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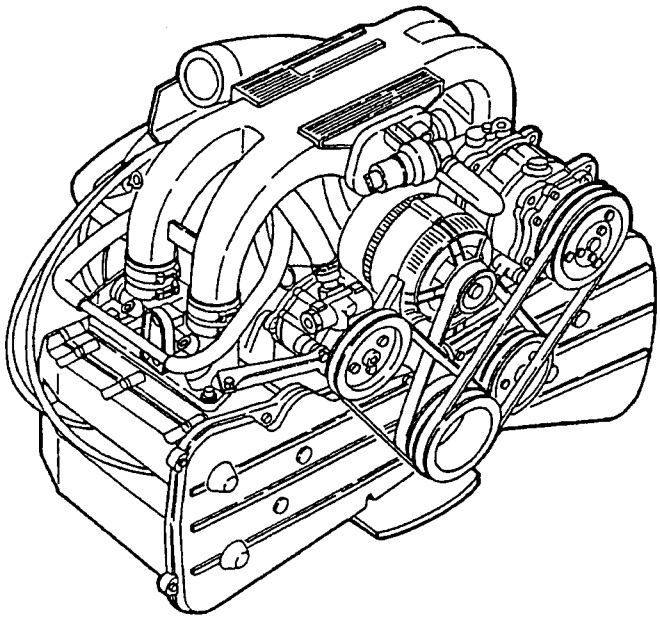
DESCRIPTION

The engine has 4 opposed cylinders, double camshaft for each cylinder head, four valves per cylinder controlled by hydraulic tappets, BOSCH M2.10.3 multipoint electronic injection and static ignition controlled by a single control unit.
The clutch - gearbox - differential unit is connected behind the engine and forms an integral part of the power unit.

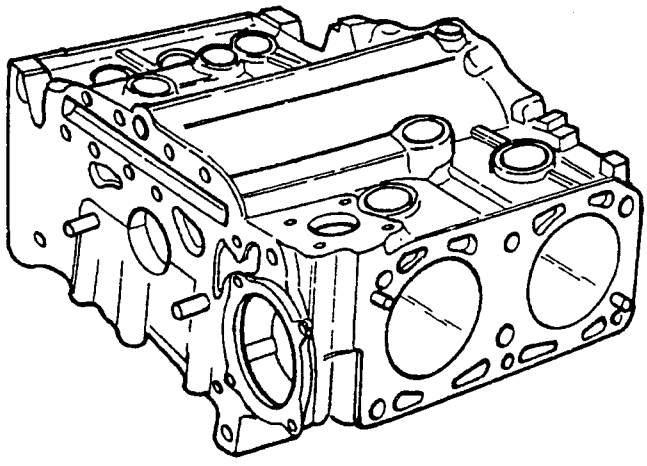


The latter is front mounted and set longitudinally with a 3° inclination.
The power unit is fastened to the body by "suspension" type mounts through a support frame connected to the gearbox - differential unit.
The various connections of the power unit to the support frame are made with appropriate flexible mounts to absorb engine vibrations.
The fuel supply system, with unleaded petrol, combined with the suitable antipollution systems described in the specific paragraphs, ensure low exhaust emission levels meeting "USA 83" regulations.

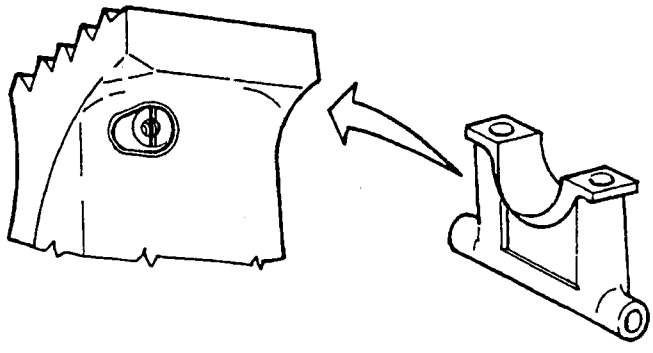
CRANKCASE

This is a single cast iron block with high mechanical strength.
The crankshaft is supported by 3 main bearings which house the same number of thin-walled half bearings.
The cylinders are machined directly in the crankcase and they are selected in five classes of dimensions.
If cylinder wear exceeds the specified values, they must be bored to the specified diameters according to the oversizes of the pistons available from Spares (see CPT).

Special grooves machined in the crankcase walls allow the circulation of coolant fluid and lubricating oil.

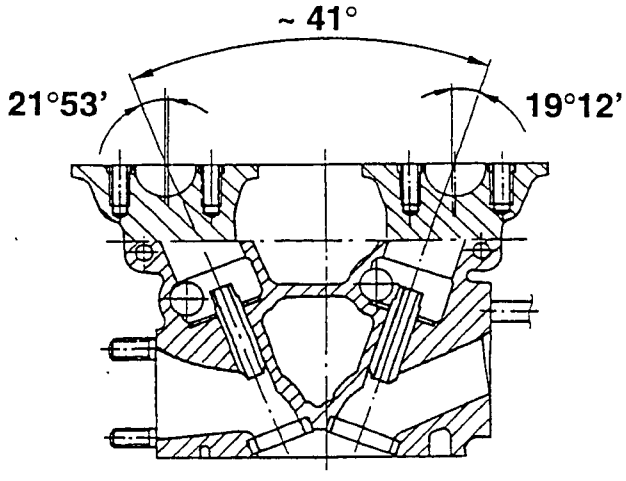


Oil spray jets installed on the front and centre main bearing caps spray oil on the piston crowns to partially cool them.

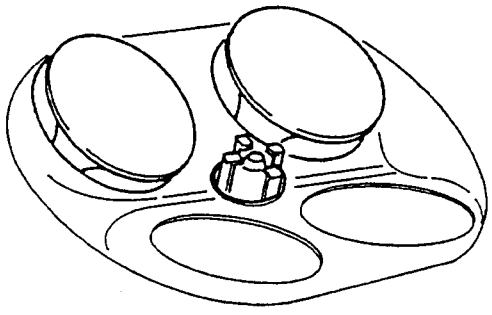


CYLINDER HEADS

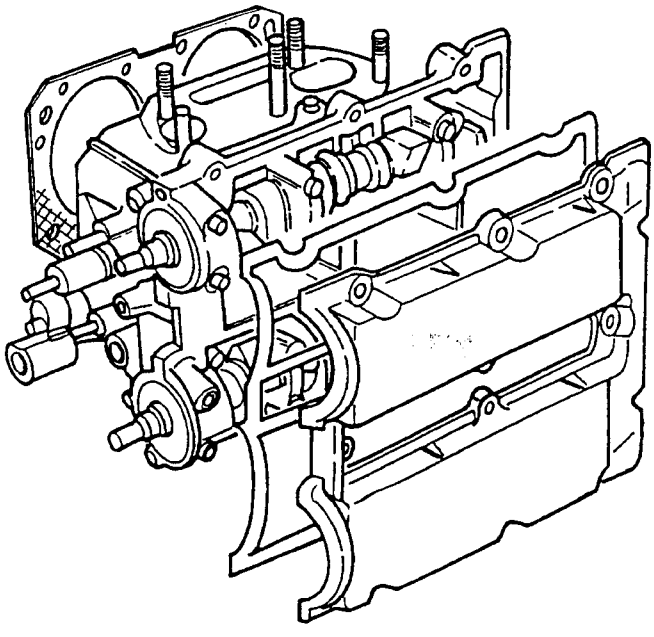
This is one-piece, compact and chill-cast in aluminium and silicium alloy.
The four valves per cylinder are fitted in their guides arranged in a "V" of ~ 41° and they are controlled by two camshafts through hydraulic tappets.



Due to the arrangement of the spaces, the combustion chamber accommodates the four mushrooms of the valves and the centre hole of the spark plug without weakening the structure of the head.
The solution with the spark plug in the centre of the four valves (two inlet valves and two smaller exhaust valves) enables even distribution of the mixture and optimum development of combustion with improved thermal yield of the engine and lower harmful emissions at the exhaust.

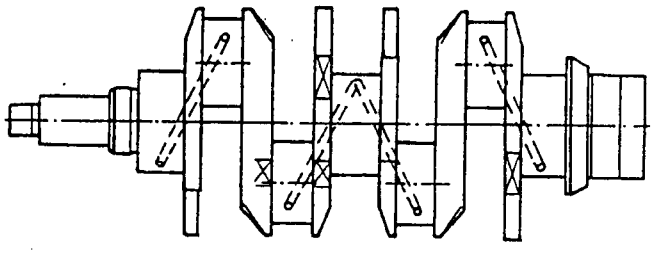


The camshafts turn on three supports and they are driven through toothed belts.
The valve seats are fitted on the cylinder heads after heating them to a temperature of 100° ÷ 120°C.
The valve guides are force-fitted in their housings on the cylinder heads with intereference and the inside diameter is perfected after assembly using a specific reamer and checked using a pair of go-no go gauges.
The seals between the cylinder heads and crankcase are of the ASTADUR type.
Due to the special material with which they are made, these seals are polymerized when the engine is running and harden considerably during use, therefore it is no longer necessary to tighten the cylinder heads at the first service coupon.



CRANKSHAFT

This is forged in high-strength, hardened and tempered steel.
It rests on three main bearings and its end float is adjusted by two half rings housed in the rear main bearing.
Six counterweights accurately balance the rotating masses.
A set of grooves run inside the shaft to lubricate the main and connecting rod journals.

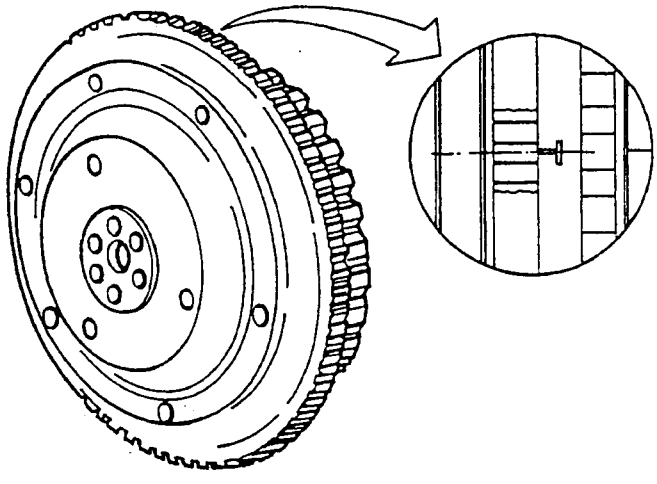


MAIN AND CONNECTING ROD HALF BEARINGS

These are of the three-metal, thin shell type subdivided into two dimensional classes.
The main half bearings have a hole and groove for lubricating the rod journals.

FLYWHEEL

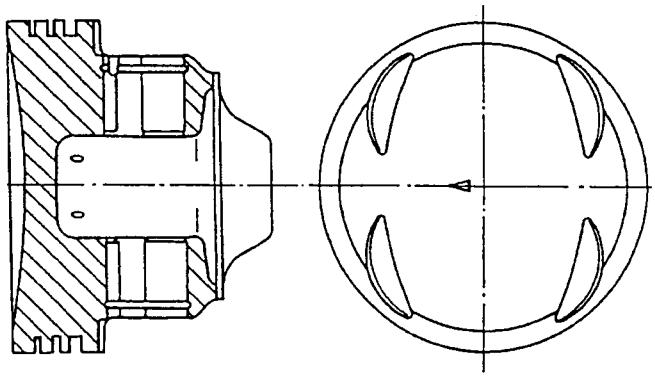
This is in cast iron, with two ring gears in hardened and tempered steel: one for connection with the starter motor and one for the rpm sensor facing it.
The "T" notch for checking engine timing is stamped on the flywheel.



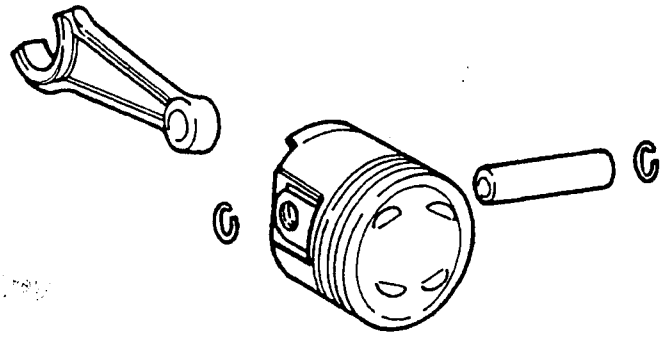
PISTONS AND CONNECTING RODS

The pistons in aluminium silicium alloy are subdivided into five dimensional classes and they are available as Spares in three other oversize classes.

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 copper alloy bush for coupling with the piston gudgeon pin.
As the pins are floating on both the piston hubs and on the bush force-fitted in the connecting rod small end, their side stroke stop is made by two expanding circlips which are housed in special hollows machined on the actual hubs.

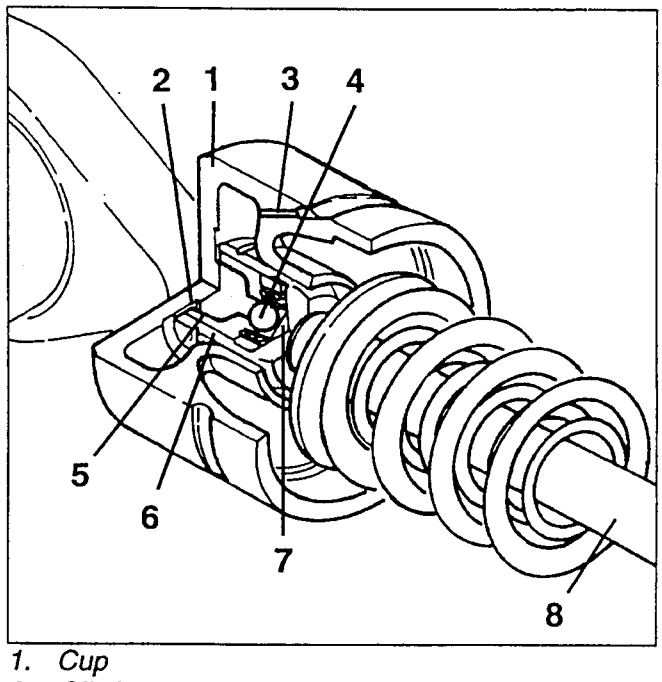


The right cylinder head pistons are positioned with the arrow stamped on the piston crown facing upwards and those of the left cylinder heads with the arrow pointing downwards.

TIMING

Direct drive by toothed belts, with overhead camshafts in case-hardened alloy steel.
The hydraulic tappets in contact with the cams operate the valves directly.
This device automatically eliminates "valve play" when the engine is running, thereby enormously reducing the need for periodic maintenance.

The exhaust valve stem is chromium-plated and inside it has a hollow filled 50 ÷ 60% with sodium which improves dispersion of the heat to which they are subjected.
The valve seats are sintered in material suitable for use with unleaded petrol.



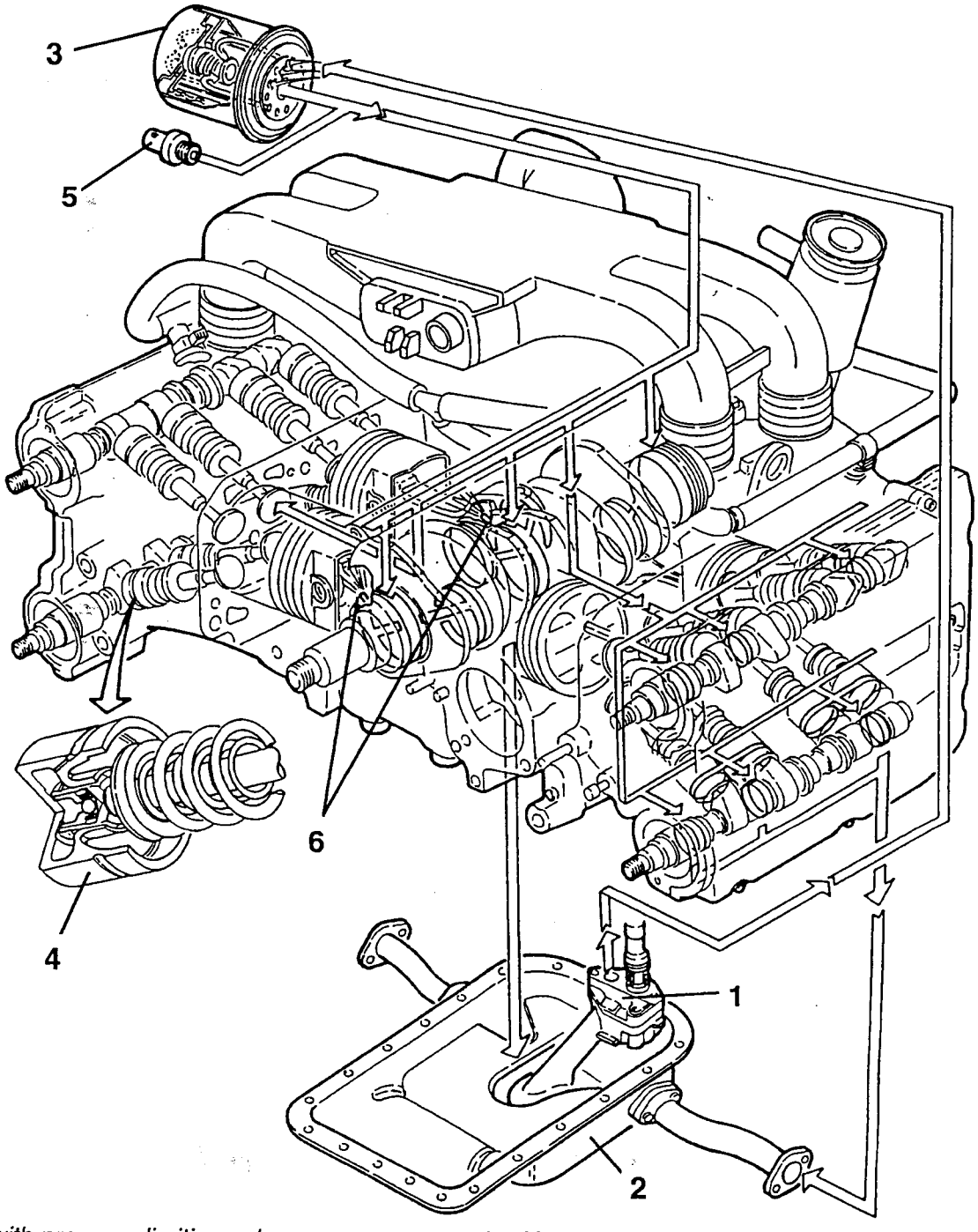
1. *Cup*
2. *Oil circulation between inlet chambers*
3. *Oil inlet groove*
4. *Check valve*
5. *Piston*
6. *Cilinder*
7. *Pressure chamber*
8. *Valve stem*

LUBRICATION

Lubrication is forced by gear pump. The oil pump is fitted on the rear engine cover and it is operated by a shaft that receives motion from a gear installed behind on the crankshaft. The oil withdrawn from the sump through a suction device is filtered by the mesh filter on the actual suction device and then sent under pressure by the pump through a groove to the oil filter with full-flow cartridge fitted with a safety by-pass valve which ensures that the oil can still pass if the filter is clogged.
The maximum lubricating pressure is adjusted by a special limiting valve fitted on the pump. After being filtered, the oil flows through a transversal duct into the main longitudinal delivery duct machined in the crankcase. From here, it is ducted through three grooves to the lubricating grooves of the crankshaft main and rod bearings.

To improve cooling of the pistons on the right main bearing spray jets have been fitted on the front and centre main journals.
Through two transversal grooves and suitable branches machined in the crankcase and cylinder heads the oil reaches the camshaft bearings and allows the hydraulic tappets to work.
The lubrication oil of the main and rod journals falls back into the sump.

The cylinder head lubricating oil collected in the trays of the camshaft bearings returns to the sump through two special outside connection hoses.
The lubrication system is fitted with an oil vapour recirculation system which recovers the vapours from the sump.
A warning light on the instrument cluster connected to a sensor in the rear engine cover indicates low engine oil pressure.



1. *Oil pump with pressure limiting valve*
2. Oil sump
3. *Oil filter with by-pass valve*
4. *Hydraulic tappet*
5. *Low oil pressure warning light sensor*
6. *Spray jets*

INTRODUCTION

The instructions given in the following paragraphs refer to the complete overhaul of the engine on the bench, after removing the power unit from the engine. The instructions are subdivided as follows:

- Dis-assembly of the engine:
removal of the engine accessories and components and dis- assembly into its main component parts.

- Dis-assembly and checks of the crankcase:
complete overhauling of the crank mechanisms.

- Cautions for re-assembly:
these include specific re-assembly operations where they differ substantially from the instructions for dis-assembly.

- Checks and inspections of electrical components of the lubrication circuit.

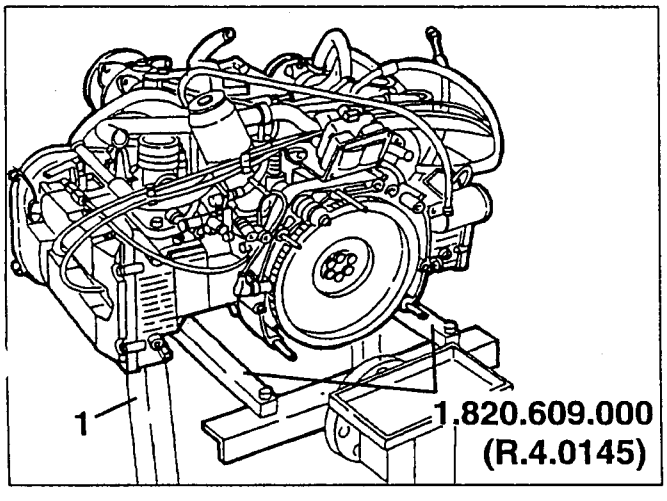
For re-assembly, the sequence for all the dis-assembly instructions described hereafter, should be reversed unless otherwise specified.

The following procedures refer to complete overhauling of the whole engine; it is however possible to use individual parts of these instructions when dealing with specific components.

ENGINE DIS-ASSEMBLY

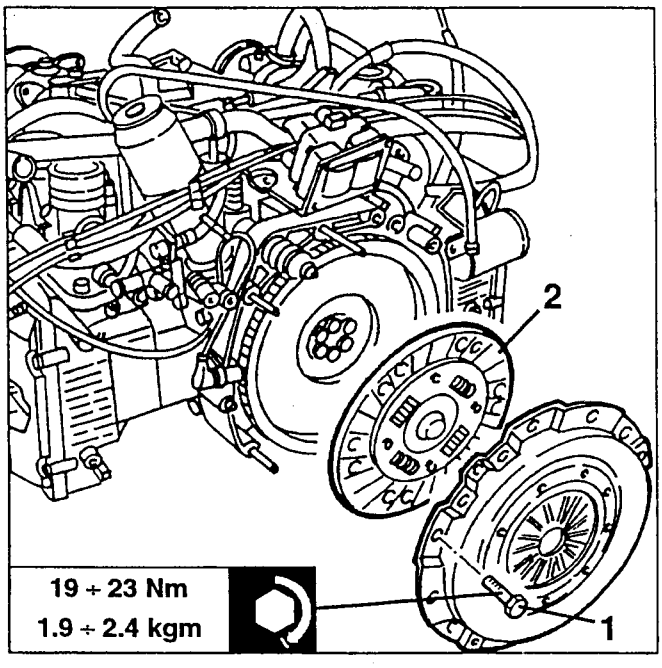
Preliminary operations

1. Set the assembly on a special overhauling stand using supports N° 1.820.609.000 (R.4.0145).



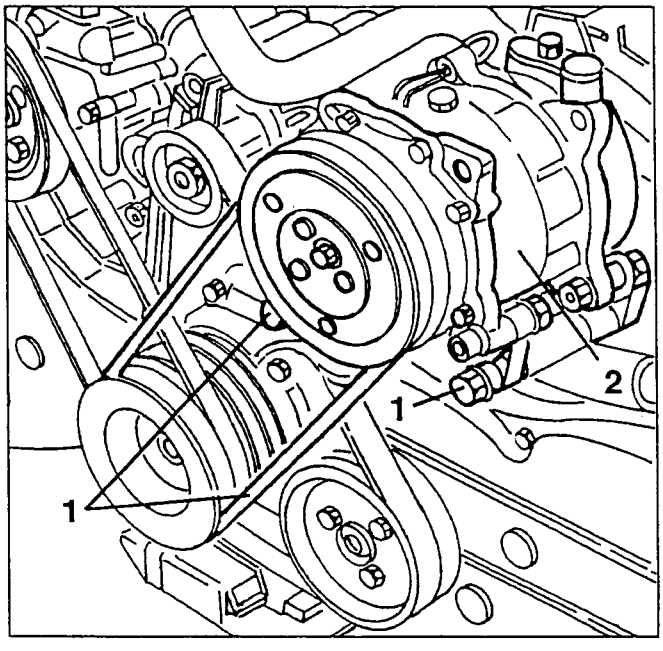
Removing the clutch plate

1. Slacken the fastening screws and remove the clutch pressure plate.
2. Remove the clutch plate.



Removing the conditioner compressor

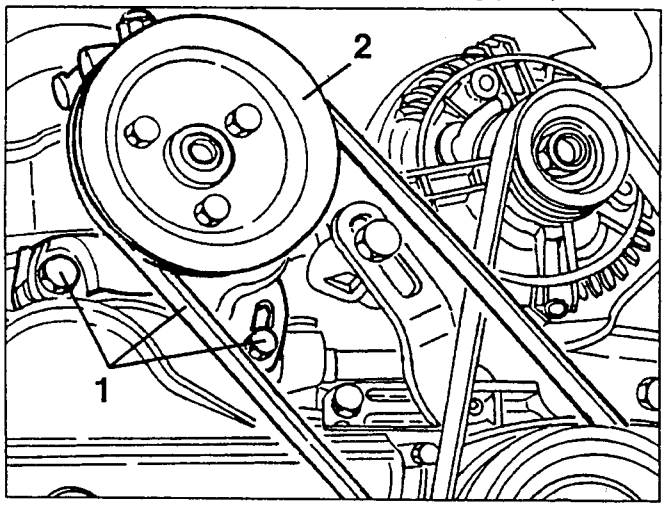
1. Slacken the compressor fastening bolt and screw; prise and remove the drive belt.
2. Completely unscrew the bolt and screw slackened previously and remove the compressor.



Removing the power steering pump

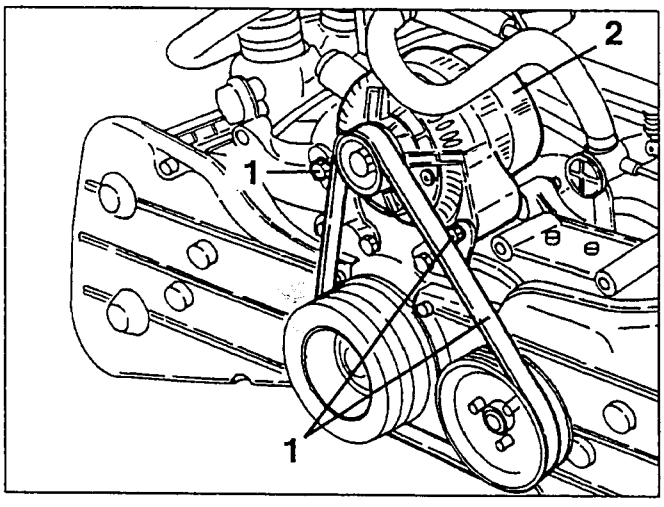
1. Slacken the two power steering pump fastening bolts; prise and remove the drive belt.

2. Completely unscrew the two bolts slackened previously and remove the power steering pump.



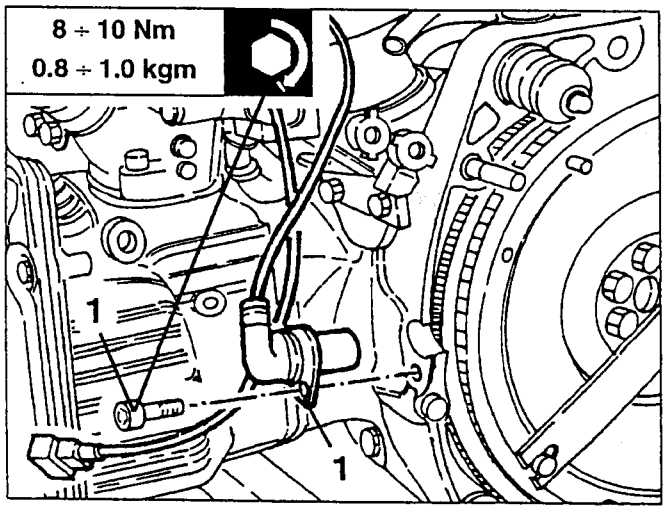
Removing the alternator

1. Slacken the two alternator fastening bolts; prise and remove the drive belt.
2. Completely unscrew the two bolts slackened previously and remove the alternator.

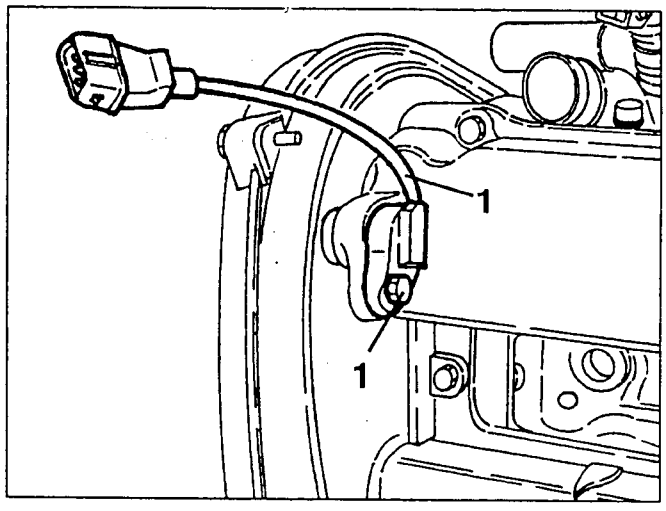


Removing the rpm and timing sensor

1. Slacken the fastening screw and remove the rpm sensor.

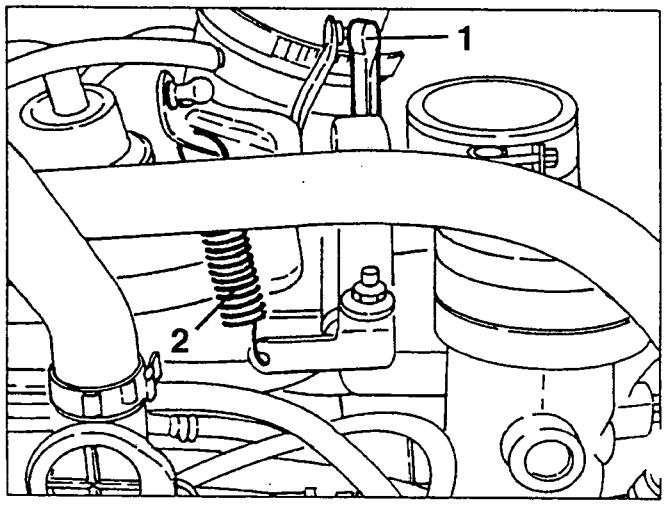


1. Slacken the fastening screw and remove the timing sensor.

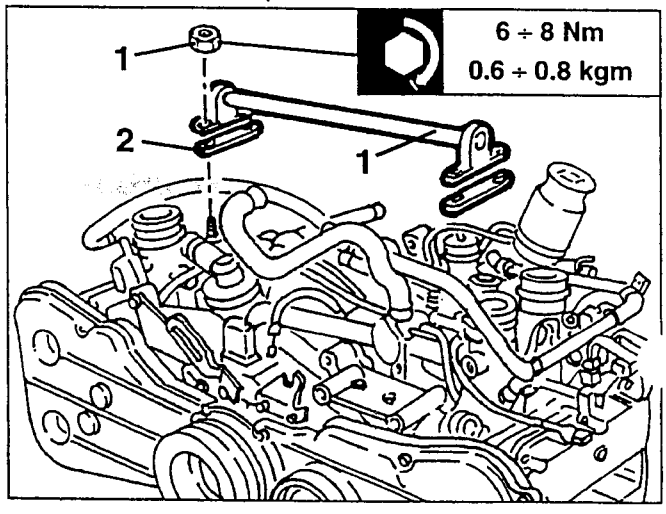


Removing the throttle control shaft

1. Disconnect the throttle valve control tie-rods.
2. Slacken the throttle control shaft return spring.

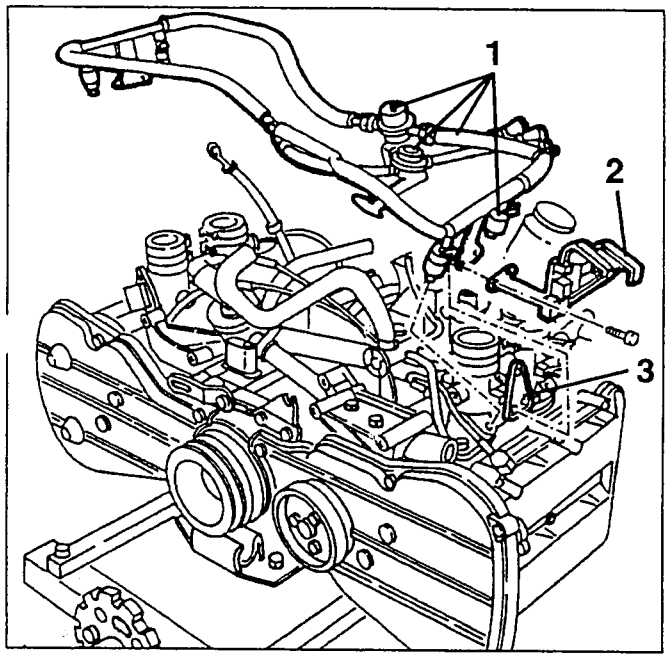


1. Slacken the fastening nuts and remove the throttle control shaft.
2. Retrieve the two spacers.



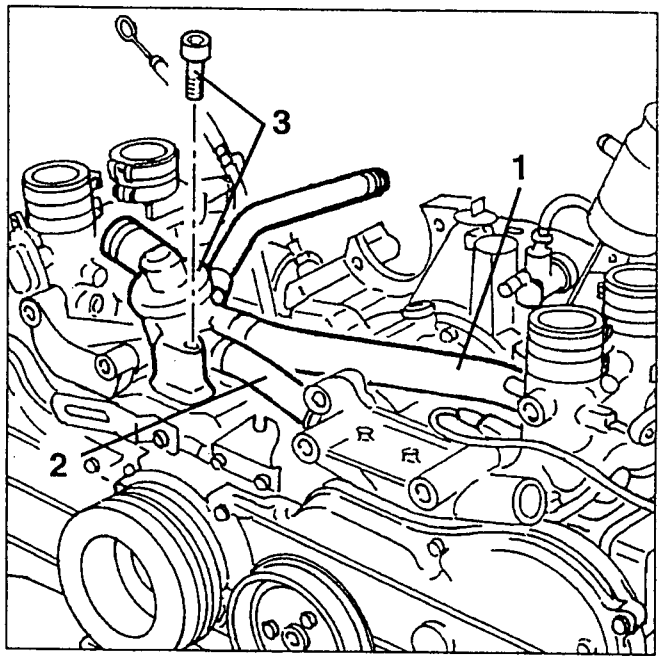
Removing the fuel distributor manifold

1. Slacken the screws fastening the fuel manifold support brackets and remove it complete with injectors, pulse damper and pressure regulator.
2. Retrieve the cable and hose support bracket.
3. Retrieve the engine lifting brackets.



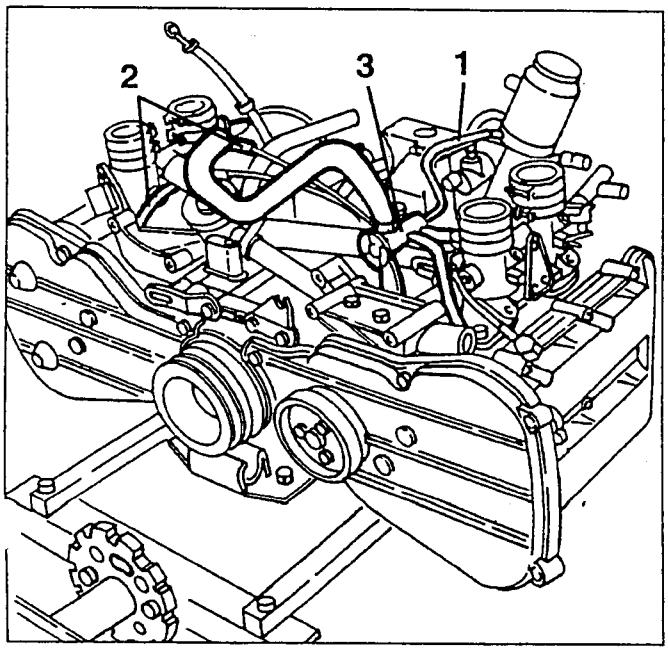
Removing the thermostat unit

1. Disconnect the coolant outlet hoses from the intakes.
2. Disconnect the thermostat unit connection pipe from the pump coolant inlet union.
3. Slacken the fastening screw and remove the thermostat unit complete with hoses.



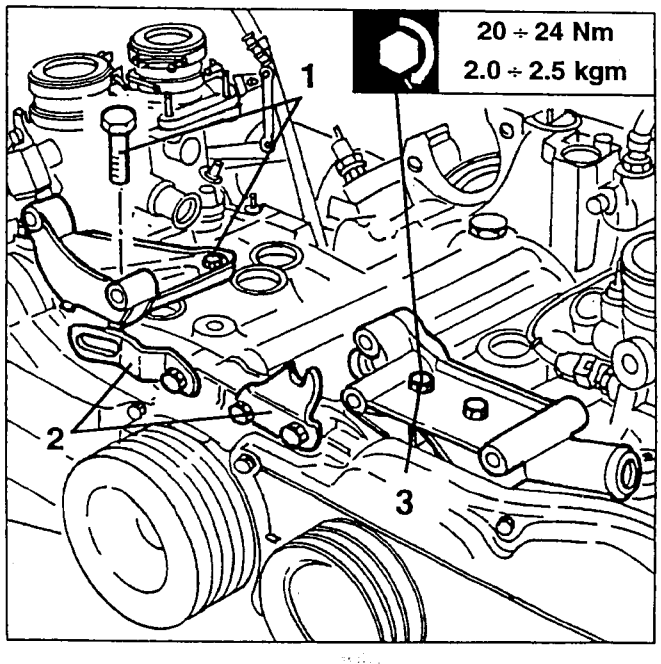
Removing the idle air distributor

1. Disconnect the oil vapour recirculation pipe from the separator.
2. Disconnect the additional air hoses for idle speed from the intakes.
3. Slacken the fastening screw and remove the idle air distributor complete with hoses.

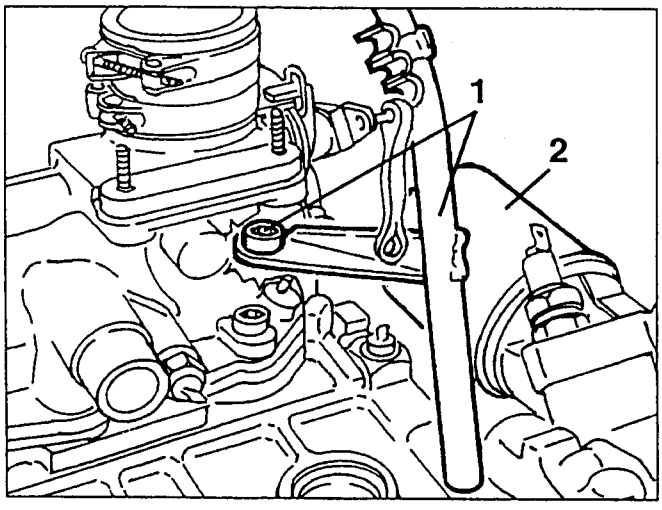


Removing the brackets

1. Slacken the fastening screws and remove the power steering pump support bracket.
2. Slacken the fastening screws and remove the alternator support bracket.
3. Slacken the fastening screws and remove the water pump inlet union and conditioner compressor support; retrieve the seal.

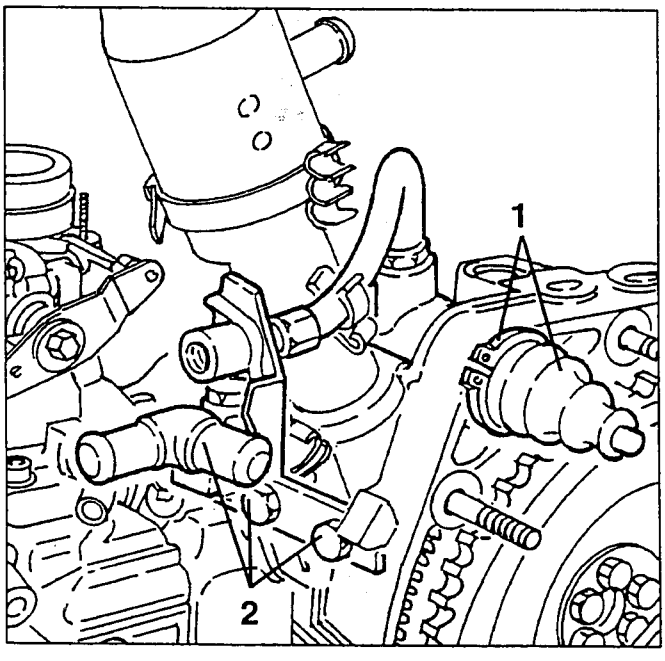


1. Slacken the fastening screw and remove the oil dipstick complete with guide.
2. Using a suitable tool, remove the engine oil filter.



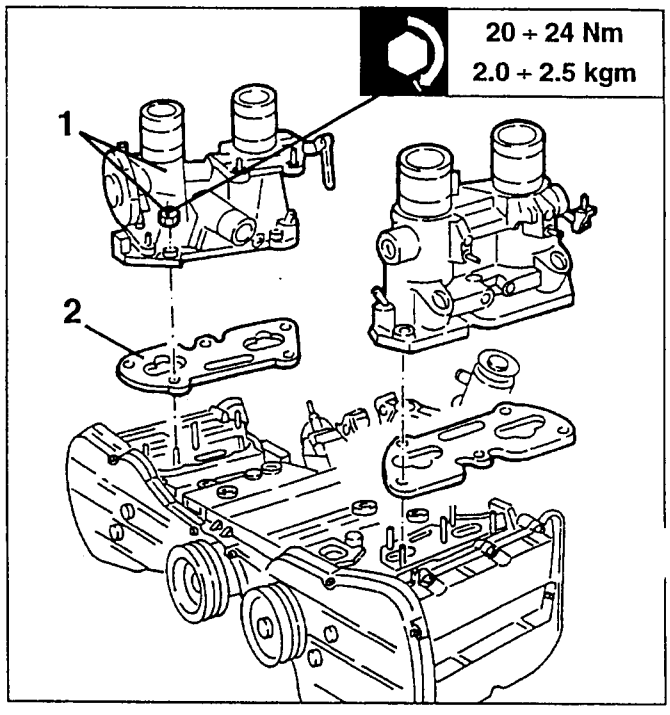
Removing the clutch control cylinder

1. Remove the fastener ring and remove the clutch control cylinder complete with hose after disconnecting the latter from the support bracket.
2. Slacken the fastening screws and remove the engine cooling system three-way support bracket and the clutch control cylinder hose.



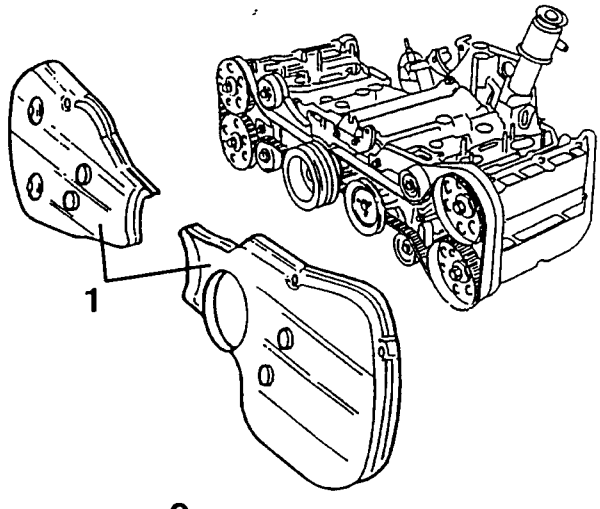
Removing the intake bodies

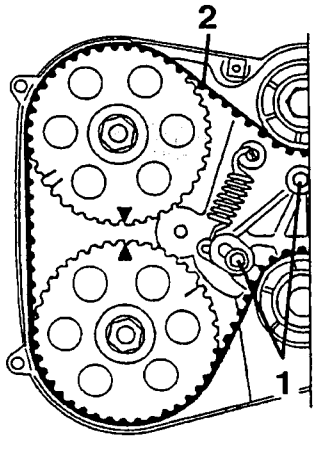
1. Slacken the fastening nuts and remove the intake bodies.
2. Retrieve the seals.



Removing the timing drive pulley

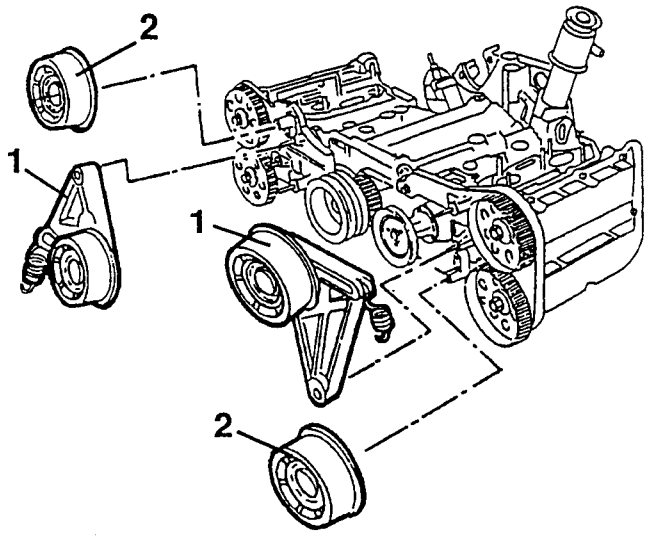
1. Slacken the fastening screws and remove the timing belt front guards.



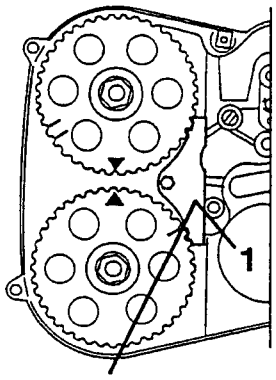


1. Release the two nuts fastening the right belt tensioner, then press on the pulley until overcoming the spring tension load and lock the belt tensioner in the slack position.
2. Prise and remove th right timing drive belt anu repeat the above-mentioned procedure to remove the left one.

1. Slacken the fastening nuts and remove the belt tensioner complete with springs.
2. Slacken the fastening screws and remove the pulleys.

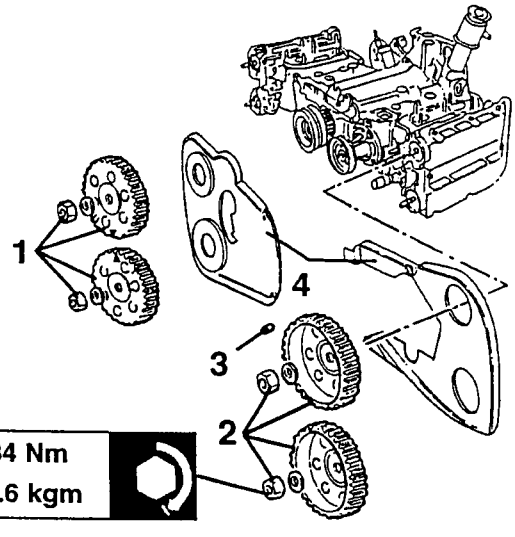


1. Fit the pulley locking tool N° 1.820.206.000.



1.820.206.000

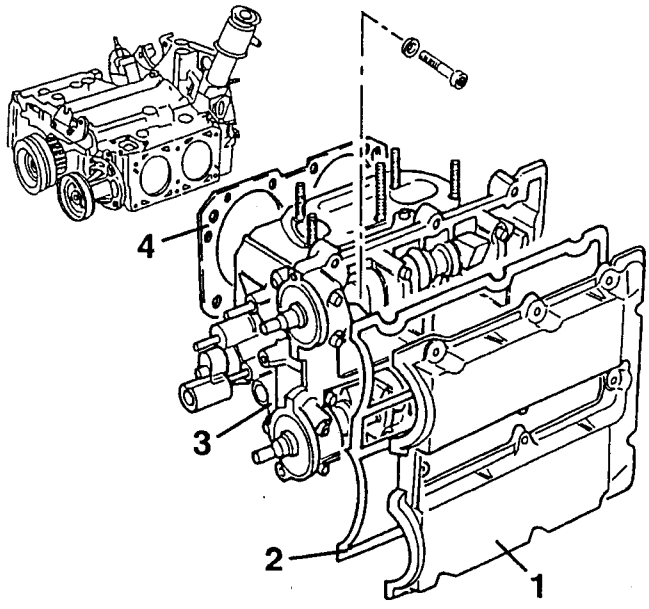
1. Slacken the fastening screws and remove the right head pulleys.
2. Using tool N° 1.820.206.000, slacken the fastening nuts and remove the left head pulleys.
3. Retrieve the keys.
4. Slacken the fastening screws and remove the rear guards.



76 ÷ 84 Nm 7.7 ÷ 8.6 kgm

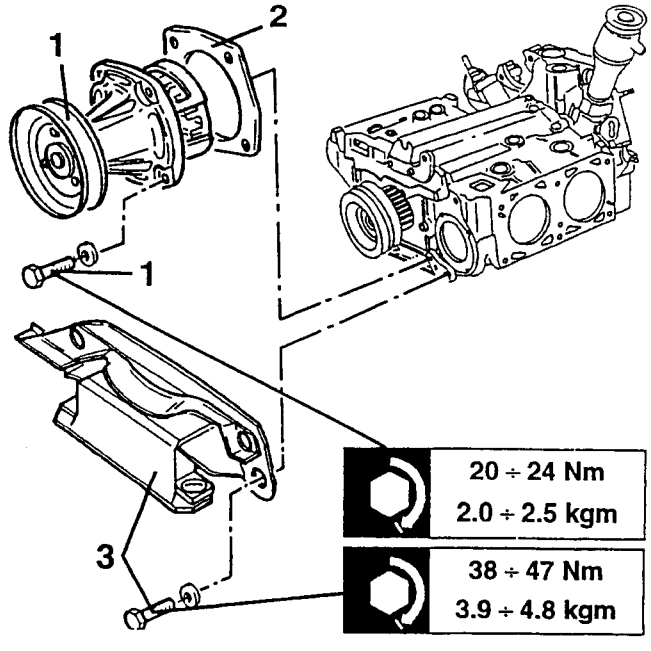
Removing the cylinder heads

1. Slacken the fastening screws and remove the head cover.
2. Remove the seal.
3. Slacken the six fastening screws and remove the cylinder head from the crankcase.
4. Remove the cylinder head seal.
- Proceed in the same manner to remove the other cylinder head.



Removing the water pump

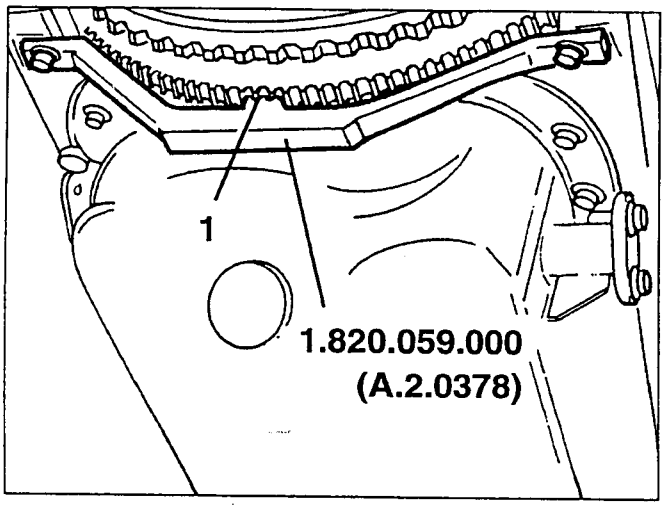
1. Slacken the four fastening screws and remove the water pump from the crankcase.
2. Remove the seal.
3. Slacken the four fastening screws and remove the front flexible mount.



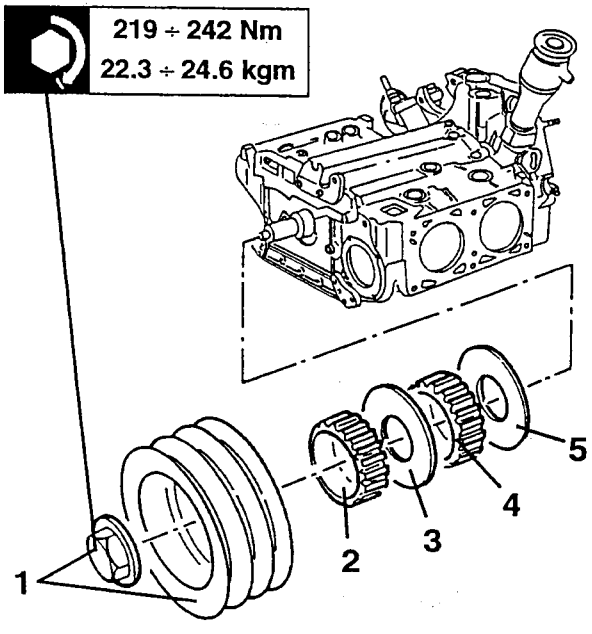
20 ÷ 24 Nm 2.0 ÷ 2.5 kgm
38 ÷ 47 Nm 3.9 ÷ 4.8 kgm

Removing the crankshaft pulley

1. Using tool N° 1.820.059.000 (A.2.0378), prevent the flywheel from turning.

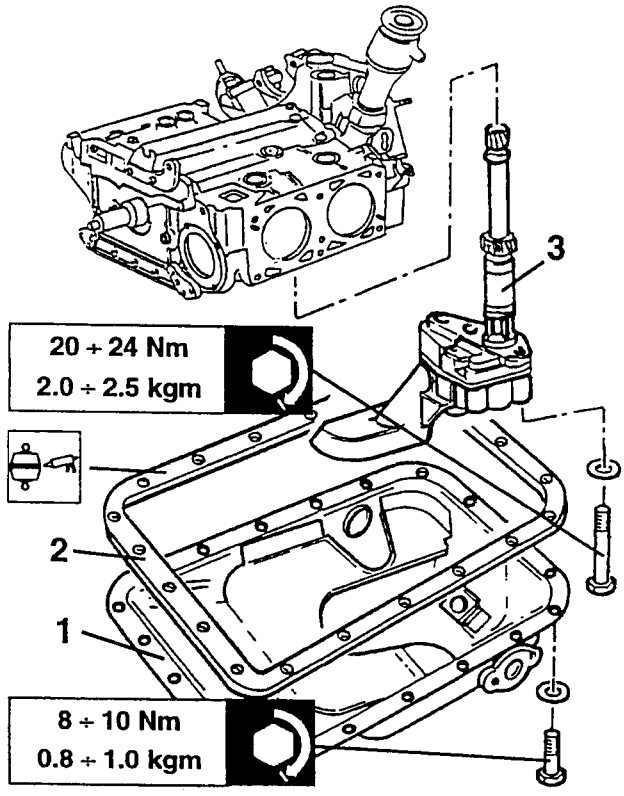


1. Slacken the fastening nut and remove the auxiliary drive pulley.
2. Remove the right timing belt toothed pulley.
3. Remove the spacer.
4. Remove the left timing belt toothed pulley.
5. Remove belt guide washer.



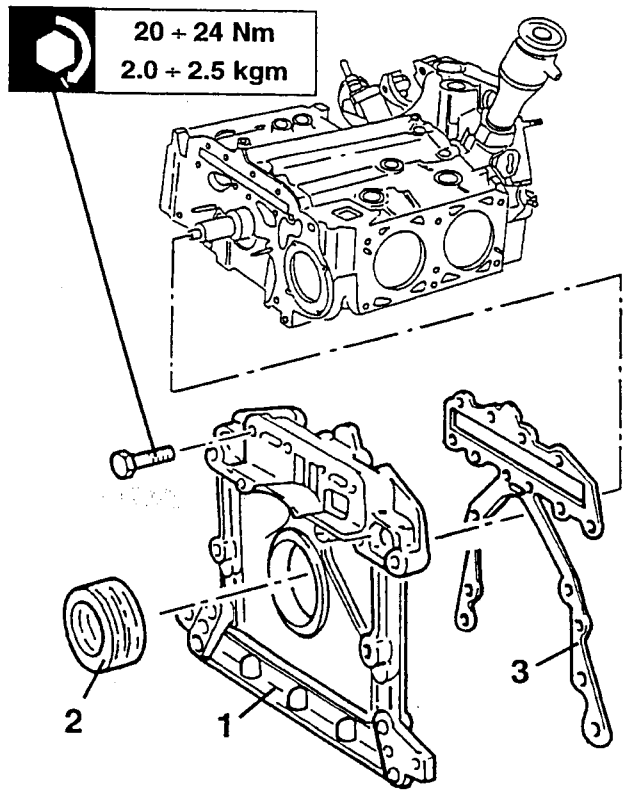
Removing the oil sump and pump

1. Slacken the fastening screws and remove the oil sump.
2. Remove the seal.
3. Slacken the fastening screws and remove the oil pump.

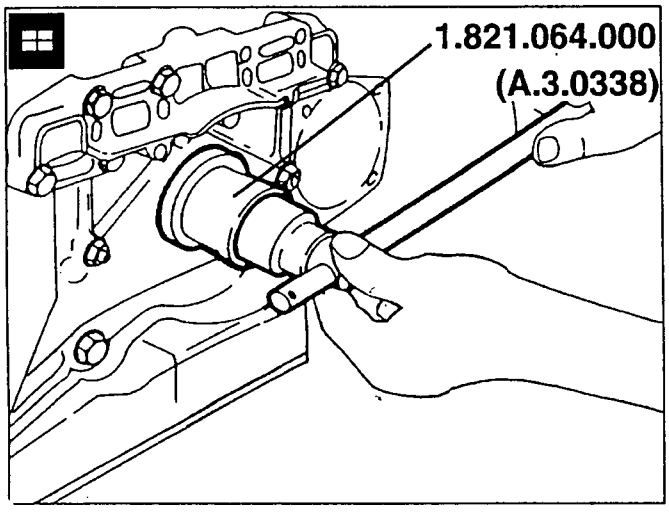


Removing the front crankcase cover

1. Slacken the fastening screws and nuts and remove the front crankcase cover.
2. Remove the oil seal from the front cover.
3. Remove the seal.

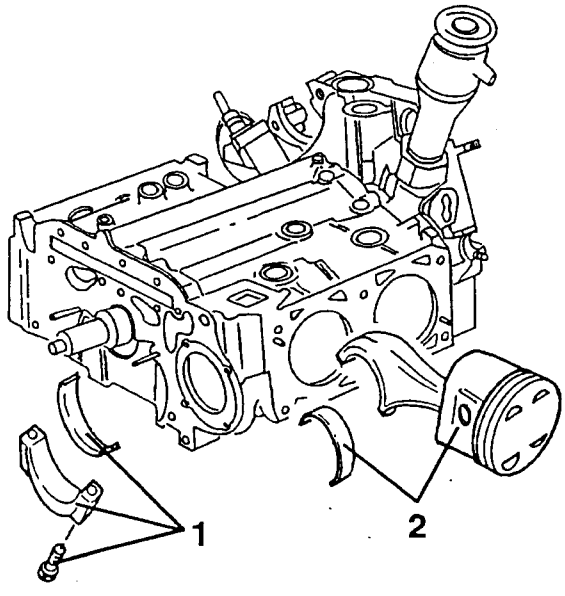


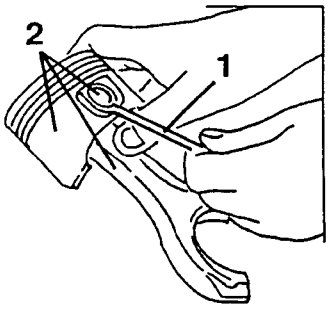
When refitting insert the oil seal on the front cover using tool N° 1.821.064.000 (A.3.0338).



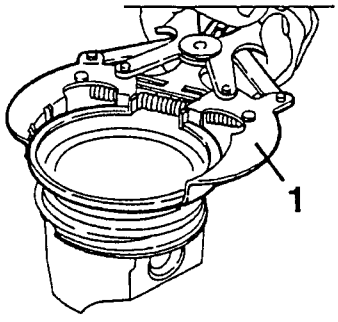
Removing the pistons and connecting rods

- Fit a suitable tool on the flywheel to allow the crankshaft to turn, then turn it to gain access to the connecting rod cap fastening screws.
1. Slacken the fastening screws and remove the connecting rod caps with their half bearings.
2. Remove the pistons complete with connecting rods and half bearings.





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

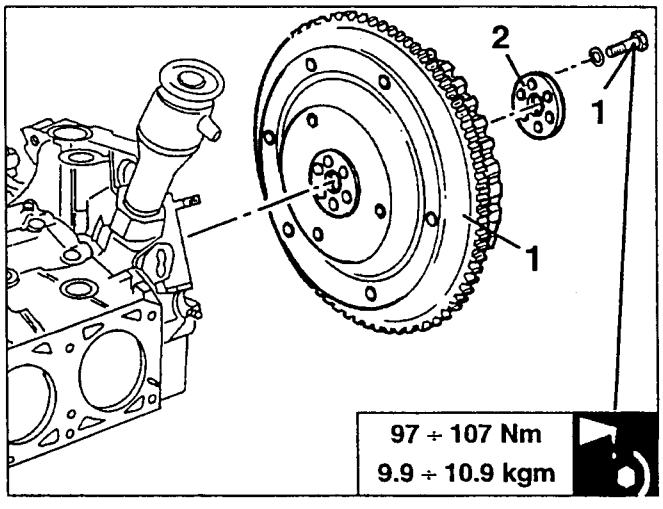


1. Using a suitable tool remove the seal rings and oil scraper ring from the piston.

Work carefully to avoid breaking any rings that might be re- used.

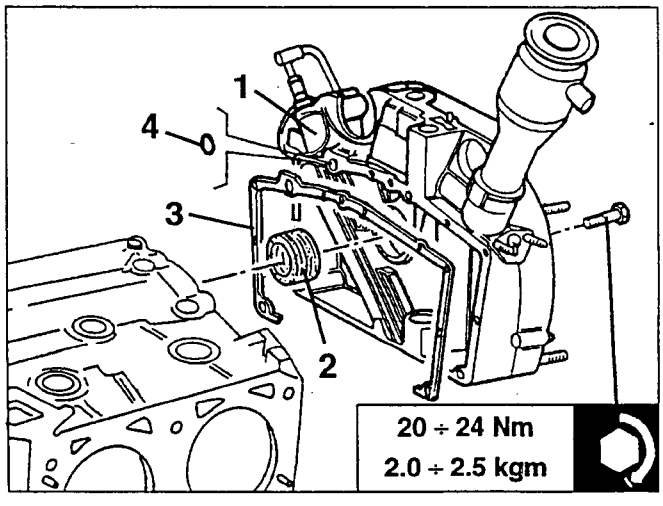
Removing the flywheel

- Remove the tool for turning the crankshaft fitted previously and install tool N° 1.820.059.000 (A.2.0378).
1. Slacken the fastening screws and remove the flywheel.
2. Retrieve the safety plate.

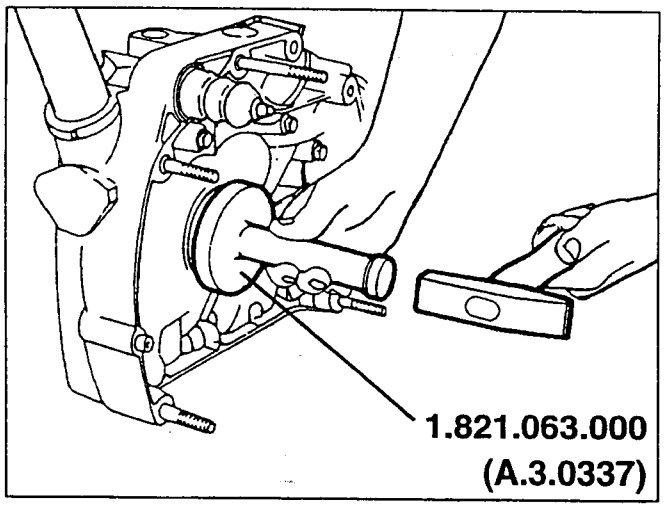


Removing the rear crankcase cover

1. Slacken the fastening screws and remove the rear crankcase cover.
2. Remove the oil seal from the cover.
3. Remove the seal.
4. Remove the seal ring from the main lubricating duct.



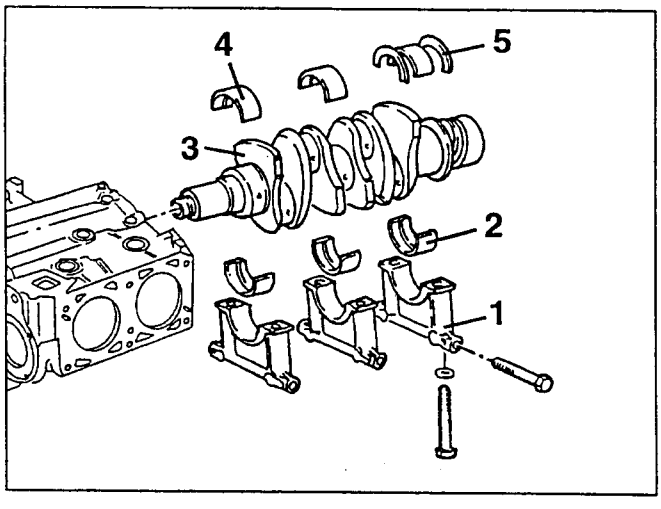
When refitting, use tool N° 1.821.063.000 (A.3.0337) to insert the oil seal on the rear cover.



Removing the crankshaft

1. Slacken the fastening screws and remove the main bearing caps.
2. Retrieve the corresponding bearing halves.
3. Remove the crankshaft from the crankcase.
4. Retrieve the main bearing halves.
5. Retrieve the thrust half rings.

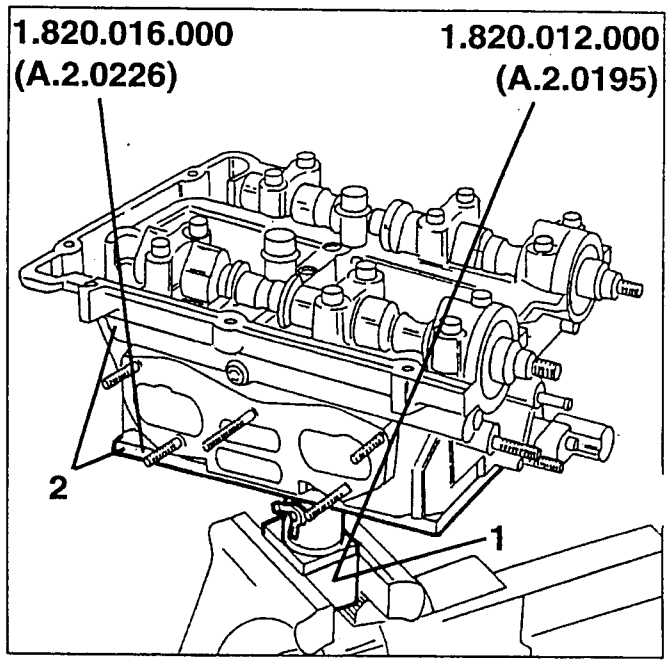
When refitting, install the two main bearing caps with oil spray jets with the jets pointing towards the right cylinder head.



DIS-ASSEMBLY OF CYLINDER HEADS

Preliminary operations

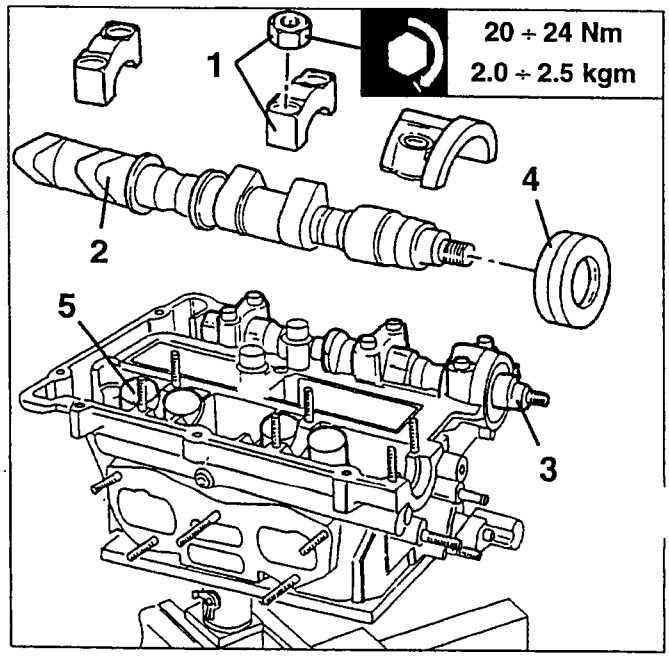
1. Clamp the swivelling stand N° 1.820.012.000 (A.2.0195) in a vice.
2. Fasten tool N° 1.820.016.000 (A.2.0226) on the swivelling stand and fasten the cylinder head on the latter.



Removing the camshafts

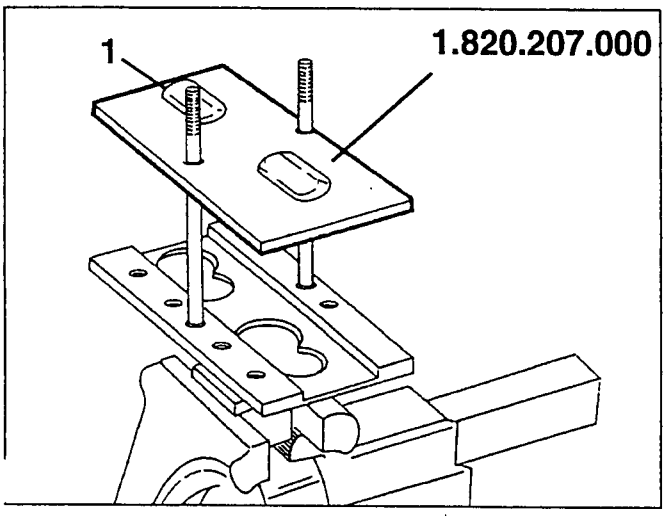
1. Slacken the fastening nuts and remove the camshaft caps.
2. Remove the intake side camshaft.
3. Remove the exhaust side camshaft.
4. Remove the two oil rings.
5. Remove the cups and set them in order for re-assembly.

CAUTION:
The intake and exhaust camshafts a' not interchangeable.



Dis-assembly of valves

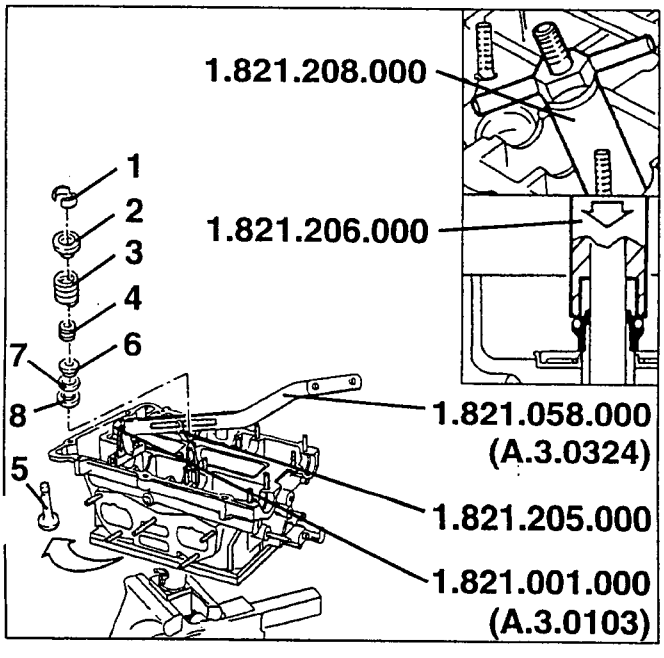
1. Interpose tool N° 1.820.207.000 between the cylinder head and the support stand.



1. Using tools N° 1.821.001.000 (A.3.0103), N° 1.821.058.000 (A.3.0324) and N° 1.821.205.000 remove the valve stem half cones.
2. Remove the upper plate.
3. Remove the outer spring.
4. Remove the inner spring.
5. Raise the head from tool N° 1.820.207.000 and retrieve the valve.
6. Using tool N° 1.821.208.000 remove the oil seal cap.

When refitting use tool N° 1.821.206.000 to insert the oil seal caps.

7. Remove the spring contact ring.
8. Remove the lower plate.

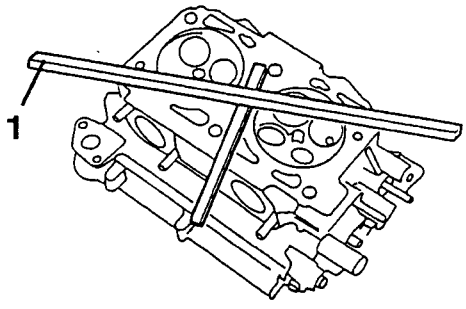


CHECKS AND INSPECTIONS FOR CYLINDER HEADS

Checking the lower surface of cylinder heads

1. Check that the lower plane of the cylinder heads is level: if the lower plane is excessively worn, reface both heads.

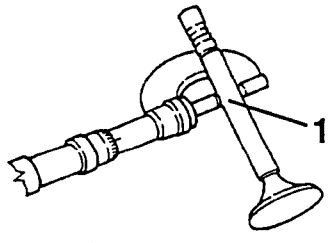
Maximum head lower plane flatness error
0.03 mm



Checking the clearance between valve guides and stems

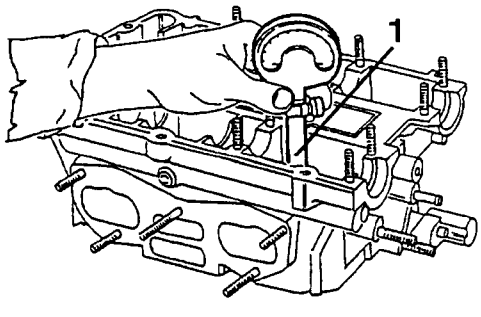
1. Measure the diameter of the valve stems and check that they are within the specified limits.

Diameter of valve stems
6.965 ÷ 6.980 mm



1. Measure the inside diameter of the valve guides and check that they are within the specified limits.

Inside diameter of valve guides
7.000 ÷ 7.015 mm

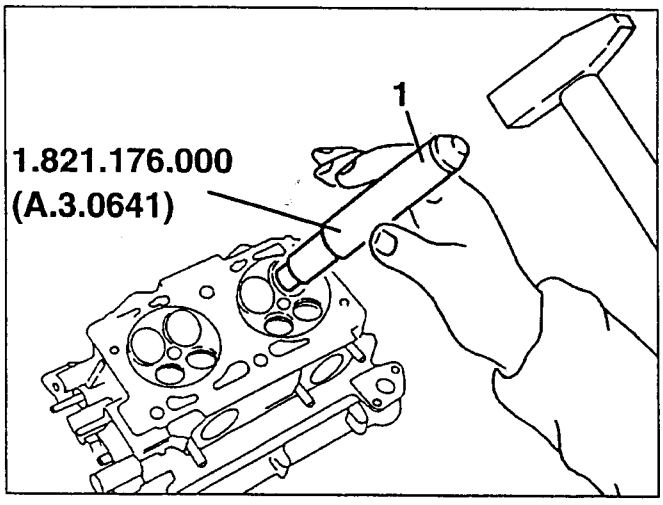


- Calculate the clearance between valve guides and stems and check that they are within the specified limit, if not change any worn parts.

Radial clearance between valve guides and stems
0.02 ÷ 0.05 mm

Changing the valve guides

1. Remove the worn valve guides using puller tool N° 1.821.176.000 (A.3.0641).



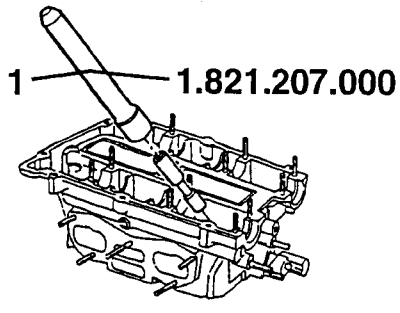
- Check that the outside diameter of the valve guides and of their seats on the head are within the specified limits and that interference is within the specified tolerance.

Valve guide outside diameter	
Intake	12.040 ÷ 12.051 mm
Exhaust	12.050 ÷ 12.068 mm

Diameter of valve guide seats
12.000 ÷ 12.018 mm

Interference between seats and valve guides	
Intake	0.022 ÷ 0.051 mm
Exhaust	0.032 ÷ 0.068 mm

1. Insert the new valve guides using tool N° 1.821.207.000.



NOTE: The guide valves are supplied also with a 0.2 mm oversize on the outside diameter.

- Ream the inside diameter of the valve guides to calibrate the holes to the specified diameter.

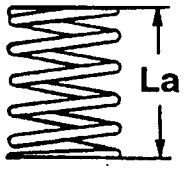
Inside diameter of valve guides "d"
7.000 ÷ 7.015 mm

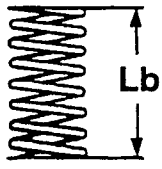
Checking the valve springs

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

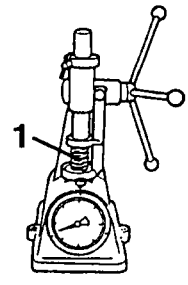
NOTE: The rest surfaces must be parallel with each other and perpendicular to the axis of the spring with a maximum error of 2

Length of valve springs	
outer spring "La"	~ 51.8 mm
inner spring "Lb"	38 mm





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



Outer spring		
Spring length mm		Control load kg
Valve closed	32.5	21.4 ÷ 22.6
Valve open	22.9	35.5 ÷ 35.7

Inner spring		
Spring length mm		Control load kg
Valve closed	30.5	13.6 ÷ 14.4
Valve open	20.9	31.9 ÷ 33.7

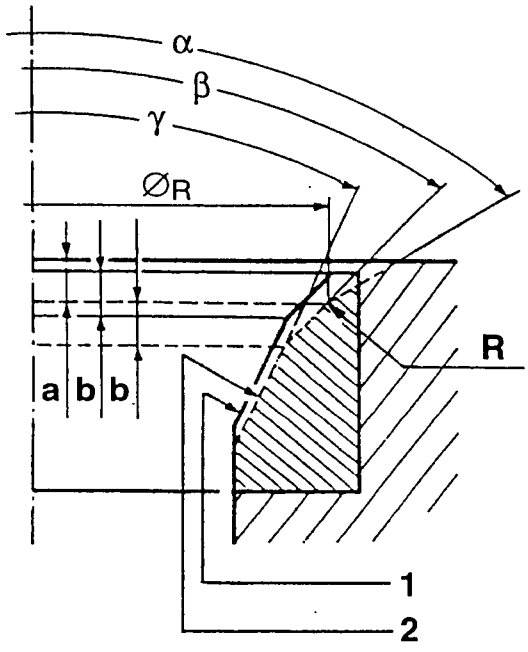
Turning the valve seats

1. Turn the valve seats using suitable tools with the cylinder heads cold.

Taper "β" valve contact area	90° ± 20'
Taper "α" upper valve seat area	Int. 150°
	Exh. 120°
Taper "γ" lower valve seat area.	Int. 75°
	Exh. 60°

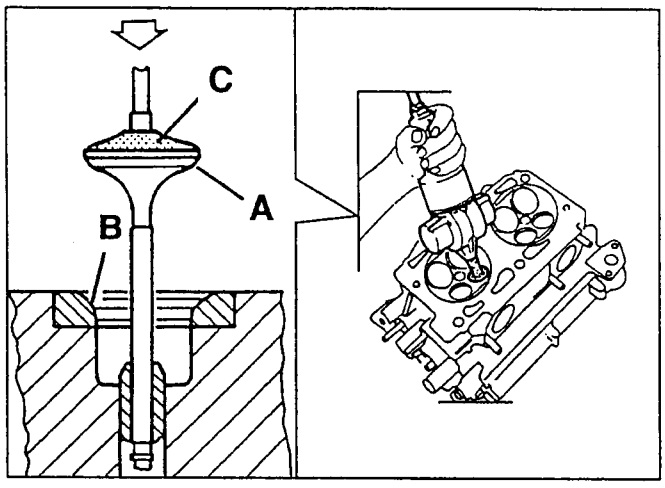
Dimension "a" at refacing limit	Int. 0.4 mm
	Exh. 1.1 mm
Height "b" valve contact area	Int. R = 0.9 mm
	Exh. b = 1.1 mm

Reference diameter ØR	
Intake	31.0 mm
Exhaust	24.5 mm



1. Original profile
2. Profile after max. refacing

- After machining grind each valve in its housing as follows:
- coat the contact surfaces "A" and "B" of the valves and seats with abrasive paste (SIPAL AREXONS arbosilicium for valves).
- lubricate 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 seat.

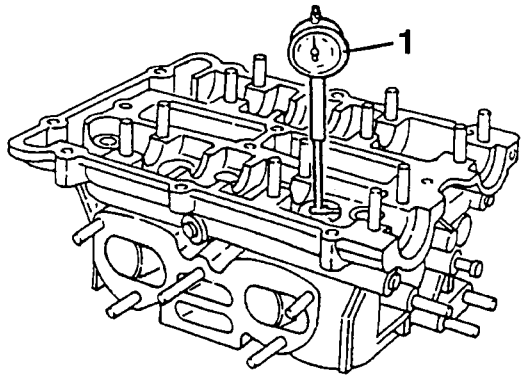


- When changing the valve guides, thus refacing and grinding the valve seats, it is advisable to check the valve tightness with the spark plugs in place, proceeding as follows:
- Fill the hollow of the combustion chamber with petrol.
- Admit low pressure air to the intake manifolds and check that no air 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.

Checking the clearance between cups and seats

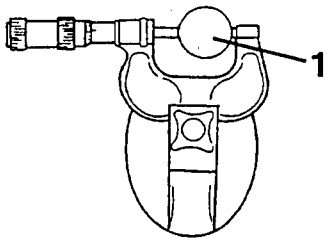
1. Check that the diameter of the seats is within the specified limits.

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 cups and seats, checking that it is within the specified limits.

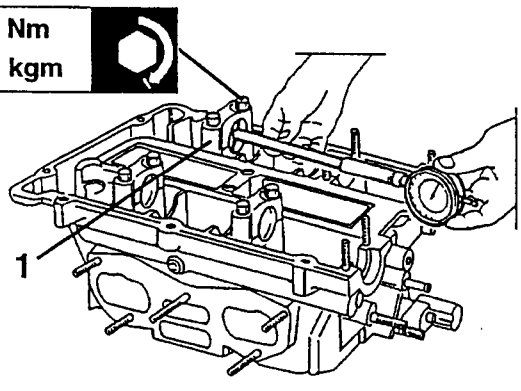
Clearance between cups and seats
0.025 ÷ 0.066 mm

Camshafts and timing system bearings

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

Diameter of camshaft bearings
27.000 ÷ 27.033 mm

20 ÷ 24 Nm
2.0 ÷ 2.5 kgm



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

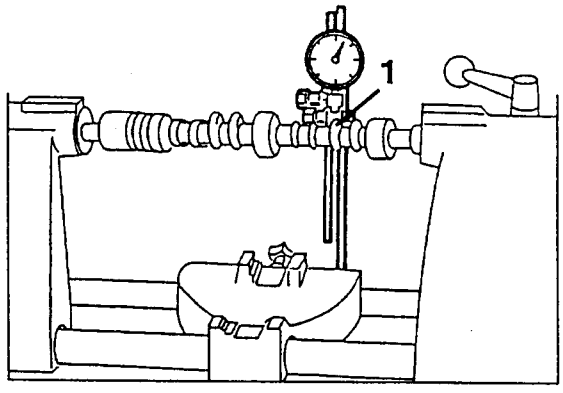
Diameter of camshaft journals
26.959 ÷ 26.980 mm

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

Clearance between camshafts and bearings
0.02 ÷ 0.074 mm

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

Minimum cam lift	
Intake	9.5 mm
Exhaust	9.4 mm



CHECKS AND INSPECTIONS 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 sealar from the crankcase surfaces.

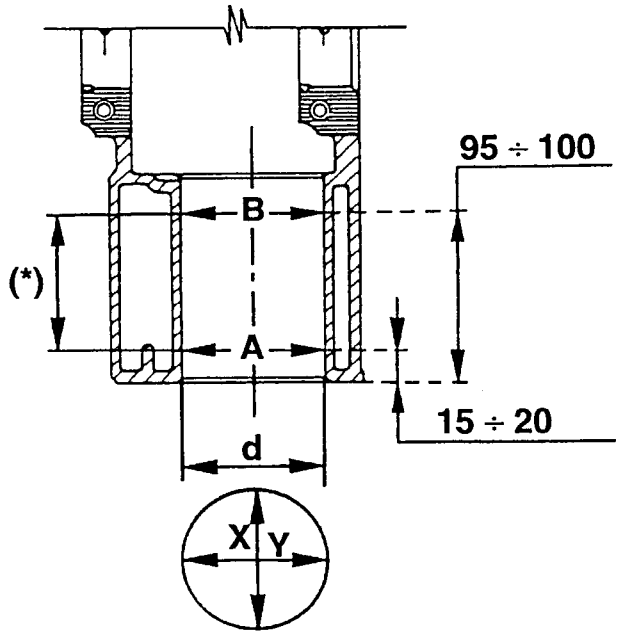
Checking the cylinders

- Use a bore meter fitted on a dial gauge to measure the inside diameters of the cylinders and check that it is within the specified limits.

Inside diameter "d"	
Class A	87.000 ÷ 87.010 mm
Class B	87.010 ÷ 87.020 mm
Class C	87.020 ÷ 87.030 mm
Class D	87.030 ÷ 87.040 mm
Class E	87.040 ÷ 87.050 mm

Maximum taper
A - B = 0.02 mm

Maximum ovalization
X - Y = 0,02 mm



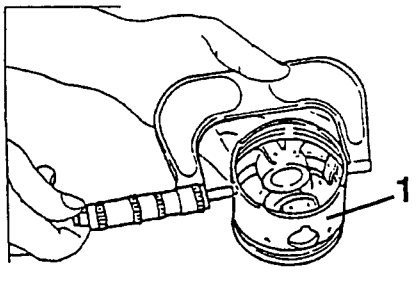
(*) Area for dimensional inspection

Checking the piston

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

Outside diameter of pistons (mm) (1)	
Class A (Blue)	86.950 ÷ 86.960
Class B (Pink)	86.960 ÷ 86.970
Class C (Green)	86.970 ÷ 86.980
Class D (Yellow)	86.980 ÷ 86.990
Class E (White)	86.990 ÷ 87.000

(1) The outer diameter of the piston must be measured perpendicular to the gudgeon pin hole a t a distance of 13.9 mm from the axis of the gudgeon pin.



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

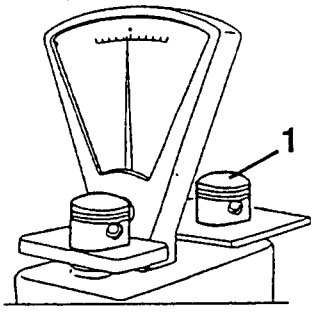
Clearance between cylinders - pistons
0.04 ÷ 0.06 mm

- If the dimensions are not within tolerance, the liners should be refaced, bearing in mind that pistons in three oversizes are available as spares; therefore the diameter is to be made within the tolerances given in the "Technical Characteristics and Specifications" GROUP 00.
- Fit the main bearings caps on the crankcase and tighten the fastening screws to the specified torque.
- Then bore the cylinders to within the tolerances given in the "Technical Characteristics and Specifications" GROUP 00.

Grinding should be carried out so that the signs of machining are crossed with an angle of 90° ÷ 120°.

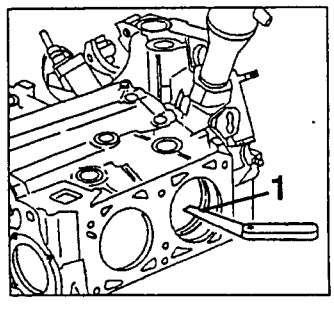
1. Check that the difference in weight between the pistons complete with gudgeon pins and seal rings is within the specified limits.

Difference in weight betwen pistons
≤ 2 g



Checking the seal ring gap

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

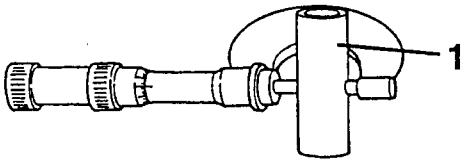


Ring gap	
First ring	0.30 ÷ 0.50 mm
Second ring	0.30 ÷ 0.50 mm
Oil scraper ring	0.25 ÷ 0.50 mm

Checking the play between pins and seats on pistons

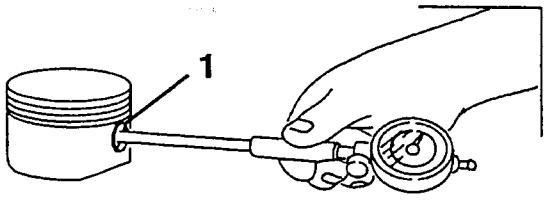
1. Measure the outside diameter of the pins and check that it is within the specified limits.

Outside diameter of pins
20.996 ÷ 21.000 mm



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

Diameter of pin hole on pistons
21.004 ÷ 21.008 mm



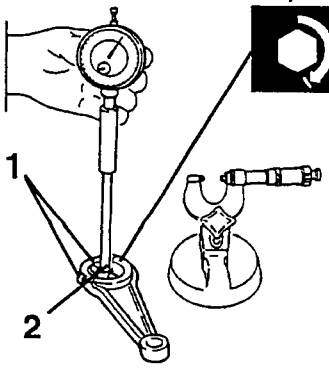
- Calculate the clearance between the pins and their seats on the pistons and check that it is within the specified limits.

Clearance between pins and seats on pistons
0.004 ÷ 0.012 mm

Checking the clearance between connecting rod journals and the 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.

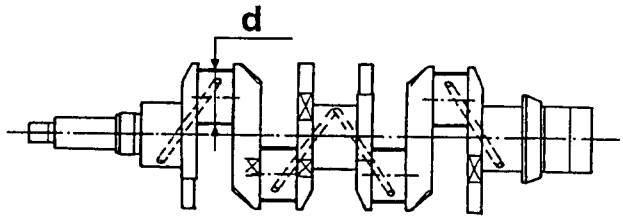
53 ÷ 58 Nm 5.4 ÷ 5.9 kgm



Inside diameter of connecting rod half bearings	
Class A - Blue	50.032 ÷ 50.056 mm
Class B - Red	50.024 ÷ 50.048 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 - Blue	49.992 ÷ 50.000 mm
Class B - Red	49.984 ÷ 49.992 mm



NOTE: Due to the nitriding treatment the crankshaft has undergone, no grinding operations are possible; therefore it must be changed in the event of excessive wear.

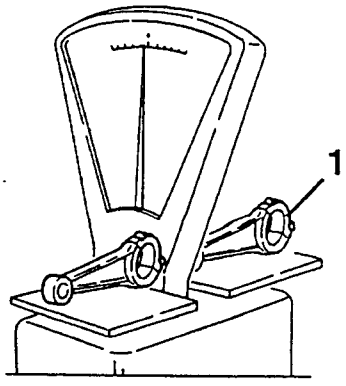
- Calculate the clearance between the rod journals and the corresponding half bearings and check that it is within the specified limits.

Clearance between rod journals and half bearings
0.032 ÷ 0.064 mm

Checking the connecting rods

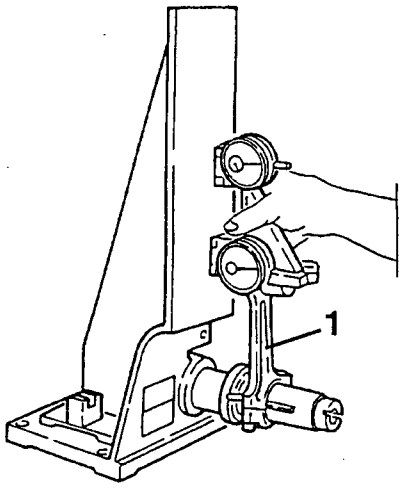
1. Check that the difference in weight between the rods complete with half bearings, caps and screws is within the specified limits.

Difference in weight between connecting rods
≤ 2 g



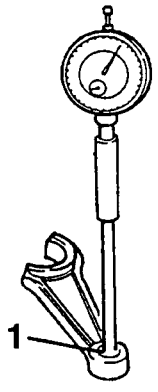
1. Check that the rods are perpendicular using a reference plane as illustrated.

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 bushing

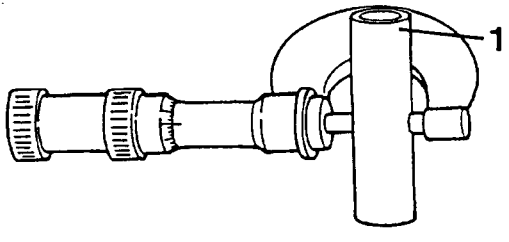
1. Measure the inside diameter of the small end bushing and check that it is within the specified limits, if not, change the bushing.



Inside diameter of small end bushing
21.007 ÷ 21.015 mm

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

Outside diameter of pins
20.996 ÷ 21.000 mm



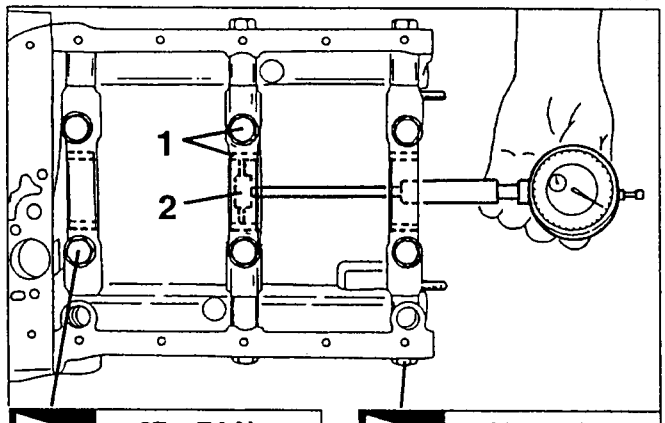
- Calculate the clearance between the pins and the small end bushing and check that it is within the specified limits.

Clearance between pins and small end bushing
0.007 ÷ 0.019 mm

Checking the clearance between main bearing journals and the corresponding half bearings

1. House the half bearings and fit the main bearing 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.

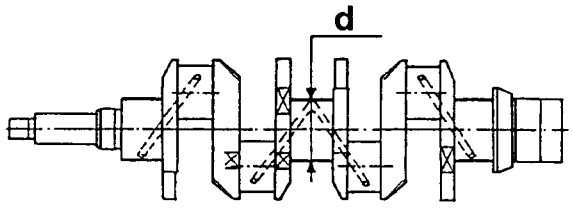
Diameter of main bearings	
Class A - Red	59.987 ÷ 60.009 mm
Class B - Blue	59.979 ÷ 60.001 mm



67 ÷ 74 Nm 6.8 ÷ 7.5 kgm	41 ÷ 50 Nm 4.2 ÷ 5.1 kgm

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

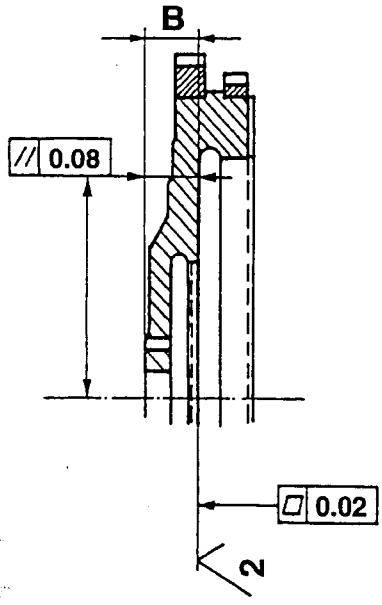
Diameter of main bearing journals	
Class A - Red	59.954 ÷ 59.964 mm
Class B - Blue	59.944 ÷ 59.954 mm



Clearance between main bearing journals/half bearings
0.023 ÷ 0.055 mm

Checking the engine flywheel

- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, proceed as follows to change them:
• remove the old ring gears;
• accurately clean the contact surfaces of the new ring gears and of the flywheel;
• evenly heat the new ring gears to 120° ÷ 140° C and fit them on the flywheel;
• leave to cool naturally, do not force cool.
- Check that the surface of the flywheel on which the clutch driven plate works has no nicks, material removal or signs of overheating. If not, check that dimension "B" shown in the diagram is above the specified limit and that the machining allowance enables refacing.



Refacing dimension
B ≥ 21.15 mm

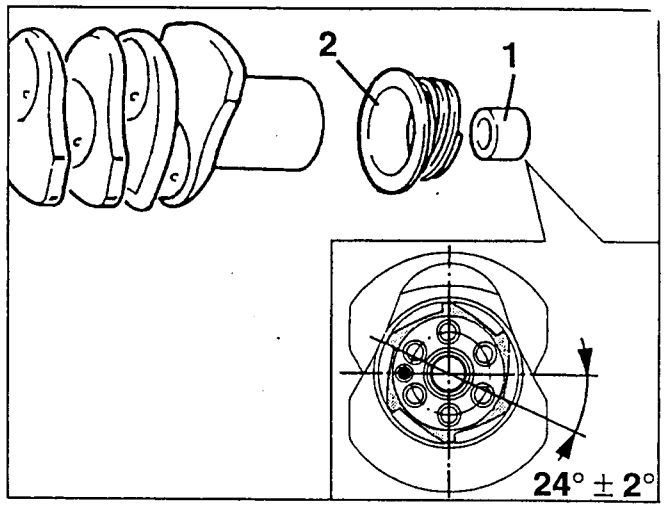
CAUTIONS FOR RE-ASSEMBLY

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

- Check valve tightness when the cylinder heads are assembled.

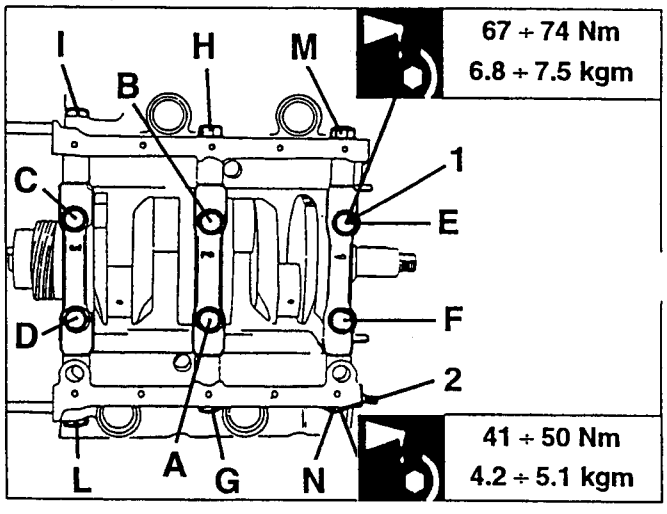
Reassembling the crankshaft

1. If removed previously, the crankshaft rear bushing should be refitted using tool N° 1.821.104.000 (A.3.0450).
2. Heat the oil pump drive gear to 150°C and shrink it onto the crankshaft directing it as illustrated.



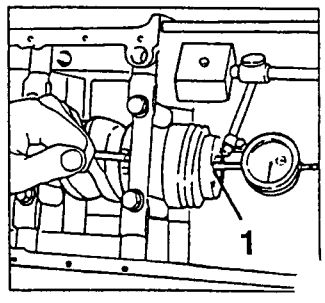
Tightening the main bearing caps

- Assemble the main bearing caps on the crankcas bearings in the correct position and tighten the fastening screws in oil without locking them.
1. Tighten the main bearing cap fastening screws to the respective crankcase bearings two or three times in the sequence shown (from A to F).
2. Then in two or three operations, tighten the screws fastening the main bearing caps to the crankcase in the sequence shown (from G to N).
- Turn the crankshaft by hand and check that it turns smoothly.



Checking the crankshaft end float

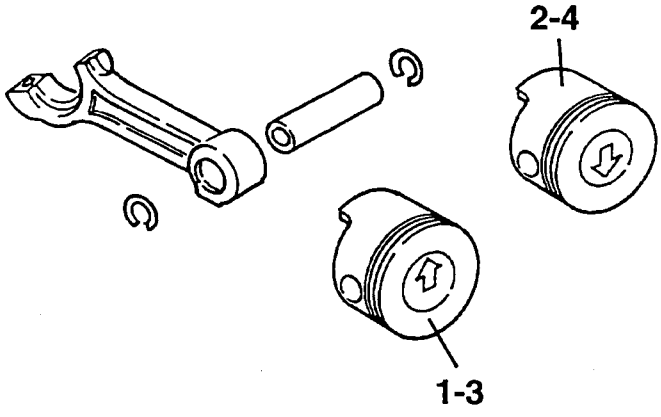
1. Using a dial gauge on a magnetic base, measure the crankshaft end float and check that it is within the specified limits.



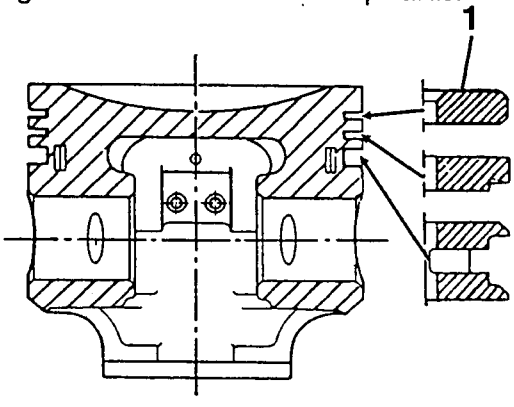
Crankshaft end float
0.35 mm

Reassembling the pistons and connecting rods

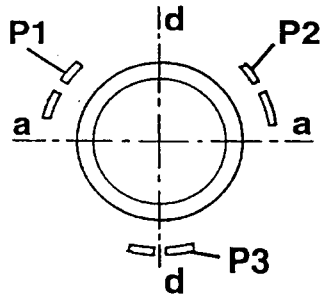
1. Assemble the pistons and connecting rods so that the pistons of the right cylinder head 1-3 have the arrow stamped on the crown pointing upwards and the pistons of the left head 2-4 have the arrow pointing downwards.



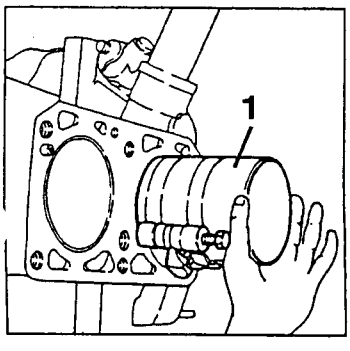
1. Insert the rings on the piston making sure that the wording on the flat surface faces upwards.



- Direct the rings on the pistons with the cuts offset by 120°.

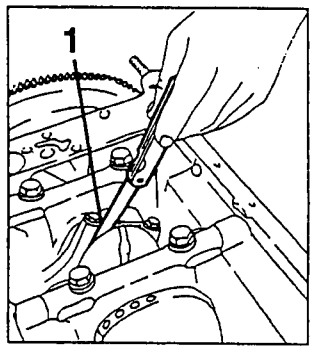


***P1**. Position of upper ring;*
***P2**. Position of lower ring;*
***P3**. Position of oil scraper ring;*
***aa**. Gudgeon pin axis;*
***dd**. Direction of thrust.*



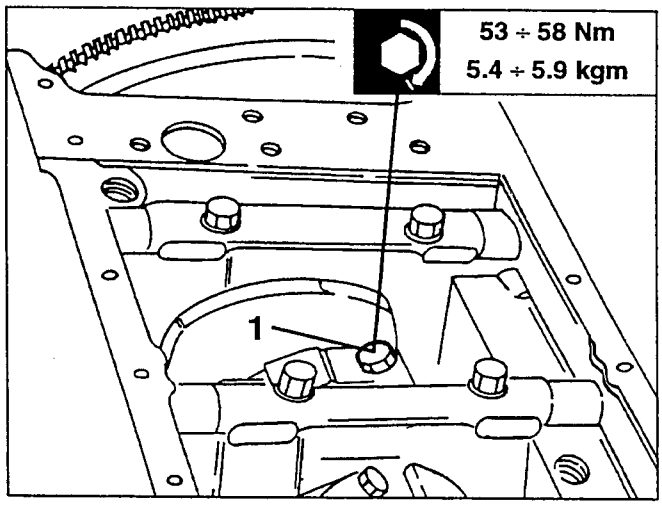
1. Assemble the half bearings on the connecting rod big end and insert the piston-connecting rod assembly in the corresponding cylinders using the special tool.

When assembling direct the pistons with the arrow stamped on the crown pointing in the direction of rotation of the engine, i.e. upwards for the right head pistons and downwards for the left head pistons.
The position of the connecting rod big end must make it possible to read the identification number.



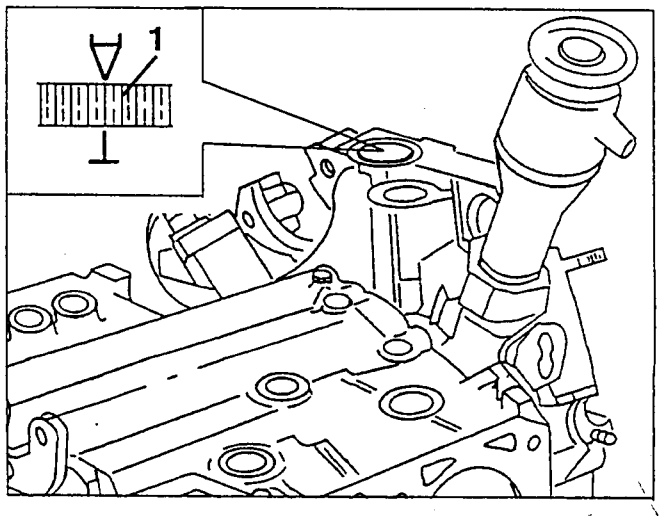
1. Position the connecting rod caps with the corresponding half bearings and check that there is the specified play between the crankshaft shoulder and the connecting rod-cap profile.

1. Suitably turn the crankshaft to gain access to the connecting rod cap fastening screws and tighten them to the specified torque.



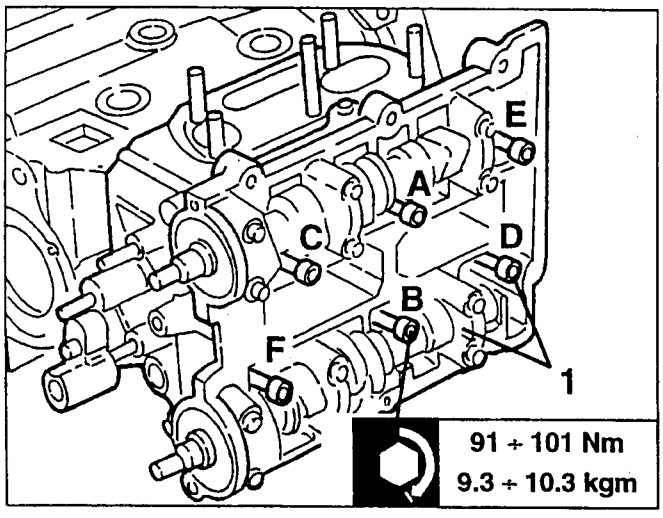
Reassembling the cylinder heads

1. Turn the crankshaft to take piston no. 1 to the T.D.C. (bursting stroke); making sure that the notch "T" on the flywheel coincides with the fixed reference of the rear cover.



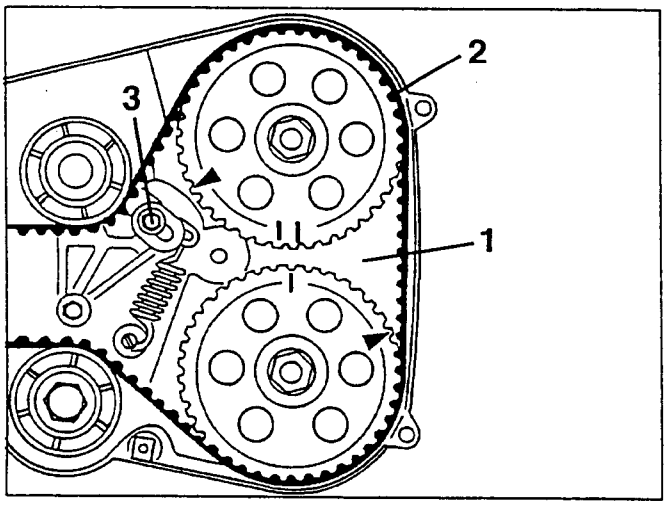
CAUTION:
Turn the camshafts to a neutral position.

1. Assemble the cylinder heads with the seals interposed on the crankcase and tighten the fastening screws in two or three operations to the specified torque following the sequence indicated (from A to F).



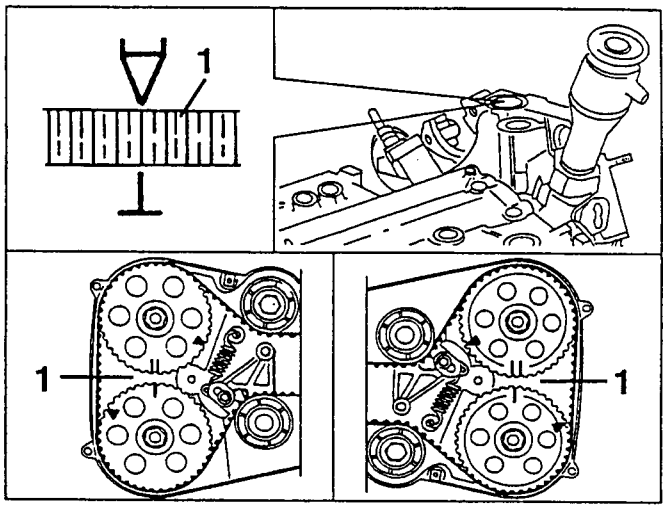
Assembling the timing belts

1. Turn the camshafts of the left head so that the area between the two notches of the intake pulley coincides with the notch of the exhaust pulley.
- Turn the crankshaft until the notch "T" on the flywheel is aligned with the fixed reference of the rear cover.
2. Fit the left timing belt.
3. Slacken the belt tensioner fastening nut so that it can exert the load impressed by the spring on the belt.

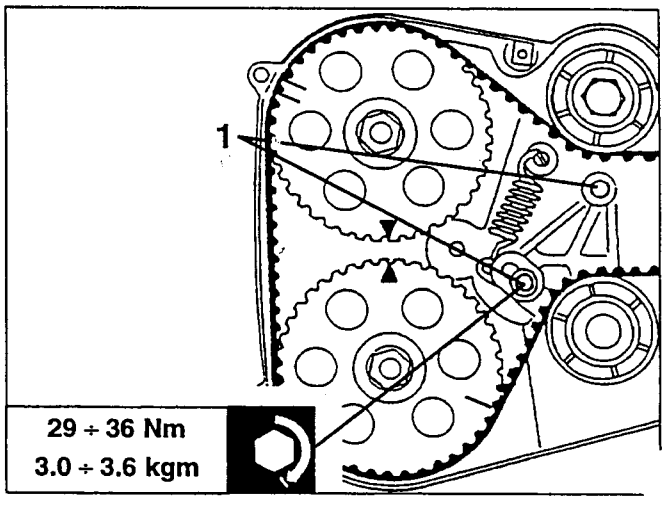


- Repeat the previous operations for assembly and timing of the right timing belt.
- Turn the crankshaft a few times in its direction of rotation to allow the belts to take their final position.

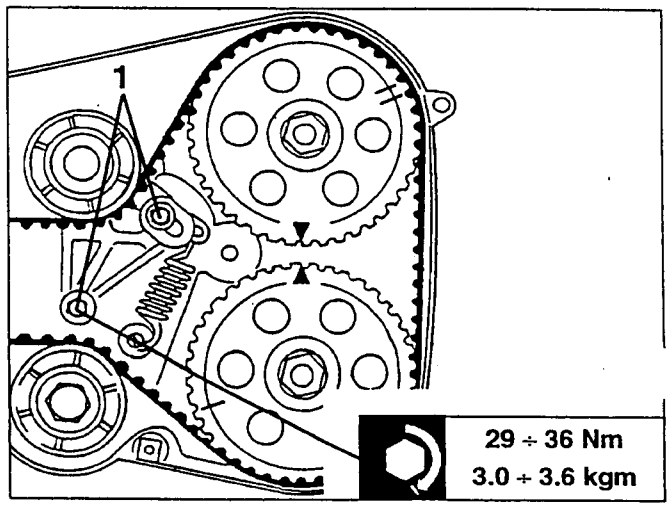
1. Check engine timing.



- Turn the crankshaft 90° to obtain: the impression ● on the flywheel aligned with the fixed index ar alignment of the notches ▲ on the pulleys.
1. Slacken the fastening nuts of the right belt tensioner to settle it then tighten them to the specified torque.



- Turn the crankshaft 360° to obtain: the impression ● on the flywheel aligned with the fixed index and alignment of the notches ▲ on the pulleys.
1. Slacken the fastening nuts of the left belt tensioner to settle it then tighten them to the specified torque.



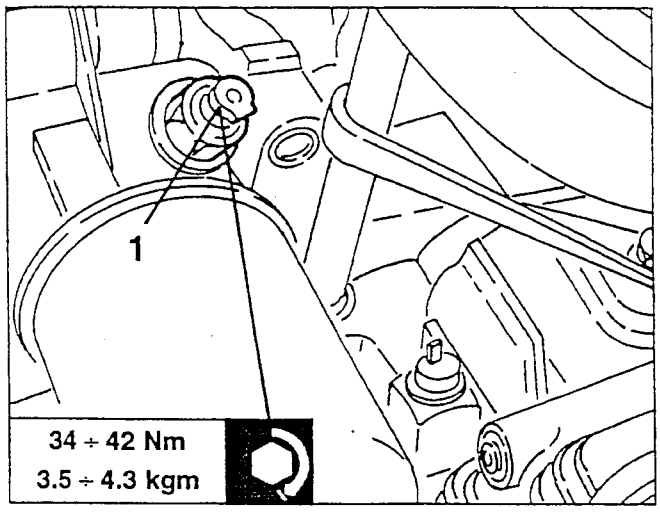
- Turn the crankshaft a few turns and check again that the timing references correspond.

CHECKING THE ELECTRICAL COMPONENTS OF THE LUBRICATION CIRCUIT

Minimum engine oil pressure warning light sensor

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

Contact opening/closing pressure	0.2 ÷ 0.5 bar



For the other sensors and electrical components located in the engine compartment, refer to the specific Groups in which an extensive description is given.