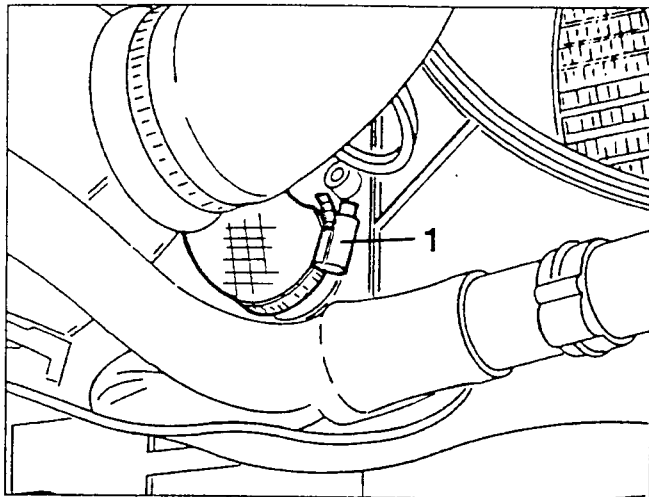
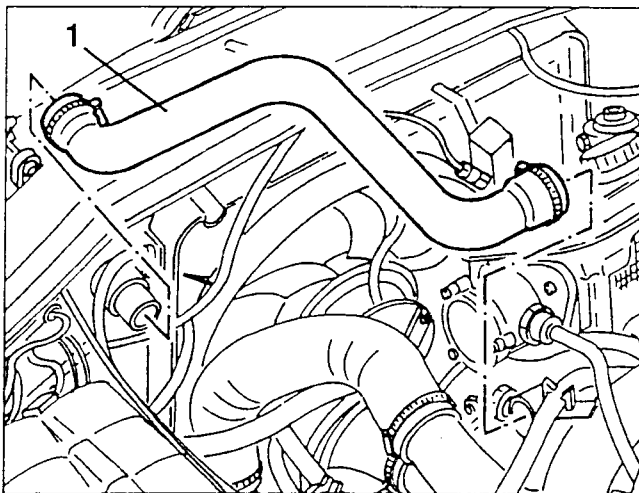


- Raise the vehicle.

1. Drain off the engine coolant, by disconnecting the liquid outlet sleeve from the radiator and recover it in a suitable container.

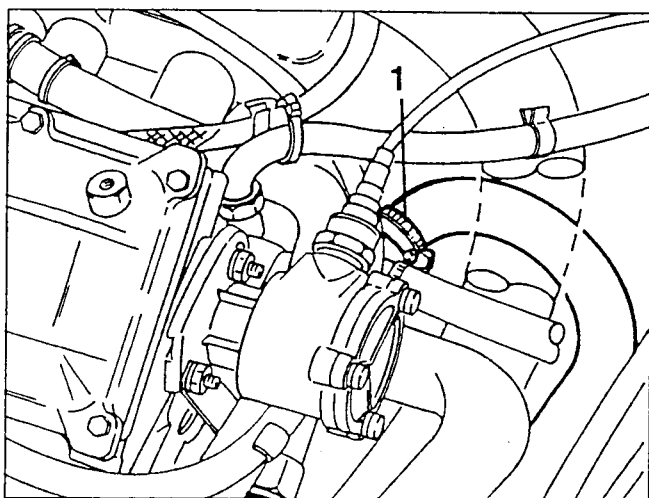


1. Remove the engine coolant from thermostatic cup to radiator delivery sleeve.

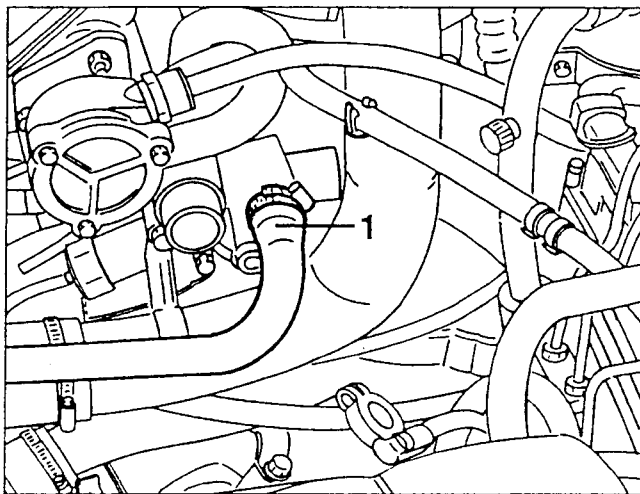


- Lower the vehicle.

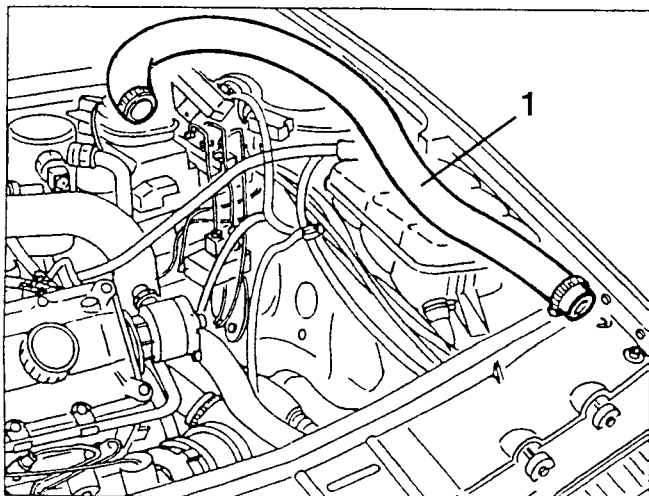
1. Disconnect the engine coolant from radiator return sleeve from the thermostatic cup.



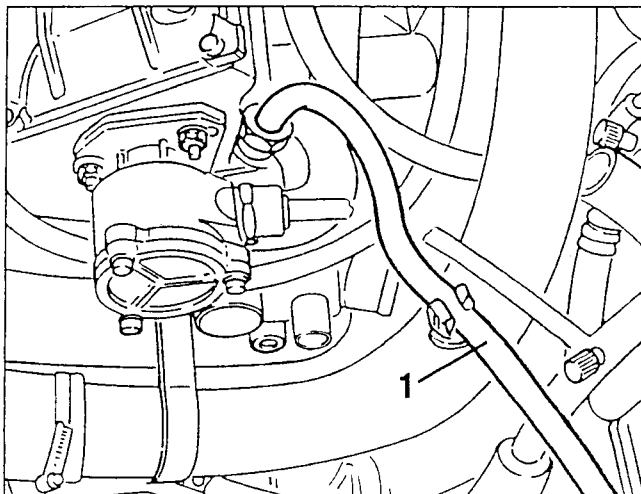
1. Disconnect the system loading sleeve originating from the expansion tank from the thermostatic cup.



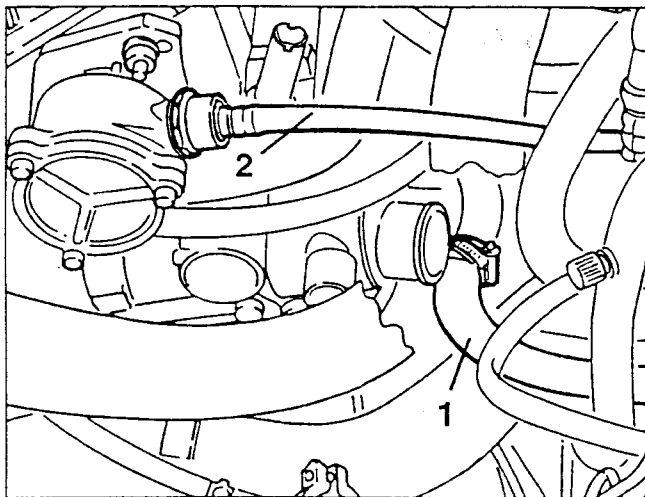
1. Remove the engine coolant from radiator to thermostatic cup delivery sleeve.



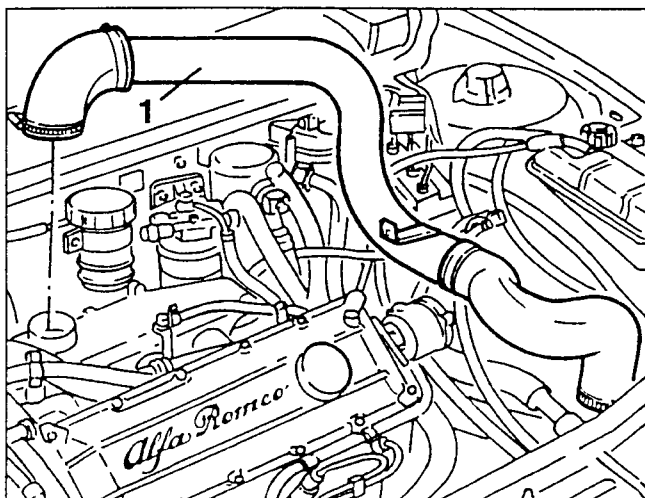
1. Disconnect the engine coolant to expansion and system deaerating tank return pipe from the cylinder head.



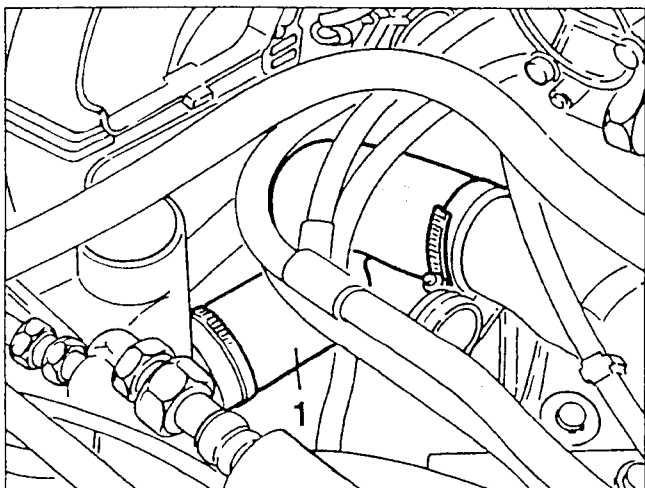
1. Disconnect the engine coolant from heater return sleeve from the engine coolant to pump manifold.
2. Disconnect the vacuum pipe from the vacuum pump for the servo brakes.



1. Remove the air from intercooler to air intake box delivery manifold.

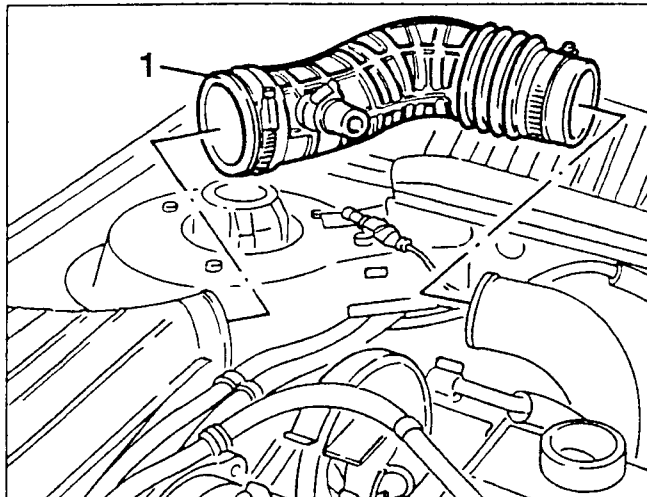


1. Remove the air from turbocharger to intercooler delivery sleeve.



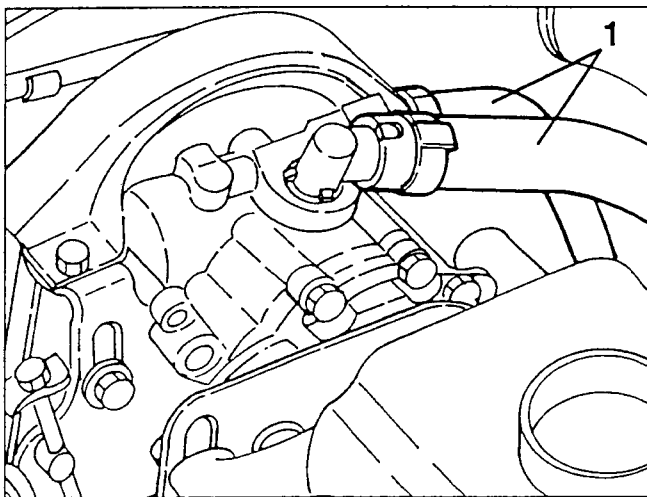
- Disconnect the oil vapour recirculation pipe from the intaken air corrugated sleeve.

1. Remove the corrugated air intake from filter to turbocharger sleeve.

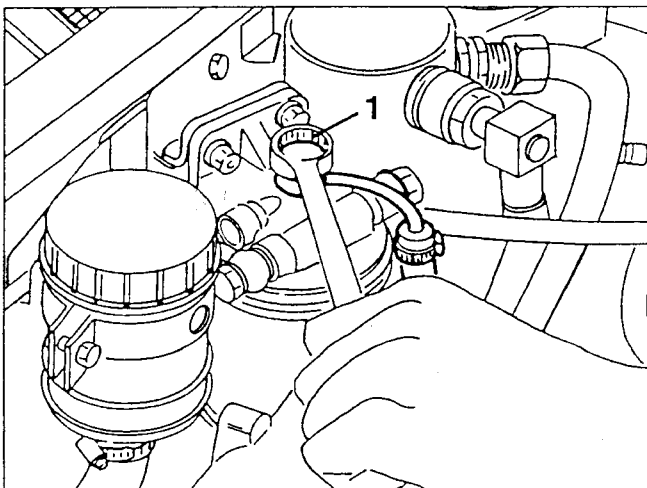


- Using a suitable syringe, drain oil from the power steering system reservoir.

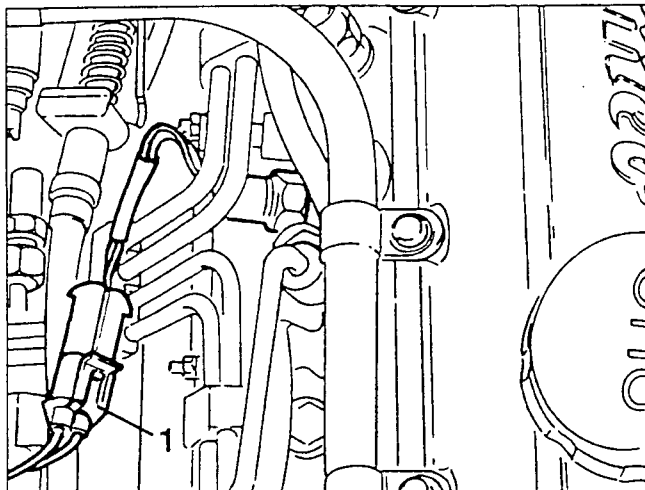
1. Disconnect the intake and oil delivery connectors from the power steering pump.



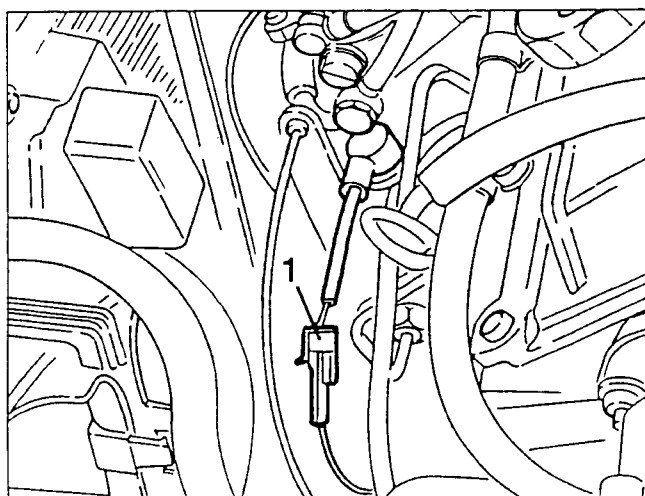
1. Disconnect the fuel delivery to injection pump pipe from the filter.



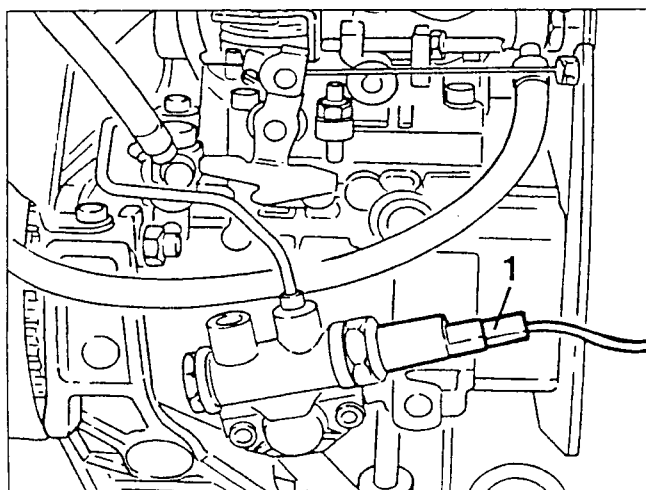
1. Disconnect the electrical connection from the engine coolant temperature indicator transmitter and max. temperature warning light contact.



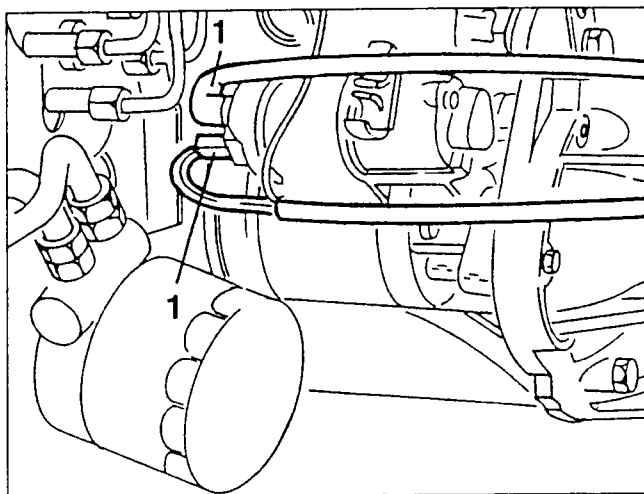
1. Disconnect the electrical connection of the engine stop solenoid valve.



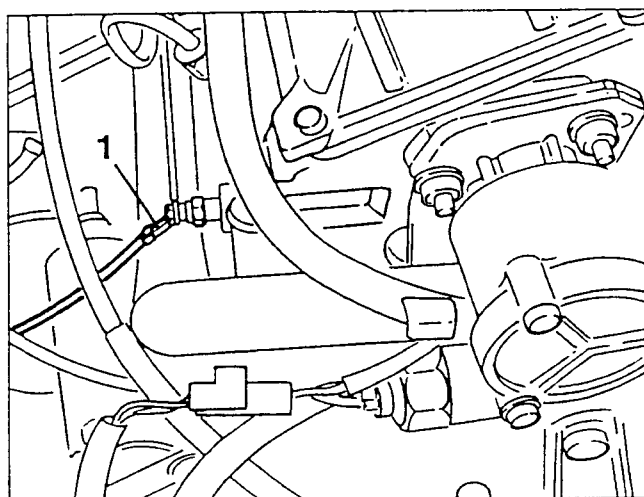
1. Disconnect the electrical connection of the KSB cold injection advance automatic control device.



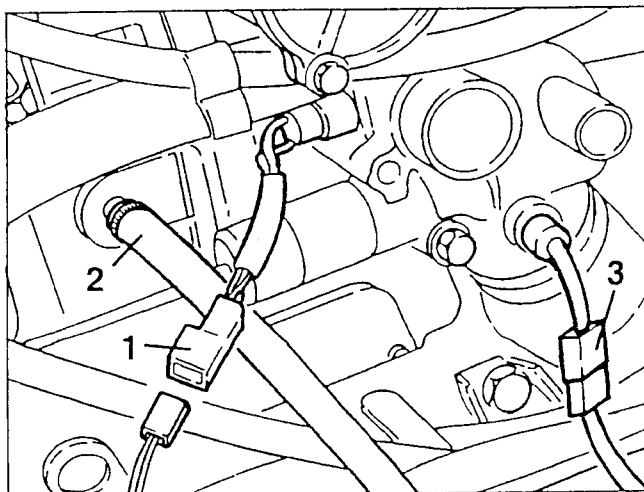
1. Disconnect the electrical power supply and starter motor energizing connections.



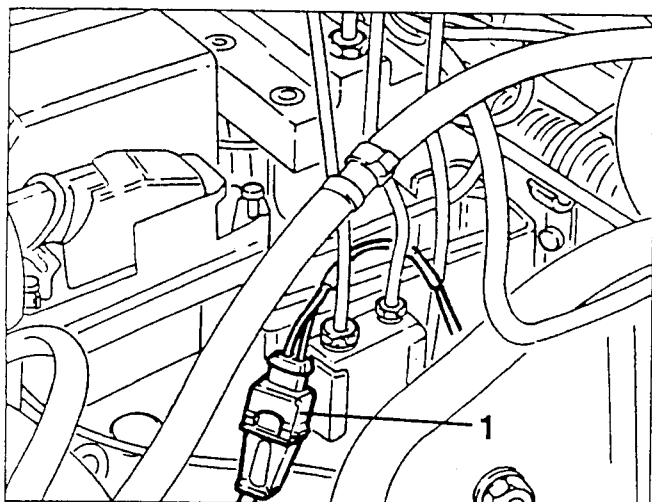
1. Disconnect the power supply electrical connection to the heater plug.



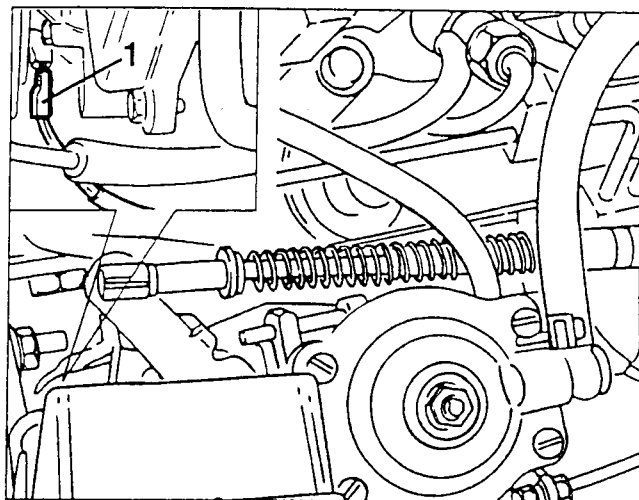
1. Disconnect the electrical connection of the KSB consensus thermoswitch.
2. Disconnect the engine coolant to heater delivery pipe from the cylinder heads.
3. Disconnect the electrical connection of the conditioner compressor cut-off thermal contact.



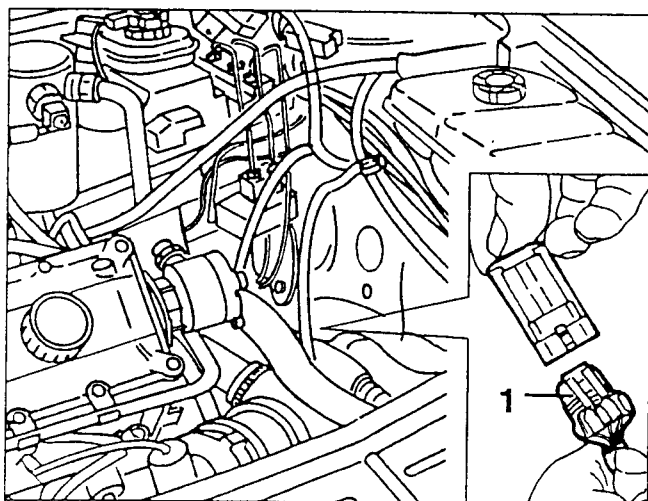
1. Disconnect the electrical connection for the electronic revs counter.



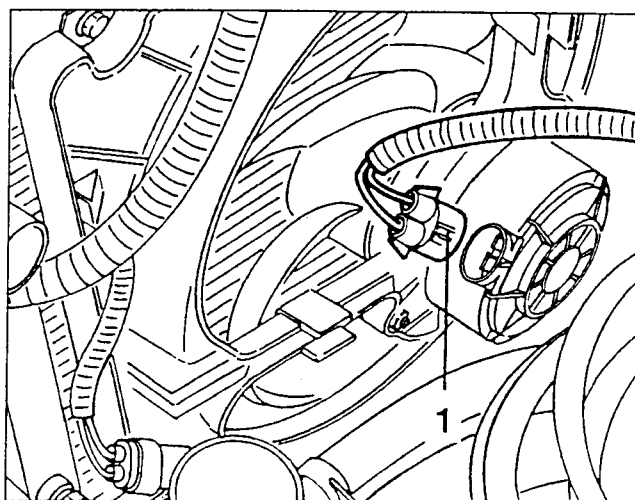
1. Disconnect the two electrical connections from the air conditioning compressor.



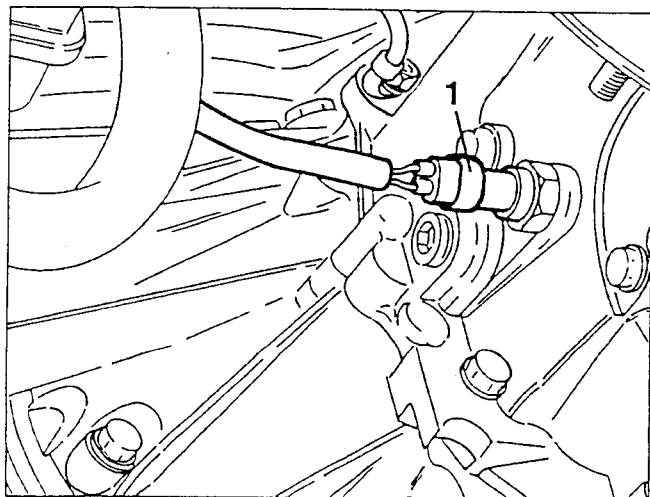
1. Disconnect the electrical connection of the mileage recorder sensor.



1. Disconnect the electrical connection from the cooling electric fan.

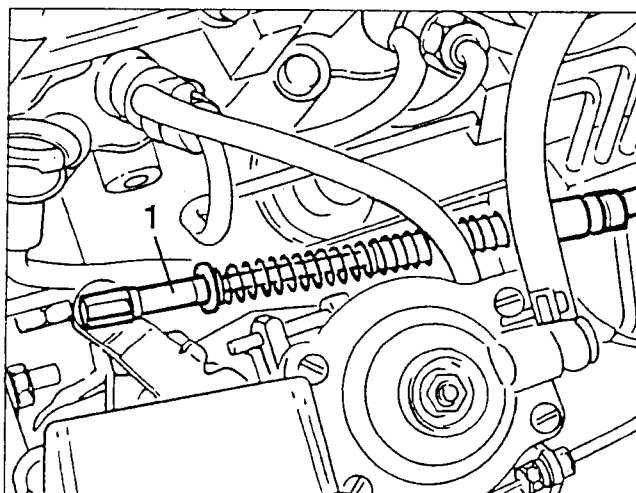


1. Disconnect the electrical connection from the reverse switch.

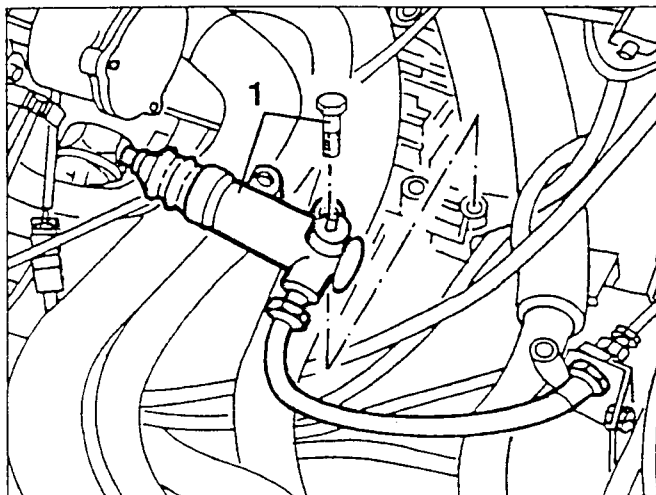


- Remove engine cooling electric fan (see specific paragraph).

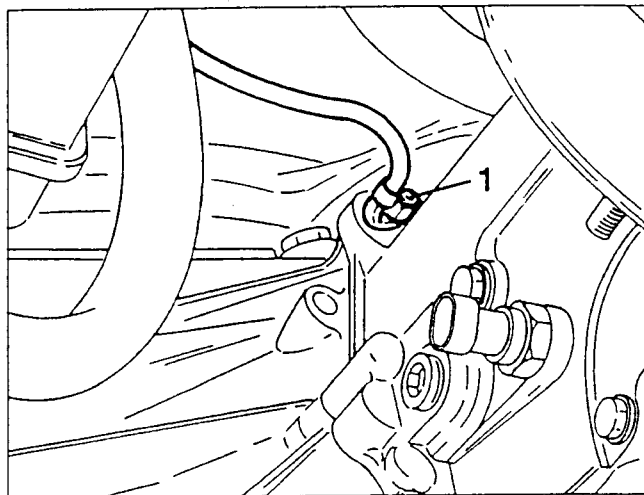
1. Disconnect the accelerator control cable.



1. Slacken the screws fastening the clutch control cylinder, then move it to one side without disconnecting the control hose.

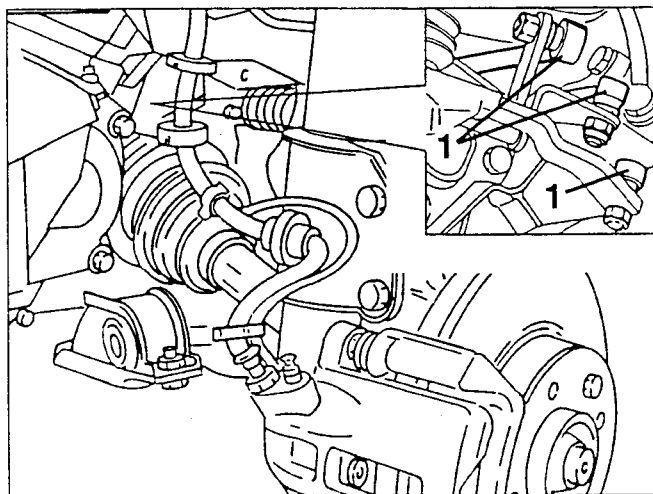


1. Disconnect the ground point of negative (-) terminal of battery.



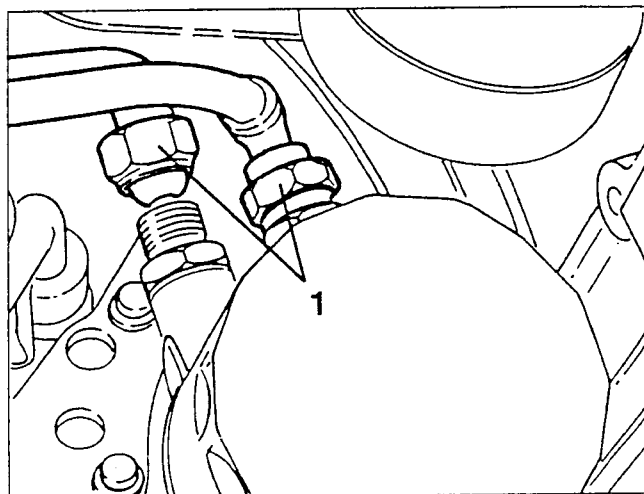
- Raise the vehicle.

1. Disconnect the gear control rod.

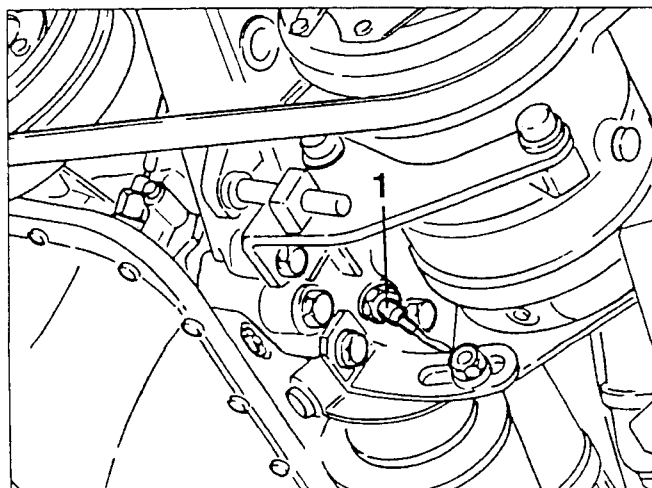


- Drain off engine oil (see GROUP 00).

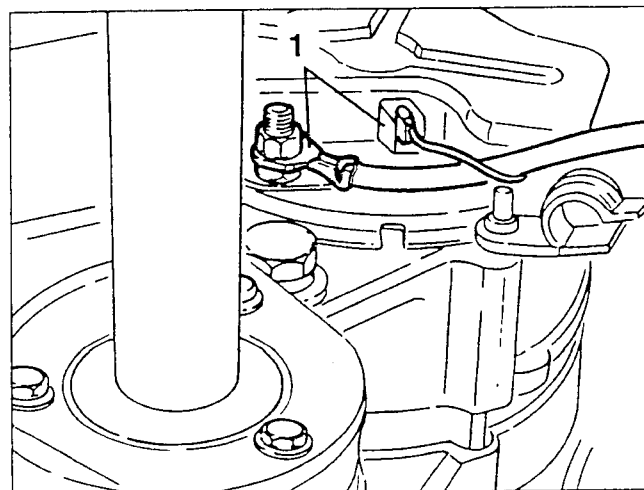
1. Disconnect the two oil to radiator delivery and return connectors from the oil filter support.



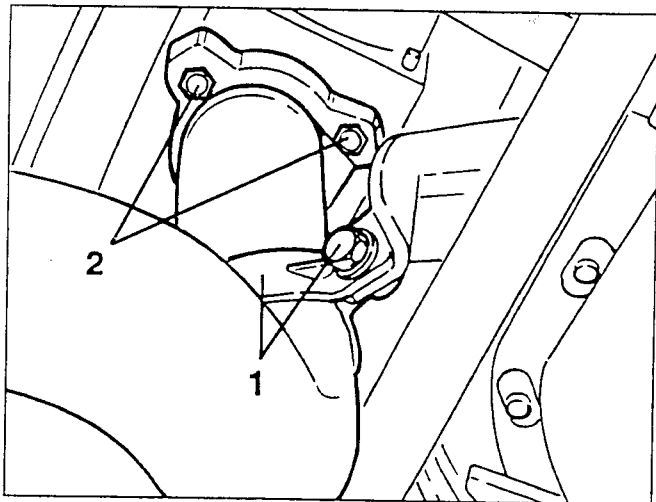
1. Disconnect the electrical connection from the engine oil minimum pressure warning light sensor.



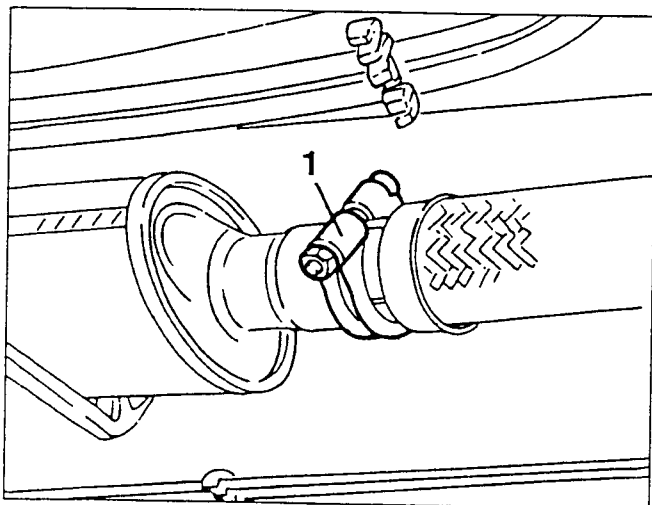
1. Disconnect the electrical connections from the alternator.



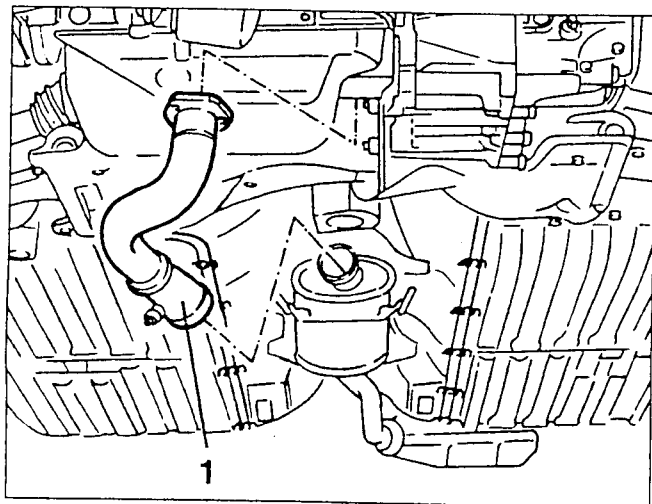
1. Remove the support clamp on the first section of the exhaust pipe.
2. Unscrew the fastening screws of the flanges connecting the front section of the exhaust pipe to the turbocharger.



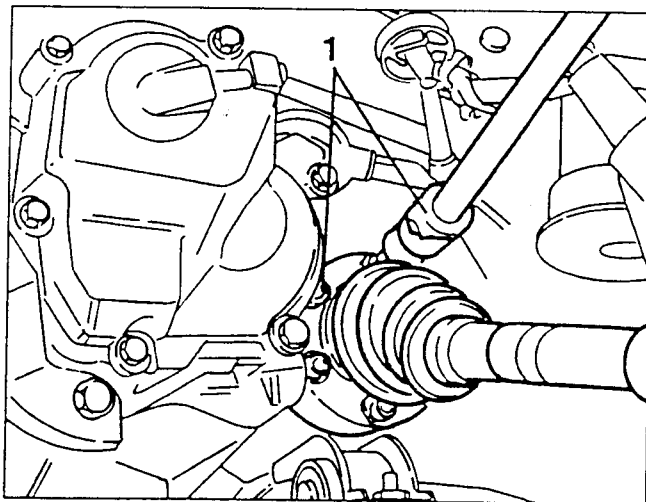
1. Loosen the clamp fastening the front section of the exhaust pipe to the central section.



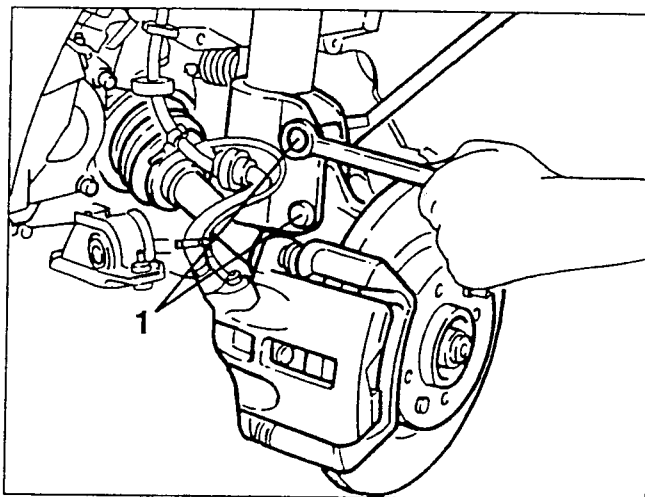
1. Remove the front section of the exhaust pipe.



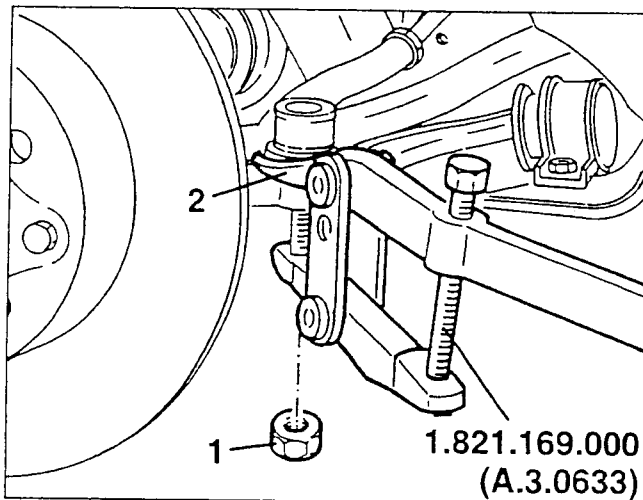
1. Disconnect the lefthand homokinetic connection from the relative flange.



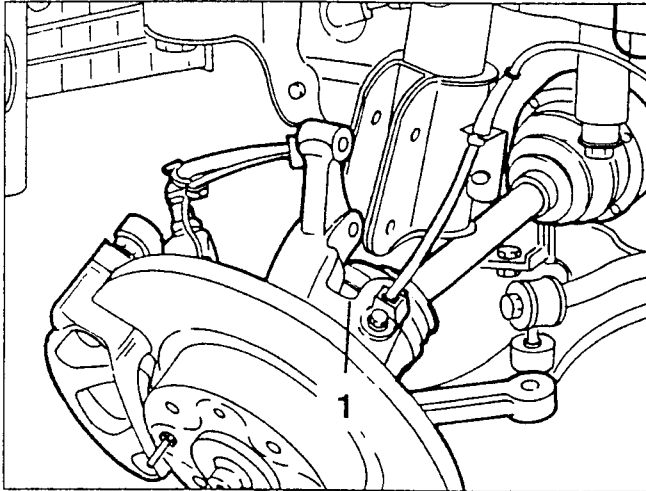
1. Disconnect the complete upright from the lefthand shock absorber.



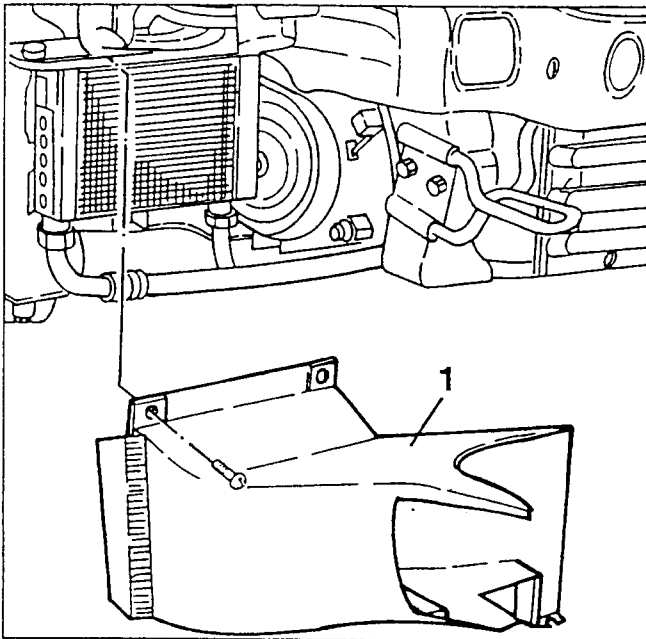
1. Unscrew the fastening nut of the lefthand steering rod ball joint.
2. Using extractor N° 1.821.169.000 (A.3.0633) separate the steering rod from the control lever on the upright.



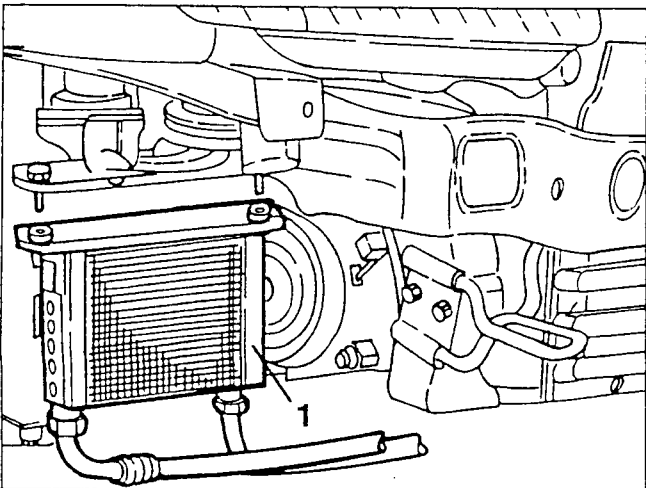
1. Tip forward, as far as possible, the wheel hub and move the axle shaft forward in this way.
- Carry out the same operations on the righthand axle shaft.



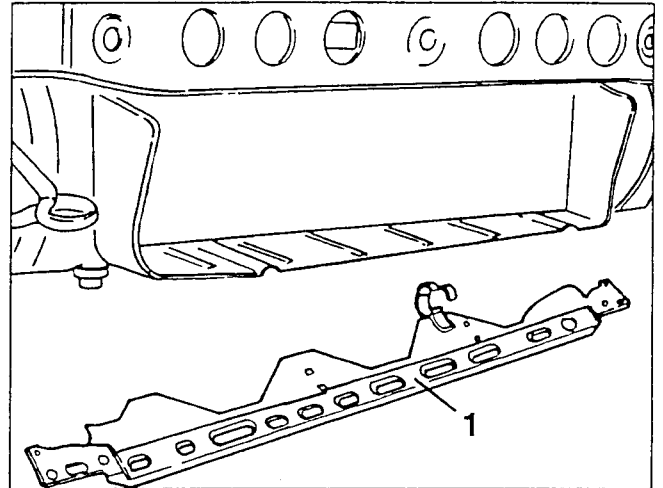
1. Remove the air to engine oil cooling radiator conveyor.



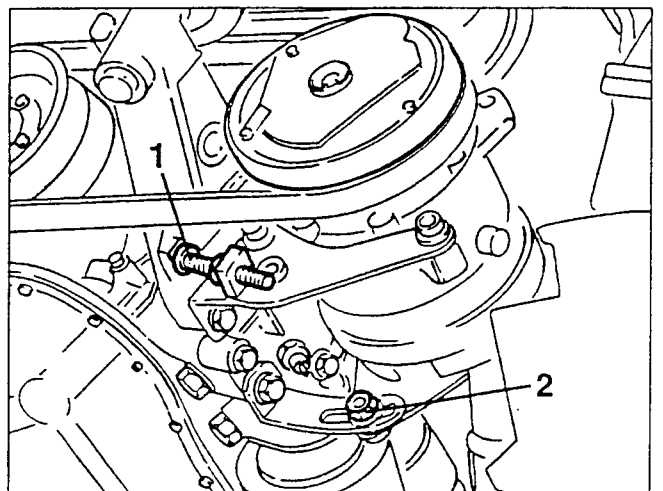
1. Unscrew the fastening screws and remove the oil radiator complete with tubes.



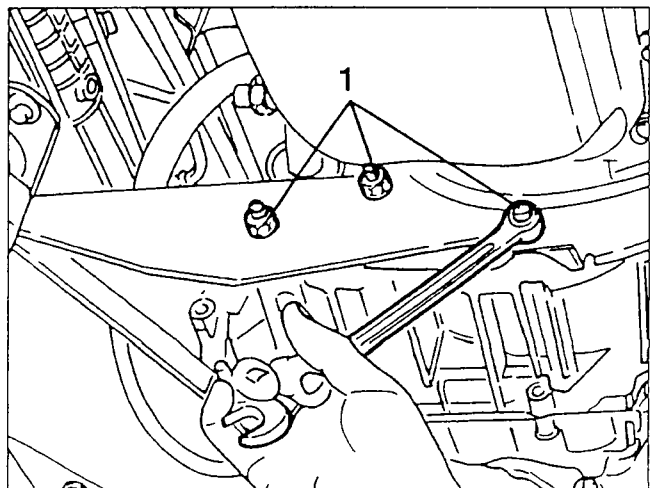
1. Unscrew the fastening screws and remove the lower radiator support cross member.



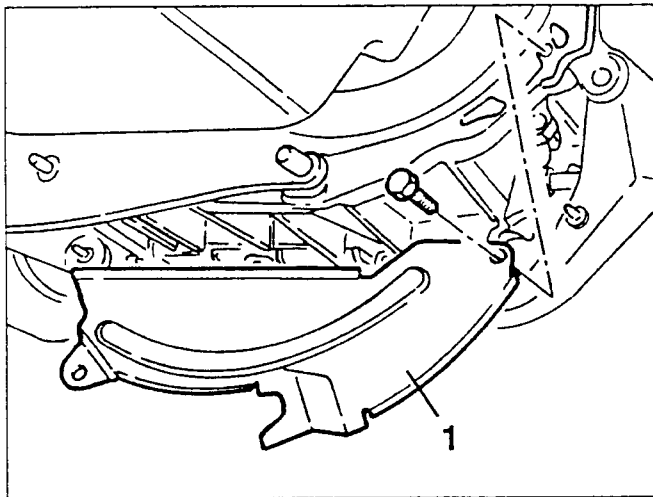
1. Acting on the micrometric tightener, loosen the air conditioning control belt.
2. Unscrew the fastening screws of the air conditioning compressor.



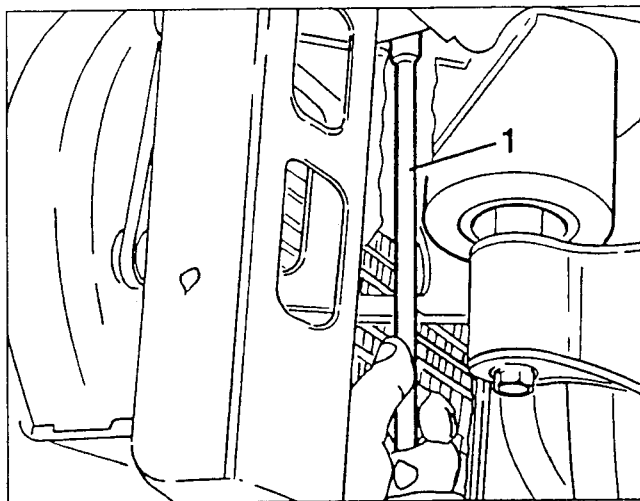
1. Loosen the three gearbox fastening nuts to the relative support bracket.



1. Unscrew the fastening screws and remove the small flywheel protection panel.



1. Unscrew the screws fastening the gearbox side support to the body



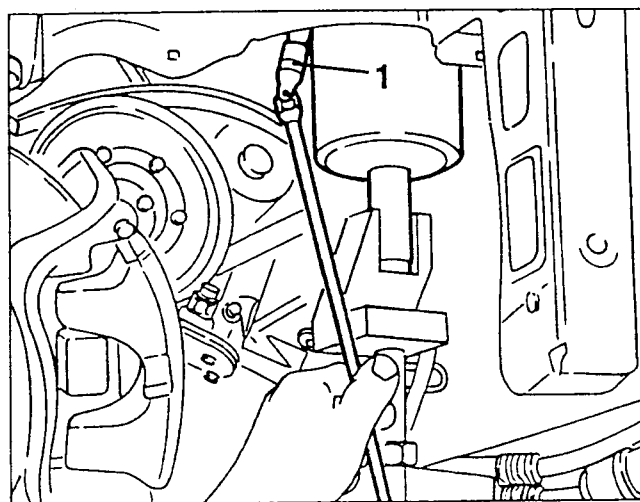
1. Install the support tools N° 1.820.233.000, N° 1.820.283.000 and N° 1.820.225.000 ready to remove the engine from the vehicle, positioning them as indicated in the figure.

2. Position a hydraulic jack under the tools of the engine support.

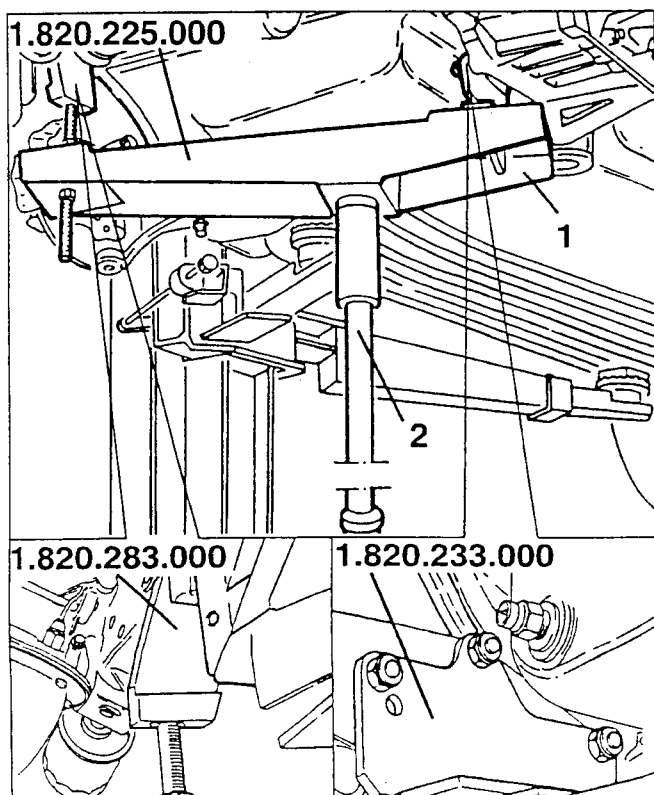
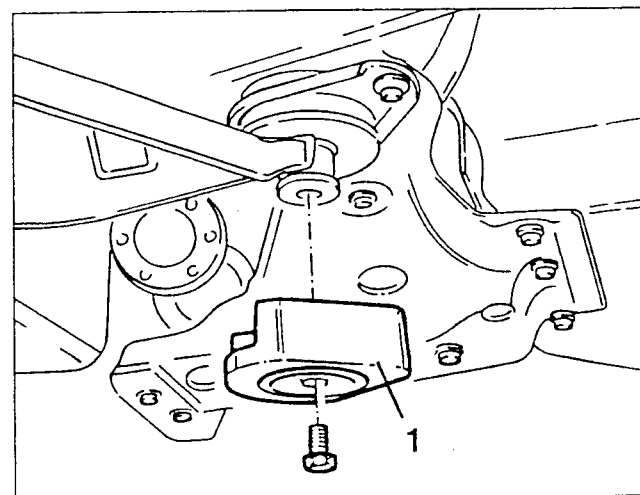


CAUTION:
The hydraulic jack must have a capacity of at least 1000 kg.

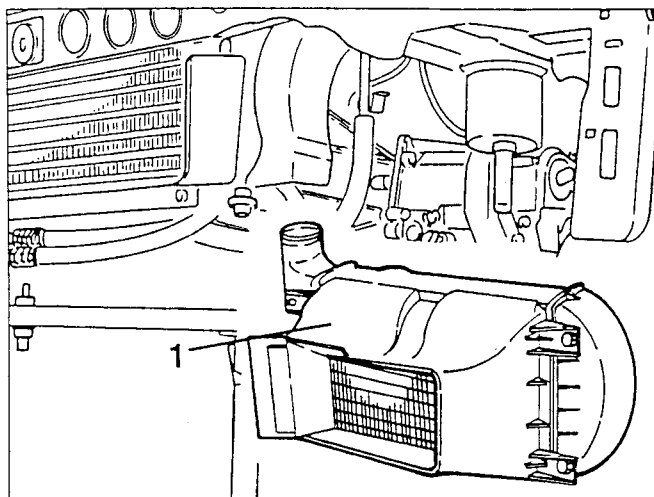
1. Unscrew the screws fastening the timing side support to the body.



1. Unscrew the screws fastening the rear support to the body and recover the buffer.



1. Lower the engine slightly and take the intercooler and manifold.



- Lower the hydraulic jack and remove the engine from the engine compartment.



IMPORTANT:

When lowering check there are no attached wires or pipes.

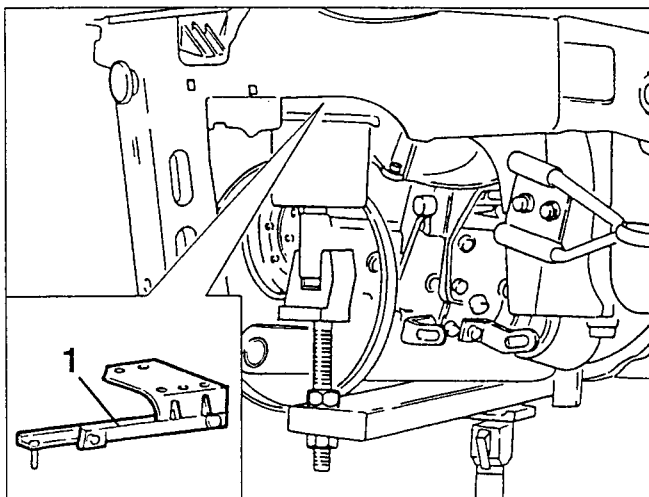


IMPORTANT:

Pay attention not to damage parts.

- Support the engine with an hydraulic lift and the hydraulic jack used for removal.

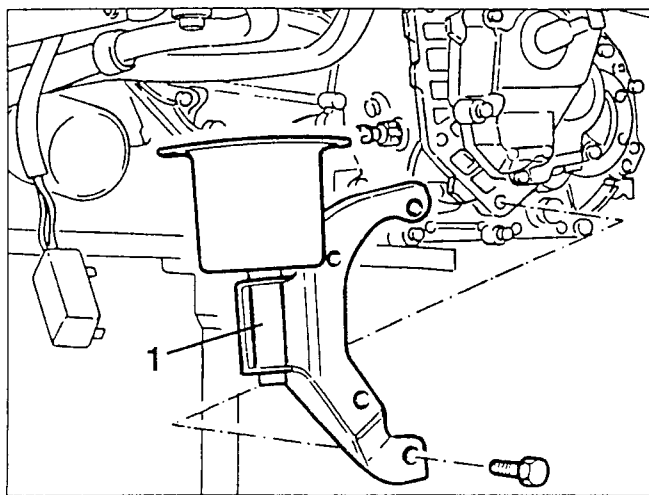
1. Take the oil radiator support rod.



NOTE: Some engines are not equipped with a gearbox side lifting bracket.

In this case, fit the bracket, supplied as a spare part, and torque the fastening screw at $47 \div 58 \text{ Nm}$.

1. Remove the complete gearbox side bracket.



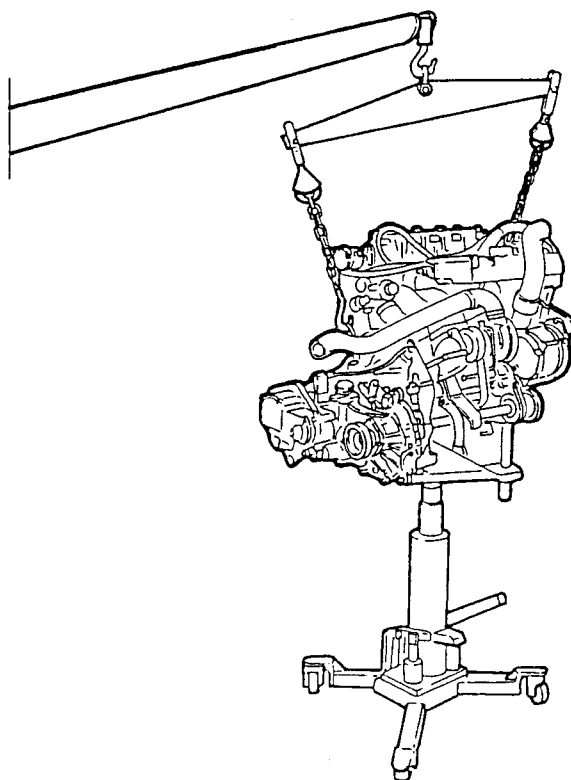
IMPORTANT:

Disconnect electric wires from clips and shift them away from the engine.



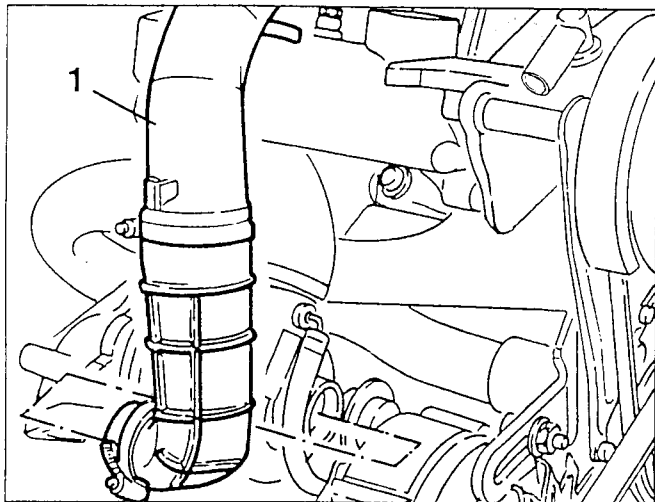
IMPORTANT:

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

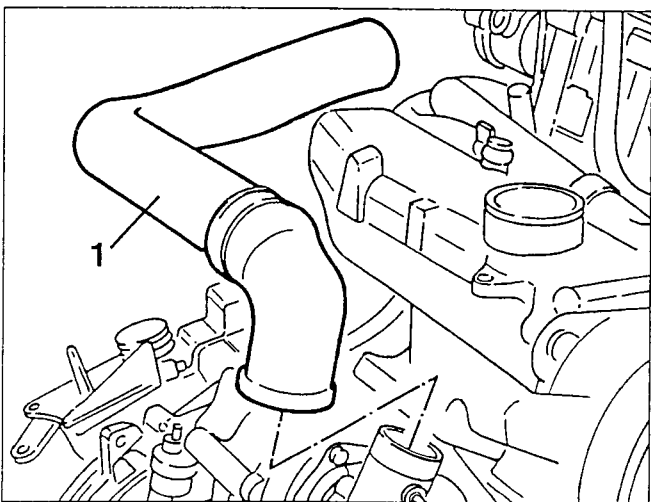


REMOVING LEFT-HAND SIDE COMPONENTS

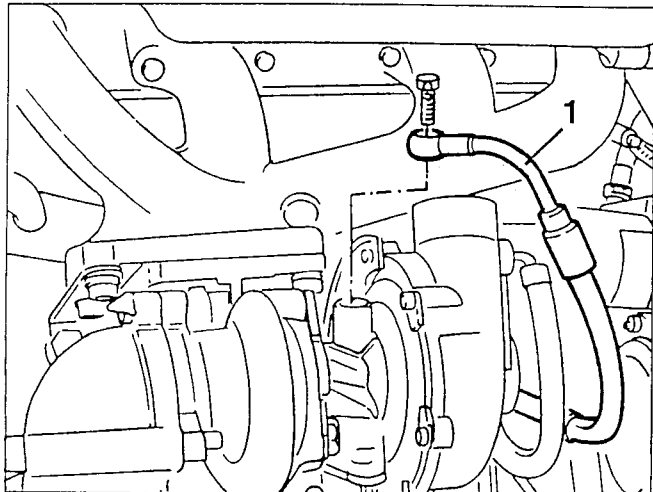
1. Remove the air intake manifold from the turbo compressor.



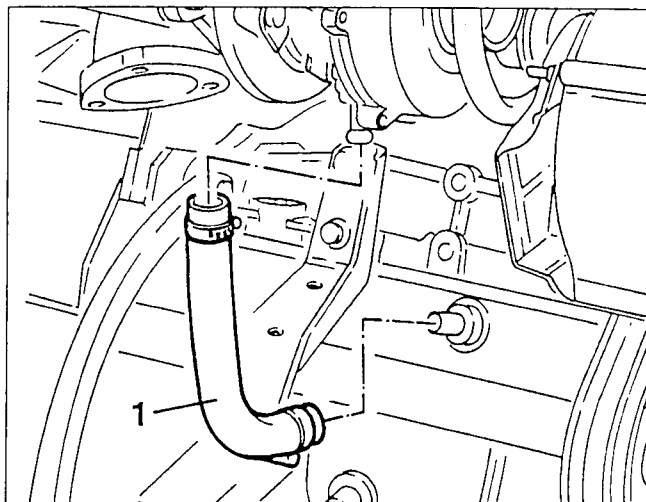
1. Remove the intercooler air intake manifold from the turbo compressor.



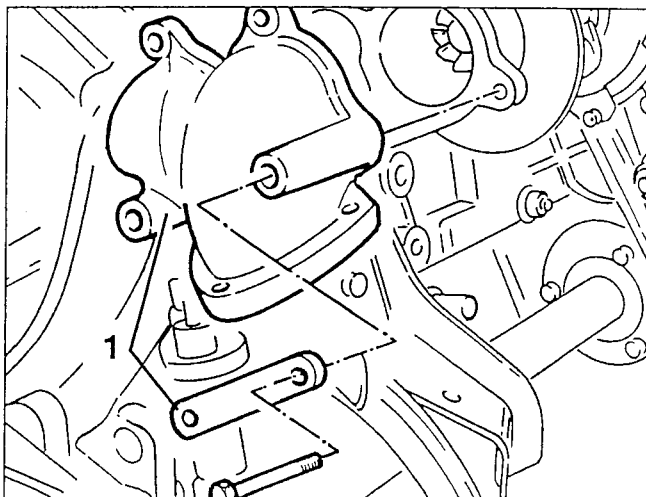
1. Remove the oil delivery pipe from the turbo compressor.



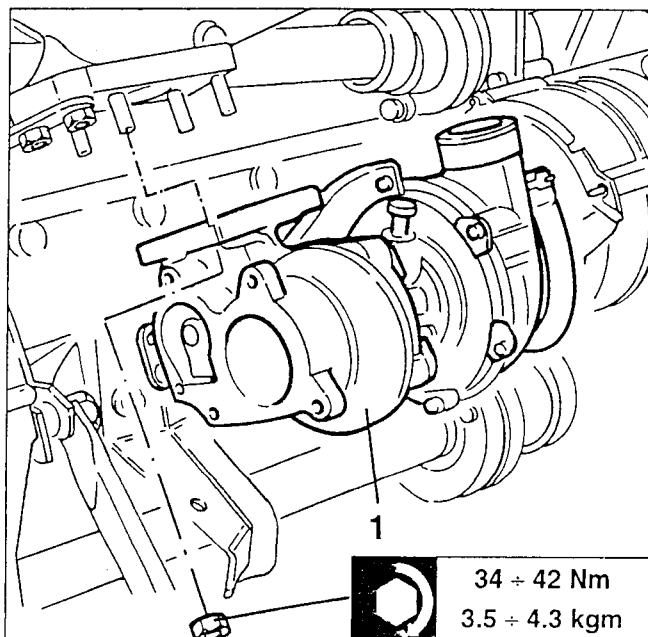
1. Remove the oil return to sump pipe from the turbo compressor.



1. Release the safety plates and remove the turbo compressor scroll.



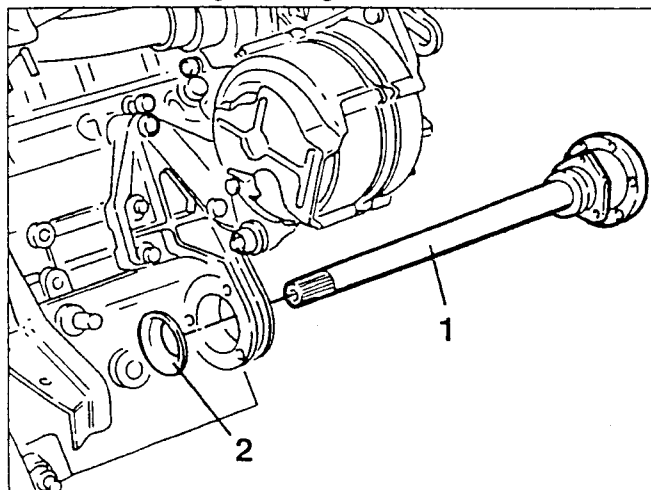
1. Remove the fastening nuts and remove the turbo compressor.



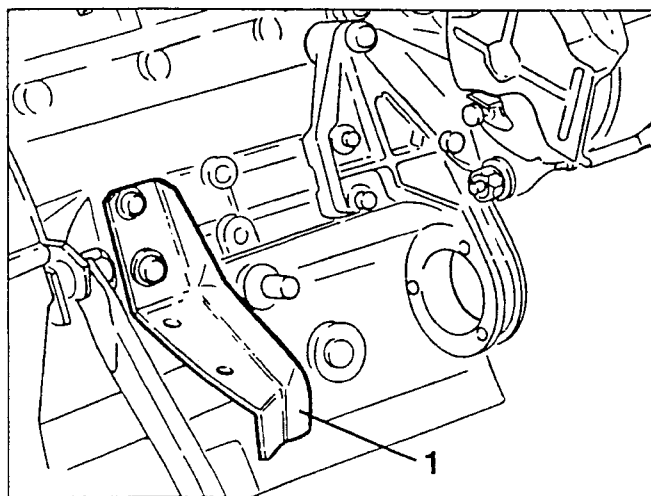
34 ÷ 42 Nm
3.5 ÷ 4.3 kgm

- Drain off oil from the gearbox by unscrewing relative plug.

1. Unscrew the fastening screws and remove intermediary shaft.
2. Remove dust guard ring.

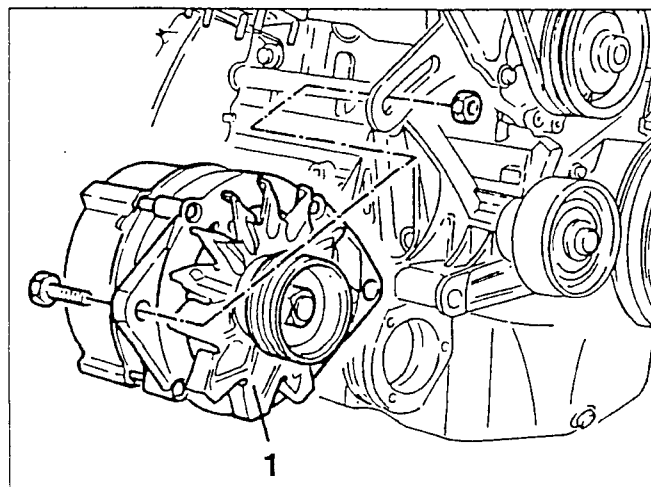


1. Remove the small support plate on the front section of the exhaust pipe.



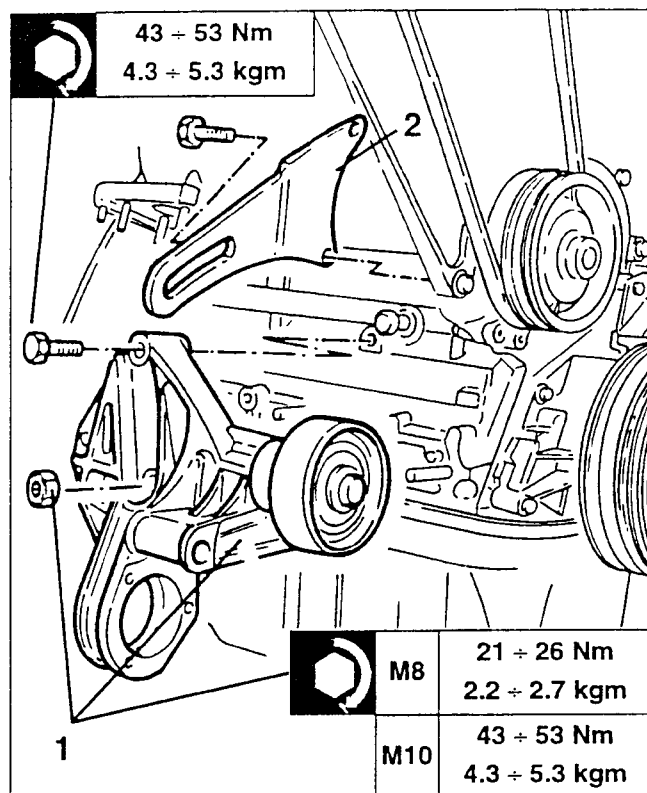
- Loosen the two alternator fastening bolts and remove the control belt.

1. Unscrew completely the fastening screws and remove the alternator.



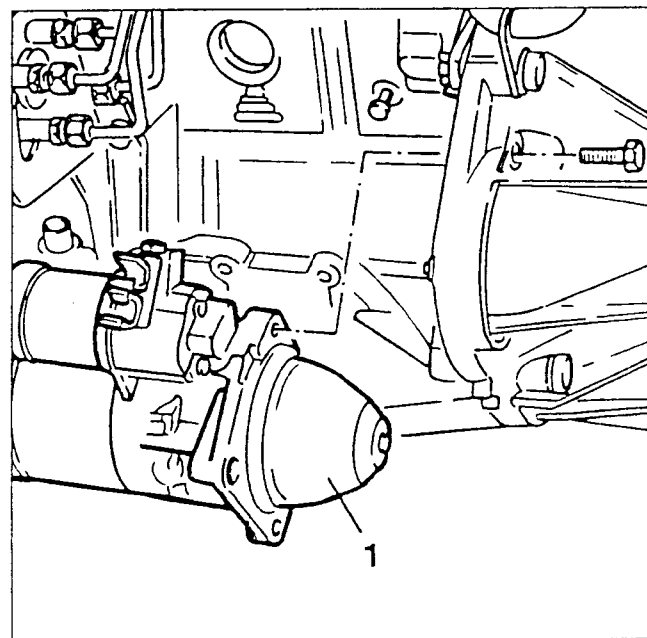
1. Remove the alternator support bracket and the intermediary shaft complete with alternator - water pump control belt jockey pulley.

2. Remove the alternator support upper bracket.

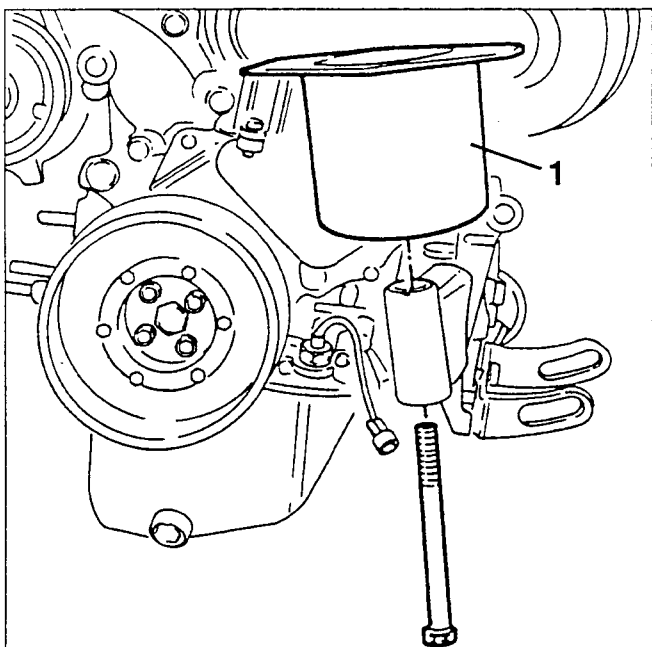


REMOVAL OF RIGHTHAND SIDE COMPONENTS

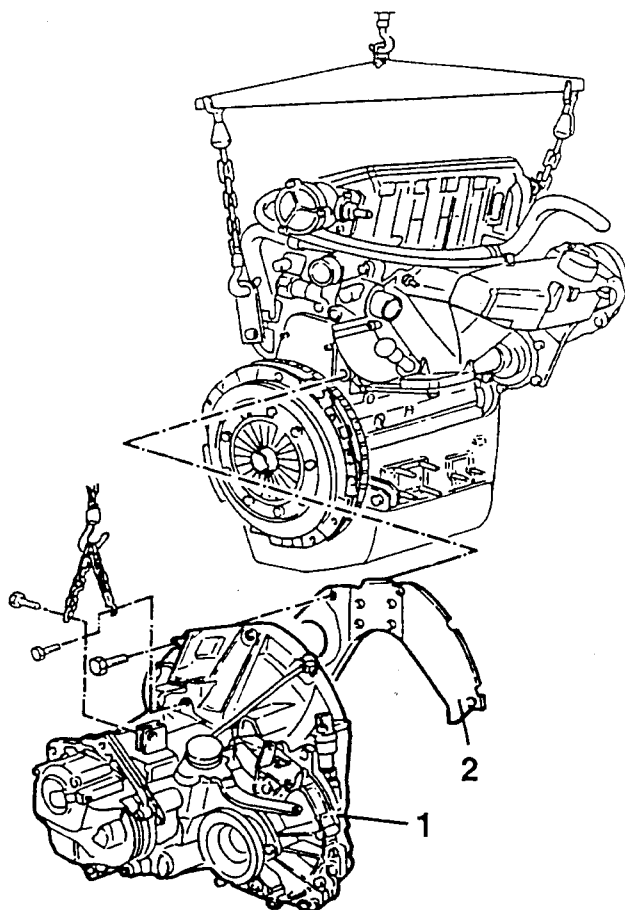
1. Unscrew the fastening screws and remove the starter motor.



1. Remove the engine unit elastic support timing side.



2. Recover the protective casing.

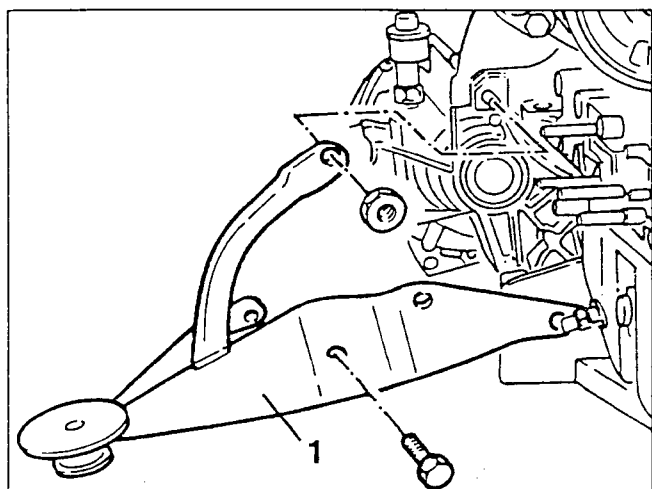


REMOVAL OF GEARBOX-DIFFERENTIAL GROUP

1. Removal of engine unit rear support.

CAUTION:

Stretch the chains of the engine support hydraulic lift, so that the engine is blocked by the support tool when the support is removed.



- Raise the engine enough to separate it from the support tool and the hydraulic jack.

1. Using a hydraulic lift unscrew the fastening screws and remove the gearbox - differential unit from the engine.

NOTE: See the specific volume for complete gearbox overhauling.

REFITTING

Repeat the above operations in the reverse order and note the following:

- Prepare the engine compartment for the insertion of the engine unit, positioning all the electrical cables, pipes etc. so as to avoid them becoming caught when the engine is installed.
- Be particularly careful when installing the engine unit that the components are not damaged in any way.
- When installation is completed, check belt tensioning, refill the cooling system, the power steering system and the engine lubricating system with the correct amount (see GROUP 00).
- Check the level of oil other fluids.
- Carry out all checks and interventions indicated in GROUP 00.

CAUTION:

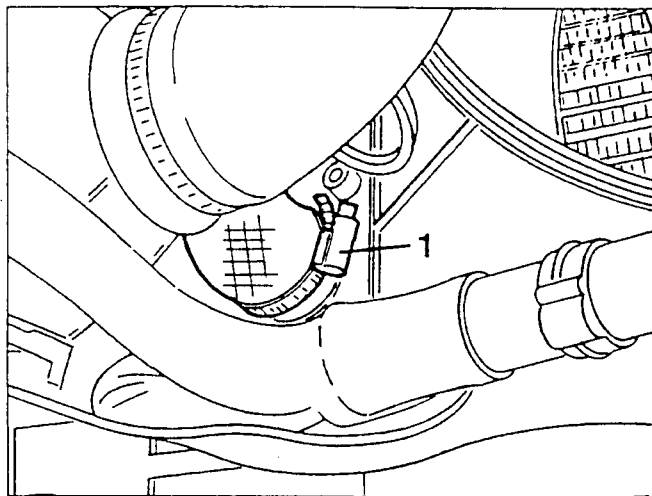
Ensure that the engine unit support points are correctly fixed.

CYLINDER HEADS

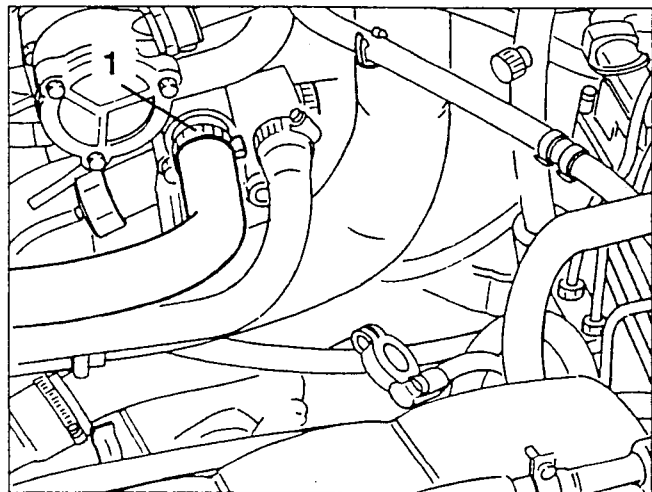
REMOVAL/REFITTING

- Remove the battery.

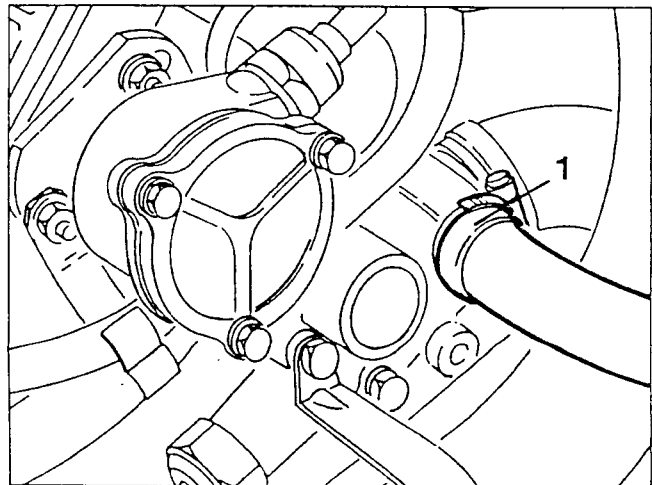
1. Drain off the engine coolant, by disconnecting the liquid from radiator outlet sleeve.



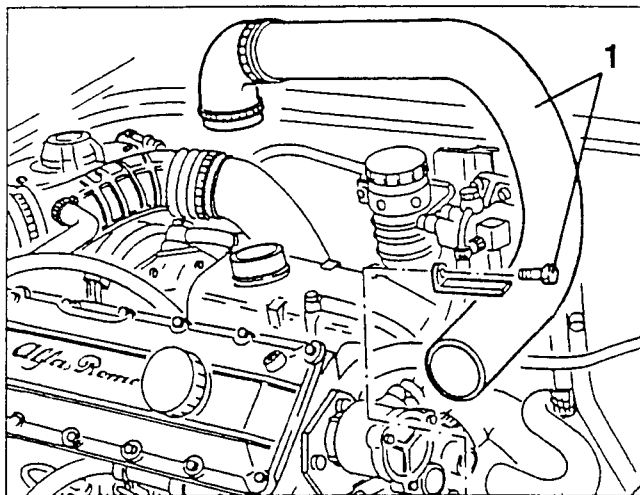
1. Disconnect the engine coolant to radiator delivery sleeve from the thermostatic cup.



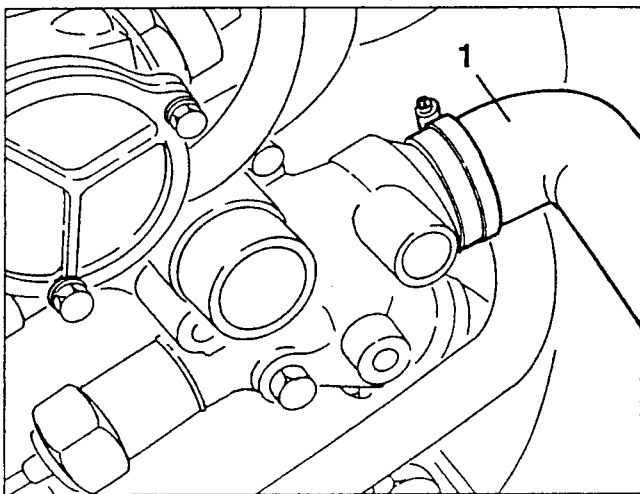
1. Disconnect the system loading sleeve originating from the expansion tank from the thermostatic cup.



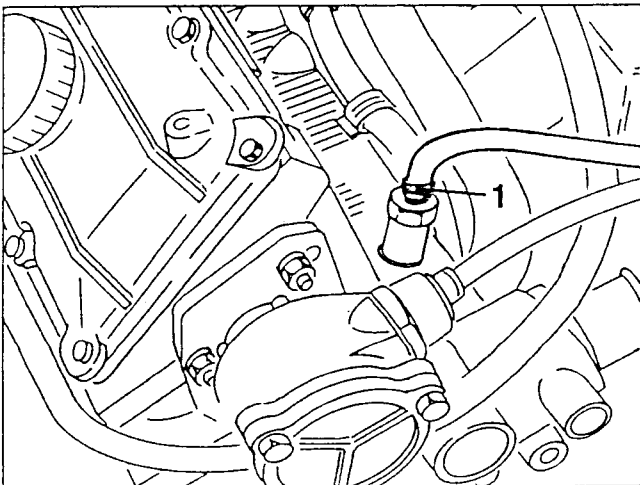
1. Remove the second section of the air from inter-cooler to air intake box delivery manifold.



1. Disconnect the engine coolant from radiator return sleeve from the thermostatic cup.

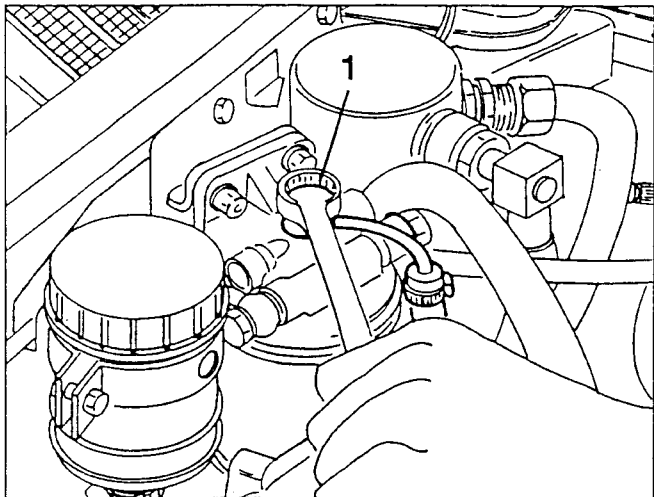


1. Disconnect the engine coolant to expansion tank and deaereating system delivery sleeve from the cylinder heads.

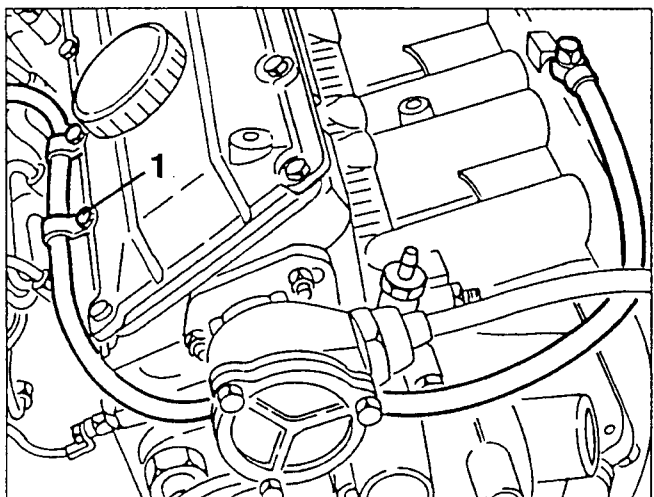


- Disconnect the oil vapour recirculation pipe from the corrugated air intake sleeve.

1. Disconnect the delivery pipe to the injection pump from the fuel filter.



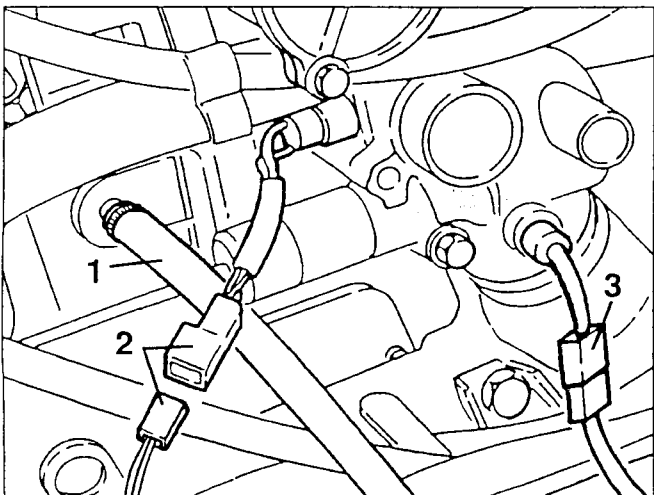
1. Disconnect the overpressure pipe for the flow rate limiting device from the intake box and timing gear cover.



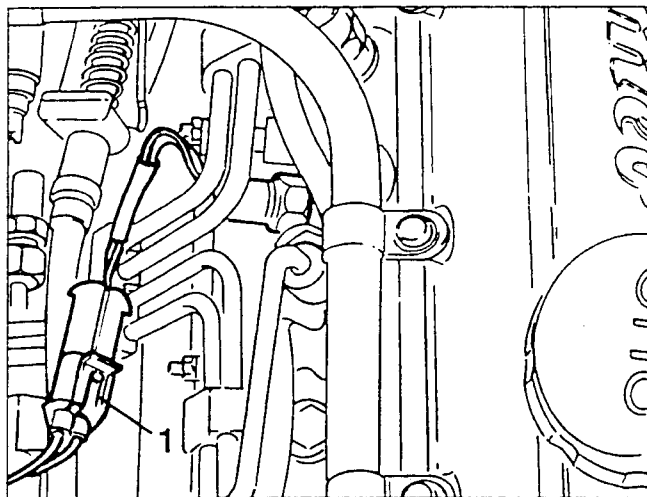
1. Disconnect the engine coolant to heater delivery pipe.

2. Disconnect the electrical connection of the KSB consensus thermoswitch.

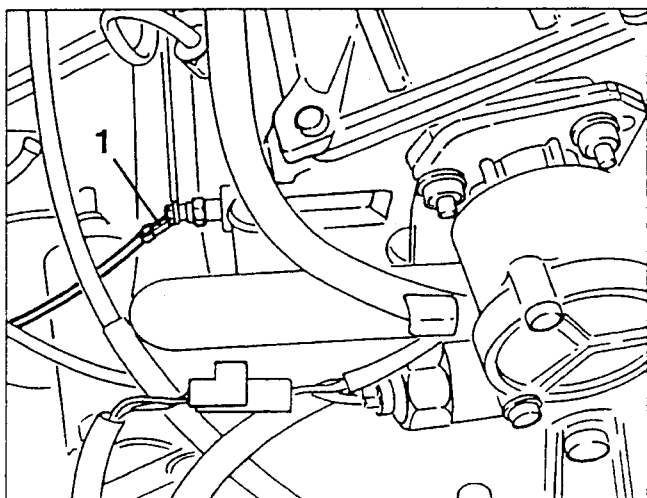
3. Disconnect the electrical connection of the conditioner compressor cut-off thermal contact.



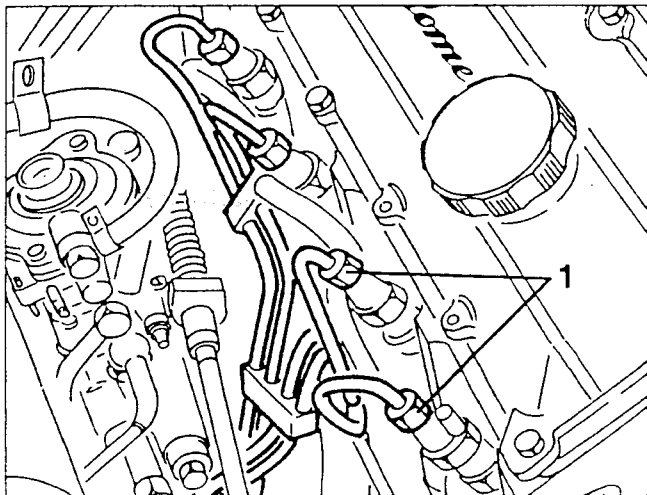
1. Disconnect the electrical connection of the engine coolant temperature indicator transmitter and the maximum temperature warning light contact.



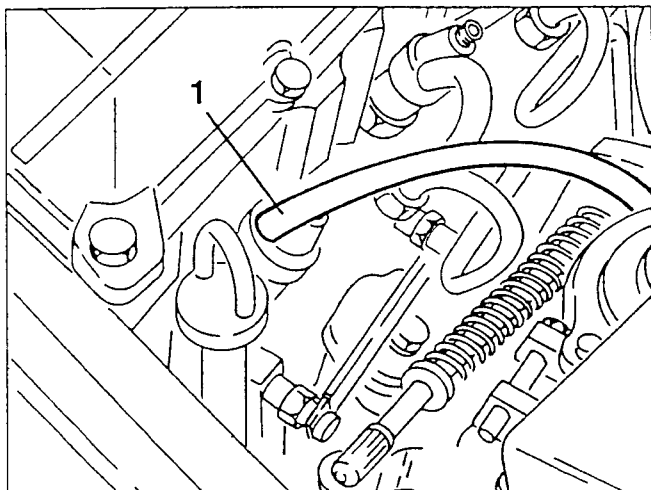
1. Disconnect the heater plugs supply electrical connection.



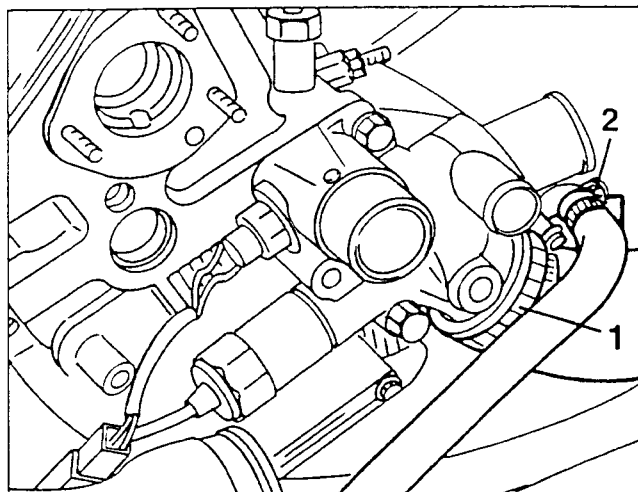
1. Disconnect the fuel from injection pump arrival pipe from the injectors.



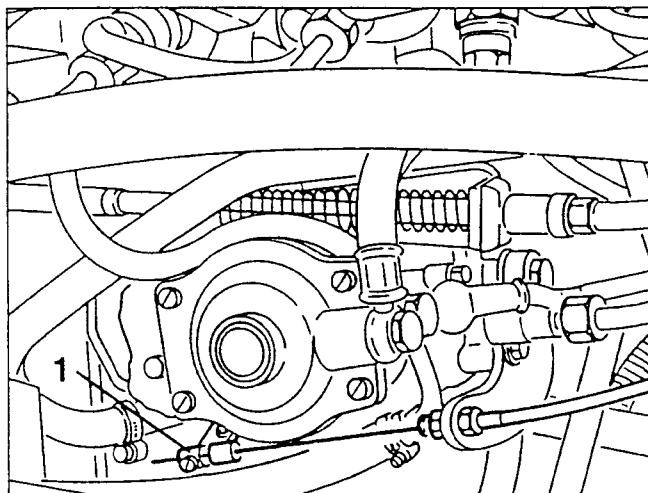
1. Disconnect the fuel return pipe from the injectors to the injection pump.



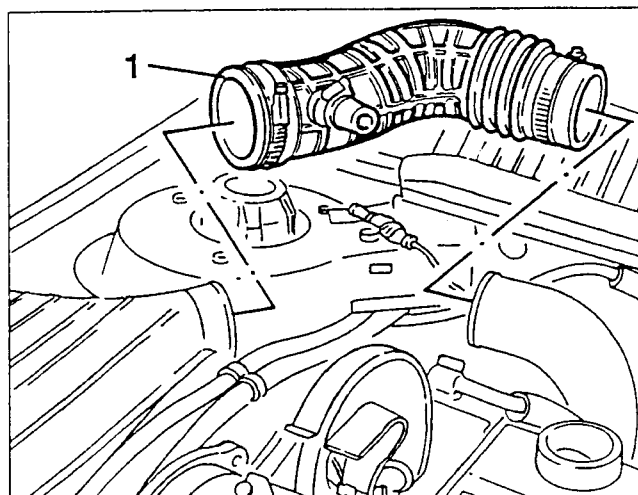
2. From the pump coolant fluid return manifold disconnect the sleeve for the fluid returning from the heater.



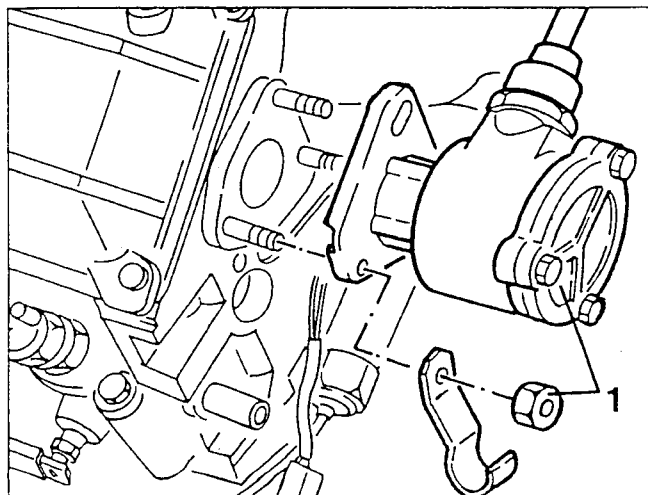
1. Disconnect the automatic idle speed device from the injection pump.



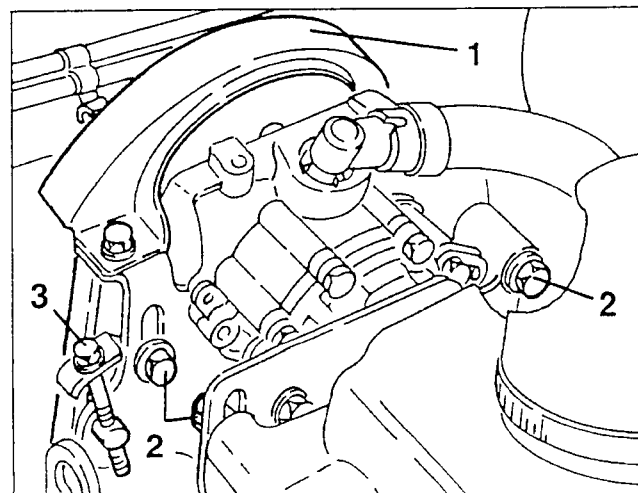
1. Remove the corrugated air from filter to turbo-charger intake sleeve.



1. Unscrew the screws and remove the rotor vacuum pump for the servo brake from the cylinder heads.

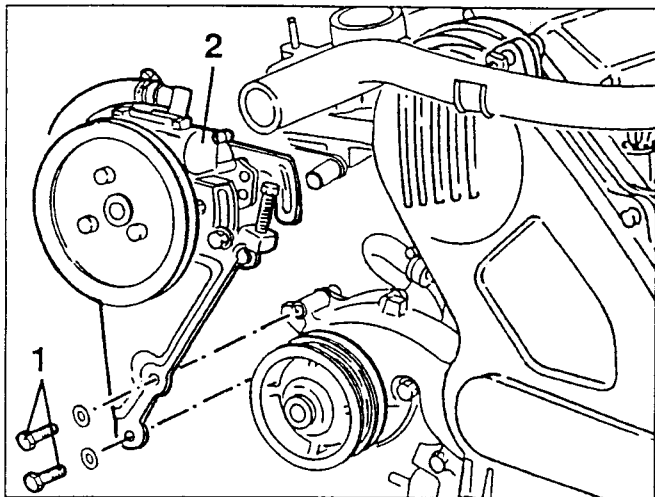


1. Remove the power steering pump belt guard.
2. Loosen the power steering fastening screws, indicated in the figure.
3. Decrease the voltage of the power steering pump control belt by acting on the micrometric tensioning screw.

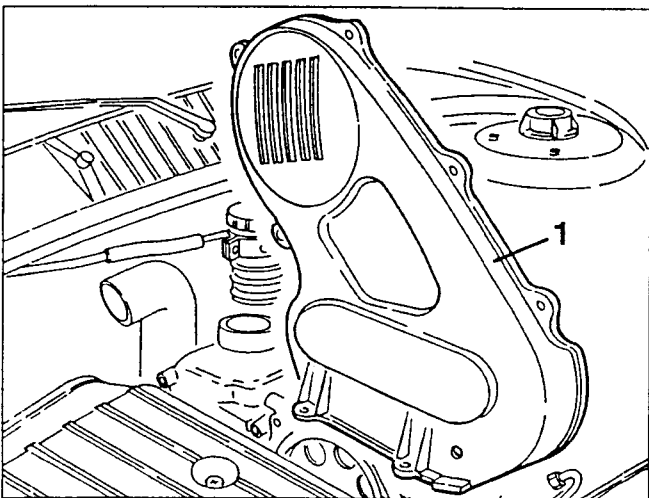


1. Disconnect the sleeve of the engine coolant to pump return manifold from the thermostatic cup.

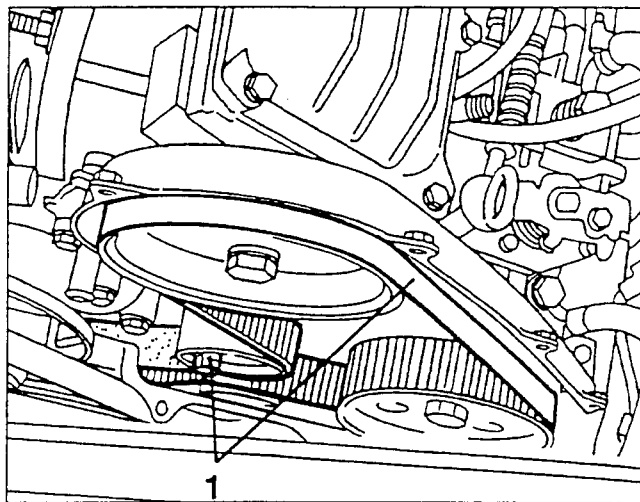
1. Unscrew completely the screws loosened beforehand and the two screws indicated in the figure.
2. Remove the power steering pump complete with front bracket without disconnecting the tubes and move them sideways.



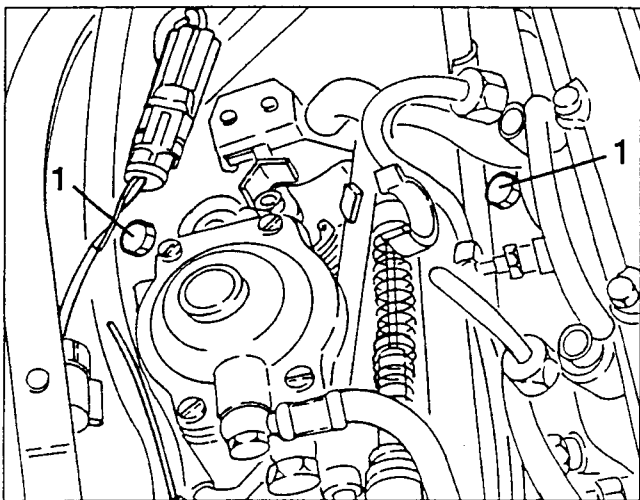
1. Remove the timing belt front cover.



1. Loosen the jockey pulley fastening screw and extract the timing belt from the camshaft control pulley.

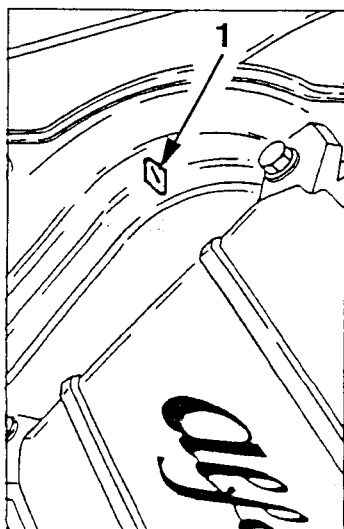


1. Unscrew the screws securing the timing belt rear cover.



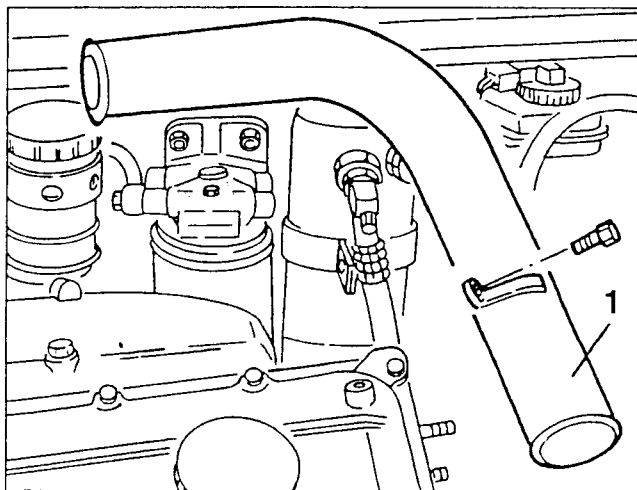
- Remove the right front wheel and mud flap.

1. Acting on the auxiliary part belt control pulley, rotate the crankshaft in order to rotate the camshaft control pulley so that the notch engraved on it corresponds with the hole on the timing belt rear cover.

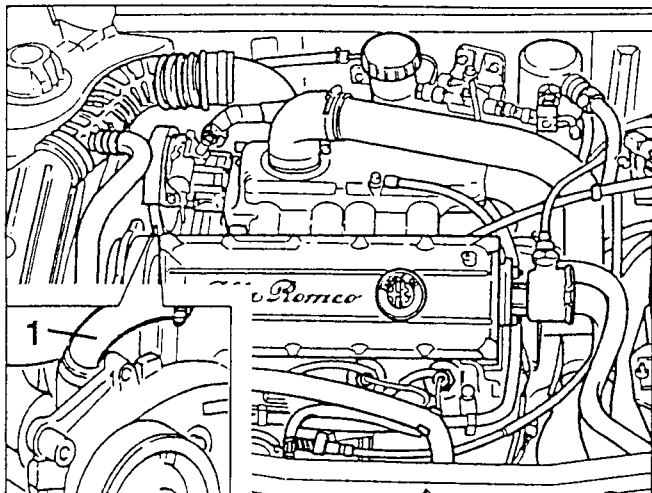


- Unscrew the screws securing the engine oil level dipstick.

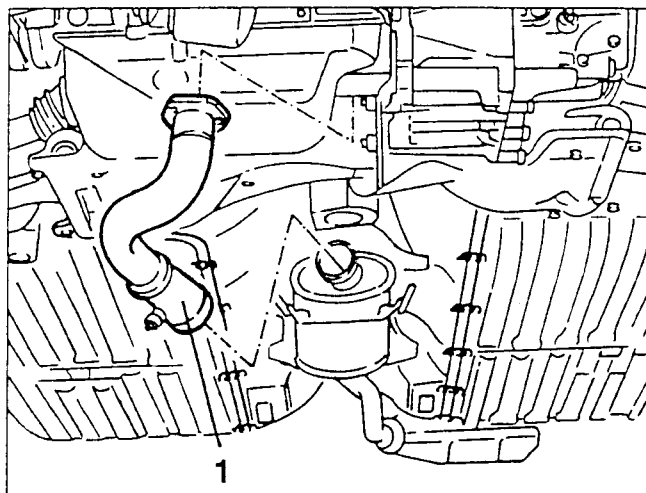
1. Remove the first section of the air delivery manifold from the turbocharger to the intercooler.



1. Disconnect the engine coolant to pump return pipe from the cylinder heads.

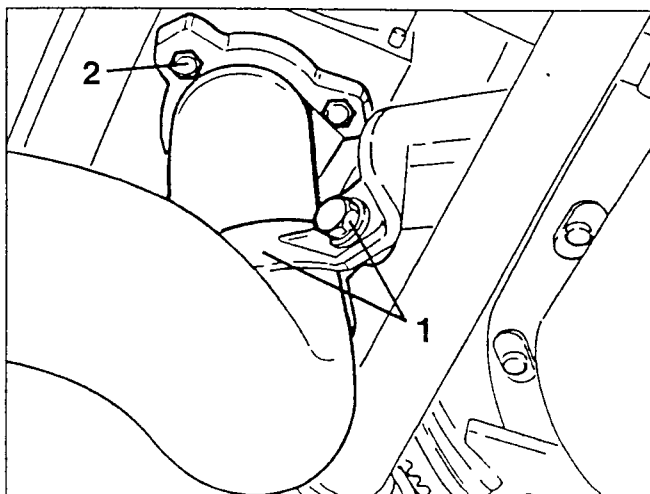


1. Remove the front section of the exhaust pipe.



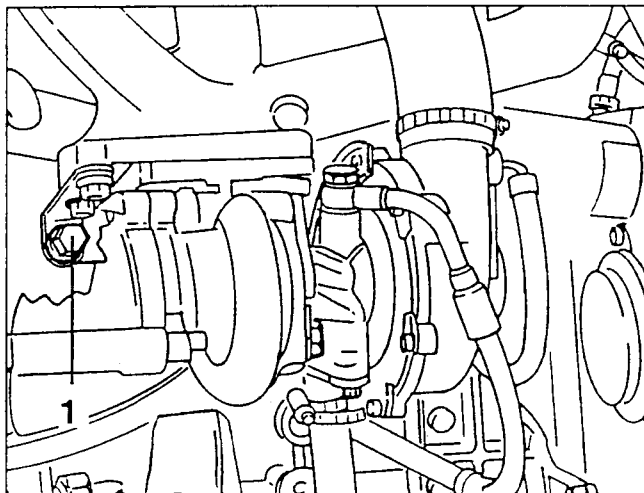
- Raise vehicle.

1. Remove the support clamp on the first section of the exhaust pipe.
2. Unscrew the screws securing the flange which connects the front section of the exhaust pipe to the turbocharger.

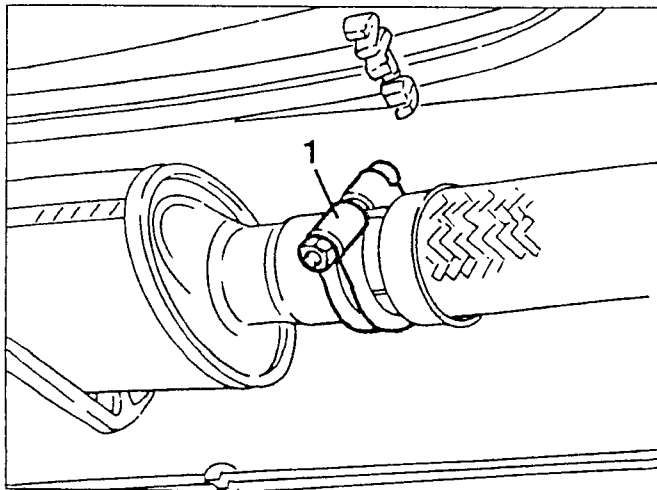


- Remove the support to the front section of the exhaust pipe.

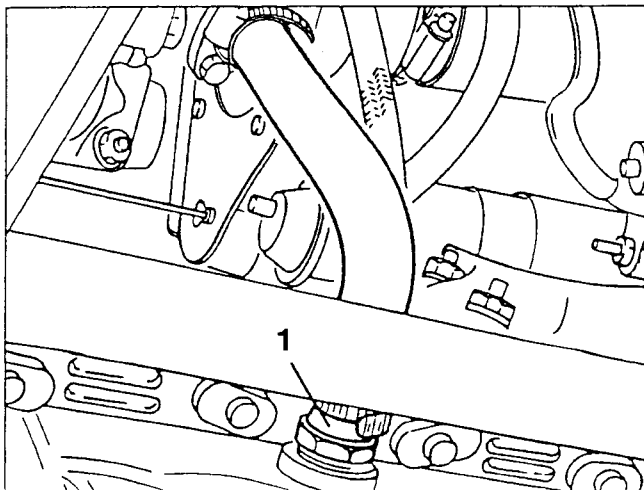
1. Unscrew the screw securing the turbocharger support bracket to the engine block.



1. Loosen the clamp securing the front section of the exhaust pipe to the central section.

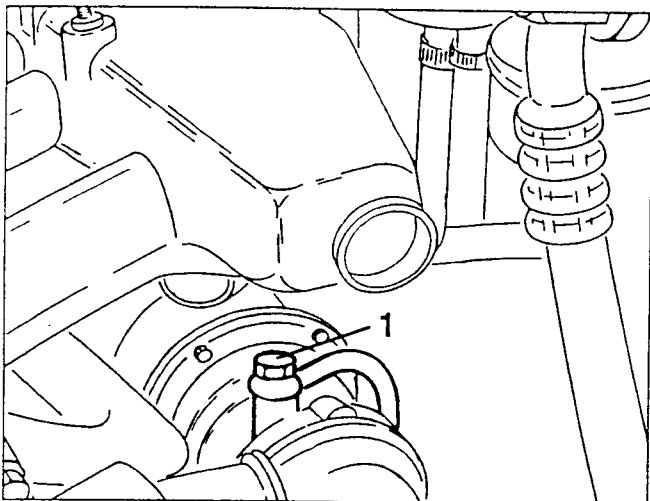


1. Disconnect the oil from turbocharger return pipe from the sump.

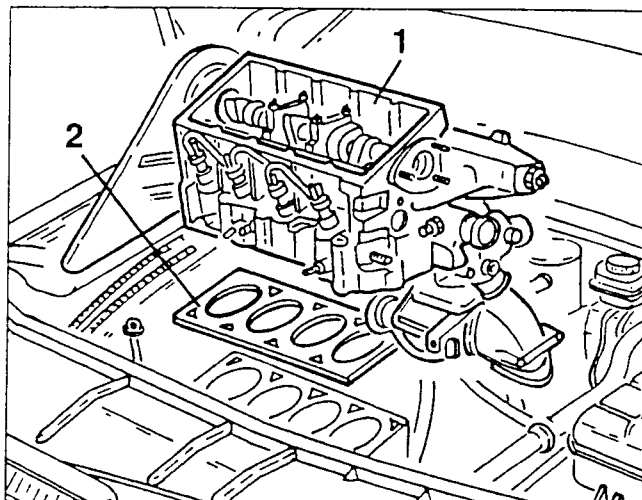


- Raise vehicle.

1. Disconnect the oil arrival pipe from the turbo-charger.

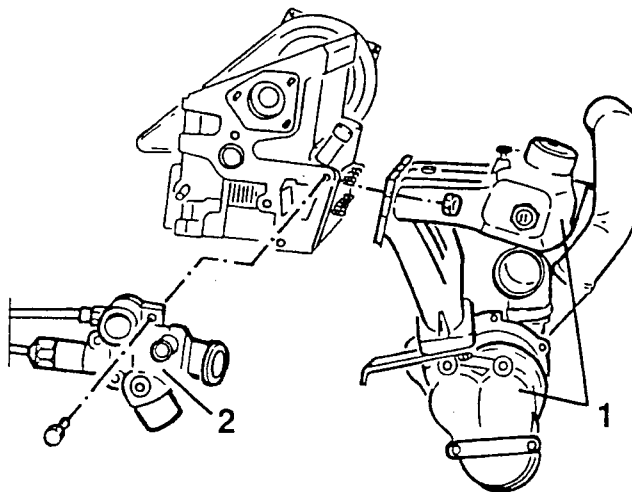
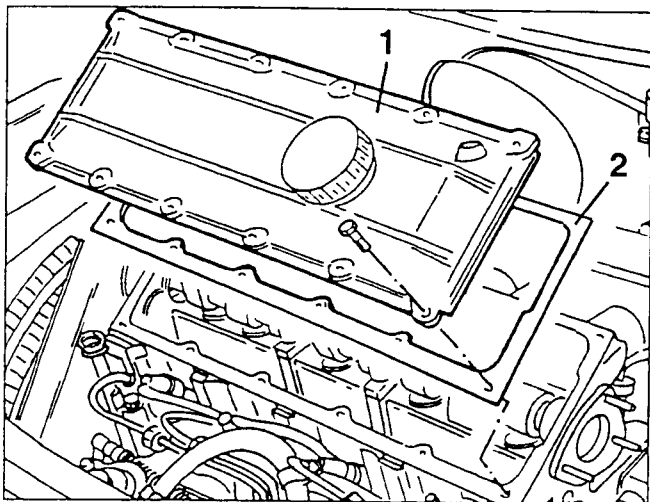


2. Remove gasket.

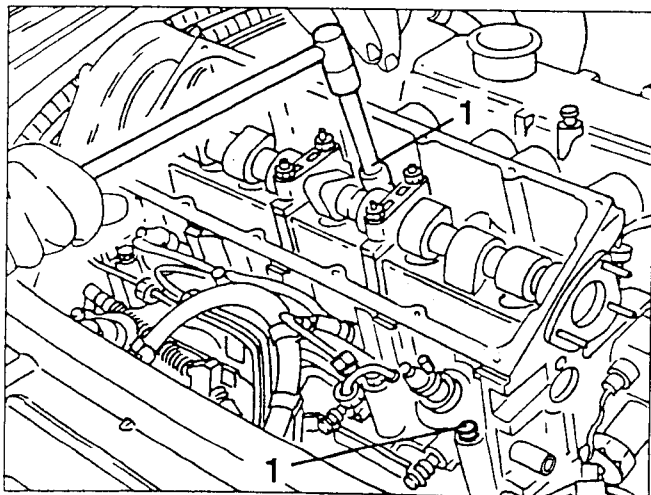


1. At the bench, remove the air intake box and the exhaust manifolds with turbocharger from cylinder heads.
2. Remove the thermostatic cup from the cylinder heads.

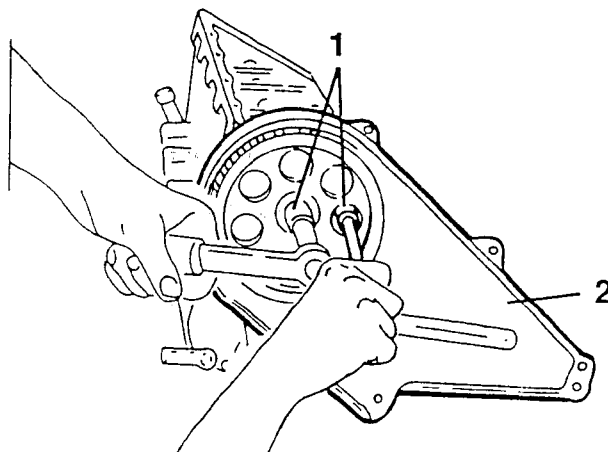
1. Unscrew the screws and remove the timing cover.
2. Remove gasket.



1. Unscrew the screws securing the cylinder heads.



1. Using a wrench of 13 mm, unscrew the screws and remove the timing control pulley.
2. Remove the timing belt rear cover.



1. Remove complete cylinder heads (two operators necessary).

WARNINGS FOR REFITTING

Repeat the above operations in the reverse order taking note of the following indications:

- Position a new cylinder head gasket on the engine block making sure that it is the same thickness as the one that has been removed.

NOTE: The cylinder head gasket is the ASTADUR type.

This gasket, due the special material from which it is made, undergoes a polymerization process when the engine is functioning so that it hardens significantly.

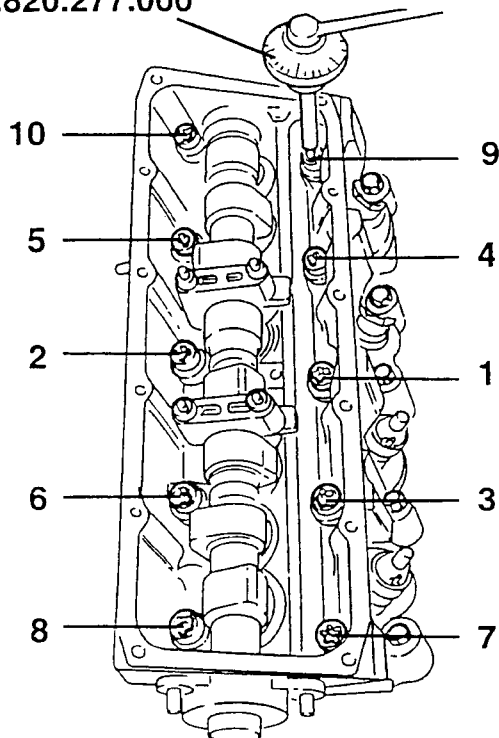
INSTALLING CYLINDER HEAD GASKET

In order that the polymerization process takes place, the following indications should be adhered to:

- keep the gasket in its packaging;
- only remove it from the packaging a short time before installation;
- do not lubricate or dirty the gasket with oil;
- during installation, thoroughly clean the surfaces of the cylinder heads and the engine block.

- Install the complete cylinder head on the engine block.
- Tighten the **internal screws** securing the cylinder heads operating as described below and follow the tightening order indicated in the figure.

1.820.277.000



- Tighten the **internal screws** to a torque of 100 Nm (10.2 kgm).
- Tighten the **internal screws** with angle of 90° + 90° with tool N° 1.820.277.000.
- Tighten **external** cylinder head **screws** to the engine block to the prescribed torque:



26 ÷ 32 Nm
2.6 ÷ 3.2 kgm

NOTE: For external cylinder head screws no particular order need be followed.



CAUTION:

The ASTADUR gaskets are connected with cylinder heads screws of the tighten to yield point type.

If the ASTADUR gasket is used, it is no longer necessary to tighten the cylinder screws.

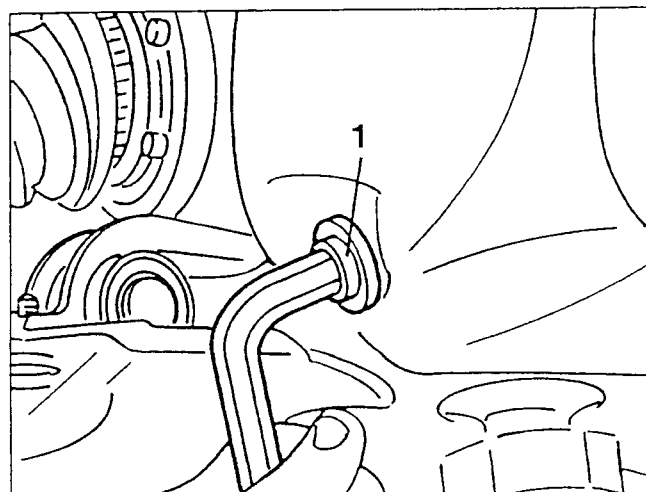


To install the timing drive belt, and check the timing, installation and tensioning of the power steering drive belt, see GROUP 00.

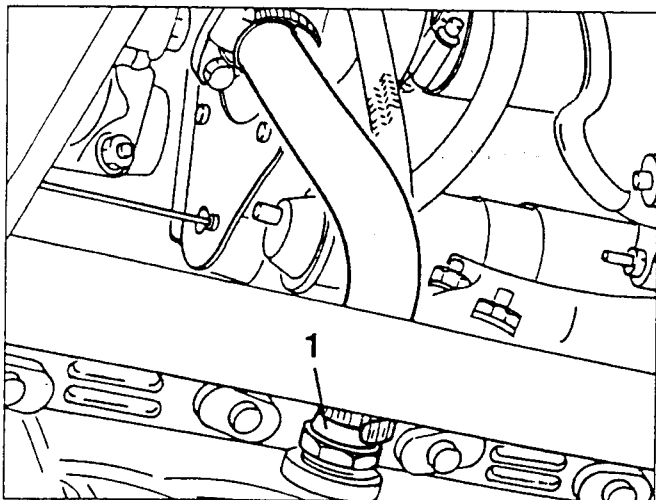
OIL SUMP

REMOVAL/REFITTING

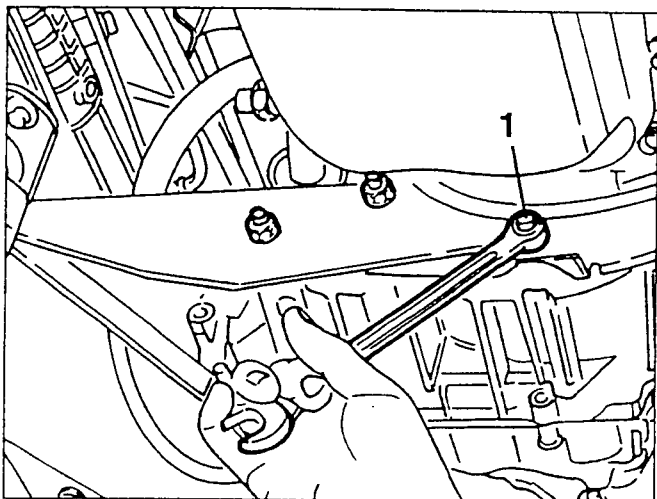
- Position the vehicle on the lift.
 - Disconnect the negative (-) battery cable.
 - Raise the vehicle.
1. Unscrew the plug, leave the engine oil to drain, and recover it in a suitable container.



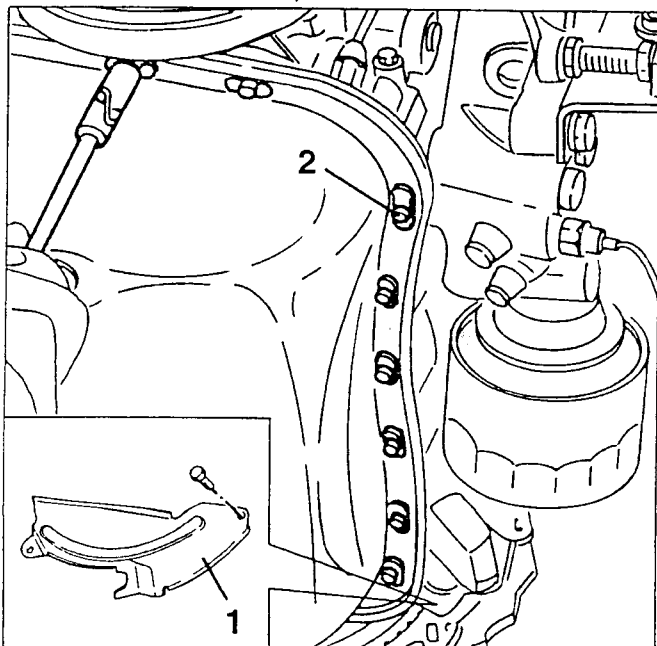
1. Disconnect the oil from turbocharger return pipe from the sump.



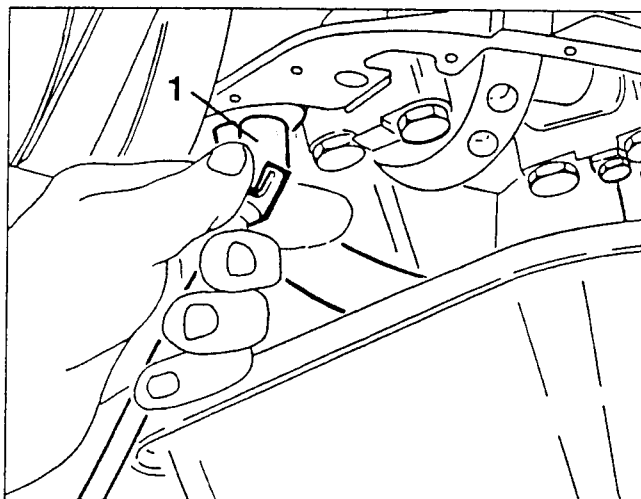
1. Loosen the front nut securing the gearbox to the relative support bracket.



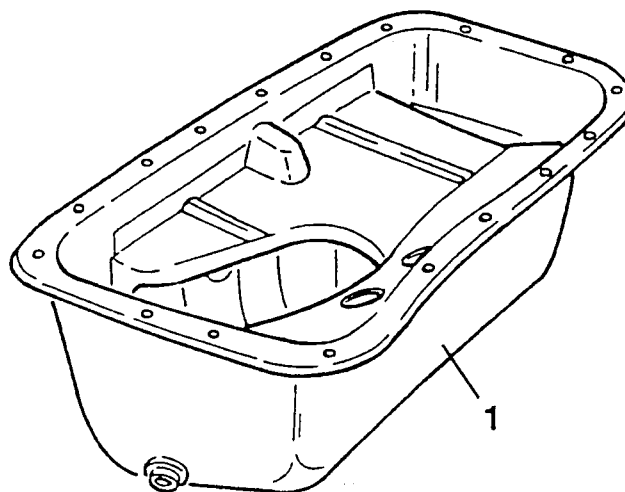
1. Unscrew the screws and remove the flywheel protection.
2. Unscrew the oil sump screws.



1. Lower the sump enough to loosen the oil pump suction device screws.



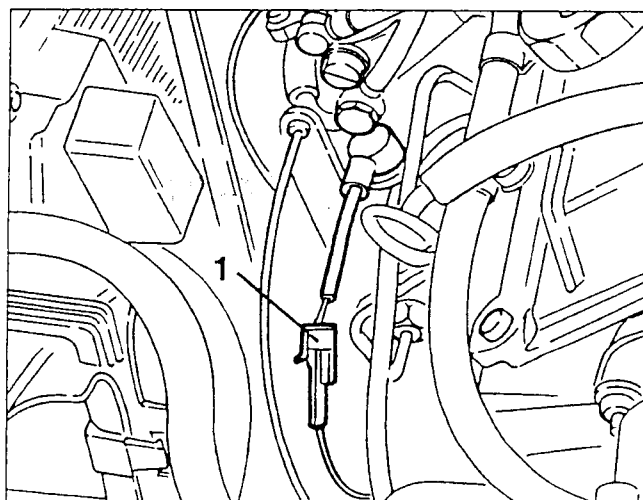
1. Remove the oil sump and the relative gasket.



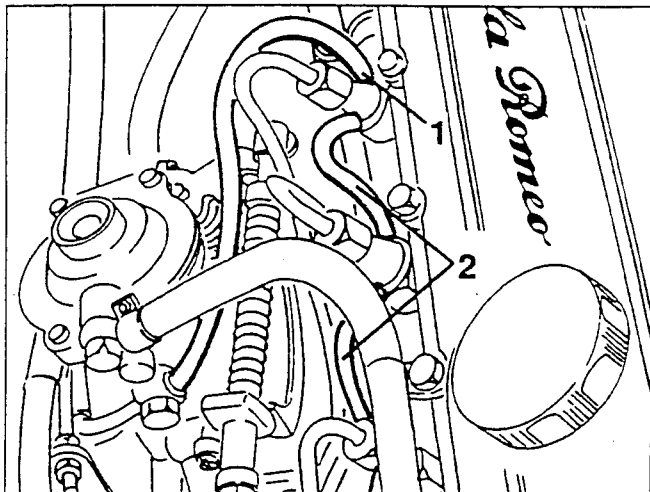
CYLINDER COMPRESSION TEST

- Start up engine and bring it to a normal running temperature.

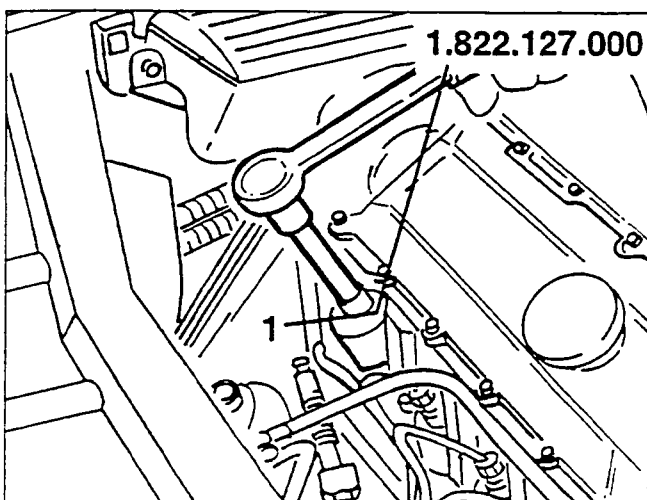
1. Turn off engine and disconnect the electrical connection of the engine stop solenoid valve.



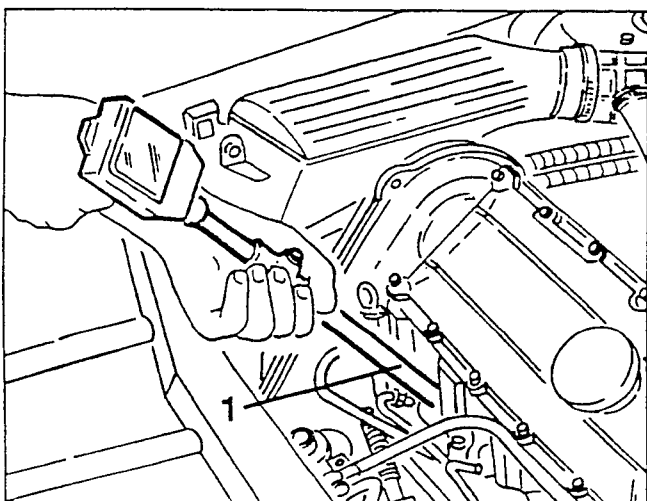
1. Disconnect the fuel to injection pump return pipe from the injectors.
2. Disconnect the fuel from injection pump arrival pipe from the injectors.



1. Remove the injectors from the cylinder heads using tool N° 1.822.127.000.



1. Using a suitable tool and operating as indicated by the manufacturer, carry out the cylinder compression test.



NOTE: If the pressure values in the cylinders are significantly different, search for the causes by checking the valve seals and, if necessary, the elastic seal rings and the pistons.

RPM SENSOR

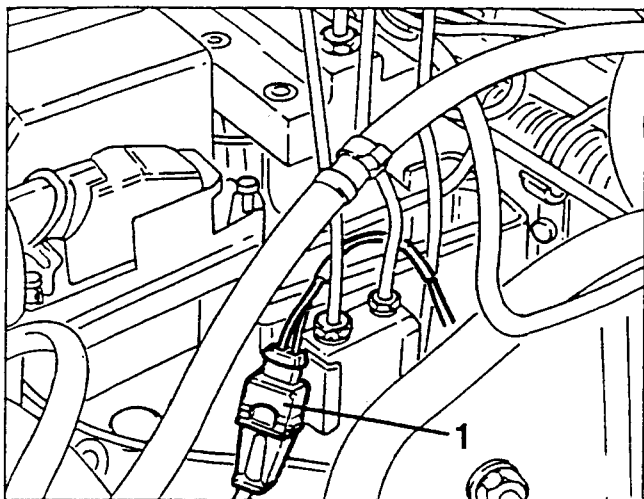
This is fitted on the flywheel ring gear so that it constantly reads the engine rpm.

The sensor is inductive and detects engine rpm through the change in the magnetic field produced by the passage of the teeth of the flywheel ring gear.

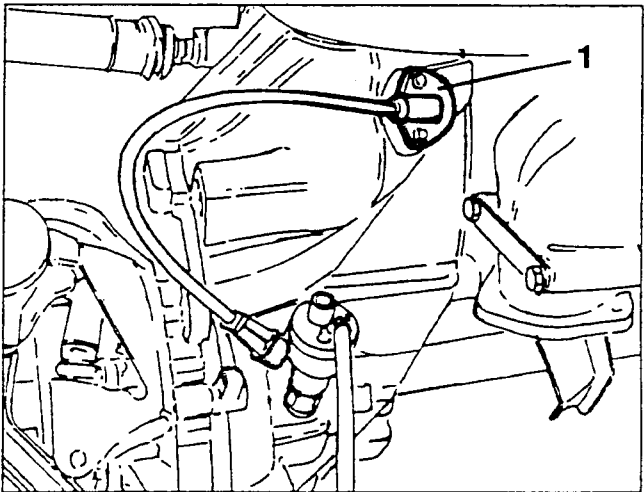
REMOVAL/REFITTING

- Disconnect the battery (-) terminal.

1. Disconnect the rpm sensor connection.



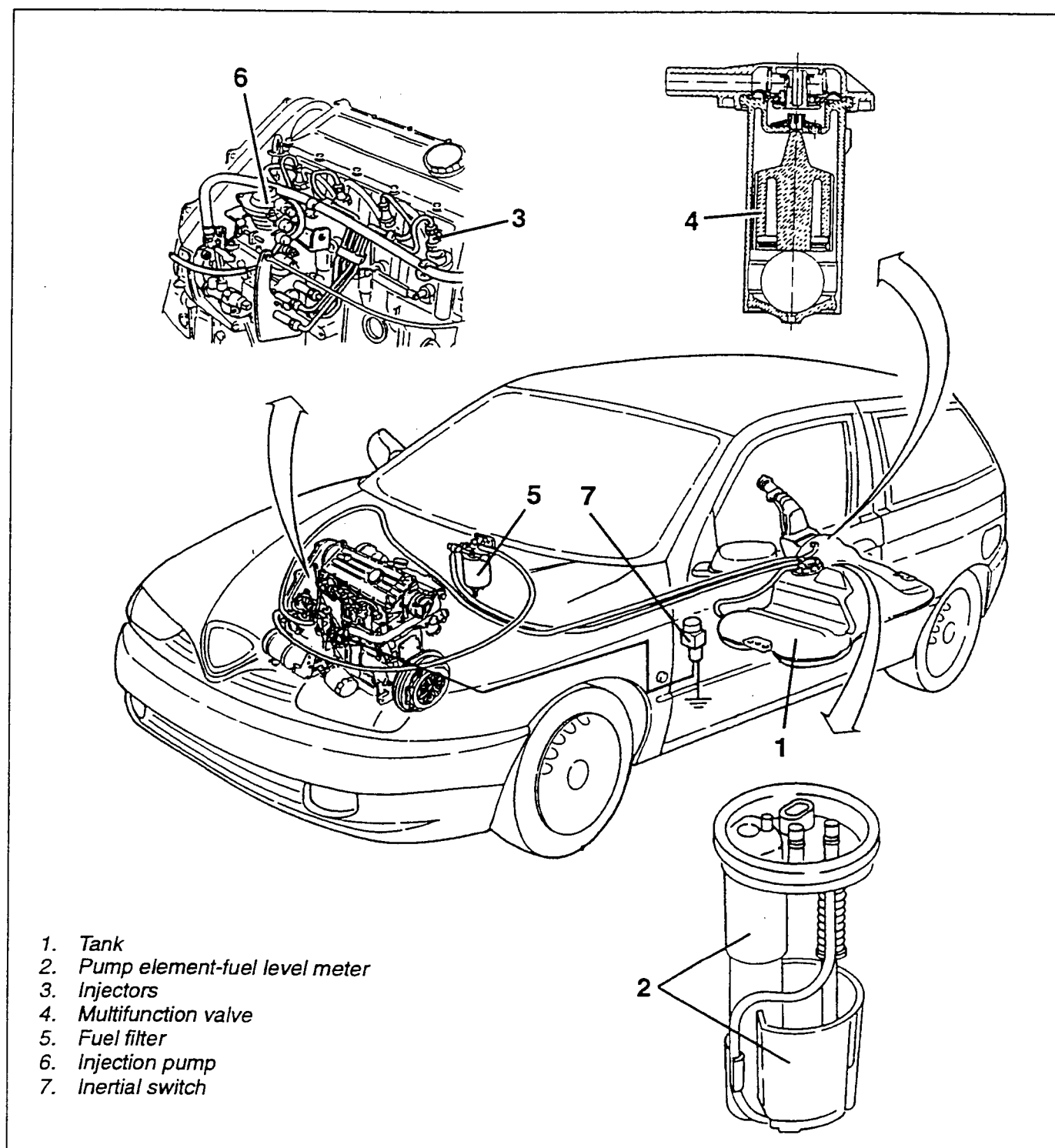
1. Raise the car, slacken the fastening screw and remove the rpm sensor.



CHECKING THE GAP

For this procedure refer to Boxer 16V engine.

Gap	0.25 ± 1.3 mm
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FUEL SUPPLY SYSTEM DESCRIPTION

1. Tank
2. Pump element-fuel level meter
3. Injectors
4. Multifunction valve
5. Fuel filter
6. Injection pump
7. Inertial switch

The fuel supply system consists of a suction device, situated in the tank, through which the fuel is sucked, filtered and sent to the fuel filter.

Here it is filtered and, if necessary, heated; it is then sent to the injection pump which sends it under pressure, through suitable metal pipes, to the injectors which force it into the precombustion chamber.

A pipe collects the fuel which has been drawn by the injectors and sends it to a three way connector on the

injection pump from where, together with any excess fuel, it returns to the tank.

The fuel supply system is fitted with an inertial switch located under the driver's seat, which is triggered in the event of a crash cutting of the circuit that supplies the engine stop electromagnet on the injection pump thereby stopping the engine immediately.

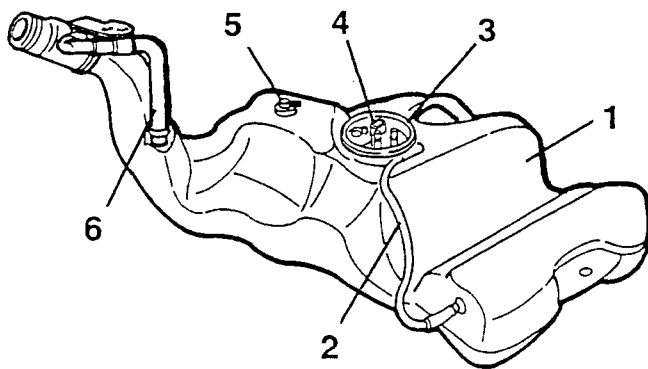
CAUTION:

Before operating on any of the fuel supply components, closely follow the indications below:

- Check that all the necessary safety equipment is available in the workshop (extinguishers, etc.).
- Disconnect the battery earth cable to avoid the voltage cables accidentally coming into contact with the bodywork causing sparks which may cause fires.
- Place the drained fuel in a suitable container with a safety lid.
- Do not smoke or use naked flames nearby.

Note regarding refuelling:

Pay very close attention that the fuel tank is not accidentally filled with petrol; if this should happen, **do not start the engine**, but empty the tank and bleed the entire diesel supply system; if these indications are not followed the engine will be seriously damaged. Always refuel before the tank is completely empty, to prevent air from entering the supply system; if this happens the entire system must be bled before the engine is started.

FUEL TANK

1. Tank
2. Air breather pipe between the low and high part of the tank.
3. Pump element-fuel level meter
4. Filler neck
5. Multifunctional valve
6. Antibubbling pipe

The fuel tank is made from plastic and has a capacity of 51 litres, including a 5 + 8 litres reserve.

The refuelling neck is integrated into the main part of the tank which is fitted with the most recent type of filler cap.

A mechanism within the cap ensures that it is tightened to the prescribed torque; overtightening is prevented by a clicking device.

The tank is fixed under the body in correspondance with the parcel shelf and the back seat, there is a compartment designed in the most suitable way to prevent interference with the rear suspension axle.

The particular shape of the tank requires a breather pipe which allows air to be taken in the upper part of the tank during refuelling.

The corrugated pipe on the filler neck acts as an antibubbling pipe.

Higher up, the tank has an opening which houses the suction device - fuel level meter assembly and the multifunctional valve.

REMOVAL/REFITTING

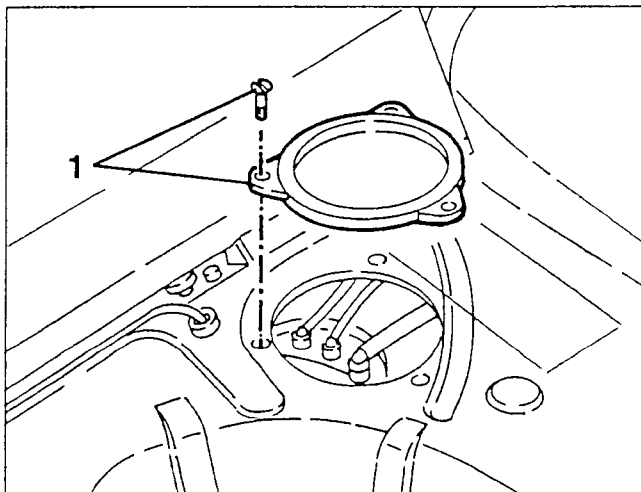
- Position the vehicle on a lift.
- Disconnect the battery (-) terminal
- Empty the tank by sucking the fuel through the filler neck with a suitable pump.

**CAUTION:**

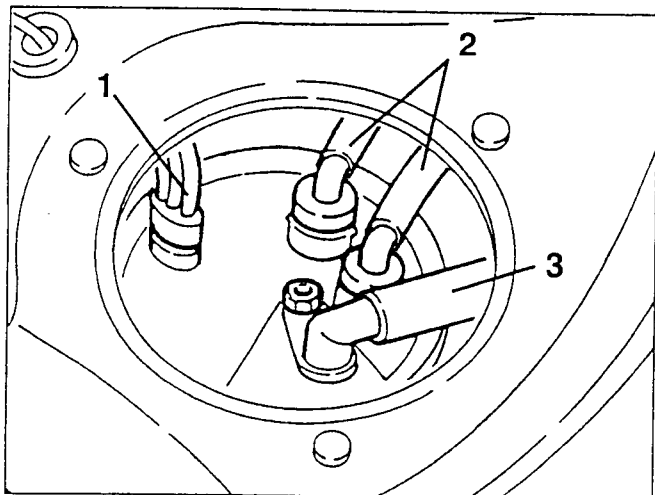
Place the fuel drained from the tank in a suitable container.

- Remove the rear right wheel.

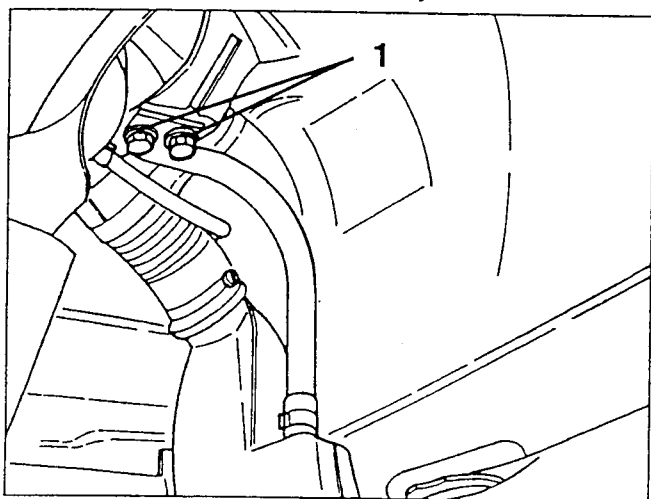
1. Working from the luggage compartment, pull back the trim and remove the lid to gain access to the pump element-fuel level meter.



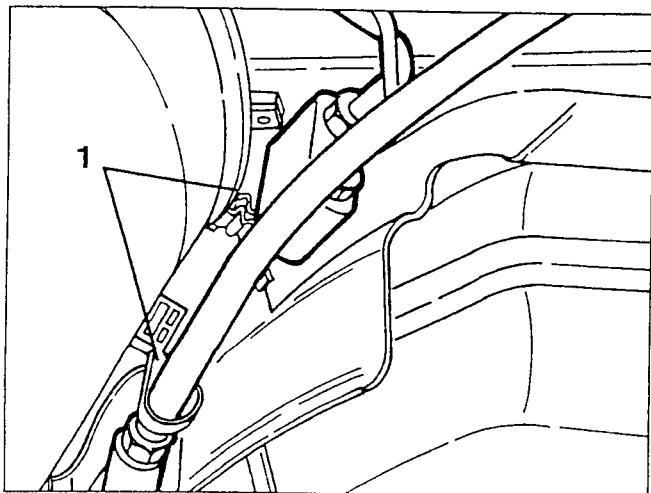
1. Disconnect the electrical connection from the fuel level meter.
2. Disconnect the connection from the fuel delivery and return hoses.
3. Loosen the nut and disconnect the air breather hose connecting the upper and lower parts of the tank.



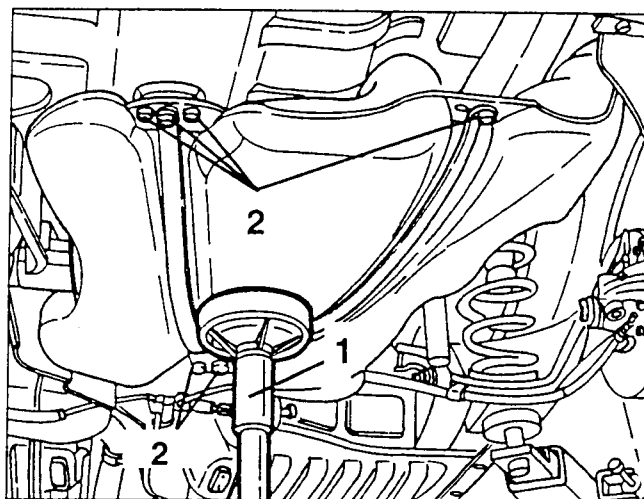
1. Operating from the wheel arch, unscrew the screws securing the filler neck to the body.



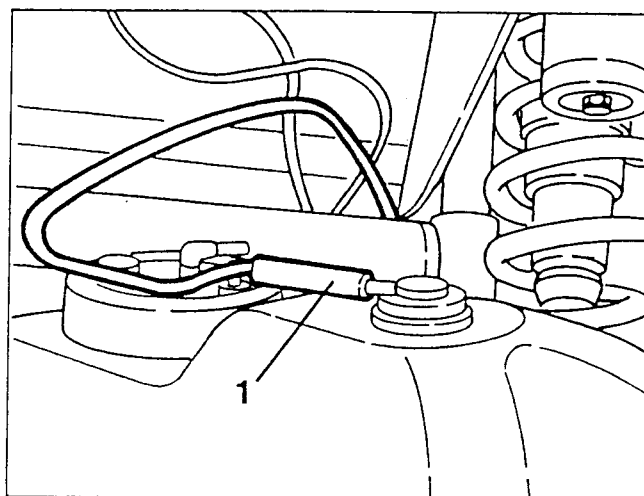
1. Disconnect the handbrake cables and brake pipes from the fastenings on the fuel tank.



1. Set a hydraulic jack under the fuel tank.
2. Prise off the plastic buttons and slacken the fuel tank fastening screws.

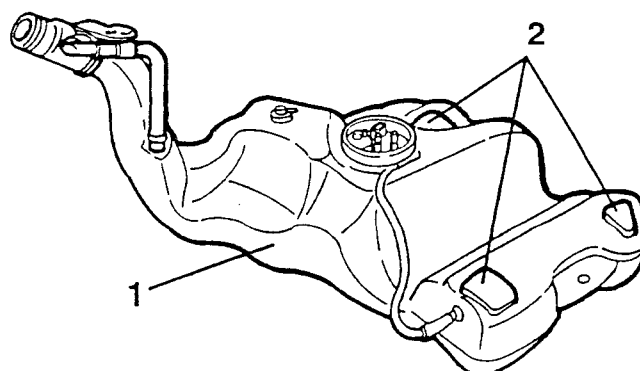


1. Using the hydraulic jack, lower the fuel tank just enough to disconnect the fuel vapour breather pipe from the multipurpose valve.



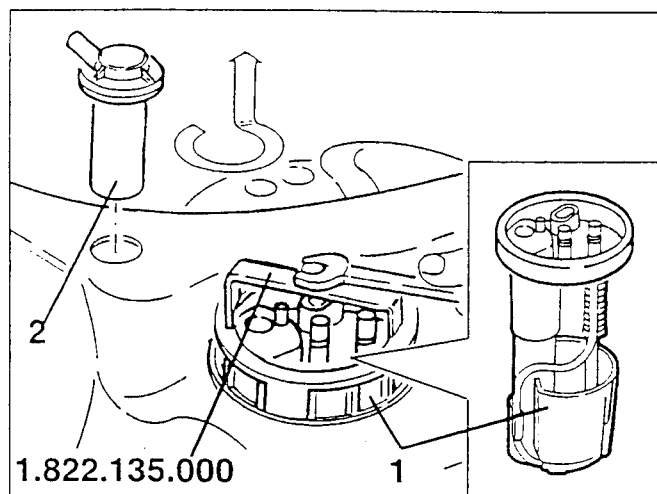
1. Completely lower the hydraulic jack and remove the fuel tank.

When refitting the fuel tank, check the presence of the rubber pads (2) on it.

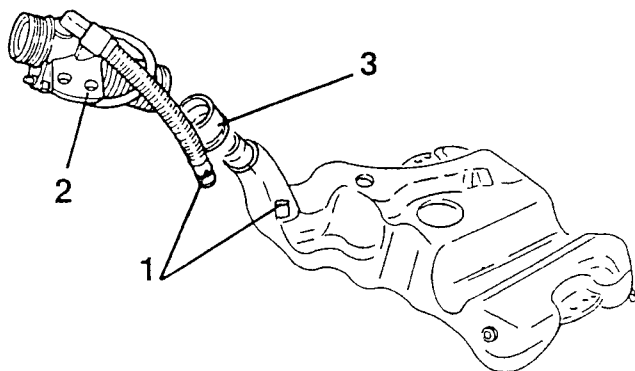


DISASSEMBLY/REASSEMBLY

1. Using tool N° 1.822.135.000 remove the ring-nut and withdraw the pump element-fuel level meter from the tank.
2. Remove the multifunctional valve.



1. Disconnect the anti-flow back tube from the fuel tank.
2. Slacken the clamp and remove the complete fuel filter.
3. Remove the seal.

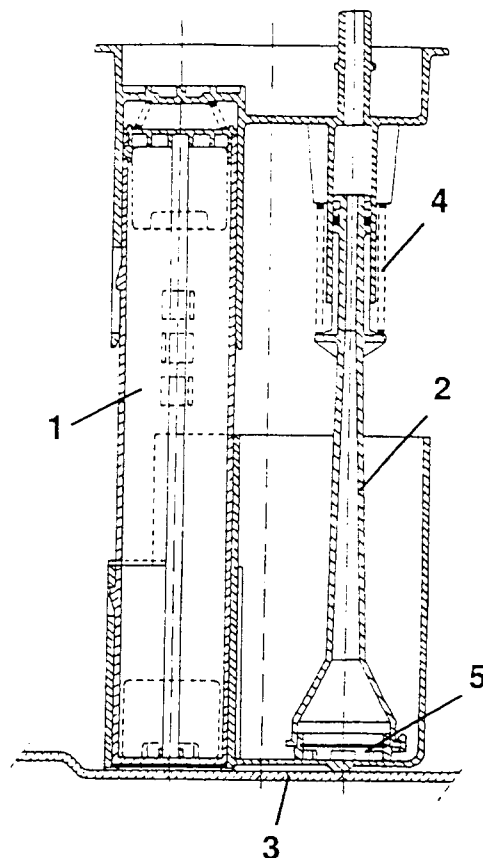
**PUMP ELEMENT-FUEL LEVEL METER**

This is fixed to the tank using a threaded plastic ring nut.

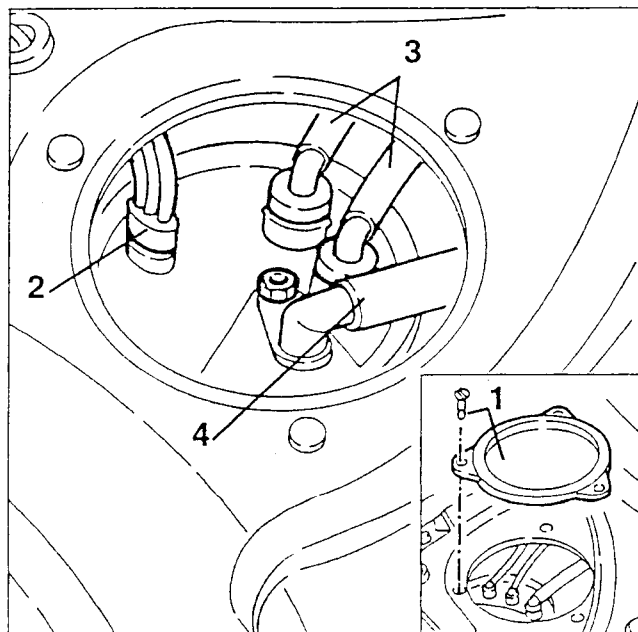
The fuel level gauge (1) incorporated in the suction unit cannot be replaced alone.

This suction system consists of an "elastic" intake tube (2) which runs along the bottom of the tank (3) itself via a spring (4) fitted on the tube itself.

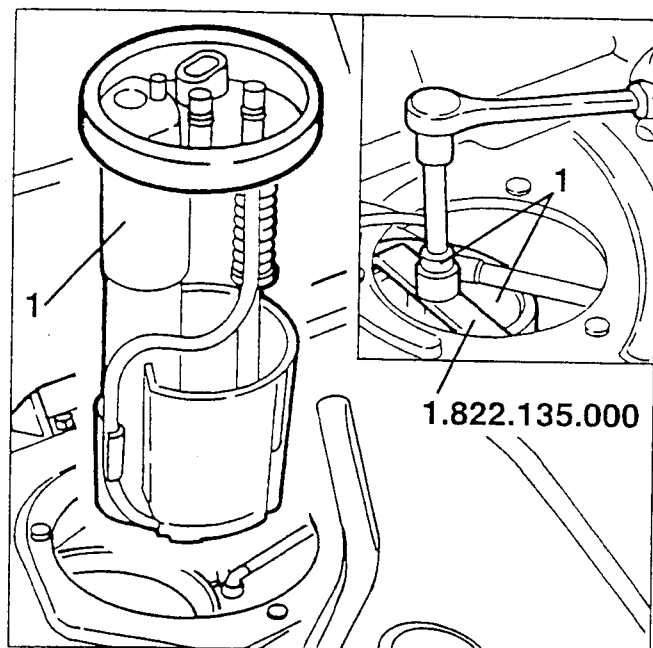
The suction device (5) is fitted on the end of the intake tube with a built-in wire gauze filter.

**REMOVAL/REFITTING**

- Disconnect the negative cable from the battery.
- 1. Working in the luggage compartment tip back the covering and remove the pump element-fuel level meter access cover.
- 2. Disconnect the electrical connection from the fuel level meter.
- 3. Disconnect the fuel delivery and return hose unions.
- 4. Loosen the nut and disconnect the air breather hose connecting the lower and upper parts of the tank.



1. Using tool N° 1.822.135.000 remove the ring-nut and withdraw the pump element-fuel level meter from the tank.



• Anti roll-over and anti-tipping up

In the lower part of the valve body there is a conic seating, which houses a suitable weighted sphere (5) which, rotating on that seating, under the centrifugal thrust which the vehicle transmits to it, lifts and closes the needle valve (6) to prevent the fuel from spilling if the vehicle rolls or turns over.

If the needle valve (6) blocks and its conic end blocks the passage of the fuel vapours out into atmosphere, there is a safety valve (7) which prevents pressure from building up in the tank.

The safety valve diaphragm (7) opens allowing the passage of fuel vapours through a calibrated hole when the tank reaches a pressure of $0.1 \div 0.2$ bar.

REMOVAL/REFITTING

Follow "REMOVAL/REFITTING FUEL TANK".

FUEL FILTER

MULTIFUNCTION VALVE

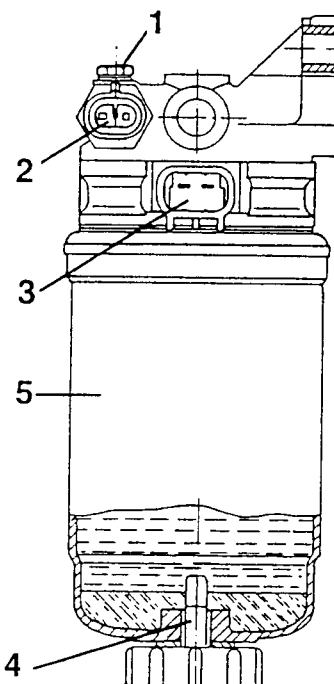
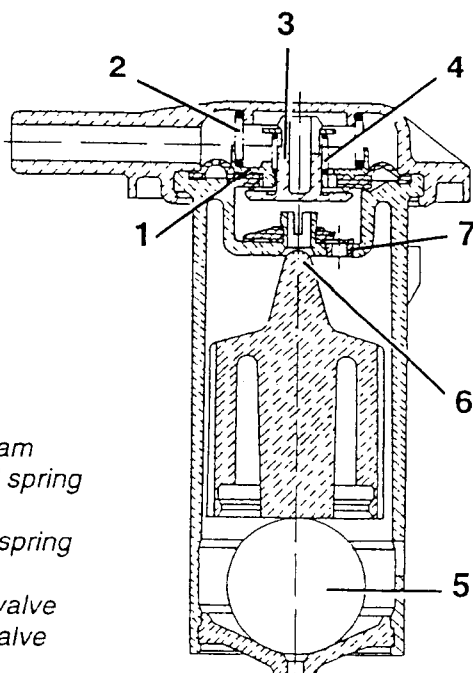
The functions of this valve are:

• Fuel vapour breather pipe

when the pressure reaches a value of $0.055 \div 0.075$ bar the diaphragm (1) opposed by a spring (2) allows the fuel vapours in the atmosphere to be sucked in.

• Tank ventilation

to ventilate the tank with vacuum values lower than -0.020 bar, the cup (3) acting on the diaphragm (1) opposed by a spring (4), allows air to be intaken into the tank.



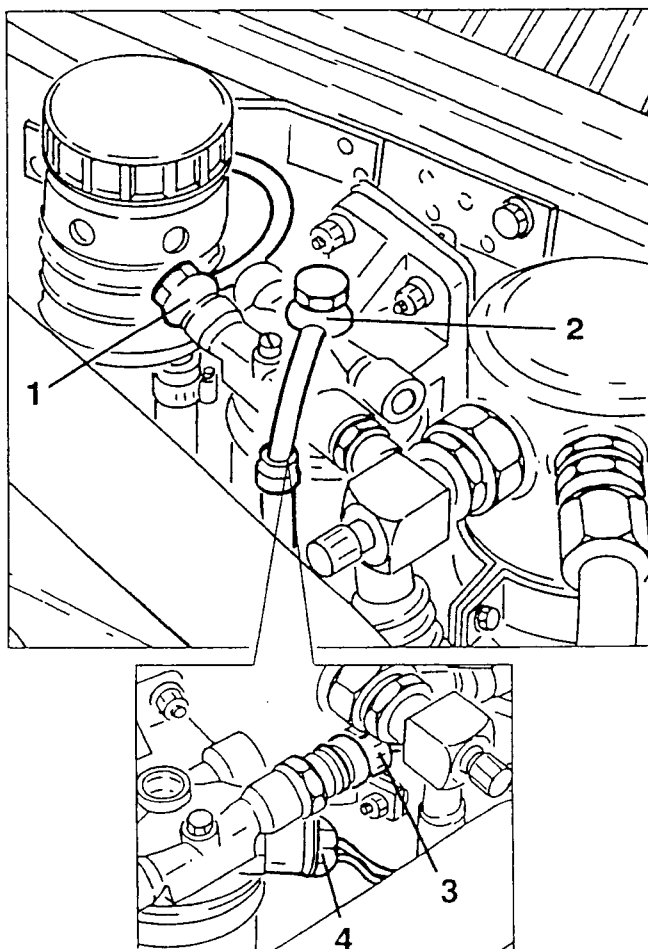
1. Bleed screw
2. Fuel preheating device control sensor
3. Fuel preheating device supply connector
4. Water drain cap
5. Fuel filter cartridge

The fuel filter is fitted in the engine compartment and is inserted into the fuel from tank to injection pump delivery pipe.

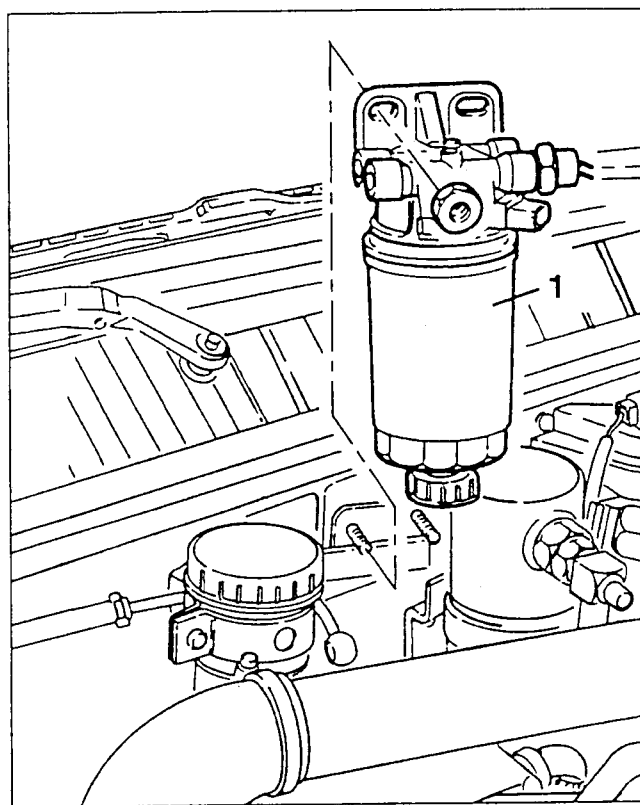
It is of the cartridge type with a filtering element consisting of a pack of paper disks with a filtering surface of 5300 cm^2 and a filtering degree of $4 + 5 \mu\text{m}$. The filter is fitted with a fuel preheating device, controlled by a thermo switch fitted on the filter itself. When the diesel temperature is lower than 6°C an electric resistance heats it to a maximum temperature of 15°C before sending it to the injection pump. At the base of the fuel filter cartridge is a cap used to drain water from the filter.

REPLACEMENT OF FUEL FILTER CARTRIDGE FILTER

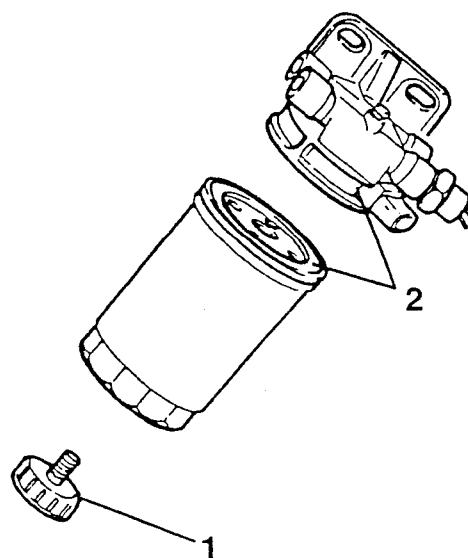
- Disconnect the negative (-) battery cable.
- 1. Disconnect the fuel from tank arrival pipe connector from the filter.
- 2. Disconnect the fuel to injection pump delivery pipe connector from the filter.
- 3. Disconnect the electrical connection from the fuel preheating device control sensor.
- 4. Disconnect the electrical supply connection of the fuel preheating device.



1. Unscrew the two nuts and remove the complete fuel filter.



1. Working on a bench remove the water drainage cap from the fuel filter.
2. Unscrew the filter cartridge with the relative gasket from the support.

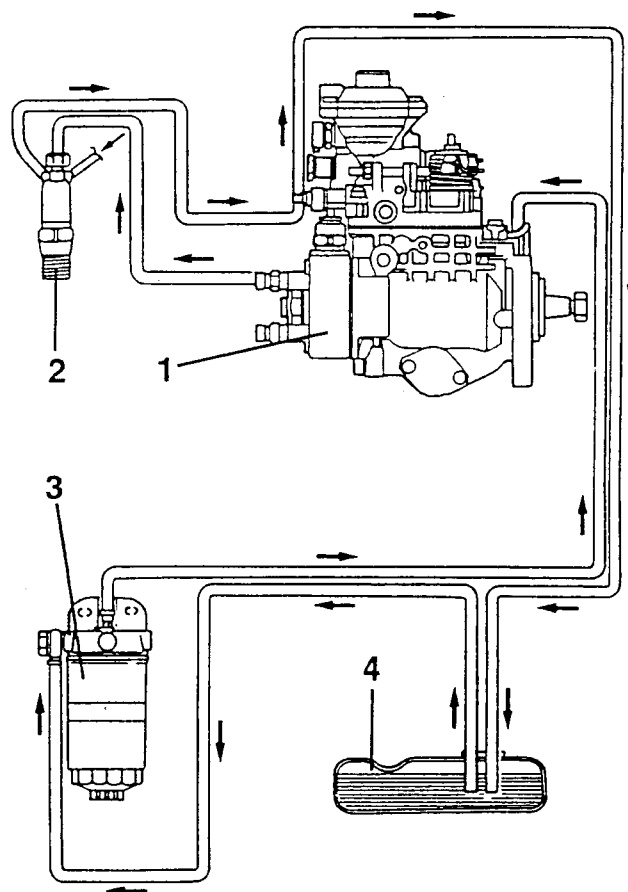


- Fit a new cartridge with relative gasket on the fuel filter support.
- Fit the water drainage cap onto the fuel filter and then refit by reversing the procedure followed for removal.
- Bleed the air from the fuel supply system (see specific paragraph).

BLEED AIR FROM THE FUEL INJECTION PUMP HYDRAULIC CIRCUIT

If the engine stops because it has run out of fuel, or if the fuel low pressure tubes become disconnected, or if the fuel filter has been replaced, the following indications should be followed to facilitate the self-triggering of the injection pump:

- loosen the delivery connectors on the injectors;
- start-up the engine until fuel starts to come out from the injectors' open connectors;
- close the injector connectors whilst the engine is still running.

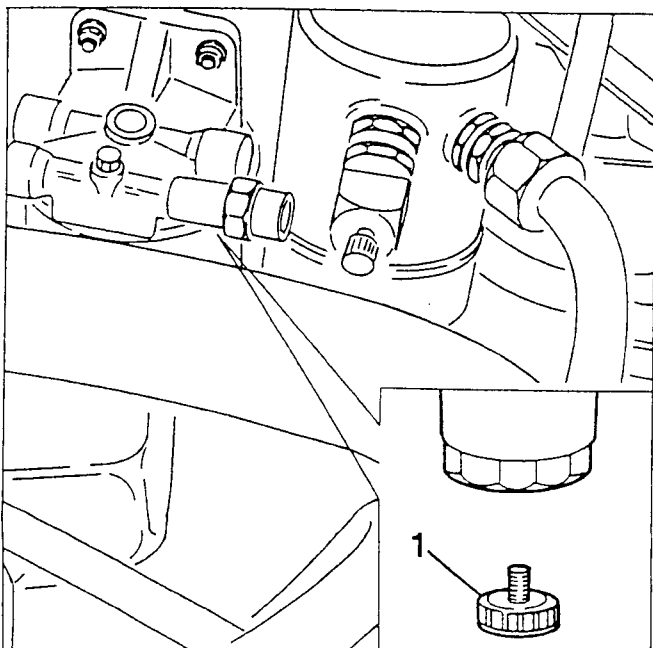


1. Injection pump
2. Injector
3. Fuel filter
4. Tank

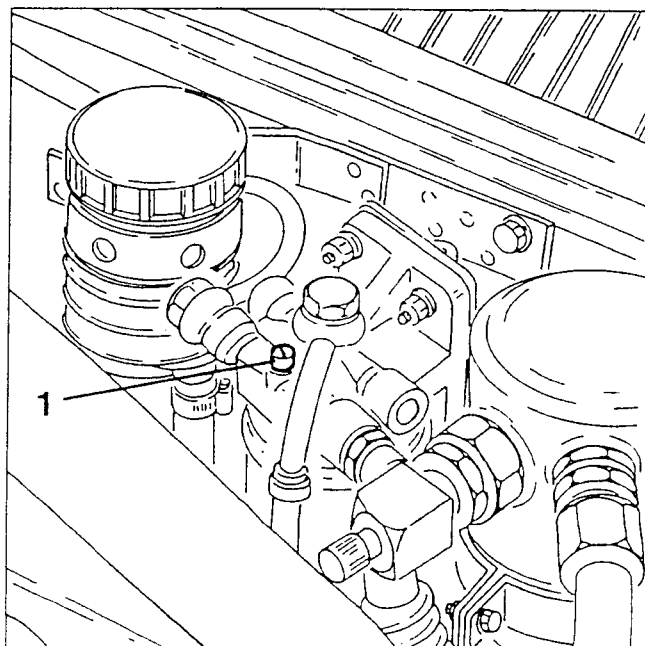
If it is not possible to start the engine, check all the fuel intake pipe joints and connections and replace the seal washers, in order to stop air from entering.

BLEED AIR FROM FUEL FILTER

1. Loosen the water drainage cap located under the fuel filter.

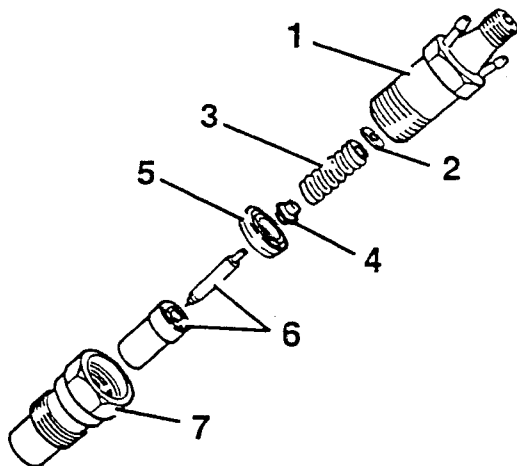


1. Unscrew the air bleed screw located above the fuel filter.



INJECTORS

The injectors' task is to spray the fuel supplied by the injection pump into the engine combustion chamber. The injector consists of a nozzle and a nozzle holder.



1. Upper nozzle holder
2. Adjusting washer
3. Spring
4. Pressure rod
5. Spacer
6. Nozzle
7. Lower nozzle holder

The compressed fuel from the injection pump arrives in the nozzle chamber below the conic end (pressure shoulder).

When the fuel pressure exceeds the spring setting value (150 + 158 bar), the nozzle needle is lifted and finely atomized fuel flows out under pressure.

The force to open the needle is determined by the adjustable spring preload in the nozzle holder.

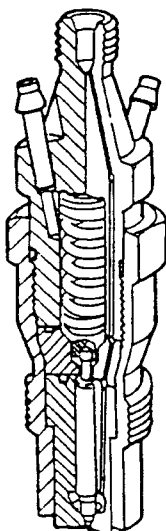
When injection is completed the spring pushes against the needle through the pressure rod in its seating.

Given the high fuel pressure, a small quantity of fuel returns between the pressure rod stem and its seating on the nozzle body.

This fuel is drained through a hole connected to the fuel to tank return pipe.

The diameter of the pipe between the pump and the injectors is small enough to reduce the volume of the diesel contained in the pipe, which is subjected to the compression effect.

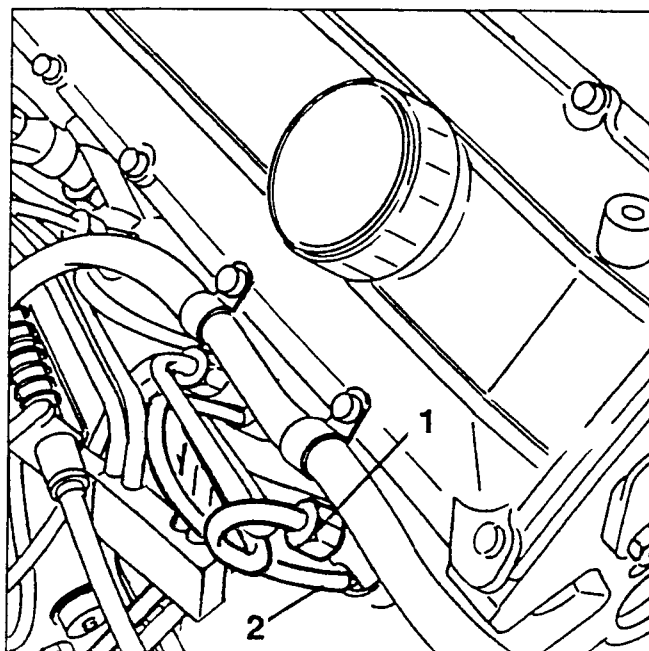
The use of thick walled pipes prevents elastic pulsations which may be great enough



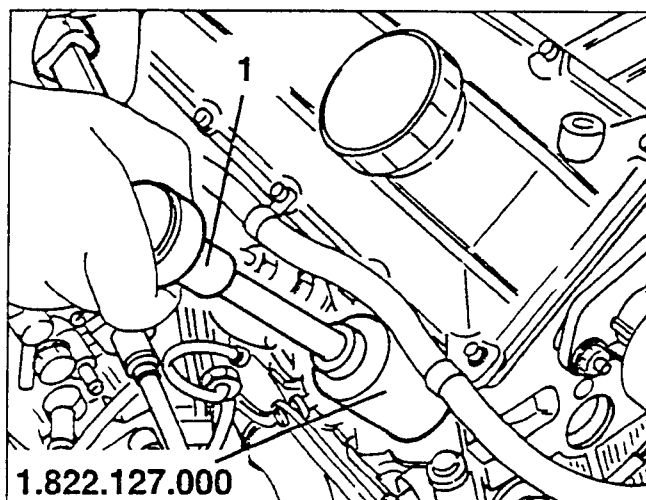
and of a frequency that could alter the injection. These pipes must be short to prevent the pressure waves, due to the injector closing, from returning to the nozzle and lifting it which would allow more diesel to flow out at the incorrect time.

REMOVAL/REFITTING

1. Disconnect the fuel from injection pump delivery pipe from the injector.
2. Disconnect the two fuel to injection pump return pipes from the injector (one for the fourth injector).



1. Remove the injector from the cylinder heads, using tool N° 1.822.127.000.



- At the bench unscrew the nozzle holder and disassemble the injector.

CHECKS AND INSPECTIONS

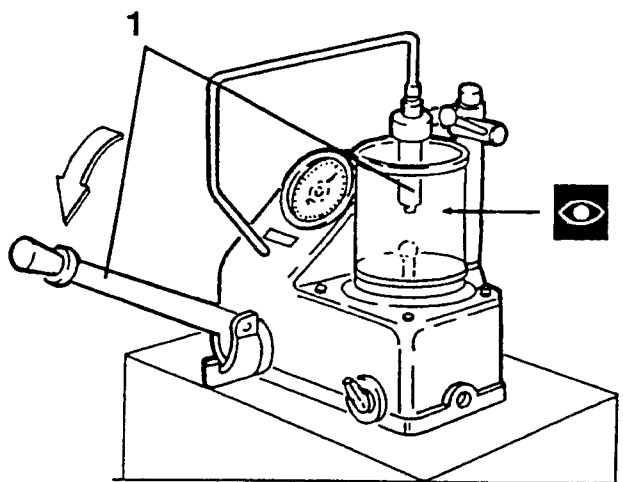
- Before inspecting the injector, thoroughly clean the outer part, in particular the end of the nozzle. Any deposits should be eliminated with a suitable metal brush (brass).

1. Position the injector in the piece of equipment, activate the equipment's lever until the specified pressure is reached; when these conditions have been obtained, check that nozzle does not drip for 10 seconds; if this is not the case, replace it.



Injector seal control pressure

130 + 138 bar



- With the injector still on the test equipment, activate the equipment lever and check that the fuel atomizing takes place at the specified pressure.

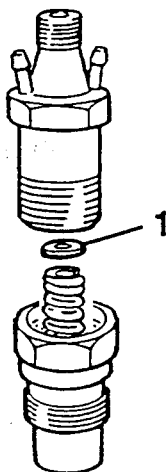


Injector setting pressure

150 + 158 bar

- If this is not the case and depending on the pressure value obtained, disassemble the injector and replace the adjusting washer with one with the correct thickness.

The thickness of spare washers is 1.000 to 1.975 mm, with 0.025 mm increases.



INERTIAL SWITCH

Also the Turbodiesel system has a security system with inertial switch to be found under the driver's seat: this device is an electromechanical switch, which in the event of a heavy crash opens to cut off the circuit that supplies the engine stop electromagnet: this way the engine is stopped immediately.

The supply to other "risky" circuits, i.e. always supplied, is also cut off (cold advance, glow plugs, engine stop solenoid valve).

This greatly reduces the hazard of fire which, though restricted, is also a risk on diesel vehicles.

REMOVING/REFITTING

Refer to the instructions for the Boxer 16V engine.

DISTRIBUTOR INJECTION PUMP

GENERAL DATA

Unlike the in line injection pump, the VE distributor pump has a single pumping element (pump cylinder and piston) even for engines with more cylinders. The diesel pumped from the piston is distributed through a groove at the outlets; there are the same number of grooves as there are engine cylinders.

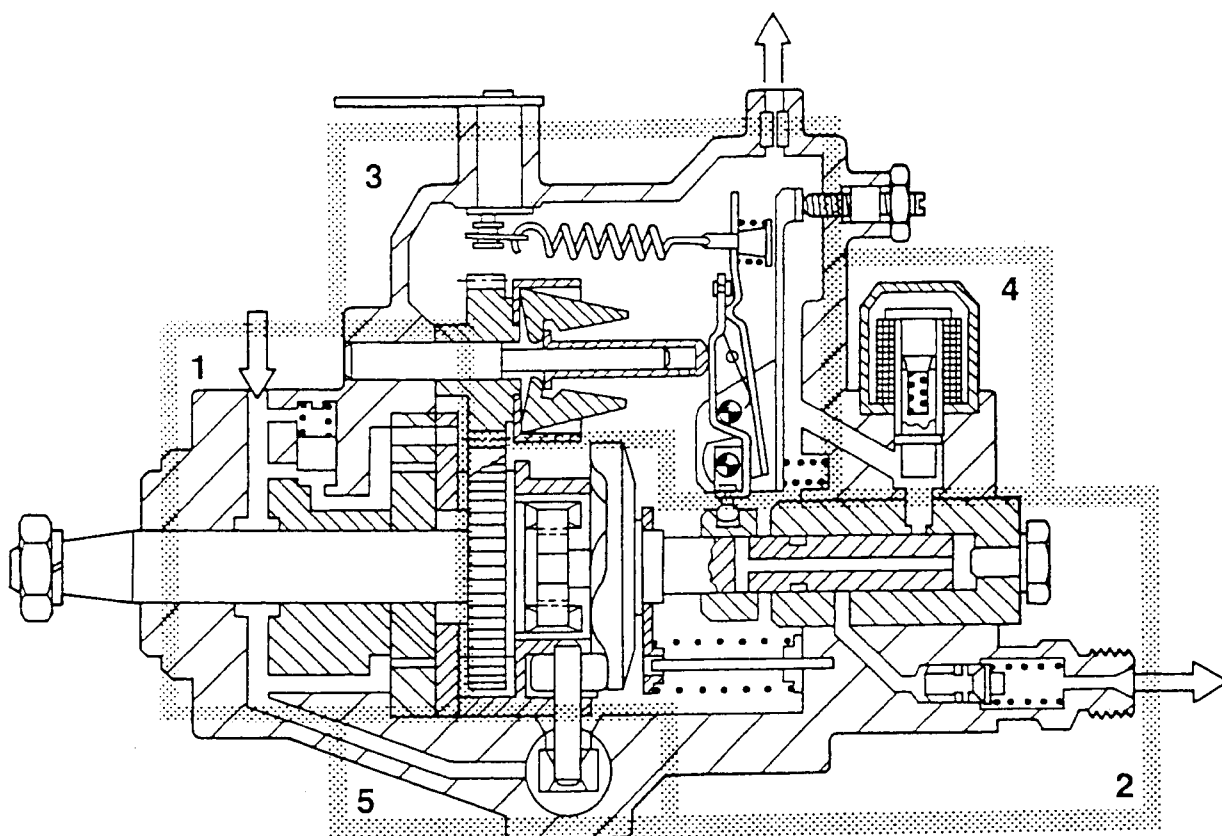
The injection pump casing is made up of the following units:

- Blade type fuel pump
- High pressure pump with distributor
- r.p.m. mechanical adjusting device
- Stop device
- Injection advance hydraulic variator

The pump distributor can be fitted with different correction devices, which allow it to adapt to any of the engine's specific requirements.

The reasons why these correction devices are necessary, their structure and their functioning is explained further on.

On the injection pump in correspondence of the accelerator control cable fastening lever, there is a switch which informs the air conditioner control unit about the "full load" condition, as a result of this the control unit cuts out the compressor.



1. **Blade type fuel pump**
This pump sucks in the diesel and sends it to the pump internal chamber.
2. **High pressure pump with distributor**
This pump generates the injection pressure, pumps and distributes the diesel.
3. **R.p.m. mechanical adjuster**
This device adjusts the r.p.m. and corrects the flow ensuring it remains within the established limits.
4. **Stop device**
Interrupts the diesel supply
5. **Injection advance variator**
Depending on the r.p.m. this device varies the start time of the delivery.

STRUCTURE

The distributor pump control shaft is supported in the pump casing and the blade type fuel pump is fitted on it.

The roller holder ring is located behind the fuel pump, which is also located in the pump casing, even though it is not integral with the control shaft.

The cam disk, which rests on the roller holder ring and is activated by the control shaft, generates a rotation-lift type movement which is transmitted to the piston distributor.

The piston distributor is guided in the distributor head, which is screwed to the pump casing.

The electric stop device which interrupts the fuel supply, the threaded cap with the bleed screw and the connectors for the delivery valves are fixed in the distributor head.

The mechanical stop device, on the other hand, is located in the regulating device cover.

The adjusting lever group is made up of control, starting and tension levers and its fulcrum is housed in the distributor pump. The adjusting lever group varies the position of the adjusting cursor on the pump piston.

The adjusting spring, hooked to the shaft of the control and tension levers, is located in the upper part of the casing.

The control lever, which affects the functioning of the pump, is located through the shaft in the regulating device cover.

The regulating device cover, which also acts as a cover for the upper part of the pump, also houses the adjusting screws for the full load flow, the flow throttler and the r.p.m. adjusting screw.

The hydraulic injection advance variator is fitted transversally to the longitudinal axis under the lower part of the distributor pump.

The functioning of the variator is influenced by the pressure in the internal chamber, which, in turn, is determined by the fuel pump and by the pressure regulating valve. The variator is fixed with two covers on the sides of the pump.

ACTIONING THE PUMP

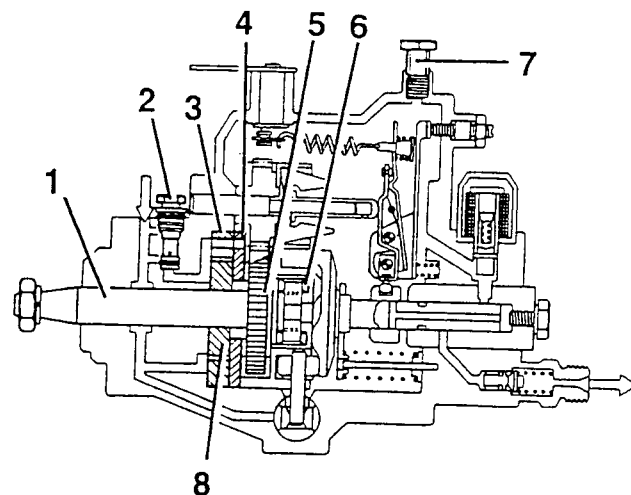
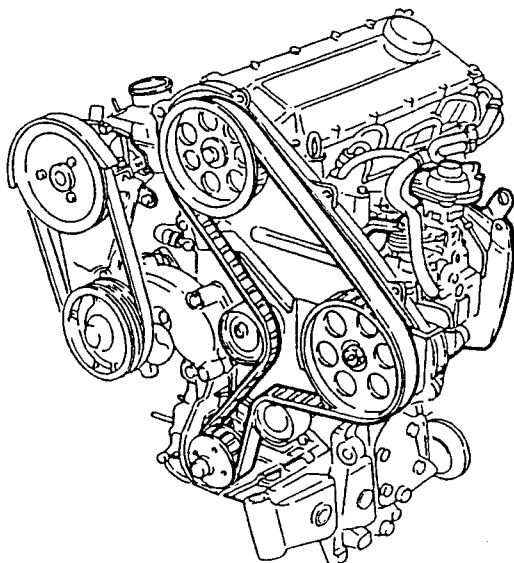
The distributor pump is activated by the engine timing belt. In four stroke engines, the r.p.m. of the pump is exactly half of the those of the engine crankshaft. In other words the distributor pump has the same number of revs as the camshaft.

The desmodronic actioning (system of rigid bodies the movement of which is blocked so that they have only one grade of freedom) takes place in such a way that the rotation of the control shaft of the distribution pump is synchronised perfectly with the crankshaft.

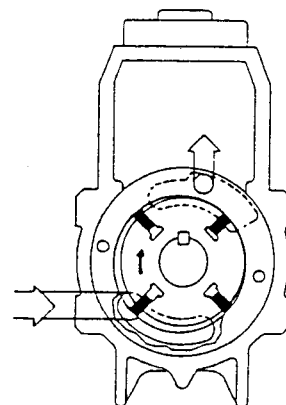
The desmodronic actioning is achieved through a drive belt, a coupling pinion, gears.

Righthand and lefthand rotating distributor pumps exist and so their injection order is also different, but in such a way that the drainage holes open in the same geometric order.

To avoid confusion with the numbering of the engine cylinders, the distributor pump drainage holes are marked with A, B, C, etc.



1. Control shaft
2. Pressure regulating valve
3. Eccentric ring
4. Support ring
5. Regulating control pinion
6. Tooth of the control shaft
7. Flow throttler
8. Blade pump



Blade type fuel pump

The fuel pump is fitted on the control shaft within the pump.

The impeller is fitted concentrically to the control shaft and is motored over by a key.

The impeller is housed in an eccentric ring located in the casing.

The centrifugal force, generated by the rotary movement, pushes the four impeller blades outwards and against the eccentric ring.

This centrifugal movement of the blades is facilitated by the diesel, which is between the lower part of the blade and the wall of the impeller cavity.

Through the inflow hole on the casing of the pump, the diesel arrives in the kidney shaped chamber (formed by the impeller, blade and eccentric ring) and from here it is pumped into the inner chamber of the pump through the second kidney shaped chamber, which is diametrically opposed to the first. During this cycle, a part of the diesel passes to the pressure regulating valve through the second hole.

FUEL SUPPLY

Low pressure supply

In the injection systems with distributor pump, the blade type fuel pump sucks the diesel from the tank and sends it into the pump.

The fuel pump sends an almost constant amount of fuel for every rotation.

The pressure regulating valve is necessary to obtain a pressure defined on the basis of the r.p.m. within the pump. In this way, the pressure increases in direct proportion to the r.p.m.; ie. the higher the r.p.m the higher the pressure.

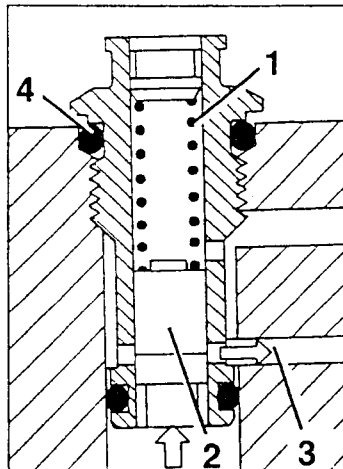
Pressure regulating valve

The pressure regulating valve is fitted directly, close to the fuel pump, and is connected to the kidney shaped upper chamber through a hole.

This is a spring loaded sliding valve, which modifies the internal pressure of the pump on the basis of the amount of fuel delivered.

When the diesel pressure exceeds a certain value, the valve cursor opens the return hole and the diesel returns in the intake side of the valve through a small channel. When the diesel pressure is low, the thrust of the spring keeps the return hole closed.

The opening pressure of the regulating valve is determined by the setting of the spring load.

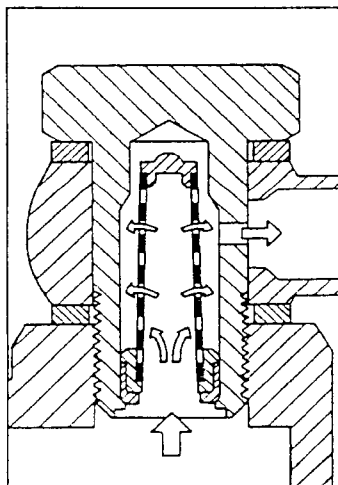


1. Spring
2. Cursor
3. Fuel return hole at intake side
4. O-Ring

Flow throttler

The flow throttler is screwed to the regulator cover and is connected with the inside of the distributor pump.

This allows a small amount of diesel to flow back to the tank through a very small hole (diameter 0.6mm). This hole resists the flow of diesel and maintains the pressure constant within the pump. As the pressure value within pump is strictly connected to the r.p.m., the flow throttler and the regulating valve function interdependently.

**High pressure supply****Distributor piston actioning**

The rotating movement of the control shaft is transmitted to the distributor piston through a coupling. The teeth of the control shaft and the cam disks interlock with the Oldham coupling.

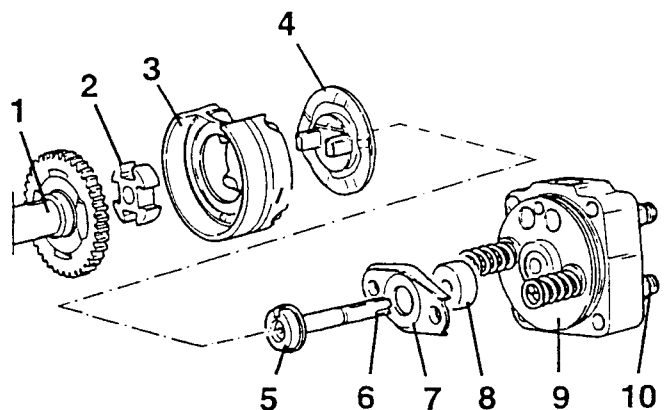
By sliding along the roller holding ring, the cam disks transform the simple rotational movement of the control shaft into a rotational-rising movement.

The distributor pumping element and its adaptor are connected to the cam disk and are fixed with a key, which also acts as a motoring over device.

The piston distributor is pushed towards the top dead center (TDC) by the cam disk and in towards the bottom dead center (BDC) by the thrust spring, which are positioned symmetrically.

The thrust springs rest on the hydraulic head and act on the piston distributor through a beam, and prevent the cam disks from being raised by the rollers on the ring following strong centrifugal force.

The length of the springs is fixed in such a way that the piston can not be pushed out of its guide in the hydraulic head.



1. Regulating control pinion
2. Oldham coupling
3. Roller holding ring
4. Cam disk
5. Compensation washers
6. Distribution Timing
7. Beam
8. Regulating cursor
9. Distributor head
10. Delivery connector

Cam disk and shape of the cams

As well as activating the distributor piston, the cam disks also influence the pressure and the length of the injection on the basis of the following two parameters: cam lift and speed of the lift. The injection conditions must be individually adapted to the shape of the cam and to the combustion procedure of the different types of engine, for which the profile of the cam sliding track must be calculated and reproduced on the disk. The cam disk obtained in this way is then fitted on the injection pump. For this reason, it is not possible to interchange the cam disks intended for different injection pumps.

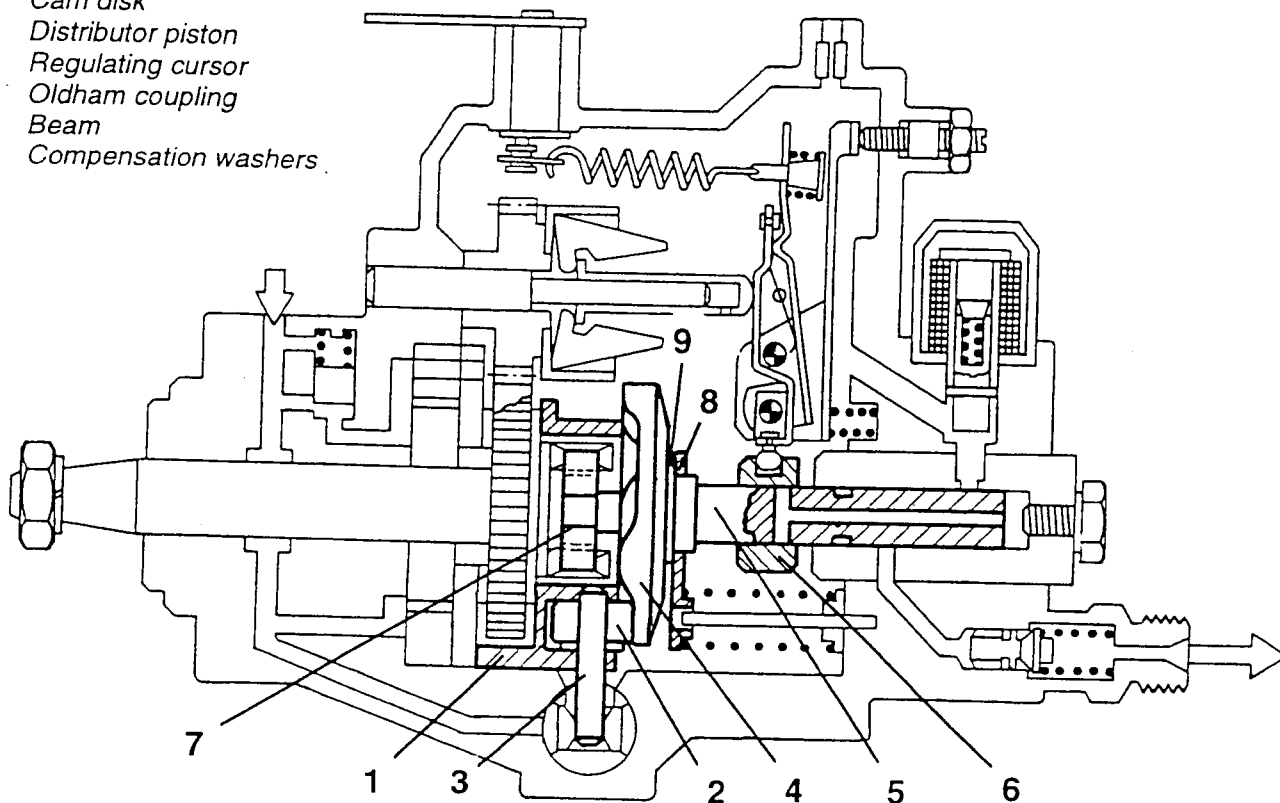
Pumping element group

The distributor head, distributor piston and the regulating cursor are adapted (lapped) with micrometric accuracy to ensure the seal, even at very high pressures.

Small leaks are inevitable, but also necessary to ensure that the distributor piston is lubricated.

For this reason the complete pumping element must be replaced, and never only the piston and the distributor head, or the regulating cursor.

1. Roller holder ring
2. Rollers
3. Journal
4. Cam disk
5. Distributor piston
6. Regulating cursor
7. Oldham coupling
8. Beam
9. Compensation washers

**Fuel dosage**

The fuel delivery is a dynamic process carried out by the injection pump in several stages. The pressure necessary for the injection is generated by the pump piston.

In four stroke engines, the piston distributor completes one fourth of a revolution between BDC and TDC.

The distributor piston passes from the TDC and BDC with a axial-rotational movement and frees an inflow hole in the distributor head through one of the control grooves; the diesel under pressure passes from within the distributor piston to the high pressure chamber, above the piston, through an inflow hole.

Once the BDC has been reached, the distributor piston's movement is inverted in order to return to the TDC and the inflow hole which was opened before is closed, whilst an exhaust hole (with a set section) in the distributor head is opened.

The pressure which has built up in the high pressure chamber and the longitudinal hole opens a delivery valve, and the diesel is forced through the delivery pipe to the injector.

The effective stroke ends as soon as the distributor piston transversal hole is uncovered by the regulating cursor (end of the delivery).

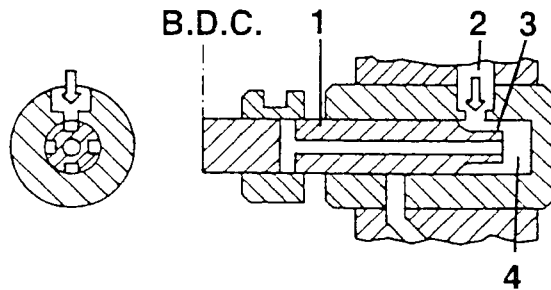
From this moment onwards, the diesel is no longer delivered, and so the delivery valve closes the delivery pipe. As the piston moves towards the TDC, the diesel returns into the pump through a connection opened between the transversal hole and the inside of the pump.

This piston stage is called the "residual rise".

During its axial-rotational return movement, the piston closes its transversal hole, whilst the control groove opens the fuel inflow hole which fills up the high pressure chamber once again (above the piston).

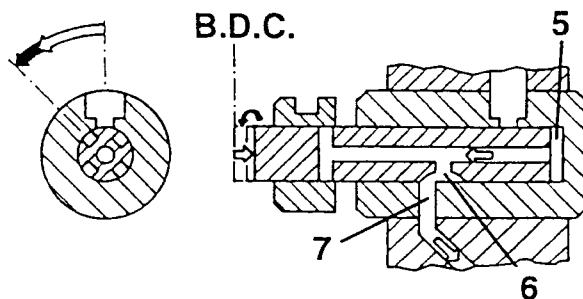
■ Diesel inflow

With the piston (1) in BDC, the diesel passes into the high pressure chamber (4) through the inflow channel (2) and the control groove (3).



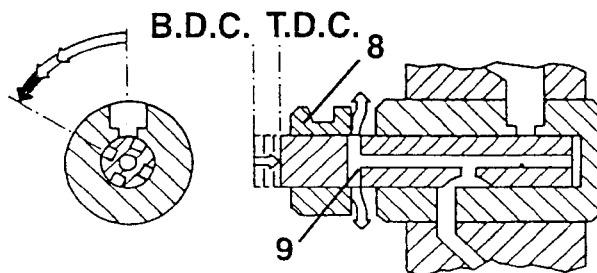
■ Diesel delivery

As the piston rises, the inflow channel closes and compresses the diesel in the high pressure chamber (5), whilst the rotational movement of one of its grooves (6) opens the exhaust hole (7) on the corresponding engine cylinder.



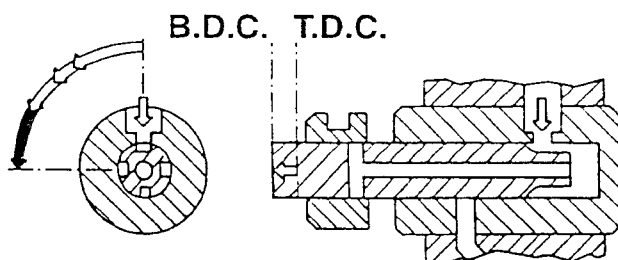
■ End of delivery

The delivery of the diesel ends as soon as the regulating cursor (8) opens the "end of delivery" hole (9).



■ Diesel inflow

The piston returns with an axial-rotational movement to the BDC and closes the "end of delivery" hole. The high pressure chamber fills up again.



Delivery valve

The delivery valve prevents the fuel in the pipe from flowing into the distributor head and quickly lowers the pressure in the injection pipe to prevent the nozzle from dripping.

It is in this way that the nozzle closes completely at the exact point in which the injection stage ends.

At the same time the stability of the pressure in the delivery pipe between one injection stroke and the next is ensured, irrespective of the flow at that moment.

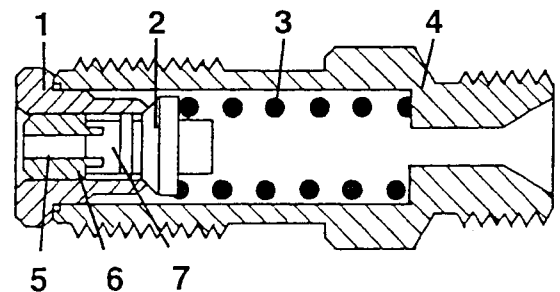
The delivery valve is a hydraulic piston valve, which is opened by the diesel and closed by the spring.

During the interval between the two subsequent distributor piston delivery strokes, the valve for the same cylinder remains closed, and so the delivery pipe and the distributor head exhaust hole are isolated.

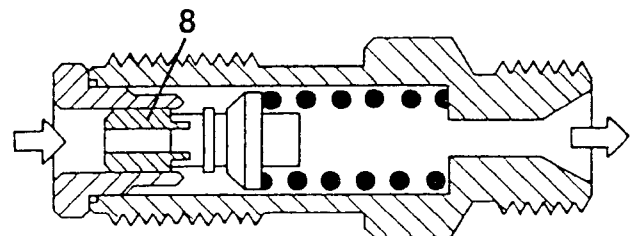
During the delivery stroke, high pressure builds up which raises the delivery valve from its seating and opens it; the diesel passes through a ring groove and the longitudinal grooves connected to it, the valve holder connector, the delivery pipe and the nozzle holder upto the nozzle.

As soon as the delivery end has been reached (transversal hole of the distributor piston is open) the pressure in the high pressure chamber falls to the pressure value within the pump, and the spring pushes the valve back into its seating.

■ Valve open



■ Valve closed



1. Valve holder
2. Valve seating
3. Valve spring
4. Delivery connector

5. Stem
6. Pressure reducing piston
7. Ring groove
8. Longitudinal groove

Delivery valve with return throttler

The necessary and accurate reduction in the pressure at the end of the injection stroke, generates pressure waves which strike the delivery valve causing the nozzle needle to open repeatedly or vacuums in the injection pipe.

These secondary effects provoke repeated injections, which adversely affect the pollution value of the exhaust gases, or cavitations which subject the injection and nozzle pipes to wear.

To avoid these pressure waves, a throttler has been fitted upstream from the delivery valve which acts only in the return direction.

This throttler is formed by a valve in a flat seating and a compression spring, so that it remains inactive in the flow direction and generates a damping effect in the return direction.

R.P.M. REGULATOR

The running performance of diesel vehicles is only satisfactory when the engine reacts quickly to the movements of the accelerator pedal.

During acceleration from zero, the engine must not stop.

Depending on the position of the accelerator pedal, the vehicle must accelerate or decelerate without jerking.

When the accelerator remains in the same position and the inclination remains constant, the speed should also remain the same.

When the accelerator pedal is released the engine must decelerate the vehicle.

These requirements of diesel engines are satisfied by the injection pump r.p.m. regulator.

Tasks of the r.p.m. regulator

- **Regulate the idle speed.**
The diesel engine idle speed must not fall below the set value.
- **Regulate peak r.p.m.**
By decreasing the engine load, the highest r.p.m. of the full load is maintained at the upper idle speed level. The regulating device recognises this situation and calls the regulating cursor back in the "stop" direction, so that the engine receives less diesel.

As well as its regulating function, the regulator also performs some control functions:

- unblocking and blocking the diesel supplement necessary for start up;
- varying the full load flow on the basis of the r.p.m. (adequately).

Some adaptation devices are necessary for these complementary functions.

Regulating accuracy

The percentage deviation of the r.p.m. (P grade) is the parameter used to measure the accuracy of the regulator.

This is the percentage increase in the r.p.m. which is produced when there is a reduction in the engine load but without the position of the control lever varying. Following this, the increase in the r.p.m. within the regulated field must not exceed a certain value.

The peak r.p.m. is taken as the maximum value.

This r.p.m. is set when the engine reduces its speed from full load to zero load.

The increase in the r.p.m. is inversely proportional to the variation in the load, ie. the greater the reduction in the load, the larger the increase in the r.p.m.

The engine usage conditions determine the grade P to be chosen.

For example, for generators, a low P grade is preferable, in order that the variations in the load produce a limited variation in the r.p.m.

On the contrary, for autovehicles a higher P grade is preferable in order that the regulating is more stable and the running performance is better even when the variations in the load are smaller (acceleration or deceleration).

A high P grade would cause a reduction in the engine's elasticity (jerking) during load variations.

Idle speed and peak r.p.m. regulator

This regulator adjusts the idle speed and the peak r.p.m. only, whilst the intermediary speeds are set directly by the accelerator pedal.

Structure

The control shaft activates the regulating unit, which is made up of centrifugal masses with relative casing, regulating spring and lever assembly.

The regulating group rotates around the regulator axis, which is integrated with the pump casing.

The radial movement of the centrifugal masses is transformed into an axial movement by the regulating sleeve.

The stroke of the regulating sleeve generates a thrust which varies the position of the regulating mechanism, which is made up of a control lever, tension lever and starting lever.

The control lever is housed in the shaft in the pump casing and can be adjusted by the delivery adjusting screw.

The tension and starting levers are pivoted on a common fulcrum and connected with a r.p.m. control lever. On the lower part of the starting lever, a spheric pin is fixed, which is pivoted to the adjusting cursor; whilst on the upper part, the starting spring is fixed.

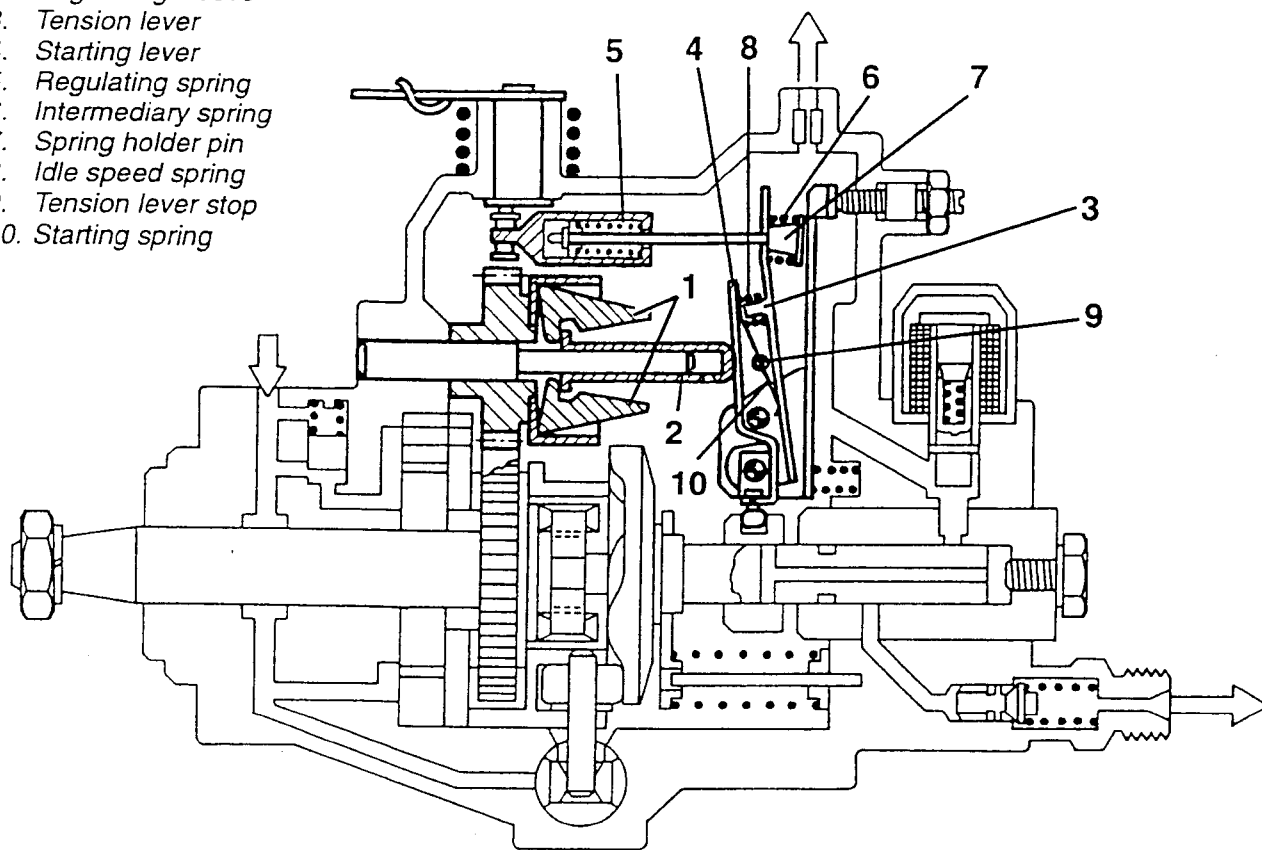
The idle speed spring is fixed on the upper part of the tension lever by a pin, to which the regulating pressure spring, guided in a capsule, is hooked.

The external control lever and the internal r.p.m. control lever are fixed onto a common shaft.

The position of the regulating mechanism is defined by the common action of the spring's force and the thrust of the sleeve.

The control movement is transmitted to the regulating cursor, which determines the distributor piston delivery.

1. Centrifugal masses
2. Regulating sleeve
3. Tension lever
4. Starting lever
5. Regulating spring
6. Intermediary spring
7. Spring holder pin
8. Idle speed spring
9. Tension lever stop
10. Starting spring



Starting

The regulating sleeve is in the start position because the centrifugal masses are at rest, and for this reason the start spring pushes the start lever against the regulating sleeve.

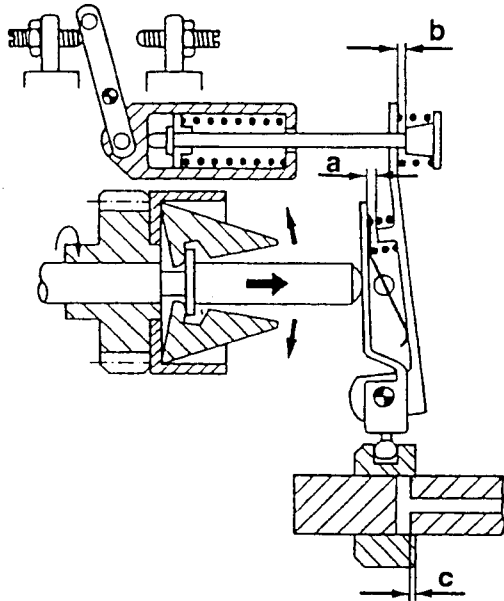
The regulating cursor on the distributor piston is found in the start supplement position.

Regulating the idle speed

After the engine has been started and the accelerator pedal has been released, the r.p.m. control lever returns to the "idle speed" position, activated by the return spring.

As the r.p.m. increases, the centrifugal force of the masses increases, which presses the regulating sleeve against the start lever.

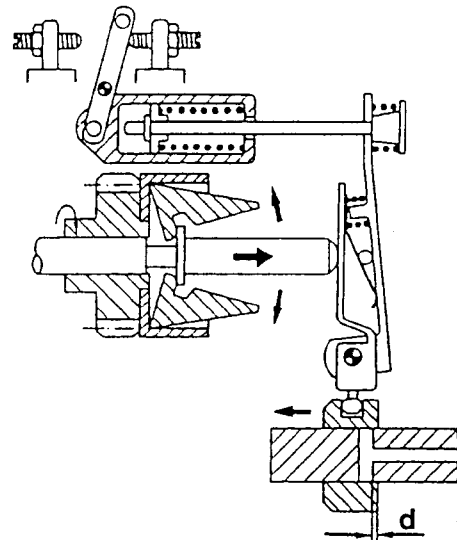
The adjustment is carried out by the idle speed spring fitted on the tension lever. As the start lever rotates, it pushes against the regulating cursor in the "reduced flow" direction. The position of the regulating cursor is established by the combined action of the centrifugal force and the spring.



- a. Start spring and idle speed stroke
- b. Intermediary spring stroke
- c. Idle speed minimum effective stroke

The limitation of the max speed starts to function within the nominal speed range only after the sleeve thrust has won over the force of the regulating spring's load.

When the engine is completely unloaded, it reaches the idle speed upper limit and stops the engine from racing.



d. Effective stroke of full load

VARIATION OF THE INJECTION ADVANCE

Injection advance variator

The injection advance variator advances the start of the delivery of the distributor pump with respect to the crankshaft and in relation to the r.p.m. to compensate for delays in injection and ignition.

Structure

The hydraulic control injection advance variator is incorporated onto the lower side of the distributor pump casing, perpendicularly to the longitudinal axis of the pump.

The variator piston is guided into the pump casing and closed at the ends by two covers.

In the variator piston there is a hole through which the diesel passes; a pressure spring is fitted in a position diametrically opposed to the hole.

The variator piston is connected with a roller holder ring through a journal and a pad.

Function

During the injection pump delivery process, the nozzle is opened by a wave of pressure which spreads at the speed of sound through an injection pipe.

Operating under load

When the driver presses the accelerator pedal, the r.p.m. control lever rotates by a set angle and cancels the effect of the start and idle speed spring and so the intermediary lever enters into play in their place. The intermediary spring of the regulator allows a greater idle speed limit to be obtained.

If the control lever of the r.p.m. is made to rotate even more in the "full load" direction, the intermediary spring performs its stroke until the guiding pin knocks against the tension lever.

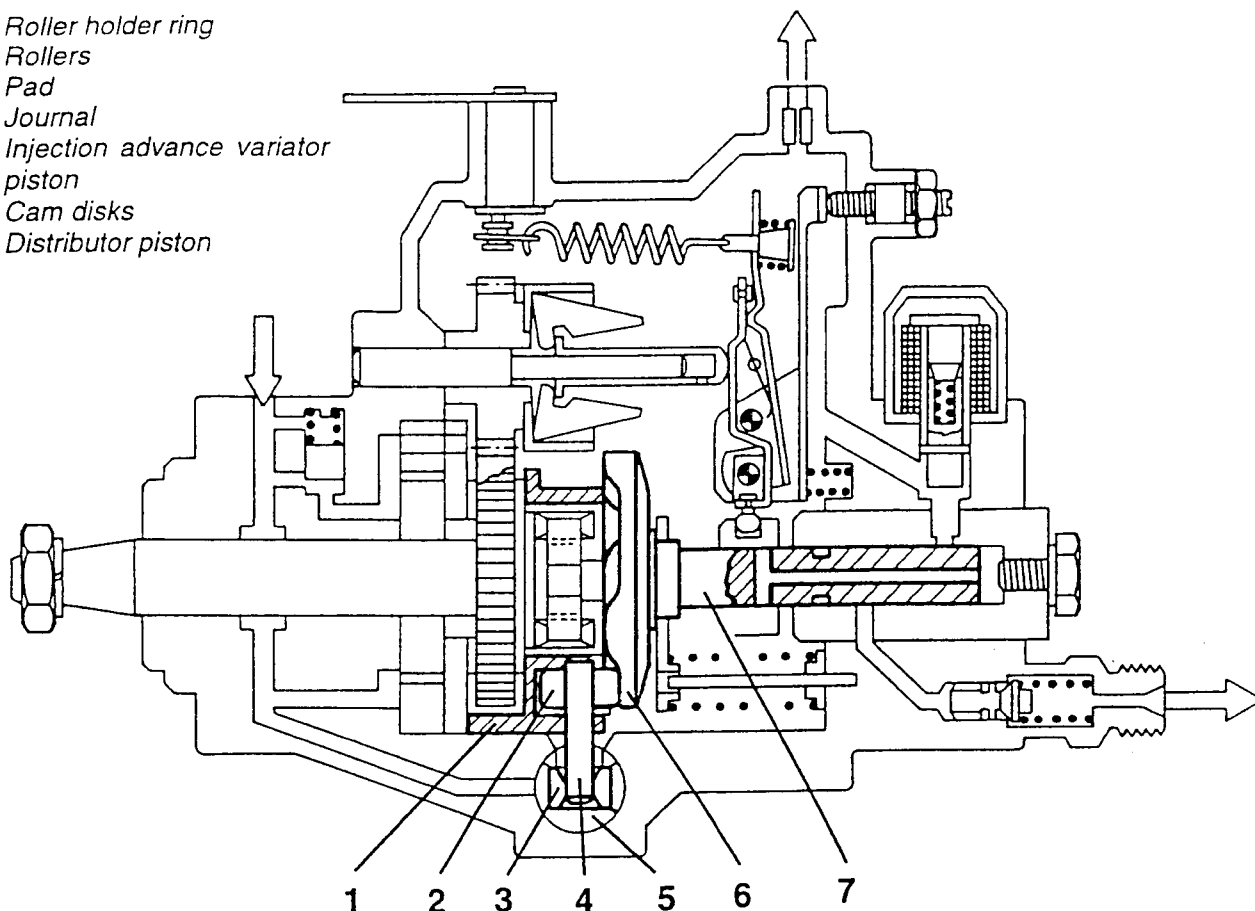
From that moment the effect of the intermediary spring ceases and the non regulated ranges begin, the amplitude of which is determined by the load of the regulating spring.

Within the non regulated ranges, the regulating spring can be considered as though it were rigid.

The movement of the r.p.m. control lever (ie. the accelerator pedal) set by the driver is transmitted directly to the regulating cursor by the regulating mechanism.

If the r.p.m. control lever remains in the same position and there is a decrease in the engine load and the flow does not change, the engine speed will increase.

1. Roller holder ring
2. Rollers
3. Pad
4. Journal
5. Injection advance variator piston
6. Cam disks
7. Distributor piston



As the spreading time passes irrespective of the r.p.m., the crank angle between the start of the delivery and the start of the injection becomes even greater as the r.p.m. increases.

It is therefore necessary to correct this by anticipating the start of the delivery.

The spreading time of the pressure wave is established by the size of the injection pipe and by the speed of sound, which for diesel is approx. 1500 m/s. This time is known as the "injection delay".

So the start of the injection is delayed with respect to the delivery.

Following this phenomenon, the nozzle opens later at higher speeds than at lower speeds with respect to the position of the engine piston.

After having been injected, the diesel takes a set period of time to pass from the gas state and to form a mixture which together with air is inflammable.

The preparation time for the mixture does not depend on the r.p.m.

In diesel engines, the time which passes between the start of injection and the start of combustion is called the "ignition delay".

The ignition delay depends on the inflammability quality of the diesel (indicated by the cetane number), by the compression ratio, by the air temperature and by the pulverization of the fuel.

The ignition delay is usually around 1 millisecond. When the engine speed is increasing and when the start of delivery is constant, the crank angle between

the start of injection increases so that combustion does not start at the right moment (with reference to the position of the engine piston).

As optimal combustion and the maximum power of the Diesel engine are only reached when the crankshaft, ie. the piston, has reached a clearly defined position, it is necessary to advance the start of delivery of the distributor pump in time with the increase in the engine speed to compensate for the time lost due to injection and ignition delays.

This correction is performed by the injection advance variator, that intervenes in function with the r.p.m.

Functioning

The injection advance variator piston is kept in the start position by the loaded spring.

During functioning, the fuel pressure within the pump is regulated in relation to the r.p.m. through a delivery valve and the flow throttler.

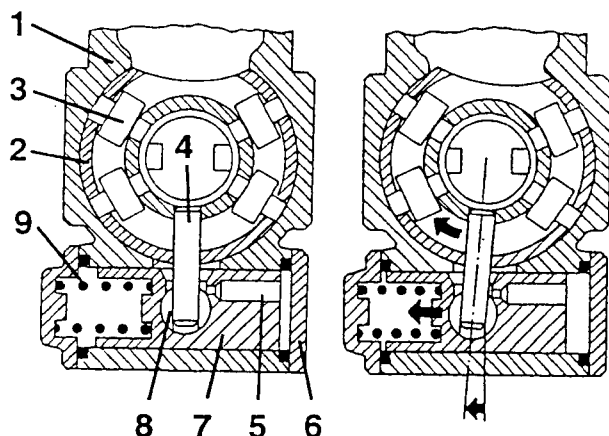
So the piston head, on the opposite side to the spring, is loaded with the same pressure as the fuel within the pump.

The pressure of the fuel only wins over the spring load and pushes it against the variator piston above a certain r.p.m.

The axial movement of the piston is transmitted through a journal and a pad to the rotating roller holder ring, which changes its timing with the cam disks as it rotates, ie. the roller holder ring is moved by a specified angle with respect to the cam disks and to the distributor piston.

■ Rest position

■ Work position



1. Pump casing
2. Roller holder ring
3. Rollers
4. Journal
5. Hole in variator piston

6. Cover
7. Variator piston
- Injection advance
8. Pad
9. Injection advance variator spring

CORRECTION DEVICES

The distributor injection pump is built according to a modular principal, and so different supplementary correction devices can be fitted to it which satisfy the needs of the engine. The modular system permits several corrections to be made which allow the torques, power, consumption and exhaust gases to be brought to optimum levels. In this chapter the correction devices and their effect on diesel engines are described.

Adjusting

The expression "adjusting" means the adaptation of the flow of diesel to the engine fuel requirement curve, in relation with the r.p.m.

Some requirements characteristic of full load (optimization of the exhaust gases, the torque curves and the fuel consumption) make this adjusting indispensable. The quantity of injected fuel must correspond to the engine's requirements in that moment.

The fuel consumption decreases slightly as the r.p.m. increases.

If the pump is not adjusted it will send more at faster speeds than at lower ones, as long as the position of the regulating cursor on the distributor pump remains unchanged.

This delivery excess is caused by the throttling effect on the transversal hole of the distributor piston.

If the pump flow is fixed so that the max torque is reached at a low r.p.m., when the speed increases the engine is no longer able to burn the diesel injected without creating smoke.

The engine will overheat if an excessive amount of fuel is injected.

If, on the other hand, the maximum flow is fixed so that the engine reaches full load at high speeds, the engine is no longer able to provide its maximum power at low speeds because the flow is reduced as the r.p.m. decreases.

So the power supply is not "optimal", and consequently the volume of diesel injected must be adjusted to the engine's requirements.

In the distributor pump this adjustment is ensured by the delivery valve and by the modified lever group.

The adjustment of the full load through the regulating lever group takes over when the positive adjustment with the delivery valve is no longer enough or when a negative adjustment is necessary.

Positive adjustment

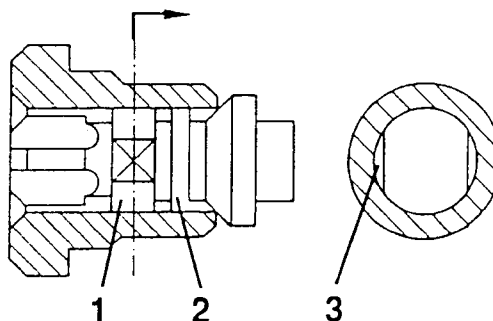
The positive adjustment of the full load is necessary when an excessive amount of diesel is injected at a high r.p.m. value.

To reduce this excessive delivery, the delivery is reduced by increasing the r.p.m.

■ Positive adjustment with the delivery valve

It is possible to adjust the delivery valves, even within very tight limits. In this case, the delivery valves have an extra supplementary collar as well as the plunging collar, upon which one or two flat surfaces have been grinded.

The sections produce the throttling effect, which reduces the flow in relation to the increase in r.p.m. of the pump.



1. Plunging collar
2. Adjusting collar
3. Throttling section

■ Positive adjustment with the regulating levers

The specific r.p.m. at which point adjustment should be started depends on the different settings of the adjusting spring loading.

As soon as this r.p.m. has been reached, a balance should be made established between the force of the sleeve and the spring load force, and the adjusting lever rests against the tension lever through the stop journal.

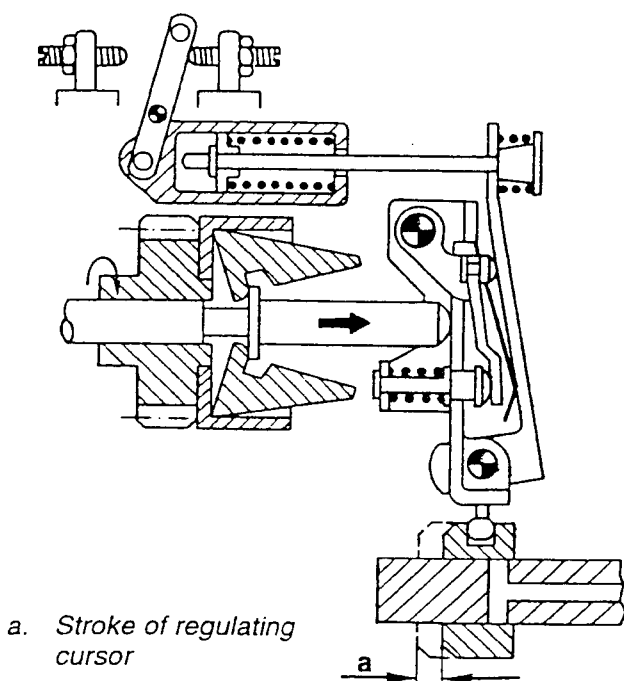
The free end of the adjusting lever rests against the adjusting journal.

As the r.p.m. increases, the thrust of the sleeve against start lever also increases; the fulcrum common to both the start and adjusting levers changes position.

At the same time, the adjusting lever levers the stop journal and pushes the adjusting journal towards its stop.

Afterwards the start lever rotates around the fulcrum and pushes the regulating cursor towards the "injection volume reduction" direction.

The adjusting phase stops as soon as the collar of the adjusting pin knocks against the start lever.



Negative adjusting

The negative adjusting of the full load may be necessary in engines which tend to develop black smoke at a low r.p.m. or which need a significant increase in the torque.

Boosted engines also need to be fitted with the negative adjustment, when the full load stop dependent on the boosting pressure (LDA) is not fitted.

In these cases, the increase in the r.p.m. produces a significant increase in delivery.

■ Negative adjustment with the regulating lever group

The adjustment lever rests with the stop journal against the tension lever after having totally compressed the start spring.

The adjusting journal also rests against the tension lever.

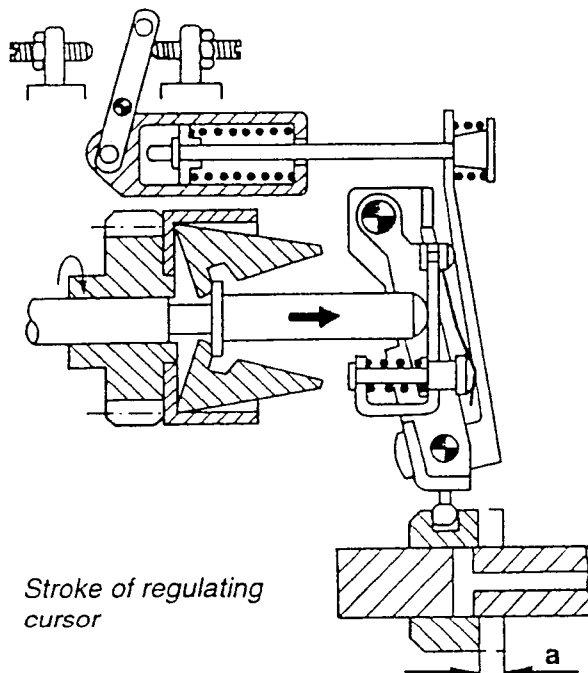
When the force of the sleeve increases following the increase in the r.p.m., the adjusting lever presses against the preloaded adjusting spring.

As soon as the force of the sleeve exceeds the force of the adjusting spring, the adjusting lever is pushed towards the journal collar.

Consequently the fulcrum common to the starting and adjusting levers changes position.

At the same time, the starting lever rotates in its fulcrum pushing the regulating cursor towards the "greatest flow" position.

The adjustment ends at the moment in which the adjustment lever rests against the journal collar.



Correction depending on the boosting pressure

The full load stop (LDA) reacts to the exhaust gas turbocharger boosting pressure in relation to the boosting pressure.

Full load stop dependent on the boosting pressure (LDA)

■ Function

The full load stop dependent on the boosting pressure is fitted on turbocharged engines.

In these diesel engines the flow of diesel is strictly connected to the volume of air filling the engine cylinders (working with turbocharger). If the turbocharged diesel engine turns over with a reduced volume of air, the fuel flow must also be adapted to the reduced volume of air. This function is performed by the full load stop dependent on the boosting pressure, which reduces the full load flow below a certain boosting pressure (selectable).

■ Structure

The full load stop dependent on the boosting pressure is fitted on the upper part of the distributor pump, on which the attachment is also located for the boosting pressure and the exhaust hole.

A diaphragm divides the inside of the stop capsule into two watertight chambers.

A compression spring acts against the diaphragm, the opposite end of which rests against an adjusting nut, used to set the preload spring.

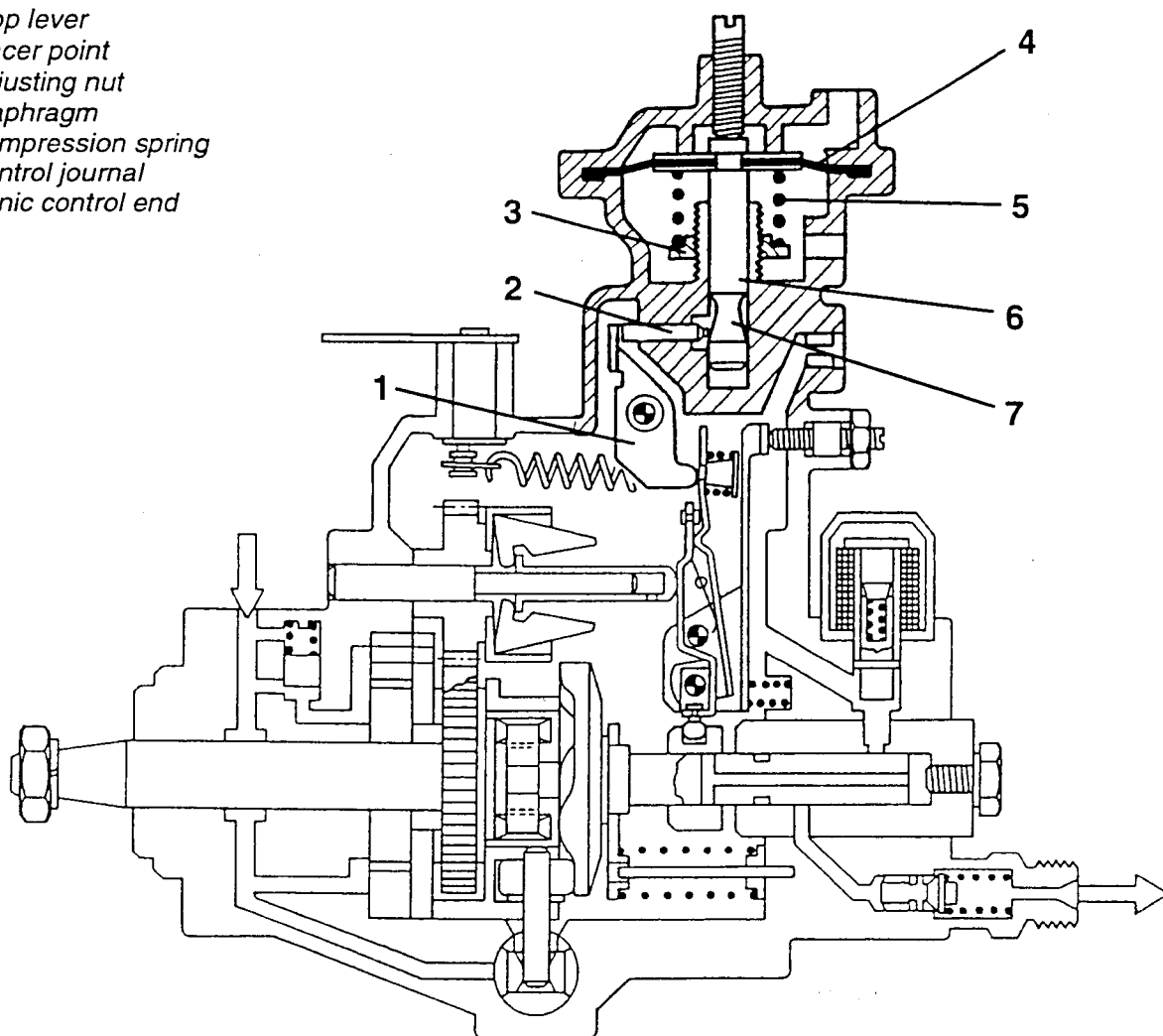
In this way the intervention point of the full load stop is regulated with the boosting pressure of the turbocharger.

The diaphragm is integrated with the control journal. The control journal has a conic end upon which the spine shaped tracer point runs.

The tracer point transmits the movements of the full load stop to the stop lever, which varies the position of the full load stop.

The initial position of the diaphragm and the control journal is set by a suitable dowel on the upper side of the LDA stop.

1. Stop lever
2. Tracer point
3. Adjusting nut
4. Diaphragm
5. Compression spring
6. Control journal
7. Conic control end



■ Functioning

At low r.p.m., the boosting pressure generated by a turbocharger is not enough to win over force of the spring, and so the diaphragm remains in the starting position.

The increase in the boosting pressure on the diaphragm pushes it downwards together with the control journal with the conic end, and wins over the force of the compression spring.

The movement of the journal with the conic end makes the tracer point move, which in turn makes the lever rotate around the fulcrum.

The traction force of the regulating spring establishes a dynamic coupling between the tension lever, the stop lever, the tracer point and the conic end of the lever; for this reason the tension lever follows the rotating movement of the stop lever.

The start lever follows the tension lever as they are pivoted on a common fulcrum and both move the regulating cursor towards the "greater flow".

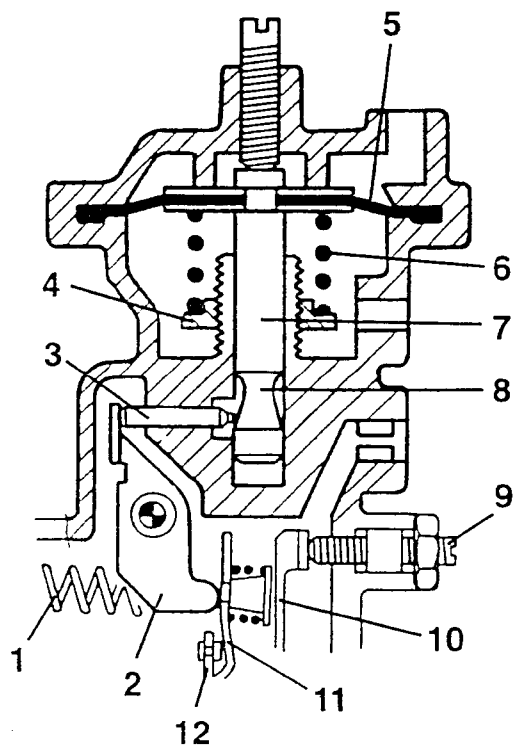
In this way the amount of diesel is adapted to the increased volume of air in the engine combustion chamber.

As the boosting pressure falls, the compression spring pushes the diaphragm and the control journal upwards.

Now the regulating mechanism moves in the opposite direction and the amount of diesel is reduced in parallel with the decrease in the boosting pressure.

When the turbocharger is disenabled, the LDA stop returns to the start position and limits the flow of full load so as to ensure a combustion without smoke.

The flow of full load with boosting is regulated by the full load stop screw, which is fitted on the regulator cover.



- | | |
|-----------------------|------------------------------|
| 1. Regulating spring | 7. Control journal |
| 2. Stop lever | 8. Control conic end |
| 3. Tracer point | 9. Full load adjusting screw |
| 4. Adjusting nut | 10. Adjusting lever |
| 5. Diaphragm | 11. Tension lever |
| 6. Compression spring | 12. Starting lever |

Correction dependent on the load

The start of the delivery must be corrected either by an "advance" or a "delay" depending on the load of the diesel engine.

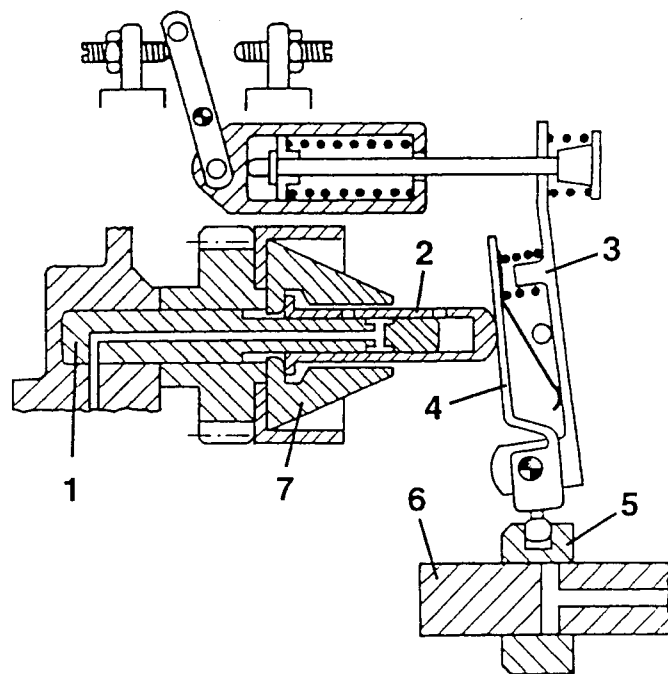
Start of delivery dependent on the load (LFB)

■ Function

The start of the delivery dependent on the load is calculated in such a way so as to correct with a "delay" when the load decreases (eg. from full load to partial load) even if the control lever position remains unchanged.

When the load increases, the point in which the delivery starts (ie. the injection point) is corrected by an "advance".

With this correction the engine functions more evenly.



1. Regulating axis
2. Regulating sleeve
3. Tension lever
4. Start lever

5. Regulating cursor
6. Distributor piston
7. Centrifugal masses

■ Structure

The correction of the "delivery start dependent on the load" has been realized by modifying the regulator sleeve, the regulator axis and the pump casing.

A transversal hole has been made in the regulator sleeve and a longitudinal hole and two transversal holes have been made in the regulator axis.

A hole has also been made in the pump casing in order to connect the inside of the pump with the intake side of the blade type fuel pump.

Injection advance when cold automatic device (KSB)

This automatic device has a double function:

- it advances the start of the injection in order to favour a normal functioning when the engine is cold
- it improves start up.

Functioning

The fuel flow of the fuel pump or transfer pump (5) is greater than the requested value for injection, and so the excess flow is drained off through the regulating valve of the transfer pressure (1) to the intake pump, which generates pressure within the pump body (transfer pressure).

The transfer pump flow (5) and consequently the transfer pressure vary in function with the r.p.m.

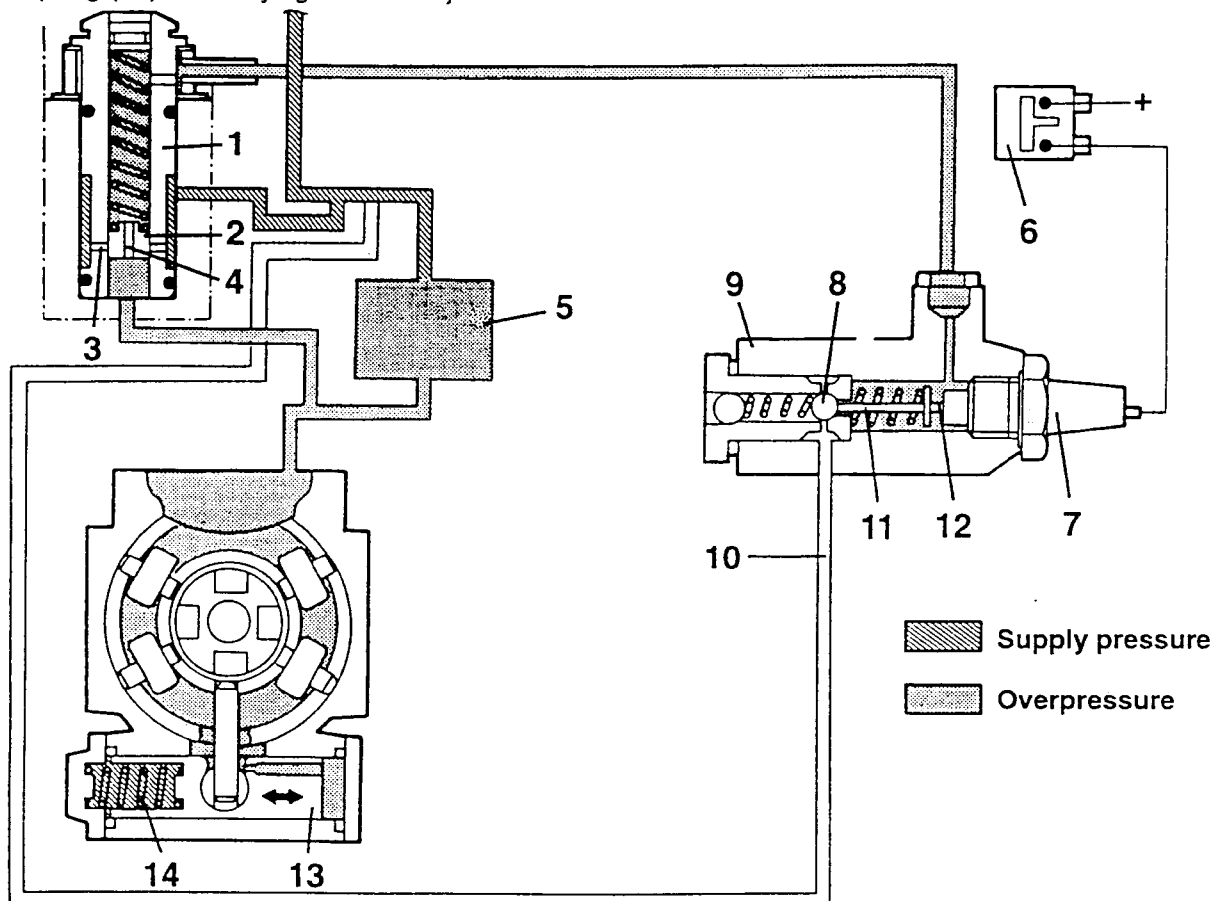
This transfer pressure acts on one side of the injection advance variator piston (13), pressing against the reaction spring (14) and varying the start injection.

With cold engine:

With engine coolant temperatures $\leq 60\text{ }^{\circ}\text{C}$ the spheric valve (8) of the KSB device is closed because the thrust effect of the cap (11) of the thermal wax bulb (7) is missing.

With the spheric valve (8) in the closed position, the drainage of part of the fuel through the calibrated hole (4) on the piston valve (2) is eliminated; this causes an increase in the transfer pressure, and consequently in advance, because the whole flow must pass through the only drainage holes (3).

The increase in the transfer pressure is felt on the piston (13) of the injection start advance variator (through the articulated cap of the roller holder cage).



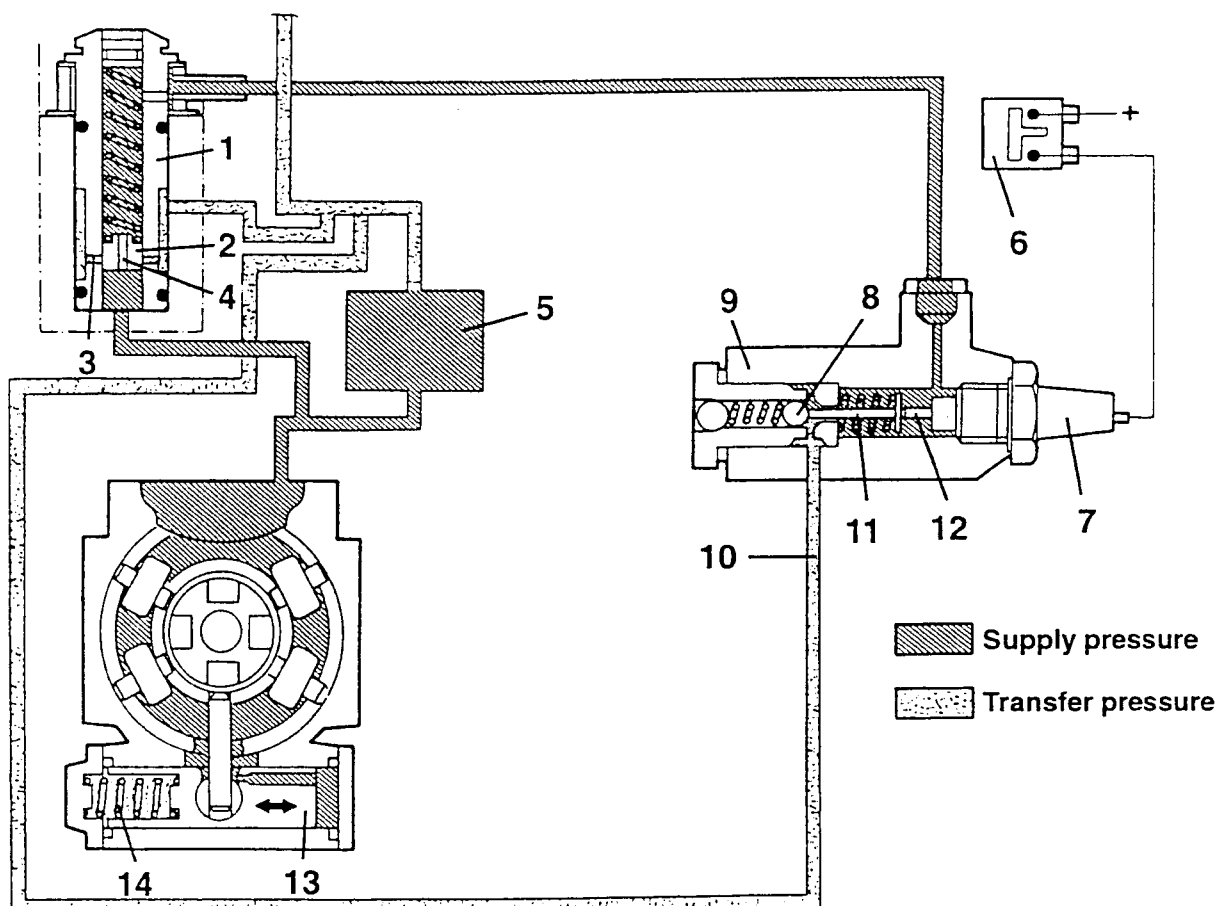
1. Transfer pressure regulating valve
2. Piston valve
3. Drainage holes
4. Piston calibrated hole
5. Transfer pump
6. Thermoswitch
7. Thermal wax bulb

8. Sphere for pressure seal
9. Body of automatic advance device
10. Drainage hole
11. Sphere control cap
12. Cap of thermal bulb
13. Advance variator piston
14. Reaction spring for piston

With hot engine:

When the engine coolant temperature reaches 60 °C, the thermostatic switch (6), on the thermostat body closes and gives the consensus for the wax bulb (7) to be supplied (electrically), which makes the cap (12) come out, due to the expansion effect of the wax, and which in turn opens the spheric valve (8).

The opening of the spheric valve (8) causes a decrease in the transfer pressure (consequently the piston advance stroke 13 is eliminated) because a part of the flow is drained by the calibrated hole (4) as well as by the holes (3), which connects the pressure regulating valve (1) with the supply channel, located upstream from the transfer pump (5).



1. Regulating valve transfer pressure
2. Piston valve
3. Drainage holes
4. Piston calibrated hole
5. Transfer pump
6. Thermostatic switch
7. Thermal wax bulb

8. Sphere for pressure seal
9. Automatic advance device body
10. Drainage hole
11. Sphere control cap
12. Thermal bulb cap
13. Advance variator piston
14. Reaction spring for the piston

Correction dependent on the atmospheric pressure

From certain altitudes and upwards, the intaken air mass is less due to the reduced air density. The full load flow injected is not completely burned; smoke and engine overheating are the direct consequences.

To eliminate this disadvantage, a full load stop is fitted, which corrects the full load flow on the basis of the atmospheric pressure.

Full load stop dependent on the atmospheric pressure (ADA)

■ Structure

As with the LDA stop, the full load stop dependent on the atmospheric pressure is fitted on the regulator cover.

This has a barometric capsule in place of the diaphragm.

The compression spring is housed between the regulator cover and the spring plate; this serves to set the point at which the barometric capsule intervenes.

The barometric capsule is in contact with the atmosphere through a breather hole.

■ Functioning

The decrease in the atmospheric pressure within the limits in which the barometric capsule functions, causes it to lengthen.

The control journal moves and wins over the spring's counterthrust, the tracer point slides on the conic control end and moves it horizontally.

The rest of the correction process takes place as already described for the LDA stop.

STOP

The diesel engine is stopped by interrupting the supply of fuel.

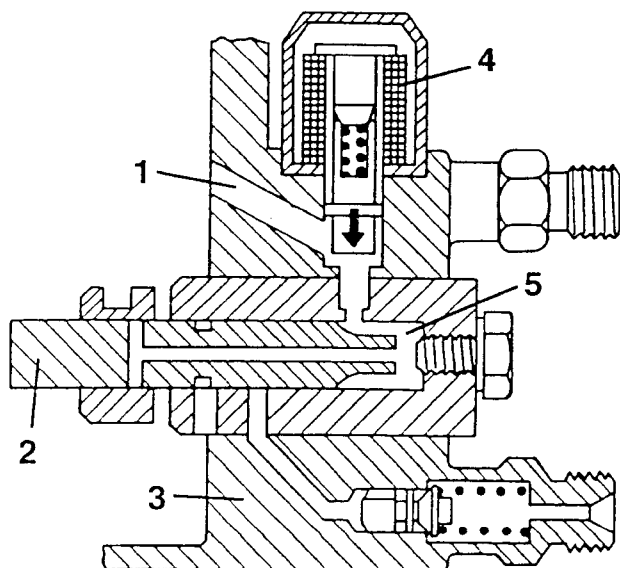
Functioning

Due to its working principle (spontaneous ignition) the diesel engine can only be stopped by interrupting the supply of fuel (electric stop device).

The electromagnetic fuel supply interruption valve is fitted on the upper part of the pump distributor head. When enabled, i.e. when the engine is functioning, the electromagnet keeps the inflow hole into the high pressure chamber open (valve impeller is energized). By disabling the ignition, the electrical supply to the electromagnet coil is interrupted; the magnetic field falls, the spring presses the impeller and the valve against the seating of the latter.

Consequently, the inflow hole into the high pressure chamber is interrupted and the distributor piston can no longer deliver the fuel.

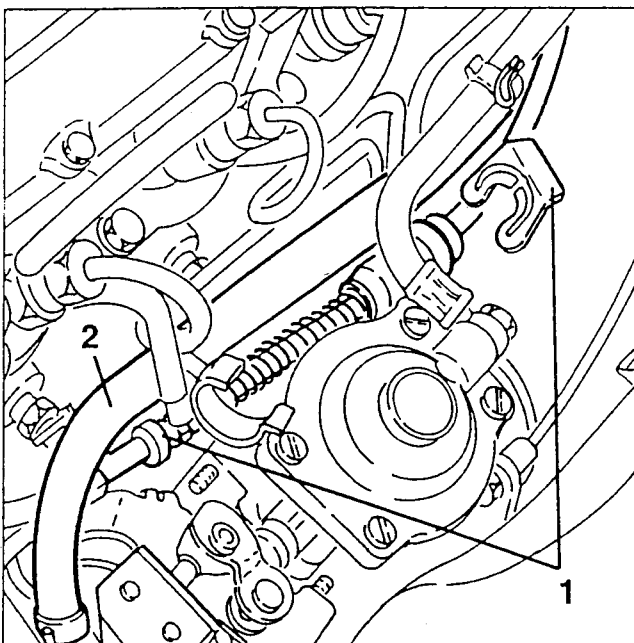
The electric stop can not be realized with electrical circuits conceived differently (return and thrust electromagnets).



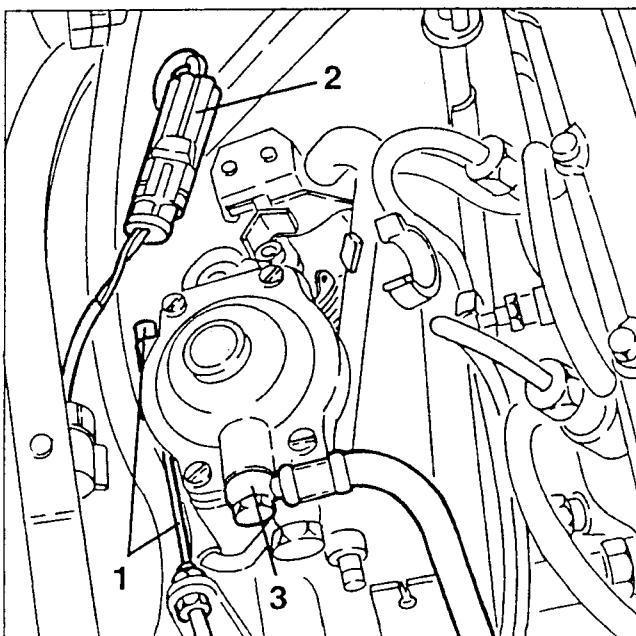
- | | |
|-----------------------|------------------------------------|
| 1. Inflow hole | 4. Return and thrust electromagnet |
| 2. Distributor piston | 5. High pressure chamber |
| 3. Distributor head | |

REMOVAL/REFITTING

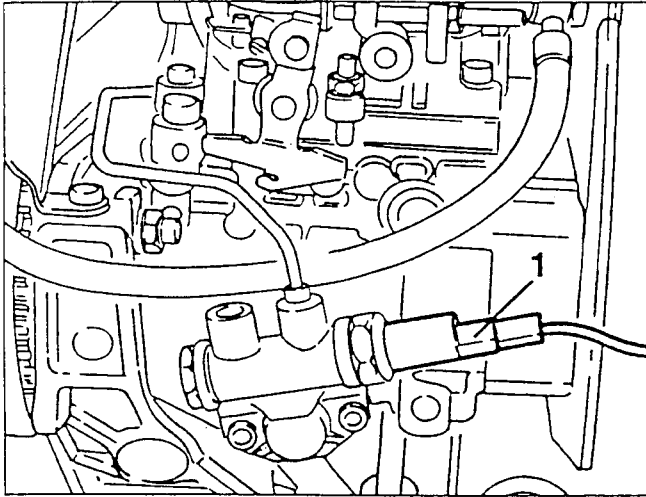
- Position the vehicle on a lift.
- Disconnect the negative (-) battery cable.
- Disconnect the oil vapour recirculation hose from the corrugated sleeve and move it to one side.
- 1. Disconnect the accelerator control cable from the injection pump.
- 2. Disconnect the fuel arrival pipe from the injection pump.



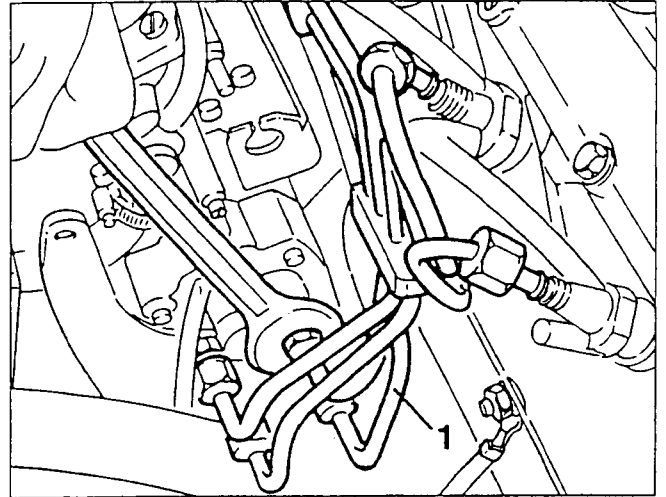
1. Disconnect the automatic idle speed device control cable from the injection pump.
2. Disconnect the electrical connection of the full load switch.
3. Disconnect the overpressure pipe connector for the flow limiter from the injection pump.



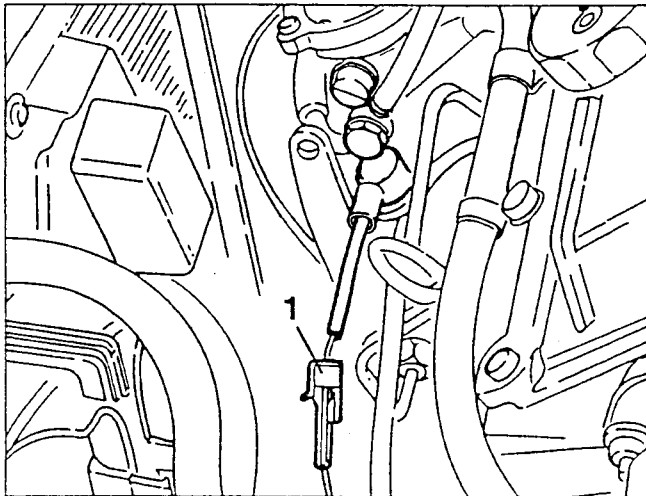
1. Disconnect the electrical connection of the automatic injection advance when cold device KSB.



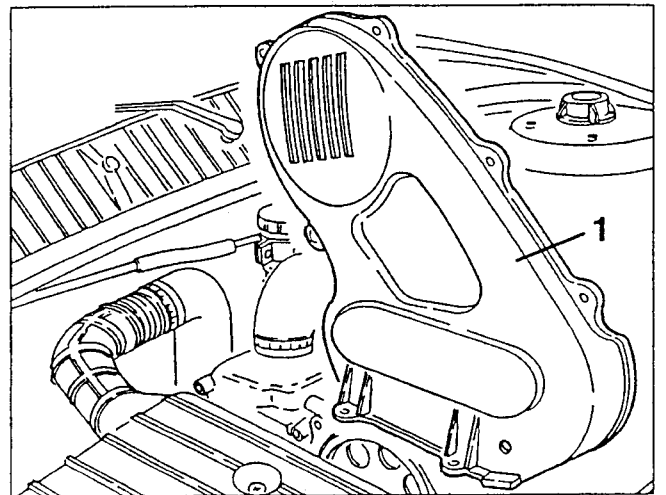
1. Remove the fuel delivery pipes from the pump to the injectors.



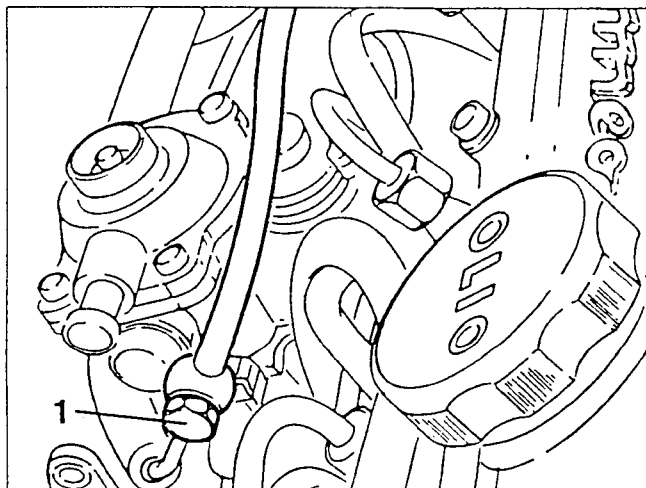
1. Disconnect the electrical connection of the engine stop solenoid valve.



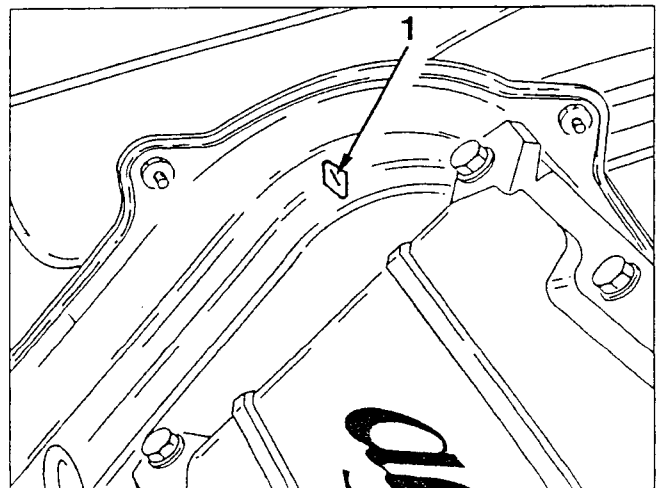
1. Unscrew the screws and remove the timing belt front cover.



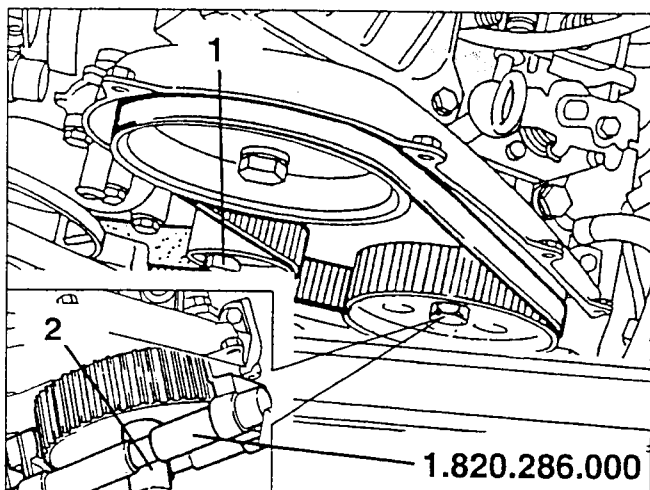
1. Disconnect the excess fuel to tank return pipe connector from the injection pump and remove it.



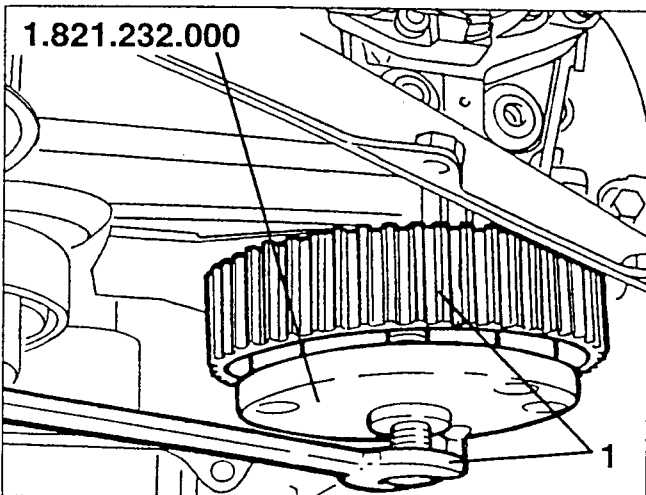
1. Check that the notch on the camshaft control pulley is in line with the hole on the timing belt rear guard.



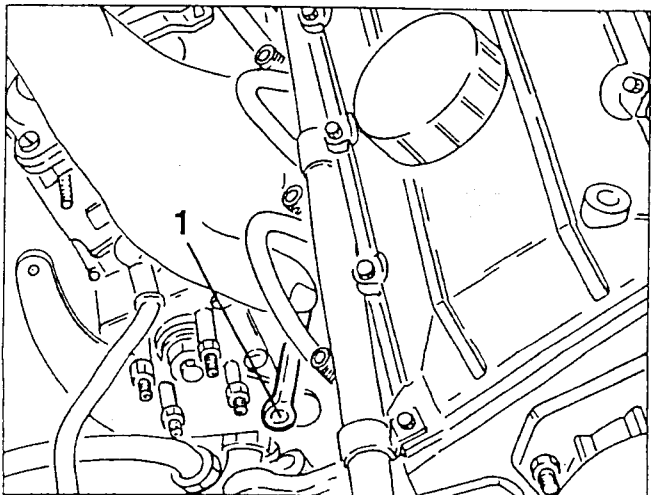
1. Loosen the nuts securing the belt tensioner jockey pulley and extract the timing belt.
2. Using tool N° 1.820.286.000, unscrew the nut securing the injection pump control pulley.



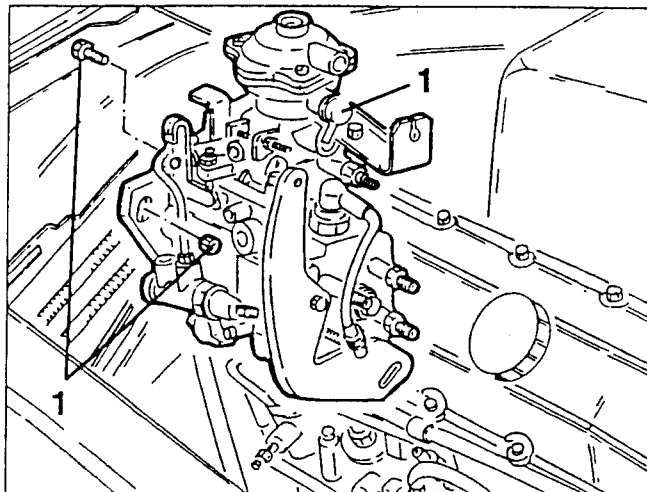
1. Using tool N° 1.821.232.000 remove the injection pump control pulley.



1. Unscrew the screws securing the injection pump support rear bracket.

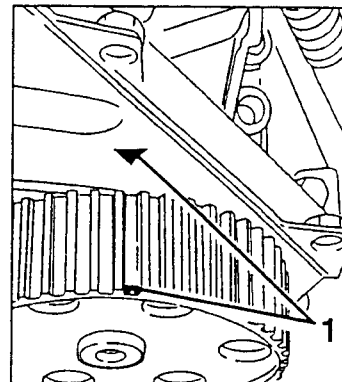


1. Unscrew the two upper nuts and lower screws securing the injection pump to the support and remove it.

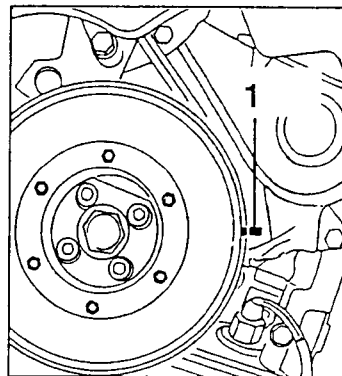


To refit the injection pump, reverse the sequence of the operations described for removal, with the exception of the timing operations given below.

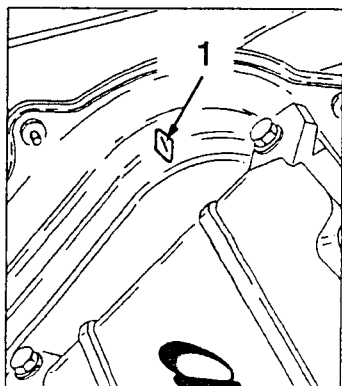
1. Turn the injection pump control pulley so that the notch engraved on it corresponds with the rise on the timing belt rear cover.



1. Check that the notch on the auxiliary parts control pulley is in line with the notch on the timing belt lower cover.



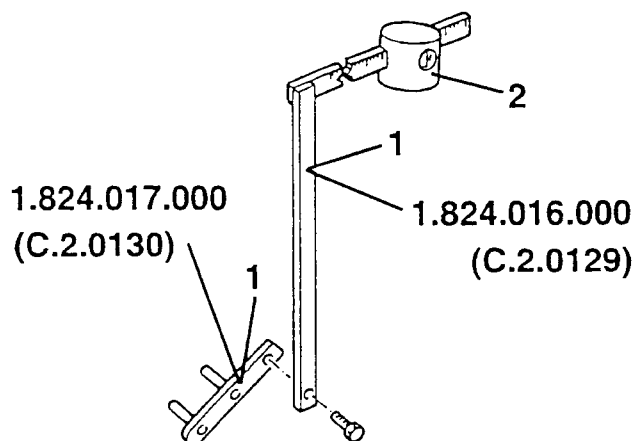
1. Check that the notch on the camshaft control pulley is in line with the hole on the timing belt rear cover.



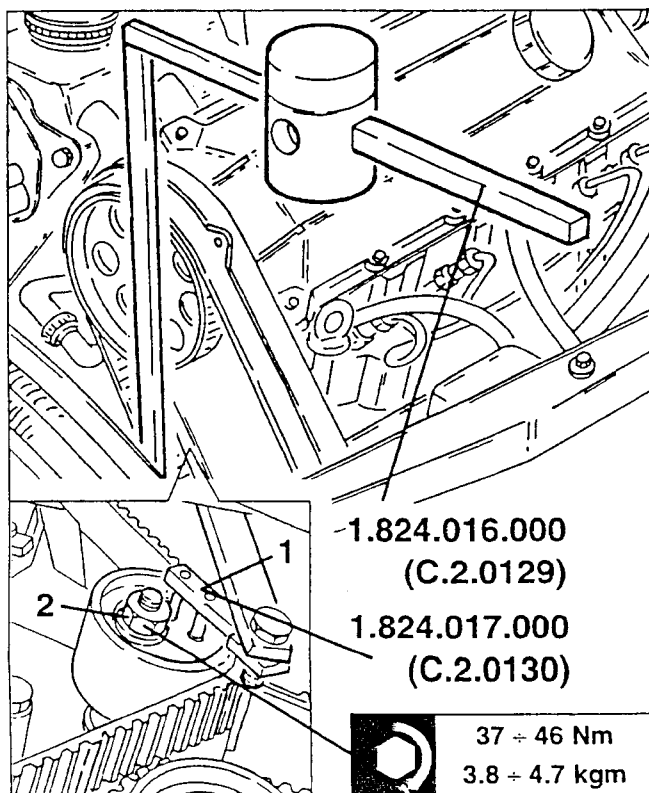
- Install the timing drive belt, and check that the teeth over the whole pulley are correctly coupled.

When the belt is fitted, do not under any circumstances bend the belt otherwise the structure of the fibres may be compromised.

1. Fit support N° 1.824.017.000 (C.2.0130) onto tool N° 1.824.016.000 (C.2.0129).
2. Position the weight with the knurled part at a distance of 120 mm on the millimetric rod and block it there.

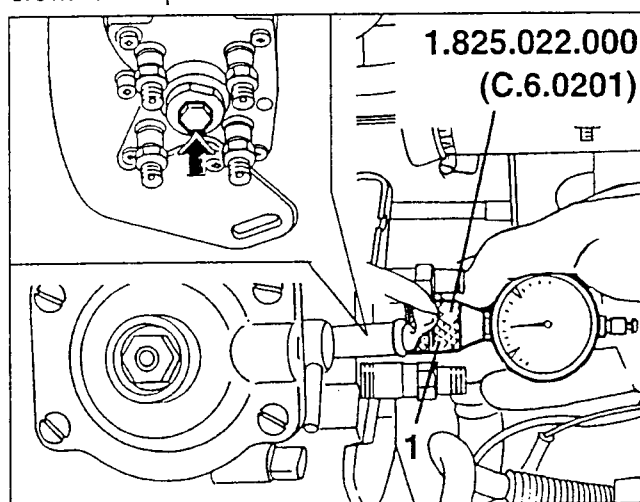


1. Apply the tool, assembled in this way, on the belt tensioner as illustrated in the figure and acting on the joint, turn the millimetric rod so that it is horizontal.
- Set the drive belt by making the crankshaft complete two revolutions in the normal rotation direction.
2. Tighten the belt tensioner nuts to the correct torque.

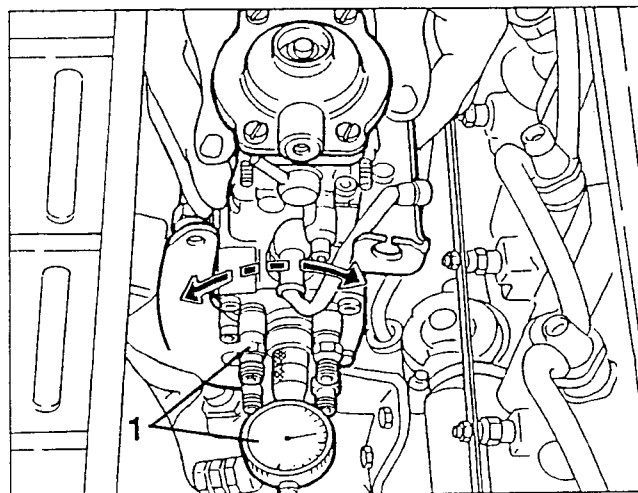


During this latest phase, the millimetric rod may move from its horizontal position; if this is the case it must be returned to its original position by acting on the belt tensioner and the operation must be repeated.

- Remove the tools for tensioning the belt.
- Check the correct engine timing again as described previously.
- After having refitted the injection pump, check that it is timed by operating as follows:
 1. Remove the plug on the pump cover and in its place screw tool N° 1.825.022.000 (C.6.0201) complete with a comparator with tracer point in contact with the crown of the piston distributor.

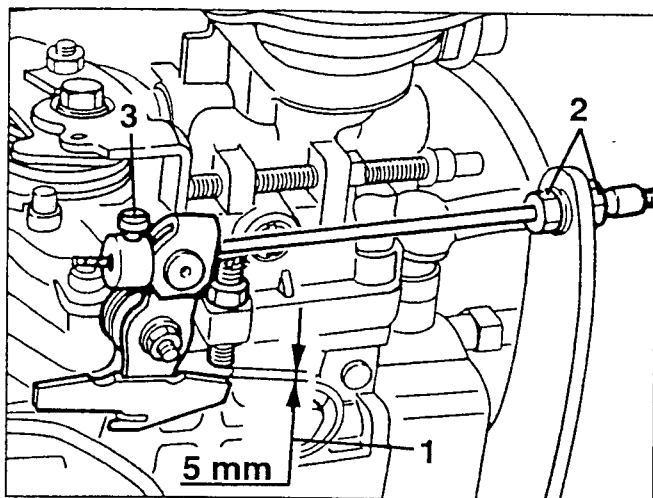


- Rotate the crank shaft in the opposite direction to the rotating direction until the piston distributor of the pump reaches the B.D.C.; set the dial gauge to 0.
 - Rotate the crank shaft in the direction of rotation until the cylinder piston N° 1 is at T.D.C.
- In this position, the piston distributor of the pump must have completed a stroke of 0.8 mm.
1. If the prescribed stroke is not completed, the pump body must be rotated in its slot until the correct value, then tighten the screws securing.



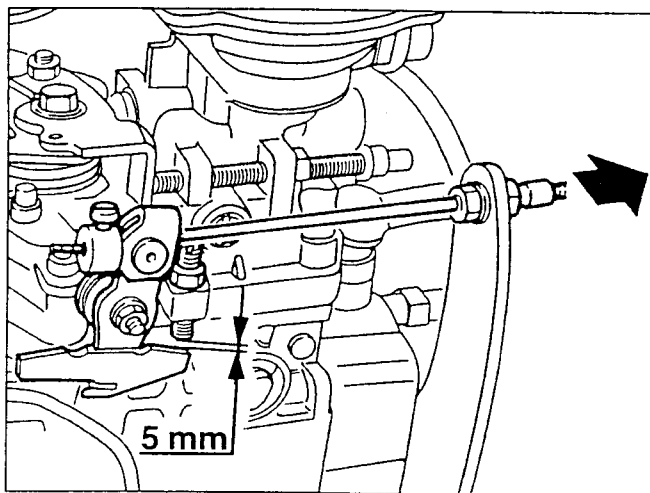
- After having connected the automatic idle speed device control cable to the injection pump, adjust as follows.

1. Check that when the engine is cold (with the automatic minimum idle speed set at 1180 ± 1220 r.p.m.), there is a gap of 5 mm between the end of the lever and the adjusting screw.
2. If the gap measured does not correspond to the specified value adjust the nut and locknut.
3. If the correct gap is not obtained even after adjusting, act on the bushing anchoring the cable.



AUTOMATIC IDLE SPEED DEVICE

Functioning when engine is cold:



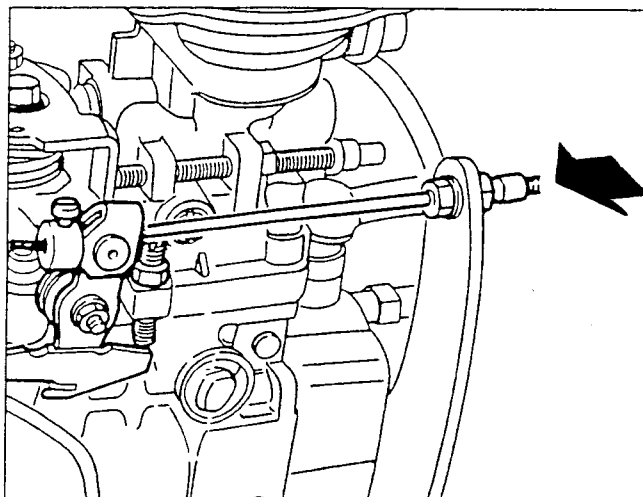
The thermostatic sensor, screwed to the thermostatic cup, acts through a connecting cable on the automatic idle speed control lever.

When the engine is cold, the thermostatic sensor is in the rest position as the engine coolant has not reached the temperature at which it starts to intervene ($60^\circ\text{C} \pm 2^\circ\text{C}$).

In these conditions the control lever of the device is kept in the idle speed position by the cables and there

must be a gap of 5 mm between the end of the lever and the idle speed adjusting screw.

Functioning when engine is hot



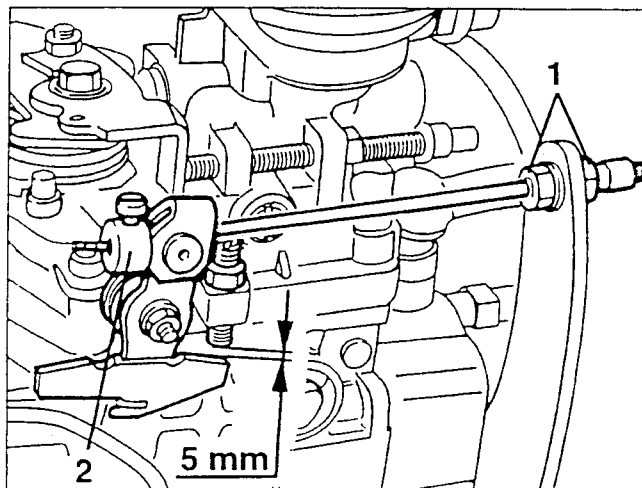
When the engine coolant reaches the intervention temperature of ($60^\circ \pm 2^\circ\text{C}$), the thermostatic sensor starts to act and the cap slowly moves in function with the gradual increase in the engine coolant temperature.

Consequently the cable allows the lever to move until the idle speed position is reached, i.e. when the end of the lever is in contact with the idle speed adjusting screw.

Adjusting the automatic idle speed

- When the engine is cold, in order that the prescribed automatic idle speed of (1180 ± 1220 r.p.m.) is obtained, there must be a 5 mm gap between the end of the control lever and the idle speed adjusting screw.

1. If the gap measured does not correspond to the specified value adjust the nut and locknut.
2. If the correct gap is not obtained even after adjusting, act on the bushing anchoring the cable.



Asdjusting the idle speed

NOTE: Before adjusting the idle speed, check that this adjustment is not conditioned by the position of the residual flow adjustment screw.

- Start up the engine and bring it to a normal operating speed.

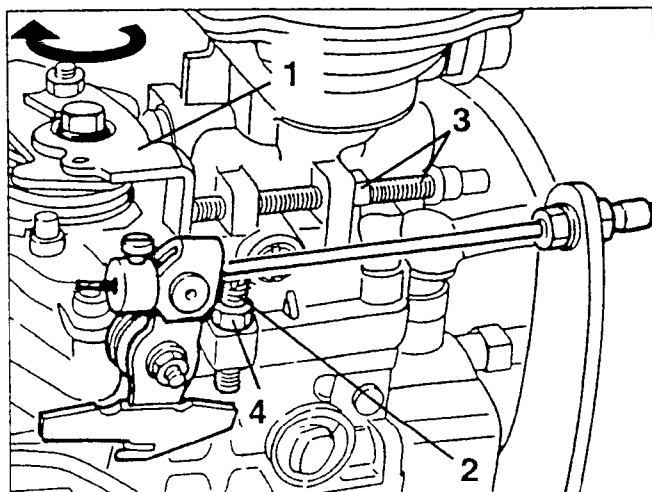
1. Activate the accelerator control lever and move it by $1 \div 2 \text{ mm}$ from the rest position, without increasing the engine revs.

- If this is not the case, unscrew the residual flow adjustment screw and repeat the test until the condition described above no longer occurs.

2. Once the test has been carried out, adjust the idle speed by acting on the adjusting screw until the prescribed r.p.m. is obtained ($880 \div 920 \text{ r.p.m.}$).

3. When the adjustment is complete, screw the residual flow adjusting screw until an increase in the r.p.m. $\sim 10 \text{ r.p.m.}$ is obtained, then unscrew it by $0.5 \div 1 \text{ turn}$ and block it with a suitable lock nut.

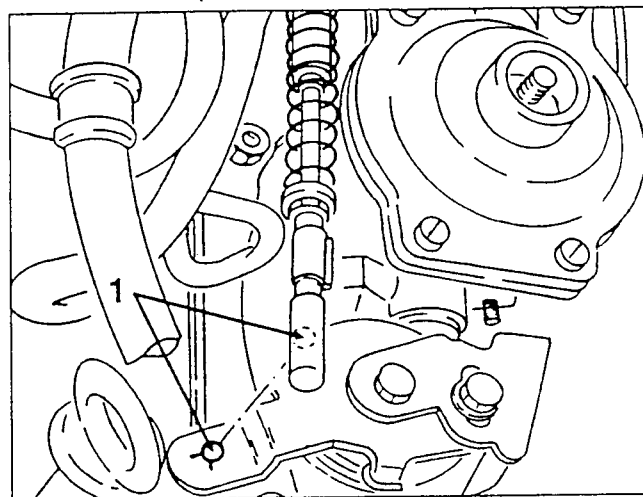
4. Block the idle speed adjusting screw with a suitable lock nut.



ADJUSTING ACCELERATOR CABLE

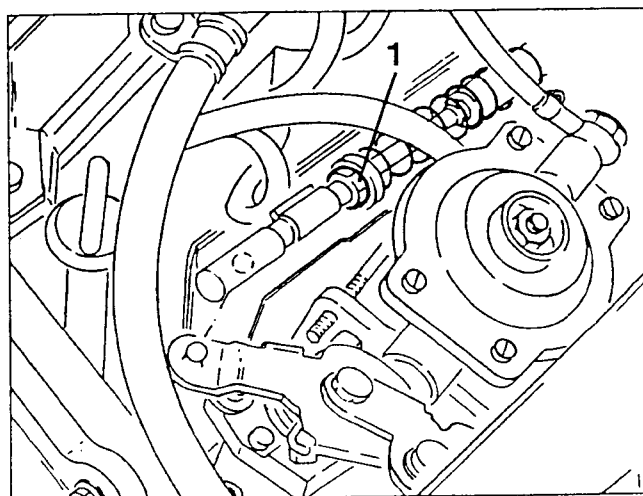
- Disconnect the accelerator cable from the control lever.

1. With the accelerator pedal completely raised, check that the sphere on the control lever corresponds with the hole on the pawl of the accelerator cable.



1. If this is not the case, loosen the nut on the accelerator cable pawl and unscrew/screw it until it corresponds.

- Reconnect the accelerator cable to the control lever on the injection pump.



AIR BOOSTING SYSTEM DESCRIPTION

The engine power is directly proportional to the air mass and the corresponding fuel quantity introduced into the cylinders.

It is therefore possible to increase the engine power by introducing, during each cycle, an amount of air greater than the amount that the engine is able to intake through the "pumping" of the pistons.

This increased quantity of air (in weight) allows a proportionally increased quantity of fuel to be burned and the pressure, work and power developed by the engine to be increased.

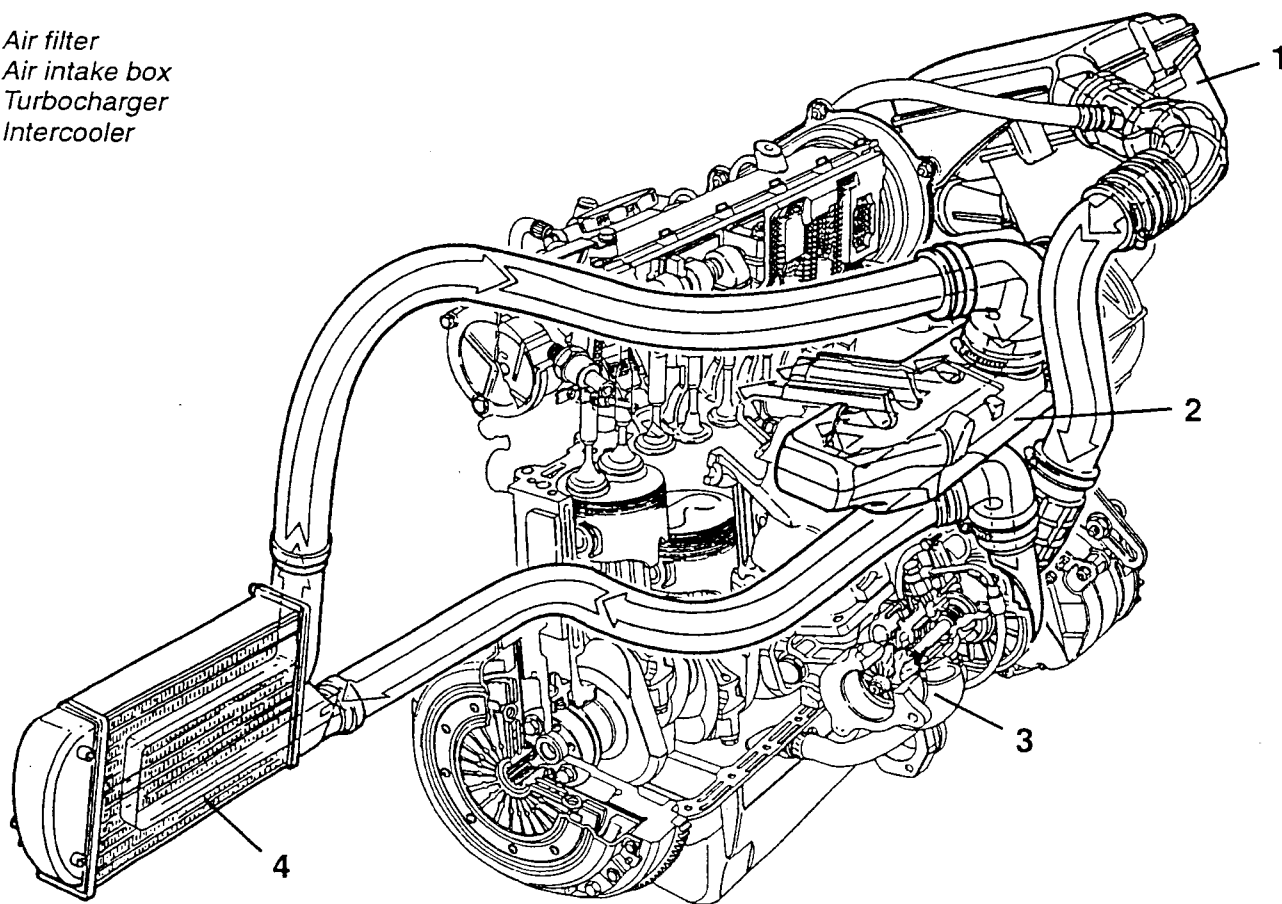
Adopting the boosting system also increases the engine's turbulence which reduces consumption.

The air intaken through a dynamic inlet and filtered through a cartridge element, arrives at the turbo-charger from where it is sent, under pressure, to the intercooler.

Here the air is cooled by an air - air thermic exchange and sent to the air intake box from where it is sent into the cylinders.

As regards the treatment of the individual components, see the paragraphs below.

1. Air filter
2. Air intake box
3. Turbocharger
4. Intercooler

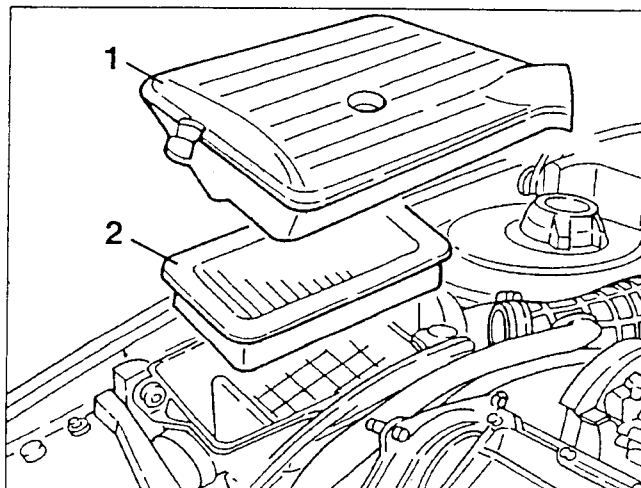


AIR FILTER

The filter is of the cartridge type, with a filtering element which is easy to replace and which traps the particles and dust present in the air sucked into the engine and also acts as an "intake silencer".

REPLACEMENT OF AIR FILTER CARTRIDGE

- Disconnect the corrugated sleeve from the air filter cover.
- Unscrew the screws securing the air filter cover.
- 1. Remove the air filter cover.
- 2. Remove the air filter cartridge.



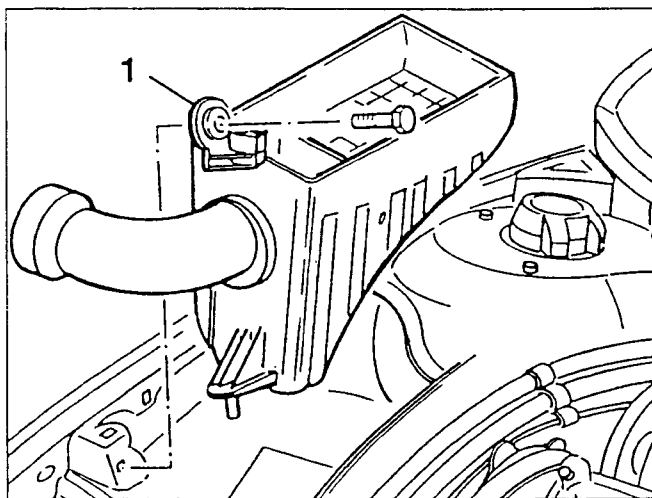
Any filter cleaning operation may damage it and risk compromising the correct functioning of the engine supply system.

- Carefully clean the air filter cartridge container.
- Check the condition of the cartridge and, if necessary, replace it.
- Refit the cover and fix it with the relative screws.
- Connect the corrugated sleeve to the air filter cover.

If the filter shows traces of oil, check the whole circuit for possible infiltrations.

REMOVAL/REFITTING

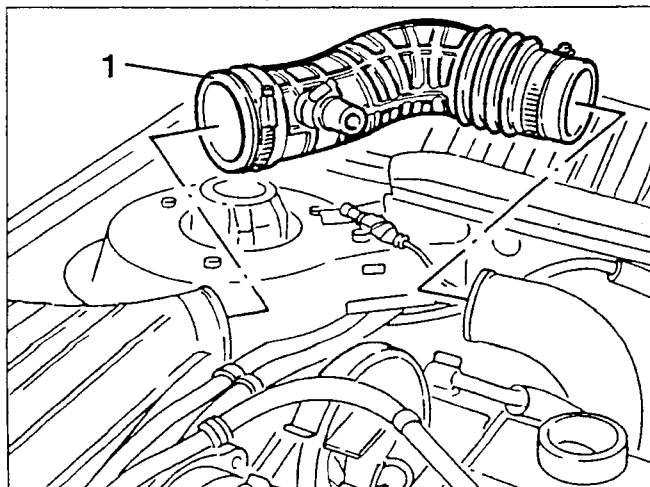
- Remove the air filter cartridge (see specific procedure).
- 1. Unscrew the screws and remove the air filter box.



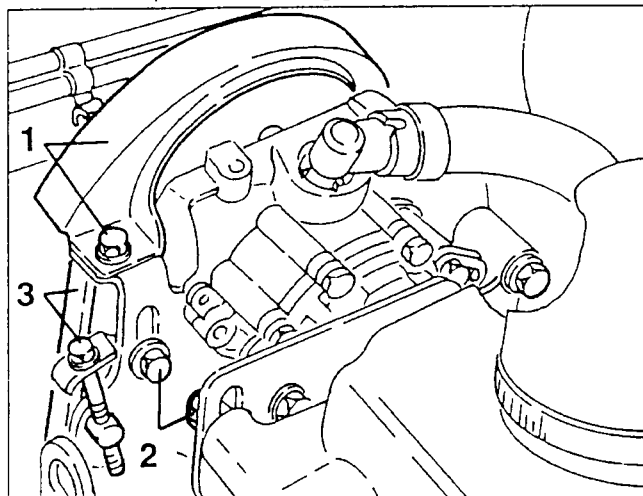
AIR INTAKE BOX

REMOVAL/REFITTING

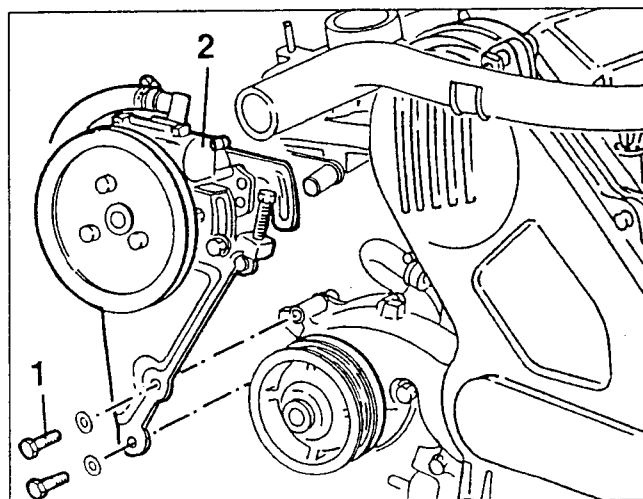
- Disconnect the negative (-) clamp from the battery.
- Disconnect the oil vapour recirculation pipe from the air intake corrugated sleeve.
- 1. Remove the corrugated air intake sleeve from the filter to the turbocharger.



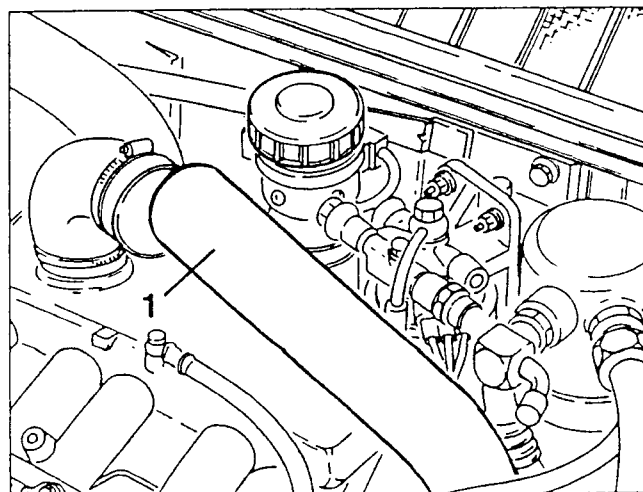
1. Remove the power steering pump belt guard.
2. Loosen the screws securing the power steering pump.
3. Loosen the screw of the micrometric tensioner and remove the power steering pump drive belt.



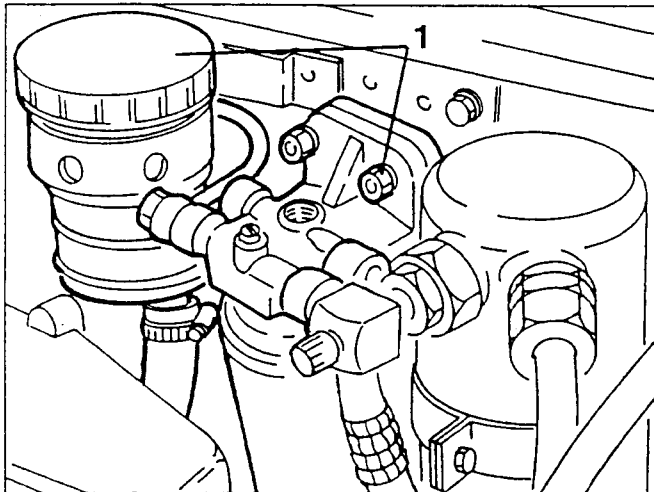
1. Unscrew completely the screws loosened beforehand and the two screws indicated in the figure.
2. Remove the power steering pump complete with front bracket without disconnecting the pipes and move it sideways.



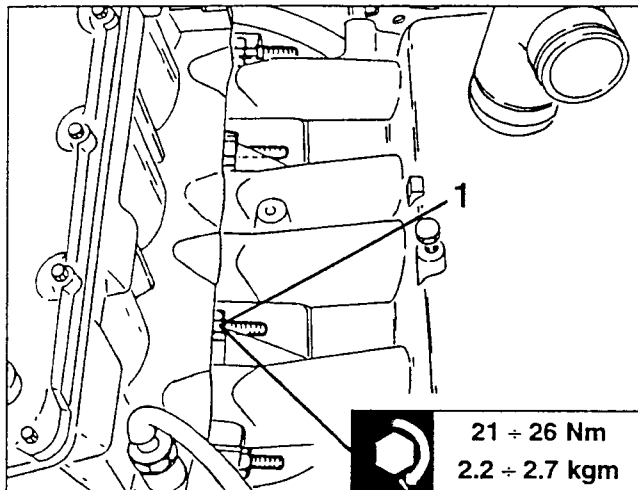
1. Disconnect the stiff air pipe leading from the inter-cooler from the elbow on the intake box.



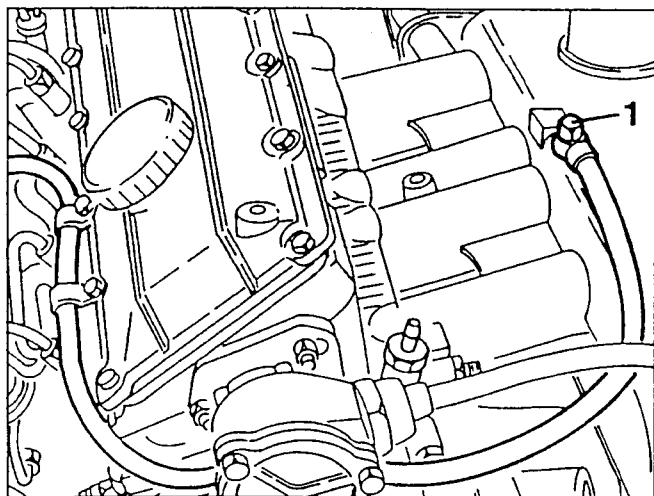
1. Slacken the fastenings of the fuel filter and power steering reservoir, then move them aside without disconnecting their hoses.



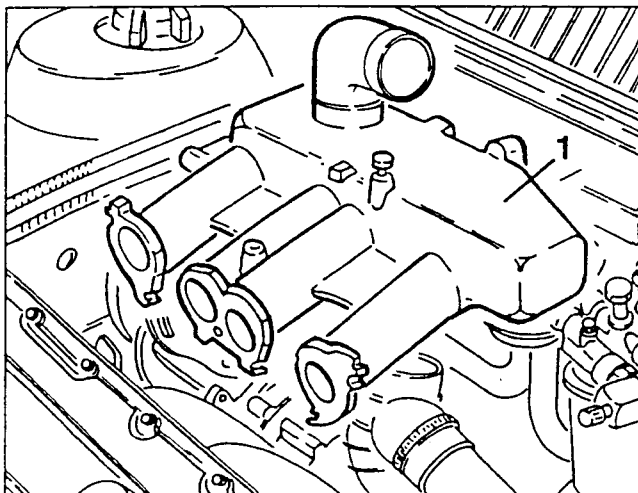
1. Unscrew the screws securing the air intake box to the cylinder heads.



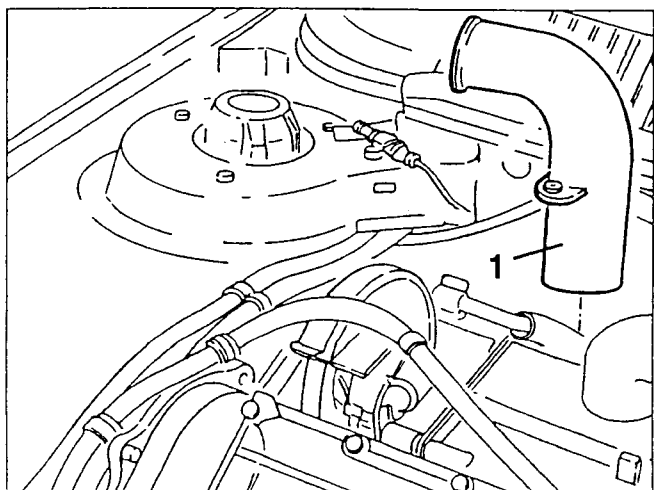
1. Disconnect the connector of the overpressure pipe for the flow limiter from the air intake box.



1. Remove the air intake box.



1. Remove the air intake pipe from the turbocharger.



TURBOCHARGER

This consists of two rotors keyed onto the same shaft, which rotates on lubricated floating bearings through a branch of the engine lubrication circuit.

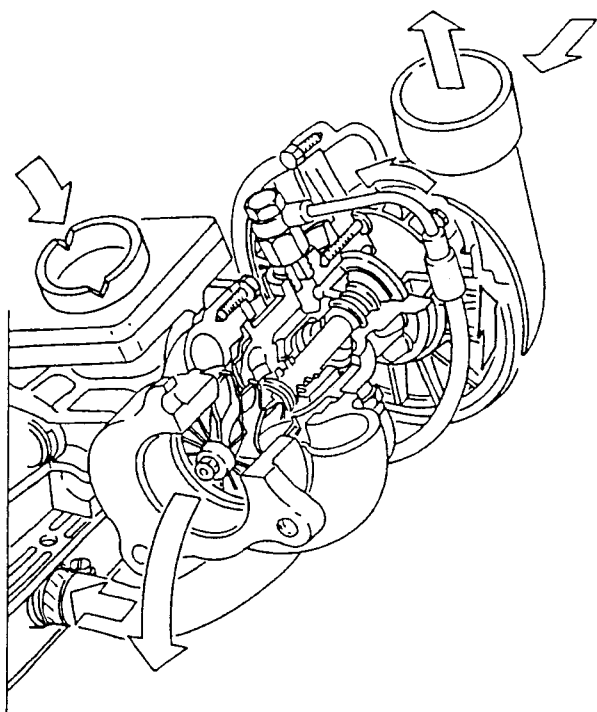
The oil is also used to absorb some of the heat given off by the turbine exhaust gas.

A "turbine" rotor connected to the exhaust manifold rotates thanks to the energy of the exhaust gas conveyed on it.

The turbine makes the other "compressor" rotor, connected to the intake manifold, move (at the same speed).

Thanks to its rotational speed and the particular form of its blades, the rotor draws external air and compresses it in the intake manifold and consequently in the engine cylinders.

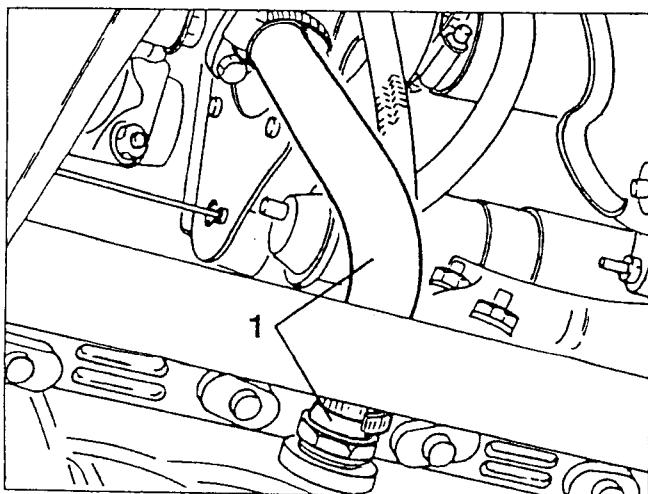
If the r.p.m. increases, the turbine and the compressor also increase their speed of rotation and increase the quantity of air supplied to the engine.
A WASTE-GATE valve is fitted on the turbocharger which allows the exhaust gas to by-pass (or not by-pass) the turbine in accordance with the engine power/torque requested.



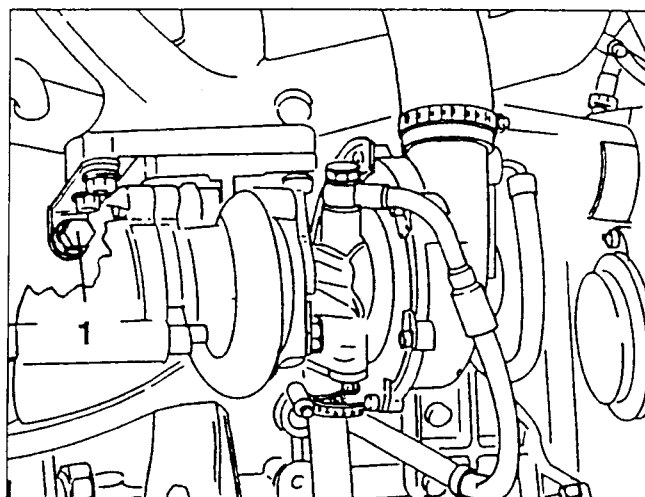
REMOVAL/REFITTING

- Remove the air intake box (see specific procedure).
- Raise the vehicle.
- Remove the front section of the exhaust pipe (see specific procedure).

1. Disconnect the oil from turbocharger outlet pipe from the sump.

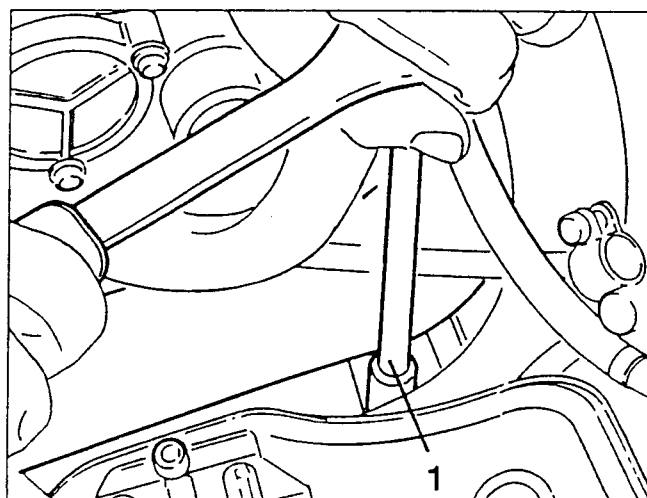


1. Unscrew the screws at the base of the turbocharger support bracket.

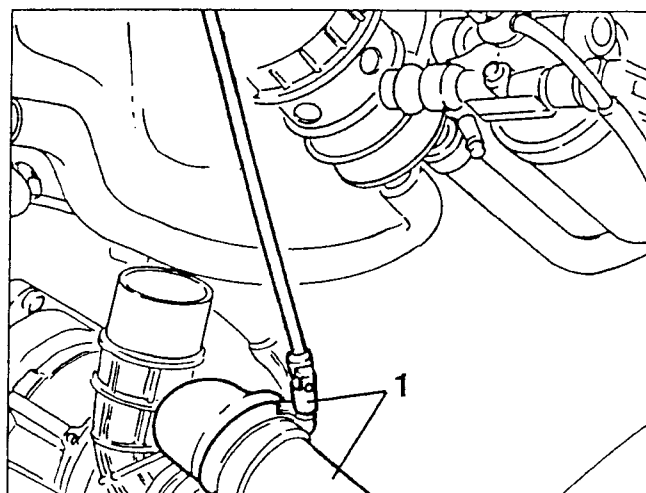


- Lower the vehicle.

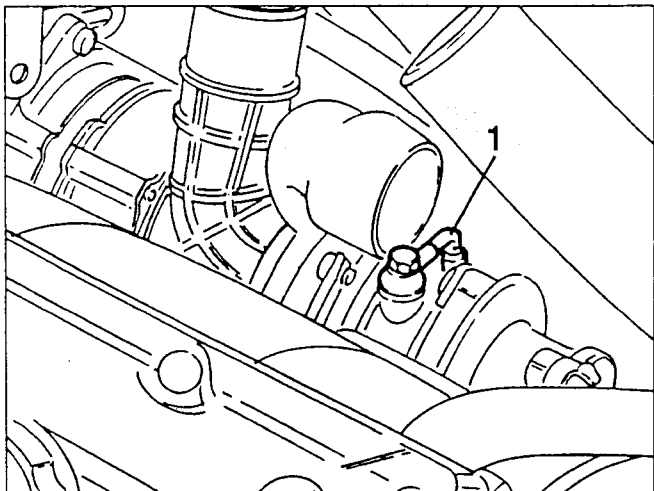
1. Remove the battery and slacken the screw fastening the air delivery pipe from the turbocharger to the intercooler.



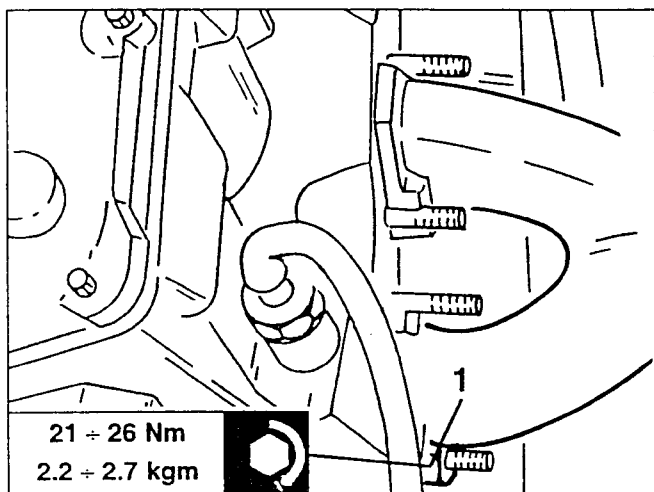
1. Disconnect the air to intercooler delivery pipe from the turbocharger.



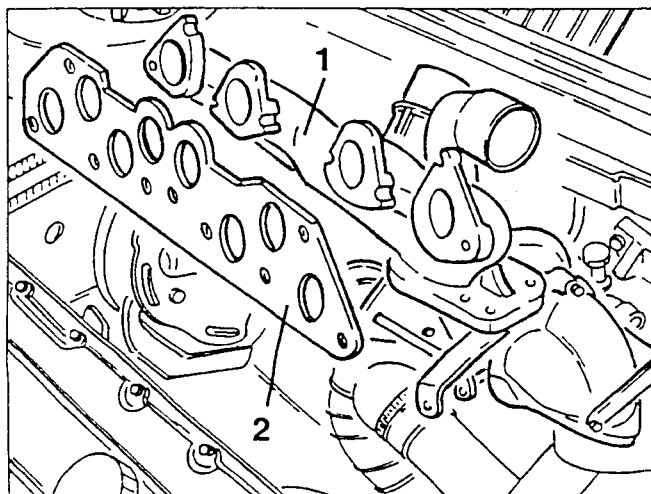
1. Disconnect the oil from engine block arrival pipe from the turbocharger.



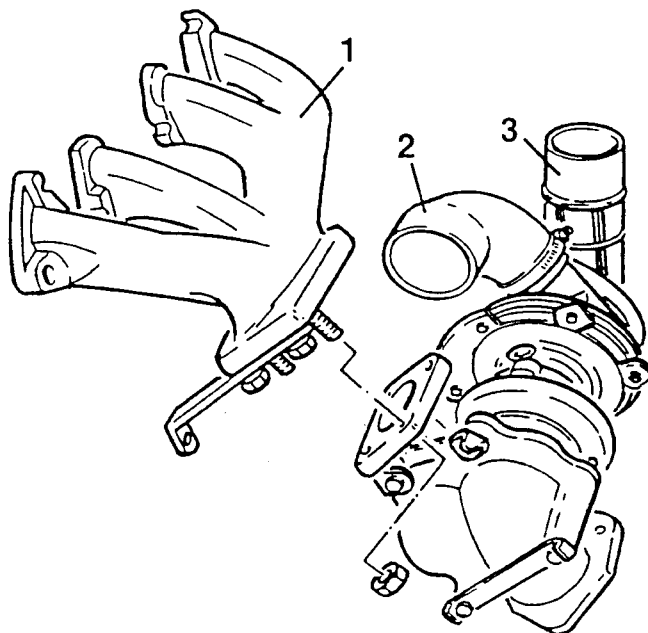
1. Unscrew the nuts securing the exhaust manifold to the cylinder heads.



1. Remove the exhaust manifold assembly, turbocharger and sleeves.
2. Remove the gasket.

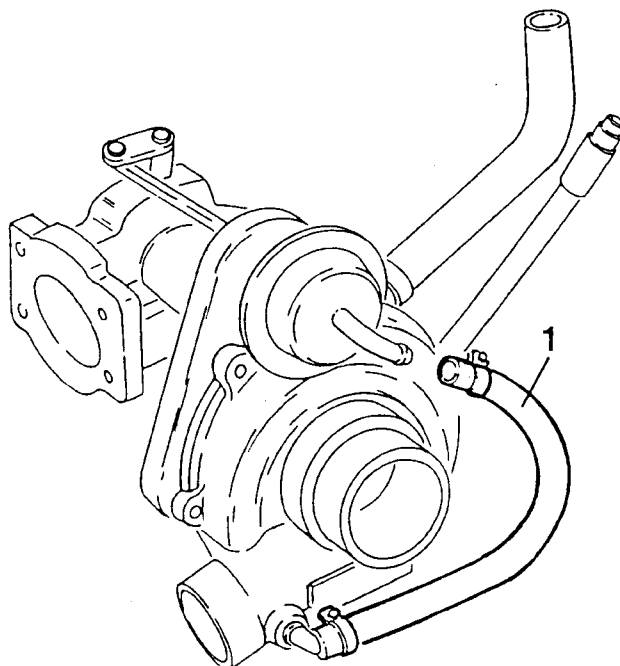


1. At the bench, unscrew the nuts and separate the exhaust manifold from the turbocharger.
2. Remove the air outlet sleeve from the turbocharger.
3. Remove the air inlet sleeve from the turbocharger.

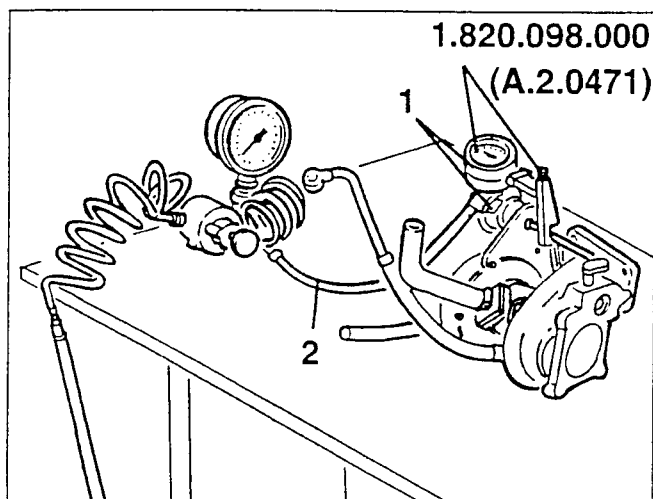


CHECK SETTING OF WASTE-GATE OVER PRESSURE VALVE

- Remove the turbocharger from the engine (see specific paragraph).
- 1. Disconnect the actuator control pipe from the WASTE-GATE over pressure valve actuator.



1. At the bench apply tool N° 1.820.098.000 (A.2.0471) equipped with a comparator to the WASTE-GATE over pressure valve actuator.
2. Connect a compressed air pipe with a pressure gauge to the actuator.



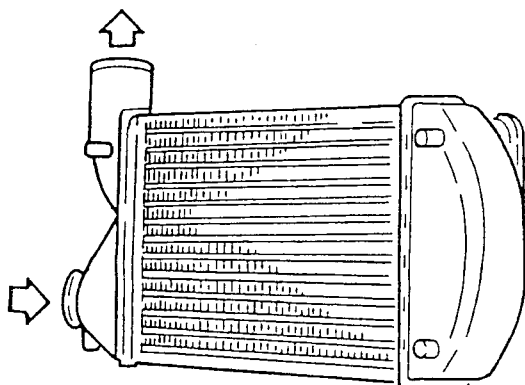
- Inject air at the pressure indicated and check on the comparator that the actuator's stroke is of the prescribed value.

WASTE-GATE valve setting	
Control pressure	Corresponding actuator stroke
0.96 ÷ 1.04 bar	2 mm
1.10 ÷ 1.19 bar	4 mm

INTERCOOLER

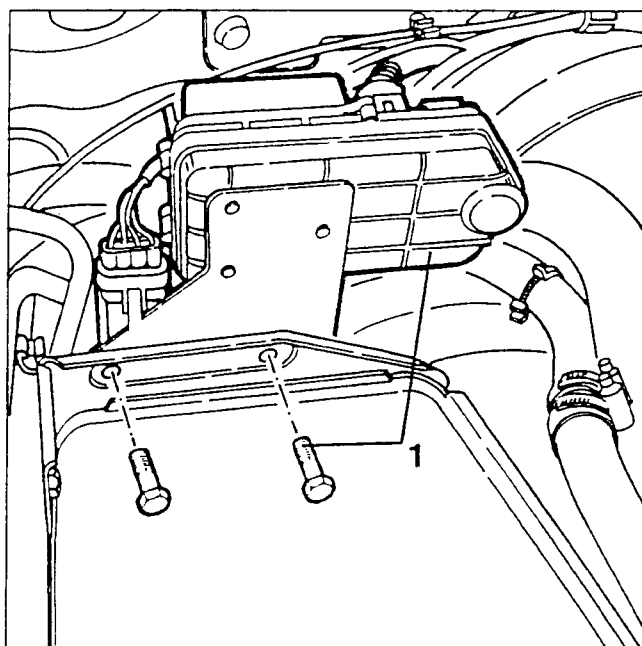
This is an air-air heat exchanger which allows the performance level of the engine to be improved, as lowering the temperature of the air in the cylinders improves their filling up because of the increased density.

The intercooler is positioned in front of the lefthand front wheel arch.

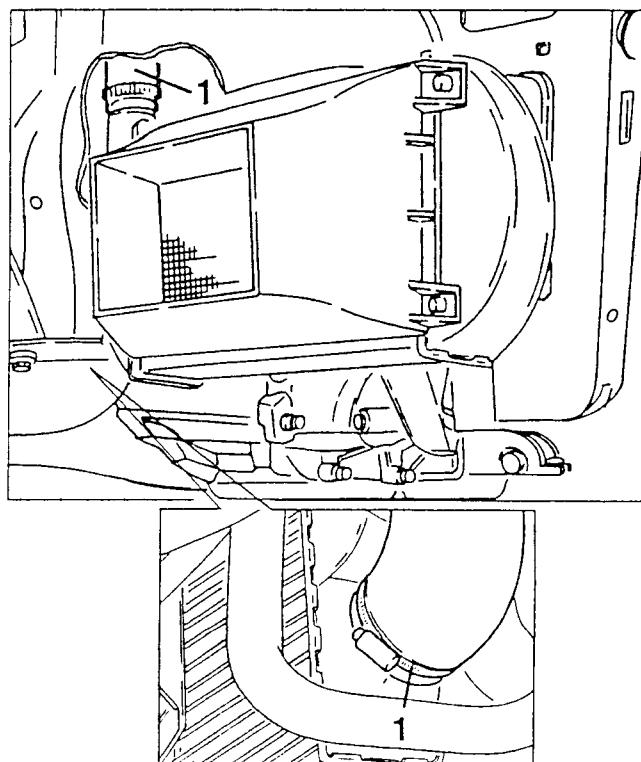


REMOVAL/REFITTING

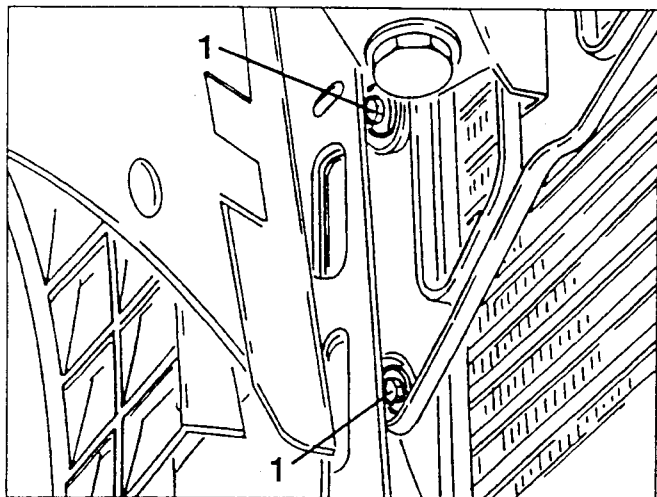
- Position the vehicle on the lift.
 - Remove the battery.
 - Remove the left front wheel.
 - Remove the front bumper (see GROUP 70).
1. Slacken the two screws fastening the relay and electrical connection bracket to the battery, then move it to one side.



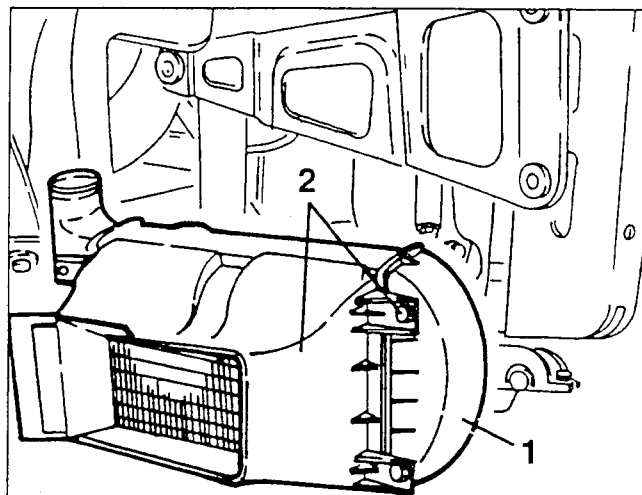
- Raise the vehicle.
1. Disconnect the air inlet and outlet pipe from the intercooler.



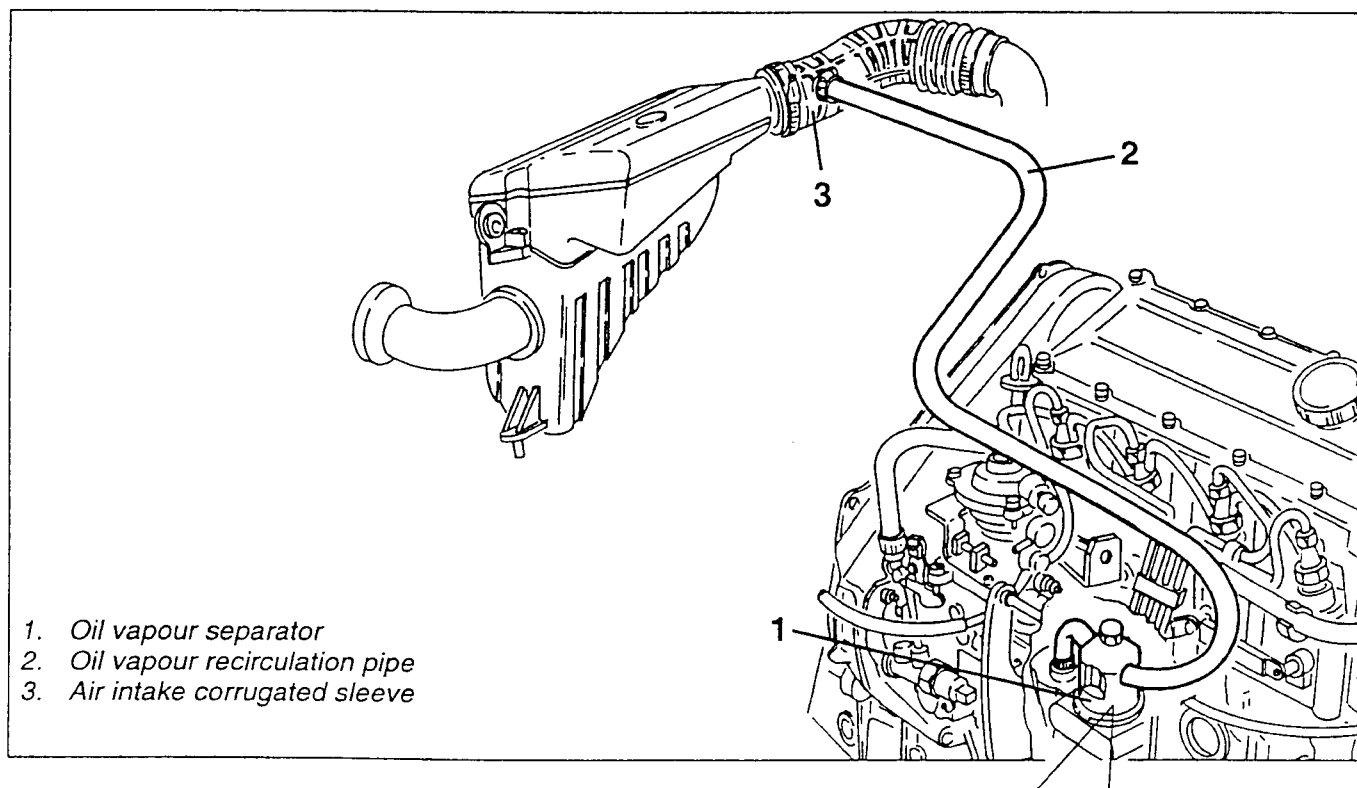
1. Unscrew the three screws securing the intercooler to the support bracket.



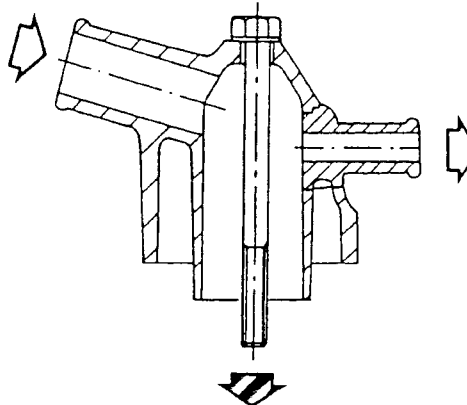
1. Remove the intercooler.
2. If necessary, slacken the fastening screws and separate the duct from the intercooler.



OIL VAPOUR RECIRCULATION SYSTEM



The control of oil vapour emissions is carried out by a cyclone separator which collects the engine block vapours and partially condenses them. The condensed vapours fall back on the engine block in the form of small drops, whilst the vapours are sent through a suitable tube, to the air intake corrugated sleeve.



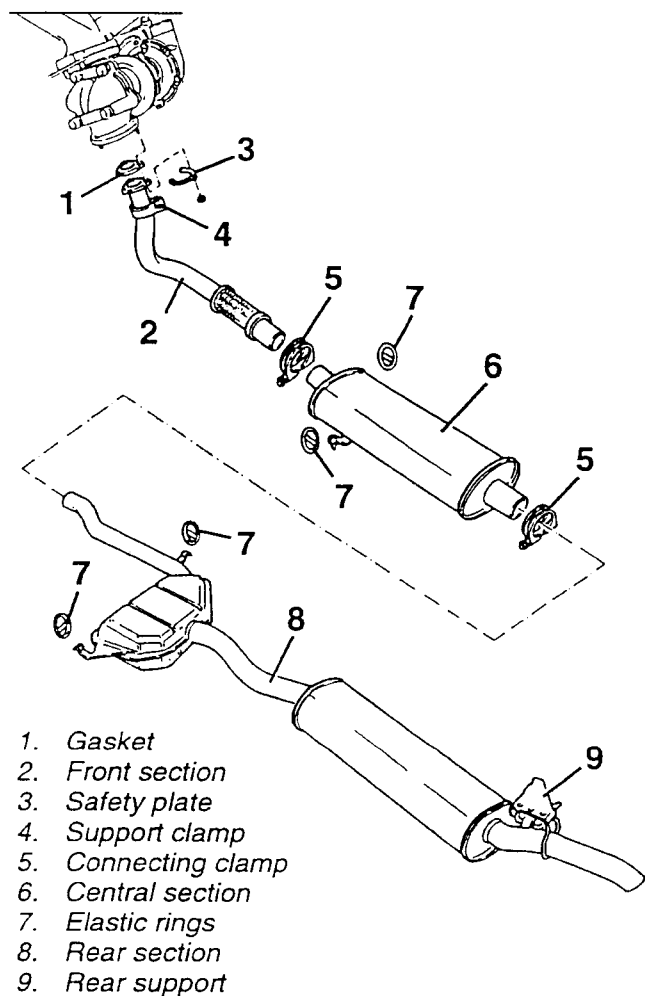
DESCRIPTION

The engine exhaust gases flow through a manifold into the turbine for engine boosting.

From the turbine, through an elbow, the exhaust gases reach the front section of the exhaust pipe.

In the front section of the exhaust pipe, there is a flexible bellow type section which compensates for the thermic expansion and vibrations from the engine. From the front section the exhaust gases flow into the central silencer and from here to the two rear silencers.

The connection of the various sections of the exhaust pipes is achieved with clamps and they are supported by rings and elastic supports.



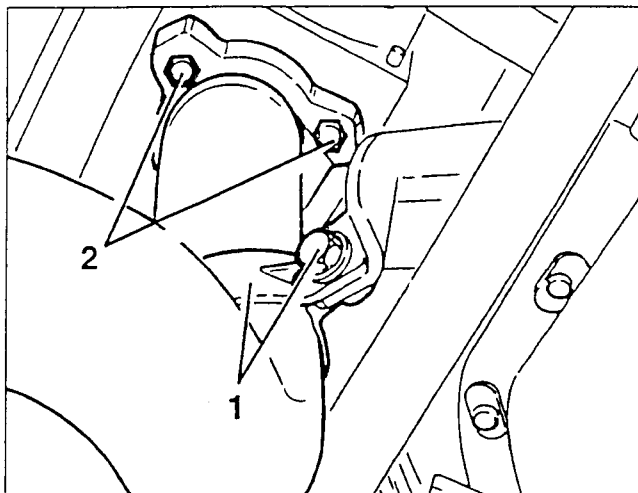
FRONT SECTION

REMOVAL/REFITTING

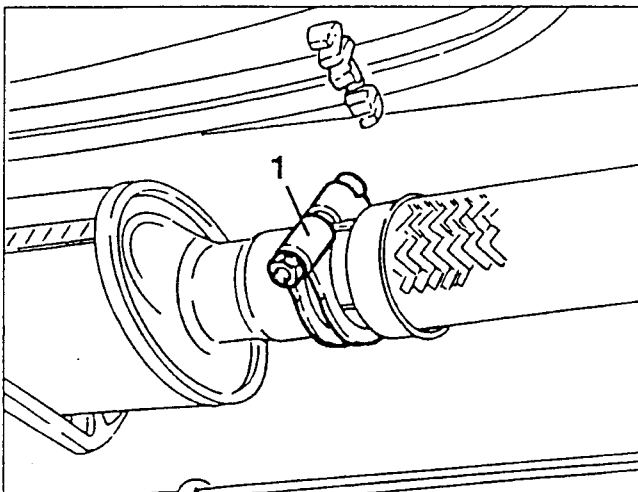
- Raise the vehicle.

1. Unscrew the bolt securing the clamp on the exhaust pipe front section.

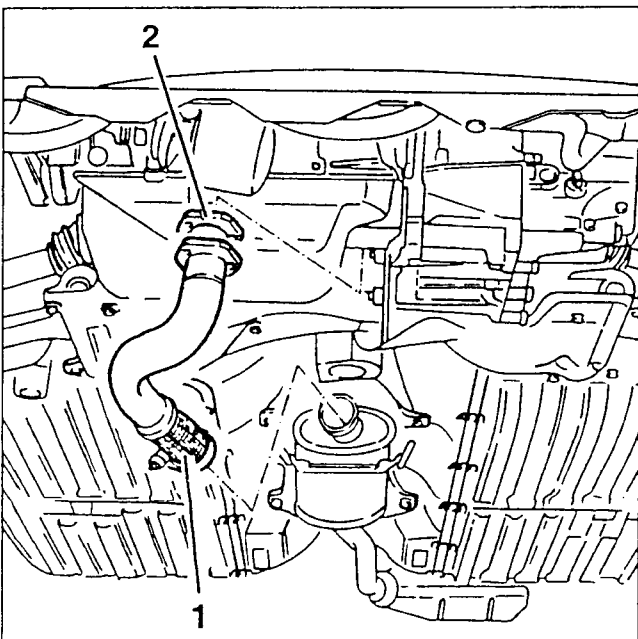
2. Unscrew the screws securing the front section of the exhaust pipe to the turbocharger.



1. Loosen the clamp securing the front section of the exhaust pipe central section.



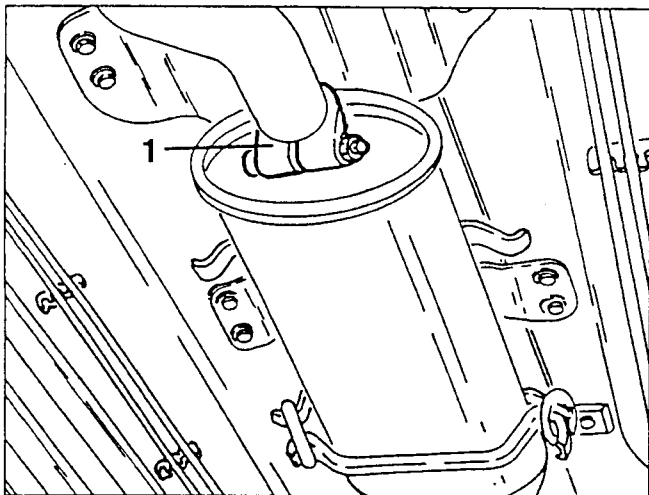
1. Remove the front section of the exhaust pipe.
2. Remove the gasket.



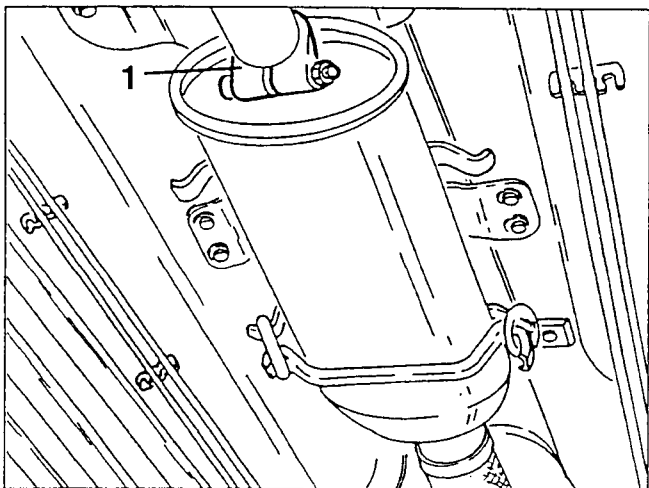
CENTRAL SECTION**REMOVAL/REFITTING**

- Remove the front section of the exhaust pipe (see specific procedure).

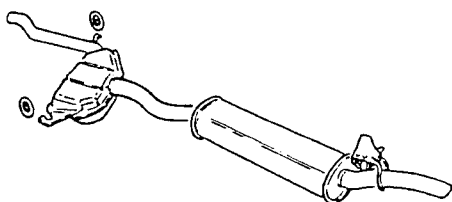
1. Loosen the clamp securing and remove the central section.

**REAR SECTION****REMOVAL/REFITTING**

1. Loosen the clamp securing the rear section of the exhaust pipe to the central section.

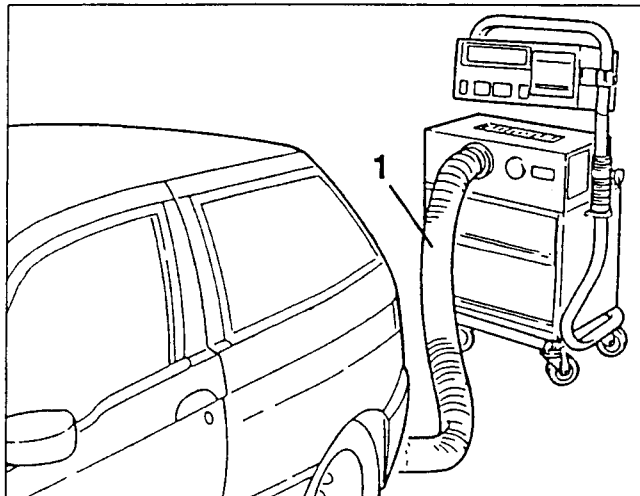


- Unscrew the screws securing the brake pipe support bracket and the handbrake cable.
- Unscrew the screw securing the exhaust pipe rear elastic support to the body and remove it.

**CHECK SMOKE LEVEL AT EXHAUST**

- Start up the engine and bring to a normal running temperature.

1. Insert the exhaust gas drawing pipe of the opacimeter in the end section of the exhaust pipe.



- Make all the necessary connections and adjust the equipment in accordance with the procedures indicated by the manufacturer.

- Press the accelerator down fully three times until the maximum power speed is reached or until the revs limiter intervenes.

- Take the measurements after five consecutive cold accelerations and record the maximum values.

- To obtain the test value, calculate the arithmetic average of the three values closest together.

NOTE: Where there is more than one set of three values suitable, choose the one which gives the highest average value.

- Check that the smoke level falls within the prescribed values.

Maximum smoke level value at exhaust

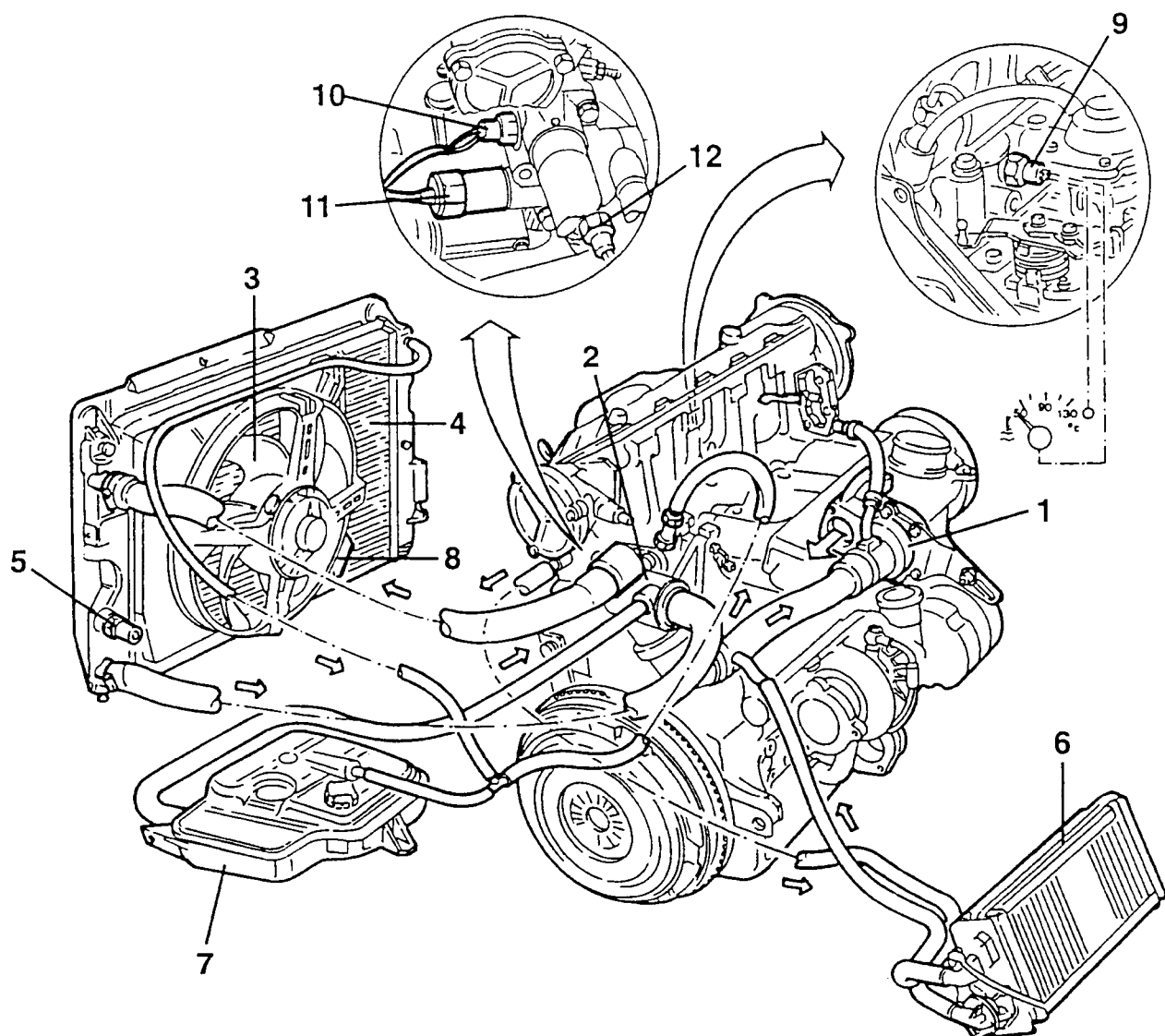
< 70 %

- If the smoke level value at the exhaust is greater than the prescribed value, the following checks should be carried out:

- check condition of air filter;
- check timing of injection pump;
- check valve clearance and setting of timing;
- check setting and clean injectors;
- check compression ratio.

- If, regardless of the above checks, the smoke level remains outside the prescribed limits, the injection pump must be overhauled.

ENGINE COOLING SYSTEM DESCRIPTION



1. Water pump
2. Thermostatic cup
3. Cooling electric fan
4. Radiator
5. Electric fan thermocontact
6. Heater
7. Expansion tank
8. Electric fan additional resistance

9. Engine coolant temperature indicator transmittor and max. temperature warning light contact
10. Cold injection advance automatic device (KSB) thermostwitch
11. Automatic idle speed device thermostat sensor
12. Air conditioning compressor cut-off thermal contact

The cooling system is of the sealed type and the flow of coolant is forced by a centrifugal pump activated by the crankshaft by the Poly V belt.

A thermostatic valve, positioned on the rear side of the cylinder heads, keeps the engine temperature at optimal levels:

it opens when the coolant reaches a temperature of ~ 80 °C, allowing the passage of liquid to the radiator. This radiator cools the liquid by dynamic air and through a two speed electric fan controlled by a two stage thermocontact located on the radiator.

An additional resistance and a relay activate the second speed of the electric fan when the temperature reaches 92 °C.

In versions fitted with an automatic heater/ventilation system with air conditioner, the second speed is enabled after the first speed has been enabled for approx. 10 seconds as well as when the second temperature stage has been reached.

The expansion tank's function is to supply the system should the level fall and it functions like a sort of lung by absorbing the variations in coolant volume due to the variations in temperature; this also ensures that air is bled from the system.

The system is also fitted with a sensor which has the following functions: coolant temperature transmitter, indicator and temperature maximum warning light contact for the warning light on the instrument panel which lights up when the coolant temperature exceeds 115 °C.

SYSTEM OPERATION

The coolant, after having cooled the engine, reaches the thermostat unit through the cylinder heads.

From here, if the temperature is lower than 80 °C, it is sucked up by the pump through a return manifold. If the temperature exceeds this value, the coolant is sent, through the thermostat towards the radiator.

After having been cooled, the liquid returns, through the manifold, to the pump which channels it once again towards the engine.

From the radiator and the cylinder heads, there are two coolant to expansion tank return pipes which also aereate the system.

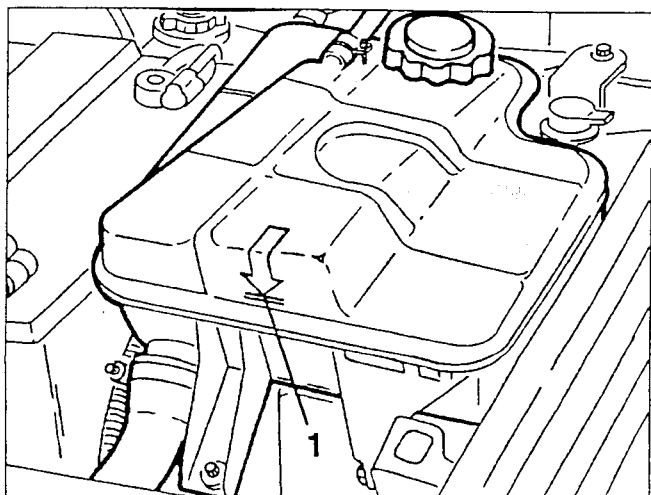
The tank supplies the system through a connection pipe to the thermostatic cup.

The coolant arrives at the heater in the passenger compartment from the cylinder heads through a suitable pipe and returns to the intake manifold of the water pump through another pipe.

CHECK LEVEL AND REPLACE THE ENGINE COOLANT

Check

1. Visually check that the level of the coolant when the engine is cold reaches the notch indicated by the arrow on the expansion tank, if not top up the system with the recommended coolant.

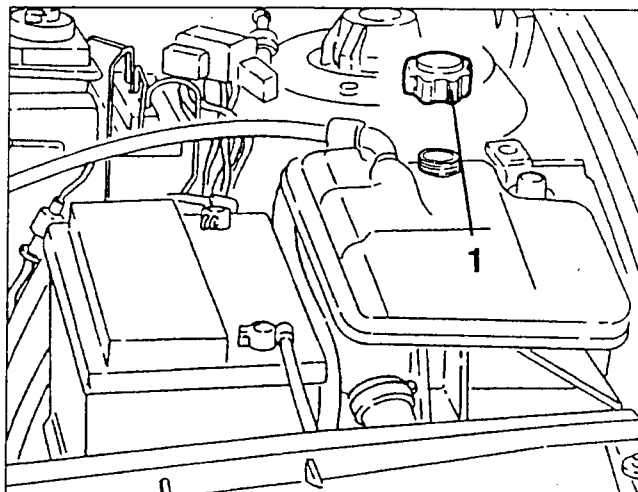


Replacement

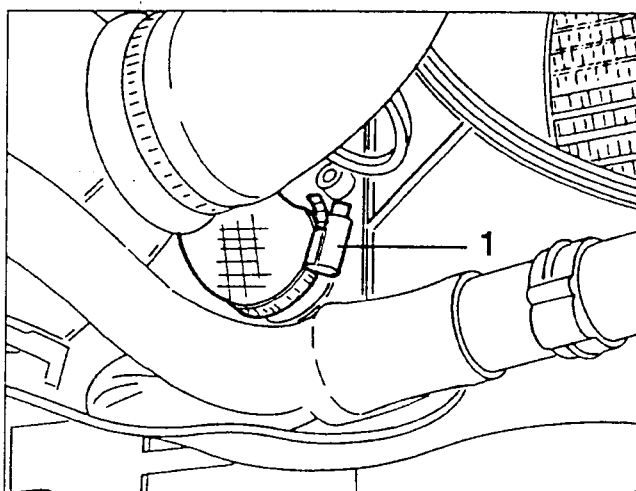
- Position the vehicle on the lift.
- 1. Unscrew and remove the expansion tank cap.

CAUTION:

Do not, under any circumstances remove the expansion tank cap when the engine is hot!



- Raise the vehicle.
- 1. Drain off the engine coolant by disconnecting the coolant from radiator outlet sleeve, and recover it in a suitable container.



- Reconnect the radiator sleeve and all the pipes which have been disconnected, and check that all the clamps have been tightened.
- Top up the expansion tank to the notch.
- The quality and approximate quantity of engine coolant are contained in the table below:

Alfa Romeo Climafluid Super Permanent -40°C	8.9 Litres
--	------------

- Start the engine and bring it to a normal running temperature so that the thermostat opens and frees the residual air present in the system.
- When the engine is cold, top up to the level indicated on the expansion tank.
- Screw the pressurized cap on the expansion tank.

CAUTION:

It is not advisable to mix the antifreeze liquid with different types and brands!

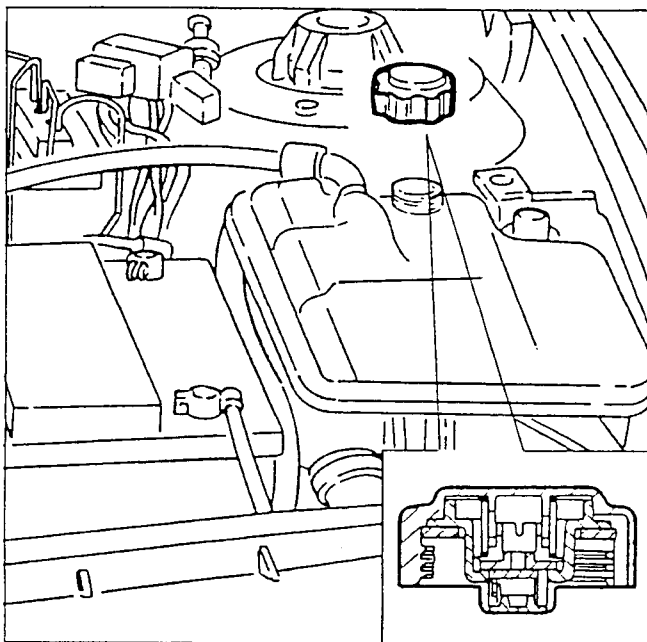
Do not use antirust additives: they may not be compatible with the type of antifreeze used.

EXPANSION TANK

The function of the expansion tank is to supply the system and absorb the variations in coolant volume due to the variations in temperature.

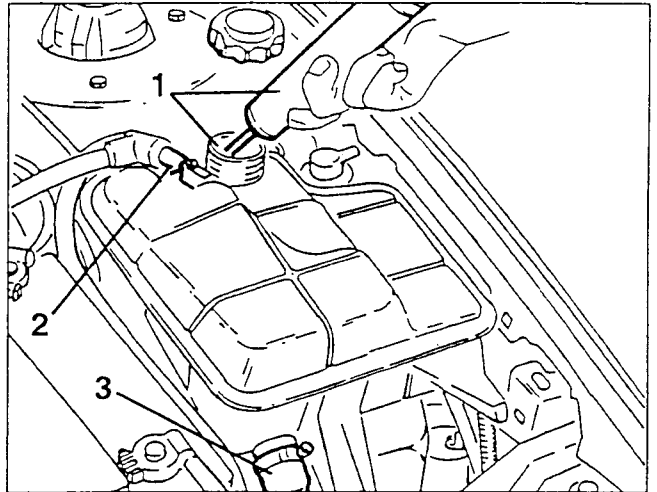
The tank also allows air to be bled from the system through a valve on the pressurized cap, which is collected by the pipe originating from the thermostatic cup.

This valve also washes air coming from outside, to compensate for the vacuum created as the engine cools.

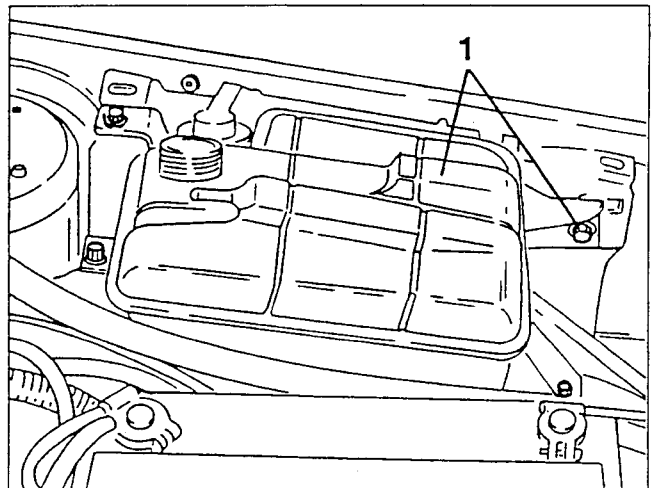
**REMOVAL/REFITTING**

1. Drain the engine coolant expansion tank, using a suitable syringe.
2. Disconnect coolant return and deaerating pipe from the expansion tank.

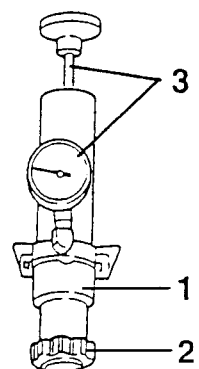
3. Disconnect the coolant supply pipe from the expansion tank.



1. Unscrew the screws securing the expansion tank to the body and remove it.

**ENGINE COOLANT PRESSURIZED CAP SEALING TEST**

1. Screw the connector on the lower end of the test instrument.
2. Fit the expansion tank pressurized cap on the connector.
3. Manually operate on the piston, pressurize and check on the pressure gauge that the exhaust valve on the cap opens at the prescribed setting value.

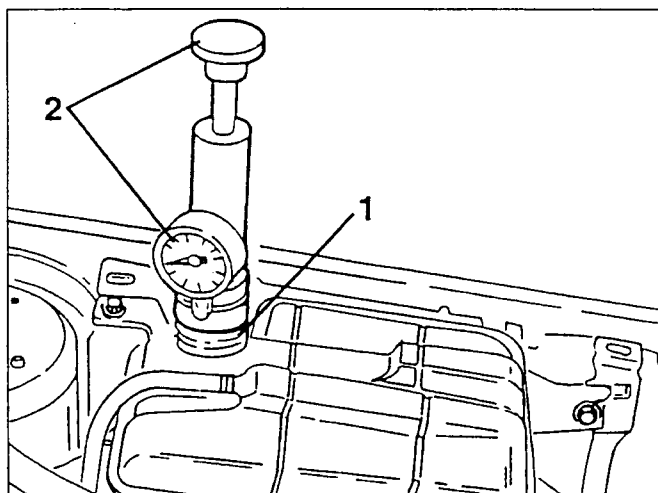
**Pressurized cap setting**

$0.98 \pm 0.1 \text{ bar}$ ($1 \pm 0.1 \text{ kg/cm}^2$)

ENGINE COOLING SYSTEM SEALING TEST

- Unscrew and remove the pressurized cap from the expansion tank.

1. Screw the sealing test instrument on the neck of the expansion tank, equipped with the suitable connector.
2. Manually pressurize the system and check that the pressure remains at the prescribed value. Otherwise check that there are no losses from sleeves or from the radiator.



Hydraulic system test pressure

1.08 bar (1.1 kg/cm²)

CAUTION:

For safety motives do not let the pressure exceed 1.38 bar (1.4kg/cm²) during the checks with the test instrument.

It is fixed on the engine block and is activated, through a Poly V belt, by the crankshaft. A gasket guarantees the seal between the engine block and the pump.

The water pump functions constantly guaranteeing that the engine coolant circulates constantly.

REMOVAL/REFITTING

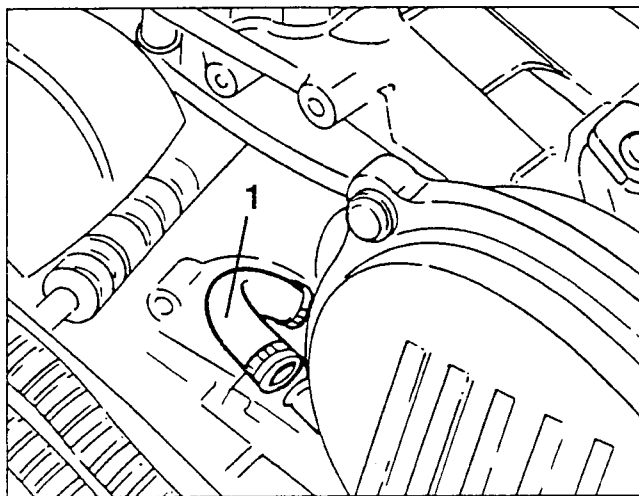
- Position the vehicle on the lift.
- Disconnect the (-) lead of the battery.
- Drain the engine coolant.

CAUTION:

The antifreeze mixture used as an engine coolant damages paint; avoid any contact with painted parts.

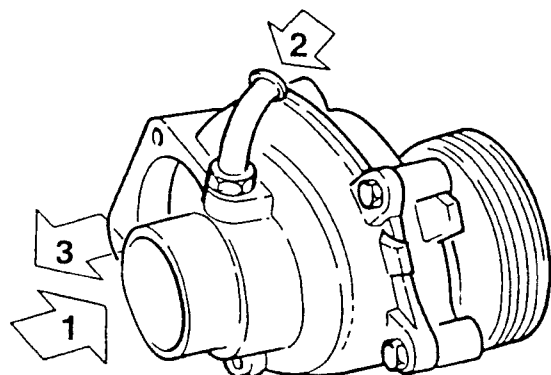
- Remove the alternator (see specific paragraph).

1. Disconnect the coolant to pump return pipe from the cylinder heads.



WATER PUMP

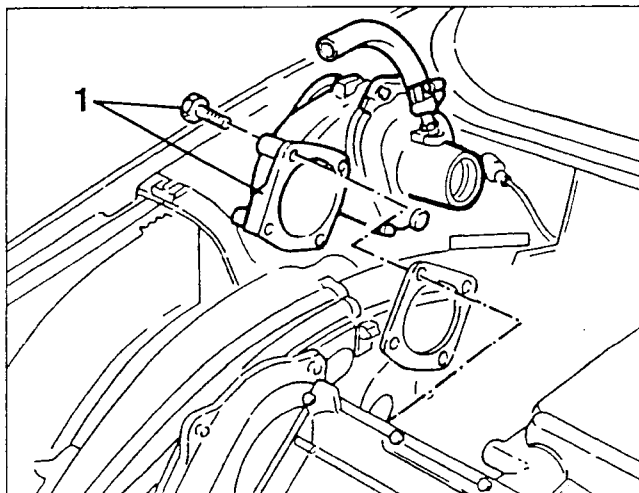
The water pump is of the centrifugal blade type with the pump body made from an aluminium alloy and the impeller in a phenolic resin.



1. Intake

2. Return from head

3. Delivery



1. Unscrew the screws and remove the water pump by extracting it from the engine coolant return manifold.



When the pump is fitted, lightly grease the engine return to pump manifold with the prescribed grease.

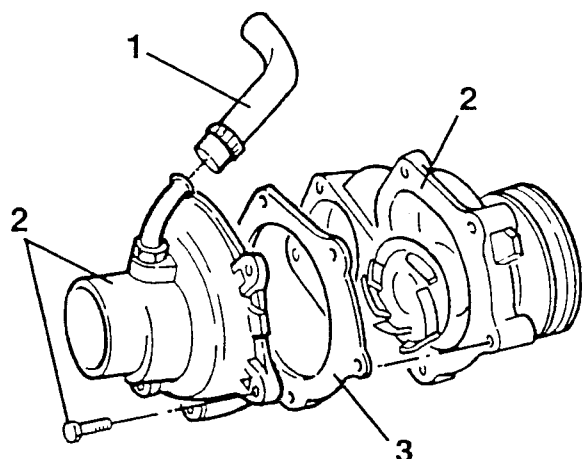


Clearance between impeller and pump body

$$G = 0.53 \div 1.37 \text{ mm}$$

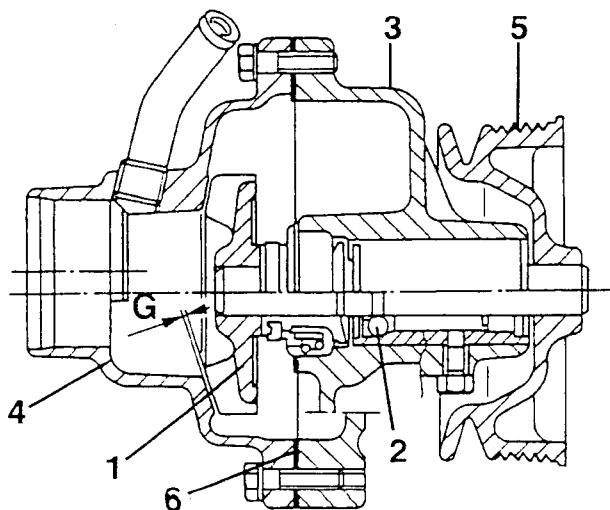
1. At the bench, remove the coolant from cylinder heads return pipe from the water pump.
2. Unscrew the screws and disassemble the pump body.
3. Remove the gasket.

If one of these faults is found, replace the whole water pump.



CHECKS AND INSPECTIONS

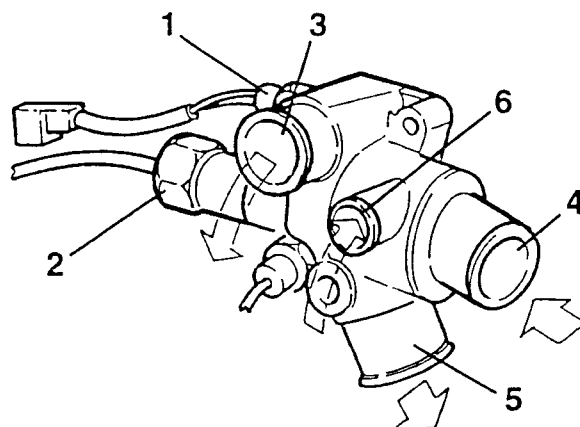
- Check that the pump body and the rotor are in good condition and that there are no signs of oxidation or corrosion;
- Check that the clearance between the rotor and the pump body fall within the prescribed values;
- Check that the gasket between the pump and the engine block and gasket between the front cover and the rear cover are in good condition and do not permit infiltrations;
- Check that the bearing does not crawl during rotation.



1. Impeller
2. Bearing
3. Front body

4. Rear body
5. Control pulley
6. Gasket

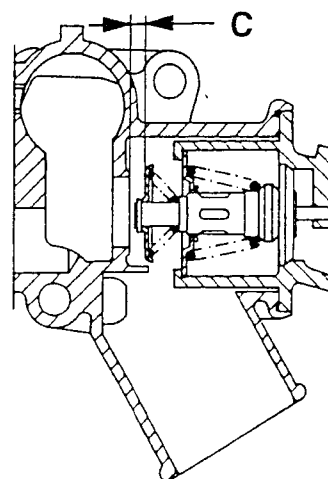
THERMOSTAT UNIT



1. Injection advance when cold automatic device (KSB) thermostatic sensor
2. Automatic idle speed device thermostatic sensor
3. Delivery to radiator
4. Return from radiator
5. Delivery to pump intake manifold
6. Arrival from expansion tank
7. Conditioner compressor cutoff thermal contact

The thermostat unit is fitted on the rear side of the cylinder heads.

Its function is to ensure that the engine does not exceed the optimal temperature: whilst the temperature remains below $80^\circ \pm 2^\circ \text{C}$, the thermostatic valve directs the coolant towards the pump; at higher temperatures, the thermostatic valve opens allowing the passage of coolant towards the radiator.



Thermostat opening start temperature

$80^\circ \pm 2^\circ \text{C}$



Stroke of valve "C" 90°C

$\geq 7.5 \text{ mm}$

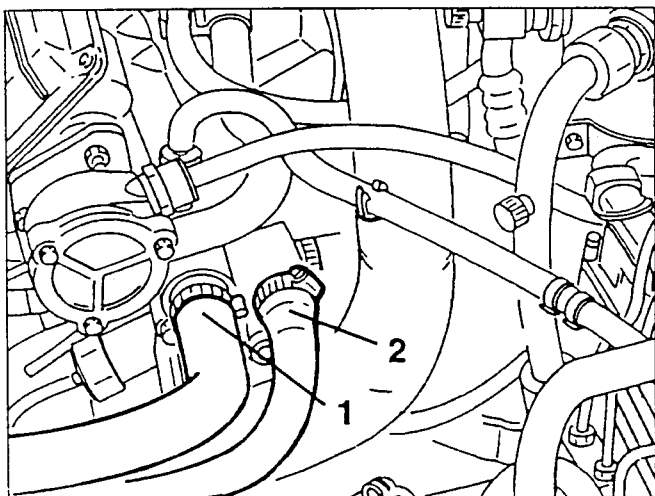
REMOVAL/REFITTING

- Remove the battery.
- Drain the engine coolant, by disconnecting the outlet sleeve from the radiator and recover it in a suitable container.

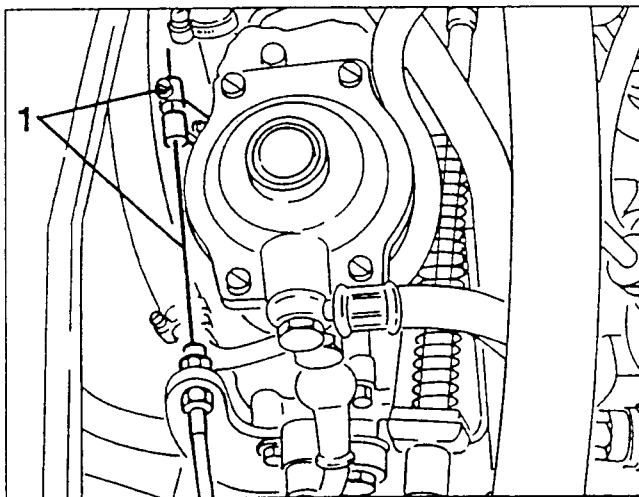
CAUTION:

The antifreeze mixture used as an engine coolant damages paintwork: avoid all contact with painted parts.

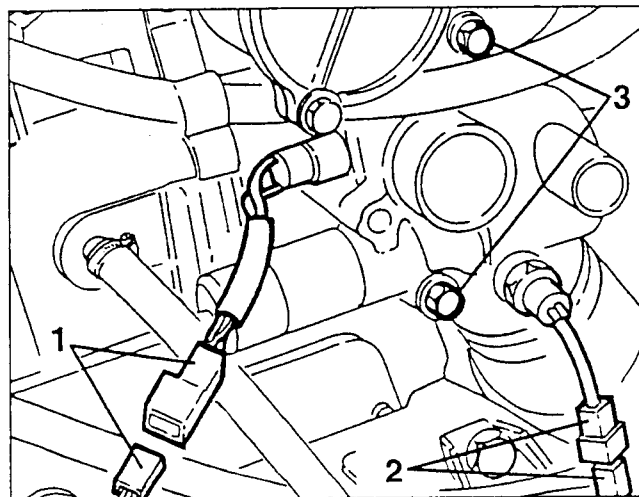
1. Disconnect the coolant to radiator delivery sleeve from the thermostatic cup.
2. Disconnect the supply sleeve originating from the expansion tank from the thermostatic cup.



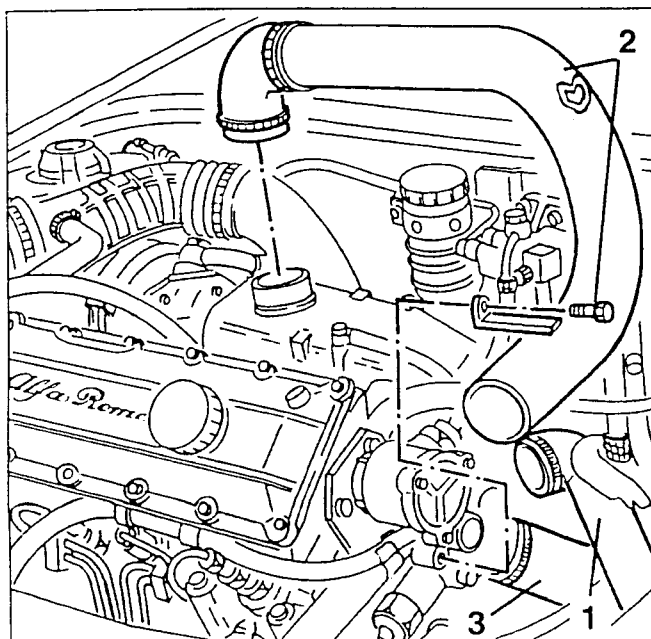
1. Disconnect the automatic idle speed device control cable from the injection pump.



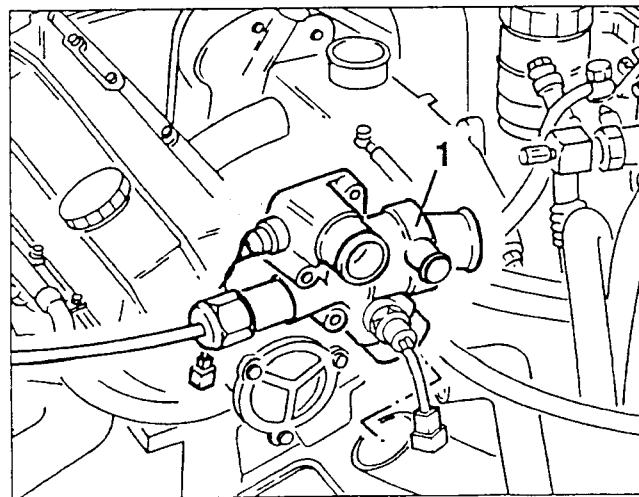
1. Disconnect the thermoswitch electrical cable for the injection advance when cold automatic device (KSB).
2. Disconnect the electrical connection from the air conditioning compressor cut-off thermal contact.
3. Unscrew the screws securing the thermostatic cup to the cylinder heads.



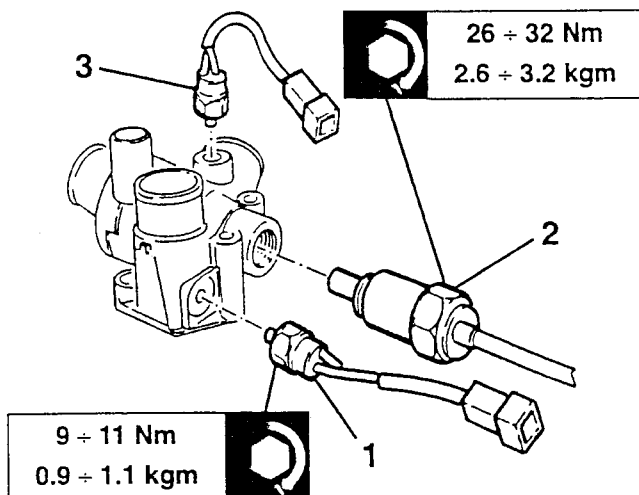
1. Disconnect the coolant from radiator return sleeve from the thermostatic cup.
2. Remove the second section of the air delivery pipe from the intercooler to the air intake box.
3. Loosen the coolant from pump return sleeve clamp from the thermostatic cup.



1. Remove the thermostatic cup by extracting it from the water to pump return sleeve.



1. At the bench, remove the thermoswitch for the injection advance when cold automatic device (KSB) from the thermostatic cup.
2. Remove the thermostatic sensor for the automatic idle speed device from the thermostatic cup.
3. Remove the air conditioning compressor cut-off thermal contact from the thermostatic cup.



At reassembly regulate the automatic idle speed device cable (see specific paragraph).

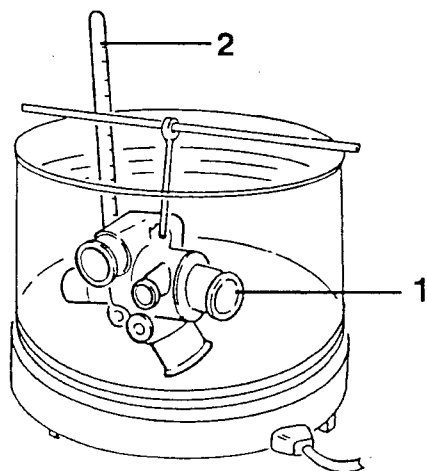
CHECKS AND INSPECTIONS

Check the setting of the thermostat by operating in the following way:

1. Hang the thermostat in a container full of water and heat it.
2. Check, by way of a thermometer, that the thermostat starts to open at the temperature indicated in the table.

CAUTION:

Neither the thermometer nor the thermostat must touch the bottom of the container.



- Also check that the total stroke of the bulb at the temperatures indicated, corresponds with that in the table.

Thermostat setting

Start of opening	$80^{\circ} \pm 2^{\circ} \text{C}$
Valve stroke at 90°C	$\geq 7.5 \text{ mm}$

- If the correct values are not found replace the thermostat.

RADIATOR

The radiator is sized to satisfy the heat dissipation requirements when the engine is running. It is made up of a radiator core and two side tanks fitted with necks for the inlet and outlet of coolant; the pipes and fins of the radiator core are in aluminium, the tanks are plastic.

On the radiator, a thermocontact is fitted to control the cooling electric fan.

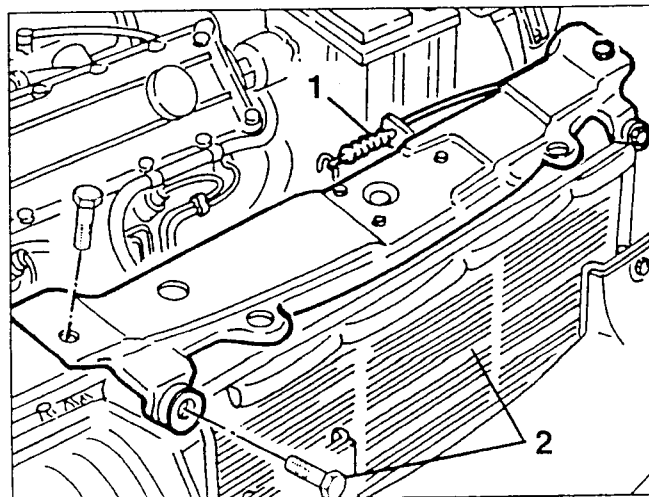
REMOVAL/REFITTING

- Disconnect the (-) lead of the battery.
- Drain off the engine coolant by disconnecting the coolant from the radiator outlet sleeve and recover it in a suitable container.

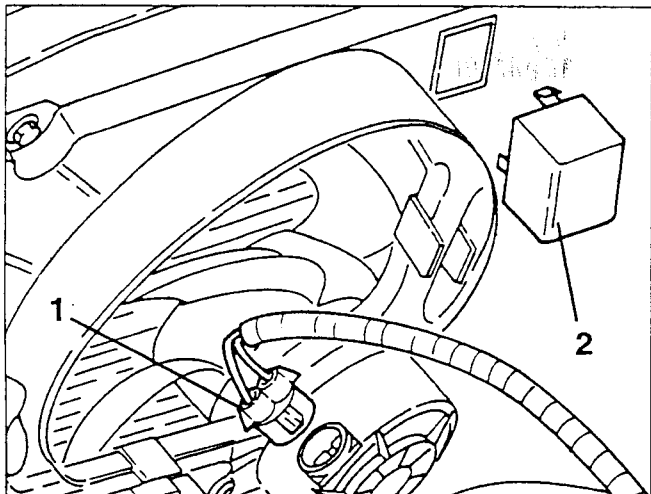
CAUTION:

The antifreeze mixture used as an engine coolant damages paintwork; avoid all contact with painted parts.

- Remove the radiator grille and front bumper (see GROUP 70).
- 1. Disconnect the bonnet release cable from its lock.
- 2. Loosen the screws and remove the upper cross-member.



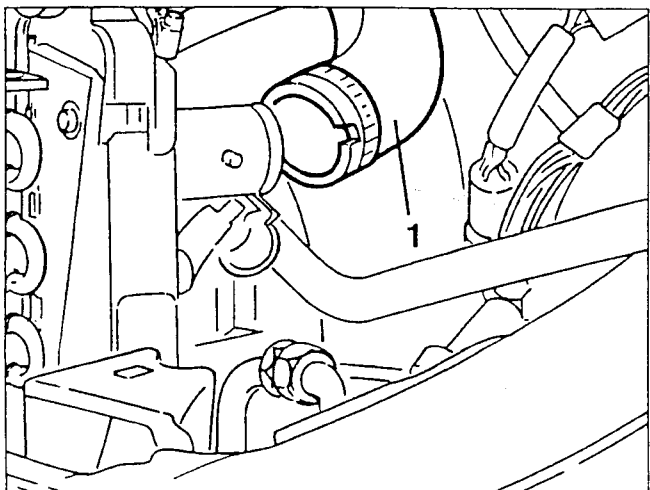
1. Disconnect the electrical connection to the cooling electric fan motor.
2. Remove the relay box from the electric fan conveyor.



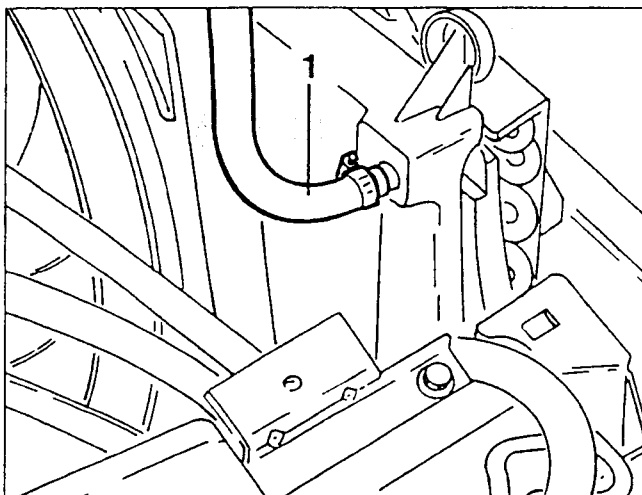
1. Disconnect the two electrical connectors from the electric fan additional resistance.



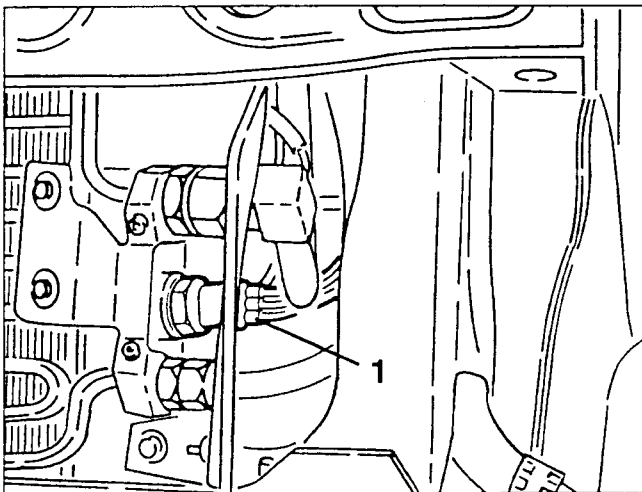
1. Disconnect the engine coolant entry sleeve from the radiator.



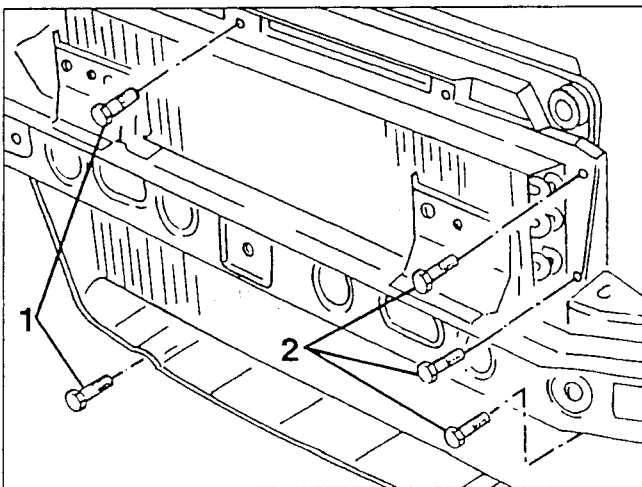
1. Disconnect the coolant to expansion tank delivery and system deaereating pipe.



1. Disconnect the electrical connector of the cooling electric fan thermocontact.



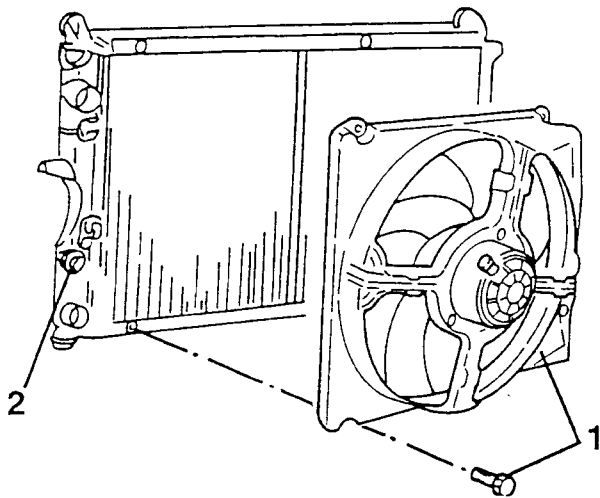
1. Unscrew the screws securing the radiator to the condensor.
2. Unscrew the screws securing the air conveyor to the radiator.



- Free the electrical cables from the clamps on the radiators, then remove it by extracting it upwards.

DISASSEMBLY/REASSEMBLY

1. Unscrew the four screws and remove the cooling electric fan from the radiator.
2. Remove the cooling electric fan control thermocontact from the radiator.

**COOLING ELECTRIC FAN**

The two speed cooling electric fan allows the engine's heat dissipation capacity to be increased.

A two stage thermocontact detects if the coolant reaches an excessively high temperature and activates the electric fan: the first stage contact closes at $88^{\circ} \pm 2^{\circ} \text{C}$ and opens at $83^{\circ} \pm 2^{\circ} \text{C}$ (first speed), the second stage closes at $92^{\circ} \pm 2^{\circ} \text{C}$ and opens at $87^{\circ} \pm 2^{\circ} \text{C}$ (second speed).

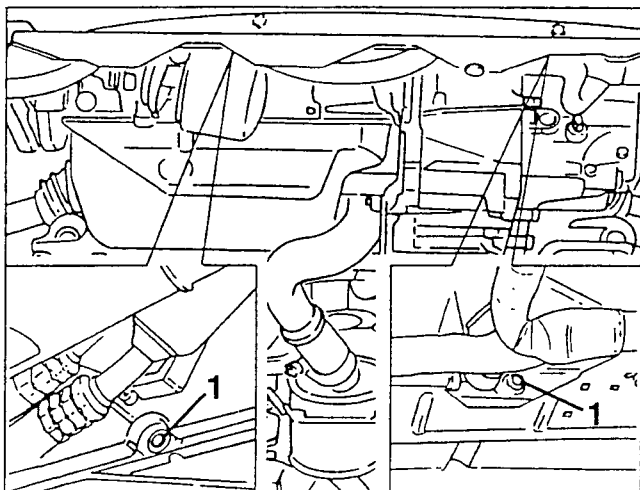
In versions fitted with the automatic heater/ventilation system with air conditioner, the second speed is enabled after the first one has been enabled for 10 seconds and after the second temperature stage has been reached.

1. Disconnect the two electrical connections from the electric fan additional resistance.



- Raise the vehicle.

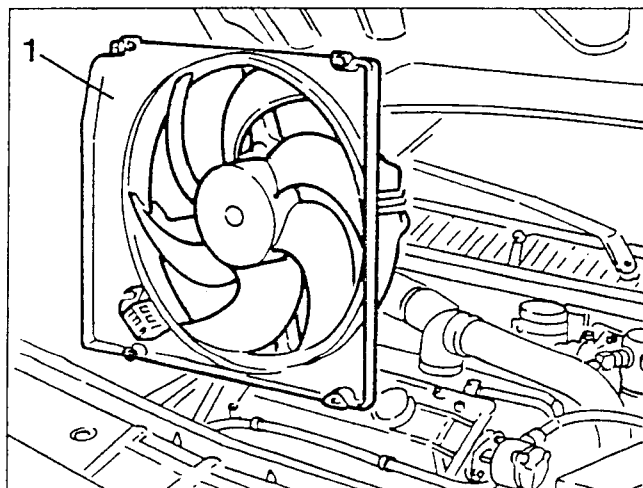
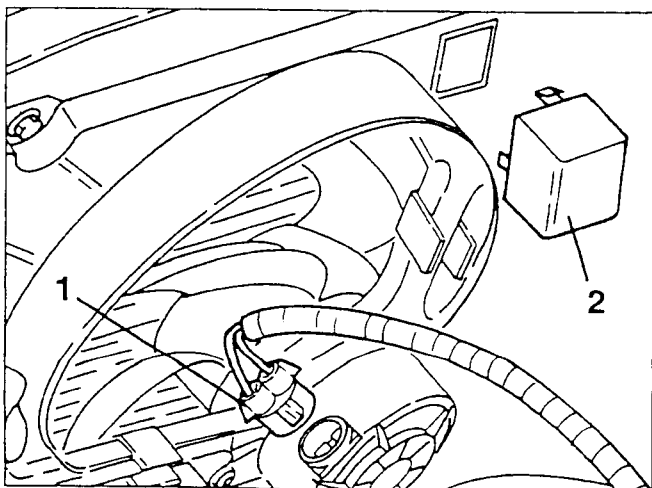
1. Unscrew the lower screws securing the cooling electric fan to the radiator.



- Raise the vehicle.

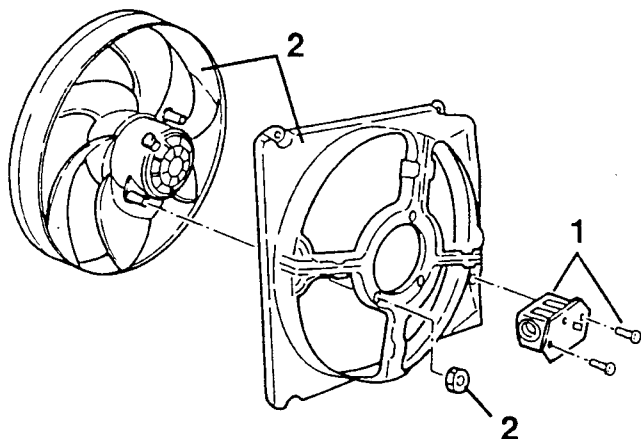
- Unscrew the upper screws securing the cooling electric fan to the radiator.

1. Remove the cooling electric fan by extracting it upwards.



DISASSEMBLY/REASSEMBLY

1. Unscrew the screws and remove the additional resistance from the electric fan conveyor.
2. Unscrew the three nuts and separate the electric fan from the conveyor.



ELECTRIC FAN THERMOCONTACT

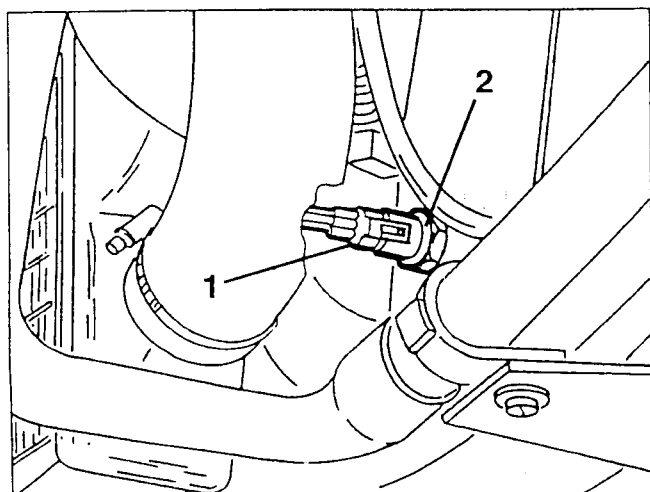
REMOVAL/REFITTING

- Position the vehicle on the lift.
- Disconnect the (-) negative lead of the battery.
- Raise the vehicle.
- Drain off the engine coolant, by disconnecting the coolant from radiator outlet sleeve and recover it in a suitable container.

CAUTION:

The antifreeze mixture used as an engine coolant liquid damages paintwork: avoid contact with all painted parts.

1. Disconnect the two electrical connections of the electric fan thermocontact.
2. Remove the electric fan thermocontact from the radiator.



CHECKS AND INSPECTIONS

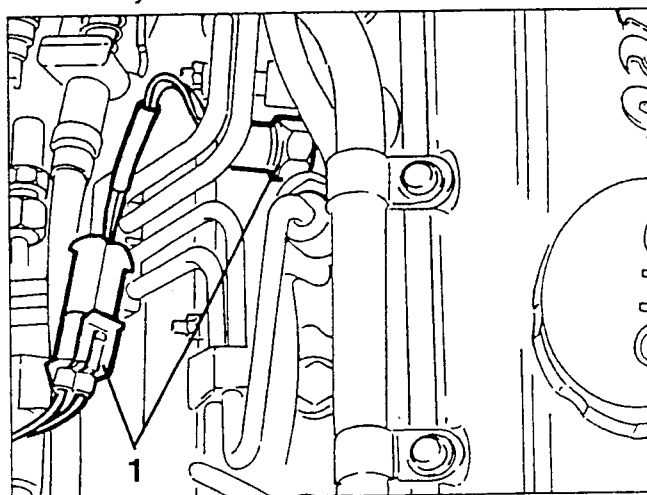
Cooling electric fan cut-in/cut-out temperature		
1 ^a speed	Cut-in (contacts closed)	88 ° ± 2 °C
	Cut-out (contacts open)	83 ° ± 2 °C
2 ^a speed	Cut-in (contacts closed)	92 ° ± 2 °C
	Cut-out (contacts open)	87 ° ± 2 °C

- If the correct values are not found, replace the thermocontact.

ENGINE COOLANT TEMPERATURE INDICATOR TRANSMITTER AND MAXIMUM TEMPERATURE WARNING LIGHT CONTACT

REMOVAL/REFITTING

1. Disconnect the connection and remove the sender from the cylinder head.



CAUTION:

Plug the sensor seating on the cylinder heads to avoid engine coolant leaks.

CHECKS AND INSPECTIONS



Contact closing temperature	115° ± 3 °C
Contact opening temperature	85 °C

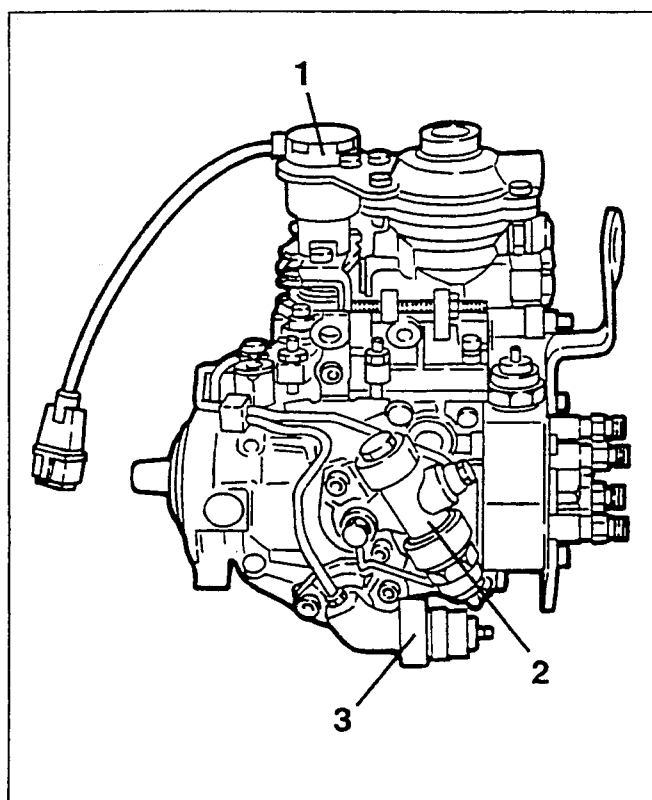
If the correct values are not found, replace the transmitter.

VE - R - 508 INJECTION PUMP

The injection pump installed on this model possesses some specific innovations which optimise the operating features under all conditions.

These innovations are:

- the adoption of an accelerator lever potentiometer (1) fitted on the injection pump;
- the adoption of a solenoid valve (2) for controlling the KSB device;
- the adoption of a solenoid valve (3) for controlling the LFB device.



The following pages describe how these devices work.

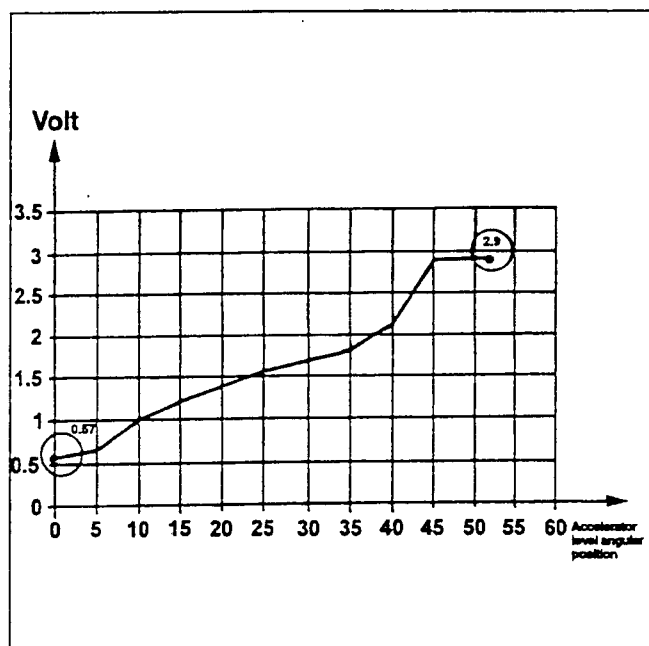
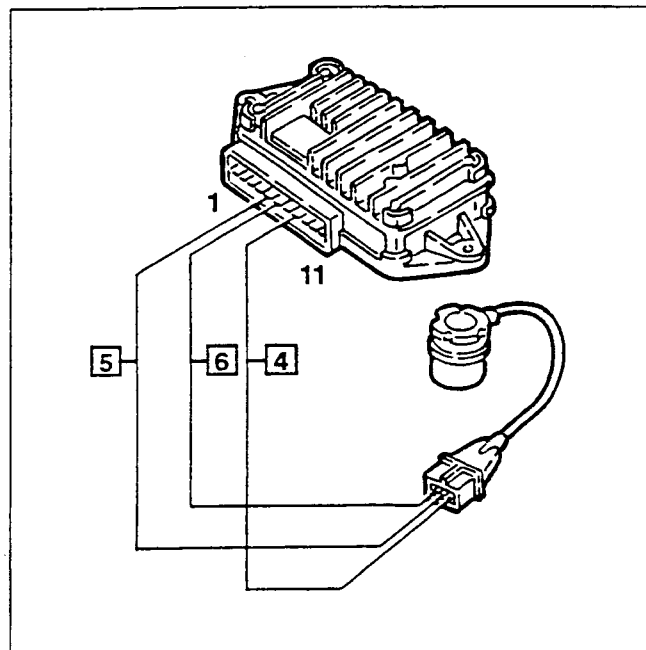
ACCELERATOR LEVER POTENTIOMETER

The potentiometer fitted on the injection pump detects the angular position of the accelerator lever and informs the control unit of the engine load.

The rotation of the lever changes the resistance inside the potentiometer, therefore, with a constant supply of 3.7 ± 0.2 V from the control unit, output voltages are obtained which are variable between 0.57 V at idle speed > 2.5 V at maximum load.

Therefore, this voltage rate is an important operating datum for the engine and it is used by the control unit

to command the opening of the E.G.R. valve of the exhaust gas recirculation system.



AUTOMATIC COLD INJECTION ADVANCE DEVICE (KSB)

The automatic KSB device has a dual purpose:

- advancing the start of injection to enable smoother operation when the engine is cold;
- improving starting.

Operation

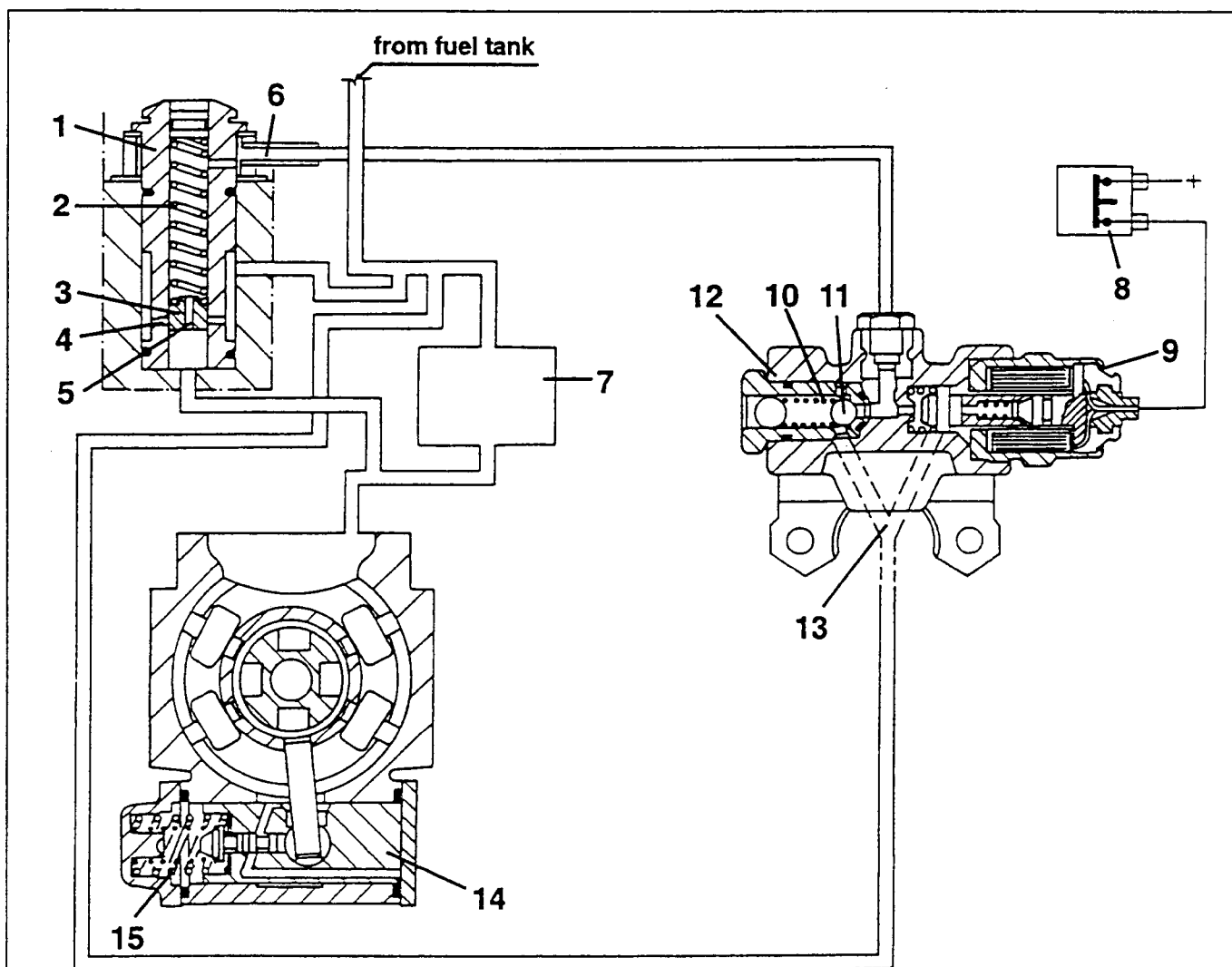
The fuel flow rate of the supply or transfer pump (7) is higher than needed for injection, so the excess fuel is discharged through the transfer pressure adjustment valve (1) at the pump inlet, generating a pressure inside the pump casing (transfer pressure).

The flow rate of the supply pump (7) consequently the transfer pressure change in relation to the engine rpm. This transfer pressure acts on one side of the piston of the injection advance variator (14), pushing against the reaction spring (15), thereby changing the start of injection.

Cold engine

With an engine coolant temperature of $\leq 60^{\circ}\text{C}$ the solenoid (9) of the KSB device is supplied, eliminating the relief of part of the fuel through the calibrated hole (5) of the piston valve (3); this causes an increase of the transfer pressure, thus of the advance, because the whole reflux flow must pass (flow) only through the outlet holes.

The increase of the transfer pressure acts on the piston (14) of the advance variator which overcomes the force of the reaction spring (15) changes the start of injection advance (through the prod hinged with the roller cage).



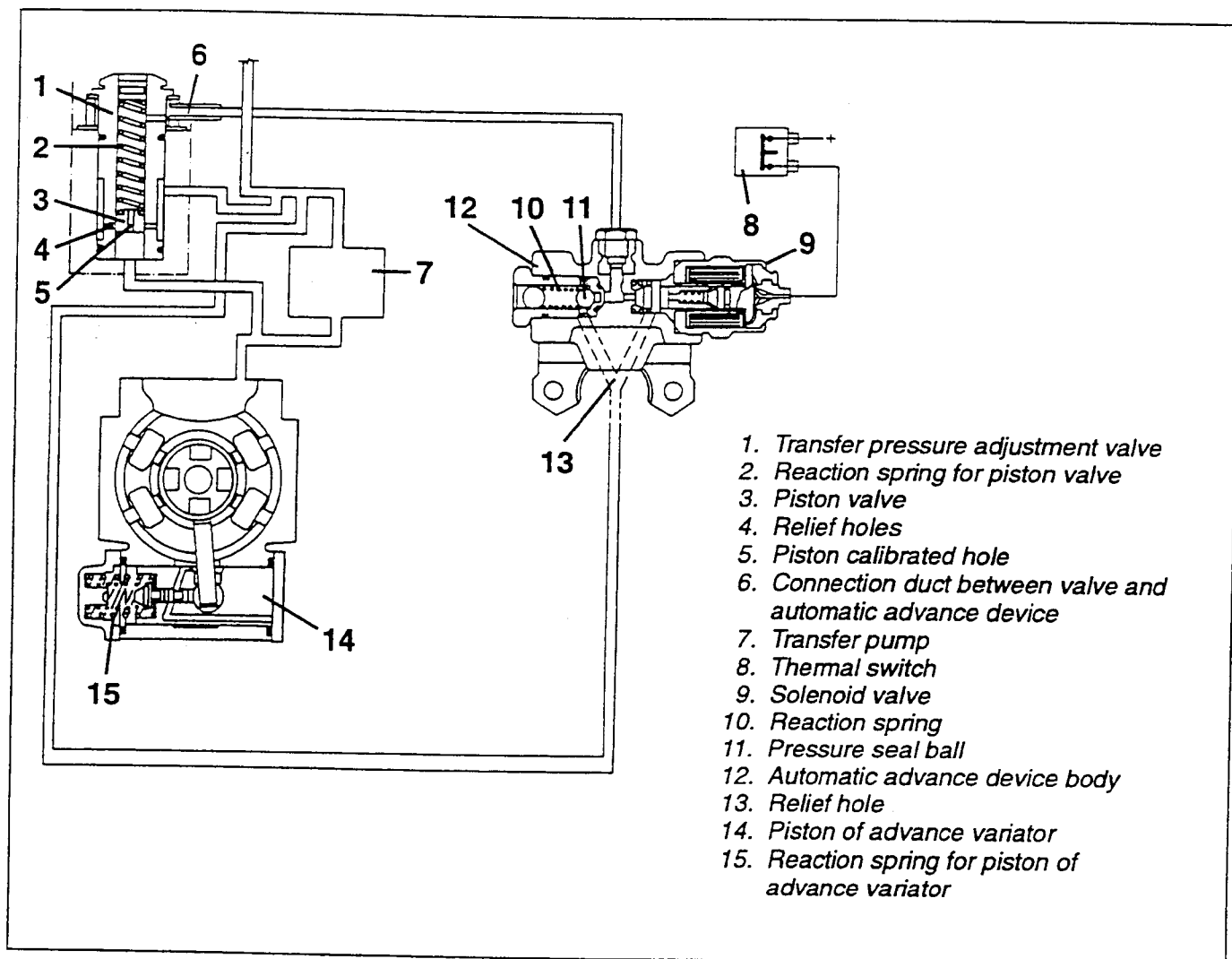
1. Transfer pressure adjustment valve
2. Reaction spring for piston valve
3. Piston valve
4. Relief holes
5. Piston calibrated hole
6. Connection duct between valve and automatic advance device
7. Transfer pump
8. Thermal switch

9. Solenoid valve
10. Reaction spring
11. Pressure seal ball
12. Automatic advance device body
13. Relief hole
14. Piston of advance variator
15. Reaction spring for piston of advance variator

Warm engine

When the temperature of the coolant fluid exceeds 60°C, the thermal switch (8), on the thermostat body, opens deactivating the electrical supply of the solenoid (9) which, due to the load of the reaction spring (10), causes the valve to open admitting the flow towards the duct (13).

The opening of the valve causes a lowering of the transfer pressure (consequently the over-advance stroke of piston 14 is annulled) because part of the reflux flow is relieved through holes (4) and also by the calibrated hole (5), which puts the pressure adjustment valve (1) into communication with the supply duct, upstream of the transfer pump (7).

**AUTOMATIC DELAYING
DEVICE IN RELATION TO
THE LOAD LFB**

The pump is fitted with a device which changes the advance according to the load (LFB) (1), this is obtained by sending part of the fuel at transfer pressure towards the advance variator (7).

In this version an ON-OFF solenoid valve has been introduced which with the engine temperature below 60°C, cuts off the flow towards the advance variator (7) thereby annulling the effect of the delaying device.

Operation

The LFB device modulates the flow of fuel between the transfer pressure chamber and the advance variator, according to the engine rpm.

Modulation takes place in relation to the extension of the sliding sleeve forming part of the device and it is controlled by centrifugal masses turned by the pump main shaft.

Experiments on engines of this type have revealed the presence of phenomena which adversely affect operation due to the engagement of the LFB device when the engine is cold, this is why the device needs to be fitted with a solenoid valve which prevents it from operating with coolant fluid temperatures below 60°C.

Cold engine

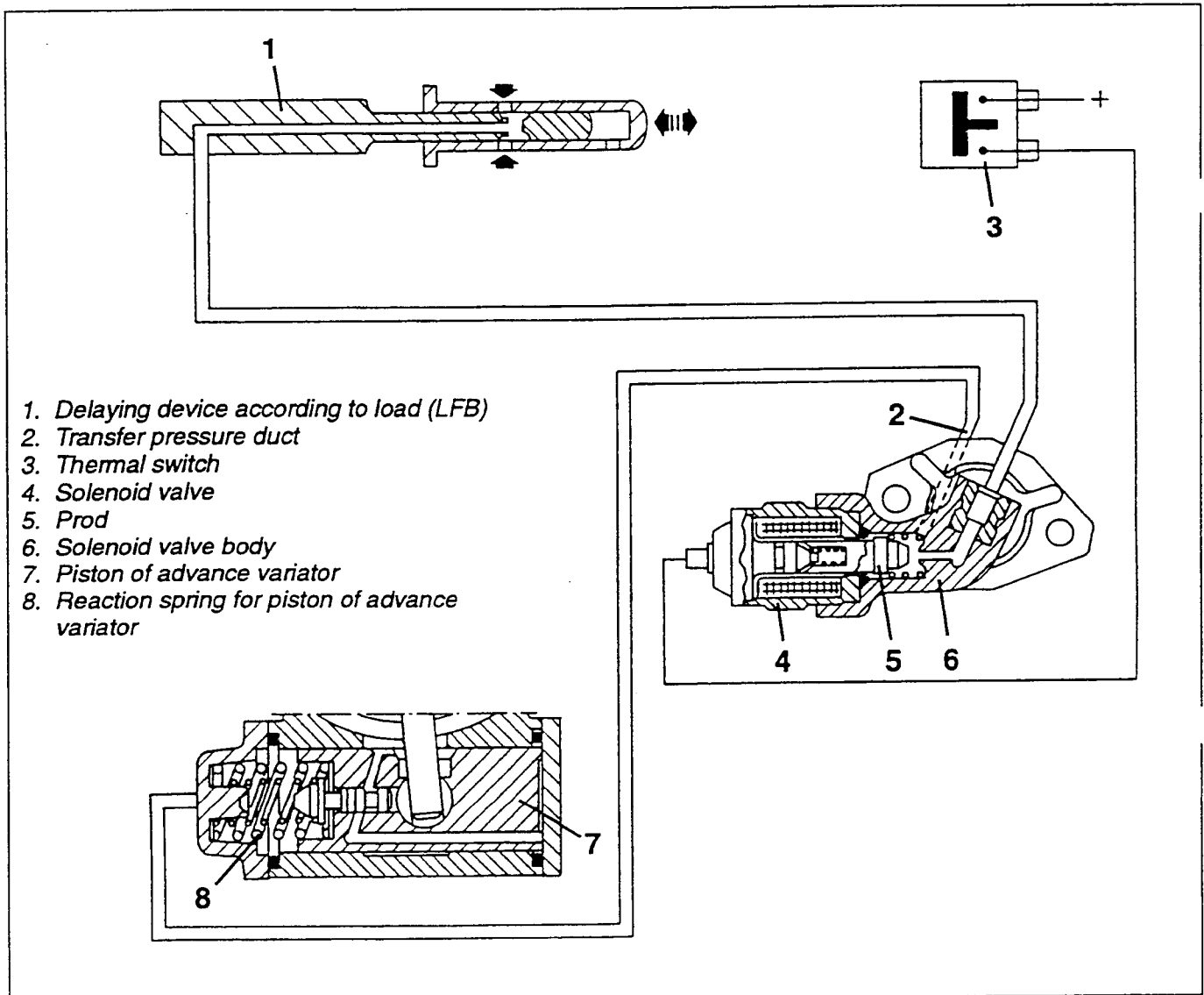
When the engine coolant temperature is below 60°C the thermostatic switch (3) is closed, supplying the solenoid (4) which cuts off the flow between the delaying according to load device (1) and the advance variator (7).

In this case the LFB device is inhibited.

Warm engine

When the temperature of the coolant fluid reaches 60°C, the thermal switch (3) on the thermostat body opens, cutting off the supply of the solenoid (4).

The prod (5) of the valve (6) withdraws allowing the passage of the flow towards duct (2) consequently towards the advance variator (7). In this condition the LFB device comes into operation in full.

**AUTOMATIC FAST IDLE**

Though the injection pump adopted is fitted with an automatic fast idle device it does not use it (no connection with thermostatic switch).

However the presence of parts forming the device make it possible to adjust the idle speed particularly accurately.

GENERAL DESCRIPTION

This system makes it possible to send to the intake part (5 + 15%) of the exhaust gas, under determinate operating conditions of the engine.

This way the fuel mixture is diluted with the inert gases lowering the temperature peak in the combustion chamber: this reduces the formation of nitric oxides (NOx), thereby reducing them by 30 ÷ 50% at the exhaust.

The recirculation of burnt gas is only allowed at medium-low loads, when the air-fuel ratio is very high and engine operation is not adversely affected by the presence of inert gas instead of air.

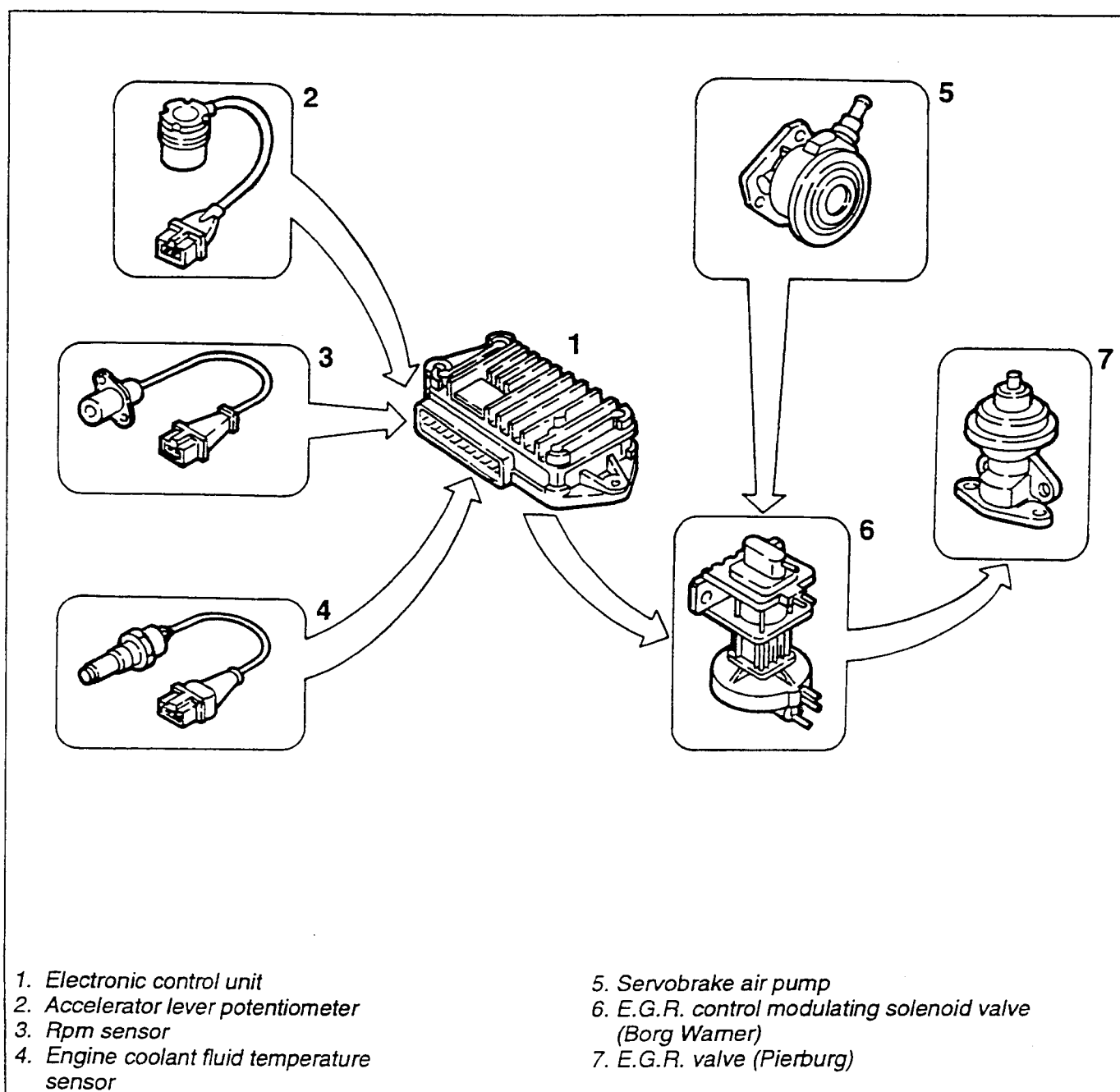
The recirculation system is controlled by a control unit (1) which at the input receives signals of the poten-

tiometer (2) on the accelerator lever and from the rpm sensor (3) and coolant temperature sensor (4), and at the output it supplies a command signal for the modulating solenoid valve (Borg Warner) (6) for E.G.R. control.

The latter is connected with the environment through a filter and on the basis of the command signal received it transmits more or less vacuum, leading from the servobrake air pump (5), to the E.G.R. valve (Pierburg) (7).

This valve, if the vacuum is sufficient, opens, putting the exhaust manifold into communication with the intake box.

It is then possible to send the quantity of recirculated gas adjusting the opening of the E.G.R. valve continuously using the maps of the degree of opening in relation to the signals received.



ELECTRONIC CONTROL UNIT

This is a digital unit with microprocessor to which the data on the engine operating conditions converge, transmitted from the engine load sensor (through the accelerator lever potentiometer), the rpm sensor and the engine coolant temperature sensor.

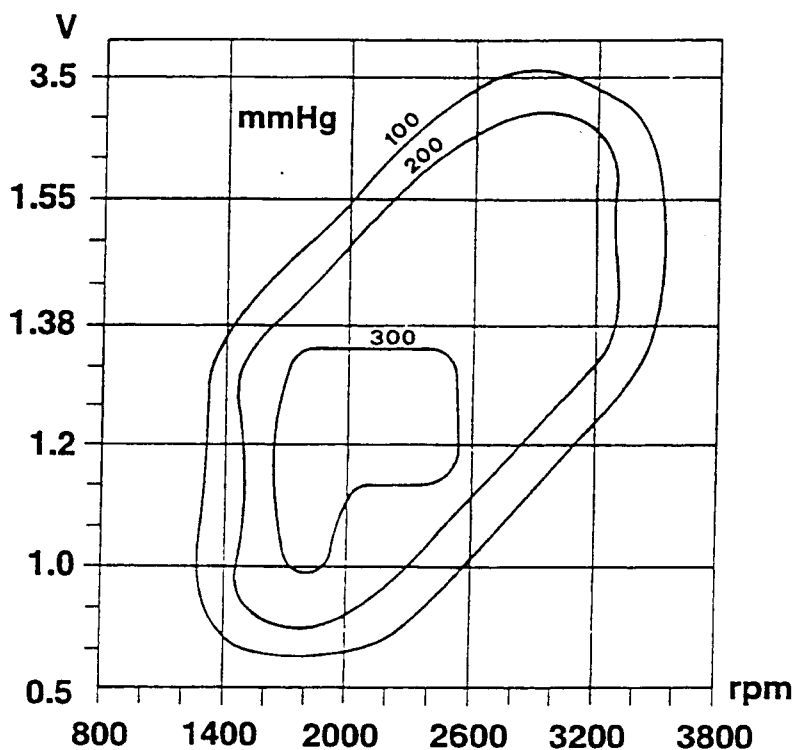
On the basis of these signals the control unit (C) is capable of driving the modulating solenoid valve with a square-wave signal because of the E.G.R. memorised inside it.

The map is shown (see diagram A) on the plane of the angular position of the accelerator lever/engine turning speed and as level curve parameters, it has E.G.R. valve control vacuum ratings in mmHg.

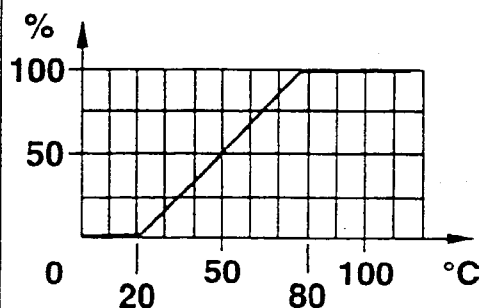
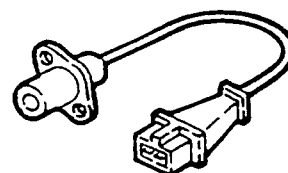
Correction in relation to the temperature is carried out in a second time, still by the control unit: correction (B) corresponds to a resetting of the intensity values for temperatures below 20°C, and a reduction from 100% to 0% variable between temperatures from 20°C to 80°C.

For engine coolant temperatures above 80°C, no corrections of the solenoid valve control current take place.

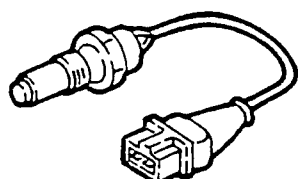
Lastly, the control unit has an electrical connection for the serial output for the ALFA TESTER, through which it is possible to see any faults detected during operation for servicing purposes.



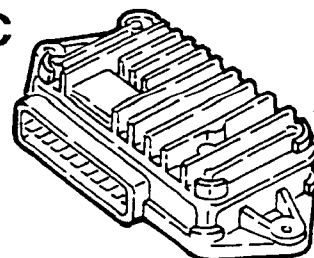
A



B



C

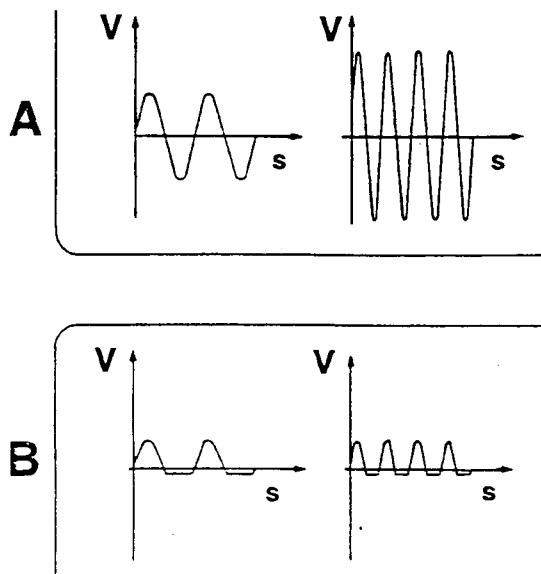
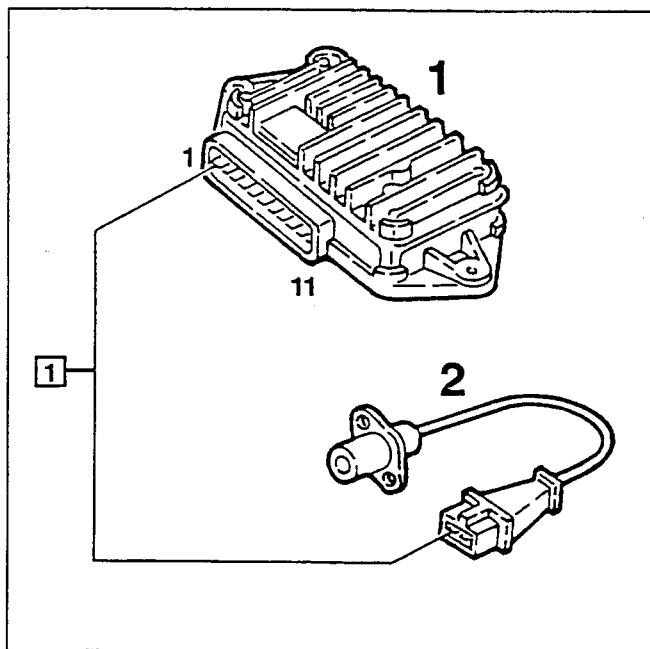


RPM SENSOR

The rpm sensor (2) fitted on the gearbox cover in correspondence of the flywheel ring gear, is a passive electromagnetic detector with a gap of 0.25 ± 1.3 mm between the upper part of the teeth of the ring gear and its winding.

At the passage of each tooth of the ring gear, the sensor supplies a sinusoidal voltage, variable in amplitude and frequency depending on the engine rpm (diagram A).

The control unit (1) stabilizes the positive half wave in amplitude and cuts the negative one (diagram B).



ENGINE COOLANT FLUID TEMPERATURE SENSOR

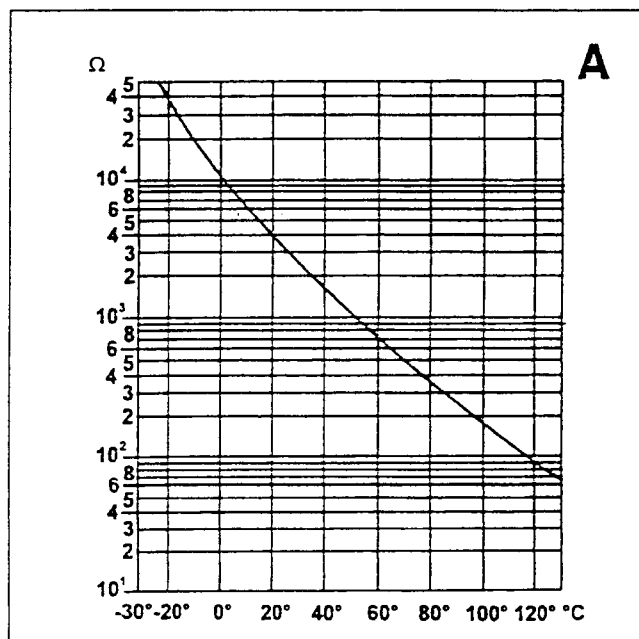
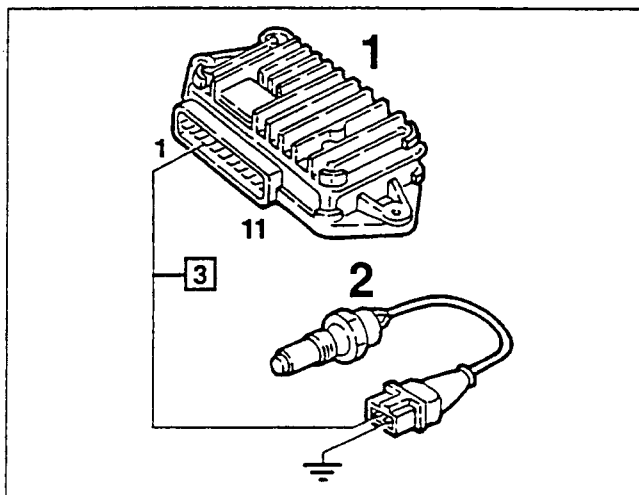
The sensor is fitted on the thermostat body with the sensitive part in contact with the coolant fluid.

It comprises an NTC resistance (Negative Temperature Coefficient) which changes its resistance inversely proportionately with the temperature, as shown in diagram A.

The electronic control unit (1) supplies the coolant fluid temperature sensor (2) according to the rating of its resistance, and detects the temperature of the coolant fluid on the basis of the change of voltage proportionate with the intensity of the current circulating in the sensor, in order to correct the control of the modulating solenoid valve.

This prevents the engine from taking in too much unburnt gas when the optimal operating temperature has not been reached, or when particularly harsh environmental conditions do not allow it to reach this temperature.

Therefore, this sensor guarantees good operating conditions of the engine after starting, avoiding a lowering of the amount of oxygen in the intake air, to warrant the best conditions possible for combustion when the engine is cold.



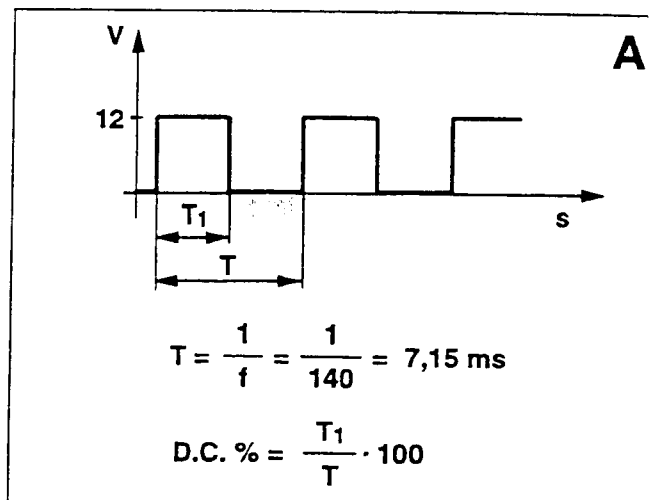
BORG WARNER MODULATING SOLENOID VALVE

The Borg Warner solenoid valve (2) is fitted in the rear section of the engine compartment, in a vertical position on the bulkhead which separates the engine bay from the passenger compartment.

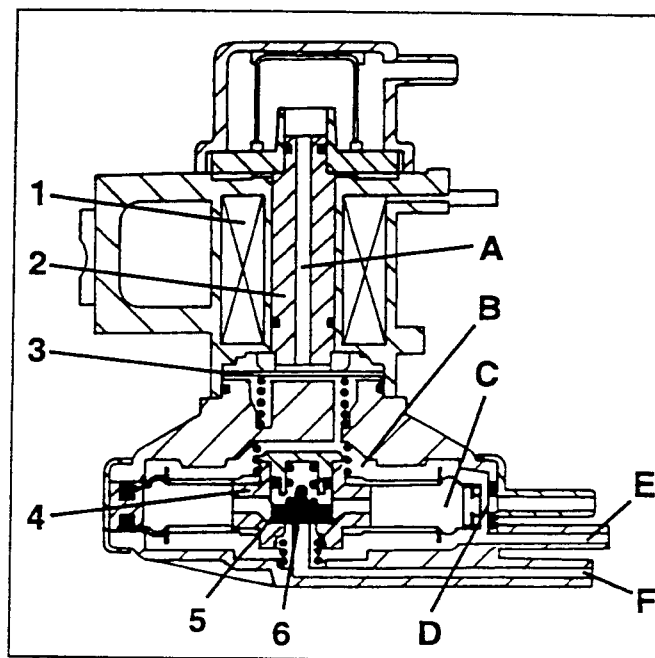
It is connected to the E.G.R. pneumatic system with a takeoff for the vacuum leading from the servobrake air pump (4), with an outlet to be connected to the Pierburg E.G.R. valve (3) and with two atmospheric pressure sockets which withdraw from a filter (5).

The solenoid valve is driven directly by the electronic control unit (1) with a square-wave signal with a frequency of 140 Hz, a voltage rate of 12V and variable Duty-Cycle (see diagram A) which determines a current from 0 to appr. 800 mA, the condition in which the highest vacuum rating is sent to the E.G.R. valve. The Duty-Cycle is the ratio between the time in which the signal is at 12 V and the total period of the cycle (1/140 s).

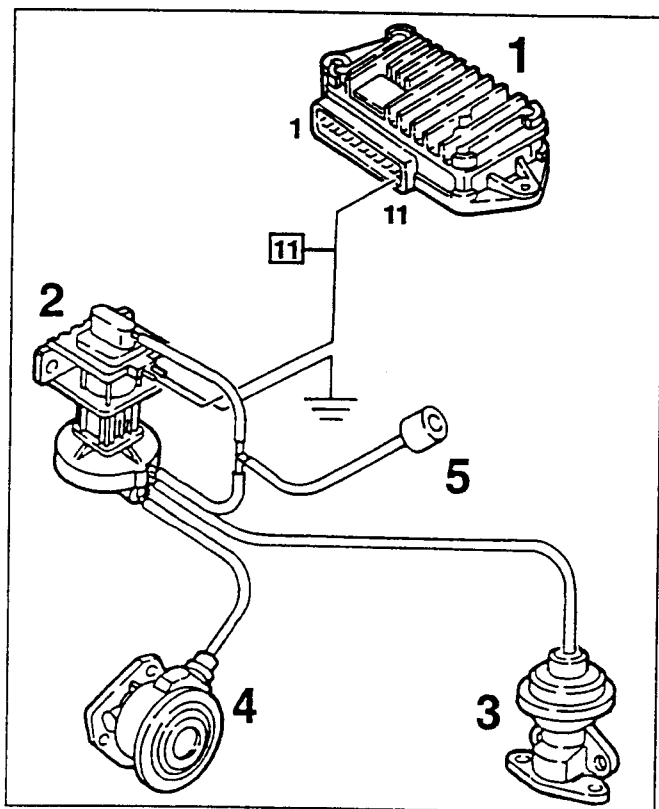
It should be noted that the vacuum modulated does not depend on the value of the input vacuum, but only on the Duty-Cycle of the controlling electric signal.



OPERATION



1. Electromagnetic coil
2. Magnetic core
3. Mobile modulating disk
4. Mobile equipment
5. Diverter valve
6. Counter spring
- A. Atmospheric pressure inlet duct
- B. Upper modulated pressure chamber
- C. Atmospheric pressure chamber and duct
- D. Compensation hole for chambers B and E
- E. Lower chamber and connection duct to E.G.R. valve
- F. Vacuum inlet from servobrake air pump



1. Electronic control unit
2. E.G.R. control modulating solenoid valve (Borg Warner)
3. E.G.R. valve (Pierburg)
4. Servobrake air pump
5. Atmosphere takeoff filter

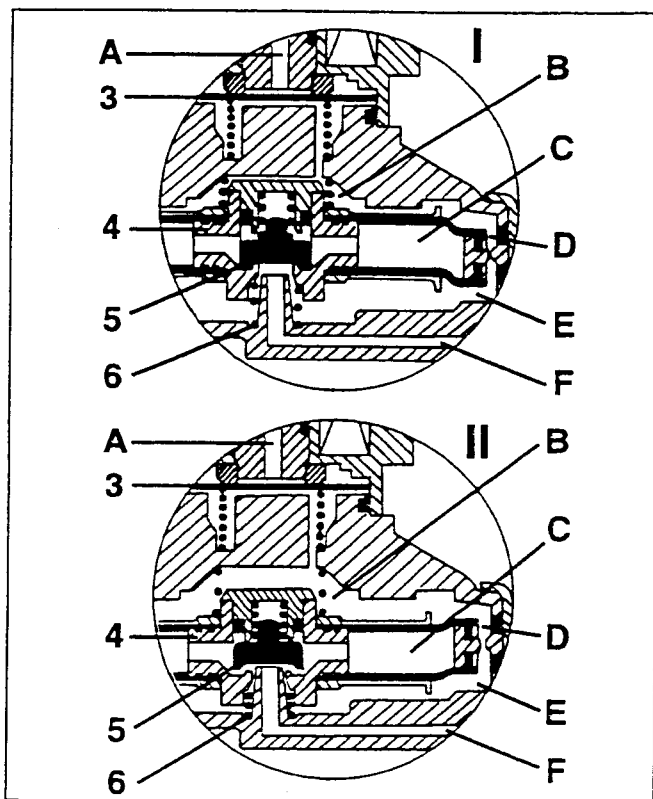
Maintenance position

The vacuum reaches chamber E from duct F (pos. I), as the force of the spring (6) acts on the mobile equipment (4) and the diverter valve (5) allows it to pass.

Through the compensation hole D, the vacuum then involves chamber B and the lower surface of the disk shutter (3).

Once the forces acting on the disk (3) are balanced, the atmospheric pressure in duct A enters chamber B, moving the mobile equipment downwards (pos. II), this way the shutter of the valve (5) closes duct F and puts chamber E into communication with chamber C at atmospheric pressure, lowering the vacuum in duct E.

The decreased vacuum or increased absolute pressure in chamber E makes the mobile equipment rise (4) (pos. I), closing the passage C-E and bringing valve (5) to the ideal position (E in communication with F), to repeat the cycle.



Adjustment phase

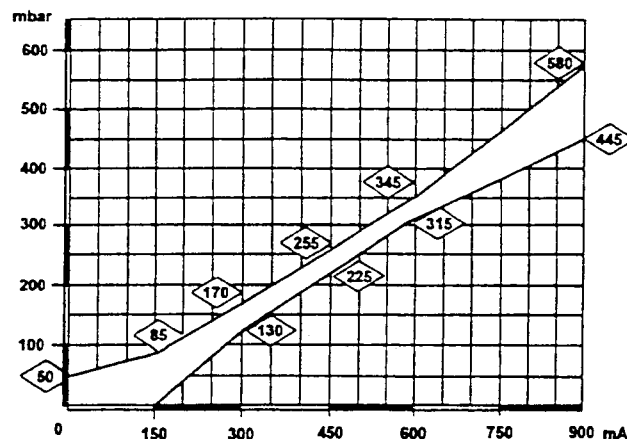
As the engine operating conditions change, the control unit sends a different Duty-Cycle signal to the E.G.R. control modulating valve.

With the increase of the Duty-Cycle the mean current and the force of attraction on the shutter disk (3) increase.

In this new condition chamber B is put into communication with duct A at a higher vacuum rating, to overcome the electromagnetic force of the coil.

The cycles are repeated keeping a vacuum in chamber E in relation only to the Duty-Cycle.

The vacuum that controls and modulates the opening section of the E.G.R. valve therefore depends solely on the value of the signal sent by the electronic control unit.

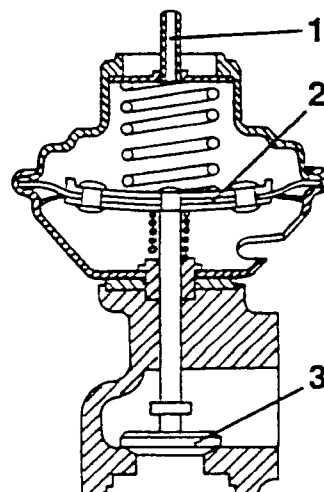


PIERBURG E.G.R. VALVE

This valve is driven by a vacuum generated by the servobrake air pump and modulated by the modulating solenoid valve.

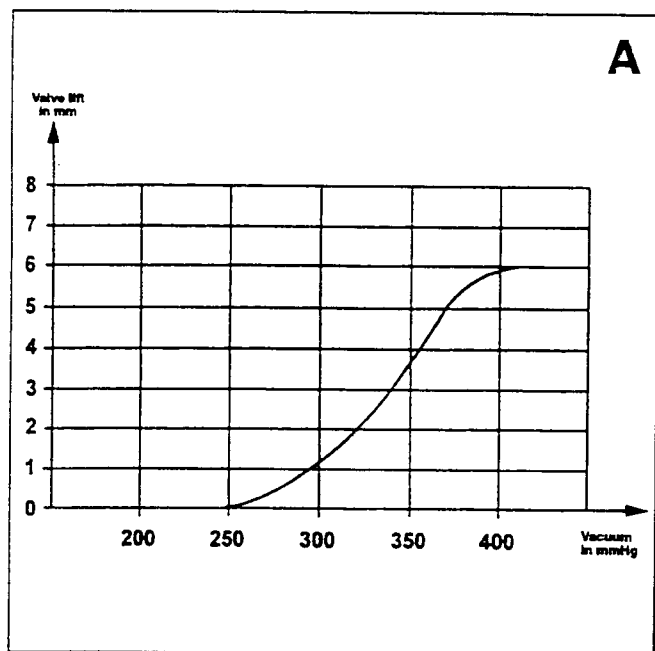
The E.G.R. valve is driven as follows:

- if following the signal from the electronic control unit, the modulating solenoid valve sets duct (1), under vacuum, the diaphragm (2) and the shutter (3) connected to it rise, opening the section of passage for the gas in relation to the vacuum rating in duct (1): this enables the circulation of a suitable quantity of burnt gas towards the intake box;
- if it is not energised, the solenoid valve puts duct (1) into communication with the atmosphere, thereby closing the shutter (3): this prevents the recirculation of burnt gas to ensure correct operation of the engine cold, at idle speed and at medium-high load.

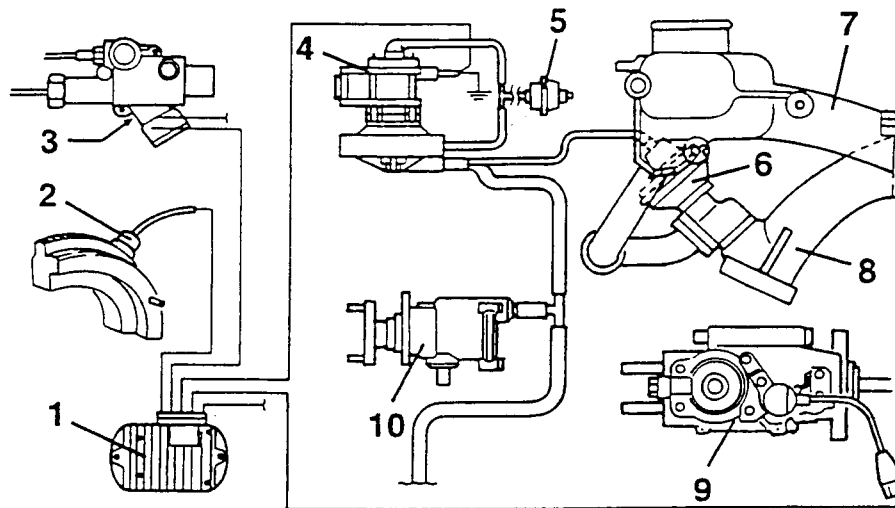


The opening of the section of passage of the exhaust gas depends on the modulated pressure rating, which reaches duct (1), as shown indicatively in diagram (A). On this indicative diagram, the vacuum ratings are expressed in mmHg.

The complete opening of 6 mm of the E.G.R. is obtained with vacuum ratings of above 420 mmHg.

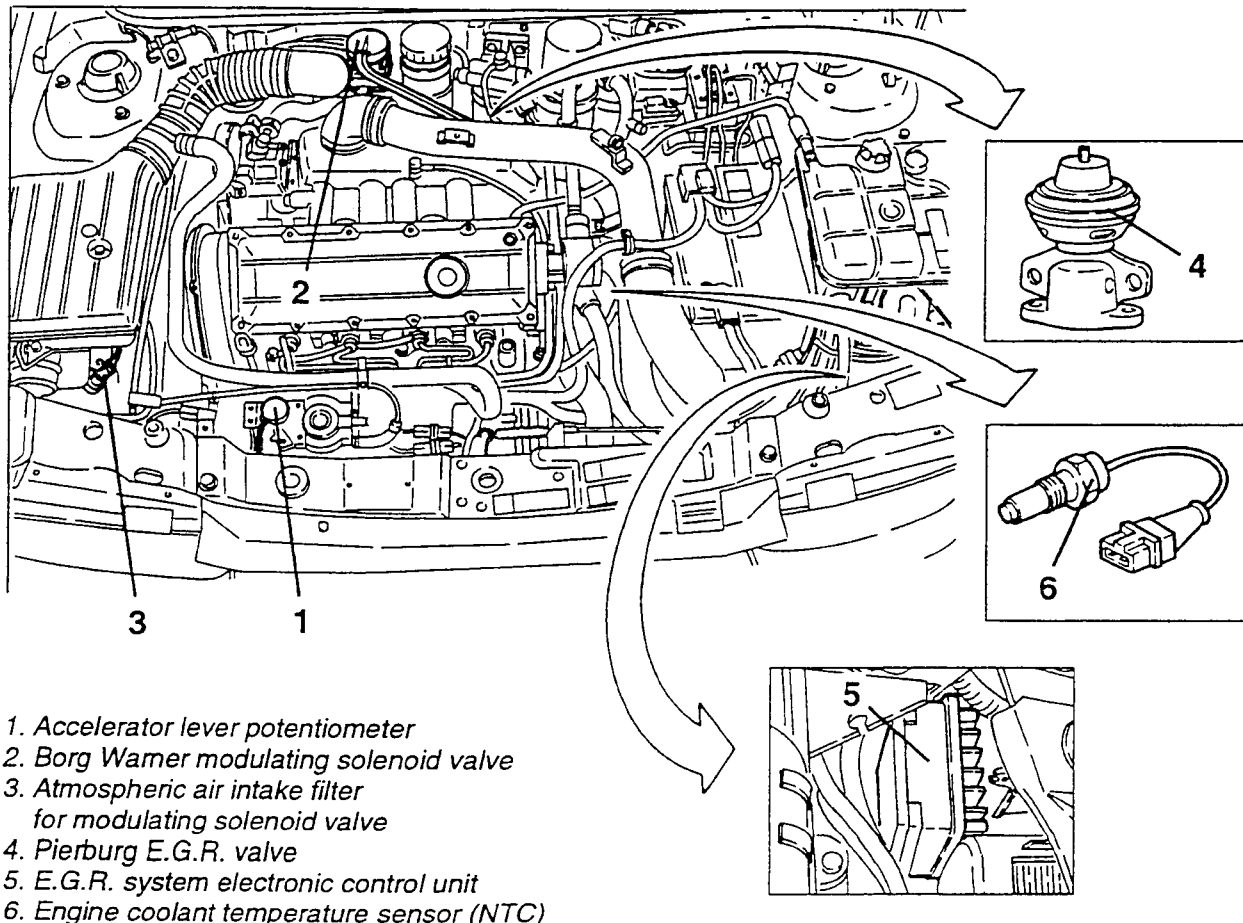


E.G.R. SYSTEM LAYOUT



- | | |
|--|------------------------------------|
| 1. E.G.R. system electronic control unit | 6. Pierburg E.G.R. valve |
| 2. Rpm sensor | 7. Intake box |
| 3. Engine coolant temperature sensor (NTC) | 8. Exhaust manifold |
| 4. Borg Warner modulating solenoid valve | 9. Accelerator lever potentiometer |
| 5. Atmospheric air intake filter for modulating solenoid valve | 10. Vacuum pump for servobrake |

LOCATION OF COMPONENTS IN THE ENGINE COMPARTMENT



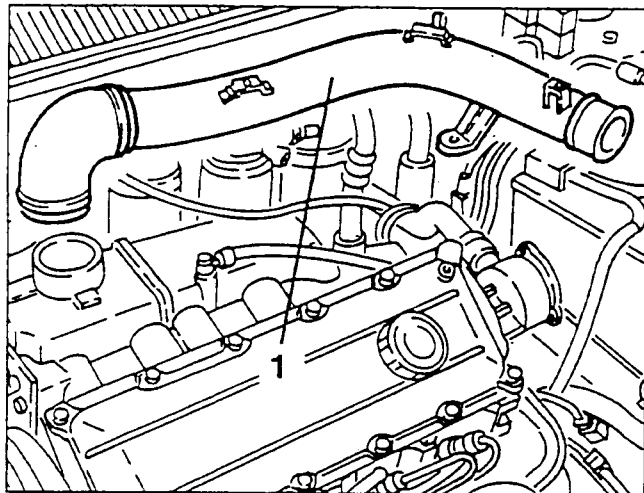
- | |
|--|
| 1. Accelerator lever potentiometer |
| 2. Borg Warner modulating solenoid valve |
| 3. Atmospheric air intake filter for modulating solenoid valve |
| 4. Pierburg E.G.R. valve |
| 5. E.G.R. system electronic control unit |
| 6. Engine coolant temperature sensor (NTC) |

REMOVING/REFITTING

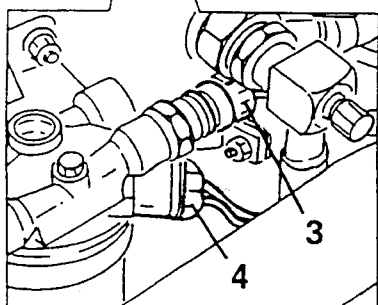
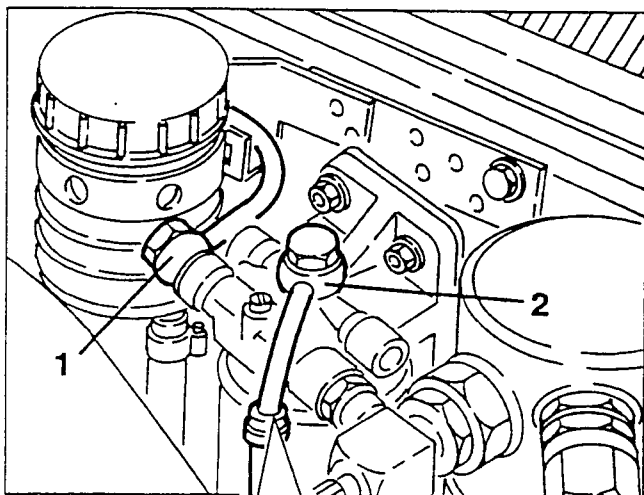
PIERBURG E.G.R. VALVE

- Disconnect the battery (-) terminal.

1. Release the battery cable from the fastening bracket, slacken the fastening clamps, then remove the second section of the air delivery pipe from the intercooler to the intake box.

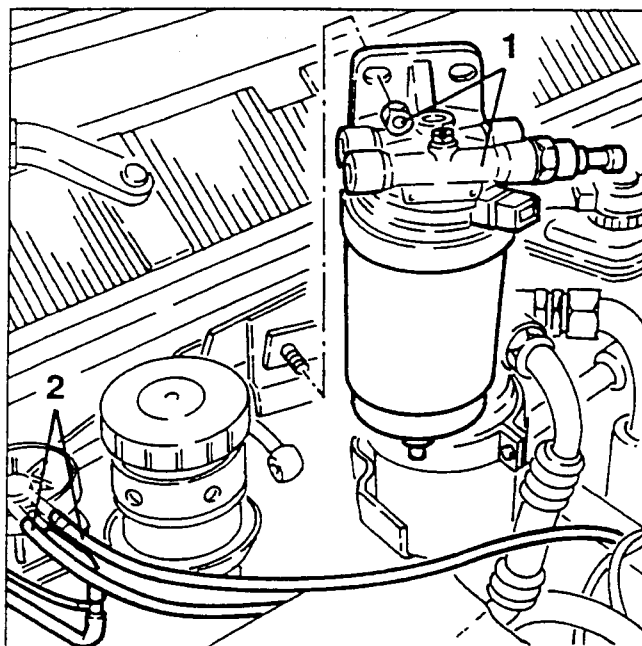


1. Disconnect the fuel tank delivery pipe fitting from the filter.
2. Disconnect the injection pump delivery pipe fitting from the filter.
3. Disconnect the electrical connection from the fuel warming device sensor.
4. Disconnect the electrical connection supplying the fuel warming device.



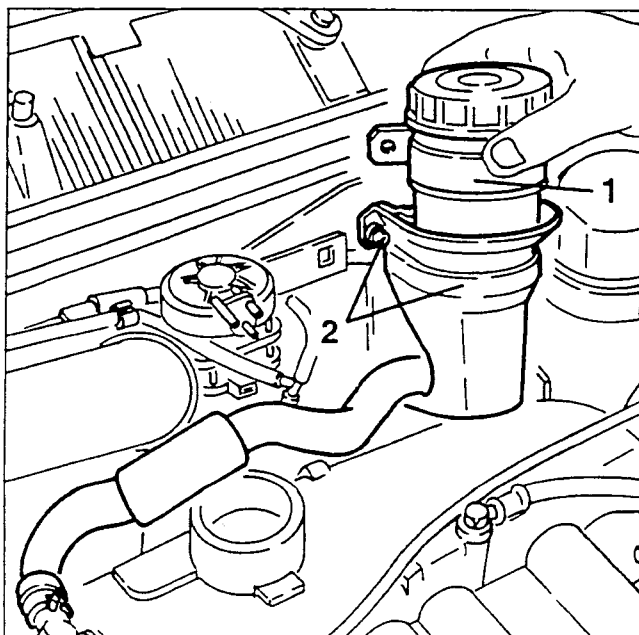
1. Loosen the two fastening nuts and remove the fuel filter complete.

2. Disconnect the pipes from the Borg Warner modulating solenoid valve.

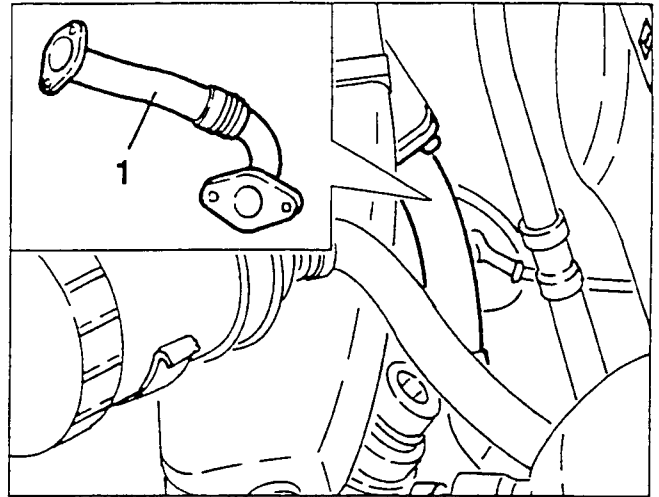
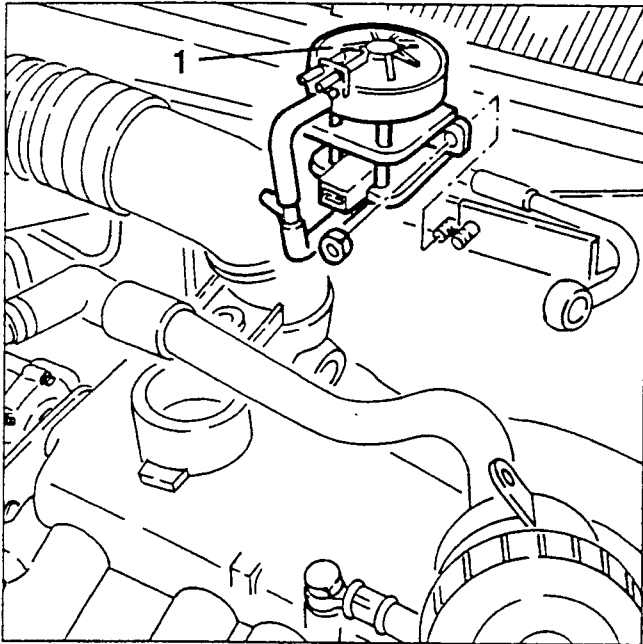


1. Loosen the two screws fastening the power steering oil tank complete with cover and raise it just enough without disconnecting the pipes.

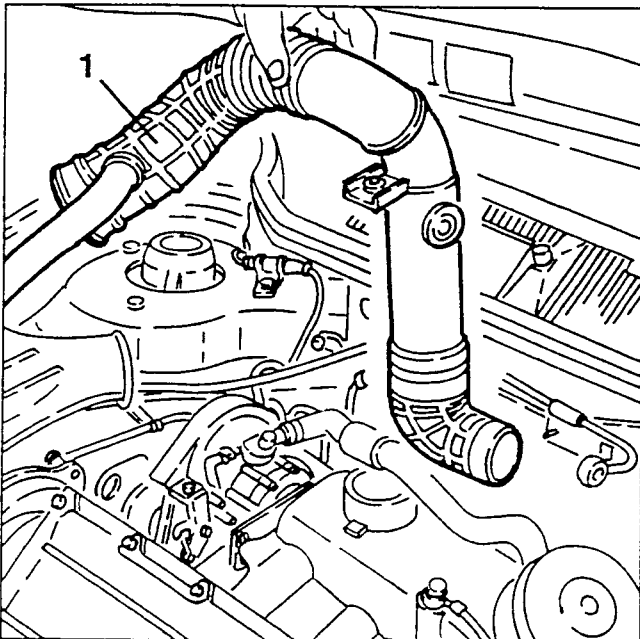
2. Loosen the two fastening screws and remove the heat shield from the power steering oil tank, then move the tank to one side to prevent it from hindering the following operations.



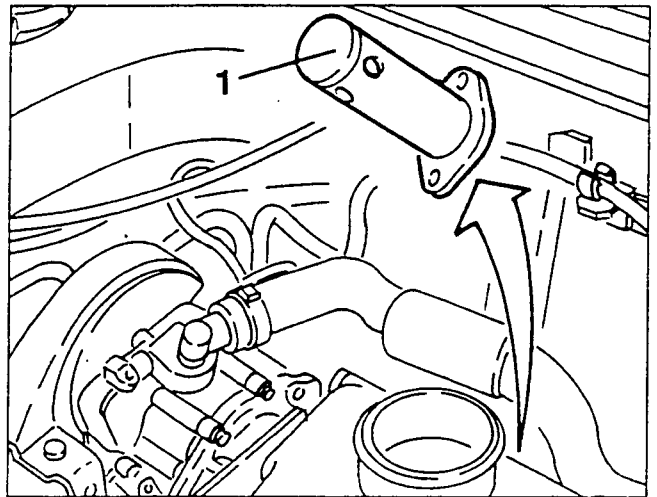
1. Disconnect the electrical connection, slacken the two fastening nuts, then remove the Borg Warner modulating solenoid valve.



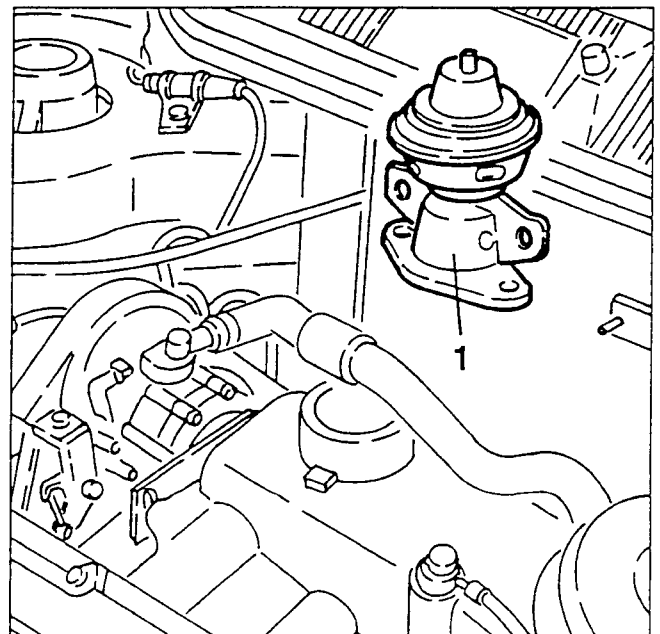
1. Slacken the fastening clamps, release from the intermediate fastening, then remove and set on one side the air delivery pipe from the filter to the turbo-charger without disconnecting the oil vapour recirculation pipe.



1. From the exhaust gas inlet hole in the intake box retrieve the recirculated exhaust gas "diffuser".



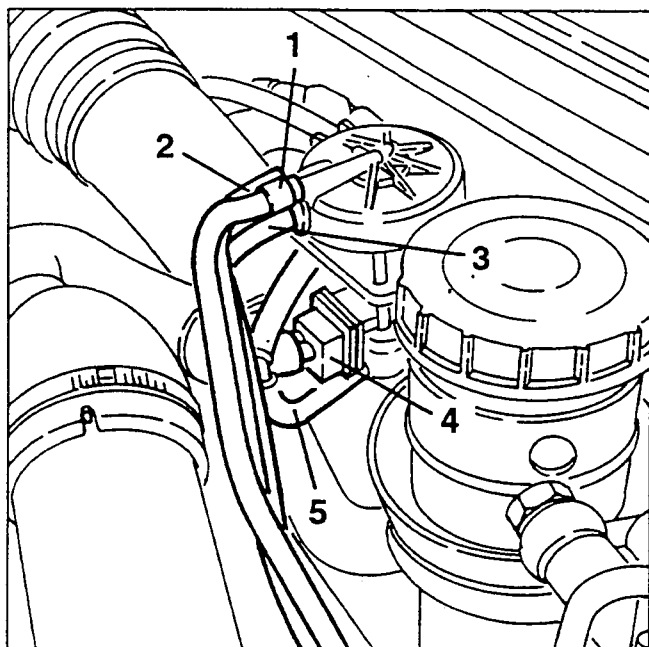
1. Loosen the fastening nuts and remove the Pierburg E.G.R. valve from the exhaust manifold.



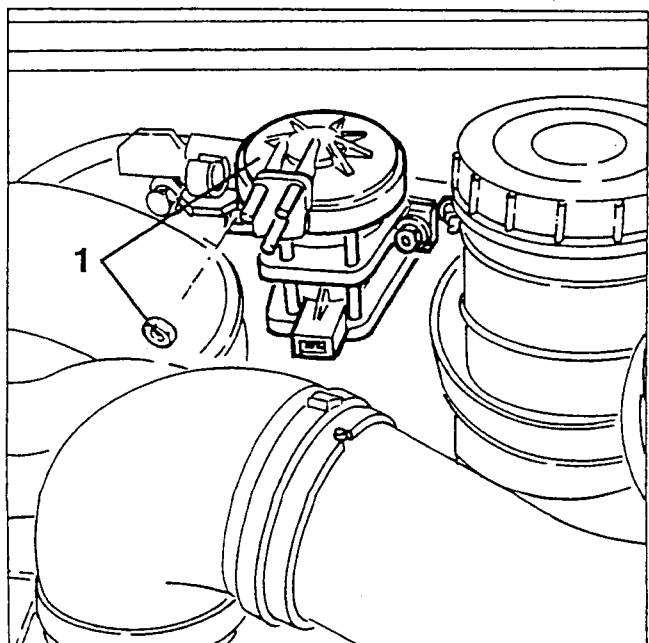
1. Loosen the fastenings screws and remove the exhaust gas delivery pipe from the E.G.R. valve to the intake box.
- Retrieve the seals.

BORG WARNER MODULATING SOLENOID VALVE

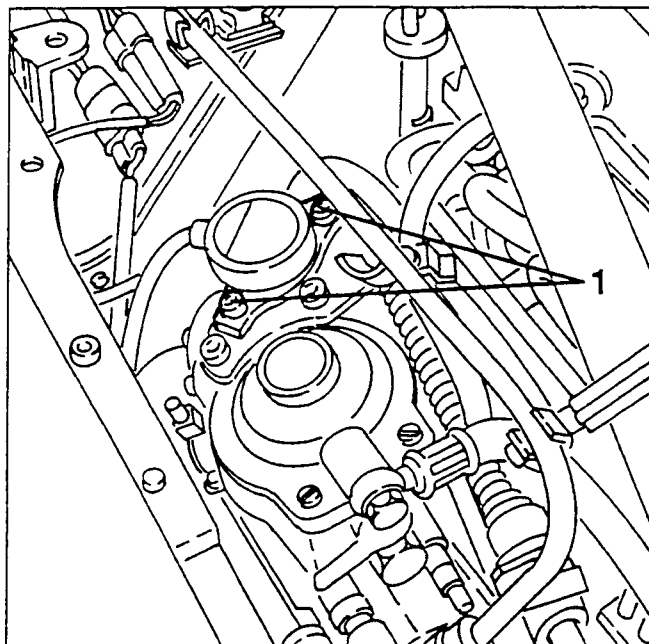
- Disconnect the battery (-) terminal.
- 1. Disconnect the vacuum takeoff pipe from the modulating solenoid valve.
- 2. Disconnect the pipe connecting with the E.G.R. valve from the modulating solenoid valve
- 3. Disconnect the upper atmospheric air takeoff pipe from the modulating solenoid valve.
- 4. Disconnect the electrical connection from the modulating solenoid valve.
- 5. Disconnect the lower atmospheric air takeoff pipe from the modulating solenoid valve.



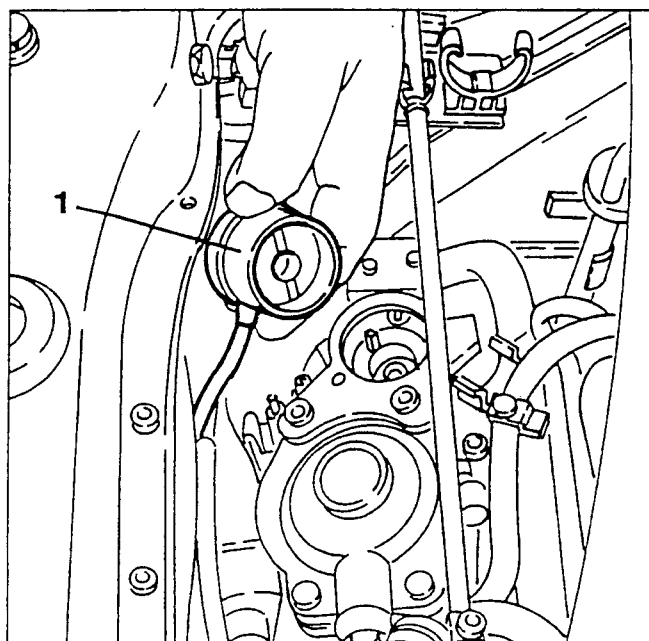
1. Loosen the two fastening nuts and remove the Borg Warner modulating valve complete.

**ACCELERATOR LEVER POTENTIOMETER**

- Disconnect the battery (-) terminal.
- Disconnect the electrical connection of the accelerator lever potentiometer.
- 1. Slacken the two fastening screws and remove the brackets fastening the accelerator lever potentiometer.



1. Remove the accelerator lever potentiometer complete with wiring.



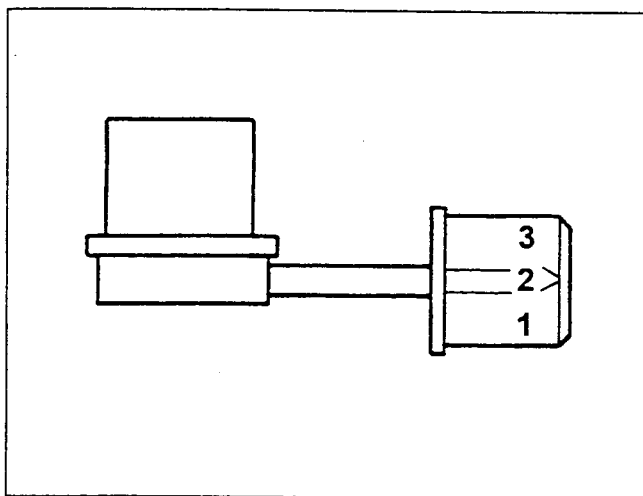
When refitting check the accelerator lever potentiometer setting proceeding as described below.

Checking the potentiometer setting

1. With the control panel on, check that the voltage between PIN 3 (positive) and PIN 1 (negative) of the accelerator lever potentiometer electrical connection is within the specified limits.

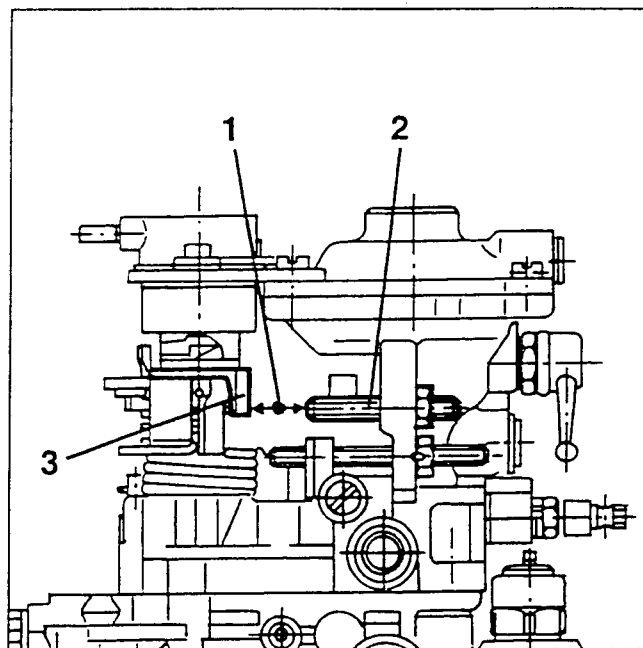
Voltage to be found between PIN 3 (positive) and PIN 1 (negative)

3.7 ± 0.2 Volt



PIN 1 - negative
PIN 2 - signal
PIN 3 - positive

- The output signal of the potentiometer, to be measured between PIN 2 and PIN 3 (positive) of the potentiometer should be checked setting a 12 mm spacer between the third stop screw and the tooth on the accelerator lever as illustrated.



1. 12 mm spacer
2. Third stop screw
3. Tooth on accelerator lever

- After setting the accelerator lever tooth against the spacer, check that the potentiometer output signal is within the specified limits.

Potentiometer output signal measured between PIN 2 and PIN 3 (positive)

1.37 ± 0.1 Volt

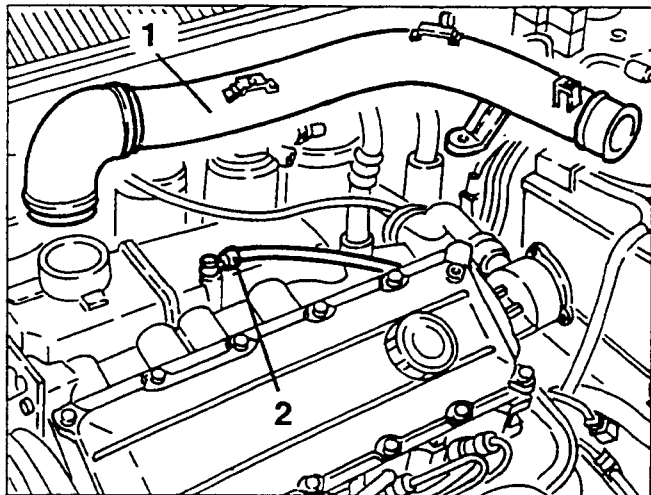
- If the potentiometer output signal is not within the specified limits, slacken the potentiometer fastening screws and turn it until the required voltage is obtained.

INTAKE BOX**REMOVING/REFITTING**

- Disconnect the battery (-) terminal.

1. Release the battery cable from the fastening bracket, slacken the fastening clamps, then remove the second section of the air delivery pipe from the intercooler to the intake box.

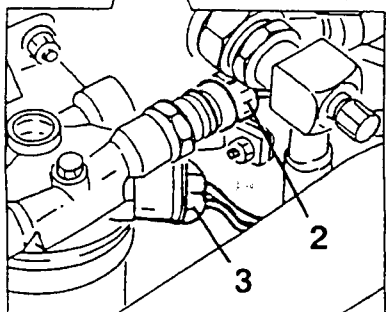
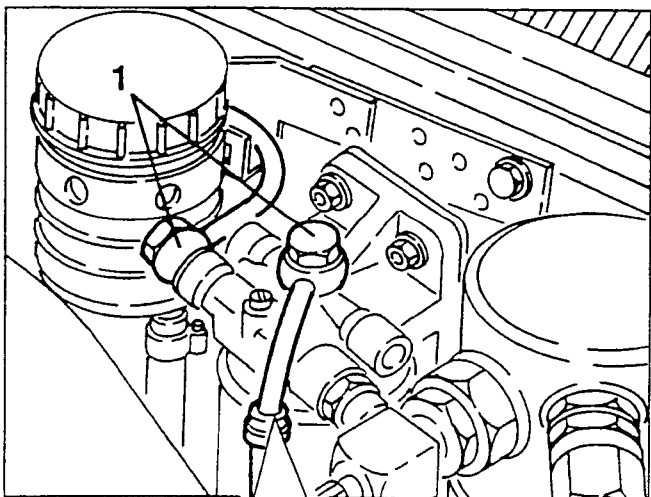
2. From the intake box disconnect the fitting of the overpressure pipe for the flow-rate limiting device.



1. From the filter disconnect the fittings of the fuel inlet and delivery pipes.

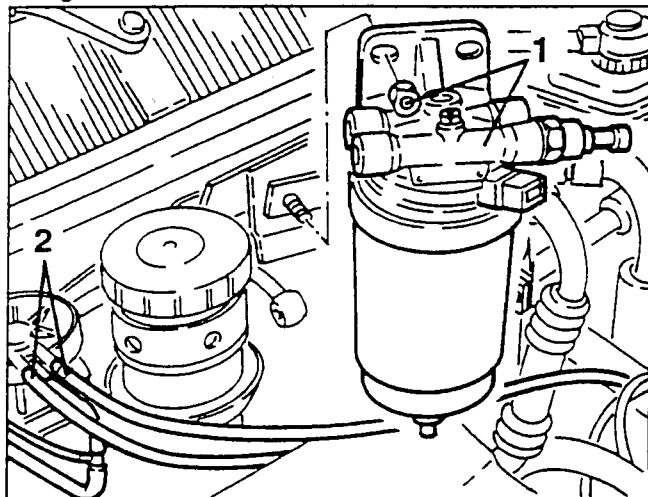
2. Disconnect the electrical connection of the fuel warming device sensor.

3. Disconnect the electrical connection supplying the fuel warming device.

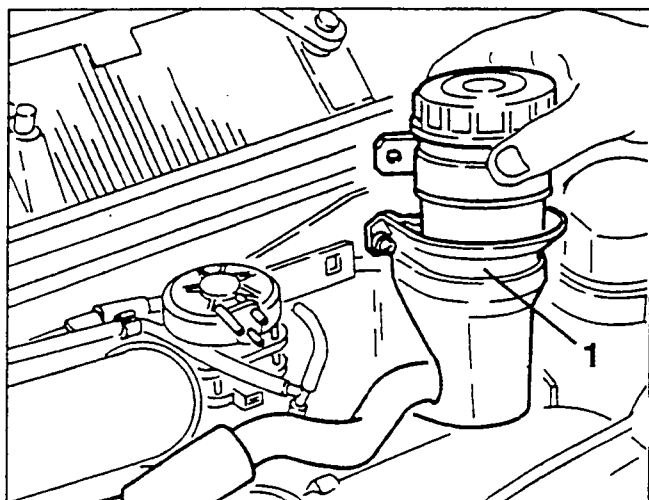


1. Slacken the two fastening nuts and remove the fu filter complete.

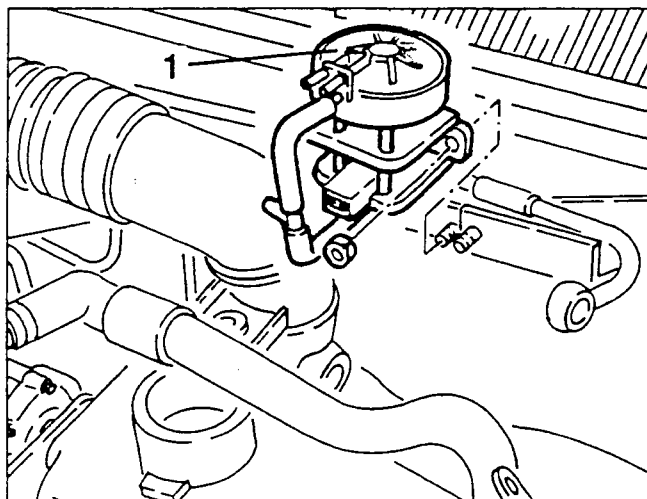
2. Disconnect the pipes from the Borg Warner modulating solenoid valve.



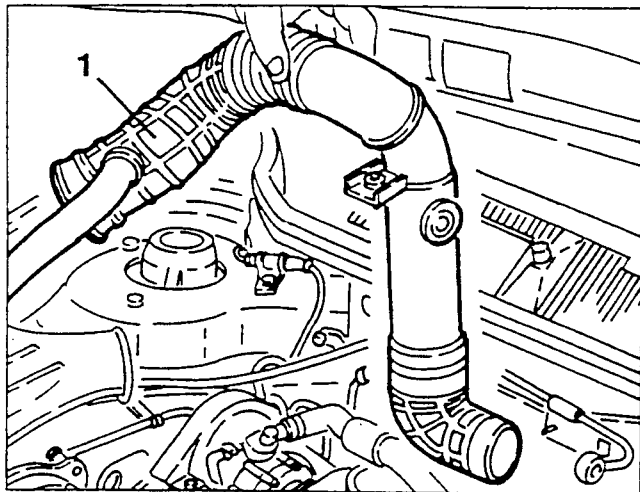
1. Slacken the two fastening screws, raise the power steering tank just enough without disconnecting the pipes, then remove the cover from the tank and set it aside.



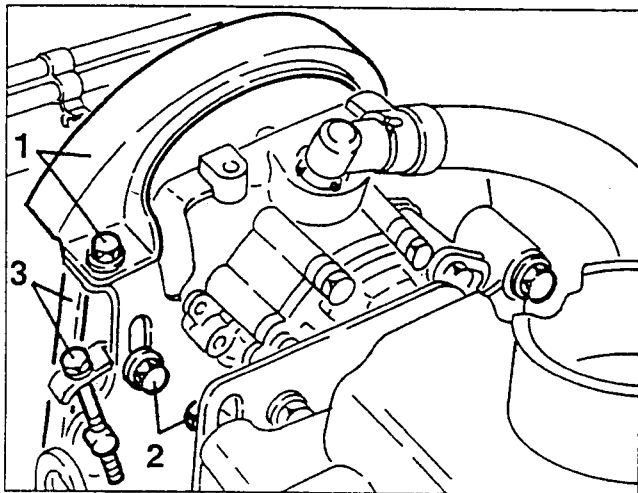
1. Disconnect the electrical connection, slacken the two fastening nuts, then remove the Borg Warner modulating solenoid valve.



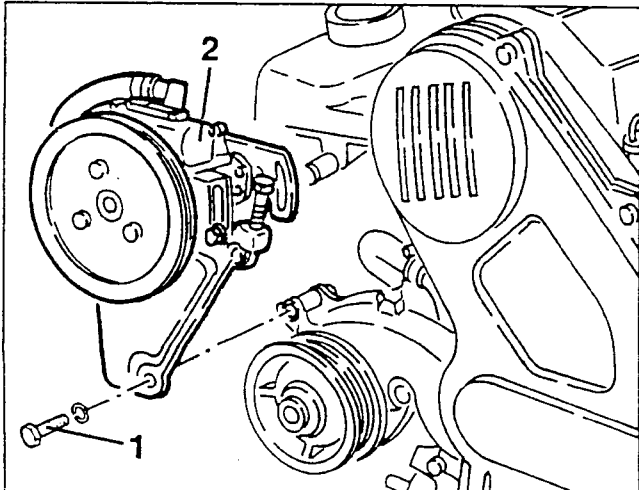
1. Loosen the clamps and move aside the air delivery pipe from the filter to the turbocharger without disconnecting the oil vapour recirculation pipe.



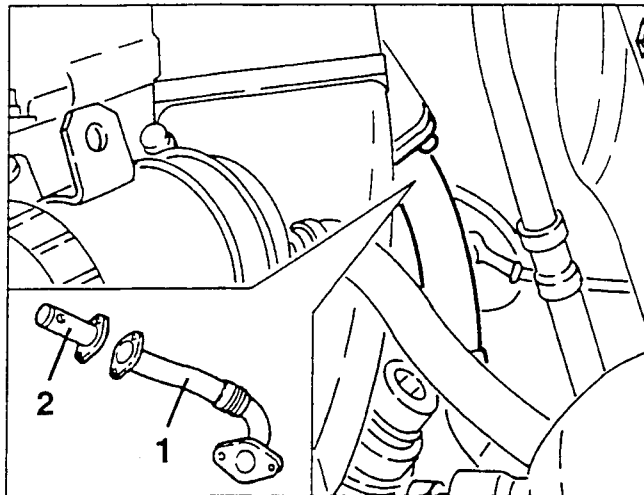
1. Remove the power steering pump belt guard.
2. Loosen the power steering pump fastening screws.
3. Loosen the tensioner screw, then remove the pump drive belt.



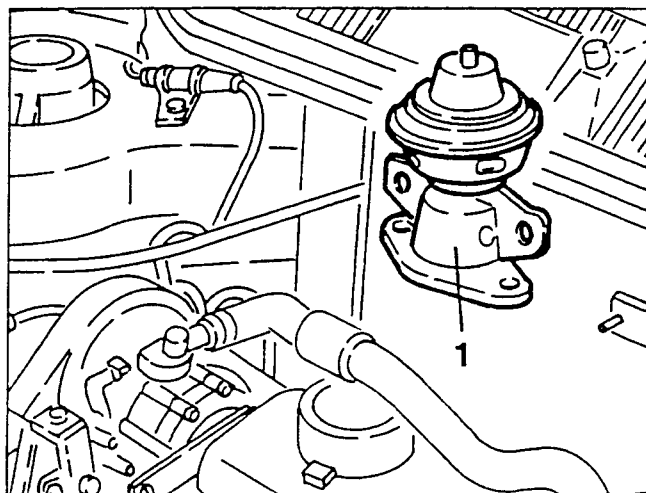
1. Completely back off the screws loosened previously and the screw illustrated.
2. Remove the power steering pump complete with front bracket without disconnecting the pipes and move it to one side.



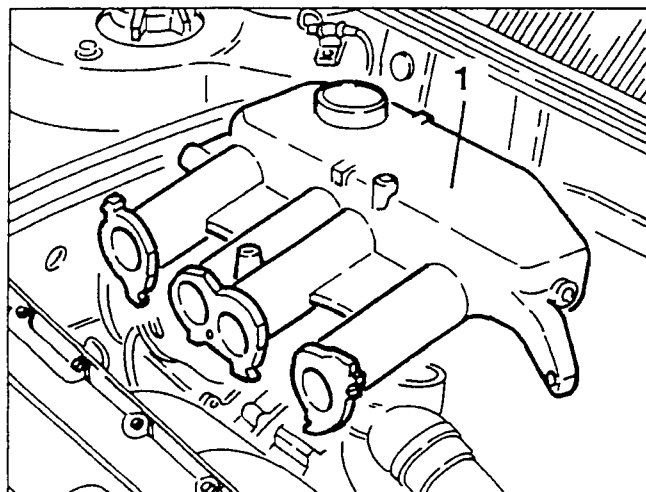
1. Slacken the fastening screws and remove the exhaust gas delivery pipe from the E.G.R. valve to the intake box.
- Retrieve the seals.
2. From the exhaust gas inlet hole in the intake box retrieve the recirculated exhaust gas "diffuser".



1. Slacken the fastening nuts and remove the Pierburg E.G.R. valve from the exhaust manifold.



1. Slacken the fastenings of the intake box to the cylinder head and to the air delivery pipe from the turbocharger, then remove it.



145



TD
Cat

ENGINE
Air over-boosting system

10

WHITE

DEGUSSA CATALYTIC CONVERTER

The oxidative catalyst is a simple and effective after-treatment device, used to oxidise CO, HC and particulate, transforming them into carbon dioxide (CO₂) and water vapour (H₂O).

The Degussa catalytic converter is cylindrical in shape and comprises a single piece ceramic honeycomb (1), the cells of which are impregnated with platinum (2), a catalysing substance with oxidising reactions. The total volumetric capacity is 600 cm³ with a density of 400 cells per square inch.

The exhaust gases that cross the cells heat the catalyst, triggering conversion of the pollutants into inert compounds.

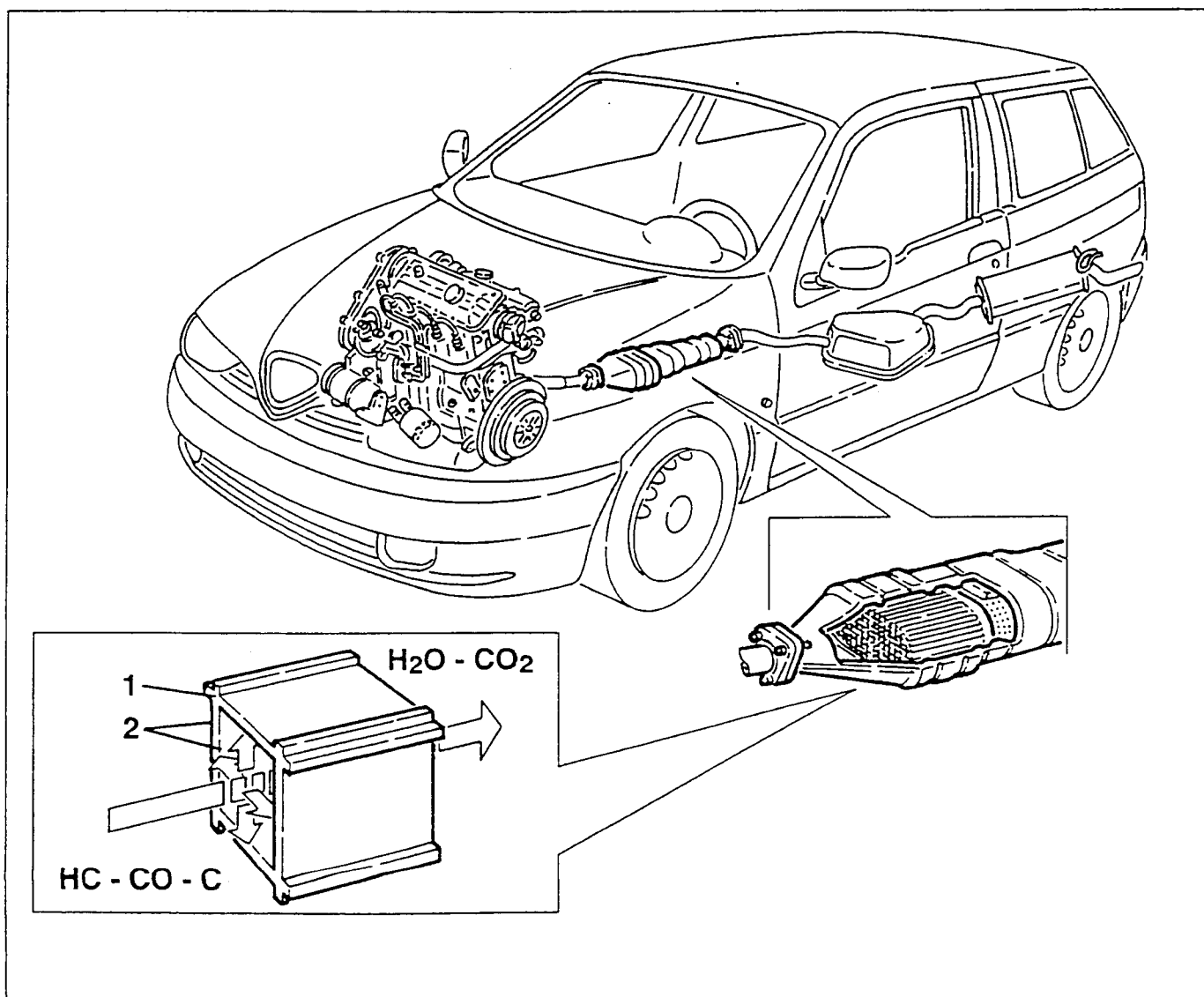
The chemical oxidising reaction of CO, HC and particulate is effective with temperatures above 200°C. They should however not exceed 350°C because at this temperature the sulphur contained in fuel oil begins to oxidise, originating sulphur dioxide (SO₂) and sulphuric dioxide (SO₃), which are the cause of acid rain.

Correct sizing of the catalytic converter makes it possible to contain the temperature, obtaining the maximum percentage of conversion of polluting emissions, while limiting oxidation of the sulphur compounds.

The catalytic converter also treats the saturated unburnt hydrocarbons and the aromatic hydrocarbons produced by combustion, while the substances forming part of the particulate, such as carbon in the form of smut, metals, water and sulphur compounds are expelled at the exhaust.

The reduction efficiency of the single pollutants is as follows:

- 50% of CO;
- 50% of HC;
- 35% of particulate.



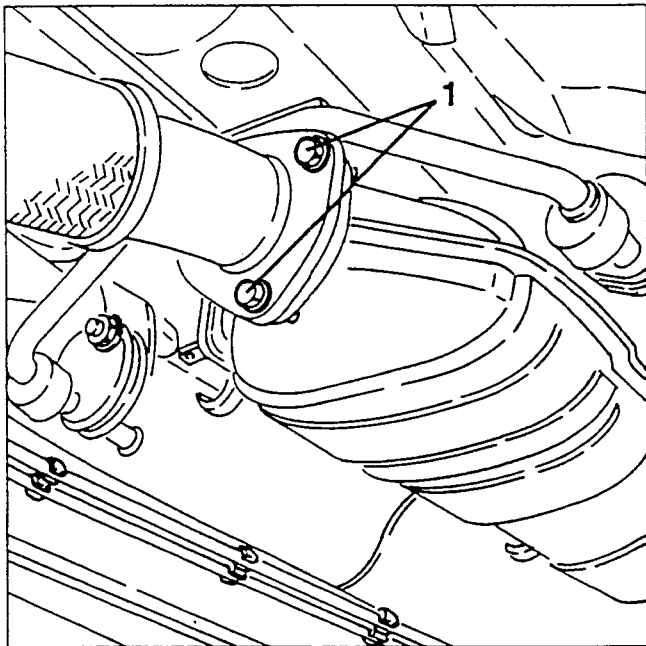


WHITE

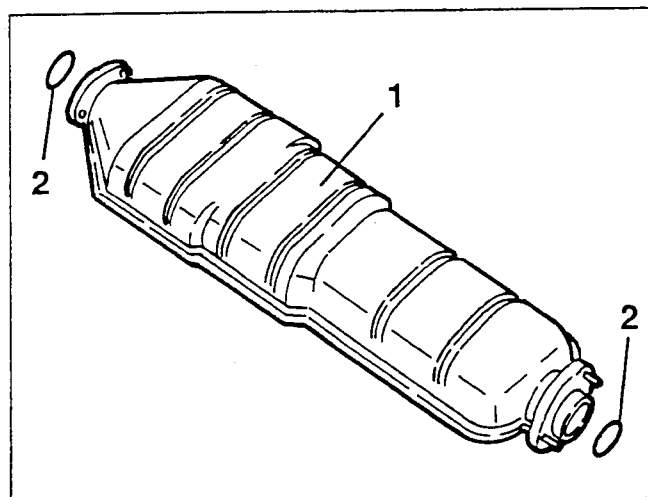
REMOVING/REFITTING


- 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.

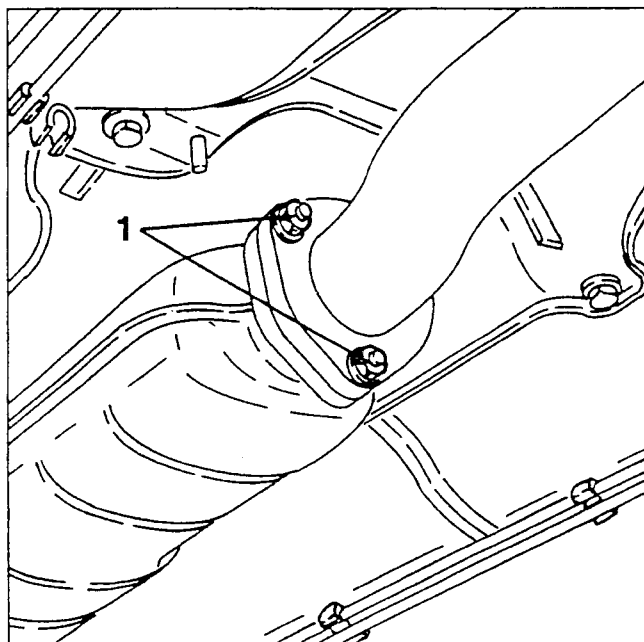


1. Remove the catalytic converter.
2. Retrieve the seal rings.

**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.

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

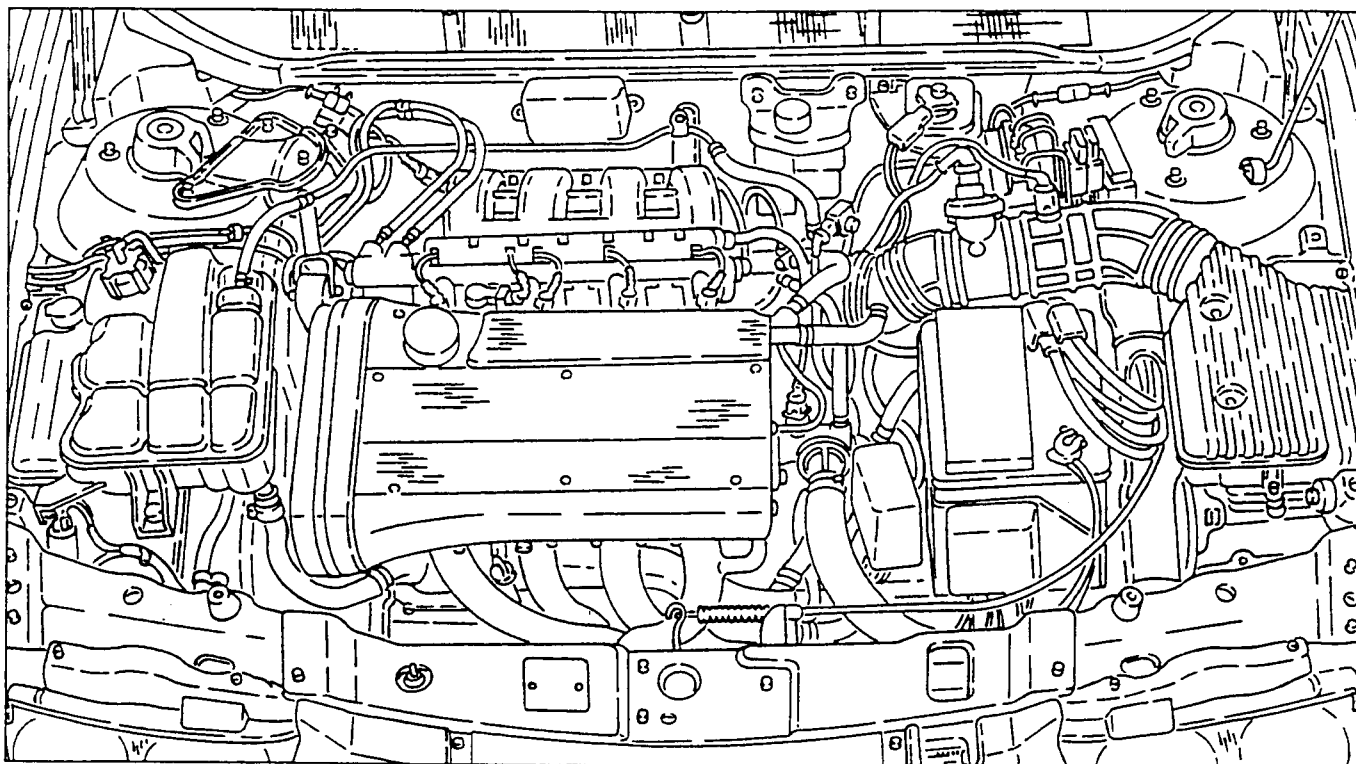


GENERAL DESCRIPTION

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.

