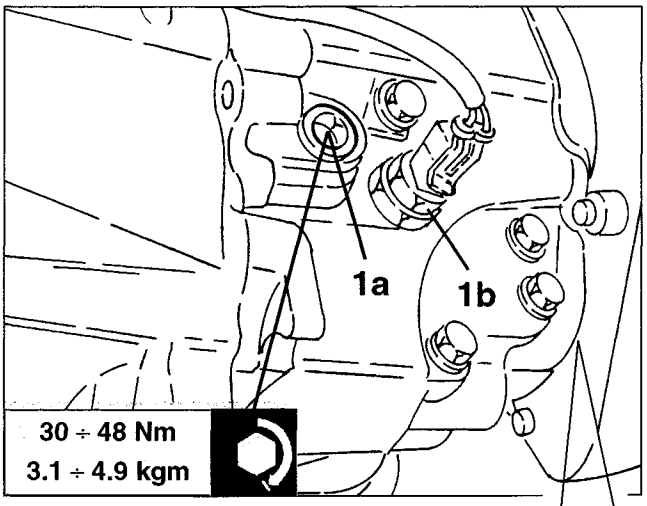
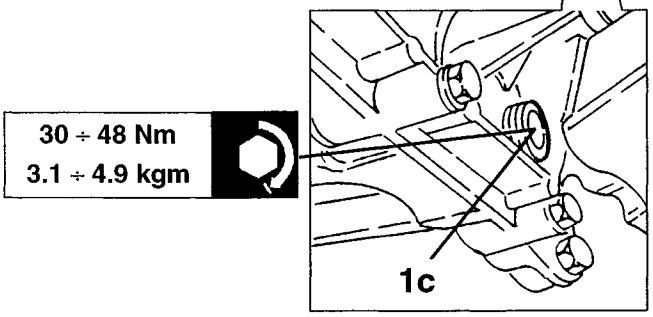
Changing the oil

- Set the car on a lift.
1. Remove the filler cap (1a), the reversing light switch (1b) and the drain cap (1c).



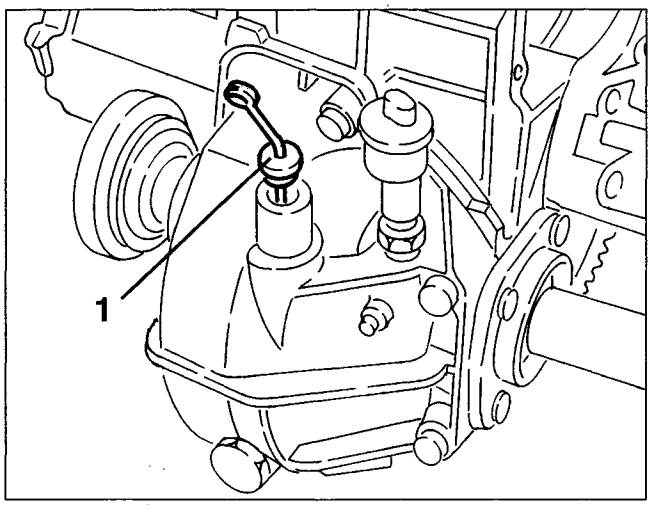


- Allow the oil to drain off completely.
- Clean the drain cap and screw it back on.
- Fill with oil of the specified type and quantity, through the filler hole.
- When the correct level has been reached (see previous paragraph) screw the filler cap and reversing light switch back on and reconnect the electrical connection.

Specific for 2959 c.c.

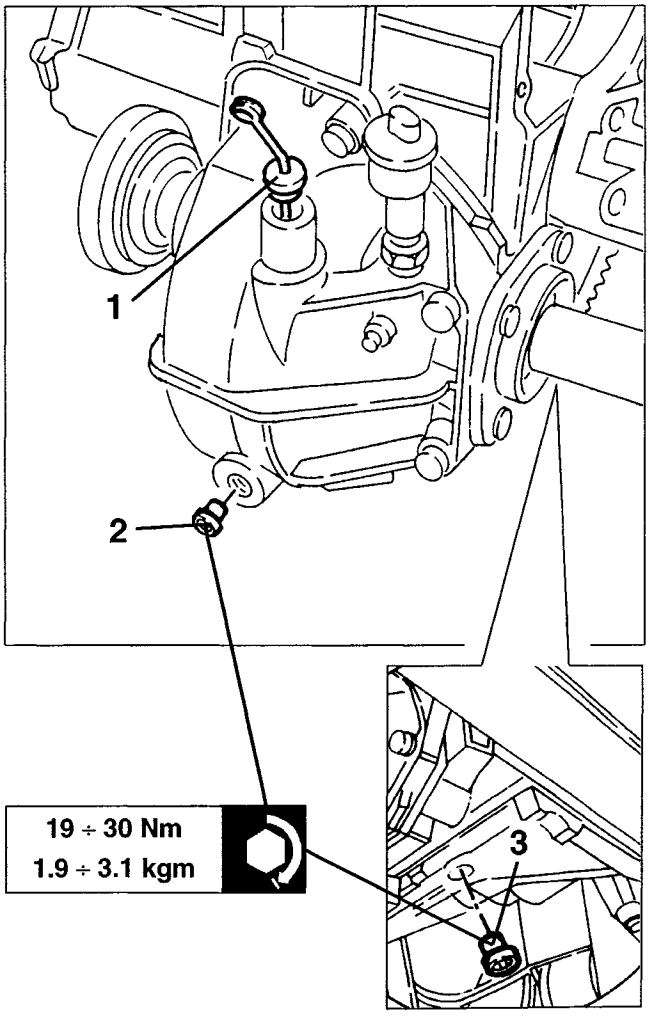
Checking the oil level

1. With the engine cold remove the gearbox/differential oil dipstick. Clean the dipstick with a lintfree cloth and insert it completely in its housing.
- Remove the dipstick again and check that the oil level coincides with the reference on the dipstick.
- If necessary fill with oil of the specified type to the correct level.
- Insert the dipstick completely in its housing.



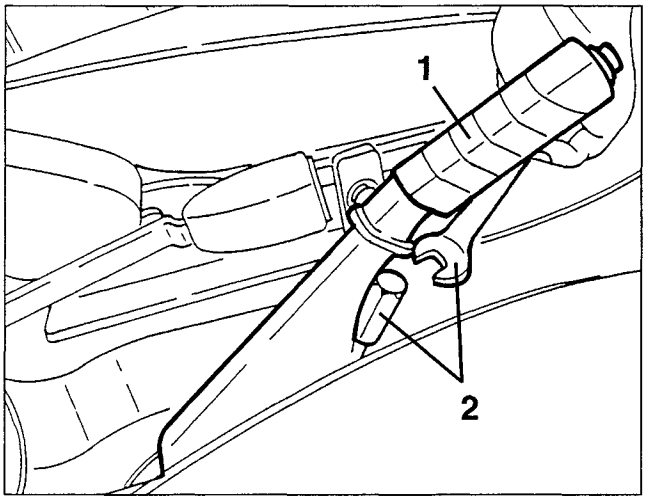
Changing the oil

- Set the car on a lift.
1. Remove the oil dipstick.
2. Raise the car and slacken the differential drain cap.
3. Remove the gearbox drain cap and allow the oil to drain off completely.
- Clean the caps and refit them.
- Fill with oil of the type and quantity specified, through the dipstick hole.
- Check that the correct level has been reached (see previous paragraph) and refit the dipstick.



CHECKING THE HANDBRAKE STROKE

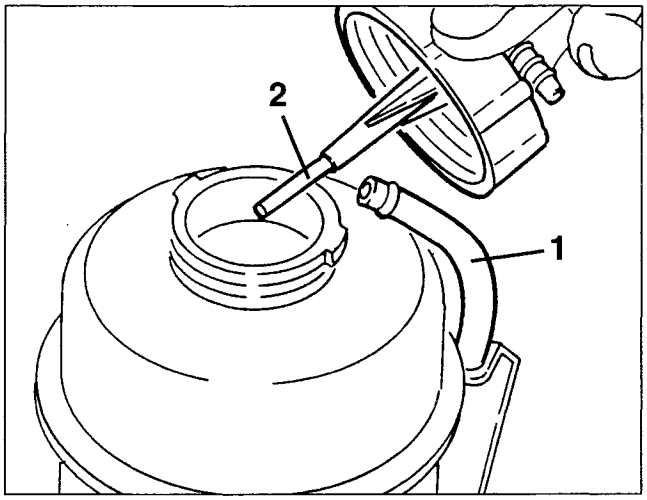
1. Move the control lever to the third - fourth click on the toothed sector, with the lever in this position check that the wheels are locked.
2. If not, tighten the adjustment screw until the wheels are locked.



- Exerting a force of appr. 30 kg on the control lever check that there are 3 clicks on the toothed sector.
- Check the wheels are free when the lever is in the rest position.

CHECKING THE POWER STEERING OIL LEVEL

- With the engine stationary, clean the power steering tank cover and the areas surrounding it.
1. Disconnect the breather pipe from the cover on the tank.
2. Remove the cover checking that the level reaches the upper notch on the dipstick.



- If necessary top up with the specified oil proceeding as follows:
• Start the engine and wait for the level of the oil in the tank to stabilize.
• With the engine running, turn the steering wheel completely to the right and left a few times.
• Top up to the "MAX" level then refit the cover and insert the breather pipe.

ENGINE 10

INDEX

(*): See 2959 V6 for Spider models and 1996 TB for GTV models

(□): See 1996 TB

ENGINE 10

INDEX

1747 T. SPARK 16V 1970 T. SPARK 16V ENGINES

'98 MODELS

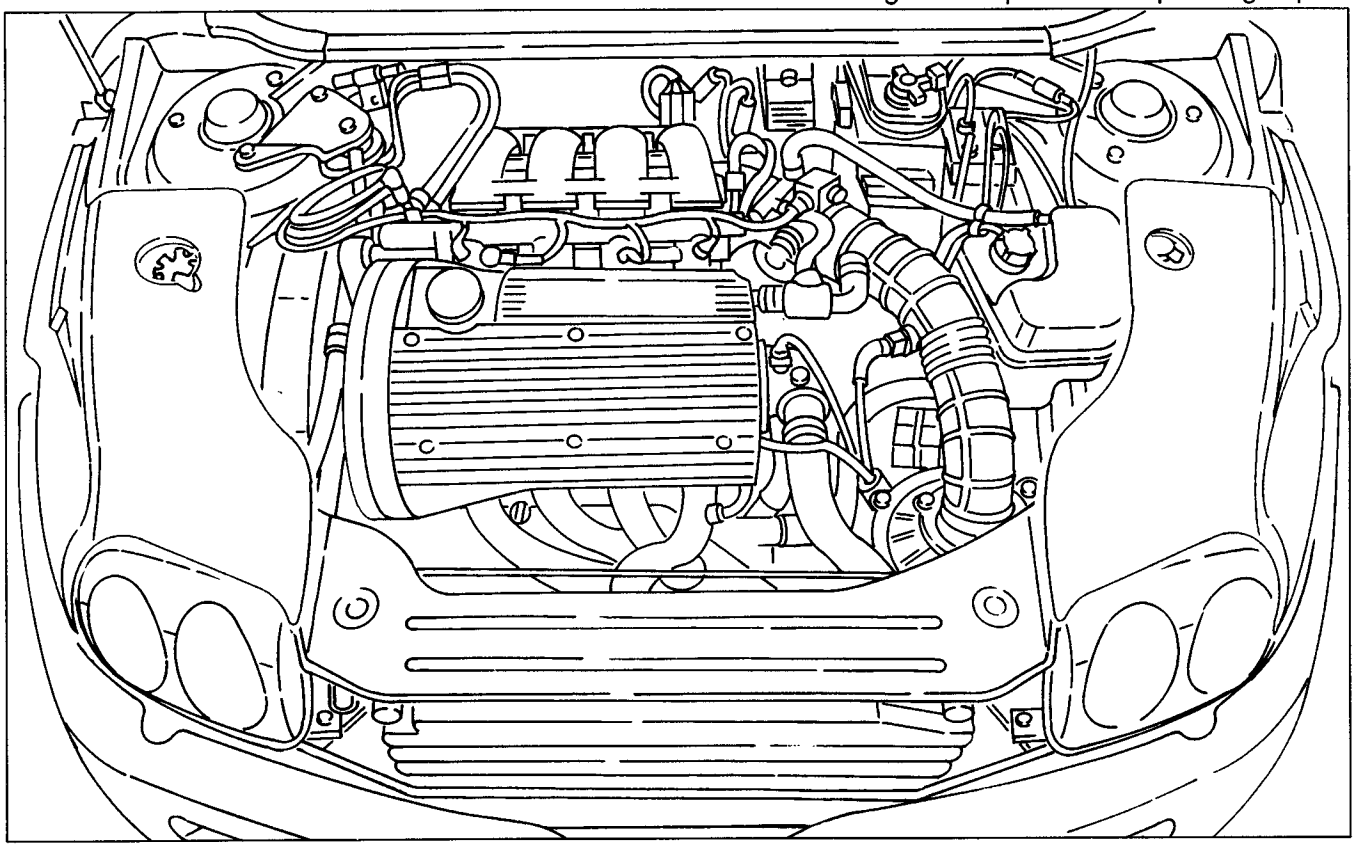
(O): See 1970 T. SPARK 16V

(□): See 1996 TB

DESCRIPTION

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

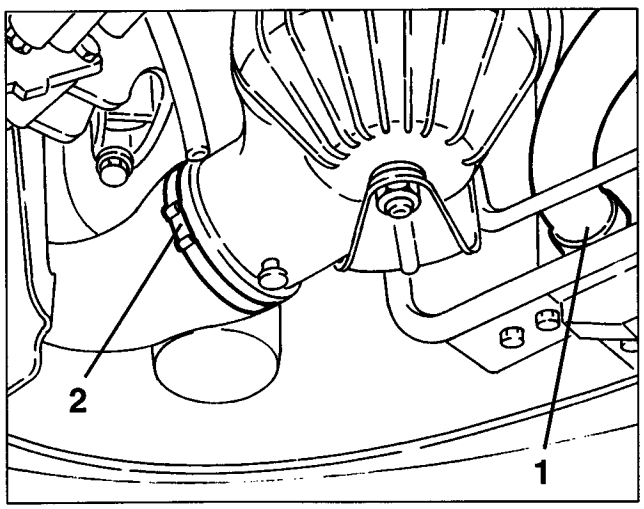
Dis-assembly of the single components on the bench is described in the volume "ENGINE OVERHAULING".
The following procedure may be used only in part according to requirements.
For further information and details, refer to the chapters concerning the components or specific groups.

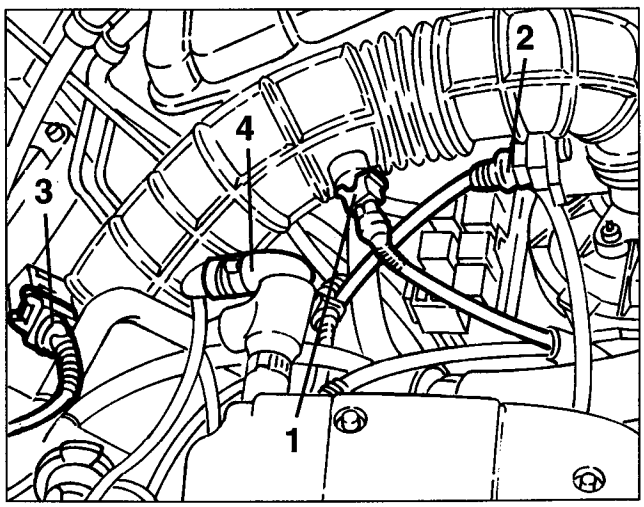


REMOVAL

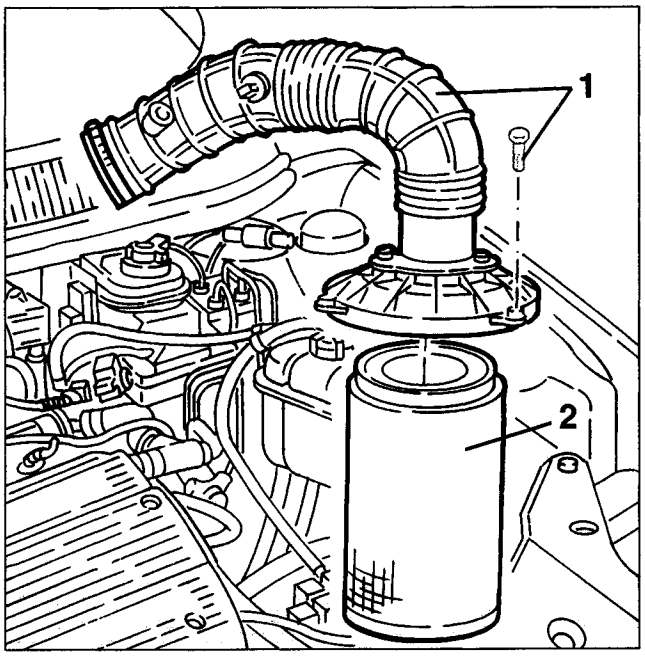
- Set the car on a two-column lift.
- Disconnect the battery (-) terminal.
- Remove the front wheels and mud flaps.

1. Raise the car and drain the coolant fluid disconnecting the radiator outlet sleeve.
2. Slacken the clamp fastening the air intake sleeve to the air cleaner box.
1. Lower the car and disconnect the electrical connection from the intaken air temperature sensor.
2. Disconnect the electrical connection from the air-flow meter.
3. Disconnect the electrical connection from the constant idle speed actuator.
4. Disconnect the oil vapour recirculation pipe from the corrugated sleeve.

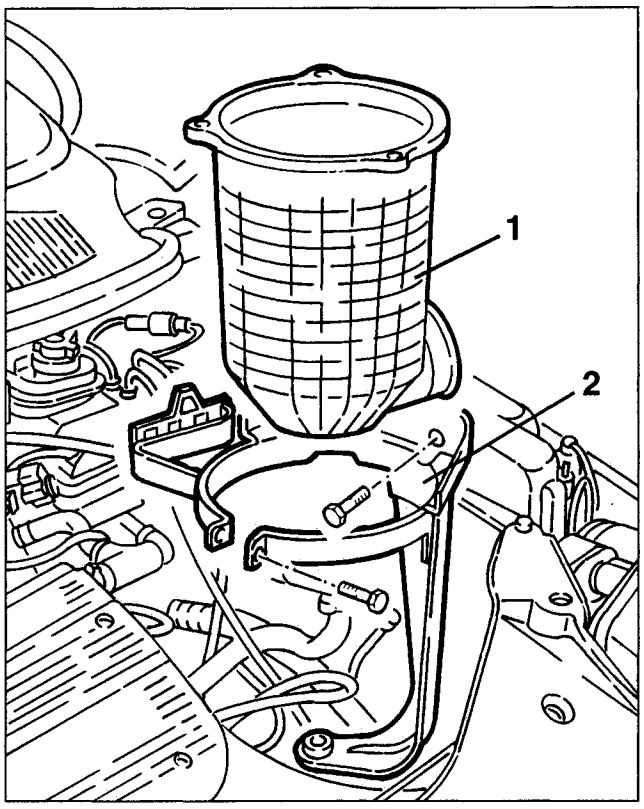




1. Slacken the clamp, back off the fastening screws and remove the air cleaner cover complete with air-flow meter and corrugated sleeve.
2. Remove the filtering element.

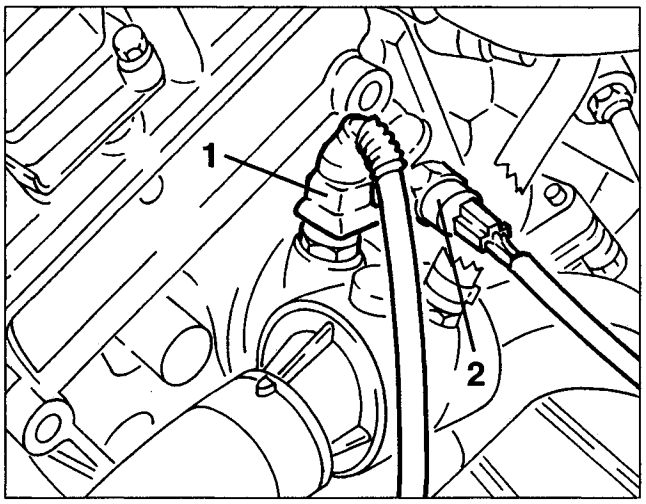


1. Slacken the fastening clamp and remove the air cleaner box.
2. Slacken the screws fastening the air cleaner support bracket, then remove it.

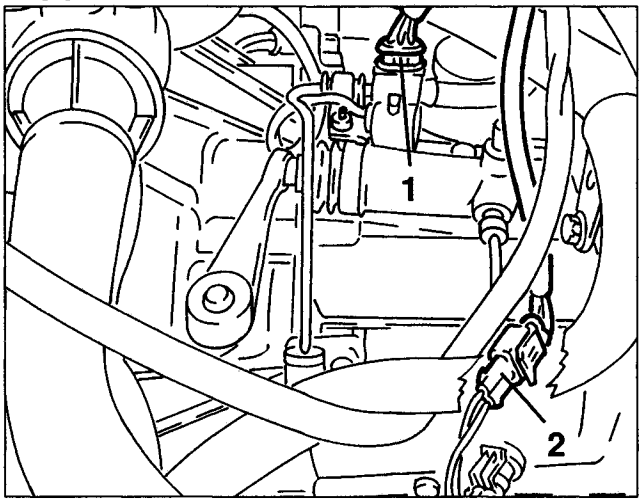


1. Disconnect the electrical connection from the coolant temperature sensor (NTC).

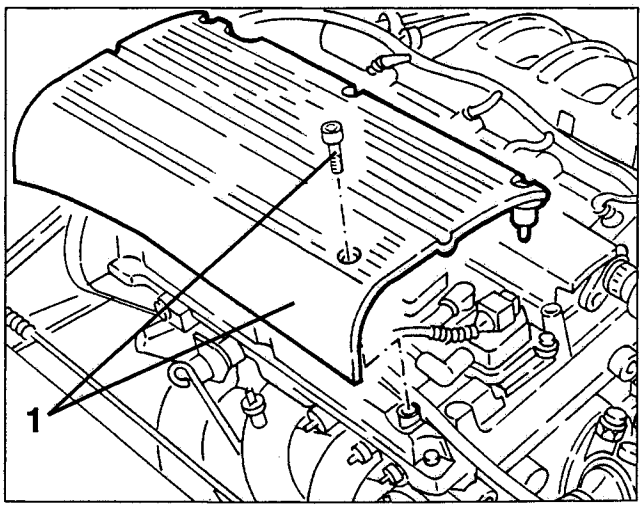
2. Disconnect the electrical connection from the coolant temperature gauge transmitter and max. temperature warning light contact, then move aside the wiring.



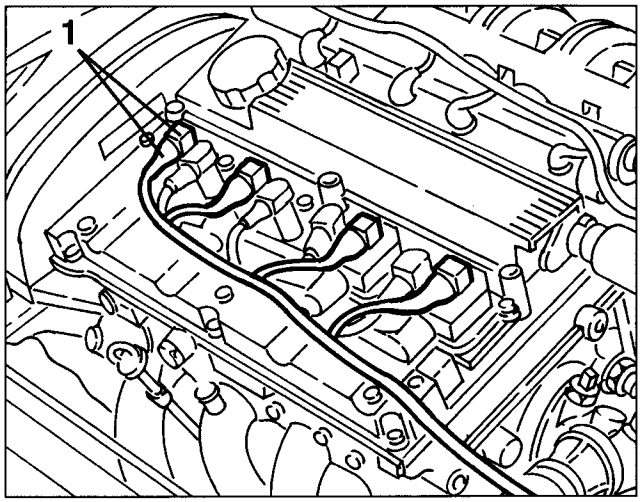
1. Disconnect the electrical connection from the speedometer sensor.
2. Disconnect the electrical connection from the reversing gear sensor.



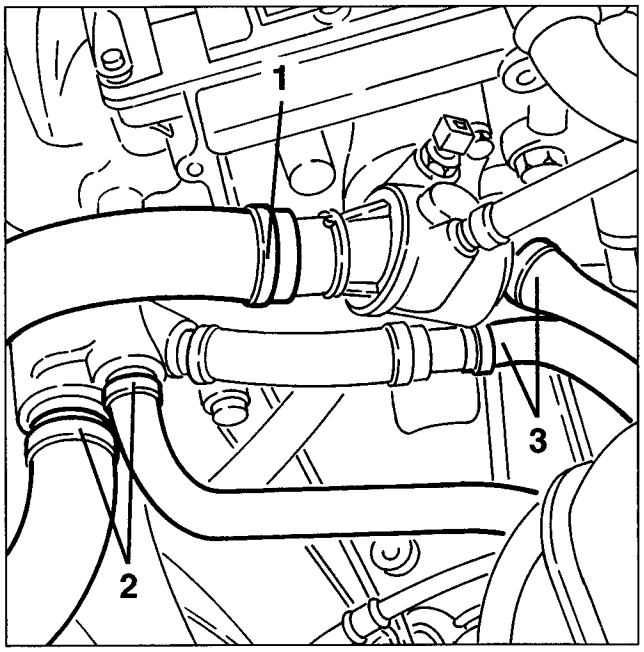
1. Slacken the fastening screws and remove the ignition coils cover.



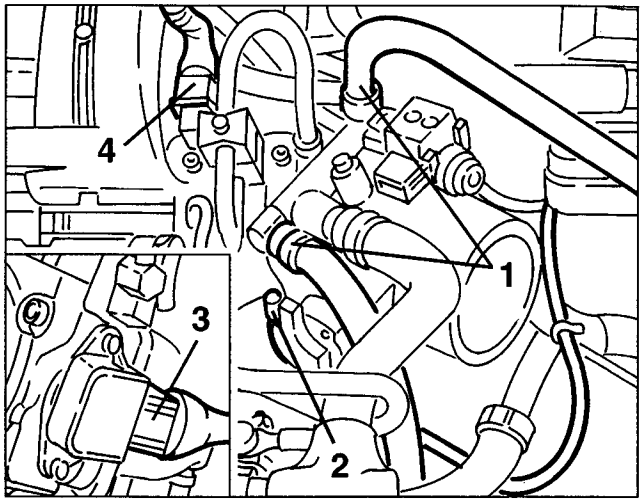
1. Disconnect the electrical connections from the ignition coils and move the wiring to one side.



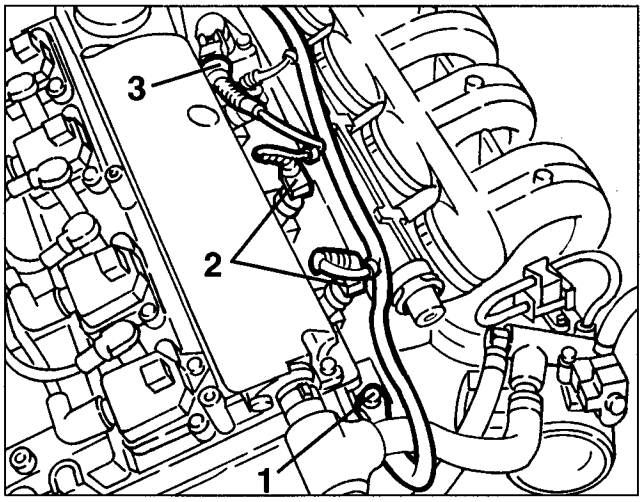
1. From the thermostatic cup disconnect the coolant delivery sleeve to the radiator.
2. From the coolant return manifold to the pump disconnect the return sleeve from the radiator and the system supply pipe leading from the header tank.
3. Disconnect the two coolant delivery and return pipes to the heater from the climate control system.



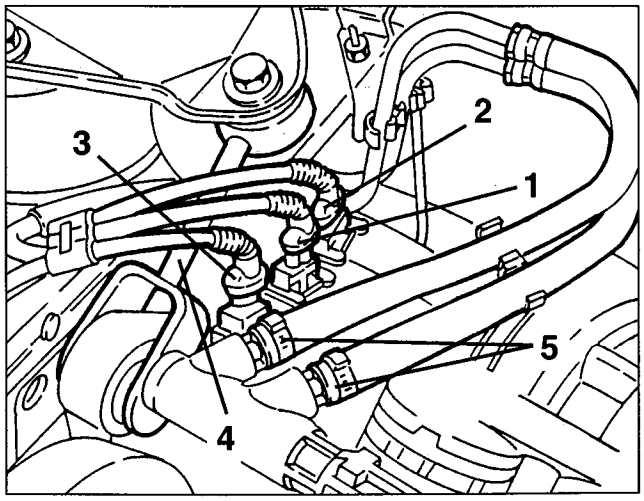
1. Disconnect the two coolant inlet and outlet pipes from the throttle body.
2. Disconnect the accelerator cable from the throttle body.
- Disconnect the servobrake vacuum takeoff pipe.
3. Disconnect the electrical connection from the throttle potentiometer.
4. Disconnect the electrical connection from the E.G.R. modulation solenoid valve.



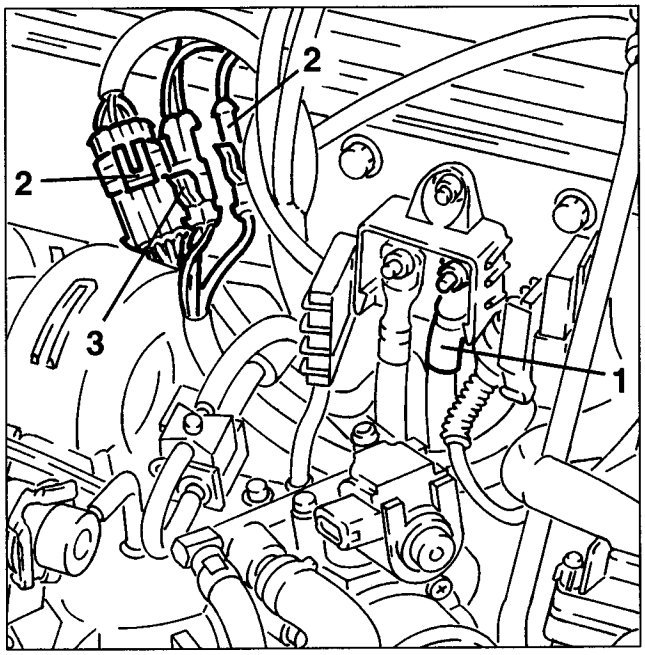
1. Disconnect the earth cable from the cylinder head.
2. Disconnect the electrical connections from the injectors.
3. Disconnect the electrical connection from the timing variator and move the wiring to one side.



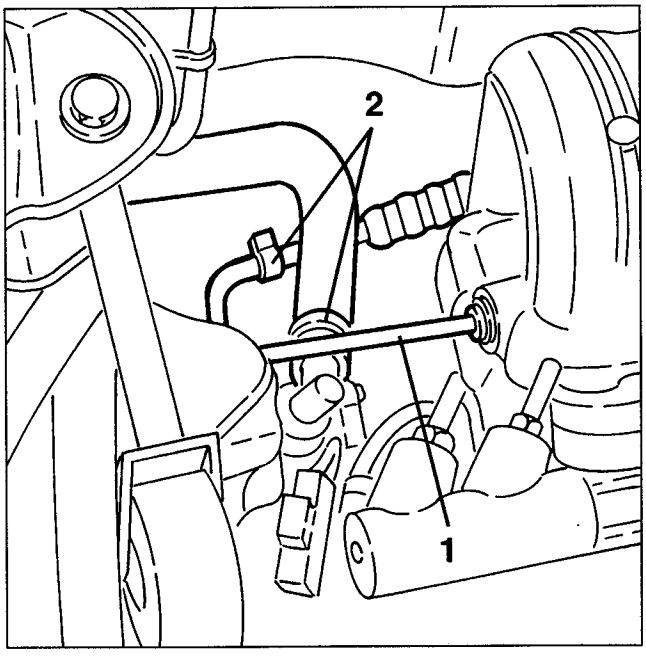
1. Disconnect the rpm and timing sensor connection.
2. Disconnect the timing sensor connection.
3. Disconnect the pinging sensor connection.
4. Disconnect the stay rod from the support on the engine.
5. Disconnect the fuel inlet and outlet pipes from the distributor manifold.



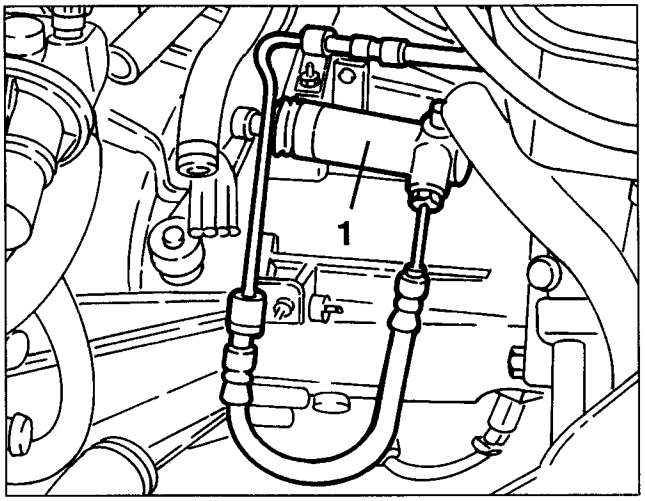
1. Open the control box and disconnect the electrical connection of the starter motor.
2. Disconnect the electrical connections of the lambda sensor.
3. Disconnect the electrical connection of the minimum engine oil pressure warning light sensor.



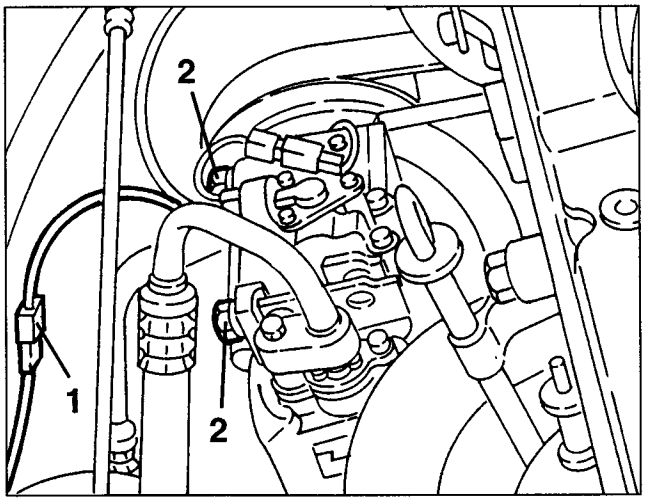
1. From the intake box disconnect the fuel vapour recirculation pipe.
- Empty the power steering tank using a suitable syringe.
2. Disconnect the oil inlet and delivery pipes from the power steering pump.



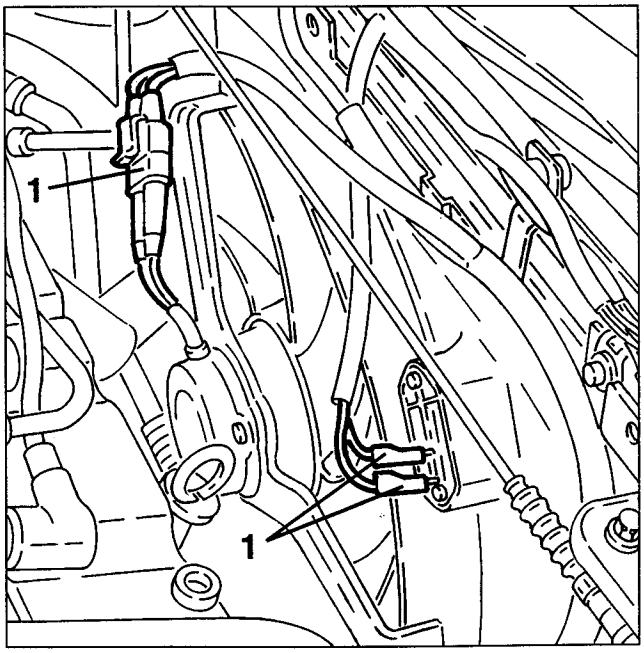
1. Slacken the two screws and the nut, then move the clutch control cylinder to one side disconnecting the associated piping.



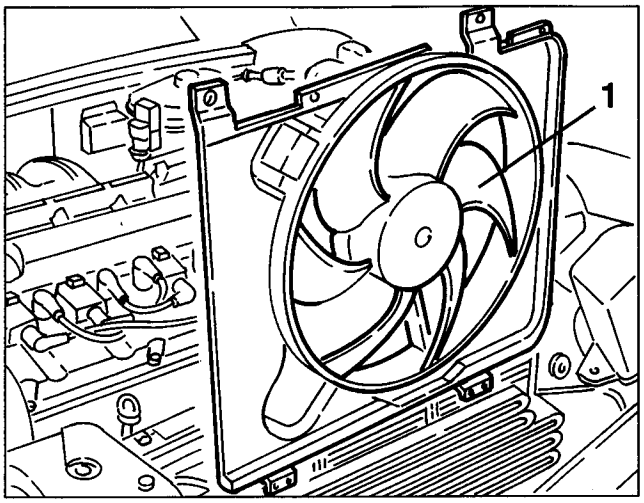
1. Disconnect the intermediate electrical connection of the air conditioner compressor.
2. Slacken the two upper screws fastening the conditioner compressor.



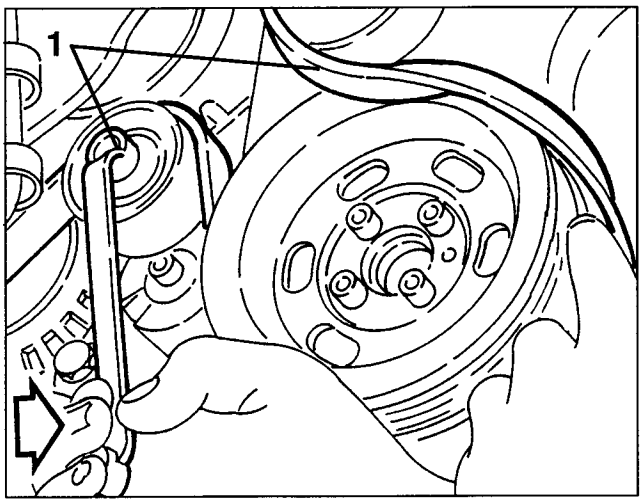
- Slacken the fastening screws and remove the upper radiator crossmember.
1. Disconnect the electrical connections from the cooling fan.



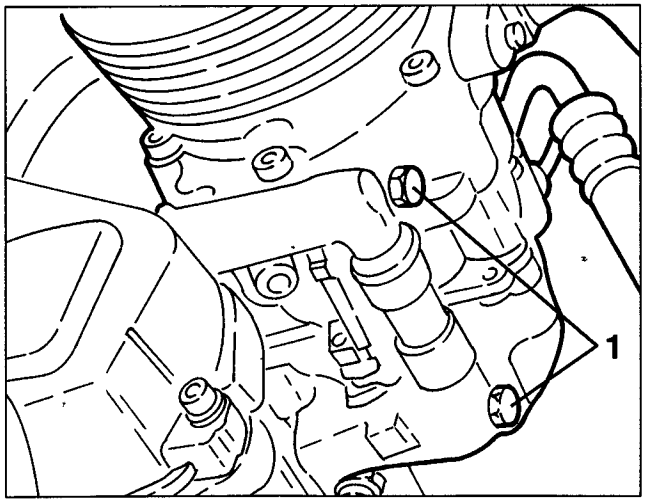
1. Slacken the fastening screws and remove the cooling fan.



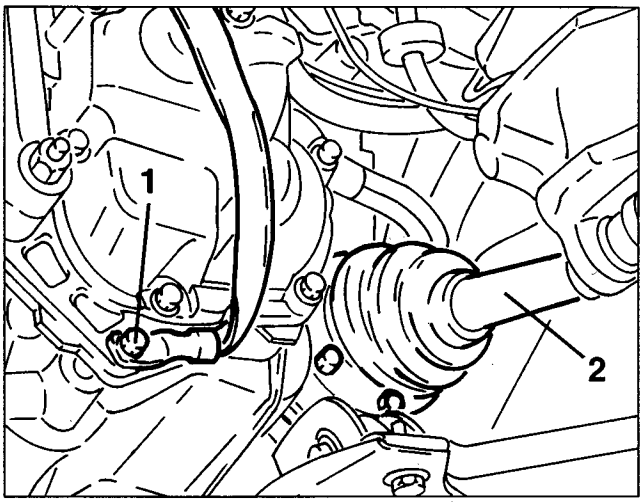
1. Raise the car and working as illustrated on the guide pulley, slacken the tension of the auxiliary components drive belt and remove it.



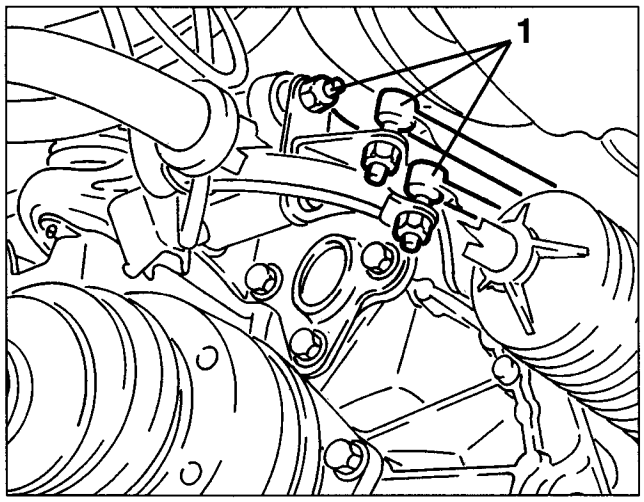
1. Slacken the two lower screws fastening the conditioner compressor, then, without disconnecting the piping, fasten it to one side so that it does not hinder the following operations.



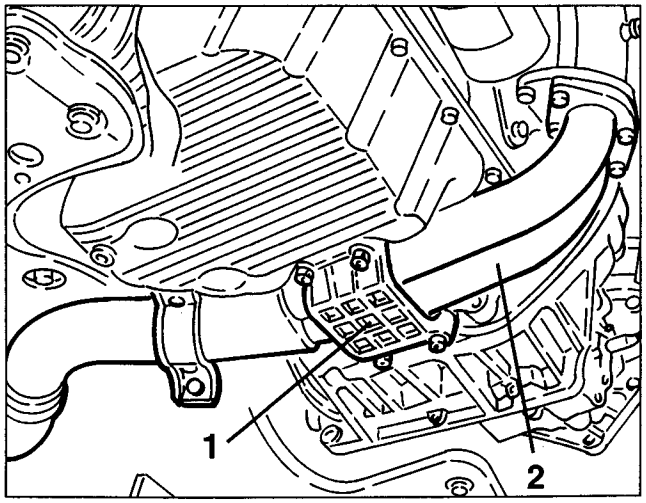
1. Disconnect the earth braid from the gearbox.
2. Slacken the fastening bolts and disconnect the axle shafts.



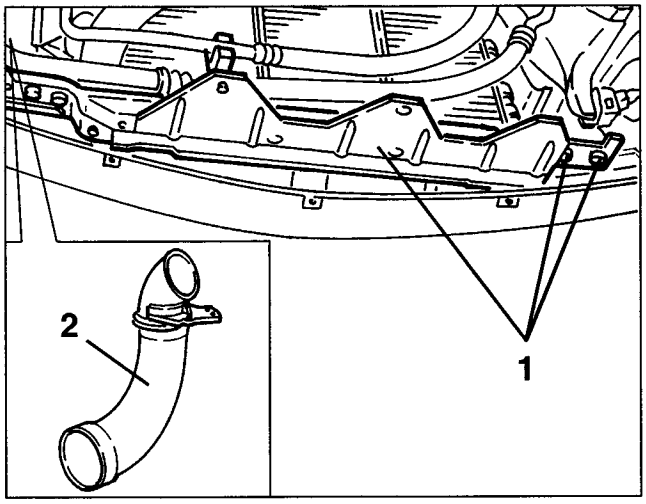
1. Slacken the fastening nuts and disconnect the gearshift control rods.



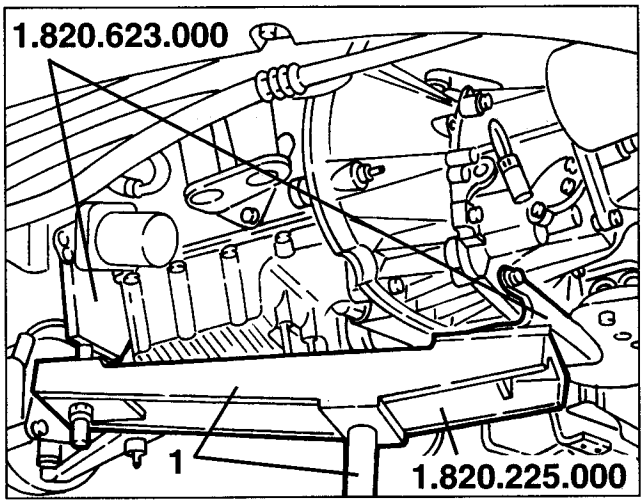
1. Remove the reinforcement brackets.
2. Remove the front section of the exhaust pipe complete with lambda probe after slacken the associated clamps.



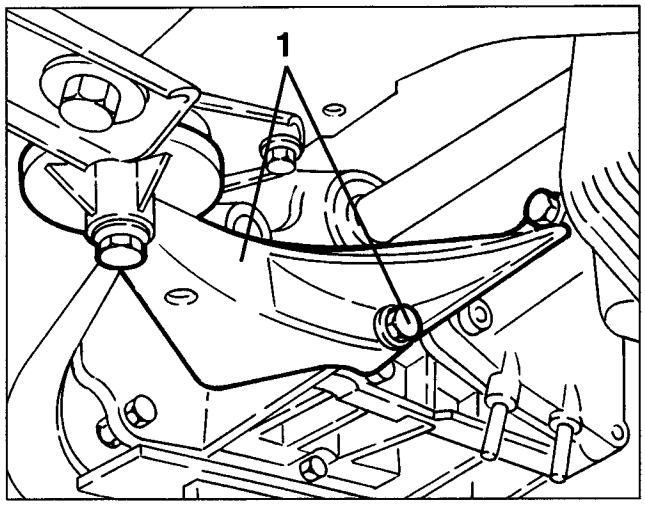
1. Slacken the fastening screws and remove the lower radiator crossmember after freeing the pipes from the fastening clamps on the crossmember itself.
2. Slacken the fastening clamps and remove the air intake elbow.



1. Position a hydraulic jack complete with tool no. 1.820.225.000 and no. 1.820.623.000.

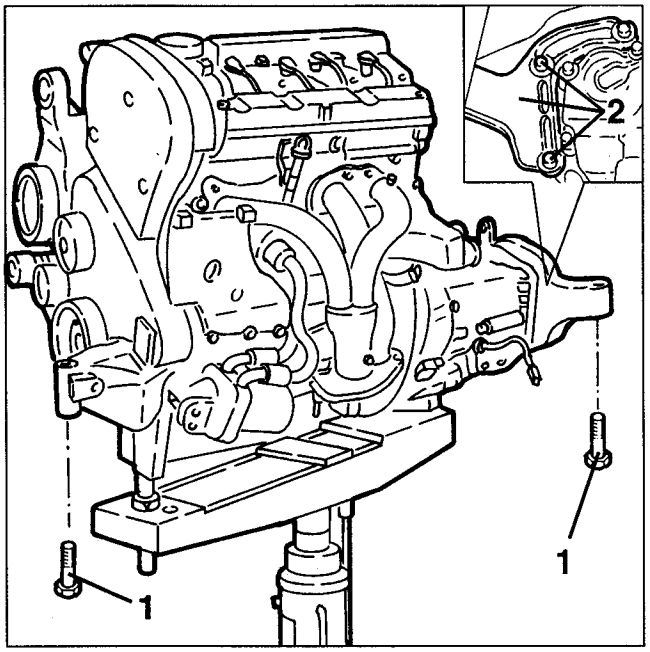


1. Slacken the fastening screws and remove the rear power unit support.



1. Slacken the screws fastening the power unit supports to the body on the gearbox side and camshaft side.
2. Slightly lower the power unit, then slacken the fastening screws and remove the gearbox side support.
3. Lower the hydraulic jack and remove the power unit from the engine compartment.

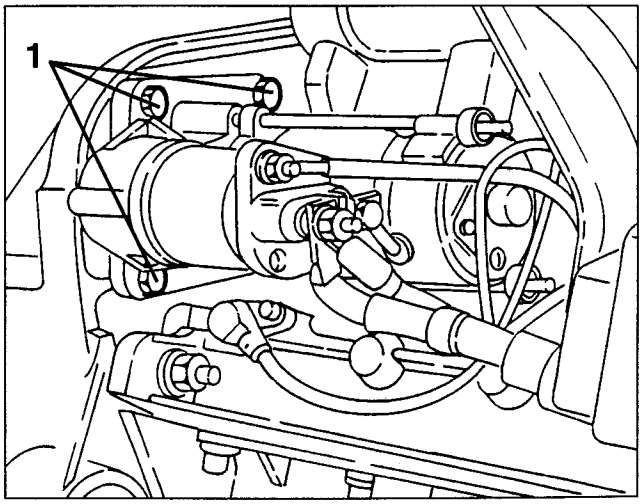
WARNING:
The hydraulic jack must have a capacity of at least 1000 kg.



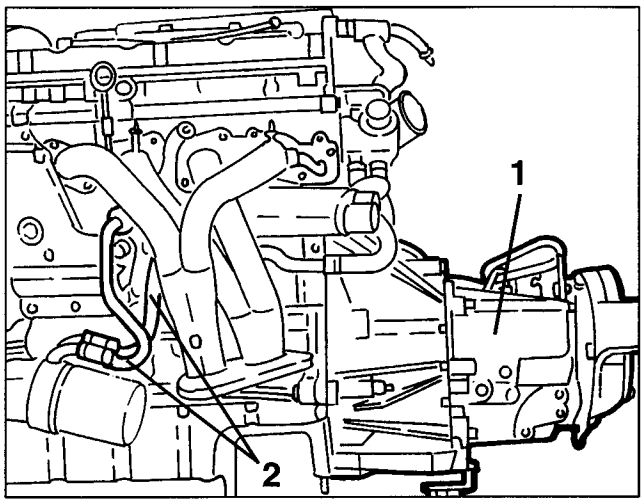
- Support the power unit with a hydraulic hoist as well as with the hydraulic jack used for removal.

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

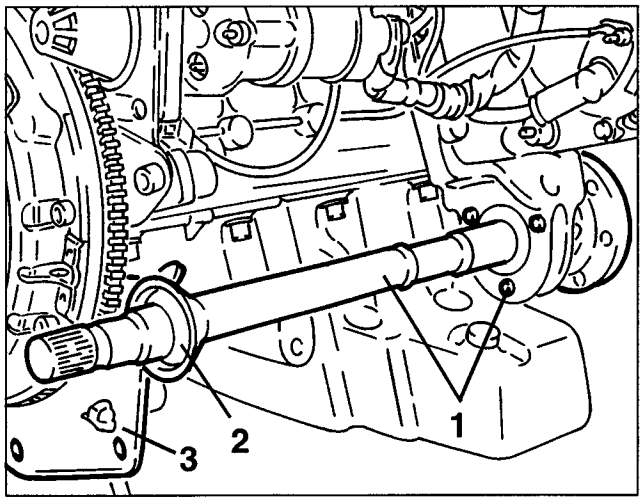
- Release the power unit from the support tools, then set it on a special work bench.
1. Slacken the starter motor fastening screws.



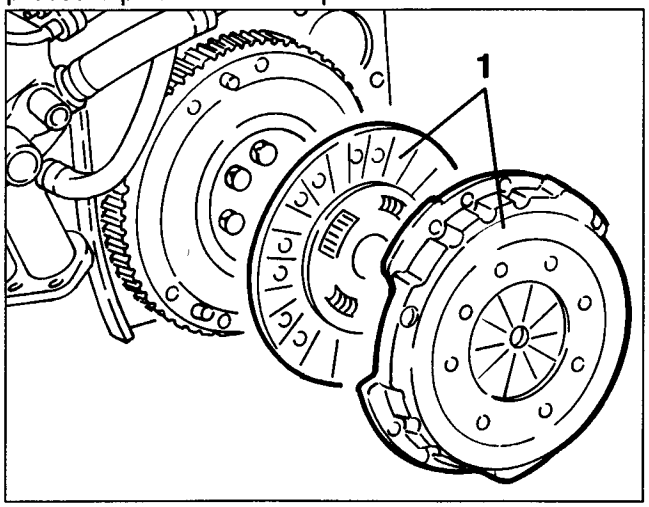
1. Slacken the fastening screws and nuts and remove the gearbox and differential unit.
2. Remove the heat exchanger coolant return and delivery pipes.



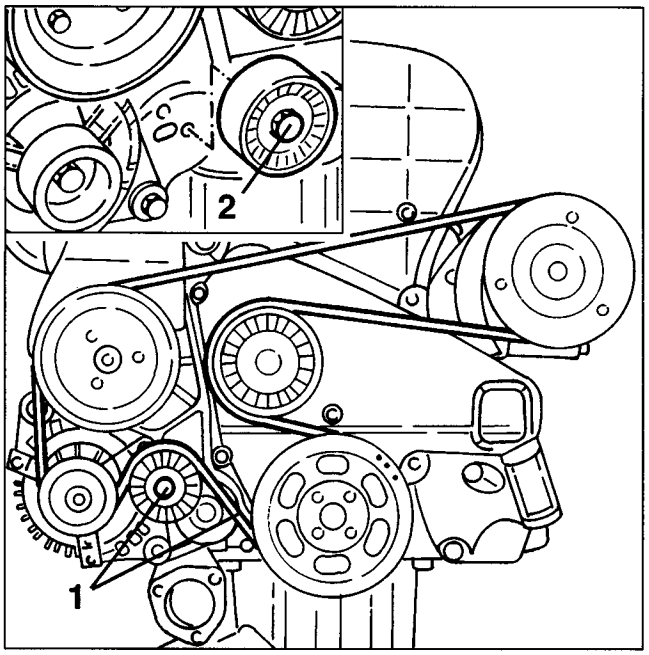
1. Slacken the three fastening screws and remove the intermediate shaft.
2. Remove the dust guard ring.
3. Retrieve the lower flywheel cover.



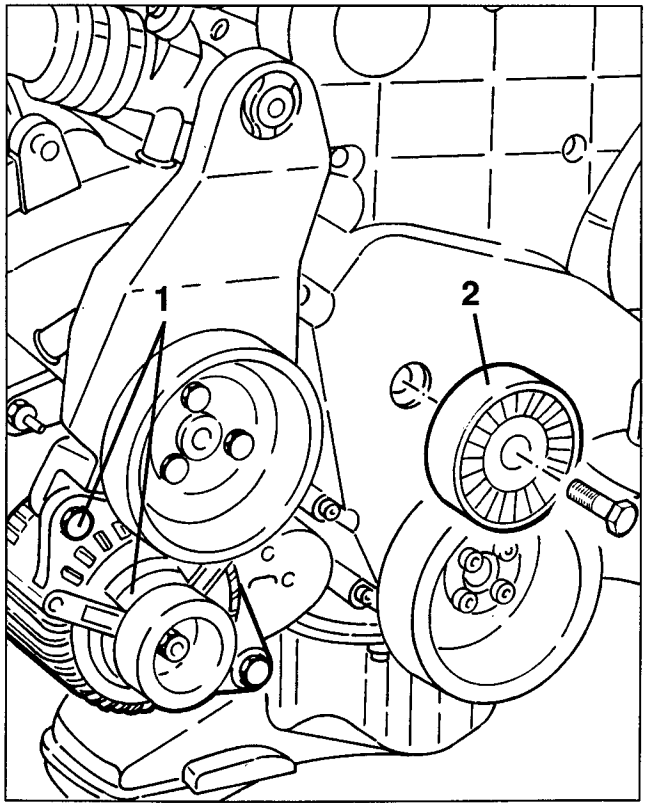
- Release the starter motor from the electric cables, then remove it.
1. Slacken the fastening screws and remove the pressure plate and clutch plate.



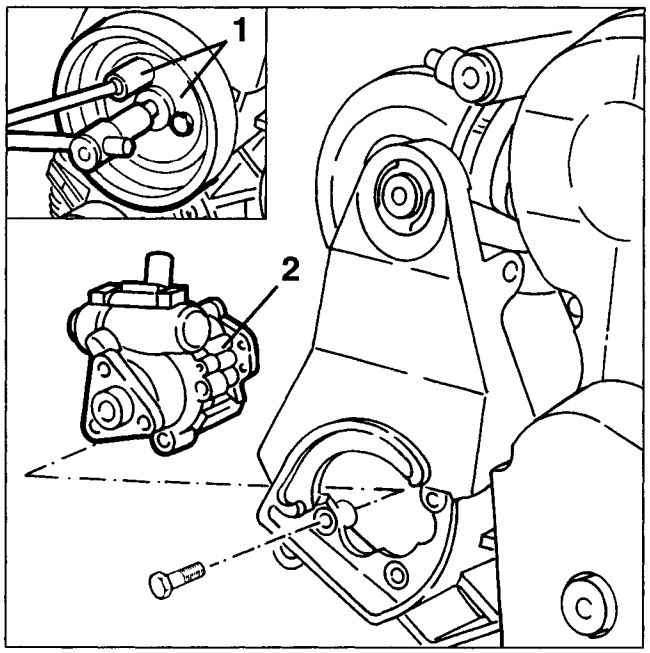
1. Slacken the screw fastening the belt tensioner to loosen the tension on the auxiliary components drive belt, then prise and remove the belt.
2. Back off the fastening screw completely and remove the belt tensioner.



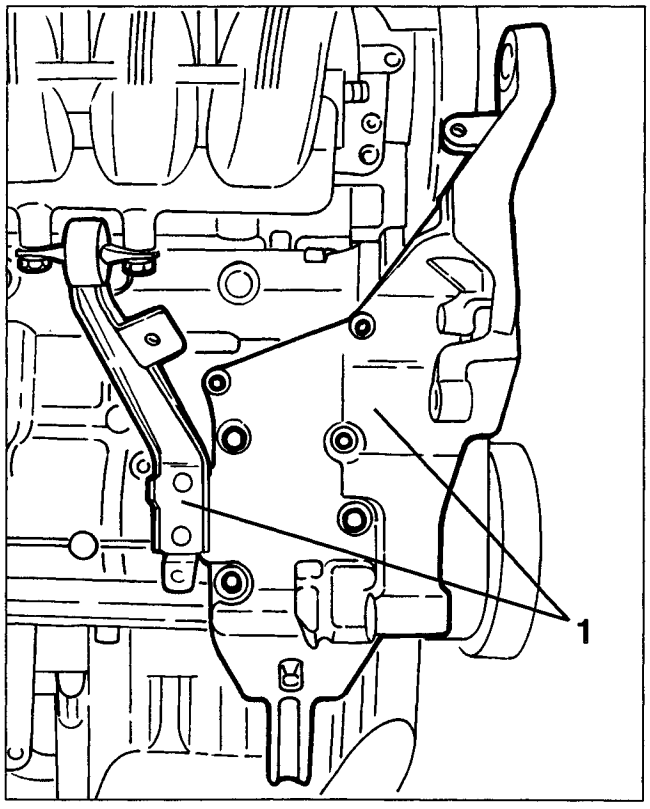
1. Slacken the two fastening bolts and remove the alternator.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.



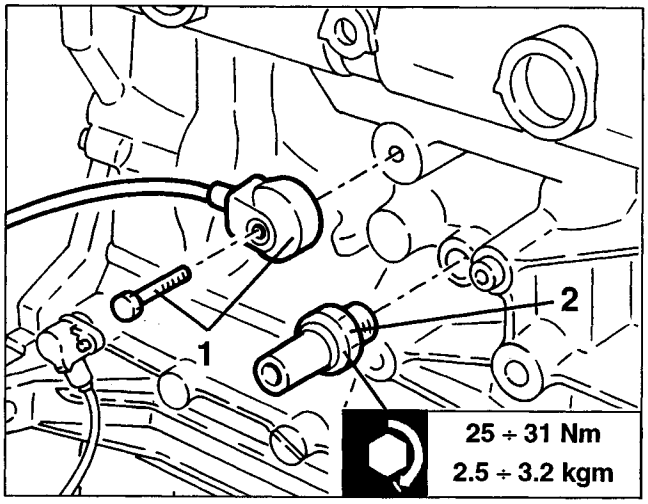
1. Using a 3/8" Allen wrench as counter-torque, slacken the three fastening screws and remove the power steering pump pulley.
2. Slacken the three fastening screws and remove the power steering pump.



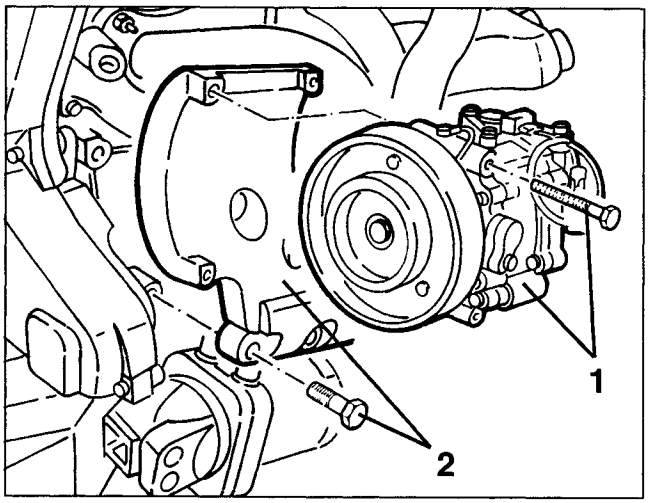
1. Slacken the fastening screws and remove the power steering pump support and alternator complete of air intake box.



1. Slacken the fastening screws and remove the pinging sensor from the crankcase.
2. Slacken and remove the minimum oil pressure sensor from the crankcase.



1. Slacken the four fastening screws and remove the conditioner compressor.
2. Slacken the five fastening screws and remove the conditioner compressor support.



REFITTING

Reverse the sequence followed for removing operations adhering to the following instructions:
- Prepare the engine compartment to receive the power unit assembly, positioning all the electrical cables, pipes, etc. so that they do not interfere with assembly operations.

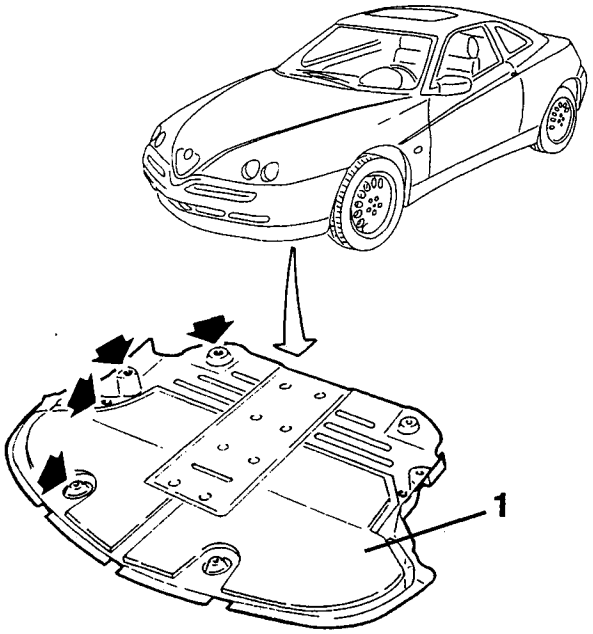
WARNING:
Make sure that the support points of the power unit have been fastened correctly.

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

GUARD UNDER ENGINE

REMOVING/REFITTING

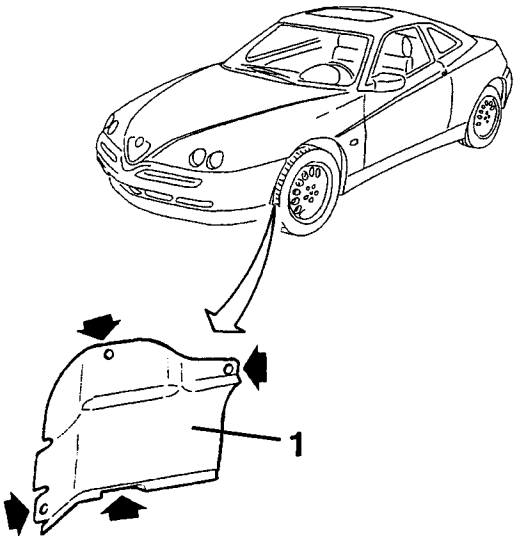
- Set the car on a lift and raise it.
1. Remove the plastic buttons, slacken the fastening screws and remove the guard under the engine.



WHEELHOUSE GUARDS

REMOVING/REFITTING

- Set the car on a lift and raise it.
- Turn the left wheel just enough to gain access to the left guard.
1. Slacken the fastenings and remove the left wheelhouse guard.
- Carry out the same procedure for removing/refitting the right guard.



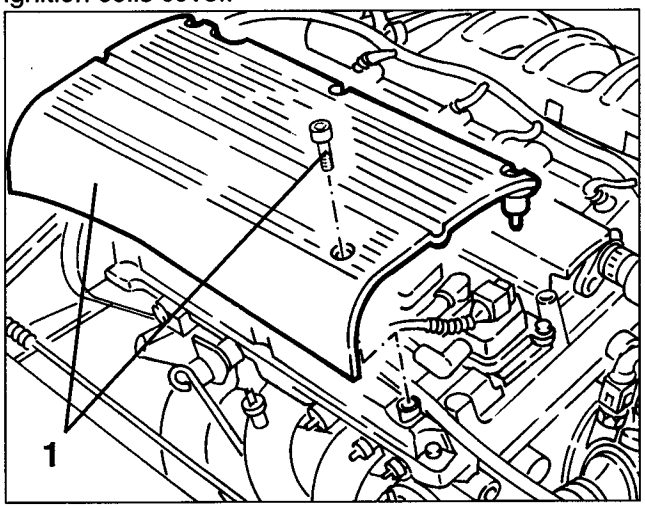
WHITE

CYLINDER HEAD

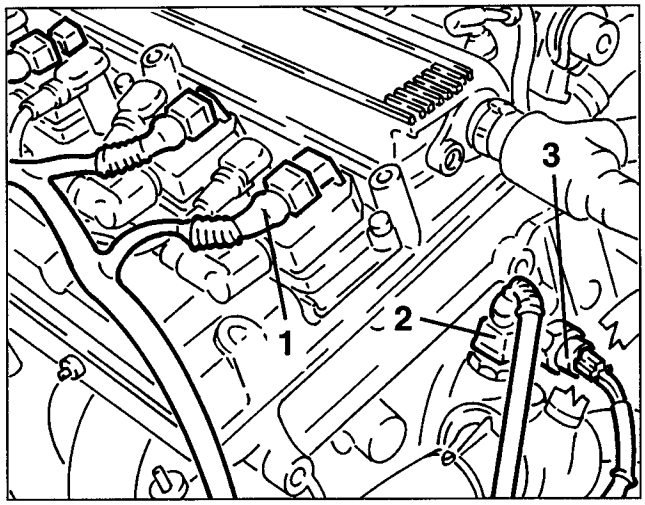
REMOVAL/REFITTING

- Proceed as described in the first steps of the procedure described in the paragraph "Engine - Removal/Refitting" up to removal of the air cleaner box.

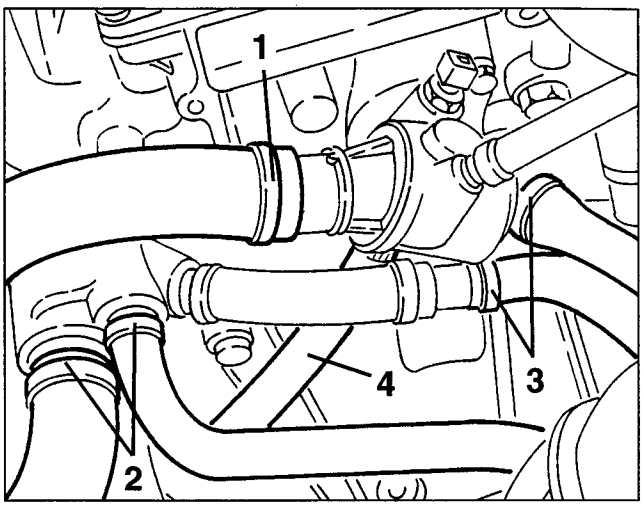
1. Slacken the fastening screws and remove the ignition coils cover.



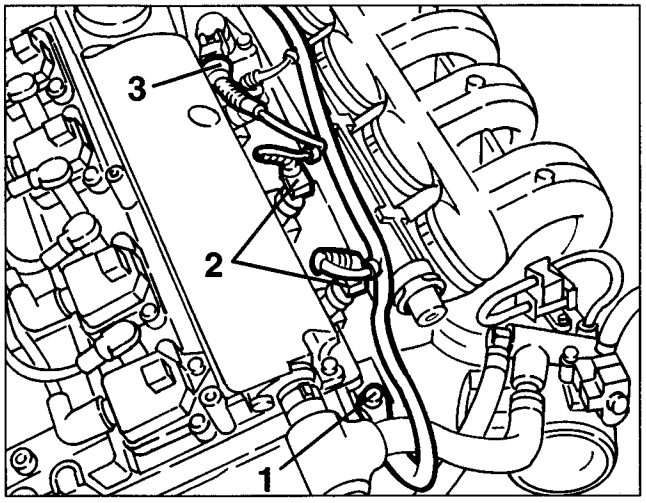
1. Disconnect the electrical connections from the ignition coils.
2. Disconnect the electrical connection from the coolant temperature sensor.
3. Disconnect the electrical connection from the engine coolant temperature gauge transmitter and maximum temperature warning light contact.



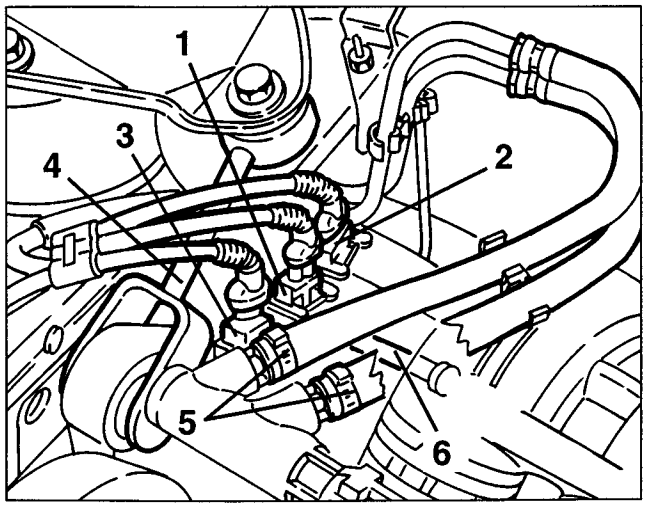
1. Disconnect the coolant delivery sleeve to the radiator from the thermostatic cup.
2. From the coolant return duct to the pump, disconnect the return sleeve from the radiator and the delivery pipe leading from the header tank.
3. Disconnect the two climate control heater coolant return and delivery pipes.
4. From the thermostatic cup disconnect the coolant delivery pipe to the heat exchanger for the engine lubrication circuit.



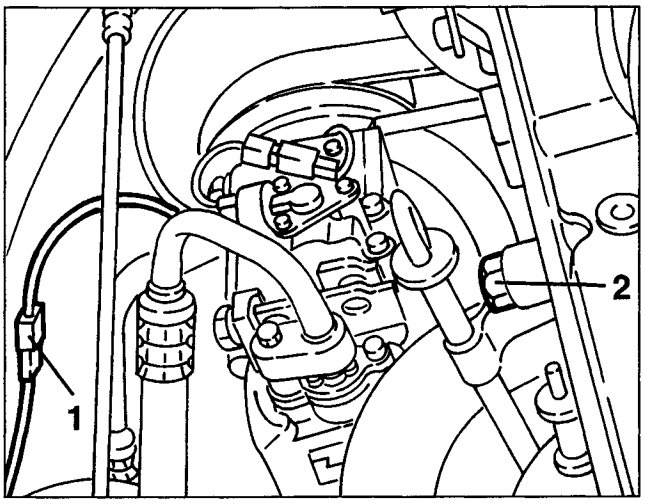
1. Disconnect the earth cable from the cylinder head.
2. Disconnect the electrical connections from the injectors.
3. Disconnect the electrical connection from the timing variator and move the associated wiring to one side.



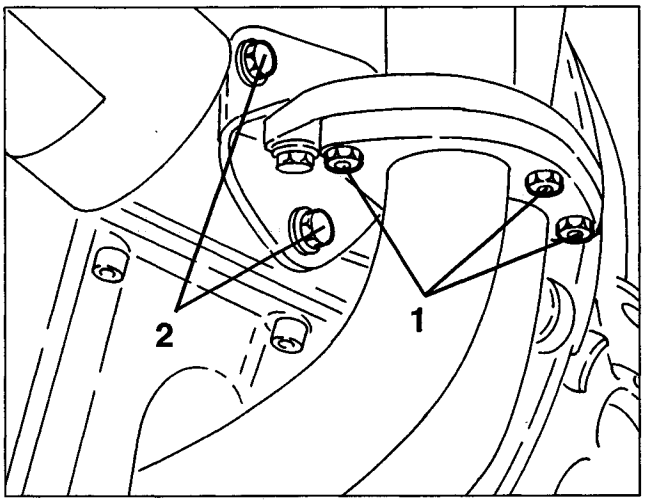
1. Disconnect the connection from the rpm and timing sensor.
2. Disconnect the connection from the timing sensor.
3. Disconnect the connection from the pinging sensor.
4. Remove the engine stay rod.
5. Disconnect the fuel inlet and outlet pipes from the distributor manifold.
6. Disconnect the fuel vapour recirculation pipe.



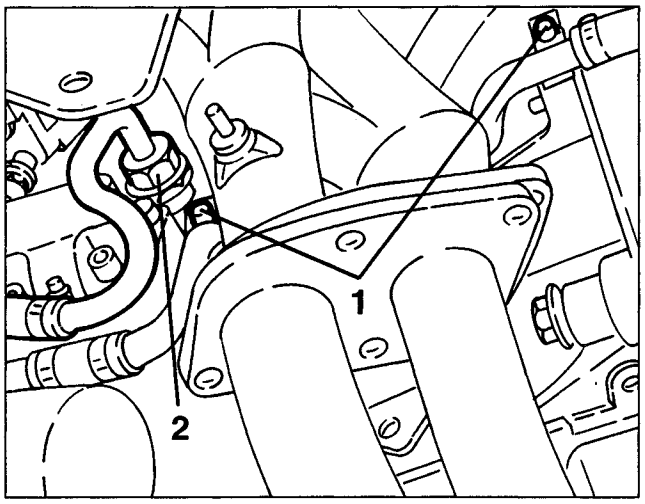
1. Disconnect the intermediate electrical connection from the air conditioning system compressor.
2. Slacken the engine oil dipstick fastening screw.



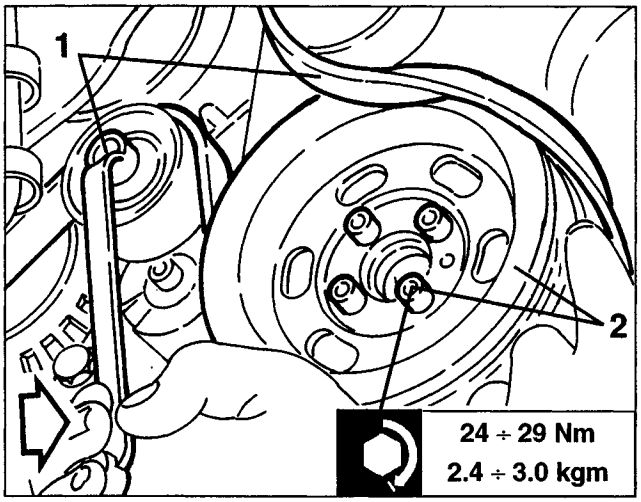
1. Raise the car and slacken the bolts fastening the front section of the exhaust pipe to the manifolds.
2. Slacken the screws fastening the exhaust manifold support bracket to the crankcase.



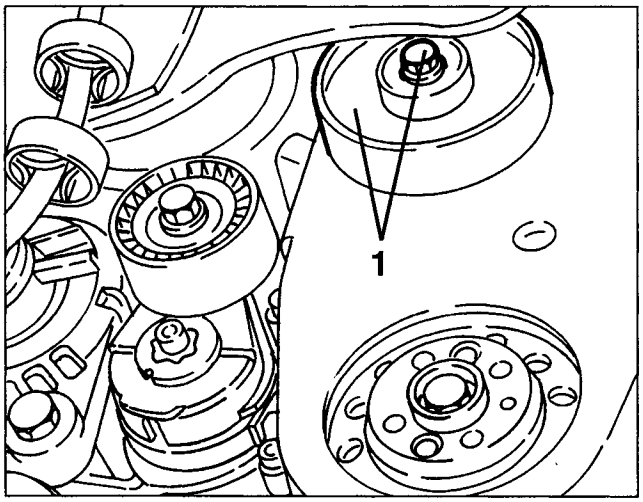
1. Slacken the two screws fastening the coolant delivery pipe to the heat exchanger.
2. Disconnect the coolant outlet pipe from the heat exchanger.



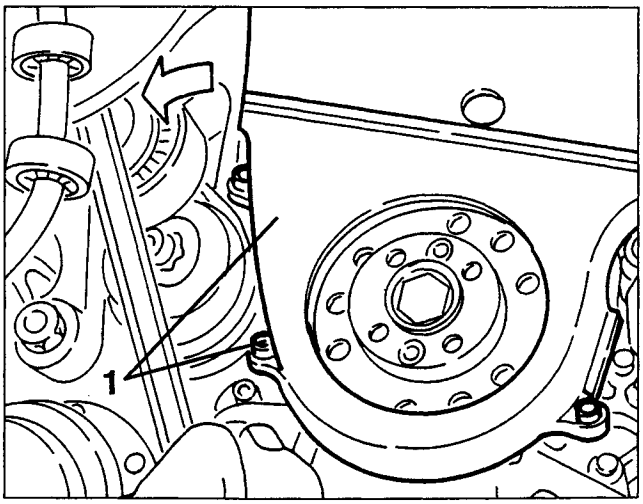
1. Working as illustrated on the guide pulley, loosen the tension of the auxiliary components drive belt and prise it off.
2. Slacken the four fastening screws and remove the auxiliary components drive pulley.



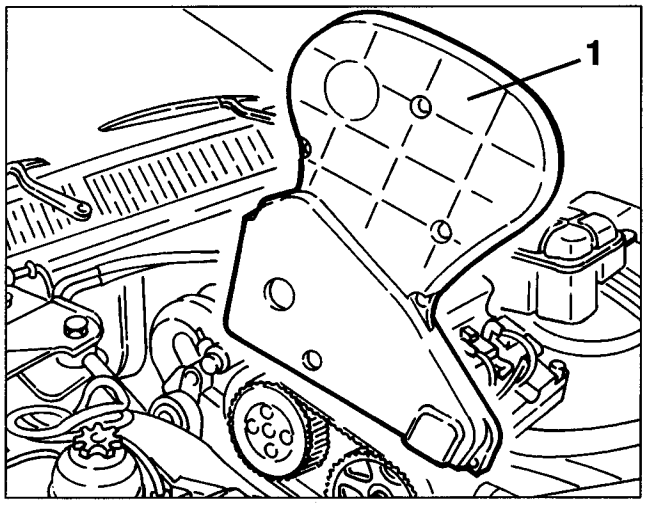
1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.



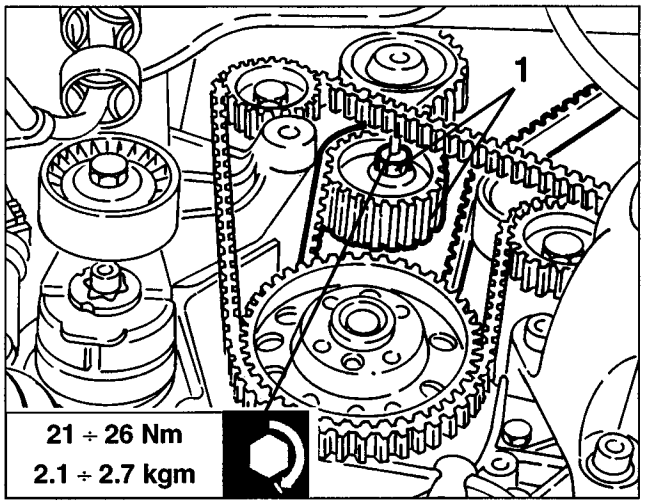
1. Slacken the fastening screws and remove the lower cover of the timing belts and counter-rotating shafts.
NOTE: To gain access to the rear screw, turn the belt tensioner as illustrated.



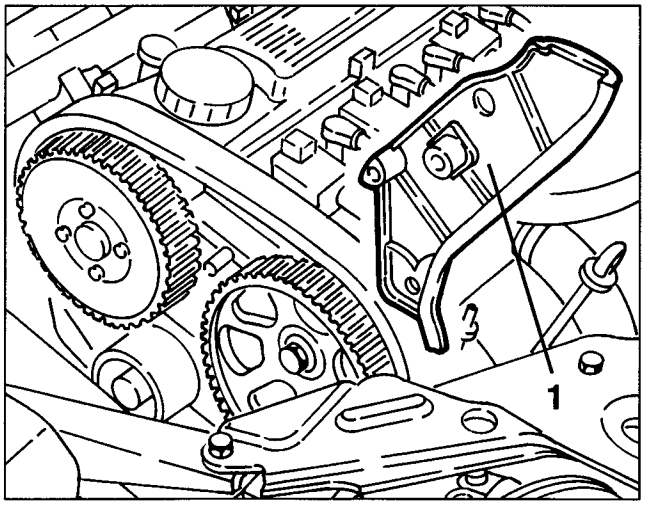
- Slacken the lower screws of the upper cover for the timing gear and counter-rotating shafts drive belts.
1. Lower the car, slacken the remaining fastening screws and remove the upper cover.



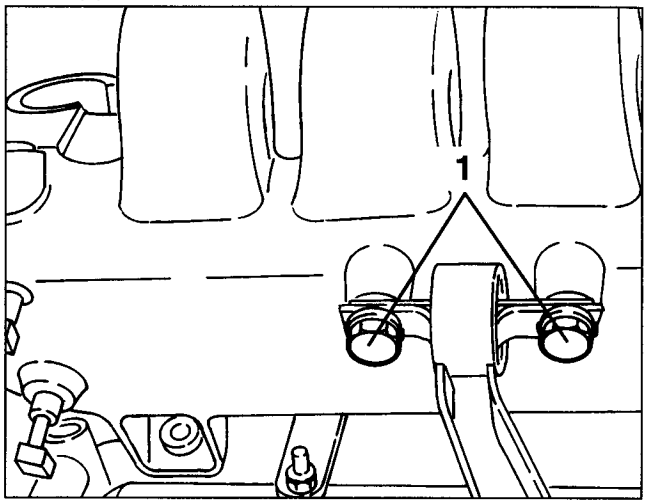
1. Working on the timing gear belt tensioner, loosen the tension of the belt, then prise it off the camshaft driving pulleys.



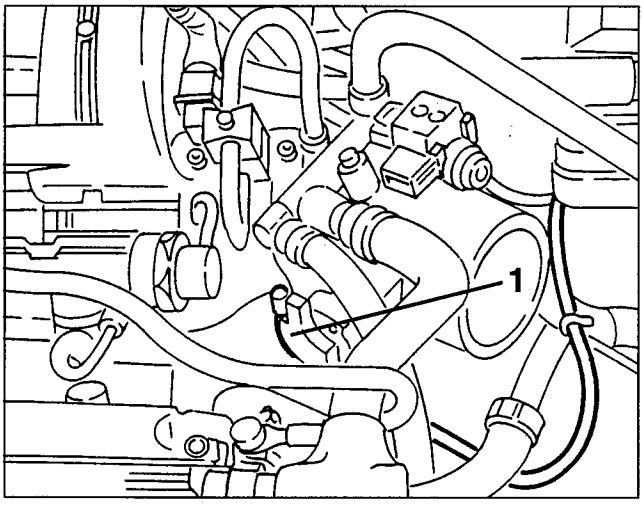
1. Slacken the fastening screws and remove the two timing gear belt side covers.



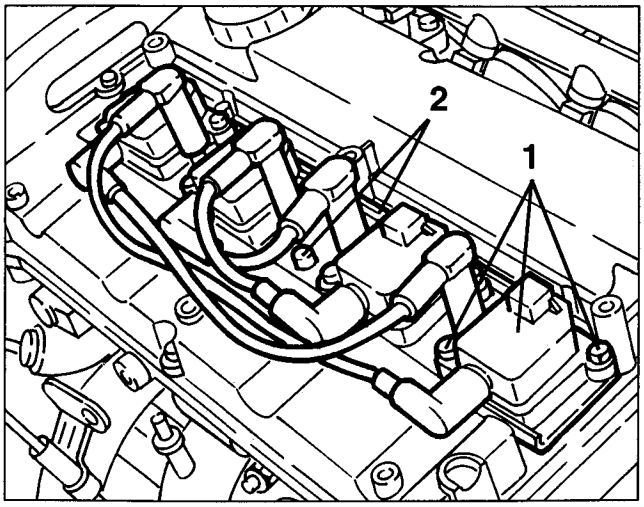
- Remove the bracket connecting the cylinder head to the engine stay rod support.
1. Raise the car and slacken the two screws fastening the support to the intake box.



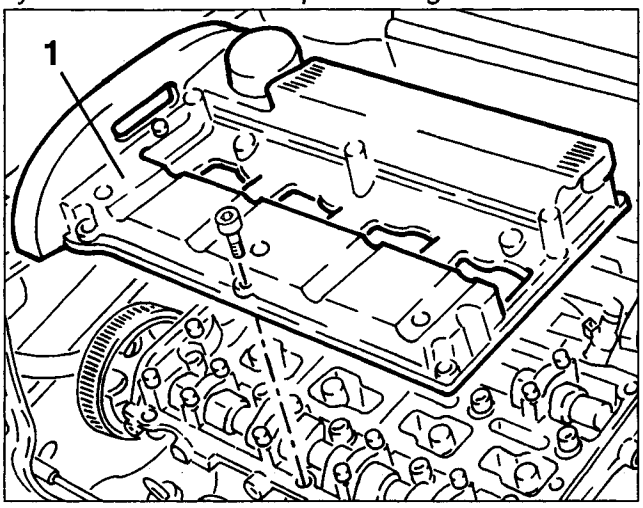
- Disconnect the vacuum takeoff pipe from the servo-brake.
1. Disconnect the accelerator cable from the throttle body.



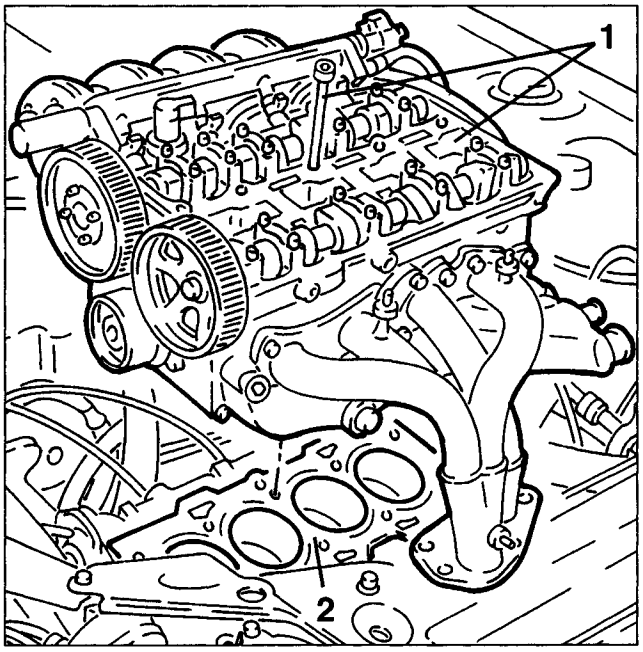
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



- Disconnect the oil vapour recovery pipe from the cylinder head.
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



1. Slacken the cylinder head fastening screws and remove it.
2. Remove the gasket.

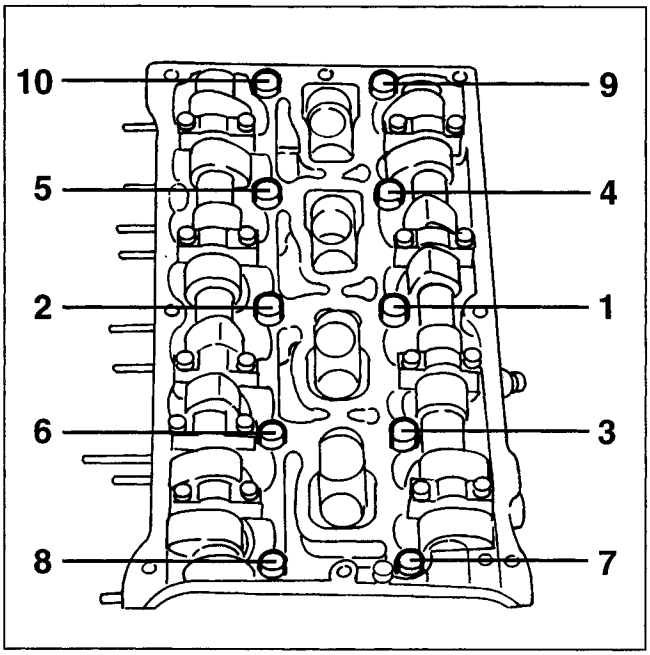


- Strip down the cylinder head and overhaul as described in the volume "Overhauling - Engines".

Re-assemble the cylinder head reversing the sequence described for removal and following the instructions given below.
- Turn the crankshaft to move the pistons of the 1st and 4th cylinder to the T.D.C.
- Position a new gasket on the cylinder head.
NOTE: The cylinder head gasket is in aramidic fibre and cylinder head retightening is unnecessary throughout the life of the engine.

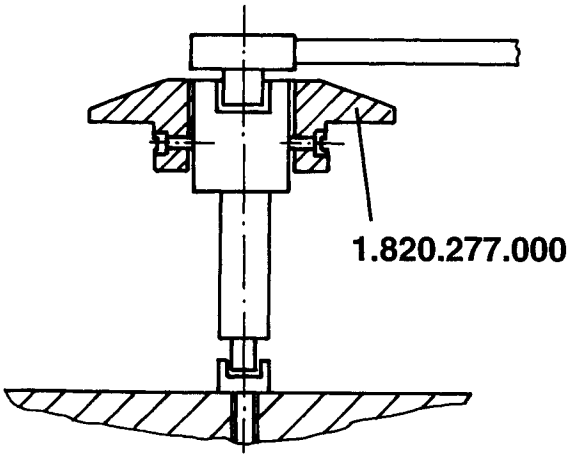
WARNING: Before assembly, accurately clean the cylinder head and crankcase surfaces.

- Assemble the complete cylinder head on the crankcase.
- Tighten the cylinder head fastening screws as described below and bearing in mind that, for each step, the tightening sequence is the one illustrated.



Tightening procedure	
Set in all the screws to a torque of:	20 Nm (2.0 kg)
Tighten the screws to the preliminary torque of:	40 Nm (4.1 kg)
Turn all the screws with an angle of:	90° + 90° + 90°

- For angle tightening use graduated disk no. 1.820.277.000 as illustrated.



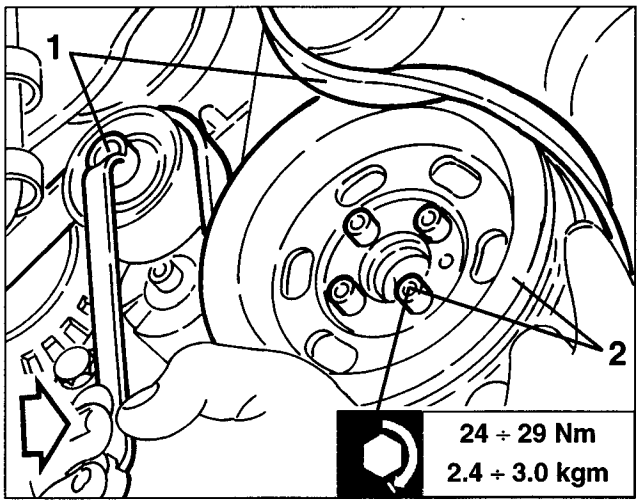
For re-assembly of the timing gear drive belt and timing and for assembly of the auxiliary components drive belt see GROUP 00.

OIL SUMP

REMOVAL/REFITTING

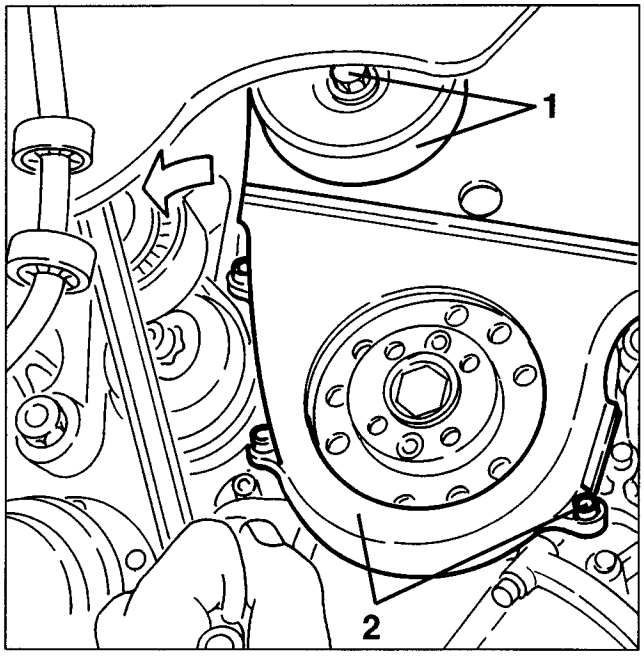
- Set the car on a lift.
- Drain the engine oil (see GROUP 00).
- Remove the right front wheel and mud flap.

1. Raise the car and working as illustrated on the belt tensioner, loosen the tension of the auxiliary components drive belt prise it off.
2. Slacken the four fastening screws and remove the auxiliary components drive pulley.



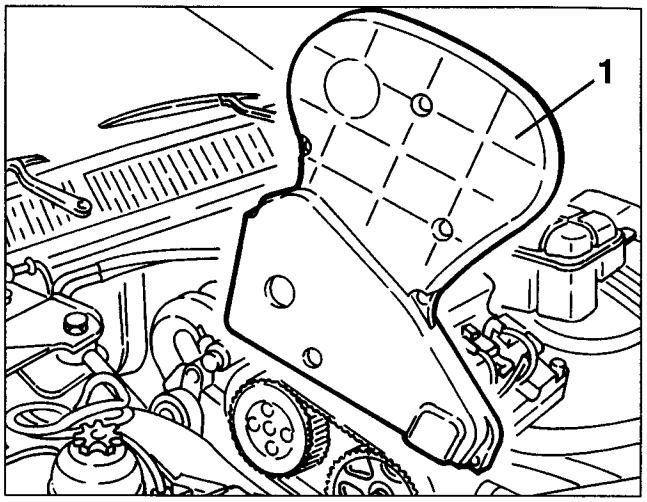
1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
2. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft belts.

NOTE: To gain access to the rear screw, turn the belt tensioner as illustrated.



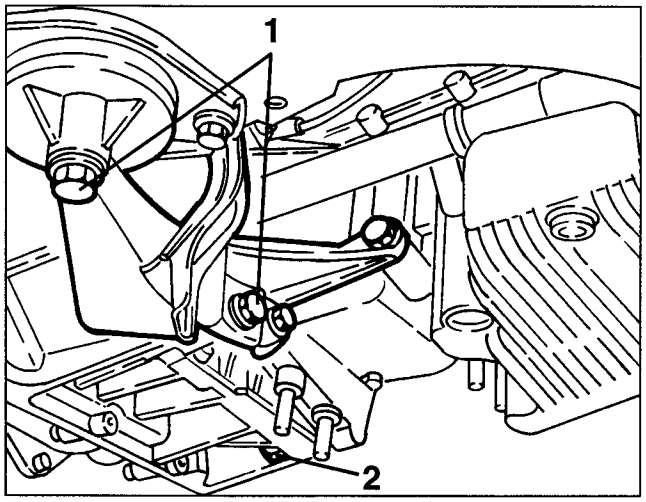
- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft belts.

1. Lower the car, slacken the remaining fastening screws and remove the upper cover.

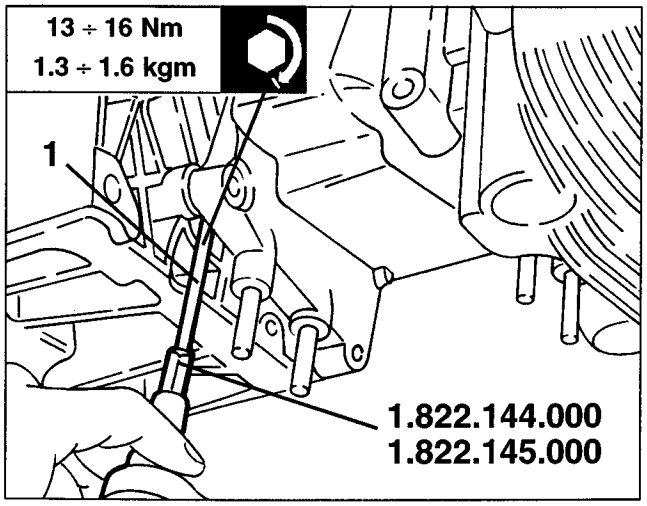


- Remove the front section of the exhaust pipe.
- Position a hydraulic jack under the gearbox.

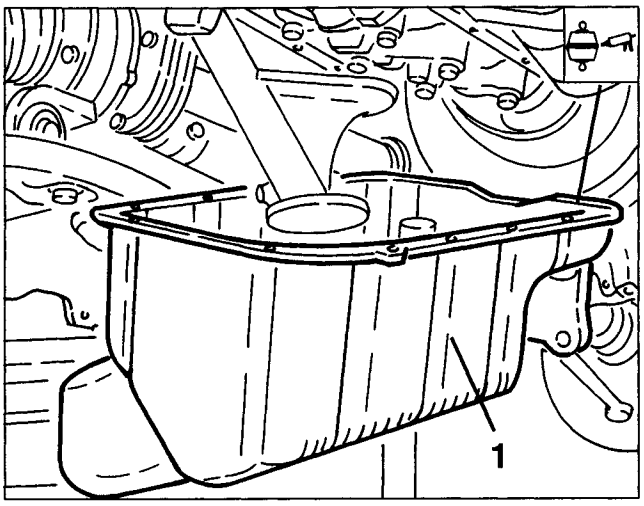
1. Slacken the fastening screws and remove the power unit rear support.
2. Slacken the screws fastening the gearbox to the oil sump.



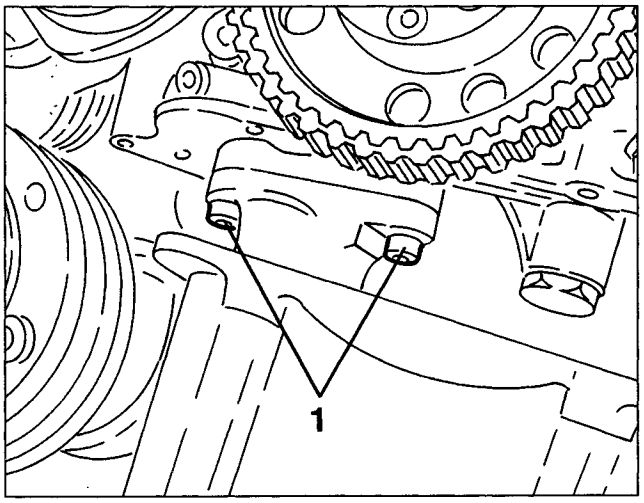
1. Slacken the oil sump fastening screws using tool no. 1.822.144.000 and no. 1.822.145.000 for those to which access is not possible.



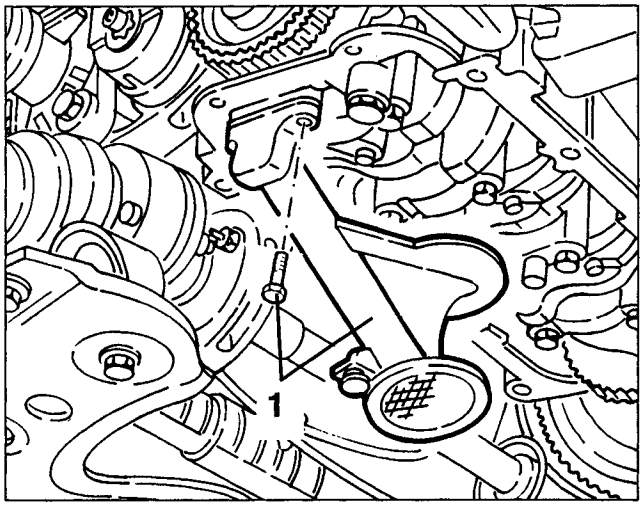
1. Lower the hydraulic jack as required and remove the oil sump.



NOTE: if difficulty is encountered in removing the oil sump, slacken the fastening screws (1) of the suction device.



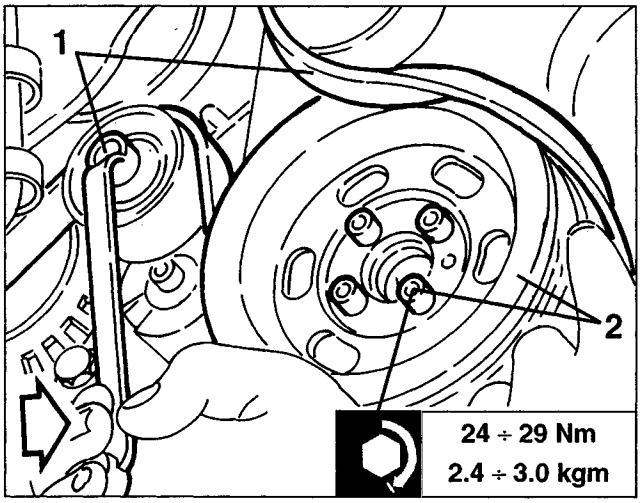
1. Slacken the fastening screws and remove the suction device.
- Remove the seal.



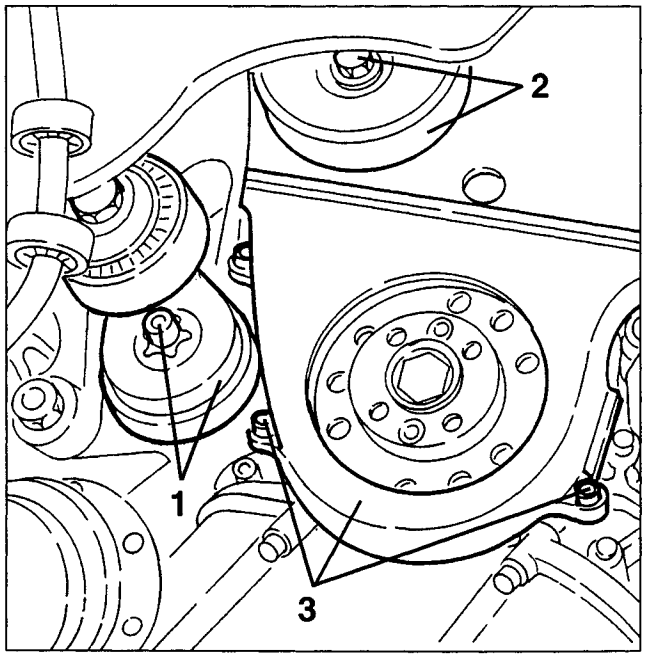
CHANGING THE CRANKSHAFT FRONT OIL SEAL

- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Remove the right front wheel and mud flap.

1. Raise the car and working as illustrated on the belt tensioner, loosen the tension of the auxiliary components drive belt prise it off.
2. Slacken the four fastening screws and remove the auxiliary components drive pulley.

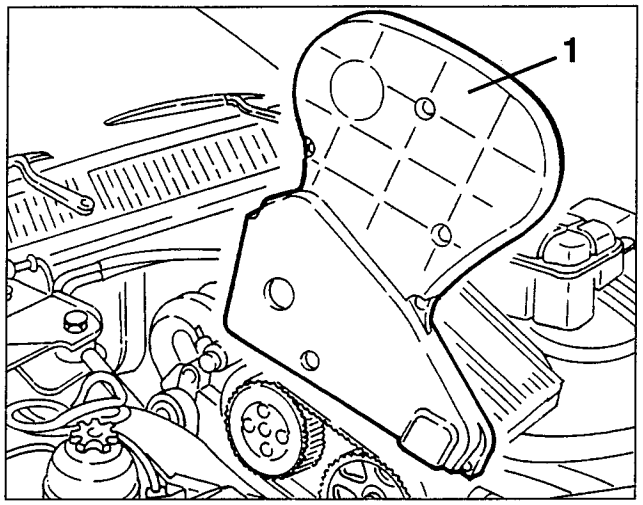


1. Slacken the fastening screw and remove the belt tensioner.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.

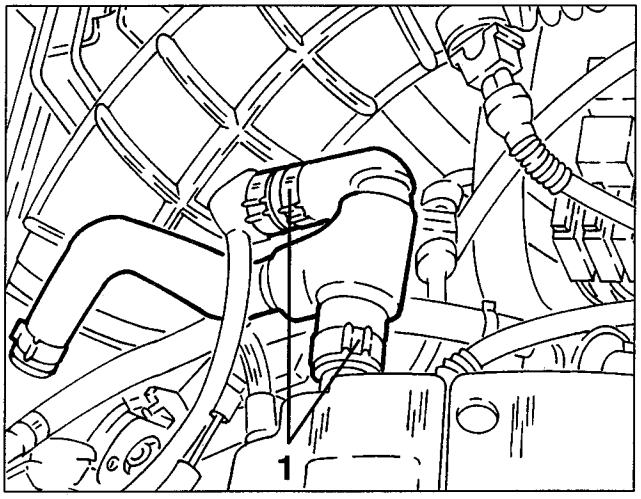


- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.

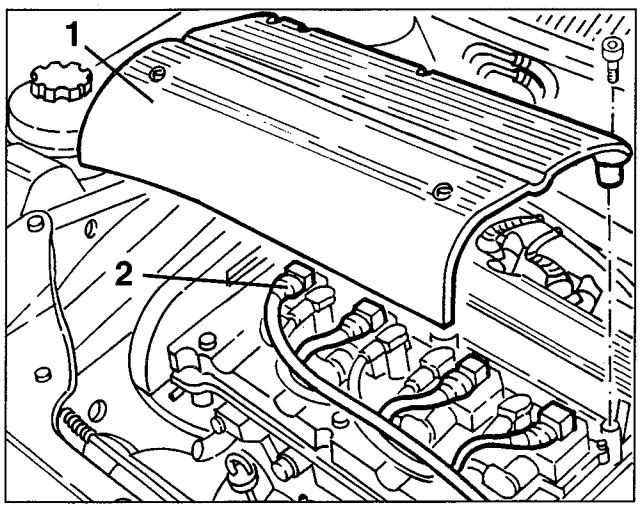
1. Lower the car, slacken the fastening screws and remove the upper cover.



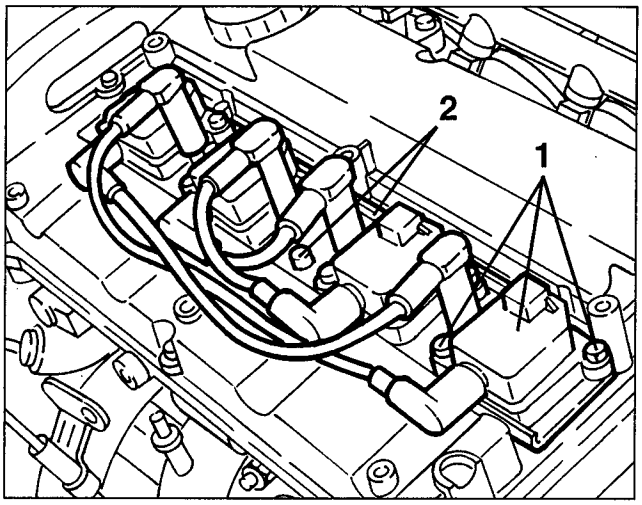
1. Disconnect and remove the oil vapour recovery pipes.



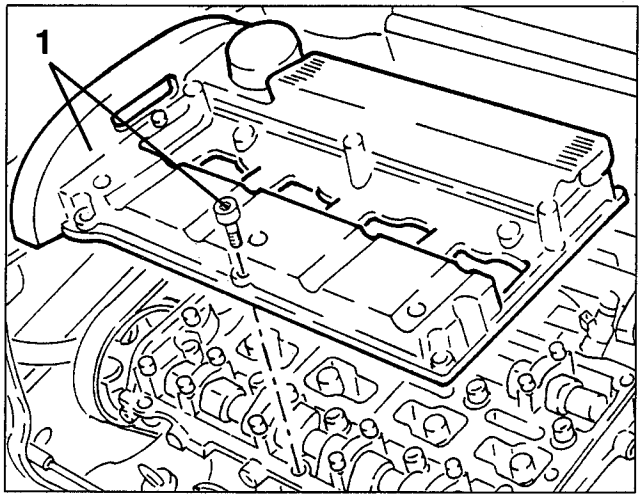
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



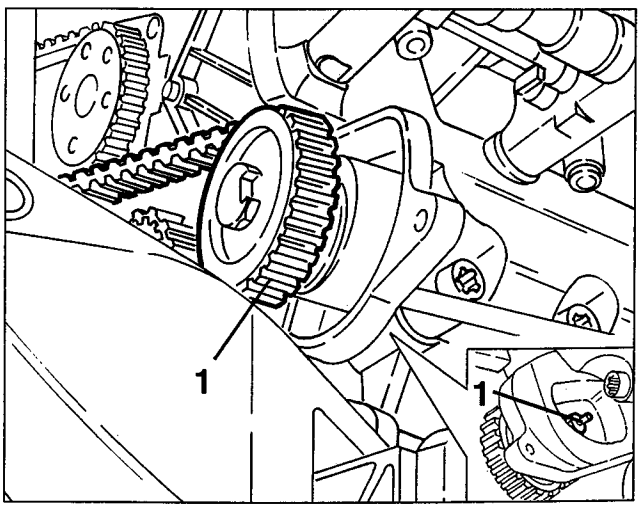
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



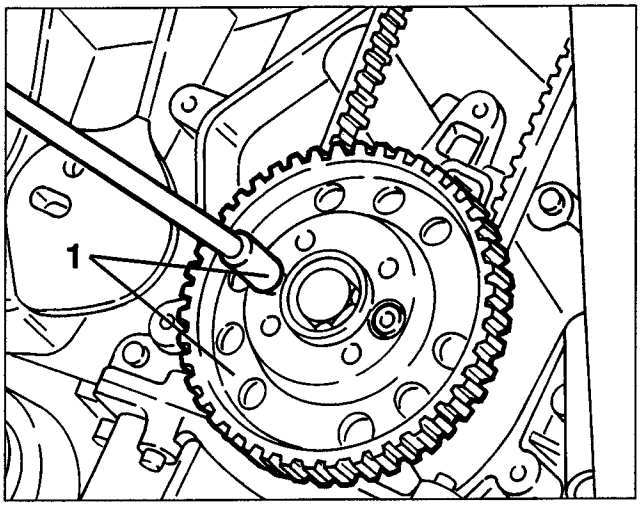
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



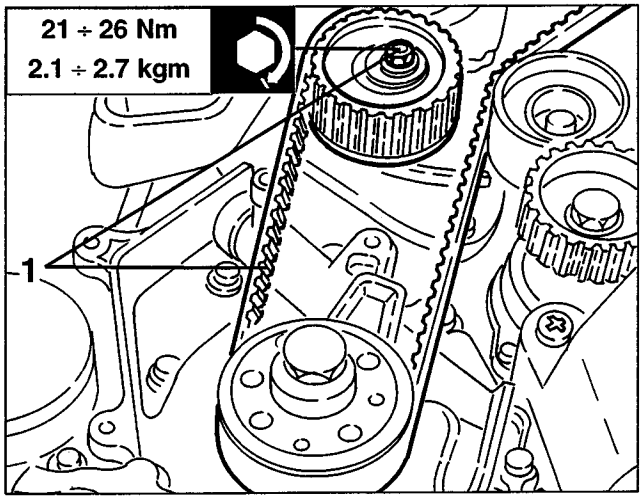
1. Loosen the tension of the counter-rotating shaft belt slackening the fastening nut of the corresponding belt tensioner, then prise and remove the belt.



1. Slacken the two fastening screws and remove the counter-rotating shaft belt driving pulley.

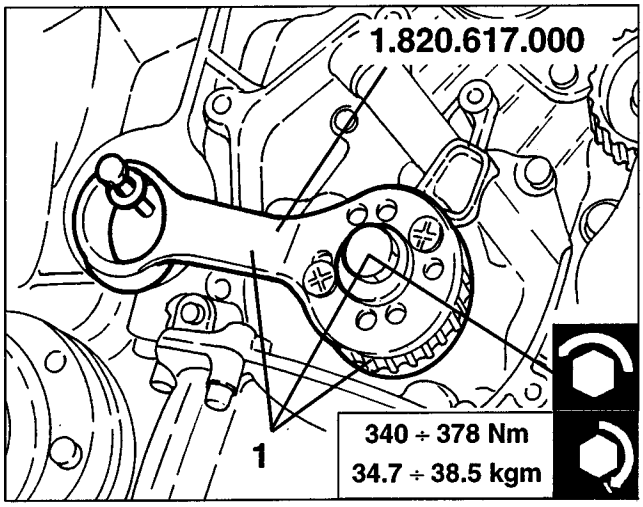


1. Working on the timing gear belt tensioner, loosen the tension of the belt, then prise it off.



Solution for engines before change

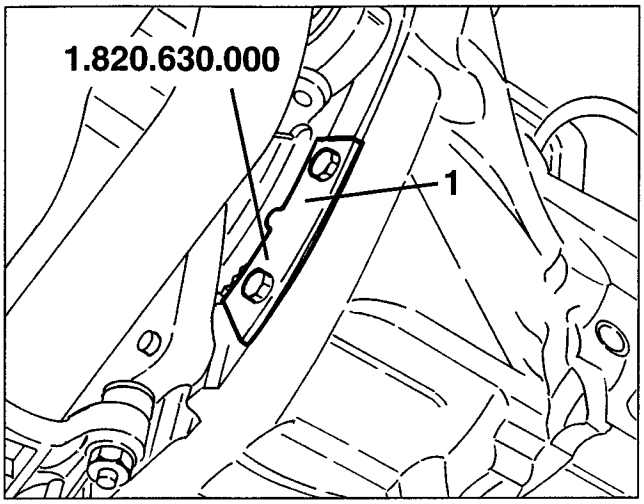
1. Using tool no. 1.820.617.000 as counter torque, slacken the screw (lefthand) fastening the timing gear belt drive pulley, then remove the pulley.



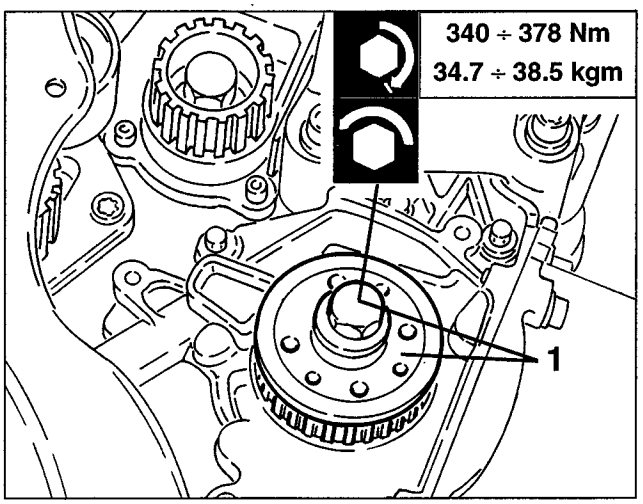
Solution for engines after change

- Slacken and remove the flywheel cover.

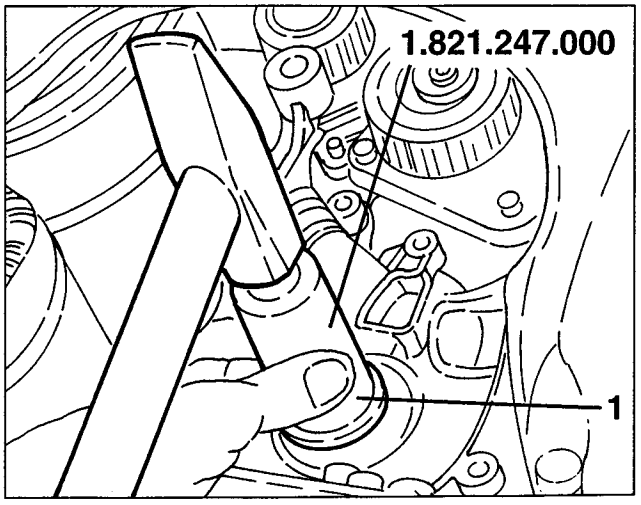
1. Install the flywheel stopper tool no. 1.820.630.000 as illustrated.



1. Slacken the screw (lefthand) fastening the timing gear belt drive pulley, then remove the pulley.



1. Remove the oil seal and install a new one using tool no. 1.821.247.000.

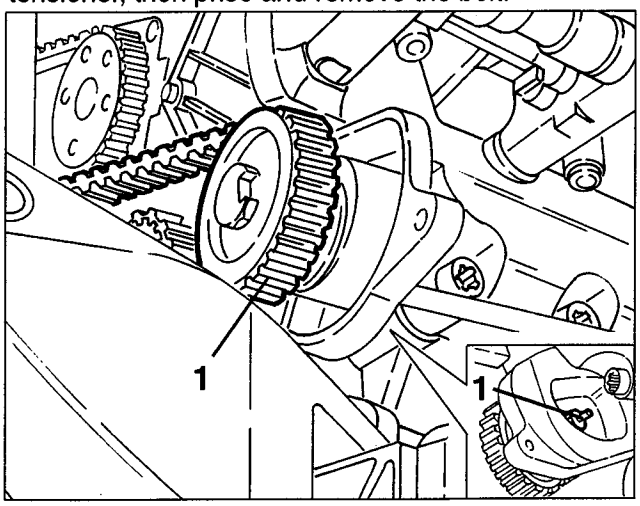


- Re-assemble reversing the sequence followed for removal.
Refer to GROUP 00 for re-assembly of the timing gear belts, counter-rotating shaft belts and their timing and for assembly of the auxiliary components drive belt.

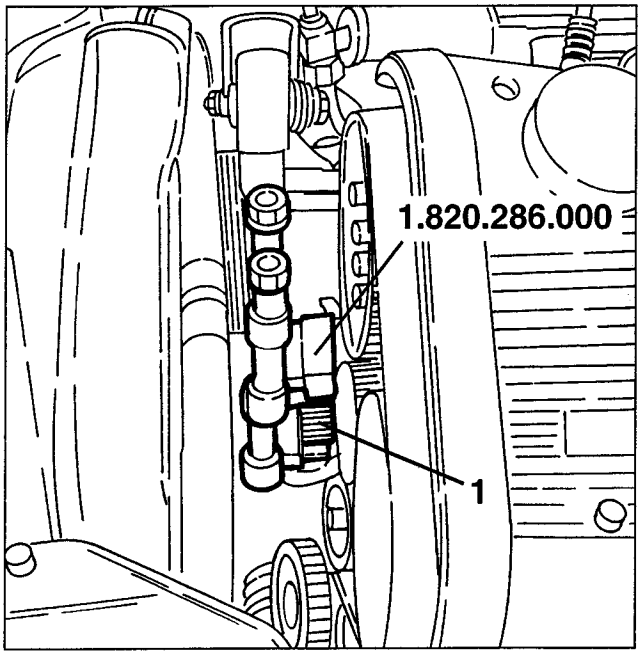
CHANGING THE COUNTER-ROTATING SHAFT SEALS

- Proceed as described in the procedure for "Changing the crankshaft front oil seal" up to removal of the upper cover for the timing gear and counter-rotating shaft belts.

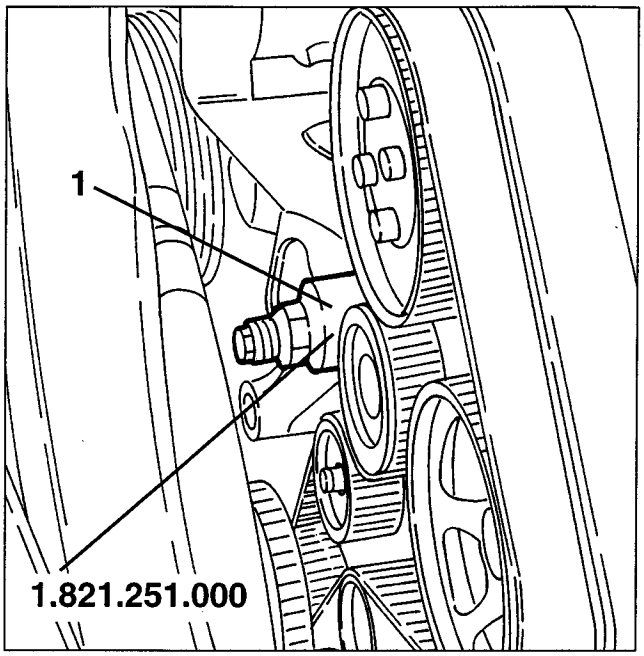
1. Loosen the tension of the counter-rotating shaft belt slackening the nut fastening the corresponding belt tensioner, then prise and remove the belt.



1. Using tool no. 1.820.286.000 slacken the screw fastening the counter-rotating shaft pulley and remove it.



1. Remove the oil seal and install a new one using tool no. 1.821.251.000.

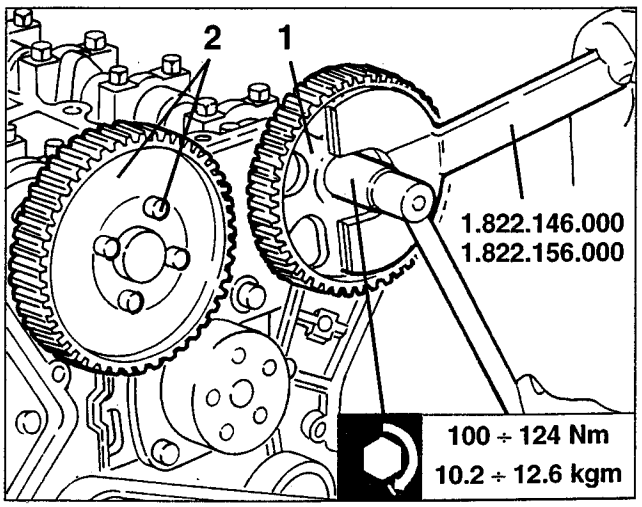


- Carry out re-assembly reversing the sequence described for removal referring to GROUP 00 for assembly of the counter- rotating shaft belt and for assembly of the auxiliary components drive belt.

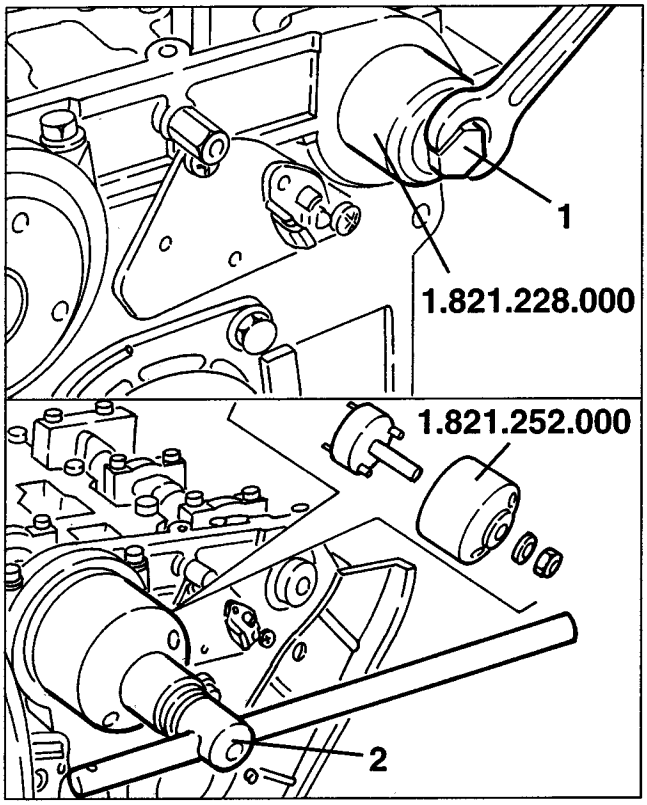
CHANGING THE CAMSHAFT OIL SEALS

- Proceed as described n the procedure "Changing the crankshaft front oil seal" up to removing the timing gear drive belt.

1. Using tool no. 1.822.146.000 complete with tool no. 1.822.156.000 slacken the screw fastening the camshaft pulley on the exhaust side and remove it.
2. Slacken the four screws and remove the camshaft drive pulley on the intake side.



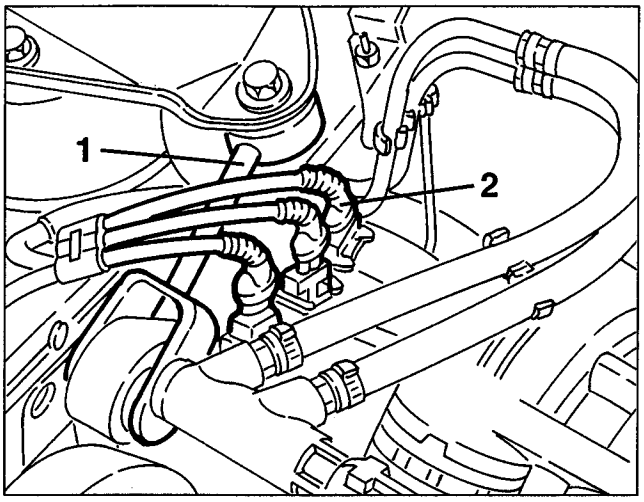
- Remove the camshaft oil seals.
1. Install a new camshaft front oil seal on the exhaust side using tool no. 1.821.228.000.
2. Install a new camshaft front oil seal on the intake side using tool no. 1.821.252.000.



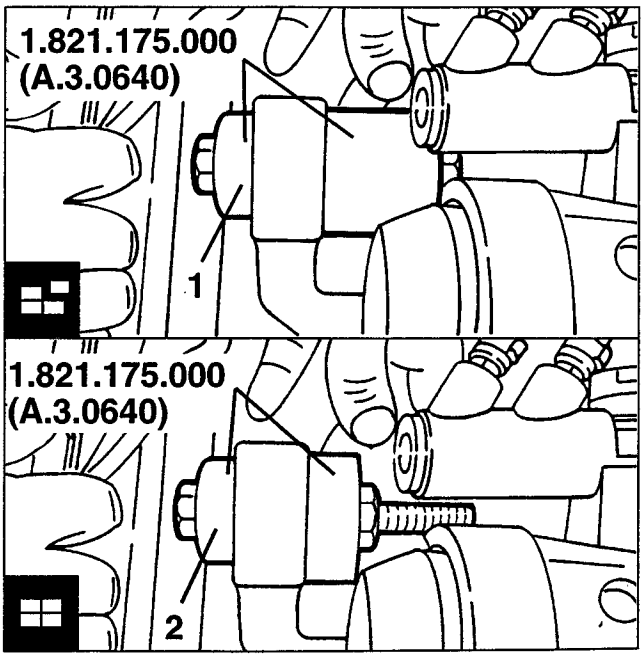
- Carry out re-assembly reversing the sequence described for removal
Refer to GROUP 00 for assembly of the timing gear and counter- rotating shaft belts and for assembly of the auxiliary components drive belt.

CHANGING THE FLEXIBLE BUSHING OF THE ENGINE STAY ROD ANCHOR BRACKET

1. Slacken the fastening screws and remove the engine stay rod.
2. Move to one side the support with the electrical connections.
- Move to one side the electrical wirings lateral protection.

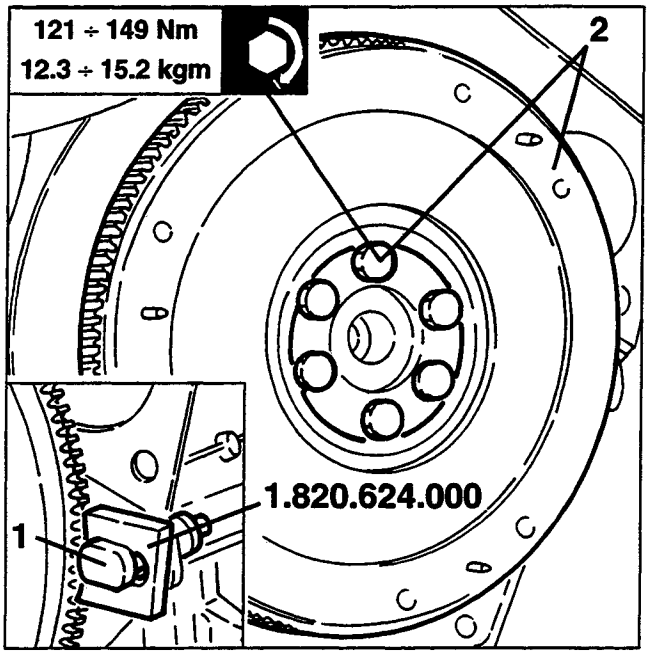


1. Using tool no. 1.821.175.000 (A.3.0640) as illustrated remove the flexible bushing from the engine stay rod anchor bracket.
2. Refit a new flexible bushing still using tool no. 1.821.175.000 (A.3.0640) as illustrated.
- Complete re-assembly reversing the sequence followed for removal.

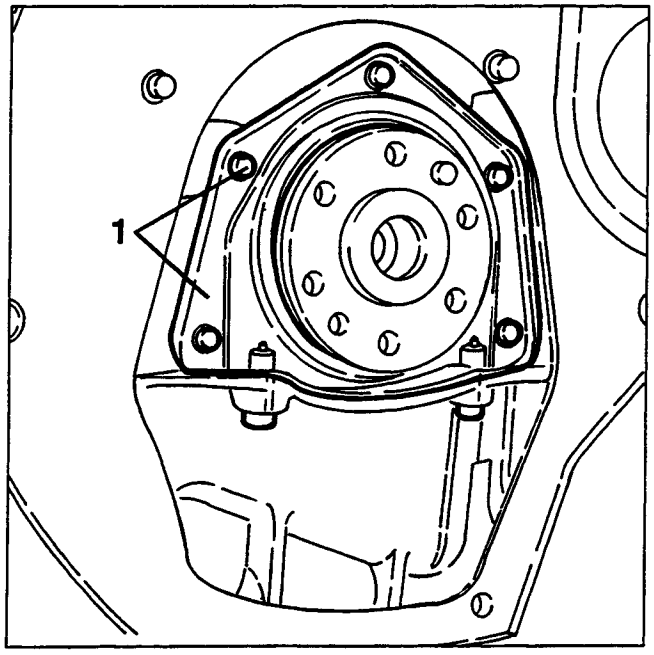


CHANGING THE REAR CRANKCASE COVER (with oil seal)

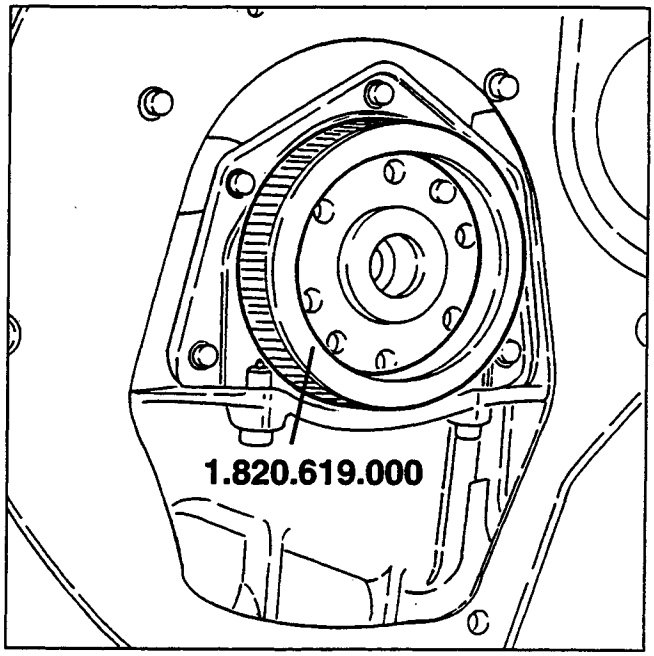
- Remove the gearbox (see specific paragraph).
- Remove the clutch (see specific paragraph).
1. Fit flywheel stopper tool no. 1.820.624.000.
2. Slacken the fastening screws and remove the flywheel.



1. Slacken the screws fastening the oil sump to the crankcase, then remove the rear crankcase cover with integrated oil seal ring.



- Refit the rear cover proceeding as follows:
- Fit tool no. 1.820.619.000 on the oil seal of the rear crankcase cover.
- Assemble the tool - rear cover assembly and tighten the screws fastening the crankcase and the oil sump.
- Remove the centering tool no. 1.820.619.000.



GENERAL DESCRIPTION

An electronic control system supervises and regulates all the parameters of the engine, optimising performance and consumption levels through response in real time to the different operating conditions: this sophisticated latest generation system consists of a single control unit which controls both ignition (static with lost spark) and injection (timed).
This is the M 2.10.3 version of the proven and reliable BOSCH MOTRONIC system.
Compared with the previous versions this new M 2.10.3 system adopts a control unit - with 55 pins - with advanced design and production technology, it also possesses many possibilities for inserting auxiliary functions.
As a result of the use of new sensors and revision of the control programmes, the system makes it possible to achieve considerable improvements in terms of consumption and emission levels and vehicle handling.
Another feature of this system is self-adaptation, i.e. the capability to recognise the changes that take place in the engine and to compensate them, according to functions which mainly correct:
- the mixture titration
- the caburetion parameters according to the command of the evaporative solenoid valve
- an adaptive programme for idle speed control.

FUNCTIONS OF THE SYSTEM

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

With this control unit, fuel injection is sequential and timed for each cylinder: the injection instant (delivery of fuel into the intake manifolds by the opening of the injectors) is not simultaneous for all the cylinders, but takes place for each cylinder in correspondence with the optimal point of injection, calculated by the control unit according to special maps depending on the load, speed and temperature of the engine.
NOTE: the instant considered in the design of the maps is that of the start of injection (the cylinder is in the exhaust stroke - intake valve still closed).

Static ignition

An electronic ignition system has been adopted with "static distribution" (with semi-conductors, without distributor). This solution makes it possible to eliminate rotary components; in addition, it does not produce external sparks thus reducing the risk of interferences; lastly it reduces the number of high voltage cables and connectors; as the power modules for controlling the primary windings of the coil are inside the control unit.
Static ignition takes place through four coils, according to the so-called "lost spark" logic: this solution exploits the different pressures and environments existing contemporaneously in a pair of cylinders: when one of the cylinders approaches the bursting stroke, with a mixture of air and fuel, the corresponding cylinder is at the end of the exhaust stroke in the presence of exhaust gas.
In a 4-cylinder in line engine, the paired cylinders are 1/4 and 2/3.
The solution adopted for this engine (T.SPARK - 16 valves) has required the adoption of a larger "central" spark plug and a smaller "side" spark plug. Each of the four coils supplies the small spark plug of the cylinder below and simultaneously the large one of the paired cylinder.
NOTE: This way it is impossible to invert the spark plug cables during servicing operations.

Metering the air flow rate

The air flow meter adopted is of a more modern design known as the "hot film" type.
Outside, the air-flow meter looks like a part of duct between the intake manifold and the air cleaner. Inside the air-flow meter there is an electronic circuit and a plate that is crossed by the air which passes into the duct. The film plate is kept at a constant temperature (appr. 120°C over the temperature of the incoming air) by a heating resistance placed in contact with it. The mass of air flowing through the manifold tends to withdraw heat from the plate: therefore, to keep its temperature constant, a certain current needs to flow through the heating resistance: this current, suitably measured, is proportionate with the mass of flowing air.
N.B. This air flow meter measures directly the mass of air (and not the volume as in the previous versions with "floating port", thereby eliminating problems of temperature, altitude, pressure, etc.), enabling an optimum ratio between the weight of the air and the weight of the fuel.

Cylinder detection

Following the sequential and timed injection system, a timing sensor has been introduced (cam angle sensor): this makes it possible to detect which cylinder is in the bursting stroke when the engine is started, in order to be able to start the correct injection sequence. The sensor is formed of a Hall-effect device by which the voltage signal sent to the control unit "lowers" suddenly when the tooth machined on the camshaft pulley passes in front of the actual sensor; therefore a signal is sent every two turns of the crankshaft.
Conversely, the rpm sensor sends a reference signal for each turn of the engine and each subsequent tooth of the phonic wheel informs the control unit of an increase of the angular position of the crankshaft, so that injection is sent correctly from the suitable cylinder and the spark to the corresponding pair of cylinders.

Fuel pump

The control logic of the fuel pump carried out by the control unit (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.

Timing variator

This T.SPARK - 16 valve engine is fitted with an electro- mechanical-hydraulic timing variator which is connected to the camshaft and controls and adjusts intake timing (advance) in such a way that a larger amount of air is taken in. This device is activated by the control unit only after exceeding a determinate rpm and engine load to avoid adversely affecting correct operation of the engine at low speeds.

Percentage of exhaust gas recirculation

Nox (nitric oxide) is developed at high temperatures in the combustion chambers. To reduce these emissions an E.G.R. (Exhaust Gas Recirculation) system is adopted which by recirculating part of the exhaust gases, lowers the temperature, thus the Nox produced, in the combustion chambers.
In fact, part of the exhaust gas is withdrawn through the special EGR Valve and re-admitted to the intake box where it is mixed with the intaken air and burnt again in the engine. The EGR valve is modulated by a solenoid valve controlled by the injection control unit and, as a result of the type of control, in addition to reducing the amount of Nox, consumption levels are also optimised.
The percentage of exhaust gas to be returned to the engine is established by the control unit taking account of a specific characteristic curve which depends on the load, speed and temperature of the engine.

OPERATING LOGIC

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

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

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

– **Cold starting control:**
during cold starts the control unit uses special advance values and injection times.
When a determinate temperature/rpm ratio is reached, the control unit resumes normal operating conditions.

– **Control of enrichment during acceleration:**
upon the need for acceleration, the control unit increases injection in order to reach the required 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 cut-off 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 fitted directly on the throttle body which acts on the throttle by-pass: 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": 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.

– **Timing variator control:**
The electro-mechanical-hydraulic timing variator, connected to the camshaft, controls and adjusts the intake timing according to the load and rpm of the engine. This device is activated by the control unit at higher engine operating speeds (above 1,600 rpm and with load above 30%).

– **Knocking control:**
Through a knock sensor 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.
N.B. The intaken air temperature sensor to be found just downstream of the air-flow meter, is not used to calculate the engine load but to control the knocking parameters.

– **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 fuel by reducing delivery to the injectors.

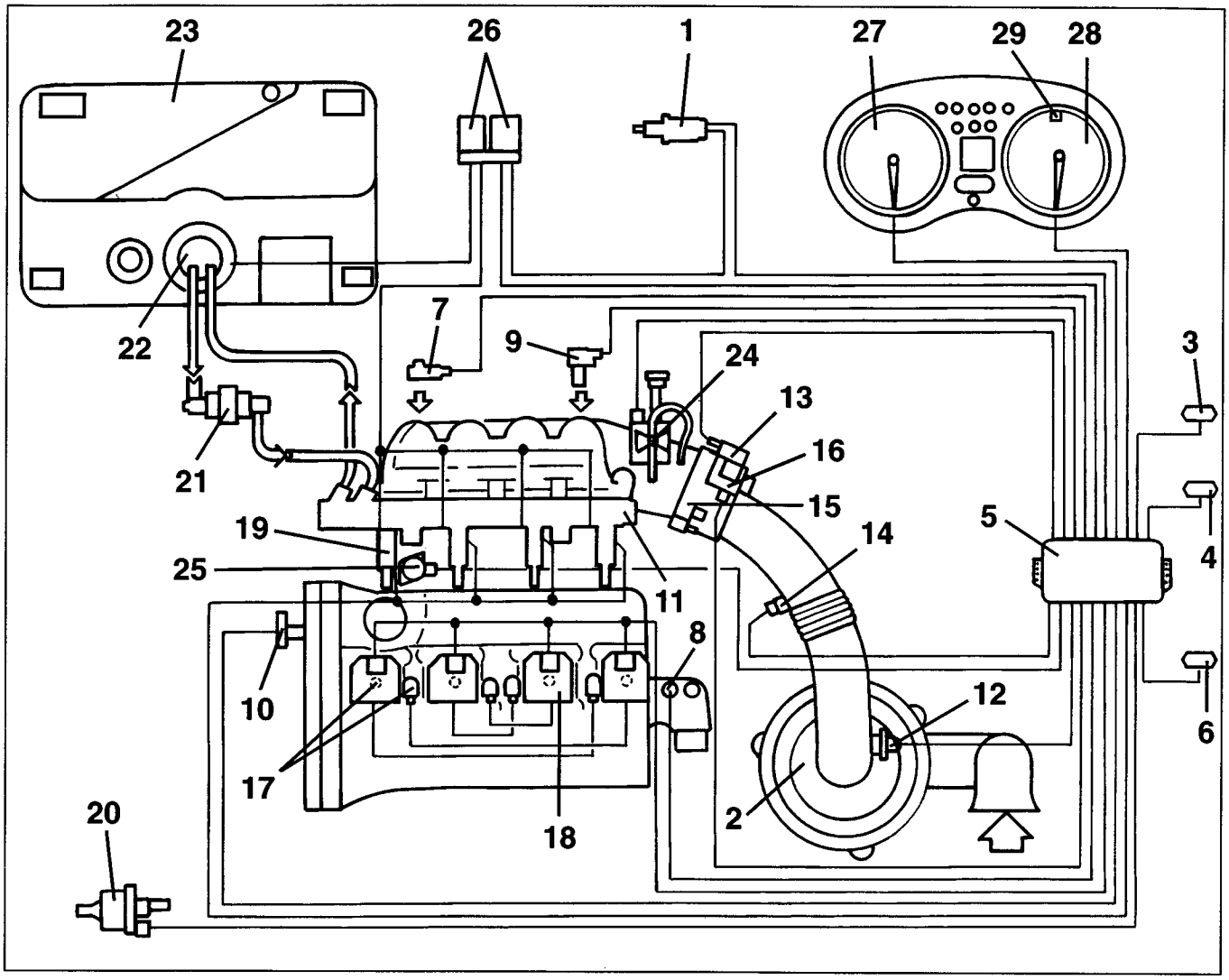
– **E.G.R. valve control**
The percentage of exhaust gas to be returned to the engine is determined by the control unit taking account of a specific characteristic curve which depends on the engine load and speed: recirculation is only activated when the engine speed is between 2500 and 4000 rpm., also 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.
For specifications see GR. 50 - CLIMATE CONTROL.

– **Connection with ALFA ROMEO CODE system:**
on cars fitted with "electronic key" (ALFA ROMEO CODE), as soon as the Motronic control unit receives the signal that the key has been turned to MARCIA, it "asks" the Alfa Romeo CODE 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 two control units takes place on diagnosis line K already used for the Alfa Romeo Tester (see specific paragraph).
N.B. Before working on the system you are advised to read the corresponding chapter.

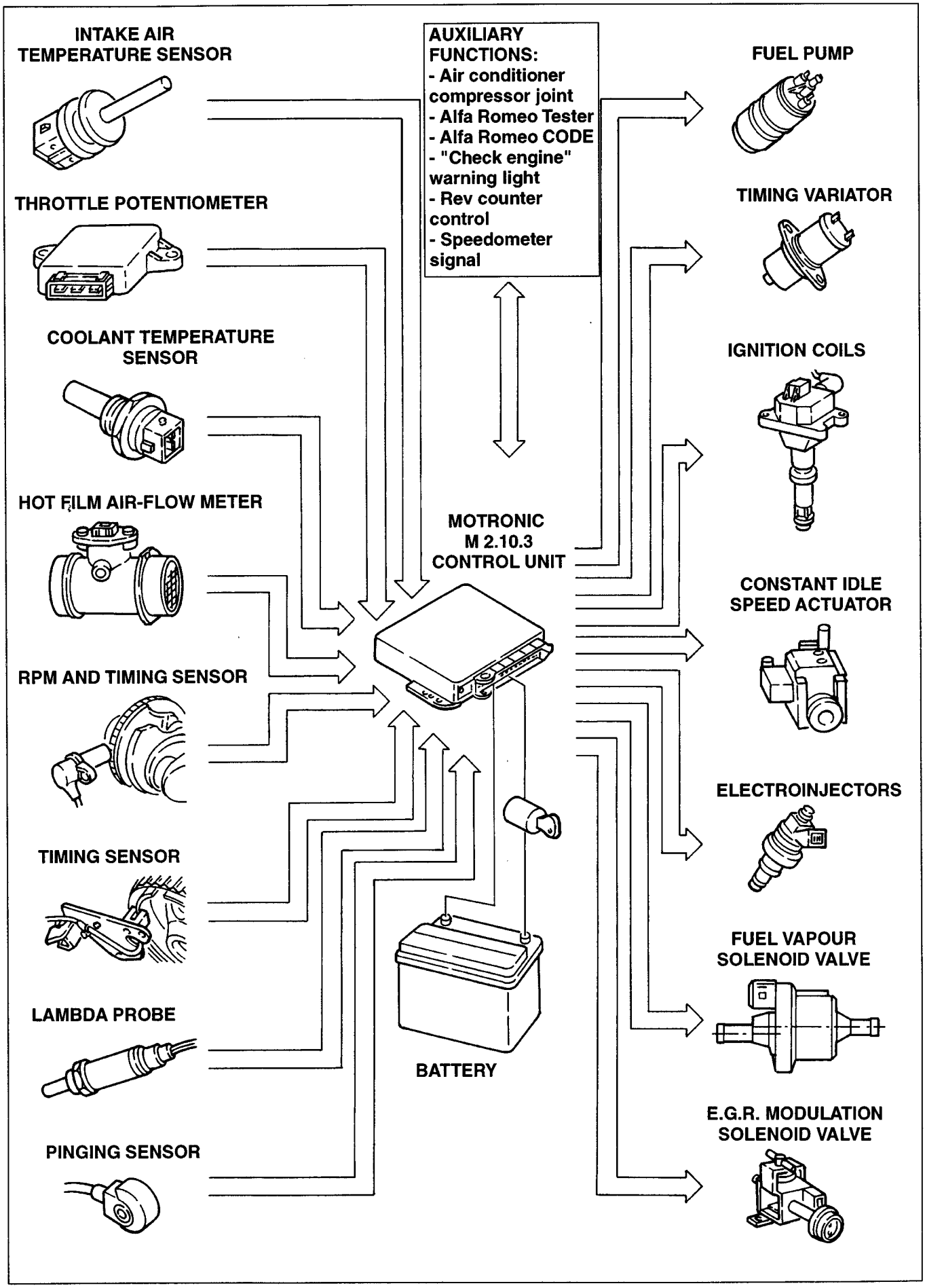
– **Self-diagnosis:**
the control unit possesses a **self-diagnosis system**, which continuously monitors the plausibility of the signals from the various sensors and compares them with the limits allowed: if these limits are exceeded, the system detects a fault and turns on the corresponding warning 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 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 2.10 ELECTRONIC INJECTION AND IGNITION SYSTEM



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

FUNCTIONAL LAYOUT OF MOTRONIC M 2.10.3 INJECTION - IGNITION SYSTEM



GENERAL DESCRIPTION

An electronic control system supervises and regulates all the parameters of the engine, optimising performance and consumption levels through response in real time to the different operating conditions.
This is the M 2.10.4 version of the proven and reliable BOSCH MOTRONIC system.
Compared with the previous versions this new M 2.10.4 system adopts a control unit - with 55 pins - with advanced design and production technology, it also possesses many possibilities for inserting auxiliary functions engine cooling fan). Owing to the use of new sensors and updated programmes the system also makes it possible to achieve considerable improvements in terms of consumption, emission levels and vehicle handling.
Another feature of this system is self-adaptation, namely the capability of detecting the changes that take place in the engine and compensate them, according to functions which mainly correct:
- mixture titration;
- carburetion parameters according to the command of the evaporative solenoid valve;
- the adaptation plan for idle speed control.

FUNCTIONS OF THE SYSTEM

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

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

Static ignition

An ignition system has been adopted with "static distribution" (with semi-conductors, without distributor). This solution makes it possible to eliminate rotary components; in addition, it does not produce external sparks thus reducing the risk of interferences; lastly it reduces the number of high voltage cables and connectors.
Static ignition takes place through four coils, according to the logic known as "lost spark".
Each of the four coils supplies the spark plug of the cylinder below and simultaneously that of the cylinder paired cylinder but in the same position (central with central, side with side).
NOTE: this way it is impossible to invert the spark plug cables during servicing operations.
This solution exploits the different environment conditions existing contemporaneously in a pair of cylinders: when one of the cylinders approaches the bursting stroke, with a mixture of air and fuel, the spark is useful, whereas for the corresponding cylinder which is at the end of the exhaust stroke in the presence of exhaust gas, the spark is lost.
This T.SPARK - 16 valve engine requires the adoption of two spark plugs of different size: a "central" larger one and a smaller "side" one.

Metering the air flow rate

The air flow metering system has been newly designed and it is of the "heated film" type.
Outside the air-flow meter looks like a part of duct between the intake manifold and the air cleaner.
Inside the air-flow meter there is an electronic circuit and a plate that is crossed by air which passes into the duct. The film plate is kept at a constant temperature (appr. 120°C above the temperature of the incoming air) by a heating resistance placed in contact with it.
The mass of air flowing through the duct tends to withdraw heat from the plate; therefore, to keep its temperature constant, a certain current needs to flow through the heating resistance: this current, suitably measured, is proportionate with the mass of flowing air.
N.B. This air flow meter measures directly the mass of air (and not the volume as in the previous versions with "floating port"), thereby eliminating problems of temperature, altitude, pressure, etc.
This air flow meter does not incorporate the intaken air temperature sensor which is separate, to be found just upstream of the air flow meter itself.

Cylinder detection

Following the adoption of the sequential and timed injection system, a timing sensor has been introduced (cam angle sensor): this makes it possible to detect which cylinder is in the bursting stroke when the engine is started, in order to be able to start the correct injection sequence.
The sensor is formed of a Hall-effect device by which the voltage signal sent to the control unit "lowers" suddenly when the hollow machined on the camshaft pulley passes in front of the actual sensor; therefore a signal is sent every two turns of the crankshaft. Conversely, the rpm sensor sends a reference signal each turn of the engine and each subsequent tooth of the phonic wheel informs the control unit of an increase in the angular position of the crankshaft, so that the correct injection and ignition are sent to the appropriate cylinder.

Fuel pump

The complex control logic of the fuel pump carried out by the control unit (chiefly based on the rpm signal) immediately cuts off the supply to the engine as soon as the engine stops.
Moreover, the pump will not operate with the key engaged and the engine not running.
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 which do not cause the engine to stop immediately.

Timing variator

This T. SPARK 16 valve engine is fitted with an electromechanical-hydraulic timing variator which is connected to the camshaft and controls and adjusts the intake timing (advance) so that timing that offers the best performance levels is obtained.
This mechanism is activated by the control unit only after exceeding a determinate engine rpm and load so that correct operation of the engine at low speed is not adversely affected.

Exhaust gas recirculation (only for certain cars)

NOx (nitric oxide) is generated at high temperatures in the combustion chamber.
To reduce these emissions an E.G.R. (Exhaust Gas Recirculation) system has been adopted which, by recirculating part of the exhaust gas, lowers the temperature in the actual chamber, thereby also the Nox.
Part of the exhaust gas is withdrawn by the special E.G.R. valve and then re-admitted to the intake box where it is mixed with the intake air and recycled in the engine. The E.G.R. valve is modulated by a control solenoid valve controlled by the control unit and as a result of the type of control, in addition to reducing Nox it is also possible to optimise consumption.
The percentage of exhaust gas to be sent back to the engine is determined 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.

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

- **Cold starting control:**
during cold starts the control unit uses special advance values and injection times in order to reach the required load more rapidly.

- **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 values 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, fitted directly on the throttle body, 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.
The system also controls the cutting in of the radiator cooling fan, if necessary, compensating the engine idling speed.

- **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 probe (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": this way the engine operates as far as possible around the ideal lambda rating.
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 also possible to adjust engine carburetion precisely. Among other items, this makes it possible to meet emission limit regulations.

- **Timing variator control:**
the electromechanical-hydraulic timing variator, connected to the camshaft, controls and adjusts intake timing depending on the engine load and rpm. This device is activated by the control unit over idle speed (over 1,600 rpm and with load above 30%).

- **Pinging control:**
the control unit is informed about pinging or "knocking" through the pinging sensor and it corrects ignition advance delaying it accordingly.

- **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 fuel by reducing delivery to the injectors.

- E.G.R. control valve (only for certain cars):
the percentage of exhaust gas to be sent back 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 operated only when the engine speed is between 2500 and 4000 rpm, also depending on the temperature of the engine (recirculation percentage higher with high temperatures).

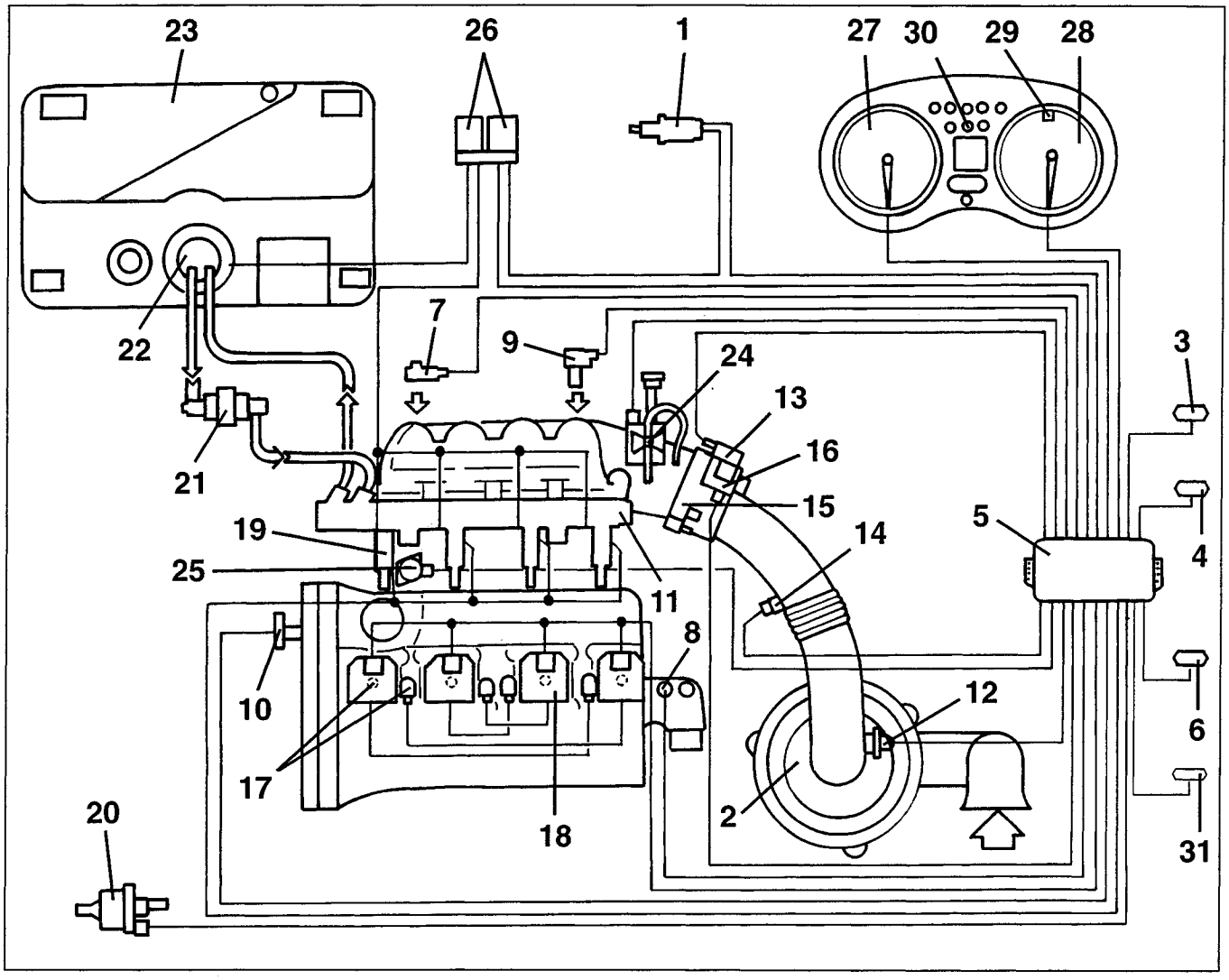
- Connection with the conditioner compressor:
the control unit is connected with the air conditioning system and controls the cutting in of the compressor and fan according to the operating conditions of air conditioning system.

- Connection with the radiator cooling fan:
in this version the cooling fan control thermal contact on the radiator has been eliminated.
The fan command for the first and second speed is supplied by the injection control unit depending on the temperature measured by the coolant fluid temperature sensor of the MOTRONIC system.

- Connection with the Alfa Romeo Code system:
as soon as the Motronic control unit receives the "key at MARCIA" signal, it "asks" the Alfa Romeo CODE control unit for consent to start the engine; this consent only takes place if the Alfa Romeo CODE control unit recognises the code of the key engaged in the ignition switch as correct. This conversation between the two control units takes place on the special serial line that connects them.

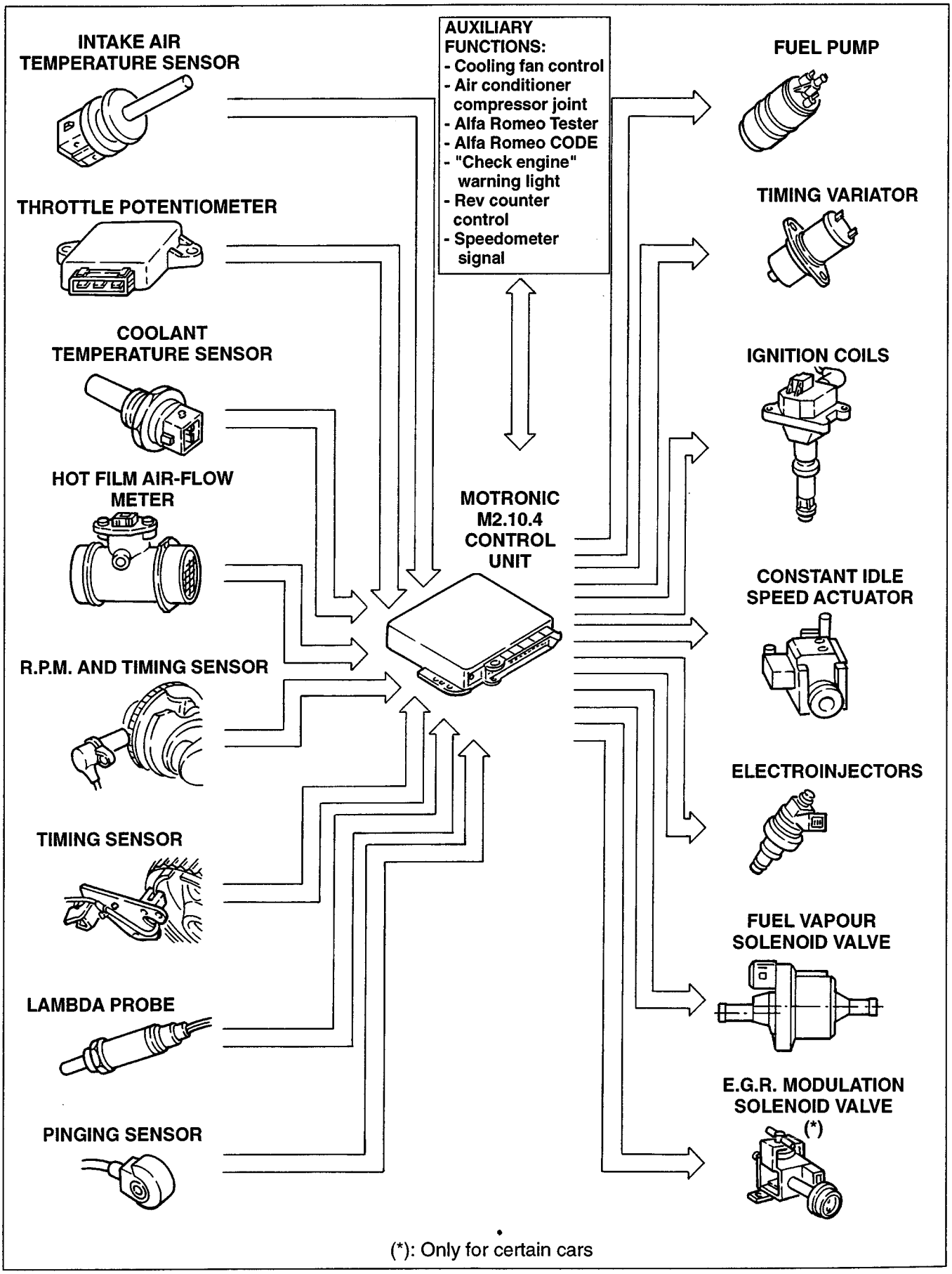
- Self-diagnosis:
The control unit possesses a diagnosis system which continuously monitors the signals leading from the various sensors checking their plausibility and comparing them with the permissible limits: if these limits are exceeded, the system detects a fault and turns on the warning light on the instrument cluster.
The warning light turns on when the engine is started to indicate the initial test of the whole system (appr. 4 seconds), then it goes off if no errors are memorised: otherwise it stays on.
For certain parameters, the control unit replaces the abnormal values with suitable mean ones to enable the car to "limp" to a point of the Service Network.
These are known as "recovery" values, they depend on the other correct signals and are defined individually by the control unit operating logic.
The system also makes it possible to quickly and effectively locate any faults connecting to the Alfa Romeo Tester (using the special cartridge MA15-A), through which all the errors memorised can be displayed.
It is also possible to check the operating parameters recorded by the control unit and command the turning on of the single actuators to check whether they are working properly.

COMPONENTS OF THE MOTRONIC M 2.10.4 INJECTION-IGNITION SYSTEM



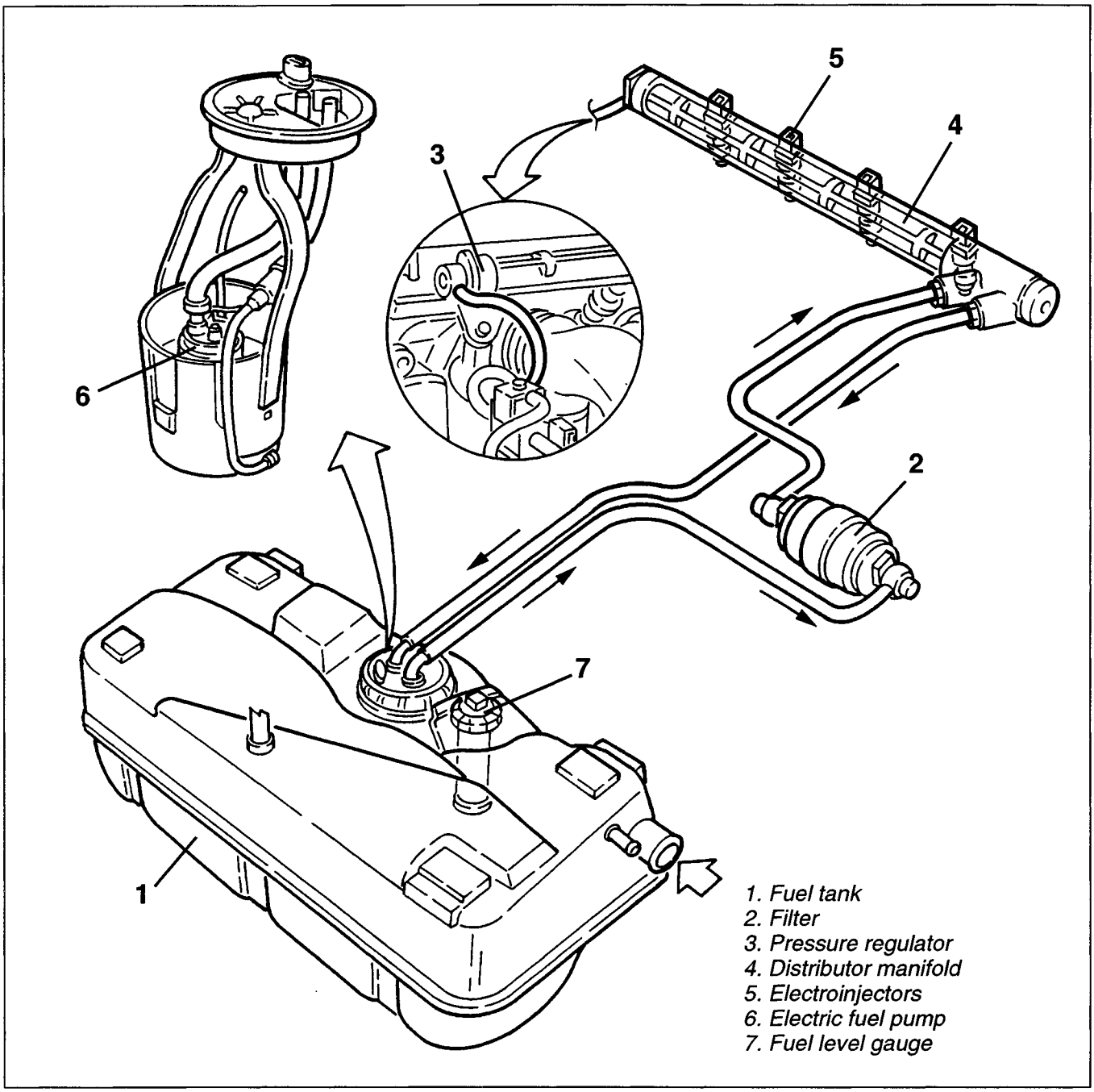
1. *Lambda sensor*
2. *Air cleaner*
3. *Climate control system connector*
4. *Diagnosis socket (Alfa Romeo Tester)*
5. *Injection - ignition control unit*
6. *Alfa Romeo CODE control unit connector*
7. *Pinging sensor*
8. *Coolant temperature sensor (NTC)*
9. *Rpm and timing sensor*
10. *Timing sensor*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

FUNCTIONAL LAYOUT OF THE MOTRONIC M 2.10.4 INJECTION-IGNITION SYSTEM



(*): Only for certain cars

DESCRIPTION OF SYSTEM



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

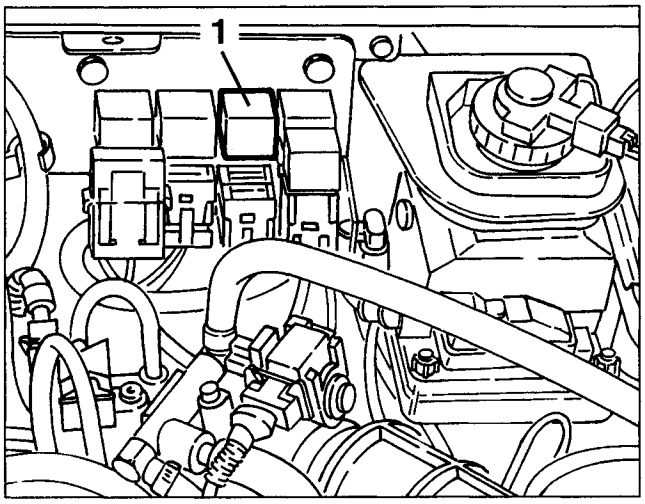
The fuel supply circuit comprises an electric fuel pump (6) located in the fuel tank (1) which sends the fuel under pressure through a special tube to the filter (2). From here the fuel is sent to the distributor manifold (4) which distributes it to the electroinjectors (5).
The fuel in excess returns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

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

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

WARNINGS

Before doing any work on components of the fuel supply system, in order to prevent any dangerous leaks, proceed as follows:
- Disconnect the fuel pump supply relay (1).



- Run the engine until it stops.

FUEL PIPE CONNECTION FITTINGS

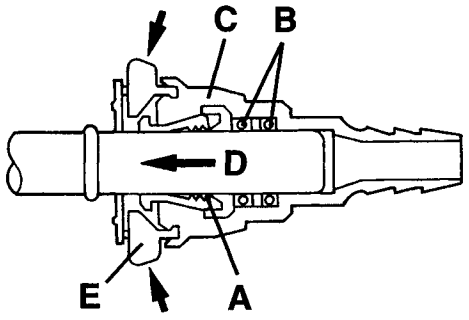
Cleaning for disconnection

Preferably use one of the following systems described in order of effectiveness.
a) Jet of warm water (max. 50°C) on the fitting and drying with jets of compressed air to prevent residual water in the interstices getting into the pipe after disconnection.
b) Jet of cold water and drying with compressed air.
c) Jet of hot water with neutral soap.
d) Jet of cold water with neutral soap.

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

Disconnection operations

When installed, the fitting tends to act as follows for a certain length of time:
- pincer "A" grips the tang with its steel teeth;
if they are in plastic the teeth might mark the tang slightly without adversely affecting tightness.
- the seals (O'Rings) "B" tend to stick to the surface of the tang in time whether it is of plastic or metal, as a result of this the coupling seems to be seized and impossible to release by only pressing the fins "E" and pulling the coupling.

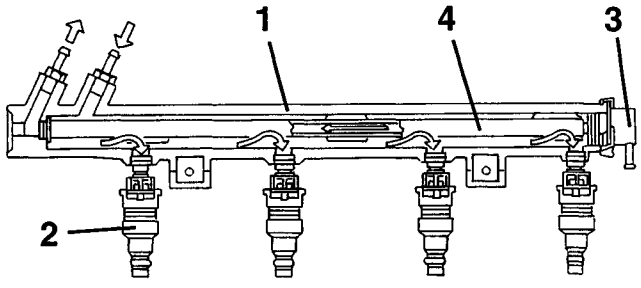


Therefore, to disconnect proceed as follows:
- Turn 1/4 - 1/2 of a turn to right and left several times (at least five) body "C" of the fitting in relation to the tang in order to eliminate friction of the seals on the tang and at the same time push the fitting towards the arrow "D" to loosen the grip of the pincers.
- Press with the fingers on the release buttons.
- Pull the fitting to disconnect it.
If disconnecting is still difficult, repeat these operations firstly checking that the pipe fitting is clean and that there is no mud or dirt in the interstices hindering the movement of the release mechanisms.

NOTE: Do not use pliers, screwdrivers, etc.. for disconnecting.
If the coupling has not been tampered with and the above operations are correctly carried out, no tools are necessary.

FUEL DISTRIBUTOR MANIFOLD

This device is die-cast and incorporates the pressure regulator and the injectors fastened on the manifold itself by special catches.
The fuel returns to the tank through a pipe contained inside the manifold connected to the fuel pressure regulator.

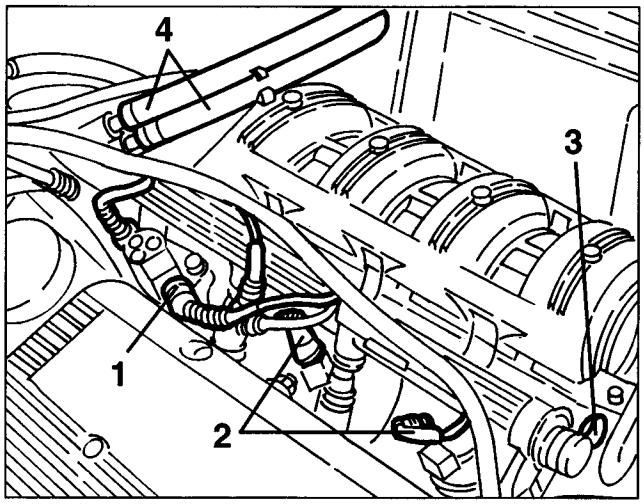


1. Fuel distributor manifold
2. Electroinjectors
3. Pressure regulator
4. Excess fuel return pipe

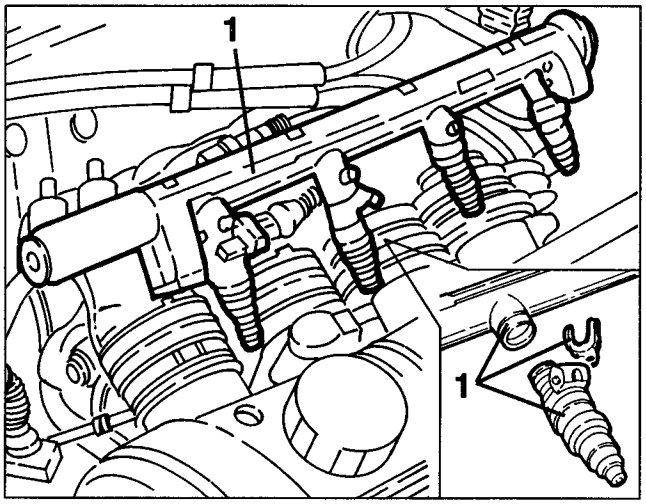
NOTE: Never wash the fuel distributor manifold with aggressive fluids, this operation may only be carried out on the outside using a brush. Otherwise, damage may occur to the seals (O-rings) and to the return circuit plastic piping.

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the timing variator.
2. Disconnect the electrical connections from the electroinjectors and move the wiring to one side.
3. Disconnect the vacuum takeoff pipe from the pressure regulator.
4. Disconnect the fuel return and delivery pipes from the distributor manifold.

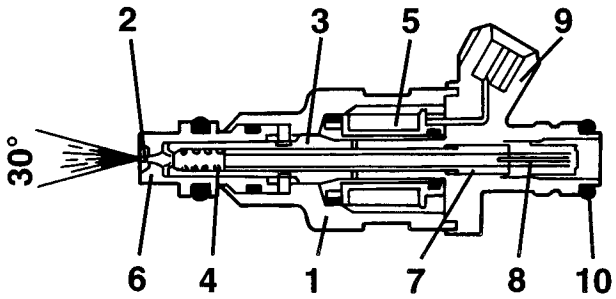


1. Slacken the two fastening screws and remove the fuel distributor manifold complete with injectors and pressure regulator and, if necessary, separate them on the bench.



ELECTROINJECTORS

The electroinjectors are installed on a new aluminium distributor manifold which on one side incorporates the pressure regulator.
The injector nozzle is formed so that the jet of fuel atomizes into a 30° cone.
The injectors are locked by the fuel distributor which presses them into their housings machined on the intake ducts.
The injectors are also anchored to the fuel distributor by "safety catches" and sealed by two O-Rings.
The electroinjectors have the task of metering the amount of fuel needed by the engine.
They are "ON-OFF" devices i.e. they only have two possible conditions, either open or closed.
They will let the fuel pass when they are "open" and prevent it from being delivered when they are "closed".
They basically comprise a nozzle controlled by an electromagnet and by a return spring.
In the rest position, the needle, which forms one piece with the core, is pushed by the spring onto the electroinjector nose to close the hole and ensure that unwanted fuel is unable to come out.
As soon as the winding is energized, the core is attracted, it compresses the spring opening the nozzle hole, thereby allowing the fuel to flow out.
Considering the physical characteristics of the fuel (viscosity, density) and the pressure difference (pressure regulator) constant, the amount of fuel injected depends on the injector opening time only.
The winding energizing time is normally called the "injection time".



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

CHECKING FOR CORRECT OPENING OF ELECTROINJECTORS

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

CHECKING THE SEALING OF ELECTROINJECTORS

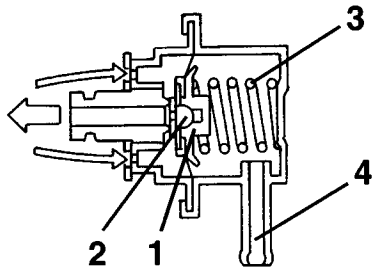
- Remove the electroinjectors complete with fuel distributor manifold, keeping the fuel supply circuit connected.
- Disconnect the electrical connections from the electroinjectors.
- Operate the starter motor and check that there are no leaks of fuel from the electroinjectors; if so replace the faulty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

REMOVAL/REFITTING

Proceed as described in the procedure "Fuel distributor manifold - Removal/Refitting".

FUEL PRESSURE REGULATOR

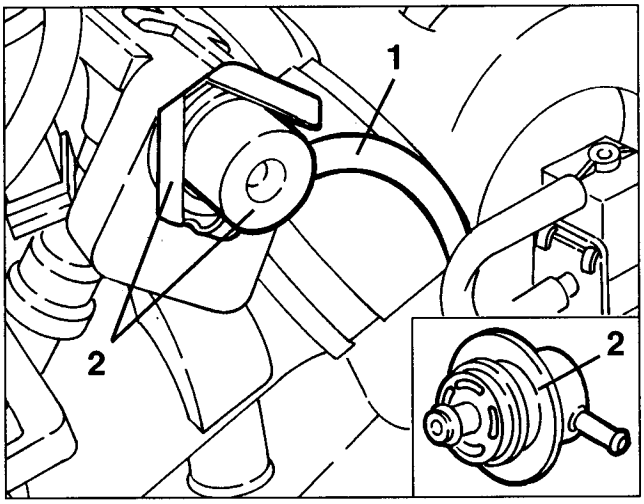
The task of the fuel pressure regulator is to keep the difference between the pressure of the fuel and the pressure in the intake manifold constant.
This way it is possible to meter the amount of fuel solely on the basis of the injector opening time.
The pressure regulator is fitted ddirectly on the fuel distributor manifold.
It is a limiting regulator a diaphragm which regulates the fuel pressure to appr. 3 bar.
When the fuel pressure exceeds the maximum rating, the diaphragm acts on a valve which opens the return pipe, through which the excess fuel is returned to the fuel tank.
A tube connects the regulator spring chamber to the air intake box.
An interdependence is created by this connection between the pressure in the fuel circuit and the pressure in the intake manifold, so that the pressure between the inlet and outlet of the electroinjectors is always the same, when they are open.



1. *Diaphragm*
2. *Flow valve*
3. *Adjustment spring*
4. *Vacuum takeoff*

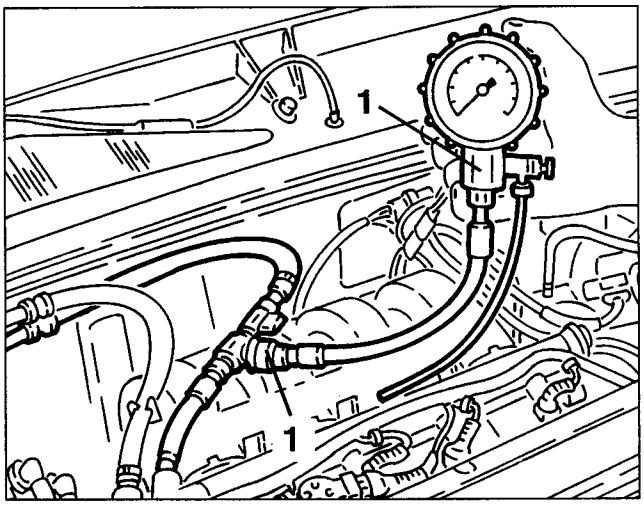
REMOVAL/REFITTING

1. Disconnect the vacuum takeoff pipe from the fuel pressure regulator.
2. Remove the catch and withdraw the fuel pressure regulator complete with O-Ring from the fuel distributor manifold.



CHECKING THE PRESSURE AND TIGHTNESS OF THE FUEL CIRCUIT

1. Disconnect the fuel delivery pipe from the distributor manifold, then connect a pressure gauge, using a "T" adapter, between the damper and the disconnected pipe.



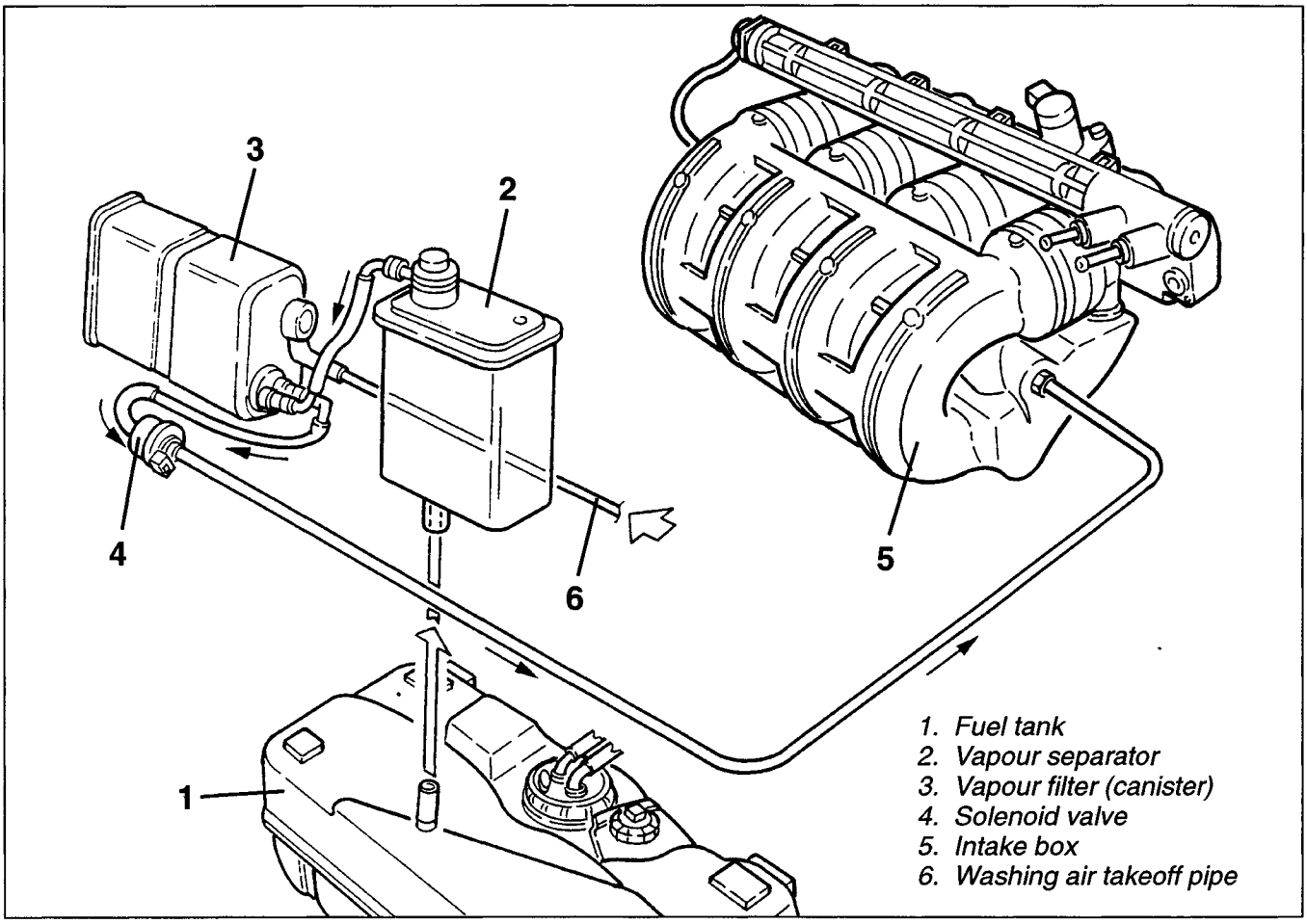
- Disconnect the fuel pressure regulator vacuum takeoff pipe to avoid any irregularities in the rotation speed from causing abnormal readings.
Start the engine and at idle speed check that the fuel pressure is within the specified limits.

Fuel pressure at idle speed
3 bar

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

- Keeping the vacuum takeoff pipe connected to the regulator and with the engine running at idle speed, choke the distributor manifold outlet pipe noting the increase in pressure up to ~ **4 bar** (do not allow the pressure to exceed this rating).
- If the pressure does not reach this rating and no leaks are detected, check the fuel filter and/or that the pump is working properly.

DESCRIPTION OF THE FUEL VAPOUR RECOVERY SYSTEM



The fuel contained in the tank produces a considerable amount of vapours, which would pollute the environment if released.
The vapour control and recovery system gathers these vapours and burns them in the engine. The vapours leading from the fuel tank (1) through a special pipe reach the vapour separator (2) which due to its special shape allows the condensed fuel to return in droplet form to the fuel tank. The remaining vapours are then sent to the fuel vapour filter canister (3) where they are absorbed and stored by the active carbon contained in the filter.
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 is closed and the fuel vapours are collected in the canister in the active carbon.

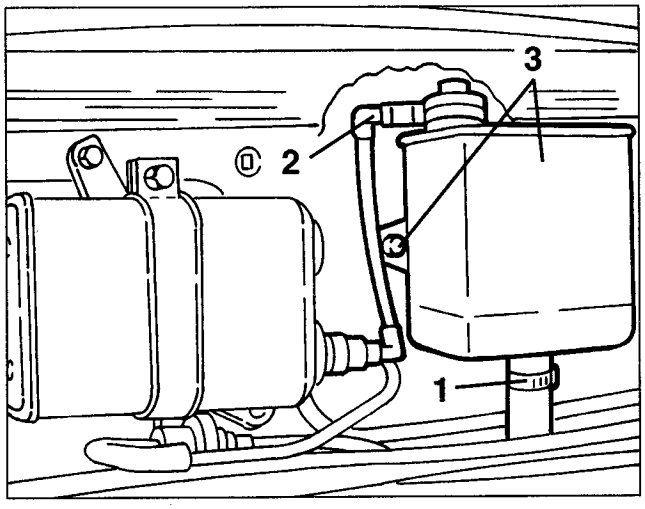
Under certain load conditions the control unit controls the opening of the solenoid valve allowing any fuel vapours in the canister to be withdrawn. This condition remains even if at the exhaust the lambda sensor detects a reduction of oxygen which, due to the presence of too much fuel in the combustion chamber, is signalled to the control unit which delivers less fuel to the injectors so that the engine is always supplied under optimal conditions.
If there is a lack of fuel vapours in the canister, resulting in withdrawing only air, the lambda sensor detects this and signals the control unit of an increase in the oxygen.
In this case the control unit closes the solenoid valve thus preventing the connection of the canister with the intake box, thereby eliminating the excess air.

FUEL VAPOUR SEPARATOR

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

REMOVAL/REFITTING

- Remove the spare wheel and the luggage compartment front panel.
1. Disconnect the fuel vapour inlet pipe from the separator.
2. Disconnect the fuel vapour delivery pipe to the canister from the separator.
3. Slacken the two fastening screws and remove the fuel vapour separator.

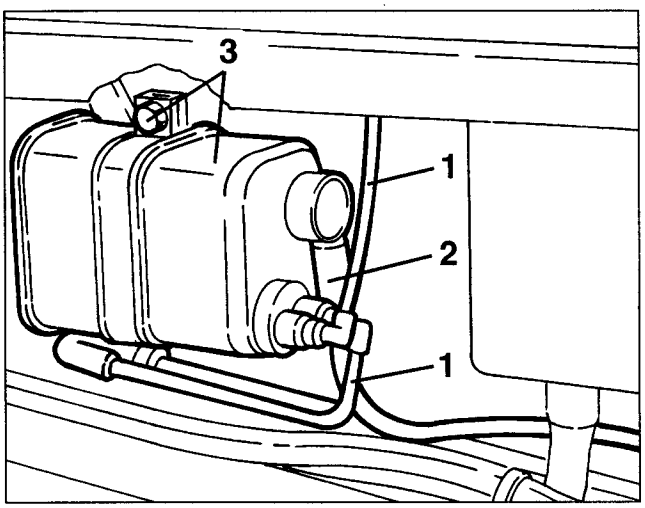


FUEL VAPOUR FILTER (CANISTER)

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

REMOVAL/REFITTING

- Remove the spare wheel and the luggage compartment front panel.
1. Disconnect the fuel vapour inlet and outlet pipes from the canister.
2. Disconnect the outside air inlet pipe from the one-way valve on the canister.
3. Slacken the fastening clamp screw and remove the canister.

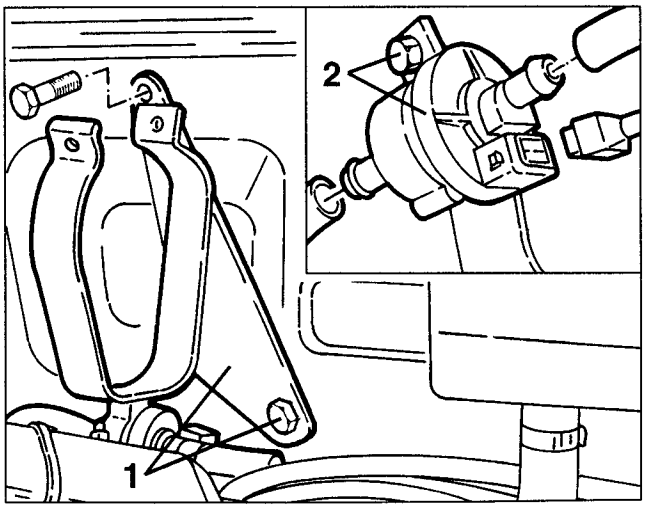


FUEL VAPOUR SOLENOID VALVE

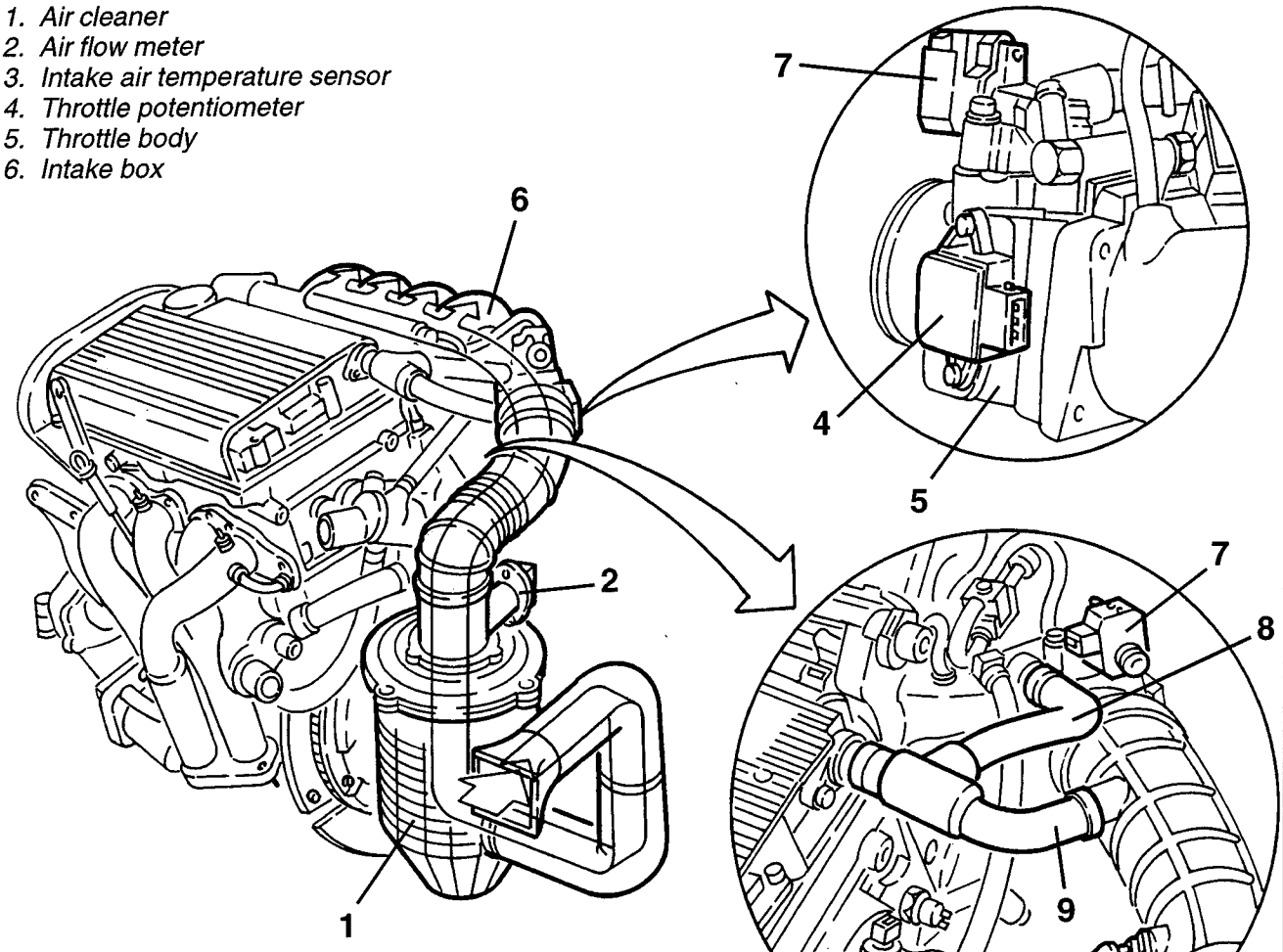
The reason for the use of this valve, controlled by the electronic control unit, is to send the vapours stored in the canister to the engine intake.
This valve enclosed in a casing, comprises a mobile part or shutter, restrained to a plate spring; the fixed part is formed of a metal cylinder, perforated inside, on which the coil is wound.

REMOVAL/REFITTING

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



AIR SUPPLY AND OIL VAPOUR RECOVERY SYSTEM



NOTE: From chassis no. ..... the air supply system is fitted with intake resounders (for removing/refitting see specific paragraph).

DESCRIPTION

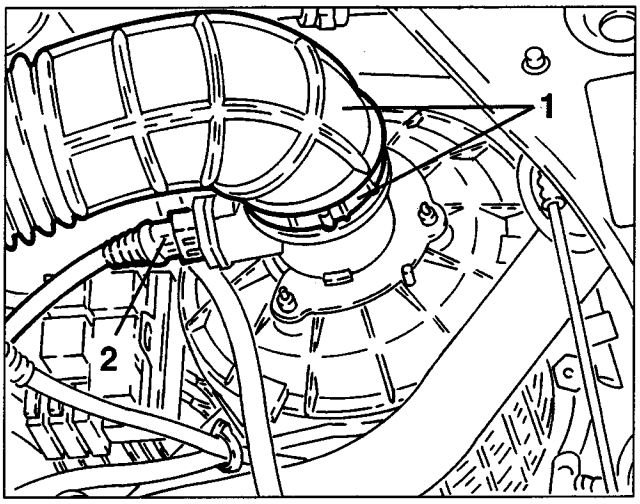
The air taken in through a dynamic inlet and filtered by a cartridge element (1), passes through the hot film air-flow meter (2) and from this through the corrugated sleeve, which houses the intake air temperature sensor (3), it reaches the throttle body (5). The latter, controlled by the accelerator cable, adjusts the amount of air drawn into the box (6). On one side of the throttle body there is the potentiometer (4) fastened to the pivot pin of the throttle itself which informs the control unit of the position of the throttle. An additional air solenoid valve (7) on the throttle body by- passes the throttle through a special pipe to keep the idle rpm constant during particular operating conditions of the engine. The fuel vapours (see specific paragraph) and the oil vapours flow to the air supply system. The oil vapours are formed when the engine is running and they are collected in the cylinder head from which the condensed oil returns to the crankcase, while the remaining vapours are sent to the intake through two pipes.

When the engine is running at idle speed the oil vapours are ducted to the throttle body through the special pipe (8).

At higher loads, the vapours are sent upstream of the throttle valve through a pipe (9) connected with the corrugated sleeve and then burnt in the engine.

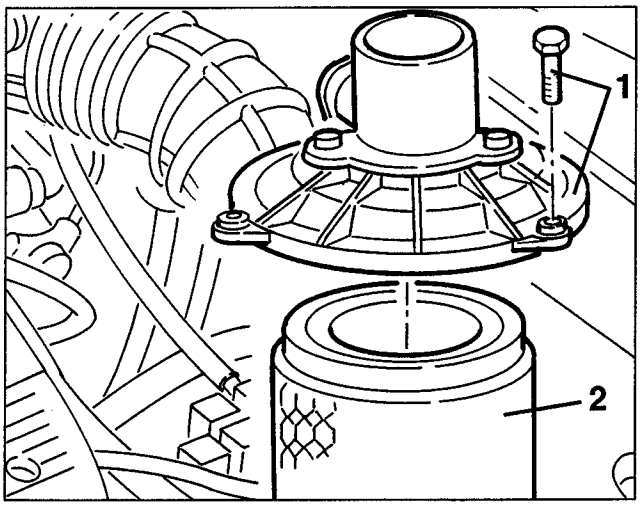
CHANGING THE AIR CLEANER CARTRIDGE

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



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

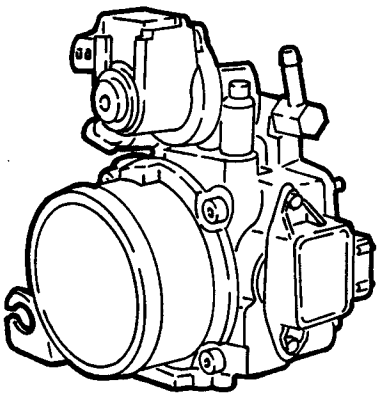
WARNING:
Any cleaning operation on the filter can cause damage to it, and might compromise the correct functioning of the engine supply system.
If the filter shows traces of oil, check the whole air circuit for possible leaks.



THROTTLE BODY

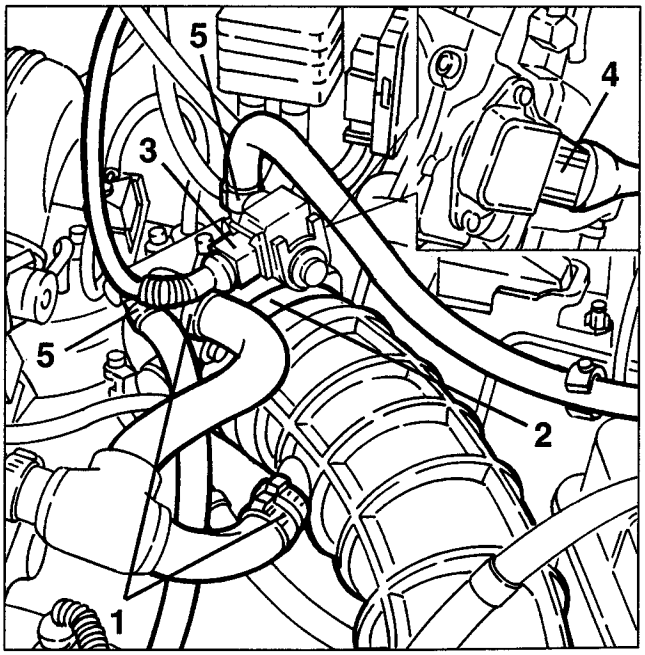
The throttle body adjusts the amount of air sent to the intake box in relation to the position of the accelerator pedal.

In fact, the accelerator acts on a specific sector of pulley locked on the throttle valve pivot pin.
A coil spring allows the throttle to return to the closed position.
To prevent the formation of ice on the throttle valve which would prevent it from closing, the throttle body is heated by the engine coolant fluid.
The constant idle speed actuator is installed directly on the throttle body.

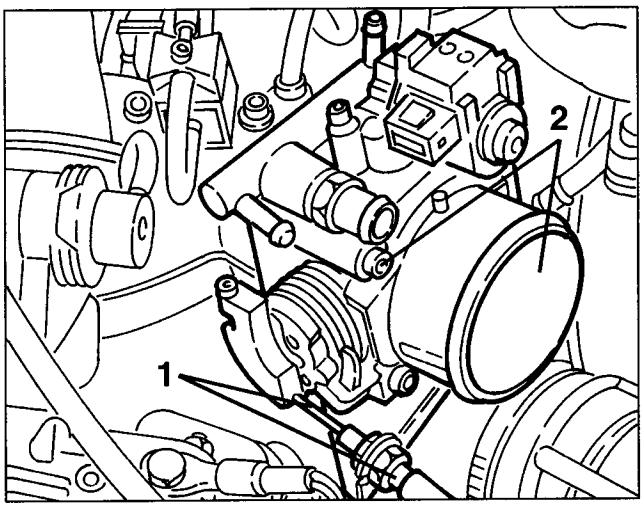


REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the oil vapour recirculation pipes from the throttle body and from the corrugated sleeve.
2. Slacken the fastening clamp and disconnect the corrugated sleeve from the throttle body.
3. Disconnect the electrical connection from the constant idle speed actuator.
4. Disconnect the electrical connection from the throttle potentiometer.
5. Disconnect the two engine coolant fluid inlet and outlet pipes from the throttle body.



1. Disconnect the accelerator cable from the throttle.
- Release the pipes from the fastenings on the bracket under the throttle body.
2. Slacken the four fastening screws and remove the throttle body complete with potentiometer and constant idle speed actuator and separate them on the bench.
- Remove the throttle body seal.

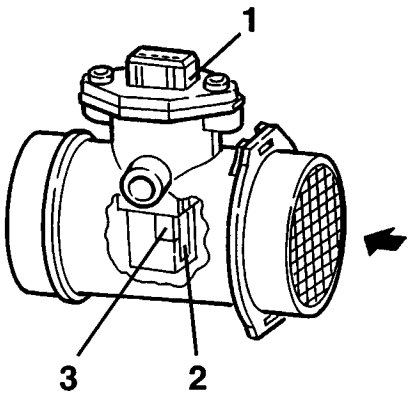


AIR-FLOW METER

The air flow meter is of the "heated film" type.
Its operating principle is based on a heated diaphragm interposed in a measurement duct through which the air admitted to the engine flows.
The hot film diaphragm is kept at a constant temperature (~ 120°C above the temperature of the incoming air) by the heating resistance in contact with it.
The mass of air crossing the measurement duct tends to withdraw heat from the diaphragm, therefore, in order to keep its temperature constant, a certain amount of current must flow through the resistance.
This current is measured by a suitable Wheatstone bridge.
Thus, the current is proportionate with the mass of flowing air.

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

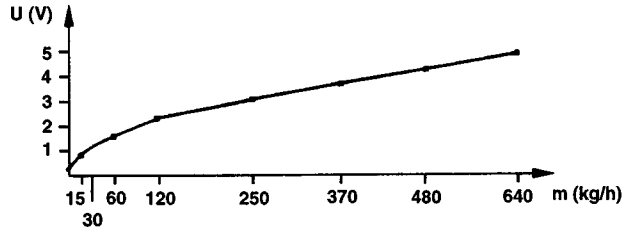
The correct operation of the air flow meter depends on the condition of the air cleaner, which must therefore be checked often.



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

CARATTERISTICHE TECNICHE	
Current that crosses the diaphragm:	
flow rate (kg/h)	current (A)
0 640	≤ 0.25 ≤ 0.80

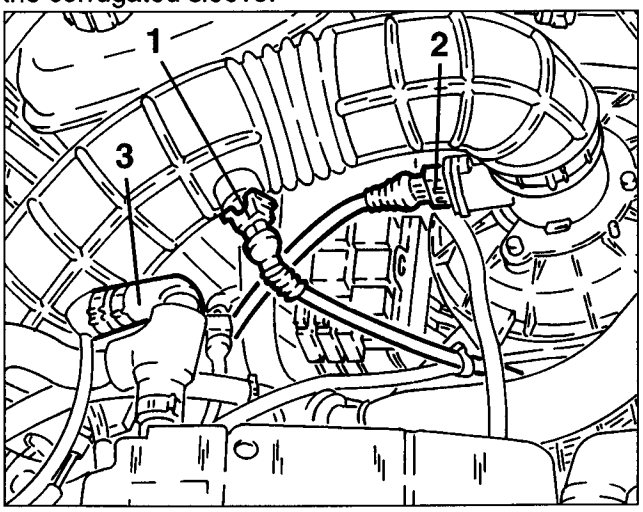
Characteristic curve of sensor



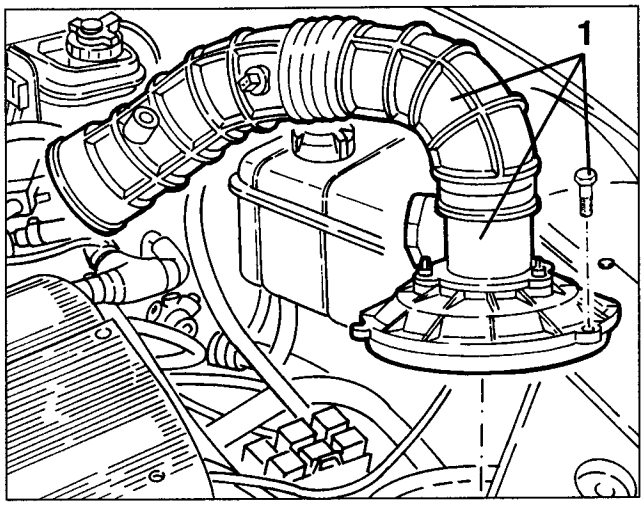
m = flow rate
U = voltage between pins 4 and 2

REMOVAL/REFITTING

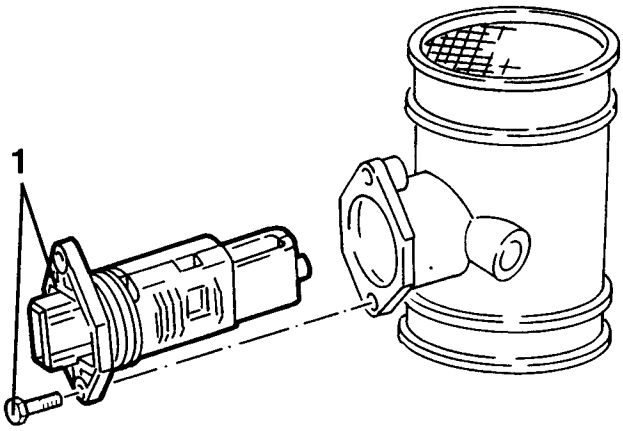
1. Disconnect the electrical connection from the intake air temperature sensor.
2. Disconnect the electrical connection from the air-flow meter.
3. Disconnect the oil vapour recirculation pipe from the corrugated sleeve.



1. Slacken the clamp fastening the corrugated sleeve to the throttle body, slacken the air cleaner cover fastening screws, then remove it complete with air-flow meter and separate them on the bench.



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



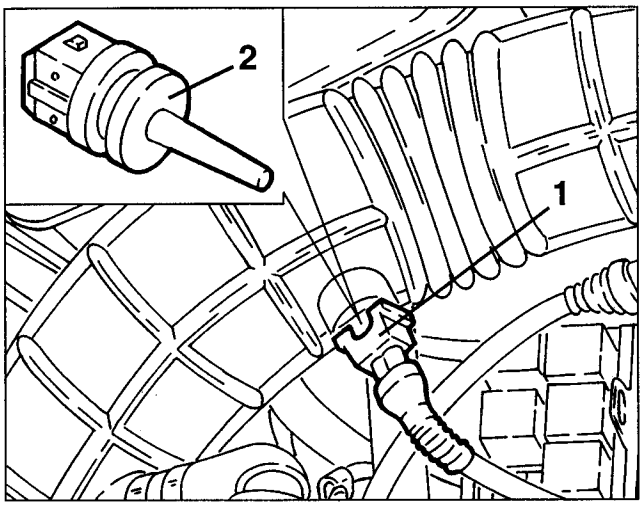
INTAKE AIR TEMPERATURE SENSOR (NTC)

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

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the intake air temperature sensor.

2. Withdraw and remove the intake air temperature sensor from the corrugated sleeve.

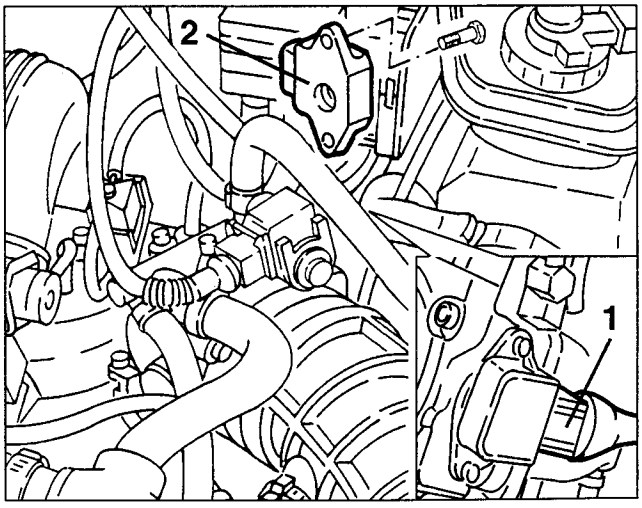


THROTTLE POTENTIOMETER

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

REMOVAL/REFITTING

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



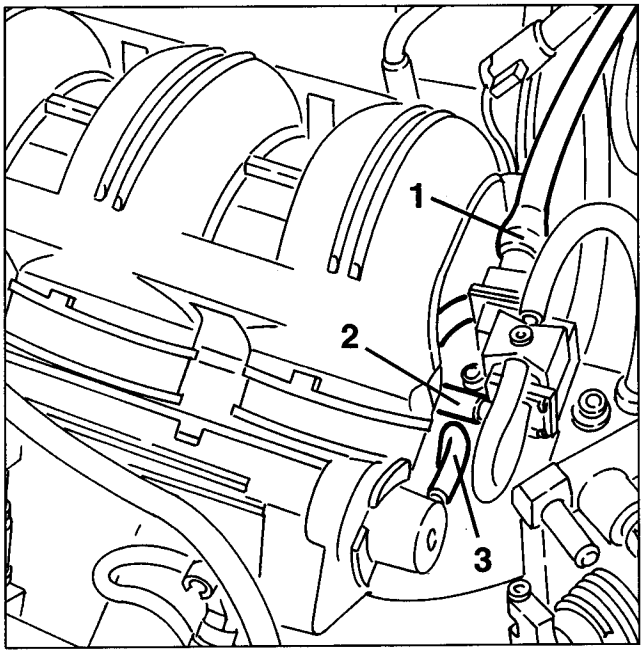
AIR INTAKE BOX

REMOVAL/REFITTING

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

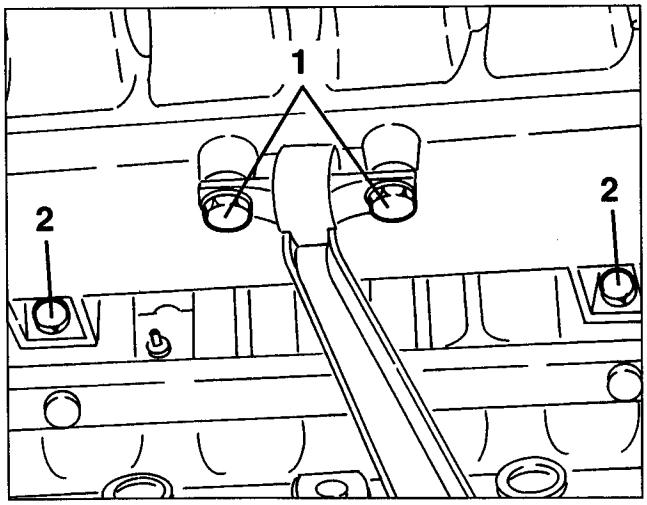
Proceed as in the first steps of the procedure "Throttle body - Removal/Refitting" up to disconnecting the accelerator cable.

1. Disconnect the electrical connection from the E.G.R. modulation solenoid valve.
2. Disconnect the E.G.R. valve connection pipe from the modulation solenoid valve.
3. Disconnect the fuel pressure regulator vacuum takeoff pipe.

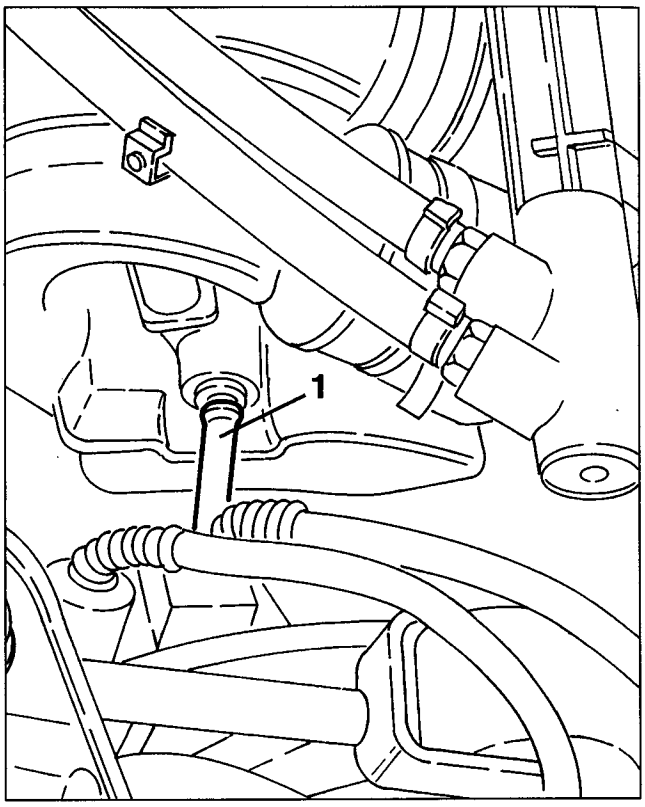


- Disconnect the vacuum takeoff pipe from the servo-brake.

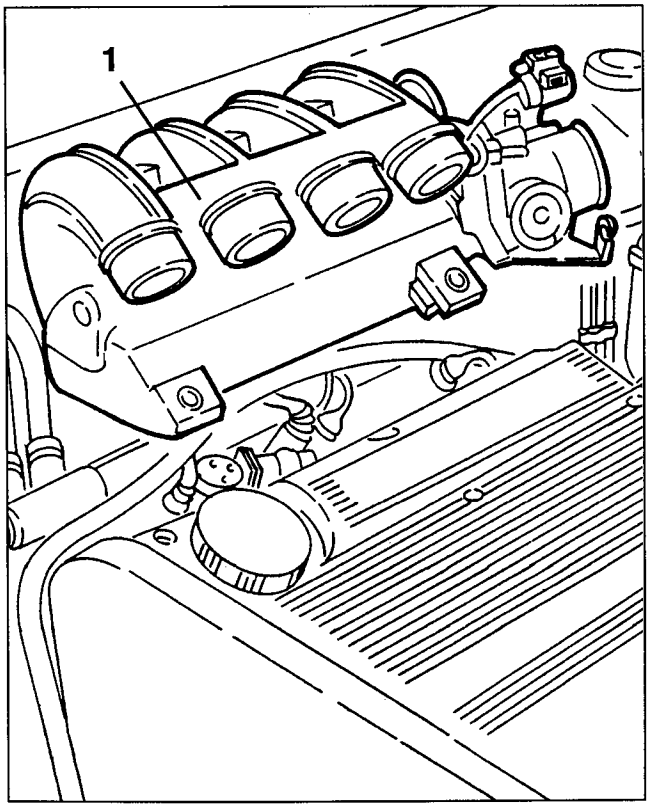
1. Raise the car and slacken the two screws fastening the support to the intake box.
2. Slacken the two screws fastening the intake box to the cylinder head.



1. Disconnect the fuel vapour recirculation pipe from the intake box.

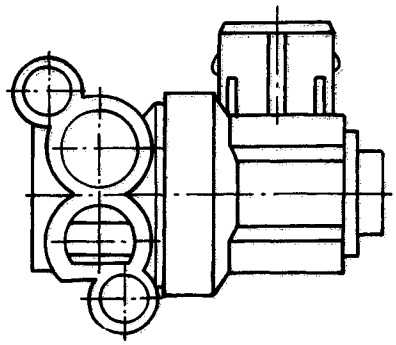


1. Slacken the fastening clamps and remove the intake box pulling it upwards.



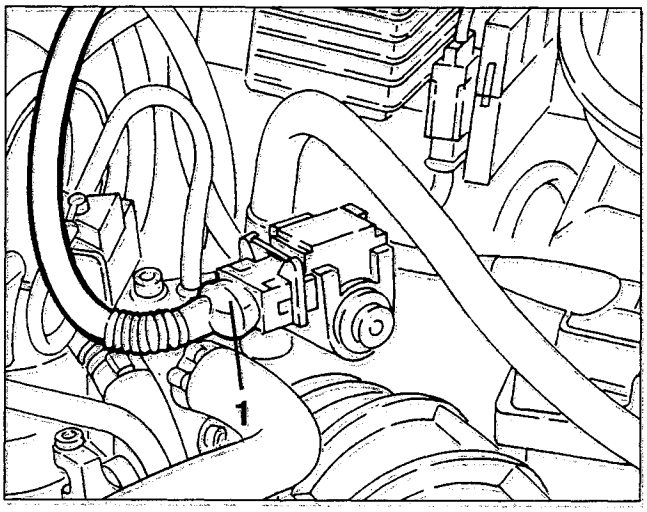
CONSTANT IDLE SPEED ACTUATOR

Idle speed rpm is controlled by an actuator fitted directly on the throttle body, but since it is more compact and can be operated individually, it is on the whole more cost- effective and reliable. The actuator adjusts the amount of air taken in by the engine when the throttle valve is closed. This makes it possible to compensate the power required by the various services (conditioner compressor, power steering, alternator) so that the engine speed remains unaffected.
The opening and closing controls are independent due to a double electromagnetic circuit with considerable advantages in terms of prompt adjustment.
In fact, as the control unit is "self-adaptive", it is necessary to follow and "detect" the changes that occur in the engine (different internal frictions at different temperatures, settling of the engine over the course of time etc.) so that idle speed remains constant under all conditions.
Lastly, in the event of a fault, a spring moves the actuator to an intermediate degree of opening to enable the car to reach an authorised service centre.

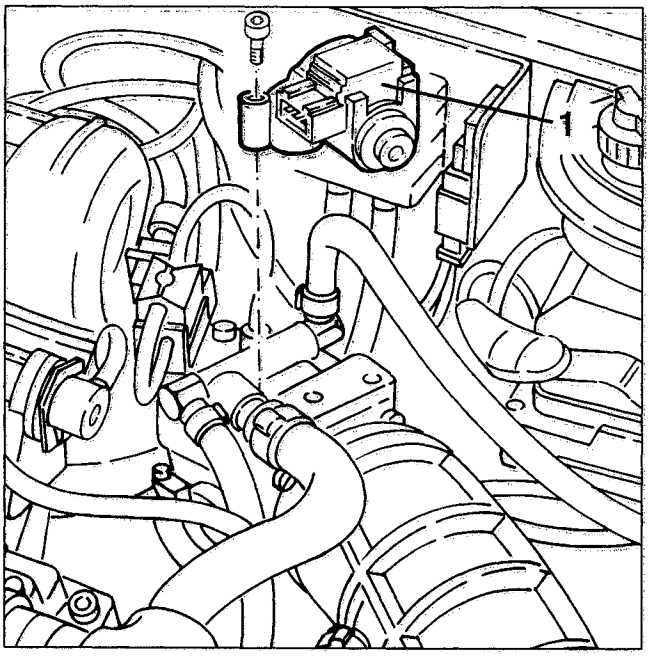


REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the constant idle speed actuator.



1. Slacken the two fastening screws and remove the constant idle speed actuator from the throttle body.
- Remove the seal.

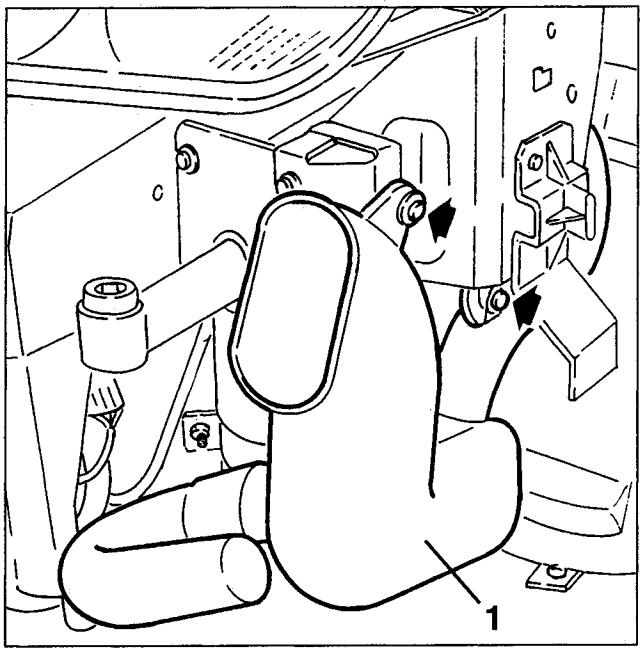


AIR INTAKE RESOUNDERS

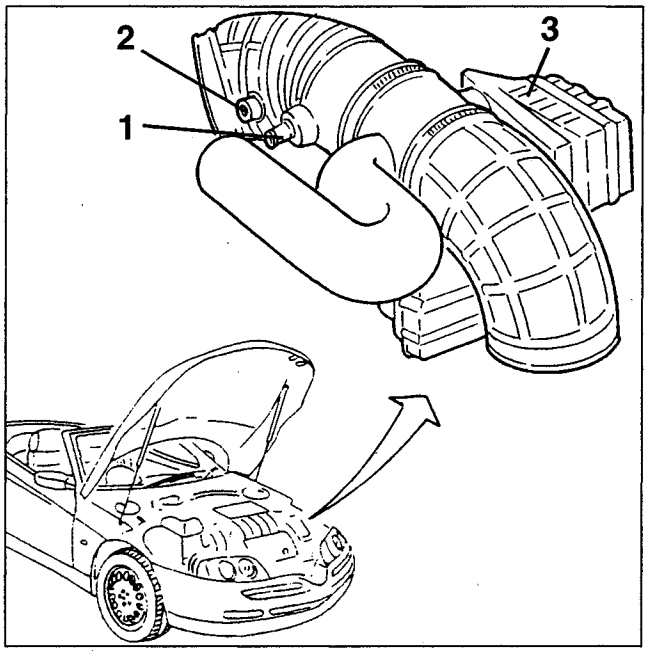
REMOVING/REFITTING

- Set the car on a lift and raise it.
- Remove the front bumper.

1. Slacken the fastening and remove the air intake resounder upstream of the cleaner.

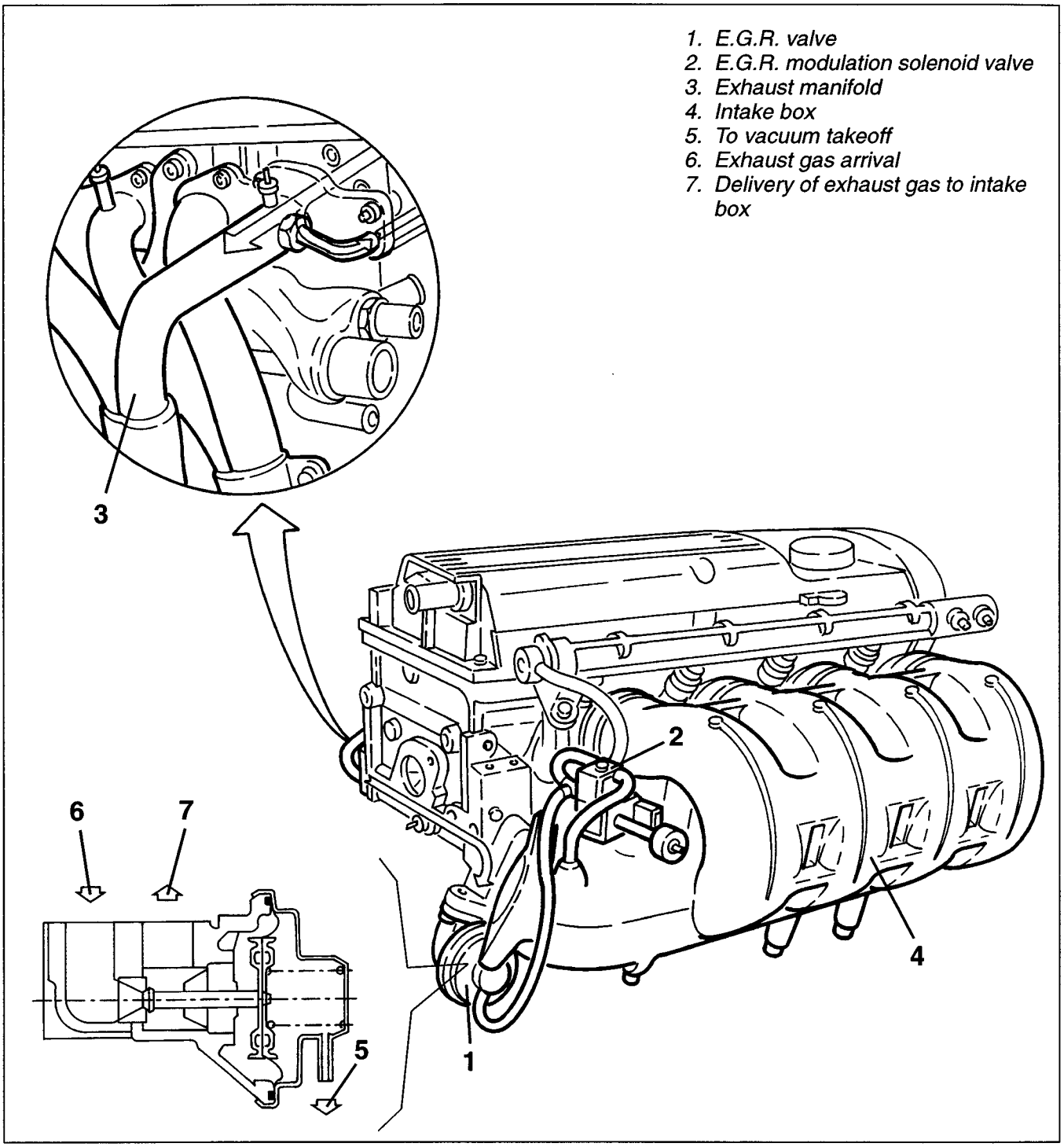


1. Lower the car and disconnect the electrical connection of the intake air temperature sensor.
2. Disconnect the oil vapour recirculation pipe from the corrugated sleeve.
3. Slacken the fastening clamps and remove the air intake resounder downstream of the cleaner complete with corrugated sleeve.



WHITE

DESCRIPTION OF SYSTEM

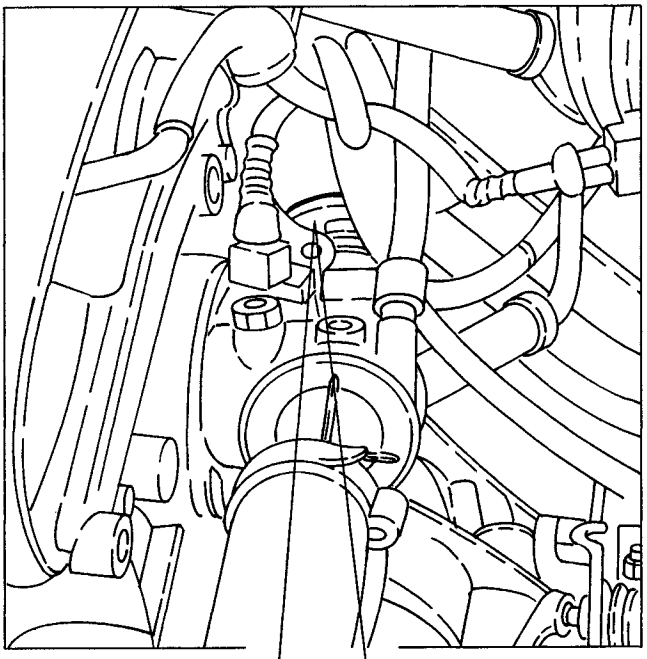


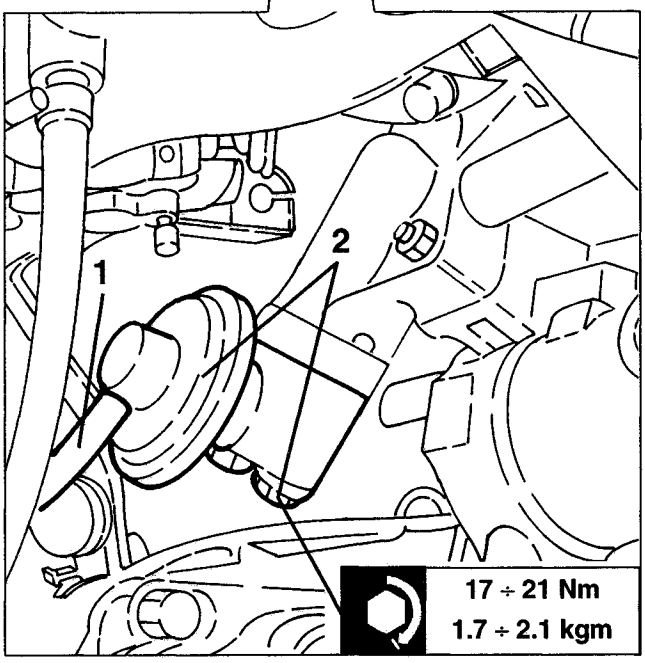
To further reduce emissions of NOx (nitric oxides) the supply system is fitted with an E.G.R. valve (1).
The E.G.R. valve (Exhaust Gas Recirculation) withdraws part of the exhaust gas and returns it to the intake box (4), where it is mixed with the intake air and burnt in the engine.
The E.G.R. valve is operated by the vacuum modulated by the solenoid valve (2) controlled by the MOTRONIC control unit.
The amount of exhaust gas sent to the engine is determined by the MOTRONIC control unit, taking account of the characteristic curve of the E.G.R. control depending on the engine load and speed and on the temperature of the coolant fluid.
Through the MOTRONIC control unit the solenoid valve modulates the vacuum to be sent to the E.G.R. valve for opening.
The E.G.R. valve is not activated at idle speed, in neutral gear and for engine speeds below 2000 rpm. When the engine coolant fluid temperature excedds 60 °C the E.G.R. valve is operational and it it is completely closed at engine speeds in excess of 4600 rpm.

E.G.R. VALVE

REMOVAL/REFITTING

1. Working from the engine compartment, disconnect the connection pipe with the modulation solenoid valve from the E.G.R. valve.
2. Slacken the two fastening screws and remove the E.G.R. valve from the intake box.

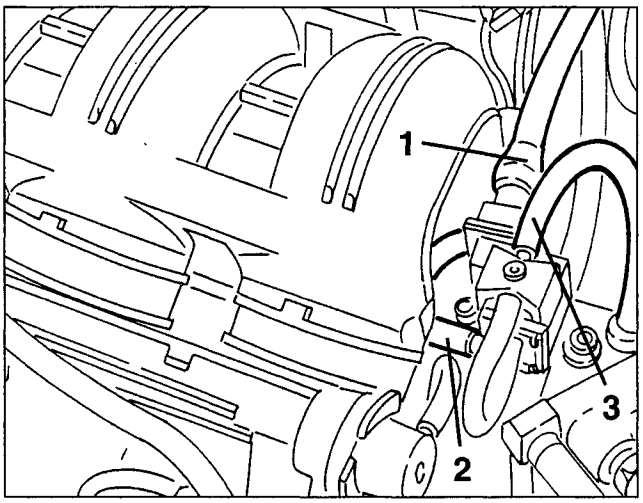




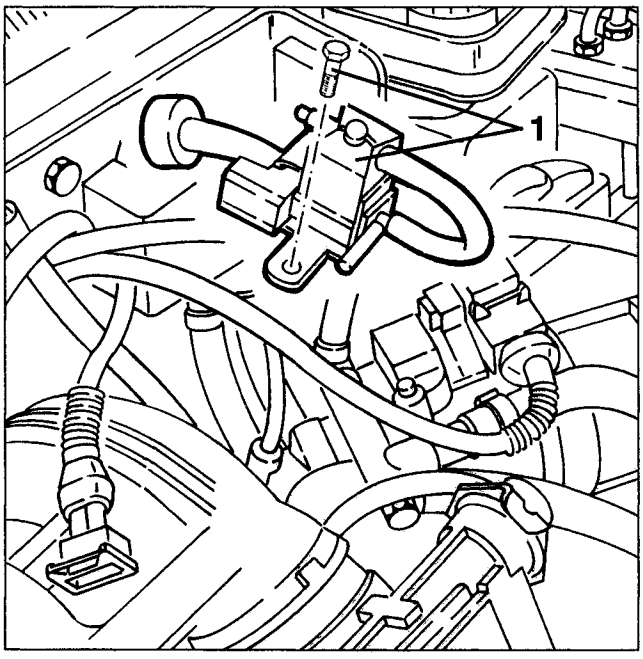
E.G.R. MODULATING SOLENOID VALVE

REMOVAL/REFITTING

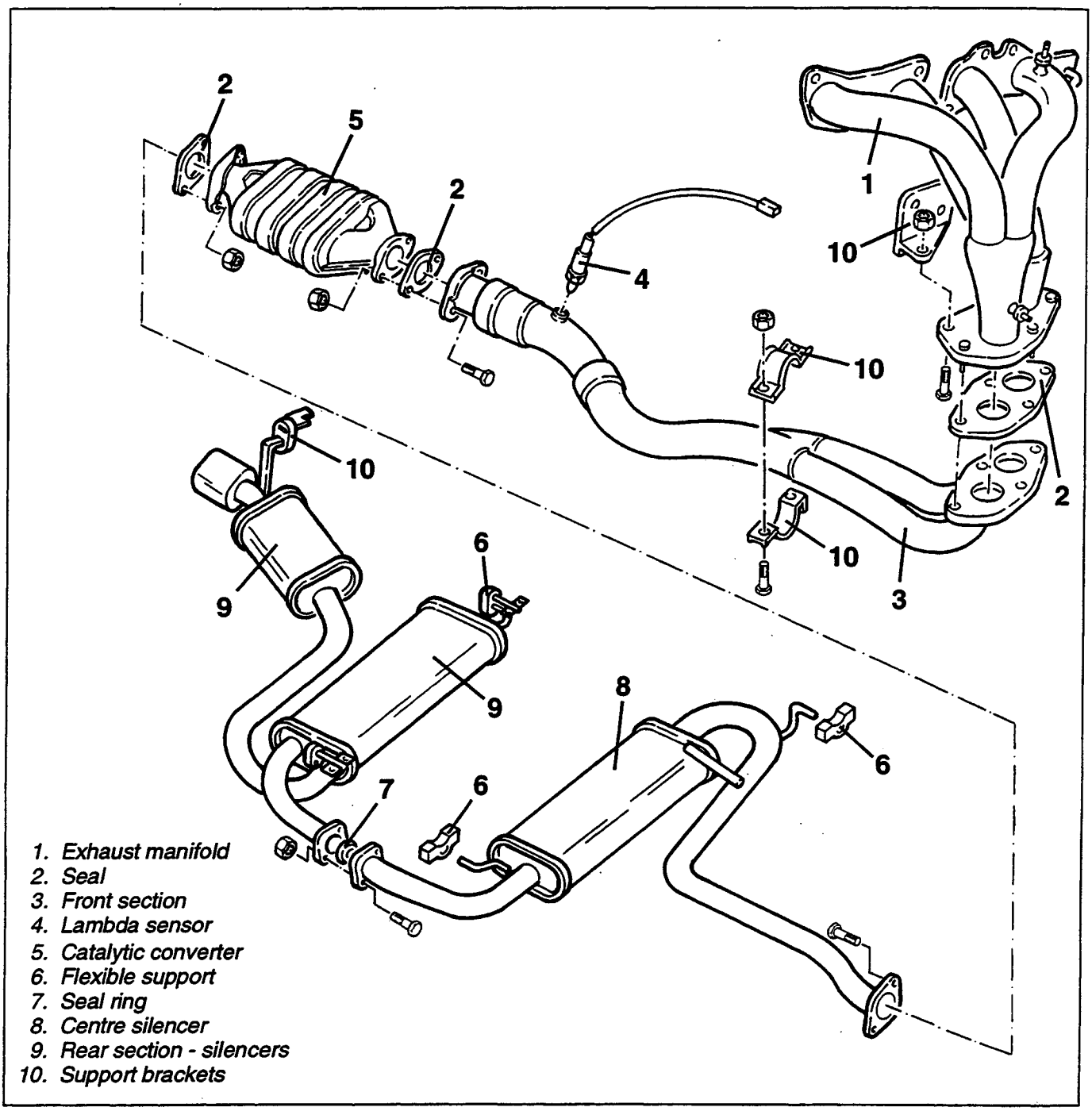
- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the E.G.R. modulating solenoid valve.
2. Disconnect the the connection pipe with the E.G.R. valve from the modulation solenoid valve.
3. Disconnect the vacuum takeoff pipe from the E.G.R. modulation solenoid valve.



1. Slacken the two fastening screws and remove the E.G.R. modulation solenoid valve.



DESCRIPTION



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

The exhaust gas from the cylinder head converged in two double manifolds (1) connected below by a single flange. From these, via the front section of the exhaust pipe (3), it reaches the three-way catalytic converter (5) where most of the polluting substances are transformed.
On the front section of the exhaust pipe there is a flexible piece which limits the transmission of vibrations and allows the takeoff of exhaust gas upstream of the catalytic converter.
The lambda sensor (4) is fitted on the front section of the exhaust pipe at the inlet of the catalytic converter and it informs the control unit of the oxygen content in the exhaust gas making it possible to adjust the injection time to keep stoichiometric ratio (air-fuel) at an optimum level.
The exhaust gas leaving the catalytic converter crosses three special silencers (8 - 9).
The various parts of the exhaust pipe are connected by flanges with interposed seals and they are supported at the underbody by flexible supports.
The very high amount of heat radiated to the body by the catalytic converter is limited by a set of heat shields between the exhaust pipe and the body itself.

WARNING:
When the engine is running all the exhaust pipes and the catalytic converter in particular heat considerably. Before doing any work, it is therefore necessary to leave the engine off for an adequate length of time.
Never touch the catalytic converter without adequate protection, such as gloves, etc.
Do not leave easily inflammable materials nnear the catalytic converter.

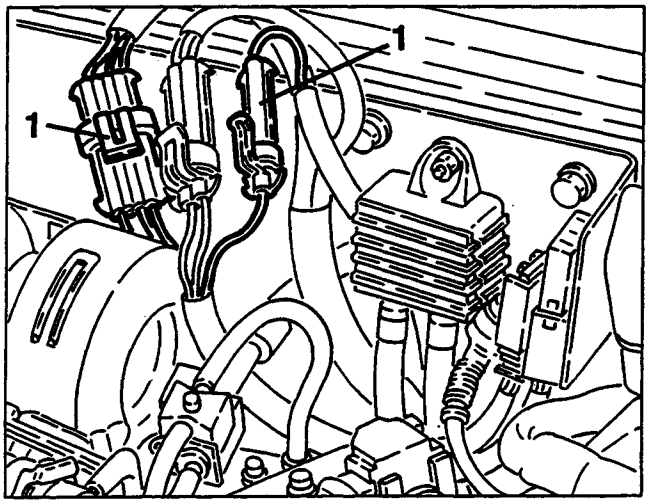
LAMBDA SENSOR

For this subject, refer to the 1996 TB.

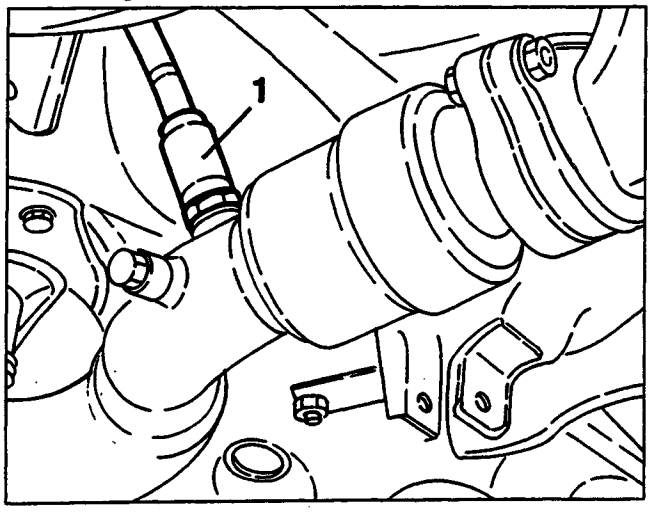
REMOVING/REFITTING

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

1. Disconnect the lambda sensor electrical connections.



1. Slacken and remove the lambda sensor complete with wiring.



CHECKING EMISSIONS AT THE EXHAUST

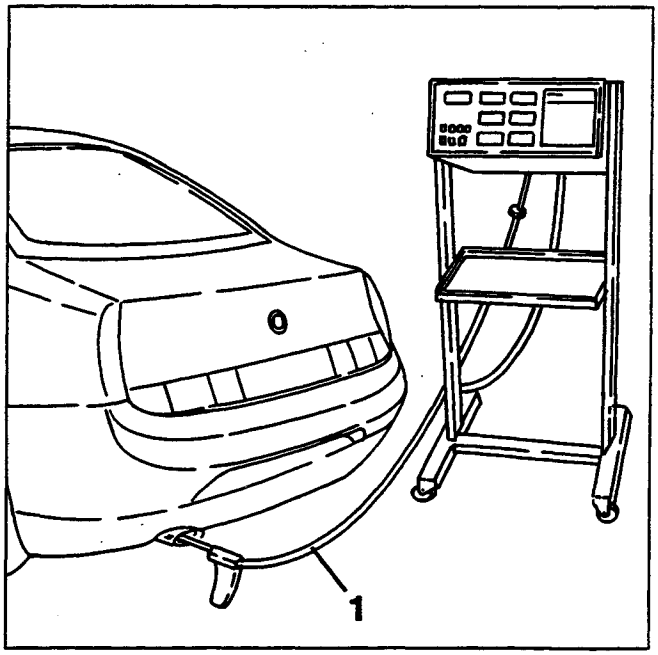
WARNING:
Exhaust emissions must be checked outdoors, or at least in a suitable place equipped according to the regulations in force.

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

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

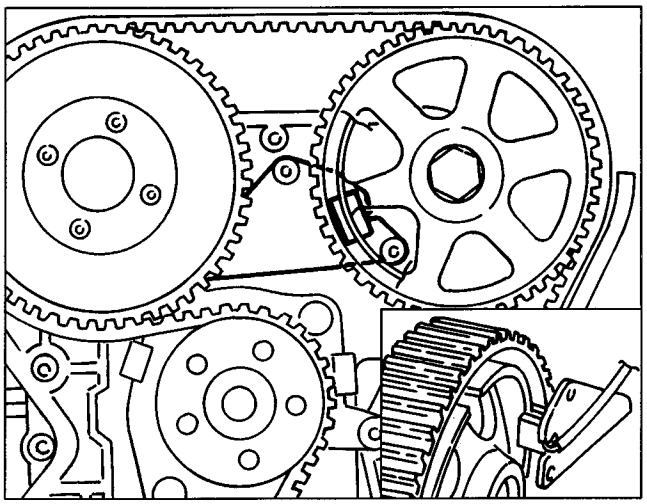
1. Insert the feeler of the analyzer in the end piece of the exhaust pipe anch check that the amount of CO and HC are within the specified limits.

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



TIMING SENSOR

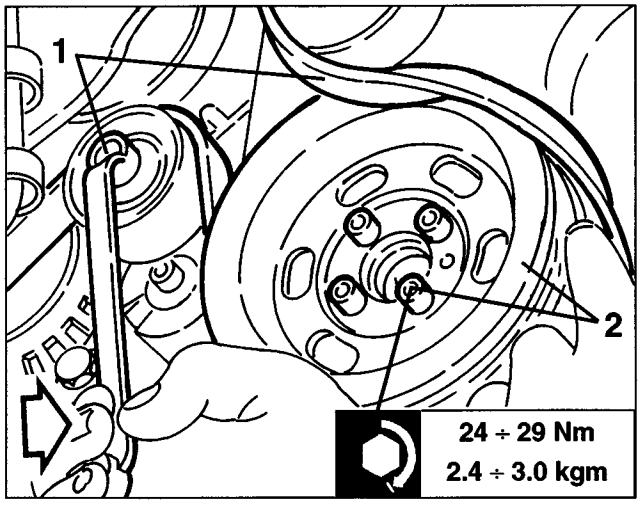
The timing sensor (cam angle sensor) comprises a Hall effect device.
The voltage signal "lowers" sharply when the tooth machined on the camshaft drive pulley opposite the sensor passes in front of it.



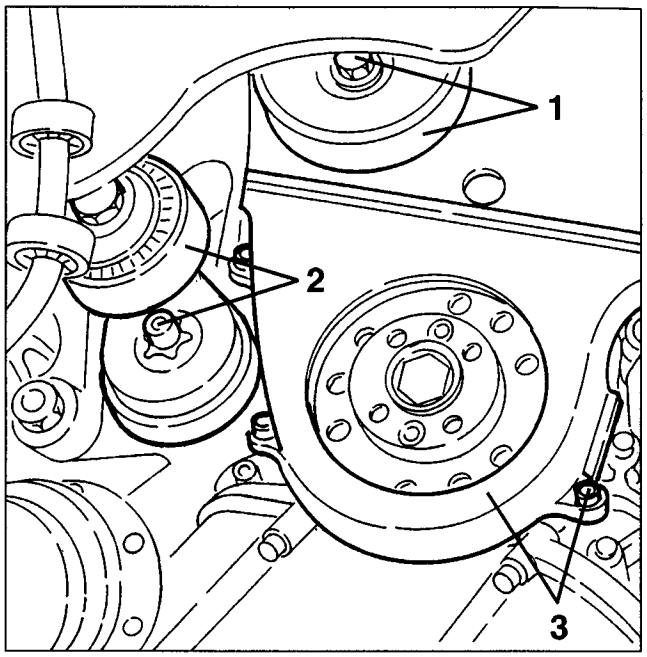
REMOVAL/REFITTING

- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Remove the right front wheel and mud flap.

1. Raise the car and working as illustrated on the belt tensioner loosen the tension of the auxiliary components drive belt and remove it.
2. Slacken the four fastening screws and remove the auxliary components drive pulley.

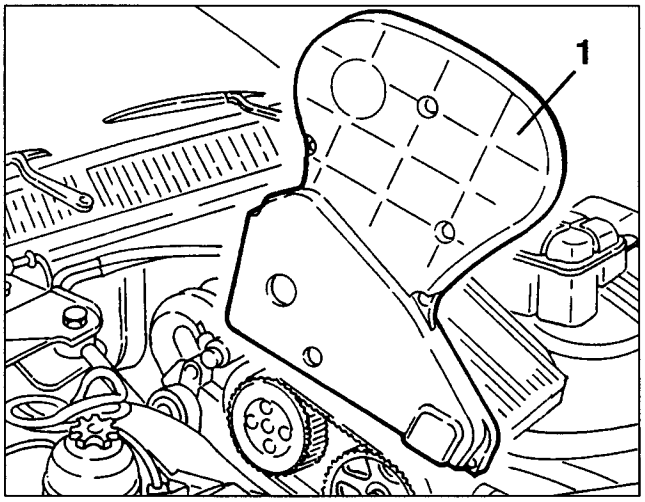


1. Slacken the fastening screw and remove the belt tensioner.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.

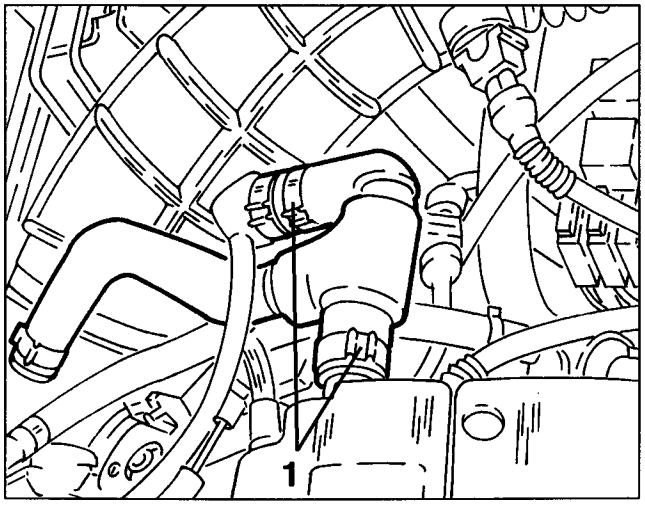


- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.

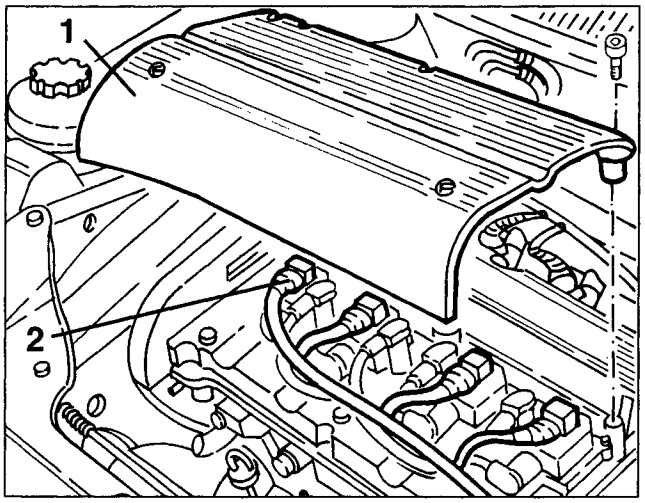
1. Lower the car, slacken the fastening screws and remove the upper cover.



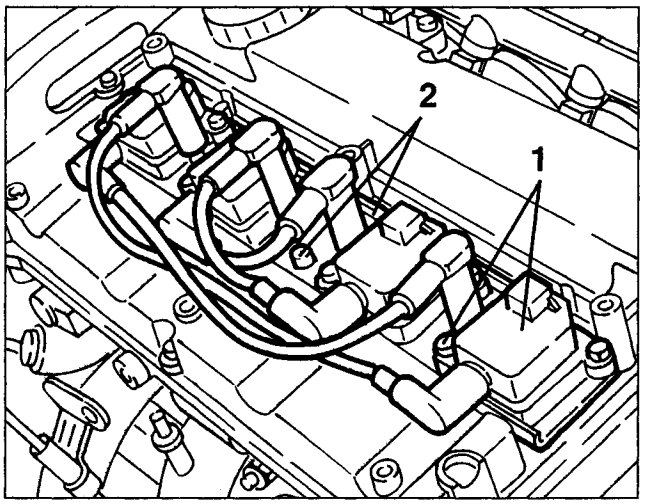
1. Disconnect and remove the oil vapour recovery pipes.



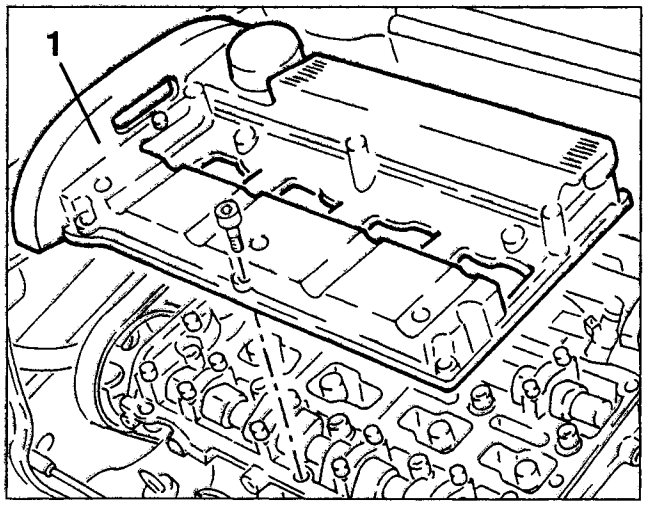
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



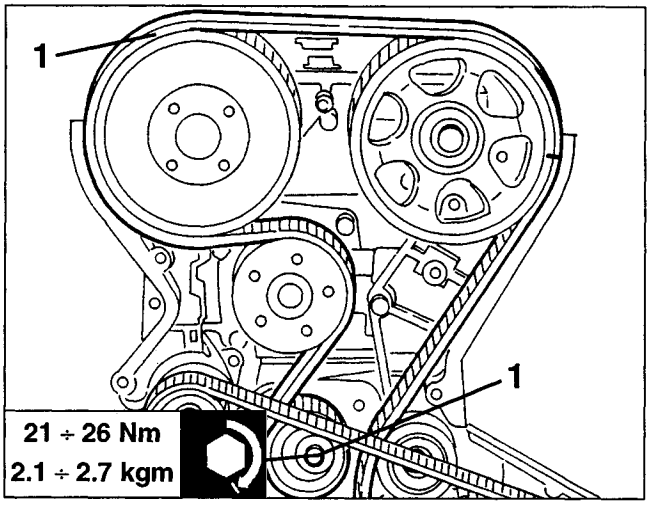
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



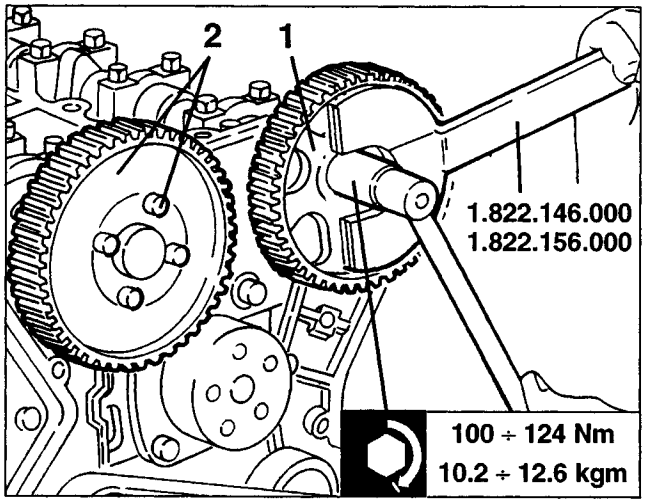
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



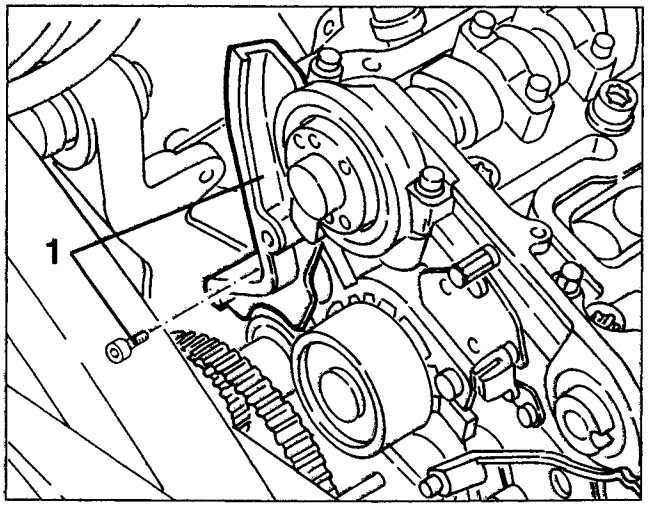
1. Working on the timing gear belt tensioner, loosen the tension on the belt, then take it off the timing gear drive pulleys.



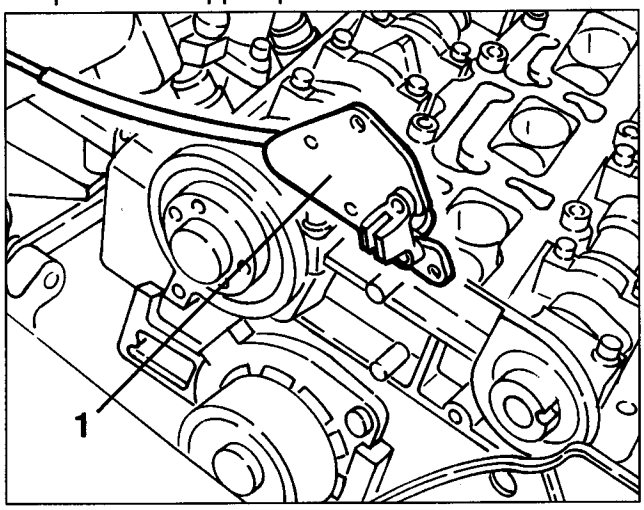
1. Using tools no. 1.822.146.000 and no. 1.822.156.000 slacken the screw fastening the timing gear exhaust side drive pulley and remove it.
2. Slacken the four screws fastening the timing gear intake side drive pulley and remove it.



1. Slacken the fastening screws and remove the intake side cover.



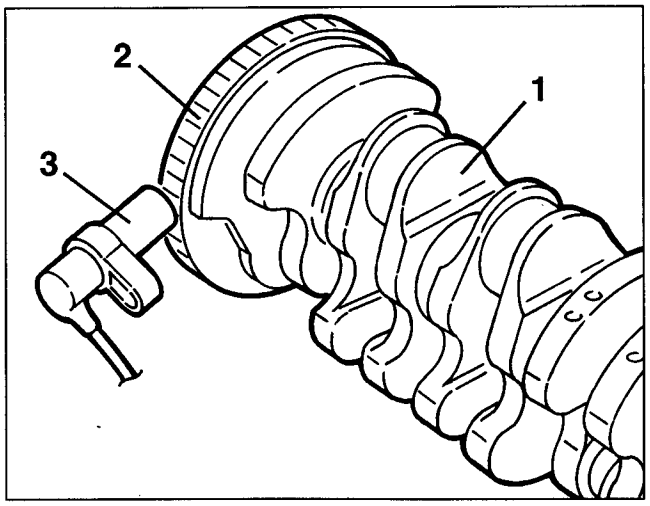
1. Disconnect the electrical connection, slacken the two fastening screws and remove the timing sensor complete with support plate.



For re-assembly of the timing gear drive belt, valve gear timing and assembly and tensioning the auxiliary components drive belt see GROUP 00.

RPM SENSOR AND TIMING SENSOR

The sensor for detecting the rpm and engine timing is of the inductive type which operates through the change of a magnetic field generated by the passage of the teeth of a toothed pulley (phonic wheel) shrunk onto the crankshaft.
The teeth which pass in front of the magnetic field generator change the gap between the pulley and the sensor; therefore, the dispersed flux, which consequently varies, induces an alternate sinusoidal voltage in the coils of the sensor, the amplitude of which depends on the peripheral speed of the phonic wheel, the gap between the tooth and the sensor, the shape of the teeth, the magnetic characteristics of the sensor and on the support system.



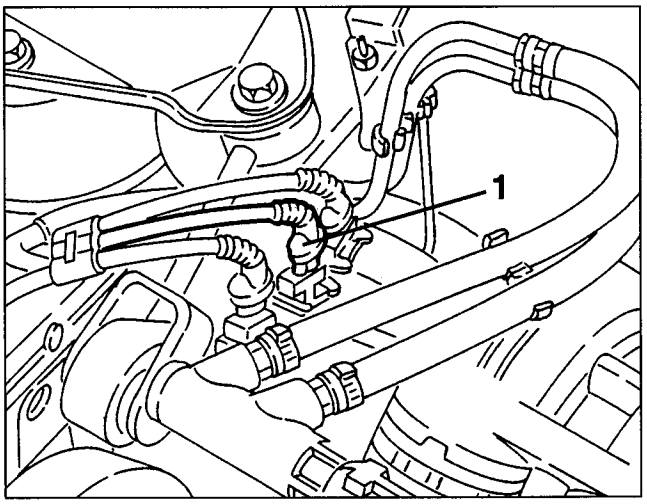
1. Crankshaft
2. Phonic wheel
3. Rpm and timing sensor

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

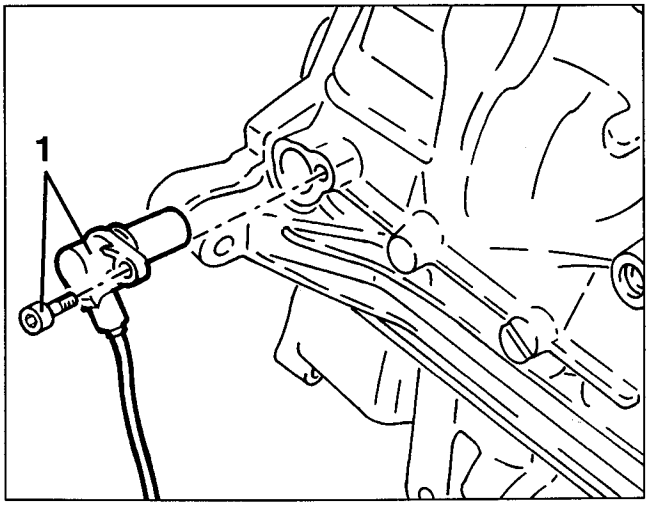
REMOVAL/REFITTING

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

1. Disconnect the timing sensor electrical connection.

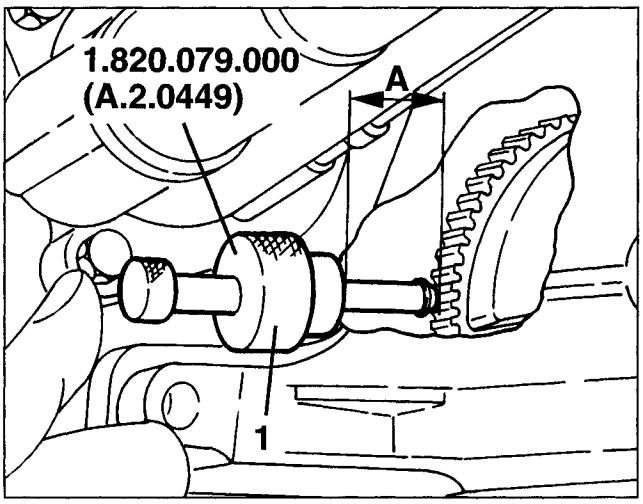


1. Raise the car, slacken the fastening screw and remove the rpm and timing sensor.

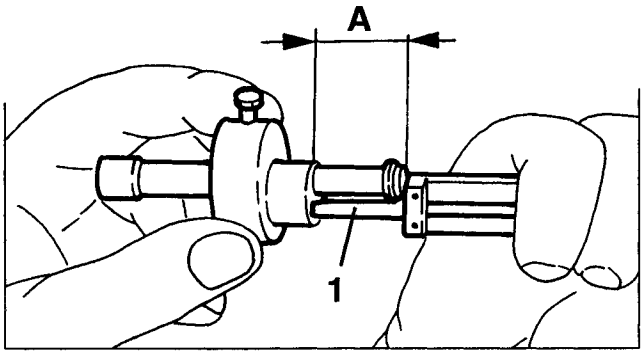


CHECKING THE GAP

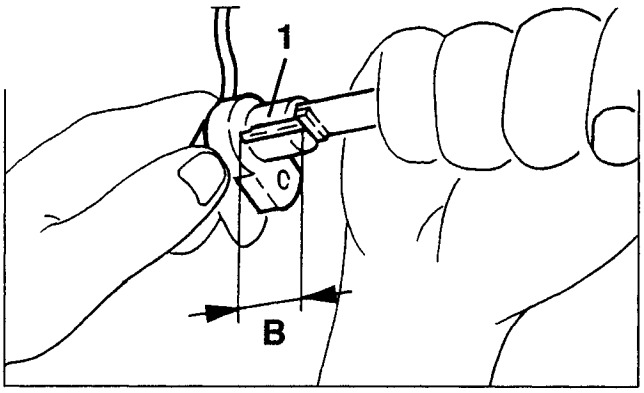
- Set the car on a lift and remove the front section of the exhaust pipe.
- Remove the rpm and timing sensor (see specific procedure).
1. Using tool no. 1.820.079.000 (A.2.0449), find dimension "A".



1. Using a gauge measure dimension "A".



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

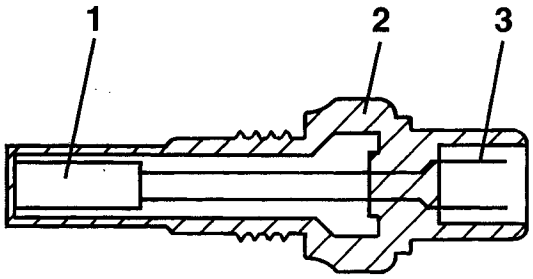


- Calculate the rpm and timing sensor gap and check that it is within the specified limits.

Rpm and timing sensor gap
A - B = 0.5 ÷ 1.5 mm

ENGINE COOLANT TEMPERATURE SENSOR (NTC)

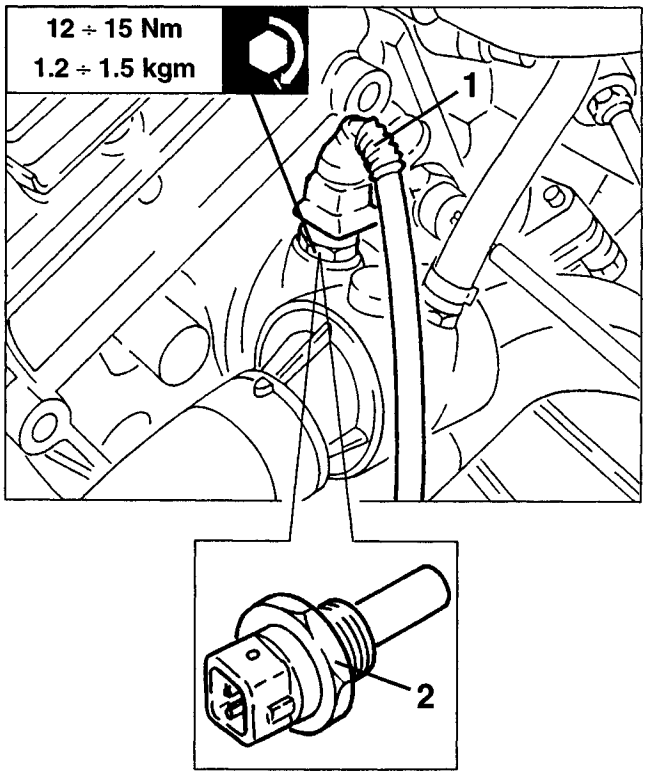
This sensor detects the engine coolant temperature on the thermostatic cup through a thermistor (NTC) with a negative resistance coefficent, i.e. capable of lowering its resistance as the temperature increases. The electric signal obtained reaches the electronic control unit where it is used to correct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



1. NTC resistance
2. Body
3. Connector

REMOVAL/REFITTING

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

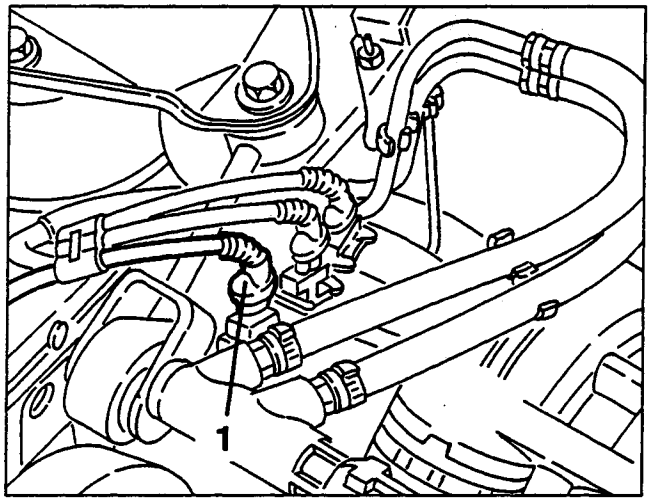


KNOCKING SENSOR

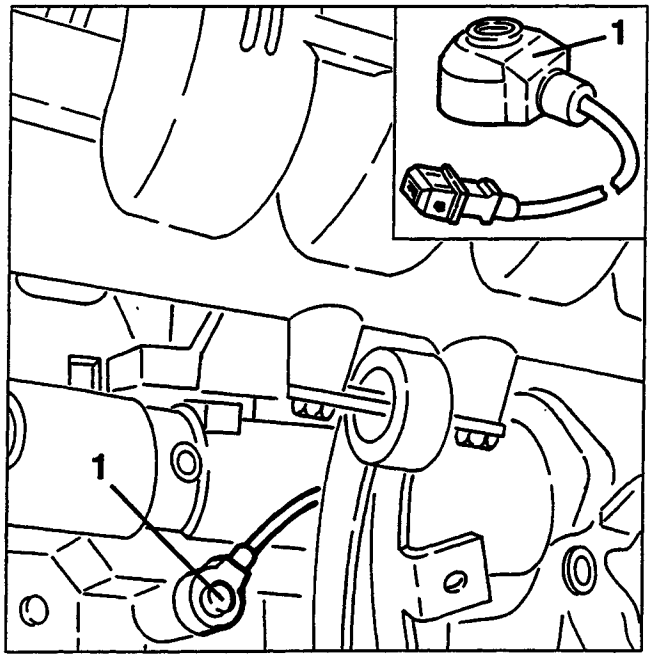
The knocking sensor detects the intensity of the vibrations (pinging in the cylinder head) caused by knocking in the combustion chamber.
In this condition the control unit increases the amount of fuel and reduces the advance ratings calculated from the special map, in order to eliminate knocking as quickly as possible: in fact the advance curves are reduced by appr. 2°, then if necessary by another 2° etc:, until pinging ceases, after which the normal advance corresponding to the original map is resumed.

REMOVAL/REFITTING

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



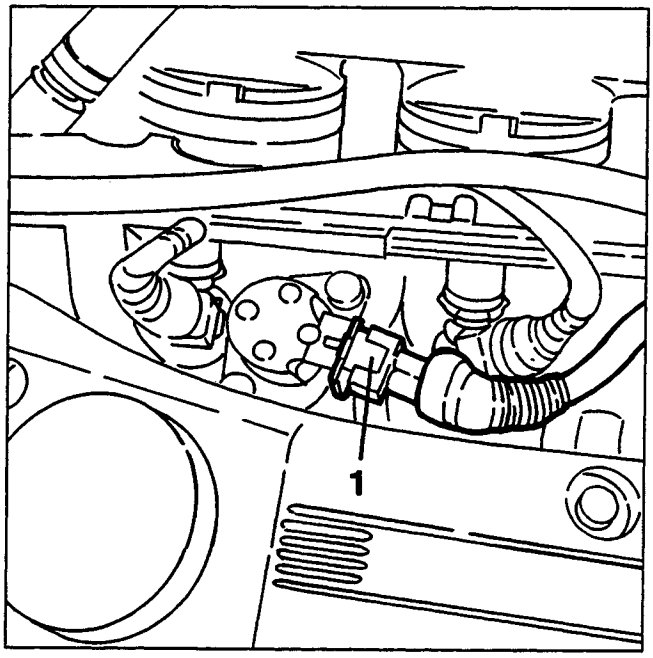
1. Slacken the fastening screw and remove the pinging sensor.



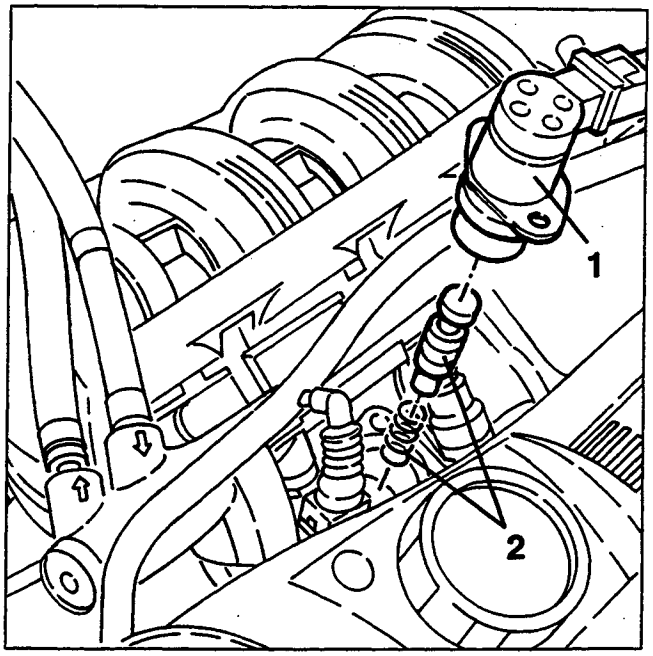
TIMING VARIATOR SOLENOID

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection from the timing variator solenoid.

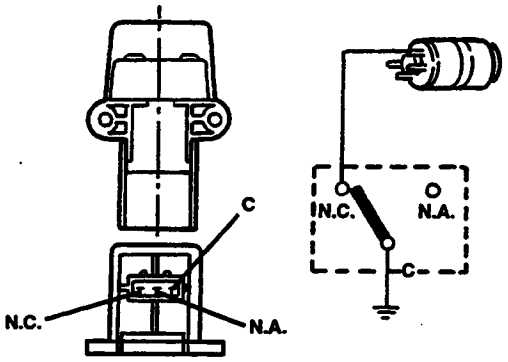


1. Slacken the two fastening screws and remove the timing variator solenoid.
2. Remove the valve complete with the timing variator spring.



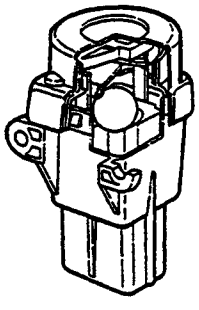
INERTIAL SWITCH

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



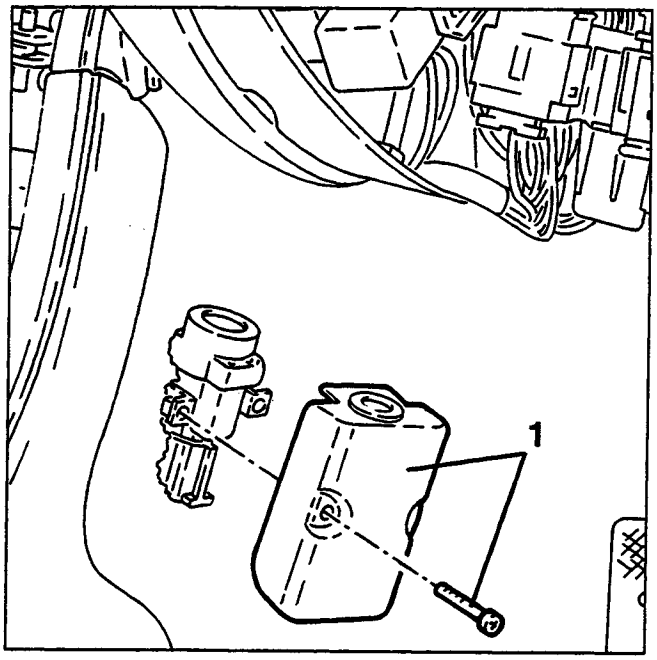
A steel ball fitted in a taper housing is normally held in place by the force of attraction of an adjacent magnet.
Under specific acceleration loads the ball releases itself from the magnetic force and gradually moves out of the taper support rising upwards following the angle of the taper.
A quick snap connection is fitted above the ball which forms the normally closed (N.C.) electric circuit.
When the mechanism is hit by the ball it changes position, from N.C. circuit to normally open circuit (N.A.), cutting off the fuel pump earth circuit.
In the event of impact in any one of the three orthogonal directions, the switch will be triggered above 12 g peak equivalent to a speed of 25 kph.
The switch can be reset pressing the pushbutton protected by a flexible cover (this also protects against foreign particles which might prevent the switch from operating or reprogramme it.

If after even a light crash, there is the smell of petrol or leaks are noted from the fuel supply system, do not reset the switch, but firstly seek the failure and repair it to prevent the hazard of fire.
Conversely, if there are no leaks and the car can be restarted, press the pushbutton to reactivate the fuel pump.



REMOVAL/REFITTING

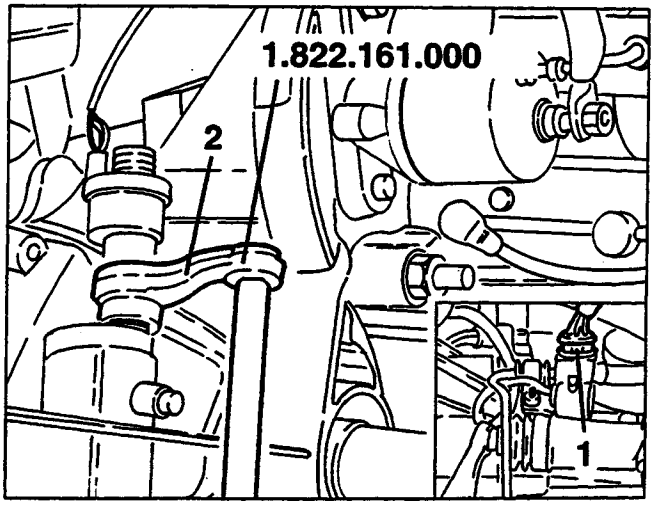
- Disconnect the battery (-) terminal.
1. Slacken the two fastening screws and remove the plastic cover protecting the inertial switch.
- Slacken the two fastening screws, disconnect the electrical connection and remove the inertial switch.



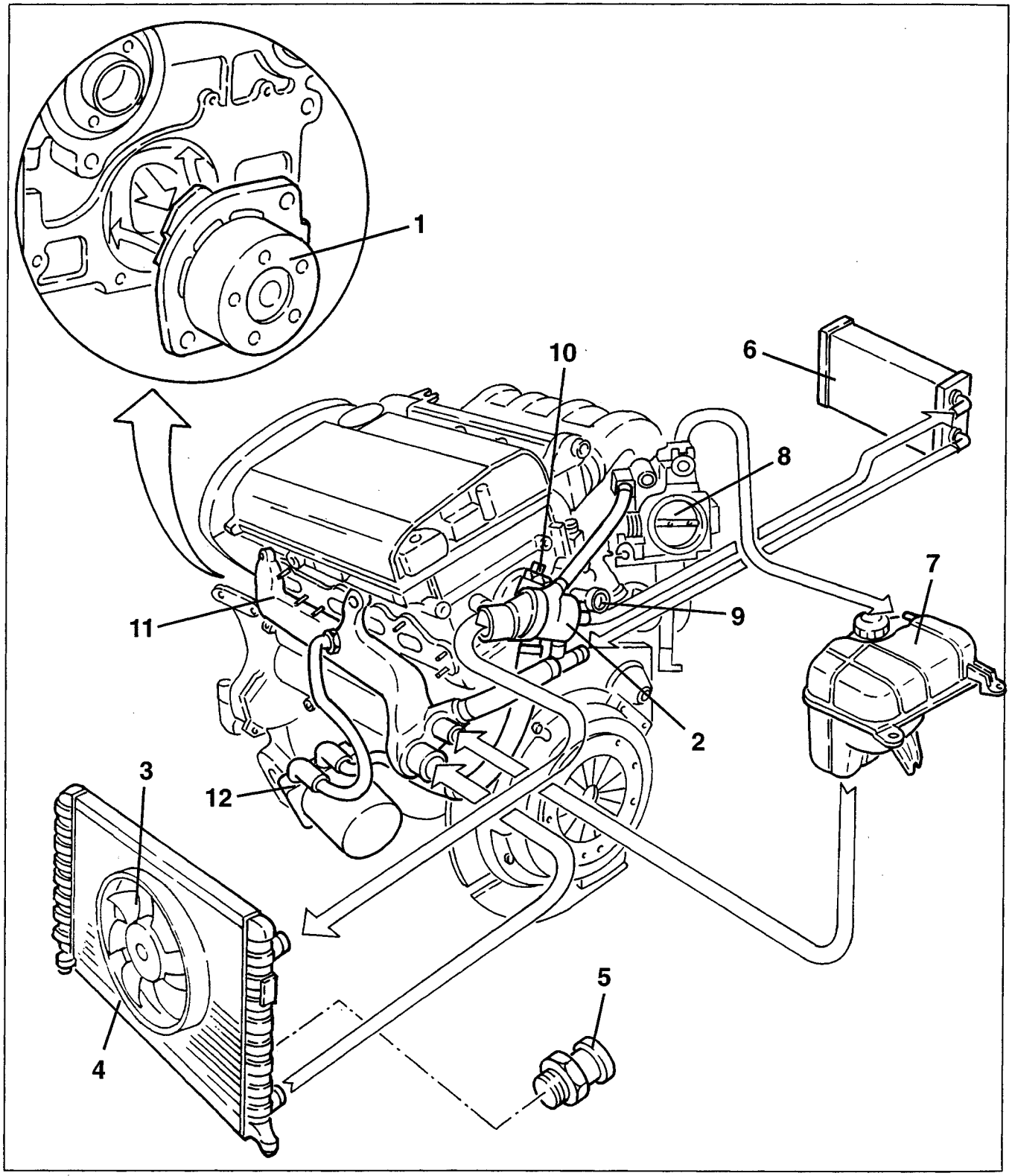
SPEEDOMETER SENSOR

REMOVAL/REFITTING

- Set the car on a lift.
- Disconnect the battery (-) terminal.
1. Disconnect the electrical connection of the speedometer sensor.
2. Raise the car and using wrench no. 1.822.161.000, slacken and remove the speedometer sensor.



ENGINE COOLING SYSTEM



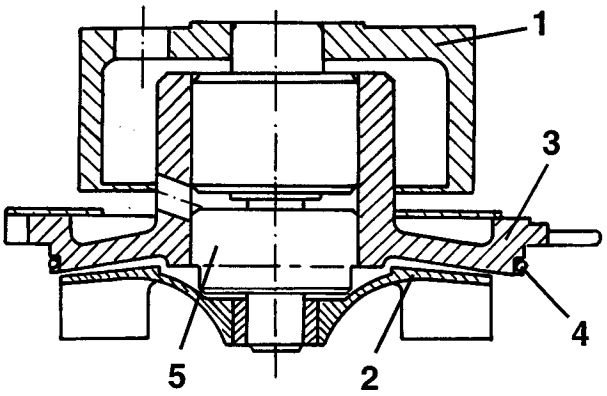
1. *Water pump*
2. *Thermostatic cup*
3. *Cooling fans*
4. *Radiator*
5. *Fan control thermal contact (Specific for versions with M2.10.3 injection-ignition system)*
6. *Climate control unit heater*
7. *Expansion tank*
8. *Throttle body*
9. *Coolant temperature gauge sender and maximum temperature warning light contact*
10. *Coolant temperature sensor (NTC)*
11. *Longitudinal manifold*
12. *Coolant - engine oil heat exchanger*

DESCRIPTION

The cooling system is of the sealed type with forced circulation by a centrifugal pump (1) located on the cylinder head and operated by the timing gear belt.
A thermostatic valve (2), fitted on the rear of the engine keeps the engine temperature at an optimum level; it opens when the coolant reaches a temperature of 83 °C.
The radiator (4) cools the engine fluid by the dynamic air and also by a fan (3) which is turned on:
- for versions with M2.10.3 injection-ignition system, by a thermal contact (5) on the radiator;
- for versions with M2.10.4 injection-ignition system, directly by the MOTRONIC control unit, depending on the signal received from the engine coolant temperature sensor (NTC).
(For further details about how the fan works, see ELECTRIC- ELECTRONIC DIAGNOSIS - Sect. 26 for versions with air conditioner and Sect. 27 for versions without air conditioner).
The expansion tank (7) tops up the circuit if the level falls and absorbs the changes in the volume of the coolant due to changes in temperature: it also vents air from the circuit.
The circuit is fitted with a coolant fluid temperature sender for the max. temperature gauge and thermal contact (9) for the warning light.

WATER PUMP

The water pump is of the centrifugal type with blades. It is fastened to the cylinder head and operated by the crankshaft via the timing gear belt. An O-Ring ensures tightness between the cylinder head and the pump. The water pump is kept running constantly to ensure that the coolant fluid circulates continuously.



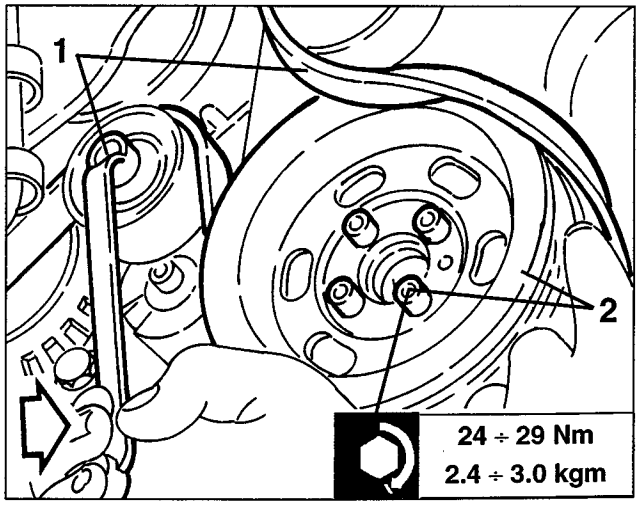
1. Pulley
2. Impeller
3. Pump casing
4. O-Ring
5. Bearing

OPERATION OF THE CIRCUIT

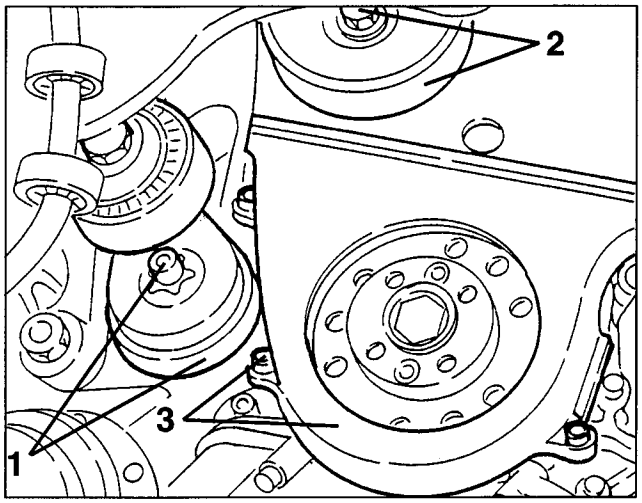
After the fluid has cooled the engine, it leaves the cylinder head and reaches the thermostatic unit (92). From here, if the temperature is below 83 °C, it is drawn into the pump (1) through a longitudinal coolant return manifold located on the left-hand side of the cylinder head.
Conversely, if the temperature exceeds this value, the fluid is directed to the radiator (4) through the opening of the thermostat.
After being cooled in the radiator, the fluid returns, still through the longitudinal manifold, to the pump which directs it to the engine.
From the thermostatic cup the fluid is also sent to:
- heat the throttle body (8) from which it flows to the expansion tank (7) also venting air from the system;
- the climate control system heater (6) from which it returns to the longitudinal manifold;
- the heat exchanger (12) for cooling the engine oil before being ducted directly into the longitudinal manifold through which it returns to the pump.
The expansion tank supplies the engine cooling system via a special pipe connected with the longitudinal manifold.

REMOVAL/REFITTING

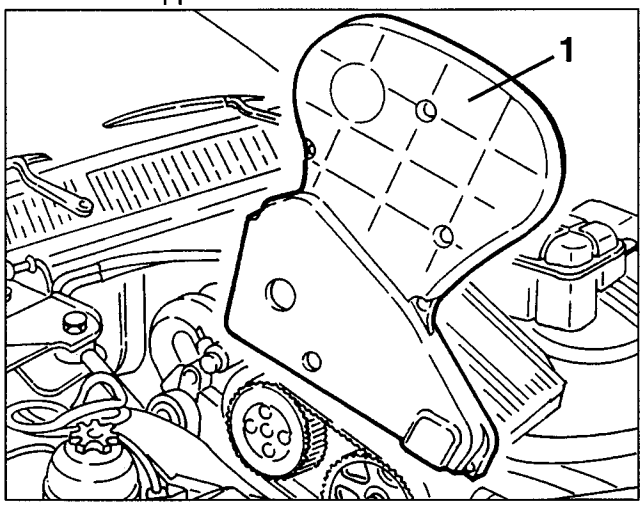
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Remove the right front wheel and mud flap.
1. Raise the car and working as illustrated on the belt tensioner loosen the tension of the auxiliary components drive belt and remove it.
2. Slacken the four fastening screws and remove the auxliary components drive pulley.



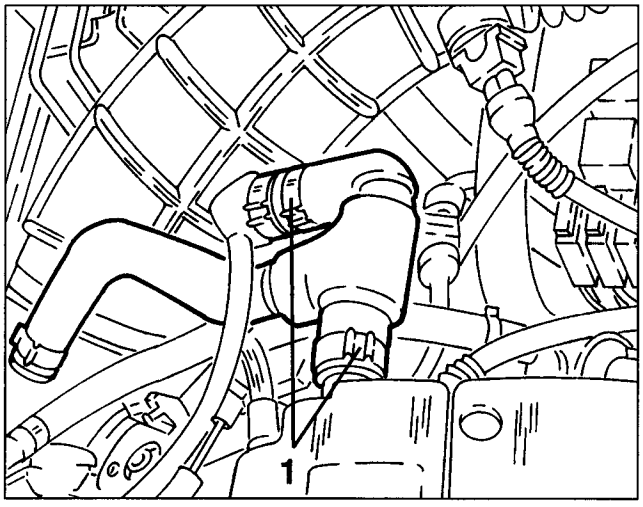
1. Slacken the fastening screw and remove the belt tensioner.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.



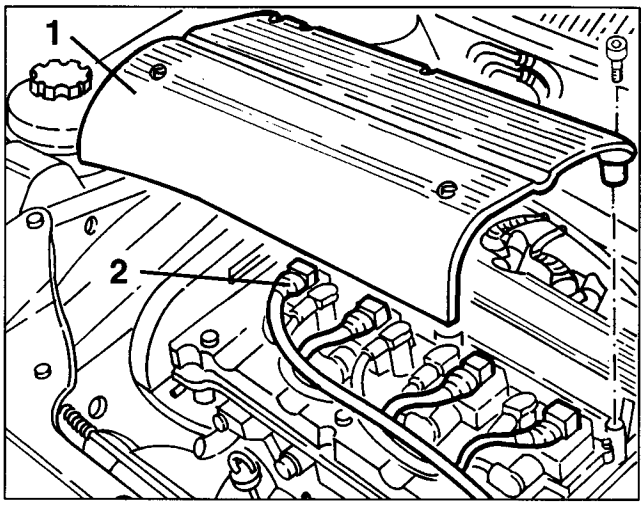
- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.
1. Lower the car, slacken the fastening screws and remove the upper cover.



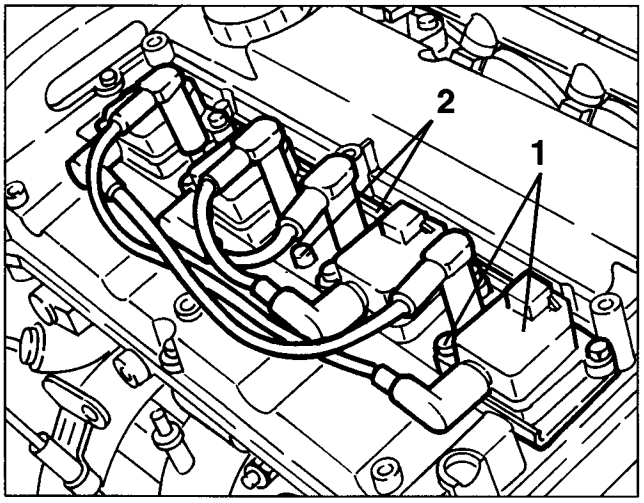
1. Disconnect and remove the oil vapour recovery pipes.



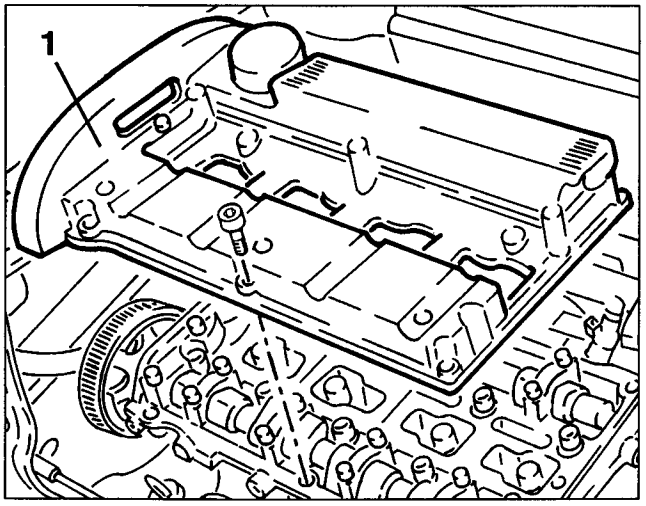
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



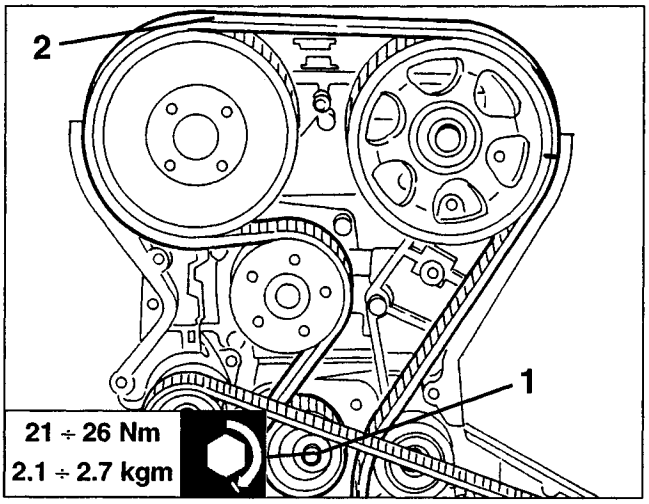
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



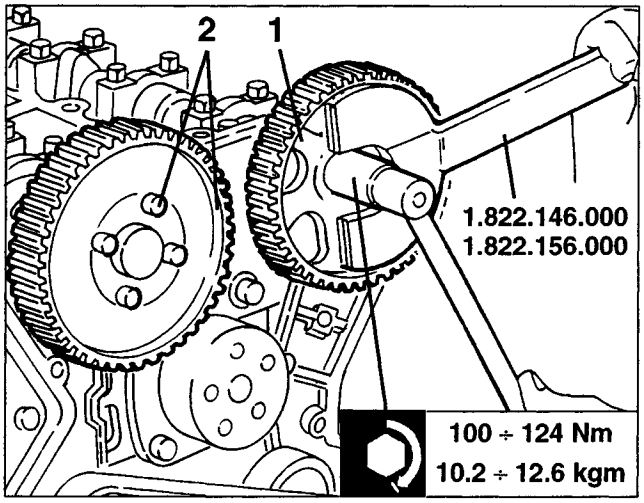
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



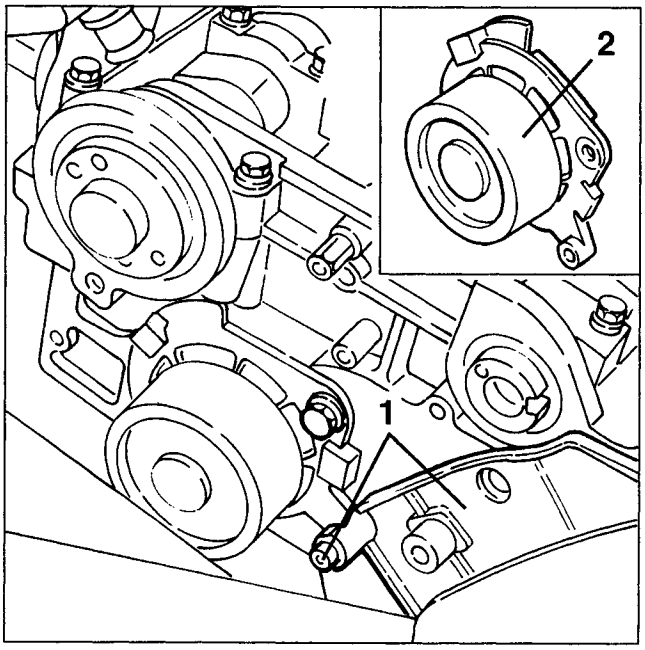
1. Working on the timing gear belt tensioner, loosen the tension on the belt, then take it off the timing gear drive pulleys.



1. Using tools no. 1.822.146.000 and no. 1.822.156.000 slacken the screw fastening the timing gear exhaust side drive pulley and remove it.
2. Slacken the four screws fastening the timing gear intake side drive pulley and remove it.



1. Slacken the fastening screws and remove the exhaust side cover.
2. Slacken the two fastening screws and remove the water pump complete with O-Ring.



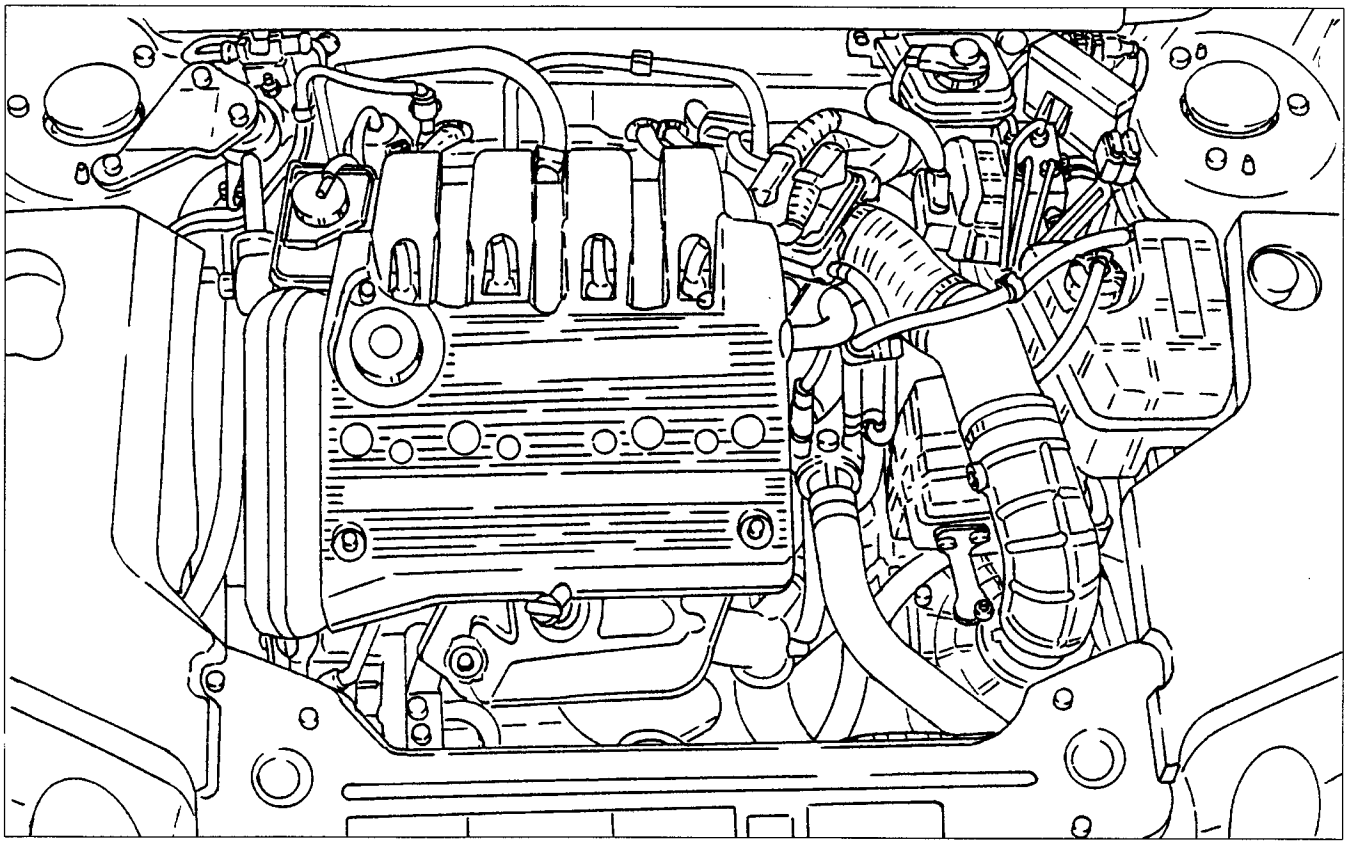
- Re-assembly reversing the sequence followed for removal.

For re-assembly of the timing gear drive belt and timing and for assembly of the auxiliary components drive belt see GROUP 00.

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.



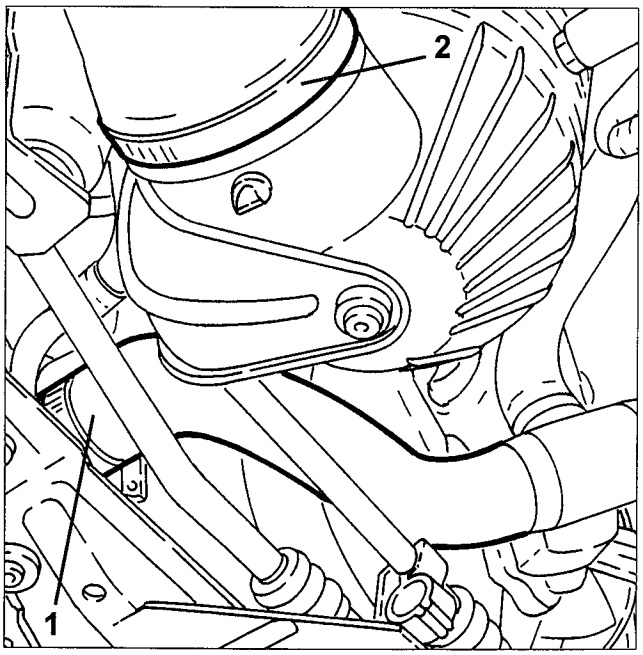
REMOVAL

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Drain the conditioning system (see ASSEMBLY 50).
- Remove the front wheels and the respective mudguard.
- Lift the vehicle, loosen the fasteners and remove the guard under the engine.

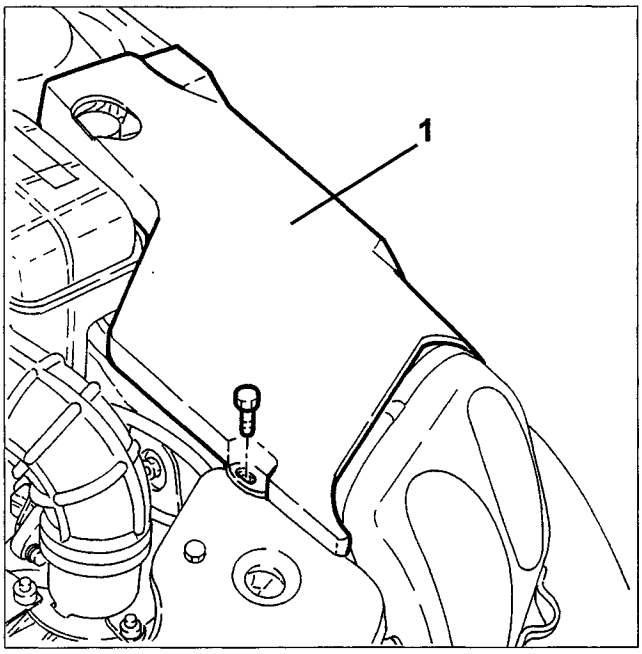
1. Drain the engine coolant by disconnecting the radiator fluid output sleeve.

NOTE: Collect the coolant in a suitable container.

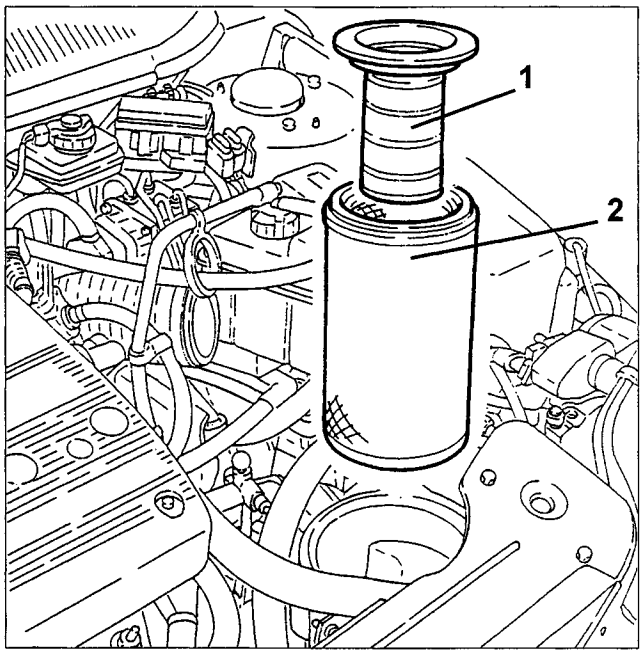
2. Loosen the clip fastening the front resonators to the air cleaner.



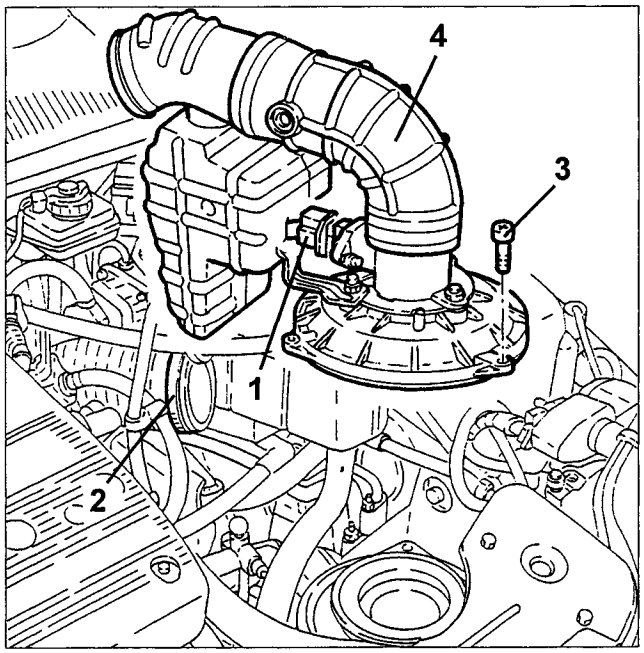
1. Lower the vehicle, loosen the fastening screws and remove the engine compartment side guards.



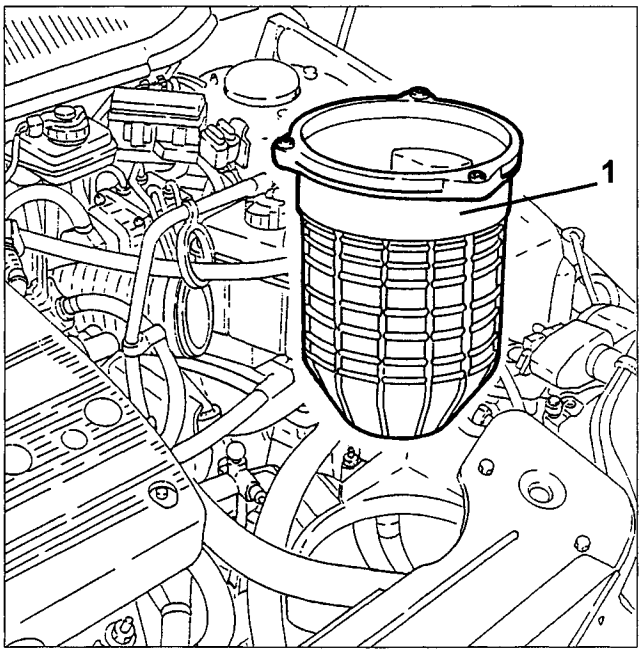
1. Remove the air cleaner manifold.
2. Remove the air cleaner.



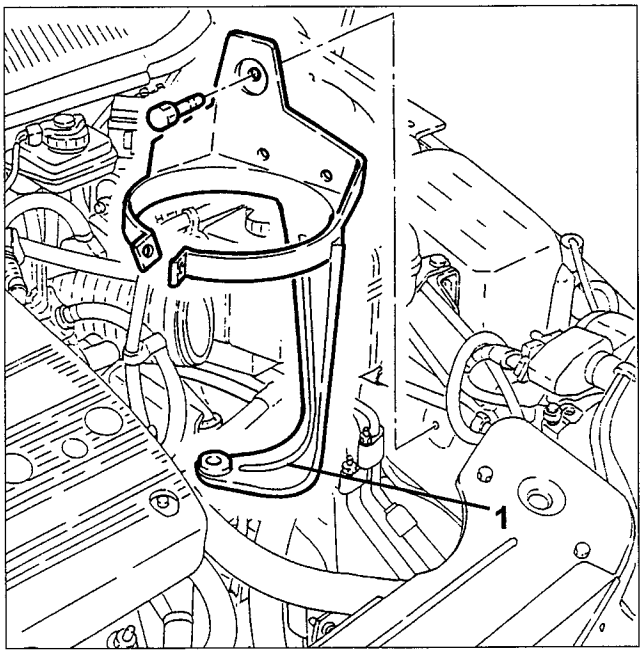
1. Disconnect the air flow meter electrical connection.
2. Loosen the clip fastening the resonator sleeve to the corrugated sleeve second section.
3. Loosen the air cleaner cover fastening screws.
4. Remove the first corrugated sleeve section with resonator, air flow meter and air cleaner cover.



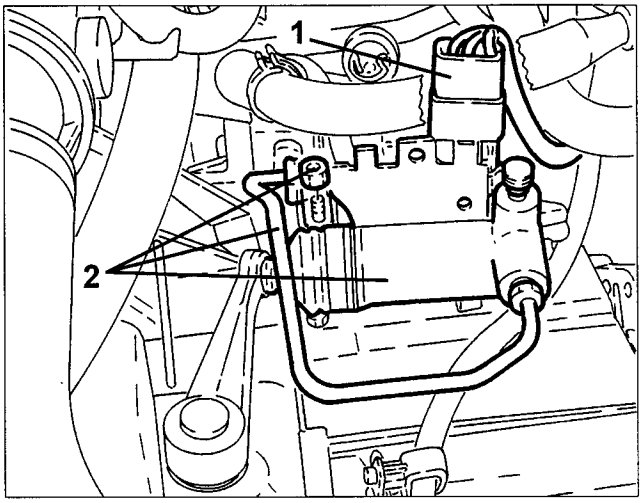
1. Remove the air cleaner casing.



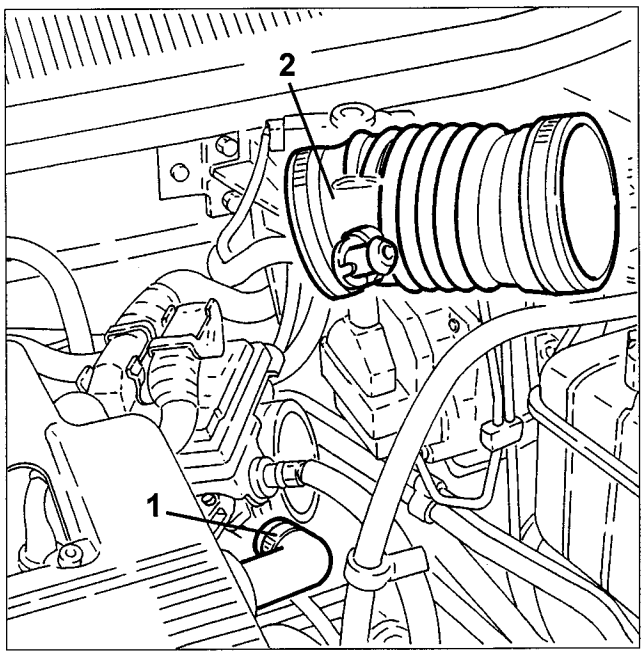
1. Loosen the fastening screws and remove the air cleaner bracket.



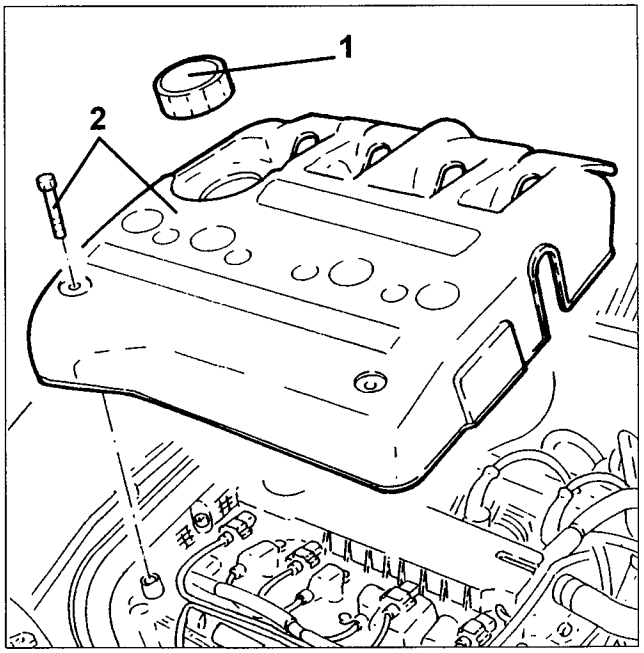
1. Disconnect the tachometer sensor electrical connection.
2. Loosen the fasteners and move the clutch cylinder aside without disconnect the respective pipes.



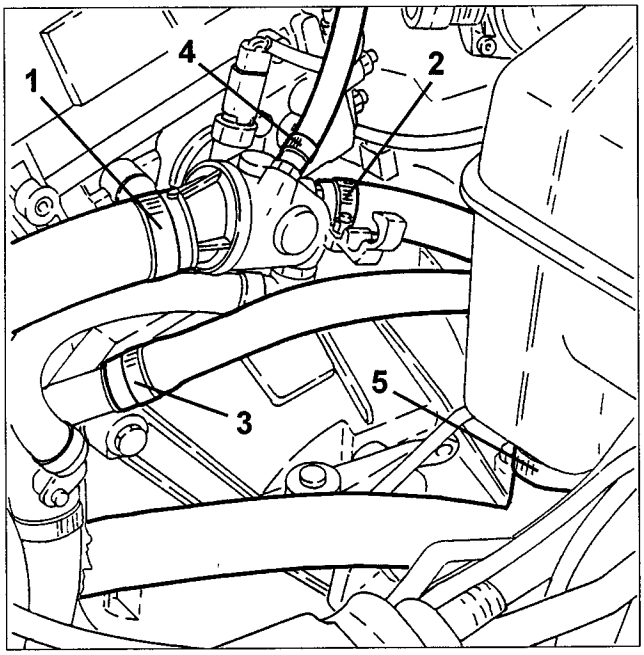
1. Disconnect the oil vapour recovery pipe form the corrugated sleeve second section.
2. Loosen the clip and remove the corrugated sleeve second section.



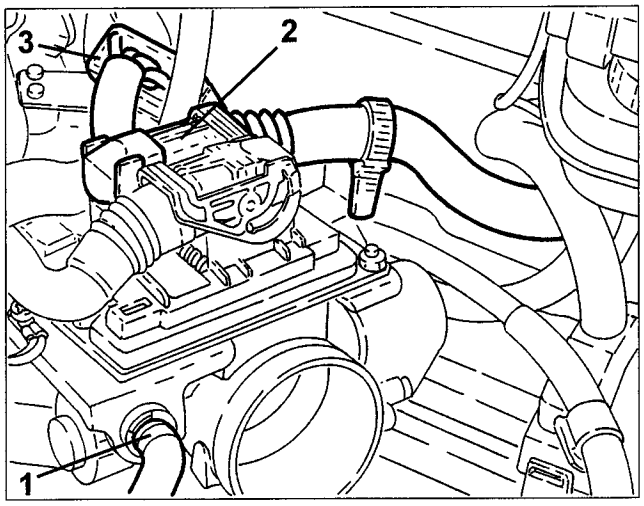
1. Remove the engine oil filler cap.
2. Loosen the fastening screws and remove the ignition coil covers.
- Refit the engine oil filler cap.



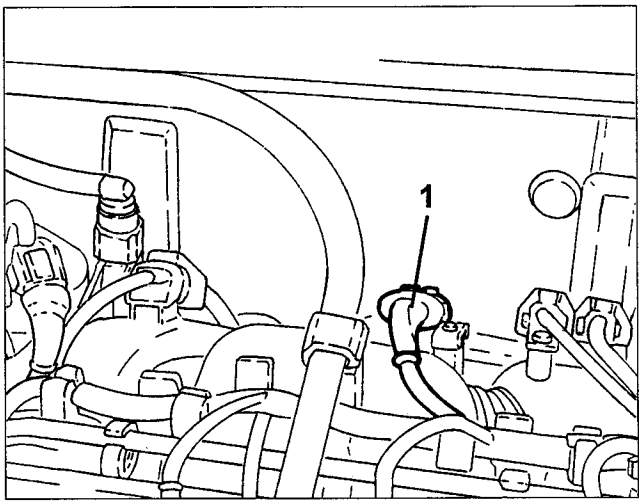
1. Disconnect the radiator coolant delivery sleeve from the thermostat cup.
2. Disconnect the climate control heater radiator coolant delivery sleeve from the thermostat cup.
3. Disconnect the climate control heater coolant return pipe from the coolant pump return pipe.
4. Disconnect the expansion reservoir delivery pipe from the thermostat cup.
5. Disconnect the radiator coolant outlet sleeve from the coolant pump return pipe.



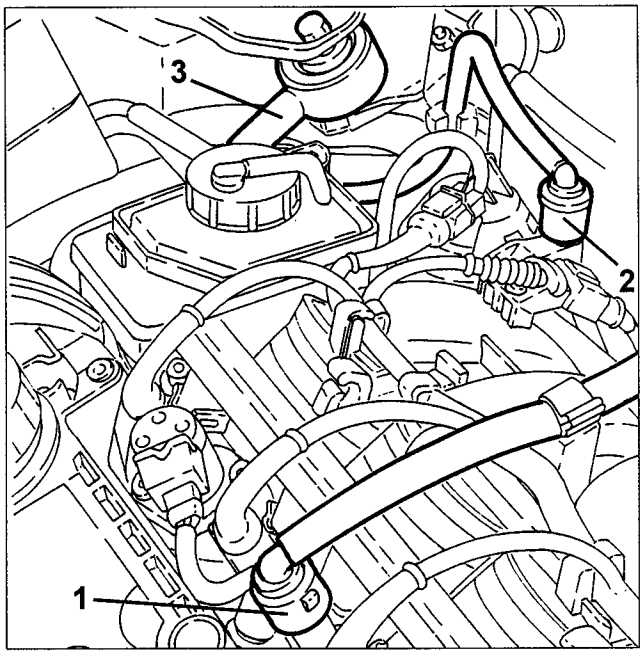
1. Disconnect the accelerator wire from the throttle casing with built-in MDS.
2. Disconnect the injection-ignition ECU electrical connection.
3. Disconnect the front engine wiring electrical connection.



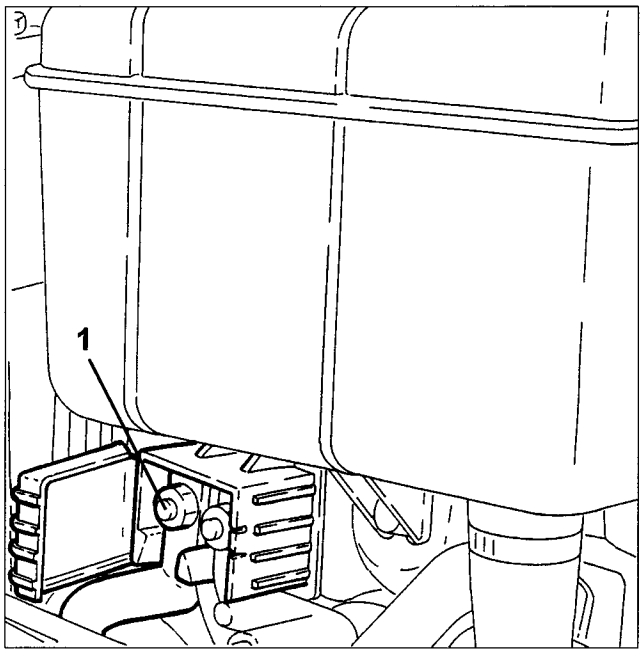
1. Disconnect the knock sensor electrical connection and release the wiring from the fastening clips.



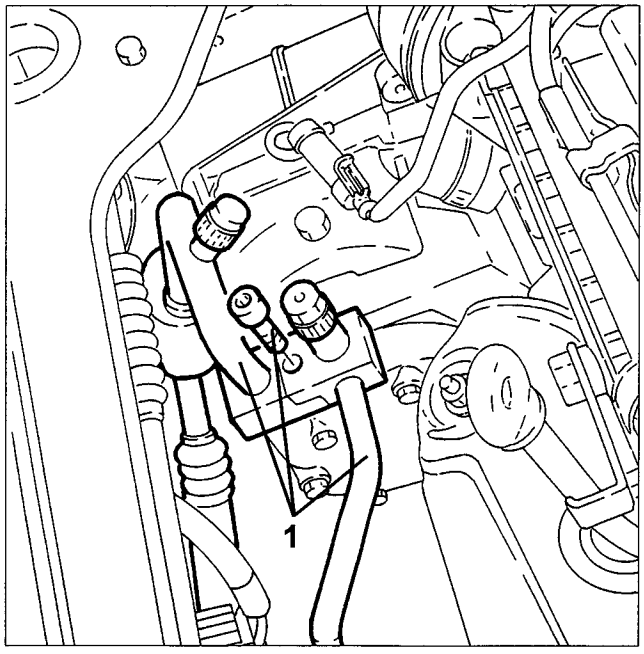
1. Disconnect the fuel delivery pipe from the fuel distribution manifold.
2. Disconnect the fuel vapour recirculation pipe quick coupling.
3. Loosen the reaction screws and remove the engine tie-rod.



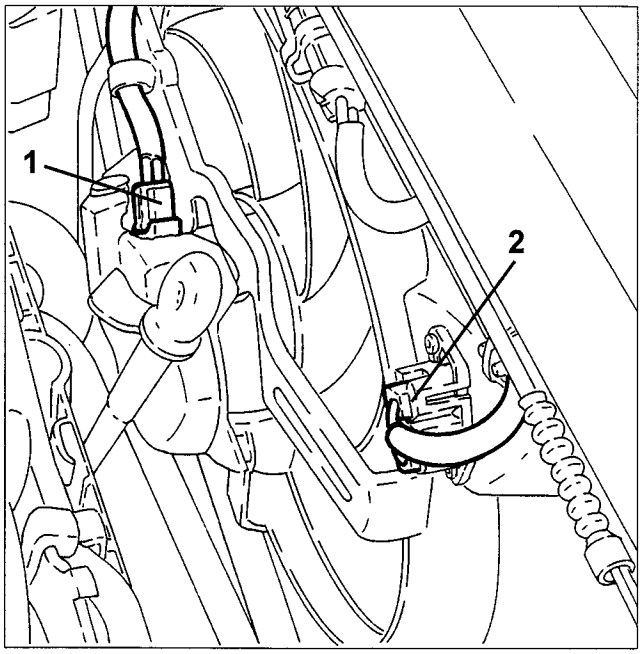
1. Open the junction box under the expansion reservoir and disconnect the starter motor power wire.



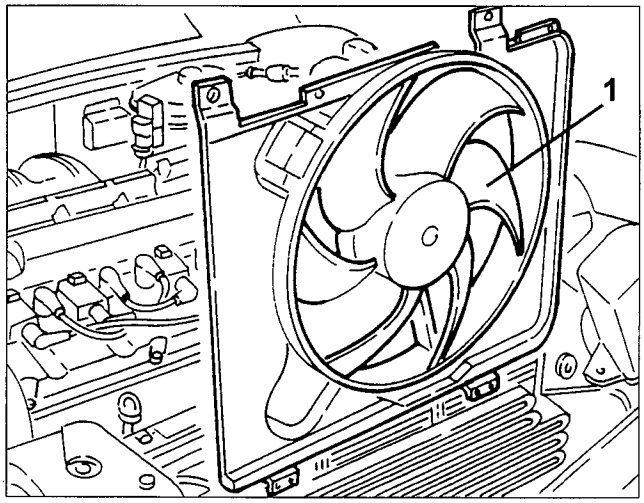
- Use a suitable syringe to empty the power steering reservoir.
- Disconnect the oil intake and delivery pipes from the power steering pump.
1. Loosen the screw and disconnect the coolant inlet and outlet pipes from the conditioner compressor.



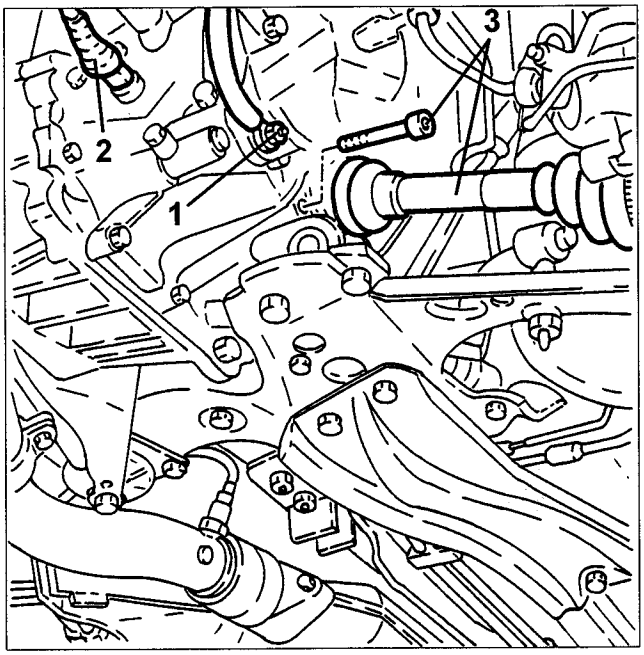
- Loosen the fastening screws and remove the upper radiator crossmember.
1. Disconnect the cooling fan electrical connection.
2. Disconnect the cooling fan resistor electrical connections.



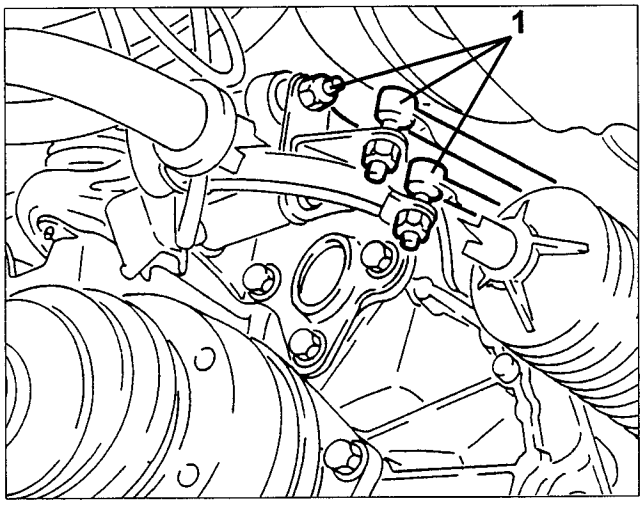
1. Loosen the fastening screws and remove the cooling fan.



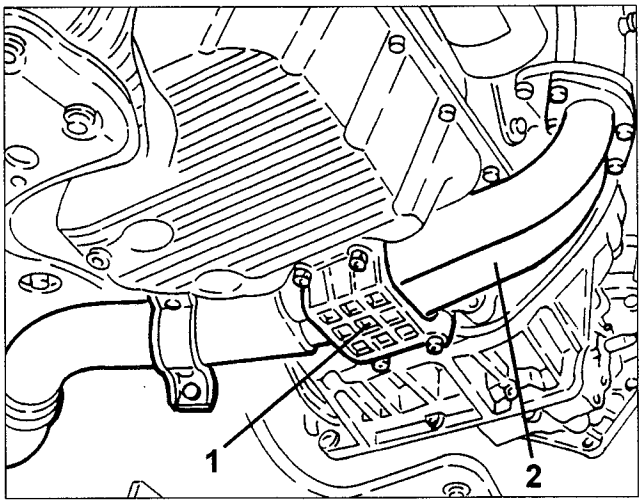
1. Disconnect the gearbox earth braid.
2. Disconnect the reversing light switch electrical connection.
3. Loosen the fastening bolts and disconnect the drive shafts.



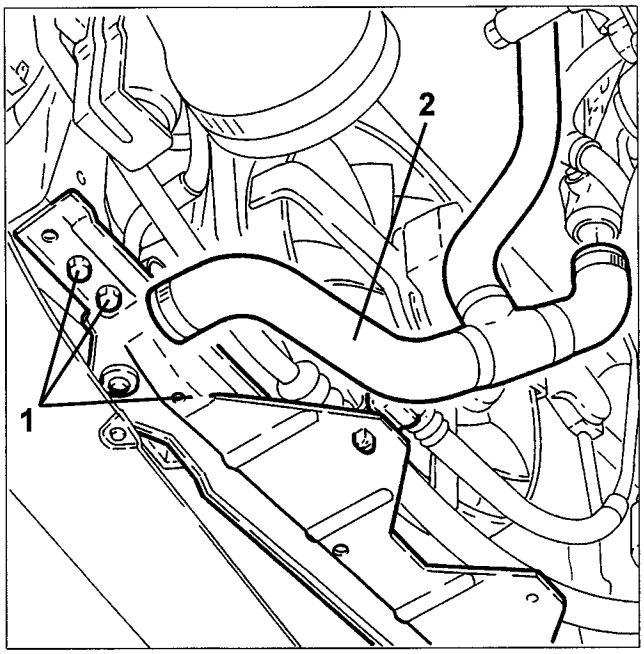
1. Loosen the fastening nuts and disconnect the gearbox control rods.



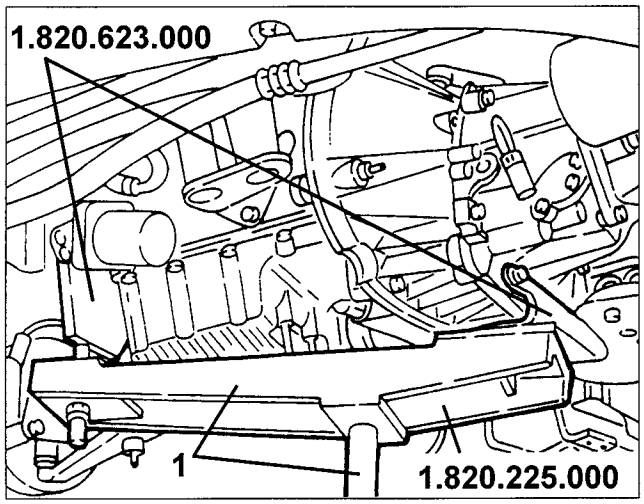
1. Loosen the fastening nuts and remove the reinforcement bar.
2. Loosen the fasteners and remove the front exhaust pipe section with lambda sensor.

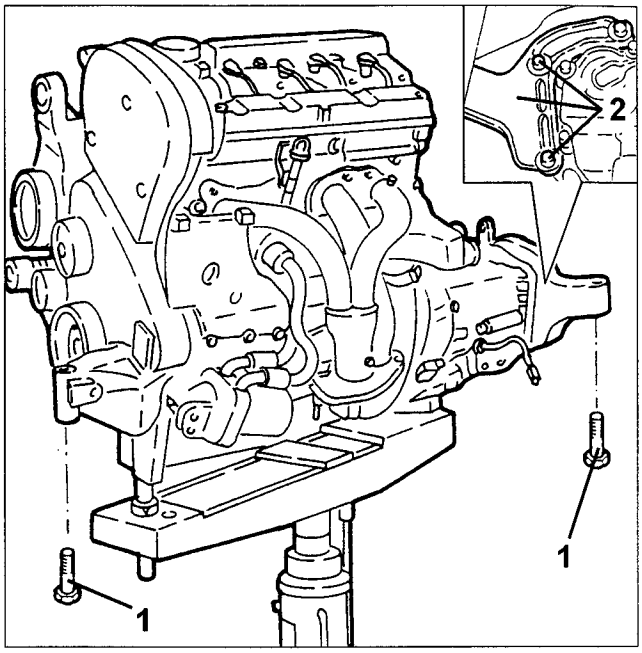


1. Loosen the fastening screws and remove the lower radiator crossmember after releasing the pipe clips from the crossmember.
2. Disconnect the radiator coolant outlet pipe from the coolant pump return pipe and remove it.

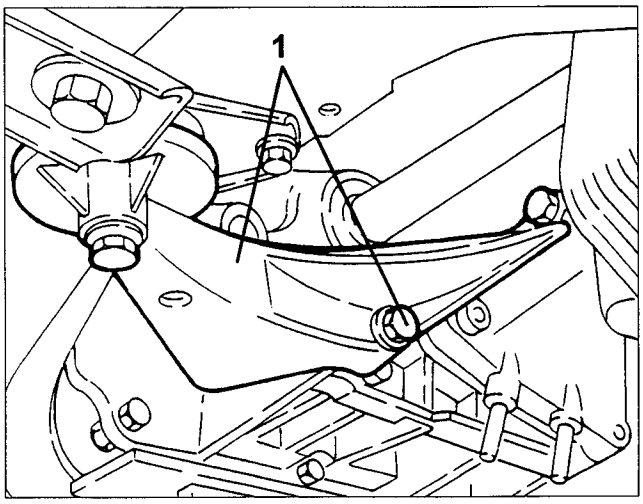


1. Position a hydraulic jack with tools no. 1.820.225.000 and no. 1.820.623.000.





1. Loosen the fastening screws and remove the engine rear mount.



1. Loosen the screws fastening the engine mounts on gearbox side and timing side to the body.
2. Lower the engine slightly, loosen the fastening screws and remove the mount on gearbox side.
3. Lower the hydraulic jack and remove the engine from the engine compartment.

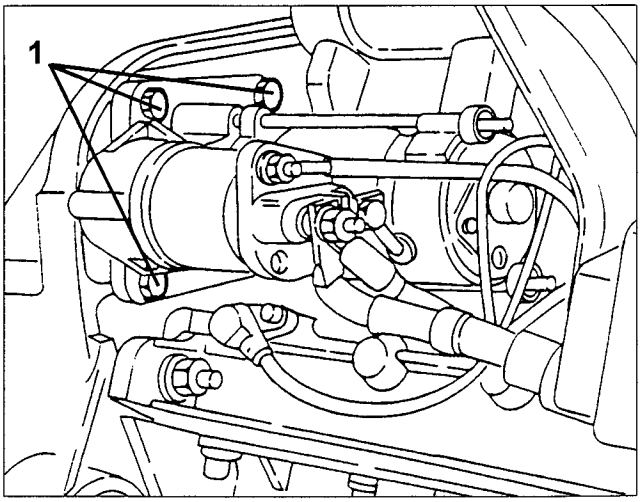
IMPORTANT: The hydraulic jack must have a payload of at least 1000 kg.

- Support the engine with the hydraulic jack used for removal and with a hydraulic crane.

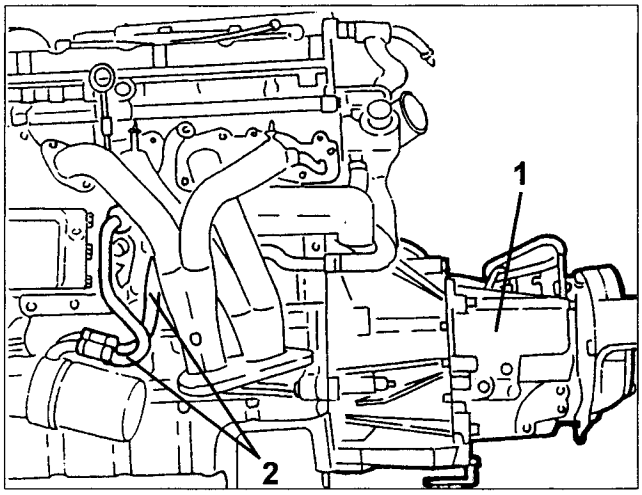
IMPORTANT: Use a hydraulic crane to move the engine after releasing it from the hydraulic jack.

- Release the engine from the tools used for removal. Then position it on a stand.

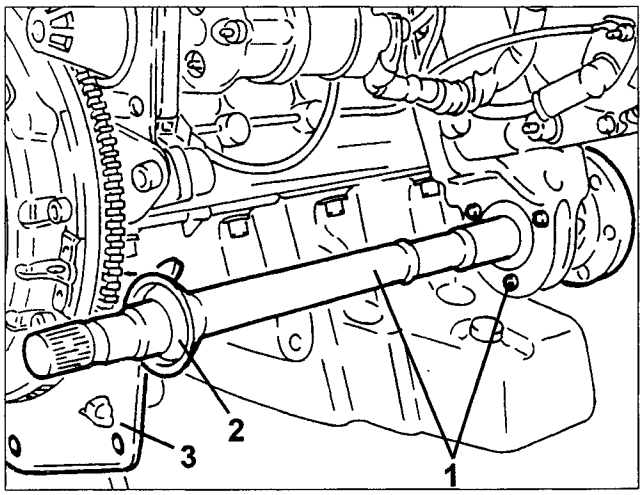
1. Loosen the starter motor fastening screws.



1. Loosen the fastening screws and nuts and remove the gearbox-differential assembly.
2. Remove the two heat exchanger coolant delivery and return pipes.

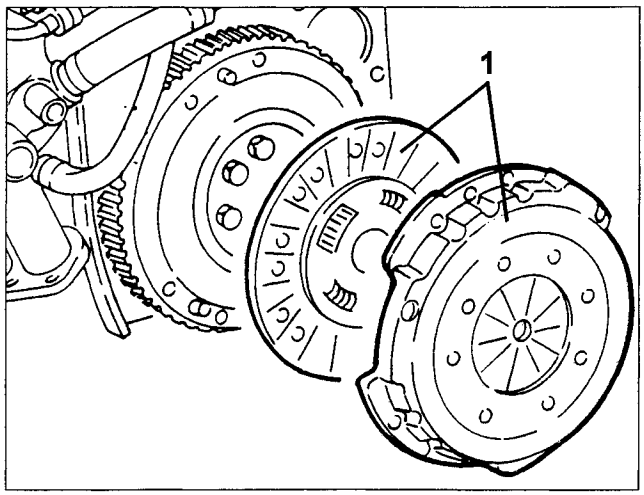


1. Loosen the fastening screws and remove the intermediate drive shaft.
2. Remove the dust guard ring.
3. Take the lower flywheel guard.

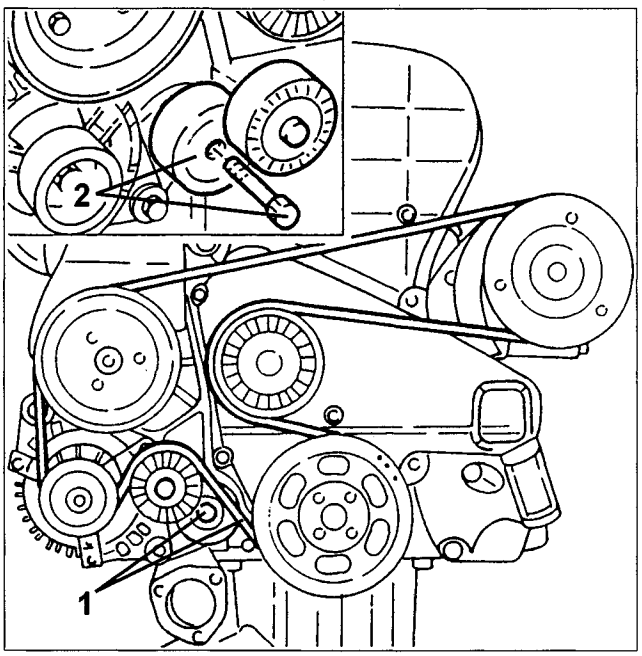


- Release the starter motor for its electrical wiring and remove it.

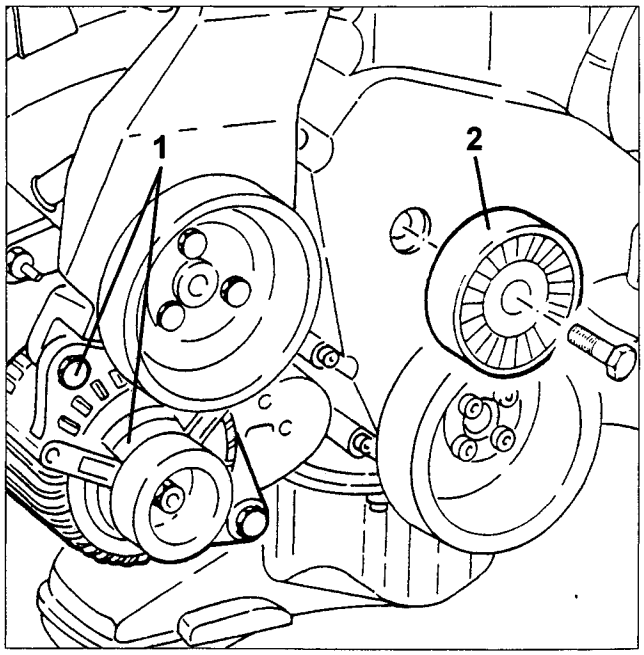
1. Loosen the fastening screws and remove the thrust plate and the clutch plate.



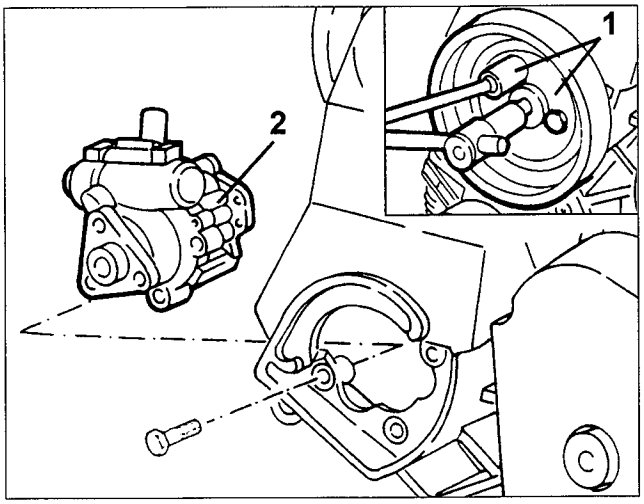
1. Loosen the engine unit belt take-up device fastening screw. Loosen the device and remove the belt.
2. Completely loosen the fastening belt and remove the engine unit belt take-up device.



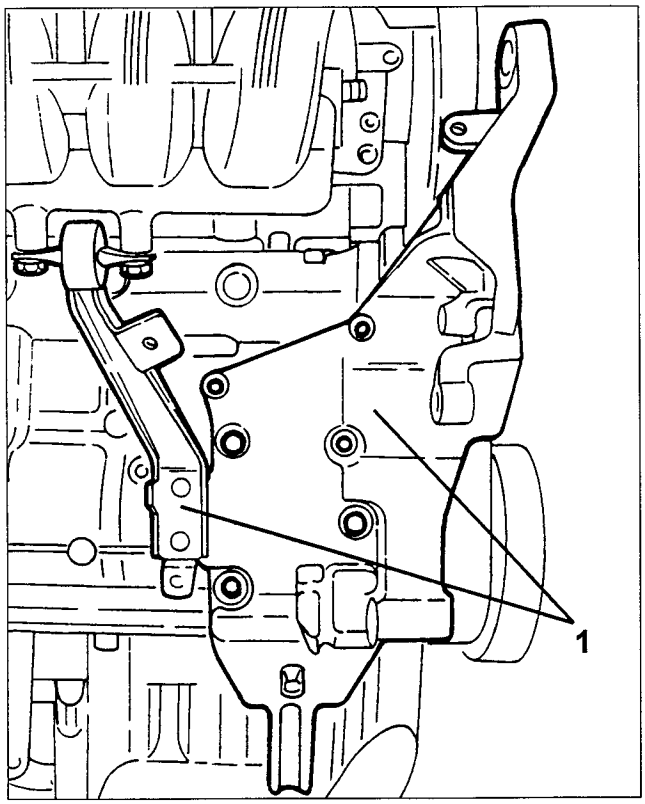
1. Loosen the two fastening bolts and remove the alternator.
2. Loosen the fastening screw and remove the engine unit belt runner.



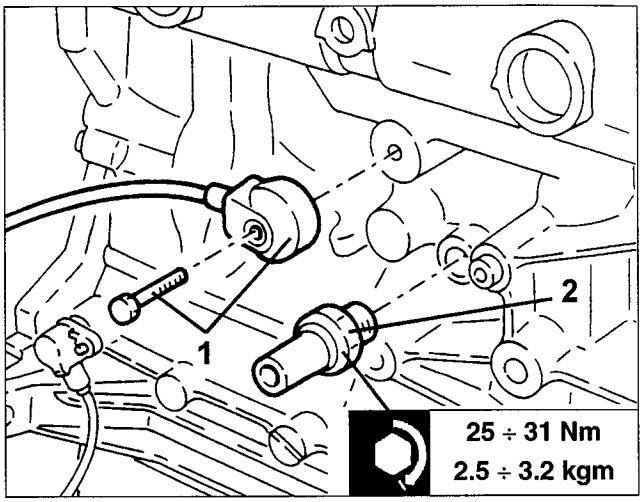
1. Use a 3/8" Allen wrench to contrast torque and loosen the three power steering pump pulley fastening screws. Remove the pulley.
2. Loosen the fastening screws and remove the power steering pump.



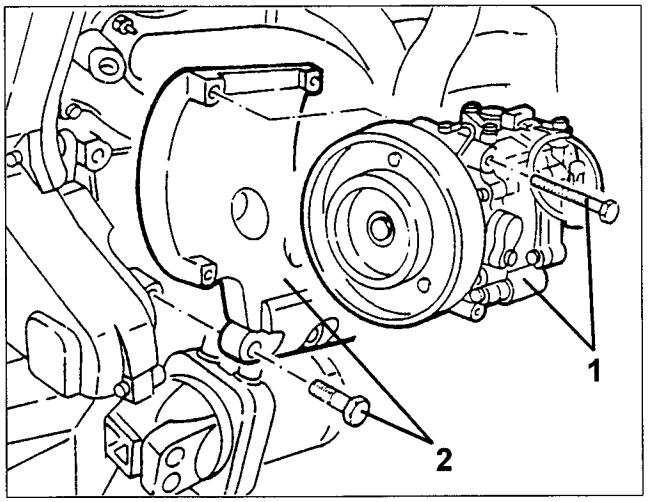
1. Loosen the fastening screws and remove the power steering pump and alternator bracket with intake manifold bracket.



1. Loosen the fastening screw and remove the knock sensor from the crankcase.
2. Loosen and remove the minimum engine oil pressure sensor from the crankcase.



1. Loosen the four fastening screws and remove the conditioner compressor.
2. Loosen the five fastening screws and remove the conditioner compressor bracket.



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.

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

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

CYLINDER HEAD

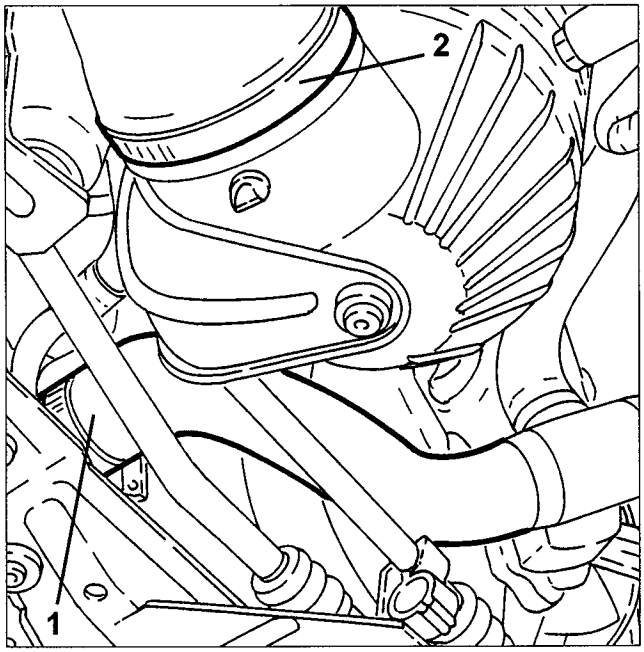
REMOVAL/REFITTING

- Position the vehicle on a shop jack.
- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Remove the front right-hand wheel and mudguard.
- Lift the vehicle, loosen the fasteners and remove the guard under the engine.

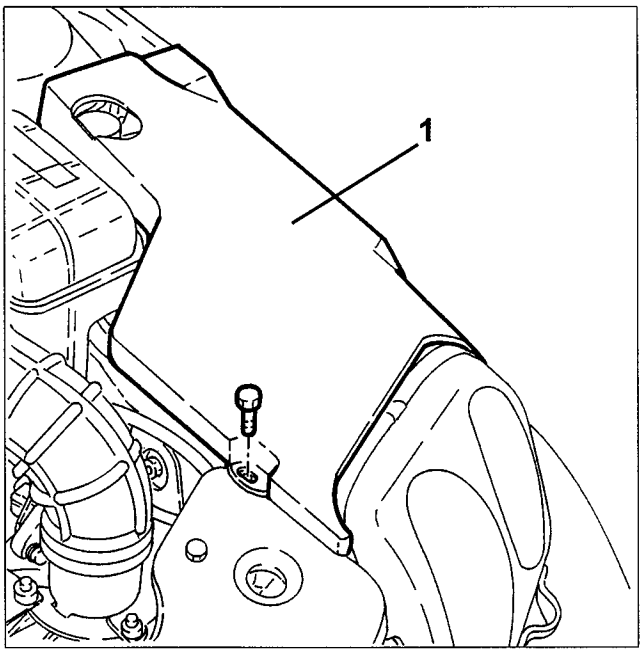
1. Drain the engine coolant by disconnecting the radiator outlet sleeve.

NOTE: Collect the engine coolant in a suitable container.

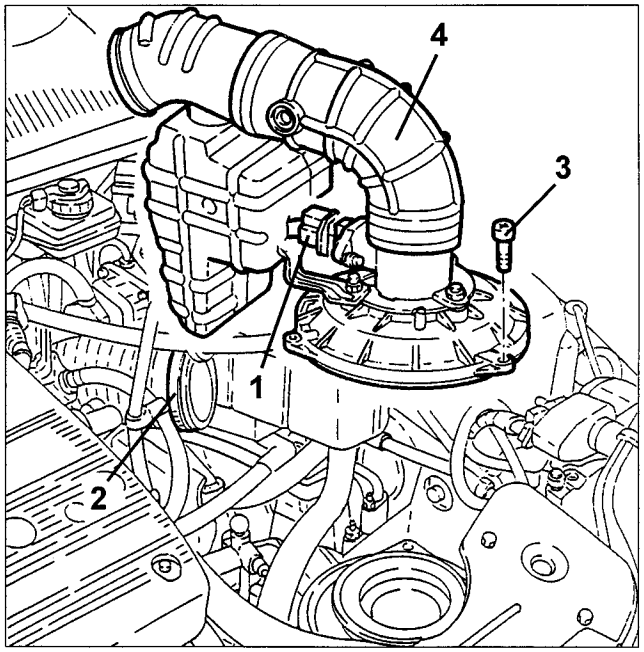
2. Loosen the clip fastening the front resonators to the air cleaner.



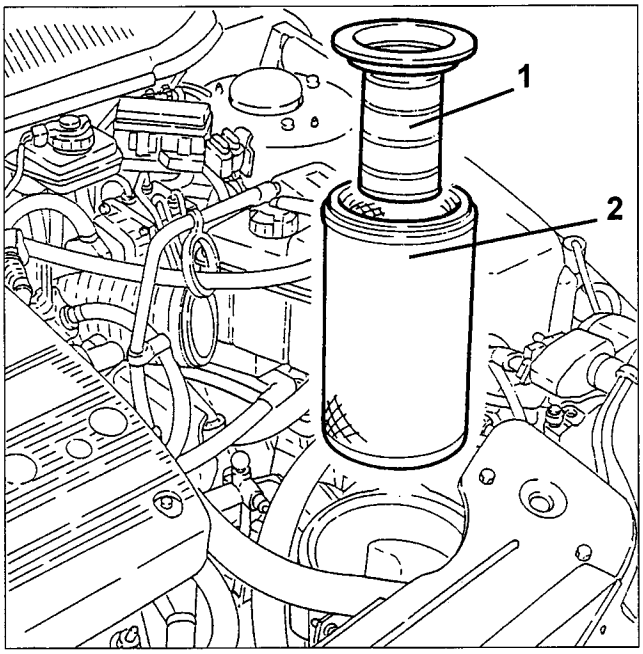
1. Lower the vehicle, loosen the fastening screws and remove the engine compartment side guards.



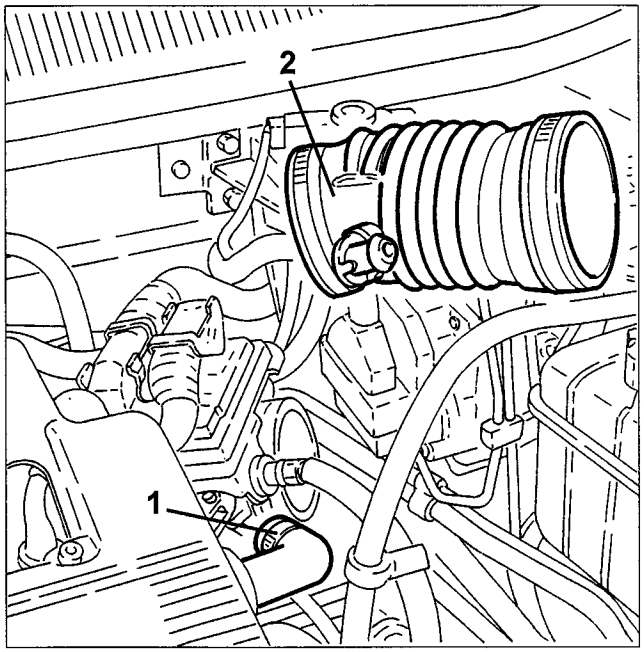
1. Disconnect the air flow meter electrical connection.
2. Loosen the clip fastening the resonator sleeve to the corrugated sleeve second section.
3. Loosen the screws fastening the air cleaner casing cover.
4. Remove the corrugated sleeve first section with air flow meter and air cleaner cover.



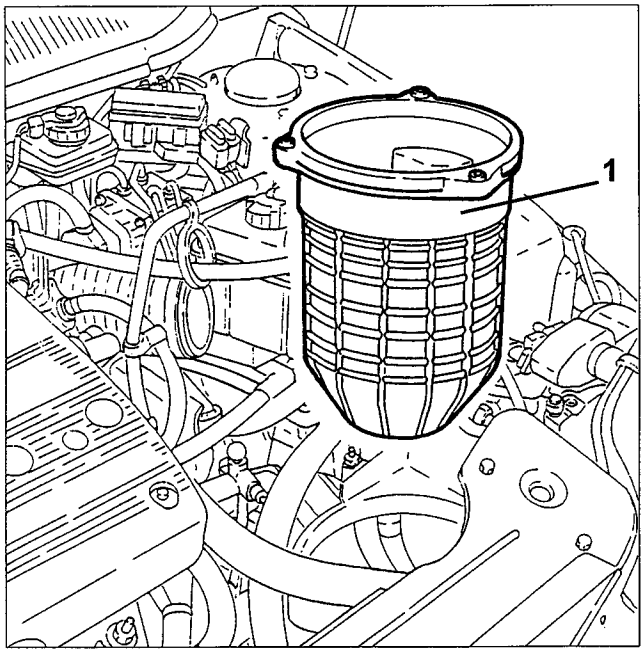
1. Remove the air cleaner conveyor.
2. Remove the air cleaner filter.



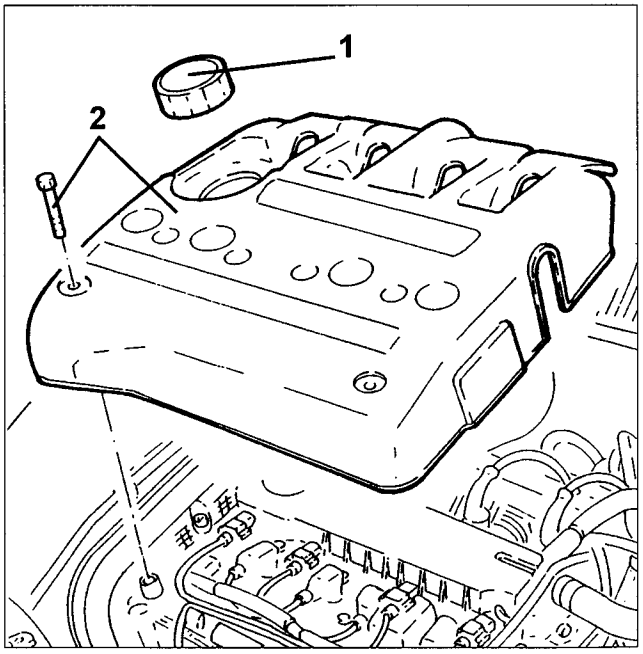
1. Disconnect the oil vapour recovery pipe from the second corrugated sleeve section.
2. Loosen the clip and remove the corrugated sleeve second section.



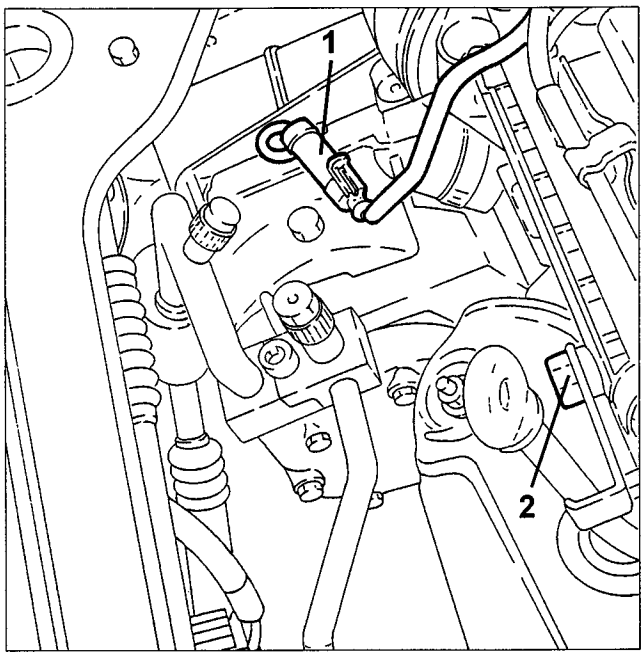
1. Remove the air cleaner casing.



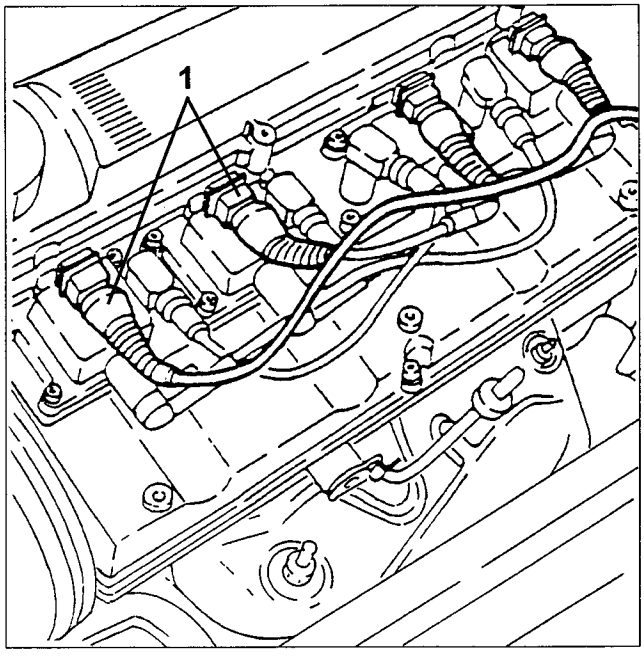
1. Remove the engine oil filler cap.
2. Loosen the fastening screws and remove the ignition coil covers.
- Refit the engine oil filler cap.



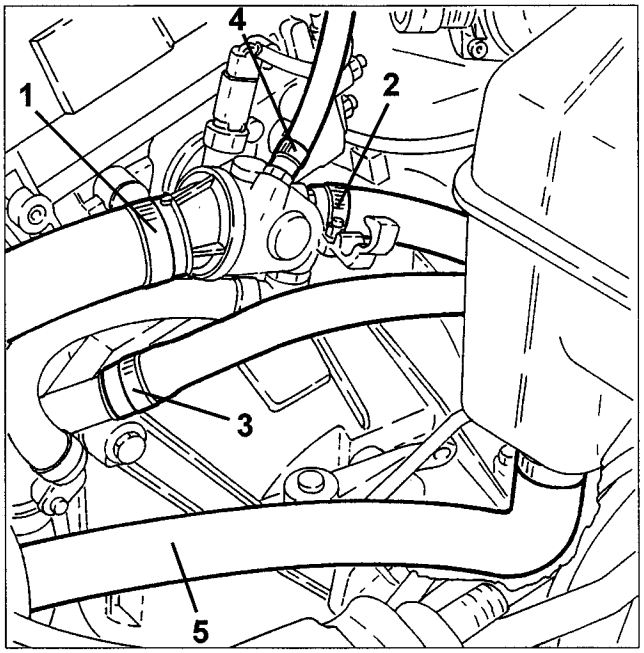
1. Disconnect the conditioner compressor electrical connection.
2. Loosen the engine oil level dipstick fastening screw.



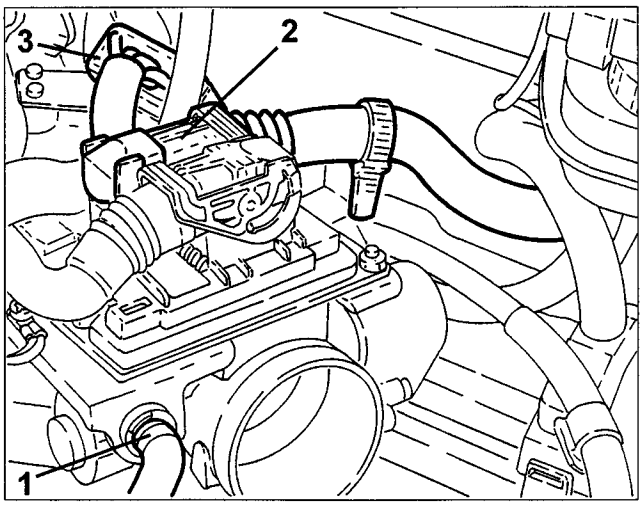
1. Disconnect the ignition coil electrical connections.



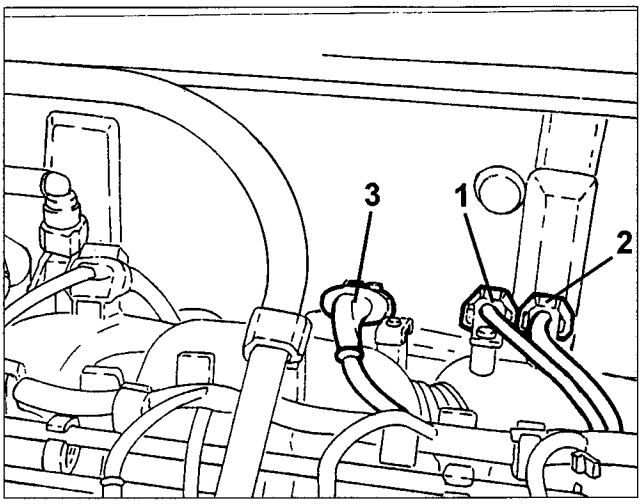
1. Disconnect the radiator coolant delivery sleeve from the thermostat cup.
2. Disconnect the climate control heater radiator coolant delivery sleeve from the thermostat cup.
3. Disconnect the climate control heater coolant return pipe from the coolant pump return pipe.
4. Disconnect the expansion reservoir delivery pipe from the thermostat cup.
5. Disconnect the radiator coolant outlet sleeve from the coolant pump return pipe.



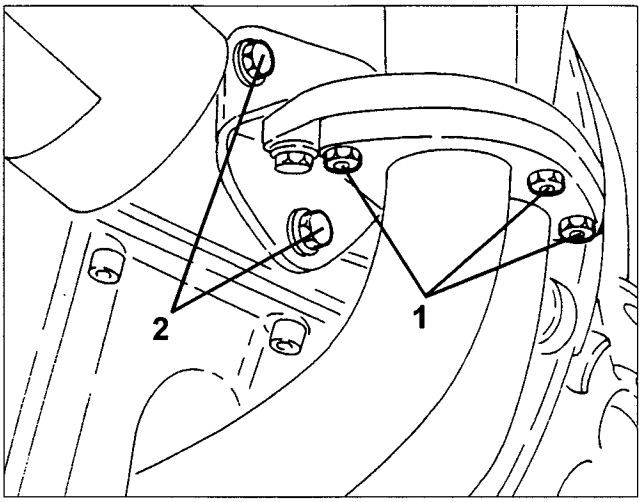
1. Disconnect the accelerator wire from the throttle casing with built-in MDS.
2. Disconnect the injection-ignition ECU electrical connection.
3. Disconnect the front engine wiring electrical connection.



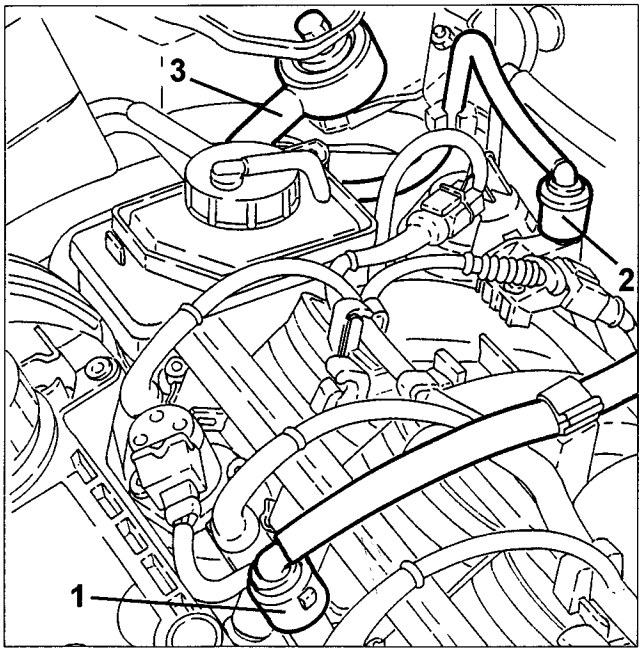
1. Disconnect the knock sensor electrical connection and release the wiring from the fastening clips.
2. Disconnect the rpm and phase sensor electrical connection and release the wiring from the fastening clips.
3. Disconnect the lambda sensor electrical connection and release the wiring from the fastening clips.



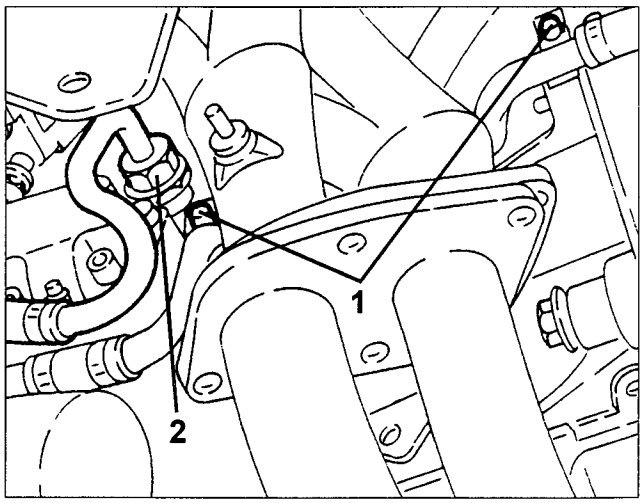
- Loosen the screws fastening the power steering reservoir to the modular intake manifold and move it aside without disconnecting the pipes.
1. Lift the vehicle and loosen the bolts fastening the front section of the exhaust pipe to the manifold.
2. Loosen the screws fastening the exhaust manifold bracket to the crankcase.



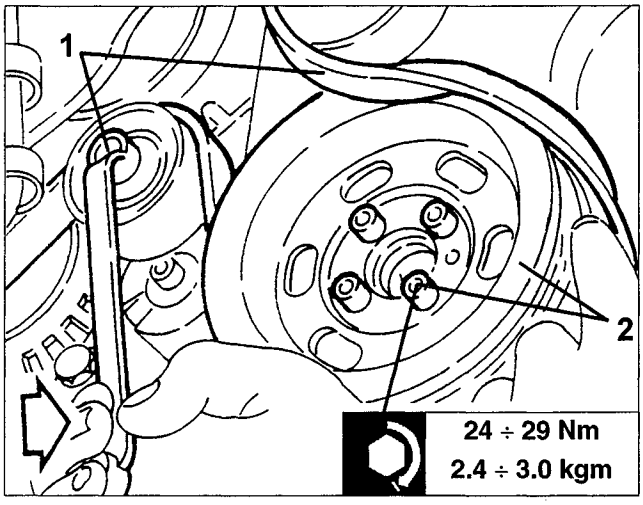
1. Disconnect the fuel delivery pipe from the fuel distribution manifold.
2. Disconnect the fuel vapour recirculation pipe quick coupling.
3. Loosen the reaction screws and remove the engine tie-rod.



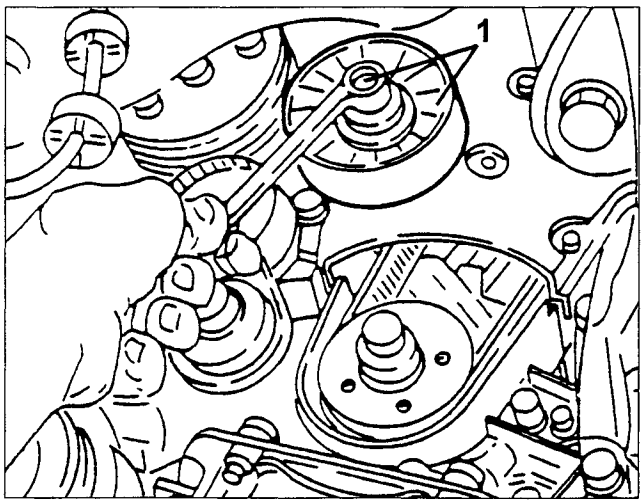
1. Loosen the two screws fastening the coolant delivery pipe to the heat exchanger.
2. Disconnect the coolant fluid outlet pipe from the heat exchanger.



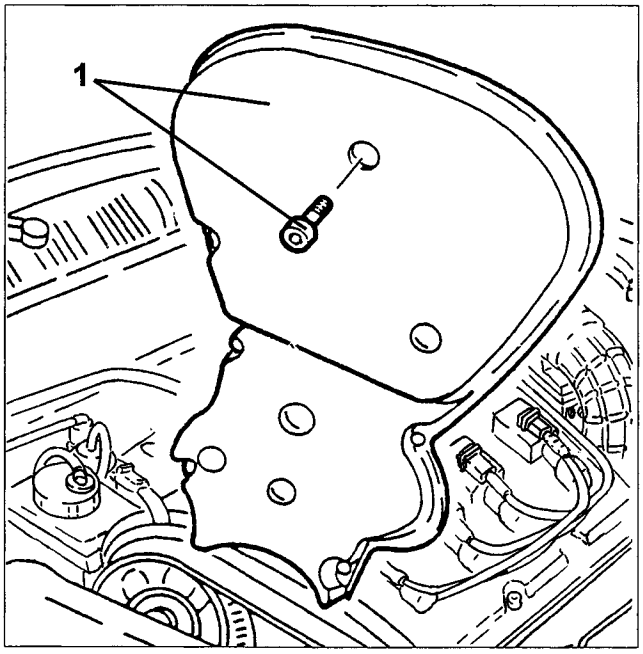
1. Move the engine unit belt take-up device as shown in the figure and remove it.
2. Loosen the fastening screws and remove the engine pulley.



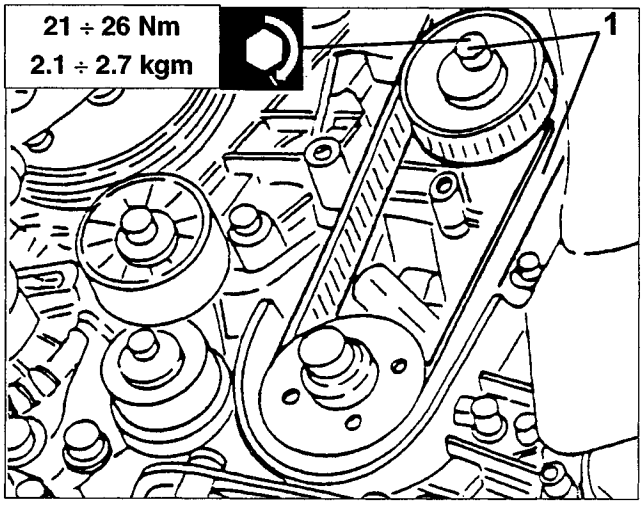
For versions without counter-rotating shafts
1. Loosen the fasten screw and remove the engine unit belt runner.



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

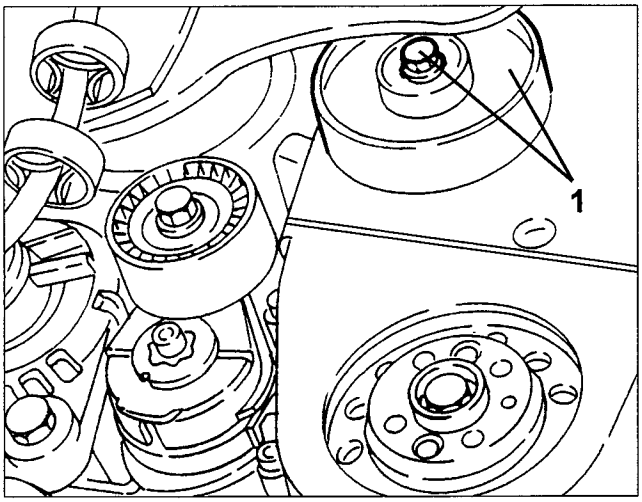


1. Turn the belt take-up and loosen the timing belt. Remove the belt from the camshaft pulleys.



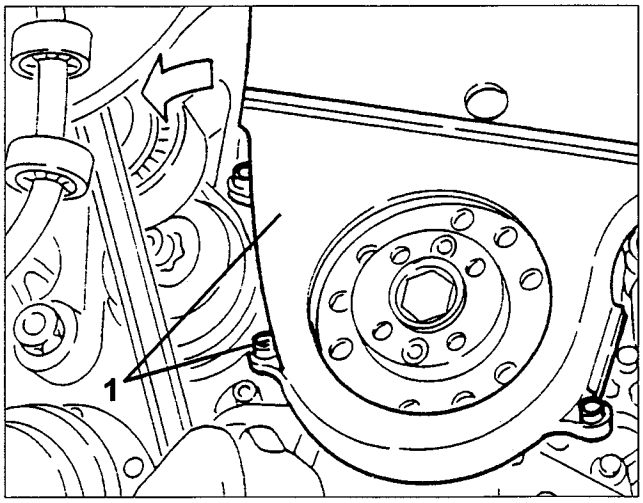
For versions with counter-rotating shafts

1. Loosen the fastening screw and remove the auxiliary unit belt runner.



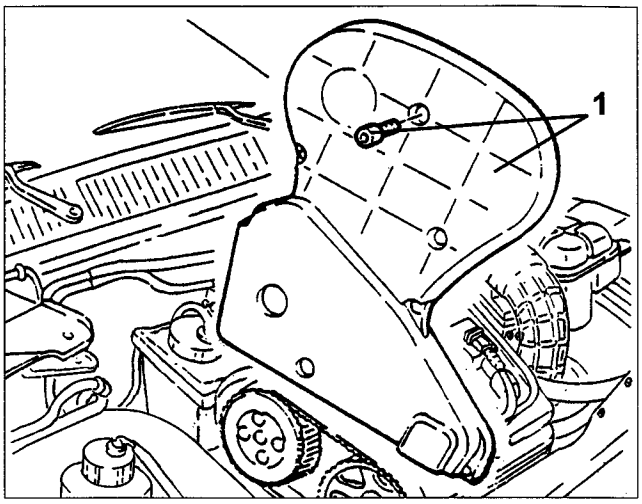
1. Loosen the fastening screws and remove the lower timing belt guard.

NOTE: Turn the auxiliary unit belt take-up device as shown in the figure to reach the rear screw.

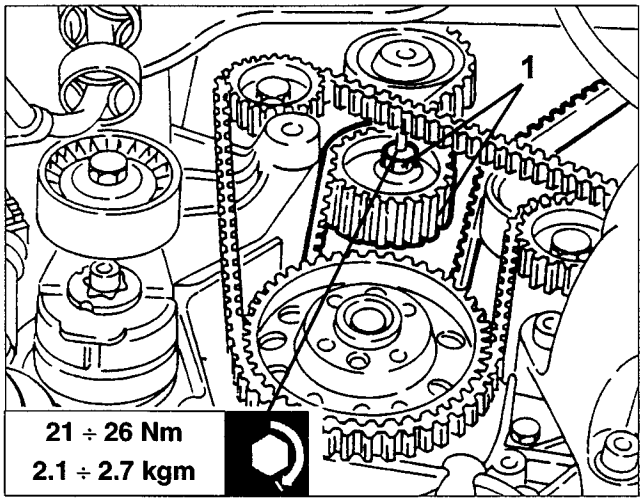


- Loosen the upper timing belt guard lower screws.

1. Lower the vehicle, loosen the remaining fastening screws and remove the upper timing belt guard.

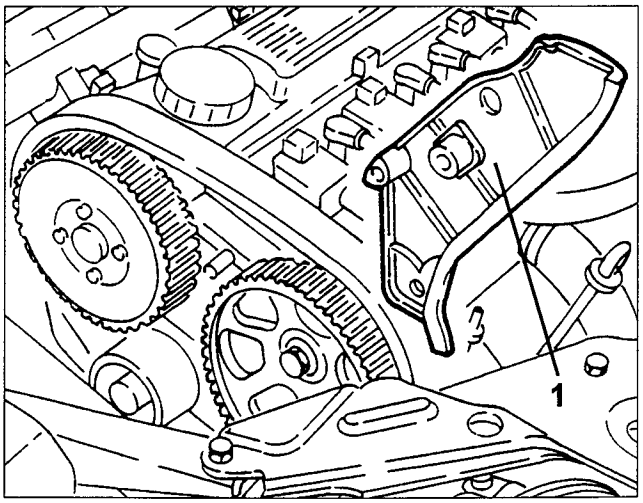


1. Turn the belt take-up, loosen the timing belt and remove it from the camshaft pulleys.

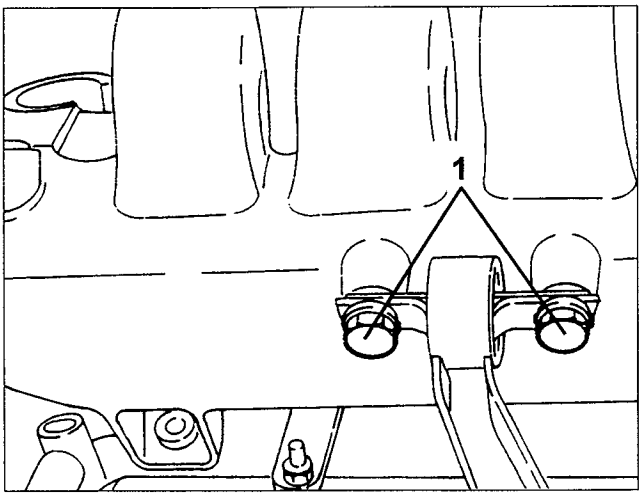


For all versions

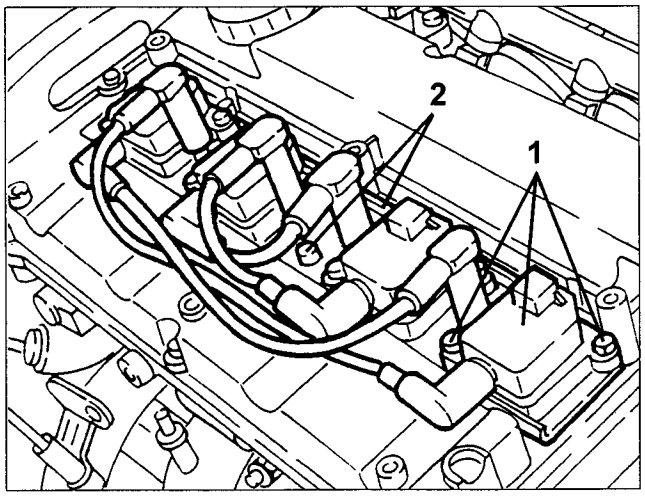
1. Loosen the fastening screws and remove the two timing belt side guards.



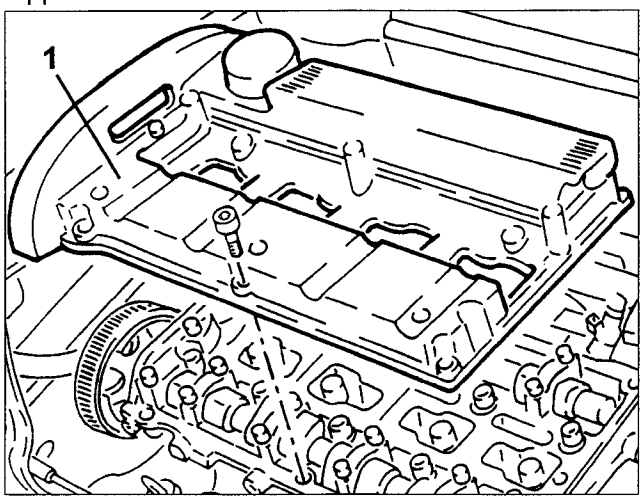
1. Lift the screws fastening the bracket to the modular intake manifold.



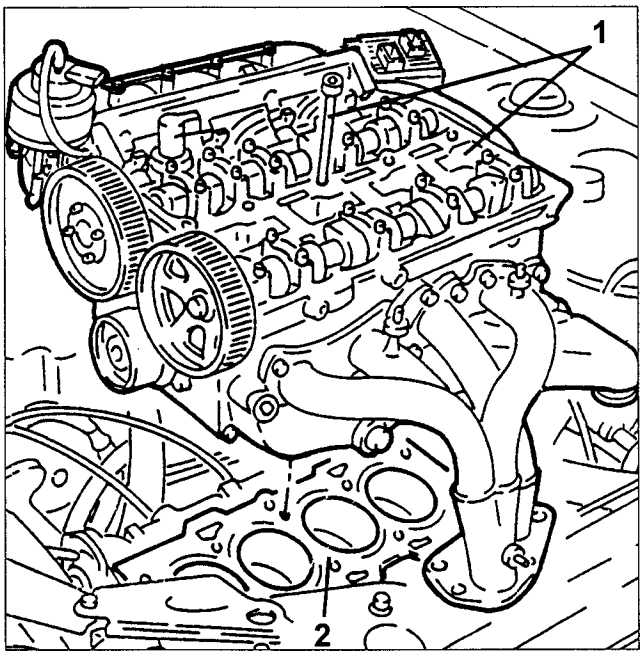
- Disconnect the brake booster vacuum intake pipe from the modular intake manifold.
1. Loosen the fastening screws and remove the ignition coils.
2. Loosen the fastening screws and remove the ignition coil bracket.



- Disconnect the oil vapour recirculation pipe from the tappet cover.
1. Loosen the fastening screws and remove the tappet cover and seal.



1. Loosen the fastening screws and remove the cylinder head.
2. Remove the respective seal.



- Disassemble and overhaul the cylinder head as described in the "ENGINE OVERHAUL" book.

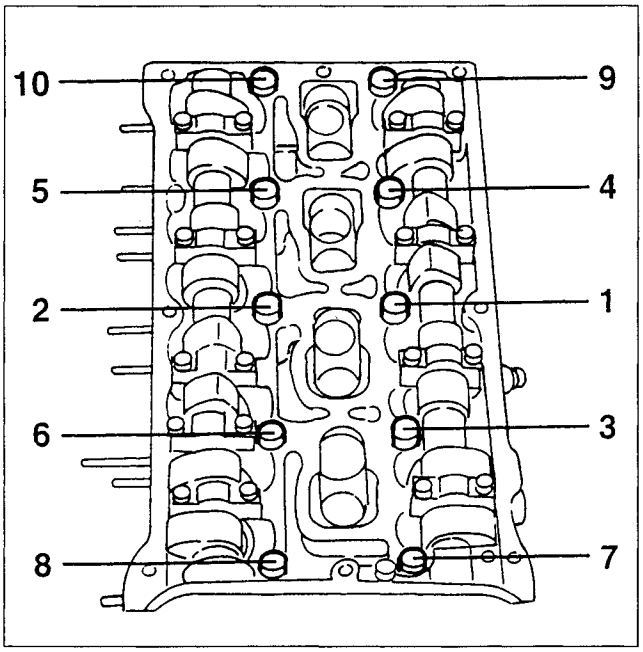
Refit the cylinder head by reversing the removal sequence. Observe the following precautions.
- Turn the crankshaft so that the pistons of cylinder 1 and 4 are at TDC.
- Position a new cylinder head seal on the crankcase.

NOTE: The cylinder head seal is made of aramidic fibre and no head re-torque is required for the entire engine life.

IMPORTANT: When refitting, clean the cylinder head and crankcase surfaces accurately.

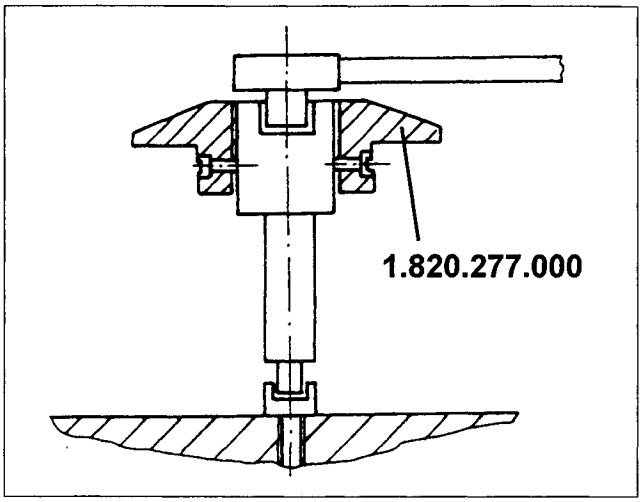
- Fit the cylinder head on the crankcase.

- Torque the cylinder head fastening screws as described below according to the order shown in the figure.



Tightening sequence	
Fasten all screws at a torque of:	20 Nm (2.0 kgm)
Torque all screws at a pre-torque of:	40 Nm (4.1 kgm)
Turn all screws by an angle of:	90° + 90° + 90°

- Use tool no. 1.820.277.000 as shown in the figure for angle torque.



For refitting the timing belt, for timing and for refitting the auxiliary unit belt, see ASSEMBLY 00.

GENERAL DESCRIPTION

The Bosch Motronic M1.5.5 belongs to the category of integrated system governing:
- inductive discharge electronic ignition
- statistic timing
- phased sequential electronic injection (1-3-4-2).

When idling the ECU controls:
- spark instant
- air intake

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:
- injection time adjustment
- spark advance
- cold start control
- acceleration enrichment control
- fuel cut-off upon accelerator pedal release
- idling control and management
- engine rpm limitation;
- fuel-lambda sensor control
- cylinder position acknowledgement
- fuel vapour recovery
- connection to climate control system (where fitted)
- connection to Alfa Romeo CODE ECU (Immobilizer)
- system self-adapting
- self-test
- cooling fan control.

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 (built-in the constant idling actuator) to acknowledge idling, partial and full charge
- 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.

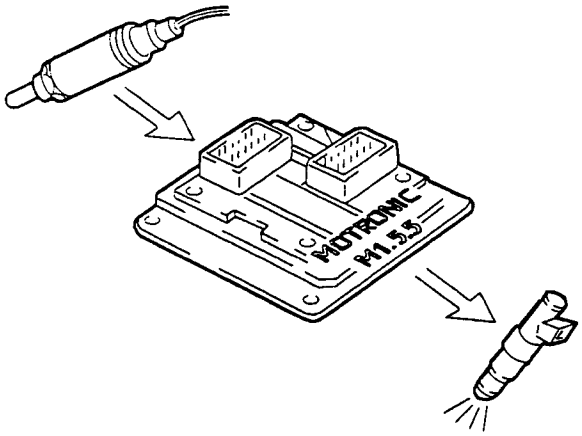
A map containing the entire set of optimal spark advance values (for each cylinder at power stroke) which the engine can adopt according to the ratio and the engine load is stored in the ECU. The ECU corrects spark advance mainly according to:
- air coolant temperature
- air intake temperature
- knock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

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 rear part of the crankcase between cylinder 2 and 3) to acknowledge the cylinder where detonation is occurring and to correct spark advance
- throttle potentiometer (built-into the constant idling actuator) to acknowledge load conditions (idling, partial and full).

INJECTION SYSTEM OPERATING LOGIC

System self-adaption

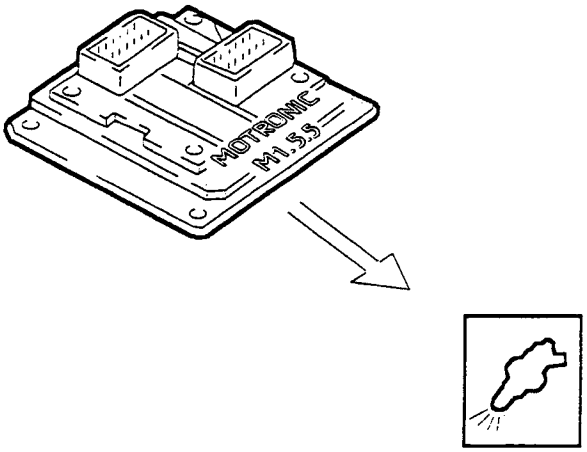
The ECU is equipped with a self-adapting feature which acknowledged the changes in the engine and in its components due to time and ageing. The changes are memorised as basic maps and have the function of adapting the system to the progressive engine component alterations which respect to new conditions. The self-adapting feature also allows to compensate for the inevitable differences (due to production tolerance) of replaced components.
The exhaust fume analysis changes the basic mapping with respect to new engine conditions.
Self-adapting parameter as not deleted when the battery is disconnected.



Self-test

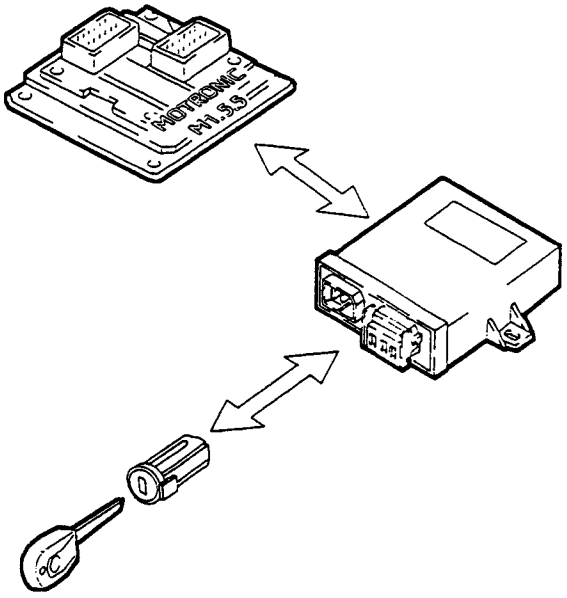
The ECU self-test system checks the signals from the sensors and compares them against the allowed thresholds:
- fault signalling at key on
• warning light on for four seconds indicates test phase
• warning light off after four seconds indicates no faulty components which can alter the pollution prevention system effectiveness have been found
• warning light on after four seconds indicates a fault.

- fault signalling during operation
• warning light on signals a fault
• warning light off indicates no faulty components which can alter the pollution prevention system effectiveness have been found.
- recovery
• the ECU defines the type of recovery according to the faulty components
• the recovery parameter are controlled by the components which are not faulty.



Alfa Romeo CODE acknowledgement

When the ECU receives the key on signal (key at "MAR") it interfaces with the Alfa Romeo CODE ECU to enable start-up. Communication is ensured via a two-way diagnostic serial line between the two ECUs.

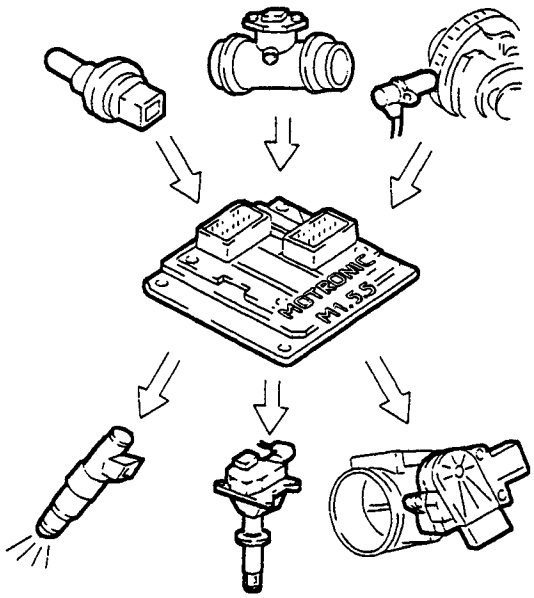


Cold start control

Normally, in cold start conditions:
- the mixture is naturally lean due to poor turbulence of the fuel particles at low temperatures
- fuel evaporation is reduced
- fuel condenses on the intake manifold internal walls
- lubricating oil is more viscous.

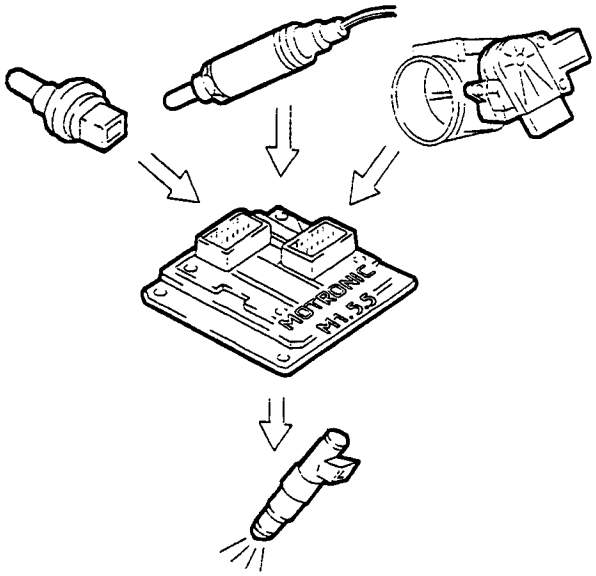
The ECU acknowledges this condition and corrects the injection time according to:
- coolant temperature
- intake air temperature
- battery voltage
- engine rpm.

Spark advance is exclusively controlled according to rpm and to engine coolant temperature.
During start-up, the ECU controls an initial simultaneous injection for all injectors (full-group injection) and, after acknowledging cylinder stroke, it starts the normal, sequential phased operation.
While the engine is being taken to temperature, the ECU pilots the idling actuator to adjust the amount of air required to ensure idling ratio.
Engine ratio is decreased as the coolant temperature increases until the engine temperature nominal value is reached.



Fuel-lambda sensor control

The ECU processes with lambda sensor signal by means of a specific integrator and defines the injector opening time according to:
- idling ratio
- average load
- temperature > 30°C.



Phase variator control and modular intake manifold

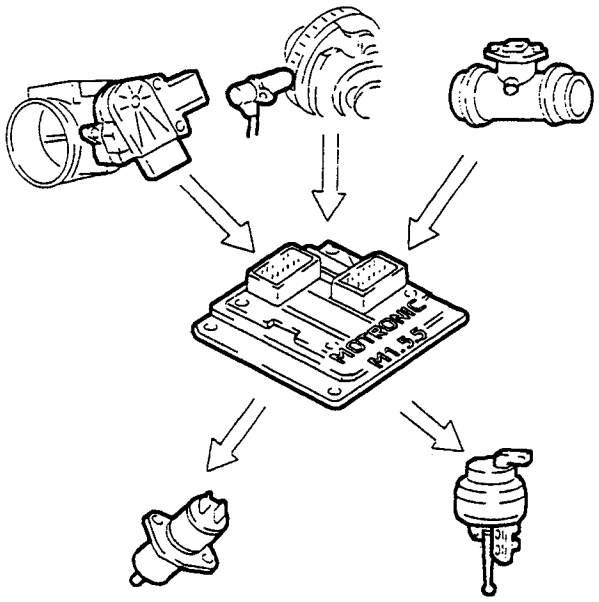
The ECU, in order to optimise the amount of air taken in by the engine, controls:
- intake phasing on two angular positions
- intake manifold geometry on two lengths.

At maximum torque, the ECU sets the "open" phase:
- cam advanced by 25° engine
- long intake manifold ducts.

At maximum power, the ECU sets the "closed" phase:
- cam in normal position
- short intake manifold ducts.

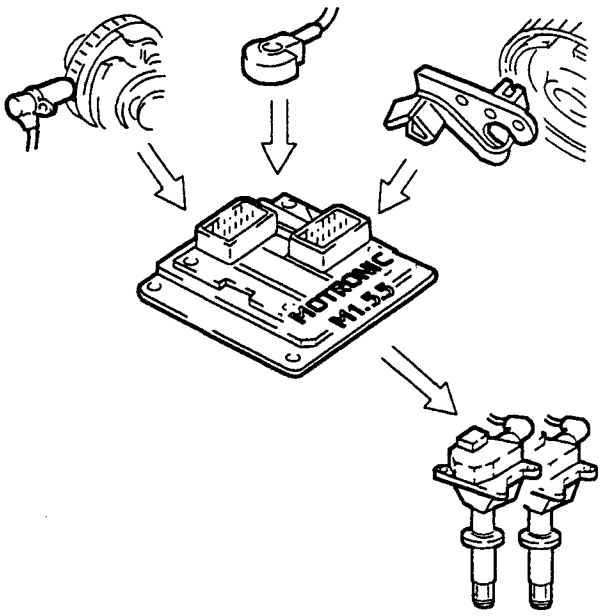
At idling ratio, the ECU sets the "closed" phase:
- cam in normal position
- short intake manifold ducts.

In other conditions of engine operation, the ECU chooses the most suitable configuration to optimise performance, consumption and emission.
At cut-off the intake manifold ducts are always "short".



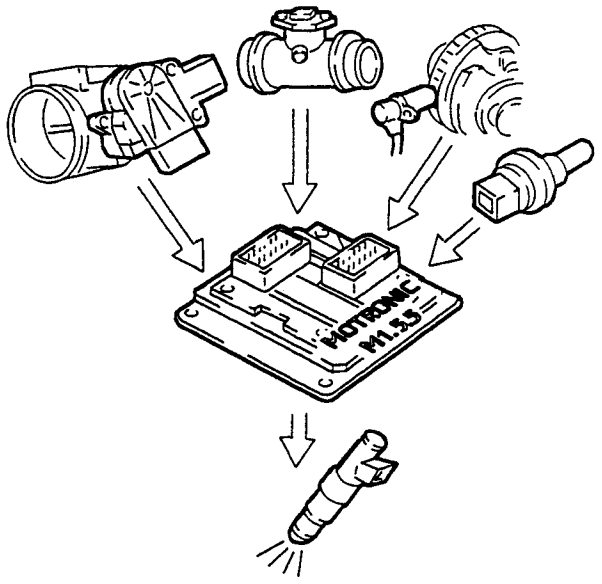
Knock control

The ECU acknowledges knock by processing the signal from the respective sensor. The ECU constantly checks the sensor signal with a threshold value. The threshold value is constantly updated considering basic noise and engine ageing.
Consequently, the ECU can acknowledge knock (or early knock) and reduces the spark advance by 3° steps to a maximum of 6° until the phenomenon disappears. Advance is then gradually restored to the basic value (in 0.8° steps).
During acceleration, the ECU employs a higher threshold to adapt to increased engine noise.
Knock control is also equipped with a self-adapting feature which memorises advance reductions which repeat constantly so to update the maps to the different conditions in which the engine is working.



Acceleration enrichment control

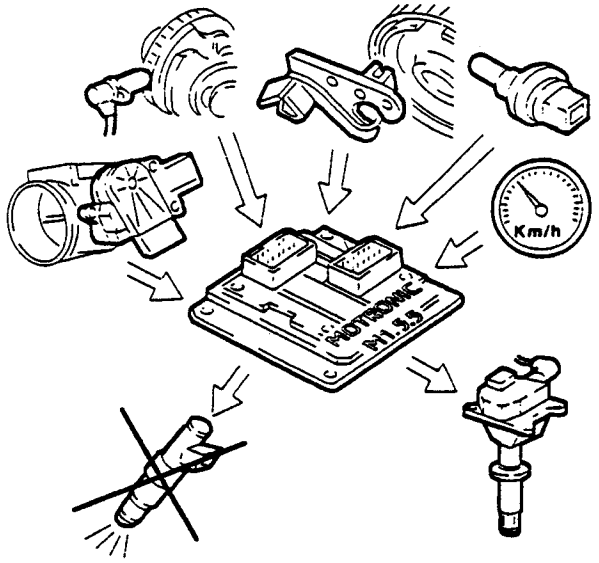
If in acceleration, the air flow meter signal exceeds a certain predefined increase, the ECU increases injection (injection time) to rapidly reach the required rpm. As the define rpm approaches, the injection increase is progressively eliminated.
Recovery:
- the ECU replaces the signal from the faulty air flow meter with the signal from the throttle potentiometer.



Fuel cut-off upon accelerator pedal release

When the accelerator pedal is released at over a predefined engine rpm threshold, the ECU:
- cuts feed to injectors
- supplies feed to injectors at 1300 - 1500 rpm.

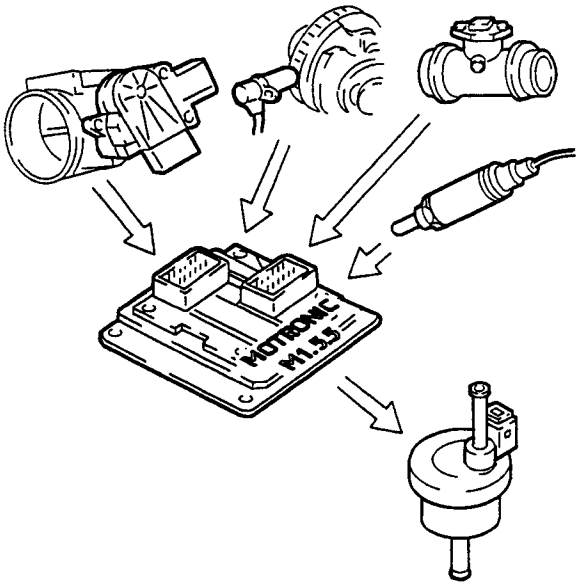
When the throttle is closed and engine rpm exceeds 1700 rpm, the ECU inhibits injector opening.
When fuel is cut off, rpm decreases at different speeds according to vehicle speed. Before reaching idling speed, the rpm drop is checked. If it exceeds a certain threshold, fuel feed is partially reactivated to take the engine smoothly to idling speed.
The fuel start and cut-off thresholds vary according to:
- engine coolant temperature
- vehicle speed
- engine rpm.



Fuel vapour recovery

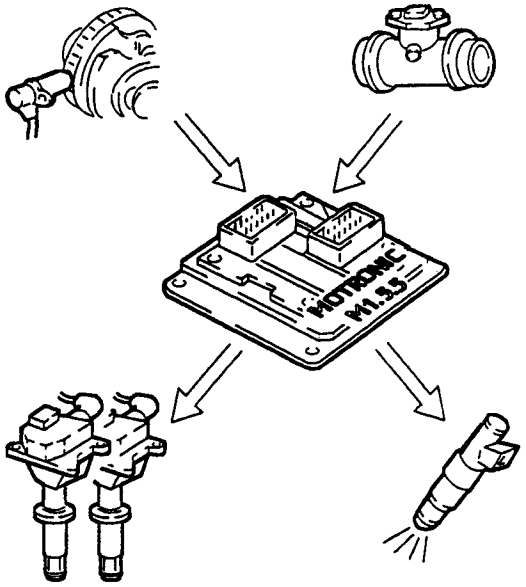
Fuel vapours (pollutants) are collected in an active carbon canister and are conveyed to the intake ducts to be burnt. This is ensured by means of a solenoid valve controlled by the ECU when engine conditions allow.

The ECU in fact compensates for this amount of additional fuel by reducing feed to injectors.



Engine rpm limitation

According to the engine rpm, the ECU:
- reduces injection time over 6800 rpm
- stops feed to the injectors at over 7000 rpm
- start piloting the injectors again under 6800 rpm.

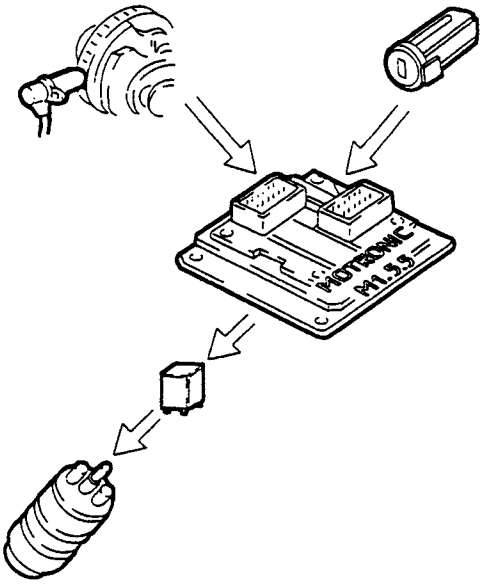


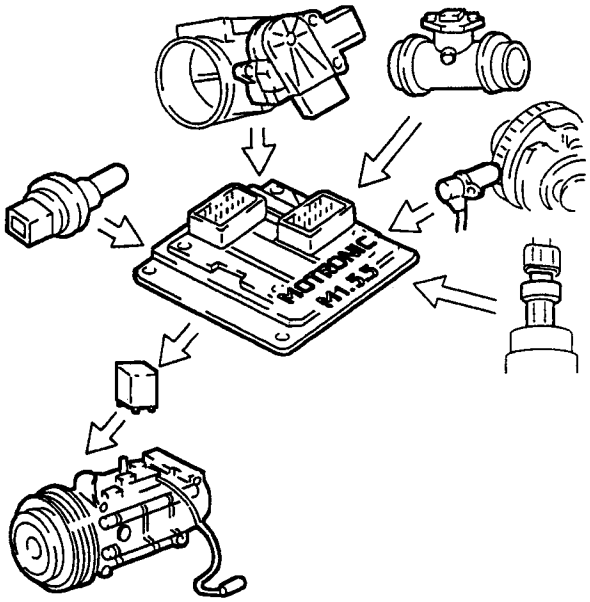
Fuel pump power control

The ECU powers the pump:
- with key is at MAR for 0.8 sec.
- with key at AVV and rpm > 23.

The ECU cuts pump power:
- with key at STOP
- with engine rpm < 23.

The fuel system is returnless and fuel pressure is constant at 3.5 bar.





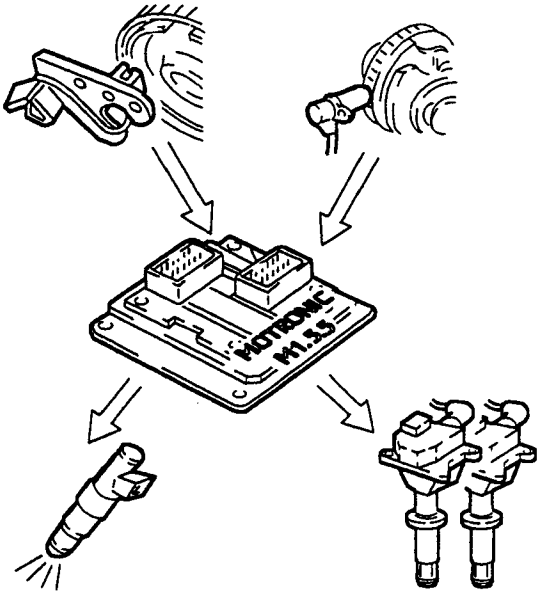
Cylinder position acknowledgement

At each engine revolution, the ECU acknowledges which cylinder is detonating and:
- controls the injection and ignition sequence to the suitable cylinder.

The ECU with no phase sensor signal:
- deactivates the knock sensor
- keeps injection timed when the vehicle is moving
- controls simultaneous ignition in cylinders 1-4 and 2-3 if the vehicle is stopped.

Climate control system connection

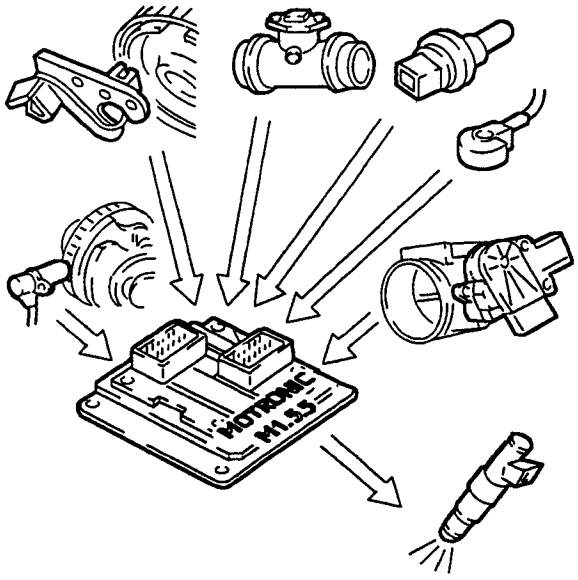
When the request for power increases due to the compressor operation, the ECU pilots the idling actuator to increase air delivery. In conditions of high power demand, the ECU temporarily cuts power to the compressor:
- at over 6500 rpm
- with engine coolant > 112°C.



Injection time adjustment

The ECU computes the injector opening time and controls the injectors extremely fast and accurately according to:
- engine load (rpm and air intake)
- battery voltage
- engine coolant temperature.

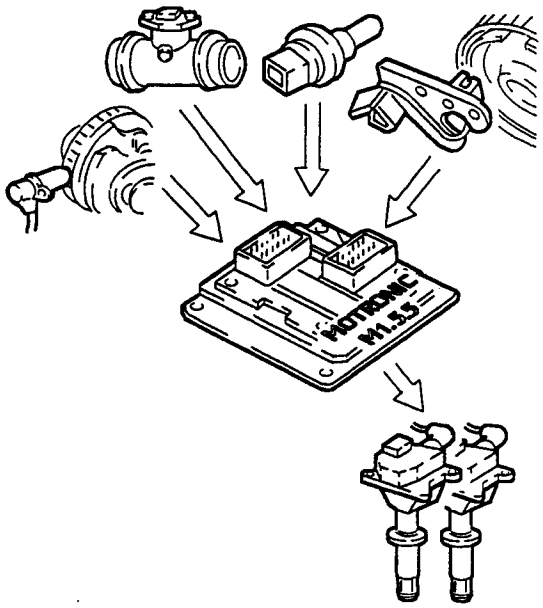
Injection is sequential and phased for each cylinder and corresponds to the optimal injection start point while the injection end point is constant.



Spark advance adjustment

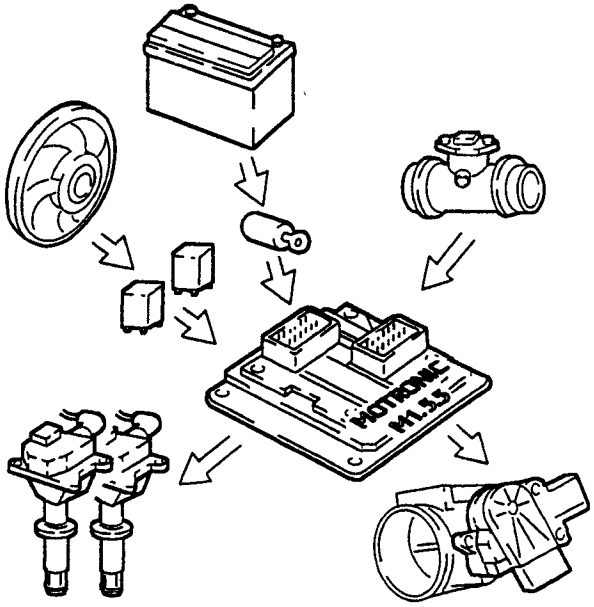
The ECU thanks to a memorised map computes spark advance according to:
- engine load (minimum, partial, full, according to rpm and air intake)
- air intake temperature
- engine coolant temperature.

It is possible to selectively delay ignition on the cylinder requiring it by a combination of the values recorded by the rpm and phase sensors.



Idling control - management

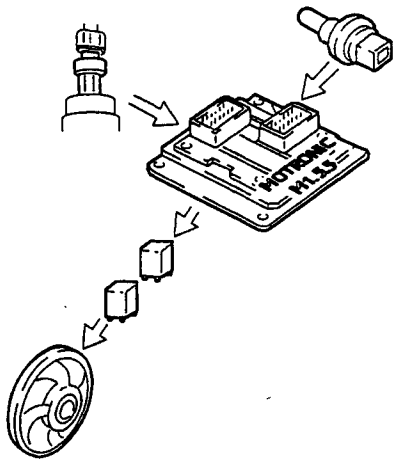
Idling is acknowledged by the ECU by means of the potentiometer built into the idling actuator and fitted on the throttle casing (throttle axis).
The ECU according to the devices which are no controls idling ratio (850 ± 30 rpm) as follows:
- adjusting spark advance
- piloting the throttle position (0° - 15°) by means of the idling actuator to adjust air intake.



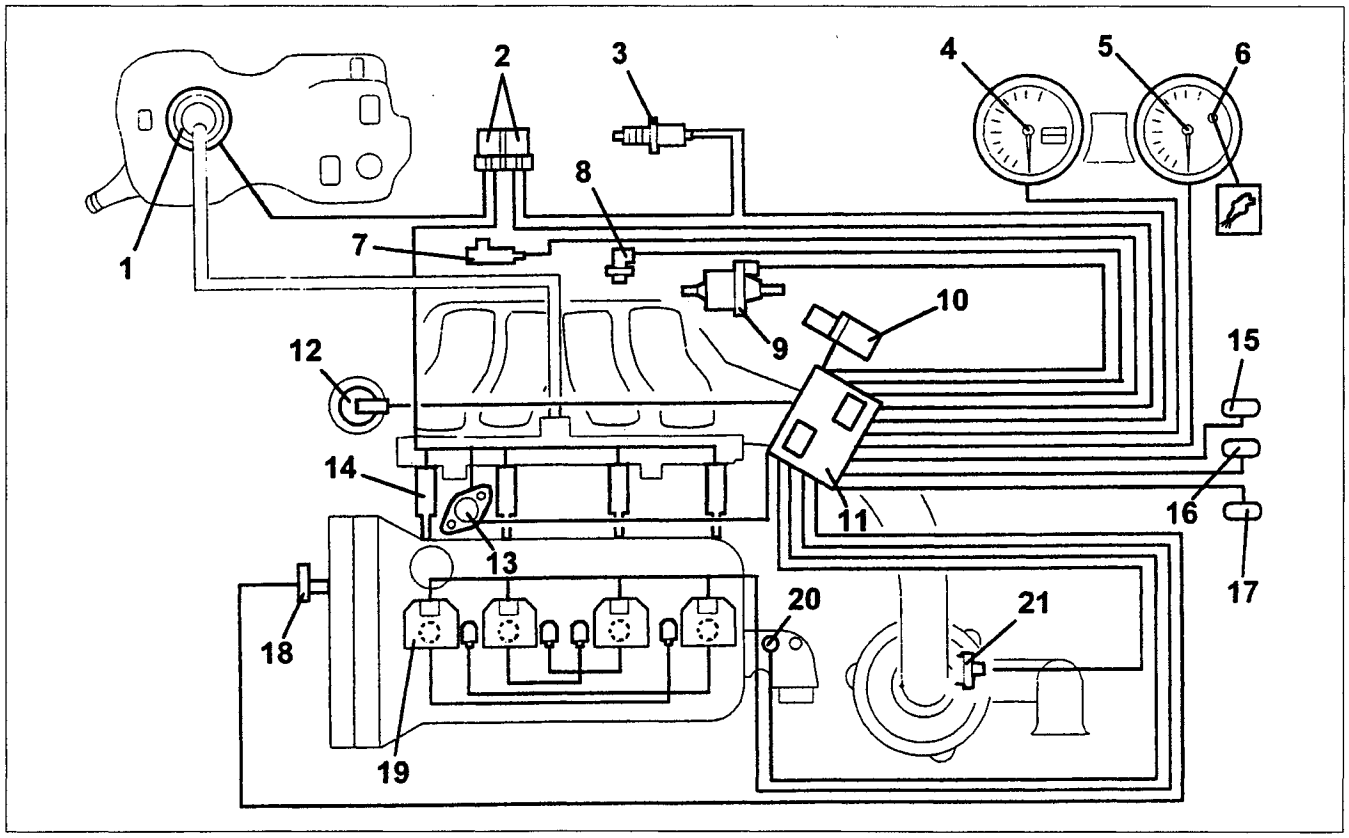
Radiator cooling fan control

The ECU controls fan operation according the to coolant temperature:
- 1st speed temperature threshold: 98°C
- 2nd speed temperature threshold: 101°C

Furthermore, an additional check (quadrinary signal) starts the fan at 1st or 2nd speed according to the cooling gas pressure when the climate control system is on.
If the coolant temperature signal is missing, the ECU implements a recovery strategy which starts the fan at 2nd speed until the error disappears.

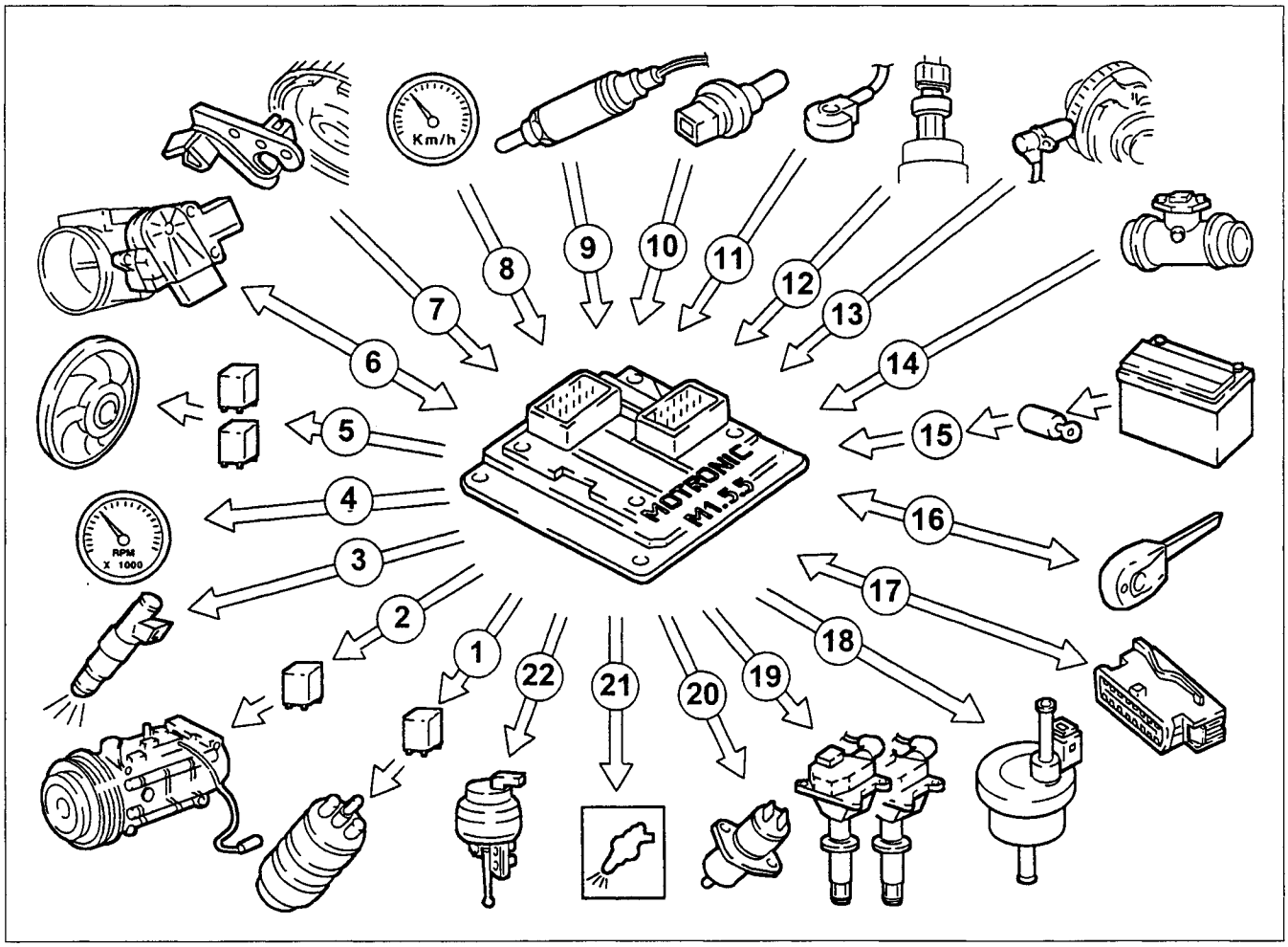


M1.5.5 INJECTION-IGNITION SYSTEM COMPONENTS



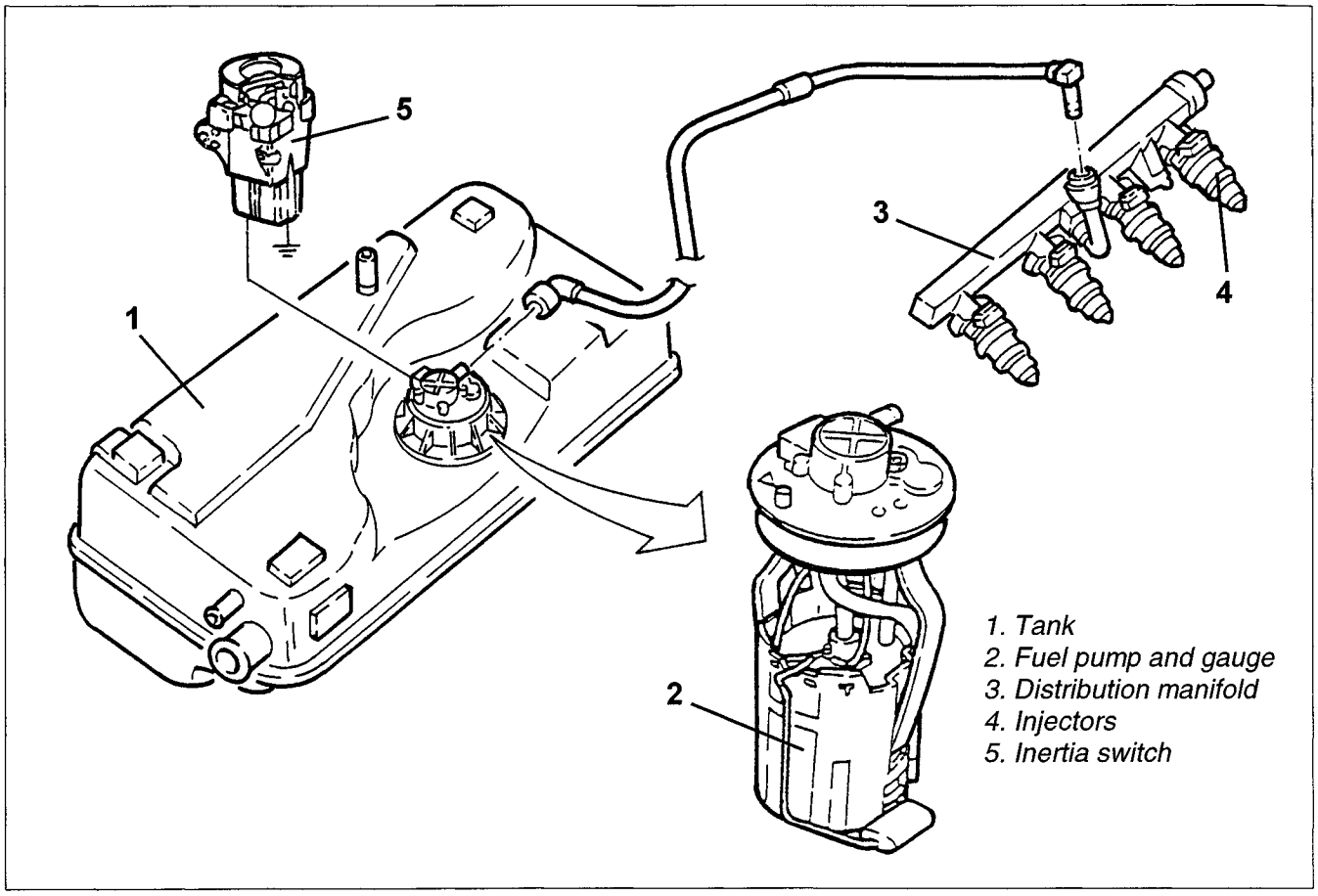
1. Fuel pump
2. Relays
3. Lambda sensor
4. Tachometer
5. Rpm counter
6. Check Engine warning light
7. Knock sensor
8. Rpm sensor
9. Fuel vapour recirculation solenoid valve
10. Throttle casing with built-in MDS
11. Injection-ignition ECU
12. Modular intake manifold solenoid valve
13. Phase variator
14. Injectors
15. Climate control connection
16. Diagnostic connection
17. Alfa Romeo CODE connection
18. Phase sensor
19. Ignition coils
20. Coolant temperature sensor
21. Air flow meter with built-in air temperature sensor

M1.5.5 INJECTION-IGNITION FUNCTIONAL DIAGRAM



1. *Fuel pump*
2. *Conditioner compressor*
3. *Injectors*
4. *Rpm counter*
5. *Fan*
6. *Throttle casing with built-in MDS*
7. *Phase sensor*
8. *Tachometer*
9. *Lambda sensor*
10. *Coolant temperature sensor*
11. *Knock sensor*
12. *Quadrinary*
13. *Rpm sensor*
14. *Flow meter with built-in air temperature sensor*
15. *Battery*
16. *Alfa Romeo CODE*
17. *Diagnostic socket*
18. *Fuel vapour recirculation solenoid valve*
19. *Ignition coils*
20. *Phase variator*
21. *Check Engine warning light*
22. *Modular intake manifold solenoid valve*

SYSTEM DESCRIPTION



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.

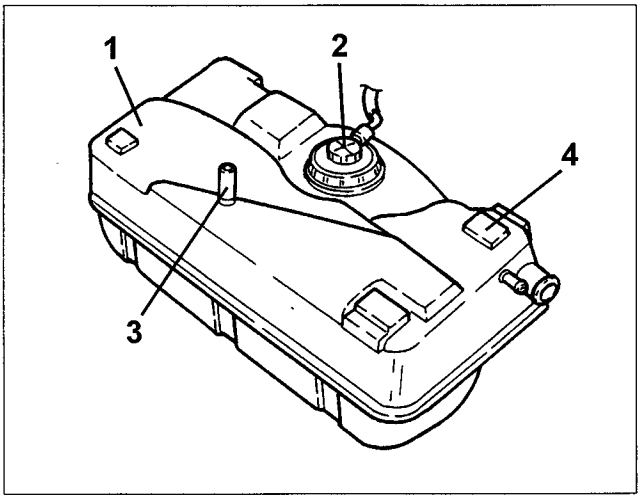
The filler cap is fitted on the steel fuel tank main casing.

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 fuel tank is made of steel and has a capacity of 70 litres including a reserve of approximately 9 litres. The fuel filler is fitted on the main casing in a specific compartment so that is can be removed.



1. Tank
2. Fuel pump and gauge
3. Vapour recovery pipe
4. Vibration damper pads

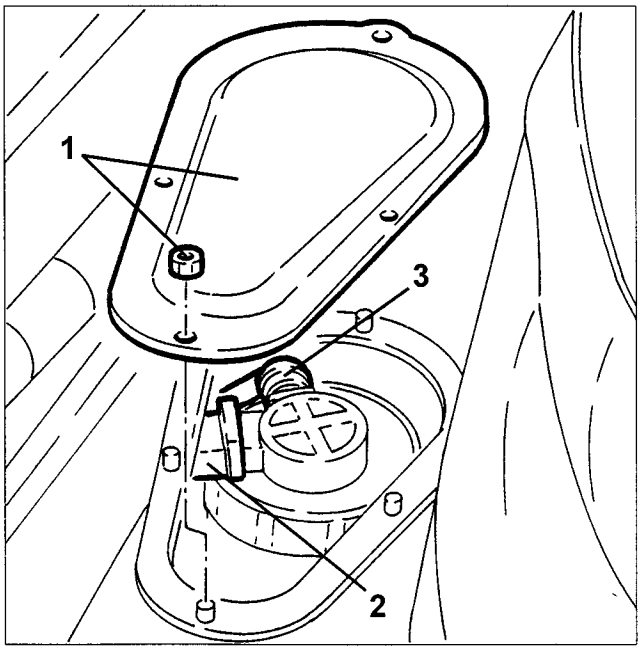
The filler cap presents a system which ensures it can only be closed at the prescribed torque. Excessive torque (exceeding prescriptions) will cause the notches to turn without locking.
The tank is located:
- **Spider** version: under the hood compartment and is fastened by means of two metal belts to the underbody. It is protected by a steel partition;
- **Gtv** version: under the rear seat and is fastened by means of two metal belts to the underbody. It is protected by a 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.

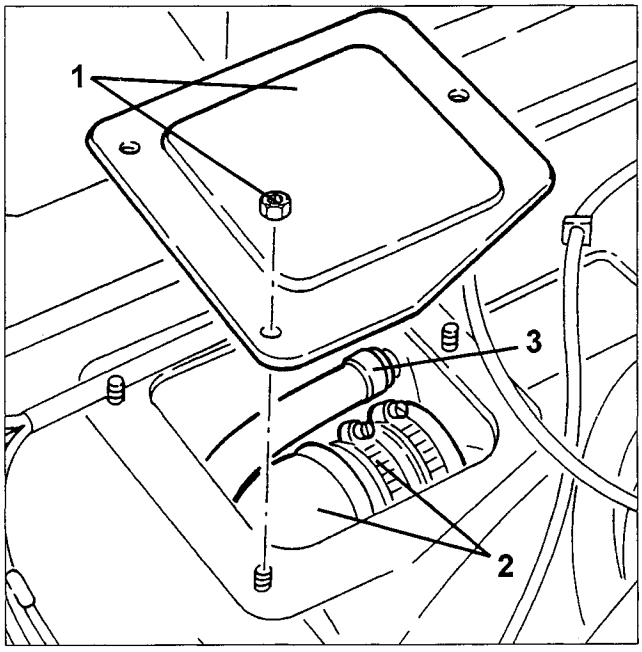
REMOVAL/REFITTING
Spider version

- 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.
- Lift the hood cover and open the upper hood bonnet.

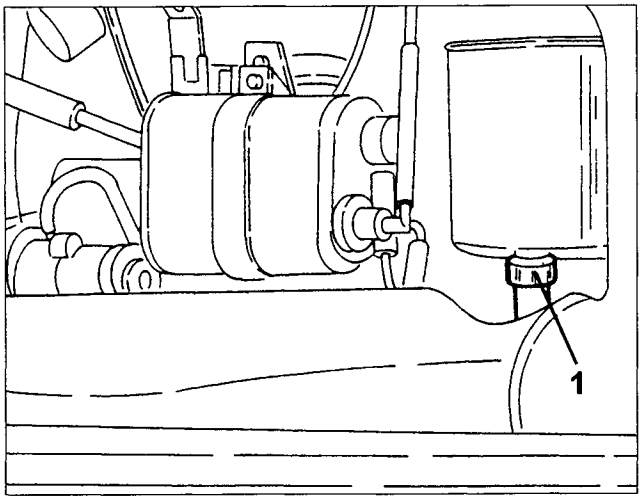
1. Move the hood compartment panel. Loosen the fastening nuts and remove the fuel pump and gauge cover.
2. Disconnect the fuel pump and gauge electrical connection.
3. Disconnect the fuel pump and gauge delivery pipe.



1. Loosen the fastening nuts and remove the fuel tank filler cover.
2. Loosen the fastening clip and disconnect the fuel filler from the tank.
3. Loosen the fastening clip and disconnect the breather pipe from the fuel tank.

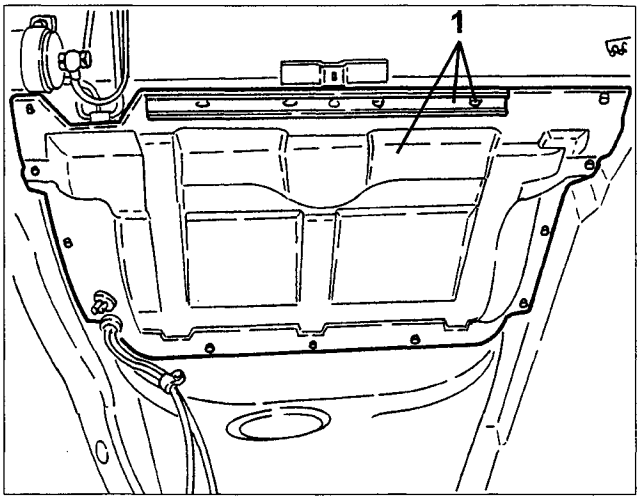


1. From inside the boot, lift the panel and disconnect the tank vapour pipe from the fuel vapour separator.

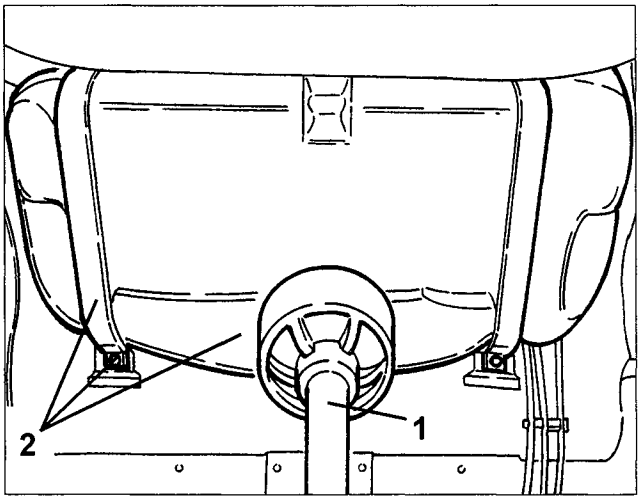


- Lift the vehicle and remove the rear suspension (see specific paragraph).

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

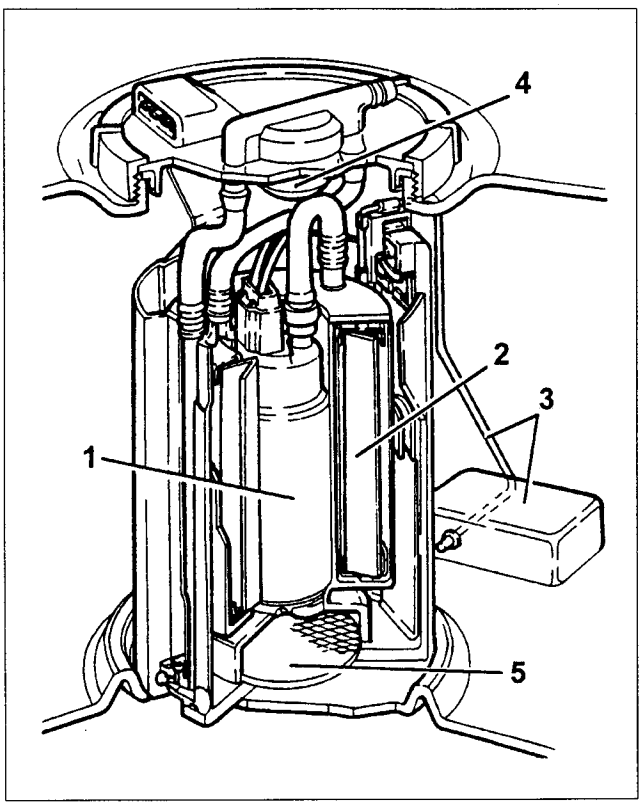


REMOVAL/REFITTING
GTV version

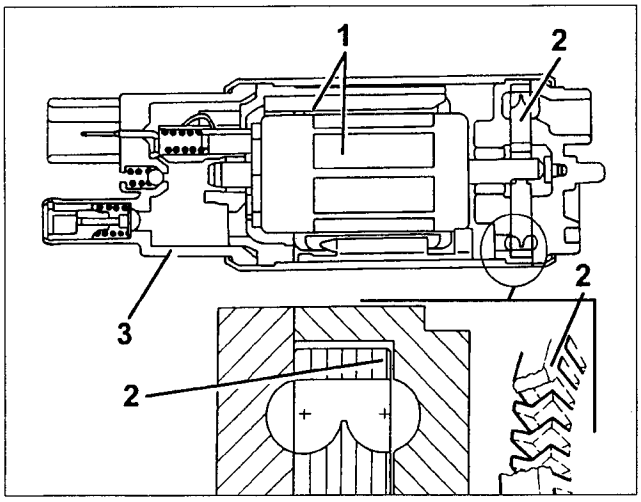
- See **Gtv** 2959 **24V** *'98.*

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.

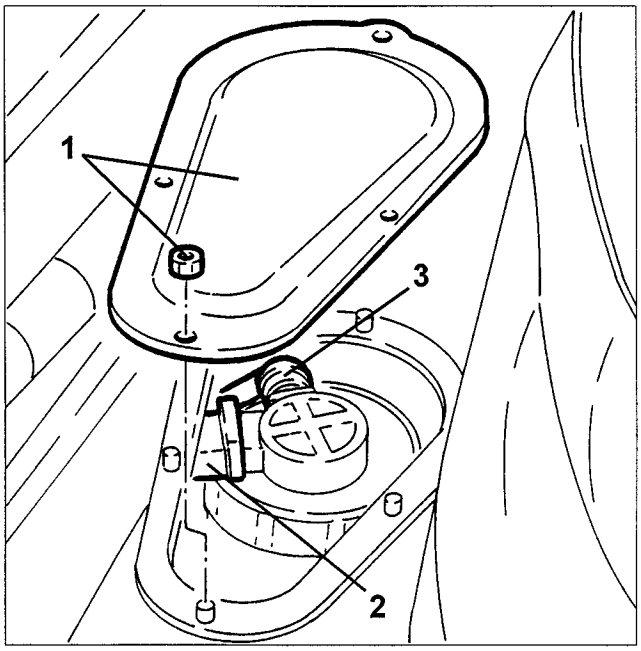


The pump is a single stage, peripheral flow device which ensures high performance at low voltage and temperature. The advantages with respect to volumetric pumps are:
- lower weight
- smaller size.

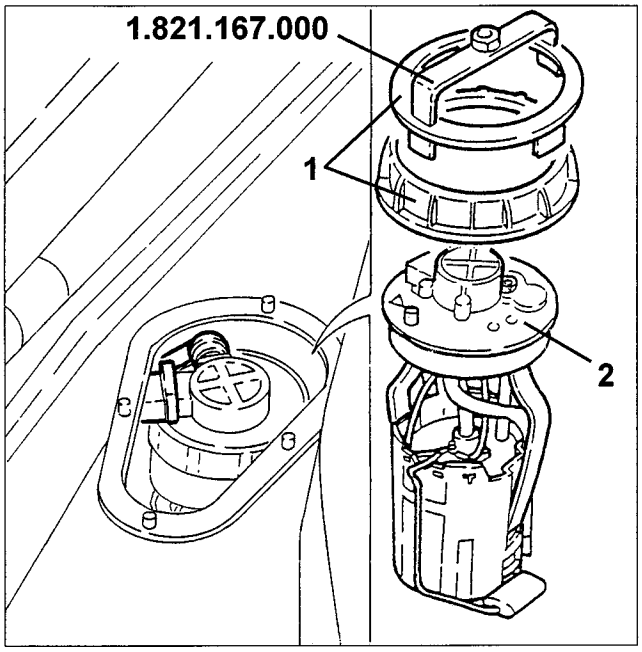
REMOVAL/REFITTING
Spider version

- Make sure the ignition key is at "STOP" and disconnect the (-) battery terminal.
- Lift the hood cover and open the upper hood bonnet.

1. Move the hood compartment panel. Loosen the fastening nuts and remove the fuel pump and gauge cover.
2. Disconnect the fuel pump and gauge electrical connection.
3. Disconnect the fuel pump and gauge delivery pipe.



1. Use tool no. 1.821.167.000 to loosen 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.

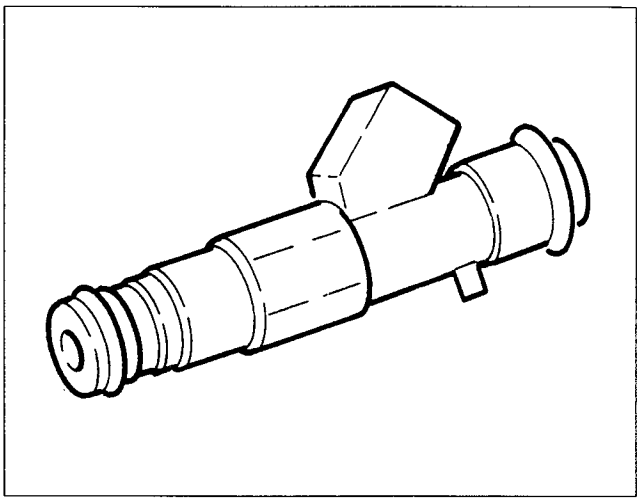
REMOVAL/REFITTING
Gtv version

- See **Gtv** 2959 **24V** *'98.*

INJECTORS

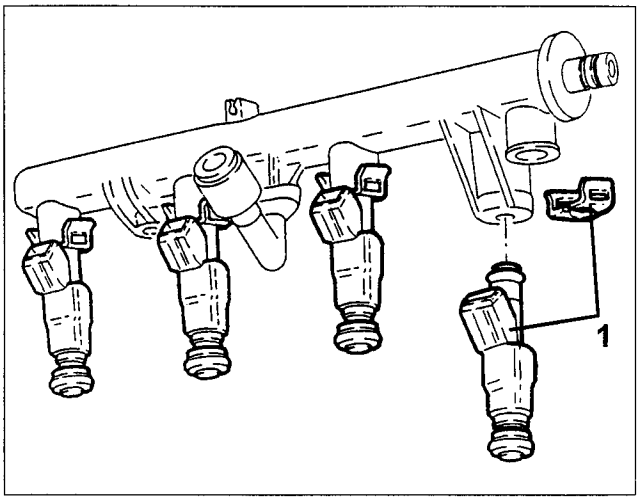
The double jet injectors and fitted on the distribution manifold. They are fastened to the distribution manifold by means of a safety retainer. Tightness is ensured by two O-rings.
The injectors feed the feed required to the engine.

They are "all or nothing" devices: they present only two stable positions, i.e. open or closed. They let fuel through when they are open and stop the fuel flow when closed.



REMOVAL/REFITTING

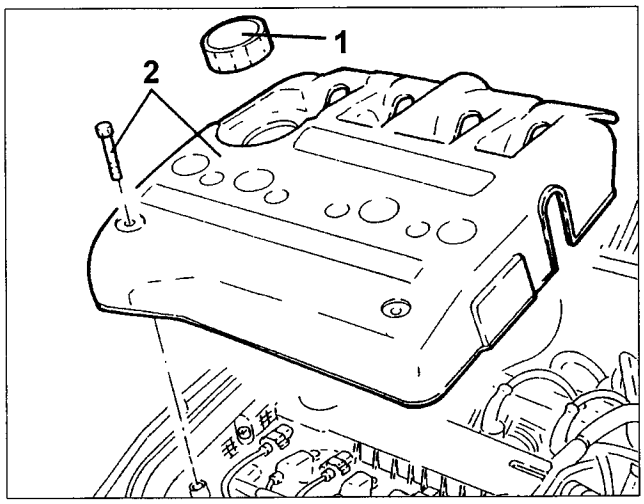
- Remove the fuel distribution manifold (see specific paragraph).
1. At the bench, remove the retainers and remove the injectors from the distribution manifold.



FUEL DISTRIBUTION MANIFOLD

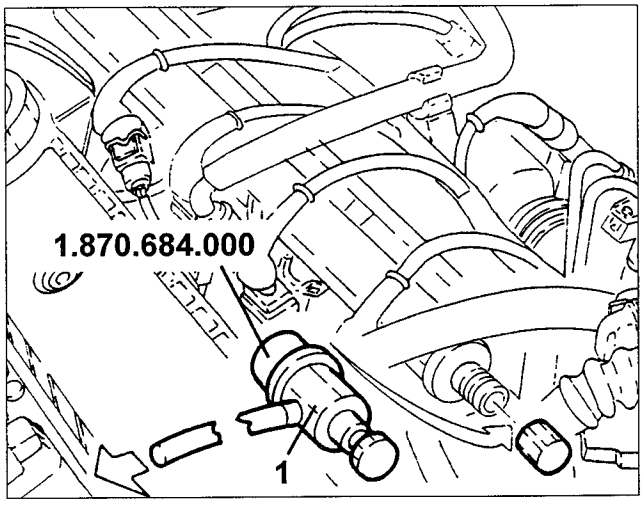
REMOVAL/REFITTING

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

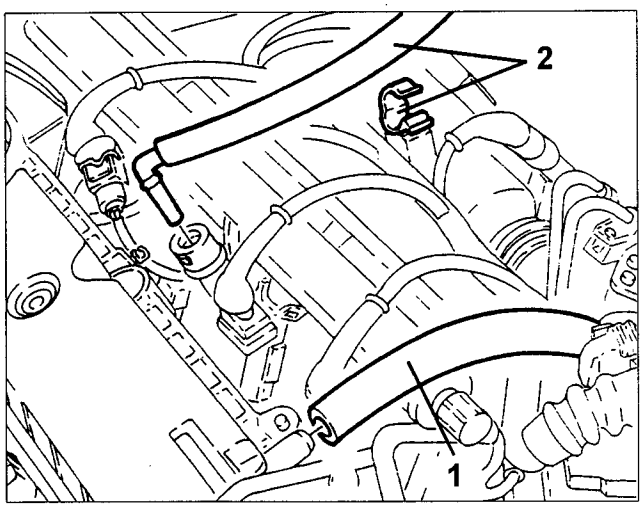


1. Connect tool no. 1.870.684.000 to the distribution manifold bleeder valve and drain the fuel pressure.

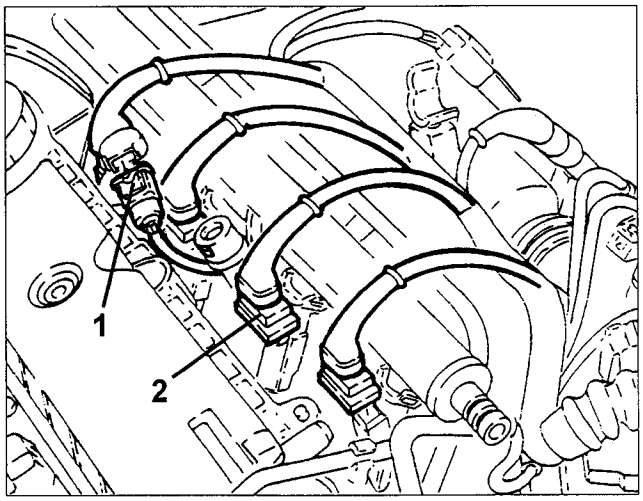
NOTE: Collect the fuel in a suitable container.



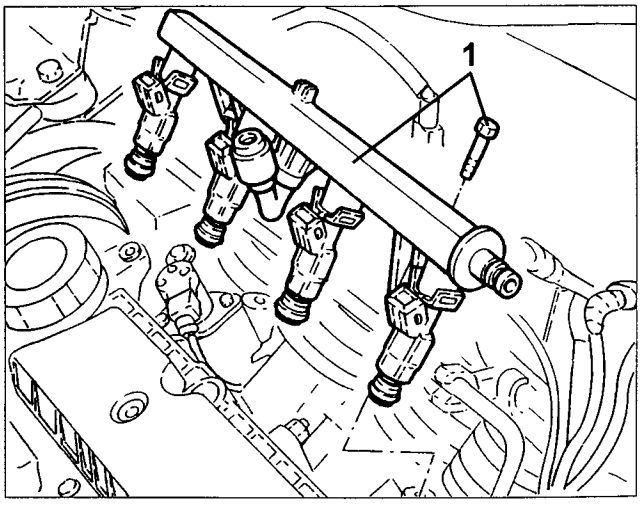
1. Disconnect the oil vapour recovery pipe from the tappet cover.
2. Disconnect the fuel delivery pipe from the fuel distribution manifold, release it from the clip on the modular intake manifold and move it aside.



1. Disconnect the phase variator electromagnet electrical connection.
2. Disconnect the injector electrical connections.



1. Loosen the fastening screws and remove the fuel distribution manifold and injectors.

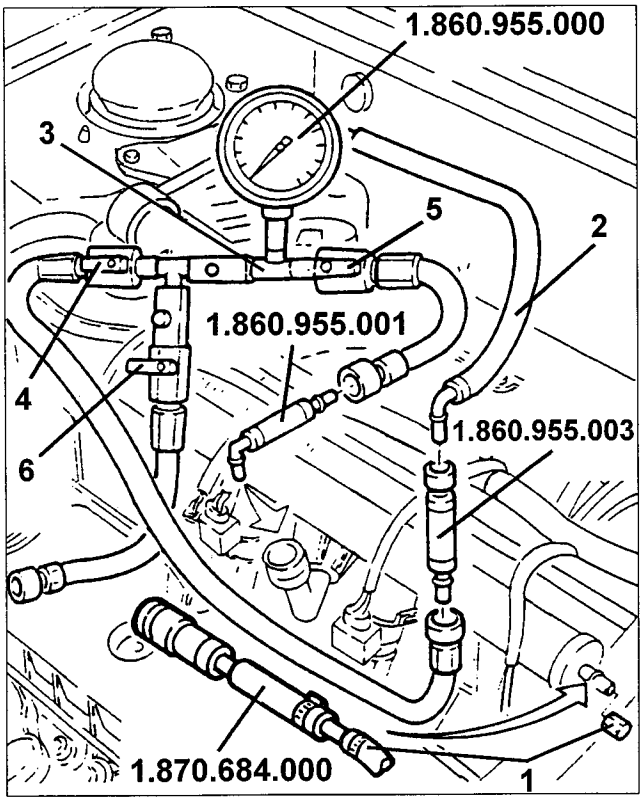


FUEL CIRCUIT PRESSURE CHECK

1. Connect tool no. 1.870.684.000 to the distribution manifold bleeder valve and drain the fuel pressure.
2. Disconnect the fuel delivery pipe from the distribution manifold.
3. Fit fittings no. 1.860.955.003 and no. 1.860.955.001 on pressure gauge no. 1.860.955.000.
- Connect the resulting equipment to the fuel delivery pipe and the fuel distribution manifold.
4. Open the ball valve.
5. Open the ball valve.
6. Close the ball valve.
- Start the engine and idle it. Check that the fuel pressure falls within prescribed values.

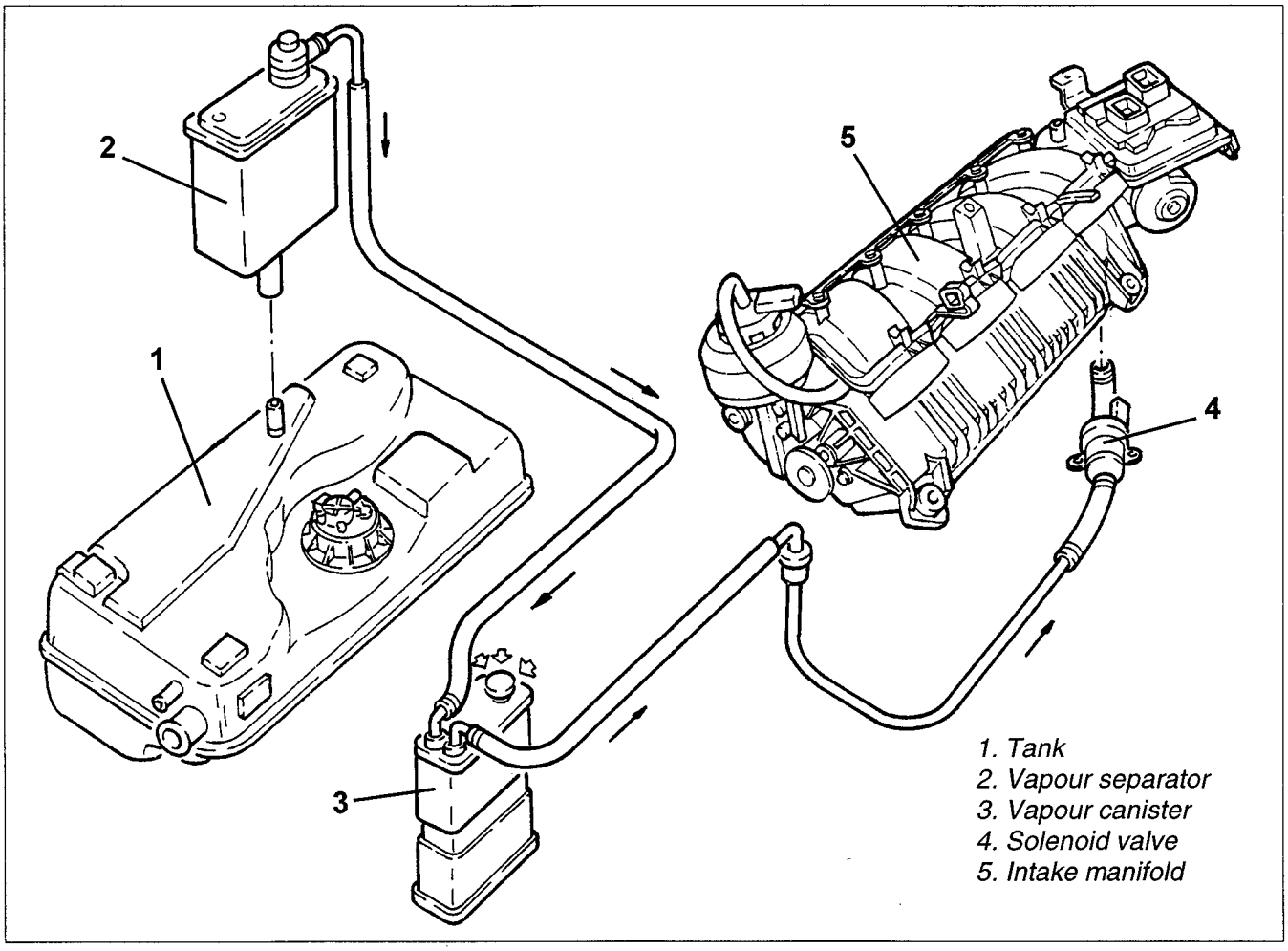
Idling fuel pressure
3.3 ÷ 3.7 bar

- Stop the engine.



- Disconnect the test tools from the fuel distribution manifold and from the fuel delivery pipe.
- Connect the fuel delivery pipe to the distribution manifold.

FUEL VAPOUR RECOVERY SYSTEM DESCRIPTION



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.

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. In this case, the ECU reduces injector feed so that the engine is constantly run at optimal conditions.
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.

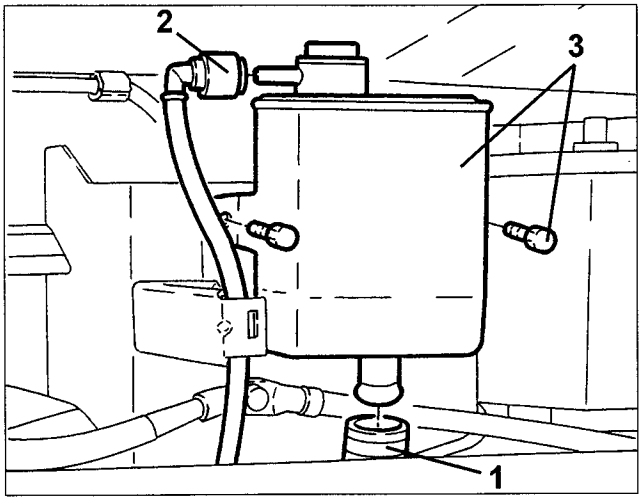
FUEL VAPOUR SEPARATOR

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.



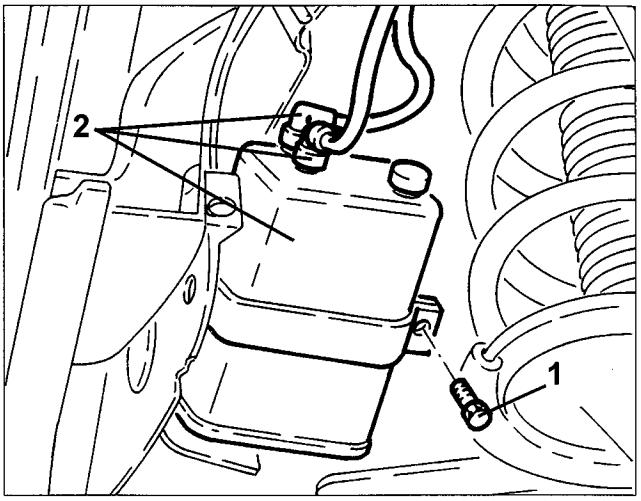
FUEL VAPOUR CANISTER

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

- Remove the throttle casing (see specific paragraph).

1. Disconnect the pipe shown the figure from the modular intake manifold to reach the fuel vapour valve fasteners.
2. Disconnect the fuel vapour valve electrical connection.
3. Disconnect the pipes and remove the fuel vapour valve by removing it from the bracket.