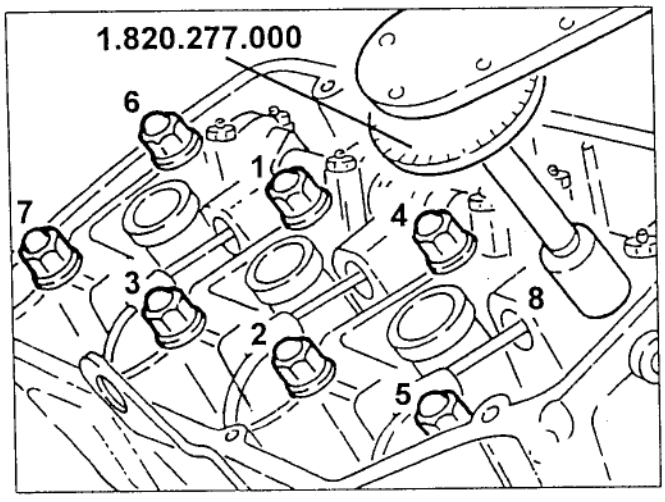
INDEX

GENERALITIES
- Description....1
- Lubrification....4

OVERHAULING
- Introduction....1
- Engine dis-assembly....1
- Dis-assembly of cylinder heads....12
- Cheks and inspections cylinder heads....15
- Cheks and inspections crankcase....25
- Cautions for re-assembly....33
- Cheking the electrical components of the lubrication circuit....39

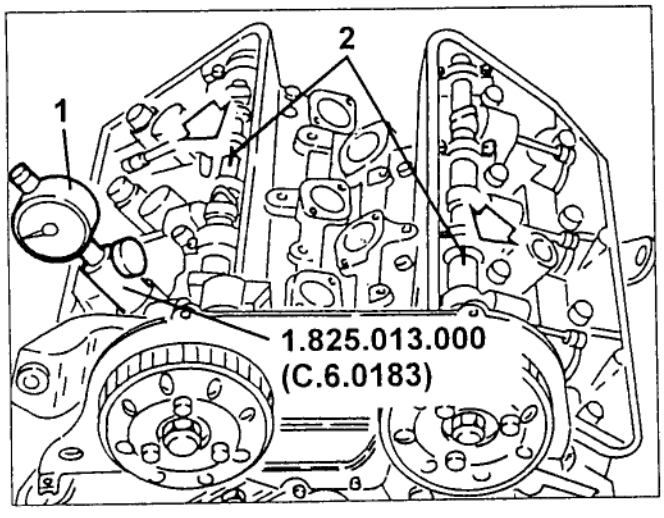
· Torque the cylinder head fastening screws as follows. The tighten torque order for each stroke is given in the figure.



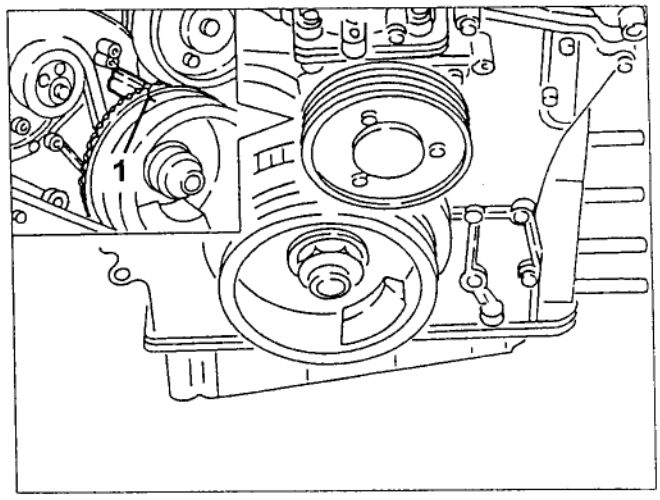
Tightening torque procedure	
Fasten all screws at:	25 Nm
Complete torque by an additional angle of:	240° ± 1°30'

Refitting timing belt and checking timing

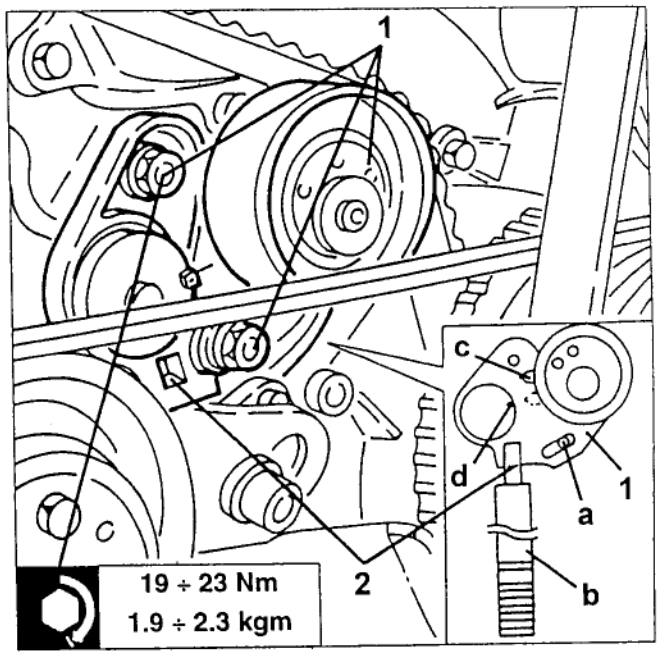
1. Turn the crankshaft to take cylinder 1 piston to TDC firing stroke with tool no. 1.825.013.000 (C.6.0183) and gauge.
2. Check alignment of the notches on the camshafts and those on the respective caps.



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

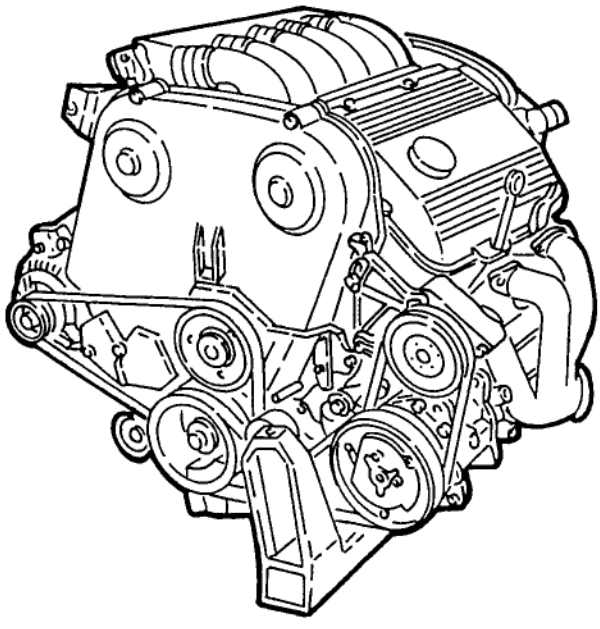


1. Position the timing belt take-up device so that stud "a" is as shown in the figure. Then torque the two fastening nuts locking them slightly.
- Fit the timing belt on the pulleys from the drive pulley anti-clockwise.
- Loosen the two belt take-up device fastening nuts.
2. Insert a template 10 mm from 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".



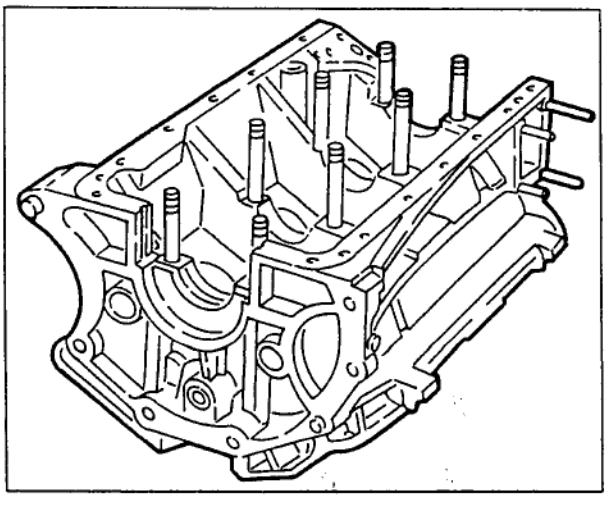
DESCRIPTION

The engine is of the type with six 60° V mounted cylinders in light alloy with a total cylinder displacement of 2959 cm^3 with injection and static ignition controlled by a single MOTRONIC M 3.7.1 control unit.
The "V" arrangement and the 60° angle make the engine extremely compact and well balanced from the dynamic point of view.
With a piston stroke of 72.6 mm and a bore of 93 mm, the engine is of the super square type (stroke and bore ratio below 1), which enables a better arrangement of the valves and optimal filling of the cylinders (high volumetric ratio).
The gearbox-clutch-differential unit is connected at the rear of the engine and is an integral part of the power unit.
The power unit is installed in the front of the vehicle arranged transversally with a 14° inclination forwards.
It is fastened to the body by two "suspension" type flexible damping mounts and by a third to the suspension crossmember.
To reduce vibrations, a rod above the engine connected to the body prevents excessive shaking.
The fuel supply system, with unleaded petrol, combined with adequate anti-pollution systems described in the specific paragraphs, feature low exhaust emission levels meeting "EEC STAGE 2" regulations.

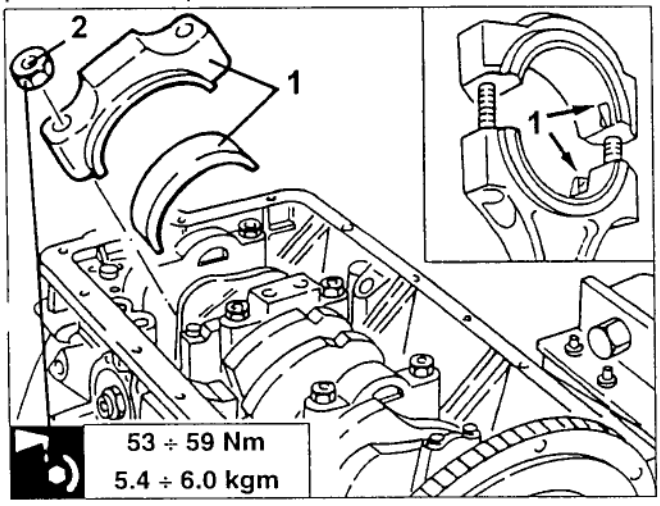


CRANKCASE

A single block in light aluminium and silicium alloy with high mechanical strength and thermal conductivity.
The crankshaft is supported by four main bearings which house the thin shell half bearings.
Special grooves, machined in the walls of the crankcase allow the passage of the engine coolant fluid and lubricating oil.
There are jets at the base of the cylinders from which oil is sprayed to cool the pistons.



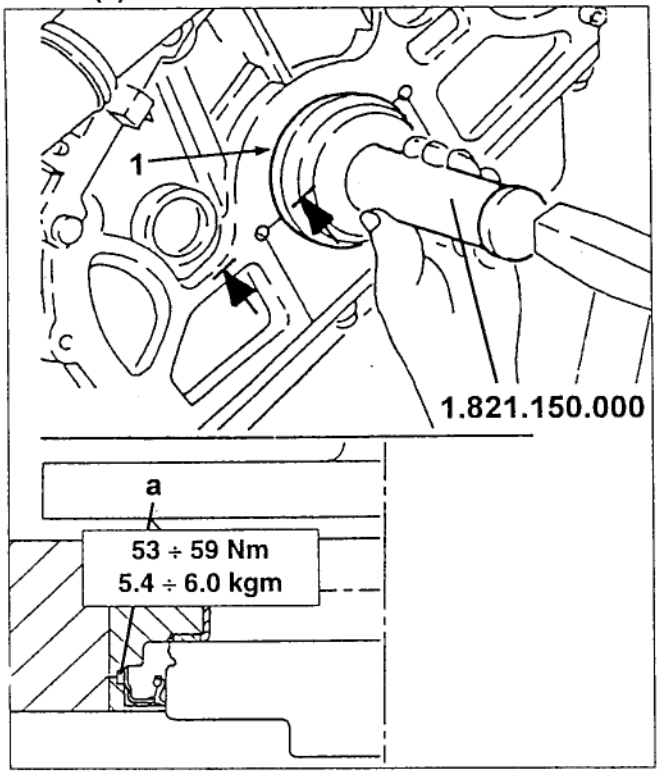
- Turn the crankcase on the overhaul stand.
1. Fit the connecting rod caps and half-bearings on the bank. Address the safety notch towards the notch on the connecting rod cap.
NOTE: The cylinder number is shown on the side of each connecting rod cap. When refitting, this number should be on the same 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.

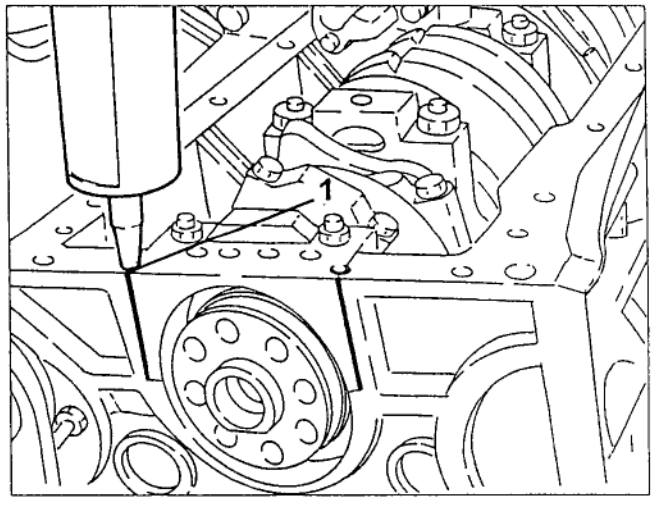
Oil sump refitting

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.

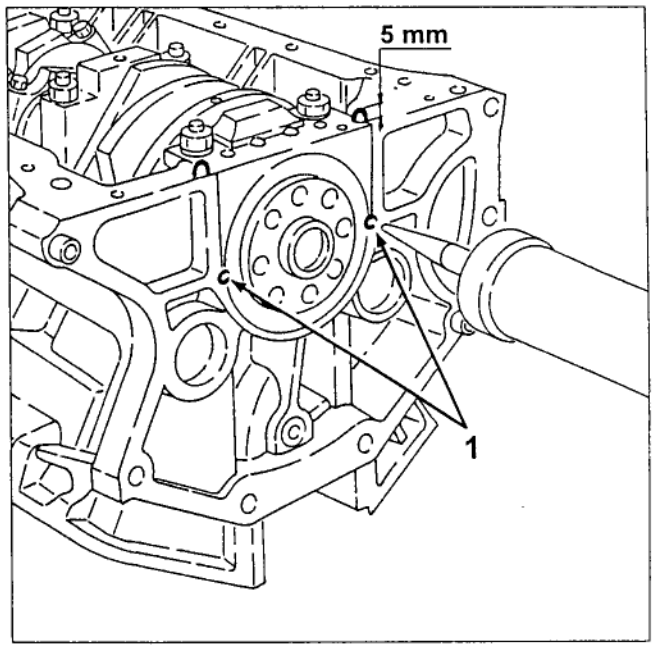


For pre-change versions (to engine no. 02054)
1. Apply "DOW CORNING 7091" silicon sealant with a mechanical gun through the holes shown in the figure.

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



For pre-change versions (to engine no. 02055)
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.



MAIN AND ROD BEARING HALVES

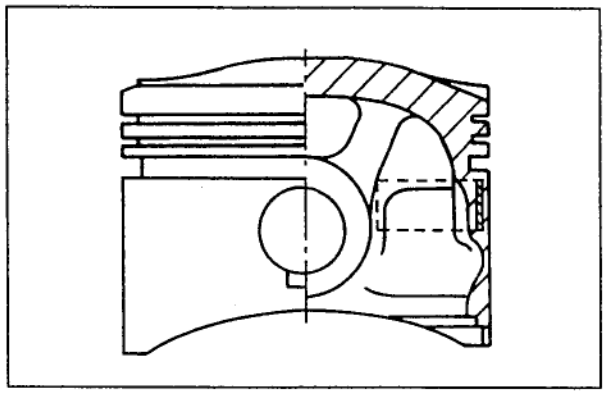
These are of the three-metal, thin shell type, divided into three dimensional classes, for the main bearing halves and two for the connecting rod bearing halves.

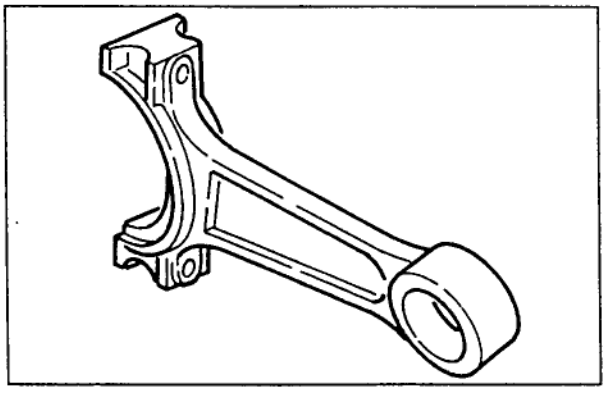
FLYWHEEL

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

PISTONS - CONNECTING RODS

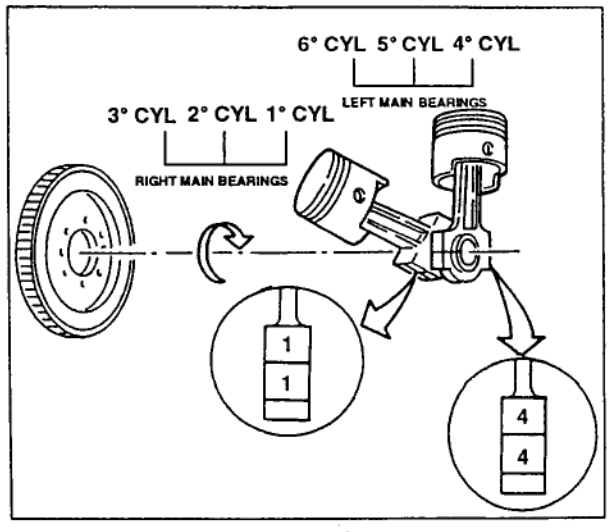
The pistons are in aluminium-silicium alloy with self-heating inserts and are divided into three dimensional classes. To ensure correct assembly an arrow is stamped on the piston crown to indicate the direction of rotation of the engine.



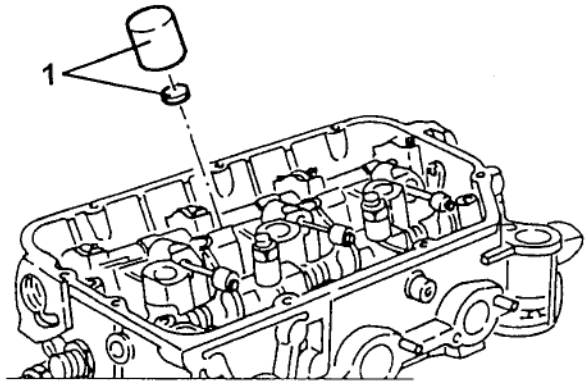


The connecting rods are in hardened and tempered alloy steel with a bushing in copper alloy force-fitted for coupling with the piston gudgeon pin.
As the gudgeon pins are floating on the piston hubs and on the connecting rod small end, their side movement is stopped by two expansion circlips housed in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

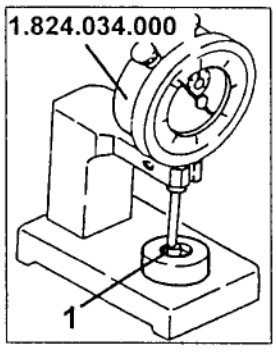
Each connecting rod is stamped with the number of the cylinder to which it refers; this number is towards the righthand side of the connecting rods of the right main bearings and on the lefthand side of the connecting rods of the left main bearings. Also the connecting rod caps have the number of the cylinder to which they refer on one side. When refitting this number should be on the same side as the one stamped on the connecting rod big end.



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



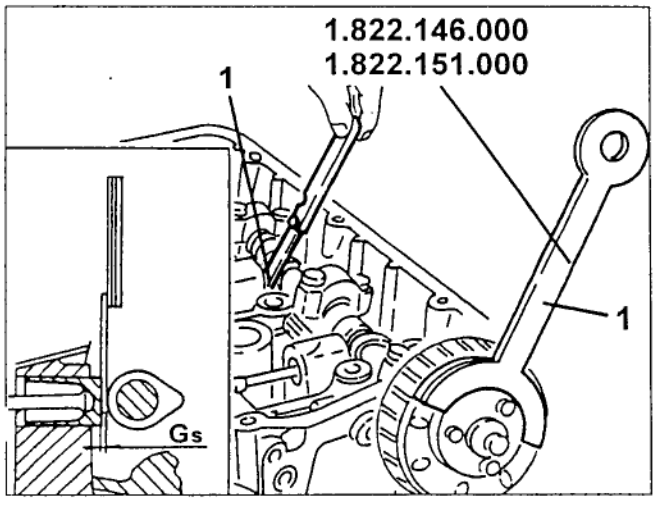
1. Measure cap thickness with gauge no. 1.824.034.000. Then choose from the no. 1.820.150.000 (R.9.0001) set the suitable tool to restore correct tappet clearance according to the measured values.



- Refit the cups, the camshaft and the respective caps. Fasten the caps at the prescribed torque and check the intake tappet clearance.

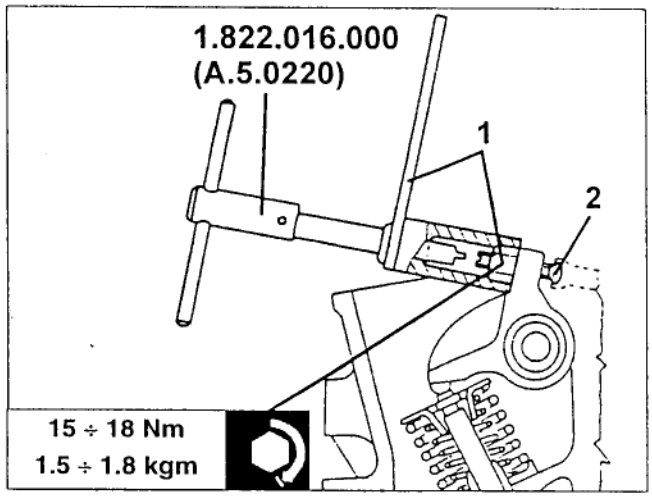
Exhaust side tappets

- Temporarily fit the hub and the camshaft drive pulley.
1. Turn the camshaft with tools no. 1.822.146.000 and no. 1.822.151.000. Then measure the clearance between lowered cam radius and corresponding cup. Check whether the value falls within prescriptions.



"Gs" exhaust tappet clearance
0.225 ÷ 0.250 mm

- If the exhaust tappet clearance is not included within the prescribed values, adjust as follows:
1. With tool no. 1.822.016.000 (A.5.0220) intermediate lever, loosen the adjustment screw lock nut.
2. Turn the adjustment screw until the prescribed exhaust tappet clearance is reached with the same tool.
- Torque the lock nut and check tappet clearance.

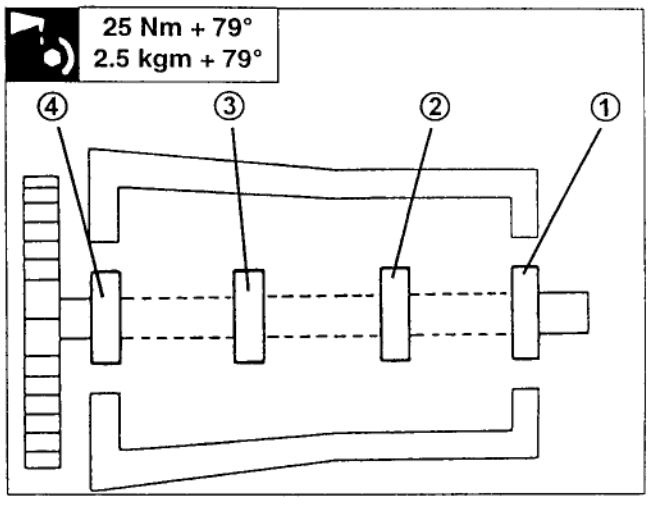


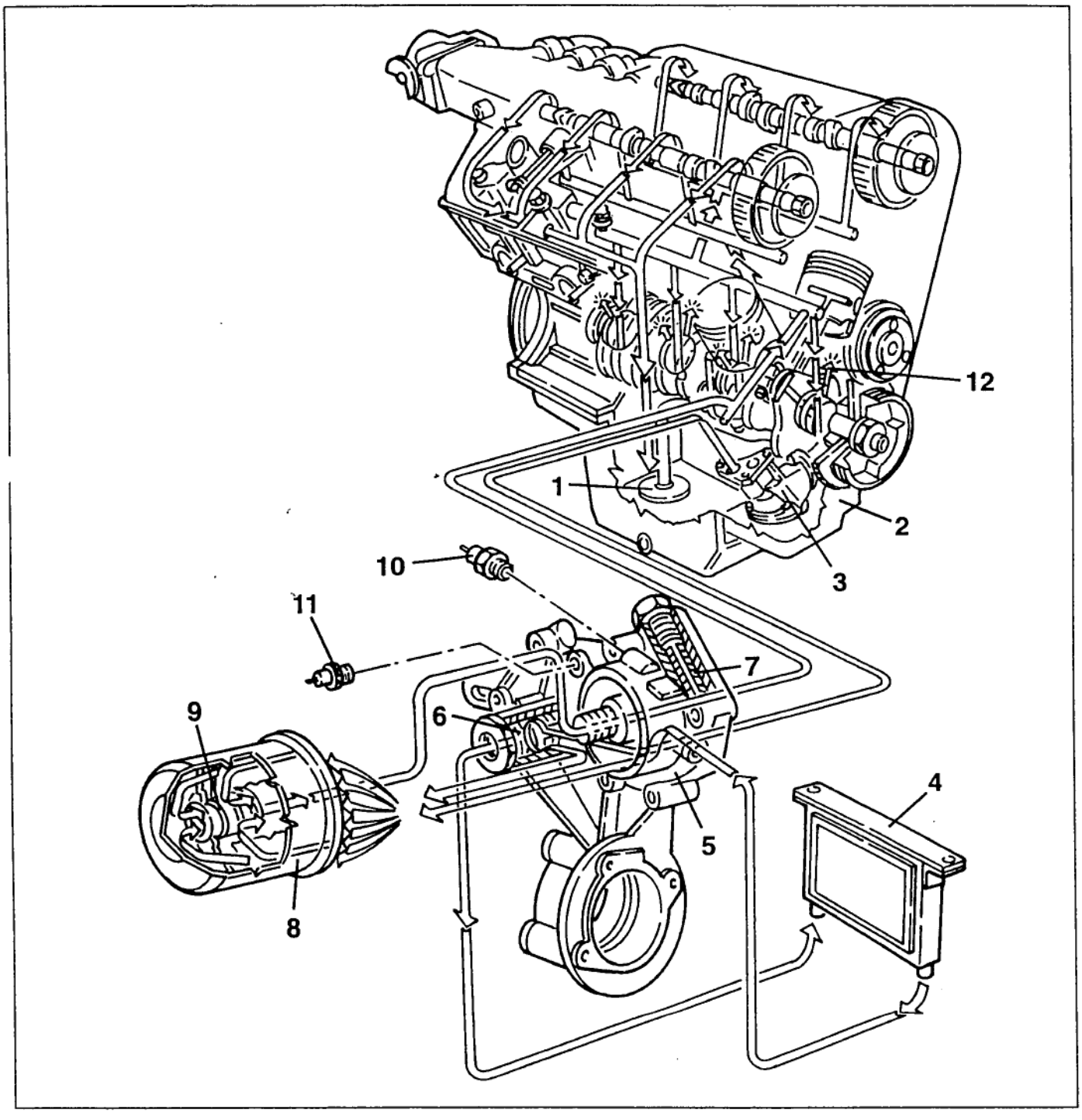
Crankshaft refitting

- Fit the crankshaft with half-bearings and thrust rings on the crankcase.
NOTE: Refit the thrust half-rings with the grooved surface 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.





1. *Suction device*
2. *Oil sump*
3. *Oil pump*
4. *Oil radiator*
5. *Oil filter support*
6. *Thermostatic valve*
7. *Oil pressure limiting valve*
8. *Oil filter*
9. *By-pass valve*
10. *Engine oil temperature transmitter*
11. *Low engine pressure warning light sensor*
12. *Spray jets*

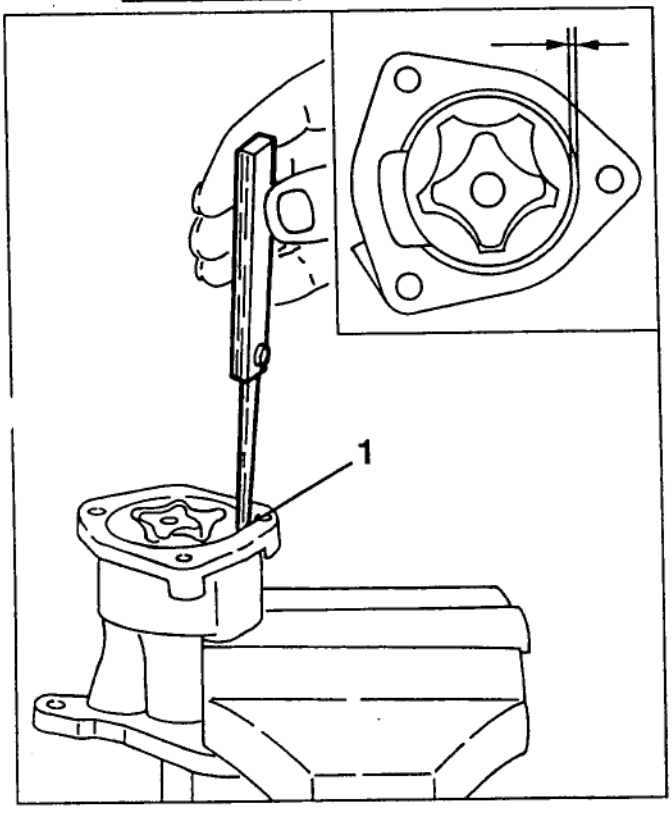
Checking the engine flywheel

- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
- working under the press remove the old ring gear;
- accurately clean the contact surfaces of the new ring gear and of the flywheel;
- evenly heat the new ring gear to 120° ÷ 140°C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

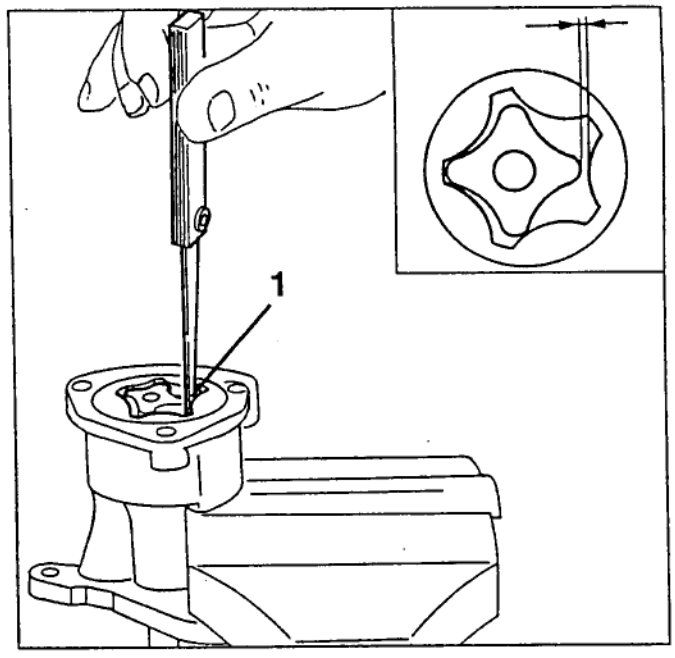
'. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.170 ÷ 0.275 mm



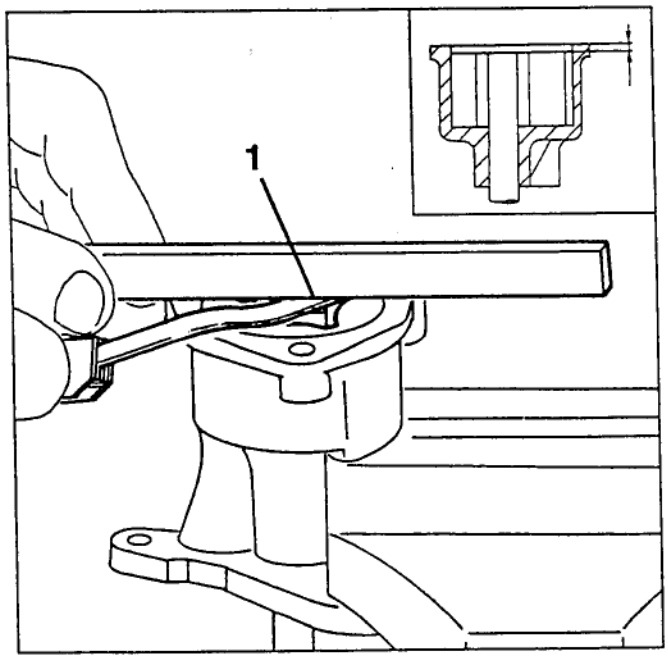
1. Check that the clearance between the lobe of the inner gear and that of the driven gear is within the specified limits.

Clearance between driven gear and inner gear
0.040 ÷ 0.290 mm



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

Clearance between pump casing rest surface and upper side of gears
0.025 ÷ 0.075 mm

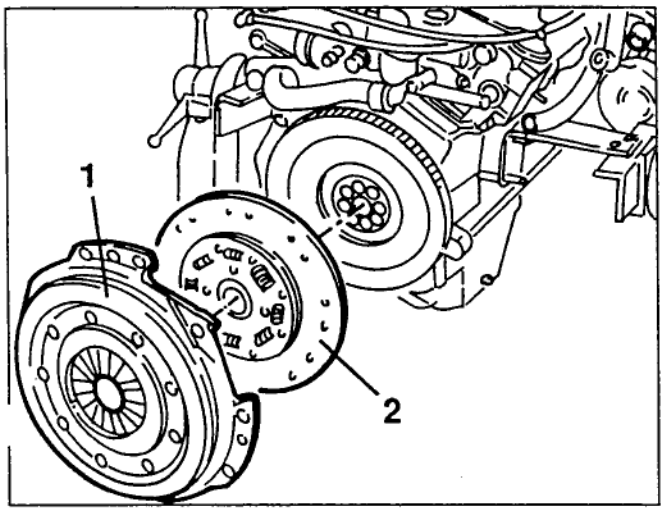


- Using a torque meter, check that the characteristic data of the engine oil pressure limiting valve control spring are within the specified limits.

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

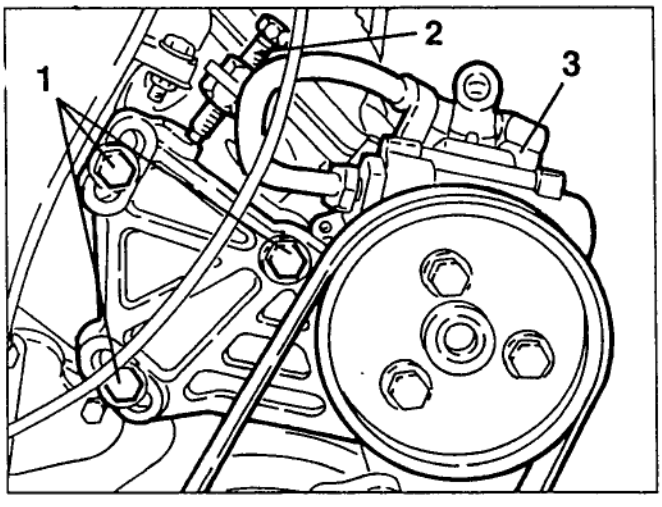
REMOVING THE CLUTCH PLATE

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



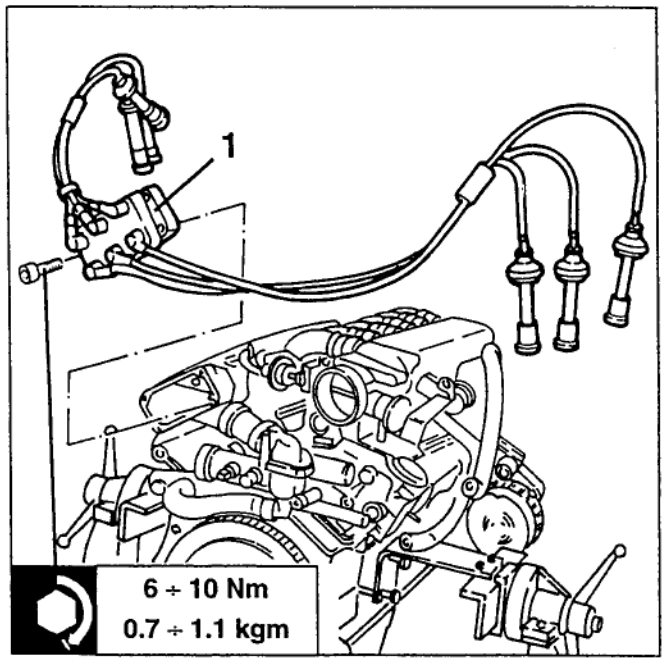
REMOVING THE POWER STEERING PUMP

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

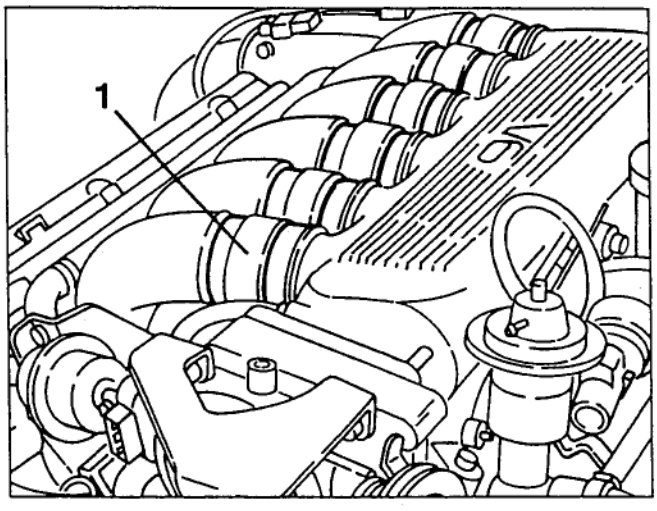


REMOVING THE AIR INTAKE BOX

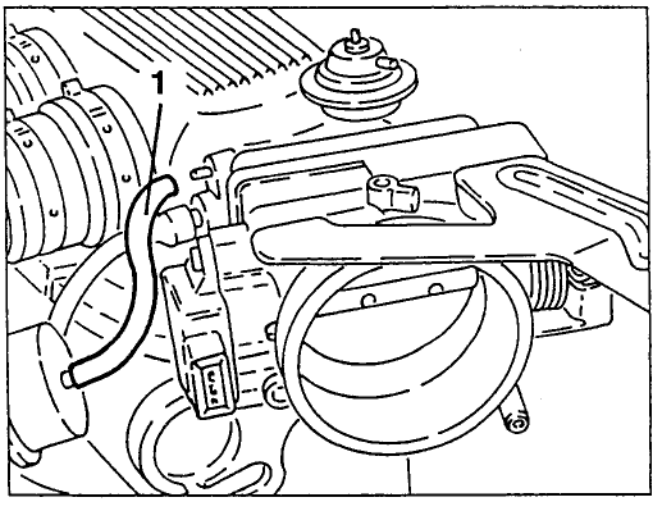
1. Slacken the ignition coil fastening screws, then remove the coils complete with high voltage cables after disconnecting them from the spark plugs.



1. Slacken the clamps fastening the air intake ducts to the intake box.



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



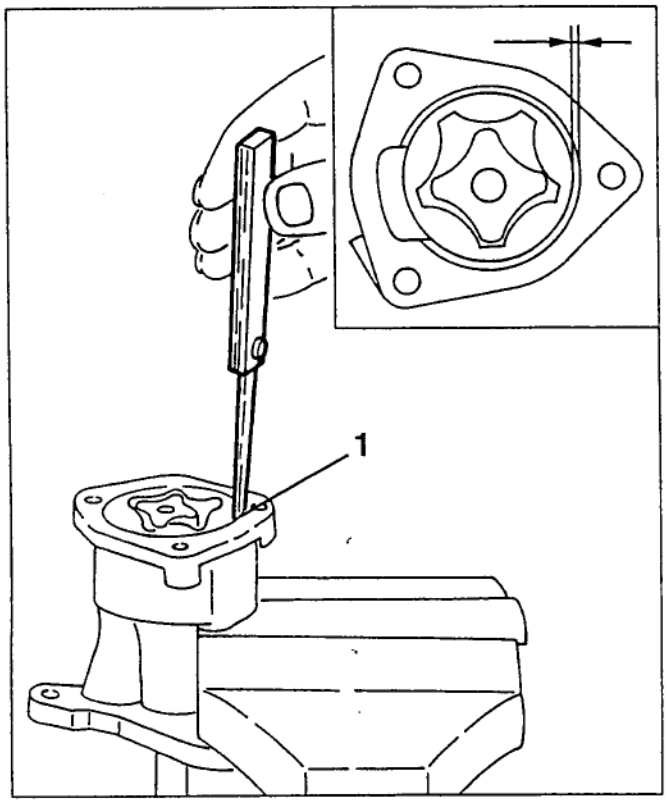
Checking the engine flywheel

- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
• working under the press remove the old ring gear;
• accurately clean the contact surfaces of the new ring gear and of the flywheel;
• evenly heat the new ring gear to 120° ÷ 140°C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

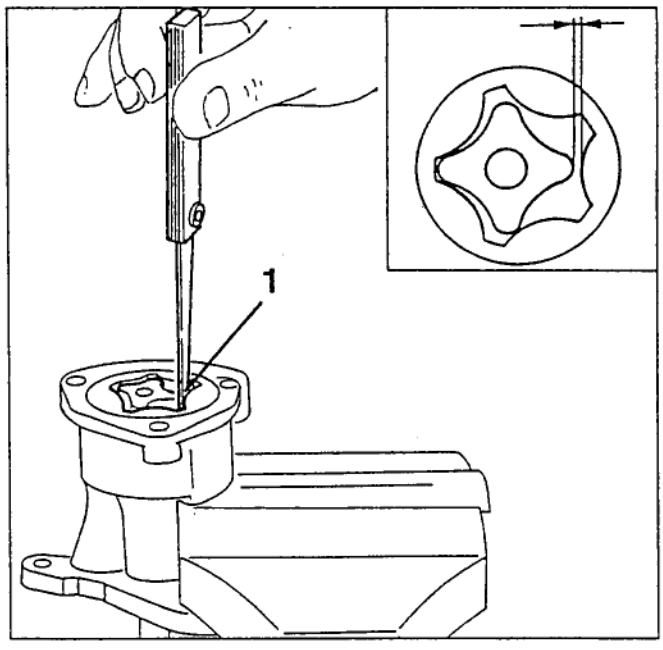
1. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.170 ÷ 0.275 mm



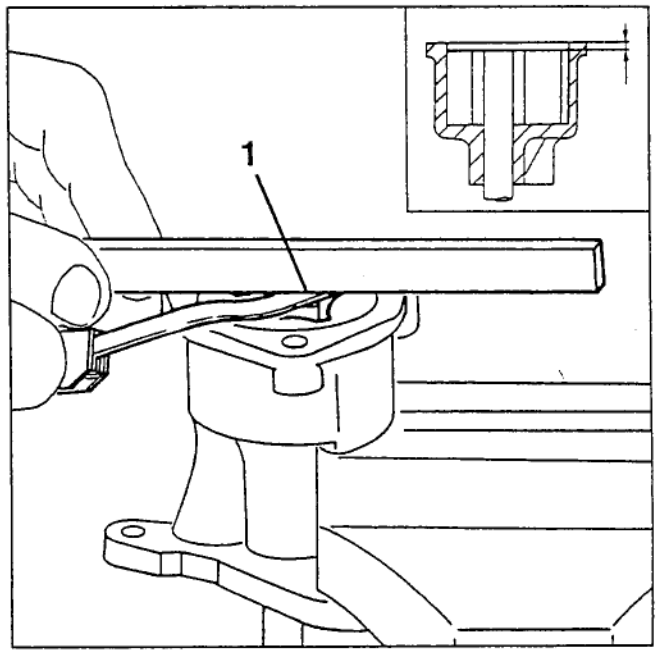
1. Check that the clearance between the lobe of the inner gear and that of the driven gear is within the specified limits.

Clearance between driven gear and inner gear
0.040 ÷ 0.290 mm



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

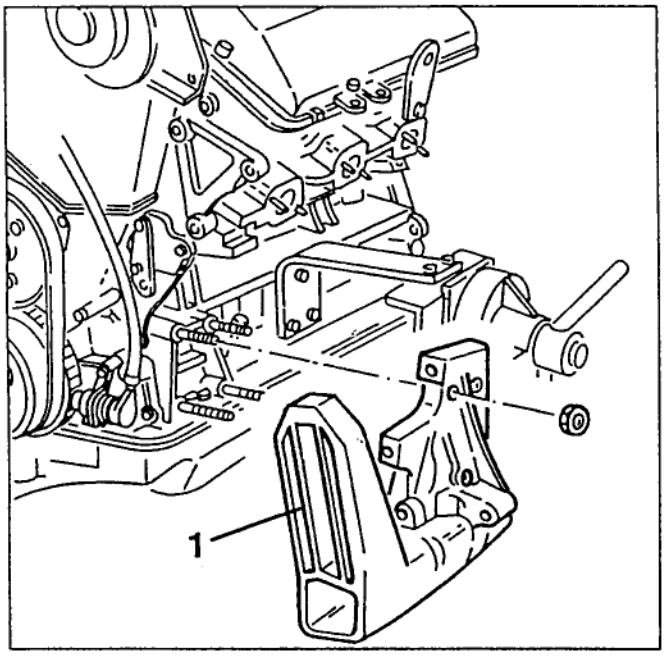
Clearance between pump casing rest surface and upper side of gears
0.025 ÷ 0.075 mm



- Using a torque meter, check that the characteristic data of the engine oil pressure limiting valve control spring are within the specified limits.

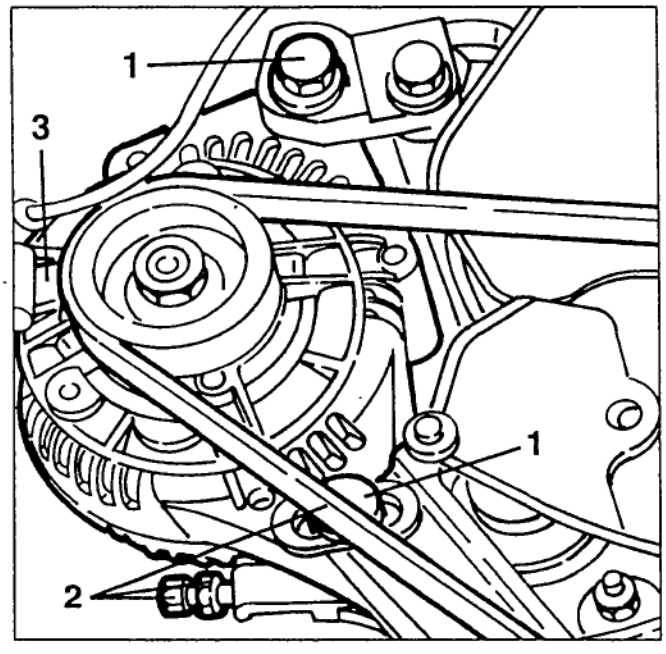
Spring length	
With spring free	54 mm
With static load (14.6 kg)	36 mm
With dynamic load (21 kg)	28 mm

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

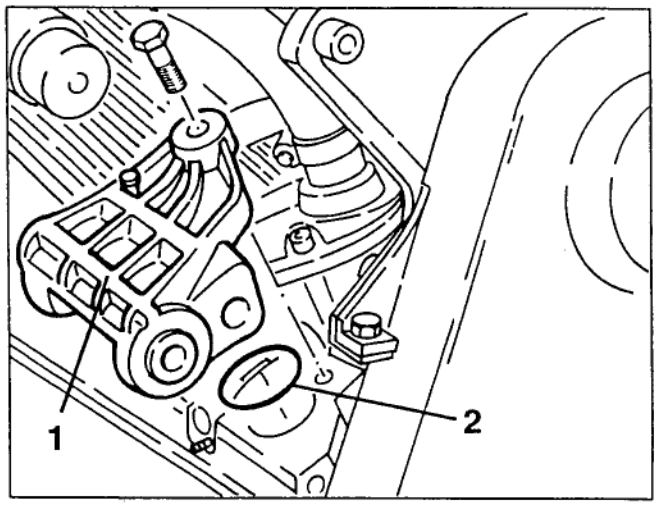


REMOVING THE ALTERNATOR

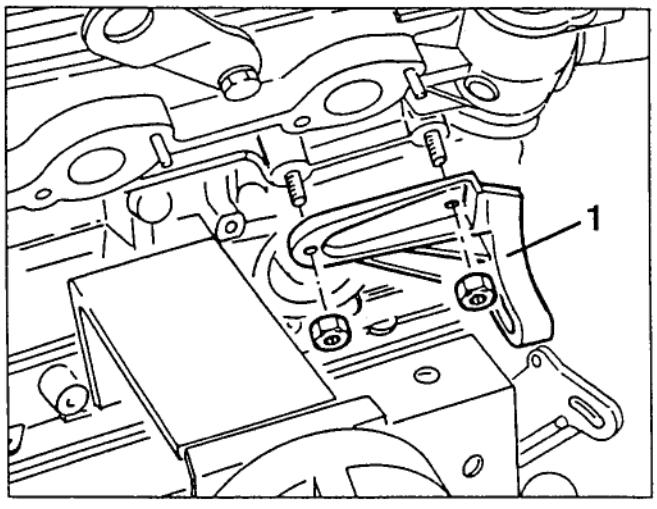
1. Slacken the two bolts fastening the alternator to the support brackets.
2. Loosen the locknut, slacken the micrometric tensioner screw, then prise and remove the alternator - water pump drive belt.
3. Completely back off the two bolts loosened previously and remove the alternator.



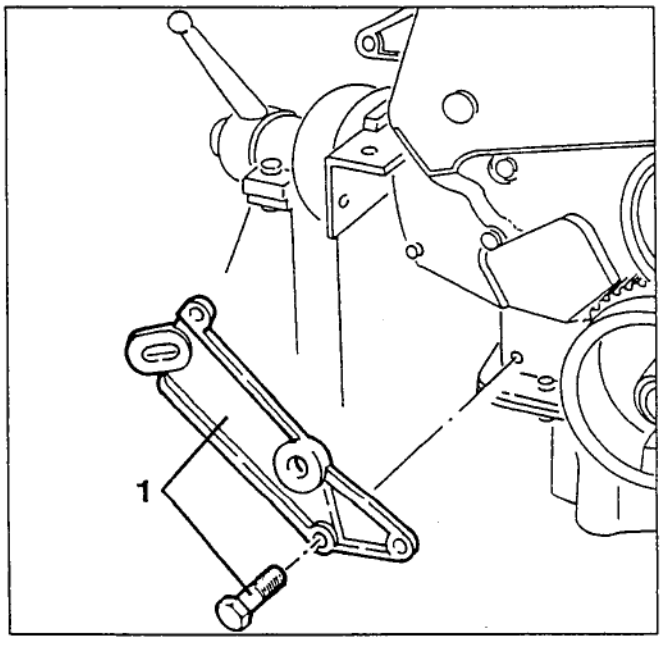
1. Remove the upper alternator support bracket.
2. Remove the O-Ring.



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



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



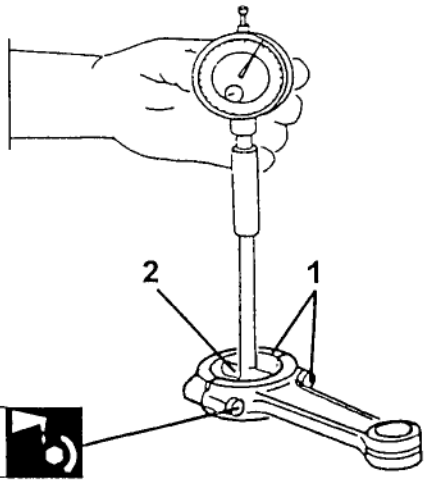
- Calculate the play between pins and respective piston seats. Check whether the value falls within prescriptions.

Play between pins and piston seats
0.006 ÷ 0.012 mm

Play between connecting rod journal and respective half-bearings

1. Fit the connecting rod half-bearings in the connecting rod big end and on the respective cap. Then assemble, fastening the screws at the prescribed torque.
2. Measure the connecting rod big end internal diameter and check whether it falls within the prescribed values.

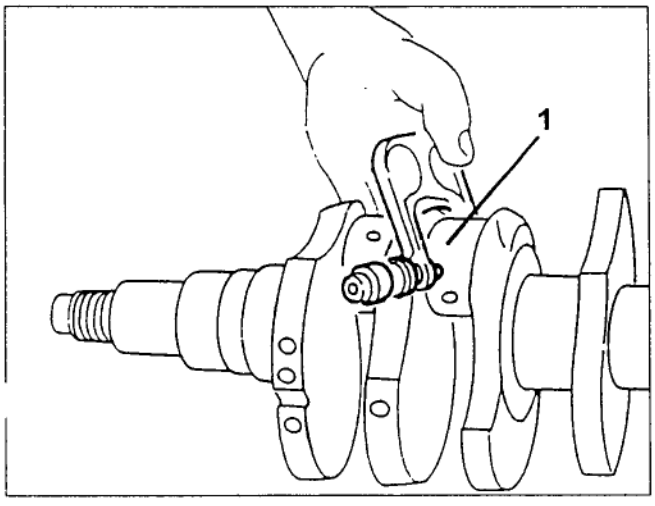
Connecting rod half-bearing internal diameter	
Class A (Red)	52.021 ÷ 52.050 mm
Class B (Blue)	52.013 ÷ 52.042 mm



53 ÷ 59 Nm
5.4 ÷ 6.0 kgm

1. Measure the connecting rod journal diameter and check whether it falls within the prescribed values.

Connecting rod journal diameter	
Class A (Red)	51.990 ÷ 52.000 mm
Class B (Blue)	51.980 ÷ 51.990 mm



NOTE: The crankshaft nitriding treatment does not allow re-facing. Consequently, it should be replaced if excessively worn.

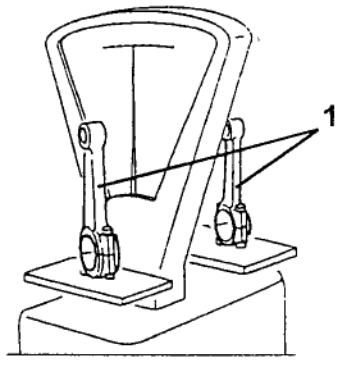
- Calculate the play between connecting rod journals and the respective half-bearings. Check whether the value falls within prescriptions.

Connecting rod journals and respective half-bearing diameter	
Class A (Red)	0.021 ÷ 0.060 mm
Class B (Blue)	0.023 ÷ 0.062 mm

Connecting rod check

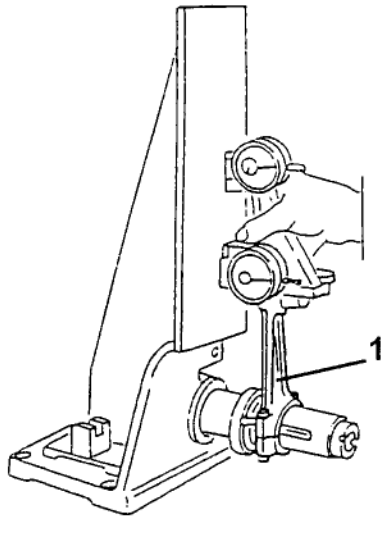
1. Check the difference in weight between connecting rods with half-bearings, caps and screws. Check whether the value falls within prescriptions.

Connecting rod weight difference
± 4 g

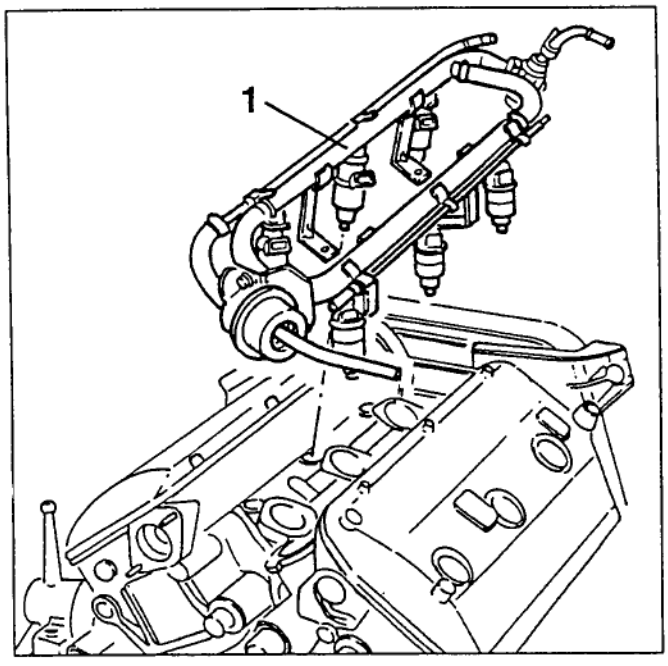


1. Check connecting rod squaring with a reference as shown in the figure.

NOTE: If squaring is not perfect, replace the connecting rod to avoid improper stress during engine operation with consequent irregular piston and connecting rod wear.

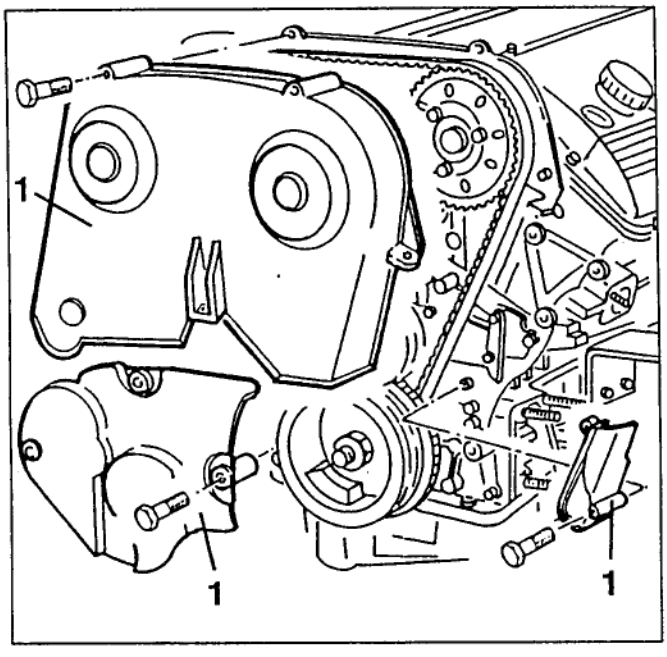


1. Slacken the fastening screws and remove the fuel distributor manifold complete with injectors, pressure regulator and pulse damper.

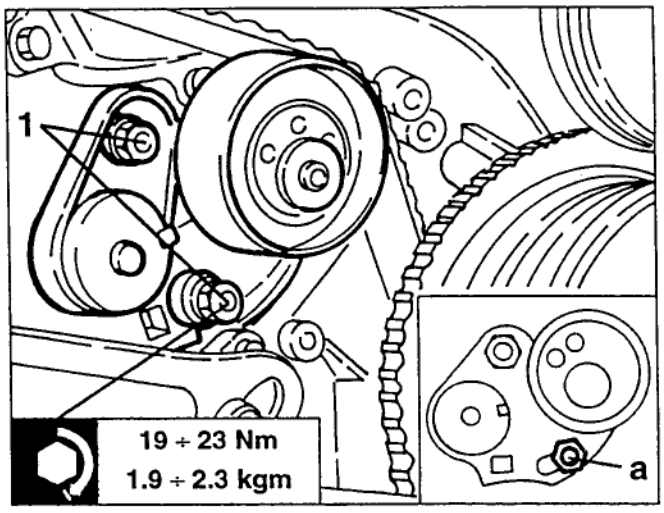


REMOVING THE TIMING GEAR BELT

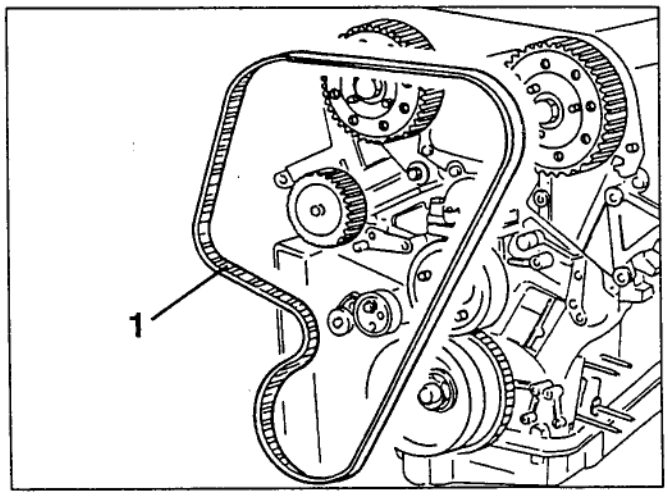
1. Slacken the fastening screws and remove the timing gear belt front covers.



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



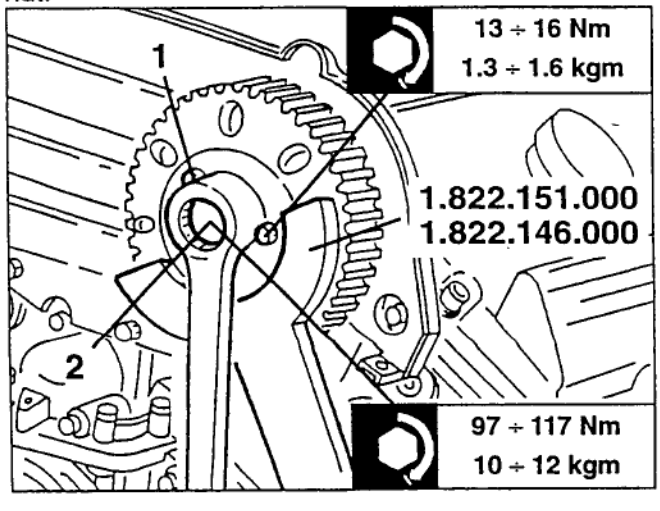
1. Remove the timing gear drive belt prising it off the camshaft toothed drive pulley and withdrawing it from the drive pulley.



- Completely slacken the two nuts fastening the timing gear belt tensioner and remove it.

REMOVING THE TIMING GEAR PULLEYS

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



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 plugs of the lubricating and cooling ducts and clean the dusct using a suitable detergent, then dry them with a jet of air and refit new plugs.
- Remove any traces of seals and sealant from the crankcase surfaces.

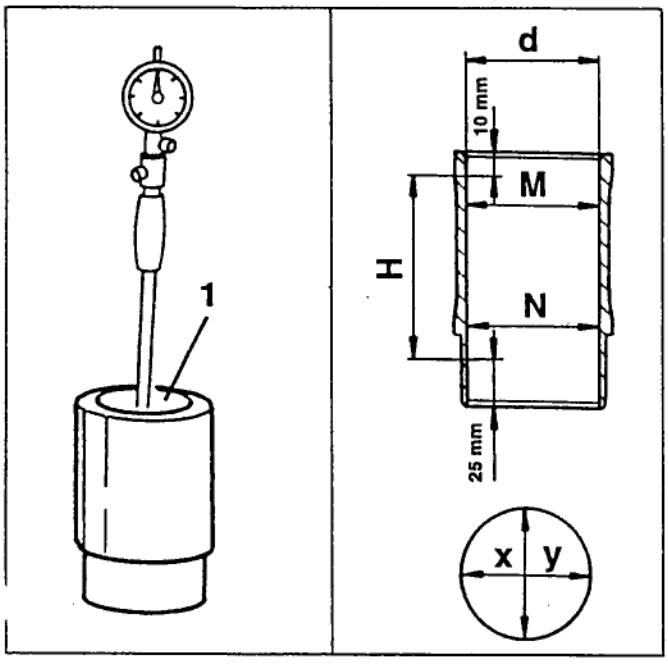
Checking the cylinder liners

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

Inside diameter "d" of cylinder liners	
Class A (Blue)	92.895 ÷ 92.994 mm
Class B (Pink)	92.995 ÷ 93.004 mm
Class C (Green)	93.005 ÷ 93.014 mm

Maximum cylinder taper
0.01 mm

Maximum cylinder ovalization
0.01 mm

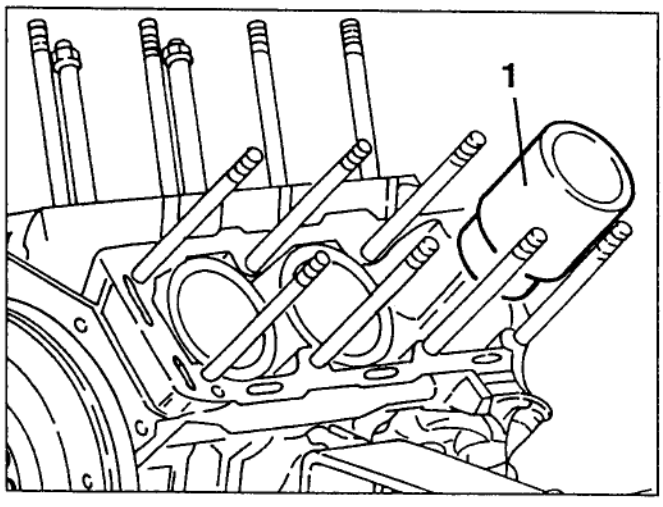


H : Area for dimensional inspection

Checking the cylinder liner protrusion (without seal rings)

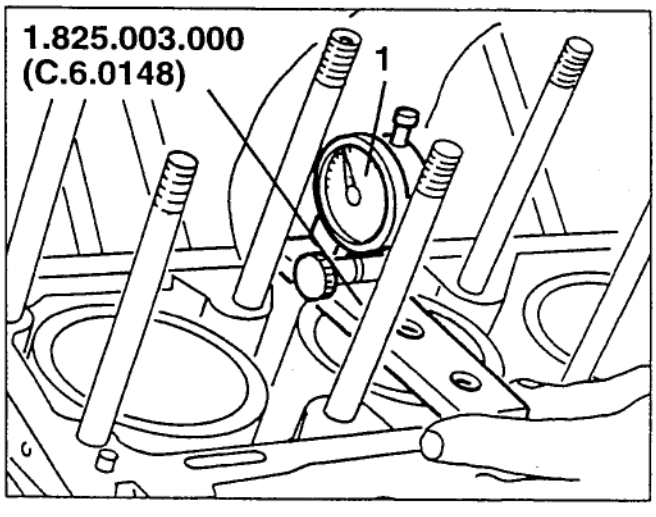
NOTE: This procedure, to be carried out as a preliminary control of the correct coupling between the cylinder liners and crankcase, should be carried out without the seal rings, therefore there is no need for the liner stopper tool, which if tightened to the specified torque would annul the thickness.

1. Insert the cylinder liners in the crankcase ensuring that they reach the stroke limit.

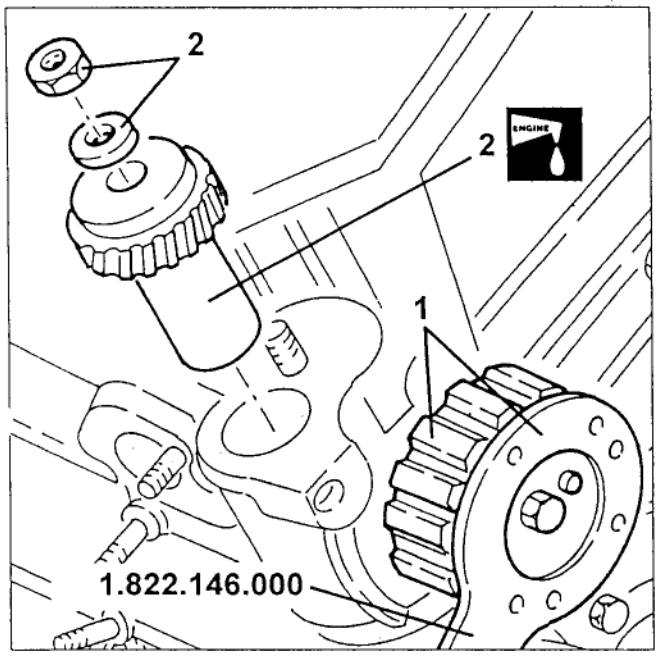


1. Assemble tool no. 1.825.003.000 (C.6.0148) complete with centesimal dial gauge suitably set to zero, on the crankcase first on one side and then on the other so that the feeler rests on the edges of the cylinder liner and check that the protrusion is within the specified tolerances.

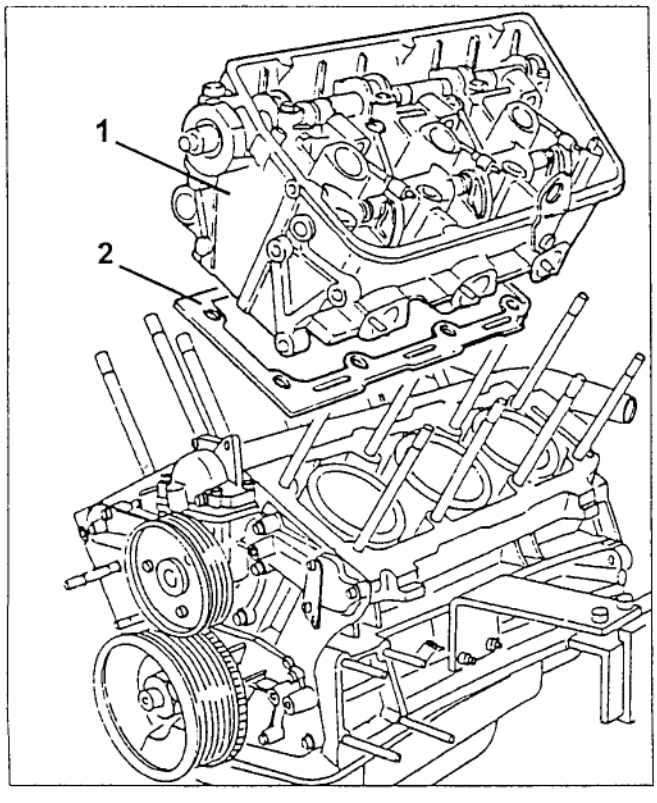
Cylinder liner protrusion from crankcase
0.01 ÷ 0.06 mm



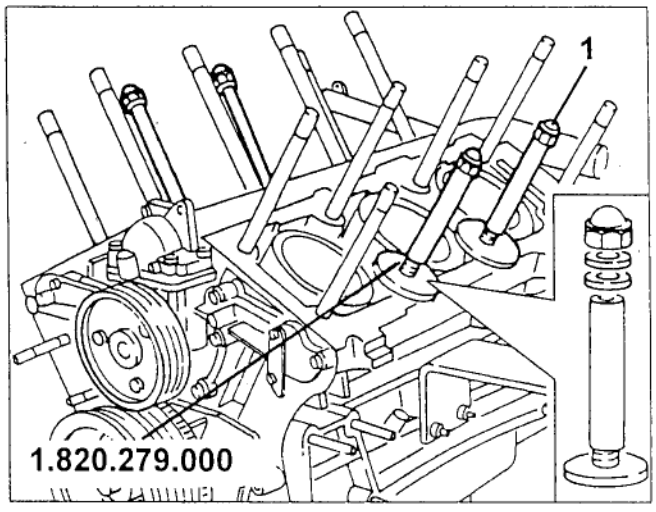
Proceed as follows (right-hand cylinder head only):
1. Lock engine oil pump drive pulley rotation with tool no. 1.822.146.000.
2. Loosen the fastening nut and remove the oil pump intermediate drive gear from its seat.



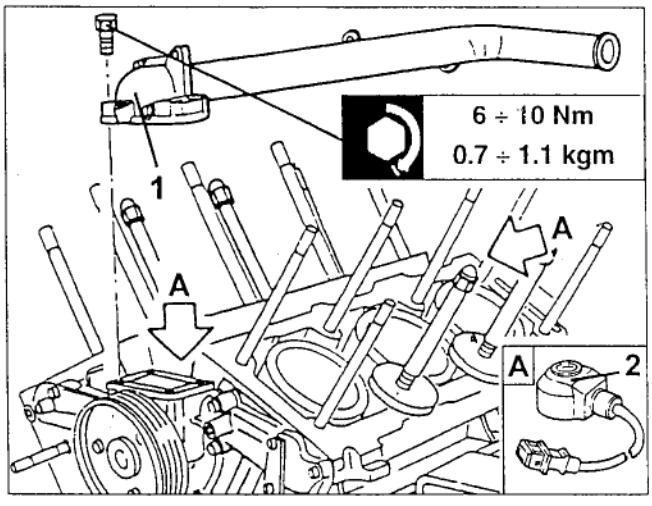
1. Loosen the fastening nuts and remove the engine crankcase cylinder head.
2. Remove the respective seals.



1. Fit liner retainer tools no. 1.820.279.000.

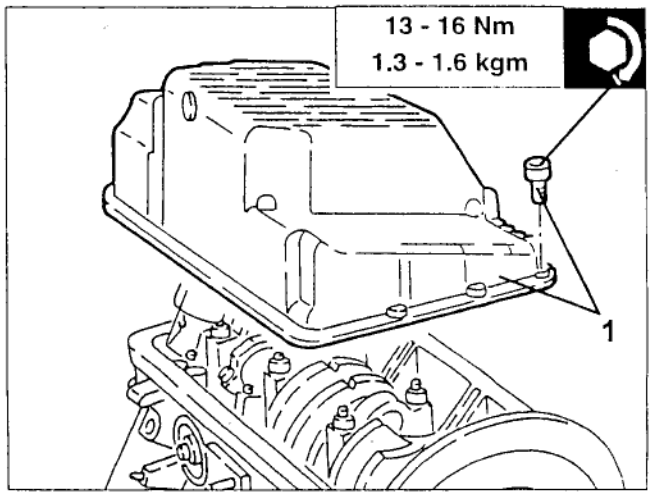


1. Loosen the fastening screws and remove the pump coolant return manifold.
2. Loosen the screws and remove the knock sensors.



OIL PUMP REMOVAL

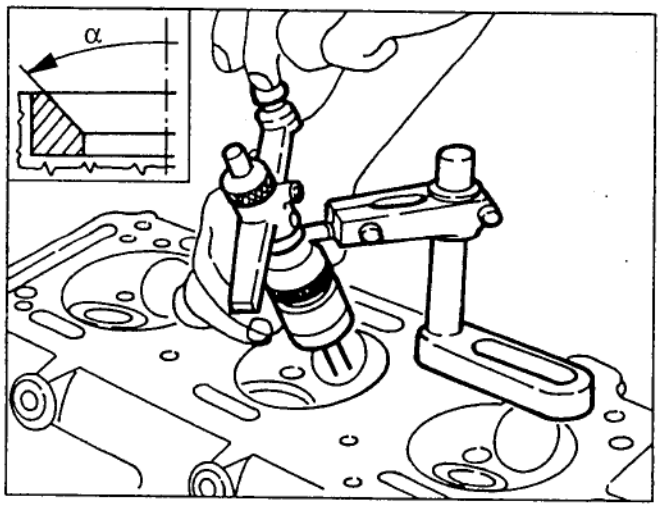
- Turn the engine on the overhaul bench.
1. Loosen the fastening screws and remove the oil sump.



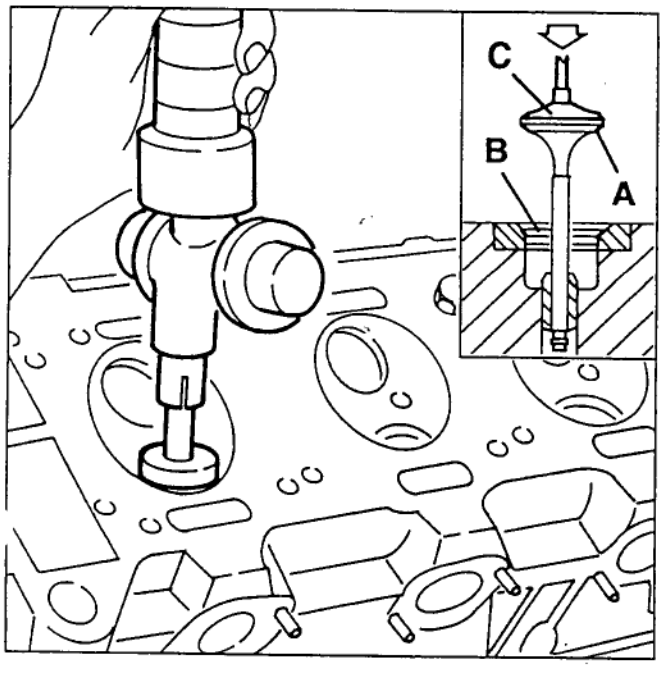
Turning the valve seats

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

Valve seat taper "α"
90° ± 20'



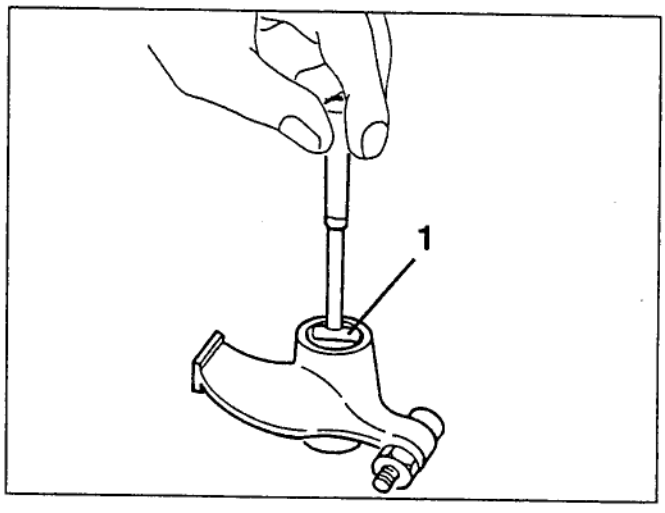
- After machining, grind each valve in its seat as follows:
- coat the contact surfaces "A" and "B" of the valves and their seats with abrasive paste (SIPAL AREXONS Carbosilicium for valves);
- lubrificate the valve stem with engine oil;
- fit the lower surface of the valve mushroom to the suction cup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



Checking the clearance between rockers and support shaft

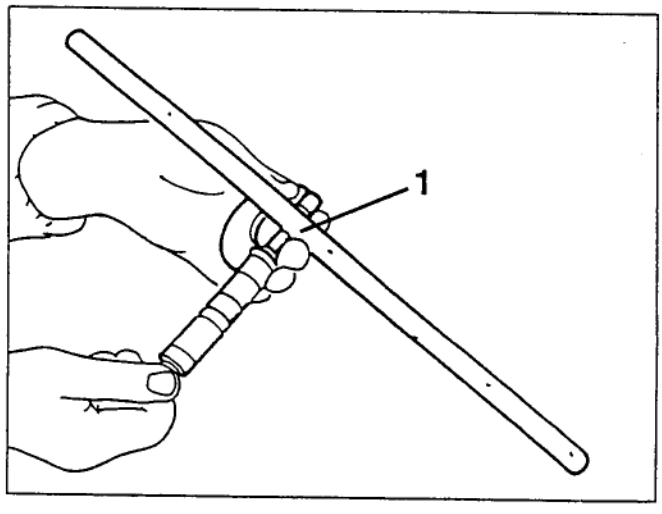
1. Check that the inside diameter of the rockers is within the specified limits.

Inside diameter of rockers
16.010 ÷ 16.028 mm



1. Check that the diameter of the rocker shaft is within the specified limits.

Diameter of rocker support shaft
15.988 ÷ 16.000 mm



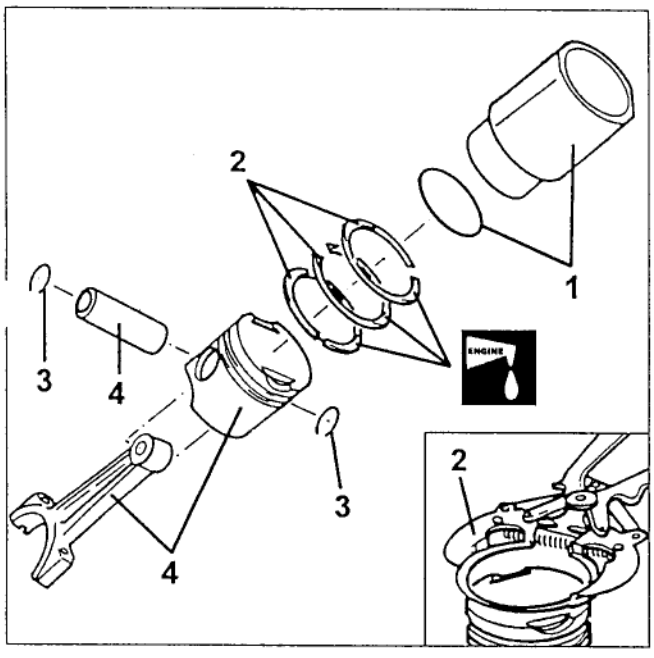
- Calculate the clearance between rockers and support shaft checking that it is within the specified limits.

Clearance between rockers and support shaft
0.010 ÷ 0.040 mm

1. Remove the cylinder liner and O-Ring.
2. Extract the gas rings and the oil scraper from the pistons with a suitable tool.

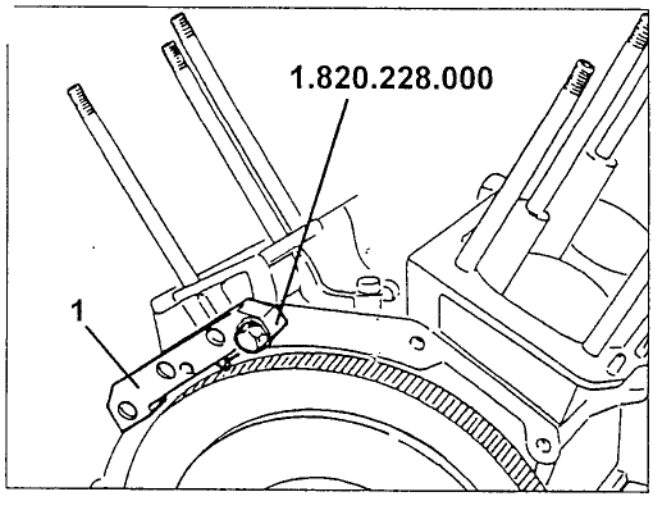
IMPORTANT: Be careful not to damage rings which could be re-used.

3. Extract the two pin snap rings.
4. Extract the pin and separate the piston from the connecting rod.



COOLANT PUMP REMOVAL

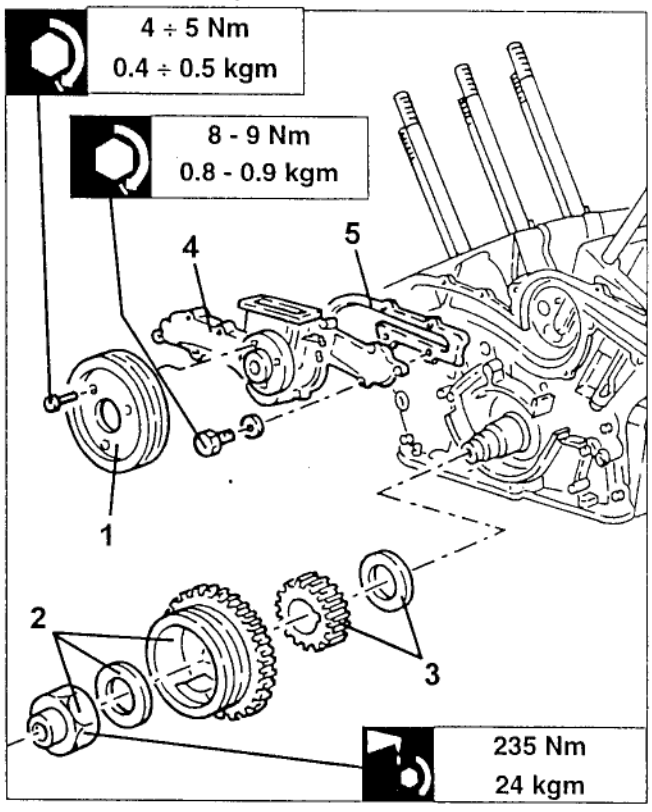
1. Remove the crankshaft rotation tool and fit the flywheel retainer no. 1.820.228.000.



1. Loosen the fastening screws and remove the coolant pump.
. Loosen the fastening nut and remove the auxiliary unit drive pulley.
3. Remove the timing belt pulley and thrust ring.

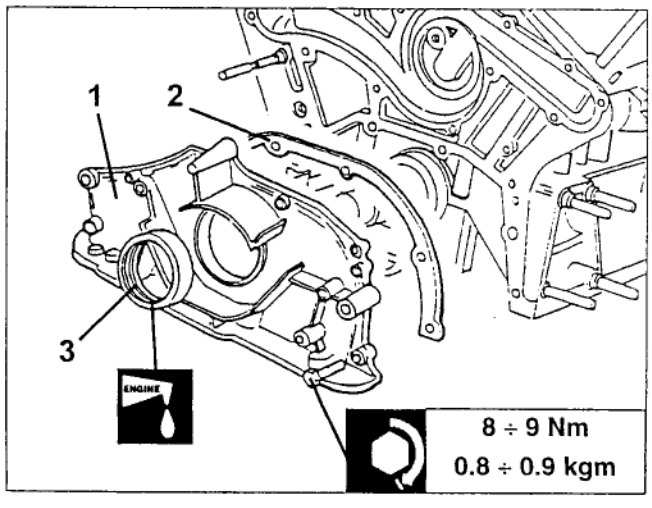
NOTE: When refitting, the thrust ring convex surface should face the front crankcase cover.

4. Loosen the fastening screws and remove the coolant pump.
5. Remove the respective seal.



FRONT CRANKCASE COVER REMOVAL

1. Loosen the fastening screws and remove the front crankcase cover.
2. Remove the respective seal.
3. Remove the front crankcase cover oil seal.

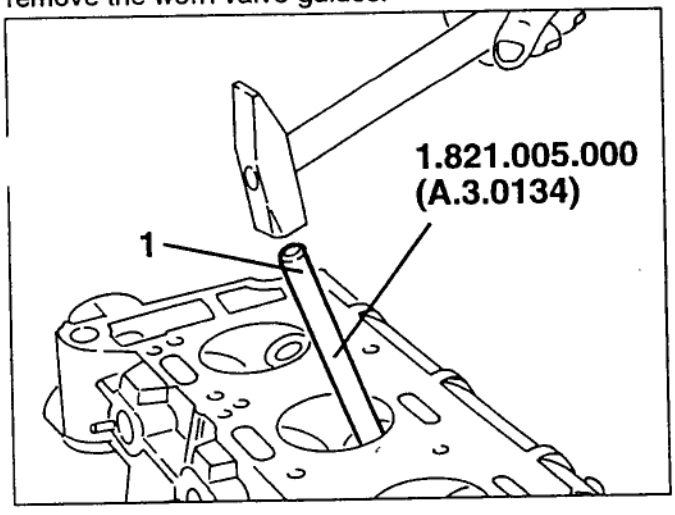


- Calculate the clearance between valve guides and valve stens and check that it is within the specified limits; if not, change any worn parts.

Radial clearance between valve guides and valve stems	
Intake	0.040 ÷ 0.090 mm
Exhaust	0.013 ÷ 0.043 mm

Changing the valve guides

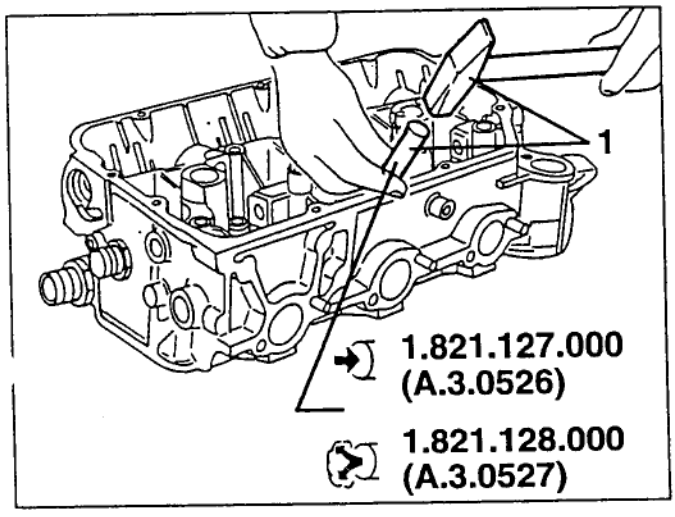
1. Using puller tool no. 1.821.005.000 (A.3.0134), remove the worn valve guides.



- Check that the outside diameters of the valve guides and their seats on the cylinder heads are within the specified limits and meet the assembly interference.

Outside diameter of valve guides	14.048 ÷ 14.059 mm
Diameter of valve guide seats	13.990 ÷ 14.018 mm
Seats - valve guide interference	0.030 ÷ 0.069 mm

1. Insert the new valve guides in their seats using the tools illustrated.



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

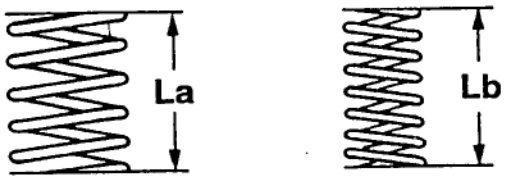
Inside diameter of valve guides
9.000 ÷ 9.015 mm

Checking the valve springs

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

NOTA: The resting planes must be parallel with one another and perpendicular to the axis of the spring with a maximum error of 2°.

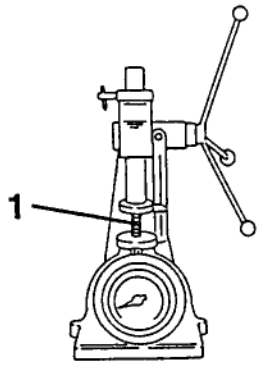
Free length of valve springs	
Outer spring "La"	44.6 mm
Inner spring "Lb"	44.1 mm



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 N (kg)
With valve closed	32.5	243 ÷ 252 (24.8 ÷ 25.7)
With valve open	23.5	470 ÷ 488 (47.9 ÷ 49.7)

Inner spring		
Spring length mm		Control load N (kg)
With valve closed	30.5	126 ÷ 130 (12.8 ÷ 13.3)
With valve open	21.5	222 ÷ 231 (22.7 ÷ 23.5)

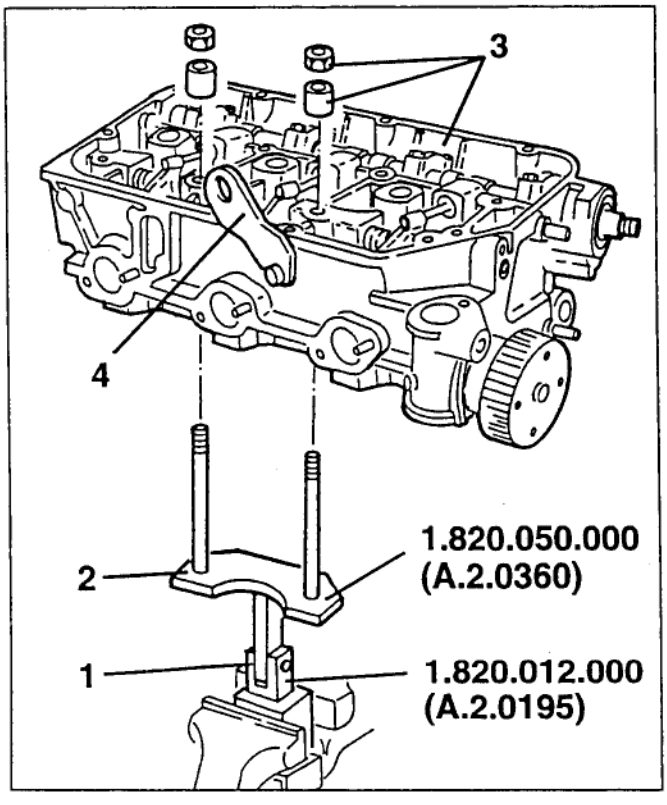


DIS-ASSEMBLING THE CYLINDER HEADS

NOTE: The dis-assembly procedures described refer to the right-hand cylinder head.
Proceed in the same way to dis-assemble the left-hand head.

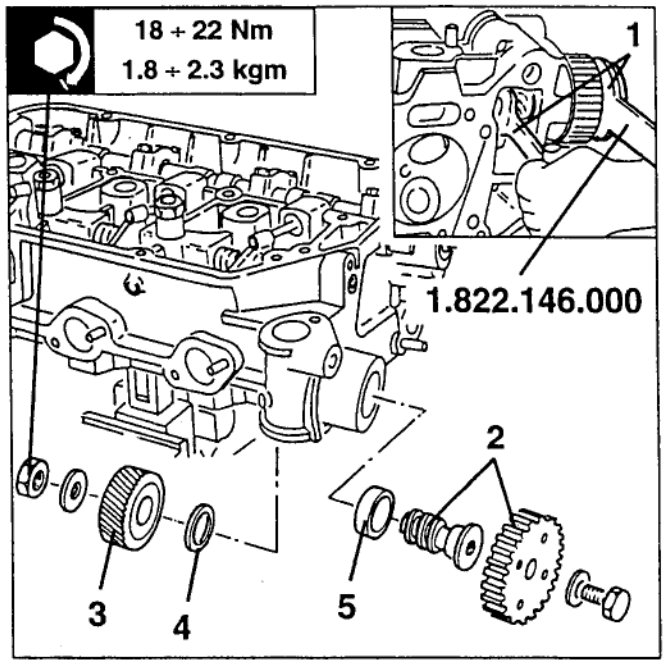
PRELIMINARY OPERATIONS

1. Clamp swivel support no. 1.820.012.000 (A.2.0195) in a vice.
2. Install fork no. 1.820.050.000 (A.2.0360) on the swivel support.
3. Fit the cylinder head on the fork studs and lock it in place using two suitable spacers and two nuts.
4. Slacken the fastening screw and remove the engine lifting bracket.

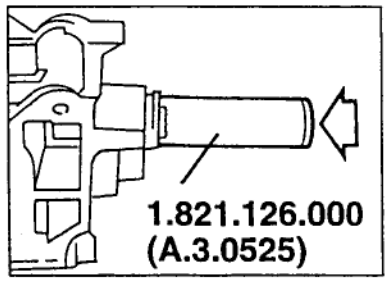


REMOVING THE OIL PUMP DRIVE PULLEY (Specific for the right-hand cylinder head)

1. Levering with tool no. 1.822. 146.000, slacken the oil pump drive pulley fastening bolt.
2. Withdraw the oil pump drive pulley and the corresponding shaft.
3. Retrieve the toothed gear.
4. Retrieve the spacer.
5. Prise and remove the oil ring.

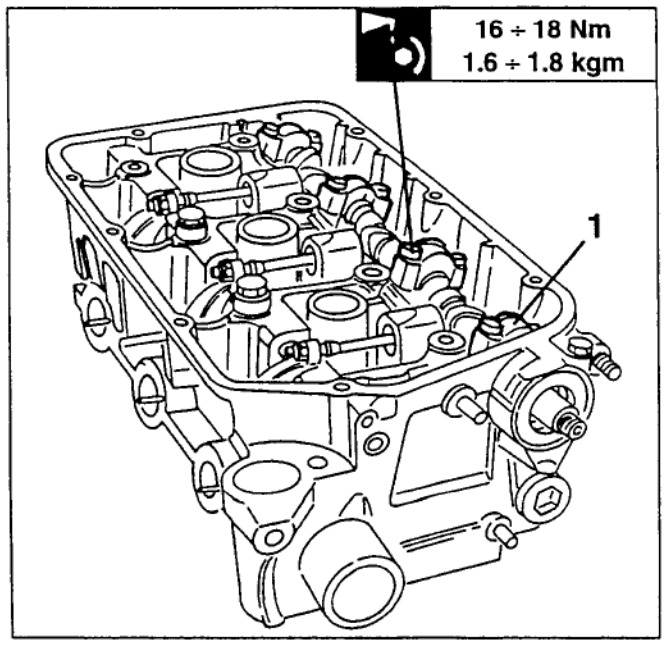


When refitting, insert a new oil ring using tool no. 1.821.126.000 (A.3.0525).



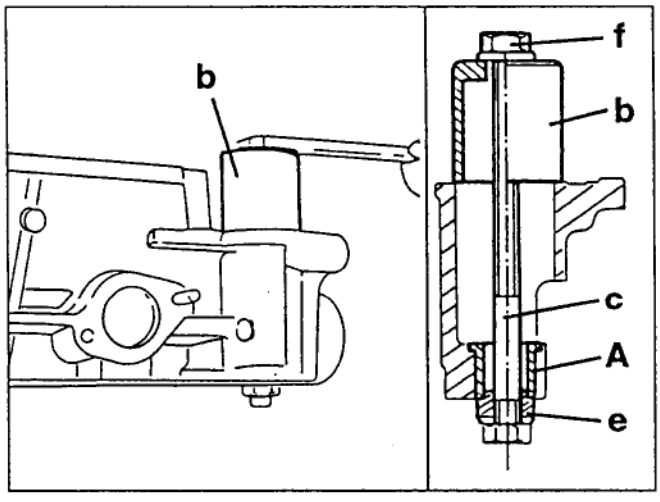
REMOVING THE CAMSHAFT

1. Slacken the fastening nuts and remove the camshaft caps.

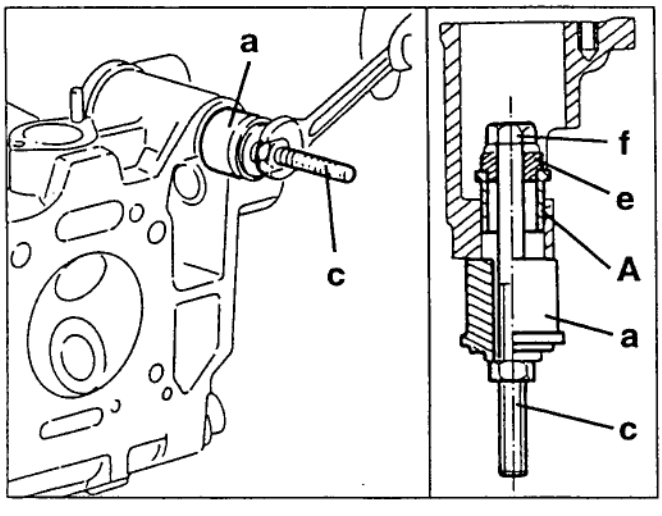


Changing the bushing for oil pump driving gear (specific for right-hand cylinder head)

- Remove bushing "A" for the oil pump driving gear, using tie-rod "c" complete with nut "f", the special washer "e" as puller tool and levering with the cup "b".

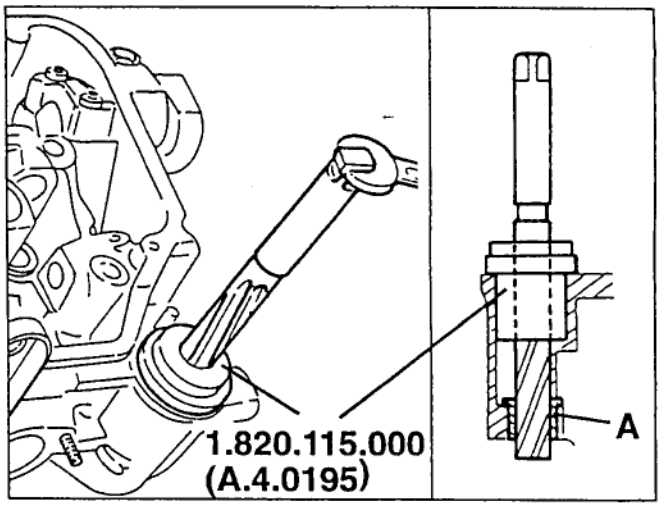


- Position a new bushing "A".
- Insert tie-rod "c" complete with nut "f" and special washer "e" as installing tool.
- From the opposite side to the tie-rod, insert the reaction coil "a" and complete insertion of the bushing "A".



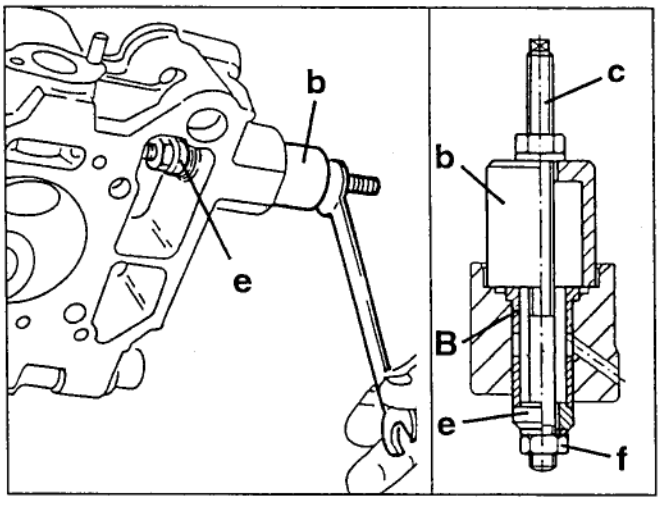
- After insertion, bushing "A" must be reamed to the specified dimension; for this purpose use guide tool no. 1.820.115.000 (A.4.0195) and a suitable reamer.

∅	Inside diameter (bore) of bushing "A" for oil pump driving gear
	19.000 ÷ 19.021 mm

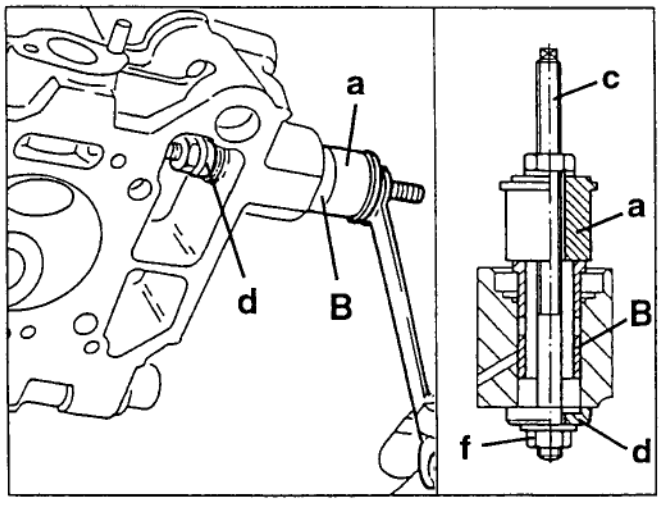


Changing the bushing for oil pump toothed driving pulley shaft (specific for right cylinder head)

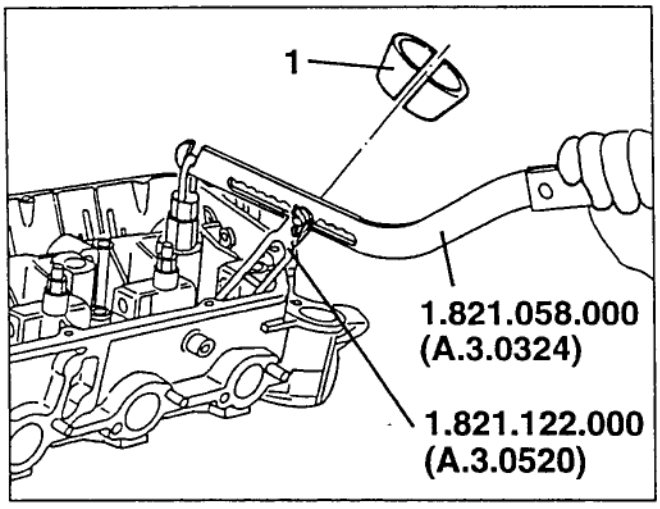
- Remove the bushing "B" for oil pump toothed driving pulley shaft, using tie-rod "c" complete with nut "f", the special washer "e" as puller tool and levering with the cup "b".



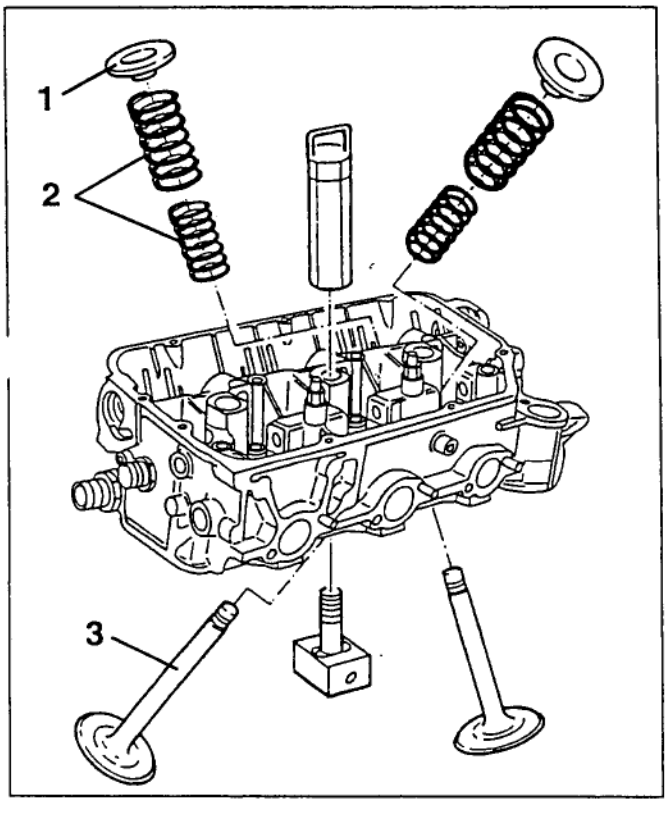
- Insert a new bushing "B" using tie-rod "c" complete with nut "f" and the coil "a" as installing tool and levering with flange "d".



1. Using lever no. 1.821.058.000 (A.3.0324) and cage no. 1.821.122.000 (A.3.0520) remove the half cones.

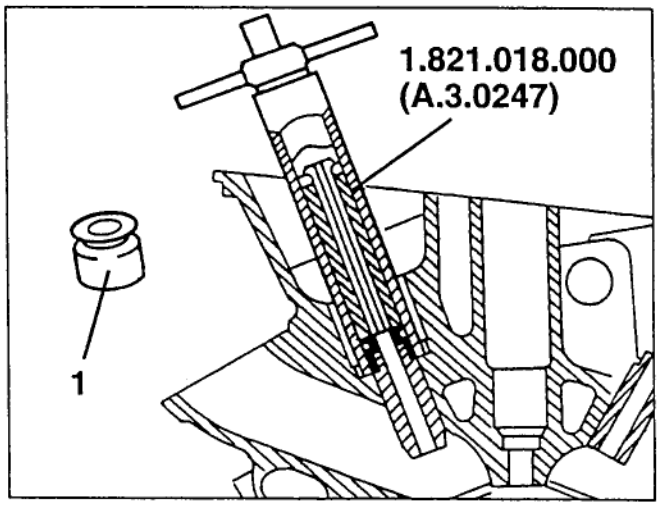


1. Remove the upper plates.
2. Remove the outer and inner springs.
3. Remove the tools used for removing the valves and remove the intake and exhaust valve pair.

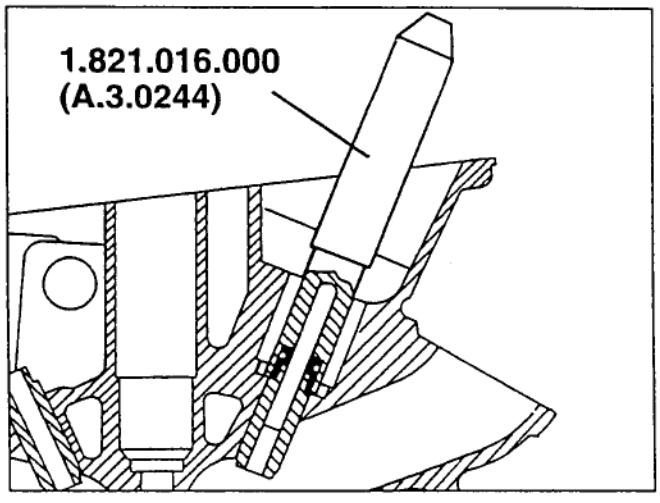


- Following the same procedure and using the same tools, remove the valves of the remaining cylinders.

1. Using puller tool no. 1.821.018.000 (A.3.0247), remove the oil seal caps.



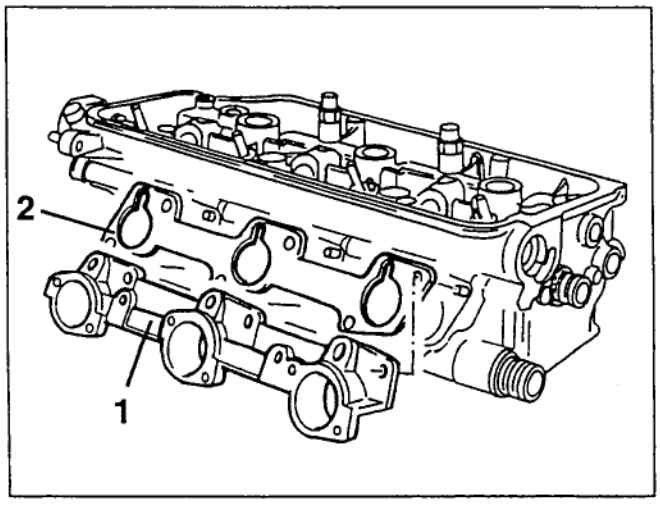
When refitting, insert new oil seal caps using tool no. 1.821.016.000 (A.3.0244).



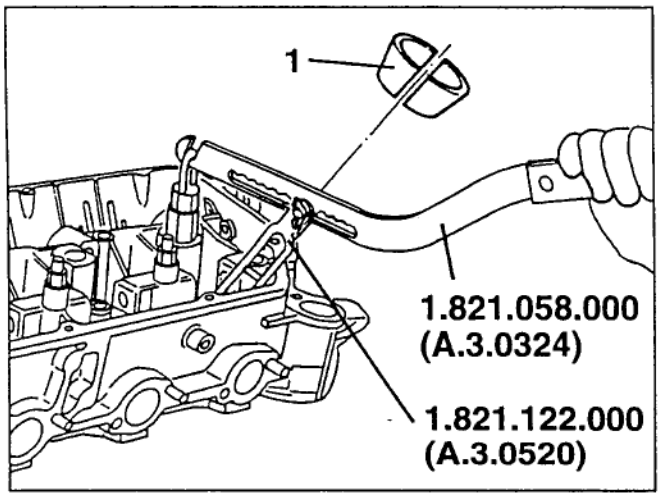
- Retrieve the valve lower plates.

REMOVING THE AIR INTAKE MANIFOLD

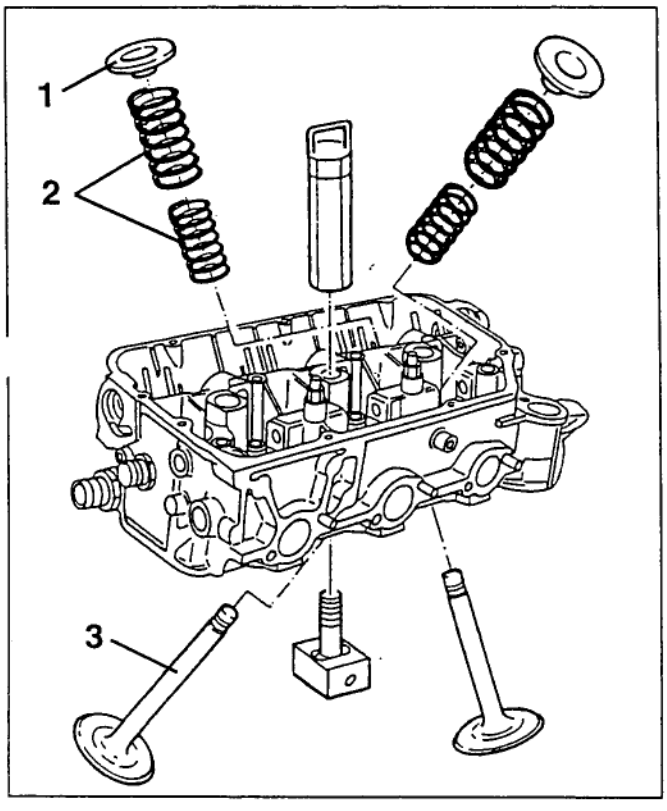
1. Slacken the fastening screws and remove the air intake manifold.
2. Remove the seal.



1. Using lever no. 1.821.058.000 (A.3.0324) and cage no. 1.821.122.000 (A.3.0520) remove the half cones.

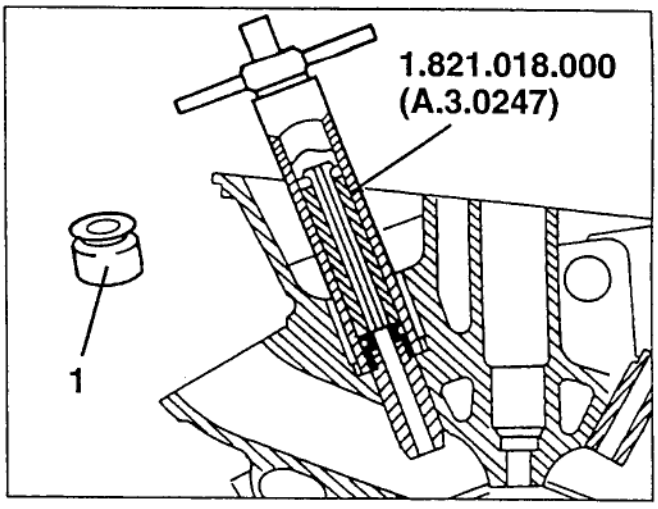


1. Remove the upper plates.
2. Remove the outer and inner springs.
3. Remove the tools used for removing the valves and remove the intake and exhaust valve pair.

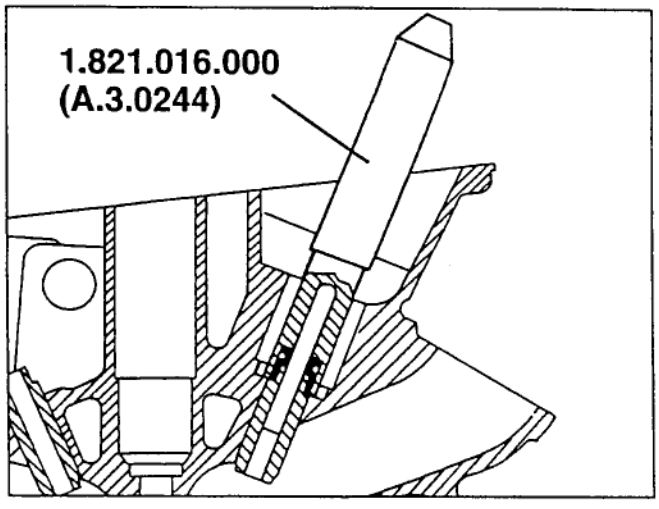


- Following the same procedure and using the same tools, remove the valves of the remaining cylinders.

1. Using puller tool no. 1.821.018.000 (A.3.0247), remove the oil seal caps.



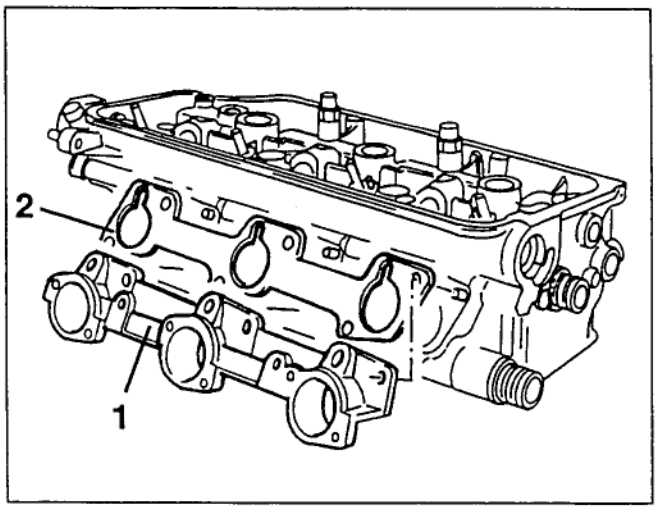
When refitting, insert new oil seal caps using tool no. 1.821.016.000 (A.3.0244).



- Retrieve the valve lower plates.

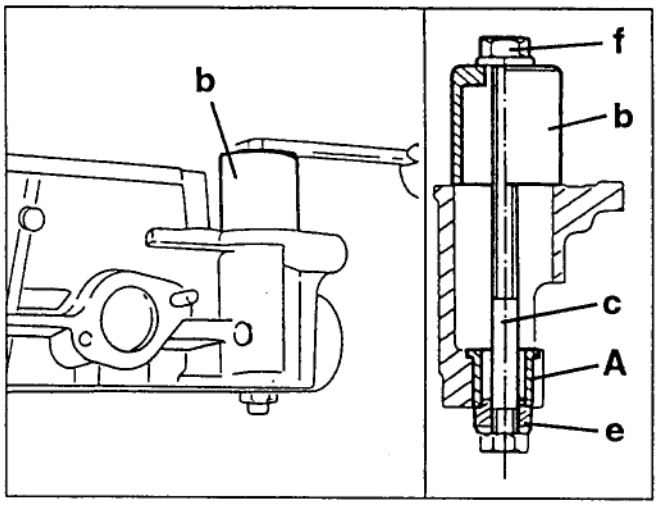
REMOVING THE AIR INTAKE MANIFOLD

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

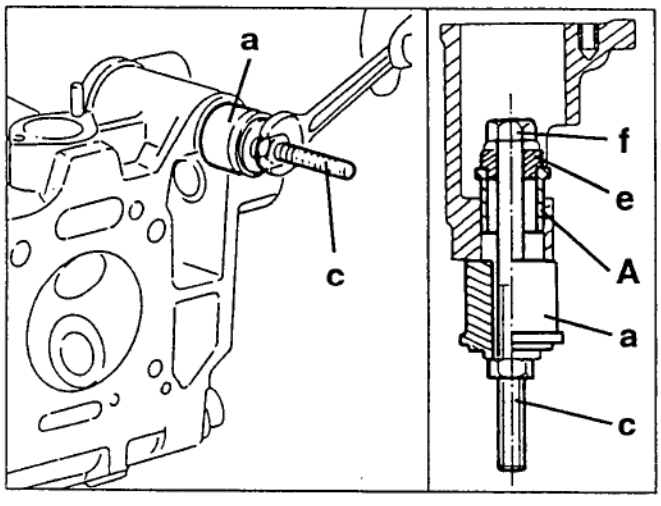


Changing the bushing for oil pump driving gear (specific for right-hand cylinder head)

- Remove bushing "A" for the oil pump driving gear, using tie-rod "c" complete with nut "f", the special washer "e" as puller tool and levering with the cup "b".

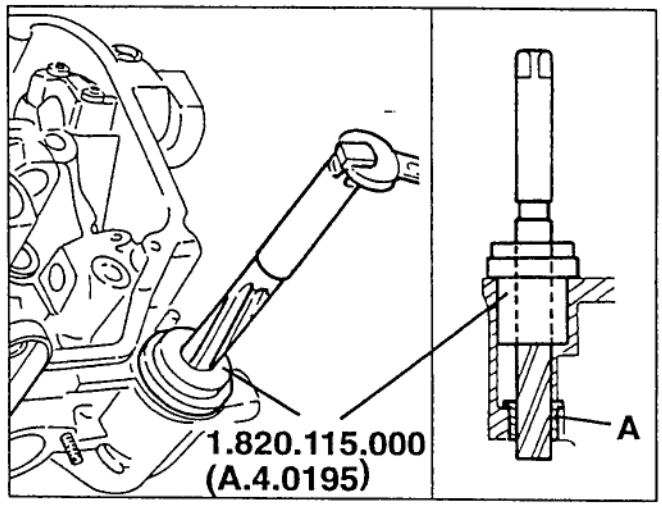


- Position a new bushing "A".
- Insert tie-rod "c" complete with nut "f" and special washer "e" as installing tool.
- From the opposite side to the tie-rod, insert the reaction coil "a" and complete insertion of the bushing "A".



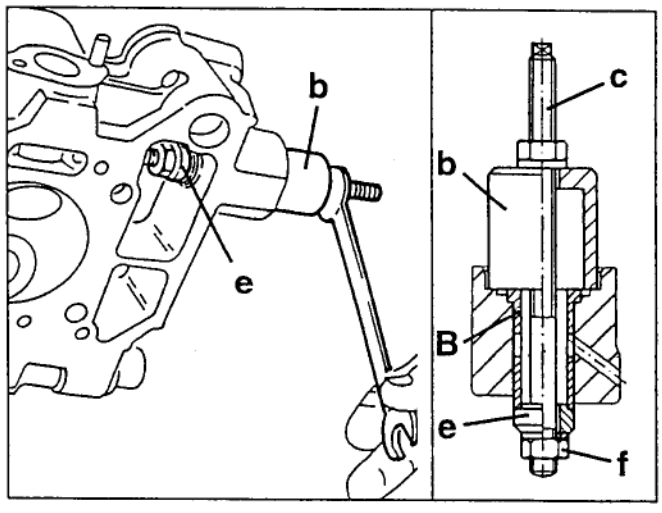
- After insertion, bushing "A" must be reamed to the specified dimension; for this purpose use guide tool no. 1.820.115.000 (A.4.0195) and a suitable reamer.

Ø	Inside diameter (bore) of bushing "A" for oil pump driving gear
	19.000 ÷ 19.021 mm

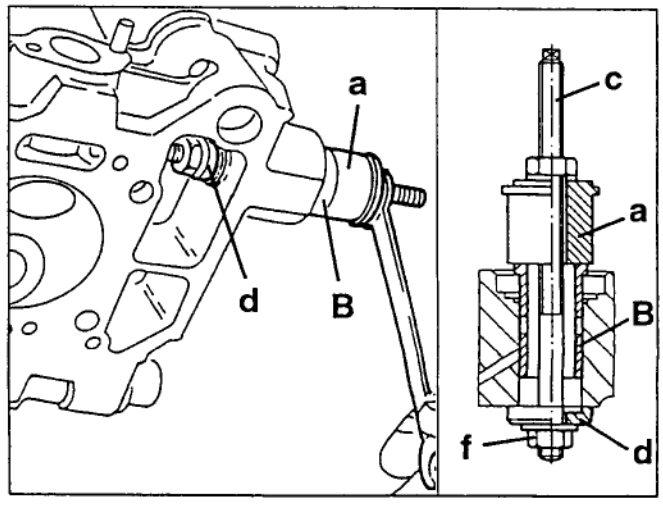


Changing the bushing for oil pump toothed driving pulley shaft (specific for right cylinder head)

- Remove the bushing "B" for oil pump toothed driving pulley shaft, using tie-rod "c" complete with nut "f", the special washer "e" as puller tool and levering with the cup "b".



- Insert a new bushing "B" using tie-rod "c" complete with nut "f" and the coil "a" as installing tool and levering with flange "d".

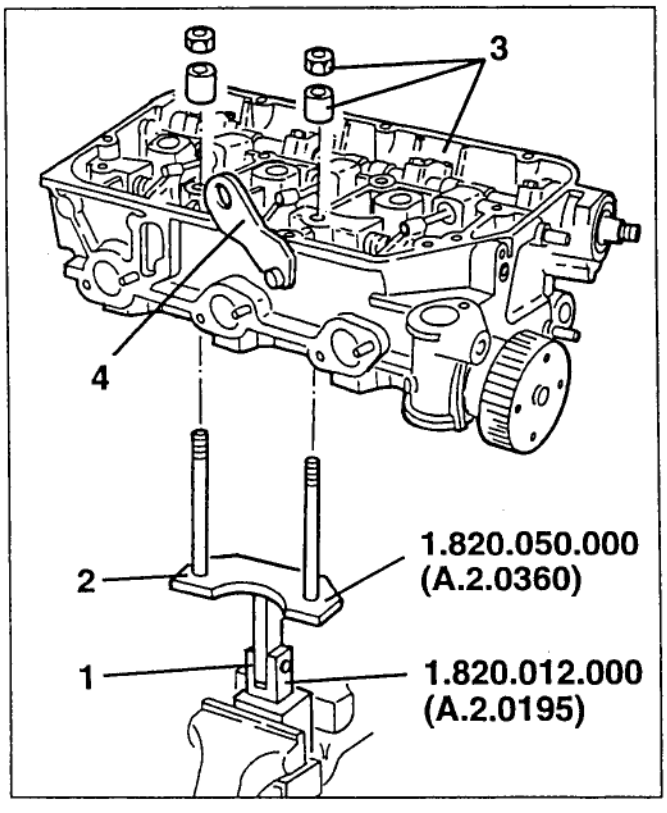


DIS-ASSEMBLING THE CYLINDER HEADS

NOTE: The dis-assembly procedures described refer to the right-hand cylinder head.
Proceed in the same way to dis-assemble the left-hand head.

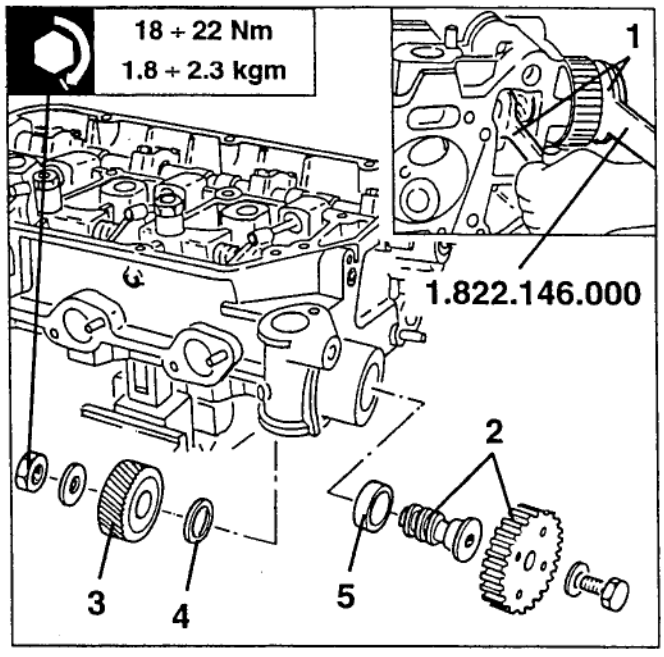
PRELIMINARY OPERATIONS

1. Clamp swivel support no. 1.820.012.000 (A.2.0195) in a vice.
2. Install fork no. 1.820.050.000 (A.2.0360) on the swivel support.
3. Fit the cylinder head on the fork studs and lock it in place using two suitable spacers and two nuts.
4. Slacken the fastening screw and remove the engine lifting bracket.

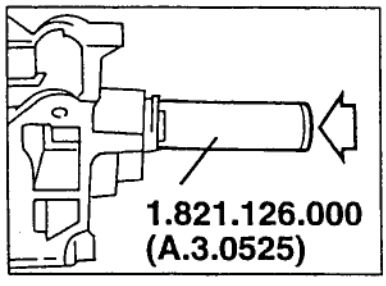


REMOVING THE OIL PUMP DRIVE PULLEY (Specific for the right-hand cylinder head)

1. Levering with tool no. 1.822. 146.000, slacken the oil pump drive pulley fastening bolt.
2. Withdraw the oil pump drive pulley and the corresponding shaft.
3. Retrieve the toothed gear.
4. Retrieve the spacer.
5. Prise and remove the oil ring.



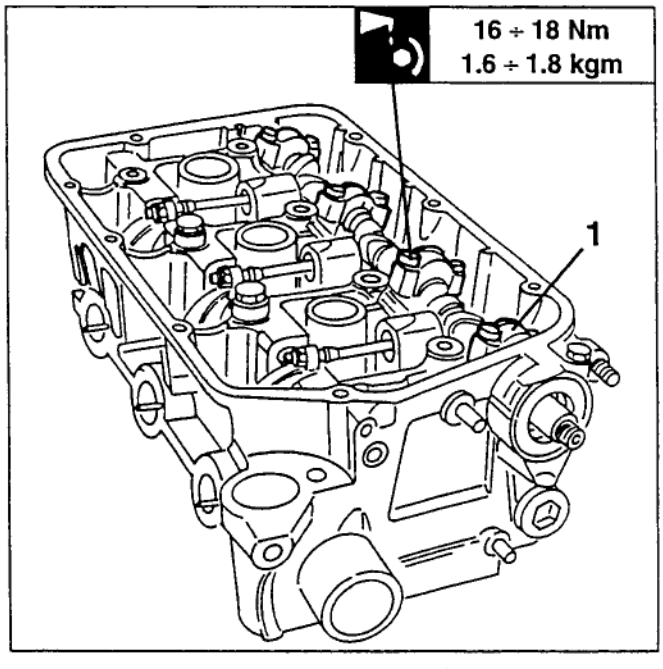
When refitting, insert a new oil ring using tool no. 1.821.126.000 (A.3.0525).



REMOVING

THE CAMSHAFT

1. Slacken the fastening nuts and remove the camshaft caps.

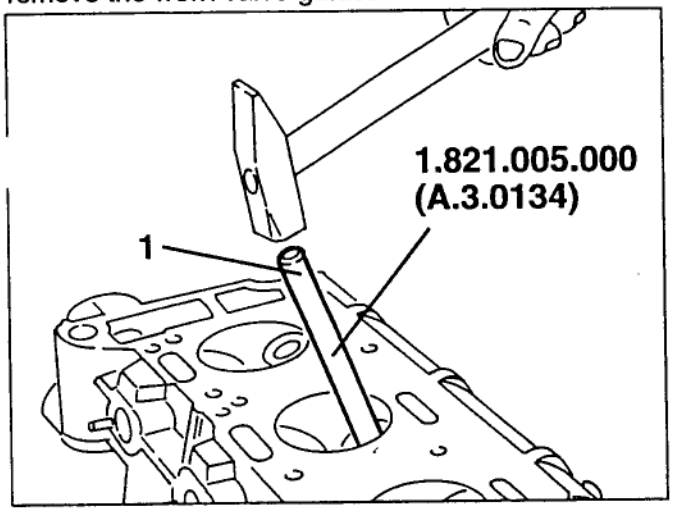


- Calculate the clearance between valve guides and valve stens and check that it is within the specified limits; if not, change any worn parts.

Radial clearance between valve guides and valve stems	
Intake	0.040 ÷ 0.090 mm
Exhaust	0.013 ÷ 0.043 mm

Changing the valve guides

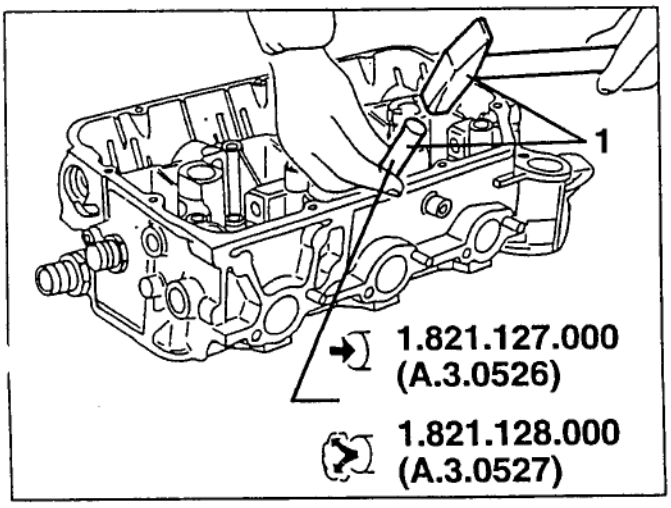
1. Using puller tool no. 1.821.005.000 (A.3.0134), remove the worn valve guides.



- Check that the outside diameters of the valve guides and their seats on the cylinder heads are within the specified limits and meet the assembly interference.

Outside diameter of valve guides	14.048 ÷ 14.059 mm
Diameter of valve guide seats	13.990 ÷ 14.018 mm
Seats - valve guide interference	0.030 ÷ 0.069 mm

1. Insert the new valve guides in their seats using the tools illustrated.



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

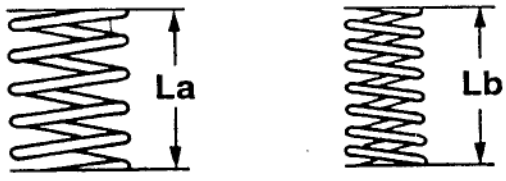
Inside diameter of valve guides
9.000 ÷ 9.015 mm

Checking the valve springs

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

NOTA: The resting planes must be parallel with one another and perpendicular to the axis of the spring with a maximum error of 2°.

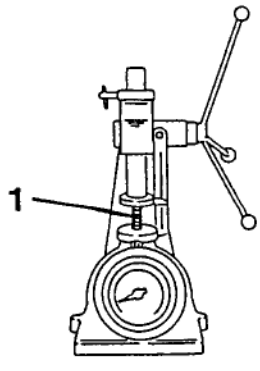
Free length of valve springs	
Outer spring "La"	44.6 mm
Inner spring "Lb"	44.1 mm



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 N (kg)
With valve closed	32.5	243 ÷ 252 (24.8 ÷ 25.7)
With valve open	23.5	470 ÷ 488 (47.9 ÷ 49.7)

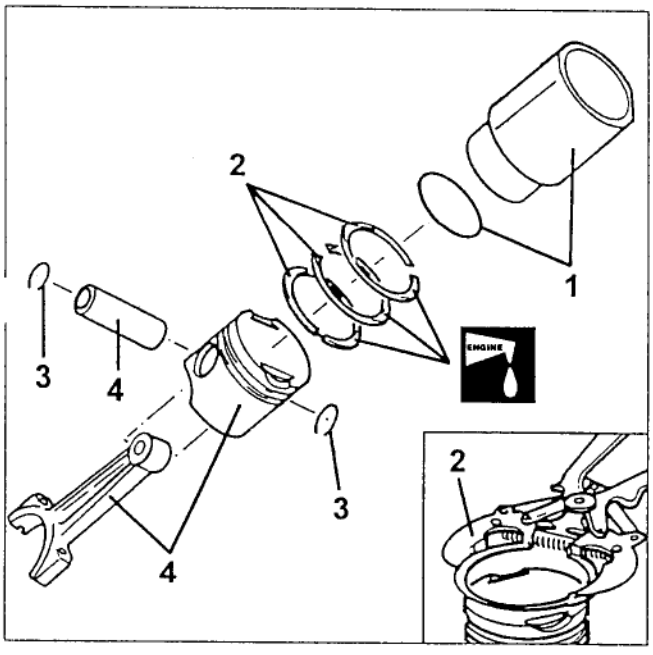
Inner spring		
Spring length mm		Control load N (kg)
With valve closed	30.5	126 ÷ 130 (12.8 ÷ 13.3)
With valve open	21.5	222 ÷ 231 (22.7 ÷ 23.5)



1. Remove the cylinder liner and O-Ring.
2. Extract the gas rings and the oil scraper from the pistons with a suitable tool.

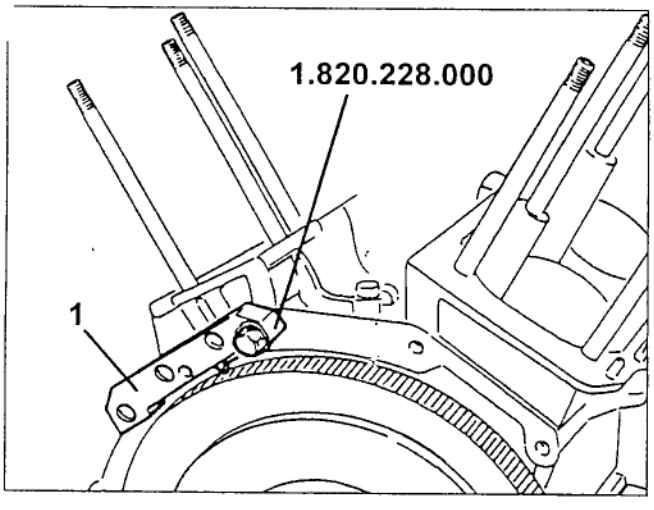
IMPORTANT: Be careful not to damage rings which could be re-used.

3. Extract the two pin snap rings.
4. Extract the pin and separate the piston from the connecting rod.



COOLANT PUMP REMOVAL

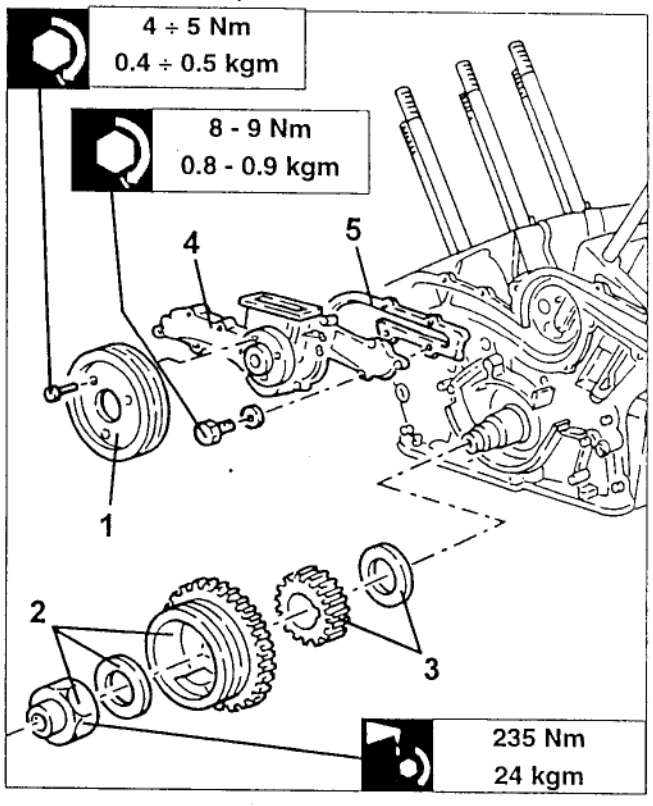
1. Remove the crankshaft rotation tool and fit the flywheel retainer no. 1.820.228.000.



1. Loosen the fastening screws and remove the coolant pump.
. Loosen the fastening nut and remove the auxiliary unit drive pulley.
3. Remove the timing belt pulley and thrust ring.

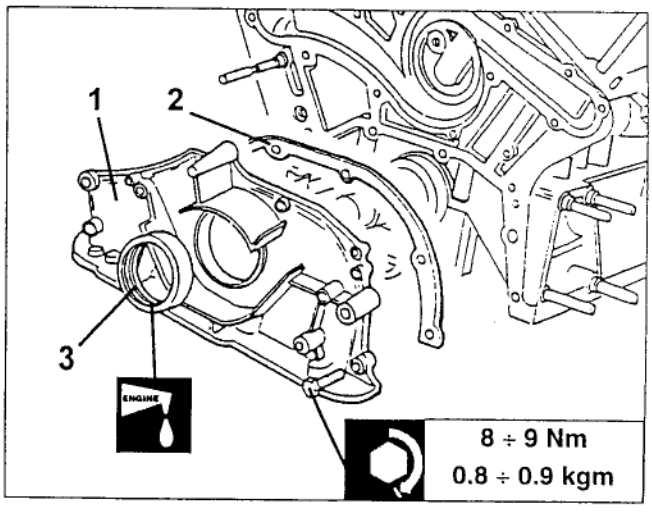
NOTE: When refitting, the thrust ring convex surface should face the front crankcase cover.

4. Loosen the fastening screws and remove the coolant pump.
5. Remove the respective seal.



FRONT CRANKCASE COVER REMOVAL

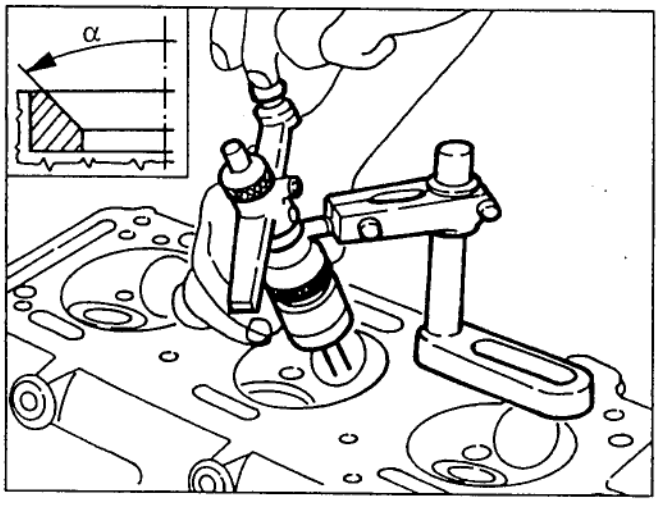
1. Loosen the fastening screws and remove the front crankcase cover.
2. Remove the respective seal.
3. Remove the front crankcase cover oil seal.



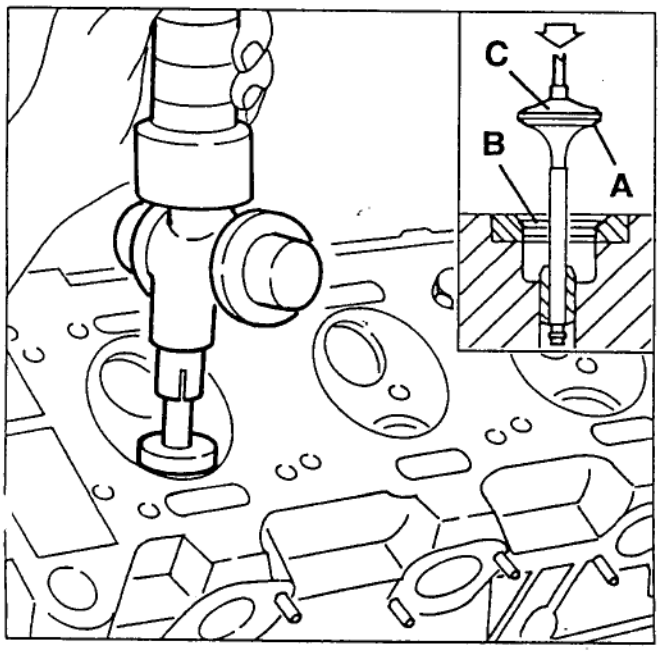
Turning the valve seats

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

Valve seat taper "α"
90° ± 20'



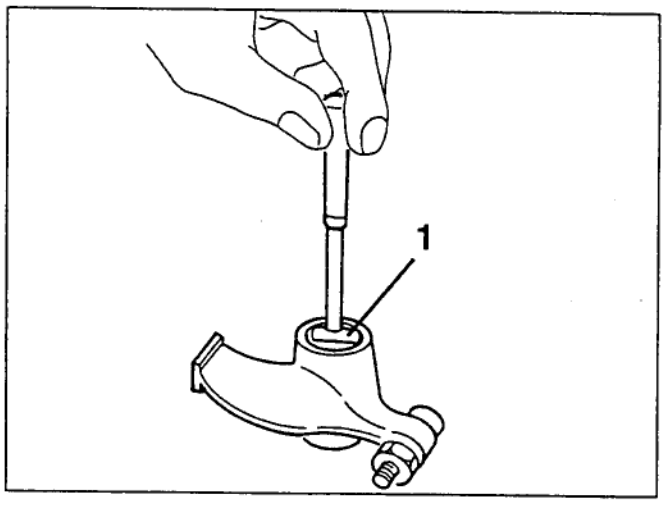
- After machining, grind each valve in its seat as follows:
- coat the contact surfaces "A" and "B" of the valves and their seats with abrasive paste (SIPAL AREXONS Carbosilicium for valves);
- lubrificate the valve stem with engine oil;
- fit the lower surface of the valve mushroom to the suction cup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



Checking the clearance between rockers and support shaft

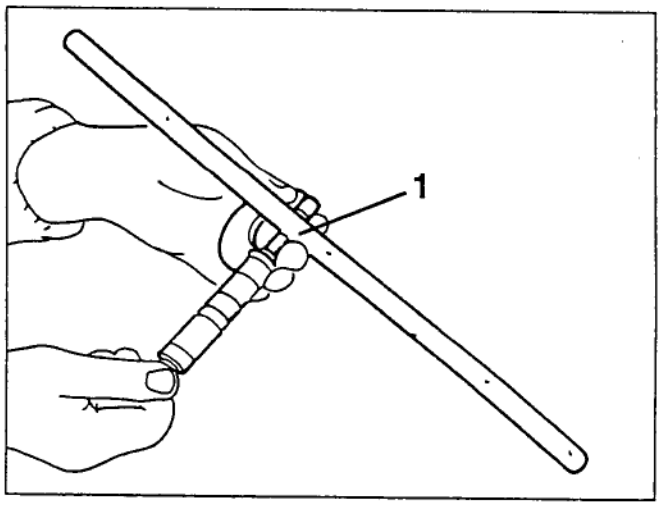
1. Check that the inside diameter of the rockers is within the specified limits.

Inside diameter of rockers
16.010 ÷ 16.028 mm



1. Check that the diameter of the rocker shaft is within the specified limits.

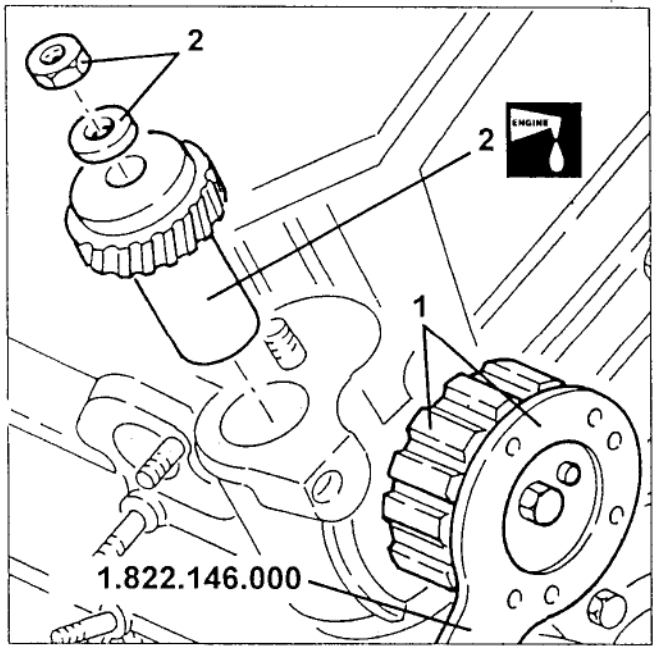
Diameter of rocker support shaft
15.988 ÷ 16.000 mm



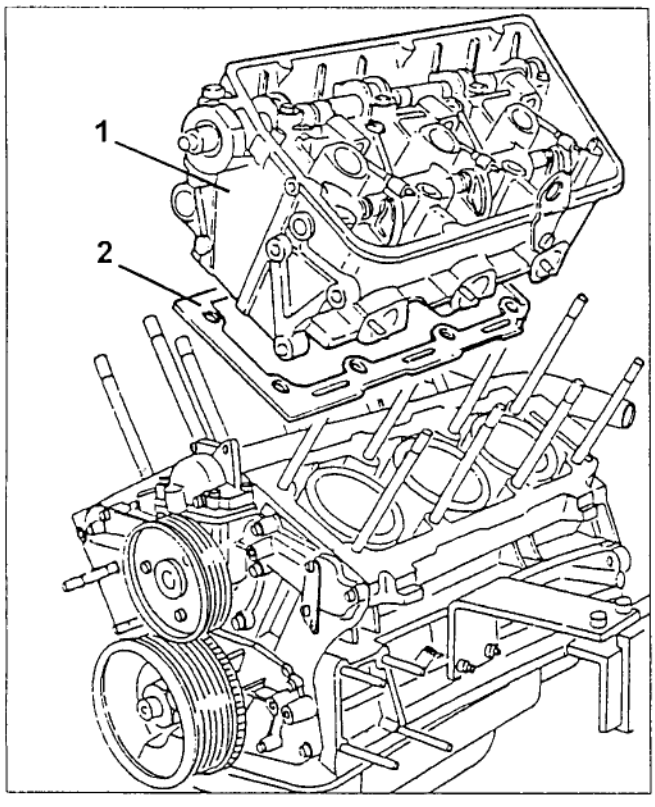
- Calculate the clearance between rockers and support shaft checking that it is within the specified limits.

Clearance between rockers and support shaft
0.010 ÷ 0.040 mm

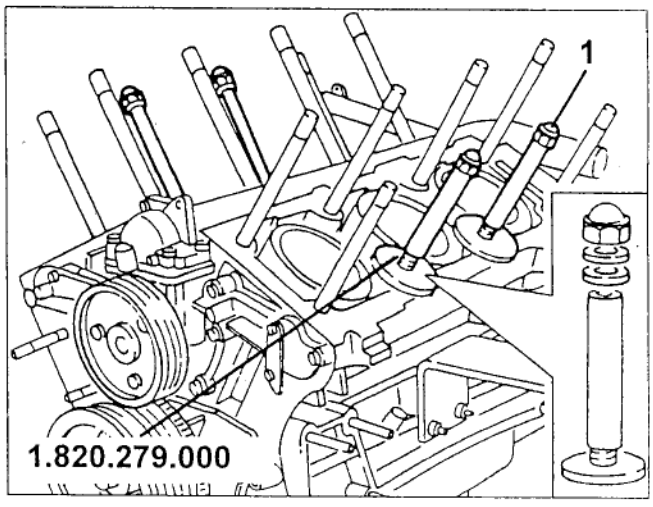
Proceed as follows (right-hand cylinder head only):
1. Lock engine oil pump drive pulley rotation with tool no. 1.822.146.000.
2. Loosen the fastening nut and remove the oil pump intermediate drive gear from its seat.



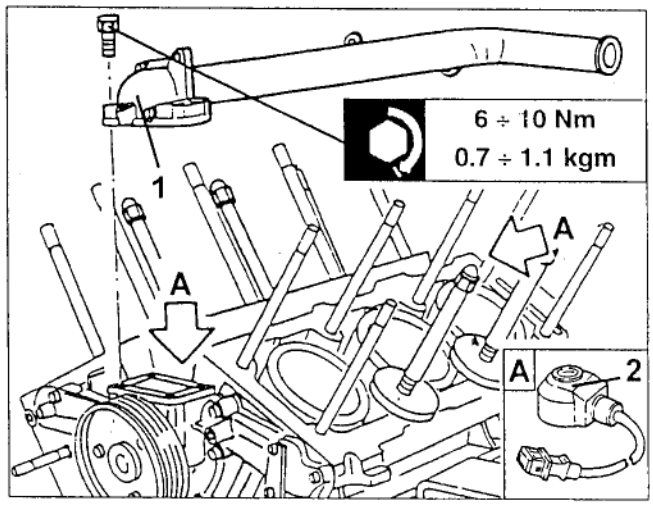
1. Loosen the fastening nuts and remove the engine crankcase cylinder head.
2. Remove the respective seals.



1. Fit liner retainer tools no. 1.820.279.000.

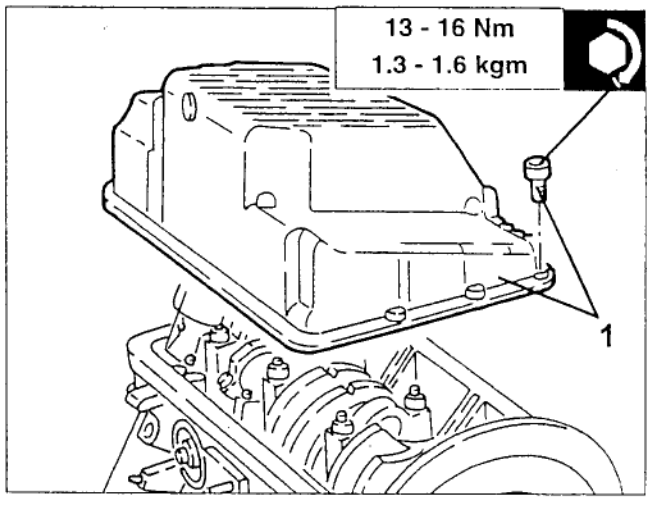


1. Loosen the fastening screws and remove the pump coolant return manifold.
2. Loosen the screws and remove the knock sensors.



OIL PUMP REMOVAL

- Turn the engine on the overhaul bench.
1. Loosen the fastening screws and remove the oil sump.



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 plugs of the lubricating and cooling ducts and clean the dusct using a suitable detergent, then dry them with a jet of air and refit new plugs.
- Remove any traces of seals and sealant from the crankcase surfaces.

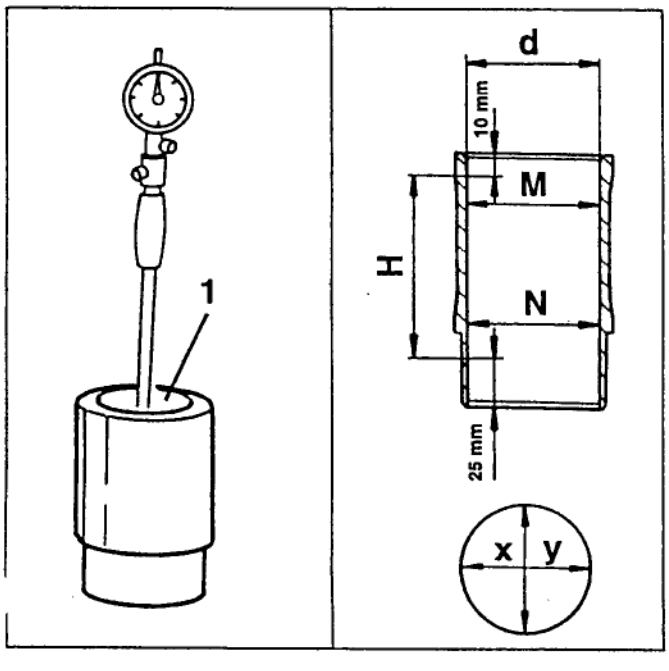
Checking the cylinder liners

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

Inside diameter "d" of cylinder liners	
Class A (Blue)	92.895 ÷ 92.994 mm
Class B (Pink)	92.995 ÷ 93.004 mm
Class C (Green)	93.005 ÷ 93.014 mm

Maximum cylinder taper
0.01 mm

Maximum cylinder ovalization
0.01 mm

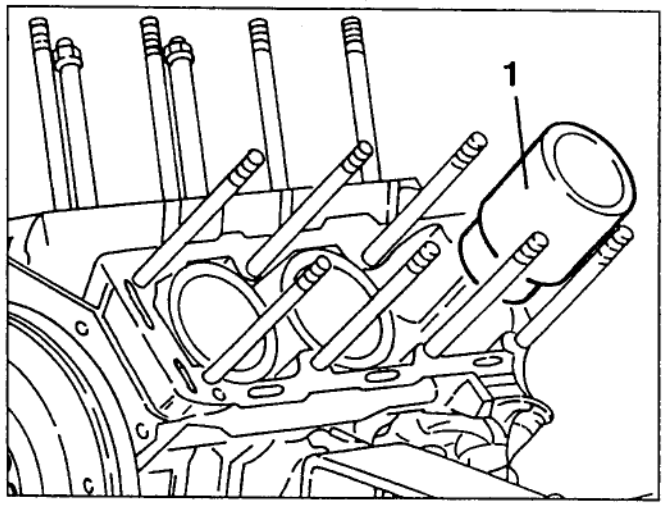


H : Area for dimensional inspection

Checking the cylinder liner protrusion (without seal rings)

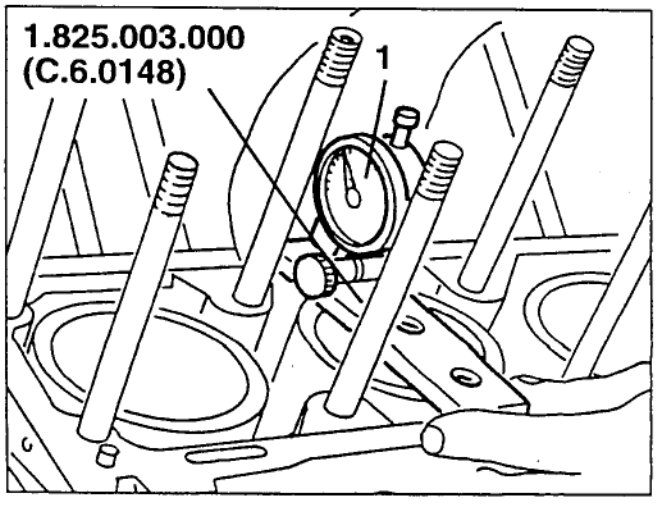
NOTE: This procedure, to be carried out as a preliminary control of the correct coupling between the cylinder liners and crankcase, should be carried out without the seal rings, therefore there is no need for the liner stopper tool, which if tightened to the specified torque would annul the thickness.

1. Insert the cylinder liners in the crankcase ensuring that they reach the stroke limit.

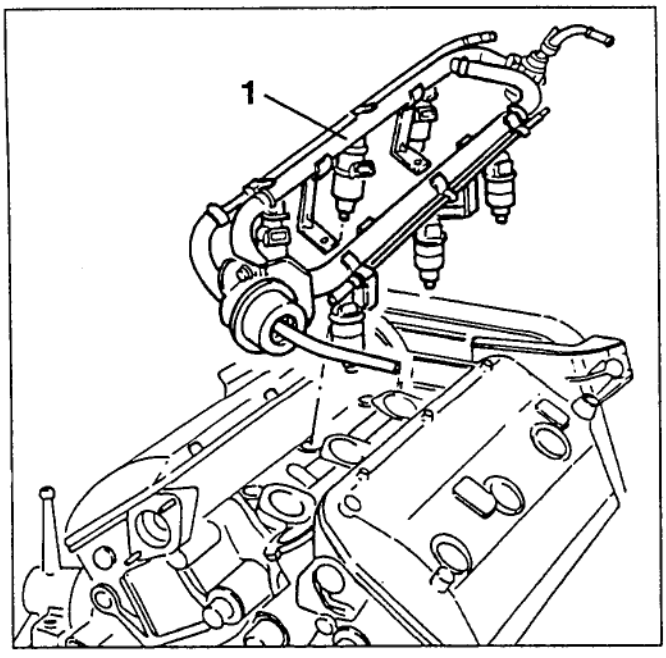


1. Assemble tool no. 1.825.003.000 (C.6.0148) complete with centesimal dial gauge suitably set to zero, on the crankcase first on one side and then on the other so that the feeler rests on the edges of the cylinder liner and check that the protrusion is within the specified tolerances.

Cylinder liner protrusion from crankcase
0.01 ÷ 0.06 mm

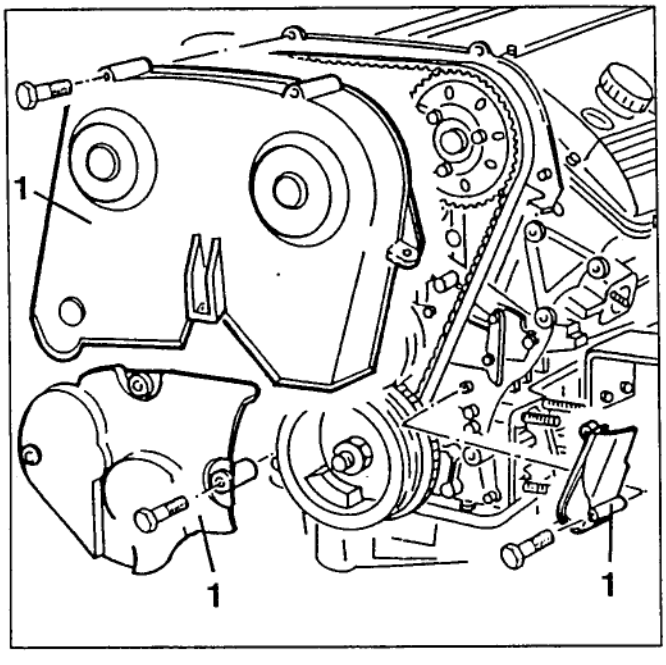


1. Slacken the fastening screws and remove the fuel distributor manifold complete with injectors, pressure regulator and pulse damper.

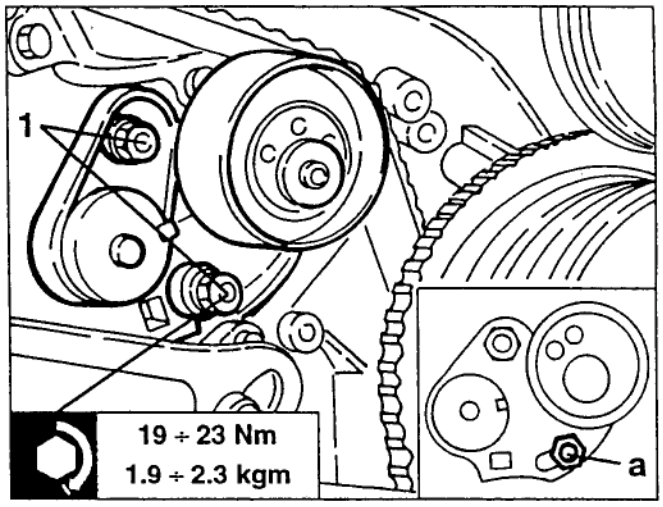


REMOVING THE TIMING GEAR BELT

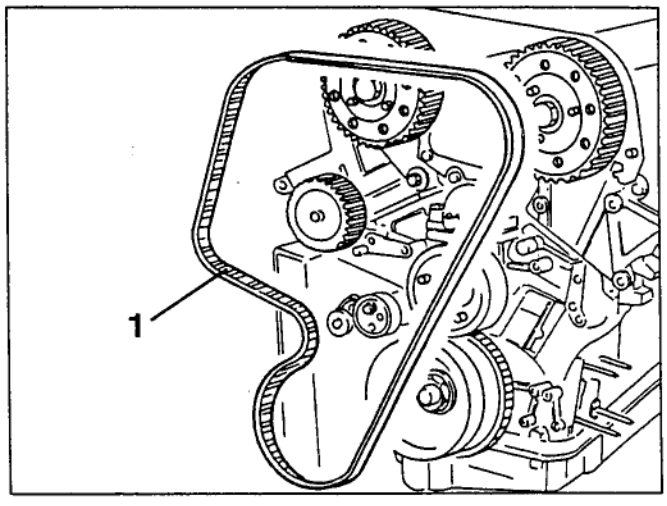
1. Slacken the fastening screws and remove the timing gear belt front covers.



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



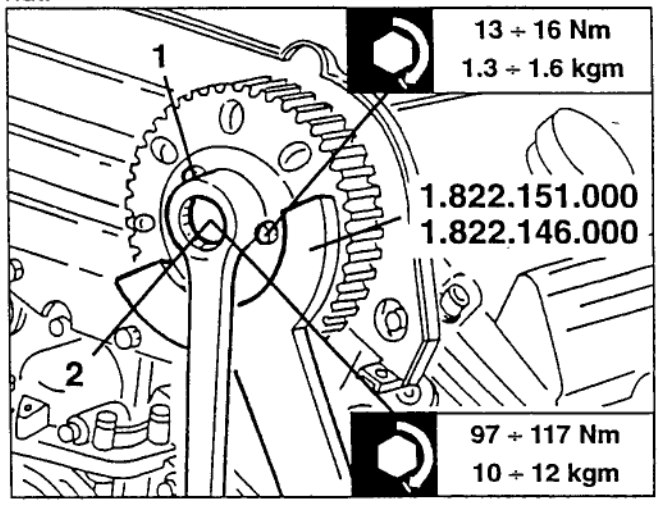
1. Remove the timing gear drive belt prising it off the camshaft toothed drive pulley and withdrawing it from the drive pulley.



- Completely slacken the two nuts fastening the timing gear belt tensioner and remove it.

REMOVING THE TIMING GEAR PULLEYS

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



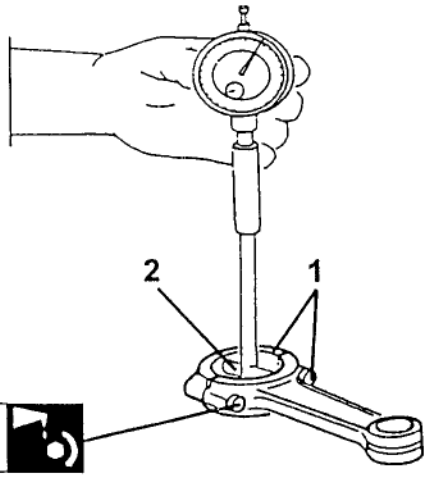
- Calculate the play between pins and respective piston seats. Check whether the value falls within prescriptions.

Play between pins and piston seats
0.006 ÷ 0.012 mm

Play between connecting rod journal and respective half-bearings

1. Fit the connecting rod half-bearings in the connecting rod big end and on the respective cap. Then assemble, fastening the screws at the prescribed torque.
2. Measure the connecting rod big end internal diameter and check whether it falls within the prescribed values.

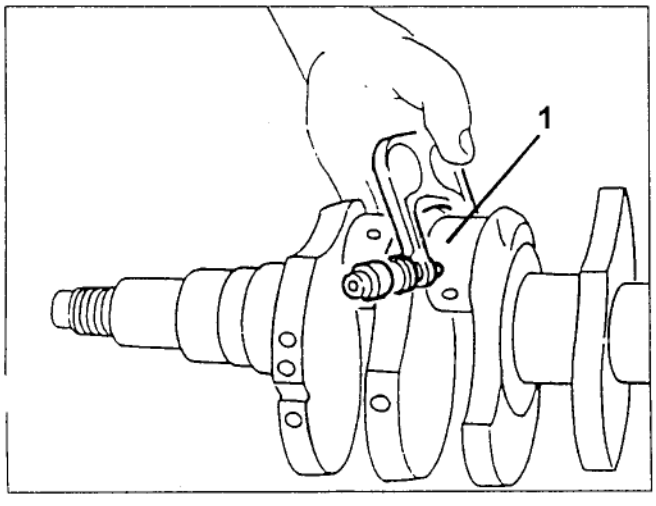
Connecting rod half-bearing internal diameter	
Class A (Red)	52.021 ÷ 52.050 mm
Class B (Blue)	52.013 ÷ 52.042 mm



53 ÷ 59 Nm
5.4 ÷ 6.0 kgm

1. Measure the connecting rod journal diameter and check whether it falls within the prescribed values.

Connecting rod journal diameter	
Class A (Red)	51.990 ÷ 52.000 mm
Class B (Blue)	51.980 ÷ 51.990 mm



NOTE: The crankshaft nitriding treatment does not allow re-facing. Consequently, it should be replaced if excessively worn.

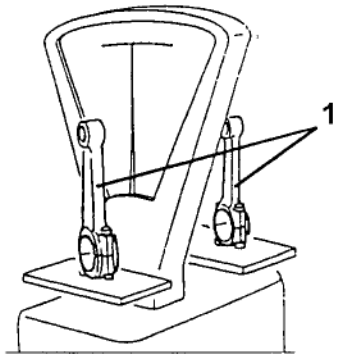
- Calculate the play between connecting rod journals and the respective half-bearings. Check whether the value falls within prescriptions.

Connecting rod journals and respective half-bearing diameter	
Class A (Red)	0.021 ÷ 0.060 mm
Class B (Blue)	0.023 ÷ 0.062 mm

Connecting rod check

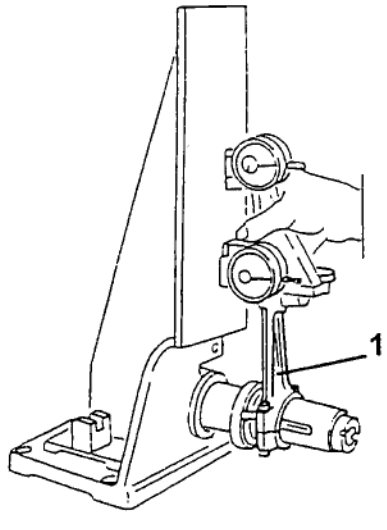
1. Check the difference in weight between connecting rods with half-bearings, caps and screws. Check whether the value falls within prescriptions.

Connecting rod weight difference
± 4 g

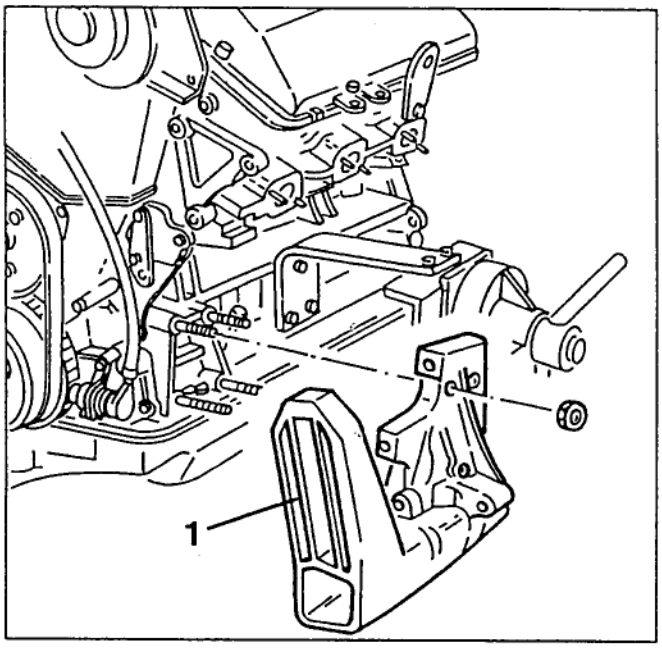


1. Check connecting rod squaring with a reference as shown in the figure.

NOTE: If squaring is not perfect, replace the connecting rod to avoid improper stress during engine operation with consequent irregular piston and connecting rod wear.

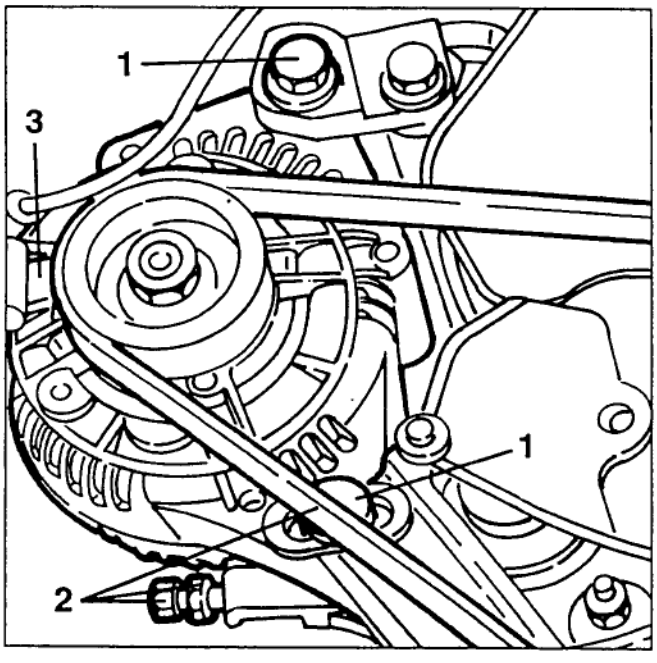


1. Slacken the fastening nuts and remove the front engine support.

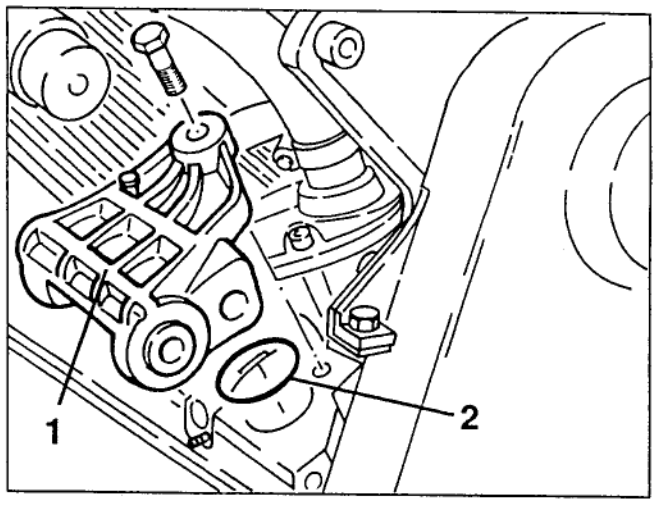


REMOVING THE ALTERNATOR

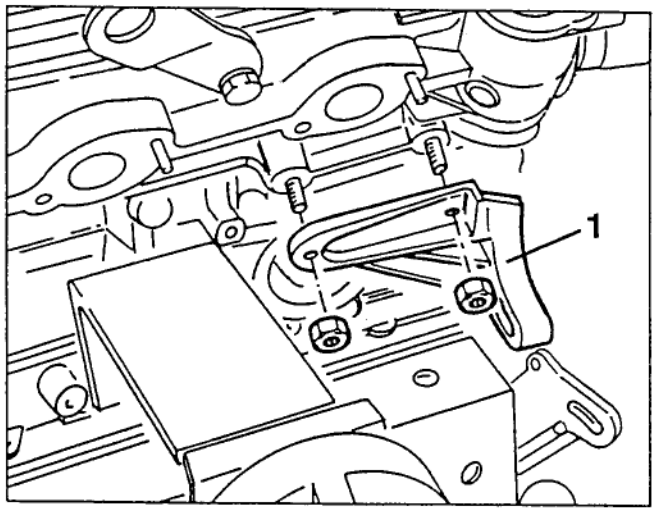
1. Slacken the two bolts fastening the alternator to the support brackets.
2. Loosen the locknut, slacken the micrometric tensioner screw, then prise and remove the alternator - water pump drive belt.
3. Completely back off the two bolts loosened previously and remove the alternator.



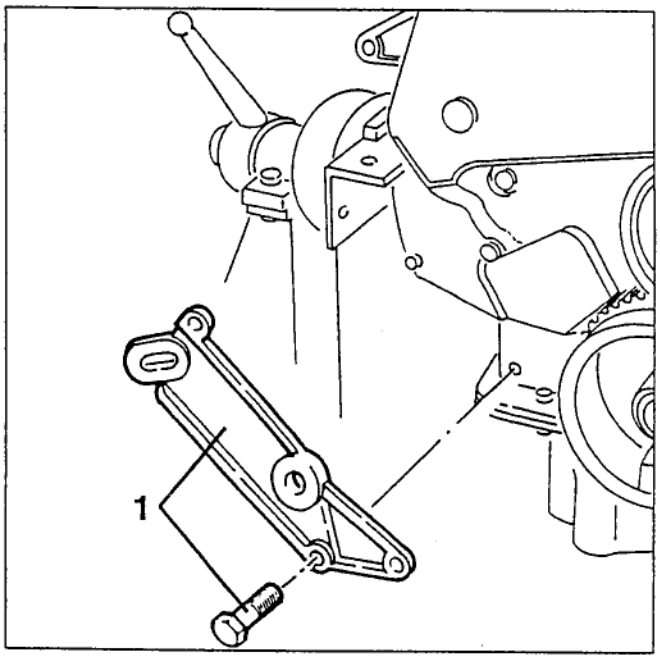
1. Remove the upper alternator support bracket.
2. Remove the O-Ring.



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



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



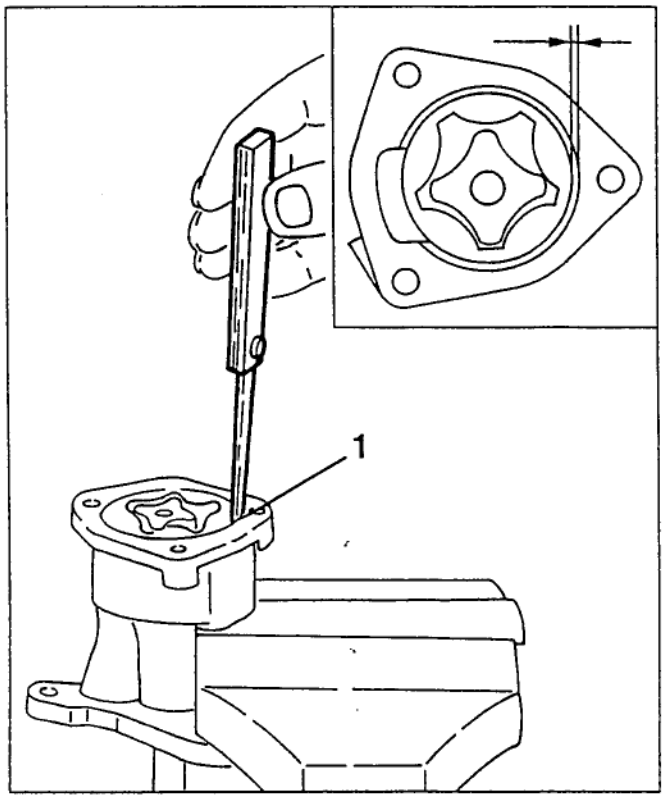
Checking the engine flywheel

- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
• working under the press remove the old ring gear;
• accurately clean the contact surfaces of the new ring gear and of the flywheel;
• evenly heat the new ring gear to 120° ÷ 140°C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

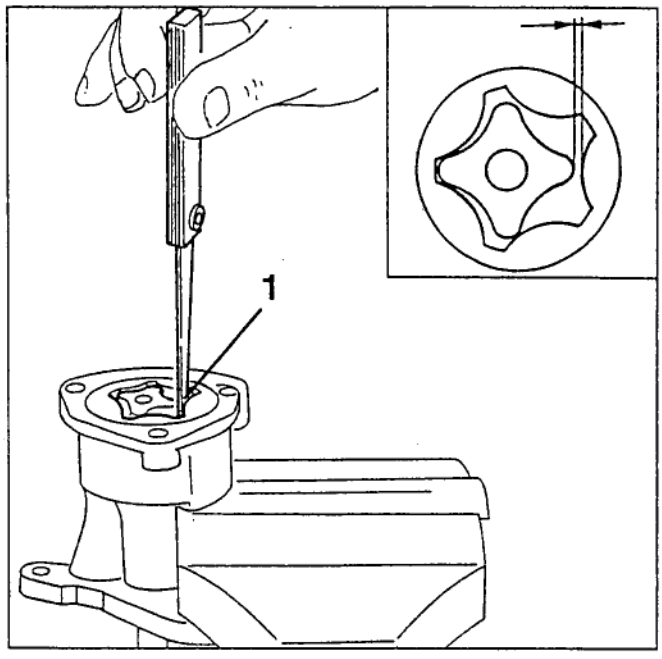
1. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.170 ÷ 0.275 mm



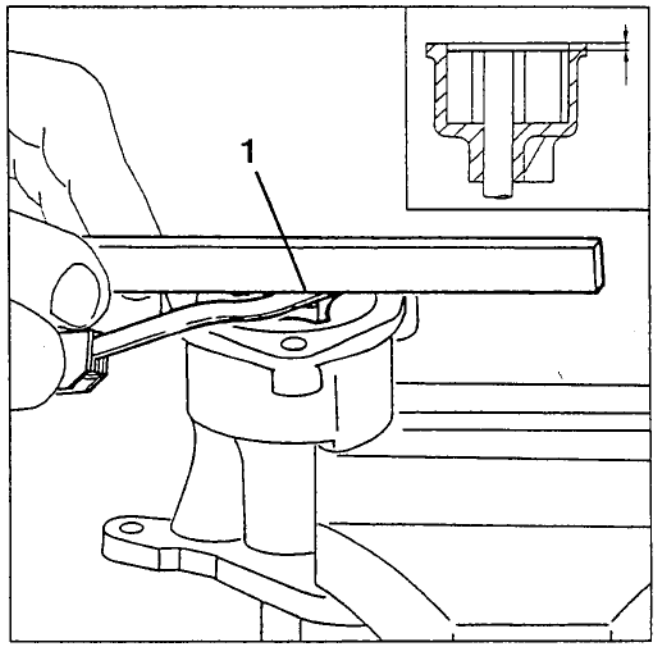
1. Check that the clearance between the lobe of the inner gear and that of the driven gear is within the specified limits.

Clearance between driven gear and inner gear
0.040 ÷ 0.290 mm



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

Clearance between pump casing rest surface and upper side of gears
0.025 ÷ 0.075 mm

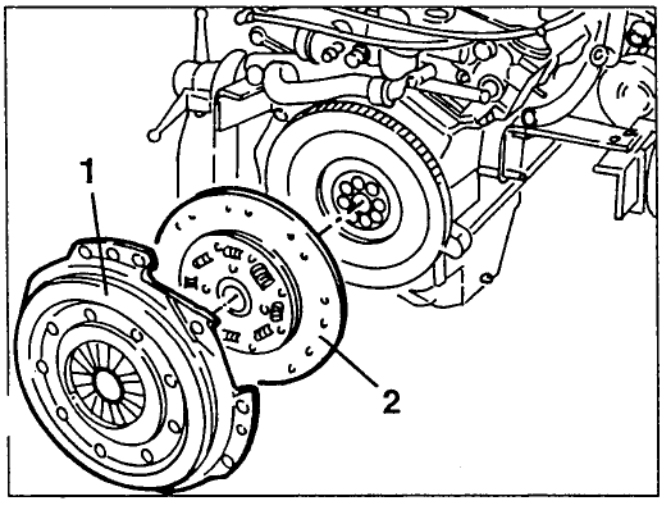


- Using a torque meter, check that the characteristic data of the engine oil pressure limiting valve control spring are within the specified limits.

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

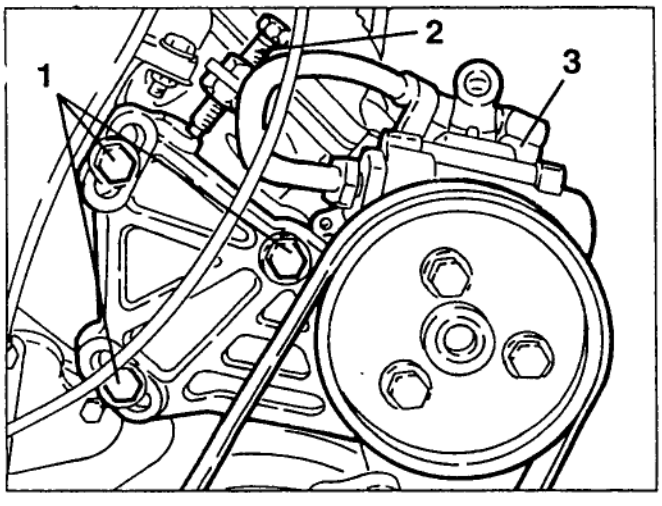
REMOVING THE CLUTCH PLATE

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



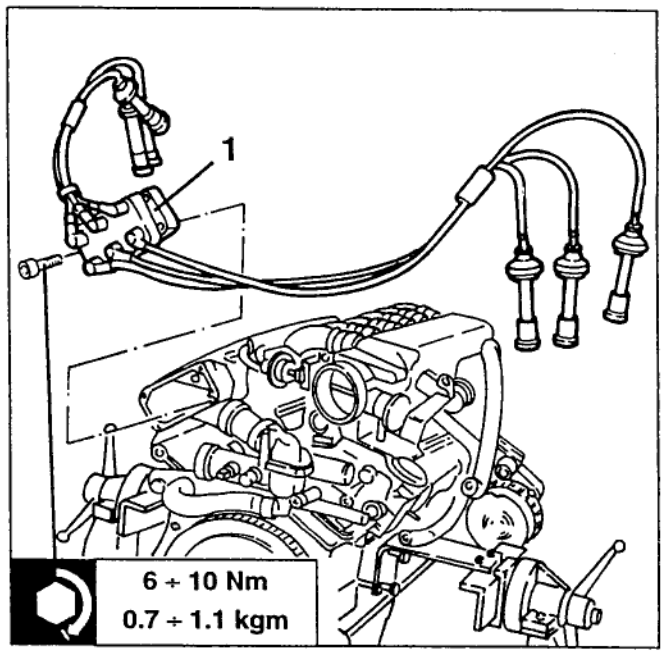
REMOVING THE POWER STEERING PUMP

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

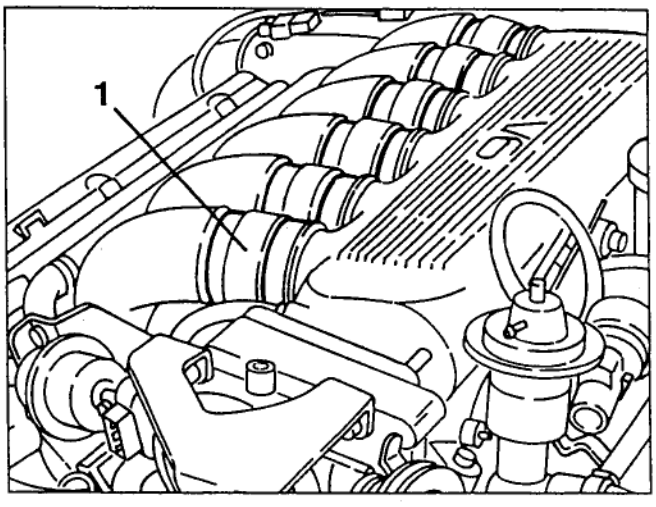


REMOVING THE AIR INTAKE BOX

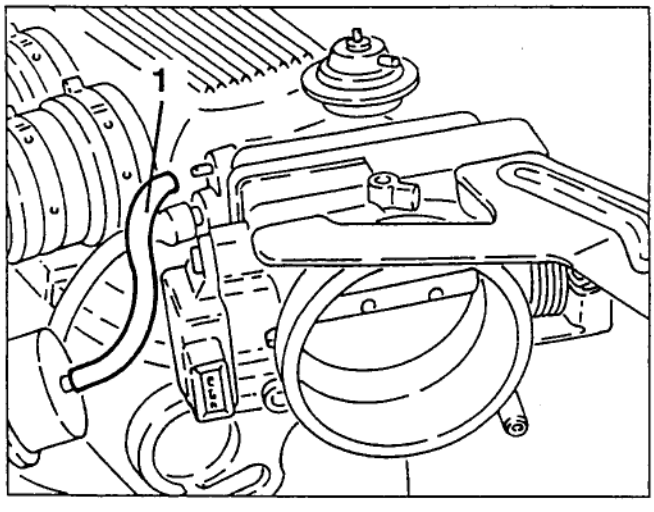
1. Slacken the ignition coil fastening screws, then remove the coils complete with high voltage cables after disconnecting them from the spark plugs.



1. Slacken the clamps fastening the air intake ducts to the intake box.



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



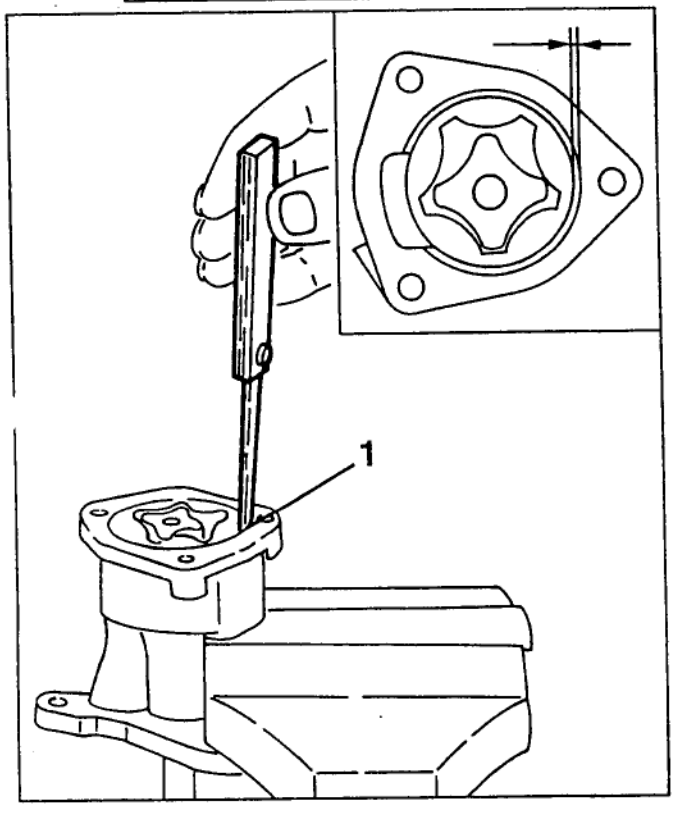
Checking the engine flywheel

- Check that the ring gear teeth are not cracked or show signs of seizure; if they do, change the ring gear as described below:
• working under the press remove the old ring gear;
• accurately clean the contact surfaces of the new ring gear and of the flywheel;
• evenly heat the new ring gear to 120° ÷ 140°C and fit it on the flywheel: leave to cool naturally, do not force cool.

Checking the oil pump

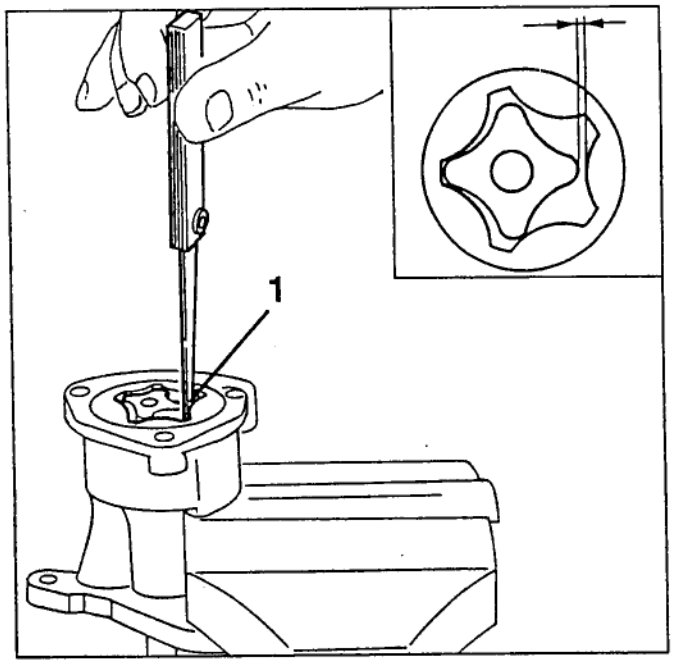
'. Check that the clearance between the pump casing and the driven gear is within the specified limit.

Clearance between pump casing and driven gear
0.170 ÷ 0.275 mm



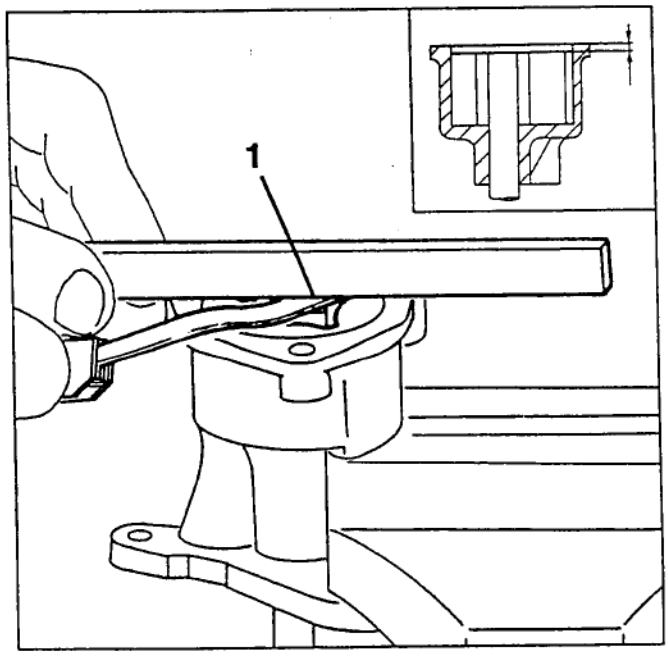
1. Check that the clearance between the lobe of the inner gear and that of the driven gear is within the specified limits.

Clearance between driven gear and inner gear
0.040 ÷ 0.290 mm



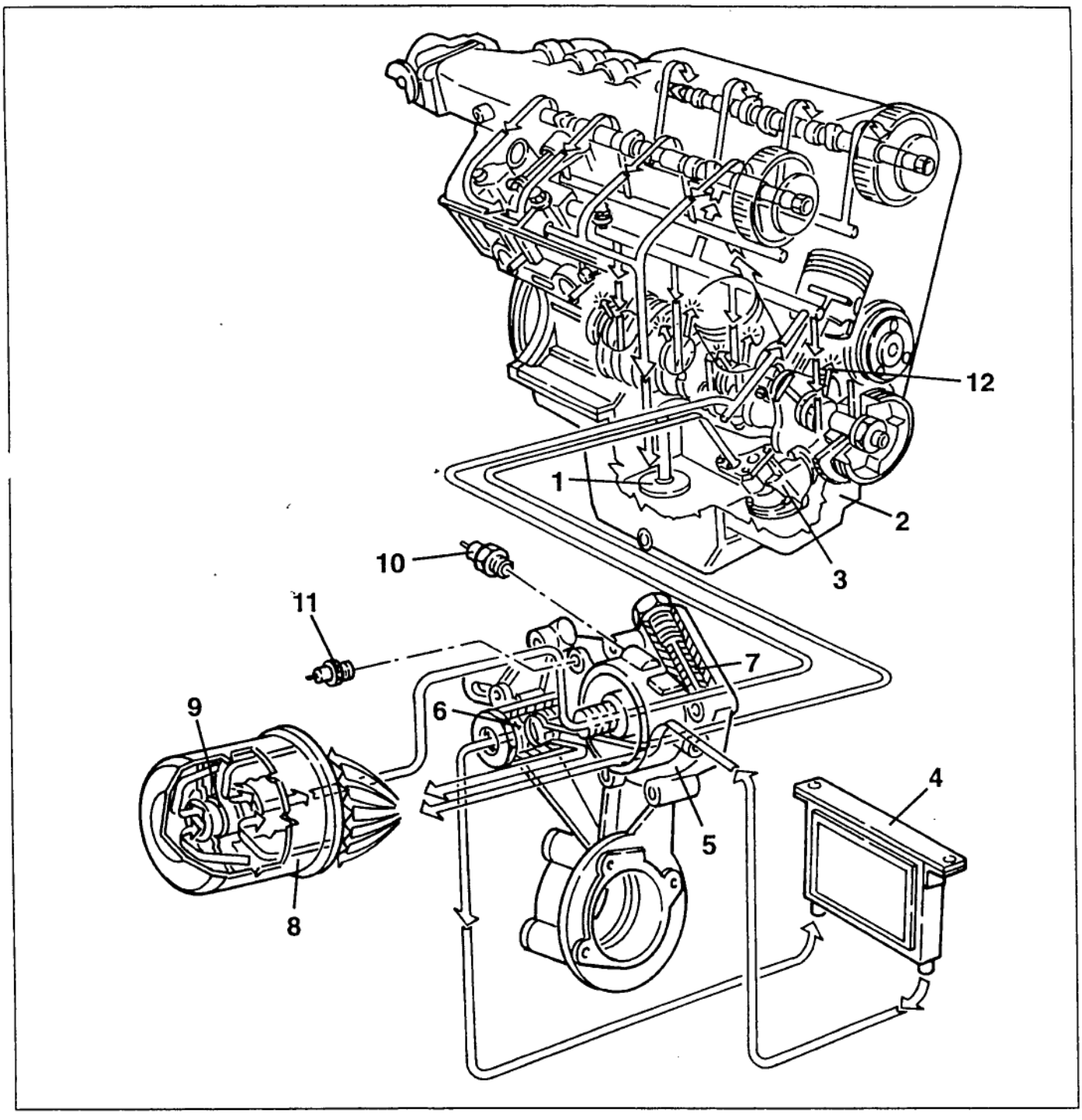
1. Check that the clearance between the rest surface of the pump casing and the upper side of the gears is within the specified limits.

Clearance between pump casing rest surface and upper side of gears
0.025 ÷ 0.075 mm



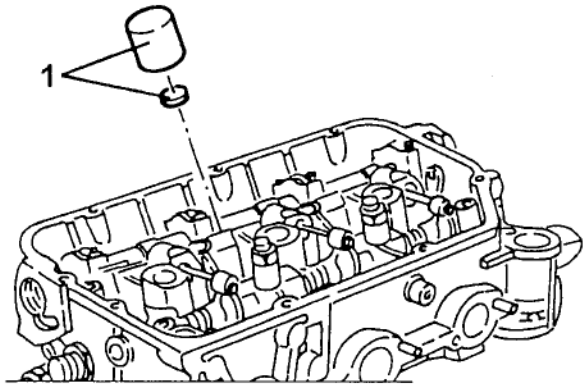
- Using a torque meter, check that the characteristic data of the engine oil pressure limiting valve control spring are within the specified limits.

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

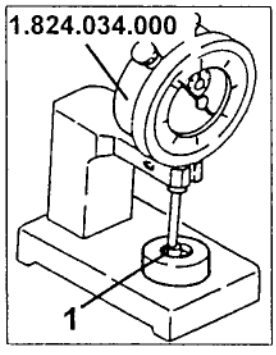


1. *Suction device*
2. *Oil sump*
3. *Oil pump*
4. *Oil radiator*
5. *Oil filter support*
6. *Thermostatic valve*
7. *Oil pressure limiting valve*
8. *Oil filter*
9. *By-pass valve*
10. *Engine oil temperature transmitter*
11. *Low engine pressure warning light sensor*
12. *Spray jets*

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



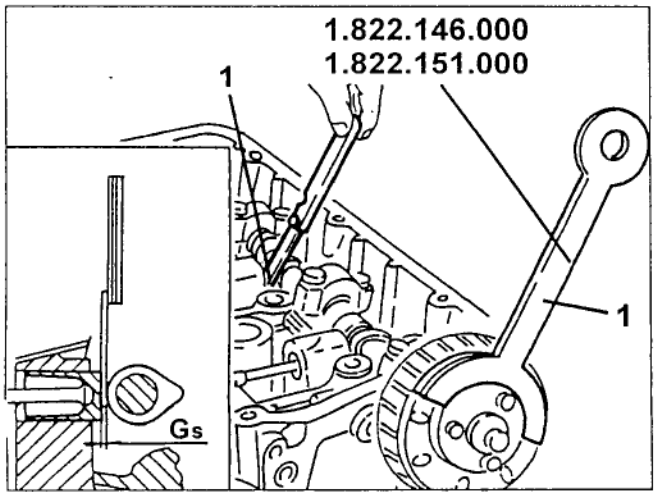
1. Measure cap thickness with gauge no. 1.824.034.000. Then choose from the no. 1.820.150.000 (R.9.0001) set the suitable tool to restore correct tappet clearance according to the measured values.



- Refit the cups, the camshaft and the respective caps. Fasten the caps at the prescribed torque and check the intake tappet clearance.

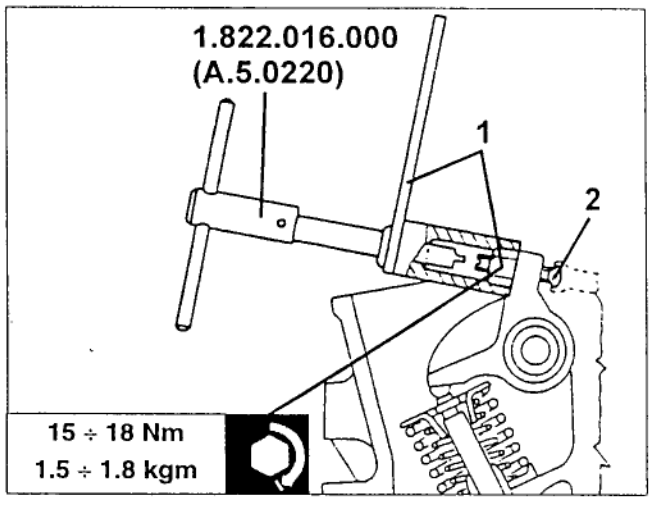
Exhaust side tappets

- Temporarily fit the hub and the camshaft drive pulley.
1. Turn the camshaft with tools no. 1.822.146.000 and no. 1.822.151.000. Then measure the clearance between lowered cam radius and corresponding cup. Check whether the value falls within prescriptions.



"Gs" exhaust tappet clearance
0.225 ÷ 0.250 mm

- If the exhaust tappet clearance is not included within the prescribed values, adjust as follows:
1. With tool no. 1.822.016.000 (A.5.0220) intermediate lever, loosen the adjustment screw lock nut.
2. Turn the adjustment screw until the prescribed exhaust tappet clearance is reached with the same tool.
- Torque the lock nut and check tappet clearance.

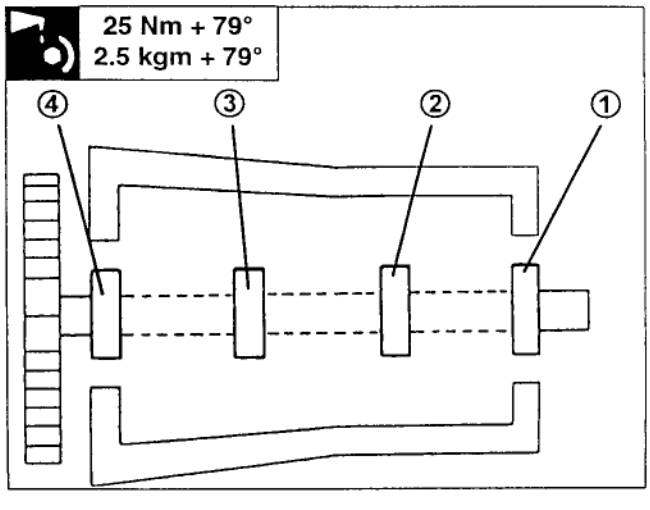


Crankshaft refitting

- Fit the crankshaft with half-bearings and thrust rings on the crankcase.
NOTE: Refit the thrust half-rings with the grooved surface 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.



MAIN AND ROD BEARING HALVES

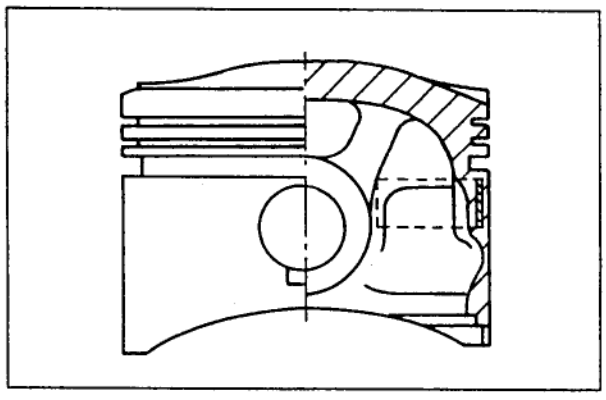
These are of the three-metal, thin shell type, divided into three dimensional classes, for the main bearing halves and two for the connecting rod bearing halves.

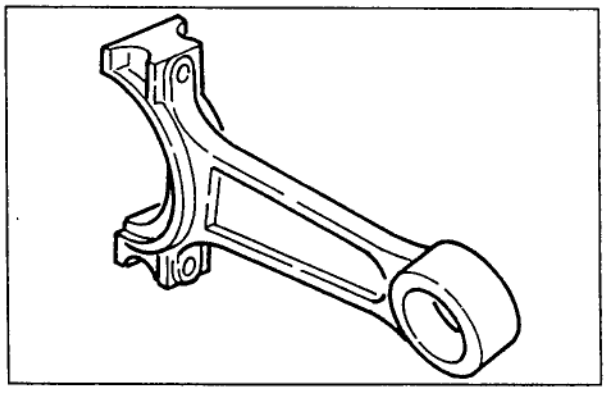
FLYWHEEL

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

PISTONS - CONNECTING RODS

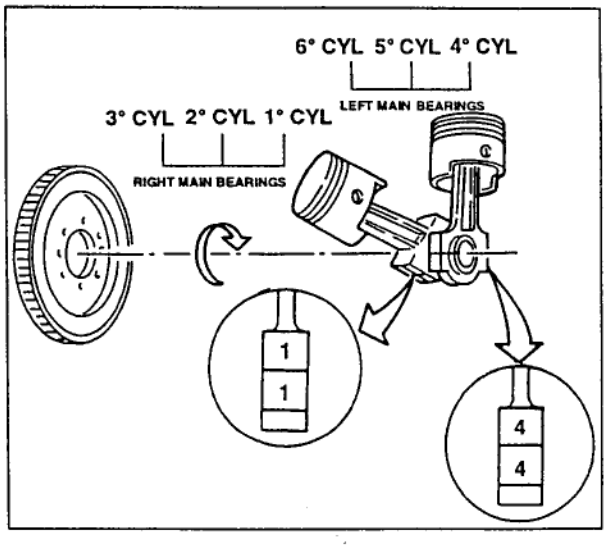
The pistons are in aluminium-silicium alloy with self-heating inserts and are divided into three dimensional classes. To ensure correct assembly an arrow is stamped on the piston crown to indicate the direction of rotation of the engine.



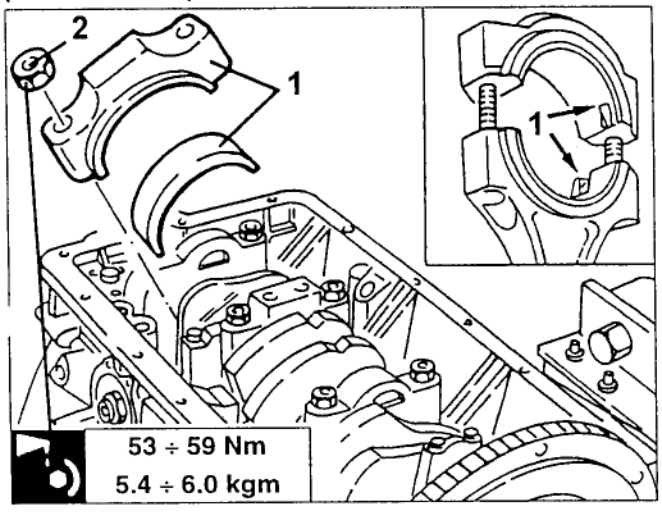


The connecting rods are in hardened and tempered alloy steel with a bushing in copper alloy force-fitted for coupling with the piston gudgeon pin.
As the gudgeon pins are floating on the piston hubs and on the connecting rod small end, their side movement is stopped by two expansion circlips housed in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

Each connecting rod is stamped with the number of the cylinder to which it refers; this number is towards the righthand side of the connecting rods of the right main bearings and on the lefthand side of the connecting rods of the left main bearings. Also the connecting rod caps have the number of the cylinder to which they refer on one side. When refitting this number should be on the same side as the one stamped on the connecting rod big end.



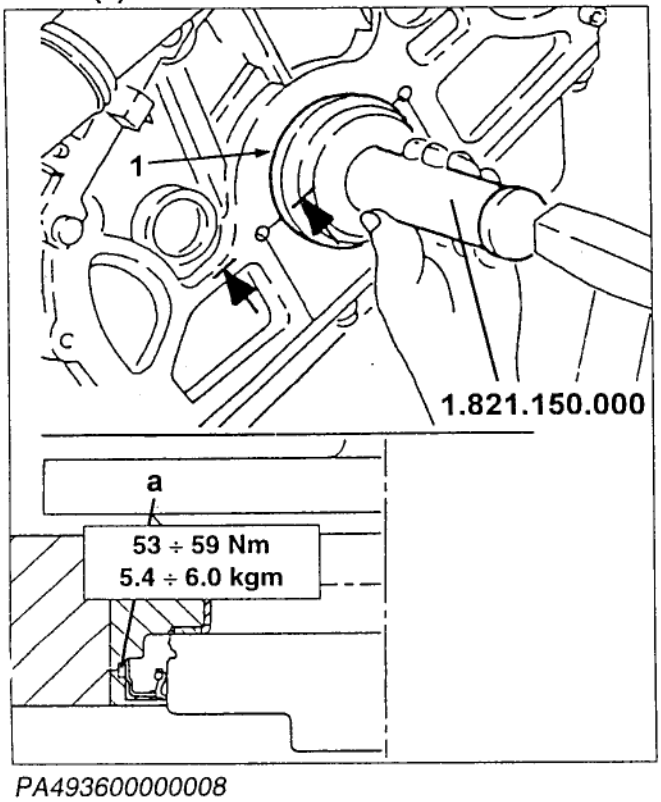
- Turn the crankcase on the overhaul stand.
1. Fit the connecting rod caps and half-bearings on the bank. Address the safety notch towards the notch on the connecting rod cap.
NOTE: The cylinder number is shown on the side of each connecting rod cap. When refitting, this number should be on the same 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.

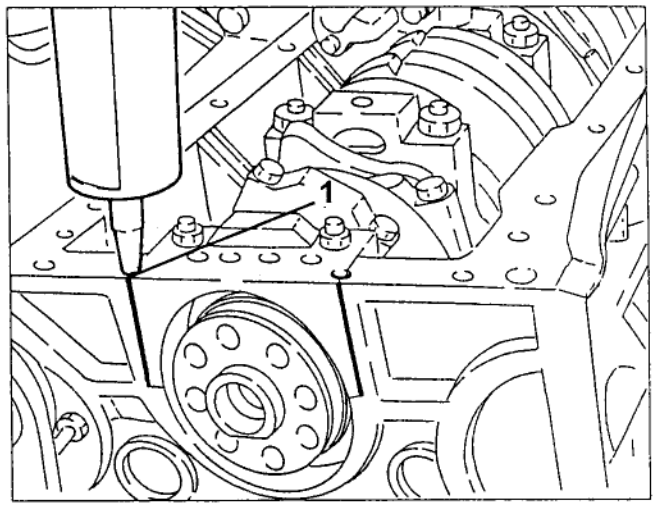
Oil sump refitting

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.

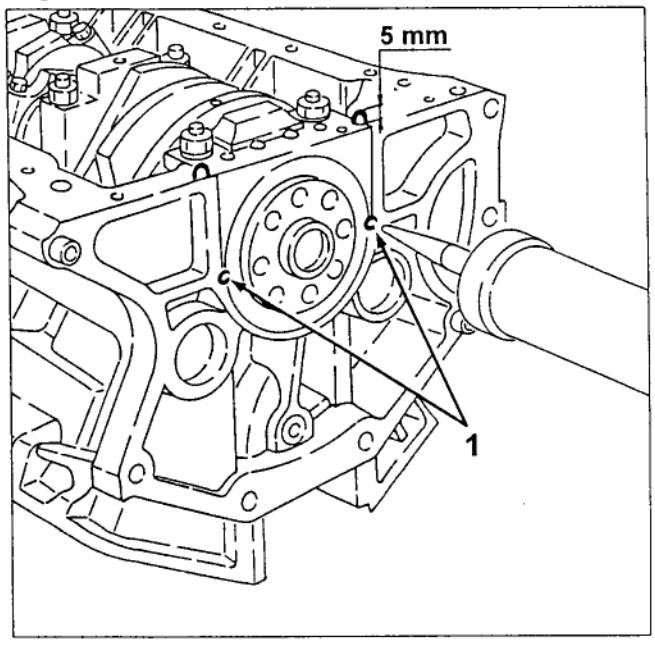


For pre-change versions (to engine no. 02054)
1. Apply "DOW CORNING 7091" silicon sealant with a mechanical gun through the holes shown in the figure.

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

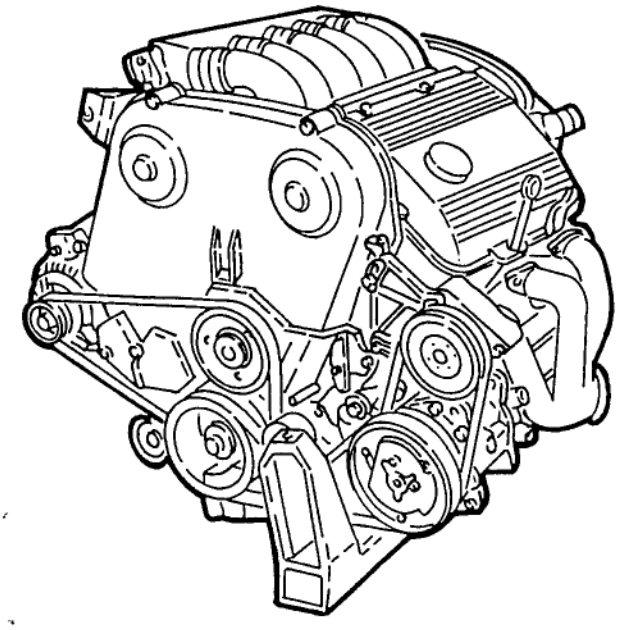


For pre-change versions (to engine no. 02055)
1. Apply "DOW CORNING 7091" silicon seals by means of a mechanical gun through the holes on the crankcase until the sealant seeps out from the engine oil sump coupling by approximately 5 mm.



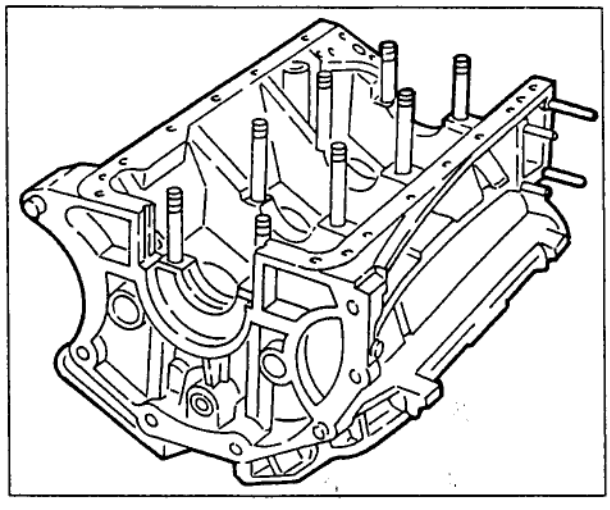
DESCRIPTION

The engine is of the type with six 60° V mounted cylinders in light alloy with a total cylinder displacement of 2959 cm^3 with injection and static ignition controlled by a single MOTRONIC M 3.7.1 control unit.
The "V" arrangement and the 60° angle make the engine extremely compact and well balanced from the dynamic point of view.
With a piston stroke of 72.6 mm and a bore of 93 mm, the engine is of the super square type (stroke and bore ratio below 1), which enables a better arrangement of the valves and optimal filling of the cylinders (high volumetric ratio).
The gearbox-clutch-differential unit is connected at the rear of the engine and is an integral part of the power unit.
The power unit is installed in the front of the vehicle arranged transversally with a 14° inclination forwards.
It is fastened to the body by two "suspension" type flexible damping mounts and by a third to the suspension crossmember.
To reduce vibrations, a rod above the engine connected to the body prevents excessive shaking.
The fuel supply system, with unleaded petrol, combined with adequate anti-pollution systems described in the specific paragraphs, feature low exhaust emission levels meeting "EEC STAGE 2" regulations.

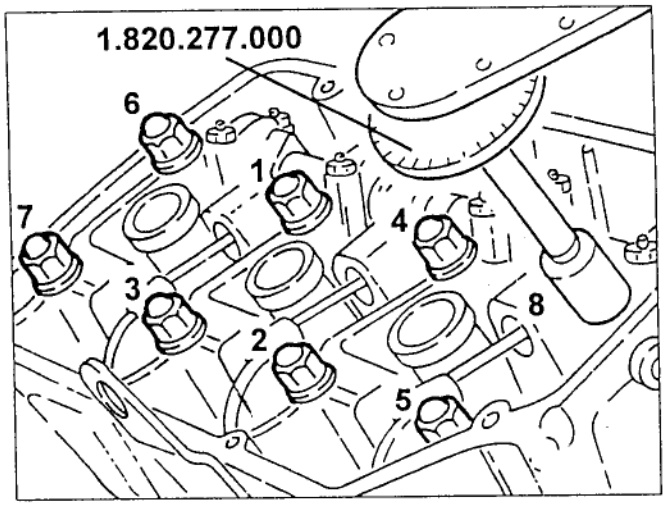


CRANKCASE

A single block in light aluminium and silicium alloy with high mechanical strength and thermal conductivity.
The crankshaft is supported by four main bearings which house the thin shell half bearings.
Special grooves, machined in the walls of the crankcase allow the passage of the engine coolant fluid and lubricating oil.
There are jets at the base of the cylinders from which oil is sprayed to cool the pistons.



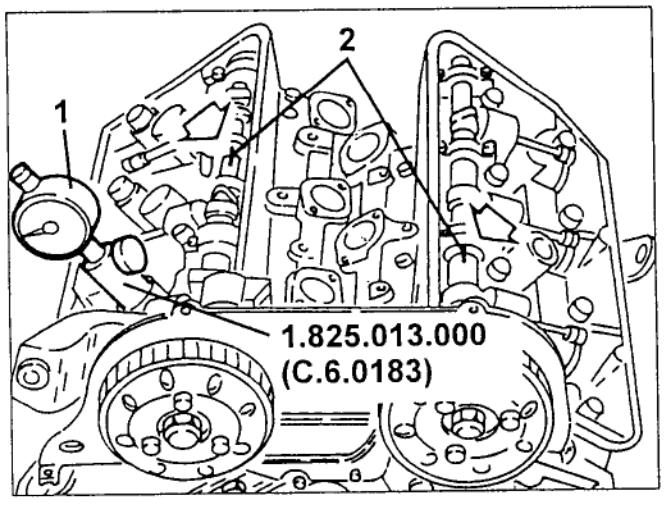
- Torque the cylinder head fastening screws as follows. The tighten torque order for each stroke is given in the figure.



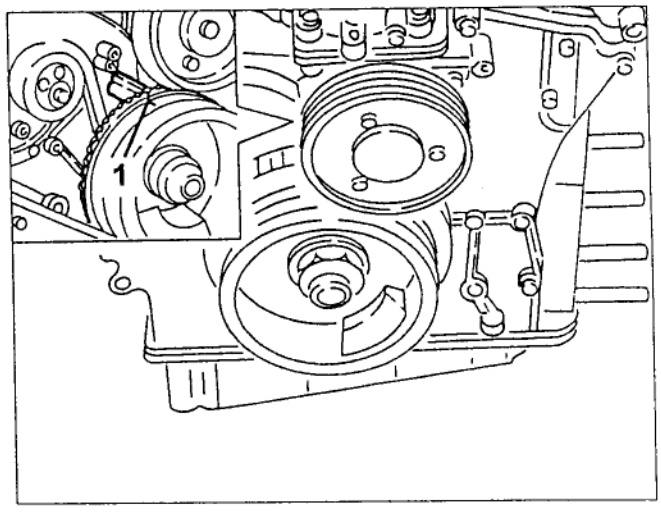
Tightening torque procedure	
Fasten all screws at:	25 Nm
Complete torque by an additional angle of:	240° ± 1°30'

Refitting timing belt and checking timing

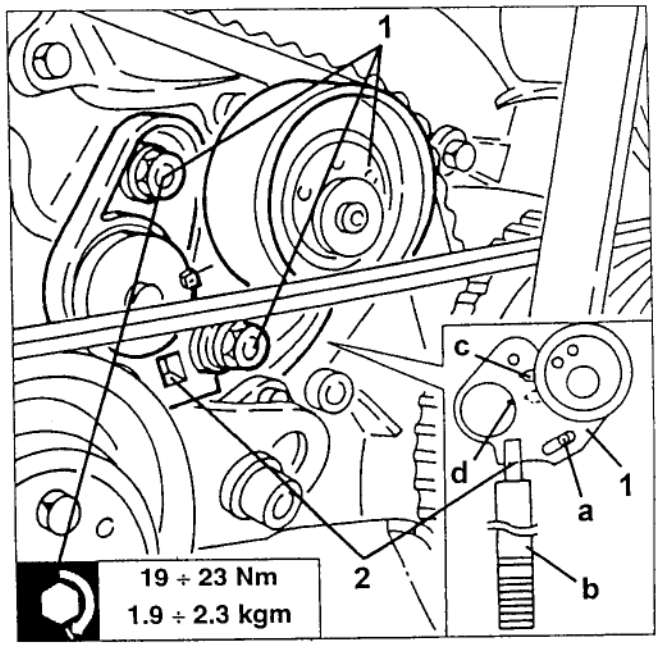
1. Turn the crankshaft to take cylinder 1 piston to TDC firing stroke with tool no. 1.825.013.000 (C.6.0183) and gauge.
2. Check alignment of the notches on the camshafts and those on the respective caps.



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



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".



INDEX

GENERALITIES
- Description....1
- Lubrification....4

OVERHAULING
- Introduction....1
- Engine dis-assembly....1
- Dis-assembly of cylinder heads....12
- Cheks and inspections cylinder heads....15
- Cheks and inspections crankcase....25
- Cautions for re-assembly....33
- Cheking the electrical components of the lubrication circuit....39