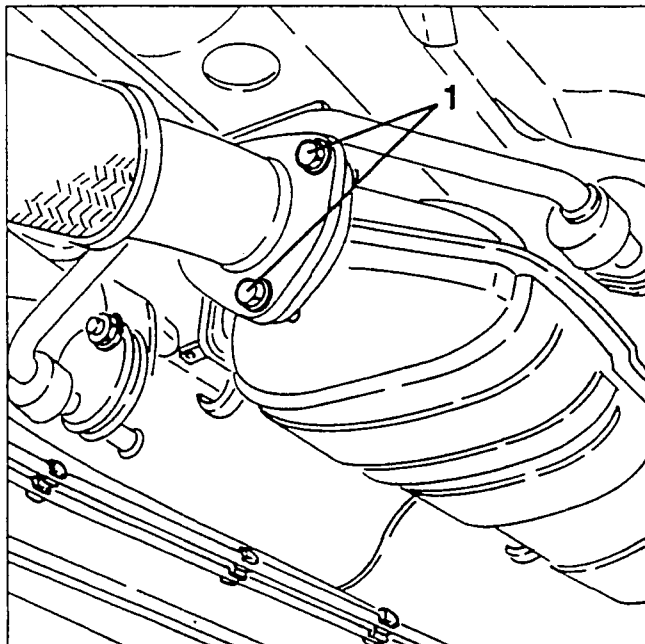


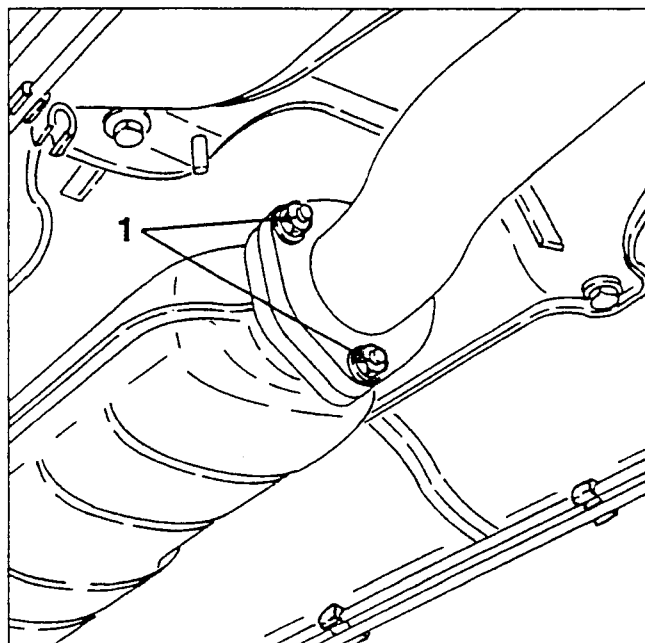
REMOVING/REFITTING

- Set the car on a lift and raise it.

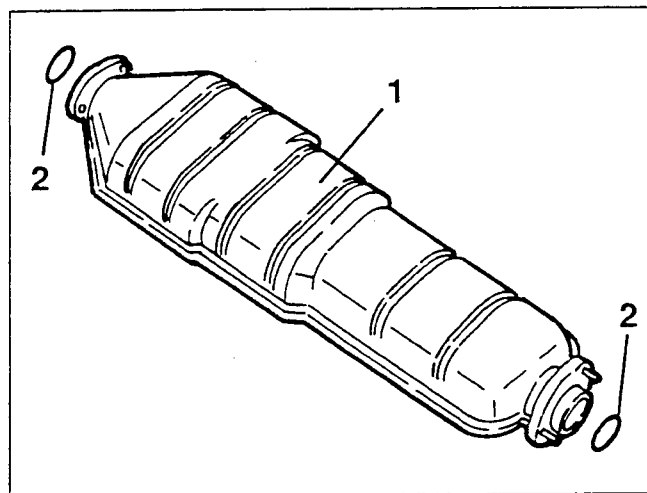
1. Slacken the three bolts fastening the front section of the exhaust piping to the catalytic converter releasing the support bracket.




1. Slacken the three bolts fastening the catalytic converter to the rear section of the exhaust piping.



1. Remove the catalytic converter.
2. Retrieve the seal rings.

**NOTE:**

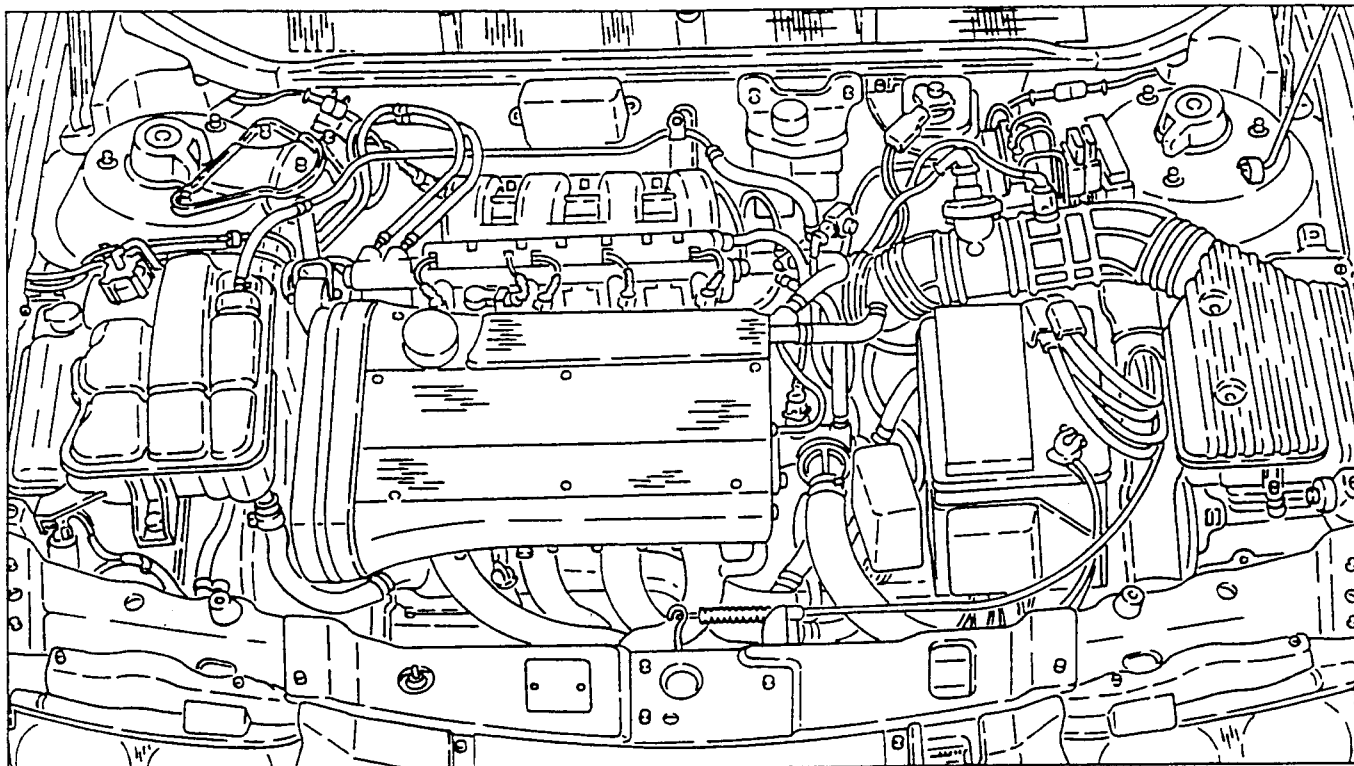
FOR REMOVING/REFITTING THE FRONT AND REAR SECTIONS OF THE EXHAUST PIPING REFER TO THE PROCEDURES GIVEN FOR VERSION  TD BEARING IN MIND THAT THEIR CONNECTION TO THE CATALYTIC CONVERTER IS MADE BY FLANGES WITH SEALS RATHER THAN BY CLAMPS.

GENERAL DESCRIPTION

The information and illustrations given below enable the rapid removal of the engine assembly from its housing in the engine compartment and its subsequent refitting. Dis-assembly of the single components on the bench is described in the volume "ENGINE OVERHAULING".

This is to be considered a single, complete procedure, with the possibility of adopting only parts of it according to necessity.

For further information and details, see the chapters referring to the specific components or groups.

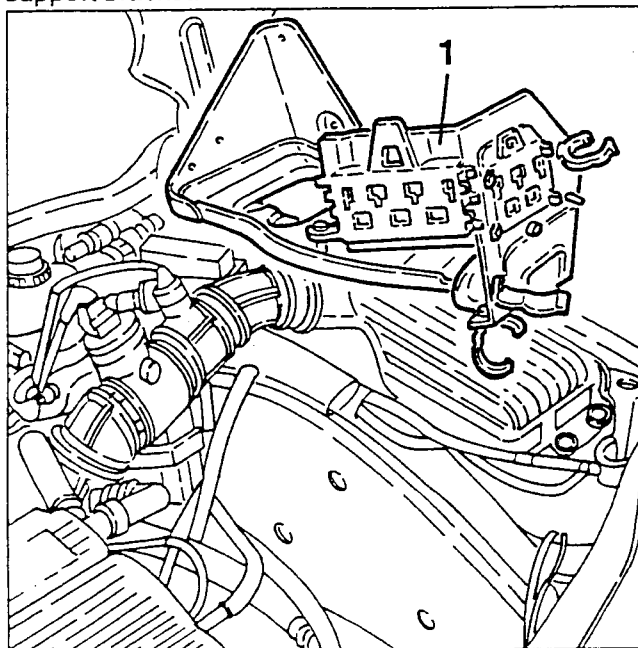
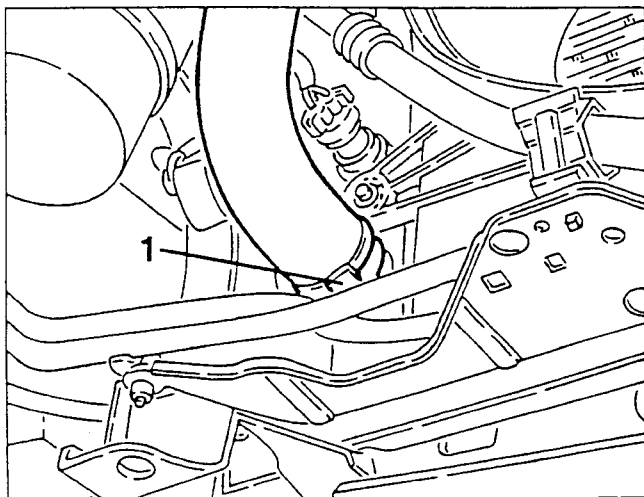


REMOVAL

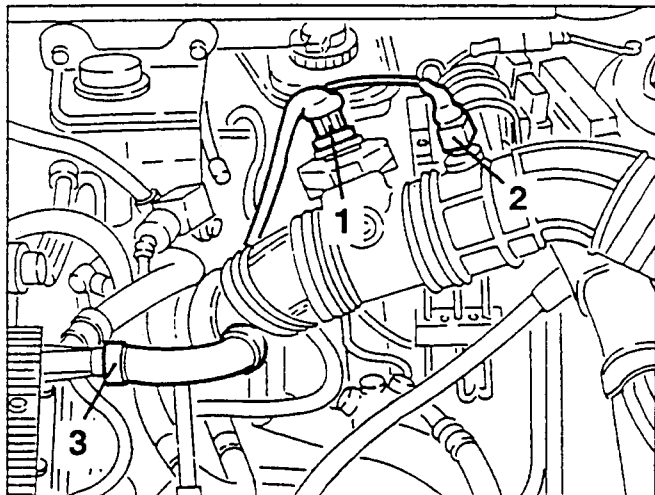
- Set the car on a 2 column lift.
 - Remove the battery.
 - Remove the front wheels and mud flaps.
1. Raise the car and drain the engine coolant fluid disconnecting the radiator outlet sleeve.

- Remove the relays from the battery support and set them to one side together with their wirings so that they do not hinder the following operations.

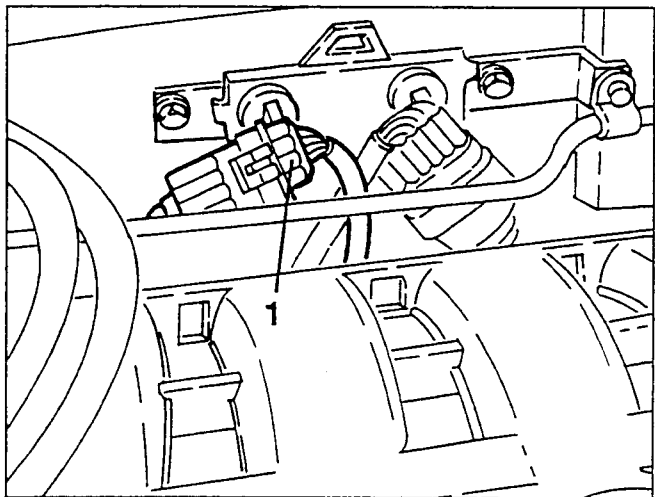
1. Slacken the fastening screws, then remove the battery support after removing it from the rear cable support bracket.



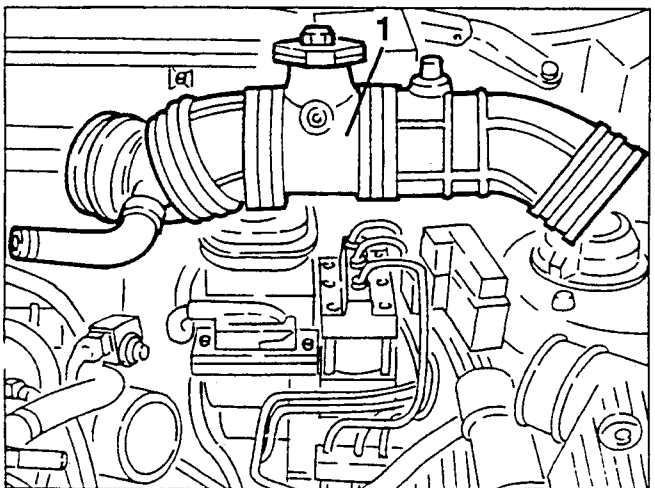
1. Disconnect the electrical connection from the air-flow meter.
2. Disconnect the electrical connection from the intake air temperature sensor (NTC).
3. Slacken the fastening clamp and disconnect the oil recirculation pipe from the cylinder head.



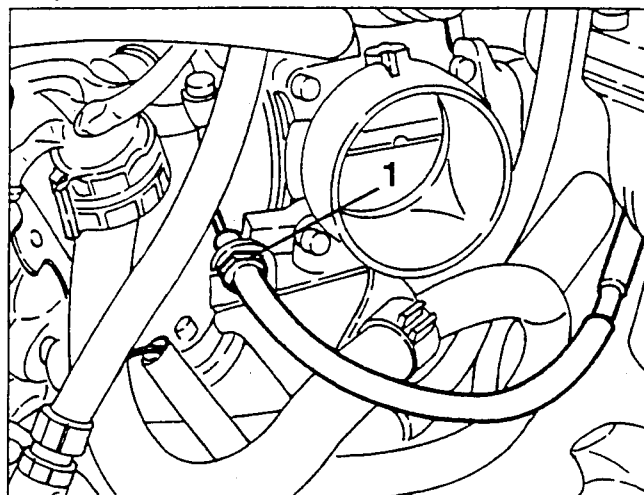
1. Disconnect the electrical connection of the lambda probe.



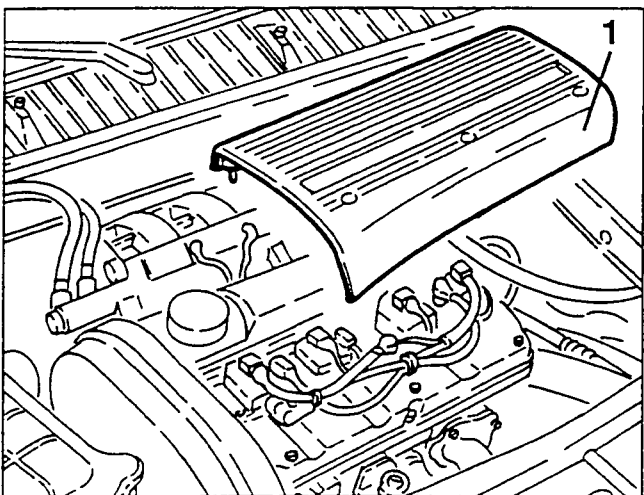
1. Slacken the fastening clamps and remove the corrugated sleeve complete.



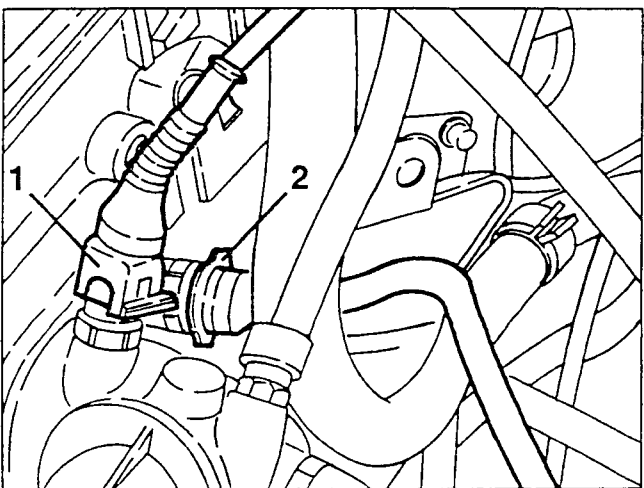
1. Disconnect the accelerator cable from the throttle body.



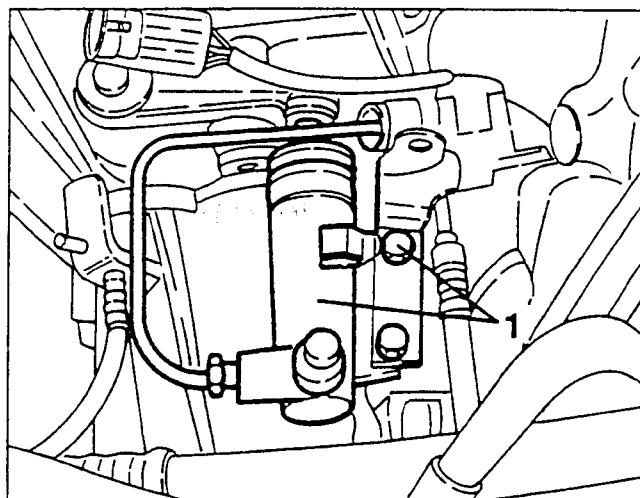
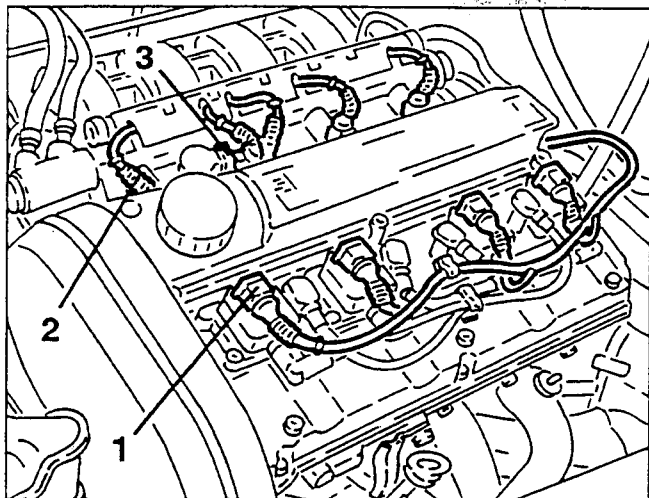
1. Slacken the fastening screws and remove the ignition coils cover.



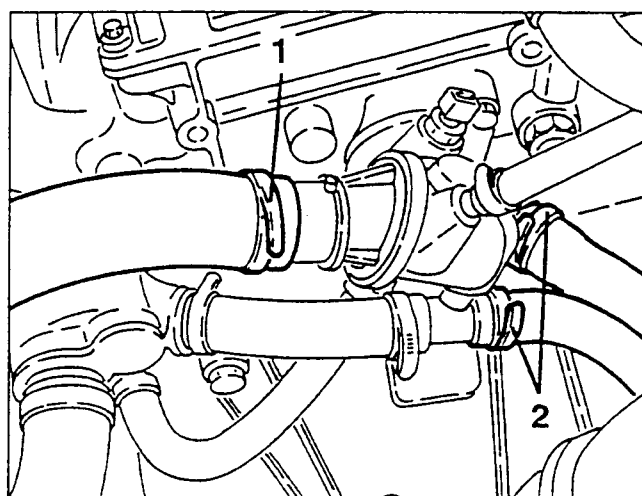
1. Disconnect the electrical connection from the engine coolant fluid temperature sensor (NTC).
2. Disconnect the electrical connection from the engine coolant temperature warning light transmitter, then move aside the wiring.



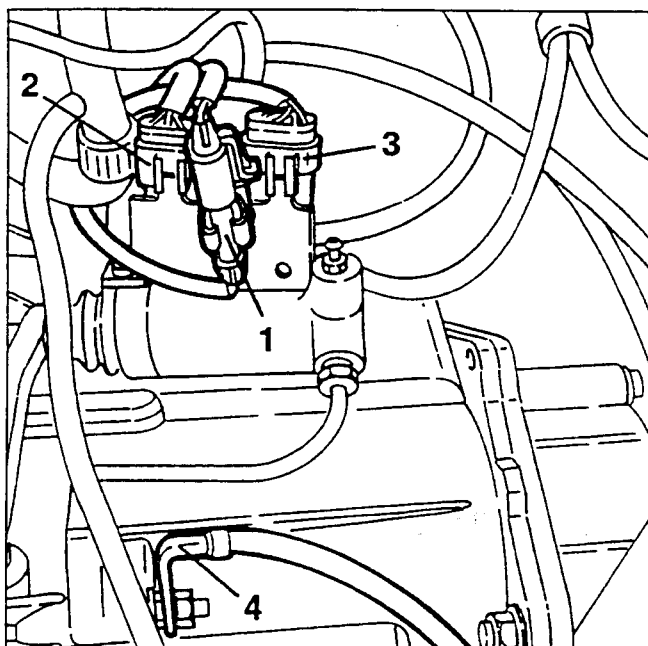
1. Disconnect the electrical connections ignition coils.
 2. Disconnect the electrical connections from the electroinjectors.
 3. Disconnect the electrical connection from the timing variator solenoid.
- Disconnect the earth cable from the cylinder head.



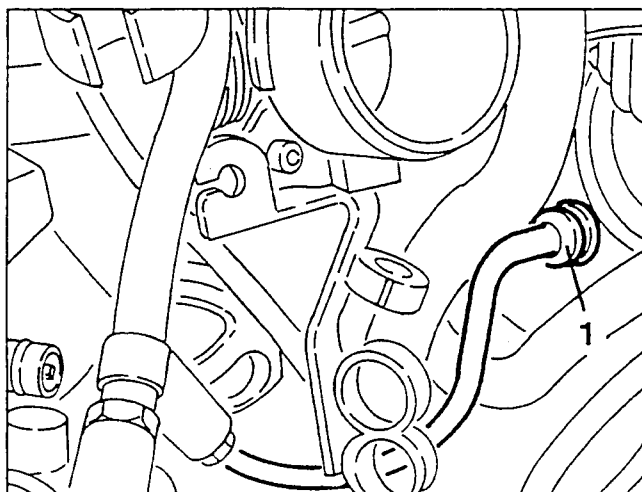
1. Disconnect the coolant fluid delivery and return pipes from the thermostatic cup to the climate control system heater and release them from the bracket.
2. Disconnect the coolant fluid delivery pipe to the radiator from the thermostatic cup.



1. Disconnect the electrical connection of the starter motor.
2. Disconnect the electrical connection of the tachometric sensor.
3. Disconnect the electrical connection of the injection system.
4. Disconnect the earth cable from the gearbox cover.

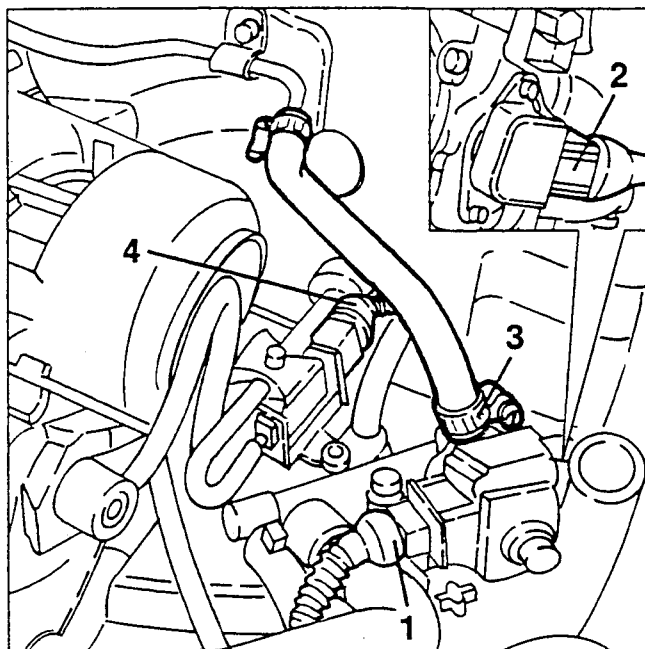


1. Disconnect the vacuum takeoff pipe from the servobrake.

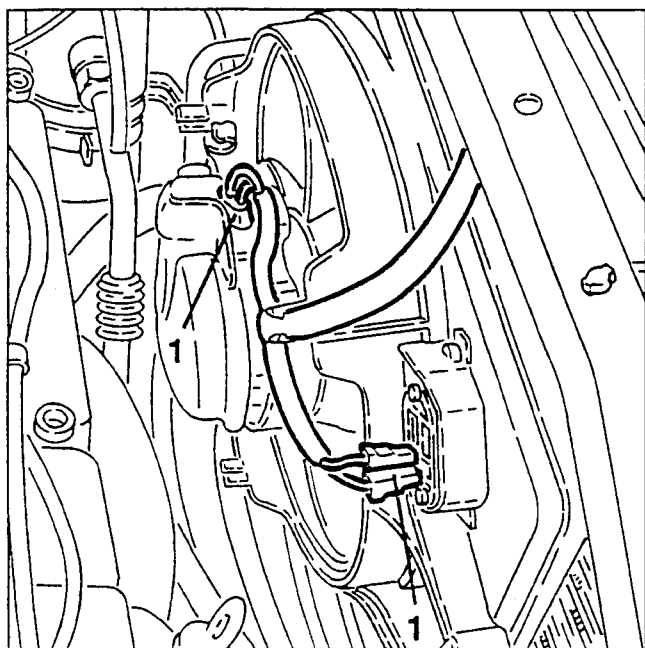


1. Slacken the fastening screws, then move the clutch control cylinder without disconnecting the pipes.

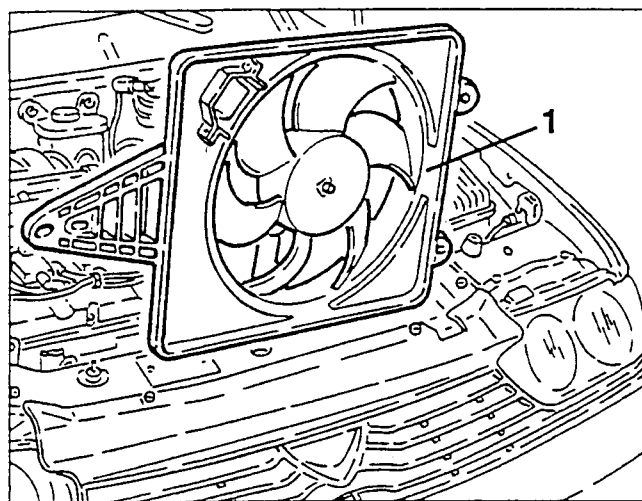
1. Disconnect the electrical connection from the constant idle speed actuator.
2. Disconnect the electrical connection from the throttle potentiometer.
3. Disconnect the the coolant delivery pipe to the header tank from the throttle body.
4. Disconnect the electrical connection from the E.G.R. modulation solenoid valve.



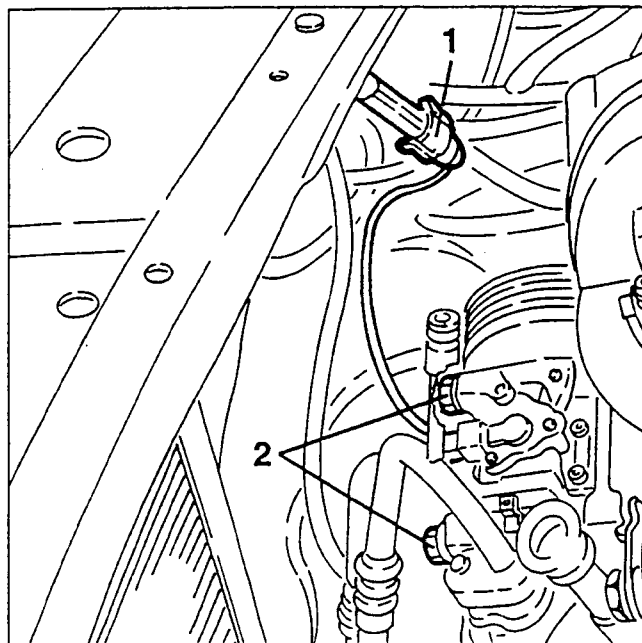
1. Disconnect the electrical connections from the cooling fan.



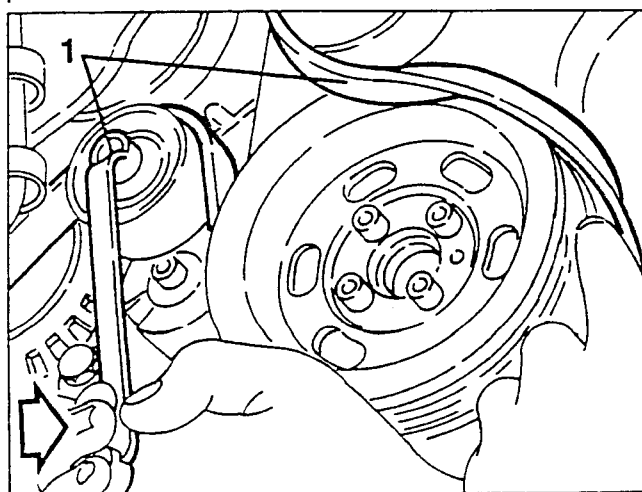
1. Slacken the fastening screws and remove the cooling fan.



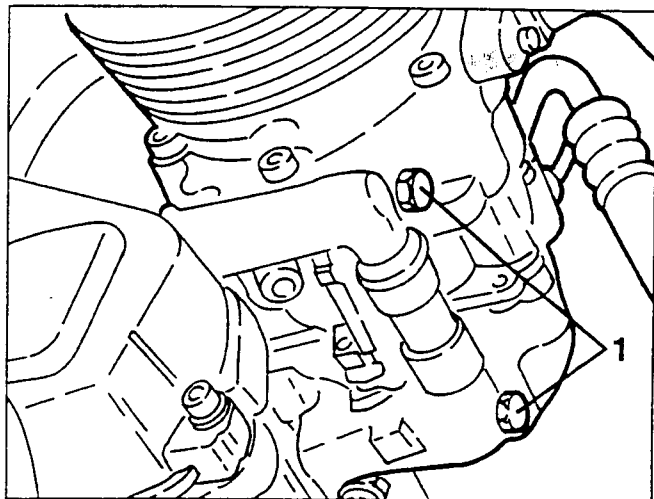
1. Disconnect the electrical connection supplying the conditioner compressor.
2. Slacken the two upper screws fastening the conditioner compressor.



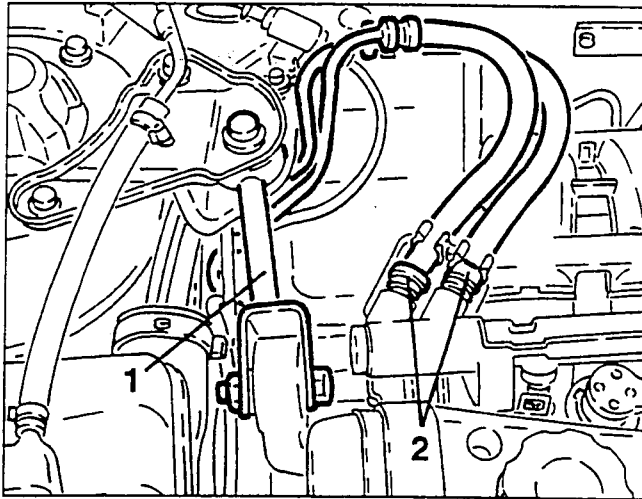
1. Raise the car and working as illustrated on the guide pulley, loosen the tension of the auxiliary components drive belt and remove it.



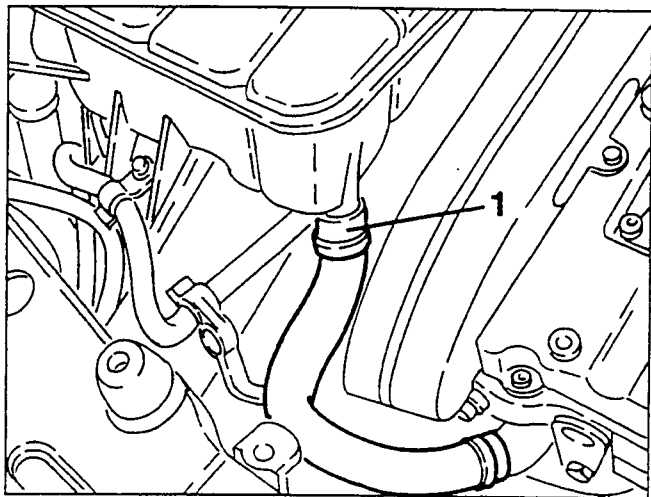
1. Slacken the two lower screws fastening the conditioner compressor, then, without disconnecting the piping, fasten it to one side to prevent hindrance in the following operations.



1. Slacken the fastening screws and remove the engine stay connecting rod.
2. Disconnect the fuel inlet and outlet pipes from the distributor manifold.

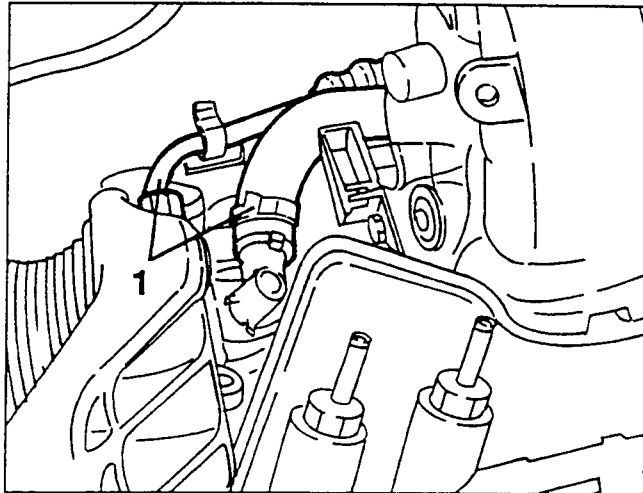


1. Lower the car and disconnect the system supply pipe from the header tank.



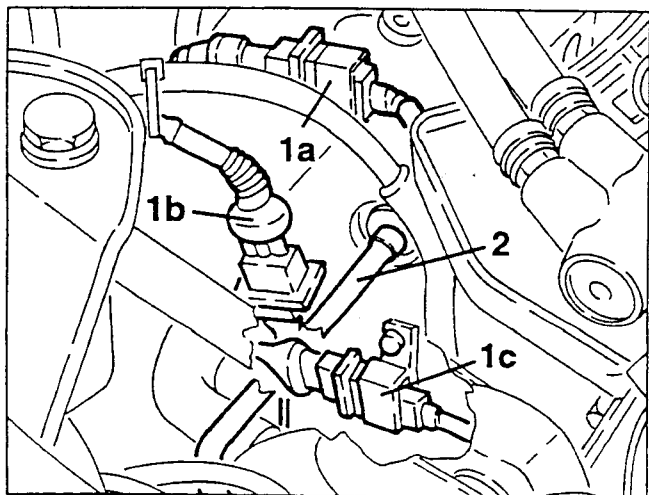
- Using a suitable syringe, drain the oil from the power steering tank.

1. Disconnect the oil inlet and delivery pipes from the power steering pump.



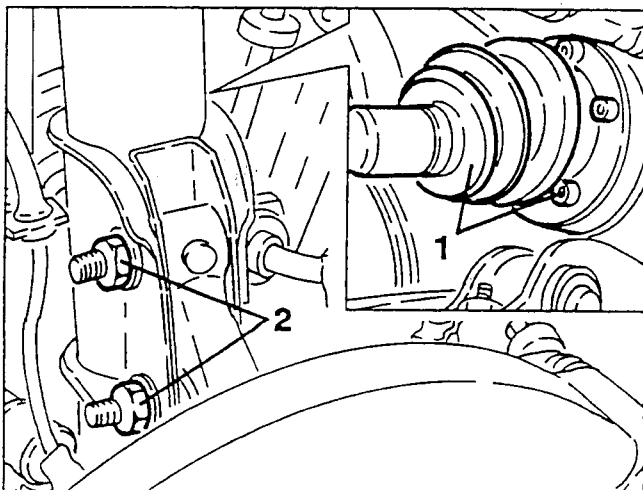
1. Disconnect the electrical connections of the timing sensor (1a), pinging sensor (1b) and rpm and timing sensor (1c).

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

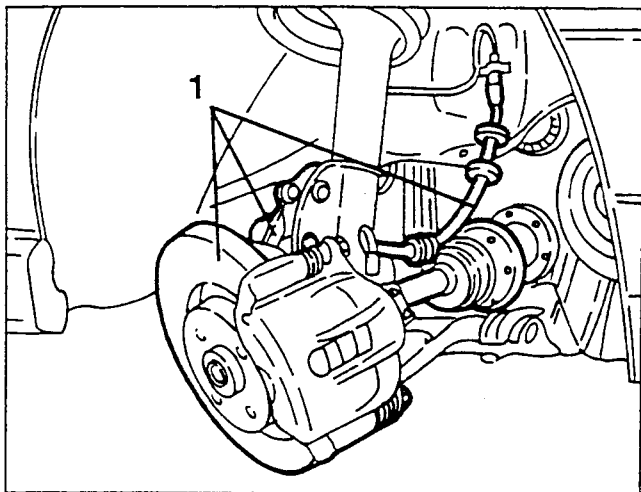


1. Raise the car, slacken the fastening bolts and disconnect the axle shafts.

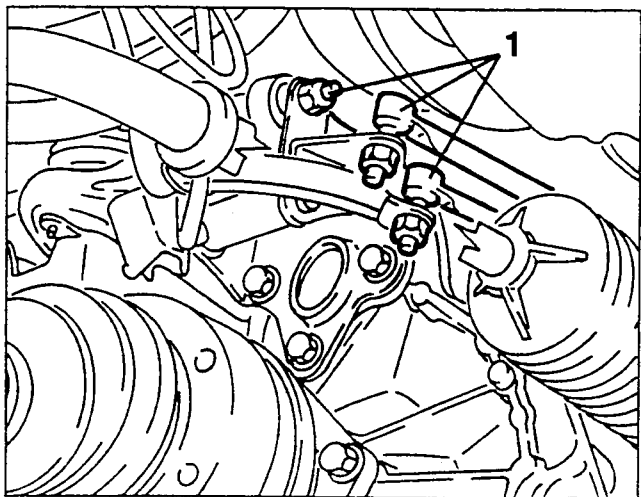
2. Slacken the two bolts fastening the uprights to the shock absorbers, then remove only the upper bolt.



1. Release the brake pipes and A.B.S. sensor cables from their clamps, then turn the wheel hubs forwards as far as possible to move the axle shafts forwards.

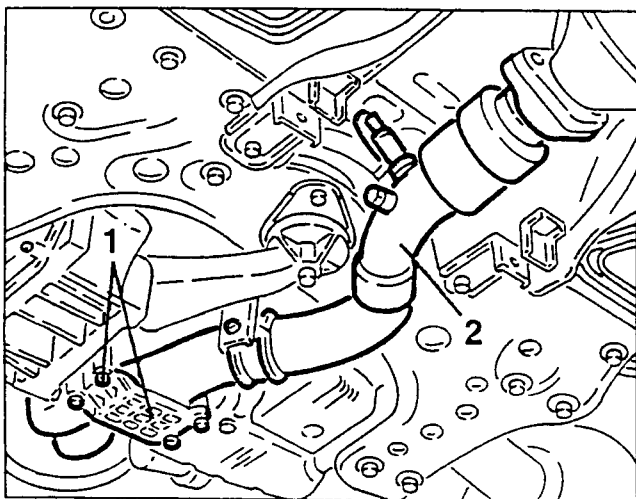


1. Working from the wheelhouse, slacken the fastening nuts and disconnect the gearshift control rods.

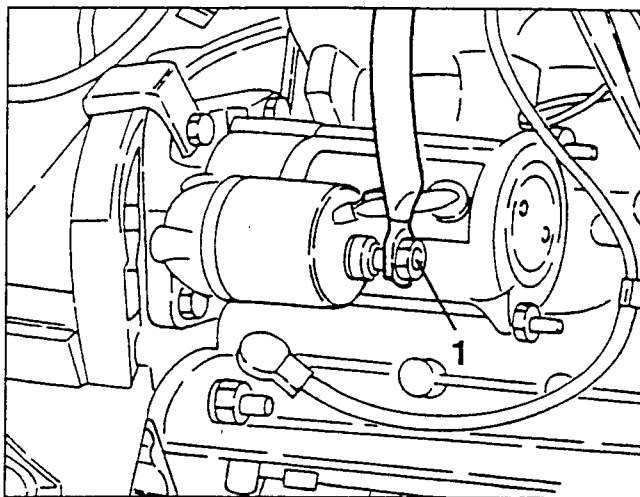


1. Slacken the fastening screws and remove the reinforcement bracket.

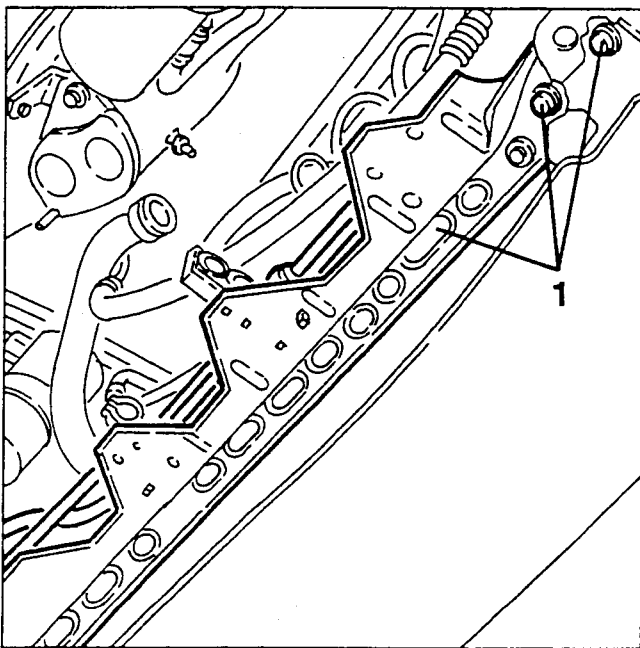
2. Remove the front section of the exhaust pipe complete with lambda probe after slackening their fastenings.



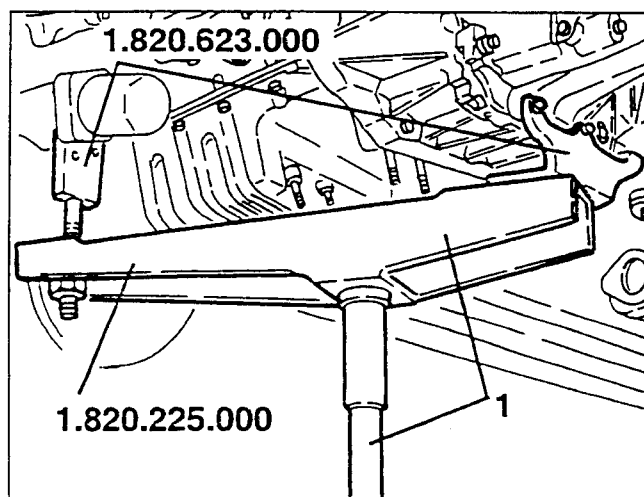
1. Disconnect the electrical connections from the starter motor.



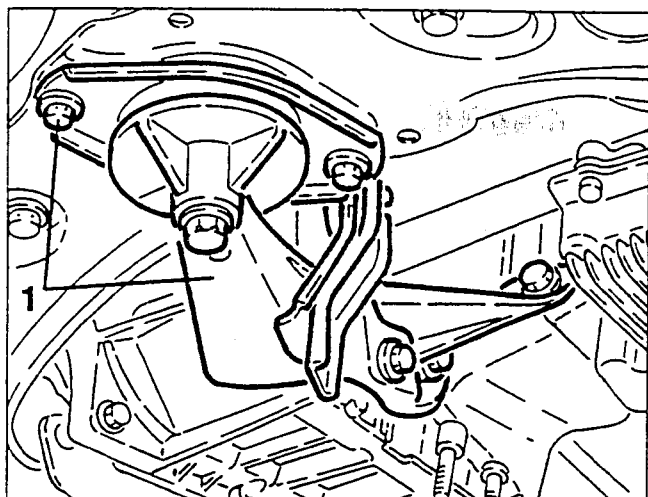
1. From the lower crossmember prise the power steering pipes, then slacken the fastening screws and remove them.



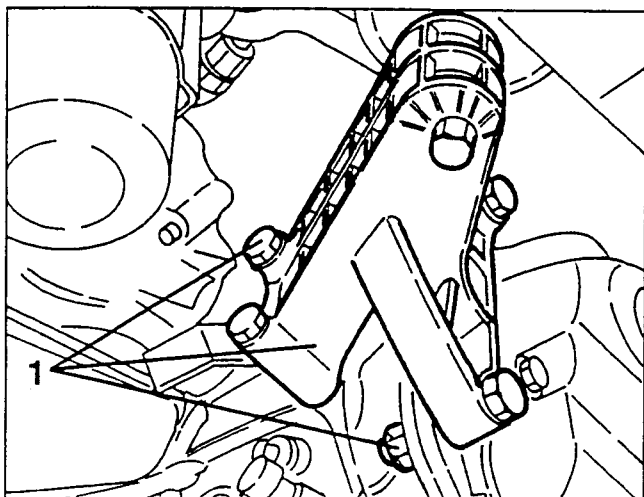
1. Position a hydraulic jack complete with tools no. 1.820.225.000 and no. 1.820.623.000 as illustrated.



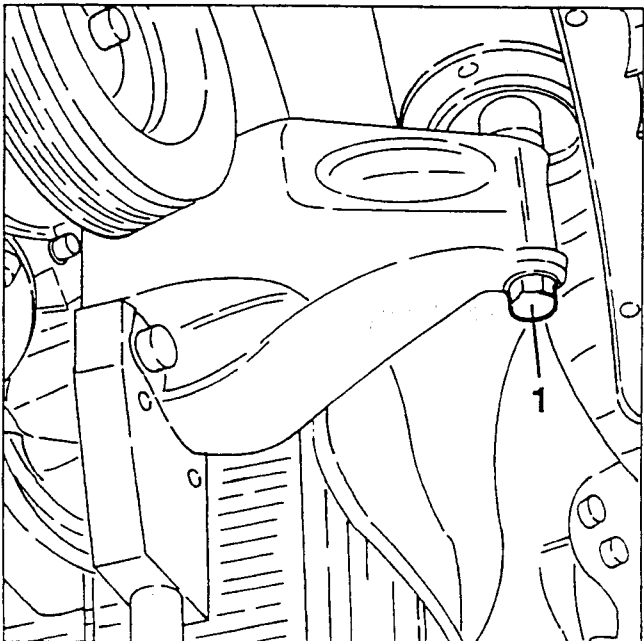
1. Slacken the fastening screws and remove the rear power unit support.



1. Slacken the fastening screws and bolts and remove the gearbox side power unit support.

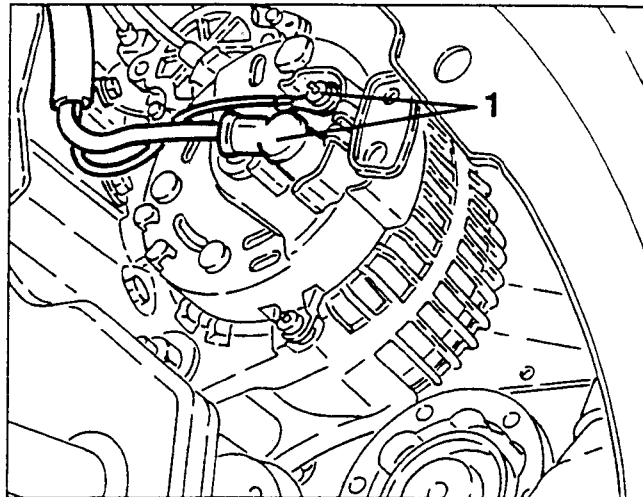


1. Slacken the screw fastening the camshaft side power unit support.

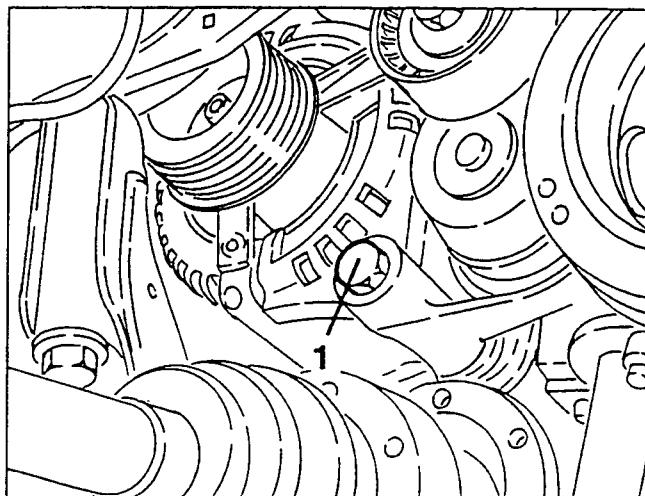


- Lower the power unit just enough with a hydraulic jack to be able to remove the alternator, proceeding as described below:

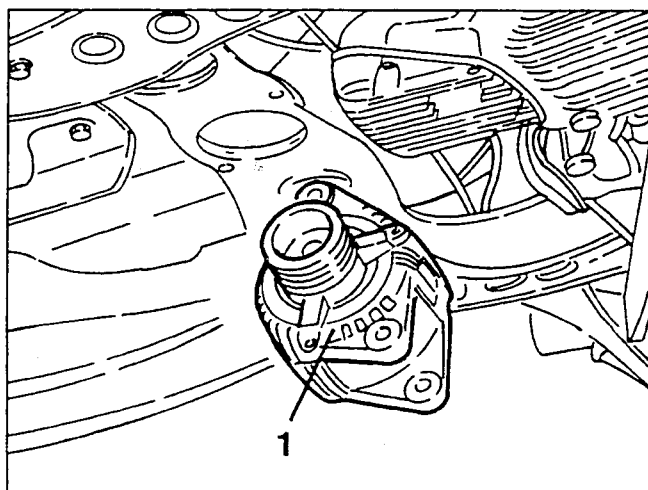
1. Disconnect the electrical connections of the alternator.



1. Slacken the two bolts fastening the alternator to the support bracket.



1. Remove the alternator withdrawing it from under the car as illustrated.



- 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.

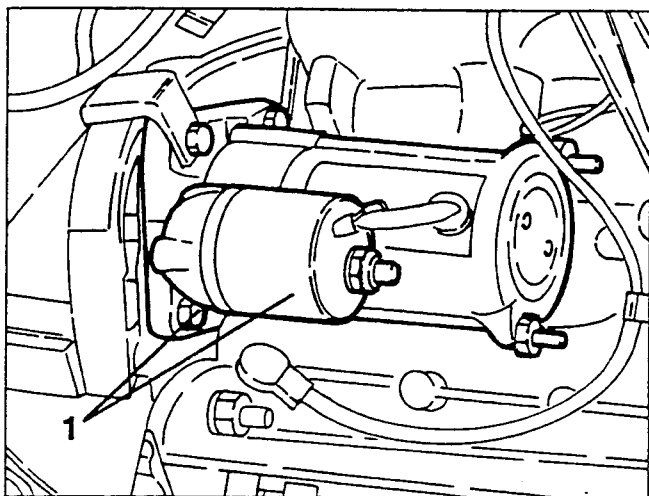
- Support the power unit with a hydraulic hoist besides the hydraulic jack used for removal.



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

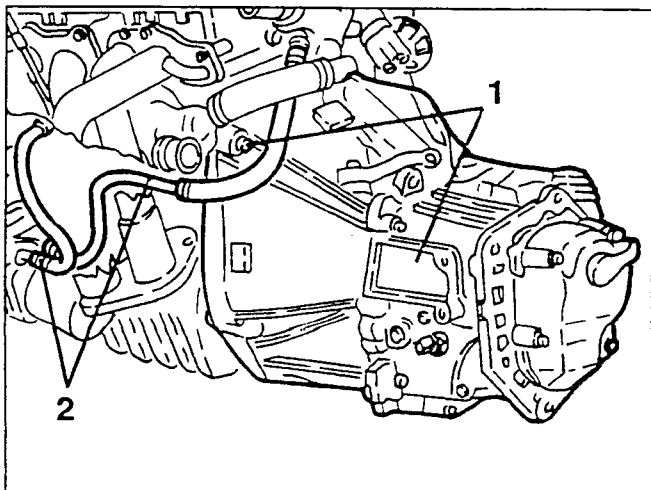
- Release the power unit from the support tools then position it on a suitable workbench.

1. Slacken the fastening screws and remove the starter motor.

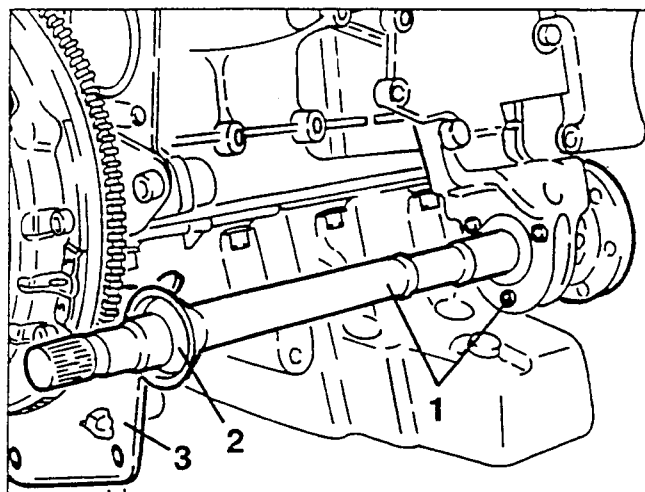


1. Slacken the fastening screws and nuts and remove the gearbox and differential unit.

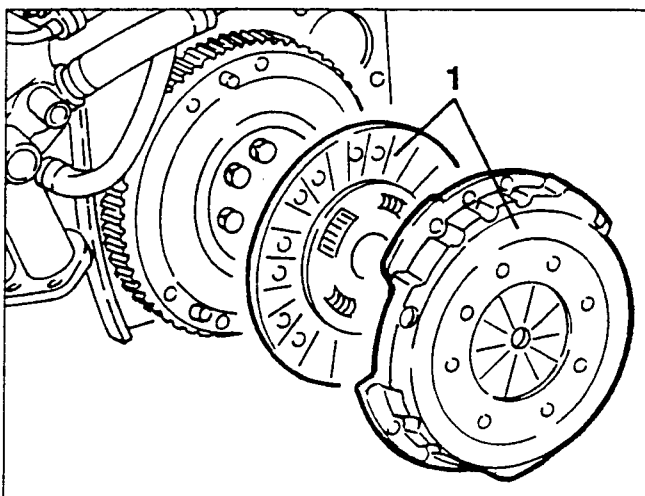
2. Remove the two heat exchanger coolant delivery and return pipes.



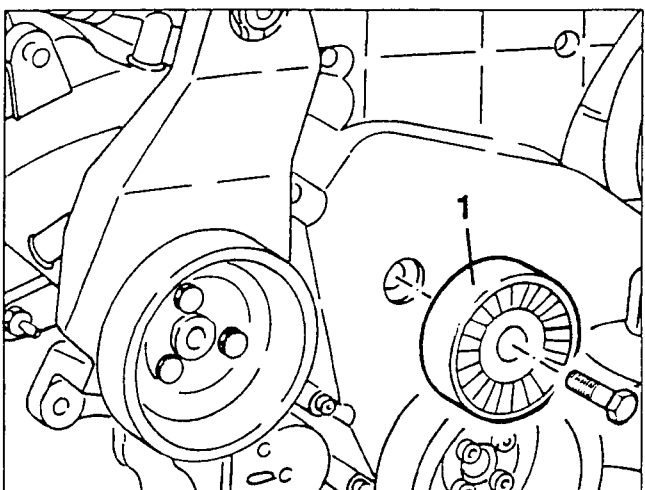
1. Slacken the three fastening screws and remove the lay shaft.
2. Remove the dust guard ring.
3. Remove the lower flywheel cover.



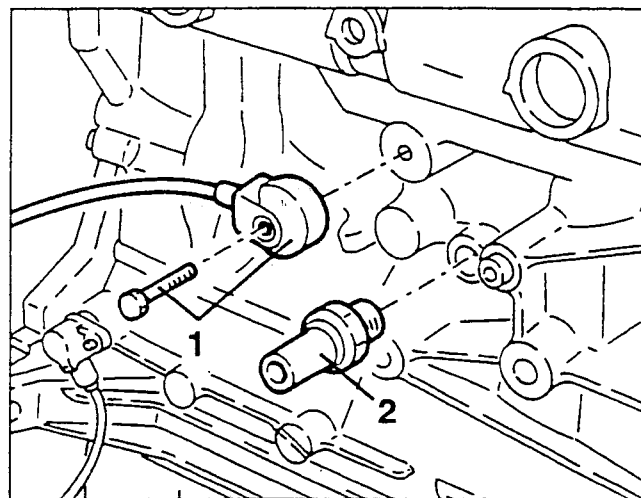
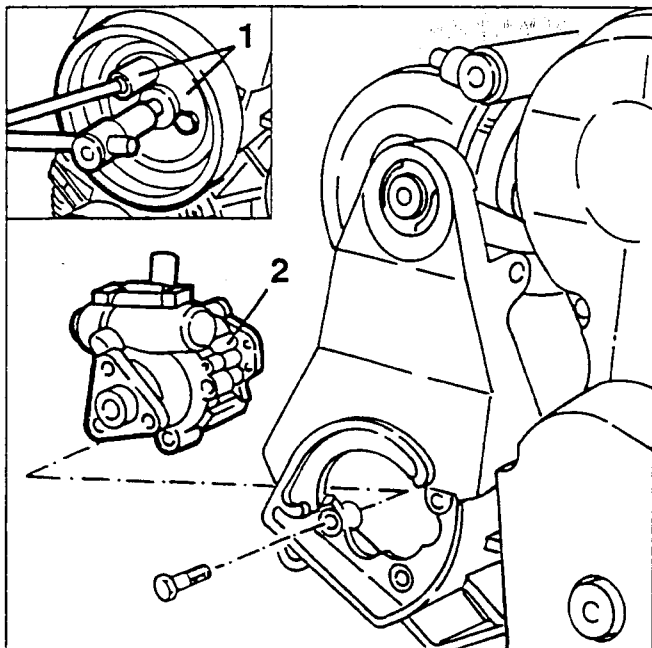
1. Slacken the fastening screws and remove the pressure plate body and clutch plate.



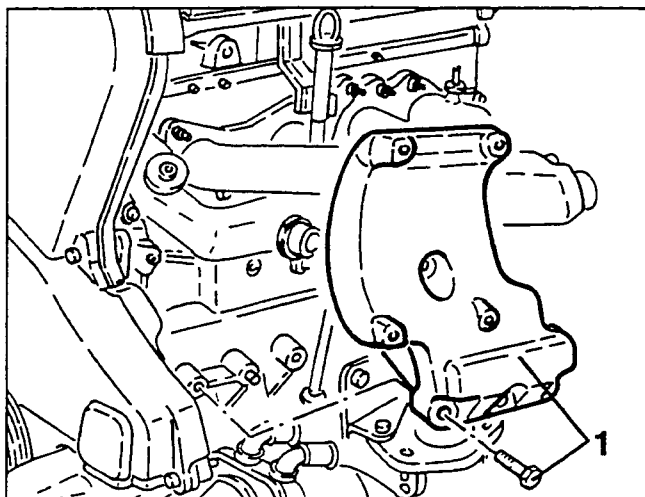
1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.



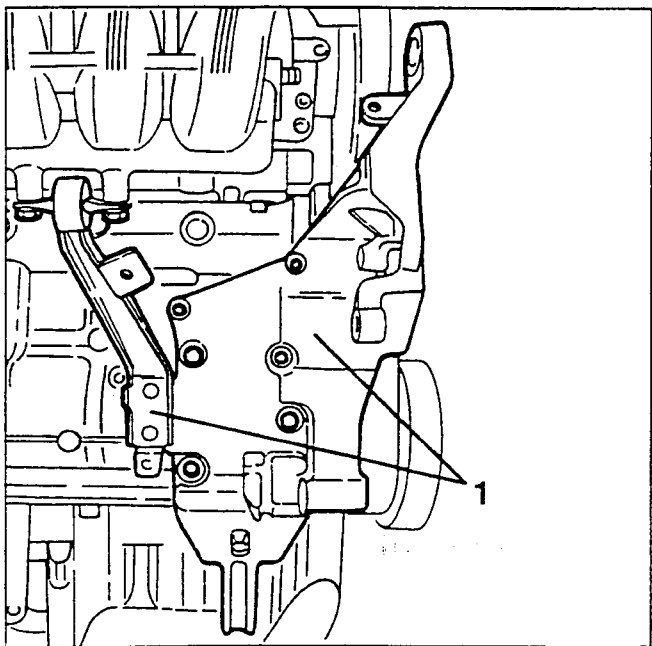
1. Using a 3/8" Allen wrench as counter torque, slacken the three fastening screws and remove the power steering pump pulley.
2. Slacken the three fastening screws and remove the power steering pump.



1. Slacken the four fastening screws and remove the air conditioning compressor support.



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



REFITTING

Reverse the sequence of the operations followed for removal, observing the following instructions:

- Prepare the engine compartment to accommodate the power unit, arranging all the electric cables, pipes, etc. so that they do not interfere with refitting operations.



WARNING:

Make sure that the power unit supporting points have been fastened correctly.

1. Slacken the fastening screw and remove the ping-pong sensor from the crankcase.
2. Slacken and remove the engine oil pressure meter.

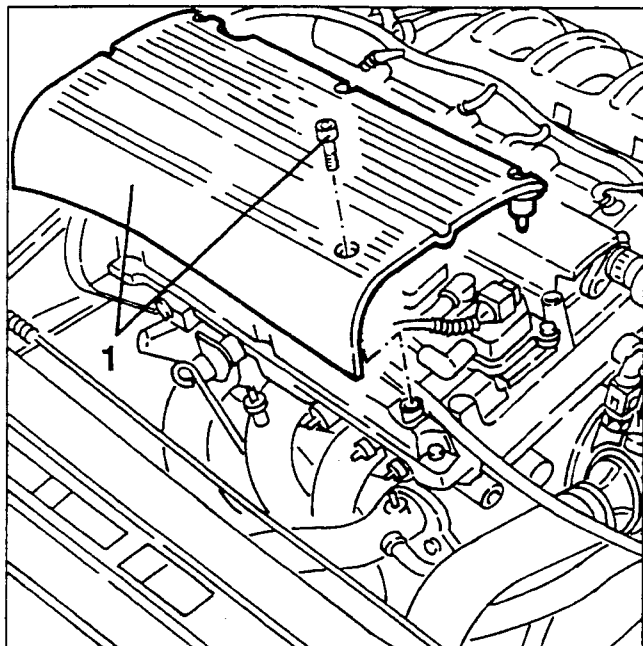
- After assembly, check the correct tensioning of the belts, fill the various systems as specified (see GROUP 00).
- Carry out all the necessary checks and operations (see GROUP 00).

CYLINDER HEAD

REMOVING/REFITTING

- Follow the first steps of the procedure "REMOVING/REFITTING ENGINE" up to removal of the corrugated sleeve.

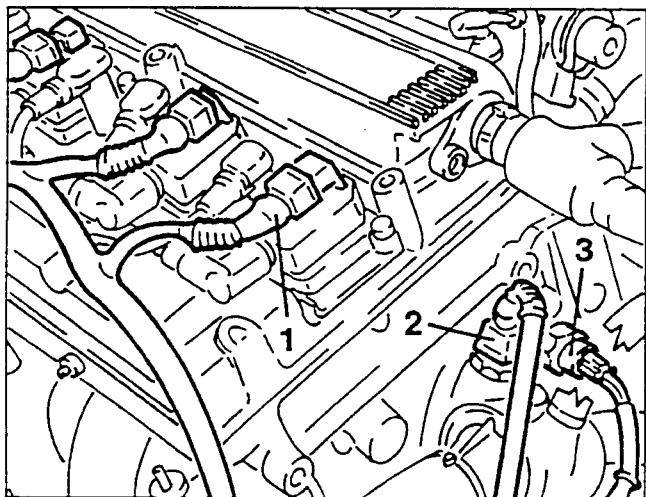
1. Slacken the fastening screws and remove the ignition coils cover.



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.

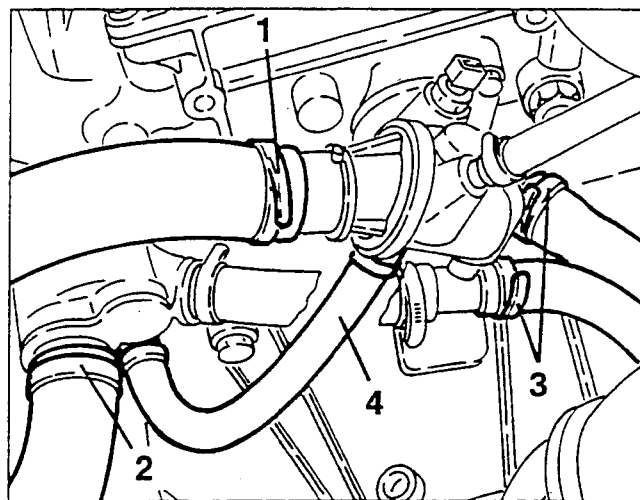


1. Disconnect the coolant delivery sleeve to the radiator from the thermostatic cup.

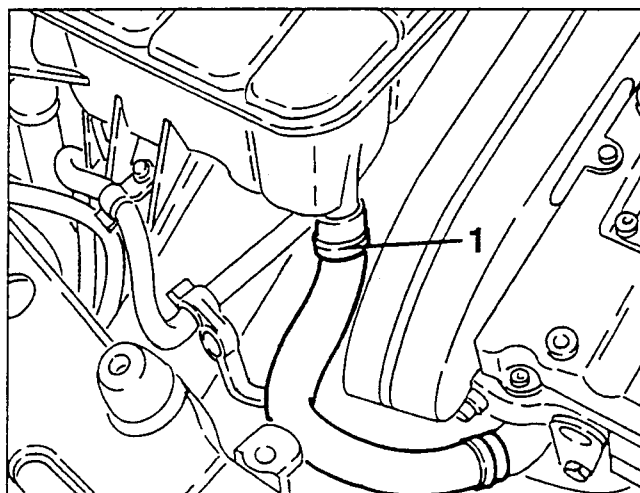
2. Disconnect the return sleeve from the radiator from the coolant return manifold to the pump.

3. Disconnect the coolant delivery and return pipe for the climate control unit heater from the thermostatic cup.

4. Disconnect the coolant delivery pipe to the heat exchanger for the engine lubrication circuit from the thermostatic cup.



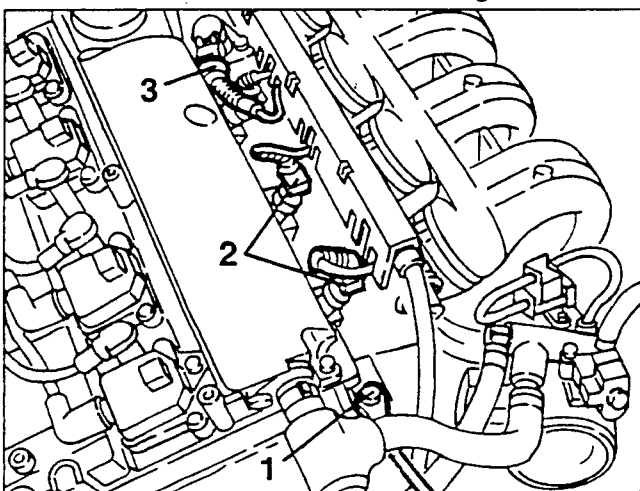
1. Disconnect the system supply pipe from the header tank.



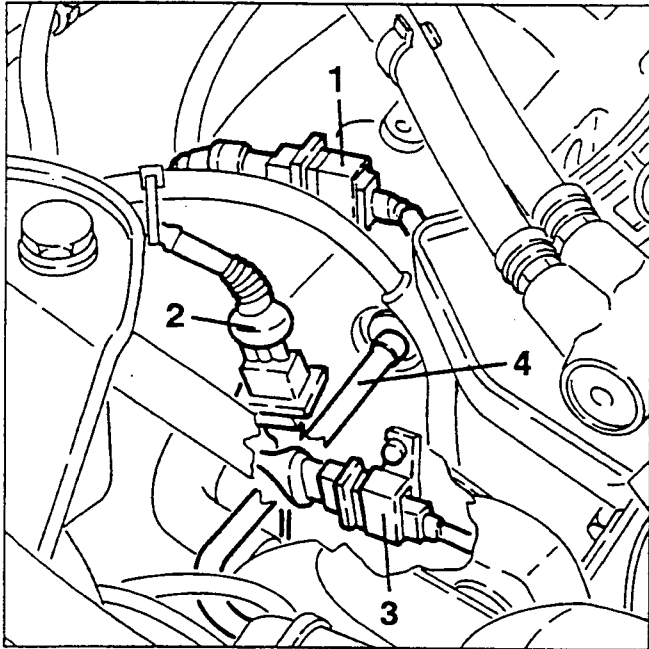
1. Disconnect the earth cable from the cylinder head.

2. Disconnect the electrical connections from the injectors.

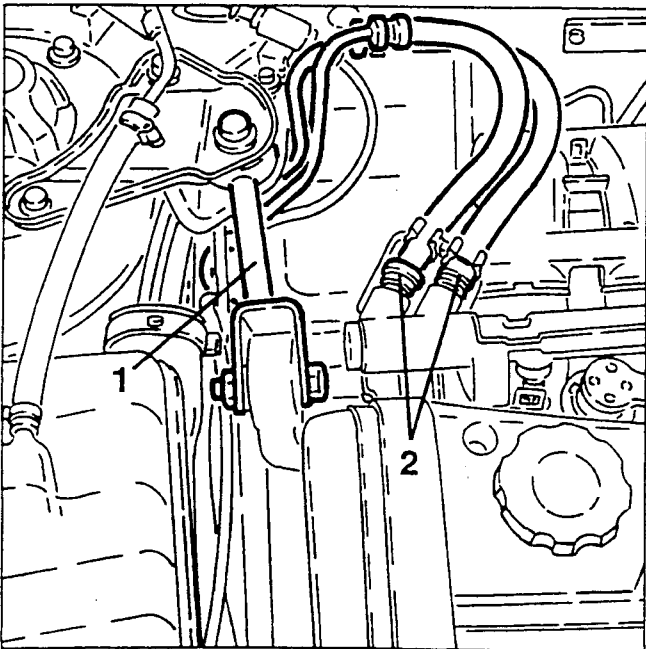
3. Disconnect the electrical connection from the timing variator and move the associated wiring to one side.



1. Disconnect the electrical connection of the timing sensor.
2. Disconnect the electrical connection pinging sensor.
3. Disconnect the electrical connection timing and rpm sensor.
4. Disconnect the fuel vapour recirculation pipes from the air intake box.

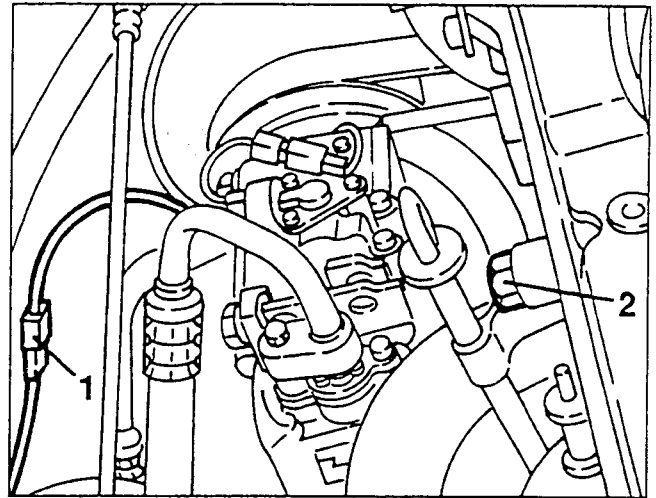


1. Slacken the fastening screws and remove the engine stay connecting rod.
2. Disconnect the fuel inlet and outlet pipes from the distributor manifold.

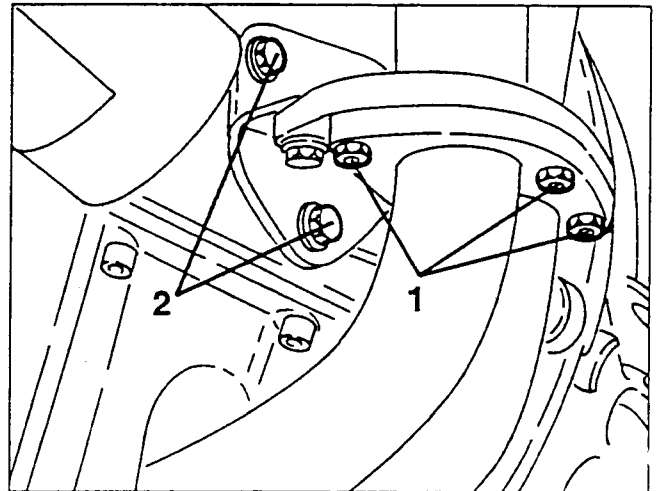


1. Disconnect the intermediate electrical connection from the air conditioning system compressor.

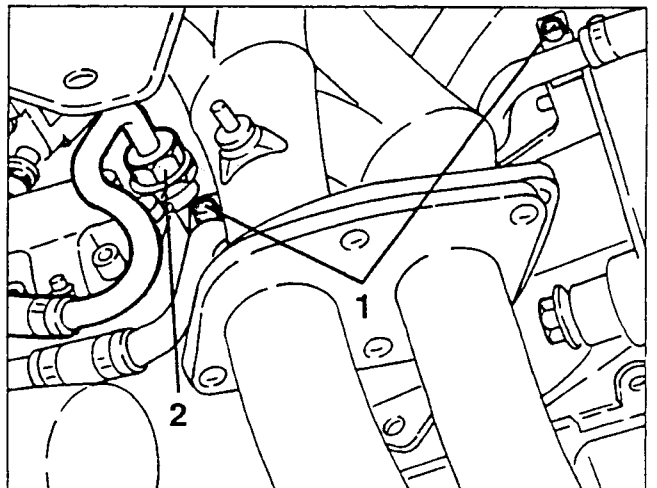
2. Slacken the engine oil dipstick fastening screw.



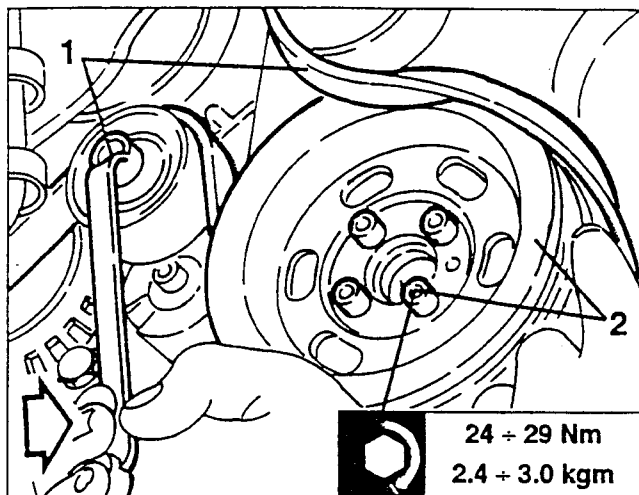
1. Raise the car and slacken the bolts fastening the front section of the exhaust pipe to the manifolds.
2. Slacken the screws fastening the exhaust manifold support bracket to the crankcase.



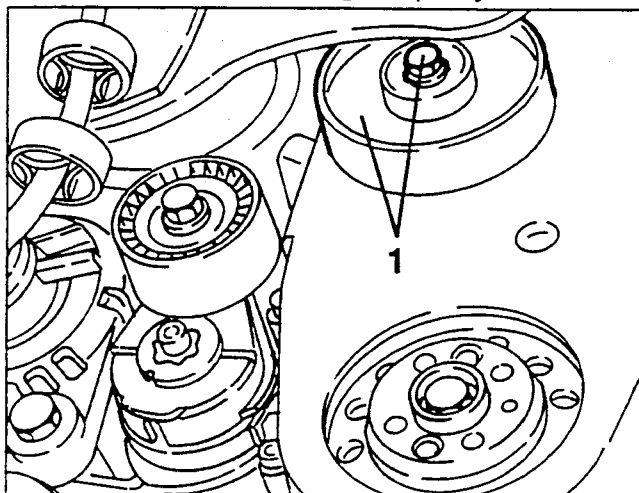
1. Slacken the two screws fastening the coolant delivery pipe to the heat exchanger.
2. Disconnect the coolant outlet pipe from the heat exchanger.



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.

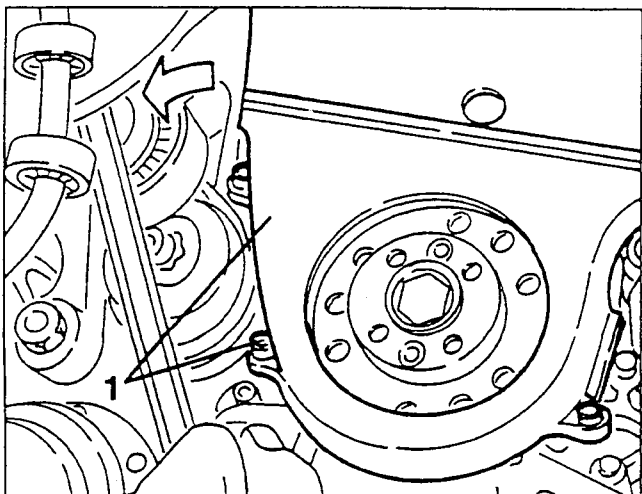


1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.

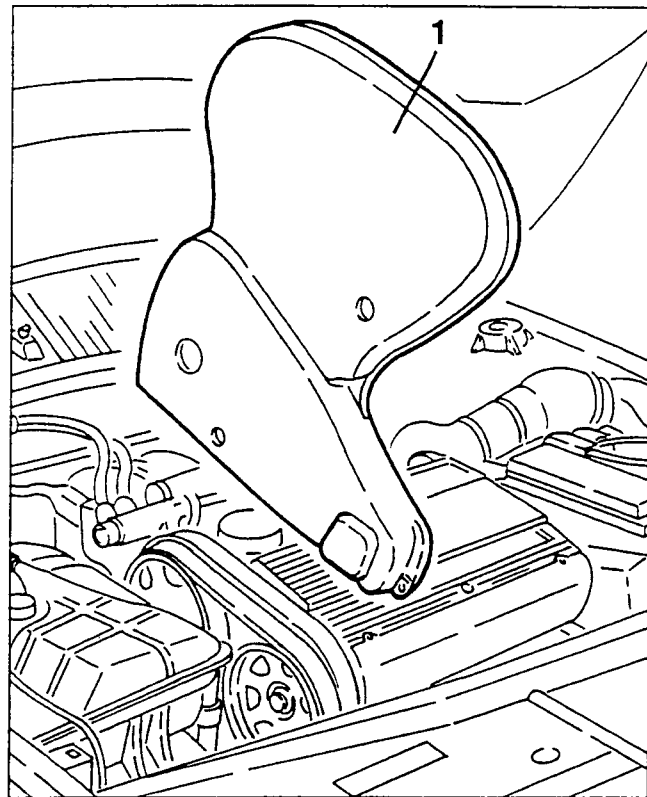


1. Slacken the fastening screws and remove the lower cover of the timing belts and counter-rotating shafts.

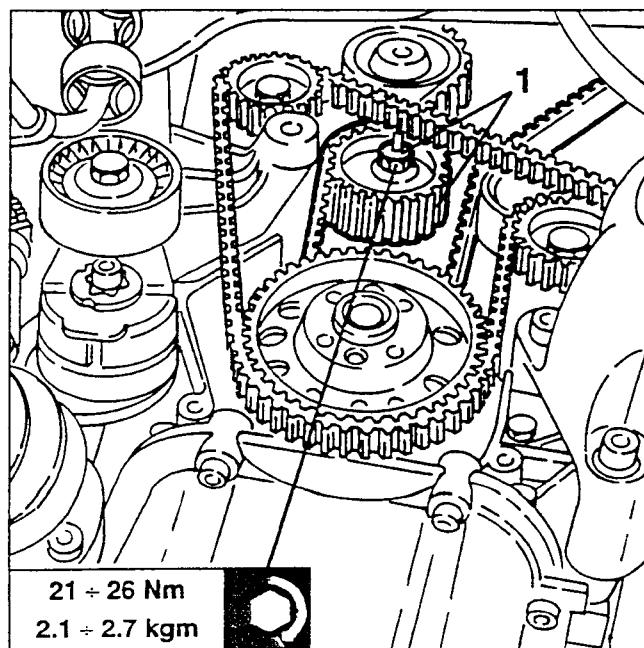
NOTE: To gain access to the rear screw, turn the belt tensioner as illustrated.



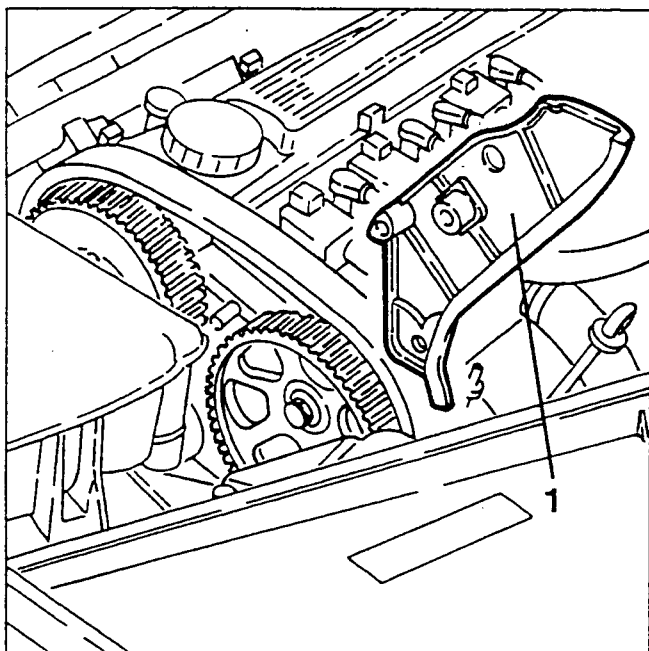
- Slacken the lower screws of the upper cover for the timing gear and counter-rotating shafts drive belts.
1. Lower the car, slacken the remaining fastening screws and remove the upper cover.



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

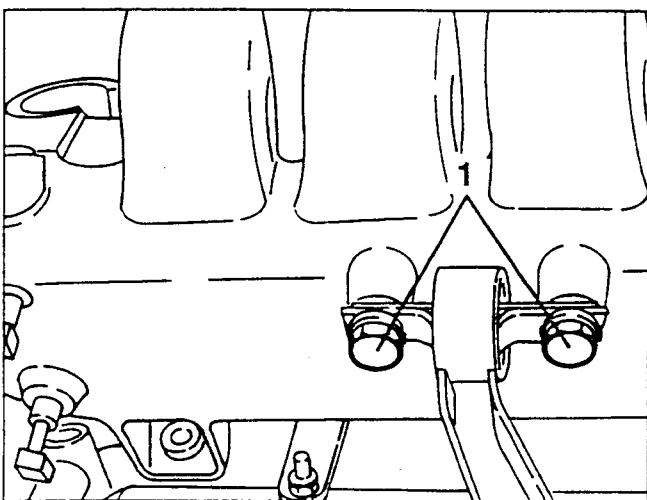


1. Slacken the fastening screws and remove the two timing gear belt side covers.



- Remove the bracket connecting the cylinder head to the engine stay rod support.

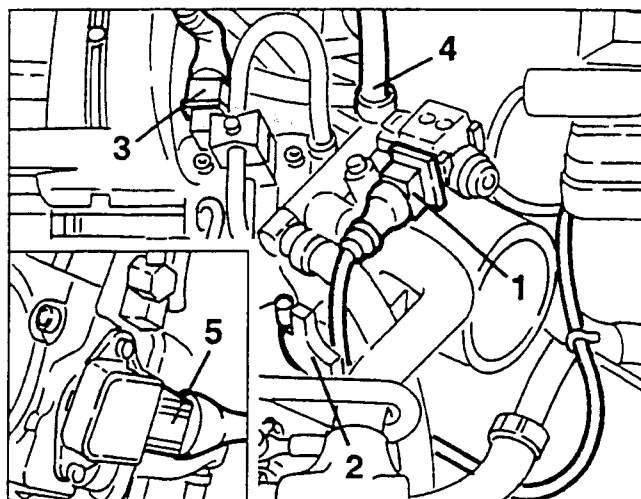
1. Raise the car and slacken the two screws fastening the support to the intake box.



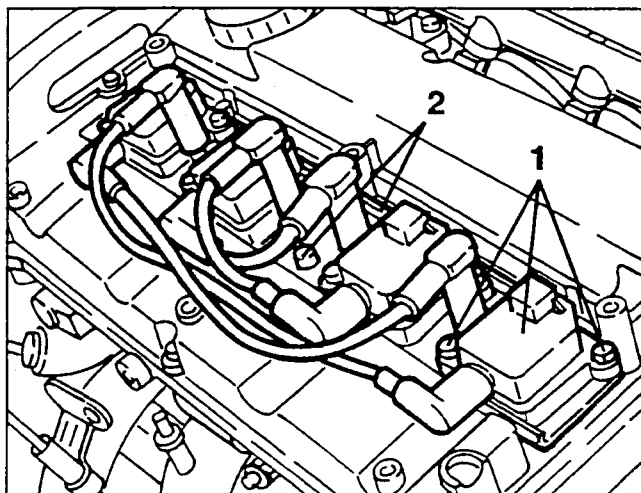
- Disconnect the vacuum takeoff pipe from the servo-brake.

1. Disconnect the electrical connection from the constant idle speed actuator.
2. Disconnect the accelerator cable from the throttle body.
3. Disconnect the electrical connection from the E.G.R. modulation solenoid valve.
4. Disconnect the coolant fluid delivery pipe to the header tank from the throttle body.

5. Disconnect the electrical connexion from the throttle potentiometer.

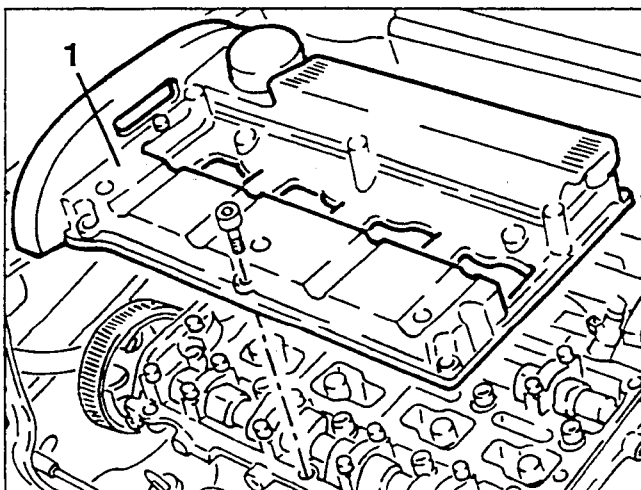


1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.

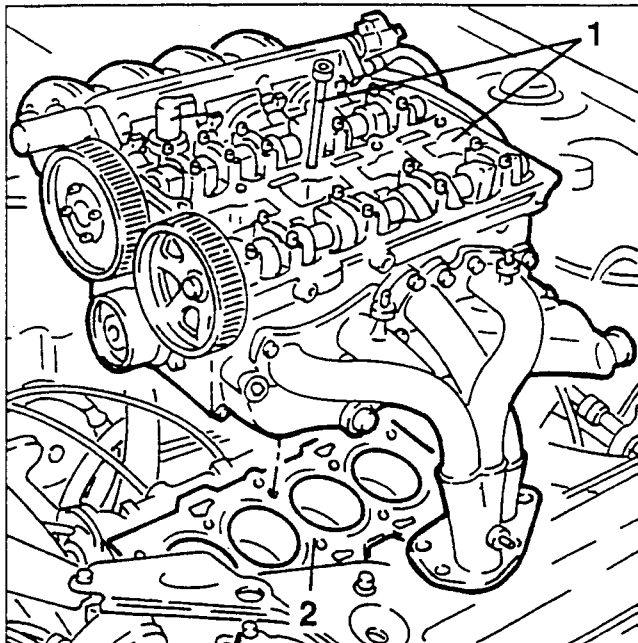


- Disconnect the oil vapour recovery pipe from the cylinder head.

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.

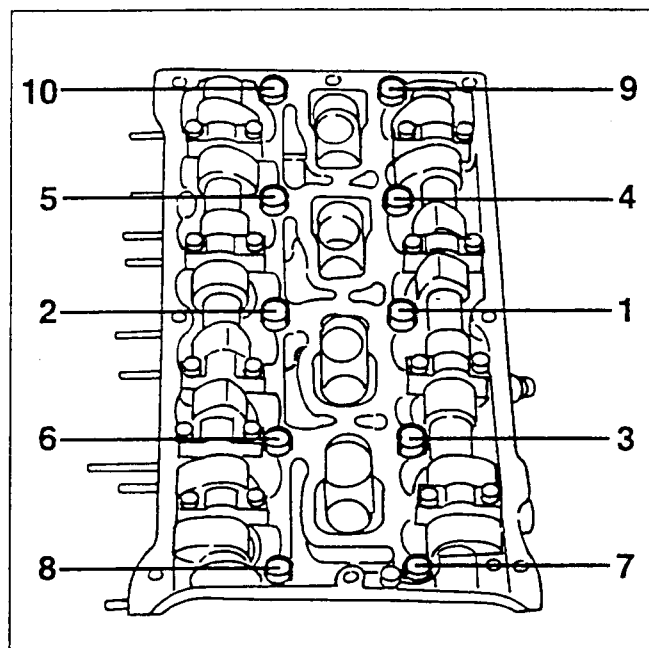
NOTE: The cylinder head gasket is in aramidic fibre and cylinder head retightening is unnecessary throughout the life of the engine.



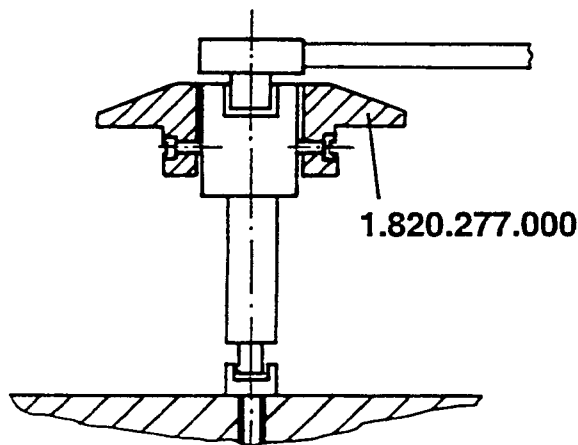
WARNING: Before assembly, accurately clean the cylinder head and crankcase surfaces.

- 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 kgm)
Tighten the screws to the preliminary torque of:	40 Nm (4.1 kgm)
Turn all the screws with an angle of:	90° + 90° + 90°



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

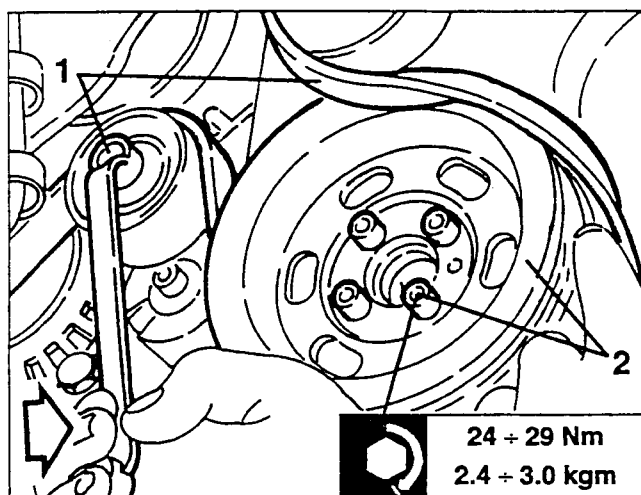


For re-assembly of the timing gear drive belt and timing and for assembly of the auxiliary components drive belt see GROUP 00.

OIL SUMP

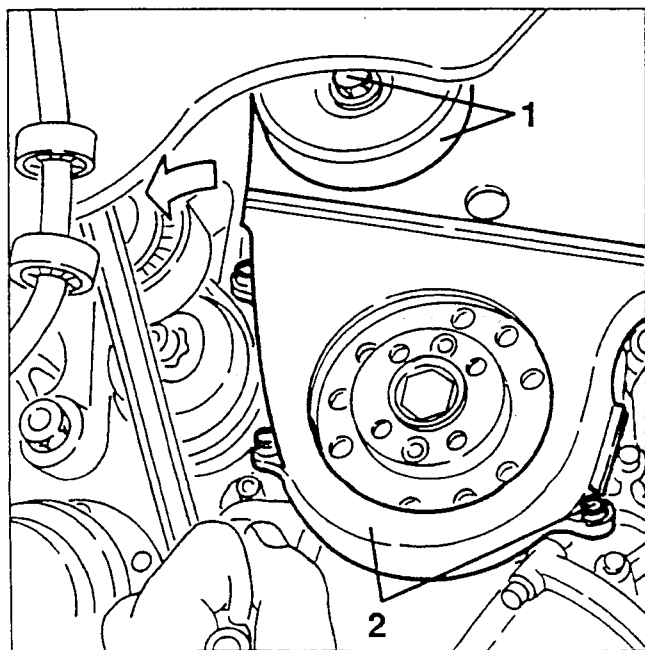
REMOVAL/REFITTING

- 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.

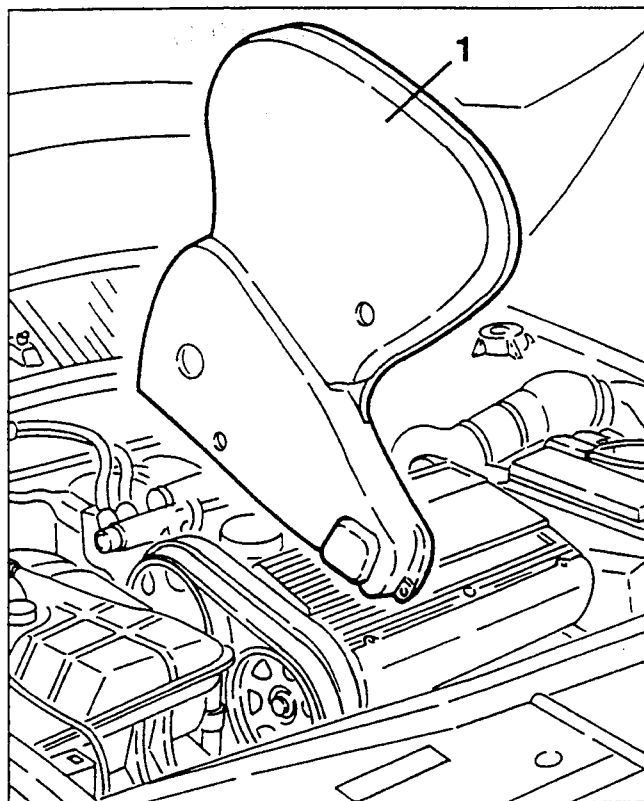


1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
2. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft belts.

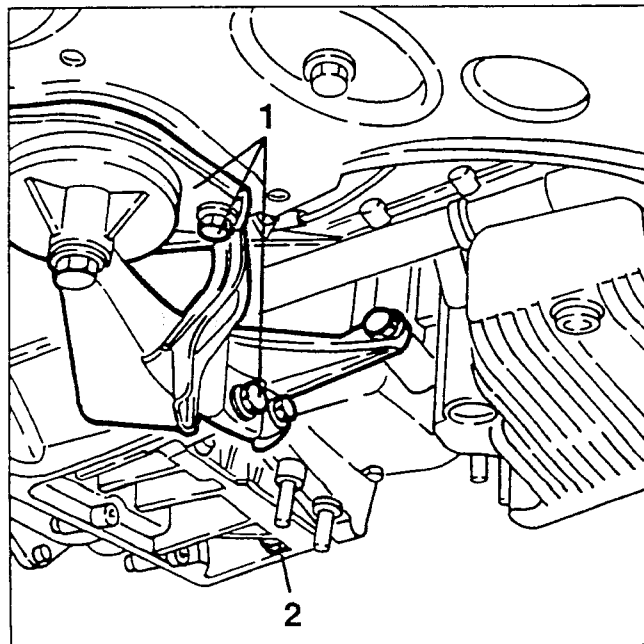
NOTE: To gain access to the rear screw, turn the belt tensioner as illustrated.



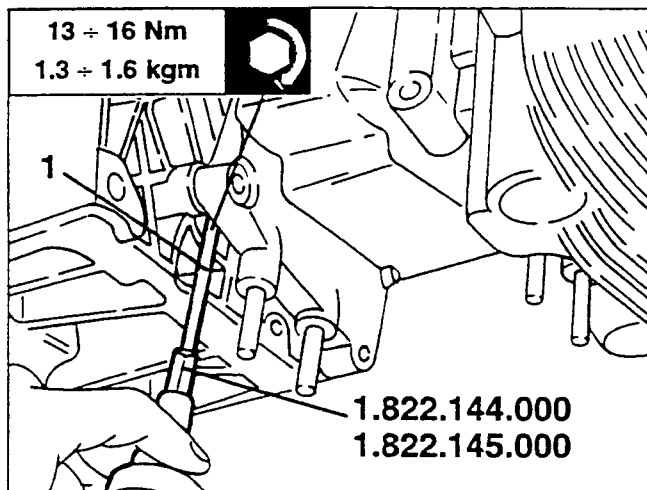
- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft belts.
1. Lower the car, slacken the remaining fastening screws and remove the upper cover.



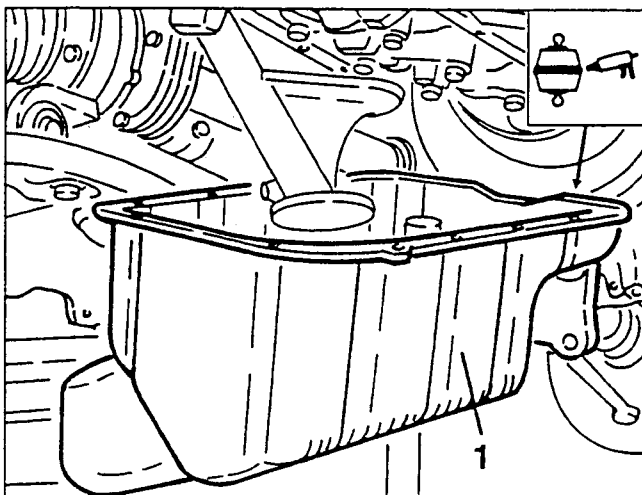
- Remove the front section of the exhaust pipe.
 - Position a hydraulic jack under the gearbox.
1. Slacken the fastening screws and remove the power unit rear support.
 2. Slacken the screws fastening the gearbox to the oil sump.



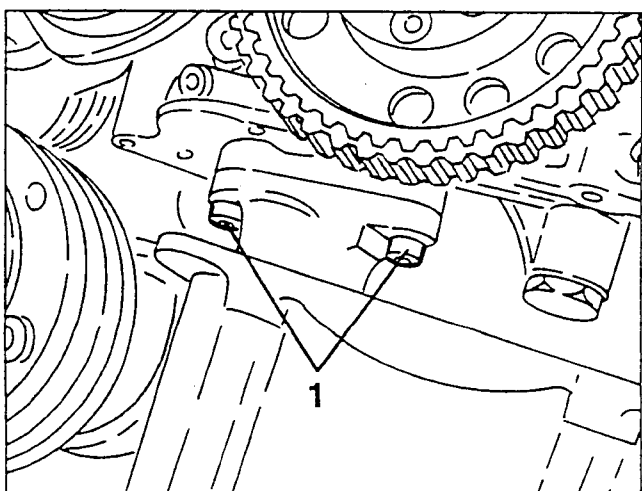
1. Slacken the oil sump fastening screws using tools no. 1.822.144.000 and no. 1.822.145.000 for those to which access is not possible.



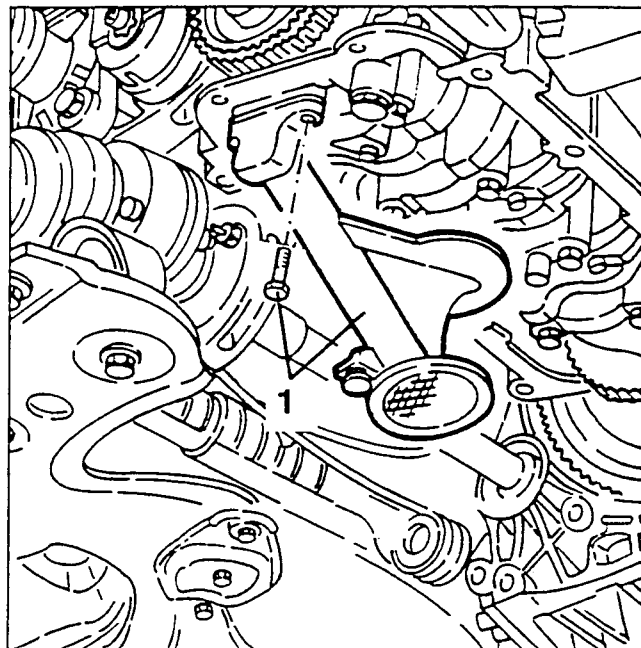
1. Lower the hydraulic jack as required and remove the oil sump.



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

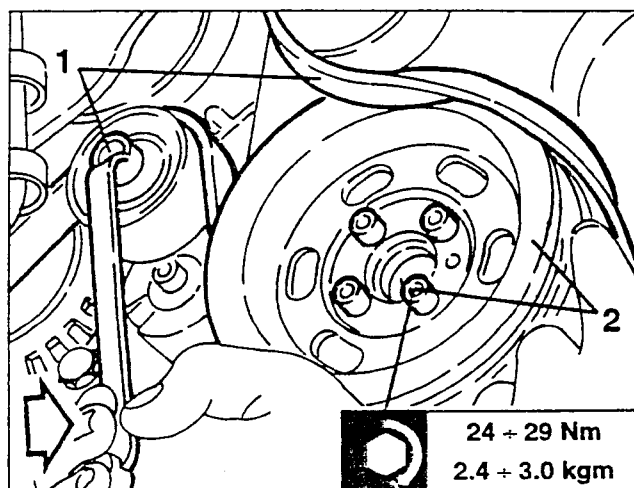


1. Slacken the fastening screws and remove the suction device.
- Remove the seal.

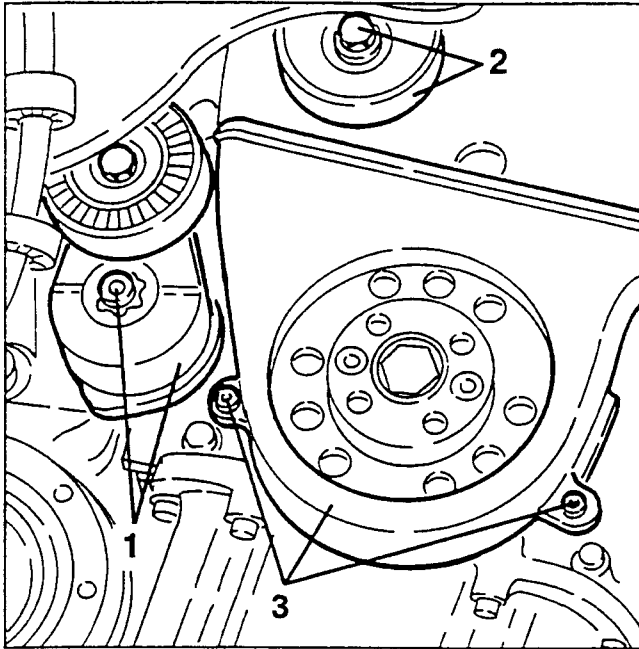


CHANGING THE CRANKSHAFT FRONT OIL SEAL

- 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.

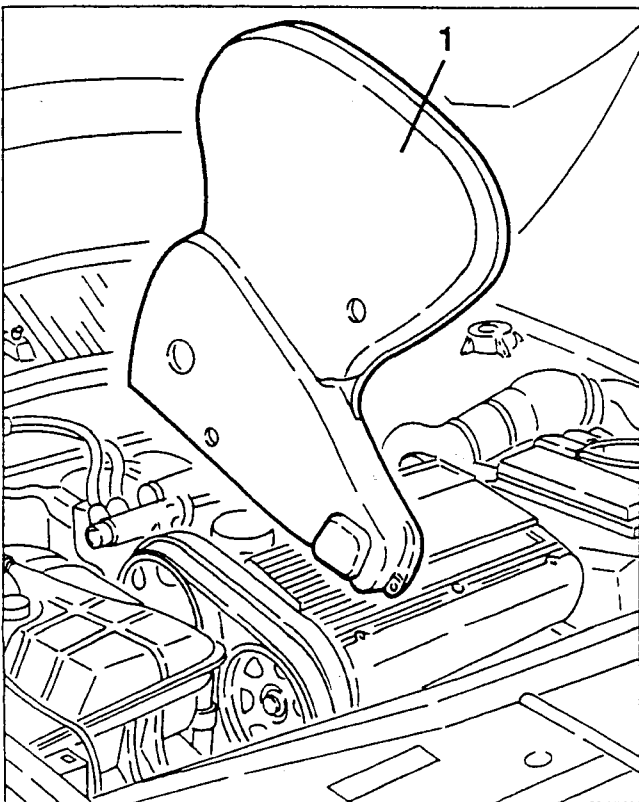


1. Slacken the fastening screw and remove the belt tensioner.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.

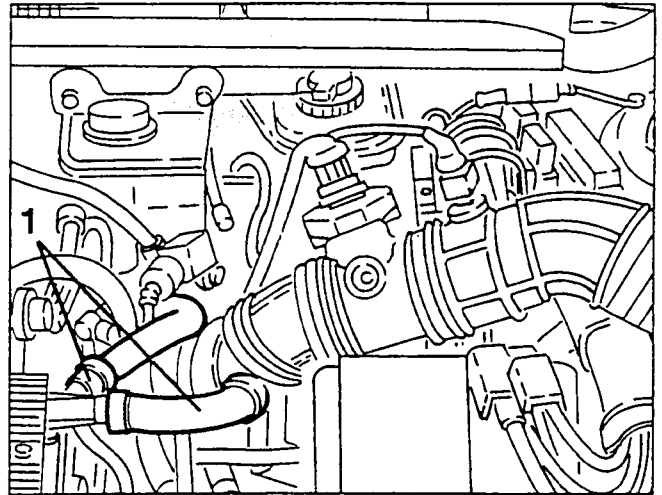


- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.

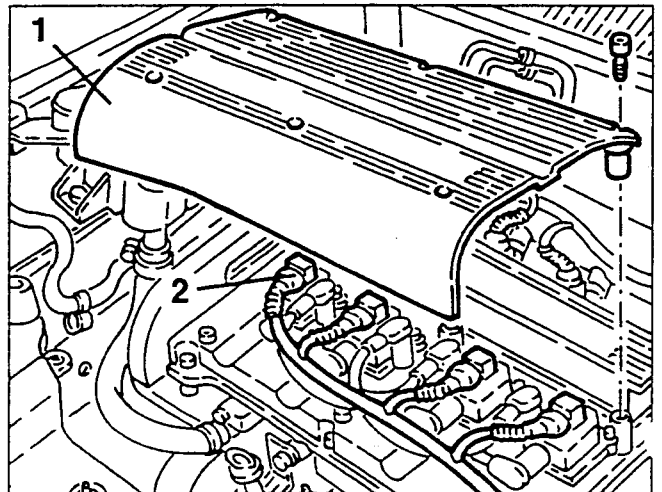
1. Lower the car, slacken the fastening screws and remove the upper cover.



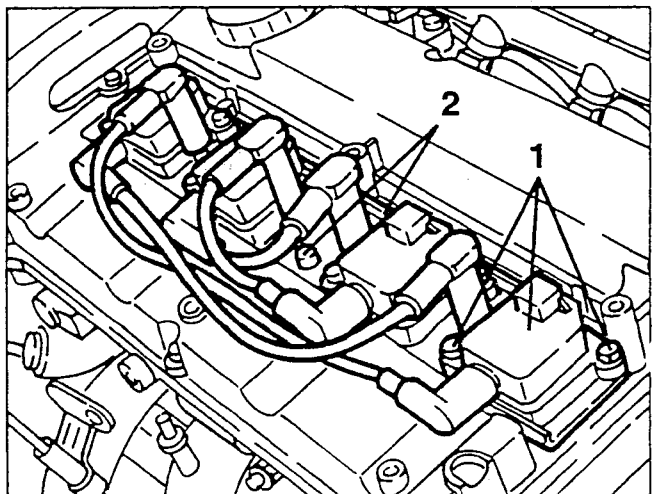
1. Disconnect and remove the oil vapour recovery pipes.



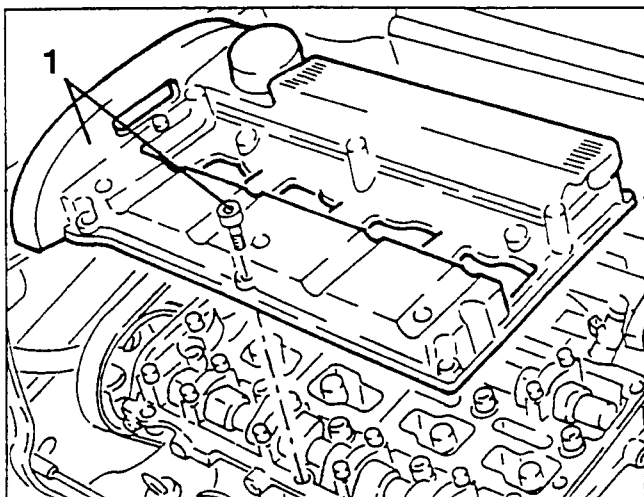
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



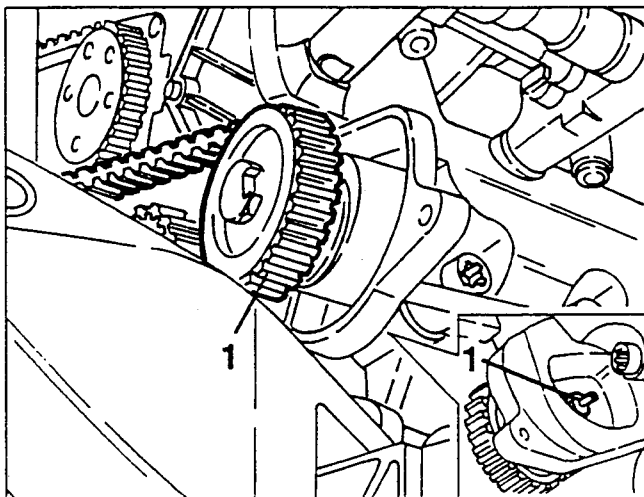
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



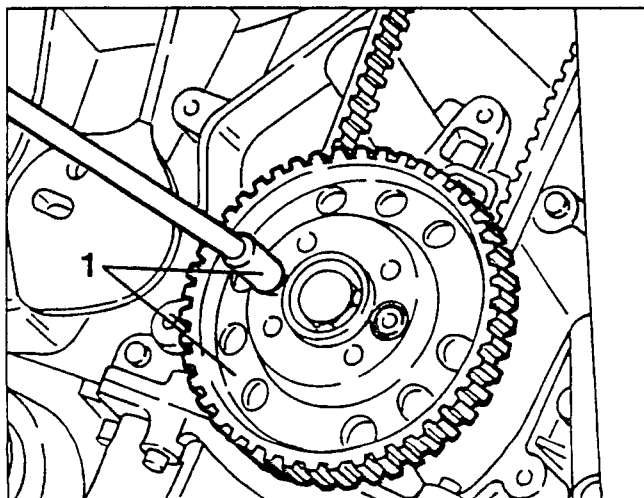
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



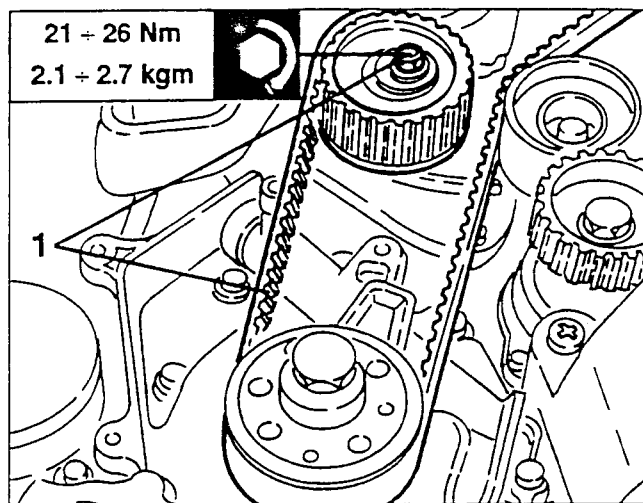
1. Loosen the tension of the counter-rotating shaft belt slackening the fastening nut of the corresponding belt tensioner, then prise and remove the belt.



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

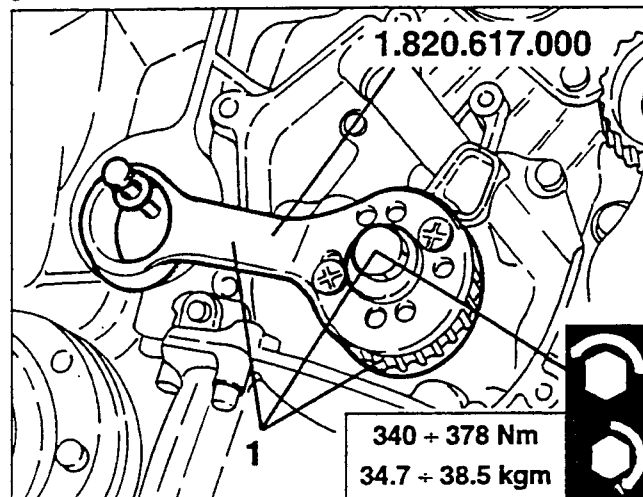


1. Working on the timing gear belt tensioner, loosen the tension of the belt, then prise it off.



Solution for engines before change

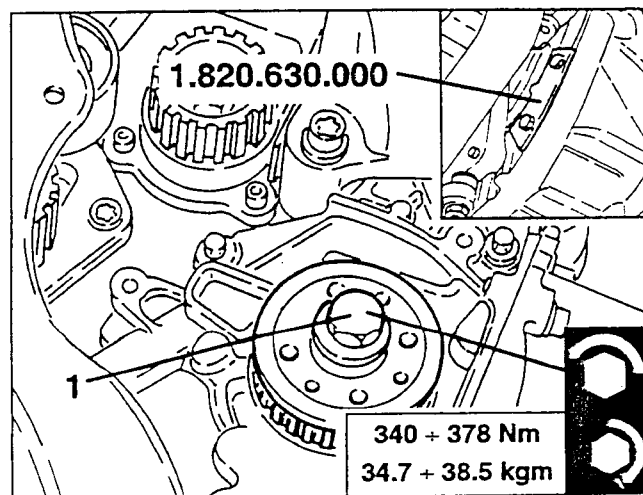
1. Using tool no. 1.820.617.000 as counter-torque slacken the screw (left-handed) fastening the timing gear drive belt pulley, then remove it.



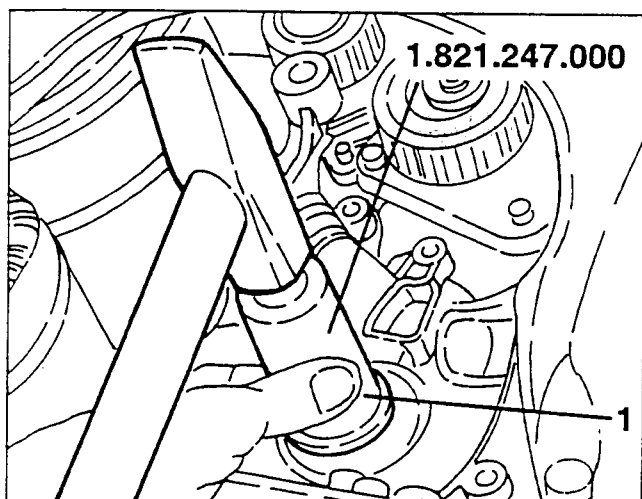
Solution for engines after change

- Slacken the fastening screws and remove the lower flywheel cover.

1. Install flywheel stopper tool no. 1.820.630.000 as illustrated, slacken the fastening screw (left-handed), then remove the timing gear pulley.



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



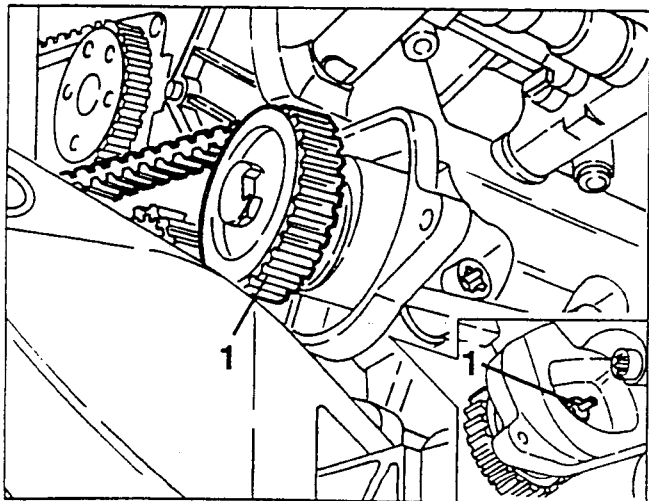
- Re-assemble reversing the sequence followed for removal.

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.

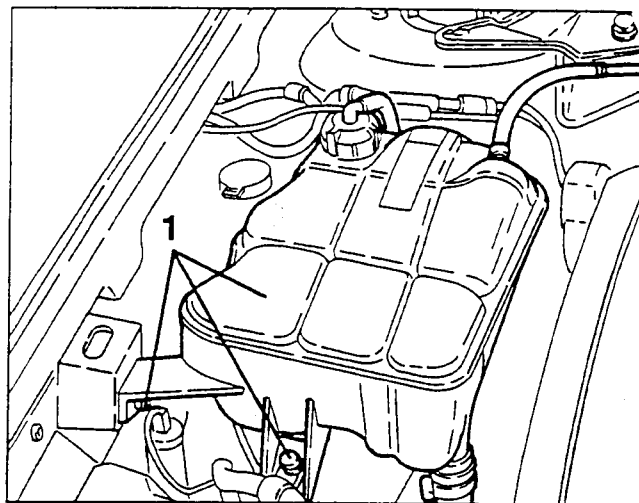
CHANGING THE COUNTER-ROTATING SHAFT SEALS

- 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.

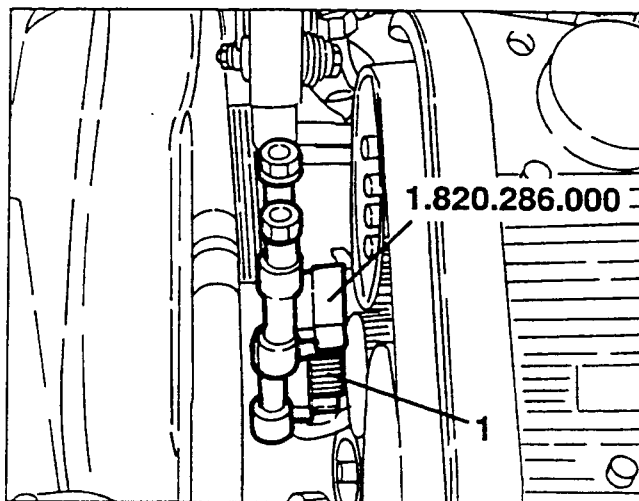
1. Loosen the tension of the counter-rotating shaft belt slackening the nut fastening the corresponding belt tensioner, then prise and remove the belt.



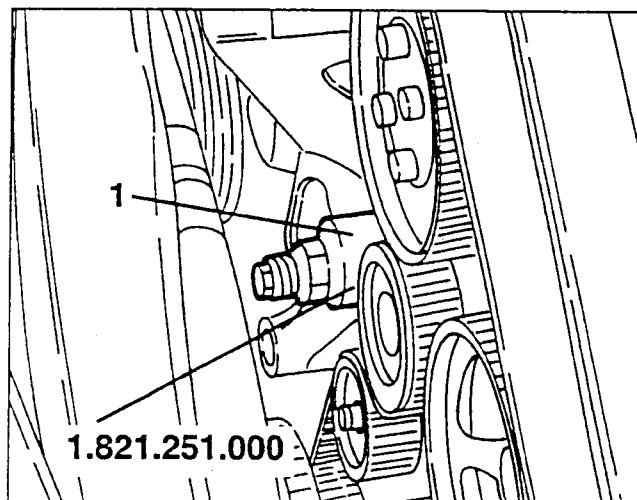
1. Slacken the screws and move the header tank to one side without disconnecting the piping.



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.

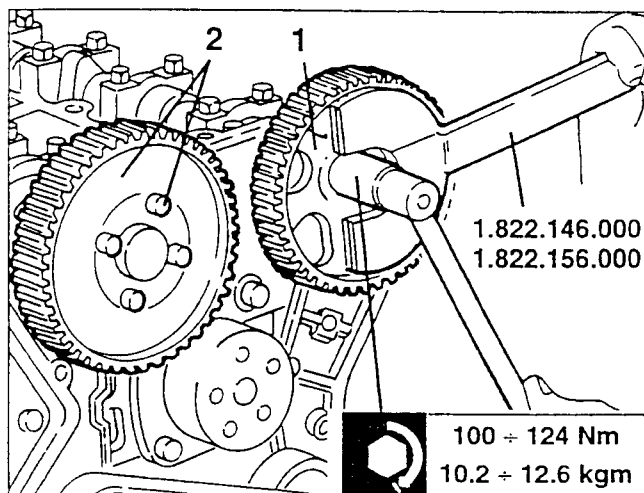


- Carry out re-assembly reversing the sequence described for removal referring to GROUP 00 for assembly of the counter-rotating shaft belt and for assembly of the auxiliary components drive belt.

CHANGING THE CAMSHAFT OIL SEALS

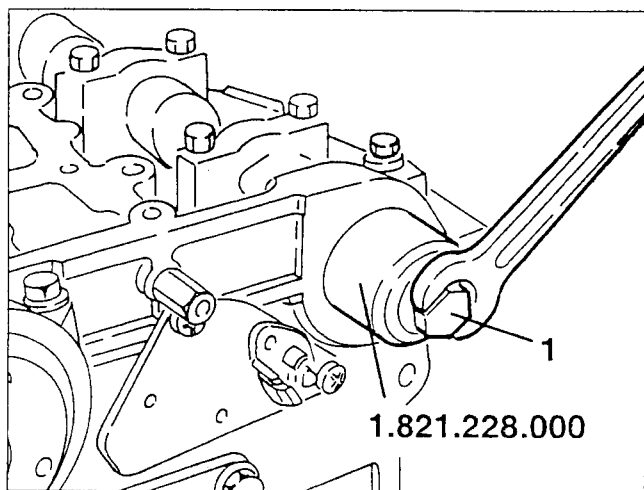
- Proceed as described in the procedure for "Changing the crankshaft front oil seal" up to removing the timing gear drive belt.

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.

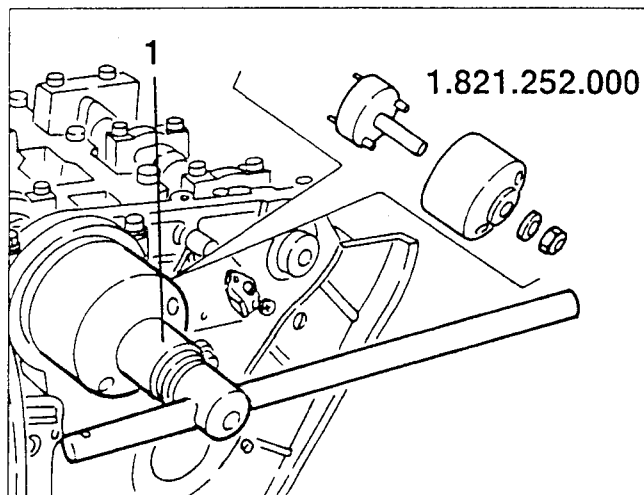


- Remove the camshaft oil seals.

1. Install a new camshaft front oil seal on the exhaust side using tool no. 1.821.228.000.



1. Install a new camshaft front oil seal on the intake side using tool no. 1.821.252.000.

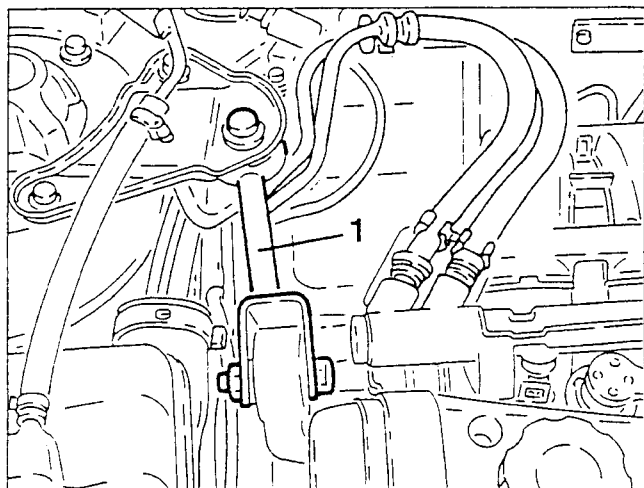


- Carry out re-assembly reversing the sequence described for removal

Refer to GROUP 00 for assembly of the timing gear and counter-rotating shaft belts and for assembly of the auxiliary components drive belt.

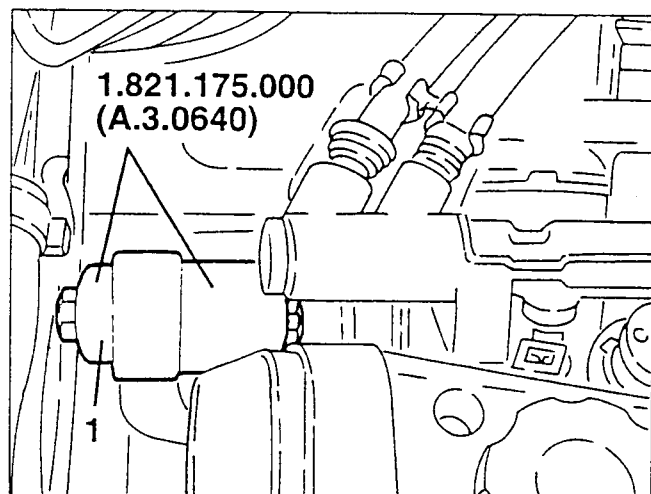
CHANGING THE FLEXIBLE BUSHING OF THE ENGINE STAY ROD ANCHOR BRACKET

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

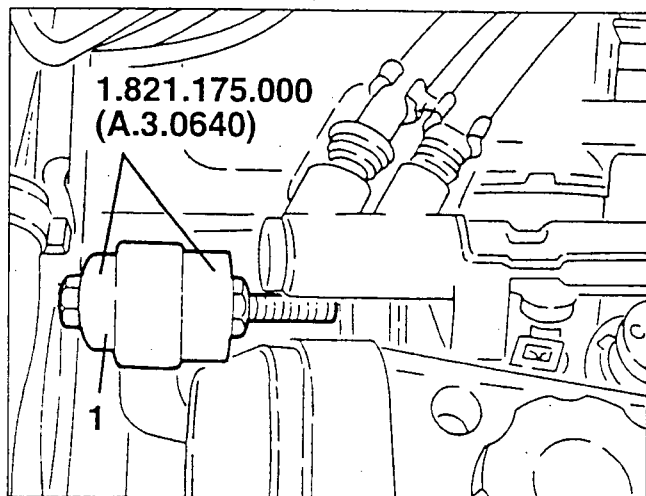


- Slacken the fastening screws and move the header tank to one side without disconnecting the piping.

1. Using tool no. 1.821.175.000 (A.3.0640) as illustrated remove the flexible bushing from the engine stay rod anchor bracket.



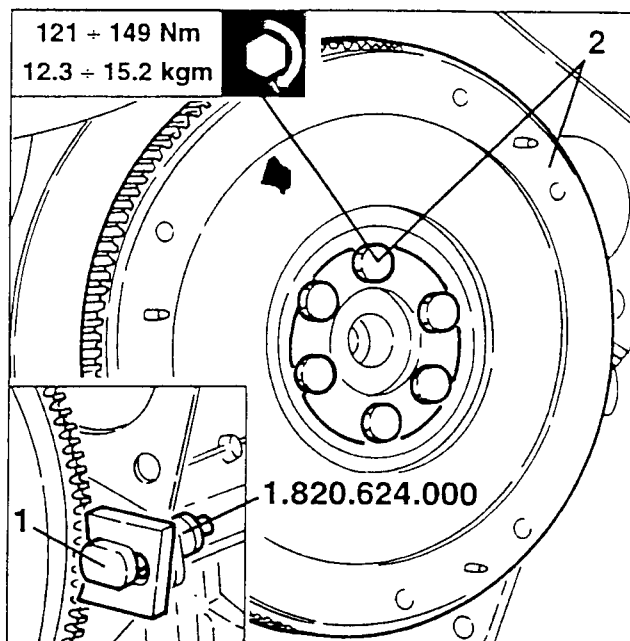
1. Refit a new flexible bushing still using tool no. 1.821.175.000 (A.3.0640) as illustrated.



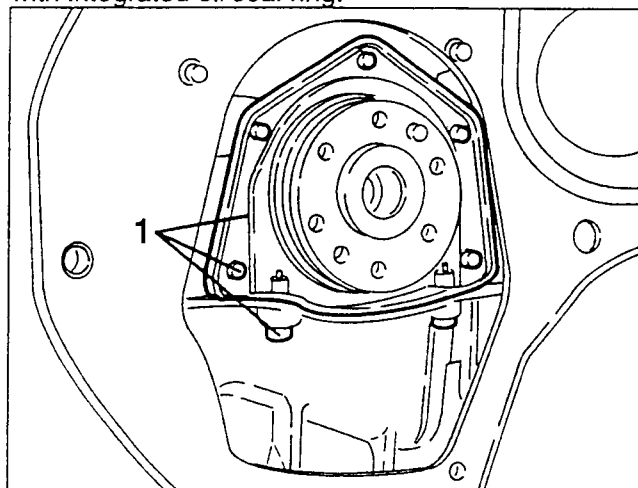
- Complete re-assembly reversing the sequence followed for removal.

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.

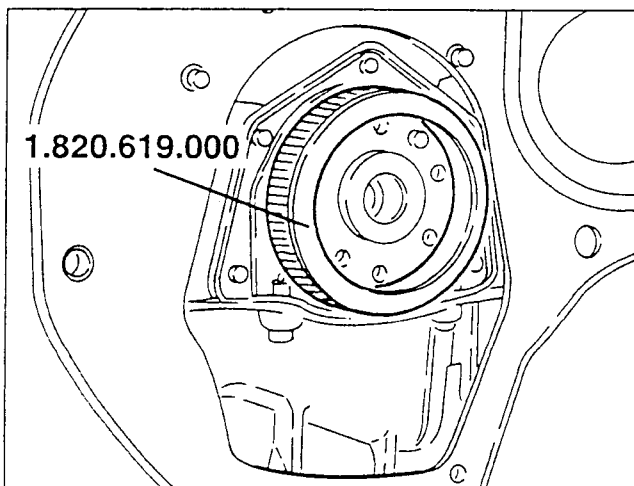


1. Slacken the screws fastening the oil sump to the crankcase, then remove the rear crankcase cover with integrated oil seal ring.



- Refit the rear cover proceeding as follows:

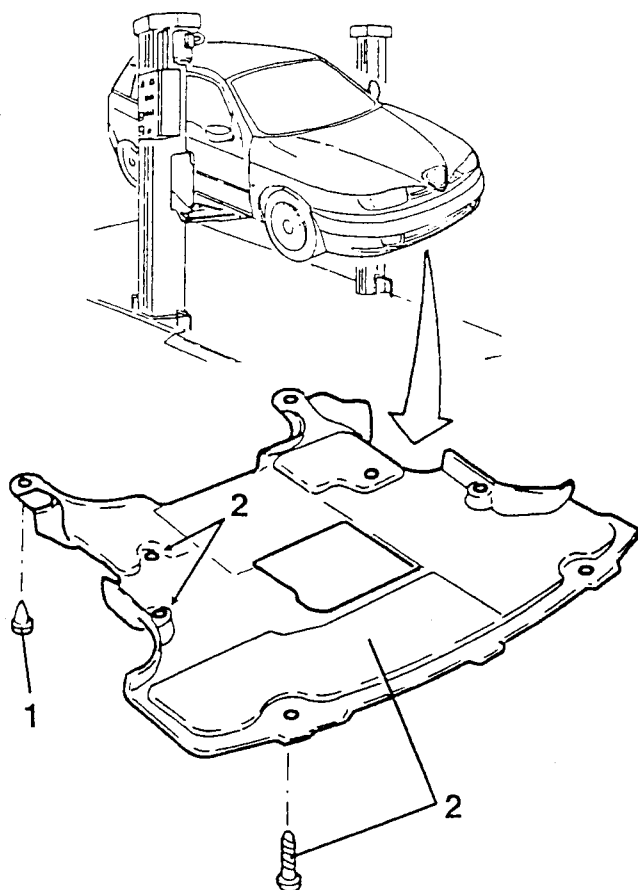
- Fit tool no. 1.820.619.000 on the oil seal of the rear crankcase cover.
- Assemble the tool - rear cover assembly and tighten the screws fastening the crankcase and the oil sump, then remove the tool.



GUARD UNDER ENGINE

REMOVING/REFITTING

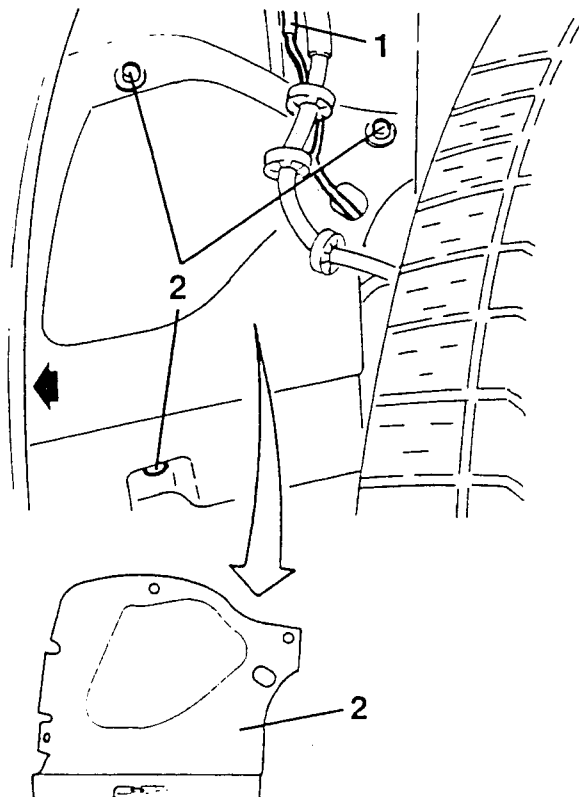
- Set the car on a lift and raise it.
- 1. Remove the two plastic buttons fastening the guard under the engine to the body.
- 2. Slacken the six fastening screws and remove the guard under the engine.



WHEEL HOUSE GUARDS

REMOVING/REFITTING

- Set the car on a lift and raise it.
- Turn the wheel just enough to gain access to the left guard.
- 1. Disconnect the electrical connection of the brake pad wear signalling cable and remove the latter from the hole on the left guard.
- 2. Slacken the fastenings and remove the left wheel house guard.
- Carry out the same procedure for removing/refitting the right wheel house guard.



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T. SPARK
16V

ENGINE
Operations in vehicle **10**

WHITE

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

FUNCTIONS OF THE SYSTEM

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

With this control unit, 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. As this service absorbs a considerable amount of power, the control unit:

- adapts the engine idle speed each time the compressor cuts in; if the engine speed falls below 700 rpm, the compressor is turned off;
- when there is the need for high power - high speed - over 6000 rpm, it momentarily cuts out the compressor
- when the engine is being started the compressor is disabled until normal operating conditions have been reached.

– Connection with 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.

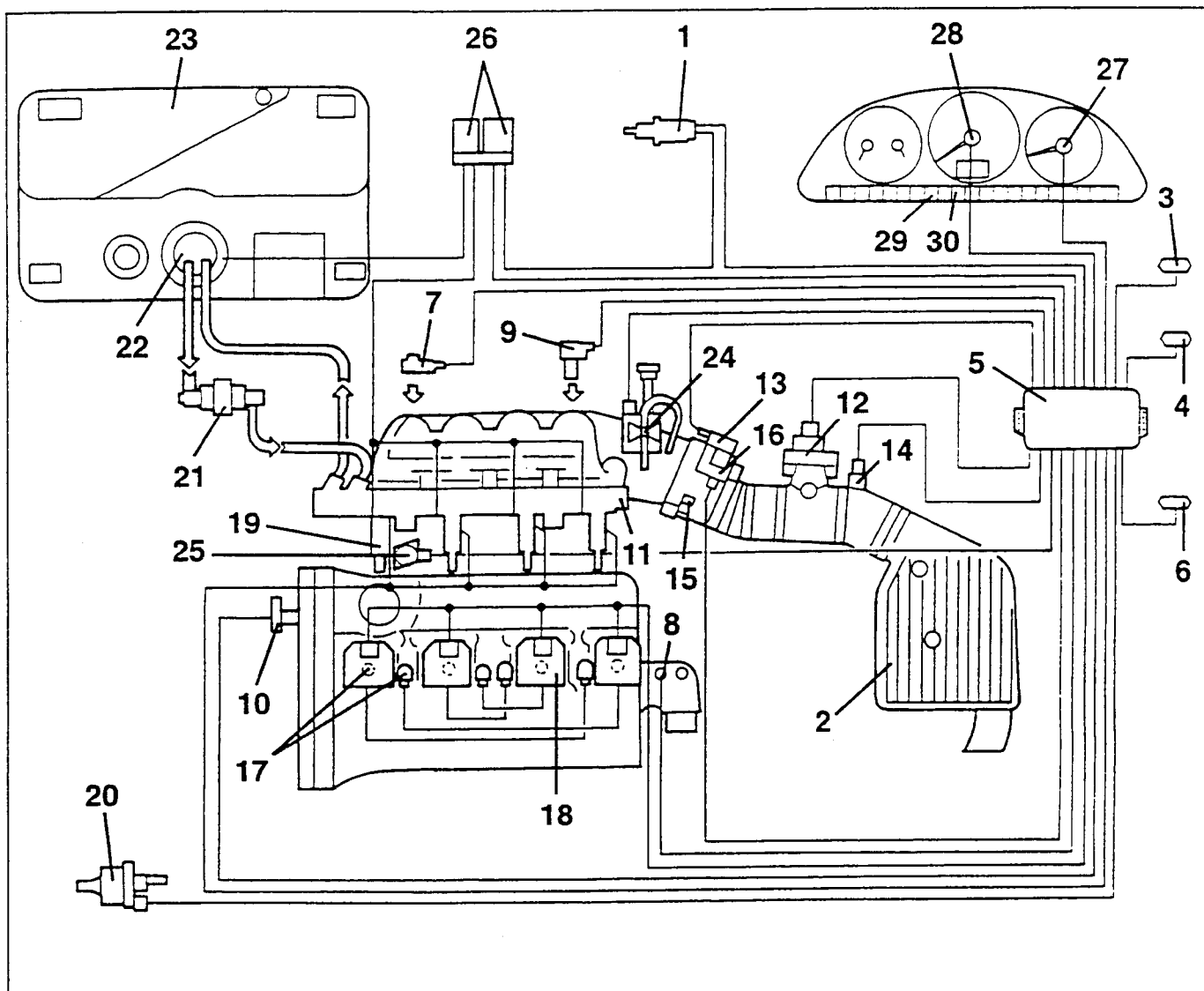
The warning light turns on when the engine is started to indicate the initial test of the entire system (appr. 4 seconds), it then turns off if no errors have been memorised: otherwise it stays on.

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.

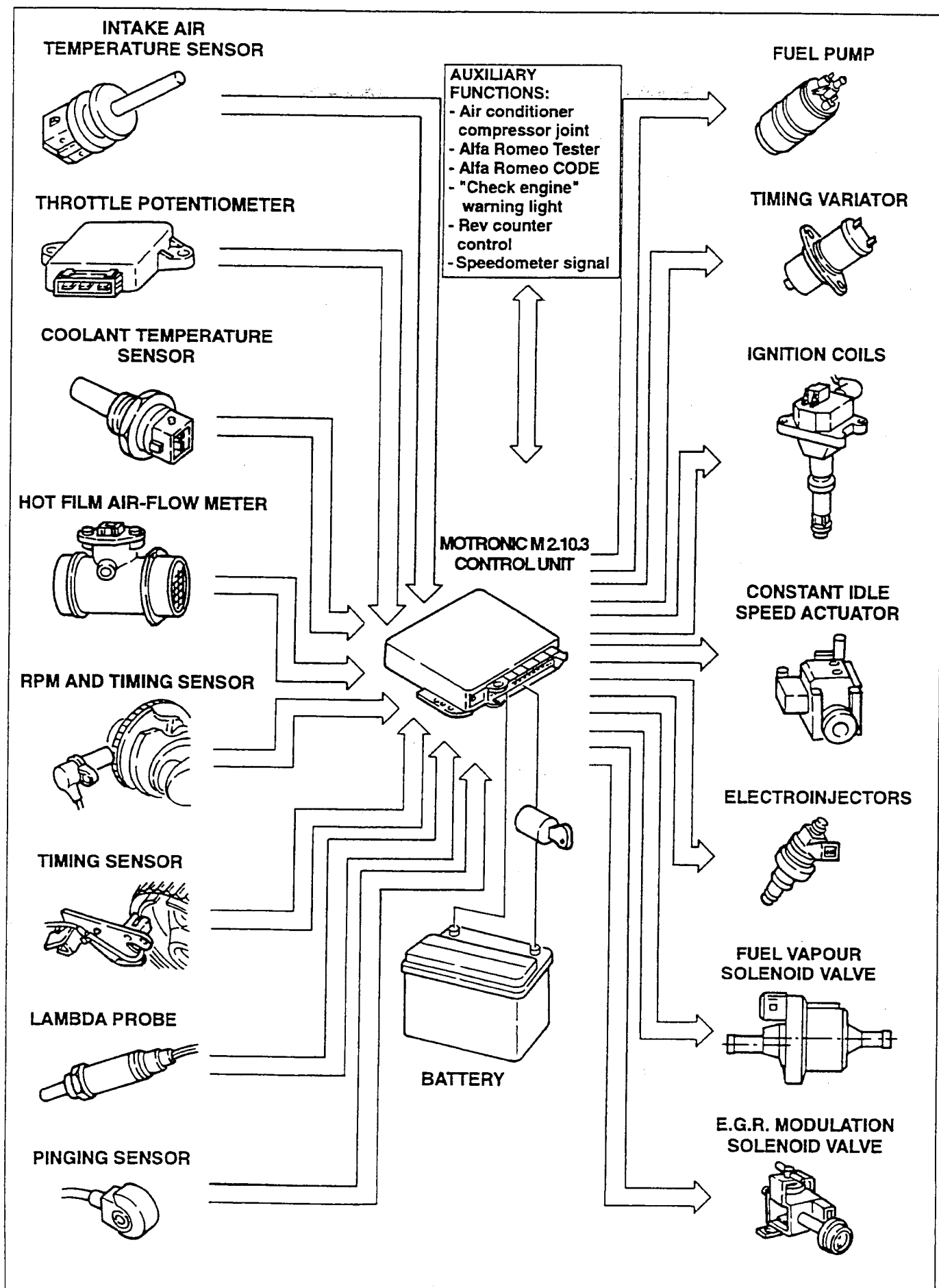
The self-diagnosis system also enables quick and effective location of faults connecting with the ALFA ROMEO Tester (see "Fault-finding"), through which all the errors memorised can be displayed. It is also possible to check the operating parameters recorded by the control unit and operate the single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

COMPONENTS OF THE MOTRONIC M 2.10.3 ELECTRONIC INJECTION AND IGNITION SYSTEM



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

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 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.

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 and timed", i.e. the injectors are opened in correspondence of the exhaust stroke of the associated 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 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 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 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.

- 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:**

on cars fitted with "electronic key" (Alfa Romeo CODE), as soon as the Motronic control unit receives the "key at MARCIA" signal, it asks the Alfa Romeo CODE system 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 diagnosis line K already used by the Alfa Romeo Tester.

- Self-diagnosis:

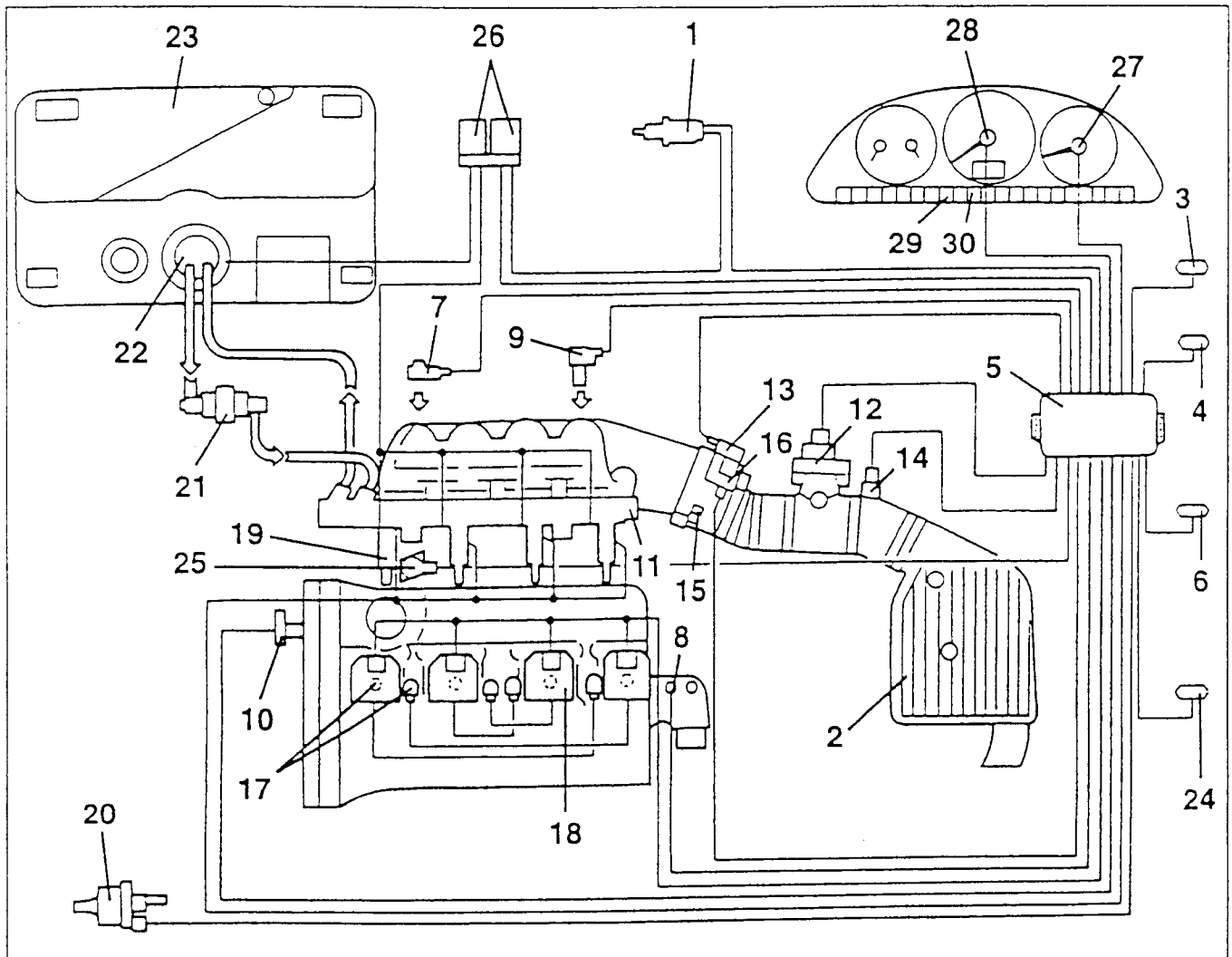
The control unit possesses a diagnosis system which continuously monitors the signals leading from the various sensors checking their plausibility and comparing them with the permissible limits: if these limits are exceeded, the system detects a fault and turns on the warning light on the instrument 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 locate faults by connecting with the Alfa Romeo Tester (see "Fault- finding"), through which all the errors memorised can be displayed.

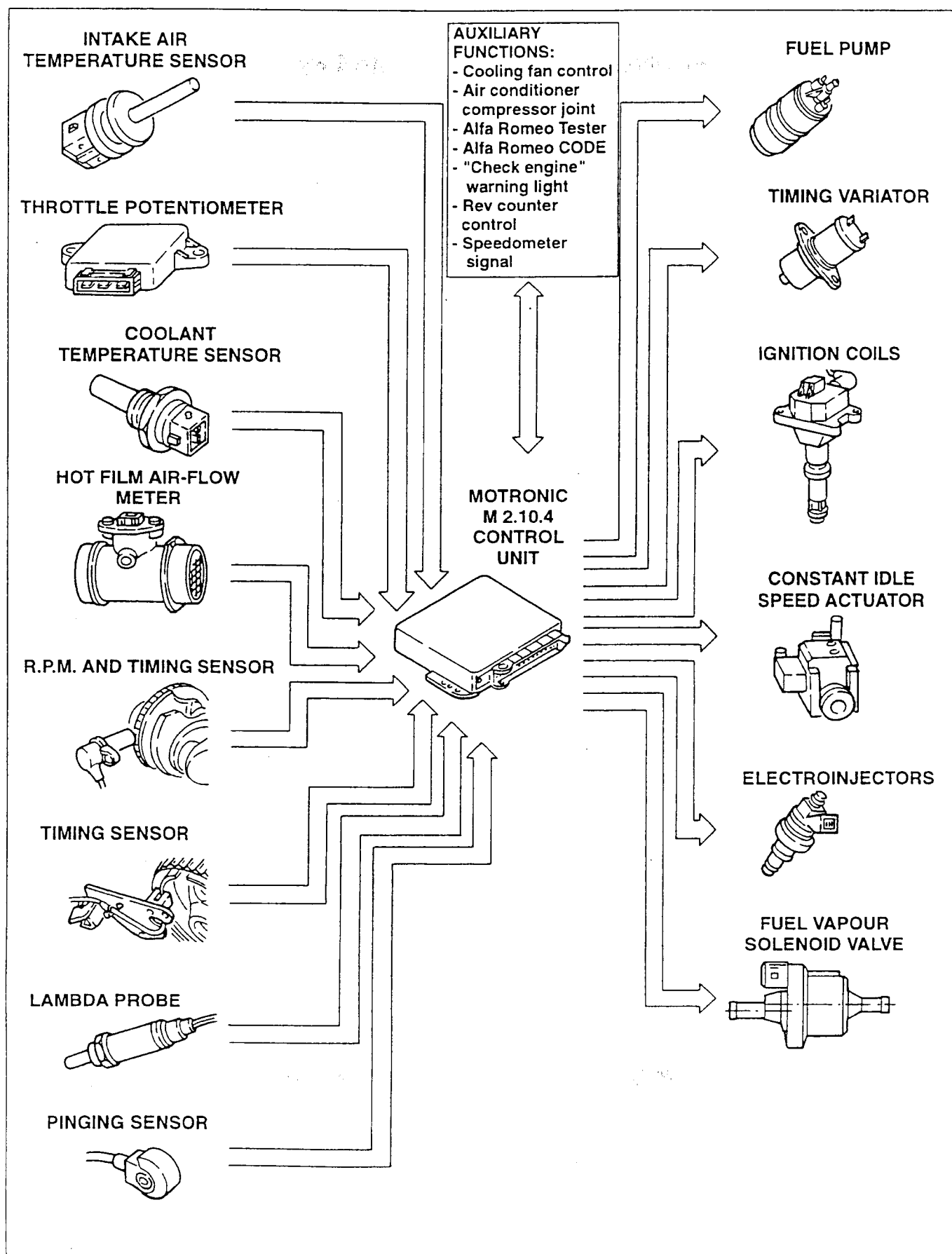
It is also possible to check the operating parameters recorded by the control unit and command the turning on of the single actuators to check whether they are working properly.

COMPONENTS OF THE MOTRONIC M2.10.4 ELECTRONIC INJECTION AND IGNITION SYSTEM



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

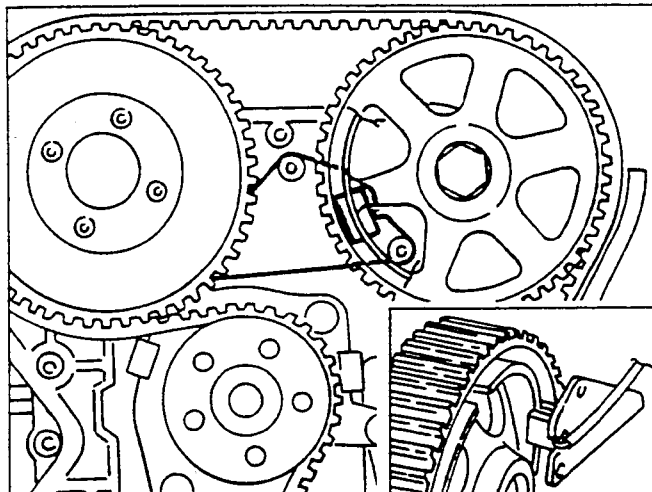
FUNCTIONAL LAYOUT OF MOTRONIC M2.10.4 INJECTION - IGNITION SYSTEM



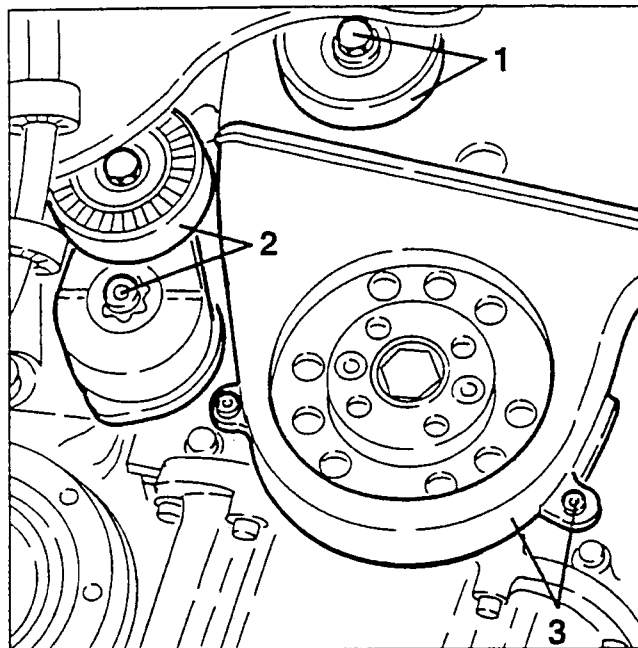
TIMING SENSOR

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.

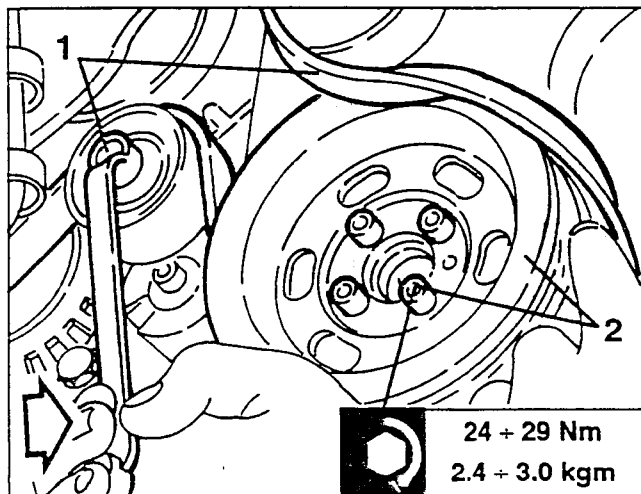


2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.



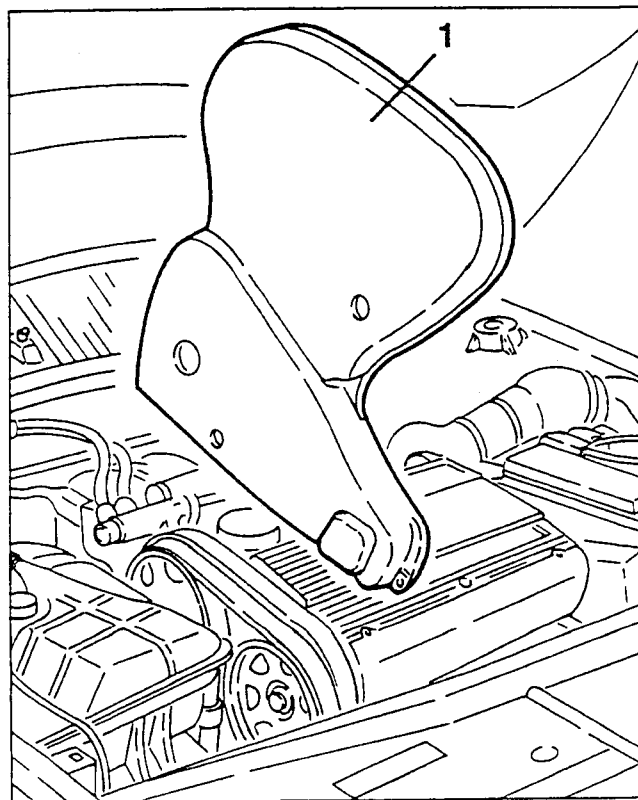
REMOVAL/REFITTING

- 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 auxiliary components drive pulley.

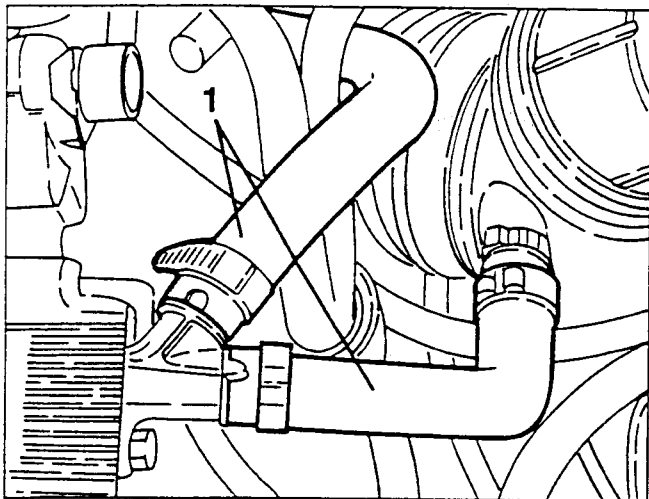


1. Slacken the fastening screw and remove the belt tensioner.

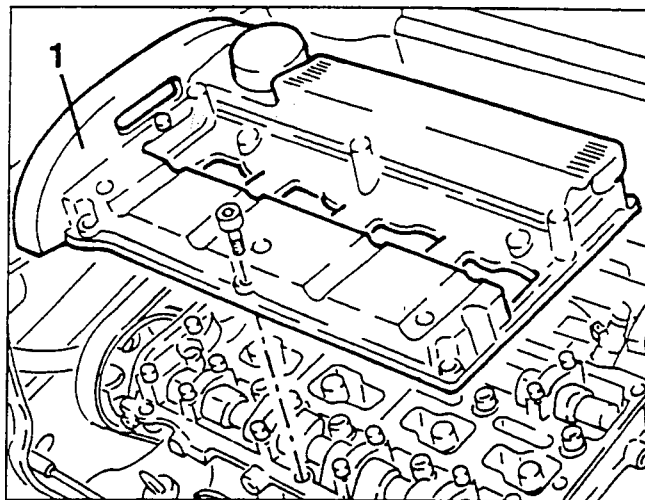
- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.
- 1. Lower the car, slacken the fastening screws and remove the upper cover.



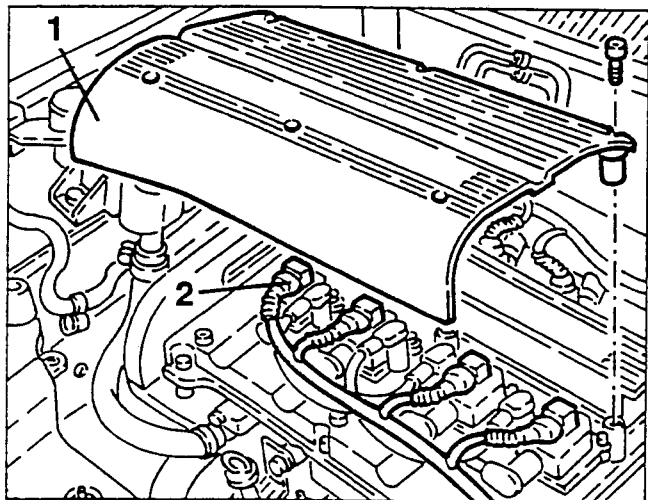
1. Disconnect and remove the oil vapour recovery pipes.



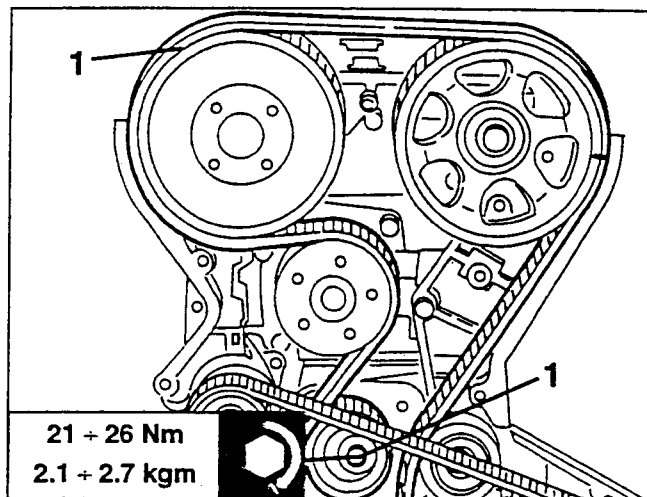
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



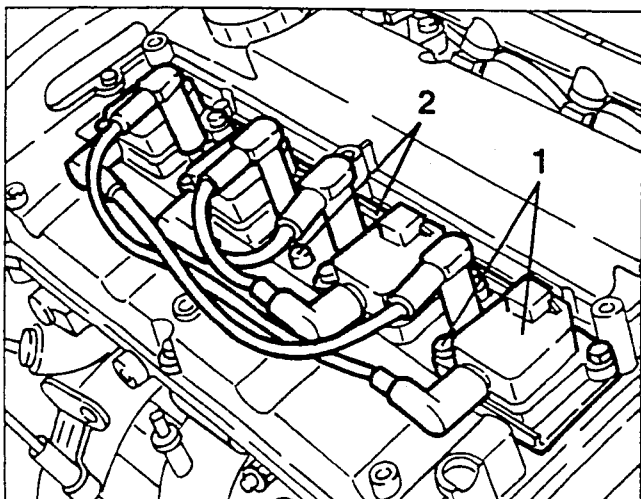
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



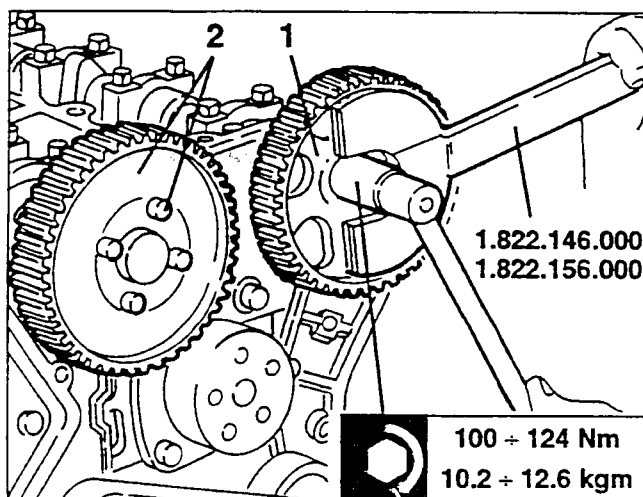
1. Working on the timing gear belt tensioner, loosen the tension on the belt, then take it off the timing gear drive pulleys.



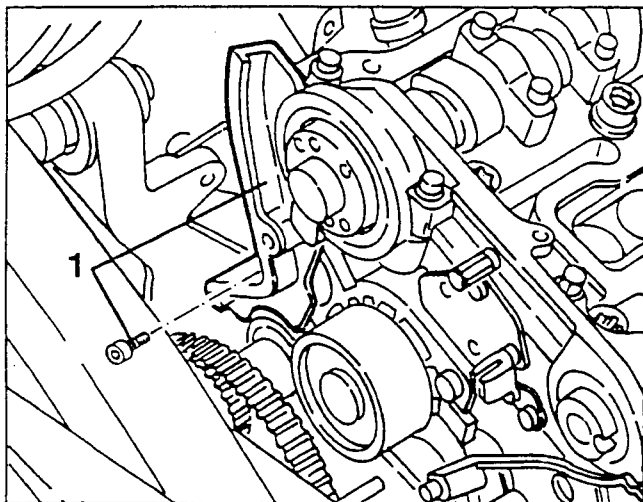
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



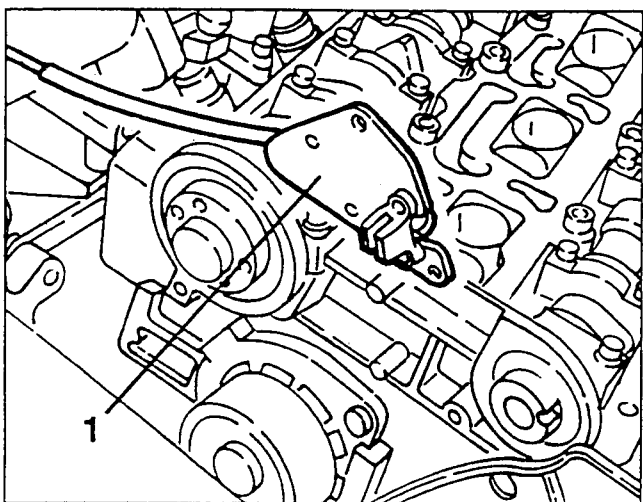
1. Using tools no. 1.822.146.000 and no. 1.822.156.000 slacken the screw fastening the timing gear exhaust side drive pulley and remove it.
2. Slacken the four screws fastening the timing gear intake side drive pulley and remove it.



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.



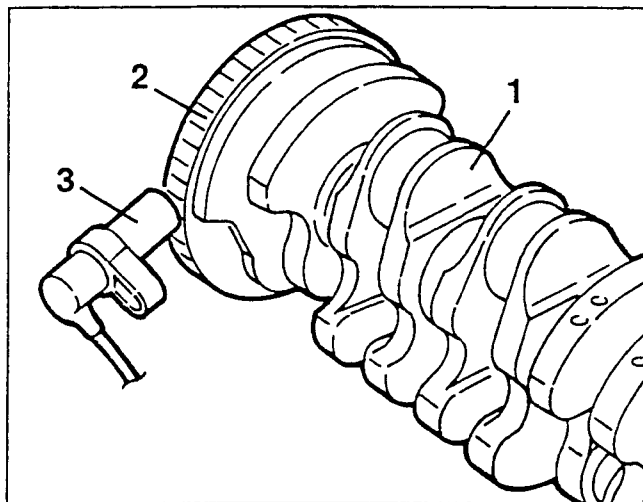
For re-assembly of the timing gear drive belt, valve gear timing and assembly and tensioning the auxiliary components drive belt see GROUP 00.

RPM 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

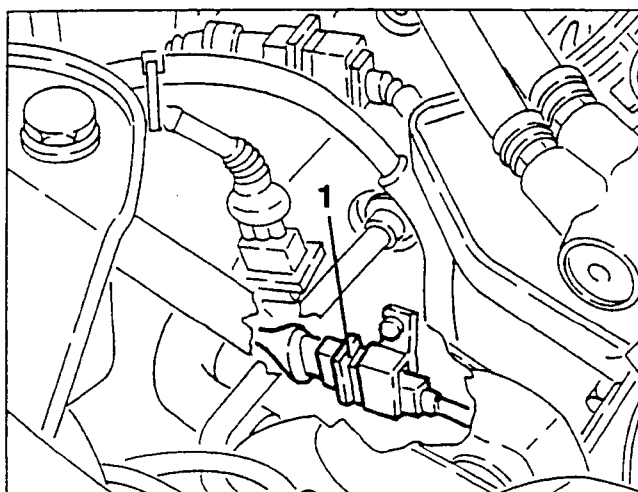
The output signal which varies in relation to the rpm is processed by the control unit to obtain a signal at each passage through zero and a constant rectangular oscillation of amplitude to enable the control of the digital circuits inside the control unit.

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.

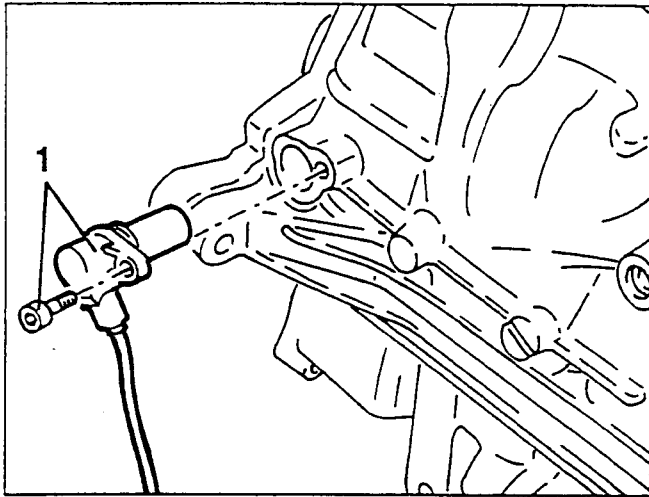
The hollow due to the lack of two teeth gives the control unit a reference point of the crankshaft and each subsequent tooth of the phonic wheel informs the control unit of an increase in its angular position.

REMOVAL/REFITTING

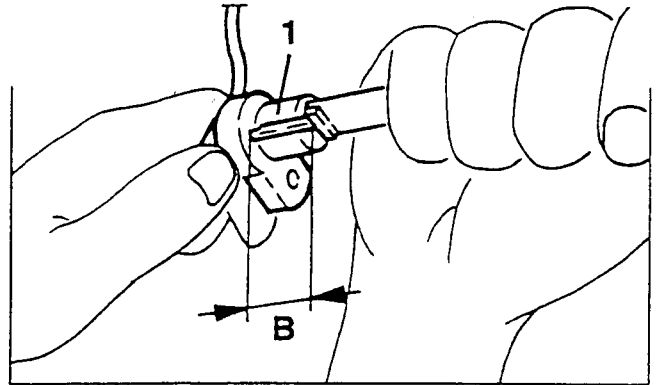
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- 1. Disconnect the timing sensor electrical connection.



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



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

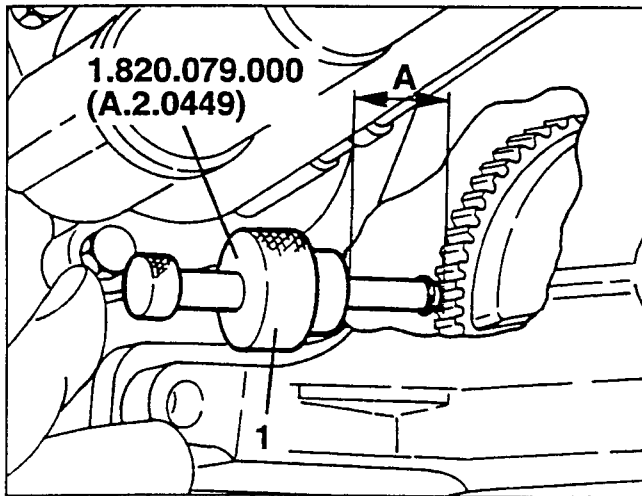


- Calculate the rpm and timing sensor gap and check that it is within the specified limits.

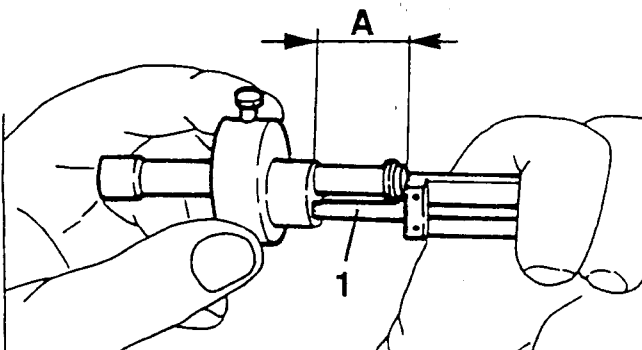
CHECKING THE GAP

- Set the car on a lift and remove the front section of the exhaust pipe.
- Remove the rpm and timing sensor (see specific paragraph).

1. Using tool no. 1.820.079.000 (A.2.0449), find dimension "A".



1. Using a gauge measure dimension "A".

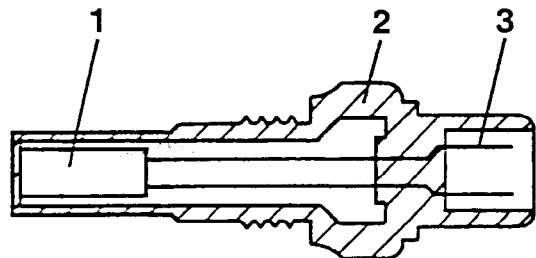


Rpm and timing sensor gap

$$A - B = 0.5 \div 1.5 \text{ mm}$$

ENGINE COOLANT TEMPERATURE SENSOR (NTC)

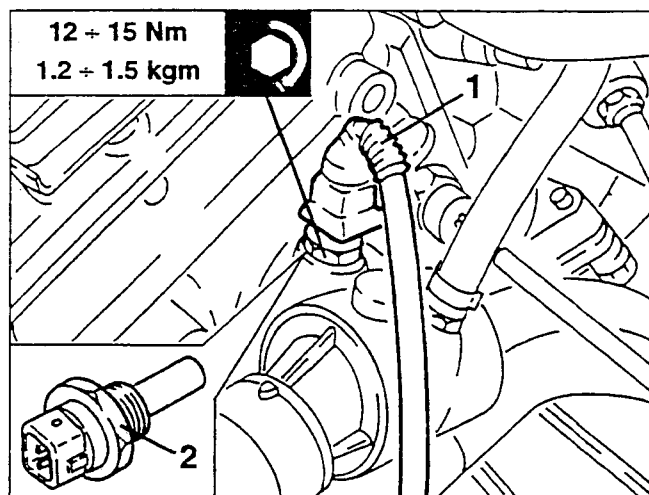
This sensor detects the engine coolant temperature on the thermostatic cup through a thermistor (NTC) with a negative resistance coefficient, i.e. capable of lowering its resistance as the temperature increases. The electric signal obtained reaches the electronic control unit where it is used to correct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



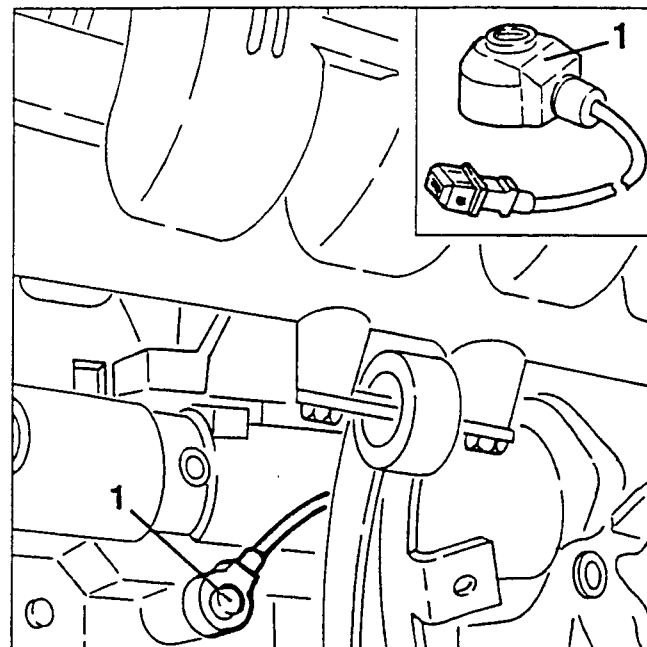
1. NTC resistance
2. Body
3. Connector

REMOVAL/REFITTING

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



- Remove the front section of the exhaust piping.
- 1. Slacken the fastening screw and remove the pinging sensor.



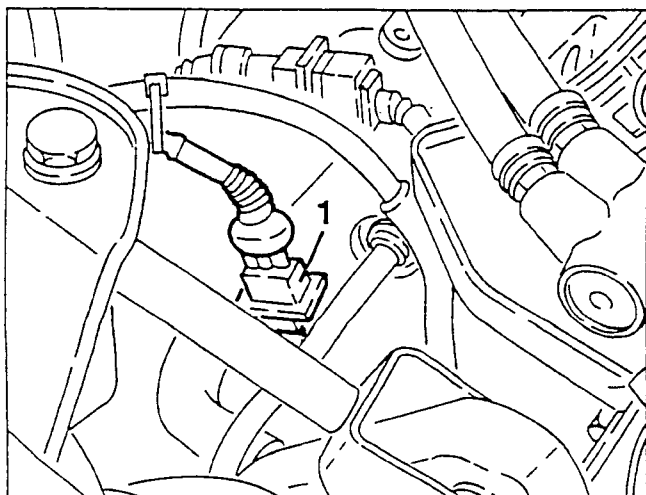
KNOCKING SENSOR

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

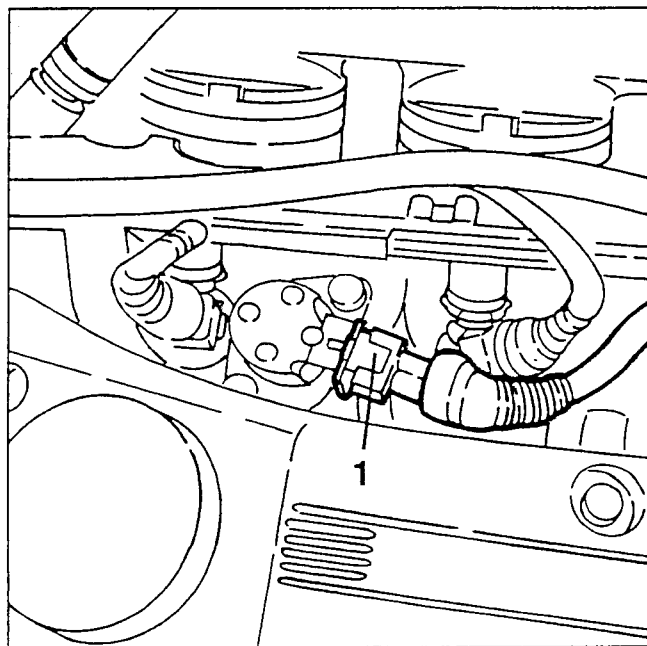
- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection of the pinging sensor.



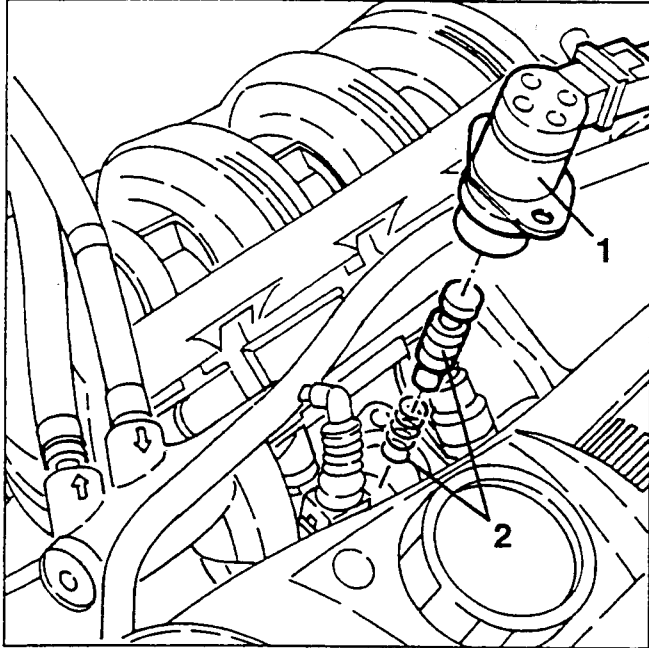
TIMING VARIATOR SOLENOID

REMOVAL/REFITTING

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



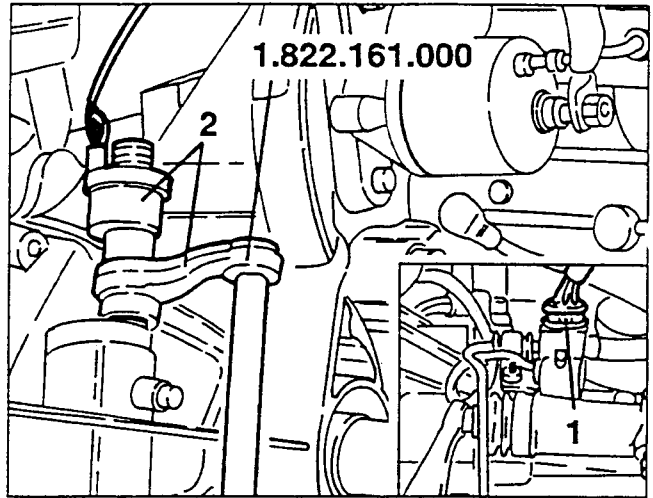
1. Slacken the two fastening screws and remove the timing variator solenoid.
2. Remove the valve complete with the timing variator spring.



SPEEDOMETER SENSOR

REMOVAL/REFITTING

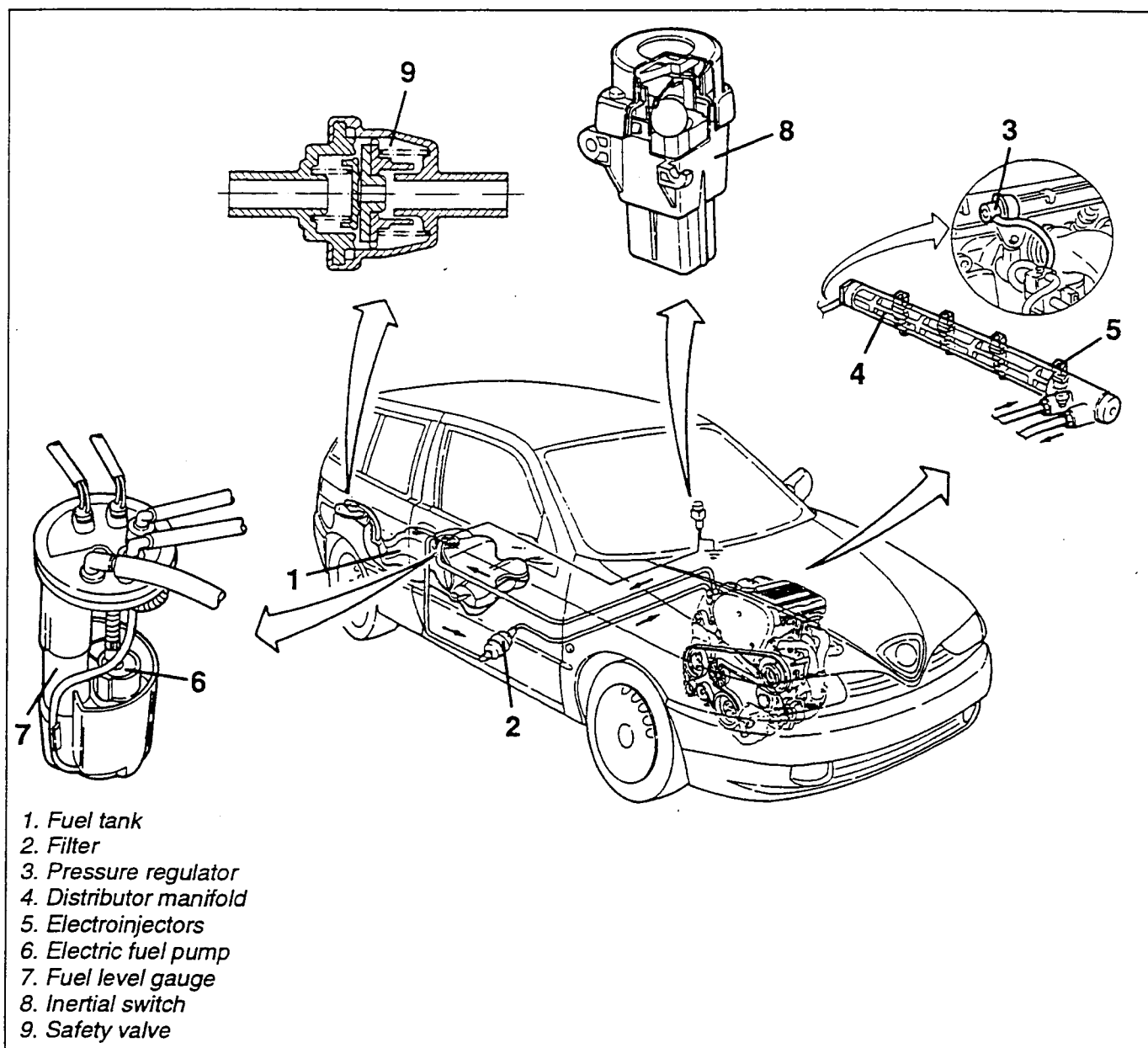
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection of the speedometer sensor.
- 2. Raise the car and using wrench no. 1.822.161.000, slacken and remove the speedometer sensor.



INERTIAL SWITCH

See  16V Boxer engine.

DESCRIPTION OF FUEL SUPPLY SYSTEM



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 the filter the fuel is sent to the distributor manifold (4) and controlled by the vacuum withdrawn from the intake box it returns to the fuel tank through the distributor and a special pipe.

The amount of fuel injected depends solely on the injection time which is controlled by the control unit. The different sections of the fuel pipes are connected by special connectors (for their disconnection see specific paragraph).

The fuel supply system is fitted with an inertial switch (8) 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:

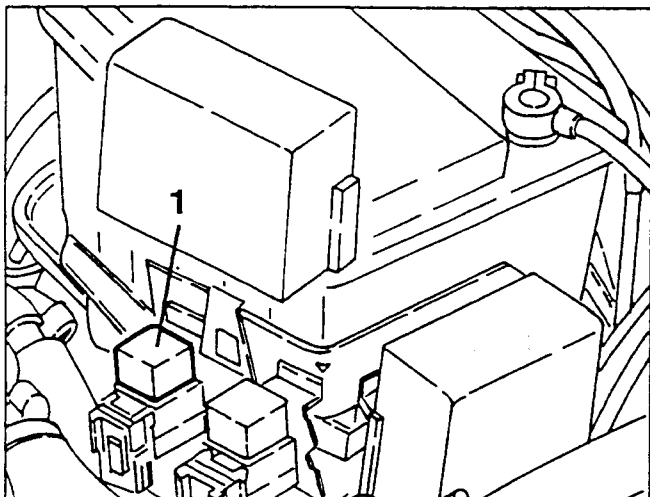
correct operation of the engine requires the use of unleaded fuels (95 R.O.N.) as the presence of lead would quickly bring about consumption of the catalytic converter at the exhaust.

NOTE: For the description and removing/refitting of the components of the fuel supply system not described here, refer to the 1712 16V Boxer engine.

CAUTION

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

- Remove the protective cap and disconnect the fuel pump supply relay (1).



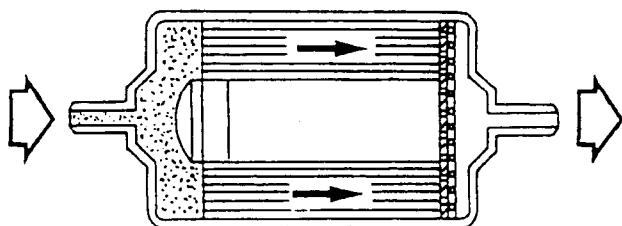
- Run the engine until it stops.

FUEL FILTER

The filter is inserted in the delivery pipe to the injectors, under the car floor next to the fuel tank.

It is formed of an outer aluminium casing and an inner polyurethane support which carries a paper element with high filtering power.

Filtering of the fuel is absolutely necessary to ensure correct functioning of the injectors as they are highly sensitive to foreign matter in the supply circuit.

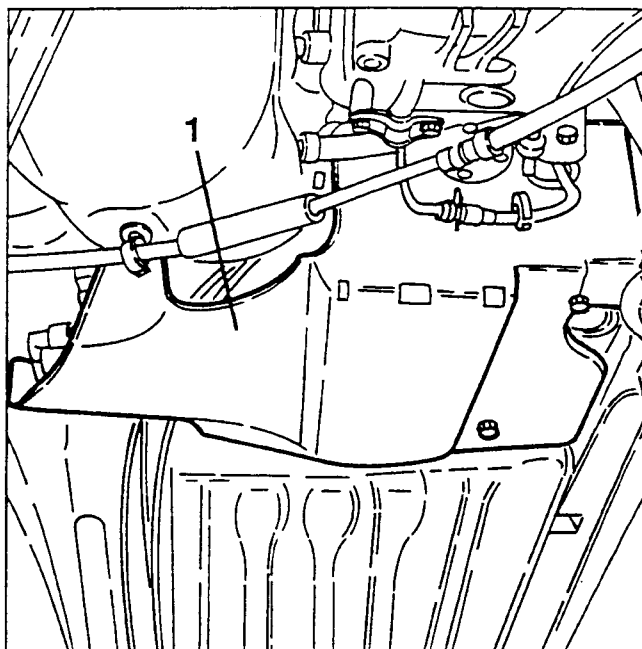


An arrow on the outer casing of the filter points in the direction of the flow of the fuel, therefore the correct assembly position.

REPLACEMENT

- Set the car on a lift and raise it.

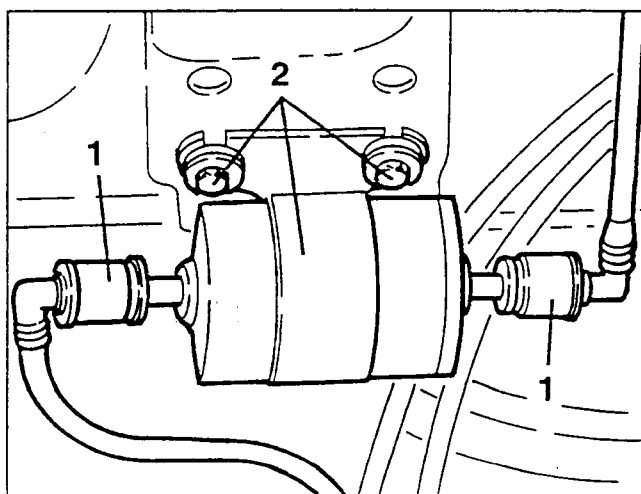
1. Slacken the fastening screws and remove the plastic cover to gain access to the fuel filter.



1. Disconnect the connections of the fuel inlet and outlet pipes from the filter (see "FUEL PIPE FITTINGS" - Boxer 18V engine)

2. Slacken the two screws fastening the support bracket, then remove it complete with fuel filter.

- Separate the fuel filter from the support bracket on the bench.

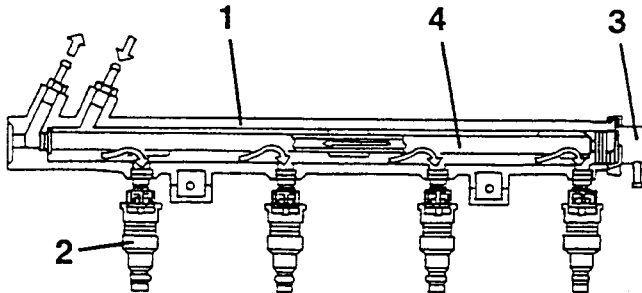


- Install the new filter so that the arrow stamped on it points in the direction of the flow of fuel.

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.



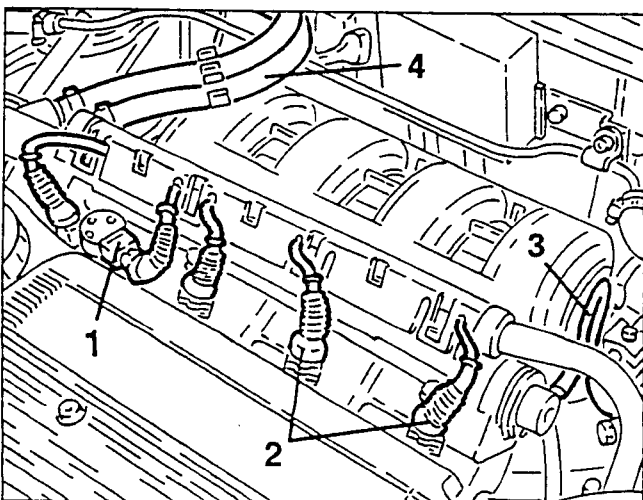
1. Fuel distributor manifold
2. Electroinjectors
3. Pressure regulator
4. Excess fuel return pipe

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.

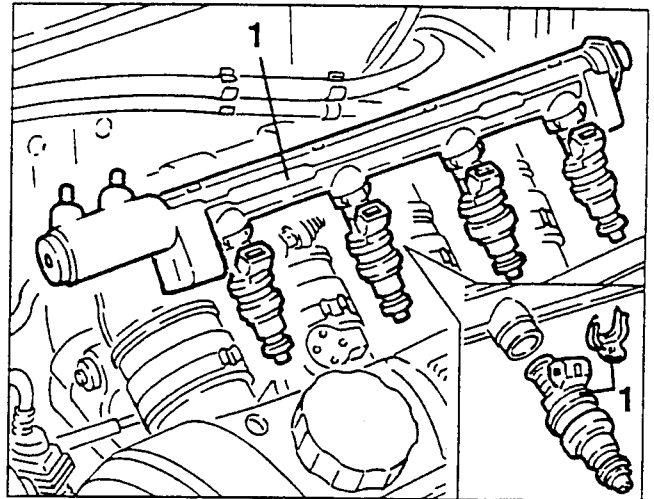
REMOVAL/REFITTING

- Disconnect the battery (-) terminal.

1. Disconnect the electrical connection from the timing variator electromagnet.
2. Disconnect the electrical connection from the injectors, then move aside the wiring after removing the cover.
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.

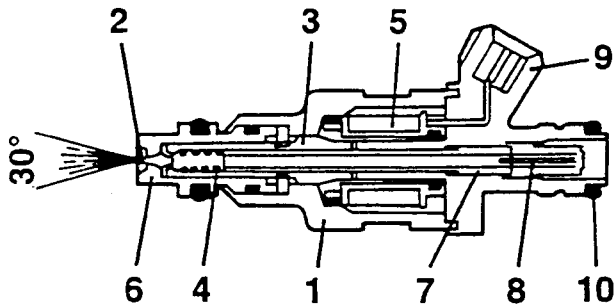
They will let the fuel pass when they are "open" and prevent it from being delivered when they are "closed".

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

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 purpose of the pressure regulator is to keep the difference between the pressure of the fuel and the pressure in the intake box constant.

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

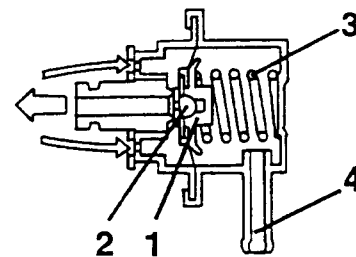
The pressure regulator is fitted directly on the fuel distributor manifold.

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.

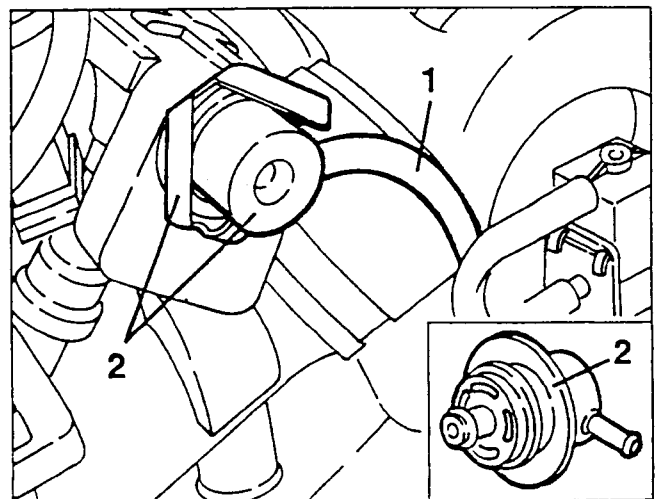
An interdependence is created by this connection between the pressure in the fuel circuit and the pressure in the intake manifold, so that the pressure between the inlet and outlet of the electroinjectors is always the same, when they are open.



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

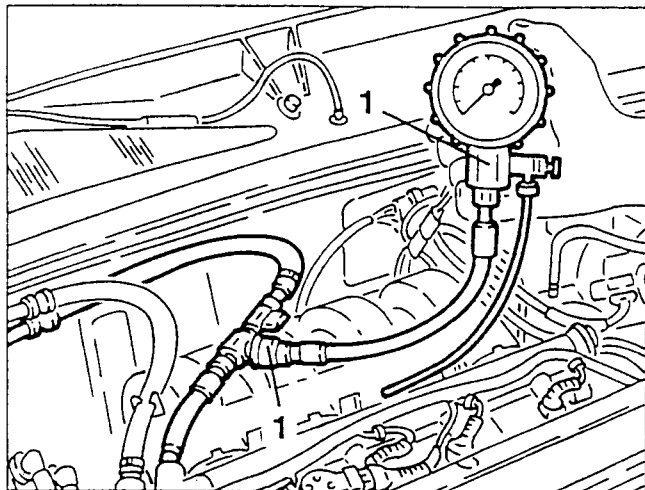
REMOVAL/REFITTING

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

2.8 ÷ 3.2 bar

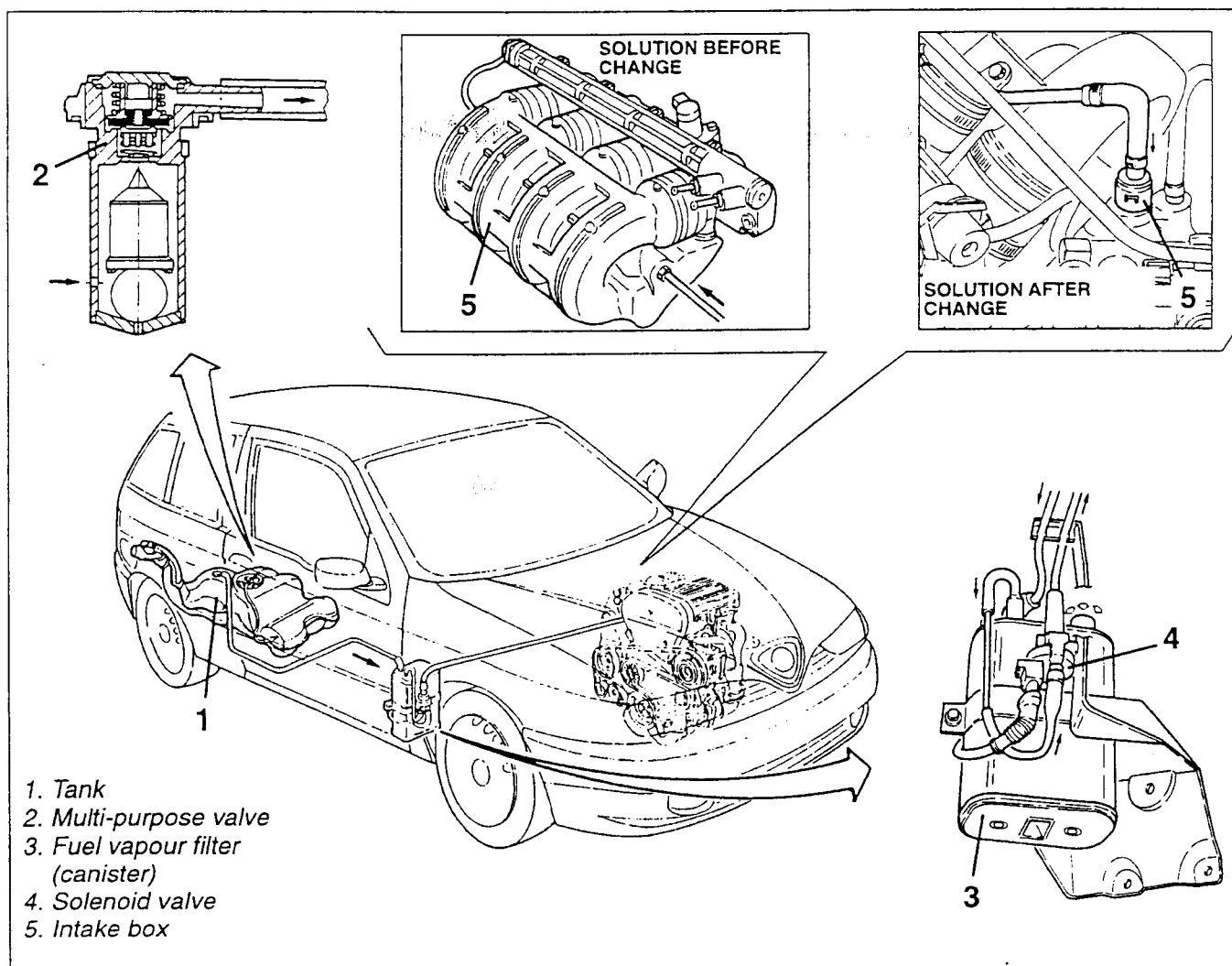
- Reconnect the vacuum takeoff pipe on the regulator and check that the fuel pressure falls by ~ 0.5 bar and then rises again when the throttle valve opens.

If this fails to occur, look for any leaks in the vacuum takeoff pipe.

- Keeping the vacuum takeoff pipe connected to the regulator and with the engine running at idle speed, choke the 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 FUEL VAPOUR RECOVERY SYSTEM



The fuel contained in the tank (1) 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.

When the pressure inside the fuel tank reaches 0.038 ± 0.053 bar, the multi-purpose valve (2) opens to send the vapours to the fuel vapour filter "canister" (3) via a special pipe. The canister absorbs and stores the vapours in the active carbon contained in the filter.


There is a solenoid valve (4) between the fuel vapour filter and the intake box (5): when the solenoid valve is not activated the connection with the intake is closed and the fuel vapours are collected in the canister.

Under certain load conditions the Motronic control unit controls the opening of the solenoid valve allowing any fuel vapours in the canister to be withdrawn.

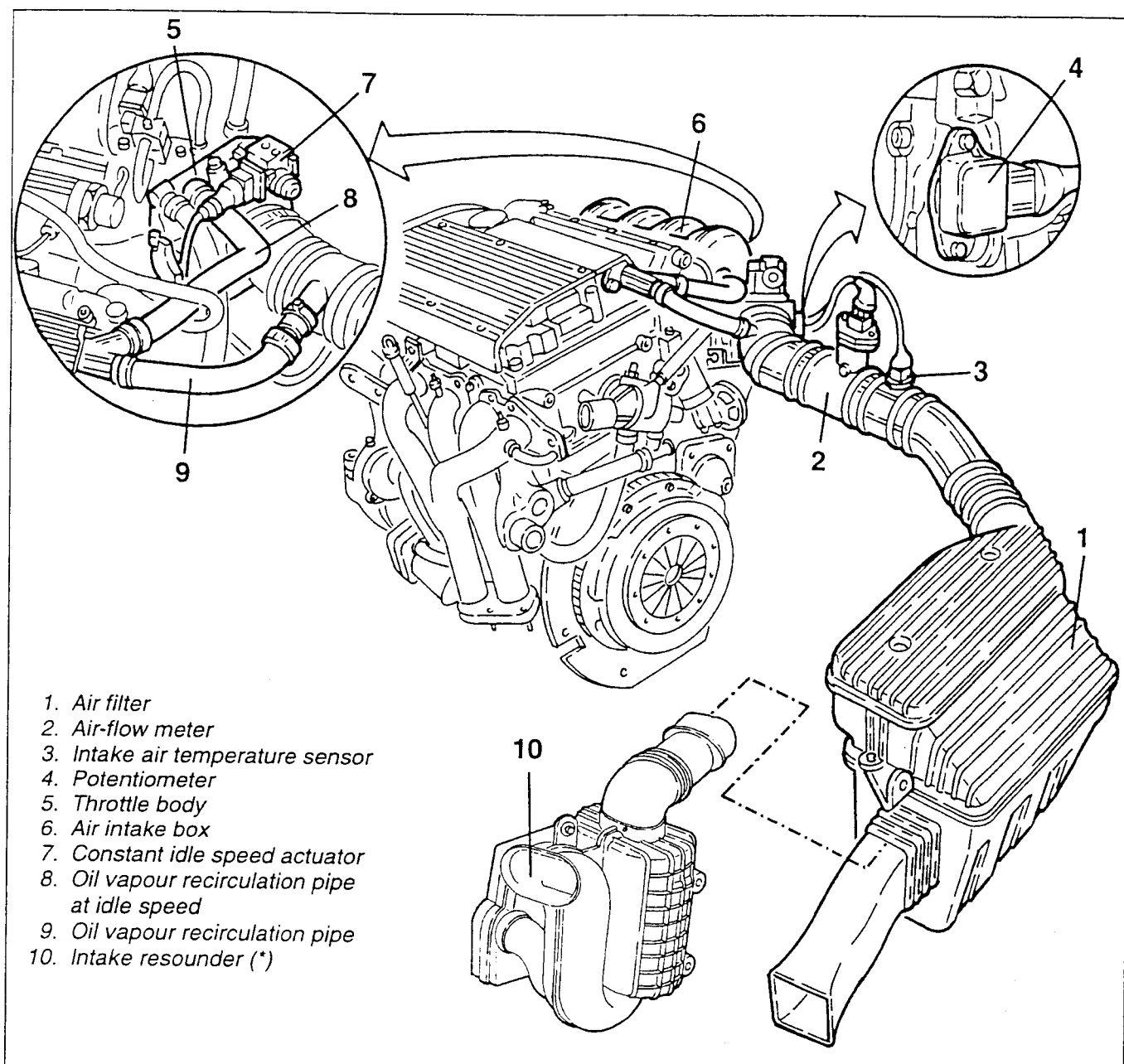
This condition remains even if at the exhaust the lambda sensor detects a reduction of oxygen which, due to the presence of too much fuel in the combustion chamber, is signalled to the control unit which delivers less fuel to the injectors so that the engine is always supplied under optimal conditions.

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.

NOTE: For the description and removing/refitting of the components of the fuel vapour recovery system see the  16V BOXER engine

DESCRIPTION OF AIR SUPPLY AND OIL VAPOUR RECOVERY SYSTEM



1. Air filter
2. Air-flow meter
3. Intake air temperature sensor
4. Potentiometer
5. Throttle body
6. Air intake box
7. Constant idle speed actuator
8. Oil vapour recirculation pipe at idle speed
9. Oil vapour recirculation pipe
10. Intake resounder (*)

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

The air, drawn in through a dynamic inlet and filtered by a cartridge element (1), reaches the throttle body (5) through the corrugated sleeve on which the hot film air-flow meter (2) and the intake air temperature sensor (3) are fitted.

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.

Still on the throttle body there is an additional air solenoid valve (7) which by-passes the throttle via a

special groove to keep engine idle rpm constant under particular operating conditions of the engine.

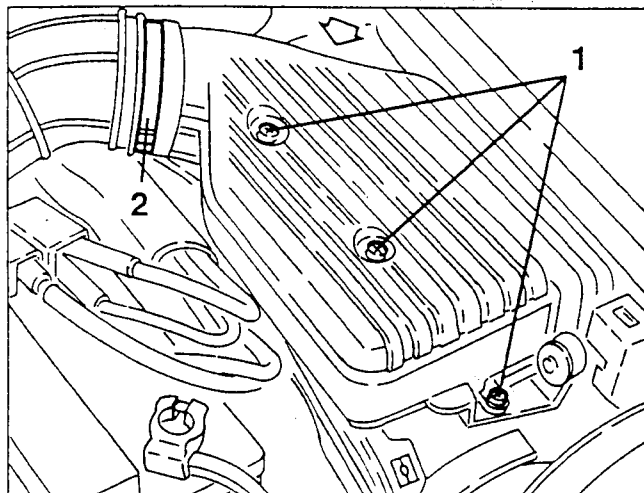
The fuel vapours (see specific paragraph) and the oil vapours flow to the air supply system.

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

1. Slacken the four air cleaner cover fastening screws.
2. Slacken the clamp fastening the air cleaner cover to the corrugated sleeve.

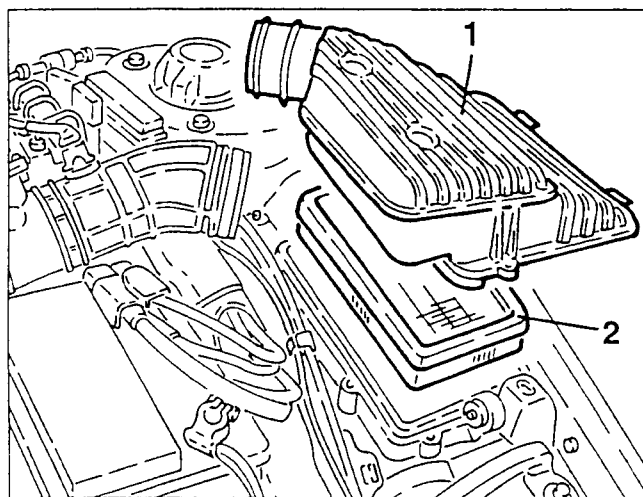


1. Remove the air cleaner cover.
2. Remove the air cleaner cartridge.



WARNING:

Any filter cleaning operation might damage it, thereby adversely affecting the correct operation of the engine.



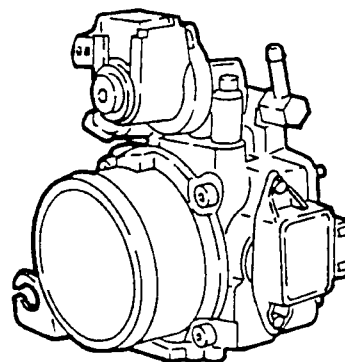
THROTTLE BODY

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.

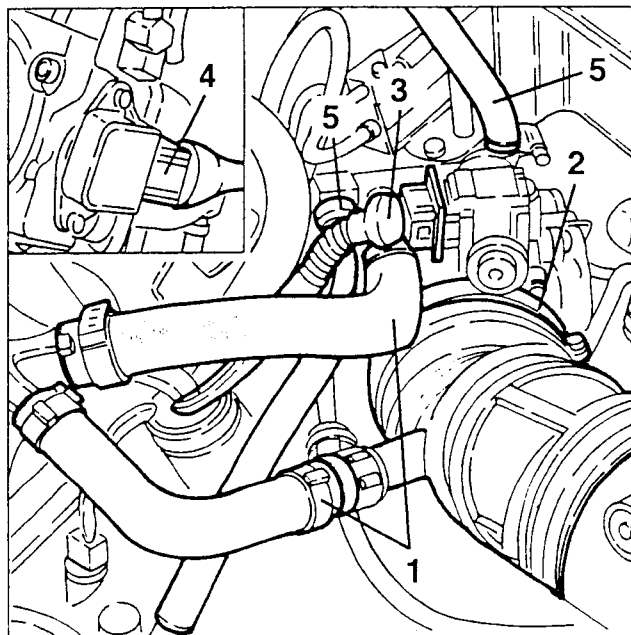
The constant idle speed actuator is installed directly on the throttle body.



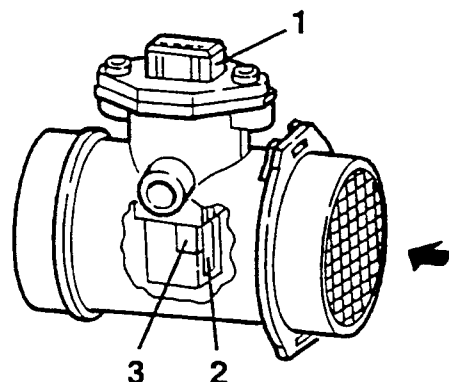
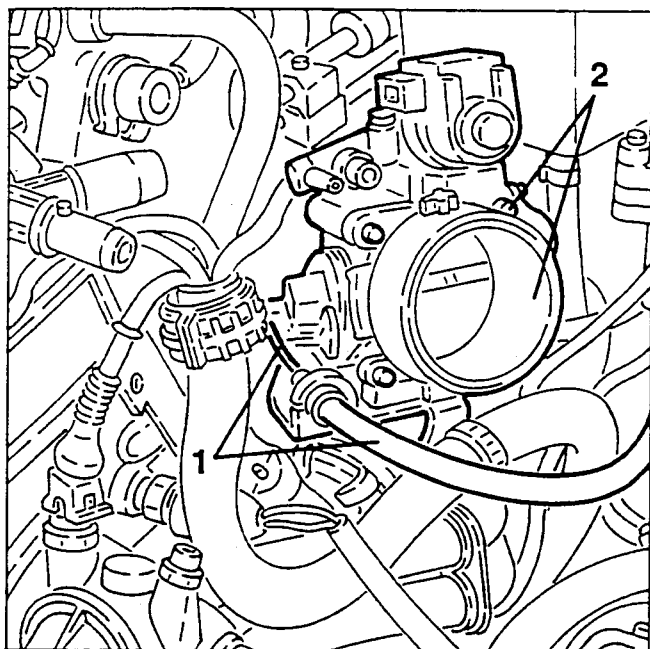
REMOVAL/REFITTING

- 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.



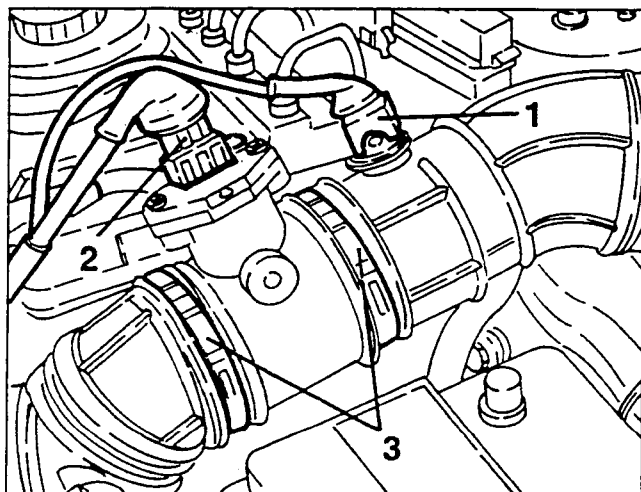
1. Disconnect the accelerator cable from the throttle.
- Release the pipes from the fastenings on the bracket under the throttle body.
2. Slacken the four fastening screws and remove the throttle body complete with potentiometer and constant idle speed actuator and separate them on the bench.
- Remove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



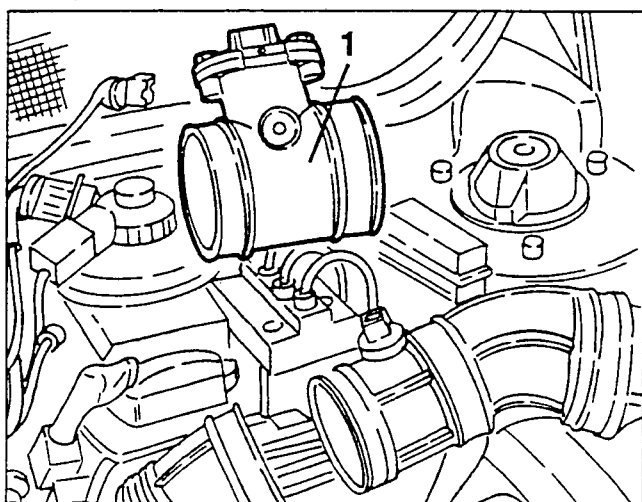
1. Connector
2. Measurement duct
3. Hot film sensor

REMOVAL/REFITTING

- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection of the intake air temperature sensor.
- 2. Disconnect the electrical connection from the air-flow meter.
- 3. Slacken the two clamps fastening the corrugated sleeve to the air-flow meter.



1. Withdraw and remove the air-flow meter from the corrugated sleeve.



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.

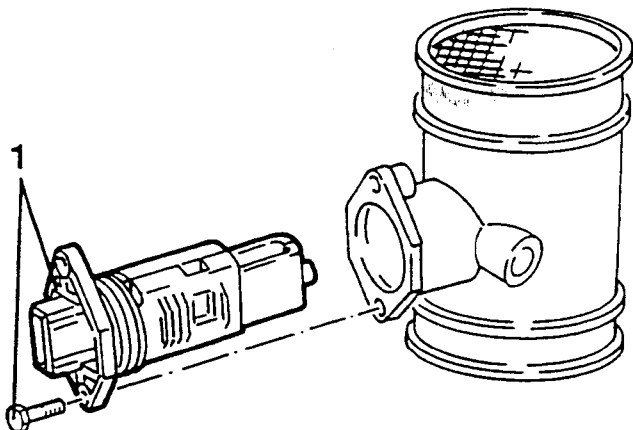
The hot film diaphragm is kept at a constant temperature (~ 120°C above the temperature of the incoming air) by the heating resistance in contact with it.

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.

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

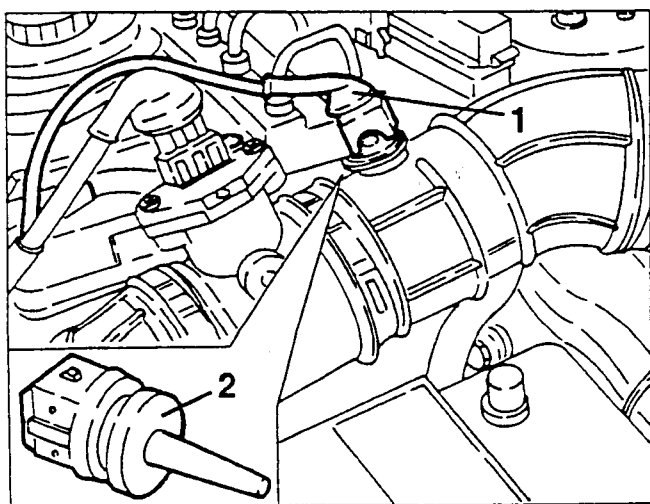


INTAKE AIR TEMPERATURE SENSOR (NTC)

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

REMOVAL/REFITTING

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

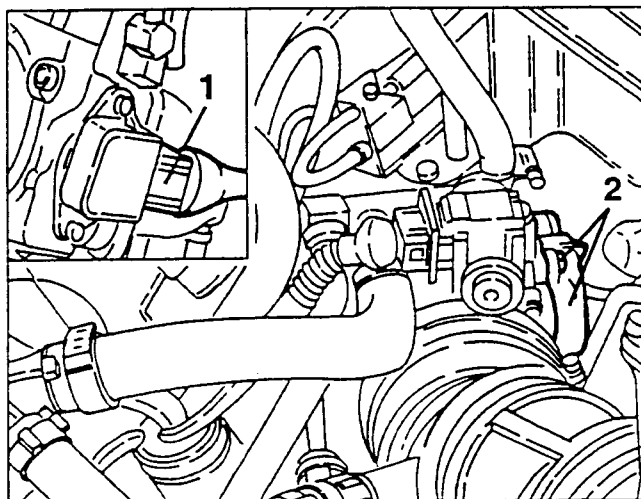


THROTTLE POTENTIOMETER

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

REMOVAL/REFITTING

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



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.

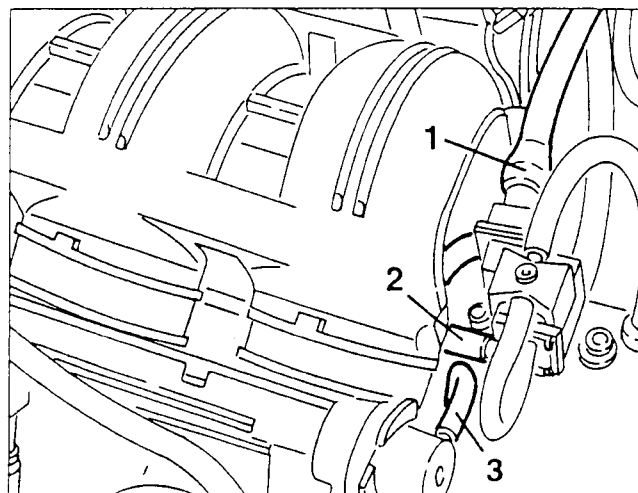
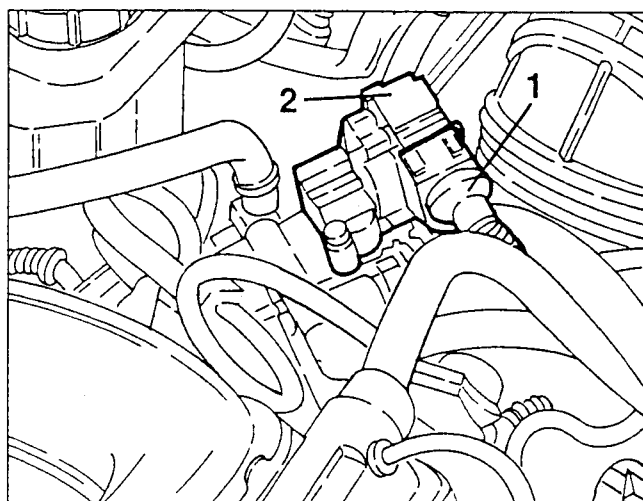
REMOVAL/REFITTING

- Disconnect the battery (-) terminal.

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

2. Slacken the two fastening screws and remove the constant idle speed actuator from the throttle body.

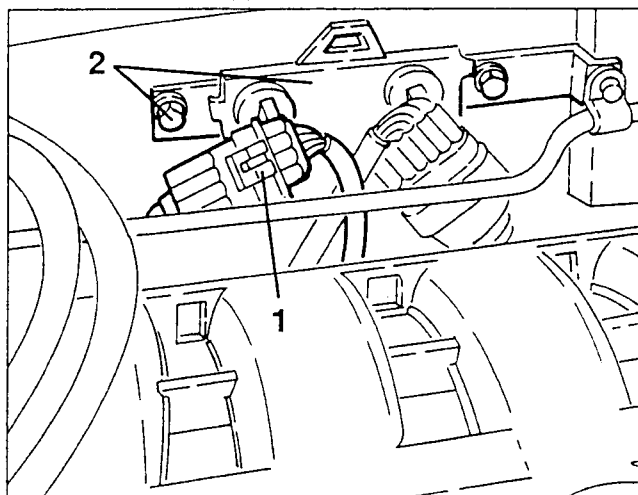
- Remove the seal.



- Disconnect the vacuum takeoff pipe from the servo brake.

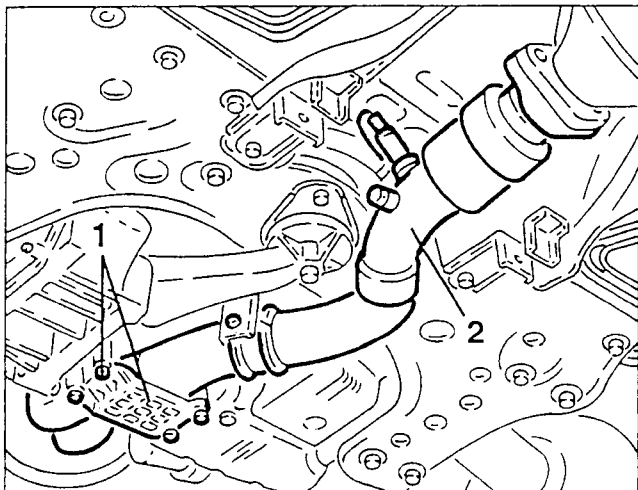
1. Disconnect the lambda probe connector.

2. Slacken the fastening screws and remove the electrical connection support bracket.



1. Raise the car, slacken the fastening screws and remove the reinforcement bracket.

2. Remove the front section of the exhaust pipe complete with lambda probe after slackening the fastenings.



AIR INTAKE BOX

REMOVAL/REFITTING

- Set the car on a lift.

- Disconnect the battery (-) terminal.

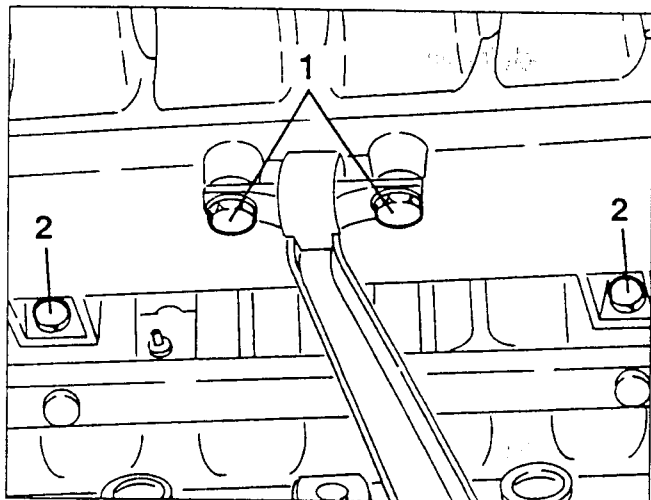
- Remove the throttle body (see specific paragraph).

1. Disconnect the electrical connection from the E.G.R. modulation solenoid valve.

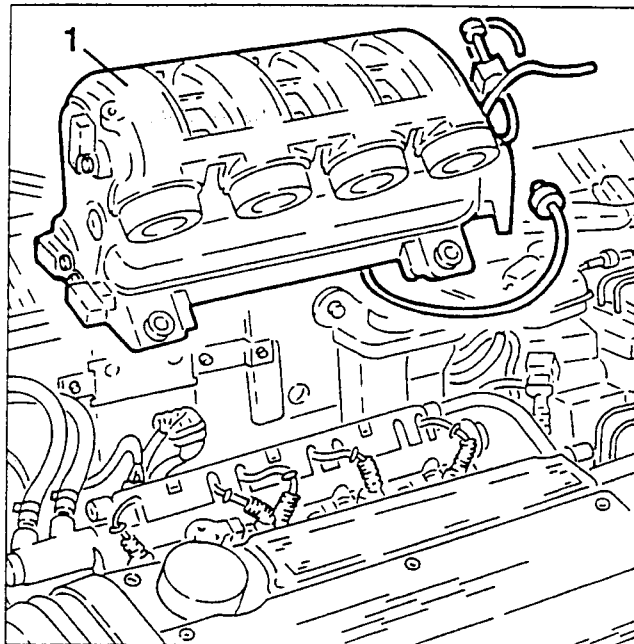
2. Disconnect the E.G.R. valve connection pipe from the modulation solenoid valve.

3. Disconnect the vacuum takeoff pipe for the fuel pressure regulator.

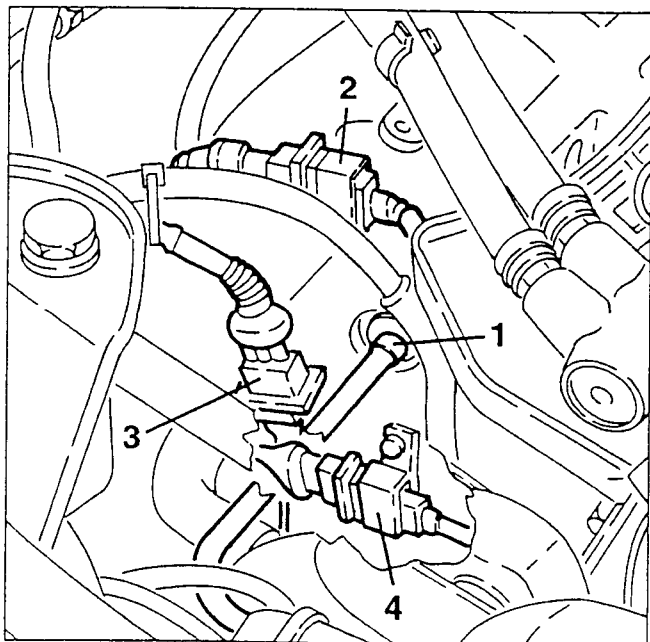
1. Slacken the two screws fastening the support to the intake box.
2. Slacken the two screws fastening the intake box to the cylinder head.



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



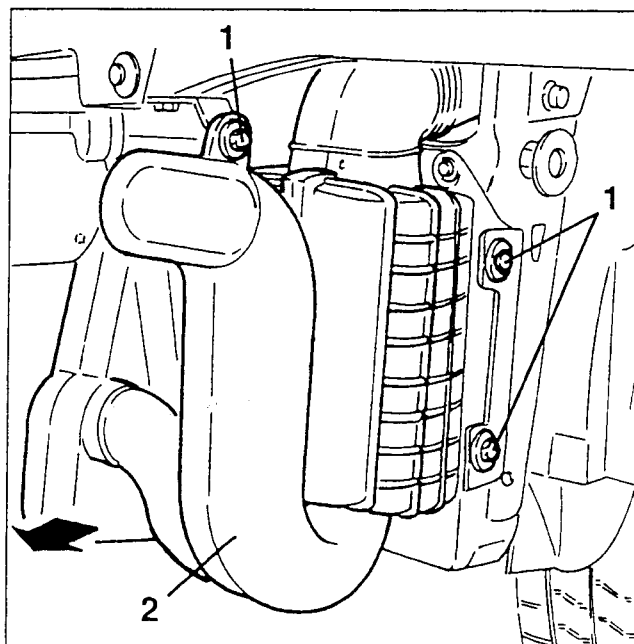
1. Lower the car and disconnect the fuel vapour recirculation pipe from the intake box.
2. Disconnect the electrical connection of the timing sensor.
3. Disconnect the electrical connection of the pinging sensor.
4. Disconnect the electrical connection of the rpm and timing sensor.



AIR INTAKE RESOUNDER

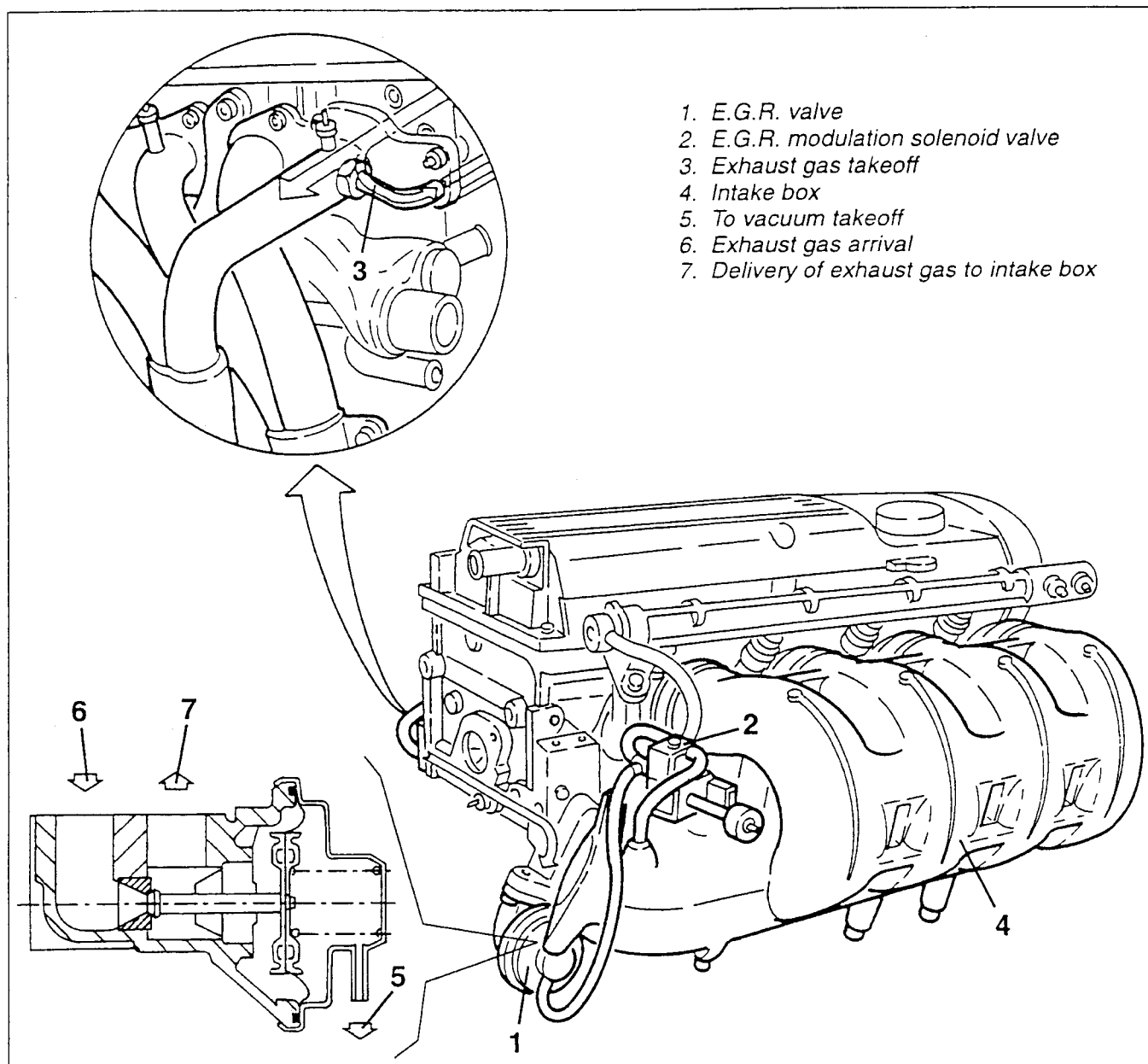
REMOVING/REFITTING

- Set the car on a lift and raise it.
- Remove the front bumper.
- 1. Slacken the three screws fastening the air intake resounder.
- 2. Remove the air intake resounder withdrawing it forwards.



DESCRIPTION OF EXHAUST GAS RECIRCULATION SYSTEM

(Specific for versions with M2.10.3 injection - ignition 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.

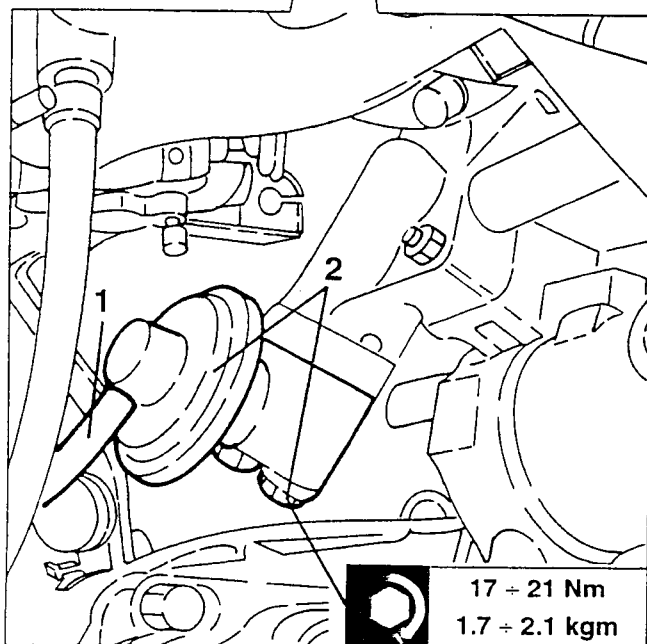
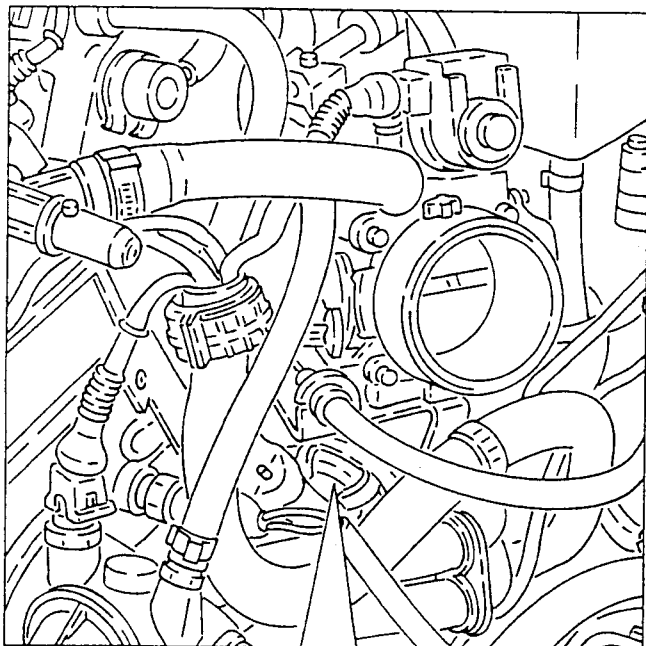
The amount of exhaust gas sent to the engine is determined by the MOTRONIC control unit, taking account of the characteristic curve of the E.G.R. control depending on the engine load and speed and on the temperature of the coolant fluid.

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

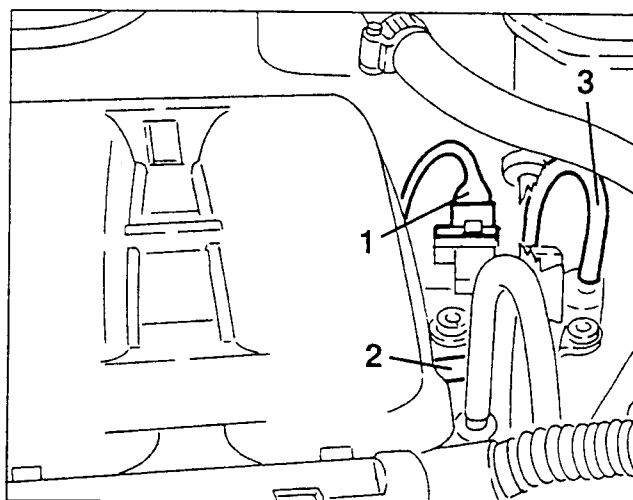
The E.G.R. valve is not activated at idle speed, in neutral gear and for engine speeds below 2000 rpm. When the engine coolant fluid temperature exceeds 60°C the E.G.R. valve is operational and it is completely closed at engine speeds in excess of 4600 rpm.

E.G.R. VALVE**REMOVAL/REFITTING**

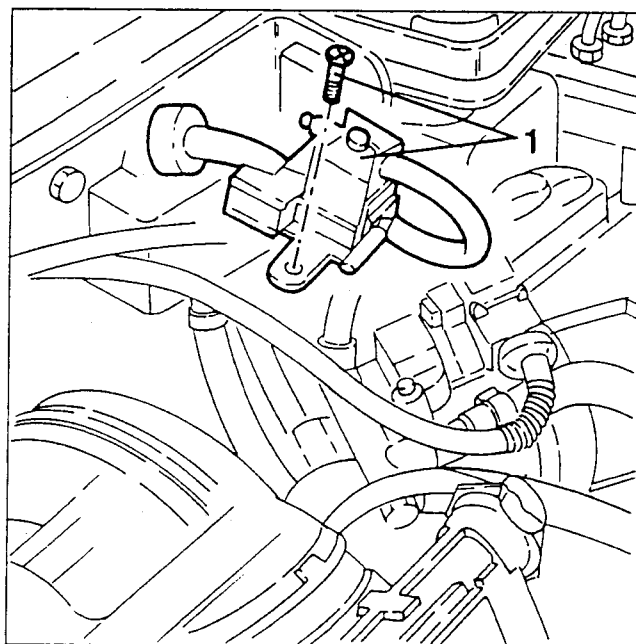
- Remove the battery.
- Loosen the fastening clamp and disconnect the corrugated sleeve from the throttle body.
- 1. Disconnect the connection pipe with the modulation solenoid valve from the E.G.R. valve.
- 2. Slacken the two fastening screws and remove the E.G.R. valve from the intake box.

**E.G.R. MODULATING SOLENOID VALVE****REMOVAL/REFITTING**

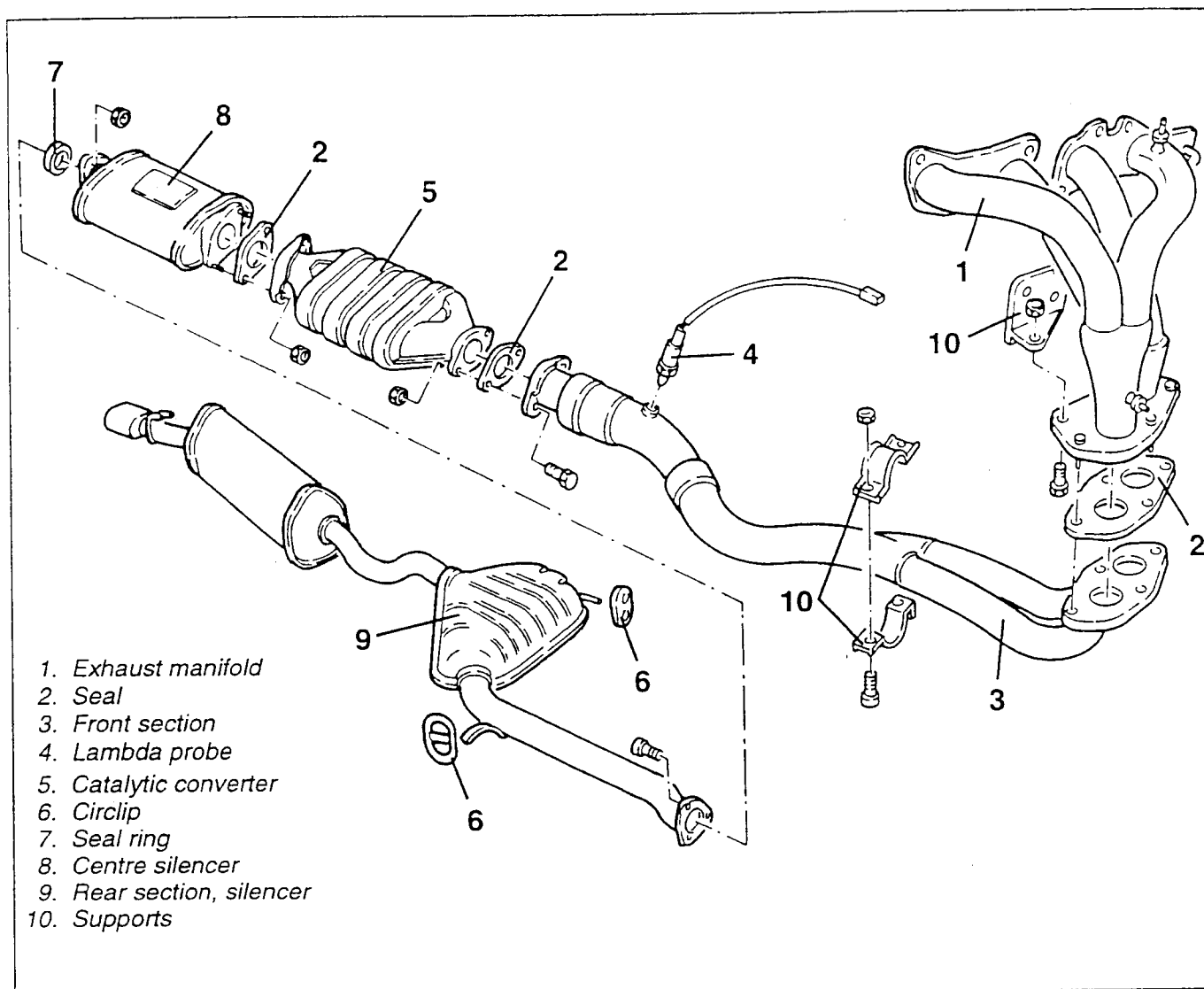
- Disconnect the battery (-) terminal.
- 1. Disconnect the electrical connection from the E.G.R. modulating solenoid valve.
- 2. Disconnect the connection pipe with the E.G.R. valve from the modulation solenoid valve.
- 3. Disconnect the vacuum takeoff pipe from the E.G.R. modulation solenoid valve.



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



DESCRIPTION OF EXHAUST SYSTEM (Specific for versions before change)



The exhaust gases from the cylinder head converge in two double manifolds (1) connected below by a single flange.

From here, through the front section of the exhaust pipe (3), they reach the three-way catalytic converter (5) where most of the pollutants are transformed.

On the front section of the exhaust pipe, there is a flexible piece which makes it possible to limit the transmission of vibrations and the exhaust gas takeoff socket downstream 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 about the oxygen content in the exhaust gas, making it possible to adapt injection times to keep the stoichiometric ratio (air - fuel) at an optimum level.

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

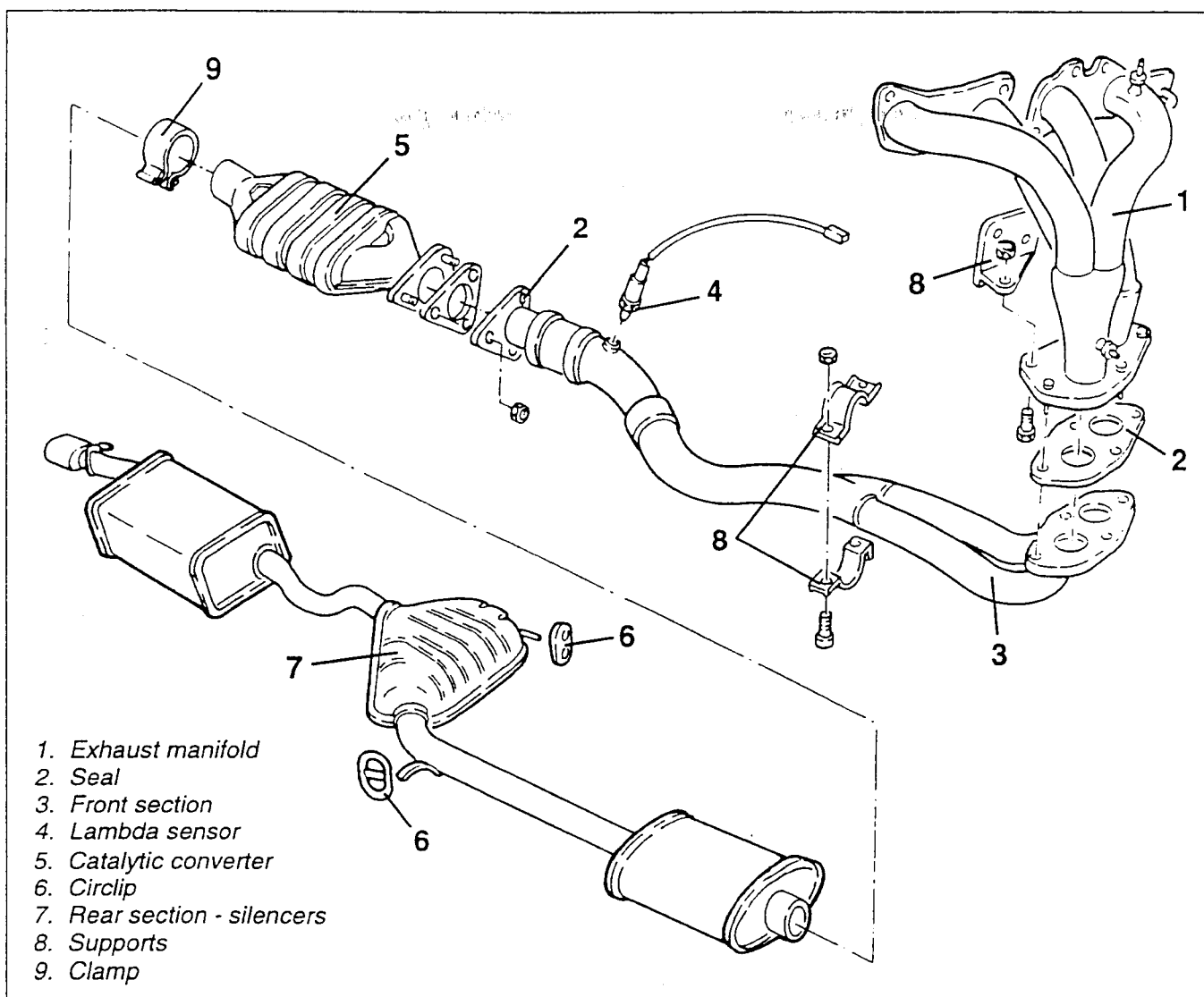
The connection between the different pieces of the exhaust pipe is made by flanges with seals. Restraint to the body is by brackets with flexible supports.

Heat radiation towards the body which is very high owing to the presence of the catalytic converter, is limited by a set of heat guards between the exhaust pipe and the body itself.

When the car is running, all the exhaust pipes and the catalytic converter in particular, heat up considerably.

Before doing any work it is therefore necessary to wait for a suitable length of time with the engine off.

**Never touch the catalytic converter without adequate protection such as gloves, etc.
Do not put easily inflammable materials near the catalytic converter.**

DESCRIPTION OF EXHAUST SYSTEM (Specific for versions after change)

The exhaust gases from the cylinder head converge in two double manifolds (1) connected below by a single flange.

From here, through the front section of the exhaust pipe (3), they reach the three-way catalytic converter (5) where most of the pollutants are transformed.

On the front section of the exhaust pipe, there is a flexible piece which makes it possible to limit the transmission of vibrations and the exhaust gas takeoff socket downstream 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 about the oxygen content in the exhaust gas, making it possible to adapt injection times to keep the stoichiometric ratio (air - fuel) at an optimum level.

The exhaust gas leaves the catalytic converter and crosses the three special silencers joined in a single section of pipe.

The connection between the different pieces of the exhaust pipe is made by flanges with seals, except for

the one between the catalytic converter and the silencers which is by a "spy glass" coupling with special clamp. Restraint to the body is by brackets with flexible supports.

Heat radiation towards the body which is very high owing to the presence of the catalytic converter, is limited by a set of heat guards between the exhaust pipe and the body itself.

When the car is running, all the exhaust pipes and the catalytic converter in particular, heat up considerably.

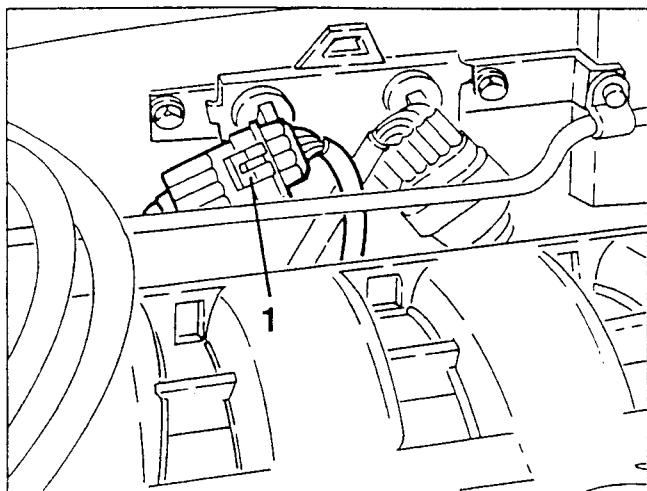
Before doing any work it is therefore necessary to wait for a suitable length of time with the engine off.

Never touch the catalytic converter without adequate protection such as gloves, etc.

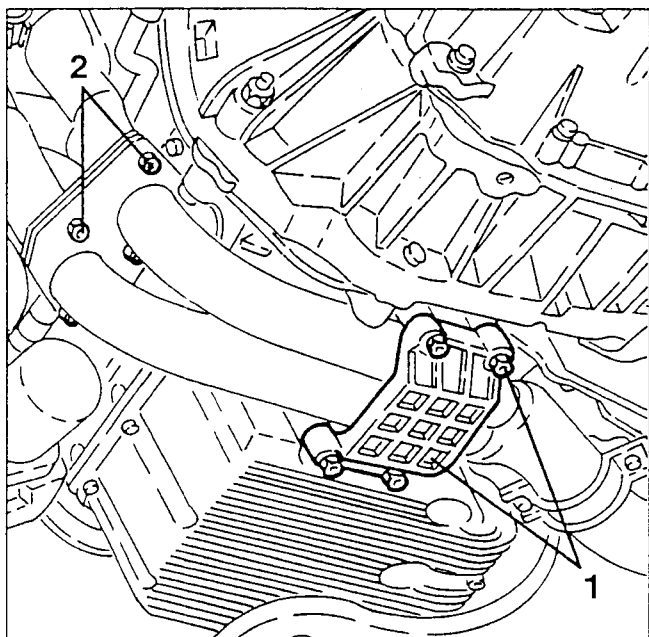
Do not put easily inflammable materials near the catalytic converter.

EXHAUST, FRONT SECTION**REMOVING/REFITTING**

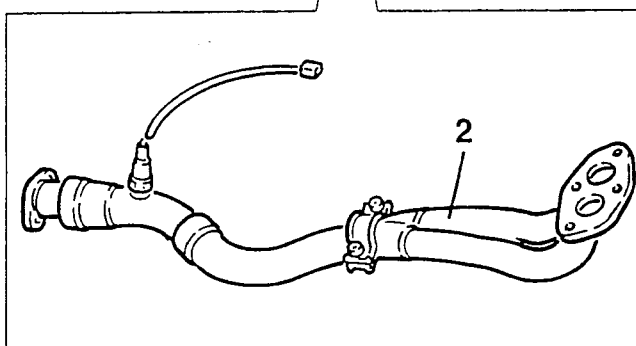
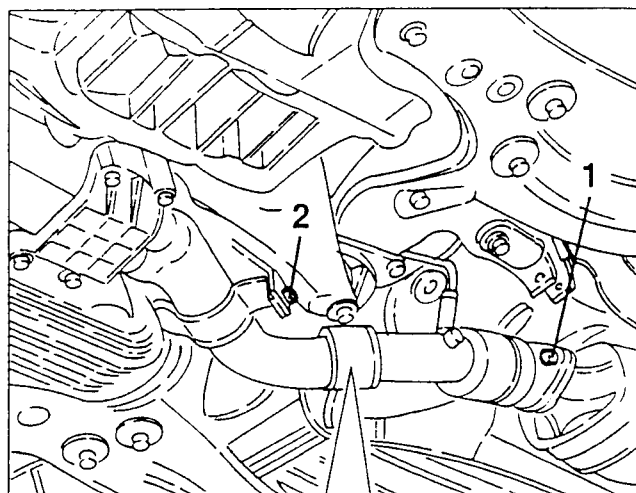
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- 1. Disconnect the lambda sensor electrical connection.




- 1. Raise the car, slacken the fastening nuts and remove the bracket.
- 2. Slacken the nuts fastening the exhaust pipe front section to the manifold.



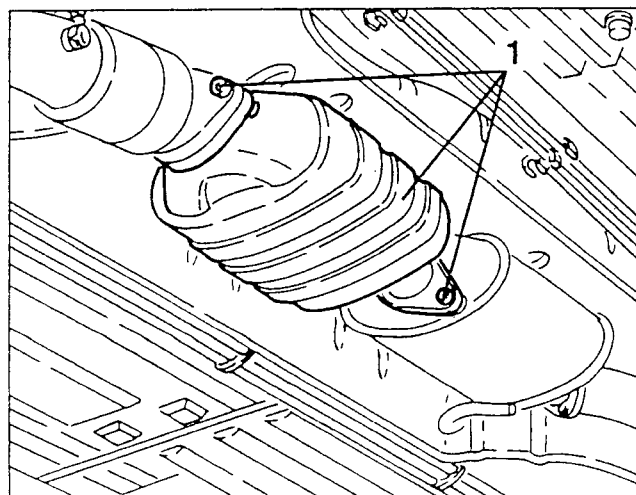
- 1. Slacken the bolts fastening the exhaust pipe front section to the catalytic converter.
- 2. Slacken the support bracket bolt, then remove the exhaust pipe front section with the lambda sensor.
- Remove the seals.

**CATALYTIC CONVERTER**

NOTE: For the description of the catalytic converter see Boxer  16V engine.

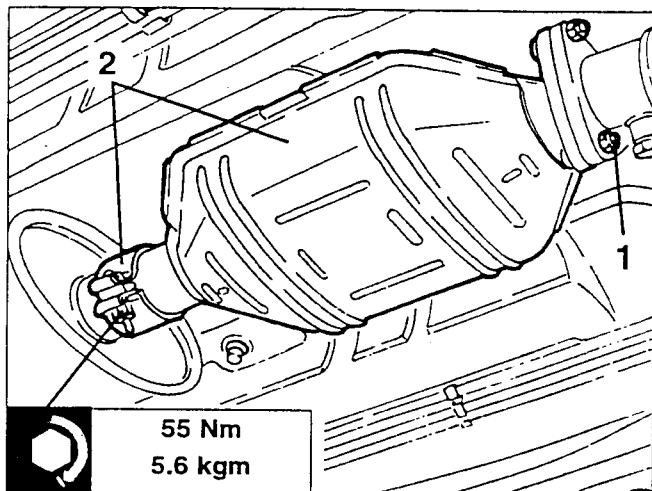
REMOVING/REFITTING
(Specific for versions before change)

- Set the car on a lift and raise it.
- 1. Slacken the bolts fastening the catalytic converter to the front section and to the exhaust pipe centre silencer, then remove it.
- Remove the seals.

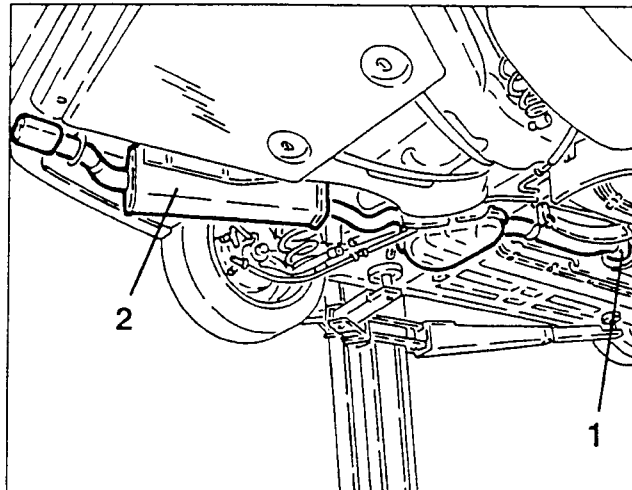


REMOVING/REFITTING
(Specific for versions after change)

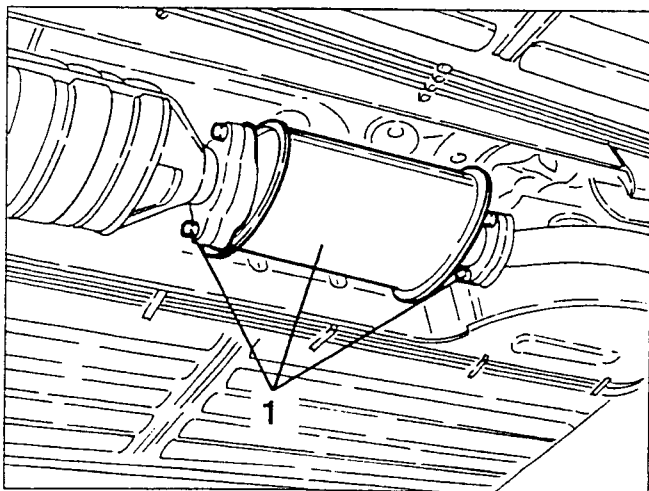
- Set the car on a lift and raise it.
- 1. Slacken the three nuts fastening the catalytic converter to the front section.
- 2. Slacken the clamp fastening the catalytic converter to the rear section, then remove it.
- Remove the seal.

**EXHAUST, REAR SECTION****REMOVING/REFITTING**
(Specific for versions before change)

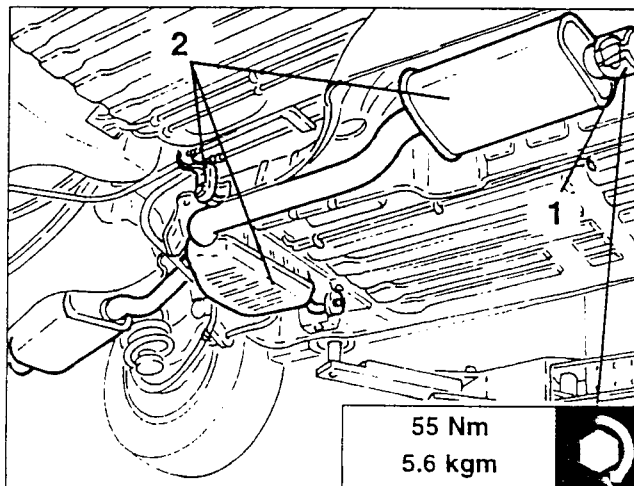
- Set the car on a lift and raise it.
- 1. Slacken the bolts fastening the exhaust pipe rear section from the centre silencer.
- 2. Remove the exhaust pipe rear section freeing it from the supporting circlips and withdrawing from the handbrake control cable.

**CENTRE SILENCER**
(Specific for versions before change)**REMOVING/REFITTING**

- Set the car on a lift and raise it.
- 1. Slacken the bolts fastening the centre silencer to the catalytic converter and the exhaust pipe rear section, then remove it.
- Remove the seals.


**REMOVING/REFITTING**
(Specific for versions after change)

- Set the car on a lift and raise it.
- 1. Slacken the clamp fastening the exhaust pipe rear section of the catalytic converter.
- 2. Remove the exhaust pipe rear section freeing it from the supporting circlips and withdrawing it from the handbrake control cable.



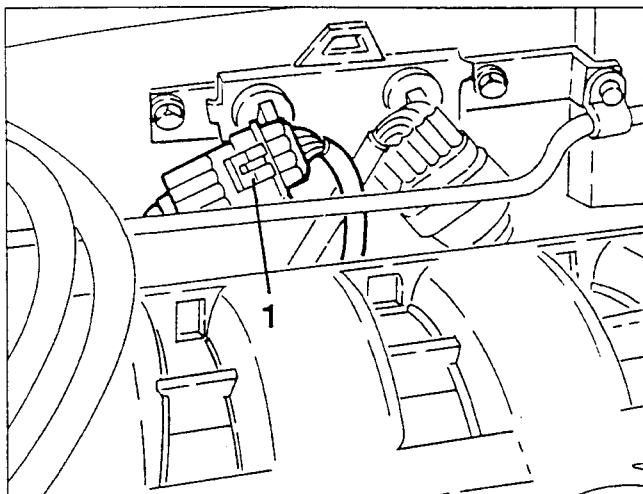
LAMBDA SENSOR

NOTE:

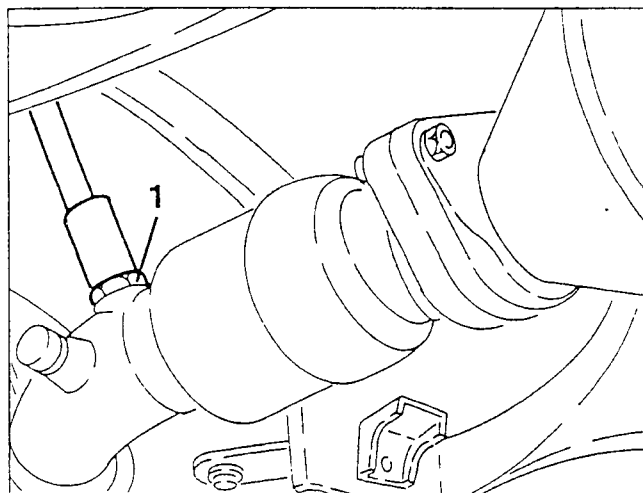
For the description of the lambda sensor see Boxer  16V engine.

REMOVING/REFITTING

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



- 1. Raise the car, then slacken and remove the lambda sensor complete with electric wiring.



CHECKING EMISSIONS AT EXHAUST

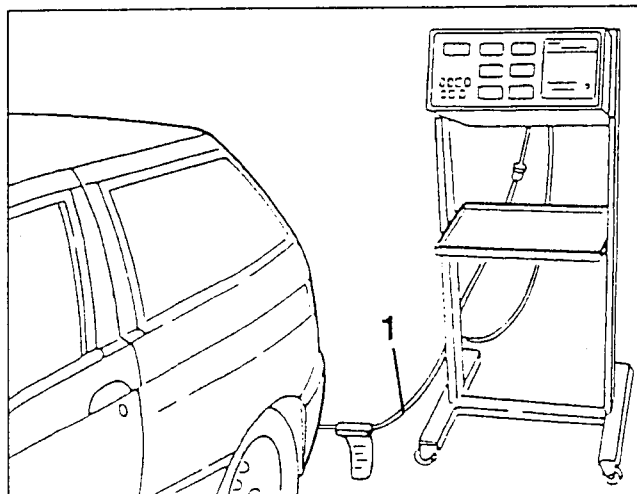
Exhaust emission should be checked outdoors or at least in a suitable place according to current regulations.

The engine should be at normal operating temperature (i.e. when the fan has come on and turned off) and at idle speed (see GROUP 00 - "TECHNICAL SPECIFICATIONS OF THE ENGINE").

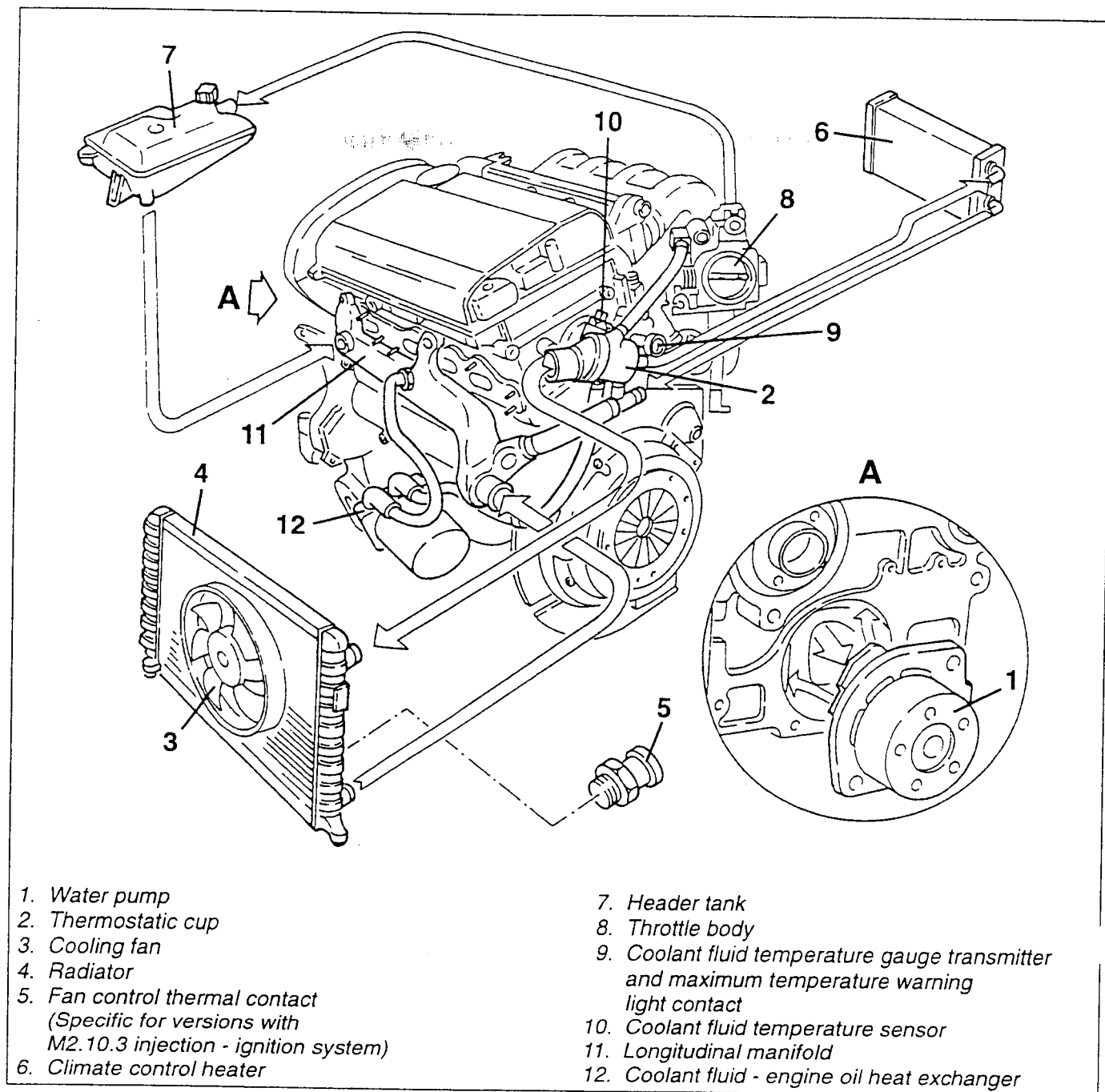
If idle speed is not within the specified limits check that the constant idle speed actuator is working properly.

- 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 analyser in the end of the exhaust pipe and check that the amount of CO and HC are within the specified limits.

CO at the exhaust	$\leq 2.2 \text{ g x km}$
HC + NOx at the exhaust	0.5 g x km



DESCRIPTION OF ENGINE COOLING SYSTEM



The cooling system is of the sealed type with forced circulation by centrifugal pump (1) located on the cylinder head and controlled by the timing gear belt. A thermostatic valve (2), on the rear of the cylinder head, keeps the engine at optimum temperatures; it opens when the coolant fluid reaches a temperature of 83 °C.

In addition to dynamic air, the radiator (4) cools the engine fluid also by a two-speed fan (3) which is engaged by:

- 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 by the engine coolant fluid temperature sensor (NTC).

(For further details about the fan see ELECTRIC-ELECTRONIC DIAGNOSIS - Sect. 26 for versions with air conditioner and Sect. 27 for versions with heater).

The purpose of the header tank (7) is to supply the circuit if the level falls and it acts as a lung absorbing the changes in volume of the fluid as the temperature changes; it also vents air from the circuit.

The circuit is fitted with coolant fluid temperature transmitter for the gauge and a maximum temperature thermal contact (9) for the warning light.

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:

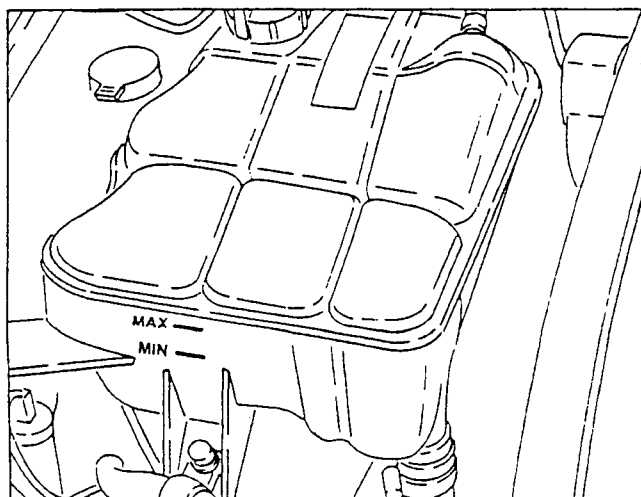
- heat the throttle body (8) from which it flows to the expansion tank (7) also venting air from the system;
- the climate control system heater (6) from which it returns to the longitudinal manifold;
- the heat exchanger (12) for cooling the engine oil before being ducted directly into the longitudinal 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.

CHECKING THE LEVEL AND CHANGING THE ENGINE COOLANT FLUID

Checking

- Check that when the engine is cold the level of the coolant fluid in the header tank is between the MIN and MAX marks.



Draining and replenishing

- Set the car on a lift.
- Slacken and remove the header tank plug.



WARNING:

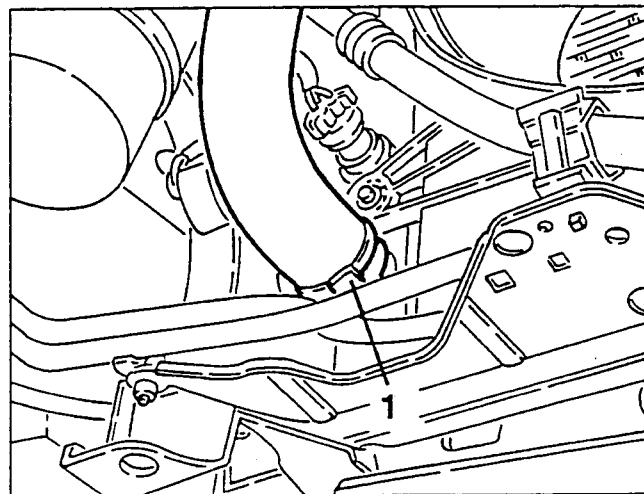
Absolutely never remove the header tank plug when the engine is hot!

- Raise the car.
- 1. Slacken the radiator outlet hose and drain the coolant into a suitable recipient.



WARNING:

The anti-freeze mixture used as coolant can harm the paintwork: therefore avoid any contact with painted components.



- Reconnect the sleeve to the radiator and any disconnected pipes, checking that all the clamps are firmly tightened.
- Fill with fluid of the specified type and quantity until reaching the MAX mark on the header tank.
- Start the engine and bring it to normal operating temperature so that the thermostat opens to release the amount of residual air in the circuit.
- With the engine cold, top up until reaching the MAX mark on the header tank.
- Retighten the pressurised cap on the header tank.



WARNING:

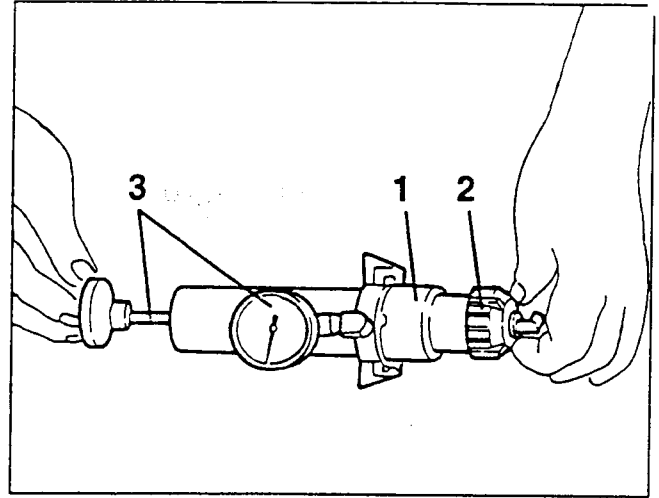
**It is unwise to mix anti-freeze fluids of different types or brands!
Never use antirust additives: they might not be compatible with the anti-freeze in use!**

EXPANSION TANK

The expansion tank supplies the circuit and absorbs the variations in coolant volume due to the changes in engine temperature.

In addition, a special calibrated valve contained in the pressurised cap and a pipe connected to it relieve air from the circuit from the pipe leading from the throttle body.

This valve also acts as a washing function enabling outside air to enter the system to compensate for the vacuum created as the system cools.

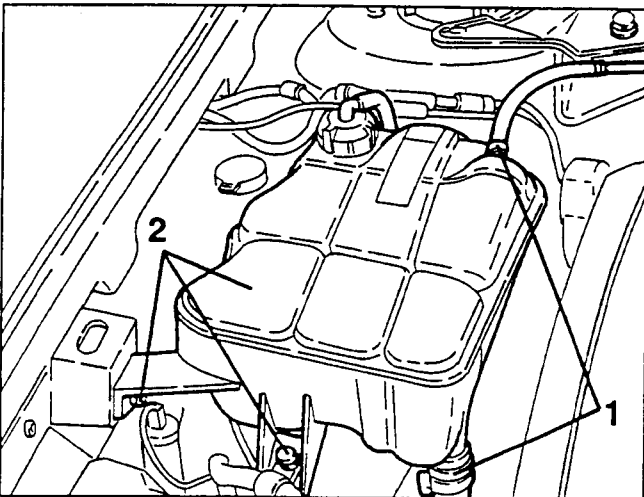


REMOVAL/REFITTING

- Drain the engine cooling system (see relative paragraph).

1. Loosen the two clamps and disconnect the coolant delivery and return hoses from the expansion tank.

2. Unscrew the three screws and remove the expansion tank.



ENGINE COOLING SYSTEM LEAK TEST

- Slacken and remove the pressurised cap from the header tank.

1. Screw the instrument for the hydraulic circuit leak test with the special fitting on the header tank filler.

2. Manually pressurise the circuit and check on the instrument that the pressure stays within the specified limit. If not, check for leaks from the sleeves or radiator.



Hydraulic circuit control pressure

1.08 bar



WARNING:

During these checks with the tester, for safety reasons, never allow the pressure to exceed 1.38 bar.

PRESSURIZED CAP SEALING TEST

- Perform the test using a seal test tool.

1. Screw the fitting to the lower end of the test tool.

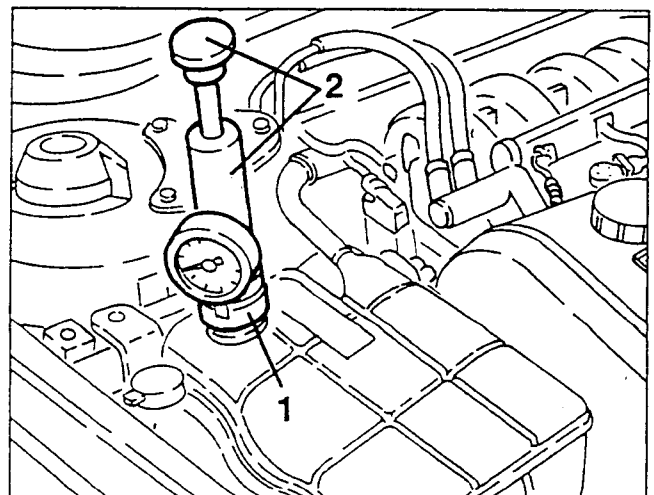
2. Install the expansion tank pressurized cap onto the fitting of the test tool.

3. Manually operate the piston of the test tool and pressurize the cap. Check that the valve opens at the specified pressure read from the manometer.



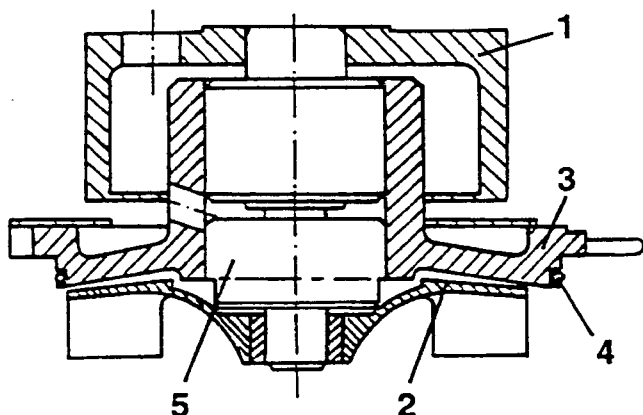
Pressurized cap setting

0.98 ± 0.1 bar



WATER PUMP

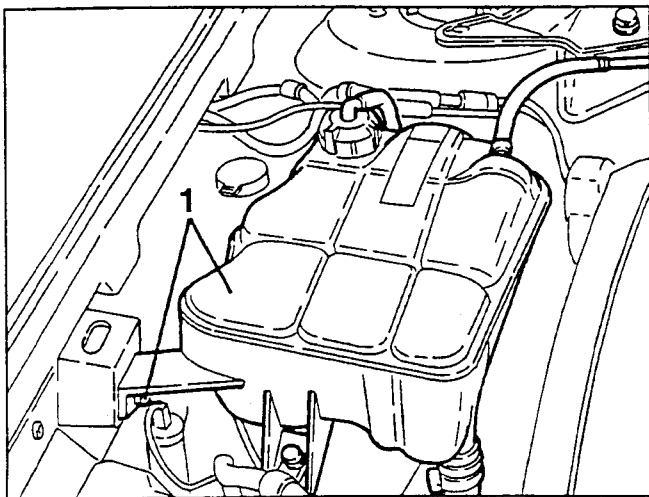
The water pump is of the centrifugal type with blades. It is fastened to the cylinder head and operated by the crankshaft via the timing gear belt. An O-Ring ensures tightness between the cylinder head and the pump. The water pump is kept running constantly to ensure that the coolant fluid circulates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



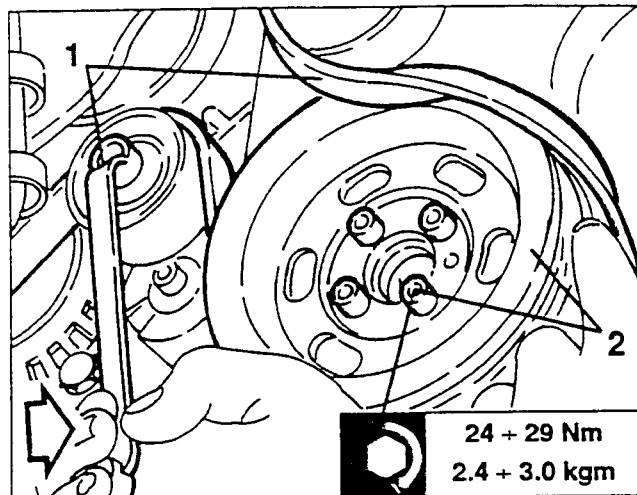
- | | |
|----------------|------------|
| 1. Pulley | 4. O-Ring |
| 2. Impeller | 5. Bearing |
| 3. Pump casing | |

REMOVAL/REFITTING

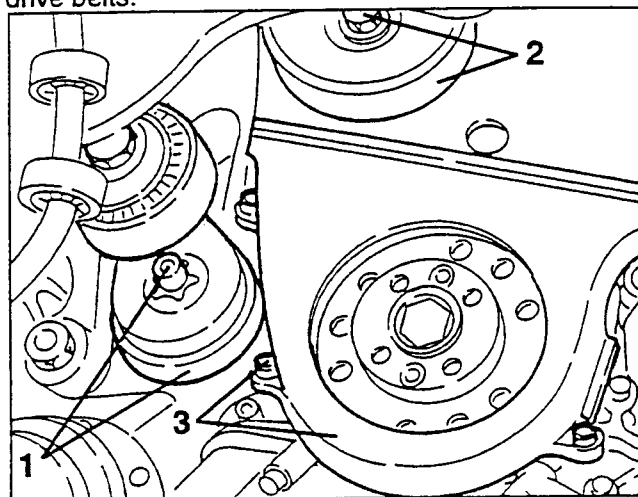
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- Drain the engine cooling system (see relative paragraph).
- 1. Slacken the screws and move the header tank to one side without disconnecting the piping.



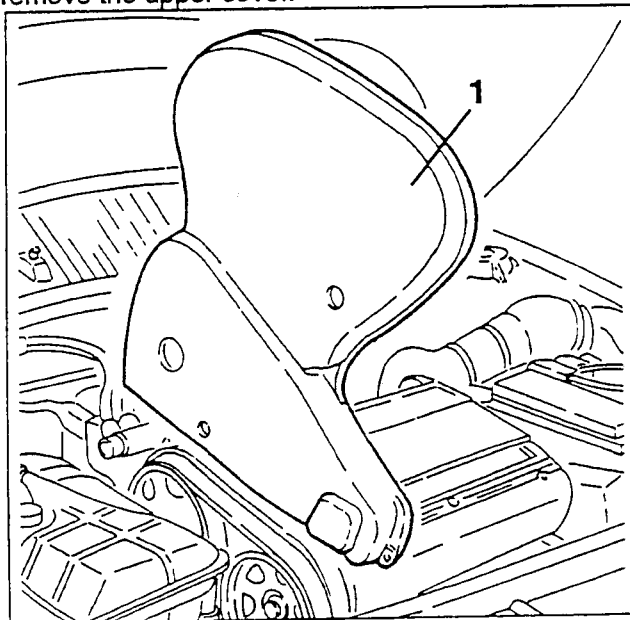
1. Raise the car and working as illustrated on the belt tensioner loosen the tension of the auxiliary components drive belt and remove it.
2. Slacken the four fastening screws and remove the auxiliary components drive pulley.



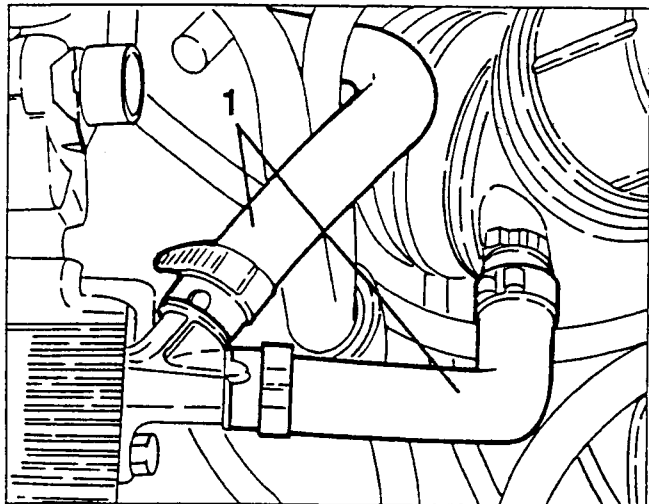
1. Slacken the fastening screw and remove the belt tensioner.
2. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.
3. Slacken the fastening screws and remove the lower cover of the timing gear and counter-rotating shaft drive belts.



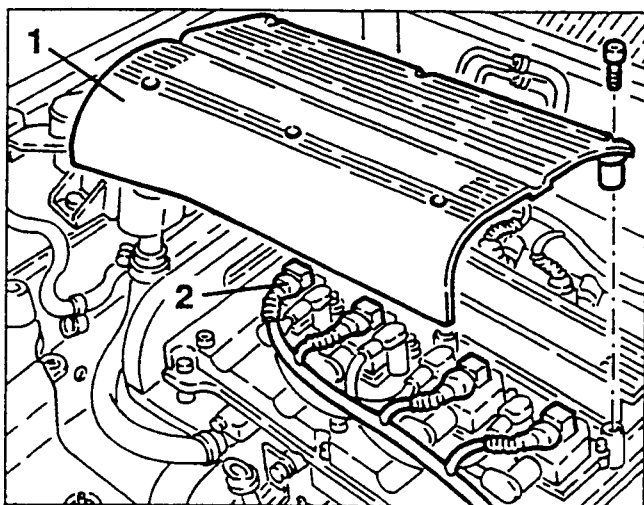
- Slacken the lower screws of the upper cover of the timing gear and counter-rotating shaft drive belts.
- 1. Lower the car, slacken the fastening screws and remove the upper cover.



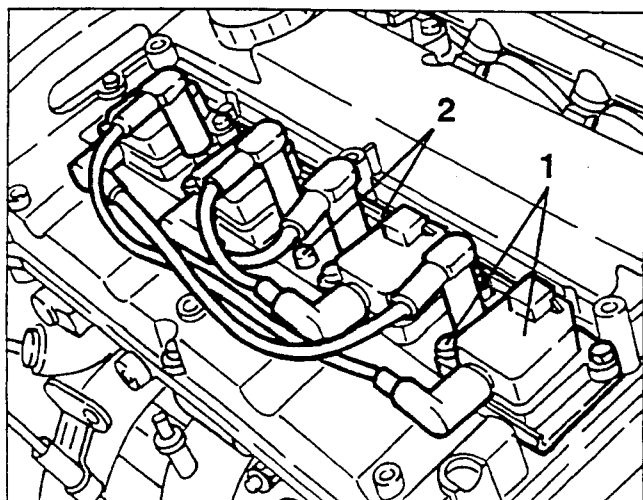
1. Disconnect and remove the oil vapour recovery pipes.



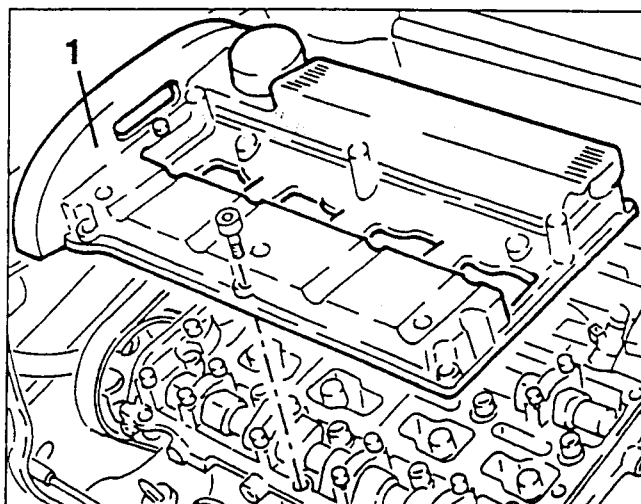
1. Slacken the fastening screws and remove the ignition coils cover.
2. Disconnect the electrical connections from the ignition coils.



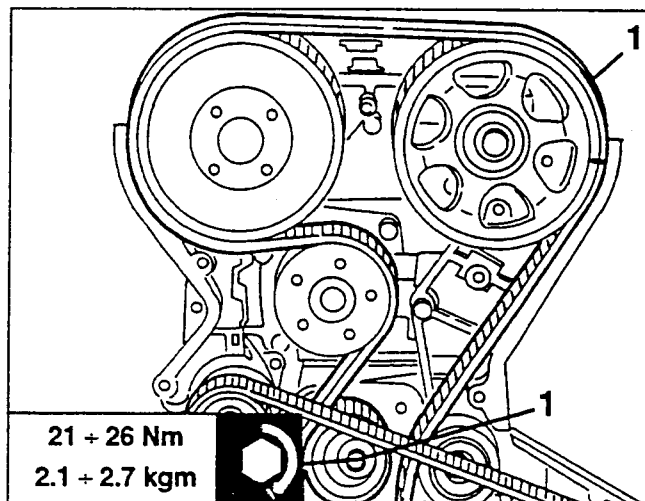
1. Slacken the fastening screws and remove the ignition coils.
2. Slacken the fastening screws and remove the ignition coils support bracket.



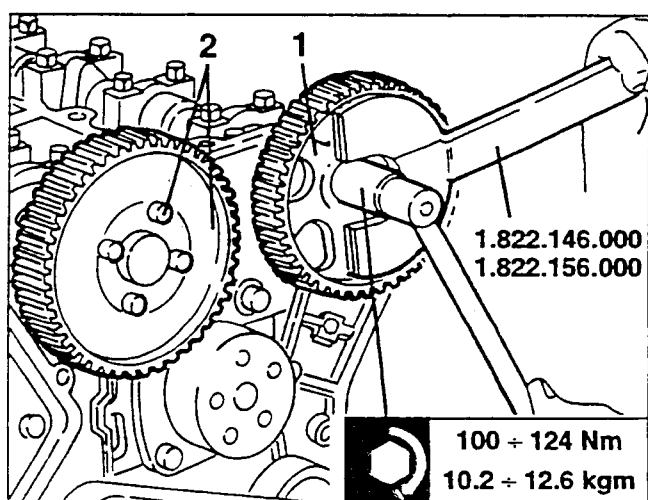
1. Slacken the fastening screws and remove the cylinder head cover complete with gasket.



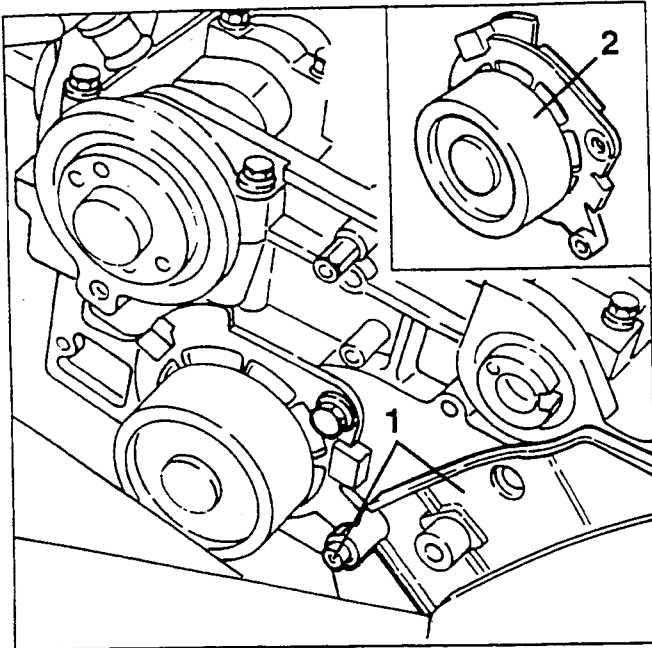
1. Working on the timing gear belt tensioner, loosen the tension on the belt, then take it off the timing gear drive pulleys.



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 side protection on the exhaust side.
2. Remove the two fastening screws and remove the water pump complete with O-Ring.



- Refit reversing the sequence followed for removal.

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

THERMOSTAT UNIT

The thermostat unit is fitted on the rear end of the cylinder head.

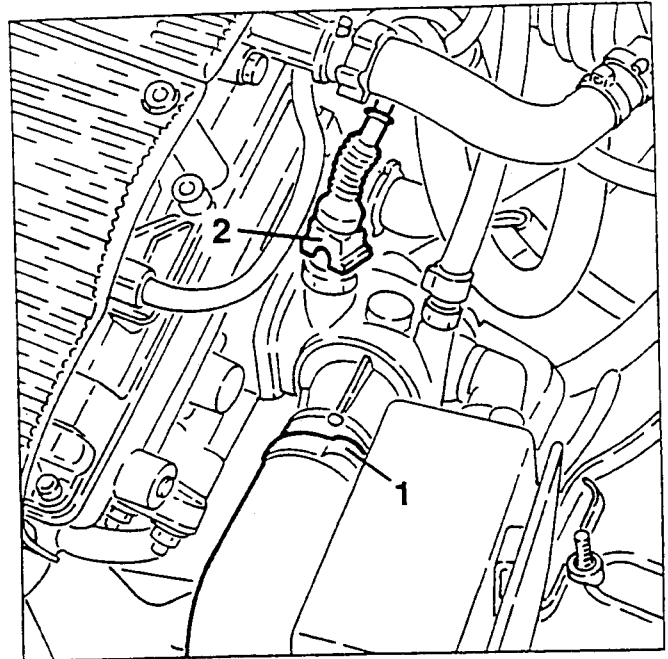
Its purpose is to prevent the engine from exceeding the optimum temperature: until the coolant temperature reaches 83 °C, the thermostatic valve diverts the coolant fluid towards the pump; at higher temperatures, the opening of the thermostatic valve enables the passage of the fluid towards the radiator.

On the thermostat unit there is a sensor (NTC) for detecting the coolant temperature to be sent to the control unit.

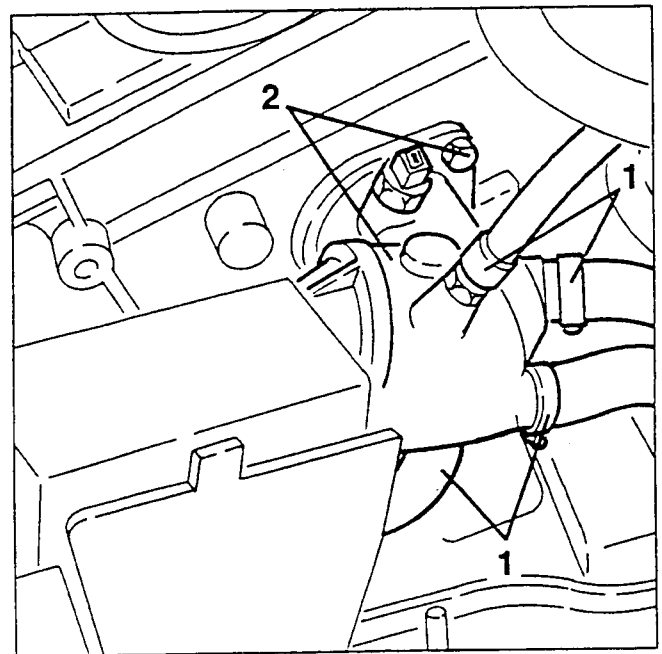
REMOVING/REFITTING

- Remove the battery.

1. Drain the engine coolant fluid disconnecting the radiator delivery sleeve from the thermostatic cup.
2. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).



1. Disconnect all the pipes connected to the thermostat unit.
2. Slacken the fastening screws and remove the thermostat unit.



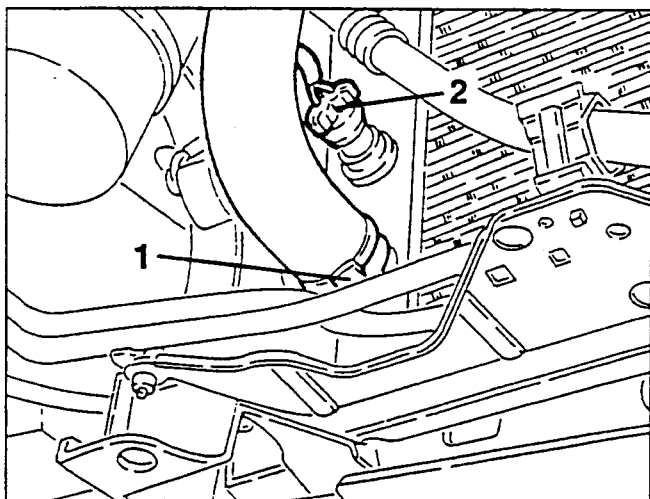
RADIATOR

The radiator is sized to meet the heat dispersal requirements when the engine is running.

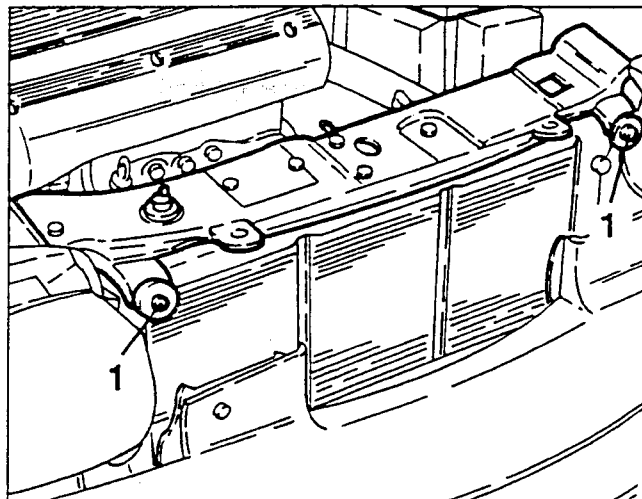
It comprises a radiant mass and two side reservoirs fitted with inlet and outlet unions for the coolant fluid; the pipes and radiant mass fins are in aluminium, the reservoirs are in plastic.

REMOVING/REFITTING
(for versions without air conditioner)

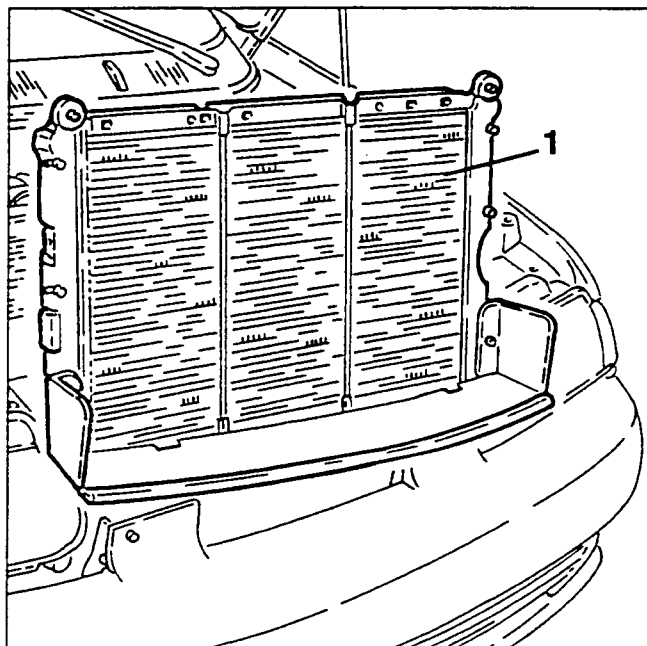
- Set the car on a lift.
 - Disconnect the battery (-) terminal
 - Remove the cooling fan (see specific paragraph)
1. Raise the car and drain the coolant fluid disconnecting the radiator outlet sleeve.
 2. Disconnect the electrical connection from the fan drive thermal contact.



1. Slacken the two screws fastening the radiator to the upper crossmember, then remove the crossmember after releasing it from the electric wiring.

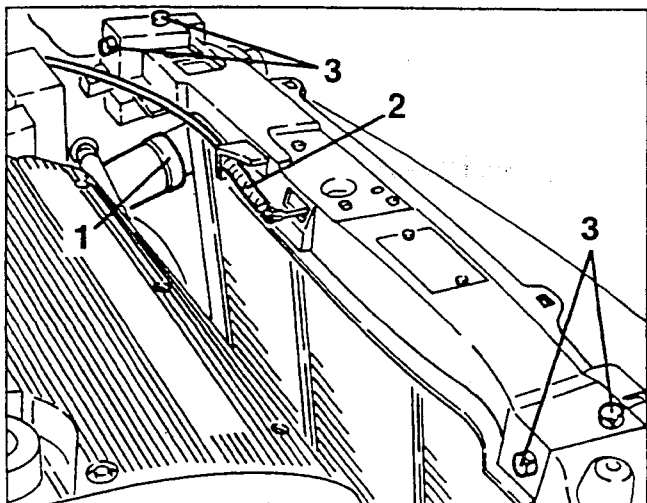


1. Remove the radiator complete with duct and fan drive thermal contact, pulling it upwards.



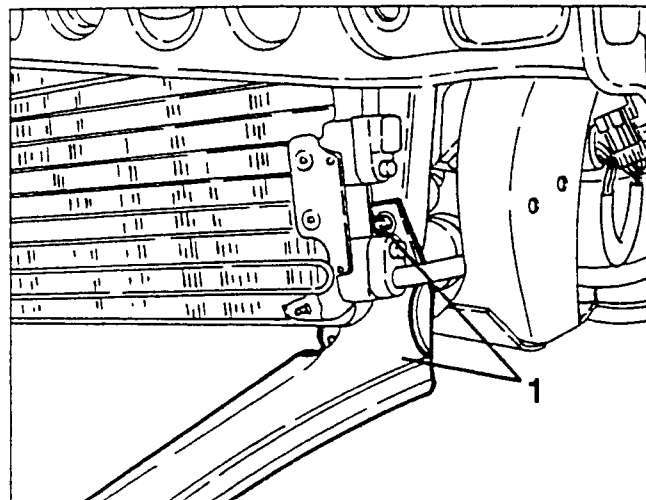
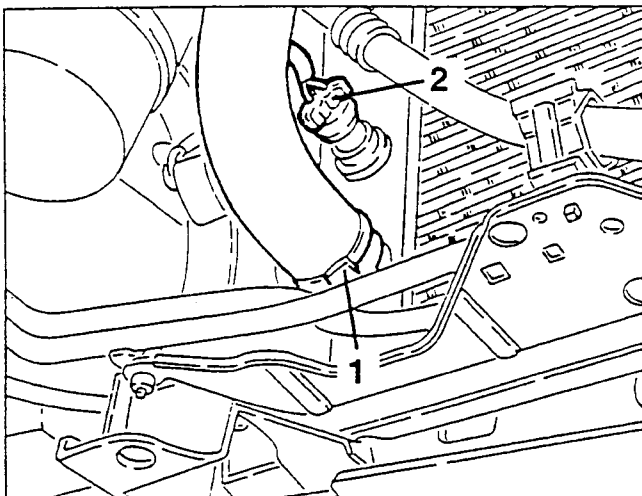
- Lower the car and remove the radiator grille (see GROUP 70).

1. Disconnect the coolant inlet sleeve from the radiator.
 2. Disconnect the bonnet opening cable from the lock.
- Disconnect the electrical connection from the anti-theft button on the radiator upper crossmember.
 - 3. Slacken the four screws fastening the upper radiator crossmember to the body.

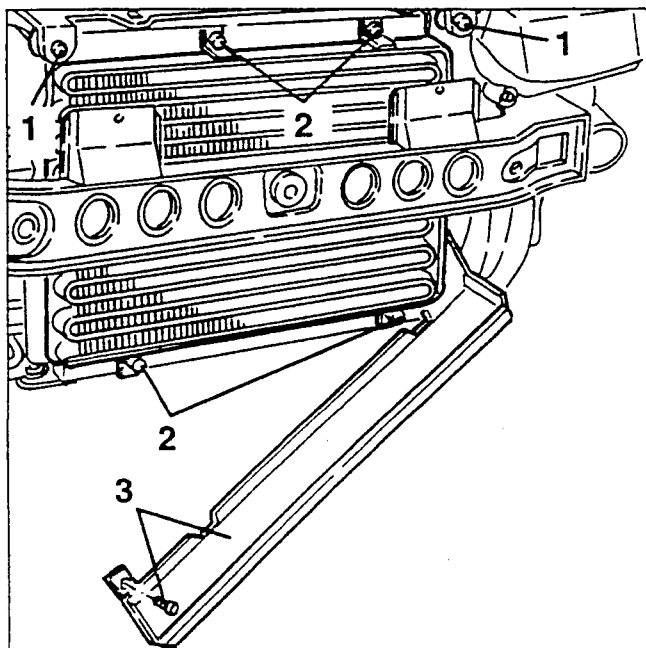
**REMOVING/REFITTING**
(for air-conditioned versions)

- Set the car on a lift.
- Disconnect the battery (-) terminal
- Remove the radiator grille and front bumper (see GROUP 70)
- Remove the cooling fan (see specific paragraph).

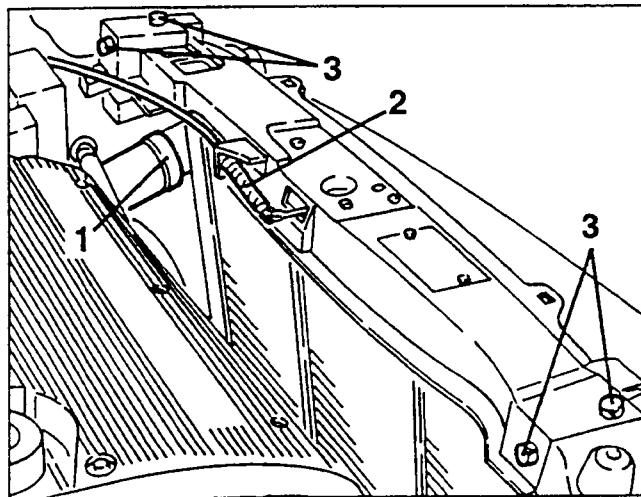
1. Raise the car and drain the coolant fluid disconnecting the radiator outlet sleeve.
2. Disconnect the electrical connection from the fan drive thermal contact.



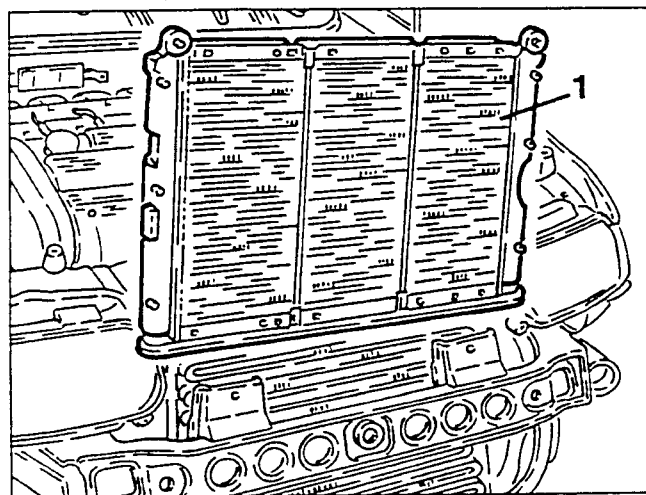
1. Lower the car, slacken the two screws fastening the radiator to the upper crossmember and retrieve the spacers.
2. Slacken the four screws fastening the conditioner condenser to the radiator, then support it suitably keeping it connected to the piping.
3. Slacken the screw on the right-hand side fastening the air duct to the radiator, then lower it as illustrated to gain access to the left-hand screw.



1. Disconnect the coolant inlet sleeve from the radiator.
2. Disconnect the bonnet opening cable from the lock.
- Disconnect the electrical connection from the anti-theft button on the radiator upper crossmember.
3. Slacken the four screws fastening the upper radiator crossmember to the body, then remove the crossmember after releasing it from the electric wiring.



1. Remove the radiator complete with fan drive thermal contact, pulling it upwards.



1. Slacken the left-hand screw fastening the air duct to the radiator, then remove it.

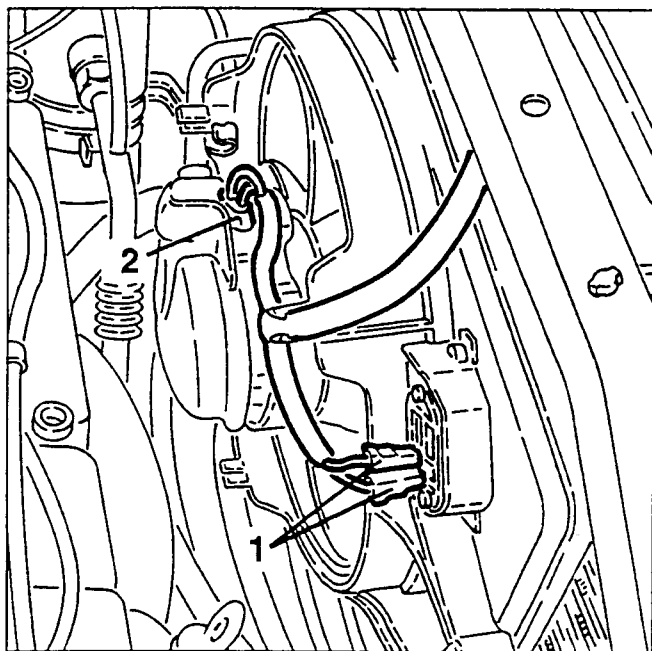
COOLING FAN

The two-speed cooling fan makes it possible to increase the heat dispersal capacity of the radiator. A thermal contact with double threshold where the first contact takes place at 92 °C and the second, through an additional resistance, at 97 °C activates the fan at two different speeds.

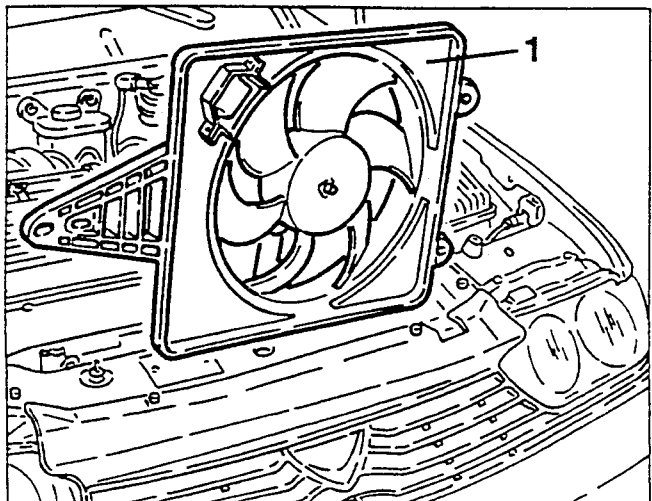
REMOVAL/REFITTING

- Disconnect the battery (-) terminal.

1. Disconnect the electrical connections of the fan additional coil.
2. Disconnect the cooling fan electrical supply connection.

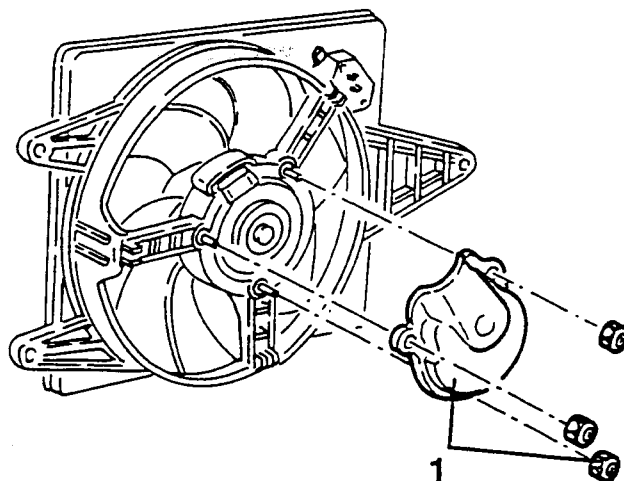


1. Slacken the fastening screws and remove the cooling fan.

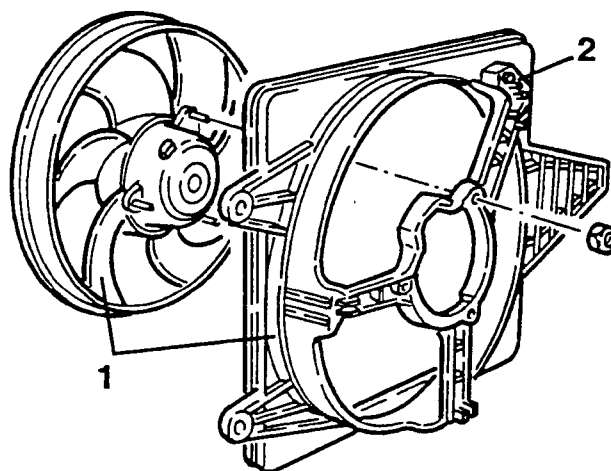


DIS-ASSEMBLY

1. Slacken the three fastening nuts and remove the heat shield.



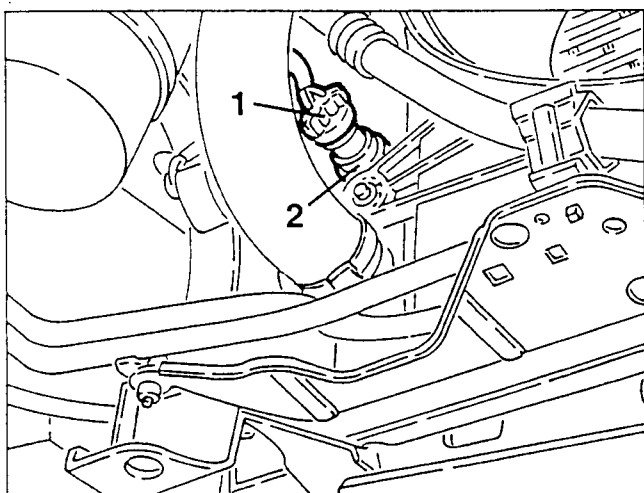
1. Slacken the three fastening nuts, then separate the fan from the duct.
2. Remove the additional resistance slackening the two fastening screws.



FAN CONTROL THERMAL CONTACT (Specific for versions with M2.10.3 injection - ignition system)

REMOVING/REFITTING

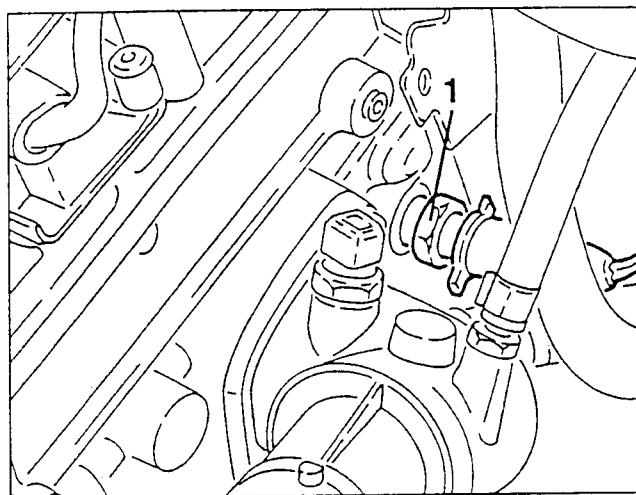
- Set the car on a lift.
- Disconnect the battery (-) terminal.
- 1. Raise the car and disconnect the electrical connection from the fan control thermal contact.
- 2. Slacken and remove the fan control thermal contact and recover the coolant that comes out.



COOLANT TEMPERATURE GAUGE TRANSMITTER AND MAXIMUM TEMPERATURE WARNING LIGHT CONTACT

REMOVING/REFITTING

- Disconnect the battery (-) terminal.
- Disconnect the electrical connection from the coolant temperature sensor (NTC).
- 1. Disconnect the electrical connection from the coolant temperature gauge transmitter and maximum temperature warning light contact, then remove it recovering the coolant that comes out.



CHECKS AND INSPECTIONS

Check the setting of the thermal contact referring to the wiring diagram of the specific manual.

Cooling fan cut-in/cut-out temperature		
1st speed	Cut in (contacts close)	$92 \pm 2^{\circ}\text{C}$
	Cut out (contacts open)	$87 \pm 2^{\circ}\text{C}$
2nd speed	Cut in (contacts close)	$97 \pm 2^{\circ}\text{C}$
	Cut out (contacts open)	$92 \pm 2^{\circ}\text{C}$

- If the values are not as specified, change the thermal contact.




CHECKS AND INSPECTIONS

Check the setting of the transmitter referring to the wiring diagram of the specific manual.


Temperature ($^{\circ}\text{C}$)	Resistance (Ω)
60 (Water test liquid)	$525 \div 605$
90 (Water test liquid)	$195 \div 245$
120 (Glycerine test liquid)	$82 \div 94$

Contact closing temperature	$122 \pm 2^{\circ}\text{C}$
Contact opening temperature	$112 \pm 3^{\circ}\text{C}$

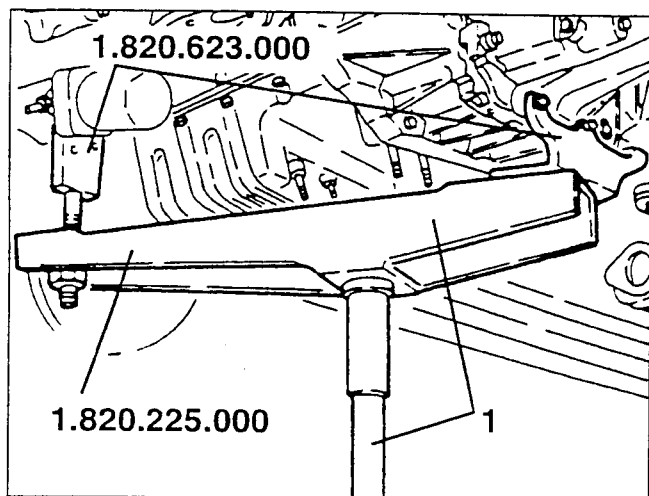
T. SPARK
16VT. SPARK
16VT. SPARK
16V

THE FOLLOWING PROCEDURE IS VALID FOR ALL ENGINES  T. SPARK 16V AND  T. SPARK 16V
WHILE FOR ENGINE  T. SPARK 16V IT IS VALID ONLY FOR VERSIONS WITH GEARBOX
C.510.5 (UP TO CHASSIS NO.)

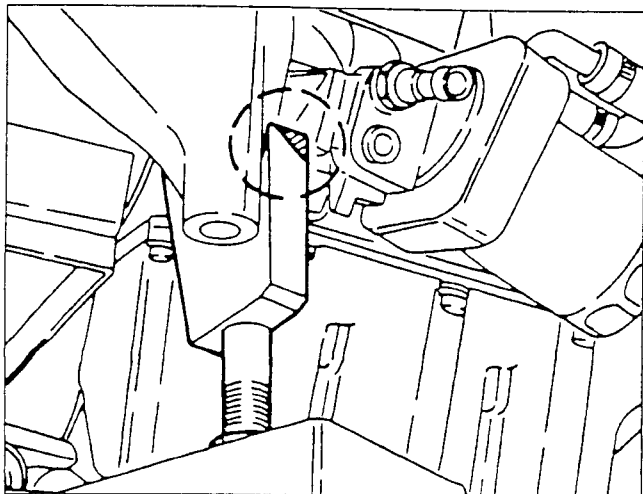
REMOVAL


Proceed as described for  T. SPARK 16V engine removal with the exception of the following steps.

1. Set a hydraulic jack complete with tools no. 1.820.225.000 and no. 1.820.623.000 as illustrated.



NOTE: The camshaft side engine support part of tool no. 1.820.623.000, is to be relieved in the area illustrated to avoid interference with the oil filter support.

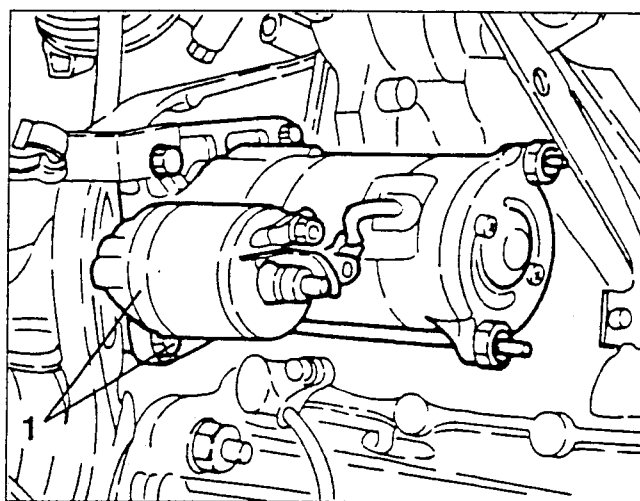


Complete removal of the engine from the car working as described for  T. SPARK 16V engine.

Once on the bench, remove the components as described below to make it possible to set the engine on the overhauling stand.

- Free the power unit from the support tools, then position it on a special work bench.

1. Slacken the fastening screws and remove the starter motor.



1. Slacken the fastening nuts and remove the gearbox and differential unit.

