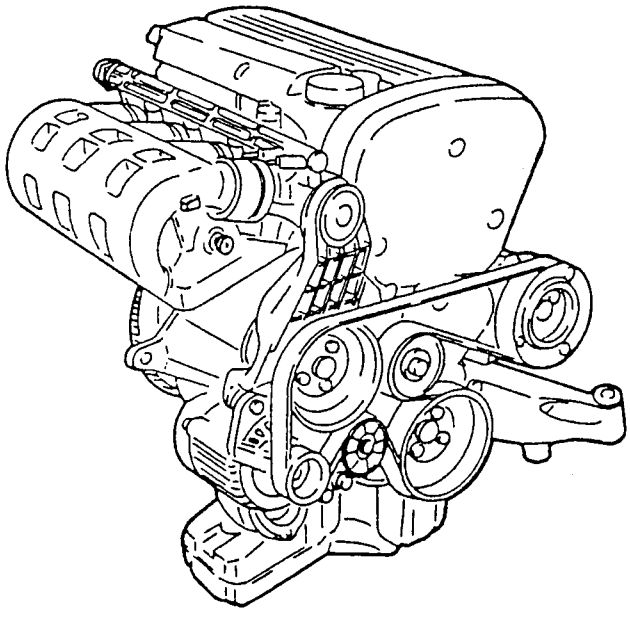
INDEX

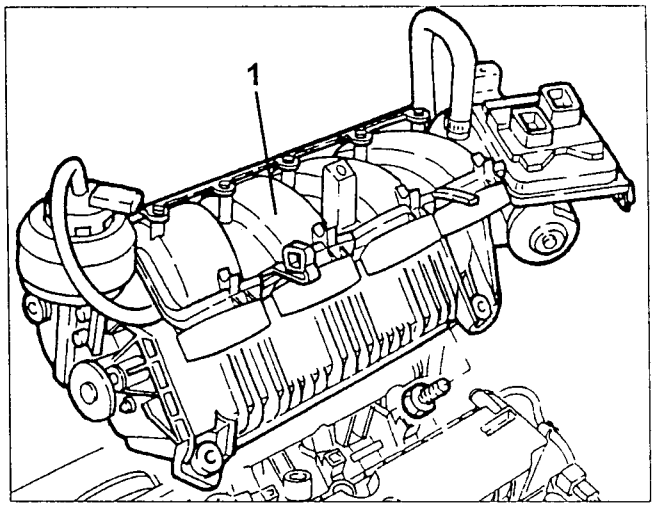
(*): See 1598 T. SPARK 16V 1747 T. SPARK 16V

DESCRIPTION

Four cylinder in line engine with double camshaft in head, four valves per cylinder, phase variator, static injection and twin ignition controlled by a single ECU.
The rear engine is connected to the clutch-gearbox-differential unit which constitutes a sole assembly.
The engine is installed frontally and transverse at a 18°30 slant.
The engine is "suspended" by means of two damper mounts to the underbody and one scissors mount to the suspension crossmember. To contain vibrations, the engine top is connected to the underbody by means of a shock-proof connecting rod.
All belts are fitted with automatic take-up devices to ensure long belt working life.
The fuel feed system (unleaded petrol) is fitted with suitable pollution prevention devices which ensure low exhaust emissions as per "EEC PHASE 2" standards.

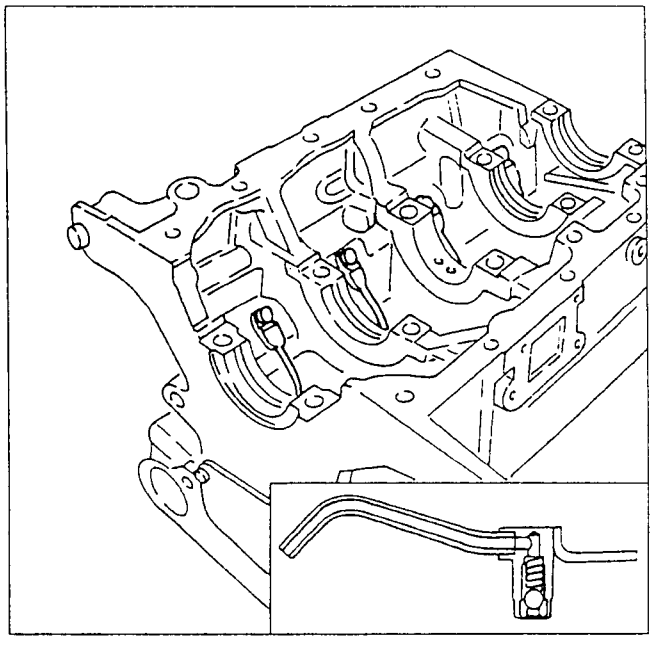


M1.5.5 injection-ignition engines are fitted with a plastic intake manifold (with variable geometry 1747 cc versions) instead of an aluminium intake manifold.
The fuel feed system is returnless, i.e. with a single feed pipe.

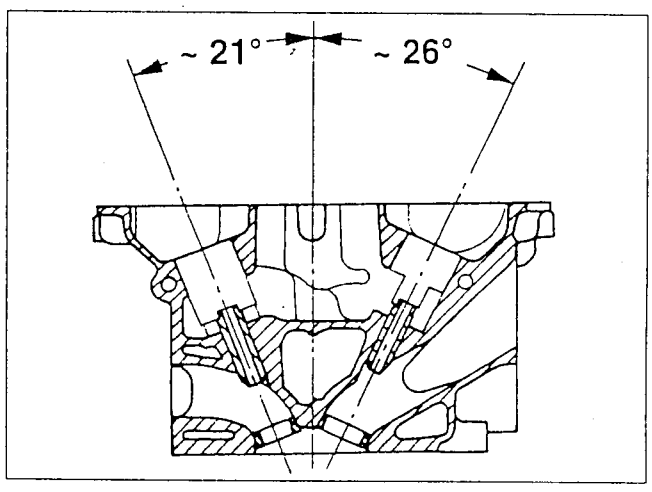


CRANKCASE

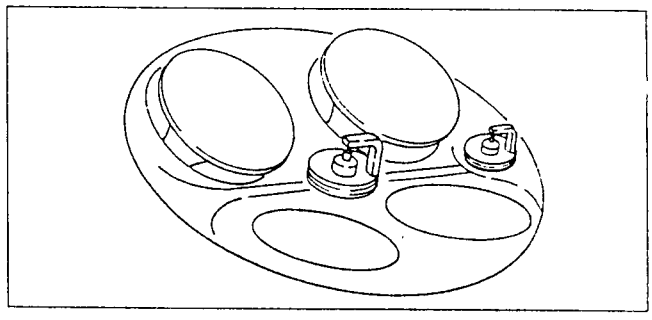
The engine block is made of high mechanical resistance cast iron.
The crankshaft is supported by means of five main journals which house five thin casing half-bearings.
The cylinders are directly cut into the crankcase and are selected according to three size classes plus three oversized classes.
Specific ducts in the crankcase walls ensure the passage of coolant and lubrication oil.
A nozzle, which sprays oils on the top of the piston thus ensuring partial cooling, is fitted in the lower part of each cylinder.



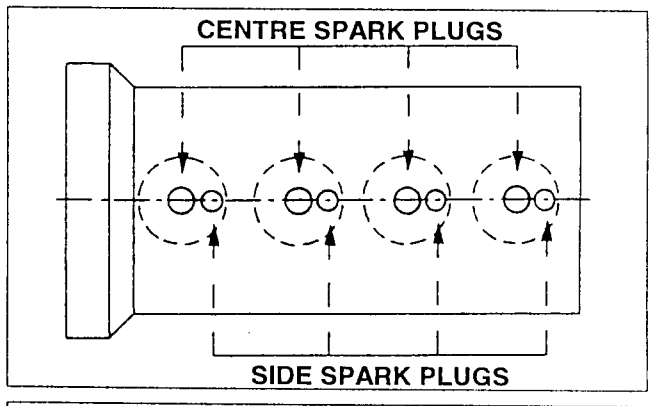
CYLINDER HEAD



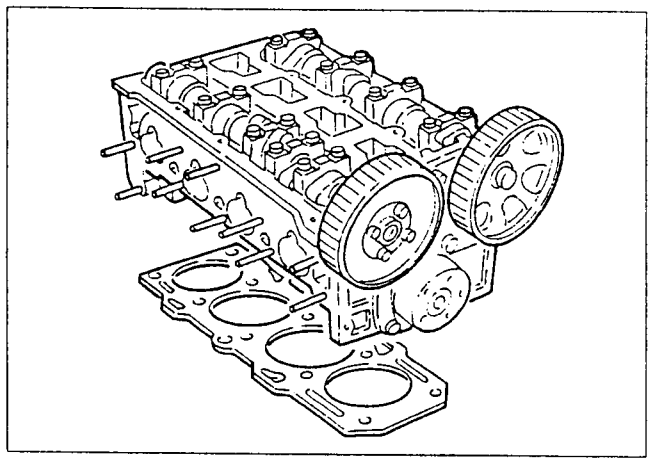
Monolith, compact, mould-cast aluminium and silicon alloy.
The four valves per cylinder are fitted in their respective V guides at approximately 47° and are controlled by two camshafts by means of hydraulic tappets.



The space is organised so that the combustion chambers can house the four valve caps and the central and side spark plug holes without weakening the head structure.
The central spark plugs (larger) at tightened at a torque of 25 - 35 Nm, while the side (smaller) spark plugs are fastened at a torque of 10 - 12 Nm.
They should be replaced every 100,000 km.
The twin spark plugs positioned in this fashion, the two intake valves and the two exhaust valves ensure uniform distribution of the mixture and optimal combustion with improved engine thermal performance and reduced harmful emission in exhaust.



The camshaft on intake side turns on six journals. The camshaft on exhaust side turns on five journals. The shafts are controlled with a timing belt.
The valve seats are fitted in the cylinder head after it is heated to a temperature of 80°C. The seats are then cooled with liquid nitrogen. The valve guides are fitted in their seats in the cylinder head. Interference and internal diameter is perfected after assembly with a specific borer and controlled by means of a go-no-go set of gauges. The cylinder head and crankcase seal is made of aramide fibre. No head re-torque is required for the entire life of the engine.

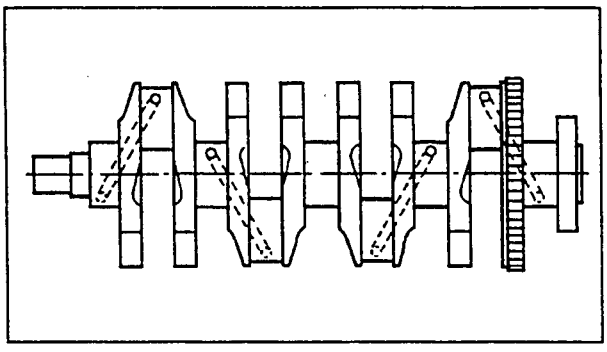


OIL SUMP

The oil sump is a structural part of the engine with mechanical functions.
It contains the engine oil and is directly connected to the gearbox and to the rear engine mount.
It is made of die-cast aluminium alloy and features internal shock-proof partitions.
It is fastened to the crankcase with a specific sealant.

CRANKSHAFT

This is forged in high strength alloy steel, induction tempered on the journals and rolled on the grooves.
It rests on five main bearings and its end float is adjusted by two half rings housed in the centre main bearings.
Eight counterweights accurately balance the rotating masses.
A groove runs inside the shaft to lubricate the main and connecting rod journals.
At the rear of the crankshaft there is the phonic wheel for detecting the rpm and timing sensor.



MAIN AND ROD BEARING HALVES

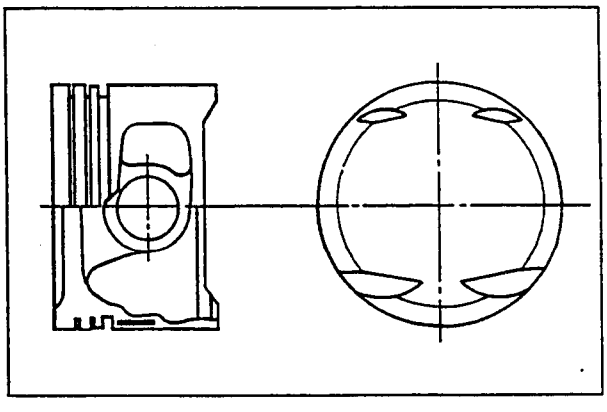
These are of the three-metal, thin shell type and they are divided into three dimensional classes.

FLYWHEEL

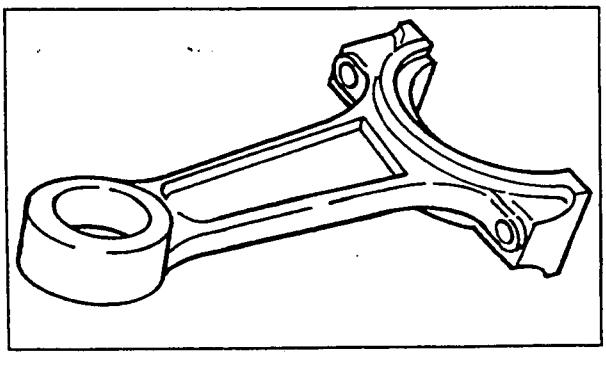
This is in cast iron with a hardened ring gear and suitably balanced.

PISTONS AND CONNECTING RODS

The pistons are in aluminium-silicium alloy with self-heating inserts and are divided into three dimensional classes. To ensure correct assembly an arrow is stamped on the piston crown to indicate the direction of rotation of the engine.
The piston crown is concave and has four notches to prevent interference with the valve mushrooms.

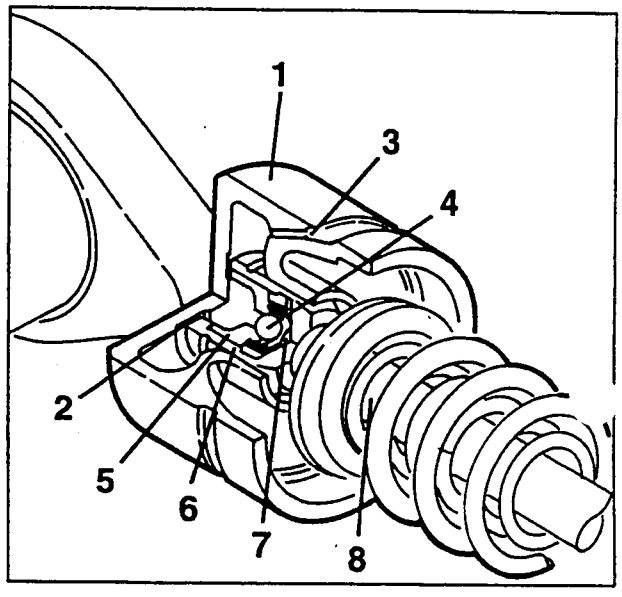


The connecting rods are in hardened and tempered alloy steel, with a bushing in copper alloy force-fitted for coupling with the piston gudgeon pin.
As the gudgeon pins are floating on the piston hubs and on the bushing force-fitted in the connecting rod small end, their side movement is stopped by two expanding circlips housed in the special hollows machined on the actual hubs.



VALVE GEAR TIMING

Direct drive by toothed belts with automatic tensioner and with overhead camshaft in cast iron with induction tempered cams and bearings. The hydraulic tappets, in contact with the cams, control the valves directly. This device automatically eliminates "valve play" when the engine is running thereby dramatically reducing the need for periodical maintenance.



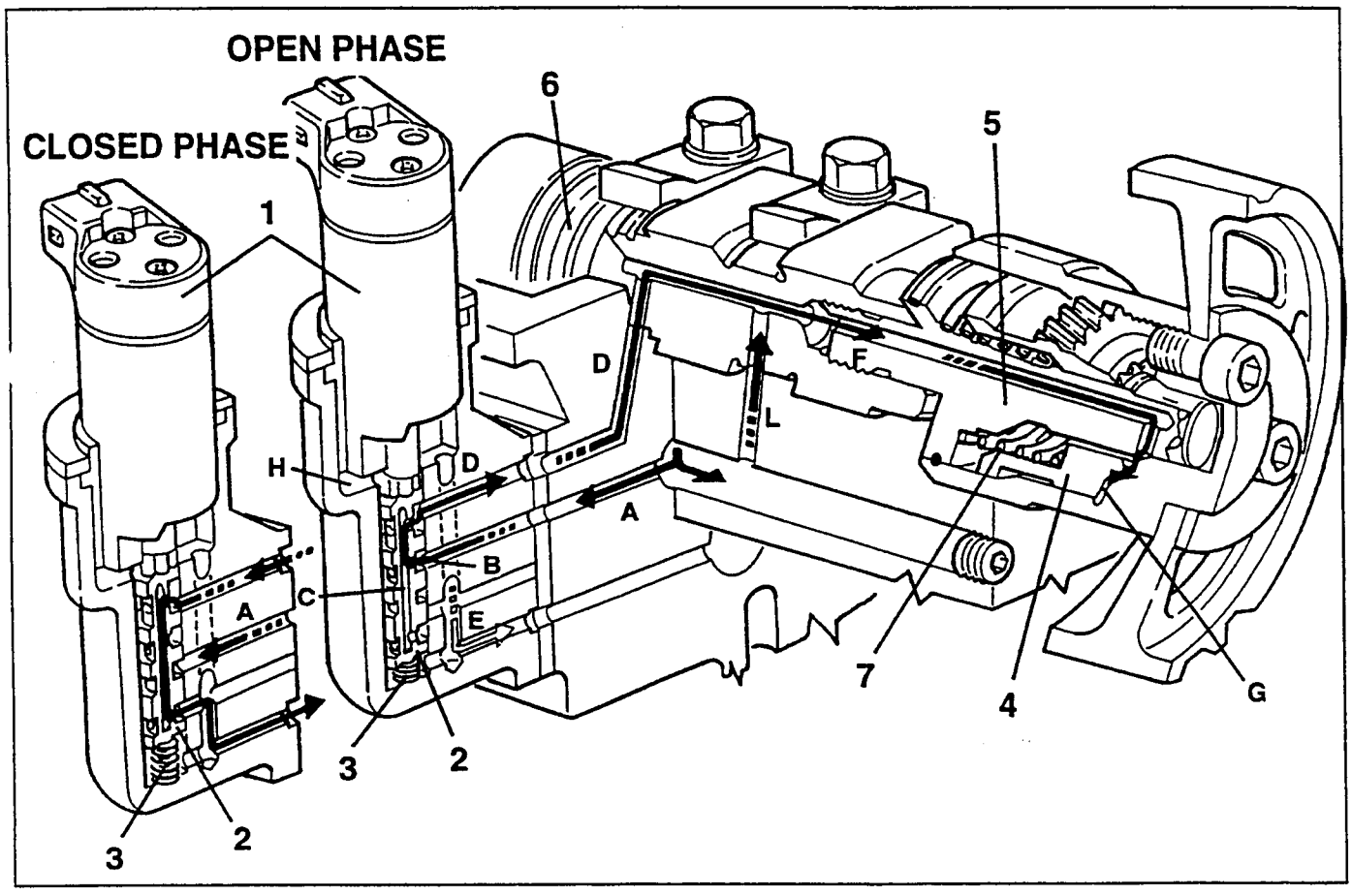
1. *Cup*
2. *Oil passage between chambers*
3. *Oil inlet groove*
4. *Check valve*
5. *Piston*
6. *Cylinder*
7. *Pressure chamber*
8. *Valve stem*

The stem of the exhaust valves is chromium plated and has a cavity inside filled 50 ÷ 60% with sodium to improve dispersion of the heat to which they are subjected.
The valve seats are sintered and made from material suitable for the use of unleaded petrol.

TIMING VARIATOR

This is of the simplified type which ensures considerable timing precision, rapid intervention and high mechanical reliability. It is coupled to the intake pulley and fitted with two half bearings which support it. The inner parts nitrided and an O-Ring keeps the oil inside when the engine is not running. In order to reduce the size of the engine, the actuation valve seat has been machined on the intake manifold with suitable grooves which also involve the cylinder head, to regulate the flow of oil to the variator.
- The purpose of this device is to change the intake valve timihg according to the engine load and speed required; this parameter is received and processed by the control unit in the form of an electric signal sent by the air flow meter and rpm sensor and transmitted as a command to the electromagnet via a relay.
- When the closed phase is required (idling and full power area), the electromagnet (1) is de-energized, thus the valve distributor (2) pushed by the counter spring (3), stays up preventing the passage of the oil leading from groove (A) from reaching the variator.
In this case the timing of the intake valves remains unchanged (closed).
- If the open phase is required (average speeds at high torque), the electromagnet (1) is energized, thus pushing the valve distributor (2) downwards. In this position the oil, leading from groove (A), enters chamber (B) of the piston, from where it passes through a special hole into groove (C) machined inside the latter.
The oil can only leave this groove through the upper hole (in communication with the oil delivery duct (D) to the variator) as the lower hole no longer leads to the exhaust duct (E) because the valve distributor (2) is lowered.
The oil passes through duct (D) and (F) and reaches the chamber (G) moving piston (4) axially towards the engine. The outside of piston (4) is fitted with helical teeth and as a result of the above-mentioned axial movement it is forced to move clockwise (as seen from the timing side). The rotation is transmitted through a straight-toothed grooved profile to the pinion (5) which is screwed onto the threaded lug of the camshaft (6) and transmits rotation to the shaft. This way the timing of the intake valves is changed by 25°.
When the electromagnet is de-energized, the valve distributor (2) returns to its initial position, shutting off the flow of pressurised oil to the piston (4), but allowing the oil to return to the exhaust due to the thrust of the counter spring (7).

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



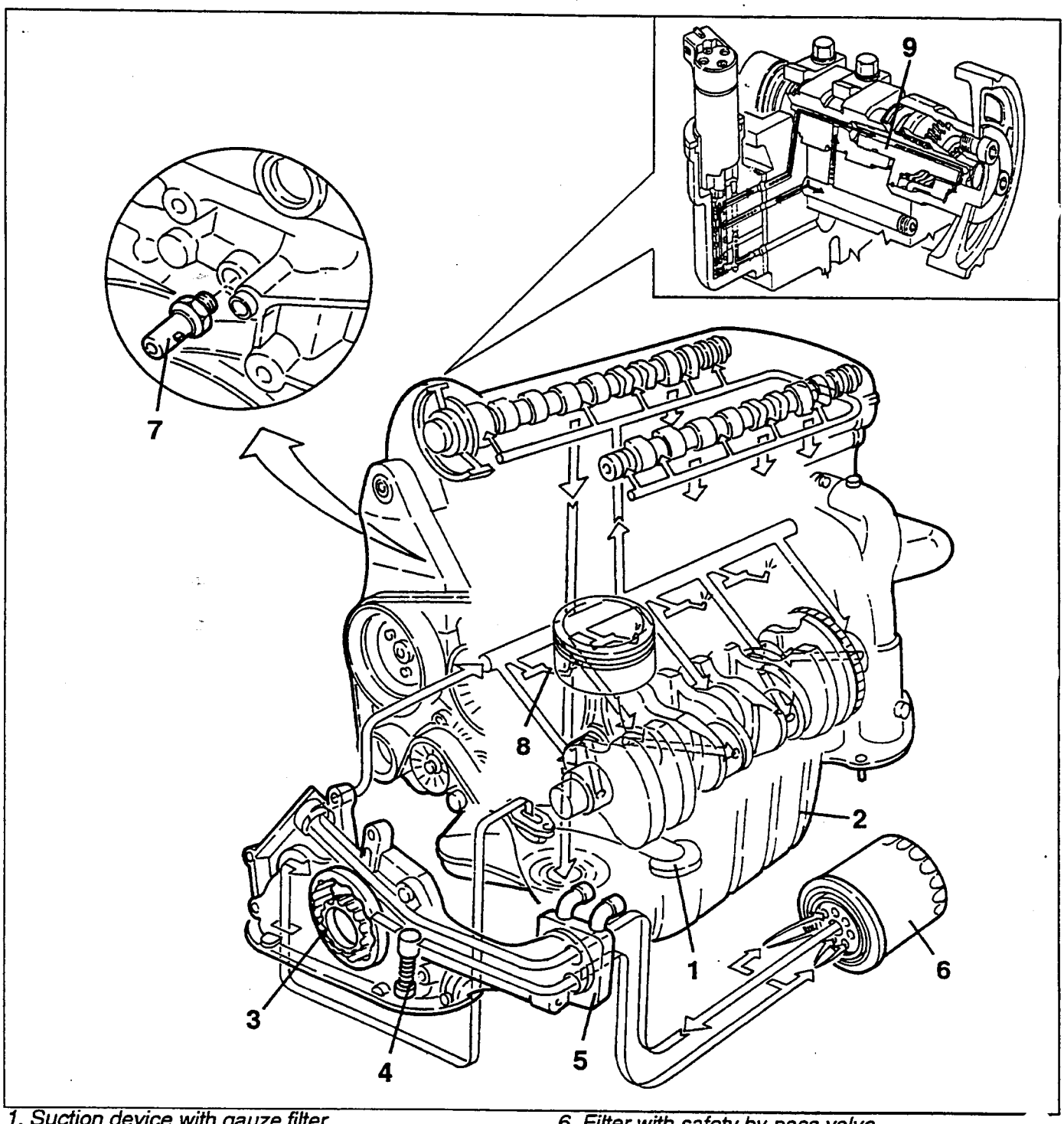
LUBRICATION

The rotary lobe pump (3) fitted on the front of the crankcase is activated directly by the crankcase through keying. The oil withdrawn from the sump by a suction device (1) is filtered by the gauze filter on the suction device and then sent under pressure by the pump through a duct to the full-flow cartridge oil filter (6) fitted with a by-pass safety valve, which ensures that the oil passes even if the cartridge is clogged.
A water-oil heat exchanger (5) is installed on the filter support to keep the oil temperature within the optimum limits.
The maximum lubricating pressure is regulated by a special limiting valve (4) fitted on the pump.
After being filtered, the oil passes through a duct machined on the front engine cover and reaches the main longitudinal delivery duct in the crankcase.
From here, it is then sent along five ducts to the grooves of the main bearings and from these to those of the connecting rod journals via special ducts machined in the crankshaft.
To improve the cooling of the piston skirts the crankcase is fitted with spray jets (8) with built-in ball valve which opens at a pressure of **2.25 ÷ 2.75 bar.**

From the main longitudinal duct in the crankcase, a vertical duct branches off which lubricates the camshaft bearings. On the intake side of the camshaft lubricating duct there are two special channels through which the oil for operating the timing variator passes. The recovery circuit is formed of a few ducts located in the cylinder head which collect the oil leading from the outlets and then drain it from the head from which it falls back into the sump.

The lubricating system is fitted with an oil vapour recirculation system which recovers the vapours leading from the sump and from the cylinder head. The system is fitted with a minimum engine oil pressure sensor (7) which indicates insufficient lubricating pressure by turning on the warning light on the instrument cluster.

On some versions there is also the engine oil temperature sensor, minimum engine oil warning light sensor and the engine oil pressure sender (see the corresponding paragraph for further details).



1. Suction device with gauze filter
2. Oil sump
3. Oil pump
4. Pressure limiting valve
5. Heat exchanger
6. Filter with safety by-pass valve
7. Engine oil minimum pressure warning light sensor
8. Spray jets
9. Timing variator

INTRODUCTION

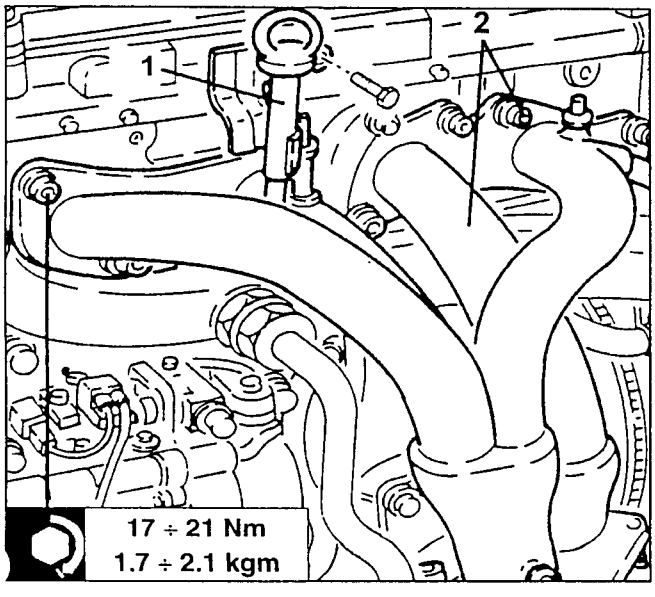
The instructions contained in the following paragraphs refer to complete engine bench overhaul after removing the engine from the vehicle. The instructions are organised as follows:
- **Engine removal:**
removal of engine accessories and components and disassembly of the main engine assemblies.
- **Cylinder head disassembly and overhauling:**
complete overhauling of component parts.
- **Crankcase overhauling:**
complete overhauling of component parts.
- **Refitting precautions:**
specific refitting operations which mainly differ from the removal instructions.
- **Lubrication electrical circuit checks.**

All the disassembly procedures described in the following paragraphs should be reversed for refitting, unless specifically indicated. The following procedures refer to complete engine overhauling. Some procedures, however, can be used separately for some parts only when required for specific components.

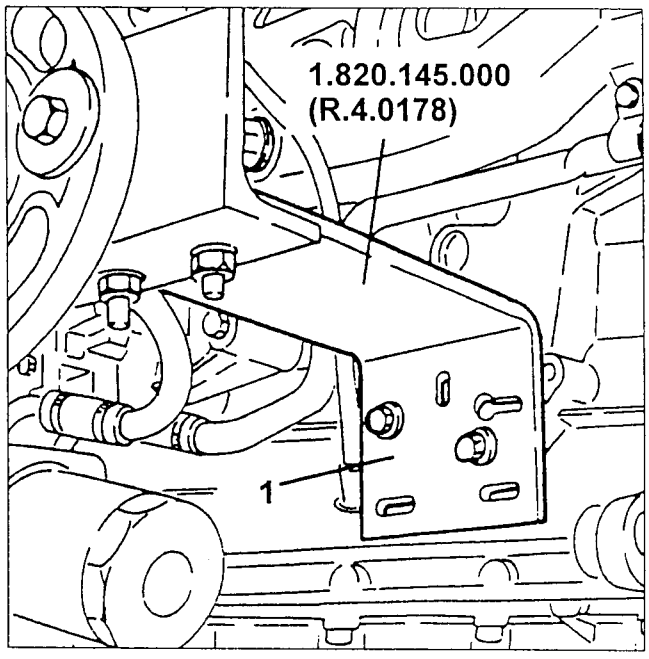
ENGINE REMOVAL

PRELIMINARY OPERATIONS

- Loosen the fastening nuts and remove the exhaust manifold guard.
1. Loosen the fastening screw and remove the oil dipstick.
2. Loosen the fastening nuts and remove the exhaust manifold.

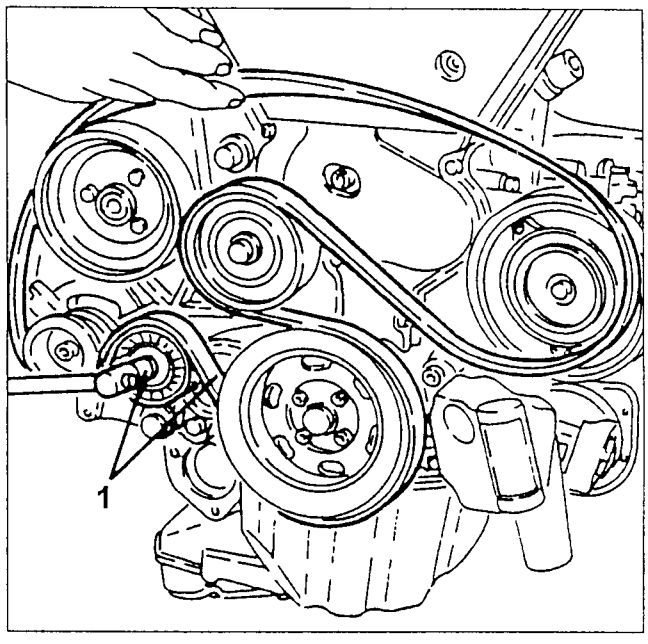


1. Position the engine on a specific overhaul stand with brackets no. 1.820.145.000 (R.4.0178).

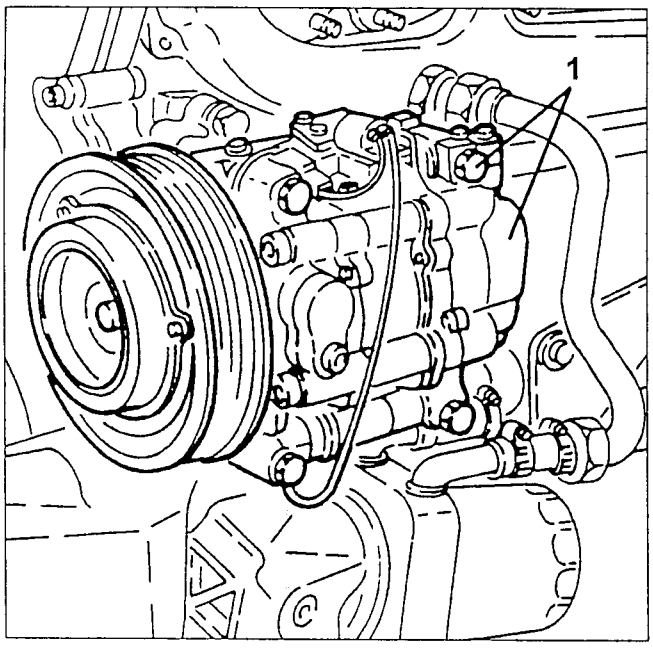


CLIMATE CONTROL COMPRESSOR REMOVAL

1. Loosen the belt-take up device as shown in the figure. Loosen the auxiliary unit drive belt and remove it.

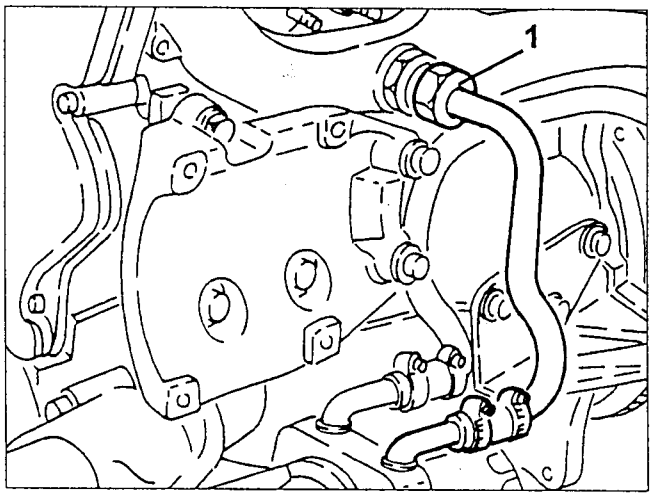


1. Loosen the four fastening screws and remove the climate control compressor.

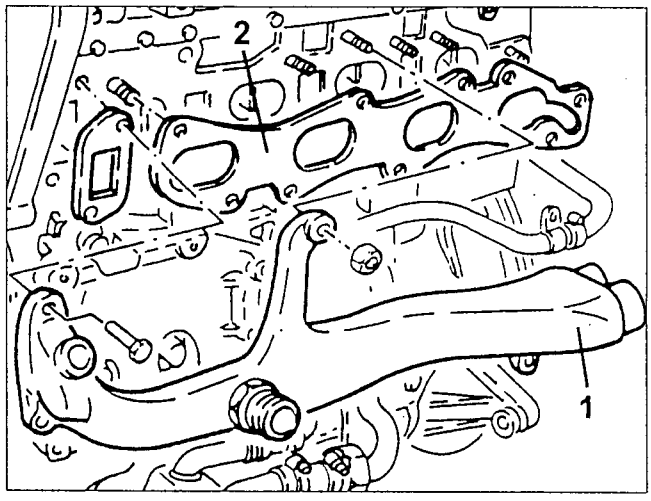


ENGINE COOLANT MANIFOLD REMOVAL

1. Disconnect the engine oil heat exchanger outlet pipe from the pump coolant return manifold.

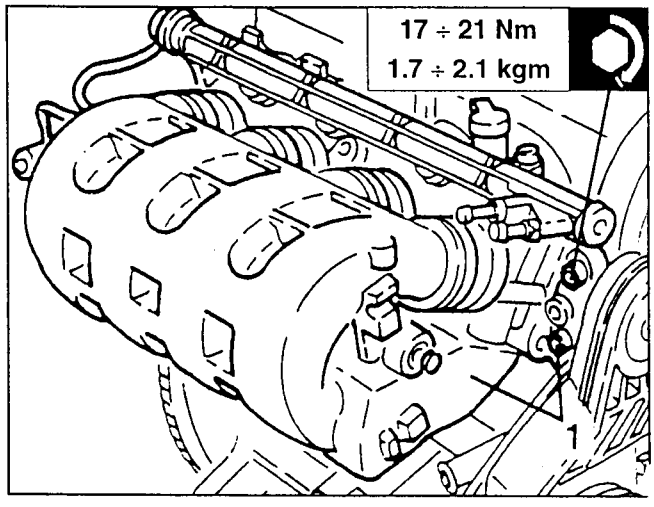


1. Loosen the fasteners and remove the pump coolant manifold and respective seal.
2. Remove the exhaust manifold seal.



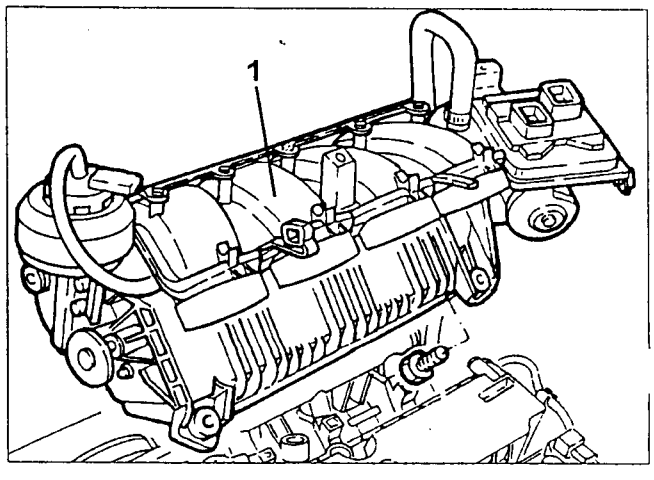
INTAKE MANIFOLD REMOVAL (pre-change versions)

1. Loosen the fastening nuts and remove the intake manifold.
- Remove the respective seal.



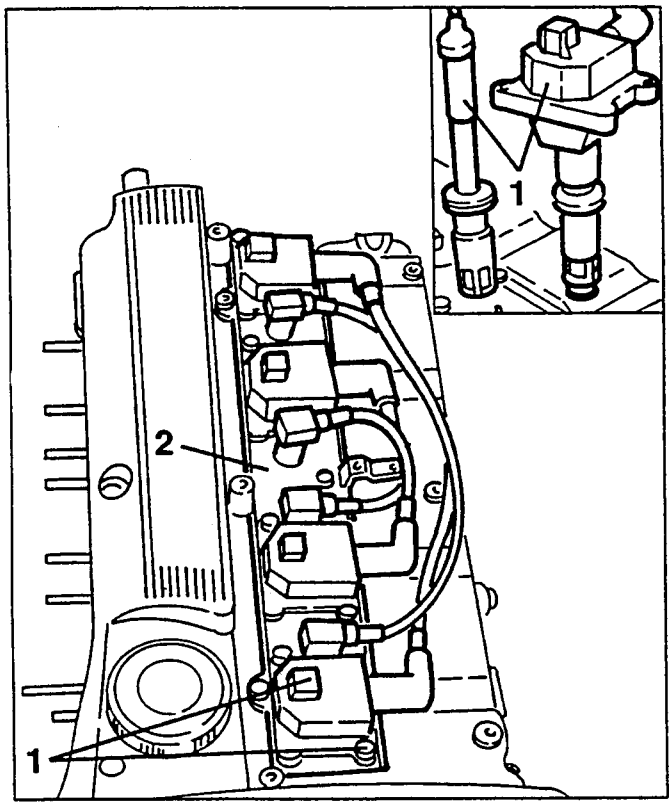
INTAKE MANIFOLD REMOVAL (post-change versions)

1. Loosen the fastening nuts and remove the intake manifold.
- Remove the respective seal.



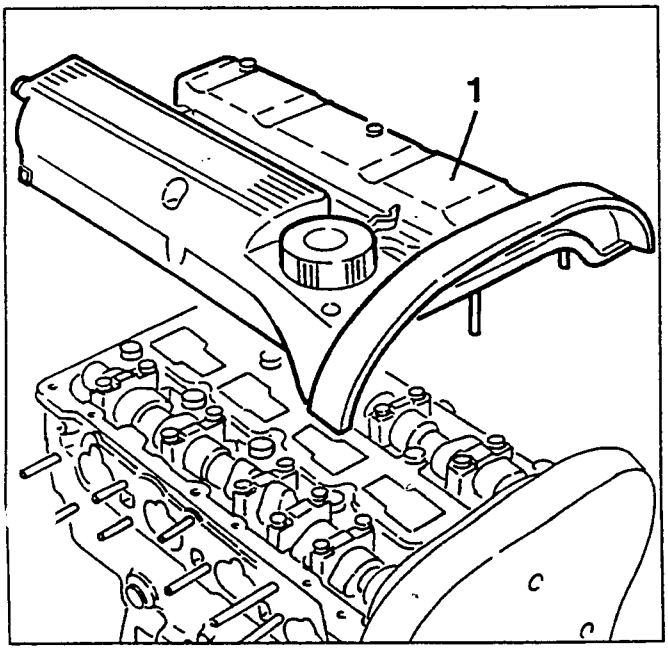
REMOVING THE IGNITION COILS

1. Slacken the fastening screws and remove the ignition coils complete with spark plug cables.
2. Slacken the fastening screws and ignition coils support bracket.
- Remove the spark plugs.

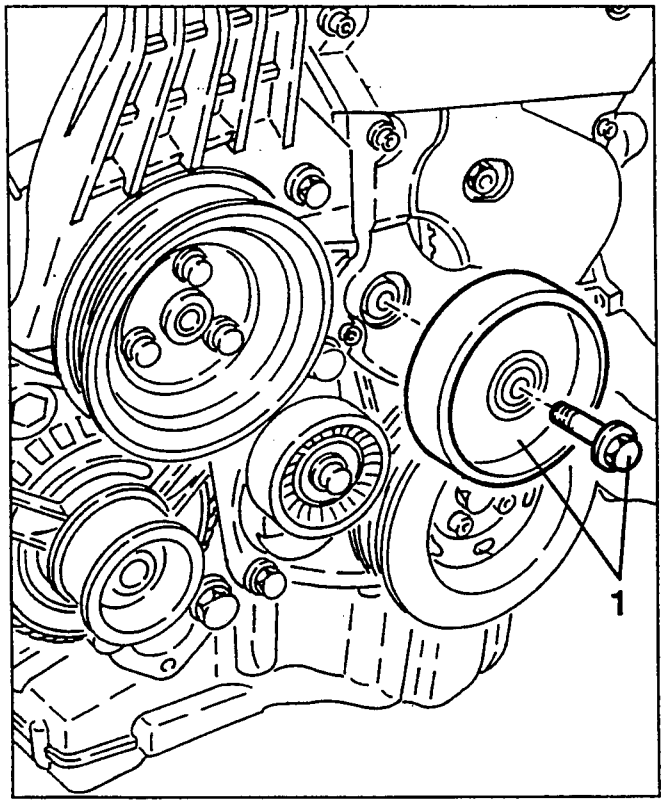


REMOVING THE TIMING GEAR DRIVE BELT

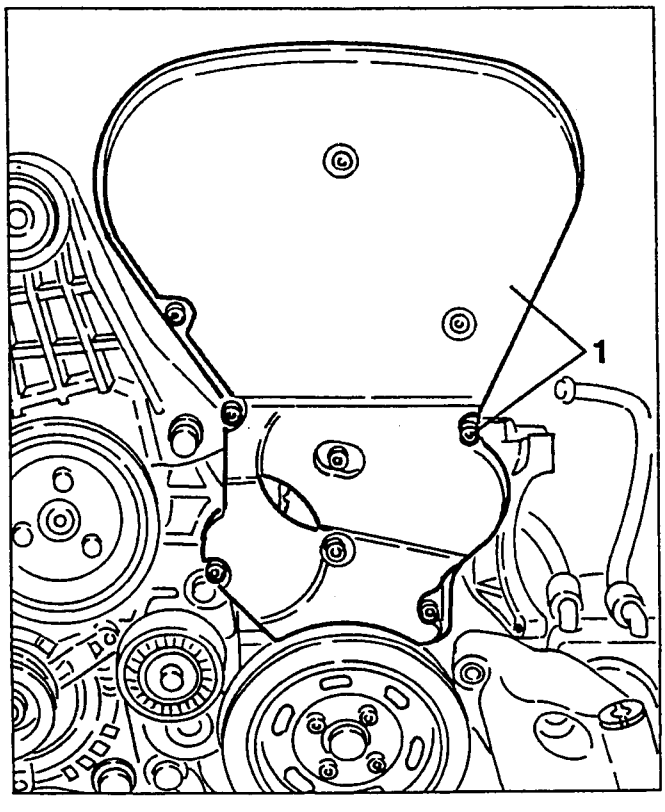
1. Slacken the fastening screws and remove the tappet cover complete with seal.



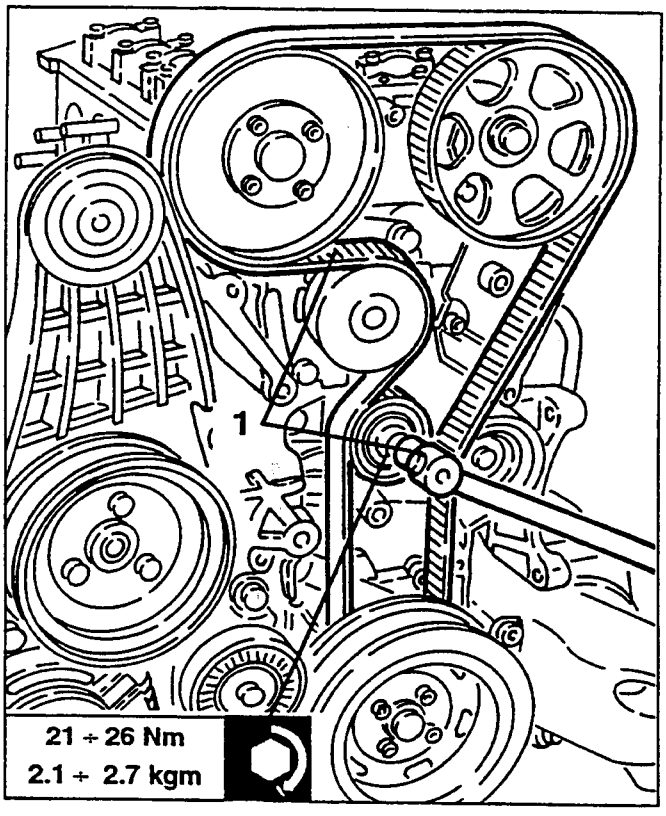
1. Slacken the fastening screw and remove the auxiliary components drive belt guide pulley.



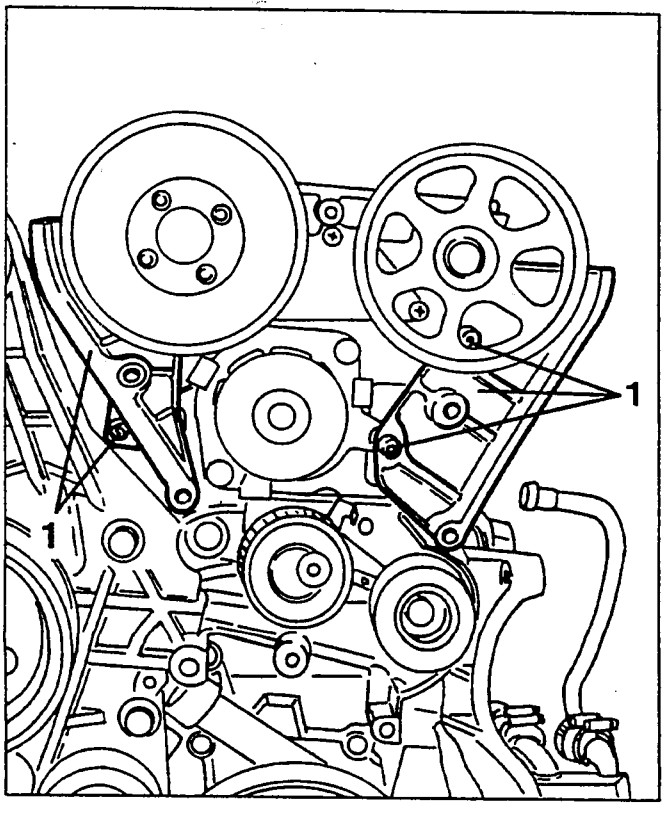
1. Slacken the fastening screws and remove the timing gear belt protective cover.



1. Slacken the timing gear belt tensioner, then remove the belt from the camshaft drive pulleys.

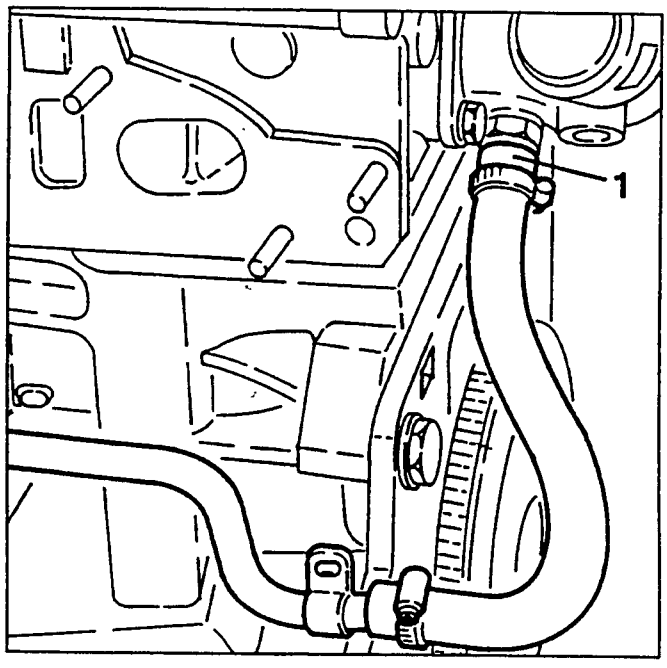


1. Slacken the fastening screws and remove the timing gear belt side guards.

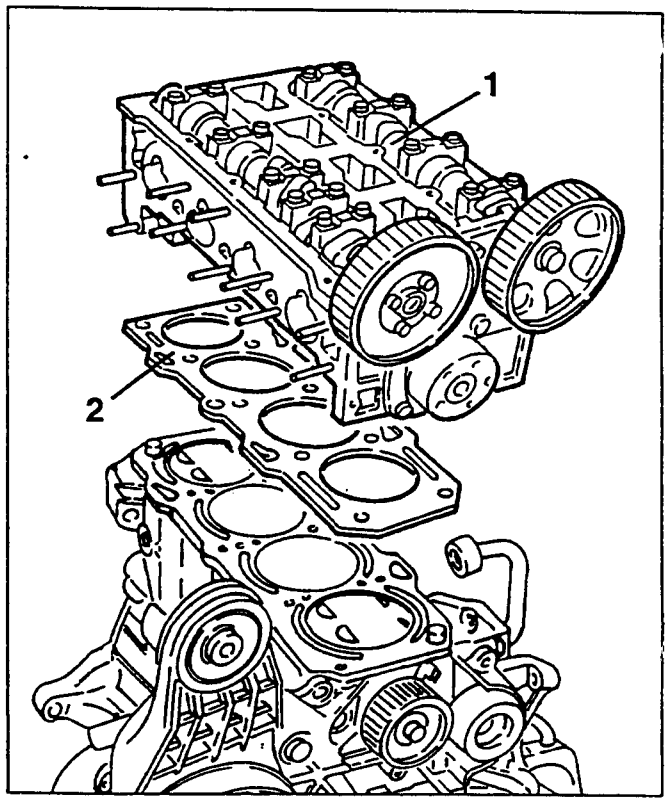


REMOVING THE CYLINDER HEAD

1. Disconnect the coolant fluid delivery pipe to the engine oil heat exchanger from the thermostatic cup.

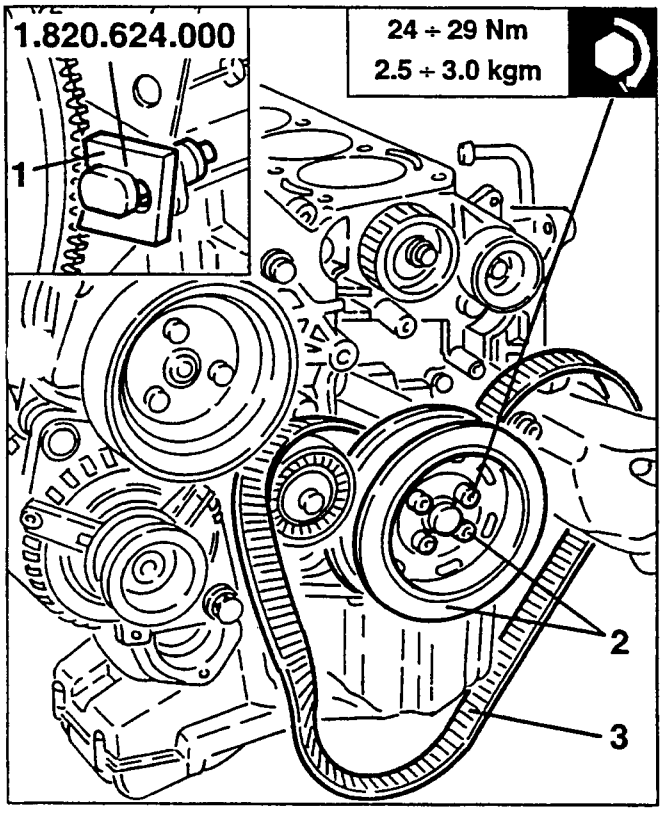


1. Slacken the fastening screws and remove the cylinder head.
2. Remove the associated seal.



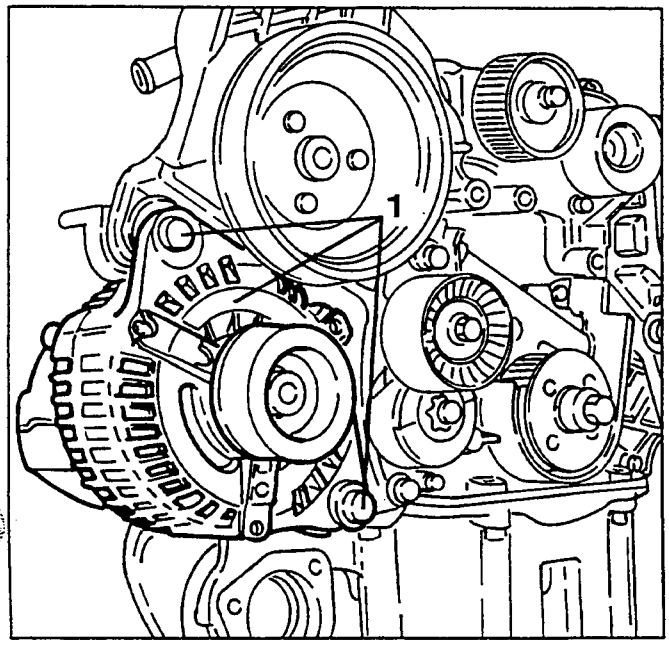
REMOVING THE AUXILIARY COMPONENTS BELT DRIVE PULLEY

1. Install the flywheel stopper tool no. 1.820.624.000.
2. Slacken the four fastening screws and remove the auxiliary components drive belt pulley.
3. Withdraw and remove the timing gear drive belt.

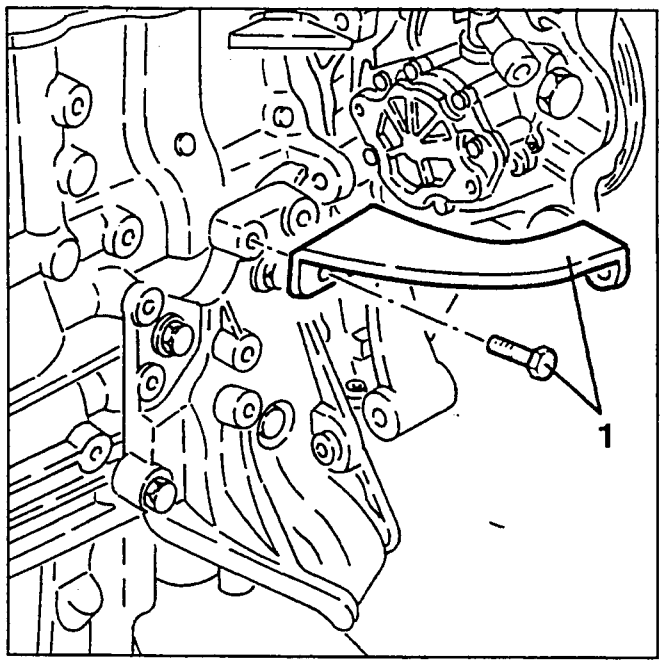


REMOVING THE ALTERNATOR

1. Slacken the two fastening bolts and remove the alternator.

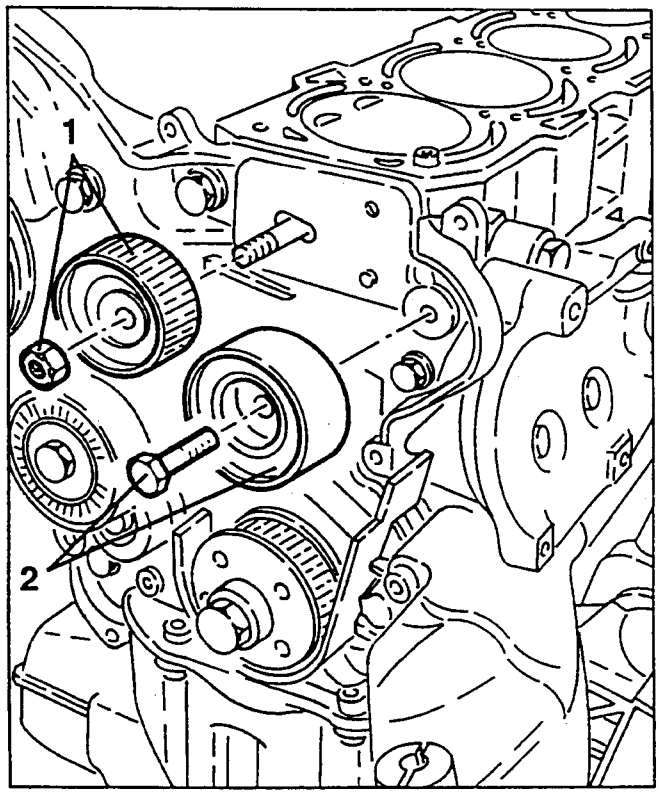


1. Slacken the two fastening screws and remove the upper alternator support bracket.

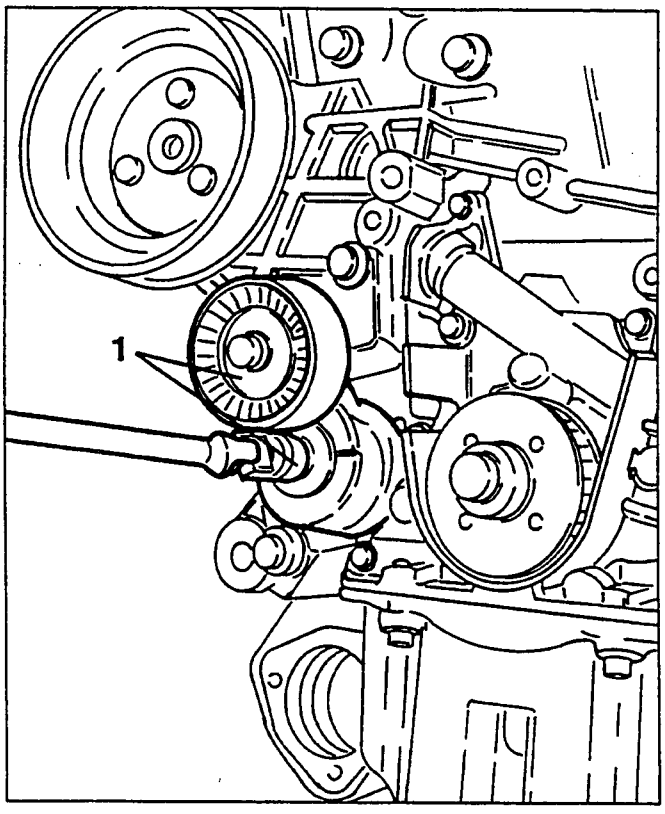


REMOVING THE ALTERNATOR AND POWER STEERING PUMP SUPPORT

1. Slacken completely the nut loosened previously and remove the timing gear belt tensioner.
2. Slacken the fastening screw and remove the timing gear belt guide pulley.

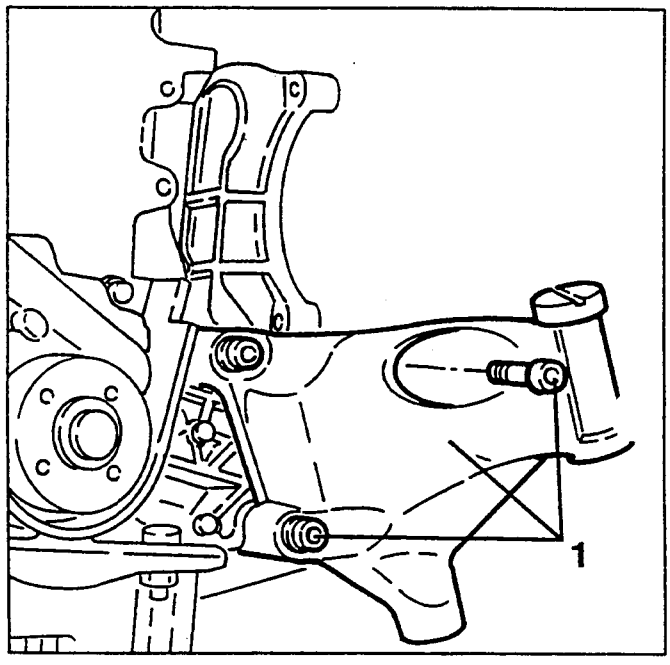


1. Slacken the fastening screw and remove the auxiliary components drive belt tensioner.

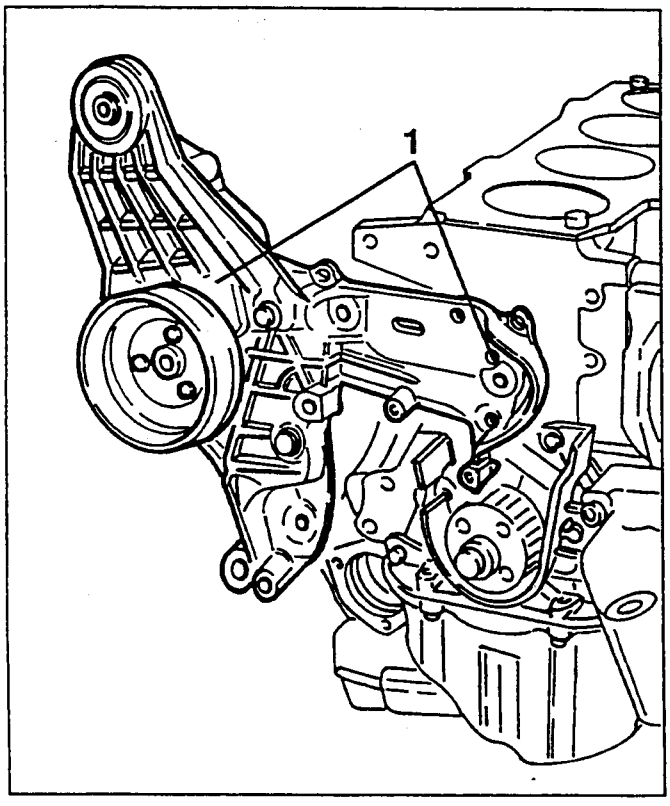


REMOVING THE POWER UNIT FRONT SUPPORT

1. Slacken the three fastening screws and remove the power unit front support.

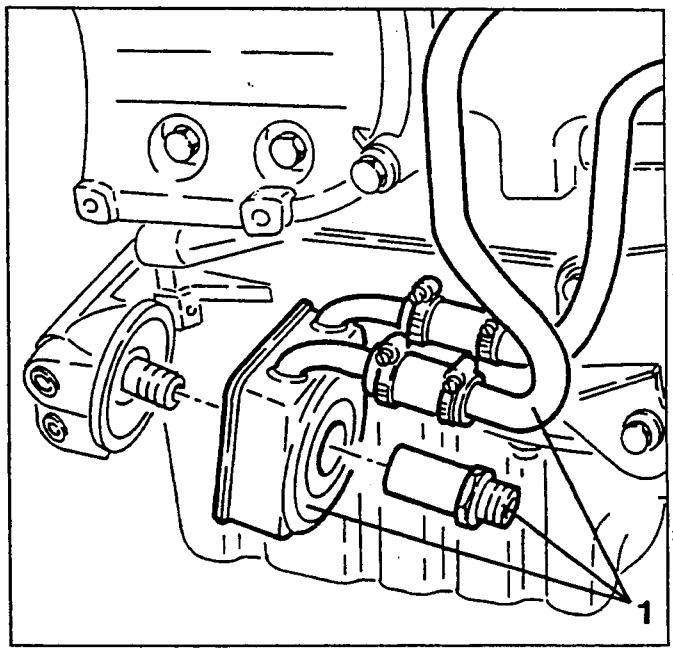


1. Slacken the fastening screws and remove the alternator and power steering pump support complete with the pump and, if necessary, separate them on the bench.



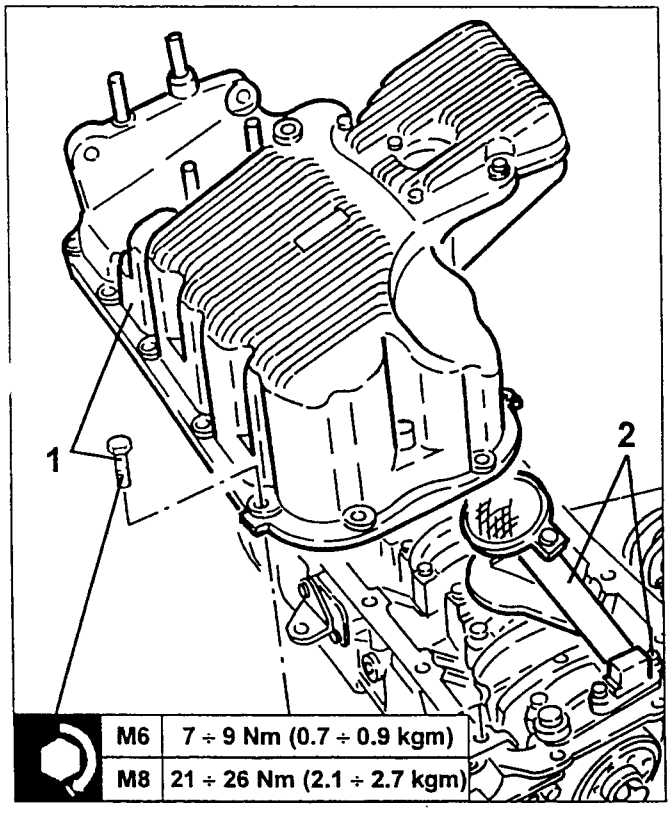
REMOVING THE ENGINE OIL COOLING FLUID HEAT EXCHANGER

- Remove the engine oil filter.
1. Slacken the fastening pin and remove the heat exchanger complete with coolant fluid inlet and o pipes.
- Remove the O-Ring.



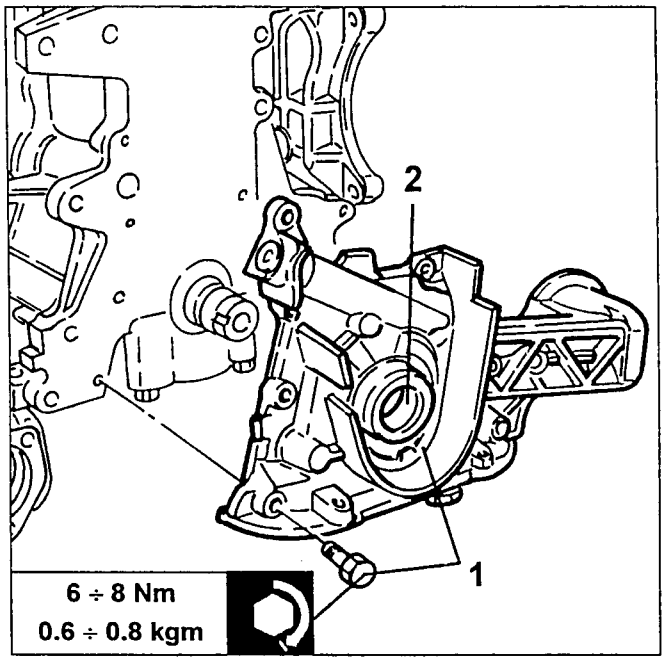
REMOVING THE OIL SUMP

1. Turn the engine on the overhauling stand, then slacken the fastening screws and remove the oil sump.
2. Slacken the two fastening screws and remove the suction device with its seal.



REMOVING THE ENGINE OIL PUMP

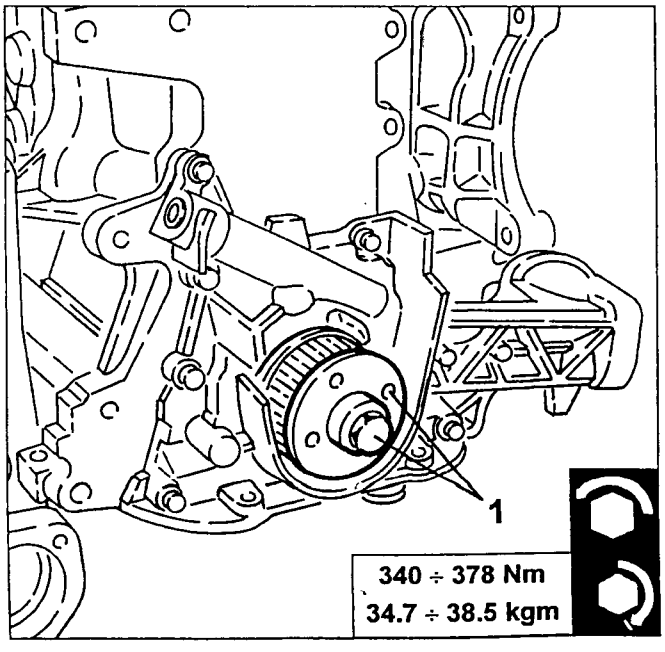
1. Slacken the fastening screws and remove the engine front cover with incorporated oil pump.
2. Prise and remove the crankshaft front oil seal.



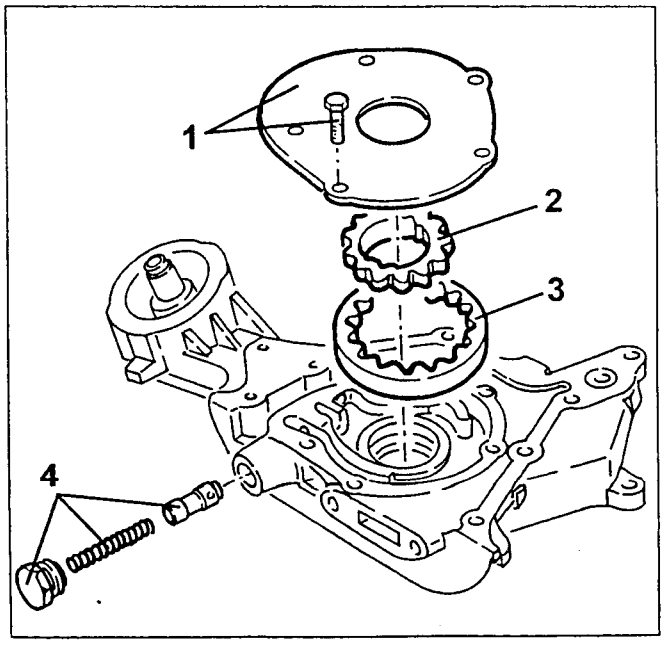
When refitting the crankshaft front oil seal, after fitting it on the oil pump assembly and assembling this on the crankcase, use tool no. 1.821.247.000.

REMOVING THE TIMING GEAR DRIVE BELT PULLEY

1. Slacken the left-handed screw and remove the camshaft drive belt pulley.

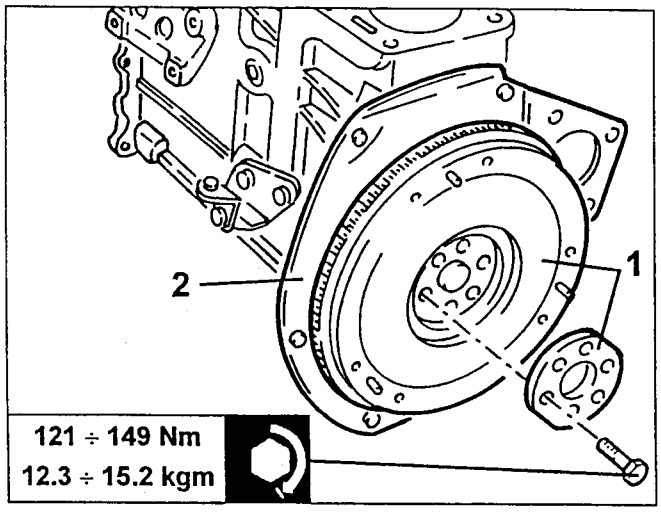


1. On the bench, slacken the fastening screws and remove the engine oil pump cover.
2. Remove the driving gear.
3. Remove the driven gear.
4. Slacken the fastening pin and remove the spring and the engine oil pump overpressure sliding valve.



REMOVING THE FLYWHEEL

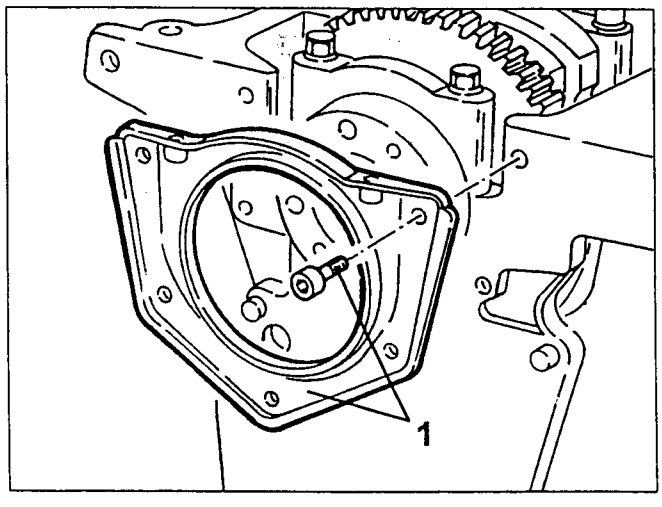
1. Slacken the fastening screws and remove the flywheel.
2. Retrieve the flywheel cover.



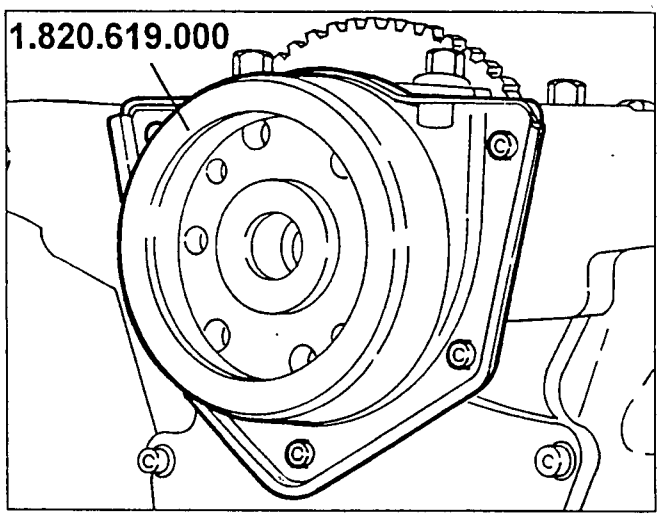
- Remove the flywheel stopper tool installed previously.

REMOVING THE CRANKCASE REAR COVER

1. Slacken the fastening screws and remove the crankcase rear cover with incorporated oil seal ring.

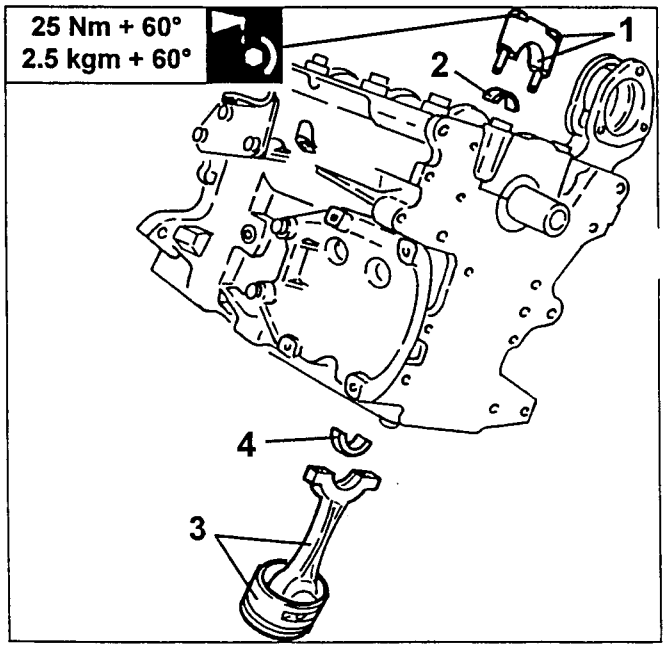


Refit the rear cover as follows:
- **fit tool no. 1.820.619.000 on the oil seal of the rear crankcase cover;**
- **fit the tool - rear cover together and tighten the screws fastening to the crankcase; the tool should be removed only after also tightening the screws fastening the rear cover to the oil sump.**



REMOVING THE PISTONS AND CONNECTING RODS

- Turn the crankshaft so that the pistons of the 1st and 4th cylinder reach the T.D.C.
1. Slacken the fastening screws and remove the connecting rod caps of the 1st and 4th cylinder.
2. Remove the corresponding connecting rod half bearings.
3. Withdraw the pistons and connecting rods of the 1st and 4th cylinder
4. Remove the corresponding connecting rod half bearings.



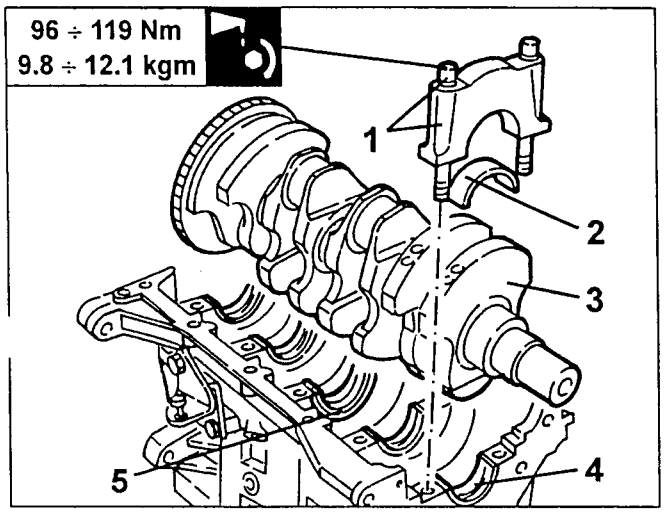
- Proceed in the same way for the 2nd and 3rd cylinder.
- Using a suitable tool, remove the seal rings and scraper ring from the piston.

WARNING: Proceed with care to avoid accidentally breaking any re-usable rings.

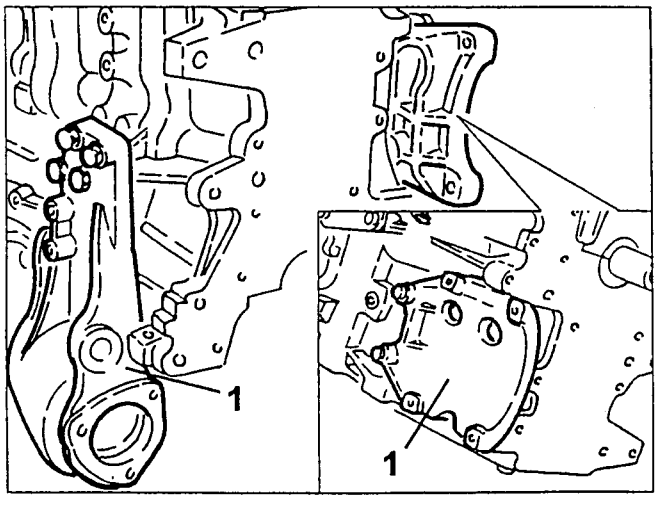
- Remove the two gudgeon pin circlips.
- Remove the gudgeon pin and separate the piston from the connecting rod.

REMOVING THE CRANKSHAFT

1. Slacken the fastening screws and remove the main bearing caps.
2. Remove the corresponding main half bearings.
3. Remove the crankshaft.
4. Remove the main half bearings from the supports.
5. Remove the two half thrust rings.



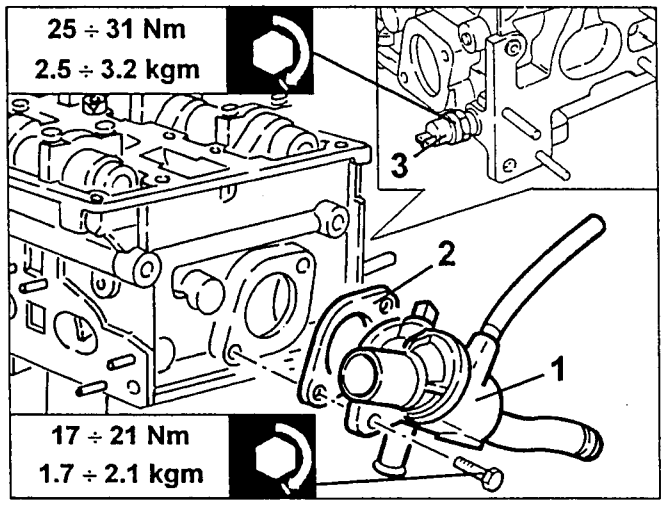
- If necessary, slacken the fastening screw and remove the engine oil spray jets for lubricating and cooling the pistons from the crankcase.
1. If necessary, slacken the fastening screws and remove the air conditioner compressor and layshaft support brackets from the crankcase.



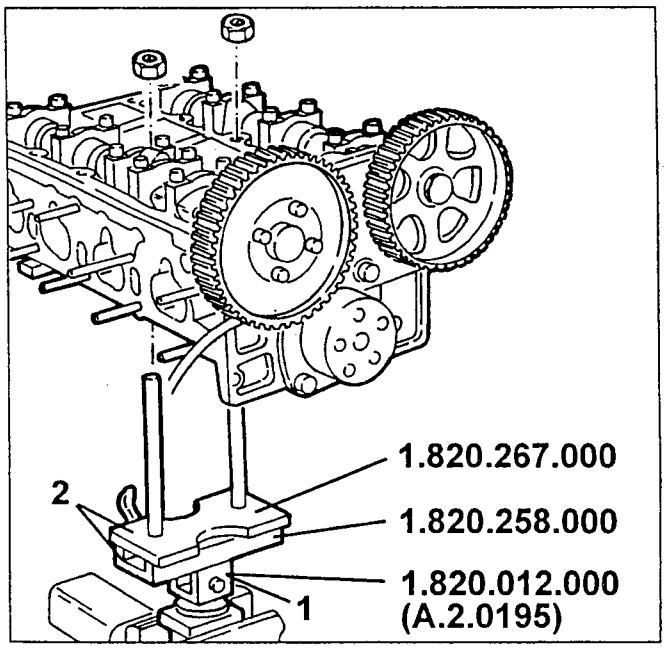
CYLINDER HEAD DISASSEMBLY

PRELIMINARY OPERATIONS

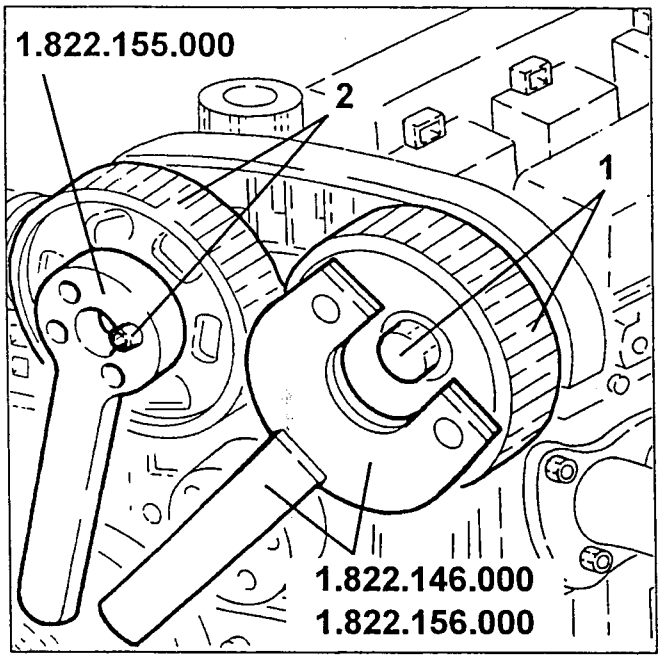
1. Slacken the fastening screws and remove the thermostatic cup complete with piping from the cylinder head.
2. Remove the corresponding seal.
3. Remove the engine coolant temperature gauge transmitter and maximum temperature warning light contact from the cylinder head.



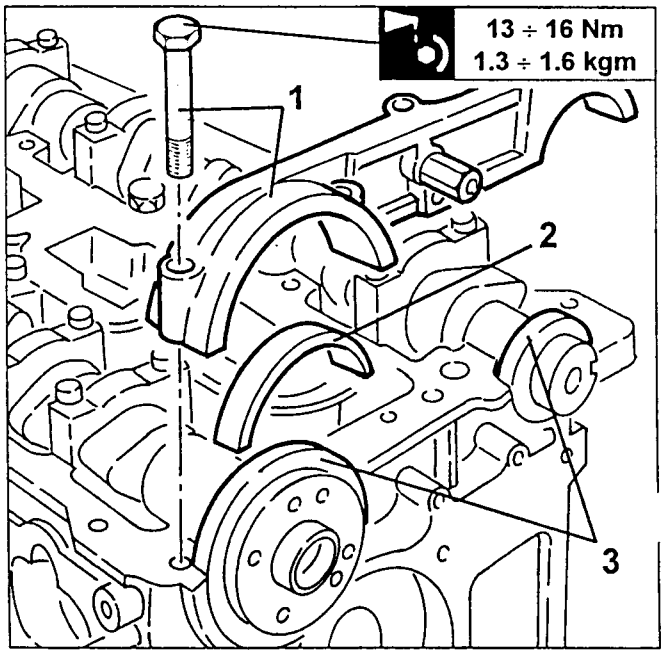
1. Fasten swivel support no. 1.820.012.000 (A.2.0195) in a vice.
2. Fasten tools no. 1.820.258.000 and no. 1.820.267.000 on the swivel support, then fasten the cylinder head on them.



1. Slacken the fastening screw using tools no. 1.822.146.000 and no. 1.822.156.000 and remove the exhaust side camshaft drive pulley.
2. Slacken the fastening screws using tool no. 1.822.155.000 and remove the intake side camshaft drive pulley.

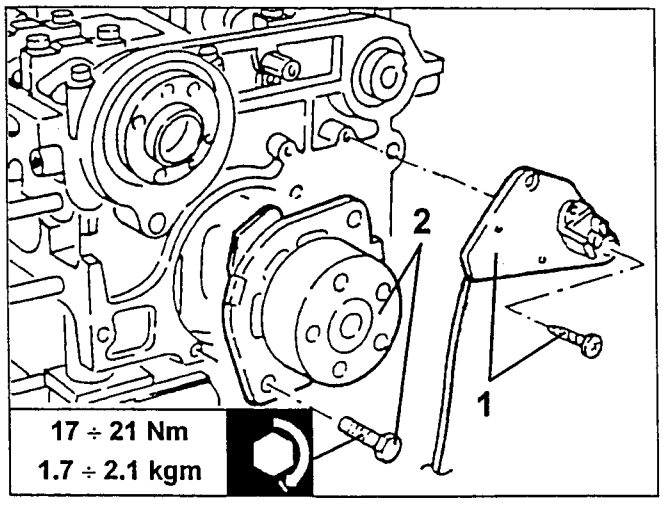


2. Remove the intake side half bearing.
3. Remove the oil seal rings from the camshafts.

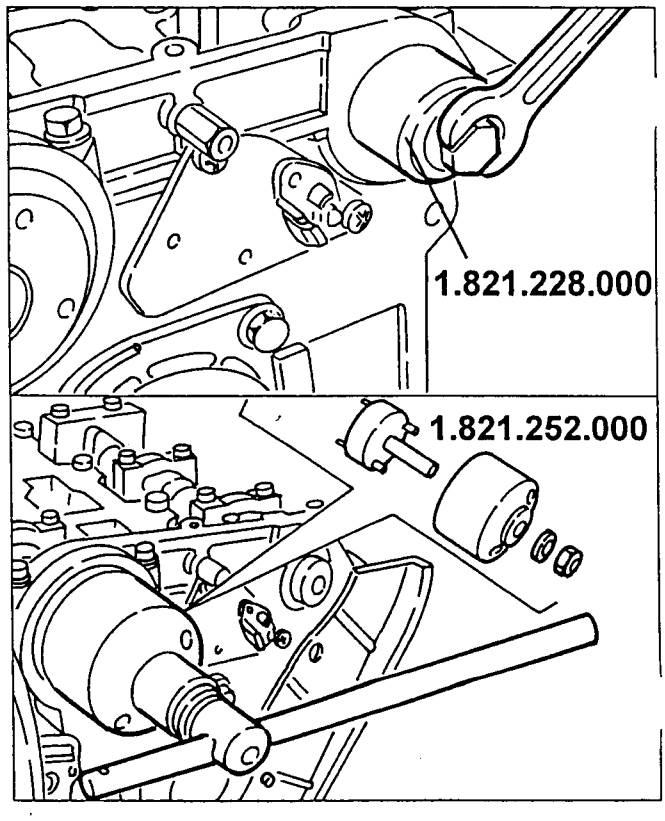


REMOVING THE WATER PUMP

1. Slacken the two fastening screws and remove the timing sensor complete with support.
2. Slacken the two fastening screws and remove the water pump complete with O-ring.



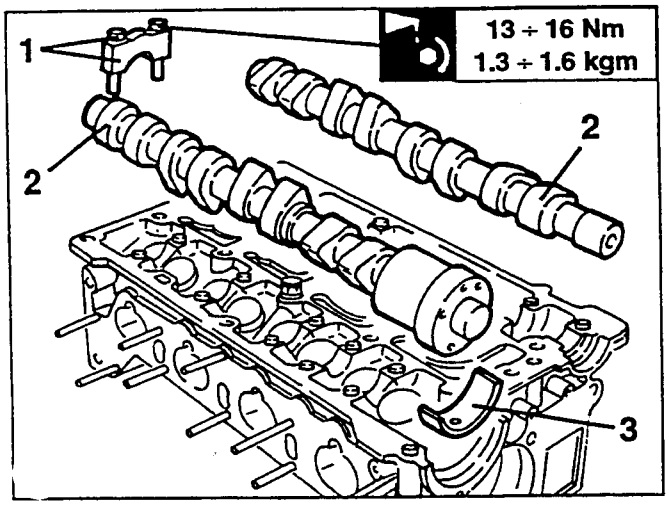
When refitting using tool no. 1.821.228.000 insert the exhaust side oil seal.
Using tool no. 1.821.252.000 insert the intake side oil seal.



REMOVING THE CAMSHAFTS

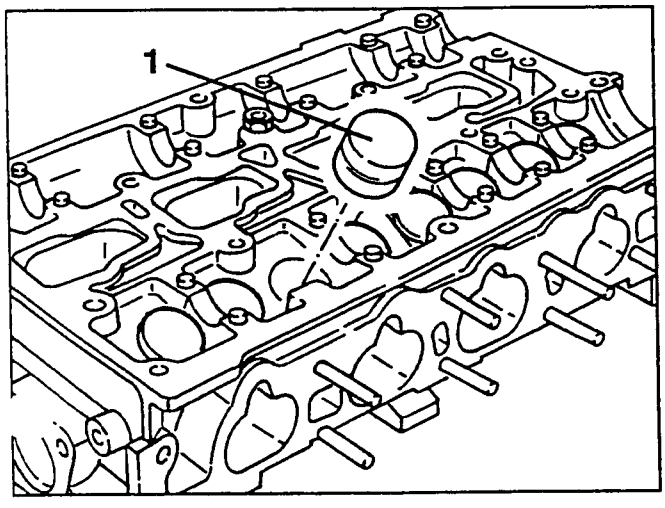
1. Slacken the four fastening screws and remove the camshaft front cap.

1. Slacken the fastening screws and remove the camshaft caps.
2. Remove the camshafts.
3. Remove the intake side half bearing.

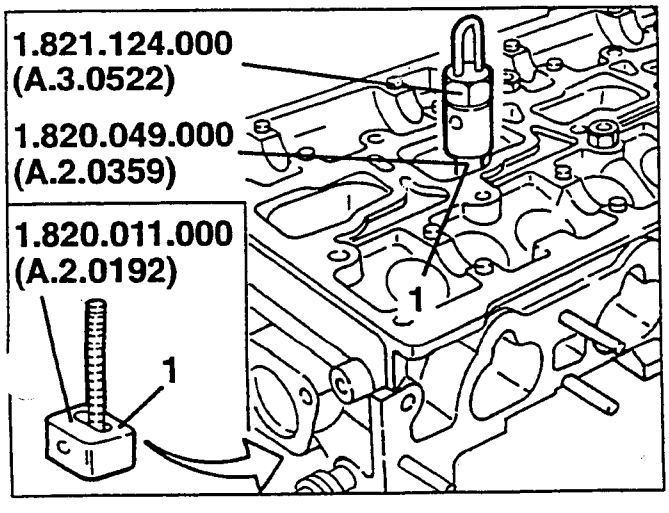


VALVES DIS-ASSEMBLY

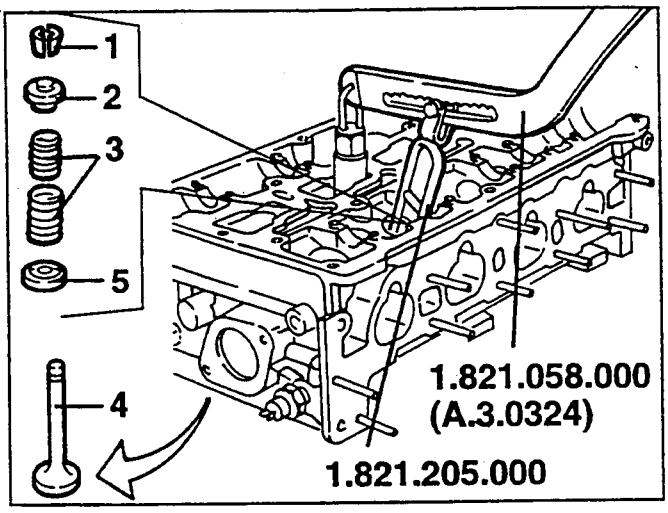
1. Withdraw the hydraulic tappets from their housings.



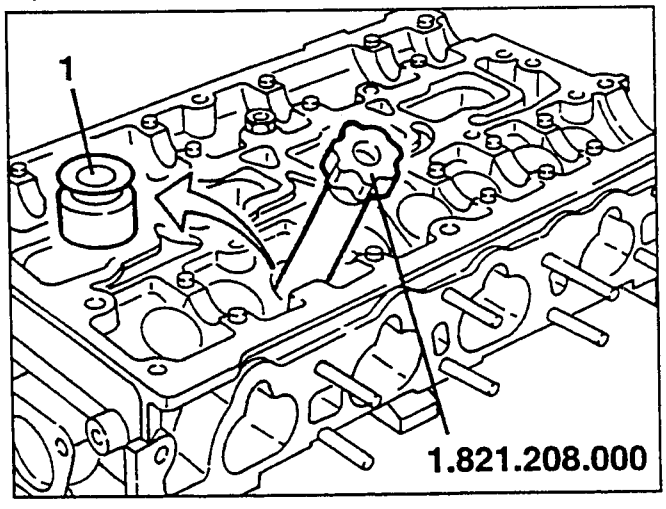
1. On the cylinder head assemble tools no. 1.820.011.000 (A.2.0192), no.1.820.049.000 (A.2.0359) and no. 1.821.124.000 (A.3.0522).



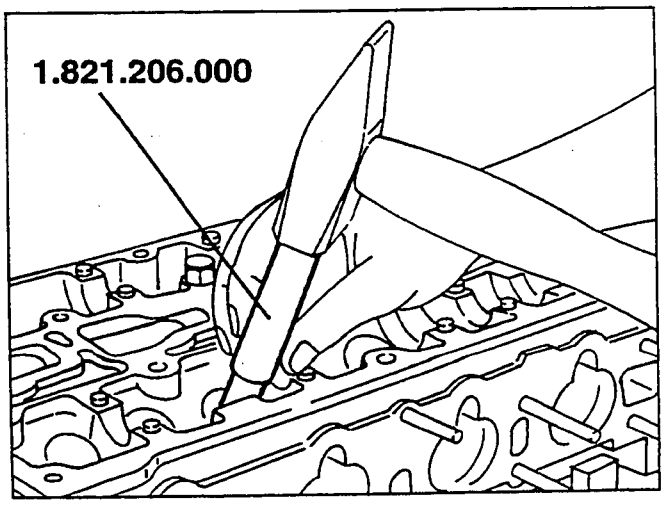
1. Using lever no. 1.821.058.000 (A.3.0324) and cage no. 1.821.205.000, remove the half cones from the valve stem.
2. Remove the upper plate.
3. Remove the outer and inner springs.
4. Remove the tools and retrieve the valve.
5. Remove the valve lower plate.



1. Using tool no. 1.821.208.000, remove the oil seal cap.



When refitting the oil seal cap use tool no. 1.821.206.000.

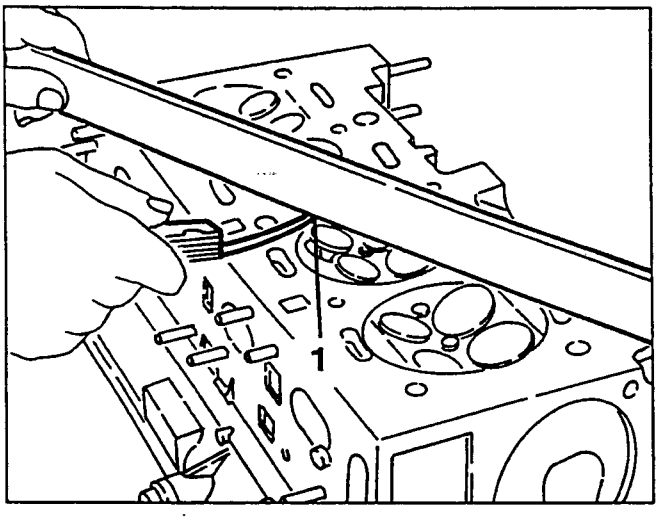


CHECKS AND INSPECTION CYLINDER HEAD

Checking the lower surface of the cylinder head

1. Check the flatness of the lower cylinder head surface; reface if it is excessively worn.

Maximum flatness error of cylinder head lower surface
0.1 mm

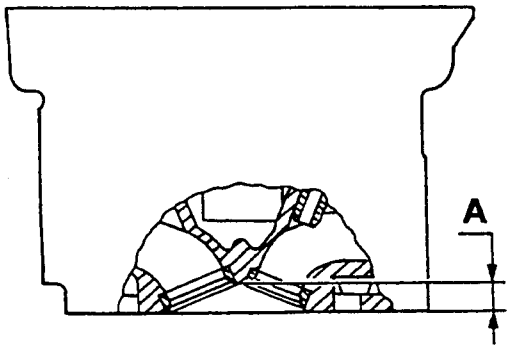


- After refacing, check that the depth of the combustion chamber, on the head, exceeds the minimum allowed limit.

WARNING:
Exceeding the minimum allowed limit involves serious engine operating failures.

Minimum depth "A" of the combustion chamber in the head
13 ± 0.2 mm

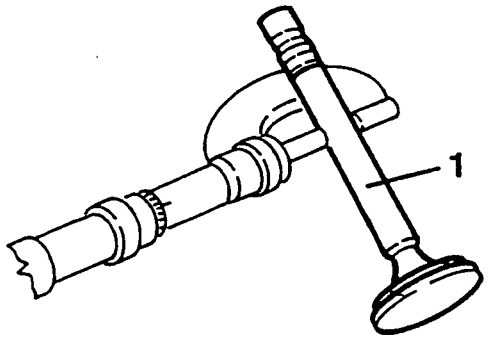
- Check that the finishing of the lower cylinder head surface is satisfactory.



Checking the clearance between valve guides and valve stems

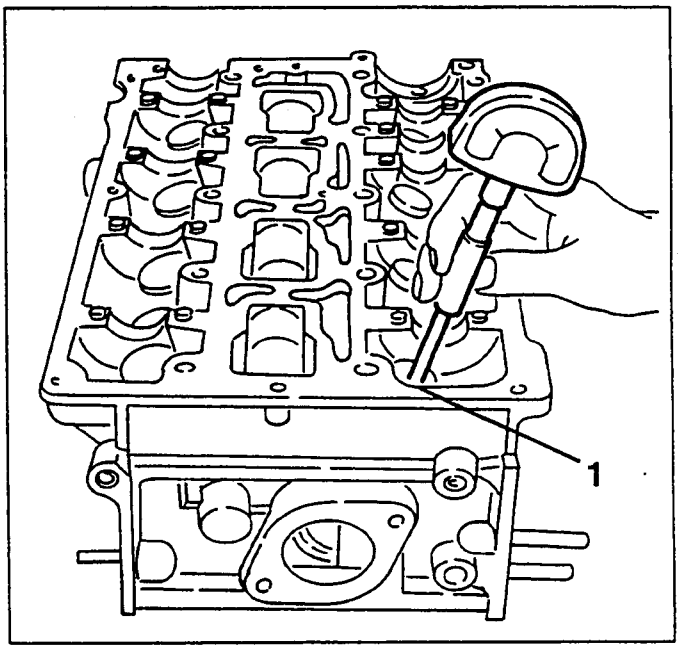
1. Measure the diameter of the valve stems and check that it is within the specified limits.

Diameter of valve stems	
Intake	6.975 ÷ 6.990 mm
Exhaust	6.960 ÷ 6.975 mm



1. Measure the inside diameter of the valve guides and check that it is within the specified limits.

Inside diameter of valve guides
7.022 ÷ 7.040 mm

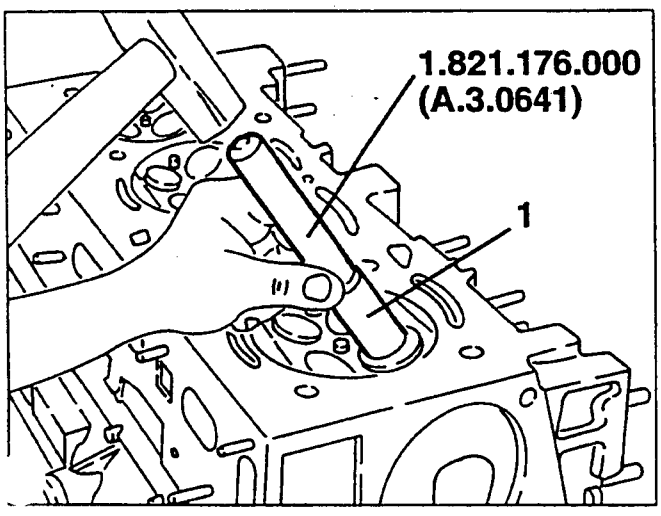


- Calculate the clearance between valve guides and stems and check that it is within the specified limits, if not, change any worn parts.

Radial clearance between valve guides and stems	
Intake	0.032 ÷ 0.065 mm
Exhaust	0.047 ÷ 0.080 mm

Changing the valve guides

1. Using puller tool no. 1.821.176.000 (A.3.0641), remove the worn valve guides.



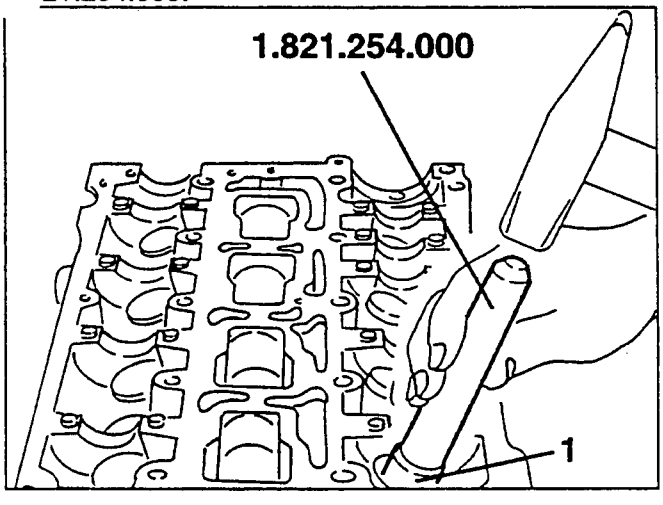
- Check that the outside diameter of the valve guides and their seats on the head are within the specified limits and that their assembly interference is correct.

Outside diameter of valve guides
13.010 ÷ 13.030 mm

Diameter of valve guide seats
12.950 ÷ 12.977 mm

Interference between valve guides and seats
0.033 ÷ 0.080 mm

1. Insert the new valve guides using tool no. 21.254.000.



- Bore the valve guide inside diameter to calibrate the holes to the specified diameter.

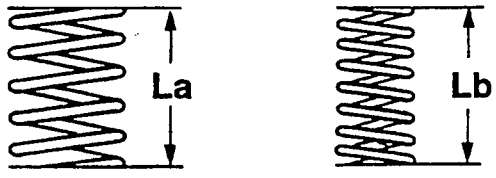
Inside diameter of valve guides
7.022 ÷ 7.040 mm

Checking the valve springs

- Check that the "free" length of the valve springs is within the specified limits.

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

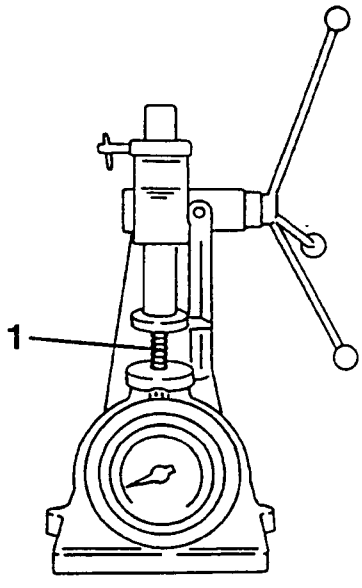
Free length of valve springs	
outer spring "La"	46 mm
inner spring "Lb"	39 mm



1. Using a torque meter, check that the characteristic data of the springs are within the specified limits.

Outer spring		
Length of spring mm		Control load N (Kg)
With valve closed	34	271 ÷ 294 (27.6 ÷ 30)
With valve open	24.5	485 ÷ 524 (49.4 ÷ 53.4)

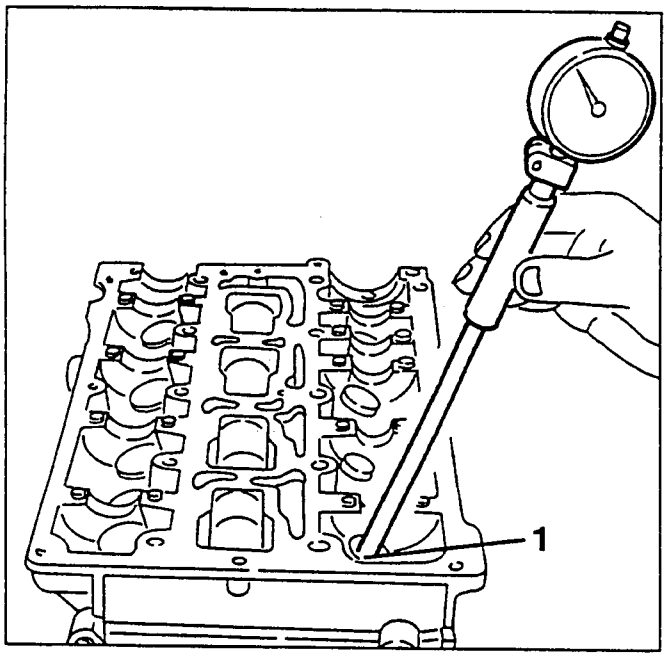
Inner spring		
Length of spring mm		Control load N (Kg)
With valve closed	29.5	96 ÷ 106 (9.8 ÷ 10.8)
With valve open	20	201 ÷ 221 (20.5 ÷ 22.5)



Checking the clearance between the cups and their seats

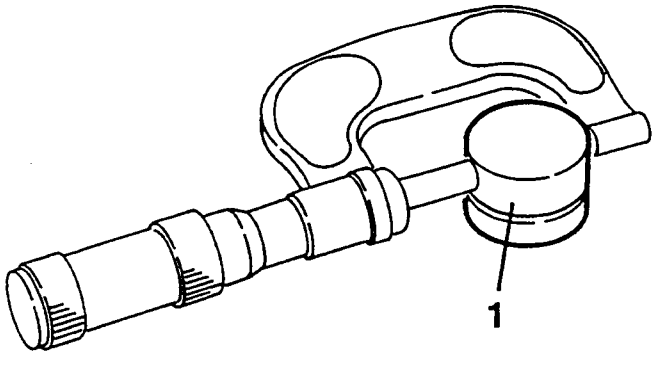
1. Check that the diameter of the cup seats is within the specified limits.

Diameter of valve cup seats
33.000 ÷ 33.025 mm



1. Check that the outside diameter of the cups is within the specified limits.

Diameter of valve cups
32.959 ÷ 32.975 mm



- Calculate the clearance between the cups and their seats checking that it is within the specified limits.

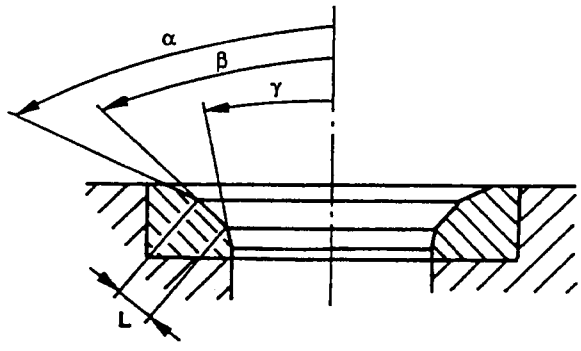
Clearance between cups and seats
0.025 ÷ 0.066 mm

Turning the valve seats

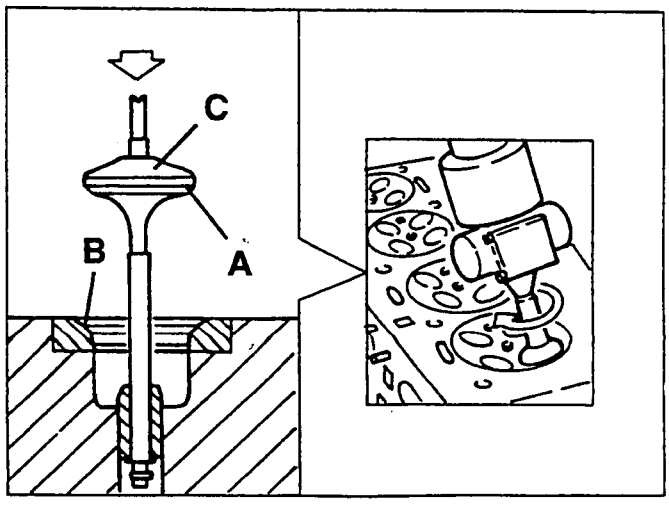
- If necessary, turn the valve seats using suitable equipment within the following limits.

Taper of contact area with valve "β"	90° ± 10'
Taper of upper valve seat area "α"	150°
Taper of lower valve seat area "γ"	30°

Dimension "L" contact area with valve	
Intake	6.5 mm
Exhaust	5.5 mm



- After machining, grind each valve in its seat as follows:
- coat the contact surfaces "A" and "B" of the valves and their seats with abrasive paste (SIPAL AREX(Carbosilicium for valves);
- lubrificate the valve stem with engine oil;
- fit the lower surface of the valve mushroom to the suction cup "C" of a pneumatic grinder;
- insert the valve in its guide and grind;
- after grinding, thoroughly clean the valve and the seat.



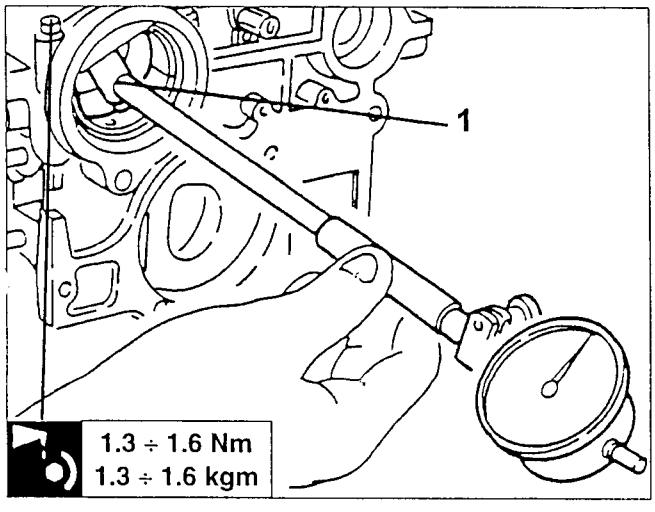
- If valve seat machining and grinding is required, perform a valve tightness test (with the spark plugs fitted) as follows:
• fill the combustion chamber with petrol;
• let low pressure air into the intake manifolds and check no air bubbles form in the petrol;
• perform the same test on the exhaust valve by letting air into the exhaust manifolds;
• if leaks are found, make sure the valves are perfectly fitted in their seats. Repeat the tightness test. If the outcome is negative, repeat the grinding operation.

Camshaft and journals

1. Fit the camshaft bearings and fasten the respective screws at the prescribed torque. Then check whether the journal bearing diameter falls within prescribed values.
NOTE: Fit the respective half-bearings on the front journal, intake side.

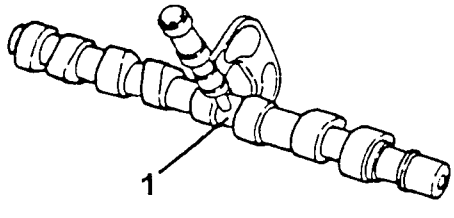
Camshaft journal bearing diameter
26.045 ÷ 26.070 mm 50.034 ÷ 50.071 mm (*)

(*) Front journal, intake side, with half-bearings fitted (for phase variator)



1. Check whether the camshaft journal fall within the prescribed values.

Camshaft journal diameter
26.000 ÷ 26.015 mm



- Calculate the play between the camshaft bearings and respective journals and check whether it falls within the prescribed values.

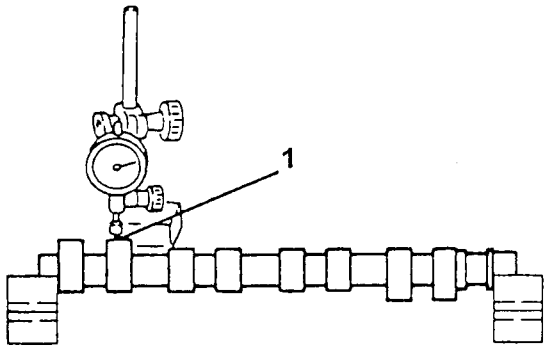
Play between camshaft and journal	
0.03 ÷ 0.07 mm	0.034 ÷ 0.086 mm (*)

(*) Specific for phase variator

1. Check whether the cam rising falls within prescribed values.

Nominal cam raising		
Intake	8.3 mm pre-change 9.0 mm post-change (*) (1)	9.5 mm (2)
Exhaust	7.5 mm (1)	9.5 mm (2)

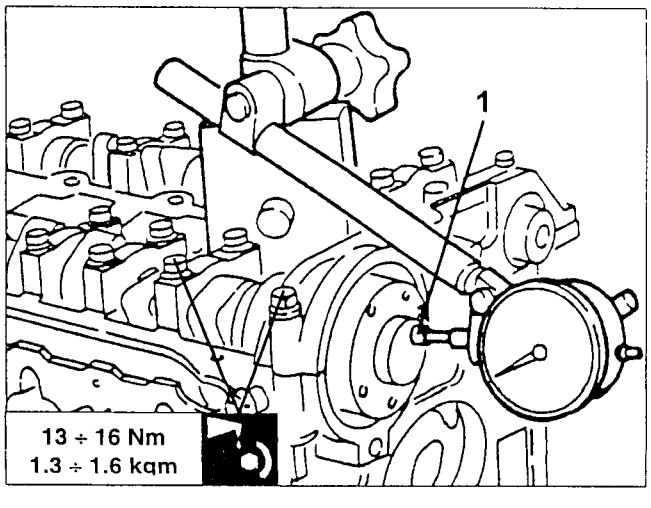
(*): with M1.5.5 injection-ignition
(1): 1598 c.c. (2) 1747 c.c.



Crankshaft axial play

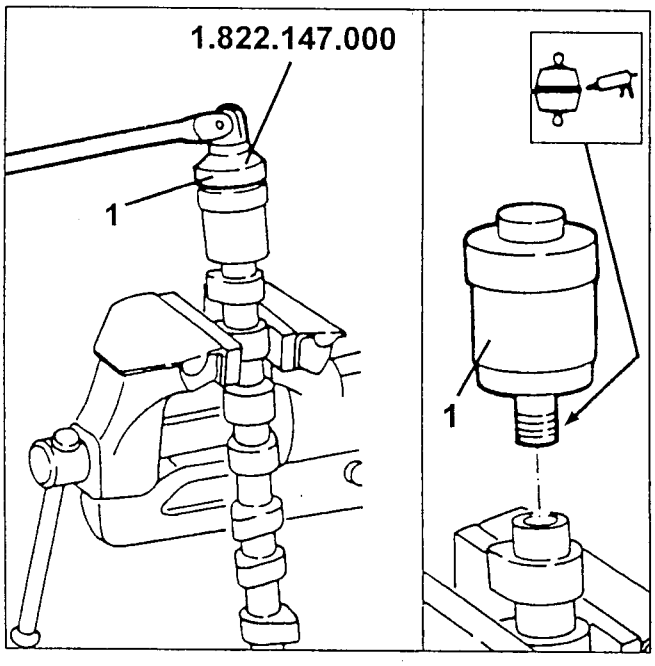
- Position the camshafts on the cylinder head, fit the respective bearings and fasten the screws as prescribed.
1. Check whether crankshaft axial play falls within prescribed values by means of a centesimal gauge applied with its magnetic base.

Crankshaft axial play
0.10 ÷ 0.23 mm

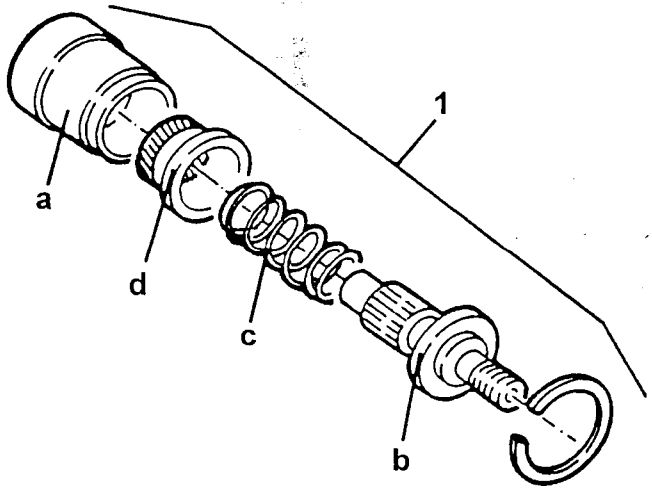


Camshaft phase variator disassembly

- Position the camshaft, intake side, in a vice with padded jaws.
1. Loosen and remove the phase variator from the camshaft with tool no. 1.822.147.000.



1. Remove the retainer ring and extract the pinion (b), the spring (c) and the piston (d) from the phase variator casing (a).



IMPORTANT:
Attain to the following instructions when refitting the phase variator:
- Make sure the glue on the camshaft phase variator coupling thread does not obstruct the oil ducts.
- Wait for approximately two hours before fitting the camshaft on the cylinder head.

CRANKCASE CHECKS AND TESTS

- Inspect the crankcase for cracks or signs of excessive wear on sliding surfaces. Check intactness of all threading.
- Remove the lubrication and cooling duct caps and clean the ducts with a suitable detergent. Dry with a jet of compressed air and fit new caps.
- Clean the crankcase surfaces from fragments of seals or sealant.

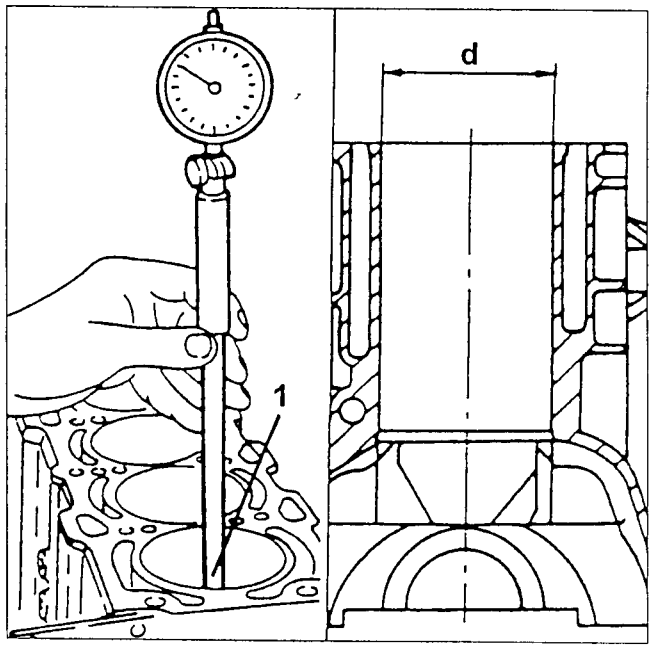
Cylinder checks

1. Measure the internal diameter of the cylinders with a gauge and check it falls within the prescribed values.

Internal diameter "d"	
Class A	82.000 ÷ 82.010 mm
Class B	82.010 ÷ 82.020 mm
Class C	82.020 ÷ 82.030 mm
0.1 mm oversize	

Maximum cylinder taper
0.010 mm

Maximum cylinder ovality
0.005 mm

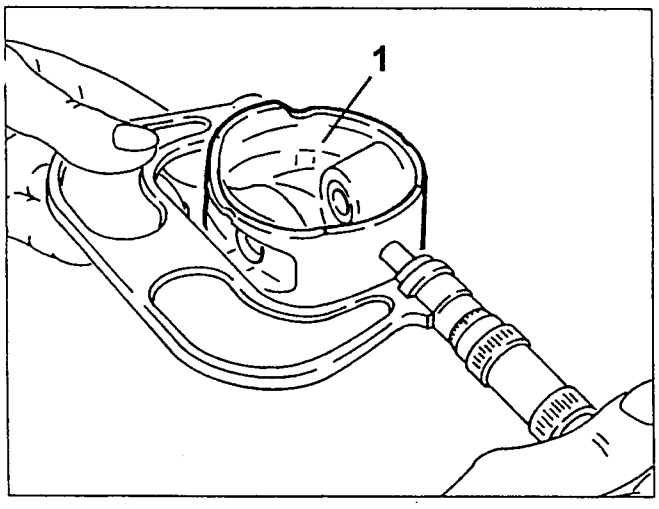


Checking the pistons

1. Measure the outside diameter of the pistons and check that it is within the specified limits.

Outside diameter of pistons (1)	
Class A (Blue)	81.952 ÷ 81.962 mm
Class B (Pink)	81.960 ÷ 81.970 mm
Class C (Green)	81.968 ÷ 81.978 mm
Oversize of 0.1 mm	

(1) To be measured at right angles to the gudgeon pin hole at a distance of 12.5 mm from the lower edge of the piston skirt.

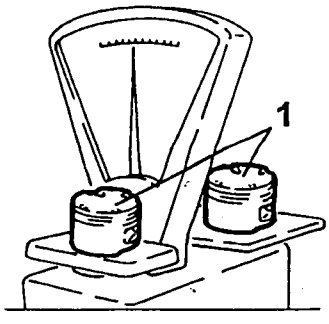


- Calculate the clearance between the cylinder and the piston and check that it is within the specified limits.

Clearance between piston and cylinder
0.038 ÷ 0.062 mm

1. Check that the difference in weight between the pistons complete with gudgeon pins and seal rings is within the specified limits.

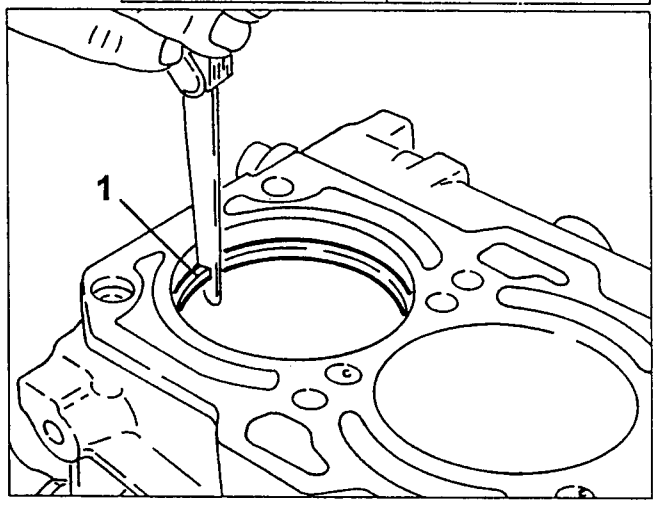
Difference in weight between pistons
± 5 g



Checking the seal ring gap

1. Insert the seal rings in the cylinder, check that they adhere to the whole circumference and that the gap is within the specified limits.

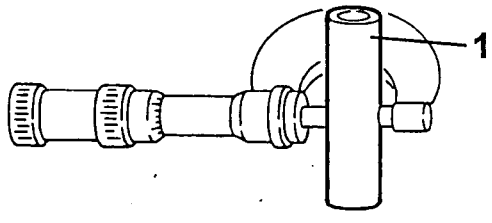
Ring gap	
First ring	0.25 ÷ 0.50 mm
Second ring	0.30 ÷ 0.50 mm
Oil scraper ring	0.25 ÷ 0.45 mm



Checking the play between gudgeon pins and seats on pistons

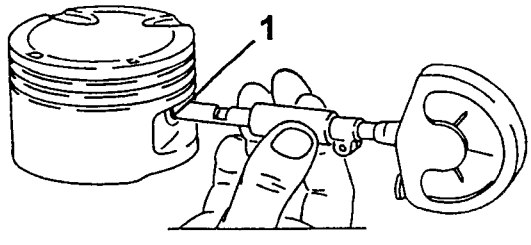
1. Measure the outside diameter of the gudgeon pins and check that it is within the specified limits.

Outside diameter of gudgeon pins
19.996 ÷ 20.000 mm



1. Measure the diameter of the pin mating hole in the piston and check that it is within the specified limits.

Diameter of pin seat in pistons
20.002 ÷ 20.007 mm



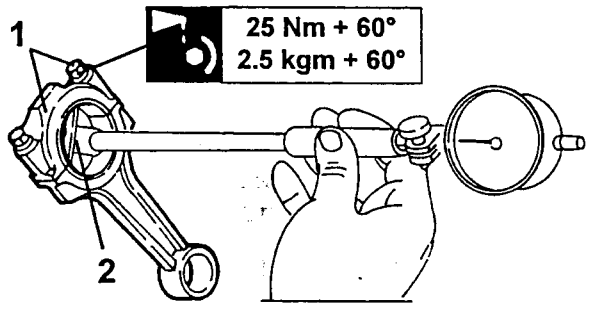
- Calculate the clearance between the pins and their seats on the pistons and check that it is within the specified limits.

Clearance between pins and seats on pistons
0.002 ÷ 0.011 mm

Checking clearance between connecting rod journals and corresponding half bearings

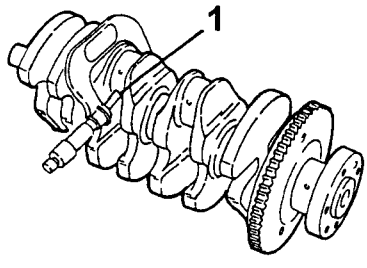
1. House the rod half bearings in the connecting rod big end and on the corresponding cap, then join them tightening the fastening screws to the specified torque.
2. Measure the diameter of the connecting rod big end and check that it is within the specified limits.

Inside diameter of connecting rod half bearings (mm)		
Class	1598	1747
Class A (Red)	48.274 ÷ 48.294	50.835 ÷ 50.855
Class B (Bleu)	48.268 ÷ 48.288	50.827 ÷ 50.847
Class C (Yellow)	48.262 ÷ 48.282	50.819 ÷ 50.839



1. Measure the diameter of the connecting rod journals and check that it is within the specified limits.

Diameter of connecting rod journals (mm)		
Class	1598	1747
Class A (Red)	48.238 ÷ 48.244	50.799 ÷ 50.805
Class B (Bleu)	48.232 ÷ 48.238	50.793 ÷ 50.799
Class C (Yellow)	48.226 ÷ 48.232	50.787 ÷ 50.793



- Calculate the clearance between the rod journals and the corresponding half bearings and check that it is within the specified limits.

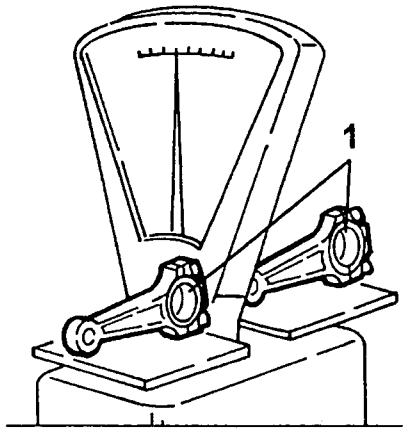
Clearance between rod journals and half bearings
0.03 ÷ 0.056 mm (1) 0.026 ÷ 0.056 mm (2)

(1): 1598 (2): 1747

Checking the connecting rods

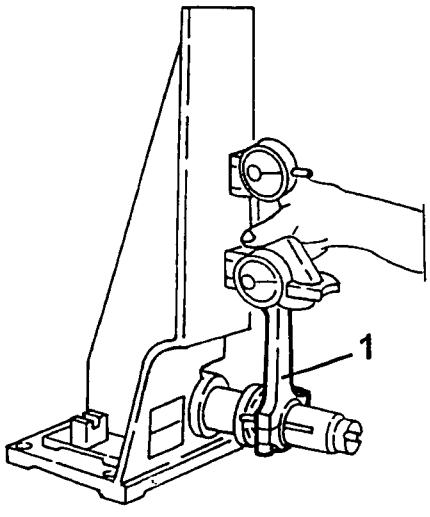
1. Check that the difference in weight between the connecting rods complete with half bearings, caps and screws is within the specified limits.

Difference in weight between connecting rods	≤ 5 g



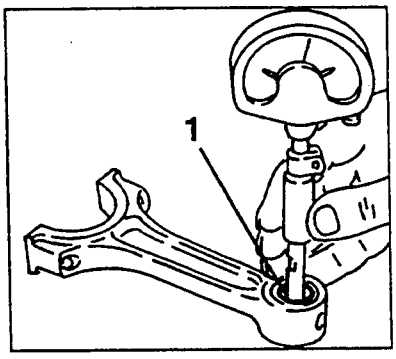
1. Check that the connecting rods are perpendicular using a reference plane as illustrated.

NOTE: If perpendicularity is not perfect, the connecting rod must be changed to avoid abnormal stresses when the engine is running, resulting in uneven wear of the piston and of the rod itself.



Checking the clearance between pins and small end bushings

1. Measure the inside diameter of the small end bushing and check that it is within the specified limits, if not, change the bushing.



Inside diameter of small end bushing
20.006 ÷ 20.012 mm

1. Measure the outside diameter of the pins and check that it is within the specified limits.

Outside diameter of pins
19.996 ÷ 20.000 mm

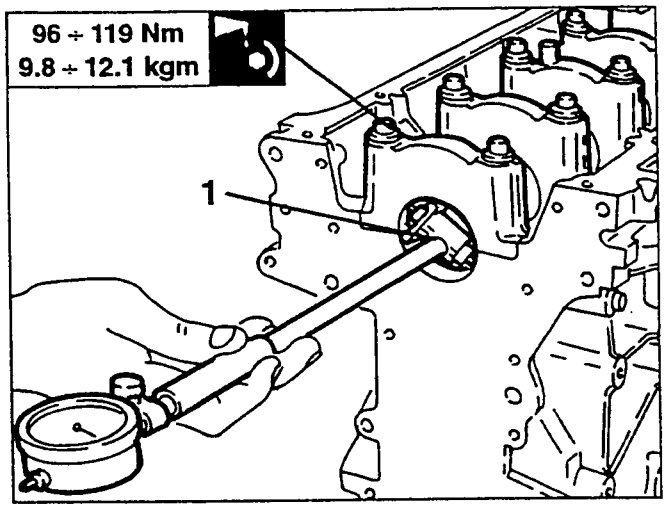
- Calculate the clearance between the pins and small end bushings and check that it is within the specified limits.

Clearance between pins and small end bushing
0.006 ÷ 0.016mm

Checking the clearance between main bearing journals and half bearings

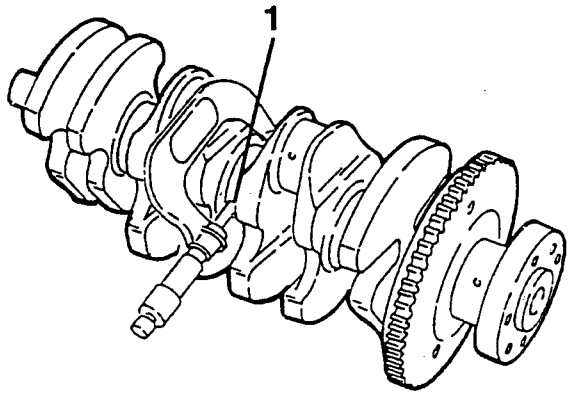
1 House the half bearings and fit the main bearings s on the crankcase tightening the fastening screws to the specified torque.
2. Measure the diameter of the main bearings and check that it is within the specified limits.

Diameter of the main bearings (mm)			
Pos.	Classe	1598	1747
Side	Class A (Red)	53.025 ÷ 53.046	53.031 ÷ 53.056
	Class B (Blue)	53.019 ÷ 53.040	53.017 ÷ 53.046
	Class C (Yellow)	53.013 ÷ 53.034	53.007 ÷ 53.032
Centre	Class A (Red)	53.035 ÷ 53.056	53.041 ÷ 53.066
	Class B (Blue)	53.029 ÷ 53.050	53.027 ÷ 53.056
	Class C (Yellow)	53.023 ÷ 53.044	53.017 ÷ 53.042



1. Measure the diameter of the main bearing journals and check that it is within the specified limits.

Diameter of main bearing journals	
Class A (Red)	52.994 ÷ 53.000 mm
Class B (Bleu)	52.988 ÷ 52.994 mm
Class C (Yellow)	52.982 ÷ 52.988 mm



- Calculate the clearance between the main bearing journals and half bearings and check that it is within the specified limits.

Clearance between main bearing journals and half bearings (mm)		
Pos.	1598	1747
Side	0.025 ÷ 0.052	0.019 ÷ 0.062
Centre	0.035 ÷ 0.062	0.029 ÷ 0.072

Checking the engine flywheel

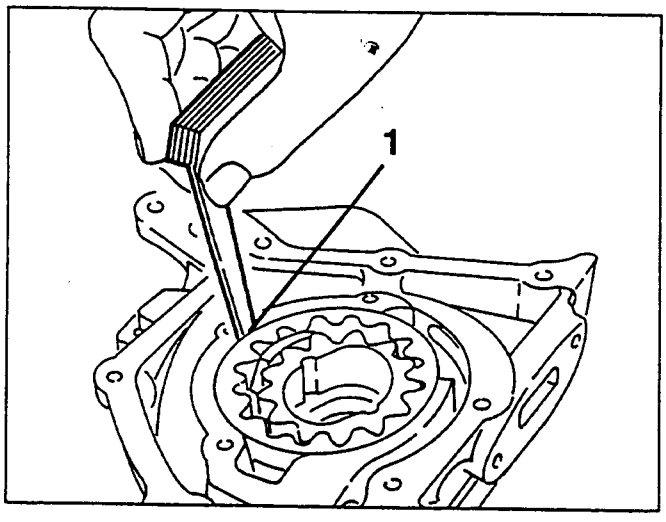
- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
- working under the press remove the old ring gear;
- accurately clean the contact surfaces of the new ring gear and of the flywheel;

• evenly heat the new ring gear to 80° ÷ 100° C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

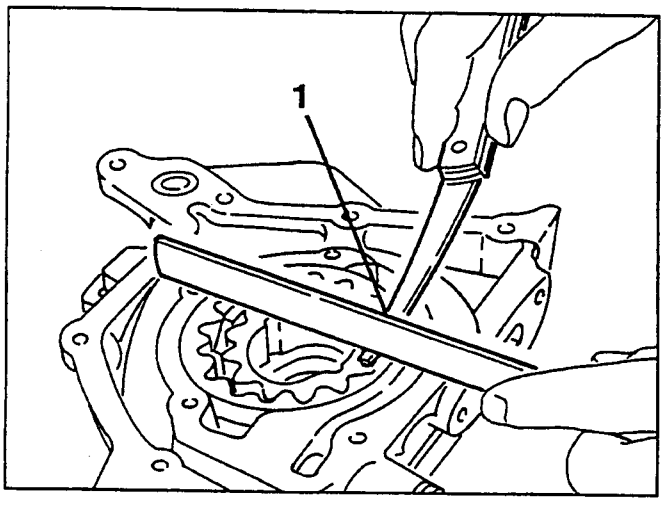
1. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.080 ÷ 0.186 mm



1. Check that the clearance between the pump cover rest surface and the upper side of the gears is within the specified limit.

Clearance between pump cover rest surface and upper side of gears
0.025 ÷ 0.070 mm



WARNING: If the clearances measured are not within the specified limits, change the front crankcase cover with oil pump incorporated.

- Using a torque meter check the characteristic values of the engine oil pressure limiting valve control spring.

Control load Kg	Spring length mm
6.4 ÷ 7.2	36

INSTRUCTIONS FOR RE-ASSEMBLY

For re-assembly operations reverse the sequence described for dis-assembly, unless otherwise indicated below.

- Check valve tightness when the cylinder head assembled (see "Turning the valve seats").

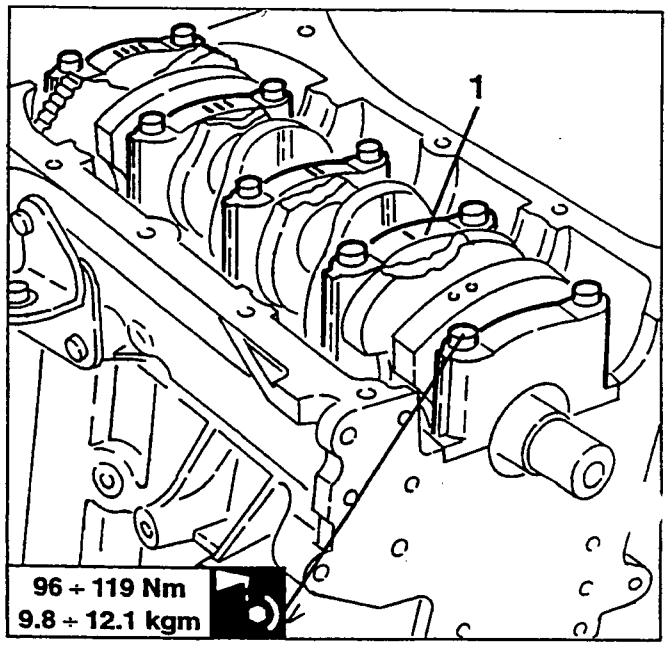
Reassembling the crankshaft

- Assemble the crankshaft on the crankcase complete with half bearings and half thrust rings.

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

1. Assemble the main bearing caps complete with half bearings on the supports and tighten the fastening screws two or three times starting from the centre main bearing cap.

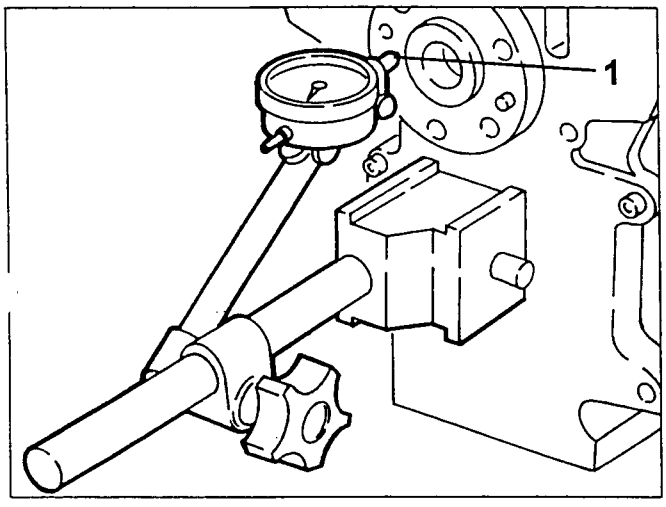
The position of each cap is given by a series of consecutive notches (from zero to four start from the front of the engine) etched on the caps themselves.



Checking the crankshaft end float

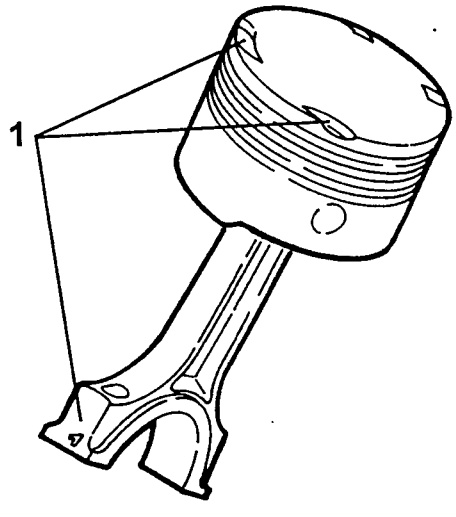
1. Using a dial gauge on a magnetic base, measure the crankshaft end float and check that it is within the specified limits.

Crankshaft end float
0.059 ÷ 0.221 mm



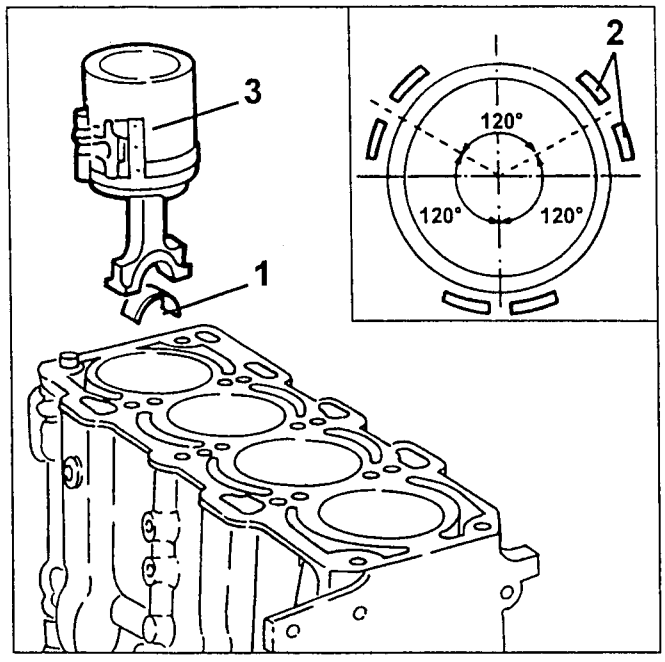
Refitting the pistons and connecting rods

1. Assemble the piston and connecting rod so that the number stamped on the connecting rod big end is on the same side as the large notches (for intake valves) on the piston crown.



- Turn the crankshaft until the connecting rod journals of the 1st and 4th cylinder are in the position corresponding to the B.D.C.
1. House the half bearings on the connecting rod big ends.
2. Insert the rings in the pistons with the cuts offset by 120° and the word TOP printed on them facing upwards.
3. Using a suitable tool, insert the pistons and connecting rods in the 1st and 4th cylinder.

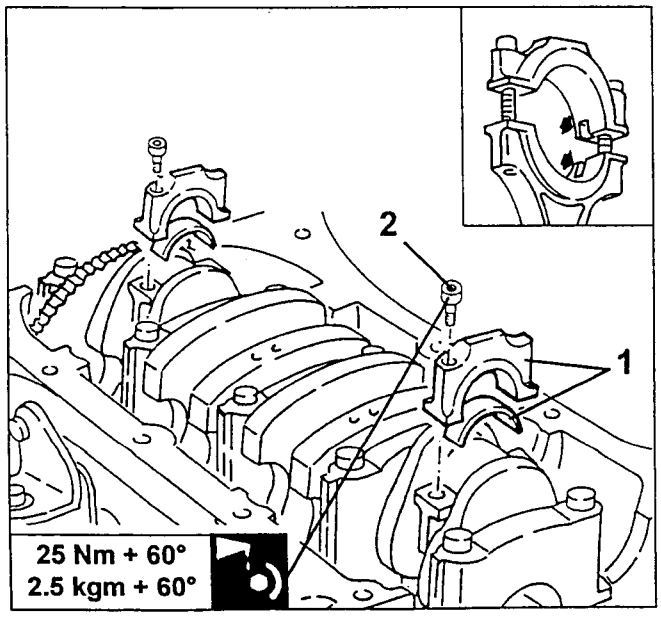
Assemble the connecting rod - piston unit in the crankcase directing the arrow stamped on the piston crown in the direction of rotation of the engine.



- Turn the crankcase 180°.
1. House the half bearings on the connecting rod caps, then assemble those of the 1st and 4th cylinder directing the safety notch towards the same side as the corresponding notch on the connecting rod big end.

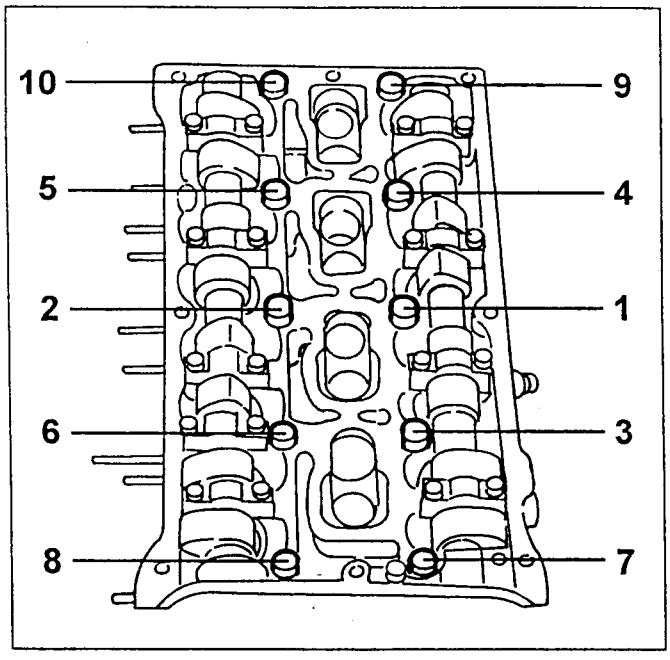
On one side, the connecting rod caps have the number of the cylinder to which they belong; when refitting, this number must always be on the same side as the one stamped on the connecting rod big end.

2. Tighten the connecting rod cap fastening screws in oil to the specified torque.
- In the same way, reassemble the pistons and connecting rods of the 2nd and 3rd cylinder.



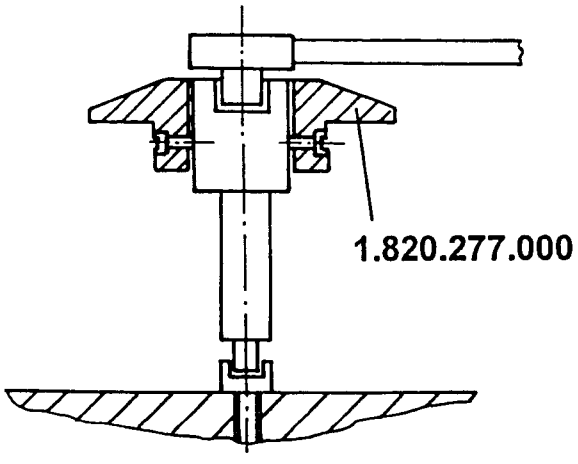
Reassembling the cylinder head

- Turn the crankshaft to take the pistons of the 1st and 4th cylinder to the T.D.C.
- Position the gasket on the crankcase, then the cylinder head.
- Tighten the cylinder head fastening screws as described below and bearing in mind that the tightening sequence is the one shown below for each phase.



Tightening procedure	
Set in all the screws to a torque of:	20 Nm (2.0 kgm)
Tighten the screws to the preliminary torque of:	40 Nm (4.1 kgm)
Turn all the screws with an angle of:	90° + 90° + 90°

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

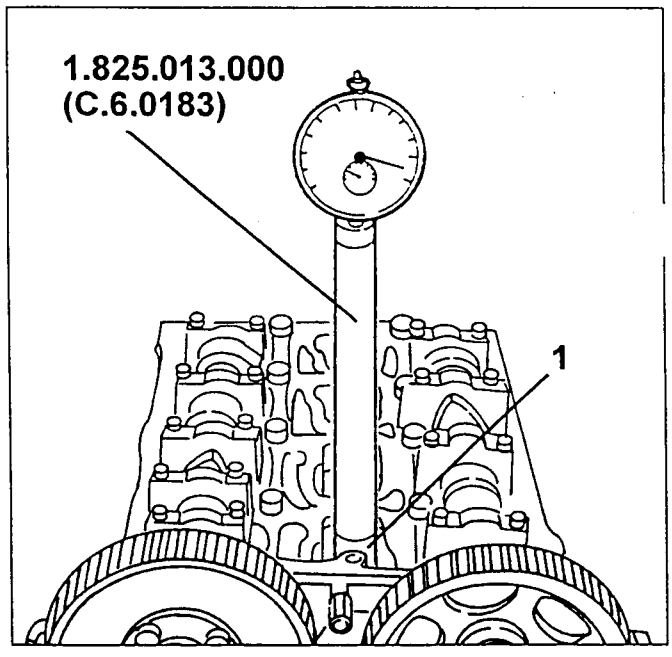


The gasket between the cylinder head and the crankcase is in aramidic fibre and cylinder head retightening is unnecessary throughout the life of the engine.

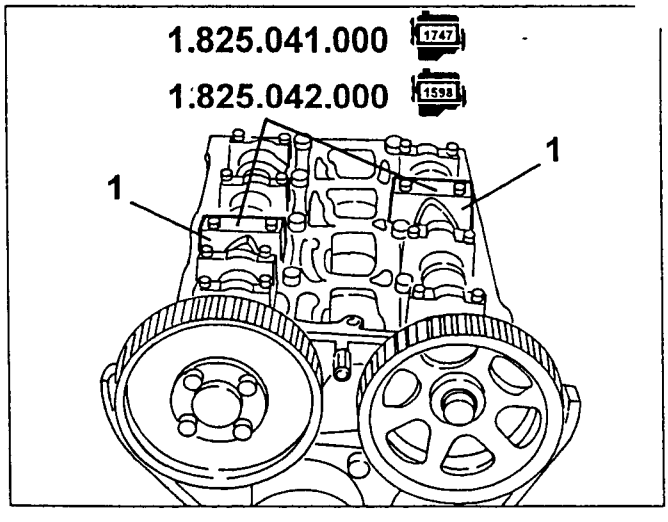
Assembling the timing gear drive belt and checking timing

- Assemble the camshaft toothed pulleys without tightening the fastening screws, the timing drive belt pulleys and the corresponding belt tensioners.

1. Install tool no. 1.825.013.000 (C.6.0183) fitted with a dial gauge in the seat of the centre spark plug of the 1st cylinder.
- Turn the crankshaft until the piston of the first cylinder reaches the T.D.C. in the bursting stroke.



1. Remove the camshaft caps illustrated and in their place insert templates, tightening the fastening screws to a maximum torque of **10 Nm (1 Kgm)** and checking for correct coupling with the cams.

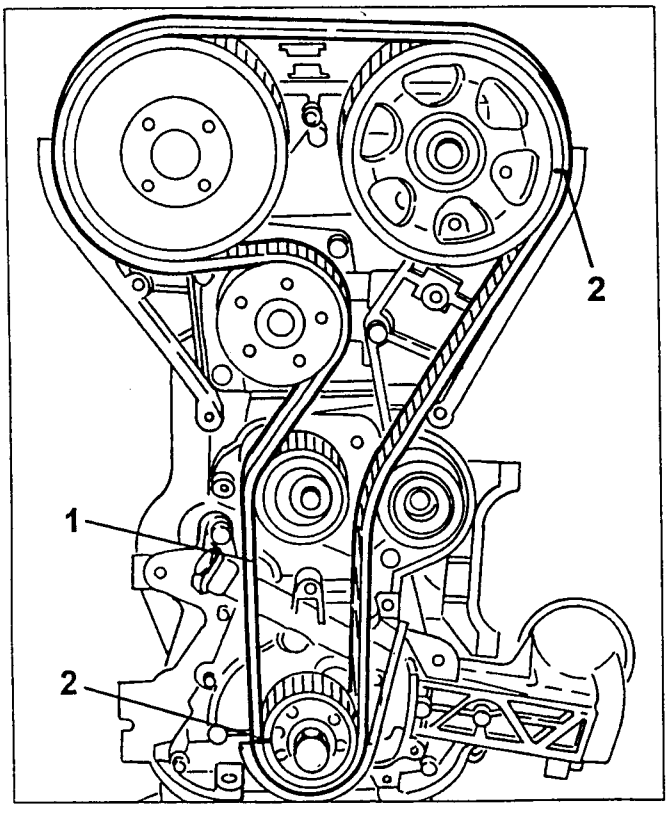


NOTE: For turning the camshafts, use tool n 1.822.155.000 for the intake side and tools no. 1.822.146.000 and no. 1.822.156.000 for the exhaust side, to be applied on the corresponding pulleys.

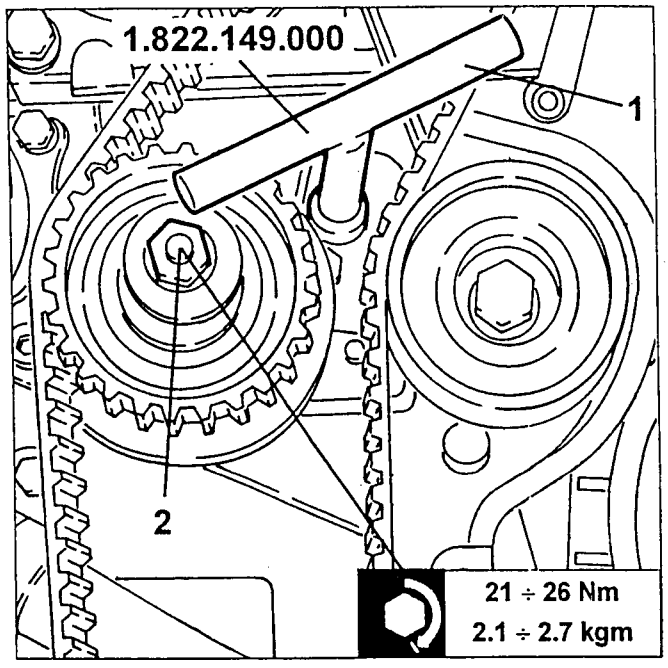
1. Assemble the timing gear drive belt taking care to check correct coupling with the pulley teeth, installing it in the following sequence:
- crankshaft pulley
- fixed tightening pulley
- exhaust side camshaft pulley
- intake side camshaft pulley
- automatic tensioner pulley
- coolant fluid pump pulley

2. The notches painted on the belt must coincide with the indexes made on the crankshaft pulley and on the exhaust side camshaft pulley.

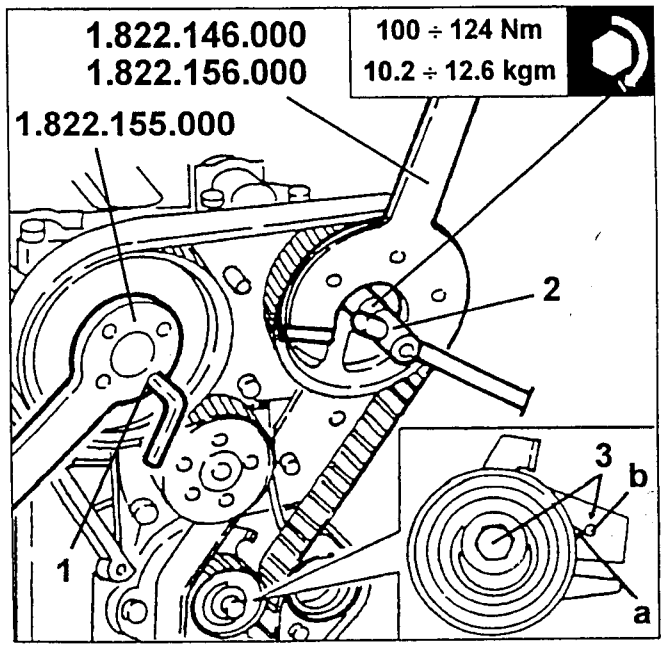
WARNING:
When assembling the toothed belt, to avoid damaging the structure of the fibres that form it, never cause sharp bends.
For correct assembly the belt has an arrow on it which shows the direction of rotation of the engine.



1. Using tool no. 1.822.149.000 as illustrated, tension the belt to the maximum.
2. Tighten the nut fastening the automatic camshaft belt tensioner.



1. Using tool no. 1.822.155.000, tighten the screws fastening the intake side camshaft drive pulley.
2. Using tool no. 1.822.146.000 complete with tool no. 1.822.156.000, tighten the screw fastening the exhaust side camshaft drive pulley.
- Remove the two templates from the camshafts and turn the crankshaft twice in its direction of rotation until the piston of the 1st cylinder reaches the T.D.C. in the bursting stroke.
3. Release the nut fastening the automatic tensioner, then using tool no. 1.822.149.000, move the mobile index (a) to coincide with the reference hole (b).
- Tighten the automatic tensioner fastening nut to the specified torque.
- Turn the crankshaft twice in its direction of rotation until the piston of the 1st cylinder reaches the T.D.C. in the bursting stroke and check that all the timing references coincide.

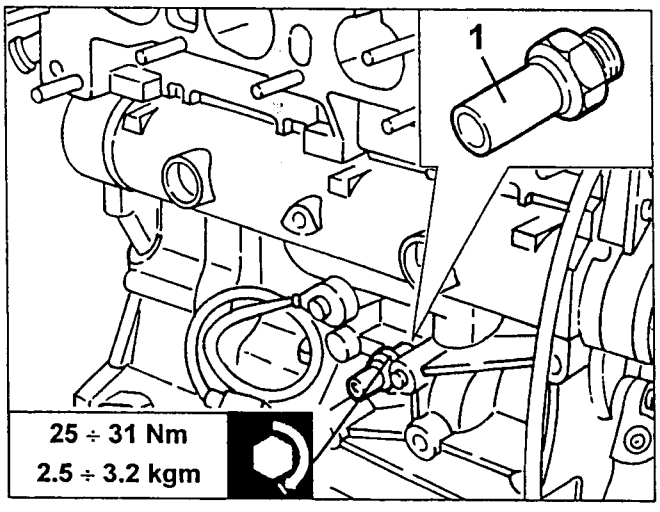


CHECKING LUBRICATION CIRCUIT ELECTRIC COMPONENTS

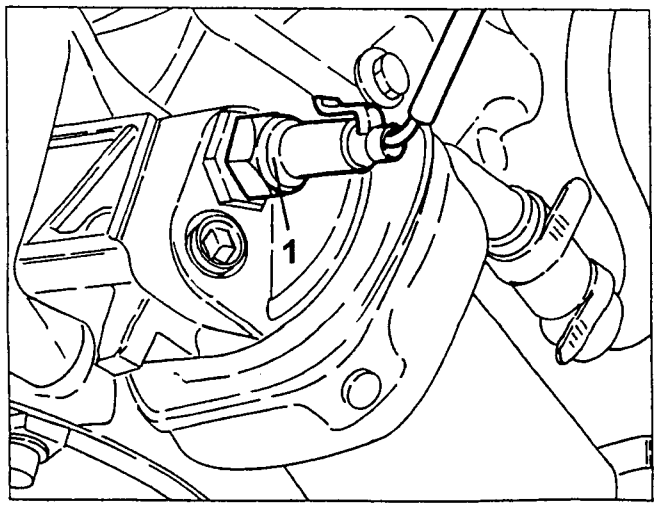
ENGINE OIL MINIMUM PRESSURE WARNING LIGHT SENSOR

1. Check the setting of the engine oil minimum pressure warning light sensor. If the ratings are not as specified, replace the sensor.

Contact opening/closing pressure
0.2 ÷ 0.5 bar



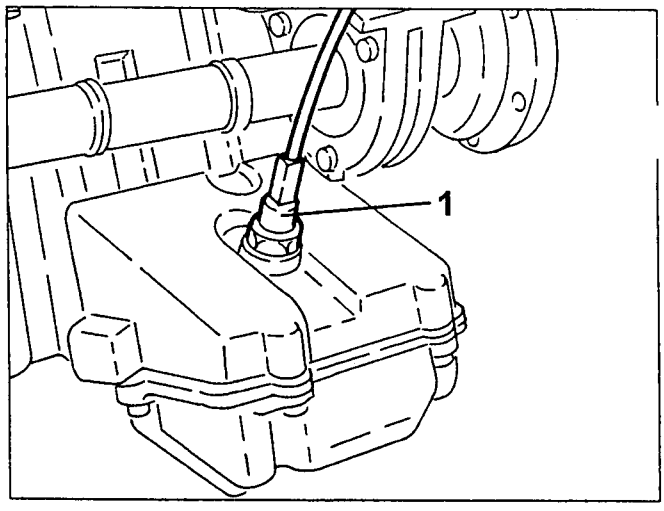
NOTE: In some versions the engine oil minimum pressure warning light sensor (1) is fitted on the oil filter support as illustrated below.



ENGINE OIL TEMPERATURE SENSOR

1. Check the setting of the engine oil temperature sensor. If the ratings are not as specified, replace the sensor.

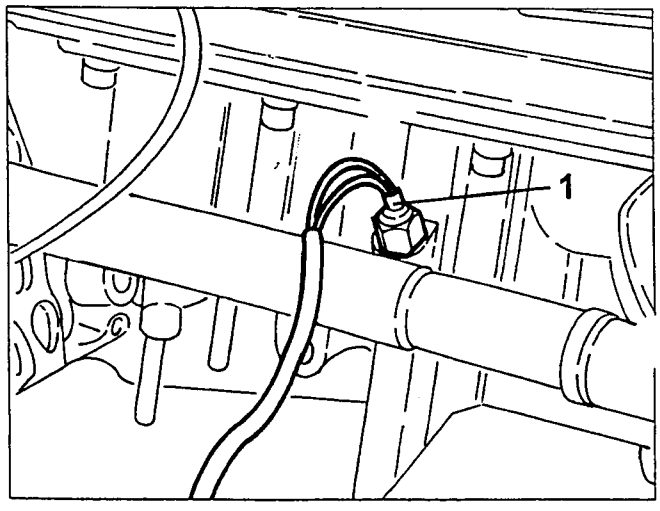
Temperature (°C)	Resistance (Ω)
50	800 ÷ 900
70	350 ÷ 450
90	180 ÷ 220



LOW ENGINE OIL LEVEL WARNING LIGHT SENSOR

1. Check the setting of the low engine oil level warning light sensor. If the ratings are not as specified, replace the sensor.

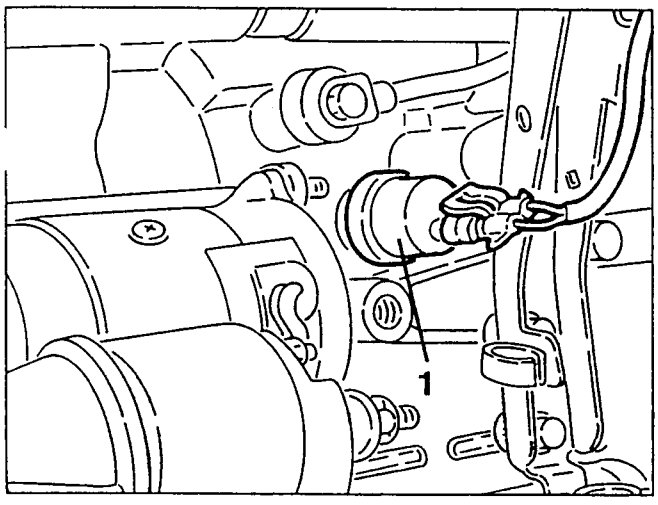
Circuit resistance	12 Ω ± 5%



ENGINE OIL PRESSURE SENDER

1. Check the setting of the engine oil pressure sender. If the values are not within the specified limits, change the sensor.

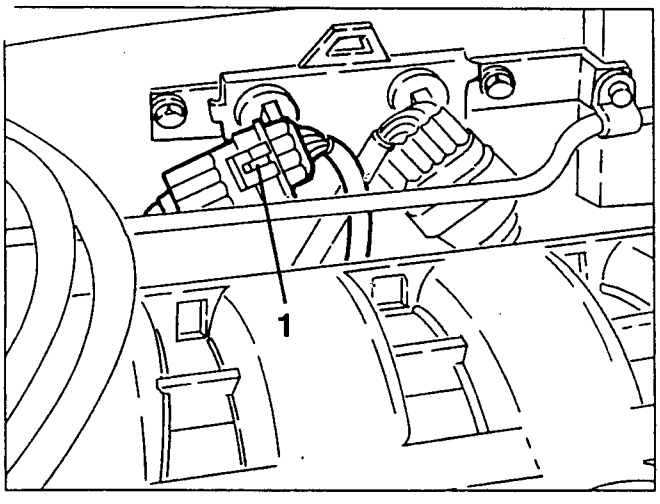
Pressure (bar)	Resistance (Ω)
0	305 ± 15
2	190 ± 15
4	118 ± 15
8	20 ± 20



Removing/Refitting

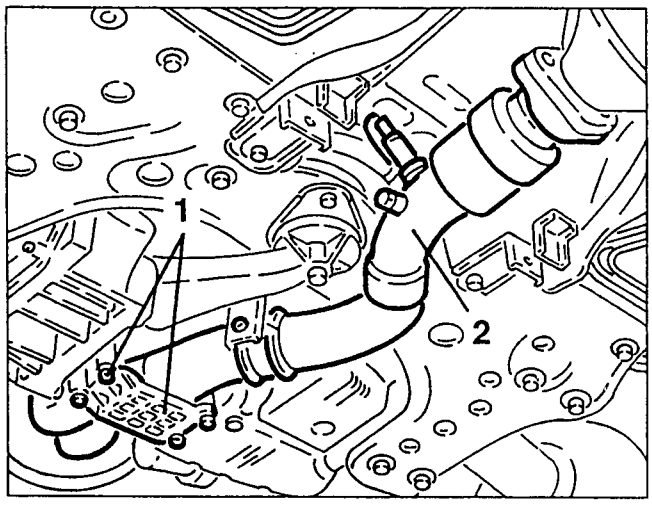
- Set the car on a lift.
- Disconect the battery (-) terminal.

1. Disconect the electrical connection of the lambda probe.

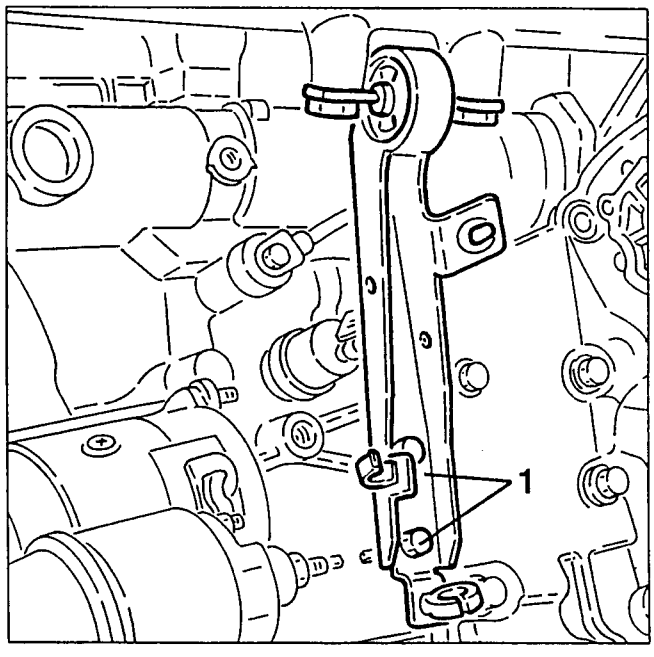


- Raise the car.

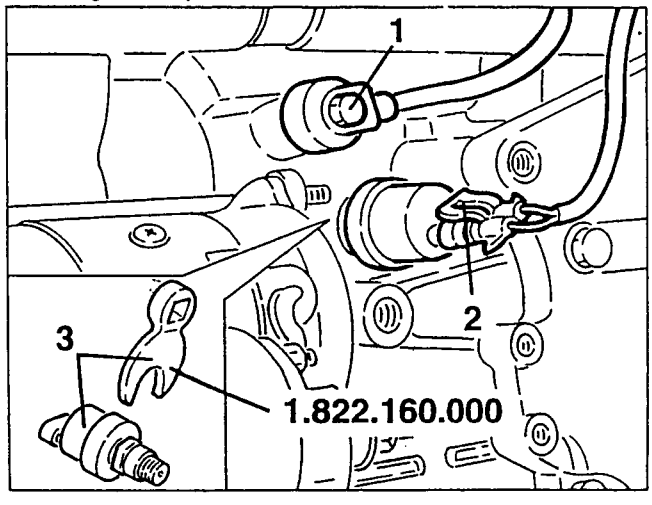
1. Slacken the fastening screws and remove reinforcement bracket.
2. Remove the front section of the exhaust pipe complete with lambda probe after slackening the fastenings concerned.



1. Slacken the fastening screws and remove the intake box support bracket.



1. Slacken the fastening screw and move aside the pinging sensor.
2. Disconect the electrical connection from the engine oil pressure transmitter.
3. Using tool no. 1.822.160.000 slacken and remove the engine oil pressure transmitter.

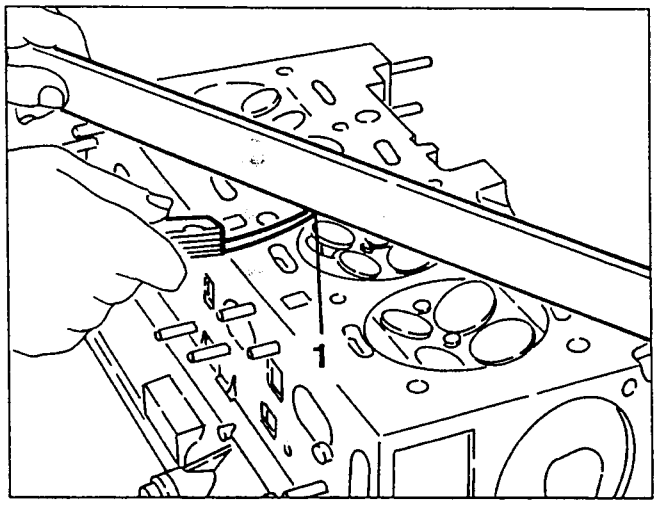


CHECKS AND INSPECTION CYLINDER HEAD

Checking the lower surface of the cylinder head

1. Check the flatness of the lower cylinder head surface; reface if it is excessively worn.

Maximum flatness error of cylinder head lower surface
0.1 mm

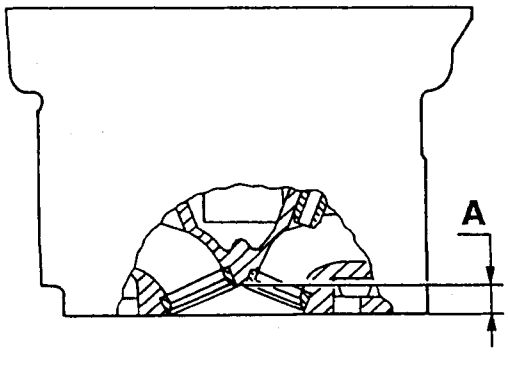


- After refacing, check that the depth of the combustion chamber, on the head, exceeds the minimum allowed limit.

WARNING:
Exceeding the minimum allowed limit involves serious engine operating failures.

Minimum depth "A" of the combustion chamber in the head
13 ± 0.2 mm

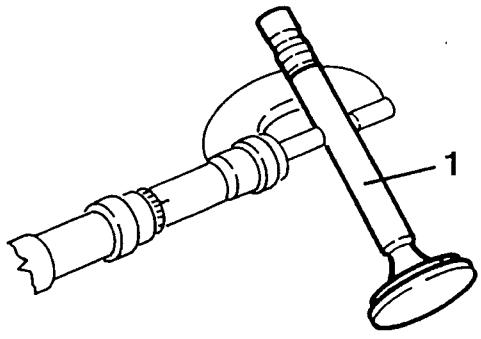
- Check that the finishing of the lower cylinder head surface is satisfactory.



Checking the clearance between valve guides and valve stems

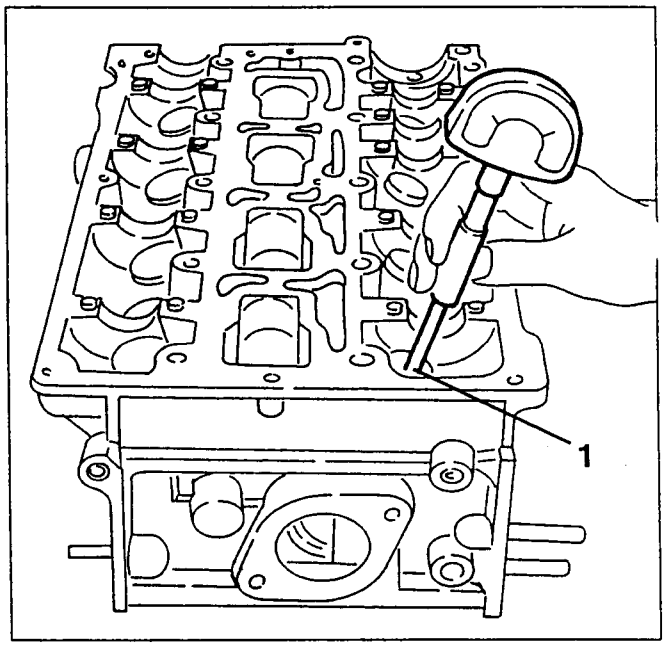
1. Measure the diameter of the valve stems and check that it is within the specified limits.

Diameter of valve stems	
Intake	6.975 ÷ 6.990 mm
Exhaust	6.960 ÷ 6.975 mm



1. Measure the inside diameter of the valve guides and check that it is within the specified limits.

Inside diameter of valve guides
7.022 ÷ 7.040 mm

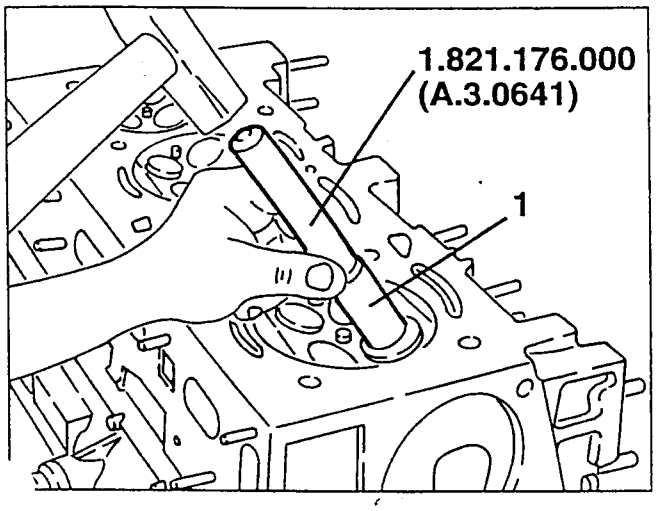


- Calculate the clearance between valve guides and stems and check that it is within the specified limits, if not, change any worn parts.

Radial clearance between valve guides and stems	
Intake	0.032 ÷ 0.065 mm
Exhaust	0.047 ÷ 0.080 mm

hanging the valve guides

1. Using puller tool no. 1.821.176.000 (A.3.0641), remove the worn valve guides.



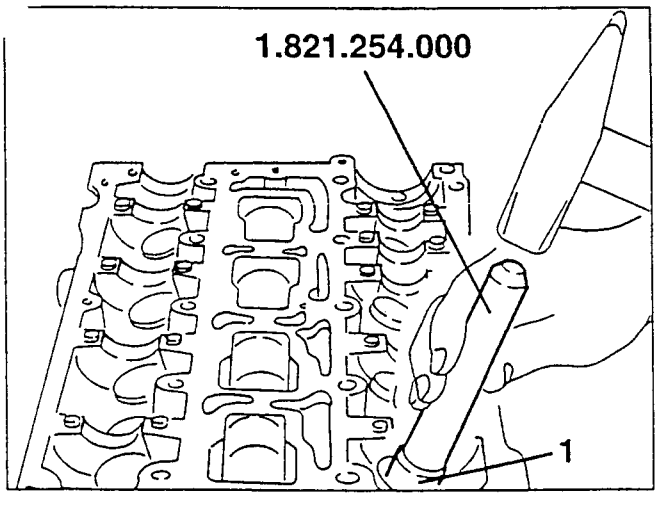
- Check that the outside diameter of the valve guides and their seats on the head are within the specified limits and that their assembly interference is correct.

Outside diameter of valve guides
13.010 ÷ 13.030 mm

Diameter of valve guide seats
12.950 ÷ 12.977 mm

Interference between valve guides and seats
0.033 ÷ 0.080 mm

1. Insert the new valve guides using tool no. 1.821.254.000.



- Bore the valve guide inside diameter to calibrate the holes to the specified diameter.

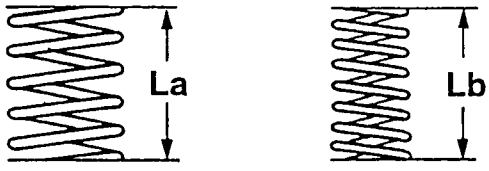
Inside diameter of valve guides
7.022 ÷ 7.040 mm

Checking the valve springs

- Check that the "free" length of the valve springs is within the specified limits.

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

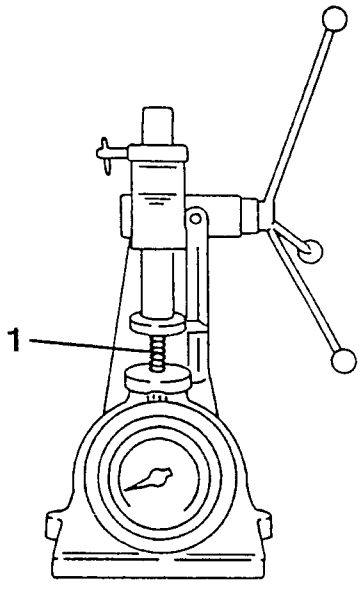
Free length of valve springs	
outer spring "La"	46 mm
inner spring "Lb"	39 mm



1. Using a torque meter, check that the characteristic data of the springs are within the specified limits.

Outer spring		
Length of spring mm		Control load N (Kg)
With valve closed	34.0	271 ÷ 294 (27.6 ÷ 30)
With valve open	24.5	485 ÷ 524 (49.4 ÷ 53.4)

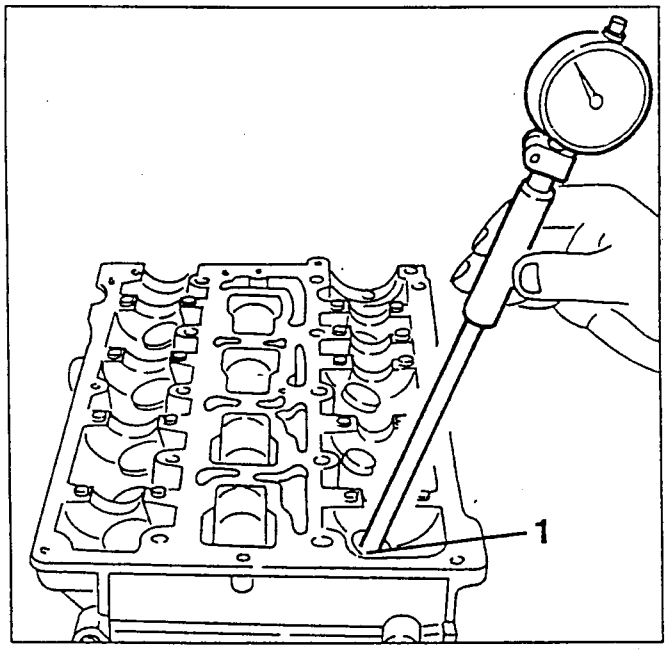
Inner spring		
Length of spring mm		Control load N (Kg)
With valve closed	29.5	96 ÷ 106 (9.8 ÷ 10.8)
With valve open	20.0	201 ÷ 221 (20.5 ÷ 22.5)



Checking the clearance between hydraulic tappets and their seats

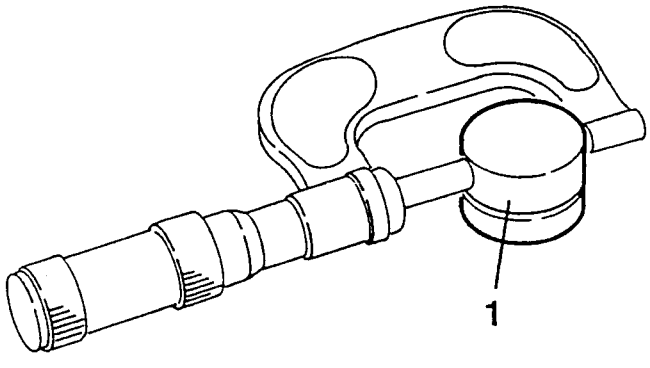
1. Check that the diameter of the hydraulic tappets seats is within the specified limits.

Diameter of hydraulic tappets seats
33.000 ÷ 33.025 mm



1. Check that the outside diameter of the hydraulic tappets is within the specified limits.

Diameter of hydraulic tappets
32.959 ÷ 32.975 mm



- Calculate the clearance between the hydraulic tappets and their seats checking that it is within the specified limits.

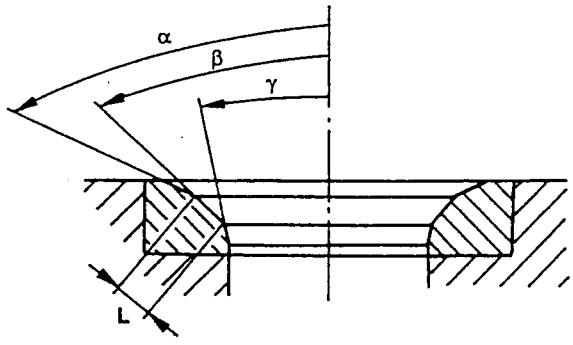
Clearance between hydraulic tappets and seats
0.025 ÷ 0.066 mm

Turning the valve seats

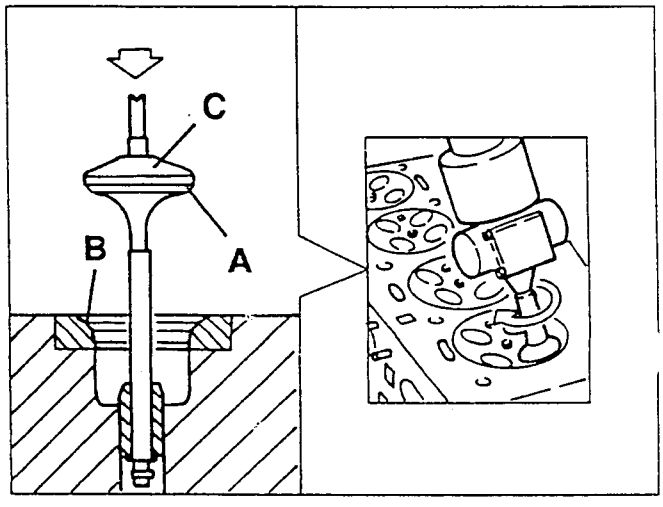
- If necessary, turn the valve seats using suitable equipment within the following limits.

Taper of contact area with valve "β"	90° ± 10'
Taper of upper valve seat area "α"	150°
Taper of lower valve seat area "γ"	30°

Dimension "L" contact area with valve	
Intake	0.8 mm
Exhaust	1 mm



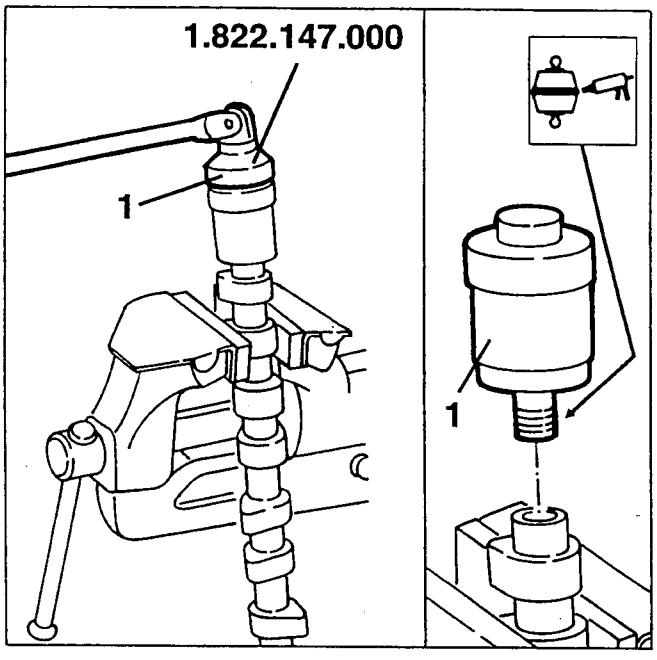
- After machining, grind each valve in its seat as follows:
- coat the contact surfaces "A" and "B" of the valves and their seats with abrasive paste (SIPAL AREXO' Carbosilicium for valves);
- lubrificate the valve stem with engine oil;
- fit the lower surface of the valve mushroom to the suction cup "C" of a pneumatic grinder;
- insert the valve in its guide and grind;
- after grinding, thoroughly clean the valve and the seat.



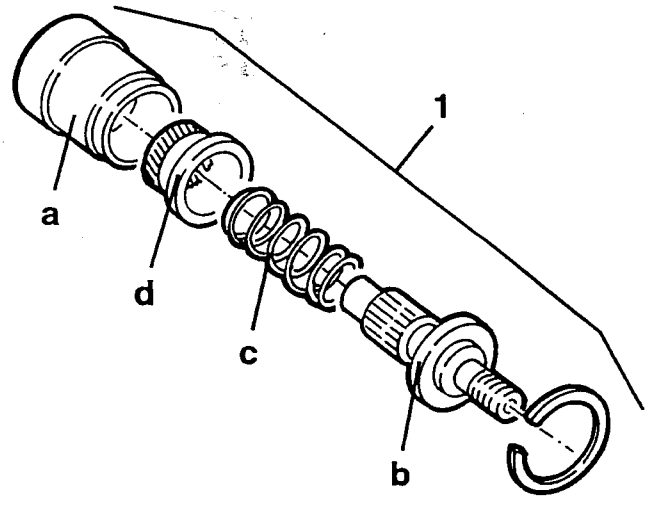
Removing the timing variator from the camshaft

- Position the camshaft intake side in a vice fitted with protective jaws.

1. Using tool no. 1.822.147.000, slacken and remove the timing variator from the camshaft.



1. Remove the stop ring and remove the outer body (a) of the variator pinion (b), spring (c) and the piston (d).



WARNING:
When refitting the timing variator, follow the instructions given below:
- Make sure that the mastic on the thread coupling the timing variator to the camshaft does not obstruct the oil ducts.
- Wait for about two hours before assembling the shaft on the cylinder head.

CHECKS AND INSPECTION CRANKCASE

- Visibly check the crankcase for cracks and signs of excessive wear of the sliding surfaces; check that all the threads are intact.
- Remove the lubrication and cooling groove caps and clean the ducts with a suitable detergent, then dry with a jet of air and fit new caps.
- Accurately remove any traces of seals or sealants from the crankcase surfaces.

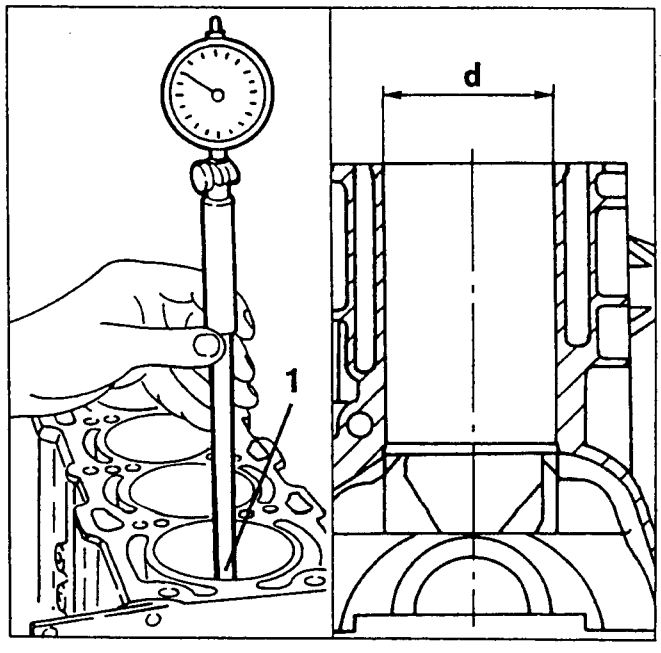
Checking the cylinders

1. Using a bore gauge fitted on a dial gauge, measure the inside diameter of the cylinders and check that it is within the specified limits.

Inside diameter of the cylinders "d"	
Class A	83.000 ÷ 83.010 mm
Class B	83.010 ÷ 83.020 mm
Class C	83.020 ÷ 83.030 mm
Oversize of 0.1 mm	

Maximum cylinder taper
0.010 mm

Maximum cylinder ovalization
0.005 mm



- When turning and grinding the valve seats it is advisable to check the valve tightness with the spark plugs in place, proceeding as follows:
• fill the hollow of the combustion chamber with petrol;
• admit low pressure air into the intake manifolds and check that no bubbles form in the petrol;
• check the tightness of the exhaust valves in the same way, admitting air to the exhaust manifolds;
• if any leaks are noted, make sure that the valves are perfectly settled in their seats and repeat the check; if the result is negative, grinding must be repeated.

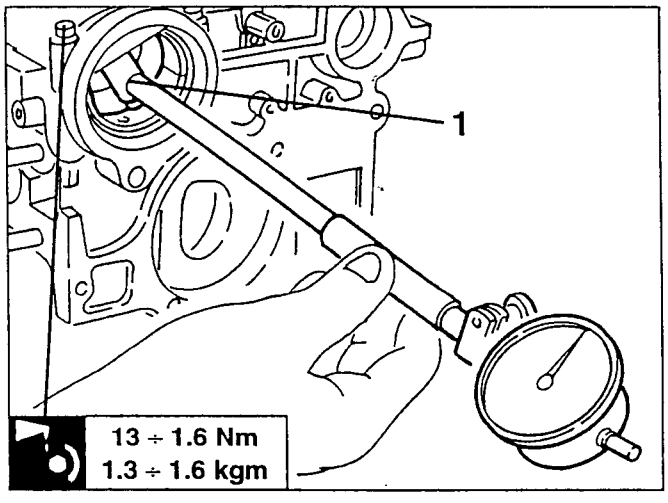
Camshafts and timing system bearings

1. Assemble the camshaft caps and tighten the fastening screws to the specified torque, then check that the diameter of the supports is within the specified limits.

NOTA: The half bearings should be assembled on the intake side front support.

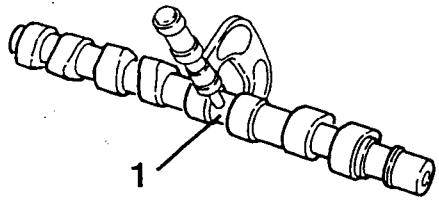
Diameter of camshaft supports
26.045 ÷ 26.070 mm 50.034 ÷ 50.071 mm (*)

(*) Front intake side support with half bearings assembled (for timing variator)



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

Diameter of camshaft journals
26.000 ÷ 26.015 mm



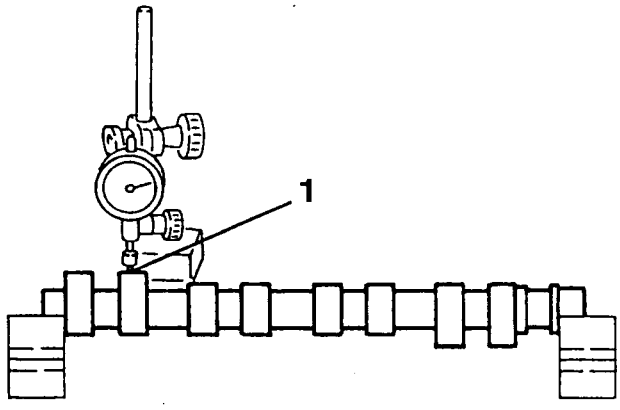
- Calculate the clearance between the camshaft journals and their bearings and check that it is within the specified limits.

Clearance between camshafts and bearings	
0.03 ÷ 0.07 mm	0.034 ÷ 0.086 mm (*)

(*) Specific for timing variator

1. Check that the cam lifts are within the specified limits.

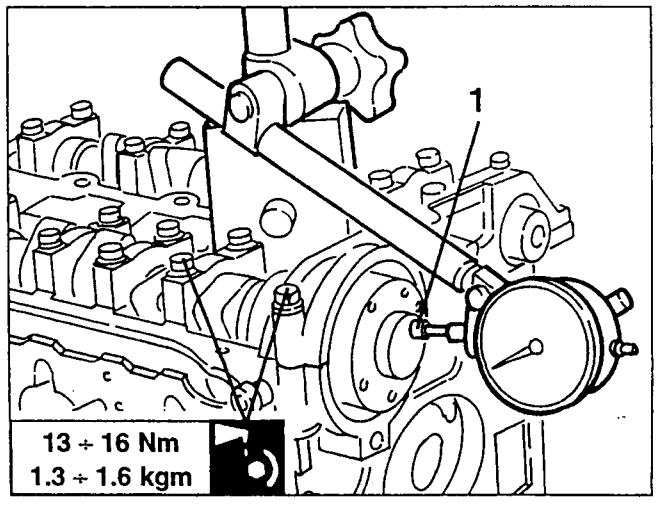
Cam nominal lift	
Intake	8.3 mm
Exhaust	7.5 mm



Checking the camshaft end float

- Place the camshafts on the cylinder head, assemble the corresponding caps and tighten the fastening screws to the specified torque.
1. Install a centesimal dial gauge and measure the end float of the camshafts checking that it is within the specified limits.

Camshafts end float
0.10 ÷ 0.23 mm

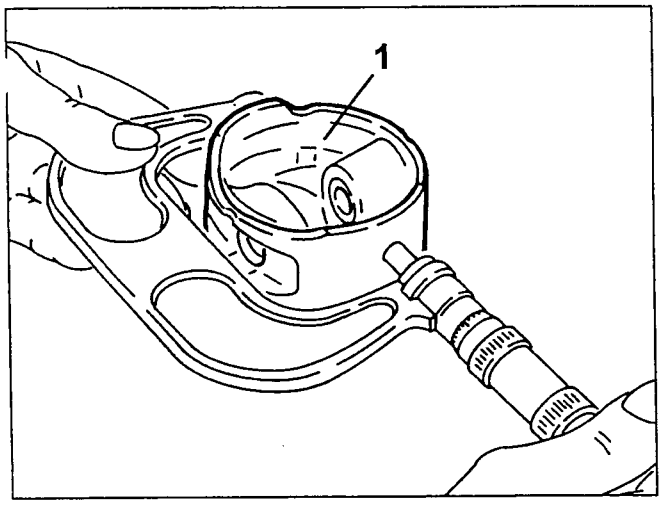


Checking the pistons

1. Measure the outside diameter of the pistons and check that it is within the specified limits.

Outside diameter of pistons (1)	
Class A - Blue	81.952 ÷ 81.962 mm
Class B - Pink	81.960 ÷ 81.970 mm
Class C - Green	81.968 ÷ 81.978 mm
Oversize of 0.1 mm	

(1) To be measured at right angles to the gudgeon pin hole at a distance of 12.5 mm from the lower edge of the piston skirt.

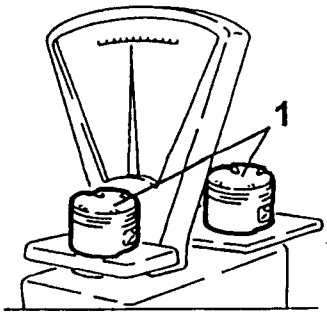


- Calculate the clearance between the cylinder and the piston and check that it is within the specified limits.

Clearance between piston and cylinder
0.040 ÷ 0.060 mm

1. Check that the difference in weight between the pistons complete with gudgeon pins and seal rings is within the specified limits.

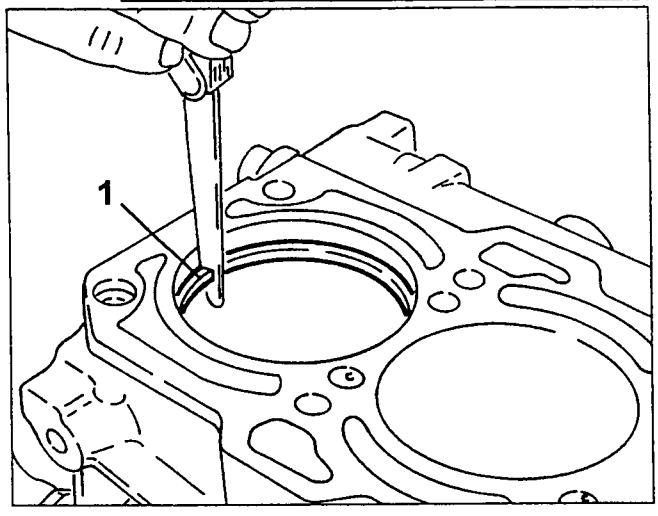
Difference in weight between pistons
± 5 g



Checking the seal ring gap

1. Insert the seal rings in the cylinder, check that they adhere to the whole circumference and that the gap is within the specified limits.

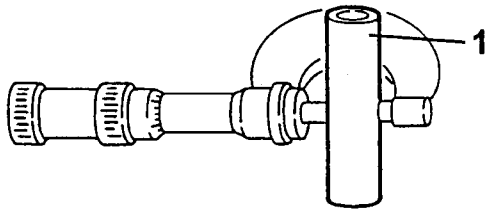
Ring gap	
First ring	0.25 ÷ 0.50 mm
Second ring	0.30 ÷ 0.50 mm
Oil scraper ring	0.25 ÷ 0.50 mm



Checking the play between gudgeon pins and seats on pistons

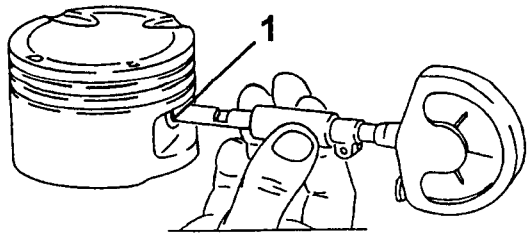
1. Measure the outside diameter of the gudgeon pins and check that it is within the specified limits.

Outside diameter of gudgeon pins
19.996 ÷ 20.000 mm



1. Measure the diameter of the pin mating hole in the piston and check that it is within the specified limits.

Diameter of pin seat in pistons
20.002 ÷ 20.007 mm



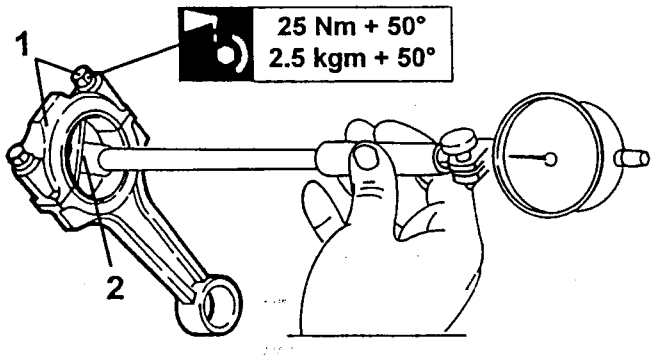
- Calculate the clearance between the pins and their seats on the pistons and check that it is within the specified limits.

Clearance between pins and seats on pistons
0.002 ÷ 0.011 mm

Checking clearance between connecting rod journals and corresponding half bearings

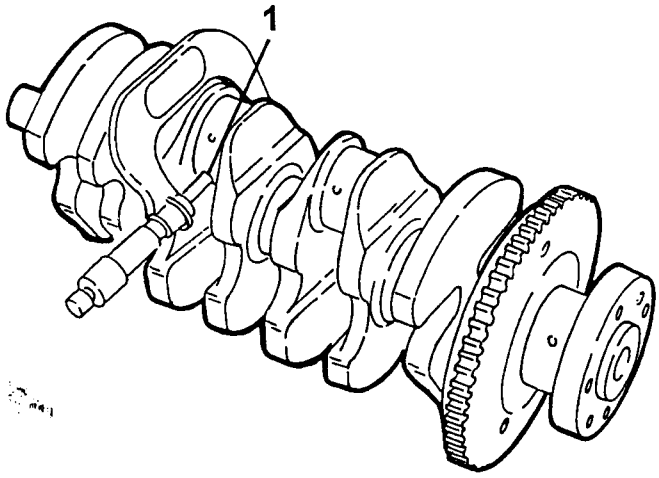
1. House the rod half bearings in the connecting rod big end and on the corresponding cap, then join them tightening the fastening screws to the specified torque.
2. Measure the diameter of the connecting rod big end and check that it is within the specified limits.

Inside diameter of connecting rod half bearings	
Class A - Red	40.920 ÷ 40.940 mm
Class B - Bleu	40.914 ÷ 40.934 mm
Class C - Yellow	40.908 ÷ 40.928 mm



1. Measure the diameter of the connecting rod journals and check that it is within the specified limits.

Diameter of connecting rod journals	
Class A - Red	40.884 ÷ 40.890 mm
Class B - Bleu	40.878 ÷ 40.884 mm
Class C - Yellow	40.872 ÷ 40.878 mm



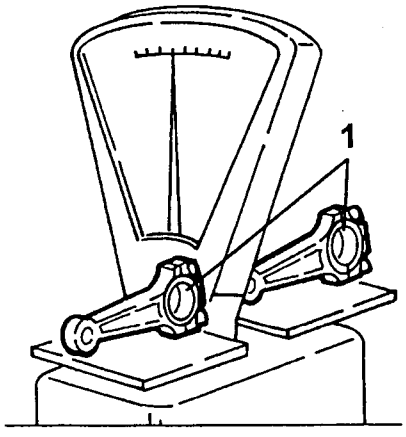
- Calculate the clearance between the rod journals and the corresponding half bearings and check that it is within the specified limits.

Clearance between rod journals and half bearings
0.030 ÷ 0.056 mm

Checking the connecting rods

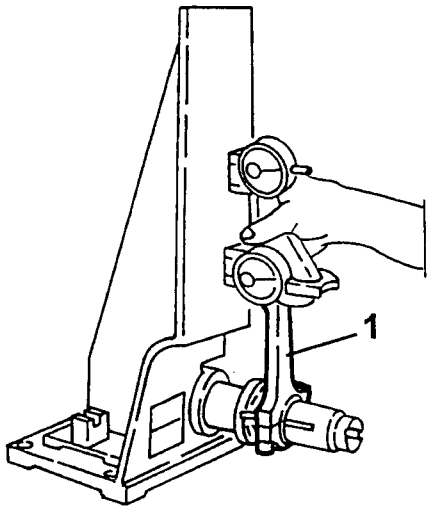
1. Check that the difference in weight between the connecting rods complete with half bearings, caps and screws is within the specified limits.

Difference in weight between connecting rods
≤ 5 g



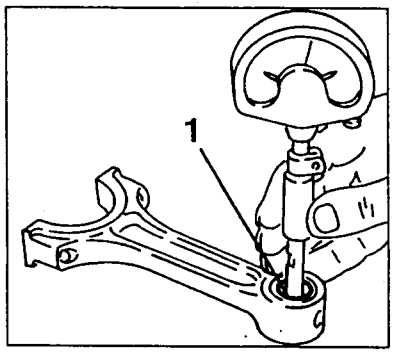
1. Check that the connecting rods are perpendicular using a reference plane as illustrated.

NOTE: If perpendicularity is not perfect, the connecting rod must be changed to avoid abnormal stresses when the engine is running, resulting in uneven wear of the piston and of the rod itself.



Checking the clearance between pins and small end bushings

1. Measure the inside diameter of the small end bushing and check that it is within the specified limits, if not, change the bushing.



Inside diameter of small end bushing
20.006 ÷ 20.012 mm

- Measure the outside diameter of the pins and check that it is within the specified limits.

Outside diameter of pins
19.996 ÷ 20.000 mm

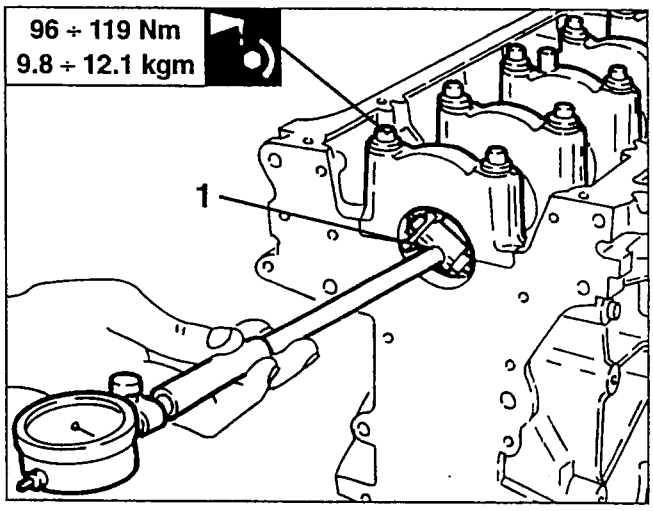
- Calculate the clearance between the pins and small end bushings and check that it is within the specified limits.

Clearance between pins and small end bushing
0.006 ÷ 0.016 mm

Checking the clearance between main bearing journals and half bearings

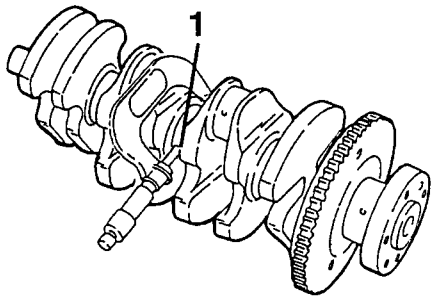
1. House the half bearings and fit the main bearings caps on the crankcase tightening the fastening screws to the specified torque.
2. Measure the diameter of the main bearings and check that it is within the specified limits.

Diameter of the main bearings	
Side	
Class A - Red	53.031 ÷ 53.056 mm
Class B - Blue	53.017 ÷ 53.046 mm
Class C - Yellow	53.007 ÷ 53.032 mm
Centre	
Class A - Red	53.041 ÷ 53.066 mm
Class B - Blue	53.027 ÷ 53.056 mm
Class C - Yellow	53.017 ÷ 53.042 mm



1. Measure the diameter of the main bearing journals and check that it is within the specified limits.

Diameter of main bearing journals	
Class A - Red	52.994 ÷ 53.000 mm
Class B - Bleu	52.988 ÷ 52.994 mm
Class C - Yellow	52.982 ÷ 52.988 mm



- Calculate the clearance between the main bearing journals and half bearings and check that it is within the specified limits.

Clearance between main bearing journals and half bearings	
Side	
Class A - Red	0.031 ÷ 0.062 mm
Class B - Blue	0.023 ÷ 0.058 mm
Class C - Yellow	0.019 ÷ 0.050 mm
Centre	
Class A - Red	0.041 ÷ 0.072 mm
Class B - Blue	0.033 ÷ 0.068 mm
Class C - Yellow	0.029 ÷ 0.060 mm

Checking the engine flywheel

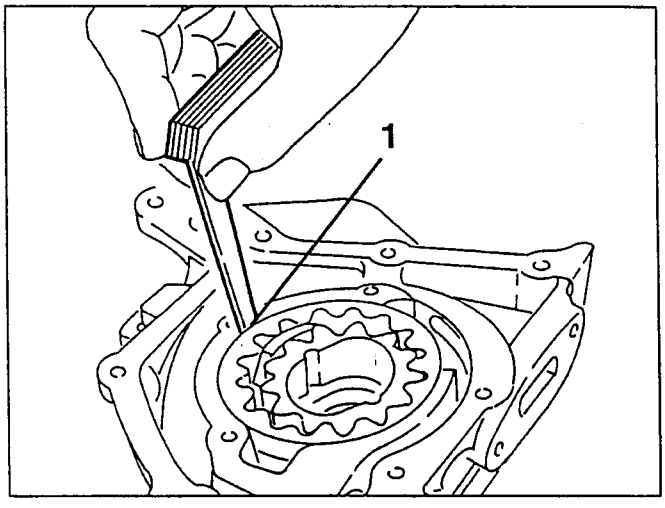
- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
• working under the press remove the old ring gear;

• accurately clean the contact surfaces of the new ring gear and of the flywheel;
• evenly heat the new ring gear to 80° ÷ 100° C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

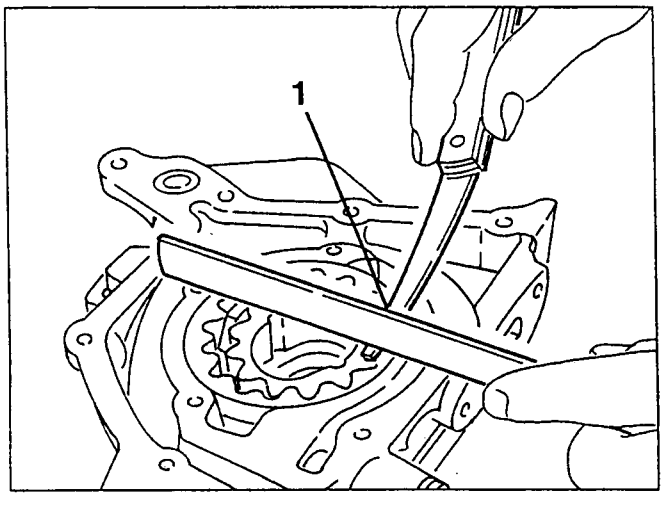
1. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.080 ÷ 0.186 mm



1. Check that the clearance between the pump cover rest surface and the upper side of the gears is within the specified limit.

Clearance between pump cover rest surface and upper side of gears
0.025 ÷ 0.070 mm



WARNING: If the clearances measured are not within the specified limits, change the front crankcase cover with oil pump incorporated.

- Using a torque meter check the characteristic value of the engine oil pressure limiting valve control spring.

Control load Kg	Spring length mm
6.4 ÷ 7.2	36

INSTRUCTIONS FOR RE-ASSEMBLY

For re-assembly operations reverse the sequence described for dis-assembly, unless otherwise indicated below.

- Check valve tightness when the cylinder head is assembled (see "Turning the valve seats").

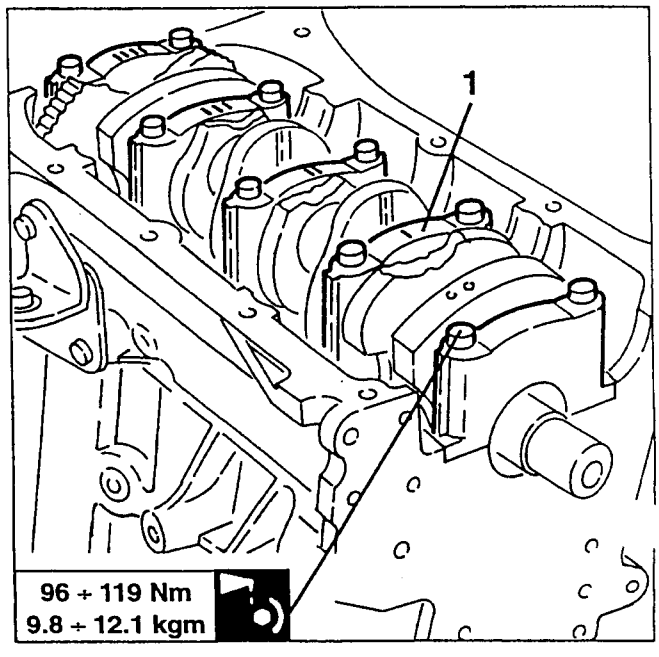
Reassembling the crankshaft

- Assemble the crankshaft on the crankcase complete with half bearings and half thrust rings.

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

1. Assemble the main bearing caps complete with half bearings on the supports and tighten the fastening screws two or three times starting from the centre main bearing cap.

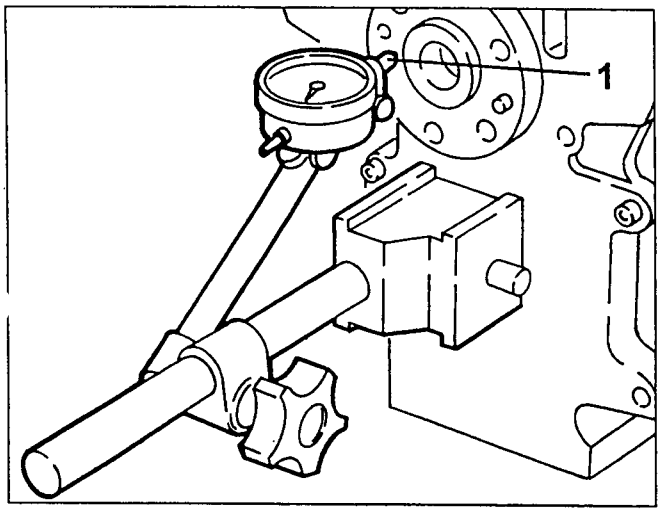
The position of each cap is given by a series of consecutive notches (from zero to four start from the front of the engine) etched on the caps themselves.



Checking crankshaft end float

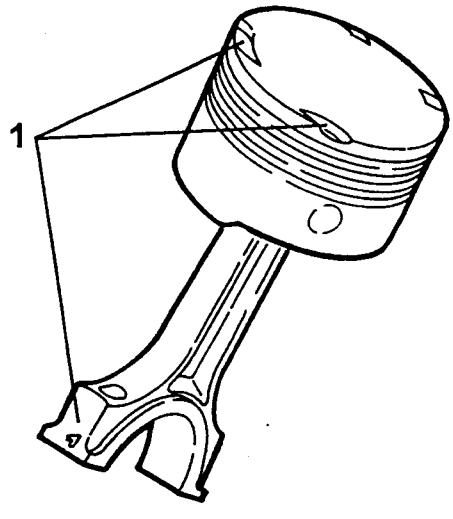
1. Using a dial gauge on a magnetic base, measure the crankshaft end float and check that it is within the specified limits.

Crankshaft end float
0.059 ÷ 0.221 mm



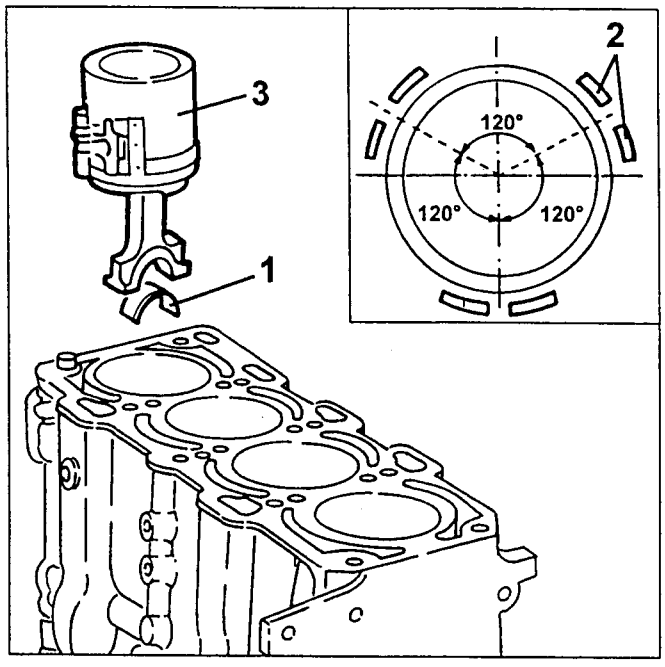
Refitting pistons and connecting rods

1. Assemble the piston and connecting rod making sure that the number stamped on the big end is on the same side as the large notches (for intake valves) on the piston crown.



- Turn the crankshaft until the connecting rod pins of the 1st and 4th cylinder reach the position corresponding to the B.D.C.
1. House the corresponding half bearings on the connecting rod big ends.
2. Place the rings in the pistons with the notches offset by 120° and the word TOP stamped on them facing upwards.
3. Using a suitable tool, insert the pistons and connecting rods in the 1st and 4th cylinder.

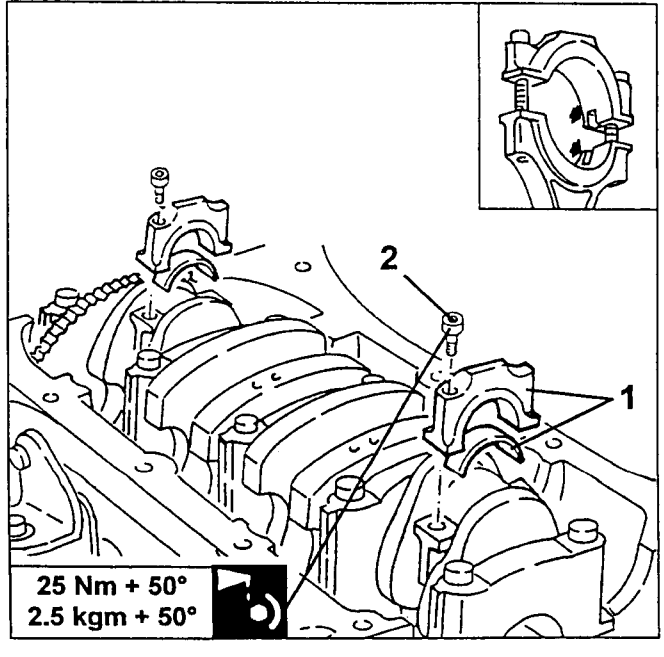
Assemble the connecting rod - piston sets in the crankcase directing the arrow stamped on the piston crown in the direction of rotation of the engine.



- Turn the crankcase 180°.
1. House the corresponding half bearings on the connecting rod caps, then assemble those of the 1st and 4th cylinder directing the safety notch towards the same side as the corresponding notch on the connecting rod big end.

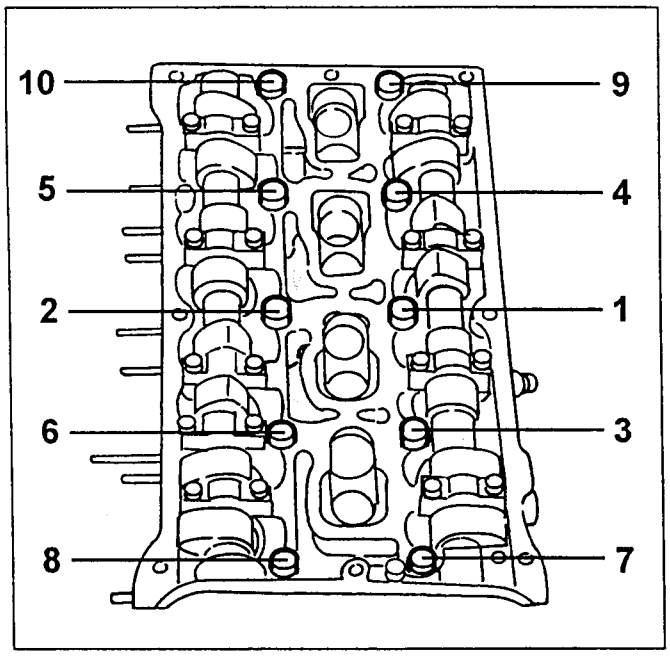
On the side, the connecting rod caps have the number of the cylinder to which to which they belong; during reassembly this number should be on the same side as the one stamped on the connecting rod big end.

2. Tighten the connecting rod cap fastening screws to the specified torque in oil.
- In the same way reassemble the pistons and connecting rods of the 2nd and 3rd cylinder.



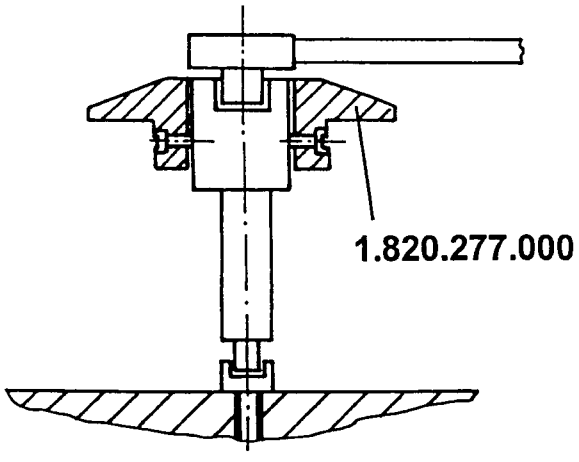
Cylinder head reassembly

- Turn the crankshaft until the pistons of the 1st and 4th cylinder reach the T.D.C.
- Position the seal on the crankcase and then the cylinder head.
- Tighten the cylinder head fastening screws proceeding as described below and bearing in mind that, for each step the tightening sequence is the one shown below.



Tightening sequence	
Approach all the screws to a torque of:	20 Nm (2.0 kgm)
Tighten the screws to a preliminary torque of:	40 Nm (4.1 kgm)
Turn the screws by an angle of:	90° + 90° + 90°

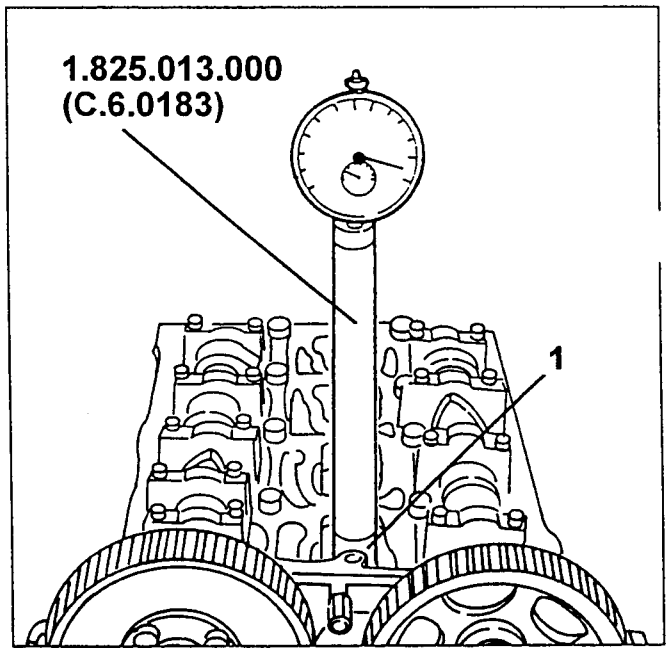
- For angle tightening use graduated disk no. 1.820.277.000 as illustrated.



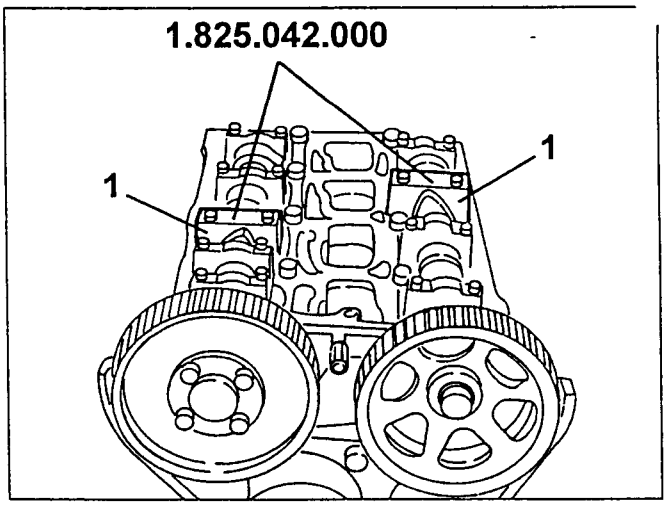
The seal between the cylinder head and crankcase is of the type in aramidic fibre and no further head tightening is scheduled throughout the whole life of the engine.

Camshaft drive belt assembly and checking valve gear timing

- Assemble the camshaft toothed drive pulleys without tightening the fastening screws, the camshaft belt drive pulleys and the corresponding belt tensioner.
1. Assemble tool no. 1.825.013.000 (C.6.0183) fitted with dial gauge in the seat of the centre spark plug of the 1st cylinder.
- Turn the crankshaft until the piston of the 1st cylinder reaches the T.D.C. in the bursting stroke.



1. Remove the camshaft caps illustrated and in place of them, fit templates no. 1.825.042.000 tightening the fastening screws to a maximum torque of **10 Nm (1 Kgm)** and checking correct mating with the cams

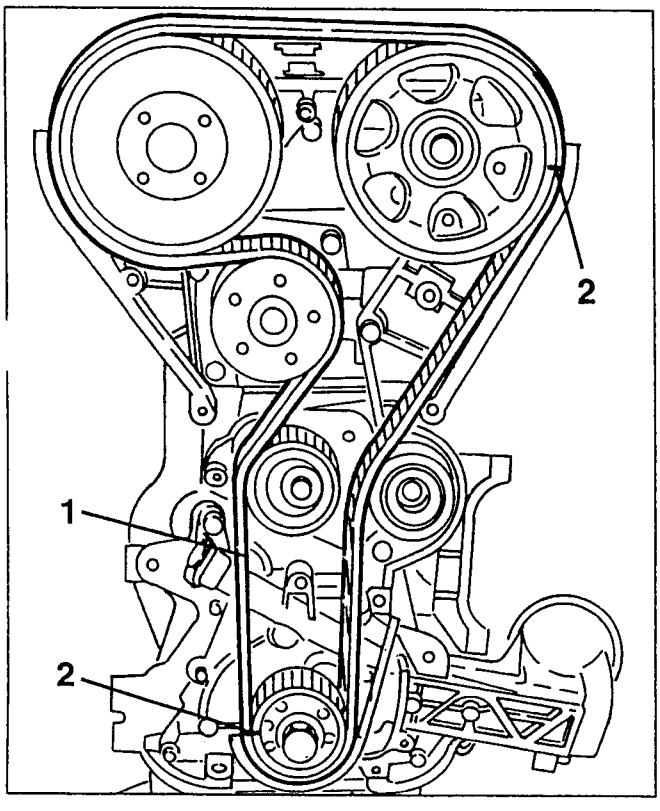


NOTE: For turning the camshafts, use tool n. 1.822.155.000 for the intake side and tools no. 1.822.146.000 and no. 1.822.156.000 for the exhaust side, to be applied to the corresponding pulleys.

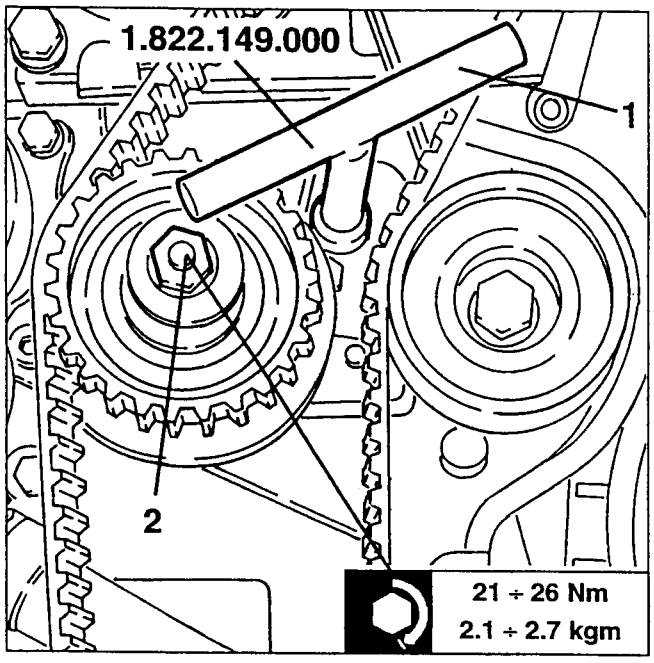
. Assemble the timing gear drive belt ensuring correct coupling with the teeth of the pulleys, fitting it in the following sequence:
- crankshaft pulley
- fixed pulley guide
- camshaft pulley on exhaust side
- camshaft pulley on intake side
- automatic tensioner guide
- coolant fluid pump guide pulley

2. The notches painted on the belt must coincide with the indexes machined on the crankshaft pulley and on the camshaft pulley exhaust side.

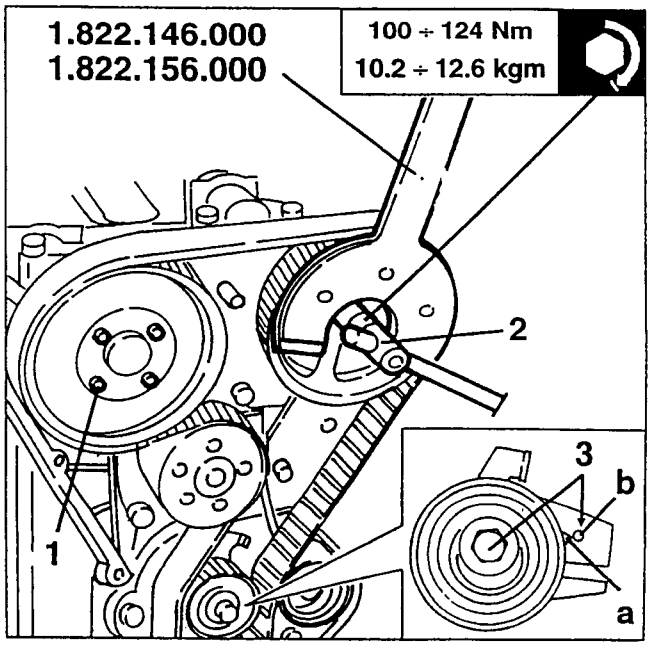
WARNING:
When assembling the toothed belt, avoid bending it sharply as this can lead to damage of the structures forming the belt.
The arrow on the belt indicates the direction of rotation of the engine.



Using tool no. 1.822.149.000 as illustrated, apply the maximum tension on the belt.
2. Tighten the nut fastening the automatic timing gear belt tensioner.



1. Tighten the screws fastening the intake side camshaft drive pulley.
2. Using tool no. 1.822.146.000 complete with tool no. 1.822.156.000, tighten screw fastening the camshaft drive pulley on the exhaust side.
- Remove the two templates from the camshafts and turn the crankshaft twice in its direction of rotation to take the piston of the 1st cylinder to the T.D.C. in the bursting stroke.
3. Release the nut fastening the automatic tensioner, then using tool no. 1.822.149.000, move the mobile index (a) coinciding with the reference hole (b).
- Tighten the automatic tensioner fastening nut to the specified torque.
- Turn the crankshaft twice in its direction of rotation until the piston of the 1st cylinder reaches the T.D.C. in the bursting stroke and check that all the references coincide.



CHECKING THE ELECTRIC COMPONENTS OF THE LUBRICATION CIRCUIT

MINIMUM ENGINE OIL PRESSURE SENSOR

1. Check the setting of the minimum engine oil pressure sensor. If the value fails to meet specifications, change the sensor.

bar

Contacts opening/closing pressure
0.2 ÷ 0.5 bar