LOW PERCENTAGE OF EXHAUST CO	TEST M

TEST PROCEDURE	RESULTS	CORRECTIVE ACTION
M1 CHECK AIR-FLOW METER – Check that the air-flow meter functions correctly - see ELECTRICAL - ELECTRONIC DIAGNOSIS manual	OK ▶ ~~OK~~ ▶	Proceed to phase K6 Follow the procedure described in the ELECTRICAL - ELECTRONIC DIAGNOSIS manual
M2 CHECK AIR-FLOW METER – Check that the tabs move freely without bending. Check that there are no traces of dirt or rubbing inside	OK ▶ ~~OK~~ ▶	Proceed to phase M3 Replace or clean the meter
M3 CHECK ELECTROINJECTORS – It is possible to feel the movement of the needles when the injectors are touched. Check the resistance of the injectors	OK ▶ ~~OK~~ ▶	Proceed to phase M4 Replace the faulty electroinjectors

(CONTINUES)

LOW PERCENTAGE OF EXHAUST CO	TEST M

TEST PROCEDURE	RESULTS	CORRECTIVE ACTION
M4 CHECK FOR AIR LEAKAGE – Check: • that air is not escaping from the circuit. Cover the connections along the pipes downstream of the air-flow meter with soap solution. With the engine at idle speed check that the solution is not sucked in by the engine • To set the flow correctly see GROUP 04 - CHECKING THROTTLE VALVE CALIBRATION	OK ▶ ~~OK~~ ▶	Proceed to phase M5 Replace the faulty components
M5 CHECK FUEL PRESSURE – Check the pressure and sealing of the fuel supply circuit - see GROUP 04 - FUEL CIRCUIT PRESSURE AND SEALING CHECK	OK ▶ ~~OK~~ ▶	Proceed to phase M6 Check that the fuel filter, pump and pressure regulator are working correctly and replace any faulty parts
M6 CHECK CONTROL UNIT – Check that the MOTRONIC M1.7 control unit is working properly (by checking the vehicle using another control unit) as the CO control function could be faulty	~~OK~~ ▶	Replace the control unit

End of test M

GROUP 05

ENGINE IGNITION, STARTING AND RECHARGING

INDEX

ILLUSTRATED INDEX

IGNITION SYSTEM

The double ignition system, of the static type, is integrated with the injection system within the MOTRONIC M1.7 system.

Static ignition does not require a distributor to supply the high volatge to the spark plugs but employs four coils located within two separate blocks each controlled by a double power module.

Each coil controls two spark plugs of different cylinders (lost spark static distribution system)

The most important advantages are:

- greater sparking power
- greater reliability
- reduction in radio disturbance
- small size

The control unit recognizes the angular position and the speed of the crankshaft through the r.p.m. and timing sensor.

Processing the signal relative to the temperature and engine loading, it calculates the ignition advance and simultaneously pilots the internal power modules, the relative pair of coils (e.g. sparking on the two plugs of cylinder number 1 and on the corresponding two on cylinder number 4 is simultaneous).

This solution exploits the different environmental and pressure conditions existing simultaneously in the two pairs of cylinders 1-4, 2-3.

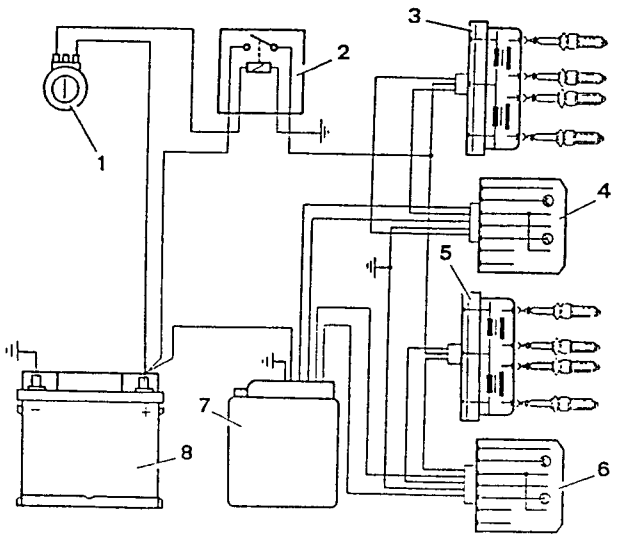
When one of the cylinders nears the firing stage in the presence of air-fuel mixture, the corresponding cylinder is at the end of the exhaust phase in the presence of exhaust gas.

Examining the voltage necessary to strike the arch between the electrodes of the spark plugs, it can be noted that in a cylinder during firing this voltage is elevated (around 10 kV), while the voltage in a cylinder during the exhaust phase is greatly reduced (around 500 V).

At the moment in which the Motronic control unit releases control from one of the power modules the flow of electricity in the main circuit of the relevant coil is interrupted generating, by induction, an increase in voltage on the secondary circuit (up to 30 kV empty).

During the increase in high voltage, one side of the secondary circuit of the coil is closed towards earth by the lost spark which, with a charge of approximately 500 V, strikes the spark plug located in the cylinder during the exhaust phase.

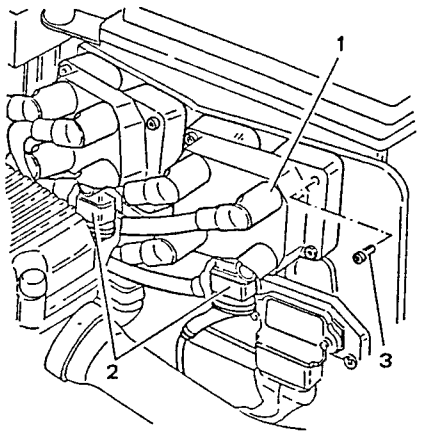
This permits a voltage increase on the spark plug connected to the other side of the secondary circuit, which is in contact with the mixture present in the cylinder, and provokes combustion.



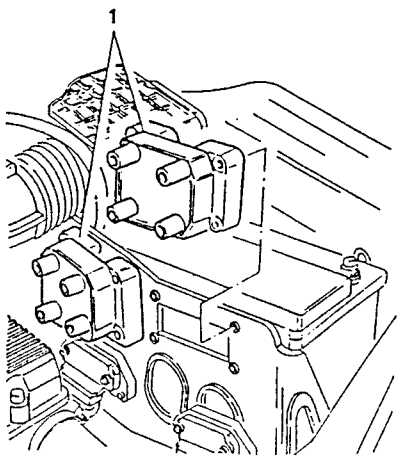
1. *Ignition block*
2. *Key operated service relay*
3. *Ignition coil*
4. *Ignition module 1*
5. *Ignition coil 2*
6. *Ignition module 2*
7. *MOTRONIC M1.7*
8. *Battery*

IGNITION COILS REMOVAL/REFITTING

- Disconnect the negative cable from the battery.
1. Disconnect the spark plug cables from the ignition coil.
2. Disconnect the electrical supply connection from the ignition coils.
3. Unscrew the four screws securing the ignition coil to the battery support.

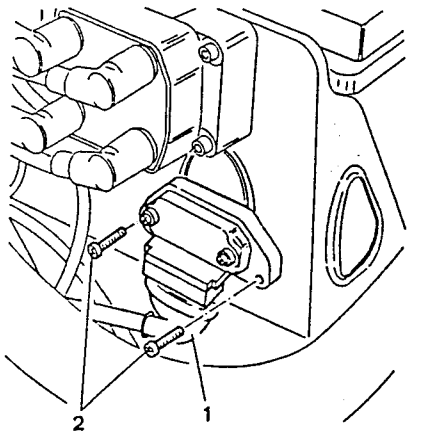


1. Remove the ignition coils.

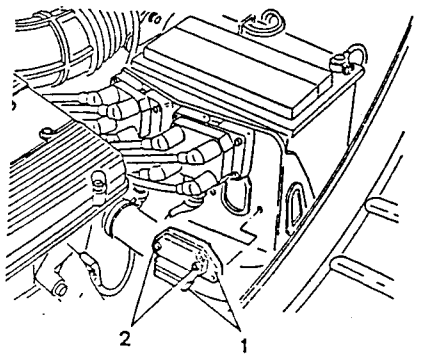


IGNITION MODULES REMOVAL/REFITTING

- Disconnect the negative cable from the battery.
1. Disconnect the electrical connections from the ignition mudule.
2. Unscrew the two screws securing the ignition module to the battery support.



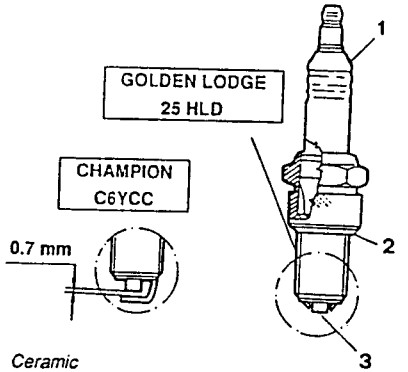
1. Remove the ignition module complete with support.
2. If necessary remove the ignition module from its support by unscrewing the two screws.



SPARK PLUGS

The spark plugs installed on the vehicle may be of the surface discharge type with either four peripheral points and a central electrode, or with one point and a single central electrode.
The distance between electrodes does not need to be adjusted on the first type of spark plug but on the second a precise measurement must be maintained.

Firing order	1 - 3 - 4 - 2



1. *Ceramic*
2. *Gasket*
3. *Electrode*

MAINTENANCE

Periodically check to see if the electrode is dirty.
Also check to see if it is worn or the ceramic insulation broken.
Replace the spark plug if these faults are detected.
When refitting, lubricate the threads using ISECO MOLYKOTE oil and tighten the spark plugs to the correct torque of:

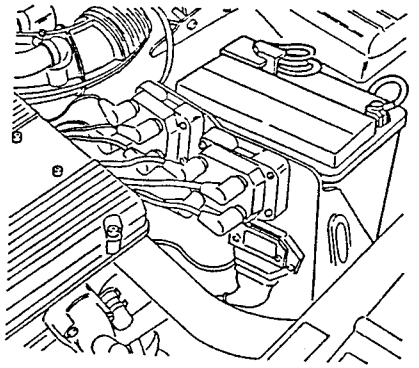
28 to 34.6 Nm (2.85 to 3.5 kg)

CAUTION
Do not use spark plugs of a type or size different from those specified as this may cause damage to the engine and alter the level of toxic exhaust fumes.

A dirty or burnt out spark plug is often symptomatic of a malfunction in the engine's supply system.
For example:
• Traces of carbon powder: incorrect mixture, air cleaner very dirty;
• Oil stains: infiltration of oil from the piston rings;
• Ash formation: presence of aluminium material especially in oil;
• Melted electrodes: overheating due to unsuitable combustion, valve defects;
• Fast wearing electrodes: damaging additives present in the fuel or oil, pinging, overheating;
• Etc.
For greater detail regarding these problems refer to the fault diagnosis contained in GROUPS 01 and 04.

BATTERY

The battery is located in the left-hand part of the engine compartment.

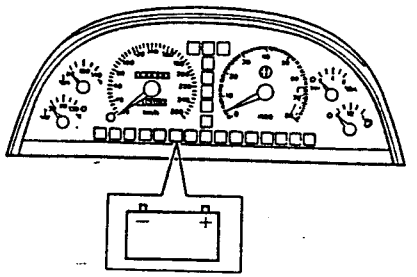


It has been designed following criteria which permit the engine to be started in the shortest possible time. Towards this aim a high torque and a fixed number of minimum revolutions are necessary. This is guaranteed by the optimal size of the 6 elements contained within the battery each of which emits approximately 2 V (12V in total).
The battery adopted does not require maintenance.
It is on the whole similar to a normal battery but it maintains its charge longer and also contains diluted sulphuric acid, for this reason it is necessary to keep it in the upright position even when it is not installed on the vehicle. The body of the battery is equipped with small ventilation holes so that the build up of gasses inside the battery during charging is kept to a minimum. Due to the reduction in the volume of gas produced there is no corrosion and good contact at the terminals is ensured.

The advantages of this battery are:
- reduced consumption of water due to the new type of alloy used in the manufacture of the grills and plates for which reason it is not necessary to periodically top-up the battery;
- exceptional suitability to long term storage (up to seven months at temperatures below 28°C) due to its excellent starting capacity, a result of reduced discharging.

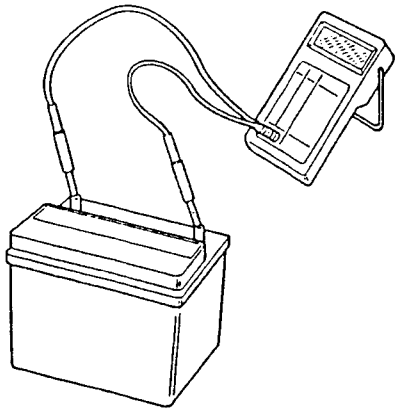
CHARGING

When the vehicle is travelling the alternator recharges the battery. Whenever the charge is insufficient or the connection between the the alternator and battery is interrupted, a warning lamp located on the instrument panel comes on to signal the malfunction.



If the battery appears to be flat, check the charge by measuring the volatge across the terminals using a voltmeter.

If the voltage is lower than 12.30 V it is only half charged, if it reaches 12.48 V it is three-quarters charged and at 12.66 V it is fully charged.



CAUTION
If the electrolyte level in one of the cells of the battery should fall below the mimimum level notch on the side of the plastic container, carefully open the cap cover and add de-ionized distilled water as with ordinary batteries.

NOTE: **Do not recharge the battery at a voltage of above 15.5 V with a strong flow of current. Use instead a normal 12 V battery charger connecting the positive cable (red) to the (+) terminal of the battery and the negative cable (black) to the (-) terminal of the battery.**
In case the battery of the vehicle is connected temporarily to an external battery connect the positive terminal to the positive terminal and the negative terminal to the negative.

CAUTION
- Do not connect or disconnect the battery to or from the electrical system of the vehicle when the engine is running.
- Do not invert the terminal connections (even for a few moments) as this would damage the alternator rectifyer.
- When connecting the battery charger to the battery, first establish the connections and then start the charger.
- If it becomes necessary to start the engine with temporary cables and with an auxillary battery, the voltage of the external battery must not exceed 12 V.
- Before charging the battery it is necessary to remove the clamp from the negative terminal.
- When recharging check that the temperature of the electrolyte does not exceed 45°C.

CAUTION
- Do not touch the negative and positive termanals at the same time.
- Keep all naked flames away from the vehicle during recharging of the battery.

When replacing the battery follow the directions for use. If the charge of the replacement battery is potentially higher than the old one the higher voltage could cause the fusion of the starter motor induction coil or damage the pinion or crown.

MAINTENANCE

The capacity of the battery to start the engine depends on the charge within it and it is therefore necessary to regularly check it and to carry out any maintenance operations required, especially during the winter when the battery may be affected due to both the greater loading required by the starter motor and the reduced battery capacity at low temperatures.
Clean the surfaces of the battery, the terminals and clamps with a solution of water and sodium bicarbonate. Before reconnecting the clamps cover them with a layer of grease.

CAUTION
Do not let any of the fluid used for cleaning to enter the battery as it will react with the electrolyte.

CAUTION
The electrolyte fluid is an acid and therefore dangerous for eyes, hands and clothes.

NOTE: **Batteries stored in a warehouse or istalled on a vehicle but unused for long periods will slowly lose their charge so it will be necessary to recharge them before use.**

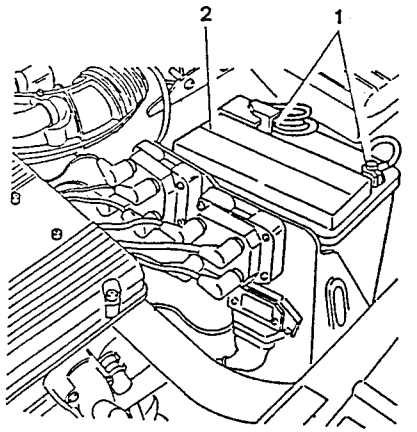
REMOVAL/REFITTING

1. Unscrew the screw securing the clamps to the terminals of the battery and disconnect the negative (-) cable first and then the positive (+) cable.

CAUTION
When disconnecting the cables from the battery ensure that the engine is not running as this would damage the alternator.

2. Remove the battery ensuring that it is kept in an upright position.

– When refitting, reverse the procedure and clean and grease the clamps and terminals of the battery.

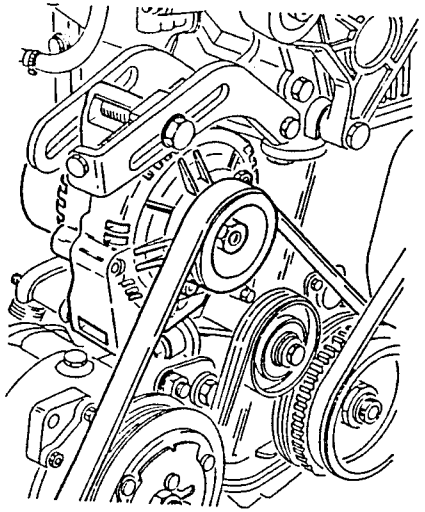


CHECKS AND INSPECTIONS

Check that the electrolyte container is not cracked and that the level of the electrolyte covers the electrodes by approximately 5 mm. Also check that the upper surface of the battery is clean and that the contacts are not oxidized.
Check that the cable clamps are well tightened onto the terminals so that an efficient contact is established.

ALTERNATOR

The alternator provides electrical energy to the electronic control units and the varoious vehicle functions when the engine is running.
It also supplies current to the accumulator (battery) in order for it to be able to supply current when the engine is stationary.



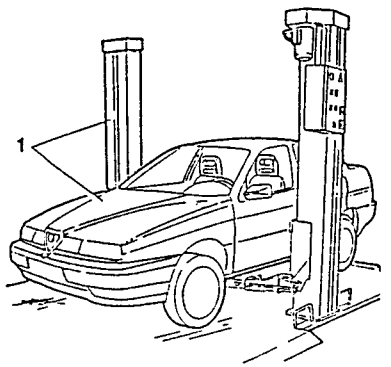
The electrical current is generated by a rotor which "cuts" a magnetic field generated by a fixed coil (stator).
The rotor is integrated with a pulley which is directly actuated by the crankshaft by way of a belt.
The contact brushes supply the rotor with the excitation current.
The alternating voltage generated by the alternator and rectifyer is regulated by diodes and by the voltage regulator located on the body of the alternator.
The electronic voltage regulator used is wear free and small in size and guarantees that a constant voltage is supplied to all the fields of operation of the engine whatever the difference in loading and r.p.m..
A cooling fan turns together with the pulley and enables the alternator to avoid reaching dangerous temperatures which would affect its operation.

The alternator installed on the vehicle is of the claw terminal type with collecting rings: it is light and compact.
It is fixed to the engine by brackets of which the lower is slotted to facilitate tensioning of the drive belt (see GROUP 00).

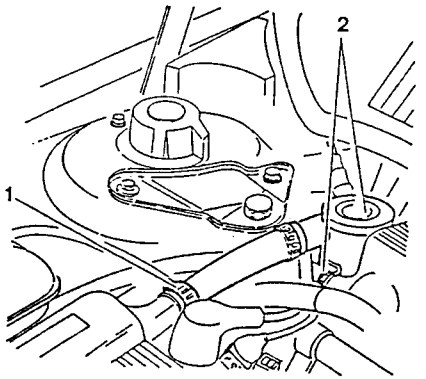
CAUTION
The fan will correctly cool the alternator if it turns in a certain direction:
CORRECT ROTATION OF THE ALTERNATOR: CLOCKWISE (SEEN FROM PULLEY SIDE).

REMOVAL/REFITTING

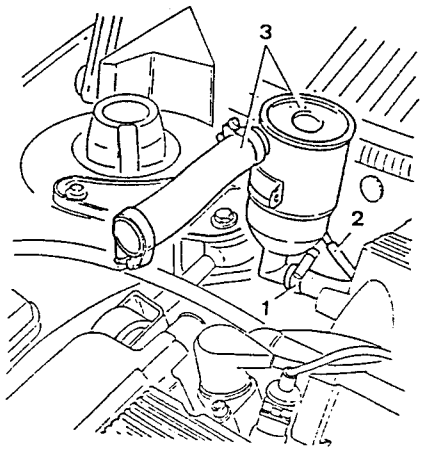
1. Place the vehicle on a lift.
- Disconnect the negative cable from the battery.



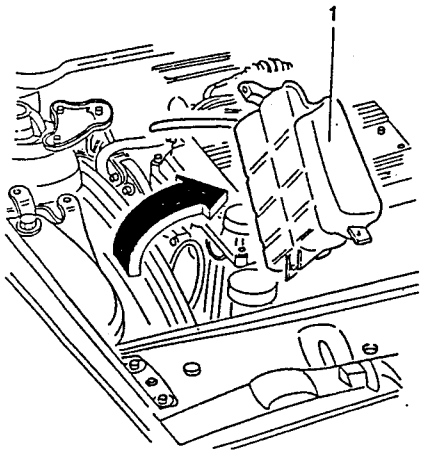
1. Disconnect the oil vapour recovery hose from the timing cover.
2. Unscrew the two screws securing the separator to the air intake box and raise it as far as possible.



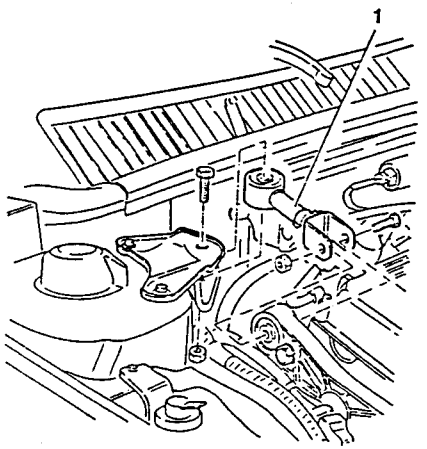
1. Disconnect the oil vapour recirculation hose from the separator.
2. Disconnect the oil recovery hose from the separator.
3. Disconnect the oil vapour support together with the oil vapour recovery hose and separate them on a bench.



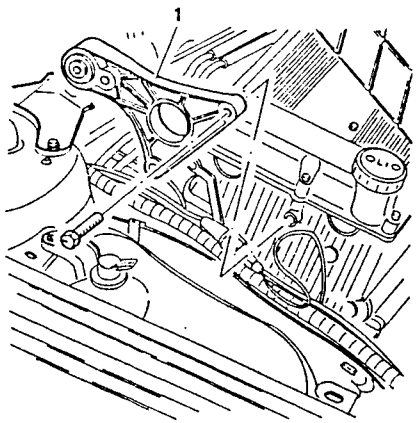
1. Unscrew the screws securing the expansion tank and, without disconnecting the hoses, move the tank to one side.



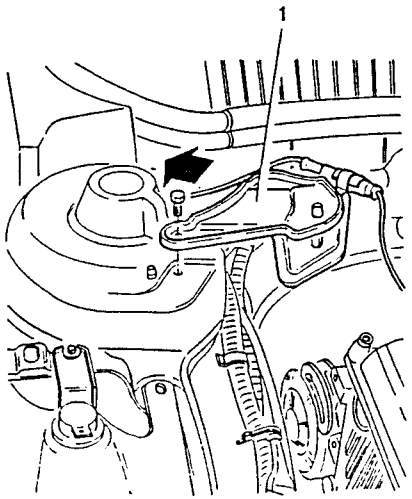
1. Unscrew the two bolts and remove the damping rod.



1. Remove the damping rod support - engine side.

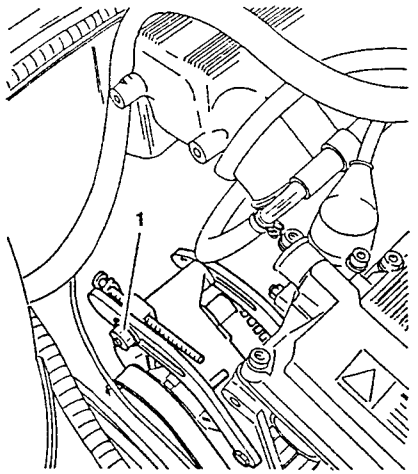


1. Remove the damping rod support bracket - body side, and, without disconnecting the ABS sensor connection, move it to one side.



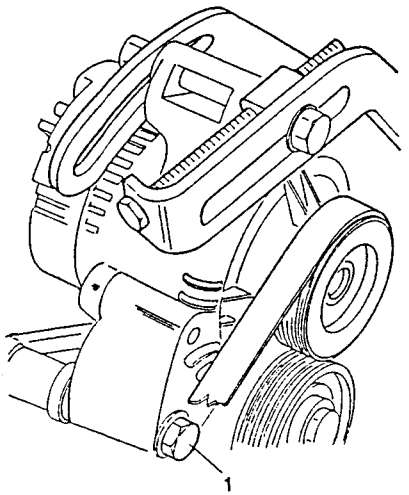
- Remove the front right-hand wheel.
- Remove the spray-guard from the right-hand wheel-housing.

1. Loosen the upper screw securing the alternator.



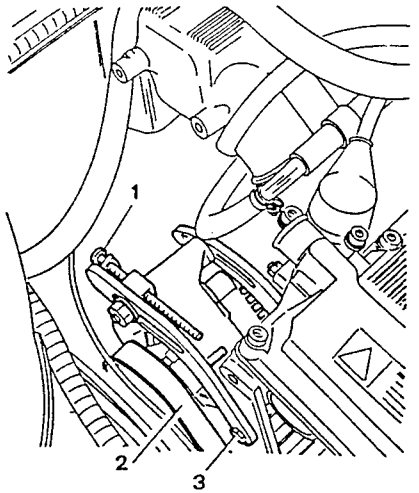
- Raise the vehicle.

1. Unscrew the lower screw securing the alternator.

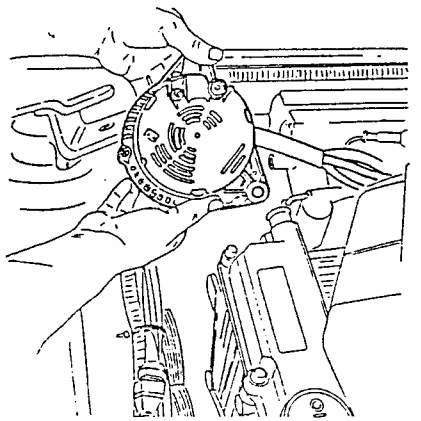


- Lower the vehicle.

1. Slacken the alternator-compressor drive belt by acting on the micrometric tensioner.
2. Remove the drive belt from the alternator.
3. Unscrew the screw securing the alternator upper support brackets.



1. Remove the bolts securing the alternator and remove the alternator after disconnecting the electrical connections.



DISASSEMBLY/REASSEMBLY

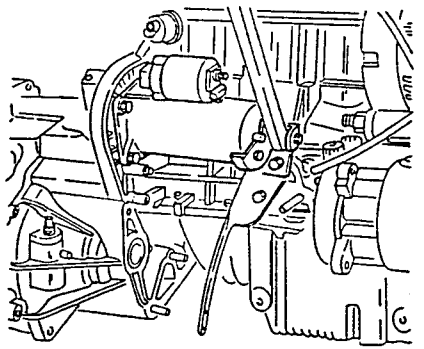
DUE FOR PUBLICATION

CHECKS AND INSPECTIONS

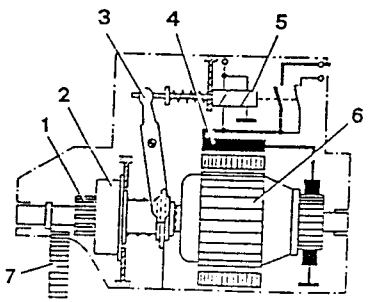
DUE FOR PUBLICATION

STARTER MOTOR

The starter motor, overcoming inertia and friction, cranks the engine to a set number of revolutions in order to begin the formation of the air-fuel mixture necessary for combustion and subsequent autonomous movement of the engine.



The movement is transmitted by a direct current electric motor powered by battery voltage through a drive pinion which rotates the ring gear on the engine flywheel.



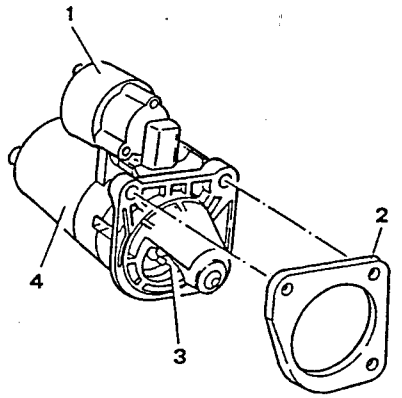
1. *Pinion*
2. *Roller type Freewheel*
3. *Coupling lever*
4. *Excitation coil*
5. *Relay*
6. *Induction*
7. *Ring gear flywheel*

Due to a free-wheel coupling the pinion disengages when the main engine unit rotates at a greater speed than the motor.

A relay, excited by the current from the motor, engages the pinion by way of a fork.

The starter motor installed on the vehicle is of the translating, screw pinion type with the relay located directly above the starter motor.

The starter is fixed to the engine by a bracket and a metalic shield protects it from excessive heat.

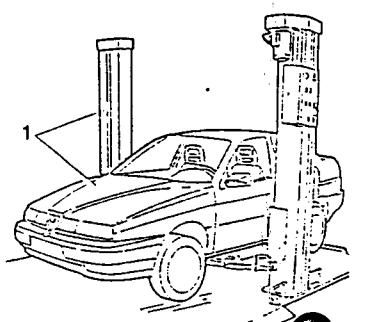


1. *Relay*
2. *Flange*
3. *Pinion*
4. *Motor*

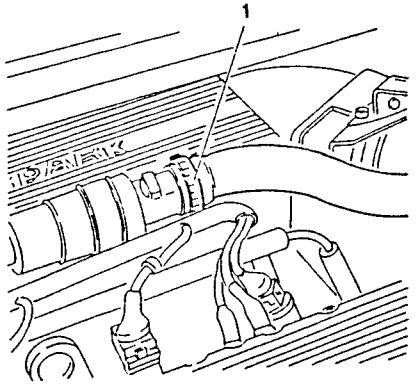
REMOVAL/REFITTING

1. Place the vehicle on a lift.

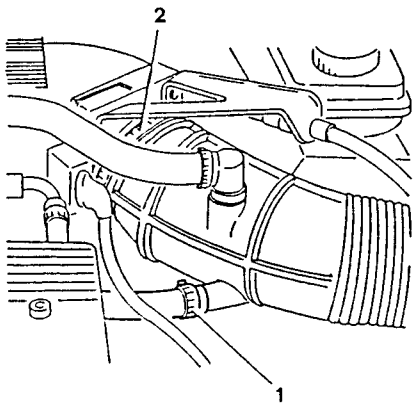
– Disconnect the negative cable from the battery.



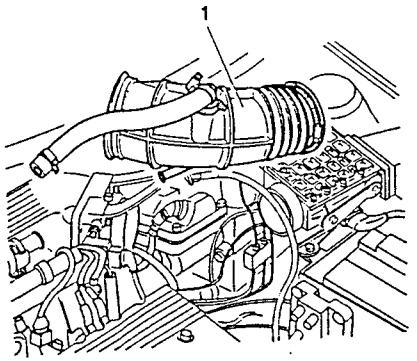
1. Disconnect the air intake hose from the constant idle speed actuator.



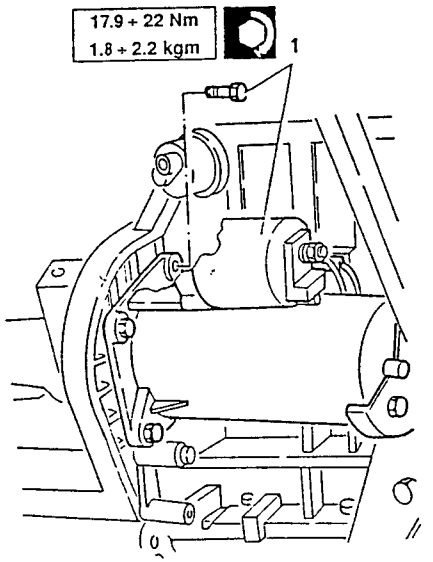
1. Disconnect oil vapour recirculation hose from the corrugated sleeve.
2. Loosen the clamps securing the corrugated sleeve to the air intake box and air-flow meter.



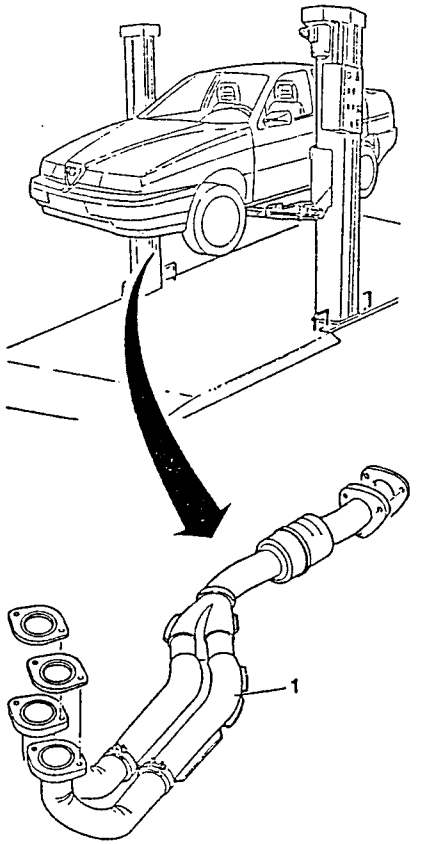
1. Remove the corrugated sleeve together with the constant idle speed actuator air intake hose.



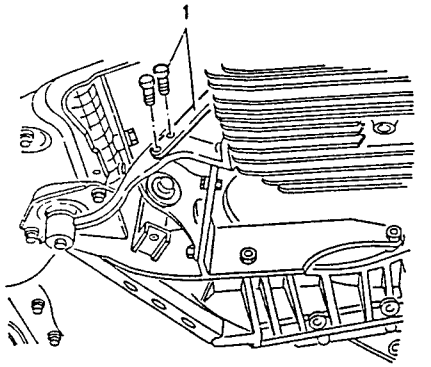
1. Unscrew the upper screw securing the starter motor to the gearbox.



– Raise the vehicle.
1. Disconnect the forward section of the exhaust pipe.

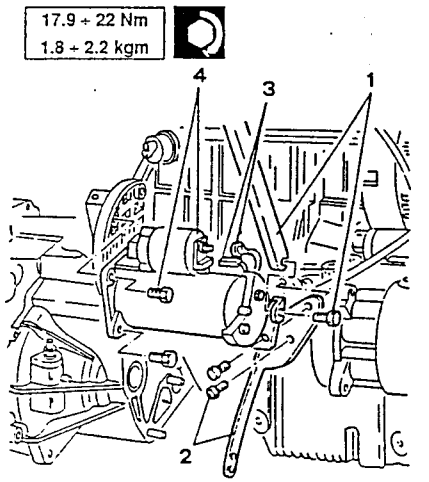


1. Unscrew the two screws securing the starter motor support bracket to the engine support.

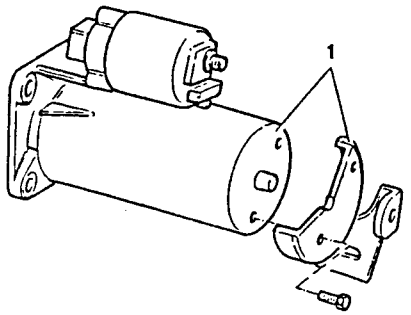


1. Unscrew the screw securing the air intake box support strut to the starter motor support bracket.
2. Unscrew the two nuts securing the engine support bracket to the engine block.
3. Disconnect the electrical connections from the starter motor.
4. Unscrew the two remaining screws securing the starter motor to the gearbox and remove the starter motor.

– Remove the engine support brackets.



1. If necessary, working on a bench, separate the starter motor from its bracket by unscrewing the screws.



DISASSEMBLY/REASSSEMBLY

DUE FOR PUBLICATION

CHECKS AND INSPECTIONS

DUE FOR PUBLICATION

FAULT DIAGNOSIS AND CORRECTIVE INTERVENTIONS

For the fault diagnosis and corrective interventions refer to GROUP 04 which also deals with the components of the ignition system.

TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

BATTERY

Nominal output	12 V
Discharge voltage (at -18°C)	320 A
Capacity (20 hrs)	60 Ah

ALTERNATOR

Nominal output		14 V
Power supply	Nominal output	80 A
	Minimum speed	1000 r.p.m.
	Speed at 40 A	~ 1600 r.p.m.
	Speed at nominal output	6000 r.p.m.

STARTER MOTOR

Nominal output		12 V
Nominal power		1.4 kW
Full load test	Voltage	9 V
	Current	≤ 350 A
	Speed	≥ 1500 r.p.m.
	Torque	8.5 Nm
Short circuit test	Voltage	4 V
	Current	≤ 750 A
	Torque	≥ 15 Nm
Flywheel overrunning torque		0.12 ÷ 0.18 Nm
Pinion teeth module		2.1167 mm

IGNITION COIL

Primary winding resistance	0.5 Ω
Secondary winding resistance	13.3 kΩ

SPARK PLUGS

Type	GOLDEN LODGE 25 HLD
	CHAMPION C6YCC

FLUIDS AND LUBRICANTS

Application	Type	Name	Quantity
Battery terminals	GREASE	Reinach E10 TAC	-
Spark plug threads	OIL	ISECO Molykote A	-

TIGHTENING TORQUES

PART	Nm	kgm
Spark plugs	28 ÷ 34.6	2.85 ÷ 3.5
Starter motor retaining screws	17.9 ÷ 22	1.8 ÷ 2.2

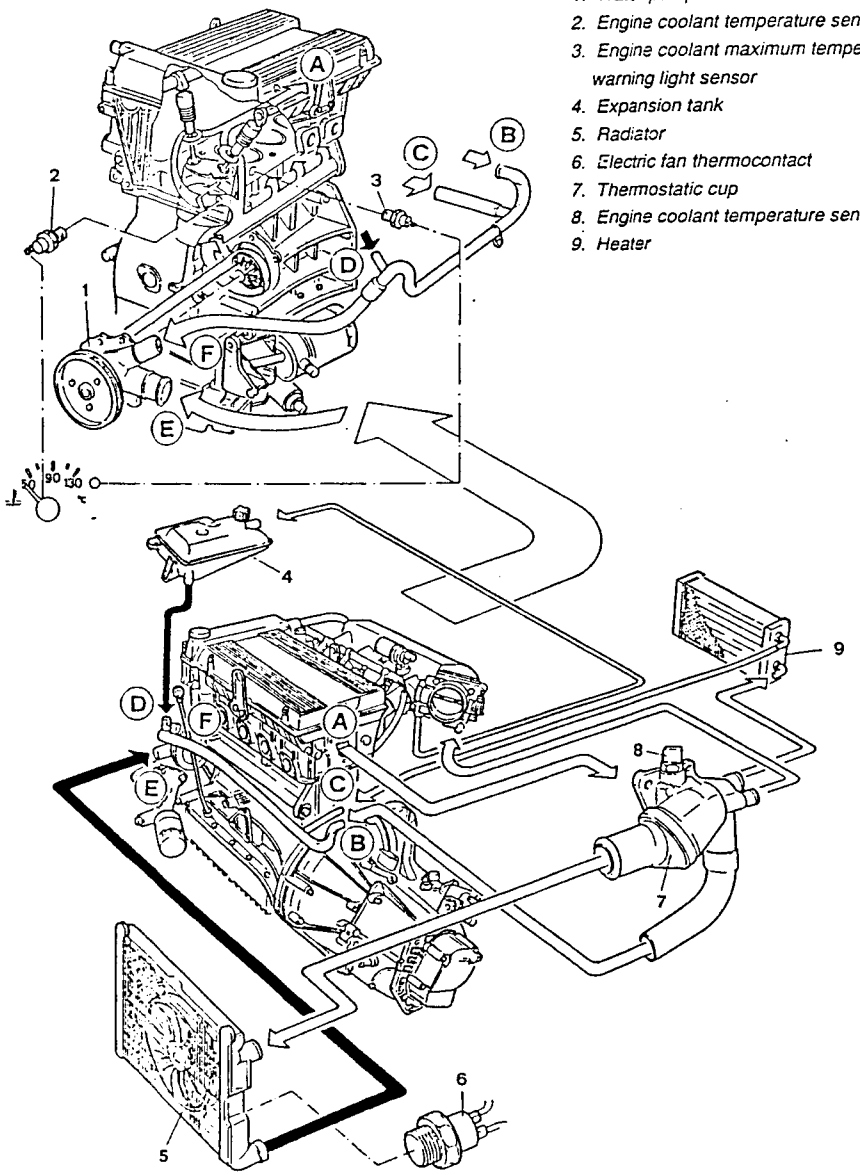
GROUP 07

ENGINE COOLING SYSTEM

INDEX

ILLUSTRATED INDEX

COOLING SYSTEM



1. *Water pump*
2. *Engine coolant temperature sender*
3. *Engine coolant maximum temperature warning light sensor*
4. *Expansion tank*
5. *Radiator*
6. *Electric fan thermocontact*
7. *Thermostatic cup*
8. *Engine coolant temperature sensor (NTC)*
9. *Heater*

DESCRIPTION

The system is of the sealed type. The flow of coolant is forced by a centrifugal pump driven by the crankshaft through a V-type belt.
A thermostat valve keeps the engine temperature at an optimum level. The thermostat opens when the coolant reaches a temperature of 87°C.
The radiator cools the liquid in the engine by dynamic air and by a two-speed cooling fan controlled by a thermal switch located on the radiator. An additional resistance and a relay select the higher fan speed if the temperature gets too high.
The expansion tank tops-up the cooling system if the coolant level falls and absorbs the changes in the volume of the coolant due to changes in temperature. The expansion tank also ensures that air is bled from the system. The cooling system also includes an engine coolant temperature sender for the indicator and a maximum temperature thermal switch for the warning lamp which comes on when the temperature of the liquid exceeds ~ 118°C.

SYSTEM OPERATION

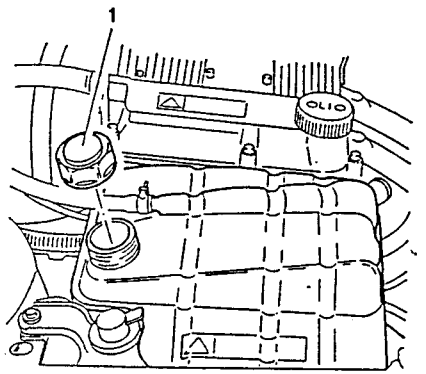
After the liquid has cooled the engine it reaches the thermostat unit. If the temperature is below 87°C, it is then sucked by the pump. If the temperature is above this value it is sent, via the opening in the thermostat, towards the radiator.
After being cooled by the radiator, the coolant returns once again to the pump which then channels it to the engine.
The circuit is also provided with a by-pass which passes through the throttle body keeping it at a constant temperature. It then returns to the expansion tank in order to remove the air from the system. Another by-pass supplies the air conditioning system heater.

CAUTION
The antifreeze mixture is harmful to paintwork. All contact with painted surfaces should be avoided.

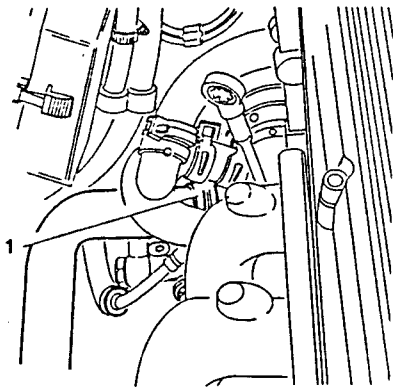
DRAINING THE HYDRAULIC SYSTEM

1. Unscrew and remove the cap from the expansion tank.

CAUTION
Never remove the cap from the expansion tank when the engine is warm!



1. Loosen the clamp securing the sleeve (delivering the engine coolant to the pump from the radiator) and disconnect the sleeve. Drain the coolant into a suitable container placed under the vehicle.

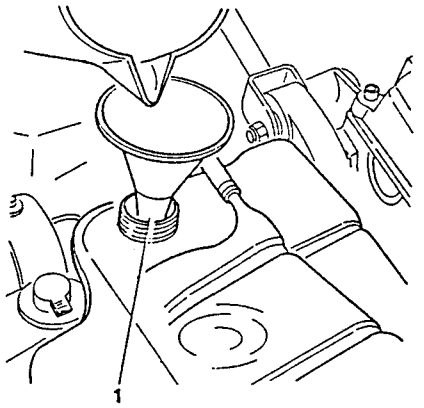


SERVICING THE HYDRAULIC SYSTEM

- Reconnect the radiator-water pump connecting sleeve along with any other previously disconnected hoses. Check that all the clamps are correctly tightened.

1. Service until the level of the liquid reaches the MAX mark on the expansion tank.
   The quality and approximate quantity of the coolant are given in the table below.

Minumum temperature		-40°C
Concentrated antifreeze	Alfa Romeo Antifreeze	4.6 litres (55%)
Distilled water		3.7 litres (45%)
Antifreeze ready for use	Alfa Romeo Climafluid Permanent -40°C	8.3 litres

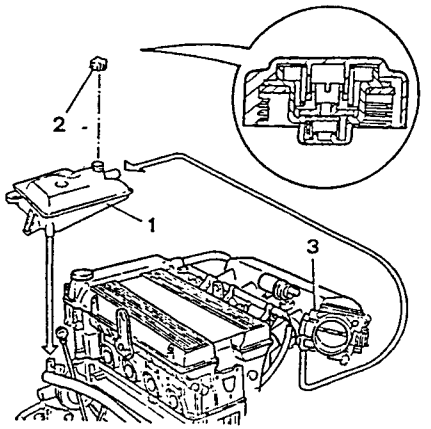


- Start the engine and run to normal operating temperature so that the opening of the thermostat will vent any air trapped in the circuit.
- When the engine is cold, top-up to the MAX level marked on the expansion tank.
- Screw on and tighten the expansion tank pressurized cap.

CAUTION
Do not mix different makes of antifreeze!
Do not use rust-proofing additives as they may not be compatible with the antifreeze used in the system!

EXPANSION TANK

The expansion tank supplies the circuit and absorbs the variations in coolant volume due to the changes in engine temperature.
The tank also allows air, collected through the pipe coming from the throttle body, to bleed from the system by way of a calibrated valve in the pressurized cap.
This valve also acts as a washing function enabling outside air to enter the system to compensate for the vacuum created as the system cools.

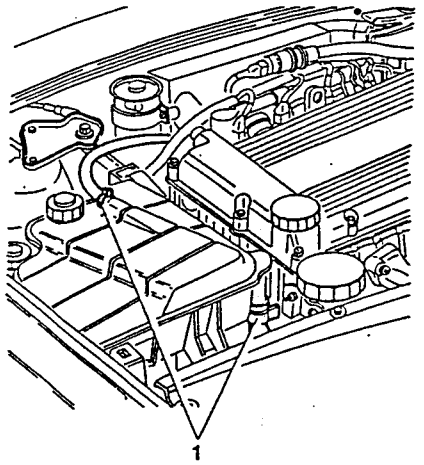


1. *Expansion tank*
2. *Pressurized cap*
3. *Throttle valve body*

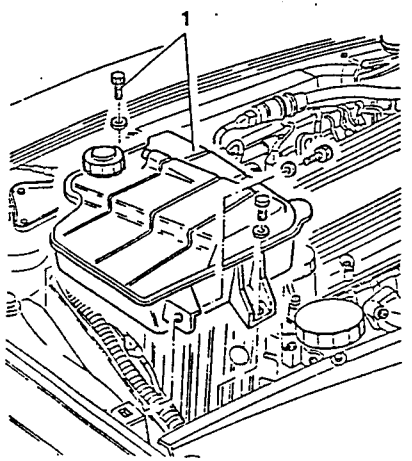
REMOVAL/REFITTING

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

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

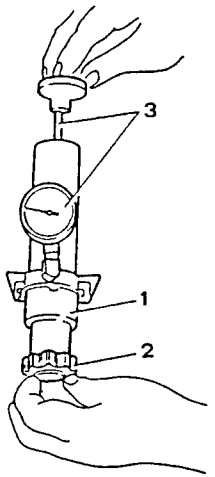


1. Unscrew the three screws and remove the expansion tank.



PRESSURIZED CAP SEALING TEST

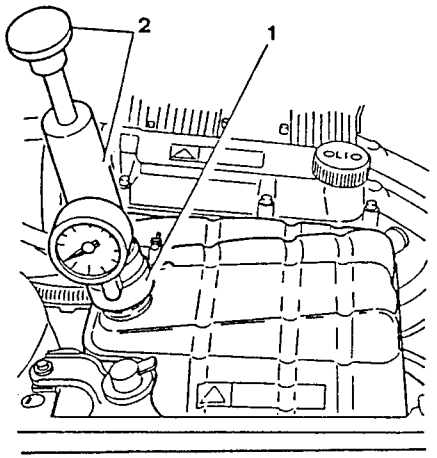
- Perform the test using a seal test tool.
1. Screw the fitting to the lower end of the test tool.
2. Install the expansion tank pressurized cap onto the fitting of the test tool.
3. Manually operate the piston of the test tool and pressurize the cap. Check that the valve opens at the specified pressure read from the manometer.



Pressurized cap setting
0.98 ± 0.1 bars (1 ± 0.1 kg/cm²)

HYDRAULIC SYSTEM PROOF TEST

- Unscrew and remove the pressurized cap from the expansion tank.
1. Screw the hydraulic system proof testing tool and relevant fitting onto the expansion tank filler neck.
2. Manually pressurize the circuit and check that the pressure is maintained at the specified value. If the pressure is incorrect, check that there are no leaks in the radiator or sleeves.



Hydraulic system test pressure
1.08 bars (1.1 kg/cm²)

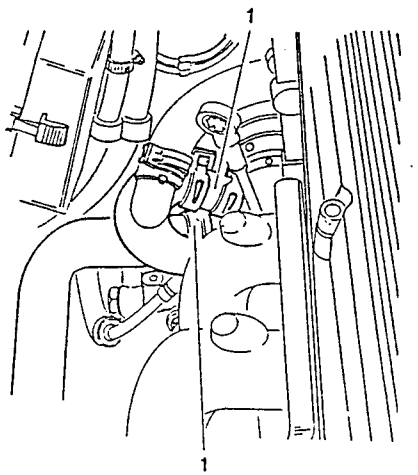
CAUTION
For safety reasons never let the pressure rise above 1.38 bars (1.4 kg/cm²) when testing with the testing tool.

WATER PUMP

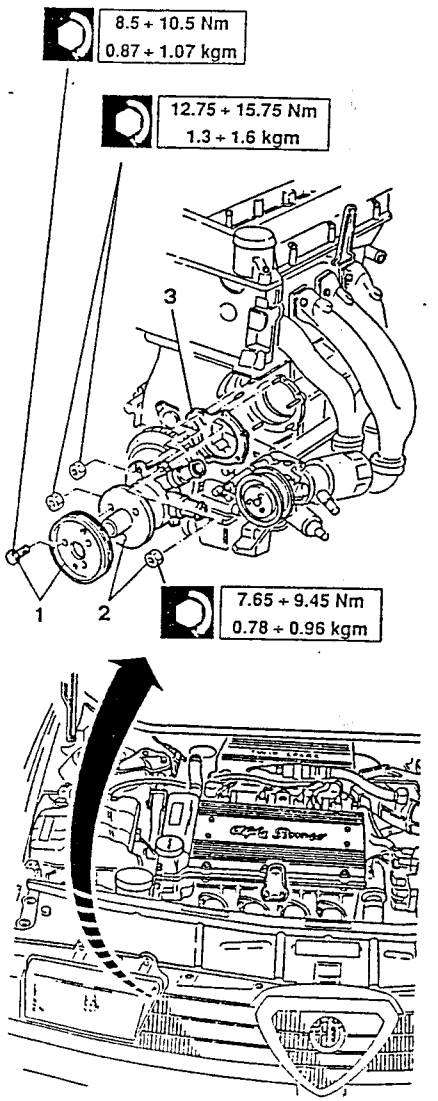
The water pump is of the centrifugal blade type. The pump body is made of aluminium alloy and the impeller of phenolic resin.
The pump is fixed to the engine block and actuated through a Poly-V drive belt by the crankshaft. A gasket seals the joint between the engine block and the pump.
The water pump operates constantly thus guaranteeing the continual circulation of the coolant.

REMOVAL/REFITTING

- Disconnect the negative cable from the battery.
- Drain off the hydraulic fluid (see relative paragraph)
- Remove the power steering pump-water pump drive belt (see GROUP 00).
1. Disconnect the sleeves returning the engine coolant to the pump.

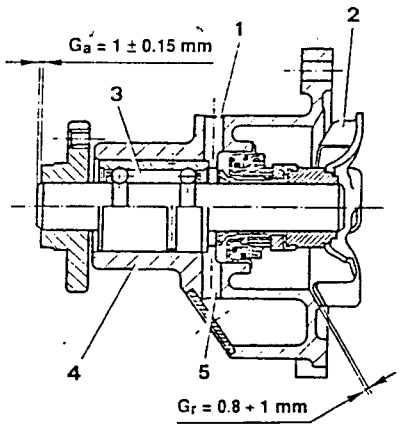


1. Remove the water pump drive pulley by unscrewing the three screws.
2. Unscrew the screws and remove the water pump.
3. Remove the gasket.



CHECKS AND INSPECTIONS

- Check that the pump body and impeller are in good condition and that there are no signs of oxidation or corrosion.
- Check that the axial clearance "Ga" of the water pump shaft is within the prescribed limits.
- Check that the clearance "Gr" between rotor and pump body is within the specified limits.



1. *Aeration hole*
2. *Impeller*
3. *Bearing*
4. *Pump body*
5. *Drainage hole*

- Check that the front gasket of the pump is in good condition and without leaks.
  NOTE: small leaks from the drainage hole of the pump are normal;
- check that the bearing does not show signs of wearing on the races and balls.

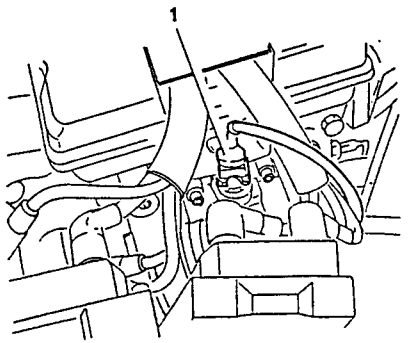
If any of these defects are detected, replace the entire pump.

THERMOSTAT UNIT

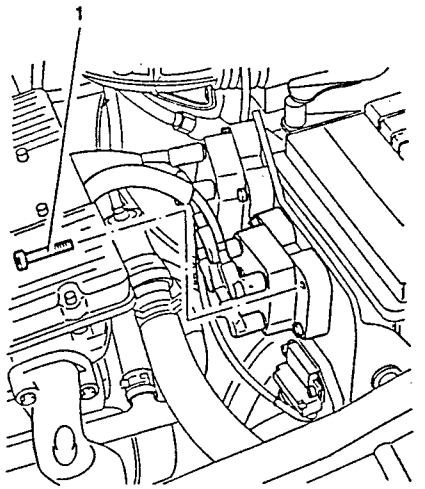
The thermostat unit is installed on the rear side of the cylinder heads.
It ensures that the engine does not exceed the optimal temperture. Until the temperature of the coolant reaches 87 ± 2°C, the thermostat valve deviates the liquid directly to the pump: at temperatures above this value the opening of the thermostat valve conveys the liquid to the radiator.
The thermostat is provided with a sensor (NTC) which measures the temperature of the coolant and sends it to the Motronic control unit.

REMOVAL/REFITTING

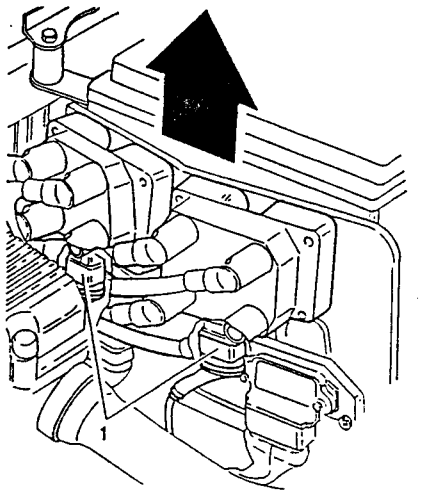
- Remove the negative cable from the battery.
1. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).



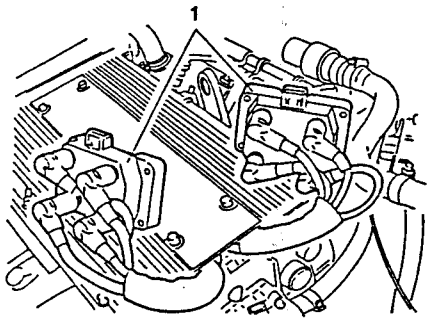
1. Unscrew the four screws securing the ignition coil.



1. Raise the ignition coils and disconnect them from the electrical connections.

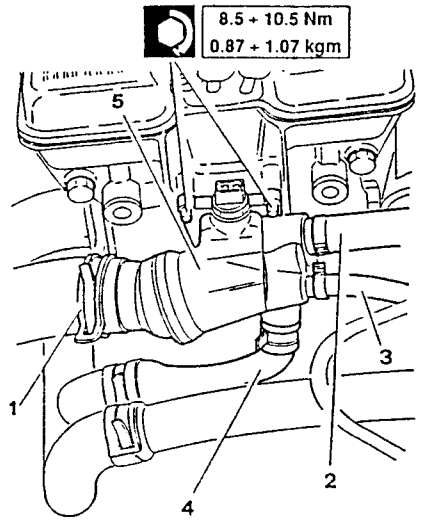


1. Place the ignition coil on the timing cover without disconnecting the spark plug cables.

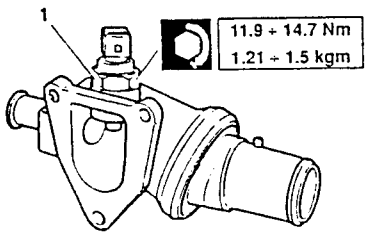


1. Disconnect the engine coolant to radiator delivery sleeve from the thermostatic cup.
2. Disconnect the engine coolant to heater delivery sleeve from the thermostatic cup.
3. Disconnect the engine coolant to throttle valve delivery sleeve from the thermostatic cup.
4. Disconnect engine coolant to rigid pipe (returning engine coolant to pump) from the thermostatic cup.
5. Unscrew the three screws and remove the thermostatic cup.

– Remove the gasket.



1. On a bench, remove the engine coolant temperature sensor (NTC).



CHECKS AND INSPECTIONS

Check the setting of the thermostat by operating as follows:

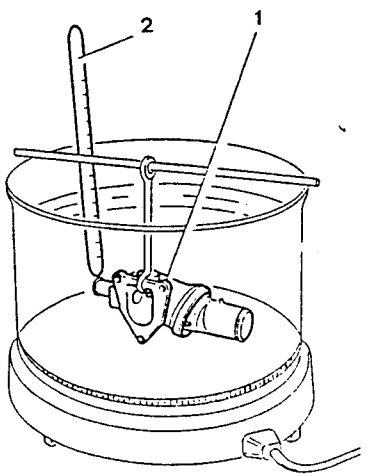
1. Hang the thermostat in a container full of water and heat the water.
2. Using a thermometer check that the temperatures at which opening is initiated and completed correspond to the values indicated in the table.

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

Also check that the total bulb travel is the same as that indicated in the table.

Thermostat setting	
Opening begins	87 ± 2°C
Fully open	101°C
Total bulb travel	9.5 mm

If the correct values are not obtained replace the thermostat.



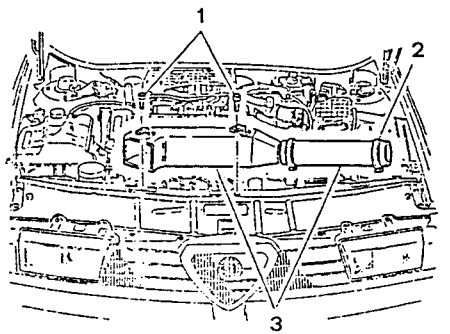
RADIATOR

The size of the radiator is such that it can fulfill the requirements of heat dissipation during operation of the engine.
It is composed of a radiator core (radiating frontal surface 18.28 dm^2) and two side tanks provided with fittings for the inlet and outlet of the coolant. The pipes and fins of the radiating core are made of aluminium and the tanks of plastic.

REMOVAL/REFITTING

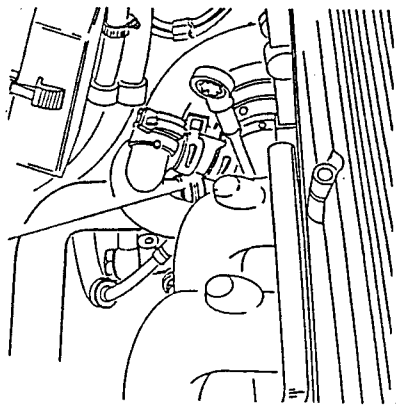
– Place the vehicle on a lift.
– Disconnect the negative cable from the battery.
– Drain off the air conditioning freon in accordance with the current regulations (see GROUP 80).

1. Unscrew the two screws securing the air intake duct to the crossmember.
2. Loosen the clamp securing the air intake sleeve to the air cleaner box.
3. Remove the duct-air intake sleeve assembly.

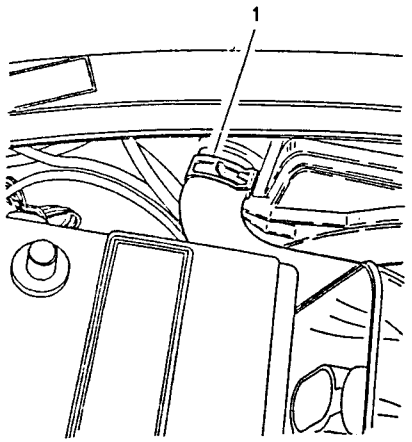


1. Disconnect the engine coolant from radiator return sleeve from the water pump and drain the coolant into a suitable container.

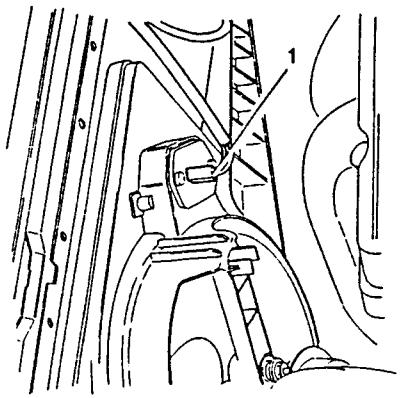
CAUTION
The anti-freeze used as an engine coolant is damaging to paintwork. Avoid all contact with painted parts.



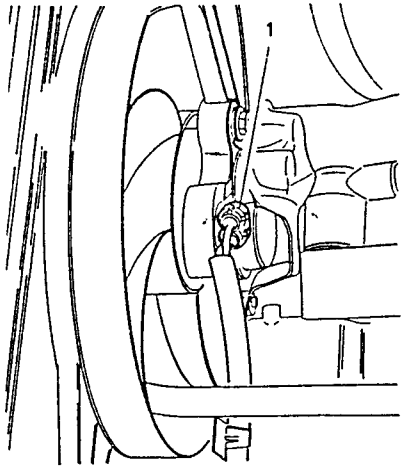
1. Disconnect the engine coolant from thermostatic cup delivery sleeve from the radiator.



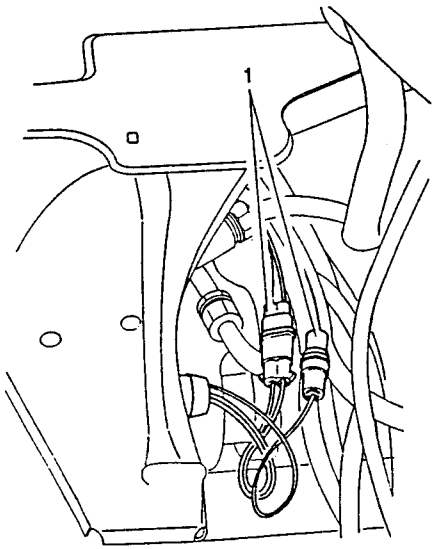
1. Disconnect the electrical connection of the electric fan resistance.



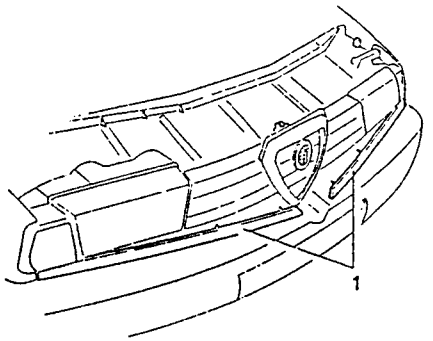
1. Disconnect the electrical connection from the engine cooling fan.



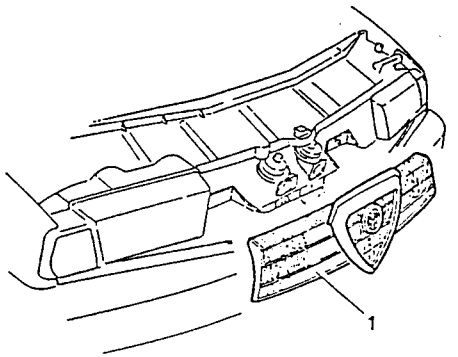
1. Disconnect the two electrical connections from the electric fan control thermocontact.
– Move the electrical wiring to one side after removing it from the clamps.



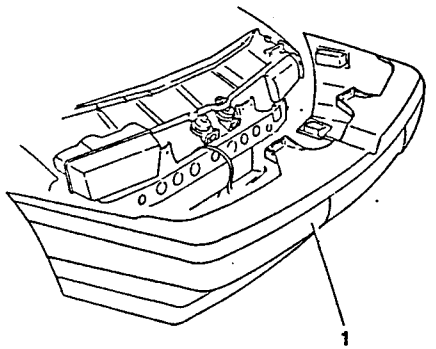
1. Remove the central part of the finishing trim from the front grill.



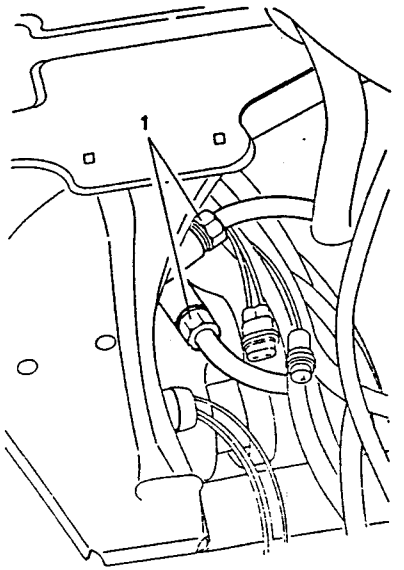
1. Remove the front grill (see GROUP 75).



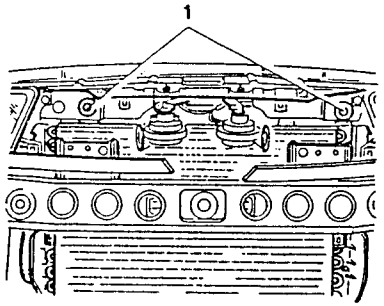
1. Remove the front bumper (see GROUP 75).



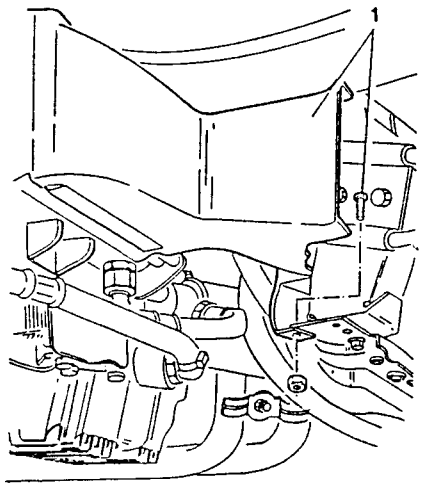
– Raise the vehicle.
1. Disconnect the two inlet and outlet connections carrying the freon from the air conditioning condenser.



1. Unscrew the two upper screws securing the radiator.

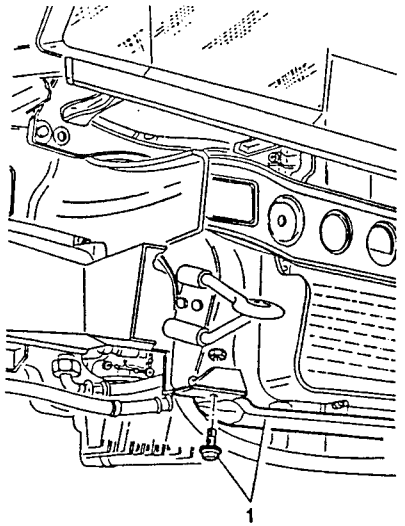


1. Unscrew the screw securing the oil radiator conveyor to the lower crossmember.

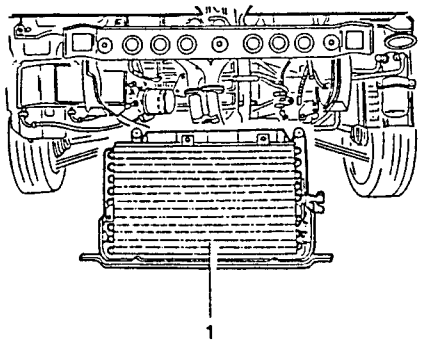


- Withdraw the two power steering system oil hoses from the clamps on the lower crossmember.

1. Unscrew the two screws securing the lower crossmember to the body.

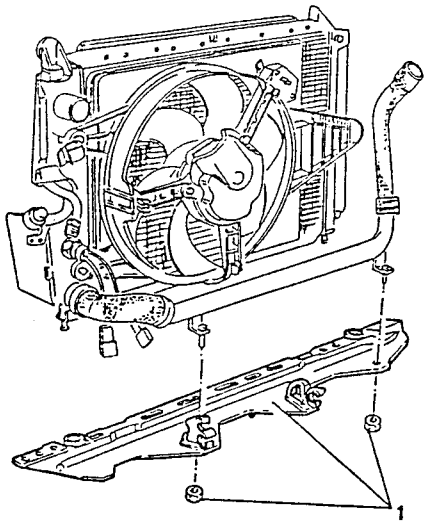


1. Remove the radiator, condenser, electric fan and lower crossmember assembly by pulling it downwards.

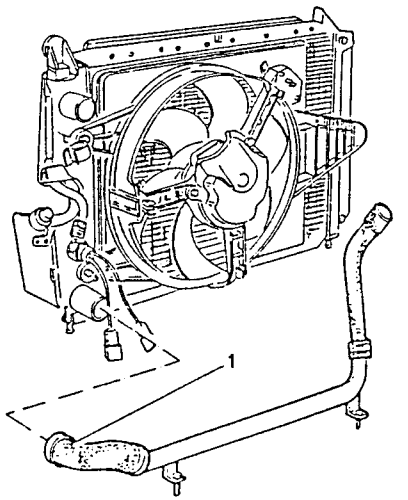


DISASSEMBLY

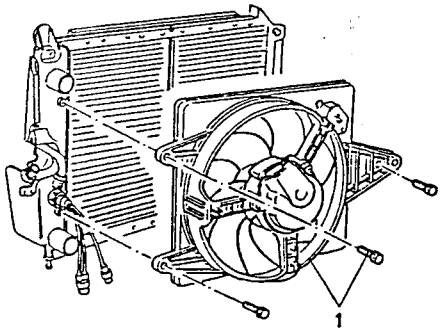
1. Unscrew the two nuts and remove the lower crossmember.



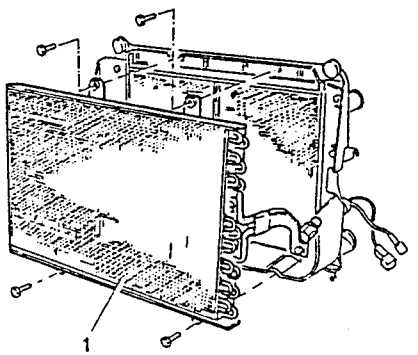
1. Disconnect the engine coolant to water pump return hose from the radiator.



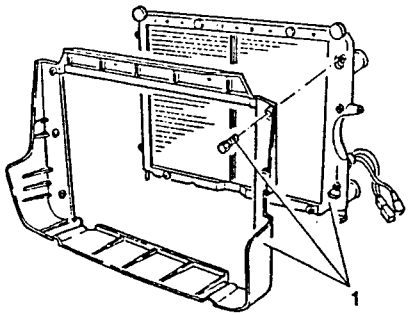
1. Unscrew the three screws and remove the complete electric fan.



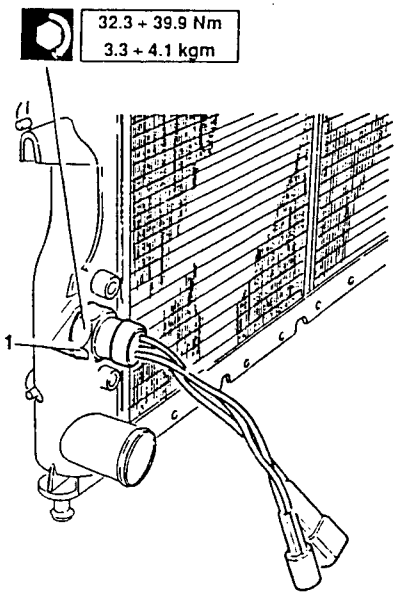
1. Unscrew the four screws and remove the air conditioning condenser.



1. Unscrew the six screws and separate the air conveyor from the radiator.



1. Remove the electric fan control thermocontact from the radiator.

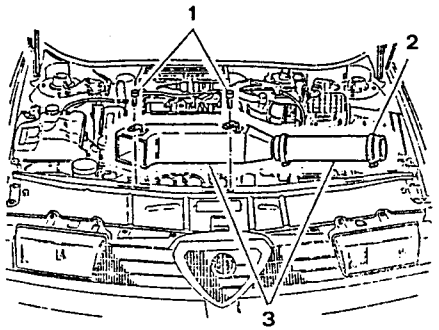


ELECTRIC COOLING FAN

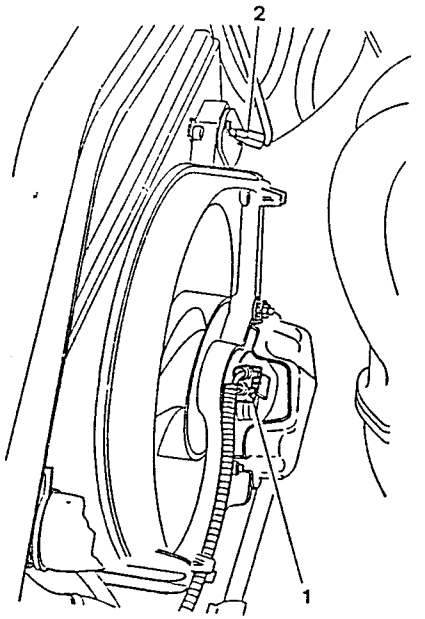
The two-speed electric cooling fan increases the radiator heat exchange capability.
A double threshold thermocontact, the first contact of which is set at 92°C and the second, by way of an additional resistance at 97°C, activates the fan at the two different speeds.

REMOVAL/REFITTING

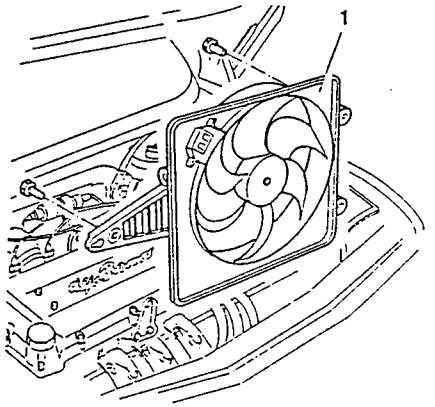
– Disconnect the negative cable from the battery.
1. Unscrew the two screws securing the air intake duct to the crossmember.
2. Loosen the clamp securing the air intake sleeve to the air cleaner box.
3. Remove the duct-air intake sleeve assembly.



1. Disconnect the electrical connection from the fan.
2. Disconnect the electrical connection from the fan resistance.

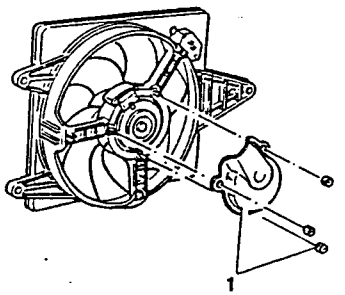


1. Unscrew the three screws and remove the complete electric cooling fan.

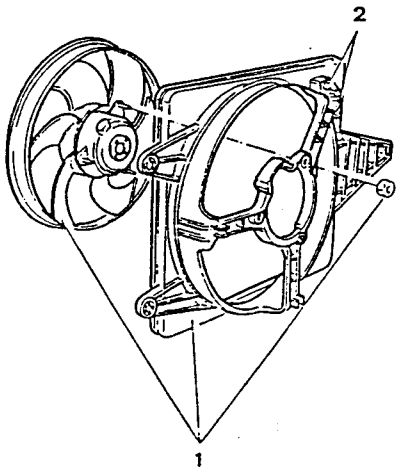


DISASSEMBLY

1. Unscrew the three nuts and remove the heat shielding.



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



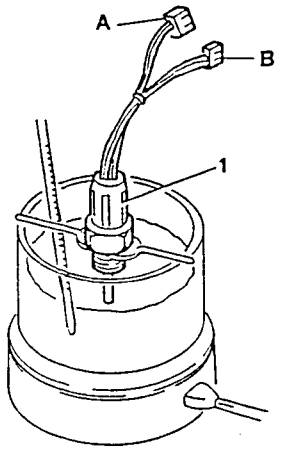
ELECTRIC COOLING FAN THERMOCONTACT

Check the setting of the thermocontact by operating as follows:

- Remove the thermocontact from the radiator.

1. Hang the thermocontact in a container full of water and heat the water.

- Using a thermometer and a multimeter, check that the contact closes on the two pins (of connector A) at the 2nd speed cut-in temperature.
- In the same way check that the thermocontact closes between the pins of connector A and B at the 2nd speed cut-in temperature.



CAUTION
Neither the thermometer or the thermocontact must touch the bottom of the container.

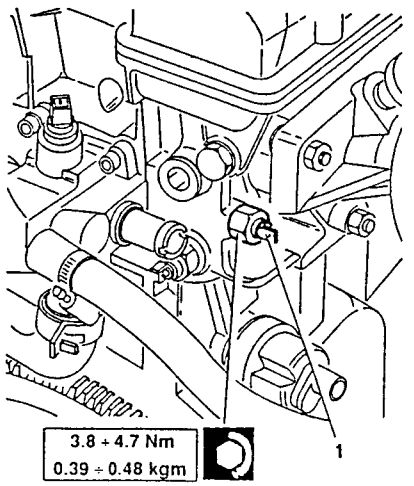
Electric fan cut-in temperature	
1st speed	92 ± 2°C
2nd speed	97 ± 2°C

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

ENGINE COOLANT MAXIMUM TEMPERATURE WARNING LIGHT SENSOR

1. Check the setting of the engine coolant maximum temperature warning light sensor. If it is incorrect, replace the sensor.

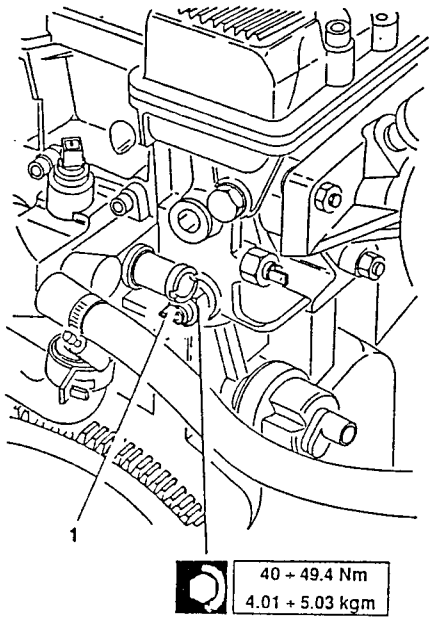
Closing temperature	118 ± 4°C
Reopening temperature	110°C



ENGINE COOLANT TEMPERATURE SENDER

1. Check the setting of the engine coolant temperature sender. If the values are incorrect, replace the sender.

Temperature (°C)	Resistance (Ω)
40	900 to 1400
60	470 to 600
80	235 to 300
90	175 to 215
100	135 to 165
120	80 to 100



TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

COOLING SYSTEM

Hydraulic circuit control pressure	1.08 bars (1.1 kg/cm^2)
Pressure setting or pressurized cap	0.98 ± 0.1 bars (1 ± 0.1 kg/cm^2)

WATER PUMP

Axial play on water pump shaft	Ga = 1 ± 0.15 mm
Play between rotor and pump body	Gr = 0.9 ± 0.1 mm

THERMOSTAT

Temperature at start of opening	87 ± 2° C
Temperature when fully open	101° C
Total bulb stroke	9.5 mm

ELECTRIC FAN

Temperature of cut-in at 1st speed	92 ± 2° C
Temperature of cut-in at 2nd speed	97 ± 2° C

ENGINE COOLANT MAXIMUM TEMPERATURE WARNING LIGHT SENSOR

Closing temperature	118 ± 4°C
Reopening temperature	≥ 110°C

ENGINE COOLANT TEMPERATURE SENDER

Temperature (°C)	Resistance of thermistors (Ω)
40	900 ÷ 1400
60	470 ÷ 600
80	235 ÷ 300
90	175 ÷ 215
100	135 ÷ 165
120	80 ÷ 100

ENGINE COOLANT

Minimum temperature		-40°C
Concentrated antifreeze	Alfa Romeo Antifreeze	4.6 litres (55%)
Distilled water		3.7 litres (45%)
Antifreeze ready for use	Alfa Romeo Climafluid Permanent -40°C	8.3 litres

TIGHTENING TORQUES

PART	Nm	kgm
Nuts securing water pump to engine block	12.75 ÷ 15.75	1.3 ÷ 1.6
Nuts securing water pump to front cover	7.65 ÷ 9.45	0.78 ÷ 0.96
Screws securing thermostat group to cylinder head	8.5 ÷ 10.5	0.87 ÷ 1.07
Screws securing water pump pulley	8.5 ÷ 10.5	0.87 ÷ 1.07
Engine coolant temperature sender	40 ÷ 49.4	4.01 ÷ 5.03
Engine coolant maximum temperature warning light sensor	3.8 ÷ 4.7	0.39 ÷ 0.48
Engine coolant temperature sensor (NTC)	11.9 ÷ 14.7	1.2 ÷ 1.5
Electric fan thermocontact	32.3 ÷ 39.9	3.3 ÷ 4.1

FAULT DIAGNOSIS AND CORRECTIVE INTERVENTIONS

FAULTS AND SYMPTOMS	CHECK	TEST REFERENCE
LOSS OF ENGINE COOLANT - (If shown by low level of engine coolant and white-green sediment around the site of the leak)	- If the loss is not evident carry out the "HYDRAULIC CIRCUIT PROOF TEST"	A
ENGINE OVERHEATING	- Start the engine and run it to normal operating temperature. - When the temperature is excessively high the warning light and indicator on the instrument panel will come on. NOTE: **In cases where the warning light and temperature indicator are broken, a valve located on the expansion tank will release the high pressure created within the cooling system.** CAUTION: **Dusty or muddy roads or air containing pollen or small insects may block the front area of the engine cooling device and reduce the cooling capacity leading to overheating of the engine.**	B

LOSS OF ENGINE COOLANT	TEST A

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
A1 CHECK CLAMPS – Check that the clamps are not loose, damaged, incorrectly installed or of the wrong size.	OK ▶ ~~OK~~ ▶	Proceed to **phase A2** Tighten or replace the faulty clamps
A2 CHECK GASKETS, SLEEVES AND PLUGS – Check that the gaskets, sleeves, unions and plugs are not leaking	OK ▶ ~~OK~~ ▶	Proceed to **phase A3** Replace the faulty elements
A3 CHECK RADIATOR – Check that the radiator is not leaking	OK ▶ ~~OK~~ ▶	Proceed to **phase A4** Replace the radiator
A4 CHECK EXPANSION TANK – Check that the expansion tank is not leaking from around the cap or through the drainage valve.	OK ▶ ~~OK~~ ▶	Proceed to **phase A5** Replace the tank if damaged

(CONTINUES)

LOSS OF ENGINE COOLANT	TEST A

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
A5 CHECK GASKETS – Check tht there are no leaks from around the coolant pump gaskets or from the thermostat group	OK ▶ ~~OK~~ ▶	Proceed to **phase A6** Replace the gasket between the pump and the engine or the gaskets between the engine and the thermostat unit
A6 CHECK PUMP AND THERMOSTAT GROUP – Check that there are no cracks or other defects on the water pump or thermostat group	OK ▶ ~~OK~~ ▶	Proceed to **phase A7** Replace the faulty parts
A7 CHECK CYLINDER HEADS – Check that the cylinder heads are tightened to the correct torque. If the torque is incorrect, check the condition of the cylinder head gaskets	~~OK~~ ▶	Tighten the screws to the correct torque or replace the gaskets of the cylinder heads. (In this case check that the engine oil has not been contaminated by engine coolant)

End of test A

ENGINE OVERHEATING	TEST B

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
B1 CHECK WARNING LIGHT AND INDICATOR – Check that the engine coolant temperature warning light and indicator on the instrument panel and the senders on the engine are functioning correctly - see ELECTRICAL - ELECTRONIC DIAGNOSIS	OK ▶ ~~OK~~ ▶	Proceed to phase B2 Repair or replace the faulty parts
B2 CHECK LEVEL OF ENGINE COOLANT – Check the level of the engine coolant	OK ▶ ~~OK~~ ▶	Procced to phase B3 Top-up the system to the correct level. Check tightness of the circuit
B3 CHECK LEVEL OF ENGINE OIL – Check the level of the engine oil	OK ▶ ~~OK~~ ▶	Proceed to phase B4 Top-up the engine oil to the correct level (see GROUP 00)
B4 CHECK BELT – Check that the water pump drive belt is correctly tensioned and that it is not worn	OK ▶ ~~OK~~ ▶	Proceed to phase B5 Tighten the belt to the correct value or replace it if it is damaged or excessively worn (see GROUP 00)

(CONTINUES)

ENGINE OVERHEATING	TEST B

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
B5 CHECK ENGINE COOLING FAN – Check functioning of the electric cooling fan (see ELECTRICAL - ELECTRONIC DIAGNOSIS)	OK ▶ ~~OK~~ ▶	Proceed to phase B6 Replace the cooling fan or the faulty elements from the corresponding electrical system
B6 CHECK THERMOCONTACT – Check the setting of the cooling fan thermocontact	OK ▶ ~~OK~~ ▶	Proceed to phase B7 Replace the thermocontact
B7 CHECK DUCTS – Check that there are no obstructions in the coolant ducts: visually check that the sleeves are not squashed or bent	OK ▶ ~~OK~~ ▶	Proceed to phase B8 Restore or renew the affected ducts
B8 CHECK FLOW OF ENGINE COOLANT – Check that the coolant flows freely in the ducts by manually pumping it in the tubes and checking the agitation of the fluid in the expansion tank	OK ▶ ~~OK~~ ▶	Proceed to phase B9 Clean the obstructed duct with specific detergent: ensure that the engine coolant is of the correct type

(CONTINUES)

ENGINE OVERHEATING	TEST B

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
B9 CHECK RADIATOR – Check that the radiator is not encrusted and that it contains no foreign particles	OK ▶ ~~OK~~ ▶	Proceed to **phase B10** Wash the radiator with specific detergent: ensure that the engine coolant is of the correct type
B10 CHECK COOLANT PUMP – Check the condition and correct functioning of the water pump	OK ▶ ~~OK~~ ▶	Proceed to **phase B11** Replace pump and seal
B11 CHECK THERMOSTAT – Run the engine to operating temperature and touch the duct between the thermostat and radiator: check that it gradually heats up	OK ▶ ~~OK~~ ▶	Proceed to **phase B12** Replace the thermostat unit and relative gasket
B12 CHECK THERMOSTAT – Check the correct setting of the thermostat	OK ▶ ~~OK~~ ▶	Proceed to **phase B13** Replace the thermostat unit and relative gasket

(CONTINUES)

ENGINE OVERHEATING	TEST B

TEST PROCEDURE	RESULT	CORRECTIVE ACTION
B13 CHECK TIMING – Check engine timing	~~OK~~ ▶	Adjust engine timing

End of TEST B

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REPAIR MANUAL

• ENGINES

- Engine 2492 cm^3 (code AR 67301)

GROUP 01 - ENGINE MAIN MECHANICAL UNIT

GROUP 04 - FUEL SYSTEM

GROUP 05 - ENGINE IGNITION, STARTING AND CHARGING

GROUP 07 - ENGINE COOLING SYSTEM

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GROUP 01

ENGINE

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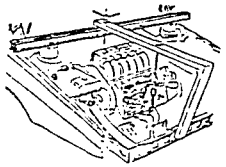
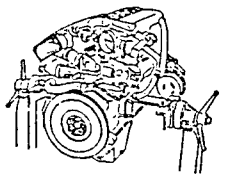
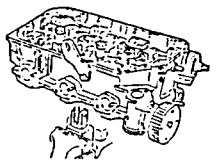
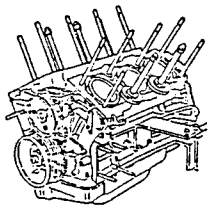
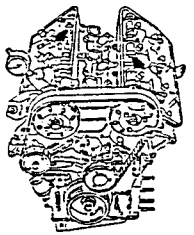
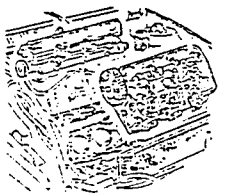












ENGINE

GENERALITIES

The engine is of the six 60° V mounted cylinder type in light alloy and has a total cubic capacity of 2492 cm^3 with static ignition and injection controlled by a single BOSCH MOTRONIC M 1.7 control unit.
From a dynamic point of view the "V" arrangement and the 60° angle make the engine extremely compact and well balanced.
With a piston stroke of 68,3 mm and a bore of 88 mm, the engine is of the super square type (stroke and bore ratio lower than 1), which permits a better arrangement of the valves and an optimal filling of the cylinders (high volumetric ratio).
The clutch-gearbox-transmission assembly is connected towards the rear of the engine and forms and integral part of the engine.
The engine is installed in the front of the vehicle and is arranged transversally with a 14° inclination forwards. It is supported by "suspended" type attachments and fixed to the body by two supports with flexible damping and to the suspension cross member by a third.
To reduce the shaking of the engine to a minimum, a retaining rod is mounted on the body.
The engine described below conforms to the "USA 83" exhaust emissions limits.

STRUCTURE

Engine block:

a single block in light aluminium and silicon alloy with high mechanical resistance and thermal conductivity.
The crankshaft is supported by five main supports.
Grooves in the wall of the engine block permit the passage of the cooling liquid and oil.
Jets which spray oil to cool the pistons are located at the base of the cylinders.

Cylinder liners:

these, in cast iron, are of the low-slung type and are directly reached fromthe outside by the cooling liquid for a more rational heat dissipation (humid).
The dimensions of the cylinder liners permits the gas to be contained and avoids deformation.
The cylinder liners are already coupled with their relative pistons when supplied and are divided into three dimensional classes.

Cylinder heads:

these are of the monilithic type, compact fused in shell of aluminium and silicon alloy.
The 47° "V" position of the valves gives the combustion chamber and optimal configuration.
Each cylinder head is supported by a camshaft for the intake valves and a system of rods and rocker arms for the control of the exhaust valves.

Oil sump:

this is of light aluminium formed by die-casting and is completely surrounded by anti-lapping panels.
A gasket with a silicon rubber insert is fitted between the sump and the engine block.

ORGANS OF MOVEMENT

Crankshaft:

this is forged in high resistance light alloy steel and soft nitrided, a treatment which increases reliability (resistance to stress).
It rests on four main supports and is shouldered on the rear main support.
Nine counterweights accurately balance the rotating parts.
A groove runs along the inside of the shaft for the lubrication of the main and crankpins.

Rod and main half bearings:

these are of the trimetal soft shell type and are divided into three dimensional classes for the main bearing halves, and into two for the rod half bearings.

Flywheel:

this is in cast iron with a suitably balanced integral applied ring gear in hardened steel.

Pistons and rods:

the pistons are in sillicon alluminium alloy and are divided into three dimensional classes. For correct assembly an arrow indicating the direction of engine rotation is stamped onto the ceiling:
the rods are in tempered alloy steel with a copper alloy bushing fixed to couple with the piston gudgeon pin.

AUXILLARY ORGANS

Timing:

this is conferred by two camshafts in hardened, cemented alloy steel, one for each row of cylinders.
The camshafts are controlled by a toothed belt, with a hydraulic tensioner which regulates and automatically maintains belt tension.
The shaft acts directly on the intake valves by way of the camms and on the exhaust valves by way of rods and rocker arms.
On the intake the tappets are of the "light" mechanical type, made up of a valve cup in hardened alloy steel in contact with the cams.
Valve cup control is transmitted to the valve through a cap in hardened, carbonitrided steel used for the regulation of valve play.
On the exhaust, timing occurs through a valve cup in hardened alloy steel which, in direct contact with the cam, transmits movement to the valves by way of a system of rod-rocker arm.
The regulation of valve play is carried out, using a suitable tool, by acting on a screw which in turn acts directly on the tappet rods.

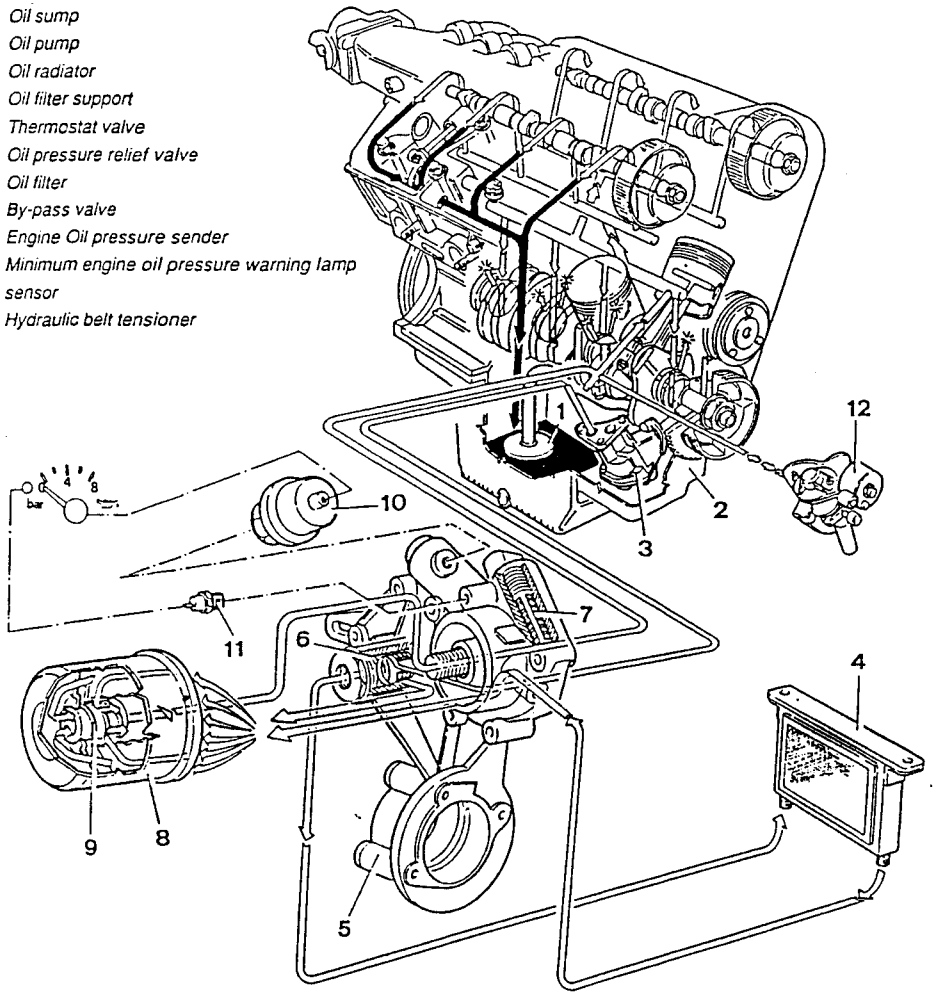
LUBRICATION

The lubrication system is pressurized by a rotating lobe type pump attached to the lower inner side of the engine block. The oil pump is driven by a toothed timing belt by way of a pulley and a shaft.
A pressure relief valve controls the pressure of the system. During suction the oil is filtered by a screen filter located on the suction body and is then filtered by a replaceable filter element on the supply line.
A longitudinal central oil hole in the engine block makes it possible to lubricate the crankshaft, the pistons and the rods.
Another two passages make it possible to lubricate the cylinder heads and as a result, all the components of the engine timing system. In addition, the oil lubricates the toothed timing belt hydraulic tensioner.
A recirculation system and vapour separator allows the oil vapours to be recovered from the right-hand cylinder head. The lubricating pressure is indicated by a pressure gauge located on the instrument panel and a warning lamp alerts the driver when the oil pressure is too low.
Pressure signals are supplied by a sender and a thermal switch located on the oil filter support.
The temperature of the oil is indicated on the instrument panel and receives a signal from a sender mounted on the engine block.
An oil level sensor located to one side of the oil dipstick provides the input signal for the illumination of the low oil level warning lamp located on the instrument panel.
The oil filler cap is located on the timing cover of the left hand cylinder head.

- The lubrication system is equipped with a radiator for cooling the engine coolant and a thermostat valve located in the oil filter support.
  With a temperature below 82 ± 2°C, the oil passes to the cartridge filter and returns to the engine; with a temperature in excess of the above value the thermostat valve is opened and lets the oil flow to the radiator to be cooled.
- In order to cool the piston skirt more efficiently jets in the engine block are fitted with an incorporated valve which opens at a pressure of **1.25 to 1.75 bars.**

LUBRICATION SYSTEM

1. *Suction device*
2. *Oil sump*
3. *Oil pump*
4. *Oil radiator*
5. *Oil filter support*
6. *Thermostat valve*
7. *Oil pressure relief valve*
8. *Oil filter*
9. *By-pass valve*
10. *Engine Oil pressure sender*
11. *Minimum engine oil pressure warning lamp sensor*
12. *Hydraulic belt tensioner*



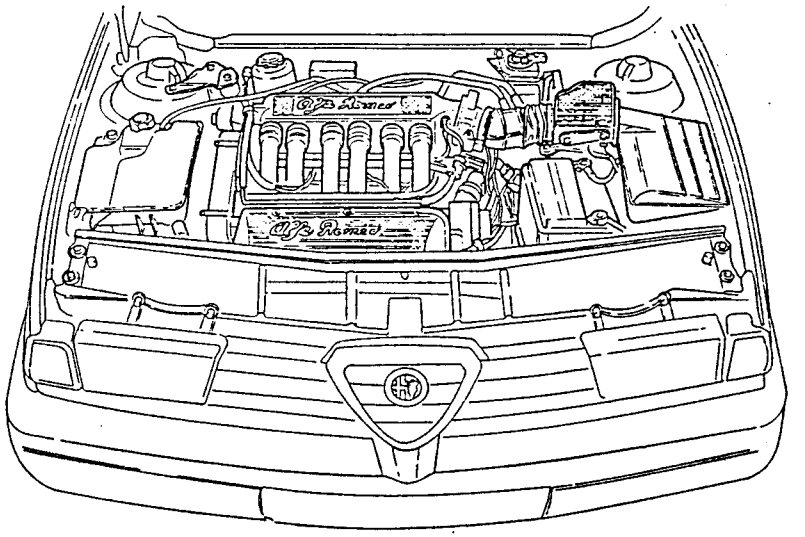
ENGINE REMOVAL/ INSTALLATION

The information and illustrations given below permit a rapid removal of the complete engine from its housing in the engine compartment, and its subsequent re-installation.

Bench disassembly of the single components is described in a separate chapter.

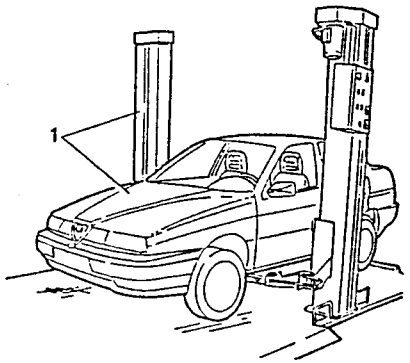
This procedure is considered to be single and complete, nevertheless, parts of the procedure can be used as required.

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

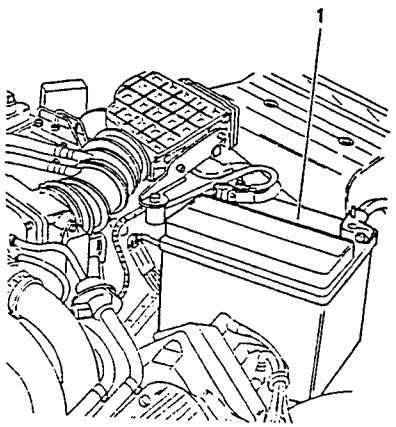


REMOVAL

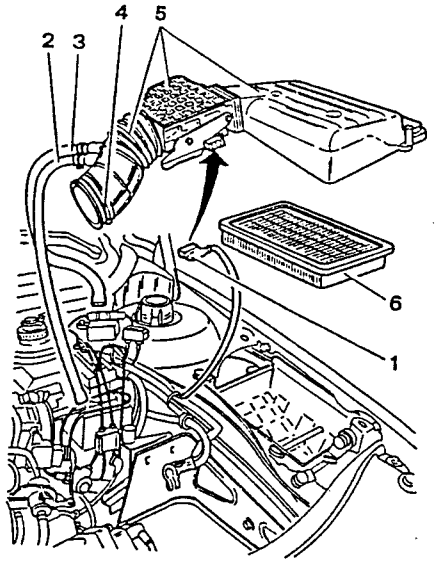
1. Place the vehicle on a lift and release the pressure in the fuel supply system as follows:
- disconnect the fuel pump supply fuse;
- start the engine and run until it stops.



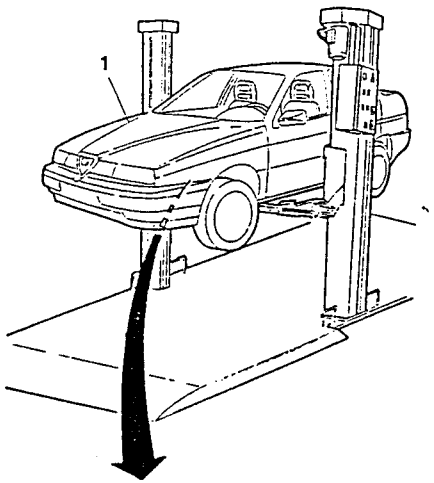
- Drain the freon from the heating/ventilation system in accordance with the current laws (see GROUP 80).
1. Disconnect the negative lead (-) and then the positive lead (+) from the battery and remove the battery.

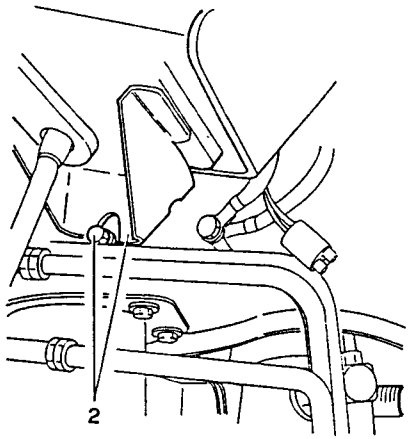


1. Disconnect the air flow meter electrical connection.
2. Disconnect the oil vapour recirculation hose from the oil vapour separator.
3. Disconnect the air intake box hose from the constant idle speed actuator.
4. Loosen the clamp securing the corrugated sleeve to the air intake box.
5. Remove the group consisting of air cleaner cover, air flow meter and corrugated sleeve.
6. If necessary, remove the filter element.

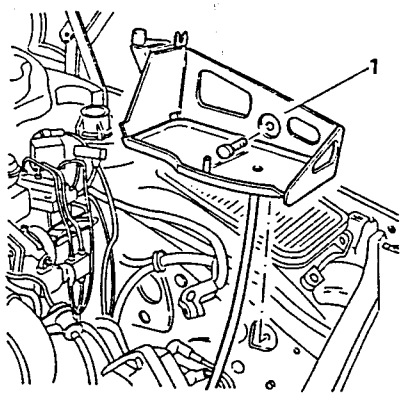


1. Raise the vehicle.
2. Loosen the lower screws securing the battery support to the body.



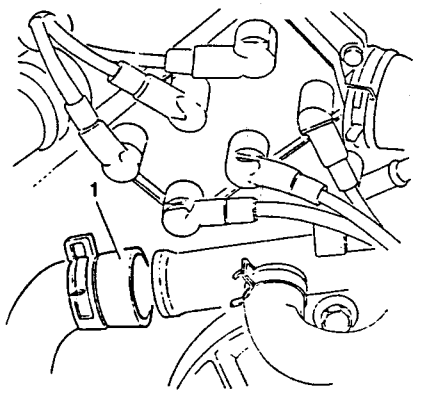


- Lower the vehicle.
1. Unscrew the remaining 3 screws securing the battery support to the body and remove it.

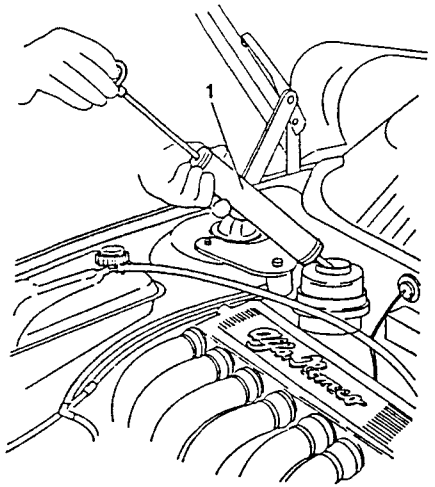


1. Remove the expansion tank cap, disconnect the radiator outlet sleeve and drain the engine coolant into a suitable container.

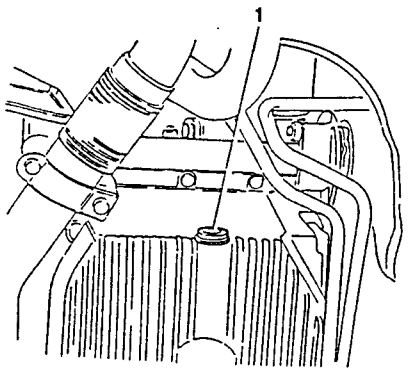
CAUTION
The antifreeze mixture used as engine coolant is harmful to paintwork; avoid all contact between antifreeze and paintwork.



1. Empty the power steering oil tank using a suitable syringe.

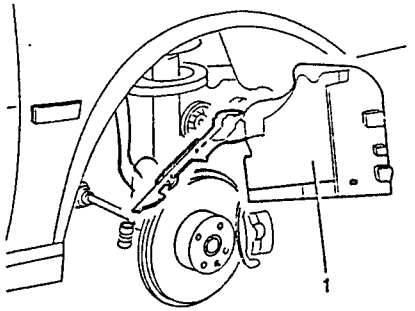


1. Drain off the engine oil by unscrewing the reltive cap on the oil sump (see GROUP 00).

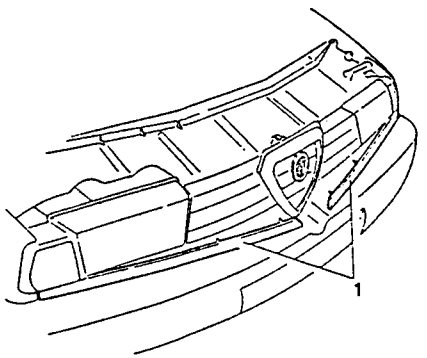


– Remove the front wheels.

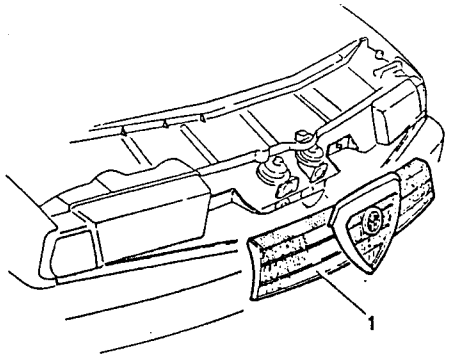
1. Remove the central engine protection covers through the right and left wheel arches.



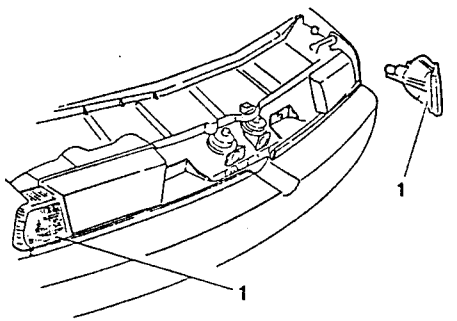
1. From the centre, detatch the two strips of grill trim.



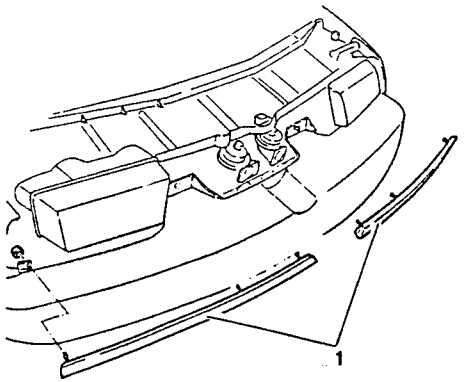
1. Remove the grill (see GROUP 75).



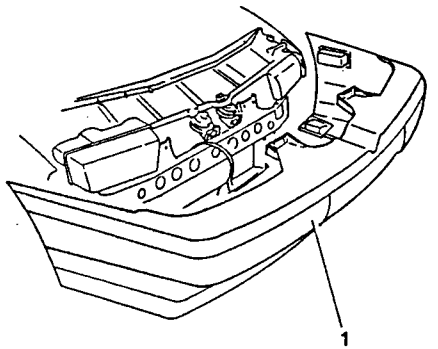
1. Remove the front direction indicators (see GROUP 40).



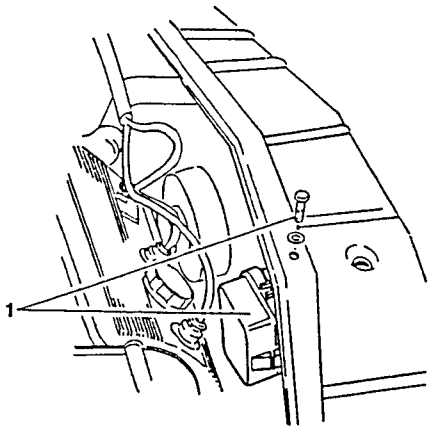
1. Unscrew the side nut securing the two strips of trim to the body and remove them.



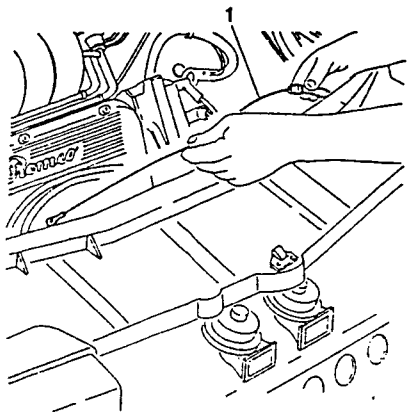
1. Remove the front bumper (see GROUP 75)



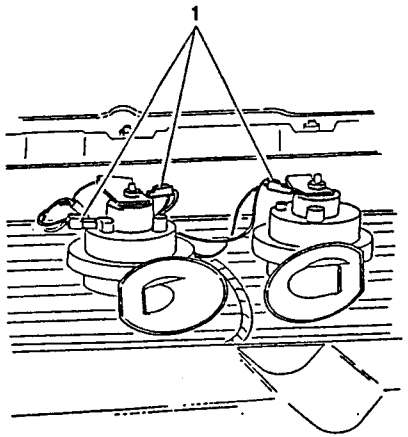
1. Unscrew the screws securing the relay box to the cross member. Move the relay box and tie it so that it does not interfere with the removal of the engine.



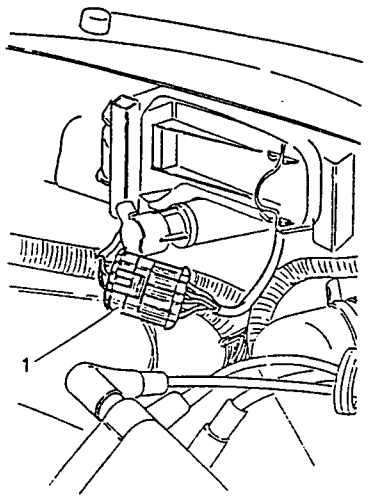
1. Disconnect the bonnet release cable from the two locks (see GROUP 56).



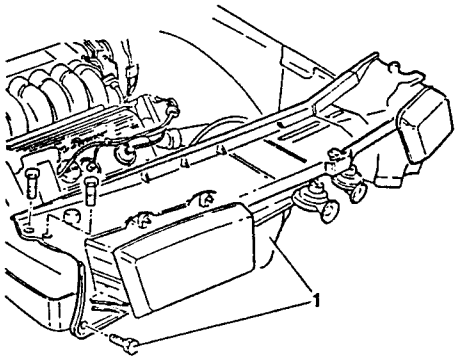
1. Disconnect the electrical connections from the horns.



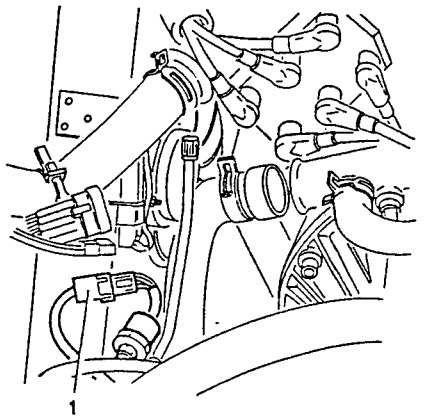
1. Disconnect the electrical connections from the headlight assemblies.



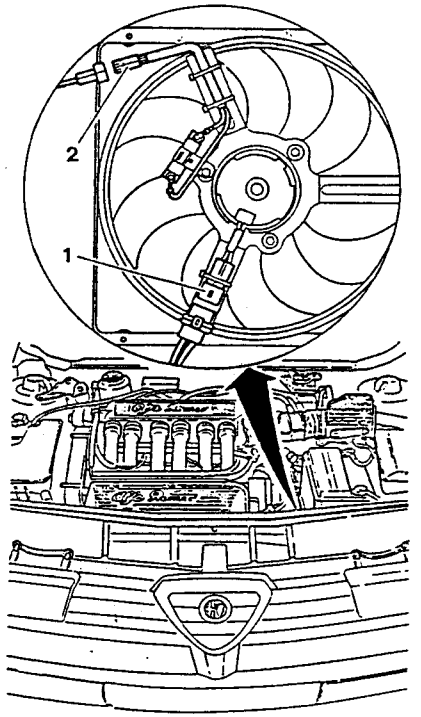
1. Unscrew the screws fixing the upper cross member to the body and remove it complete with headlights and horns.



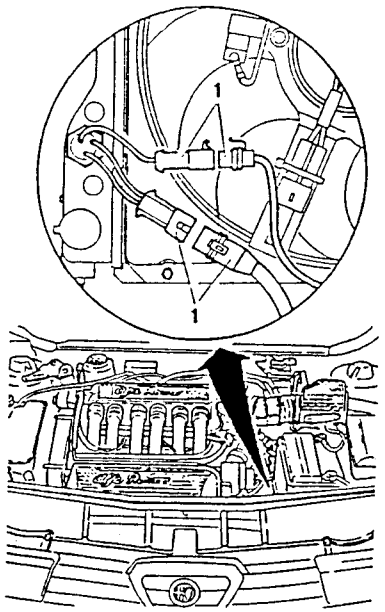
1. Disconnect the pressure switch (trinary) connection of the air conditioning system.



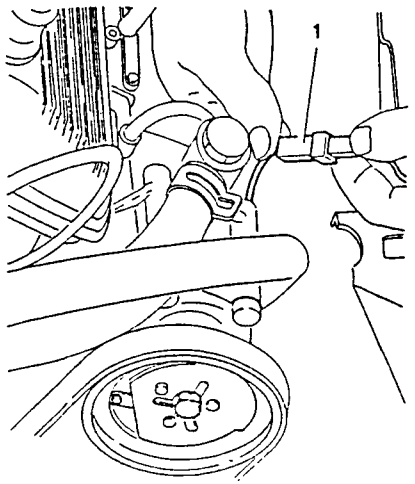
1. Disconnect the electrical connections from the electric cooling fan.
2. Disconnect the electrical connections from the electric fan resistor.



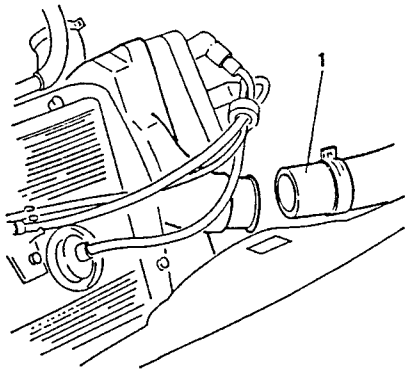
1. Disconnect the two connections of the engine cooling fan thermal contact.



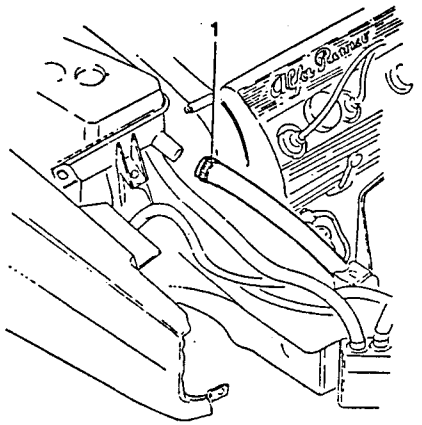
1. Disconnect the supercharger supply cable connection of the conditioning system.



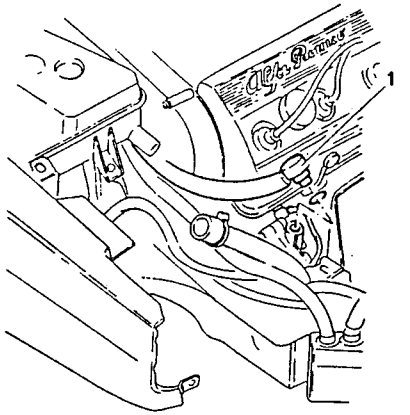
1. Disconnect engine coolant to radiator connecting sleeve from ignition coil support.



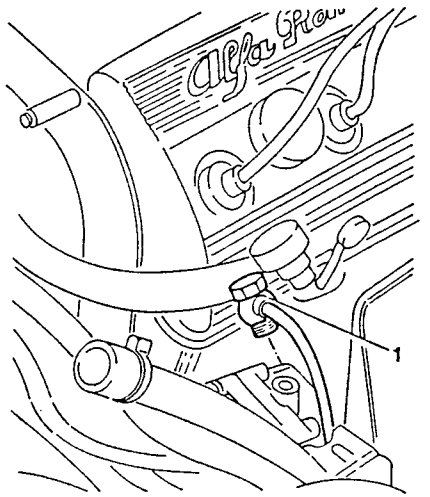
1. Disconnect the engine coolant to radiator delivery hose from the expansion tank.



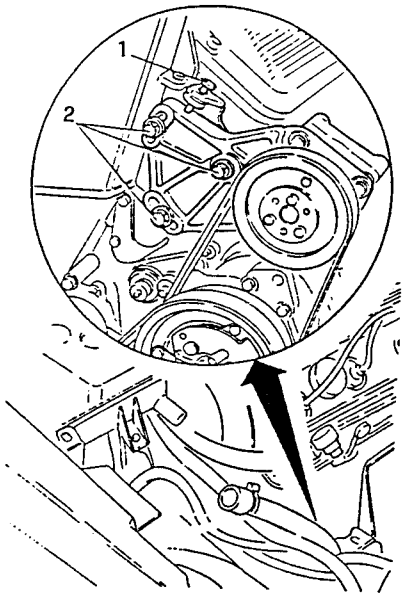
1. Disconnect the oil return connection from the power steering pump.



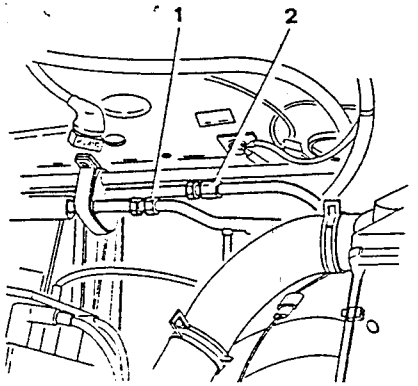
1. Disconnect the oil delivery connection from the power steering pump.



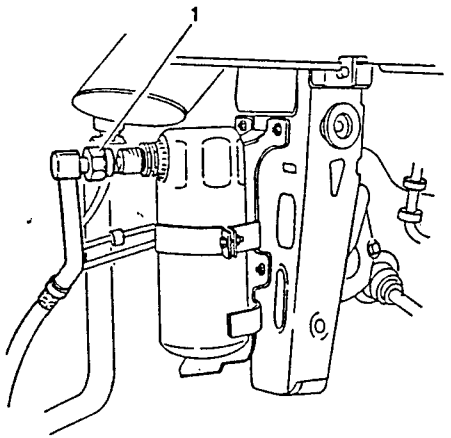
1. Loosen the power steering drive belt tension micrometric adjustment screw.
2. Remove the power steering pump complete with support bracket.



1. Disconnect the air conditioning system intermediate connection.
2. Disconnect the power steering system intermediate connection.

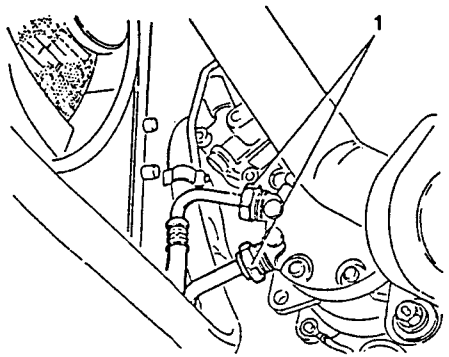


1. Disconnect the air conditioning system filter dehydrator connection.

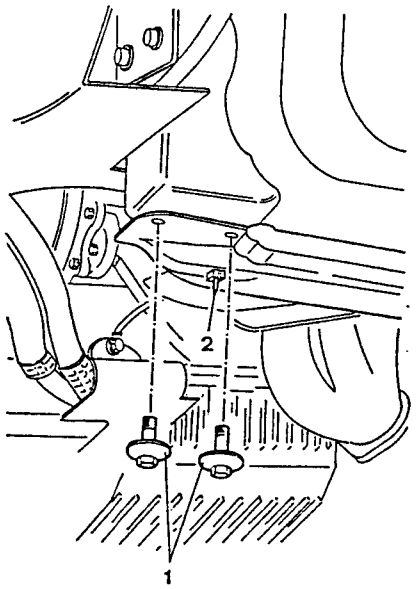


– Raise the vehicle.

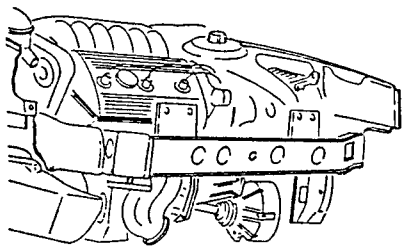
1. Disconnect the suction and delivery unions from the compressor.

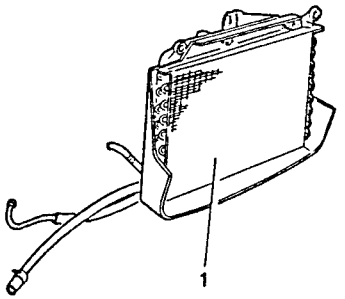


1. Unscrew the two screws securing the lower cross member to the body
2. Unscrew the screws securing the oil radiator air baffle to the cross member.



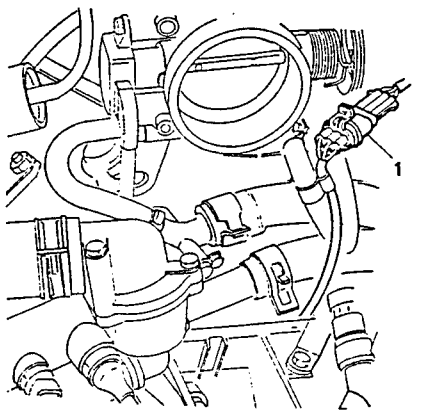
1. Remove air conditioning system radiator and condenser group complete with electric fan and hoses.



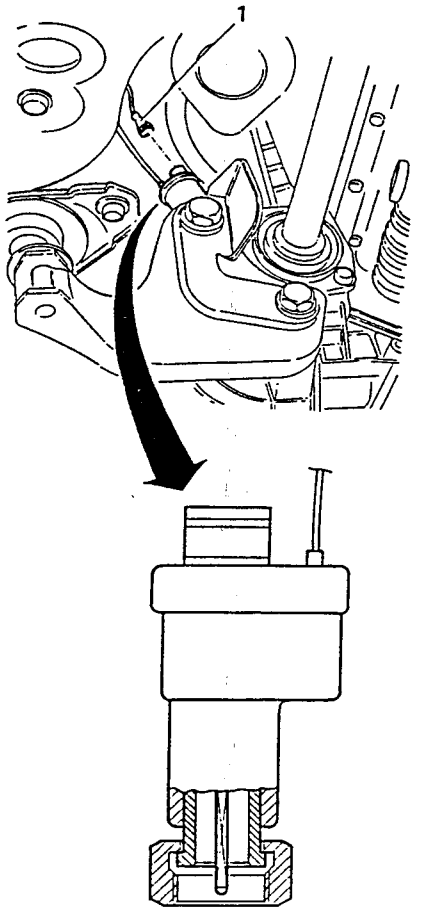


– Lower the vehicle.

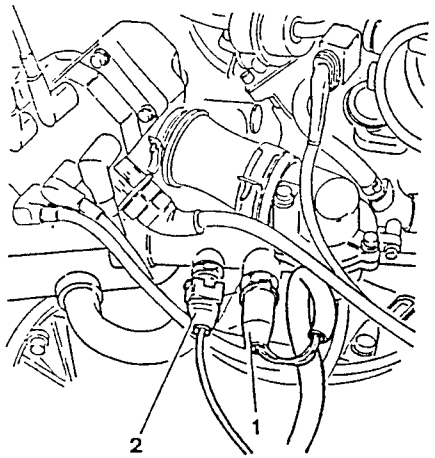
1. Disconnect the speedometer sensor electrical connection.



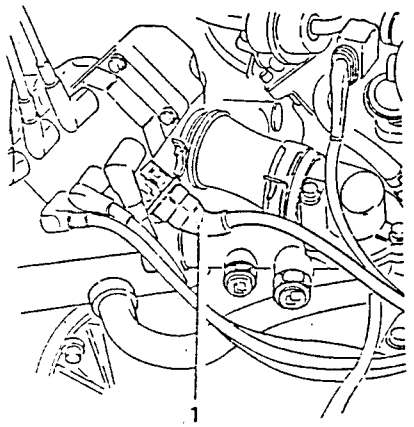
1. Disconnect cable from the odometer sensor.



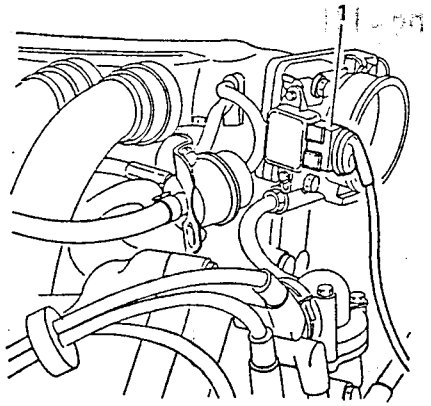
1. Disconnect the engine coolant temperature gauge sender and maximum temperature warning lamp contact.
2. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).



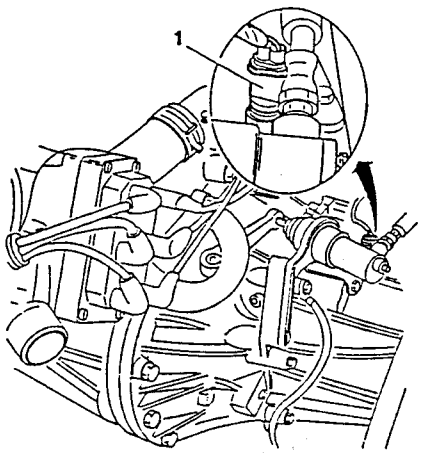
1. Disconnect the ignition coil supply electrical connection.



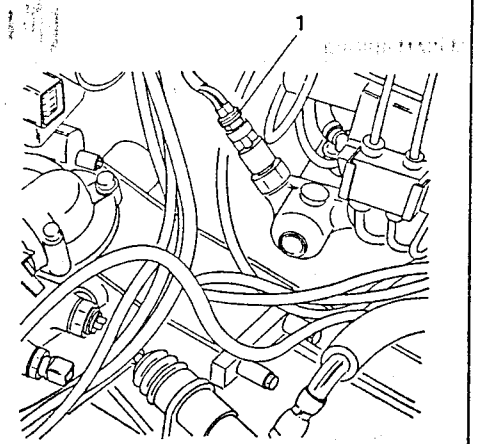
1. Disconnect the throttle valve potentiometer connection.



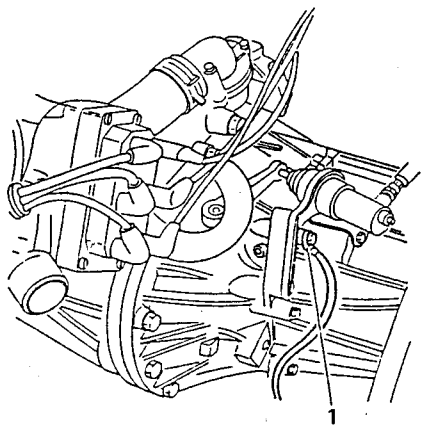
1. Disconnect the reverse speed switch electrical connection.



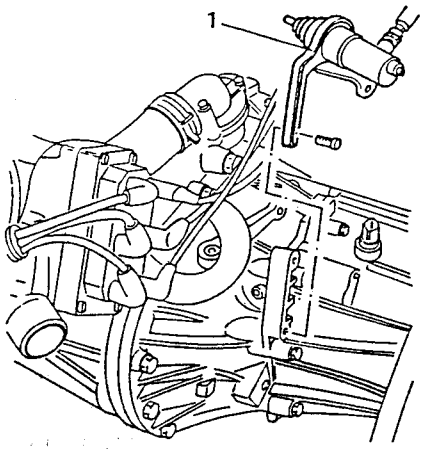
1. Disconnect the braking sensor electrical connection.



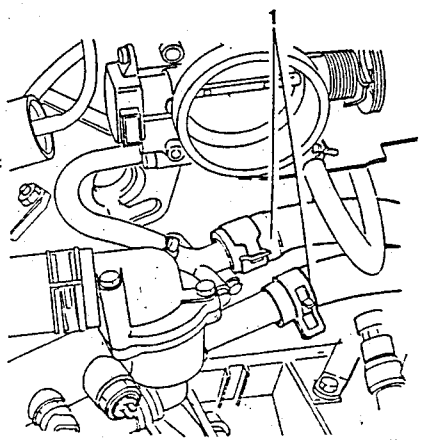
1. Disconnect the earth point of the negative pole (-) of the battery.



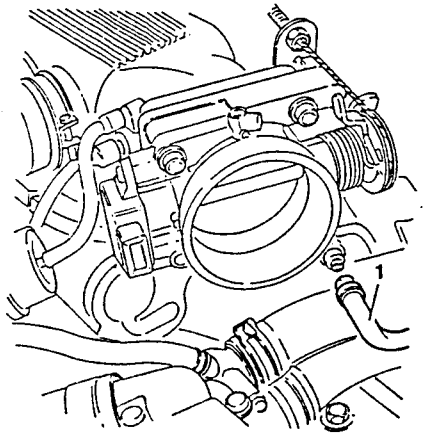
1. Remove the bracket complete with hydraulic clutch control cylinder without disconnecting the hoses.



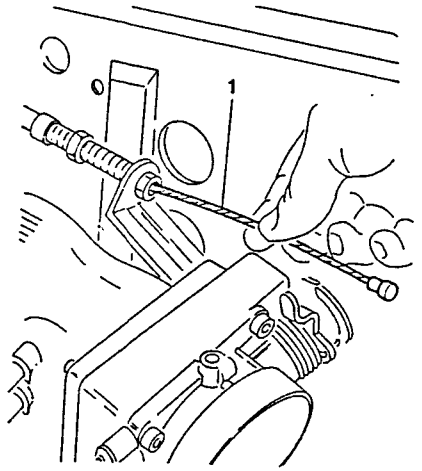
1. Disconnect the two coolant to heater delivery and return sleeves from the thermostat housing.



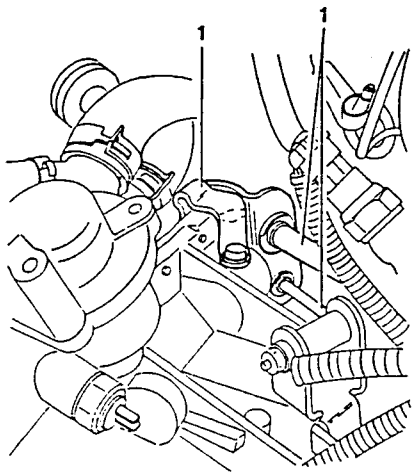
1. Disconnect the throttle valve from the engine coolant to expansion tank return hose.



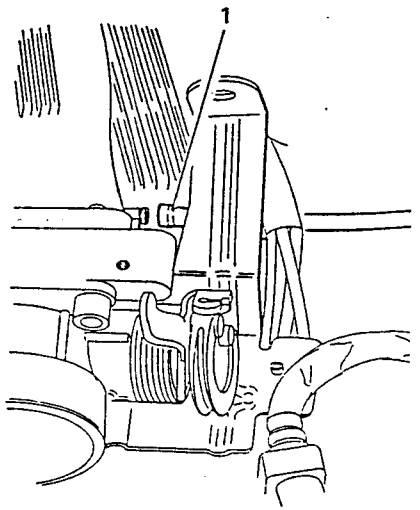
1. Disconnect the accelerator cable from the throttle body.



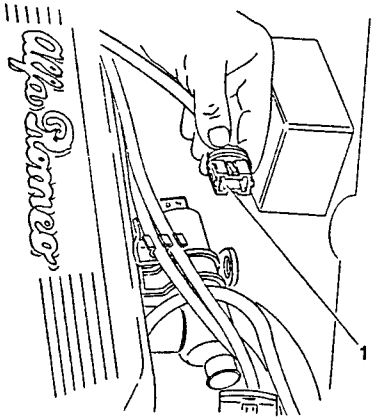
1. Disconnect the speed control cables and remove the relative support bracket and secure it in the lower part of the engine compartment.



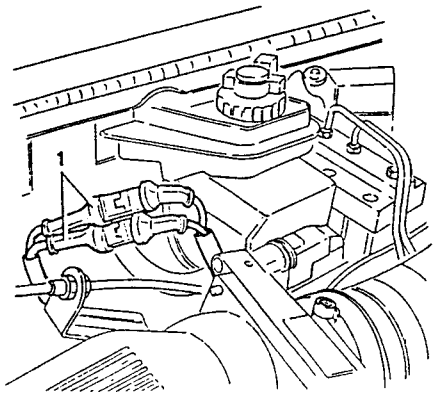
1. Disconnect the servo brake vacuum intake hose from the air intake box.



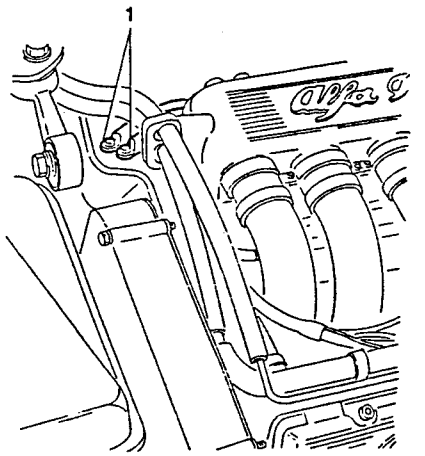
1. Disconnect the electrical connection from the constant idle speed actuator.



1. Disconnect the two electrical connections from the Lambda probe.

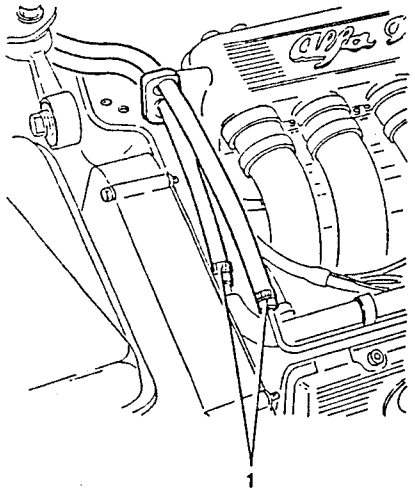


1. Disconnect the earth leads on the engine mounting.

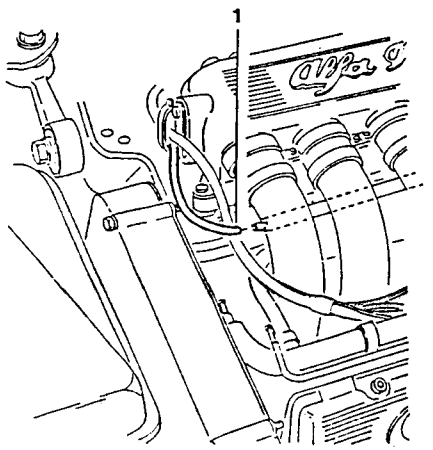


CAUTION:
When operating on fuel system components, the following indications should be rigidly observed:
- ensure that the workshop is equipped with the prescribed safety apparatus (fire extinguishers etc...);
- always remove the negative lead (-) from the battery;
- place any fuel drained from the system into a suitable container fitted with a safety lid;
- the fuel system may be under pressure: operate with care;
- do not smoke.

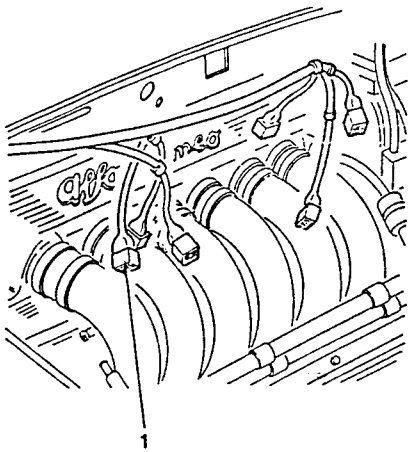
1. Disconnect the delivery and return fuel lines from the supply manifold.



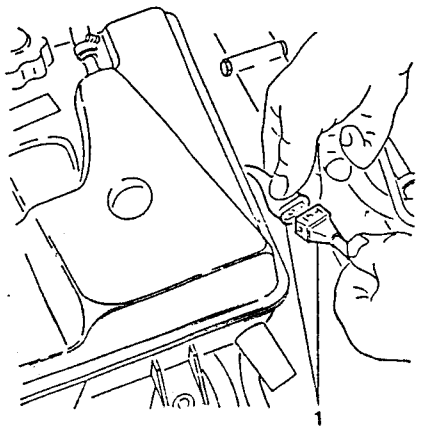
1. Disconnect the fuel vapour hose from the rigid intermediate pipe.



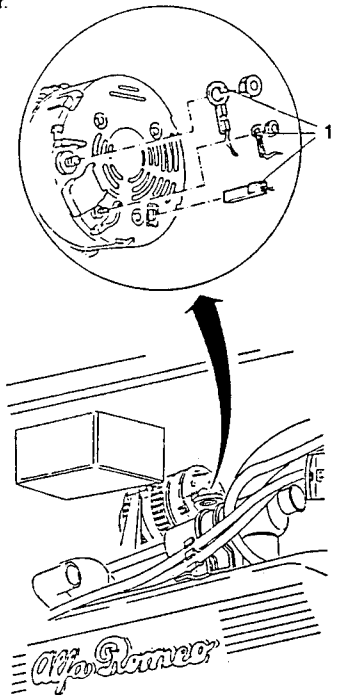
1. Disconnect the electroinjector connections and after disconnecting the cables from the clamps, move them to one side.



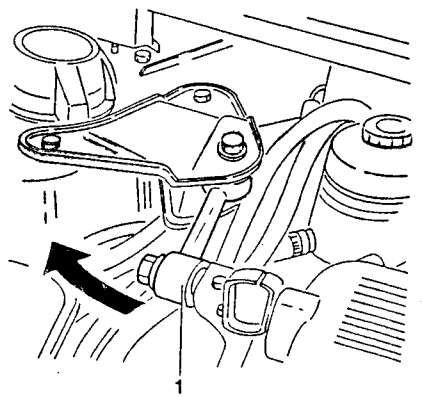
1. Disconnect the r.p.m. and timing sensor.



1. Disconnect the electrical connections from the alternator.

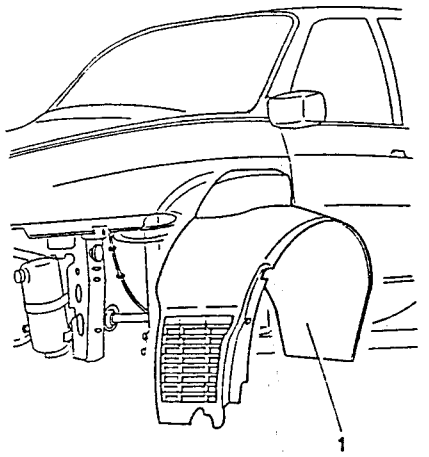


1. Disconnect the antivibration rod from the engine and move it sideways.

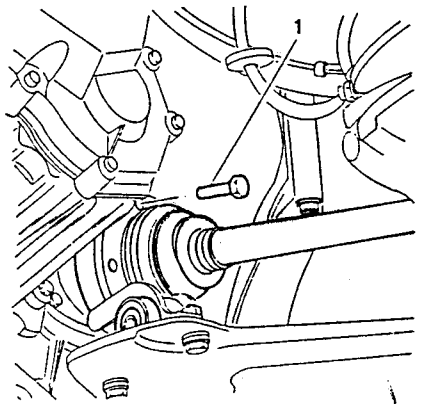


– Raise the vehicle.

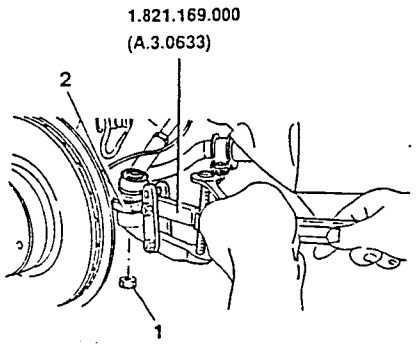
1. Remove the left-hand wheel housing.



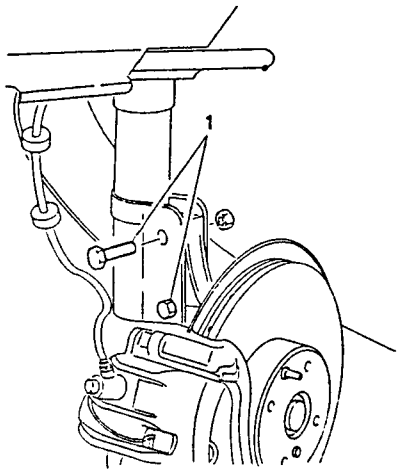
1. Disconnect the left-hand drive shaft.



1. Unscrew the retaining nut of the steering rod ball joint - left side.
2. Using puller N° 1.821.169.000 (A.3.0633) remove the tie rod from the control lever on the pillar.

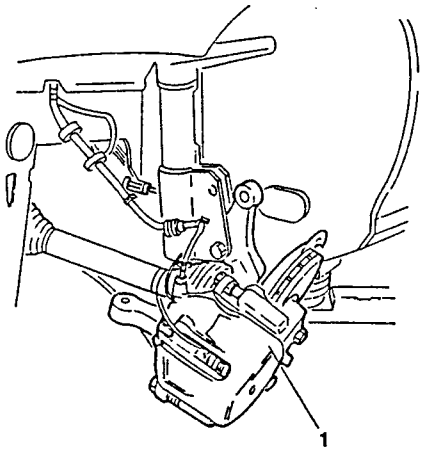


1. Loosen the two bolts securing the hub support to the front right shock absorber and remove the upper bolt only.

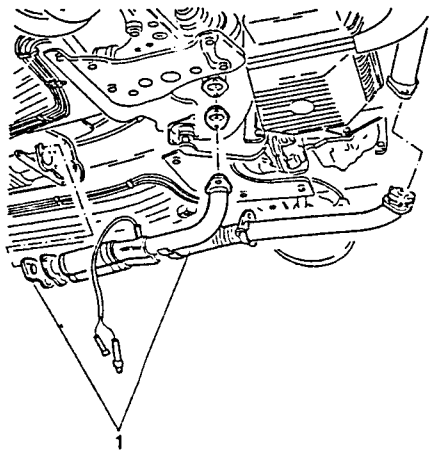


1. As far as possible, tip the wheel hub forward so that the drive shaft moves forward.

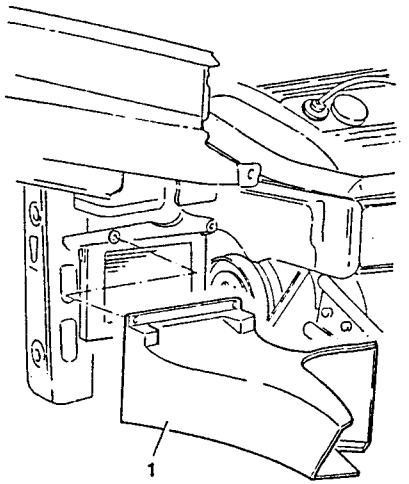
– Advance the right-hand drive shaft from its support proceeding in the same fashion as on the left-hand side.



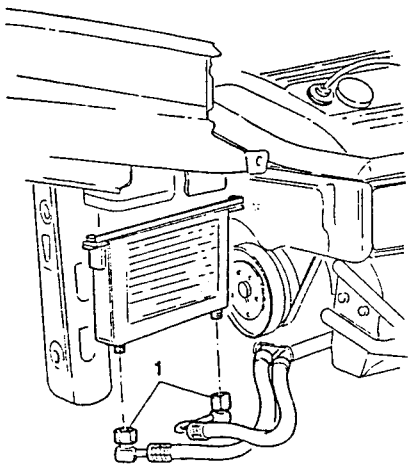
1. Disconnect the front part of the exhaust pipe and remove it together with the relevant gaskets.



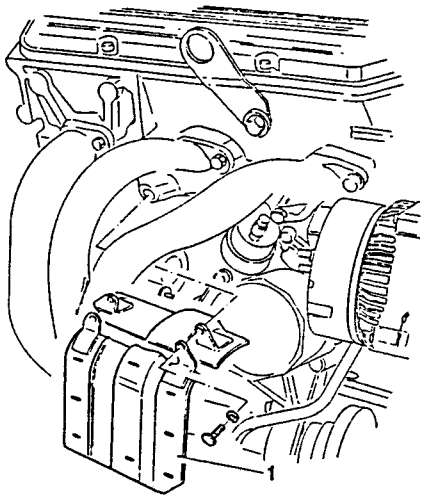
1. Remove air to engine oil cooling radiator baffle.



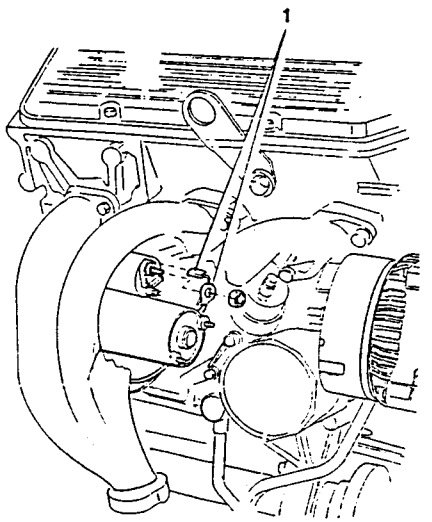
1. Disconnect the oil to radiator delivery and return



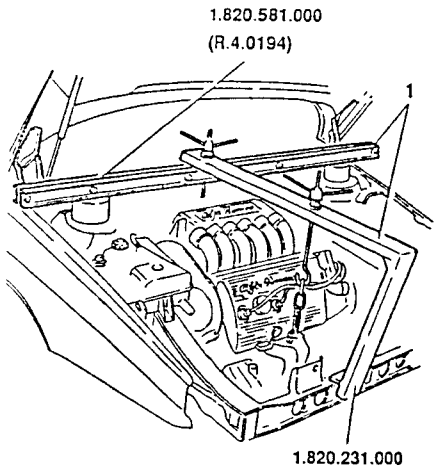
1. Remove the heat shielding from the starter motor.



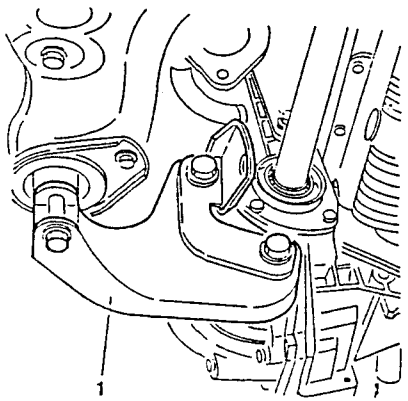
1. Disconnect the starter motor electrical connections.



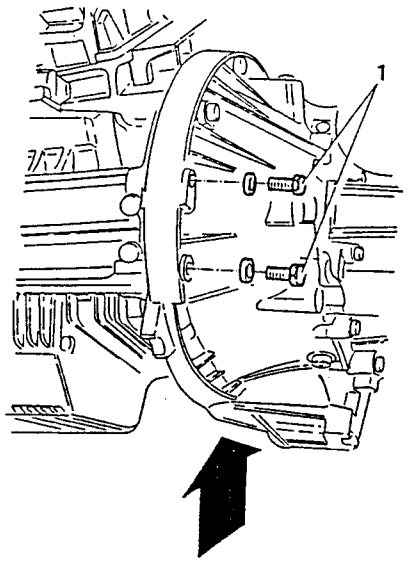
1. Position tools N° 1.820.231.000 e N° 1.820.581.000 (R.4.0194) to support the engine as shown in the diagram. Attach the engine support hooks and take the strain on the rods.

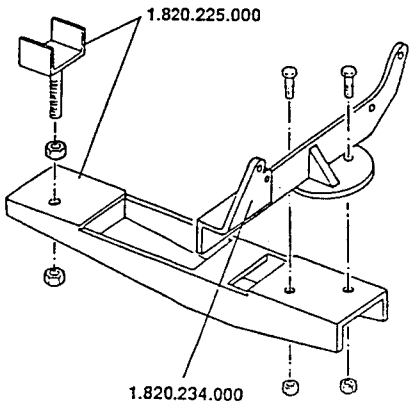


1. Remove the engine support bracket from the body.



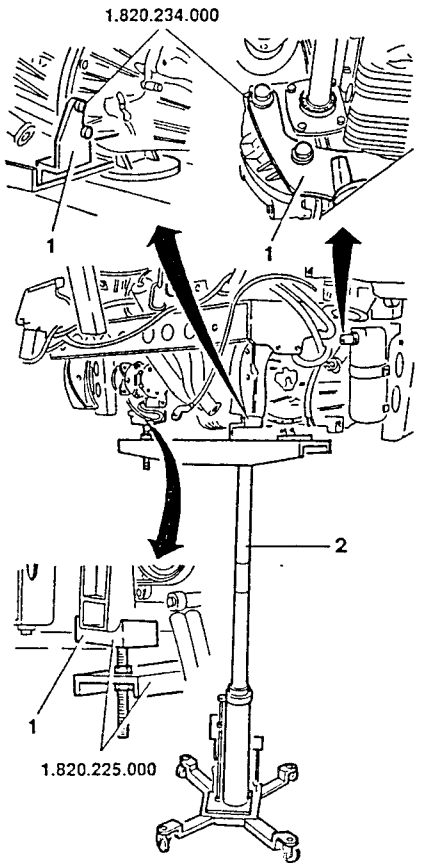
1. Unscrew and remove the two screws securing the gearbox to the engine as shown in the illustration.



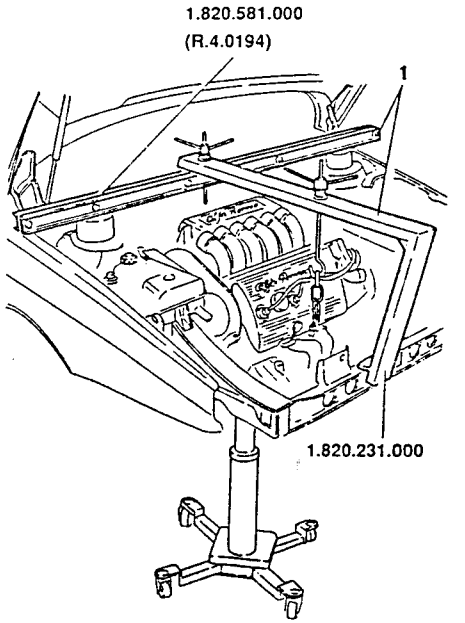


1. Install support tools N° 1.820.225.000 and N° 1.820.234.000 for removal of engine from engine compartment locating them as shown in the diagram.
2. Position a hydraulic jack under the engine support tools.

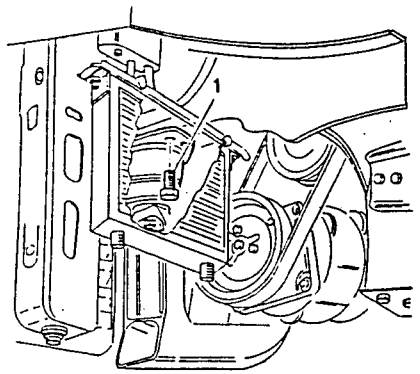
CAUTION:
The hydraulic jack must have a loading capacity of 1000 kg.



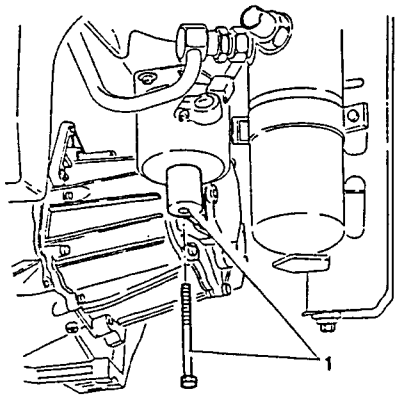
1. Remove the previously installed tools.



1. Disconnect the timing side engine mounting from the body.



1. Disconnect the engine support bracket on the gearbox side from the hydraulic support.

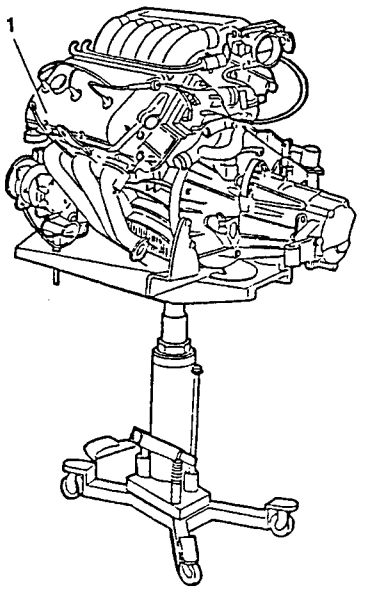


CAUTION:
To prevent the electric cables from getting in the way during engine removal, disconnect them from the cable clamps and move them away from the engine.

1. Lower the hydraulic jack and remove the engine group from the engine compartment.

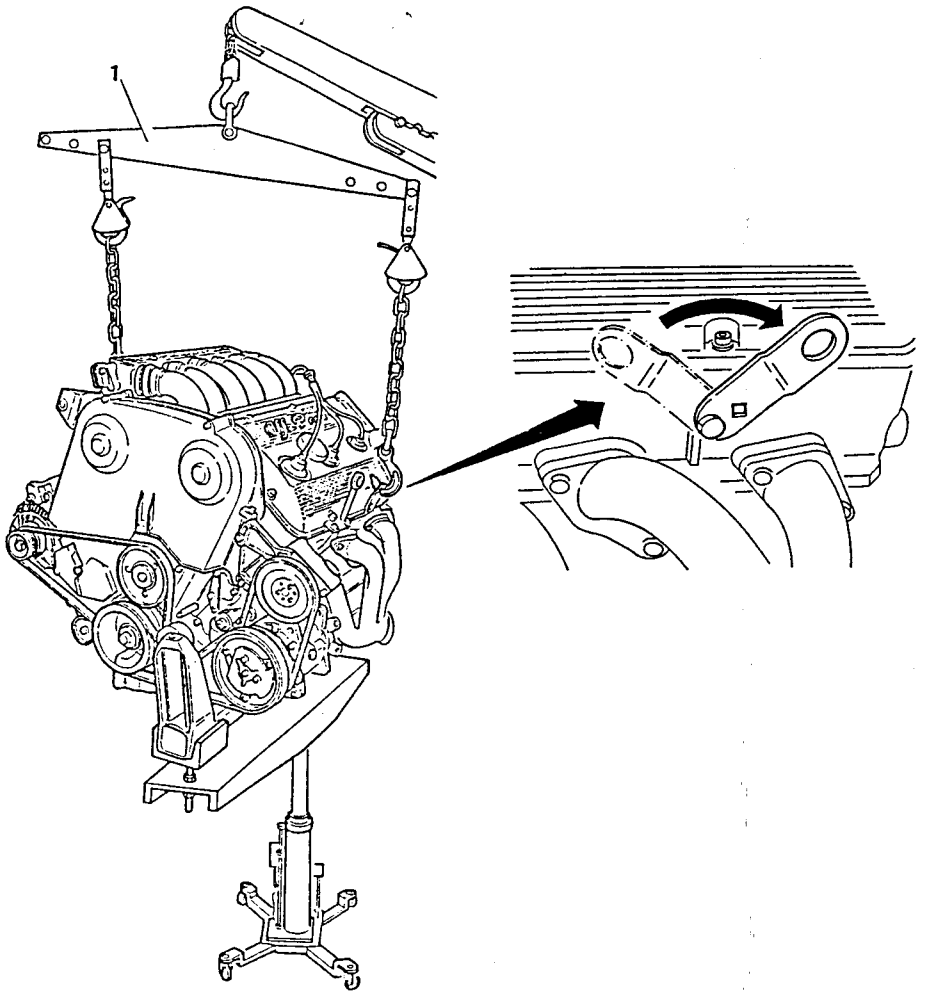
CAUTION:
Before lowering, check that all cables and hoses have been disconnected.

CAUTION:
Take all necessary precautions to avoid damaging components.



1. Support the engine group with a hydraulic lift in addition to the hydraulic jack used for engine removal. The following indications should be heeded:
   - Rotate the left side engine support bracket and balance the weight of the engine by adjusting the chain hooks attached to the swing bar as shown in the diagram.

CAUTION:
To move the engine use a hydraulic crane after disenganging the supporting hydraulic jack.



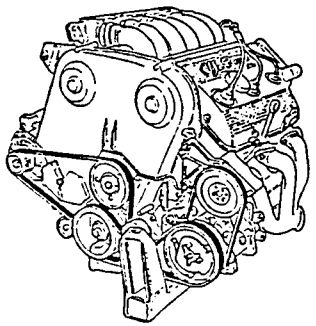
INSTALLATION

Repeat the removal procedure in reverse order taking the following recommendations into account:

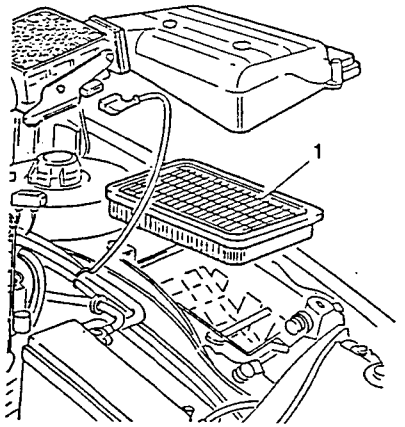
- Prepare the engine compartment for the insertion of the engine group by arranging all electric cables, pipes etc. in such a way that they do not interfere with the operation of engine installation.
- Take the necessary precautions to ensure that no components are damaged when the engine is being lowered into the engine compartment.

CAUTION:
To move the engine group, use a hydraulic crane after having removed the supporting hydraulic jack.

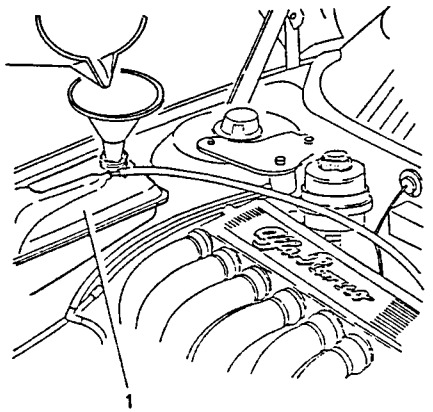
Following installation, check the belts for correct tension (see **GROUP 00**).



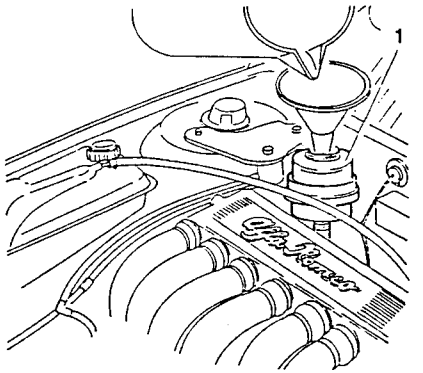
1. Install the air cleaner ensuring that it is positioned as shown in the diagram.



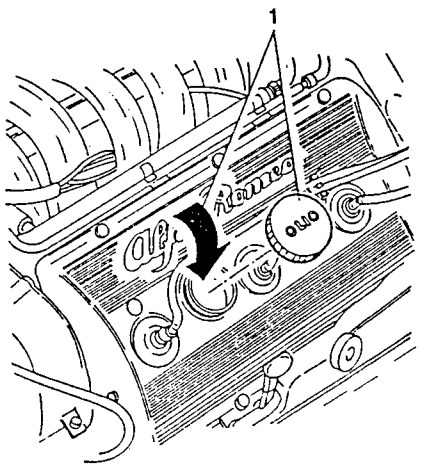
1. Service the cooling system with the prescribed type and quantity of coolant (see **GROUP 00**).



1. Service the power steering system with the prescribed type and quantity of fluid (see **GROUP 00**).



1. Service the lubrification system with the prescribed type and quantity of oil (see **GROUP 00**).



- Service the conditioning system (see **GROUP 80**).
- Check that all other fluids are at the correct level.
- Carry out all the prescribed checks and adjustments indicated in **GROUP 00**.

ENGINE BENCH OVERHAUL

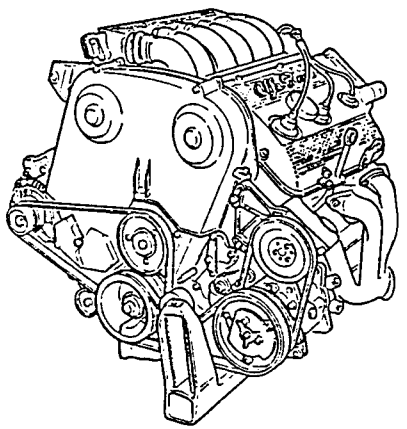
The instructions given in the following paragraphs describe the complete bench overhaul of the engine after it has been removed from the vehicle.
The instructions are divided as follows:

- **Engine disassembly and reassembly:** removal (and successive installation) of the gearbox, accessories etc. from the engine, and disassembly of the engine into its major groups.
- **Disassembly and overhaul of the cylinder heads:** complete overhaul of all the components of the cylinder heads.
- **Engine block checks and inspections:** complete overhaul of the crank gear components.
- **Precautionary instructions for installation:** including specific reassembly operations which are different from the disassembly instructions.

All the disassembly procedures given below are also applicable for engine reassembly if performed in the reverse order except where specifically stated.

- **Checking and inspection of electrical components:** checks and inspections of the electrical components installed in the engine compartment.

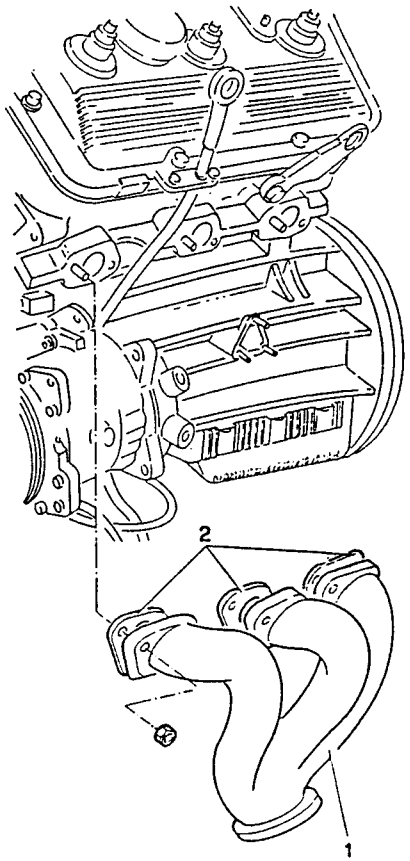
The following procedures refer to the complete overhauling of the entire engine; it is however possible to use parts of these procedures separately when necessary, for the treatment of specific parts.



ENGINE DISASSEMBLY AND REASSEMBLY

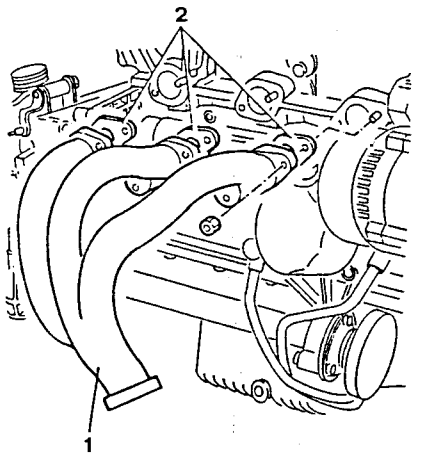
REMOVAL OF COMPONENTS FROM LEFT SIDE

1. Remove the exhaust manifold.
2. Remove the gaskets.

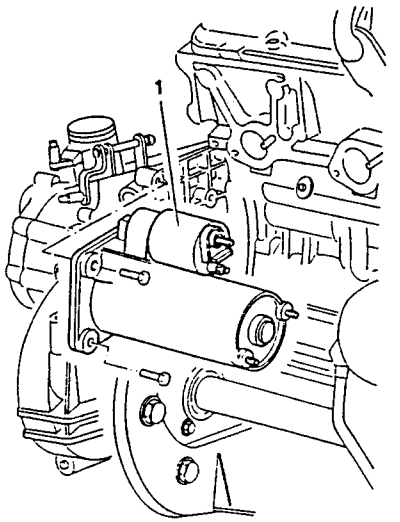


REMOVAL OF COMPONENTS FROM RIGHT SIDE

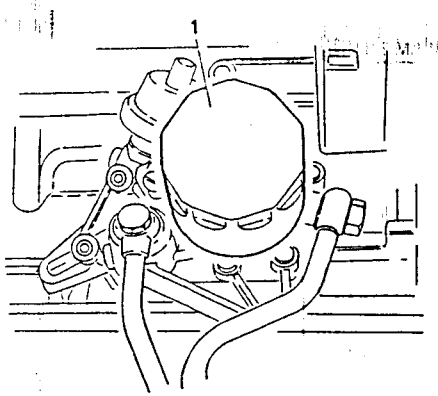
1. Remove the exhaust manifold.
2. Remove the gaskets.



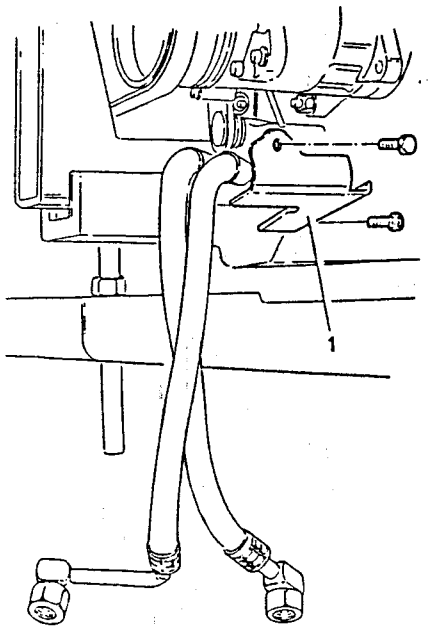
1. Remove the starter.



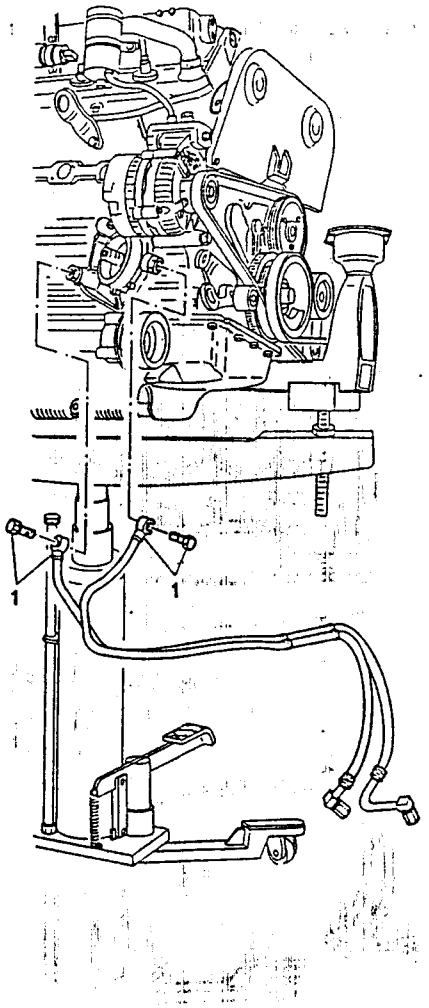
1. Remove oil filter.



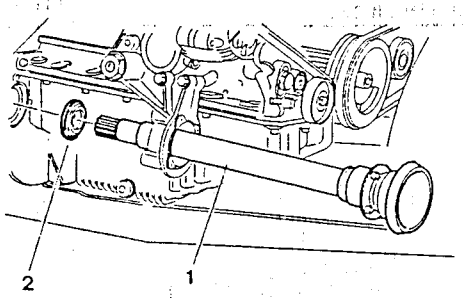
1. Remove bracket supporting oil to radiator delivery and return hoses.



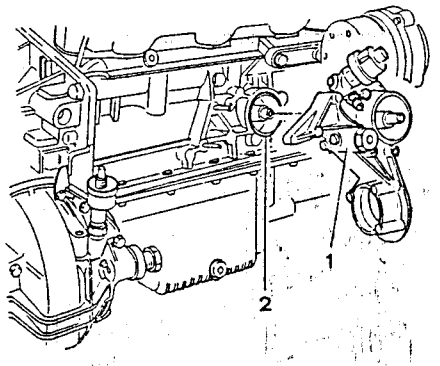
1. Unscrew the two oil to radiator delivery and return connections and remove the hoses.



1. Disconnect intermediate shaft from differential.
2. Withdraw the dust ring.

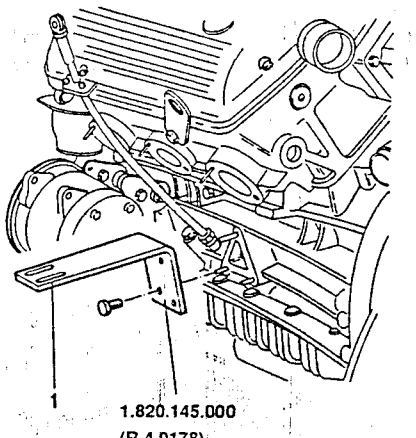


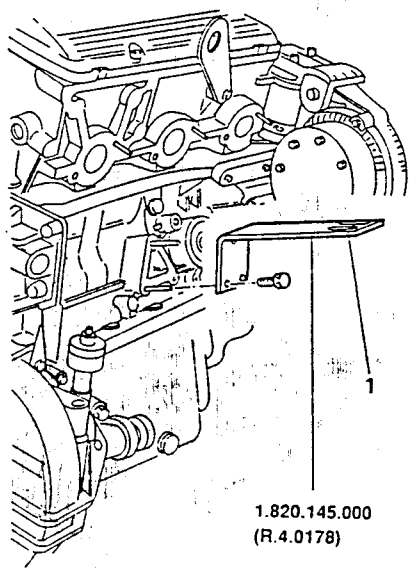
1. Remove oil filter/intermediate shaft support.
2. Remove O-Ring.



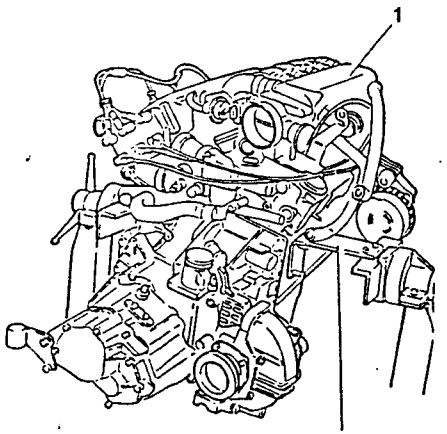
REMOVAL OF GEARBOX-DIFFERENTIAL GROUP

1. Install the two brackets N° 1.820.145.000 (R.4.0178) on the engine block ready for positioning on overhaul stand.

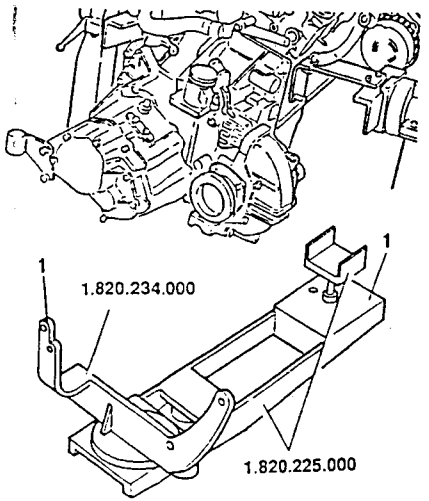




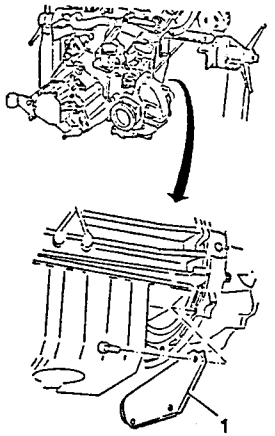
1. Raise the engine using a hydraulic lift and releasing it from the supporting jack. Place it on a rotary stand and secure it using brackets N° 1.820.145.000 (R.4.0178).



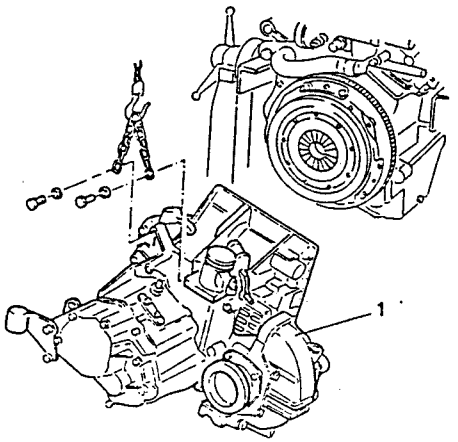
1. Remove tools N° 1.820.225.000 supporting the engine and N° 1.820.234.000 used to remove the engine from the engine compartment.



1. Remove the flywheel cover.

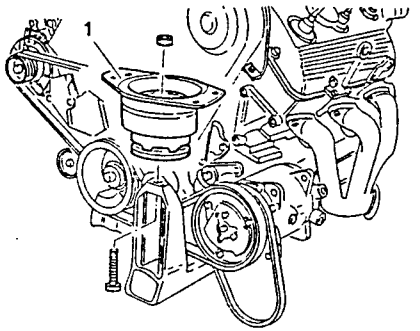


1. Unscrew the retaining screws and using a hydraulic crane remove the gearbox-differential group.



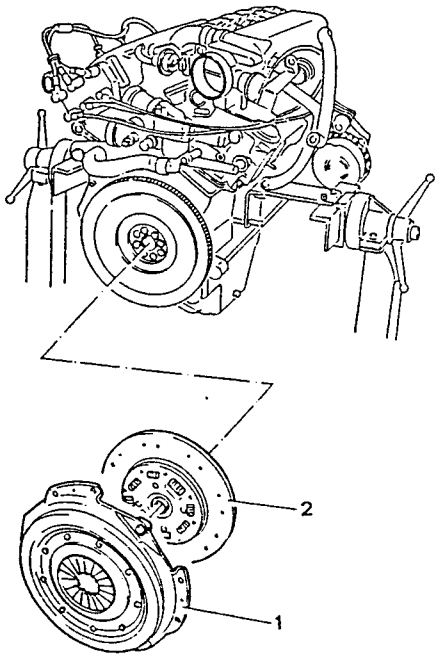
NOTE: For complete overhaul of gearbox, refer to GROUP 13.

1. Remove the hydraulic support - timing side.



CLUTCH PLATE REMOVAL

1. Remove disk pressure plate body.
2. Remove clutch disk.

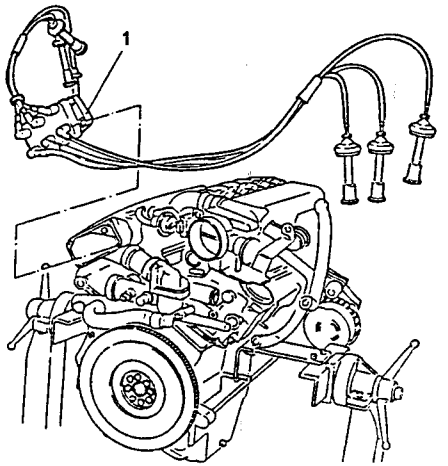


NOTE: For further details regarding the clutch and its components, refer to GROUP 12.

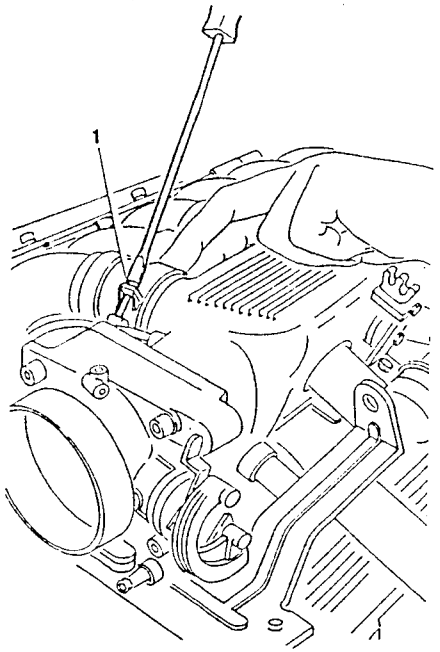
REMOVAL OF AIR INTAKE BOX

NOTE: for additional disassembly and checks regarding the fuel supply system, refer to GROUP 04.

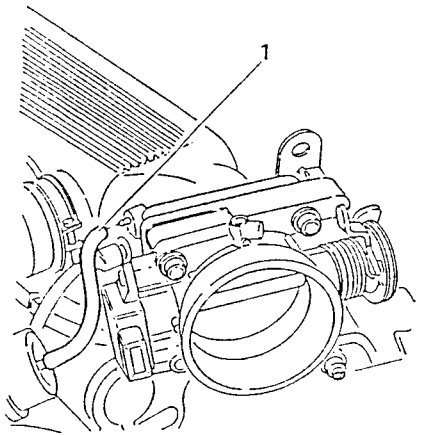
1. Disconnect spark plug leads and remove ignition coils.



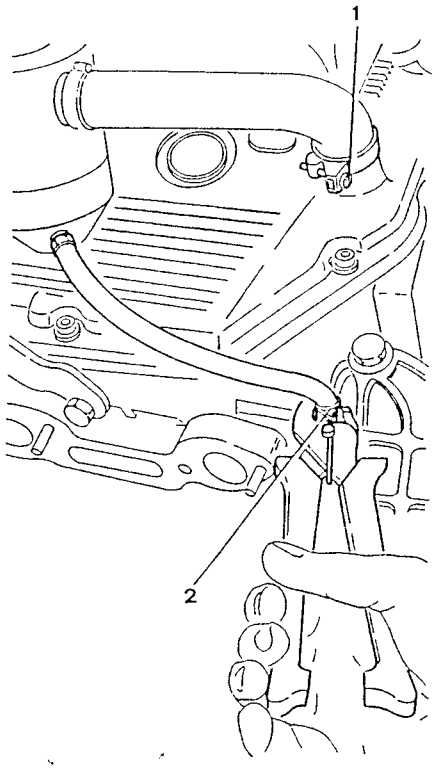
1. Loosen the six clamps securing the air delivery duct to the air intake box.



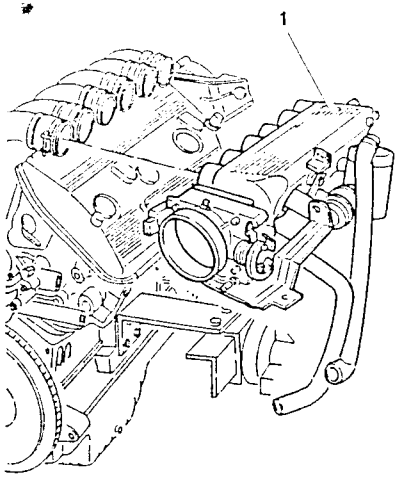
1. Disconnect fuel pressure regulator vacuum intake hose from air intake box.



1. After loosening the clamp securing the oil vapour recirculation pipe, disconnect it from the cylinder head.
2. Loosen the clamp on the oil recirculation pipe and disconnect it from the engine block.

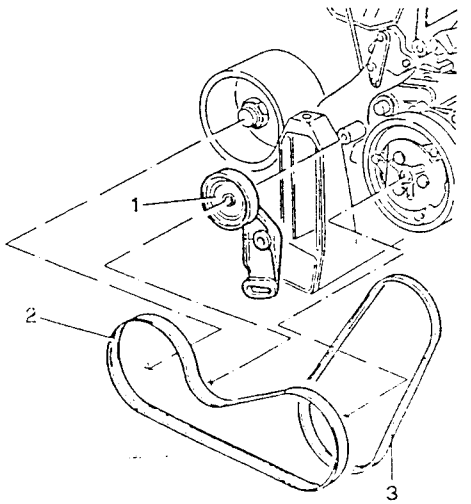


1. Remove the air intake box complete with oil vapour separator, engine idle speed actuator and throttle body.

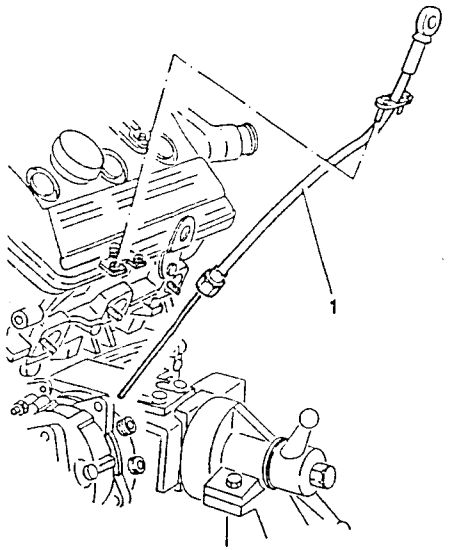


REMOVAL OF COMPRESSOR

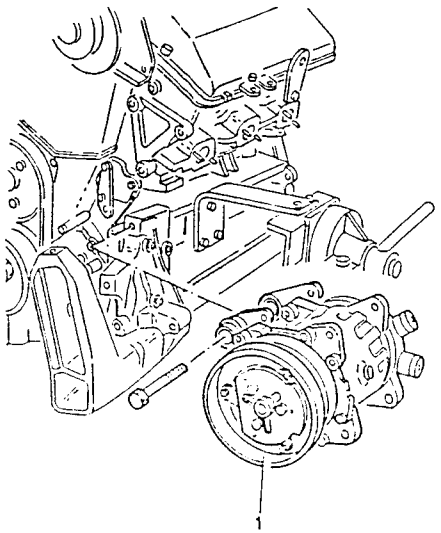
1. Remove the compressor belt stretcher.
2. Remove the compressor drive belt.
3. Remove the power steering drive belt.



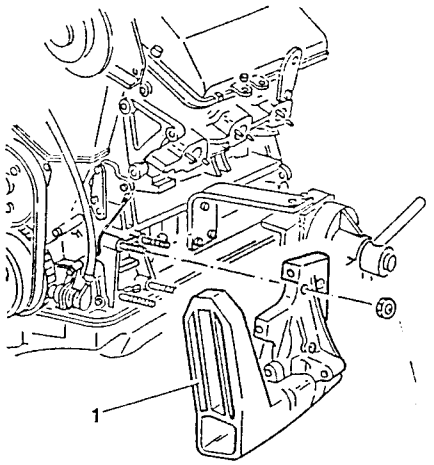
1. Remove engine oil dipstick.



1. Remove compressor and supports.

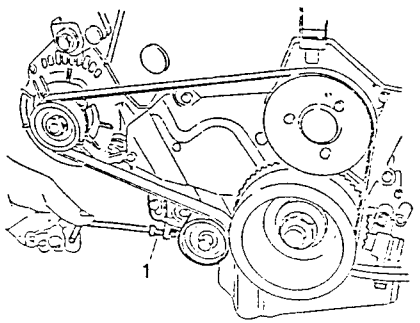


1. Remove the front engine support.

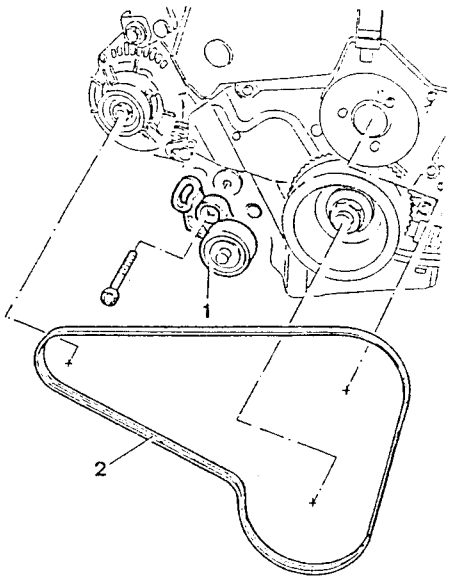


REMOVAL OF ALTERNATOR

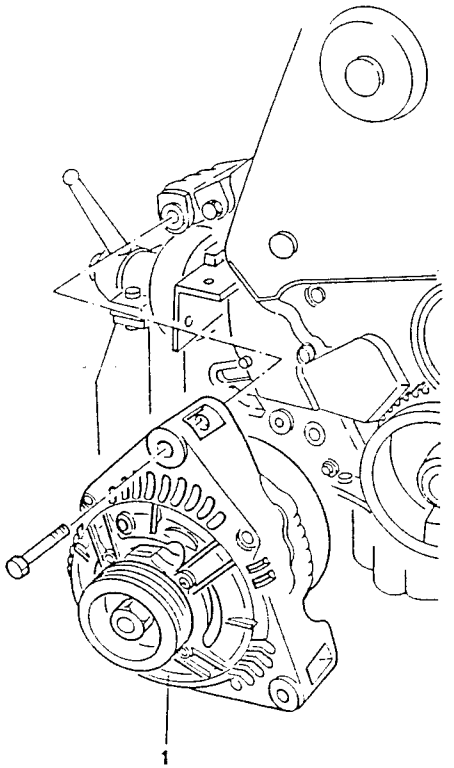
1. Loosen the micrometric screw regulating alternator/water pump belt tension.



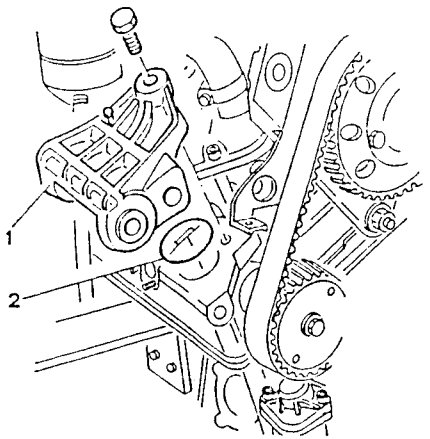
1. Remove the belt tensioner.
2. Remove alternator/water pump drive belt.



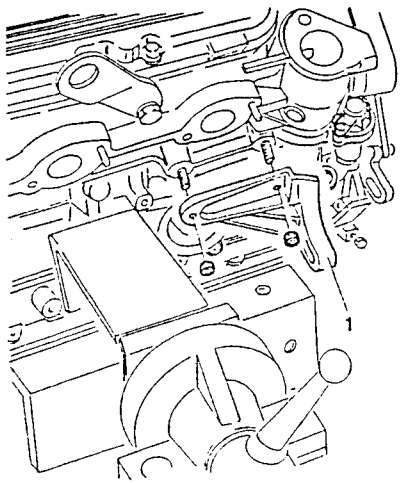
1. Remove alternator.



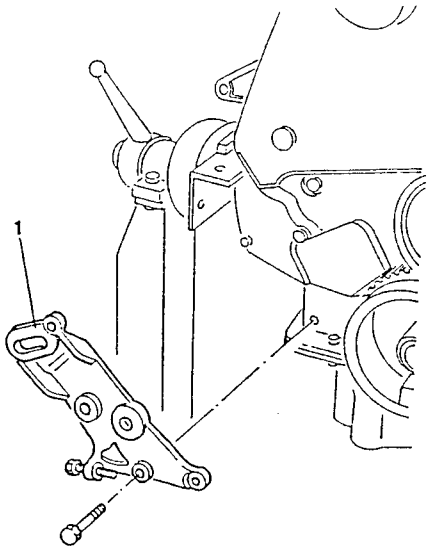
1. Remove upper bracket supporting alternator.
2. Remove O-Ring.



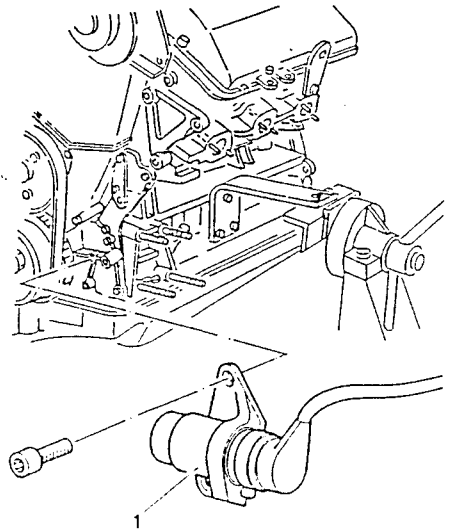
1. Remove the lower bracket (flywheel side) supporting alternator.



1. Remove the lower bracket (timing side) supporting alternator.

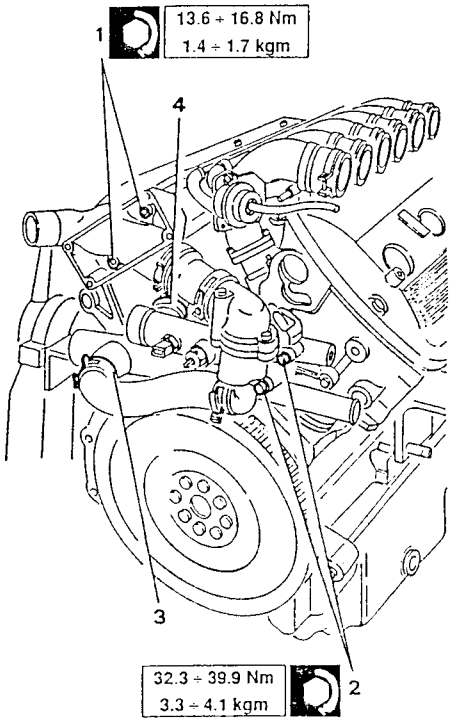


1. Remove the r.p.m. and timing sensor and bracket.

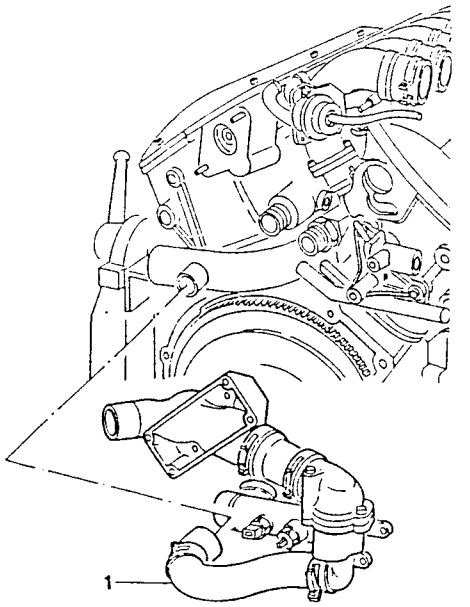


REMOVAL OF THERMOSTAT GROUP

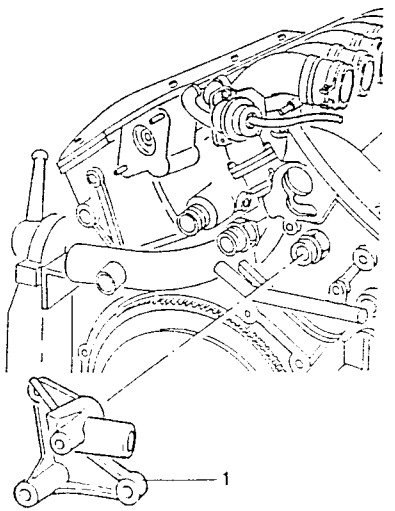
1. Unscrew the two screws securing the ignition coils support.
2. Unscrew the two screws securing the thermostatic cup.
3. Disconnect the engine coolant to pump return sleeve.
4. Disconnect the sleeve connecting the thermostatic cup to the left-hand head.



1. Remove the thermostatic cup together with ignition coil support and connecting sleeves.

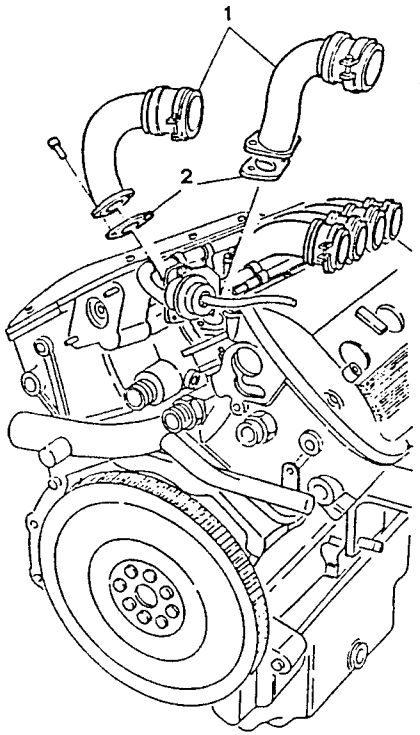


1. Remove the engine coolant to throttle body and heater delivery connection.

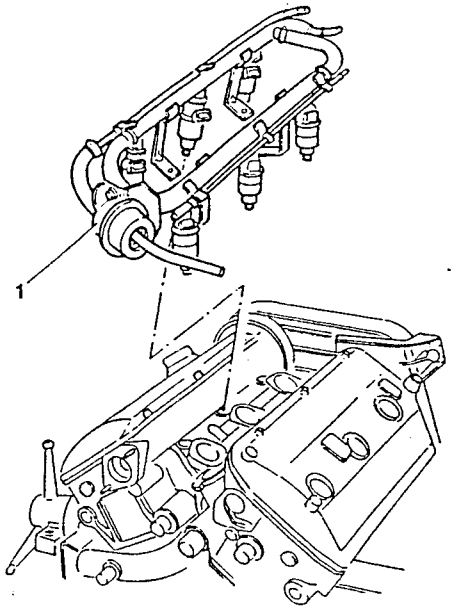


REMOVAL OF FUEL SEPARATOR MANIFOLD

1. Remove the air feed ducts.
2. Remove the air feed duct gaskets.

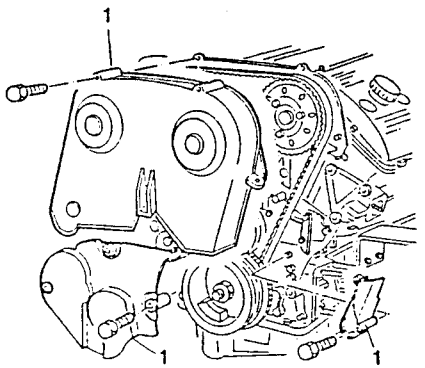


1. Remove the fuel distribution manifold complete with electroinjectors and pressure regulator.



REMOVAL OF TIMING BELT

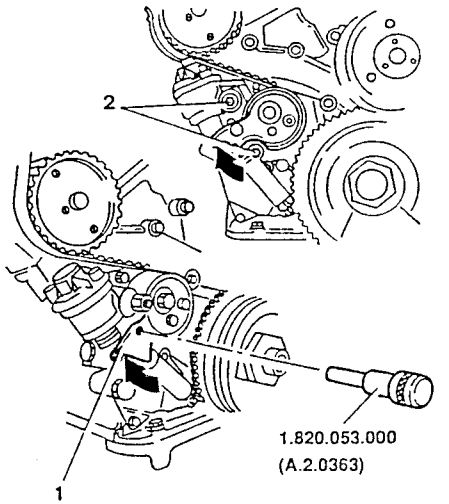
1. Remove the front timing belt covers.



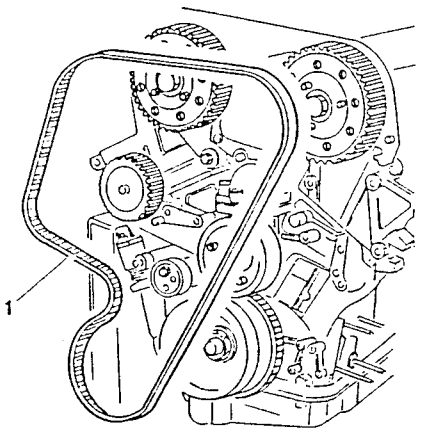
1. Raise the arm of the hydraulic belt tensioner and using tool N° 1.820.053.000 (A.2.0363), lock the belt tensioner.

NOTE: **To permit tool N° 1.820.053.000 (A.2.0363) to be inserted, it is necessary to align the housing hole with the hole on the tightner body.**

2. Loosen the two nuts securing the tensioner body to the engine block.
- Rotate the hydraulic tensioner upwards and lock it in this position by tightening the previously loosened screws.

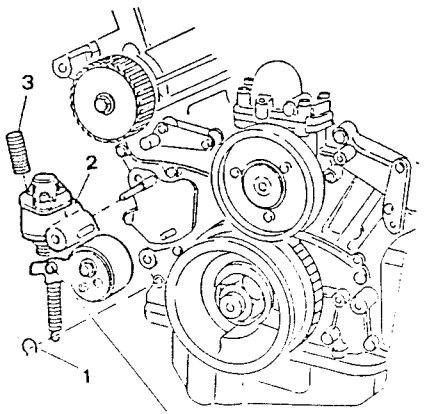


1. Remove the timing belt from the toothed pulleys installed on the cylinder heads and from the front pulley of the crankshaft.

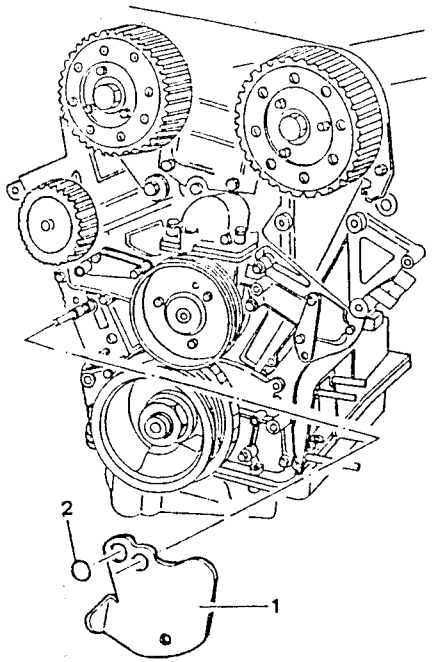


REMOVAL OF HYDRAULIC BELT TENSIONER

1. Remove the retaining ring.
2. Remove the hydraulic belt tensioner.
3. Withdraw the pre-load spring.

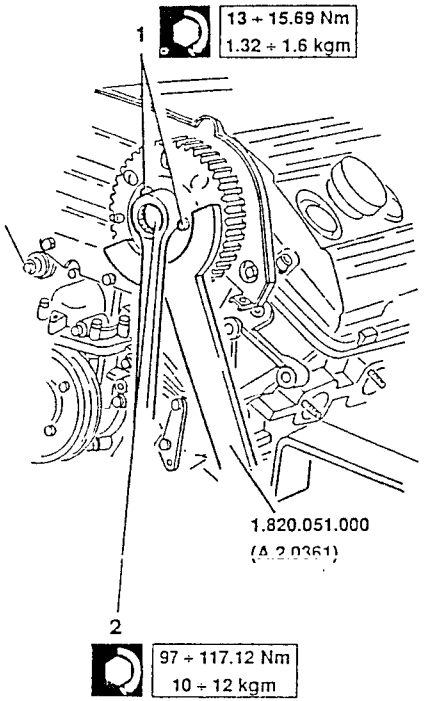


1. Remove spring cover plate.
2. Remove the O-ring.

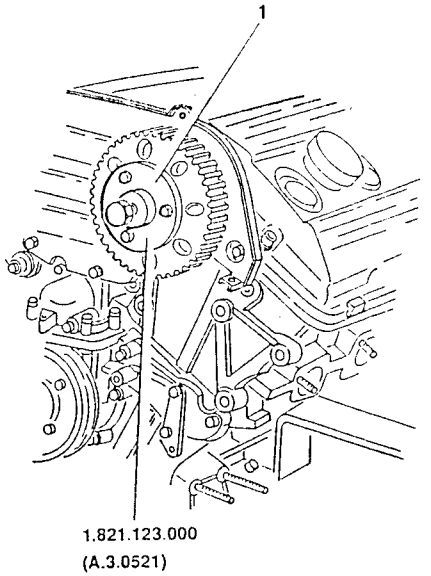


REMOVAL OF TIMING PULLEY

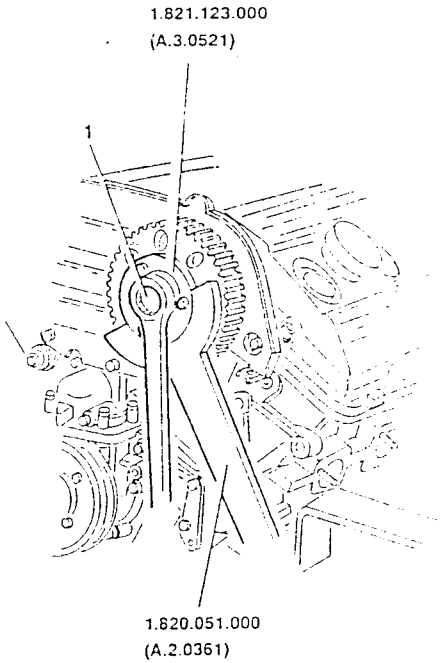
1. Loosen the screws securing the pulley to the support hub.
2. Loosen and remove the locknut using tool N° 1.820.051.000 (A.2.0361) as a reactor.



– Remove the previously loosened screws.
1. Install tool N° 1.821.123.000 (A.3.0521) on the timing pulley by tightening the three screws of the tool onto the support hub.

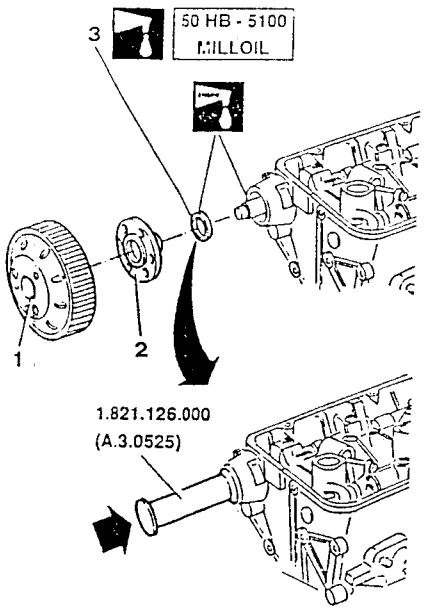


1. Tighten the nut of tool N° 1.821.123.000 (A.3.0521) using tool N° 1.820.051.000 (A.2.0361).



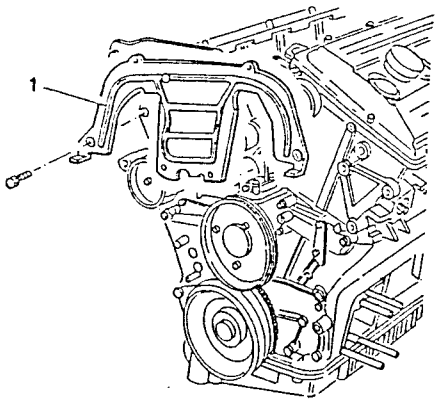
1. Remove the previously installed tools and remove the toothed pulley.
2. Withdraw the support hub.
3. Remove the oil seal.

During installation replace the oil seal and install it using inserting tool N° 1.821.126.000 (A.3.0525).

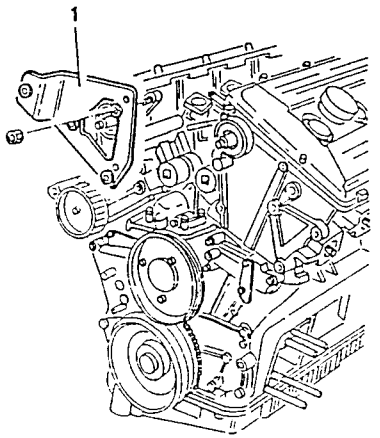


– Remove the right-hand timing pulley following the instructions given for removal of the left-hand pulley.

1. Remove the rear cover of the toothed timing pulley.

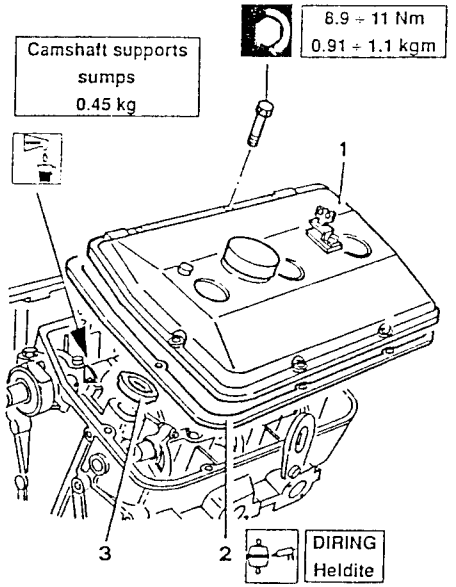


1. Remove the support of the antivibration rod from the right- hand head.



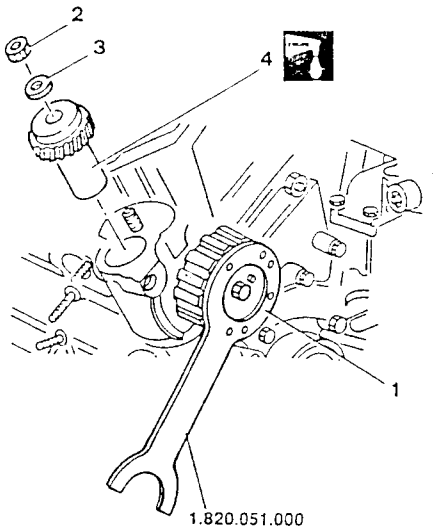
REMOVAL OF CYLINDER HEADS

1. Remove timing system cover.
2. Remove gaskets between the timing system covers and the cylinder heads.
3. Remove the spark plug seat caps.

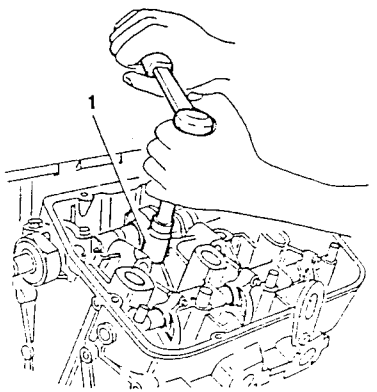


– **The following steps 1,2,3 and 4 refer to the right-hand head.**

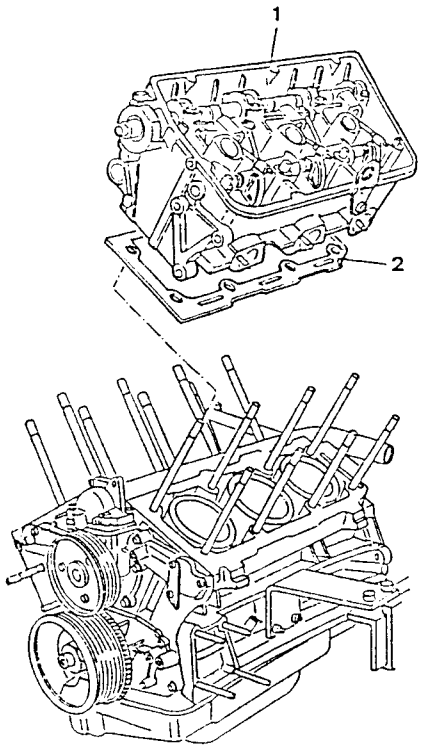
1. Using tool N° 1.820.051.000 (A.2.0361), prevent rotation of the oil pump drive pulley.
2. Unscrew the retaining nut securing the oil pump drive intermediate gear.
3. Remove washer.
4. Remove intermediate gear.



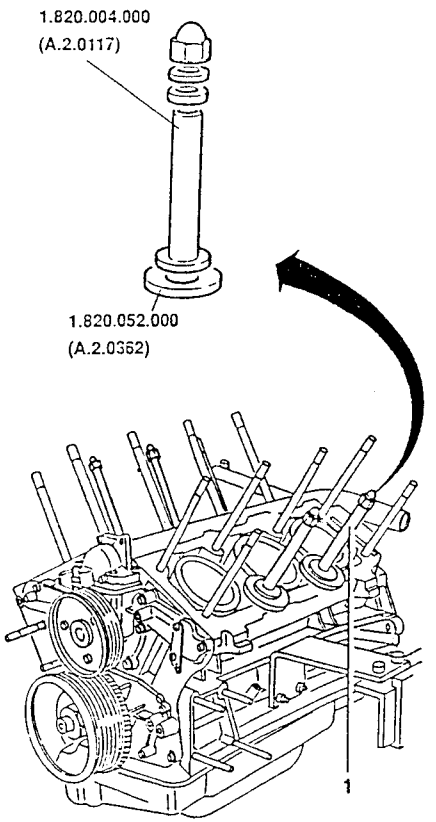
1. Loosen and remove the nuts and washers securing the cylinder heads to the engine block.



1. Remove the cylinder heads.
2. Remove the gaskets between the cylinder heads and engine block.

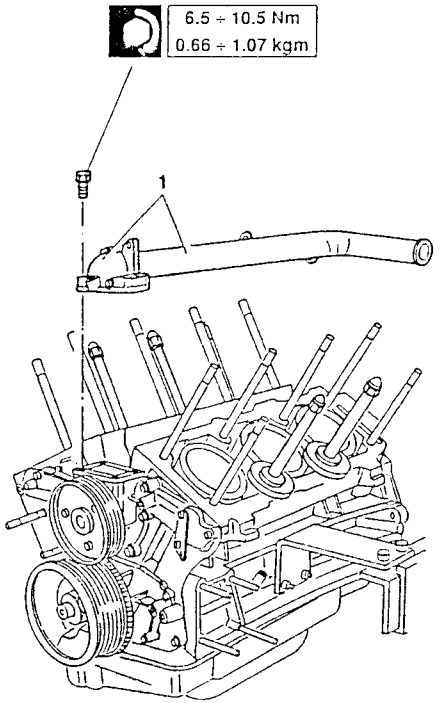


1. Install the cylinder liner retainers N° 1.820.004.000 (A.2.0117) and relative washers N° 1.820.052.000 (A.2.0362).



See relevant paragraph for installation of cylinder heads.

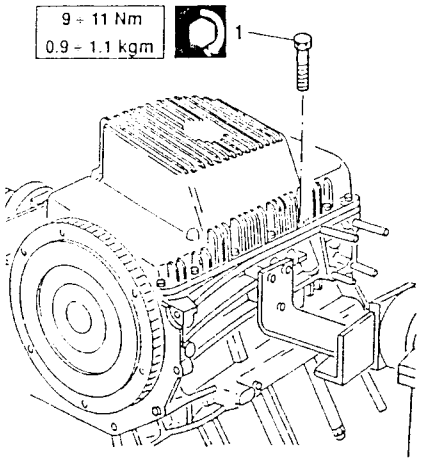
1. Together with the upper pump cover, remove the manifold returning engine coolant to the pump.



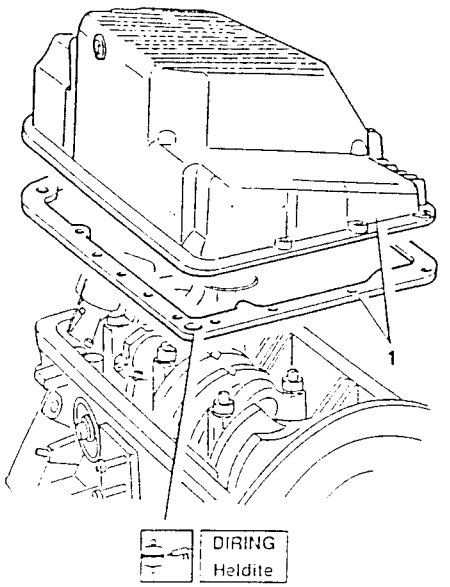
REMOVAL OF OIL SUMP

– Unlock the rotary stand and rotate the engine block 180°.

1. Loosen all the bolts and nuts securing the oil sump to the engine block.

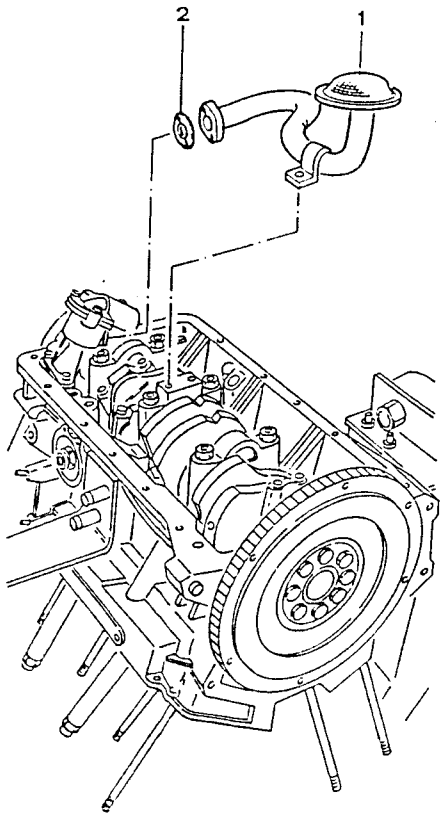


1. Remove the complete oil sump along with its gasket. If necessary remove all traces of sealant from the oil sump and engine block.

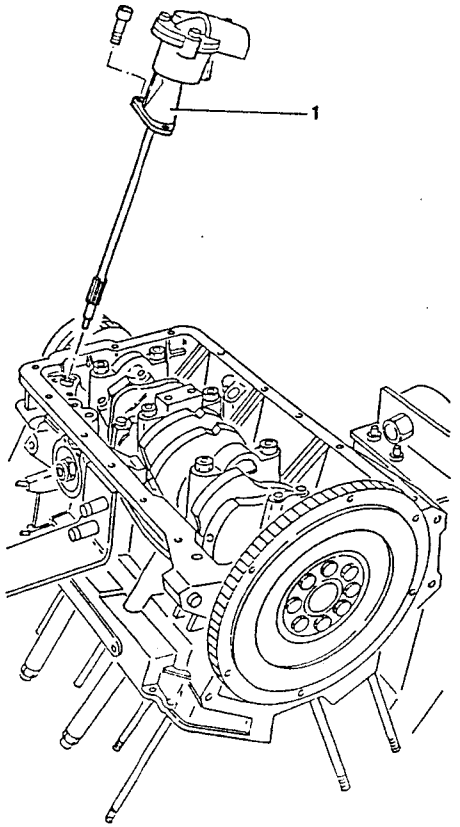


REMOVAL OF OIL PUMP

1. Remove the oil pump suction head.
2. Remove the gasket.



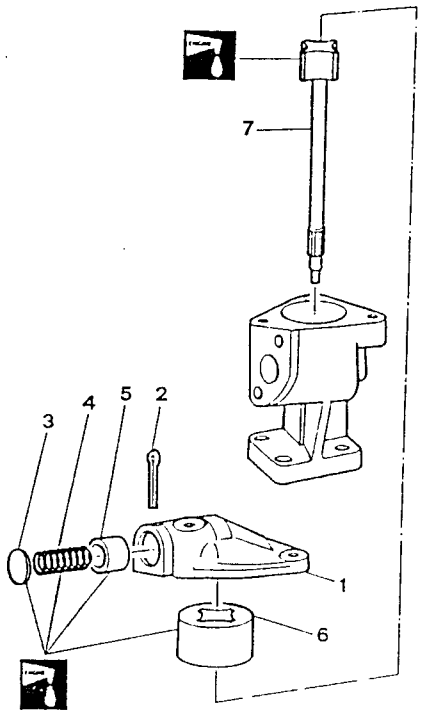
1. Remove the complete oil pump.



OIL PUMP DISASSEMBLY

1. Remove the cover.
2. Remove cotter pin.
3. Remove cover plate.
4. Remove spring.
5. Remove the oil pressure relief valve.
6. Withdraw the driven rotor from the pump body.
7. Withdraw the inner rotor and shaft from the pump body.

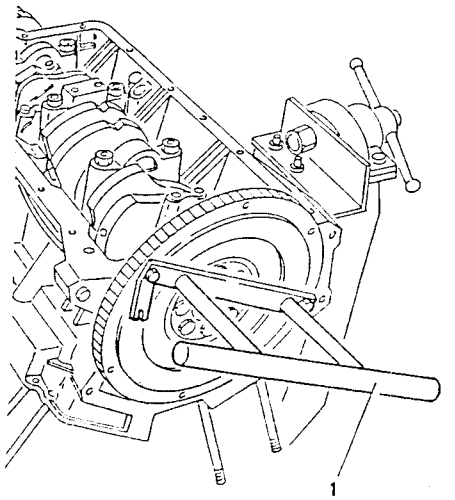
NOTE: The inner rotor must never be separated from the shaft.



NOTE: Before installing the pump, carry out the checks and inspections given in the relevant paragraph.

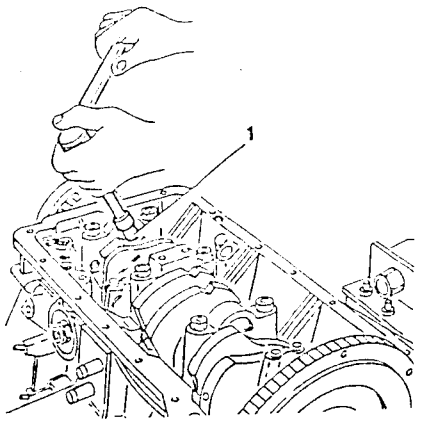
REMOVAL OF THE CYLINDER LINERS AND PISTONS

1. Install a suitable tool permitting the crankshaft to be rotated.

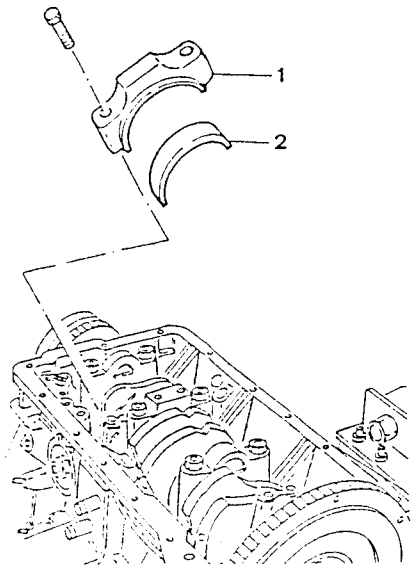


- Operate on the right-hand row of cylinders (1st, 2nd and 3rd cylinders).
- Rotate the crankshaft as required in order to gain access to the rod cap retaining screws.

1. Loosen and remove the screws securing the rod caps.



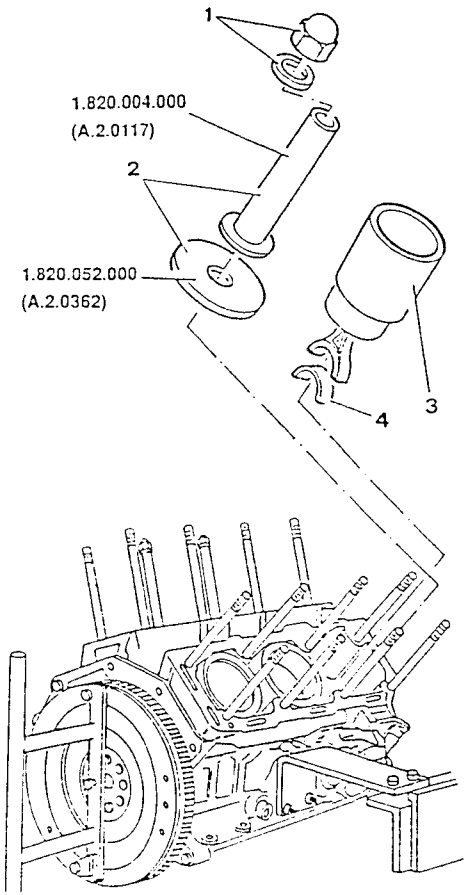
1. Remove the rod caps from the 1st, 2nd and 3rd cylinder.
2. Remove the relevant rod bearing halves.



– Unlock the rotary stand and rotate the engine block 180°.

1. Unscrew the nuts and washers of the cylinder liners.
2. Remove the cylinder liner retainers N° 1.820.004.000 (A.2.0117) with their washers N° 1.820.052.000 (A.2.0362) from the relevant row of cylinders only.
3. Withdraw all piston-rod groups and cylinder liners from the engine block.
4. Remove the relevant rod bearing halves.

– Rotate the engine block 180° and operate in the same way on the left-hand row of cylinders (4th, 5th and 6th cylinders).



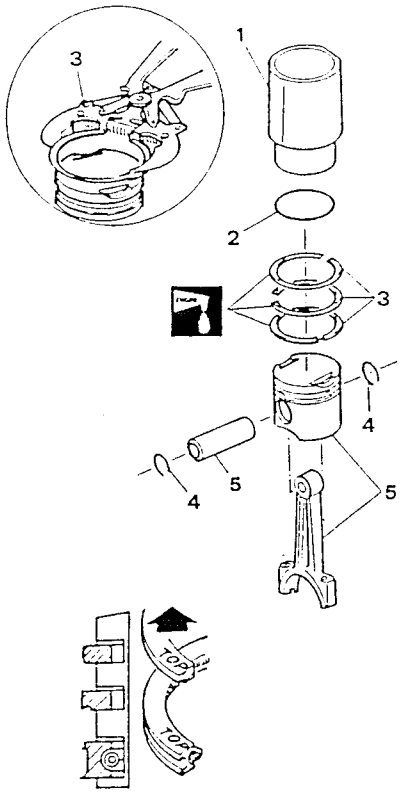
1. Withdraw the cylinder liners.
2. Remove the O-Ring.
3. Using a suitable tool withdraw the piston rings and oil scraper ring from the piston.

CAUTION:
Proceed with care in order to avoid accidental breakage of the piston rings which may otherwise be reused.

Install the piston rings so that the word "TOP" stamped on to the rings faces upwards.

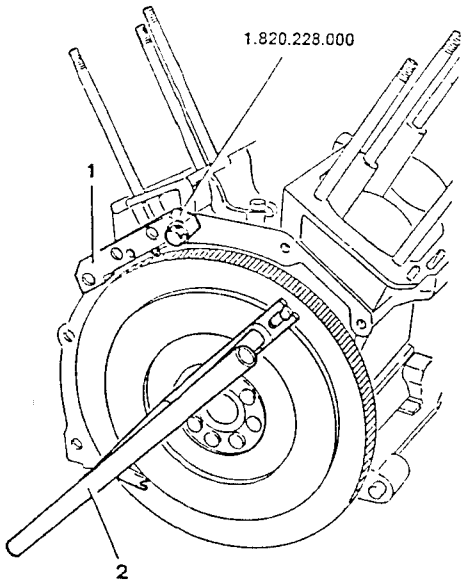
4. Remove the two flexible rings securing the gudgeon pin.
5. Withdraw the gudgeon pin and separate the piston from the rod.

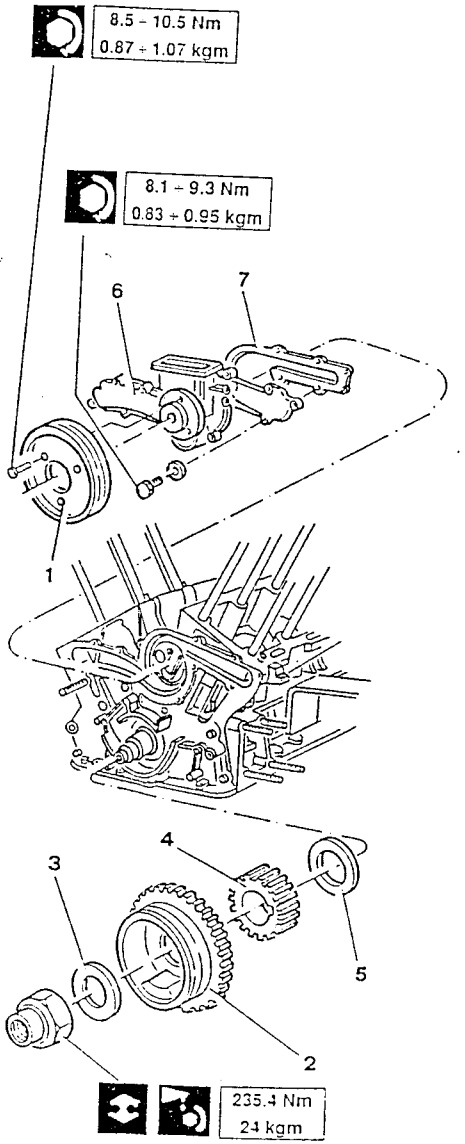
For subsequent installation, refer to the indications given in the relevant paragraph.



REMOVAL OF WATER PUMP

1. Install tool N° 1.820.228.000 to prevent rotation of the engine flywheel.
2. Remove flywheel rotation tool.

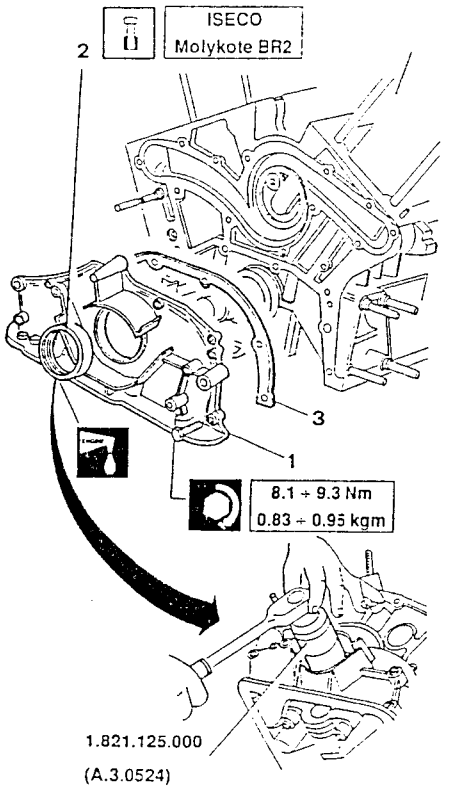




1. Remove the water pump drive pulley.
2. Remove the crankshaft pulley.
3. Remove the washer.
4. Remove the toothed pulley driving the timing belt.
5. Remove the shoulder ring (During installation the convex surface should face the front cover).
6. Remove the water pump.
7. Remove the water pump gasket.

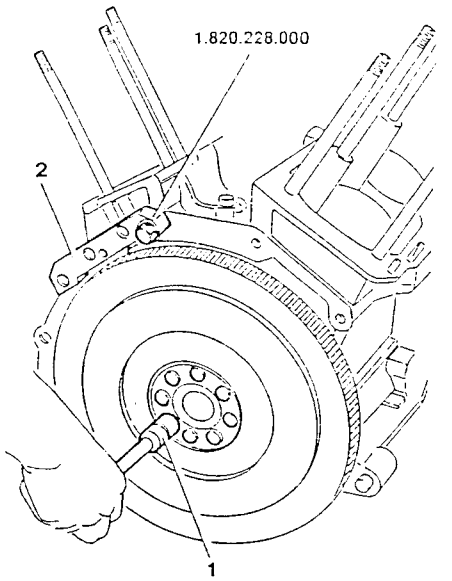
REMOVAL OF FRONT COVER

1. Remove the front cover.
2. Remove the oil seal (install using inserting tool N° 1.821.125.000/A.3.0524).
3. Remove the gasket between the front cover and the engine block.

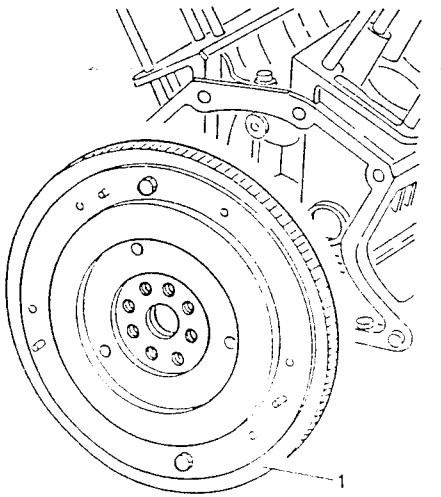


REMOVAL OF FLYWHEEL

1. Unscrew the screws securing the flywheel to the crankshaft.
2. Remove tool N° 1.820.228.000.



1. Remove the flywheel.

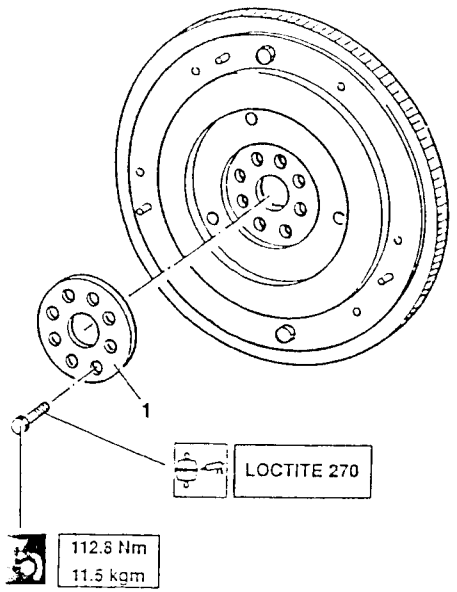


NOTE: When grinding the flywheel, observe the dimensions given in "Technical Characteristics and Specifications".

During installation, before applying the prescribed fixative to the screw threads, remove all traces of the old fixative.

NOTE: The engine flywheel can be installed in one position only, due to the asymmetric spacing of the screw holes.

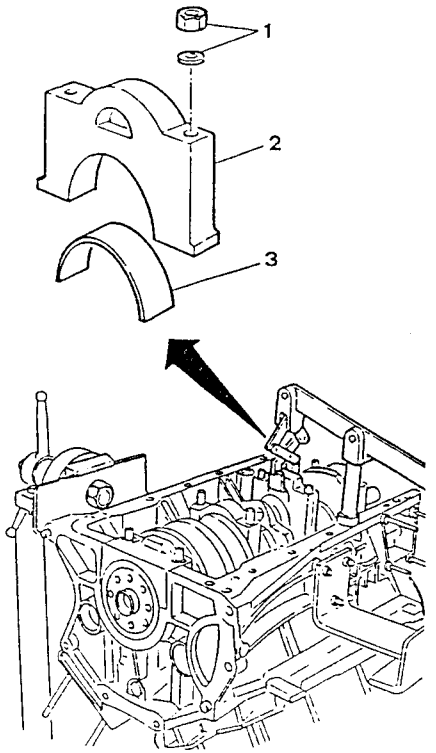
1. Remove the safety washer.



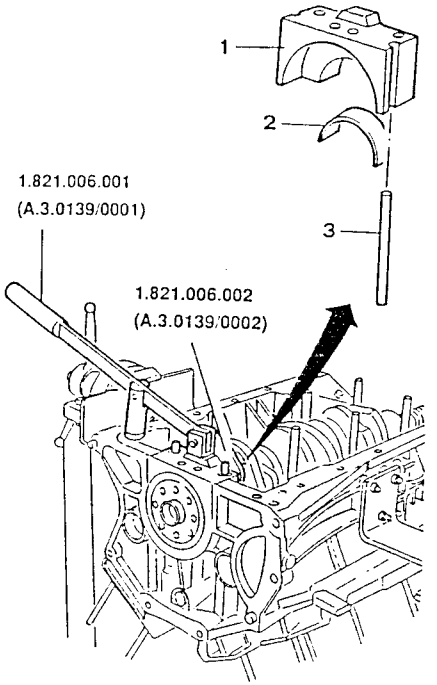
REMOVAL OF CRANKSHAFT

– Unlock the rotary stand and rotate the engine block 180°.

1. Remove the six nuts and screws securing the front and central main bearing caps.
2. Remove the three front and central main bearing caps using a suitable puller.
3. Remove the relative main bearing halves.



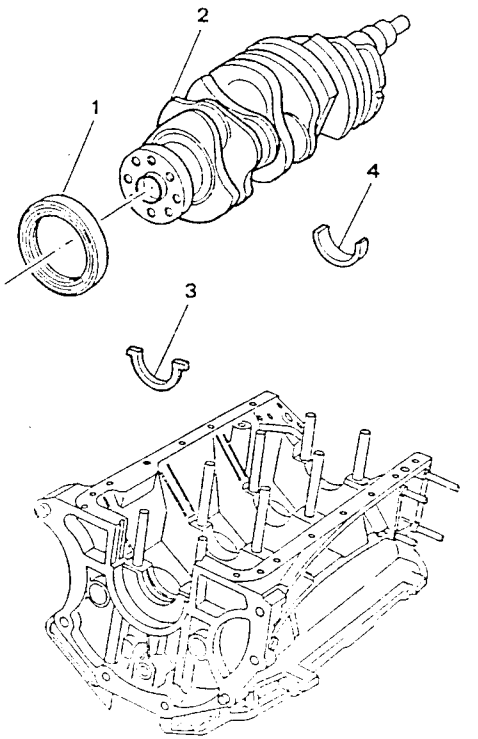
1. Remove the rear main bearing cap using a puller consisting of lever N° 1.821.006.001 (A.3.0139/0001) and fork N° 1.821.006.002 (A.3.0139/0002).
2. Remove the relative main bearing half.
3. Remove rubber pads.



1. Remove the oil seal.
2. Remove the crankshaft.
3. Remove the thrust half-bearings.
4. Remove the main half-bearings from the engine block.

NOTE: Note the reciprocal position if the parts are to be reassembled.

For installation of the crankshaft, observe the warnings given in the relevant paragraph.

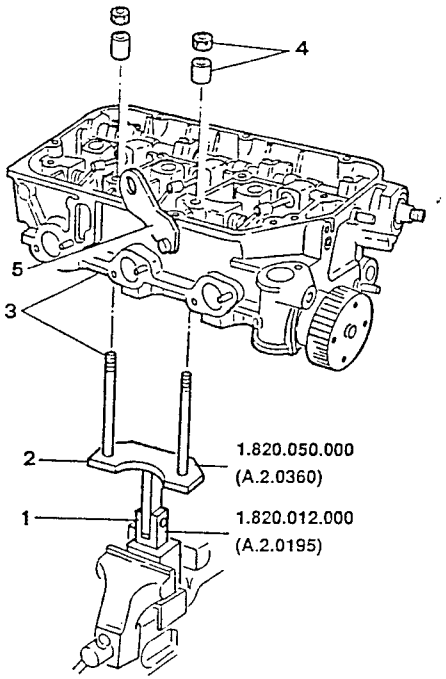


DISASSEMBLY OF THE CYLINDER HEADS

PRELIMINARY OPERATIONS

NOTE: The operations described below refer to the right-hand cylinder head (unless stated otherwise).
The procedure for disassembly of the left cylinder head is similar to that given for the right.

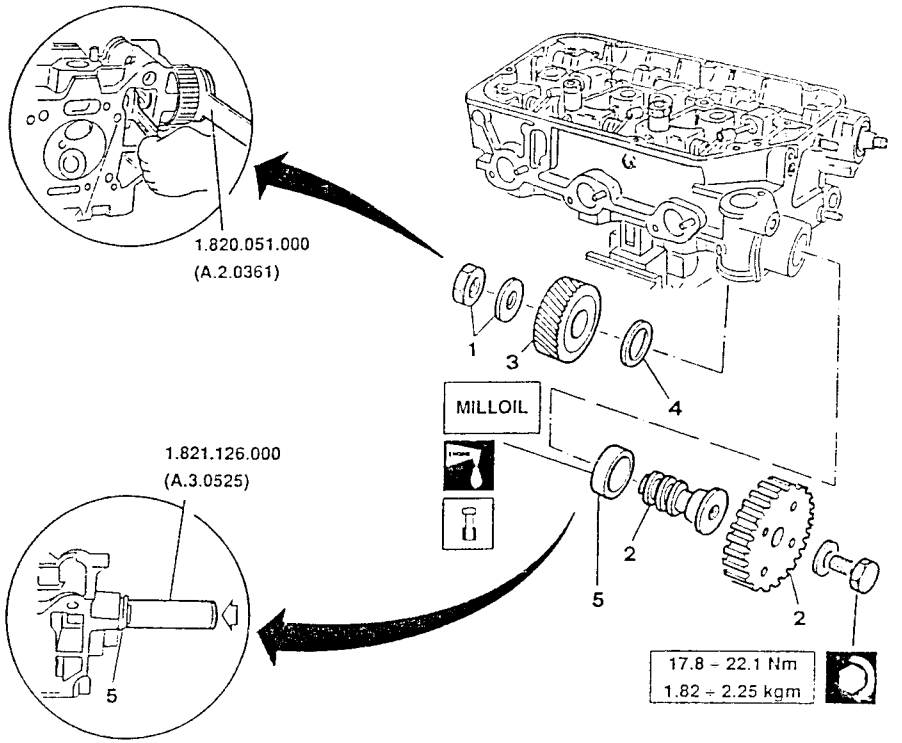
1. Lock the adjustable support N° 1.820.012.000 (A.2.0195) in a vice.
2. Install the fork N° 1.820.050.000 (A.2.0360) and lock it to the support.
3. Install the cylinder head on the fork studs.
4. Lock the cylinder head using two spacers and two lock-nuts.
5. Remove the engine lifting bracket.



REMOVAL OF THE OIL PUMP DRIVE PULLEY (Right-hand cylinder head only)

1. Using tool N° 1.820.051.000 (A.2.0361), remove the retaining nut and relative washer.
2. Withdraw the toothed pulley together with the control shaft.
3. Remove the toothed wheel.
4. Remove the spacer.
5. Remove the oil seal ring.

For installation use inserting tool N° 1.821.126.000 (A.3.0525).

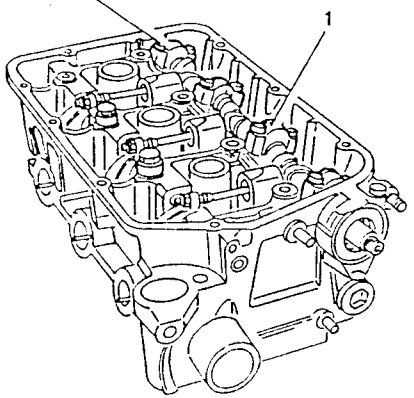


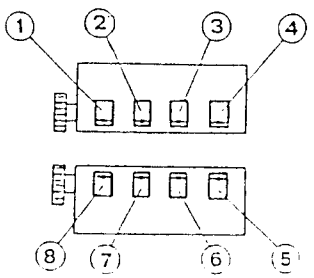
REMOVAL OF CAMSHAFT AND ROCKER ARMS SUPPORT SHAFT

1. Remove the camshaft caps.

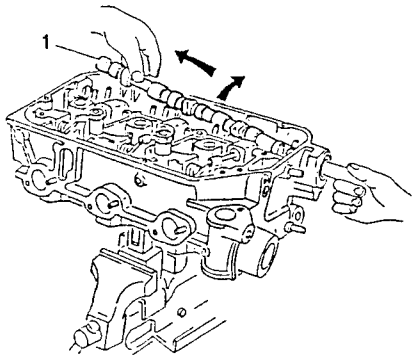
The caps are numbered in sequence (1, 2, 3 and 4 on the right-hand cylinder head; 5, 6, 7 and 8 for the left-hand cylinder head). On installation, replace the caps in the same order.

16 ÷ 18 Nm
1.63 ÷ 1.84 kgm





1. Remove the camshaft by first lifting the rear end, and then withdrawing it as indicated by the arrows in the diagram.

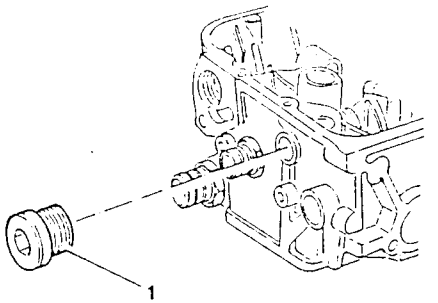


CAUTION:
Proceed with care; the cams and support mating surfaces are easily damaged.

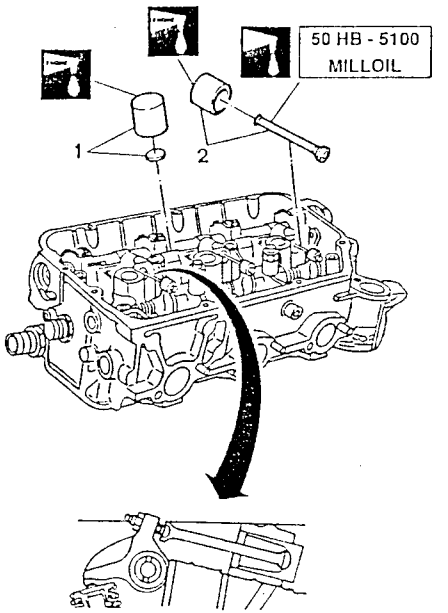
1. Withdraw the intake side valve cups and relative valve clearance adjustment shims.
2. Withdraw the exhaust side valve cups and relative rocker arm rods.

NOTE: Arrange the components in sequence order if they are to be re-used.

NOTE: For checking and adjustment of valve clearance follow the indications given in the relevant paragraph.



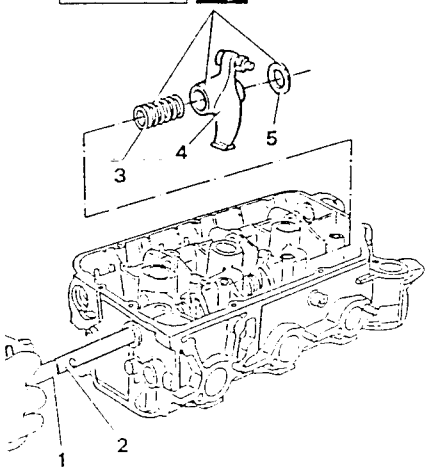
50 HB - 5100
MILLOIL



1. Remove the rocker arm shaft plug.

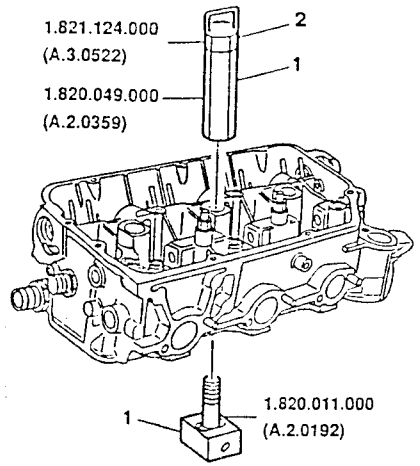
1. Screw a suitable tool onto the threaded tug of the rocker arm shaft.
2. Gradually withdraw the rocker arm shaft.
3. Remove the springs.
4. Remove the rocker arms.
5. Remove the washers.

50 HB - 5100
MILLOIL

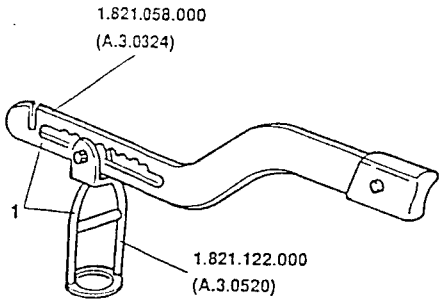


VALVE DISASSEMBLY

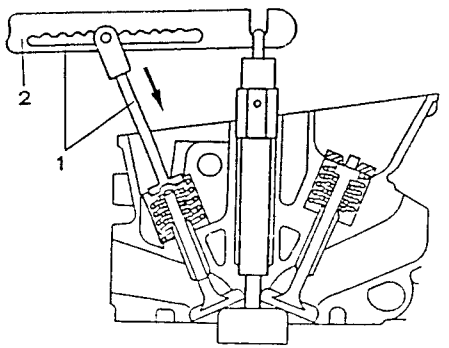
1. Insert valve supporting tool N° 1.820.011.000 (A.2.0192) throught the lower side of the spark plug well and lock it with the special nut N° 1.820.049.000 (A.2.0359).
2. Screw support tool N° 1.821.124.000 onto the threaded end of tool N° 1.820.049.000 (A.2.0359).



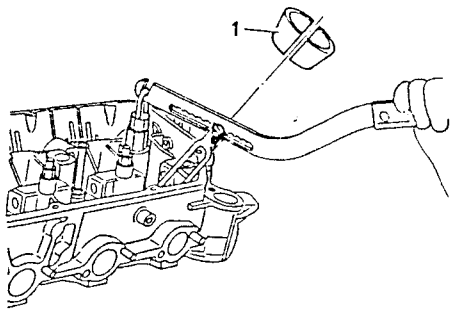
1. Install the cone halves disassembly/reassembly cage N° 1.821 122.00 (A.3.0520) onto lever N° 1.821 058 000 (A.3.0324).

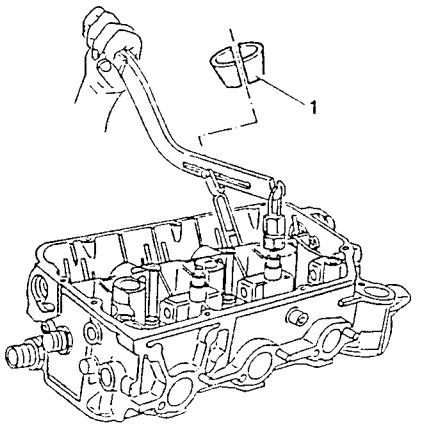


1. Position the previously assembled tools as shown in the diagram.
2. Press the lever of tool N° 1.821.058.000 (A.3.0324) to contrast the resistance of the valve springs.



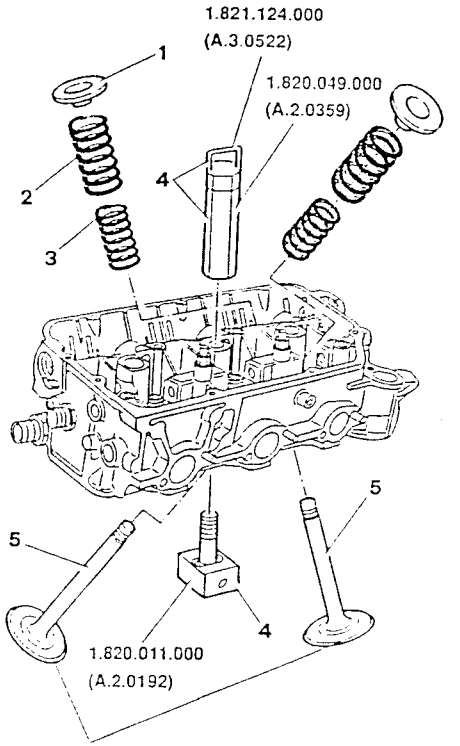
1. Remove the intake and exhaust valve cotters.





1. Remove the upper caps.
2. Remove the outer springs.
3. Remove the inner springs.
4. Remove tools N° 1.820.049.000 (A.2.0359) with N° 1.821.124.000 (A.3.0522) and N° 1.820.011.000 (A.2.0192).
5. Remove the two valves (intake and exhaust).

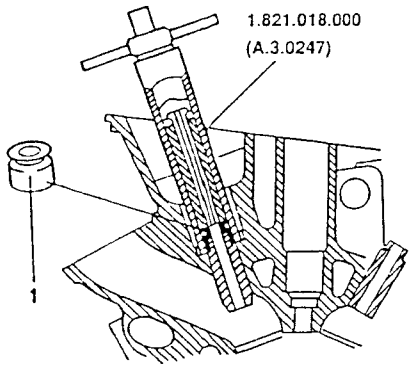
NOTE: **Operate on the remaining cylinder heads following the same procedure and using the same tools.**

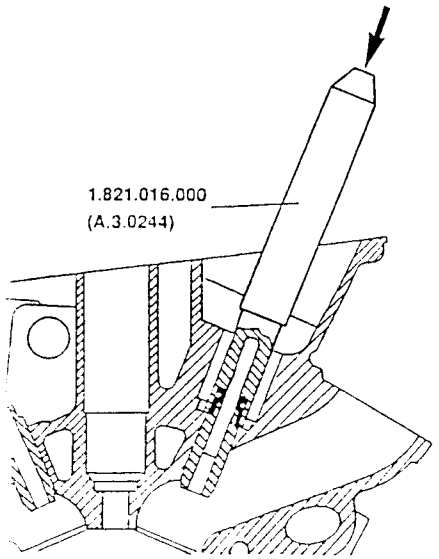


Vaseline

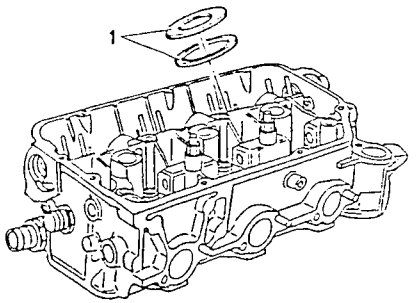
1. Using puller N° 1.821.018.000 (A.3.0247) remove the oil sealing pads.

For installation, use inserting tool N° 1.821.016.000 (A.3.0244).



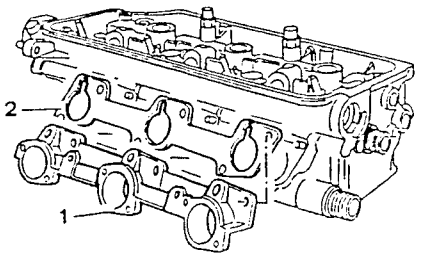


1. Remove the lower caps.



REMOVAL OF INTAKE MANIFOLD

1. Remove intake manifold.
2. Remove the gasket located between the manifold and the cylinder head.



CYLINDER HEAD - INSPECTIONS AND CHECKS

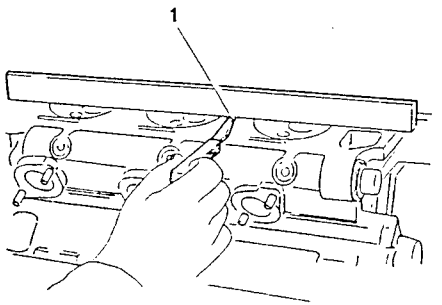
CYLINDER HEAD LOWER PLANE CHECK

- Thoroughly clean the cylinder head plane of all traces of old gasket.
- Visually inspect the cylinder head for signs of cracking, overheating, scoring or excessive wear.

1. Check that the lower plane is flat and, if it is found to be excessively distorted, reface the surface.

NOTE: Facing must be carried out on both heads.

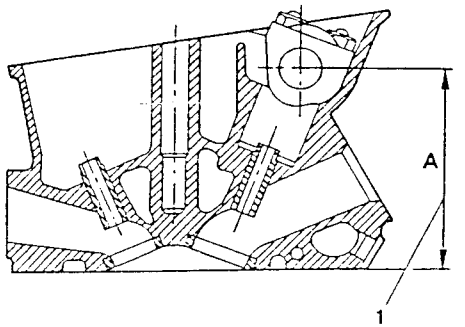
Maximum head lower plane flatness error
0.05 mm



1. After facing, check that the height of the heads exceeds the permitted minimum and that the surfacing of the lower plane of the heads is of the required quality.

CAUTION:
Do not exceed the permitted minimum value as this may cause serious engine malfunction.

Minimum permitted height of the heads after facing
A = 124.85 to 125.15 mm



CYLINDER HEAD BUSHINGS CHECK

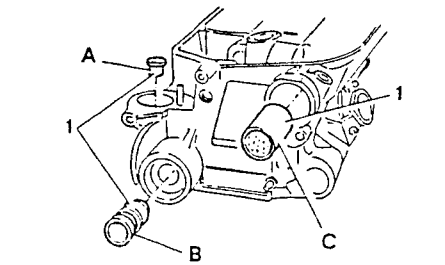
1. Measure the inner diameter "d" of the bushings installed on the cylinder heads and check that it is within the prescribed limits.

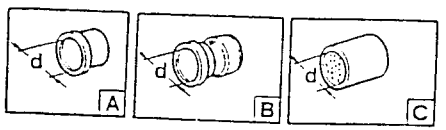
«A» (Right-hand cylinder head only) Oil pump drive gear bushing.

«B» (Right-hand cylinder head only) Oil pump drive toothed pulley shaft bushings.

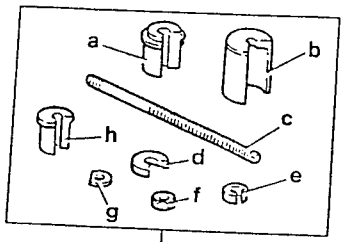
«C» Camshaft drive toothed pulley hub bushings.

Inner diameter of bushings "d"	
"A"	19.000 to 19.021 mm
"B"	19.000 to 19.021 mm
"C"	32.000 to 32.025 mm





NOTE: If the values measured do not fall within the prescribed limits, the bushings should be replaced using tool N° 1.821.129.000 (A.3.0528).

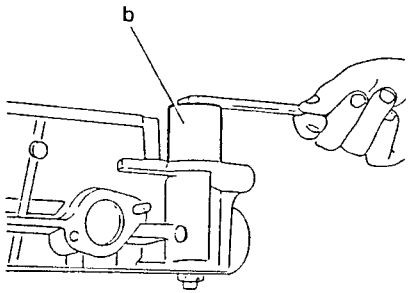


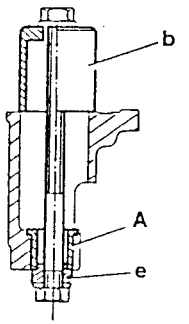
1.821.129.000
(A.3.0528)

Parts of tool 1.821.129.000 (A.3.0528)	
a. Reactor block	e. Special washer
b. Cup	f. Hexagonal nut
c. Tie rod	g. Shaped washer
d. Flange	h. Reactor block

REMOVAL OF BUSHING «A» (For oil pump drive gear)

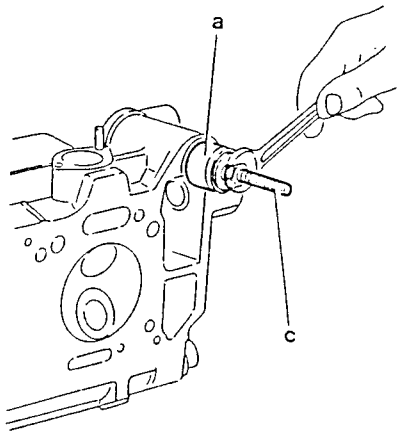
- Withdraw the oil pump drive gear bushing "A" using the special washer "e" as a pressure disc and cup "b" as a reactor.

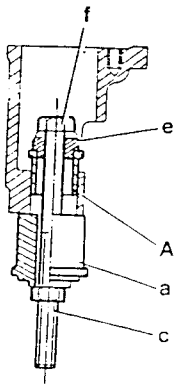




INSERTION OF BUSHING «A» (For oil pump drive gear)

- Position new bushing.
- Insert tie-rod "C" together with nut "F" and special washer "e" (as a pressure disc)
- Insert the reactor block "a" from the opposite side of the tie-rod, and complete bushing installation.

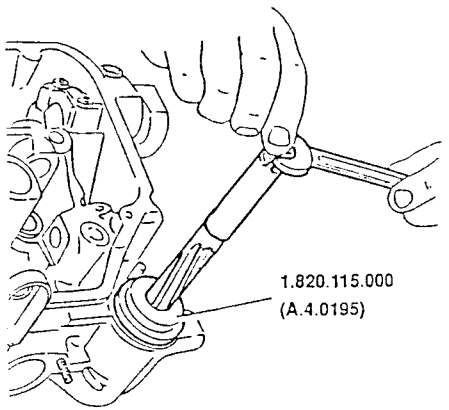


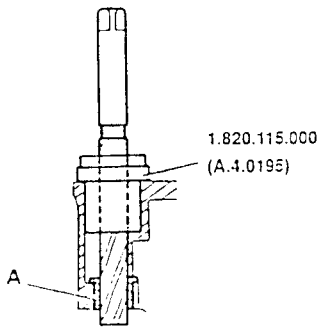


REAMING OF BUSHING «A» (For oil pump drive gear)

– After installation, ream bushing «A» to the prescribed dimension using drive tool N° 1.820.115.000 (A.4.0195) and a suitable reamer.

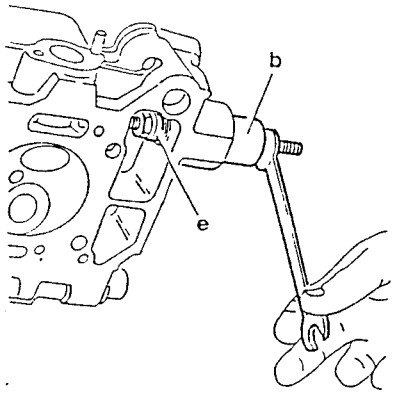
Ø	Pump drive gear hub bushing inner diameter (reaming)
	19.000 to 19.021 mm

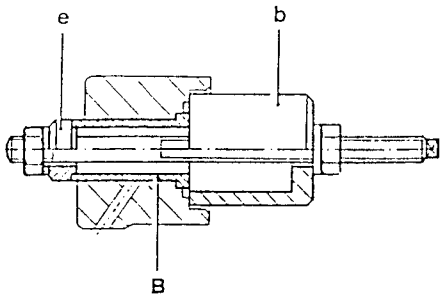




REMOVAL OF BUSHING «B» (For oil pump drive pulley shaft)

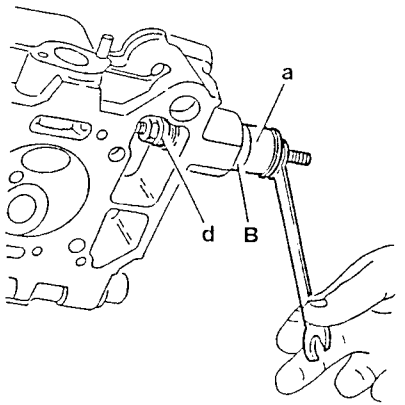
– Withdraw the oil pump drive pulley shaft bushing «B» using the special washer "e" as a pressure disc, and cup "b" as a reactor.

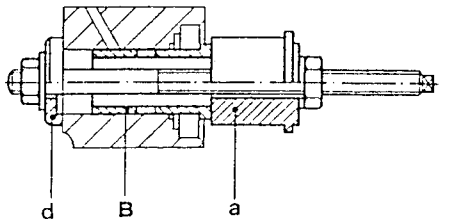




INSERTION OF BUSHING «B» (For oil pump drive pulley shaft)

– Insert oil pump drive pulley shaft bushing using reactor block "a" as a pressure disc and flange "d" as a reactor.

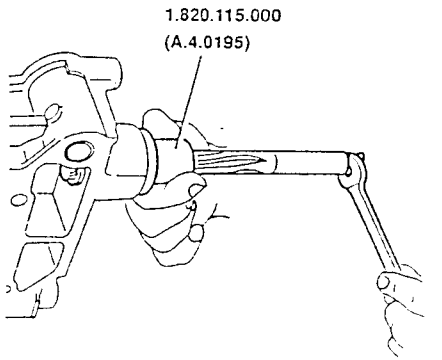


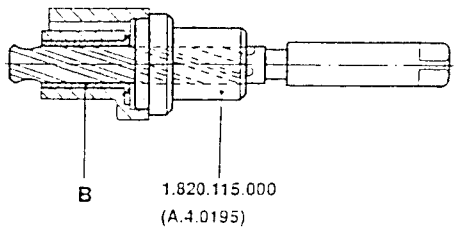


REAMING OF BUSHING «B» (For oil pump drive pulley shaft)

– After installation, ream bushing «B» to the prescribed dimension using drive tool N° 1.820.115.000 (A.4.0195) and a suitable reamer.

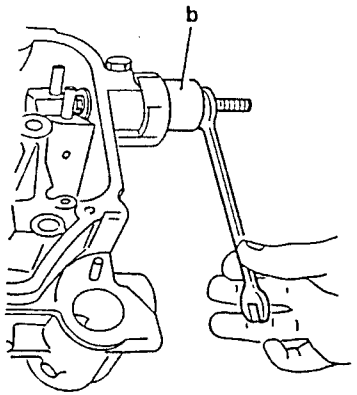
Ø	Oil pump drive pulley hub bushing inner diameter
	19.000 to 19.021 mm

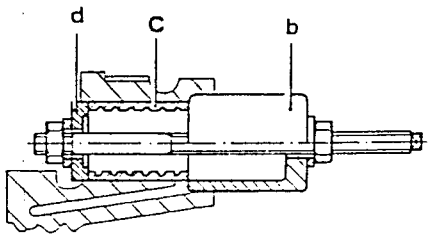




REMOVAL OF BUSHING «C» (For camshaft drive pulley hub)

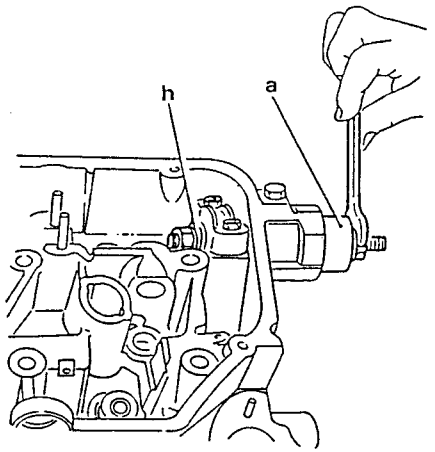
- Withdraw camshaft drive pulley hub bushing "C" using flange "d" as a pressure disc and cup "b" as a reactor.

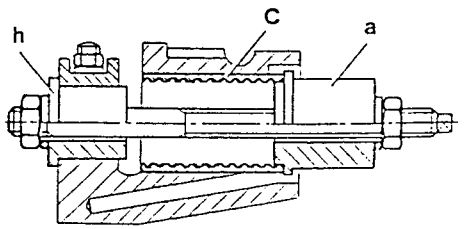




INSERTION OF BUSHING «C» (For camshaft drive pulley hub)

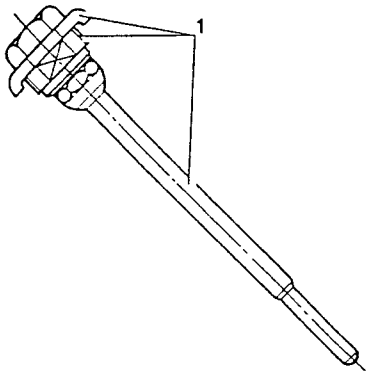
- Install adjacent camshaft cover and lock it with the two nuts.
- Point bushing «C» and insert bushing using the reactor block "a" as a pressure disc and block "h" as a reactor.



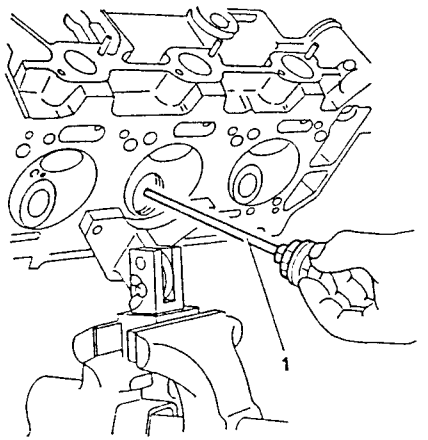


REPALCEMENT OF VALVE SEATS

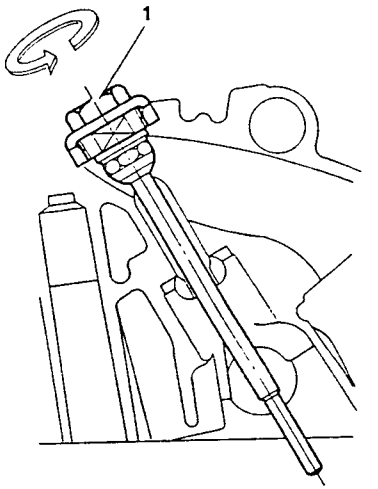
1. Install and lock onto the mandrel the lock ring and tap selected to fit the diameter of the valve seat to be removed.



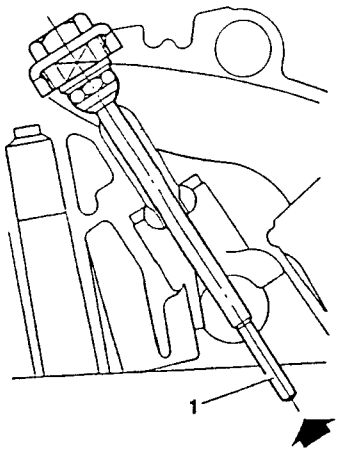
1. Insert the assembly prepared as above, into the valve guide until the tap contacts against the valve seat.



1. Thread the valve seat using a suitable spanner and acting on the mandrel head until the ring touches the valve seat plane; then unscrew by half a turn.

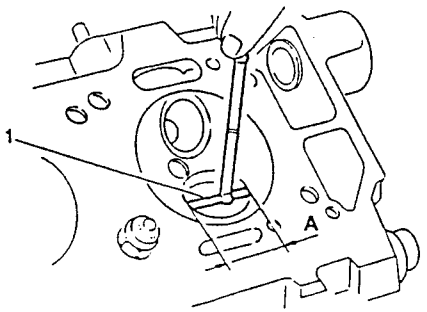


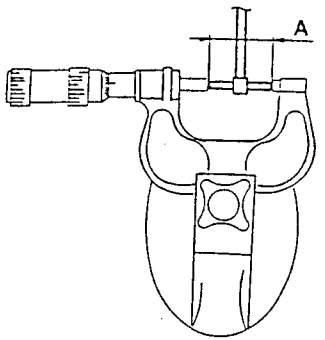
1. Withdraw the valve seat while tapping on the mandrel end protruding from the cylinder head.



1. Check that the diameter of the valve seat housing "A" is within the prescribed limits.

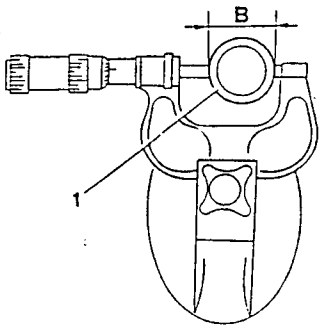
∅	Valve seat housing diameter "A"
intake	42.000 to 42.025 mm
exhaust	37.000 to 37.025 mm



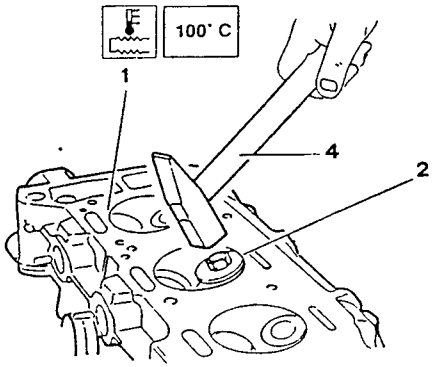


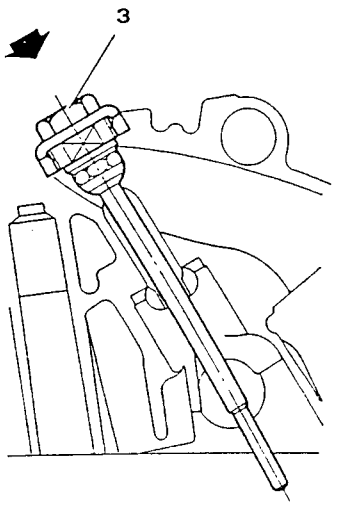
1. Check that the outer diameter of the replacement valve seat «B» is within the prescribed limits.

∅	Valve seat outer diameter "B"
intake	42.065 to 42.100 mm
exhaust	37.095 to 37.111 mm



1. Preheat the head to a temperature of about 100°C.
2. Install the lock ring (selected to fit the diameter of the valve seat to be installed) onto the mandrel and lock it into position.
3. Insert the assembly prepared above into the valve guide until the lock ring contacts against the valve seat.
4. Insert the valve seat by tapping on the end of the mandrel protruding from the cylinder head.

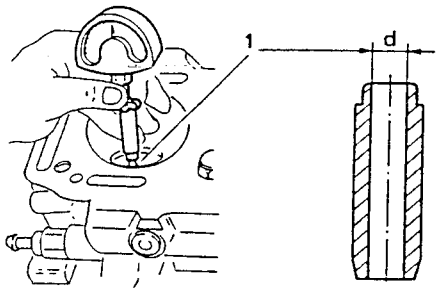




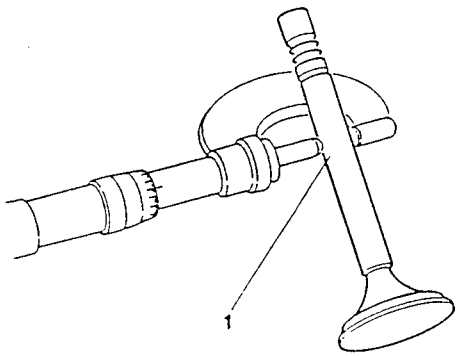
CLEARANCE BETWEEN VALVE GUIDE AND STEM

1. Measure the inner diameter "d" of the valve guide and check that the dimension is within the prescribed limits.

∅	Valve guide internal diameter
Intake and ehaust	d = 9.000 to 9.015 mm



1. Measure the diameter of the valve stem in at least three different points at right-angles from each other.



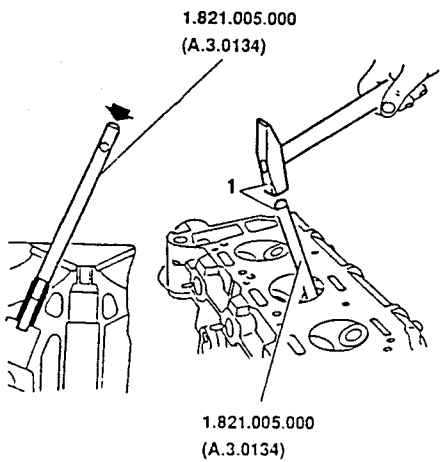
- Calculate the clearance by subtracting the diameter of the valve stem from the inner diameter of the valve guide; replace the parts if the clearance is not within the prescribed limits.

Radial clearance between valve stem and valve guide inner diameter		
intake	LIVIA	0.023 to 0.058 mm
	ATE	0.020 to 0.065 mm
exhaust		0.055 to 0.090 mm

REPLACING VALVE GUIDES

- Visually check the valve guides for nicks, signs of scoring, distortion or displacement from the original installation position.

1. If necessary withdraw the valve guide using puller N° 1.821.005.000 (A.3.0134).



- Measure the diameter of the valve guide seat and outer diameter of the new valve guide; the installation interference must be within the prescribed tolerances.

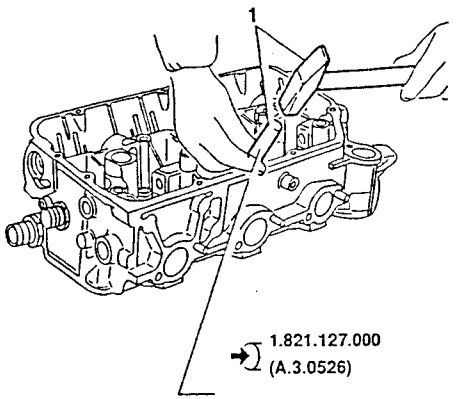
Diameter of valve guide seat	
intake and exhaust	13.990 to 14.018 mm

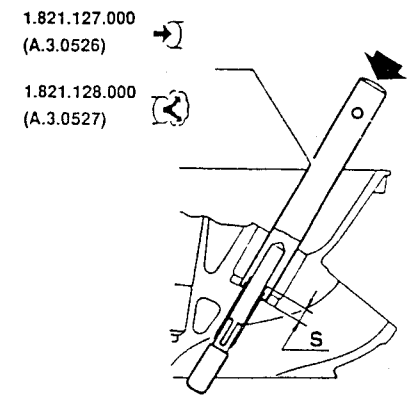
Outer diameter of valve guide	
intake and exhaust	14.048 to 14.059 mm

Interference between valve guide and seat	
intake and exhaust	0.030 to 0.069 mm

1. Insert the new valve guides using the special inserting tools which also ensure correct protrusion values.

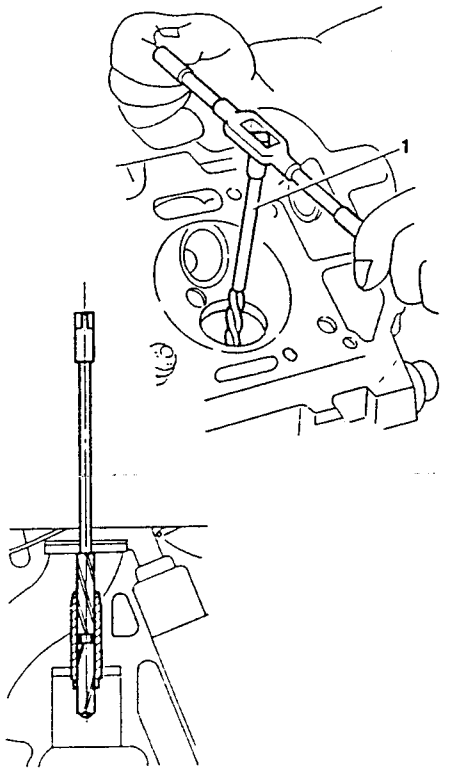
Valve guide protrusion	
intake and exhaust	10.2 to 10.6 mm





1. Ream the new valve guides (intake and exhaust) using a reamer to bring the holes to the prescribed diameter.

Internal diameter of the valve guide	
intake and exhaust	9.000 to 9.015 mm

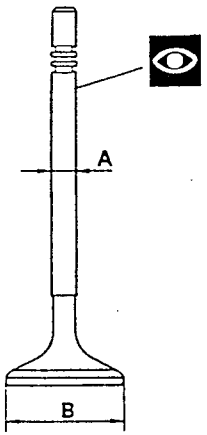


VALVES

- Check valves for nicks, burning or noticeable traces or scoring with the corresponding seatings on the cylinder heads; replace vales if necessary.
- If tha valves are in good condition proceed to a dimensional check of the stem and head diameters which should be within the prescribed limits.

Diameter of valve stem «A»		
intake	LIVIA	8.957 to 8.977 mm
	ATE	8.950 to 8.980 mm
exhaust		8.925 to 8.945 mm

Diameter of valve head «B»		
intake	LIVIA	40.850 to 41.000 mm
	ATE	40.800 to 41.000 mm
exhaust		36.450 to 36.600 mm



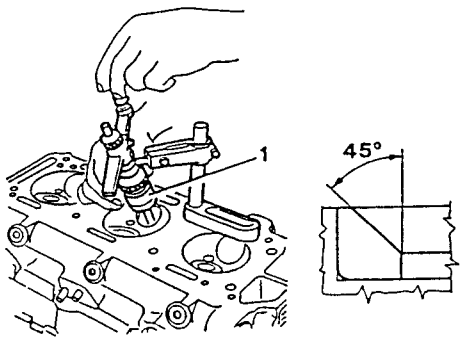
NOTE: If the valves are found to be "burned", check that the springs are operating properly and check the valve clearance.

VALVE SEAT TURNING

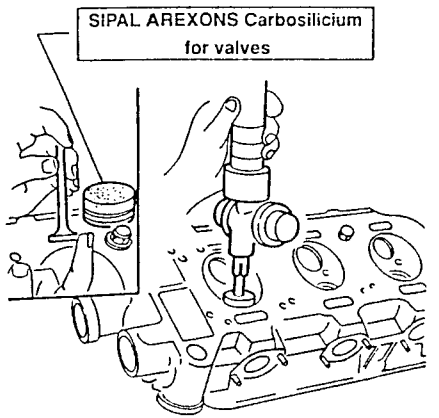
1. If necessary carry out valve seat turning using a suitable tool.

NOTE: Taper "C" can be obtained by positioning the hand lathe tool at an angle of 45°.

Valve seat taper	
ntake and exhaust	"C" = 90° ± 20'



- Smear the stop limit surfaces of the valves and relevant seats with abrasive paste.
- Lubricate the valve stem with engine oil.
- Fix the lower surface of the valve head to the suction cup of a pneumatic lap.
- Insert the valve into the relative guide and grind.
- After grinding thoroughly clean both the valves and their seats.



VALVE SPRINGS

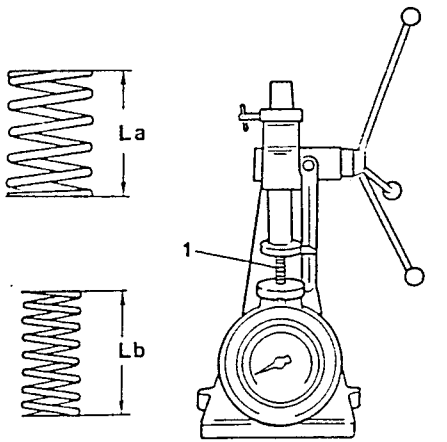
- Check that the length of the "free" springs is within the prescribed limits.
  The terminal planes must be parallel to each other and perpendicular to the spring axis (maximum allowable margin of error = 2°).

1. Using a dynamometer check that the characteristic data of the springs are within the prescribed limits.

Length of free springs	
outer spring La	44.6 mm
inner spring Lb	44.1 mm

Outer spring		
Length of the spring	mm	Control loading N(kg)
Valve closed	32.5	243 to 252 (24.8 to 25.7)
Valve open	23.5	470 to 488 (47.9 to 49.7)

Inner spring		
Length of the spring	mm	Control loading N(kg)
Valve closed	30.5	126 to 130 (12.8 to 13.3)
Valve open	21.5	222 to 231 (22.7 to 23.5)

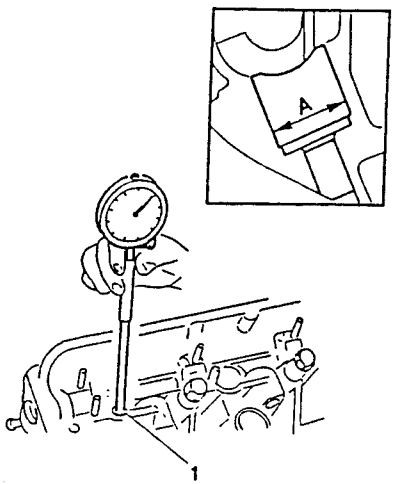


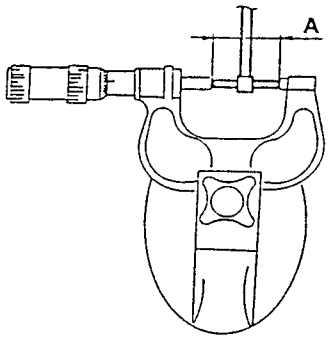
VALVE CUPS AND SEATS - INTAKE SIDE

- Check that the outer surfaces of the cups, and the upper plane, on which the cams work, are free from any traces of seizing, nicks or abnormal wear. If the cups are still serviceable carry out a dimensional check.

1. Check that the valve cup seat diameter is within the prescribed limits.

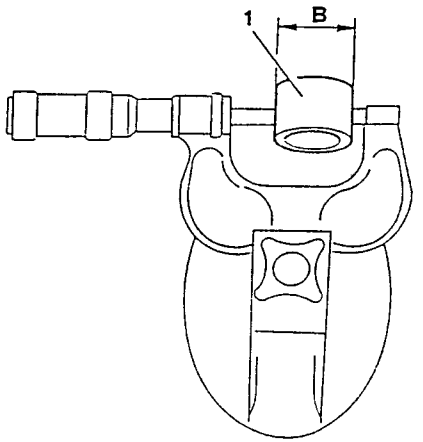
Diameter of intake valve cup seating
A = 35.000 to 35.025 mm





1. Check that the outer diameter of the valve cups is within the prescribed limits.

Diameter of intake valve cup
B = 34.973 to 34.989 mm

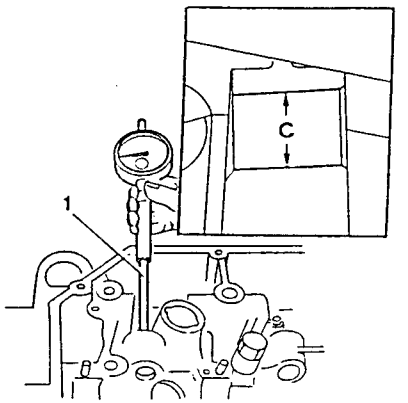


VALVE CUPS AND SEATS - EXHAUST SIDE

- Check that the outer surface of the valve cups and the upper plane on which the cams work are free from traces of seizing, nicks or abnormal wear. If the cups are still serviceable, carry out a dimensional check.

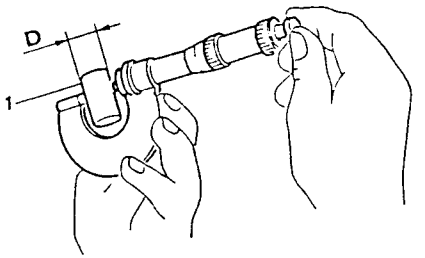
1. Check that the diameter of the valve cup seats is within the prescribed limits.

Exhaust valve cup seat diameter
C = 22.000 to 22.021 mm



1. Check that the external diameter of the valve cups is within the prescribed limits.

Diameter of exhaust valve cup
D = 21.971 to 21.989 mm

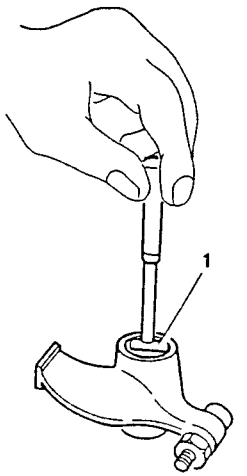


NOTE: **If the dimensions of the cups are not within the prescribed limits, the engine will be excessively noisy.**

ROCKER ARMS AND ROCKER ARM SHAFT

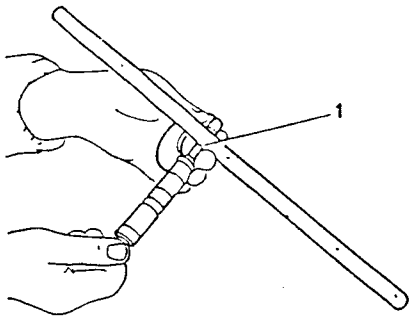
1. Check that the inner diameter of the rocker arms is within the prescribed limits.

Diameter of rocker arm bore
16.016 to 16.034 mm



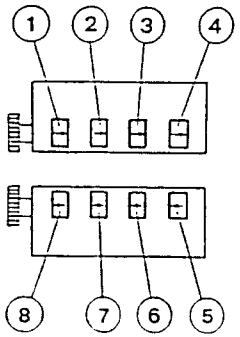
1. Check that the diameter of the rocker arm shaft is within the prescribed limits.

Diameter of rocker arm shaft
15.988 to 16.000 mm



CAMSHAFTS AND SUPPORTS

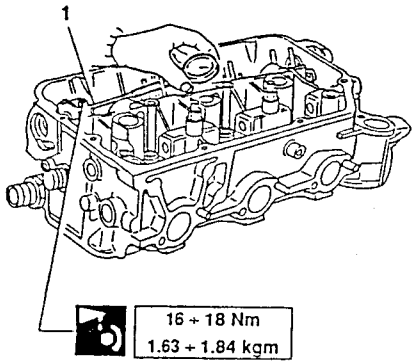
- Install the caps following the numbering and the direction shown by the arrow on the caps; Tighten the lubricated nuts to the prescribed torque.



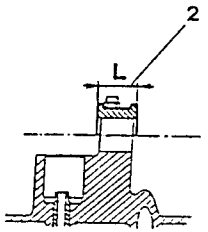
1. Check that the diameter of the camshaft supports is within the prescribed limits.
2. Check that the maximum width "L" of the shoulder is within the prescribed limits.

Camshaft support diameter
27.000 to 27.033 mm

Maximum shoulder width
26.851 to 26.935 mm



16 ÷ 18 Nm 1.63 ÷ 1.84 kgm



- Carefully check that the cams and camshaft working surfaces are free from scoring, traces of binding or overheating and abnormal wear.

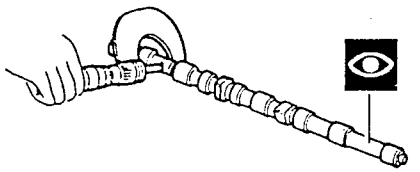
- Check that the diameter "A" of the journals is within the prescribed limits.
- Check that the height of the cams is above the minimum allowable value.
- Check that the cam shoulder length "B" is within the prescribed limits.
- Check that the the maximum eccentricity between the journals does not exceed the prescribed limit.

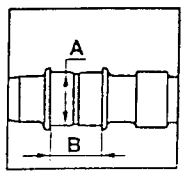
Diameter of camshaft journal
A = 26.949 to 26.970 mm

Minimum height of cams	
intake	9.6 mm
exhaust	9 mm

Shoulder length
B = 27.000 to 27.052 mm

Maximum eccentricity between camshaft journals
0.03 mm





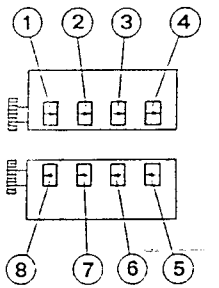
CAMSHAFT AXIAL PLAY CHECK

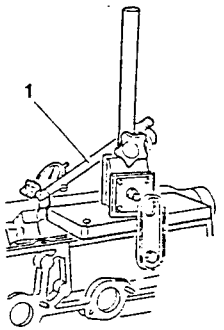
- Position the camshafts.
- Install the caps following the identification numbers and direction as shown by the arrow on the caps; tighten the lubricated nuts to the prescribed torque:

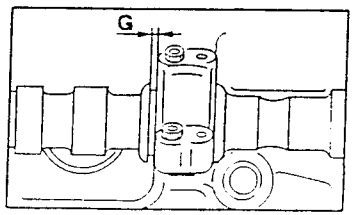
16 to 18 Nm (1.6 to 1.8 kgm)

1. Apply a centesimal dial gauge and measure the axial play "G" of the camshafts; check that the play is within the prescribed limits.

Camshaft axial play
G = 0.065 to 0.201 mm



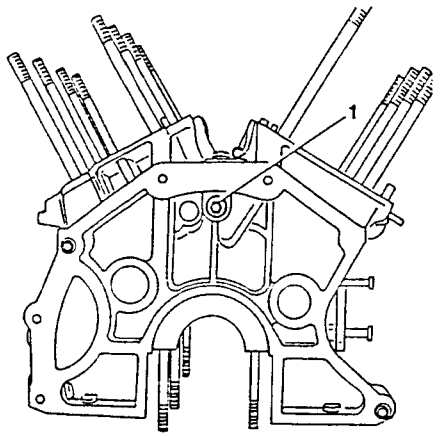


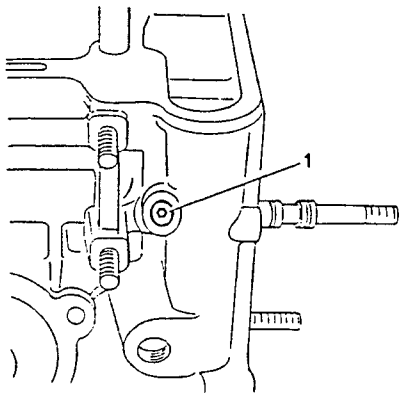


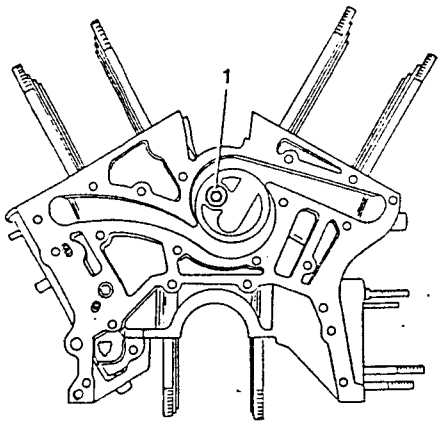
ENGINE BLOCK CHECKS AND INSPECTIONS

- Visibly check the enine block for signs of cracking, excessive wear of the sliding surfaces: check that the threads are all intact.

1. Remove the caps from the main engine lubrication channel and clean with a suitable detergent, Blow off with compressed air and install new caps.





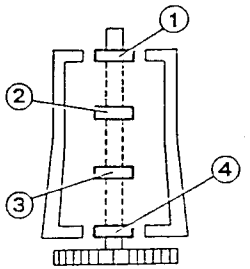


- Thoroughly clean the engine block faces with butyl acetate or methylethylketone to remove any fragments of gasket.

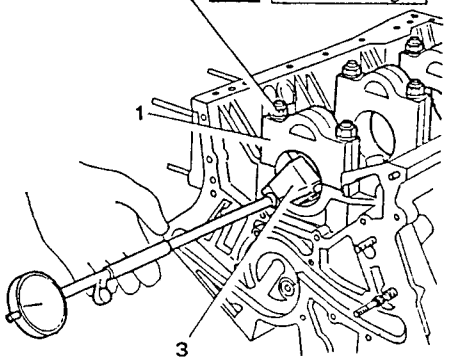
MAIN BEARING CAPS

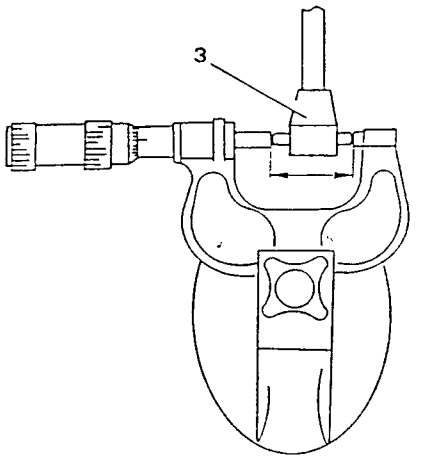
1. Install the main bearing caps in the position and direction identified by the numbering on the cap itself.
2. Tighten the lubricated nuts to the prescribed torque.
3. Using a bore gauge fixed to a centesimal dial gauge, check that the diameter of the main bearing is within the prescribed limits.

Classes	Diameter of main bearings
A-Red	63.657 to 63.663 mm
B-Blue	63.663 to 63.669 mm
C-Green	63.669 to 63.675 mm



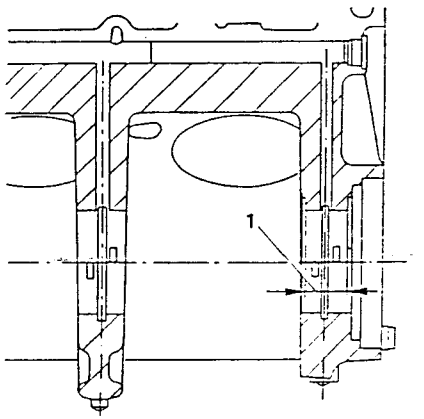
84 ÷ 92.7 Nm
8.56 ÷ 9.45 kgm





- Check that the length of the rear main bearing shoulder is within the prescribed limits.

Rear main bearing shoulder length
26.450 to 26.500 mm

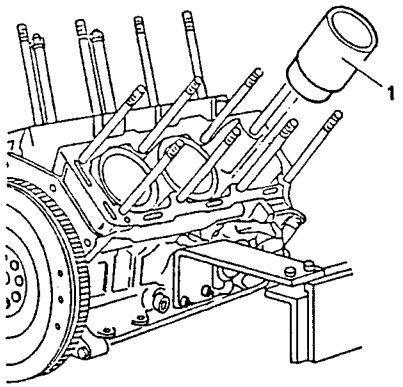


CYLINDER LINER PROTRUSION CHECK

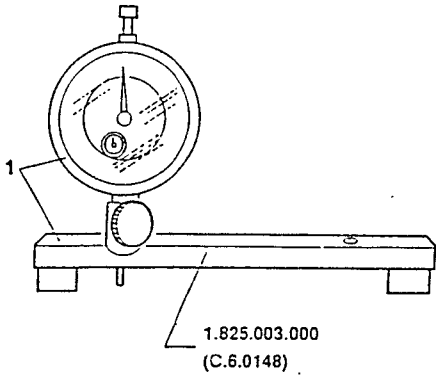
Without seal rings

NOTE: This procedure, a preliminary check to verify the correct mating of the cylinder liners with the engine block, should be carried out without seal rings and the cylinder liner retainer, which tightened to the correct torque would eliminate the thickness, is not therfore required.

1. Insert the cylinder liners into the engine block ensuring that they reach the stop limit.

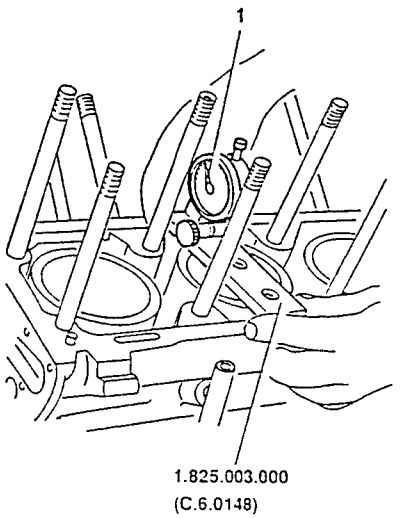


1. Apply a centesimal dial gauge to tool N° 1.825.003.000 (C.6.0148) and reset them on a datum plane.



1. Place tool N° 1.825.003.000 (C.6.0148) on the engine block, first on one side and then on the other, so that the dial gauge probe rests on the edge of the liner; then check that the protrusion is within the prescribed limits.

Protrusion of cylinder liners from the engine block
0.01 to 0.06 mm



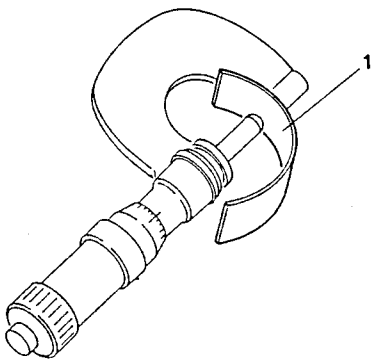
MAIN AND ROD BEARING HALVES THRUST HALF RINGS

- Clean the main and rod bearing halves and visually check for scoring or traces of binding. Replace all bearing halves if traces of wear are detected.

NOTE: Coupling between the main and rod bearing halves and the crankshaft must be carried out by matching the parts of the same dimensional class identified by dots of the same colour on the side of the bearing half and on the relevant crankshaft journal.

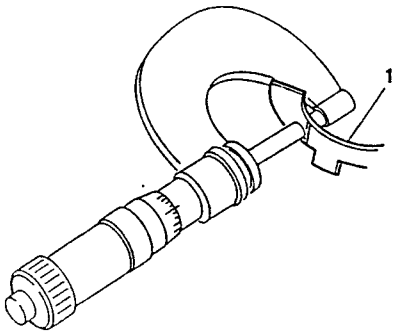
1. Using a micrometer, measure the thickness of the bearing halves and check that they are within the prescribed limits.

Thickness of bearing halves		
RED (A)	MAIN	1.833 to 1.839 mm
	ROD	1.737 to 1.745 mm
BLUE (B)	MAIN	1.839 to 1.845 mm
	ROD	1.741 to 1.749 mm
GREEN (C)	MAIN	1.845 to 1.851 mm
	ROD	-



1. Check that the thickness of the thrust half rings is within the prescribed limits.

Thickness of thrust ring halves
2.310 to 2.360 mm



CRANKSHAFT

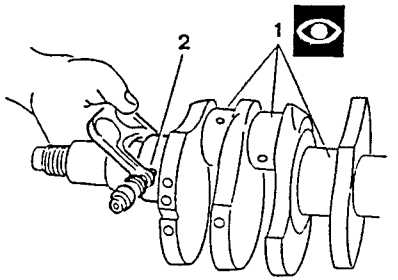
Main and rod journals

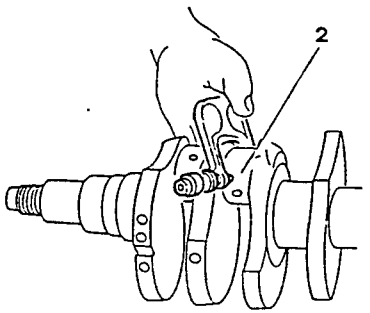
1. Check that the main and rod journal working surfaces do not show traces of irregular wear, nicks, seizing or overheating.

NOTE: **The nitring treatment to which the crankshaft has been subject does not permit grinding operations to be carried out, therefore, if it is excessively worn it should be replaced.**

2. Place the crankshaft on a tailstock bench and measure the diameter of the main and rod journals to check that they are within the prescribed limits.

NOTE: **The crankshaft journals are subdivided into two classes distinguished by a coloured mark in accordance with the operational tollerances.**



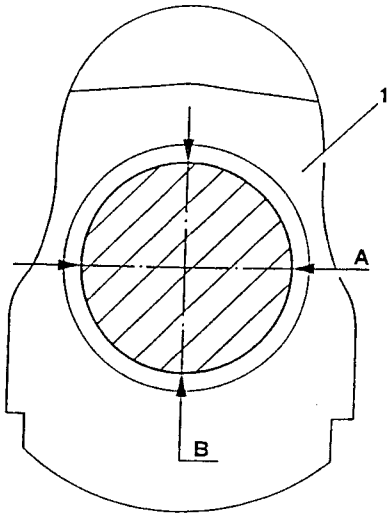


Diameter of main journal	
RED (A)	59.973 to 59.979 mm
BLUE (B)	59.967 to 59.973 mm
GREEN (C)	59.961 to 59.967 mm

Diameter of rod journal	
RED (A)	51.990 to 52.000 mm
BLUE (B)	51.980 to 51.990 mm

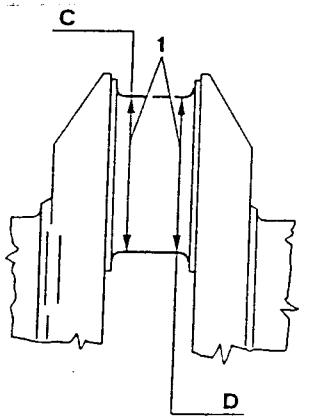
1. Check that the ovalization of the main and rod journals is within the prescribed limits.

Main and rod journals maximum ovalization error
A - B = 0.004 mm



1. Check that the taper of the main and rod journals is within the prescribed limits.

Main and rod journals maximum taper error
C - D = 0.010 mm



- Check eccentricity of central main journal and front and rear main journals.

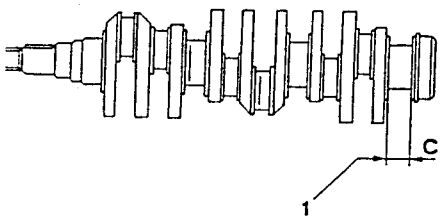
Main journals maximum eccentricity
0.040 mm

- Check parallelism between main and rod journals.

Maximum parallelism error between main and rod journals
0.015 mm

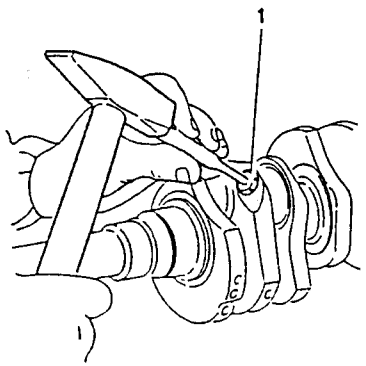
1. Check that the length of the rear main journal "C" is within the prescribed limits.

Length of rear main journal
31.300 to 31.335 mm



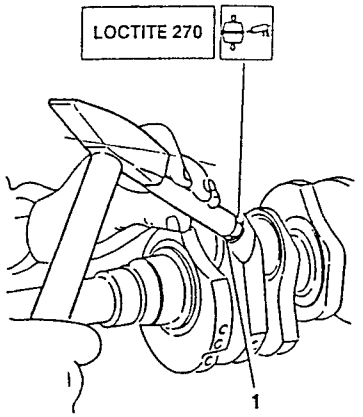
Cleaning of lubrication grooves

1. Using a punch make a hole in the oil groove plugs and remove any burrs left by the previous chamfering.

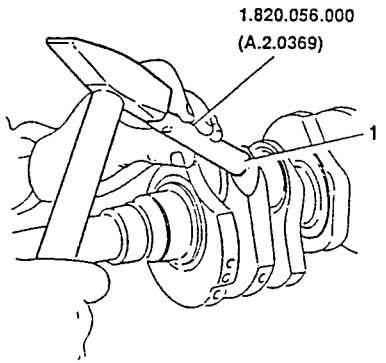


- Thoroughly clean the lubrication grooves using warm diesel oil and then dry with compressed air.

1. Apply the prescribed sealant to the new plugs and then insert them into the orifices of the lubrication groove using a suitable tool.

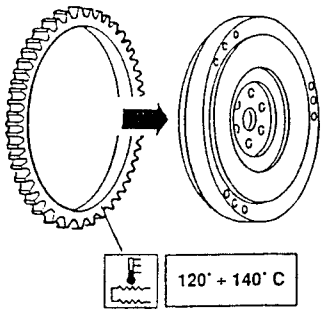


1. Chamfer the plugs using tool N° 1.820.056.000 (A.2.0369)



REPLACEMENT OF FLYWHEEL RING GEAR

- Inspect the flywheel ring gear and, if necessary, replace it as follows:
  - remove the old ring gear using a hydraulic press.
  - thoroughly clean the mating surfaces of the new ring gear and of the flywheel.
  - uniformly pre-heat the new ring gear to 120 to 140°C and fit it to the engine flywheel.
  - leave the parts to cool to ambient temperature: do not force the cooling of the parts.



CYLINDER LINERS

- Check the class of the cylinder liners.

NOTE: Cylinder liners are selected according to their inner diameter and are divided into three categories - A, B and C. These categories are identified by BLUE, PINK AND GREEN dots located on the outer surface.

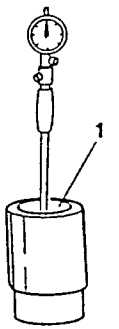
1. Using a reamer applied to a centesimal dial gauge, measure the inner diameter of the cylinder liners.

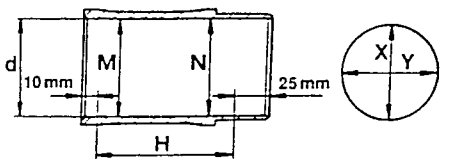
- Check that the inner diameter, taper and ovalization of the cylinder liners are within the prescribed limits.

Internal diameter "d"	
Class A (Blue)	87.985 to 87.994 mm
Class B (Pink)	87.995 to 88.004 mm
Class C (Green)	88.005 to 88.014 mm

Maximum taper (M-N)
0.01 mm

Maximum ovalization (X-Y)
0.01 mm





H = area for dimensional control

PISTONS AND GUDGEON PINS

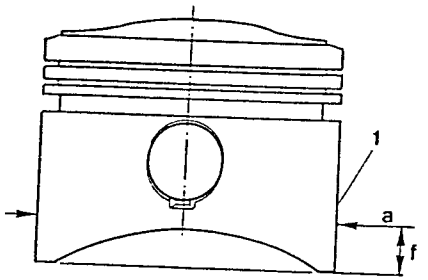
– Check the class of the pistons.

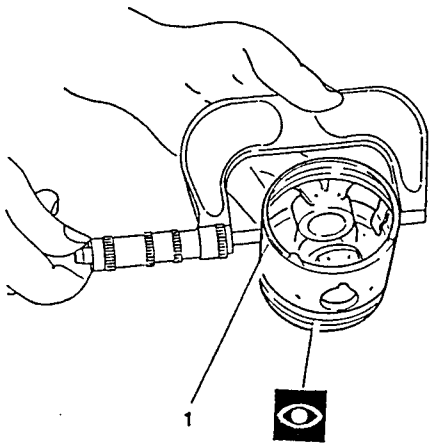
NOTE: Like the cylinder liners, the pistons are divided into three classes according to their manufacturing tollerances. These classes are identified by the letters A, B and C and are differentiated by BLUE, PINK and GREEN dots located on the piston ceiling.

1. Check that the outer diameter of the piston is within the prescribed limits.

NOTE: **The diameter of the pistons must be measured perpendicularly to the gudgeon pin hole, and value f = 12 mm in from the lower edge of the skirt.**

External diameter "a"		
Class A (Blue)	Borgo	87.935 to 87.945 (1)
	Mondial	87.925 to 87.935 (2)
Class B (Pink)	Borgo	87.945 to 87.955 (1)
	Mondial	87.935 to 87.945 (2)
Class C (Green)	Borgo	87.955 to 97.965 (1)
	Mondial	87.945 to 87.955 (2)



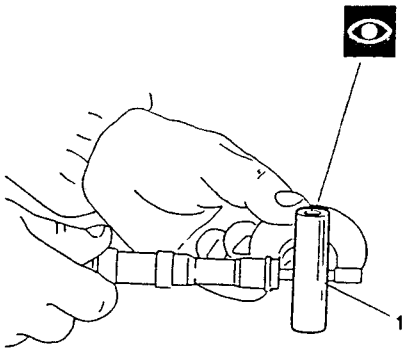


– Check the class of the gudgeon pins.

NOTE: **The gudgeon pins and relative mating holes on the piston are divided into two classes according to the manufacturing tollerances. These classes are identifies by BLACK or WHITE dots on the inner surface of the pins and on the outer surface of the piston hub.**

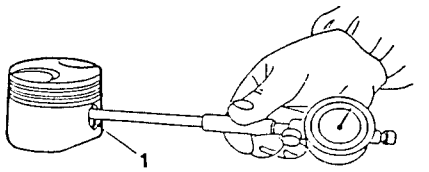
1. Using a micrometer, measure the outer diameter of the gudgeon pin and check that it is within the prescribed limits.

External diameter of gudgeon pin	
Black	21.994 to 21.997 mm
White	21.997 to 22.000 mm



1. Using a reamer measure the diameter of the mating hole in the gudgeon pin and check that it is within the prescribed limits.

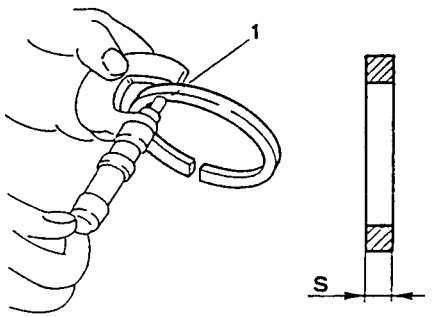
Diameter of the gudgeon pin hole in the piston	
Black	22.003 to 22.006 mm
White	22.006 to 22.009 mm



PISTON RINGS AND OIL SCRAPER RING

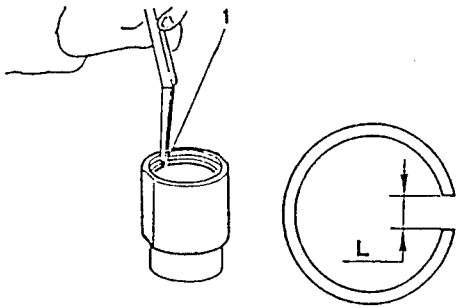
1. Check that the thickness "S" of the piston rings and the oil scraper ring is within the prescribed limits.

Thickness of piston rings "S"	
First ring	1.475 to 1.490 mm
Second ring	1.475 to 1.490 mm
Oil scraper ring	3.475 to 3.490 mm



1. Insert the piston rings inside the cylinder liner and check the dimension of the gap "L" with a feeler gauge.

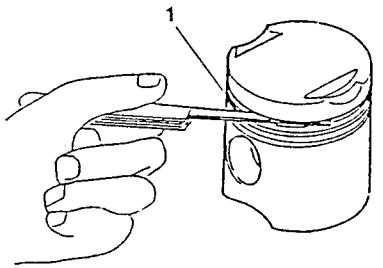
Gap "L"		
First ring		0.30 to 0.50 mm
Second ring		0.30 to 0.50 mm
Oil scraper ring	Borgo	0.30 to 0.50 mm
	Goetze	0.25 to 0.50 mm



- Lubricate the piston rings with clean engine oil, and install them onto the piston.

1. Using a feeler gauge measure the play between piston rings and oil scraper ring and relative seatings on piston and check that it is within the prescribed limits.

Axial play between oil rings and seatings	
First ring	0.035 to 0.070 mm
Second ring	0.035 to 0.070 mm
Oil scraper ring	0.025 to 0.055 mm

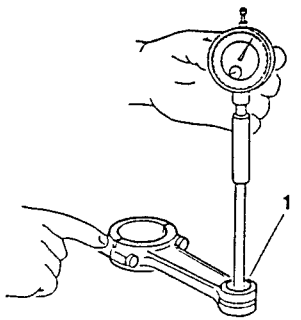


RODS

- Visually check the rods for signs of cracking, scoring or excessive wear.

1. Using a bore gauge and a centesimal dial gauge, measure the diameter of the rod bushing and check that it is within the prescribed limits.

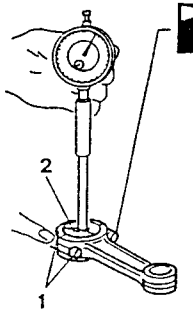
Diameter of rod small end bushing hole
22.005 to 22.015 mm

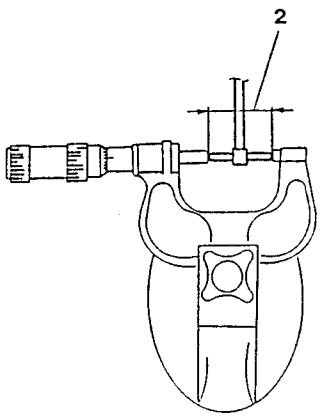


1. Install the rod caps, and tighten the lubricated screws to the prescribed torque.
2. Using a reamer, measure the inner diameter of the rod head and check that it is within the prescribed limits.

Inner diameter of rod head
55.511 to 55.524 mm

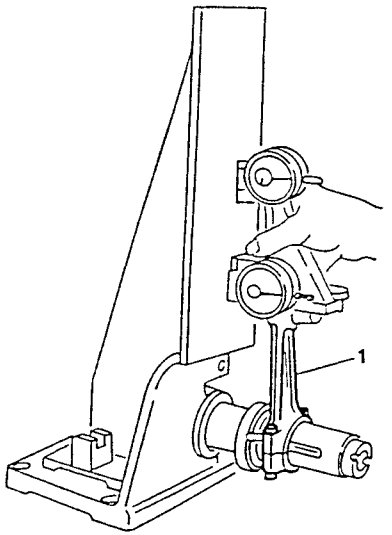
53.4 ÷ 59 Nm
5.45 ÷ 6 kgm





1. Check that the rods are perpendicular using a surface plate as shown in the illustration.

NOTE: **If the perpendicularity of the rods is not suitable, the rod must be replaced in order to prevent abnormal loading during engine operation which would lead to abnormal wear of the piston and rod.**



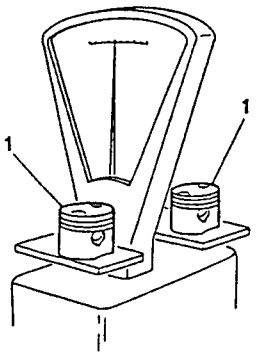
VERIFICATION OF THE WEIGHT DIFFERENCE BETWEEN SINGLE PISTONS AND RODS

– Select gudgeon pins and pistons matched according to the BLACK or WHITE colour coding.

NOTE: **If parts are to be re-used, ensure that the working surfaces, particularly the seating of the gudgeon pin, do not show the slightest trace of scratching.**

1. Weigh the pistons together with the oil rings and oil scraper ring and gudgeon pin and check that the difference is within the prescribed limits.

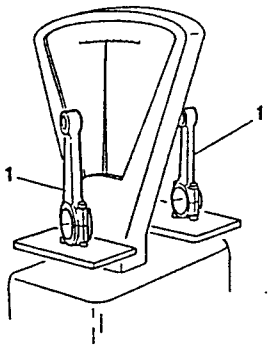
Weight difference between pistons
± 2 gramms

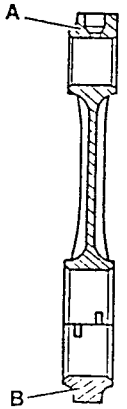


1. Weight the rods together with caps, bearing halves and check that the weight difference is within the prescribed limits.

Weight difference between rods
≤ 2 gramms

– To restore the correct weight, remove excess metal from points A and B as shown in the illustration.

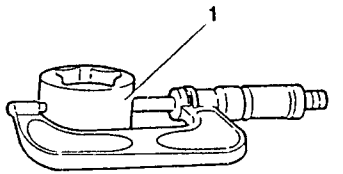


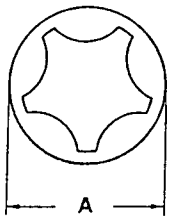


CHECKING AND INSPECTION OF THE OIL PUMP

1. Check that the outer diameter of the driven rotor is within the prescribed limits.

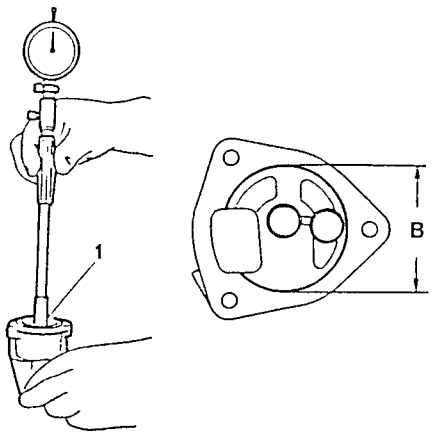
External diameter of the driven rotor
A = 49.100 to 49.155 mm





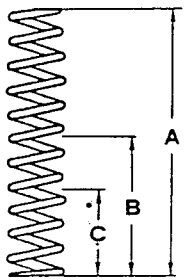
1. Check that the diameter of the rotor seating in the pump body is within the prescribed limits.

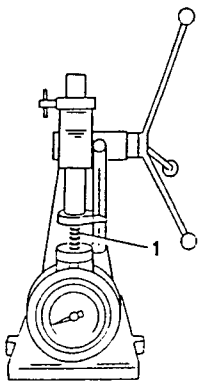
Diameter of the rotor seating in the pump body
B = 49.325 to 49.375 mm



1. Using a dynamometer check the characteristic values of the oil pressure relief valve control spring.

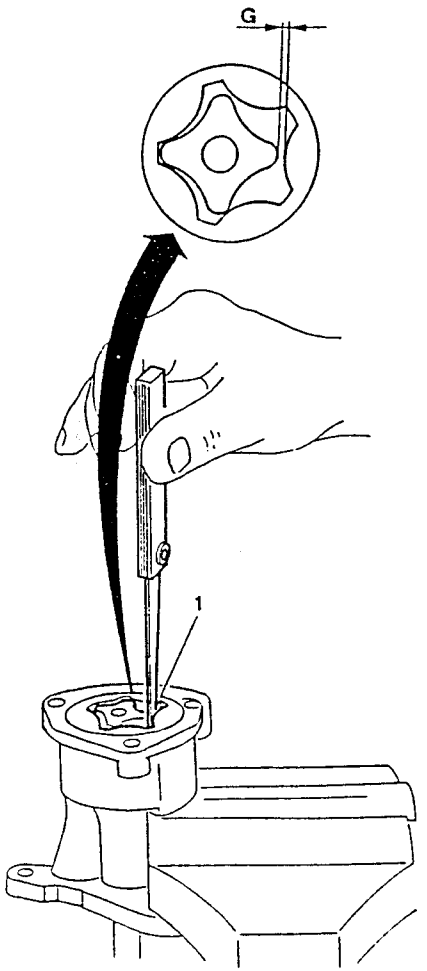
Spring length	
Free spring	A = 54 mm
Under static load	B = 36 mm (14.6 kg)
Under dynamic load	C = 28 mm (21 kg)





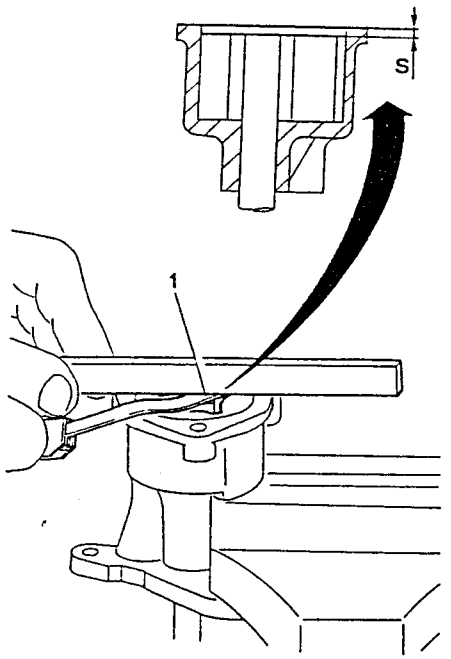
1. Position the two rotors inside the pump body and check that the clearance "G" between the lobe of the inner rotor and that of the driven rotor is within the prescribed limits.

Clearance between driven and inner rotors
G = 0.040 to 0.290 mm



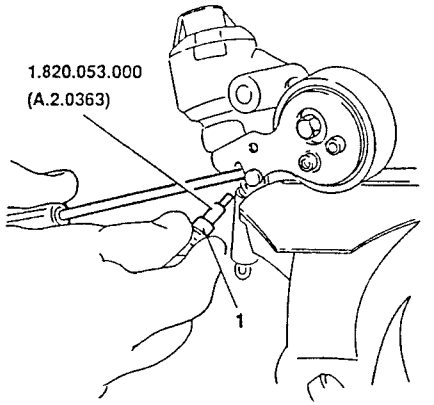
1. Check that the axial play "S" between the two rotors in relation to the plane of the pump body is within the prescribed limits.

Axial play between the two rotors in relation to the pump body
S = 0.025 to 0.075 mm

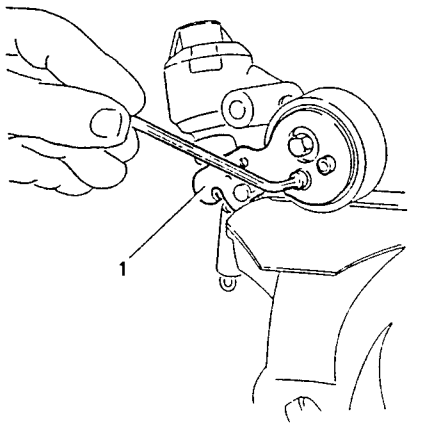


HYDRAULIC BELT TENSIONER OVERHAUL

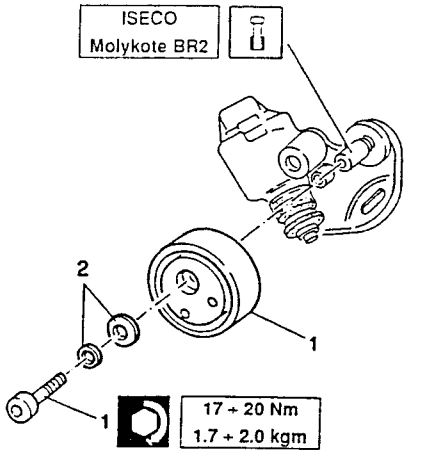
1. Extract tool N° 1.820.053.000 (A.2.0363), used during disassembly in order to release the inner spring.



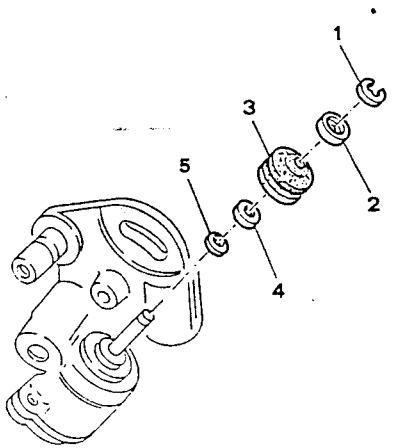
1. Remove the belt tensioner plate together with the spring.



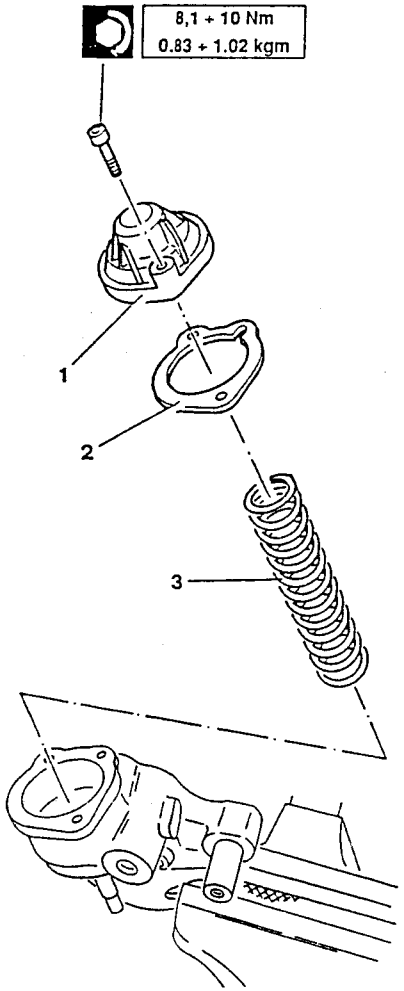
1. Unscrew the screws and remove the belt tensioner pulley.
2. Remove the washers.



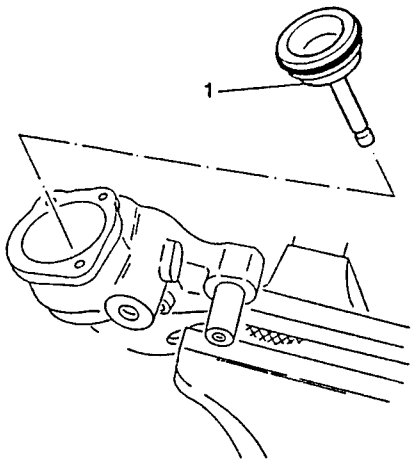
1. Remove the retaining ring.
2. Remove the washer.
3. Withdraw the bellows.
4. Remove the washer.
5. Remove the pad



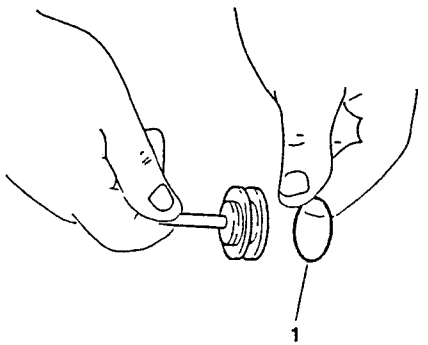
1. Remove the cover.
2. Remove the gasket.
3. Remove the spring.



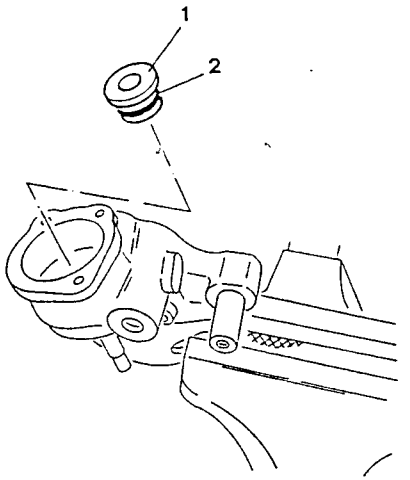
1. Withdraw the piston from the belt tensioner body.



2. Remove the O-ring from the piston.

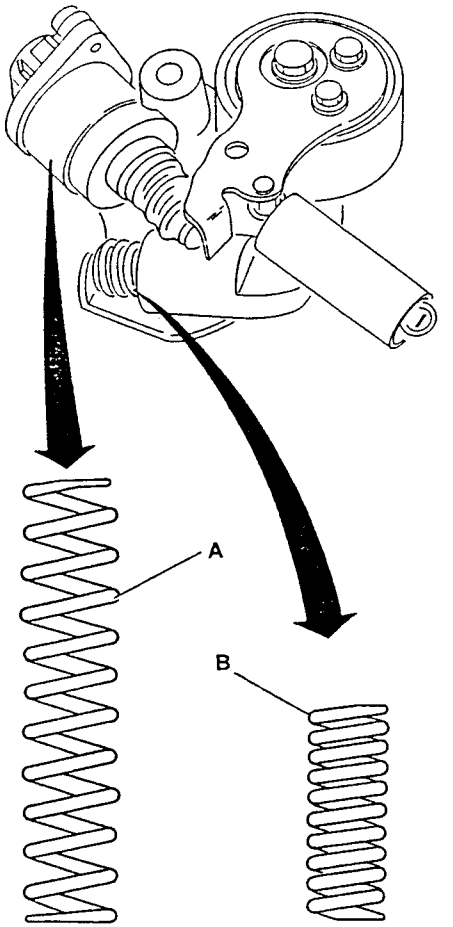


1. Remove the piston stem guide
2. Remove the O-ring.



– Check spring "A" (which acts on the piston) and spring "B" (which preloads the hydraulic belt tensioner) and check that the characteristic data conform to the prescribed values.

	Sprong A	Spring B
Useful number of turns	12	9
Length of free spring	93 mm	45.5 mm
Static test load	93,2 N (9.5 kg)	98 N (10 kg)
Length of loaded spring	48 mm	30mm



– Reassemble the hydraulic belt tensioner by reversing the disassembly procedure.

CAUTION:
The oil seals should be replaced each time the belt tensioner is overhaulled.

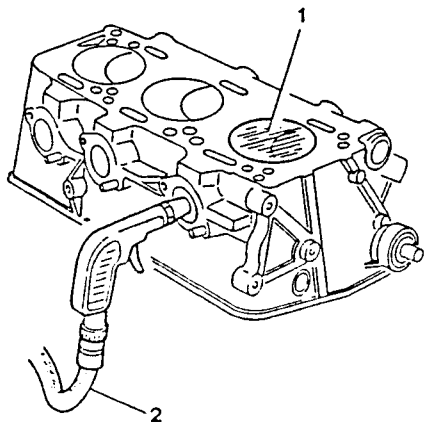
INDICATIONS FOR REASSEMBLY

For reassembly, reverse the procedure followed for disassembly except where otherwise stated.

VALVE LEAKAGE TEST

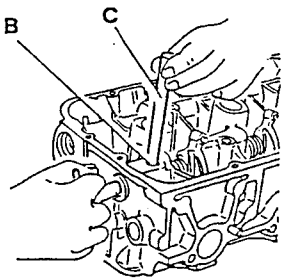
- Insert the spark plugs in their seats.

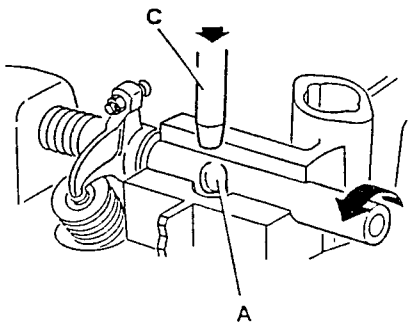
1. Pour some petrol into one of the combustion chambers so that it just covers the valve heads.
2. Blow low-pressure air into the intake and exhaust ports and check that no bubbles form in the petrol; if there are bubbles, check for correct assembly and grind the valve seats again if necessary.



CORRECT POSITIONING OF THE ROCKER ARM SHAFT

- After reassembling the washers, rocker arms and springs, rotate the shaft to alin notches "A" with the holes "B" in order to permit ther passage of the cylinder head support studs. Use pin "C" (diam. 12mm) to ensure correct alignment.





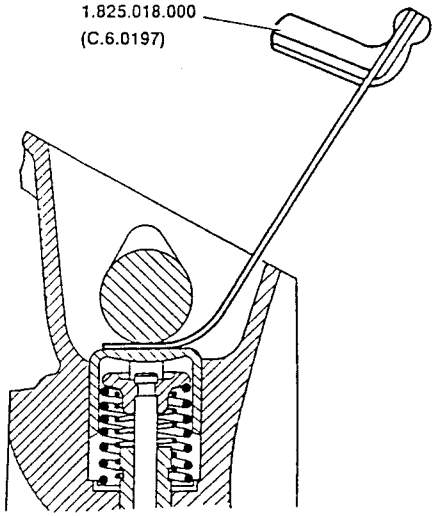
CHECKING AND ADJUSTMENT OF VALVE CLEARANCE

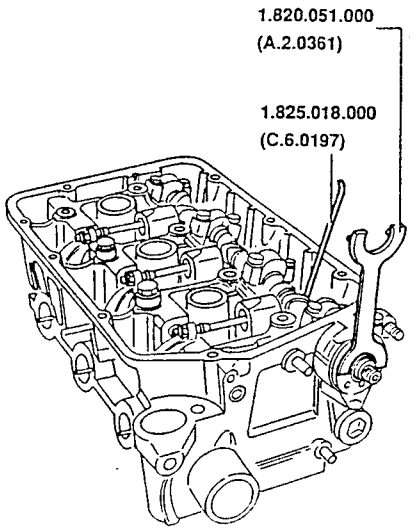
Intake valve clearance check

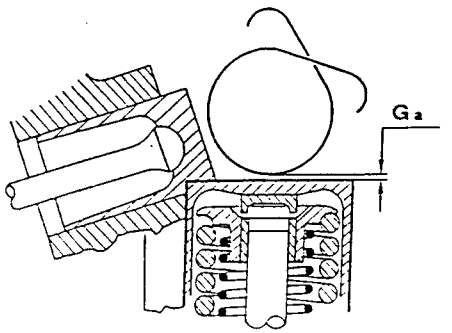
After installation of the camshaft, check the clearance of the intake valves as follows:

- temporarily install the timing system drive toothed pulley hub.
- using tool N° 1.820.051.000 (A.2.0361) for the rotation of the camshaft and feeler gauge N° 1.825.018.000 (C.6.0197), checkthat the clearance "G_a" between the cam heel radius and valve cups is within the prescribed limits.
  If not, replace the intake valve caps with others of a suitable thickness.

Valve clearance intake side
G_a = 0.475 to 0.500 mm

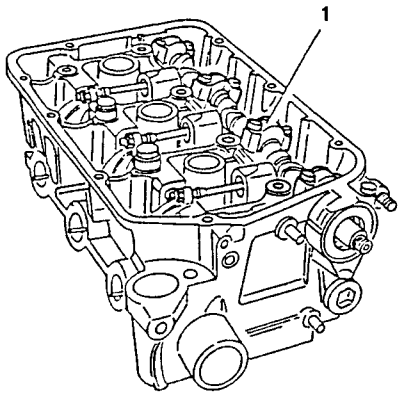




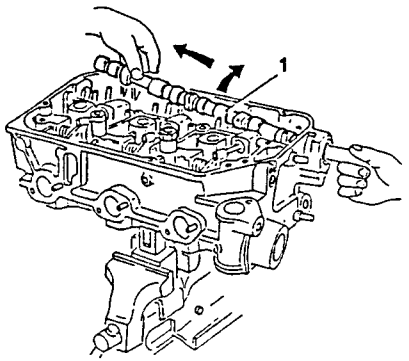


Intake valves clearance adjustment

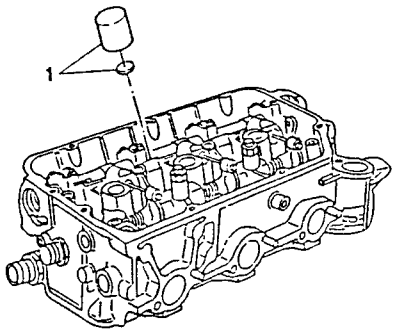
1. Remove the camshaft caps.



1. Remove the camshaft.

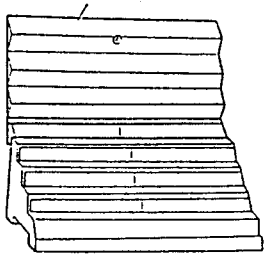


1. Remove the valve cups and valve clearance adjustment caps.

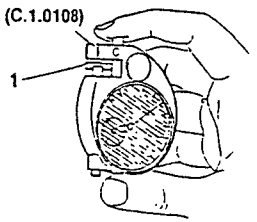


1. Measure the thickness of the caps with dial gauge N° 1.827.002.000 (C.1.0108) and then, for the difference in relation to the previously measured dimension, select caps of a thickness suitable to restore the correct valve clearance from among the parts of set N° 1.820.150.000 (R.9.0001).

1.820.150.000
(R.9.0001)



1.827.002.000
(C.1.0108)



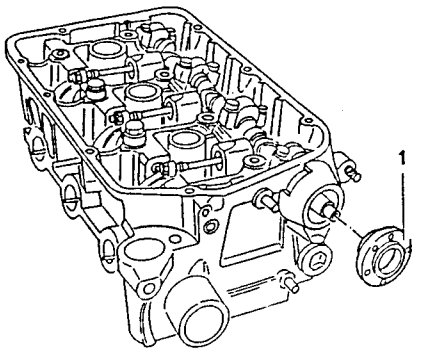
- Install the valve cups, camshaft and caps; tighten the camshaft cap nuts to the prescribed torque and check that valve clearance is within the prescribed limits.

Checking and adjustment of exhaust valve clearance

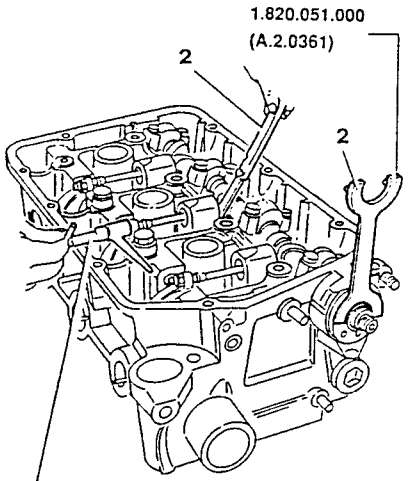
1. Temporarily install the timing system drive toothed pulley hub.
2. Using tool N° 1.820.051.000 (A.2.0361) rotate the camshaft until the feeler gauge can be inserted between the cam heel radius and the relative cups.

- Record the values obtained for each valve and compare them with the prescribed values.

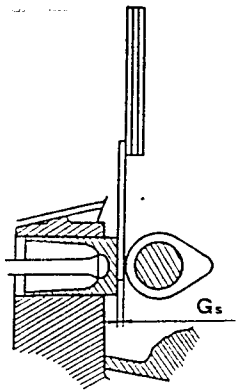
Valve clearance exhaust side
G_s = 0.310 to 0.345 mm



1.820.051.000
(A.2.0361)

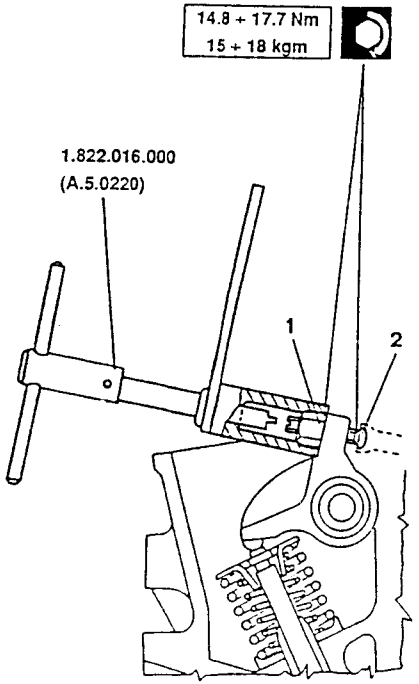


1.822.016.000
(A.5.0220)



1. If necessary act on the intermediate lever of tool N° 1.822.016.000 (A.5.0220) and loosen the locknut securing the adjustment screw.
2. Using the same tool, act on the adjustment screw until the prescribed clearance is obtained.

– Lock the locknut and re-check valve clearance.

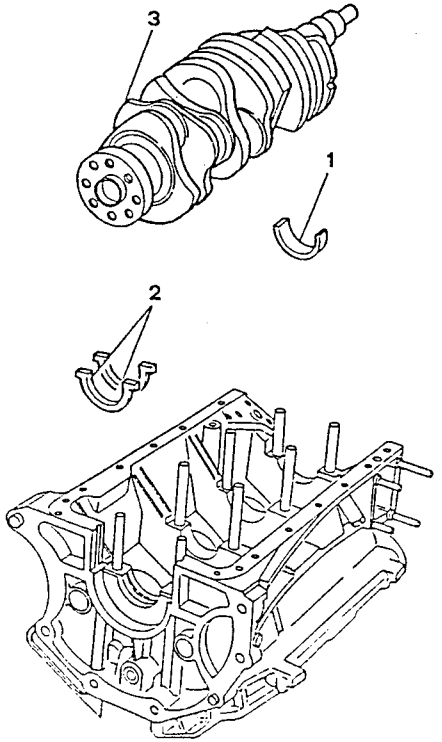


INSTALLATION OF THE CRANKSHAFT

1. Set the main bearing halves onto the relative supports.

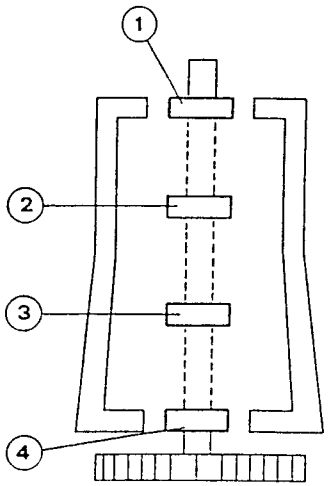
NOTE: **The assembly onto the crankshaft must be carried out by matching the parts of the same dimensional class (identified by coloured dots on the side of the half bearing and relative crankshaft journal).**

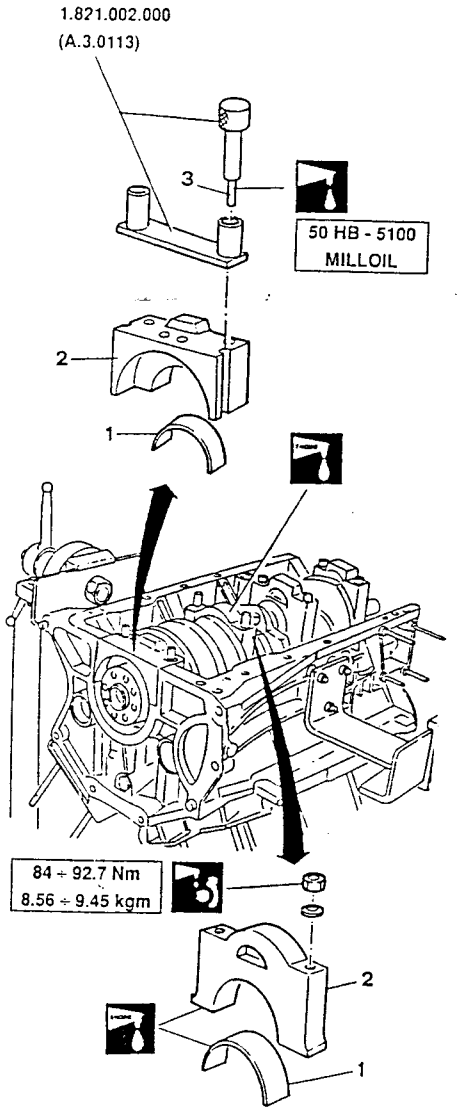
2. Install thrust ring halves into their seatings and ensure that the lubrication grooves face the crankshaft shoulders.
3. Position the crankshaft.



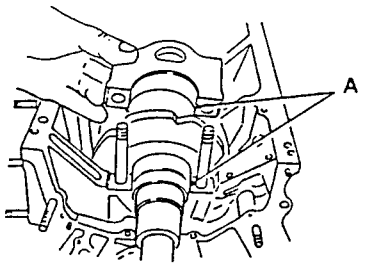
1. Set the main bearing halves into the main bearing caps.
2. Install the four main bearing caps following the numbering shown the caps themselves.
3. Insert the rubber pads onto the rear main bearing cap using tool N° 1.821.002.000 (A.3.0113).

NOTE: **The assembly onto the crankshaft must be carried out by matching the parts of the same dimensional class (identified by coloured dots on the side of the half bearing and relative crankshaft journal).**

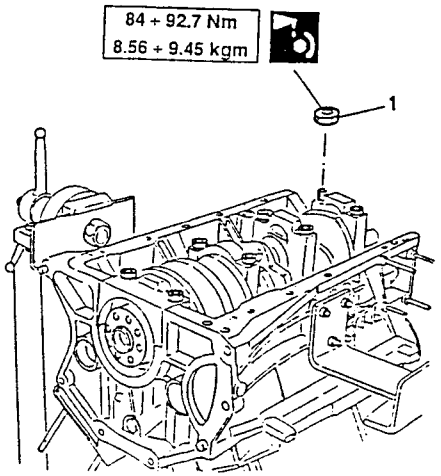




CAUTION:
Safety marks (A) located on the engine block and on the main bearing caps must be on the same side, as shown in the illustration.



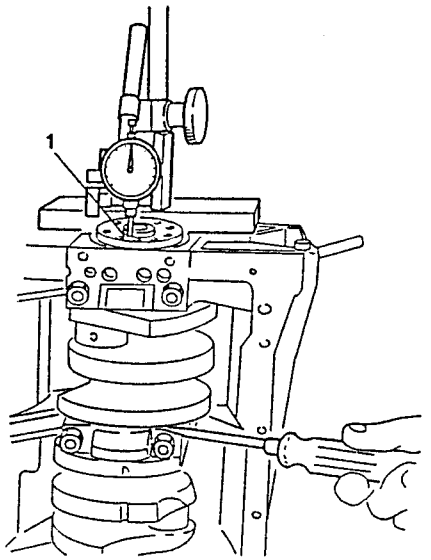
1. Tighten the lubricated main bearing cap nuts to the prescribed torque (in two or three stages).



CRANKSHAFT AXIAL PLAY CHECK

1. Using a centesimal dial gauge mounted on a magnetic platform, check that the axial play of the crankshaft is within the prescribed limits.

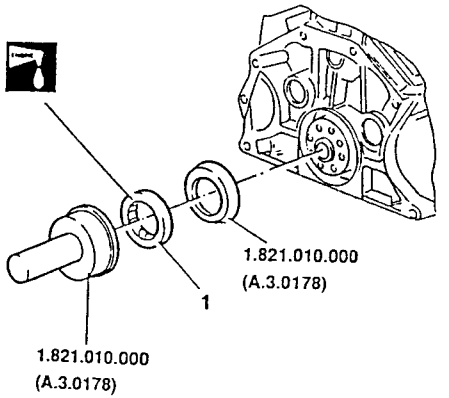
Crankshaft axial play
0.080 to 0.265 mm



INSTALLATION OF CRANKSHAFT REAR OIL SEAL

1. Using inserting tool N° 1.821.010.000 (A.3.0178) install the rear oil seal.

CAUTION:
During installation ensure that the inner spring and oil seal are correctly positioned.



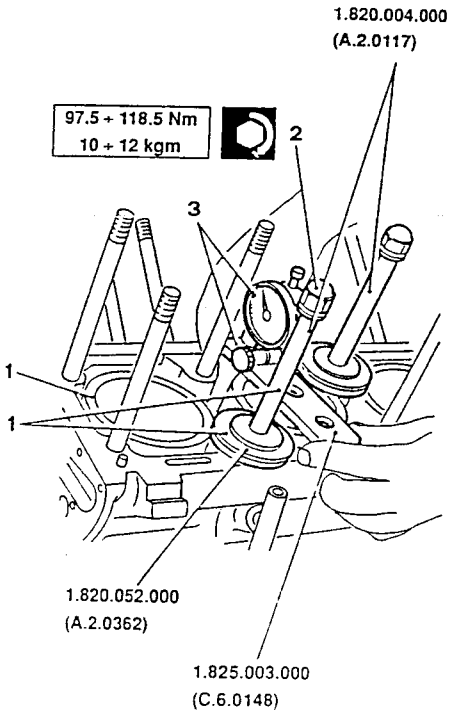
REFITTING CYLINDER LINERS, PISTONS AND RODS

Cylinder liner protrusion check with seal rings

- Thoroughly clean the cylinder liners and install the seal rings.
- Insert the cylinder liners into the engine block ensuring that they reach the stop limits.

1. Lock the cylinder liners to the engine block with cylinder liner retainers N° 1.820.004.000 (A.2.0117) along with supplementary rings N° 1.820.052.000 (A.2.0362).
2. Tighten the cylinder liner nuts to the specified torque.
- Apply a centesimal dial gauge to tool N° 1.825.003.000 (C.6.0148) and reset it on a surface plate.
3. Place tool N° 1.825.003.000 (C.6.0148) on the engine block first on one side and then on the other so that the probe rests on the edge of the cylinder liners and check that the protrusion is within the specified limits.

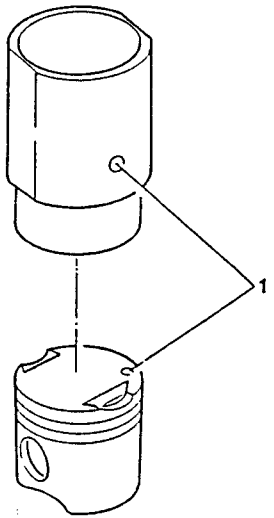
Protrusion ofcylinder liners from engine block
0.01 to 0.06 mm



Matching of cylinder liners and pistons

1. Match parts of the same dimensional class identified by dots of the same colour: A (BLUE), B (PINK) or C (GREEN) marked on the piston ceiling and on the outside of the cylinder liners.

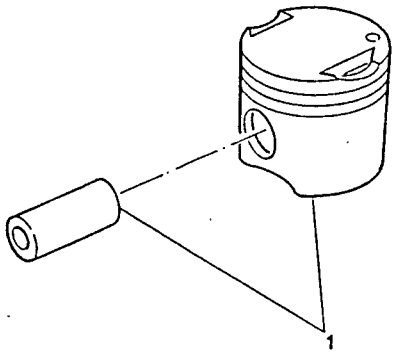
Clearance between cylinder liner and piston
0.040 to 0.059 mm



Matching of pistons and gudgeon pins

1. Match parts of the same dimensional class identified by dots of the same colour: BLACK or WHITE on the inner surface of the gudgeon pin and on the outer surface of the piston hub.

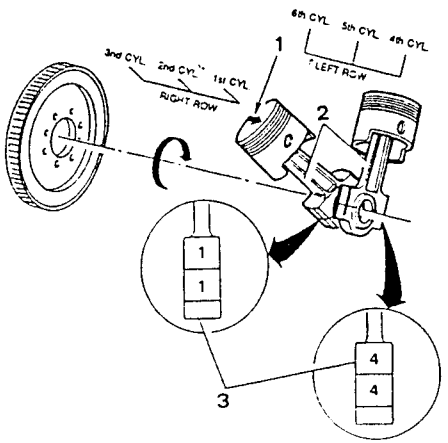
Clearance between piston hole and gudgeon pin
0.006 to 0.012 mm



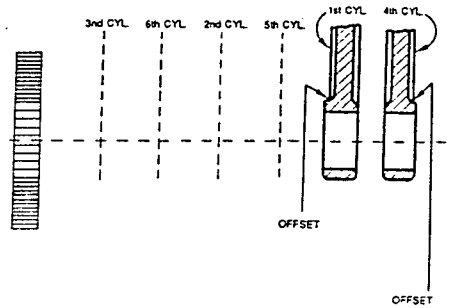
Matching of pistons and rods and rods and crankshaft

1. The arrows engraved on the top of the piston must be be turned towards the front side of the engine.
2. The lubrication holes on the side of the rods, as seen from the flywheel side, must be turned towards the right hand side of the engine block (for rods on both the right and left side).
3. Each rod is provided with a number on the big end which identifies the relative cylinder number; this number is located on the right-hand side of the rods on the right row and on the left side of the rods on the left row.
   Similarly the rod caps have numbers on their side which identify the relative cylinder number; during installation these numbers must be located on the same side as those engraved on the rod big end.

Clearance between rod small end bushing gudgeon pin	
Black	0.008 to 0.021 mm
White	0.005 to 0.018 mm



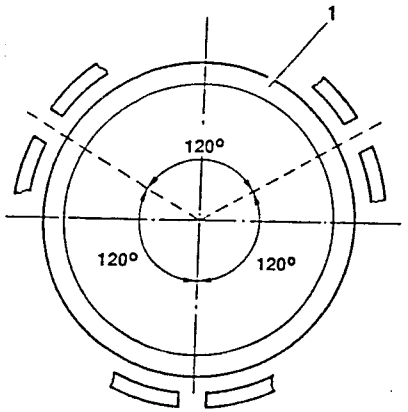
– Rods pertaining to the right side of the engine (1st, 2nd and 3rd cylinders) will be installed with the offset facing the rear end of the engine; rods pertaining to the left side of the engine (4th, 5th and 6th cylinders) will be turned so that the offset faces the front end of the engine.



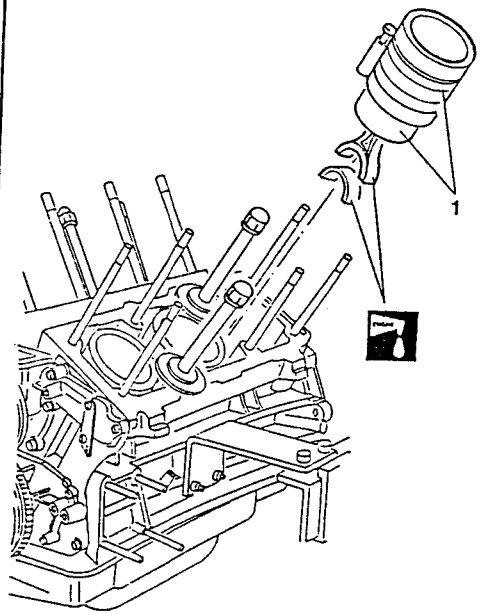
– Set the rod bearing halves on the rod big ends.

NOTE: The assembly onto the crankshaft must be carried out by matching the parts of the same dimensional class (identified by coloured dots on the side of the half bearing and relative crankshaft journal).

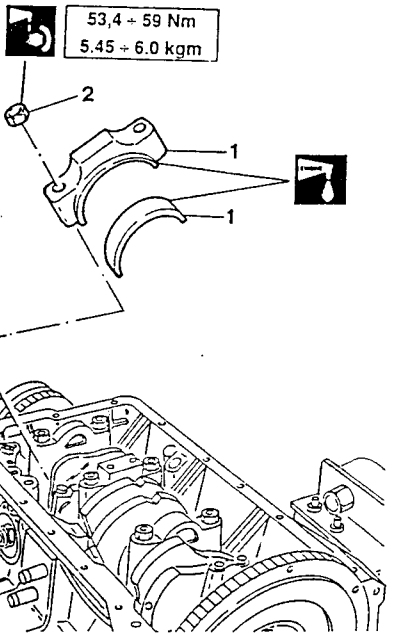
1. Place the piston rings on the pistons with the gaps staggered by 120°C.

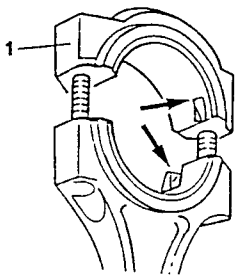


1. Using a suitable tool, install the pistons and rods into the cylinder liners along one row.
– With the cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) and supplementary washers N° 1.820.052.000 (A.2.0362) which were previously installed to check the cylinder liner protrusion, rotate the engine block by 180° using a rotary stand.



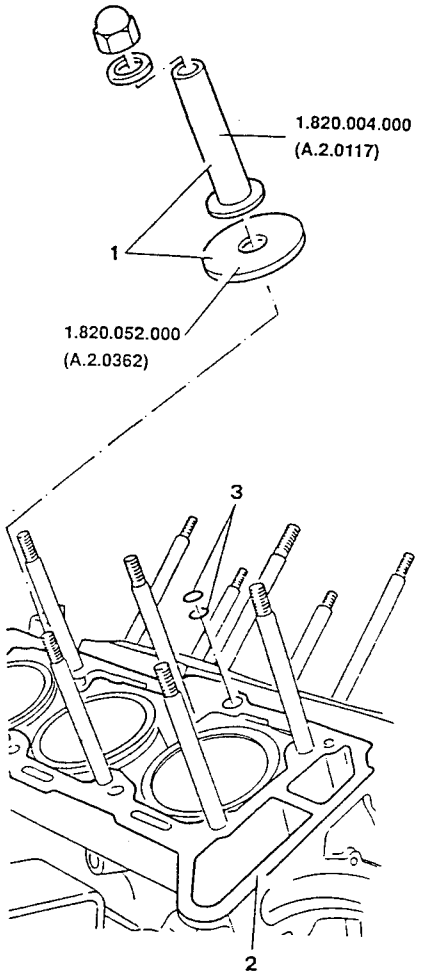
1. Position the rod bearing halves in the rod caps and install those of the row of cylinders being assembled, positioning the reference notches towards the corresponding notch on the rod big end.
2. Tighten the lubricated cap nuts to the prescribed torque.





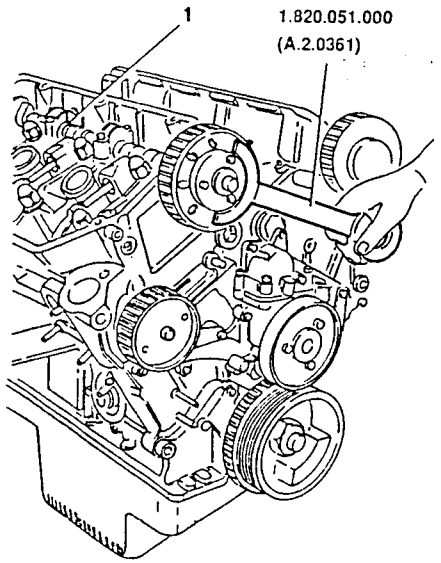
INSTALLATION OF CYLINDER HEADS

– Rotate the crankshaft until the piston of the first cylinder is at T.D.C.
1 Remove the cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) and the supplementary washers N° 1.820.052.000 (A.2.0362).
2. Position the cylinder head gaskets.
3. Position the oil rings sealing the oil passages.

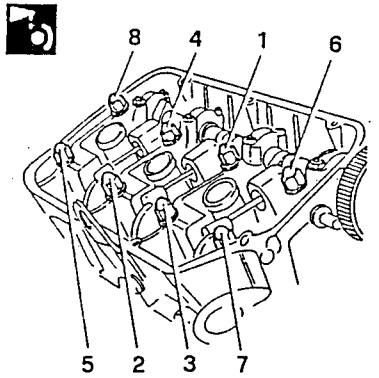


1. Using lever tool N° 1.820.051.000 (A.2.0361) rotate the camshaft of each cylinder head to align the timing marks on the camshaft to those on the camshaft caps.

NOTE: **On the right-hand cylinder head, the timing mark is located on cap N° 3, while on the left cylinder head that mark is located on cap N° 7.**



- Install the cylinder heads on the engine block.
- Lubricate the nuts and washers with engine oil and tighten, in two or three stages, the eight nuts securing each cylinder head following the indications given in the table.

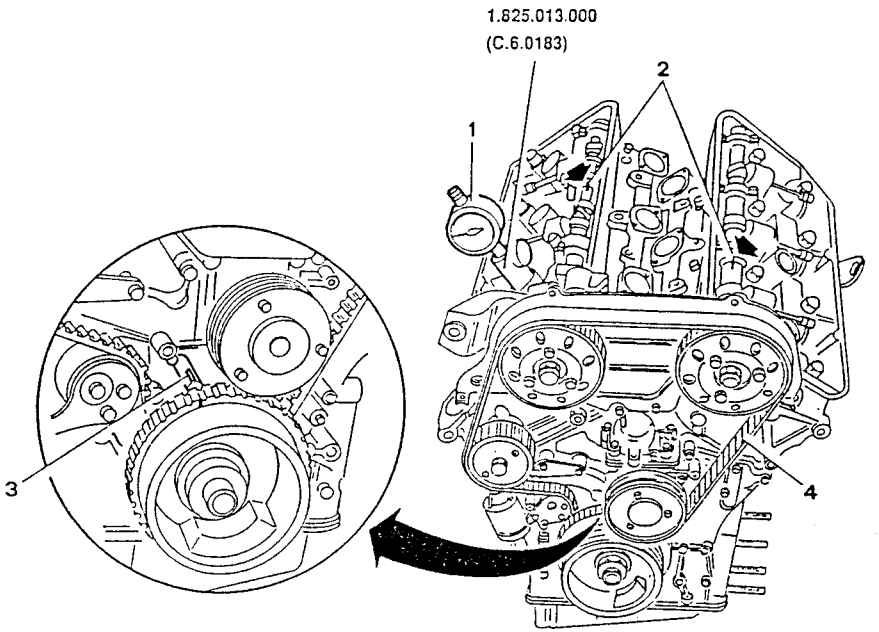


On installation Lubricate the nuts, washers and threads of the studs with oil and tighten to the prescribed torque in the order shown.	88.5 to 97.8 Nm 9 to 10 kgm
After bench testing when the engine is cold, one at a time loosen the nuts by one revolution following the sequence indicated; wipe the surfaces betweem washers and nuts with oil and tighten to the prescribed torque once again.	97.8 to 108.2 Nm 10 to 11 kgm

INSTALLATION OF TIMING BELT AND CHECKING OF ENGINE TIMING

1. Install tool N° 1.825.013.000 (C.6.0183) complete with dial gauge, into the the seat of the first cylinder spark plug.
- Rotate the crankshaft in the direction of normal rotation and bring the piston of the first cylinder to the exact T.D.C. in the firing phase.
2. Check that the marks engraved on the camshafts are aligned to those on the relative caps.
3. Check that the reference marks on the phonic wheel are aligned with the reference pin on the front cover of the engine block.
4. Fit the timing belt keeping the arms under tension and following the order indicated below:

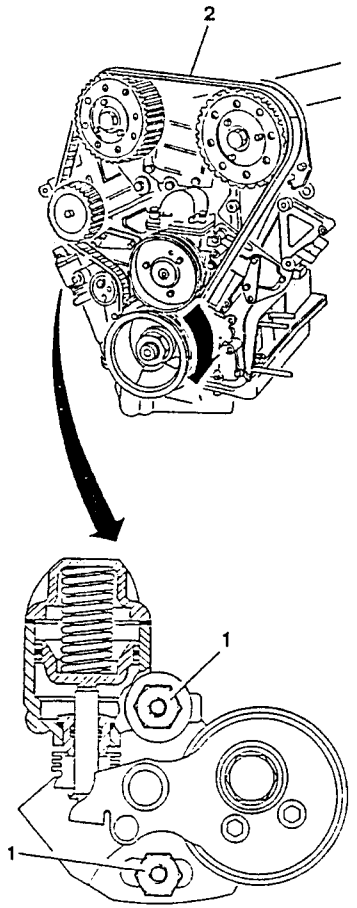
   1°- Crankshaft toothed pulley
   2°- Left cylinder head toothed pulley
   3°- Right cylinder head toothed pulley
   4°- Oil pump drive toothed pulley
   5°- Hydraulic belt tensioner pulley



CAUTION:
Oils and solvents can affect the elasticity of the belt and cause slipping of the teeth.

1. Loosen the belt tensioner securing screws.
2. Settle the timing belt by slightly rotating the crankshaft in the normal sense of rotation.

– Tighten the two previously loosened belt tensioner securing screws.

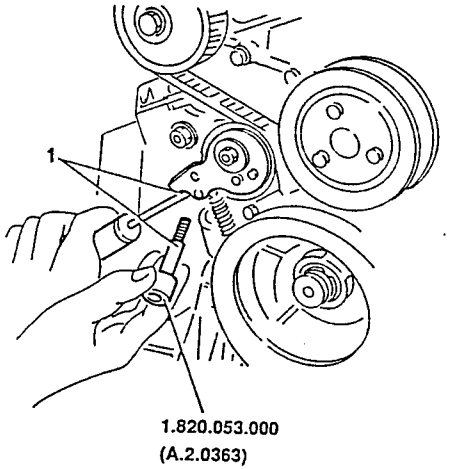


– Further rotate the crankshaft in the normal direction of rotation for two or three complete revolutions ensuring that the drive arms of the toothed belt continue to be taught.

NOTE: **Never rotate the crankshaft in the direction opposite to the normal direction of rotation.**

1. Slightly lift the belt tensioner arm and remove tool N° 1.820.053.000 (A.2.0363).

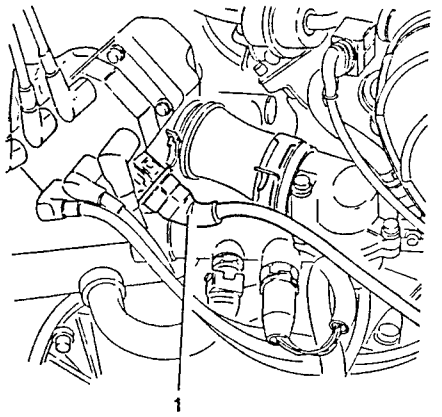
– Return the piston of the first cylinder to T.D.C. in the firing phase and check the alignment of all the timing marks.



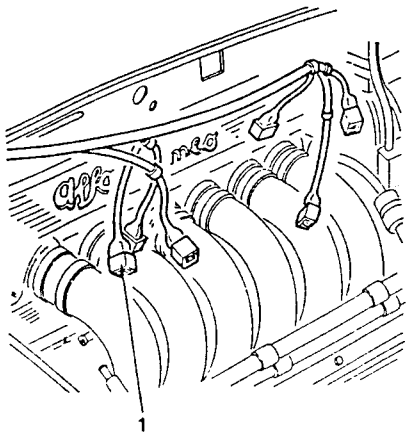
CYLINDER COMPRESSION TEST

– Start the engine and run it until it reaches normal operating temperature.
– Disconnect the high voltage cables from the spark plugs and remove them.

1. Disconnect the electrical connection from the ignition coil.



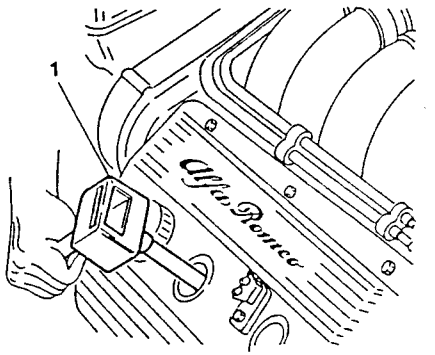
1. Disconnect the electrical connections from the electroinjectors.



1. Insert the test instrument into the seating of one of the spark plugs.

– Using the starter motor, turn the engine a few times and fully depress the accelerator pedal.

CAUTION:
Ensure that there are no leaks from the instrument's joint.



– Repeat the test on the other cylinders remembering to reset the writing point.

NOTE: **If the pressure values noted in the cylinders are greatly different, check the sealing of the valves and the flexible sealing rings and pistons.**

AFTER REFITTING OF THE ENGINE it is advisable the carry out the CYLINDER COMPRESSION TEST in addtion to the routine maintenance checks and inspections (see GROUP 00), fuel supply system checks (see GROUP 04) and engine cooling system (see GROUP 07).

ELECTRICAL COMPONENTS - CHECKS AND INSPECTIONS (located in the engine compartment)

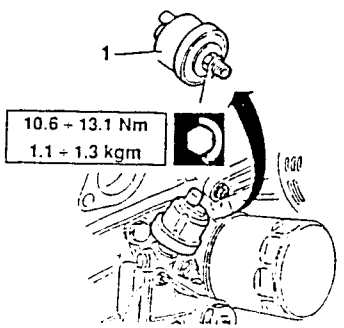
- Engine oil pressure meter.
- Engine oil minimum level sensor.
- Minimum engine oil pressure warning lamp.
- Engine oil temperature sender.

For the other sensors and electrical components located in the engine compartment, refer to the detailed information given under the specific groups.

ENGINE OIL PRESSURE METER

1. Check the calibration of the oil pressure meter.
   Replace the meter if the values are incorrect.

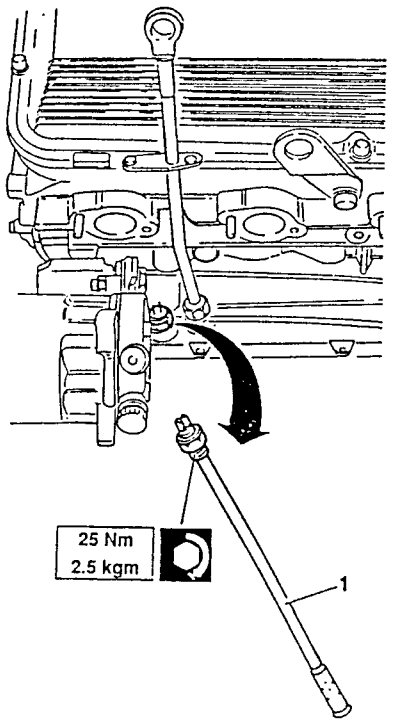
Pressure	Resistence
bars (kg/cm²)	Ω
0	290 to 320
0.39 (0.4)	255 to 285
3.9 (4)	103 to 133
7.8 (8)	0 to 40



MINIMUM ENGINE OIL LEVEL SENSOR

1. Check the calibration of the minimum oil level warning lamp sensor.
   Replace the sensor if the values are incorrect.

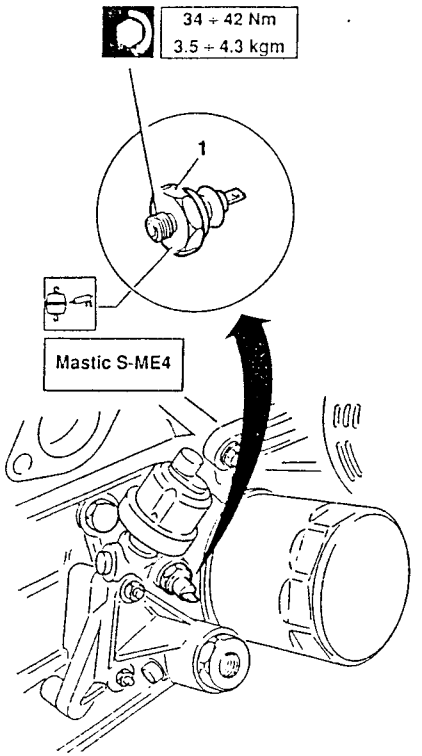
Circuit resistance pressure
12Ω ± 5%



MINIMUM OIL PRESSURE SENSOR WARNING LIGHT

1. Check the calibration of the engine oil pressure sensor warning light.
   If the values are found to be incorrect, replace the sensor.

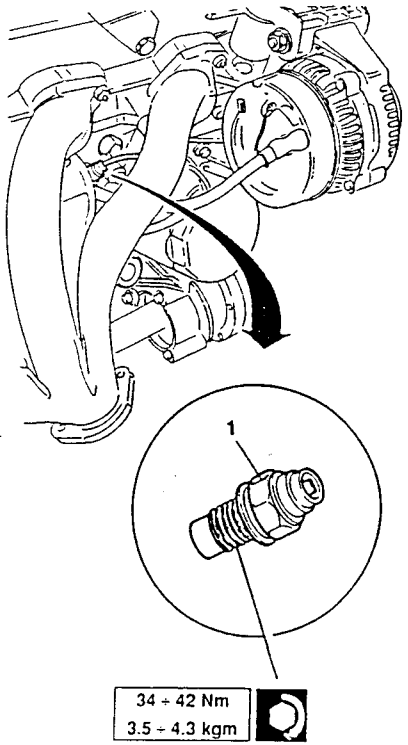
Pressure	bars (kg/cm²)
Contact open	0.196 to 0.49 (0.2 to 0.5)
Non-continuous peak of lubricating oil	9.8 (10)



ENGINE OIL TEMPERATURE SENSOR

1. Check calibration of the engine oil temperature sensor.
   If the values are found to be incorrect, replace the sensor.

Temperature	Resistance
°C	Ω
60 ± 0.5	525 to 605
90 ± 0.5	195 to 215
120 ± 0.5	82 to 94
140 ± 0.5	49 to 55



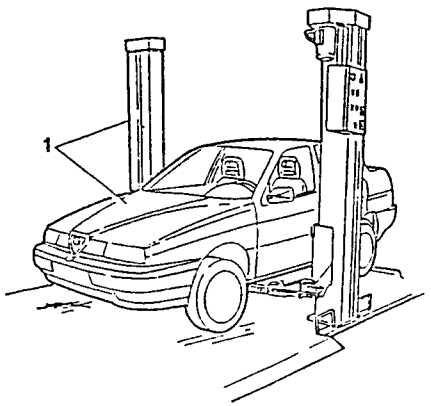
"ON VEHICLE" OPERATIONS

The preceding chapter included and illustrated the complete engine bench overhaul.
However some of these operations can be carried out on the vehicle, without necessitating the removal of the engine from the vehicle.
Among the most common operations which can be performed with out removing the engine are the **removal and refitting of the cylinder heads** and the **removal and refitting of the oil sump**. These can be carried out by following the indications given below.

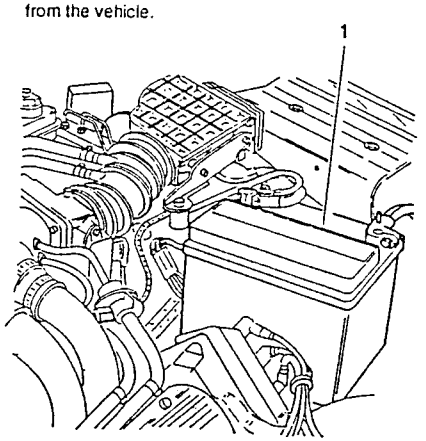
NOTE: **Refer to GROUP 00 for details of the most frequent maintenance operations which can be carried out with the engine installed on the vehicle.**

REMOVAL OF THE CYLINDER HEADS

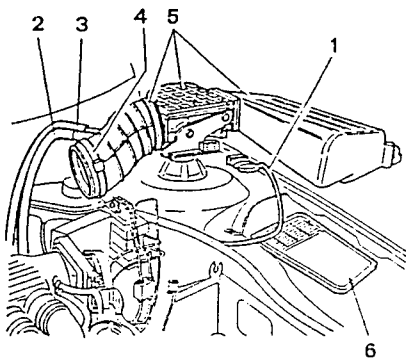
1. Place the vehicle on a two pillar auto lift.



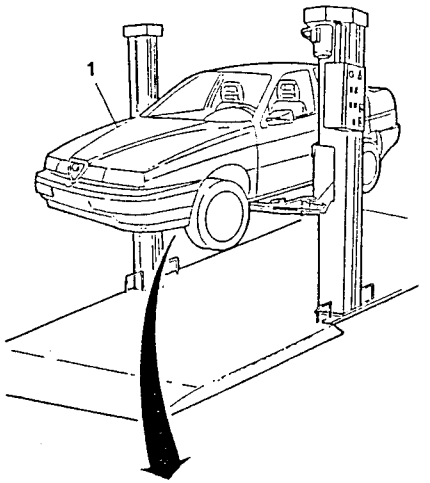
1. Disconnect the negative (-) and then the positive (+) cables from the battery and then remove the battery from the vehicle.

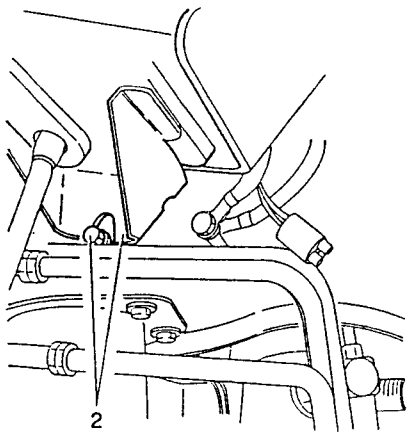


1. Disconnect the air flow meter electrical connections.
2. Disconnect the oil vapour recirculation pipe from the oil vapour filter.
3. Disconnect the air intake tube to the air intake box from the constant idle speed actuator.
4. Loosen the clamps and separate the corrugated sleeve from the air intake box.
5. Remove the air cleaner cover, air flow meter and corrugated sleeve assembly.
6. If necessary remove the filter element.

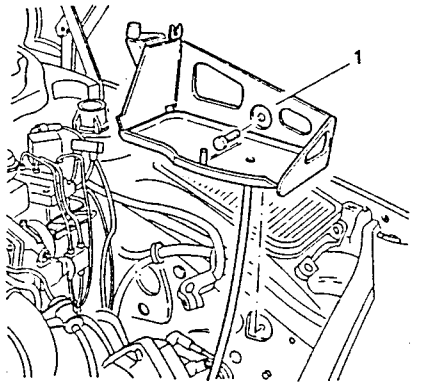


1. Raise the vehicle.
2. Loosen the lower screw securing the battery support to the body.



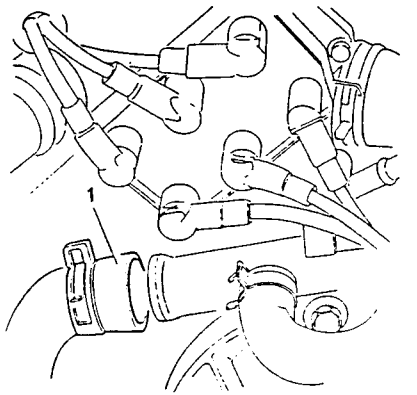


– Lower the vehicle.
1. Unscrew the remaining three screws securing the battery support to the body and remove the support from the vehicle.

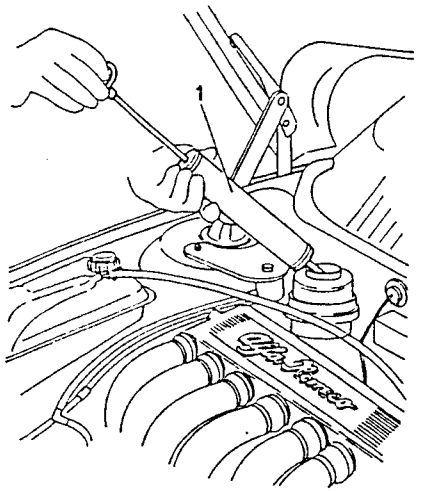


1. Drain the engine coolant into a suitable container by removing the cap from the expansion tank and disconnecting the outlet pipe from the radiator.

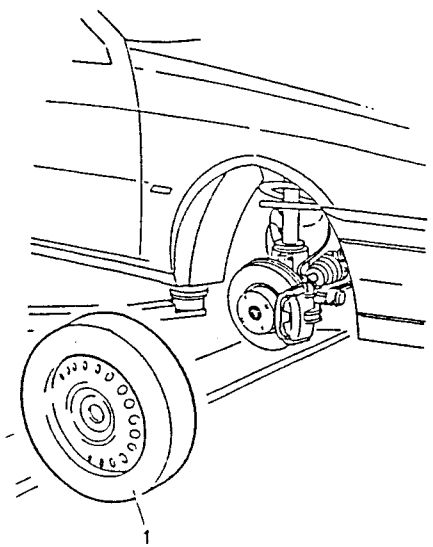
CAUTION
The antifreeze mixture, used as engine coolant can damage paintwork.



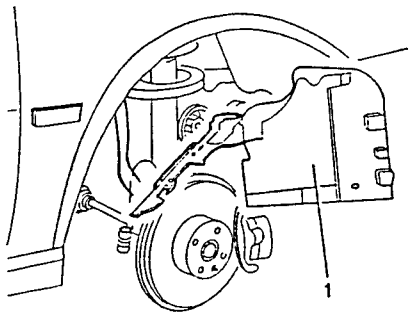
1. Drain the power steering system fluid reservoir using a suitable syringe.



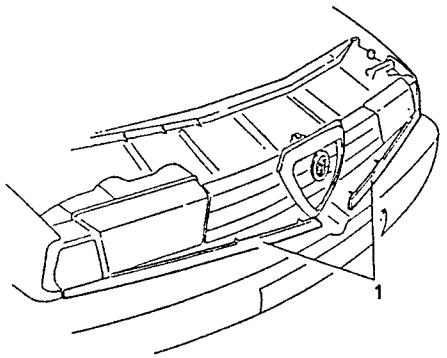
1. Remove the front right wheel.



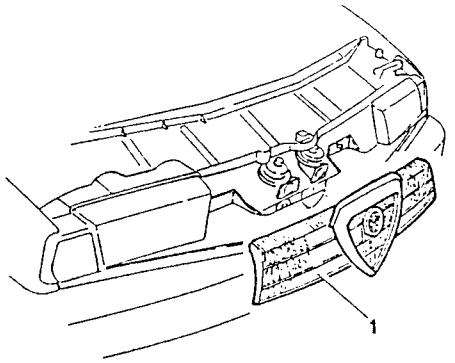
1. Remove the dust cover from the front right-hand wheelhousing.



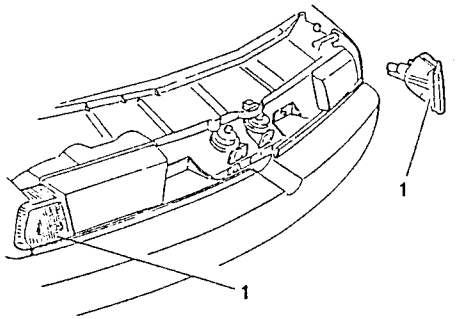
1. Working from the centre, remove the two strips of front grill trim.



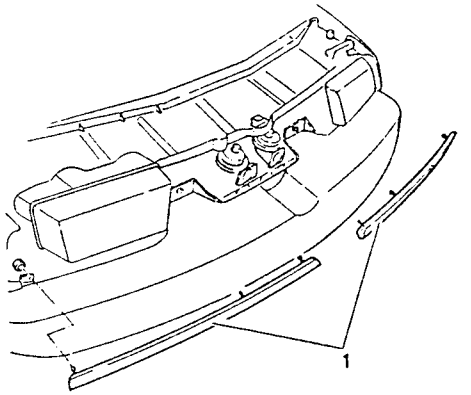
1. Remove the grill (see GROUP 75).



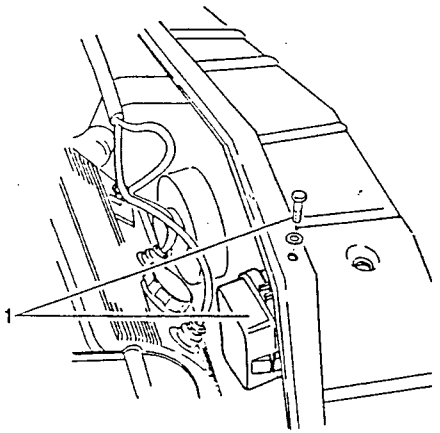
1. Remove the front direction indicators (see GROUP 40).



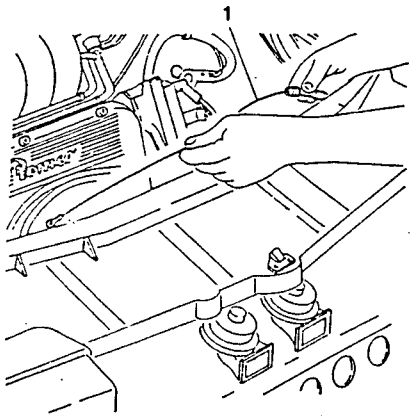
1. Remove the two strips of trim by unscrewing the lateral nut securing them to the body.



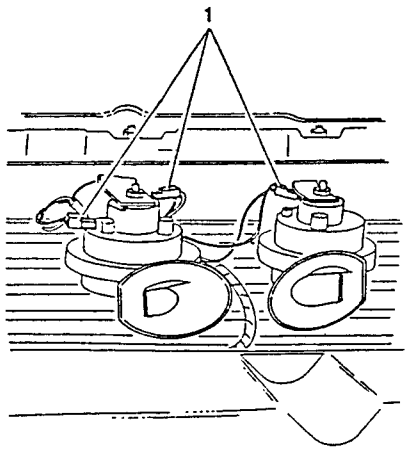
1. Unscrew the screws securing the relay box to the cross-member, and tie it to one side so that it does not get in the way when the cylinder heads are removed.



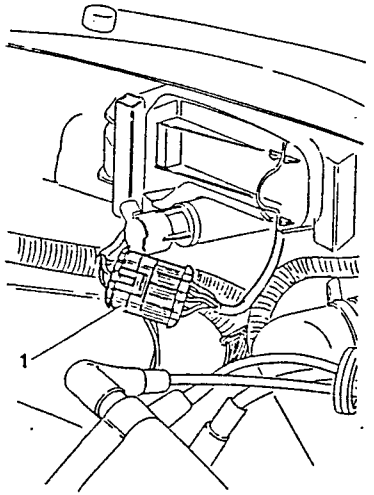
1. Disconnect the bonnet release cable from the two locks (see GROUP 56).



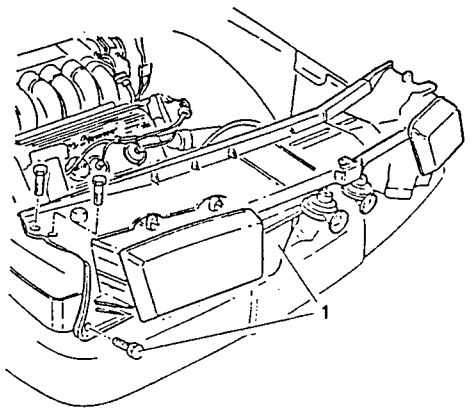
1. Disconnect the electrical connections from the horns.



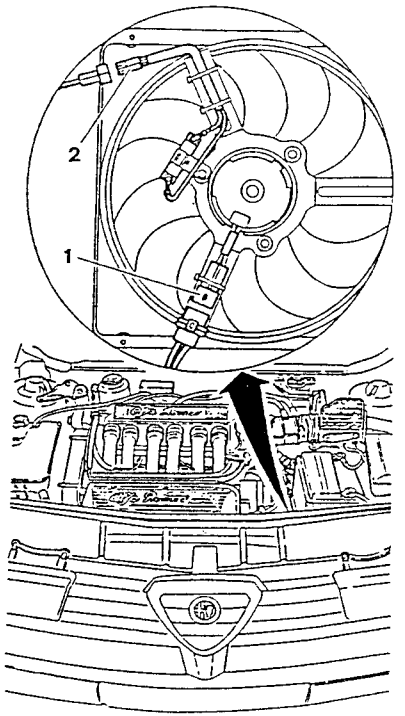
1. Disconnect the headlight assembly electrical connections.



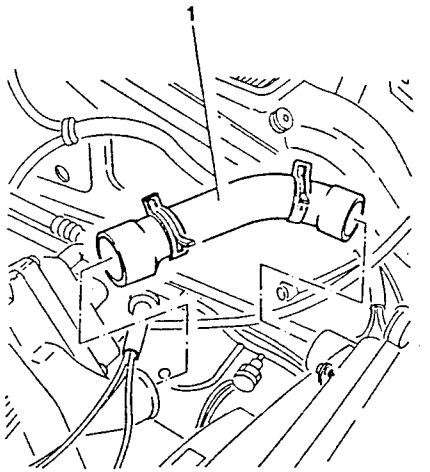
1. Unscrew the screws securing the the upper cross-member to the body and remove it together with the headlight assembly and horns.



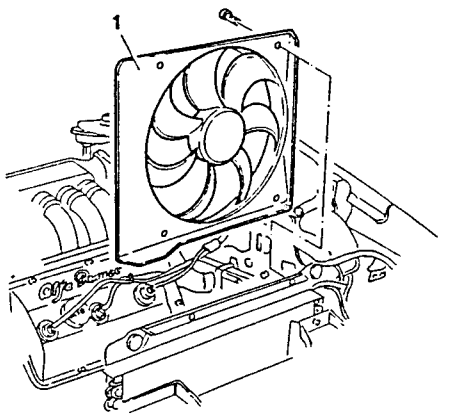
1. Disconnect the electrical connections of the engine cooling fan.
2. Disconnect the electrical connections of the engine cooling fan resistor.



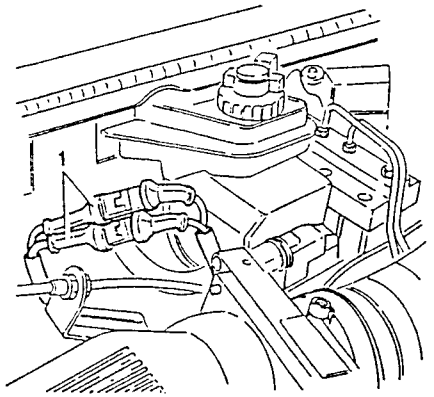
1. Remove the hose connecting the radiator to the ignition coil support.



1. Remove the electric fan after removing the 4 screws securing it to the radiator.

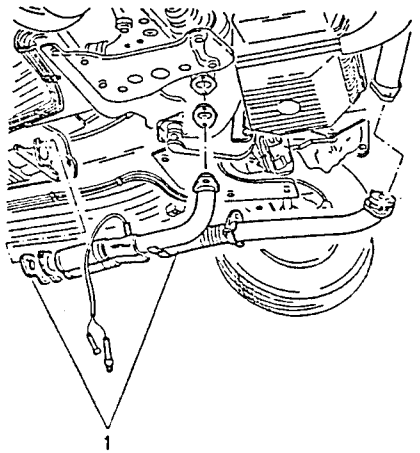


1. Disconnect the two electrical connections of the Lambda probe.

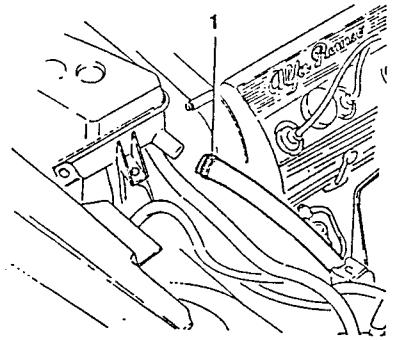


– Raise the vehicle.

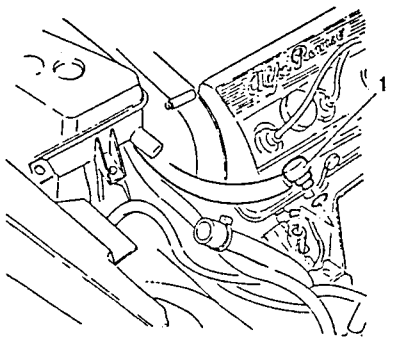
1. Disconnect and remove the front section of the piping and remove the gaskets.



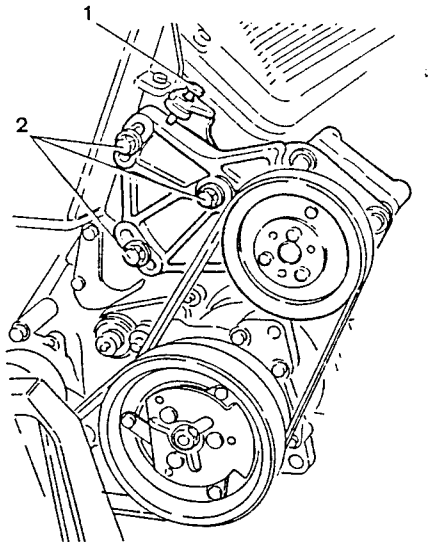
1. Disconnect the engine coolant to radiator delivery sleeve from the expansion tank.



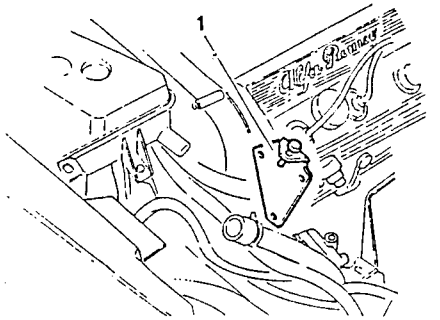
1. Disconnect the intake connection from the power steering pump.



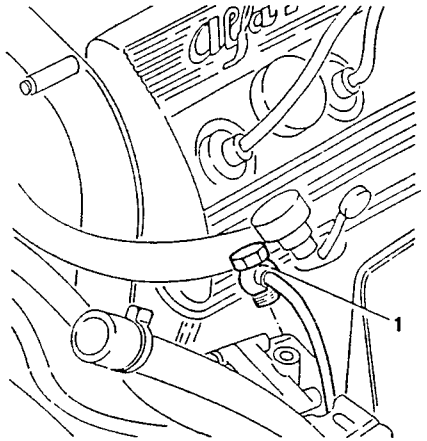
1. Loosen the screws of the power steering pump drive belt micrometric tensioner.
2. Remove the 3 screws securing the power steering support bracket.



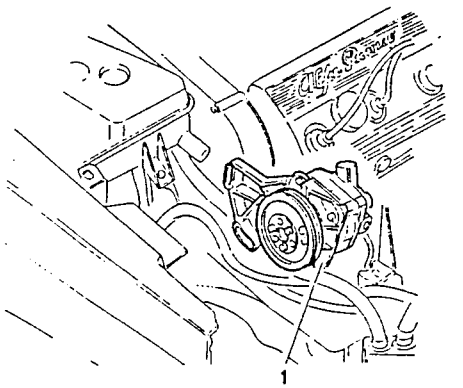
1. Remove the plate with the micrometric tensioner.



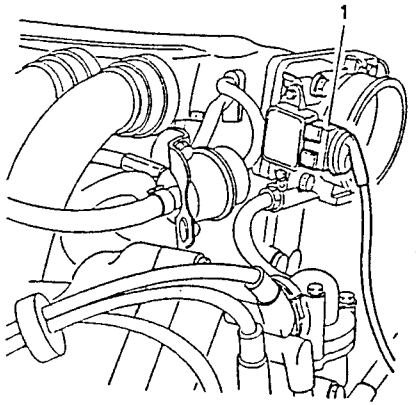
1. Disconnect the delivery connection from the power steering pump.



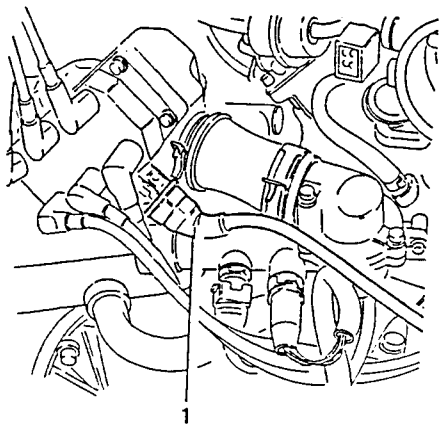
1. Remove the power steering pump together with the support bracket.



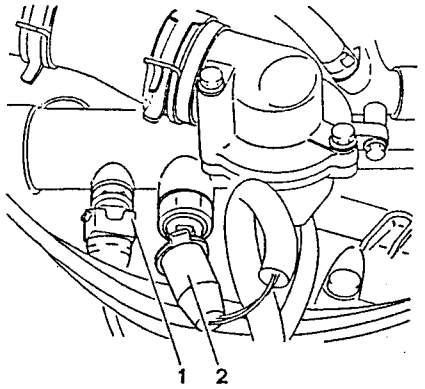
1. Disconnect the throttle valve potentiometer connection.



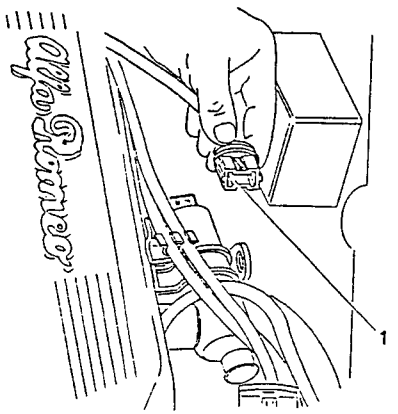
1. Disconnect the ignition coil connection.



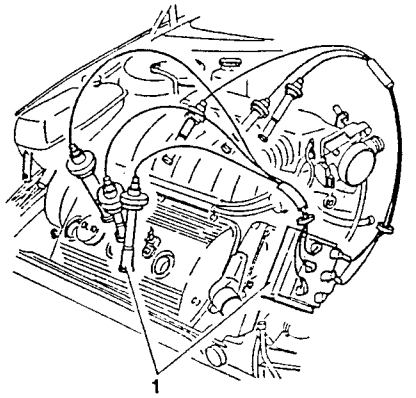
1. Disconnect electrical connection from the engine coolant temperature sensor (NTC).
2. Disconnect the electrical connection from the engine coolant temperature indicator sender and the maximum temperature warning light contact connections.



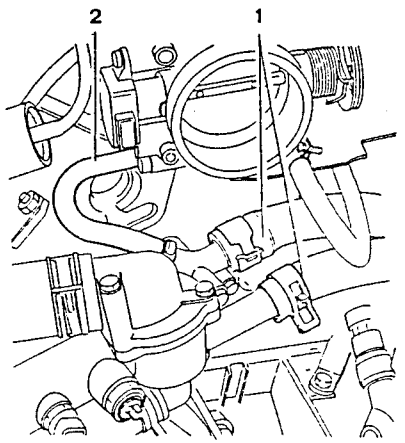
1. Disconnect electrical connection of the constant idle speed actuator.



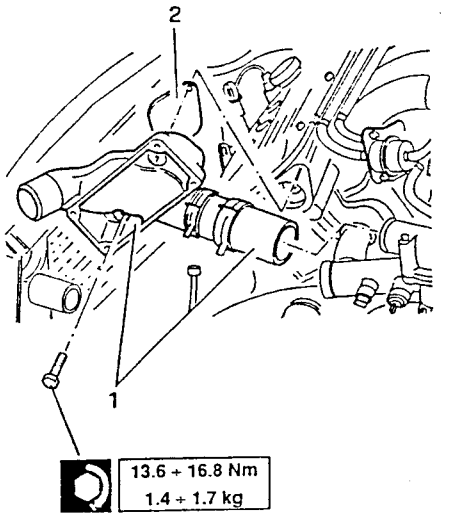
1. Remove the ignition coils together with the spark plug leads.



1. Disconnect the two engine coolant sleeves (delivery and return to heater) from the thermostatic cup
2. Disconnect the engine coolant outlet hose from the throttle valve.

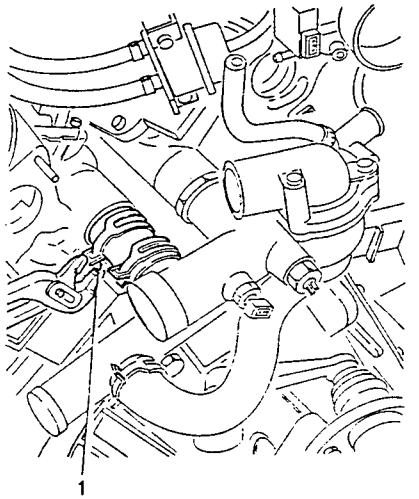


1. Remove the ignition coils support together with sleeve connected to the thermostatic cup.
2. Remove the gasket.

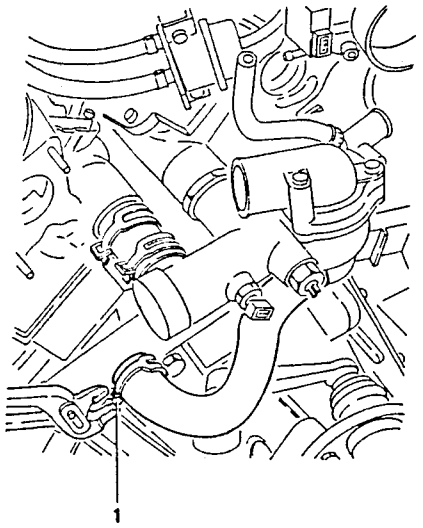


13.6 ÷ 16.8 Nm
1.4 ÷ 1.7 kg

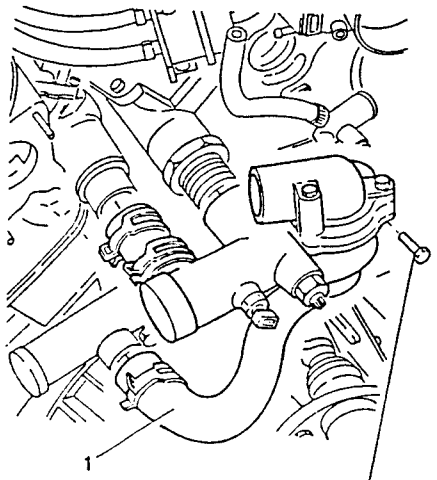
1. Disconnect the sleeve connecting the thermostatic cup to the left cylinder head.



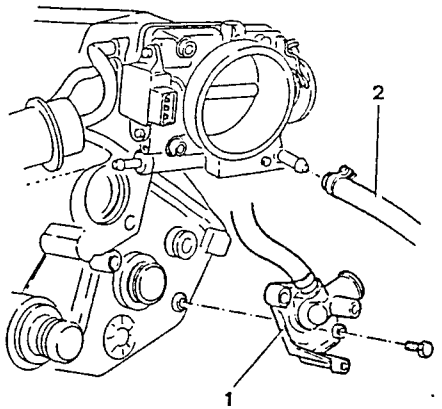
1. Disconnect the sleeve returning engine coolant to the pump



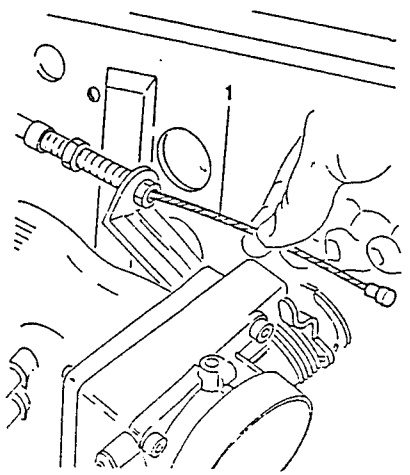
1. Remove the thermostat unit together with sleeves.



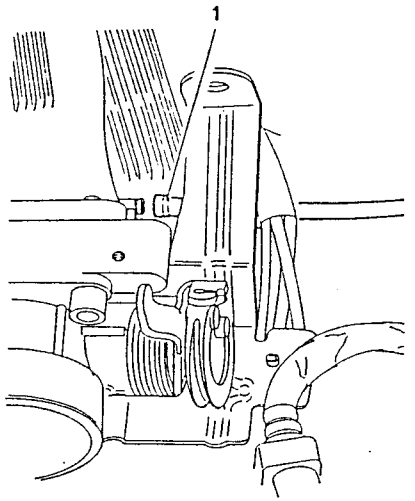
1. Remove the engine coolant to throttle body and heater connection.
2. Disconnect the engine coolant outlet hose from the throttle valve.



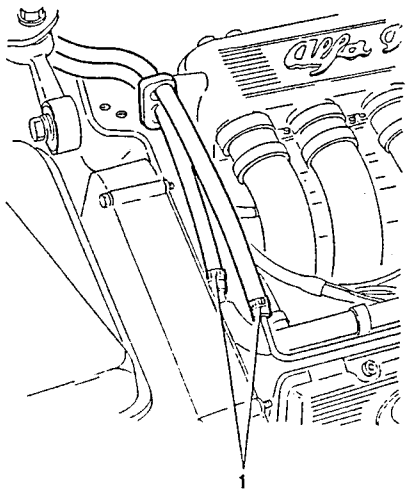
1. Disconnect the accelerator cable from the throttle body.



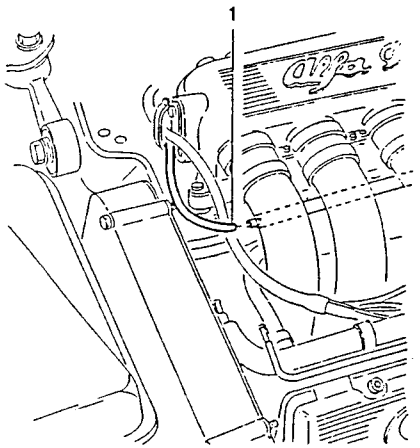
1. Disconnect the servo brake vacuum intake hose from the air intake box.



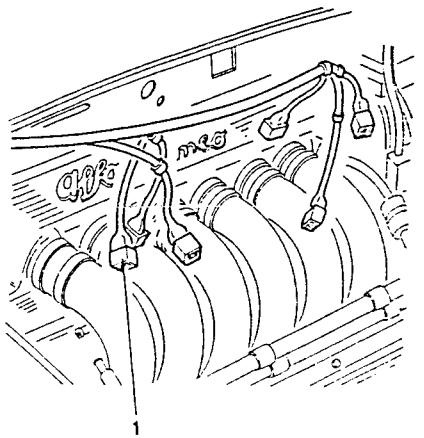
1. Disconnect the fuel delivery and return hoses from the fuel supply manifold.



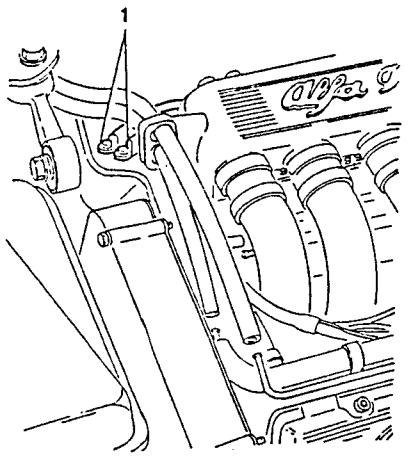
1. Disconnect the fuel vapour delivery hose from the rigid intermediate pipe.



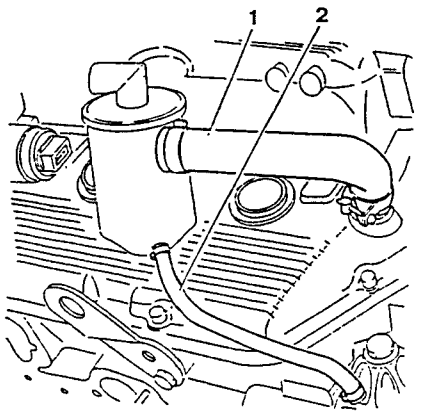
1. Disconnect the electrical connections from the electroinjectors, and move the cables to one side after having freed them from the clamps.



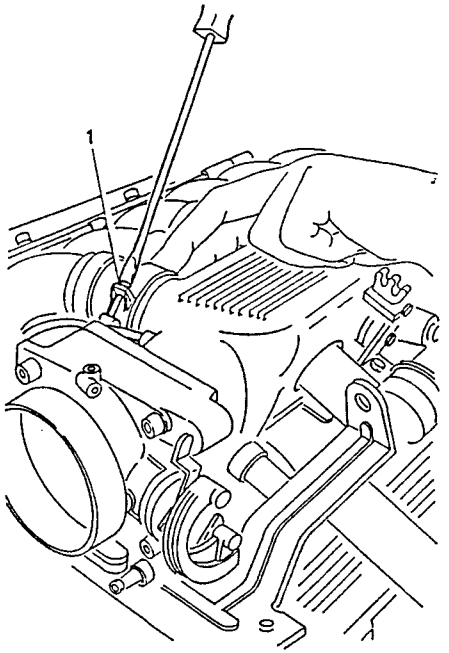
1. Disconnect the earth leads on the engine support.



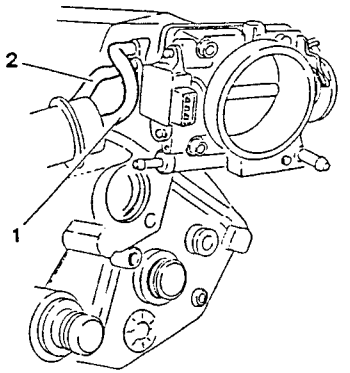
1. Disconnect the vapour delivery hose from the oil vapour separator.
2. Disconnect the oil recirculation hose from the separator.



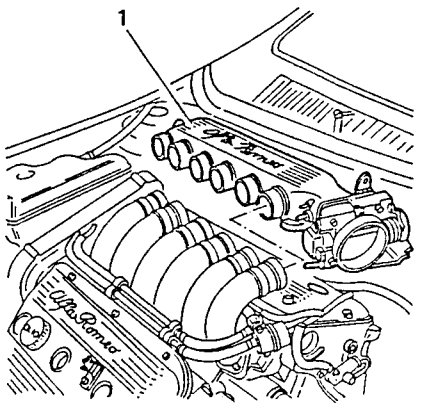
1. Loosen the clamps securing the air delivery conduits to the intake box.



1. Disconnect the pressure regulation vacuum intake hose from the intake box.
2. Disconnect the fuel vapour recirculation hose from the air intake box.

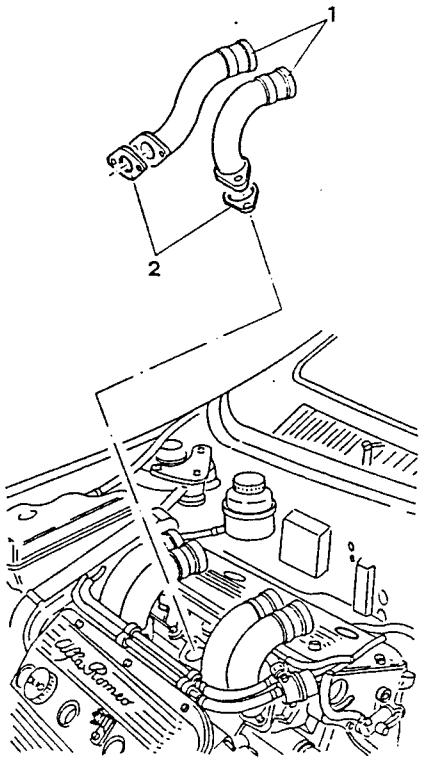


1. Unscrew the screws and remove the complete air intake box.

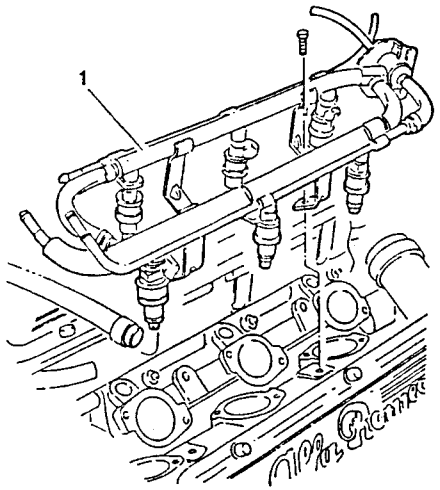


1. Unscrew the screws and remove the air supply ducts.
2. Remove the gaskets.

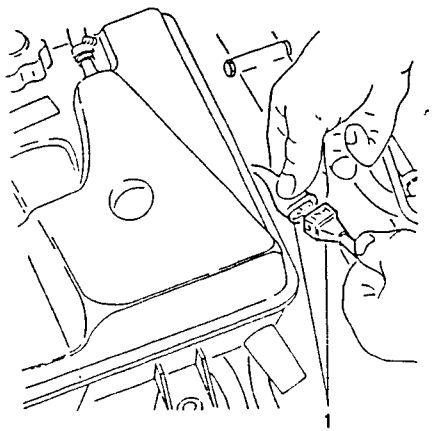
CAUTION
Suitably close off the holes of the intake manifold to prevent foreign matter from entering.



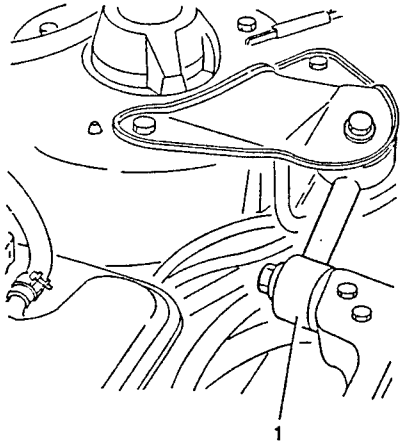
1. Unscrew the screws and remove the fuel supply manifold together with the electroinjectors and pressure regulator.



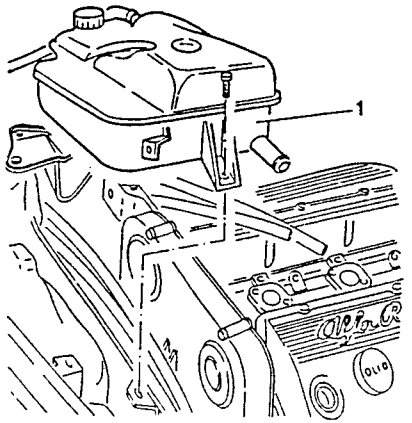
1. Disconnect the engine RPM and timing sensor electrical connection.



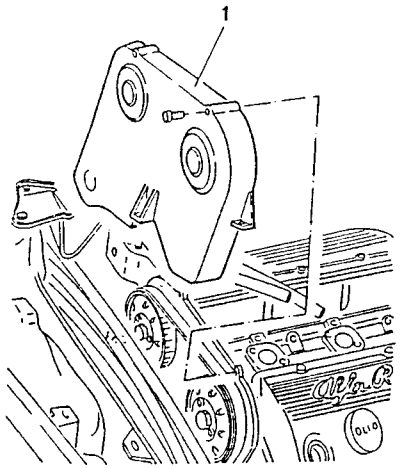
1. Disconnect the engine antivibration rod.



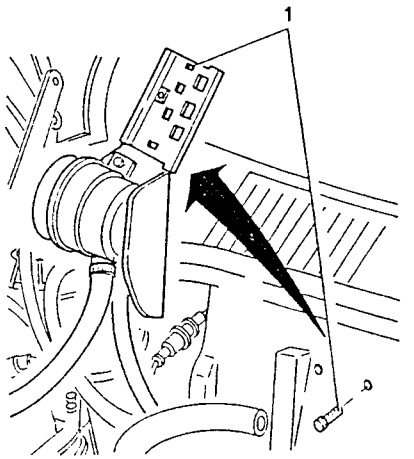
1. Remove the engine coolant expansion tank.



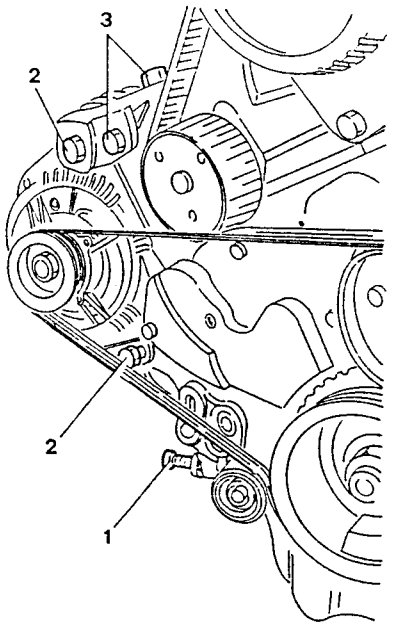
1. Remove the timing belt front cover.

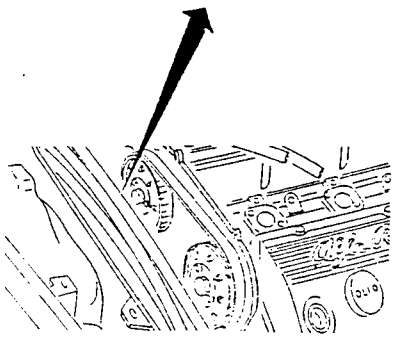


– Remove the relay box bracket plastic protection.
1. Unscrew the two screws securing the relay box bracket and power steering fluid reservoir support and move these to one side after disconnecting the relays from the support bracket.

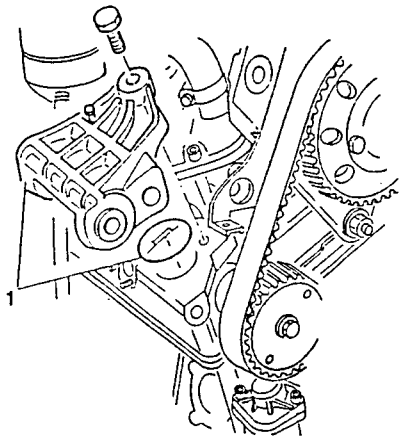


1. Slacken the tension of the alternator drive belt by acting on the micrometric adjustment screws.
2. Loosen the bolts securing the alternator.
3. Unscrew the bolt and screw securing the upper alternator support to the right cylinder head.

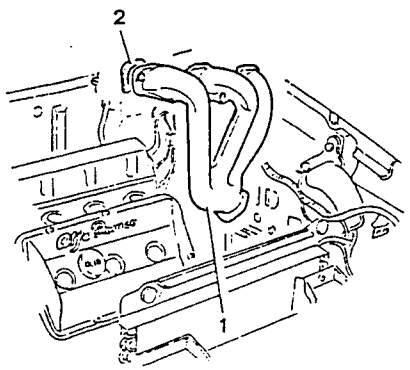




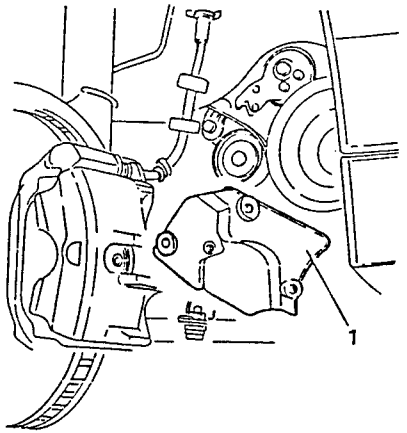
1. Remove the previously loosened upper alternator support bulb and remove the alternator support together with the O-ring.



1. Remove the exhaust manifolds
2. Remove the gaskets.



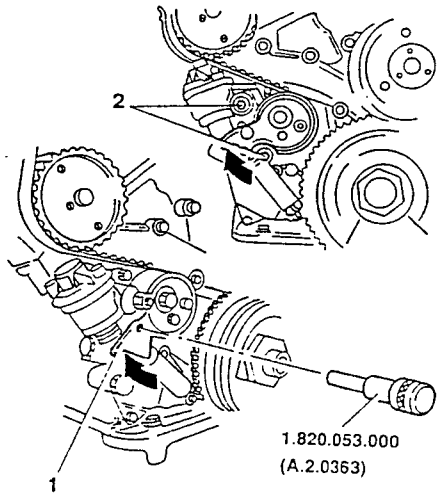
- Raise the vehicle on a lift.
1. Remove the hydraulic belt tensioner protection plate.



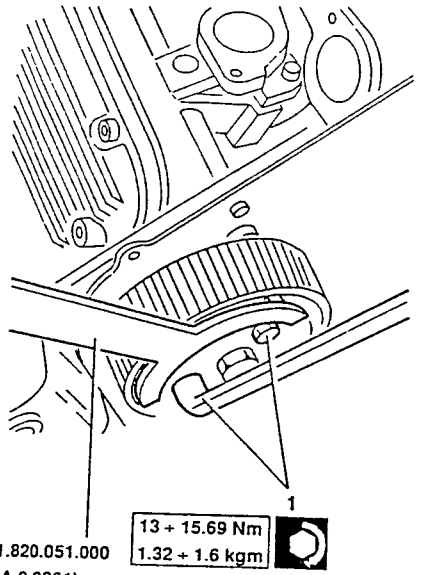
1. Raise the arm of the hydraulic belt tensioner and lock the belt tensioner with tool N° 1.820.053.000 (A.2.0363).

NOTE: To introducce tool N° 1.820.053.000 (A.2.0363) it is necessary to align the housing hole with that in the belt tensioner body.

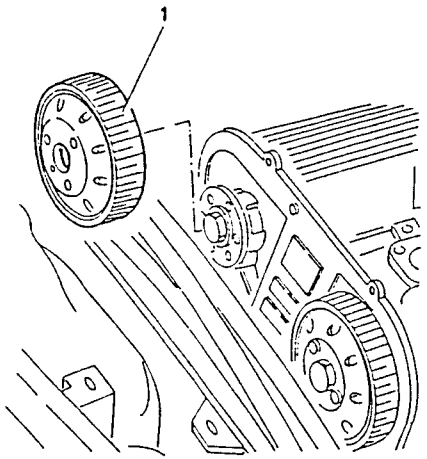
2. Loosen the two nuts securing the body of the belt tensioner to the engine block.
- Rotate the hydraulic belt tensioner upwards and lock it in position by tightening the previously loosened nuts.



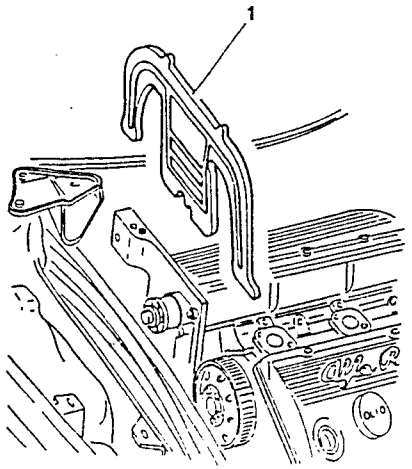
- Lower the vehicle.
- Slide the timing belt off the pulleys.
1. Using tool N° 1.820.051.000 (A.2.0361) as a reactor, unscrew the three screws securing the right-hand timing pulley to the support hub.



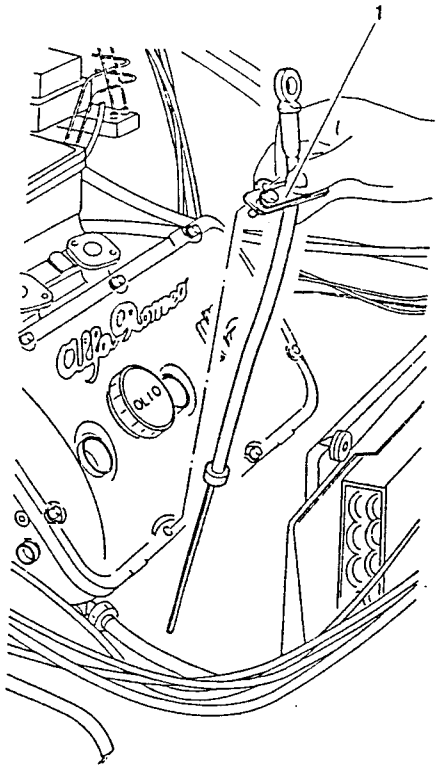
1. Remove the right-hand timing pulley.



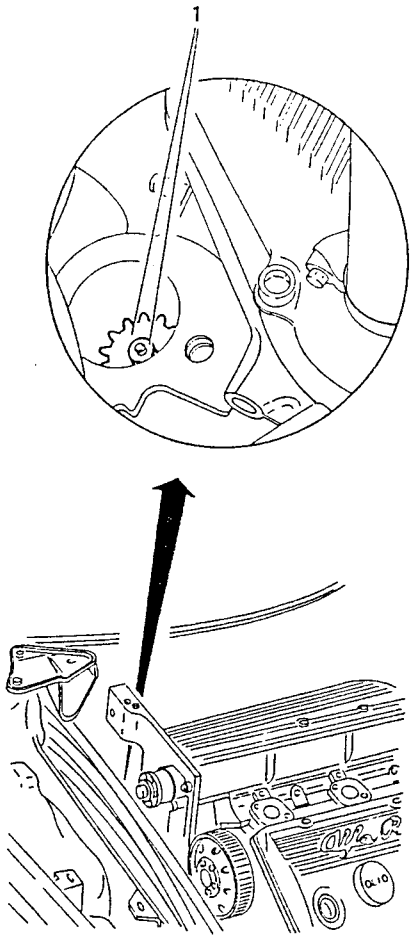
1. Remove the toothed timing pulley rear cover.



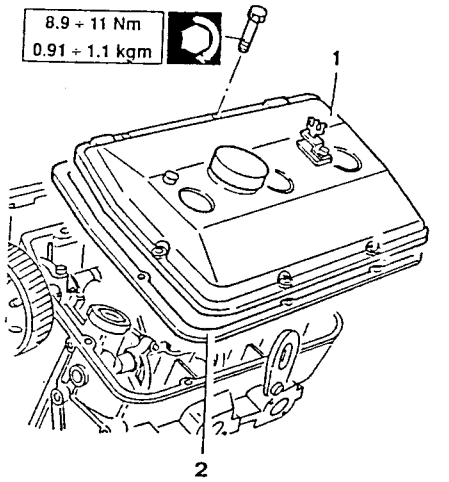
1. Remove the oil dipstick.



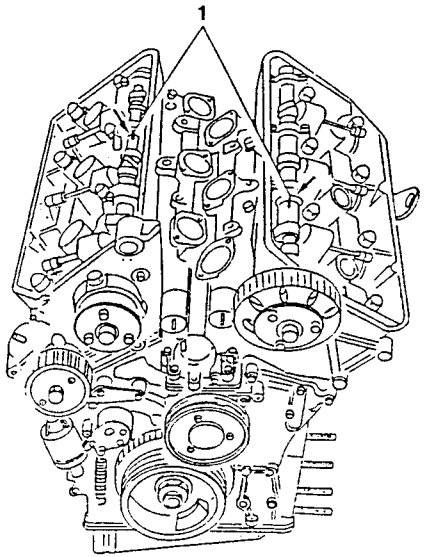
1. Unscrew and remove the oil pump intermediate drive gear nut.



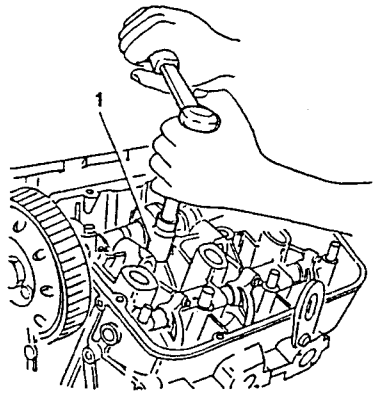
1. Remove the timing cover.
2. Remove the gaskets.



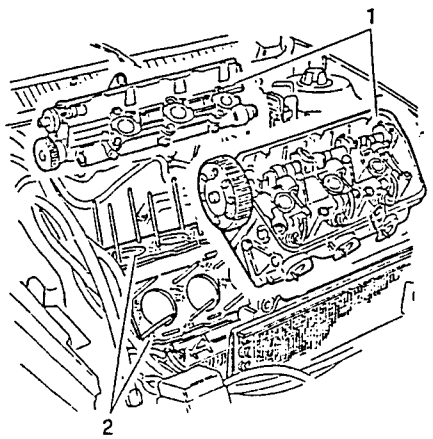
1. Rotate the crankshaft until the reference notches on the camshafts are aligned with those on the relative caps.



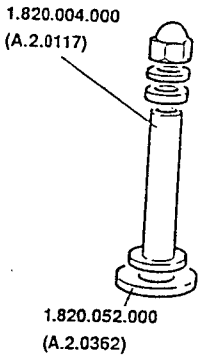
1. Release and remove the the nuts and relative washers securing the cylinder heads to the engine block.

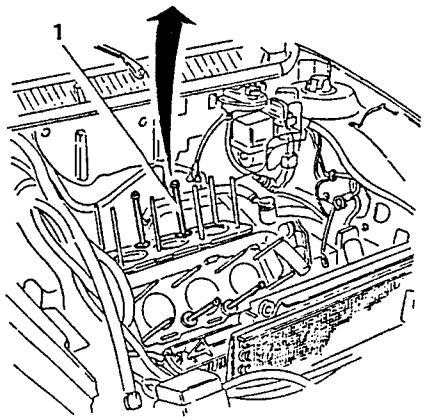


1. Remove the cylinder heads.
2. Remove the gaskets.



1. Install the cylinder liner retainers N° 1.820.004.000 (A.2.0117) with the relative supplementary washers N° 1.820.052.000 (A.2.0362).



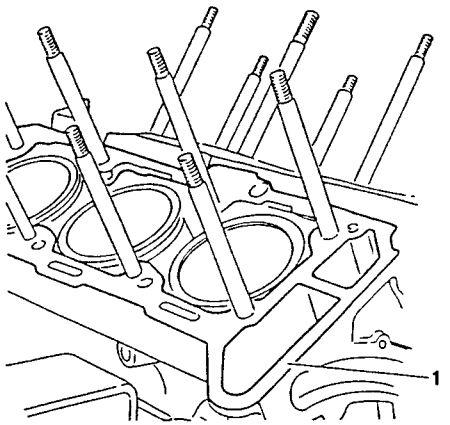


INSTALLATION OF CYLINDER HEADS

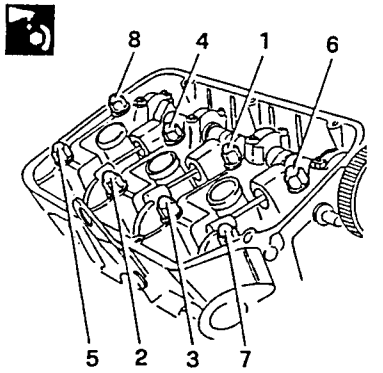
Reverse the order of the disassembly procedure taking note of the following indications:

- Rotate the crankshaft and bring the piston of the first cylinder to the T.D.C. position.
- Remove cylinder liner retainers N° 1.820.004.000 (A.2.0117) and the supplementary washers N° 1.820.052.000 (A.2.0362).

1. Position the cylinder head gaskets.



- Ensure that the timing notches on the camshaft are aligned to those on one of the camshaft caps and then install the cylinder heads on the engine block.
- Lubricate the nuts and washers with engine oil and, in two or three stages, tighten the eight nuts securing each cylinder head as shown in the table below.

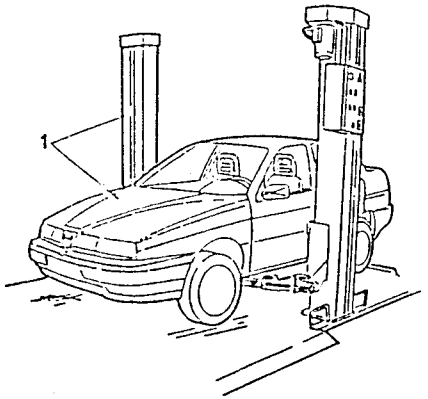


On installation Lubricate the nuts, washers and threads of the studs with oil and tighten to the prescribed torque in the order shown.	88.5 to 97.8 Nm 9 to 10 kgm
After bench testing when the engine is cold, one at a time loosen the nuts by one revolution following the sequence indicated; wipe the surfaces betweem washers and nuts with oil and tighten to the prescribed torque once again.	97.8 to 108.2 Nm 10 to 11 kgm

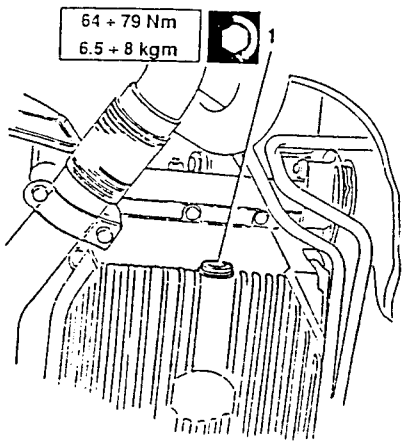
- Refer to the specific procedures for the installation of the timing belt and timing check see **GROUP 00**.

REMOVAL/REPLACEMENT OF THE OIL SUMP

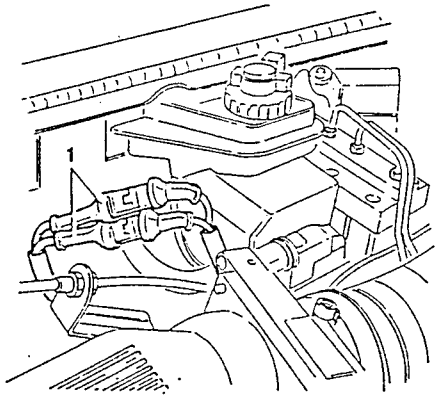
1. Place the vehicle on a lift.



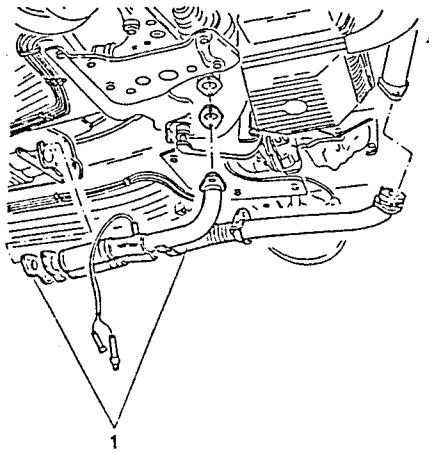
– Disconnect the negative cable from the battery.
– Raise the vehicle.
1. Drain the engine oil by unscrewing the cap on the oil sump (see GROUP 00).



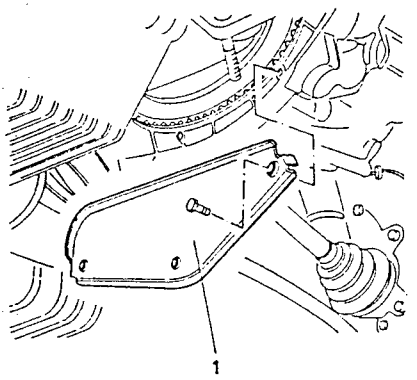
1. Disconnect the Lambda probe connections.



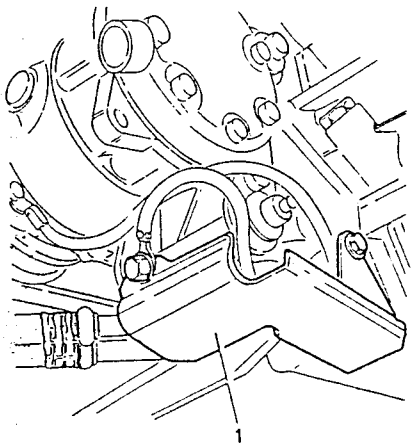
1. Remove the forward section of the piping and remove it along with the relative gaskets.



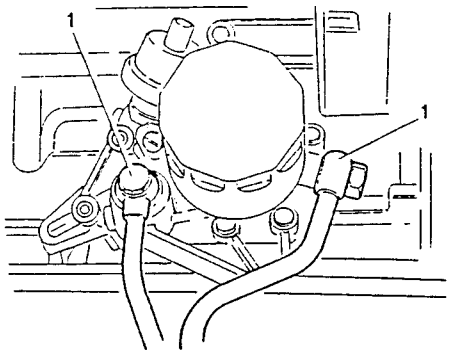
1. Remove the flywheel protection cover.



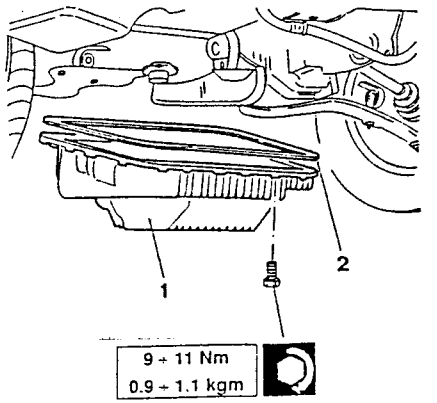
1. Remove the oil to radiator delivery and return hoses support bracket.



1. Disconnect the oil to radiator delivery and return connections from the oil filter support and leaving them connected to the radiator, tie them to one side so that they don't get in the way during removal of the oil sump.



1. Unscrew the the two screws and remove the oil sump.
2. Remove the gasket.



TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

All technical, dimensional checks and inspections relevant to the AR 67301 engine are presented below.

The same information has been included in the description of the repair procedure presented earlier, where reference can also be made to the figures.
The information below has been synthetically enlarged with other data useful for the complete inspection of the engine and its parts.
The order in which the components are presented is the same as that for the reassembly of overhaulled engines.

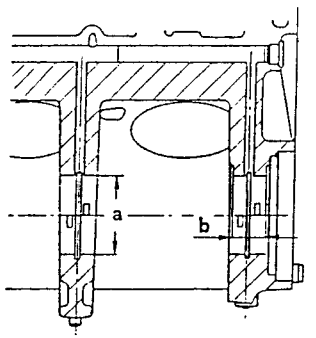
TECHNICAL CHARACTERISTICS OF THE ENGINE

Engine		AR 67301
Cycle		eight cycles, four stroke
Fuel supply		electronic injection
Displacement	cm^3	2492
Number of cylinders		6 a V di 60°
Bore	mm	88
Stroke	mm	68.3
Maximum Power	CV DIN (kW CEE) giri/min	166 (121) 5800
Maximum torque	kg DIN (Nm CEE) r.p.m.	21,7 (216) 4500
Compression ratio		10
Engine oil pressure (1) - at idle speed - at 4000 r.p.m.	kPa (bars; kg/cm^2)	 147 (1.5; 1.53) 500 (5; 5.1)

(1) With engine at operating temperature (oil at 100° C)

COMPLETE ENGINE BLOCK

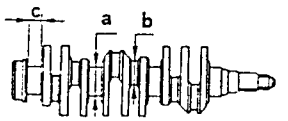
Engine block

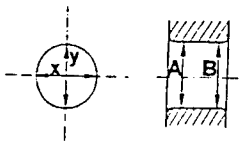


Unit: mm

Diameter of main supports (a)	A - Red	63.657 ÷ 63.663
	B - Blue	63.663 ÷ 63.669
	C - Green	63.669 ÷ 63.675
Length of rear main support shoulder (b)		26.450 ÷ 26.500

Crankshaft



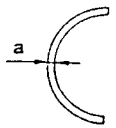


(1) Ovalization X:Y
(2) Taper A:B

Unit: mm

Diamter of main journal (a)	A - Red	59.973 ÷ 59.979
	B - Blue	59.967 ÷ 59.973
	C - Green	59.961 ÷ 59.967
Diameter of rod journal (b)	A - Red	51.990 ÷ 52.000
	B - Blue	51.980 ÷ 51.990
Length of rear main journal (c)		31.300 ÷ 31.335
Maximum ovalization of main and rod journal (1)		0.004
Maximum taper of main and rod journals (2)		0.010
Maximum error of parallelism between main and rod journals		0.015
Maximum eccentricity between main journals		0.040
Maximum deviation between centre lines of handle and main journal		0.300

Main half bearings



Unit: mm

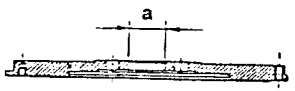
Thickness of main half bearings (a)	A - Red	1.833 ÷ 1.839
	B - Blue	1.839 ÷ 1.845
	C - Green	1.845 ÷ 1.851
Radial play between main pin and bearing	A - Red	0.000 ÷ 0.024
	B - Blue	0.006 ÷ 0.018
	C - Green	0.000 ÷ 0.024

Thrust half rings

Unit: mm

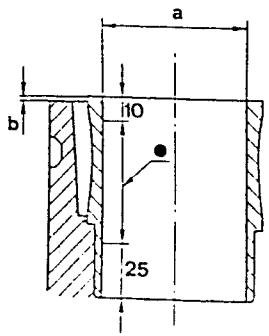
Thickness of thrust half rings (a)	2.310 ÷ 2.360
Crankshaft axial play	0.080 ÷ 0.265

Flywheel



Internal diameter of central bushing (a)	35.000 ÷ 35.025 mm
Heating temperature of ring gear for installation on engine flywheel	120 ÷ 140° C

Cylinder liner

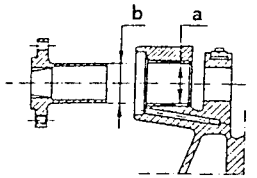


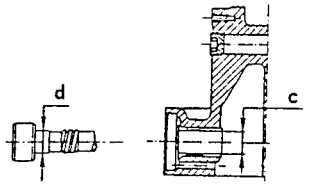
Unit: mm

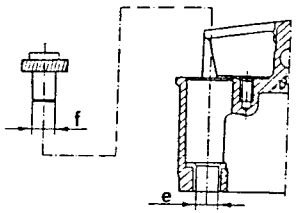
Diameter of cylinder liners (a)	A - Red	87.985 ÷ 87.994
	B - Blue	87.995 ÷ 88.004
	C - Green	88.005 ÷ 88.014
Protuberance of cylinder liners from engine block (b)		0.01 ÷ 0.06 *
Limit of ovalization and cylinder liner taper		0.01

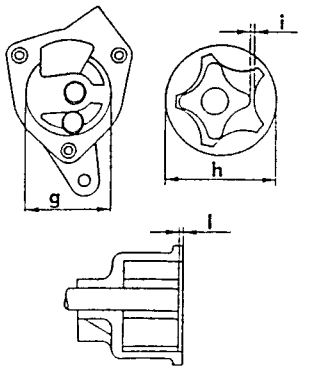
(*) Dimensional control area

Oil pump







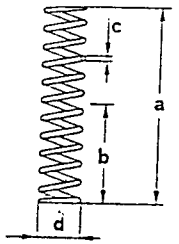


Unit: mm

Diameter of camshaft pulley hub bushing	(a)	32.000 ÷ 32.025
Diameter of camshaft pulley hub	(b)	31.959 ÷ 31.975
Diameter of pump drive pulley hub bushing (1)	(c)	19.000 ÷ 19.021
Diameter of oil pump drive pulley hub (1)	(d)	18.967 ÷ 18.980
Diameter of oil pump drive gear hub bushing (reaming)	(e)	19.000 ÷ 19.021
Diameter of pump drive gear hub (1)	(f)	18.967 ÷ 18.980
Diameter of seating for driven rotor in pump body	(g)	49.325 ÷ 49.375
Outer diameter of oil pump driven rotor	(h)	49.100 ÷ 49.155
Clearance between driven rotor and inner rotor	(i)	0.040 ÷ 0.290
Axial play between rotors and plane of pump body	(l)	0.025 ÷ 0.075
Radial play between outer rotor and bump body		0.170 ÷ 0.275
Radial play between camshaft pulley hub and bushing		0.025 ÷ 0.066
Radial play between pump drive pulley hub and bushing (1)		0.020 ÷ 0.054
Radial play between pump drive gear hub and bushing (1)		0.020 ÷ 0.054

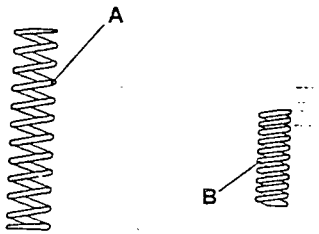
(1) only on right-hand cylinder head

Oil pressure relief valve spring



Length of spring at rest (a)		54 mm
Length of spring under test loading (b)	STATIC	36 mm
	DYNAMIC	28 mm
Test loading	STATIC	36 N (14.6 kg)
	DYNAMIC	28 N (21 kg)
Wire diameter (c)		2.1 mm
Spring diameter (d)		16.3 mm

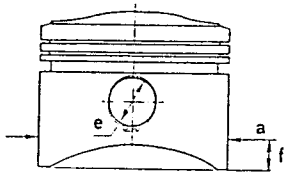
Hydraulic belt tensioner spring

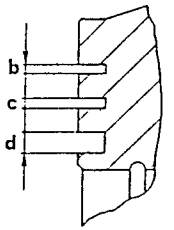


Spring A (piston)	Numbero of serviceable turns	12
	Length of spring at rest	93 mm
	Length of loaded spring	48 mm
	Static control loading	93.16 N (9. 5 kg)
Spring B (pre-loading)	Number of serviceable turns	9
	Length of spring at rest	45.5 mm
	Length of loaded spring	30 mm
	Static control loading	98 N (10 kg)

ROD - PISTON ASSEMBLY

Piston



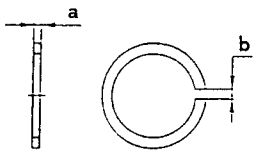


Unit: mm

		MONDIAL	BORGO
Piston diameter (a) (1)	A - Blue	87.925 ÷ 87.935	87.935 ÷ 87.945
	B - Pink	87.935 ÷ 87.945	87.945 ÷ 87.955
	C - Green	87.945 ÷ 87.955	87.955 ÷ 87.965
Height of first seal ring seating (b)		1.525 ÷ 1.545	
Height of second seal ring seating (c)		1.525 ÷ 1.545	
Height of oil scraper ring seating (d)		3.515 ÷ 3.535	
Diameter of gudgeon pin hole in (e) piston	Black	22.003 ÷ 22.006	
	White	22.006 ÷ 22.009	
Clearance between cylinder liner and piston		0.040 ÷ 0.059	
Weight difference between pistons		± 2 g	

(1) To be measured perpendicular to the gudgeon pin hole at a distance of f = 12 mm from the lower edge of skirt.

Piston rings

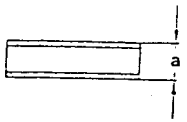


Unit: mm

Thickness of rings (a)	First ring	1.475 ÷ 1.490
	second ring	1.475 ÷ 1.490
	oil scraper ring	3.475 ÷ 3.490
Ring gap (1) (b)	First ring	0.30 ÷ 0.50
	second ring	0.30 ÷ 0.50
	oil scraper ring	0.30 ÷ 0.50 (2) 0.25 ÷ 0.50 (3)
Axial play between piston rings and seatings	First ring	0.035 ÷ 0.070
	second ring	0.035 ÷ 0.070
	oil scraper ring	0.025 ÷ 0.055

(1) To be measured in the checking ring nut or in the cylinder liner
(2) Borgo
(3) Goetze

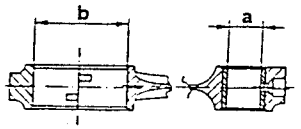
Gudgeon pin



Unit: mm

Outer diameter of gudgeon pin (a)	Black	21.994 ÷ 21.997
	White	21.997 ÷ 22.000
Clearance between piston hole and gudgeon pin	Black	0.006 ÷ 0.012
	White	0.006 ÷ 0.012

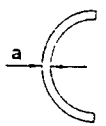
Rod



Unit: mm

Diameter of rod small end bushing bore (a)		22.005 ÷ 22.015
Inner diameter of rod big end (b)		55.511 ÷ 55.524
Weight difference between rods		≤ 2 g
Clearance between rod small end bushing and gudgeon pin	Black	0.008 ÷ 0.021
	White	0.005 ÷ 0.018

Rod bearing halves

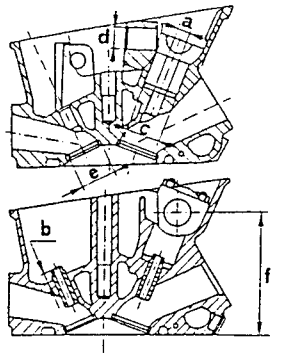


Unit: mm

Thickness of rod half bearing (a)	Red	1.737 ÷ 1.745
	Blue	1.741 ÷ 1.749
Radial play between pins and rod bearings	Red	0.021 ÷ 0.060
	Blue	0.023 ÷ 0.062
Axial play of rod head		0.2 ÷ 0.3

CYLINDER HEADS

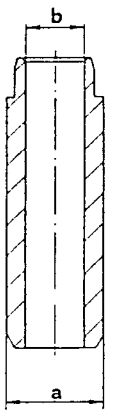
Heads



Unit: mm

Diameter of valve guide seating (a)		13.990 ÷ 14.018
Valve guide protrusion (b)		10.2 ÷ 10.6
Diameter of valve cup seating (c)	Intake	35.000 ÷ 35.025
Diameter of valve guide seating (d)	Exhaust	22.000 ÷ 22.021
Diameter of valve seat housing (e)	Intake	42.000 ÷ 42.025
	Exhaust	37.000 ÷ 37.025
Minimum permissable height of the head after facing (f)		124.85 ÷ 125.15
Maximum error of flatness of head lower plane		0.05
Inclination of head upper surface		7°55' ÷ 8°5'

Valve guides

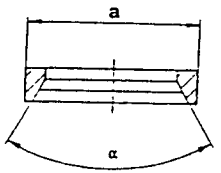


Unit: mm

Outer diameter of valve guide (a)		14.048 ÷ 14.059 14.062 ÷ 14.073 (1)
Inner diameter of valve guide (reaming) (b)		9.000 ÷ 9.015
Interference between valve guide and seating		0.030 ÷ 0.069 0.044 ÷ 0.083 (1)

(1) Valid only for spare parts

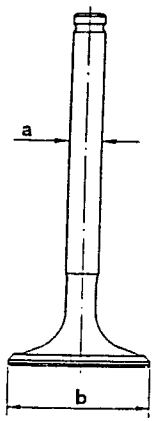
Valve seatings



Unit: mm

Outer diameter of valve seat	(a)	Intake	42.065 ÷ 42.100
		Exhaust	37.095 ÷ 37.111
Valve seat taper		(α)	90° ± 20'
Interference between valve seat and housing		Intake	0.040 ÷ 0.100
		Exhaust	0.070 ÷ 0.111
Cylinder head shrink-fit temperature for installation of valve seatings			100°C

Valve

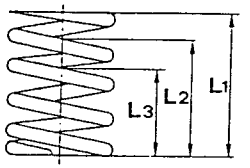


Unit: mm

Diameter of valve stem	(a)	Intake	8.957 ÷ 8.977 (1) 8.950 ÷ 8.980 (2)
		Exhaust	8.925 ÷ 8.945
Diameter of valve head	(b)	Intake	40.850 ÷ 41.000 (1) 40.800 ÷ 41.000 (2)
		Exhaust	36.450 ÷ 36.600
Radial play between valve stem and guide		Intake	0.023 ÷ 0.058 (1) 0.020 ÷ 0.065 (2)
		Exhaust	0.055 ÷ 0.090

(1) Livia (2) Ate

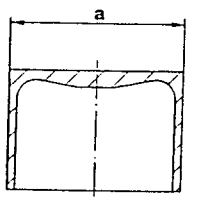
Valve springs



Unit: mm

Length of valve spring at rest (L_1)	Outer spring	44.6
	Inner spring	44.1
Length of valve spring with closed valve (L_2)	Outer spring	32.5
	Inner spring	30.5
Length of valve spring with open valve (L_3)	Outer spring	23.5
	Inner spring	21.5
Load corresponding to spring length with valve closed	Outer spring	243 ÷ 252 N (24.8 ÷ 25.7 kg)
	Inner spring	126 ÷ 130 N (12.8 ÷ 13.3 kg)
Load corresponding to spring length with valve open	Outer spring	470 ÷ 488 N (47.9 ÷ 49.7 kg)
	Inner spring	222 ÷ 231 N (22.7 ÷ 23.5 kg)

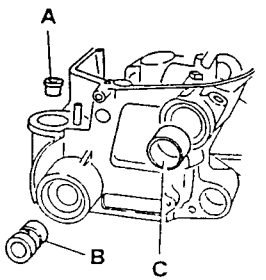
Valve cups



Unit: mm

Diameter of valve cups	(a)	Intake	34.973 ÷ 34.989
		Exhaust	21.971 ÷ 21.989
Radial play between valve cups and seating		Intake	0.011 ÷ 0.052
		Exhaust	0.011 ÷ 0.050

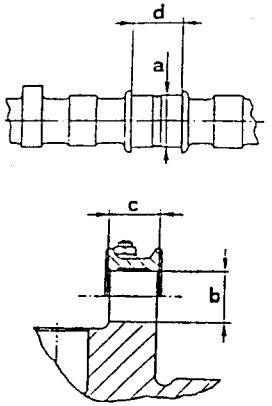
Cylinder head bushings



Unit: mm

Inner diameter of bushing "A"	19.000 ÷ 19.021
Inner diameter of bushing "B"	19.000 ÷ 19.021
Inner diameter of bushing "C"	32.000 ÷ 32.025

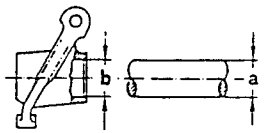
Camshaft



Unit: mm

Diameter of camshaft pin	(a)	26.949 ÷ 26.970
Diameter of camshaft supports	(b)	27.000 ÷ 27.033
Maximum eccentricity between pins		0.03
Width of support shoulder	(c)	26.851 ÷ 26.935
Widht of shaft support	(d)	27.000 ÷ 27.052
Radial play between weight and camshaft seating		0.030 ÷ 0.084
Camshaft axial play		0.065 ÷ 0.201

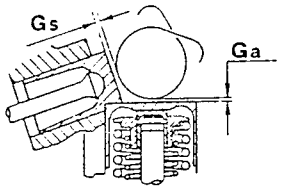
Rocker arms



Unit: mm

Diameter of rocker arm shaft	(a)	15.988 ÷ 16.000
Inner diameter of rocker arm bore	(b)	16.016 ÷ 16.034
Radial play between valve cup and rocker arm shaft		0.016 ÷ 0.046

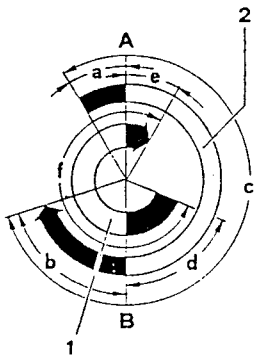
Valve clearance



Unit: mm

Valve clearance (cold engine)	(G_a)	Intake	0.475 ÷ 0.500
	(G_s)	Exhaust	0.310 ÷ 0.345
Nominal height		Intake	9.6
		Exhaust	6.4
Angular value of timing reference marks on caps		Right-hand head	15°
		Left-hand head	15°

ANGULAR VALUES OF ACTUAL TIMING DIAGRAM



(1) Exhaust (2) Intake
(A) TDC (B) BDC

Intake	Opening (before TDC)	(a)	31°26'
	Closing (after BDC)	(b)	73°26'
	Intake angular value	(c)	284°52'
Exhaust	Opening (before BDC)	(d)	67°04'
	Closing (after TDC)	(e)	30°04'
	Exhaust angular value	(f)	277°08'

FLUIDS AND LUBRICANTS

Application	Type	Prescribed classification	Name	Q.ty litres
Engine oil	oil	API SG	SELENIA SPECIAL	
– Total capacity		CCMC G5	FORMULA ALFA ROMEO	8
– Partial capacity (filter and pan) for routine changes		SAE 10W/40	10W/40	6
– Filter				0.5
– Camshaft sumps				1
Cylinder head stud bolts				-
Piston and piston rings				-
Rod screws				-
Crankshaft rod journals				-
Intake and exhaust valve cups and seatings				-
Shaft, rotors and oil pump valve				-
Outer surface of camshaft oil seal and return shaft oil seal				-
Outer surface of crankshaft front oil seal				-
Outer surface and inner lip of crankshaft rear oil seal				-
Rear main journal cap seal sleeves	Fluid		MILLOIL lubricant for rubber parts	-
Shaft for auxiliary organ pulley				-
Rear hub				-
Seal ring between front and rear hubs			UNION CARBIDE	-
Rocker arm rods and rocker arm shaft			CHEMICALS CO.	-
Rocker arm drive shaft			Ucon lubrificant	-
Inner lip of camshaft oil seal and return shaft oil seal			50HB-5100	-

(CONTINUES)

FLUIDS AND LUBRICANTS (Continued)

Application	Type	Name	Q.ty
Inner lip of crankshaft front oil seal	Grease	ISECO Molykote BR2	-
Seal rings of hydraulic belt tensioner pin			-
			-
Spark plug thread	Oil	ISECO Molykote A	-
Valves (only lower part of stem on head side)		Vaseline	-

SEALANTS AND FIXATIVES

Application	Type	Name	Q.ty
Cylinder head cover gaskets (head side)	Mastic	DIRING Heldite	-
		DOW CORNING Hermetite	
Oil sump gasket			-
Screw securing flywheel to crankshaft	Mastic	Loctite 270 (green)	-
Caps on crankshaft lubrication ducts			-
Engine oil minimum pressure warning lamp sensor	Mastic	Mastic class S-ME4	-
Mating surfaces between oil sump and engine block	Mastic	MASCHERPA Q37091 (black)	-

ABRASIVES

Application	Type	Name	Q.ty
Grinding of valve seats	Abrasive	SIPAL AREXONS	-
		Carbosilicium for valves	

TIGHTENING TORQUES

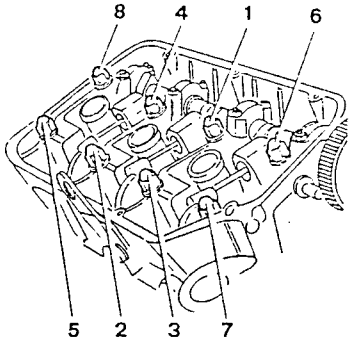
Engine block

Part	Nm	kgm
Nuts securing main caps to supports on engine block (in oil)	84 ÷ 92.7	8.56 ÷ 9.45
Screws securing flywheel to crankshaft (with fixative)	112.8	11.5
Nut securing crankshaft front pulley (in oil)	235.4	24
Screws securing rod caps (in oil)	53.4 ÷ 59	5.45 ÷ 6.0
Screws securing water pump body to engine block	8.1 ÷ 9.3	0.83 ÷ 0.95
Screw securing belt tensioner pulley	17 ÷ 20	1.7 ÷ 2.0
Screws securing exhaust manifold	25.5	2.6
Screws securing front cover	8.1 ÷ 9.3	0.83 ÷ 0.95
Tightening starter motor	38.25 ÷ 45	3.9 ÷ 4.6
Oil sump drainage plug	64 ÷ 79	6.5 ÷ 8
Oil filter	14.7 ÷ 19.6	1.5 ÷ 2
Screws securing hydraulic belt tensioner cover	8.1 ÷ 10	0.83 ÷ 1.02
Oil sump retaining screws	9 ÷ 11	0.9 ÷ 1.1
Water pump pulley retaining screws	8.5 ÷ 10.5	0.87 ÷ 1.07
Water pump cover retaining screws	6.5 ÷ 10.5	0.66 ÷ 1.07
Thermostat unit retaining screws	32.3 ÷ 39.9	3.3 ÷ 4.1

Cylinder head

Part	Nm	kgm
Nut securing camshaft (in oil)	16 ÷ 18	1.63 ÷ 1.84
Nut securing camshaft front hub	97 ÷ 117.12	10 ÷ 12
Spark plug tightening (in ISECO Molykote A oil)	24.5 ÷ 34.3	2.5 ÷ 3.5
Engine oil pressure meter (on oil filter support)	10.6 ÷ 13.1	1.1 ÷ 1.3
Minimum engine oil level sensor (on engine block)	25	2.5
Minimum engine oil pressure warning lamp sensor (on oil filter support)	34 ÷ 42	3.5 ÷ 4.3
Engine oil temperature sensor (on engine block)	34 ÷ 42	3.5 ÷ 4.3
Nut-screw regulating rocker arm clearance	14.8 ÷ 17.7	1.5 ÷ 1.8
Screws securing return pulley	17.8 ÷ 22.1	1.82 ÷ 2.25
Screws securing timing cover	8.9 ÷ 11	0.91 ÷ 1.1
Screws securing pulley to front and rear hubs	13 ÷ 15.69	1.32 ÷ 1.6

Tightening nuts securing cylinder head to engine block

Tightening sequence	Phase	Nm	kgm
	When refitting: Gradually tighten following the indicated sequence	88.5 ÷ 97.8	9 ÷ 10
	After trials and bench testing: With engine cold, loosen the nuts by one turn following the sequence indicated, smear with engine oil and tighten in the sequence shown		10 ÷ 11

SPECIAL TOOLS

1.820.004.000 (A.2.0117)	Tool for locking cylinder liners
1.820.011.000 (A.2.0192)	Valve support apparatus
1.820.012.000 (A.2.0195)	Base for cylinder head support tool
1.820.049.000 (A.2.0359)	Support for valve disassembly and assembly
1.820.050.000 (A.2.0360)	Cylinder head support yoke
1.820.051.000 (A.2.0361)	Tool for rotating camshaft pulley and auxiliary organ control
1.820.052.000 (A.2.0362)	Tool for locking cylinder liners
1.820.053.000 (A.2.0363)	Pin for locking hydraulic belt tensioner
1.820.115.000 (A.4.0195)	Tool for reamingoil pump drive return shaft seats (with 19 mm diam. reamer)
1.820.145.000 (R.4.0178)	Engine support bracket
1.820.150.000 (R.9.0001)	Container for valve clearance adjustment caps
1.820.225.000	Support for removal/refitting engine group
1.820.228.000	Tool to prevent rotation of flywheel
1.820.231.000	Supports for removing/refitting engine group
1.820.234.000	Bracket for removal/refitting of engine group
1.820.531.000 (R.4.0194)	Bar for removal/refitting engine

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1.821.002.000 (A.3.0113)	Tool for inserting rear main bearing rubber caps
1.821.005.000 (A.3.0134)	Valve guide puller
1.821.006.001 (A.3.0139/0001)	Lever for extracting rear main bearing cap
1.821.006.002 (A.3.0139/0002)	Fork for extracting rear main bearing cap
1.821.010.000 (A.3.0178)	Tool for inserting crankshaft rear oil seal
1.821.016.000 (A.3.0244)	Tool for inserting valve guide seal cover
1.821.018.000 (A.3.0247)	Puller for valve guide seal cover
1.821.058.000 (A.3.0324)	Lever for valve disassembly/assembly
1.821.122.000 (A.3.0520)	Cage for valve disassembly/assembly
1.821.123.000 (A.3.0521)	Puller for camshaft pulley
1.821.124.000 (A.3.0522)	Support for valve disassembly/assembly
1.821.125.000 (A.3.0524)	Tool for inserting crankshaft front oil seal
1.821.126.000 (A.3.0525)	Tool for inserting camsnafts front oil seal and auxiliary control return
1.821.127.000 (A.3.0526)	Inserting tool for intake valve guide
1.821.128.000 (A.3.0527)	Tool for inserting exhaust valve guide
1.821.129.000 (A.3.0528)	Puller/inserting tool for cylinder head bushings

(CONTINUES)

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1.821.169.000 (A.3.0633)	Puller for steering tie-rod ball joint
1.822.016.000 (A.5.0220)	3 mm and 11 mm spanner for adjusting exhaust side tappets
1.825.003.000 (C.6.0148)	Tool for checking cylinder liner or piston protrusion from engine block
1.825.013.000 (C.6.0183)	Tool for checking TDC
1.825.018.000 (C.6.0197)	Curved feeler gauge for checking valve clearance
1.827.002.000 (C.1.0108)	Dial gauge for checking valve caps

PROCEDURE FOR FAULT RECTIFICATION

ENGINE - LUBRIFICATION

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
OIL LEAKS	Visual detection of oil leaks causing drips or soiling of the engine	A
LOSS OF OIL PRESSURE	The pressure gauge on the instrument panel indicates a decrease (sudden or gradual) of engine oil pressure: at very low pressure the relevant warning lamp comes on. NOTE: It is advisable to first ascertain that the pressure gauge on the instrument panel, pressure meter and minimum pressure sensor are operational, checking the actual engine oil pressure with a pressure gauge - refer to WIRING DIAGRAMS AND ELECTRICAL DIAGNOSIS manual - INSTRUMENT PANEL	B
EXCESSIVE OIL CONSUMPTION NOTE: High oil consumption during the first 8000 miles must not be considered abnormal as this is due to the engine settling.	Oil consumption will increase notably in relation to the stated values and those noted during the life of the vehicle.	C

ATTENTION:
- Engine oil is harmfull to the skin: reduce all contact, stains or drops of oil on your skin to a minimum: wash off oil with soap and water.
- Do not dispose of used oil in the environment: find out where used oil is collected in your area.

OIL LOSS	TEST A

TEST STEPS	RESULTS	REMEDY
FOREWORD: It is absolutely necessary to accurately identify the engine component or area causing the leak. If the cause cannot be visually identified, it is advisable to wash the engine with water, dry it, and then start it on a level surface or perform a short test cycle and wait until the leaks become evident. Following this, act on the affected component and tackle the other components at a later date.		
A1 CHECK DRAIN PLUG – Check drain plug for correct torque and for absence of damage	OK ▶ ~~OK~~ ▶	Carry out **step A2** Torque or replace plug if necessary
A2 CHECK OIL SUMP – Check: • the oil sump for damage, distortion or micro-cracks • sealing of gasket between sump and engine block • screws securing sump for correct torque	OK ▶ ~~OK~~ ▶	Carry out **step A3** Replace sump or gasket if necessary. Tighten the sump screws to the correct torque
A3 CHECK OIL FILTER – Check for absence of leaks in the oil filter area; check that the seal is tight	OK ▶ ~~OK~~ ▶	Carry out **step A4** Replace seal and tighten filter to the correct torque

(CONTINUED)

OIL LOSS	TEST A

TEST STEPS	RESULTS	REMEDY
A4 CHECK OIL SEALS – Remove the covers in order to gain access to the crankshaft and camshaft oil seals: check for leaks in these areas	OK ▶ ~~OK~~ ▶	Carry out **step A5** Replace defective oil seals
A5 CHECK HYDRAULIC BELT TENSIONER – Check for leakage from hydraulic belt tensioner	OK ▶ ~~OK~~ ▶	Carry out **step A6** Replace hydraulic belt tensioner or oil seal
A6 CHECK MISCELLANEOUS COMPONENTS – Check for leaks from any other component not listed in the previous test steps. Correct the fault on the basis of the remedies mentioned above.	~~OK~~ ▶	Replace defective components

End of test A

LOSS OF OIL PRESSURE	TEST B

TEST STEPS	RESULTS	REMEDY
B1 CHECK OIL LEVEL – Using the dipstick, check that the oil level is correct	OK ▶ ~~OK~~ ▶	Carry out step B2 Top-up oil level
B2 CHECK QUALITY OF OIL AND FILTER – Check that: • the engine oil is of the prescribed type • that the oil filter is of the prescribed type and correctly installed	OK ▶ ~~OK~~ ▶	Carry out step B3 Service with the prescribed oil to the proper level. If necessary replace the filter
B3 CHECK OIL PUMP – Check oil pump for traces of binding, overheating of its components. In addition, check dimensions and clearances.	OK ▶ ~~OK~~ ▶	Carry out step B4 Replace defective parts

(Continued)

LOSS OF OIL PRESSURE	TEST B

TEST STEPS	RESULTS	REMEDY
B4 CHECK PRESSURE RELIEF VALVE – Check: • pressure relief valve of correct seal, integrity and cleanliness • the valve spring for yielding or breakage	OK ▶ ~~OK~~ ▶	Carry out step B5 Replace defective components
B5 CHECK OIL PASSAGES Only relevant to complete engine overhaul: – Check the passages in the engine block and cylinder heads for obstructions caused by oil residues or foreign matter. – Check plugs on cranckshaft for sealing and integrity.	~~OK~~ ▶	Thoroughly clean affected parts and replace them if necessary.

End of test B

EXCESSIVE OIL CONSUMPTION	TEST C

TEST STEPS	RESULTS	REMEDY
FOREWORD: Check that excessive oil consumption is not caused by leakage. Refer to **Test A.**		
C1 CHECK FOR SEEPAGE THROUGH VALVES – Remove the cylinder heads and check for traces of oil in the combustion chambers. In this case check: • relevant valve guide, and between the valve guide and the valve guide seats in the cylinder head; • the integrity of the seal pad located on the valve stem • the valve stem for traces of binding or scoring.	OK ▶ ~~OK~~ ▶	Carry out step C2 Replace defective parts
C2 CHECK FOR SEEPAGE THROUGH PISTON RINGS – Check for seepage through piston rings. If this is discovered check the piston rings for: • breakage of damage; • correct installation (TOP mark facing upwards); • correct distribution of clearance around the circumference (gaps located at three different angles); • binding in their seats or excessive wear.	OK ▶ ~~OK~~ ▶	Carry out step C3 Replace the faulty rings
C3 CHECK CYLINDER LINERS – Check: • the roughness of the cylinder liners (excessive wear could cause excessively smooth surface); • that the main dimesions are within limits.	~~OK~~ ▶	Replace the faulty cylinder liners if necessary

End of test C

PROCEDURE FOR FAULT RECTIFICATION

ENGINE - NOISY OPERATION

FOREWORD:

Discover if the noises are really caused by the engine and not by other components like:
- Coolant pump
- Alternator
- Power steering pump
- Air conditioning compressor
- Hydraulic belt tensioner

Note whether the noise is mainly present when the engine is cool or at normal running temperature, when engine is at idle speed or if the noise increases as the revs increase.
Noise is produced by the engine if:
- noise is present when the vehicle is at rest and during travel
- noise is present when the clutch is engaged and disengaged

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
BEATING WHEN THE ENGINE IS IDLING	More or less constant noise is present when the engine is at idle speed, at normal running temperature; noise comes from the timing system cover area.	A
BEATING WHEN THE ENGINE IS COLD	Continuous beating of varying intensity coming from one or more of the cylinders. NOTE: **Beating disappears when the engine is at normal running temperature.** The affected cylinder can esasily be identified by disconnecting the spark plugs one at a time.	B
INTENSE AND INCONSTANT BEATING	Very intense beating which can be heard during clutch engagement and disengagement and during sudden acceleration.	C

PROCEDURE FOR FAULT RECTIFICATION

ENGINE - NOISY OPERATION

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
BACKGROUND BEATING (DUE TO INBALANCE)	A background beat that can be heard when the engine is under load or noise coming from the rod-crankshaft and piston-cylinder liner couplings	D

NOTE: **Before performing the tests indicated below, check the oil level, grade of oil and oil filter. If necessary change engine oil and filter using the prescribed quantities and grades.**

BEATING WHEN ENGINE IS AT IDLE	TEST A

TEST STEPS	RESULTS	REMEDY
A1 CHECK VALVE CLEARANCE – Check that the clearance between the cam heel radius and the top of the valve cup is within the specified limits.	OK ▶ ~~OK~~ ▶	Carry out step A2 Adjust clearance
A2 VISUALY CHECK CAMS AND CUPS – Visually check the cuspid of the cams and the top of the cups for wear, scoring, binding etc.	OK ▶ ~~OK~~ ▶	Carry out step A3 Replace defective items
A3 CHECK AXIAL PLAY – Check that camshaft axial play is within the specified limits.	OK ▶ ~~OK~~ ▶	Carry out step A4 Replace defective camshaft
A4 CHECK CUPS AND SEATINGS – Check the outer diameter of the cups and the diameter of the relevant seatings; also check for scroing, binding etc.	~~OK~~ ▶	Replace affected cups and/or relevant cylinder head

End of test A

BEATING WITH ENGINE COLD	TEST B

TEST STEPS	RESULTS	REMEDY
B1 CHECK PISTON-CYLINDER LINER COUPLING – Check that the clearance between cylinder liner and piston is within the prescribed limits.	OK ▶ ~~OK~~ ▶	Carry out step B2 Replace affected cylinder liner and piston
B2 CHECK GUDGEON PIN – Check that clearances between piston hole and gudgeon pin, and between rod small end bushing hole and gudgeon pin are within the specified limits.	~~OK~~ ▶	Replace affected items

End of test B

INTENSE AND INCONSTANT BEATING	TEST C

TEST STEPS	RESULTS	REMEDY
C1 CHECK CRANKSHAFT PULLEY ATTACHMENT – Check that the nut securing the crankshaft pulley is not loose.	OK ▶ ~~OK~~ ▶	Carry out step C2 Tighten the nut to the specified torque or replace it
C2 CHECK FLYWHEEL ATTACHMENT – Check that the screws securing the flywheel to the crankshaft are not loose.	~~OK~~ ▶	Tighten screws to the specified torque or replace if damaged. Use locking compound LOCTITE 270

End of test C