

155

REPAIR MANUAL

● ENGINES

- Engine 1995 cm³ (code AR 67202)

- Engine 1773 cm³ (code AR 67102)

- Engine 1749 cm³ (code AR 67103)



GROUP 01 - ENGINE MAIN MECHANICAL UNIT



GROUP 04 - FUEL SYSTEM



GROUP 05 - ENGINE IGNITION, STARTING
AND CHARGING



GROUP 07 - ENGINE COOLING SYSTEM



GROUP 01

ENGINE

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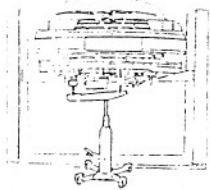
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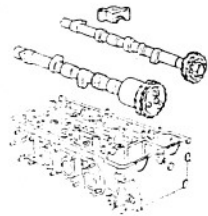
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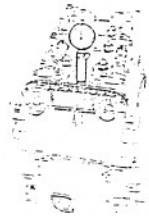
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"ON VEHICLE" OPERATIONS

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ENGINE

GENERALITIES

The engine is of the 4 cylinder in line type in light alloy with a double on-head camshaft, timing variator and double static ignition and injection controlled by a single BOSCH MOTRONIC M1.7 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 13° inclination forwards.

It is installed on the frame by suspension type mounts and fixed by two elastic damping supports. A third support of the compass type secures it to the suspension crossmember.

A rod between the engine and the body prevents excessive shaking of the engine.

The engines described below conform to the "USA 83" exhaust emissions regulations.

STRUCTURE

Engine block:

this is a single block in light aluminium and silicon with a high mechanical resistance and heat dissipation.

The crankshaft is supported by five main supports.

Grooving in the walls of the engine block permit the circulation of engine coolant and lubricating oil.

For AR67202 (1995 c.c.) engines only, oil spray jets which cool the pistons are located at the base of the cylinders.

Cylinder liners:

these are in cast iron and are of the low resting type and directly lapped on the outside by the cooling liquid for a more rational heat dissipation (wet).

The size of the cam is such that it is not deformed and is thus able to contain the gas pressure.

The cylinder liners are supplied already coupled with their relative pistons and are divided into three dimensional classes.

Front cover:

this is in die-cast in aluminium alloy and completing the forward part of the engine block, protects the timing chain.

The oil pump body is located in the lower part and the volute for the installation of the water pump rotor is located on the upper part.

Cylinder head:

this is of the monolith type, compact and chill-cast in aluminium and silicon alloy with a double camshaft with direct action valves arranged in a "V" of 46°. There are two ignition spark plugs for each cylinder. The conformation of the combustion chambers is optimal due to the position of the valves; at the same time the rectilinear intake ducts have a contained loading loss and permit maximum exploitation of the resonance, a distinct advantage with regard to volumetric performance.

Oil sump:

this is a structural part of the engine with mechanical functions in addition to that of containing the engine oil. It is made of die-cast aluminium with liquid silicone sealing.

**MOVING PARTS****Crankshaft:**

this is forged in high resistance bonded steel is soft nitrided. This treatment decreases wear and increases reliability (resistance to fatigue).

It rests on five main supports and shoulders on the central main support.

Eight counterweights arranged through 180° accurately balance the rotating masses.

A channel runs inside the shaft for the lubrication of the main and rod journals.

Main and rod bearing halves:

these are of the three-metal, thin shell type are divided into three dimensional classes to contain the radial play. There are two holes and a circumference groove for the passage of oil located on the front, central and rear main bearing halves.

Flywheel:

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

Pistons - rods:

the pistons are in silicium-aluminium alloy with self-heating inserts and are divided into three dimensional classes. To ensure correct installation an arrow is stamped onto the piston ceiling which indicates the direction of rotation of the engine.

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

The piston - rod assembly has been lightened to reduce the moving masses.

AUXILIARY ORGANS**Timing:**

direct drive by double chain with cemented and tempered on-head camshafts in steel alloy. A reference notch for correct timing has been engraved onto the central journal of the camshaft and relative cap.

The lightweight tappets, of the mechanical type, are composed of a valve cup in alloy steel in contact with the cam.

The control of the valve cup is transmitted to the valve by a cap, in tempered carbonitrided steel, used to regulate the valve clearance.

Particularly important is the introduction of sodium into the exhaust valve which improves the dissipation of the heat to which they are subjected.

The valve seats are sintered in material suitable for operation with unleaded petrol.

Timing variator:

This is of the simplified type which ensures great precision of timing, rapid intervention and high mechanical reliability.

In order to reduce the size of the engine, the actuation valve has been included in the intake manifold with suitable channeling, also present on the cylinder head, which regulates the flow of oil to the variator.

- This device varies the intake valve timing on the basis of engine loading. This parameter is received and processed by the MOTRONIC control unit in the form of an electric signal sent by the air-flow meter as a command, to the solenoid, by way of a relay.



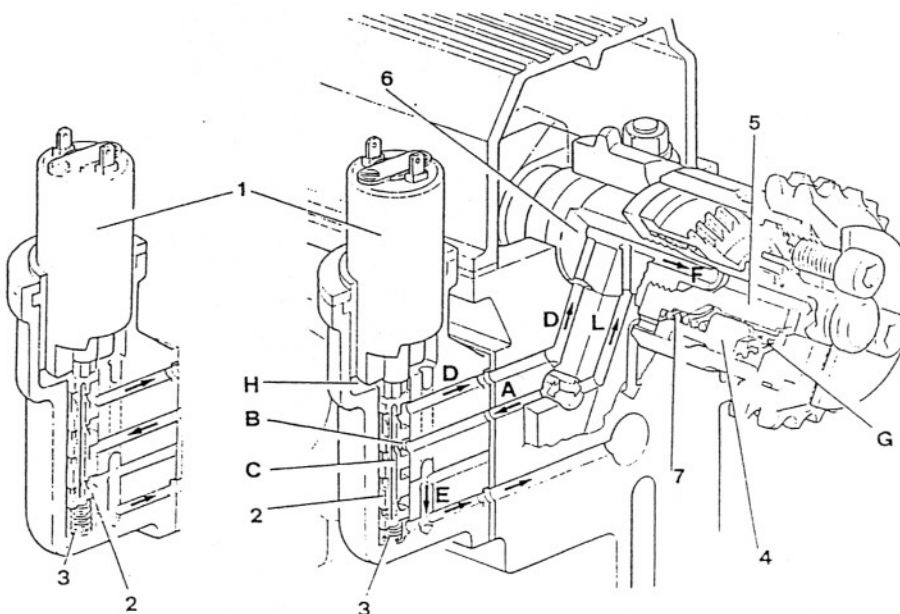
- When the quantity of air taken in by the engine is lower than a pre-set value, the solenoid (1) is deactivated and the valve box (2) pushed by the counter-spring (3) is lifted up allowing the passage of oil from the channeling (A) to reach the variator. In this case the timing of the intake valves is not changed.
- If the quantity of intake air exceeds the pre-set value, the solenoid (1) is activated and pushes the valve box (2) downwards. In this position the oil arriving from the channeling (A) enters the piston chamber (B) and passes through a hole into the internal channel (C) in the piston. The oil can only exit this channel through the upper hole (leading to the oil-to-variator delivery duct (D)) as the lower hole no longer opens onto the exhaust duct (E) as the valve box (2) is lowered. The oil passes through the channeling (D) and (F) and reaches the chamber (G) moving the piston (4) axially towards the engine.

The piston is externally equipped with helical teeth and as a result of the axial movement is forced to rotate clockwise (as seen from the timing side).

This rotation is transmitted to the pinion through a straight toothed grooved profile. The pinion (5) which is rotated by the threaded tug of the camshaft (6) transmits the rotation to the shaft, and in this way the timing of the intake valves is varied by 30°.

When the solenoid is deactivated, the valve box (2) returns to the initial position, interrupting the flow of pressurized oil to the piston (4) but permitting the return of the oil to the outlet due to the thrust from the counter spring (7).

- The channeling (L) enables the camshaft journal to be lubricated under the various operating conditions.
- The oil which leaks into the solenoid chamber (H) is discharged through the drainage hole (E).





LUBRICATION

The pump located on the front cover of the engine block is actioned directly by the crankshaft through a coupling. The oil, taken from the sump by the pump, is filtered on intake by the gauze filter and then sent under pressure through the channeling 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 becomes clogged.

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

After being filtered, the oil passes into the main lubrication ducts, which run longitudinally along the engine block and into the vertical ducts which run along both the engine block and the cylinder head.

From the main ducts, passing through the three transversal ducts, the oil is sent to the lubrication channeling of the crankshaft main and rod supports.

From the vertical ducts, the oil is sent to two ducts located longitudinally on the head and these lubricate the camshaft supports and valve cups.

On the lubrication duct relative to the camshaft, intake side, there are two channels which permit the passage of oil to actuate the timing variator.

The recovery circuit is composed of two ducts located longitudinally on the cylinder head. These collect the oil originating from the outlets located under each valve cup

and from the rear sumps, and discharge it from the head, by gravity, into the sump. The gears of the timing chain in the engine block are in this way lubricated.

A recirculation system with vapour separator permits the recovery of the oil vapours coming from the oil sump. The lubrication pressure is indicated by a pressure gauge located on the instrument panel.

A warning lamp alerts the driver to an excessively low oil pressure. The pressure signals are supplied by a sender and a thermocontact located in the engine block. The oil temperature is indicated on the instrument panel and receives the signal from a sender installed on the oil filter support.

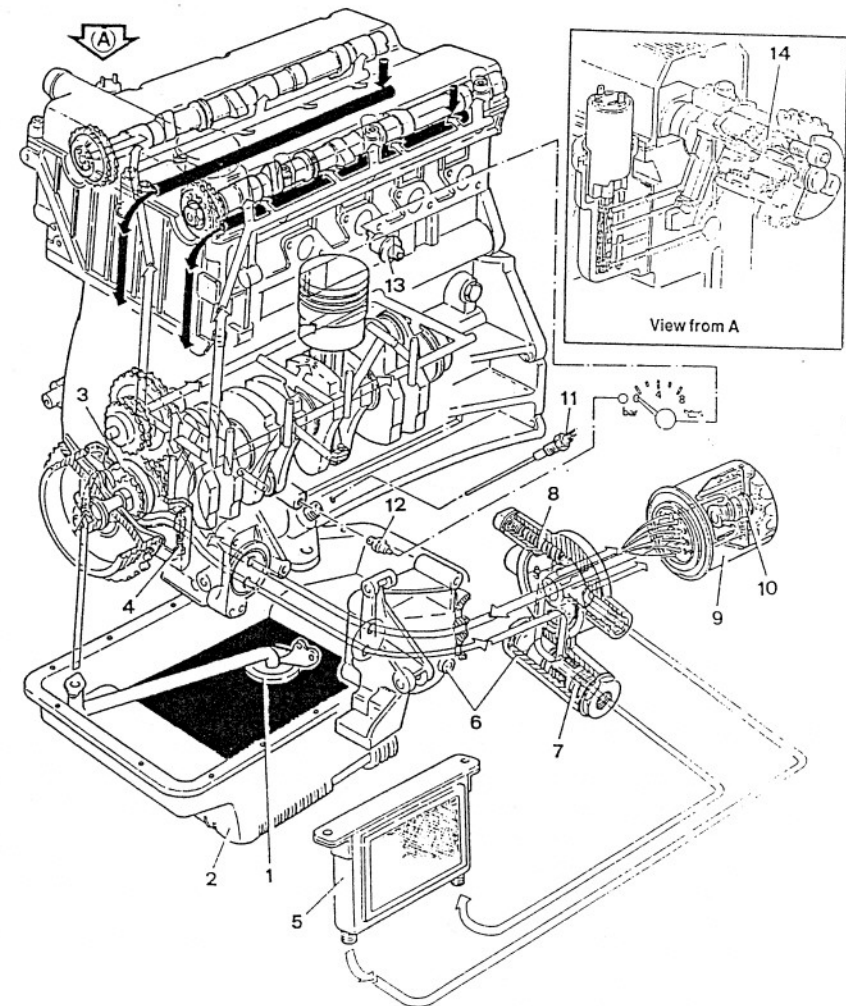
An oil level sensor located to one side of the oil dipstick supplies the input signal for the illumination of a warning light on the instrument panel which comes on if the oil falls below a certain level.

Only for AR67202 engine:

- The lubrication system is equipped with an oil cooling radiator and a thermostat valve located in the filter support. When the temperature falls below $78 \pm 2^\circ\text{C}$ the oil is sent directly to the cartridge filter from where it returns to the engine. When the temperature exceeds 83.5°C the thermostat valve opens to permit the oil to pass to the oil cooling radiator in order to reduce the temperature.
- In order to cool the piston skirt more efficiently, jets are located in the engine block. These jets incorporate a ball valve which opens at a pressure of 1.25 to 1.75 bar.



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 pressure relief valve
9. Oil filter
10. By-pass valve
11. Minimum oil level sensor
12. Minimum engine oil pressure warning light sensor
13. Engine oil pressure sender
14. Timing variator



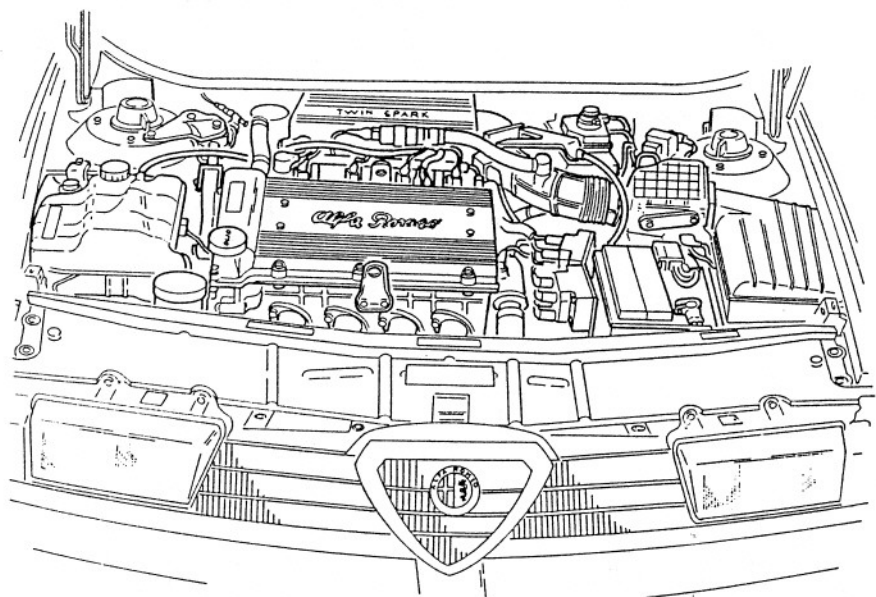
ENGINE REMOVAL/REFITTING

The information and illustrations given below permit the rapid removal of the engine from its housing in the engine compartment and its successive refitting.

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

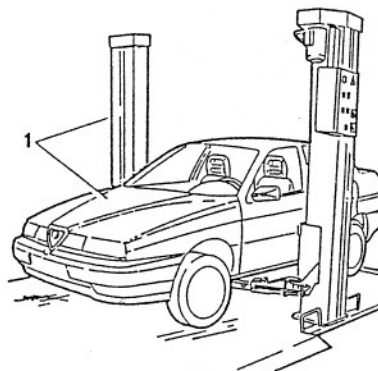
This chapter should be taken as a single, complete procedure though parts may be used as required.

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

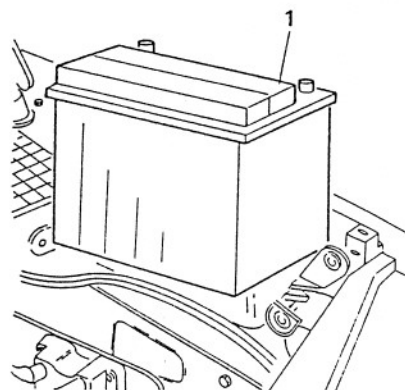


REMOVAL

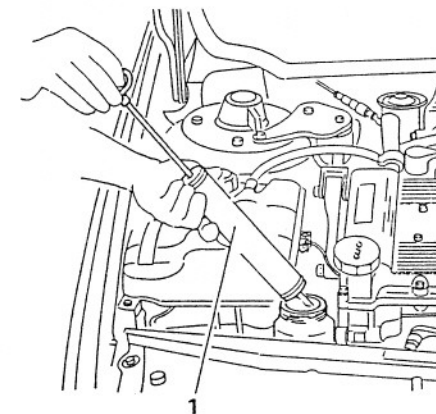
1. Place the vehicle on a two column lift and release the pressure in the fuel supply system as follows:
 - disconnect the fuel pump supply fuse;
 - start the engine and run until it stops.



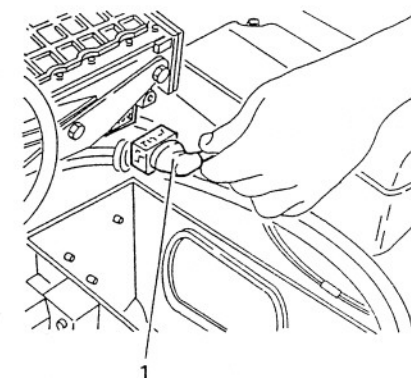
- Drain off the freon from the air conditioning system in accordance with the current regulations (see GROUP 80).
1. Remove the battery after first disconnecting the negative clamp (-) and then the positive (+).



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

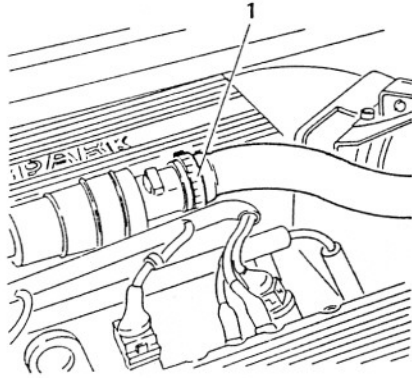


1. Disconnect the electrical connection from the air flow meter.

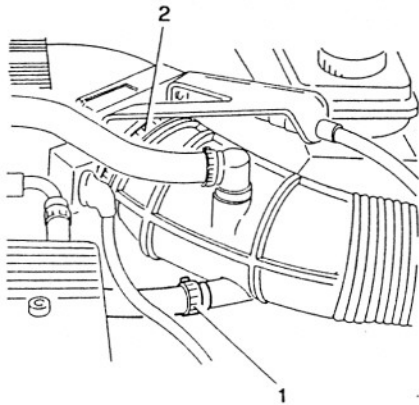




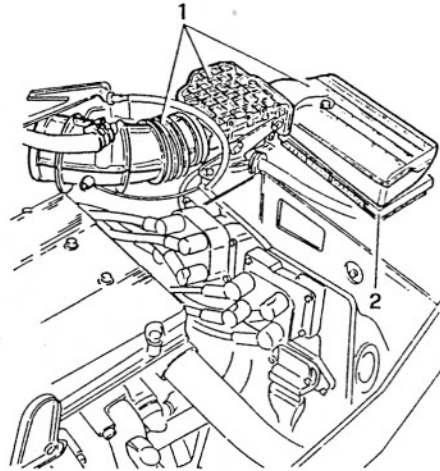
1. Disconnect the air intake pipe from the constant idle speed actuator.



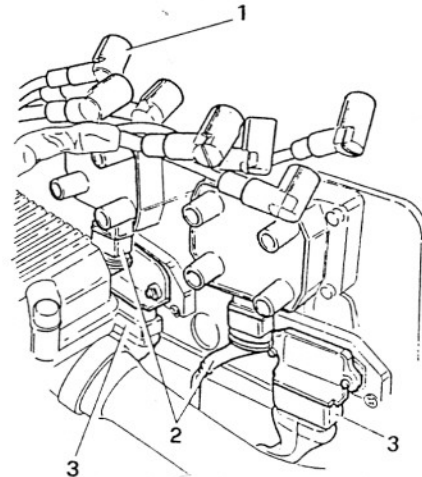
1. Disconnect the oil vapour recirculation hose from the corrugated sleeve.
2. Loosen the clamp and separate the corrugated sleeve from the air intake box.



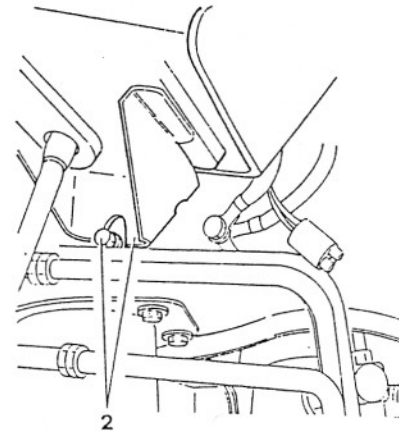
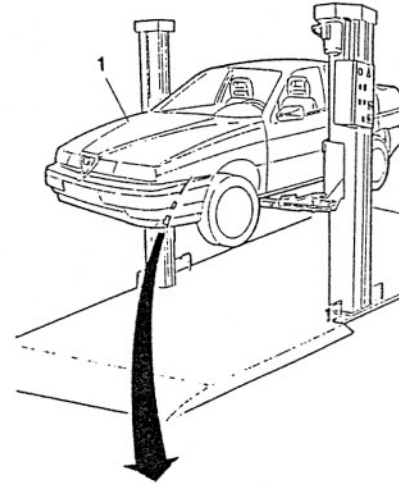
1. Remove the air cleaner cover, air flow meter and corrugated sleeve assembly.
2. If necessary remove the filter element.



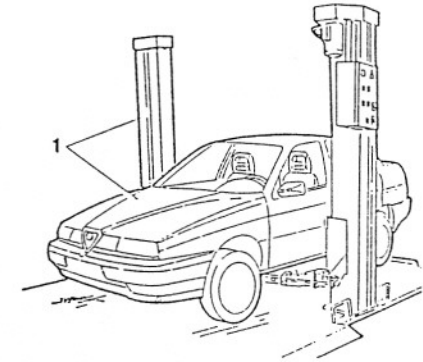
1. Disconnect the spark plug cables from the two ignition coils.
2. Disconnect the electrical connections supplying the ignition coils.
3. Disconnect the electrical connections from the two ignition modules.



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

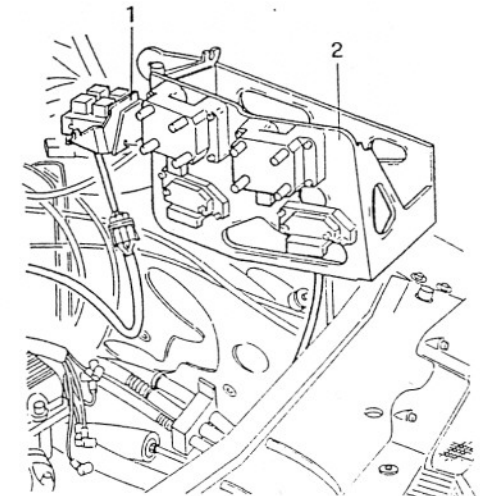


1. Lower the vehicle.



- Unscrew the remaining screws securing the battery support to the body and raise it slightly.

 1. Remove the relay box bracket from the battery by unscrewing the two screws.
 2. Remove the battery support together with the coils and ignition modules.



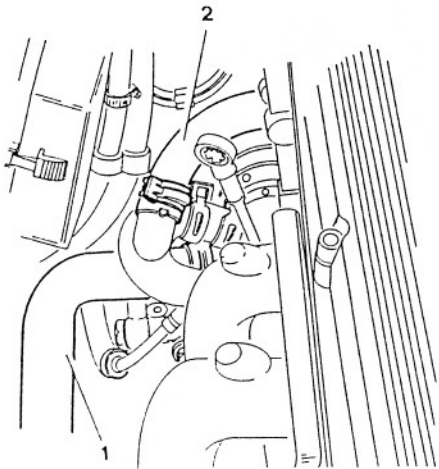
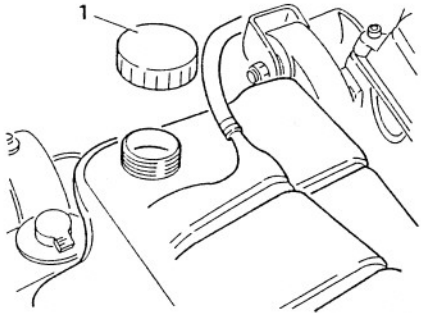


1. Remove the cap from the expansion tank, disconnect the coolant inlet sleeve from the pump and drain the engine coolant into a suitable container.

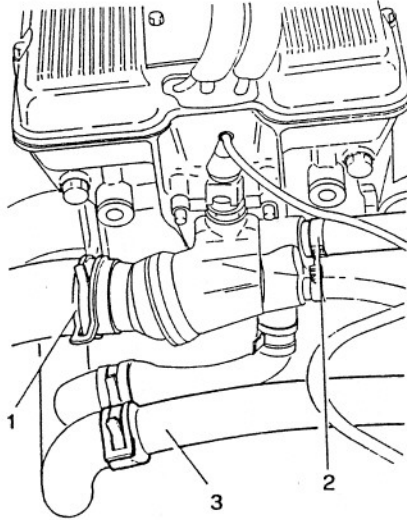
**CAUTION**

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

2. Disconnect the engine coolant delivery sleeve from the expansion tank.

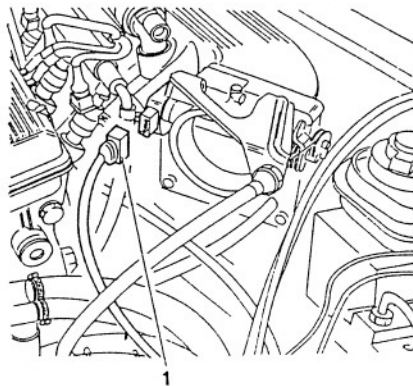


1. Disconnect the engine to coolant delivery sleeve from the thermostatic cup.
2. Disconnect the engine coolant to heater delivery sleeve from the thermostatic cup.
3. Disconnect the engine coolant return sleeve from the heater.

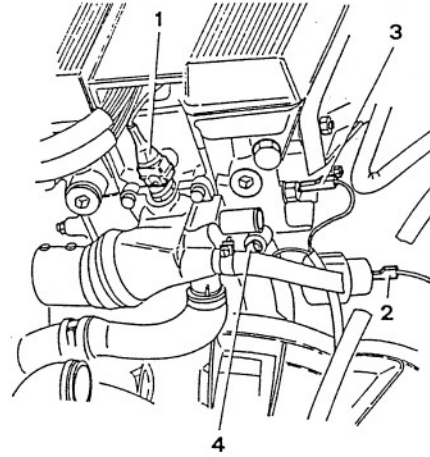


– Disconnect the engine coolant to expansion tank delivery sleeve from the throttle valve.

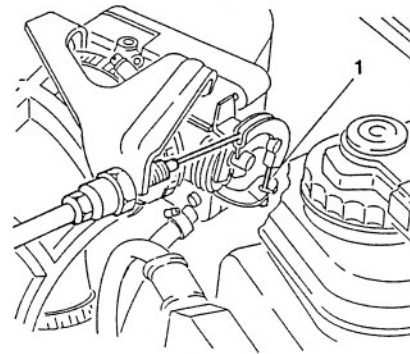
1. Disconnect the electrical connection from the throttle valve potentiometer.



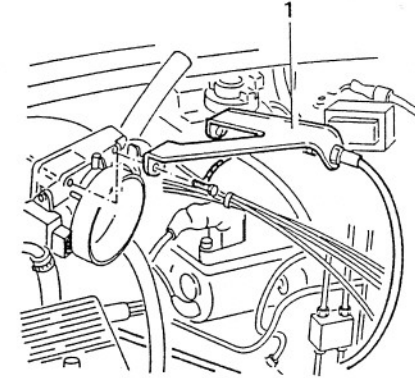
1. Disconnect the electrical connection from the engine coolant temperature sensor (NTC).
2. Disconnect the electrical connection from the engine oil pressure meter.
3. Disconnect the electrical connection from the engine coolant maximum temperature warning light sensor.
4. Disconnect the electrical connection from the engine coolant temperature sender.



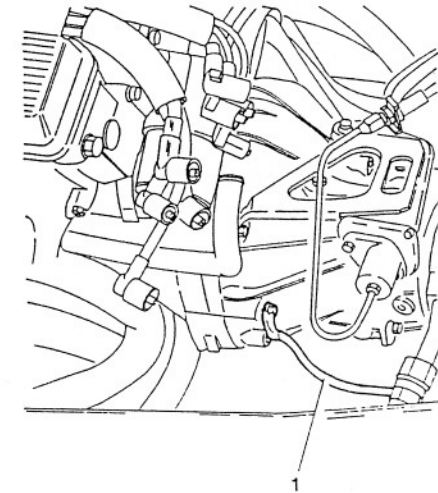
1. Disconnect the accelerator cable from the throttle body.



1. Remove accelerator cable support bracket and move it to the left-hand side of the engine compartment.

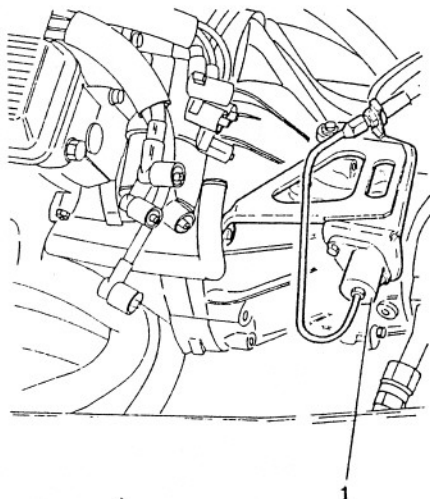


1. Disconnect the earth point from the negative (-) terminal of the battery.

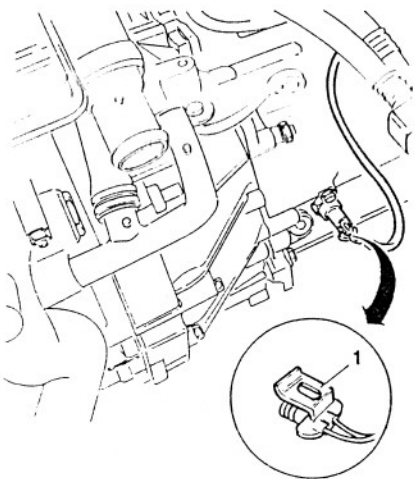




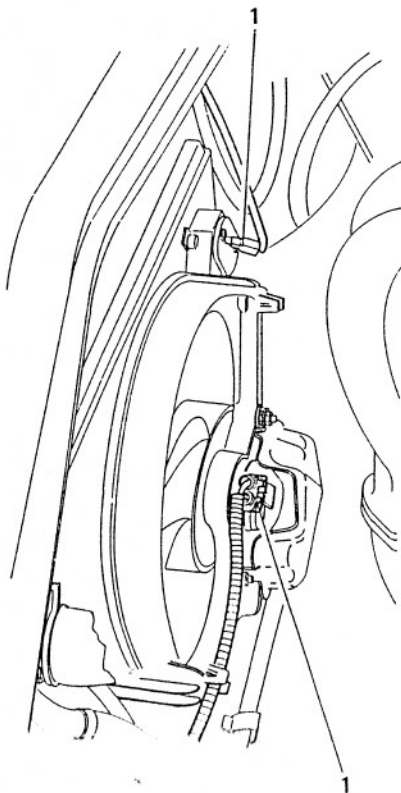
1. Unscrew the screws, and move the bracket to one side together with the hydraulic clutch control without disconnecting the oil inlet pipe.



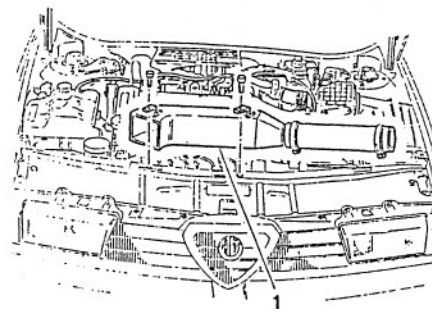
1. Disconnect the electrical connection from the reversing light switch.



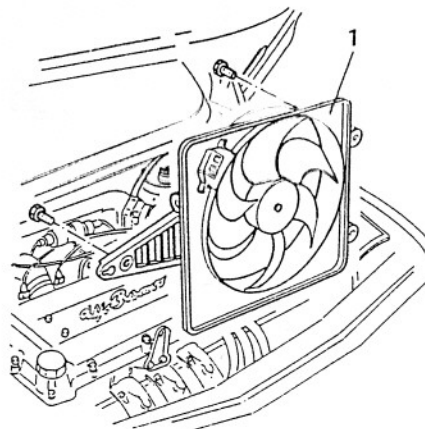
1. Disconnect the two electrical connections from the engine cooling fan.



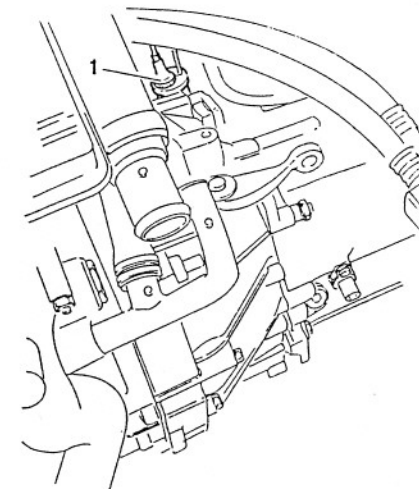
1. Remove the air intake duct from the cleaner together with the brackets.



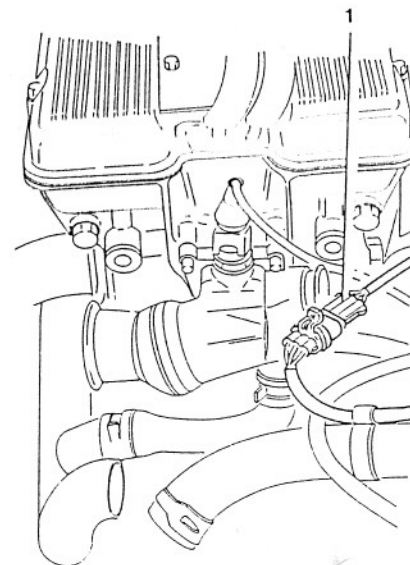
1. Remove the engine cooling fan.



1. Disconnect the cable from the odometer sensor.

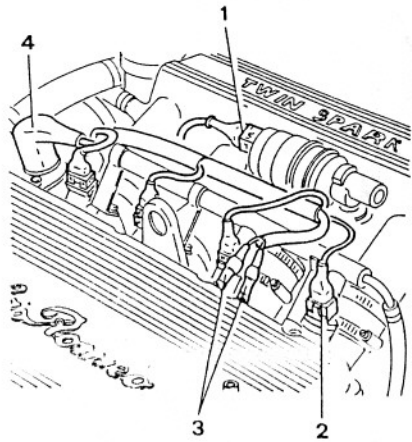


1. Disconnect the electrical connection from odometer sensor.

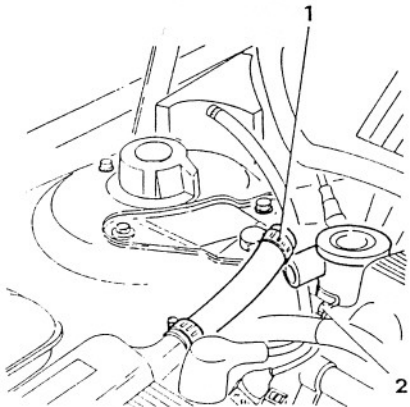




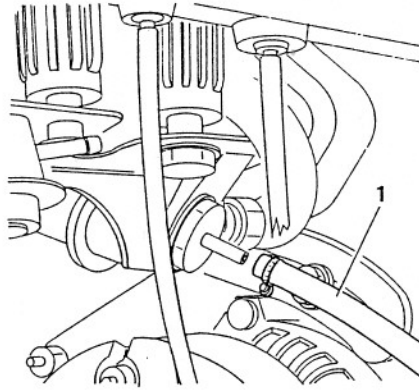
1. Disconnect the electrical connection from the constant idle speed actuator.
2. Disconnect the electrical connections from the electroinjectors.
3. Remove the earth cables from the timing cover.
4. Disconnect the electrical connection from the timing variator.



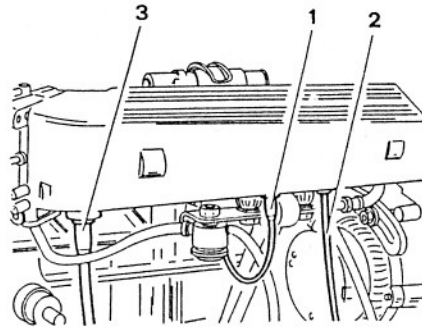
1. Disconnect the oil vapour recovery hose from the oil vapour separator.
2. Unscrew the two screws securing oil vapour separator to the air intake box and move it to one side.



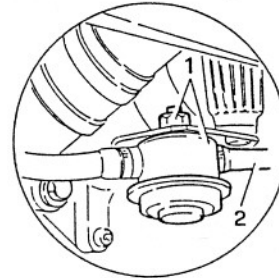
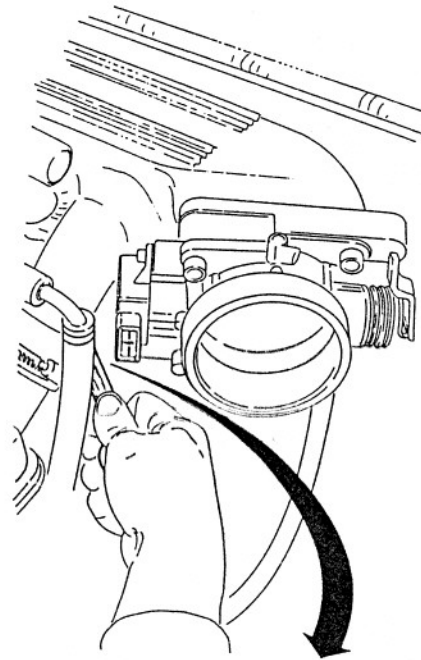
1. Disconnect the excess fuel to tank return hose from the pressure regulator.



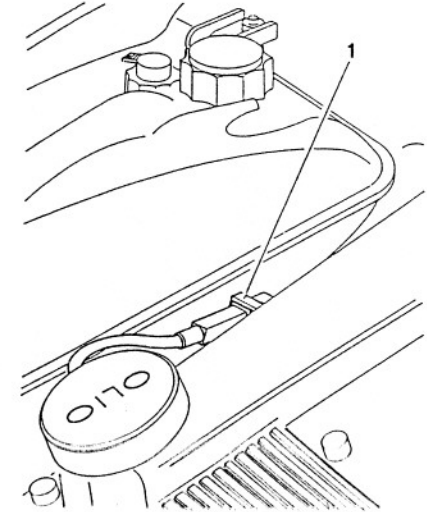
1. Disconnect the fuel pressure regulator vacuum intake hose from the air intake box.
2. Disconnect fuel vapour recirculation hose from the air intake box.
3. Disconnect the servo brake vacuum intake hose from the air intake box.



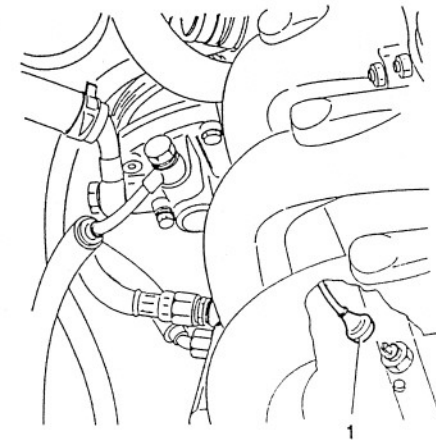
1. Unscrew the nut securing the impulse dashpot the support bracket.
2. Disconnect the fuel delivery hose from the impulse dashpot.



1. Disconnect the electrical connection from the r.p.m. and timing sensor.

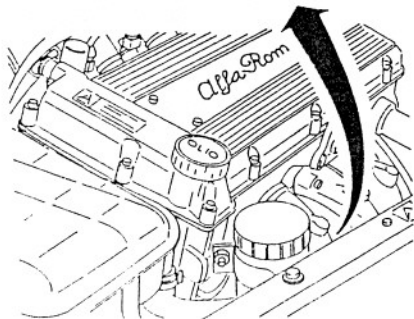
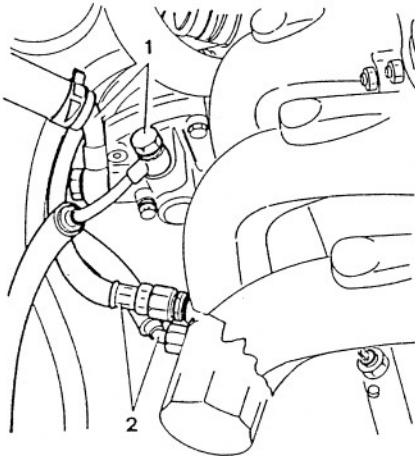


1. Disconnect the electrical connection from the engine oil minimum pressure warning light sensor.

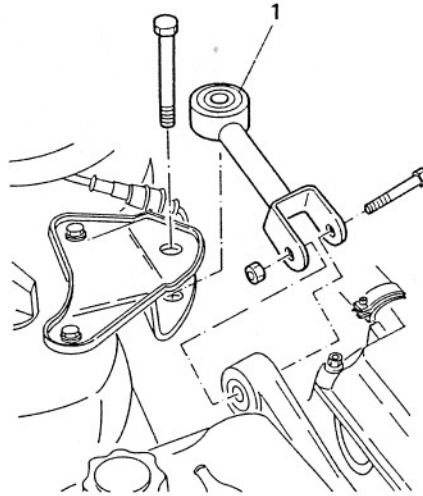




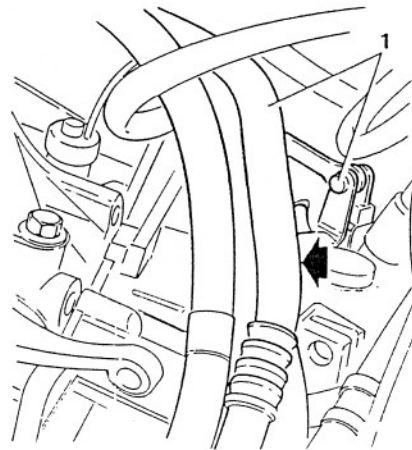
1. Disconnect the oil to power steering pump intake and delivery unions.
- Drain off the engine oil (see GROUP 00).
2. Specific procedure for AR67202 (1995 c.c.) engines. Disconnect the engine oil to relative cooling radiator intake and delivery unions from the oil filter support.



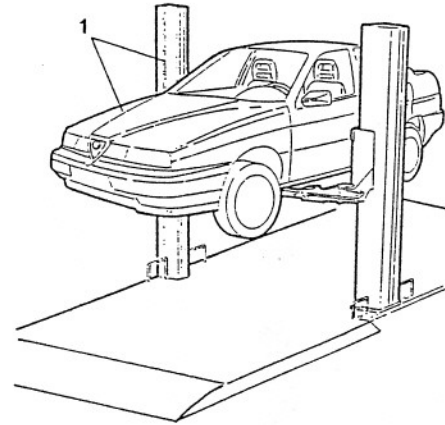
1. Remove the engine damping rod.



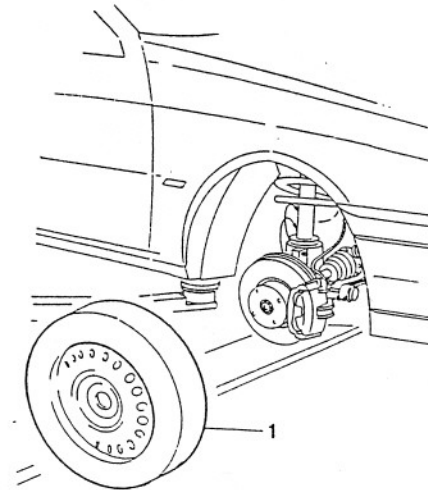
1. Move the air conditioning hoses in order to disconnect the upper gears selection rod.



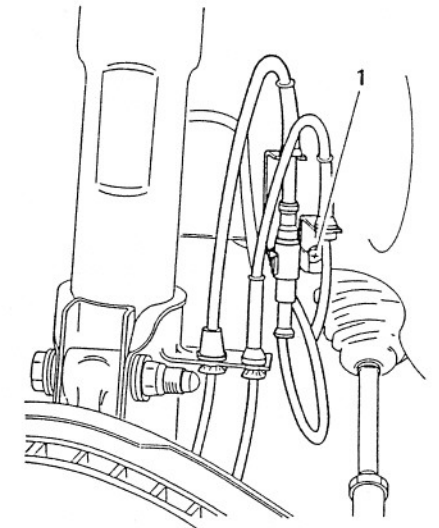
1. Raise the vehicle on the lift.



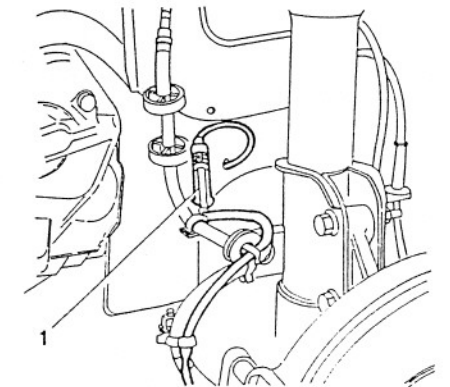
1. Remove the front wheels.



1. Working from the front left wheel arch, remove the bracket supporting the intelligent suspension and ABS sensors without disconnecting them.

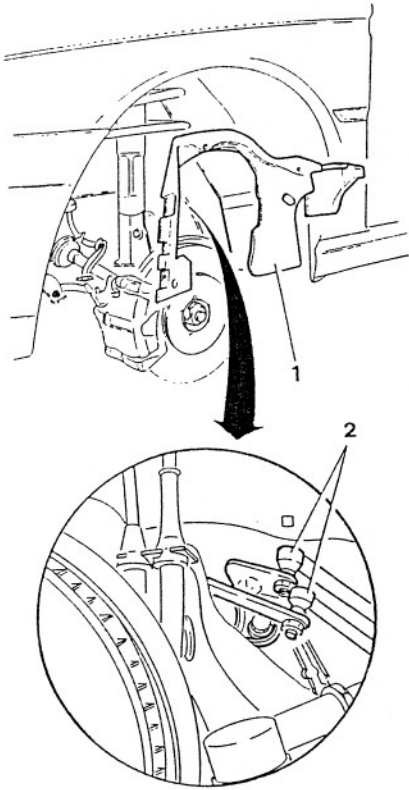


1. Disconnect brake pad wear sensor connection.

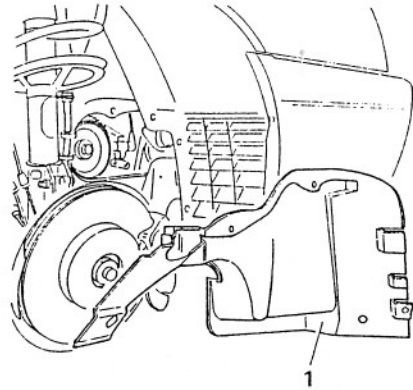




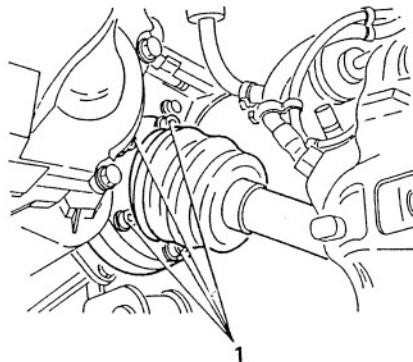
1. Remove the central engine protection cover from the left-hand wheelhousing.
2. Disconnect the two remaining gear selection rods.



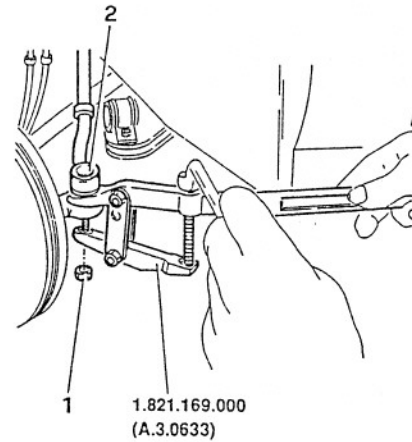
1. Remove the central engine protection cover from the right-hand wheelhousing.



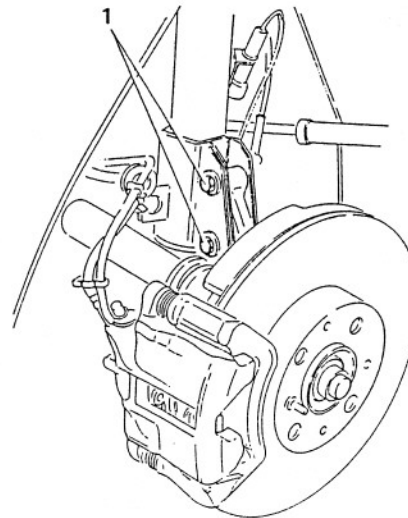
1. Unscrew the relative screws and disconnect the left-hand axle-shaft.



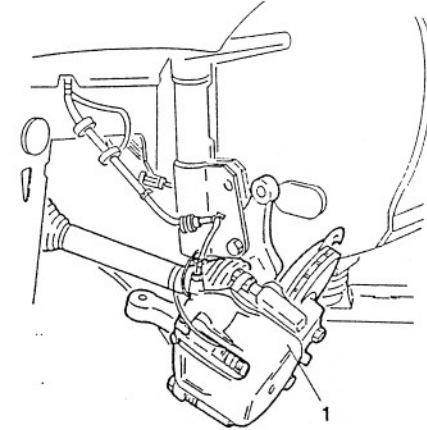
1. Unscrew the nut securing the articulated joint pin of the side steering tie-rod - left-hand side.
2. Remove the steering tie-rod from the control lever on the support using tool N° 1.821.169.000 (A.3.0633).



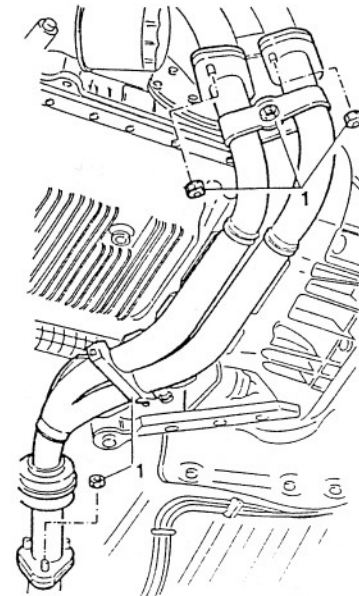
1. Loosen the two bolts securing the support to the front right shock absorber and remove only the upper bolt.



1. Tip the wheel hub as far forward as possible which will also move the axle shaft forward.

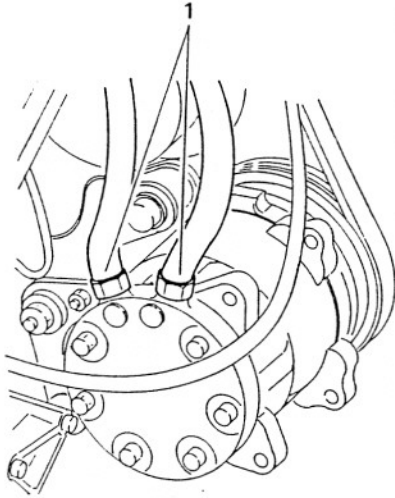


- Operate on the right-hand side as for the left to move the axle shaft forward from its support.
1. Remove the forward section of the exhaust pipe (see GROUP 04).

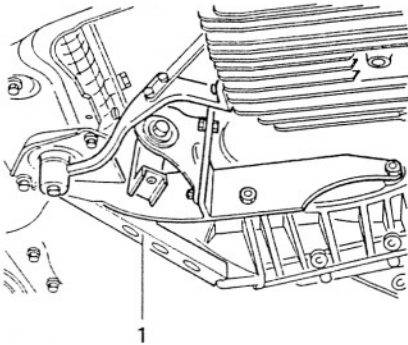




- Disconnect the electrical connections from the starter motor and alternator.
- 1. Disconnect the intake and delivery unions from the air conditioning compressor.



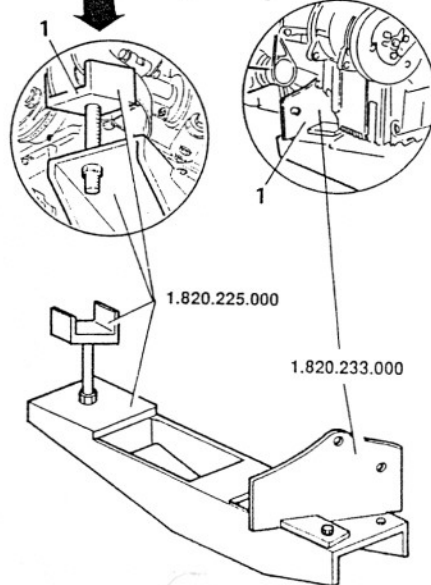
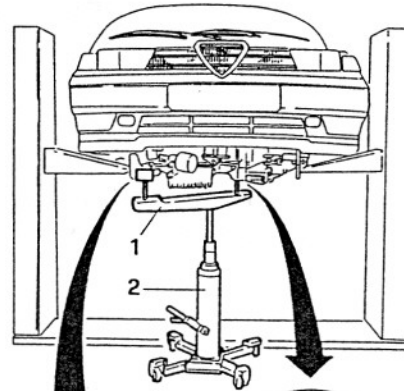
1. Remove the engine support bracket.



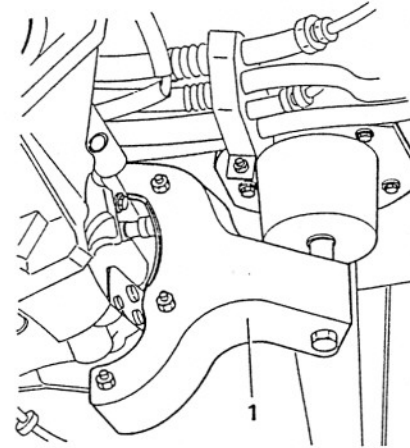
1. Install support tools N° 1.820.225.000 and N° 1.820.233.000 to remove the engine from the vehicle and position them as shown in the illustration.
2. Position a hydraulic jack under the engine support tools.



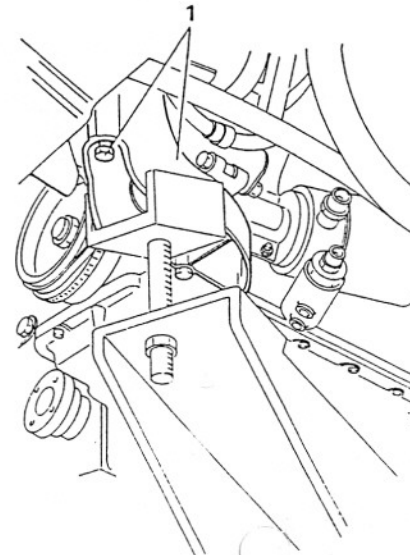
CAUTION
The hydraulic jack must be able to support a minimum of 1000 kg.



1. Remove the gearbox side engine support.



1. Remove the screw securing the engine front support.



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

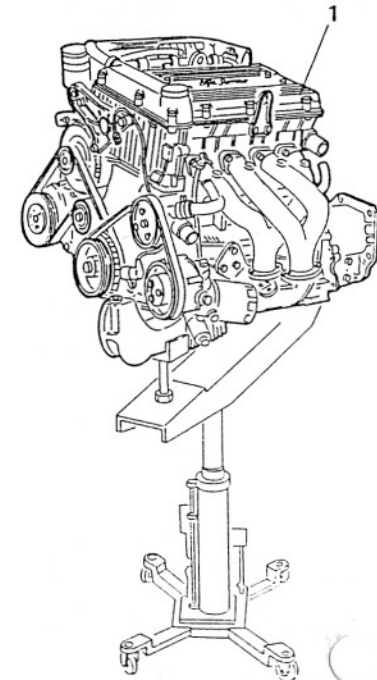
1. Lower the jack and remove the engine from the engine compartment.



CAUTION
When lowering the jack check that no hoses or cables are still attached to the vehicle.



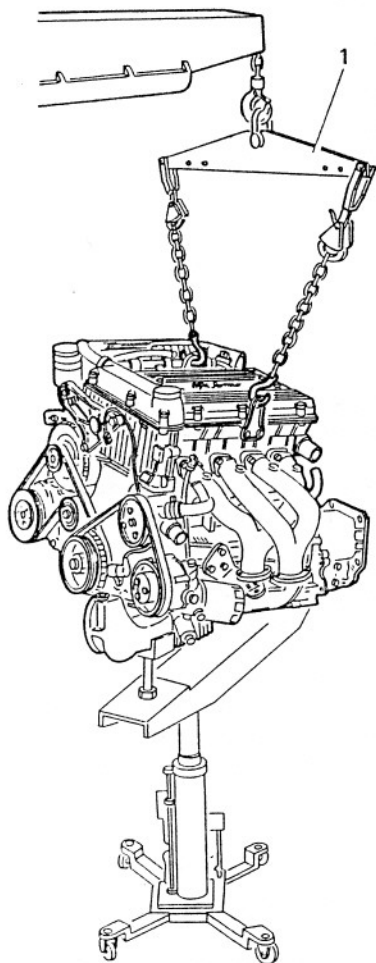
CAUTION
Pay close attention to avoid damaging components.



1. Support the engine 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

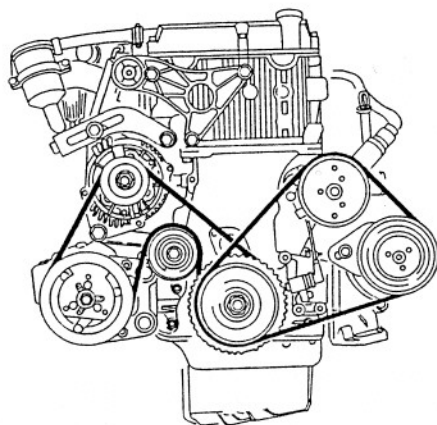
Repeat the above operations in the reverse order and note the following:

- Prepare the engine compartment for the insertion of the engine ensuring that 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, to ensure that no individual components are damaged.

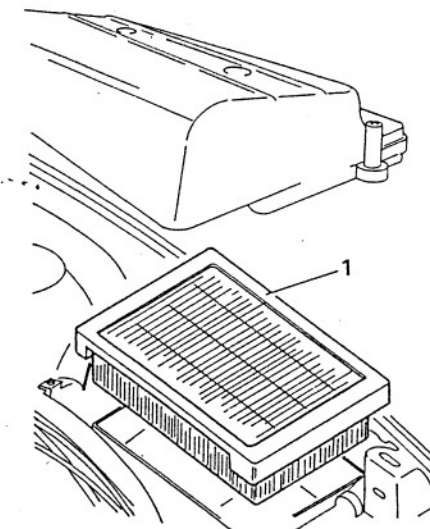

CAUTION

Ensure that the engine support points are correctly secured.

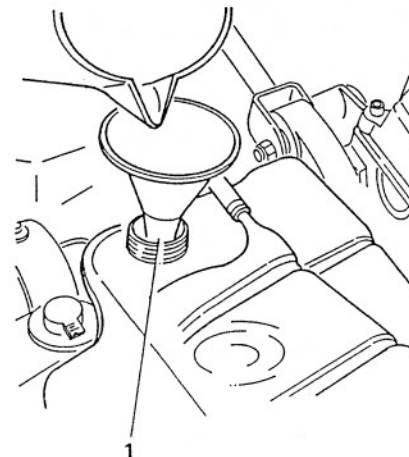
After installation check belt tensioning (see GROUP 00).



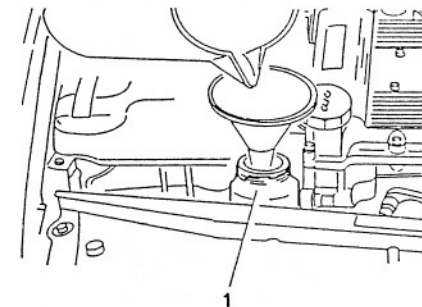
1. Refit the air cleaner ensuring that it is positioned as shown in the illustration.



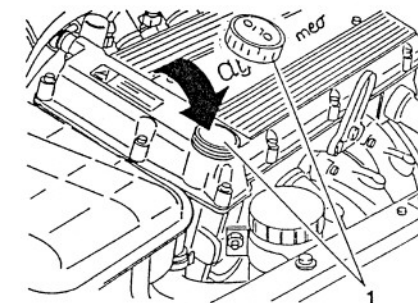
1. Fill the cooling system with the necessary fluid (see GROUP 00).



1. Fill the power steering system with the necessary fluid (see GROUP 00).



1. Fill the lubrication system with the necessary oil (see GROUP 00)



- Fill the air conditioning system (see GROUP 80)
- Check the levels of all the other fluids.
- Carry out all the checks and interventions indicated in GROUP 00.

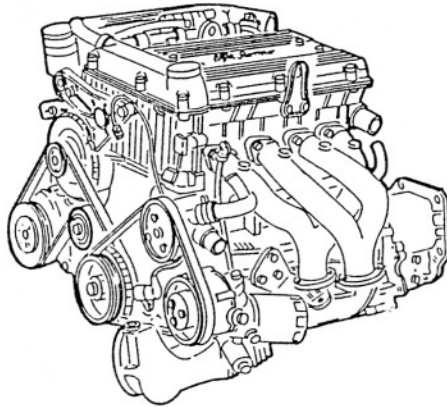


ENGINE BENCH OVERHAUL

The instructions given in the following paragraphs refer to the complete overhaul of the engine on a bench after removal from the vehicle.

The instructions are divided as follows:

- Disassembly and reassembly of engine: removal (and successive 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 the components of the crank mechanisms.



- Precautions for refitting: comprising the refit 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 indicated otherwise.

- Checks and inspections of the electrical components: Checks and inspections of the electrical components relative to the engine.

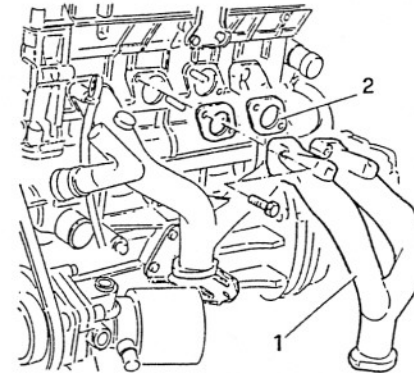
The procedures which follow refer to the complete overhaul of the complete engine unit: it is however possible to use individual parts of these instructions when dealing with specific components.



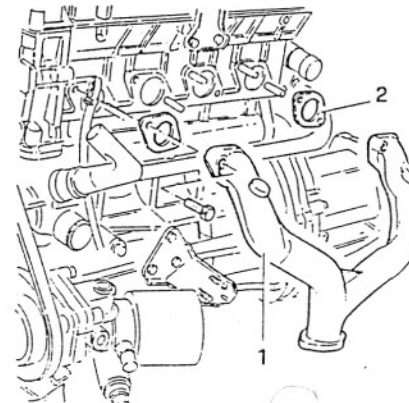
ENGINE DISASSEMBLY AND REASSEMBLY

REMOVAL OF LEFT-SIDE COMPONENTS

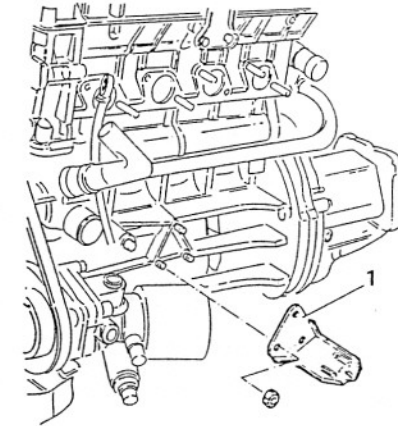
1. Remove the exhaust manifolds from the second and third cylinders.
2. Remove the gaskets.



1. Remove the exhaust manifolds from the first and fourth cylinders.
2. Remove the gaskets.



1. Remove the exhaust pipe forward section support bracket.



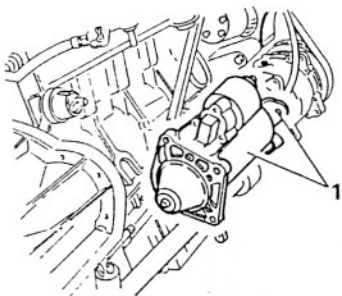
REMOVAL OF RIGHT-SIDE COMPONENTS

1. Remove the bracket supporting the freon to compressor delivery and return hoses and the starter motor electric supply cables.

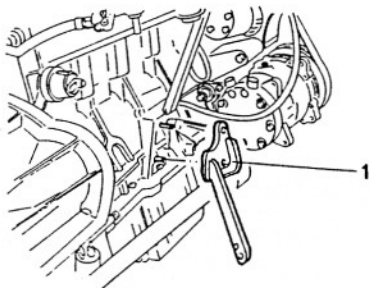




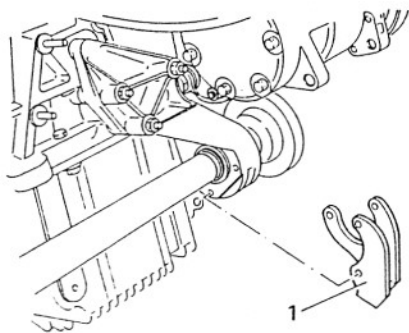
1. Remove the starter motor together with the rear support bracket.



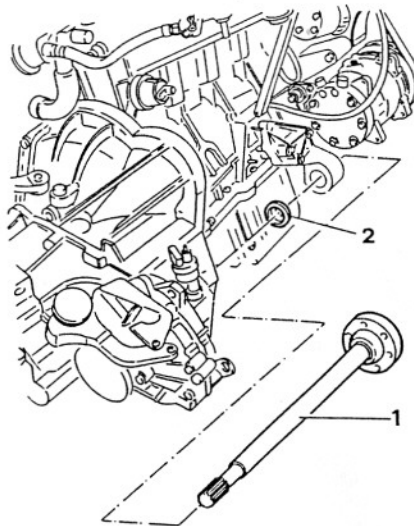
1. Remove the engine support bracket.



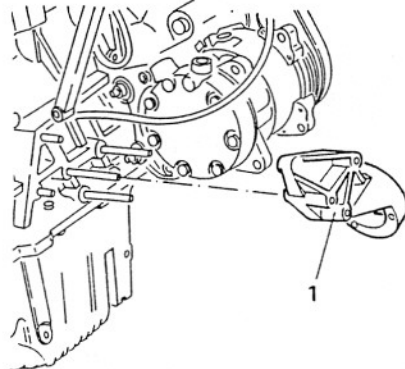
1. Remove the bracket securing the intermediate shaft to the support.



1. Withdraw the intermediate shaft.
2. Remove the dustband.

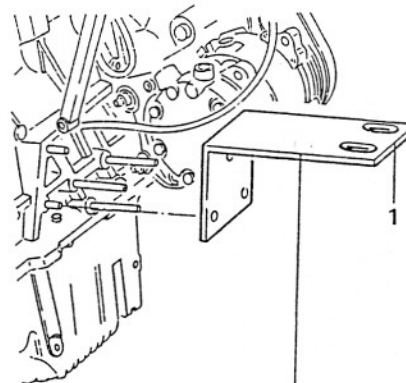


1. Remove the intermediate shaft support.

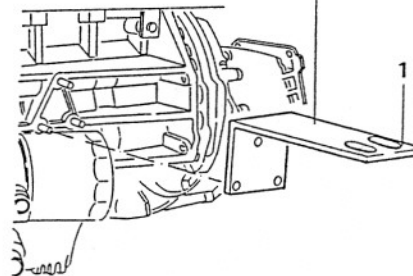


REMOVAL OF GEARBOX-DIFFERENTIAL GROUP

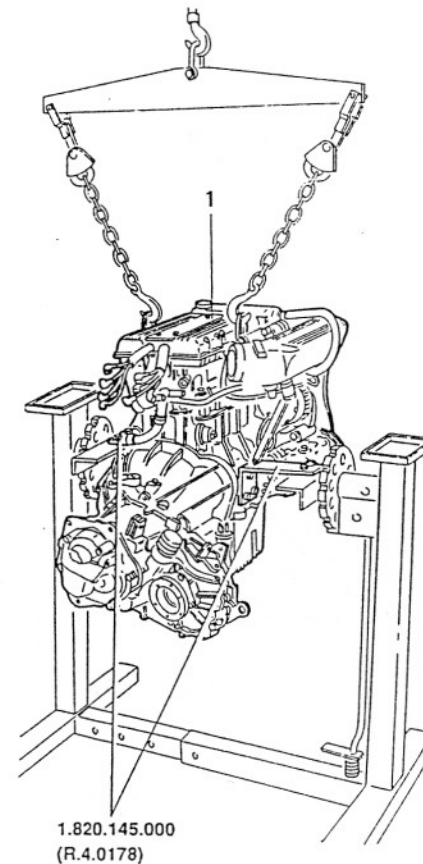
1. Install the two brackets N° 1.820.145.000 (R.4.0178) onto the engine block ready for positioning the overhaul stand.



1.820.145.000
(R.4.0178)



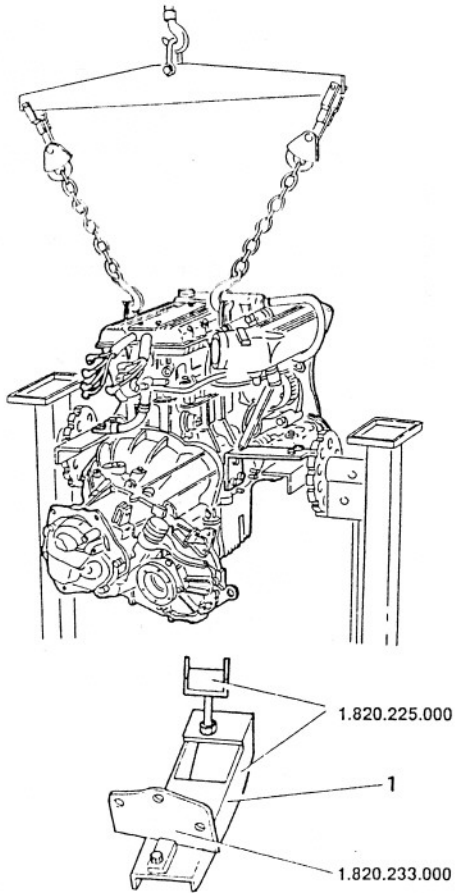
1. Raise the engine using a hydraulic lift and releasing it from the supporting jack. Place it on a rotary overhaul stand and secure it using brackets N° 1.820.145.000 (R.4.0178).



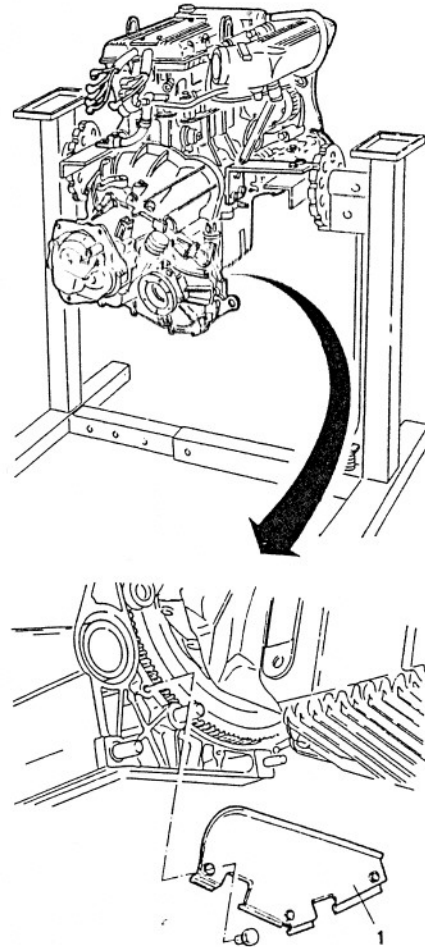
1.820.145.000
(R.4.0178)



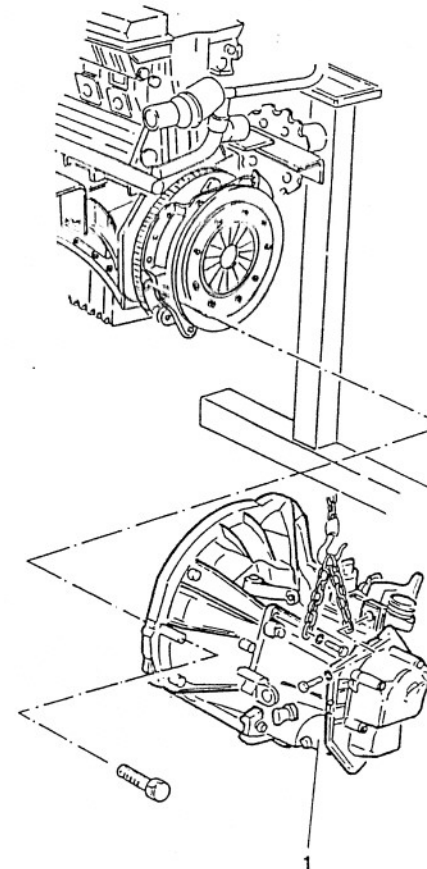
1. Remove tools N° 1.820.225.000 and N° 1.820.233.000 used to remove the engine from the engine compartment.



1. Remove the flywheel cover.

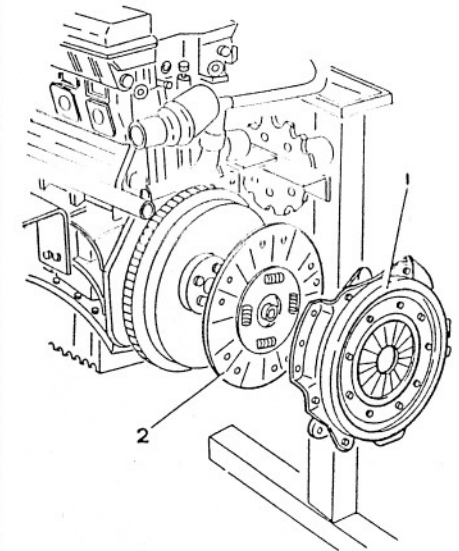


1. Using a hydraulic crane remove the gearbox-differential group from the engine.



CLUTCH PLATE REMOVAL

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



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

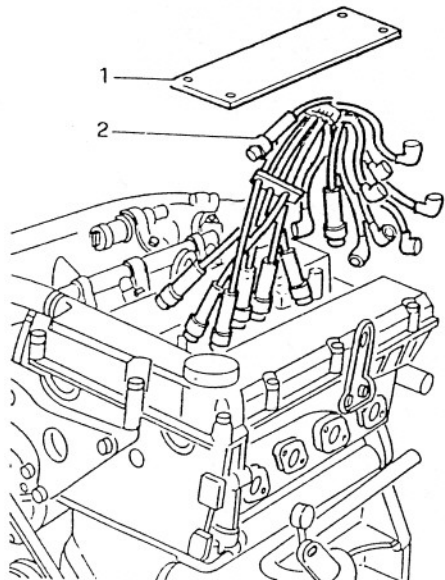
NOTE: For the complete overhaul of the gearbox refer to GROUP 13.



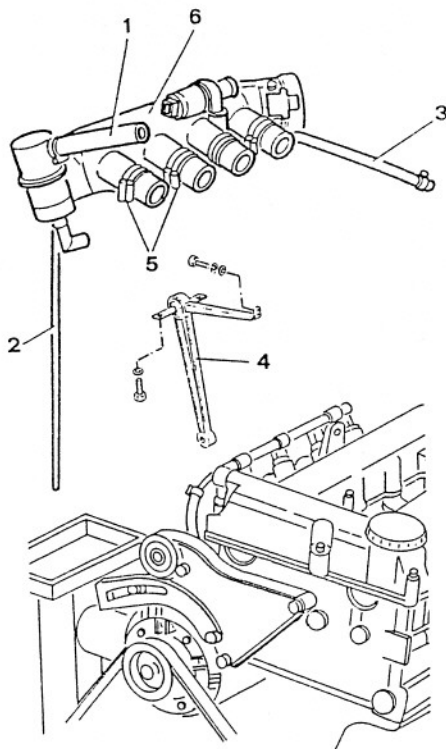
REMOVAL OF AIR INTAKE BOX

NOTE: For additional disassembly and inspections regarding the fuel supply system refer to GROUP 04.

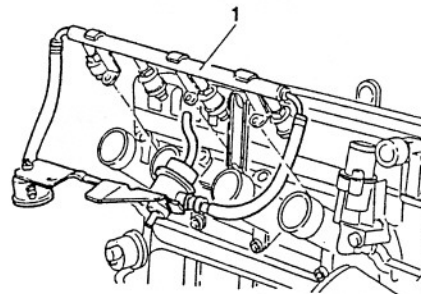
1. Remove the spark plug cover.
2. Disconnect the leads from the spark plugs and remove them together with their clamps.



1. Disconnect the oil vapour hose from the cylinder head cover.
2. Disconnect the oil recirculation hose from the engine block.
3. Disconnect the water to throttle body delivery hose from the thermostatic cup.
4. Remove the strut supporting the air intake box.
5. Loosen the clamps holding the sleeves connecting the intake box to the cylinder head.
6. Remove the complete air intake box.

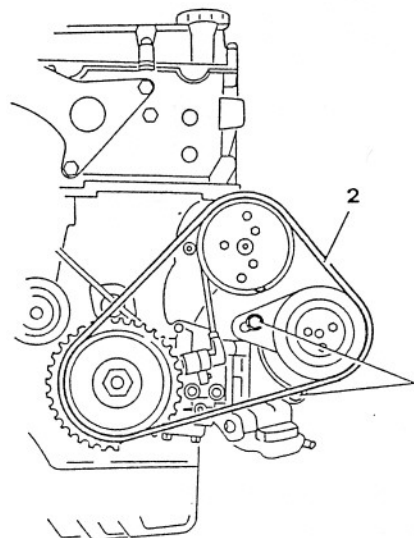


1. Remove the fuel supply manifold complete with injectors and supporting bracket with fuel pressure regulator and impulse dashpot.

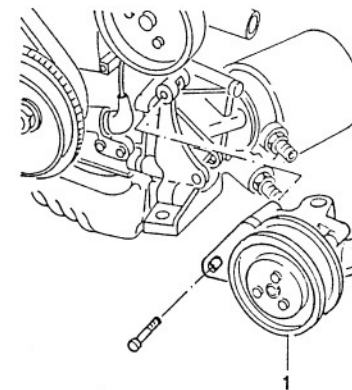


REMOVAL OF POWER STEERING PUMP

1. Loosen the two bolts securing the power steering pump.
2. Remove the water pump/power steering pump drive belt.

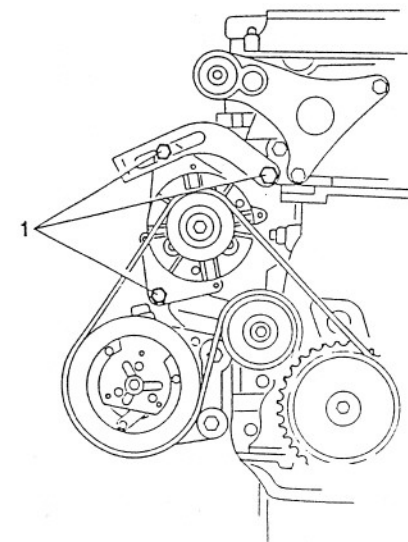


1. Withdraw the bolts and remove the power steering pump.



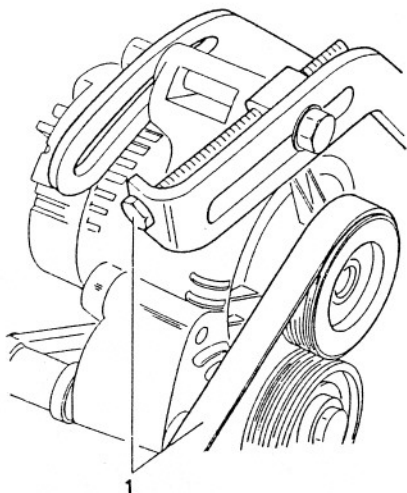
REMOVAL OF ALTERNATOR

1. Loosen the bolts securing the alternator.

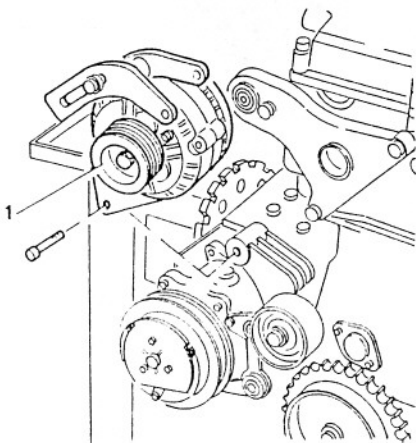




1. Loosen the drive belt by acting on the micrometric tensioner and withdraw it from the alternator pulley.

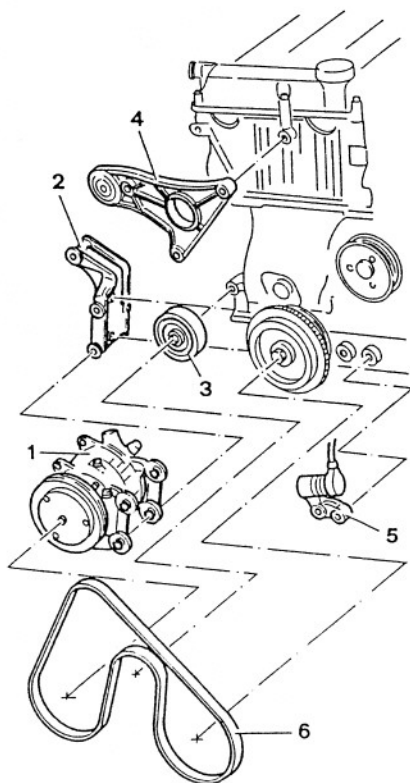


1. Withdraw the pins and remove the alternator together with belt tensioner brackets.




REMOVAL OF AIR CONDITIONING COMPRESSOR


1. Unscrew the two pins and remove the compressor.
2. Remove the alternator and compressor support.
3. Remove the guide pulley.
4. Remove the front engine support bracket.
5. Remove the r.p.m. and timing sensor.
6. Remove the air conditioning compressor - alternator drive belt.

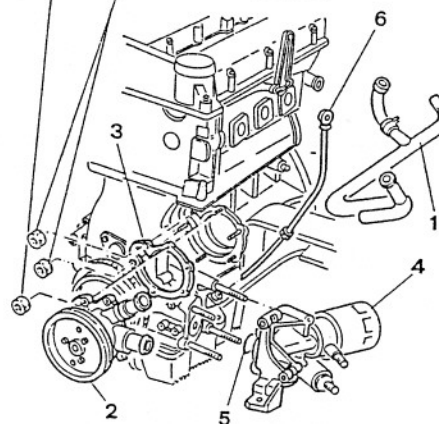


REMOVAL OF WATER PUMP


1. Remove the engine coolant to pump intake hose.
2. Remove the water pump.
3. Remove the water pump gasket.
4. Remove the oil filter support assembly.
5. Remove the O-ring.
6. Remove the oil dipstick.

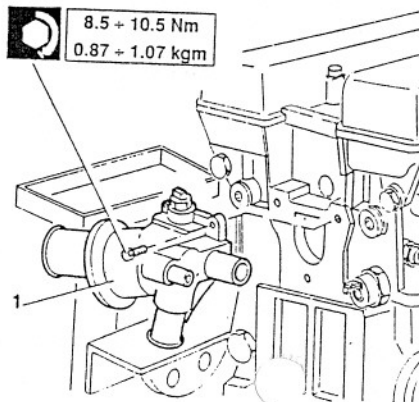
 7.65 – 9.45 Nm
0.78 – 0.96 kgm

 12.75 + 15.75 Nm
1.3 + 1.6 kgm



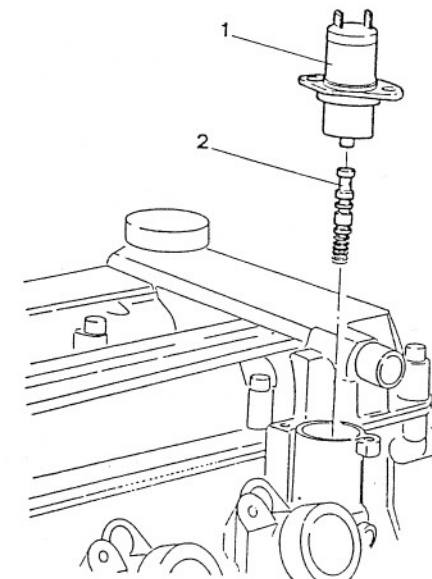
1. Remove the thermostat group.

 8.5 + 10.5 Nm
0.87 + 1.07 kgm

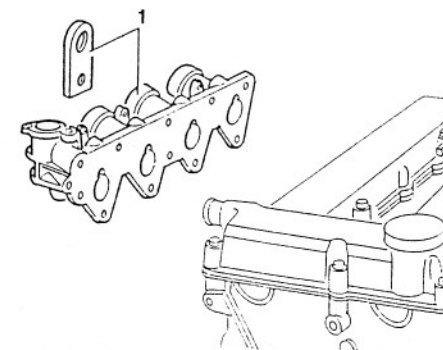


REMOVING CYLINDER HEAD

1. Remove the timing variator controlling solenoid.
2. Remove the timing variator control valve and spring.

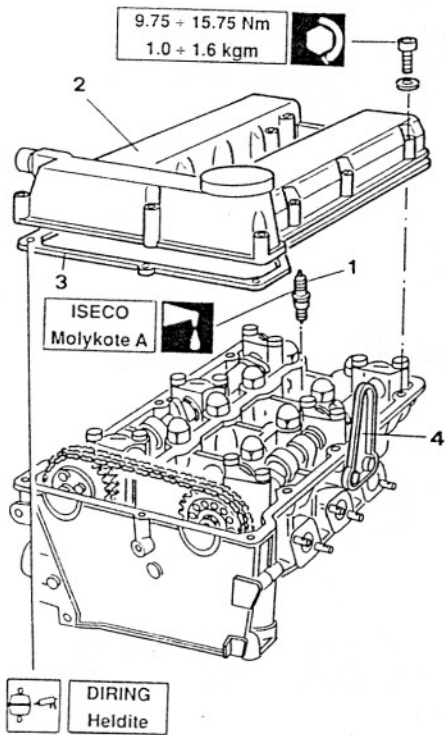


1. Remove the intake manifolds and right-hand engine support bracket.

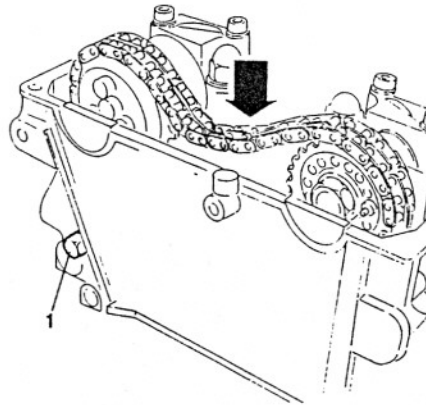




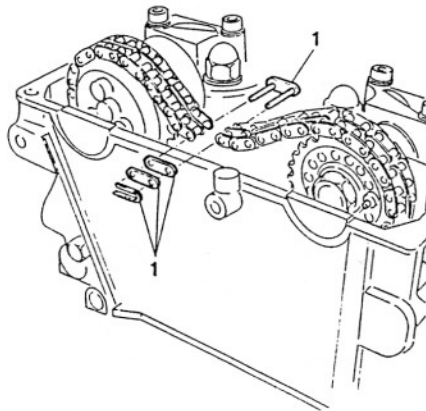
1. Remove the spark plugs.
2. Remove the timing cover.
3. Remove the gasket.
4. Remove the left-hand engine support bracket.



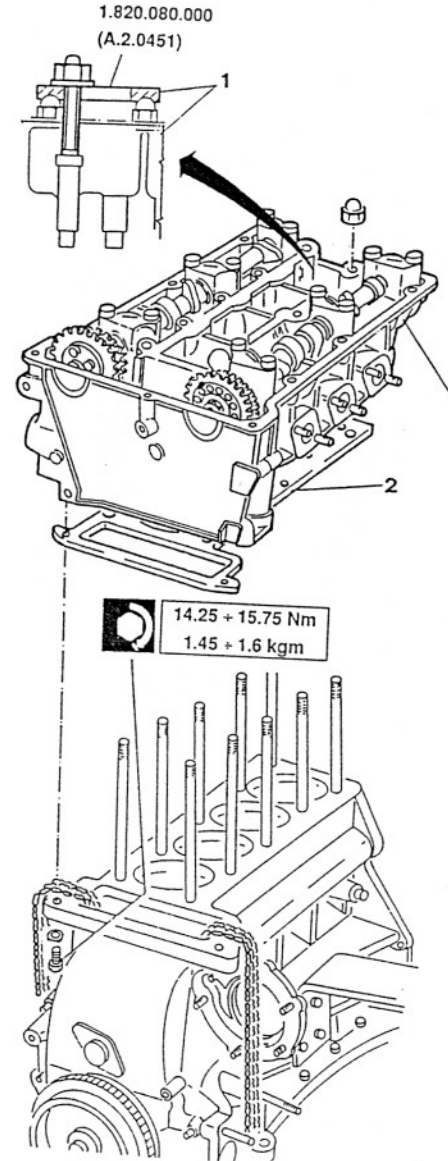
- Rotate the crankshaft until the connecting chain link is at the top.
1. Unlock the belt tensioner screw and push the chain downwards. Lock the belt tensioner in this position by re-tightening the relative screw.



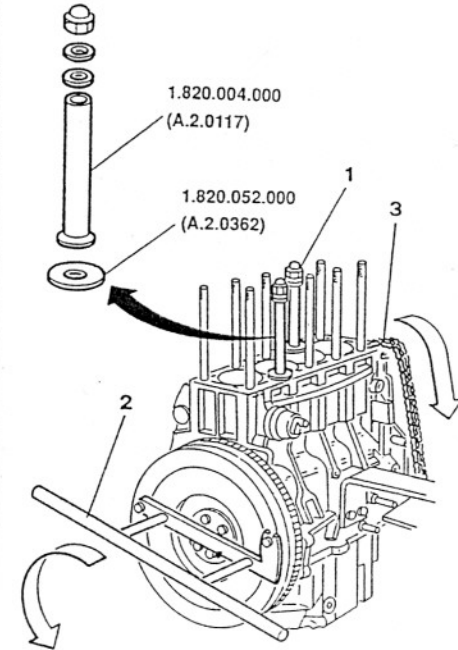
1. Remove the connecting link from the timing chain.



1. Using tool N° 1.820.080.000 (A.2.0451), release the cylinder head and remove it.
2. Remove the gasket.



1. Install the cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) with washers N° 1.820.052.000 (A.2.0362).
2. Install a suitable tool to permit rotation of the crankshaft.
3. Withdraw the timing chain by rotating the crankshaft.

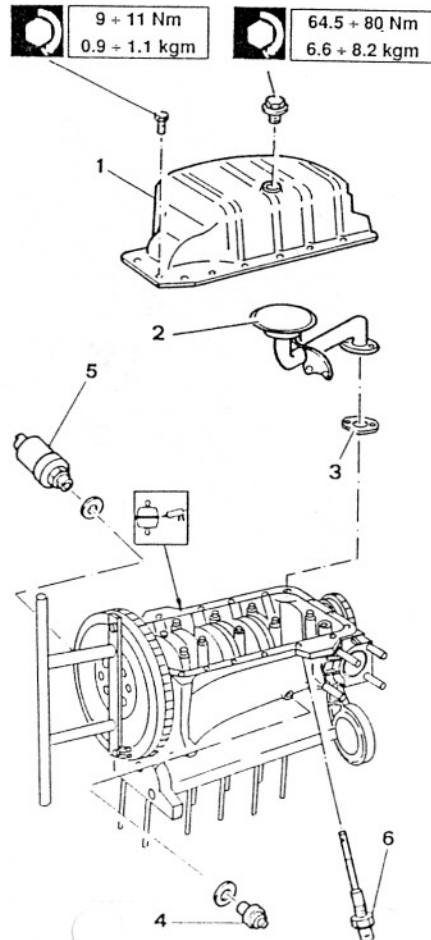


To refit the cylinder head refer to the relevant paragraph.



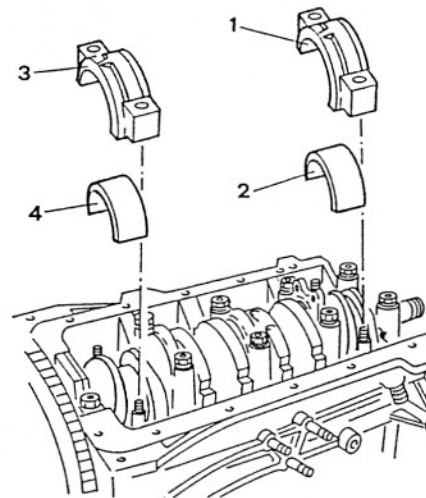
REMOVAL OF COMPONENTS FROM THE ENGINE BLOCK

- Release the rotary stand and rotate the engine block 180°.
- 1. Remove the oil sump.
- 2. Remove the oil pump suction body.
- 3. Remove the gasket.
- 4. Remove the engine oil minimum pressure warning light sensor.
- 5. Remove the engine oil pressure meter.
- 6. Remove the engine oil level sensor.

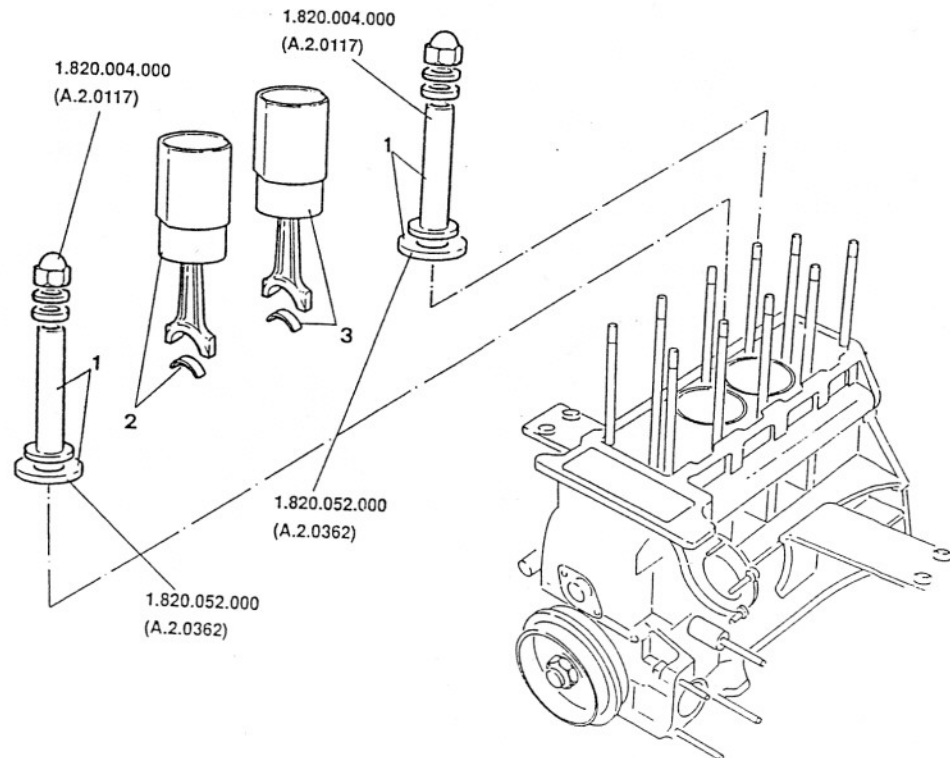


REMOVAL OF CYLINDER LINERS AND PISTONS

- Rotate the crankshaft so that the first and fourth pistons are at B.D.C.
- 1. Remove the rod cap from the first piston.
- 2. Remove the relative rod half-bearing.
- 3. Remove the rod cap from the fourth piston.
- 4. Remove the relative rod half-bearing.



- Release the rotary stand and rotate engine block 180°.
- 1. Remove the cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) and washers N° 1.820.052.000 (A.2.0362).
- 2. Withdraw the cylinder liner with piston from the first cylinder. Remove the relative rod half-bearing.
- 3. Withdraw the cylinder liner and piston from the fourth cylinder. Remove the relative rod half-bearing.
- Rotate the engine block 180° and proceed in the same way for the second and third cylinders.





1. Withdraw the liner.
2. Remove the O-ring.
3. Using a suitable tool, withdraw the seal rings and oil scraper ring from the piston.

**CAUTION**

Proceed with care in order to avoid breaking the rings which may otherwise be re-used.

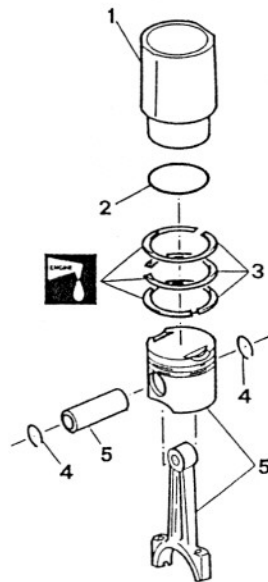
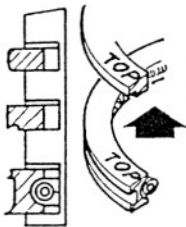
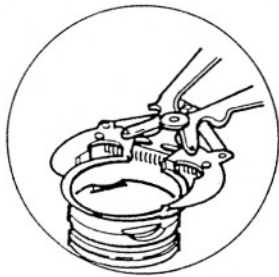


When refitting, install the seal rings so that the word «TOP» stamped onto them faces upwards.

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



To refit, follow the indications given in the relative paragraph.

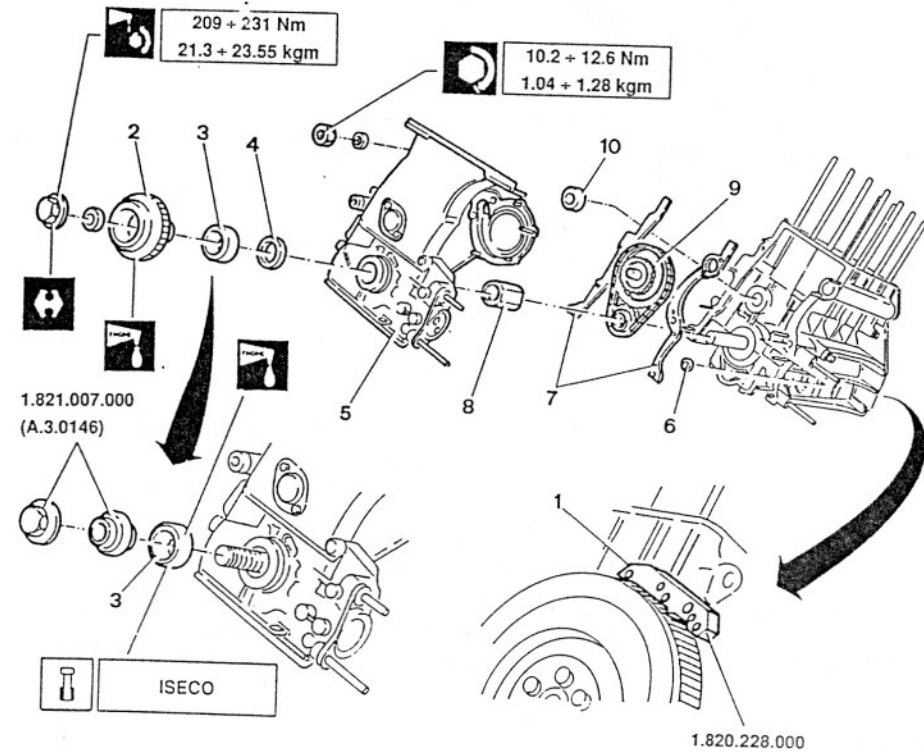
**REMOVAL OF COMPONENTS FROM THE ENGINE BLOCK (Continued)**

– Remove the previously installed tool for rotating the flywheel.

1. Install tool N° 1.820.228.000 to prevent rotation of the flywheel.
2. Remove the crankshaft pulley.
3. Remove the oil seal ring.

When refitting use inserting tool N° 1.820.007.000 (A.2.0146).

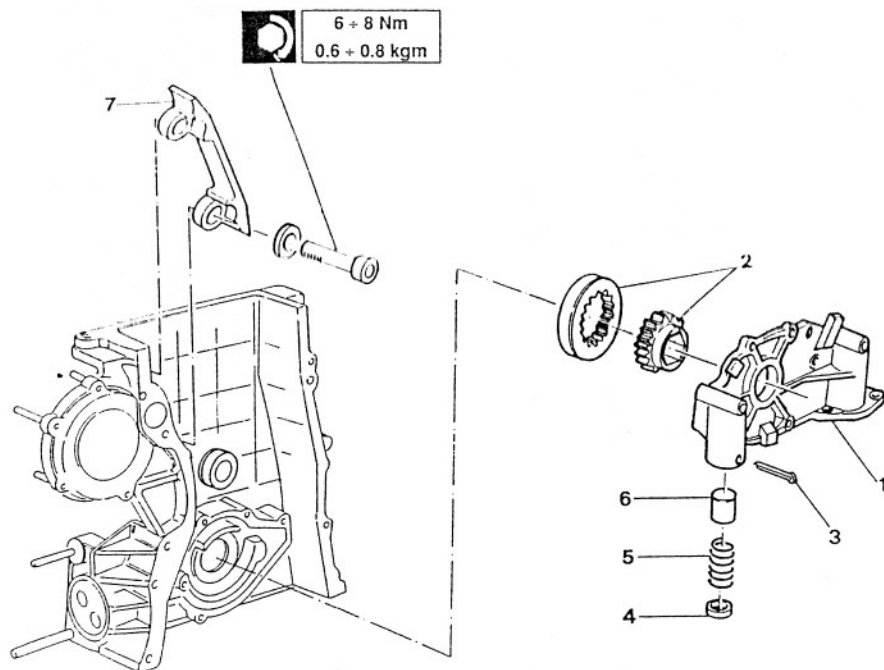
4. Remove the washer.
5. Remove the front cover.
6. Remove the seal ring.
7. Remove the gaskets between the front over and the engine block.
8. Remove the oil pump control pinion.
9. Withdraw the toothed wheels and relative chain.
10. Remove the the shoulder.





DISASSEMBLY OF OIL PUMP

1. Remove the front cover from the pump body.
2. Remove the toothed wheels.
3. Withdraw the cotter pin.
4. Remove the cap.
5. Remove the spring.
6. Remove the oil pressure relief valve.
7. Remove the timing chain shoe.



REMOVAL OF COMPONENTS FROM ENGINE BLOCK (Continued)

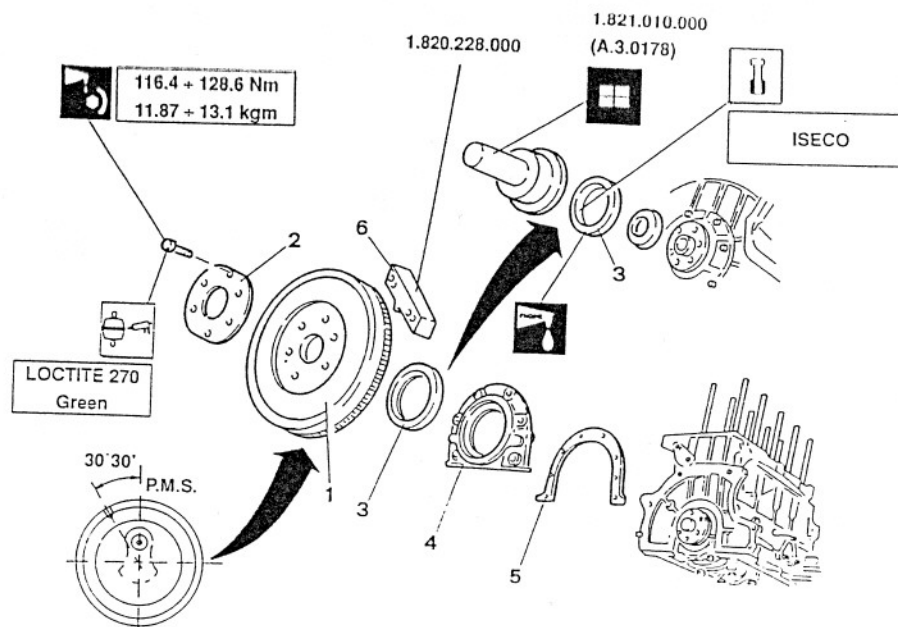
1. Remove the flywheel.



When installing, rotate the crankshaft until the rod journal of the first and fourth cylinder is at T.D.C.; position the flywheel and check that the small hole located on the outer edge is at 31°30' in relation to the vertical.

Before applying the specified fixative to the threads of the flywheel retaining screws, remove all traces of the old fixative.

2. Remove the safety washer.
3. Remove the oil seal.
When refitting use inserting tool N° 1.821.010.000 (A.3.0178).
4. Remove the rear cover.
5. Remove the gasket between rear cover and engine block.
6. Remove the tool N° 1.820.228.000 which was previously installed to lock the flywheel.





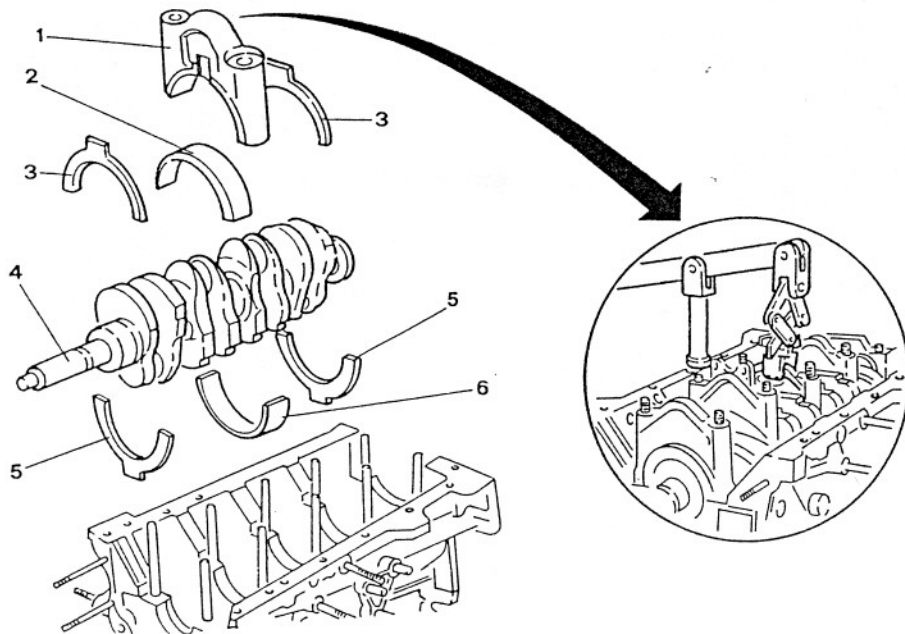
REMOVING THE CRANKSHAFT

1. Remove the main journal caps using a suitable tool.
2. Remove the the main half-bearings from the main journal caps.
3. Remove the lower thrust half-rings.
4. Remove the crankshaft.
5. Remove the upper thrust half-rings.
6. Remove the main half-bearings from the supports.

NOTE: Mark the position of the various components in case they are to be reused.



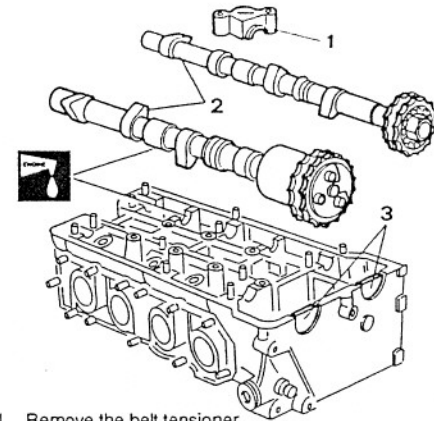
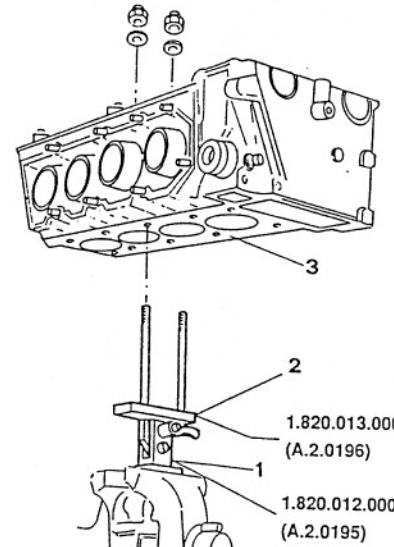
To refit the crankshaft follow the indications given in the relative paragraph.



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° 1.820.013.000 (A.2.0196) and lock it to the support.
3. Insert the cylinder head onto the rods of the fork and lock it into position.



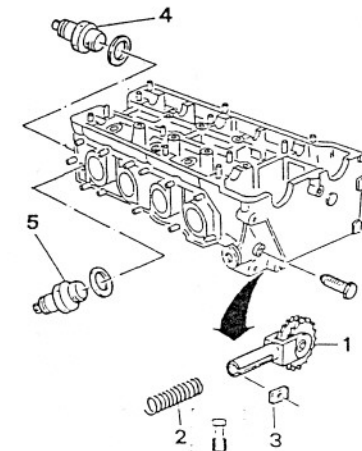
1. Remove the belt tensioner.
2. Remove the spring.
3. Remove retaining plate.



CAUTION

Restrain the belt tensioner when releasing the retaining screw and release the spring.

4. Remove the engine coolant temperature sender.
5. Remove the engine coolant maximum temperature sensor.



REMOVING THE CAMSHAFTS

1. Remove the camshaft caps.

NOTE: Arrange the caps in order in case they are to be reused.

2. Remove the camshafts.
3. Remove the rubber pads.

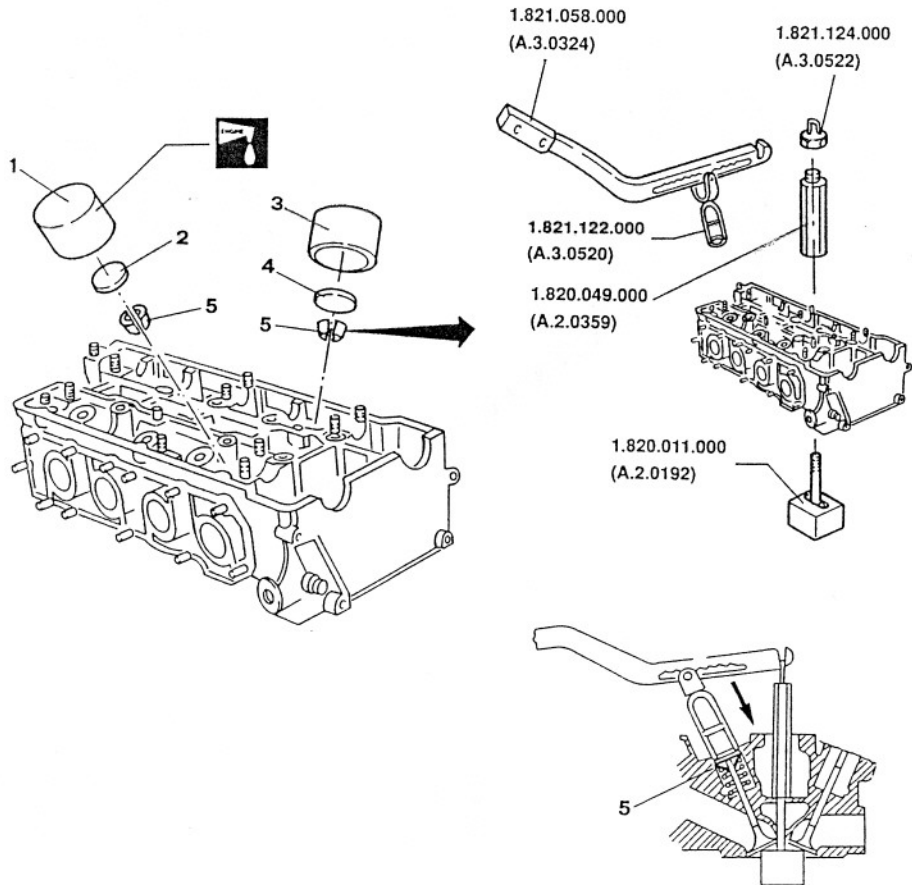


DISASSEMBLY OF VALVES

- Operate on one cylinder at a time.
- 1. Withdraw the valve cup from the intake side.
- 2. Remove the valve clearance adjustment cap - intake side.
- 3. Withdraw the valve cup - exhaust side.
- 4. Remove the valve clearance adjustment cap - exhaust side.

NOTE: Arrange the components in order in case they are to be reused.

- 5. With the tool illustrated below, remove the exhaust and intake side cotters.

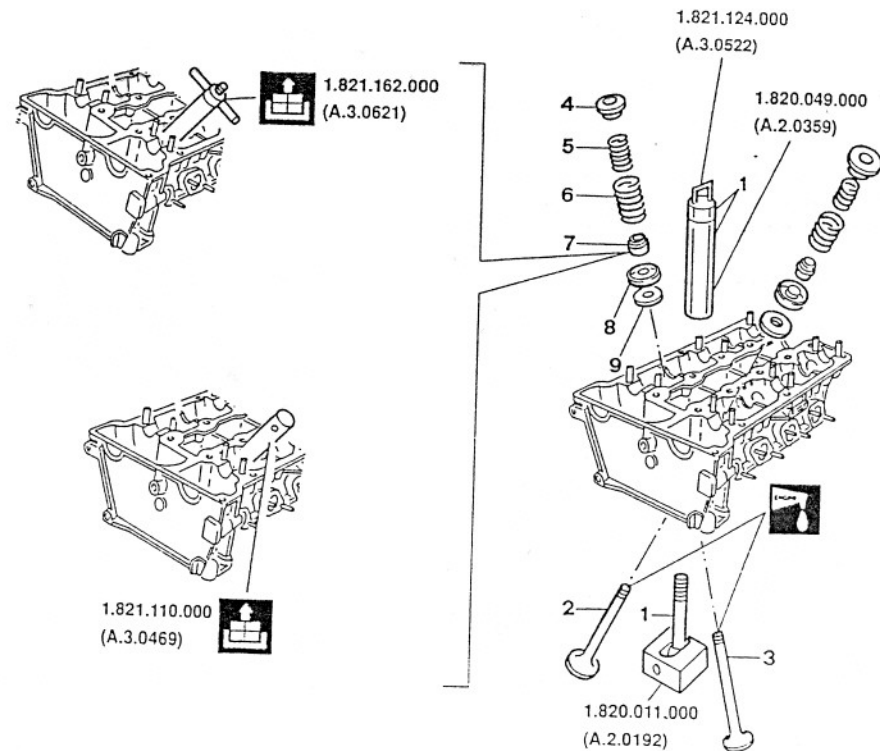


1. Remove the previously installed tools.
2. Withdraw the intake valve.
3. Withdraw the exhaust valve.
- Operate on the exhaust side.
4. Remove the upper cap.
5. Remove the inner spring.
6. Remove the outer spring.
7. Using puller N° 1.821.162.000 (A.3.0621), remove the oil seal.



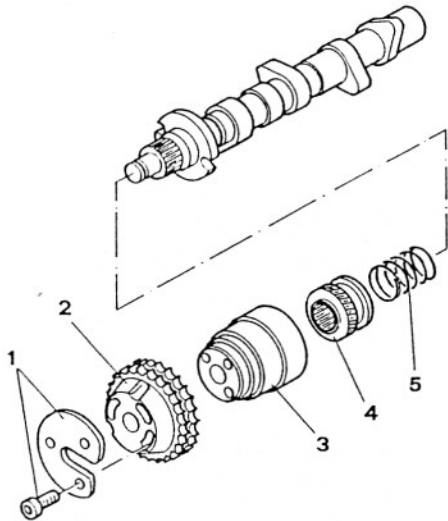
When refitting use inserting tool N° 1.821.110.000 (A.3.0469).

8. Remove the spring retaining ring.
9. Remove the lower cap.
- Proceed likewise for the components on the exhaust side.
- Following the same procedure and using the same tools, operate on the other cylinders.



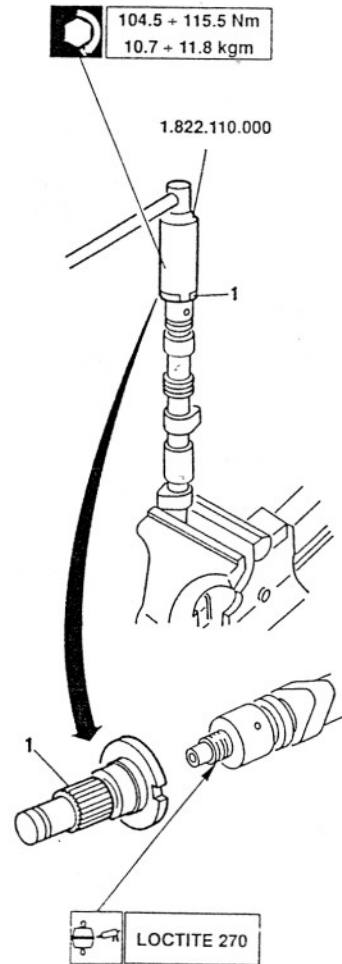
**DISASSEMBLY OF THE CAMSHAFT
- INTAKE SIDE**

1. Unscrew the three screws and remove the safety plate.
2. Remove the timing gear.
3. Remove the body.
4. Remove the piston.
5. Remove the piston return spring.

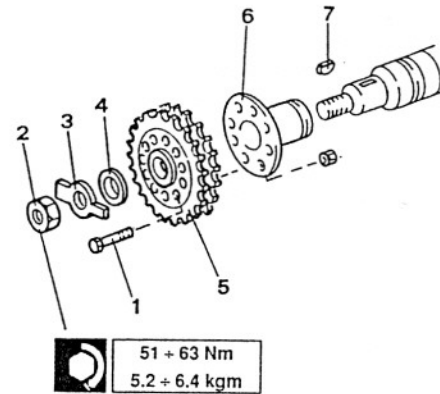

When reassembling:

- ensure that the sealant does not block the oil channels.
- Do not tighten the three retaining screws so that the timing can be adjusted if necessary.
- Wait for approximately two hours before installing the shaft on the cylinder head.

1. Remove the support using tool N° 1.822.110.000.


**DISASSEMBLY OF CAMSHAFT
- EXHAUST SIDE**

1. Remove the bolt.
2. Remove the nut.
3. Remove the safety retainer.
4. Remove the washer.
5. Remove the timing gear.
6. Remove the flange.
7. Remove the feather.

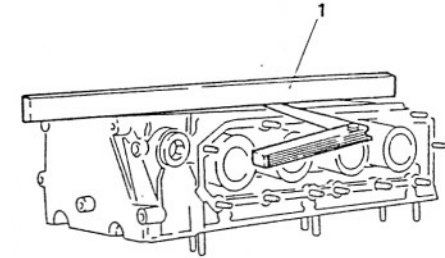

**CYLINDER HEAD CHECKS AND
INSPECTIONS**
**CHECKING LOWER PLANE OF
CYLINDER HEAD**

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



Maximum head lower plane flatness error

0.05 mm



1. After resurfacing check that the height of the head exceeds the permitted minimum.


CAUTION

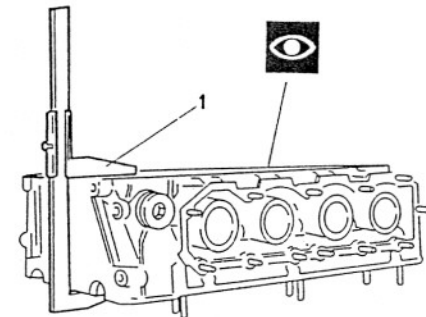
Do not exceed the permitted minimum value as this may cause serious engine malfunction.

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



Minimum permitted height of the head after facing

134.900 mm

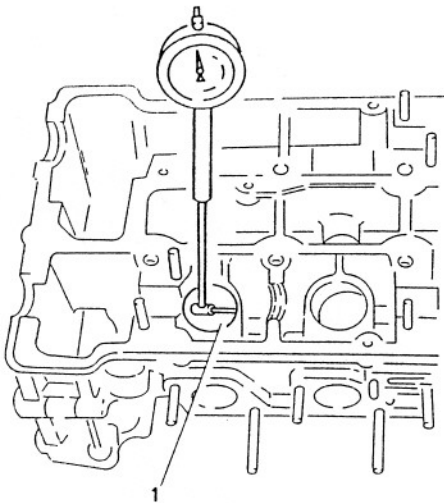




VALVE CUP SEATINGS AND VALVE CUPS

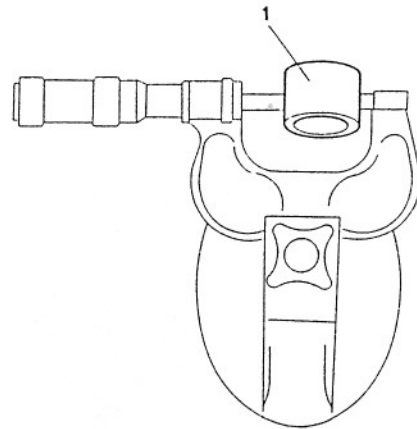
1. Check that the diameter of the valve cup seats is within the specified limits.

Diameter of valve cup seating	
Intake and exhaust	35.000 to 35.025 mm



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

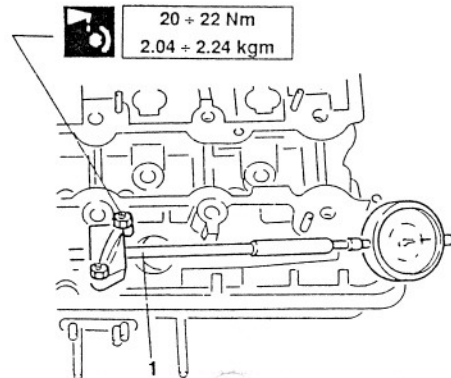
Diameter of valve cup	
Intake and exhaust	34.973 to 34.989 mm



CAMSHAFT SUPPORTS

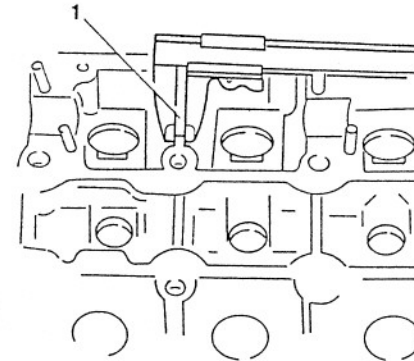
1. Install the caps, tighten the lubricated nuts to the prescribed torque and check that the diameter of the supports is within the prescribed limits.

Diameter of camshaft supports	
	27.000 to 27.033 mm



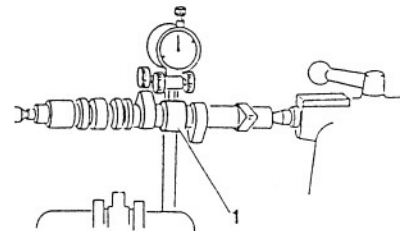
1. Check that the width of the camshaft support shoulder is within the prescribed limits.

Width of camshaft support shoulder	
	7.898 to 7.920 mm



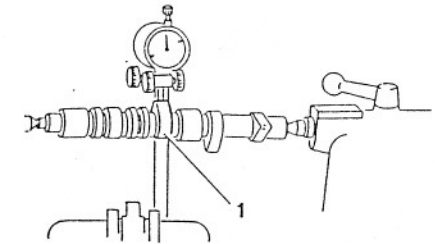
1. Check that the diameter of the camshaft journals is within the prescribed limits.

Diameter of camshaft journals	
	26.959 to 26.980 mm



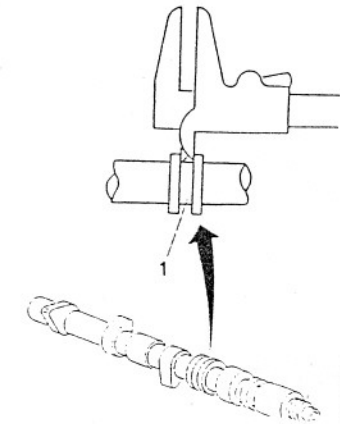
1. Check that the height of the cams exceeds the prescribed minimum

Minimum cam height	
intake	11.5 mm
exhaust	10.1 mm



1. Check that the width of the camshaft shoulders is within the prescribed limits.

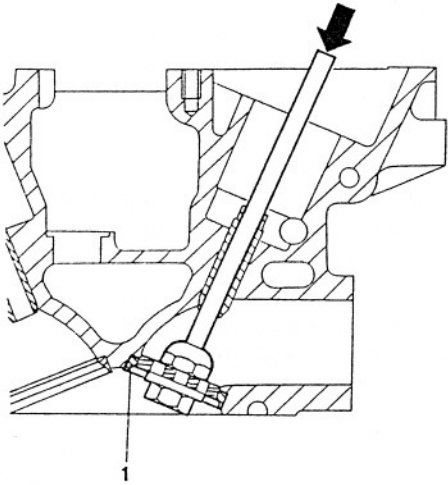
Width of camshaft shoulders	
	8 to 8.022 mm





VALVE SEAT REPLACEMENT

1. Extract worn valve seats using suitable equipment.

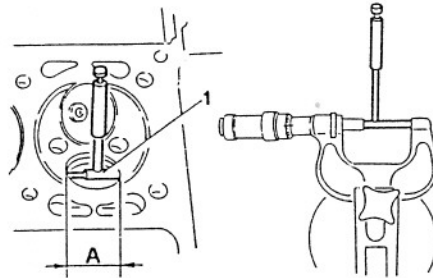


1. Check that the diameter of the valve seat housings is within the prescribed limits.



Valve seat housing diameter «A»

intake	45.000 to 45.025 mm
Exhaust	39.000 to 39.025 mm

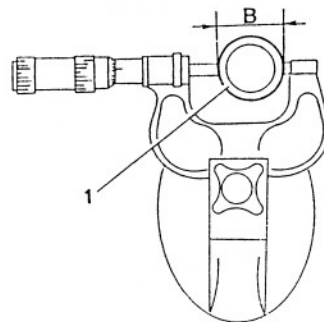


1. Check that the outer diameter of the new valve seat is within the prescribed limits.

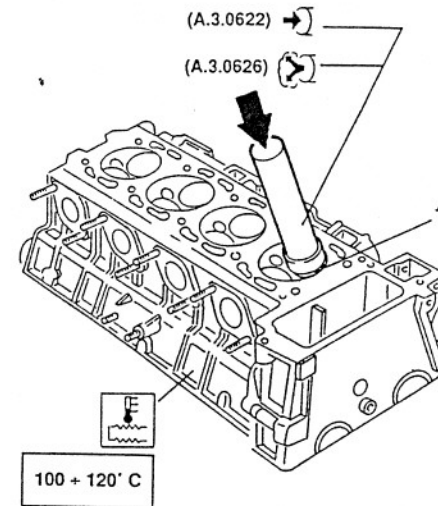


Outer diameter of valve seat «B»

intake	45.100 to 45.116 mm
exhaust	39.095 to 39.111 mm



1. Heat the head to a temperature of about 100°C and install the new valve seats using the special inserting tools.



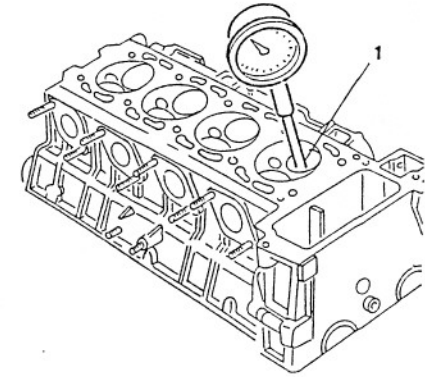
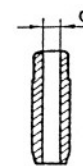
CLEARANCE BETWEEN VALVE GUIDE AND STEM

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



Internal diameter of valve guide «d»

intake and exhaust	8.000 to 8.015 mm
--------------------	-------------------

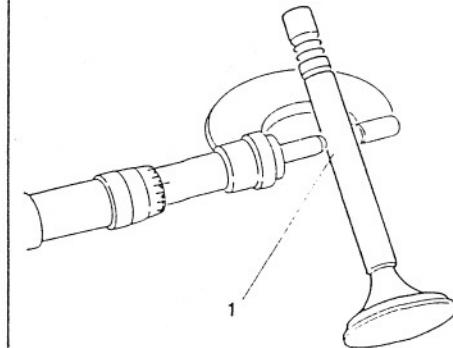


1. Measure the diameter of the valve stem in at least three places and at right-angles to each other.
 - Calculate the clearance and check that it is within the prescribed limits. If not, replace the worn parts.



Radial clearance between valve stem and inner diameter of valve guide

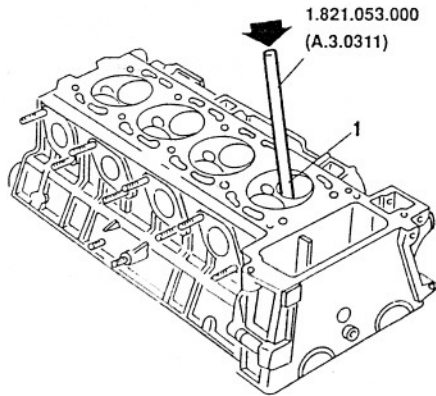
intake	0.015 to 0.045 mm
exhaust	0.040 to 0.070 mm





REPLACING VALVE GUIDES

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



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

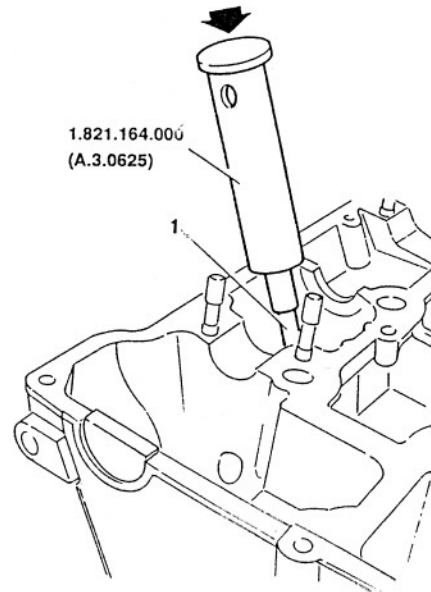
∅	Diameter of valve guide seats	
	15.000 to 15.018 mm	

∅	External diameter of valve guides	
	intake	15.039 to 15.050 mm
	exhaust	15.050 to 15.068 mm

↖	Interference between valve guide and valve guide seat	
	intake	0.021 to 0.050 mm
	exhaust	0.032 to 0.068 mm

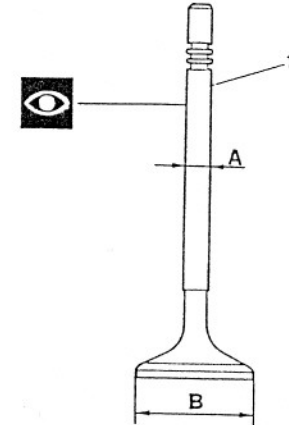
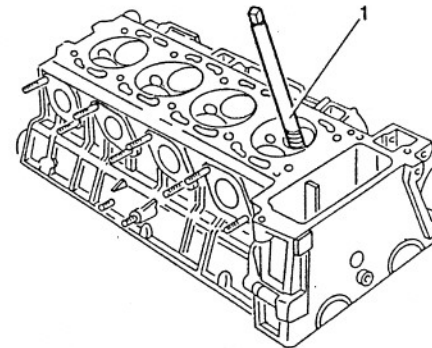
1. Insert the new valve guides using inserting tool N° 1.821.164.000 (A.3.0625) which will also ensure correct protrusion.

	Valve guide protrusion	
	intake and exhaust	9.850 to 10.150 mm



1. Ream the new valve guides to free them from burring and calibrate the holes to the prescribed diameter.

∅	Inner diameter of valve guides	
	intake and exhaust	8.000 to 8.015 mm



TURNING OF VALVE SEATS

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

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

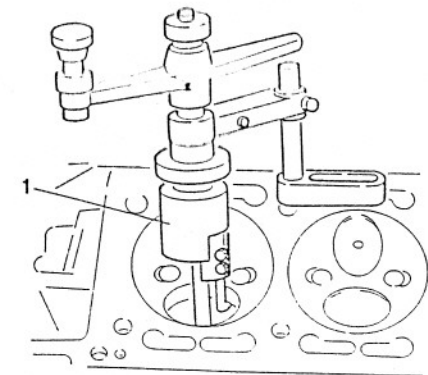
△	Valve seat taper - intake and exhaust	
	C = 90° ± 20°	

VALVES

1. Check that the diameter of the stem and the diameter of the head are within the prescribed limits.

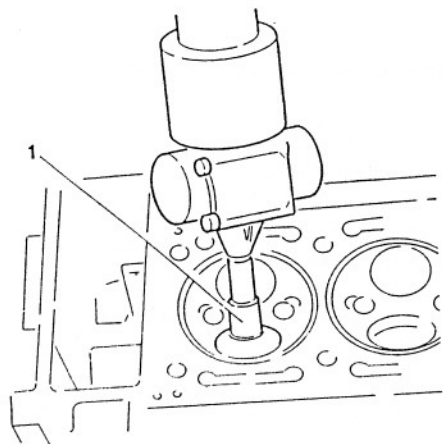
∅	Diameter of valve stem «A»	
	intake	7.970 to 7.985 mm
	exhaust	7.945 to 7.960 mm

∅	Diameter of valve head «B»	
	intake	43.850 to 44.000 mm
	exhaust	37.850 to 38.000 mm





- After turning, grind each valve in its relative seat as follows:
 - spread the stop limit surfaces of the valves and seats with abrasive paste (SIPAL AREXONS Carbo-silicium for valve).
 - Lubricate the valve stem with engine oil.
 - Fix the lower surface of the valve head to the suction cup of a pneumatic lap.
 - insert the valve into the relative guide and grind.
 - After grinding, thoroughly clean both the valves and their seats.



VALVE SPRINGS

- Check that the length of the «free» springs is within the prescribed limits.

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

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

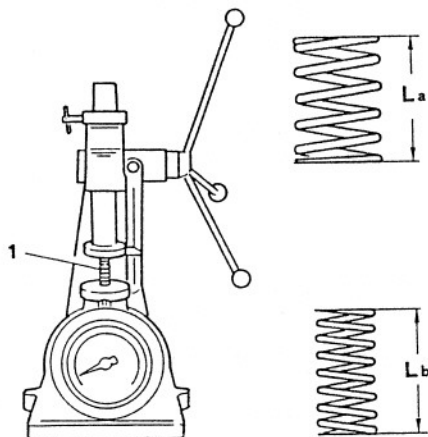
Length of free spring		
outer spring	L _a	48.7 mm
inner spring	L _b	46.2 mm

Outer spring

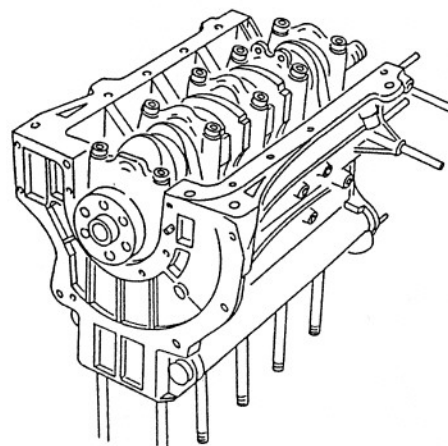
Length of the spring	mm	Control loading N(kg)
Valve A closed	36.5	212 to 220 (21.6 to 22.4)
Valve A open	25.5	452 to 470 (46.1 to 47.9)

Inner spring

Length of the spring	mm	Control loading N(kg)
Valve A closed	34.5	115 to 120 (11.8 to 12.2)
Valve A open	23.5	244 to 252 (24.9 to 25.7)

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 main engine lubrication and coolant channel 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.

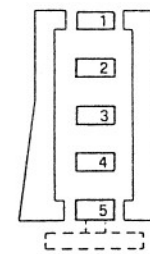


MAIN BEARING CAPS

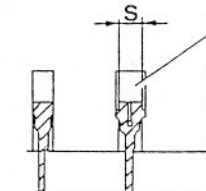
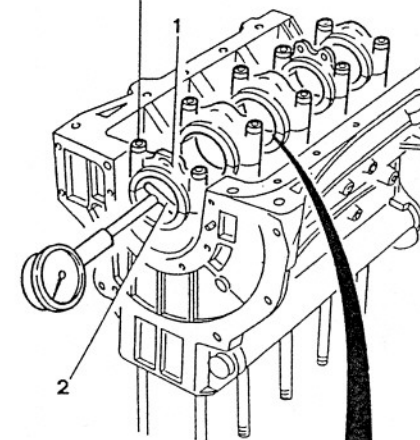
- Install the main bearing caps in the position and direction identified by the numbering on the caps themselves.
- Tighten the lubricated nuts to the correct torque and check that the diameter of the main supports is within the prescribed limits.
- Check that the length "S" of the central main support shoulder is within the prescribed limits.

Diameter of main supports	
63.652 to 63.664 mm	

Length of central main support shoulder "S"	
25.15 to 25.20 mm	



20 Nm + 115'
2.04 kgm + 115'



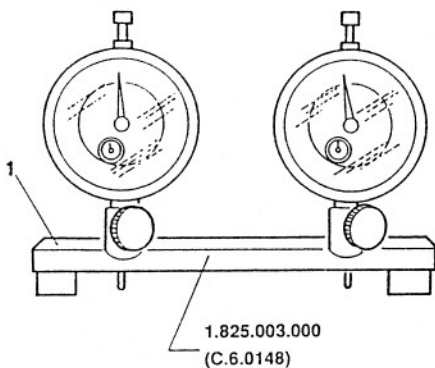


CYLINDER LINER PROTRUSION

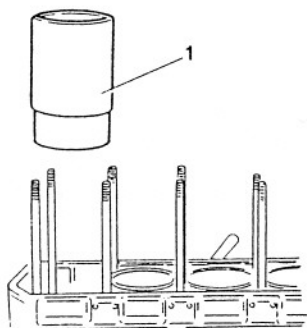
Carry out the check without the seal rings

NOTE: Procedure to be followed during the bench overhaul as a preliminary check of the correct coupling of the cylinder liners and engine block.

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

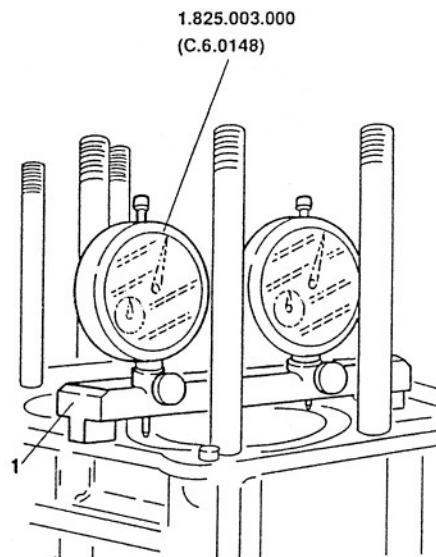


1. Introduce the cylinder liners into the engine block without the seal rings.



1. Place tool N° 1.825.003.000 (C.6.0148) on the engine block so that the probes rest on the edge of the cylinder liner, then check that the protrusion is within the prescribed tolerances.

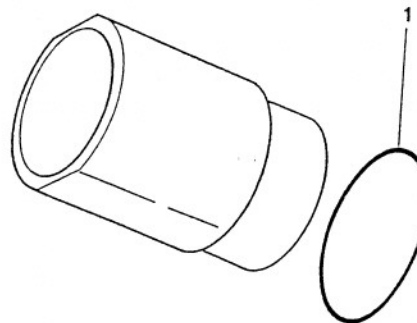
	Cylinder liner protrusion from engine block
	0.01 to 0.06 mm



Check with seal rings

NOTE: Procedure to be carried out when refitting.

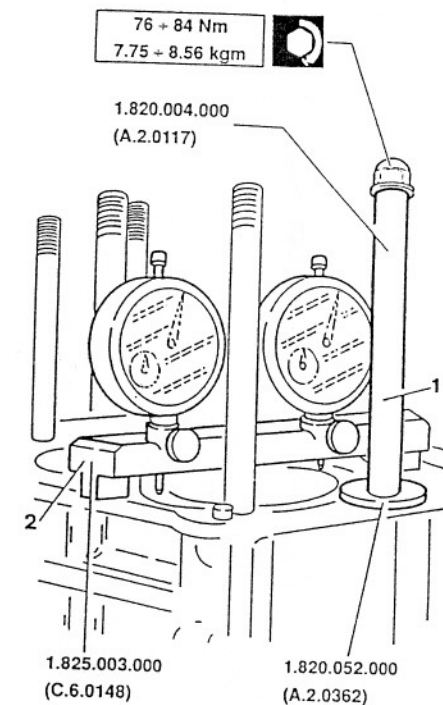
1. Insert the seal rings in the cylinder liners.



– Insert the cylinder liners into the engine block.

1. Lock the cylinder liners using cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) and washers N° 1.820.052.000 (A.2.0362) and tightening the relative nuts to the prescribed torque.
2. Place tool N° 1.825.003.000 (C.6.0148) on the engine block so that the probes rest on the edge of the cylinder liners and check that the protrusion is within the prescribed tolerances.

	Cylinder liner protrusion from engine block
	0.01 to 0.06 mm

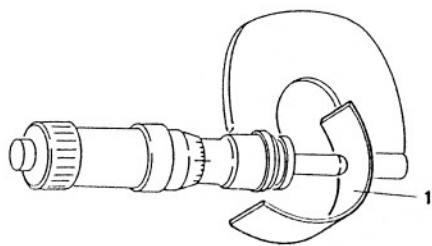


MAIN AND ROD BEARING HALVES AND THRUST HALF-RINGS

- The main and rod bearing halves and the crankshaft must be coupled by matching the parts of the same dimensional class, identified by dots of the same colour on the side of the bearing half and on the relevant crankshaft journal.
- 1. Check that the thickness of the bearing halves is within the prescribed limits.



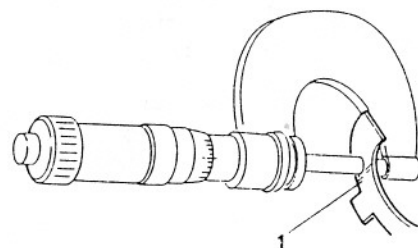
Class		Thickness of bearing halves	
A	RED	Main	1.830 to 1.835 mm
B	BLUE		1.835 to 1.839 mm
C	YELLOW		1.839 to 1.844 mm
A	RED	Rod	1.832 to 1.836 mm
B	BLUE		1.836 to 1.841 mm
C	YELLOW		1.841 to 1.845 mm



1. Check that the thickness of the thrust ring halves is within the prescribed limits.



Thickness of thrust half-rings	
2.311 to 2.362 mm	


CRANKSHAFT
Main and rod journals

- The crankshaft journals are divided in to two classes and marked with a blob of paint; RED, BLUE or YELLOW depending on the manufacturing tolerances.

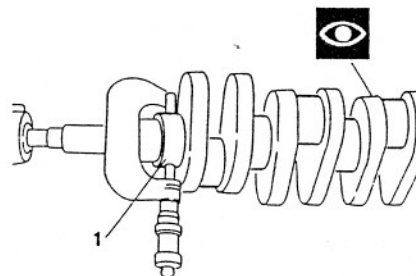
1. Check that the diameter of the main and rod journals is within the prescribed limits.



Diameter of main journals	
RED	59.970 to 59.976 mm
BLUE	59.963 to 59.970 mm
YELLOW	59.956 to 59.963 mm



Diameter of rod journals	
RED	49.992 to 49.998 mm
BLUE	49.985 to 49.992 mm
YELLOW	49.978 to 49.985 mm



1. Check that the ovalization of the main and rod journals is within the prescribed limits.
2. Check that the taper of the rod and main journals is within the prescribed limits.
3. Check that the length of the central main journal is within the prescribed limits.



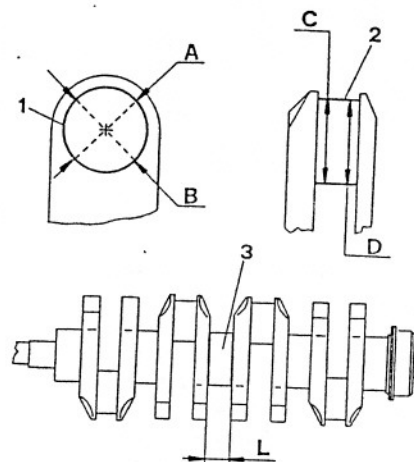
Main and rod journals maximum ovalization error	
0.007 mm	



Main and rod journals maximum taper error	
0.010 mm	



Length of central main journal	
30.000 to 30.035 mm	



- Check eccentricity between main journals.



Main journals maximum eccentricity	
0.040 mm	

- Check parallelism between main and rod journals

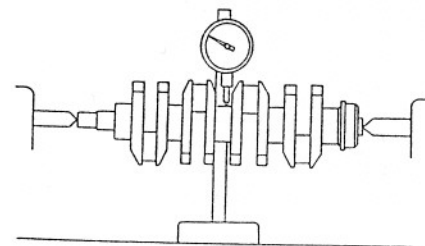


Maximum parallelism error between main and rod journals	
0.015 mm	

- Check the deviation between the axes of the two pairs of rod journals and the axes of the main journals.

Maximum derivation between the shaft of the two pairs of rod journals and the shaft of the main journals

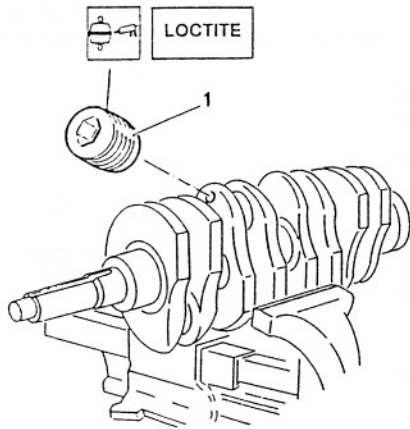
0.300 mm





Cleaning lubrication channels

1. Unscrew the cylindrical caps closing the ends of the lubrication channels.



- Thoroughly clean the lubrication channels using warm diesel oil and blow-off.
- Close the holes of the lubrication channels with new caps.

CYLINDER LINERS

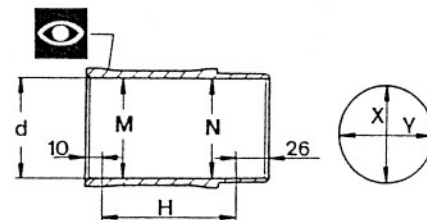
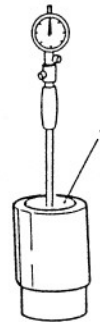
- The cylinder liners are selected according to their inner diameter and are divided into three categories - A, B and C. These categories are identified by BLUE, PINK and GREEN dots, located on the outer surface.
1. Check that the inner diameter, taper and ovalization of the cylinder liners are within the prescribed limits.

Diameter of cylinder liners (d)	
Class A (Blue)	83.985 to 83.994 mm (1)
	83.385 to 83.394 mm (2)
Class B (Pink)	83.995 to 84.004 mm (1)
	83.395 to 83.404 mm (2)
Class C (Green)	84.005 to 84.014 mm (1)
	83.405 to 83.414 mm (2)

- (1) For AR67102 and AR67202 engines
- (2) For engine AR67103

Maximum taper (M - N)	
0.01 mm	

Maximum ovalization (X - Y)	
0.01 mm	

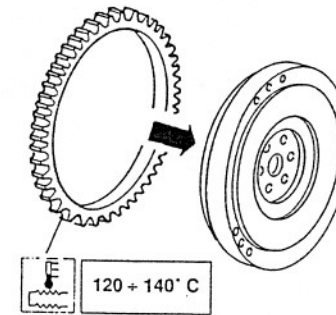


H = area for dimensional control



REPLACING THE ENGINE FLYWHEEL RING GEAR

- When replacing the ring gear of the engine flywheel, proceed as follows:
 - remove the old ring gear.
 - thoroughly clean the mating surfaces of the new ring gear and the flywheel.
 - Uniformly heat the new ring gear to 120 - 140° C and fit it to the engine flywheel.
 - leave the parts to cool naturally to ambient temperature: do not force the cooling of the parts.



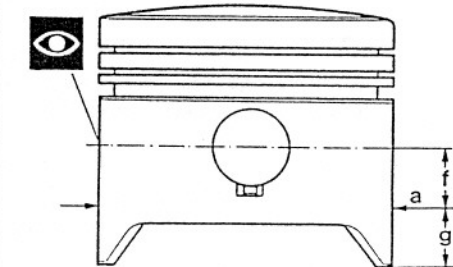
Outer diameter «a» (3)	
Class A (Blue)	83.935 to 83.945 mm (1)
	83.345 to 83.355 mm (2)
Class B (Pink)	83.945 to 83.955 mm (1)
	83.355 to 83.365 mm (2)
Class C (Green)	83.955 to 83.965 mm (1)
	83.365 to 83.375 mm (2)

- (1) For AR67102 and AR67202 engines
- (2) For engine AR67103

(3) to be measured perpendicularly to the gudgeon pin hole at a distance of:

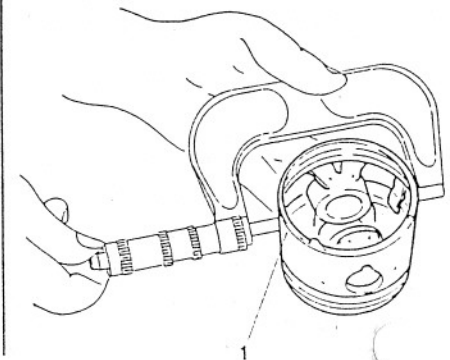
AR67202	MONDIAL	g = 10.3 mm (4)
AR67102	MONDIAL	f = 16.5 mm (5)
	BORGIO	g = 17 mm (4)
AR67103	BORGIO	g = 15 mm (4)

- (4) = from the lower edge of the skirt
- (5) = from the gudgeon pin shaft



PISTONS AND GUDGEON PINS

- Like the cylinder liners, the pistons are divided into three classes according to their manufacturing tolerances: These classes are identified by the letters A, B and C and are differentiated by dots located on the piston ceiling.
1. Check that the outer diameter of the piston is within the prescribed limits.

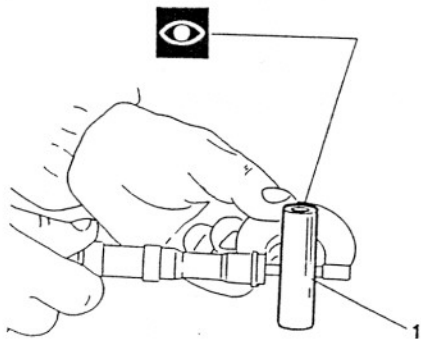




- Both the gudgeon pins and relative mating holes on the piston are divided into two classes according to the manufacturing tolerances. These classes are identified by BLACK or WHITE dots on the inner surface of the pins and on the outer surface of the piston hub.

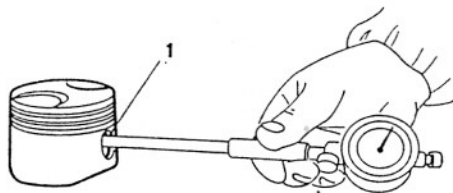
- Check that the outer diameter of the gudgeon pin is within the prescribed limits.

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



- Check that the diameter of the mating hole on the piston is within the prescribed limits.

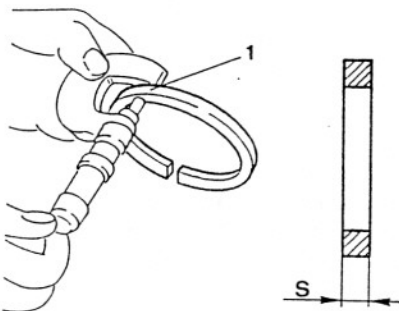
Diameter of the gudgeon pin mating hole on the piston	
Black	22.000 to 22.002 mm
White	22.002 to 22.005 mm



PISTON RINGS AND OIL SCRAPER RING

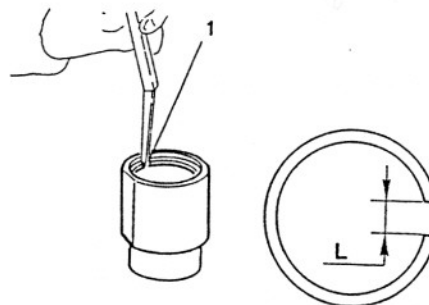
- Check that the thickness "S" of the piston rings and the oil scraper ring is within the prescribed limits.

Thickness rings «S»		
First ring		1.478 to 1.490 mm
Second ring	Goetze	1.475 to 1.490 mm
	Borgo	1.478 to 1.490 mm
Oil scraper ring	Goetze	3.475 to 3.490 mm
	Borgo	3.478 to 3.490 mm



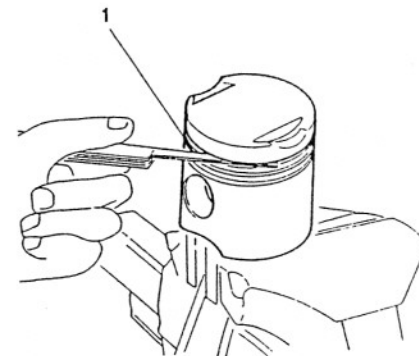
- Insert the rings in the control ring or in the cylinder liner and check that gap "L" is within the prescribed limits.

Gap «L»		
First ring		0.30 to 0.50 mm
Second ring		0.30 to 0.50 mm
Oil scraper ring	Borgo	0.25 to 0.40 mm
	Goetze	0.25 to 0.50 mm



- Check that the axial play between the piston rings and oil scraper ring with their relative seatings on the piston is within the prescribed limits.

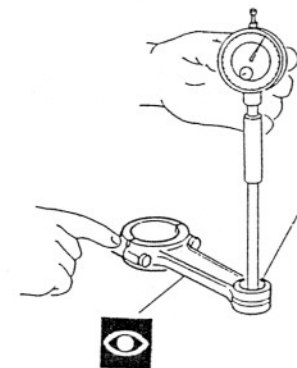
Axial play between oil rings and seating		
First ring		0.035 to 0.067 mm
Second ring	Borgo	0.035 to 0.067 mm
	Goetze	0.035 to 0.070 mm
Oil scraper ring	Borgo	0.025 to 0.057 mm
	Goetze	0.025 to 0.060 mm



RODS

- Check that the diameter of the bushing of the rod small end is within the prescribed limits.

Diameter of the rod small end bushing hole	
	22.005 to 22.015 mm

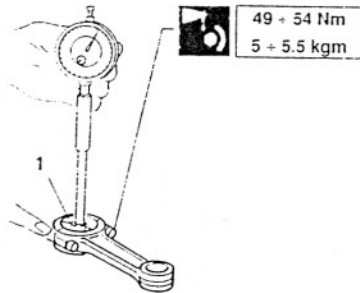




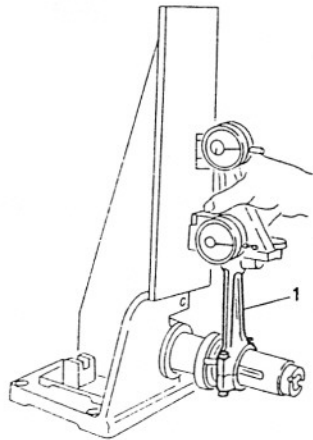
1. Install the rod caps and tighten the lubricated nuts to the prescribed torque. Check that the diameter of the rod big end is within the prescribed limits.

Inner diameter of rod big end	
53.695 to 53.708 mm	
53.695 to 53.705 mm (*)	

(*) For engine AR67202



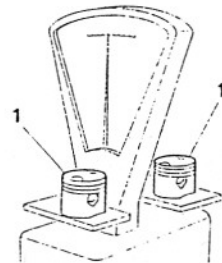
1. Check that the rods are perpendicular.



CHECKING WEIGHT DIFFERENCE BETWEEN THE SINGLE PISTONS AND THE SINGLE RODS

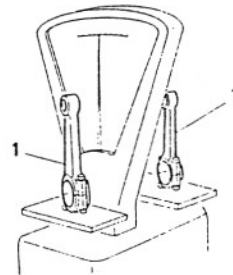
1. Group the gudgeon pins and pistons according to the dimensional class (BLACK or WHITE). Insert the gudgeon pins in the pistons and lock them with the flexible rings. Install the piston rings and the oil scraper ring. Check that the difference in weight between the pistons is within the prescribed limits.

Weight difference between pistons	
± 2 g	



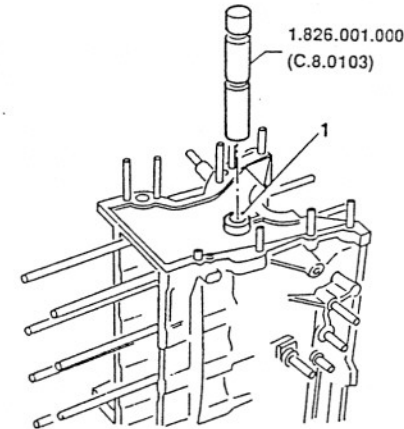
1. Similarly check that the difference in weight between the rods, together with the bearing halves, caps and bolts is within the prescribed limits.

Weight difference between rods	
≤ 2 g	

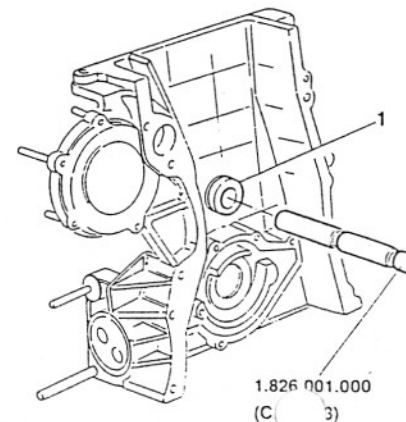


TIMING SYSTEM IDLE GEAR BUSHING

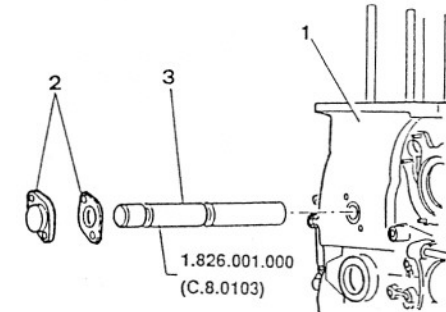
1. Using a plug gauge (passes-doesn't pass) N° 1.826.001.000 (C.8.0103), check the inner wear of the timing control idle shaft housing bush.



1. Also check the corresponding bushing on the front cover.

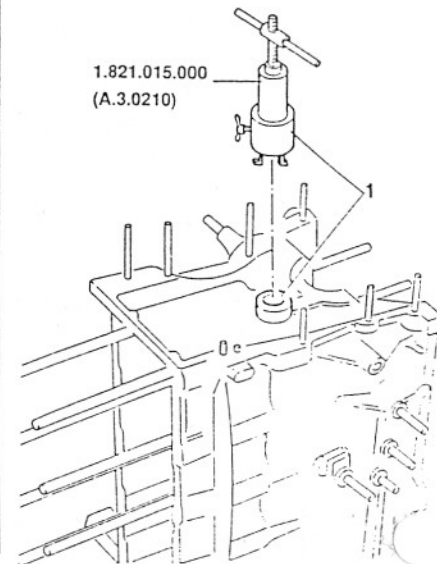


1. Temporarily install the front cover.
2. Remove the cover and relative gasket.
3. Using tool N° 1.826.001.000 (C.8.0103), check the alignment of the two bushings.



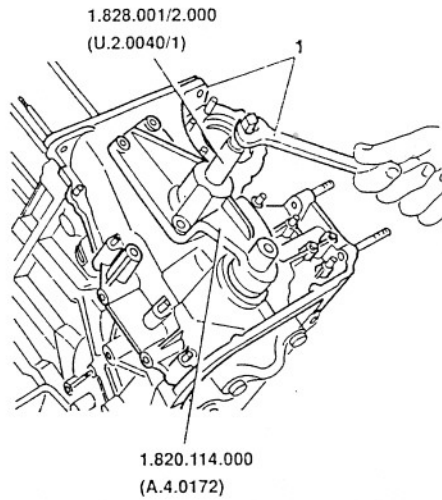
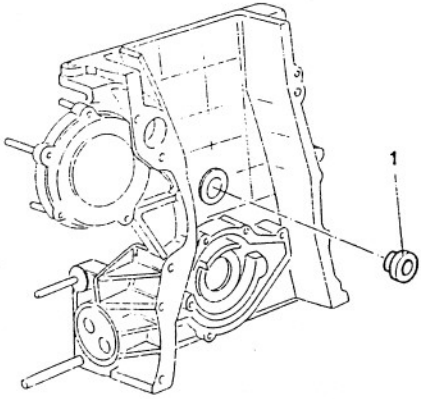
- If the two bushings are excessively worn, replace them proceeding as follows:

1. Remove the engine block bushing using tool N° 1.821.015.000 (A.3.0210).





- Install a new bushing using a suitable inserting tool.
1. Remove the bushing on the front cover and install a new one using suitable tools



- Remove the tools and using plug gauge N° 1.826.001.000 (C.8.0103) check that the inner diameter of the two bushings is correct.



When replacing one bushing, the other must also be replaced.

1. Temporarily install the front cover onto the engine block and ream the two bushings at the same time, using guide tool N° 1.820.114.000 (A.4.0172) and reaming tool N° 1.828.001/2.000 (U.2.0040/1).



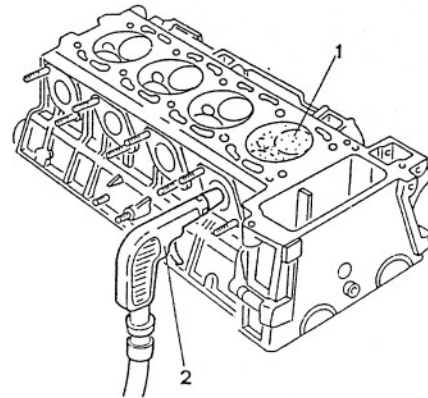
INDICATIONS FOR REASSEMBLY



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

CHECKING VALVE LEAKAGE

- Insert the spark plugs in their seatings.
1. Pour a small quantity of fuel in one of the combustion chambers so that it just covers the valve heads.
 2. Blow low pressure air into the intake and exhaust ports and check that no bubbles form. If there are bubbles check for correct assembly and grind the valve seats again if necessary (see specific procedure).

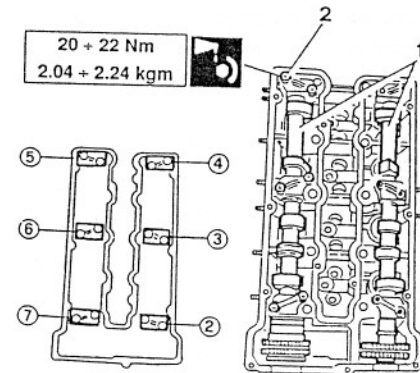


REASSEMBLING CAMSHAFTS, ADJUSTING VALVE CLEARANCE



Locking the nuts of the camshaft caps when the timing marks do not correspond means that the valves overlap and strike each other leading to irreparable damaged. It is therefore necessary to scrupulously follow the refitting procedure given below.

1. Position the camshafts.
- Position the caps and turn them in accordance with the numbering marked on them.
2. Tighten the lubricated camshaft cap nuts on the intake side to the prescribed torque.



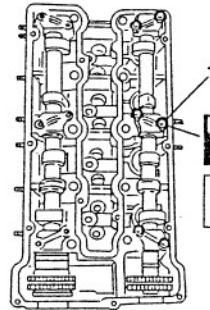
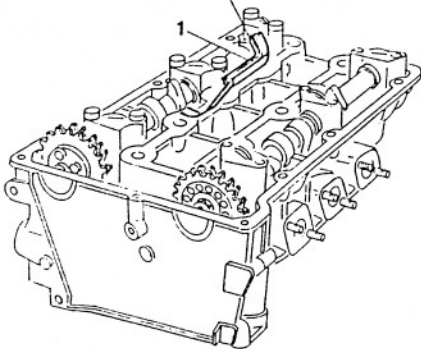


1. Check that the clearance between the cam heel radius and corresponding valve cup is within the prescribed limits, otherwise replace the intake valve caps with others of a suitable thickness.



Intake side valve clearance

0.380 to 0.450 mm

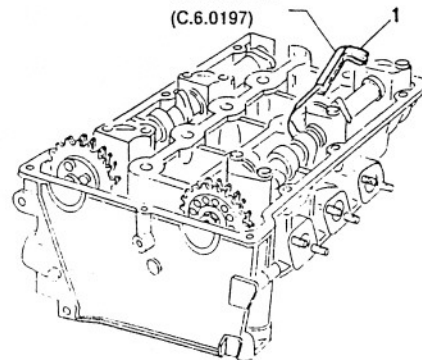
1.825.018.000
(C.6.0197)20 ± 22 Nm
2.04 ± 2.24 kgm

1. Check that the clearance between the cam heel radius and corresponding cup is within the prescribed limits, otherwise replace the exhaust valve caps with others of a suitable thickness.



Exhaust side valve clearance

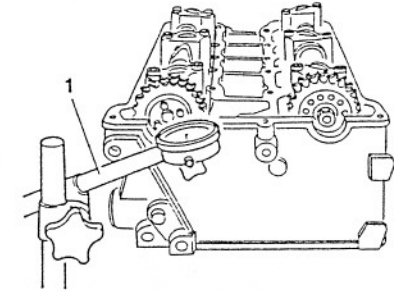
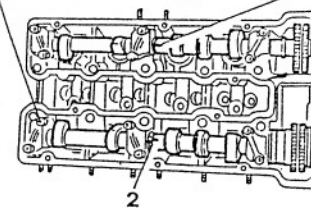
0.430 to 0.500 mm

1.825.018.000
(C.6.0197)

- Unlock and remove the intake side camshaft cap nuts
- 1 Tighten the lubricated exhaust side cap nuts to the correct torque.



1. Rotate the exhaust side camshaft until the cam of the first cylinder faces outwards and the timing mark corresponds with that on the central cap (first cylinder in firing phase).
2. Rotate the intake side camshaft until the cam of the first cylinder faces outwards and the reference notches are staggered by 3 to 4 mm in advance so that the marks will be perfectly aligned after the timing chain has been tensioned.

20 ± 22 Nm
2.04 ± 2.24 kgm

REFITTING CRANKSHAFT

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

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

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

CHECKING AXIAL PLAY OF THE CAMSHAFTS

1. Apply a centesimal dial gauge and measure the axial play of the camshafts. Check that the value is within the prescribed tolerances.



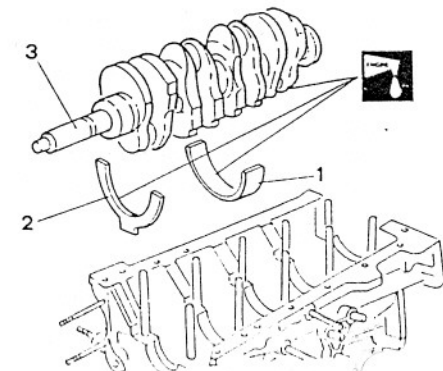
CAUTION

Do not rotate the camshafts: the valves which are overlapping may strike each other and cause irreparable damage.

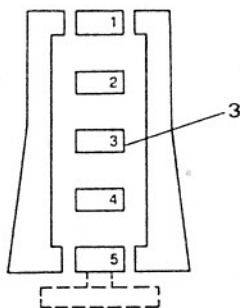


Camshaft axial play

0.080 to 0.124 mm

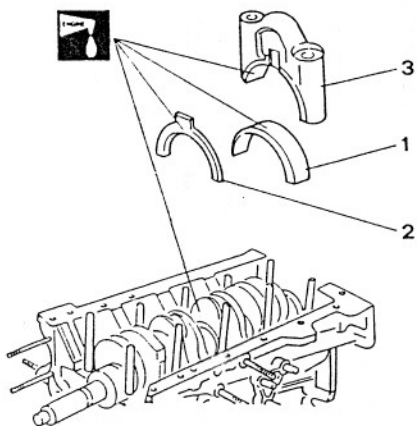
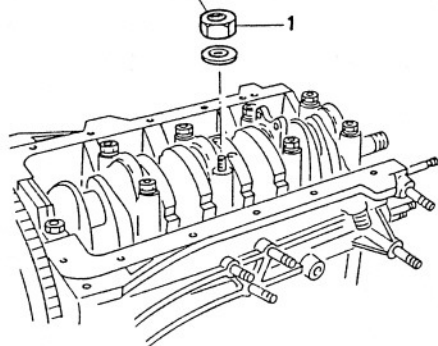


1. Set the main bearing halves into the main bearing caps.
 2. Set the thrust ring halves onto the central main cap.
 3. Install the central main caps setting them in accordance with the numbering marked on them (the safety mark must be on the same side as the corresponding mark on the engine block); tighten but do not lock the retaining nuts.
- In the same way install the remaining main caps without locking the nuts.



1. In two or three operations starting from the central main cap, tighten the lubricated nuts securing the main caps.

20 Nm + 115°
 2.04 kgm + 115°



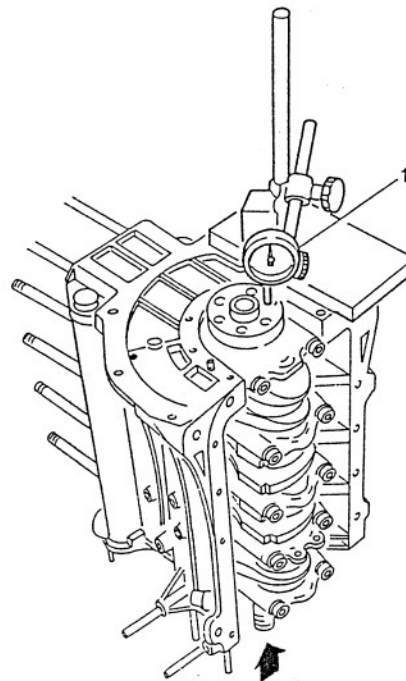
CHECKING CRANKSHAFT AXIAL PLAY

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



Crankshaft axial play

0.076 to 0.263 mm



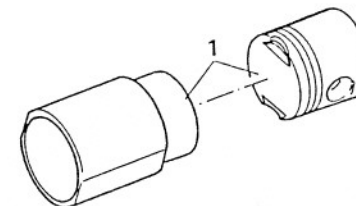
REFITTING CYLINDER LINERS, PISTONS, RODS, COUPLING OF RODS AND PISTONS

1. Coupling must be carried out by matching the parts of the same dimensional class marked with paint of the same colour, A (Blue), B (Pink) or C (Green), onto the piston ceiling and on the outside of the cylinder liner.



Clearance between cylinder liner and piston

0.040 to 0.059 mm



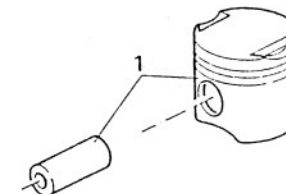
MATCHING OF PISTONS AND GUDGEON PINS

1. Match parts of the same dimensional class, identified by dots of the same colour: BLACK or WHITE on the inside of the gudgeon pins and on the outside of the relative piston hub.



Clearance between piston hole and gudgeon pin

Black	0.003 to 0.008 mm
White	0.002 to 0.008 mm





MATCHING OF PISTONS, RODS AND CRANKSHAFT

1. The rods must be set with the offset turned towards the crankshaft intermediate supports.
2. The pistons must be positioned so that the arrow stamped onto the ceiling points in the direction of engine rotation.

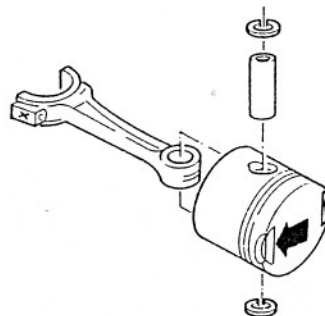
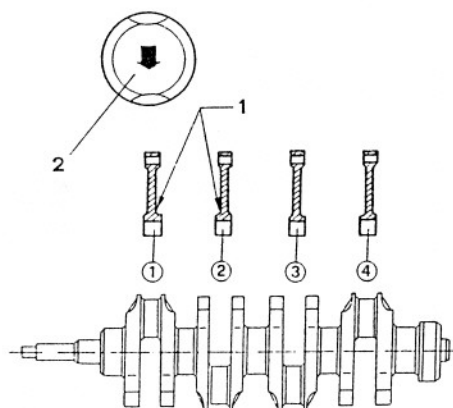


Each rod has the cylinder number to which it refers stamped onto the big end.

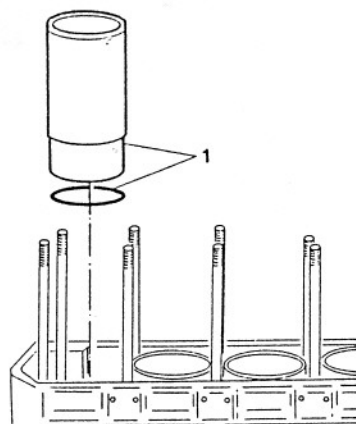


Clearance between rod small end bushing and gudgeon pin

Black	0.008 to 0.021 mm
White	0.005 to 0.018 mm



1. Install the cylinder liners and seal rings onto the engine block.
- Check the cylinder liner protrusion as described in the relative paragraph.



- Rotate the crankshaft until the position corresponding to the B.D.C. of the first and fourth cylinders is reached.

1. Set the bearing halves onto the rod big ends.

NOTE: The assembly onto the crankshaft must be carried out by matching the parts of the same dimensional class indicated by blobs of colour, RED or BLUE on the side of the bearing half and RED and LIGHT BLUE on the relative crankshaft journal.

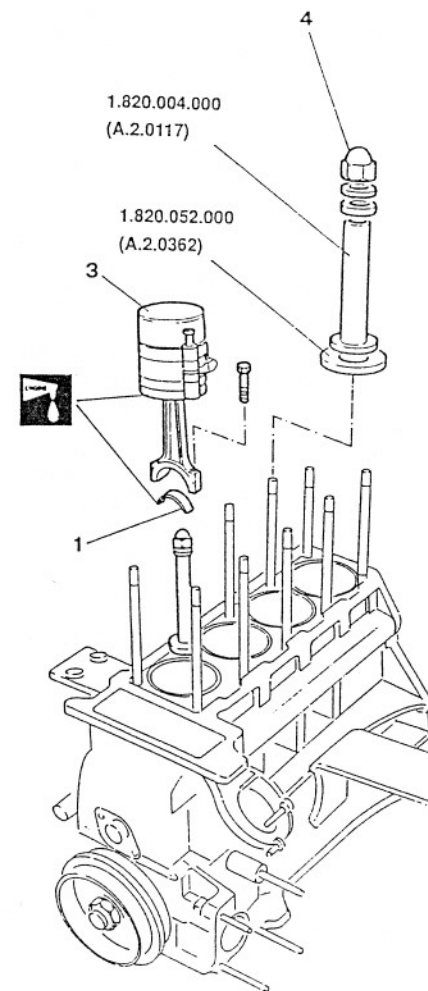
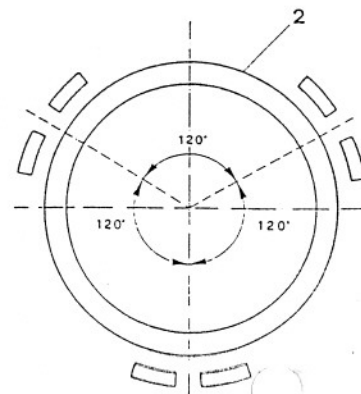
2. Place the piston rings on the pistons with the gaps staggered by 120°
3. Using a suitable tool, install the pistons and rods into the first and fourth cylinders.

**CAUTION**

The arrows stamped onto the piston ceiling should indicate the direction of rotation.

Position the rods with the offset facing the crankshaft intermediate supports.

4. Install the cylinder liner fixing tools N° 1.820.004.000 (A.2.0117) and supplementary washers N° 1.820.052.000 (A.2.0362).





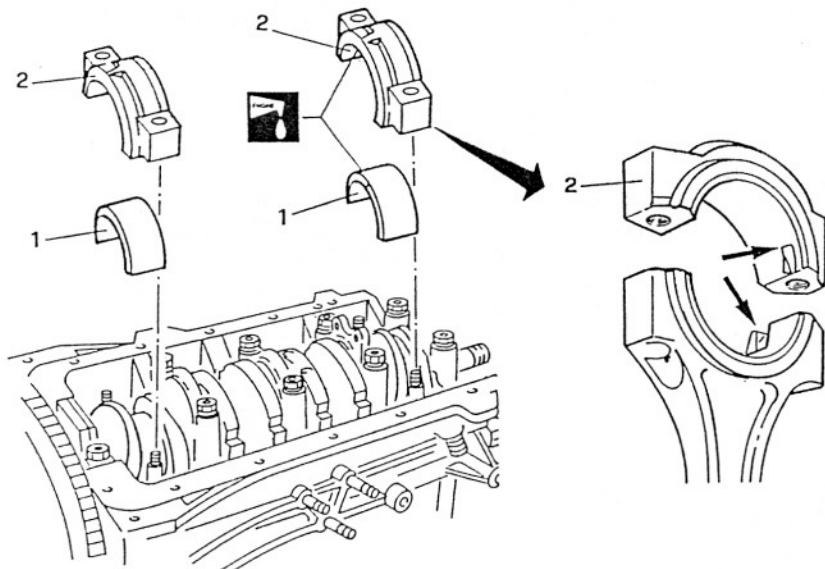
- Rotate the engine block 180°.
1. Set the rod bearing halves onto the rod caps.

NOTE: The assembly onto the crankshaft must be carried out by matching the parts of the same dimensional class indicated by blobs of colour, RED or BLUE on the side of the bearing halves and RED or LIGHT BLUE on the relative crankshaft journal.

2. Install the rod caps of the first and fourth cylinders and set the safety notches so that they are facing the corresponding notches on the rod big end. Lubricate but do not tighten the retaining bolts.

**CAUTION**

The number of the cylinder to which the rod caps refer is stamped onto the side of the caps.



- In the same way, refit the pistons and rods of the second and third cylinder.

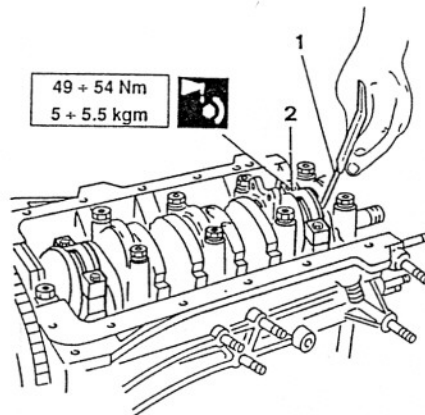
1. Before locking the bolts of the rod caps, use a thickness gauge to check that the axial play between crankshaft shoulder and rod-cap profile is within the prescribed limits.



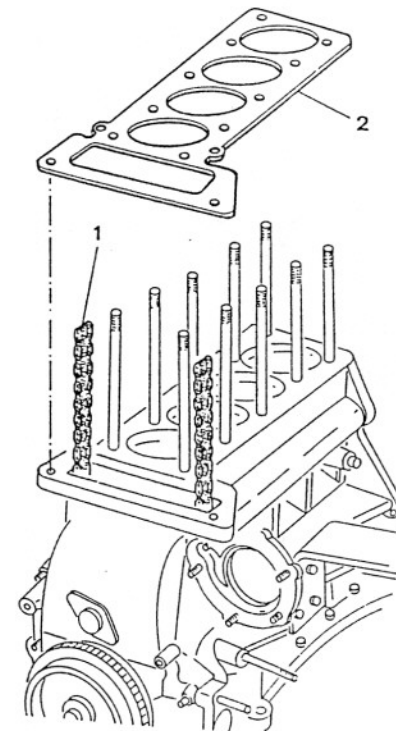
Axial play between crankshaft shoulder and rod-cap profile

0.2 to 0.3 mm

2. Tighten the lubricated rod cap bolts to the correct torque.

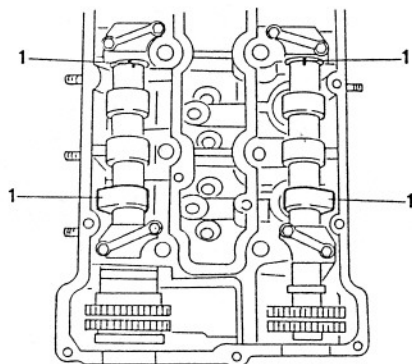
**REFITTING THE CYLINDER HEAD**

1. Position the timing chain.
- Rotate the crankshaft until the piston of the first and fourth cylinders is at T.D.C.
2. Position the cylinder head gasket.

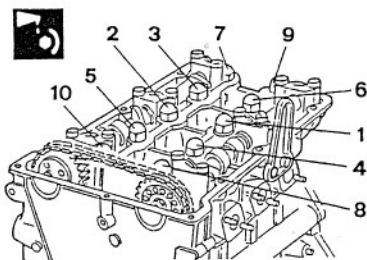
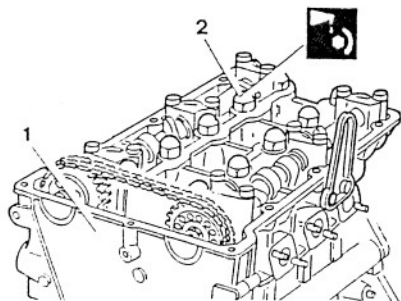




1. Ensure that the cams of the first cylinder face the outside and that the timing marks on the camshaft (exhaust side) are aligned and on the intake side, staggered by 3 to 4 mm in advance.



1. Install the cylinder head on the engine block.
2. Lubricate the threads, nuts and washers with engine oil and tighten, in two or three operations, the ten nuts securing the cylinder head. Follow the order shown in the table.



When refitting
torque gradually following
the sequence indicated:

76 to 84 Nm
7.75 to 8.56 kgm

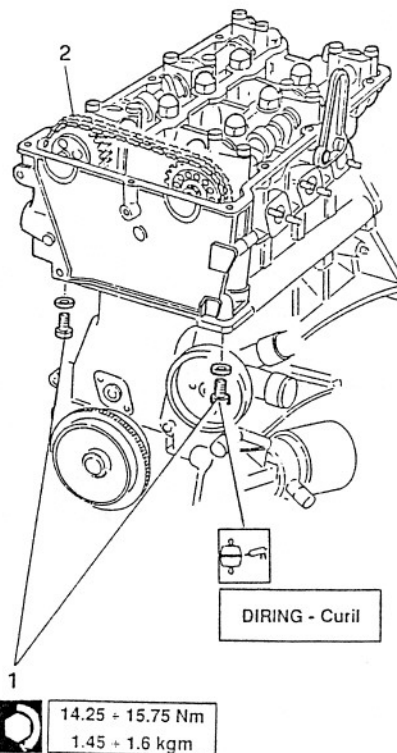
After bench testing and trials

when the engine is cool
loosen the nuts by one turn
following the sequence indicated;
lubricate with engine oil
and tighten to the correct:

82.65 to 91.35 Nm
8.43 to 9.3 kgm

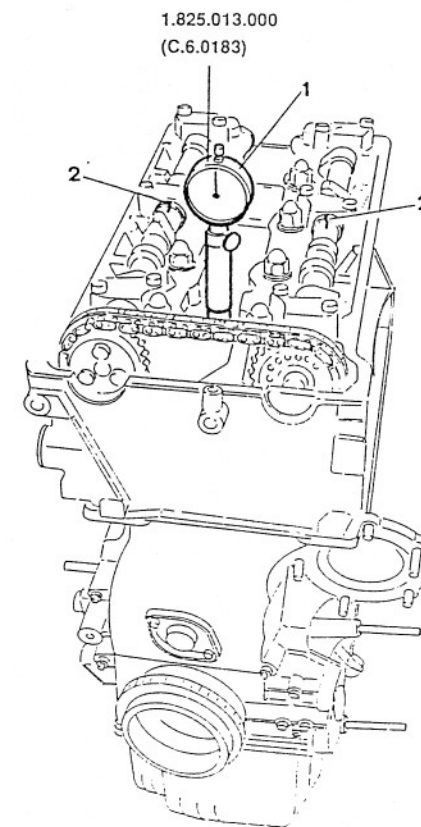


1. Tighten and lock the two screws securing the lower side of the cylinder head.
2. Install the timing chain and tension it.



CHECKING ENGINE TIMING

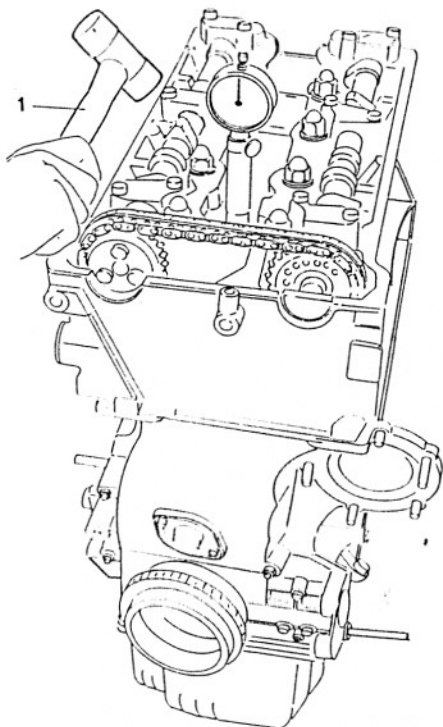
1. Install probe N° 1.825.013.000 (C.6.0183) with dial gauge into the spark plug seat of the first cylinder.
 - Rotate the crankshaft until the piston of the first cylinder is at T.D.C. in the firing phase.
2. Check that the marks engraved on the camshafts are aligned to those of the relative central caps.
 - If the marks on the camshafts are not aligned with the relative caps, operate as described below.



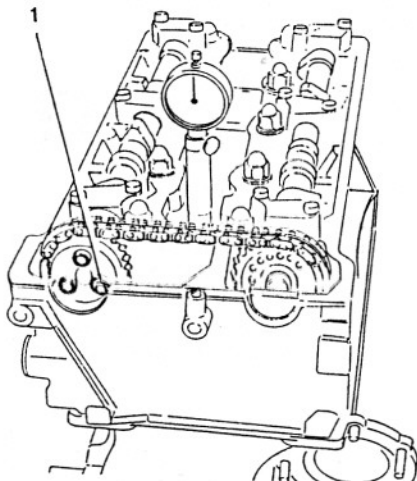
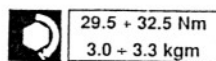
**Intake side camshaft**

1. Using a plastic mallet, rotate the camshaft until the reference notches are aligned.

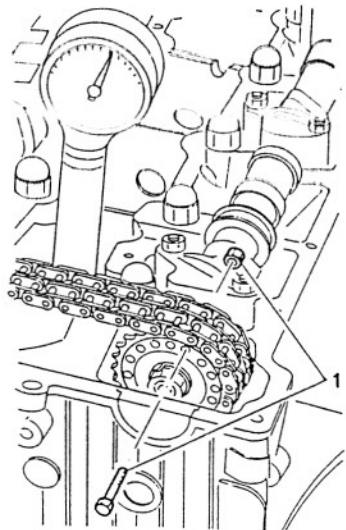
NOTE: The rotation of the camshaft is permitted by the slotted holes present on the toothed wheel and by having left the three retaining screws untightened when refitting.



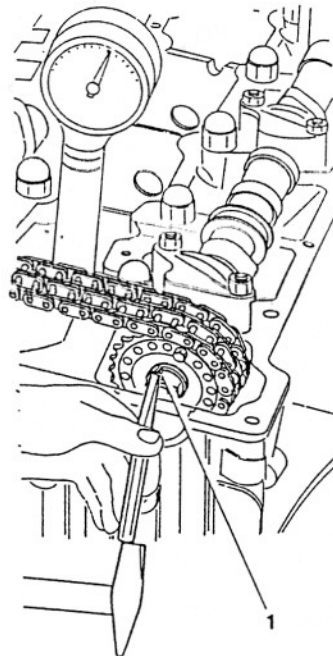
1. Tighten the three screws of the timing variator.

**Exhaust side camshaft**

1. Remove the bolt securing the toothed wheel to the flange.

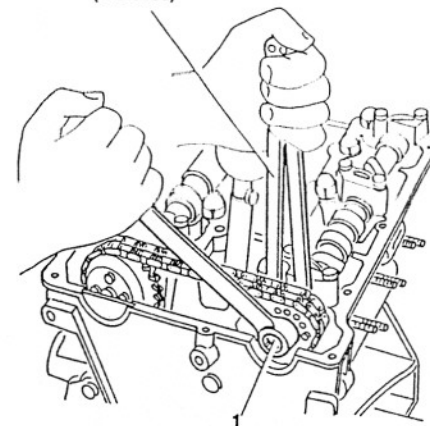


1. Raise the edge of the nut retainer.



1. Using tool N° 1.822.001.000 (A.5.0103) as a counter-torque, loosen the nut securing the toothed wheel to the camshaft.

1.822.001.000
(A.5.0103)

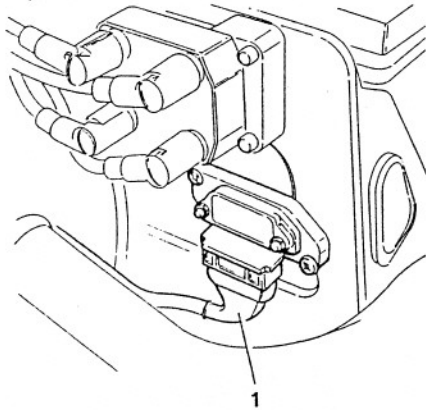


- Using tool N° 1.822.001.000 (A.5.0103), rotate the shaft without moving the chain, until the timing marks are aligned.
- Refit the bolt securing the toothed wheel to the flange and ensuring that the hole in the toothed wheel coincides with the hole in the flange.
- Using tool N° 1.822.001.000 (A.5.0103), lock the nut securing the toothed wheel and bend the edge of the safety retainer back down.

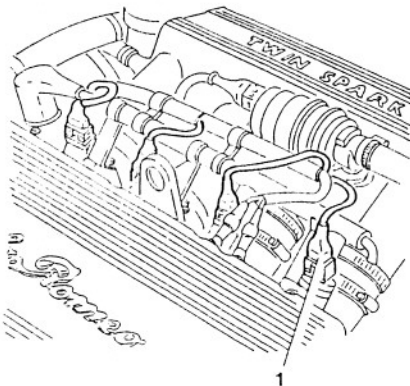


CYLINDER COMPRESSION TEST

- Start the engine and let it run until it reaches normal operating temperature.
 - Remove the spark plug cover.
 - Disconnect the high voltage cables from one spark plug per cylinder and remove the disconnected spark plug.
1. Disconnect the electrical connections from the power modules.



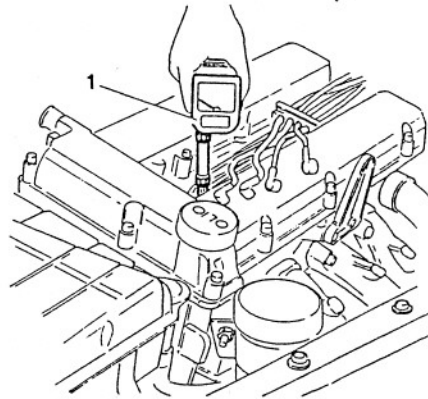
1. Disconnect the electrical connections from the electroinjectors.



1. Insert the test instrument into the seat of a spark plug.
- Using the starter motor, turn the engine a few times keeping the accelerator pedal pressed to the stop limit.



CAUTION:
Ensure that the connection to the instrument is not leaking.



- Repeat the test on the other cylinders ensuring that the instrument is reset each time.

NOTE: If the pressure values measured in the cylinder differ greatly, the cause should be looked for by checking for leaks in the valve, flexible rings and pistons.



AFTER INSTALLATION OF THE ENGINE a CYLINDER COMPRESSION TEST should be carried out in addition to the normal maintenance checks and inspections (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 (located in the engine compartment)

- Engine oil pressure meter.
 - Engine oil temperature sensor.
 - Minimum engine oil pressure warning light
 - Minimum engine oil level warning light sensor.
- For the other sensors and electrical components located in the engine compartment refer to the specific groups where they are dealt with in detail.

ENGINE OIL TEMPERATURE SENSOR

1. Check the setting of the engine oil temperature sensor. If the values are incorrect, replace the meter.



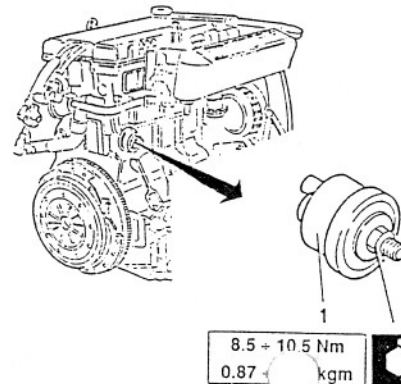
Temperature	Resistance
°C	Ω
60 ± 0.5	525 to 605
90 ± 0.5	195 to 215
120 ± 0.5	82 to 94
140 ± 0.5	49 to 55

ENGINE OIL PRESSURE METER

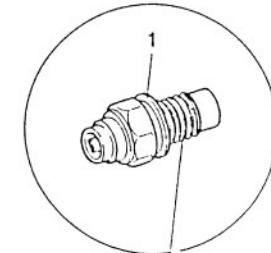
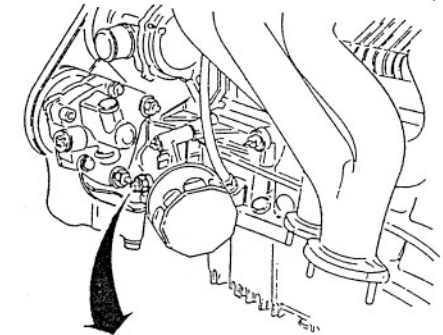
1. Check the setting of the engine oil pressure meter. If the values are incorrect, replace the meter.

Pressure	Resistance
bar (kg/cm ²)	Ω
0	290 to 320
0.39 (0.4)	255 to 285 (1) 270 to 300 (2)
3.9 (4)	103 to 133
7.8 (8)	0 to 40 (1) 0 to 25 (2)

(1) Jeger (2) Sicea



8.5 - 10.5 Nm
0.87 kgm



21.3 - 26.3 Nm
2.2 - 2.7 kgm




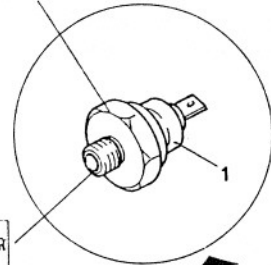
MINIMUM ENGINE OIL PRESSURE WARNING LIGHT SENSOR

1. Check the setting of the minimum engine oil pressure warning light sensor. If the values are incorrect, replace the sensor.

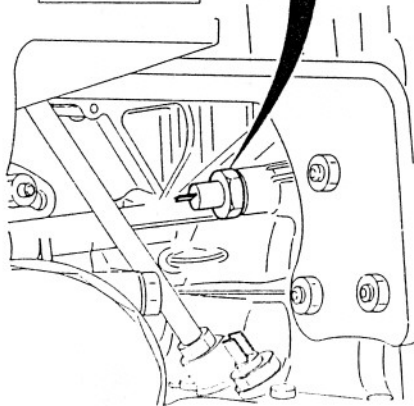


Pressure	bar (kg/cm ²)
Contact opening	0.147 to 0.44 (0.15 to 0.45)
admissible	5.88 (6)
admissible point with cold starting	9.8 (10)

 35.7 + 44.1 Nm
3.64 + 4.5 kgm



Mastic S - ME4




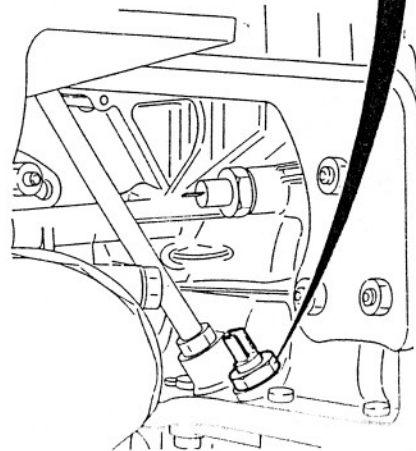
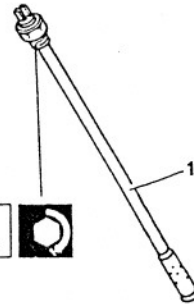
MINIMUM ENGINE OIL LEVEL WARNING LIGHT SENSOR

1. Check the setting of the minimum engine oil level warning light sensor. If the values are incorrect, replace the sensor.

Circuit resistance

12 Ω ± 5%

25 Nm
2.5 kgm 



"ON VEHICLE" OPERATIONS

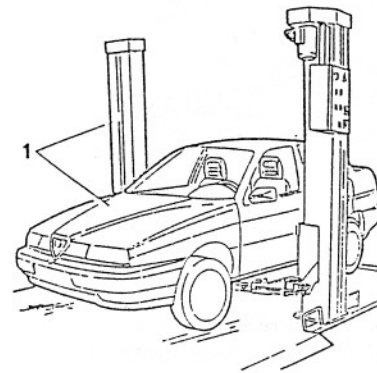
The preceding chapter described and illustrated the complete engine bench overhaul. Some of these operations can be carried out with the engine installed without necessitating its removal from the engine compartment.

Among the most frequent operations, it is possible to remove and refit the oil sump and engine pulley by following the indications given below.

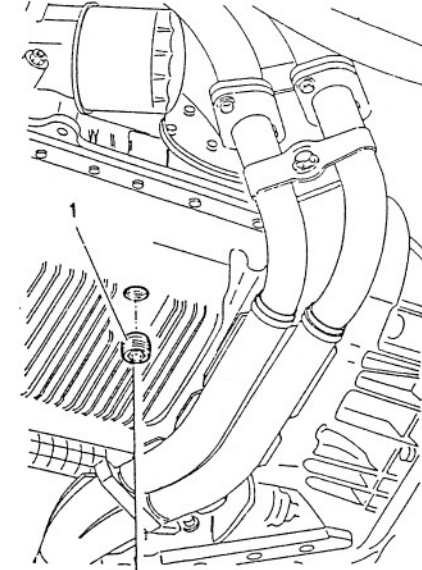
NOTE: Refer to GROUP 00 for the most frequent maintenance operations carried out with the engine installed on the vehicle.


REMOVAL/REFITTING OF OIL SUMP

1. Place the vehicle on a lift.

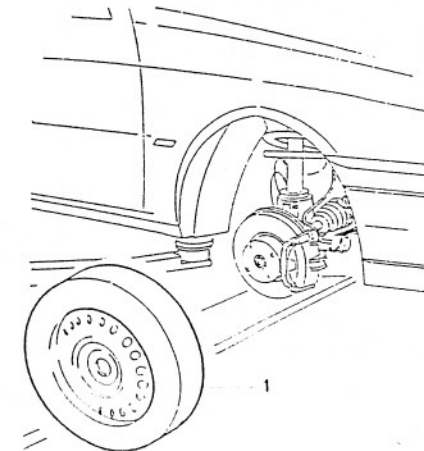


1. Drain off the engine oil by unscrewing the cap on the oil sump.



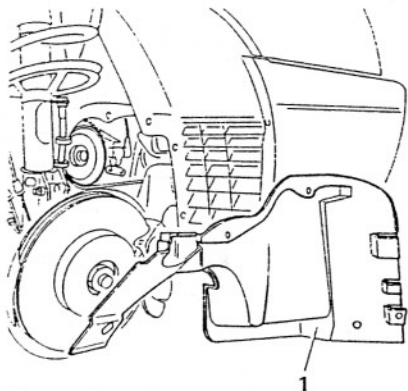
 64.5 + 80 Nm
6.6 + 8.2 kgm

1. Remove the front right-hand wheel.

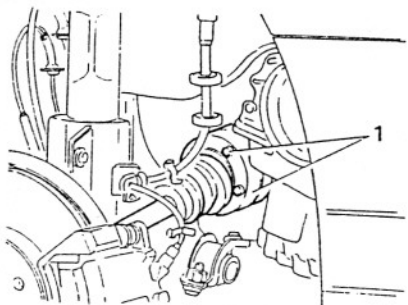




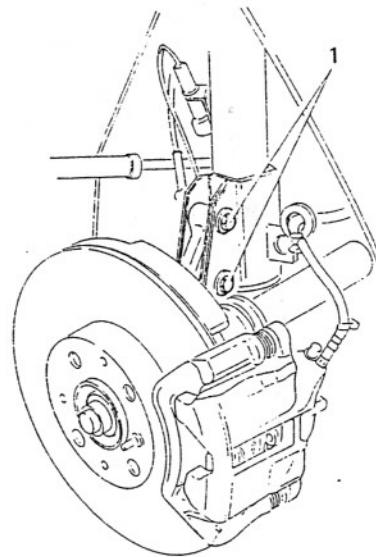
1. Remove the central engine protection cover from the right-hand wheel arch.



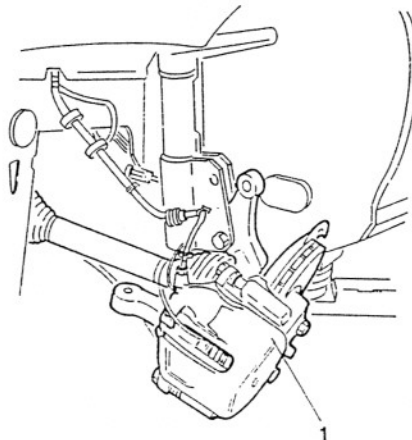
1. Disconnect the right-hand half-shaft from the intermediate transmission shaft by unscrewing the relative screws.



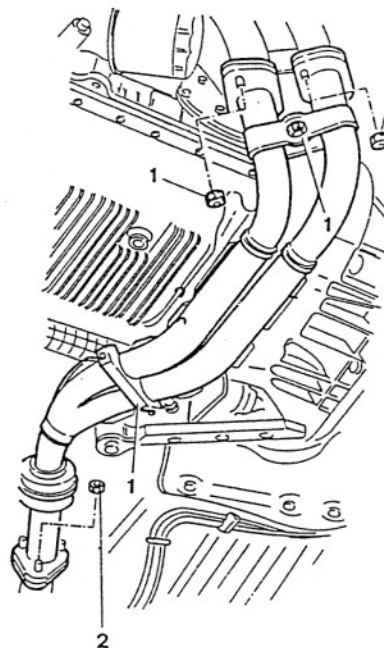
1. Loosen the two bolts securing the right-hand support to the shock absorber and remove only the upper bolt.



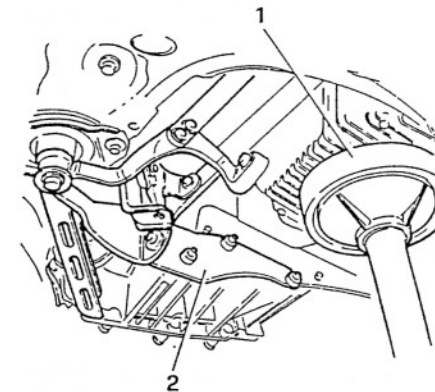
1. As far as possible, tip the wheel hub forwards to advance the half-shaft.



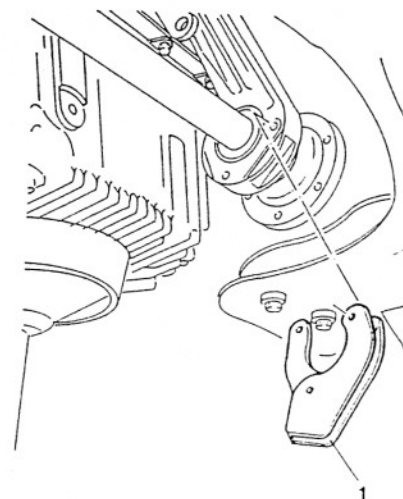
1. Disconnect the forward section of the exhaust pipe from the manifolds by unscrewing the relative nuts and intermediate supports.
2. Disconnect the flange securing the forward section of the catalytic converter and remove it.



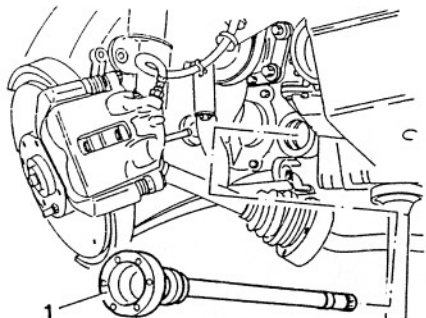
1. Place a suitable column lift under the oil sump.
2. Remove the engine support bracket.



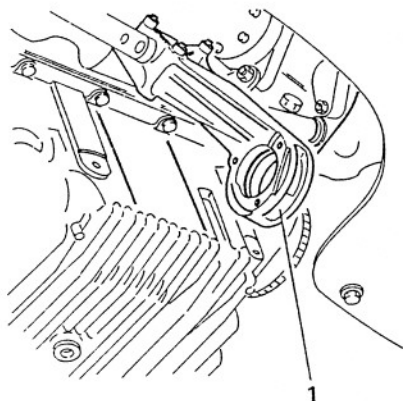
1. Remove bracket locking the intermediate shaft to the support.



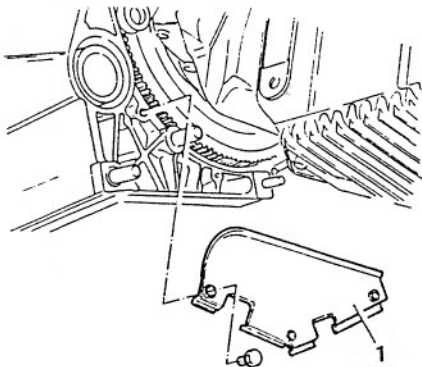
1. Withdraw the intermediate shaft and the dust ring.



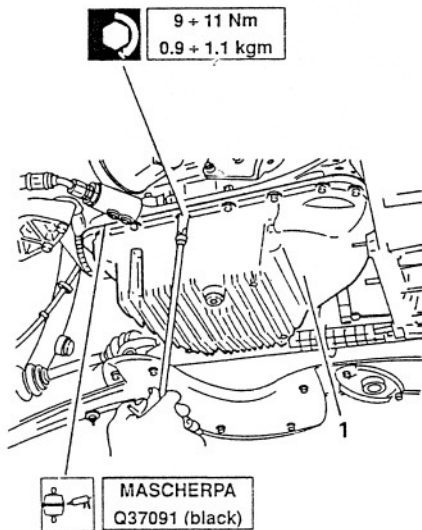
1. Remove the intermediate transmission shaft.



1. Remove the flywheel protection cover.

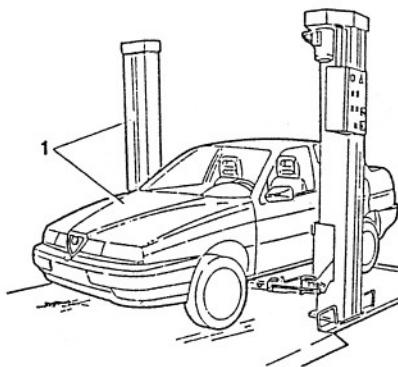


1. Unscrew the screws and bolts and remove the oil sump.

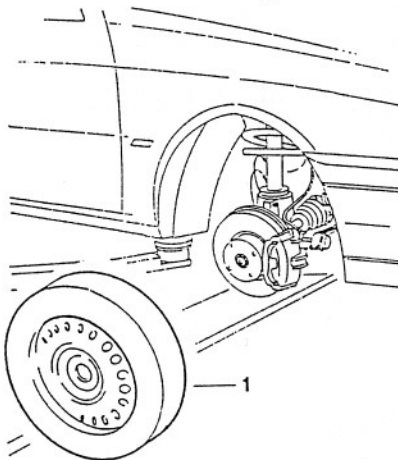


REMOVAL/REFITTING OF THE ENGINE PULLEY

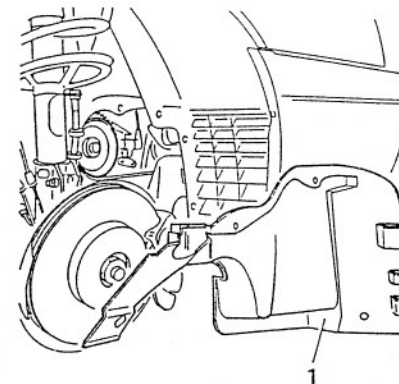
1. Place the vehicle on a lift.



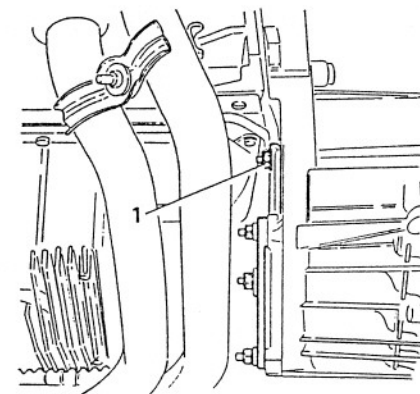
1. Remove the front right-hand wheel.



1. Remove the central engine protection cover from the right-hand wheel arch.

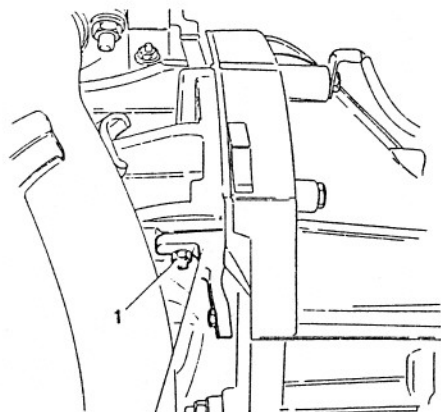


1. Remove the front screw securing the flywheel cover to the gearbox.



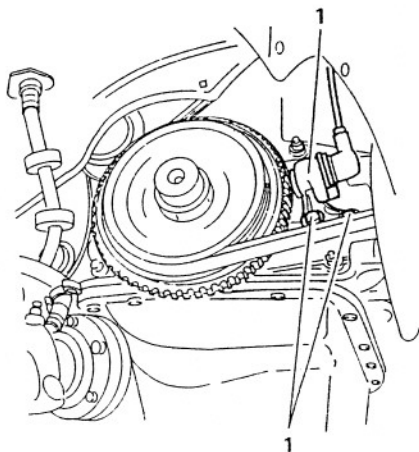


1. Install flywheel locking tool N° 1.820.240.000.

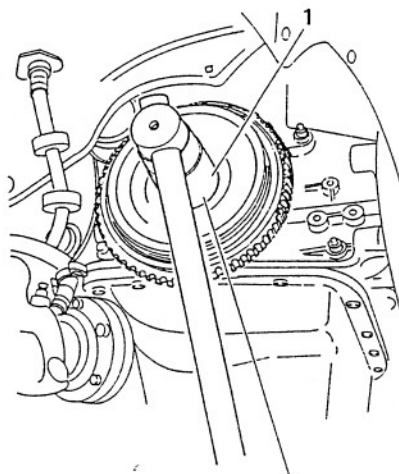


1.820.240.000

1. Unscrew the screws securing the r.p.m. and timing sensor and move it to one side without disconnecting the electrical connections.



- Remove the water pump, power steering pump and alternator drive belts (see GROUP 00)
1. Unscrew the nut and remove the crankshaft pulley.



209 + 231 Nm
21,3 + 23,55 kgm



TECHNICAL CHARACTERISTICS AND SPECIFICATIONS

All technical dimensional checks and inspections relative to the AR67102, AR67202 and AR67103 engines 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 overhauled engines.

TECHNICAL CHARACTERISTICS OF THE ENGINE

Engine	AR 67103	AR 67102	AR 67202
Cycle	eight cycles, four stroke		
Fuel supply	electronic injection		
Displacement	cm ³ 1749	1773	1995
Number of cylinders	4 in a line		
Bore	mm 83.4	84	84
Stroke	mm 80	80	90
Maximum Power	CV DIN (kW CEE) r.p.m. (*)	129 (93) 6000	143 (104) 6000
Maximum torque	kg DIN (Nm CEE) r.p.m. (*)	17 (165) 5000	19.3 (186.8) 5000
Compression ratio	(*)	10	10
Engine oil pressure	kPa (bars; kg/cm ²)		
- at idle speed	(*)	100 (1; 1.02)	147 (1.5; 1.53)
- at 4000 r.p.m.		500 (5; 5.1)	500 (5; 5.1)

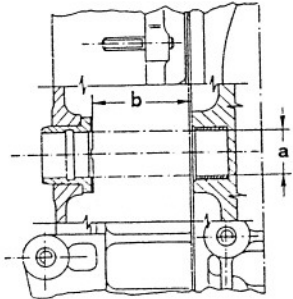
(*) Values not available at time of going to press.



COMPLETE ENGINE BLOCK

Engine block

Unit: mm

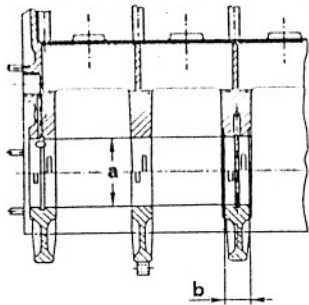


Internal diameter of timing belt idle shaft housing bushings (1)	(a)	20.667 + 20.698
Width of shoulder between the two timing belt idle shaft housing bushings (2)	(b)	44.320 + 44.420

- (1) During interventions both bushings must be replaced.
 (2) Measurement must be carried out with the cover locked and the relative gasket installed.

Main supports

Unit: mm

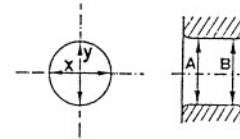
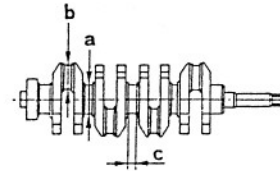


Diameter of main supports	(a)	63.652 + 63.664
Length of central main support shoulder	(b)	25.15 + 25.20



Crankshaft

Unit: mm

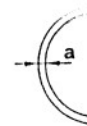


- (1) Ovalization X:Y
 (2) Taper A:B

Diameter of main supports (a)	A - Red	59.970 + 59.976
	B - Blue	59.963 + 59.970
	C - Yellow	59.956 + 59.963
Diameter of rod journal (b)	A - Red	49.992 + 49.998
	B - Blue	49.985 + 49.992
	C - Yellow	49.978 + 49.985
Length of central main journal (c)		30.000 + 30.035
Maximum ovalization of main and rod journal (1)		0.007
Maximum taper of main and rod journals (2)		0.010
Maximum error of parallelism between main and rod journals		0.015
Maximum eccentricity between main journals		0.040
Maximum deviation between centre lines of handle and main journals		0.300

Main half bearings

Unit: mm



Thickness of main half bearings (a)	A - Red	1.830 + 1.835
	B - Blue	1.835 + 1.839
	C - Yellow	1.839 + 1.844
Radial play between main pin and bearing	A - Red	0.006 + 0.034
	B - Blue	0.004 + 0.031
	C - Yellow	0.001 + 0.030

Thrust half rings

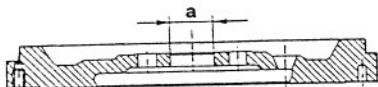
Unit: mm



Thickness of thrust half rings (a)	2.311 + 2.362
Crankshaft axial play	0.076 + 0.263



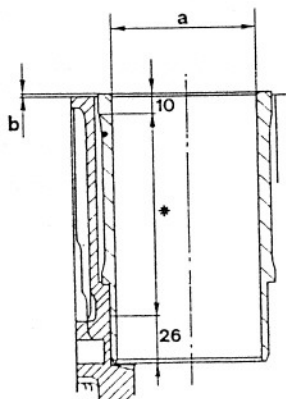
Flywheel



Internal diameter of central bushing (bore) (a)	32.000 + 32.025 mm
Heating temperature of ring gear for installation on engine flywheel	120 + 140° C

Unit: mm

Cylinder liner



		AR67103	AR67102 AR67202
Diameter of cylinder liner (a)	A - Blue	83.385 + 83.394	83.985 + 83.994
	B - Pink	83.395 + 83.404	83.995 + 84.004
	C - Green	83.405 + 83.414	84.005 + 84.014
Protuberance of cylinder liner from engine block (b)	0.01 + 0.06		
Limit of ovalization and cylinder liner taper	0.01		
Cylindrical and circular limit of cylinder liner	0.01		

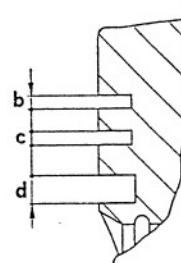
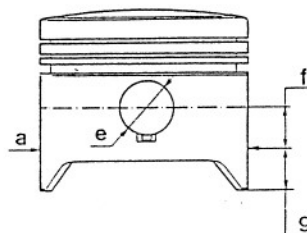
(*) Area for dimensional control



ROD-PISTON ASSEMBLY

Piston

Unit: mm



		AR67103	AR67102 AR67202
Piston diameter (1) (a)	A - Blue	83.345 + 83.355	83.935 + 83.945
	B - Pink	83.355 + 83.365	83.945 + 83.955
	C - Green	83.365 + 83.375	83.955 + 83.965
Height of first seal ring seating (b)	1.525 + 1.545		
Height of second seal ring seating (c)	1.525 + 1.545		
Height of oil scraper ring seating (d)	3.515 + 3.535		
Diameter of gudgeon pin hole in piston (e)	Black	22.000 + 22.002	22.000 + 22.002 21.999 + 22.002 *
	White	22.002 + 22.005	22.002 + 22.005
Clearance between cylinder liner and piston	0.030 + 0.049	0.040 + 0.059	
Weight difference between pistons	± 2 g		

* Value only relative to AR67202 engine

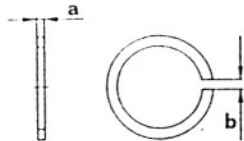
(1) To be measured perpendicular to the gudgeon pin hole at a distance of:

from the lower edge of skirt	g = 10.3 mm	AR67202 (MONDIAL)
from the gudgeon pin axis	f = 16.5 mm	AR67102 (MONDIAL)
from lower edge of skirt	g = 17 mm	AR67102 (BORGO)
from lower edge of skirt	f = 15 mm	AR67103 (BORGO)



Unit: mm

Piston rings



Thickness of rings (a)	First ring	1.478 + 1.490
	Second ring	1.478 + 1.490 (2) 1.475 + 1.490 (3)
	Oil scraper ring	3.478 + 3.490 (2) 3.475 + 3.490 (3)
Ring gap (1) (b)	First ring	0.30 + 0.50
	Second ring	0.30 + 0.50
	Oil scraper ring	0.25 + 0.40 (2) 0.25 + 0.50 (3)
Axial play between piston rings and seatings	First ring	0.035 + 0.067
	Second ring	0.035 + 0.067 (2) 0.035 + 0.070 (3)
	Oil scraper ring	0.025 + 0.057 (2) 0.025 + 0.060 (3)

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

Gudgeon pin



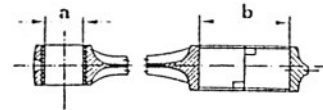
Unit: mm		
Outer diameter of gudgeon pin (a)	Black	21.994 + 21.997 21.991 + 21.994 (*)
	White	21.997 + 22.000 21.994 + 21.997 (*)
Clearance between piston hole and gudgeon pin	Black	0.003 + 0.008 0.005 + 0.011 (*)
	White	0.002 + 0.008 0.005 + 0.011 (*)

(*) Only relative to AR67202 engine



Unit: mm

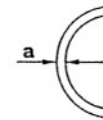
Rod



Diameter of rod small end bushing bore (a)		22.005 + 22.015
Inner diameter of rod big end (b)		53.695 + 53.708
		53.695 + 53.705 (*)
Weight difference between rods		≤ 2 g
Clearance between rod small end bushing and gudgeon pin	Black	0.008 + 0.021 0.009 + 0.024 (*)
	White	0.005 + 0.018 0.008 + 0.021 (*)

(*) Only relative to AR67202 engine

Rod bearing halves



Unit: mm		
Thickness of rod half bearing (a)	A - Red	1.832 + 1.836
	B - Blue	1.836 + 1.841
	C - Yellow	1.841 + 1.845
Radial play between pins and rod bearings	A - Red	0,025 + 0,052 0,025 + 0,049 (*)
	B - Blue	0,021 + 0,051 0,021 + 0,048 (*)
	C - Yellow	0,020 + 0,048 0,020 + 0,045 (*)
Axial play of rod head		0.2 + 0.3

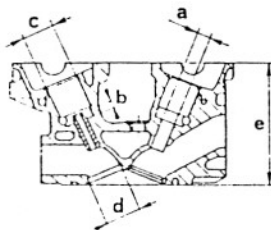
(*) Only relative to AR67202 engine



CYLINDER HEADS

Heads

Unit: mm



Diameter of valve guide seating	(a)	15.000 + 15.018
Valve guide protrusion	(b)	9.850 + 10.150
Diameter of valve cup seating	(c)	35.000 + 35.025
Diameter of valve seat housing	(d)	Intake 45.000 + 45.025 Exhaust 39.000 + 39.025
Minimum permissible height of the head after facing	(e)	134.900
Maximum error of parallelism between head planes		0.087
Maximum error of flatness of head lower plane		0.05

Valve guides



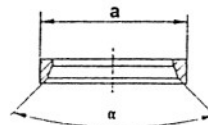
Unit: mm

Outer diameter of valve guide	(a)	Intake 15.039 + 15.050 Exhaust 15.050 + 15.068
Inner diameter of valve guide (bore)	(b)	8.000 + 8.015
Interference between valve guide and seating	Intake	0.021 + 0.050
	Exhaust	0.032 + 0.068



Valve seatings

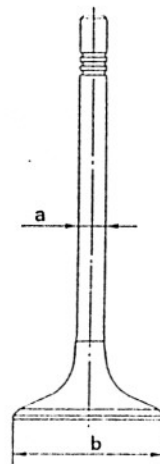
Unit: mm



Outer diameter of valve seat	(a)	Intake 45.100 + 45.116 Exhaust 39.095 + 39.111
	(alpha)	90° ± 20'
Interference between valve seat and housing	Intake	0.075 + 0.116
	Exhaust	0.070 + 0.111
Cylinder head shrink-fit temperature for installation of valve seatings		100 + 120°C

Valve

Unit: mm

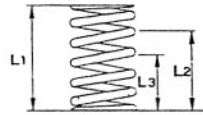


Diameter of valve stem	(a)	Intake 7.970 + 7.985 Exhaust 7.945 + 7.960
Diameter of valve head	(b)	Intake 43.850 + 44.000 Exhaust 37.850 + 38.000
Radial play between valve stem and guide	Intake	0.015 + 0.045
	Exhaust	0.040 + 0.070



Valve springs

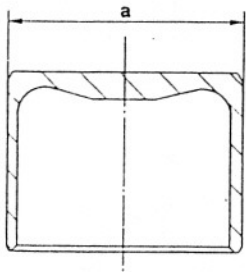
Unit: mm



Length of valve spring at rest (L ₁)	Outer spring	48.7
	Inner spring	46.2
Length of closed valve spring (L ₂)	Outer spring	36.5
	Inner spring	34.5
Length of spring with open valve (L ₃)	Outer spring	25.5
	Inner spring	23.5
Load corresponding to spring length with valve closed	Outer spring	212 + 220 N (21.6 + 22.4 kg)
	Inner spring	115 + 120 N (11.8 + 12.2 kg)
Load corresponding to spring length with valve open	Outer spring	452 + 470 N (46.1 + 47.9 kg)
	Inner spring	244 + 252 N (24.9 + 25.7 kg)

Valve cups

Unit: mm

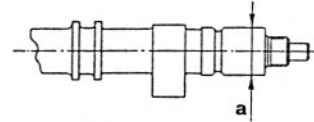


Diameter of valve cups (a)	34.973 + 34.989
Radial play between valve cups and seating	0.011 + 0.052

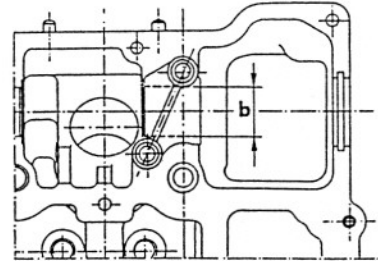


Camshaft

Unit: mm

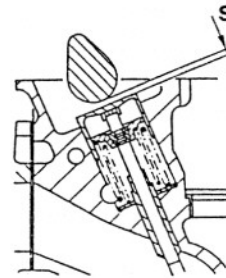


Diameter of camshaft journal (a)	26.959 + 26.980
Diameter of camshaft journal seating (b)	27.000 + 27.033
Radial play between weight and camshaft seating	0.020 + 0.074
Camshaft axial play	0.080 + 0.124



Valve clearance

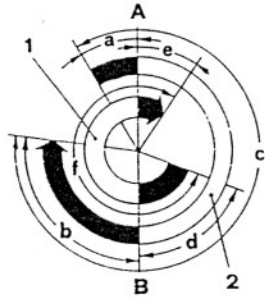
Unit: mm



Valve clearance (cold engine) (s)	Intake	0.380 + 0.450
	Exhaust	0.430 + 0.500
Nominal height	Intake	11.5
	Exhaust	9.6
Angular value of timing reference marks on caps	Intake	5°30'
	Exhaust	13°15'



ANGULAR VALUES OF ACTUAL TIMING DIAGRAM



Intake	Opening (before TDC)	(a)	30° 60' (*)
	Closing (after BDC)	(b)	98° 68' (*)
	Intake angular value	(c)	308°
Exhaust	Opening (before BDC)	(d)	67°50'
	Closing (after TDC)	(e)	34°
	Intake angular value	(f)	281°50'

(*) Values measured with timing variator engaged.

Clockwise rotation of crankshaft seen from front side

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



FLUIDS AND LUBRICANTS

Application	Type	Classification	Name	Q.ty litres
Engine oil	Oil	API SG	SELENIA SPECIAL	
- Total capacity		CCMC G5	FORMULA ALFA ROMEO	5.5; 6'
- Partial capacity (filter and pan) for routine changes		SAE 10W/40	10W/40	5
- Filter				0.5
- Camshaft sumps				0.5
Cylinder head stud bolts				-
Intake and exhaust valve cups				-
Camshaft supports				-
Oil pump shaft				-
Outer surface of crankshaft oil seals				-
Crankshaft oil seal lip	Grease		ISECO	-
Spark plug threads	Oil		ISECO Molykote A	-

(*) Only for AR 67202 engine

SEALANTS AND FIXATIVES

Application	Type	Name	Q.ty
Cylinder head screws (lower side)	Mastic	DIRING Curil	-
Upper head cover plane	Mastic	DIRING Heldite	-
Timing variator solenoid support flange			
Screws securing flywheel to crankshaft	Mastic	Loctite 270 (green)	-
Camshaft shank for installation of timing variator			
Gasket between flexible support pads and supply manifold	Mastic	DIRING Heldite DOW CORNING Hermetite	-
Contact surfaces between oil sump and engine block	Mastic	MASCHERPA Q37091 (black)	-

ABRASIVES

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



TIGHTEN TORQUES

Engine block

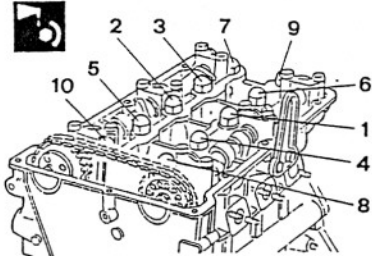
Part	Nm	kgm
Nuts securing main caps to support block (in oil)	20 + 115'	2.04 + 115'
Screws securing flywheel to crankshaft (with fixative)	116.4 + 128.6	11.87 + 13.1
Nut securing crankshaft pulley (in oil)	209 + 231	21.3 + 23.55
Screws securing belt tensioner shoe to front cover	6 + 8	0.6 + 0.8
Nuts securing front cover to engine block	10.2 + 12.6	1.04 + 1.28
Nuts securing water pump to front cover	7.65 + 9.45	0.78 + 0.96
Nuts securing water pump to engine block	12.75 + 15.75	1.3 + 1.6
Screws securing thermostat unit to cylinder head	8.5 + 10.5	0.87 + 1.07
Nuts securing rod caps	49 + 54	5 + 5.5
Oil sump drainage cap	64.5 + 80	6.6 + 8.2
Screws and nuts securing oil sump	9 + 11	0.9 + 1.1

Cylinder head

Part	Nm	kgm
Screws securing timing cover	9.75 + 15.75	1.0 + 1.6
Screws securing cylinder head to front cover	14.25 + 15.75	1.45 + 1.6
Nuts securing camshaft caps (in oil)	20 + 22	2.04 + 2.24
Spark plug tightening (in ISECO Molykote A oil)	28 + 34.65	2.85 + 3.53
Engine coolant temperature sender	40 + 49.4	4.1 + 5.0
Engine minimum oil pressure sensor	35.7 + 44.1	3.64 + 4.5
Engine oil pressure motor	8.5 + 10.5	0.87 + 1.07
Nut securing exhaust side timing gear	51 + 63	5.2 + 6.4
Engine coolant maximum temperature warning light sensor	3.8 + 4.7	0.39 + 0.48
Support securing timing variator to camshaft (with fixative)	104.5 + 115.5	10.7 + 11.8
Screws securing timing gear to timing variator	29.5 + 32.5	3.0 + 3.3
Engine oil temperature sensor	21.3 + 26.3	2.2 + 2.7
Engine oil minimum level warning light sensor	25	2.5



Tightening nuts securing cylinder head to engine block

Tightening sequence	Phase	Nm	kgm
	When refitting: Gradually tighten following the indicated sequence	76 + 84	7.75 + 8.56
	After trials and bench testing: With engine cold, loosen the nuts by one turn following the sequence indicated, smear with engine oil and tighten in the sequence shown	82.65 + 91.35	8.43 + 9.3



SPECIAL TOOLS

1.820.004.000 (A.2.0117)	Tool for locking cylinder liners
1.820.011.000 (A.2.0192)	Valve support tool
1.820.012.000 (A.2.0195)	Base for cylinder head support tool
1.820.013.000 (A.2.0196)	Cylinder head support yoke
1.820.049.000 (A.2.0359)	Special nut for valve support tool
1.820.052.000 (A.2.0362)	Tool for locking cylinder lines
1.820.080.000 (A.2.0451)	Tool for removing head from engine block
1.820.114.000 (A.42.0172)	Guide for reaming front cover and engine block bushings
1.820.145.000 (R.4.0178)	Engine support bracket
1.820.225.000	Support for removal/refitting engine group
1.820.228.000	Tool for locking flywheel
1.820.233.000	Bracket for removing/refitting engine group
1.820.240.000	Tool for locking flywheel
1.821.007.000 (A.3.0146)	Crankshaft front oil seal inserting tool
1.821.010.000 (A.3.0178)	Crankshaft rear oil seal inserting tool
1.821.015.000 (A.3.0210)	Tool for removal of bushing on engine block

(CONTINUES)



(CONTINUED)

1.821.053.000 (A.3.0311)	Valve guide puller
1.821.058.000 (A.3.0324)	Lever for valve disassembly/assembly
1.821.110.000 (A.3.0469)	Inserting tool for valve guide pads
1.821.122.000 (A.3.0520)	Cage for valve disassembly/assembly
1.821.124.000 (A.3.0522)	Support for valve disassembly/assembly
1.821.162.000 (A.3.0621)	Puller for valve guide seal cover (intake and exhaust)
1.821.164.000 (A.3.0625)	Inserting tool for valve guides (intake and exhaust)
1.822.001.000 (A.5.0103)	Spanner for rotation of camshaft
1.822.110.000	Tool for disassembly/reassembly and greasing of camshaft timing variator - intake side
1.825.003.000 (C.6.0148)	Tool for checking cylinder liner or piston protrusion from engine block
1.825.013.000 (C.6.0183)	Tool for checking TDC
1.825.018.000 (C.6.00197)	Feeler gauge for checking valve clearance
1.826.001.000 (C.8.0103)	Plug gauge for checking alignment of return gear bushings
1.828.001.000 (U.2.0040)	Tool for reaming front cover and engine block bushings
1.828.002.000 (U.2.0041)	Tool for reaming front cover and engine block bushings
(A.3.0527)	Inserting tool for intake valve seatings
(A.3.0528)	Inserting tool for exhaust valve seatings



PROCEDURE FOR FAULT RECTIFICATION

ENGINE - LUBRIFICATION

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

**ATTENTION:**

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



OIL LOSS	TEST A
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TEST STEPS	RESULTS	REMEDY
FOREWORD: It is absolutely necessary to accurately identify the engine component or area causing the leak. If the cause cannot be visually identified, it is advisable to wash the engine with water, dry it, and then start it on a level surface or perform a short test cycle and wait until the leaks become evident. Following this, act on the affected component and tackle the other components at a later date.		
A1 CHECK DRAIN PLUG - Check drain plug for correct torque and for absence of damage	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> </div>	Carry out step A2 Torque or replace plug if necessary
A2 CHECK OIL SUMP - Check: <ul style="list-style-type: none"> • the oil sump for damage, distortion or micro-cracks • sealing of gasket between sump and engine block • screws securing sump for correct torque 	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> </div>	Carry out step A3 Replace sump or restore gasket if necessary. Tighten the sump screws to the correct torque
A3 CHECK OIL FILTER - Check for absence of leaks in the oil filter area; check that the seal is tight	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 10px;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; border-radius: 50%; padding: 5px; margin-right: 10px;">OK</div> <div style="font-size: 24px; margin-right: 10px;">▶</div> </div> </div>	Carry out step A4 Replace seal and tighten filter to the correct torque

(CONTINUED)



OIL LOSS

TEST A

TEST STEPS		RESULTS	REMEDY
A4	CHECK OIL SEALS		
- Remove the covers in order to gain access to the crankshaft and camshaft oil seals; check for leaks in these areas		OK ►	Carry out step A5
		OK ►	Replace defective oil seals
A5	CHECK MISCELLANEOUS COMPONENTS		
- Check for leaks from any other component not listed in the previous test steps. Correct the fault on the basis of the remedies mentioned above.		OK ►	Replace defective components

End of test A



LOSS OF OIL PRESSURE

TEST B

TEST STEPS		RESULTS	REMEDY
B1	CHECK OIL LEVEL		
- Using the dipstick, check that the oil level is correct		OK ►	Carry out step B2
		OK ►	Top-up oil level
B2	CHECK QUALITY OF OIL AND FILTER		
- Check that: <ul style="list-style-type: none"> the engine oil is of the prescribed type that the oil filter is of the prescribed type and correctly installed 		OK ►	Carry out step B3
		OK ►	Service with the prescribed oil to the proper level. If necessary replace the filter
B3	CHECK OIL PUMP		
- Check oil pump for traces of binding, overheating of its components.		OK ►	Carry out step B4
		OK ►	Replace defective parts

(Co d)



LOSS OF OIL PRESSURE

TEST B

TEST STEPS		RESULTS	REMEDY
B4	CHECK PRESSURE RELIEF VALVE		
<ul style="list-style-type: none"> - Check: <ul style="list-style-type: none"> • pressure relief valve for correct seal, integrity and cleanliness • the valve spring for yielding or breakage 		<p style="text-align: center;">OK ▶</p> <p style="text-align: center;">OK ▶</p>	<p>Carry out step B5</p> <p>Replace defective components</p>
B5	CHECK OIL PASSAGES		
<p>Only relevant to complete engine overhaul:</p> <ul style="list-style-type: none"> - Check the passages in the engine block and cylinder heads for obstructions caused by oil residues or foreign matter. - Check plugs on crankshaft for sealing and integrity. 		<p style="text-align: center;">OK ▶</p>	<p>Thoroughly clean affected parts and replace them if necessary.</p>

End of test B



EXCESSIVE OIL CONSUMPTION

TEST C

TEST STEPS		RESULTS	REMEDY
<p>FOREWORD: Check that excessive oil consumption is not caused by leakage. Refer to Test A.</p>			
C1	CHECK FOR SEEPAGE THROUGH VALVES		
<ul style="list-style-type: none"> - Remove the cylinder heads and check for traces of oil in the combustion chambers. In this case check: <ul style="list-style-type: none"> • Dimensions and clearances between the valve stem and the relevant valve guide, and between the valve guide and the valve guide seats in the cylinder head; • the integrity of the seal pad located on the valve stem • the valve stem for traces of binding or scoring. 		<p style="text-align: center;">OK ▶</p> <p style="text-align: center;">OK ▶</p>	<p>Carry out step C2</p> <p>Replace defective parts</p>
C2	CHECK FOR SEEPAGE THROUGH PISTON RINGS		
<ul style="list-style-type: none"> - Check for seepage through piston rings. If this is discovered check the piston rings for: <ul style="list-style-type: none"> • breakage or damage; • correct installation (TOP mark facing upwards); • correct distribution of clearance around the circumference (gaps located at three different angles); • binding in their seats or excessive wear. 		<p style="text-align: center;">OK ▶</p> <p style="text-align: center;">OK ▶</p>	<p>Carry out step C3</p> <p>Replace the faulty rings</p>
C3	CHECK CYLINDER LINERS		
<ul style="list-style-type: none"> - Check: <ul style="list-style-type: none"> • the roughness of the cylinder liners (excessive wear could cause excessively smooth surface); • that the main dimensions are within limits. 		<p style="text-align: center;">OK ▶</p>	<p>Replace the faulty cylinder liners if necessary</p>

End of test C



PROCEDURE FOR FAULT RECTIFICATION ENGINE - NOISY OPERATION

FOREWORD:

Discover if the noises are really caused by the engine and not by other components like:

- Coolant pump
- Alternator
- Power steering pump
- Air conditioning compressor

Note whether the noise is mainly present when the engine is cool or at normal running temperature, when engine is at idle speed or if the noise increases as the revs increase.

Noise is produced by the engine if:

- noise is present when the vehicle is at rest and during travel
- noise is present when the clutch is engaged and disengaged

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



PROCEDURE FOR FAULT RECTIFICATION ENGINE - NOISY OPERATION

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

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



BEATING WHEN ENGINE IS AT IDLE

TEST A

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

End of test A



BEATING WITH ENGINE COLD

TEST B

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

End of test B



INTENSE AND INCONSTANT BEATING	TEST C
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TEST STEPS		RESULTS	REMEDY
C1	CHECK CRANKSHAFT PULLEY ATTACHMENT		
- Check that the nut securing the crankshaft pulley is not loose.		OK ►	Carry out step C2
		OK ►	Tighten the nut to the correct torque or replace if faults
C2	CHECK FLYWHEEL ATTACHMENT		
- Check that the screws securing the flywheel to the crankshaft are not loose.		OK ►	Tighten screws to the specified torque or replace if damaged. Use locking compound LOCTITE 270

End of test C



BACKGROUND BEAT (DUE TO INBALANCE)	TEST D
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TEST STEPS		RESULTS	REMEDY
D1	CHECK CASTING OF MAIN AND ROD BEARINGS		
- Check: <ul style="list-style-type: none"> main and rod bearings for traces of overheating, flaking etc. crankshaft journals for damage 		OK ►	Carry out step D2
		OK ►	Replace crankshaft. Wash engine block lubricating system and overhaul or replace oil pump if necessary.
D2	CHECK CONNECTING ROD AND BACKGROUND BEATING		
- Check: <ul style="list-style-type: none"> clearances between rod big end and crankshaft journals and relevant bearings tightening torques of main bearings and rod big end are within prescribed limits. 		OK ►	Carry out step D3
		OK ►	Replace crankshaft and/or affected rod. Tighten to prescribed torque
D3	CHECK CRANKSHAFT BEATING		
- Check that crankshaft axial play is within the specified limits		OK ►	Carry out step D4
		OK ►	Replace the thrust half rings

(CONTINUED)



BACKGROUND BEAT (DUE TO INBALANCE)

TEST D

TEST STEPS		RESULTS	REMEDY
D4	CHECK PISTON BINDING BEATING		
- Visually check the mating surfaces of the cylinder liners and pistons for overheating, binding, scoring etc. and that the piston rings move freely in the relative grooves on the piston			Carry out step B
			Replace cylinder liner and piston of affected cylinder

End of test D

IMPORTANT NOTE:

For any anomalies which interfere with the correct operation of the engine refer to **FAULT RECTIFICATION** included in **Group 04**.

For example

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