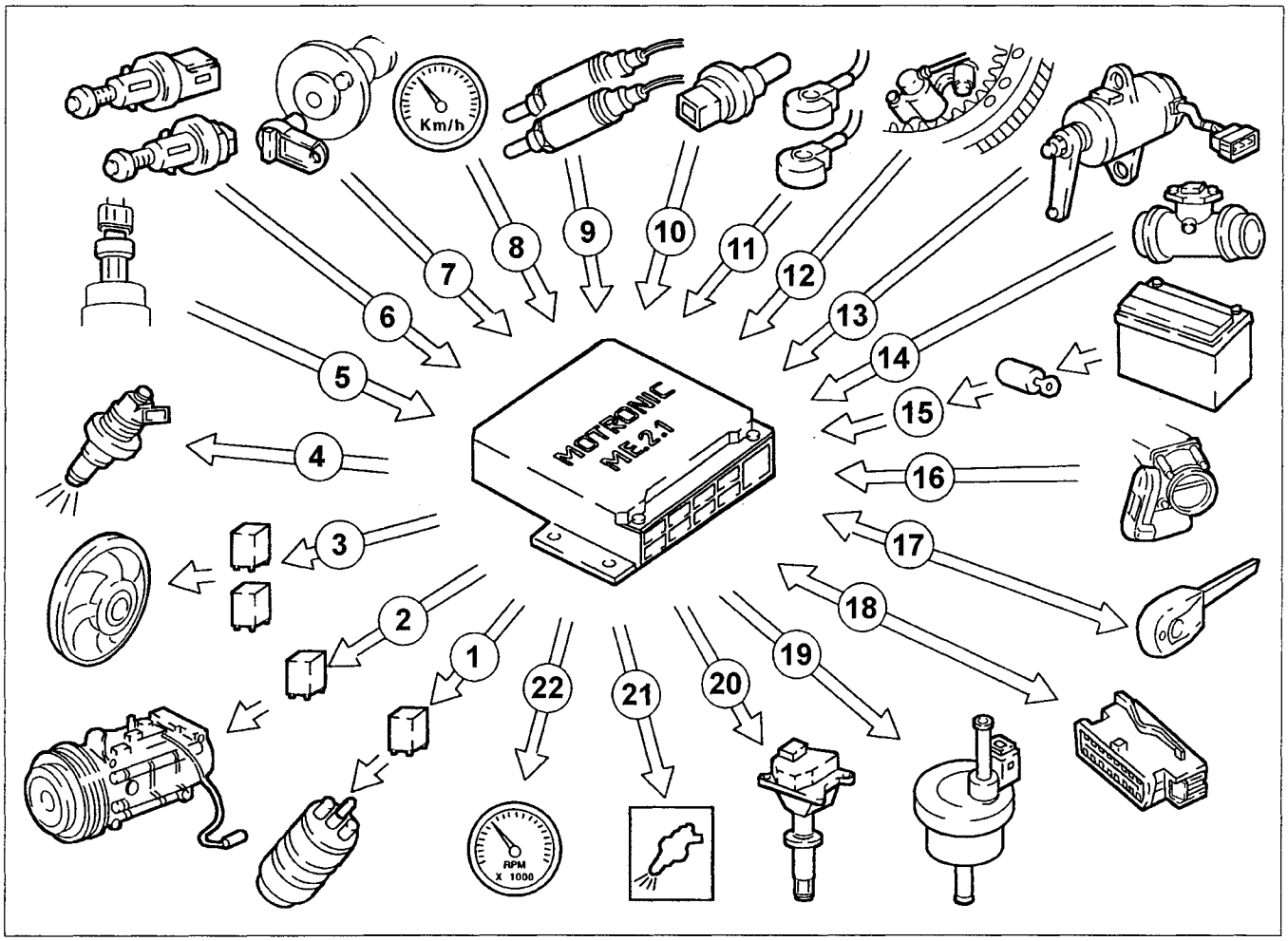


ME2.1 INJECTION-IGNITION SYSTEM COMPONENTS



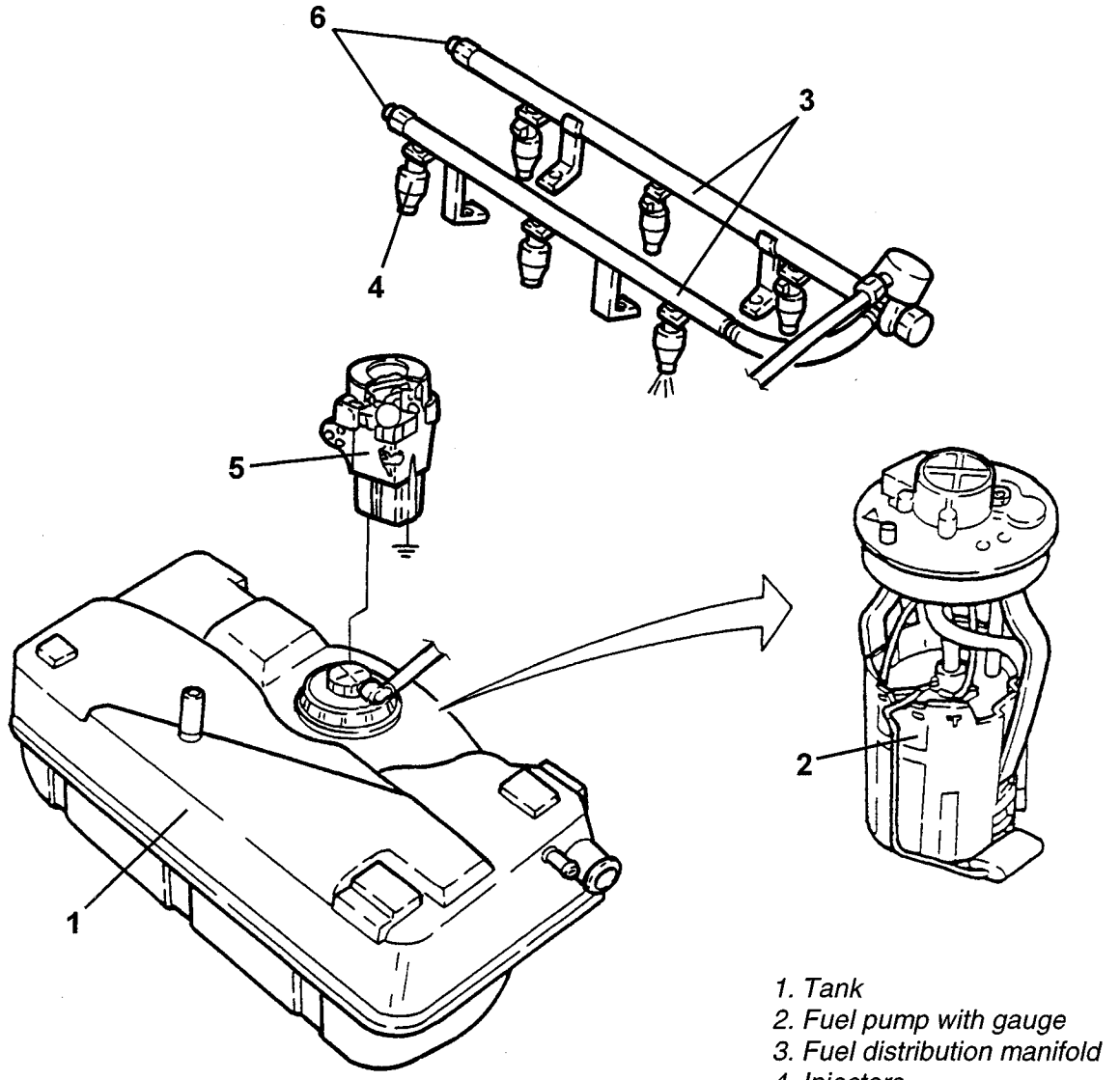
1. *Fuel pump*
2. *Relays*
3. *Lambda sensors*
4. *Tachometer*
5. *Rpm counter*
6. *Injection warning light*
7. *Throttle casing actuator with built-in DVL*
8. *Phase sensor*
9. *Climate control system connector*
10. *Diagnostic connector*
11. *Alfa Romeo CODE connector*
12. *Injection-ignition ECU*
13. *Injectors*
14. *Coolant temperature sensor*
15. *Rpm sensor*
16. *Air flow meter with temperature sensor*
17. *Ignition coils*
18. *Knock sensors*
19. *Fuel valve recirculation solenoid valve*
20. *Accelerator pedal potentiometer*
21. *Clutch pedal switch*
22. *Brake pedal switch*

ME2.1 INJECTION-IGNITION SYSTEM FUNCTION DIAGRAM



1. *Fuel pump*
2. *Climate control compressor*
3. *Fan*
4. *Injector*
5. *Four level pressure switch*
6. *Brake-clutch pedal switch*
7. *Phase sensor*
8. *Tachometer*
9. *Lambda sensor*
10. *Coolant temperature sensor*
11. *Knock sensors*
12. *Rev sensor*
13. *Accelerator pedal potentiometer*
14. *Air flow meter and temperature sensor*
15. *Battery*
16. *Throttle casing with built-in DVL*
17. *Alfa Romeo CODE*
18. *Diagnostic socket*
19. *Fuel vapour recirculation solenoid valve*
20. *Ignition coils*
21. *Injection warning light*
22. *Rpm counter*

FUEL FEED SYSTEM DESCRIPTION



1. Tank
2. Fuel pump with gauge
3. Fuel distribution manifold
4. Injectors
5. Inertia switch
6. Fuel pressure drain valves

The fuel feed system is returnless, i.e. a single pipe connects the fuel pump and the engine. Advantages are:
- reduced possibility of the car catching fire after an accident
- reduced fuel vapour emission in the atmosphere.

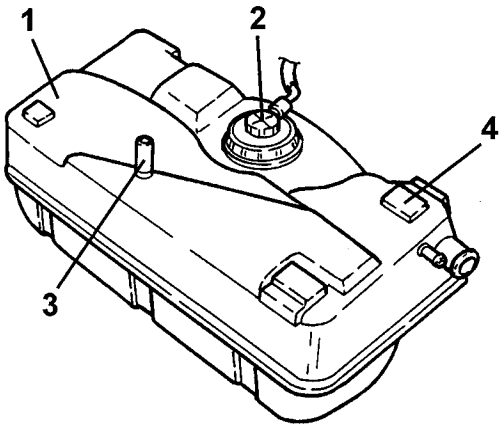
The filler cap is fitted on the steel fuel tank main casing.

The electrical fuel pump is contained in a frame which also houses the following components:
- fuel pressure regulator
- fuel gauge
- fuel filter.

The system is equipped with an inertia switch which cuts fuel pump power in the event of an impact.

FUEL TANK

The tank is made of steel and has a capacity of 70 litres, including a reserve of approximately 9 litres. The filler is on the main casing and a specific compartment so that it can be removed from the tank. This allows removing the tank.



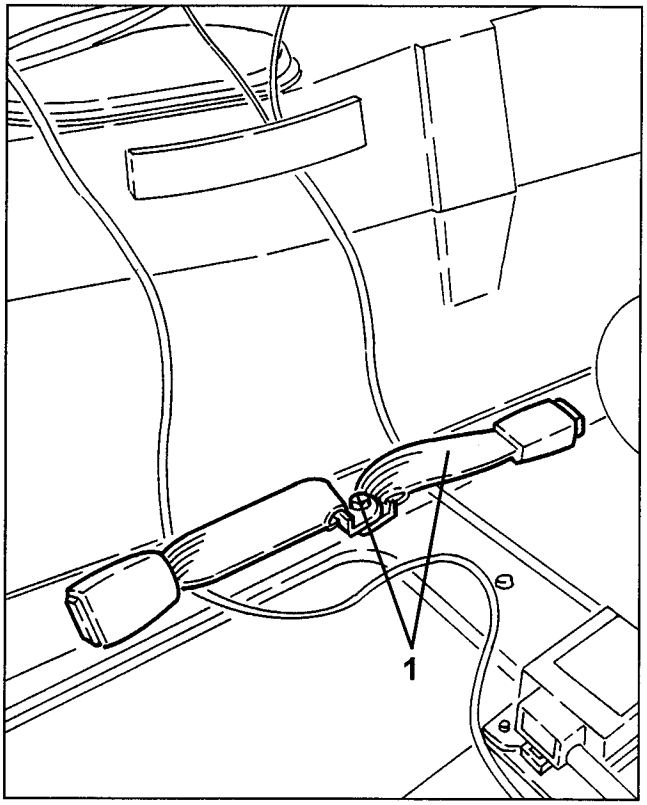
1. Tank
2. Fuel pump and gauge
3. Vapour recovery pipe
4. Dampers

The filler cap presents a system which ensures it can only be closed at the prescribed torque. Excessive torque (exceeding prescriptions) will cause the notches to turn without locking.
The tank is fitted under the rear seat and is fastened by means of two belts to the underbody. it is protected by a specific steel partition.
The fuel filler pipe doubles as a breather.
The fuel pump and gauge is housed above the tank.
A specific pipe allows the fuel vapours to reach the separator from the tank.

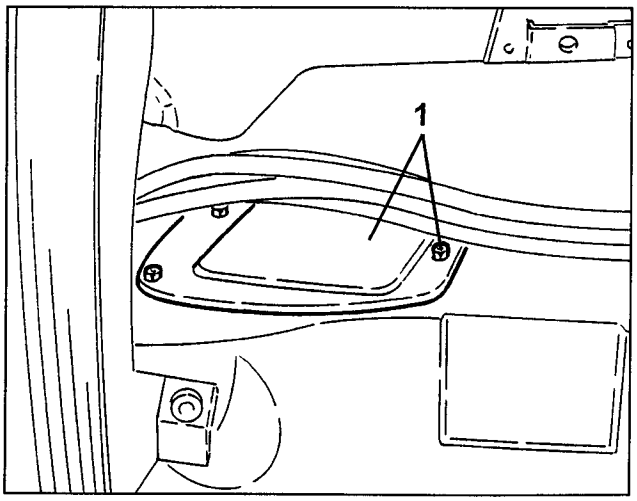
REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Empty the tank by sucking fuel from the filler with a suitable tool.
- Remove the rear seat cushion and back (see specific paragraph).

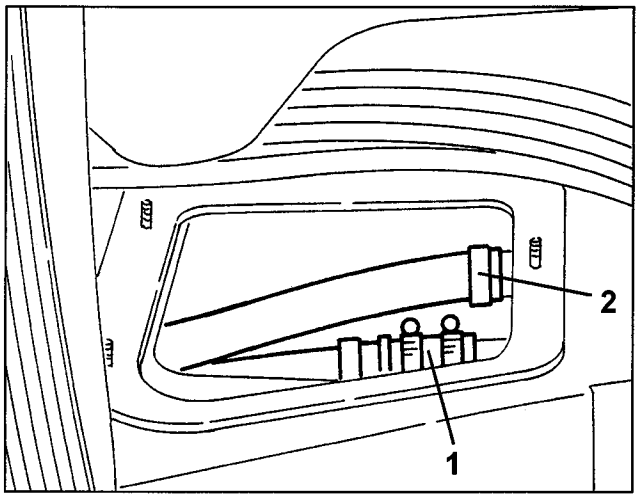
1. Loosen the fastening screw and remove the rear seat belt retainers.



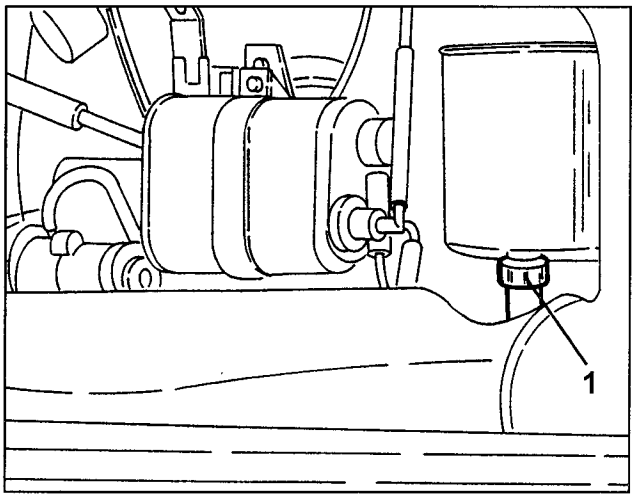
1. Loosen the fastening nuts and remove the fuel tank filler cover.



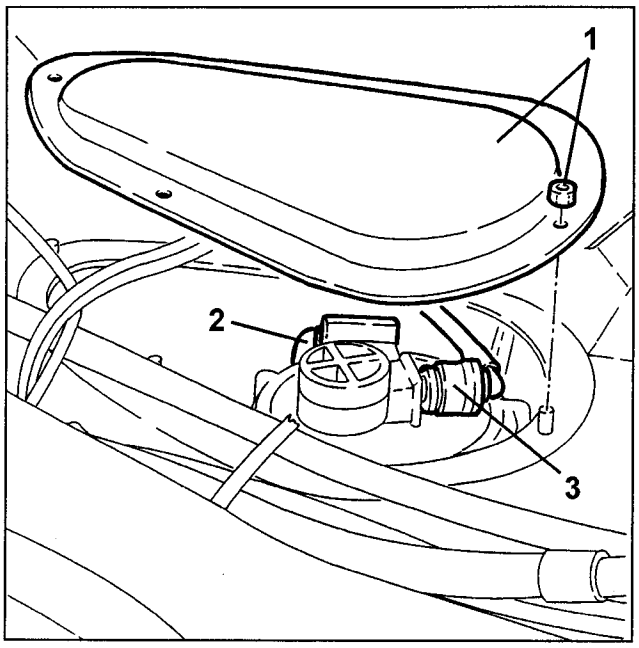
1. Loosen the fastening clip and disconnect the fuel filler from the tank.
2. Loosen the fastening clip and disconnect the breather pipe from the fuel tank.



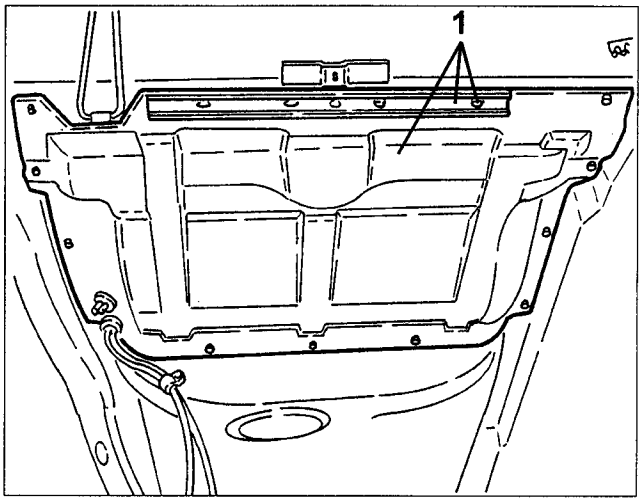
1. From inside the boot, lift the upholstery and disconnect the tank vapour inlet pipe from the fuel vapour separator.



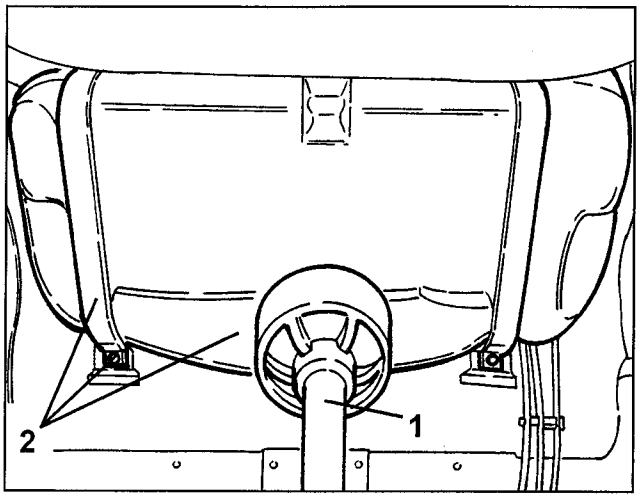
1. Loosen the fastening nuts and remove the fuel pump and gauge guard.
2. Disconnect the fuel pump and gauge electrical connection.
3. Disconnect the fuel delivery pipe from the fuel pump and gauge.



- Lift the vehicle and remove the rear suspension (see specific paragraph).
1. Loosen the fastening screws and remove the tank protection sheet and reinforcement bar.

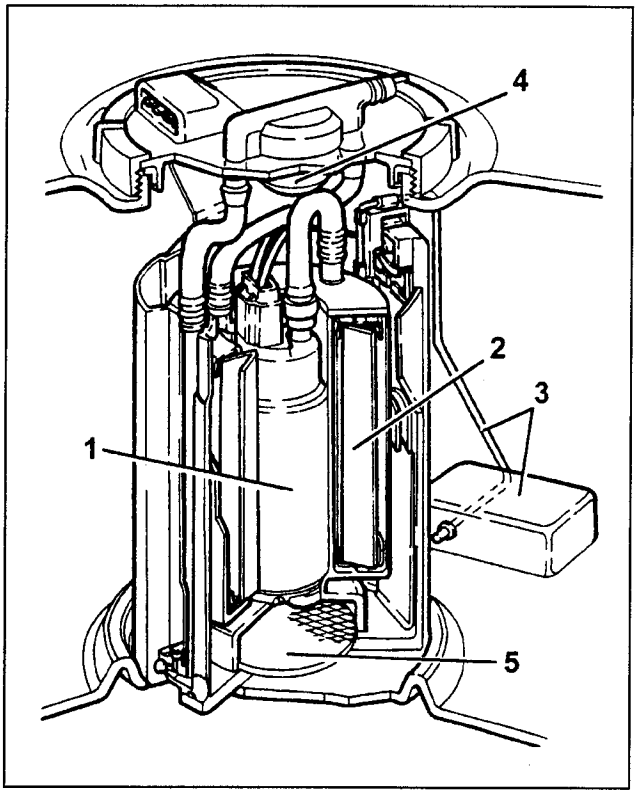


1. Position a hydraulic jack under the fuel tank.
2. Loosen the fuel tank metal belts and remove the tank by lowering the hydraulic jack.

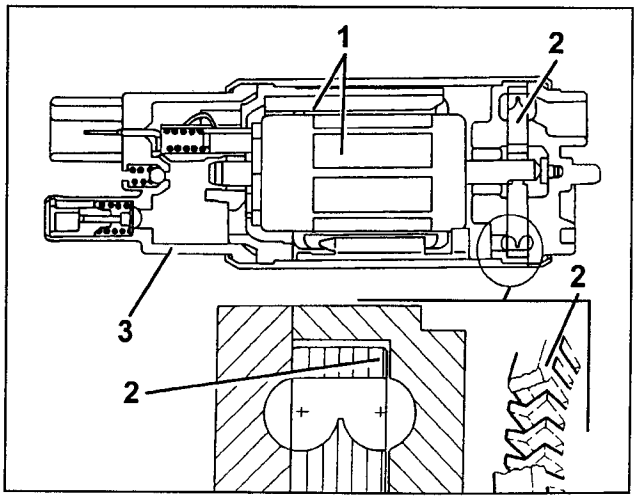


FUEL PUMP AND GAUGE

The main parts are:
- electrical fuel pump (1)
- fuel filter (2)
- float gauge (3)
- membrane pressure regulator (4)
- mesh pre-filter (5).



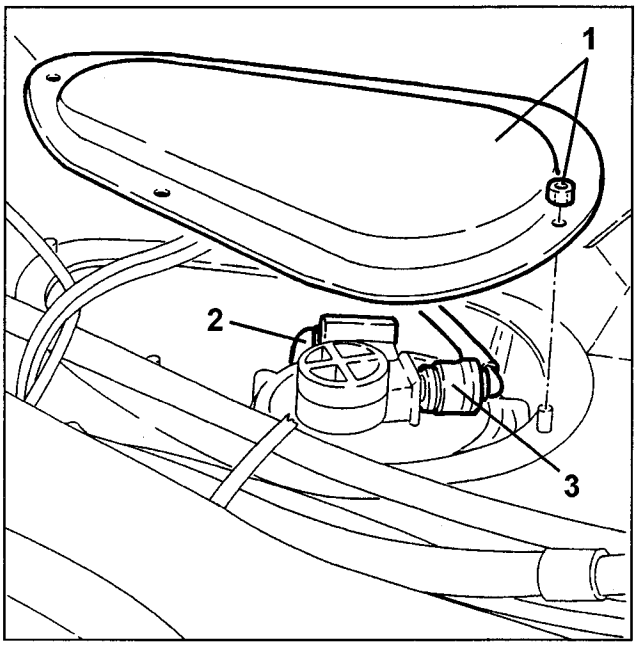
The fuel pump features a permanent magnet electrical motor (1) which controls the pump impeller (2) and a terminal guard (3) which contains the electrical and hydraulic connections.



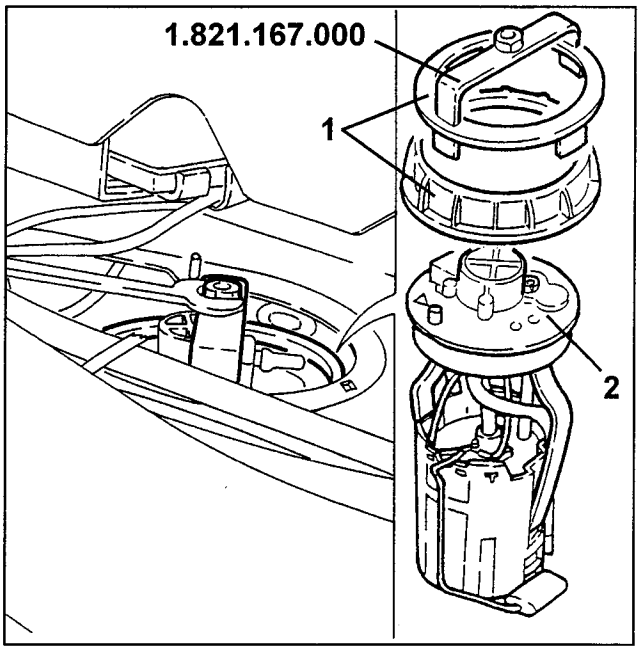
The pump is a single stage, peripheral flow device which ensures high performance at low voltage and temperature. The advantages with respect to volumetric pumps are:
- lower weight
- smaller size.

REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Remove the rear seat cushion and back (see specific paragraph).
1. Loosen the fastening nuts and remove the fuel pump and gauge guard.
2. Disconnect the fuel pump and gauge electrical connection.
3. Disconnect the fuel delivery pipe from the fuel pump and gauge.



1. Use tool no. 1.821.167.000 to remove the fuel pump and gauge fastening nut screw.
2. Remove the fuel pump and gauge.



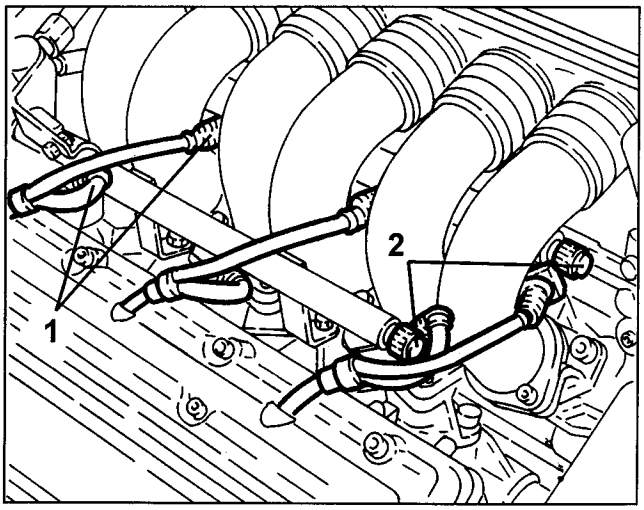
- Refit the fuel pump so that the arrow printed on the fuel pump guard is aligned with the reference mark on the tank.

INJECTORS

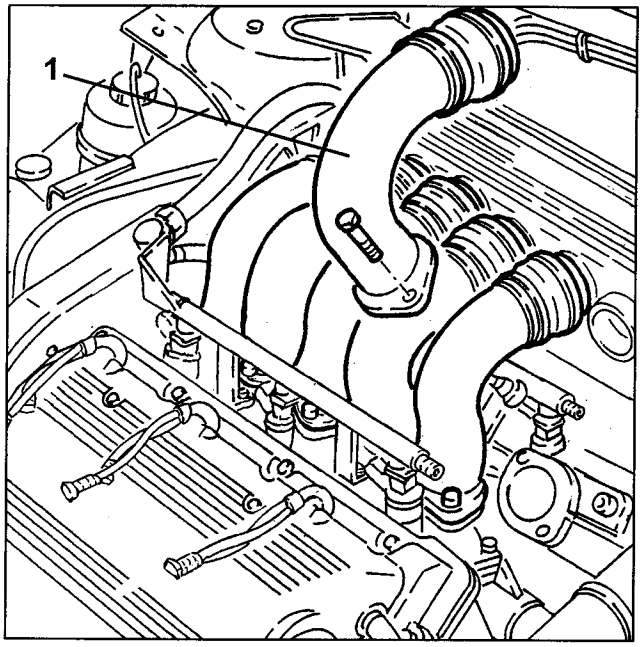
REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Disconnect the injector electrical connections.
2. Drain fuel pressure by loosening the caps on the distribution manifold and operating the underlying valves.

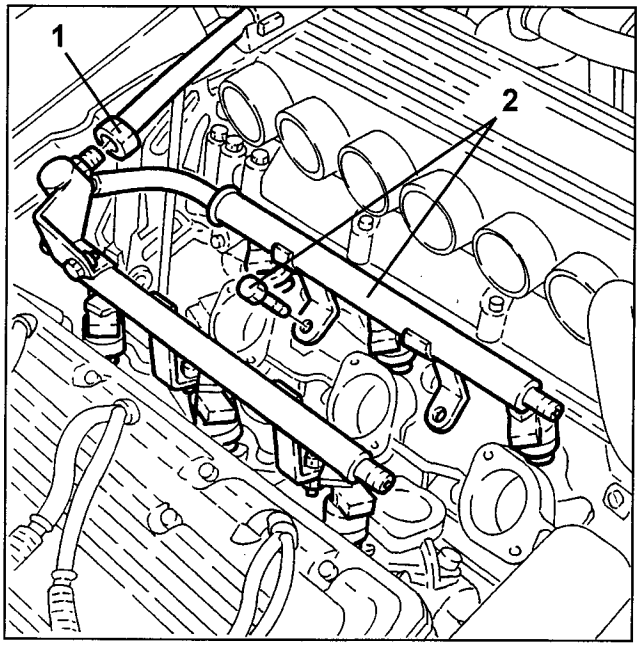
NOTE: Collect the fuel which is let out in a suitable container.



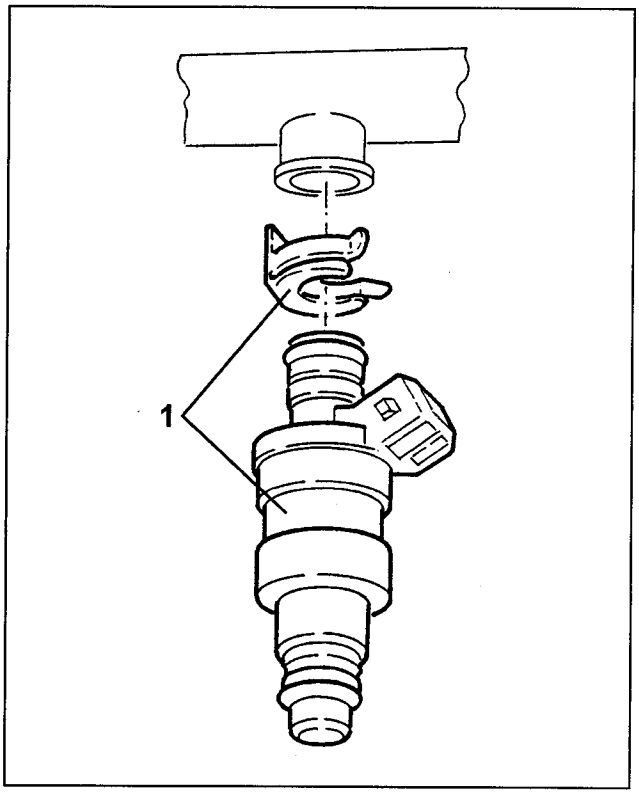
1. Loosen the clips and the screws. Then remove the intake air ducts.



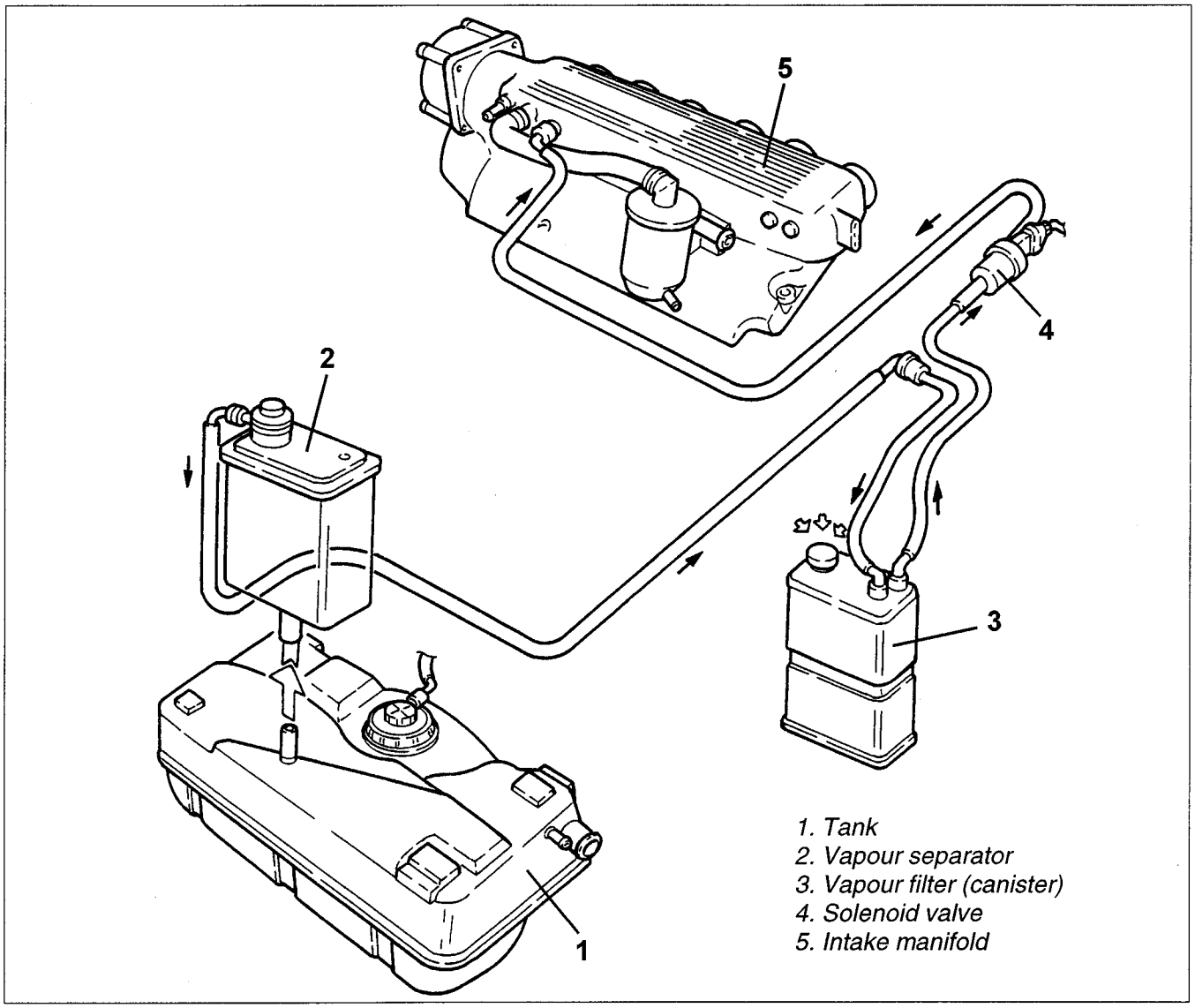
1. Disconnect the fuel delivery pipe from the distribution manifold.
2. Loosen the screws and remove the distribution manifold and injectors.



1. At the bench, remove the retainers and remove the injectors from the distribution manifold.



FUEL VAPOUR RECOVERY SYSTEM DESCRIPTION



1. Tank
2. Vapour separator
3. Vapour filter (canister)
4. Solenoid valve
5. Intake manifold

The fuel in the tank produces a considerable amount of potentially polluting vapours if released into the atmosphere.
The purpose of the vapour control and recovery system is to recover the vapours and burn them in the engine.
The vapours from the tank (1) reach the separator (2) via a specific pipe which is shaped as to allow the condensed fuel to drip back into the tank.
The remaining fuel vapours are sent to the canister (3) where they are absorbed and stored by the active carbon filter.
A solenoid valve (4) is located between the canister and the engine intake.
When the solenoid is not activated, the connection is closed and the fuel vapours remain inside the canister thanks to the active carbon filter.

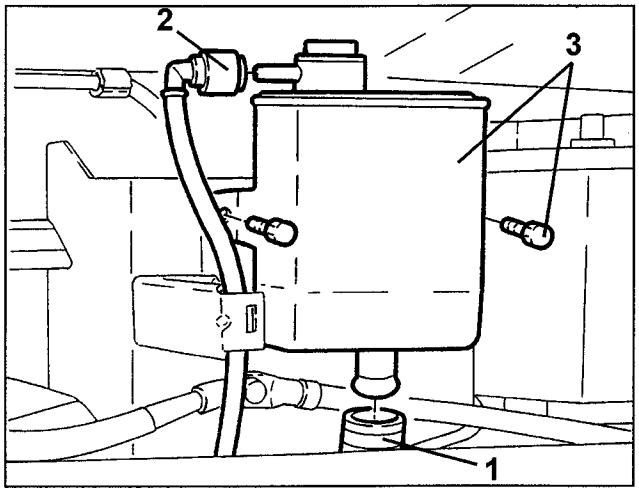
In certain conditions of load, the ECU opens the solenoid valve allowing any vapours in the canister to be taken in.
This condition persists even when the lambda sensors detect decreased oxygen in exhaust due to excessive presence of fuel in the firing chamber.
If there are no fuel vapours in the canister, and consequently only air is taken in, the lambda sensors detect and inform the ECU of an increase in oxygen. In this case, the ECU closes the solenoid valve and the connection with the canister thus eliminating the excessive air intake.

FUEL VAPOUR SEPARATOR

Located in the boot, the separator has the purpose of limiting the amount of fuel vapours which reach the canister by condensing a part of them, thanks to its shape.
It consists of a plastic container with two connections: one lower vapour inlet and condensed fuel outlet and one upper outlet to the canister.

REMOVAL/REFITTING

- Remove the space saver spare wheel.
- Remove the boot upholstery.
1. Disconnect the tank fuel vapour inlet pipe from the separator.
2. Disconnect the canister fuel outlet pipe from the separator.
3. Loosen the fastening screws and remove the fuel vapour separator.

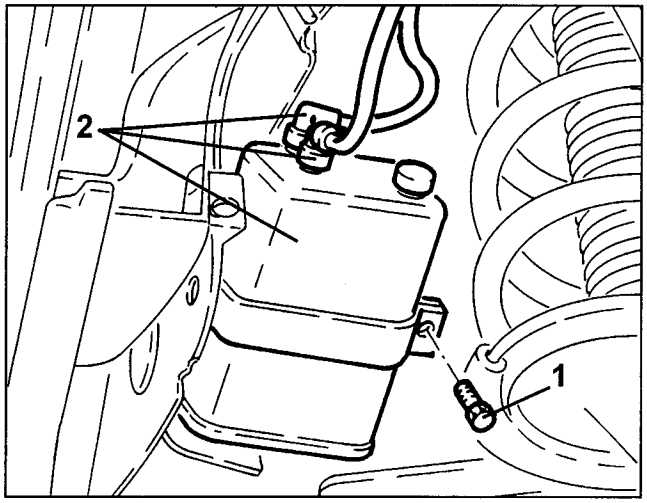


FUEL VAPOUR CANISTER

This device consists of an active carbon filtering element in a plastic casing which absorbs the fuel vapours from the separator. A one-way valve, to which it is connected via a specific pipe, allows to take in external air during vapour intake to wash the active carbon filter.

REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Remove the right-hand front wheel.
- Loosen the screws and remove the right side engine compartment guard.
- Remove the right front wheelhouse.
1. Loosen the canister fastening screw.
2. Disconnect the two canister pipes and remove the canister.

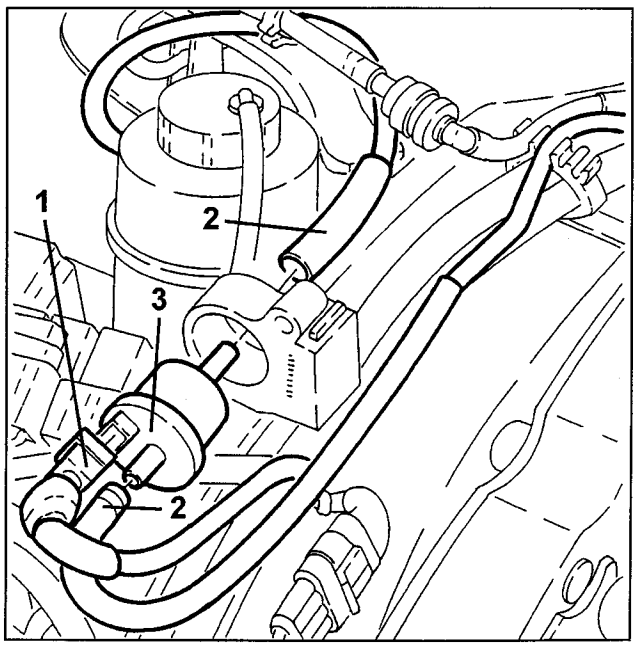


FUEL VAPOUR SOLENOID VALVE

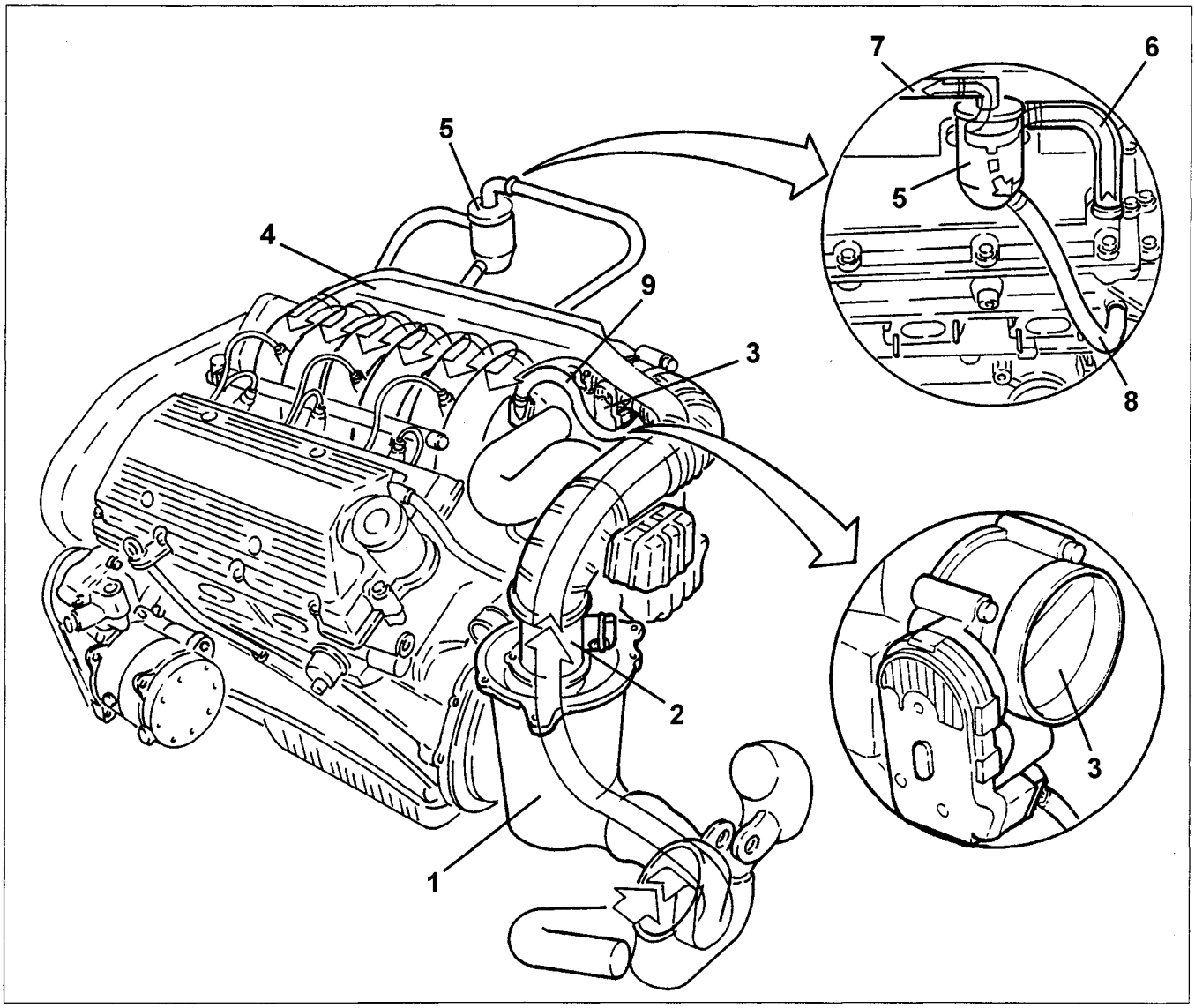
This valve is controlled by the injection ECU and lets the fuel vapours stored in the canister into the intake manifold.

REMOVAL/REFITTING

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Loosen the screws and remove the right engine compartment guard.
1. Disconnect the fuel vapour solenoid valve electrical connection.
2. Disconnect the fuel vapour solenoid valve inlet and outlet pipes.
3. Remove the fuel vapour solenoid valve by removing it from its bracket.



AIR FEED AND OIL VAPOUR RECOVERY SYSTEM DESCRIPTION



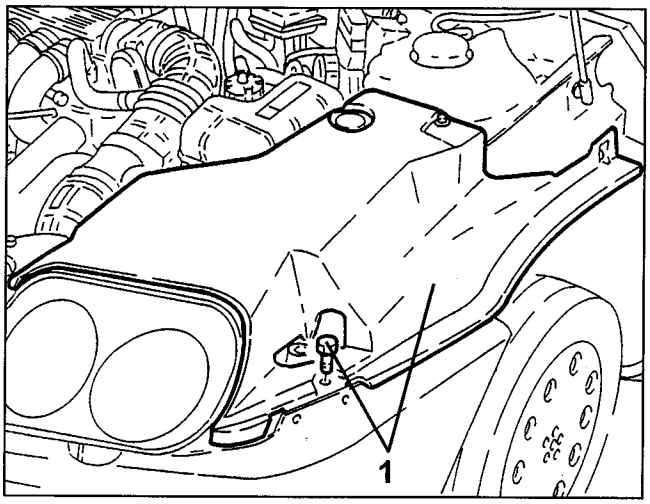
1. Air cleaner
2. Hot film flow meter
3. Throttle casing with built-in DVL.
4. Intake manifold
5. Oil vapour separator
6. Oil vapour recovery pipe
7. Oil vapour recirculation pipe
8. Condensed oil recovery pipe
9. Oil vapour recovery pipe

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 DVL (3) via the corrugated sleeve.
"Resonators" are fitted along the intake duct.
The throttle casing with built-in DVL is controlled by the injection ECU according to the accelerator pedal potentiometer and regulates the amount of air taken in by the engine.

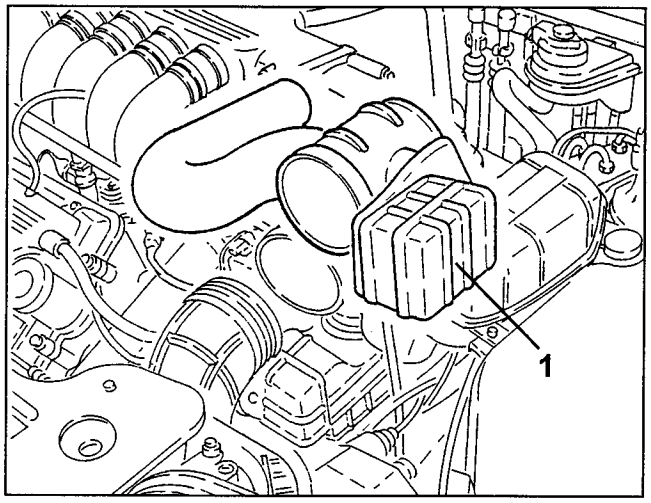
The fuel vapours (see specific paragraph) and the oil vapours reach the feed system. Oil vapour emission is controlled by means of a separator (5) which collects the vapours in the cylinder head via pipe (6). The temperature difference between the separator and oil vapours causes partial condensation. The condensed vapours are conveyed to the cylinder head via pipe (8). When idling, the oil vapours are conveyed via pipe (7) and at high loads, via pipe (9).

AIR CLEANER CARTRIDGE REPLACEMENT

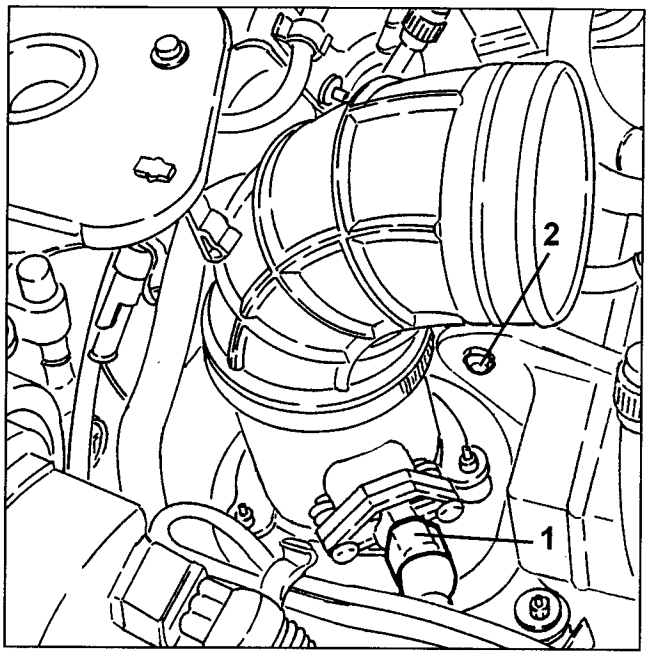
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Loosen the screws and remove the engine compartment side guard.



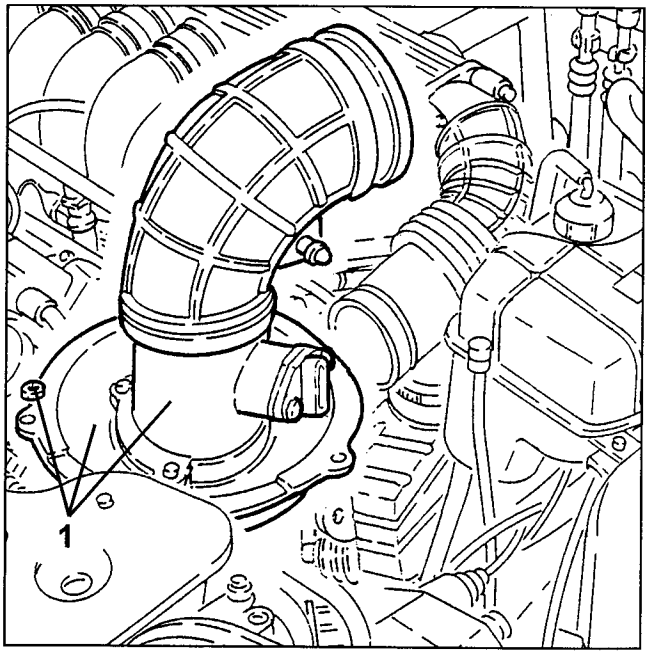
1. Loosen the fastening clips and remove the upper resonator.



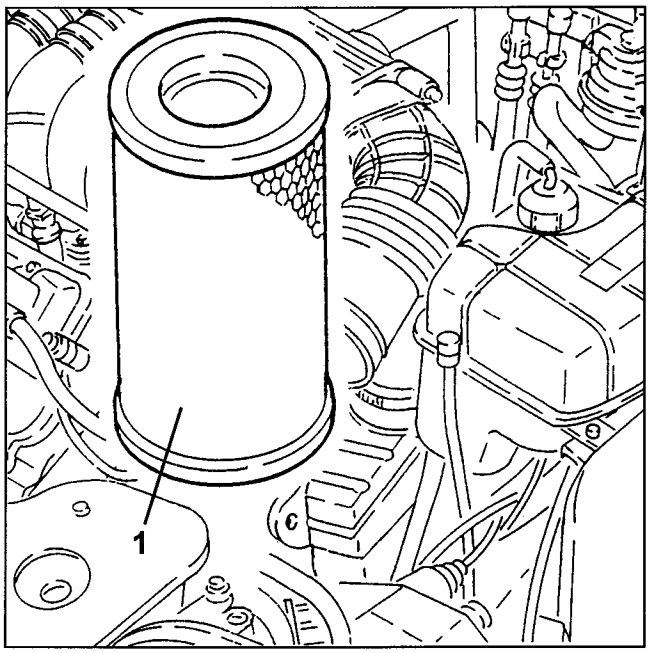
1. Disconnect the hot film flow meter electrical connection.
2. Release the corrugated sleeve elbow fastening button from the resonator.



1. Loosen the fasten nuts and remove the air cleaner cover with hot film flow meter and corrugated sleeve.



1. Remove the filtering element and manifold.



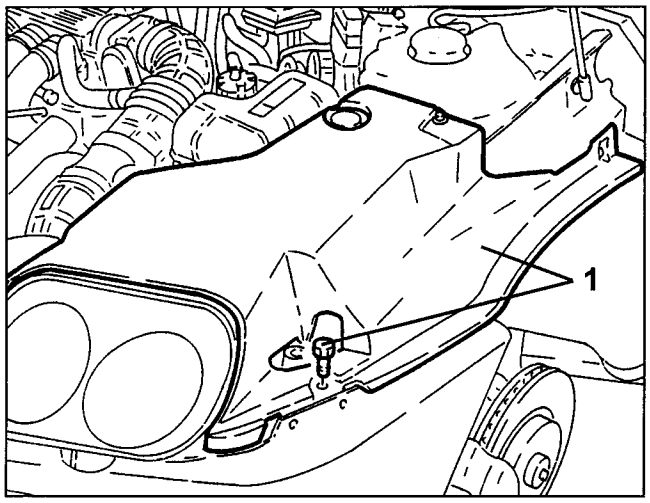
IMPORTANT: Cleaning operations can damage the filter and compromise correct engine operation.

- Refit a new air cleaner by reversing the removal sequence.

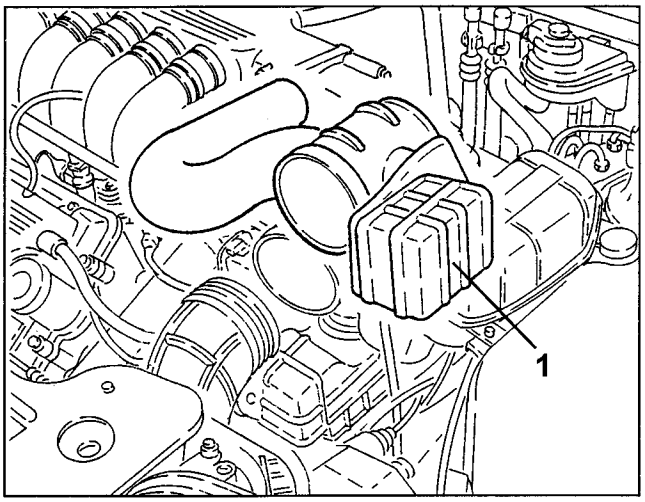
UPPER RESONATOR

REMOVAL/REFITTING

1. Loosen the screws and remove the engine compartment side guard.



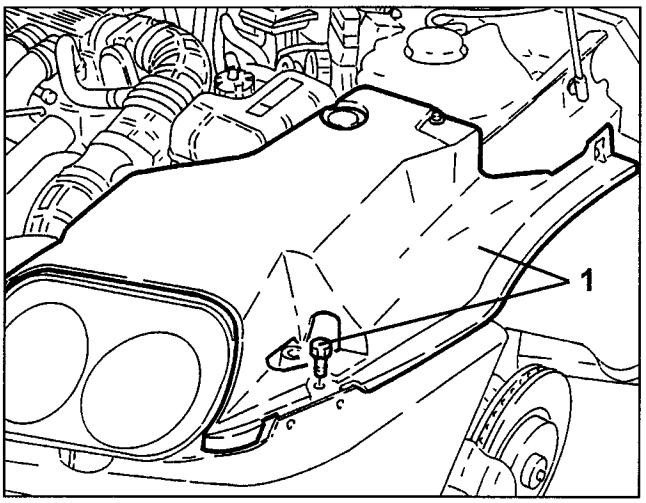
1. Loosen the fastening clips and remove the upper resonator.



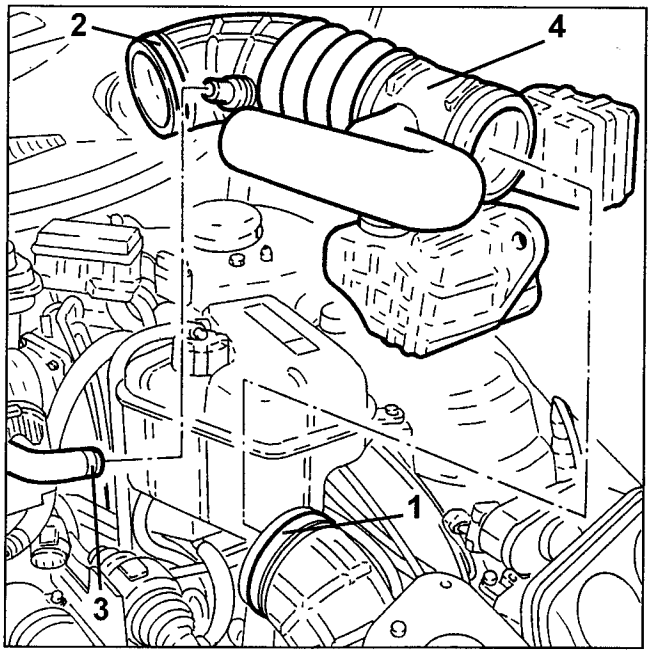
INTERMEDIATE RESONATOR

REMOVAL/REFITTING

1. Loosen the screws and remove the engine compartment side guard.



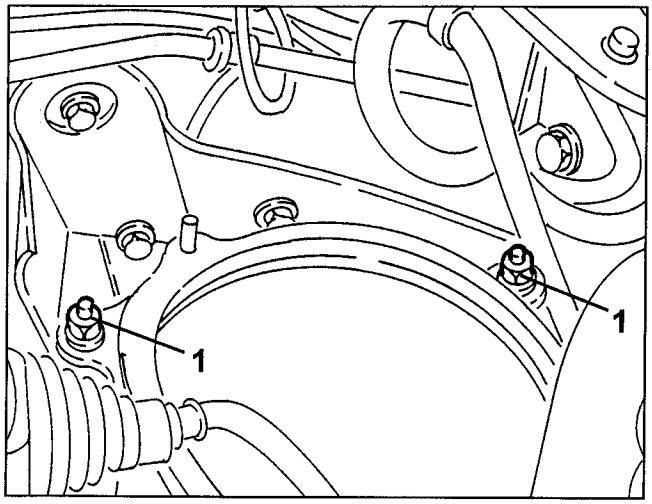
1. Loosen the clip fastening the upper resonator to the corrugated sleeve elbow.
2. Loosen the clip fastening the corrugated sleeve to the throttle casing with built-in DVL.
3. Loosen the clip and disconnect the oil vapour recirculation pipe from the corrugated sleeve.
- Release the button fastening the corrugated sleeve elbow to the resonator.
4. Remove the intermediate resonator with upper resonator and corrugated sleeve. Separate at the bench, if required.



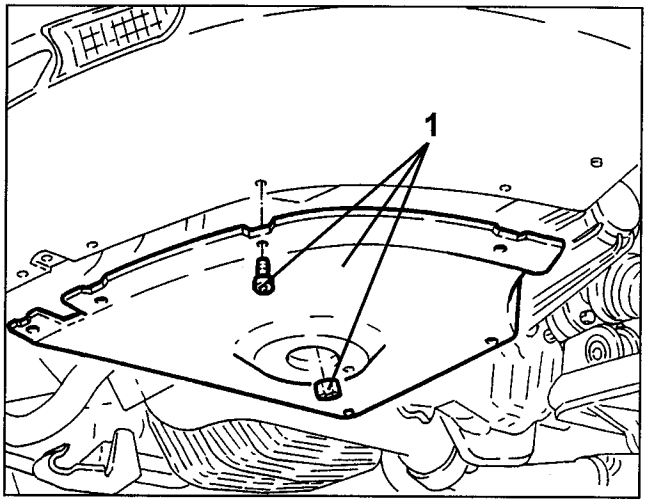
AIR CLEANER CASING

REMOVAL/REFITTING

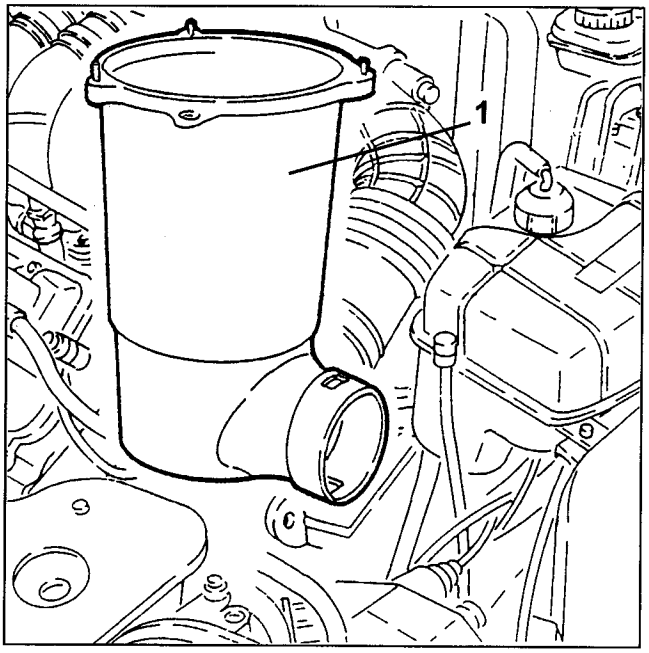
- Position the vehicle on a shop jack.
- Remove the air cleaner cartridge (see specific paragraph).
1. Loosen the air cleaner fastening nuts.



- Lift the vehicle.
1. Loosen the screws and nut and then remove the air filter lower guard.

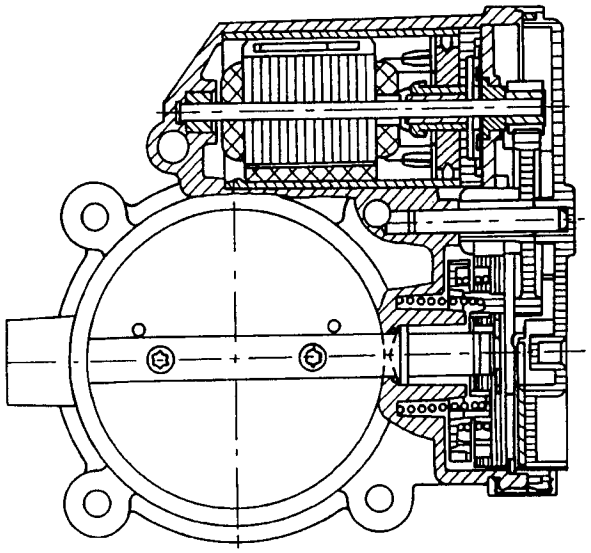


- Release the air cleaner casing from the lower resonator sleeve.
1. Lower the vehicle and remove the air cleaner casing.



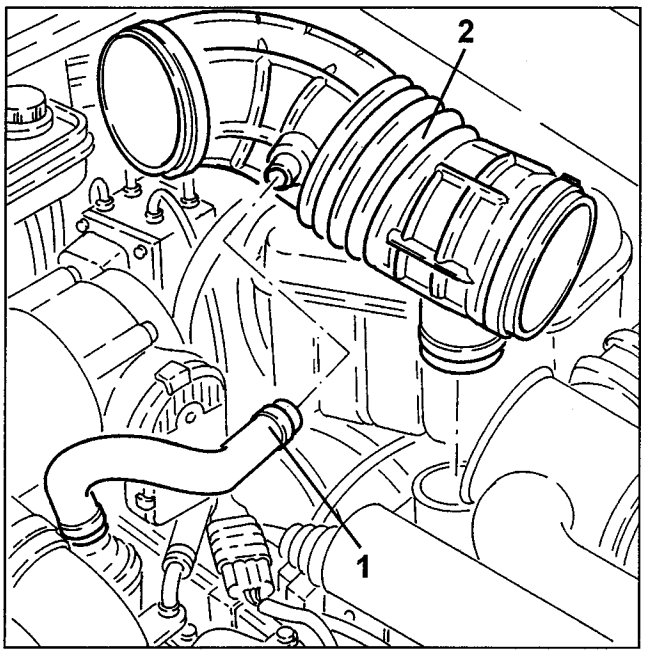
THROTTLE CASING WITH BUILT-IN DVL

The device is fitted on the intake manifold and controls the amount of engine intake air. The ECU controls the throttle opening by means of a direct current motor built into the throttle casing according to the signal from the accelerator potentiometer. The throttle can be opened from 0° to 80°, including idling ratio.
The throttle casing with built in DVL is equipped with two potentiometers which back each other up. If the potentiometers fail or if power is cut, the ECU reduces engine torque as follows:
- if the accelerator pedal is fully depressed, the ECU cuts off feed to one or more cylinders to reach a maximum engine ratio of 2500 rpm
- if the accelerator pedal is in an intermediate position, the ECU cuts feed to one or more cylinders to reach an engine ratio lower than 2500 rpm.
After replacing either the throttle casing with built-in DVL or the injection ECU, a self-learning procedure is required (see specific paragraph).

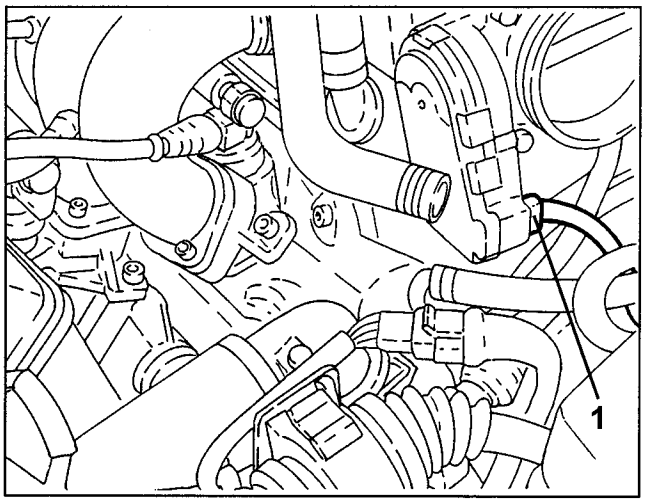


REMOVAL/REFITTING

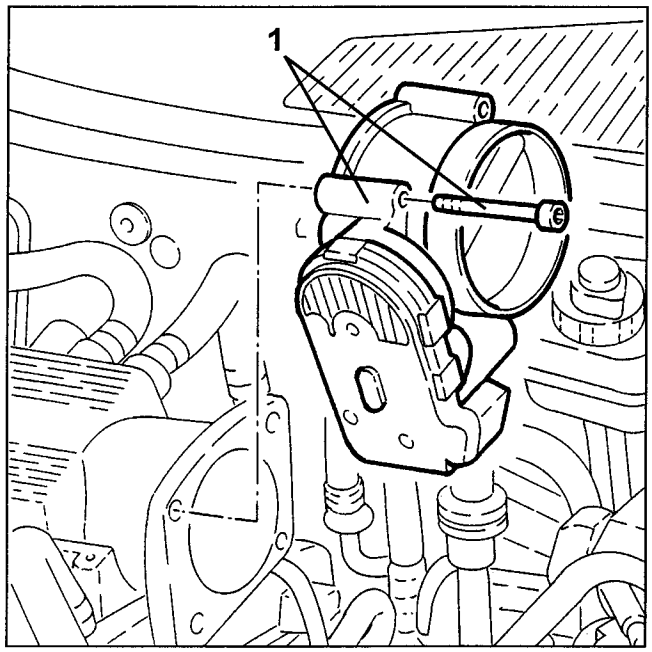
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Disconnect the oil vapour recirculation pipe from the corrugated sleeve.
2. Loosen the clips and remove the corrugated sleeve.



1. Disconnect the electrical connection from the throttle casing with built-in DVL.



1. Loosen the fastening screws and remove the throttle casing with built-in DVL and seal.



IMPORTANT: After refitting, repeat the throttle casing with built-in DVL self-learning procedure described below.

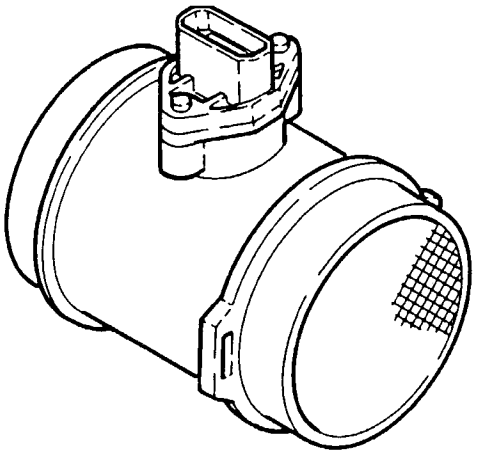
IMPORTANT: During this procedure (from when the instrument panel is powered to the end of the self-learning procedure), do not press either the accelerator pedal, the brake pedal or the clutch pedal.

- Make sure the ignition key is at STOP.
- Connect tool no. 1.806.365.000 to the diagnostic socket and turn the knob to 3.
- Connect Examiner.
- Turn the ignition key to MAR.
- Wait for 60 seconds for the ECU to check the throttle internal spring and the maximum/minimum angular positions.
- Turn the ignition key to STOP.
- Wait for 15 seconds for the ECU to record the learnt values in the EPROM.
- With Examiner, check whether the idling self-learning procedure was ended correctly (SELF-LEARNING OUTCOME - OK; SELF-LEARNING STORAGE - Done).

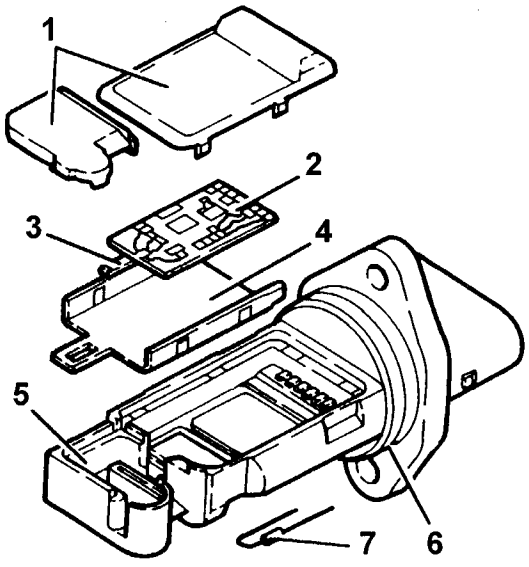
NOTE: If the self-learning procedure is not correct, take the key to STOP and repeat the procedure. If the incorrect outcome persists, check the connection to the diagnostic socket and tool operation.

AIR FLOW METER

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



An intake air temperature sensor is built into the flow meter.



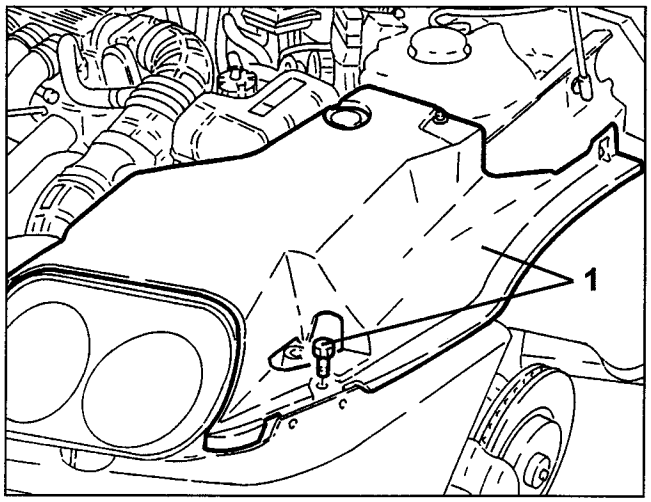
1. Covers
2. Electronic board
3. Sensor
4. Support plate
5. Bracket
6. O-Ring
7. Temperature sensor

IMPORTANT: The air flow meter cannot be disassembled.

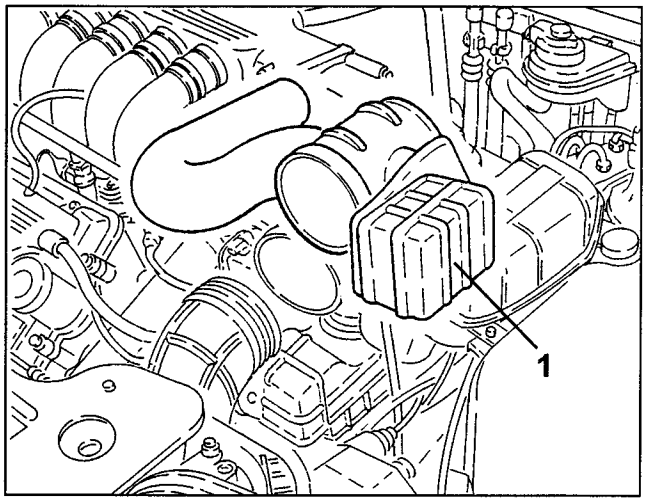
The operating principle consists of a heated membrane film in a measuring duct through which the engine intake air flows.
The film is maintained at constant temperature (approximately 120°C warmer than the intake air temperature) by a resistance.
The air flow in the duct tends to take heat from the film.
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

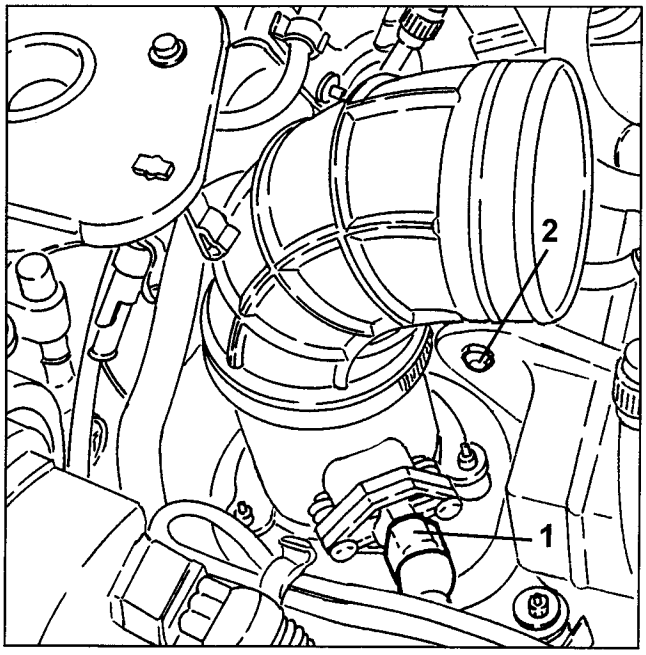
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Loosen the screws and remove the engine compartment side guard.



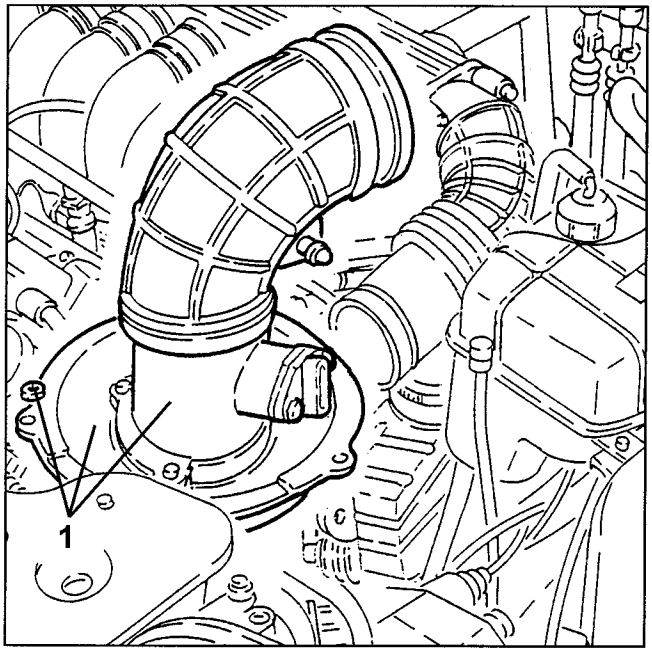
1. Loosen the fastening clips and remove the upper resonator.



1. Disconnect the hot film flow meter electrical connection.
2. Release the corrugated sleeve elbow fastening button from the resonator.



1. Loosen the fasten nuts and remove the air cleaner cover with hot film flow meter and corrugated sleeve.

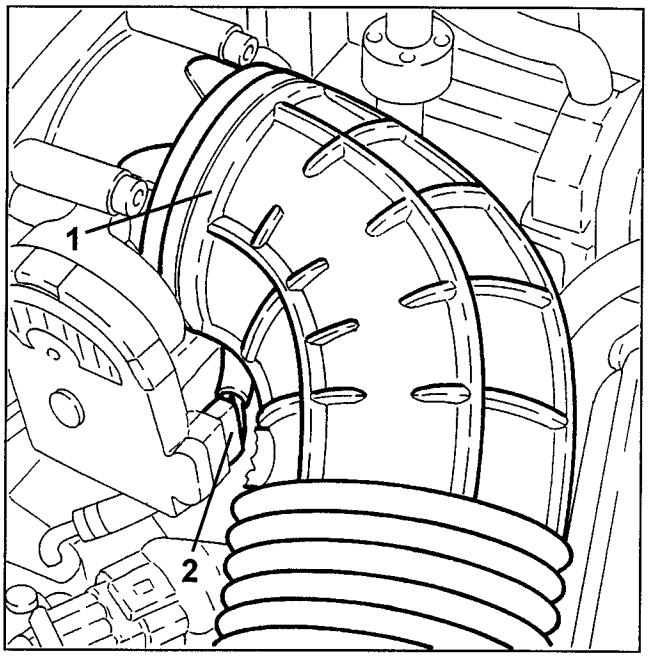


- At the bench, separate the hot film flow meter from the air filter cover and from the corrugated sleeve elbow.

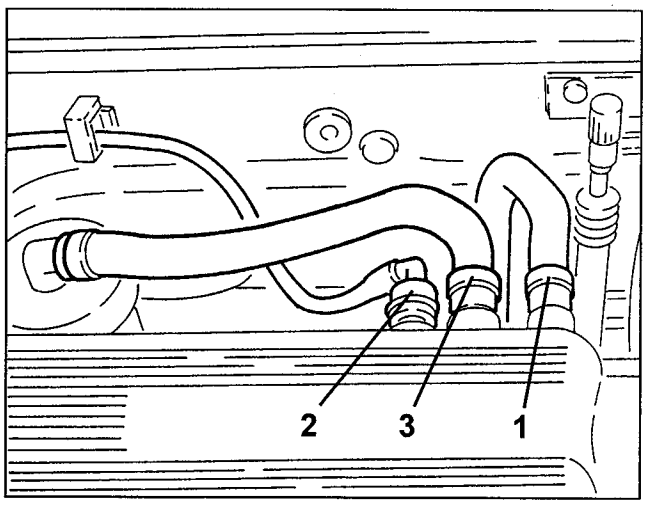
INTAKE MANIFOLD

REMOVAL/REFITTING

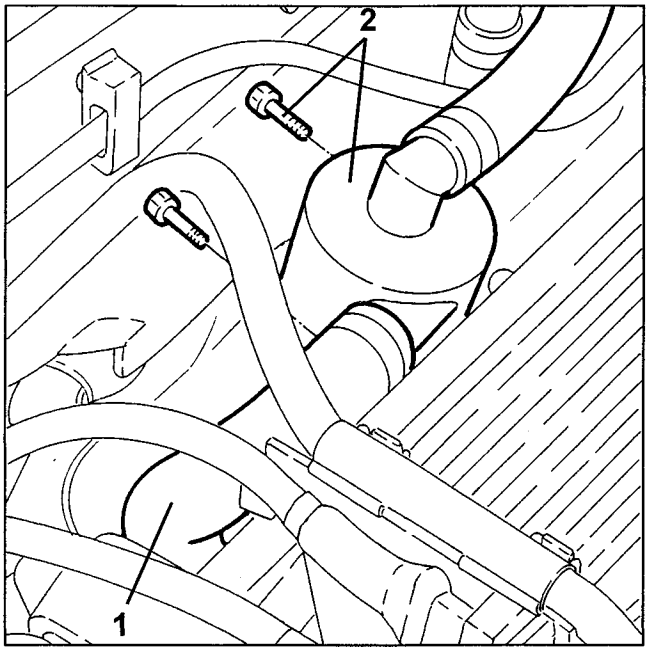
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Disconnect the corrugated sleeve from the throttle casing with built-in DVL.
2. Disconnect the electrical connection from the throttle casing with built-in DVL.



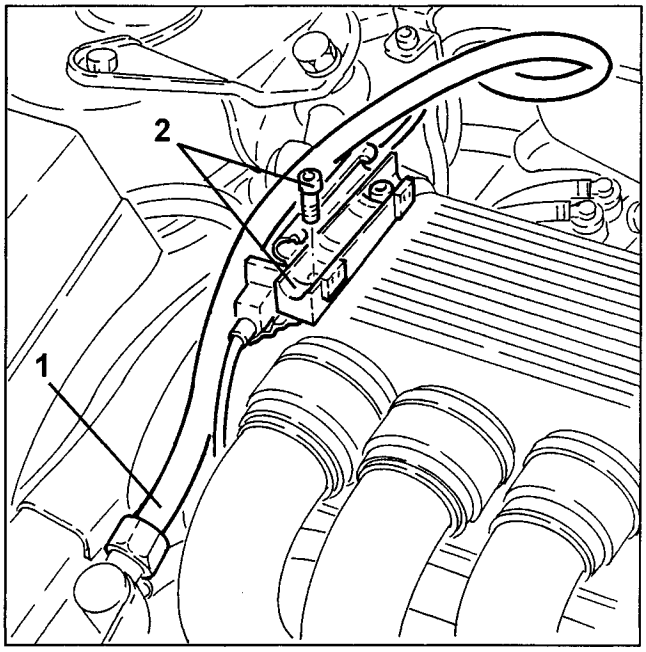
1. Disconnect the brake booster vacuum pipe from the intake manifold.
2. Disconnect the fuel vapour recovery pipe from the intake manifold.
3. Disconnect the oil vapour recirculation pipe from the intake manifold.



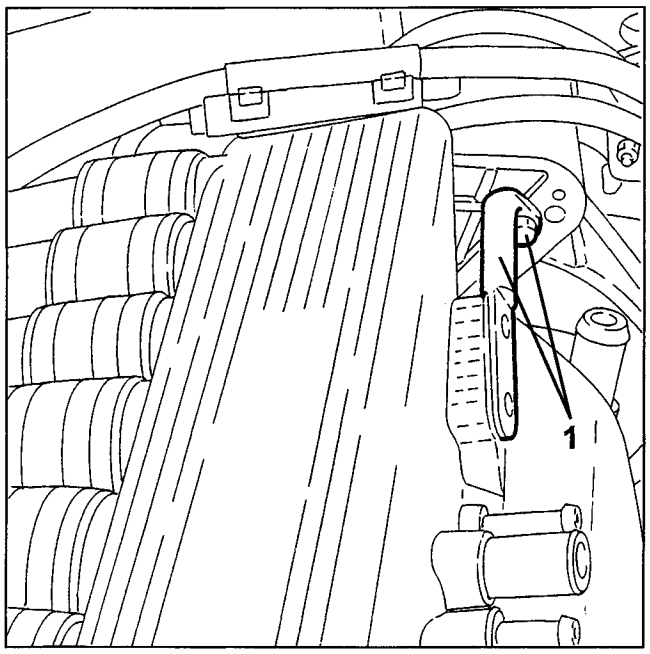
1. Disconnect the oil vapour recovery pipe from the right-hand cylinder head tappet cover.
2. Loosen the fastening screws and move the oil vapour separator from the intake manifold.



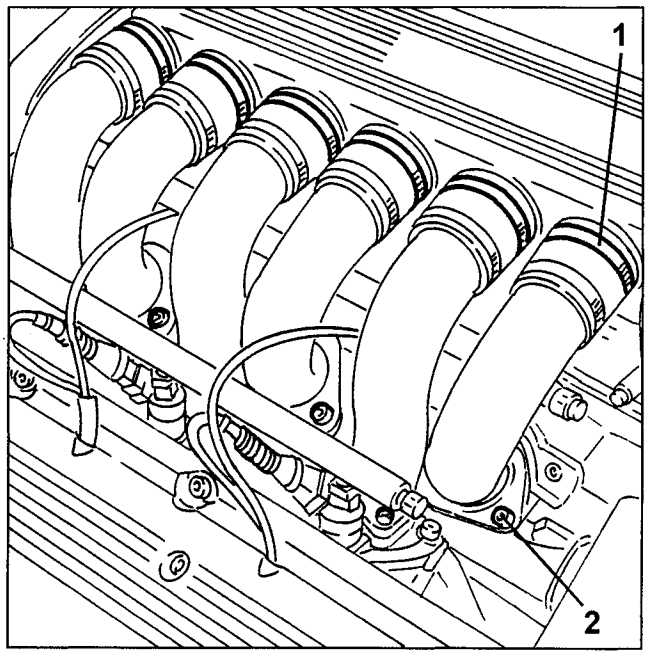
1. Release the fuel delivery pipe from the bracket.
2. Loosen the fastening screws and move the fuel feed delivery pipe bracket with front knock sensor electrical connection aside.



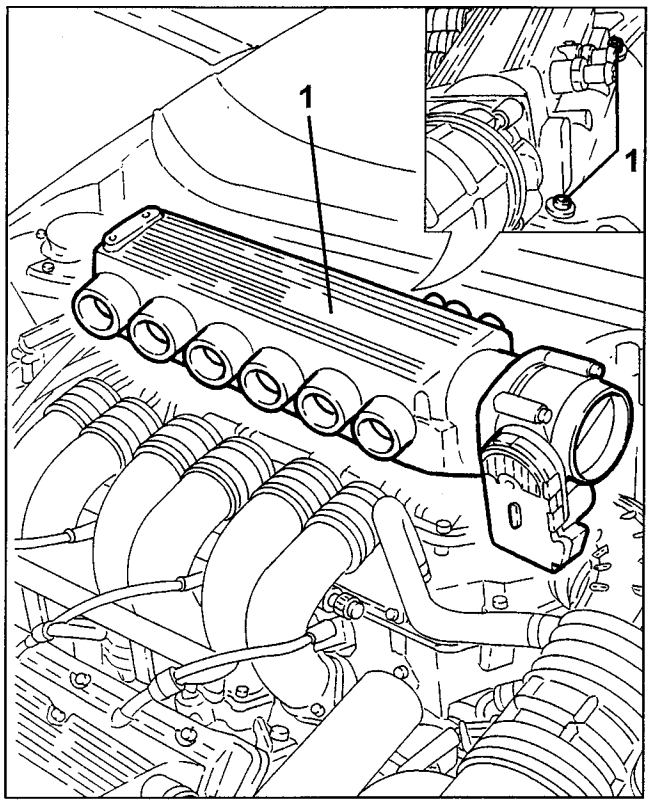
1. Loosen the screw and remove the intake manifold connection from the engine tie-rod bracket.



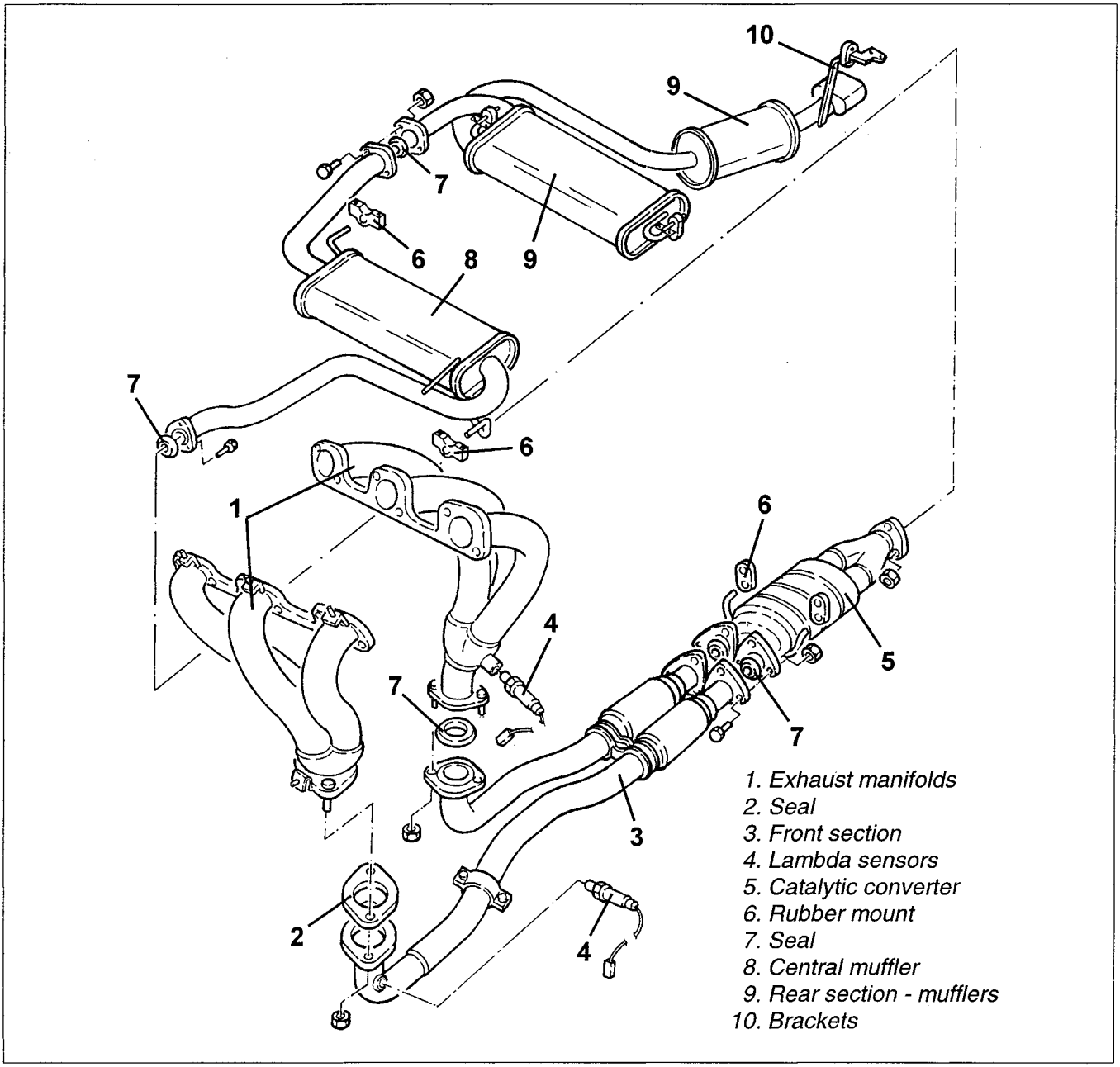
1. Loosen the intake manifold duct clips.
2. Loosen the intake manifold duct fastening screws.
- Release the ducts from the intake manifold.



1. Loosen the fastening screws and remove the intake manifold.



DESCRIPTION



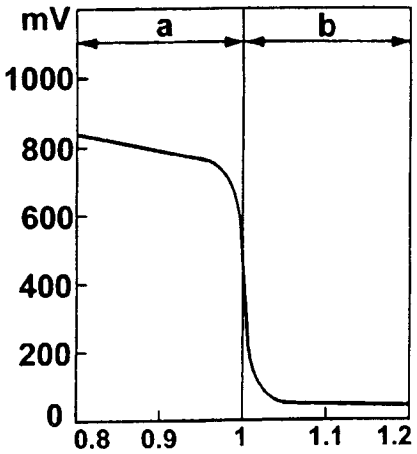
1. Exhaust manifolds
2. Seal
3. Front section
4. Lambda sensors
5. Catalytic converter
6. Rubber mount
7. Seal
8. Central muffler
9. Rear section - mufflers
10. Brackets

The gas from the cylinder heads are conveyed via the manifolds (1) to the front exhaust pipe section (3) where to rubber parts limiting the transmission of vibrations.
From the front section the exhaust gases are sent to the three way catalytic converter (5) where most of the polluting substances are transformed.
The exhaust gasses go from the catalytic converter and cross three specific mufflers (8) and (9).

The connections between the various sections of the pipe are ensured by flanges and seals. The system is linked to the underbody by means of rubber mounts. Heat radiation towards the underbody - which is considerable due to the catalytic converter - is limited by a set of firewalls located between the exhaust pipe and the underbody. The system is equipped with two lambda sensors (see "Lambda sensor" description).

LAMBDA SENSOR

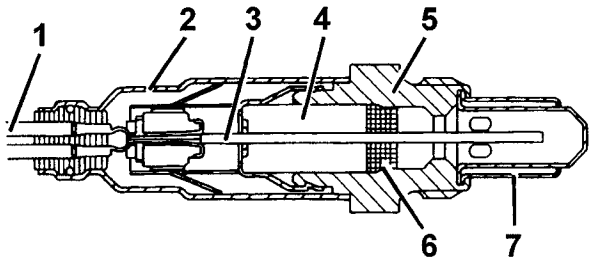
The exhaust system is equipped with two "planar" lambda sensors fitted on the front section of the exhaust pipe.
One lambda sensors controls the right-hand combustion (cylinders 1 - 2 - 3) while the other controls the left-hand side combustion (cylinders 4 - 5 - 6).
The injection ECU identifies the mixture 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)

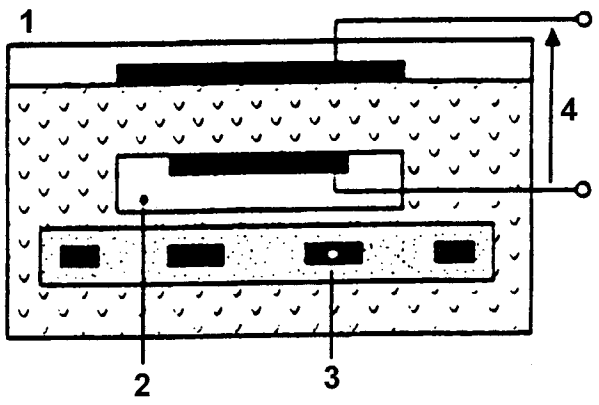
The lambda sensor, in contact with the exhaust fumes, generates an electrical signal with a voltage which varies according to the concentration of oxygen in the fumes.
The voltage is characterised by a sudden variation with the composition of the mixture differs from $\lambda = 1$.
The lambda sensor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

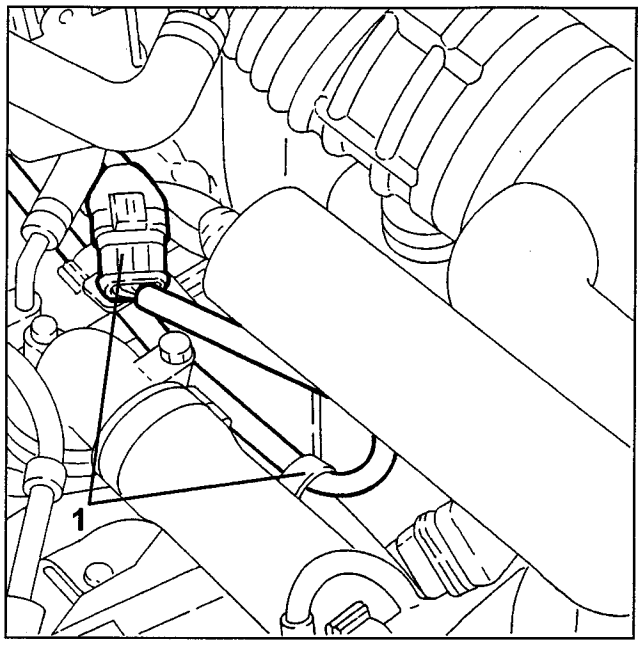
The lambda sensor operation is based on the principle of a oxygen concentration cell and solid electrolyte. The surfaces of the measuring cells are covered with noble material micro-pore layers.



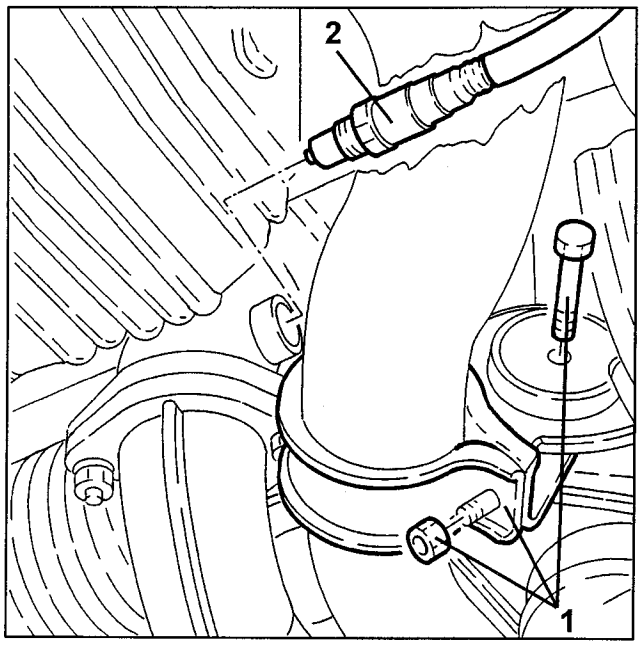
1. Exhaust fumes
2. Reference air passage
3. Heater
4. Lambda sensor voltage

RIGHT-HAND LAMBDA SENSOR 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 right-hand lambda sensor electrical connection and release the respective wiring from the fastening clips.

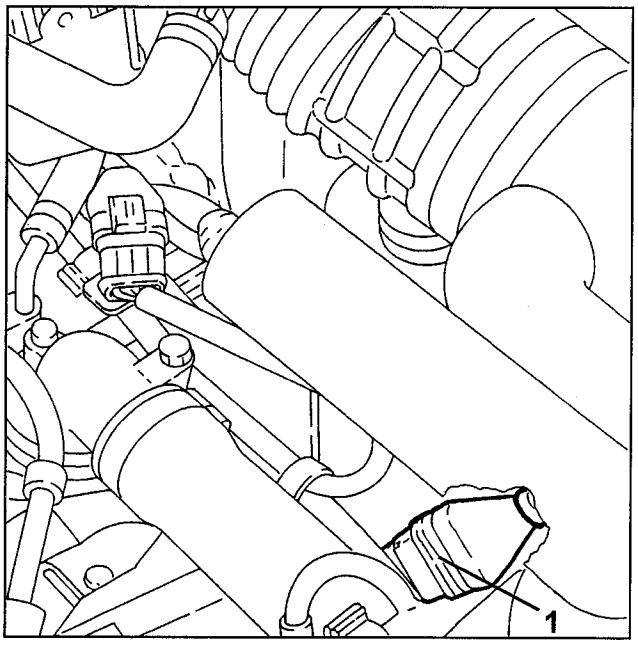


- Lift the vehicle.
1. Loosen the nuts and the screw. Then remove the exhaust pipe fastening collar from the rubber mount.
2. Loosen and remove the right-hand lambda sensor with electrical wiring.

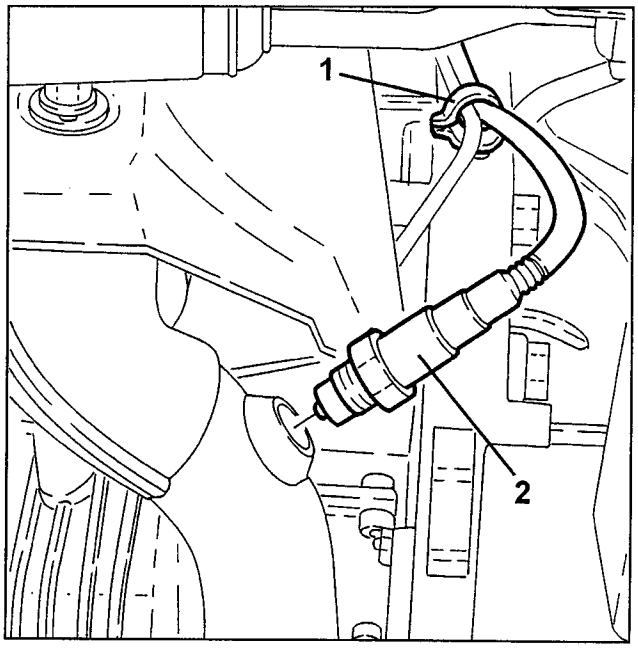


LEFT-HAND LAMBDA SENSOR REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
1. Disconnect the left-hand lambda sensor electrical connection.

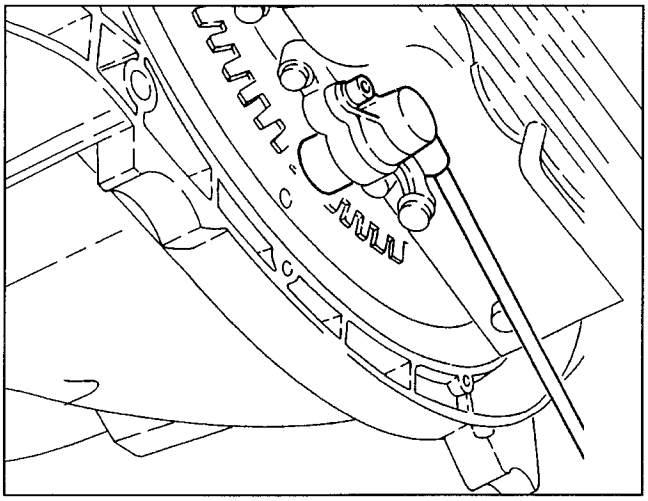


1. Release the left-hand lambda sensor wiring from the fastening clips.
2. Loosen and remove the left-hand lambda sensor with electrical wiring.

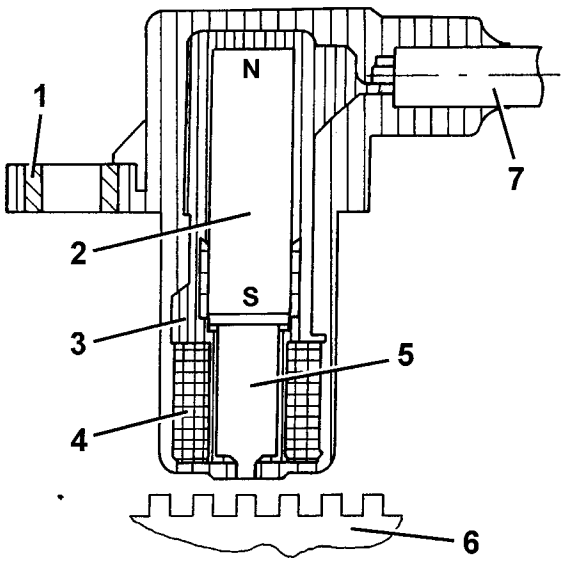


RPM AND PHASE SENSOR

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.

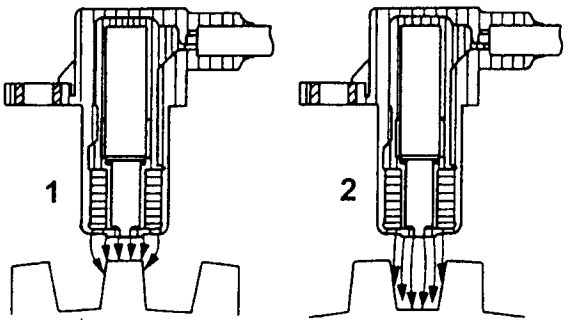


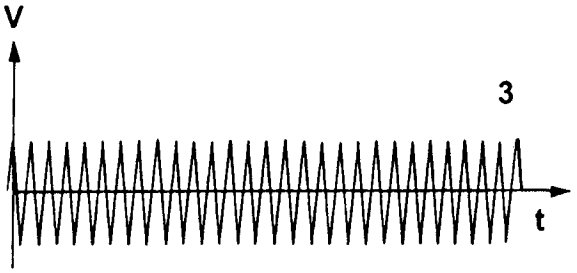
Operation
The switchover from full to none, due to the presence or the absence of a tooth, causes magnetic flow variations which generate an induced alternated voltage by counting the teeth on the phonic wheel.
The frequency and the width of the voltage sent to the ECU provides the engine angular speed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



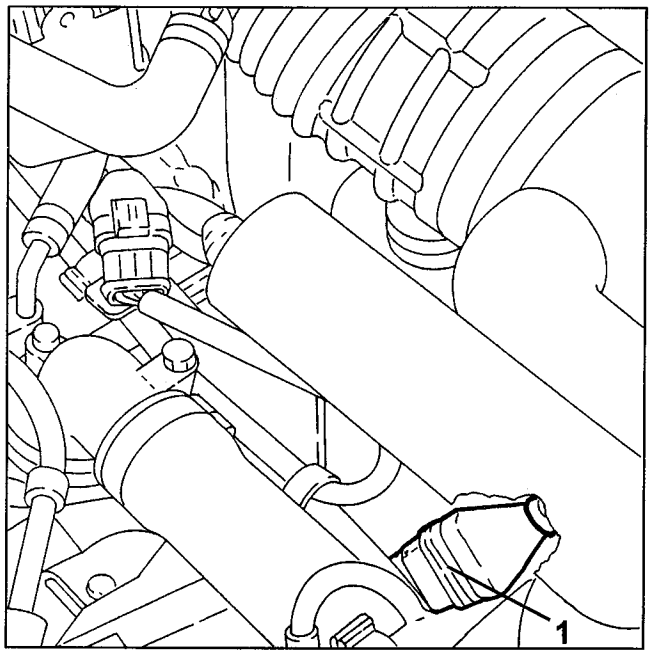


1. Maximum magnetic flow
2. Minimum magnetic flow
3. Induced alternating voltage trend.

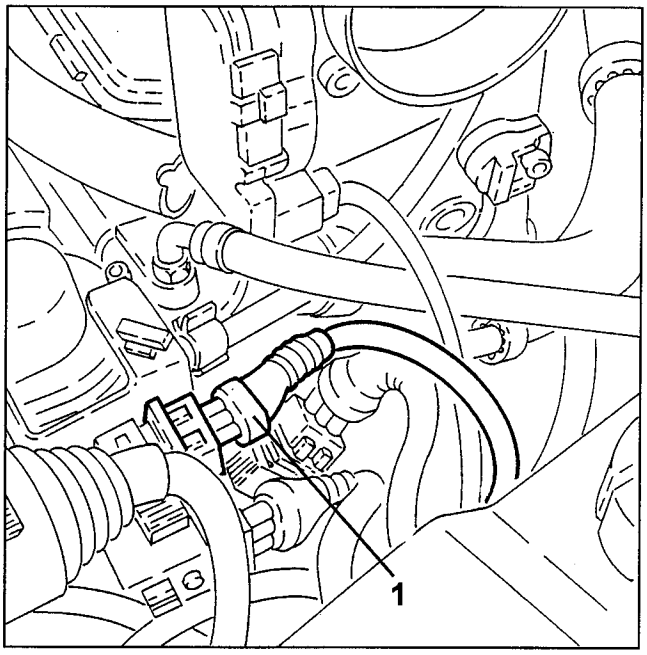
REMOVAL/REFITTING

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

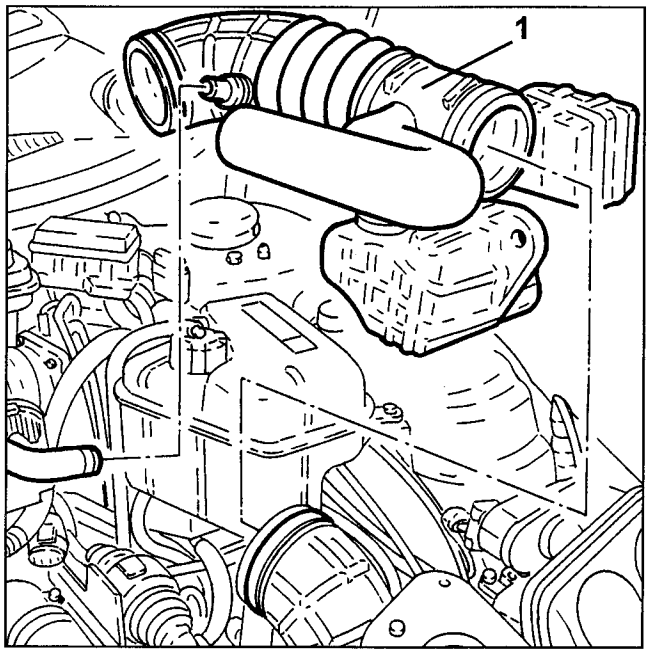
1. Disconnect the left-hand lambda sensor electrical connection.



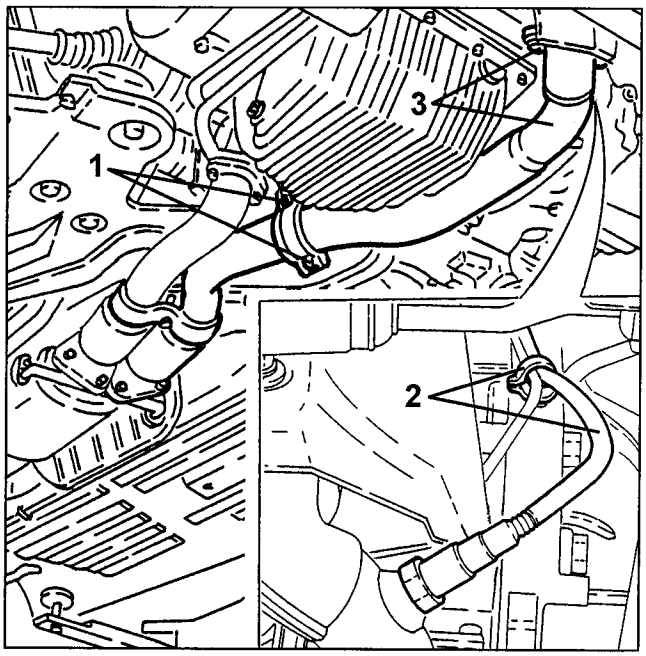
1. Disconnect the rpm and phase sensor electrical connection and release the respective electrical wiring from the fastening clips (where relevant).



1. Loosen the clips and remove the corrugated sleeve with resonators after releasing the intermediate resonator from the fastening pin.

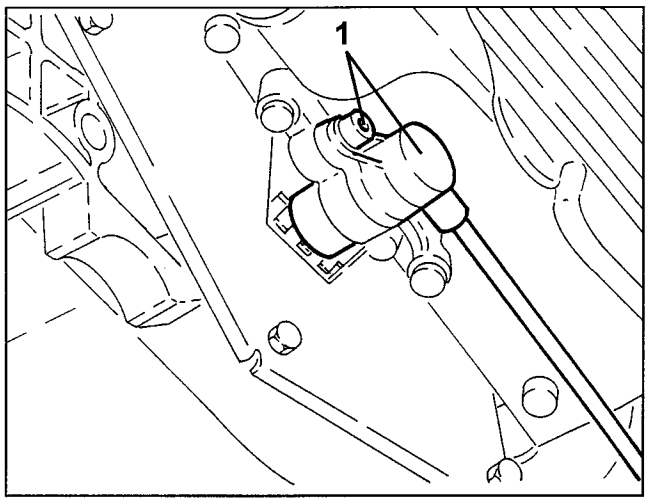


- Lift the vehicle.
1. Loosen the exhaust pipe fastening collar from the rubber mount.
2. Release the left-hand lambda sensor electrical wiring from the fastening clip.
3. Loosen the exhaust manifold fastening nuts and lower the front exhaust pipe section as required.



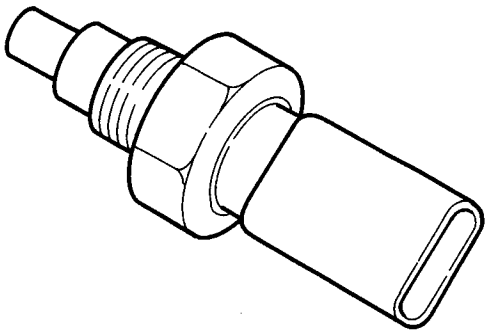
1. Loosen the fastening screws and remove the rpm and phase sensor guard.

1. Loosen the fastening screw and remove the rpm and phase sensor.
- If required, loosen the fastening screws and remove the rpm and phase sensor from its bracket.



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.



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.
- Loosen the screws and remove the left engine compartment guard.
1. Loosen the clips and remove the corrugated sleeve with resonators after releasing the intermediate resonator from the fastening pin.