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## DESCRIPTION

Turbodiesel engine, direct injection without pre-combustion chamber, 4 cylinders in line, 1910 c.c., two valves per cylinder, one overhead camshaft, air supercharging by turbocharger and intercooler, Bosch Common Rail EDC-15C electronic injection system.

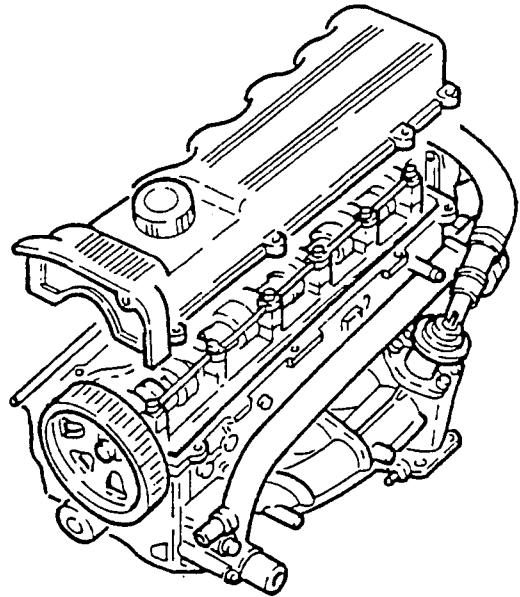
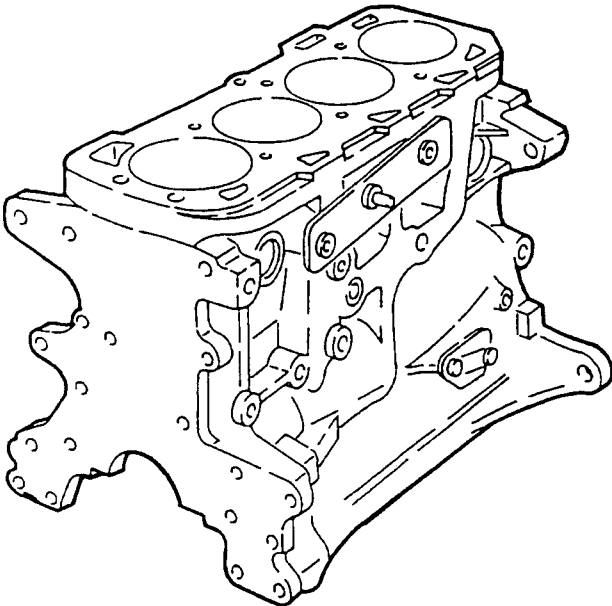
Unlike heads with pre-combustion chamber, the whole combustion process takes place in the combustion chamber machined in the piston.

The seal between the cylinder head and crankcase is made from aramidic fibre and there is no need to retighten the head throughout the whole life of the engine.

## CRANKCASE

The crankcase is in spheroidal cast iron with integral cylinder liners of the closed-deck type.

The crankshaft is supported by five main bearings. Special grooves machined in the crankcase walls allow the flow of coolant fluid and lubricating oil. A jet is installed in the lower part which sprays oil to cool the piston skirts and lubricate the gudgeon pin.



## CRANKSHAFT

This is in cast iron and rests on five main bearings and its end float is adjusted by two half rings housed in the rear main bearing.

Eight counterweights accurately balance the rotating masses.

A groove runs inside the shaft to lubricate the main bearing and connecting rod journals.

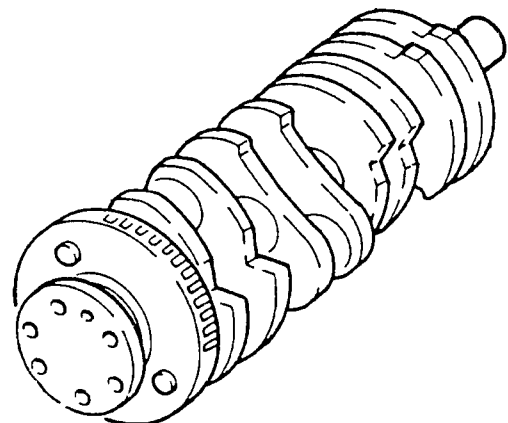
The phonic wheel for the rpm sensor is installed at the rear.

## CYLINDER HEAD

The cylinder head is in one piece and made from aluminium and silicon alloy.

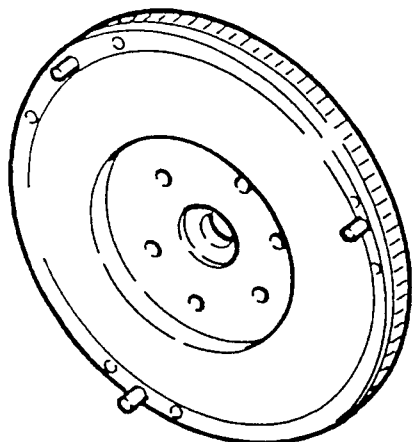
The two parallel and vertical valves per cylinder are installed in their valve guides and controlled by a single overhead camshaft, the cams of which act on mechanical tappets.

The valve guides are force-fitted in their seats on the cylinder head by interference and the inside diameter is perfected after assembly using a special bore.



## FLYWHEEL

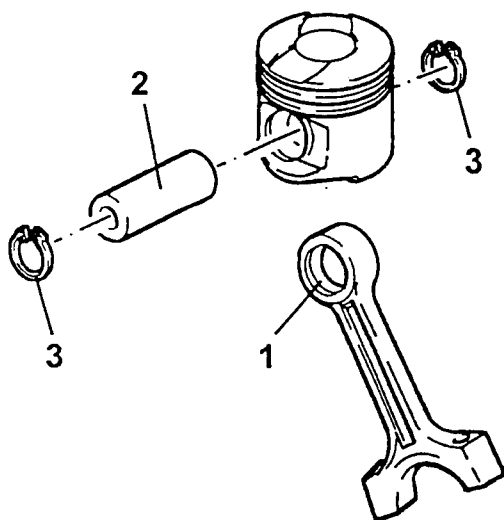
This is in cast iron, with inserted ring gear, in hardened and tempered steel, and suitably balanced.



## PISTONS AND CONNECTING RODS

The connecting rods are in hardened and tempered steel, with force-fitted copper bush (1) for mating with the gudgeon pin (2) of the piston.

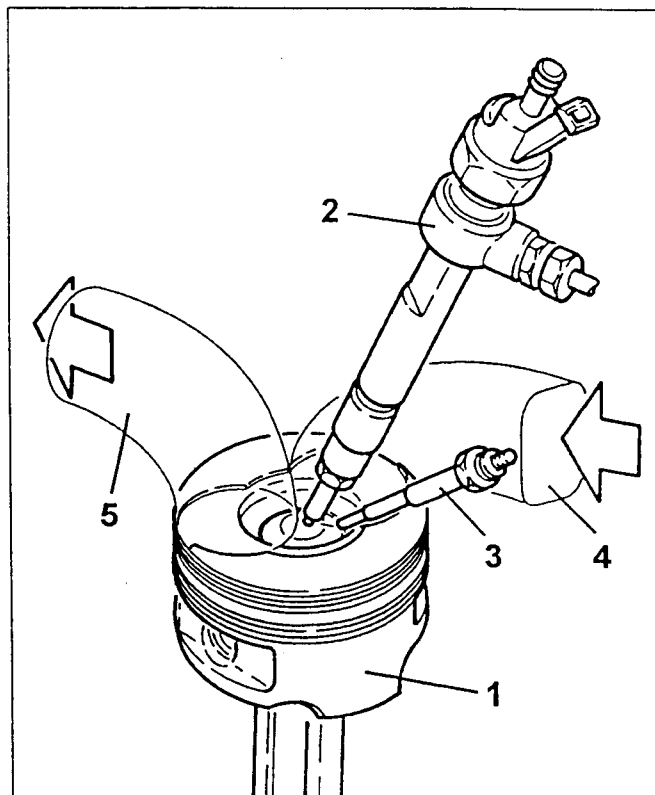
The floating type gudgeon pins are retained by two expansion circlips (3) which are housed in the special hollows machined on the piston hubs.



The pistons are in aluminium and silicon alloy with self-heating inserts and are subdivided into three dimensional classes.

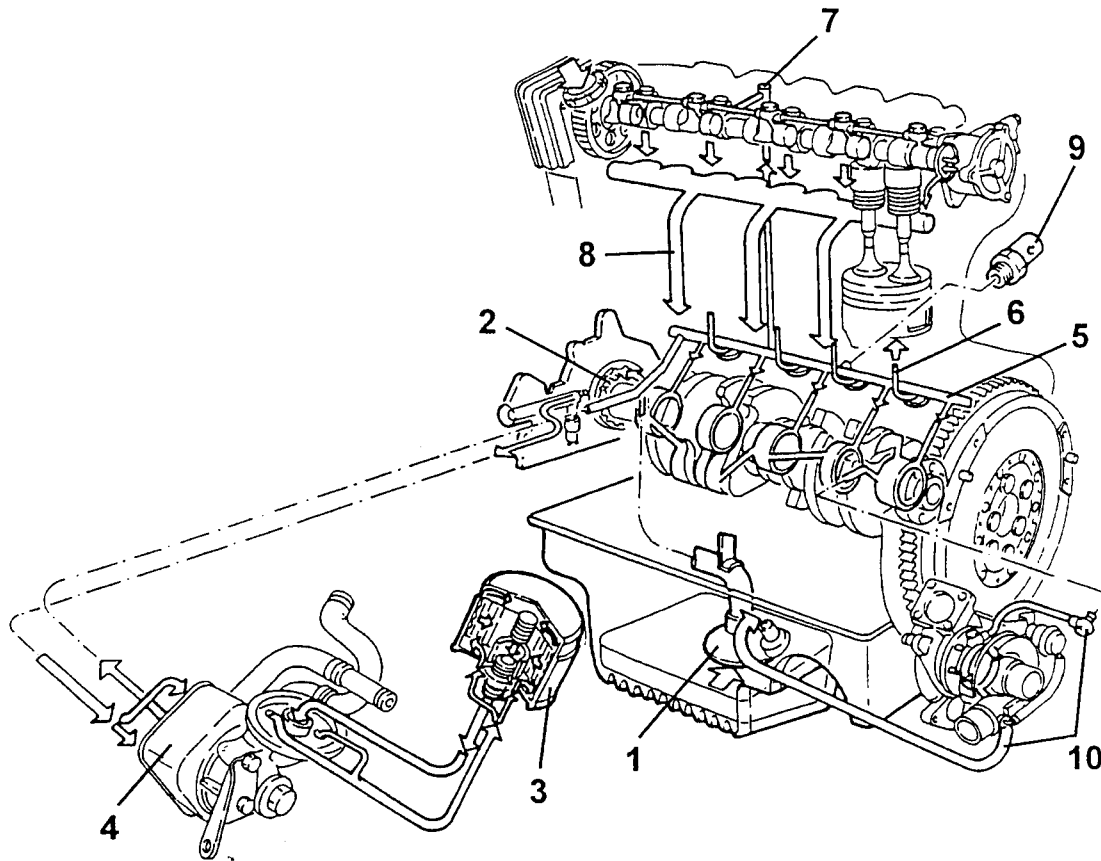
The "OMEGA" shaped combustion chamber, which improves combustion yield, is machined on the piston crown.

Mating with the gudgeon pin is through two copper alloy bushes.



1. Piston
2. Injector
3. Glow plug
4. Air inlet
5. Exhaust gas outlet

## LUBRICATION SYSTEM



1. Suction device with filtering mesh
2. Oil pump
3. Oil filter cartridge
4. Heat exchanger (water/oil)
5. Main longitudinal groove

6. Spray jets (piston skirt cooling)
7. Vertical groove (lubricating camshaft bearings)
8. Oil return to sump
9. Switch for engine oil pressure warning light
10. Turbocharger lubrication pipes

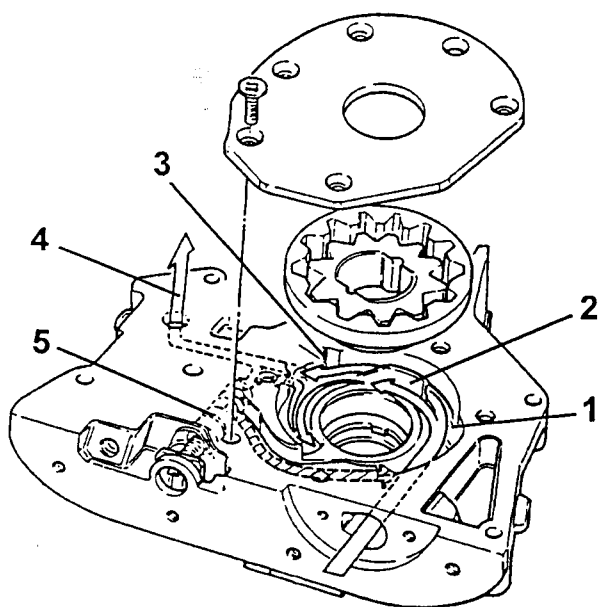
## OIL PUMP

The engine oil is withdrawn from the sump by the vacuum created by the rotation of the gears shrunk onto the crankshaft.

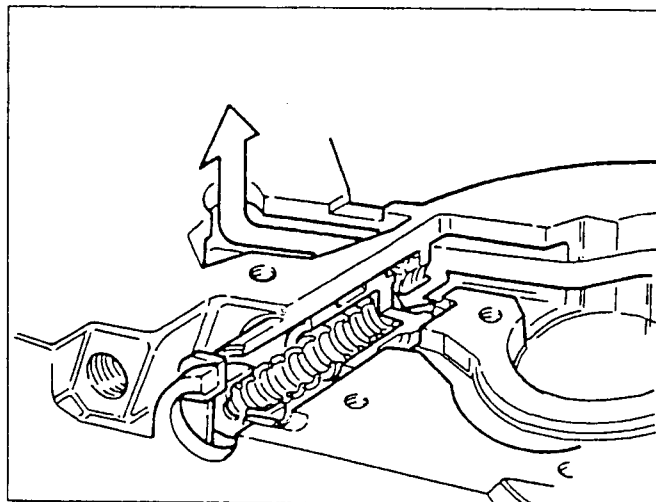
The vacuum is present starting from the separation partition (2) of the gears up to the oil sump suction device.

On the other hand, the pressure develops starting from the separation partition (2) in all the engine oil delivery ducts (4).

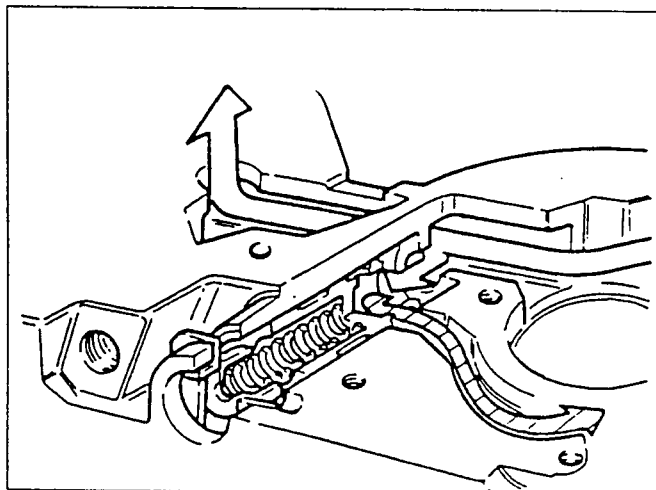
When the pressure exceeds 5 bar, the thrust exerted on the limiting valve (5) overcomes the reaction of the spring below and moves the valve until it opens the connection duct between the pressure chamber (3) and the low pressure chamber (1).



Closing operating position of the engine oil pressure limiting valve



Short circuit operating position of the limiting valve



## 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:

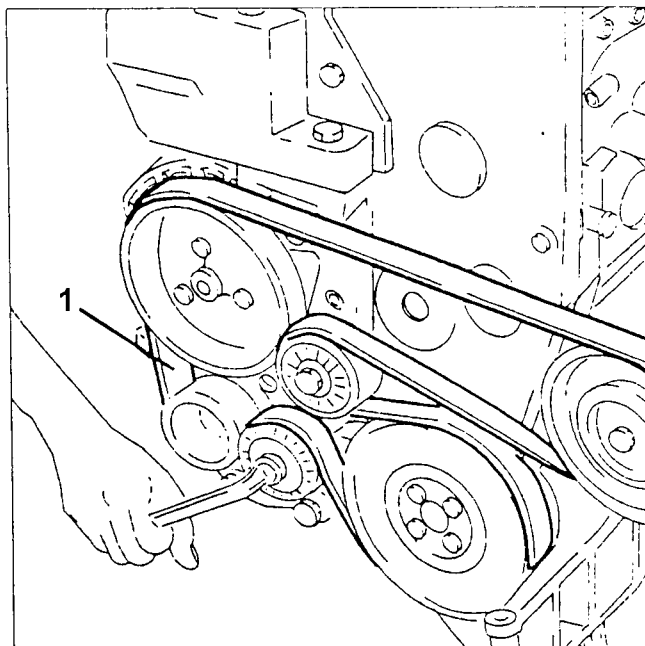
- **Engine removal:**  
removal of engine accessories and components and disassembly of the main engine assemblies.
- **Cylinder head disassembly and overhauling:**  
complete overhauling of component parts.
- **Crankcase overhauling:**  
complete overhauling of component parts.
- **Refitting precautions:**  
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.

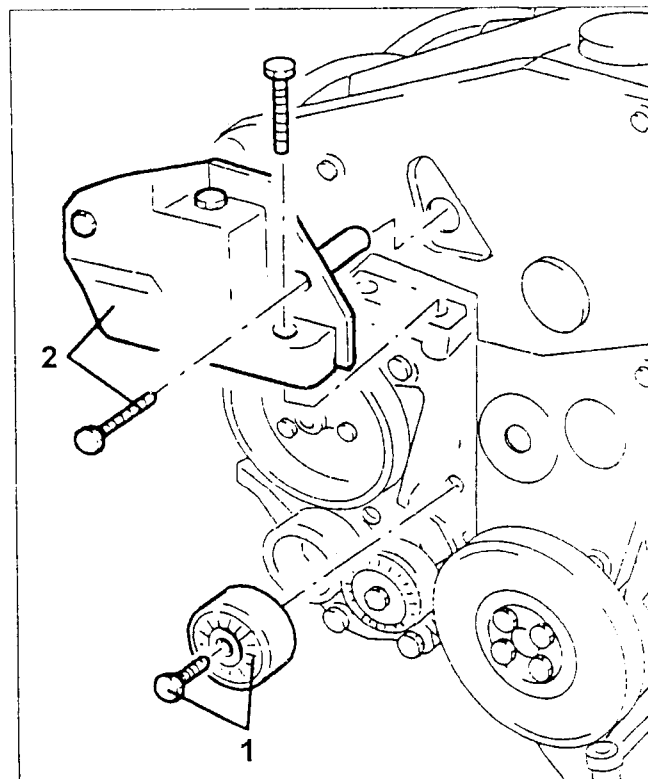
The following procedures refer to complete engine overhauling. Some procedures, however, can be used separately for some parts only when required for specific components.

## SINGLE ENGINE UNIT BELT REMOVAL

- Loosen the single engine unit belt by means of a wrench on the automatic belt take-up device.
- 1. Remove the single engine unit belt.



1. Loosen the fastening screw and remove the single engine unit belt runner.
2. Loosen the fastening screws and remove the engine tie-rod bracket.

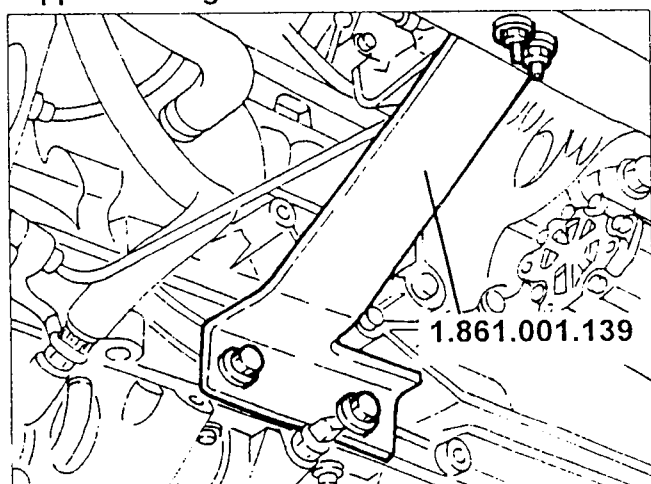


## ENGINE REMOVAL

### PRELIMINARY OPERATIONS

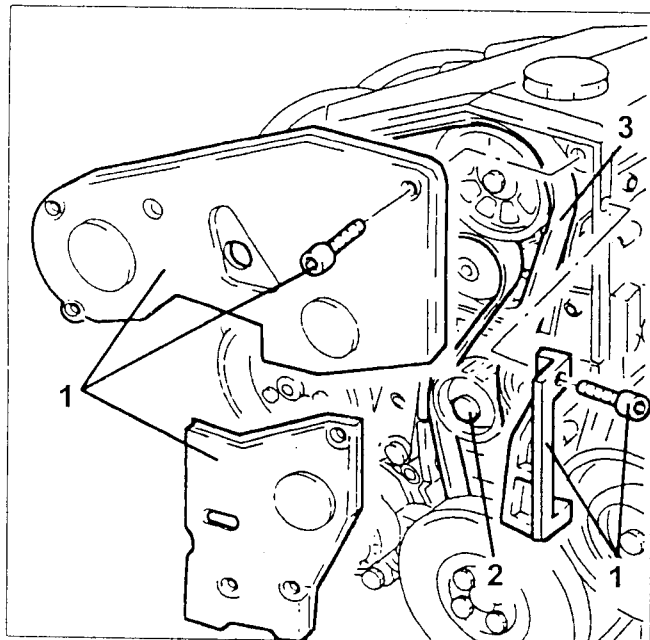
- Position the engine on a stand with common suitable tools.

**NOTE:** Tool no. 1.861.001.139 can be used to support the engine on the overhaul stand.

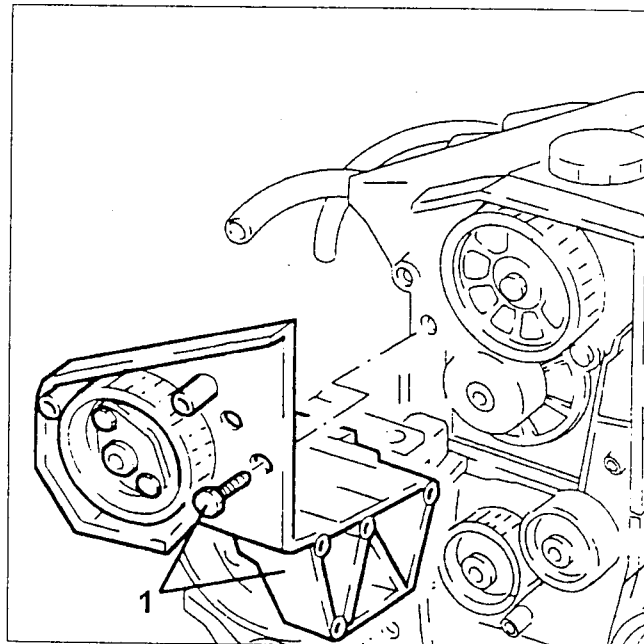


## TIMING BELT REMOVAL

1. Loosen the screws and remove the timing belt guard.
2. Loosen the timing belt take-up device nut.
3. Remove the timing belt.

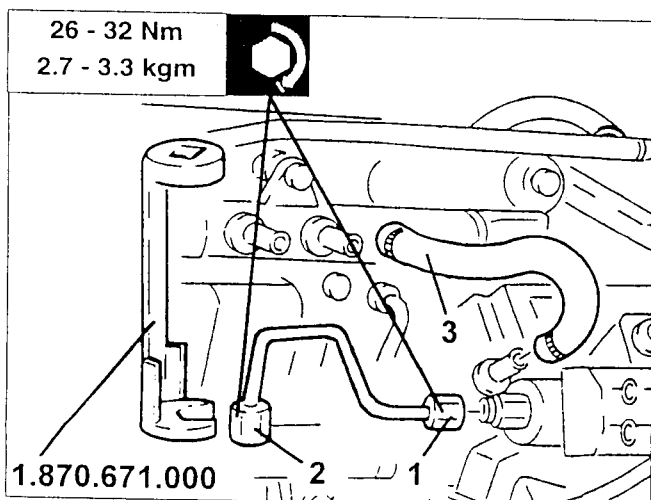


1. Loosen the remaining front screws and remove the pressure pump and bracket.



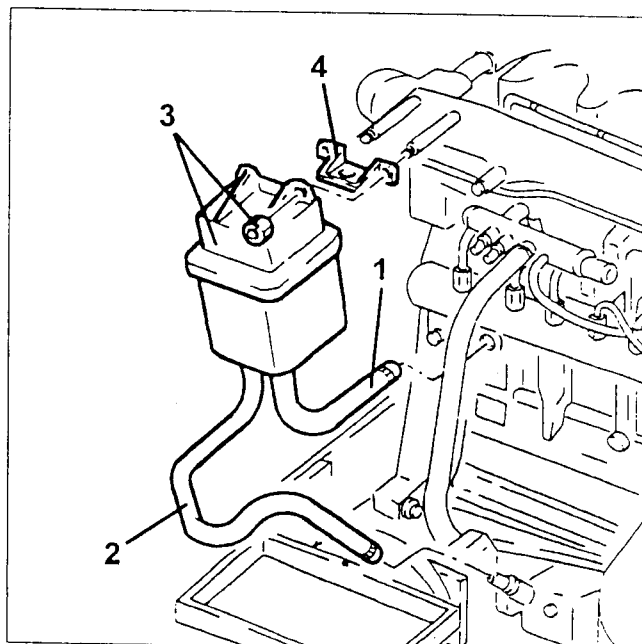
## PRESSURE PUMP REMOVAL

- Loosen the screws and remove the engine oil level dipstick.
  - Loosen the pressure pump bracket side screws.
1. Disconnect the pressure pump-fuel manifold pipe pump side fitting with a suitable tool.
  2. Loosen the pressure pump-fuel manifold pipe manifold side fitting with tool no. 1.870.671.000.
  3. Disconnect the pressure pump-fuel return pipe on pipe side.



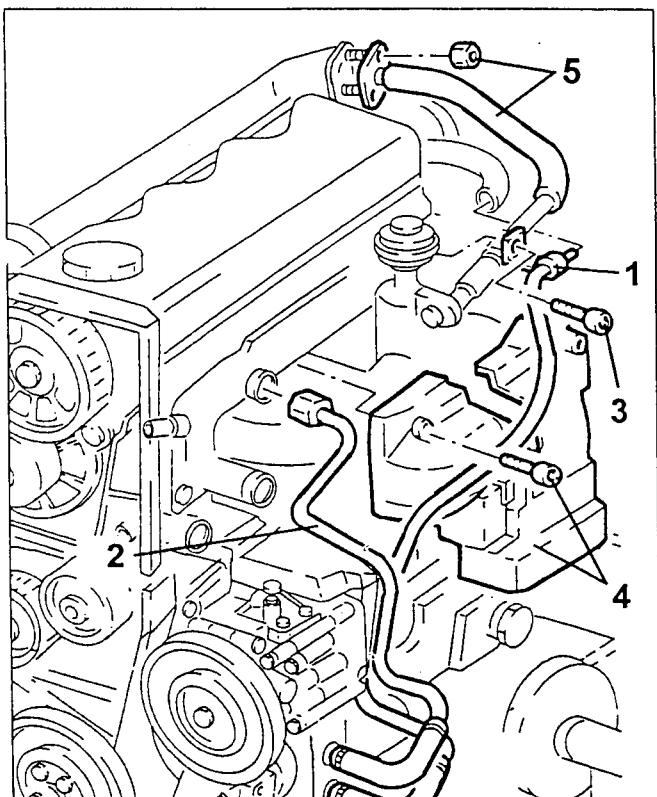
## TURBO COMPRESSOR REMOVAL

1. Disconnect the crankcase oil vapour recovery pipe.
2. Disconnect the condense oil recovery pipe from the crankcase sump.
3. Loosen the nuts and remove the oil vapour separator.
4. Remove the bracket.



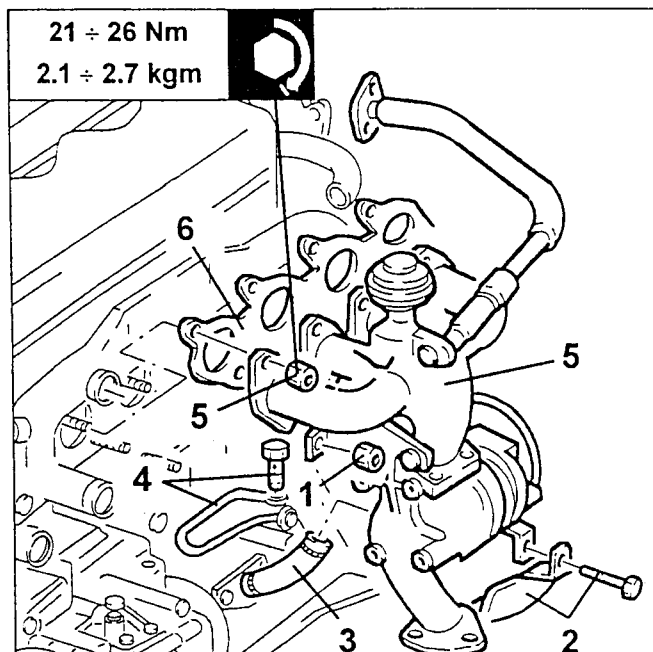


1. Disconnect the coolant delivery pipe to the water-oil heat exchanger from the thermostat.
  2. Disconnect from the water pump fluid inlet stiff pipe the outlet pipe from the water-oil heat exchanger.
  3. Slacken the screw fastening the water inlet pipe to the water-oil heat exchanger.
  4. Slacken the screws and remove the heat shield from the turbocharger.
  5. Slacken the nuts and disconnect the exhaust gas recirculation pipe from the intake box.
- Remove the seal.



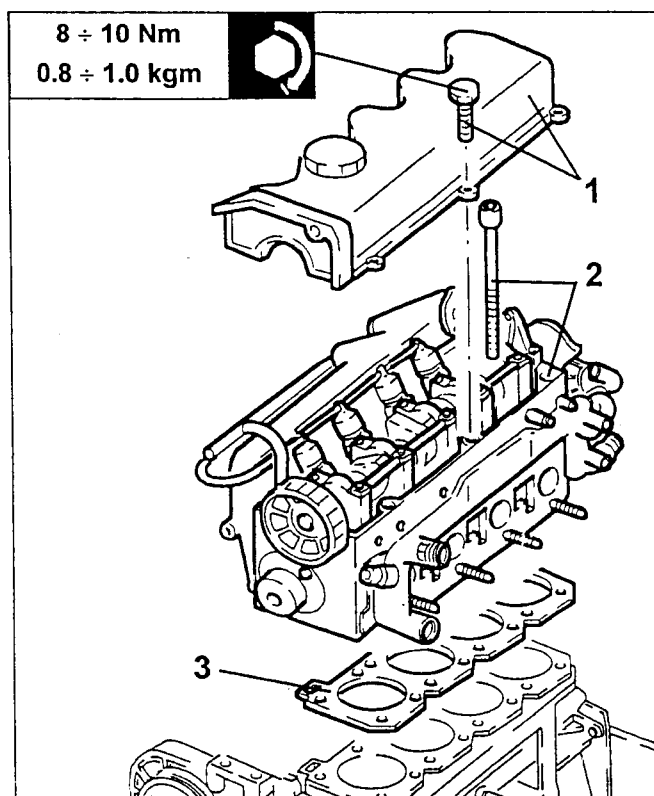
- Slacken the screw of the exhaust gas recirculation pipe support bracket.

1. Slacken the nut fastening the exhaust manifold bracket to the crankcase.
2. Slacken the screws and remove the cover of the oil return pipe to the sump from the turbocharger.
3. Disconnect the oil return pipe to the sump from the turbocharger.
4. Disconnect the oil inlet pipe from the turbocharger.
5. Slacken the fastening nuts and remove the exhaust manifold complete with turbocharger and E.G.R. valve.
6. Remove the seal.



## REMOVING THE CYLINDER HEAD

1. Slacken the fastening screws and remove the tappet cover complete with seal.
2. Slacken the fastening screws and remove the cylinder head complete.
3. Remove the cylinder head seal.

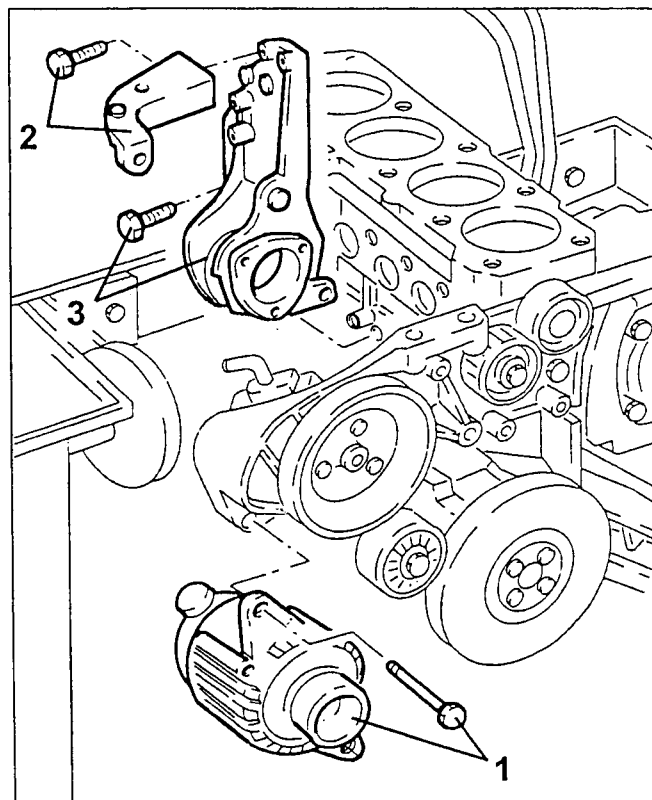
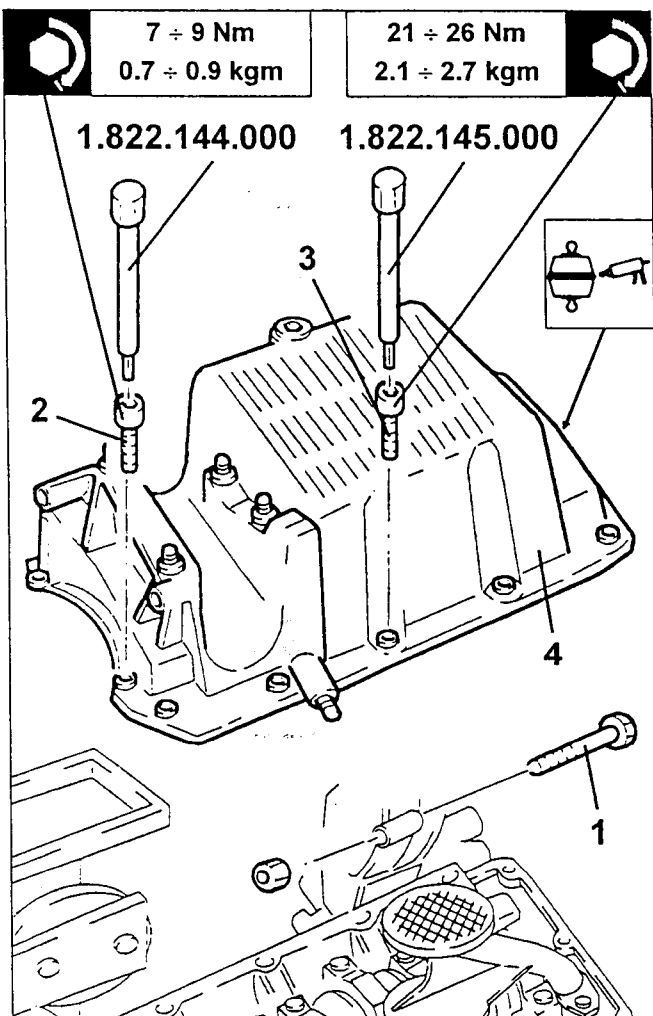


## REMOVING THE CRANKCASE SUMP

- Turn the engine by 180° on the overhauling stand.
- 1. Slacken the bolt connecting the crankcase sump to the layshaft support.
- 2. Slacken the front and rear screws of the crankcase sump using tool no. 1.822.144.000.
- 3. Slacken the side screws of the crankcase sump using tool no. 1.822.145.000.
- 4. Remove the crankcase sump.

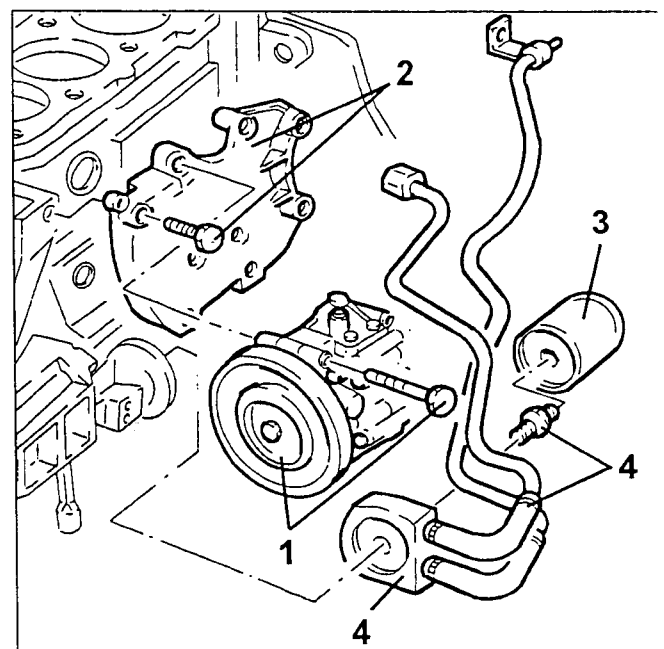


Coat silicone sealant around the whole perimeter of the sump.



## REMOVING THE AIR CONDITIONER COMPRESSOR

- 1. Slacken the fastening screws and remove the air conditioner compressor.
- 2. Slacken the fastening screws and remove the air conditioner compressor support.
- 3. Remove the engine oil filter and cartridge.
- 4. Slacken the pin and remove the water-oil heat exchanger complete with pipes.

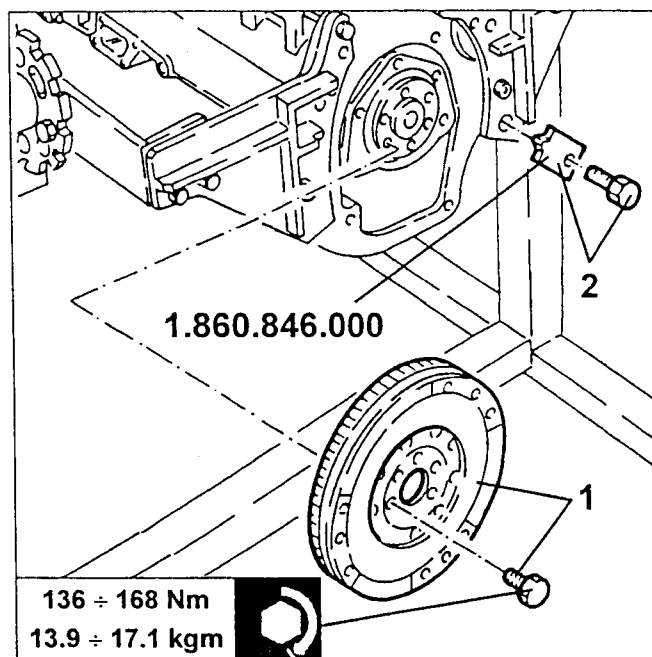
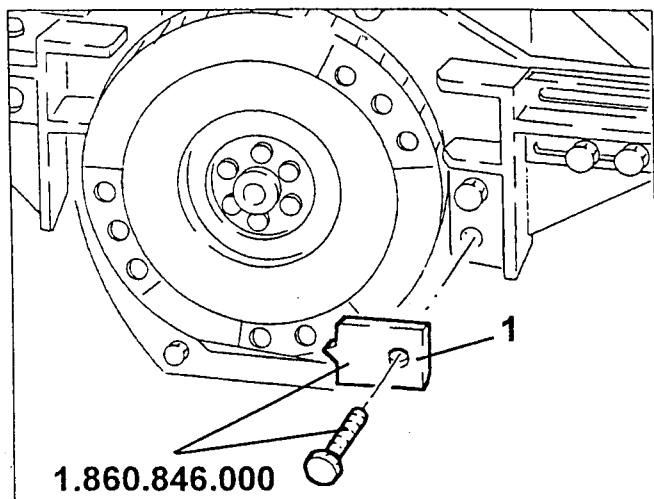


## REMOVING THE ALTERNATOR

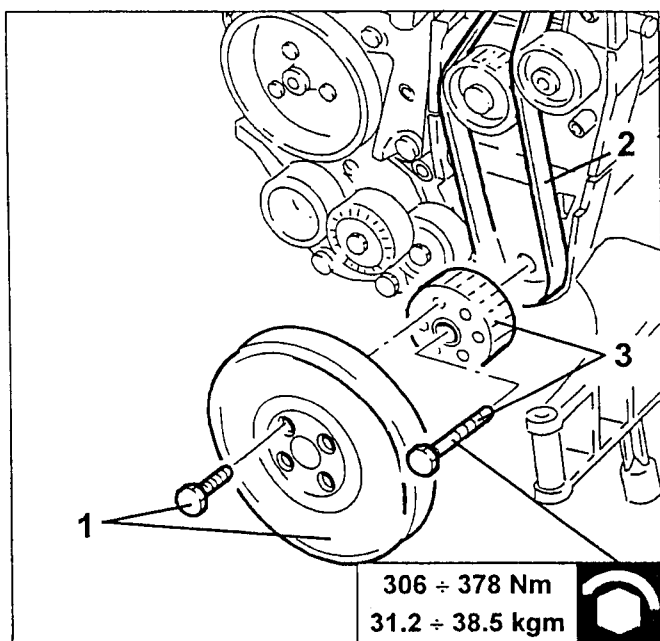
- Turn the crankcase 180° on the overhauling stand.
- 1. Slacken the fastening bolts and remove the alternator.
- 2. Slacken the fastening screws and remove the rear alternator support bracket.
- 3. Slacken the fastening screws and remove the layshaft support.

## REMOVING THE FLYWHEEL

1. Assemble the flywheel stopper tool no. 1.860.846.000.



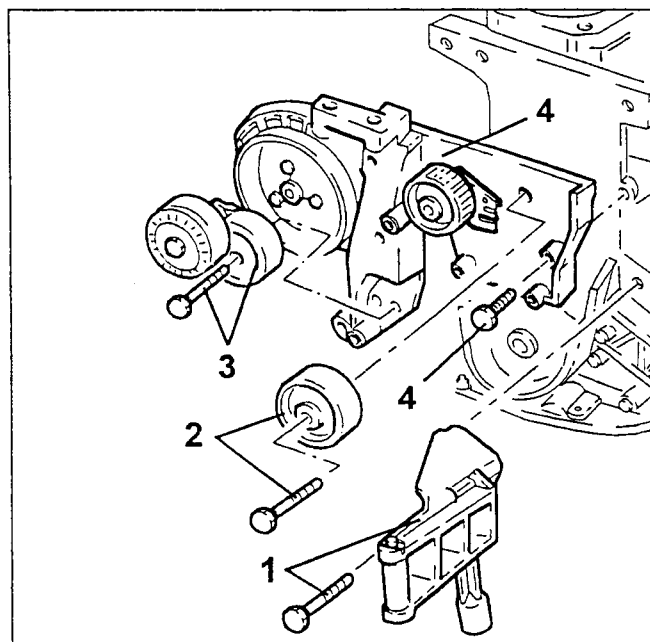
1. Slacken the fastening screws and remove the crankshaft pulley.
2. Remove the camshaft belt.
3. Slacken the screw (left-handed) and remove the driving toothed pulley.



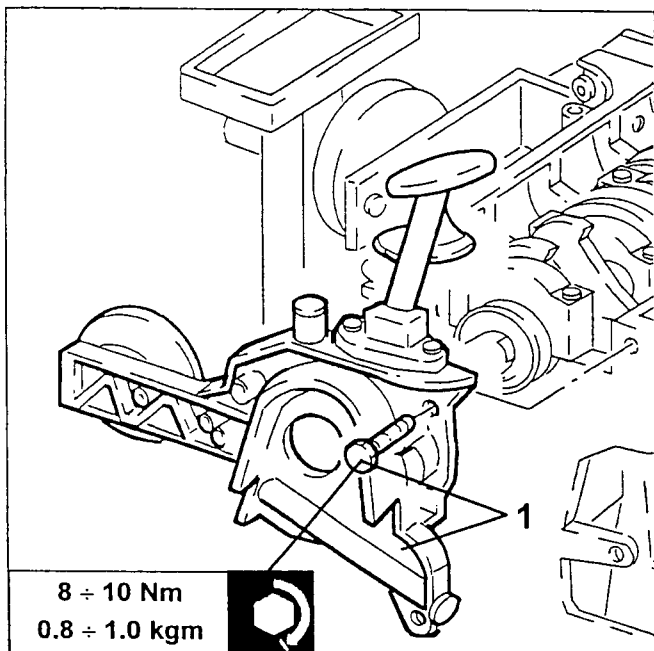
1. Slacken the fastening screws and remove the flywheel.
2. Remove the flywheel stopper tool no. 1.860.846.000.

## REMOVING THE CRANKCASE FRONT COVER

1. Slacken the fastening screws and remove the power unit rigid support on the camshaft side.
2. Slacken the fastening screw and remove the camshaft drive fixed tensioner.
3. Slacken the fastening screw and remove the engine parts drive belt automatic tensioner.
4. Slacken the screws and remove the support complete with power steering pump and mobile camshaft drive tensioner.



1. Slacken the screws and remove the front crankcase cover with incorporated oil pump complete with intake horn.
- Remove the seal.



## REMOVING THE PISTONS AND CONNECTING RODS

- Assemble tool no. 1.860.815.000 for turning the crankshaft.
- Turn the crankshaft 180° on the overhauling stand.
- Turn the crankshaft using the tool installed previously until the cylinder concerned reaches the B.D.C.
- 1. Slacken the fastening screws and remove the connecting rod cap.
- 2. Remove the lower connecting rod half bearing.
- 3. Remove the connecting rod-piston assembly.
- 4. Remove the upper connecting rod half bearing.
- Proceed in the same way for removing the pistons and connecting rods of the remaining cylinders.
- Remove the tool no. 1.860.815.000 used for turning the crankshaft.
- 5. Slacken the fastening screws and remove the crankcase rear cover with incorporated oil seal.
- Check that the crankshaft end float is within the specified limits using a magnetic base with dial gauge.

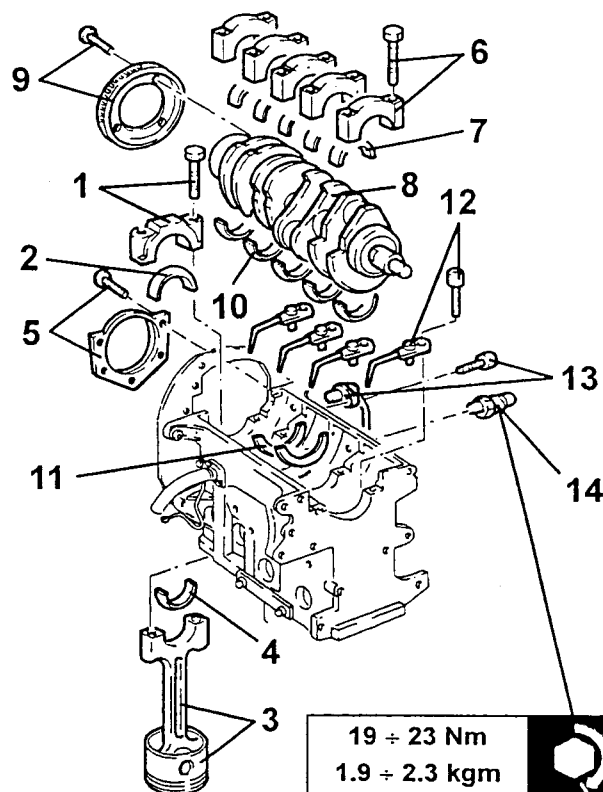


### Crankshaft end float

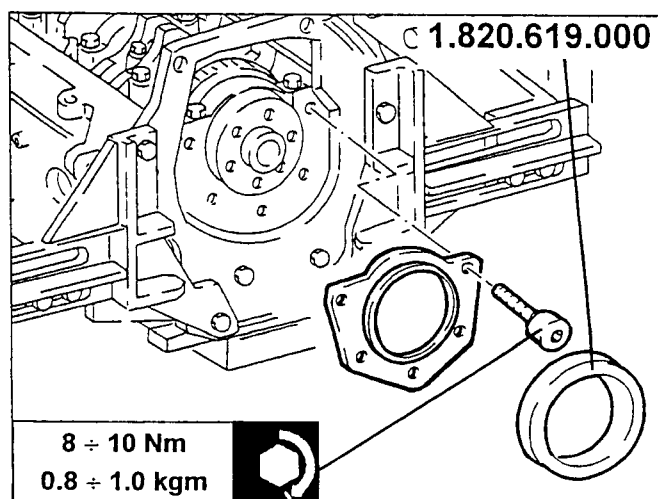
0.049 ÷ 0.211

- If the crankshaft end float is not within the specified limits, when reassembling grind the seat on the crankcase and use suitably oversized half thrust rings.
- 6. Slacken the fastening screws and remove the main bearing caps.
- 7. Remove the lower main half bearings.
- 8. Remove the crankshaft.

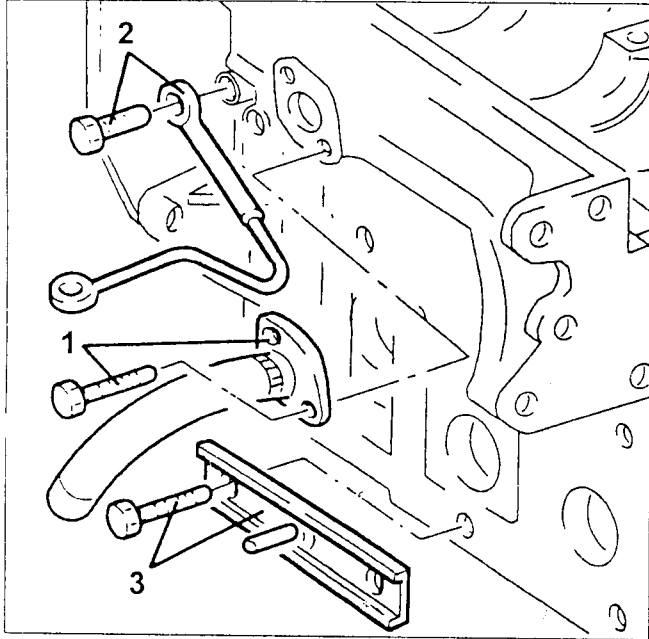
9. Slacken the fastening screws and remove the phonic wheel from the crankshaft.
10. Remove the upper main half bearings.
11. Remove the half thrust rings.
12. Slacken the fastening screws and remove the jets for cooling the pistons from the crankcase.
13. Slacken the fastening screw and remove the rpm and timing sensor.
14. Remove the minimum engine oil pressure warning light sensor.



When refitting the crankcase rear cover with incorporated oil seal ring use tool no. 1.820.619.000 for centering the oil seal.



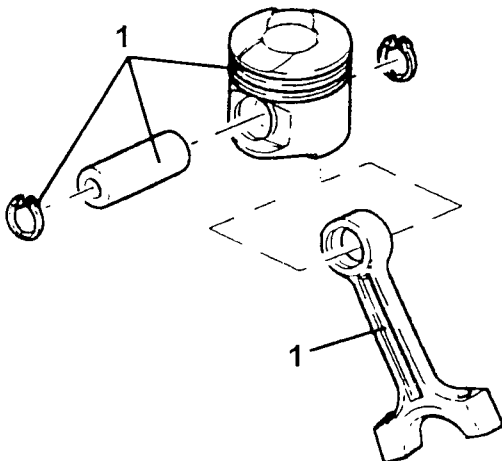
1. Loosen the fastening screw and remove the flange and turbo compressor oil return pipe.
2. Loosen the fitting and remove the turbo compressor oil delivery pipe.
3. Loosen the fastening screws and remove the turbo compressor bracket.



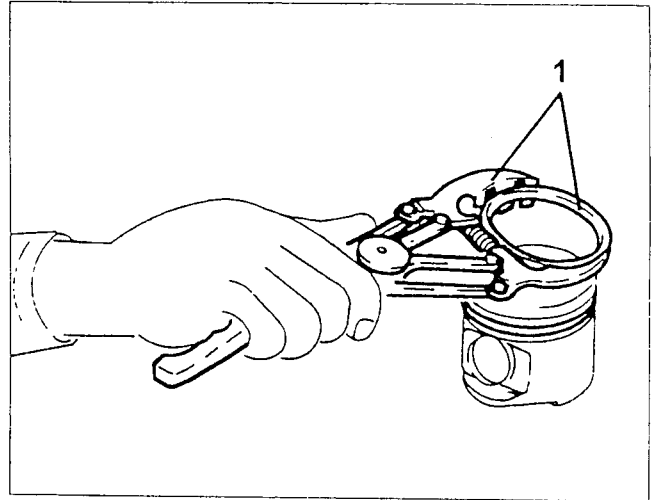
- Turn the crankcase by 90° on the overhaul stand.
- Loosen the screws and remove the crankcase from the bracket then place it on a specific stand.
- Loosen the fastening screws and remove the fly-wheel protection.

## CONNECTING ROD - PISTON REMOVAL

1. Remove the washers, remove the pin and separate the connecting rod from the piston.



1. Remove the gas rings with a suitable tool.



## OIL PUMP DISASSEMBLY

- Loosen the fastening screws and separate the suction device from the oil pump.

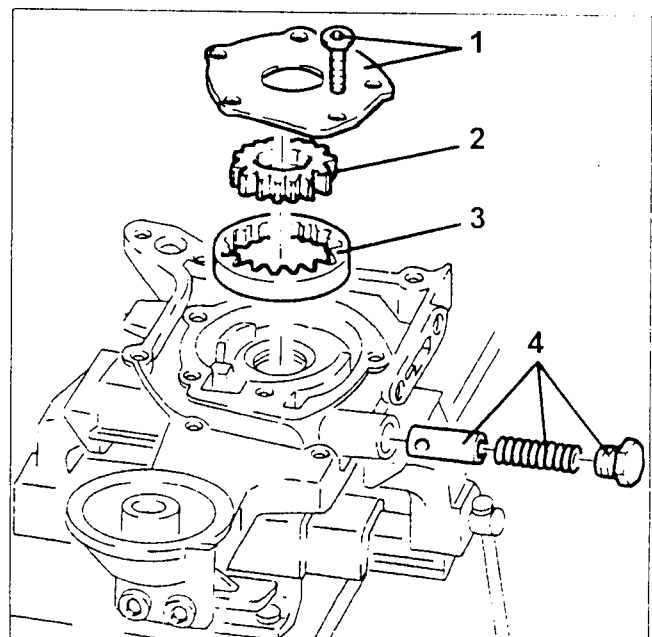
1. Loosen the fastening screws and remove the oil pump cover.
2. Remove the drive gear.
3. Remove the driven gear.



**When refitting the oil pump, manually turn the gears to make sure they turn without seizing.**

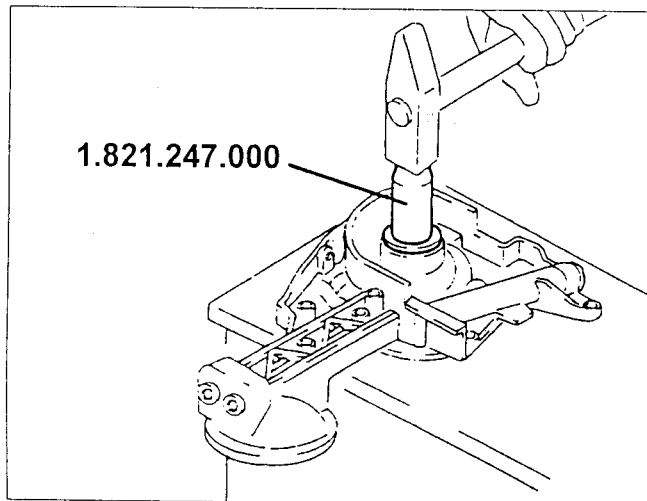
4. Remove the cap and remove the oil pressure limiting valve.

- Remove the crankshaft front oil seal.





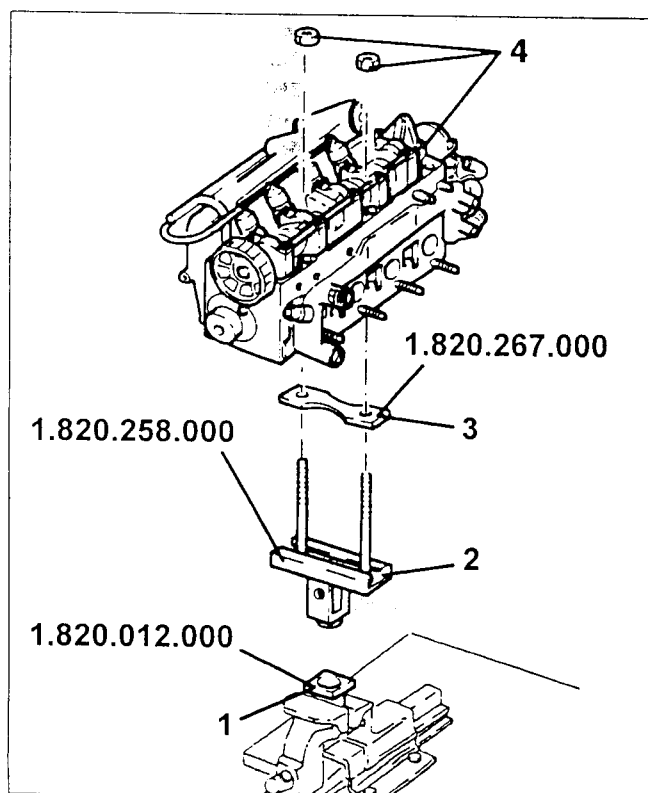
When refitting, insert a new crankshaft front oil seal with tool no. 1.821.147.000.



## CYLINDER HEAD DISASSEMBLY

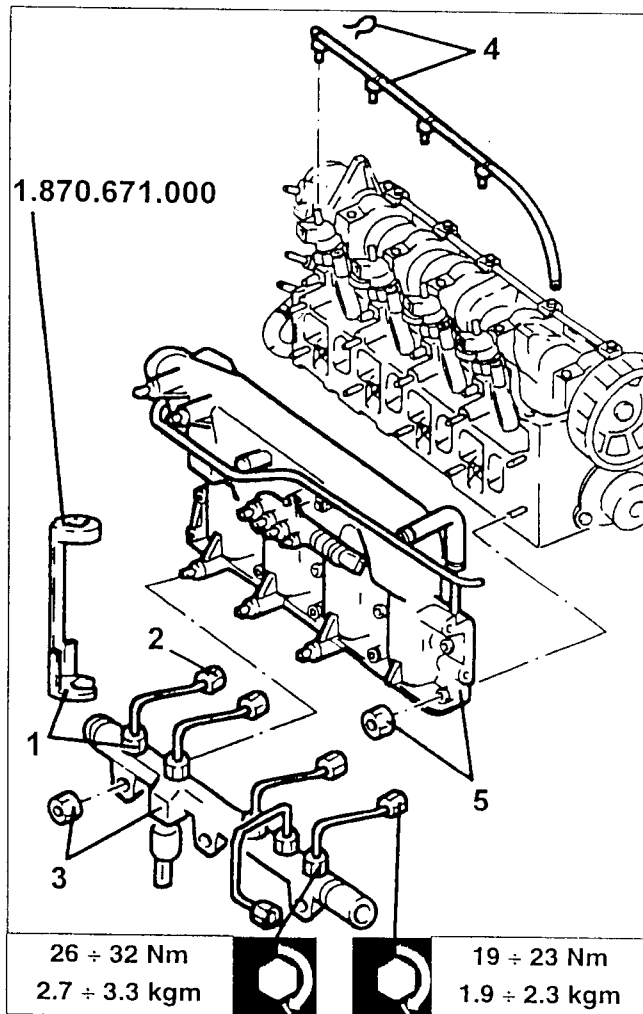
### PRELIMINARY OPERATIONS

1. Position stand no. 1.820.012.000 in a vice.
2. Fit tool no. 1.820.258.000.
3. Fit shim no. 1.820.267.000.
4. Position the cylinder head on the bracket and fasten the respective nuts.



## INTAKE MANIFOLD REMOVAL

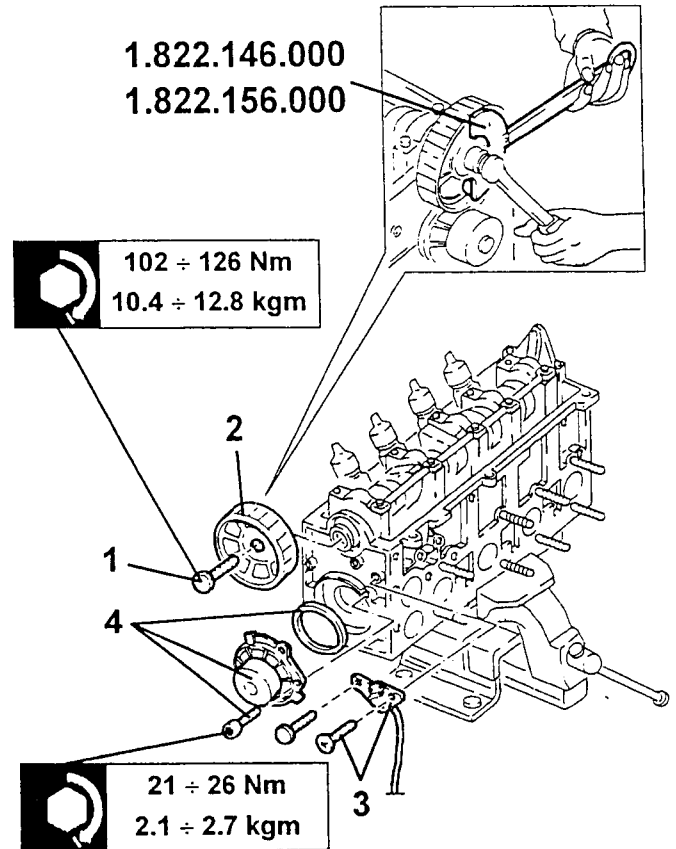
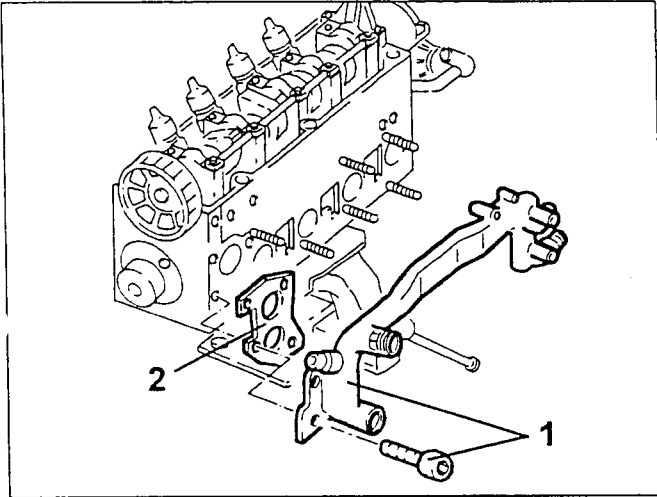
1. Loosen the fuel manifold-injector fittings on manifold side with tool no. 1.870.671.000.
2. Loosen the fuel manifold-injector fitting on injector side with a suitable tool.
3. Loosen the nuts and remove the single fuel manifold with pipes and fuel pressure sensor.
4. Remove the retainers and remove the fuel return pipe for injector lubrication.
  - Loosen the nuts and disconnect the pre-heat glow plug power wiring.
  - Disconnect the expansion reservoir coolant return pipe from the thermostat.
5. Loosen the fastening nuts and remove the complete air intake manifold.



## REMOVING THE STIFF WATER PUMP FLUID INLET PIPE

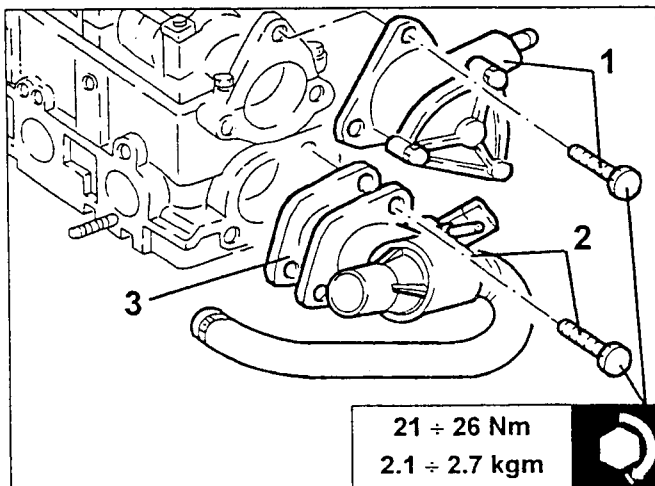
- Disconnect the delivery pipe to the pump stiff inlet pipe.

1. Slacken the fastening screws and remove the stiff water pump inlet pipe.
2. Remove the seal.



## REMOVING THE WATER PUMP

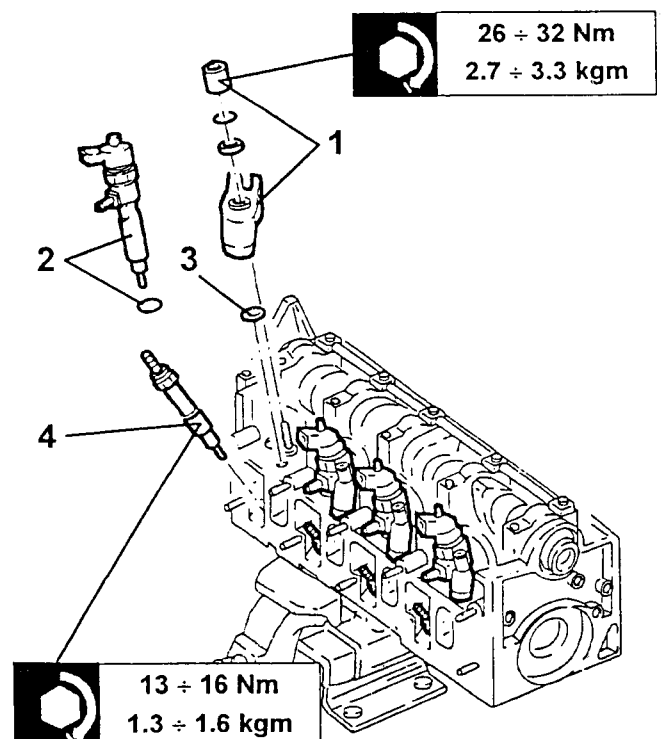
1. Slacken the fastening screws and remove the vacuum pump complete with O-Ring.
2. Slacken the fastening screws and remove the thermostat complete with pipe and sensors.
3. Remove the seal.



1. Slacken the screw of the driven toothed pulley using tools no. 1.822.146.000 and no. 1.822.156.000.
2. Remove the driven toothed pulley.
3. Slacken the fastening screws and remove the cam angle sensor.
4. Slacken the fastening screws and remove the water pump complete with O-Ring.

## REMOVING THE INJECTORS

1. Slacken the fastening nuts and remove the injector brackets.
2. Remove the injectors complete with seal.
3. Remove the injector bracket support pads.
4. Remove the glow plugs.



## REMOVING THE CAMSHAFT

- Check that the camshaft end float is within the specified limits using a dial gauge.

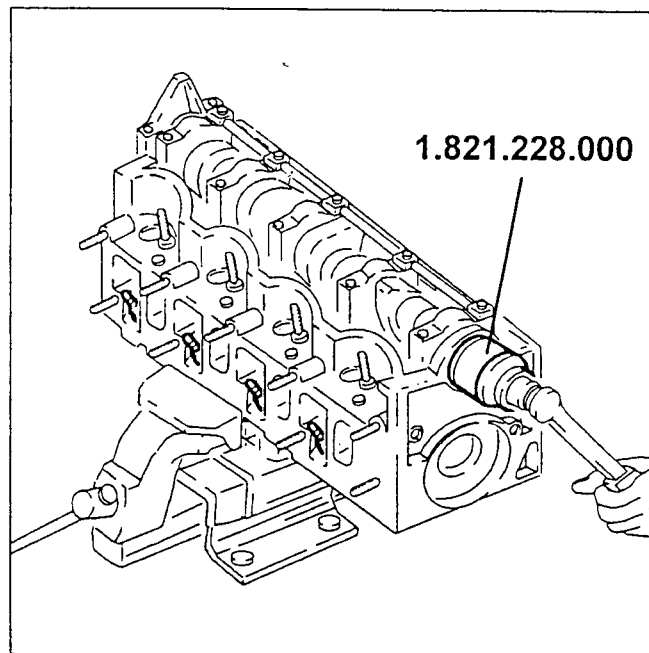
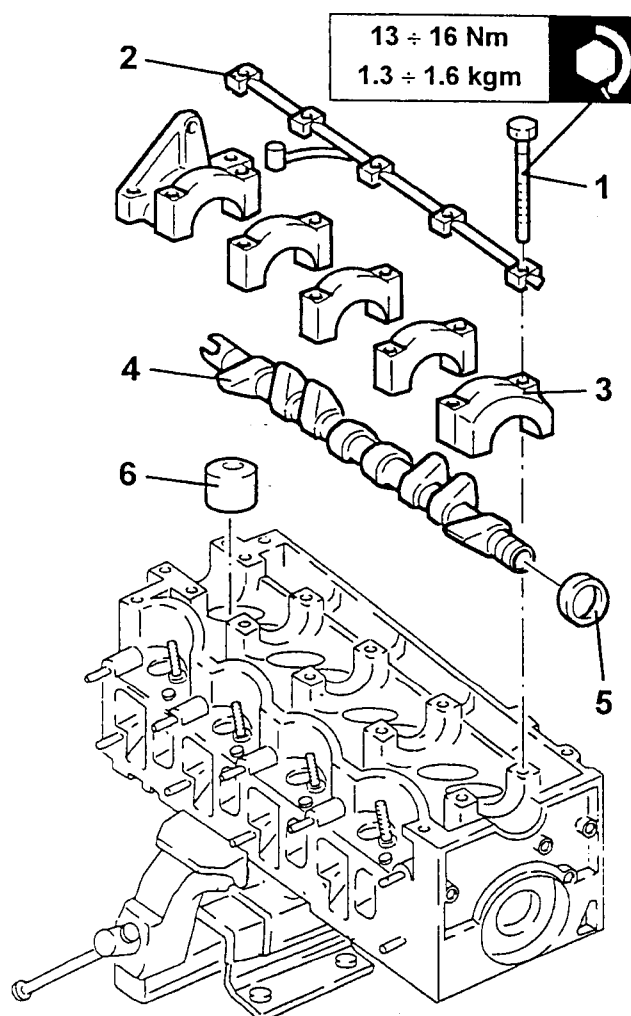


### Camshaft end float

0.100 ÷ 0.230 mm

- If the camshaft end float is not within the specified limits, when reassembling the cylinder head change the worn parts.

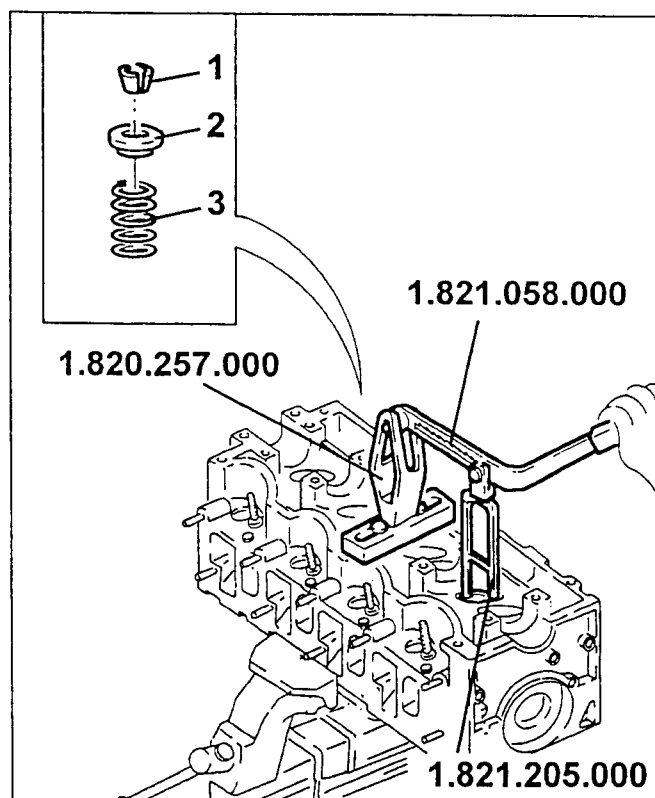
1. Slacken the camshaft cap screws.
2. Remove the camshaft support lubrication pipe.
3. Remove the camshaft caps.
4. Remove the camshaft.
5. Remove the camshaft front oil seal.
6. Remove the cups complete with valve clearance adjustment pads.



## REMOVING THE VALVES

- Remove the cylinder head from the support tools.
- Place a suitable wooden board between the support tools and the cylinder head to support the valves.
- Refit the cylinder head on the support tools and fasten it with the nuts.

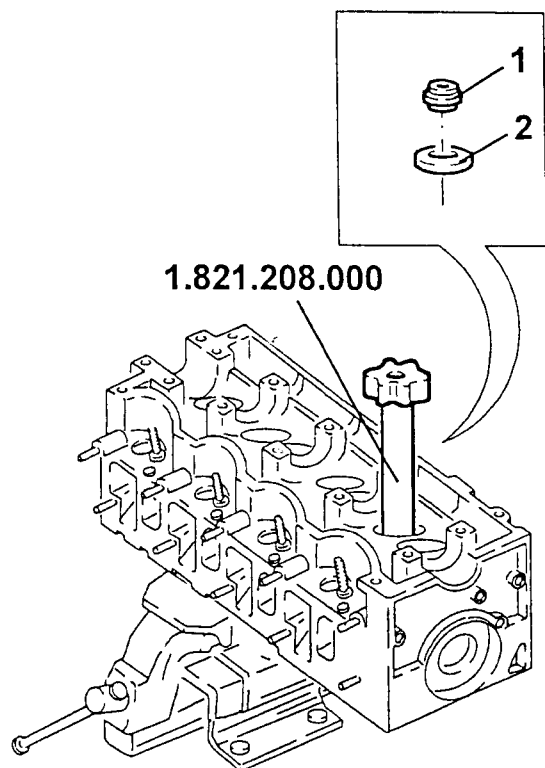
1. Remove the half tapers using support no. 1.820.257.000, lever no. 1.821.058.000 and cage no. 1.821.205.000.
2. Remove the valve upper plates.
3. Remove the valve springs.



When reassembling insert a new camshaft front seal, using tool no. 1.821.228.000.

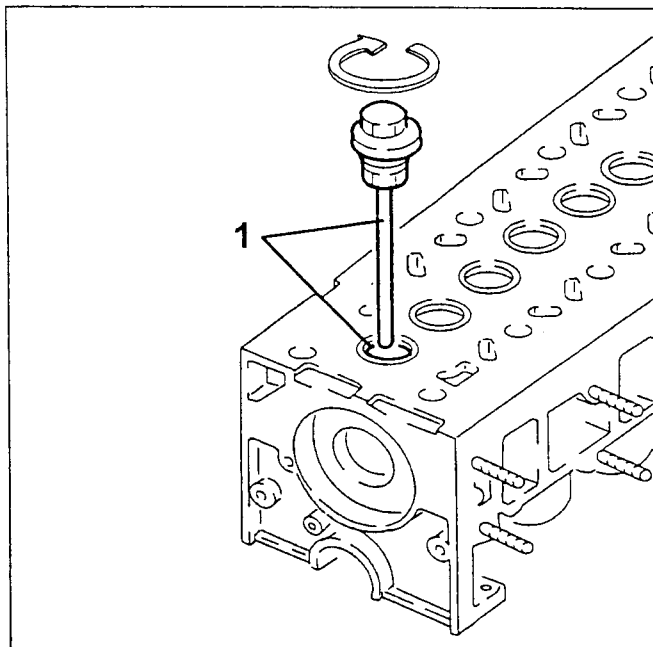


1. Remove the valve guide oil seals using tool no. 1.821.208.000.
2. Remove the valve lower plates.

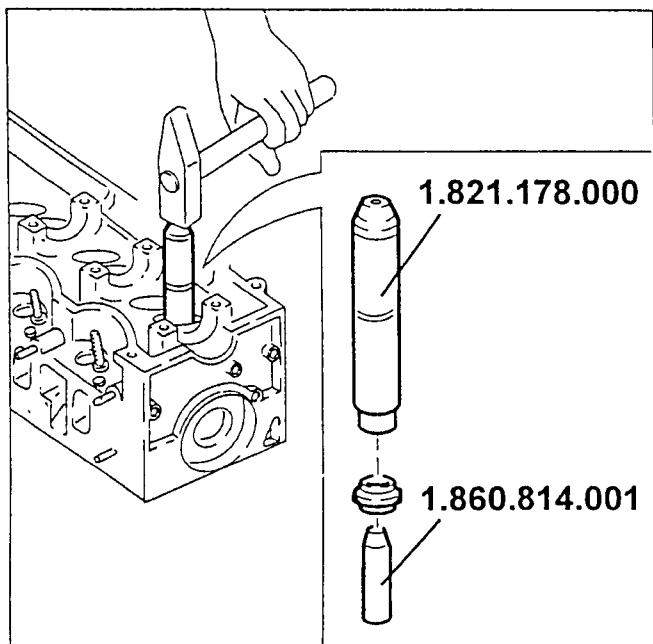


## REPLACING VALVE SEATS AND VALVE GUIDES

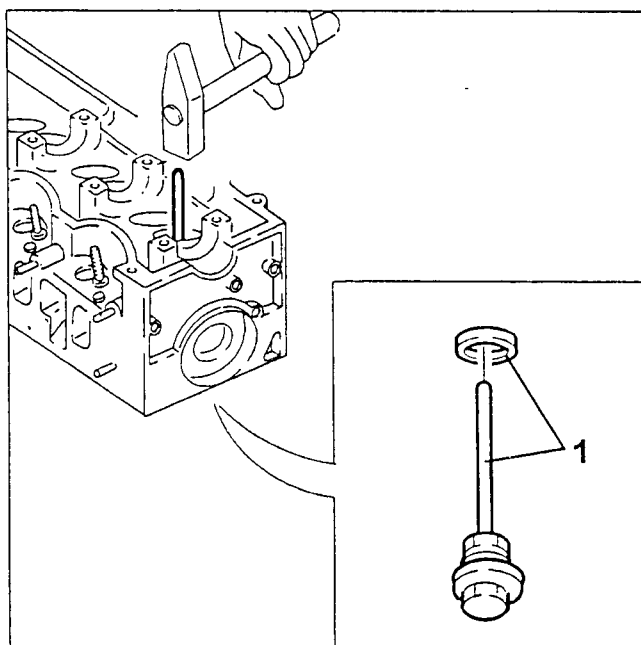
- Remove the cylinder head from the support tools and retrieve the valves.
- Place the cylinder head on the work bench.
- 1. Thread the special puller tool on the valve seat.



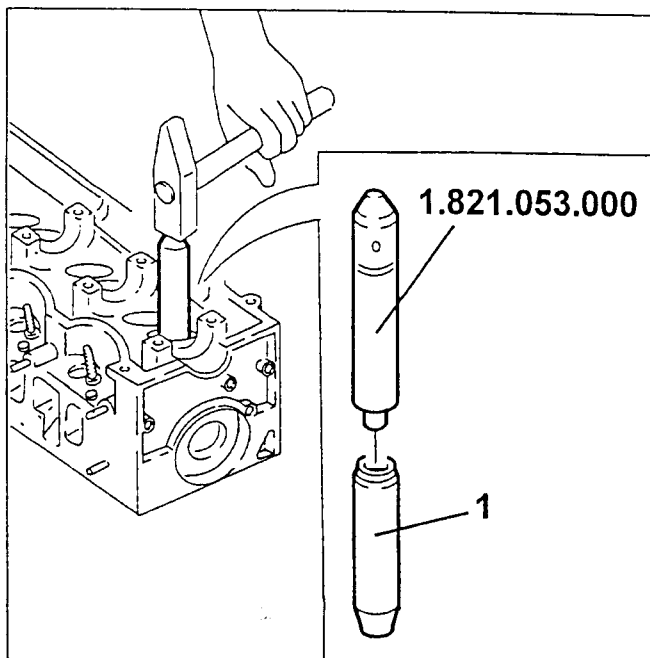
When reassembling insert new valve guide oil seals, using tools no. 1.860.814.001 and no. 1.821.178.000.



- Overturn the cylinder head on the work bench.
- 1. Remove the valve seat using the puller tool.
- Proceed in the same way on the remaining valve seats.



1. Remove the valve guides using tool no. 1.821.053.000.



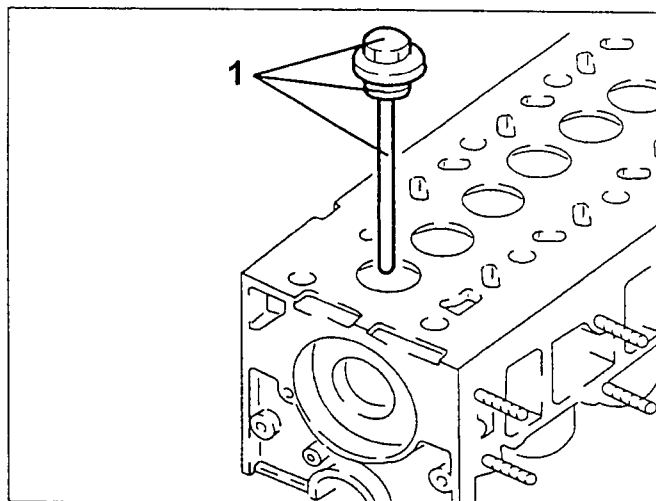
- Check that the outside diameter of the seats of the valves to be installed is within the specified limits.



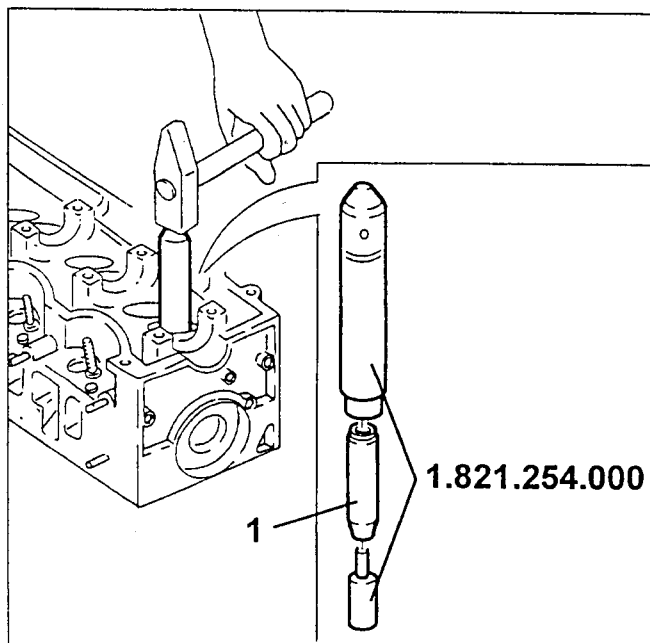
### Valve seat outside diameter

Intake	36.135 ÷ 36.150 mm
Exhaust	35.142 ÷ 35.157 mm

1. Install the valve seats using suitable equipment.



1. Install new valve guides using tool no. 1.821.254.000.

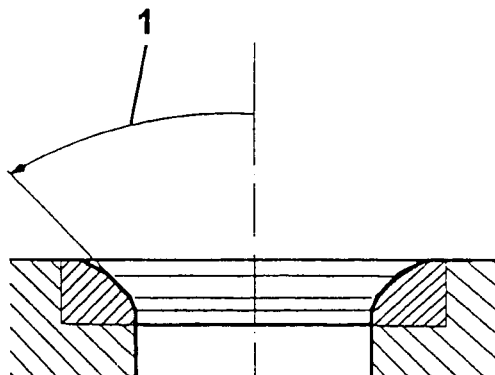


1. Grind the valve seats to the specified dimension.



### Angle of contact band with valve

90° ± 20'



- Bore the inside diameter of the valve guides to the specified value.



### Valve guide inside diameter

8.022 ÷ 8.040 mm

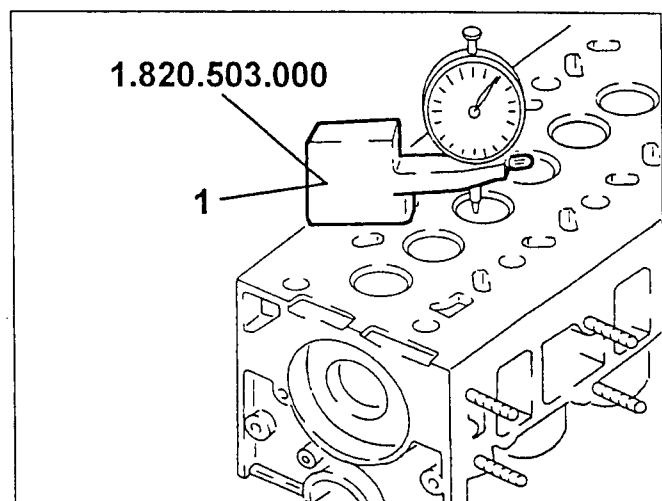
- Grind the valve seats using suitable equipment.  
- Assemble the valves temporarily.

1. Check that the embedding of the valves from the surface of the cylinder head is within the specified limits by measuring using tool no. 1.820.503.000 complete with dial gauge.



**Valve embedding  
from cylinder head surface**

0.1 ÷ 0.5 mm



If the embedding of the valves from the cylinder head surface is not within the specified limits, grind the valve seats again.

## CHECKING AND INSPECTING CYLINDER HEAD

### CHECKING THE CYLINDER HEAD LOWER SURFACE

- Remove all traces of the old seal from the lower surface of the cylinder head.
- Check that the flatness of the cylinder head lower surface is within the specified limits.



**Maximum error of flatness  
of cylinder head lower surface**

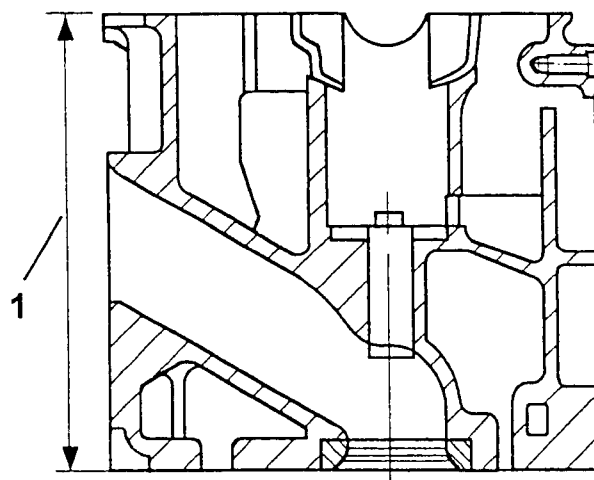
0.1 mm

1. If the flatness of the cylinder head lower surface is not within the specified limits, grind the cylinder head lower surface without exceeding the minimum permissible height.



**Minimum permissible height  
of cylinder head after refacing**

140.85 ÷ 141.15 mm



## CHECKING THE VALVES

- Check that the valves have no signs of scoring or seizing.
- Check that the valve stem diameter is within the specified limits; if not, replace the worn valves.



**Valve stem diameter**

7.974 ÷ 7.992 mm

## CHECKING THE CUPS

- Check that the outside diameter of the cups is within the specified limits; if not, replace the worn parts.



**Outside diameter of valve cups**

36.975 ÷ 36.995 mm

- Check that the diameter of the cup seats is within the specified limits; if not, replace the cylinder head.



**Diameter of valve cup seats**

37.000 ÷ 37.025 mm

## CHECKING VALVE SPRINGS

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



**Valve spring free length**


53.9 mm

- Use a torque meter to check that the specifications of the valve springs are within the specified limits; if not, replace the strained parts.

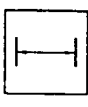
Spring length (mm)		Check load N (kg)
With valve closed	36	367 ÷ 396 (37.4 ÷ 40.4)
With valve open	26.5	560 ÷ 610 (57.1 ÷ 62.2)

## CHECKING THE CAMSHAFT


- Check that the diameter of the camshaft pins is within the specified limits; if not, replace the worn camshaft.

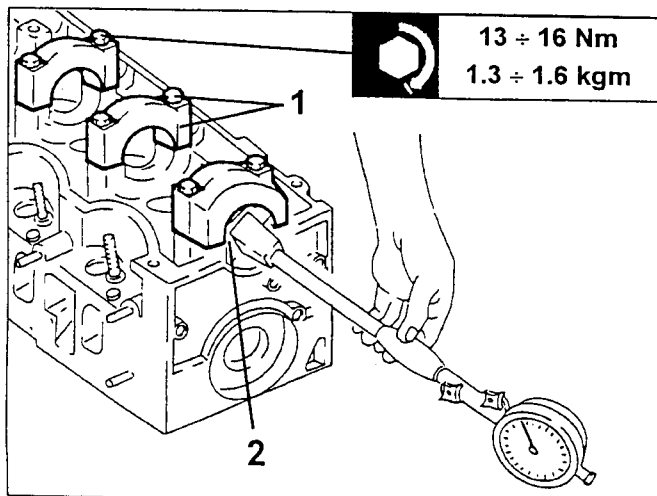
	<b>Diameter of camshaft pins</b>
	26.000 ÷ 26.015 mm

- Check that the nominal lift of the camshaft cams is within the specified limits; if not, replace the worn camshaft.

	<b>Nominal cam lift</b>
	8.5 mm

1. Assemble the camshaft caps on the cylinder head and tighten the screws to the specified torque.
2. Check that the diameter of the camshaft supports is within the specified limits; if not, replace the cylinder head.


	<b>Diameter of camshaft supports</b>
	26.045 ÷ 26.070 mm



## CHECKING AND INSPECTING THE CRANKCASE

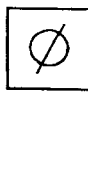
### CHECKING THE SYLINDER HEAD RESTING SURFACE

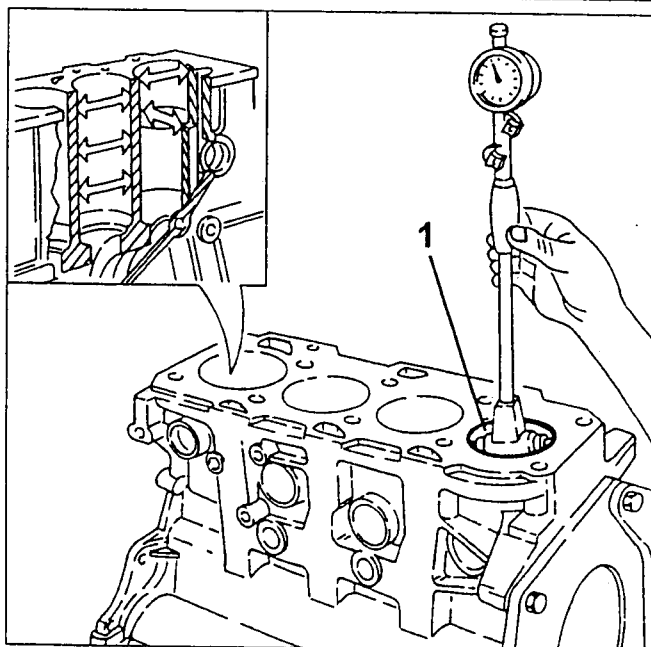
- Check the cylinder head resting surface for cracks or surface scores.
- Check that the flatness of the cylinder head resting surface is within the specified limits; if not, grind the resting surface of the cylinder head.

	<b>Flatness of cylinder head resting surface</b>
	< 0.1 mm


## CHECKING THE CYLINDER LINERS

1. Measure the diameter of the cylinder liners as illustrated.

	<b>Cylinder liner inside diameter</b>
Class A	82.000 ÷ 82.010 mm
Class B	82.010 ÷ 82.020 mm
Class C	82.020 ÷ 82.030 mm



- Check that the cylinder liner taper is within the specified limits.

	<b>Cylinder liner taper</b>
	< 0.005 mm

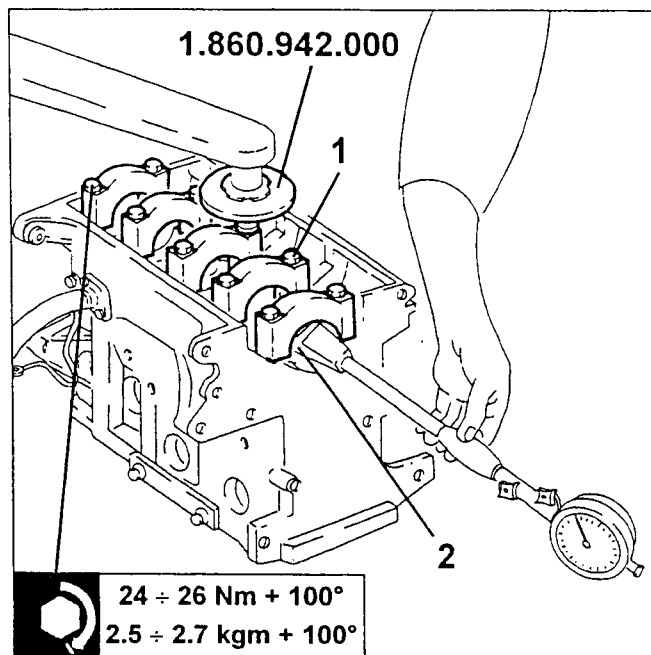
- Check that the cylinder liner ovalisation is within the specified limits.

0	<b>Cylinder liner ovalisation</b> $< 0.05 \text{ mm}$
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- If the cylinder liner diameter is not within the specified limits, bore the cylinder liners according to the specified oversizes.

**NOTE:** In the case of boring all the cylinder liners must have the same oversize.

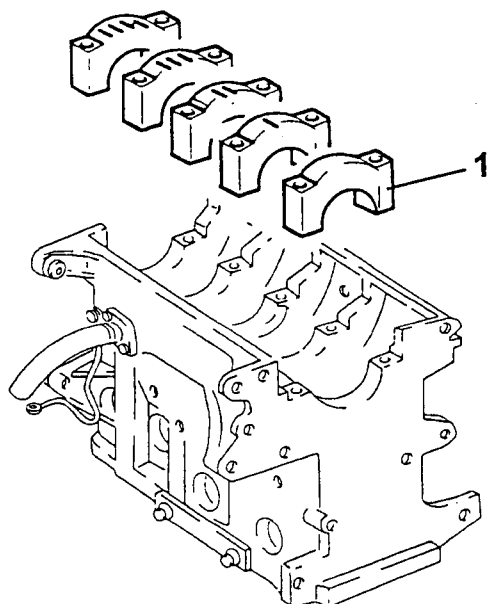
>	<b>Cylinder liner oversize</b> $0.1 \text{ mm}$
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## CHECKING THE MAIN BEARING PINS

1. Assemble the main bearing caps.

**NOTE:** The main bearings are notched consecutively (from 0 to four starting from the engine front) to define their assembly position.



1. Tighten the main bearing cap screws to the specified torque using tool no. 1.860.942.000 for angle tightening.

2. Check that the diameter of the main bearing pin seats is within the specified limits.

∅	<b>Main bearing pin seat diameter</b> $63.691 \div 63.732 \text{ mm}$
---	--

## CHECKING THE CRANKSHAFT

- Check that the lubricating ducts of the crankshaft are not scaled or clogged.

- Check that the main bearing pin diameter is within the specified limits.

∅	<b>Main bearing pin diameter</b> <table border="1"> <tr> <td>Class A</td><td><math>59.994 \div 60.000 \text{ mm}</math></td></tr> <tr> <td>Class B</td><td><math>59.988 \div 59.994 \text{ mm}</math></td></tr> <tr> <td>Class C</td><td><math>59.982 \div 59.988 \text{ mm}</math></td></tr> </table>	Class A	$59.994 \div 60.000 \text{ mm}$	Class B	$59.988 \div 59.994 \text{ mm}$	Class C	$59.982 \div 59.988 \text{ mm}$
Class A	$59.994 \div 60.000 \text{ mm}$						
Class B	$59.988 \div 59.994 \text{ mm}$						
Class C	$59.982 \div 59.988 \text{ mm}$						

- If the main bearing pin diameter is not within the specified limits, grind them according to the specified undersize.

<	<b>Main bearing pin undersizes</b> $0.127 \text{ mm}$
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- Check that the connecting rod pin diameter is within the specified limits.

∅	<b>Diameter of connecting rod pins</b> <table border="1"> <tr> <td>Class A</td><td><math>50.799 \div 50.805 \text{ mm}</math></td></tr> <tr> <td>Class B</td><td><math>50.793 \div 50.799 \text{ mm}</math></td></tr> <tr> <td>Class C</td><td><math>50.787 \div 50.793 \text{ mm}</math></td></tr> </table>	Class A	$50.799 \div 50.805 \text{ mm}$	Class B	$50.793 \div 50.799 \text{ mm}$	Class C	$50.787 \div 50.793 \text{ mm}$
Class A	$50.799 \div 50.805 \text{ mm}$						
Class B	$50.793 \div 50.799 \text{ mm}$						
Class C	$50.787 \div 50.793 \text{ mm}$						

- If the connecting rod pin diameter is not within the specified limits, grind them according to the specified undersize.

<	<b>Undersizes of connecting rod pins</b> $0.127 \text{ mm}$
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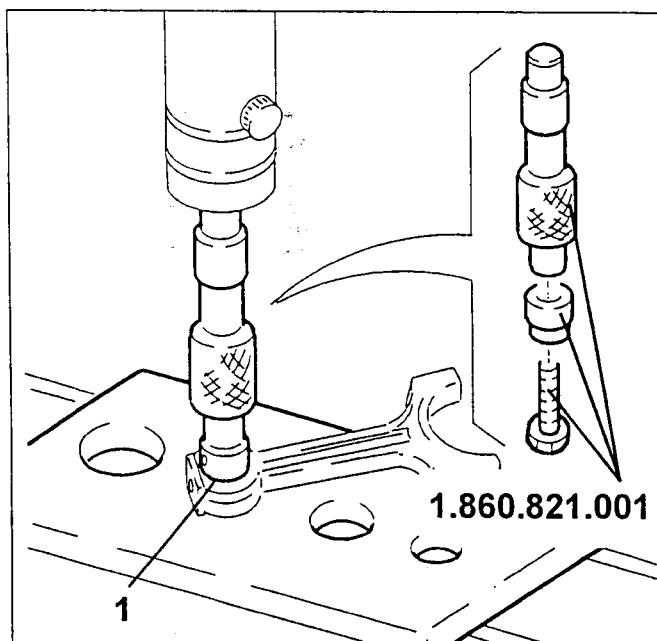
## CHECKING AND IF NECESSARY REPLACING SMALL END BUSHES

- Check that the inside diameter of the small end bushes is within the specified limits.

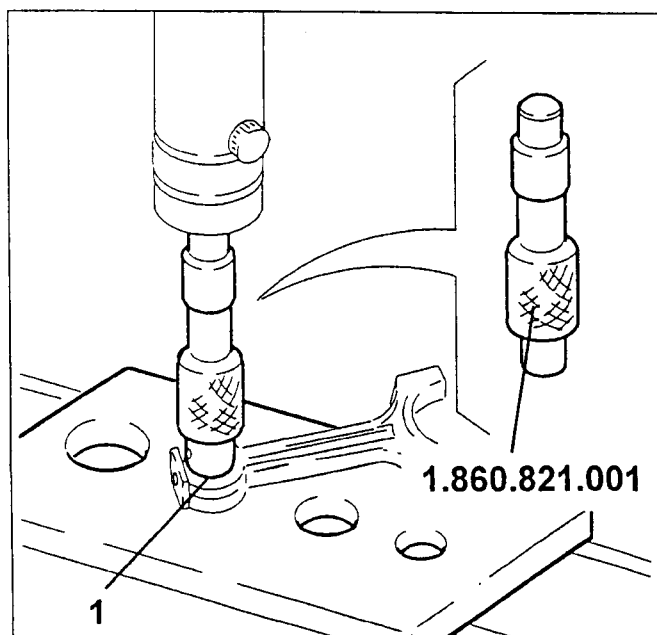
$\varnothing$	<b>Inside diameter of small end bush</b>
	26.006 ÷ 26.012 mm

- If the diameter of the small end bushes is not within the specified limits, replace the worn bushes as described below.

1. Remove the small end bush under a hydraulic press and using puller tool no. 1.860.821.001.

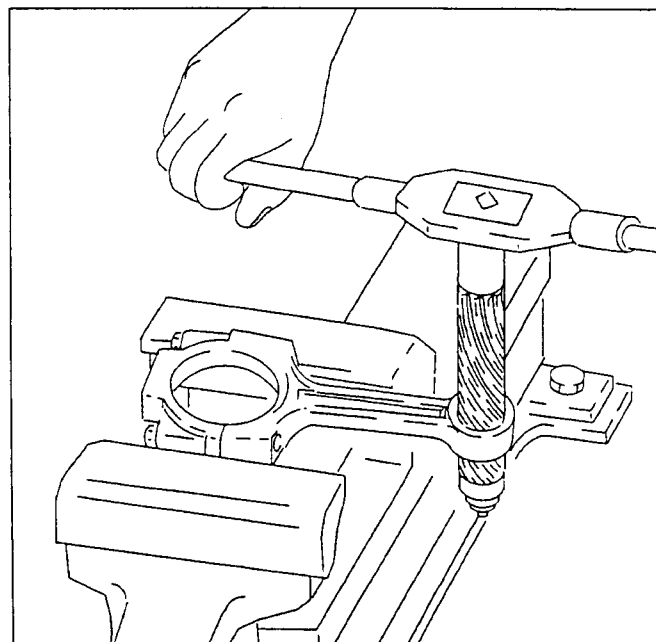


1. Install a new bush in the connecting rod small end under a hydraulic press and using installing tool no. 1.860.821.001 and a suitable reaction plate.



- Bore the inside diameter of the small end bush to the specified limits.

$\varnothing$	<b>Inside diameter of small end bush</b>
	26.006 ÷ 26.012 mm



## CHECKING THE PISTONS

- Check that the inside diameter of the piston bushes is within the specified limits; if not, replace the piston complete with seal rings, gudgeon pins and bushes.

$\varnothing$	<b>Inside diameter of bushes in pistons</b>
	25.999 ÷ 26.004 mm

- Check that the outside diameter of the piston gudgeon pins is within the specified limits; if not, replace the worn gudgeon pins.

$\varnothing$	<b>Outside diameter of piston gudgeon pins</b>
	25.982 ÷ 25.988 mm

- Insert the seal rings in the cylinder liner and check that the gap between the ends is within the specified limits; if not, change the rings.

$\text{H}$	<b>Seal ring gap</b>	
	First ring	0.25 ÷ 0.40 mm
	Second ring	0.25 ÷ 0.50 mm
	Oil scraper ring	0.25 ÷ 0.50 mm

- Check that the outside diameter of the pistons is within the specified limits; if not, replace the piston complete with seal rings and gudgeon pin.



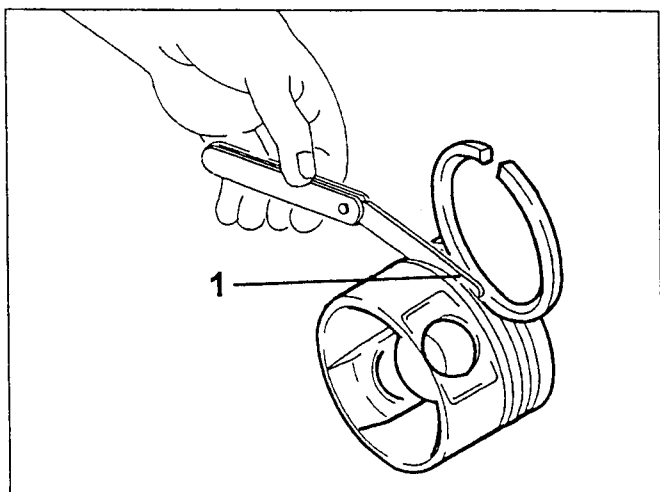
Outside diameter of pistons	
Class A	81.783 ÷ 81.797 mm
Class B	81.793 ÷ 81.807 mm
Class C	81.803 ÷ 81.817 mm

**NOTE:** The outside diameter of the piston should be measured at right angles to the gudgeon pin axis and 8 mm from the lower edge of the skirt.

1. Check that the end floats between the second ring/scrapper ring and their seats on the piston are within the specified limits.



Piston ring end float	
Second ring	0.020 ÷ 0.060 mm
Oil scraper ring	0.030 ÷ 0.065 mm

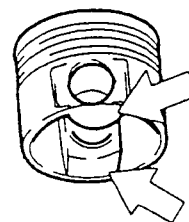


- Check that the difference in weight between the pistons is within the specified limits.



Difference in weight between pistons	
± 5 g	

**NOTE:** The arrows indicate the areas from which it is possible to remove material to obtain an equal weight.

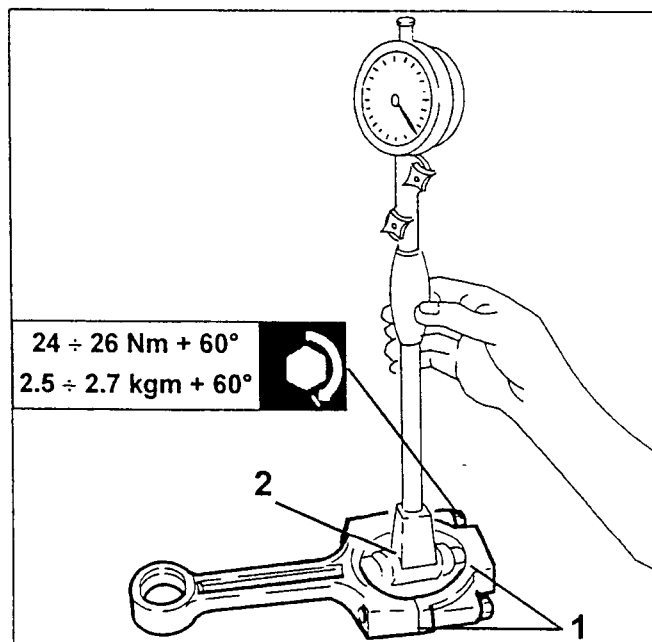


## CHECKING THE CONNECTING RODS

1. Fit the caps on the connecting rods and fasten them with their screws to the specified torque.
2. Check that the diameter of the connecting rod big end is within the specified limits; if not, replace the connecting rods.



Inside diameter of big end	
53.883 ÷ 53.923 mm	



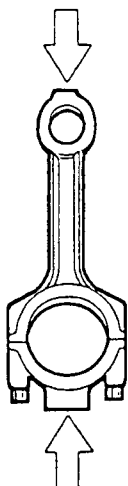
- Check the squaring of the connecting rods using suitable equipment; if squaring is less than perfect, replace the connecting rod.

- 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	
± 2.5 g	

**NOTE:** The arrows indicate the areas from which it is possible to remove material to obtain an equal weight.



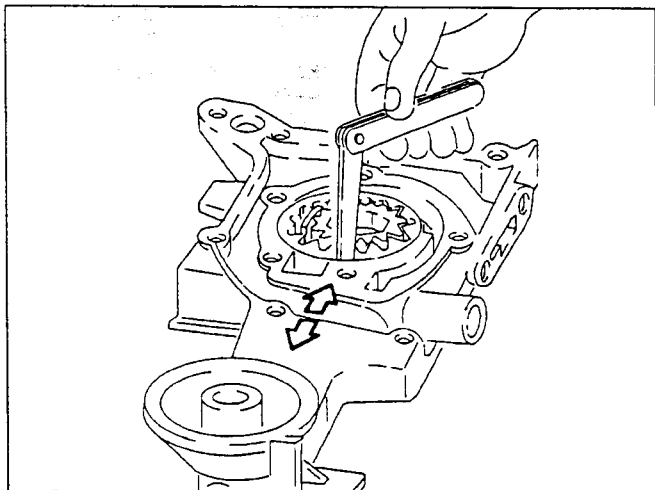
## CHECKING AND INSPECTING THE OIL PUMP

- Check that the radial clearance between the pump casing and the driven gear is within the specified limits; if not, replace the oil pump complete.



**Radial clearance between oil pump casing and driven gear**

0.080 ÷ 0.186 mm

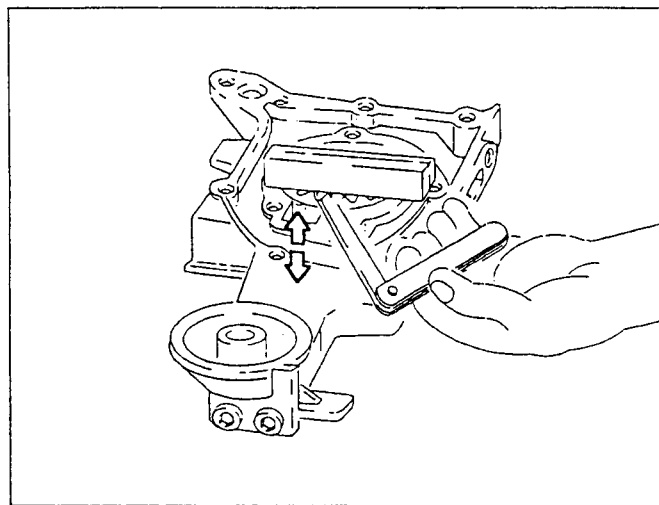


- Check that the end float between the pump cover resting surface and the gear upper side is within the specified limits; if not replace the complete oil pump.



**End float between oil pump cover resting surface and gear upper side**

0.025 ÷ 0.070 mm



- Check that the height of the spring for the oil pressure limiting valve is within the specified limits; if no, replace the spring.

Spring length (mm)	Check load N (kg)
35	117 ÷ 125 (11.9 ÷ 12.7)

## REASSEMBLY INSTRUCTIONS

For reassembly operations, reverse the sequence of the operations followed for removal, unless otherwise specified in the instructions given below.

### Checking and adjusting valve clearance

- Check that the valve clearance in the closed position, is within the specified limits.



**Valve clearance (with valves in closed position)**

Intake	0.25 ÷ 0.35 mm
Exhaust	0.30 ÷ 0.40 mm

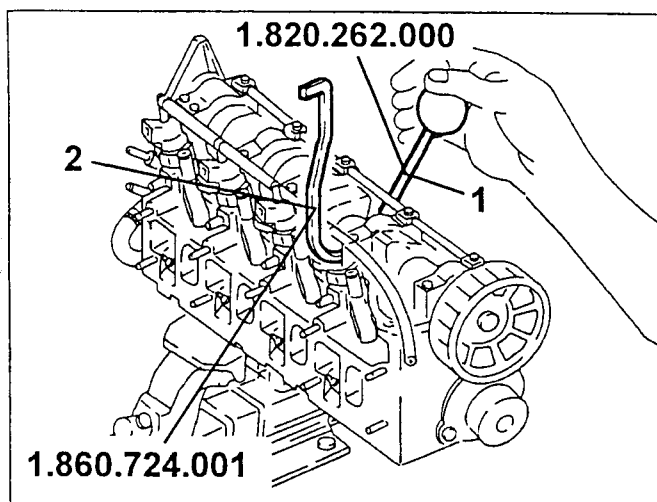
If the valve clearance is not within the specified limits, proceed as follows.



1. Lower the tappet in question using tool no. 1.820.262.000.
2. Assemble tool no. 1.860.724.001 to keep the tappets down.

**NOTE:** Direct the notches on the edge of the tappets to facilitate removal of the plate.

- Remove the valve clearance adjustment pad and replace it with another one of suitable thickness.
- Remove the tool used to keep the tappets lowered.

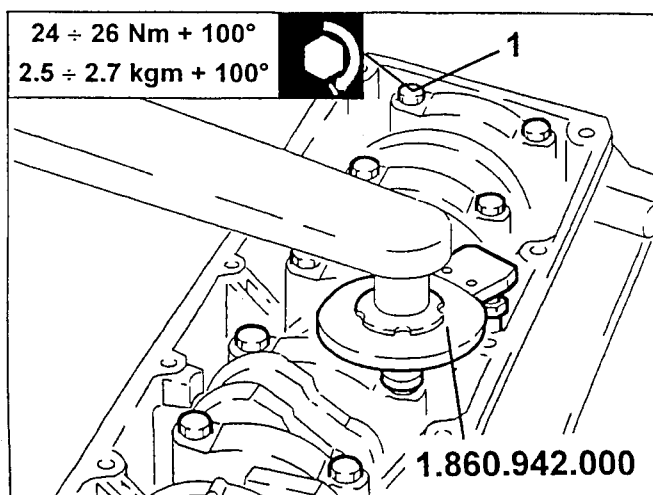


## CRANKSHAFT REASSEMBLY

- After assembling the crankshaft, fit the main bearings caps complete with half bearings.

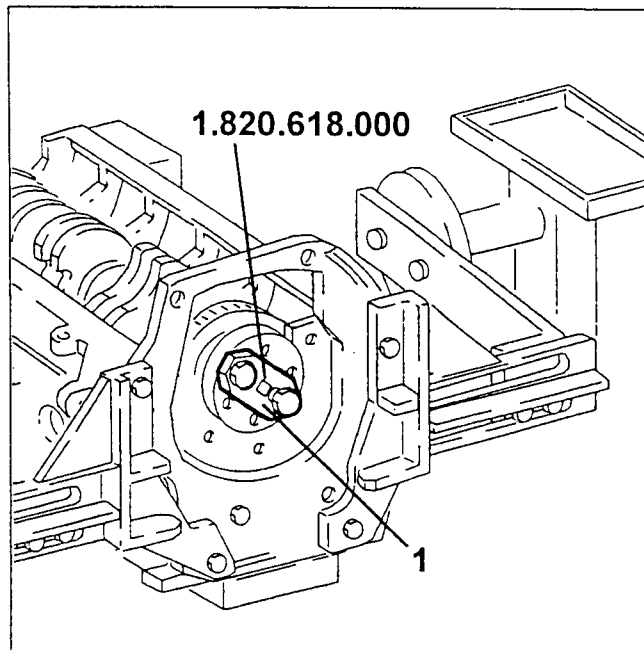
**NOTE:** The main bearing caps are notched consecutively (from 0 to four starting from the engine front) to define their assembly position.

1. Tighten the main bearing cap screws to the specified torque using tool no. 1.860.942.000 for angle tightening.

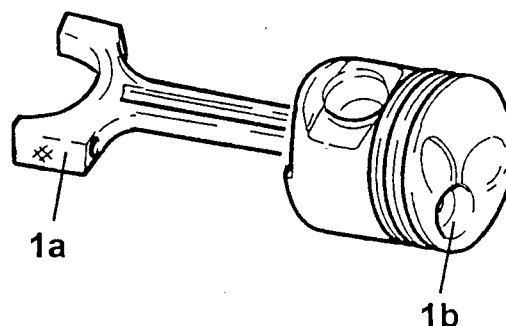


## ASSEMBLING PISTONS AND CONNECTING RODS

1. Assemble tool no. 1.820.618.000 to make it possible to turn the crankshaft.



- Assemble the piston rings using a suitable tool.
- 1. Connect the connecting rods to the corresponding pistons so that the number stamped on the big end (1a) faces the combustion chamber (1b) machined on the piston.
- Assemble the gudgeon pins and fasten them with their circlips.



- Turn the crankshaft using the tool installed previously until the cylinder concerned reaches its B.D.C.

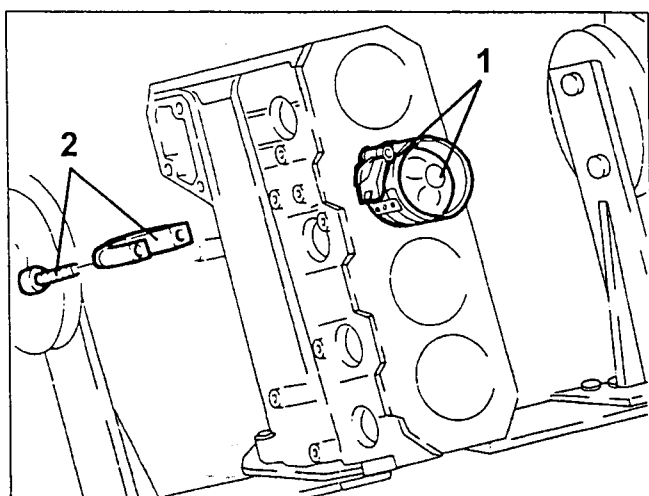
1. Assemble the connecting rod-piston set complete with half bearing using a suitable installing tool.

**NOTE:** The connecting rod-piston sets should be assembled in the crankcase with the combustion chamber on the piston facing towards the intake side.

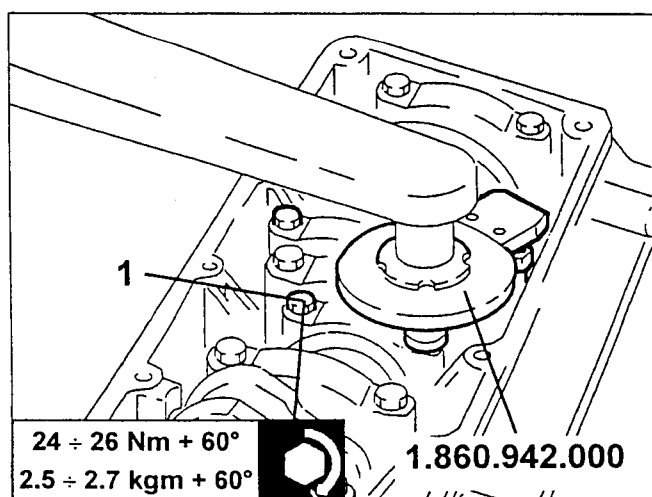
2. Assemble the connecting rod cap complete with half bearing and fasten it with its screws without locking them.

**NOTE:** The connecting rod caps should be assembled so that the number stamped on them points towards the same side as the one stamped on the connecting rod big end (intake side).

- Proceed in the same way to assemble the pistons and connecting rods of the remaining cylinders.

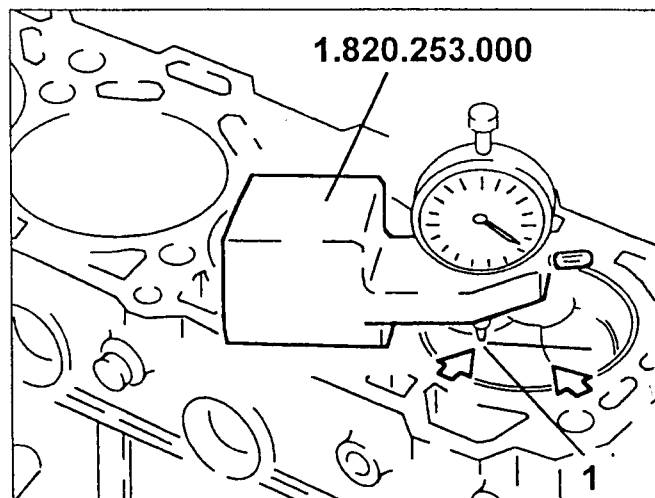


1. Tighten the connecting rod cap screws to the specified torque using tool no. 1.860.942.000 for angle tightening.



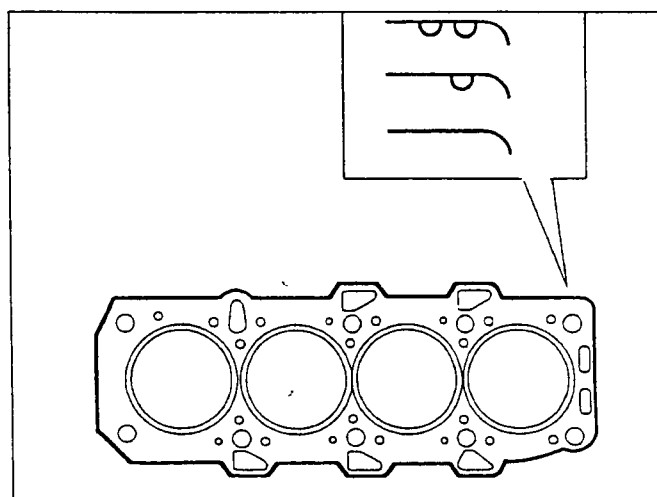
## REFITTING THE CYLINDER HEAD

1. Measure the protrusion of the pistons on two points at 180°, on the gudgeon pin axis using tool no. 1.820.253.000 and calculate the average of the two values measured for each piston.



- Choose the thickness of the cylinder seal to be used, according to the maximum value between the averages of the protrusion of each single piston.

Maximum average piston protrusion	Cylinder head seal thickness to be used
0.795 ÷ 0.881 mm	1.55 ÷ 1.65 mm (no notch)
0.881 ÷ 0.967 mm	1.65 ÷ 1.75 mm (one notch)
0.967 ÷ 1.055 mm	1.75 ÷ 1.85 mm (two notches)



- Position the cylinder head centering bushes on the crankcase.  
- Assemble the cylinder head seal of the chosen thickness.

**NOTE:** The cylinder head seal is of the ASTADUR type.

The material with which it is made undergoes a polymerising process when the engine is running, therefore it hardens considerably during use.

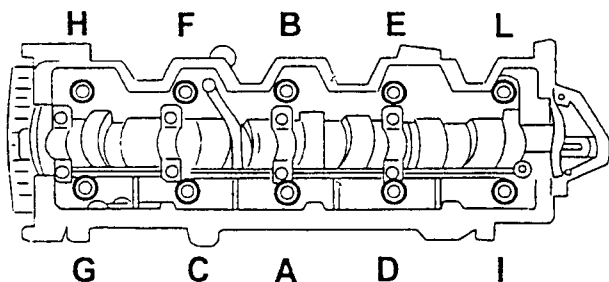
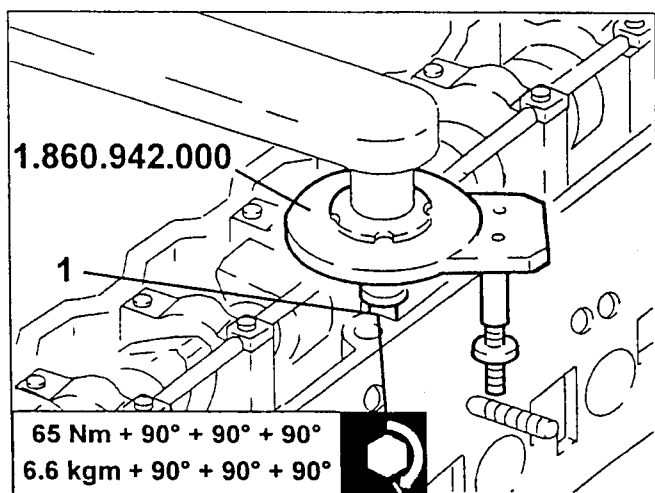
To ensure that the seal polymerises it is necessary to:

- keep the seal closed in its wrapper until assembly
- do not lubricate or soil the seal and contact surfaces with oil.

- Position the cylinder head on the crankcase.

1. Tighten the cylinder head screws to the specified torque using tool no. 1.860.942.000 for angle tightening.

**NOTE:** For each tightening sequence, follow the order given below.



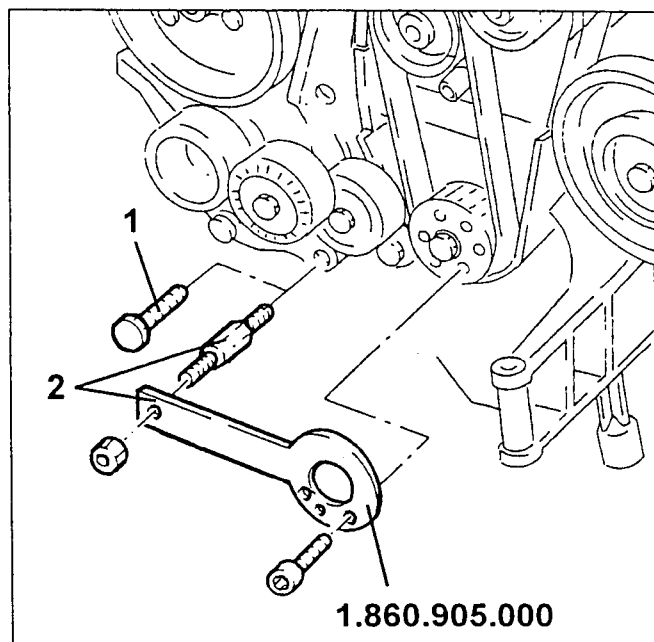
## CAMSHAFT DRIVE BELT ASSEMBLY AND CHECKING VALVE GEAR TIMING

1. Remove the oil pump screw indicated.

- Temporarily assemble the camshaft toothed drive belt on the drive pulley.

2. Assemble tool no. 1.860.905.000.

**NOTE:** To make it possible to insert the dowel on the camshaft toothed belt drive pulley with the hole on the tool, turn the crankshaft with small movements.



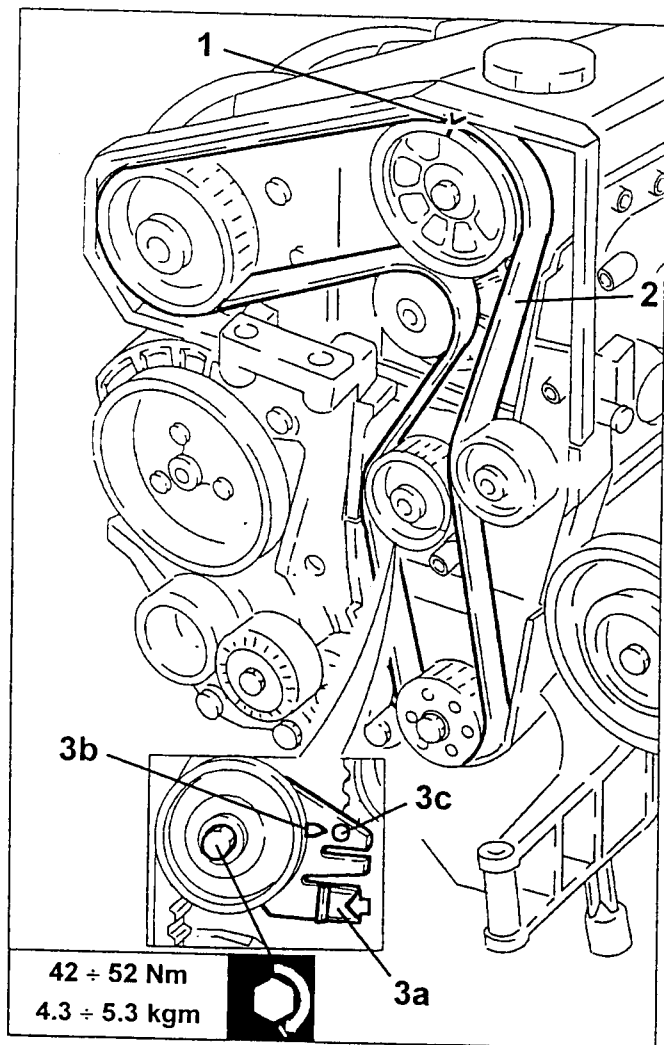
1. Turn the driven toothed pulley until the timing notches coincide.

2. Completely fit the camshaft toothed drive belt.

3. Lever with a screwdriver in the hole (3a) until the index of the tensioner (3b) coincides with the reference hole (3c) and in this position, tighten the camshaft belt tensioner nut to the specified torque.

- Turn the crankshaft twice.

- Check again that the timing references coincide and also the tensioning references on the camshaft belt tensioner.



**WHEN ENGINE REASSEMBLY HAS BEEN COMPLETED** carry out all the checks and inspections of routine maintenance (see GROUP 00) and the checks concerning the fuel supply system and the cooling system (see GROUP 10).

## CHECKING LUBRICATION CIRCUIT ELECTRIC COMPONENTS

- Engine oil minimum pressure warning light

For all the other sensors and electric components located in the engine compartment, refer to the specific Groups in which they are described in detail.

## ENGINE OIL MINIMUM PRESSURE WARNING LIGHT SENSOR

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



Contact opening/closing pressure	0.2 ÷ 0.5 bar
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