155 4

REPAIR MANUAL

• ENGINES

- Engine 1995 cm^3 TURBO (code AR 67203)

GROUP 01 - ENGINE MAIN MECHANICAL UNIT

GROUP 04 - FUEL SYSTEM

GROUP 05 - ENGINE IGNITION, STARTING AND CHARGING

GROUP 07 - ENGINE COOLING SYSTEM

PA4736B14x4000

12-1991

GROUP 01

ENGINE MAIN MECHANICAL UNIT

INDEX

ILLUSTRATED INDEX

ENGINE

GENERALITIES

The engine is of the four cylinder in line type with a double on head camshaft, four valves per cylinder, supercharging system, multipoint electronic injection and static ignition controlled by a single I.A.W. control unit.

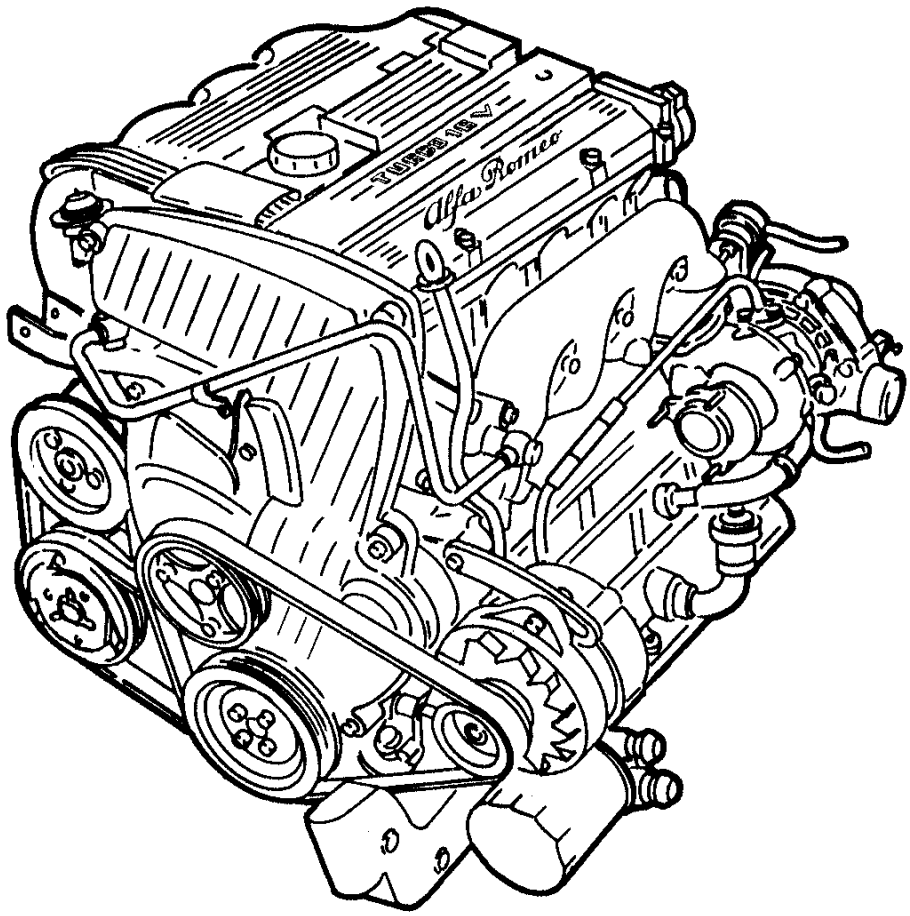
The clutch-gearbox-differential group is connected behind the engine and forms an integral part of the engine unit.

The engine itself is front mounted and set transversally with a 17° forwards.

The engine unit is installed on the frame by suspension type mounts at the front and a central fork-type support at the rear and in both cases is fixed by two elastic damping supports.

To avoid excessive vibration, the engine is connected to the upper part of the body by a rod which prevents shaking.

Unleaded petrol together with suitable anti-pollution systems, described in **GROUP 04**, characterize the low exhaust levels in accordance with "USA 83" regulation.



STRUCTURE

Engine block:

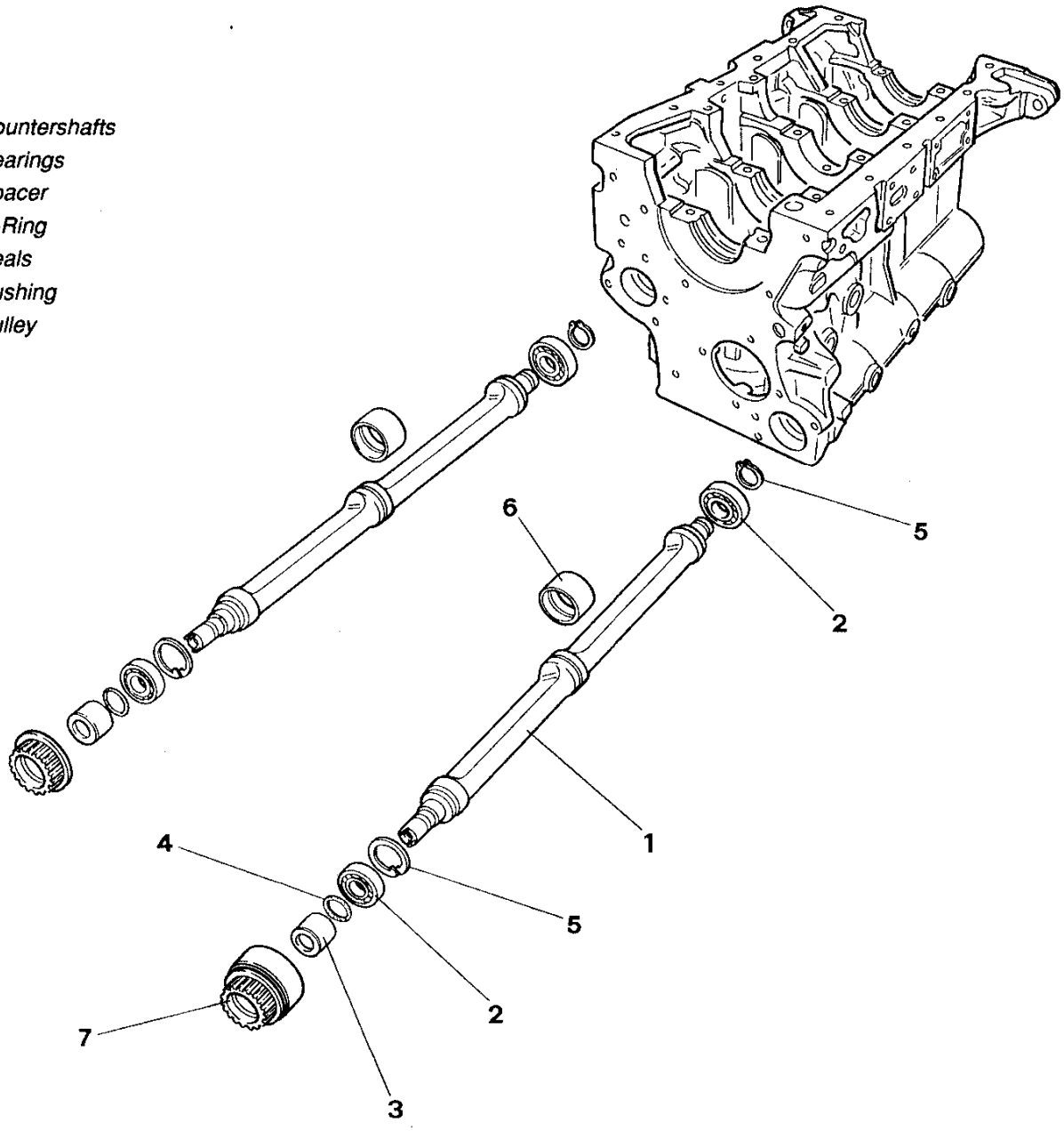
this is a single block in iron with a high mechanical resistance.

The crankshaft is supported by five main supports which also house the same number of thin shell bearings halves.

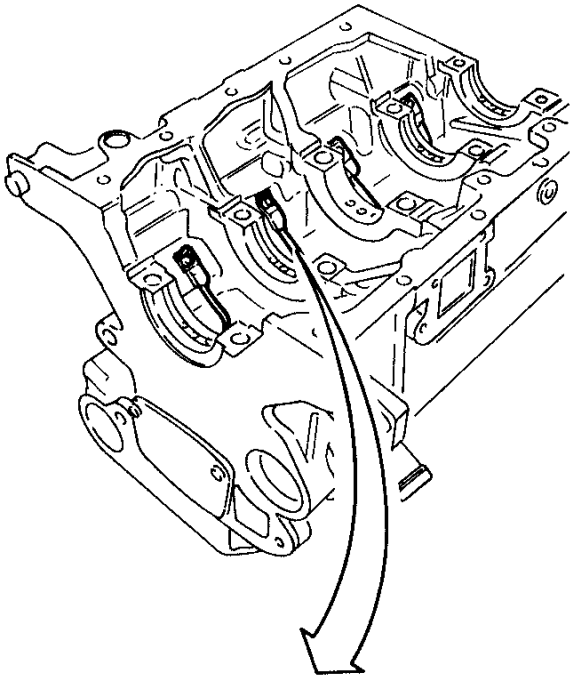
The cylinder liners are the integral type.

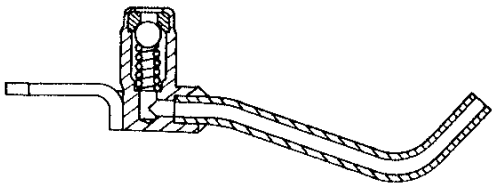
The engine block also houses the two countershafts which are each supported by three supports, the front and rear ones using ball bearings.

1. *Countershafts*
2. *Bearings*
3. *Spacer*
4. *O-Ring*
5. *Seals*
6. *Bushing*
7. *Pulley*



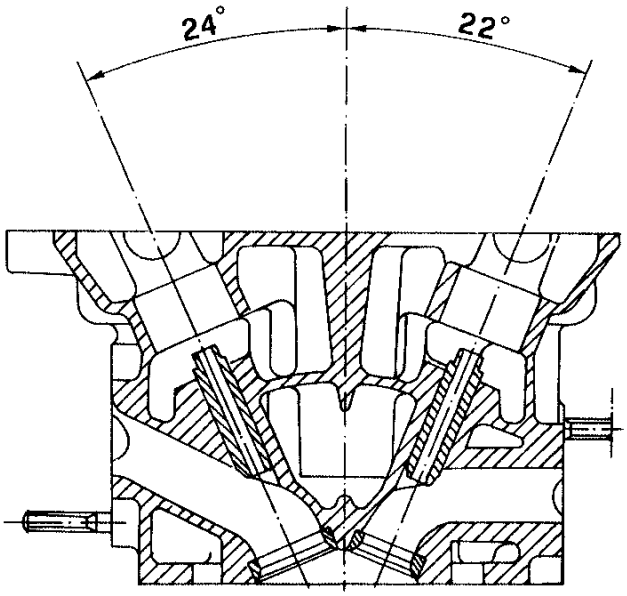
Channeling, in the walls of the engine block, permits the circulation of engine coolant and lubricating oil.
The lower part of each cylinder contains a spout from which oil is sprayed onto the upper part of the piston ensuring that it is partially cooled.



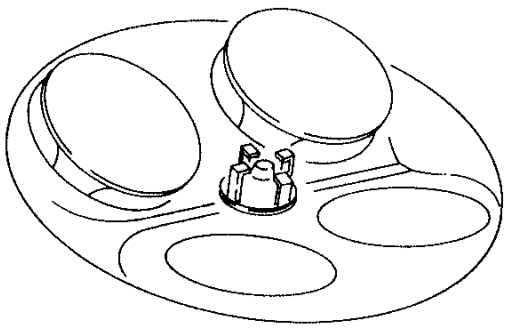


Cylinder heads:

these are of the monolith type, compact and chill-cast in an aluminium and silicium alloy.
The four valves per cylinder are mounted in their respective guides in a "V" position at 46° and controlled by two camshafts by cups and regulating shims.

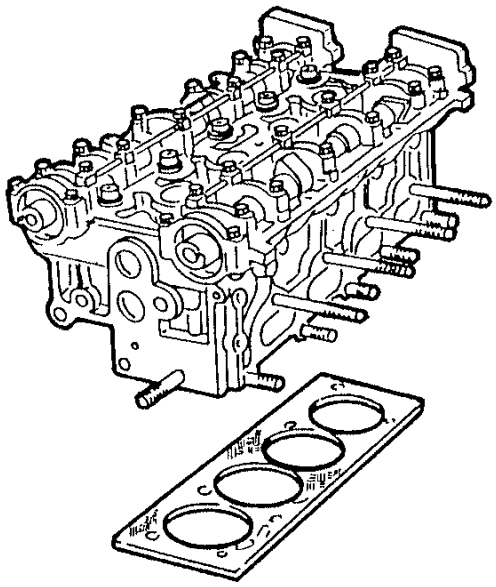


The spacing allows the combustion chamber to house the valve heads and central hole of the spark plug without weakening the structure of the head.
Positioning the spark plug at the centre of the four valves, two intake valves and two smaller exhaust valves, allows the mixture to be more evenly distributed and the best possible combustion with increased thermal efficiency by the engine and a consequent reduction in poisonous exhaust fumes.

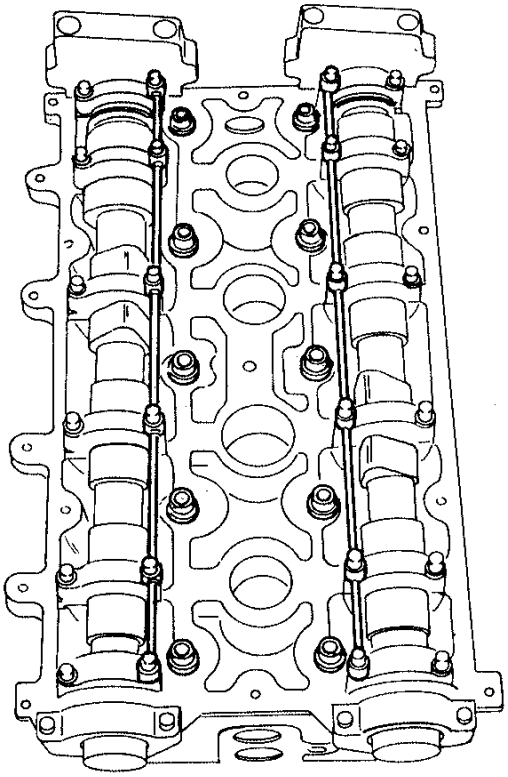


The camshafts rotate on six supports and are controlled by five drive belts.

The valve seatings are mounted on the cylinder heads after these have been heated to a temperature of 80°C and the valve seatings are cooled with liquid nitrogen.
The valve guides are roughly positioned in the relative cylinder head seatings and the internal diameter is then perfected, after assembly, with a specific boring machine and subsequently checked with a pair of "pass-doesn't pass" type gauges.
The seal used between the cylinder heads and the engine block is of the ASTADUR type.
This seal, due to the special material from which it is made, undergoes a polymerization process when the engine is operating, and in this way it becomes much harder with use. Adopting this type of seal eliminates the need for the cylinder heads to be tightened at the first service.



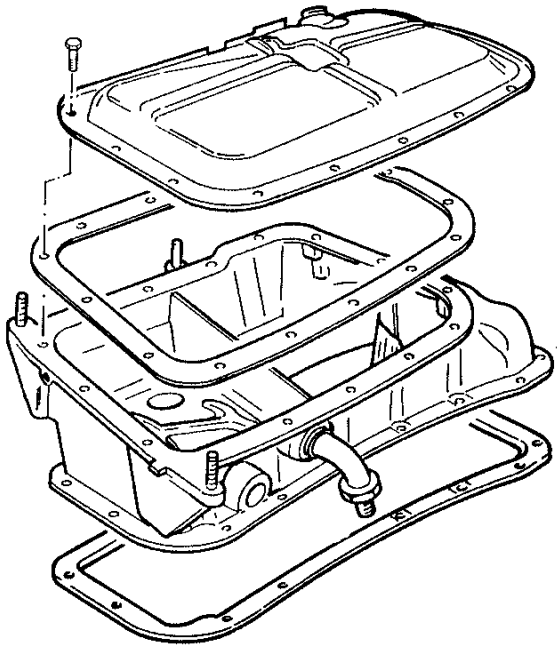
To ensure the supports are lubricated, two tubes have been mounted on the cylinder heads which distribute the oil supplied by a groove on the first support to the other five.

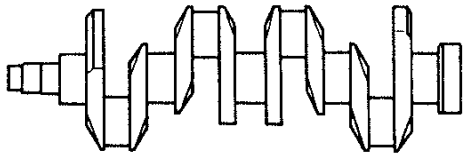


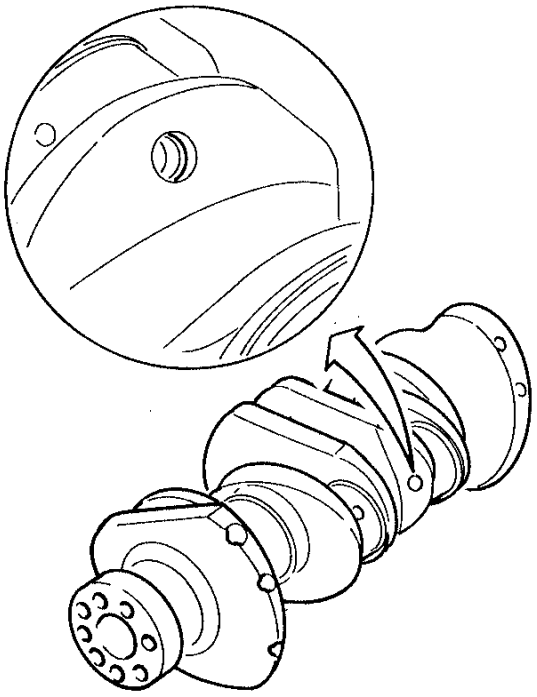
Oil sump:

this is a structural part of the engine which, as well as containing the engine oil, has other mechanical functions as the connecting plates to the differential are fixed on it.
It consists of two main parts: the sump in die-cast aluminium, and the sump protection in pressed sheet metal.
Inside the oil sump is fitted with anit-splashing walls.

The oil sump also contains connectors for the oil return tube from the turbocharger and condensed oil return tube from the oil vapour separator.
The seal between the sump and the engine block/sump protection consists of two gaskets.







MOVING PARTS

Crankshaft:

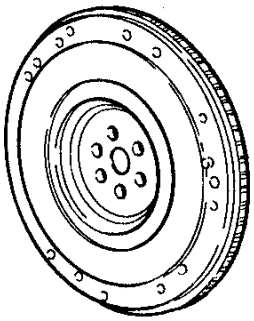
this is forged in high resistance bonded steel and hardened and tempered.
It rests on five main supports and the axial play is regulated by two half rings positioned on the rear main support.
Eight counterweights accurately balance the rotating masses of the crankshaft.
A channel runs inside the shaft for the lubrication of the main and rod journals.
The work holes on the above mentioned channels are blocked with suitable plugs that are removed and carefully cleaned when the engine is overhauled.

Main and rod bearing halves :

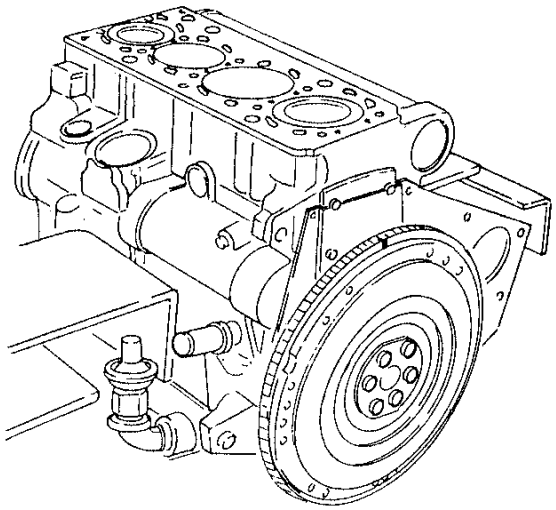
These are of the three-metal, thin shell type and are divided into three dimensional classes; they can be supplied from Parts in five other decrease classes.
The main bearing halves have three holes for the lubrication of the main journals.

Flywheel:

this is in cast iron, balanced, and with a ring gear in tempered steel.



The flywheel must be assembled in a precise position: after having brought the pistons of the first and fourth cylinders to T.D.C., the flywheel must be assembled with the notch engraved on it facing upwards.

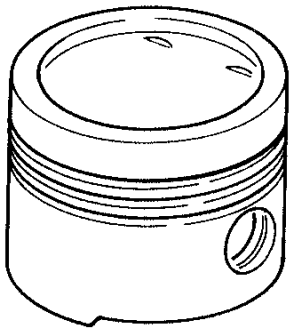


Pistons and rods:

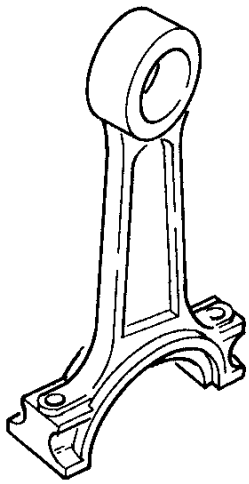
the pistons are in a silicium-aluminium alloy and are divided into five dimensional classes.

The bevel visible on the base of the piston skirt stops the oil sprayer in the block from causing interference during the B.D.C.

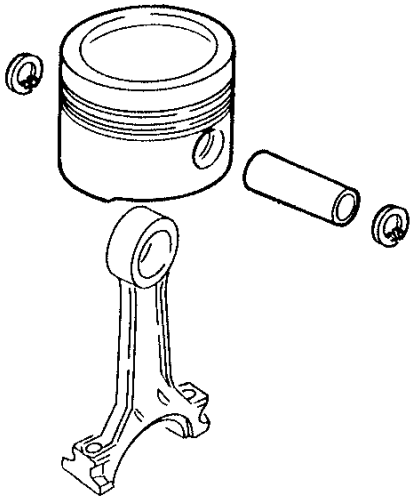
The piston crown is concave and has two incisions which prevent any eventual interference with the heads of the intake valves.



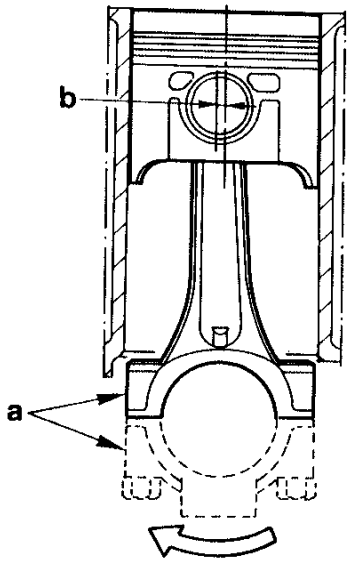
The rods are in a hardened and tempered steel alloy, with a bushing in a copper alloy inserted for the coupling with the grudgeon pin of the piston.



As the grudgeon pins float on both the piston hubs and the bushing inserted at the bottom of the rod, their lateral movement is stopped by two expanding elastic rings located in the slots carved out of the hubs themselves.



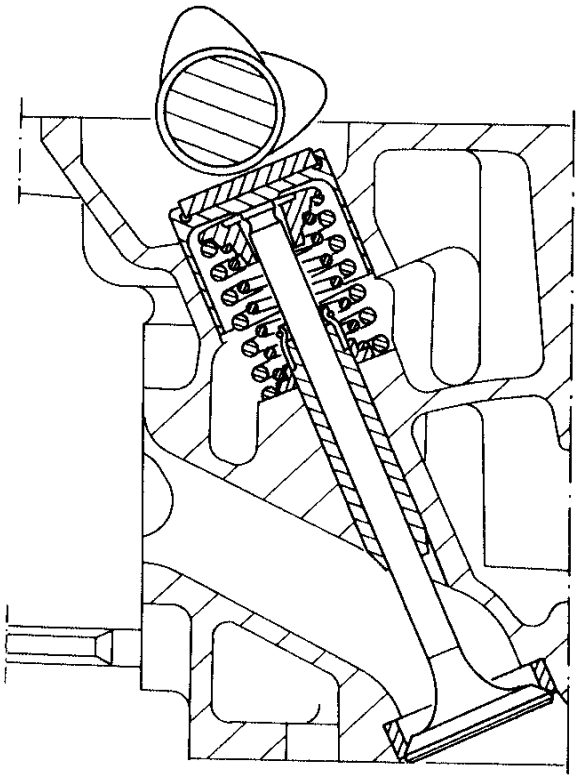
The piston-rod assembly is installed taking care that the stamp (a) on the head of the rod is on the same side as the offset of the grudgeon pin (b).



AUXILIARY PARTS

Timing:

directly driven by a drive belt with cemented and tempered on head camshafts in steel alloy.
The mechanical type tappets are made from a cemented and phosphated steel plate in contact with the cam, used to regulate the valve clearance.
The control is transmitted by the plate to the valve cup, in tempered carbonitrided steel which directly controls the valve.
The stem of the intake valve is chromium plated.
The introduction of sodium into the exhaust valve which improves the dissipation of the heat to which they are subjected is particularly important.
The valve seatings are sintered in a material suitable for operation with unleaded petrol.



Vibration dampening device for countershafts:

in explosion engines, in addition to the forces acting on the crown of the piston provoked by expanding gases, the following forces also act:

- centrifugal force of inertia, originating from the rotating masses;
- alternate forces of inertia of 1° and 2° order originating from masses with reciprocating motion.

The engine balance is intended to eliminate the vibrations which such unbalance generate during functioning.
The unbalance produced by the centrifugal and alternate forces of inertia of the 1° order eliminate each other by counterweighing on the crankshaft.

The unbalance provoked by the alternate forces of inertia of the 2° order, in the on line type four cylinder engines, do not generally eliminate each other and it becomes the task of the engine supports to partially absorb it.
However in this engine a device has been adopted which is capable of eliminating the vibrations caused by the above forces: this is made from 2 shafts, with eccentric masses, which counter rotate against each other, located in the engine block.
The driving of the countershafts has been achieved with a special double drive belt and a gear assembly which allows twice the speed to be reached and a perfect synchronisation with respect to the crankshaft.

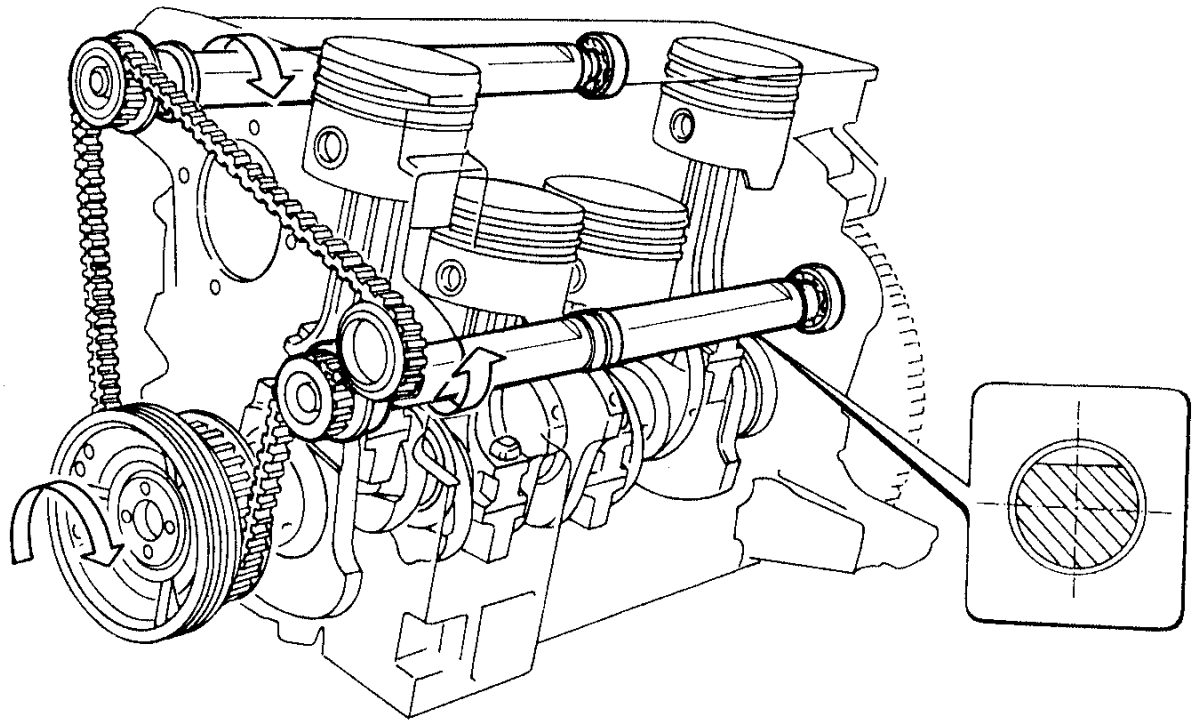
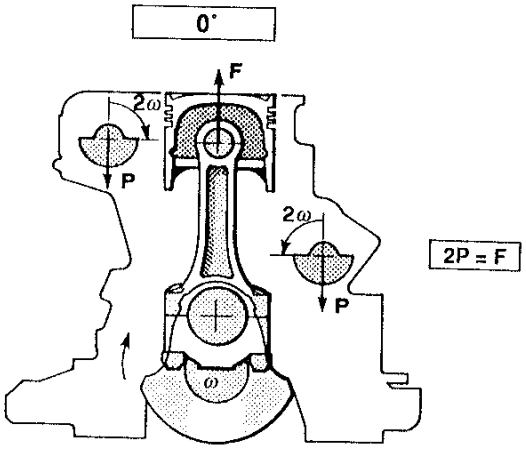
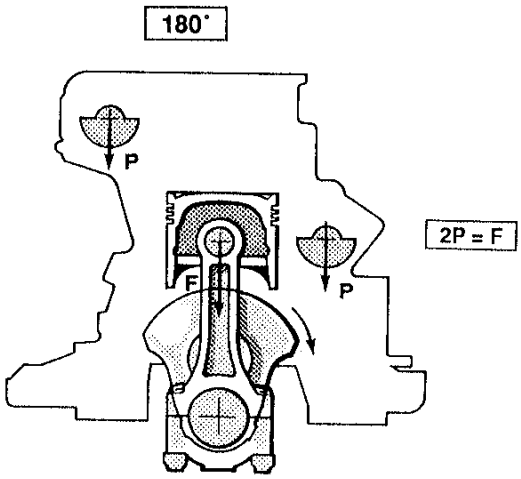
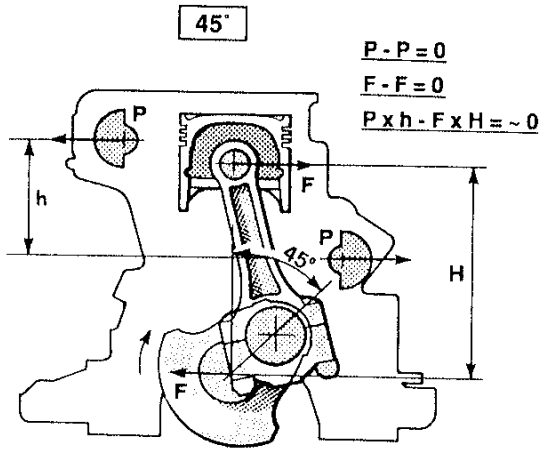
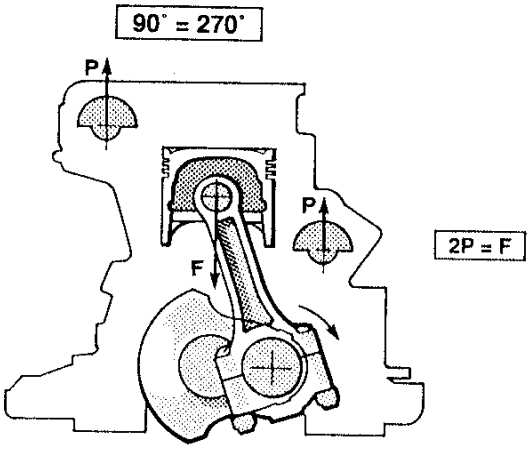


Illustration of the alternate forces of inertia of the 2° order and the balancing masses in the main functioning positions.









Supercharging:

as regards the supercharging system refer to **GROUP 04**.

LUBRICATION

The rotating lobe type pump, assembled at the front of the engine block, is actioned by the driving shaft through a coupling. The oil, taken from the pump using a suction device, is filtered by a gauze filter on the suction device itself and sent under pressure by the pump along a channel to the total flow cartridge oil filter. The filter is equipped with a safety by-pass valve which permits the oil to pass if the filter itself becomes clogged.

The maximum lubrication pressure is regulated by a relief valve installed on the pump.

A thermostatic valve is installed on the oil filter support that:

- with a temperature less than **78 ± 2°C**, sends the oil directly to the cartidge filter and then returns to the engine;
- with a temperature in excess of **83.5°C** it opens allowing the passage of oil into the cooling radiator so as to lower the temperature and guarantee a better lubrication.

After having been filtered, the oil arrives through a transversal channel in the main longitudinal delivery channel in the engine block.

From here through five channels the oil is sent into the lubrication channels of the main and rod supports of the crankshaft.

For a better cooling of the piston skirt, sprayers are inserted in the engine block equipped with a small spheric valve which opens at a pressure value of **1.25 - 1.75 bar** is reached.

Through two vertical channels in the engine block and cylinder heads the oil arrives to lubricate the front supports of the camshaft and from here an external tube takes it to the other supports.

Two more vertical channels in the engine block take care of lubricating the central support of the countershafts.

From the oil filter support, a tube branches off to lubricate the turbocharger, from where the oil then returns to the sump through an external tube.

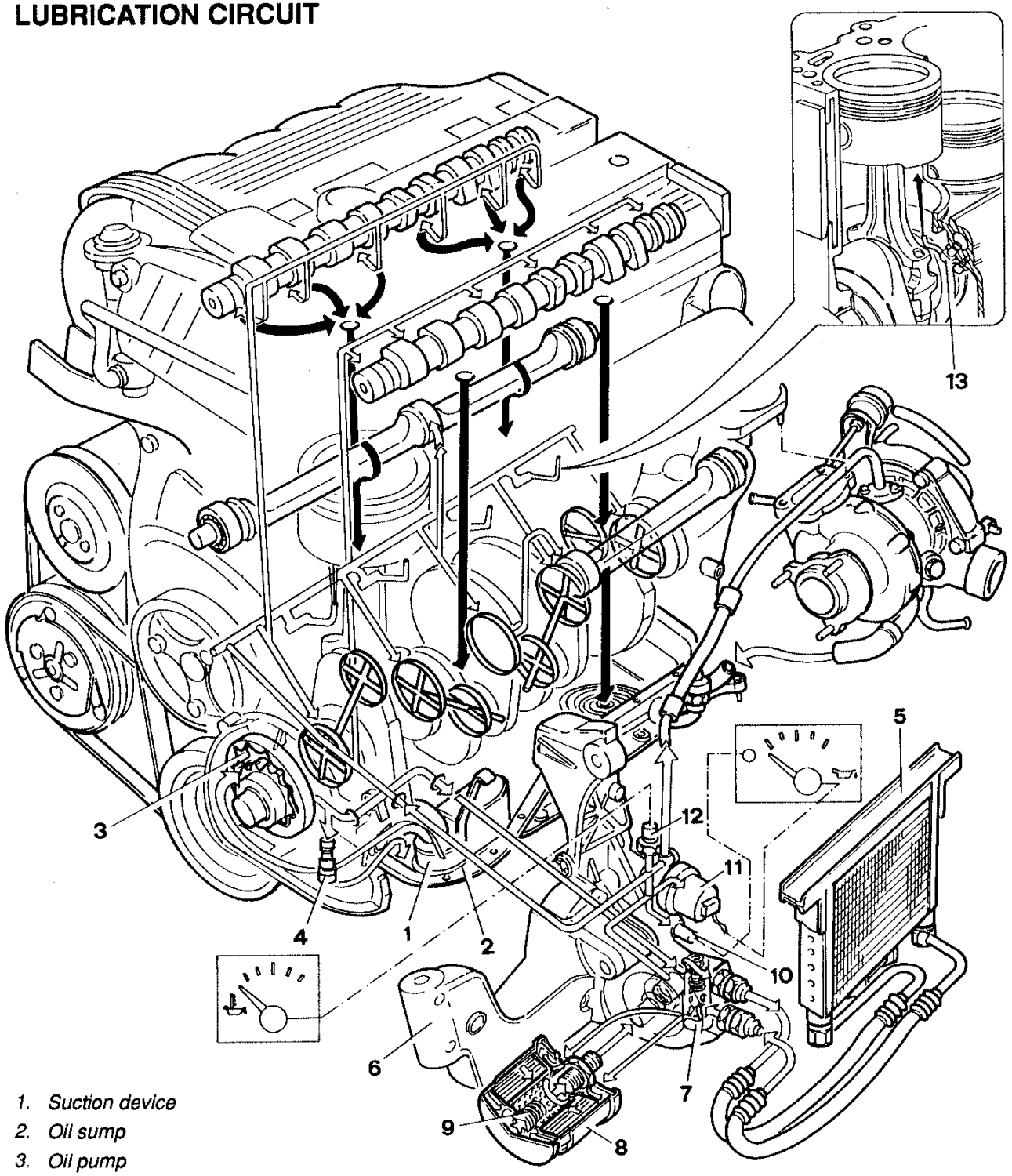
The recovery circuit is composed of several channels in the cylinder heads which take care of collecting the oil originating from the sump outlets and discharging it, by gravity, into the sump.

The lubrication system is equipped with an oil vapour recirculating system which allows the vapours originating from the sump and cylinder heads to be recovered (for more details see **GROUP 04**).

Three sensors are installed on the oil filter support which signal the following on the instrument panel:

- oil pressure;
- minimum oil pressure;
- oil temperature.

LUBRICATION CIRCUIT

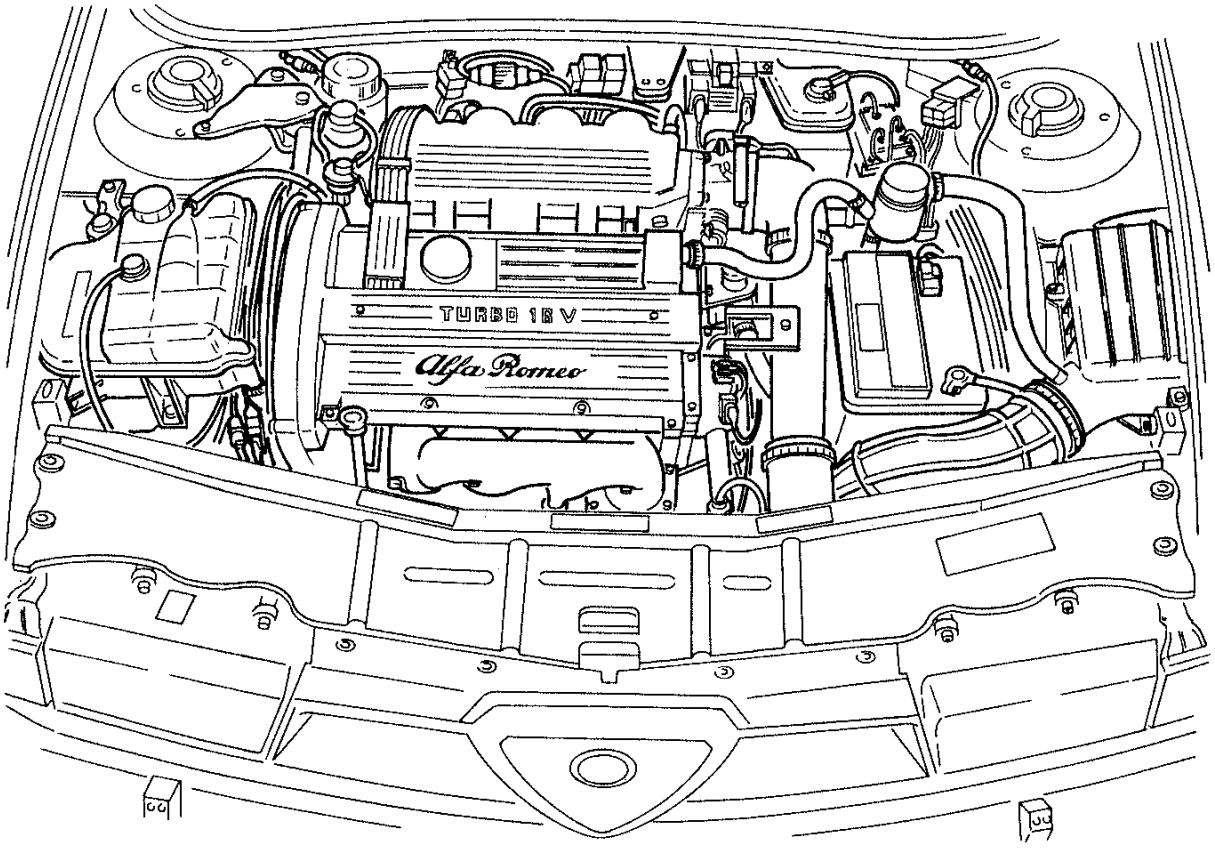


1. *Suction device*
2. *Oil sump*
3. *Oil pump*
4. *Pressure relief valve*
5. *Oil radiator*
6. *Oil filter support*
7. *Thermostat valve*
8. *Oil filter*
9. *By-pass valve*
10. *Minimum oil pressure warning light sensor*
11. *Oil pressure transmittor*
12. *Oil temperature sensor*
13. *Sprayer*

ENGINE REMOVAL/REFITTING

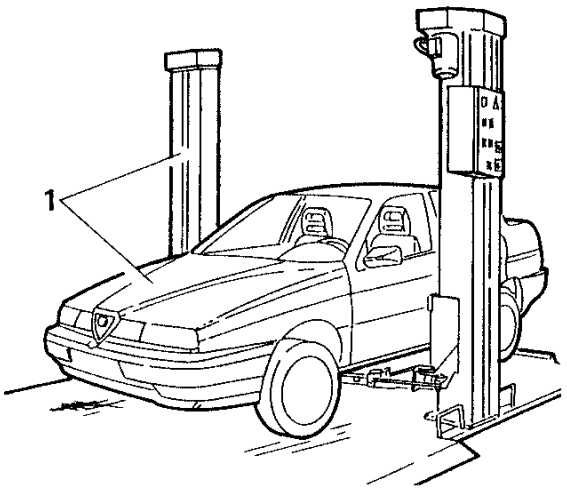
The information and illustrations given below permit a rapid removal of the engine from its housing and its subsequent refitting.

The bench disassembly of the single components is described in a separate chapter.
This chapter should be taken as a single, complete procedure though parts may be used as required.
For further information and details, refer to chapters relative to the components or specific groups.



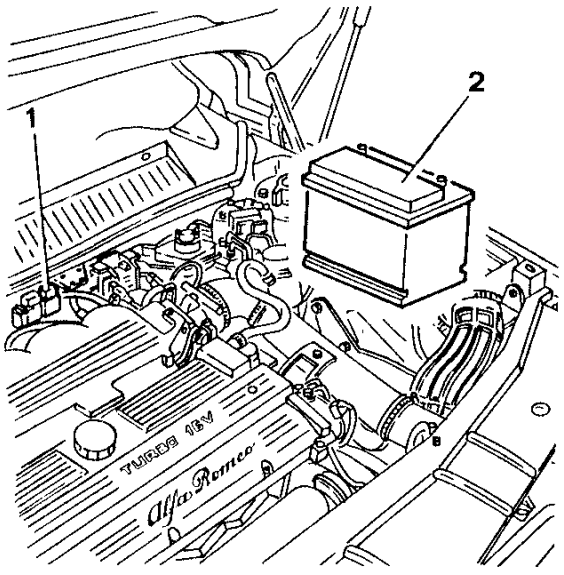
REMOVAL

1. Place the vehicle on a two column lift.



– Drain off the freon from the air conditioning system in accordance with current regulations (see **GROUP 80**).

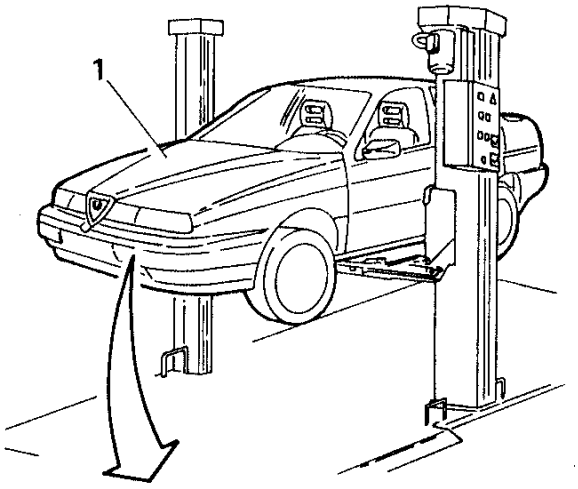
1. Release the pressure in the fuel supply system operating as follows:
   - Disconnect the fuel pump supply relay indicated in the figure;
   - Start-up the engine until it cuts out off.
2. Remove the battery after having first disconnected the negative clamp (-) and then the positive one (+).

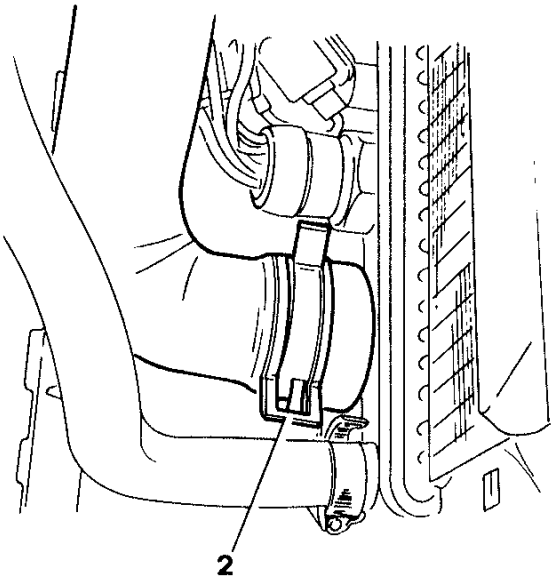


– Remove the pressurized plug from the expansion tank.

1. Raise the vehicle on the lift.
2. Loosen the hose clamp of the coolant outlet sleeve from the radiator and disconnect the sleeve itself; drain off and recover the coolant using a suitable container positioned under the vehicle.

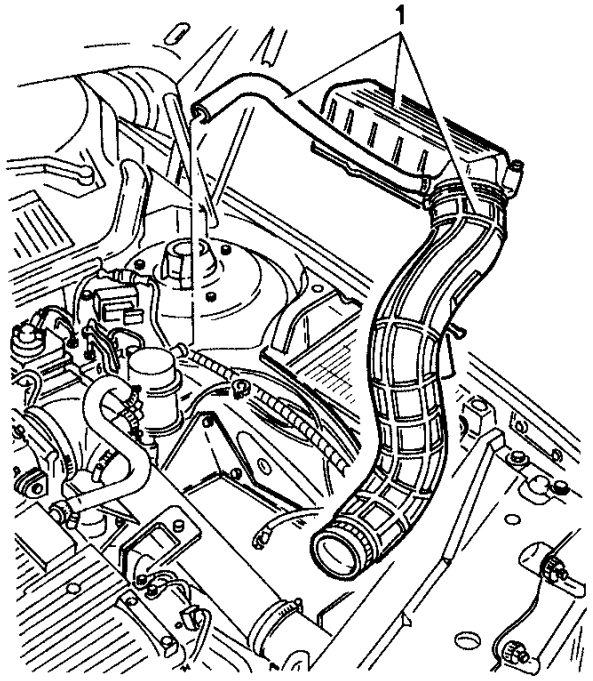
CAUTION:
The antifreeze mix used as an engine coolant damages paint: avoid contact with painted parts.



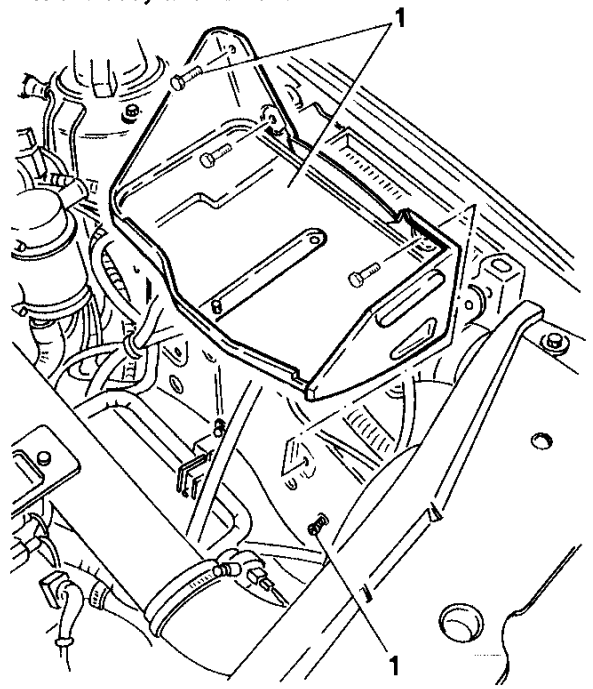


– Lower the vehicle.

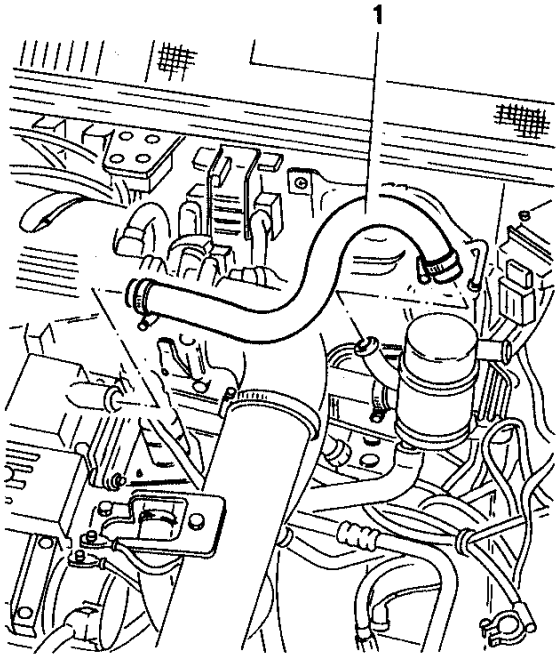
1. Remove the air filter cover complete with oil vapour recirculation hose and corrugated sleeve which feeds air to the turbocharger.



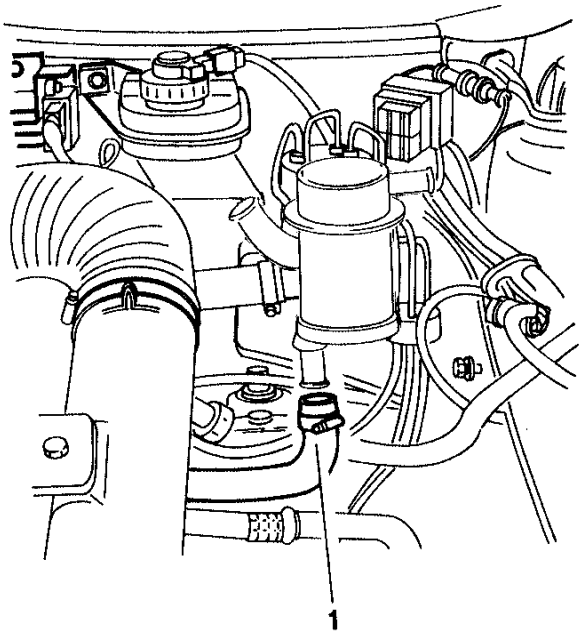
1. Unscrew and remove the three upper screws, loosen the lower screw securing the battery support to the body and remove it.



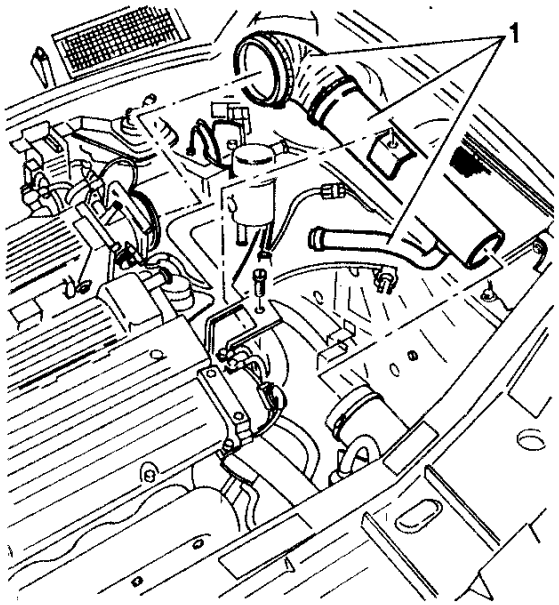
1. Remove the cylinder heads oil vapour recovery tube.



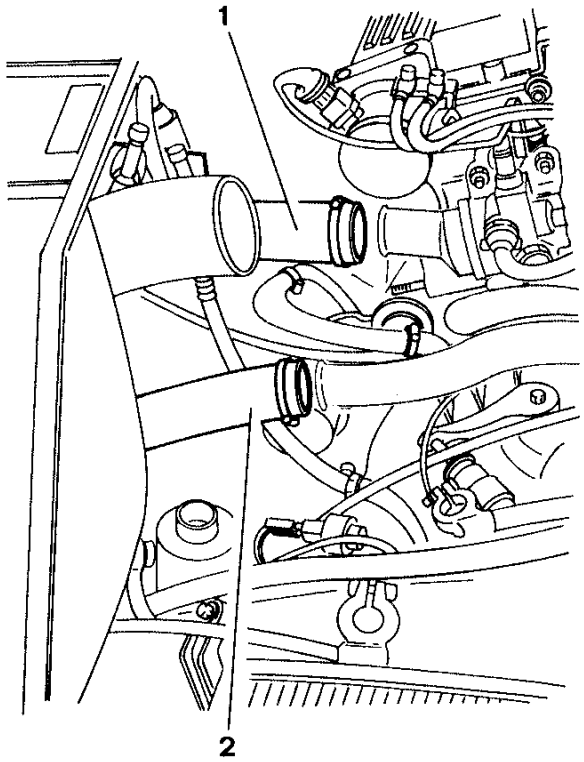
1. Disconnect the condensed oil recovery tube from the oil vapour separator.



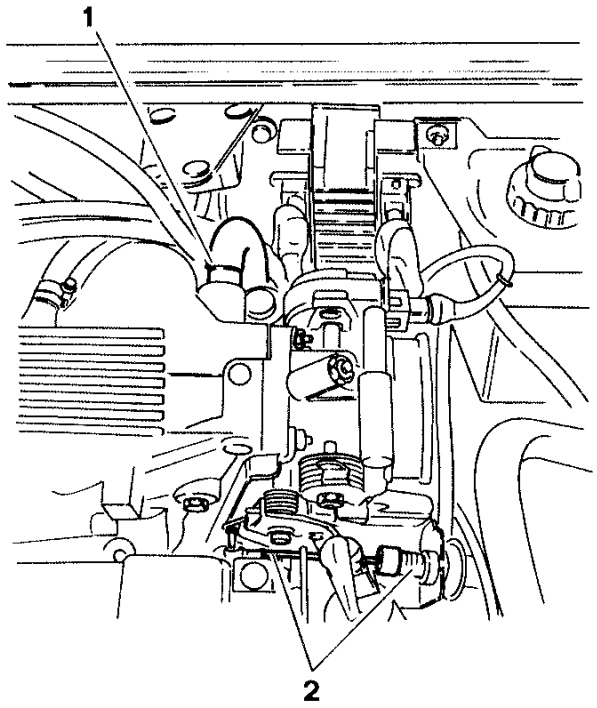
1. Remove the air intake manifold complete with connecting elbow to throttle body and air intake pipe for the constant idle speed actuator.



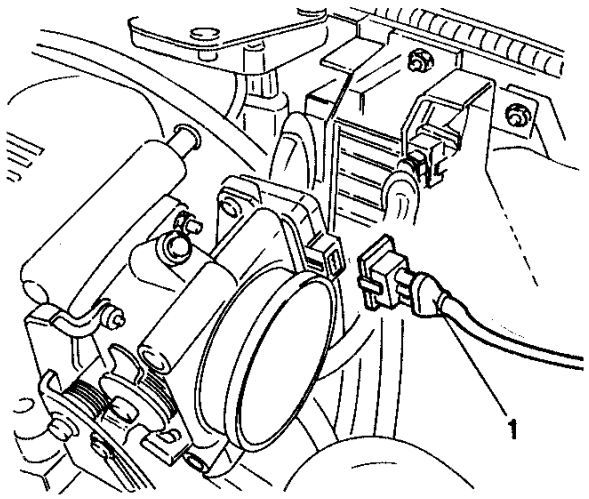
1. Disconnect the coolant to radiator delivery sleeve from the thermostatic cup.
2. Disconnect the radiator liquid outlet sleeve from the rigid coolant to pump return manifold.



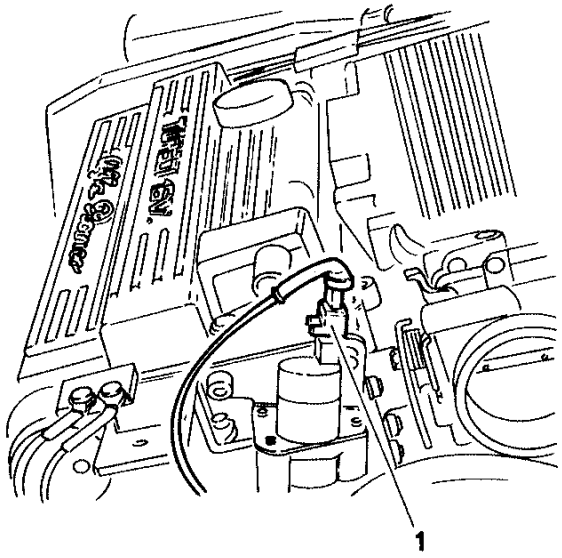
1. Disconnect the servo brake vacuum intake tube from the air intake box.
2. Disconnect the accelerator cable from the throttle body.



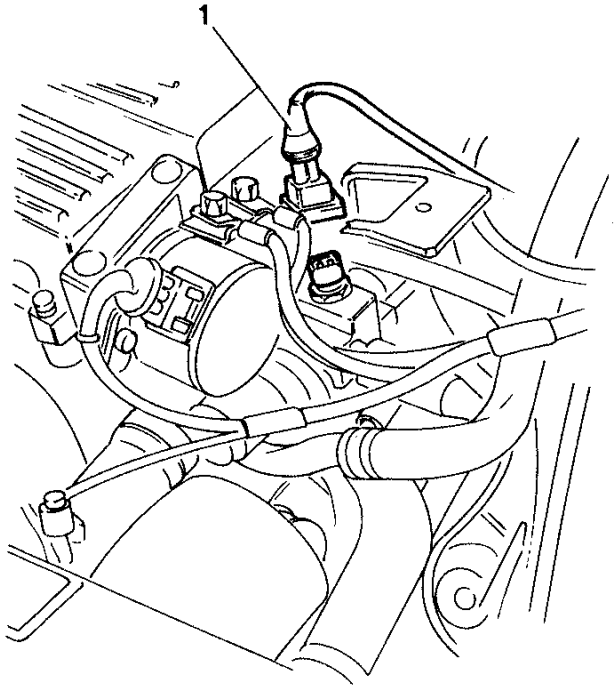
1. Disconnect the electrical connection from the throttle potentiometer.



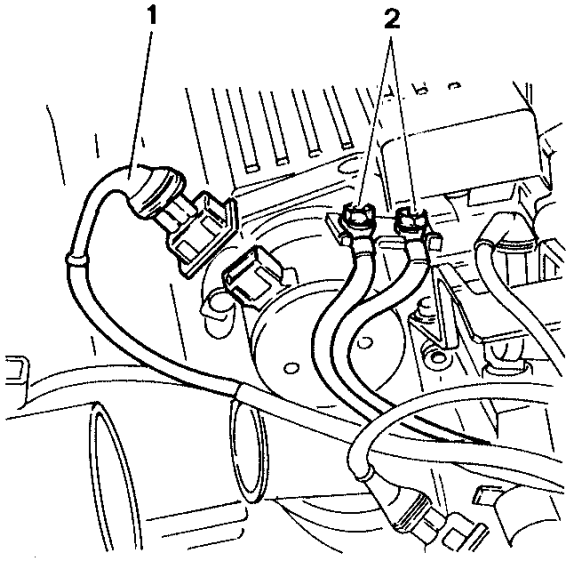
1. Disconnect the electrical connection from the constant idle speed actuator.



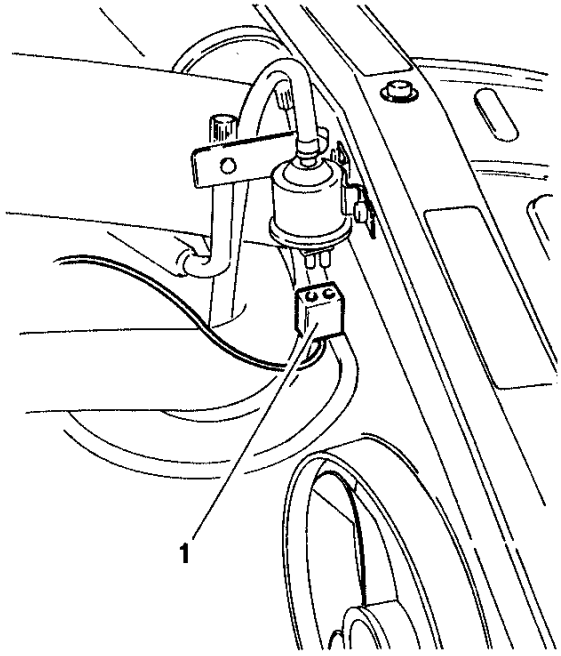
1. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).



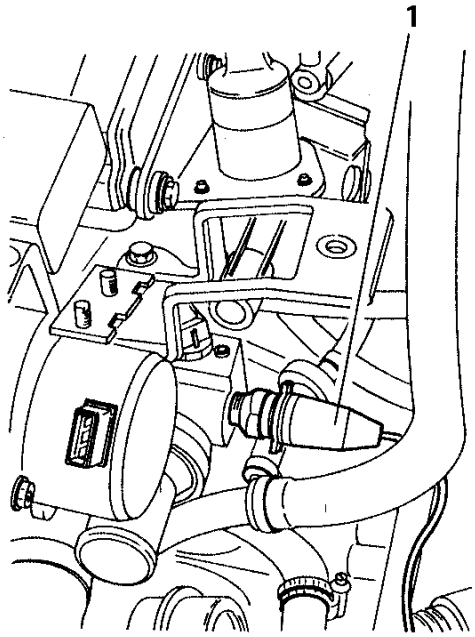
1. Disconnect the electrical connection from the stroke sensor.
2. Remove the earth cables.



1. Disconnect the electrical connection from the supercharging control device solenoid valve "PIERBURG".

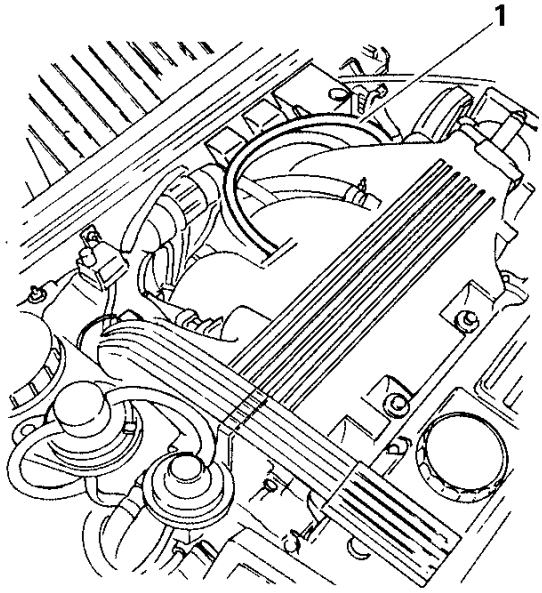


1. Disconnect the electrical connection of the engine coolant temperature indicator transmittor and the maximum temperature warning light sensor.

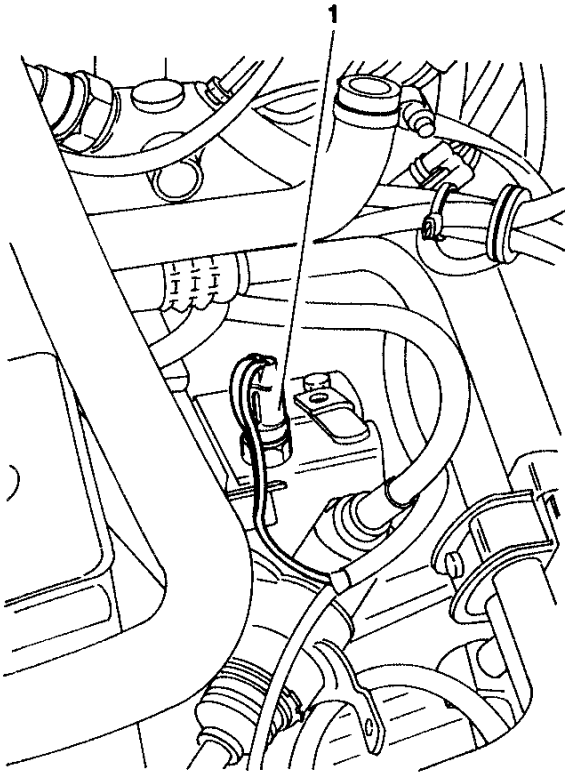


– Move the electrical wiring of the injector sidewards to prevent interference during subsequent operations.

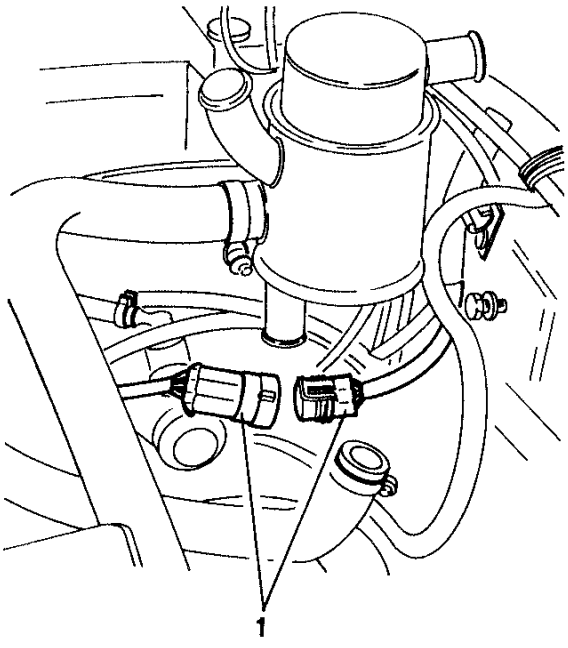
1. Disconnect the vacuum intake tube for the antistall valve from the air intake box.



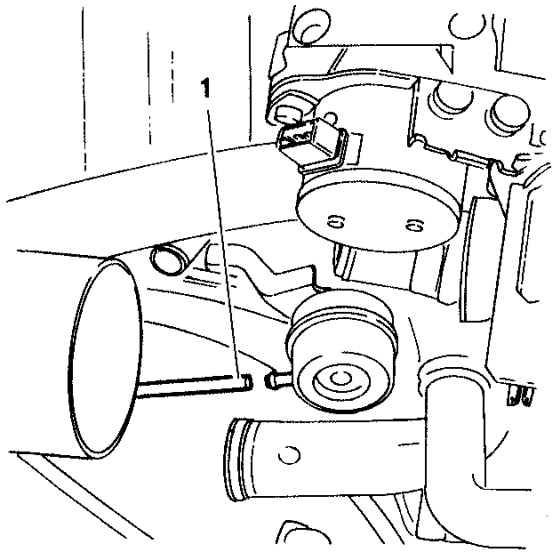
1. Disconnect the electrical connection from the reverse light relay.



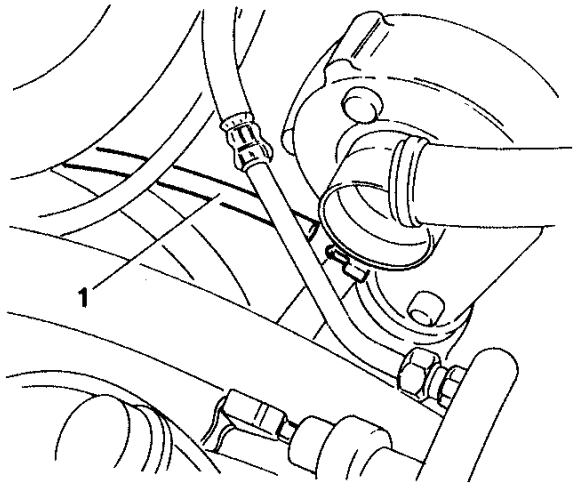
1. Disconnect the electrical connection of the tachometer sensor.



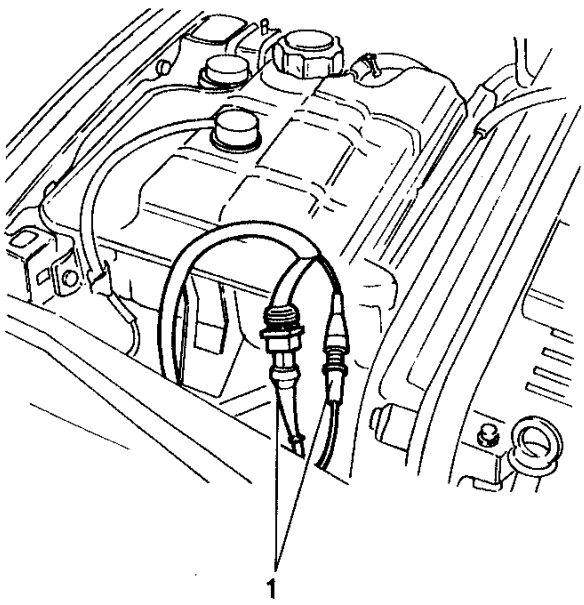
1. Disconnect the connection tube to the supercharging control device solenoid valve "PIERBURG" from the overpressure control valve actuator "WASTE GATE".



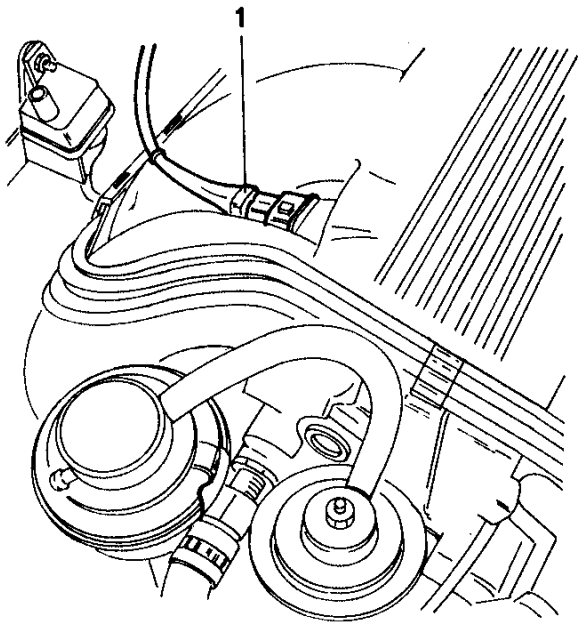
1. Disconnect the connecting tube to the supercharging control device solenoid valve "PIERBURG" from the turbocharger.



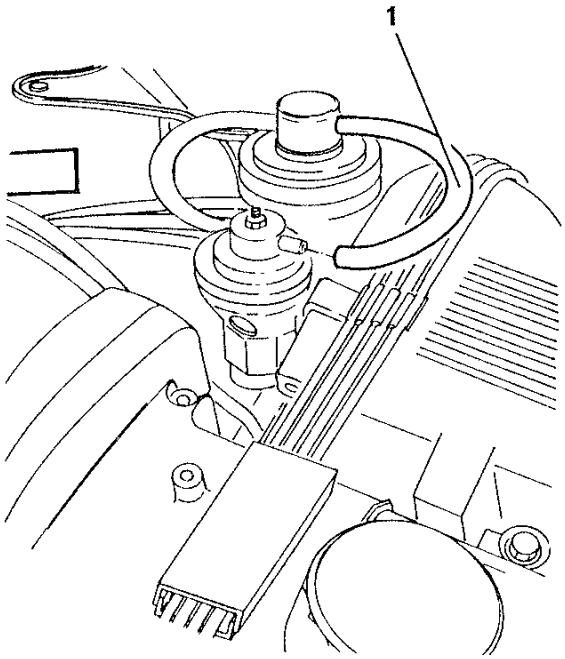
1. Disconnect the two electrical connections of the lambda probe.



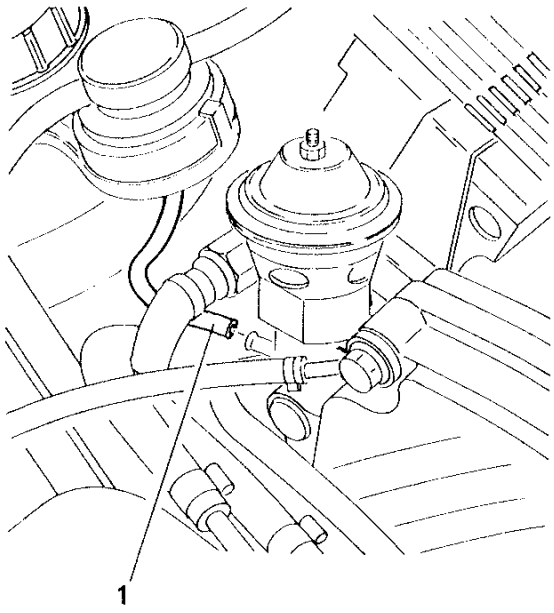
1. Disconnect the electrical connection from the intaken air temperature sensor.



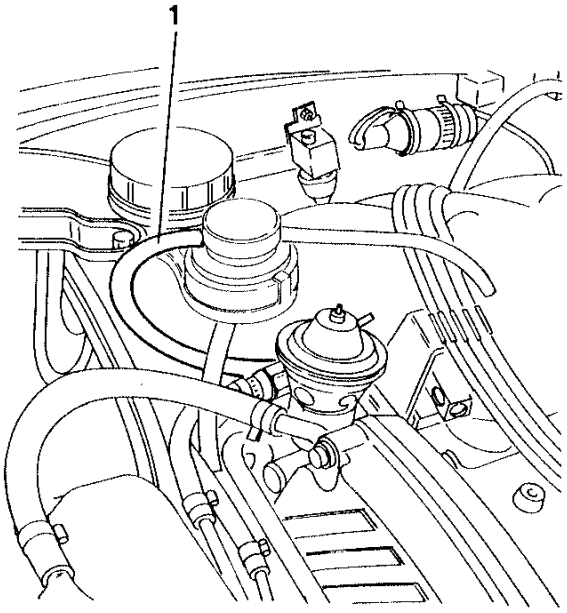
1. Disconnect the vacuum signal arrival pipe of the pneumatic signal modulation valve from the E.G.R. valve.



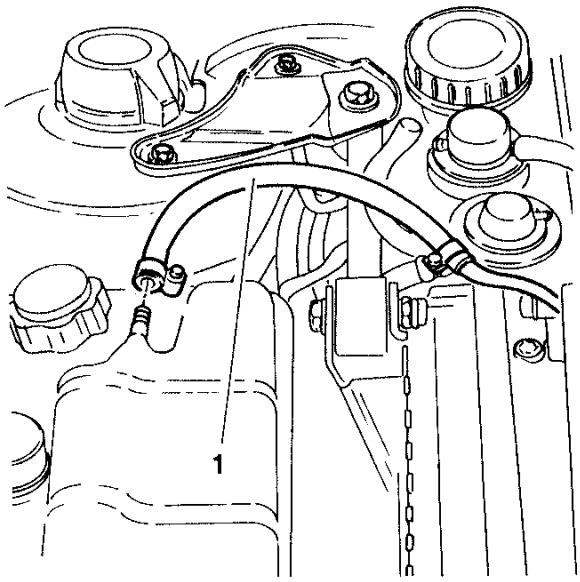
1. Disconnect the gas to pneumatic signal modulation valve delivery pipe from the spheric connection of the exhaust gas pipe.



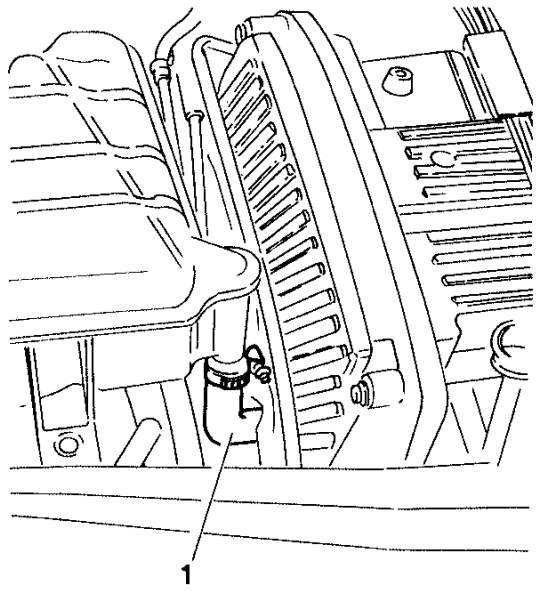
1. Disconnect the vacuum signal from thermovalve delivery tube from the pneumatic signal modulation valve.



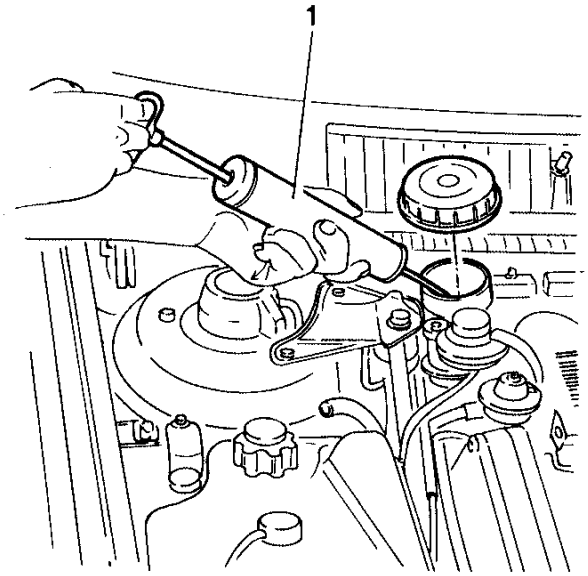
1. Disconnect the coolant return and deaereating pipe from the expansion tank.



1. Disconnect the cooling circuit feed pipe from the expansion tank.

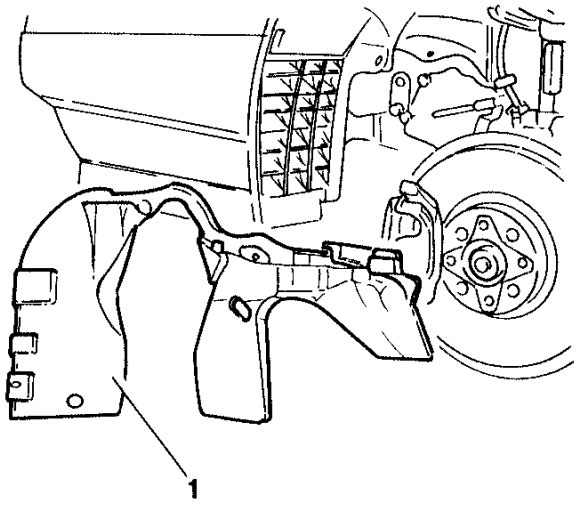


1. Empty the power steering fluid reservoir using a suitable syringe.

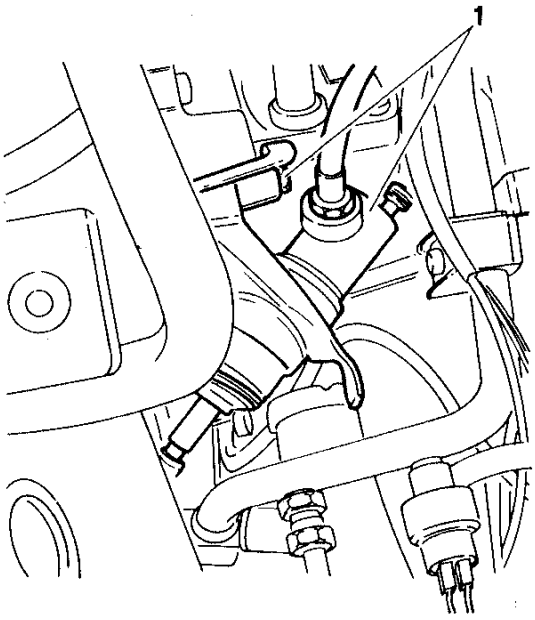


– Remove the front wheels.

1. Remove the dustguards from the front wheel arches.

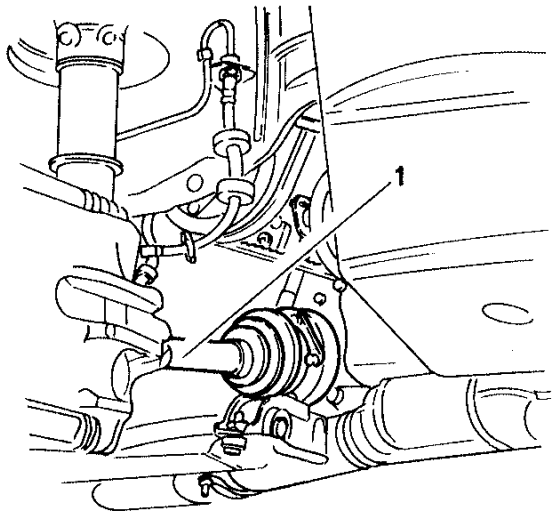


1. Operating from the lefthand wheel housing, unscrew the clutch hydraulic control cylinder support bracket screws and move it sideways.

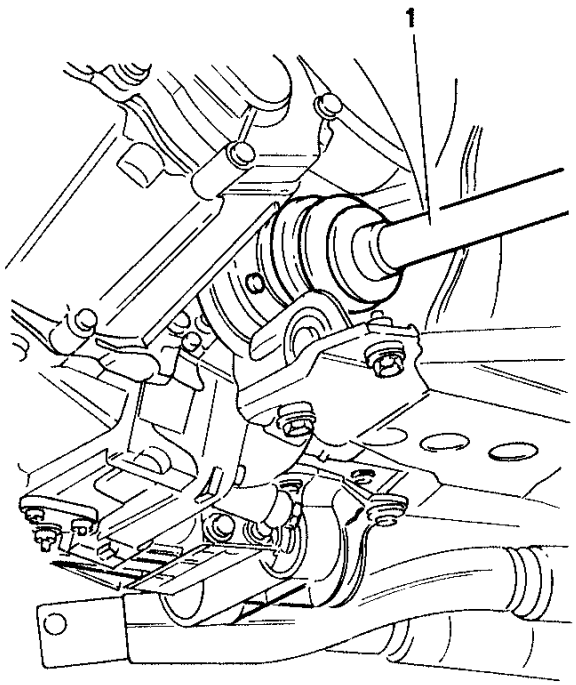


– Raise the vehicle.

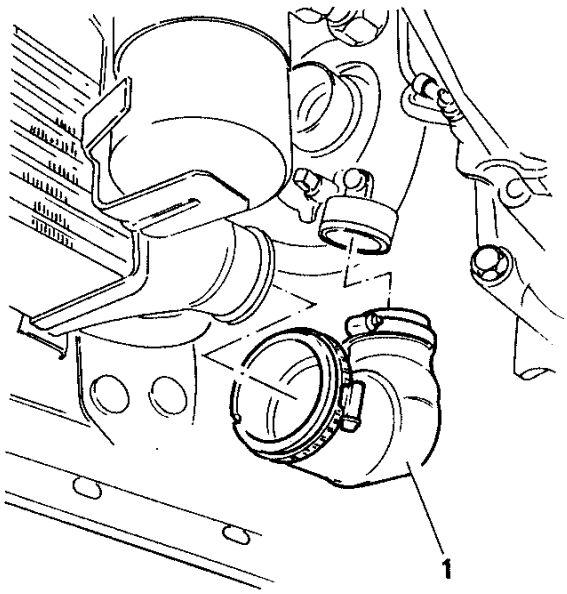
1. Disconnect the righthand axle shaft from the central differential.



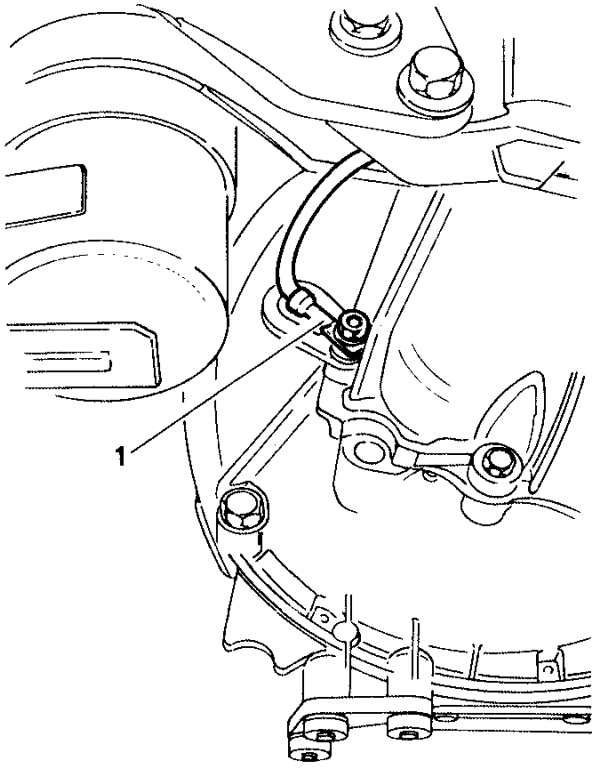
1. Disconnect the lefthand axle shaft from the differential.



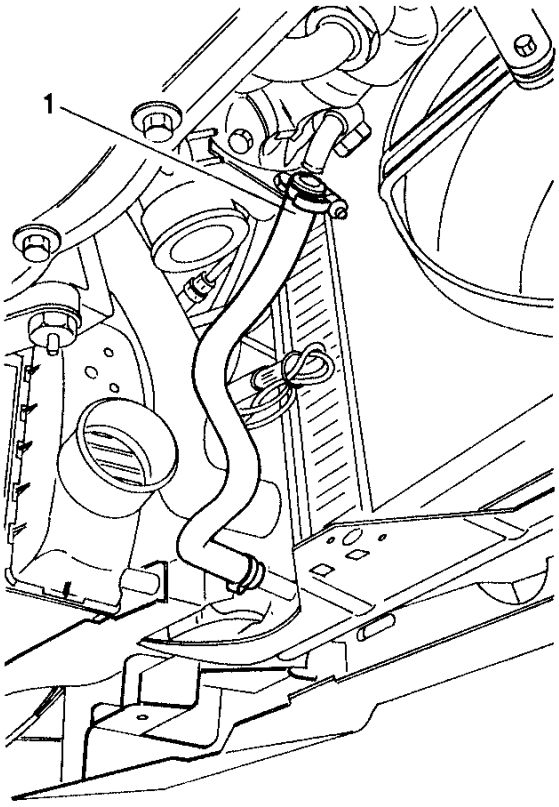
1. Remove the turbocharger connection sleeve to the intercooler.



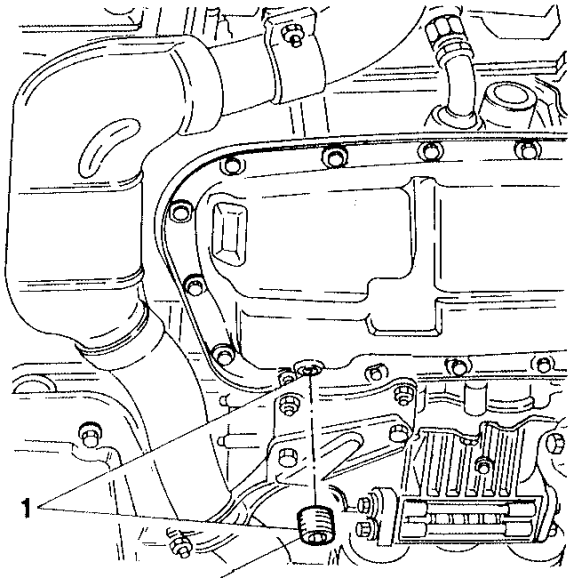
1. Disconnect the earth point of battery terminal (-).



1. Disconnect the coolant entry tube from the turbo-charger.

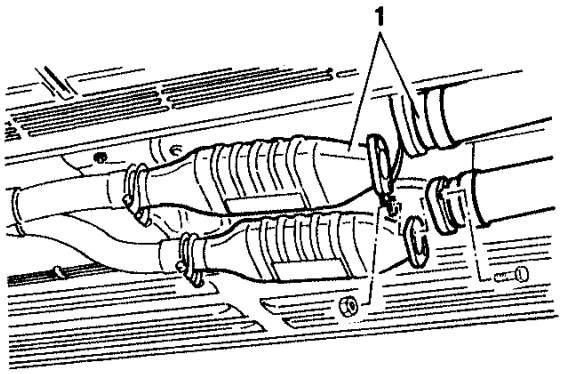


1. Drain off engine oil.

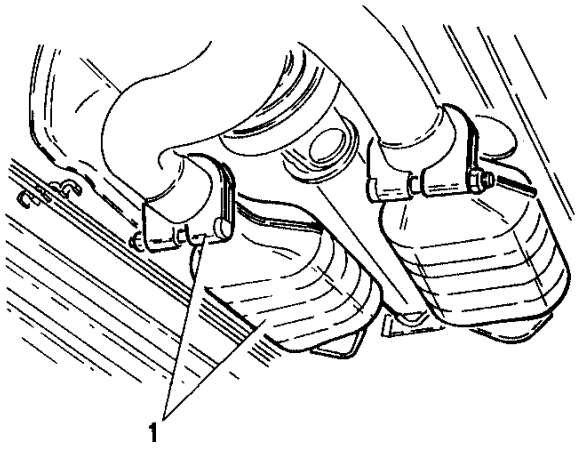


32.5 ÷ 52.5 Nm
3.3 ÷ 5.4 kgm

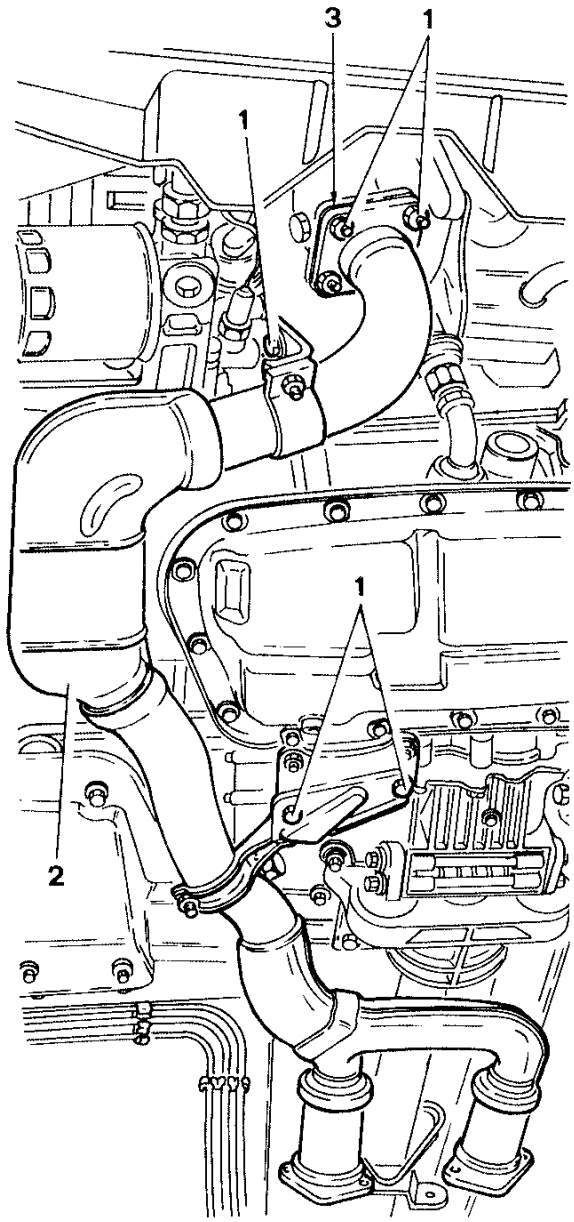
1. Disconnect the two flanges on the front exhaust section of the two catalytic convertors.



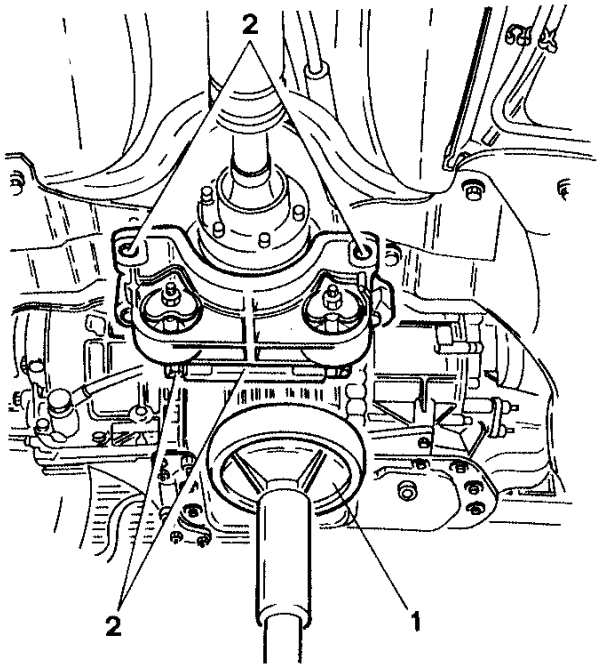
1. Loosen collars and remove catalytic convertors.



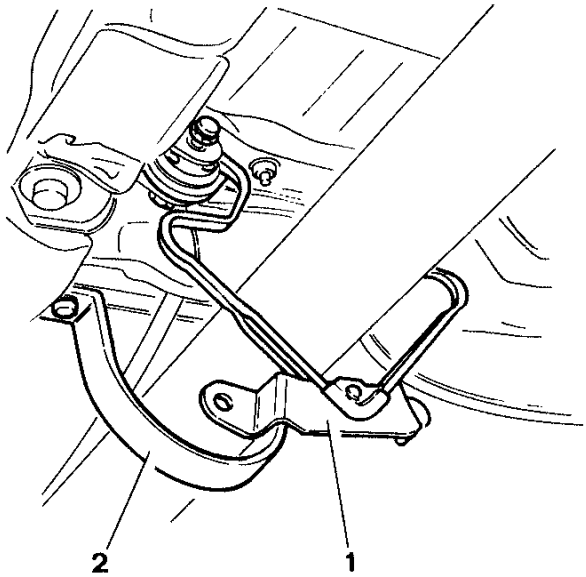
1. Unscrew screws and bolts of front section of exhaust pipe to turbocharger and the support brackets.
2. Remove front section of exhaust pipe.
3. Remove seal.



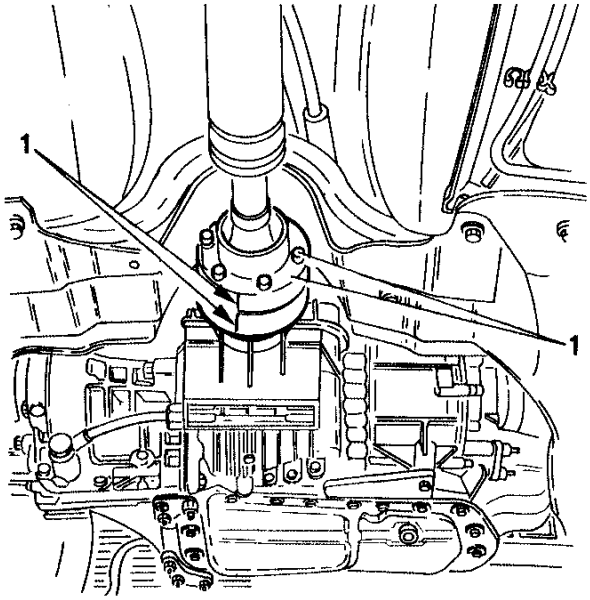
1. Position a suitable column lift under the central differential.
2. Unscrew the screws and bolts of the engine unit rear support and remove it.



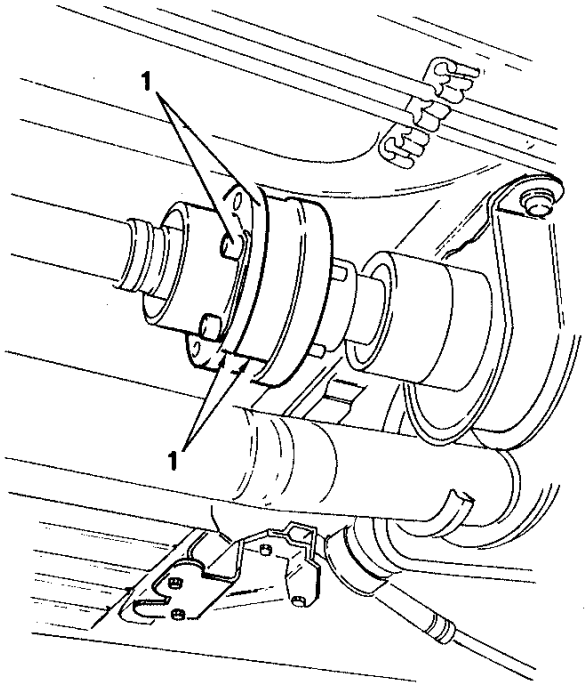
– Remove column lift.
1. Remove the exhaust pipe elastic support.
2. Remove the drive shaft saftey bracket.



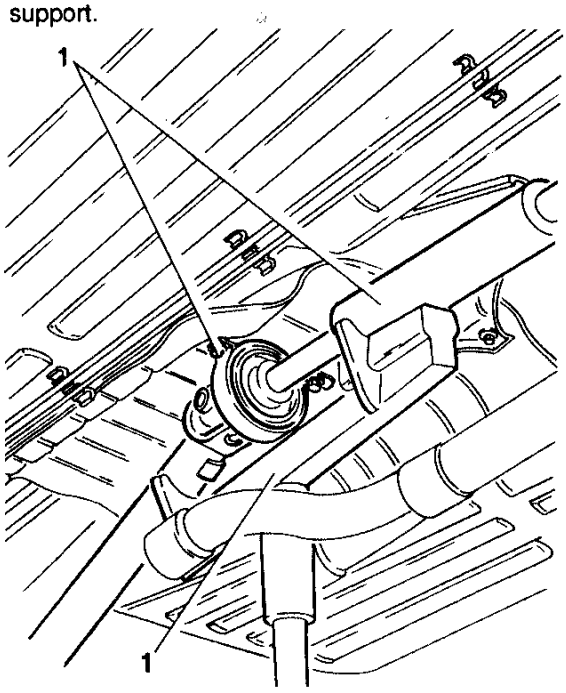
1. Make reference notches on the flanges of the joint between the front section of the drive shaft and the central differential and disconnect them by unscrewing the relative screws.



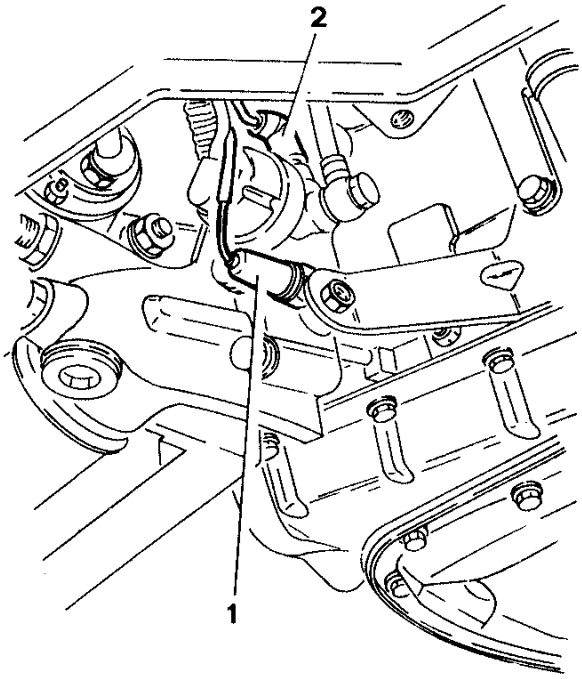
1. Make reference notches on the flanges of the joint between the central and rear sections of the drive shaft and disconnect them by unscrewing the relative screws.



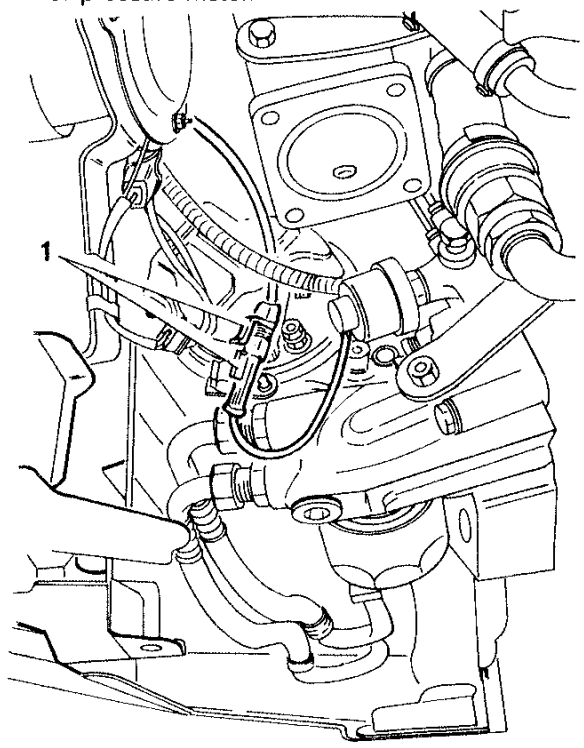
1. Support the front and central sections of the drive shaft with a suitable tool and remove them after having unscrewed the screws of the central elastic support.



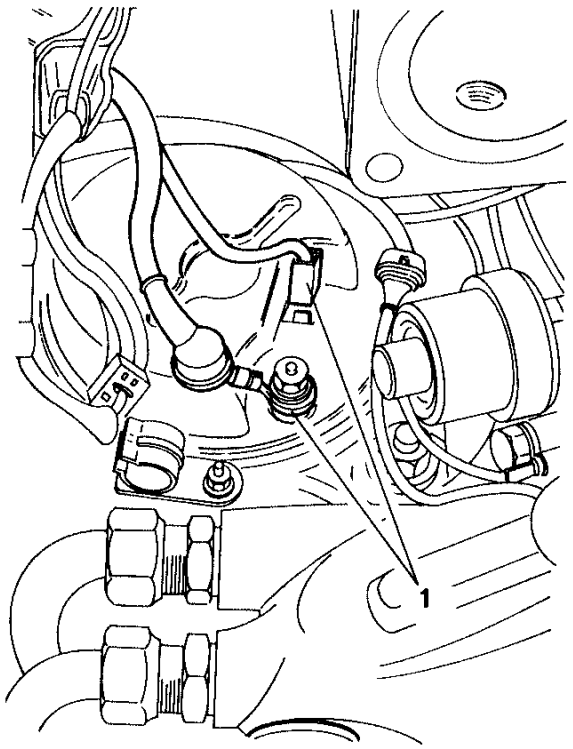
1. Disconnect the electrical connections of the engine oil minimum pressure warning light sensor.
2. Disconnect the electrical connections of the engine oil temperature sensor.



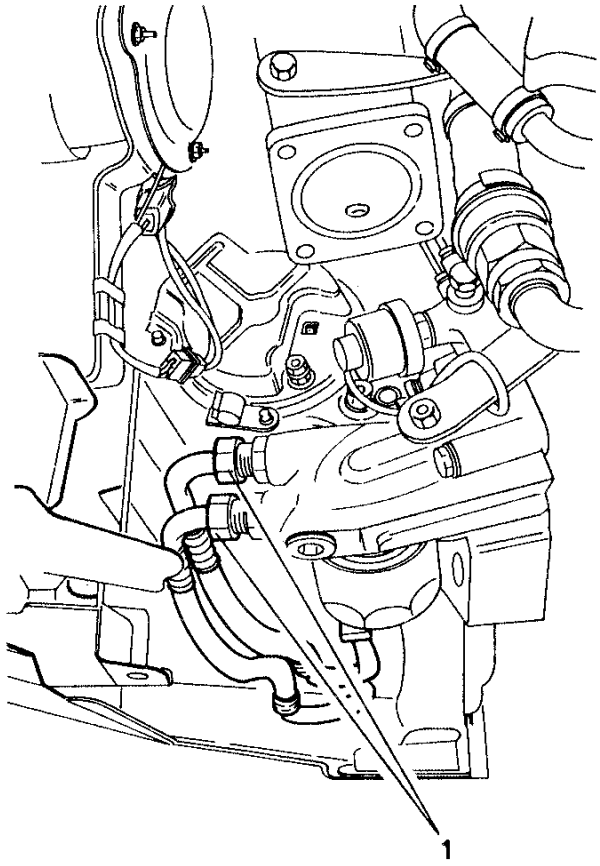
1. Disconnect the electrical connections of the engine oil pressure meter.



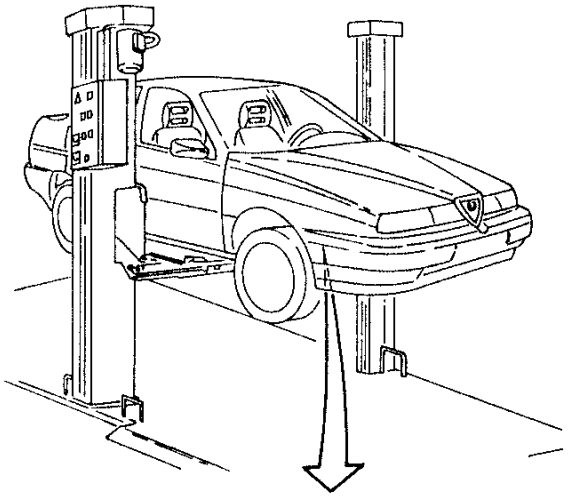
1. Disconnect the electrical connections of the alternator.

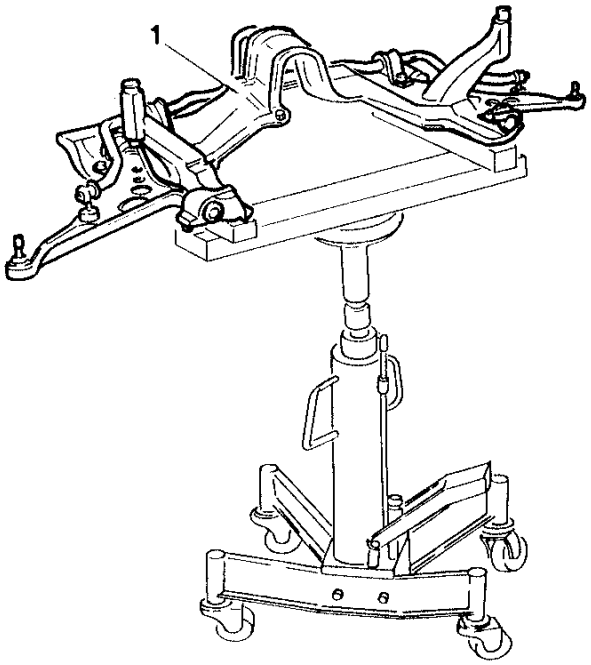


1. Disconnect the two oil delivery and return unions to the cooling radiator from the oil filter support.

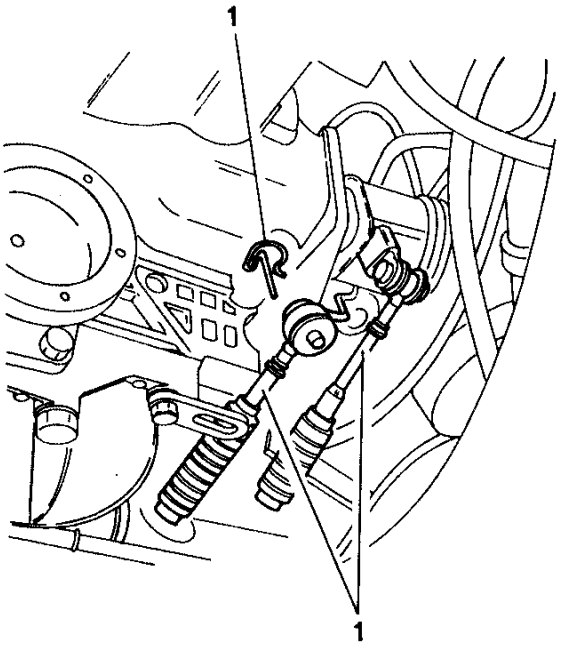


1. Unscrew the screws and remove the cross member complete with wishbones (see **GROUP 21**).

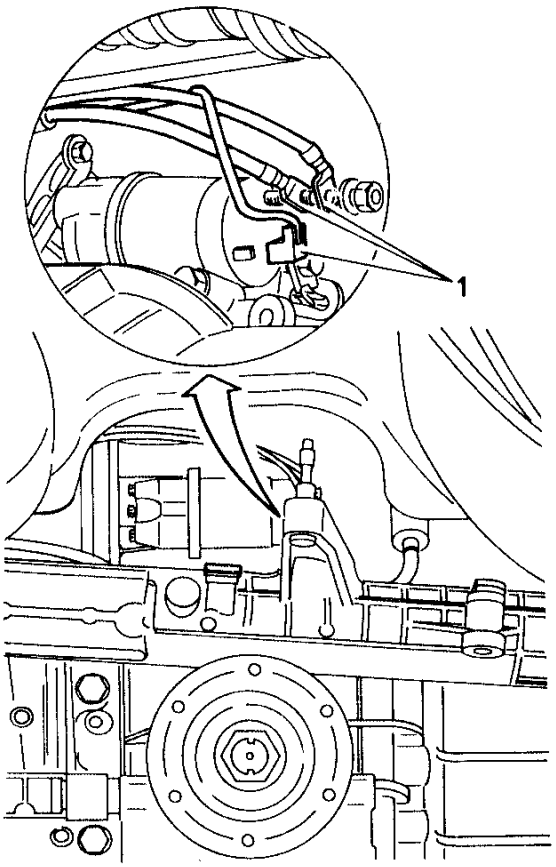




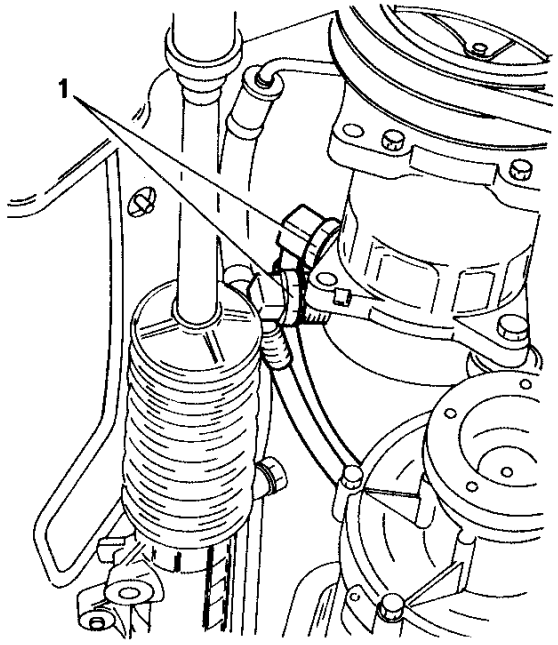
1. Disconnect the two gear selection cables.



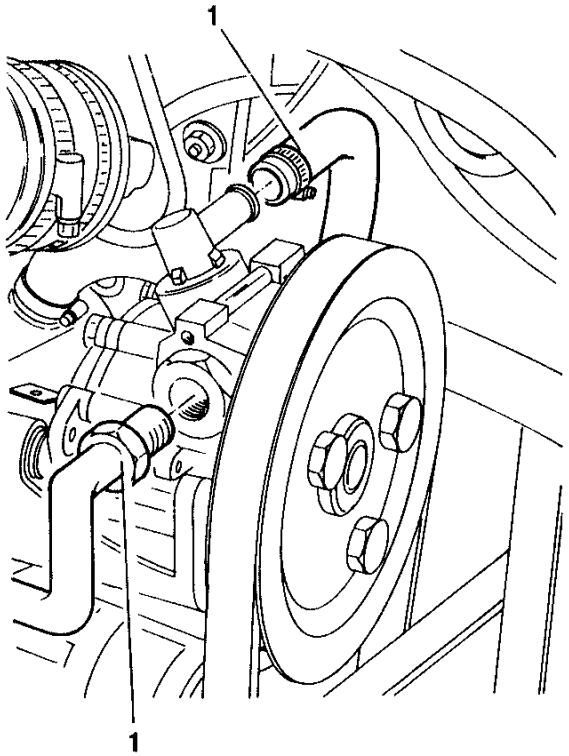
1. Disconnect the electrical connections from the starter motor.



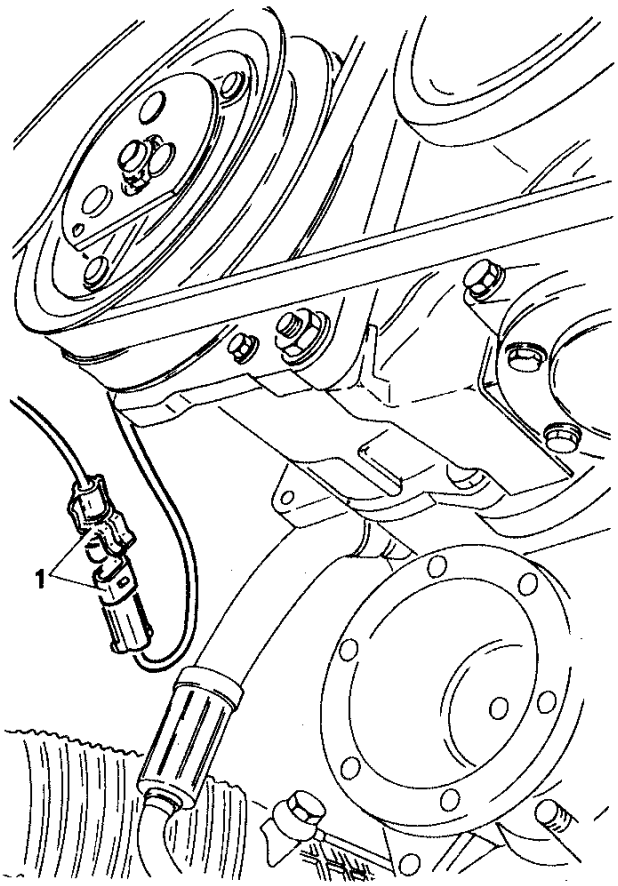
1. Disconnect the two freon delivery unions from the air conditioning system and plug the holes located on it.



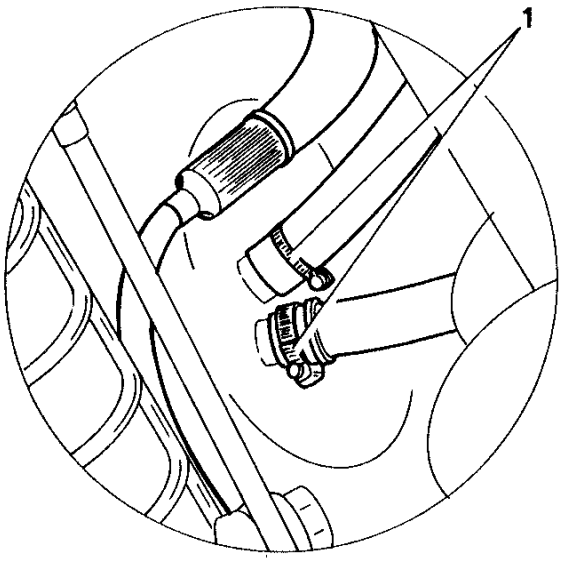
1. Disconnect the two oil intake and delivery unions from the power steering pump.

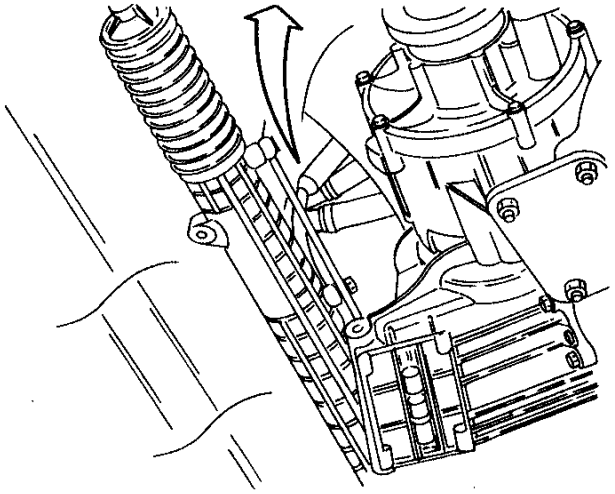


1. Disconnect the electrical connection supplying the air conditioning compressor's electromagnetic joint.

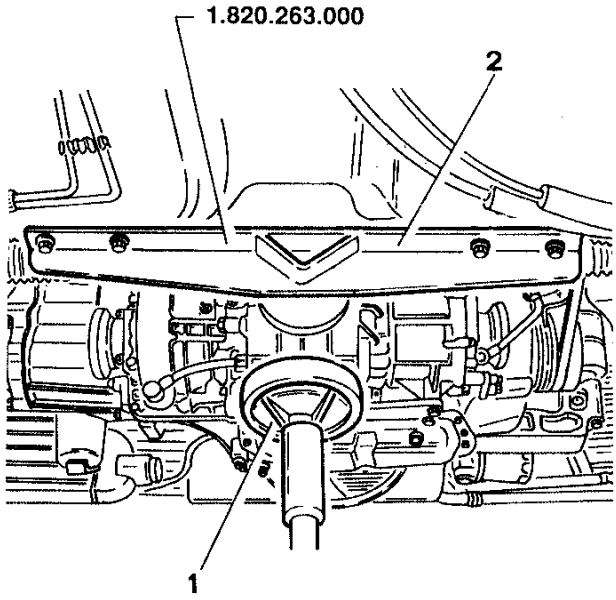


1. Disconnect the two coolant delivery and return tubes from the heater.

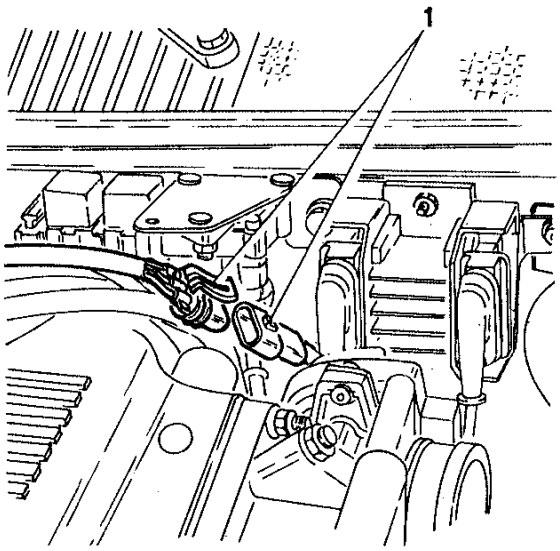




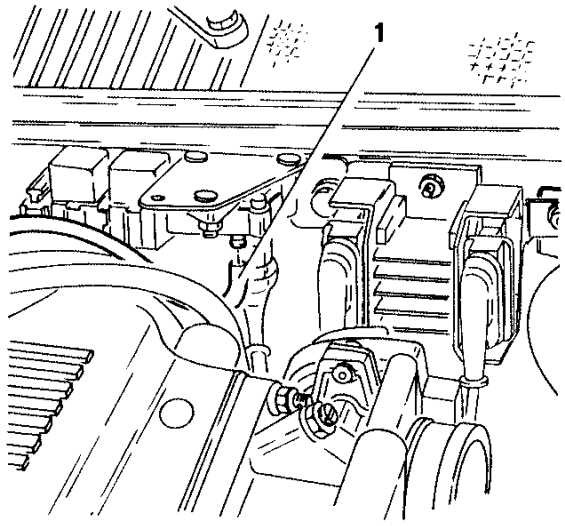
1. Position a suitable column lift under the central differential and raise the engine unit backwards.
2. Position engine unit rear support tool N° 1.820.263.000.



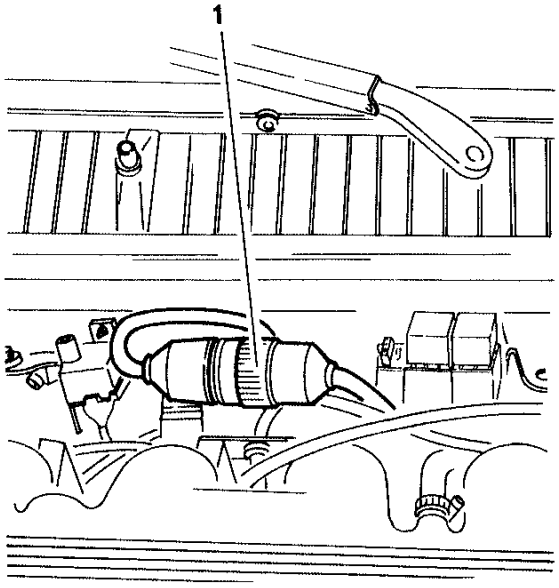
1. Disconnect the electrical connections supplying the ignition coils.



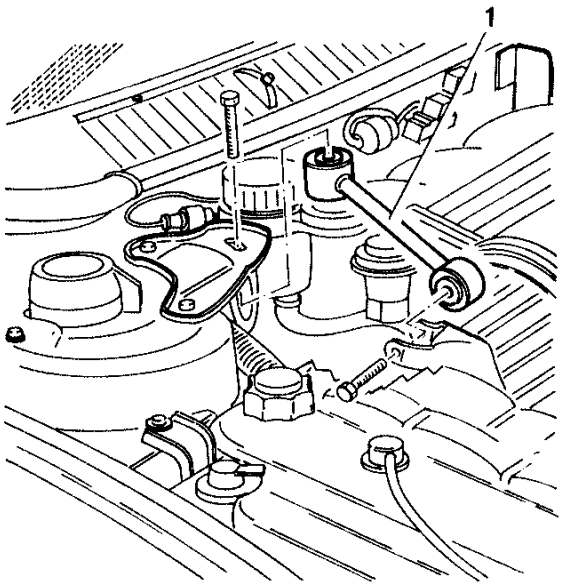
1. Disconnect the vacuum intake tube from the absolute pressure sensor.



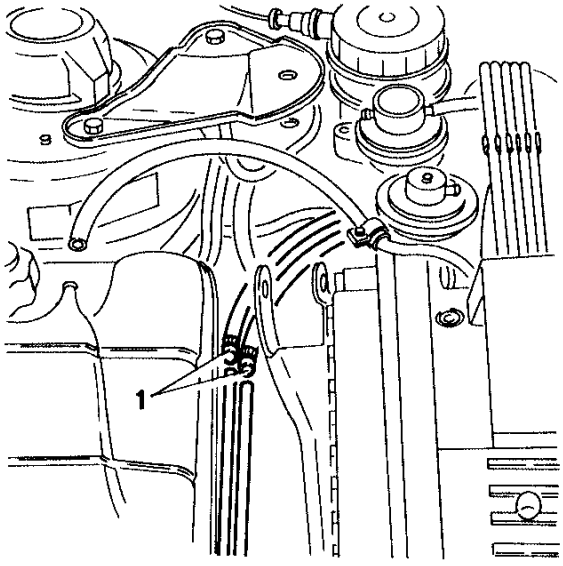
1. Disconnect the electrical connections between injection and electroinjector wiring.



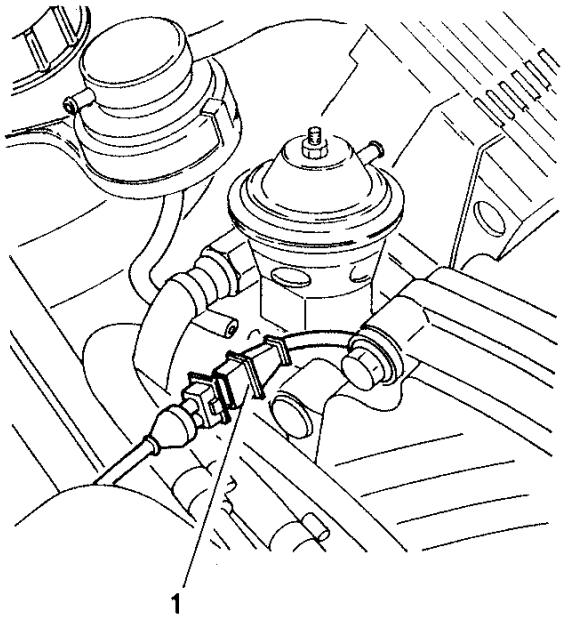
1. Remove the engine damping rod.



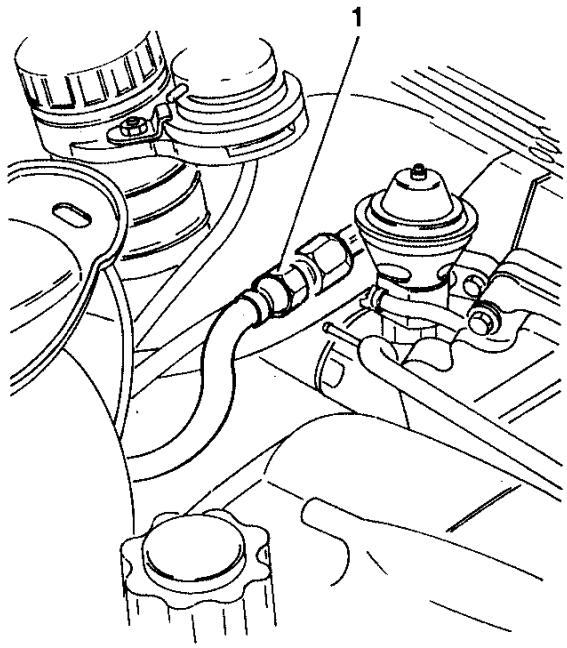
1. Disconnect the intermediary joints of the fuel vapour to air intake box delivery tube and the vacuum intake tube for the fuel vapour interception valve.



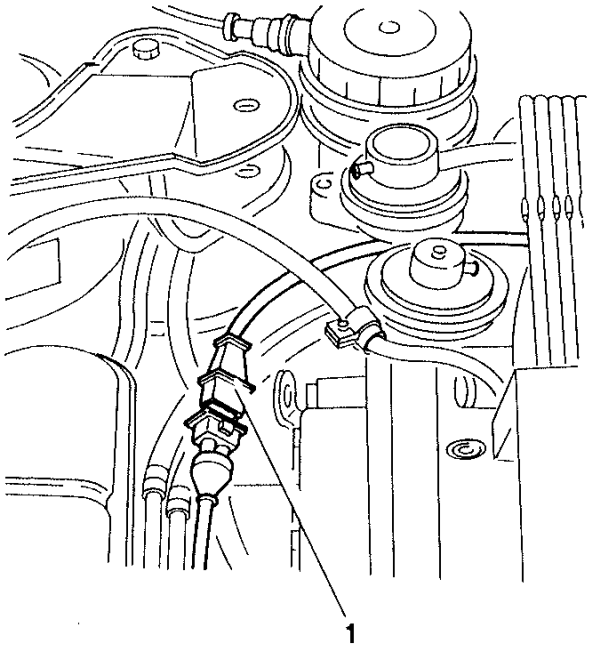
1. Disconnect the electrical connections of the revs sensor and the T.D.C.



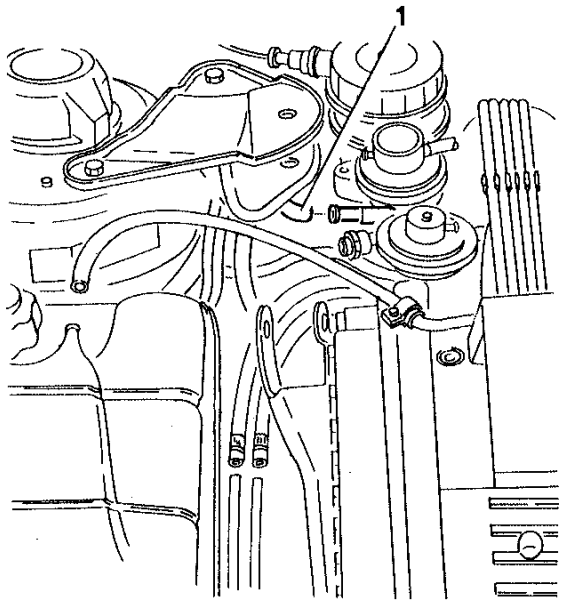
1. Disconnect the fuel delivery tube from the distribution manifold.



1. Disconnect the electrical connection of the knock sensor.



1. Disconnect the return excess fuel to the tank tube.



1. Assemble the support tools N° 1.820.225.000 and N° 1.820.233.000 ready to remove the engine unit from the vehicle as indicated in the figure.
2. Position a hydraulic jack under the engine unit support tools.

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

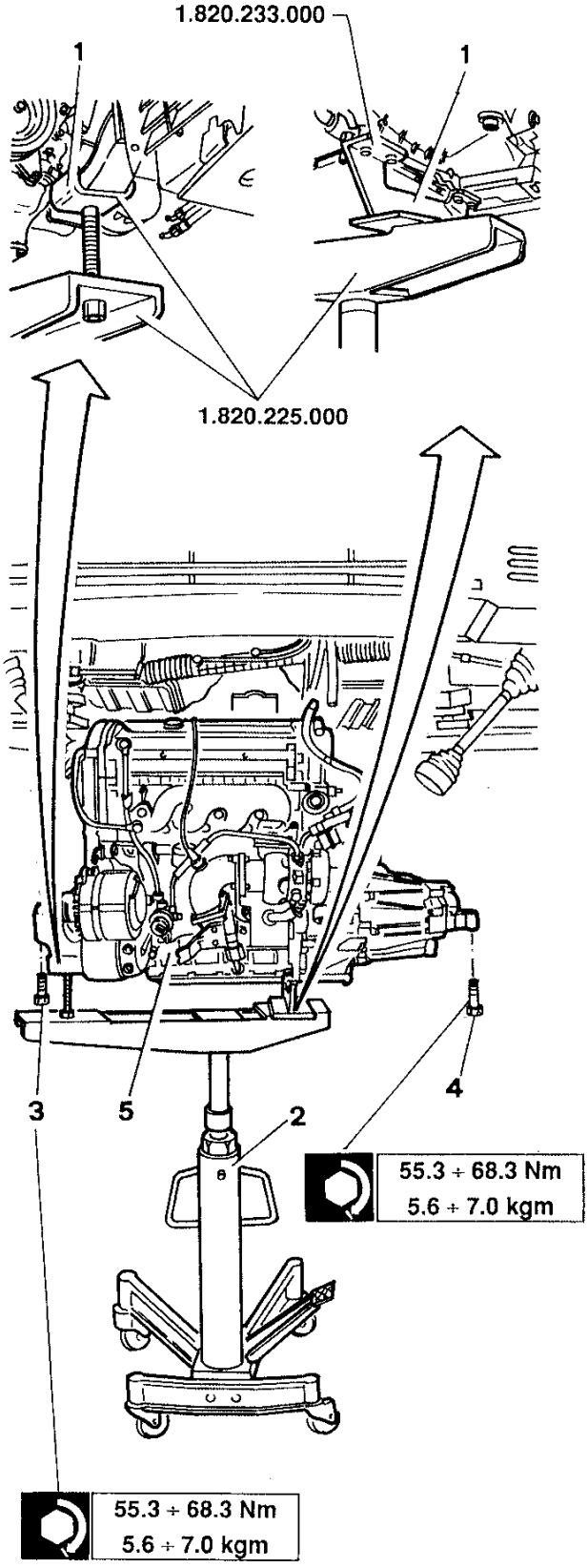
– Remove the engine unit rear support tool N° 1.820.263.000 assembled previously.

3. Disconnect the engine unit support from body, timing side.
4. Disconnect the engine unit support bracket from the elastic support, gearbox side.

CAUTION:
Disconnect the electrical cables from any clamps and move them away from the engine to avoid damaging them when the engine is removed.

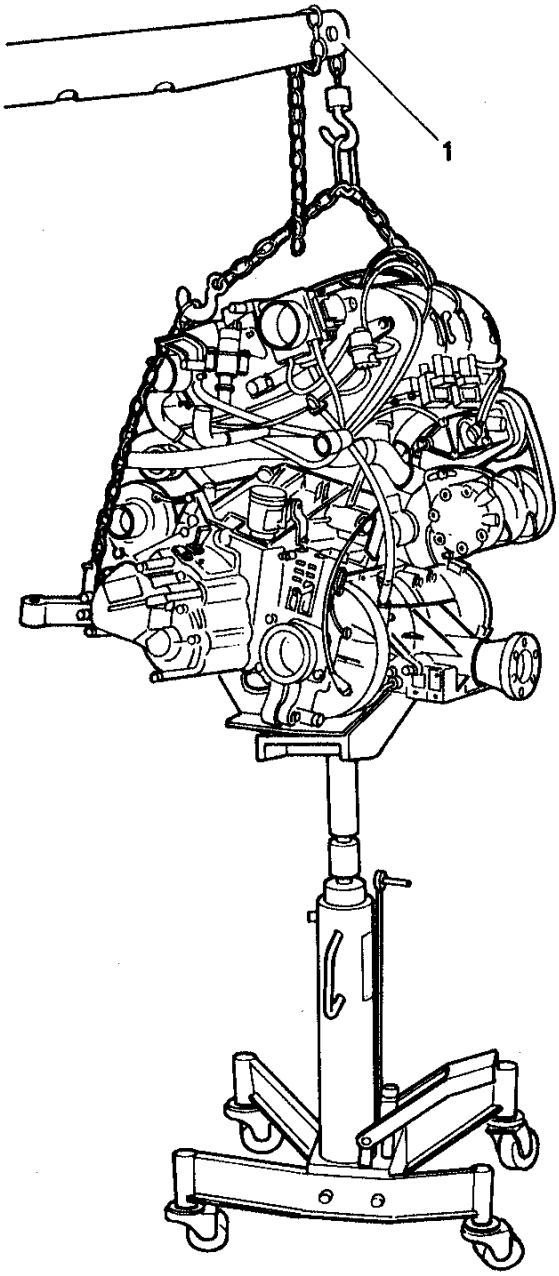
5. Slowly lower the jack and remove the engine unit from the engine compartment.

CAUTION:
When lowering the jack check that no cables or hoses are still attached to the vehicle.
Pay close attention to avoid damaging any components.



1. Support the engine unit with a hydraulic crane in addition to the hydraulic jack used for its removal.

CAUTION:
When moving the engine use a hydraulic crane after disengaging the engine from the supporting hydraulic jack.



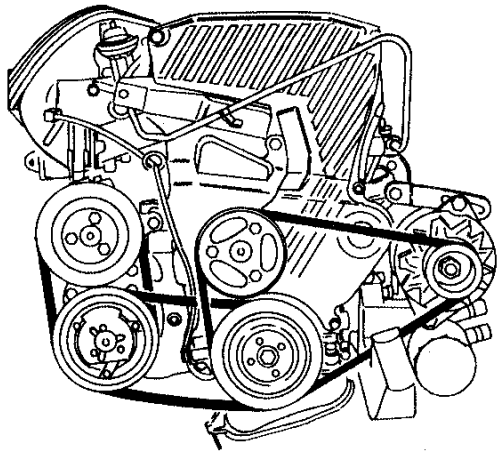
REFITTING

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

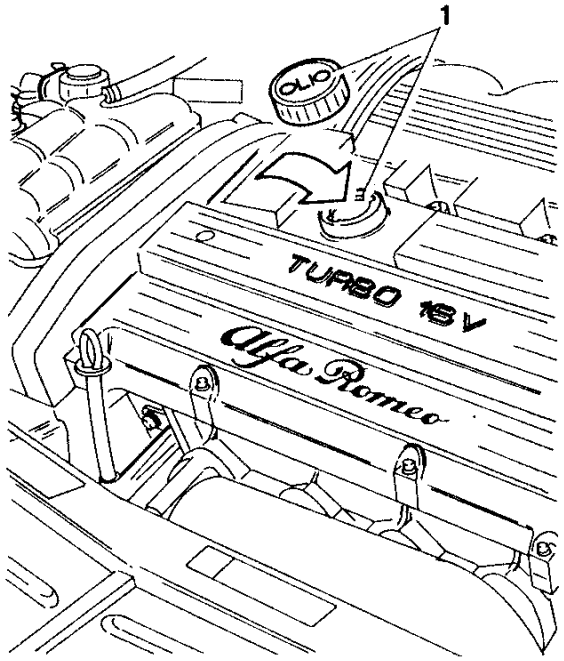
- Prepare the engine compartment for the insertion of the engine ensuring the hoses and electrical cables, etc. will not get caught in the engine when it is installed.
- Caution must be exercised when installing the engine unit to ensure that no individual components are damaged.

CAUTION:
Ensure that the engine unit support points are correctly secured.

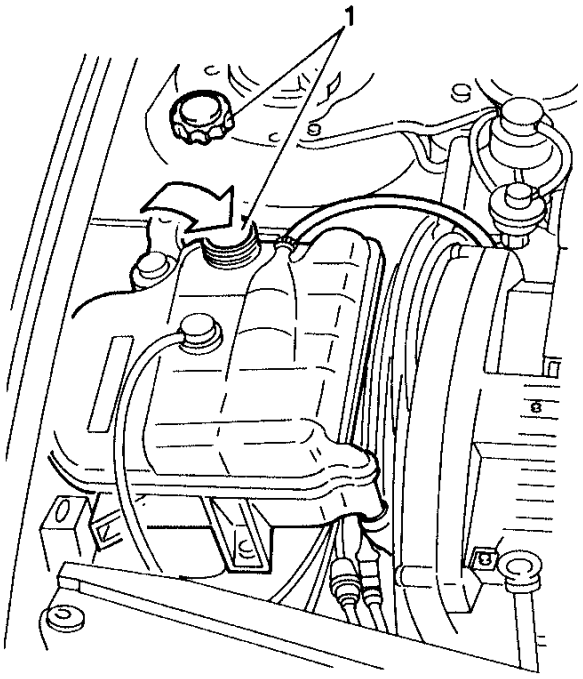
After installation check belt tensioning (see **GROUP 00**).



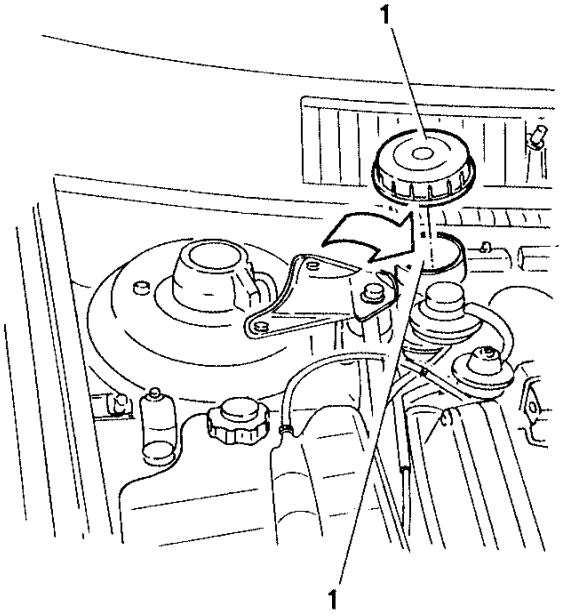
1. Fill the engine lubrication system with the correct quantity and type of oil (see **GROUP 00**).



1. Fill the engine cooling system with the correct quantity and type of fluid. (see **GROUP 00**).



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



- Fill the air conditioning system (see **GROUP 80**).
- Check the level of all other fluids.
- Perform all interventions and checks as indicated in **GROUP 00**.

ENGINE BENCH OVERHAUL

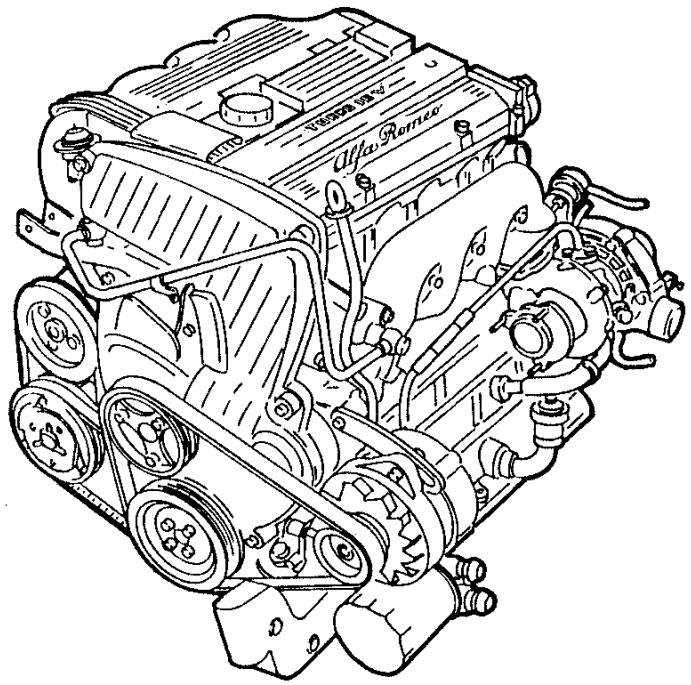
The instructions given in the following paragraphs refer to the complete overhaul of the engine unit on a bench after removal from the vehicle.
The instructions are divided as follows:

- **Disassembly and reassembly of engine:** removal (and subsequent refitting) of the gearbox, accessories, etc. from the engine and disassembly of the engine into its main component parts.
- **Disassembly and overhaul of cylinder heads:** complete overhaul of all the components of the cylinder heads.
- **Engine block checks and inspections:** complete overhaul of all the components of the crank mechanisms.
- **Indications for refitting:** comprising the refitting operations where they differ from the disassembly instructions.

All the disassembly instructions described in the following parts, when carried out in the reverse order, are also valid for refitting purposes unless otherwise indicated.

- **Checks and inspections of the electrical compenents lubrication circuit:** checks and inspections of the electrical components relative to the engine.

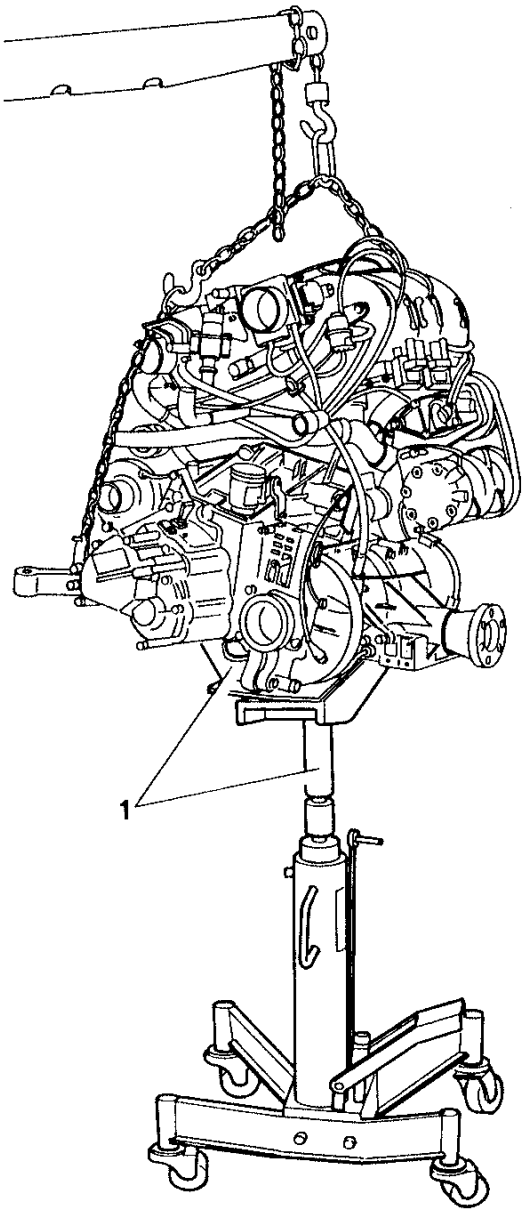
The procedures which follow refer to the complete overhaul of the complete engine: it is however possible to use individual parts of these instructions when dealing with specific components.



ENGINE DISASSEMBLY AND REASSEMBLY

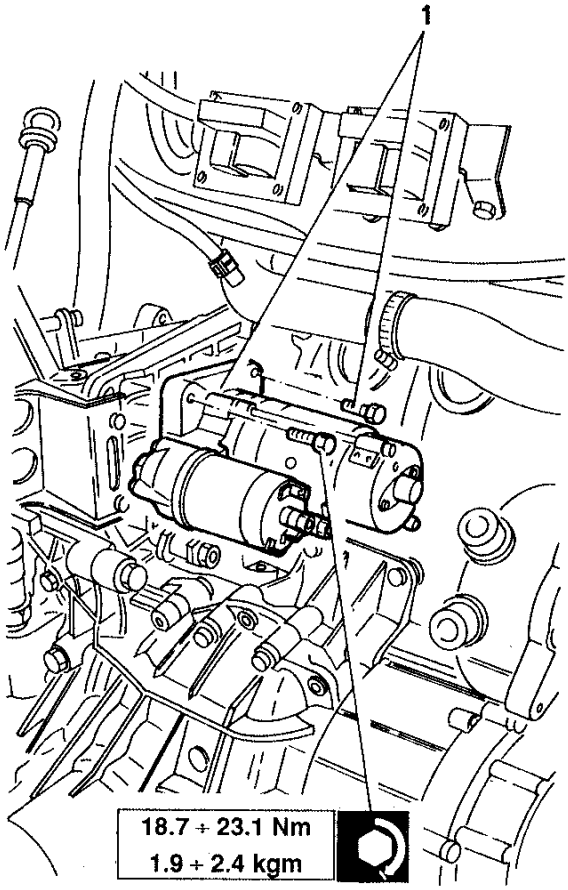
PRELIMINARY OPERATIONS

1. Remove the engine support hydraulic jack and the tools used to remove the engine from the engine compartment.

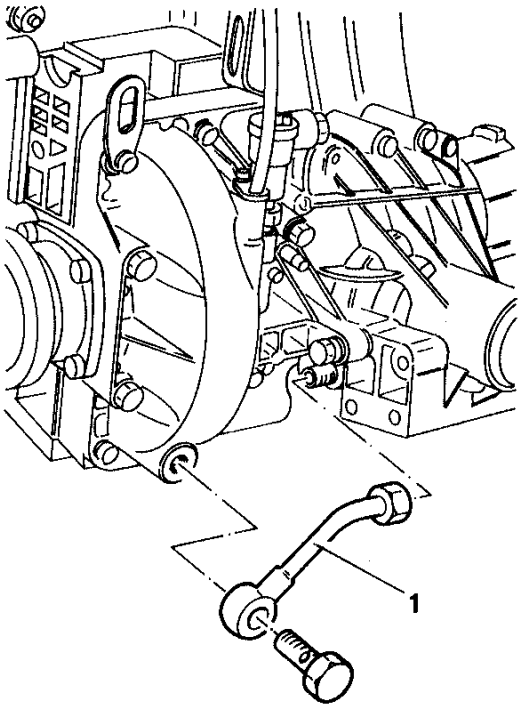


- Unscrew the two lower screws fixing the gearbox to the engine block.
- Position the engine unit on a suitable work bench.

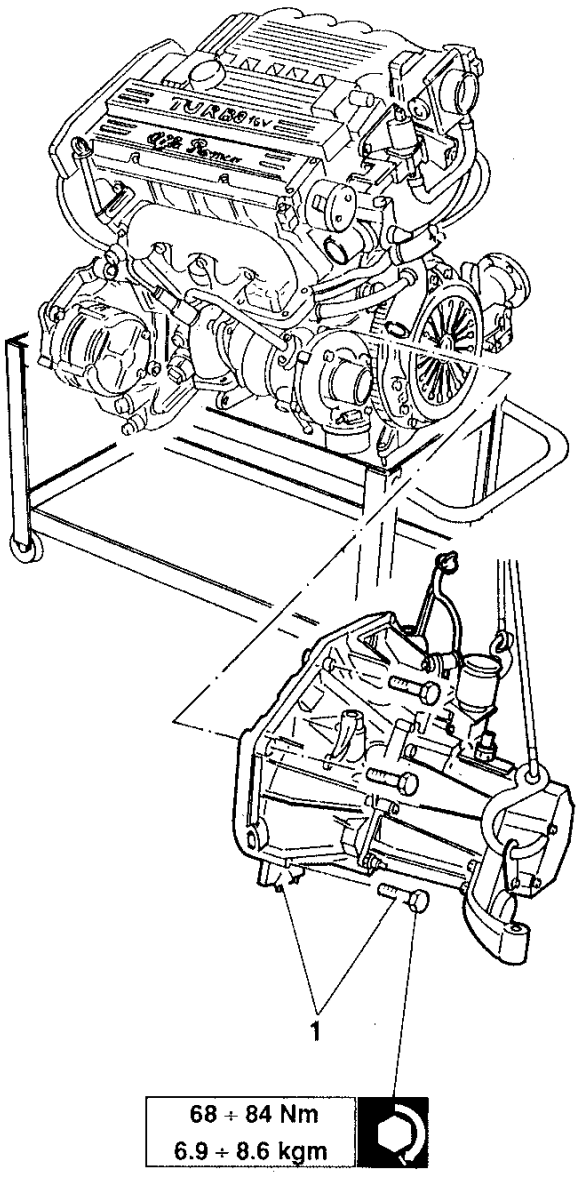
1. Remove the starter motor.



1. Remove the oil pipe between the gearbox and the differential.

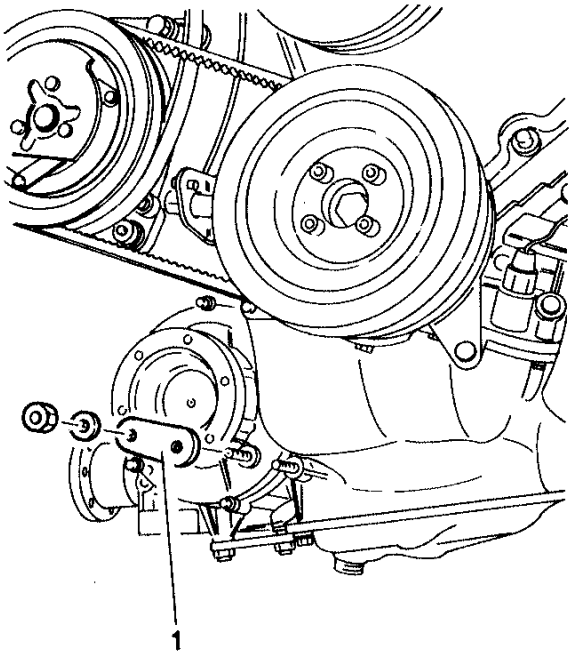


1. Unscrew the remaining screws and remove the front gearbox- differential unit.

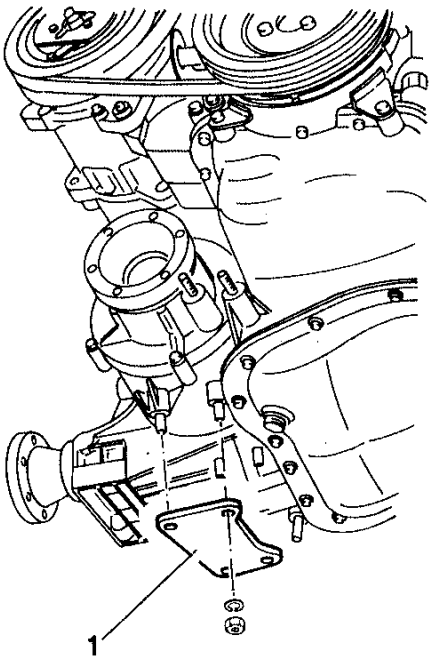


68 ÷ 84 Nm
6.9 ÷ 8.6 kgm

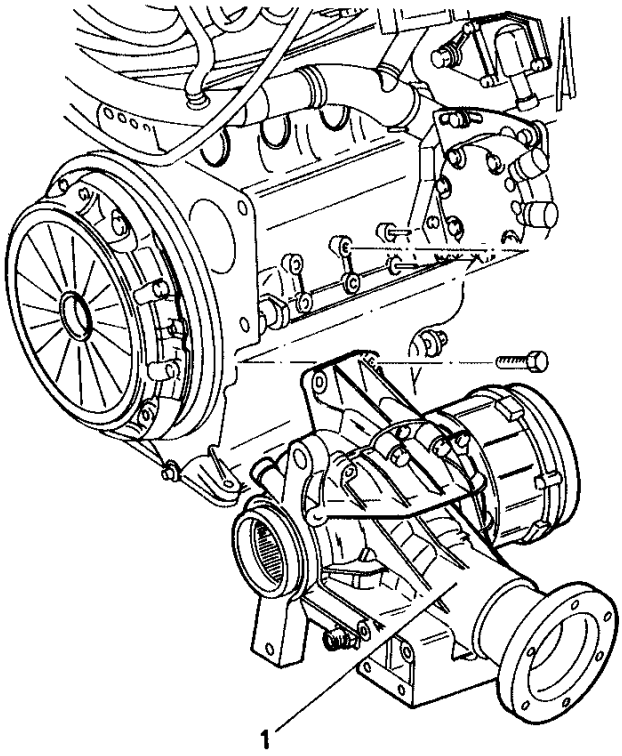
1. Remove the bracket between the oil sump and the central differential.



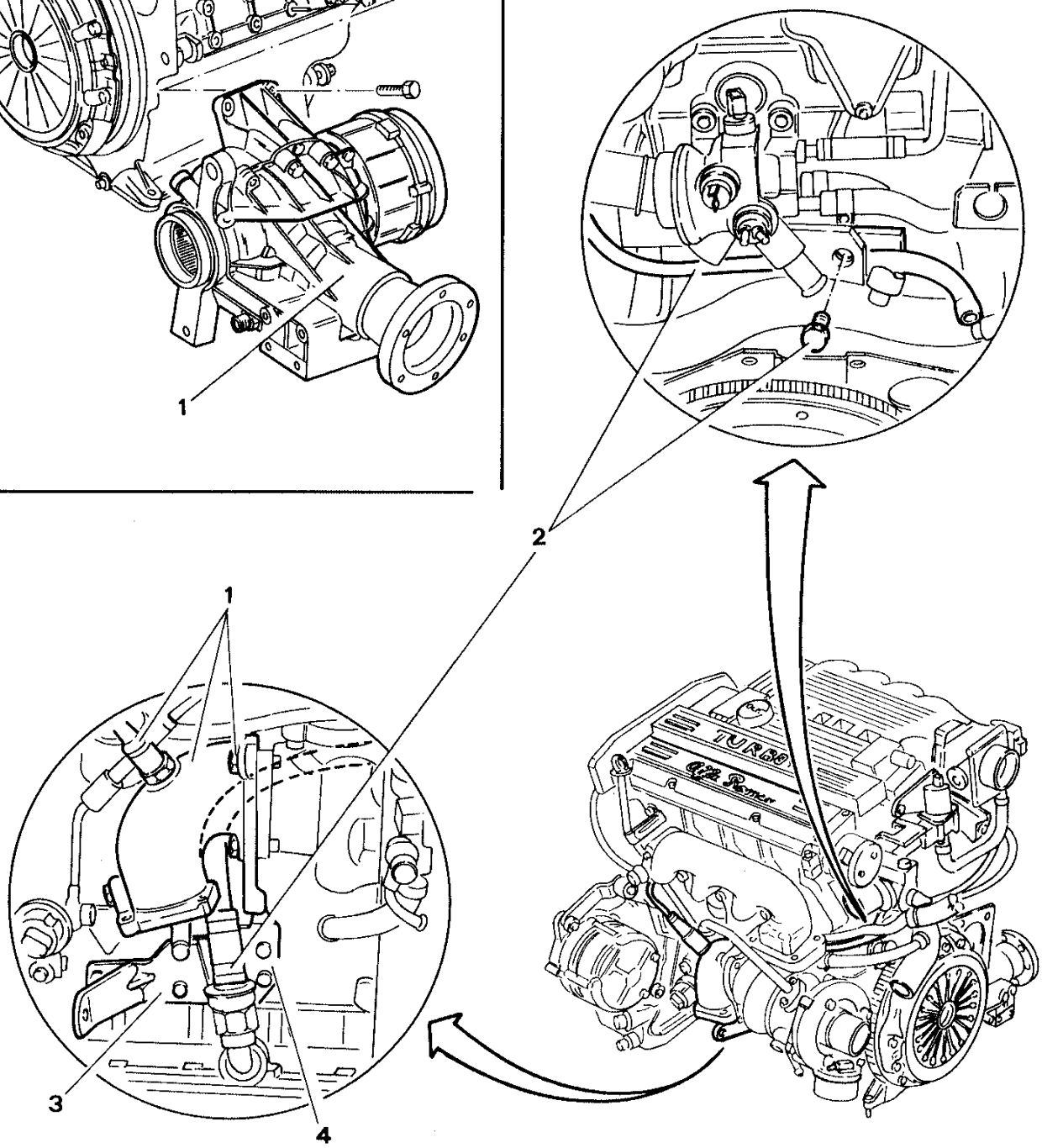
1. Remove the lower bracket between the central differential and the engine block.



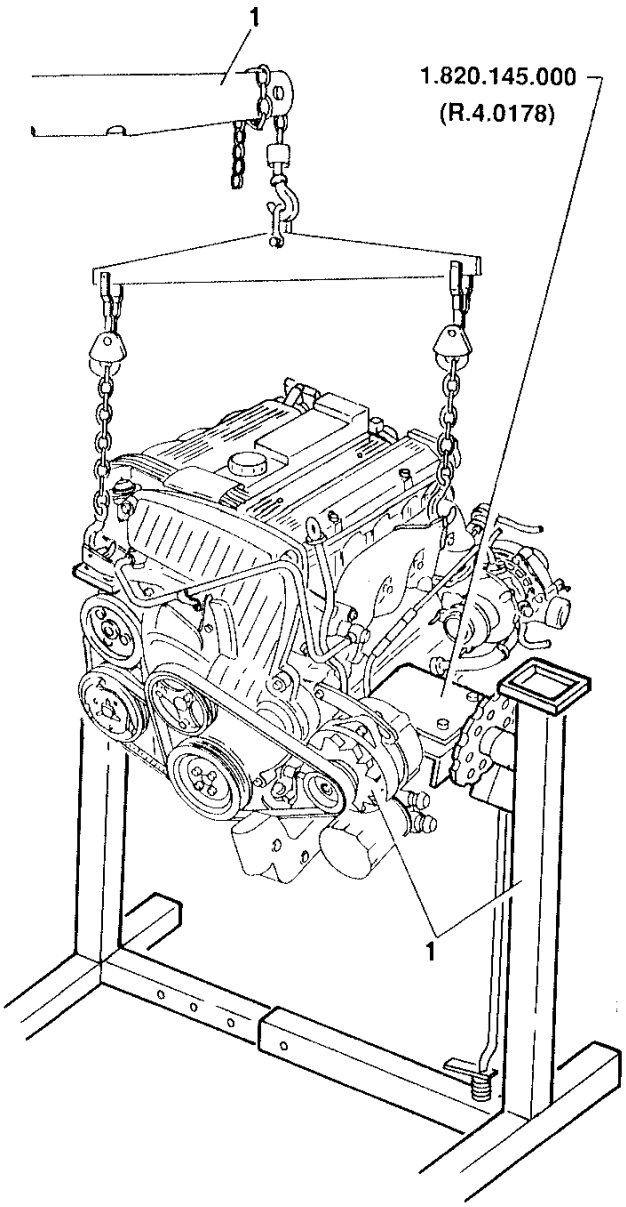
1. Unscrew the screws and remove the central differential.



1. Remove the exhaust manifold complete with lambda probe from the turbocharger.
2. Remove the oil return to sump pipe, condensated by the separator.
3. Remove the support bracket for the exhaust pipe front section.
4. Remove the turbocharger support bracket.

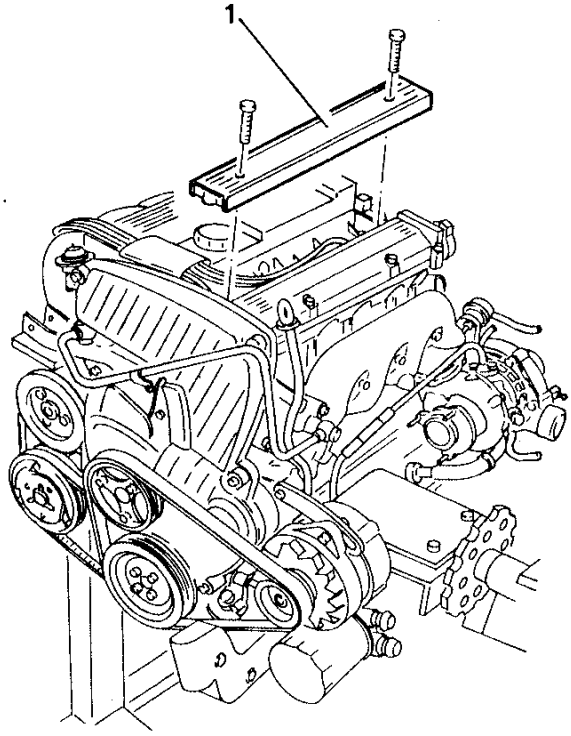


1. Raise the engine with a hydraulic lift, install the brackets N° 1.820.145.000 (R.4.0178) on the engine block and position it, using the above mentioned brackets on the rotating overhaul stand.

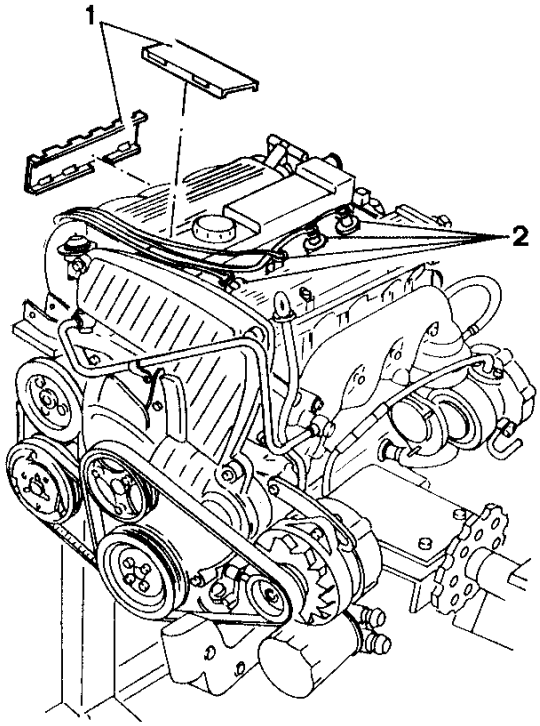


REMOVAL OF IGNITION COILS

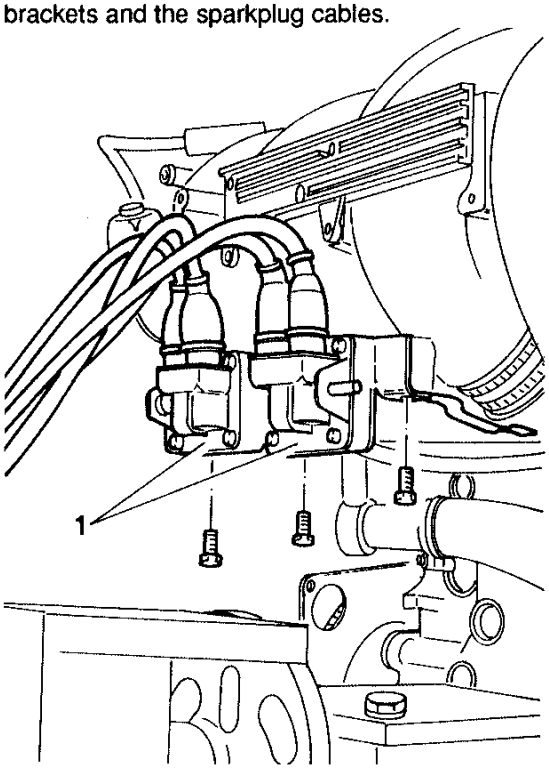
1. Remove the spark plug cover.



1. Remove the two cable clamp covers.
2. Disconnect the cables from the sparkplugs.

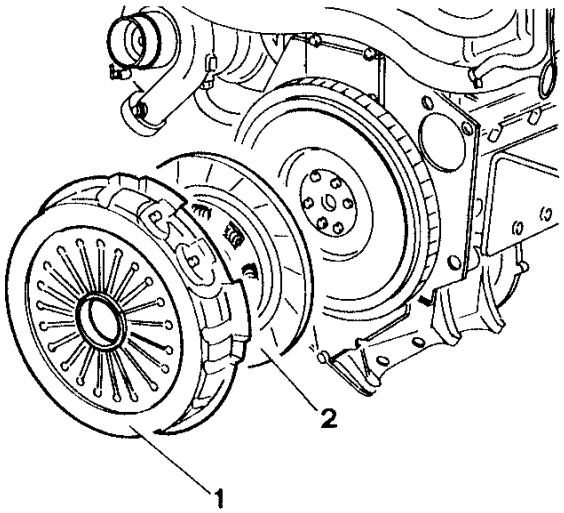


1. Remove the ignition coils complete with support brackets and the sparkplug cables.



REMOVAL OF CLUTCH PLATE

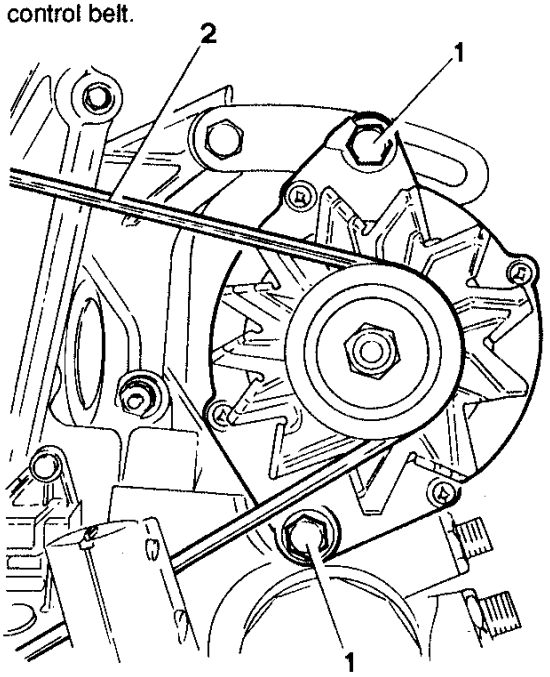
1. Remove the disk pressure plate body.
2. Remove the clutch plate.



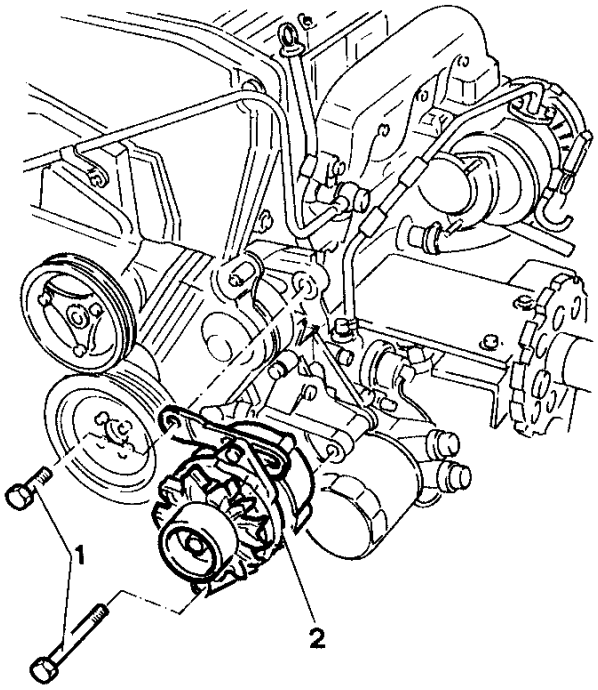
NOTE: For further details regarding the clutch and its components, see GROUP 12.

REMOVAL OF ALTERNATOR

1. Loosen the bolts securing the alternator.
2. Extract and remove the alternator - water pump control belt.

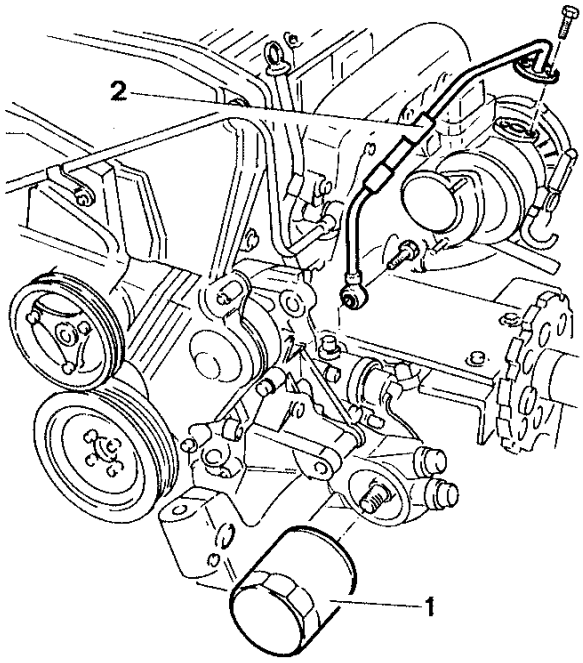


1. Unscrew the bolt securing the alternator support bracket and the lower bolt loosened beforehand.
2. Remove the alternator complete with bracket.

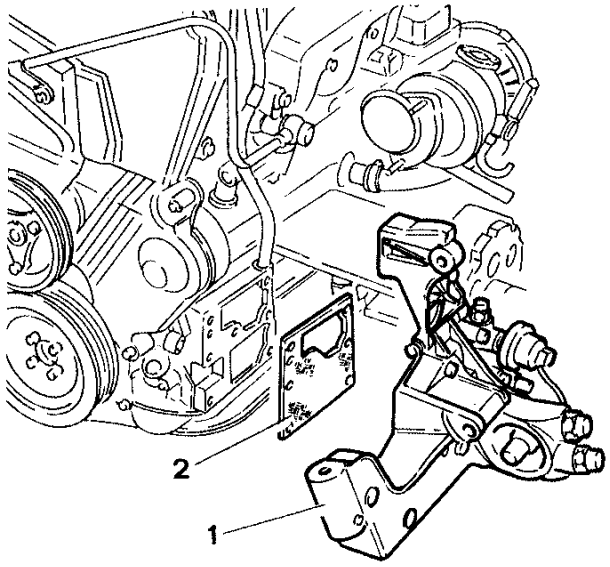


REMOVAL OF ENGINE SUPPORT

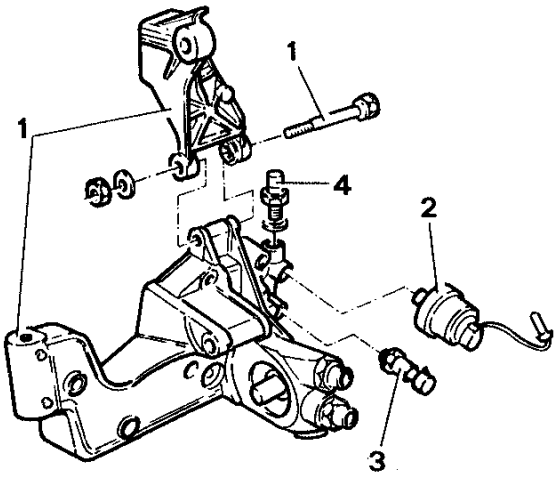
1. Remove the oil filter cartridge.
2. Remove the oil delivery to turbocharger tube.



1. Remove the complete engine support.
2. Remove gasket.

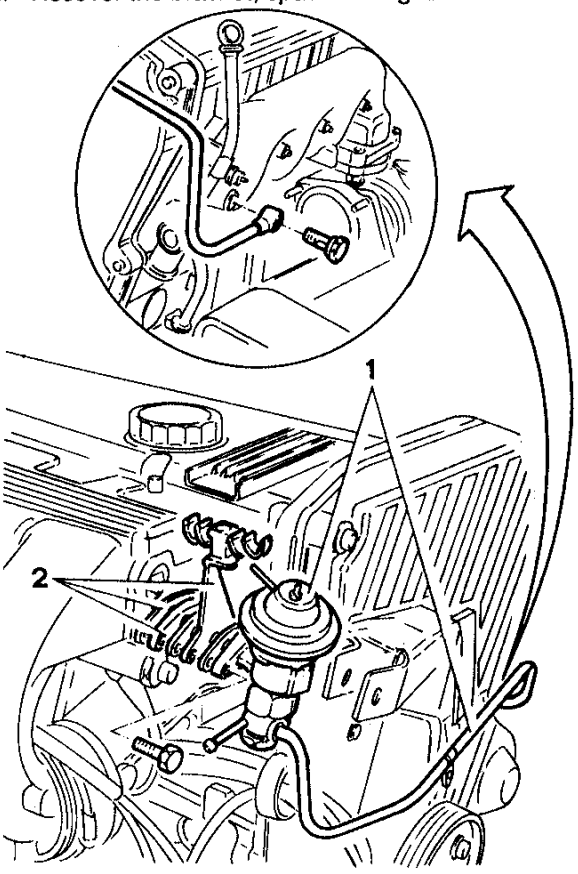


1. If necessary disassemble the support, unscrewing the relative connection bolt.
2. Remove the engine oil pressure meter.
3. Remove the engine oil pressure minimum warning light sensor.
4. Remove the engine oil temperature sensor.

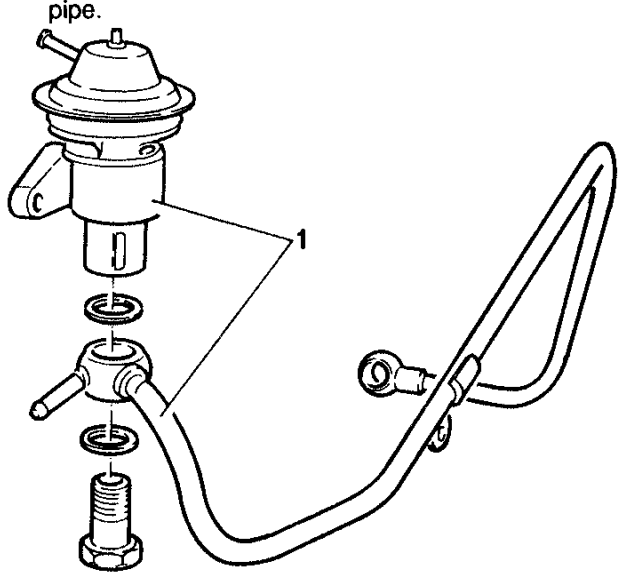


REMOVAL OF E.G.R. VALVE

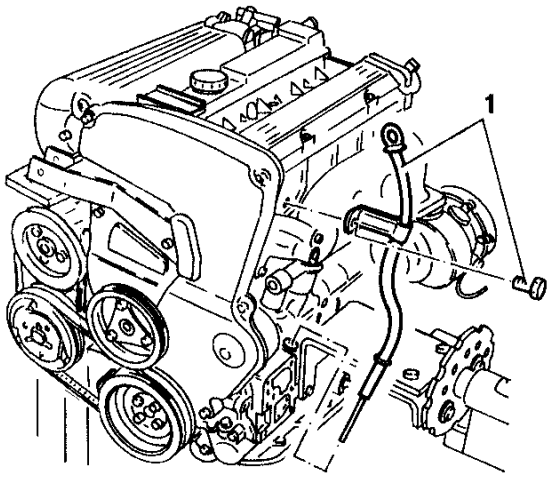
1. Remove the E.G.R. valve complete with exhaust gas delivery tube.
2. Recover the bracket, spacer and gaskets.



1. If necessary separate the E.G.R. valve from the pipe.

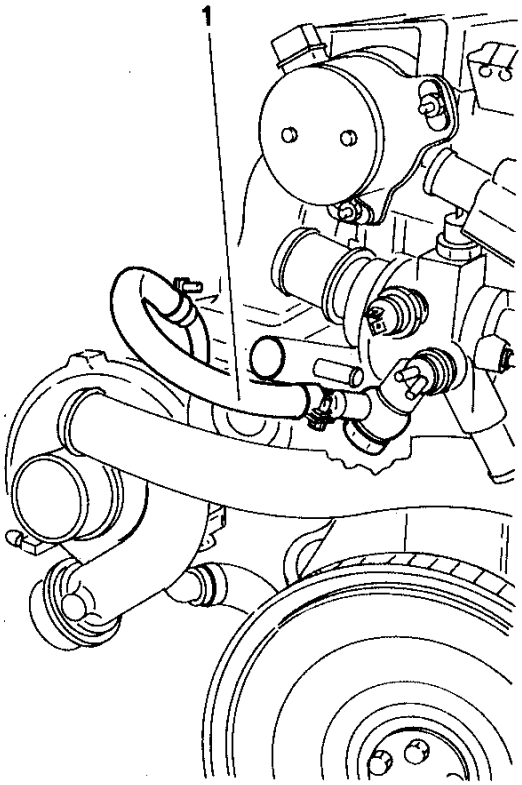


1. Remove the guide and relative engine oil dipstick

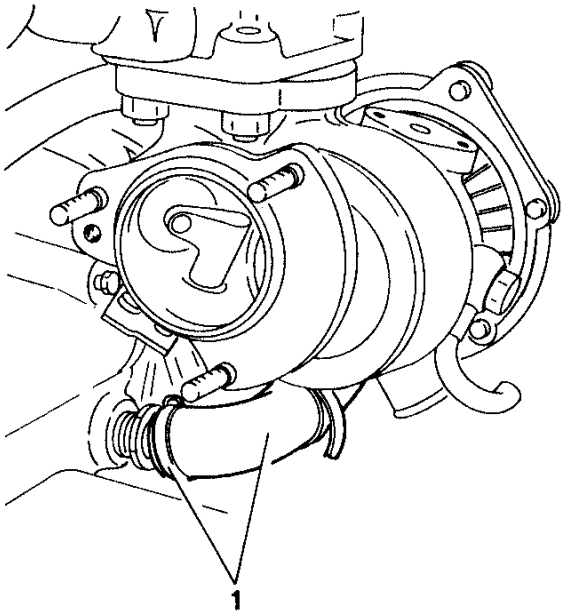


REMOVAL OF TURBOCHARGER

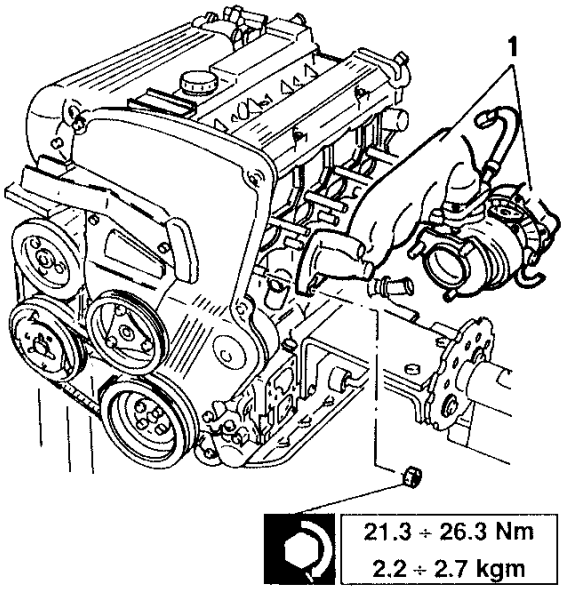
1. Disconnect the connector of the coolant return tube to the turbocharger from the thermostatic cup.



1. Loosen the clamp and disconnect the oil return tube to the turbocharger from the engine block.

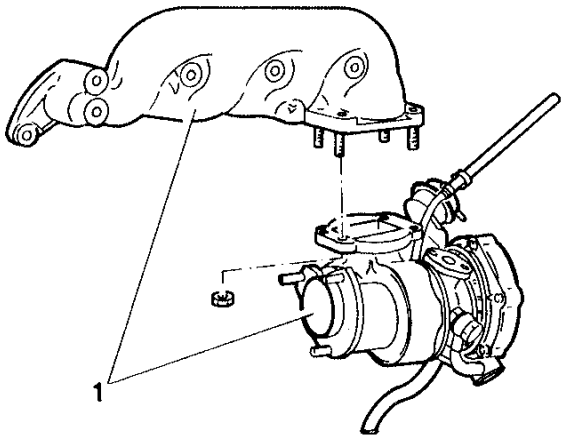


1. Unscrew the bolts securing the exhaust manifold to the cylinder heads and remove it complete with turbocharger.

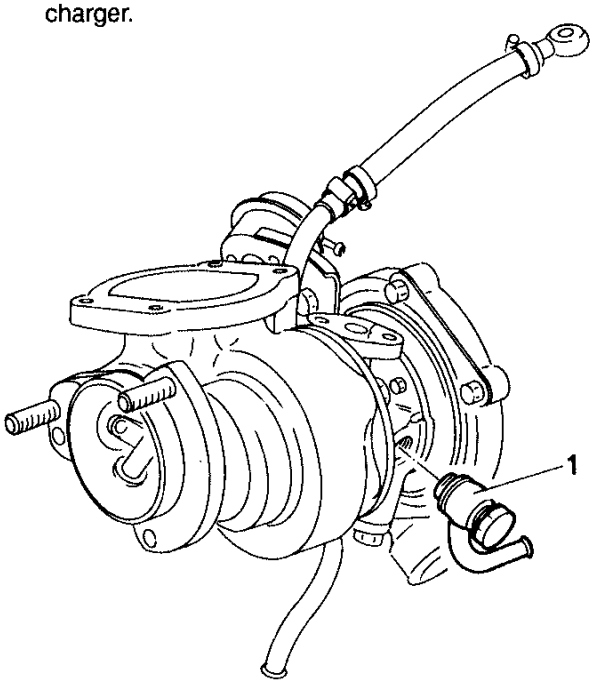


DISASSEMBLY OF TURBOCHARGER

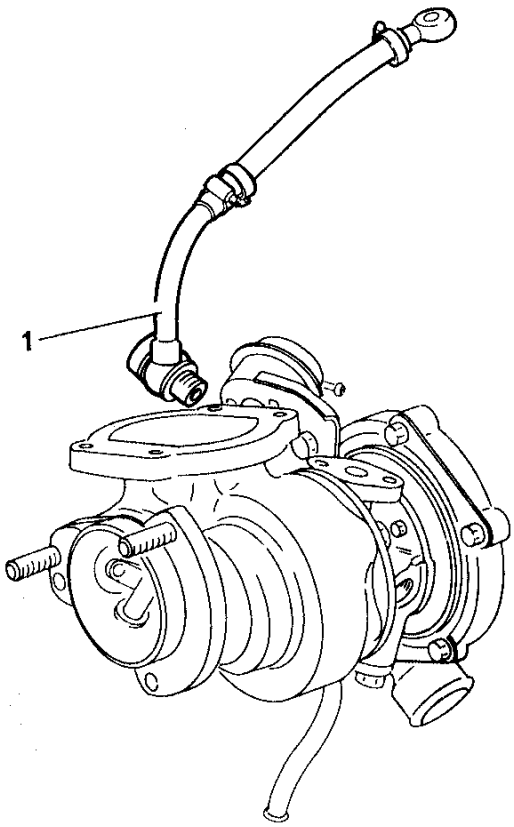
1. Unscrew the bolts and separate the exhaust manifold from the turbocharger.



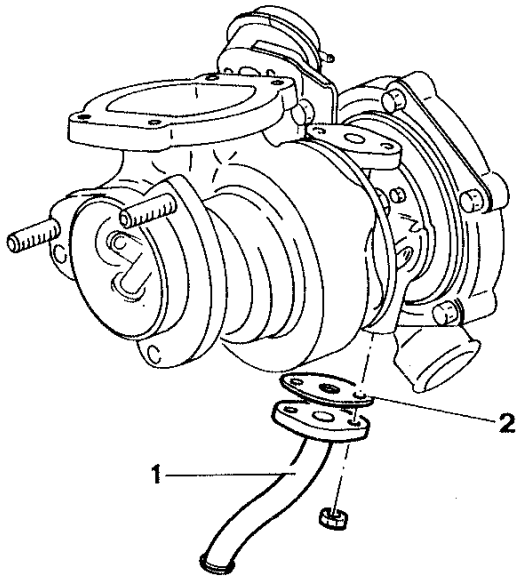
1. Remove the coolant intake union from the turbocharger.



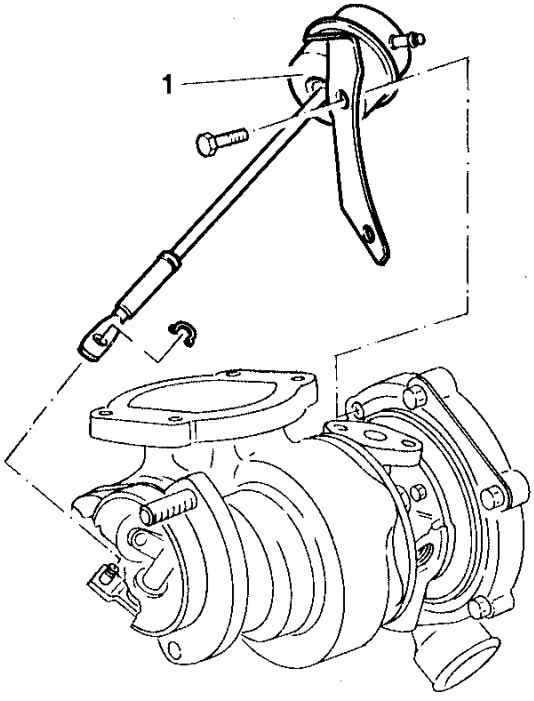
1. Remove the coolant outlet union from the turbocharger.



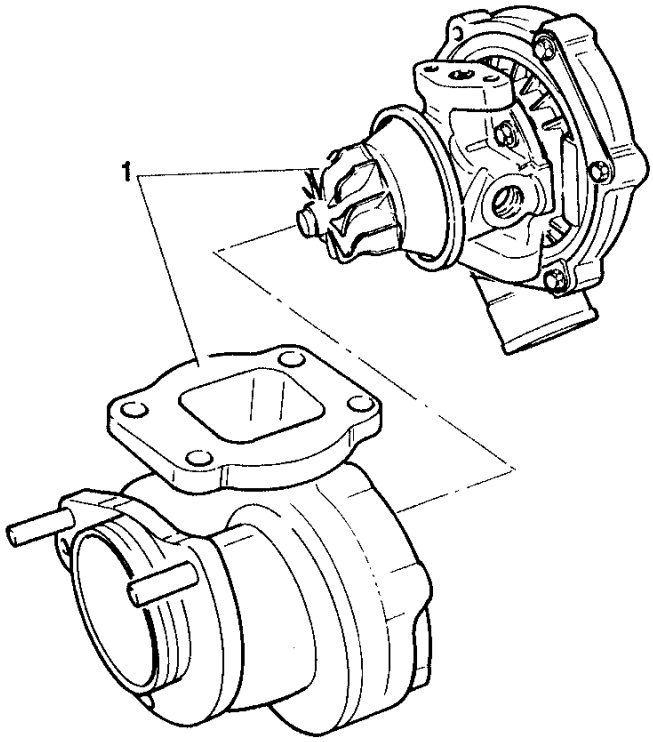
1. Remove the engine oil outlet union from the turbo-charger.
2. Remove the gasket.



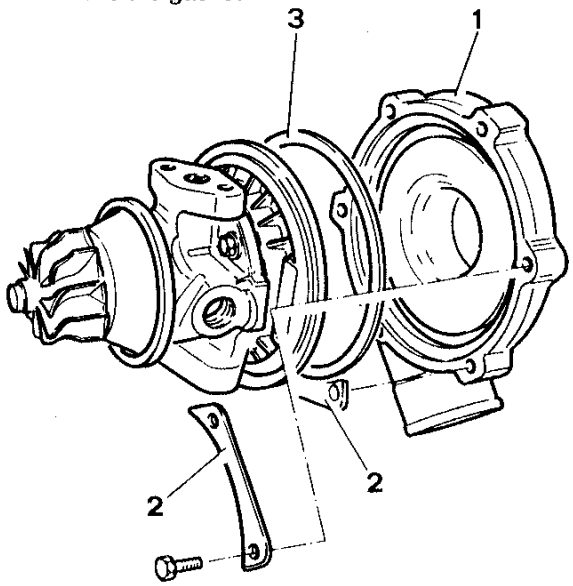
1. Remove the "WASTE-GATE" overpressure valve actuator after having disconnected the control rod.



1. Unscrew the screws and remove the turbine body.

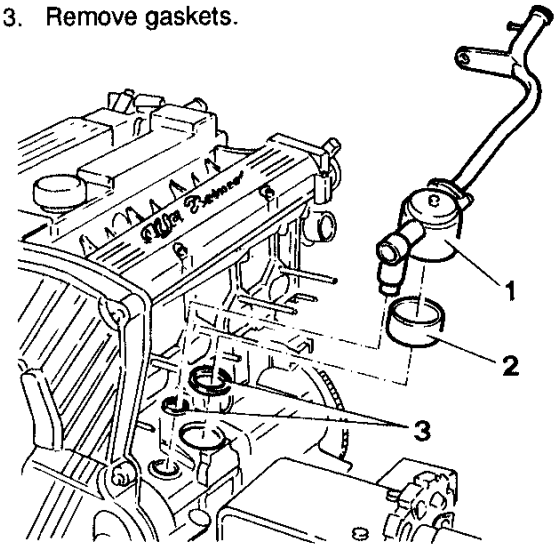


1. Unscrew the screws and remove the compressor body.
2. Recover the plates.
3. Remove the gasket.



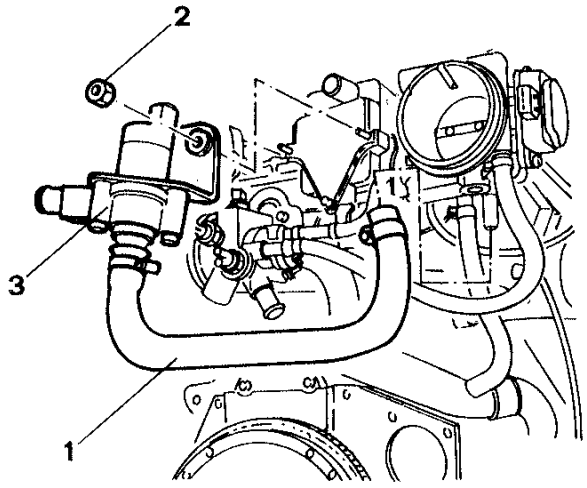
REMOVAL OF OIL VAPOUR SEPARATORS

1. Removal of oil vapour separator complete with tubing.
2. Remove cap.
3. Remove gaskets.

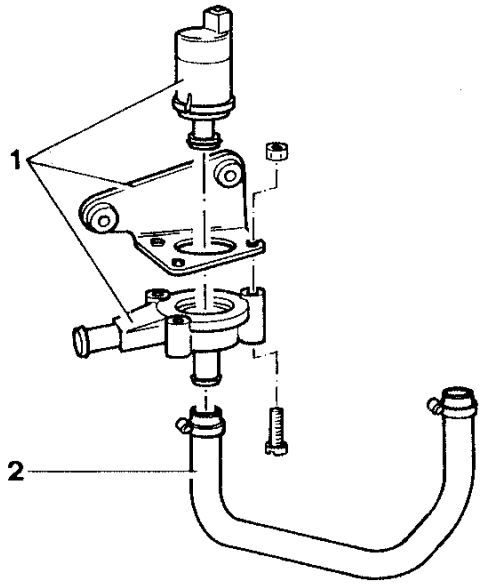


REMOVAL OF CONSTANT IDLE SPEED ACTUATOR

1. Disconnect the constant idle speed actuator air by-pass tube from the throttle body.
2. Unscrew the bolts securing the constant idle speed actuator support bracket.
3. Remove the constant idle speed actuator complete with bracket and air by-pass tube.

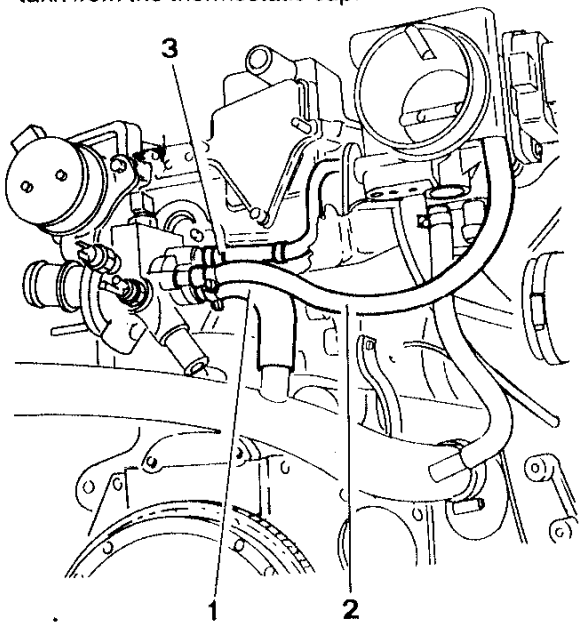


1. Unscrew the screws and separate the constant idle speed actuator from the support bracket and the by-pass union.
2. Remove the by-pass tube.

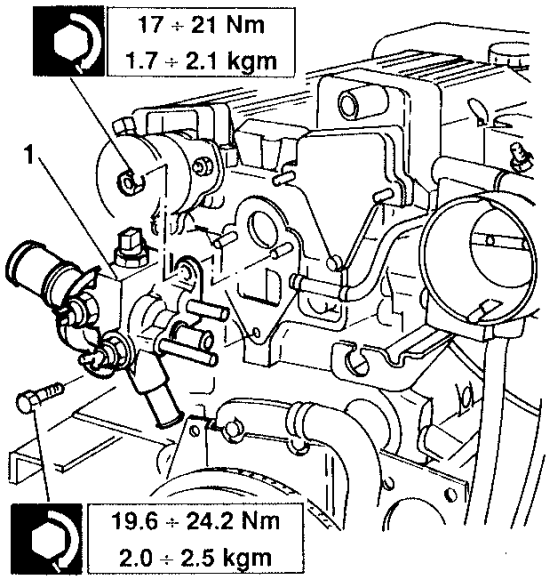


REMOVAL OF THE THERMOSTATIC CUP

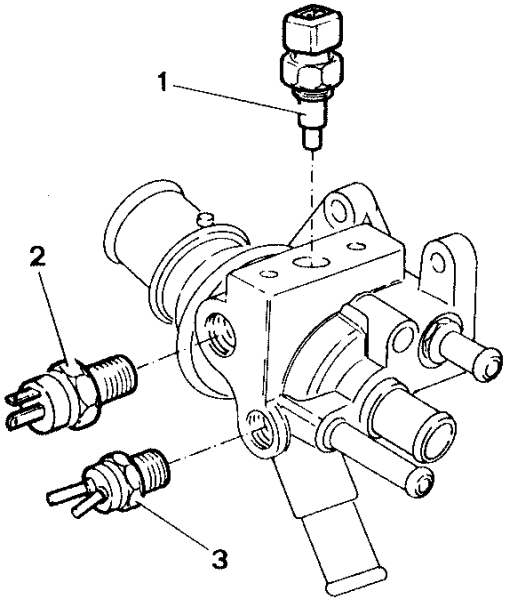
1. Disconnect the coolant return tube to the pump from the thermostatic cup
2. Disconnect the coolant delivery tube to the throttle body from the thermostatic cup.
3. Disconnect the water return tube to the expansion tank from the thermostatic cup.



1. Remove the complete thermostatic cup.

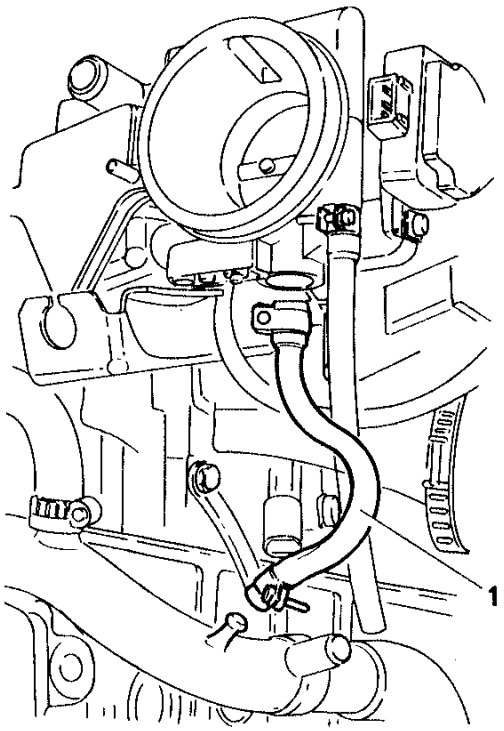


1. Remove the engine coolant temperature sensor (NTC) from the thermostatic cup.
2. Remove the engine coolant temperature indicator transmittor and the maximum temperature warning light sensor from the thermostatic cup.
3. Remove the thermovalve from the E.G.R. system.

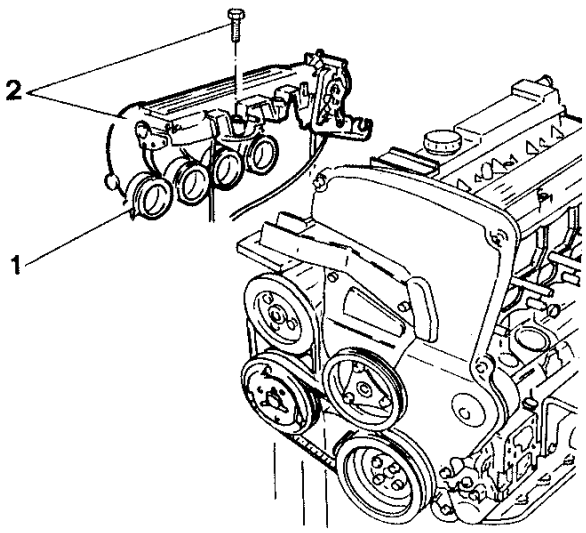


REMOVAL OF AIR INTAKE BOX

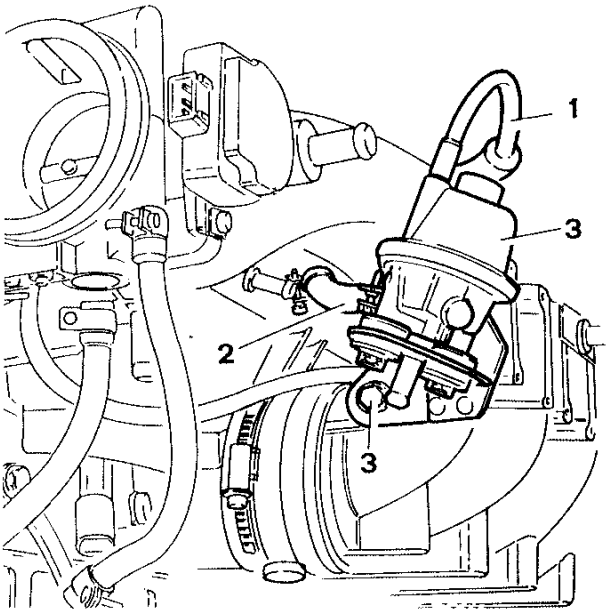
1. Disconnect the liquid from throttle body outlet tube from the coolant liquid return manifold to the pump.



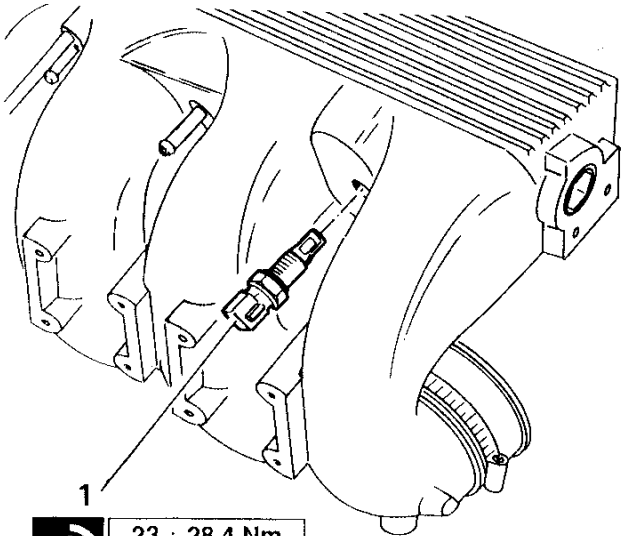
1. Loosen the clamps of the connection sleeves of the air intake box to the intake manifold.
2. Unscrew the screws securing the cylinder heads and remove the complete air intake box.



1. Disconnect the vacuum intake tube from the fuel pressure regulator.
2. Disconnect the fuel delivery tube from the fuel pressure regulator.
3. Unscrew the screws securing the air intake box and remove the pressure regulator complete with brackets.

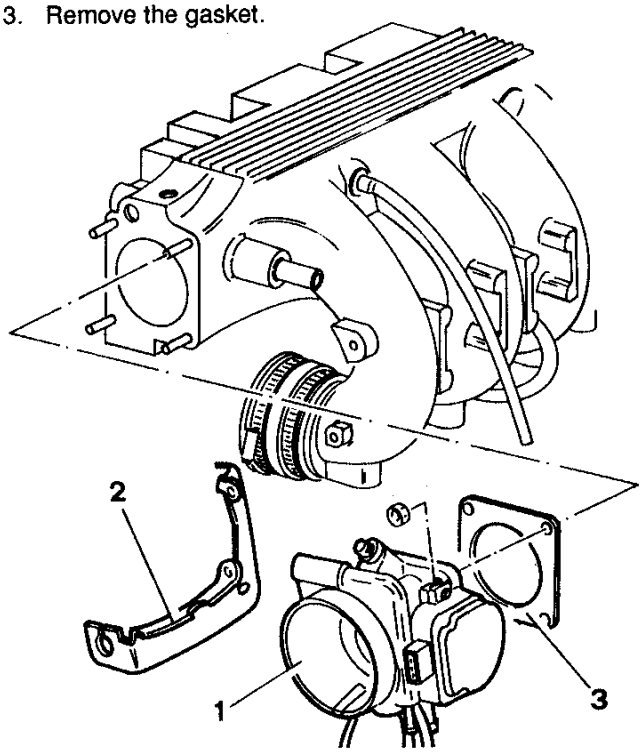


1. Remove the intaken air temperature sensor from the air intake box.

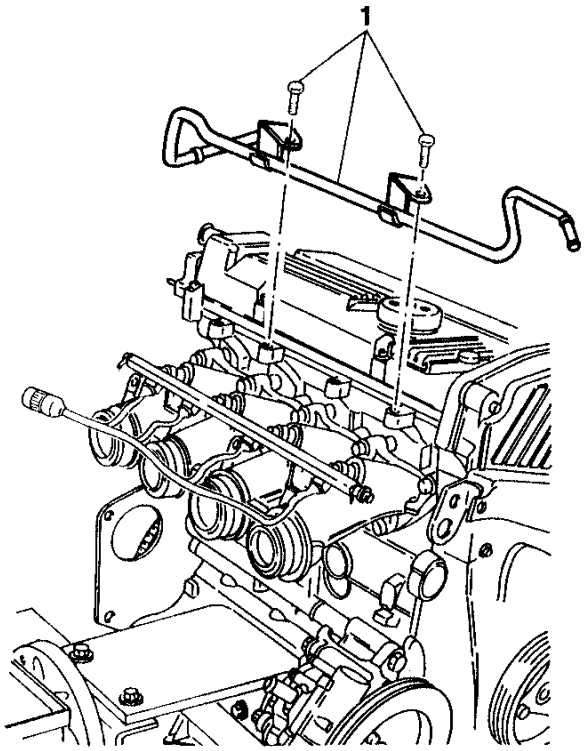


23 ÷ 28.4 Nm
2.3 ÷ 2.9 kgm

1. Remove the throttle body complete with potentiometer from the air intake box.
2. Remove the accelerator cable support bracket.
3. Remove the gasket.

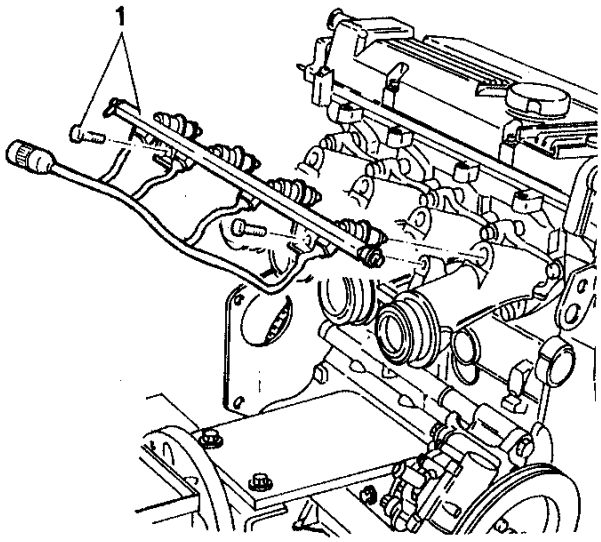


1. Unscrew the screws and remove the coolant return rigid tube to the expansion tank.

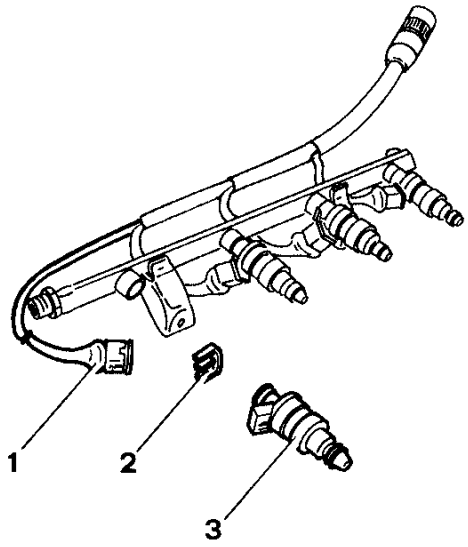


REMOVAL OF ELECTROINJECTORS

1. Unscrew the screws and remove the fuel distribution manifold complete with electroinjectors.

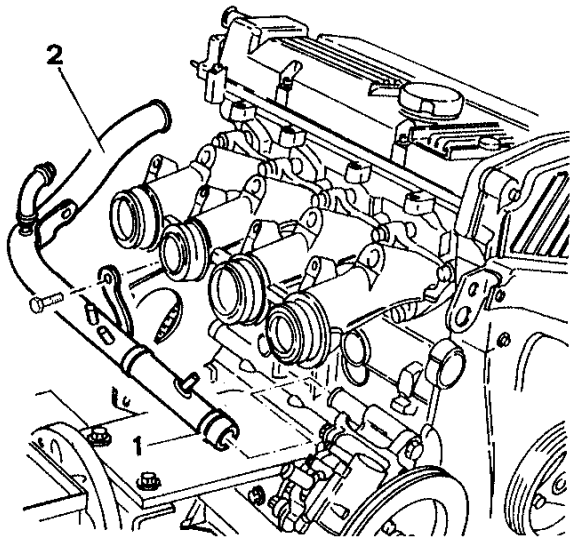


1. Disconnect the electrical connections from the electroinjectors.
2. Extract the spring securing the electroinjectors to the distribution manifold.
3. Remove the electroinjectors.

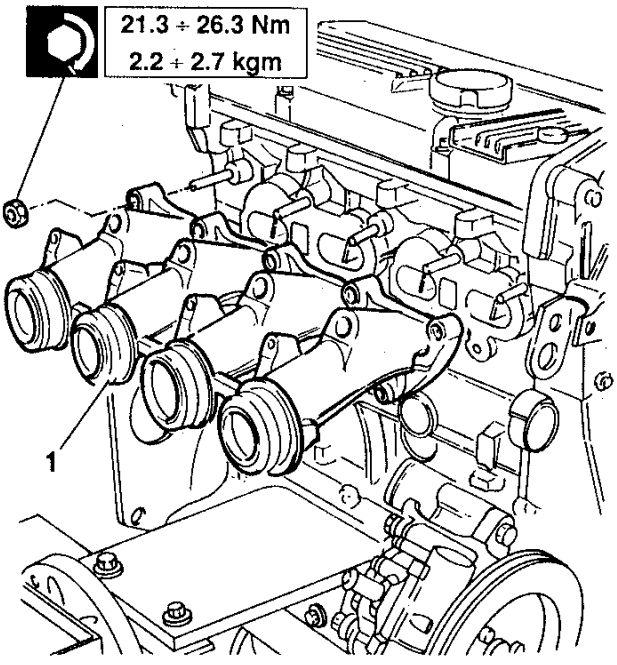


REMOVAL OF COOLANT INTAKE MANIFOLD

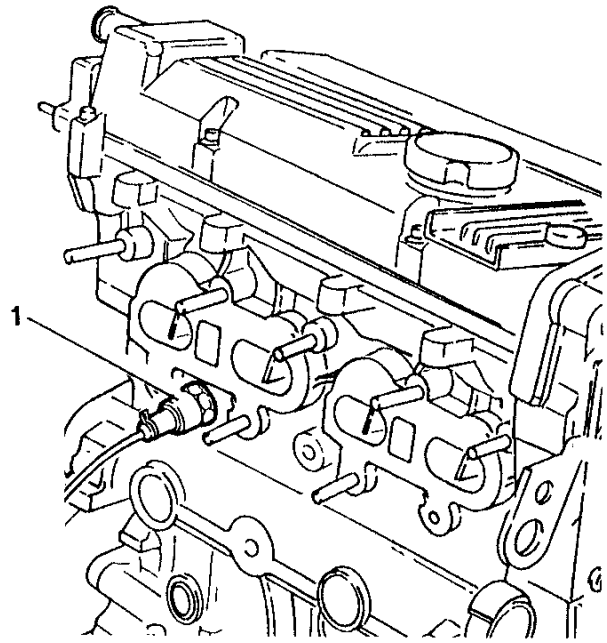
1. Loosen the clamp of the coolant return manifold to the pump.
2. Unscrew the screws and remove the coolant return manifold to the pump.



1. Remove the intake manifold complete with earth segments.

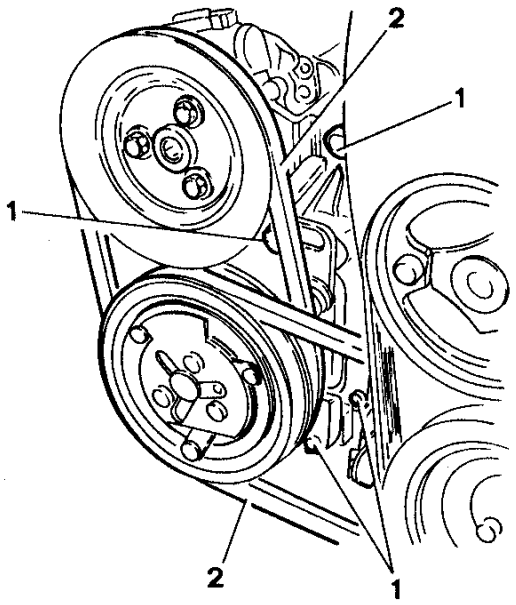


1. Remove the knock sensor.

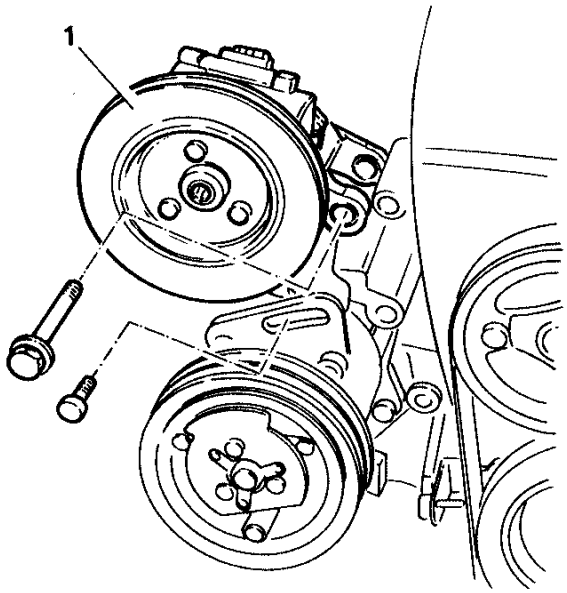


REMOVAL OF POWER STEERING PUMP AND AIR CONDITIONING COMPRESSOR

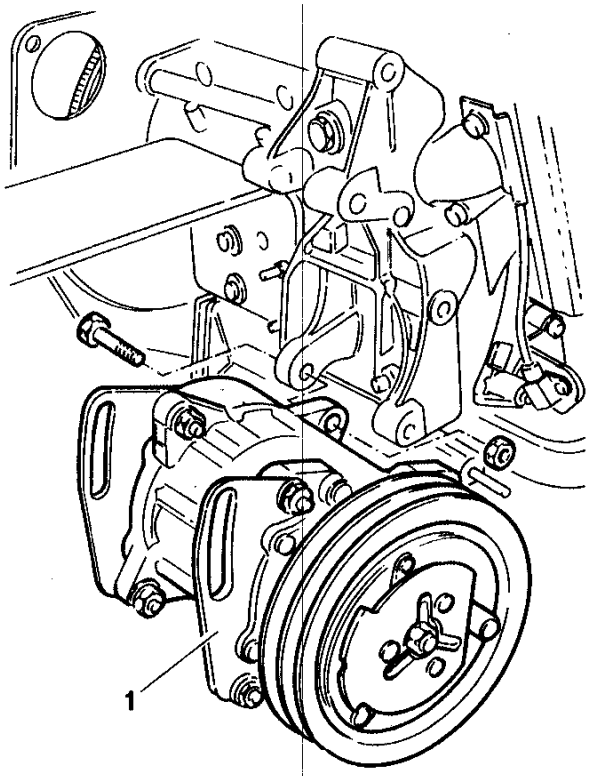
1. Loosen the screws of the air conditioning compressor and the power steering pump.
2. Extract and remove compressor control belt and power steering control belt.



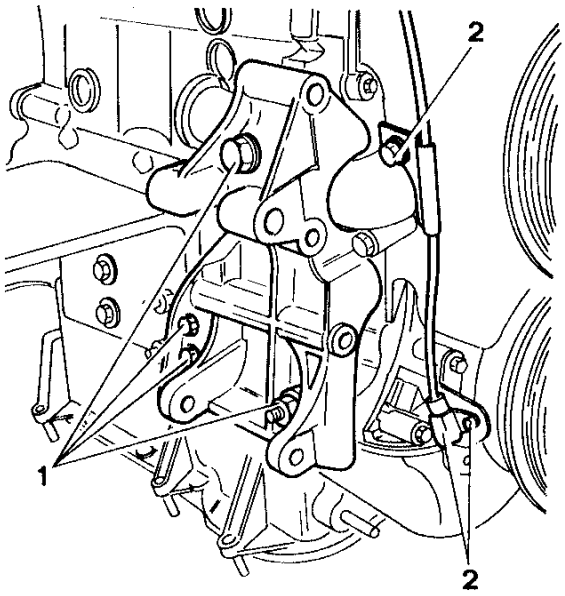
1. Unscrew completely the screws and bolts of the power steering pump loosened beforehand and remove it.



1. Unscrew completely the upper screws and the two lower bolts loosened beforehand and remove the air conditioning compressor.

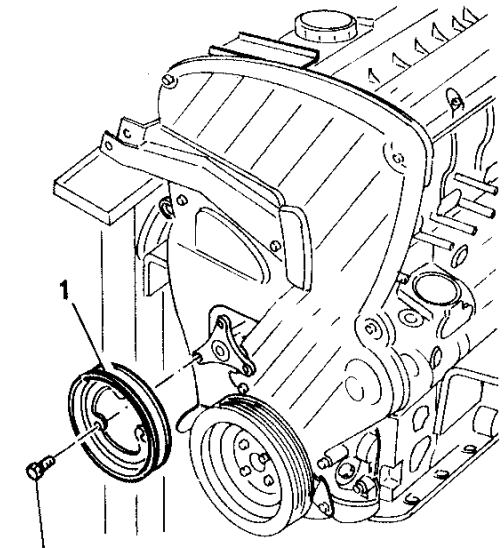


1. Unscrew the screws and nuts of the power steering pump and compressor support bracket and remove it.
2. Unscrew the screws and remove revs sensor and T.D.C.



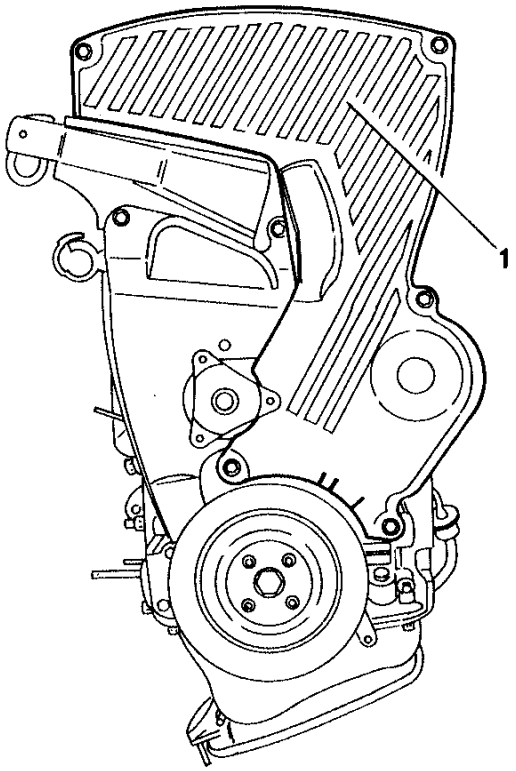
REMOVAL OF TIMING COVERS

1. Remove the water pump control pulley.

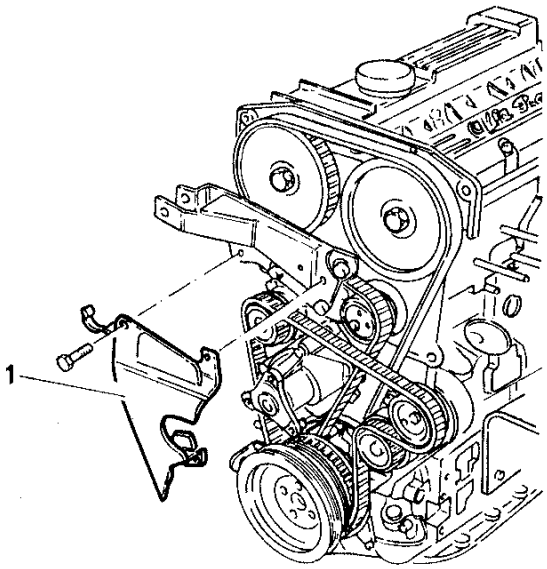


21.3 ÷ 26.3 Nm
2.2 ÷ 2.7 kgm

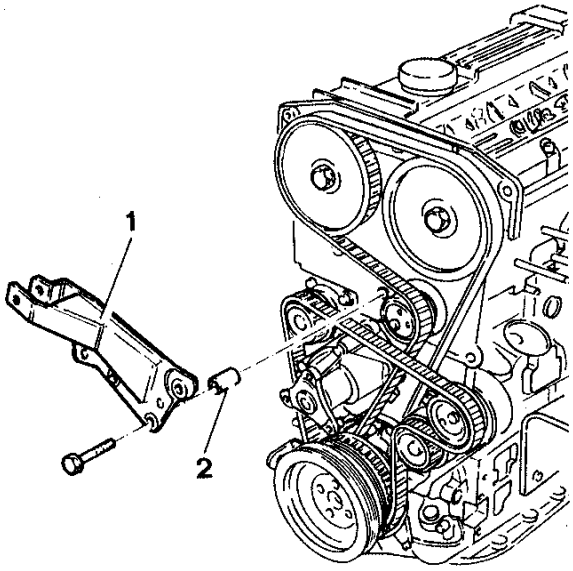
1. Remove the timing belt and countershafts cover.



1. Remove the timing belt and countershafts metal cover.

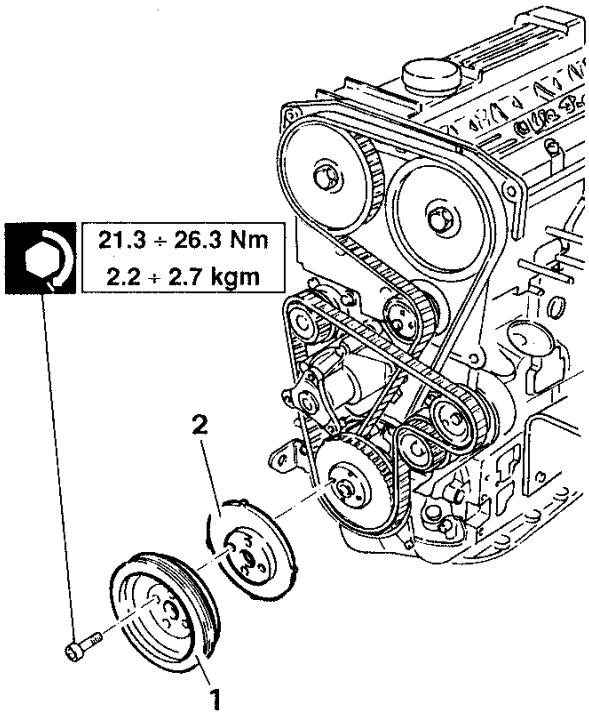


1. Remove the engine damping rod support bracket.
2. Recover the spacers.

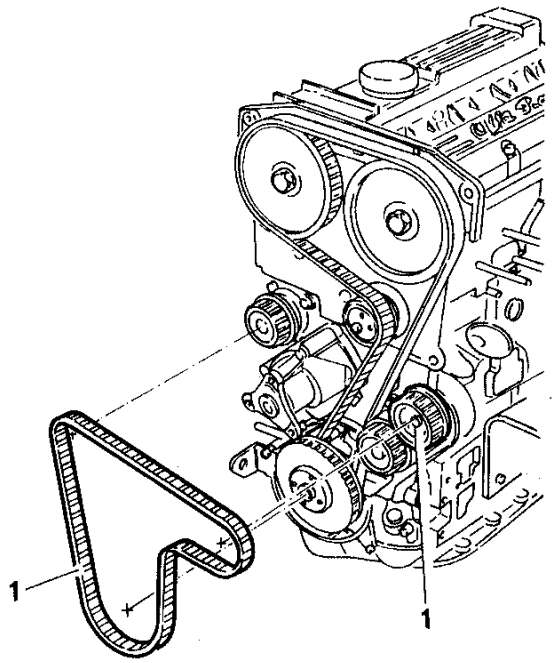


REMOVAL OF COUNTERSHAFTS CONTROL BELT

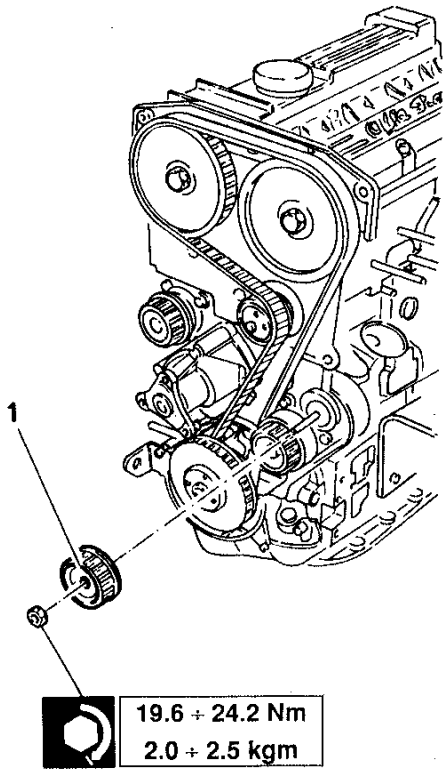
1. Remove the auxiliary parts control pulley.
2. Remove the phonic wheel of the revs sensor and T.D.C.



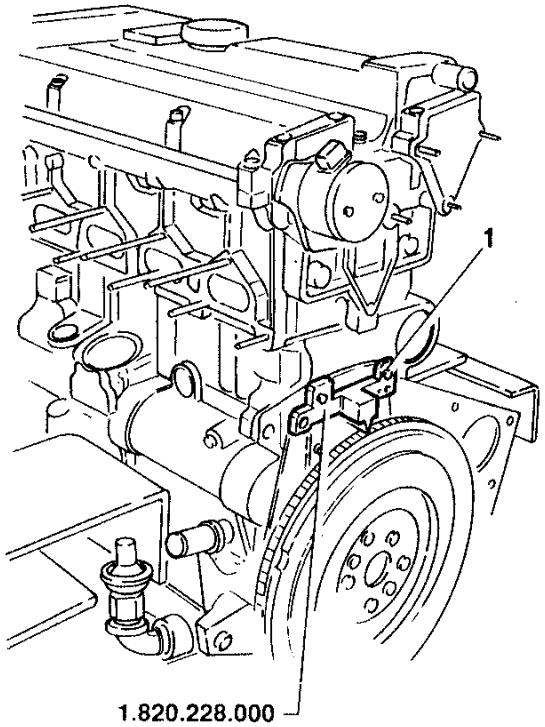
1. Loosen the belt stretcher and remove the countershaft control belt.



1. Remove the countershaft belt stretcher.

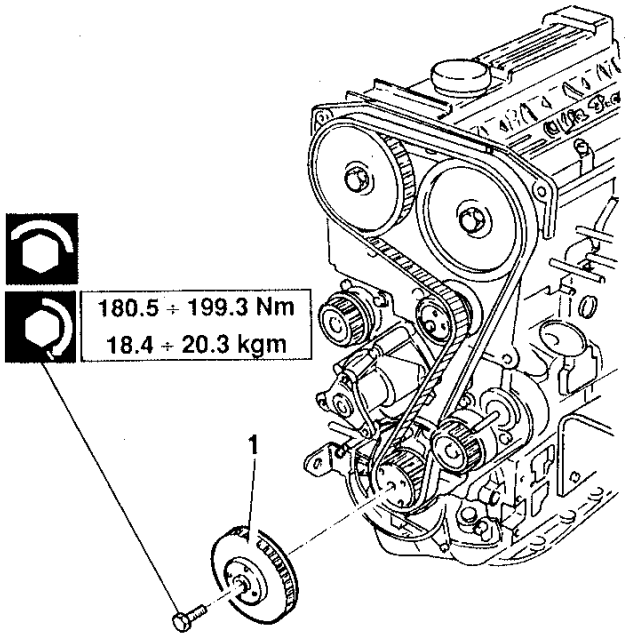


1. Assemble tool N° 1.820.228.000 to stop the flywheel from rotating.



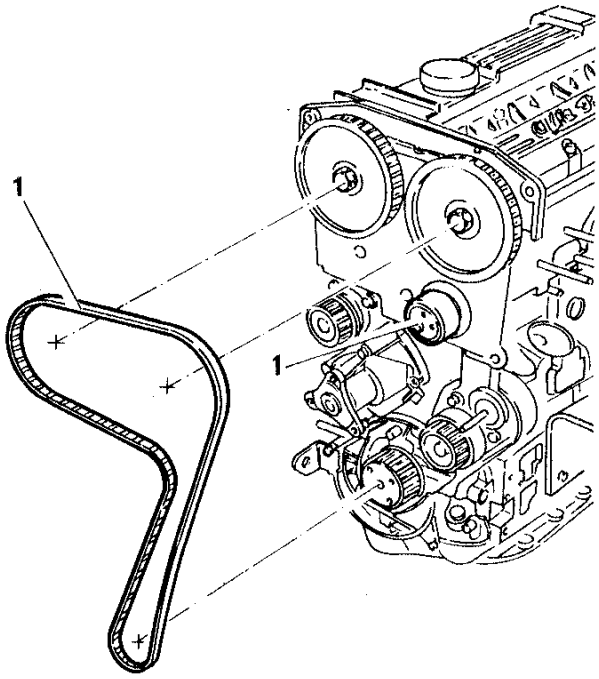
1. Remove the countershaft control belt pulley.

– Remove tool N° 1.820.228.000 blocking the flywheel assembled previously.

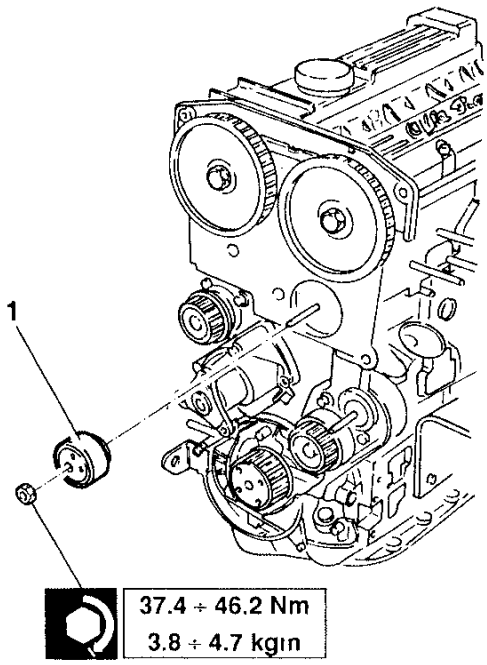


REMOVAL OF TIMING CONTROL BELT

1. Loosen the beltstretcher and remove the timing belt.

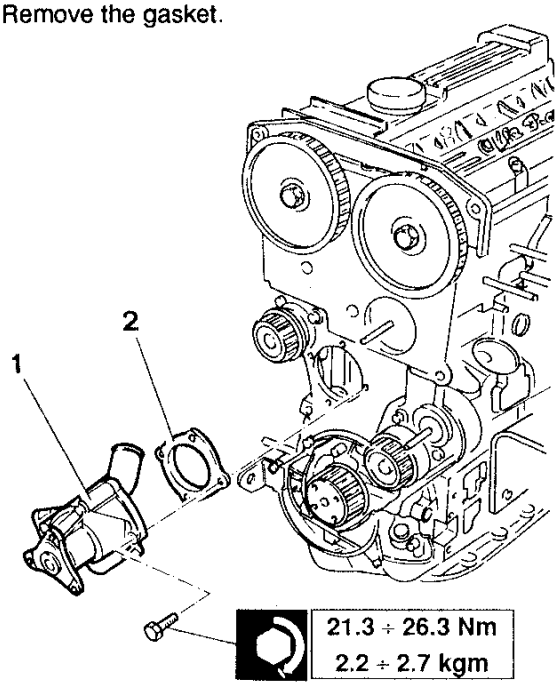


1. Remove the timing beltstretcher.



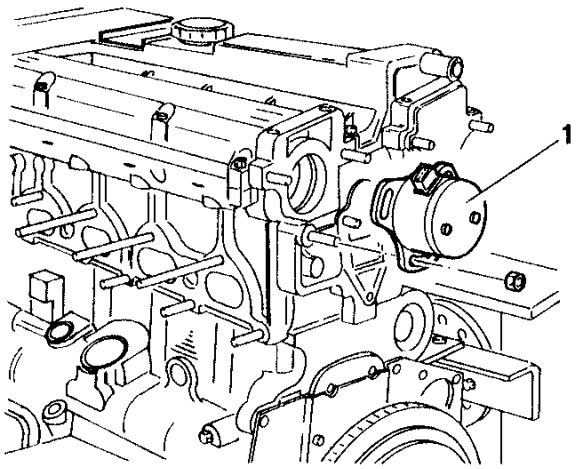
REMOVAL OF WATER PUMP

1. Remove the water pump complete with intake manifold.
2. Remove the gasket.

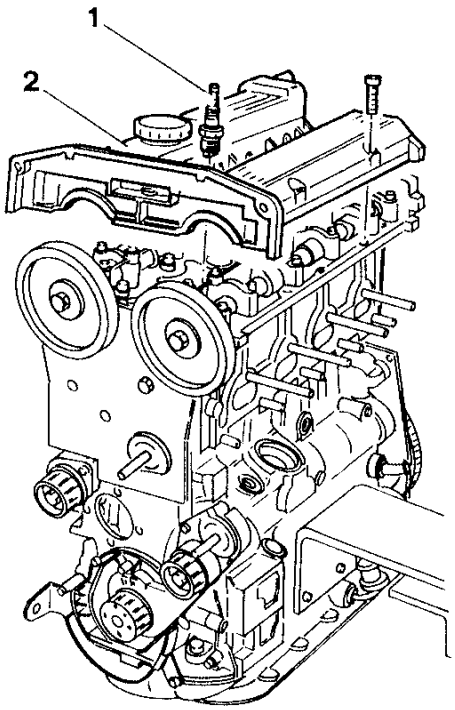


REMOVE TIMING COVER

1. Remove stroke sensor.

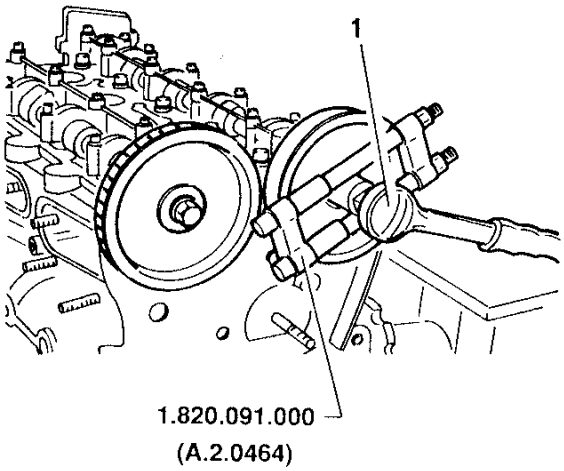


1. Remove sparkplugs.
2. Remove the timing cover complete with gasket.

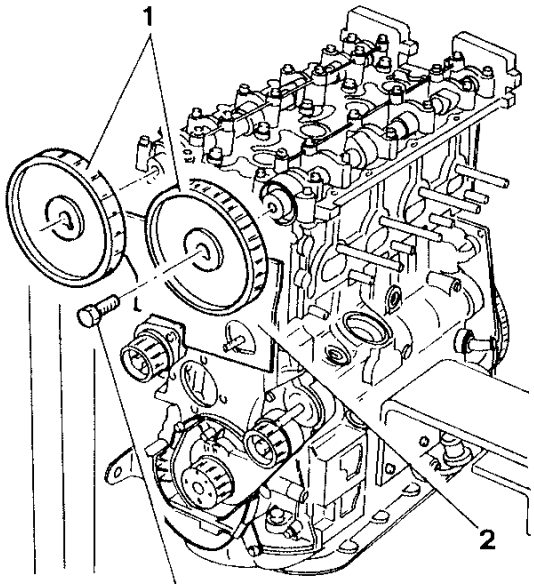


REMOVAL OF TIMING PULLEY

1. Using tool N° 1.820.091.000 (A.2.0464) unblock the screws of the two camshaft control pulleys.



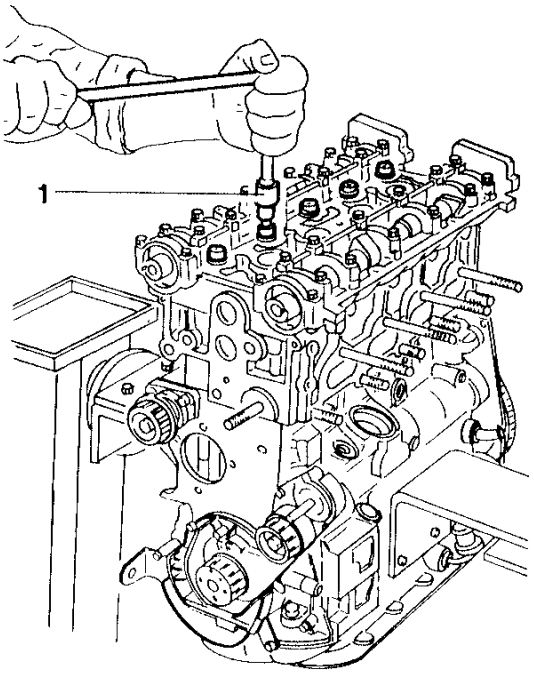
1. Remove the two camshaft control pulleys.
2. Recover rear cover.



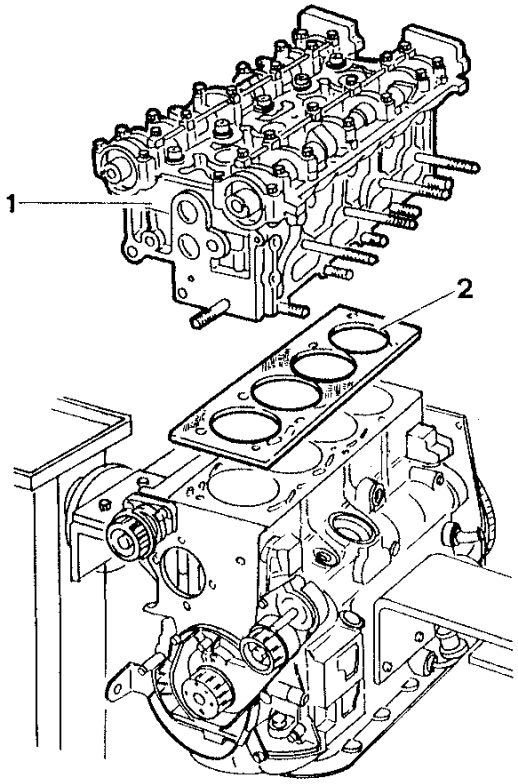
100.3 ÷ 123.9 Nm
10.2 ÷ 12.6 kgm

REMOVAL OF CYLINDER HEADS

1. Unscrew the screws securing the cylinder heads to the engine block.



1. Remove cylinder heads.
2. Remove gasket.

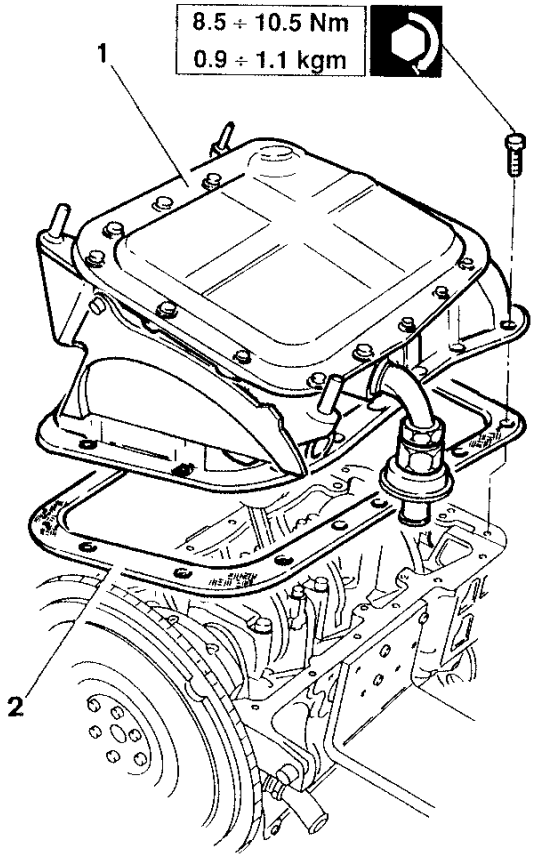


To refit the cylinder heads follow the indications contained in the relative paragraph.

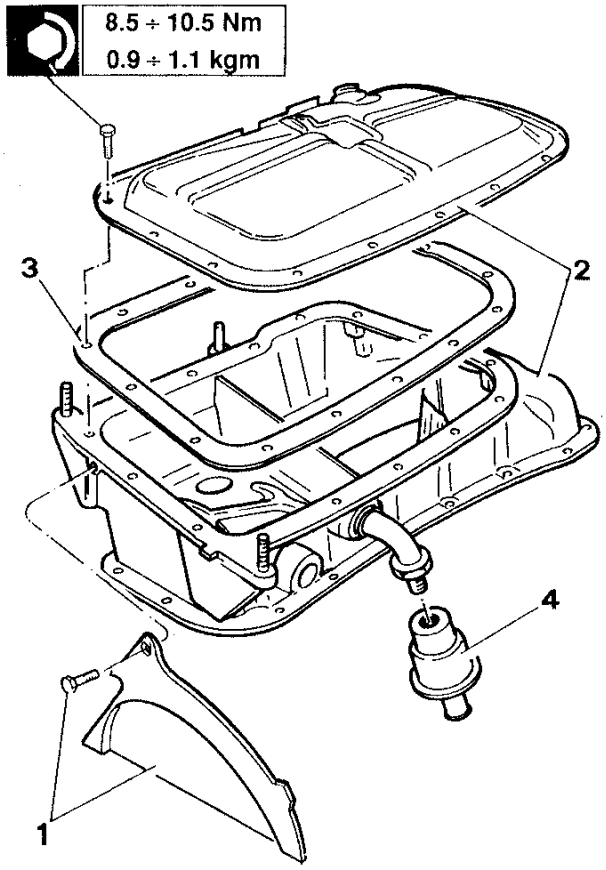
REMOVAL OF OIL SUMP

– Unblock the rotating work stand and rotate the engine base by 180°.

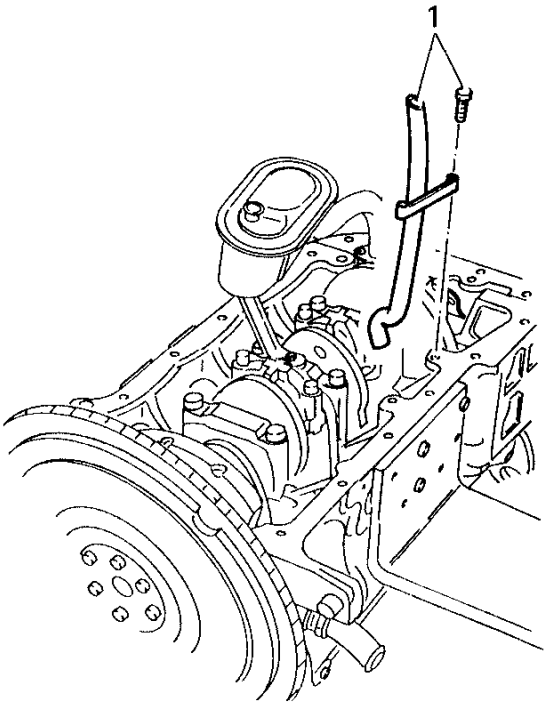
1. Unscrew the screws and remove the complete oil sump.
2. Remove the gasket.



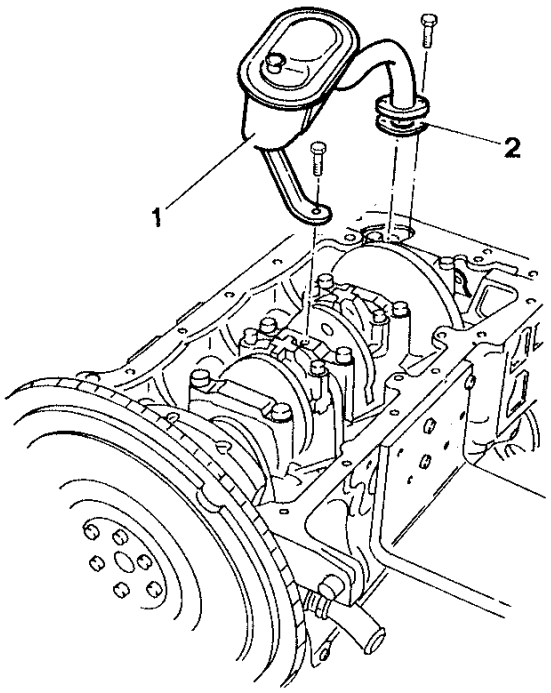
1. Unscrew the screws and remove the lower flywheel protection.
2. Unscrew the screws and disassemble the oil sump from the sump protection.
3. Remove the gasket.
4. Remove the single direction valve.



1. Remove the engine oil level dipstick guide tube.



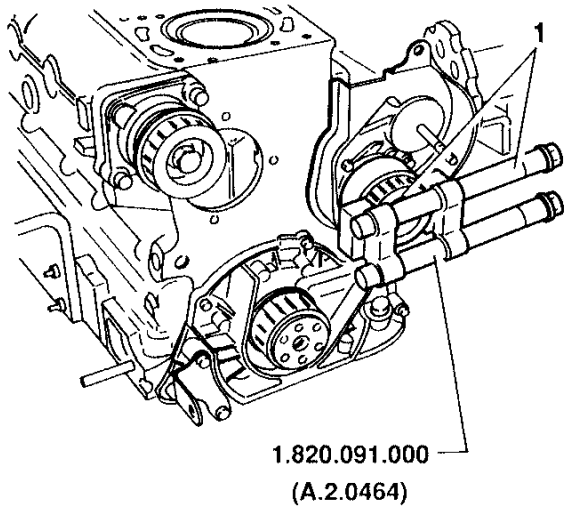
1. Remove the oil pump suction device.
2. Remove the gasket.



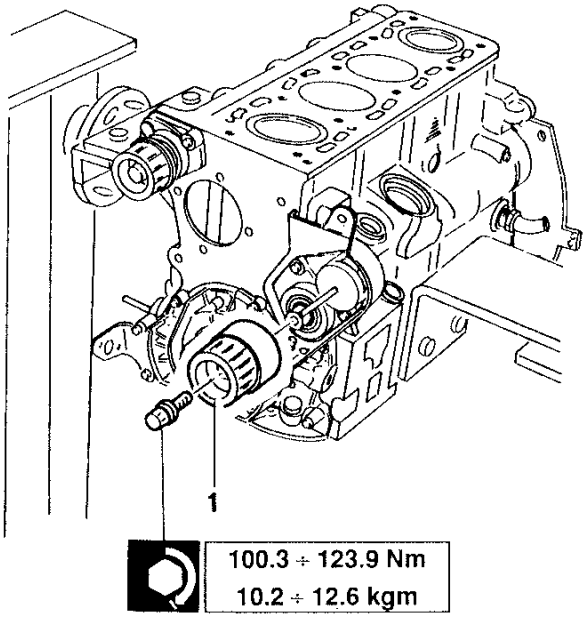
REMOVAL OF THE COUNTERSHAFT CONTROL PULLEYS

– Unblock the rotating work stand and rotate the engine block by 180°.

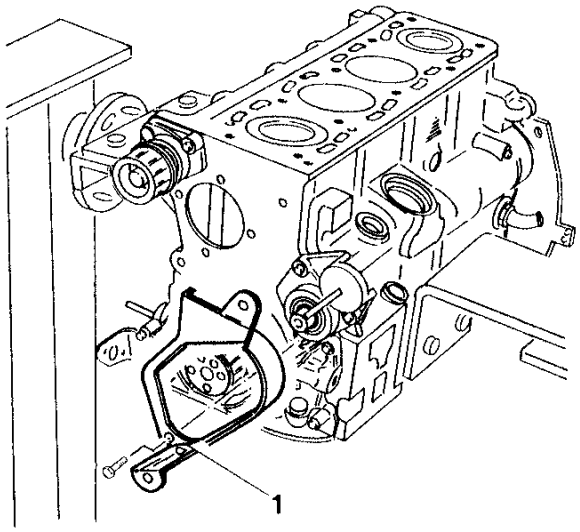
1. Using tool N° 1.820.091.000 (A.2.0464) unblock the screws of the countershafts control pulley exhaust side.



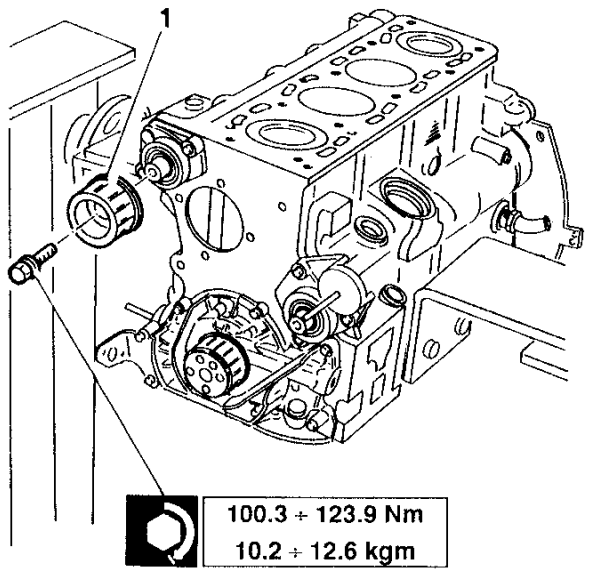
1. Remove the countershaft pulley exhaust side.



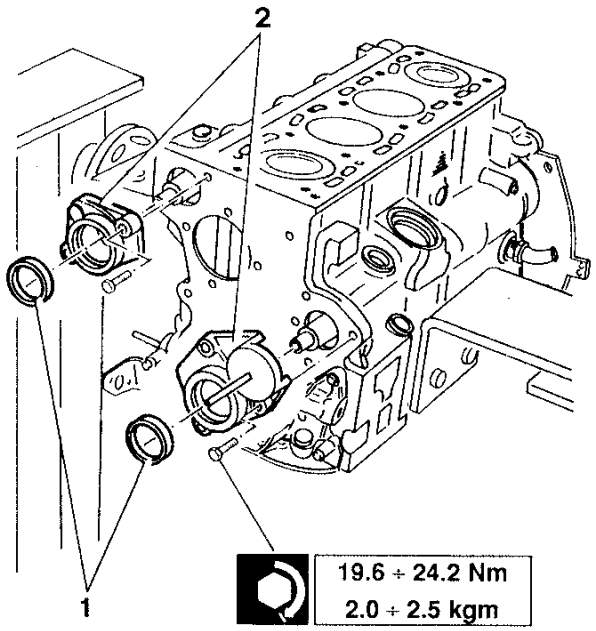
1. Remove the internal cover of the countershaft control belt.



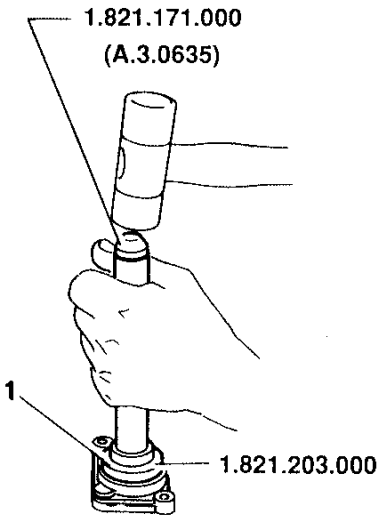
1. Using tool N° 1.820.091.000 (A.2.0464) remove the countershaft control pulley intake side.



1. Remove the countershaft oil seal rings.
2. Remove the front covers of the countershafts.

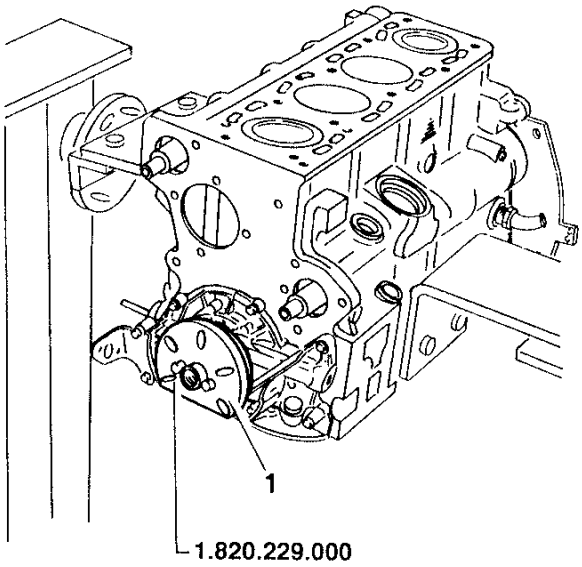


1. To reaasemble the oil seal rings use tools N° 1.821.171.000 (A.3.0635) and N° 1.821.203.000.

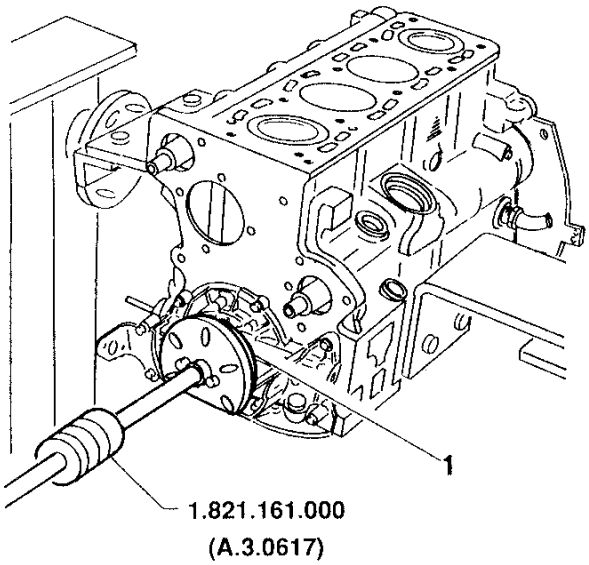


REMOVAL OF TIMING CONTROL PULLEY

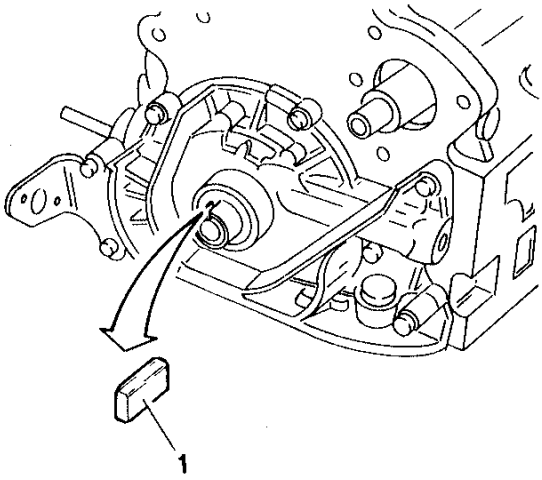
1. Assemble tool N° 1.820.229.000 on the camshaft control pulley.



1. Using ram N° 1.821.161.000 (A.3.0617), remove the timing control pulley.

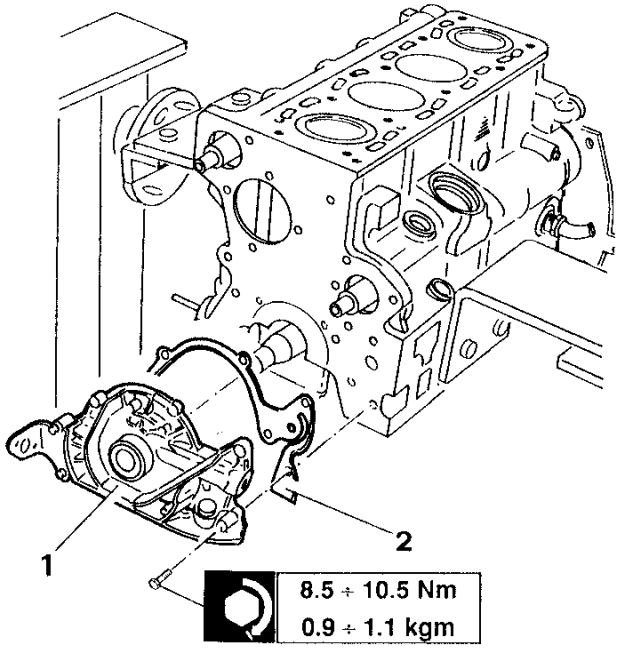


1. Remove the key from the timing control pulley.



REMOVAL OF FRONT ENGINE COVER

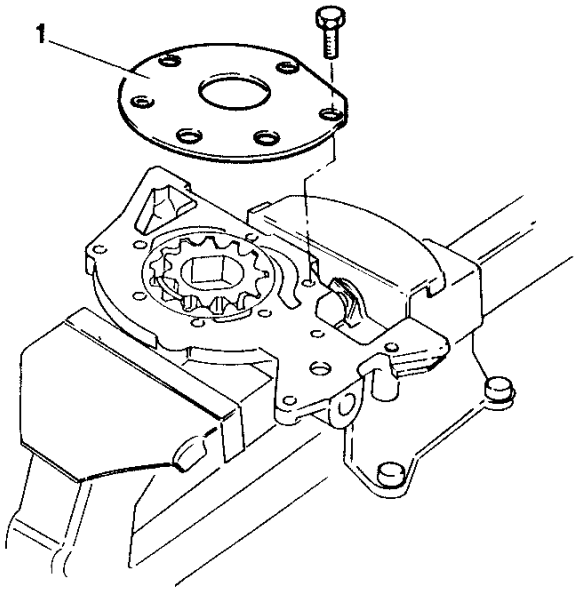
1. Unscrew the screws and remove the front engine cover complete with oil pump.
2. Remove the gasket.



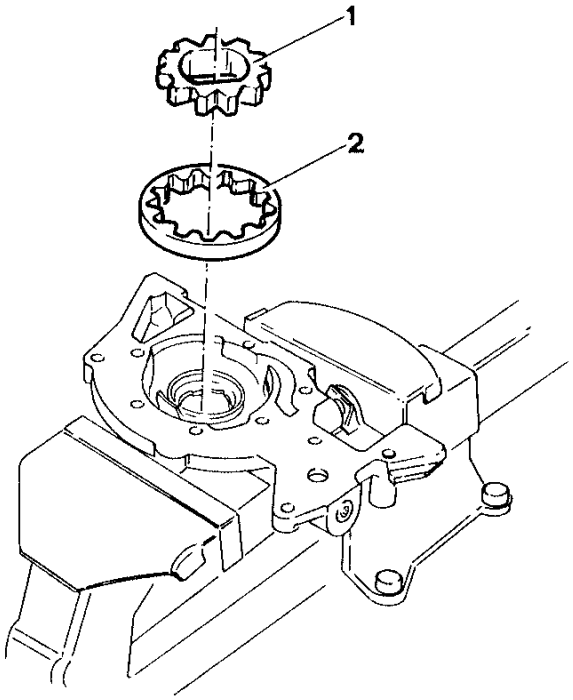
DISASSEMBLY OF OIL PUMP

– Position the front engine cover in a vice with protective jaws.

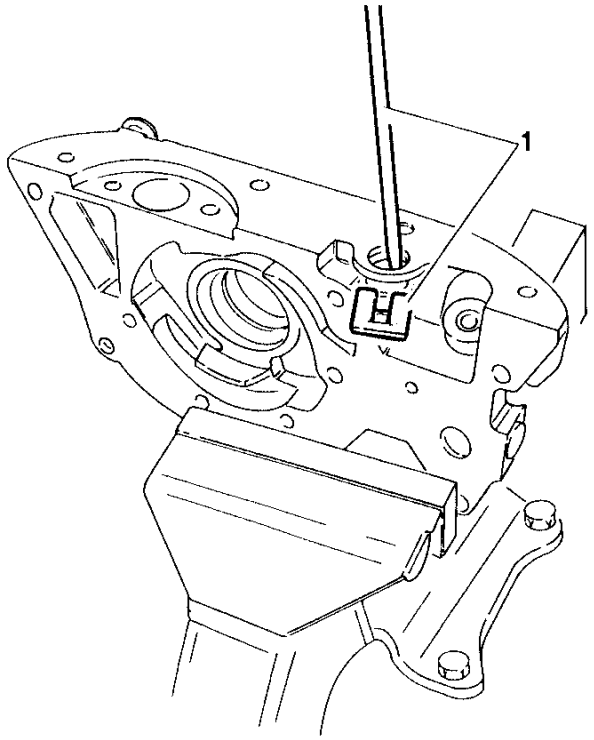
1. Unscrew the screws and remove the cover.



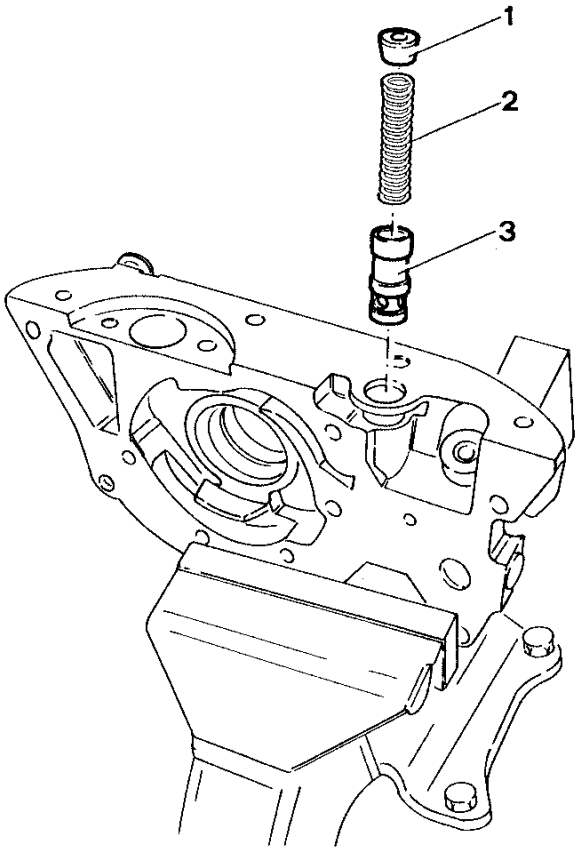
1. Remove the driving gear.
2. Remove the driven gear.



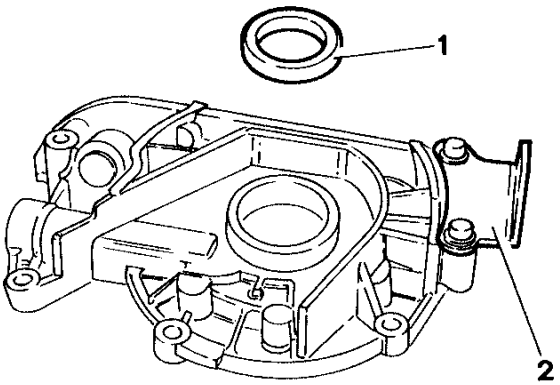
1. Press the oil pressure relief valve with a suitable punch and extract the stop plate.



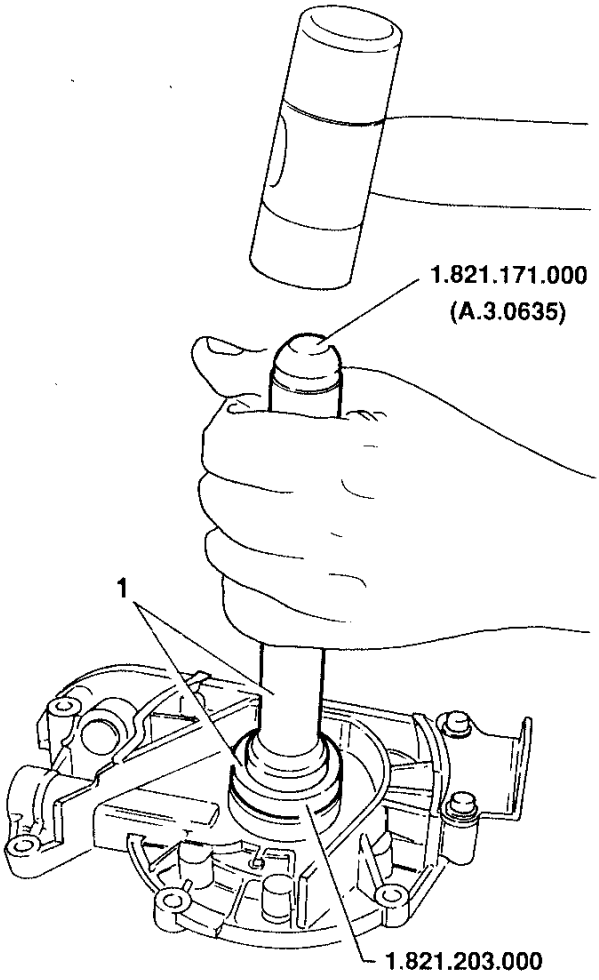
1. Remove the spring hood.
2. Remove the spring.
3. Remove the valve box



1. Remove the oil seal ring from the front engine cover.
2. If necessary remove the revs sensor support and T.D.C.
   For a correct positioning during reassembly see GROUP 04 - "REVS SENSOR AND T.D.C."

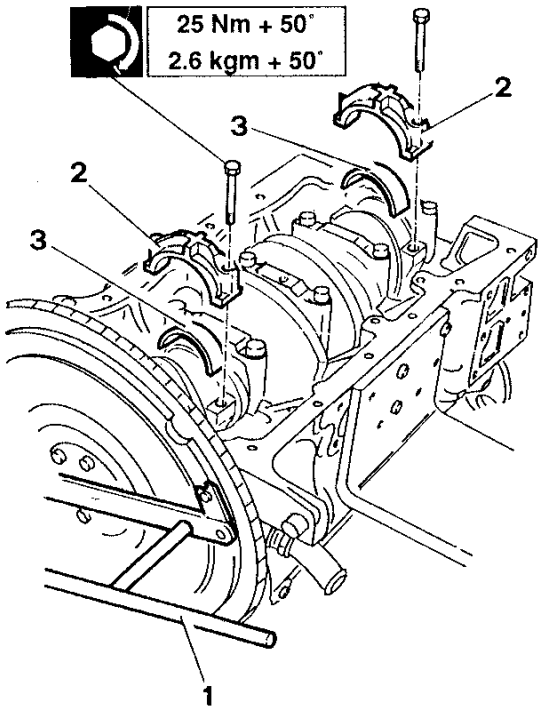


1. To reassemble the oil seal ring on the front engine cover use tools N° 1.821.171.000 (A.3.0635) and N° 1.821.203.000.

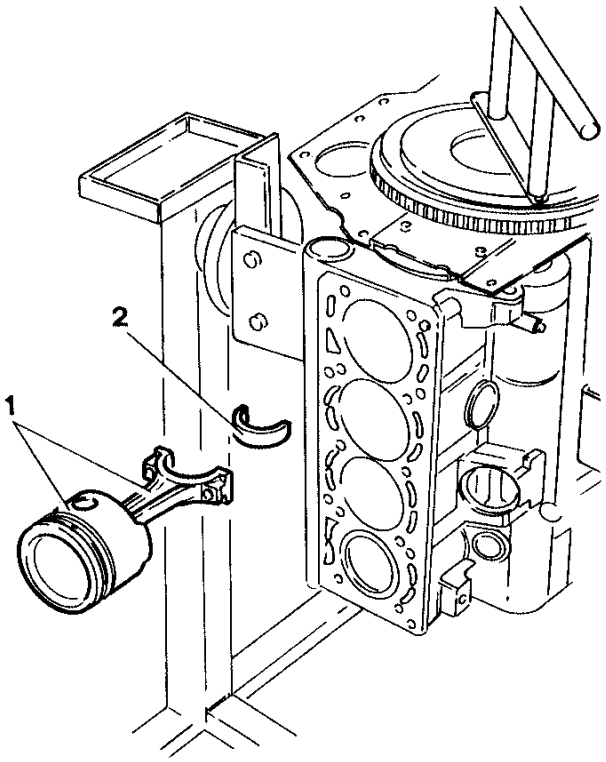


REMOVAL OF PISTONS AND RODS

1. Assemble a suitable tool on the flywheel which allows the crankshaft to be rotated.
– Rotate the engine block by 180°.
– Rotate the crankshaft so that the first and fourth pistons are at B.D.C.
2. Remove the rod caps from the first and fourth pistons.
3. Remove the relative rod bearing halves.

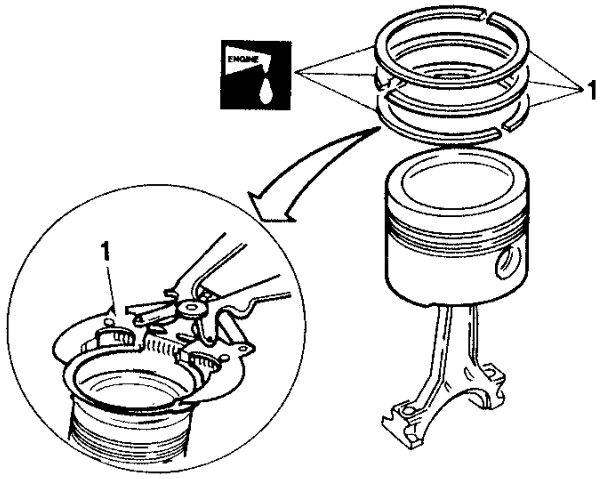


– Rotate the engine block by 90°.
1. Extract the pistons and rods from the first and fourth cylinders.
2. Remove the relative rod bearing halves.
– Proceed in the same way for the second and third cylinders.

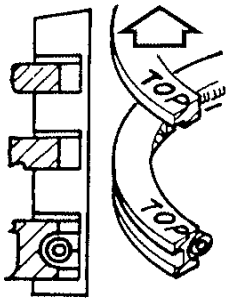


1. Using a suitable tool extract the seal rings and the scraper rings from the piston.

CAUTION:
Proceed with care to avoid accidental damage to re-usable rings.

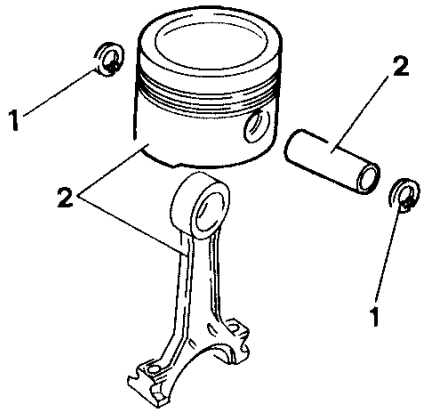


During reassembly position the seal rings so that the wording «TOP», printed on the rings themselves, faces upwards.



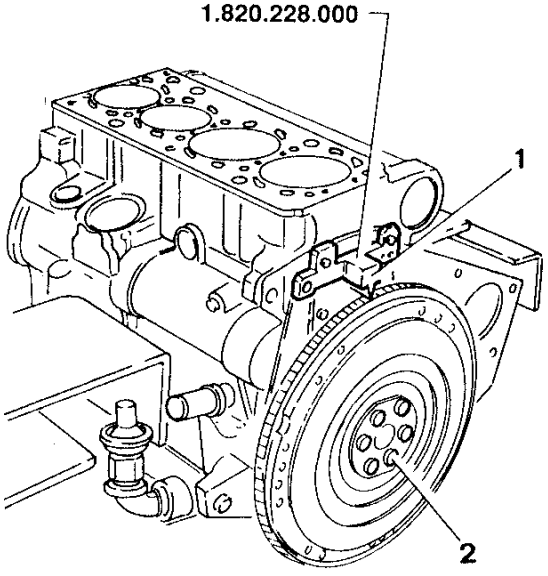
1. Extract the two elastic rings which block the grudgeon pin.
2. Extract the grudgeon pin and separate the piston from the rod.

During reassembly follow the indications contained in the relative paragraphs.

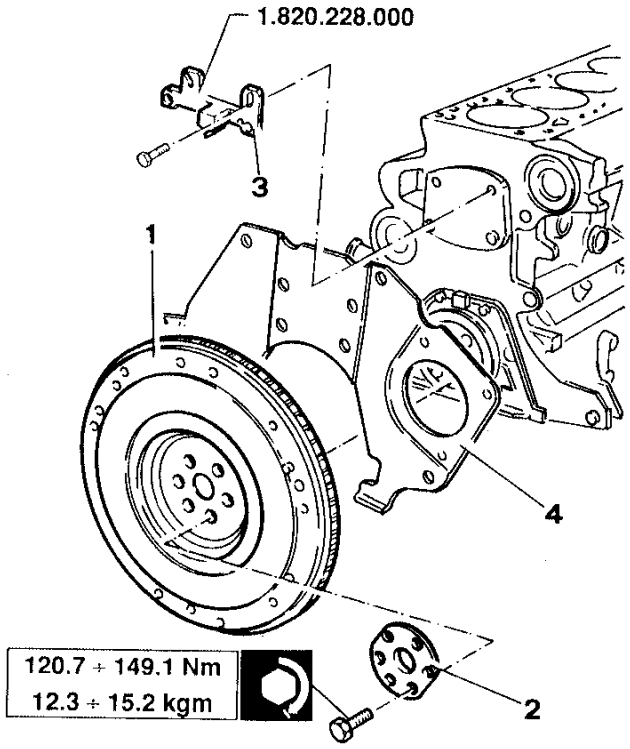


REMOVAL OF ENGINE FLYWHEEL

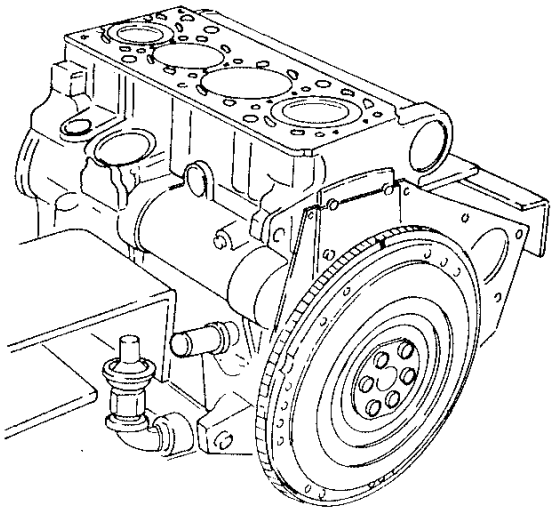
– Turn the engine block and remove the tool, assembled previously, to rotate the crankshaft.
1. Assemble tool N° 1.820.228.000 to prevent the flywheel from rotating.
2. Unscrew the screws securing the flywheel.



1. Remove the engine flywheel.
2. Recover the saftey washer.
3. Remove tool N° 1.820.228.000 previously assembled to block the flywheel.
4. Recover the upper protective flywheel casing.

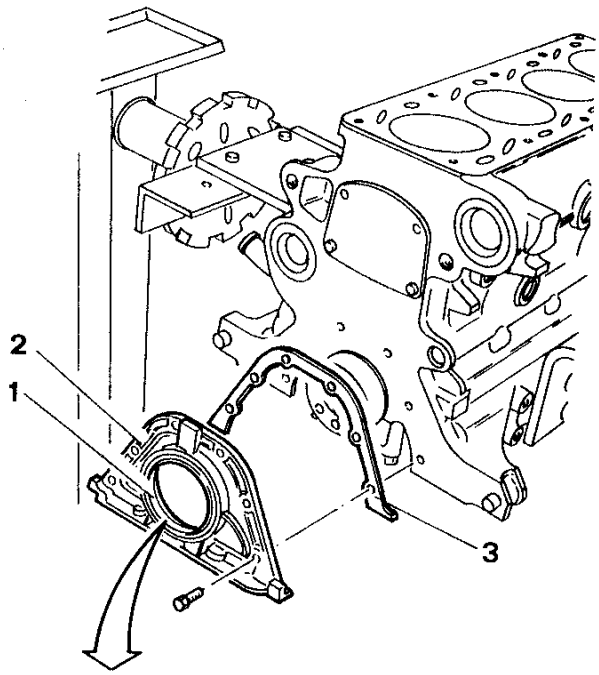


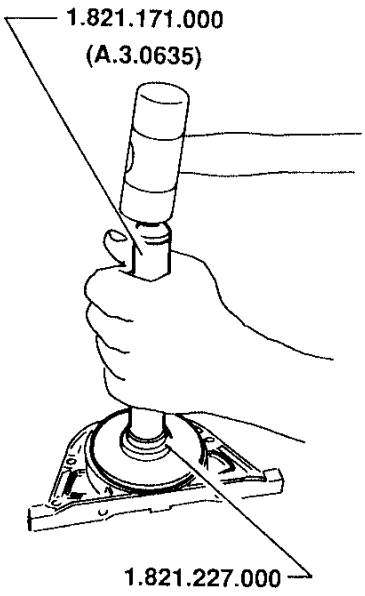
To reassemble bring the first and fourth cylinders to the T.D.C. position, and assemble the flywheel positioning the notch marked on it upwards.



REMOVAL OF REAR ENGINE COVER

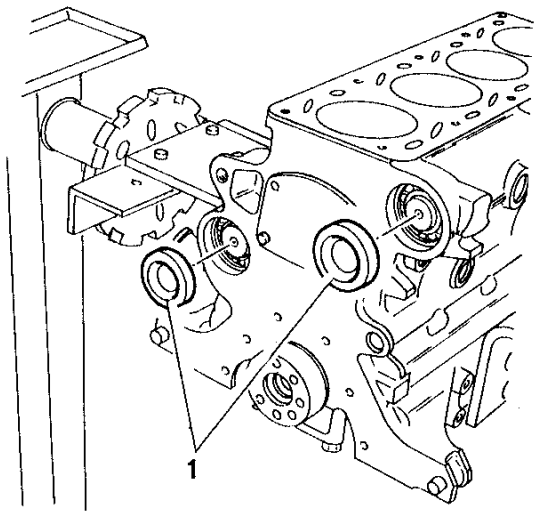
1. Remove the oil seal ring.
   For reassembly use tools N° 1.821.171.000 (A.3.0635) and N° 1.821.227.000.
2. Remove the rear engine cover.
3. Remove the seal.



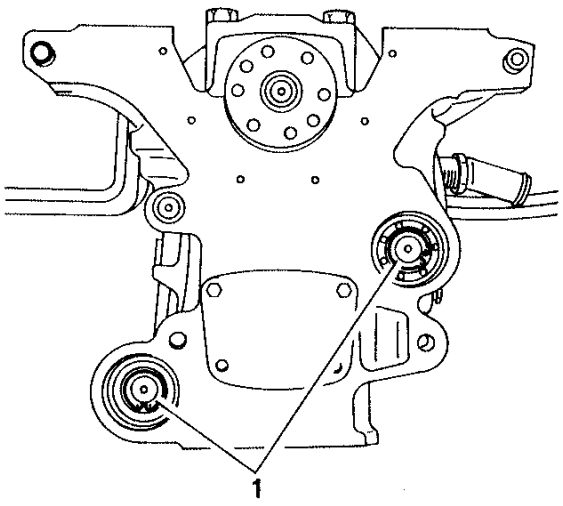


REMOVAL OF COUNTERSHAFTS

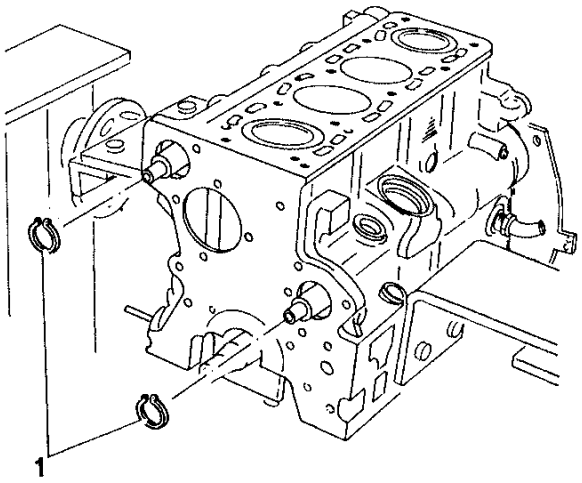
1. Remove the two rear rubber plugs of the countershafts.



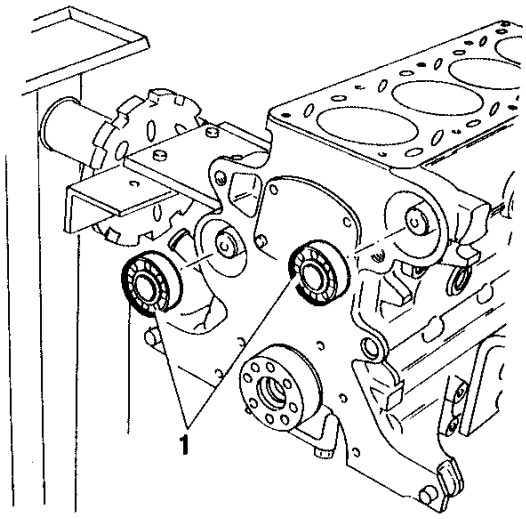
1. Remove the two rear elastic bull rings on the countershafts.



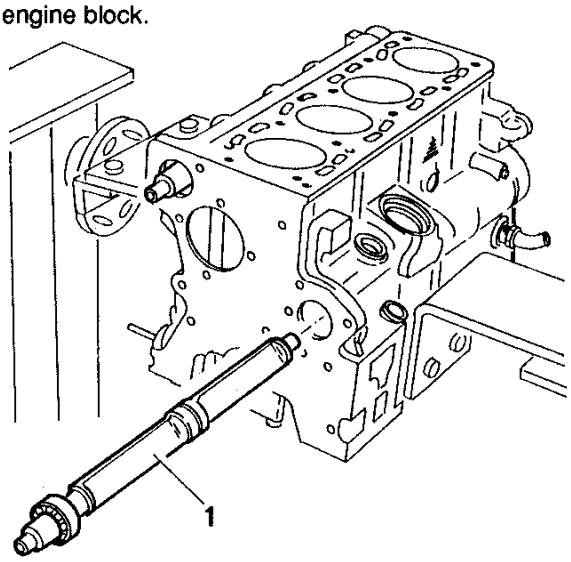
1. Remove the two front elastic bull rings on the countershafts.



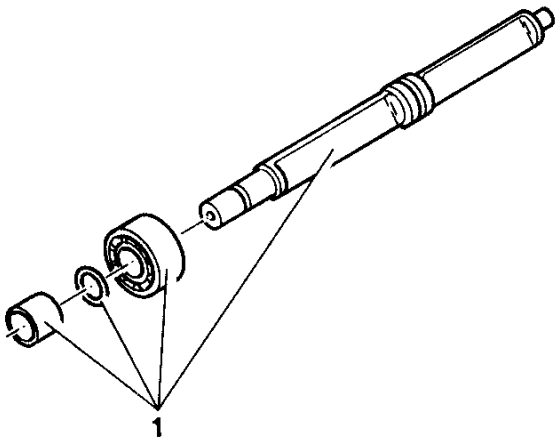
1. Using a plastic hammer, hit the front of the countershafts and extract the rear bearings.



1. Extract the countershafts from the front side of the engine block.



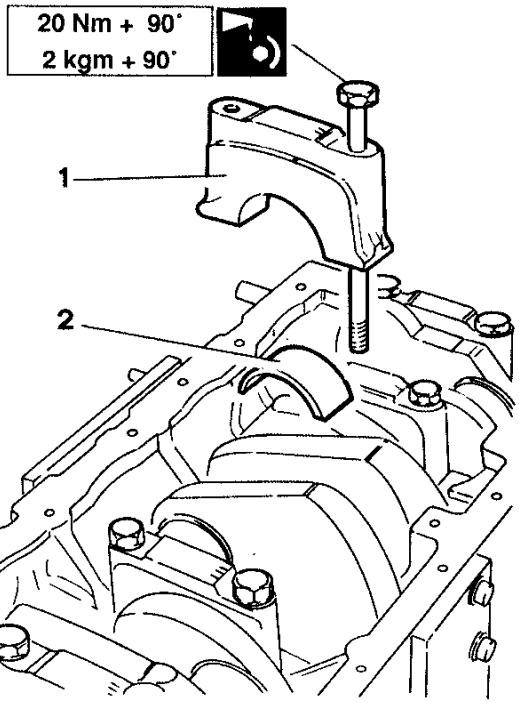
1. Remove the spacer, O-ring and bearings from the countershafts.



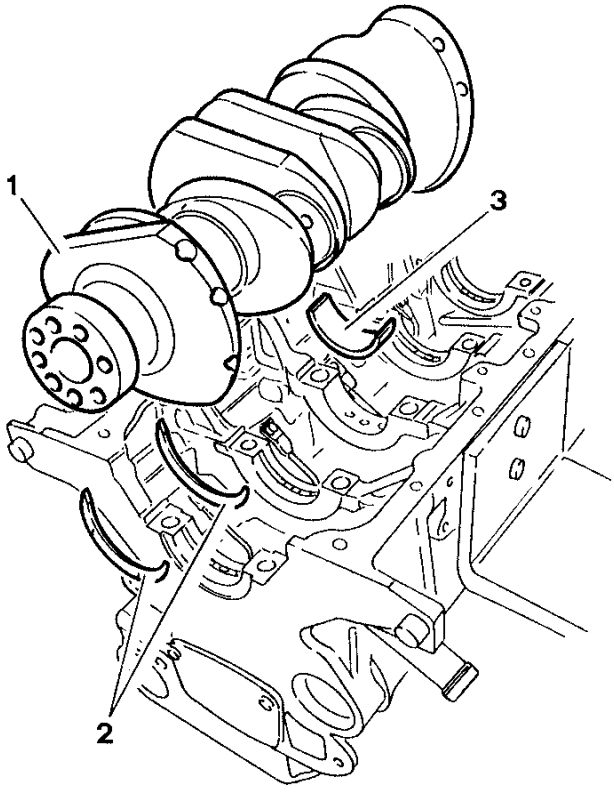
REMOVAL OF CRANKSHAFT

1. Unscrew the screws and remove the main journal caps.
2. Remove the bearing halves from the main journal caps.

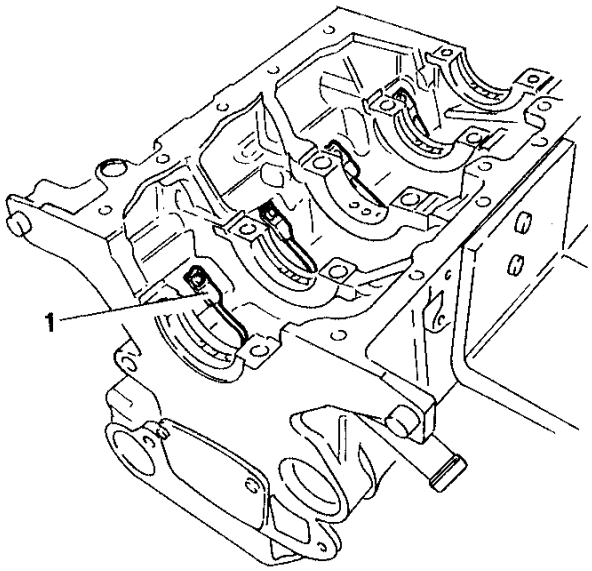
NOTE: Highlight the position of the various components should they be re-used for the reaseembly.



1. Remove the crankshaft.
2. Remove the thrust half rings.
3. Remove the main bearing halves from the supports.



1. If necessary remove the enigne oil sprayers used to lubricate and cool the pistons.

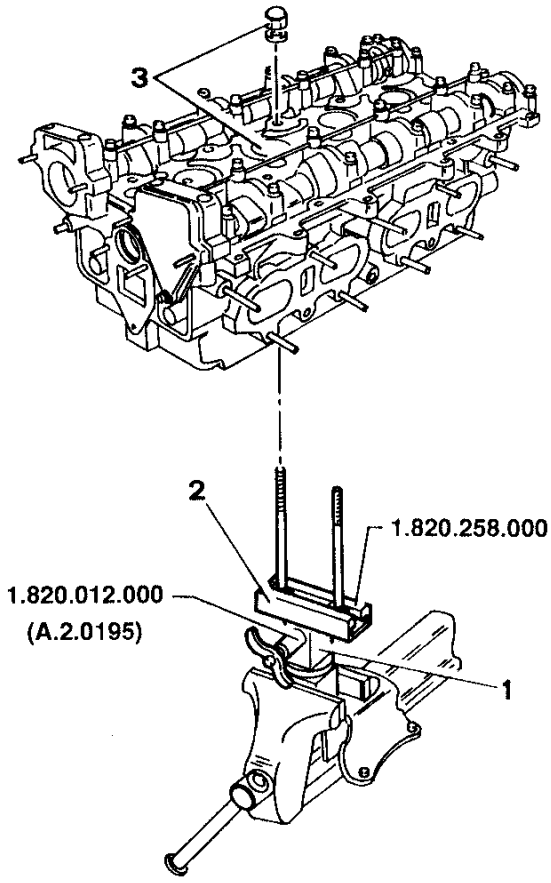


To reassemble the crankshaft follow the cautions contained in the relative paragraph.

DISASSEMBLY OF CYLINDER HEADS

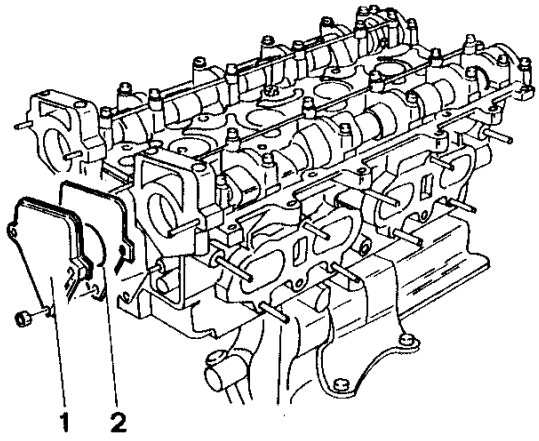
PRELIMINARY OPERATIONS

1. Lock the moveable support N° 1.820.012.000 (A.2.0195) into a vice.
2. Install fork N° 1.820.258.000 and lock it to the moveable support.
3. Insert the cylinder head onto the rods of the fork and lock it into position.

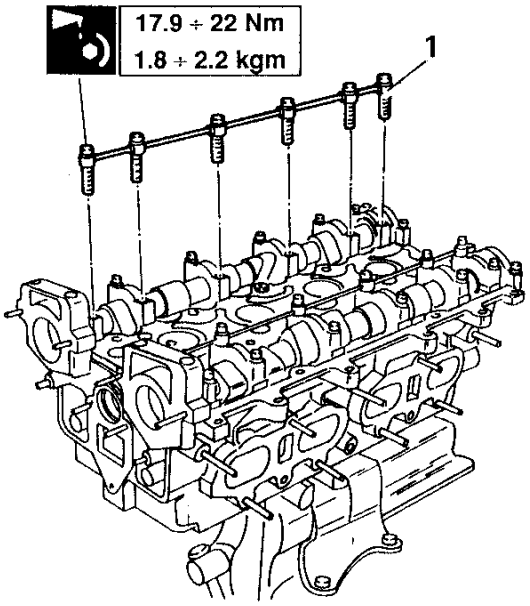


REMOVAL OF CAMSHAFTS

1. Remove the rear camshaft cover intake side.
2. Remove the relative gasket.

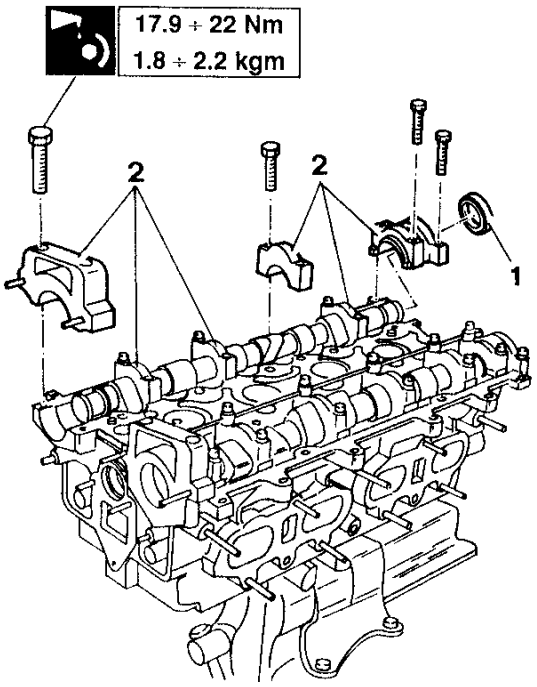


1. Remove the oil channels which lubricate the camshaft supports.

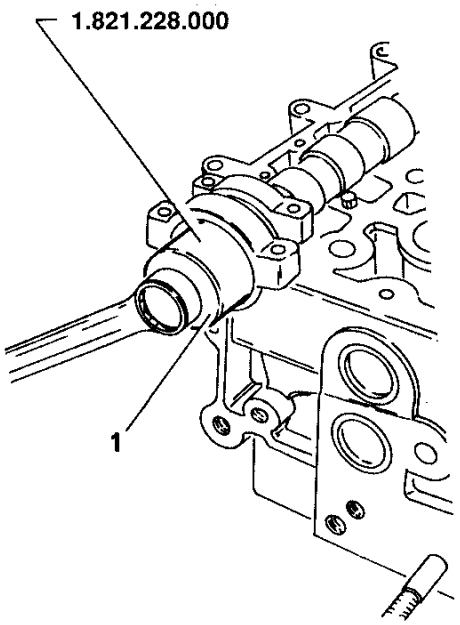


1. Remove the two camshaft oil seal rings from the front supports.
2. Remove the camshaft caps.

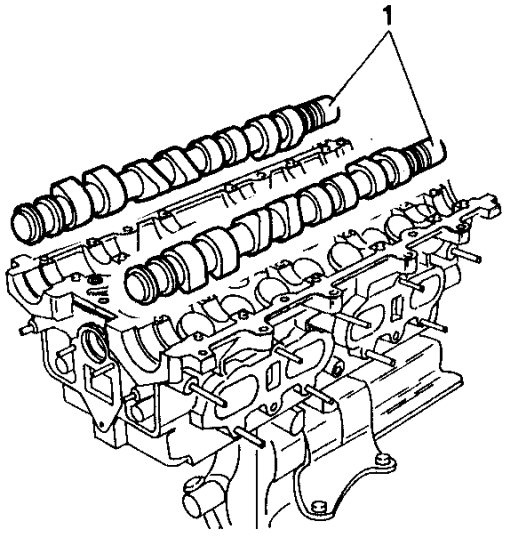
During reassembly, assemble the main caps so that the number stamped on them is the same as the number stamped on the cylinder heads.



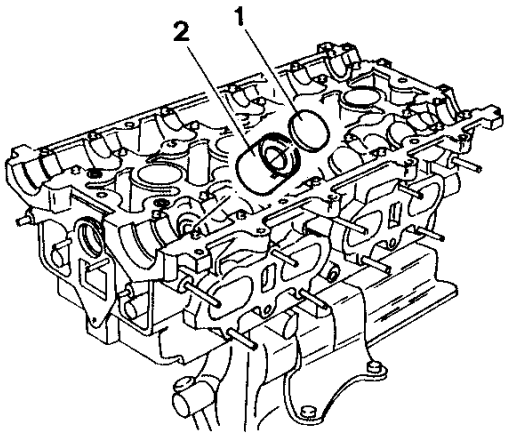
1. During reassembly, insert the two camshaft oil seal rings using tool N° 1.821.228.000.



1. Remove the camshafts.



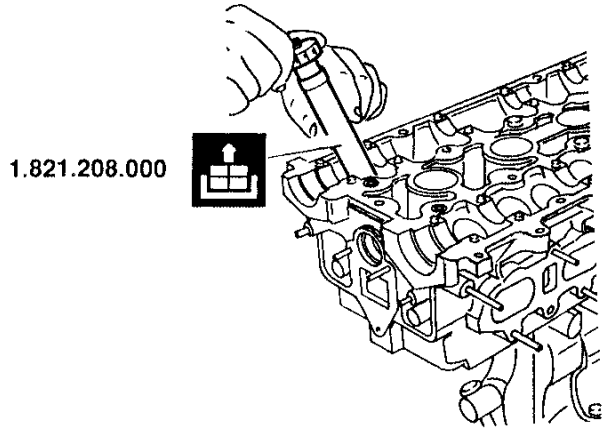
1. Remove the valve clearance regulating plates.
2. Extract the valve cups.

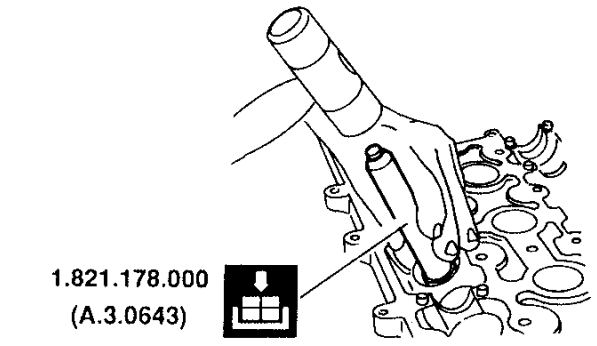


DISASSEMBLY OF VALVES

1. Using the equipment illustrated in the figure, remove the cotters.

– Remove the tools.



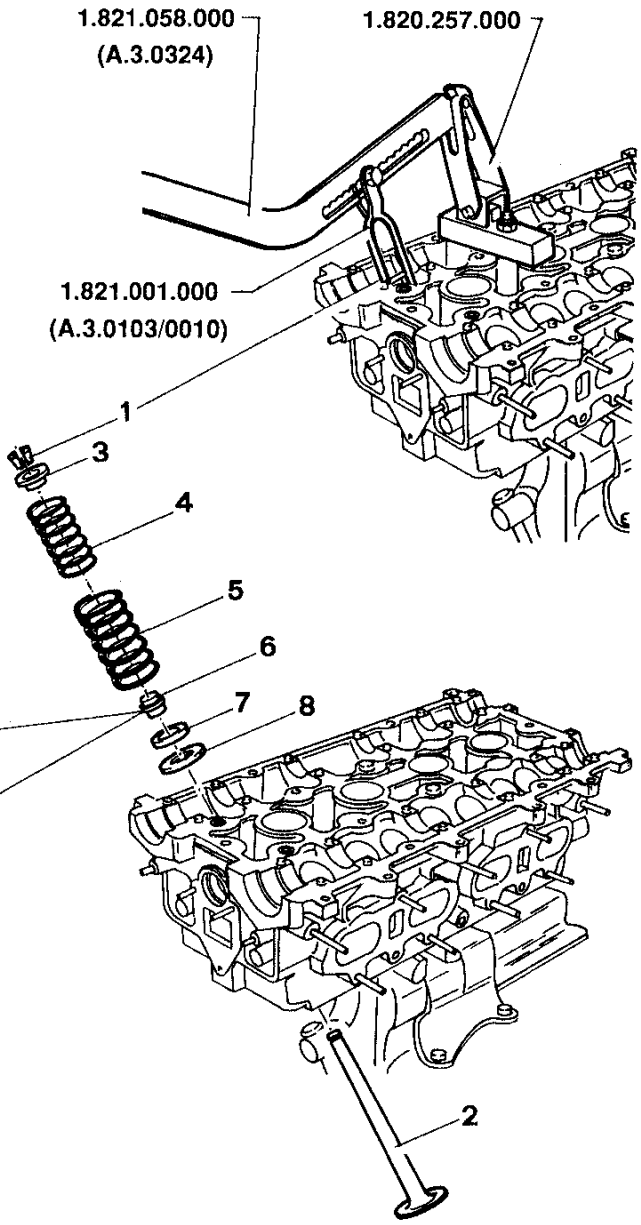


2. Extract the valve.
3. Remove upper plate.
4. Recover internal spring.
5. Recover external spring.
6. Using extractor N° 1.821.208.000, remove the oil seal hood.

During reassembly use inserting tool N° 1.821.178.000 (A.3.0643).

7. Remove spring hood.
8. Remove lower plate.

– Remove the remaining valves following the same procedure and using the same tools.

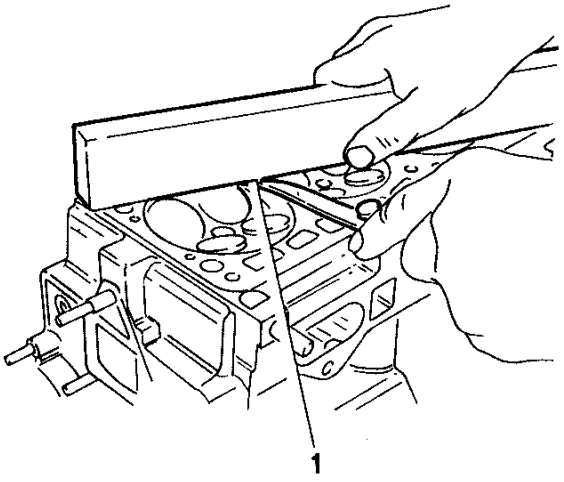


CYLINDER HEAD CHECKS AND INSPECTIONS

CHECKING LOWER PLANE OF CYLINDER HEADS

1. Ensure that the lower plane is level and reface if necessary.

Maximum head lower plane flatness error
0.1 mm

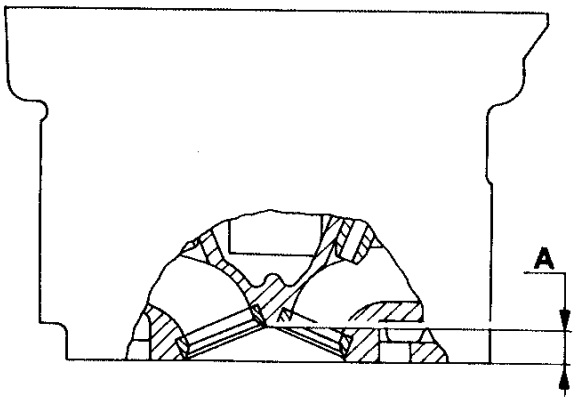


– After resurfacing, check that the depth of the combustion chamber on the head exceeds the permitted minimum value.

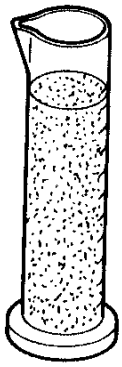
CAUTION:
Do not exceed the minimum permitted limit as this may cause serious engine malfunction.

Minimum depth "A" of combustion chamber on head
15.4 mm

– Check that the surfacing of the lower plane of the head is of the required quality.

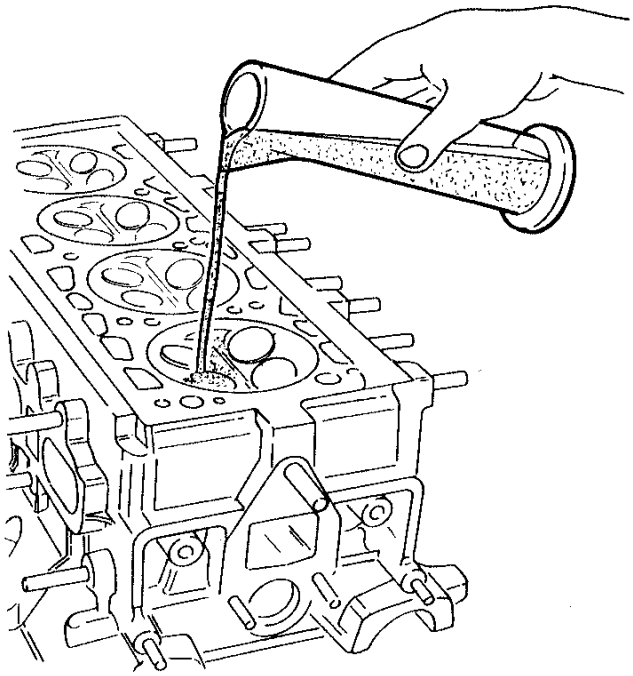


– After the cylinder heads have been resurfaced check that the combustion chamber volume, with the valves and sparkplugs assembled, meets the required value.
– To calculate the volume of the combustion chamber, follow the procedure below:
• fill a buret with a low viscosity engine oil and note the quantity introduced; leave the oil to settle in the buret for about 10 minutes.

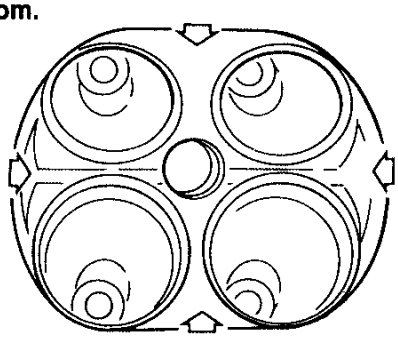


- fill the combustion chamber and leave the oil to settle in the buret for a further 10 minutes.
- the difference between the contents of the buret before and after the combustion chamber is filled, is equal to the volume of the chamber itself.

Combustion chamber volume head
40.6 cm^3



If the volume of the combustion chamber is less than the prescribed value, the correct value must be obtained by removing material from the within the combustion chamber; the arrows in the figure indicate where the material should be removed from.



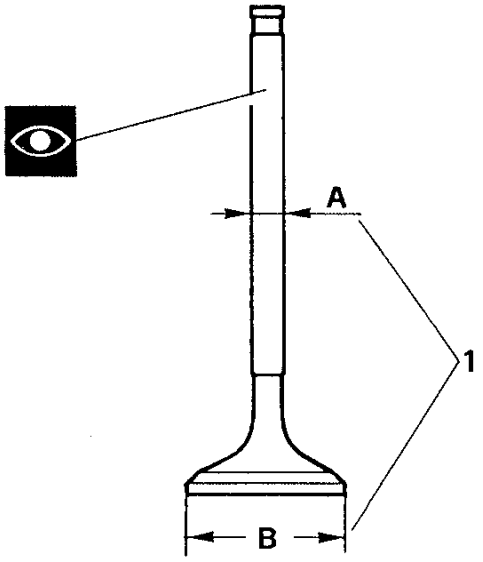
VALVES

– Check that the valve stems are not scratched and show no signs of seizing.

1. Check that the diameter of the valve stems and heads falls within the prescribed limits.

Diameter of valve stems "A"	
intake and exhaust	6.974 - 6.992 mm

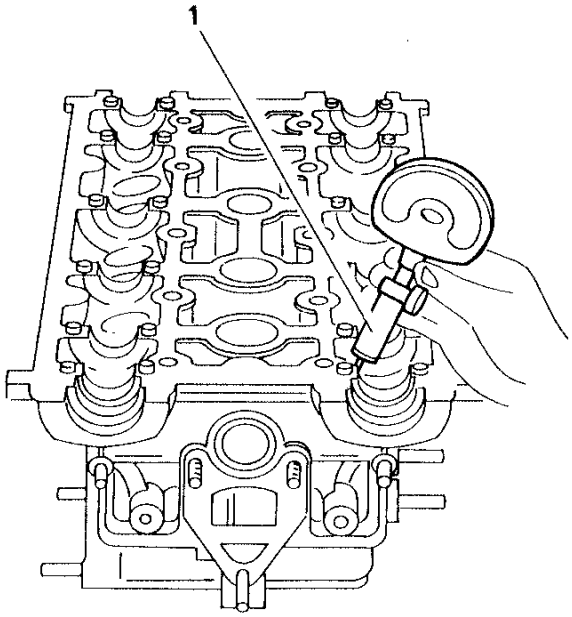
Diameter of valve heads "B»"	
intake	34.3 - 34.5 mm
exhaust	28.3 - 28.5 mm

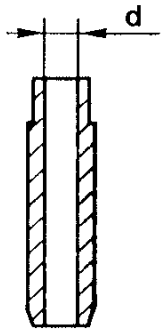


VALVE GUIDES

1. Calculate the internal diameter of the valve guides and check that it falls within the prescribed values.

Internal diameter of valve guides "d"	
intake and exhaust	7.022 - 7.040 mm





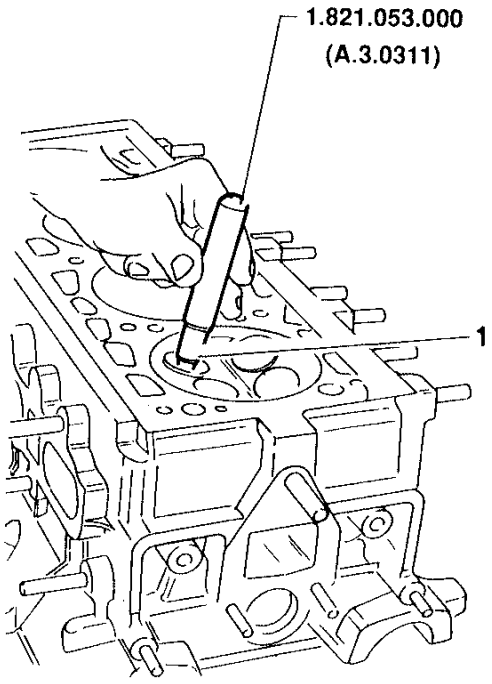
CLEARANCE BETWEEN VALVE GUIDES AND VALVE STEMS

– After having measured the diameter of the valve stems in at least three points, at right angles to each another and the internal diameter of the valve guides, calculate the clearance and check that it falls within the prescribed limits; if this is not the case replace the worn parts.

Radial clearance between the valve stems and the internal diameter of the valve guides	
intake and exhaust	0.030 - 0.066 mm

REPLACEMENT OF VALVE GUIDES

1. Extract the worn valve guides using extractor N° 1.821.053.000 (A.3.0311).



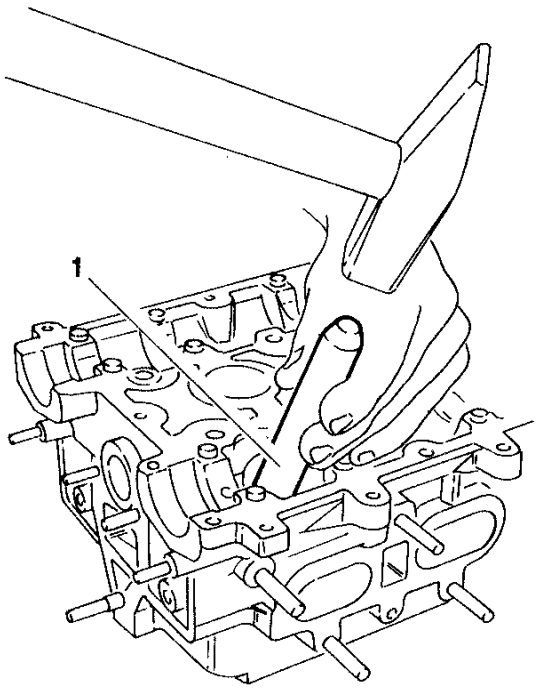
– Measure the diameter of the valve guide seatings and the external diameter of the new valve guides: the installation interference should fall within the prescribed tollerances.

Diameter of valve guide seatings	
intake and exhaust	13.950 - 13.977 mm

Valve guide external diameter	
intake and exhaust	14.010 - 14.030 mm

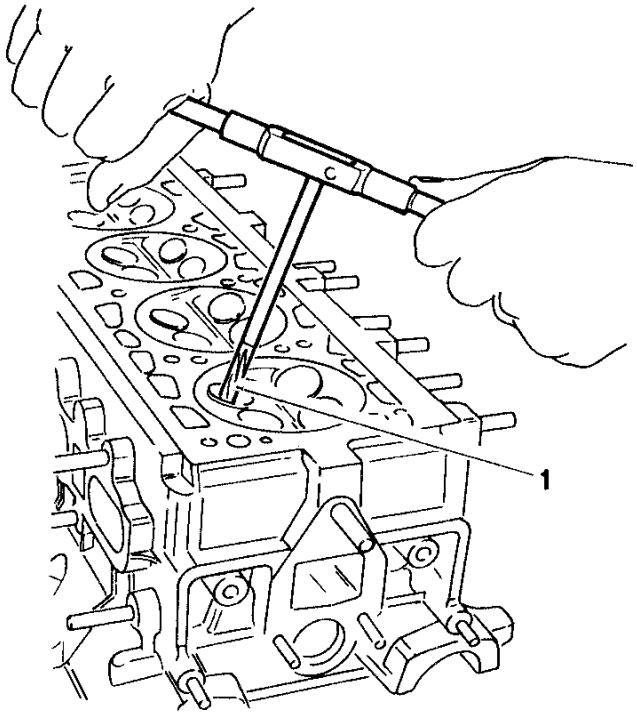
Interference between valve guides and valve guide seatings	
intake and exhaust	0.033 - 0.080 mm

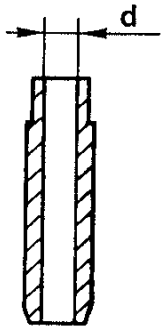
1. Insert the new valve guides using a suitable inserting tool.



1. Bore the vlave guides to gauge the holes to the prescribed diameter.

Internal diameter of valve guides "d"	
intake and exhaust	7.022 - 7.040 mm

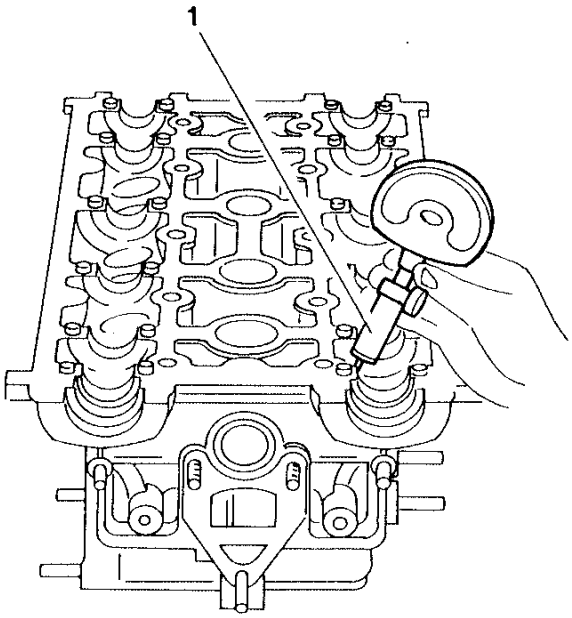


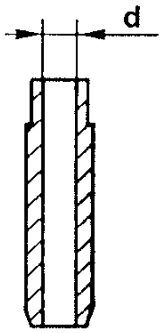


VALVE GUIDES

1. Calculate the internal diameter of the valve guides and check that it falls within the prescribed values.

	Internal diameter of valve guides "d"	
	intake and exhaust	7.022 - 7.040 mm





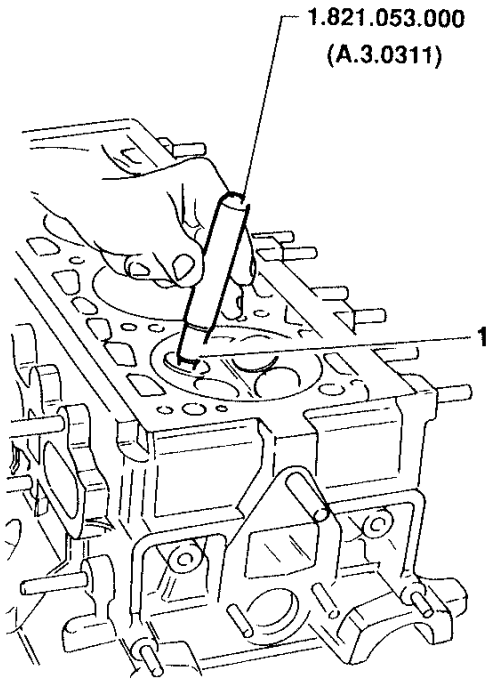
CLEARANCE BETWEEN VALVE GUIDES AND VALVE STEMS

– After having measured the diameter of the valve stems in at least three points, at right angles to each another and the internal diameter of the valve guides, calculate the clearance and check that it falls within the prescribed limits; if this is not the case replace the worn parts.

	Radial clearance between the valve stems and the internal diameter of the valve guides	
	intake and exhaust	0.030 - 0.066 mm

REPLACEMENT OF VALVE GUIDES

1. Extract the worn valve guides using extractor N° 1.821.053.000 (A.3.0311).



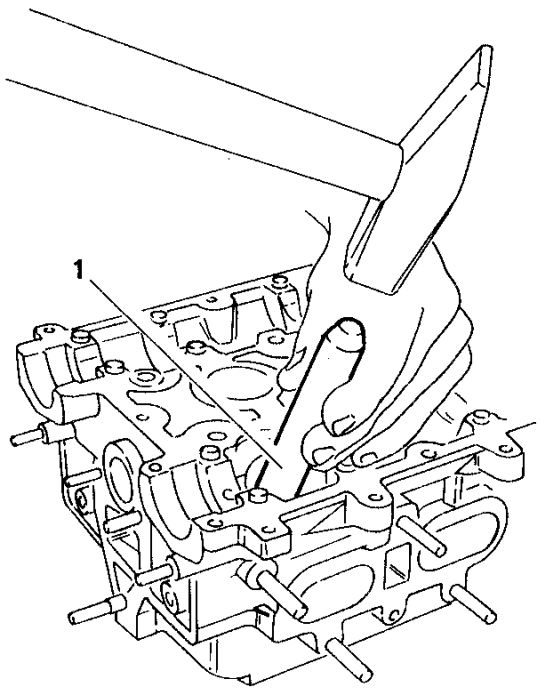
– Measure the diameter of the valve guide seatings and the external diameter of the new valve guides: the installation interference should fall within the prescribed tollerances.

Ø	Diameter of valve guide seatings	
	intake and exhaust	13.950 - 13.977 mm

Ø	Valve guide external diameter	
	intake and exhaust	14.010 - 14.030 mm

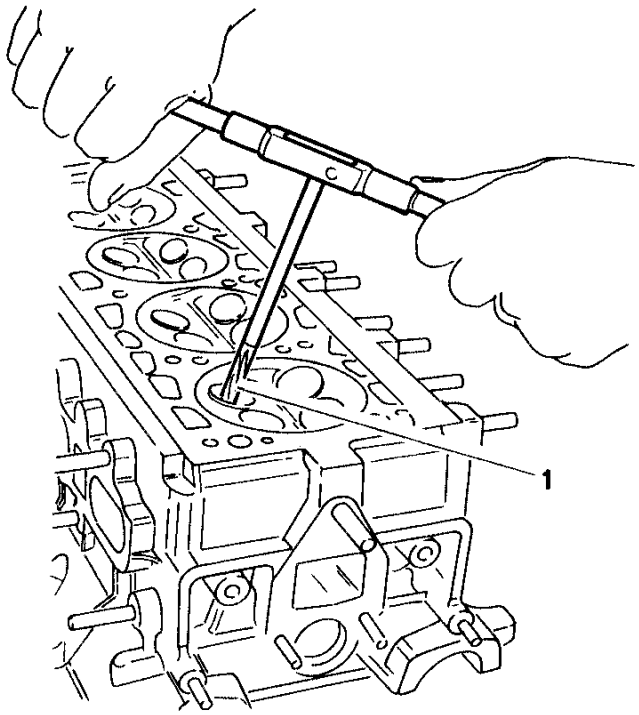
	Interference between valve guides and valve guide seatings	
	intake and exhaust	0.033 - 0.080 mm

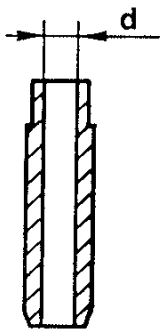
1. Insert the new valve guides using a suitable inserting tool.



1. Bore the vlave guides to gauge the holes to the prescribed diameter.

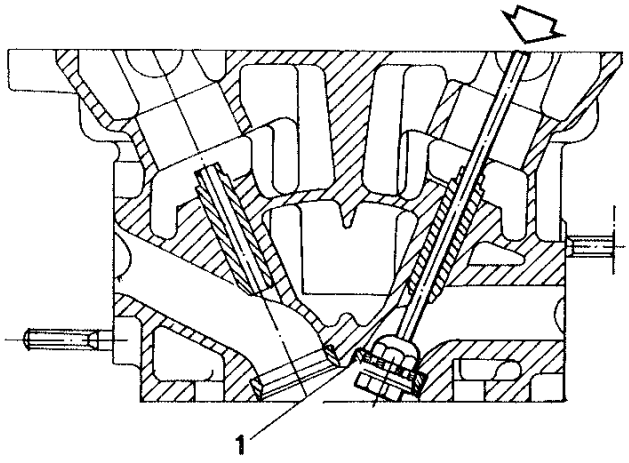
Ø	Internal diameter of valve guides "d"	
	intake and exhaust	7.022 - 7.040 mm





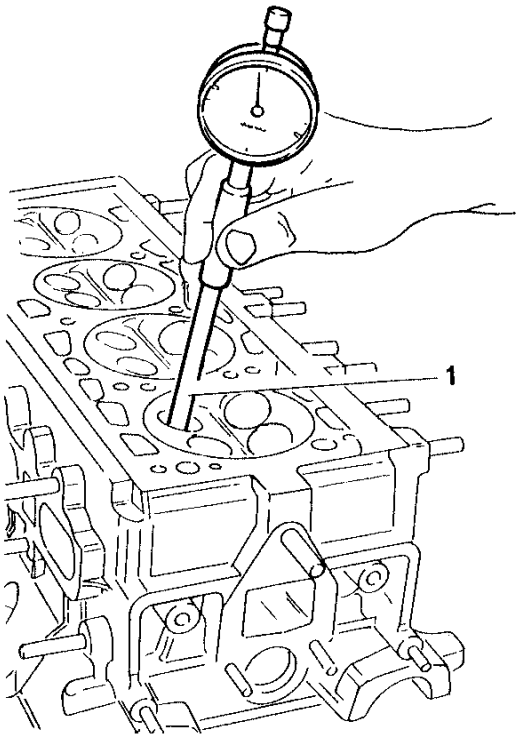
REPLACEMENT OF VALVE SEATINGS

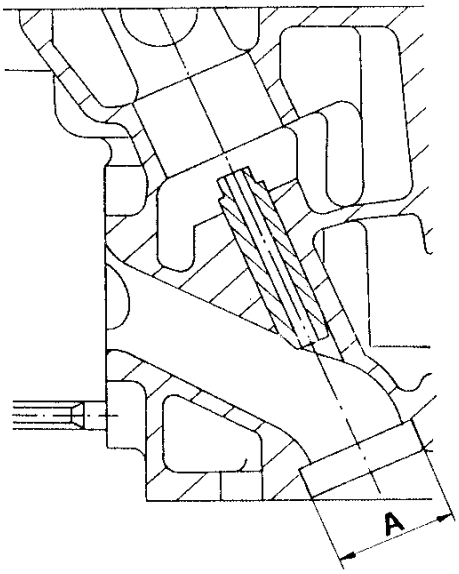
1. Extract the worn valve seatings using suitable equipment.



1. Check that the diameter of the valve seating housings falls within the prescribed limits.

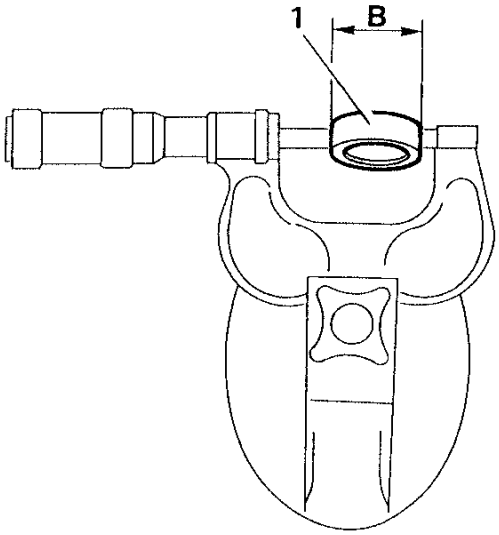
∅	Diameter of valve seating housings "A"	
	intake	35.989 - 36.014 mm
	exhaust	29.989 - 30.014 mm



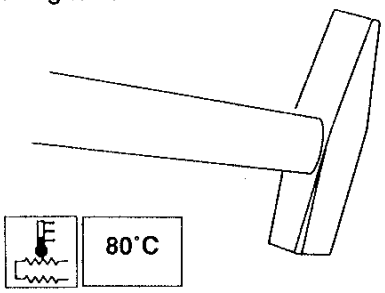


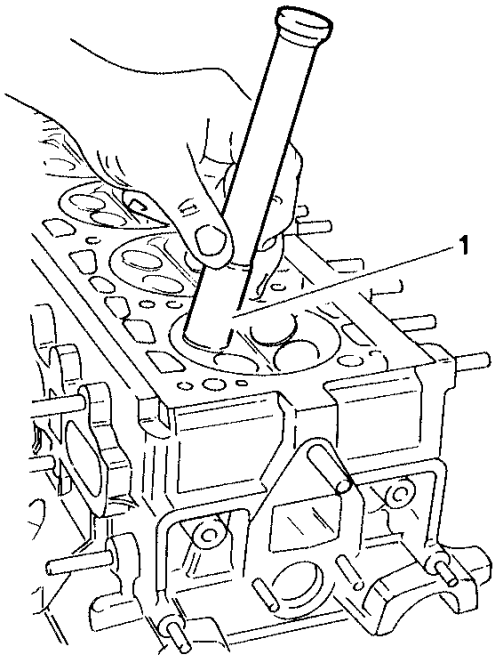
1. Check that the external diameter of the new valve seatings falls within the prescribed limits.

∅	Valve seating external diameter "B"	
	intake	36.135 - 36.150 mm
	exhaust	30.125 - 30.140 mm



1. Heat the head to the prescribed temperature and install the new valve seatings using the special inserting tools.

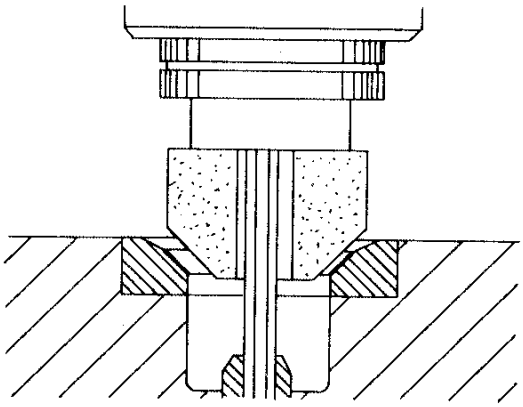




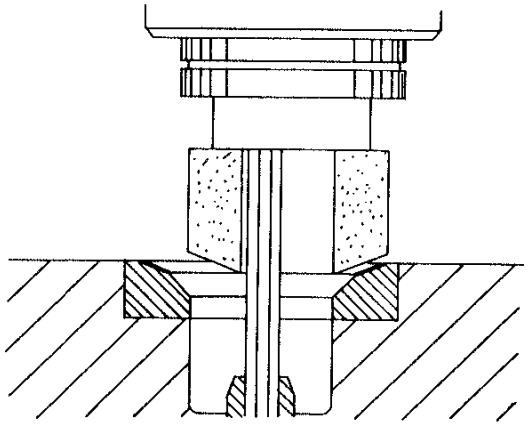
TURNING OF VALVE SEATINGS

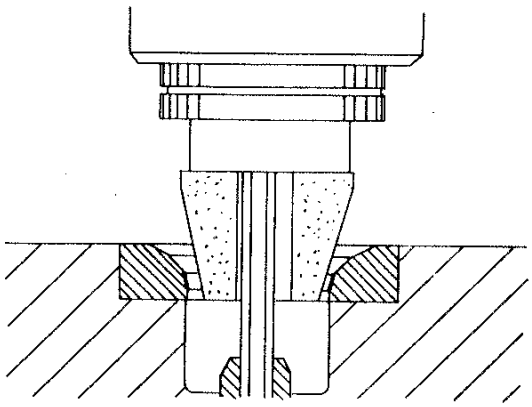
– If necessary carry out valve seating turning using a suitable tool, proceeding as follows:

• turn valve seatings with a grinder at 44°30'.

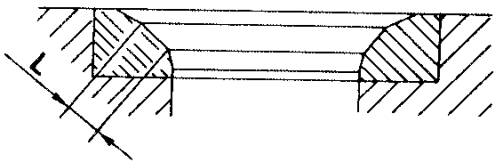


• turn the valve seatings with a grinder at 20° and at 75° as indicated in the figure in order to obtain the prescribed value "L".

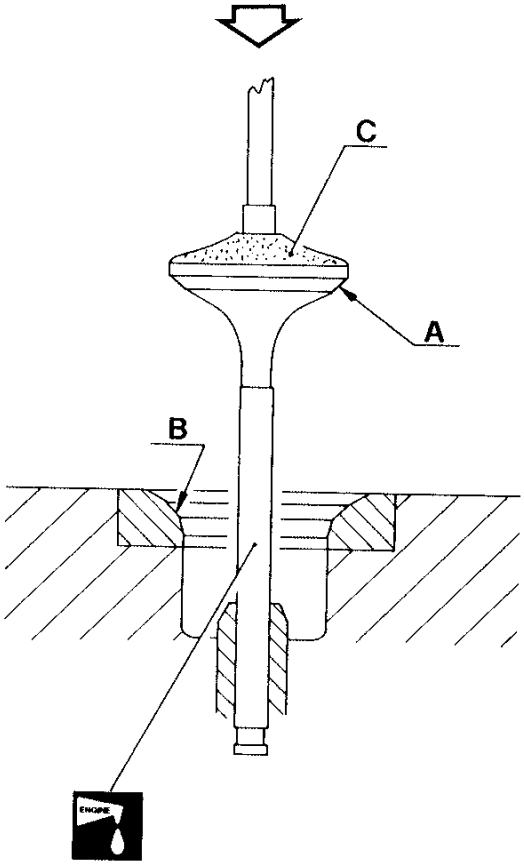


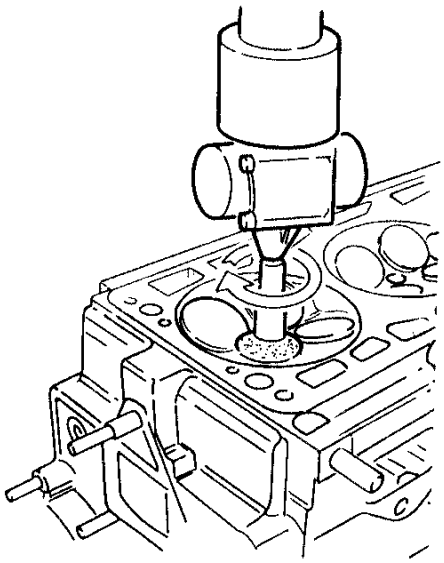


	Length "L" of valve seating section with taper at 45°
	~ 2 mm



– After turning, grind each valve in its relative seating as follows:
- spread the stop limit surfaces of the valves and seatings with abrasive paste (SIPAL AREXONS Carbosilicium for valve).
- lubricate the valve stem with engine oil.
- fix the lower surface of the valve head to the "C" suction cup of a pneumatic lap.
- insert the valve into the relative guide and grind.
- after grinding, clean both the valves and their seatings thoroughly.



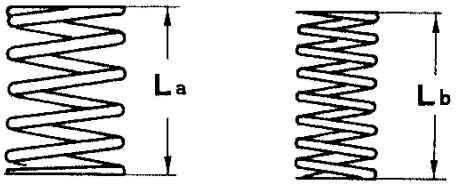


VALVE SPRINGS

– Check that the "free" length of the valve springs falls within the prescribed limits.

NOTE: The terminal planes must be parallel to each other and perpendicular to the axis of the spring with a maximum error of 2°.

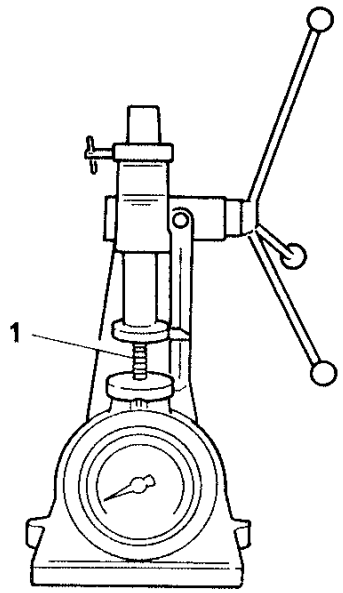
Length of valve spring	
external spring "La"	53.9 mm
internal spring "Lb"	41.8 - 42.8 mm



1. Using a dynamometer, check that the characteristics of the springs fall within the prescribed limits.

External spring		
Length of spring mm		Control loading N(kg)
valve closed	36	367 - 396 (37.4 - 40.4)
valve open	26.5	559 - 608 (57 - 62)

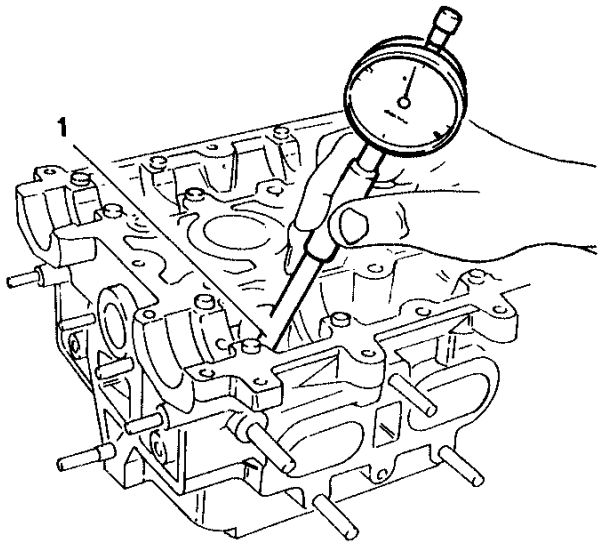
Internal spring		
Length of spring mm		Control loading N(kg)
valve closed	31	141 - 151 (14.4 - 15.4)
valve open	21.5	264 - 287 (26.9 - 29.3)

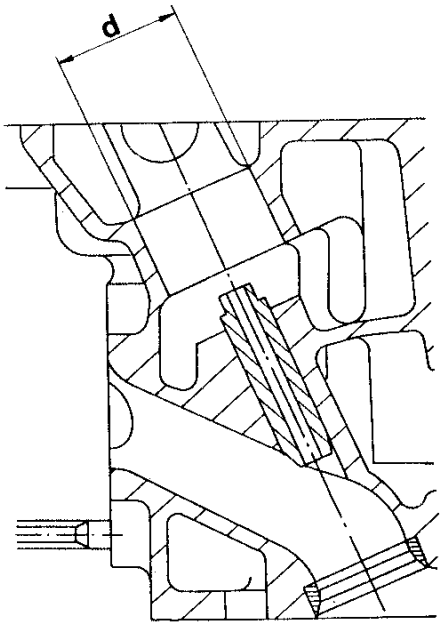


VALVE CUP SEATINGS AND VALVE CUPS

1. Check that the diameter of the valve cup seatings falls within the prescribed limits.

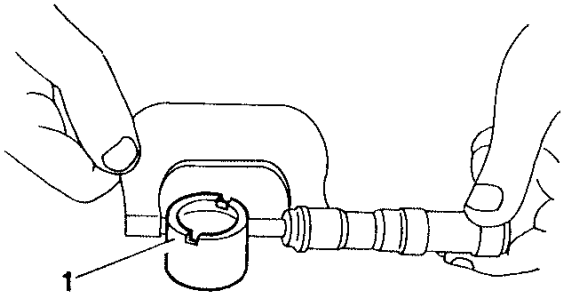
Ø	Diameter of valve cup seatings "d"	
	Intake and exhaust	37.000 - 37.025 mm





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

Diameter of valve cups	
Intake and exhaust	36.975 - 36.995 mm



– Calculate the clearance between the valve cups and the respective seatings, checking that it falls within the prescribed limits.

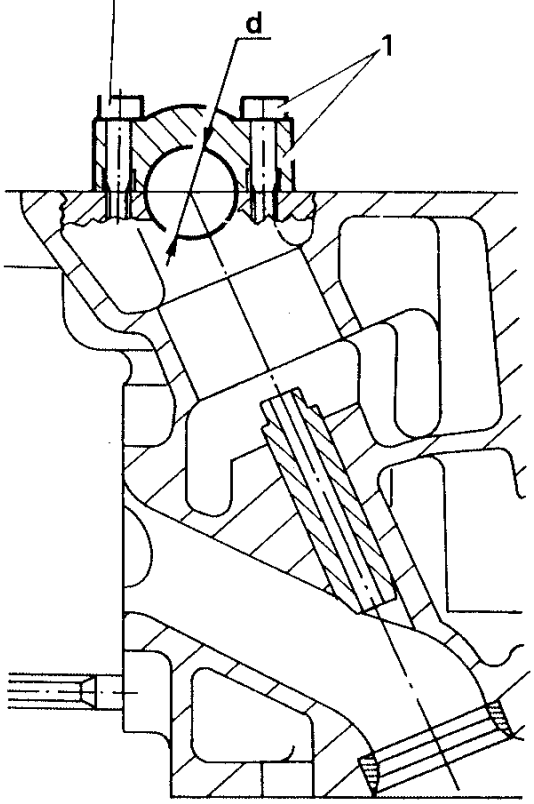
Clearance between valve cups and their relative seatings
0.005 - 0.050 mm

SUPPORTS AND CAMSHAFTS

1. Install the caps and tighten the lubricated screws to the prescribed torque and check that the diameter of the supports falls within the prescribed limits.

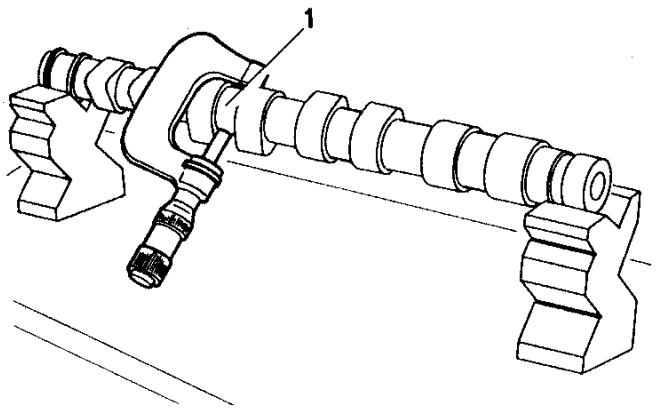
Diameter of camshaft supports "d"
28.545 - 28.570 mm

17.9 ÷ 22 Nm
1.8 ÷ 2.2 kgm



1. Check that the diameter of the camshaft journals falls within the prescribed limits.

Diameter of camshaft journals
28.480 - 28.495 mm

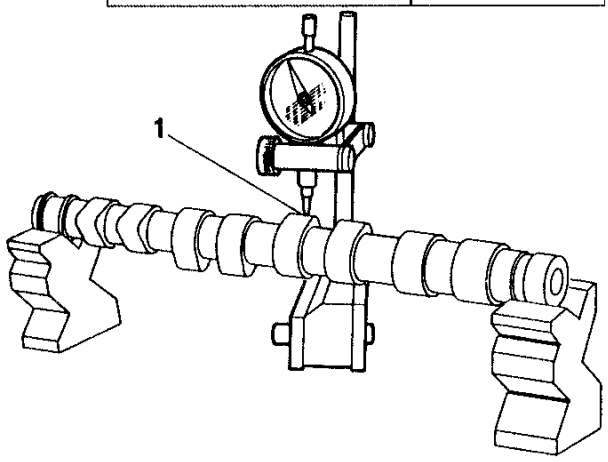


– Calculate the clearance between the camshaft journals amd the relative supports, and check that it falls within the prescribed limits.

Clearance between camshaft and relative supports
0.05 - 0.09 mm

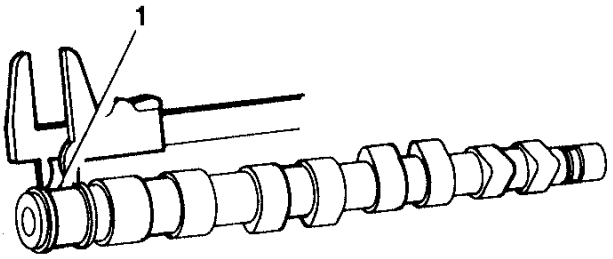
1. Check that the cam lift exceeds the prescribed values.

Minimum cam lift	
intake	8.6 mm
exhaust	7.5 mm



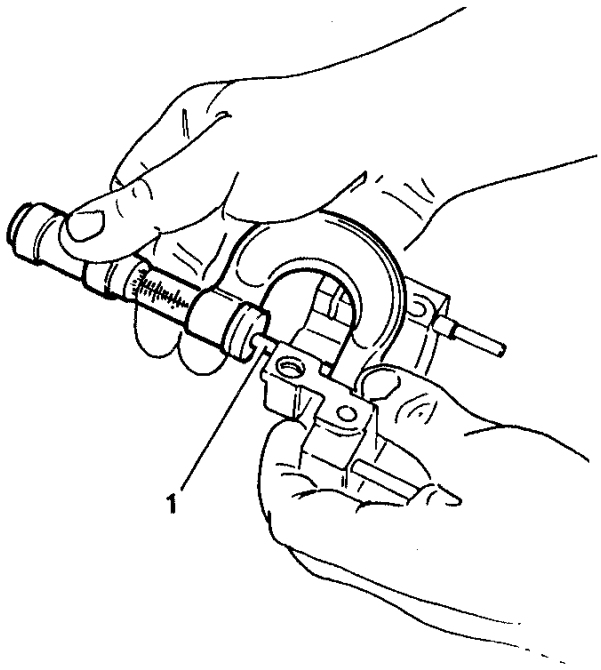
1. Check that the width of the camshaft shoulders falls within the prescribed values.

Width of camshaft shoulders
19.67 - 19.75 mm



1. Check that the width of the rear camshaft caps in function with the shoulder falls within the prescribed values.

Width of camshaft support shoulders
19.52 - 19.57 mm



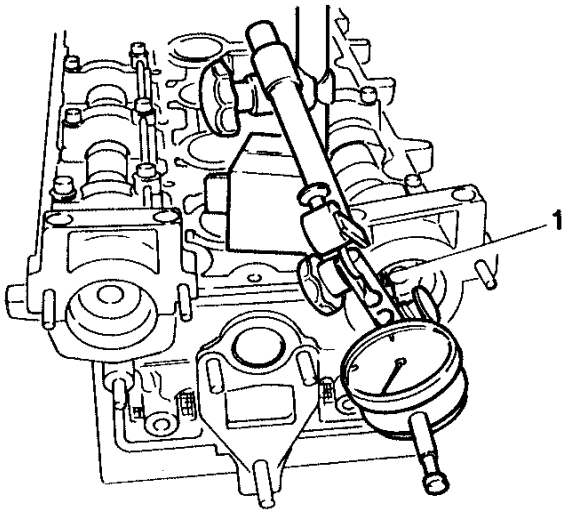
CHECK THE CAMSHAFT AXIAL PLAY

– Position the camshafts on the cylinder heads.
– Install the caps respecting the numbering printed on them and on the cylinder heads and tighten the lubricated screws to the prescribed torque.

17.9 - 22.0 Nm 1.8 - 2.2 kgm

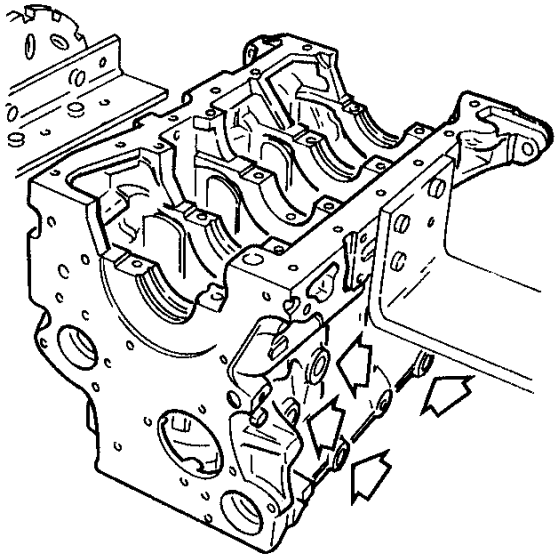
1. Using a centesimal comparator, measure the camshaft axial play and check that it falls within the prescribed limits.

Camshaft axial play
0.10 - 0.23 mm



ENGINE BLOCK CHECKS AND INSPECTIONS

- Visibly check the engine block for signs of cracking and excessive wear of the sliding surfaces: check that the threads are all intact.
- Remove the caps from the lubrication and coolant channels and clean with a suitable detergent. Blow off with compressed air and install new caps.
- Thoroughly clean the engine block faces of all traces of old gasket.

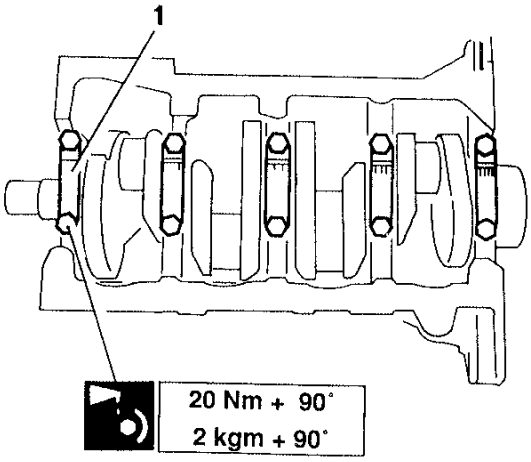


MAIN SUPPORTS

1. Install the main caps.

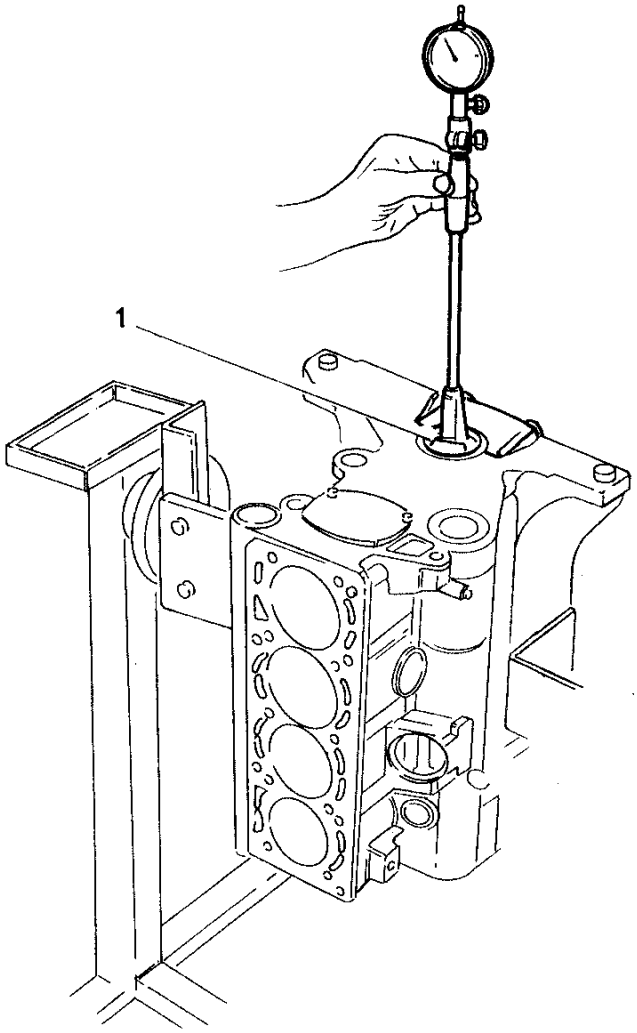
CAUTION:
The position of each cap is dictated by a seried of progressive notches (from zero to four from the front engine side) marked on the caps themselves.

- Tighten the lubricated main cap screws to the prescribed torque in two or three interventions, starting from the main central bench.



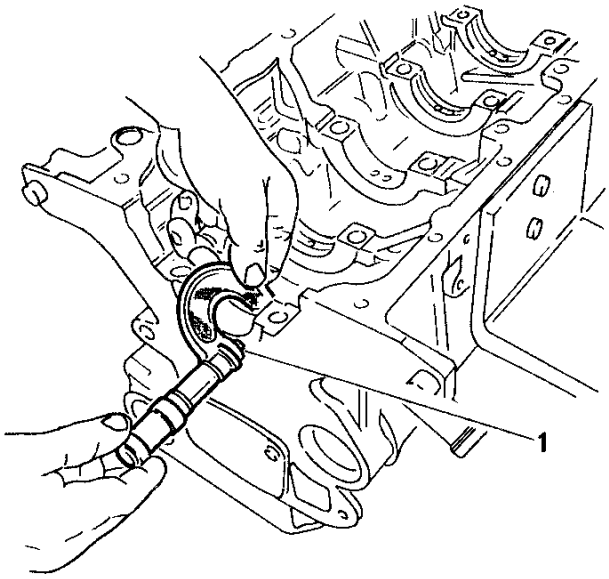
1. Measure the diameter of the main supports using an bore meter connected to a comparator, and check that the values fall within the prescribed limits.

Diameter of main supports	
Class 1	56.729 - 56.735 mm
Class 2	56.723 - 56.729 mm
Class 3	56.717 - 56.723 mm



1. Check that the width of the rear main support shoulder falls within the prescribed limits.

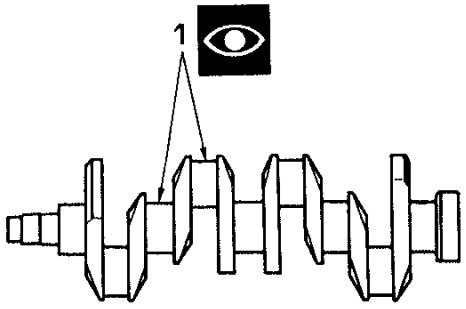
Width of rear main support shoulder
23.12 - 23.20 mm



CRANKSHAFT

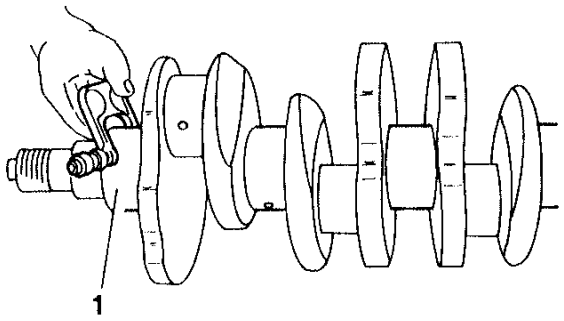
Main and rod journals

1. Check that the work surface of the main and rod journals does not show signs of wear, scratching or overheating.

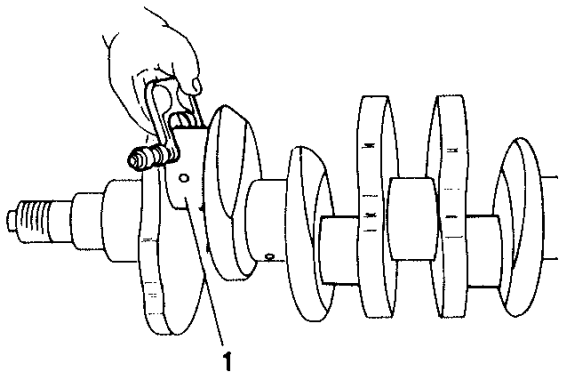


1. Measure the diameter of the main and rod journals, checking that they fall within the prescribed limits.

Diameter of main journals	
Class A	52.998 - 53.004 mm
Class B	52.992 - 52.998 mm
Class C	52.986 - 52.992 mm

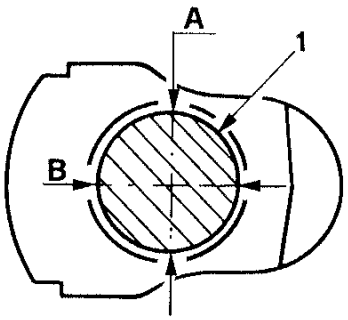


Diameter of rod journals	
Class A	50.799 - 50.805 mm
Class B	50.793 - 50.799 mm
Class C	50.787 - 50.793 mm



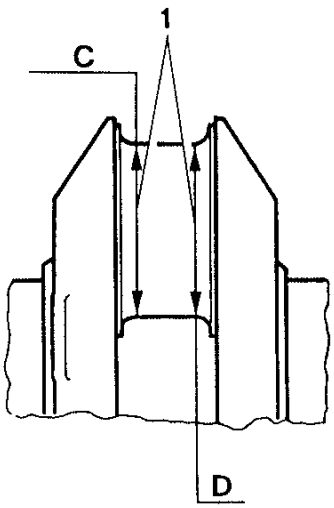
1. Check that the ovalization of the main and rod journals falls within the prescribed limits.

Main and rod journals maximum ovalization error
A - B = 0.007 mm



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

Main and rod journals maximum taper error
C - D = 0.0035 mm



– Check the eccentricity between the central main journals and the front and rear main journals.

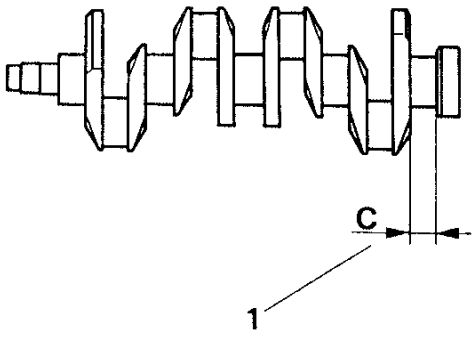
Maximum eccentricty between main journals
0.03 mm

– Check parallelism between main and rod journals.

Maximum parallelism error between main and rod journals
0.015 mm

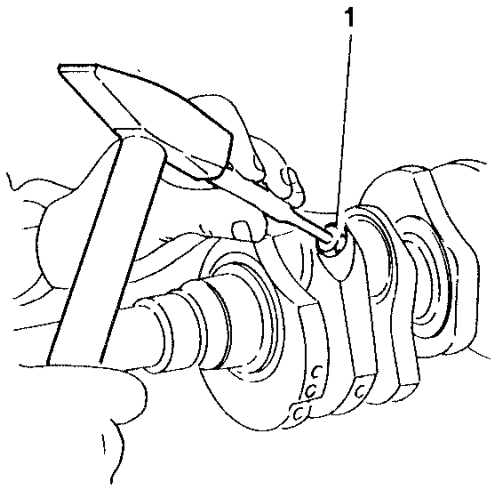
1. Check that the length of the rear main journal "C" falls within prescribed limits.

Length of the rear main journal "C"
27.975 - 28.025 mm



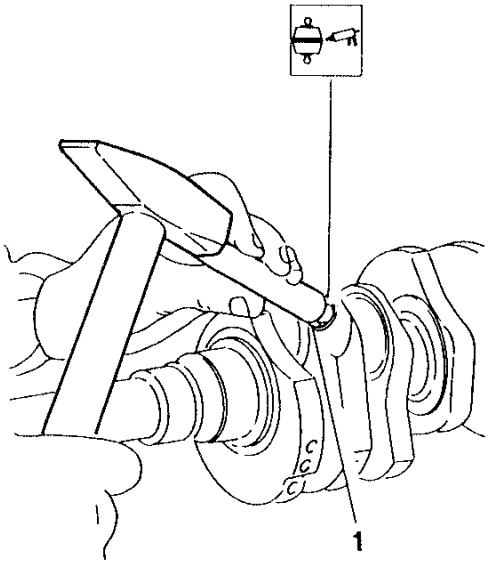
Cleaning lubrication channels

1. Punch a hole for the plugs in the lubrication channels and eliminate any eventual burrs created by the calking.

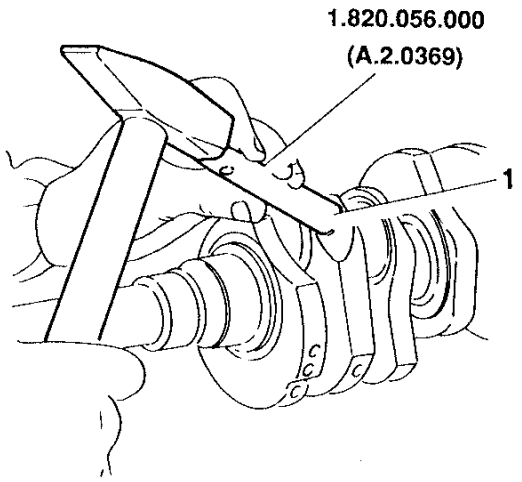


– Thoroughly clean the lubrication channels using a suitable detergent and dry by blowing compressed air.

1. Apply the prescribed sealant on the new plugs and insert them, using a suitable tool, into the lubrication channels.



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



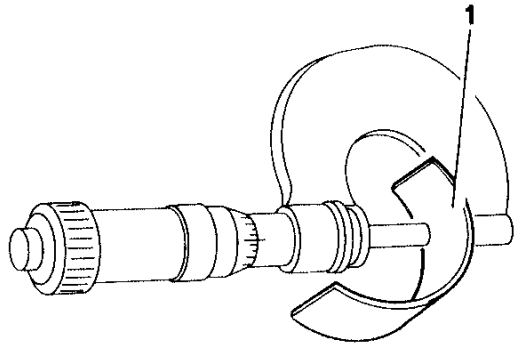
MAIN AND ROD BEARING HALVES, THRUST HALF RINGS

- Clean the main and rod bearing halves and visibly check them for scratching and signs of seizing. If there are signs of excessive wear, replace all the bearing halves.

1. Measure the thickness of the bearing halves with a micrometer and check that they fall within the prescribed limits.

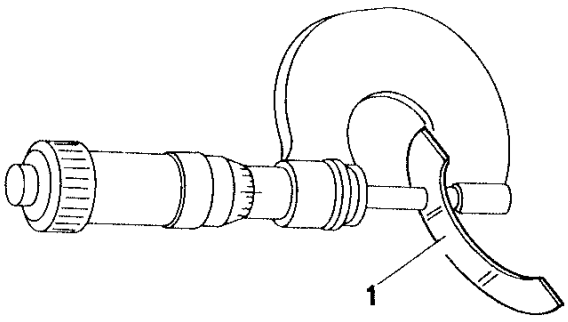
Thickness of the main bearing halves	
Class A	1.838 - 1.844 mm
Class B	1.844 - 1.850 mm
Class C	1.850 - 1.856 mm

Thickness of rod bearing halves	
Class A	1.531 - 1.537 mm
Class B	1.537 - 1.543 mm
Class C	1.543 - 1.549 mm



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

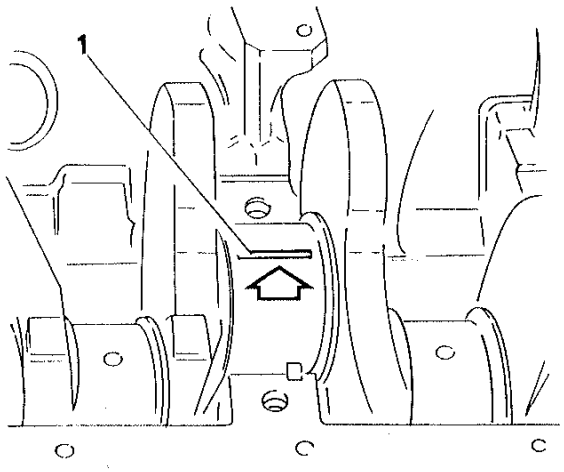
Thickness of the thrust half-ring
2.347 - 2.363 mm



MEASURE INSTALLATION CLEARANCE BETWEEN MAIN JOURNALS AND RELATIVE BEARING HALVES USING A GAUGED WIRE (PLASTIGAGE)

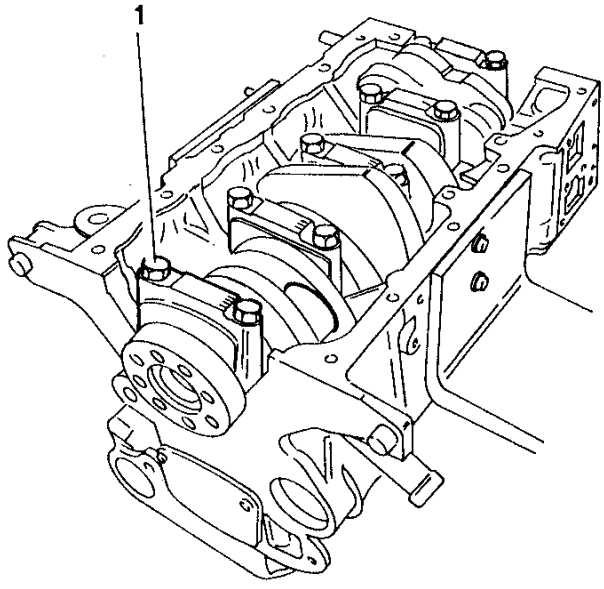
NOTE: Check one journal at a time without removing the driving shaft during the checking operations.
The bearing halves must be housed in the respective seatings.

1. Rest the gauged wire over the whole width of the main journal to be checked, paying close attention that it does not cover the lubrication hole.



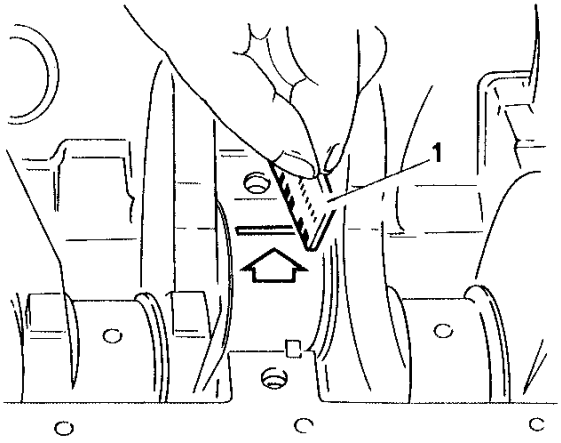
1. Tighten the lubricated main caps to the prescribed torque.

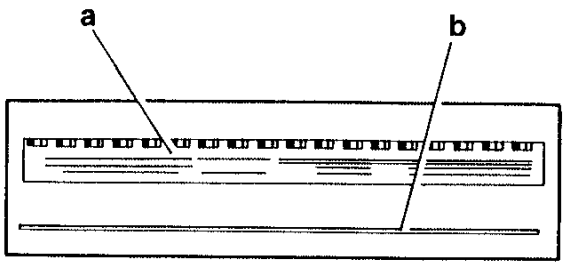
20 Nm + 90°
2 kgm + 90°



1. Remove the main cap and compare the width of the pressed gauged wire with the graduation contained in the suitable sachet.
   From the comparison between the width of the pressed wire and the graduation, it is possible to determine the clearance existing between the journals and the relative bearing halves.
- Proceed in the same way for the other main journals.

Radial clearance between main journals and bearing halves	
Class A	0.037 - 0.061 mm
Class B	0.025 - 0.049 mm
Class C	0.013 - 0.037 mm





a. Sachet with comparison graduation
b. Gauged wire

CYLINDER LINERS

- The cylinder liners are selected, on the basis of their internal diameter, in five dimensional classes.

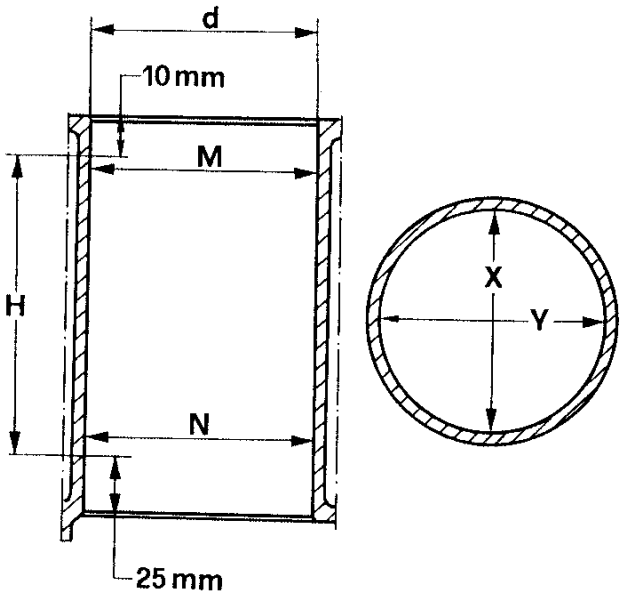
1. Measure the internal diameter of the cylinder liners with an bore meter, connected to a comparator.

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

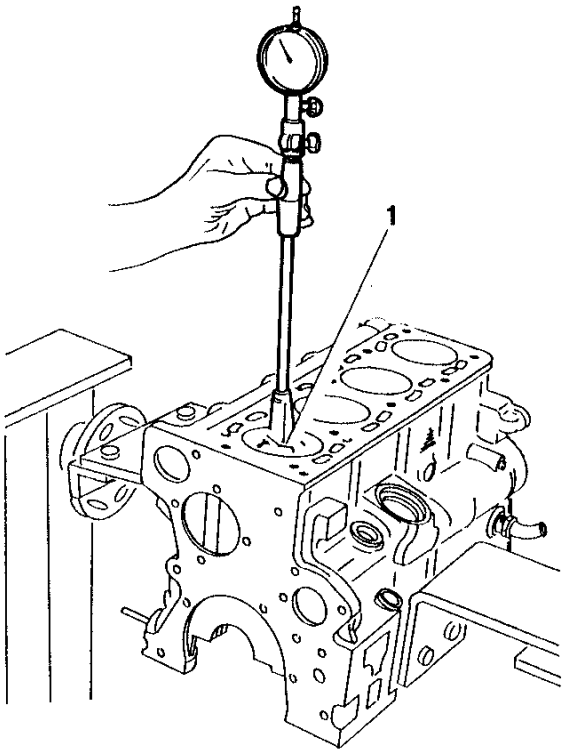
Internal diameter "d"	
Class A	84.000 - 84.010 mm
Class B	84.010 - 84.020 mm
Class C	84.020 - 84.030 mm
Class D	84.030 - 84.040 mm
Class E	84.040 - 84.050 mm

Maximum taper
M - N = 0.012 mm

Maximum ovalization
X - Y = 0.01 mm



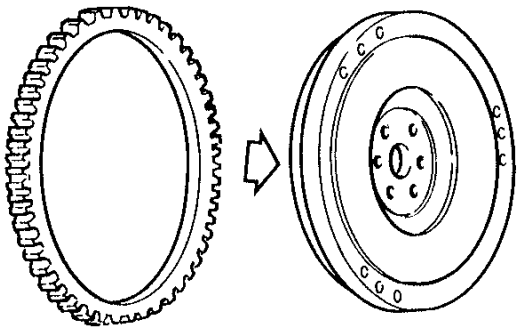
H = area for dimensional check



REPLACEMENT OF ENGINE FLYWHEEL RING GEAR

- Check the state of the engine flywheel ring gear and, if necessary, replace it proceeding in the following way:

- remove the old ring gear using a hydraulic press.
- thoroughly clean the surfaces in contact with the new ring and the flywheel.
- heat the new gear evenly to a temperature of **120 - 140°C** and fit it to the flywheel.
- leave to cool naturally; do not force cool.



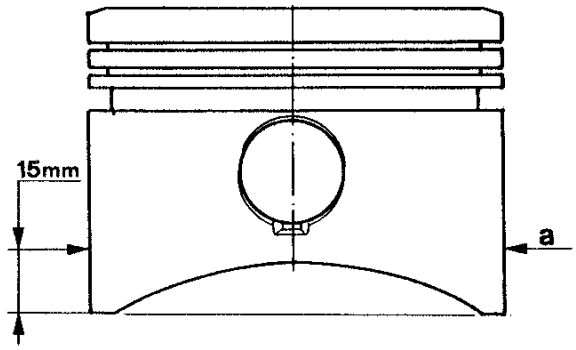
PISTONS AND GRUDGEON PINS

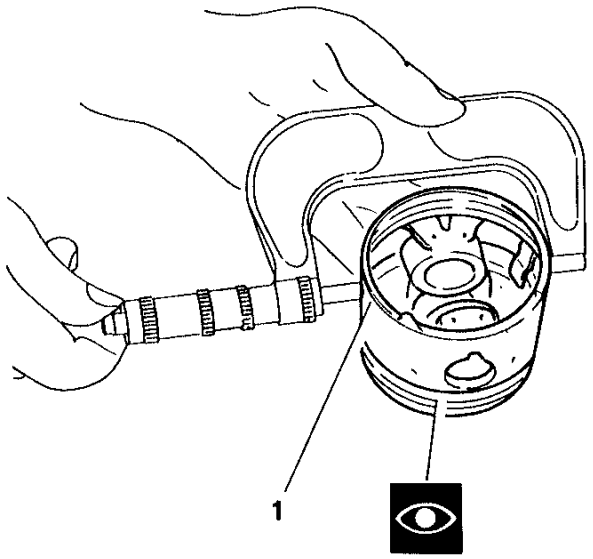
– The pistons are selected on the basis of their external diameter into five dimensional classes.

1. Check that the external diameter of the pistons falls within the prescribed limits.

∅	External diameter "a" (1)
Class A	83.940 - 83.950 mm
Class B	83.950 - 83.960 mm
Class C	83.960 - 83.970 mm
Class D	83.970 - 83.980 mm
Class E	83.980 - 83.990 mm

(1) The external diameter of the piston must be measured perpendicularly to the hole for the grudgeon pin and at a distance of 15mm from the lower edge of the skirt.

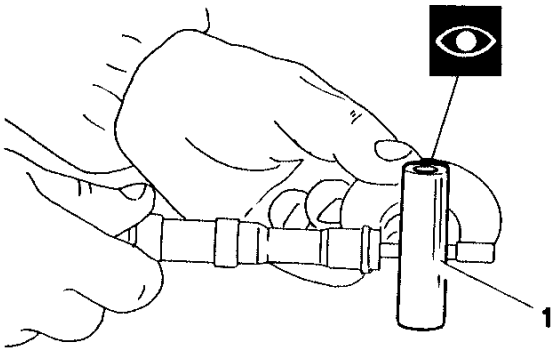




– Both the grudgeon pins and the relative coupling holes with the pistons are divided into two dimensional classes.

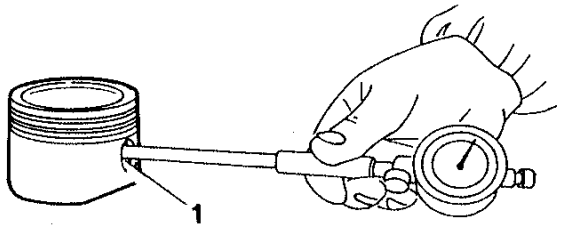
1. Check that the external diameter of the grudgeon pins fall within the prescribed limits.

∅	Diameter of external grudgeon pin
Class 1	21.991 - 21.994 mm
Class 2	21.994 - 21.997 mm



1. Check that the diameter of the coupling holes with the grudgeon pins falls within the prescribed limits.

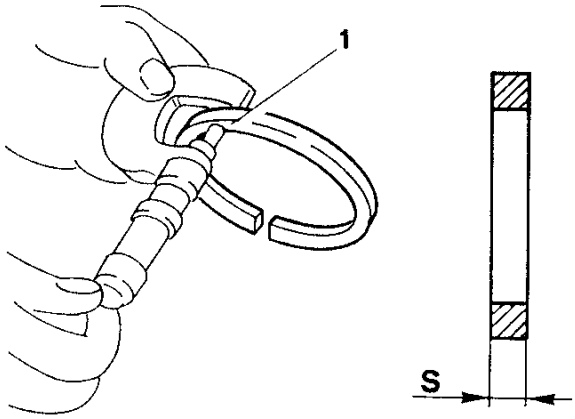
∅	Diameter of grudgeon pin hole in the piston
Class 1	21.996 - 21.999 mm
Class 2	21.999 - 22.002 mm



SEAL RING AND SCRAPER RING

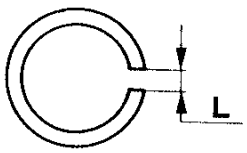
1. Measure the thickness "S" of the seal rings and that of the scraper rings and check that they fall within the prescribed limits.

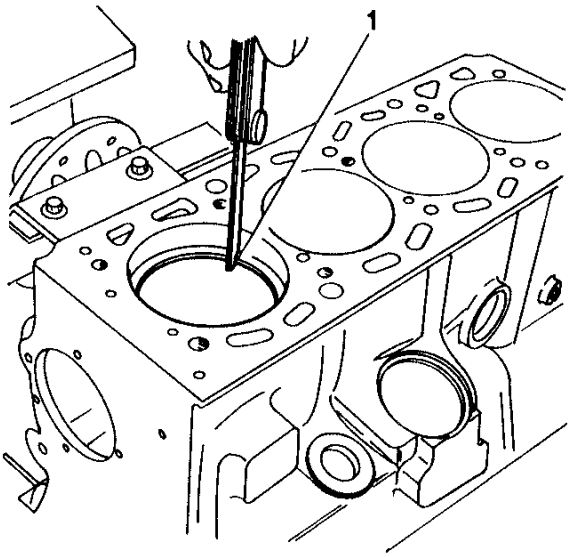
Thickness of seal ring "S"	
First ring	1.478 - 1.490 mm
Second ring	1.978 - 1.990 mm
Scraper ring	3.925 - 3.937 mm



1. Insert the seal ring in the cylinder liner and check, using a thickness gauge, that the gauge value "L" falls within the prescribed tollerances.

Ring gauge "L"	
First ring	0.30 - 0.50 mm
Second ring	0.30 - 0.50 mm
Scraper ring	0.25 - 0.40 mm

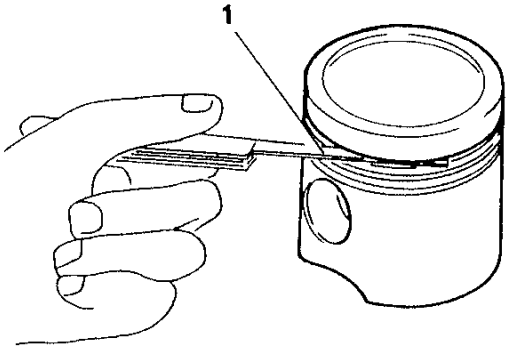




- Lubricate the seal rings with clean engine oil and assemble them to the piston.

1. Measure the clearance between the seal rings and the respective seatings on the piston using a thickness gauge and check that it falls within the prescribed limits.

Axial play between seats and seal rings	
First ring	0.045 - 0.077 mm
Second ring	0.030 - 0.062 mm
Scraper ring	0.030 - 0.062 mm

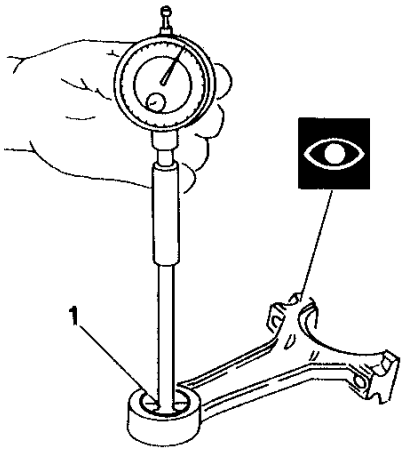


RODS

– Visibly check the rods for cracks, scratches and excessive wear.

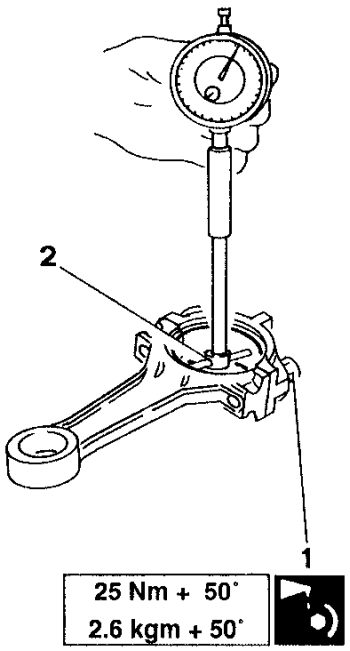
1. Measure the diameter of the bushing positioned at the bottom of the rods with an bore meter connected to a comparator and check that the value falls within the prescribed limits.

Diameter of internal bushing at bottom of rod	
Class 1	22.004 - 22.007 mm
Class 2	22.007 - 22.010 mm



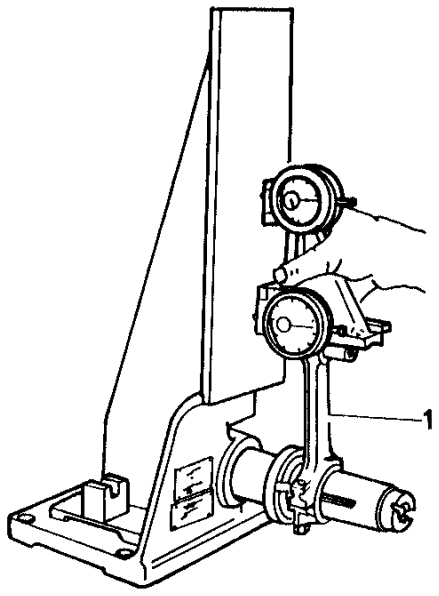
1. Install the rod caps tightening the lubricated screws to the prescribed torque.
2. Check that the internal diameter of the rod head falls within the prescribed limits.

Internal diameter of rod head	
Class 1	53.904 - 53.910 mm
Class 2	53.898 - 53.904 mm
Class 3	53.892 - 53.896 mm



1. Check that the rods are perpendicular using a surface plate as indicated in the figure.

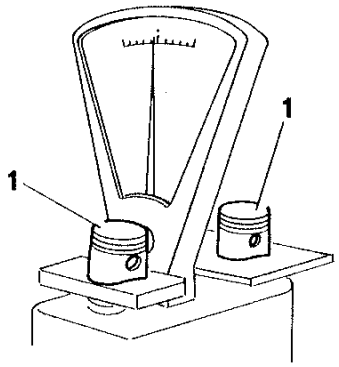
NOTE: **If the squareness is imperfect, the rod must be replaced to avoid stressing during engine functioning, with subsequent irregular wear of the piston and the rod itself.**



CHECK THE WEIGHT DIFFERENCE BETWEEN THE SINGLE PISTONS AND THE SINGLE RODS

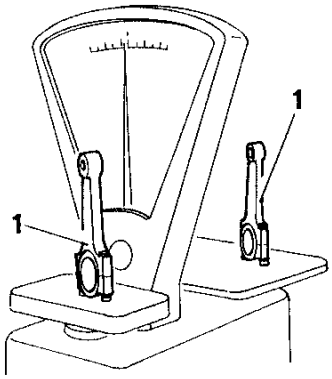
1. Weigh the pistons complete with seal ring, scraper ring and grudgeon pin and check that the weight difference falls within the prescribed limits.

Weight difference between the pistons
± 5g



1. Check, in the same way, that the weight difference between the rods complete with bearing halves, caps and screws falls within the prescribed limits.

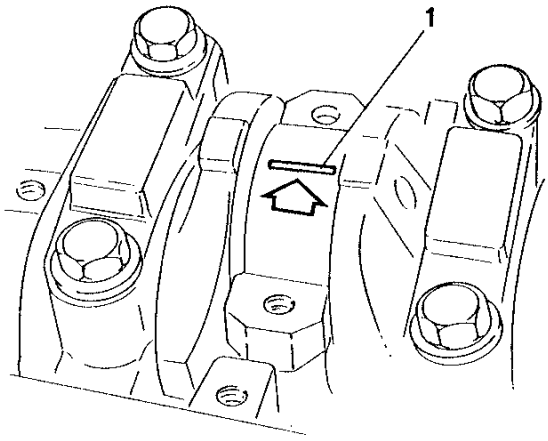
Weight difference between the rods
± 5g



MEASURE THE INSTALLATION CLEARANCE BETWEEN ROD JOURNALS AND RELATIVE BEARING HALVES USING GAUGED WIRE (PLASTIGAGE)

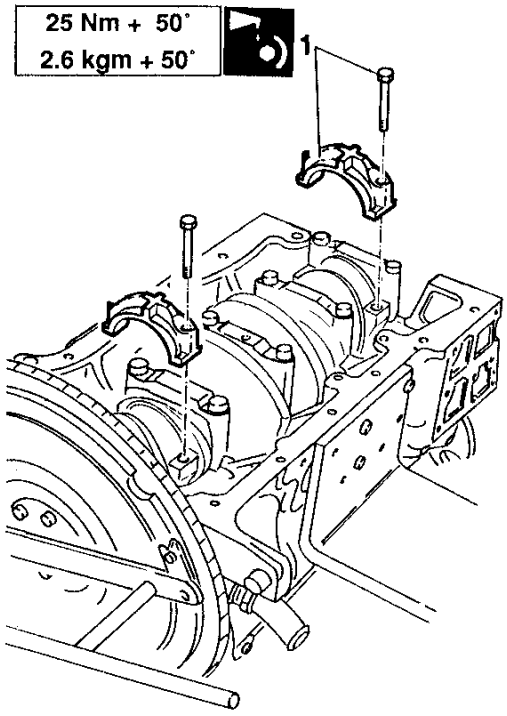
1. Rest the gauged wire on the whole width of the rod journal to be checked, paying careful attention that it does not cover the lubrication holes.

NOTE: The bearing halves must be housed in the respective seatings.



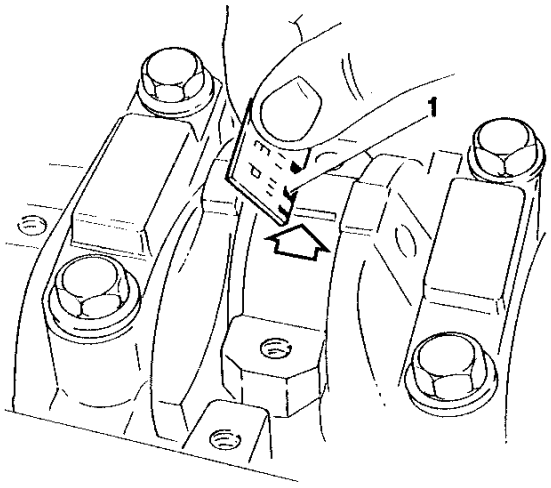
1. Tighten the lubricated screws of the rod journal to the prescribed torque.

25 Nm + 50°
2.6 kgm + 50°



1. Remove the rod journal cap and compare the width of the pressed gauged wire with the graduation contained in the sachet.
- From the comparison between the width of the pressed wire and the graduation, it is possible to determine the clearance existing between the bearing halves and the rod journals.
- Proceed in the same way for the other rod journals.

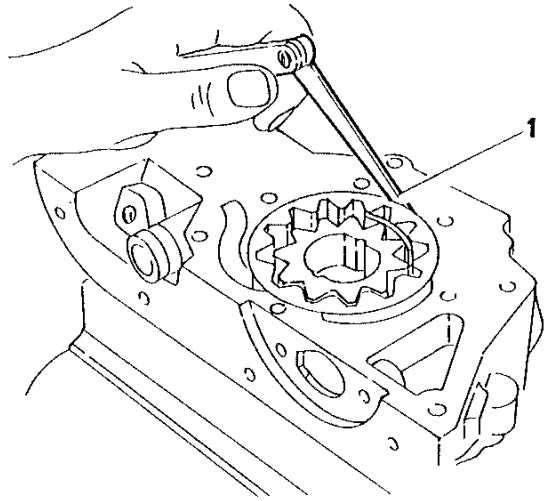
Radial clearance between the rod journals and the rod bearing halves	
Class A	0.025 - 0.049 mm
Class B	0.013 - 0.037 mm
Class C	0.001 - 0.023 mm



OIL PUMP CHECKS AND INSPECTIONS

1. Check that clearance between the pump body seating and the driven gear falls within the prescribed value.

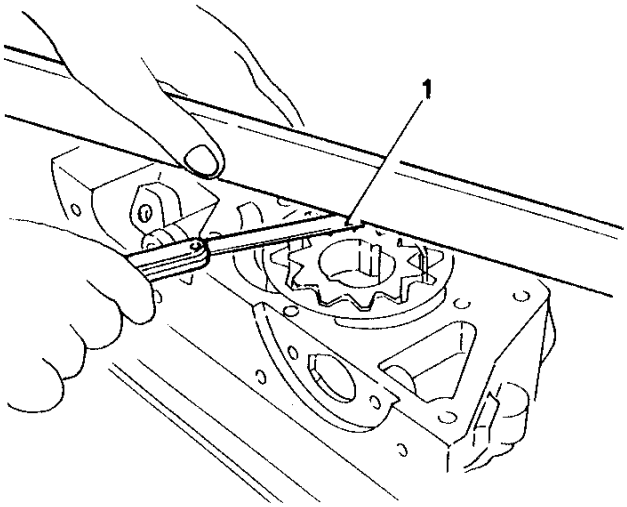
Clearance between pump body seating and driven gear
0.080 - 0.186 mm



1. Check that the clearance between the face of the pump cover and the upper side of the gears falls within the prescribed values.

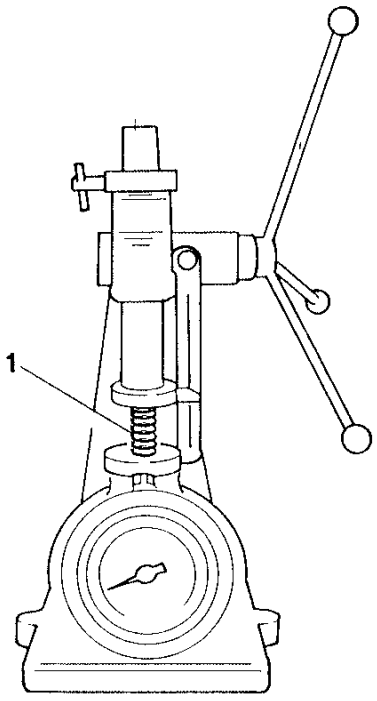
CAUTION:
If the clearance values are not within the prescribed limits, replace the front cover complete with oil pump.

Clearance between face of pump and upper side of gears
0.025 - 0.056 mm



1. Check with a dynamometer the characteristic values of the engine oil pressure relief valve control spring.

Controlling load N (kg)	Length of spring mm
113 - 121 (11.48 - 12.32)	35.3

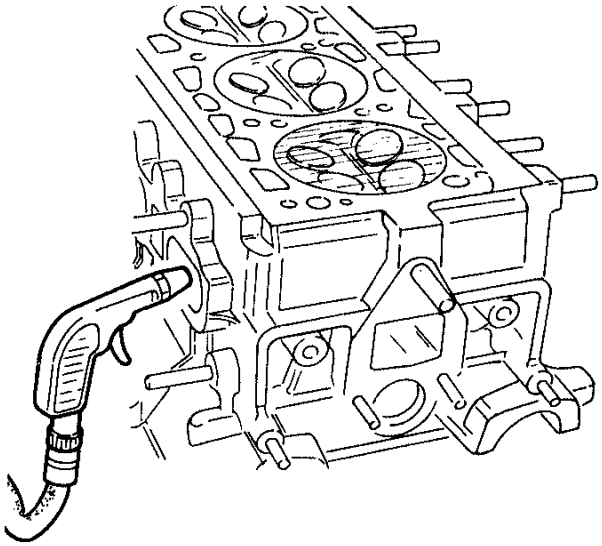


INDICATIONS FOR REASSEMBLY

For the reassembly operations, follow the procedure used for disassembly in the reverse order unless otherwise indicated below.

CHECKING VALVE LEAKAGE

- After having installed the valves complete with springs, plates and cotters, check the valve leakage in the following way:
  - insert the spark plugs in their seatings
  - pour a small quantity of petrol into one of the combustion chambers so that it just covers the valve heads.
  - blow low pressure air into the intake and exhaust ports and check that bubbles do not form in the petrol. If there are bubbles, check it is assembled correctly and grind the valve seatings again if necessary.



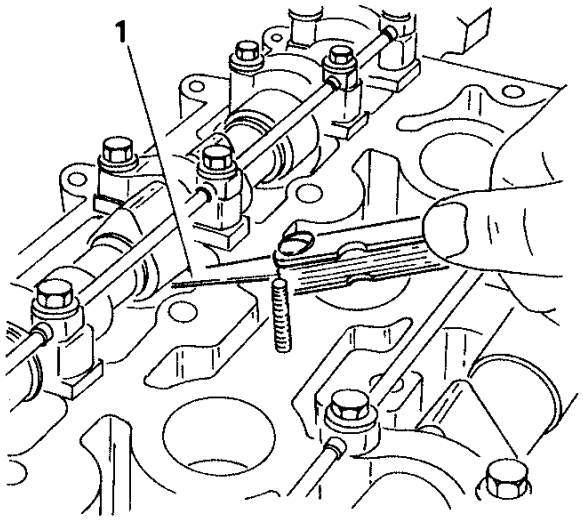
VALVE CLEARANCE CHECKS AND REGULATION

– After having reassembled the camshaft, measure the valve clearance in the following way:
  • Rotate the camshaft involved until the eccentric is perpendicular (facing upwards) to the valve clearance regulation plate being checked.

CAUTION:
During this operation, pay particular attention to avoid damaging the valve irreparably.

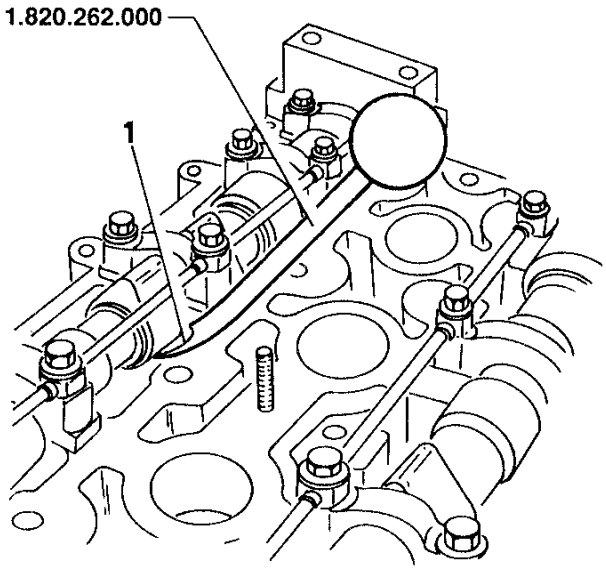
1. Check that the clearance between the lowered cam radius and the relative tappet falls within the prescribed limits.

Operating valve clearance (engine cold)	
Intake	0.36 - 0.44 mm
Exhaust	0.46 - 0.54 mm

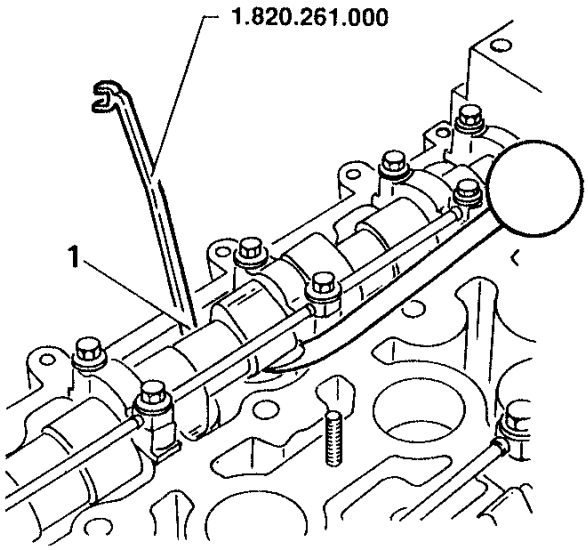


– If the clearance does not fall within the prescribed limits, proceed in the following way:

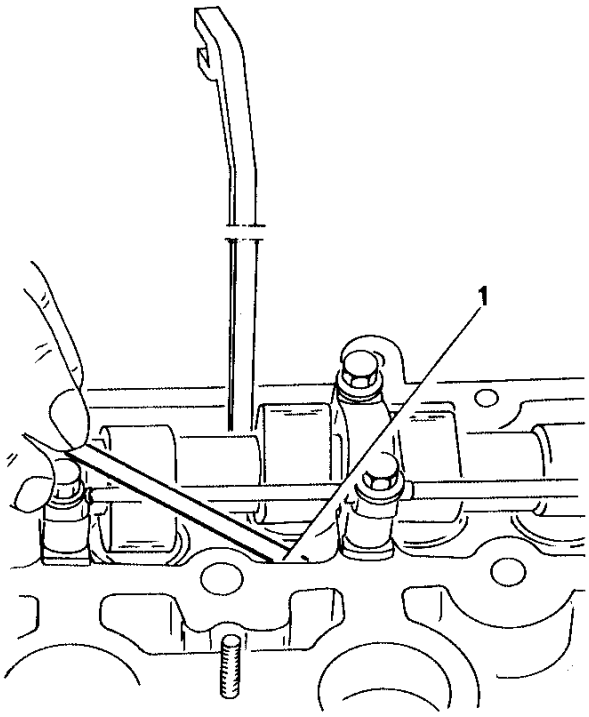
1. Using the pressure lever N° 1.820.262.000 lower the tappet.

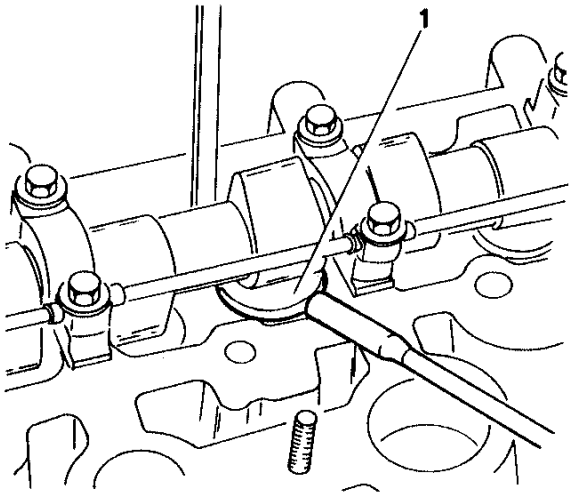


1. Position tappet blocking tool N° 1.820.261.000 directing the notches on the edge of the tappet so as to facilitate the subsequent extraction of the regulation plate to be replaced.



1. Extract the regulation plate using a scriber and extract it with a magnet.
– Replace with another plate whose thickness respects the correct clearance.





– Proceed in the same way to measure the operating clearance of the other valves.

REASSEMBLY OF CRANKSHAFT

1. Set the main bearing halves on the main supports.

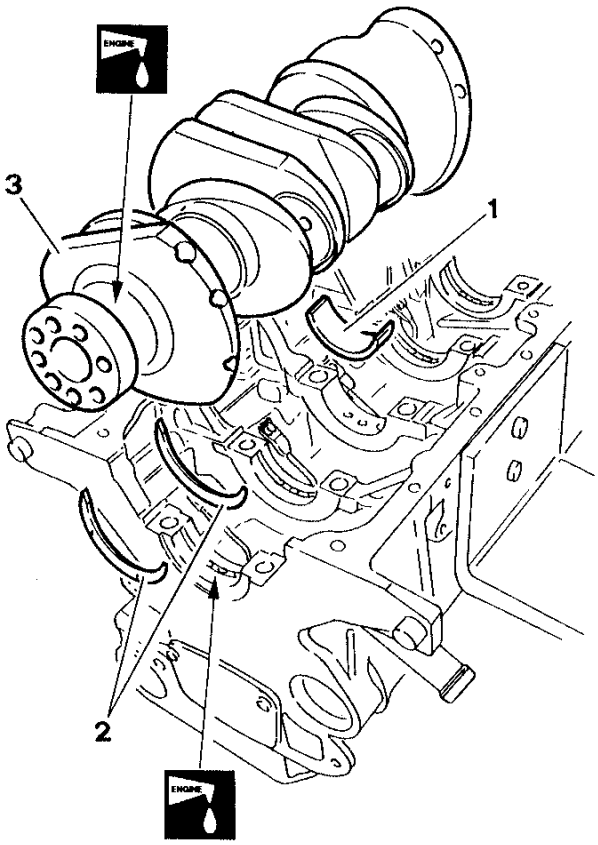
Clean the external surfaces of the bearing halves and the relative supports thoroughly.
Ensure that every bearing half rests on the whole seating of the main support.

NOTE: Installation onto the crankshaft must be carried out with parts of the same dimensional class.

2. Insert the thrust half-rings into their seatings.

Reassemble the thrust half rings with the grooved surface facing the crankshaft.

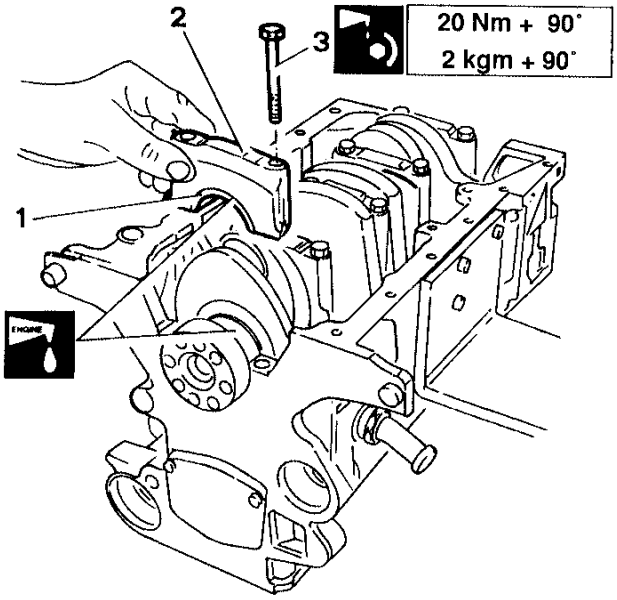
3. Position the crankshaft.

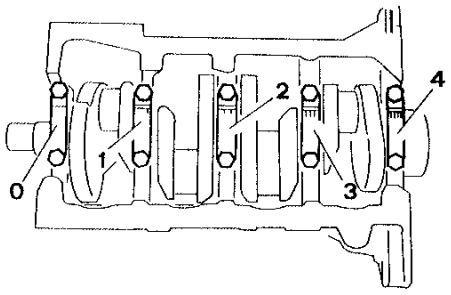


1. Fit the main bearing halves in the main caps.
2. Install the main caps.

CAUTION:
The position of each cap is dictated by a series of progressive notches (from zero to four starting front the front engine side) engraved in the caps themselves.

3. In two or three interventions, starting from the main central cap, tighten the lubricated screws of the main caps to the prescribed torque.

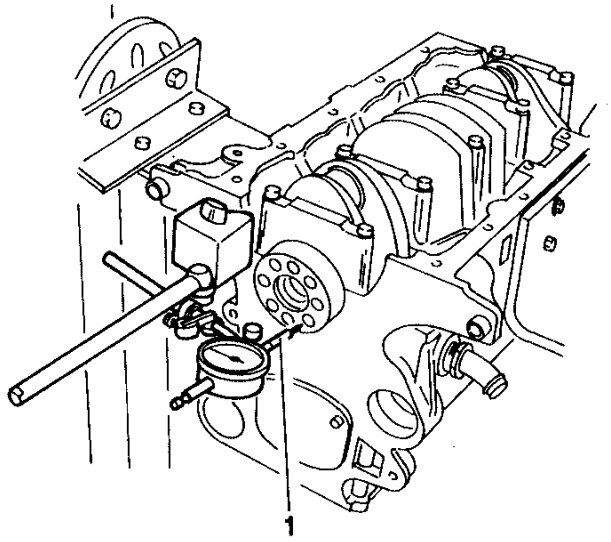




CHECK AXIAL PLAY OF CRANKSHAFT.

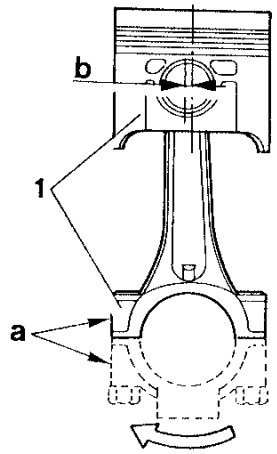
1. Using a comparator connected to a magnetic base, check that the axial play of the crankshaft falls within the prescribed limits.

Axial play of crankshaft
0.049 - 0.211 mm



REASSEMBLY OF RODS AND PISTONS

– Turn the driving shaft until the first and fourth cylinder rod journals correspond to the B.D.C. position.
1. Install the piston-rod assembly taking care that the number "a" stamped on the head of the rod is on the same side as the offset "b" of the grudgeon pin.



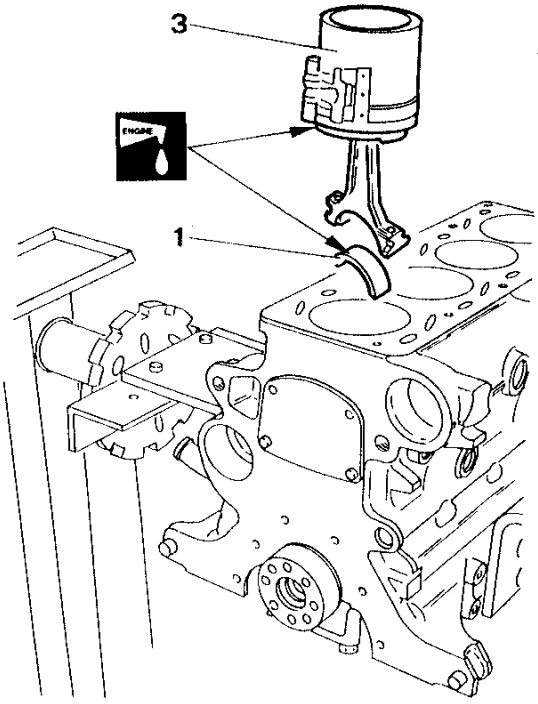
a. Number of cylinder to which the rod belongs
b. Offset of grudgeon pin

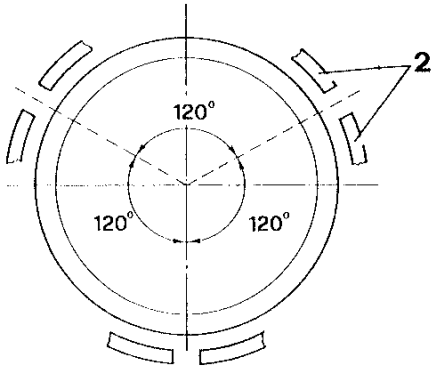
1. Set the relative bearing halves on the heads of the rod.

Clean the external surfaces of the bearing halves and their respective seatings thoroughly.

2. Set the piston rings in the pistons with the gaps staggered by 120°.
3. Using a suitable tool, insert the pistons and rods in the first and fourth cylinders.

Install the rod-piston assembly with the number of the cylinder stamped on the bottom of the rod facing towards the intake side.

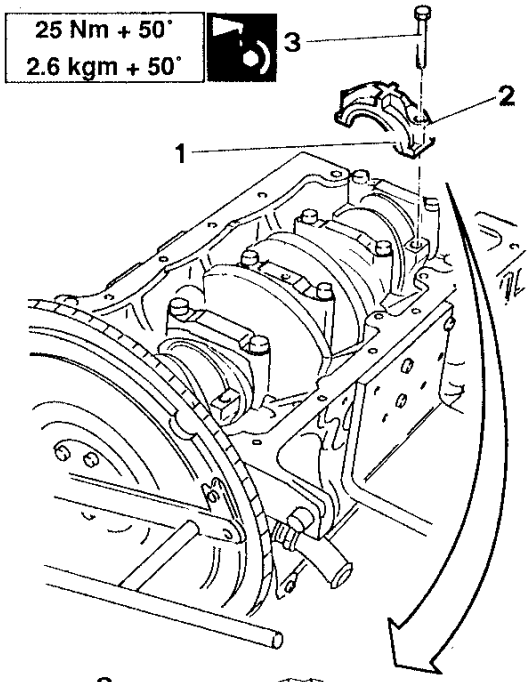


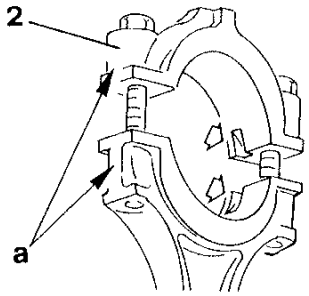


– Rotate the engine block by 180°.
1. Set the relative bearing halves on the main caps.
2. Install the first and fourth cylinder rod caps with the safety groove towards the same side as the corresponding groove on the head of the rod.

The rod caps contain the cylinder number to which they belong on the side; during reassembly, this number must be on the same side as the number stamped on the rod head.

3. Tighten the lubricated rod cap screws to the prescribed torque.
– Reassemble the second and third cylinder pistons and rods in the same way.





a. Number showing cylinder to which rods belong.

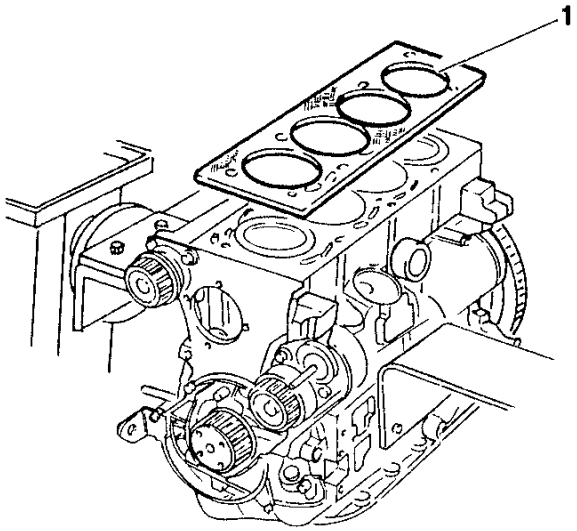
REFITTING CYLINDER HEADS

– Turn the crankshaft until the first and fourth pistons are in the T.D.C. position.

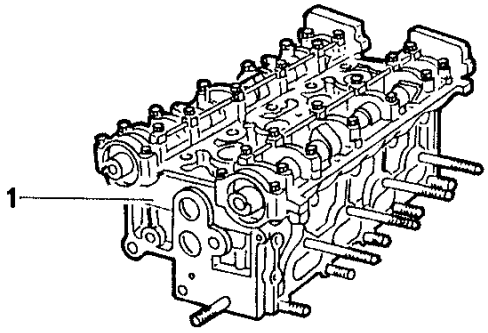
1. Position the cylinder head gasket on the engine block.

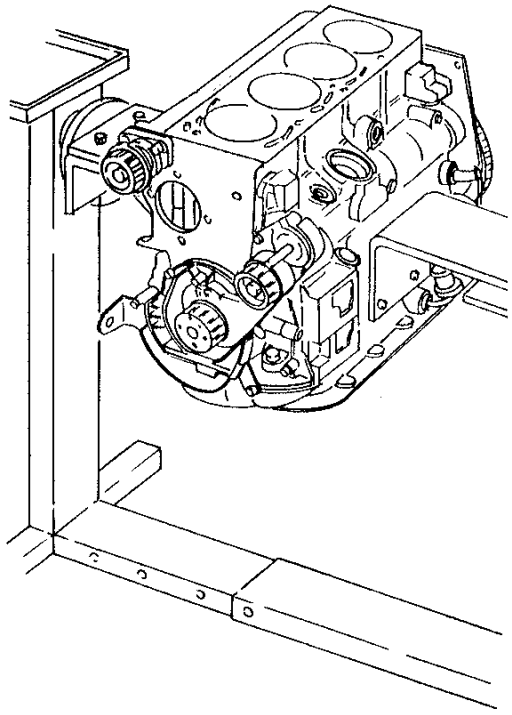
NOTE: The cylinder head gasket is of the ASTADUR type. This gasket, thanks to the special material from which it is made, undergoes a polymerization process during engine functioning and becomes considerably harder.

CAUTION:
ASSEMBLY OF CYLINDER HEAD GASKET
In order to ensure that the cylinder head gasket undergoes the polymerization process, it is necessary to:
- store the gasket in its packaging;
- remove it from the packaging just before assembly;
- do not lubricate or dirty the gasket with oil;
- during assembly, thoroughly clean the surfaces of the cylinder head and engine block.

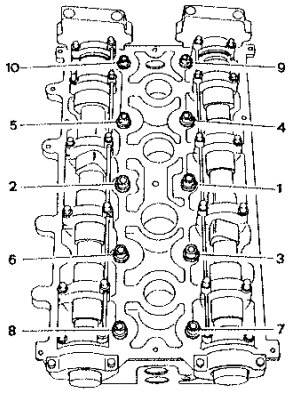


1. Install the cylinder heads on the engine block.

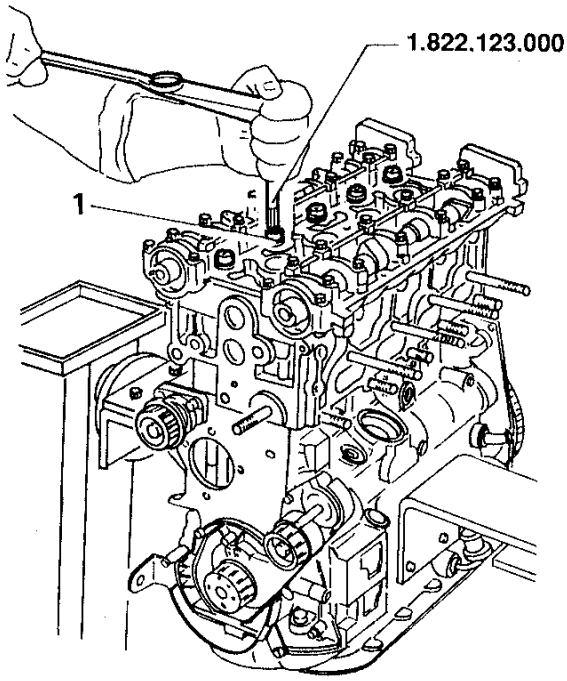




– Tighten the screws of the cylinder heads as described below and bear in mind that, for every phase, the tightening order is the one indicated in the figure.

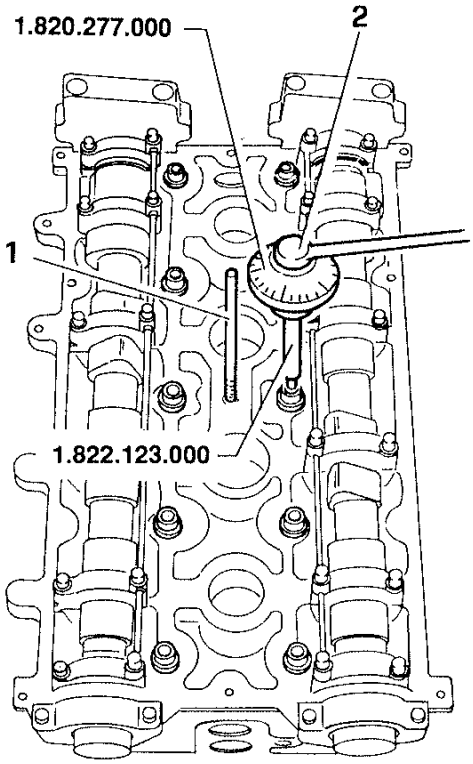


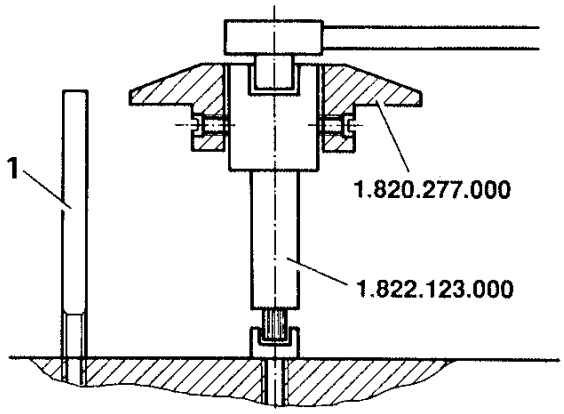
1. Using tool No. 1.822.123.000:
– tighten all screws up to a torque of 20 Nm;
– tighten all screws to the pretorque of 50 Nm.



1. Position a reference stud bolt (M5 x approx. 100 mm) near to screw No. 1.
2. Apply spanner No. 1.822.123.000 with graduated disk No. 1.820.277.000.
– Set the graduated disk to zero, with reference to the stud bolt installed previously.

– Using a suitable spanner, tighten to 90° + 90° angle.



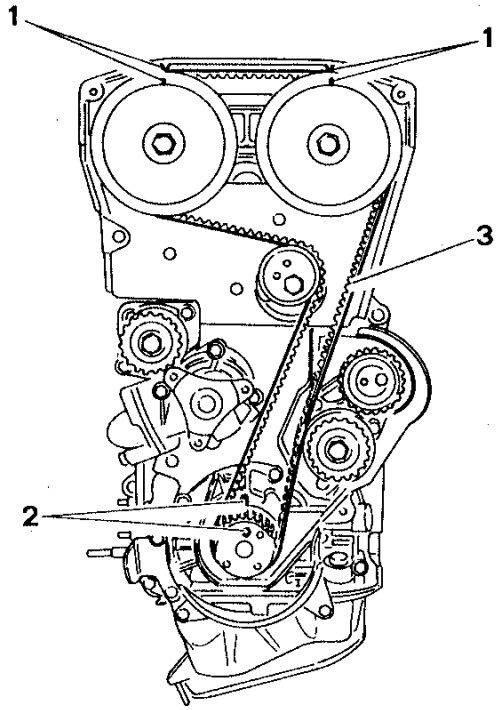


CAUTION:
The ASTADUR gaskets are coupled with cylinder head screws of the tighten to yield point type.
By using ASTADUR gaskets, it is no longer necessary to tighten the cylinder head screws at the first service

ASSEMBLY OF THE TIMING CONTROL BELT AND CHECKING OF ENGINE TIMING

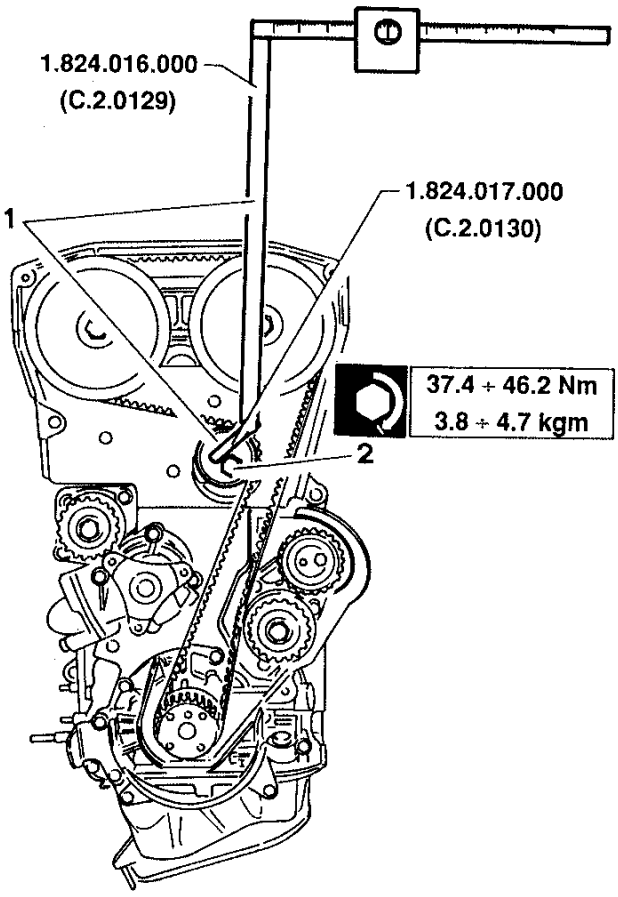
– Reassemble the toothed pulleys of the timing, the countershafts and the relative belt stretchers.
1. Position the camshaft control pulleys so that the notches correspond with those on the timing cover.
2. Rotate the crankshaft until the reference notch on the timing control belt toothed pulley is in line with the projecting part on the front cover.
3. Install the drive belt, checking that all the teeth of the pulley interlock correctly.

CAUTION:
When installing the drive belt, avoid sharply bending it so as not to compromise the structure of the belt's fibres.



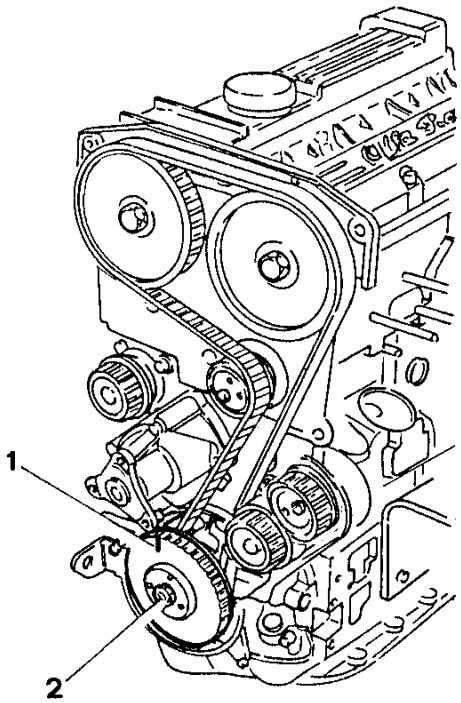
– Install on tool N° 1.824.016.000 (C.2.0129) the support N° 1.824.017.000 (C.2.0130), and position the weight, without the knurled part, **100 mm** on the millimetric rod and block it.
1. Use this tool, on the beltstretcher, as illustrated in the figure. Acting on the joint, rotate the millimetric rod so that it is horizontal.
– Set the beltstretcher making the crankshaft complete two turns in the normal rotation direction.
2. Tighten the beltstretcher screw to the prescribed torque.

CAUTION:
During this last phase the millimetric rod may move from the horizontal position; in this case, acting again on the beltstretcher, it is necessary to reset the millimetric rod in the original position and repeat the operation.



ASSEMBLY OF THE COUNTERSHAFTS CONTROL BELT AND THE CHECKING OF ENGINE TIMING

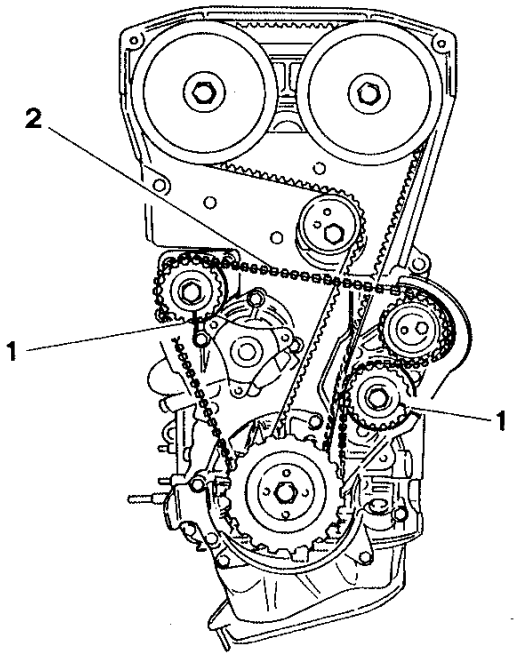
1. Check the exact timing and install the countershafts control belt pulley so that the references notches face upwards.
2. Tighten the screws to the prescribed torque.



180.5 ÷ 199.3 Nm
18.4 ÷ 20.3 kgm

1. Turn the countershaft control pulley so that the notch is in line with the reference on the water pump for the countershaft intake side and with the reference on the sheet metal internal cover for the countershaft exhaust side.
- Ensure that the reference on the countershaft control pulley on the crankshaft is facing upwards.
2. Install the drive belt, checking that all the teeth of the pulley interlock correctly.

CAUTION:
When installing the drive belt, avoid sharply bending so as to not compromise the structure of the belt's fibres.



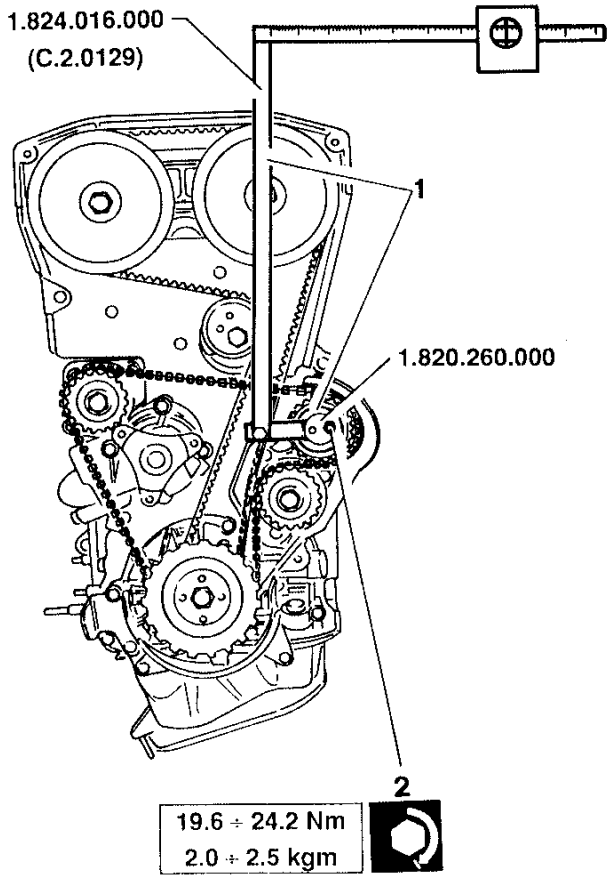
- Install on tool N° 1.824.016.000 (C.2.0129) the support N° 1.820.260.000. Position the weight, without the knurled part, at **205 mm** on the millimetric rod and block it.

1. Use this tool, on the beltstretcher, as illustrated in the figure. Acting on the joint, rotate the millimetric rod so that it is horizontal.

- Set the beltstretcher making the crankshaft complete two turns in the normal rotation direction.

2. Block the beltstretcher nut at the prescribed torque.

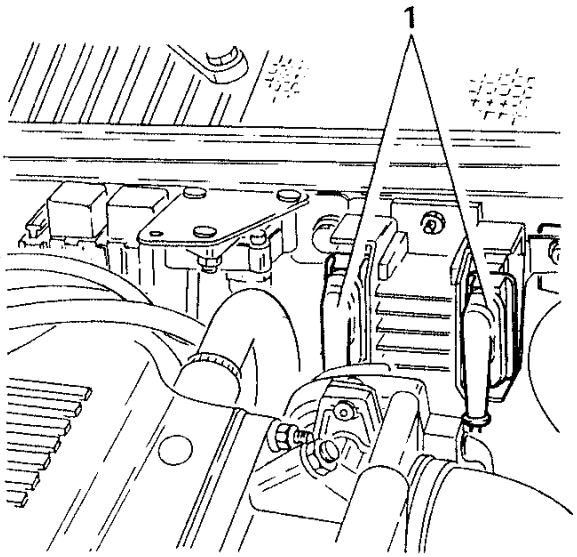
CAUTION:
During this last phase the millimetric rod may move from the horizontal position; in this case, acting again on the beltstretcher, it is necessary to reset the millimetric rod in the original position and repeat the operation.



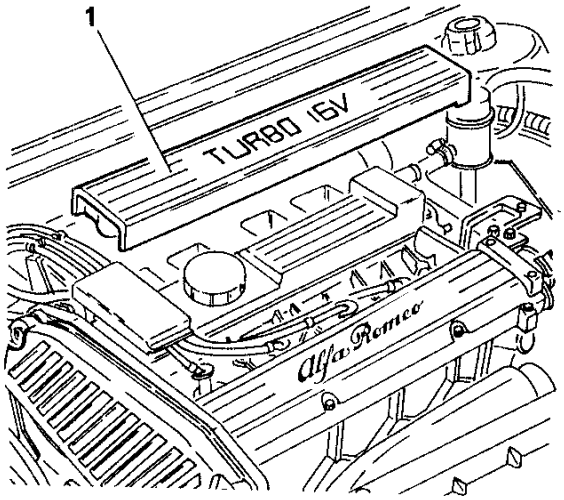
CYLINDER COMPRESSION TEST

- Start up the engine and let it run until it reaches the normal operating temperature.

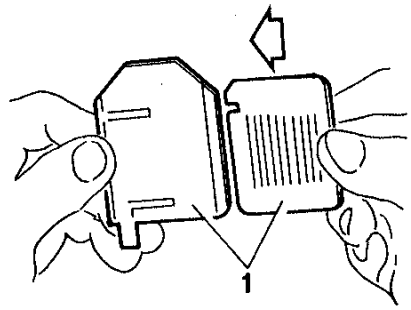
1. Disconnect the electrical connections from the power modules.



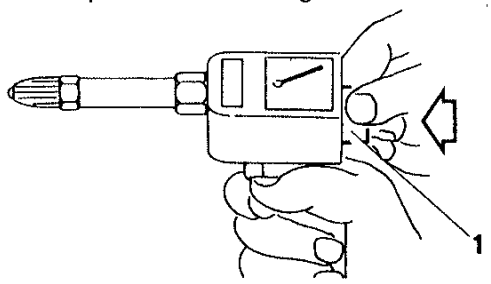
1. Remove the spark plug cover.



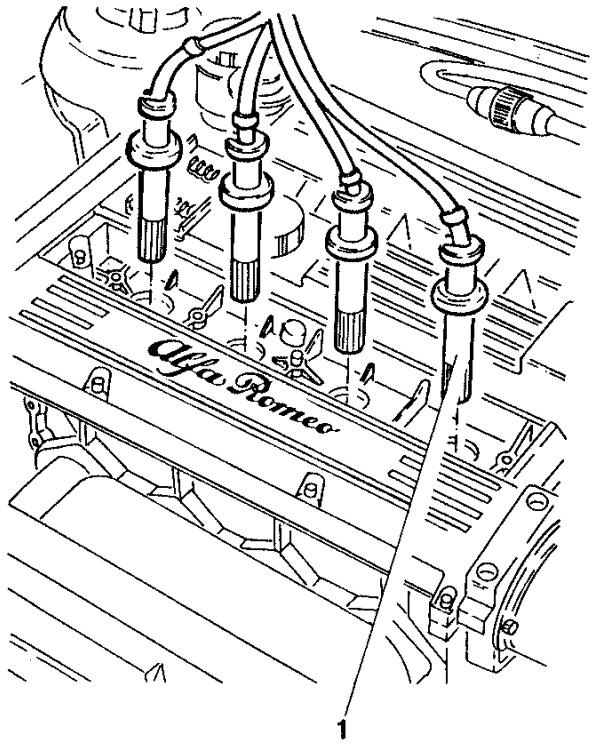
1. Fix a small card to the plate.



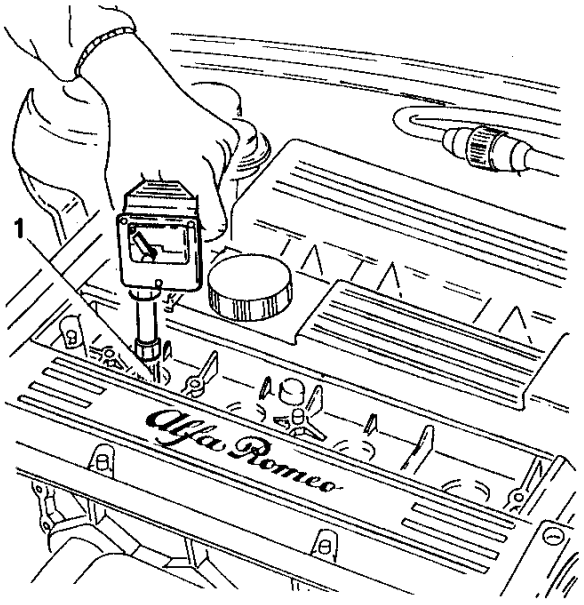
1. Insert the plate into the testing instrument.



1. Disconnect the spark plugs and remove them.

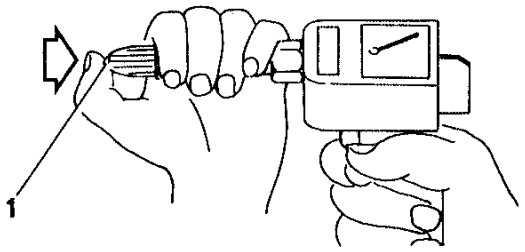


1. Press the instrument on the spark plug hole of the first cylinder

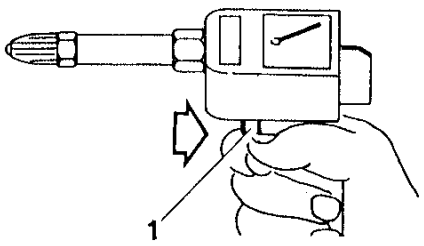


– Press the accelerator, start the engine and let it complete 10 - 12 giri.

1. Unload the testing instrument.



1. Move the card to "CYLINDER 2".



– Repeat the above mentioned operation for the remaining cylinders.

NOTE: If the pressure values measured in the cylinders show excessive differences, ascertain the causes by checking for valve leakage, the piston rings and the pistons.

AFTER INSTALLATION OF THE ENGINE a CYLINDER COMPRESSION TEST should be carried out in addition to the normal maintenance checks (see GROUP 00) and the checks regarding the fuel supply system (see GROUP 04) and the engine cooling system (see GROUP 07)

CHECKING ELECTRICAL COMPONENTS LUBRICATION CIRCUIT

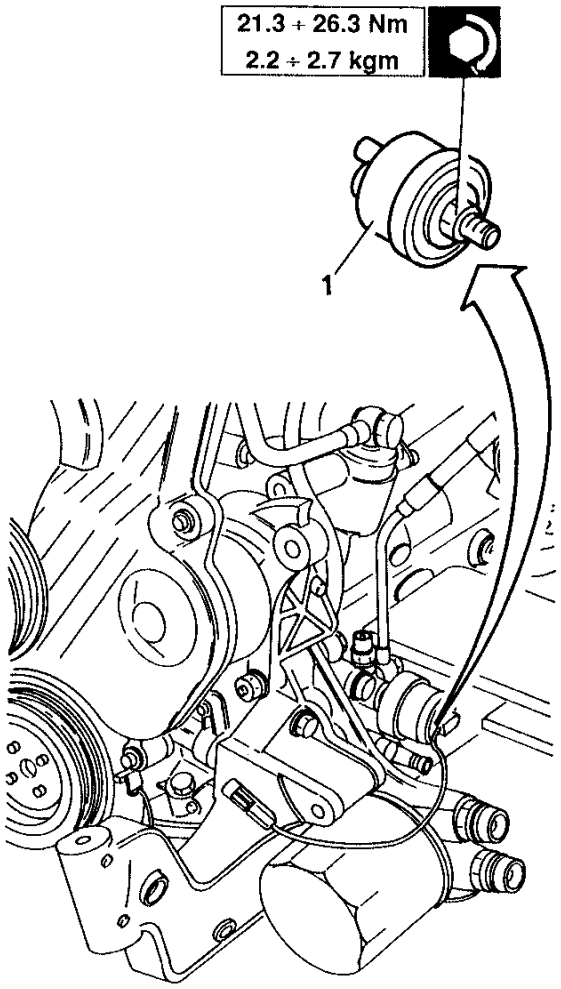
– Engine oil pressure meter.
– Engine oil temperature sensor.
– Engine oil minimum pressure warning light.

For the other sensors and electrical components located in the engine compartment refer to the specific groups where they are dealt with in more detail.

ENGINE OIL PRESSURE METER

1. Check the setting of the engine oil pressure meter. If the values do not fall within the prescribed limits, replace the meter.

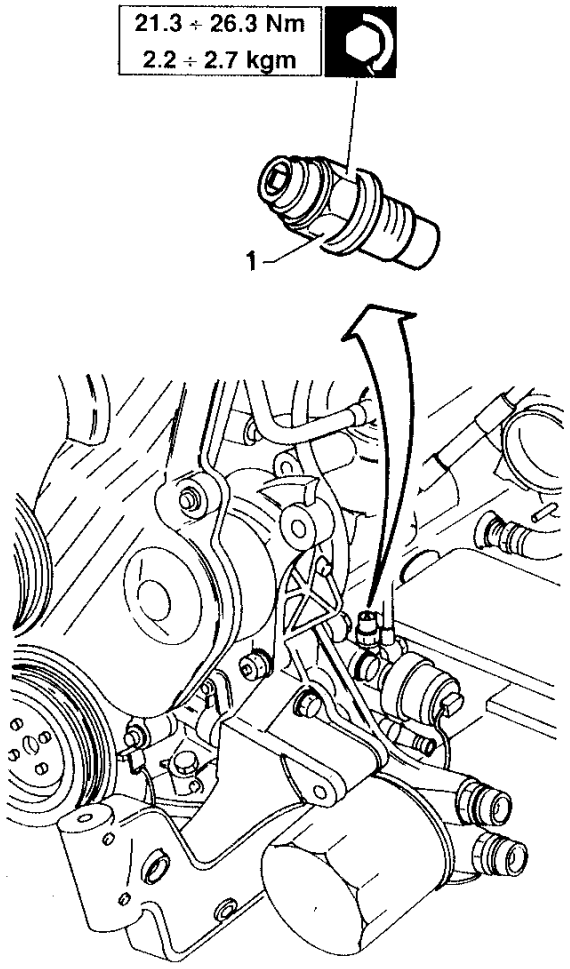
Pressure	Resistance
bar (kg/cm^2)	Ω
0	290 - 320
0.75 (0.76)	220 - 250
3 (3.06)	103 - 133
4.5 (4.6)	50 - 80
6 (6.2)	≥ 40



ENGINE OIL TEMPERATURE SENSOR

1. Check the setting of the engine oil temperature sensor. If the values do not fall within the prescribed limits, then replace the sensor.

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

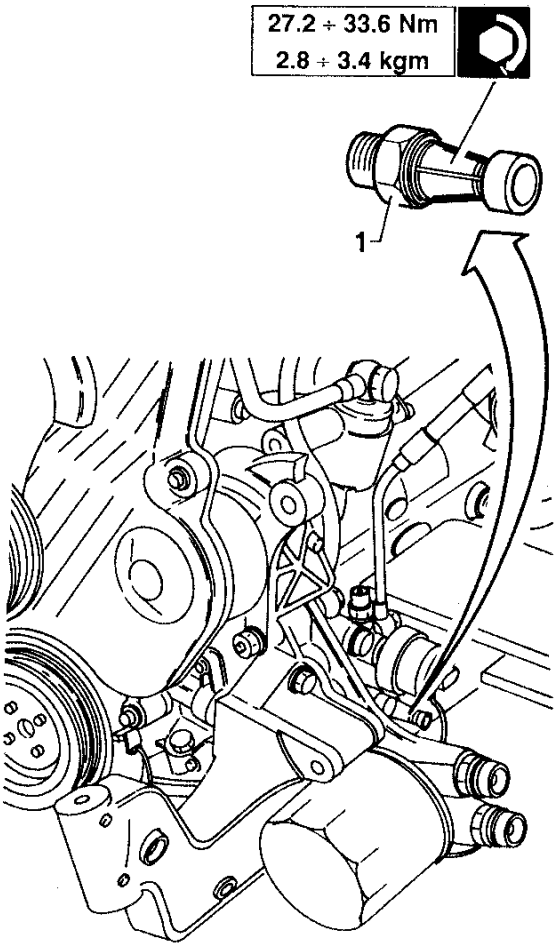


ENGINE OIL MINIMUM PRESSURE WARNING LIGHT

1. Check the setting of the engine oil minimum pressure warning light. If the values do not fall within the prescribed limits then replace the sensor.

Pressure	bar (kg/cm^2)
Setting (*)	0.20 - 0.50 (0.20 - 0.51)

(*) Value is valid during both contacts opening phase (pressure rising) and contacts closing phase (pressure falling).



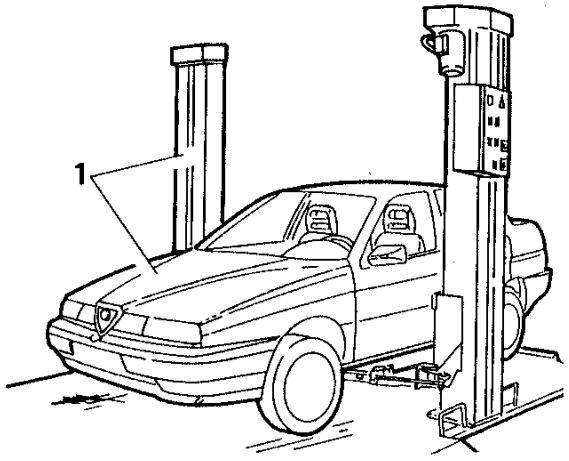
ON VEHICLE OPERATIONS

The preceding chapter described and illustrated the complete engine bench overhaul.
However, some of these operations can be carried out with the engine installed without necessitating its removal.
Among the most frequent operations, it is possible to **remove and refit the cylinder heads**, **remove and refit the oil sump** and **replace the countershaft oil seals** by following the indications given below.

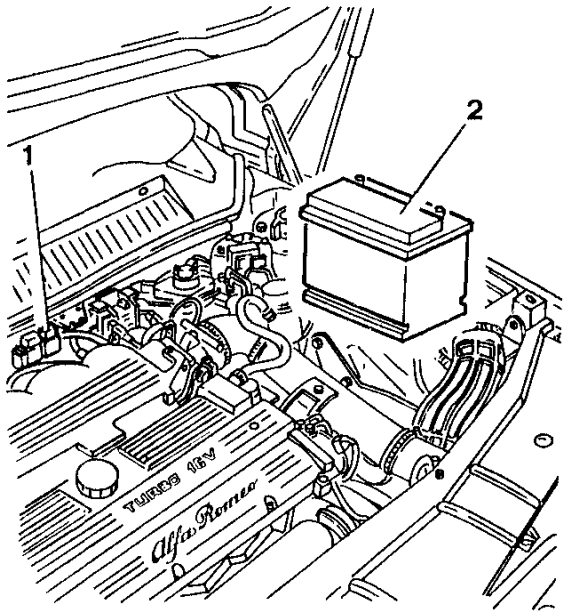
CYLINDER HEADS

REMOVAL

1. Position the vehicle on the lift.



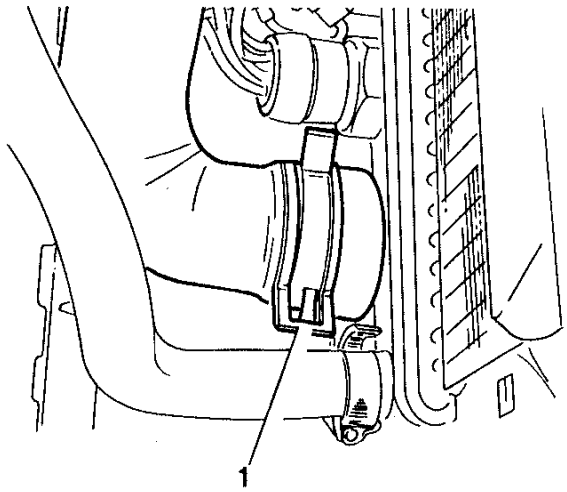
1. Release the pressure in the fuel supply system as follows:
   - disconnect the fuel pump supply relay as indicated in the figure;
   - start up the engine until it cuts out.
2. Remove the battery after having first disconnected the negative clamp (-) and then the positive one (+).



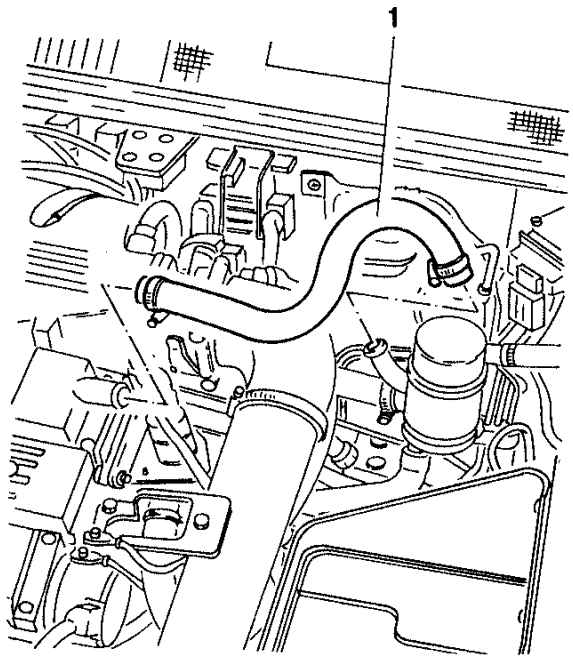
- Remove the pressurized plug from the expansion tank.
- Raise the vehicle on the lift.

1. Loosen the clamp on the engine coolant from radiator outlet sleeve and disconnect the sleeve itself; drain off and recover the coolant by placing a suitable container under the vehicle.

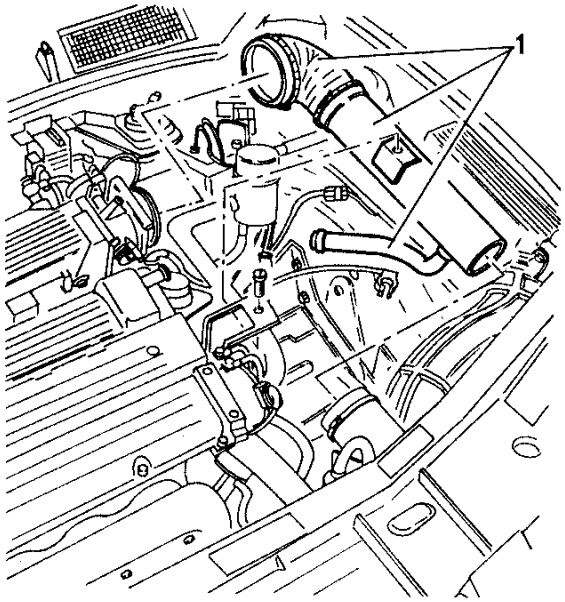
CAUTION:
The antifreeze mixture, used as a coolant, damages paint. Avoid any contact with painted parts.



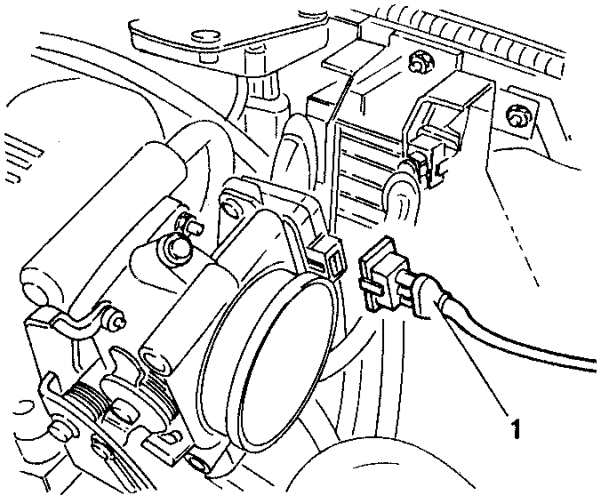
1. Remove the oil vapour recovery pipe from the head.



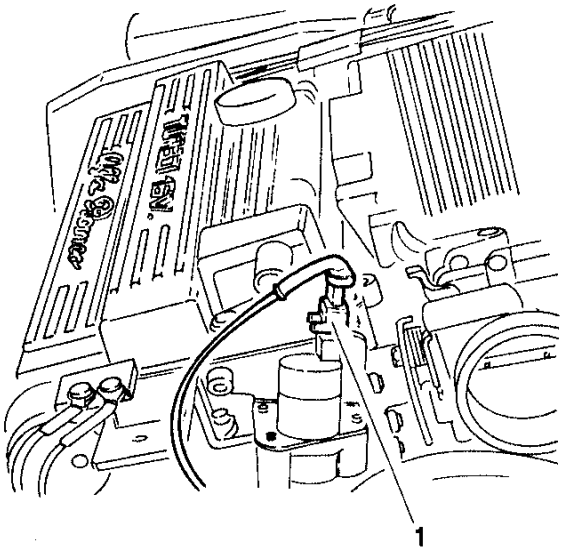
1. Remove the air intake manifold complete with connecting elbow to the throttle body and air intake tube for the constant idle speed actuator.



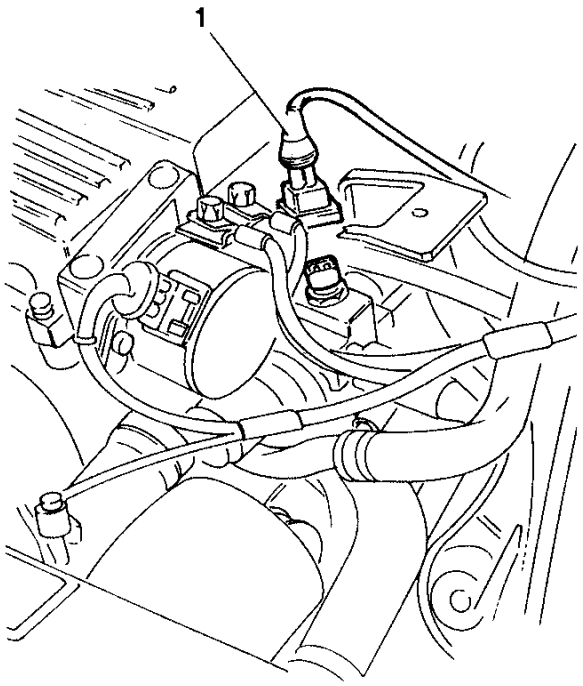
1. Disconnect the electrical connection of the throttle potentiometer.



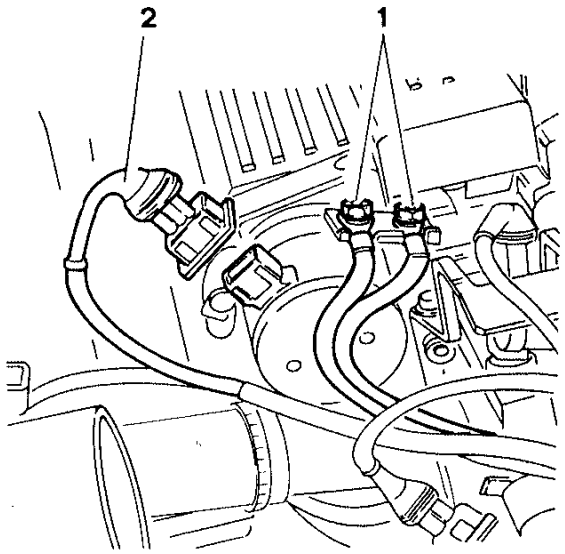
1. Disconnect the electrical connection from the constant idle speed actuator.



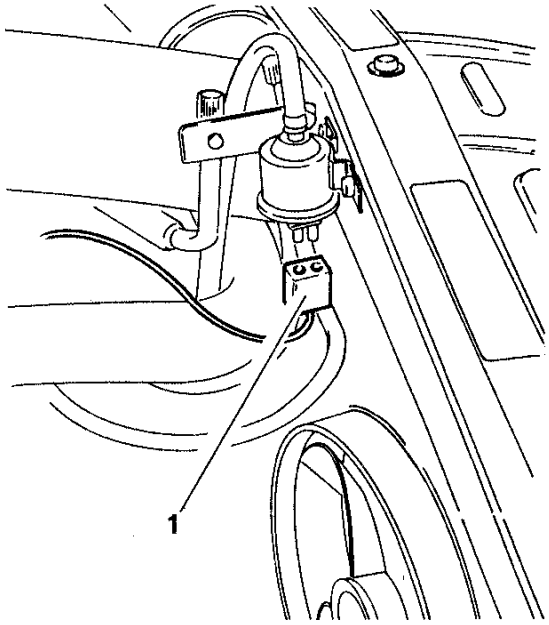
1. Disconnect the electrical connections from the engine coolant temperature sensor (NTC).



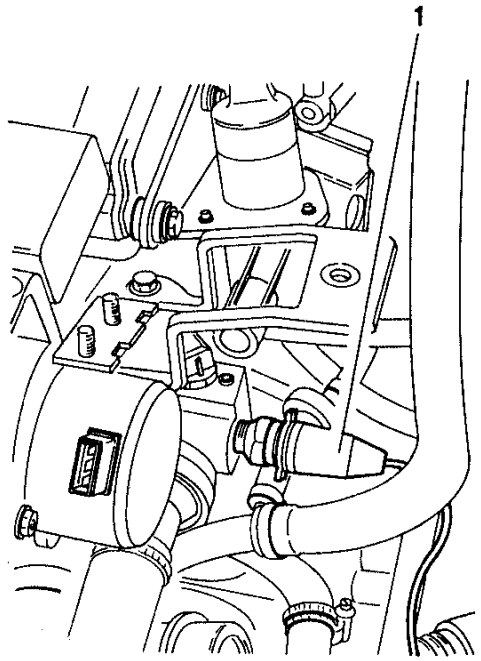
1. Disconnect the earth cables.
2. Disconnect the electrical connection of the stroke sensor.



1. Disconnect the electrical connection of the supercharging control device solenoid valve "PIERBURG".

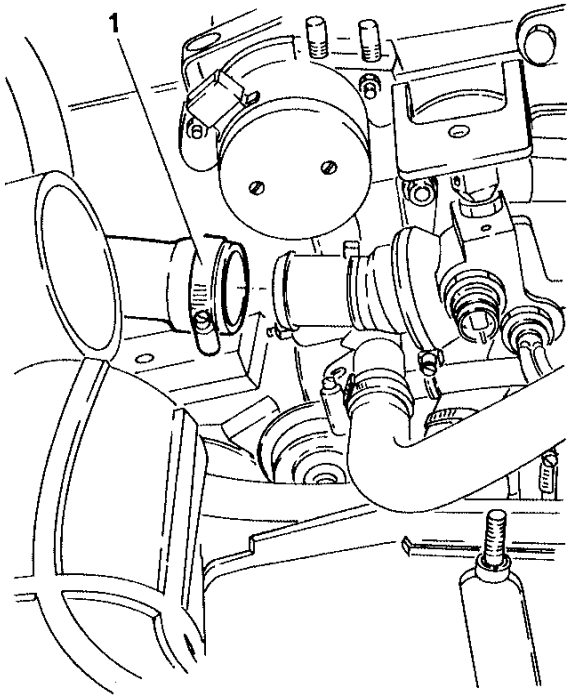


1. Disconnect the electrical connection of the engine coolant temperature transmittor and the maximum temperature warning light contact.

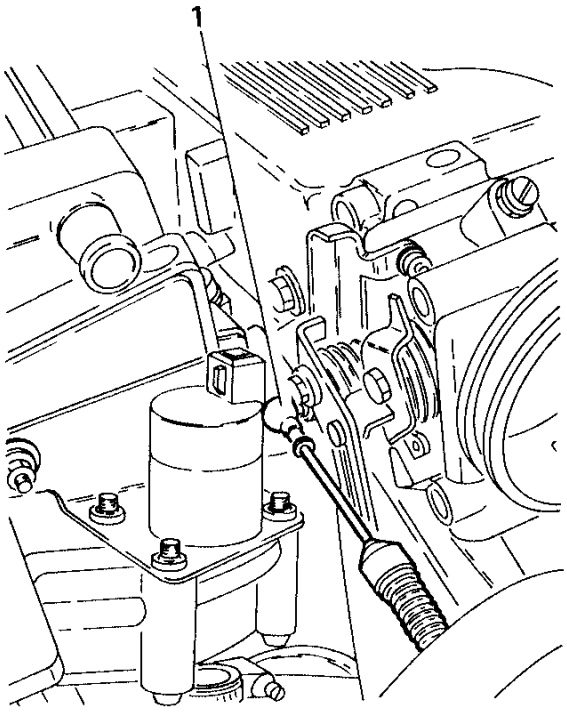


– Move the electrical wiring of the injector sideways to avoid interference during subsequent operations.

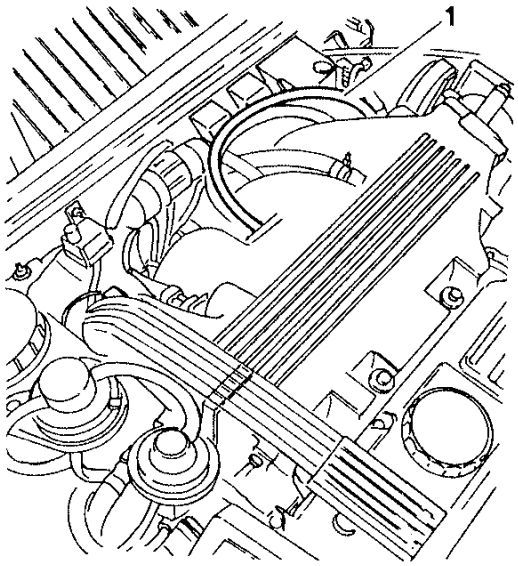
1. Disconnect the engine coolant to the radiator delivery tube from the thermostatic cup.



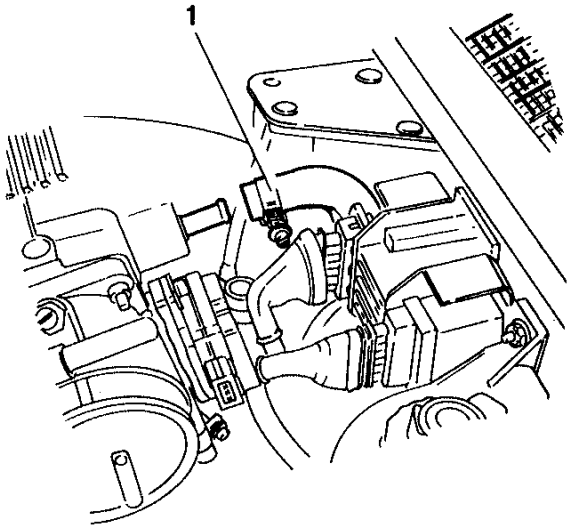
1. Disconnect the accelerator cable from the throttle valve.



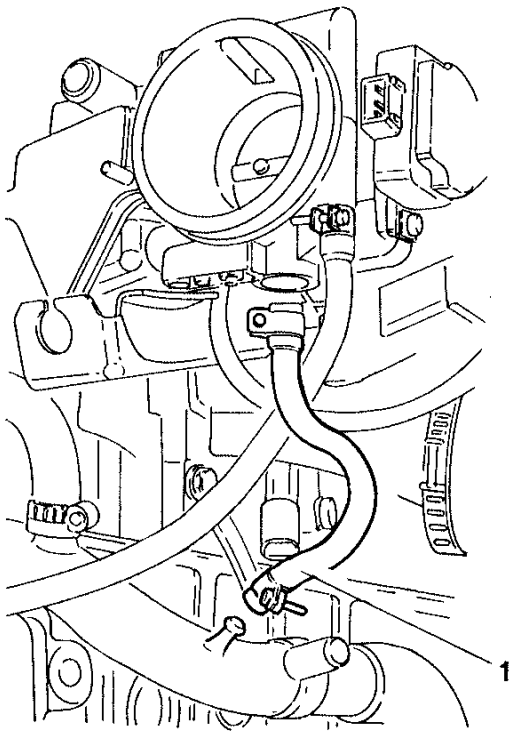
1. Disconnect the vacuum intake pipe for the antistall valve from the air intake box.



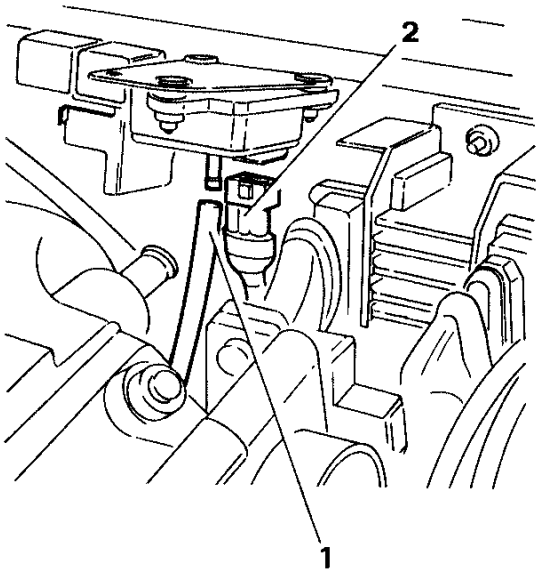
1. Disconnect the vacuum intake pipe for the servo brake from the air intake box.



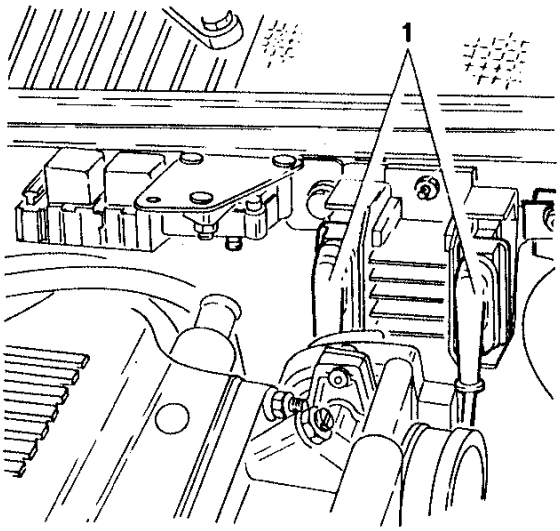
1. Disconnect the coolant outlet from the throttle body pipe from the coolant return to pump manifold.



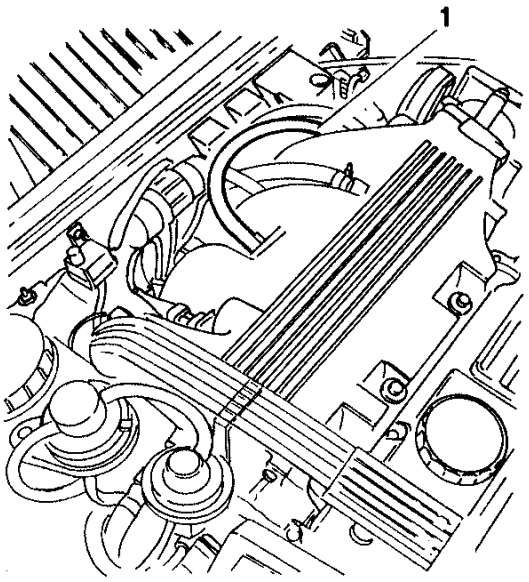
1. Disconnect the vacuum intake pipe from the absolute pressure sensor.
2. Disconnect the electrical connection of the absolute pressure sensor.



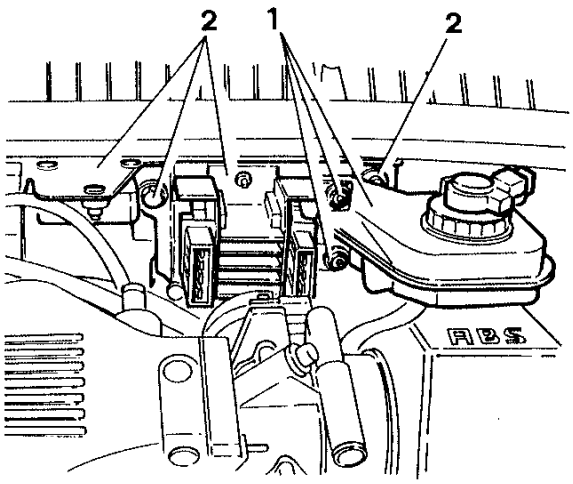
1. Disconnect the electrical connections from the ignition modules.



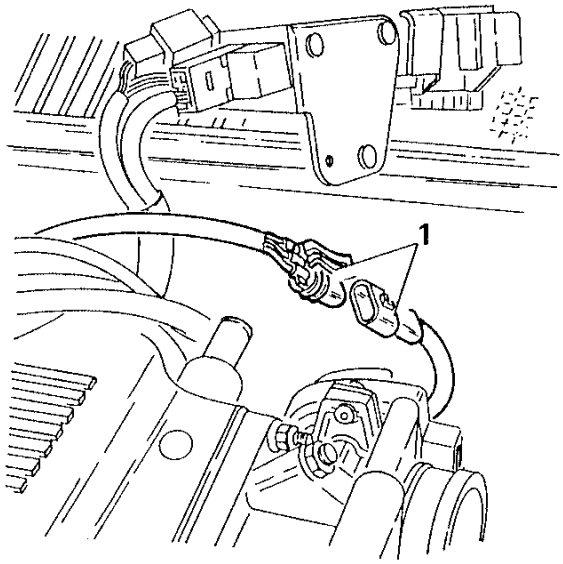
1. Disconnect the oil vapour recirculation pipe from the intake box.



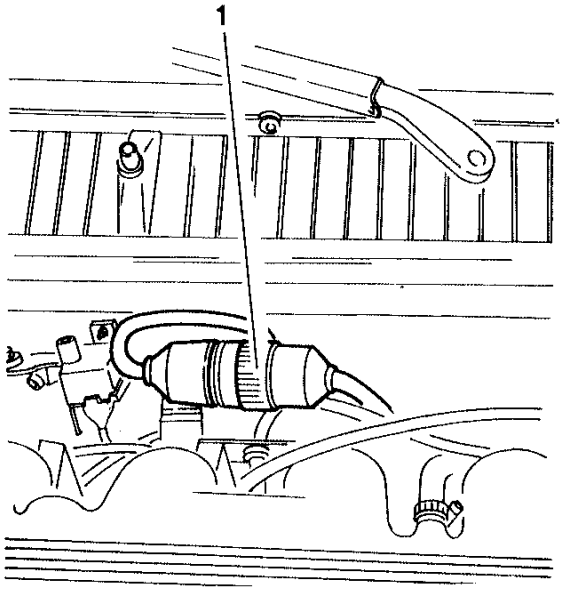
1. Unscrew the two screws securing the clutch-brake fluid reservoir.
2. Unscrew the screws securing the absolute pressure sensor support bracket and the ignition modules and move them.



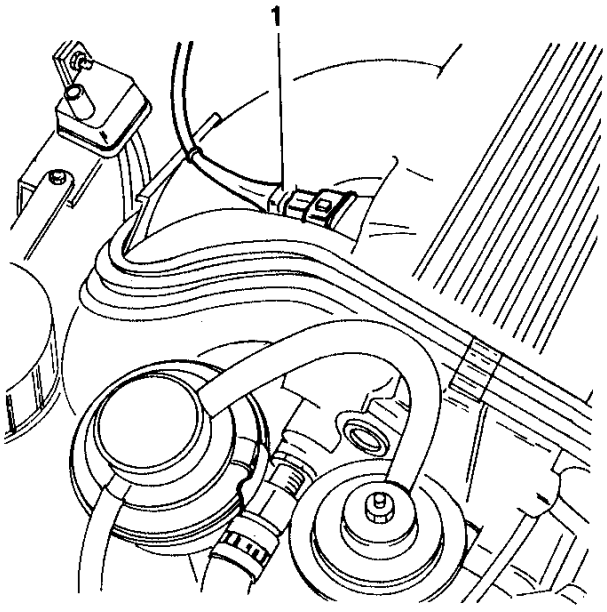
1. Disconnect the electrical connection supplying the ignition coil.



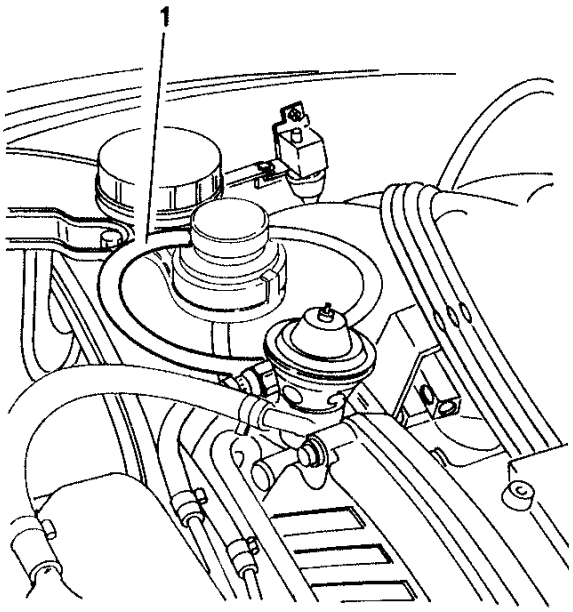
1. Disconnect the electrical connections of the injector and electroinjector wiring and move it.



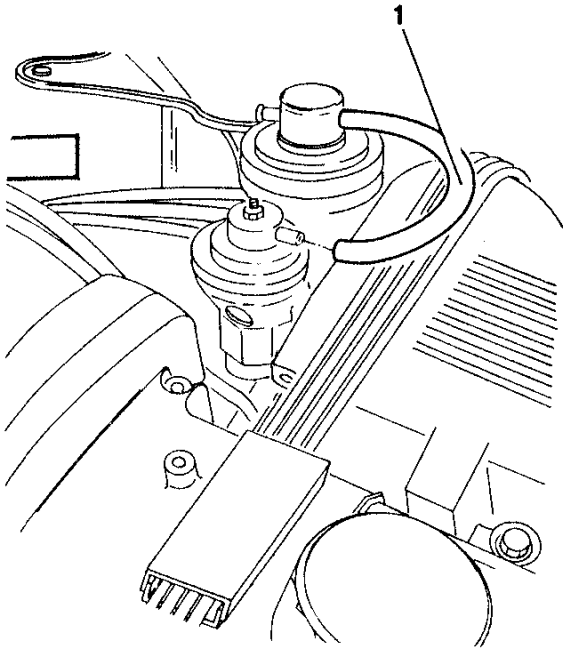
1. Disconnect the electrical connection from the intaken air temperature sensor.



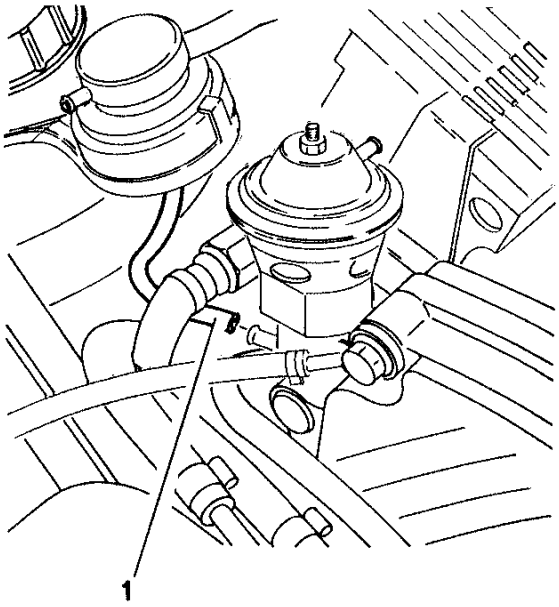
1. Disconnect the vacuum signal from the thermovalve arrival pipe from the pneumatic signal modulation valve.



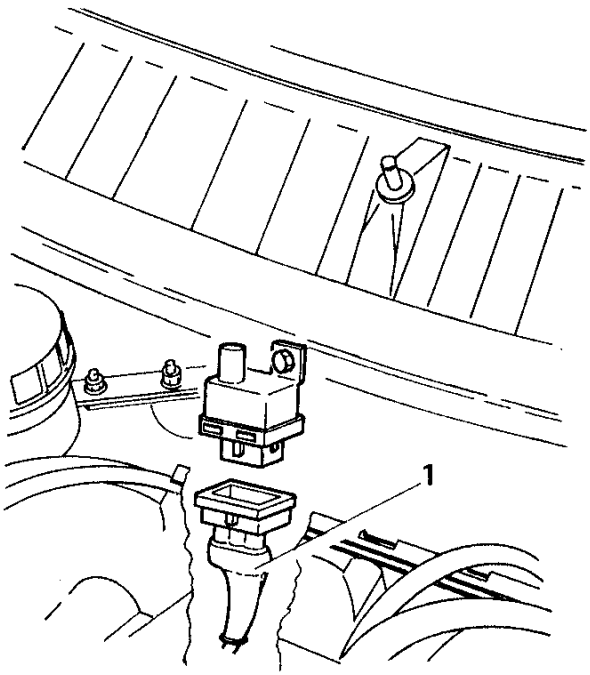
1. Disconnect the vacuum signal to the E.G.R. valve arrival pipe from the pneumatic signal modulation valve.



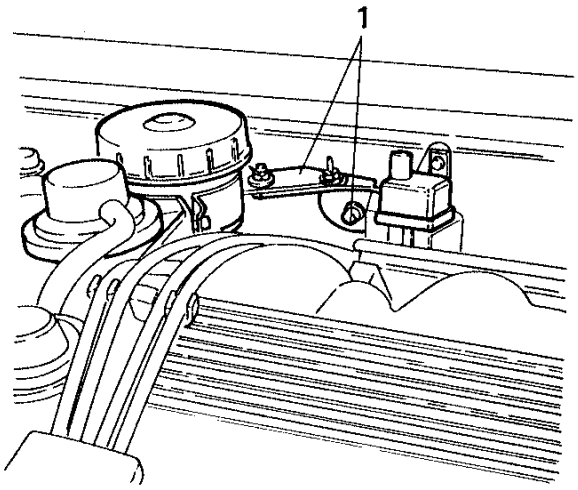
1. Disconnect the gas to the pneumatic signal modulation valve delivery pipe from the spheric connection of the gas exhaust pipe.



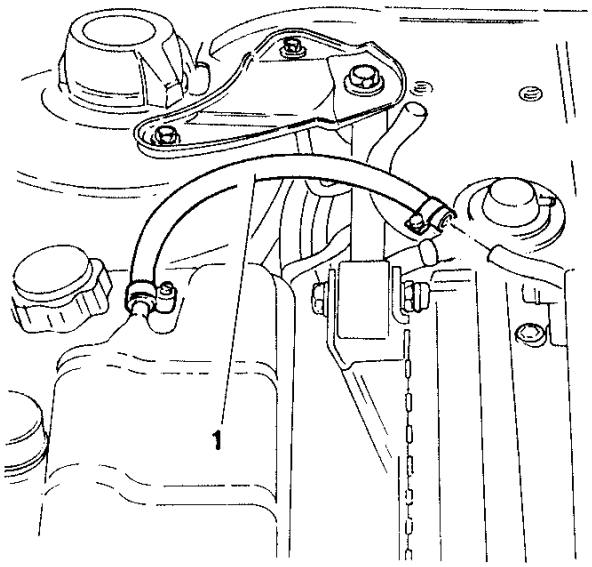
1. Disconnect the electrical connection from the CO minimum regulator (trimmer).



1. Unscrew the screws of the pneumatic signal modulator valve support bracket, power steering tank and CO minimum trimmer, and move them sideways.

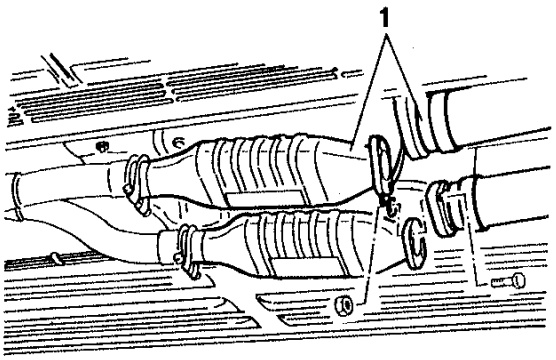


1. Disconnect the coolant return and deaereating pipes to the expansion tank.

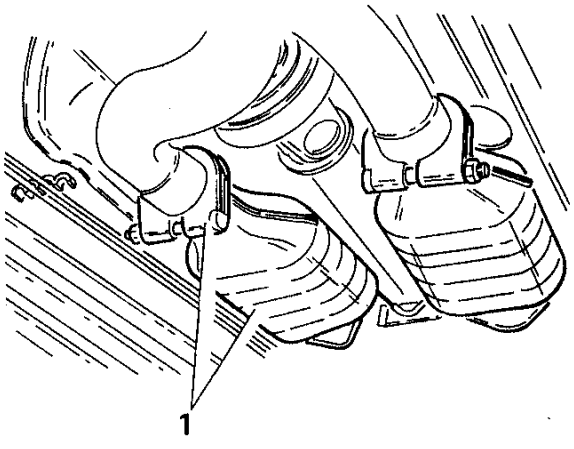


– Raise the vehicle on the lift.

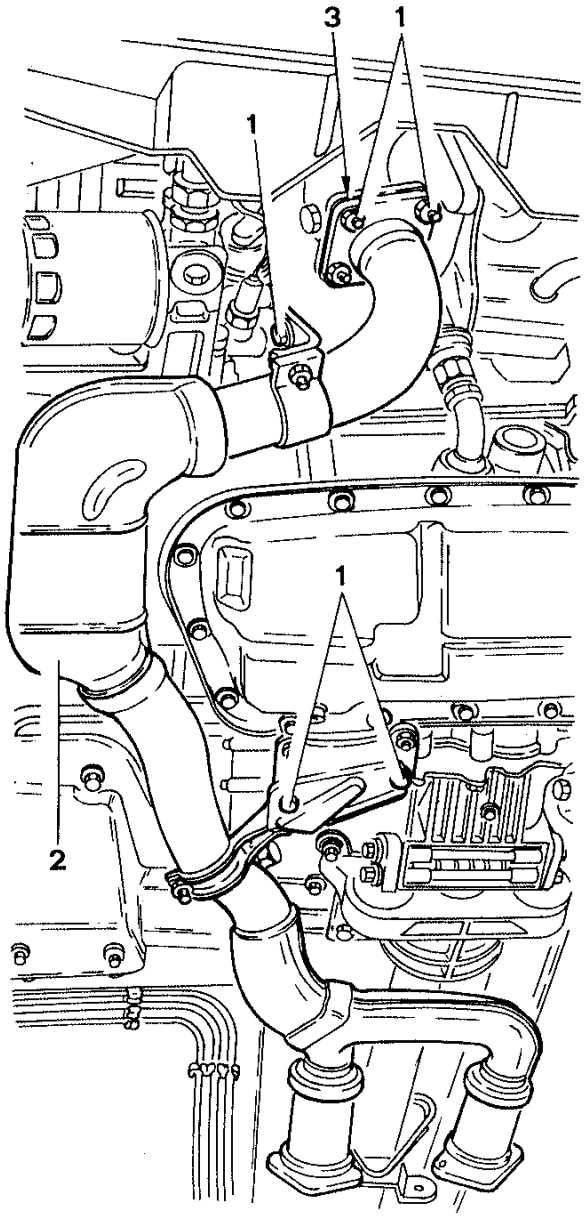
1. Disconnect the two flanges on the front exhaust section from the two catalytic convertors.



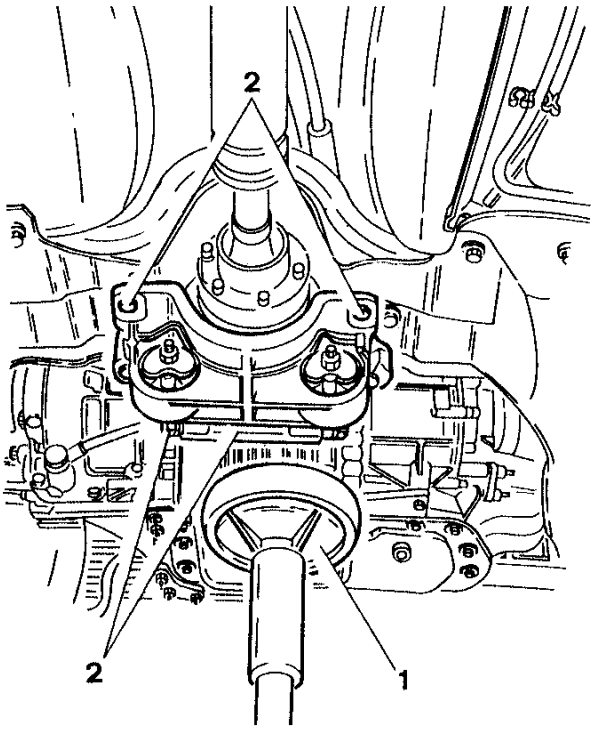
1. Loosen the collars and remove the two catalytic converters.



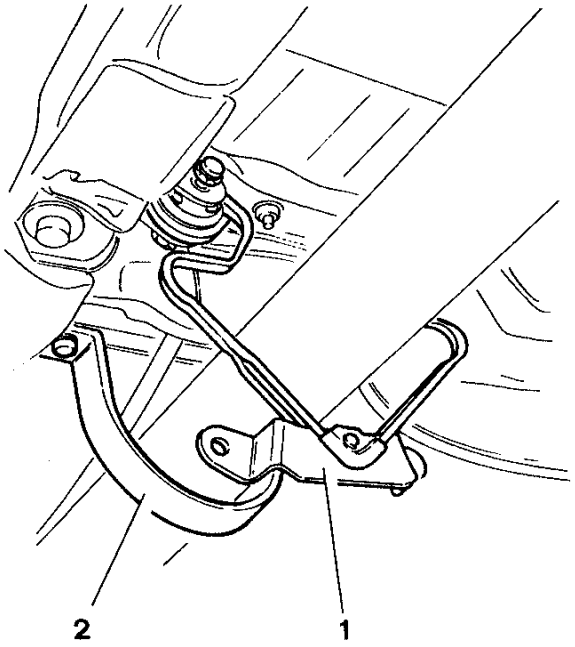
1. Unscrew the screws and bolts securing the front section of the exhaust pipe to the turbocharger and the support brackets.
2. Remove the front section of the exhaust pipe.
3. Remove the gasket.



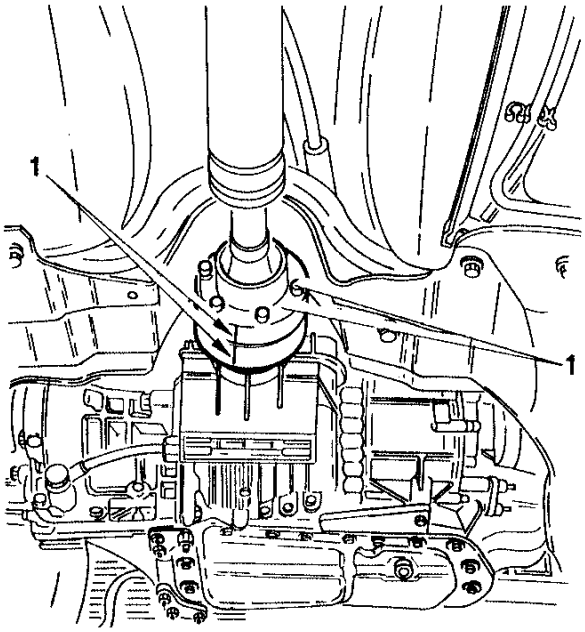
1. Position a suitable column lift under the central differential.
2. Unscrew the screws and bolts of the engine unit rear support and remove it.



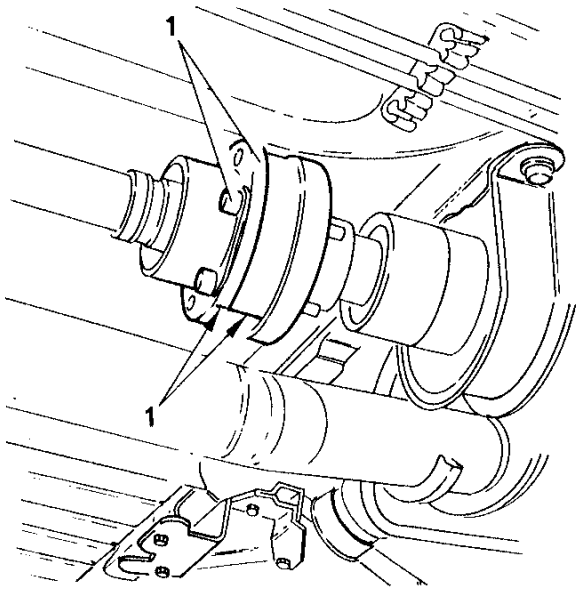
– Remove the column lift.
1. Remove the exhaust pipe elastic support.
2. Remove the drive shaft safety bracket.



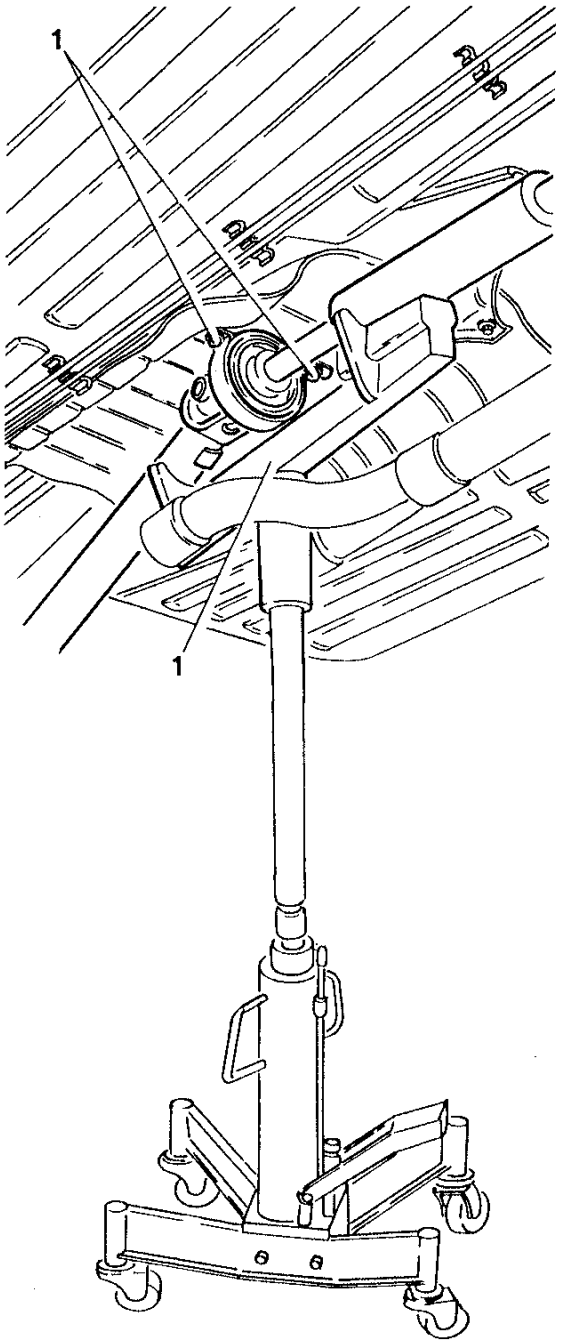
1. Make reference notches on the joint flanges between the front section of the drive shaft and the central differential, then disconnect them by unscrewing the relative screws.



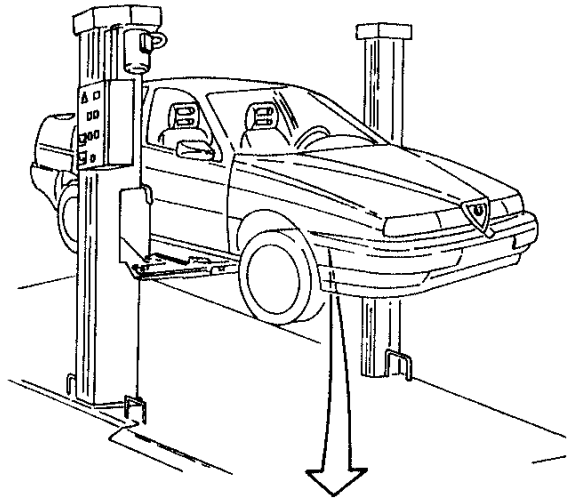
1. Make reference notches on the joint flanges between the central and rear section of the drive shaft and disconnect them by unscrewing the relative screws.

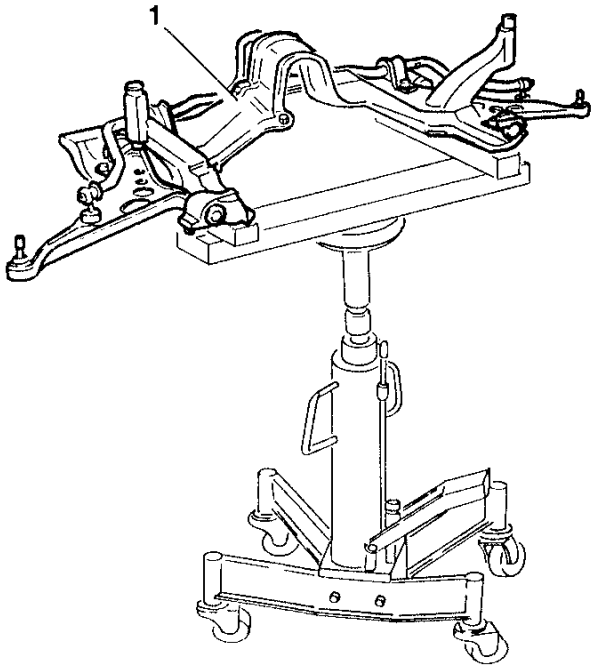


1. Support the front and central sections of the drive shaft with a suitable tool and, after having unscrewed the central elastic support, remove them.

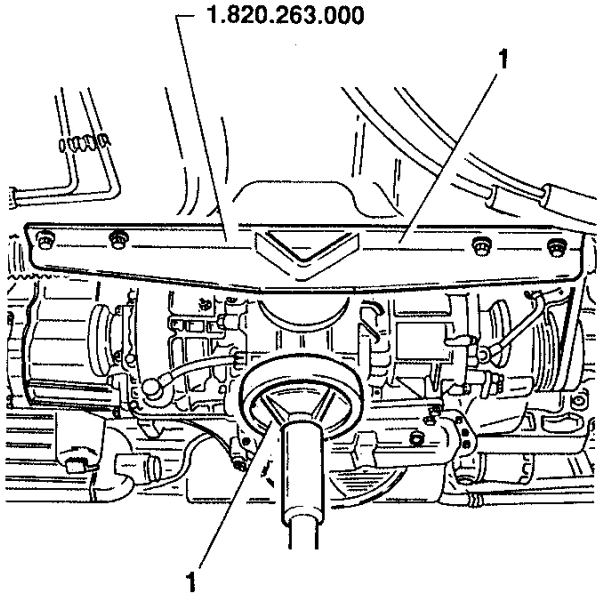


1. Unscrew the screws and remove the cross member complete with wishbones (see **GROUP 21**).



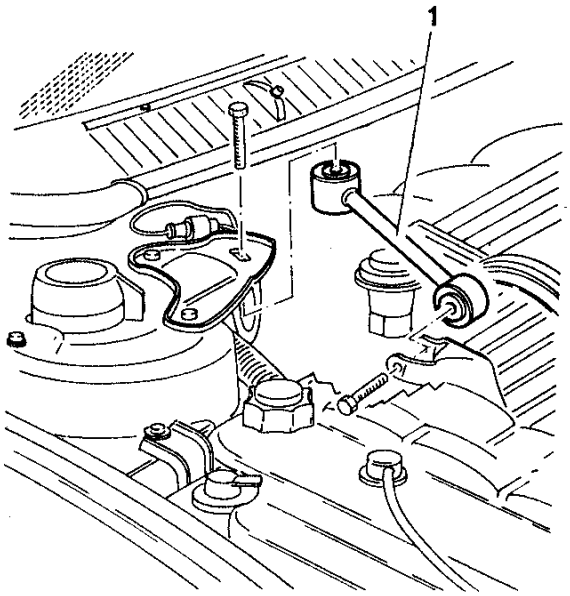


1. Position a suitable column lift under the central differential and raise it enough to install the engine unit rear support tool N° 1.820.263.000.

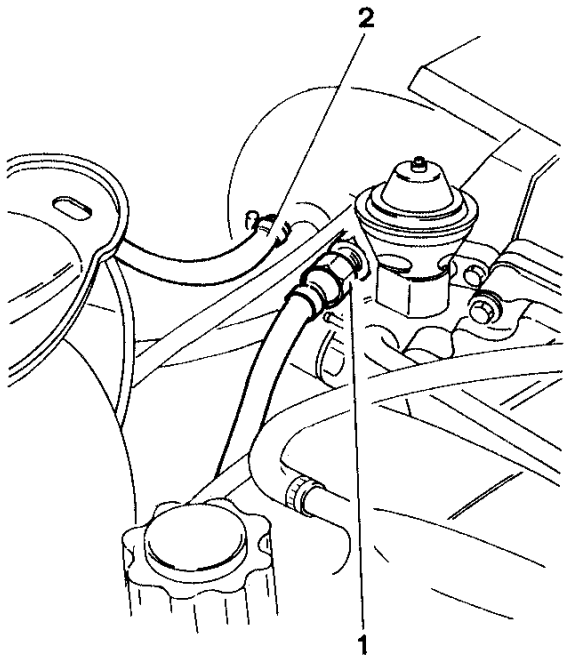


– Lower the vehicle.

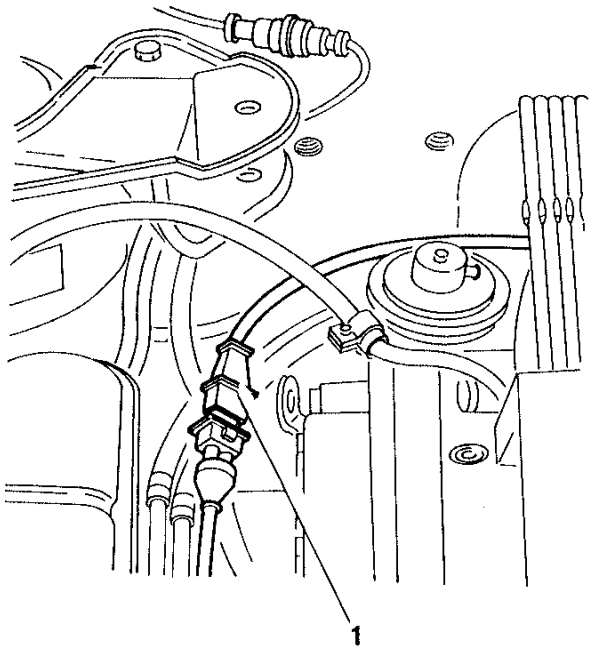
1. Remove the engine damping rod.



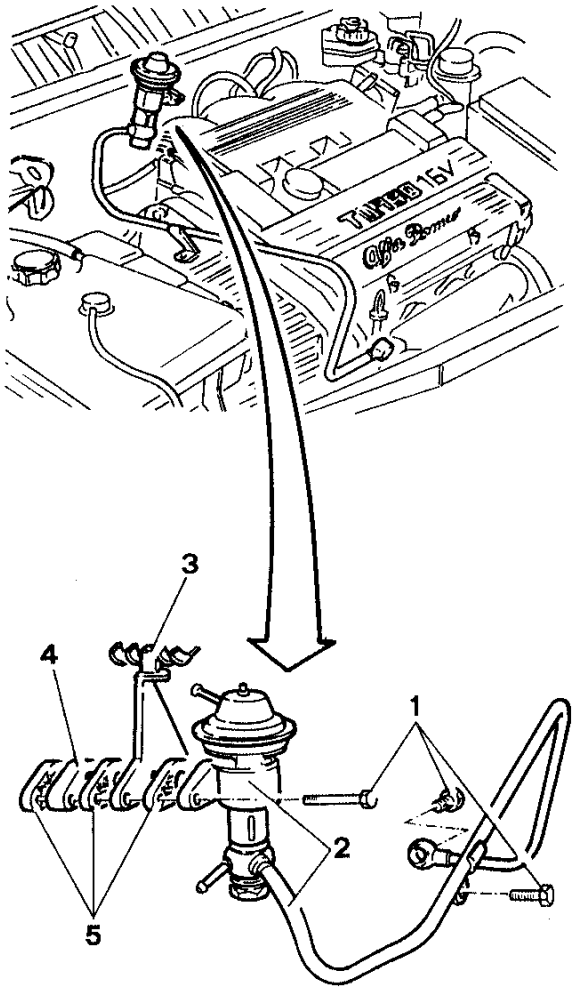
1. Disconnect the fuel delivery tube connection from the distribution manifold.
2. Disconnect the excess fuel return tube to the tank.



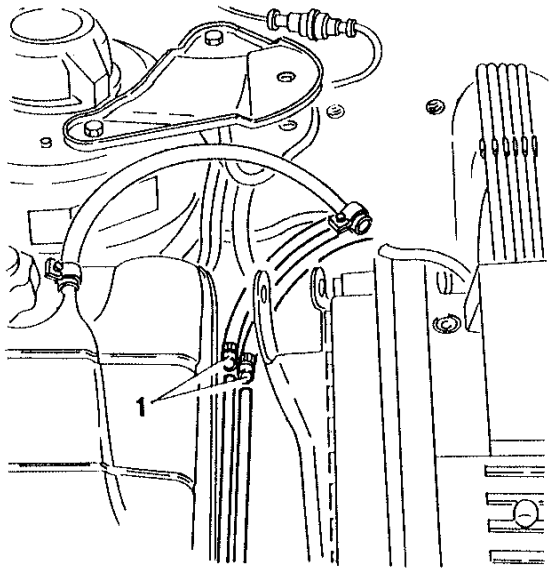
1. Disconnect the knock sensor electrical connections.



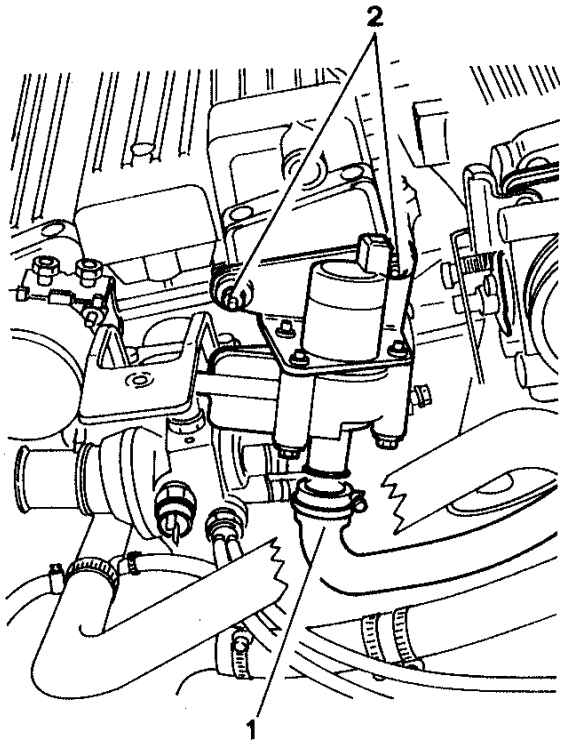
1. Unscrew the E.G.R. valve and the exhaust gas pipe screws.
2. Remove the E.G.R. valve complete with exhaust gas pipe.
3. Recover the bracket.
4. Recover the spacer.
5. Recover the gasket.



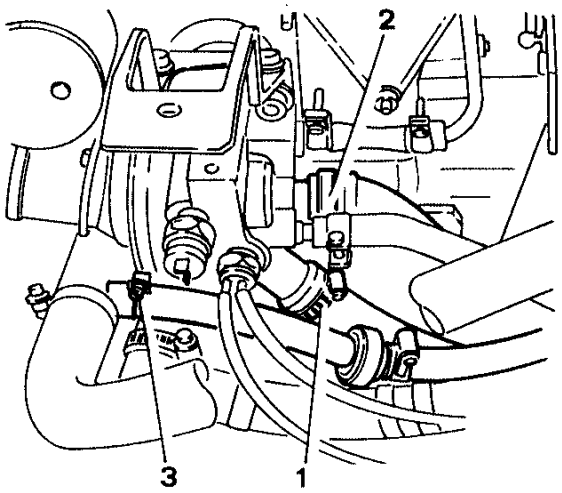
1. Disconnect the intermediary joints of the fuel vapour delivery pipes to the air intake box and the vacuum tube for the fuel vapour interception valve.



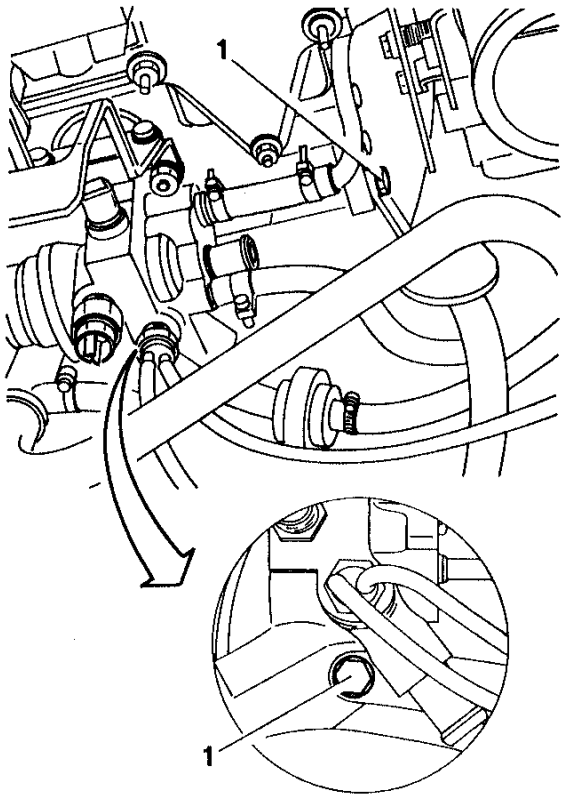
1. Disconnect the air by-pass tube to the throttle body from the constant idle speed actuator.
2. Unscrew the bolts and then remove the constant idle speed actuator complete with support bracket.



1. Disconnect the coolant delivery pipe to the heater from the thermostatic cup.
2. Disconnect the coolant return pipe to the pump from the thermostatic cup.
3. Disconnect the oil vapour delivery tube to the air intake box from the branch point.

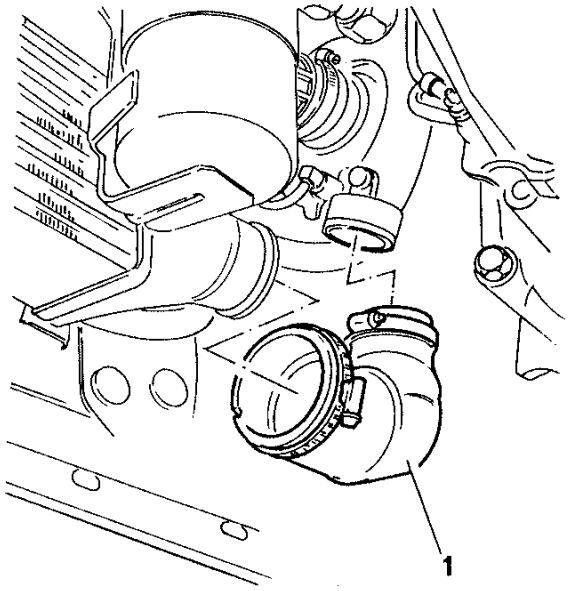


1. Unscrew the screws securing the coolant rigid return to pump pipe to the cylinder head

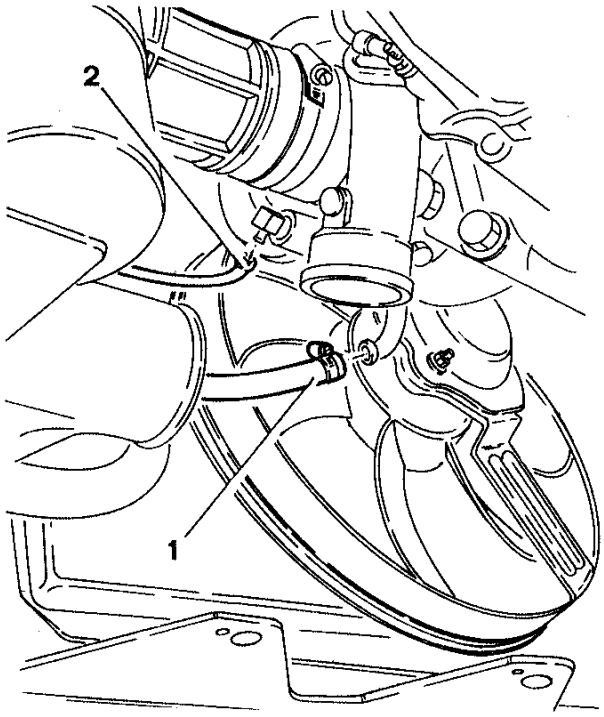


– Raise vehicle.

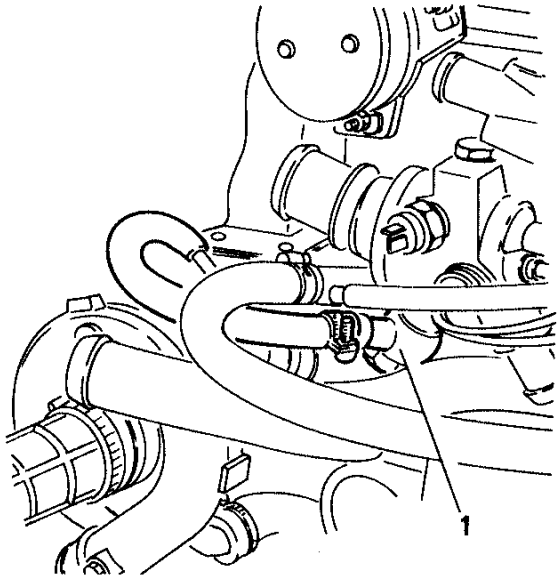
1. Remove the air delivery tube from the turbocharger to the intercooler.



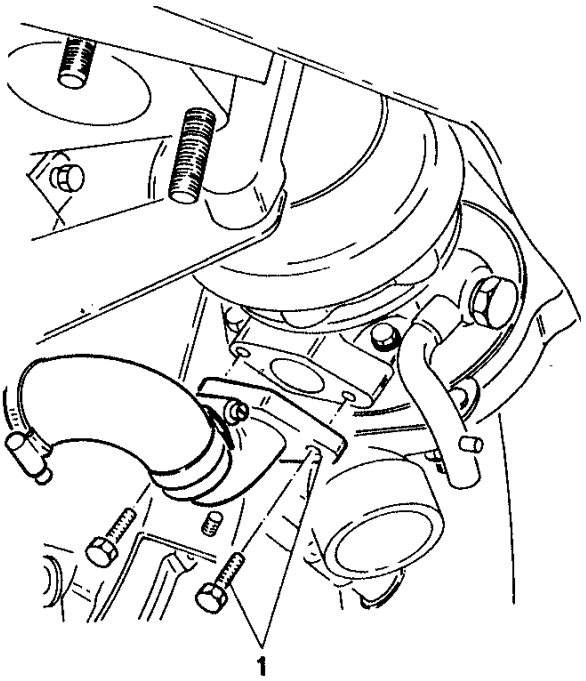
1. Disconnect the coolant entry pipe from the turbocharger.
2. Disconnect the supercharging control device solenoid valve "PIERBURG" connection tube from the turbocharger.



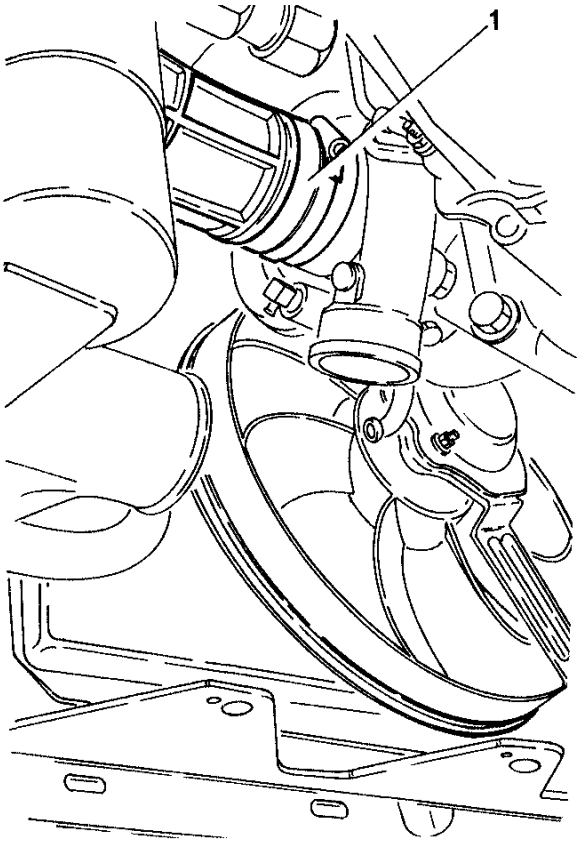
1. Disconnect the coolant from turbocharger return tube spheric connector from the thermostatic cup.



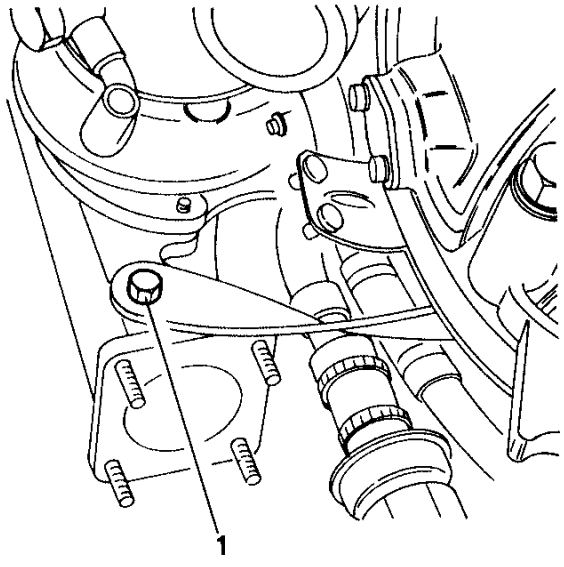
1. Disconnect the oil outlet flanged tube from the turbocharger.



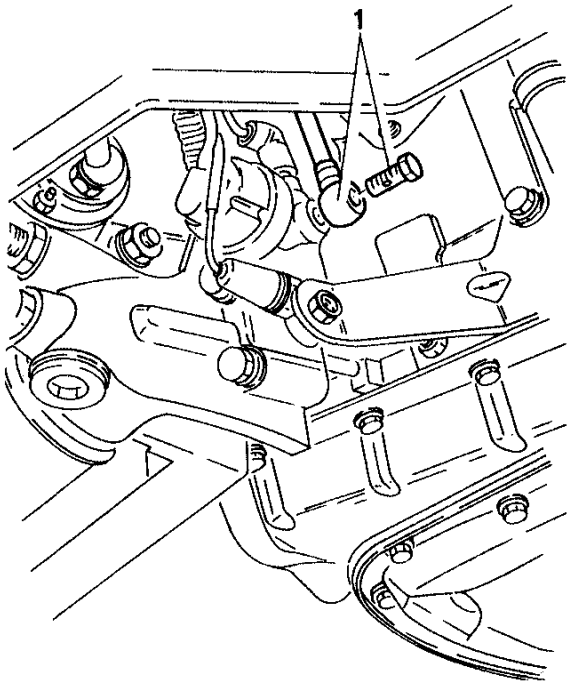
1. Disconnect the corrugated air intake from filter sleeve from the turbocharger.



1. Unscrew the screws securing the turbocharger to the support bracket.

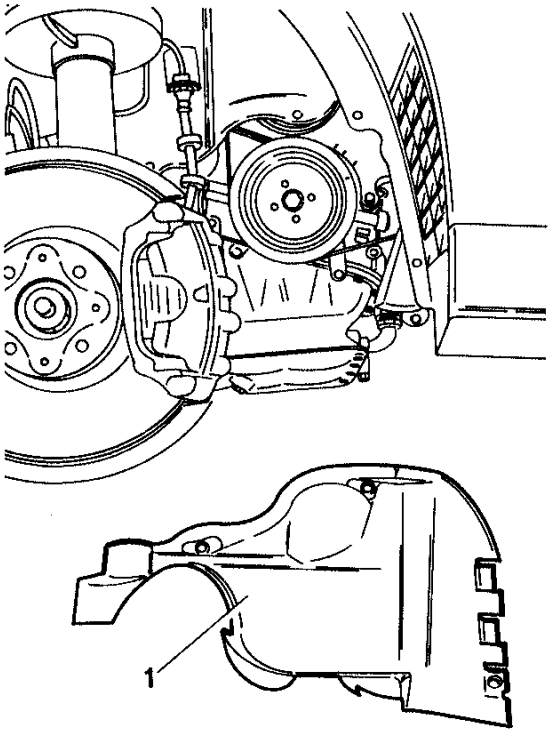


1. Disconnect the oil delivery tube to turbocharger spheric connector from the oil filter support.

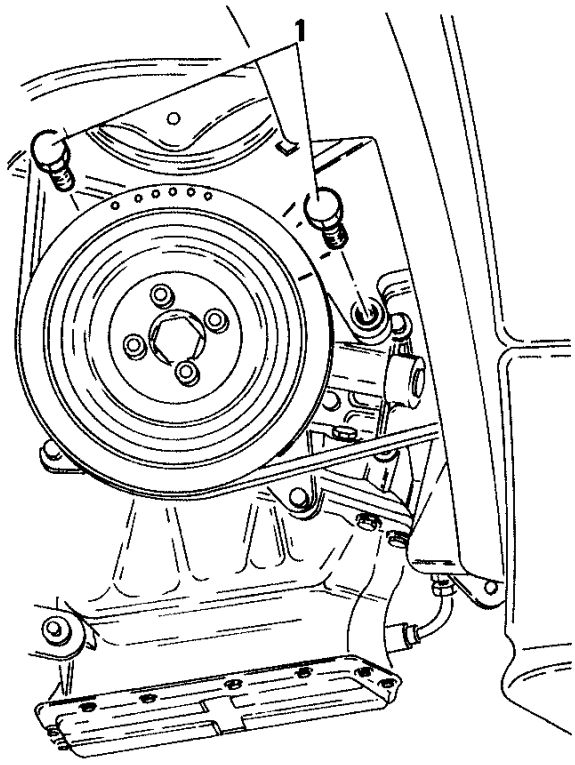


– Remove the front righthand wheel.

1. Remove the dustguard from the front righthand wheel arch.

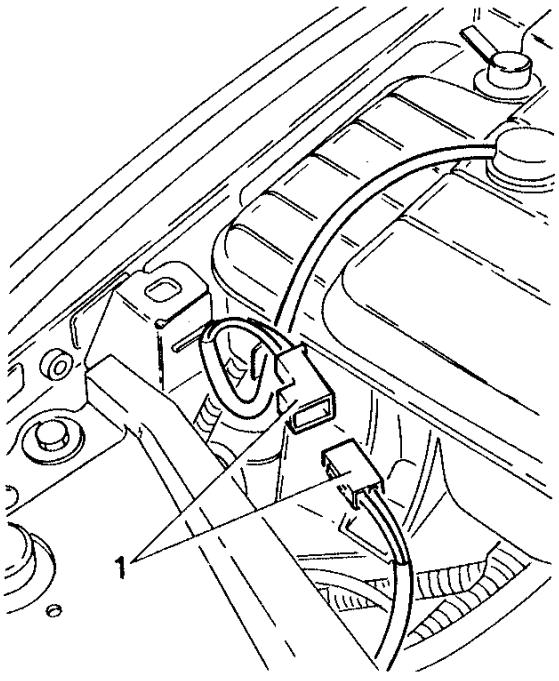


1. Operating from the wheel arch, unscrew the lower screws securing the timing belt cover.

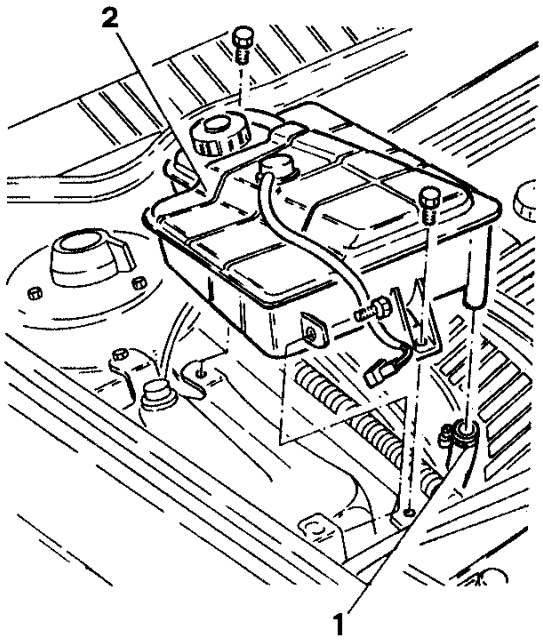


– Lower the vehicles.

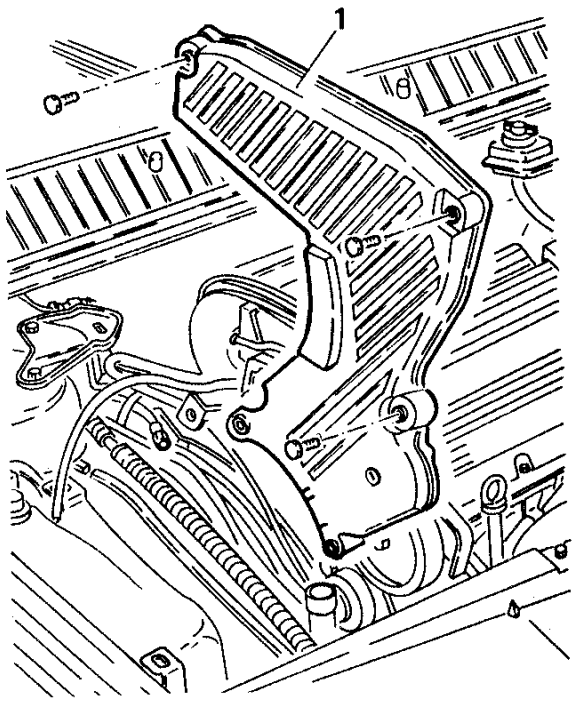
1. Disconnect the electrical connections of the engine coolant minimum level sensor.



1. Disconnect coolant feed pipe from the expansion tank.
2. Remove the expansion tank unscrewing the three screws.

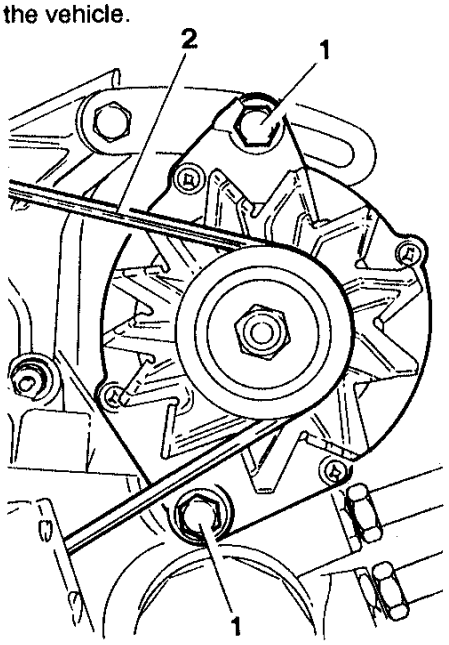


1. Unscrew the remaining screws securing the timing belt cover and remove it.

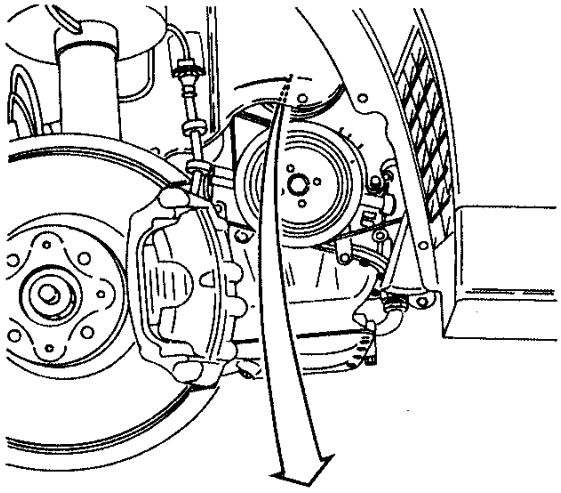


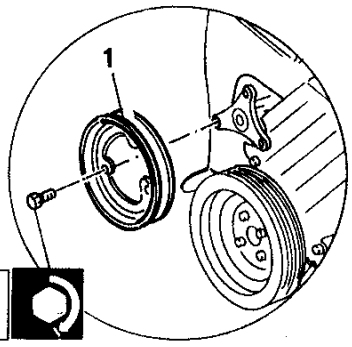
1. Loosen the alternator bolts.
2. Remove the control belt alternator - water pump.

– Raise the vehicle.



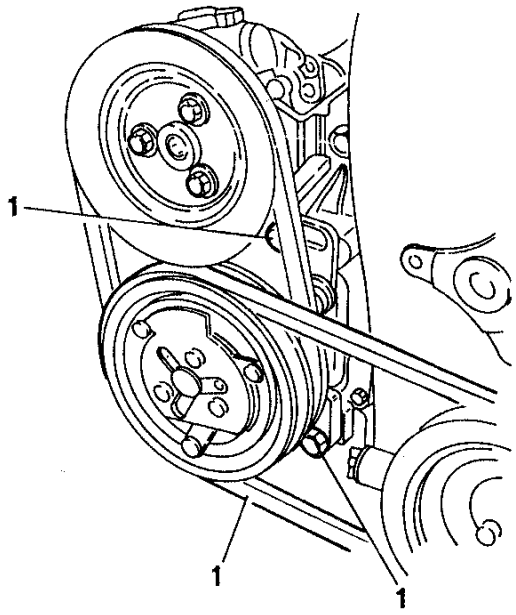
1. Unscrew the screws and remove the water pump pulley.



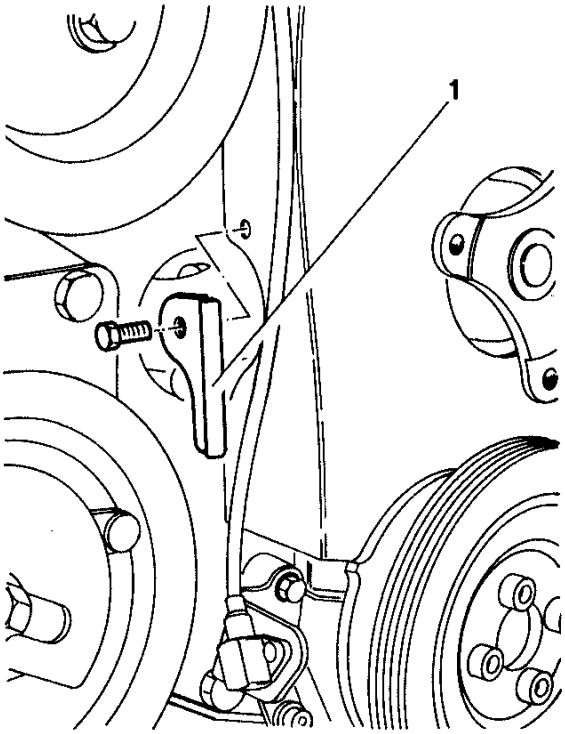


21.3 ÷ 26.3 Nm
2.2 ÷ 2.7 kgm

1. Loosen the screws and bolts securing the air conditioning compressor and remove the control belt.

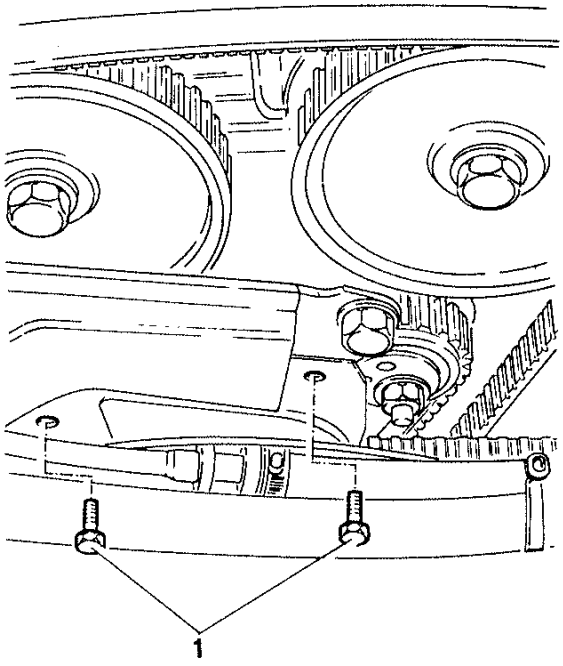


1. Unscrew the screws and remove the revs cable sensor and T.D.C. stop plate.

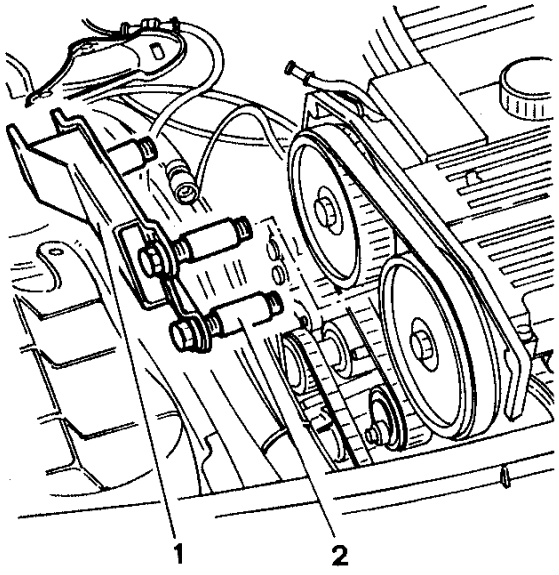


– Lower vehicle.

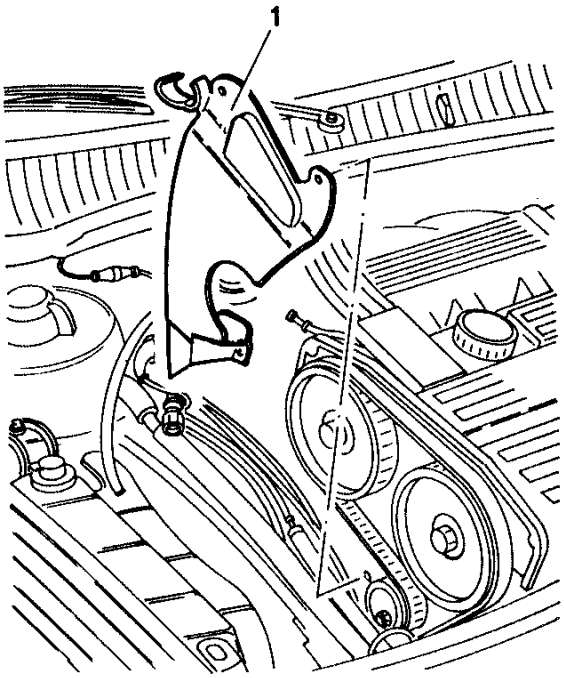
1. Unscrew the two upper screws securing the timing belt metal cover and move it as far away as possible from the engine.



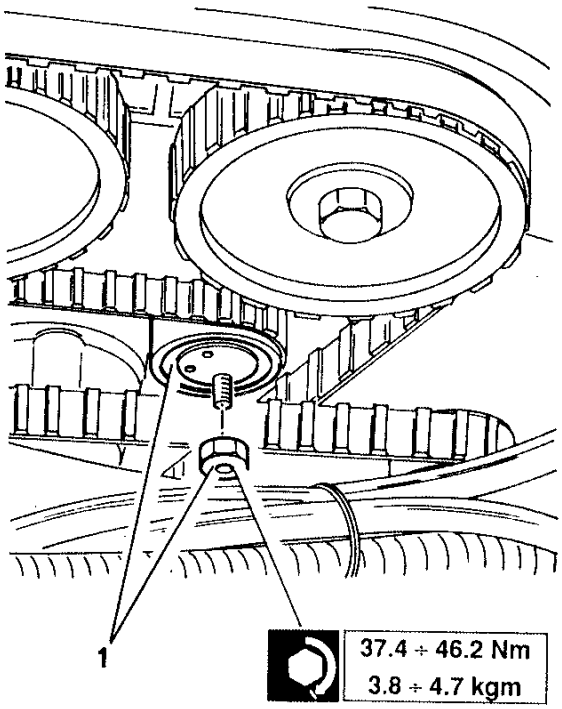
1. Unscrew the engine damping rod support bracket screws and remove it.
2. Recover the spacers.



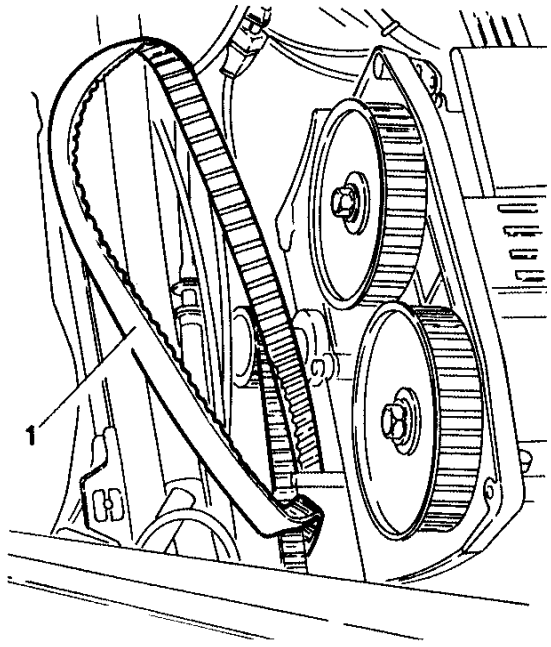
1. Recover the timing belt metal cover removed previously.



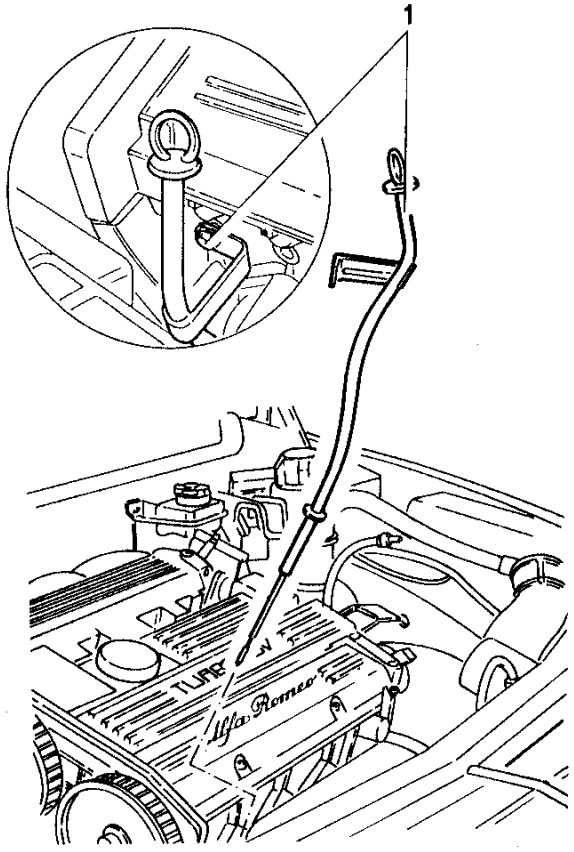
1. Unscrew the screws and remove the timing belt tensioning jockey pulley.



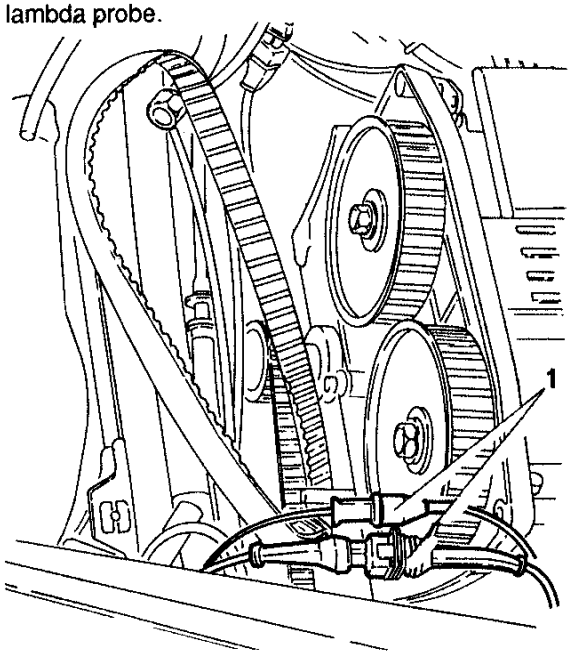
1. Disconnect the control belt from the timing pulleys.



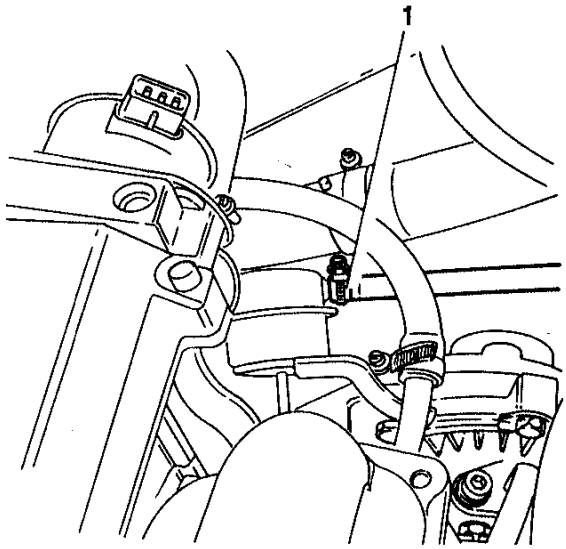
1. Unscrew the screws and remove the guide with relative engine oil level dipstick.



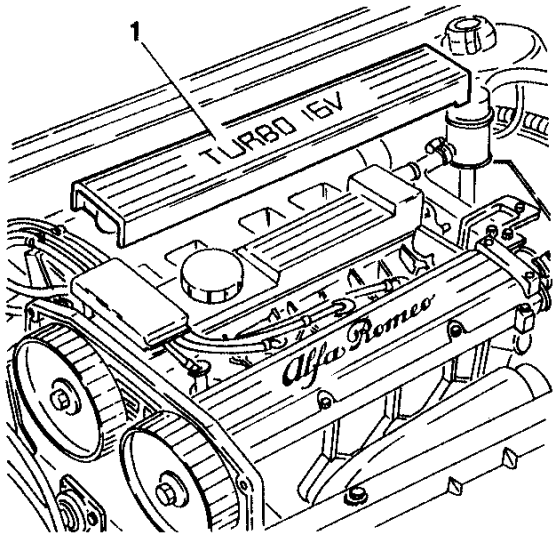
1. Disconnect the two electrical connections of the lambda probe.



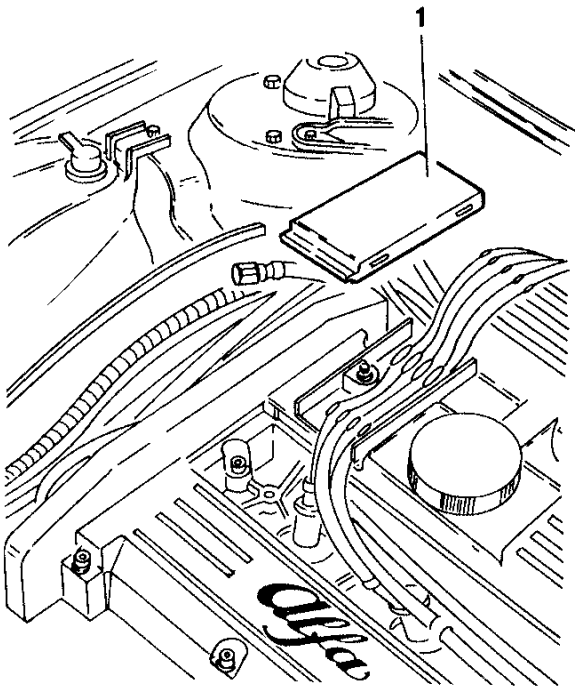
1. Disconnect the connecting tube to the supercharging control device solenoid valve "PIERBURG" from the overpressure control valve actuator "WASTE-GATE".



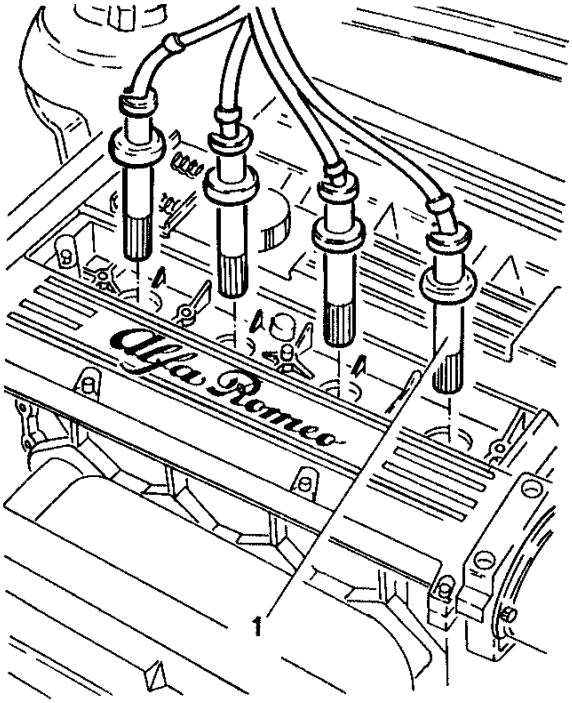
1. Remove the spark plug cover.



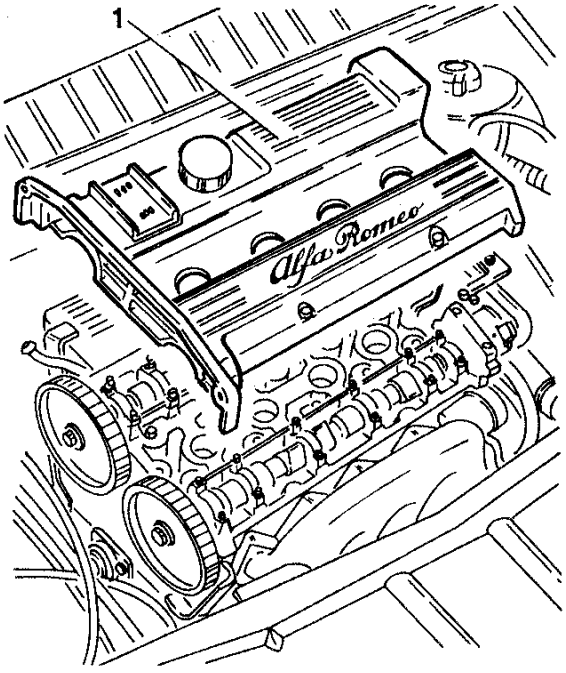
1. Remove the spark plug cables cover.



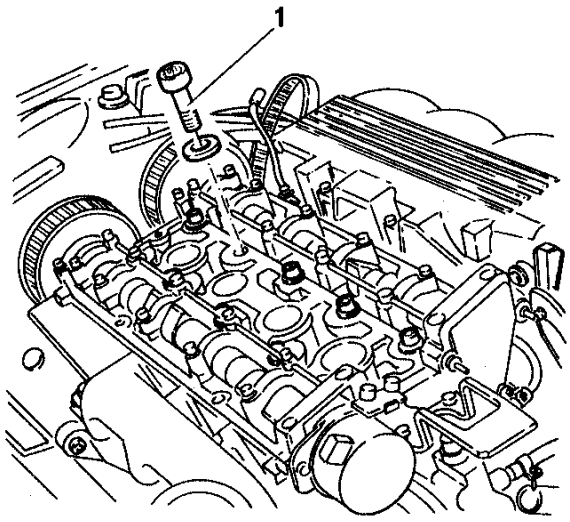
1. Disconnect the spark plug cables.



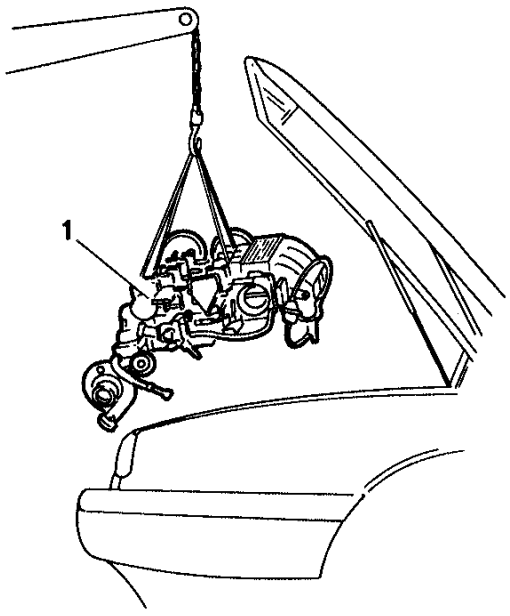
1. Unscrew the screws and remove the timing cover complete with gasket.



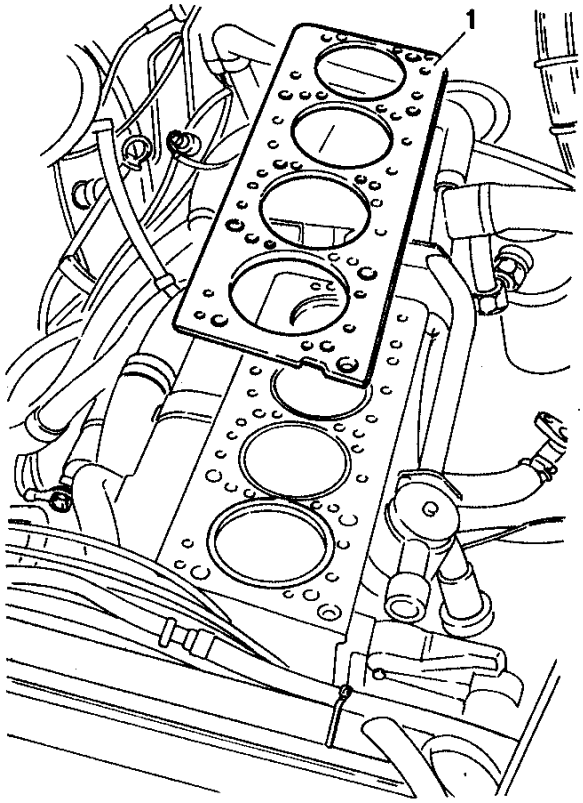
1. Unblock and remove the screws relative to the washers securing the cylinder head to the engine block.



1. Remove the complete cylinder heads using a suitable hydraulic lift.



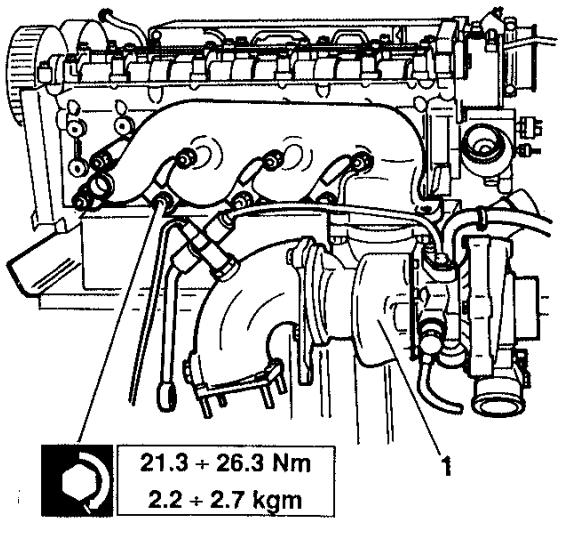
1. Remove the cylinder head gasket.



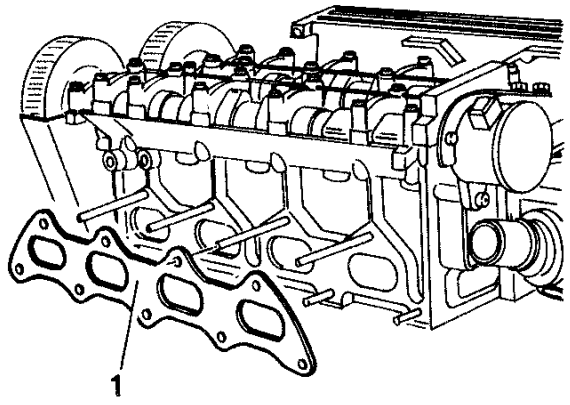
DISASSEMBLY/REASSEMBLY

– Position the complete head on a suitable workbench.

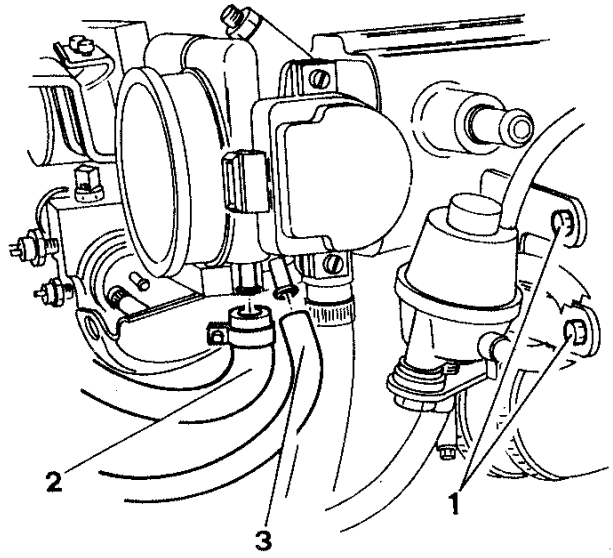
1. Unscrew the screws securing the exhaust manifold to the cylinder heads and remove it complete with turbocharger.



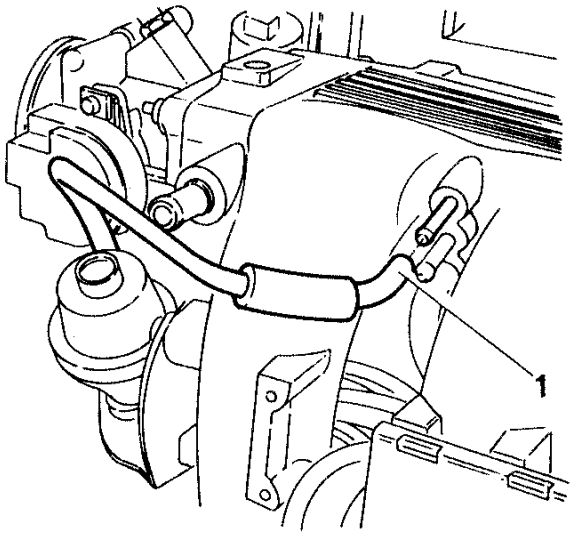
1. Remove the exhaust manifold gasket.



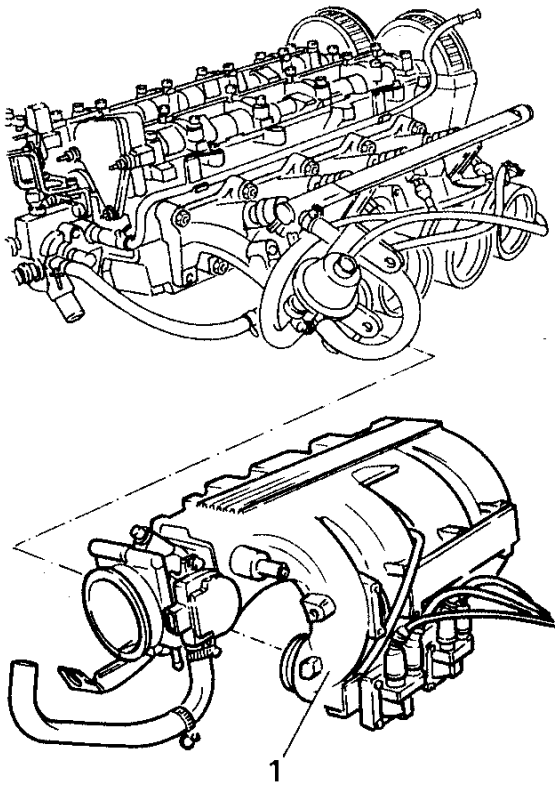
1. Unscrew the two screws securing the pressure regulator support bracket to the air intake box.
2. Disconnect the coolant from thermostatic cup arrival tube from the throttle body.
3. Disconnect the connection pipe to the E.G.R. thermovalve system from the throttle body.



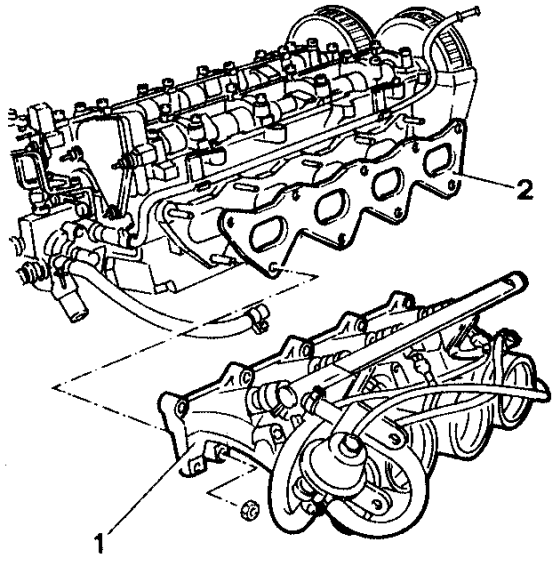
1. Disconnect the vacuum tube for the fuel pressure regulator from the air intake box.



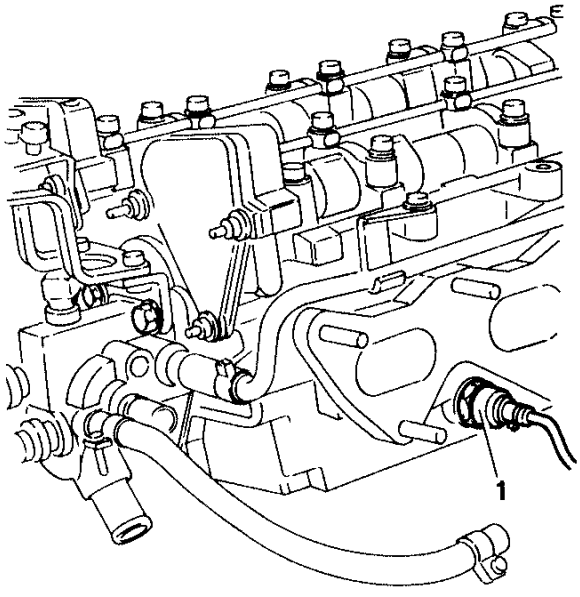
1. Remove the complete air intake box after having unscrewed the screws securing the head and the four connection clamps to the intake manifold.



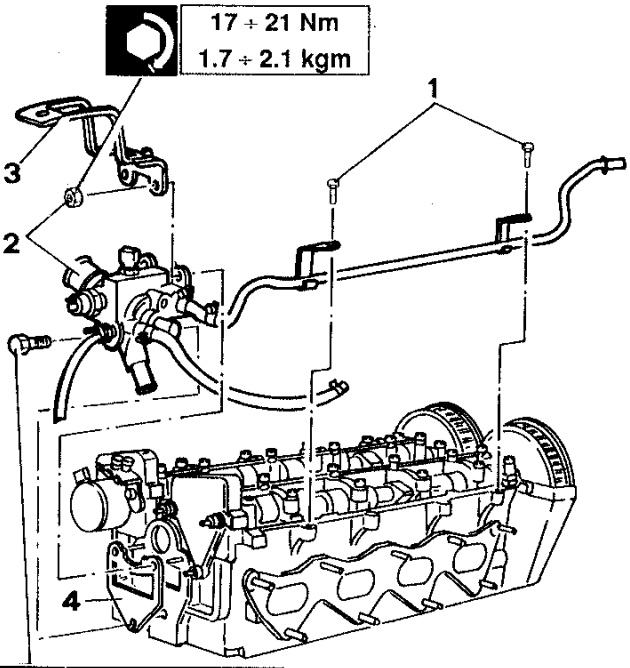
1. Unscrew the nuts and remove the intake manifold complete with electroinjectors and pressure regulator.
2. Remove the gasket.



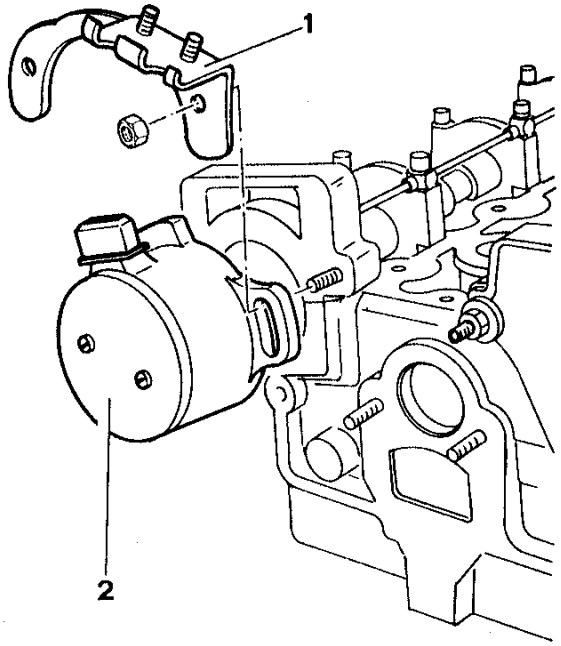
1. Remove the knock sensor.



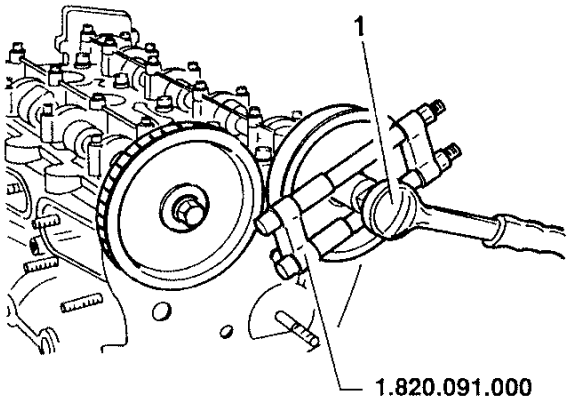
1. Unscrew the screws securing the coolant rigid return pipe and the expansion tank deaereating tube.
2. Unscrew the screws securing the thermostatic cup to the head and remove it complete with tubes.
3. Recover the bracket.
4. Remove the gasket.



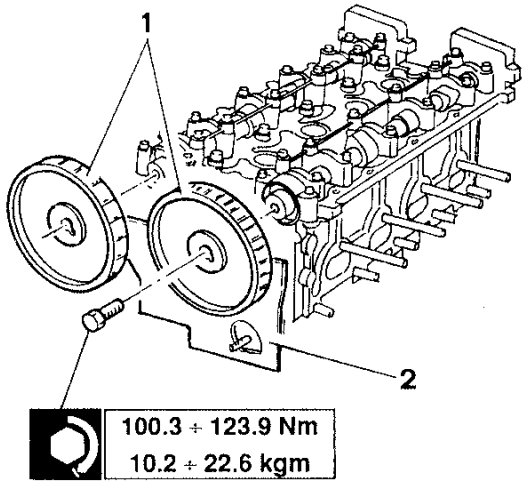
1. Unscrew the nuts and remove the bracket for the earth cables.
2. Remove the Hall effect stroke sensor.



1. Using tool N° 1.820.091.000 (A.2.0464) unscrew the screws securing the timing pulley.



1. Remove the timing pulley.
2. Remove the rear cover.



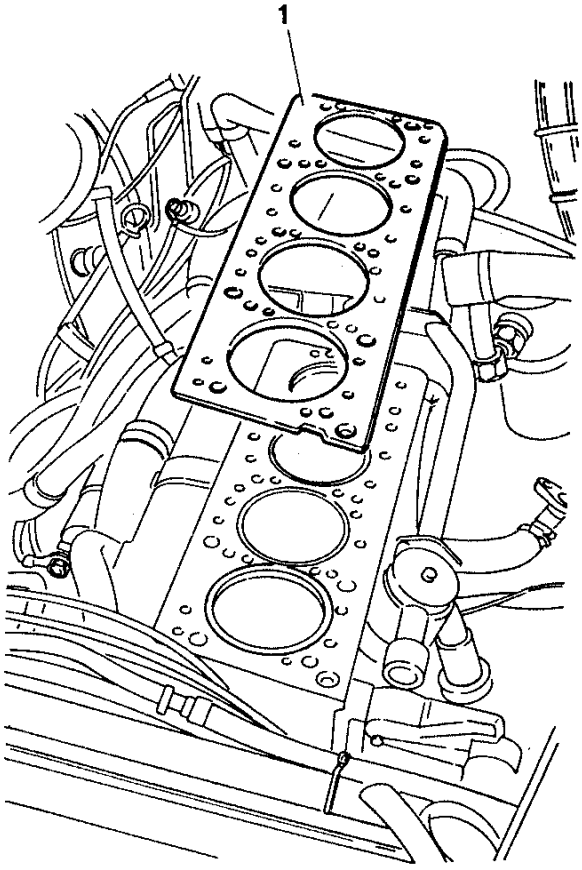
Proceed with overhauling the cylinder heads following the procedure described in the relative paragraph of this group.

REFITTING

Repeat the operations described above in the reverse order paying particular attention to the following indications:

- Rotate the crankshaft in order to bring the first and fourth cylinder pistons to the T.D.C. position.

1. Position a new cylinder head gasket on the engine block.



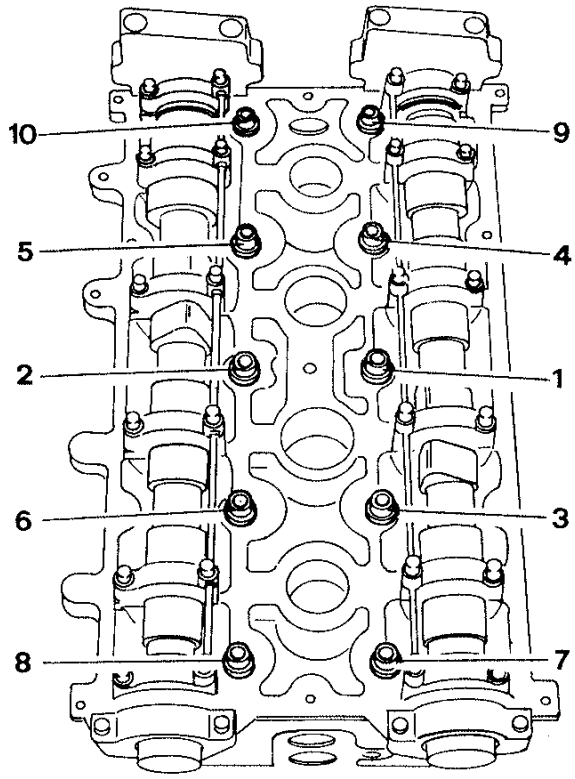
NOTE: The cylinder head gasket is of the ASTADUR type. This gasket, thanks to the special material from which it is made, undergoes a polymerization process during engine functioning and consequently becomes much harder.

CAUTION:
ASSEMBLY OF CYLINDER HEAD GASKET.
In order to ensure that the polymerization process of the cylinder head gaskets takes place, it is necessary to:
- store the gasket in its packaging;
- remove it from the envelope just before assembly;
- not lubricate or dirty the gasket with oil;
- during assembly, clean the cylinder head and engine block surfaces thoroughly.

- Assemble the complete cylinder heads on the block.
- Tighten the cylinder head screws as described in "REFITTING OF CYLINDER HEADS" and bearing in mind that, for every stroke, the tightening order is the one indicated in the figure.

Tightening procedure	
Tighten all screws to a torque of:	20 Nm
Tighten to the pretorque of:	50 Nm
Rotate all screws with an angle of:	90°
Complete the tightening with a further angle of:	90°

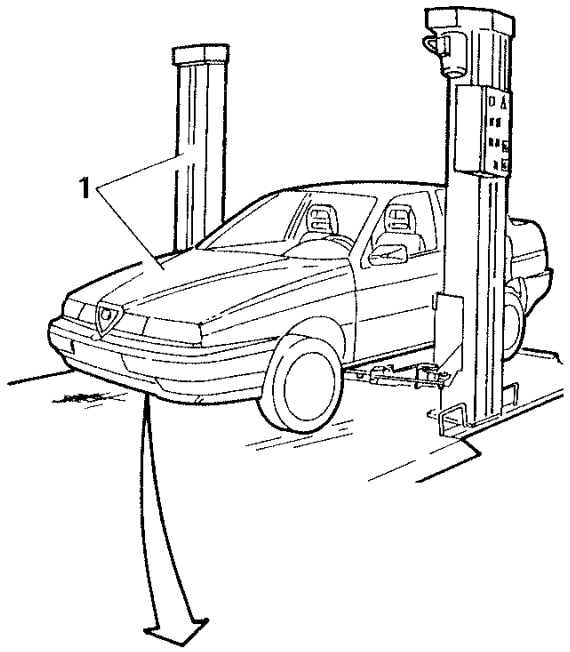
CAUTION:
The ASTADUR gaskets are connected with cylinder head screws of the tightening yield point type.
Adopting the ASTADUR gasket eliminates the need to tighten the cylinder head screws at the first service.

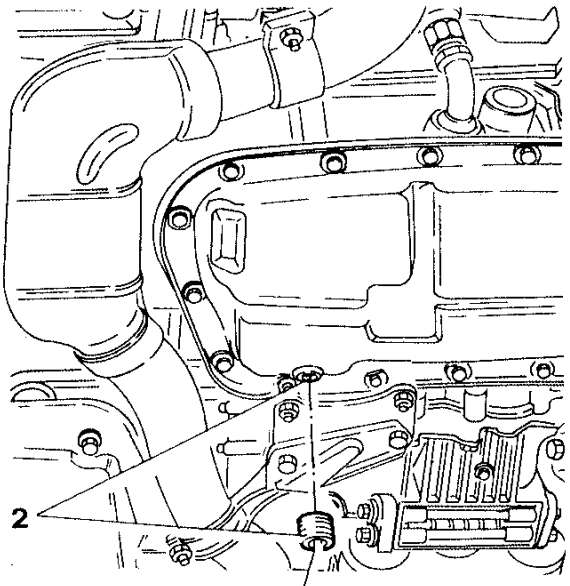


To assemble the timing control belt and check the engine timing and to assemble and stretch the auxiliary part belts see GROUP 00.

REMOVAL/REFITTING OF OIL SUMP

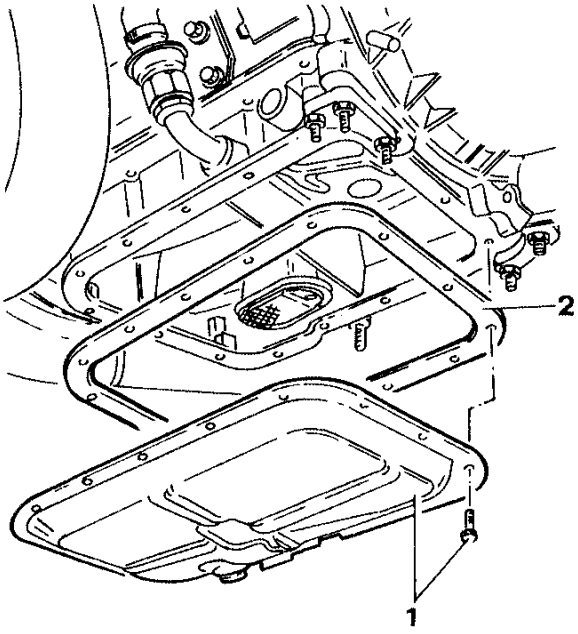
1. Position the vehicle on the lift and raise it.
2. Unscrew the plug and leave the engine oil to drain.



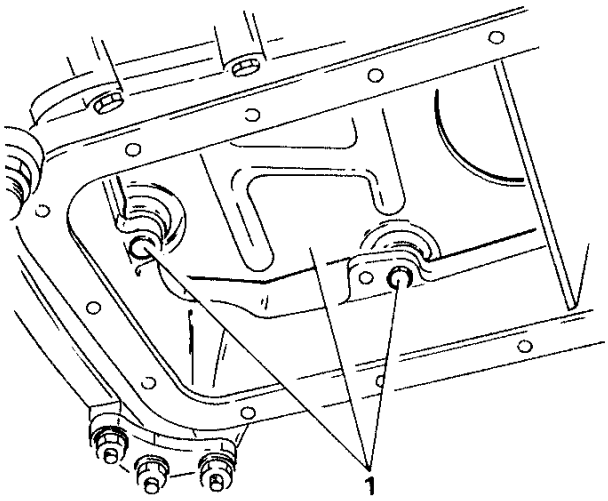


32.5 ÷ 52.5 Nm
3.3 ÷ 5.4 kgm

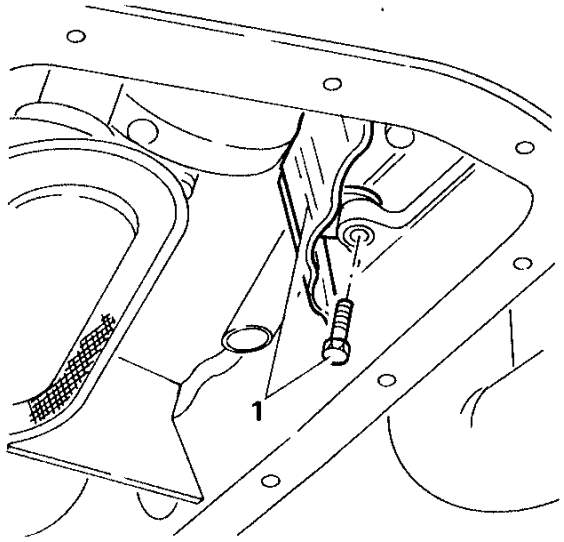
1. Unscrew the screws and remove the sump protection.
2. Remove the gasket.



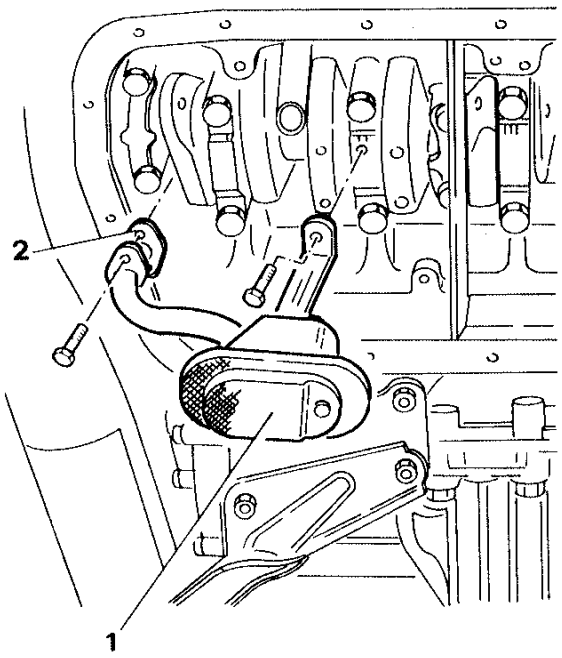
1. Unscrew the screws and remove the main anti-splashing panel.



1. Unscrew the screws and remove the side anti-splashing panel.

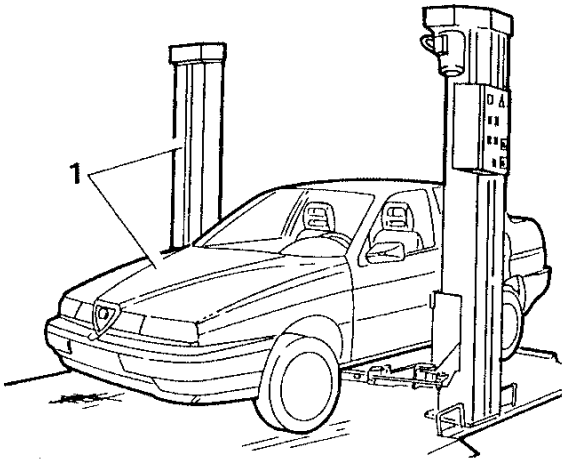


1. Unscrew the screws and remove the oil pump suction device.
2. Remove the gasket.



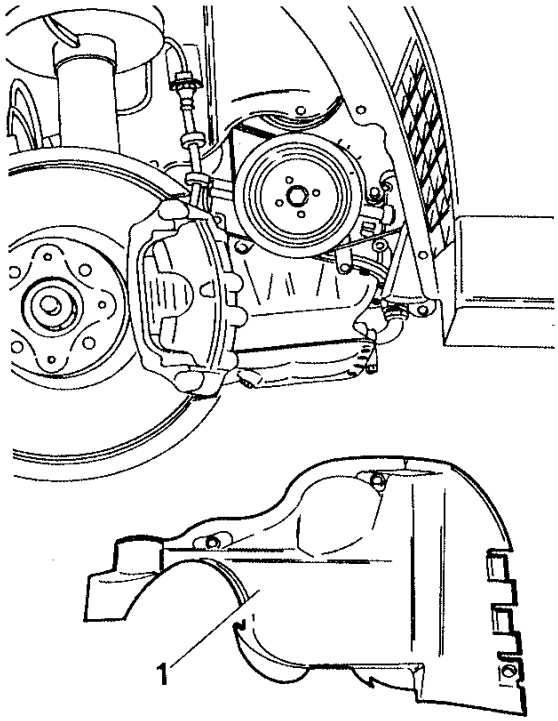
REPLACEMENT OF COUNTERSHAFT OIL SEALS EXHAUST SIDE

1. Position the vehicle on the lift.

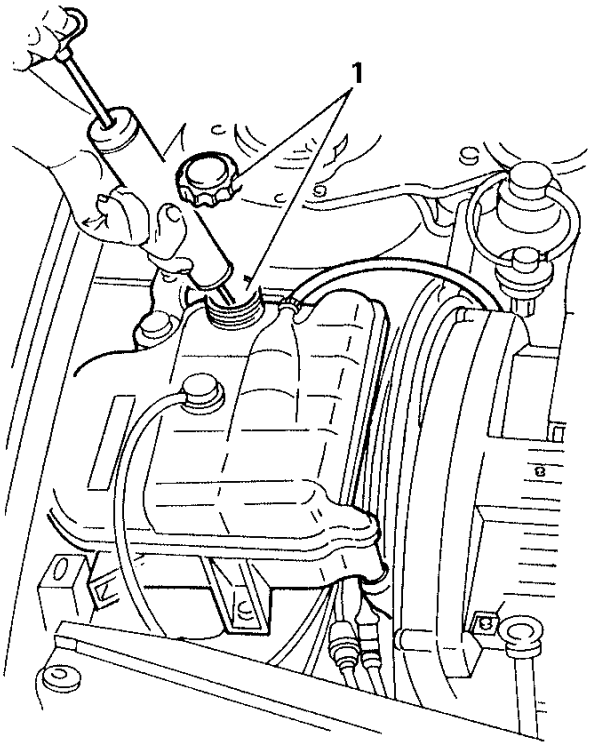


- Disconnect the negative (-) battery cable.
- Remove the front righthand wheel.

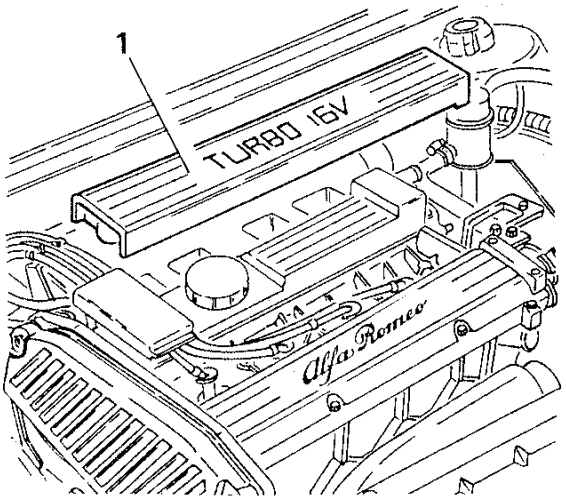
1. Remove the dustguard from the righthand wheel arch.



1. Empty the coolant from the expansion tank using a suitable syringe.

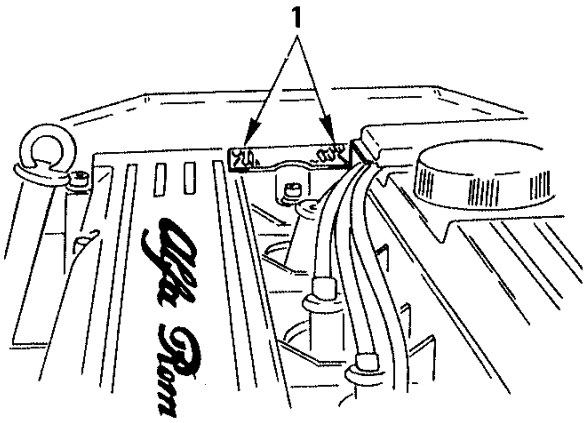


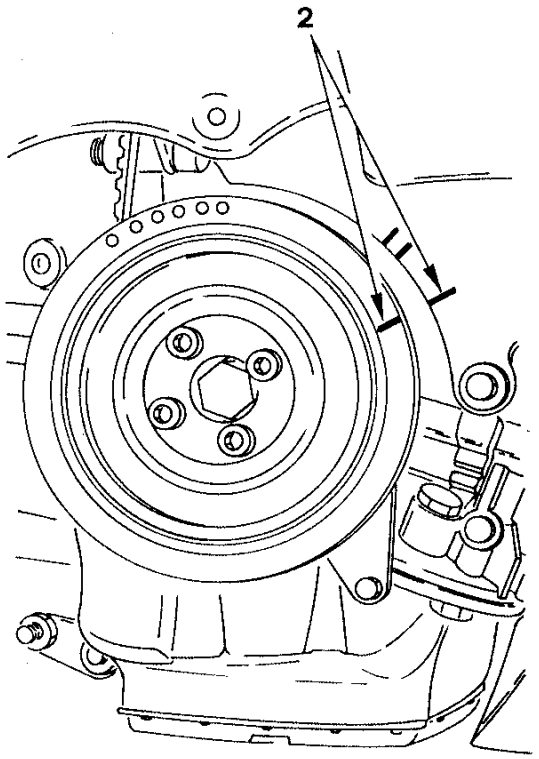
1. Remove the spark plug cover.



– Check that the piston of cylinder n° 4 is in the T.D.C. position during the explosion phase, proceeding as follows:

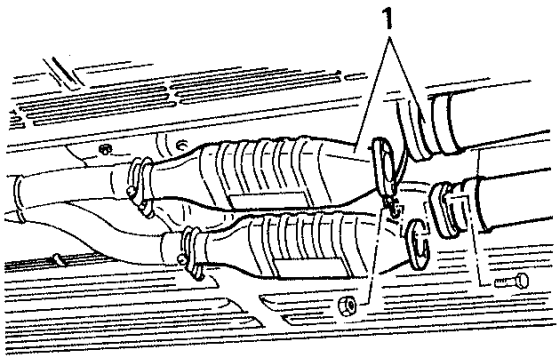
1. Check that the notches engraved on the timing pulleys coincide with the references on the timing cover .
2. Check that the notch engraved on the crankshaft pulley coincides with the notch on the timing belt cover.



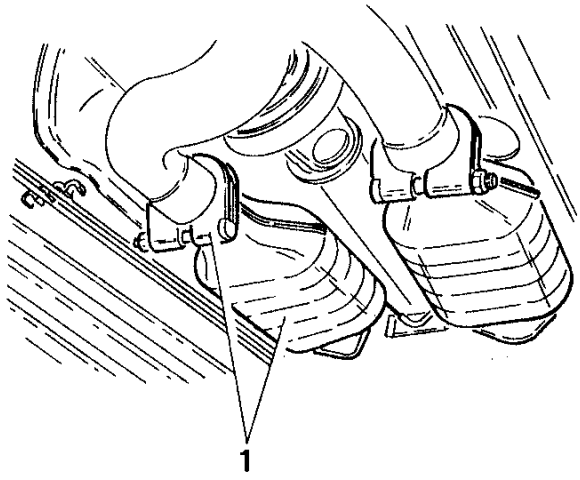


– Lift the vehicle on the lift.

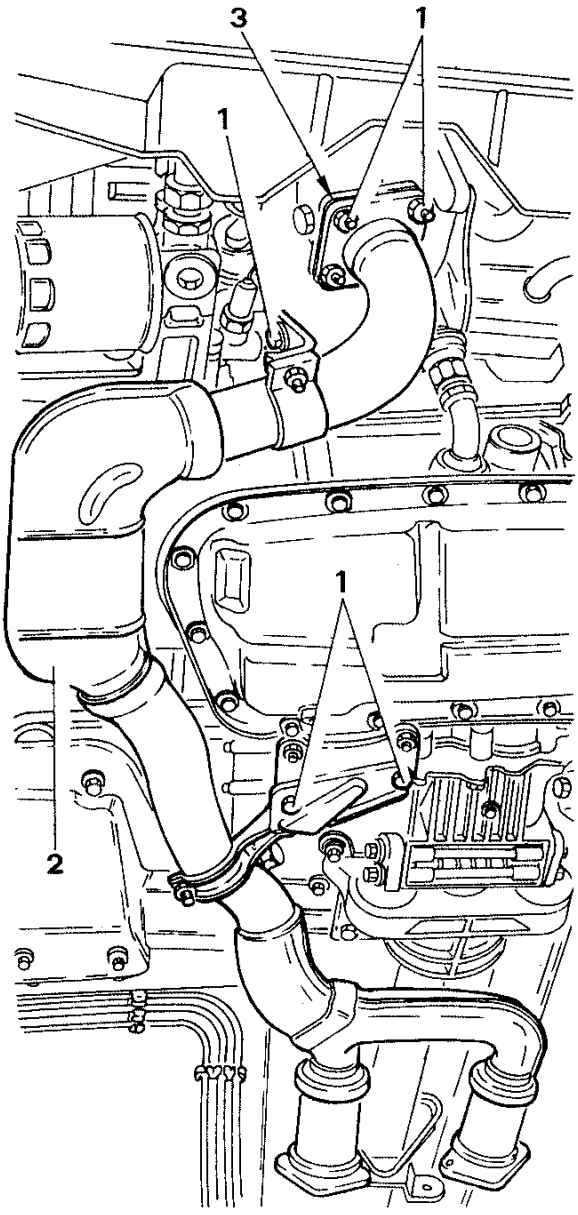
1. Disconnect the two flanges on the front exhaust section from the two catalytic convertors.



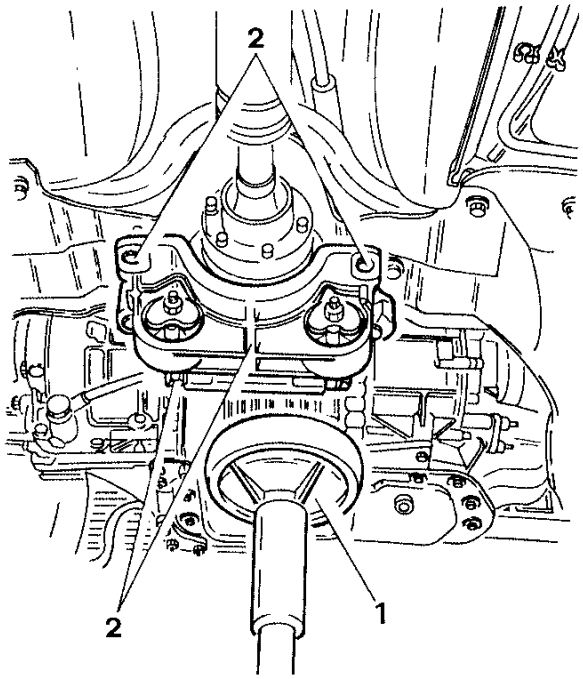
1. Loosen the collars and remove the two catalytic convertors.



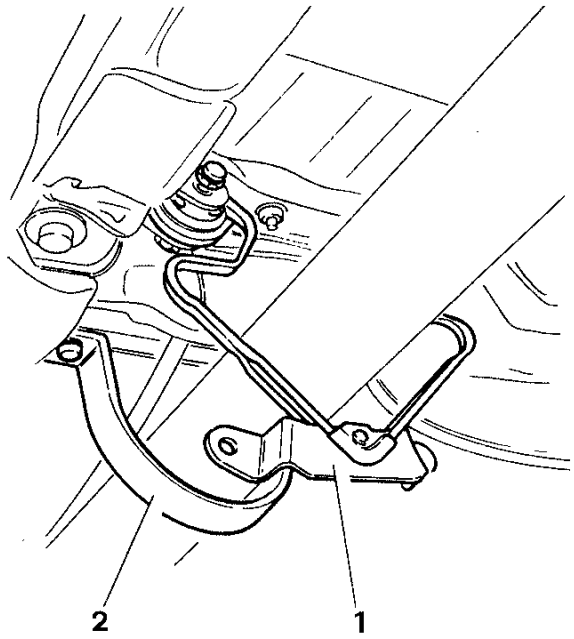
1. Unscrew the screws and nuts securing the front section of the exhaust pipe to the turbocharger and to the support brackets.
2. Remove the front section of the exhaust pipe.
3. Remove the gasket.



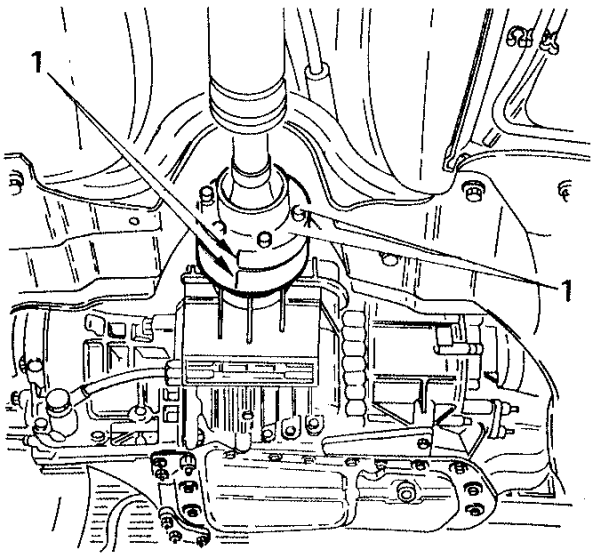
1. Position a suitable column lift under the central differential.
2. Unscrew the screws and bolts securing the engine unit rear support and remove it.



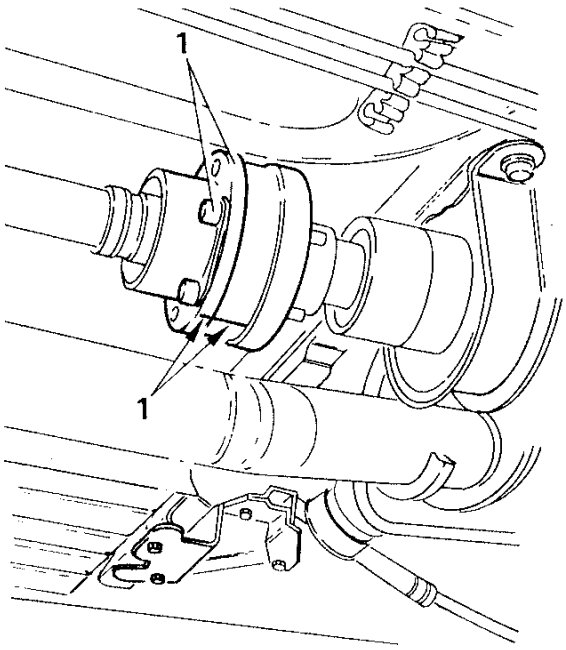
– Remove the column lift.
1. Remove the exhaust pipe elastic stop support.
2. Remove driving shaft safety bracket.



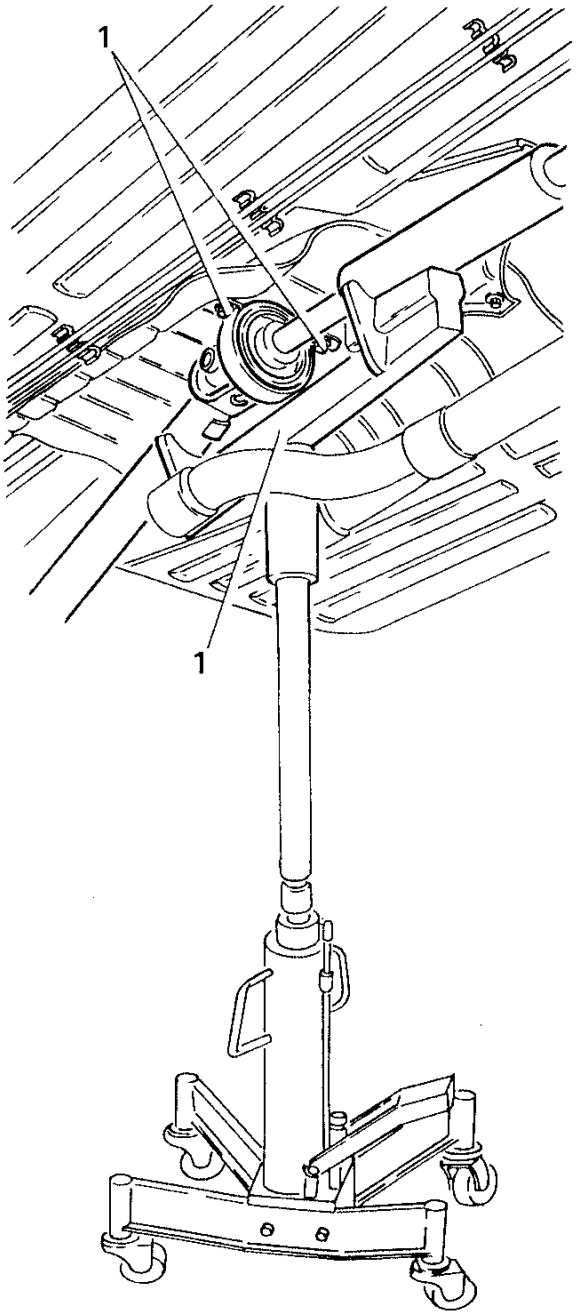
1. Make reference notches on the joint flanges between the front section of the driving shaft and the central differential, and disconnect it unscrewing the relative screws.



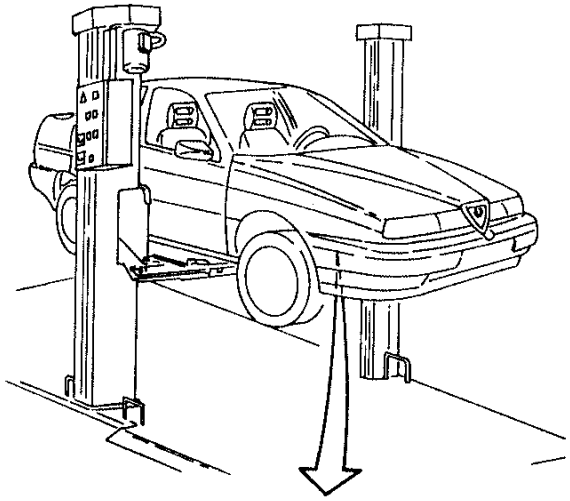
1. Make reference notches in the joint flanges between the central and rear sections of the driving shaft and disconnect them unscrewing the relative screws.

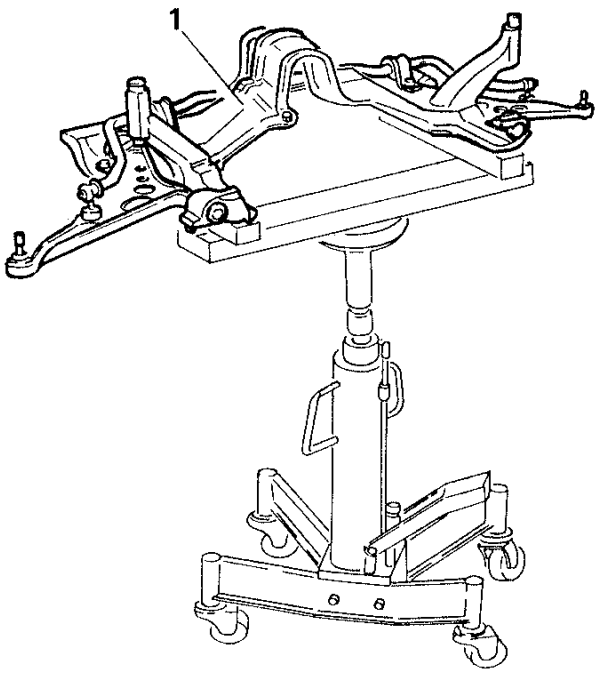


1. Support the front and central sections of the driving shaft with a suitable tool, and after having unscrewed the central elastic support's screws, remove them.

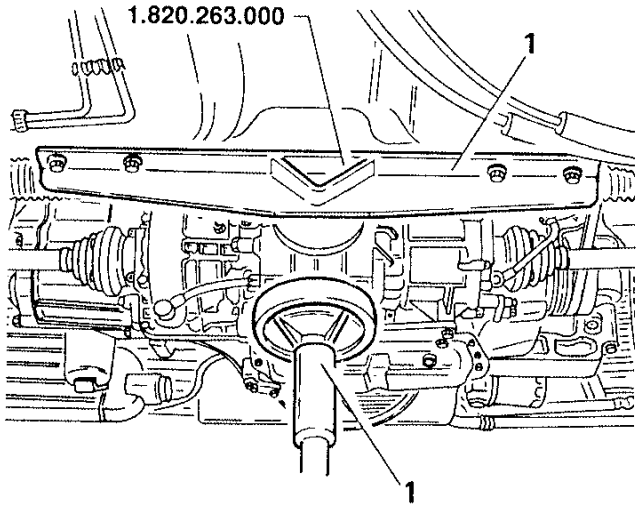


1. Unscrew the screws and remove the cross member complete with wishbones **(see GROUP 21)**.



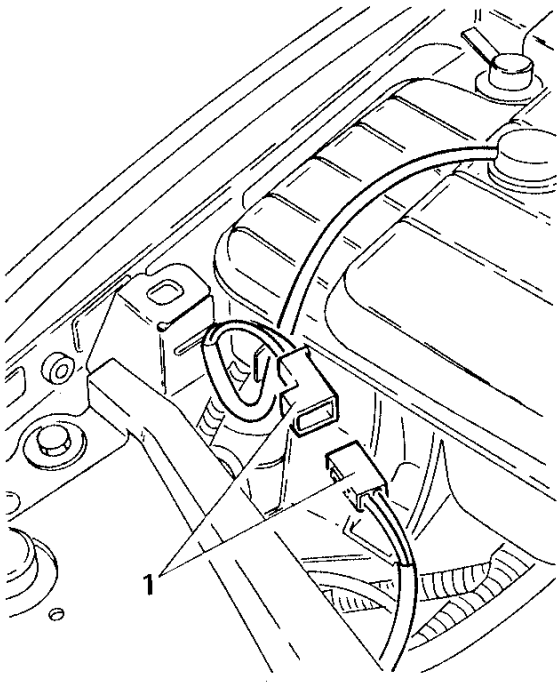


1. Position a suitable column lift under the central differential and raise it enough to install engine unit rear support tool N° 1.820.263.000.

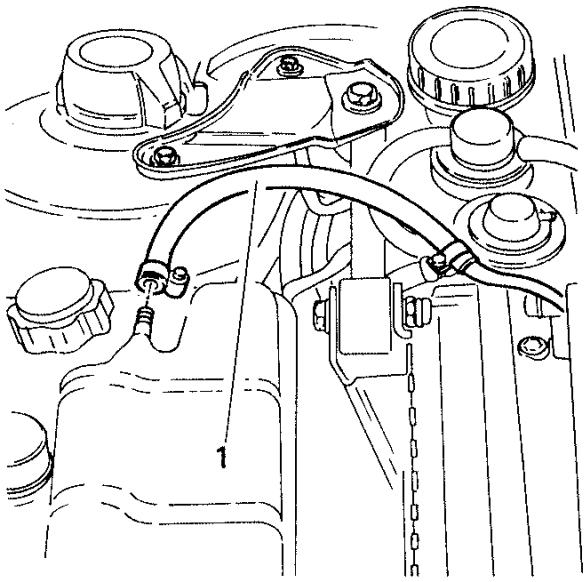


– Lower the vehicle.

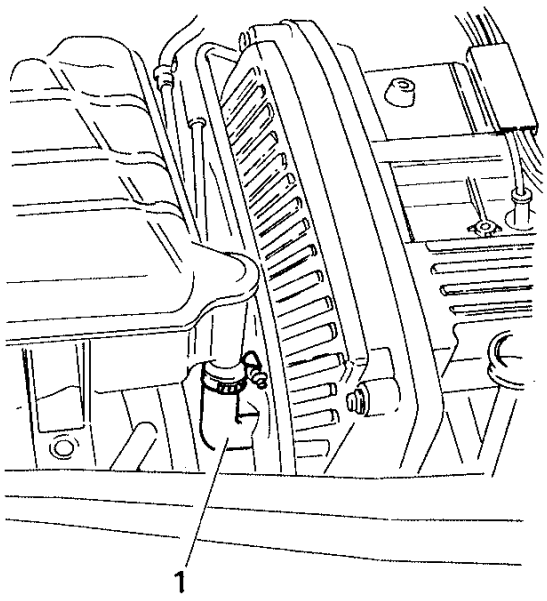
1. Disconnect the electrical connection of the engine coolant minimum level sensor.



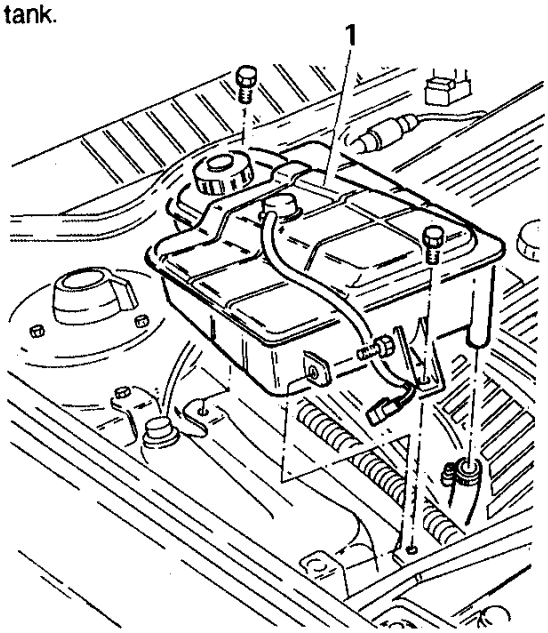
1. Disconnect the coolant arrival and deaereation pipes to the expansion tank.



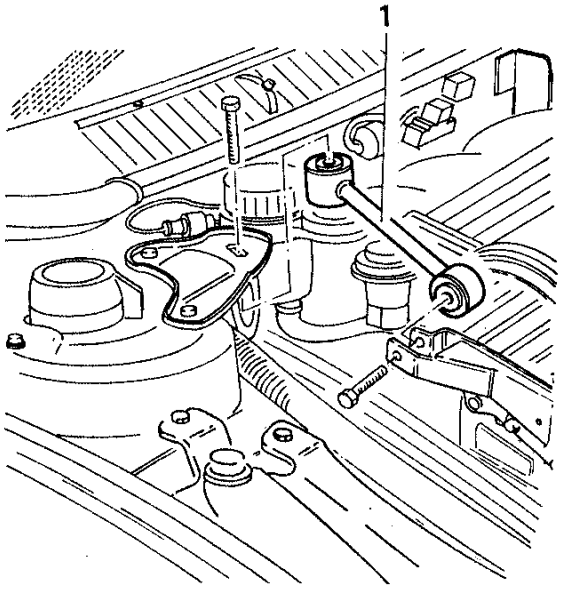
1. Disconnect the cooling circuit feed pipe from the expansion tank.



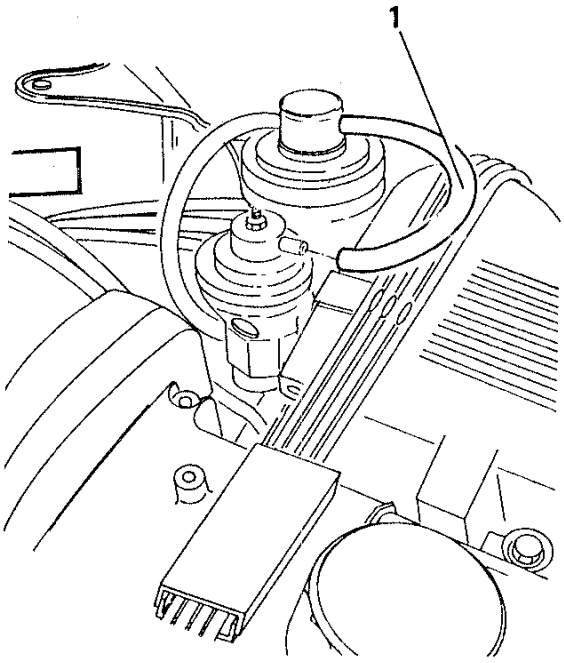
1. Unscrew the screws and remove the expansion tank.



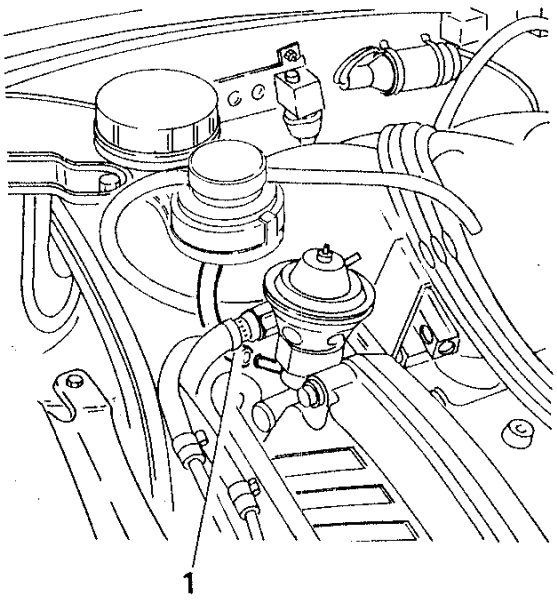
1. Remove the engine damping rod.



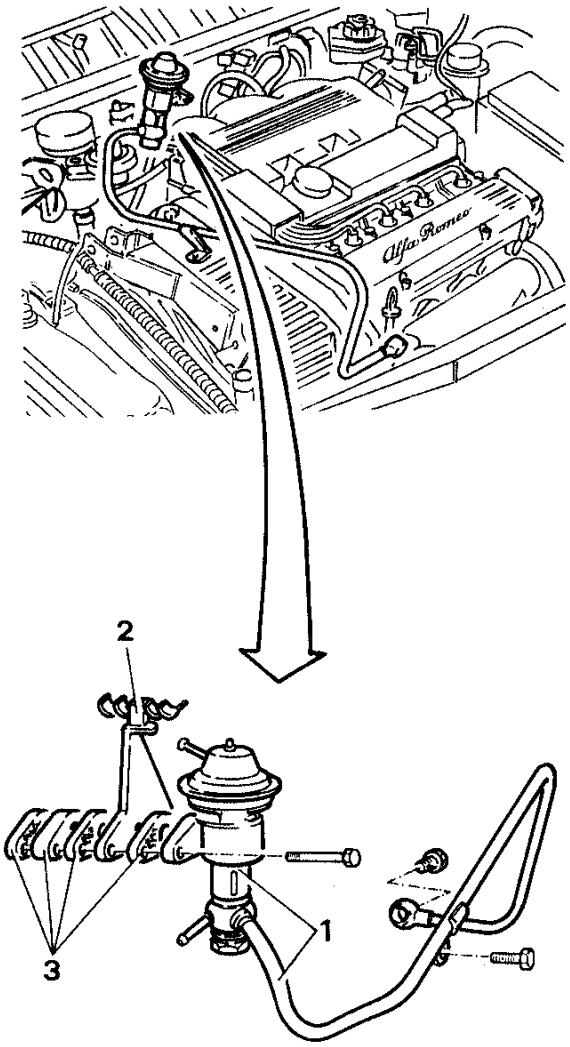
1. Disconnect the vacuum signal from pneumatic signal modulation valve arrival tube from the E.G.R. valve.



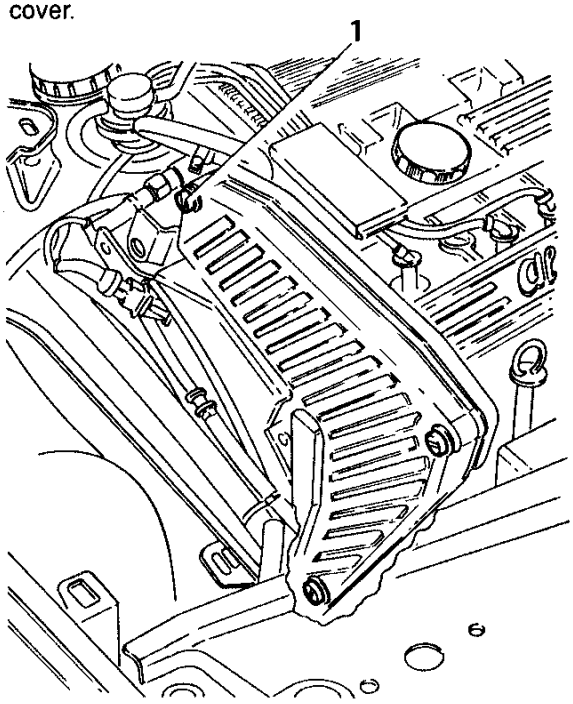
1. Disconnect the exhaust gas to the pneumatic signal modulation valve delivery tube from the E.G.R. valve.



1. Remove the E.G.R. valve complete with exhaust gas pipe.
2. Remove the spark plug cables support bracket.
3. Recover the spacer and the gaskets.

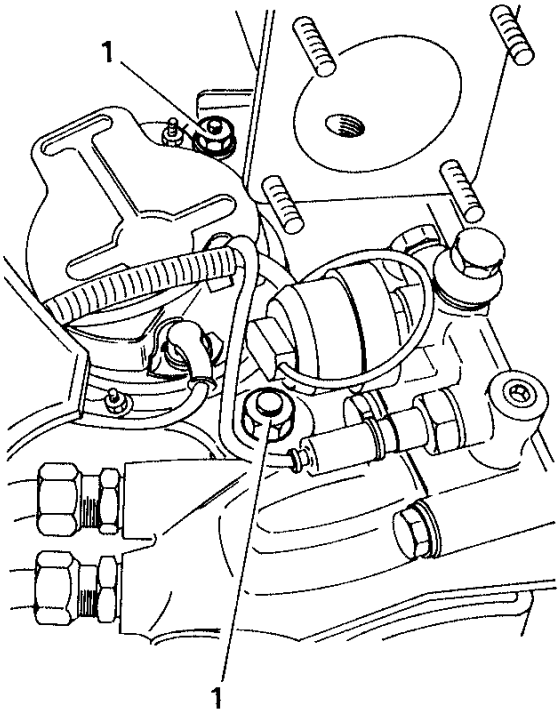


1. Remove the upper screws securing the timing belt cover.

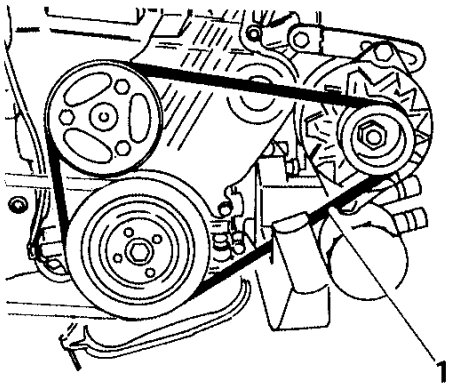


– Raise the vehicle.

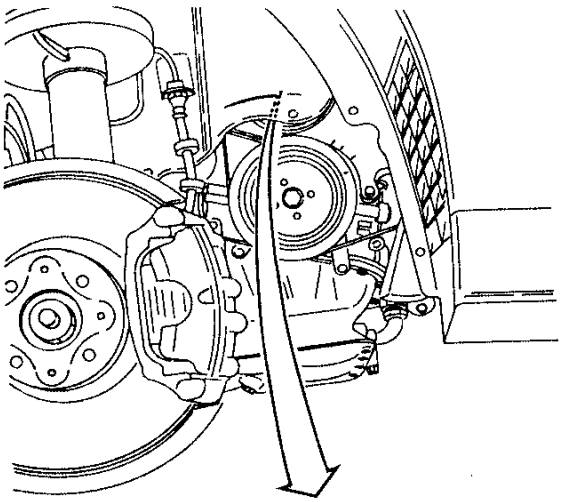
1. Loosen the two alternator bolts.

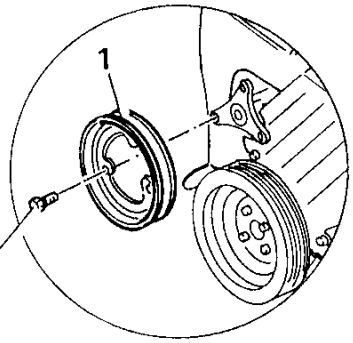


1. Remove the water pump alternator control belt.



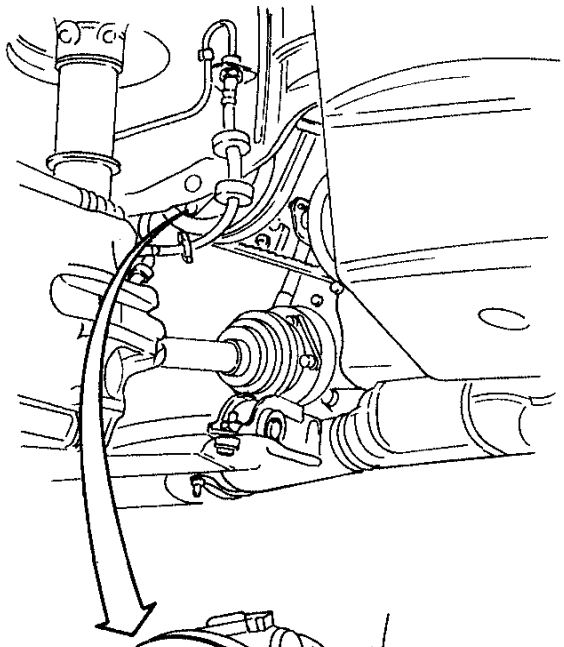
1. Unscrew the screws and remove the water pump pulley.

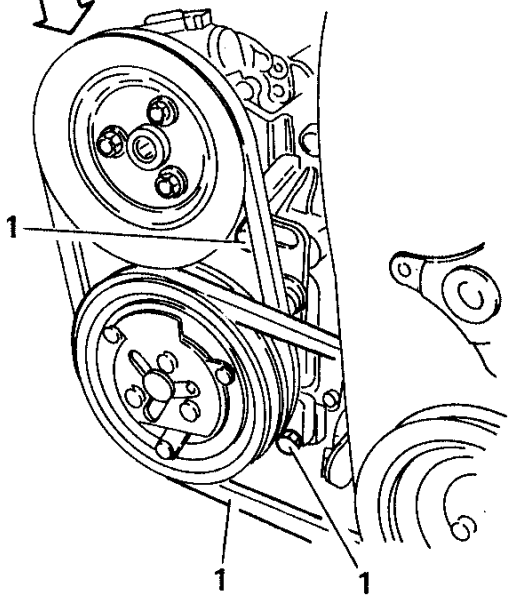




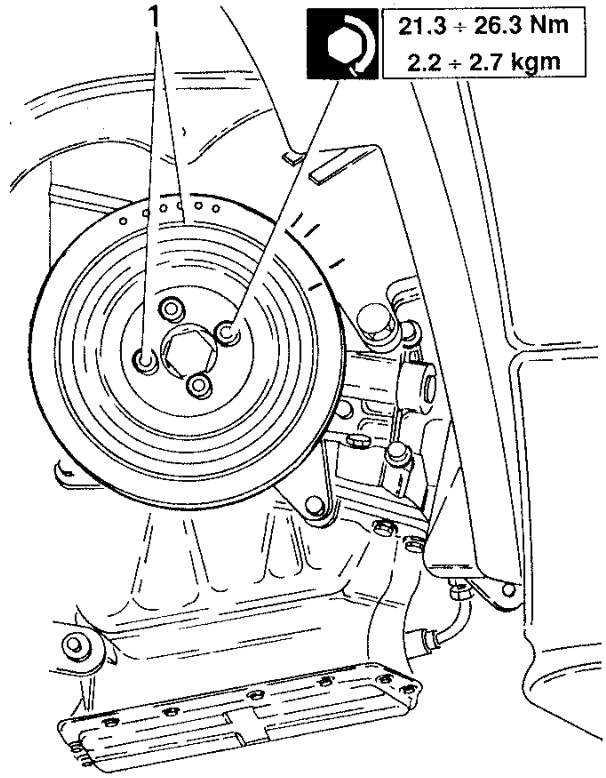
21.3 ÷ 26.3 Nm
2.2 ÷ 2.7 kgm

1. Unscrew the upper screws and the two lower bolts of the air conditioning compressor and remove the control belt.

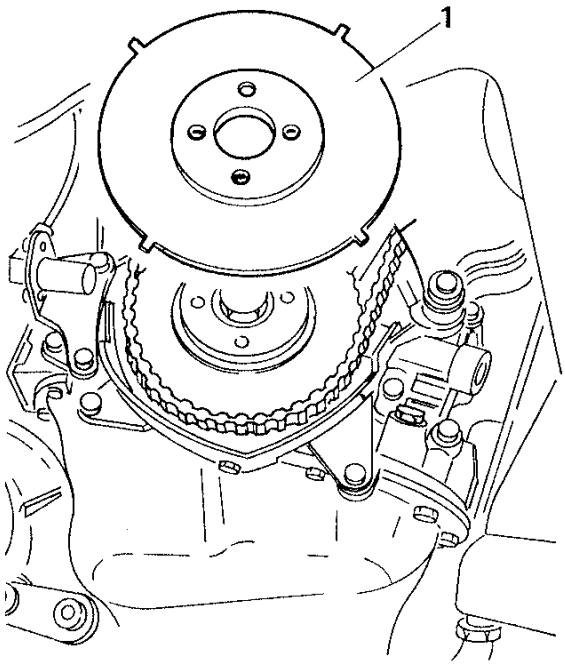




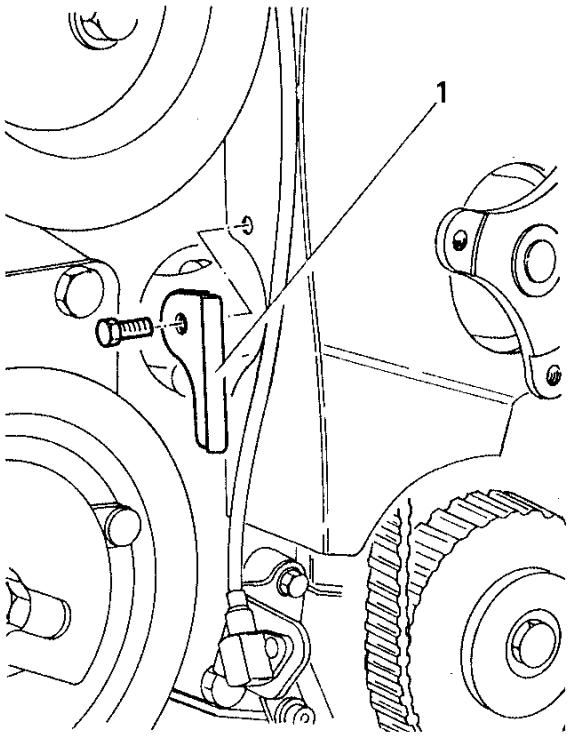
1. Unscrew the screws and remove the auxiliary functions control pulley.



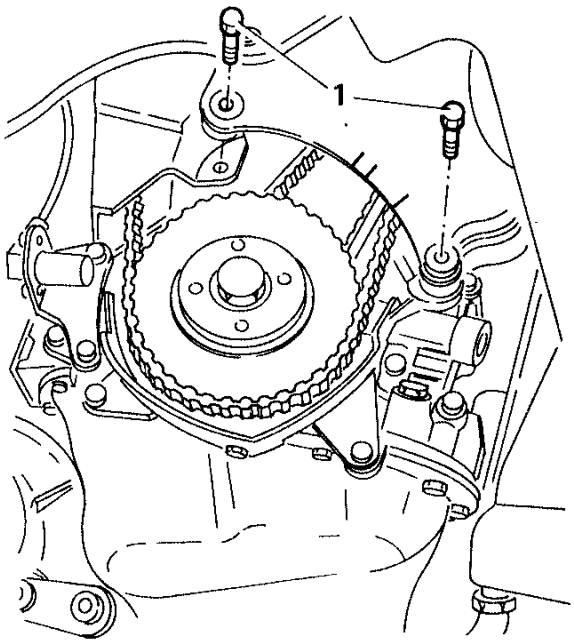
1. Recover the phonic wheel of the revs sensor and the T.D.C.



1. Unscrew the screws and remove the revs sensor cable stop plate and T.D.C.

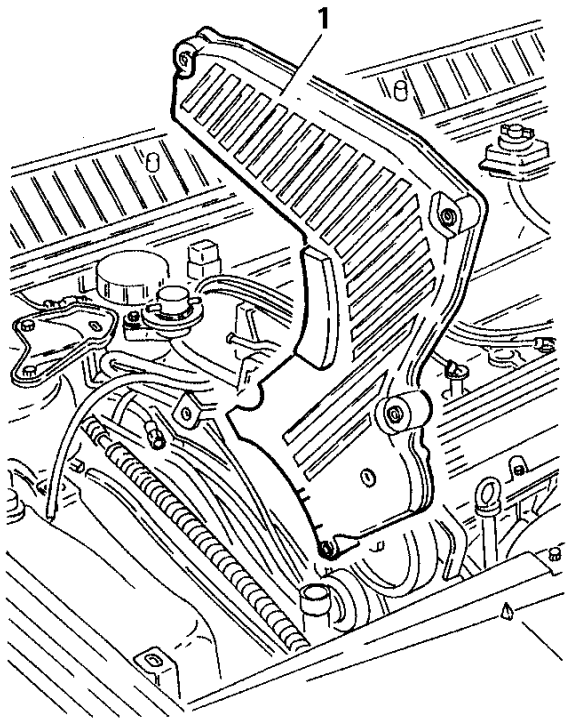


1. Unscrew the lower screws securing the timing belt cover.

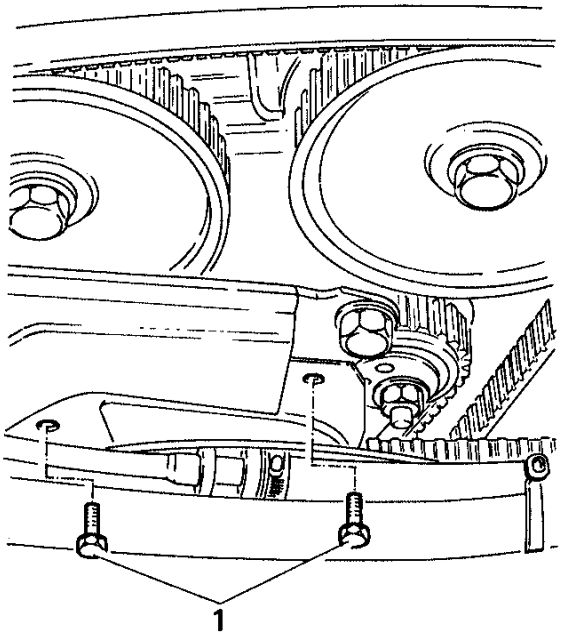


– Lower the vehicle.

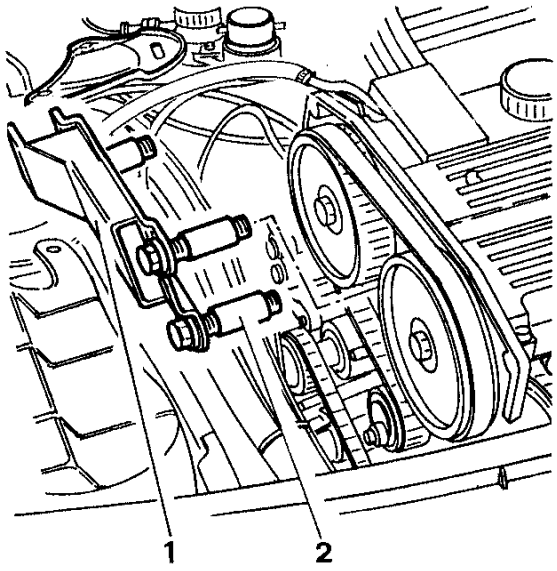
1. Recover the timing control belt.



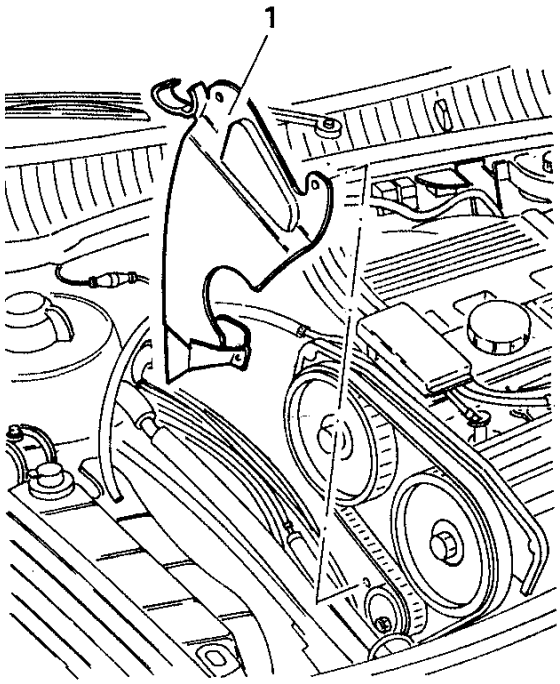
1. Unscrew the screws securing the timing belt metal cover to the engine damping rod support bracket and move it away from the engine.



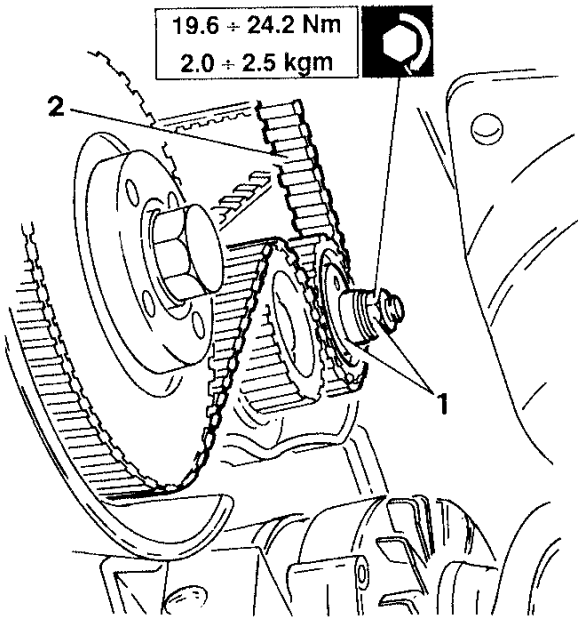
1. Unscrew the screws and remove the engine damping rod support bracket.
2. Recover the spacers.



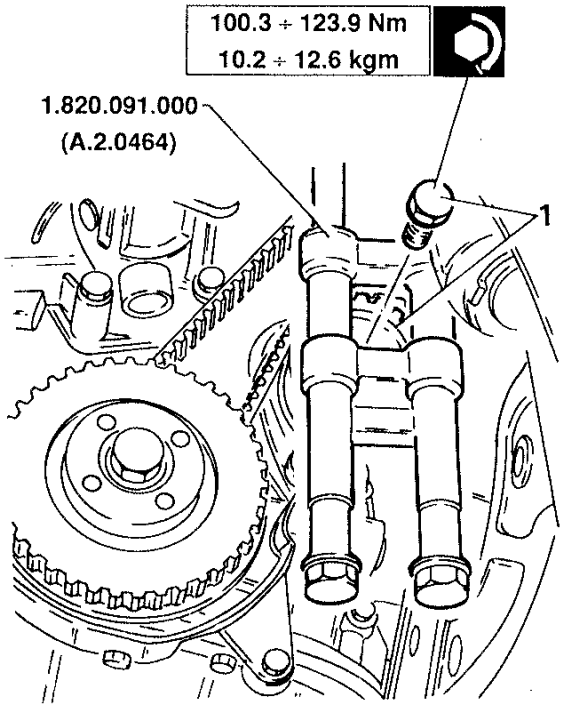
1. Recover the timing belt metal cover disconnected previously.



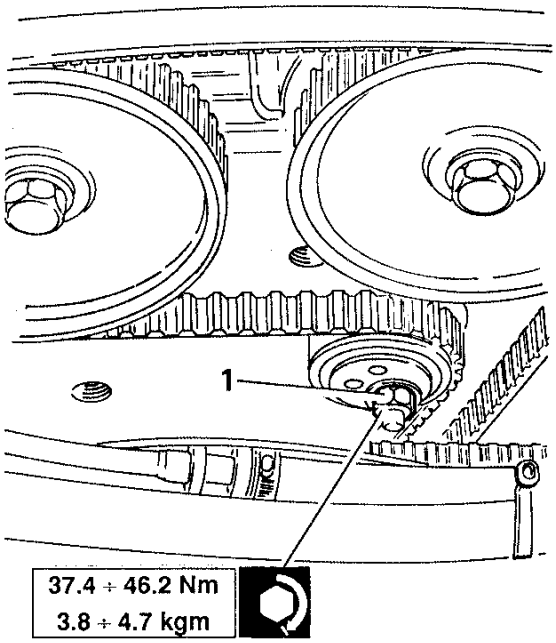
– Raise the vehicle.
1. Unscrew the screws and remove the countershaft control belt stretching jockey pulley.
2. Remove the countershafts control belt.



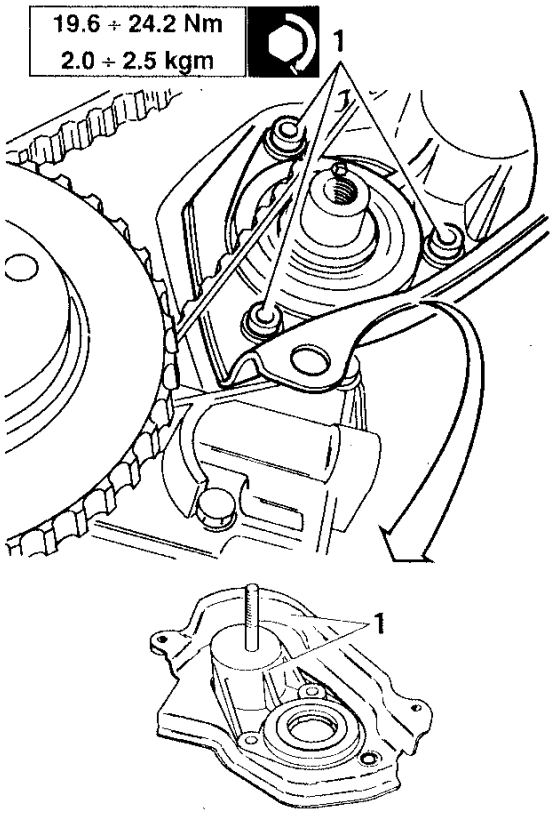
1. Using tool N° 1.820.091.000 (A.2.0464), remove the countershaft control pulley exhaust side.



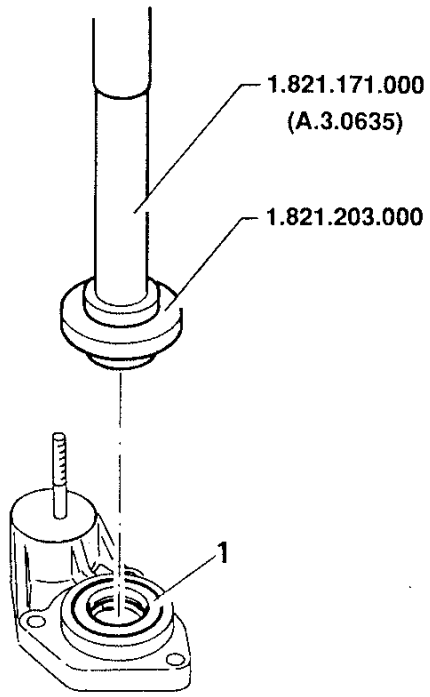
1. Loosen the timing belt tension by unblocking the nut of the relative jockey pulley.



1. Unscrew the three screws and remove the front cover of the countershaft, exhaust side and the relative protective casing.



1. Remove the oil seal ring from the countershaft front cover and install a new ring using tools N° 1.821.171.000 (A.3.0635) and N° 1.821.203.000.

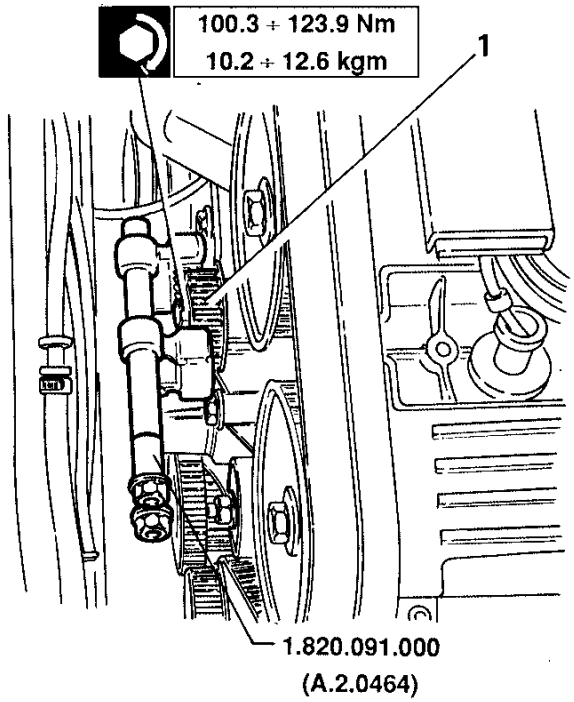


Reassemble following the above disassembly instructions in the reverse order and taking care that the timing belt is assembled the engine timing is checked and the auxiliary part belts are stretched in accordance with instructions in GROUP 00.

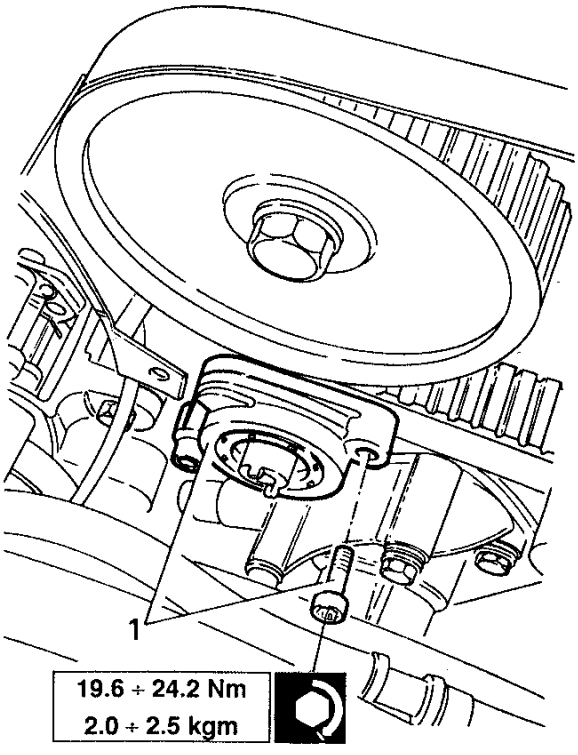
REPLACEMENT OF COUNTERSHAFT OIL SEAL INTAKE SIDE

– Follow the procedure used for the "Replacement of the countershaft oil seal intake side" upto and including the removal of the countershaft control belt.

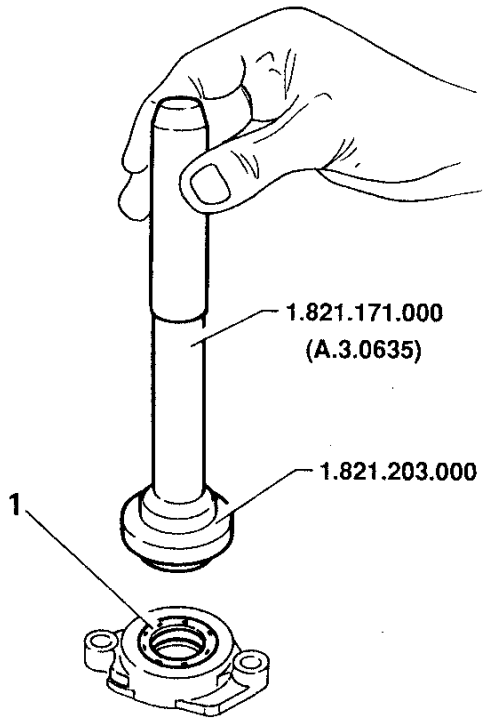
1. Using tool N° 1.820.091.000 (A.2.0464), remove the countershaft control belt intake side.



1. Unscrew the two screws and remove the countershaft front cover intake side.



1. Remove the oil seal ring from the countershaft front cover and install a new ring using tools N° 1.821.171.000 (A.3.0635) e N° 1.821.203.000.

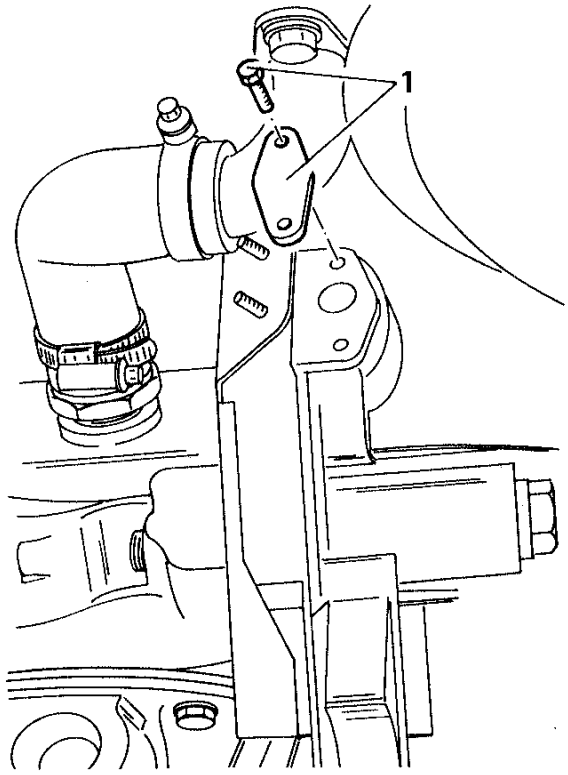


Reassemble following the above disassembly instructions in the reverse order and taking care that the timing belt is assembled, the engine timing is checked and the auxiliary part belts are stretched in accordance with instructions in GROUP 00.

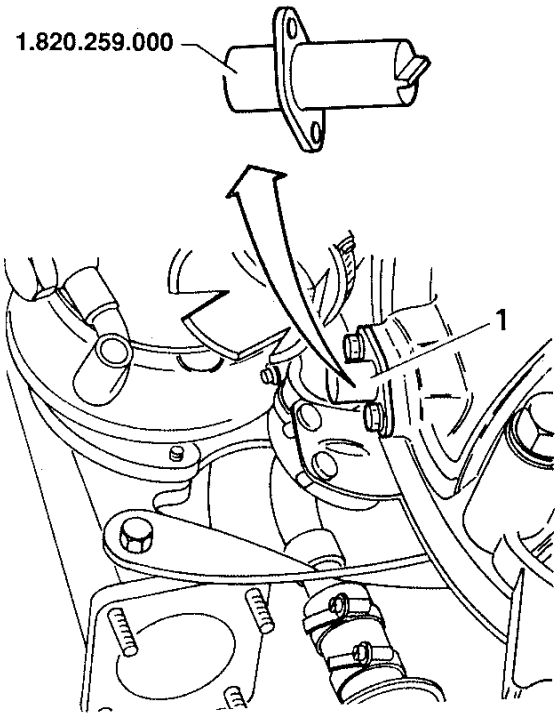
REPLACEMENT OF CRANKSHAFT FRONT OIL SEAL

– Follow the procedure used for the "Replacement of the countershaft oil seal intake side" upto and including the removal of the countershafts control belt.

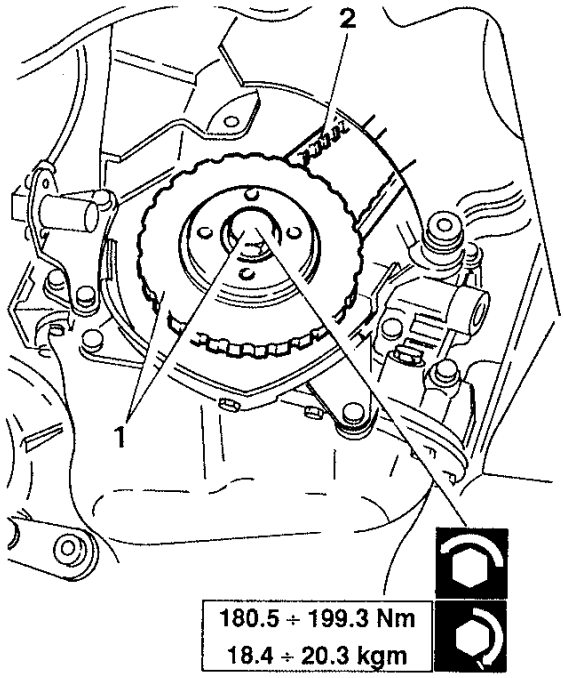
1. Unscrew the screws and remove the plate from the gearbox casing.



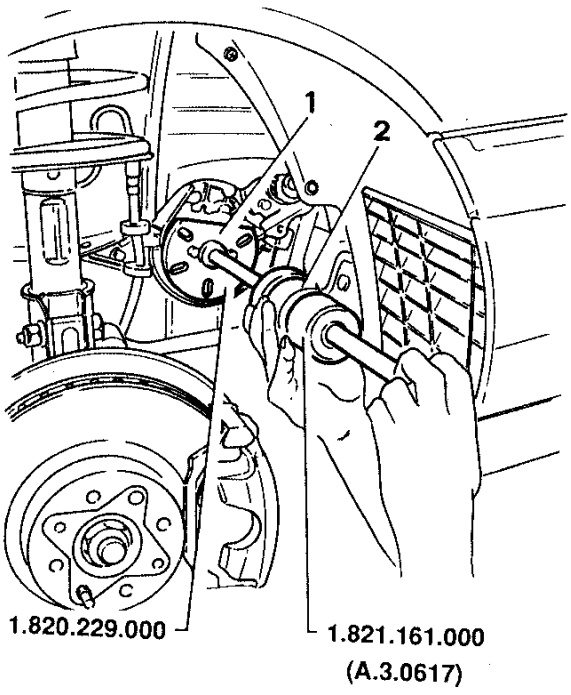
1. In the seating of the removed plate, install the flywheel blocking tool N° 1.820.259.000.



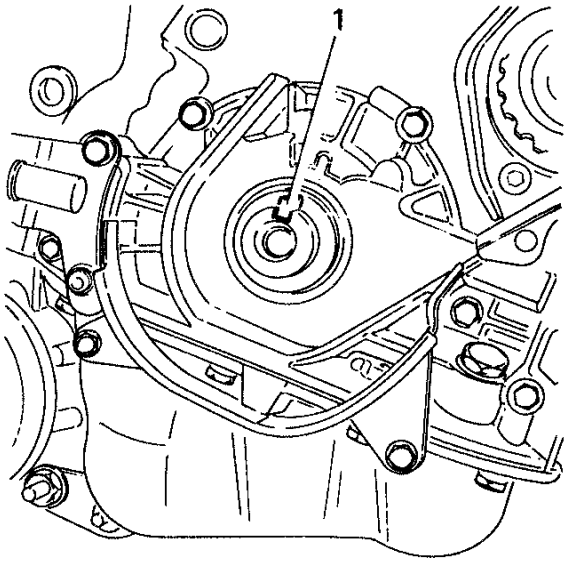
1. Unscrew the screws (lefthand) and remove the countershaft control pulley.
2. Extract the timing belt from the control pulley.



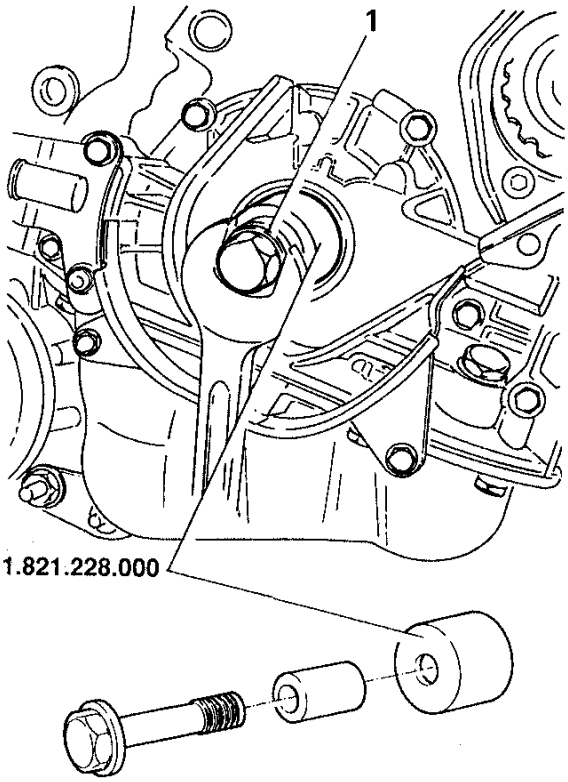
1. Install tool N° 1.820.229.000 on the timing control pulley.
2. Using the ram N° 1.821.161.000 (A.3.0617), remove the timing control pulley.



1. Remove the timing control pulley key.

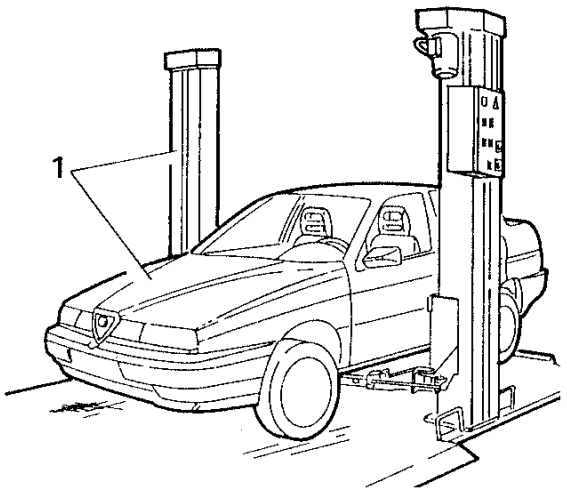


1. Remove the crankshaft oil seal ring and install a new ring using the inserting tool N° 1.821.228.000 and a suitable spacer as indicated in the figure.



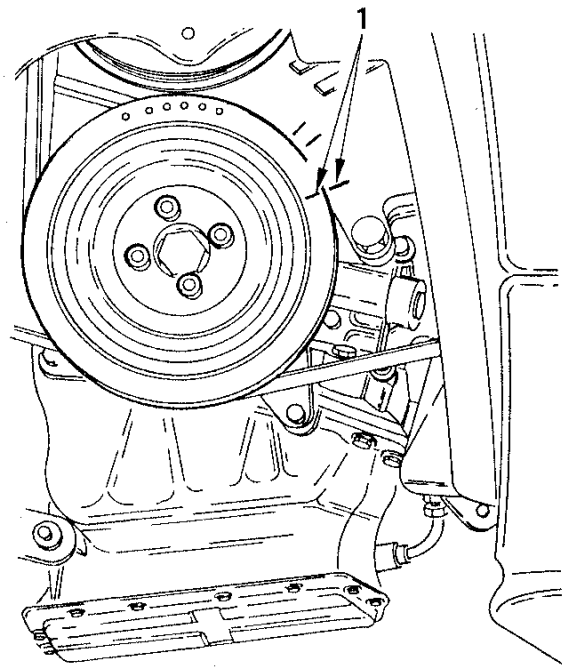
REPLACEMENT OF CRANKSHAFT REAR OIL SEAL

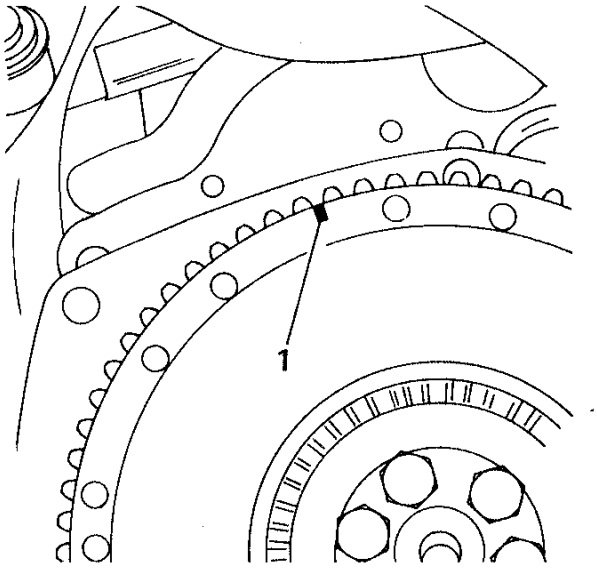
1. Position the vehicle on a lift.



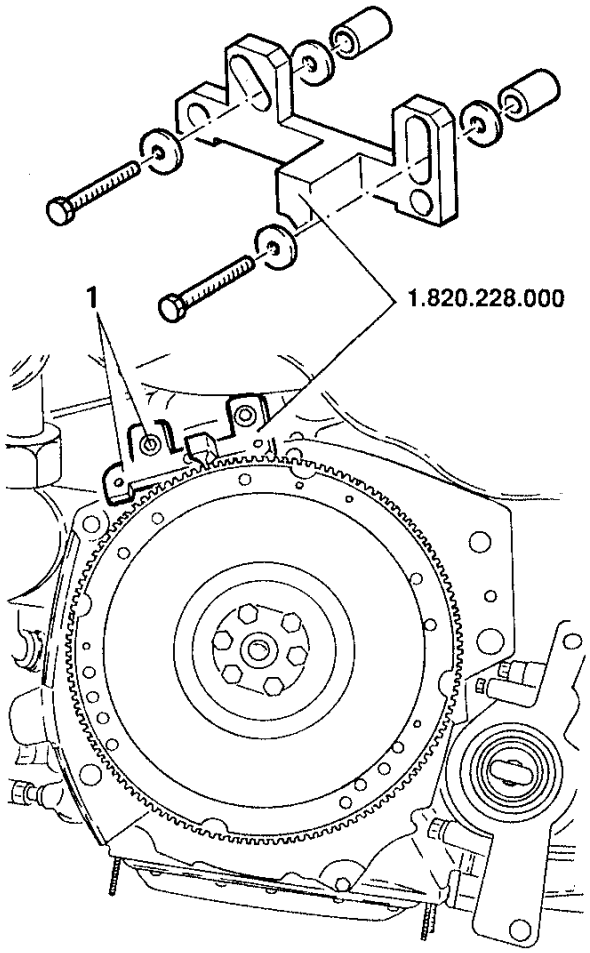
- Remove the gearbox (see **GROUP 13**)
- Remove clutch (see **GROUP 12**).
- Remove the dustguard from the front righthand wheel arch.

1. Check that the flywheel is in time checking that:
   - the notch engraved on the crankshaft pulley coincides with the one on the timing protective casing.
   - the notch engraved on the flywheel faces upwards.

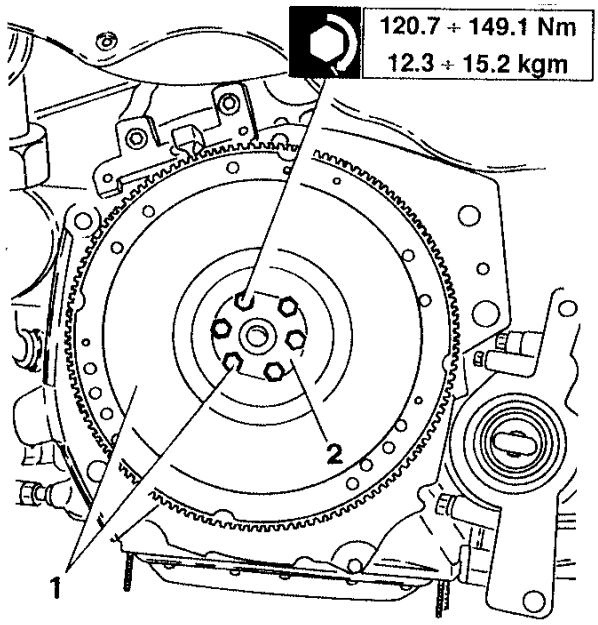




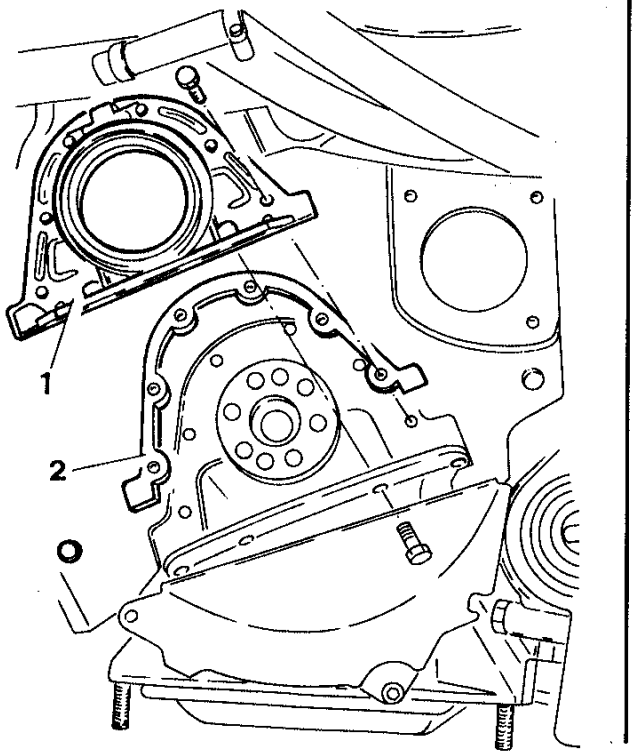
1. Install the flywheel blocking tool N° 1.820.228.000 and place two suitable spacers 20 mm in length.



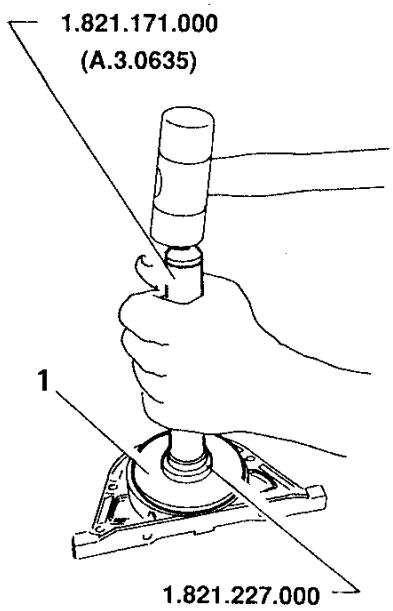
1. Unscrew the screws and remove the flywheel.
2. Recover the safety washer.



1. Unscrew the screws and remove the rear engine cover complete with oil seal ring.
2. Remove the gasket.



1. Remove the oil seal ring from the rear cover and install a new ring using tools N° 1.821.171.000 (A.3.0635) and N° 1.821.227.000.



TECHNICAL CHARACTERISTICS AND PRESCRIPTIONS

All technical dimensional checks and inspections relative to engine AR 67203 are presented below.

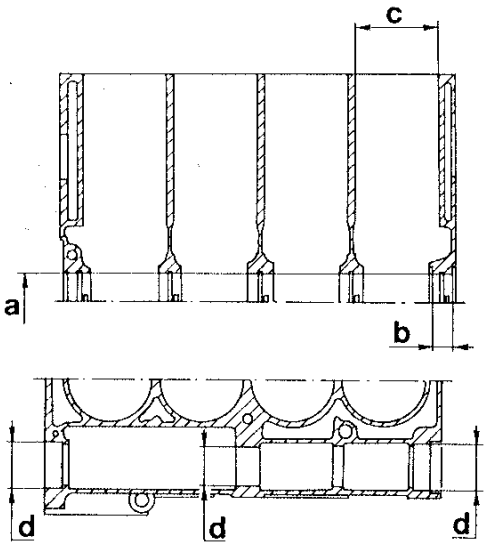
The same information has been included in the description of the repair procedure presented earlier.
The information below has been synthetically enlarged with other data useful for the complete inspection of the engine and its parts.
The order in which the components are presented is the same as that for the reassembly of the overhauled engines.

TECHNICAL CHARACTERISTICS OF ENGINE

Engine		AR 67203
Cycle		Four stroke Otto
Supply		"Multipoint IAW" Electronic injection
Cubic capacity	cm^3	1995
Number of cylinders		4 in line
Bore	mm	84
Stroke	mm	90
Maximum horsepower	CV DIN (kW CEE) r.p.m	190 (137) 6000
Maximum torque	kgm DIN (Nm CEE) r.p.m	30.3 (291) 2500
Compression ratio		8:1
Engine oil pressure (with engine oil at 100°C) - At idle speed - A 4000 r.p.m	kPa (bar; kg/cm^2)	 0.8 (0.82) 4 (4.1)

COMPLETE ENGINE BLOCK

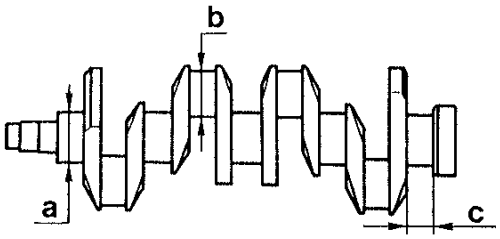
Engine block



Unit: mm

Diameter of main supports (a)	Class 1	56.729 - 56.735
	Class 2	56.723- 56.729
	Class 3	56.717 - 56.723
Length of main rear support shoulder (b)		23.12 - 23.20
Diameter of cylinder liners (c)	Class A	84.000 - 84.010
	Class B	84.010 - 84.020
	Class C	84.020 - 84.030
	Class D	84.030 - 84.040
	Class E	84.040 - 84.050
	Increased by 0.1	
Diameter of counter-shaft supports	Front and rear	46.975 - 47.000
	Central	39.979 - 40.009

Crankshaft

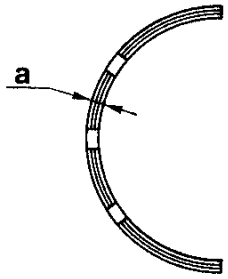


Unit: mm

Diameter of main journals (a)	Class A	52.998 - 53.004
	Class B	52.992 - 52.998
	Class C	52.986 - 52.992
	Decreased by 0.127	
Diameter of rod journals (b)	Class A	50.799 - 50.805
	Class B	50.793 - 50.799
	Class C	50.787 - 50.793
	Decreased by 0.127	
Length of main rear journal (c)		27.975 - 28.025

Main bearing-halves

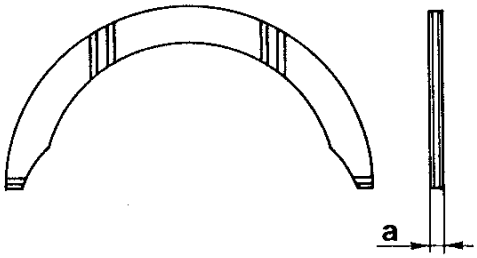
Unit: mm



Thickness of main bearing halves (a)	Class A	1.838 - 1.844
	Class B	1.844 - 1.850
	Class C	1.850 - 1.856
	Decreased by 0.127	
Radial clearance between journals and main bearings	Class A	0.037 - 0.061
	Class B	0.025 - 0.049
	Class C	0.013 - 0.037

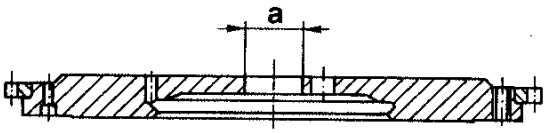
Thickness of thrust half-rings

Unit: mm



Thickness of thrust half-rings (a)	2.347 - 2.363
	Increased by 0.127
Crankshaft axial clearance	0.049 - 0.211

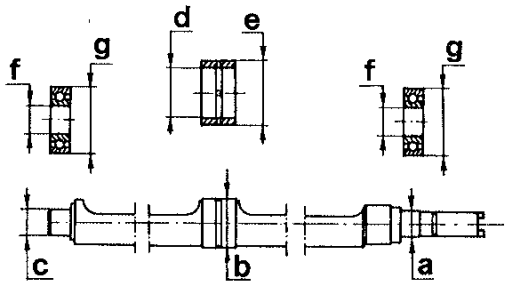
Flywheel



Diameter of inner central bushing (a)	31.950 - 31.982 mm
Heating temperature of ring gear for installation on engine flywheel	120 - 140 °C

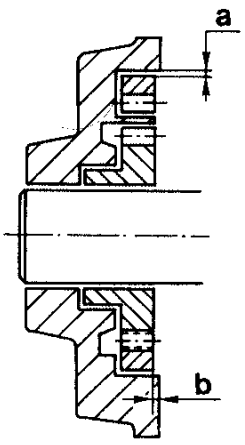
Counter-shafts

Unit: mm



Diameter of counter-shaft journals	Front (a)	19.980 - 19.993
	Central (b)	36.945 - 36.960
	Rear (c)	19.980 - 19.993
Diameter of central bushings	Inner (d)	37.020 - 37.040
	Outer (e)	40.089 - 40.129
Diameter of ball bearings	Inner (f)	19.99 - 20.00
	Outer (g)	46.989 - 47.000
Interference between central bushings and relative seatings on engine block		0.08 - 0.15
Radial clearance between bushings and central journals		0.06 - 0.095
Clearance/interference between ball bearings and relative seatings on engine block		+0.011 - -0.025
Clearance/interference between ball bearings and counter-shaft journals		+0.02 - -0.003

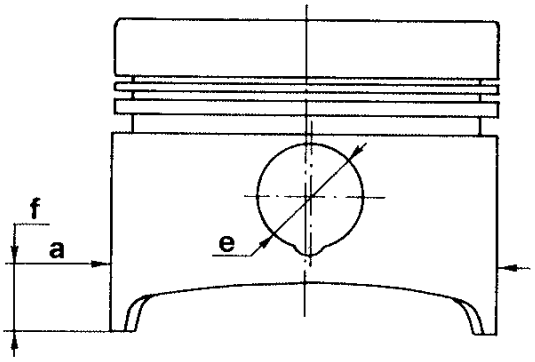
Oil pump

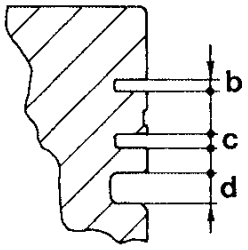


Clearance between pump body seating and driven gear (a)		0.080 - 0.186 mm
Clearance between pump cover resting plane and gears (b)		0.025 - 0.056 mm
Oil pressure release valve spring	Length	35.3 mm
	Test load	113 - 121 N (11.48 - 12.32 kg)

ROD-PISTON ASSEMBLY

Pistons



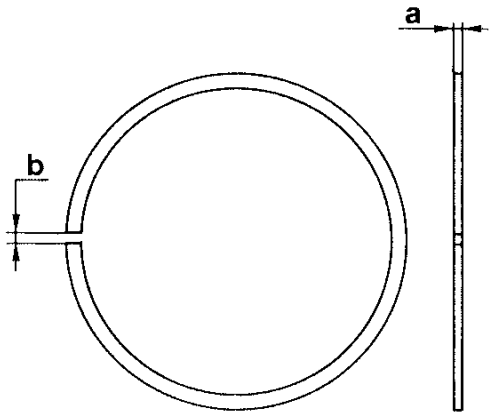


Unit: mm

Diameter of pistons (a) (1)	Class A	83.940 - 83.950
	Class B	83.950 - 83.960
	Class C	83.960 - 83.970
	Class D	83.970 - 83.980
	Class E	83.980 - 83.990
	Increased by 0.1	
Height of first seal ring seatings (b)		1.535 - 1.555
Height of second seal ring seatings (c)		2.020 - 2.040
Height of oil scraper ring seatings (d)		3.967 - 3.987
Diameter of gudgeon pin hole in pistons (e)	Class 1	21.996 - 21.999
	Class 2	21.999 - 22.002
Clearance between cylinder liners and pistons		0.05 - 0.07
Weight difference between pistons		± 5 g

(1) To be measured perpendicularly to the gudgeon pin hole at a distance of f = 15 mm from the lower edge of the skirt.

Seal rings



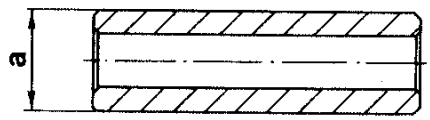
Unit: mm

Thickness of rings (a)	First ring	1.478 - 1.490
	Second ring	1.978 - 1.990
	Oil scraper ring	3.925 - 3.937
Ring gaps (1) (b)	First ring	0.30 - 0.50
	Second ring	0.30 - 0.50
	Oil scraper ring	0.25 - 0.40
Axial clearance between seats and seal rings	First ring	0.045 - 0.077
	Second ring	0.030 - 0.062
	Oil scraper ring	0.030 - 0.062

(1) To be measured in the checking ring nut or in the cylinder liner

Gudgeon pins

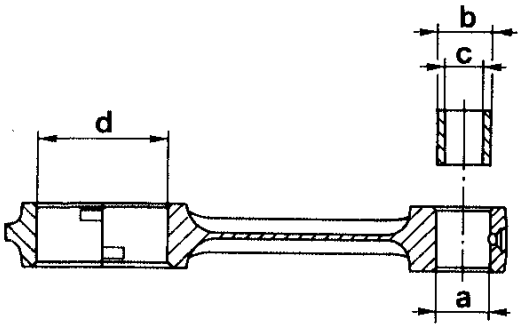
Unit: mm



Outer diameter of gudgeon pins (a)	Class 1	21.991 - 21.994
	Class 2	21.994 - 21.997
	Increased by 0.2	
Clearance between piston holes and gudgeon pins		0.002 - 0.008

Rods

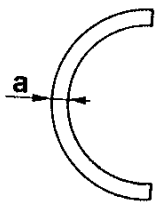
Unit: mm



Diameter of rod small end (a)		24.988 - 25.021
Outer diameter of rod bushings (b)		25.065 - 25.090
Inner diameter of rod bushings (bore) (c)	Class 1	22.004 - 22.007
	Class 2	22.007 - 22.010
Diameter of rod big ends (d)	Class A	53.904 - 53.910
	Class B	53.898 - 53.904
	Class C	53.892 - 53.896
Weight difference between rods		± 5 g
Clearance between rod small end bushings and gudgeon pins		0.010 - 0.016
Interference between rod small end bushings and bushing seats		0.044 - 0.102

Rod half-bearings

Unit: mm

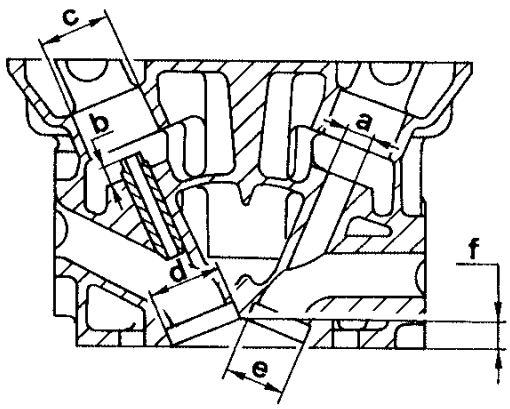


Thickness of rod half-bearings (a)	Class A	1.531 - 1.537
	Class B	1.537 - 1.543
	Class C	1.543 - 1.549
	Decreased by 0.127	
Radial clearance between journals and rod bearings	Class A	0.025 - 0.049
	Class B	0.013 - 0.037
	Class C	0.001 - 0.023

CYLINDER HEAD

Head

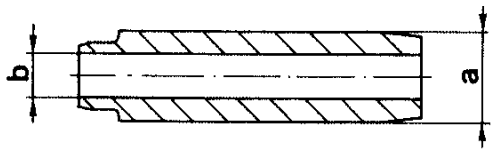
Unit: mm



Diameter of valve guide seatings (a)		13.950 - 13.977
Valve guide protuberance (b)		10.2 - 11.1
Diameter of valve cup seatings (c)		37.000 - 37.025
Diameter of valve seat housings	Intake (d)	35.989 - 36.014
	Exhaust (e)	29.989 - 30.014
Minimum depth "f" of combustion chambers in head		15.4
Maximum error of flatness on lower head plane		0.1

Valve guides

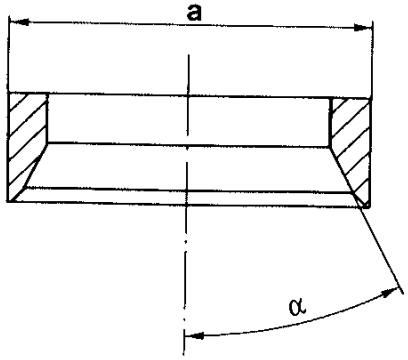
Unit: mm



Outer diameter of valve guides (a)	14.010 - 14.030
	Increased by 0.05
Inner diameter of valve guides (bore) (b)	7.022 - 7.040
Interference between valve guides and seatings	0.033 - 0.08

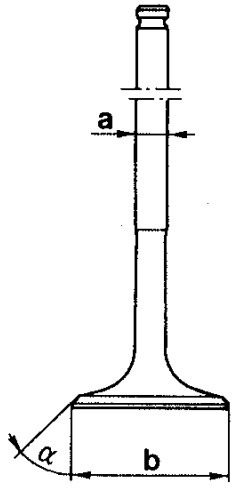
Valve seatings

Unit: mm



External diameter of valve seatings	Intake	36.135 - 36.150
	Exhaust	30.125 - 30.140
Taper of valve seatings (α)		45° ± 5'
Interference between valve seatings and housings	Intake	0.121 - 0.161
	Exhaust	0.111 - 0.151
Heating temperature of cylinder head for installation of valve seatings		80 °C

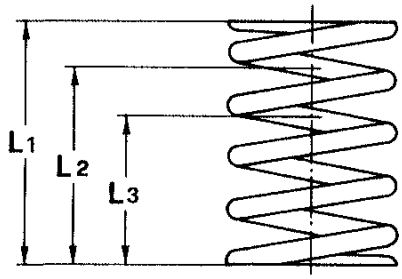
Valves



Unit: mm

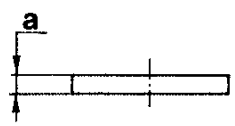
Diameter of valve stems (a)	Intake	6.974 - 6.992
	Exhaust	
Diameter of valve heads (b)	Intake	34.3 - 34.5
	Exhaust	28.3 - 28.5
Angle of valve heads (α)	Intake	45°30' ± 5'
	Exhaust	
Radial clearance between valve stems and guides	Intake	0.030 - 0.066
	Exhaust	

Valve springs



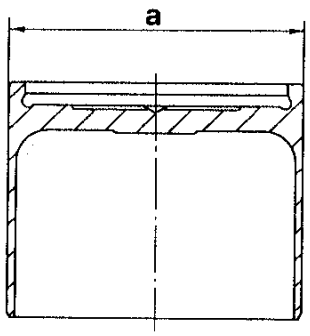
	Outer springs	Inner springs
Free length (L_1)	53.9 mm	41.8 - 42.8 mm
Spring length with closed valves (L_2)	36 mm	31 mm
Load corresponding to length of springs with closed valves	367 - 396 N (37.4 - 40.4 kg)	141 - 151 N (14.4 - 15.4 kg)
Spring length with open valves (L_3)	26.5 mm	21.5 mm
Load corresponding to length of springs with open valves	559 - 608 N (57 - 62 kg)	264 - 287 N (26.9 - 29.3 kg)

Caps



Thickness of caps (a)	3.25 - 4.70 mm (with intervals of 0.05)

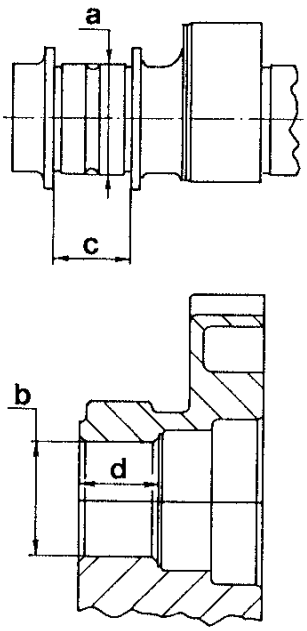
Valve cups



Unit: mm

Diameter of valve cups (a)	36.975 - 36.995
Radial clearance between valve cups and relative seatings	0.005 - 0.050

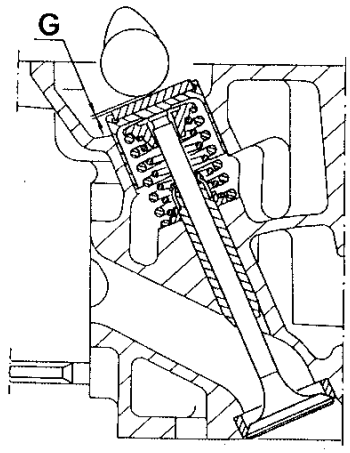
Camshafts



Unit: mm

Diameter of camshaft journals (a)		28.480 - 28.495
Diameter of camshaft supports (b)		28.545 - 28.570
Maximum eccentricity between journals		0.02
Width of shaft shoulder (c)		19.67 - 19.75
Width of shaft shoulder support (d)		19.52 - 19.57
Cam height (on valve axis without clearance)	Intake	8.6
	Exhaust	7.5
Radial clearance between journals and camshaft seatings		0.05 - 0.09
Camshaft axial clearance		0.1 - 0.23

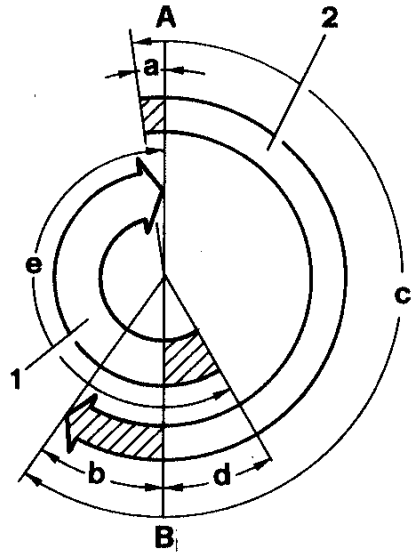
Valve clearance



Unit: mm

Valve clearance for timing check	Intake	0.8
	Exhaust	0.8
Operational valve clearance (with cold engine) (G)	Intake	0.36 - 0.44
	Exhaust	0.46 - 0.54

ANGULAR VALUES OF THE REAL TIMING DIAGRAM



(1) Exhaust (2) Intake
(A) T.D.C. (B) B.D.C.

Intake	Opening (before T.D.C.)	(a)	8°
	Closing (after B.D.C.)	(b)	35°
	Intake angular value	(c)	223°
Exhaust	Opening (before B.D.C.)	(d)	30°
	Closing (after T.D.C.)		0°
	Exhaust angular value	(e)	210°

FLUIDS AND LUBRICANTS

Application	Q.ty litres	Type	Specified classification	Name
Engine oil		Oil	API SG CCMC G5	SELENIA SPECIAL FORMULA
– Total capacity	5.5		SAE 10W/40	ALFA ROMEO 10W/40
– Partial capacity (filter and sump) for topping-up	4.5			
– Filter	0.4			
– Camshaft and radiator wells	1.0			
Oil seal covers on valve guides	–			
Intake and exhaust valve cups and relative seatings	–			
Camshaft supports	–			
Oil pump gear	–			

SEALANTS AND FIXATIVES

Application	Type	Name	Q.ty
Screws securing flywheel to crankshaft		Loctite Mastic 270 (green)	–
Crankshaft lubrication duct plugs			–

ABRASIVES

Application	Type	Name	Q.ty
Sanding of valve seatings	Abrasive	SIPAL AREXONS Carbosilicium for valves	–

TIGHTENING TORQUES

Engine block

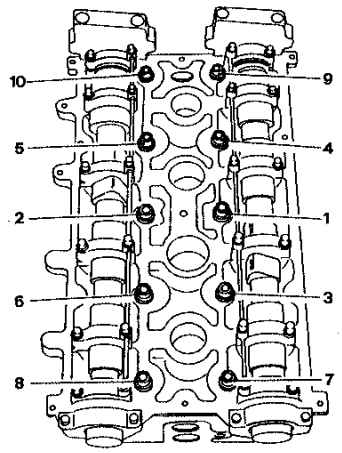
Part	Nm	kgm
Screws securing main caps to engine block (in oil)	20 + 90°	2 + 90°
Screws securing flywheel to crankshaft	120.7 - 149.1	12.3 - 15.2
Screws securing rod caps (in oil)	25 + 50°	2.6 + 50°
Nuts securing exhaust manifold to turbine	24.7 - 30.5	2.5 - 3.1
Screws securing auxiliary units drive belt pulley	21.3 - 26.3	2.2 - 2.7
Screws securing timing belt drive pulley and crankshaft crankshaft counter-shaft belt (left-hand)	180.5 - 199.3	18.4 - 20.3
Screws securing water pump to engine block	21.3 - 26.3	2.2 - 2.7
Screws securing water pump pulley	21.3 - 26.3	2.2 - 2.7
Engine oil pressure gauge (on oil filter support)	21.3 - 26.3	2.2 - 2.7
Engine oil temperature sensor (on oil filter support)	21.3 - 26.3	2.2 - 2.7
Engine oil minimum pressure warning light sensor (on oil filter support)	27.2 - 33.6	2.8 - 3.4
Screws securing counter-shaft drive pulley	100.3 - 123.9	10.2 - 12.6
Nut securing counter-shaft belt tensioner	19.6 - 24.2	2.0 - 2.5
Screws securing counter-shaft front covers	19.6 - 24.2	2.0 - 2.5
Screws securing oil sump to engine block	8.5 - 10.5	0.9 - 1.1
Screws securing lower sump to engine oil sump	8.5 - 10.5	0.9 - 1.1
Engine oil sump cap	32.5 - 52.5	3.3 - 5.4
Nut securing damping rod to engine	42.5 - 52.5	4.3 - 5.4
Screw securing damping rod to body	15.3 - 18.9	1.6 - 1.9
Screws securing oil pump to engine block	8.5 - 10.5	0.9 - 1.1
Ball connection securing exhaust gas intake hose to exhaust manifold and to EGR valve	27.2 - 33.6	2.8 - 3.4
Screws securing EGR valve to air intake box	8.5 - 10.5	0.9 - 1.1
Screws securing starter motor to gearbox union support	18.7 - 23.1	1.9 - 2.4
Screw securing engine support bracket on gearbox side to flexible plug	55.3 - 68.3	5.6 - 7.0
Screw securing engine support bracket on engine side to flexible plug	55.3 - 68.3	5.6 - 7.0
Screws securing gearbox - front differential to engine	68 - 84	6.9 - 8.6

Cylinder heads

Part		Nm	kgm
Nuts securing intake manifold to head		21.3 - 26.3	2.2 - 2.7
Screws securing timing pulley		100.3 - 123.9	10.2 - 12.6
Nut securing timing belt tensioner		37.4 - 46.2	3.8 - 4.7
Nuts securing turbocompressor to exhaust channel		50.2 - 62	5.1 - 6.3
Nuts securing exhaust manifold to head		21.3 - 26.3	2.2 - 2.7
Nuts securing thermostatic cup to head		17 - 21	1.7 - 2.1
Screws securing thermostatic cup to head		19.6 - 24.2	2.0 - 2.5
Screw securing camshaft caps (in oil)	M8	17.9 - 22.0	1.8 - 2.2
	M6	6.1 - 7.6	0.6 - 0.8
Spark plugs		23 - 28.4	2.3 - 2.9
Engine coolant temperature gauge sender and maximum temperature warning light contact (on thermostatic cup)		31.9 - 51.5	3.3 - 5.3
Engine coolant temperature sensor (NTC) (on thermostatic cup)		20.4 - 25.2	2.1 - 2.6
Intake air temperature sensor		23 - 28.4	2.3 - 2.9

Tightening cylinder head nuts to engine block

Tightening sequence

Tighten all the screws to:		20 Nm
Tighten the screws to an initial torque of:		50 Nm
Rotate all the screws to an angle of:		90°
Complete the tightening sequence to a further angle of:		90°

SPECIFIC TOOLS

1.820.012.000 (A.2.0195)	Base for cylinder head support tool
1.820.056.000 (A.2.0369)	Tool for caulking oil duct caps on crankshaft
1.820.091.000 (A.2.0464)	For locking camshaft and counter -shaft drive pulleys
1.820.145.000 (R.4.0178)	Engine support brackets
1.820.225.000	Support for removing/refitting engine unit
1.820.228.000	For locking flywheel (to use on bench)
1.820.229.000	Flange for removing timing pulley
1.820.233.000	Bracket for removing/refitting engine unit
1.820.257.000	Support for disassembly/reassembly of valves
1.820.258.000	Cylinder head support tool
1.820.259.000	For locking flywheel (to use on vehicle)
1.820.260.000	Tip for tensioning counter- shaft drive belt
1.820.261.000	Tool for securing valve tappets
1.820.262.000	Lever for substituting tappet caps
1.820.263.000	Rear support for engine support
1.820.277.000	Graduated disk for angle tightness torque
1.821.001.000 (A.3.0103/0010)	Cage for disassembly/reassembly of valves

(CONTINUED)

(CONTINUED)

1.821.053.000 (A.3.0311)	Valve guide puller
1.821.058.000 (A.3.0324)	Lever for disassembly/reassembly of valves
1.821.161.000 (A.3.0617)	Mallet for removing timing pulley
1.821.171.000 (A.3.0635)	Oil seal inserting tools support grip
1.821.178.000 (A.3.0643)	Inserting tool for valve guide seal covers
1.821.203.000	Inserting tool for crankshaft and counter-shaft front oil seals
1.821.208.000	Puller for valve guide seal cover
1.821.227.000	Inserting tool for crankshaft rear oil seal
1.821.228.000	Inserting tool for crankshaft and counter-shaft front oil seals (to use on vehicle)
1.821.229.000	Valve guide inserting tool
1.822.123.000	Spanner for cylinder head fixing screws
1.824.016.000 (C.2.0129)	Rod for tensioning timing and counter-shaft belts
1.824.017.000 (C.2.0130)	Tip for tensioning timing belt

FAULT DIAGNOSIS AND CORRECTIVE INTERVENTIONS
ENGINE - LUBRICATION

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
OIL LOSS	Visual detection of the oil leaks causing dripping, 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 relevent 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 ELECTRICAL COMPONENTS CHECKS AND INSPECTIONS.**	**B**
EXCESSIVE OIL CONSUMPTION **NOTE: High oil consumption during the first 8000 km must not be condidered adnormal as this is due to the engine settling.**	Oil consumption will increase notably with respect to the stated values and those noted during the life of the vehicle.	**C**

CAUTION:
- **Engine oil is harmful to the skin: reduce all contact, stains or drops of oil on the 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 from in your area.**

OIL LOSS	TEST A

TEST STEPS	RESULTS	REMEDY
INTRODUCTION: 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 ENGINE OIL LEVEL – Check that the engine oil level does not exceed the MAX level.	OK ▶ ~~OK~~ ▶	Carry out **step A2** Drain the excess oil until desired level is reached.
A2 CHECK DRAIN PLUG – Check that the drain plug is tightened to the correct torque and is not damaged.	OK ▶ ~~OK~~ ▶	Carry out **step A3** Tighten or replace the plug, as necessary.
A3 CHECK OIL SUMP – Check that: • the oil sump and sump protection are not damaged, distorted or broken; • the gasket seal between the sump and the engine block and between the sump and the sump protection; • the screws of the sump and the sump protection are tightened to the correct torque.	OK ▶ ~~OK~~ ▶	Carry out **step A4** If necessary replace the sump, the sump protection and the gaskets. Tighten the screws of the sump, the sump protection to the prescribed value.
A4 CHECK OIL FILTER – Ensure there are no losses in the oil filter area; check the gasket seal.	OK ▶ ~~OK~~ ▶	Carry out **step A5** Replace the gasket and tighten the filter to the prescribed torque.

(CONTINUED)

OIL LOSS	TEST A

TEST STEPS	RESULTS	REMEDY
A5 CHECK OIL SEALS – Access the crankshaft and cam shaft oil seal rings: check for any losses in these points.	OK ▶ ~~OK~~ ▶	Carry out **step A6** Replace the defective ring seals.
A6 CHECK TURBOCHARGER – Check that: • the return of oil to the engine from the turbocharger is regular; • oil does not enter the turbine; • the turbocharger rotating gaskets are not worn.	OK ▶ ~~OK~~ ▶	Carry out **step A7** Check for any obstructions or excessive wear of the rotating parts. Replace the turbocharger.
A7 CHECK MISCELLANEOUS COMPONENTS – Check there are no losses from any other components not listed in the previous test steps; resolve the fault using the remedies described above.	~~OK~~ ▶	Replace the 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 engine oil level is correct.	OK ▶ ~~OK~~ ▶	Carry out **step B2** Top up oil level.
B2 CHECK OIL AND FILTER QUALITY – Check that: • the engine oil is the prescribed type; • the oil filter is the recommended one and installed correctly.	OK ▶ ~~OK~~ ▶	Carry out **step B3** Service with the prescribed oil to the correct level. If necessary, replace the filter.
B3 CHECK OIL PUMP – Check the oil pump for any traces of seizing or overheating.	OK ▶ ~~OK~~ ▶	Carry out **step B4** Replace all defective parts.

(CONTINUED)

LOSS OF OIL PRESSURE	TEST B

TEST STEPS	RESULTS	REMEDY
B4 CHECK PRESSURE RELIEF VALVE – Check that: • the seal, the integrity and the cleanliness of the pressure relief valve; • that the valve spring is not broken or giving.	OK ▶ ~~OK~~ ▶	Carry out **step B5** Replace defective parts.
B5 CHECK OIL PASSAGES Only when the engine is completely overhauled: – Check that the oil passages in the engine block, in the cylinder heads and in the crankshaft are free from obstructions caused by residual oil or other foreign materials. – Check the seal and integrity of the crankshaft plugs.	~~OK~~ ▶	Clean the affected parts thoroughly; if necessary replace them.

End of test B

EXCESSIVE OIL CONSUMPTION	TEST C

TEST STEPS	RESULTS	REMEDY
INTRODUCTION: Check that the excessive oil consumption is not due to losses. See **Test A**.		
C1 CHECK FOR SEEPAGE THROUGH VALVES – Remove the cylinder heads and check that there are no traces of oil in the combustion chambers. If this is the case check: • dimensions and clearance between the valve stem and the relative valve guide and the corresponding seatings in the cylinder heads: • the integrity of the little rubber plug on the valve stem; • traces of seizing or abrasions on the valve stem.	OK ▶ ~~OK~~ ▶	Carry out **step C2**. Replace all defective parts.
C2 CHECK FOR SEEPAGE THROUGH THE PISTON RINGS – Check for seepage through the piston rings. If this is the case, check the piston rings for: • breakage or damage; • correct assembly (TOP notch facing upwards); • the prescribed gauge between the seal and the respective seating (to be measured in three points at 120°); • seizure in their seating or excessive wear.	OK ▶ ~~OK~~ ▶	Carry out **step C3**. Replace all defective parts.
C3 CHECK CYLINDER AND PISTON LINER – Check that the dimension of the cylinder and piston liners and the coupling clearance falls within the prescribed limits.	~~OK~~ ▶	If necessary, replace the defective piston or grind the liner and install a suitable piston.

End of test C

FAULT DIAGNOSIS AND CORRECTIVE INTERVENTIONS ENGINE - NOISY OPERATION

INTRODUCTION:

Ensure that the noise is actually caused by the engine and not by other components such as:
- Cooling pump
- Alternator
- Power steering pump
- Air conditioning compressor

Note whether the noise is mainly present when the engine is cold or at a normal operating temperature, when it is at idle speed or if the noise increases as the number of revs increases.
The noise is produced by the engine if:
- the vehicle is stationary or in motion
- when the the clutch is engaged or disengaged.

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
BEATING WHEN ENGINE IS AT IDLE SPEED	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 WITH ENGINE COLD	Constant more or less intense beating originating from one or more cylinders. **NOTE: The beating disappears when the engine is at normal operating temperature.** The cylinder in question can be easily identified, by disconnecting one spark plug at a time.	**B**
INTENSE AND INTERMITTENT BEATING	A very strong beating can be heard when the clutch is engaged and disengaged and during sudden acceleration.	**C**

(CONTINUED)

FAULT DIAGNOSIS AND CORRECTIVE INTERVENTIONS
ENGINE - NOISY OPERATION

FAULTS AND SYMPTOMS	FAULT ISOLATION	TEST REFERENCE
BACKGROUND BEAT (DUE TO UNBALANCE)	A background beat that can be heard when the engine is under load, or a noise coming from the rod-crank-shaft and piston- cylinder liner couplings.	**D**
NOISINESS/VIBRATIONS FROM TURBOCHARGER	Noisiness or vibrations originating from the turbo-charger with engine in supercharging mode.	**E**

NOTE: **Before carrying out the tests that follow, check the oil level and the type of oil and filter. If necessary, replace the oil and the filter respecting the prescribed quantities and grades.**

BEATING WHEN ENGINE IS AT IDLE SPEED	TEST A

TEST STEPS	RESULTS	REMEDY
A1 CHECK VALVE CLEARANCE – Check that the clearance between the cam heel radius and the relative tappet falls within the prescribed limits.	OK ▶ ~~OK~~ ▶	Carry out **step A2** Regulate clearance.
A2 VISUALLY CHECK CAMS AND CUPS – Check that the cam lift falls within the prescribed limits and visually check that the valve clearance regulation shims are not worn, scratched or seized, etc.	OK ▶ ~~OK~~ ▶	Carry out **step A3** Replace all defective parts.
A3 CHECK AXIAL PLAY – Check that the camshaft axial and radial play falls within the prescribed limits.	OK ▶ ~~OK~~ ▶	Carry out **step A4** Replace defective shaft.
A4 CHECK CUPS AND SEATINGS – Check the external diameter of the cups and the diameter of the relative seatings; also check there are no signs of scratching, seizure, etc.	~~OK~~ ▶	Replace the cups and/or relative defective cylinder heads.

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 the cylinder liner and the piston falls within the prescribed limits,	OK ▶	Carry out **step B2**
	~~OK~~ ▶	Replace the defective piston or grind the liner and install suitable piston.
B2 CHECK GRUDGEON PIN – Check that the clearances between the piston hole and the grudgeon pin and between the rod bushing hole and the grudgeon pin are within the prescribed limits.	~~OK~~ ▶	Replace all defective parts.

End of test B

INTENSE AND INTERMITTENT BEATING	TEST C

TEST STEPS	RESULTS	REMEDY
C1 CHECK AUXILIARY PARTS PULLEY ATTACHMENT – Check that the auxiliary parts control pulley screws are not loose.	OK ▶ ~~OK~~ ▶	Carry out **step C2** Tighten the screws to the prescribed torque or replace them if defective.
C2 CHECK TIMING AND COUNTERSHAFT CONTROL PULLEY ATTACHMENT – Check that the timing and countershafts control pulley screws are not loose.	OK ▶ ~~OK~~ ▶	Carry out **step C3** Tighten the screws to the prescribed torque or replace them if defective.
C3 CHECK FLYWHEEL ATTACHMENT – Check that the screws securing the flywheel to the crankshaft are not loose.	~~OK~~ ▶	Tighten the screws to the prescribed torque or replace them if defective. Use locking compound LOCTITE 270.

End of test C

BACKGROUND BEAT (DUE TO UNBALANCE)	TEST D

TEST STEPS	RESULTS	REMEDY
D1 CHECK CASTING OF MAIN AND ROD BEARINGS – Check: • the main and rod bearings for traces of overheating, flaking, etc. • the crankshaft journals for traces of damage.	OK ▶ ~~OK~~ ▶	Carry out **step D2** If necessary replace the crankshaft. Wash the lubrication circuit, engine block and overhaul or replace the oil pump.
D2 CHECK CONNECTING ROD AND BACKGROUND BEATING – Check: • the clearance between the rod head and the crankshaft and between the main journals and relative bearings; • that the tightening torque of the main and rod caps falls within the prescribed limits.	OK ▶ ~~OK~~ ▶	Carry out **step D3** Replace the defective shaft and/or rod. Tighten to the prescribed torque.
D3 CHECK CRANKSHAFT BEATING – Check that the crankshaft axial clearance falls within the prescribed limits.	OK ▶ ~~OK~~ ▶	Carry out **step D4** Replace the thrust half rings.
D4 CHECK PISTON SEIZING BEATING – Check the coupling surfaces of the cylinder liners and the pistons for signs of overheating, seizing, scoring, etc. and the gauge between the piston rings and their relative seatings (to be measured in three points at 120°).	OK ▶ ~~OK~~ ▶	Carry out **step B** Replace the cylinder liners and the defective cylinder piston.

End of test D

NOISINESS /VIBRATIONS FROM THE TURBOCHARGER	TEST E

TEST STEPS	RESULTS	REMEDY
E1 CHECK THE INTAKE AND EXHAUST MANIFOLDS – Check that there are no leakages or seepages from the intake or exhaust mainfold.	OK ▶ OK ▶	Carry out **step E2** Tighten the defective connection screws and/or replace the gaskets.
E2 CHECK TURBOCHARGER – Check that the rotor shaft is not unbalanced.	OK ▶ OK ▶	Carry out **step E3** Replace the turbocharger.
E3 CHECK TURBOCHARGER – Check that the rotor shaft bearings are correctly lubricated.	OK ▶	Check the engine oil pressure and the turbocharger lubrication channels.

End of test E

IMPORTANT NOTE:
For any other faults which may compromise the correct functioning of the engine, **refer to the procedure ELIMINATION OF FAULTS contained in Group 04**.

For example:

- engine does not start
- engine misfires
- irregular idle speed
- excessive fuel consumption
- percentage of CO too high
- etc.