



ENGINE V6 TURBO - AR16202

10

INDEX

OVERHAULING

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INTRODUCTION

The instructions given in the following paragraphs refer to the complete overhauling of the engine on the bench, after removing the power unit from the vehicle.

The instructions are sub-divided as follows:

- Engine dis-assembly:

removing the engine accessories and components and dis-assembly into the main units forming it.

- Cylinder head dis-assembly and overhauling:

complete overhauling of all the components of the heads.

- Crankcase overhauling:

complete overhauling of the components of the cranking mechanisms.

- Instructions for re-assembly:

these comprise the specific re-assembly operations which differ substantially from the dis-assembly instructions.

- Checking and inspecting the electric components of the lubricating circuit.

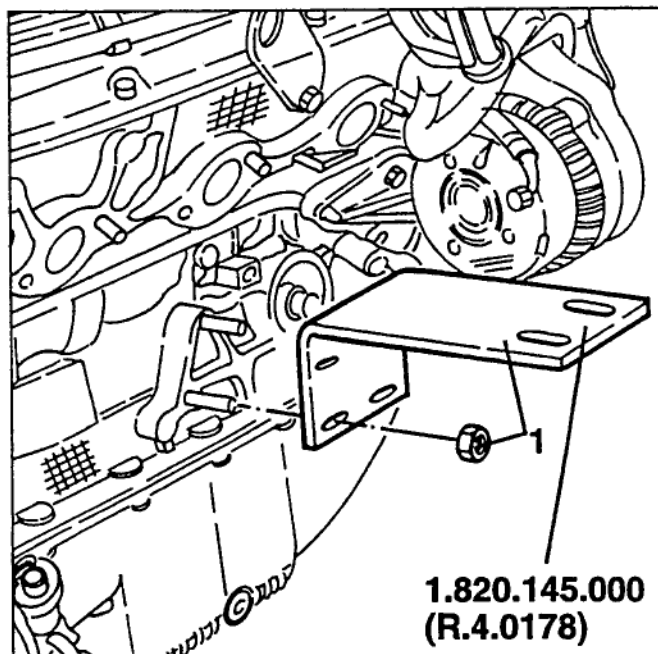
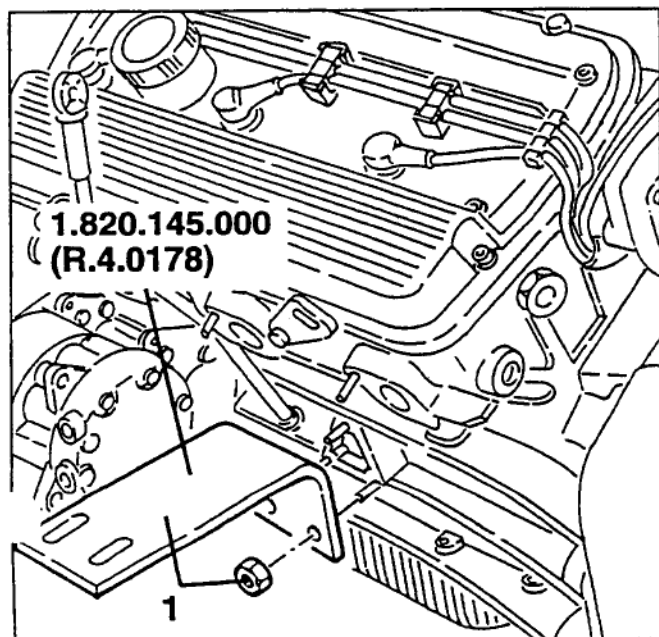
All the dis-assembly procedures described are valid in the reversed sequence for re-assembly, unless otherwise specified.

The following procedures refer to the complete overhauling of the whole engine, but it is possible to use them in part separately when required for specific components.

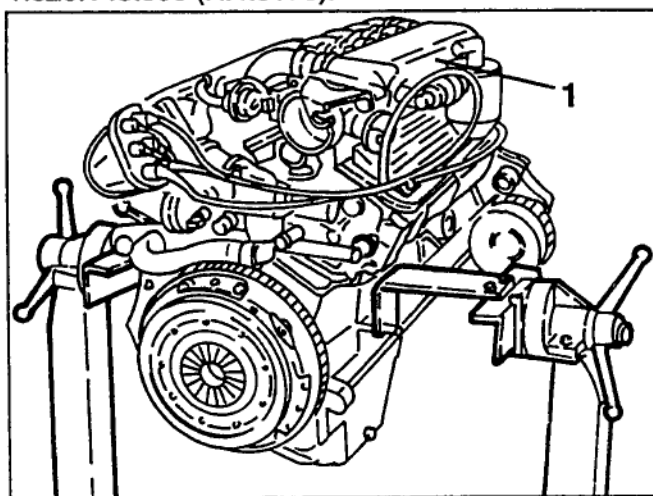
ENGINE DIS-ASSEMBLY

PRELIMINARY OPERATIONS

1. On the crankcase install the two brackets no. 320.145.000 (R.4.0178) for positioning the engine on the overhauling stand.

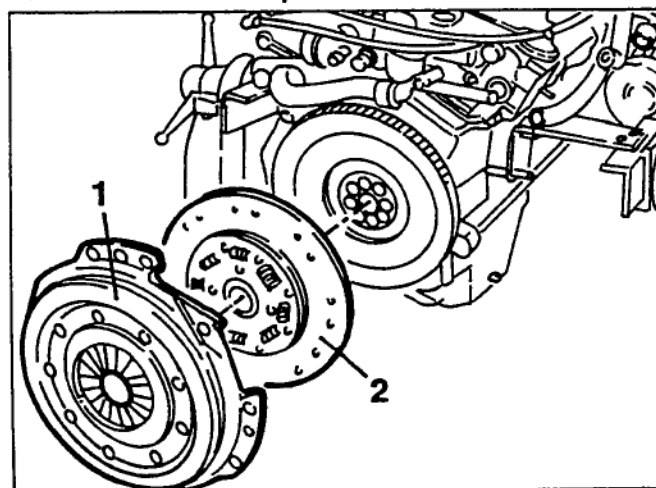


1. Raise the engine with the hydraulic lift and set it on the overhauling stand using support brackets no. 1.820.145.000 (R.4.0178).



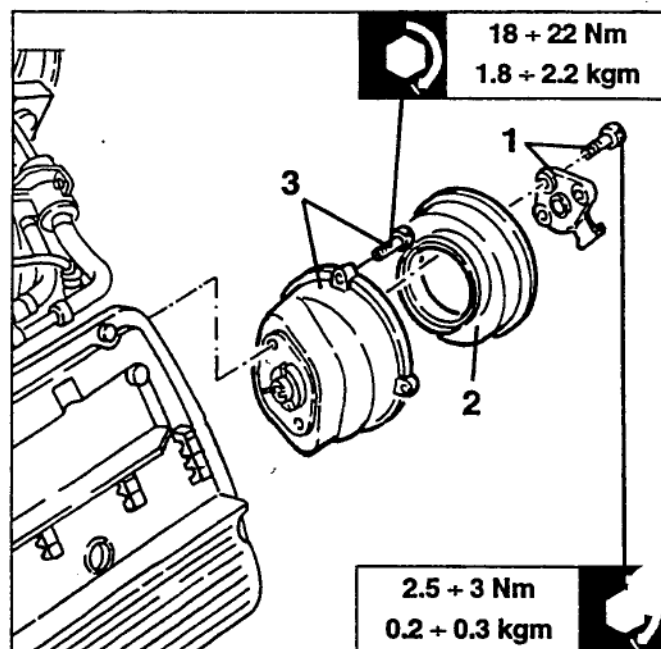
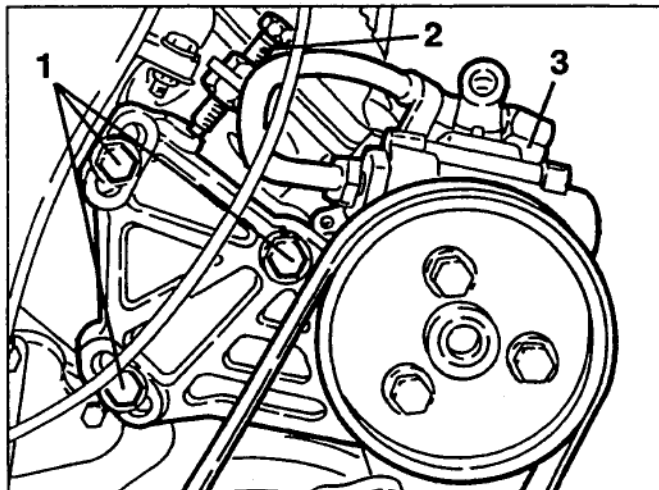
REMOVING THE CLUTCH PLATE

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

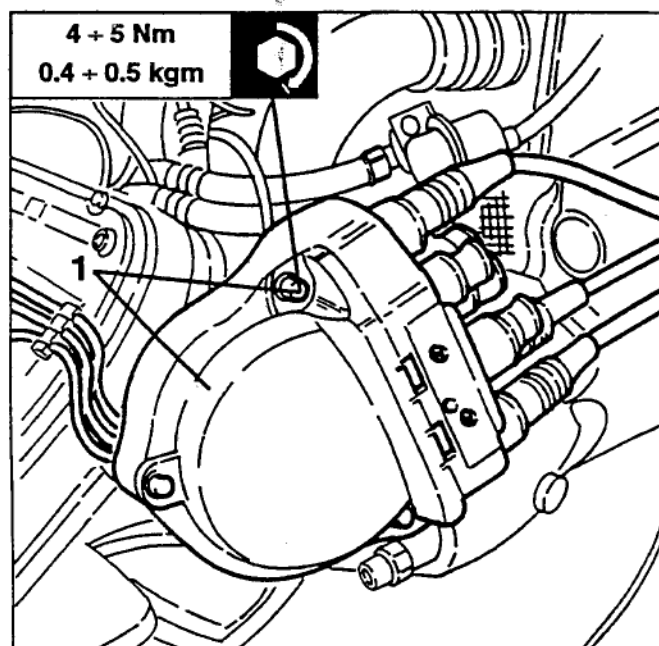


REMOVING THE POWER STEERING PUMP

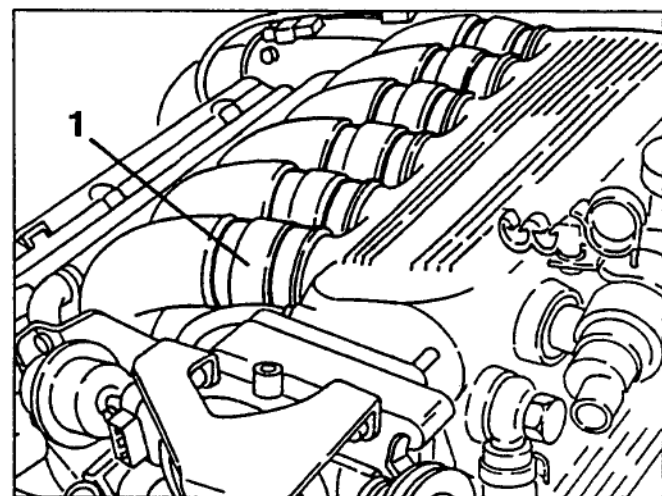
1. Slacken the three screws fastening power steering pump support bracket.
2. Slacken the locknut, slacken the screw of the micrometric tensioner, then prise off the power steering pump drive belt.
3. Unscrew the three screws slackened previously and remove the power steering pump complete with support bracket.

**REMOVING THE AIR INTAKE BOX**

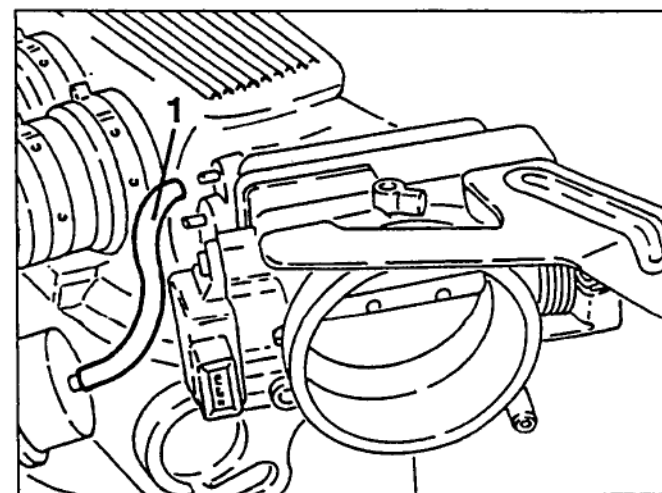
1. Slacken the ignition distributor fastening screws then remove them complete with high voltage cables and 1st cylinder detection sensor.



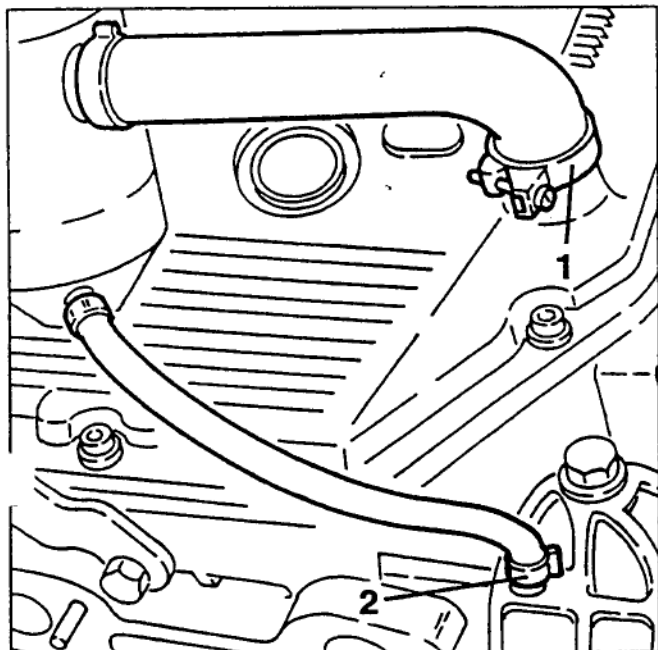
1. Slacken the three fastening screws and remove the rotary brush.
2. Retrieve the cover.
3. Slacken the two fastening nuts and remove the ignition distributor body.



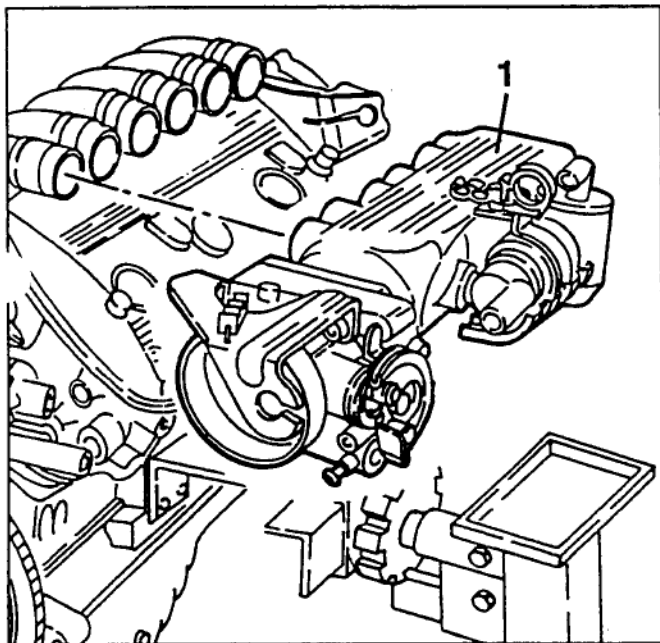
1. Disconnect the vacuum takeoff pipe for the fuel pressure regulator from the intake box.



1. Disconnect the oil vapour recovery pipe from the cylinder head.
2. Disconnect the condensed oil recovery pipe from the upper alternator support.



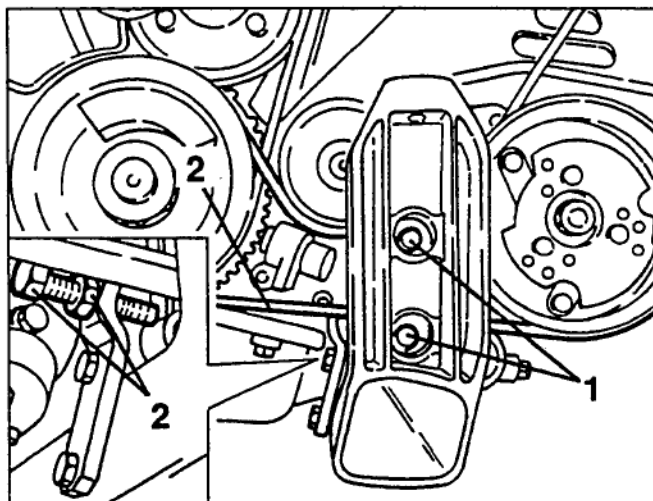
1. Remove the intake box complete with oil vapour separator, constant idle speed actuator and throttle body.



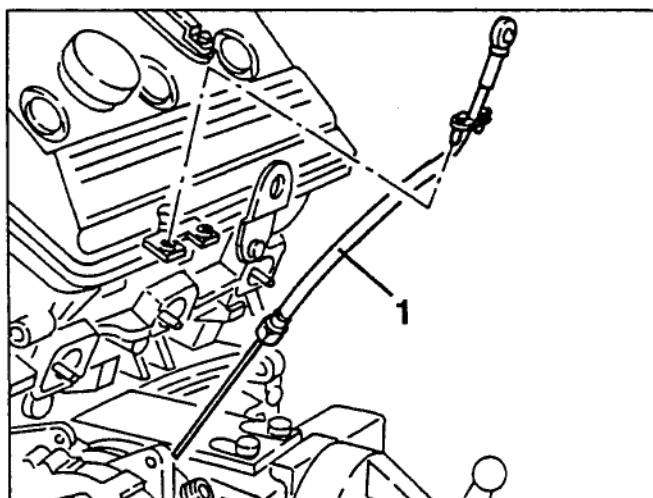
REMOVING THE CONDITIONER COMPRESSOR

1. Slacken the two screws fastening conditioner compressor belt tensioner.
2. Slacken the locknut, unscrew the screw of the micrometric tensioner, then prise and remove the conditioner compressor drive belt.

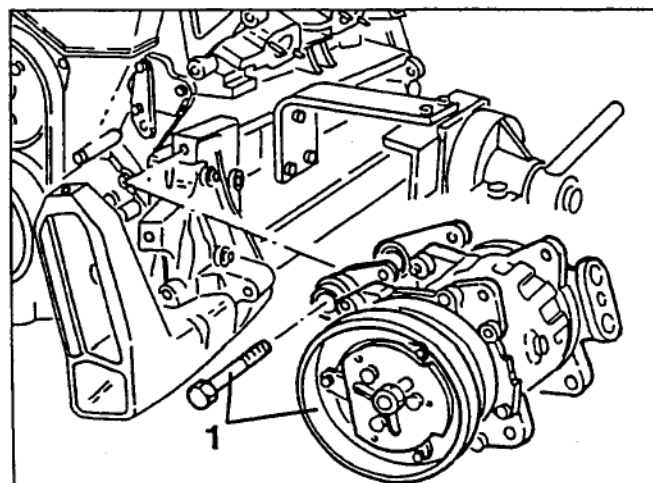
- Retrieve the power steering pump drive belt.
- Slacken the two fastening screws completely and remove the conditioner compressor belt tensioner guide.



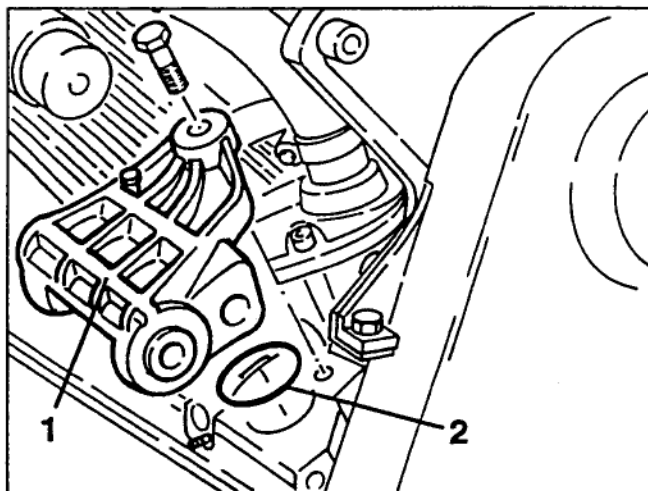
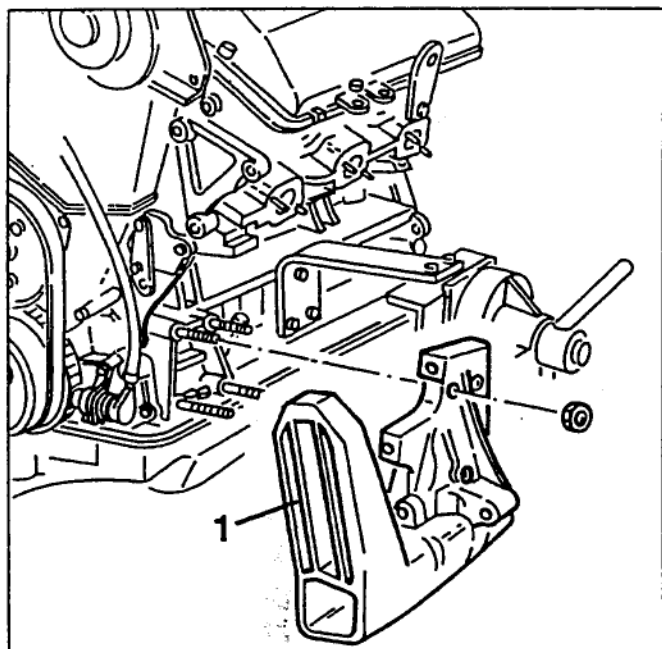
1. Remove the the engine oil dipstick complete with guide.



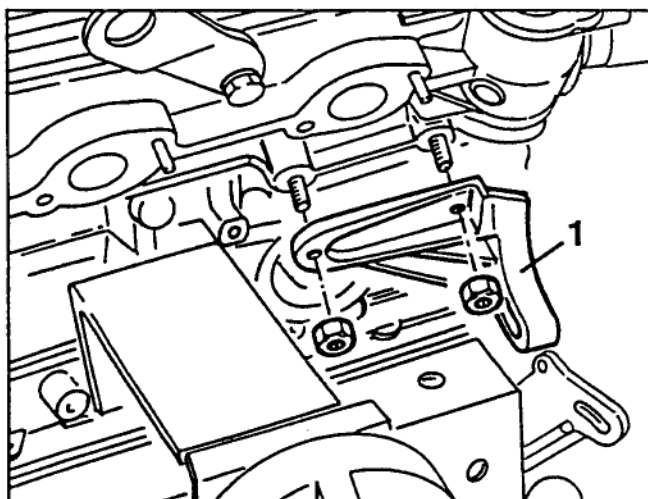
1. Slacken the fastening bolts and remove the conditioner compressor complete with support brackets.



1. Slacken the fastening nuts and remove the front engine support.

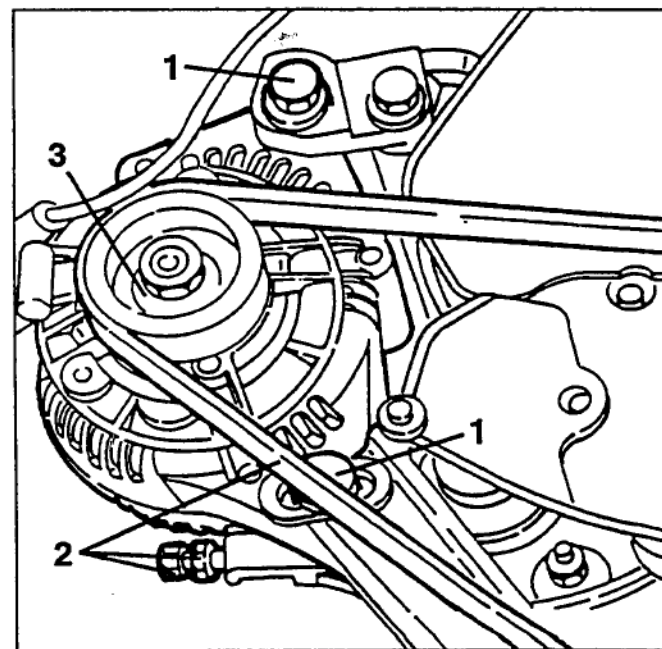


1. Slacken the fastening nuts and remove the lower rear alternator support bracket.

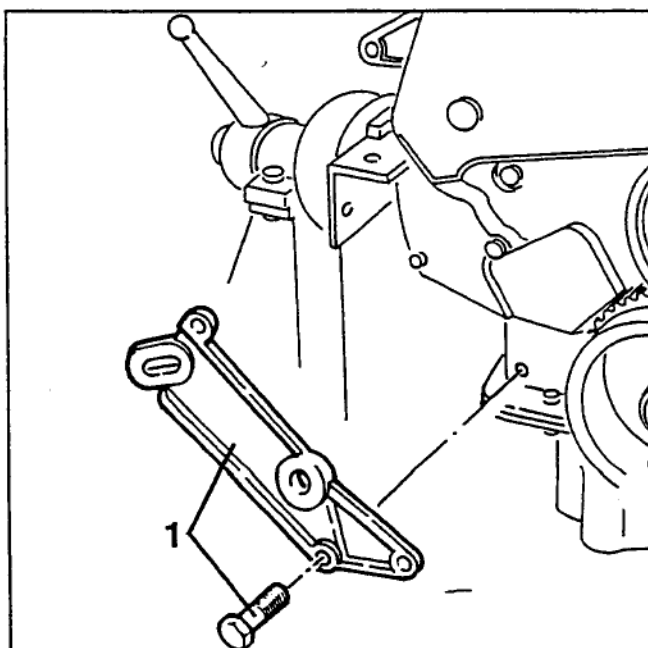


REMOVING THE ALTERNATOR

1. Slacken the two bolts fastening the alternator to the support brackets.
2. Slacken the locknut, slacken the screw of the micrometric tensioner, then prise and remove the alternator - water pump drive belt.
3. Completely unscrew the two bolts slackened previously and remove the alternator.

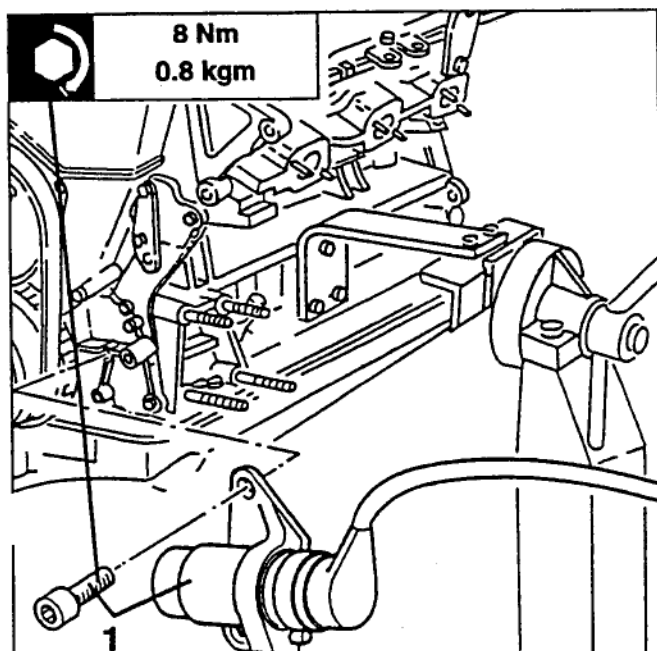


1. Slacken the fastening screws and remove the lower front alternator support bracket.

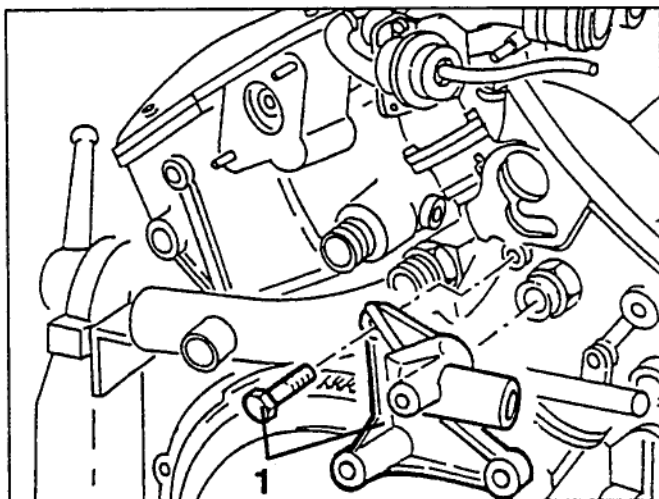


1. Remove the upper alternator support bracket.
2. Remove the O-Ring.

1. Slacken the fastening screws and remove the rpm and timing sensor complete with support bracket.

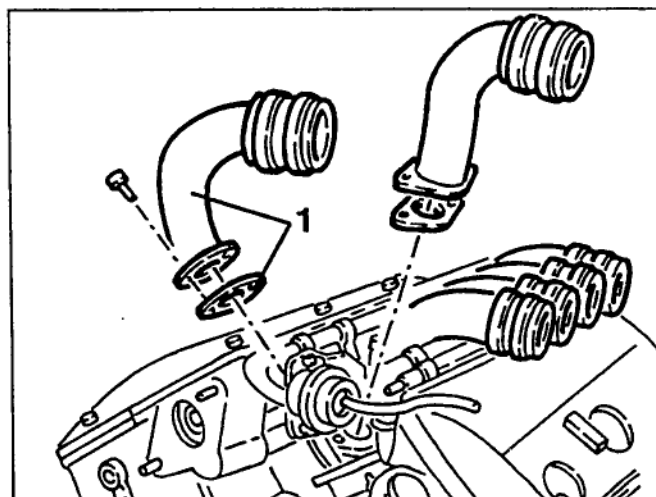


1. Slacken the fastening screws and remove the union for coolant delivery to the throttle body and to the heater of the climate control system.



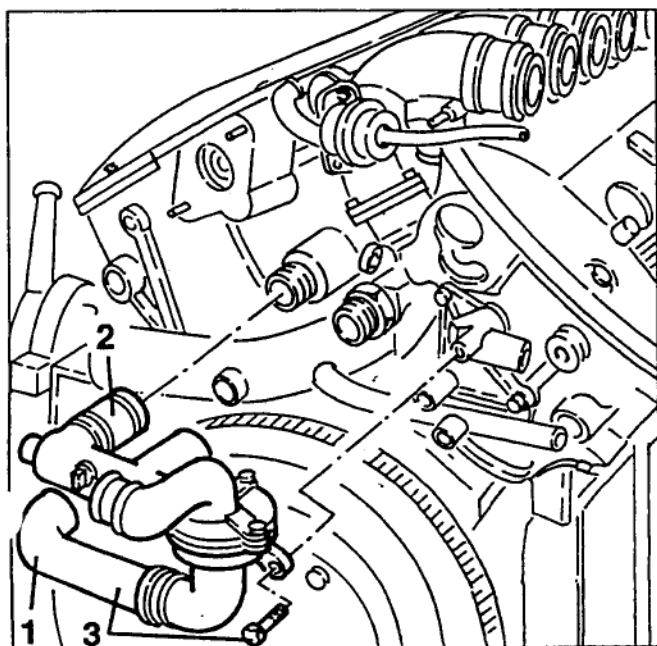
REMOVING THE FUEL DISTRIBUTOR MANIFOLD

1. Slacken the fastening screws and remove the air intake ducts complete with seals.

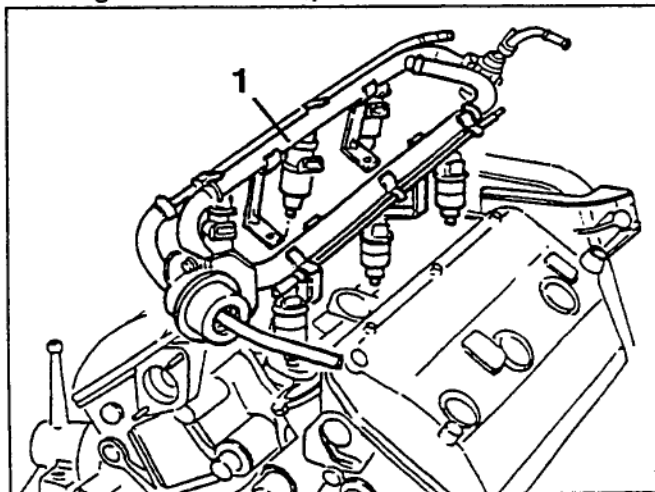


REMOVING THE THERMOSTAT UNIT

1. Disconnect the thermostatic cup fluid outlet sleeve from the coolant return manifold to the pump.
2. Slacken the clamp fastening the left-hand cylinder head coupling sleeve to the thermostat unit.
3. Slacken the two fastening screws and remove the complete thermostat unit.

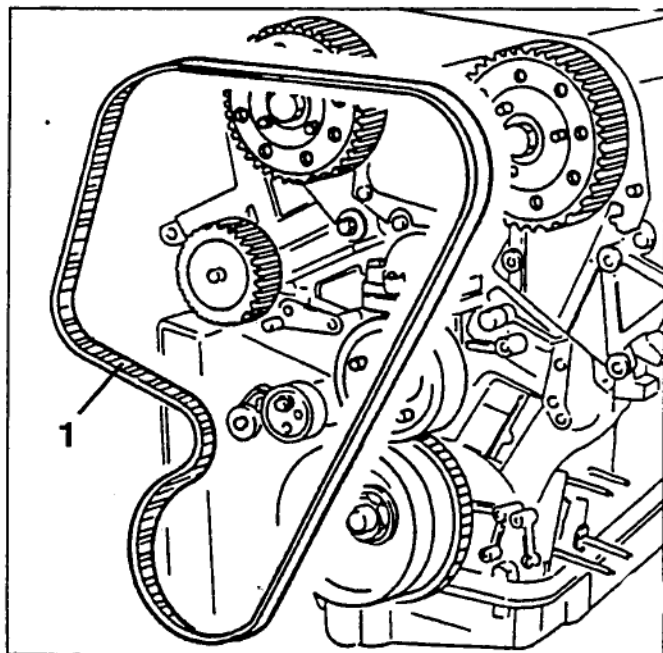
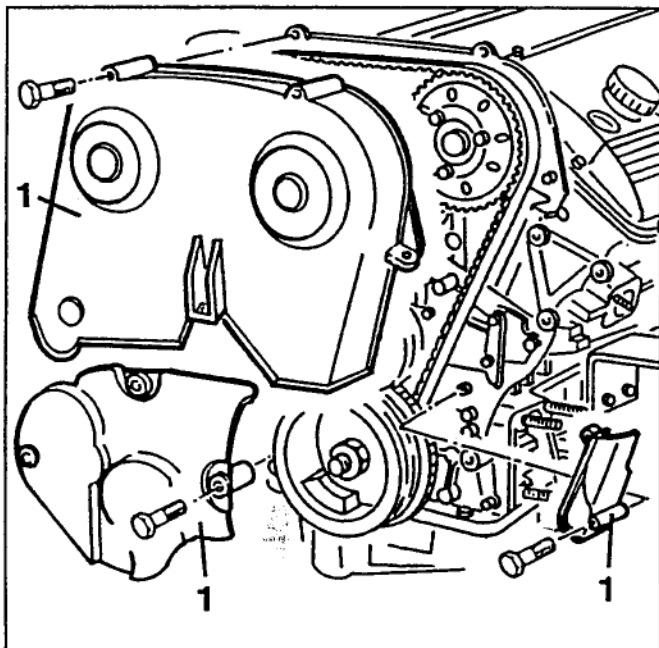


1. Slacken the fastening screws and remove the fuel distributor manifold complete with injectors, fuel pressure regulator and dash pot.



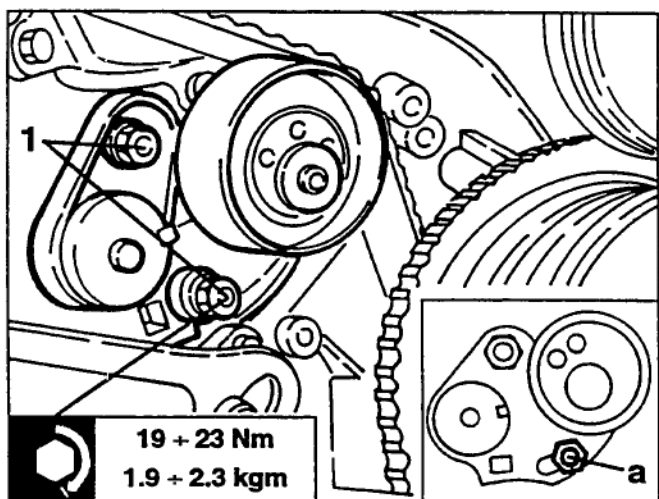
REMOVING THE VALVE GEAR TIMING BELT

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



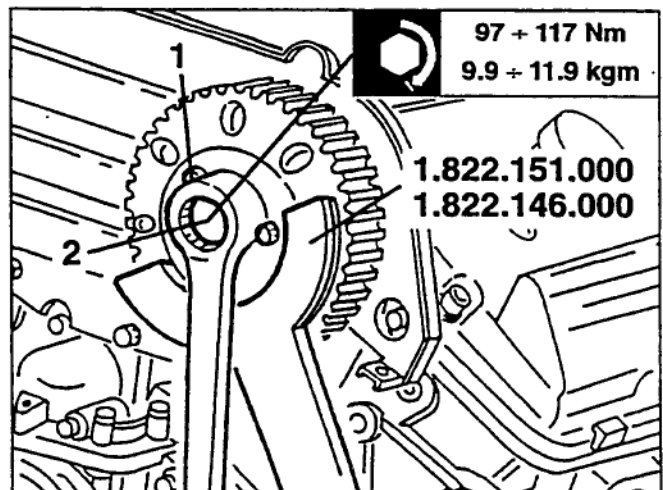
- Completely back off the two nuts fastening the timing belt tensioner and remove it.

1. Slacken the two nuts fastening the timing belt tensioner and position it so that stud "a" is as illustrated, then completely tighten the two fastening nuts, locking them lightly.



REMOVING THE TIMING GEAR PULLEYS

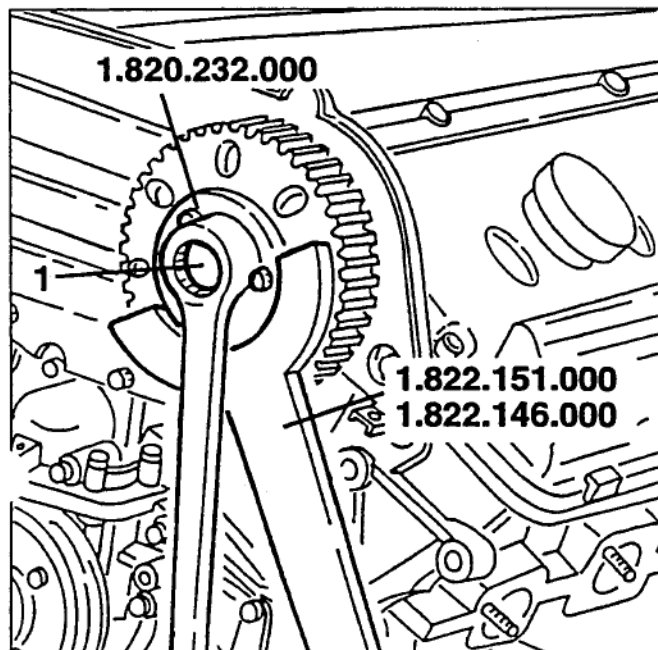
1. Slacken the screws fastening the timing gear pulley to the support hub.
2. Using tools no. 1.822.151.000 and 1.822.146.000 completely back off the hub fastening nut.



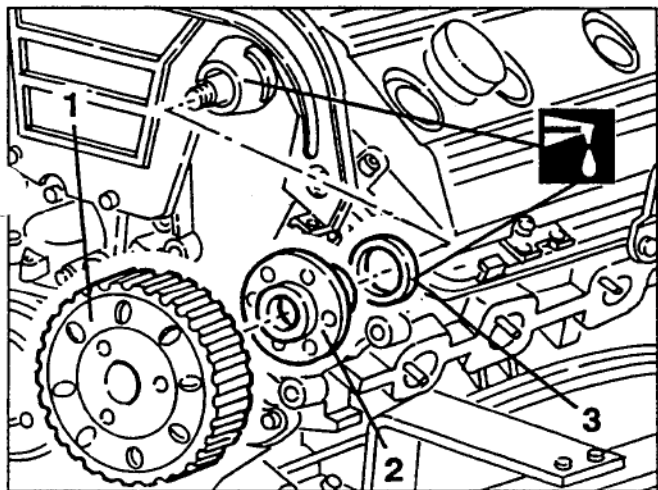
1. Remove the valve gear timing belt prising it off the toothed camshaft drive pulleys and withdrawing it from the drive pulley.

- Completely unscrew the screws slackened previously, fastening the timing gear pulley to the support hub.

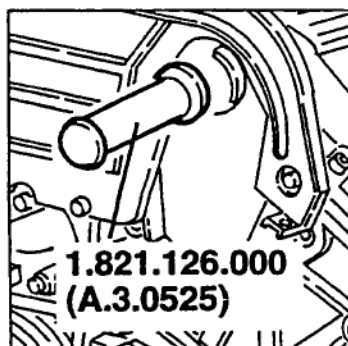
1. Install tool no. 1.820.232.000 on the timing gear pulley and tighten the nut of the tool itself levering with tools no. 1.822.151.000 and no. 1.822.146.000.



1. Remove the tools installed previously, then withdraw the timing gear pulley.
2. Withdraw the support hub.
3. Prise and remove the oil ring.

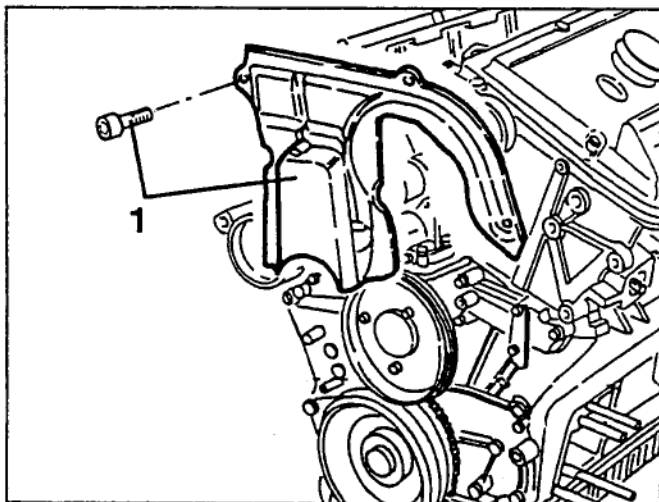


When refitting insert a new front camshaft oil ring using tool no. 1.821.126.000 (A.3.0525).

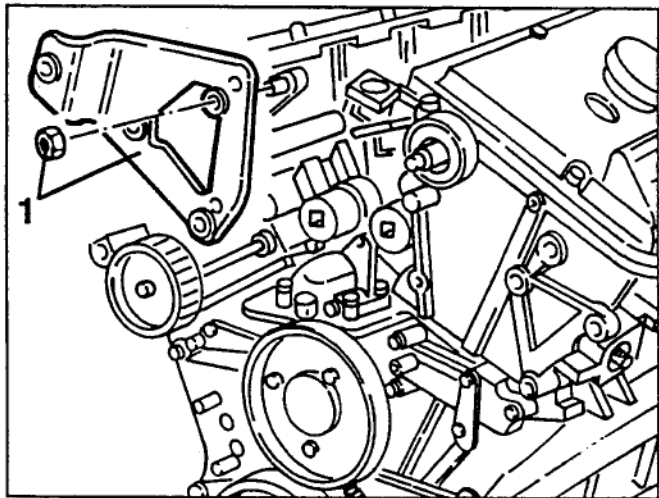


- Proceed in the same manner for removing the timing gear pulley of the right-hand cylinder head

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

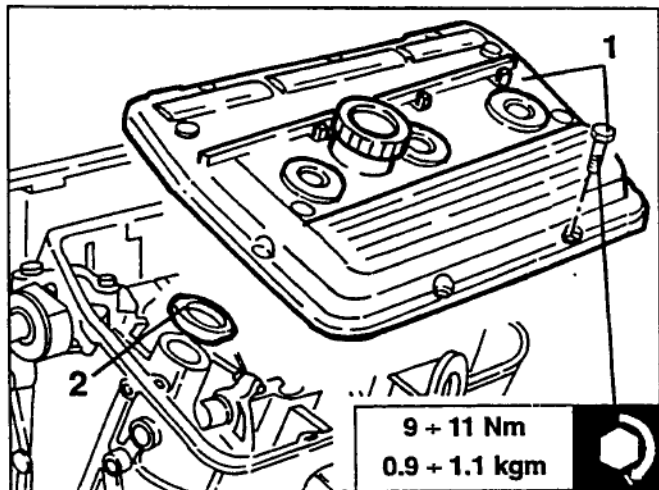


1. Slacken the fastening nuts and remove the engine stay rod connection bracket from the right-hand cylinder head.



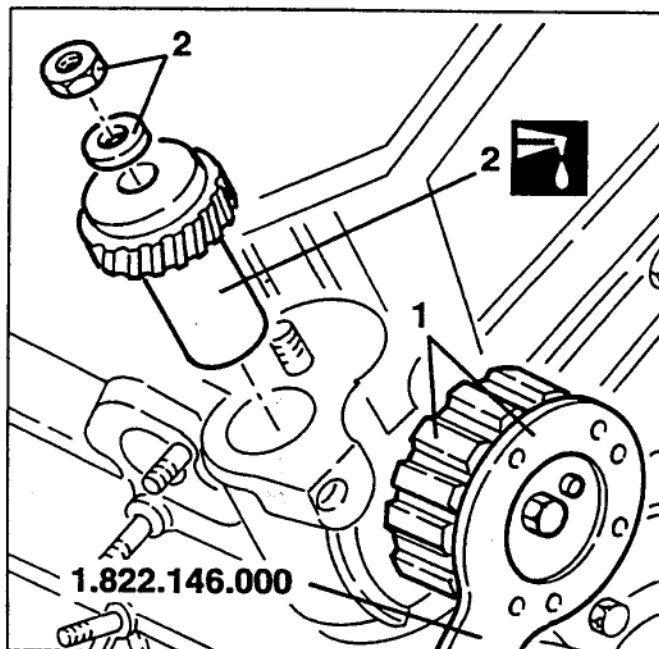
REMOVING THE CYLINDER HEADS

1. Slacken the fastening screws and remove the cylinder head covers.
2. Remove the seals from the spark plug wells.



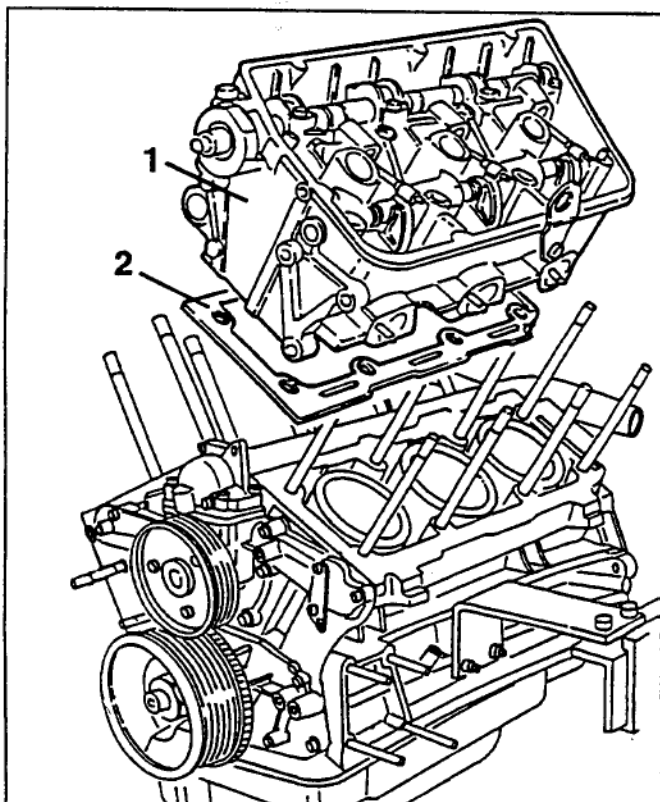
Proceed as follows, for the right-hand cylinder head only:

1. Using tool no. 1.822.146.000 prevent the engine oil pump drive pulley from turning.
2. Slacken the fastening nut and withdraw the oil pump intermediate driving gear from its housing.

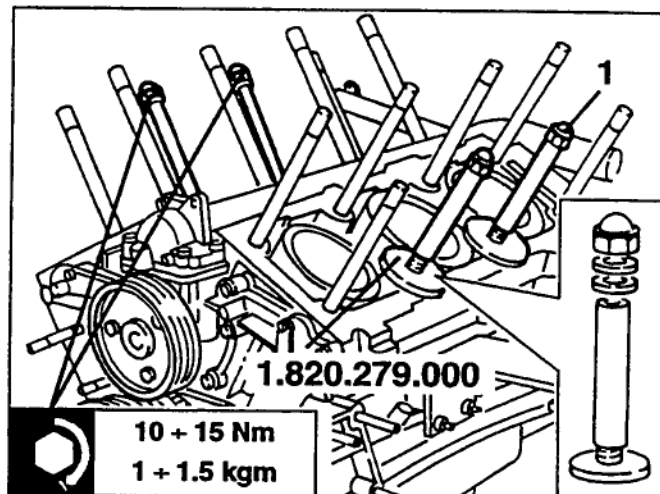


- Slacken the and remove the spark plugs.

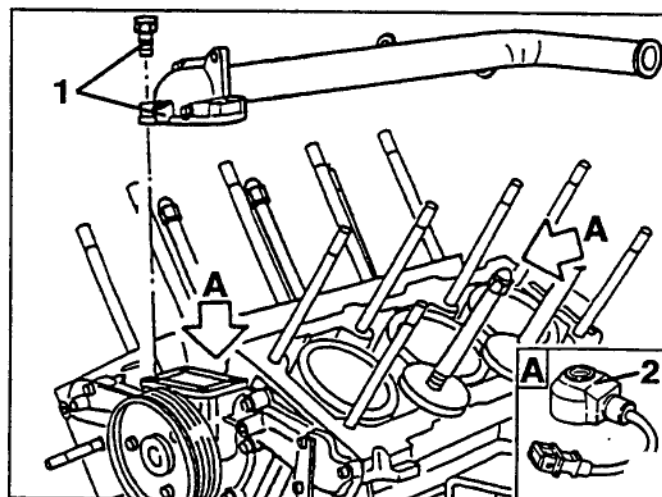
1. Slacken the fastening nuts and remove the cylinder heads from the crankcase.
2. Remove the seals.



1. Install the cylinder liner stopper tools no. 1.820.279.000.



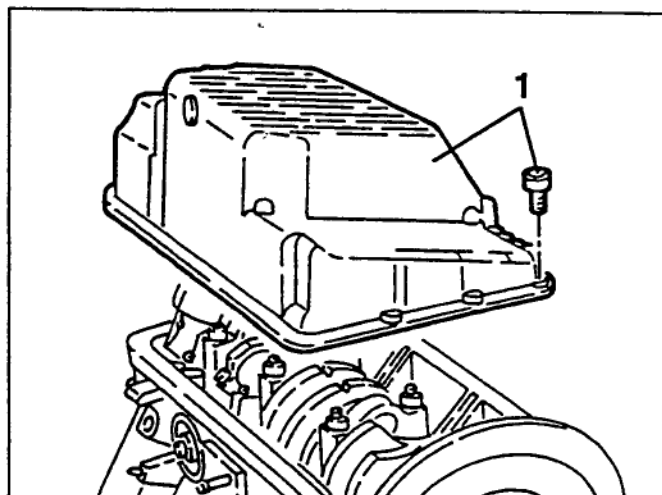
1. Slacken the fastening screws and remove the coolant return to the pump manifold.
2. Slacken the screws and remove the pinging sensors.



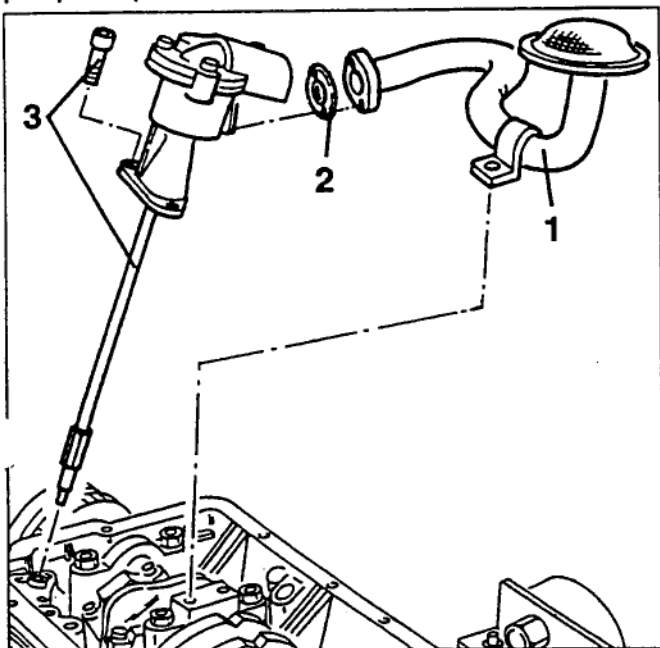
REMOVING THE OIL PUMP

- Turn the engine on the rotary overhauling stand.

1. Slacken the fastening screws and remove the oil sump.

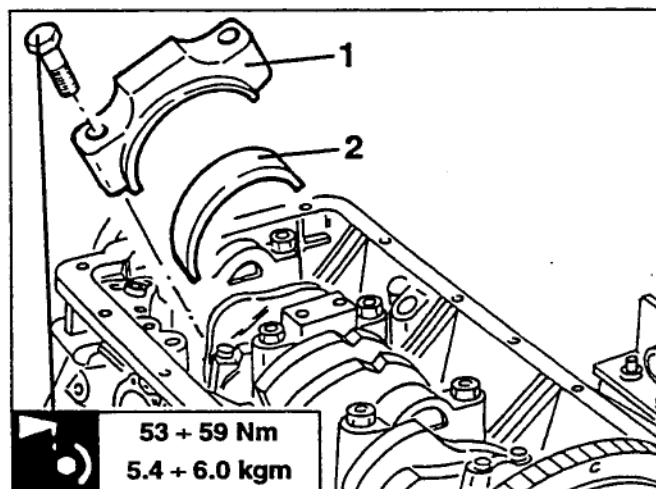


1. Slacken the fastening screws and remove the oil pump suction device.
2. Remove the seal.
3. Slacken the fastening screws and remove the oil pump complete.



REMOVING THE CYLINDER LINERS AND PISTONS

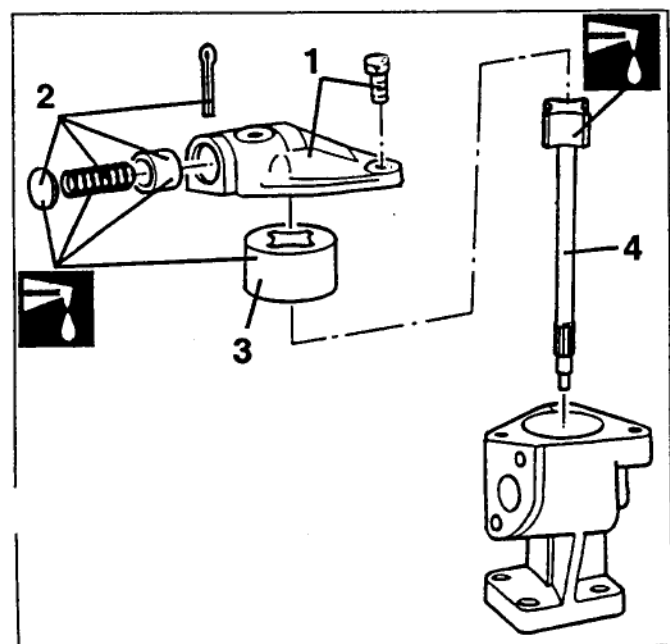
- Install a suitable tool to enable the rotation of the crankshaft.
- Turn the crankshaft to gain access to the fastening screws from the connecting rod caps of the right main bearing (1st, 2nd and 3rd cylinder).
- 1. Slacken the fastening screws and remove the connecting rod caps of the 1st, 2nd and 3rd cylinder.
- 2. Retrieve the corresponding connecting rod half bearings.



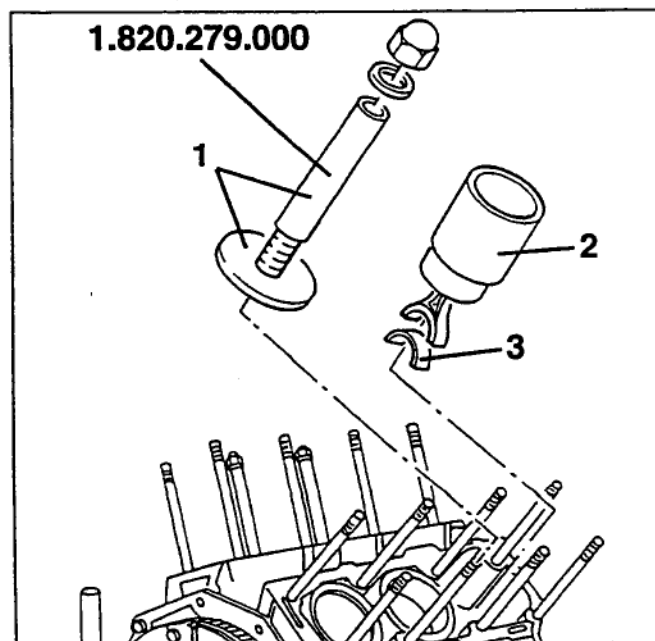
DIS-ASSEMBLING THE OIL PUMP

1. Slacken the fastening screws and remove the oil pump cover.
2. Remove the split pin and from the cover withdraw the plug, spring and engine oil pressure limiting valve.
3. Withdraw the driven rotor from the pump casing.
4. Withdraw the the shaft with driving rotor from the pump casing.

NOTE: The driving rotor must never be removed from the shaft.



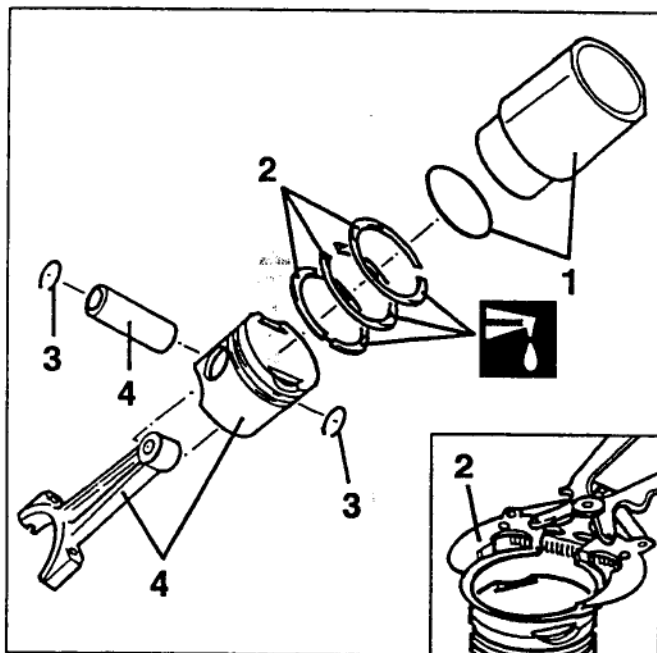
- Turn the engine on the rotary overhauling stand.
- 1. Slacken the fastening nuts and remove the cylinder liner stopper tools no. 1.820.279.000 only from the right-hand main bearing,
- 2. From the crankcase withdraw the connecting rod-piston assemblies withdrawing them together with their cylinder liners.
- 3. Retrieve the corresponding connecting rod half bearings.
- Turn the crankcase on the rotary overhauling stand and proceed as for the left-hand main bearing (4th, 5th and 6th cylinder).



1. Withdraw the cylinder liner complete with O-ring.
2. Using a suitable tool, remove the seal rings and oil scraper ring from the piston.

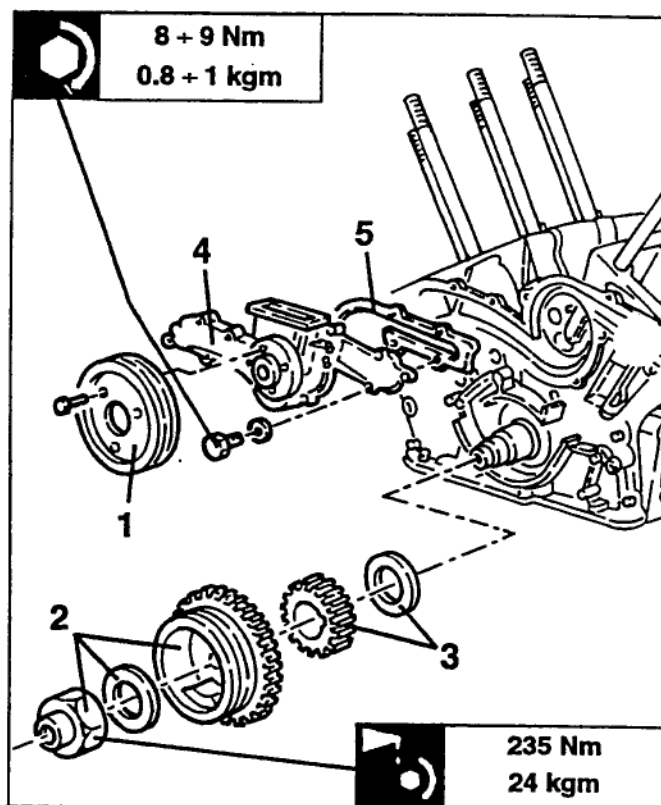
WARNING: Proceed with care to avoid breaking any re-usable rings.

3. Withdraw the two gudgeon pin seal rings.
4. Withdraw the gudgeon pin and separate the piston from the connecting rod.



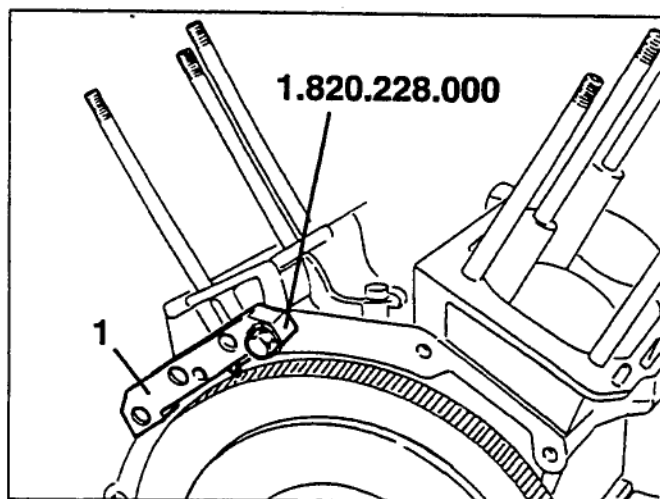
NOTE: When refitting the convex surface of the thrust ring must face the front crankcase cover.

4. Slacken the fastening screws and remove the water pump.
5. Remove the corresponding seal.



REMOVING THE WATER PUMP

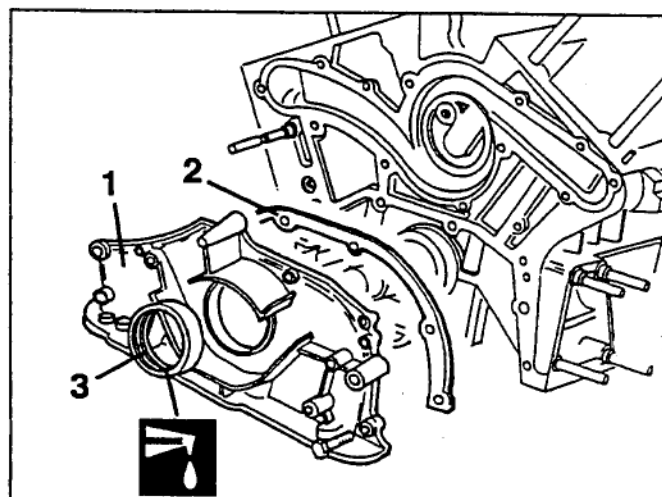
1. Remove the crankshaft turning tool and install the flywheel stopper tool no. 1.820.228.000.



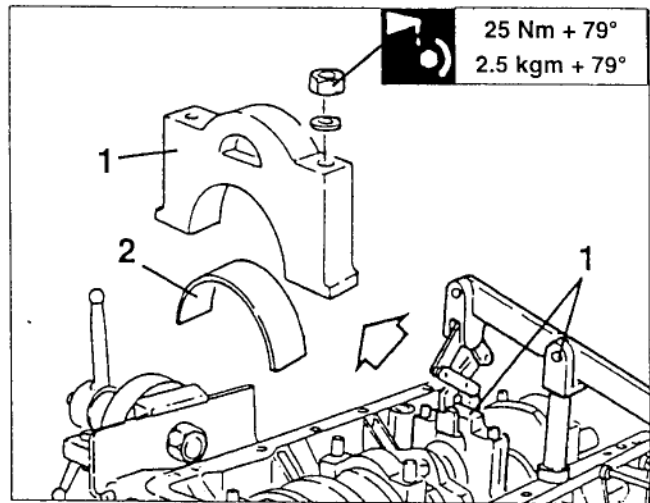
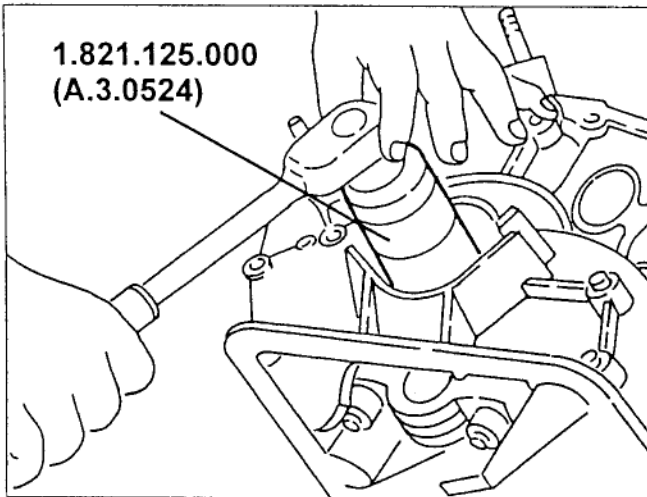
1. Slacken the fastening screws and remove the water pump pulley.
2. Slacken the fastening nut and remove the auxiliary components drive pulley.
3. Remove the toothed timing belt drive pulley complete with thrust ring.

REMOVING THE CRANKCASE FRONT COVER

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



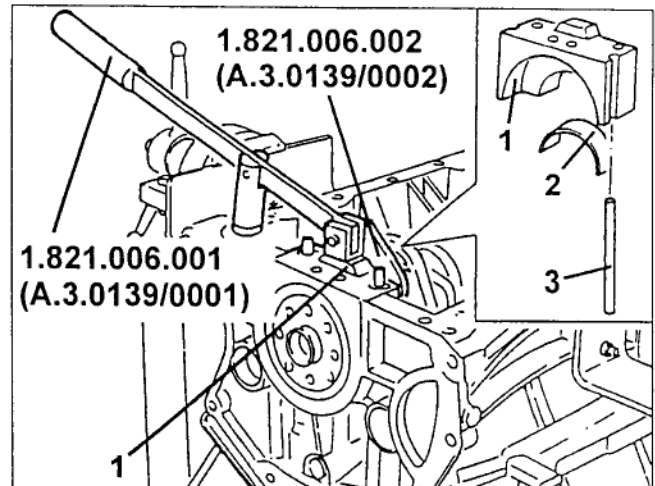
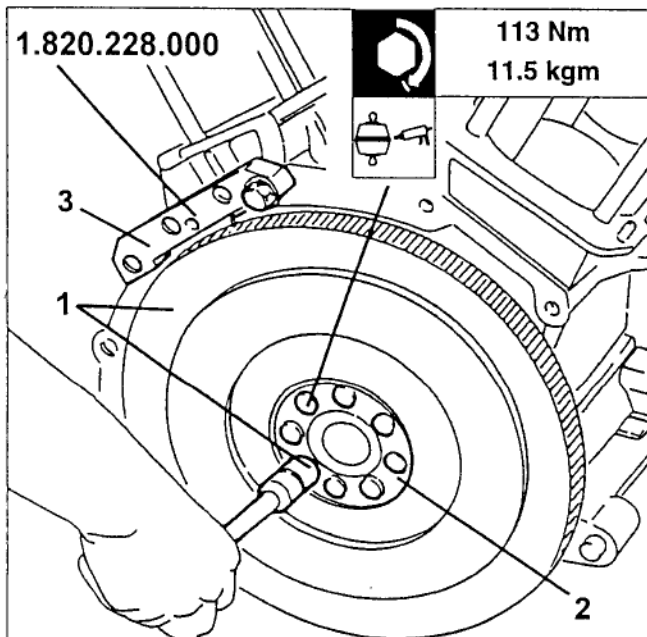
When refitting, introduce a new front crankshaft oil seal on the crankcase with tool no. 1.821.125.000 (A.3.0524).



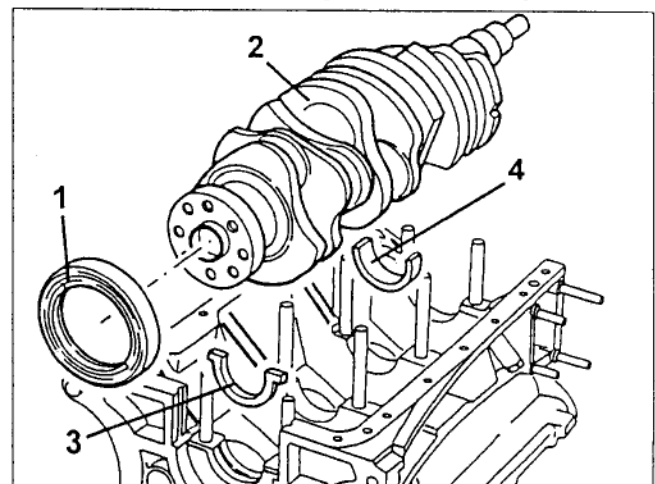
1. Remove the rear main bearing with lever no. 1.821.008.001 (A.3.0139/0001) and fork no. 1.821.008.002 (A.3.0139/0002).
2. Remove the respective main half bearing.
3. Remove the seals.

FLYWHEEL REMOVAL

1. Loosen the fastening screws and remove the flywheel.
2. Take the safety washer.
3. Remove the previously fitted flywheel retainer no. 1.820.228.000.



1. Remove the rear crankshaft ring.
2. Remove the crankshaft.
3. Remove the thrust half bearings.
4. Remove the half bearings from the main journals.



CRANKSHAFT REMOVAL

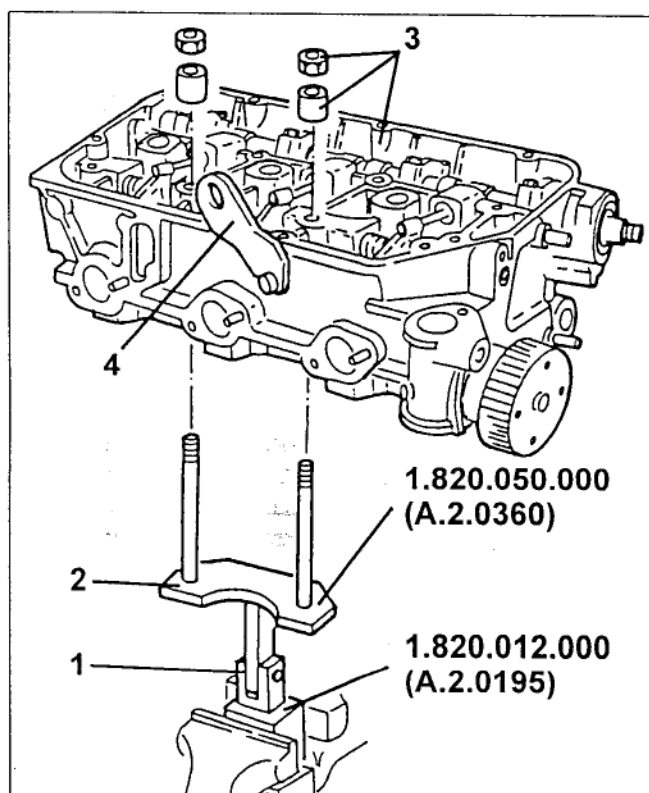
- Turn the engine on the tuning overhaul stand.
1. Loosen the lock nuts and the main bearing fastening nuts. Then use a suitable tool to remove the front and central main bearings.
 2. Remove the respective main half bearings.

CYLINDER HEAD REMOVAL

NOTE: The following operations refer to the right-hand cylinder head. Proceed in the same way from the left-hand cylinder head.

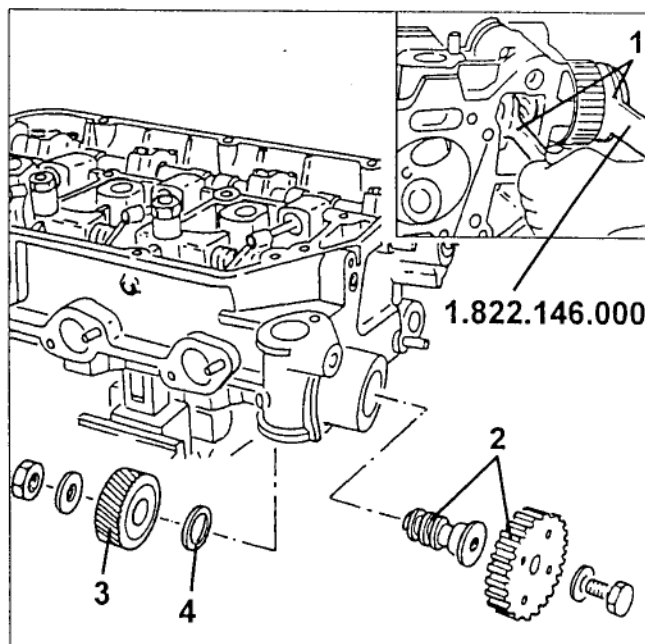
PRELIMINARY OPERATIONS

1. Fasten adjustable support no. 1.820.012.000 (A.2.0195) in a vice.
2. Fit fork no. 1.820.050.000 (A.2.0360) on the adjustable support.
3. Fit the cylinder head on the fork studs and lock it with two suitable shims and two nuts.
4. Loosen the fastening screw and remove the engine lifting rod.

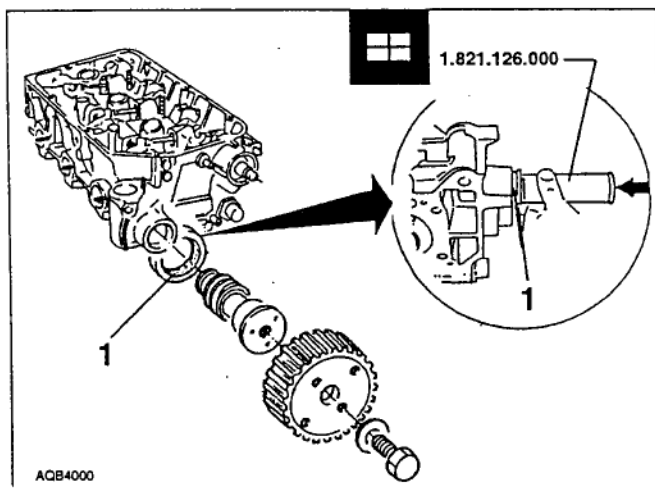


OIL PUMP PULLEY REMOVAL (Specific for right-hand cylinder head)

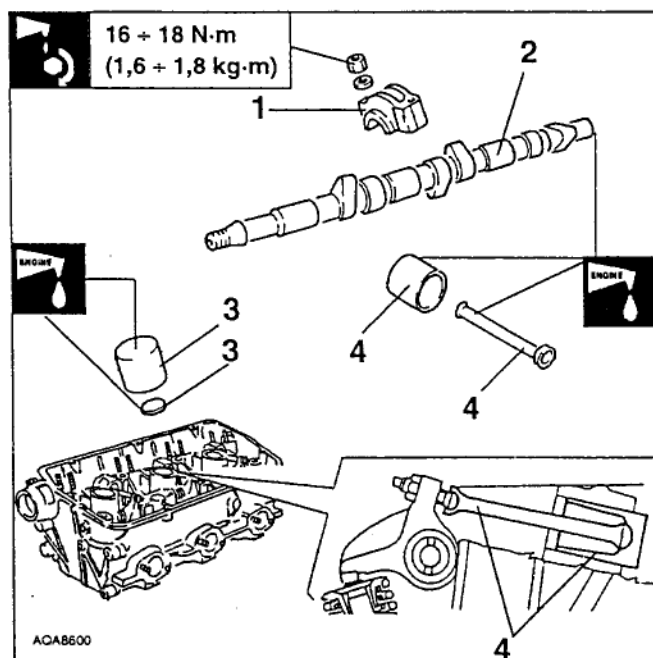
1. Use tool no. 1.822.148.000 to loosen the oil pump pulley fastening bolt.
2. Loosen the oil pump pulley and respective shaft.
2. Take the gear wheel.
4. Take the shim.



1. Remove the seal ring
(On assembling make use of inserter 1.821.126.000)



NOTE: Set the components in order, should they be re-used on assembly



TIMING CAMSHAFT AND ROCKER ARM SUPPORTING SHAFT REMOVAL

1. Remove the timing camshaft caps

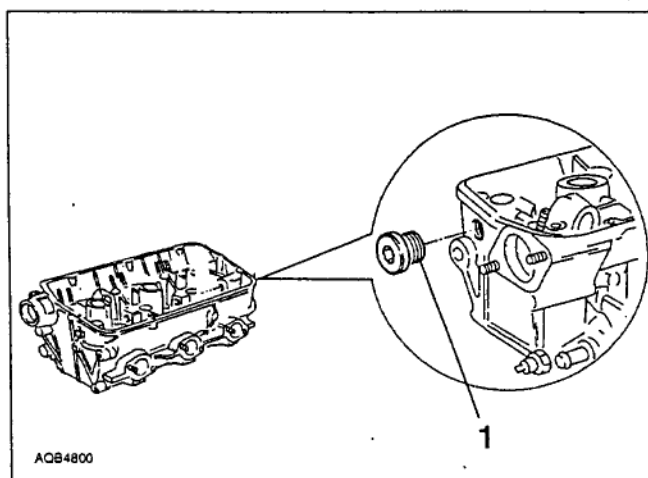


Caps are serially numbered (1, 2, 3 and 4 for the right cylinder head; 5, 6, 7 and 8 for the left cylinder head).
Observe the same order when assembling

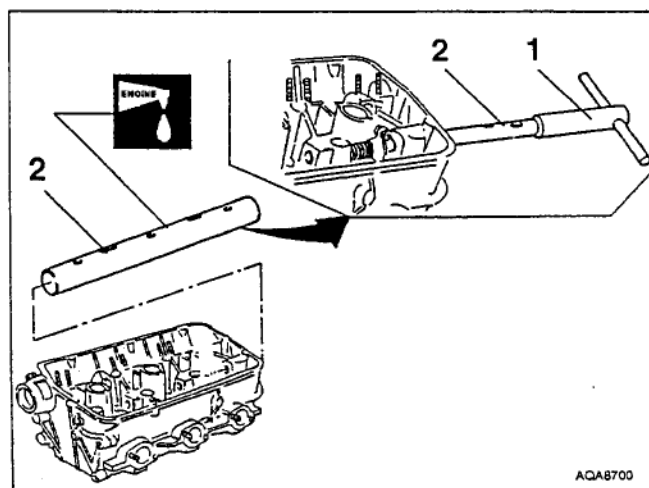
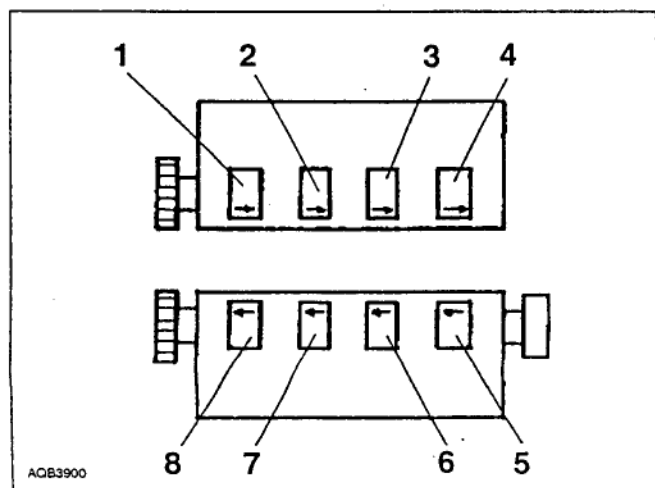
2. Remove the timing camshaft

NOTE: In case the camshaft had not been removed, remove the distributor to be able to proceed to the removal

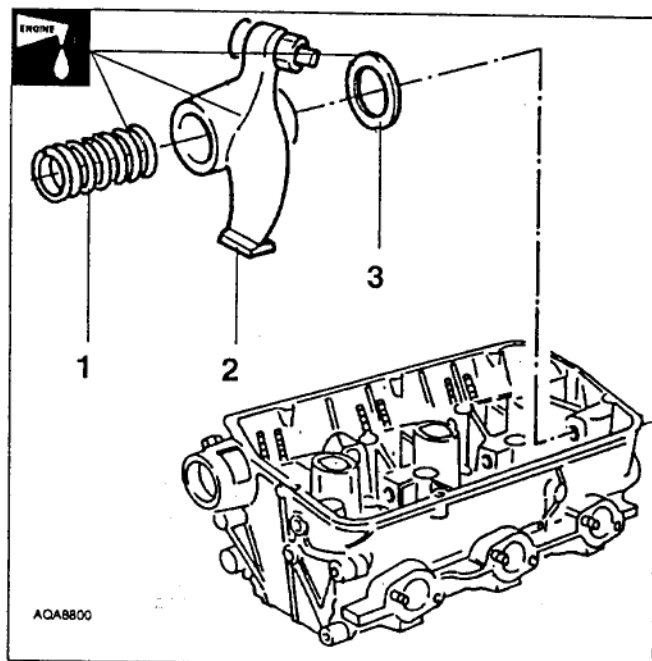
3. Withdraw the intake-side tappets with the relevant valve adjusting caps
4. Withdraw the exhaust-side tappets with the relevant rocker arm control rods



1. Screw down a suitable tool on the threaded ending of the rocker arm supporting shaft
2. Gradually withdraw the rocker arm shaft



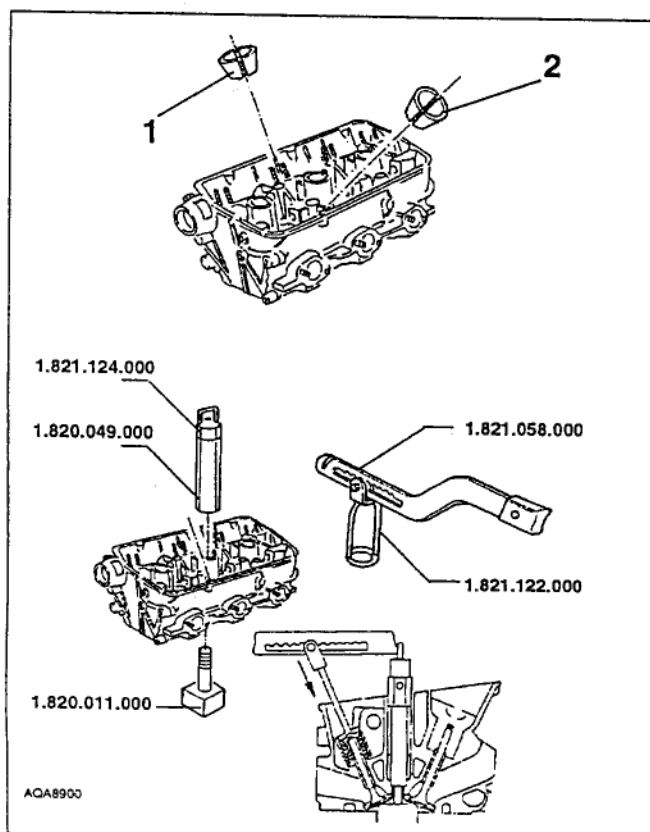
1. Remove the springs
2. Remove the rocker arms
3. Remove the washers



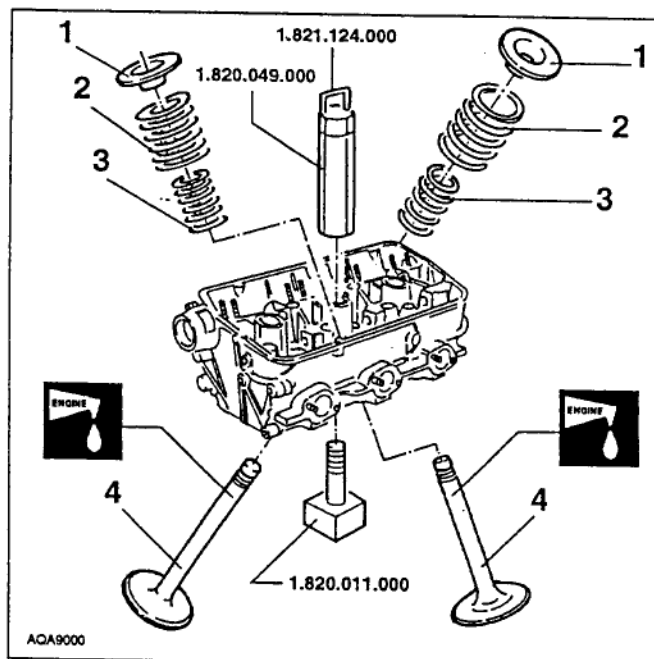
VALVE DISASSEMBLY

— Operate on one cylinder

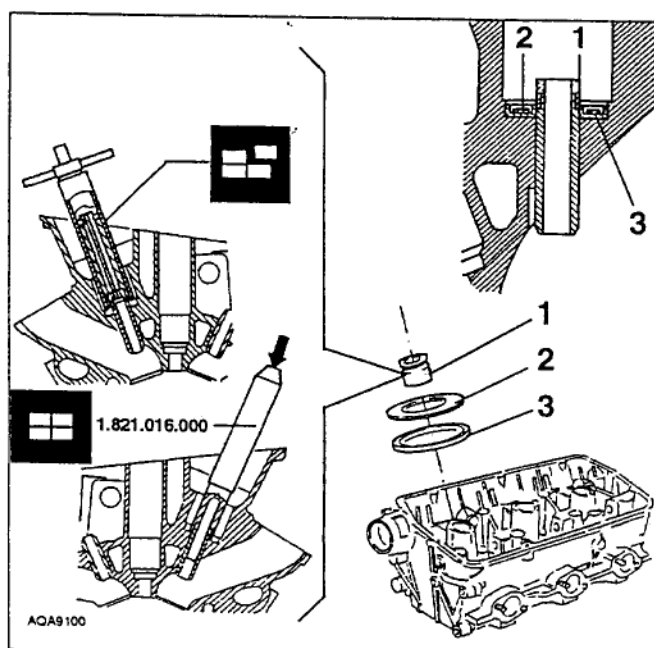
1. By means of the equipment shown in the figure, remove the exhaust-side cotteners
2. Remove the intake-side cotteners by acting in the same way



1. Remove the upper caps
2. Remove the outer springs
3. Remove the inner springs
- Remove tools 1.820.049.000 by means of 1.821.124.000 and 1.820.011.000
4. Withdraw the valve pair (intake and exhaust)
- By using the same tools and carrying out the same procedure, act on the other cylinders

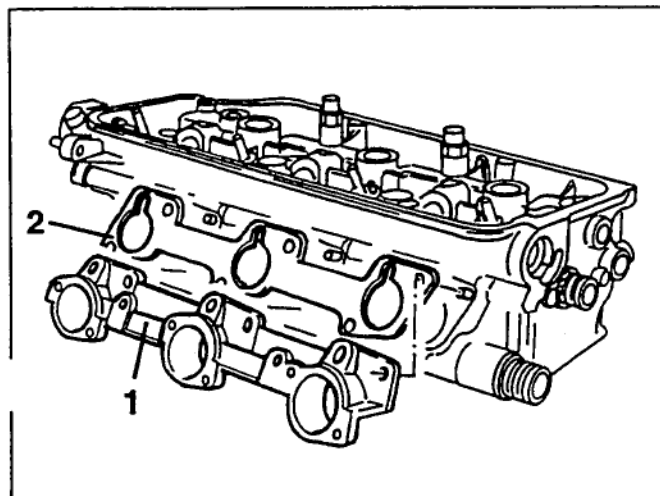


1. By means of extractor 1.821.018.000, remove the grommets (On assembling, make use of inserter 1.821.016.000)
2. Remove the stop rings
3. Remove the lower caps



REMOVING THE AIR INTAKE MANIFOLD

1. Slacken the fastening screws and remove the air intake manifold.
2. Remove the corresponding seal.

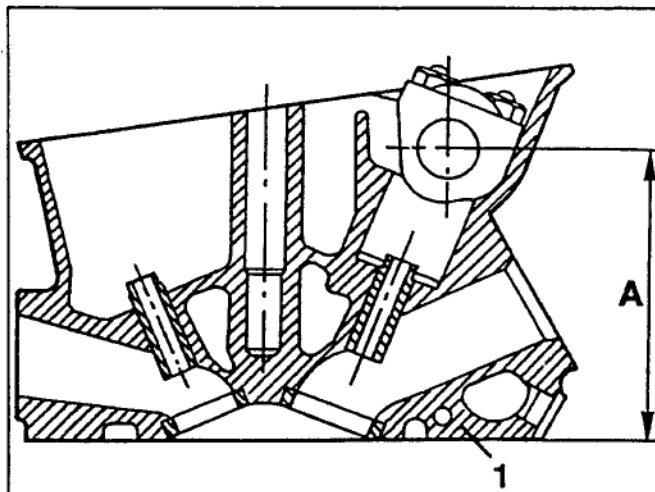


1. After refacing check that the height of the heads is within the minimum permissible limit.



Do not exceed the minimum permissible limit as serious engine failure may result.

- Check that the lower head surface is well finished.



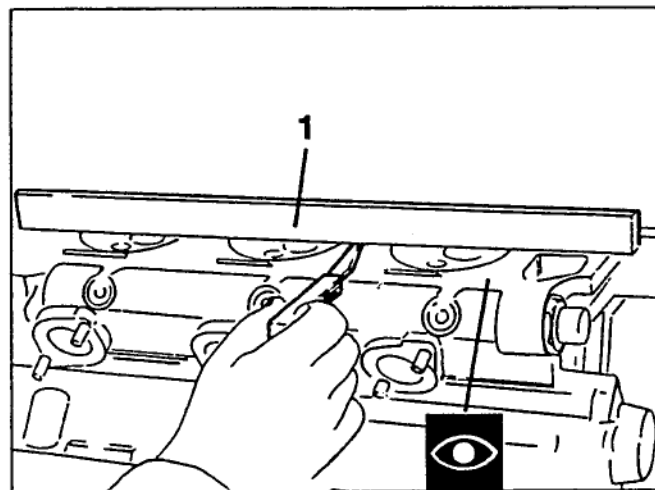
CHECKING AND INSPECTING THE CYLINDER HEADS

CHECKING THE LOWER SURFACE

1. Check the flatness of the lower surface and reface if necessary.



Refacing must be carried out on both heads.



Max. permissible height of heads after refacing

$$A = 124.85 \div 125.15 \text{ mm}$$



Maximum error of flatness of head lower surface

0.05 mm

CHECKING THE CYLINDER HEAD BUSHES

- Measure the inside diameter "d" of the bushes fitted on the cylinder heads and check that it is within the specified limits.

«A» (only on right-hand cylinder head)

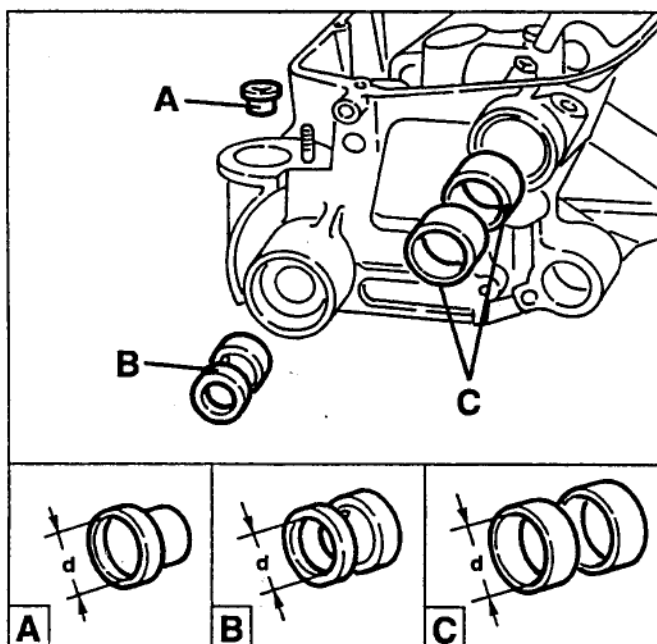
Bush for oil pump drive gear.

«B» (only on right-hand cylinder head)

Bush for toothed oil pump drive pulley spindle.

«C» Bushes for toothed camshaft drive pulley hub.

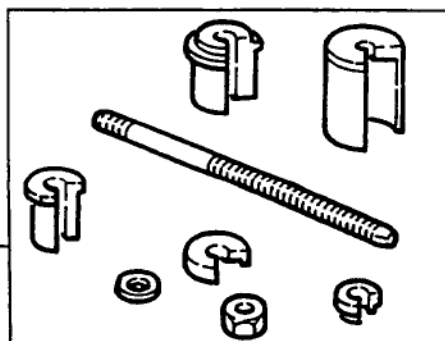
- If the values measured are not within the specified limits replace the bushes concerned using tool no. 1.821.129.000 as described in the following steps.



Inside diameter of bushes "d"

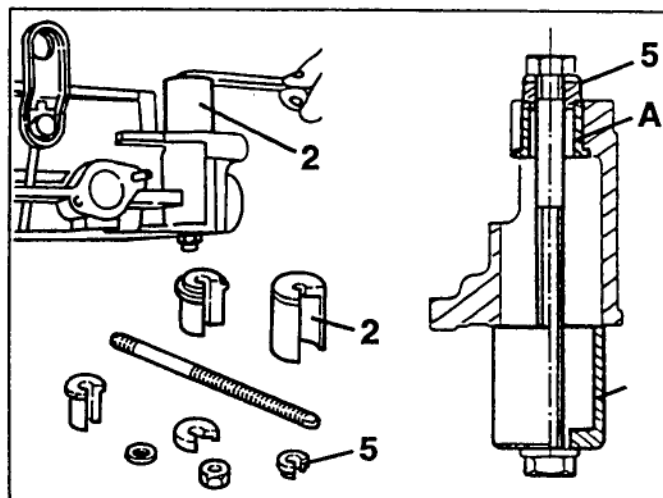
"A"	19.000 + 19.021 mm
"B"	19.000 + 19.021 mm
"C"	32.000 + 32.025 mm

1.821.129.000



REMOVING BUSH «A» (For oil pump drive gear)

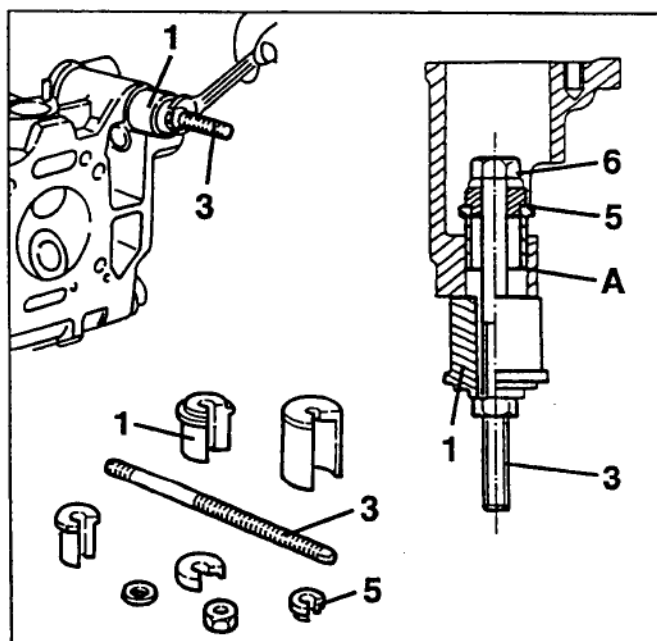
- Bush «A» of the oil pump drive gear must be removed using the special washer "5" as pusher and reacting with the cup "2".



INSERTING BUSH «A» (For oil pump drive gear)

- Bush «A» of the oil pump drive gear must be inserted as follows:

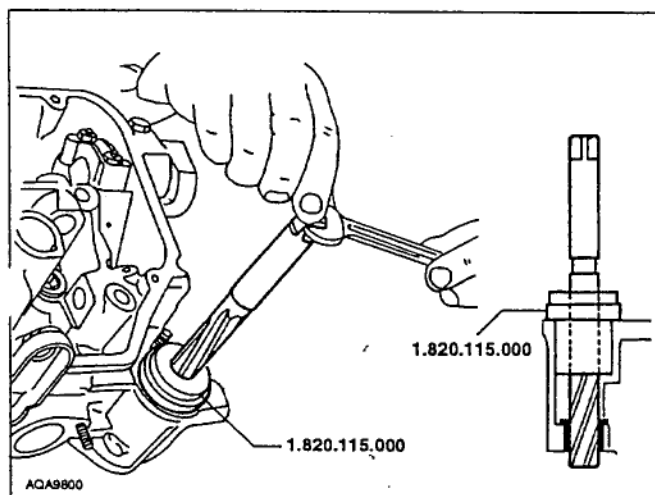
- position the new bush.
- insert tie-rod "3" complete with nut "6" and special washer "5" (as pusher).
- from the side opposite the tie-rod, insert react coil "1" and complete inserting the bush.



CYLINDER HEADS OVERHAUL

BUSH «A» REAMING (For oil pump drive gear)

— After the installation, bush «A» must be reamed to the specified value; for this purpose, make use of tool 1.820.115.000 and a suitable reamer (19 mm H7)

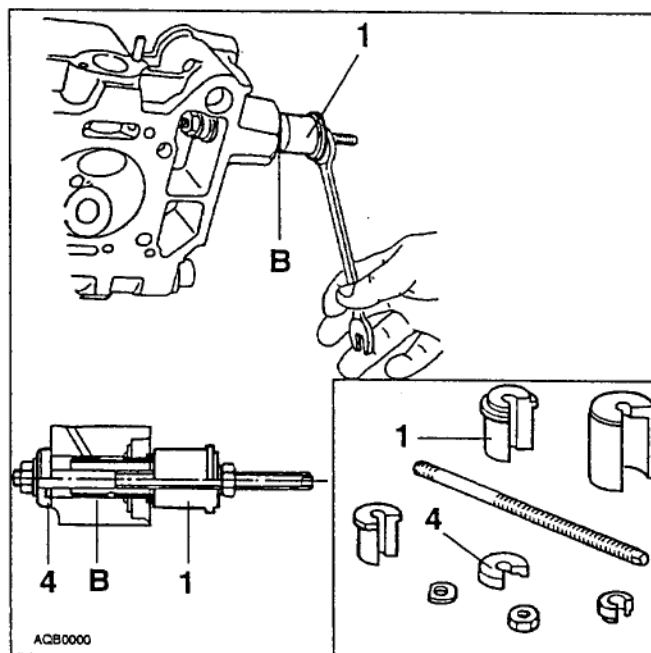


Bush inner diameter for oil pump drive gear hub (reaming)

19,000 ÷ 19,021 mm

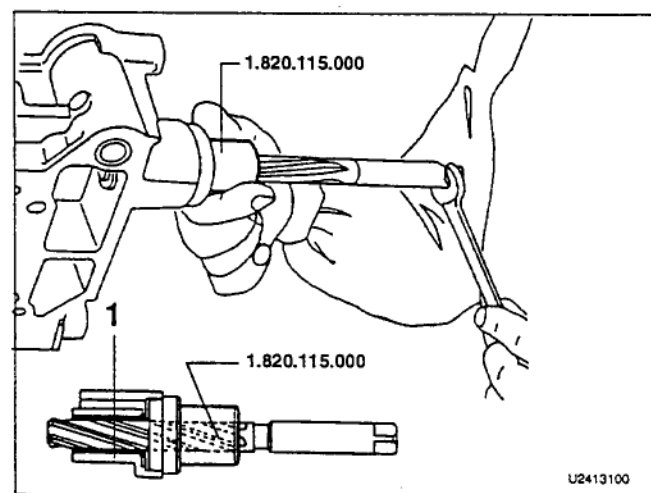
BUSH «B» INSTALLATION (For oil pump drive pulley shaft)

— Bush «B» for the oil pump drive pulley shaft must be installed by using the spool «1» as a pusher and blocking with the flange «4»



BUSH «B» REAMING (For oil pump drive pulley shaft)

— After the installation, bush «B» must be reamed to the specified value; for this purpose, make use of tool 1.820.115.000 and a suitable reamer (19 mm H7)

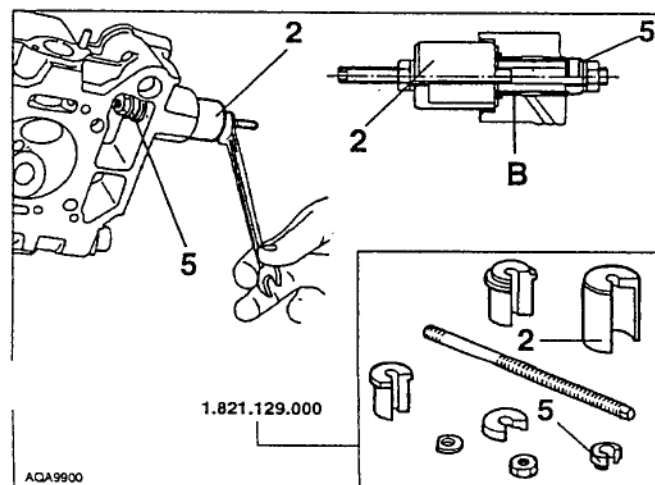


Bush inner diameter for oil pump drive pulley hub (reaming)

19,000 ÷ 19,021 mm

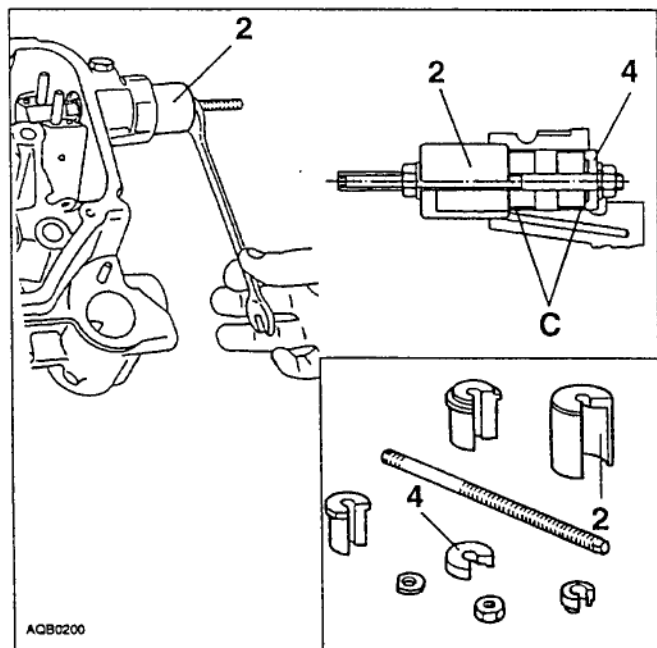
BUSH «B» REMOVAL (For oil pump drive pulley shaft)

— Bush «B» for the oil pump drive pulley shaft must be removed by means of the special washer «5» as a pusher and blocking by means of the bowl «2»



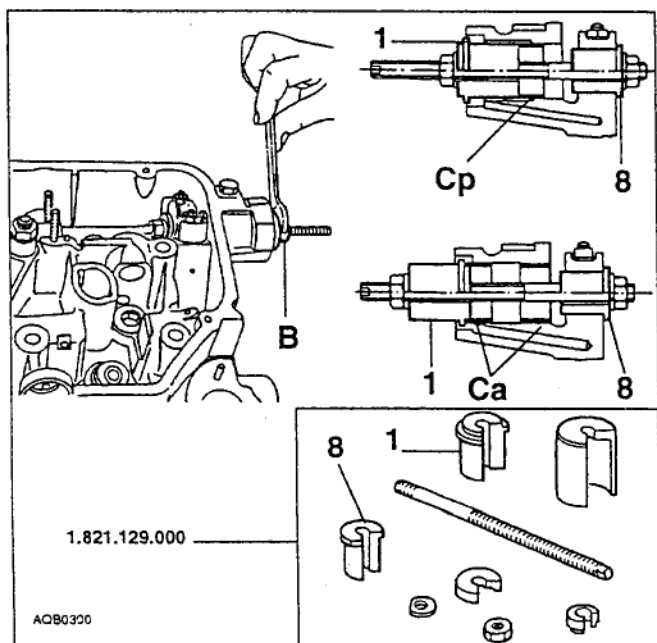
BUSH «C» REMOVAL (For timing camshaft drive pulley hub)

— Bushes «C» for the timing camshaft drive pulley hub must be removed by using the flange «4» as a pusher and blocking with the bowl «2»



BUSH «C» INSTALLATION (For timing camshaft drive pulley hub)

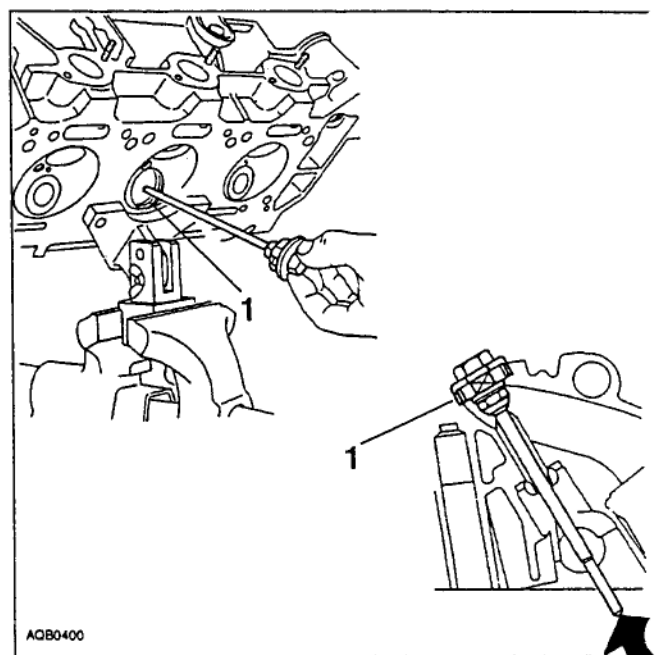
— Bushes «C» for timing camshaft drive pulley hub must be installed by acting as follows:



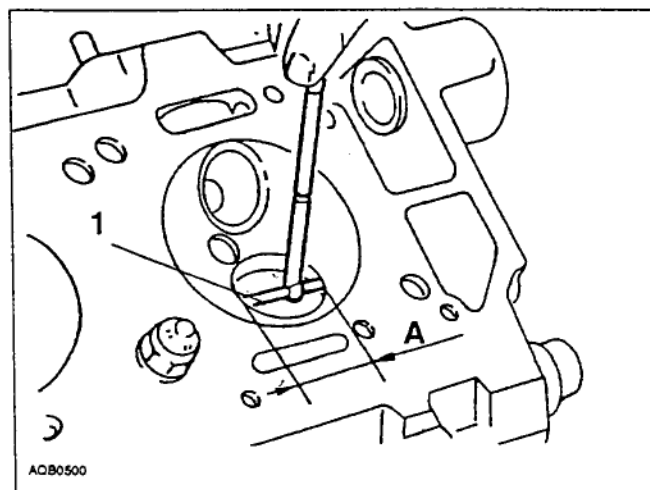
- install the adjacent cap of the timing camshaft and secure it by means of two nuts
- Fit the rear bush «C_p», (the thinner one) so as to center it in its seat
- install the bush «C_p» by using spool «1» as a pusher and spool «8»
- to install the front bush «C_f» act in the same way, but using the spool «1» in inverted position

VALVE SEAT REPLACEMENT

1. Extract the worn valve seats by using a suitable equipment

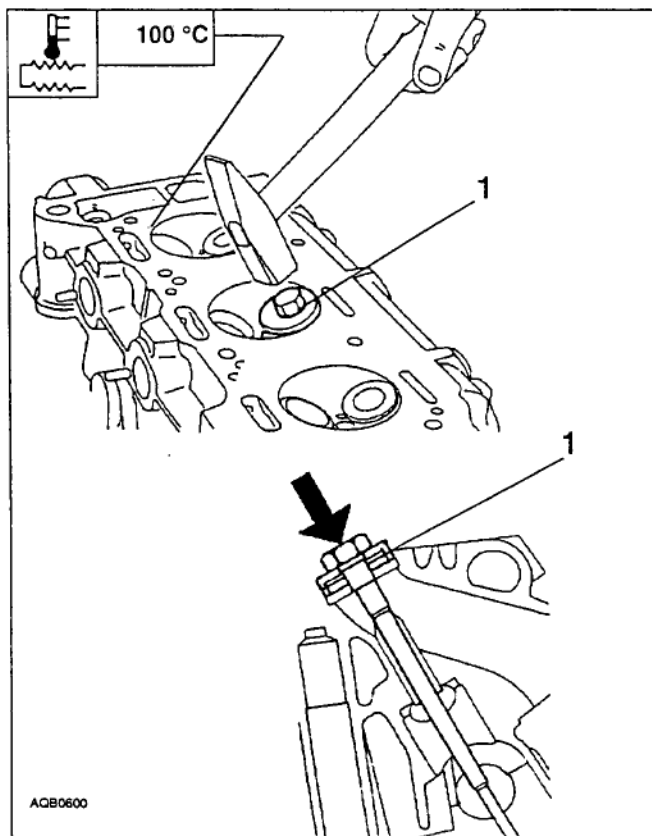
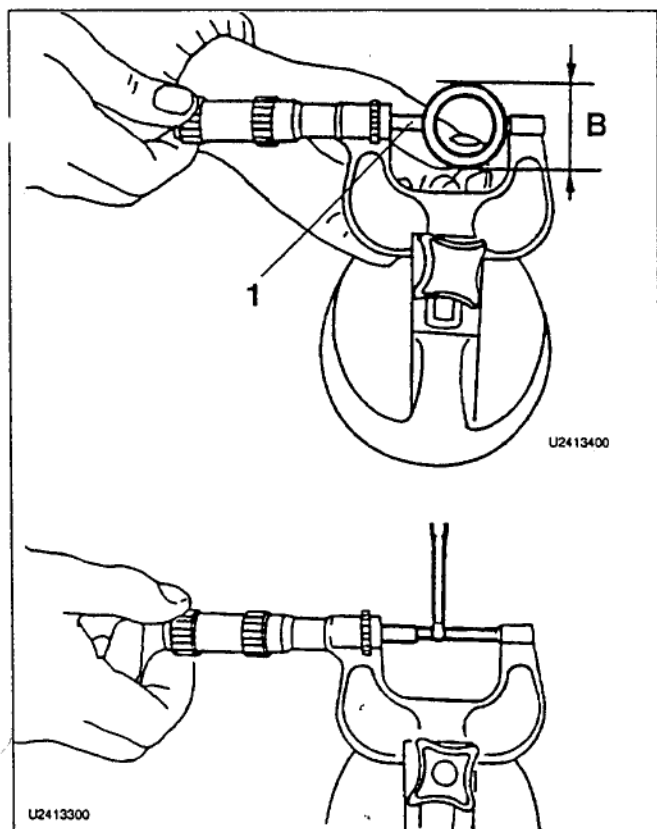


1. Check that the housing diameter of valve «A» seat ranges within the specified values



Outer diameter valve «A» seat		
Standard	intake	$37,500 \div 37,525$ mm
	exhaust	$32,500 \div 32,525$ mm
Spares	intake	$37,800 \div 37,825$ mm
	exhaust	$32,800 \div 32,825$ mm

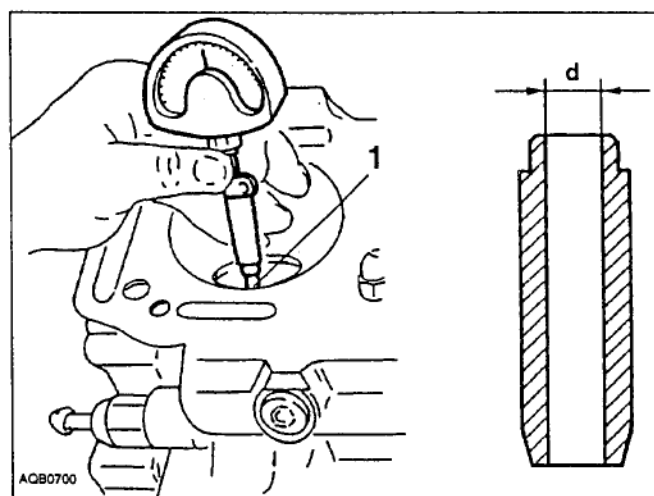
1. Check that the outer diameter of valve «B» new seat ranges within the specified values



CYLINDER HEADS OVERHAUL

VALVE GUIDE AND STEM CLEARANCE

1. Measure the inner diameter «d» of the valve guide and verify if it ranges within the specified values



Valve guide inner diameter «d»

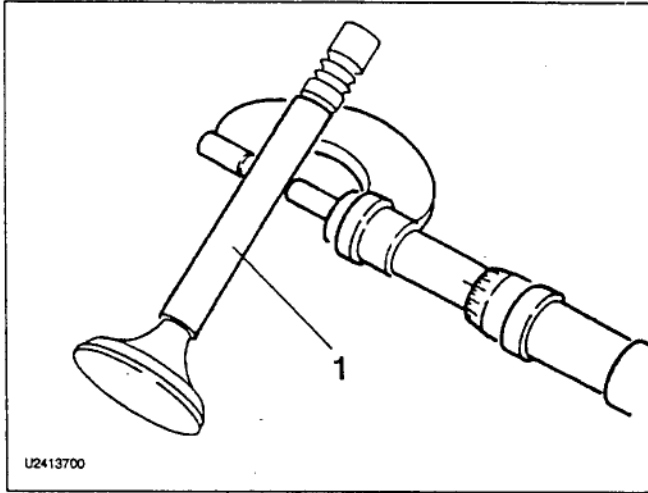
intake and exhaust	$9,000 \div 9,015$ mm
--------------------	-----------------------

Outer diameter valve «B» seat		
Standard	intake	$37,565 \div 37,600$ mm
	exhaust	$32,610 \div 32,626$ mm
Spares	intake	$37,865 \div 37,900$ mm
	exhaust	$32,910 \div 32,926$ mm

— Pre-heat the head to a temperature of **100 °C**

1. Install the new valve seats by using the mandrel and the stop ring already used during removal operations

1. Measure the valve stem diameter in at least three points and in mutually orthogonal directions — Determine the clearance and verify if it ranges within the permissible tolerances; otherwise replace the worn parts

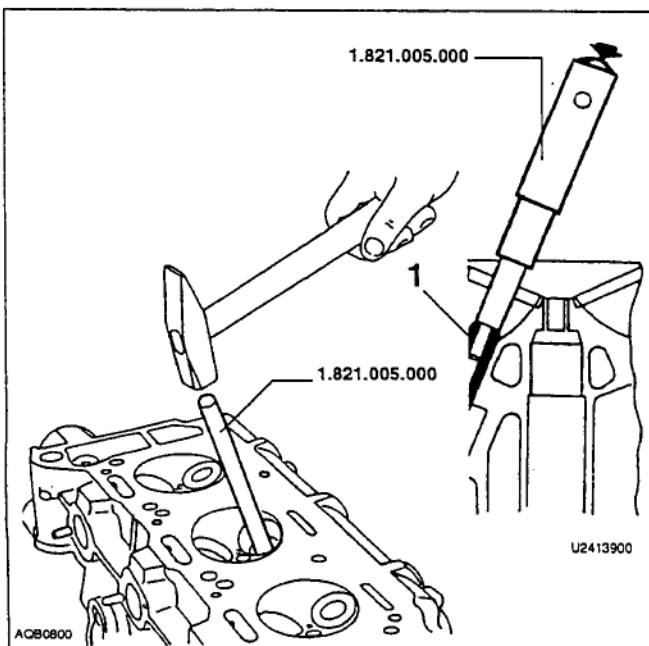


Valve stem and valve guide inner diameter radial clearance

intake	$0,013 \div 0,043 \text{ mm}$
exhaust	$0,045 \div 0,075 \text{ mm}$

VALVE GUIDE REPLACEMENT

1. Extract the worn valve guides by means of extractor **1.821.005.000** — Measure the valve guide seat diameter and the new valve guide outer diameter: the assembly interference must be within the specified tolerances



Valve guide seat diameter

$13,990 \div 14,018 \text{ mm}$



Valve guide outer diameter

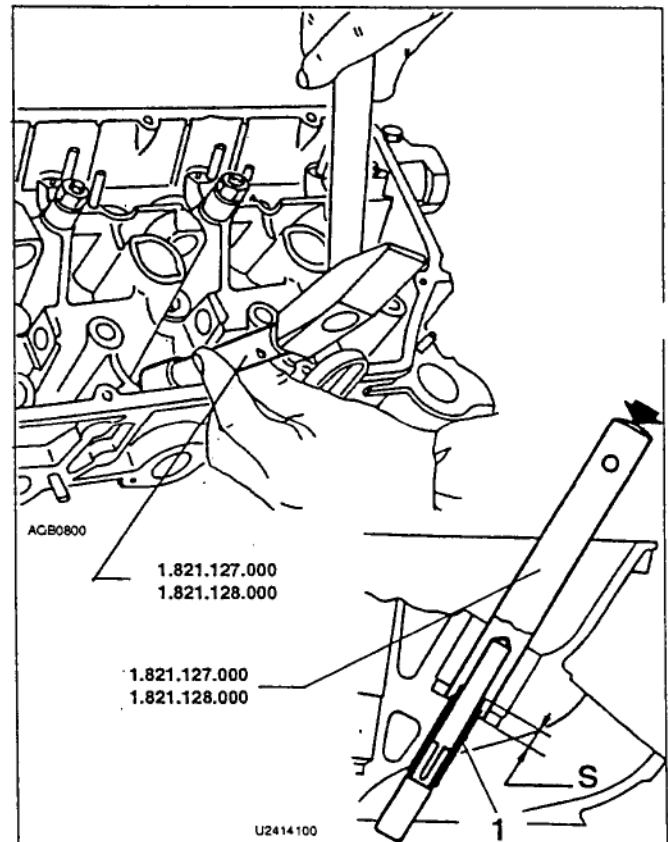
intake	$14,033 \div 14,044 \text{ mm}$ $14,047 \div 14,058 \text{ mm}^*$
exhaust	$14,033 \div 14,059 \text{ mm}$ $14,062 \div 14,073 \text{ mm}^*$

* Dimensions referred part supplied as spare

Interference between valve guide and valve guide seat

intake	$0,015 \div 0,054 \text{ mm}$
exhaust	$0,030 \div 0,069 \text{ mm}$

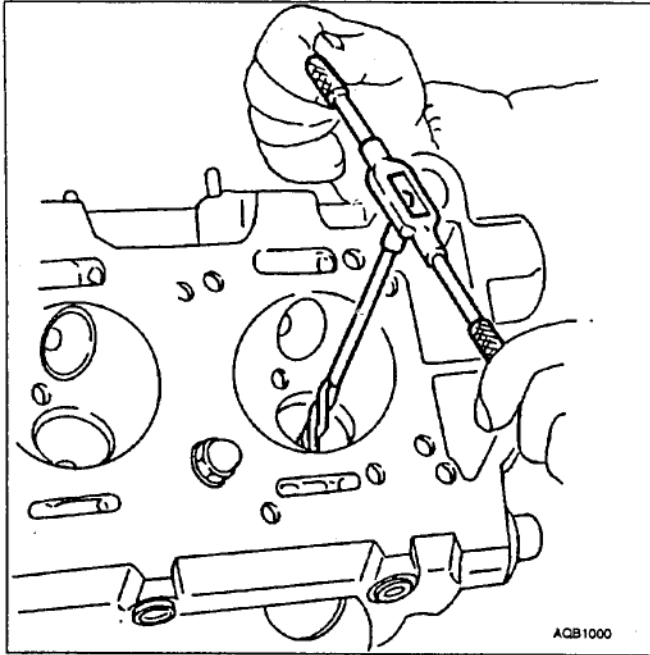
1. Install the new valve guides by using the special inserters which also ensure the correct stand out values



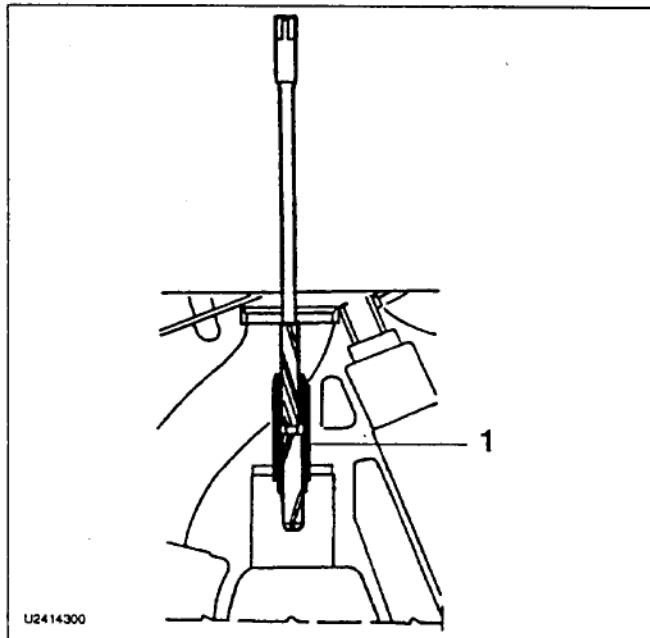
Valve guide stand-out "S"

intake and exhaust	$9,7 \div 10,1 \text{ mm}$
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1. Ream the new valve guides (intake and exhaust) by means of a suitable reamer (diameter 9 mm H7) to calibrate the bores to the specified value

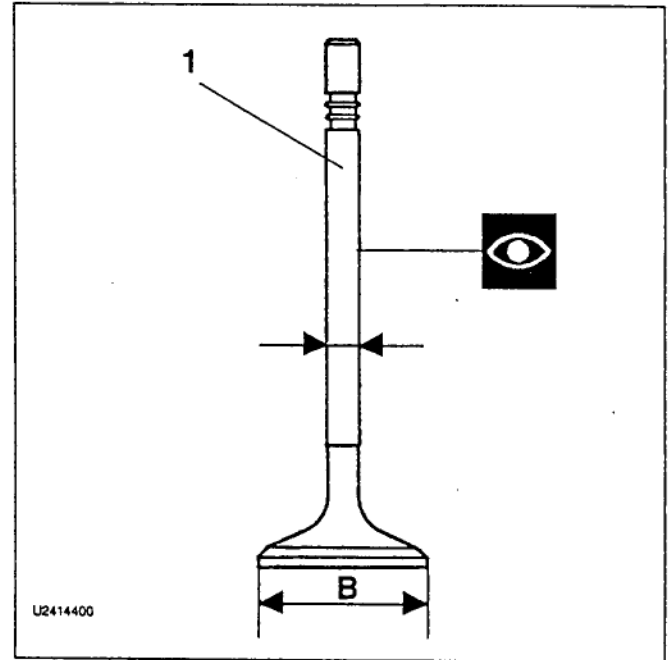


Valve guide inner diameter	
intake and exhaust	9,000 ÷ 9,015 mm



VALVES

1. Check that the valve stem and head diameters range within the specified values



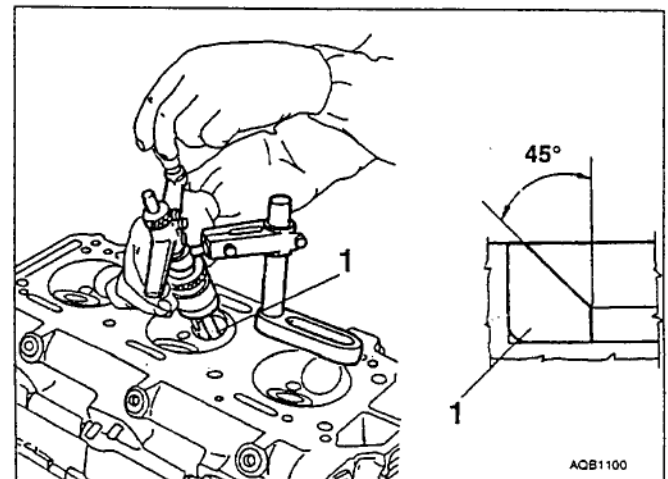
Valve «A» stem diameter	
intake	8,972 ÷ 8,987 mm
exhaust	8,940 ÷ 8,955 mm

Valve «B» head diameter	
intake	36,35 ÷ 36,5 mm
exhaust	32,45 ÷ 32,6 mm

VALVE SEAT TURNING

1. If necessary, carry out the valve seat turning by using suitable tools

NOTE: The taper "C" is obtained with the tool of the portable lathe at 45°

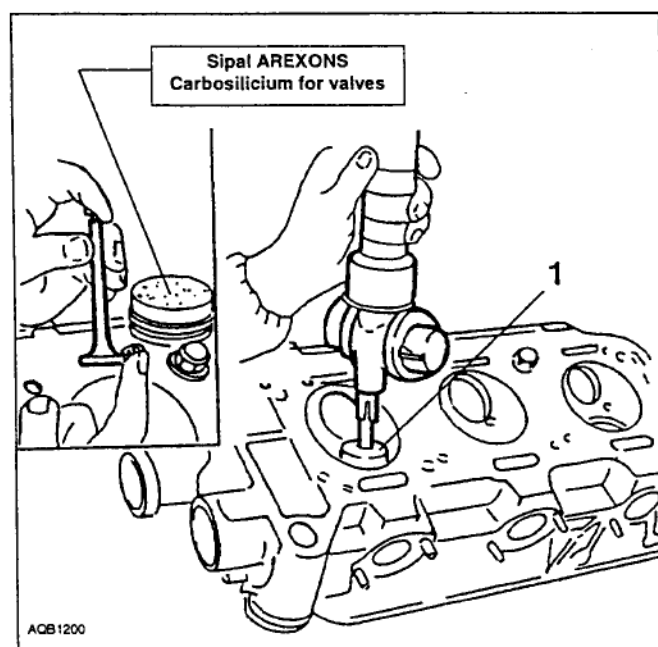


Intake and exhaust valve seat taper

$$^{\circ}C = 90^{\circ} \pm 20'$$

1. After machining, grind each valve in its seat as follows:

- smear the valve contact surfaces and relevant seats with abrasive paste (**SIPAL AREXONS Carbosilicium for valves**)
- lubricate the valve stem with engine oil
- apply a pneumatic lap suction cup to the valve head lower surface
- insert the valve into its seat and carry out the grinding
- after grinding, carefully clean all valves and relevant seats



VALVE SPRINGS

— Check that the unloaded spring length is within the specified values



The terminal turns must be parallel and perpendicular to the axis of the spring, max. error 2°

1. Using a dynamometer, measure the flexibility values and check if ranging within specified values



Unloaded spring length		
external spring	L_a	44,6 mm
internal spring	L_b	44,1 mm

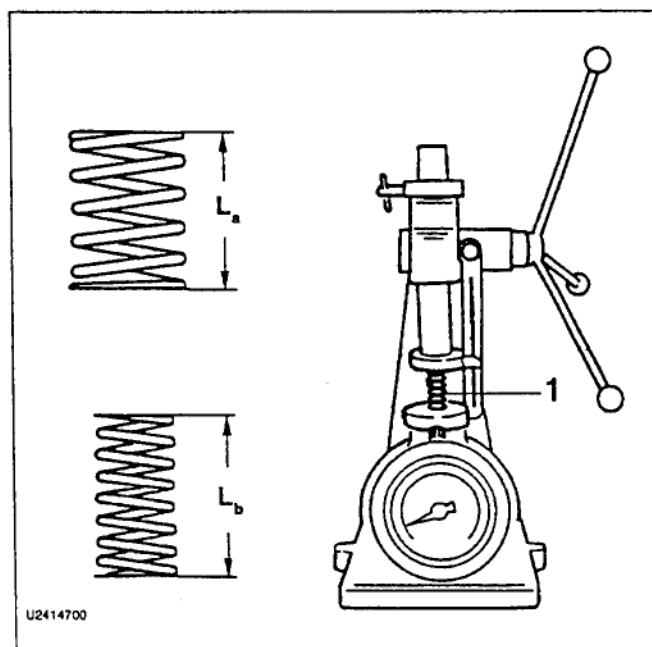


External spring

Spring length	mm	Test load N (Kg)
Valve closed	32,5	243,20 + 251,60 (24,80 + 25,66)
Valve open	23,5	470,20 + 487,80 (47,95 + 49,75)

Internal spring

Spring length	mm	Test load N (Kg)
Valve closed	30,5	125,70 + 130,20 (12,82 + 13,28)
Valve open	21,5	222,30 + 230,70 (22,67 + 23,53)



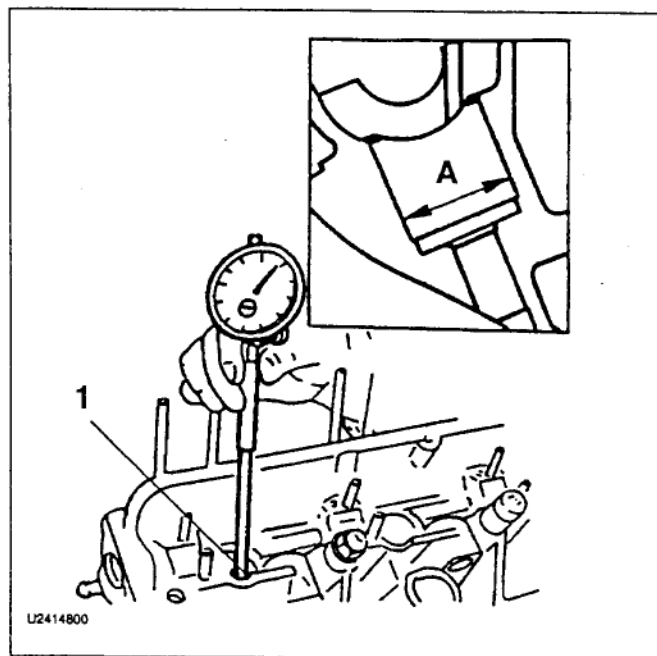
TAPPET SEATS AND INTAKE-SIDE TAPPETS

1. Check that the tappet seat diameter ranges within the specified values

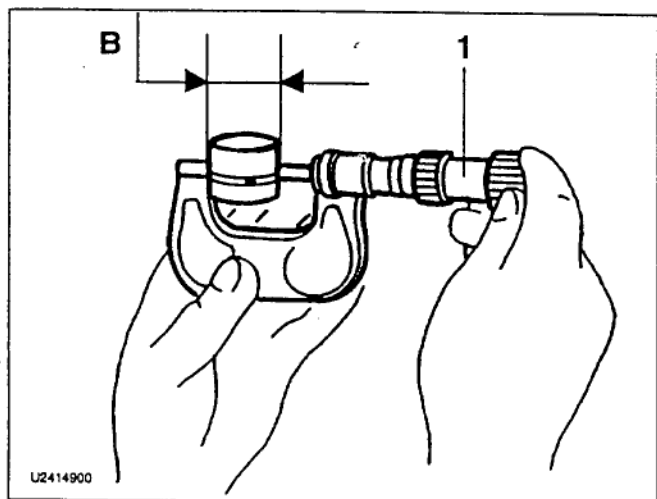


Tappet seat diameter of intake valve

$$A = 35,000 + 35,025 \text{ mm}$$



1. Check that the tappet outer diameter ranges within the specified values



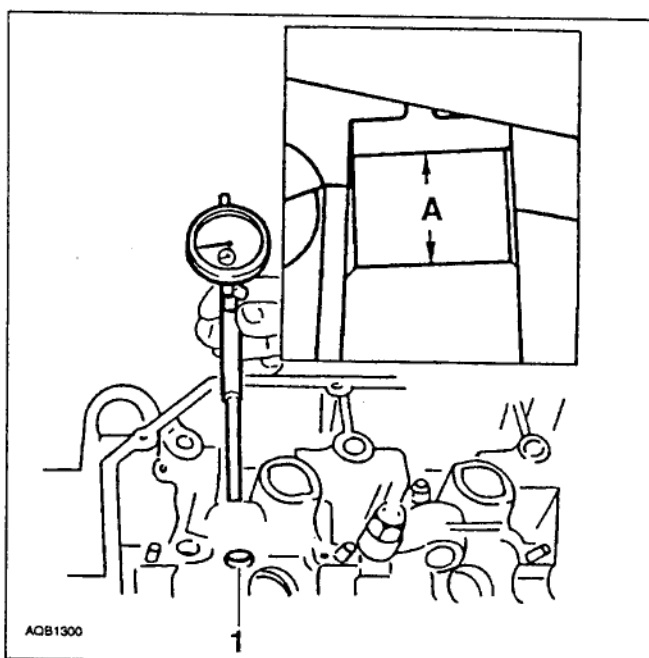
Tappet diameter of intake valve

$$B = 34,973 \div 34,989 \text{ mm}$$

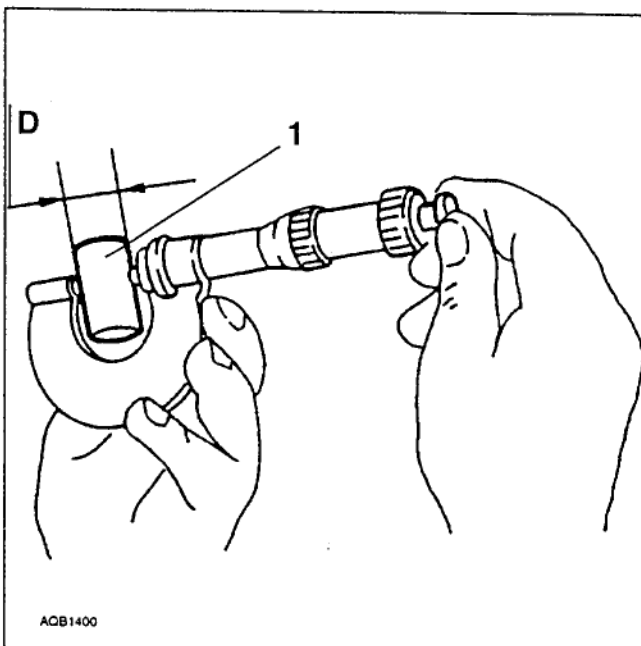


Tappet seat diameter of exhaust valve

$$C = 22,000 \div 22,021 \text{ mm}$$



1. Check that the tappet outer diameter ranges within the specified values



Tappet diameter of exhaust valve

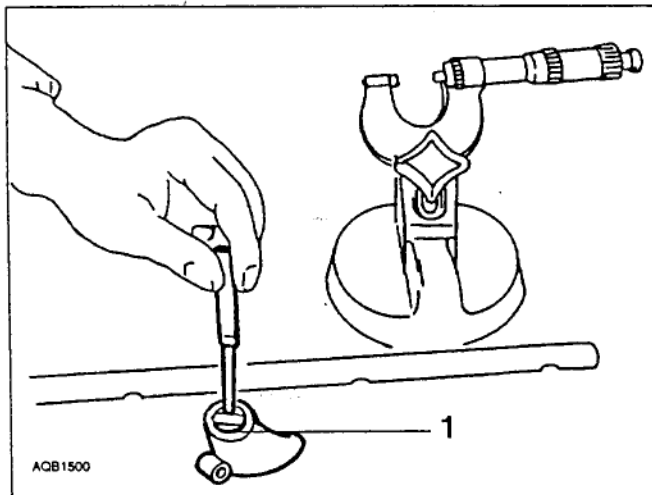
$$D = 21,971 \div 21,989 \text{ mm}$$

TAPPET SEATS AND EXHAUST-SIDE TAPPETS

1. Check that the tappet seat diameter ranges within the specified values

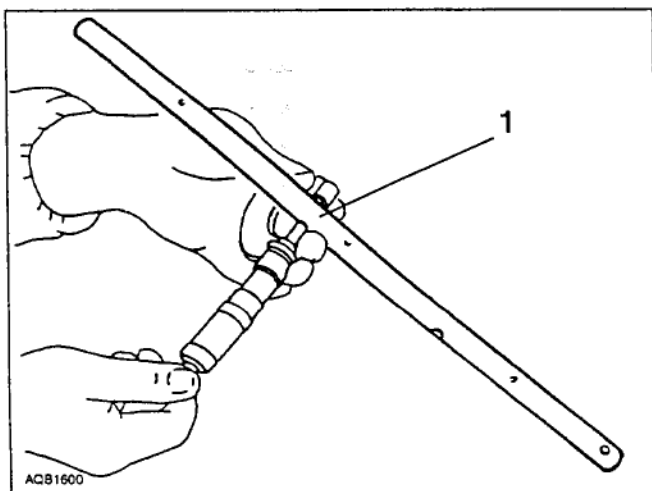
ROCKER ARMS AND ROCKER ARM SHAFT

1. Check that the rocker arm bore ranges within the specified values



	Rocker arm bore	$16,016 \div 16,034 \text{ mm}$
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1. Check that the rocker arm shaft diameter ranges within the specified values

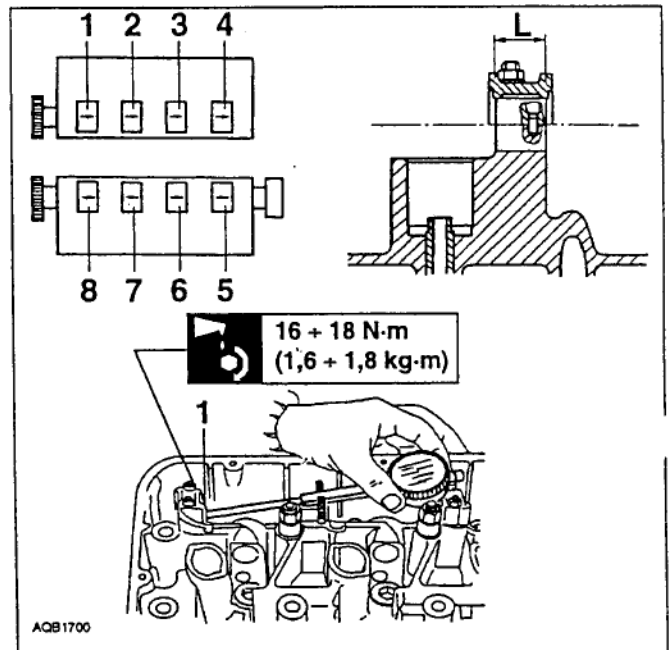


	Rocker arm shaft diameter	$15,988 \div 16,000 \text{ mm}$
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CAMSHAFTS AND JOURNAL BEARINGS

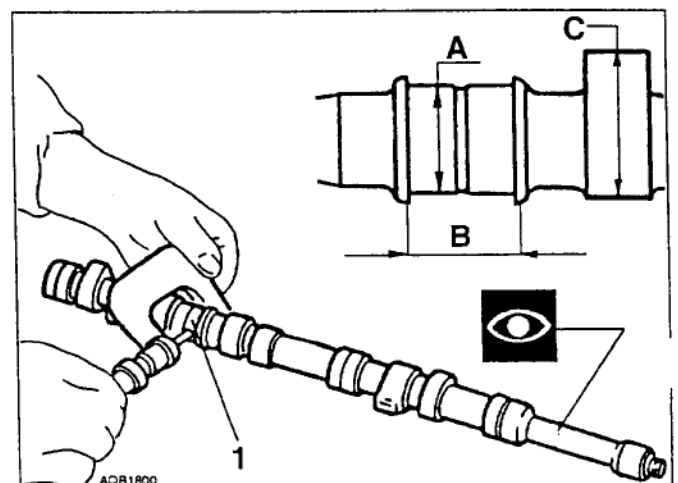
- Install the caps according to the numbering and arrows printed on them; tighten the lubricated nuts to the specified torque

1. Check that camshaft journal bearing diameter ranges within the specified values
 - Check that the maximum width "L" of the shoulder ranges within the specified values



	Camshaft journal bearing diameter	$27,000 \div 27,033 \text{ mm}$
	Maximum width "L" of the shoulder	$26,851 \div 26,940 \text{ mm}$

1. Check journals diameter "A" is within prescribed limits
 - Check cams height is above minimum allowable dimension
 - Check cam shoulder length "B" is within prescribed limits
 - Check maximum eccentricity between journals does not exceed prescribed limit



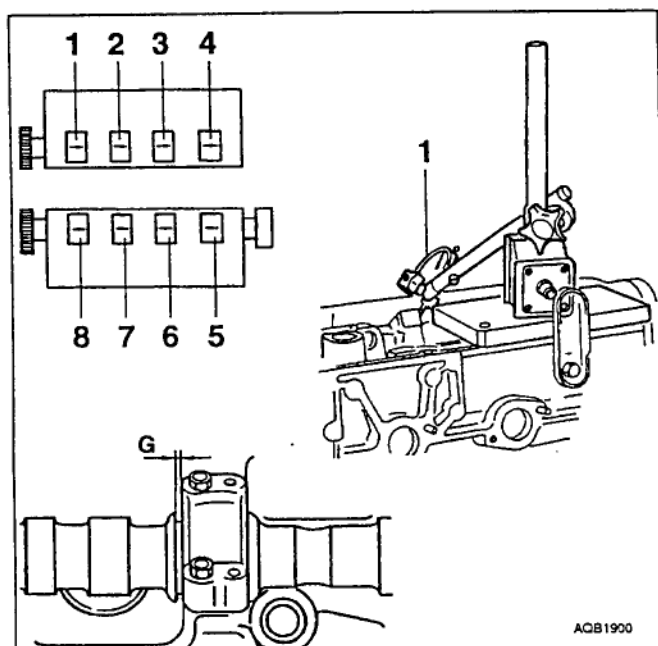
	Camshaft journal diameter	
	A = 26,949 ÷ 26,970 mm	
	Cam height	
	C = intake	35,511 ÷ 35,550 mm
	C = exhaust	34,011 ÷ 34,050 mm
	Shoulder length	
	B = 27,000 ÷ 27,052 mm	
Maximum eccentricity between journals		0,03 mm

CAMSHAFT END FLOAT CHECK

- Position the camshafts
- Install the caps according to the numbering and the arrows printed on them; tighten the lubricated nuts at the specified torque:

[16 ÷ 18 N·m (1.6 ÷ 1.8 kg·m)]

1. Apply a centesimal comparator and measure the end float "G" of the camshafts; check that the value obtained ranges within the specified tolerances



	Camshaft end float	
	G = 0,060 ÷ 0,201 mm	

CYLINDER BLOCK CHECK AND INSPECTION

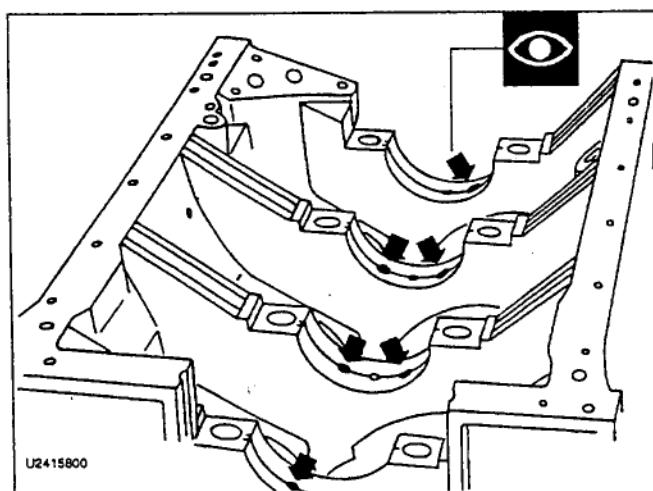
OIL JET VALVES FOR PISTON COOLING

— The cylinder block is equipped with six oil jet valves (See arrows in figure) supplied directly from main journals.

— These sprayers are meant for the cooling and lubricating of the pistons and the relevant piston pins

— Thoroughly clean the sprayers making sure they are neither damaged nor clogged

— Check with jet of compressed air that the lubrication valves open at the specified pressure



Opening pressure of lubrication valves

250 ± 25 kPa (2,5 ± 0,25 bar; 2,54 ± 0,254 Kg/cm²)

MAIN AND CONNECTING ROD HALF BEARINGS - THRUST RINGS

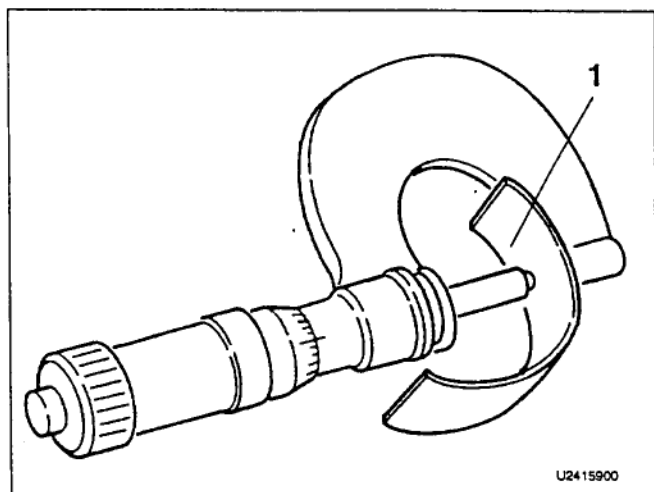


Class	Half bearing thickness main
Green	1,8450 ÷ 1,8510 mm
Blue	1,8390 ÷ 1,8450 mm
Red	1,8330 ÷ 1,8390 mm

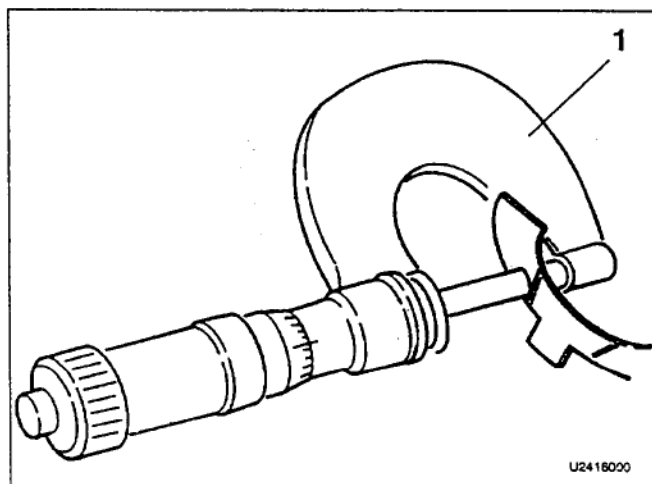
Class	Half bearing thickness big end
Red	1,7370 ÷ 1,745 mm
Blue	1,741 ÷ 1,749 mm

— The coupling between main and big end half bearings and crankshaft must be carried out by matching parts of the same class which are tagged on the half bearing side and on the relevant main journal with the same **RED** or **BLUE** coloured mark

1. Check that the half bearing thickness ranges within the specified values



1. Check that the half thrust ring thickness ranges within the specified values



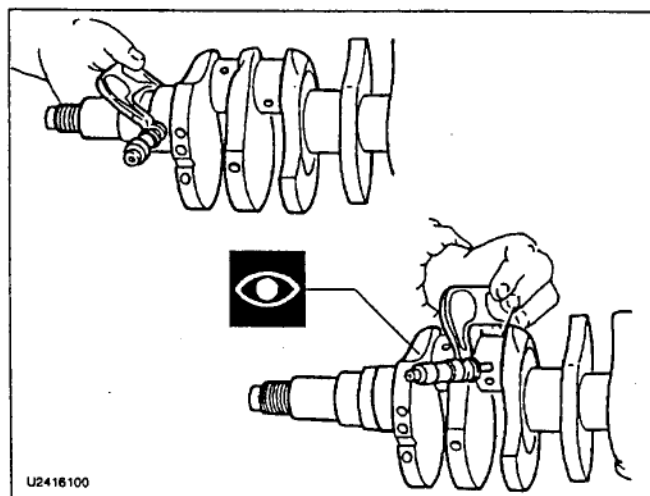
Half thrust ring thickness
2,310 ÷ 2,360 mm

CRANKSHAFT

MAIN JOURNALS AND CRANK PINS

NOTE: The nitriding treatment, which the crankshaft has undergone, does not allow any grinding operation; in case of excessive wear it is thus necessary to replace the crankshaft

- The crankshaft journals are subdivided into classes and marked with a **RED** or **BLUE** dot for the connecting rod journals and 3 green, **BLUE** or **RED** stripes for the main journals according to machining tolerances
- Verify that the main journal and crank pin diameter ranges within the specified values

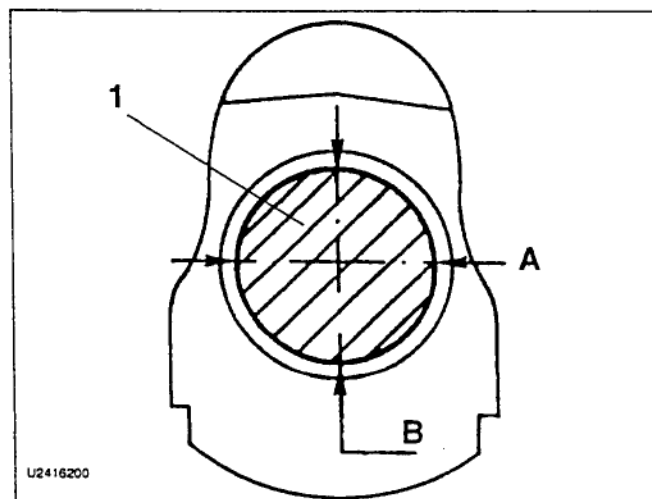


Main journal diameter	
Green	59,961 ÷ 59,967 mm
Blue	59,967 ÷ 59,973 mm
Red	59,973 ÷ 59,979 mm



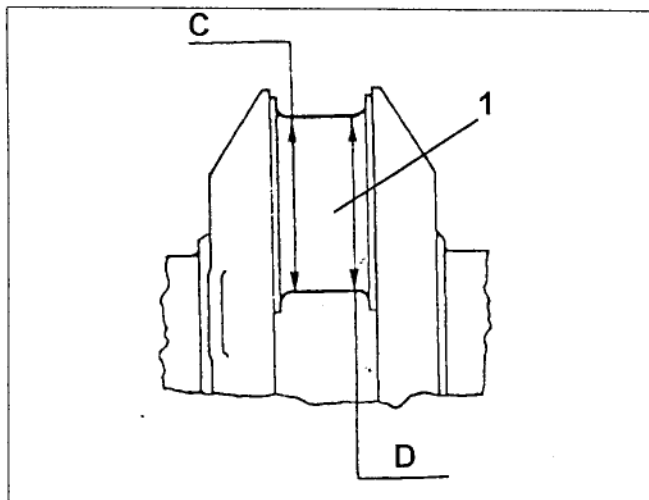
Crank pin diameter	
Red	51,990 ÷ 52,000 mm
Blue	51,980 ÷ 51,990 mm

1. Check that the ovalization of the main journals and crank pins ranges within the specified values



Main and connecting rod bearing maximum ovalisation error	$A - B = 0.004 \text{ mm}$
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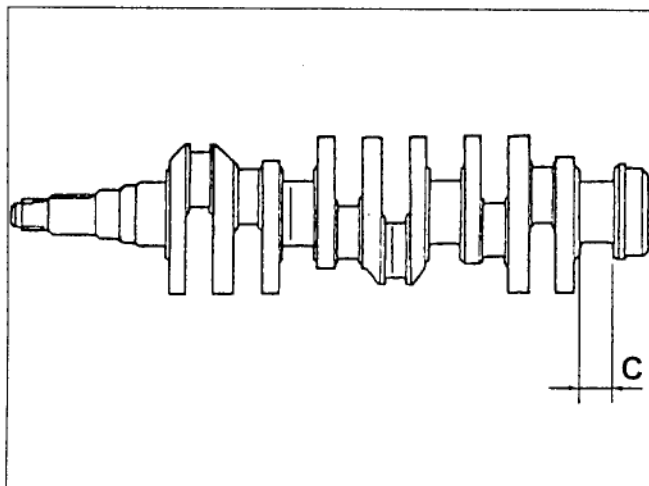
1. Check main and connecting rod bearing taper ratio falls within the prescribed values.



Main and connecting rod bearing maximum taper error	$C - D = 0.010 \text{ mm}$
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- Check:

- whether the central main journals and the front and rear main journals are concentric,
- whether the main and connecting rod journal generating lines are parallel,
- the length of rear main journal "C",
- whether the middle line shift with respect to main journal middle line falls into the prescribed value.



Main journal maximum eccentricity	0.004 mm
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Main and connecting rod maximum parallel error	0.015 mm
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	Rear main journal length
	$C = 31.300 \div 31.335 \text{ mm}$

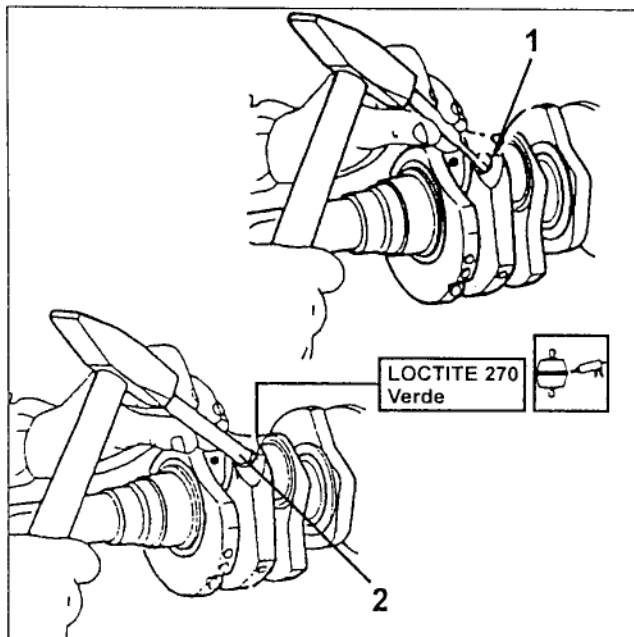
Maximum middle line shift with respect to main journal middle line	0.3 mm
--	--------

LUBRICATION DUCT CLEANING

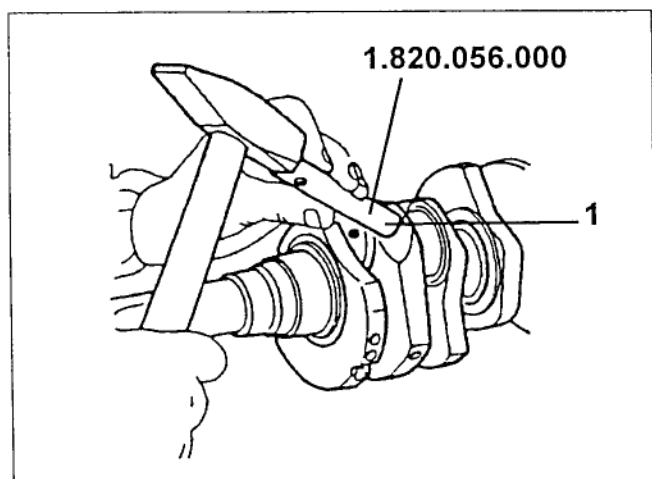
1. Pierce the lubrication duct caps with a punch and eliminate burrs created by the previous caulking.

- Clean the lubrication ducts carefully with warm diesel fuel and dry with a jet of compressed air.

2. Apply the prescribed glue (**LOCTITE 270 Green**) on the new caps and insert them with a suitable tool in the lubrication duct holes.



1. Caulk the caps with tool no. 1.820.056.000.



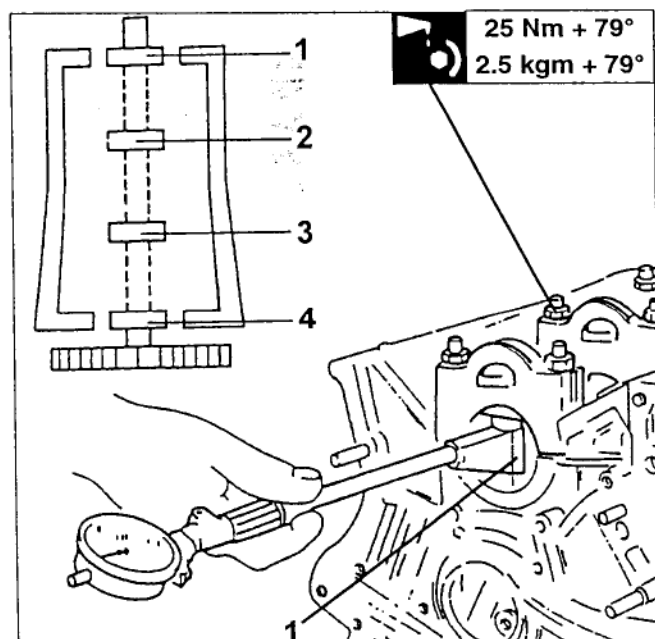
MAIN BEARINGS

- Fit the main bearings addressing them according to the indications given on the bearings.

1. Fasten the nuts to the prescribed torque in oil. Check whether the main journal diameter falls within prescribed values.

NOTE: Use goniometer no. 1.860.942.000 for angle torque.

- Check whether the rear main journal shoulder falls within the prescribed values.

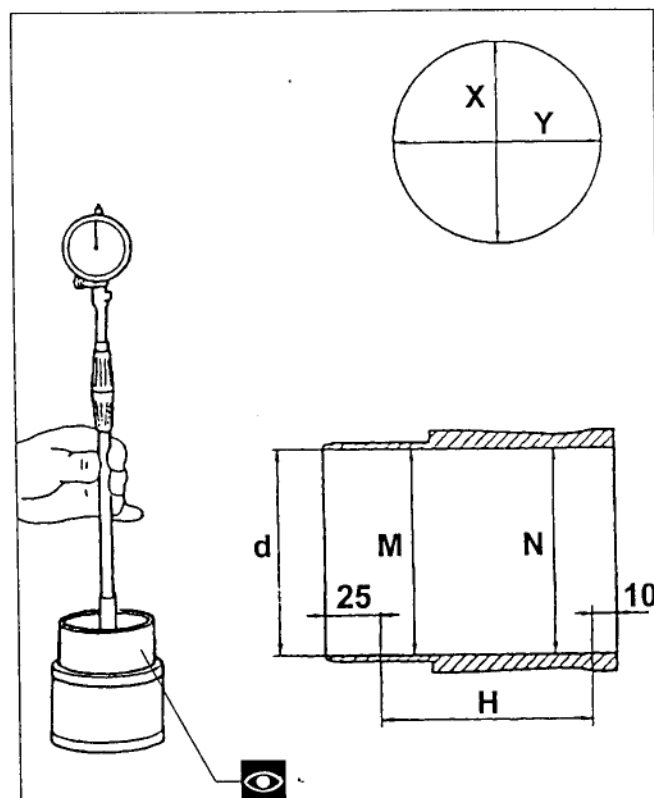


	Main journal diameter	63.657 ÷ 63.676 mm
	Rear main Journal shoulder length	26.45 ÷ 26.50 mm

CYLINDER LINERS

- The cylinder liners are organised into three classes - A, B and C - according to their internal diameter. They can be distinguished by means of the **BLUE**, **PINK** or **GREEN** labels on the outside.

- Check whether the internal diameter, taper ratio and ovality fall within prescribed values.



H = dimension check area

Diameter (d)	
Class A (Blue)	79.985 ÷ 79.994 mm
Class B (Pink)	79.995 ÷ 80.004 mm
Class C (Green)	80.005 ÷ 80.014 mm

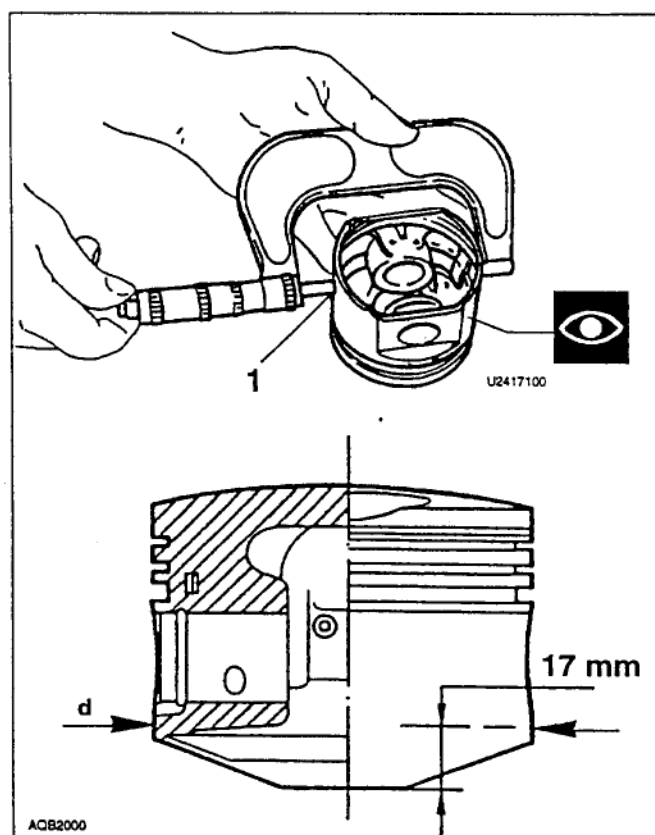
Maximum taper ratio (M-N)	0.01 mm
Maximum ovality (X-Y)	0.01 mm

PISTONS AND PINS

- The pistons - as the cylinder liners - are organised into three class according to their machining tolerance. The classes A, B and C can be distinguished by the **BLUE**, **PINK** or **GREEN** labels on the top of the piston.

1. Check whether the external diameter of the piston falls within the prescribed values.

NOTE: This diameter must be perpendicularly measured as to the piston pin hole and at 17 mm from the skirt lower edge

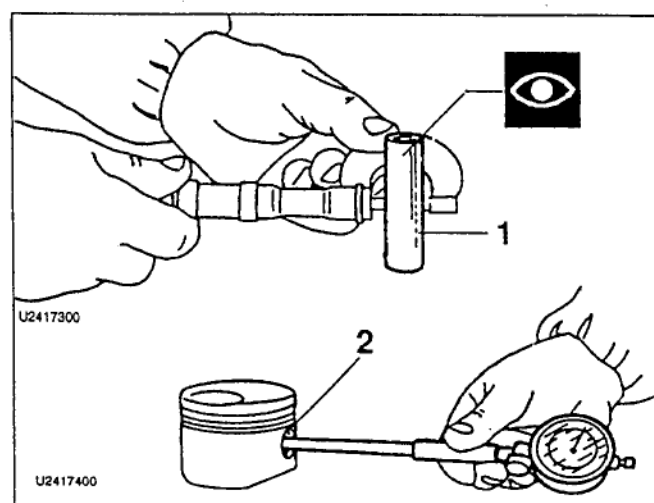


Outer diameter (d)	
Class A (Blue)	79,935 + 79,945 mm
Class B (Pink)	79,945 + 79,955 mm
Class C (Green)	79,955 + 79,965 mm

— The piston pins and the piston coupling holes are subdivided into two classes according to the manufacturing tolerances. These classes are differentiated by marks in **BLACK** or **WHITE** painted on the piston pin inner surface and the outer surface of the piston hub

1. Check that the piston pin outer diameter ranges within the specified values
2. Check that the coupling hole diameter with the piston ranges within the specified values

Piston pin outer diameter	
Black	21,994 + 21,997 mm
White	21,997 + 22,000 mm

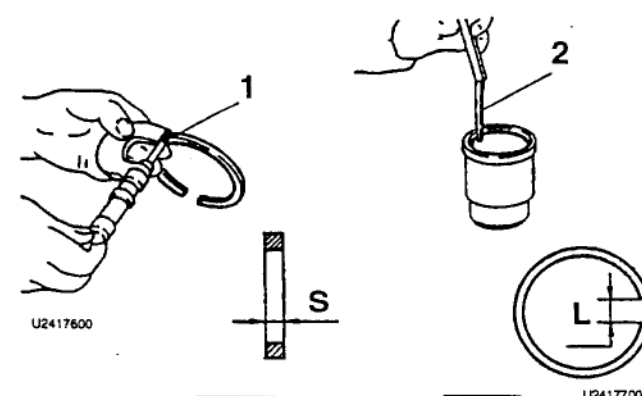


Piston pin outer diameter	
Black	21,994 + 21,997 mm
White	21,997 + 22,000 mm

Pin hole diameter in the piston	
Black	22,001 + 22,003 mm
White	22,003 + 22,005 mm

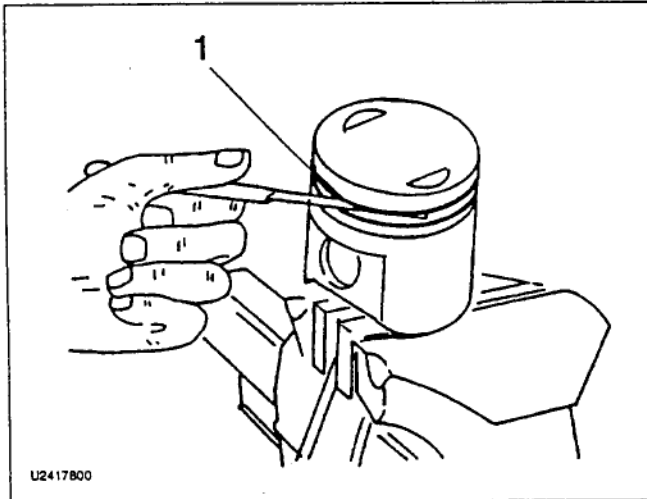
PISTON RING AND OIL SCRAPER RINGS

1. Check that thickness "S" value of the piston and oil scraper rings ranges within the specified values
2. Insert the rings into the cylinder liner and check that gap "L" ranges within the specified values



	Thickness «S»	Gap "L"
First ring	1,478 + 1,490 mm	0,30 + 0,50 mm
Second ring	1,478 + 1,490 mm	0,30 + 0,50 mm
Oil scraper ring	3,478 + 3,490 mm	0,25 + 0,50 mm

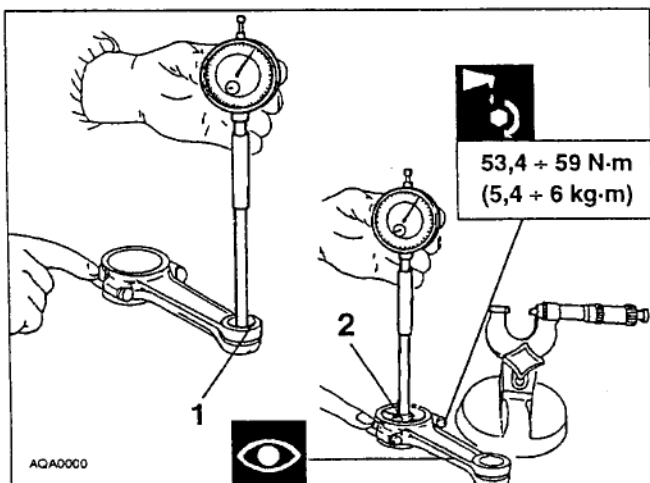
1. Check that the end float between the piston rings, the oil scraper rings and the piston seats ranges within the specified tolerances



End float between seats and piston rings

First ring	$0,035 + 0,067 \text{ mm}$
Second ring	$0,035 + 0,067 \text{ mm}$
Oil scraper ring	$0,025 + 0,057 \text{ mm}$

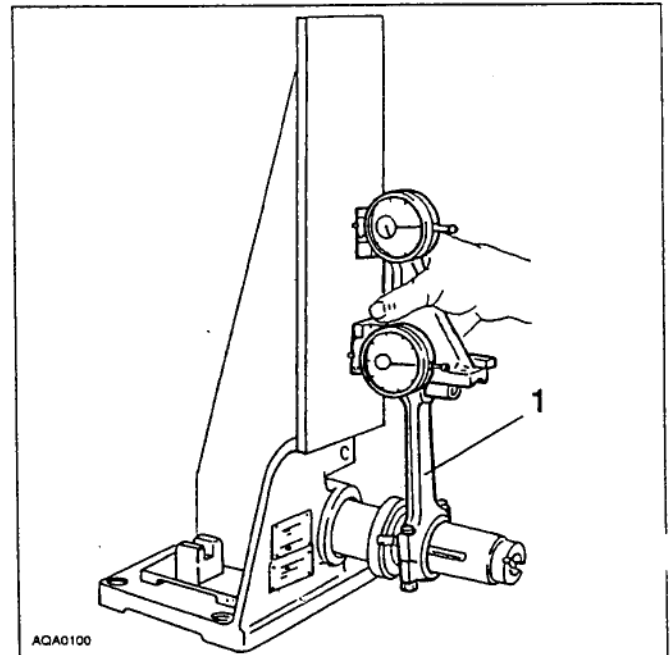
1. Check that the bushing hole diameter of the small end ranges within the specified values
 2. Install the connecting rod caps and tighten the lubricated nuts to the specified torque.
- Check that the big end diameter ranges within the specified values



Small end bushing hole diameter

$22,004 + 22,014 \text{ mm}$

1. Check the perpendicularity of the connecting rods

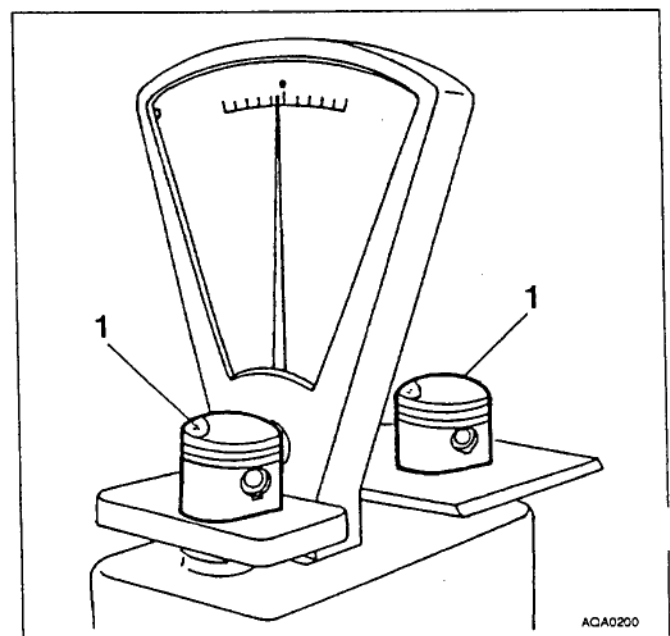


Big end inner diameter

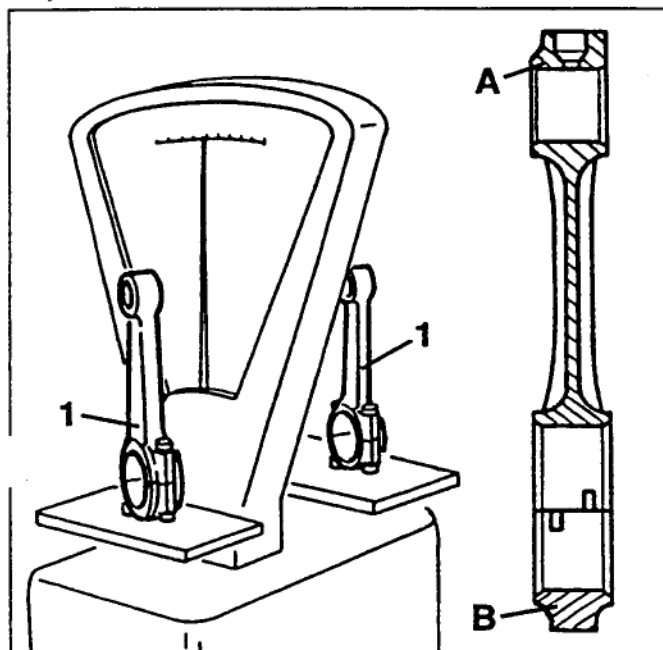
$55,511 + 55,524 \text{ mm}$

WEIGHT DIFFERENCE CHECK OF PISTON AND CONNECTING ROD PAIRS

1. Match piston pins and pistons according to the relevant dimension class (**BLACK** or **WHITE**). Insert the piston pins in the pistons and block them by means of spring rings; install the piston rings and the oil scraper ring. Check that the weight difference between pistons ranges within the specified values



Similarly, check that the difference in weight between the connecting rods, complete with half bearings, caps and bolts, is within the specified limit (if necessary remove the excess material from "A" and "B").

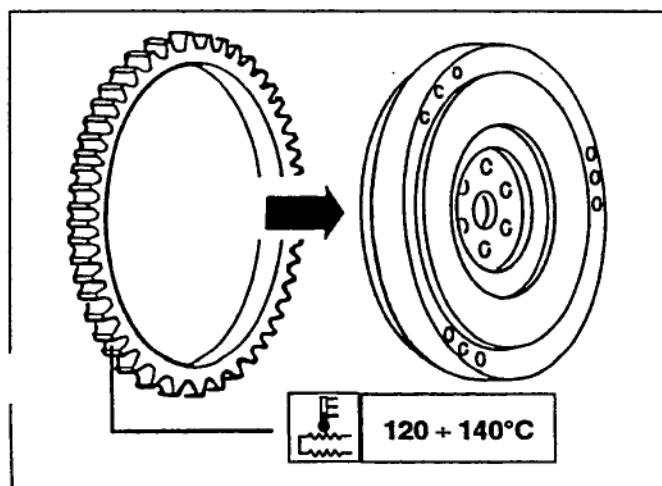


	Difference in weight between pistons
	$\leq 4 \text{ g}$

	Difference in weight between connecting rods
	$\leq 2 \text{ g}$

CHANGING THE FLYWHEEL RING GEAR

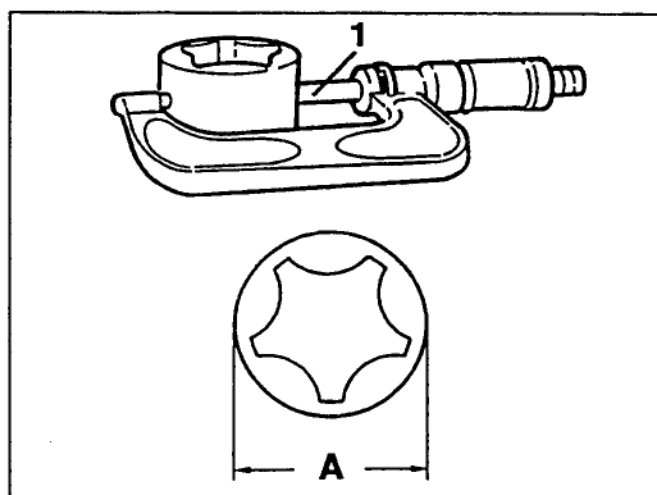
- When replacing the flywheel ring gear, proceed as follows:



- remove the old ring gear using a hydraulic press.
- accurately clean the contact surfaces of the new ring gear and flywheel.
- evenly heat the new ring gear to a temperature of $120 + 140 \text{ }^{\circ}\text{C}$ and fit it on the flywheel.
- leave to cool at environment temperature: **do not force cool.**

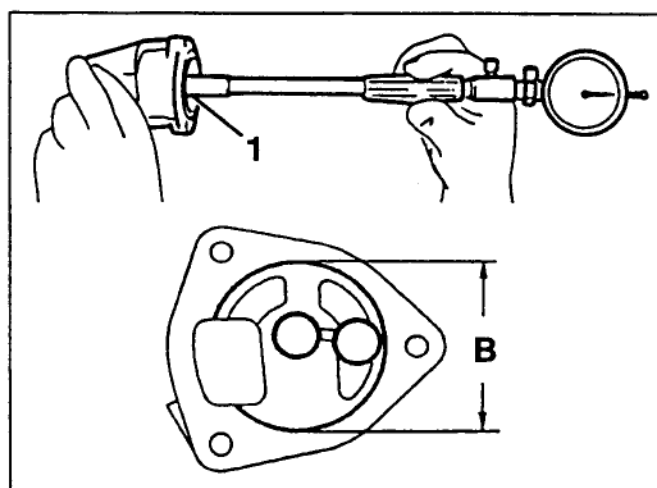
CHECKING AND INSPECTING THE OIL PUMP

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



	Outside diameter of driven rotor
	$A = 49.100 + 49.155 \text{ mm}$

1. Check that the inside diameter of the pump casing is within the specified limits.



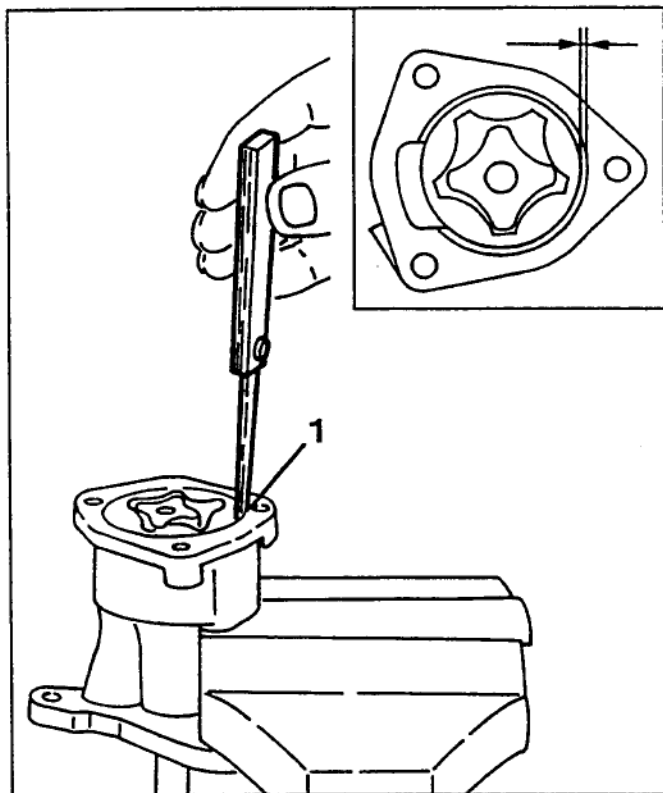
	Diameter of seat for rotor in pump casing
	$B = 49.325 + 49.375 \text{ mm}$

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



Clearance between pump casing and driven gear

$0.170 + 0.275 \text{ mm}$

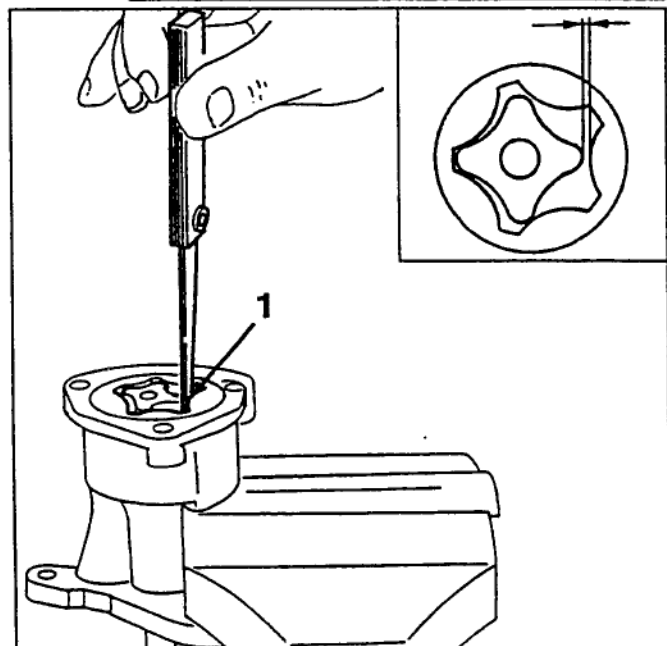


1. Check that the clearance between the lug of the inside gear and that of the driven gear is within the specified limits.



Clearance between driven gear and inside gear

$0.040 + 0.290 \text{ mm}$

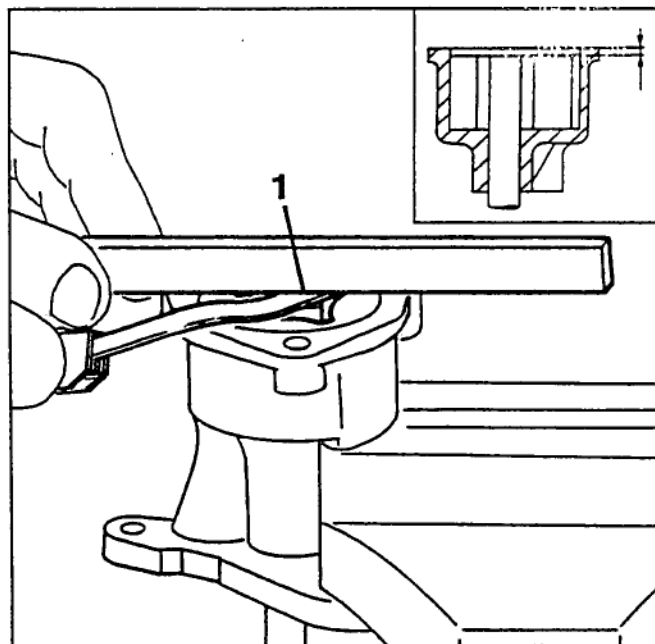


1. Check that the clearance between the pump casing rest surface and the upper surface of the gears is within the specified limits.



Clearance between pump casing rest surface and upper gear surface

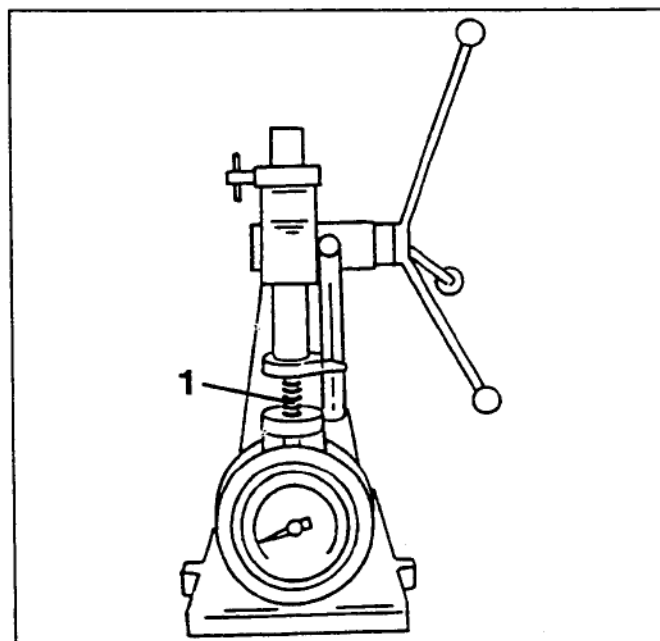
$0.025 + 0.075 \text{ mm}$



1. Check, using a torque meter, that the characteristic data of the engine oil pressure limiting valve control spring are within the specified limits.

Length of spring

With spring free	54 mm
With static load (14.6 kg)	36 mm
With dynamic load (21 kg)	28 mm



REFITTING PRECAUTIONS



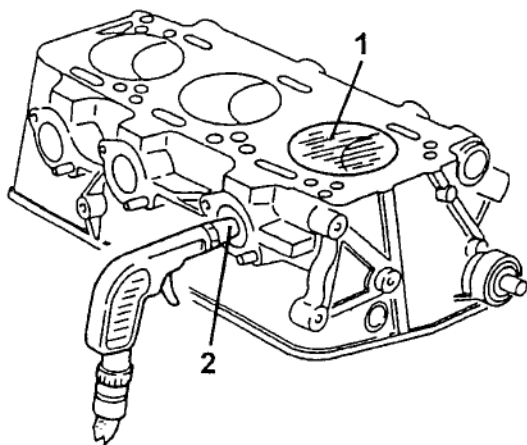
Reverse the removal sequence for refitting unless otherwise specified in the following instructions.

Valve tightness check

- Fit the spark plugs in their seats.

1. Pour some petrol in the combustion chamber so to just cover the valve caps.

2. Let low pressure air into the intake manifolds and into the exhaust manifolds. Check there are no air bubbles in the petrol. If there are bubbles, check correct position and if required machine the valve seats (see specific paragraph).



Check and adjust tappet clearance

Intake side

- Refit the camshaft and measure intake valve clearance as follows:

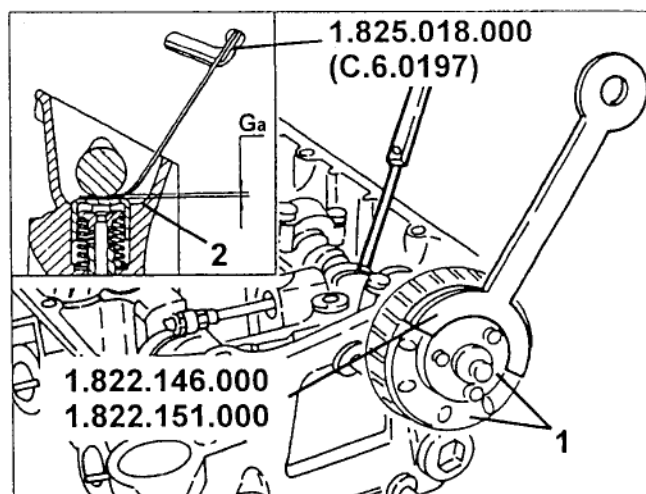
1. Temporarily fit the hub and respective camshaft drive pulley.

2. Turn the camshaft with tools no. 1.822.146.000 and no. 1.822.151.000. Check whether clearance "Ga" between the cam lower radius and the corresponding cup falls into the prescribed values with thickness gauge no. 1.825.018.000 (C.6.0197).



"Ga" intake valve clearance

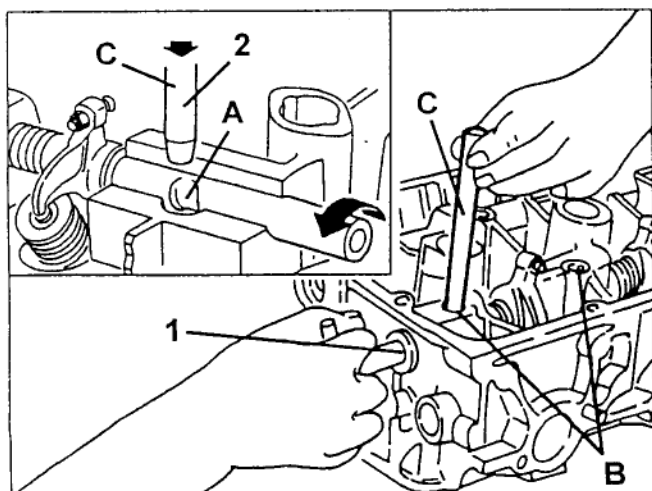
0.475 ÷ 0.500 mm



Rocker arm journal

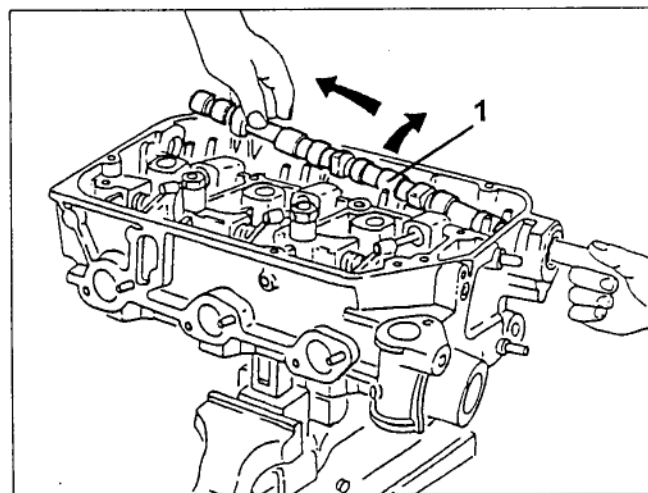
1. Fit the washers, the rocker arms and the springs. Turn the shaft so that the notches "A" correspond to holes "B" to let the cylinder head fastening studs through.

2. Use pin "C" (diameter 12 mm) to make sure it is so.

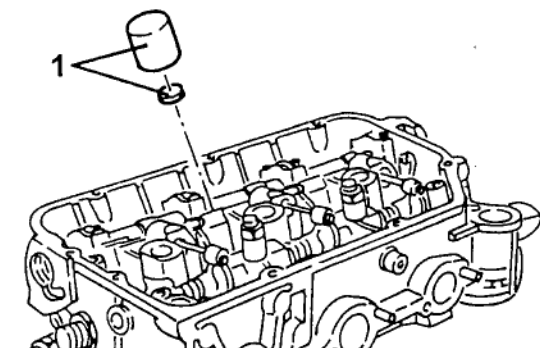


- If the intake valve clearance does not fall within the prescribed values, adjust as follows:

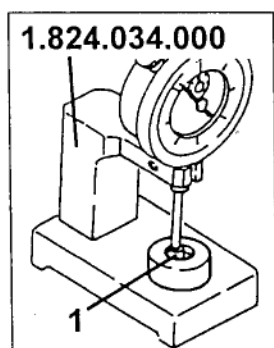
1. Remove the bearings and remove the camshaft.



1. Remove the cups and remove the tappet clearance adjustment caps.



1. Measure cap thickness with tool no. 1.824.034.000 (and gauge). Then choose from set no. 1.820.150.000 (R.9.0001) those suitable to restore correct tappet clearance.

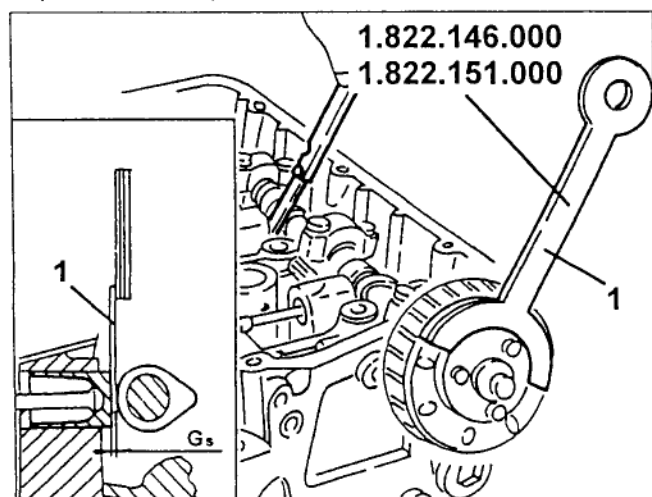


- Refit the caps, the camshaft and the respective bearings. Fasten the bearing nuts as prescribed and measure the intake valve clearance.

Exhaust side

- Refit the camshaft and measure intake valve clearance as follows:

1. Turn the camshaft with tools no. 1.822.146.000 and no. 1.822.151.000. Check whether clearance "Gs" between the cam lower radius and the corresponding cup falls into the prescribed values.



"Gs" exhaust valve clearance

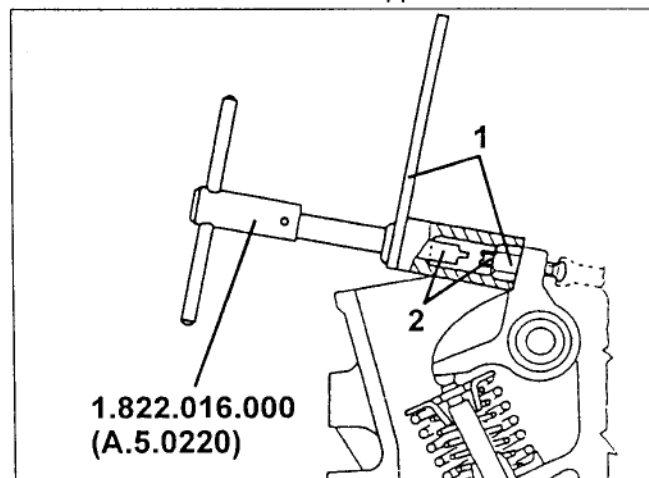
0.275 ÷ 0.300 mm

- If the intake valve clearance does not fall within the prescribed values, adjust as follows:

1. Loosen the adjustment screw lock nut with tool no. 1.822.016.000 (A.5.0220) intermediate lever.

2. Turn the adjustment screw with the tool to reach the prescribed exhaust valve clearance.

- Lock the lock nut and check tappet clearance.



Crankshaft refitting

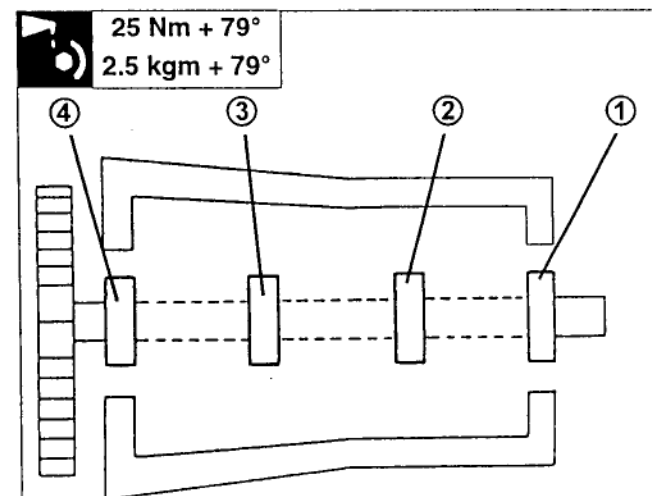
- Fit the crankshaft with half-bearings and thrust half-rings on the crankcase.

NOTE: Refit the half thrust rings with the grooved surfaces facing the crankshaft.

- Fit the main bearings and half-bearings on the journals according to the numbers. Fasten to the prescribed torque.

NOTE: Use goniometer no. 1.860.942.000 for angle torque.

NOTE: The safety notches on the crankcase and on the main bearings should be on the same side.



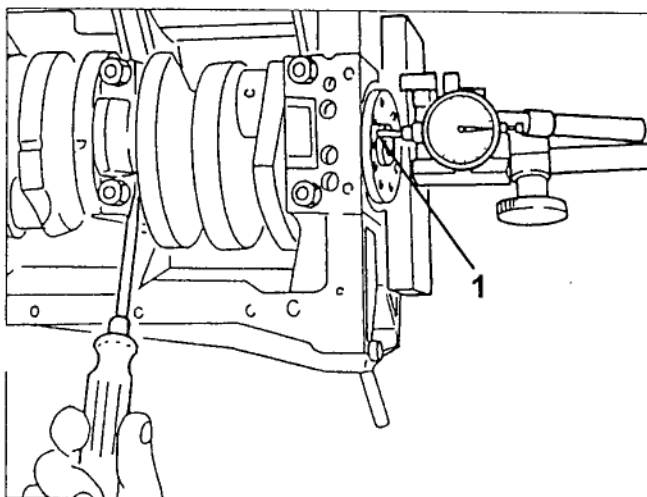
Crankshaft axial play

1. Check whether crankshaft axial play falls within prescribed values by means of a centesimal gauge applied with its magnetic base.



Crankshaft axial play

0.080 ÷ 0.265 mm



Cylinder liner, piston and connecting rod refitting

- Clean the cylinder liners carefully, fit the seals and insert in the crankcase. Make sure they reach the end of the stroke.

1. Lock the cylinder liners in the crankcase with the liner retainer tools no. 1.820.279.000 and fasten the respective nuts at the prescribed torque.

2. Fit tool no. 1.825.003.000 (C.6.0148) and the reset centesimal gauge on the crankcase. Position one side and then the other so that the feeler is in contact with the cylinder liner edges. Check the projection falls within the prescribed values.

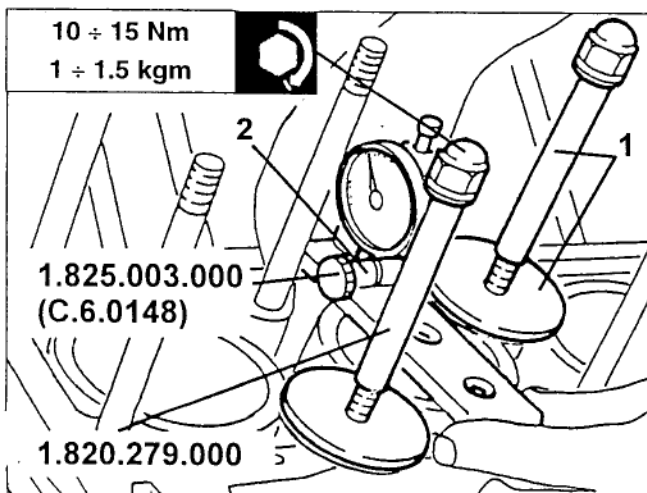


Crankcase cylinder liner projection

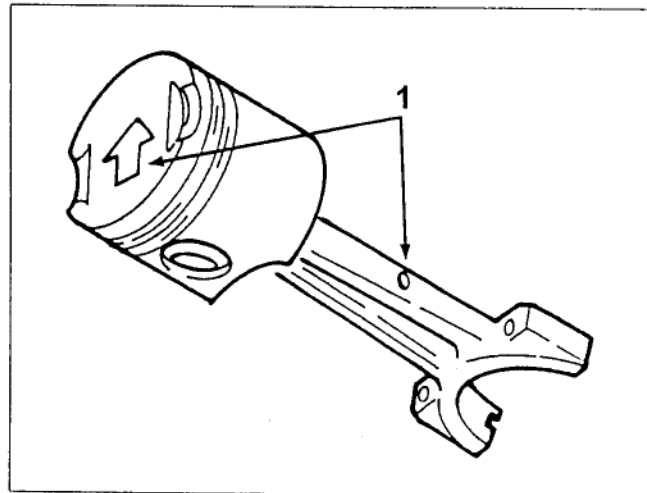
0.01 ÷ 0.06 mm

10 ÷ 15 Nm

1 ÷ 1.5 kgm



1. Couple the pistons and their respective connecting rods. Make sure the arrow printed on the top of the piston is facing the direction shown in the figure with respect to the lubrication hole on the side of the connecting rod.



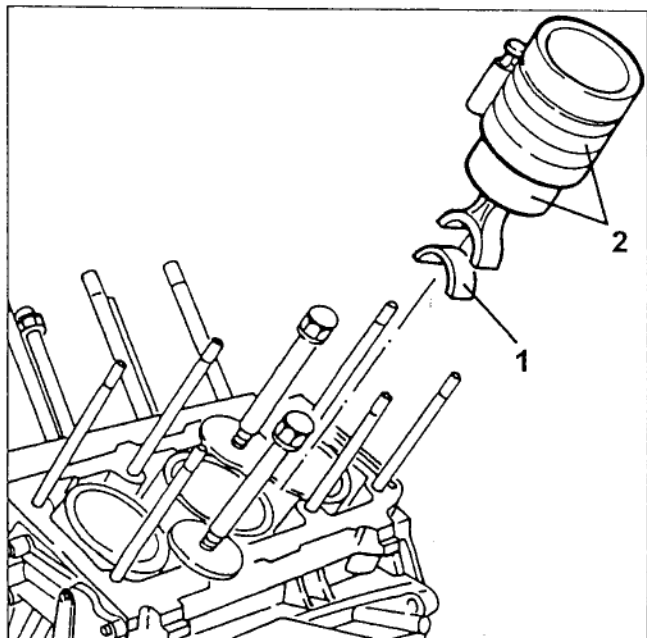
- Fit the gas rings and the oil scraper on the piston with a suitable tool.

NOTE: After refitting, address the gas ring cuts so that they do not coincide with the journal axis and at 120° one from the other.

1. Fit the respective half-bearings on the connecting rod big end.

2. Insert the connecting rod-piston assembly in the bank cylinder liner with a suitable tool.

NOTE: Fit the connecting rod-piston assembly so that the arrow printed on the top of piston is facing the front side of the motor and that the lubrication hole is facing towards the right-hand side of the crankcase.

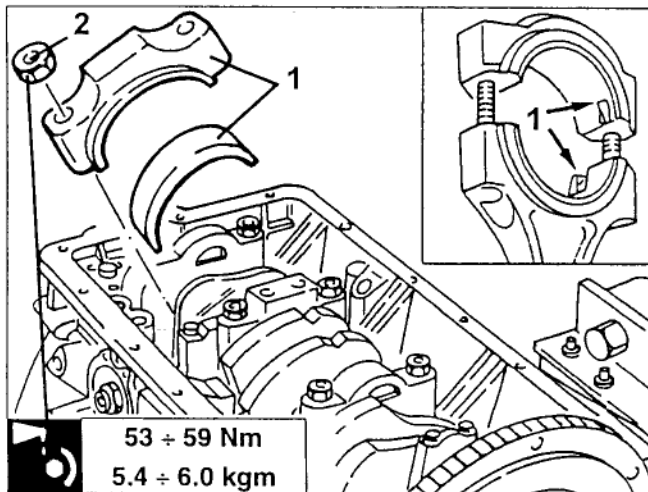


- Turn the crankcase on the overhaul stand.

1. Fit the connecting rod caps and half-bearings on the bank. Address the safety notch towards the notch on the connecting rod cap.

NOTE: The cylinder number is shown on the side of each connecting rod cap. When refitting, this number should be on the same side as the number printed on the connecting rod.

2. Fasten the connecting rod cap screws at the prescribed torque.

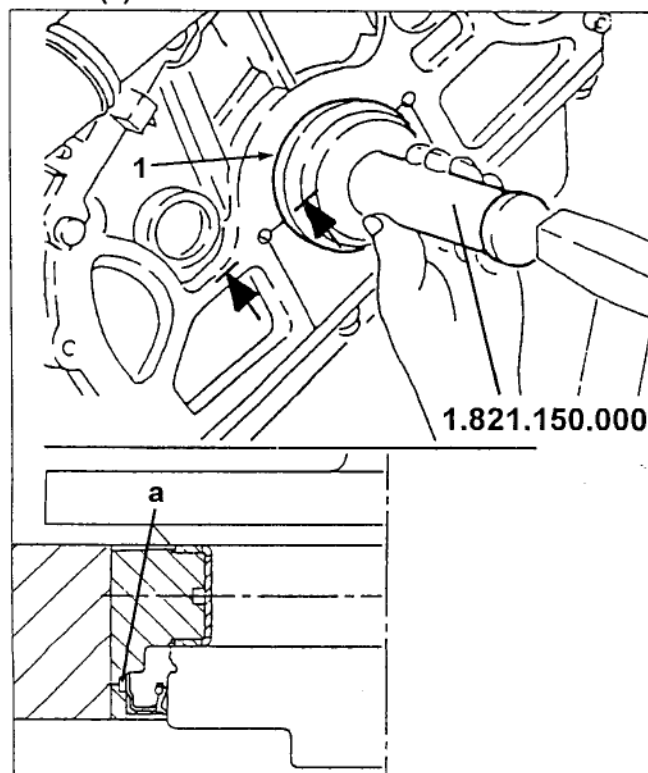


- Fit the pistons and the connecting rod of the other bank in the same way.

Oil sump refitting

1. Fit the rear crankshaft oil seal with tool no. 1.821.150.000.

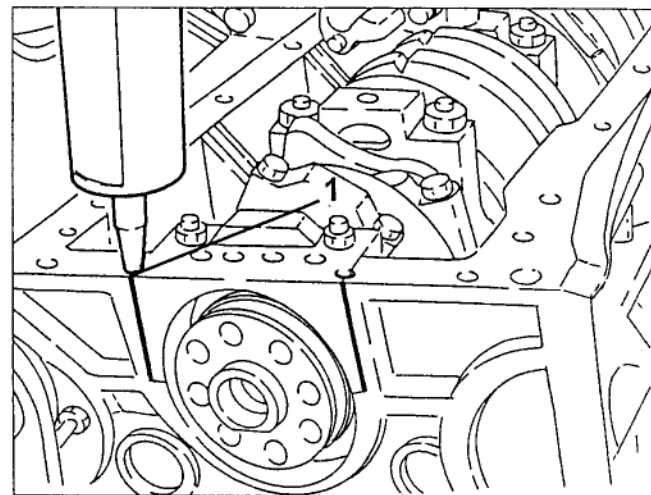
NOTE: Fit the oil seal in its seat so that the holes (a) are covered.



For pre-change versions (to engine no. 05697)

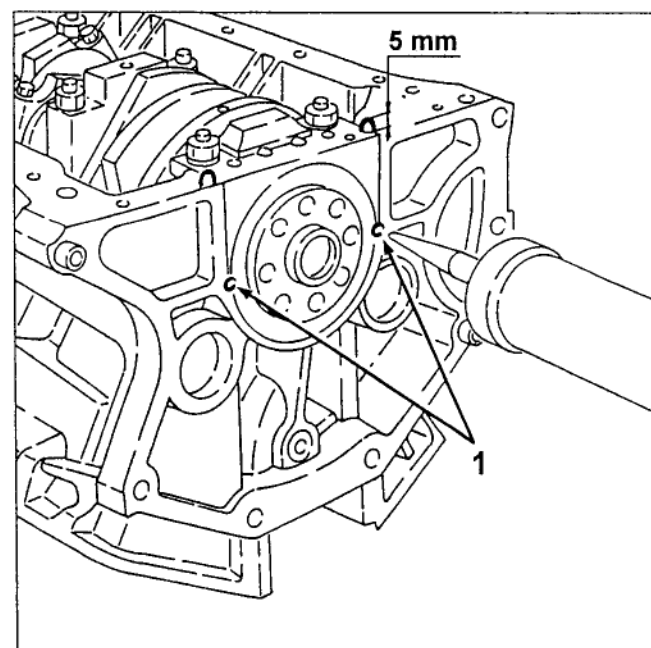
1. Apply "DOW CORNING 7091" silicon sealant with a mechanical gun through the holes shown in the figure.

NOTE: Check that the sealant seeps out from the rear crankcase-main bearing coupling along the entire length.

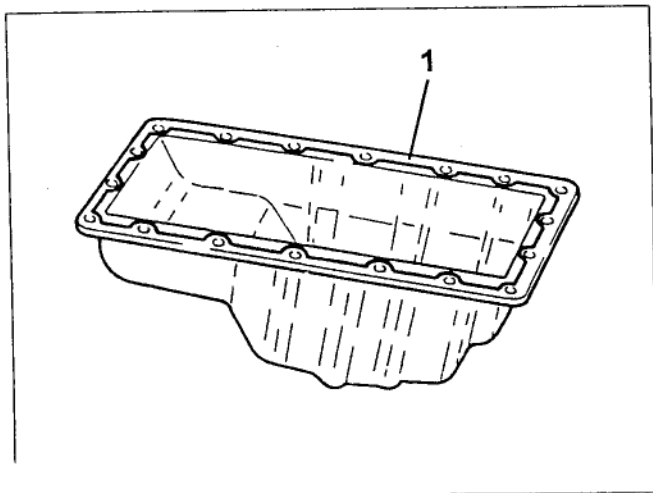


Post-change versions (from engine no. 05698)

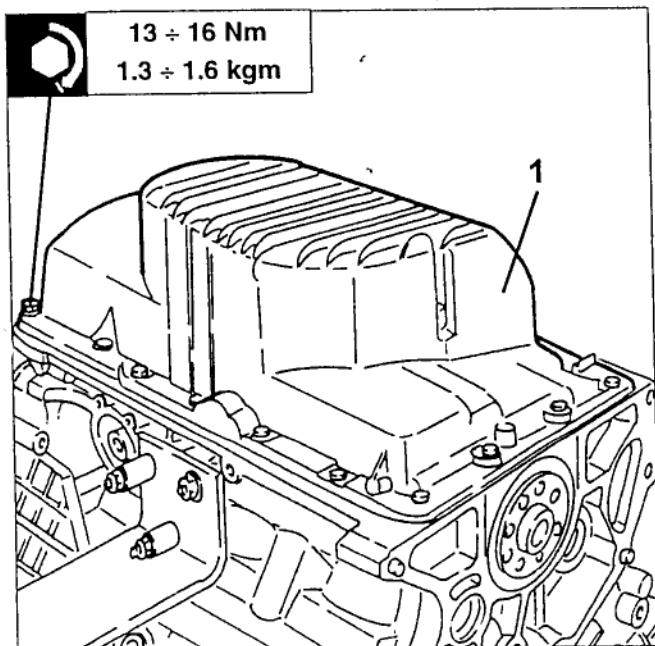
1. Apply "DOW CORNING 7091" silicon seals by means of a mechanical gun through the holes on the crankcase until the sealant seeps out from the engine oil sump coupling by approximately 5 mm.



1. Apply sealant to the oil sump. Make sure the strip of sealant (not wider than approximately 1.5 mm in diameter) is within the oil sump fastening holes (between reservoir and hole).



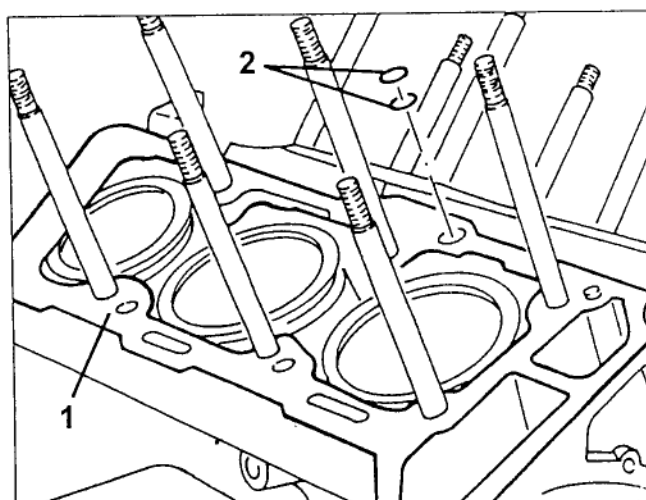
1. Position the oil sump avoiding considerable side movements which could remove the silicon sealant. Then fasten the oil sump screws at the prescribed torque.



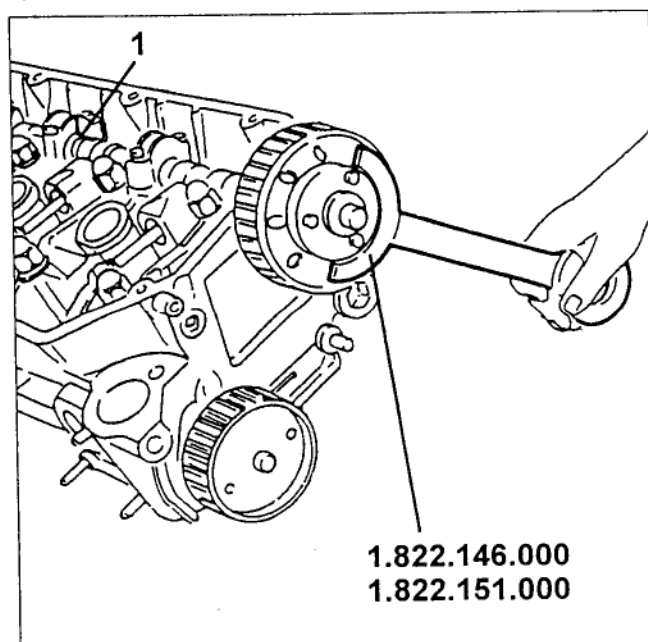
IMPORTANT: Fit the oil sump within 15 minutes from applying the sealant in the crankshaft rear seal holes.

Cylinder head refitting

- Turn the crankshaft to take cylinder 1 piston to DTC.
- Remove the previously fitted liner retainer tools no. 1.820.279.000.
- 1. Fit the cylinder head seals.
- 2. Fit the lubrication duct washer seals.

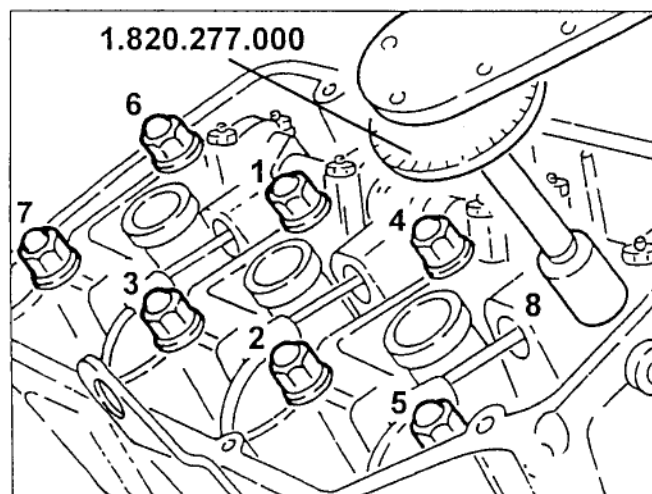


1. Turn the camshaft on each head with tool no. 1.822.146.000 and tool no. 1.822.151.000 until the timing reference notches on the camshafts correspond to those on the respective caps.



- Fit the cylinder heads on the crankcase.

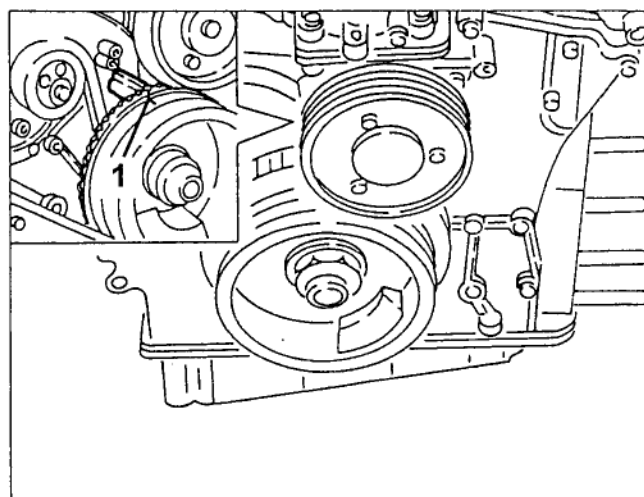
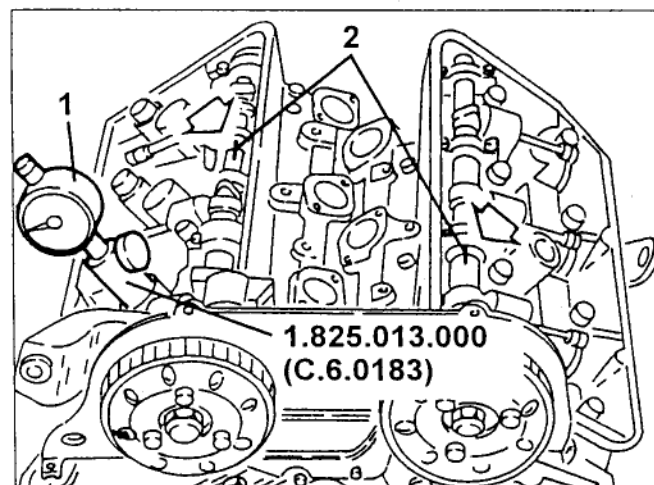
- Torque the cylinder head fastening screws as described below. The torque order is shown in the figure.



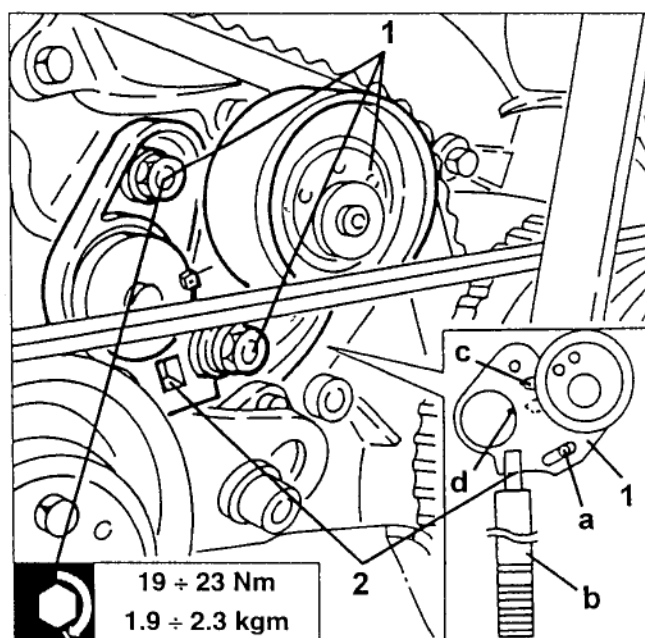
Tightening torque procedure	
Fasten all screws at:	25 Nm
Complete torque by an additional angle of:	240° ± 1°30'

Refitting timing belt and checking timing

1. Turn the crankshaft to take cylinder 1 piston to TDC firing stroke with tool no. 1.825.013.000 (C.6.0183) and gauge.
2. Check alignment of the notches on the camshafts and those on the respective caps.



1. Position the timing belt take-up device so that stud "a" is as shown in the figure. Then torque the two fastening nuts locking them slightly.
 - Fit the timing belt on the pulleys from the drive pulley anti-clockwise.
 - Loosen the two belt take-up device fastening nuts.
2. Insert a template 10 mm from tension lever "b" (3/82 ratchet) in the belt take-up device hole. Then turn it anti-clockwise so to advance hand "c" by 2 - 3 mm until they meet. Then fasten the two belt take-up device nuts without locking them.
 - Turn the crankshaft clockwise by two turns to take cylinder 1 piston to DTC.
 - Check whether hand "c" meets central notch "d" and torque the two belt take-up fastening nuts as prescribed.
 - Remove the belt take-up tension lever "b".



1. Furthermore, check alignment of the notch on the phonic wheel with the reference pin on the front crankcase cover.

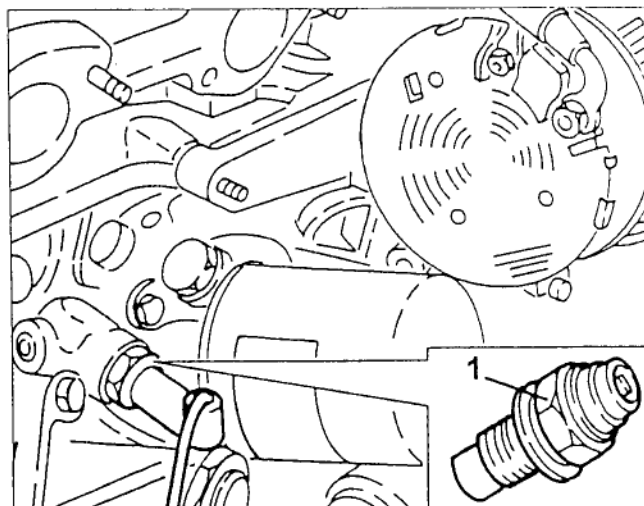
LUBRICATION CIRCUIT ELECTRICAL COMPONENT CHECKS

Minimum engine oil sensor warning light

1. Check the minimum engine oil pressure sensor calibration. If the values are not as prescribed, replace the sensor.



Contact open/close pressure
0.1 - 0.35 bar



For the other sensors and electrical components located in the engine compartment, refer to the specific assemblies where greater details are offered.

