SECTION 1B3

OM600 ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Engine Assembly

Application	N•m
Skid Plate Bolt	28 - 47
Drain Plug Bolt	30
Coolong Fan Shroud Bolt	3 - 7
Control Linkage Nut	8 - 18
Clutch Linkage Cylinder Nut	20 - 34
Exhaust Manifold Bolt	30
Propeller Shaft Bolt & Nut (Axle)	70 - 80
Propeller Shaft Bolt & Nut (T/C)	81 - 84
Engine Mounting Nut	50 - 75

Crankshaft Assembly

Application	N•m
Cooling Fan Belt Pulley Bolt	10
Socket Bolt	23
Tighten The Bolt	200 / 90°
End Cover Bolt	10
Crankshaft Bearing Cap Bolt	55 / 90°
Ball Bearing	45 / 90°
Camshaft Sprocket Bolt	25 / 90°
Oil Pump Sprocket Bolt	25

Piston

Application	N•m
Connecting Rod Bolt	35 / 90°

Flywheel

Application	N•m
12-Sided Stretch Bolt	45 / 90°

Cylinder Head

Application	N•m
Prechamber Threaded Ring	130
Cylinder Head Cover Bolt	10
Fuel Injsction Pipe Nut	18
Socket Bolt	25
Fuel Filter Pipe Bolt	25
Idle Pulley Bolt	23
Damper Bolt	21

Cylinder Head

Application	N•m
Camshaft Bearing Cap Bolt	25
Camshaft Sprocket Bolt	25 / 90°
Exhaust Pipe Bolt& Nut	25
Chain Tensioner	80
Injection Nozzle	40
Intake Manifold Not	25
Injection Nozzle Pipe Not	18
Oil Dipstick Tube Bolt	10
Screw Plug M18 x 15	50

Cam Support & Shaft

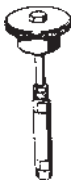
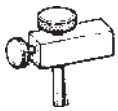
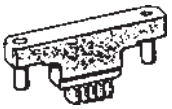
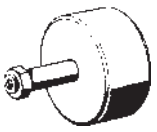
Application	N•m
Stud Bolt	12
Exhaust Manifold Not	25
CamShaft Bearing Cap Bolt	25
12-Sided Bolt (M11)	25 / 90°

Timing Cover

Application	N•m
Oil Pan Bolt-Socket Bolt	10
Oil Pan Bolt- M6	10
Oil Pan Bolt- M23	23
Belt Pulley Bolt	32
Guide Pulley Bolt	4
Guide Pulley Bracket Nut	23
Chain Tensioner	80
Tesioning Lever Bolt	23

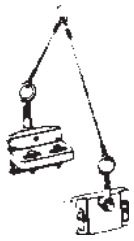
SPECIAL TOOLS

SPECIAL TOOLS TABLE

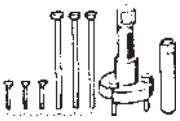
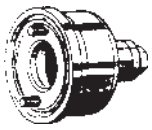
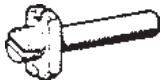
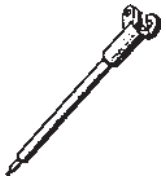
	**603 589 00 09 00** **Serration Wrench**
	**657 589 03 63 00** **Sliding Hammer**
	**601 589 00 66 00** **Counter Sink**
	**667 589 00 23 00** **Height Gauge**
	**603 589 00 40 00** **Counter Holder**
	**000 589 77 03 00** **Box Wrench Insert**
	**602 589 00 40 00** **Engine Lock**
	**116 589 20 33 00** **Sliding Hammer**

SPECIAL TOOLS TABLE (Cont'd)

	**116 589 03 07 00** **T Type Socket Wrench**
	**601 589 00 10 00** **Cylinder Head Bolt 102**
	**102 589 12 15 00** **(ϕ 17) Drift**
	**617 589 10 21 00** **RI Sensor**

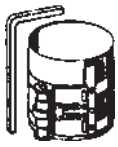
	**115 589 34 63 00**
	**601 589 00 25 00**
	**102 589 00 15 00** **(ϕ 34) Drift**
	**601 589 05 14 00** **Assembly Cage**

SPECIAL TOOLS TABLE (Cont'd)

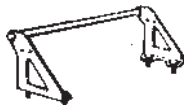
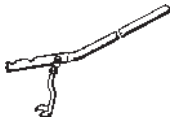
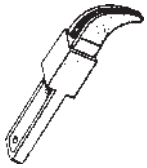
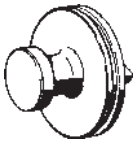
	**601 589 08 15 00** **Drift**		**103 589 00 33 00** **Puller**
	**001 589 53 21 00** **Dial Gauge**		**601 589 03 14 00** **Sleeve**
	**601 589 07 21 00** **Depth Gauge**		**601 589 03 43 00** **Oil Seal Assembler**
	**667 589 01 21 00** **Fixing Device**		**366 589 00 21 05** **Extension**

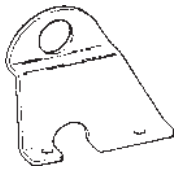
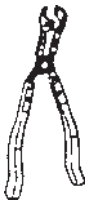
SPECIAL TOOLS TABLE (Cont'd)

	**363 589 02 21 00** **Dial Gauge Holder**
	**000 589 33 33 00** **Counter Support**
	**000 589 25 33 00** **Internal Extractor**
	**102 589 05 33 00** **Puller**

	**116 589 07 15 00** **Drift**
	**000 589 04 14 00** **Tensioning Strap**
	**102 589 03 40 00** **Magnetic Bar**
	**601 589 01 59 00** **Assembling Board**

SPECIAL TOOLS TABLE (Cont'd)

	**601 589 02 59 00** **Supporting Bridge**
	**667 589 00 31 00** **Press Lever**
	**116 589 06 63 00** **Magnetic Finger**
	**603 589 01 40 00** **Holding Wheel**

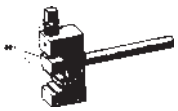
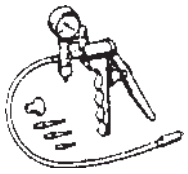
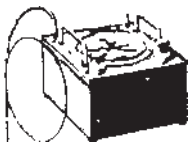
	**667 584 02 63 00** **Supporting Bar**
	**104 589 00 37 00** **Pliers**
	**601 589 02 43 00** **Drift**
	**000 589 10 68 00** **Cylinder Brush**

SPECIAL TOOLS TABLE (Cont'd)

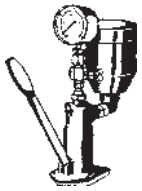
	**601 589 02 23 00** **Go/No Go Gauge**
	**105 589 03 15 00** **Drift (for Intake)**
	**103 589 02 15 00** **Drift (for Exhaust)**
	**346 589 00 63 00** **Super Cooling Box**

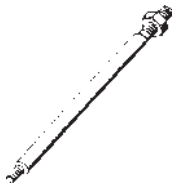
	**601 589 05 15 00** **Drift (for Intake)**
	**601 589 06 15 00** **Drift (for Exhaust)**
	**000 589 10 53 00** **Reamer (for Exhaust)**
	**000 589 21 53 00** **Reamer (for Intake)**

SPECIAL TOOLS TABLE (Cont'd)

	**001 589 32 21 00** **Dial Gauge**		**124 589 15 21 00** **Tester**
	**001 589 53 21 00** **Dial Gauge**		**667 589 02 21 00** **TDC Pulse Generator**
	**000 589 58 43 00** **Chain Assembling Device**		**501 589 73 21 00** **Vacuum Pump**
	**201 589 13 21 00** **Vacuum Tester**		**617 589 04 21 00** **Tester**

SPECIAL TOOLS TABLE (Cont'd)

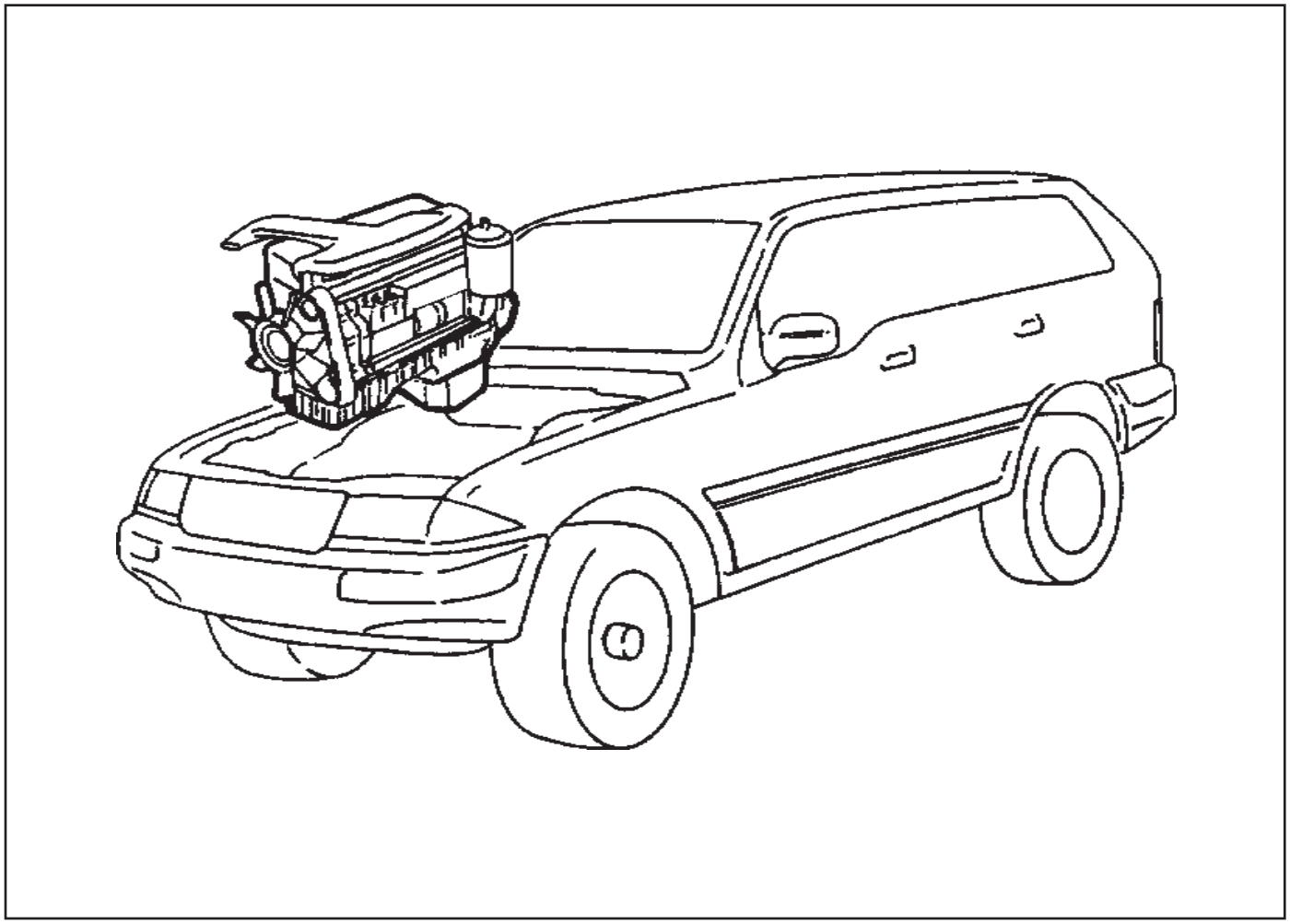
	**000 589 14 21 00** **Tester**
	**001 589 65 09 00** **Serration Wrench**
	**000 589 00 68 00** **Cleaning Set**
	**601 589 05 21 00** **Looking Screw**

	**601 589 00 08 00** **Flange**
	**116 589 02 34 00** **Thread Bolt**
	**667 589 04 63 00** **Retaining Plate**
	**617 589 08 21 00** **Position Sensor**

MAINTENANCE AND REPAIR

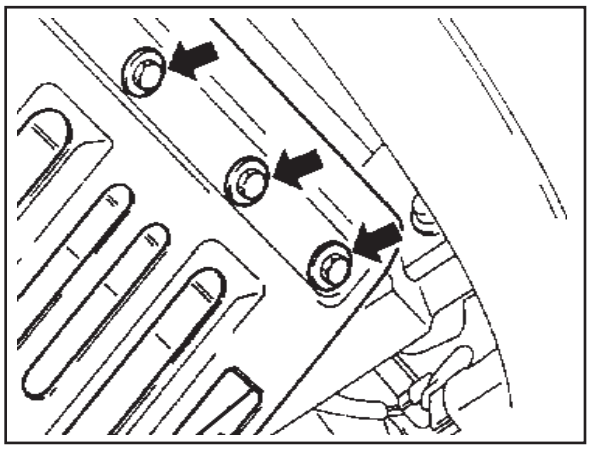
ON-VEHICLE SERVICE

ENGINE ASSEMBLY



Removal & Installation Procedure

1. Disconnect the negative terminal of battery.
2. Remove the hood.
3. Remove the skid plate.



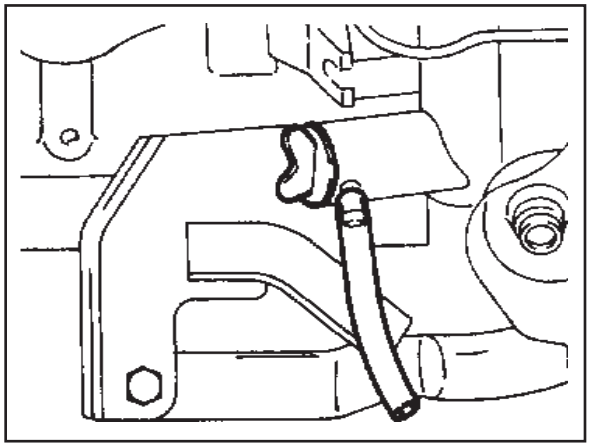
Installation Notice

Tightening Torque	28 - 47 Nm

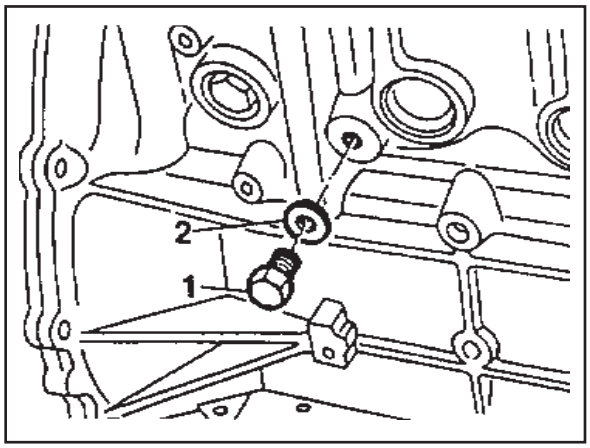
4. Remove the radiator drain cock and drain the coolant.

Notice

Open the coolant reservoir tank cap.



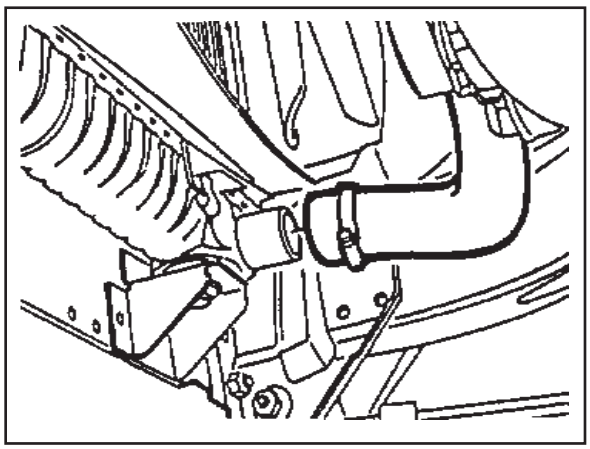
5. Remove the drain plug (1) and seal (2) from the cylinder block and drain the coolant completely.
6. After draining, replace the seal and reinstall the drain plug.



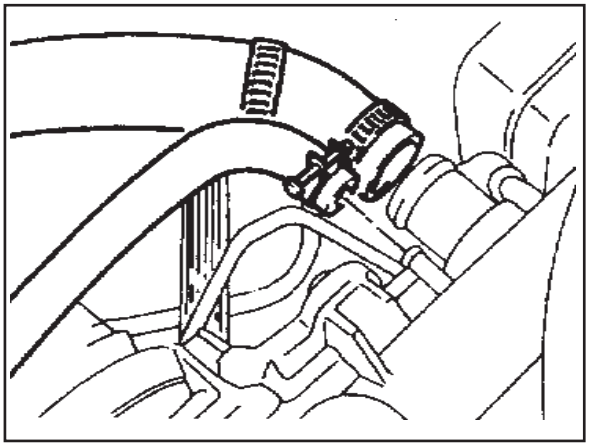
Installation Notice

Tightening Torque	30 Nm

7. Disconnect the lower coolant hose from the radiator.

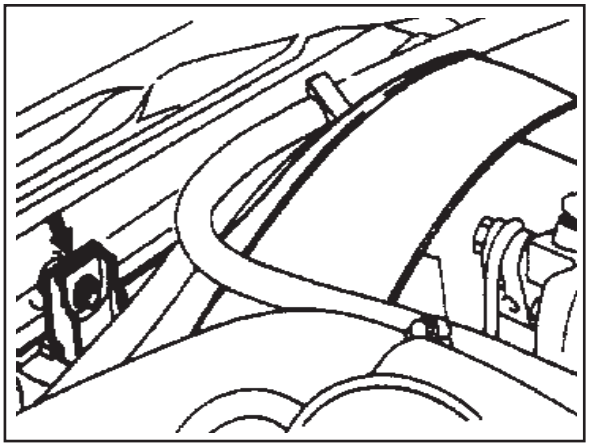


8. Disconnect the upper coolant hose from the radiator.

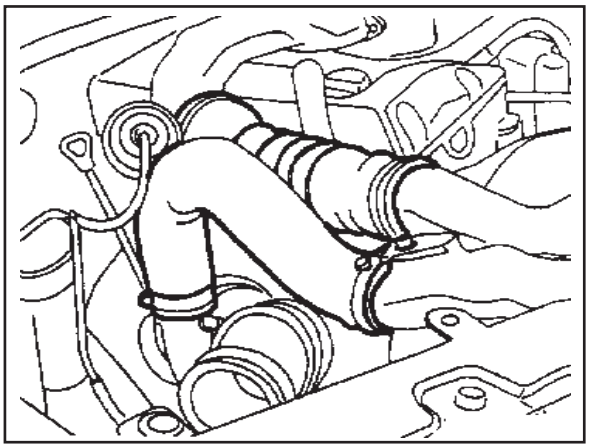


9. Loosen the bolt and remove the coolant pipe and cooling fan shroud.

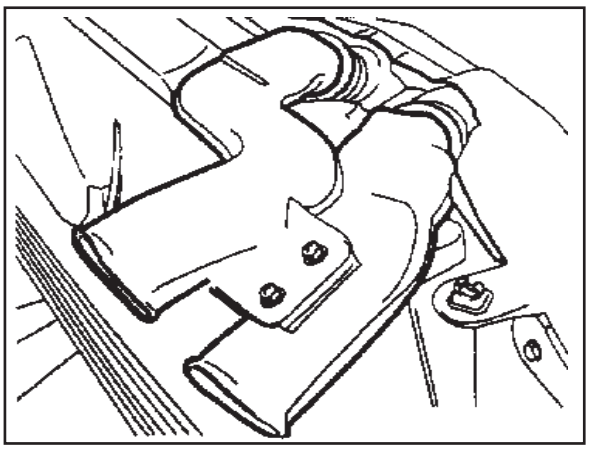
Tightening Torque	3 -7 Nm



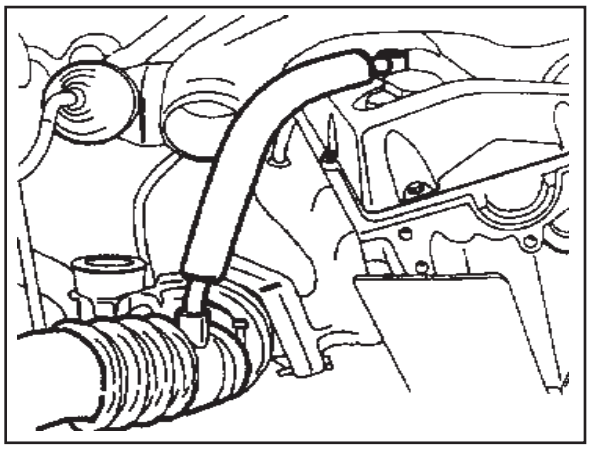
10. Remove the hoses (air intake to intercooler, intercooler to intake duct).



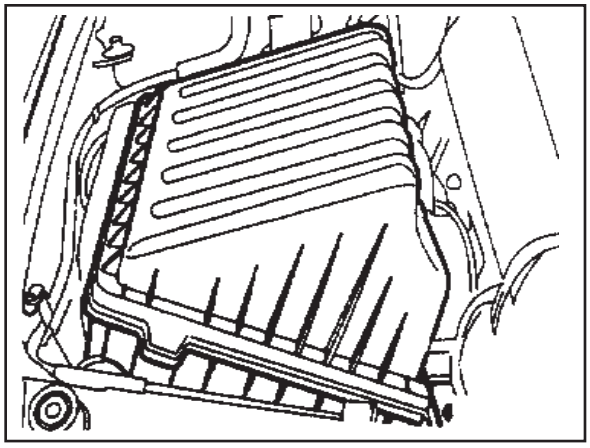
11. Remove the pipes connected to intercooler.



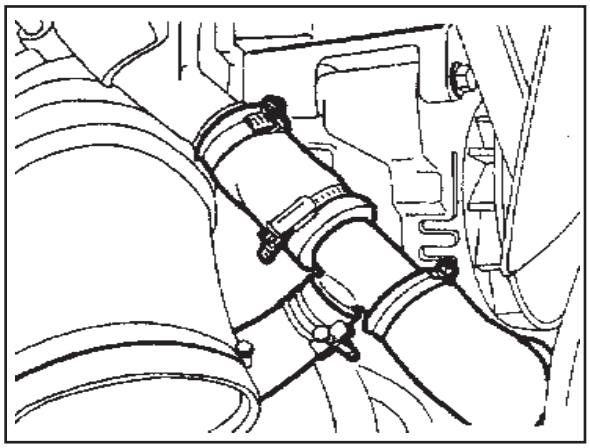
12. Remove the hose(air cleaner to turbocharger) with blow by hose.



13. Disconnect the air cleaner intake hose and remove the air cleaner cover and element.



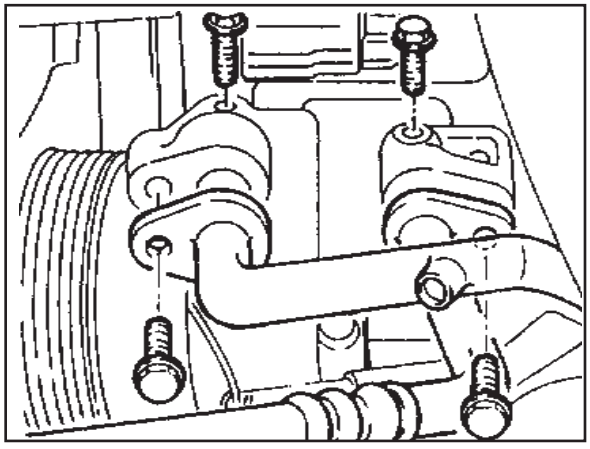
14. Disconnect the coolant hose from the water inlet.



15. Remove the air-conditioner lines from the compressor.

Notice

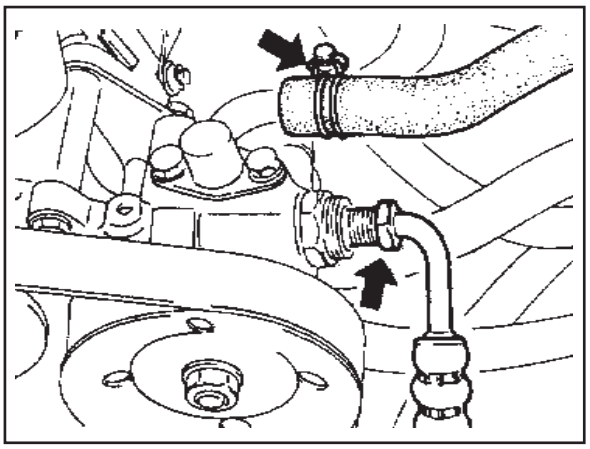
Evacuate the refrigerant before removal.



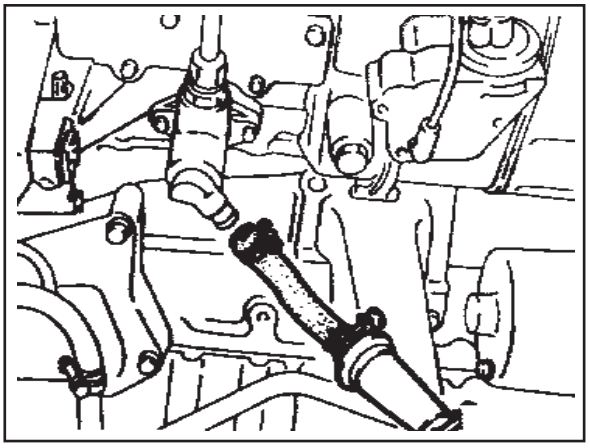
16. Remove the power steering pump lines.

    Notice

    Completely drain the fluid.

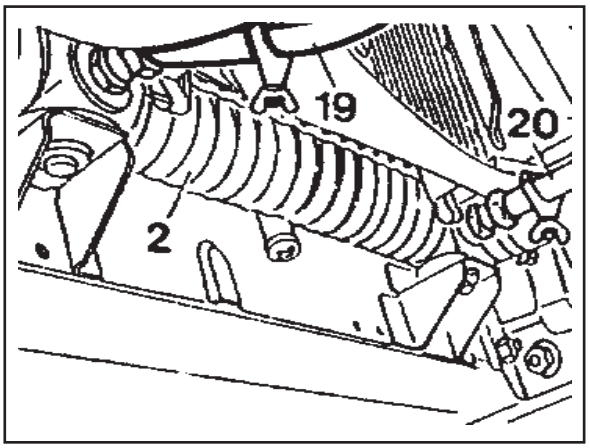


17. Disconnect the fuel feed line with prefilter from the feed pump on injection pump.

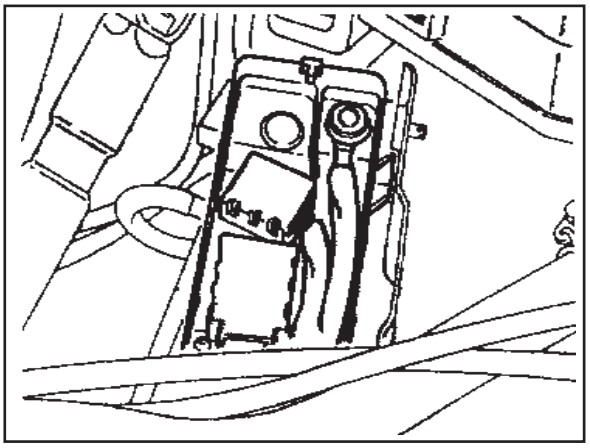


18. Vehicle with automatic transmission.

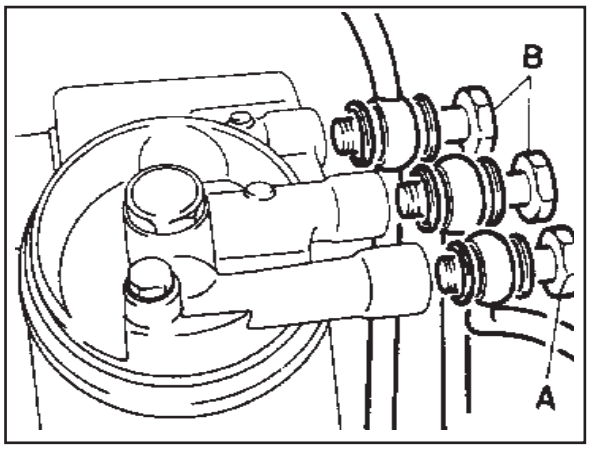
    Remove the hydraulic lines (19, 20) from oil cooler (2).



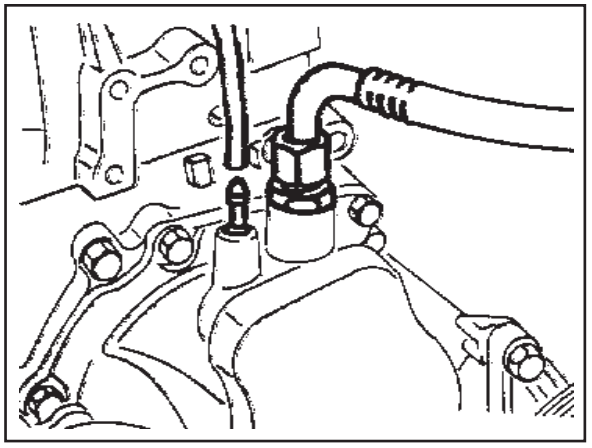
19. Disconnect the engine harness.
20. Disconnect the preheating time relay cable.



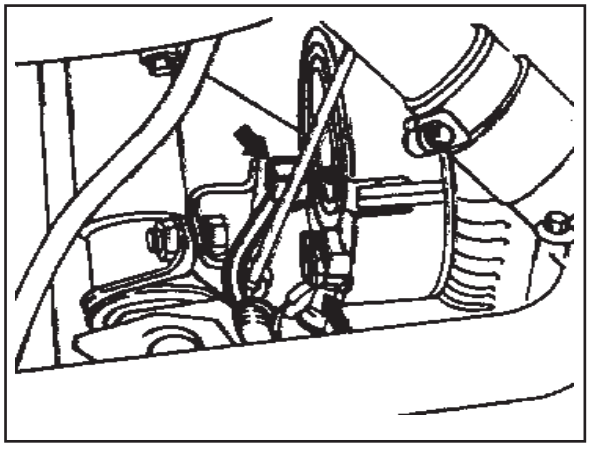
21. Remove the fuel lines from the fuel filter and cover the filter with plug.



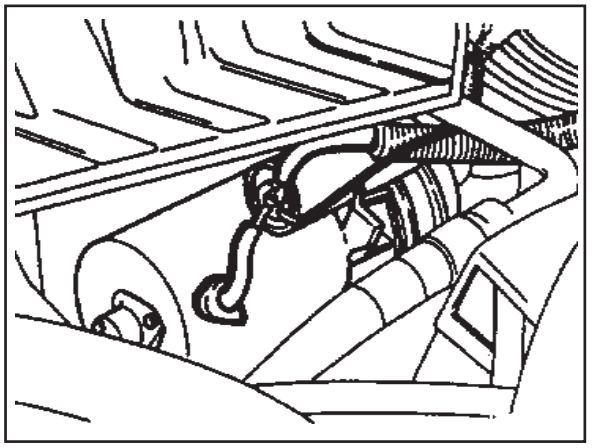
22. Disconnect the brake booster hose from vacuum pump.
23. Disconnect the other vacuum lines.



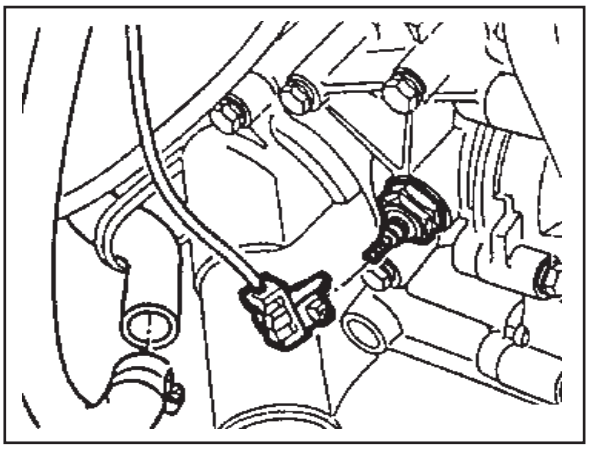
24. Disconnect the ground cable.
25. Disconnect the alternator wires.



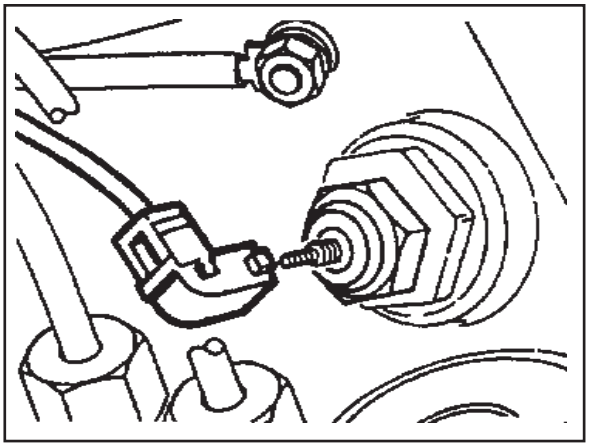
26. Disconnect the starter motor wires and remove the starter motor.



27. Disconnect the preheating time relay sensor plug.



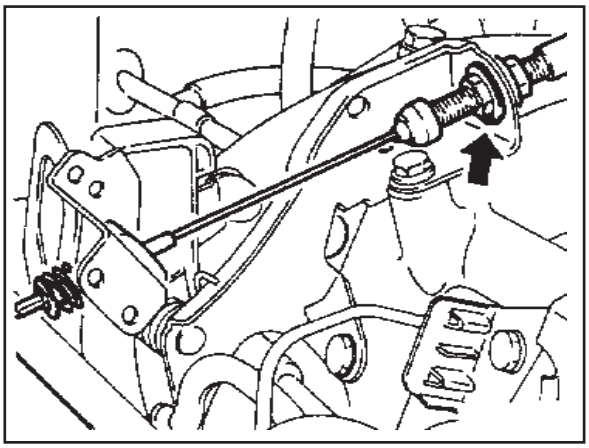
28. Disconnect the coolant temperature sensor plug.



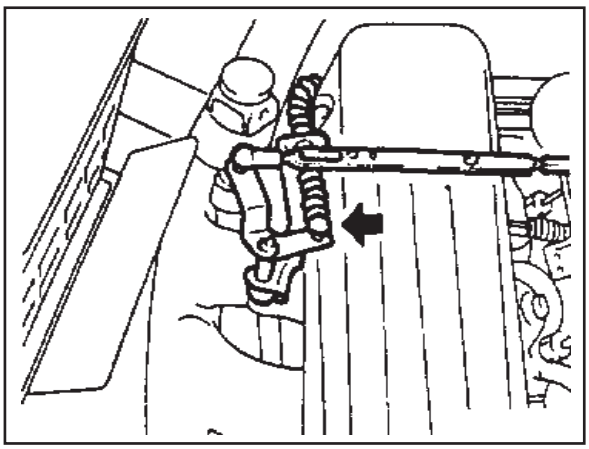
29. Disconnect the accelerator cable from the control linkage.

Installation Notice

Tightening Torque	8 - 18 Nm



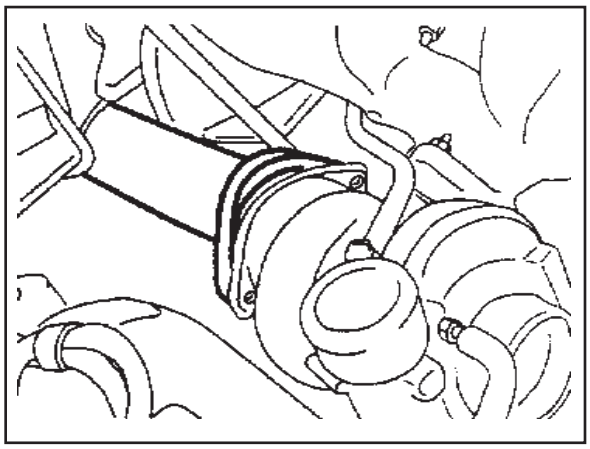
30. Loosen the connection of control pressure cable (an arrow) used in auto transmission.



31. Separate the exhaust pipe flange from the turbo charger.

Installation Notice

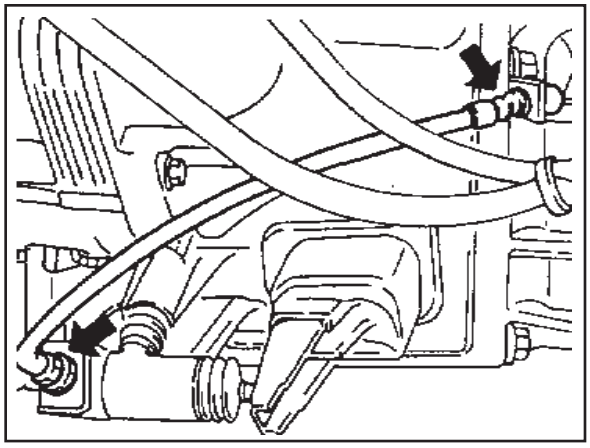
Tightening Torque	30 Nm



32. Loosen the installing bolt of clutch release cylinder and remove the clutch release cylinder.

Installation Notice

Tightening Torque	20 - 34 Nm



33. Disconnect the exhaust pipe flange from the exhaust manifold.

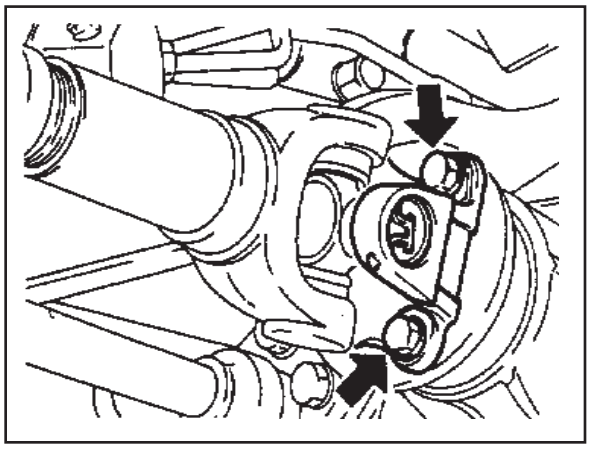
Installation Notice

Tightening Torque	30 Nm

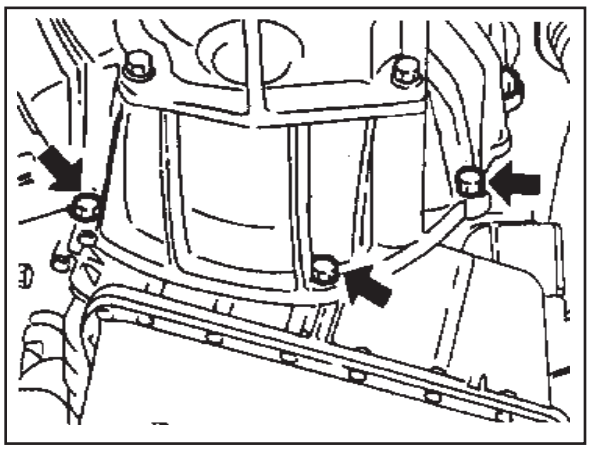
34. Remove the propeller shaft from the transmission.

Installation Notice

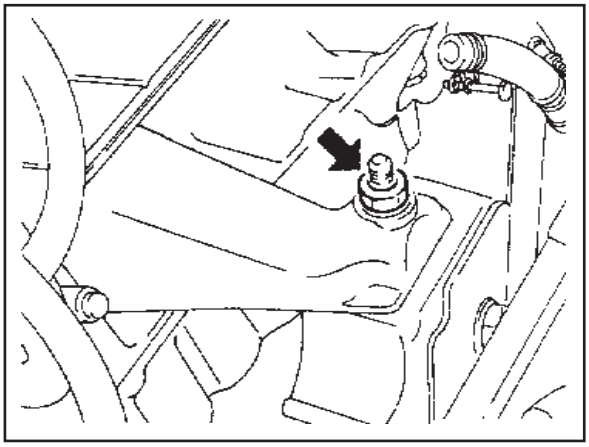
Tightening Torque	Axle 70 ~ 80 Nm
	T/C 81 ~ 89 Nm



35. Remove the shift control cable.
36. Remove the transmission.



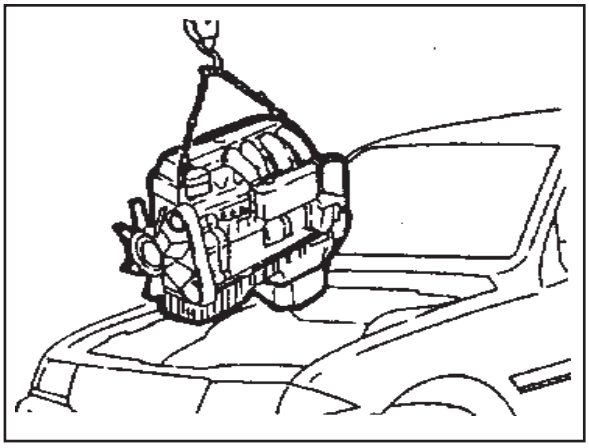
37. Loosen the engine mounting bracket nut.



Installation Notice

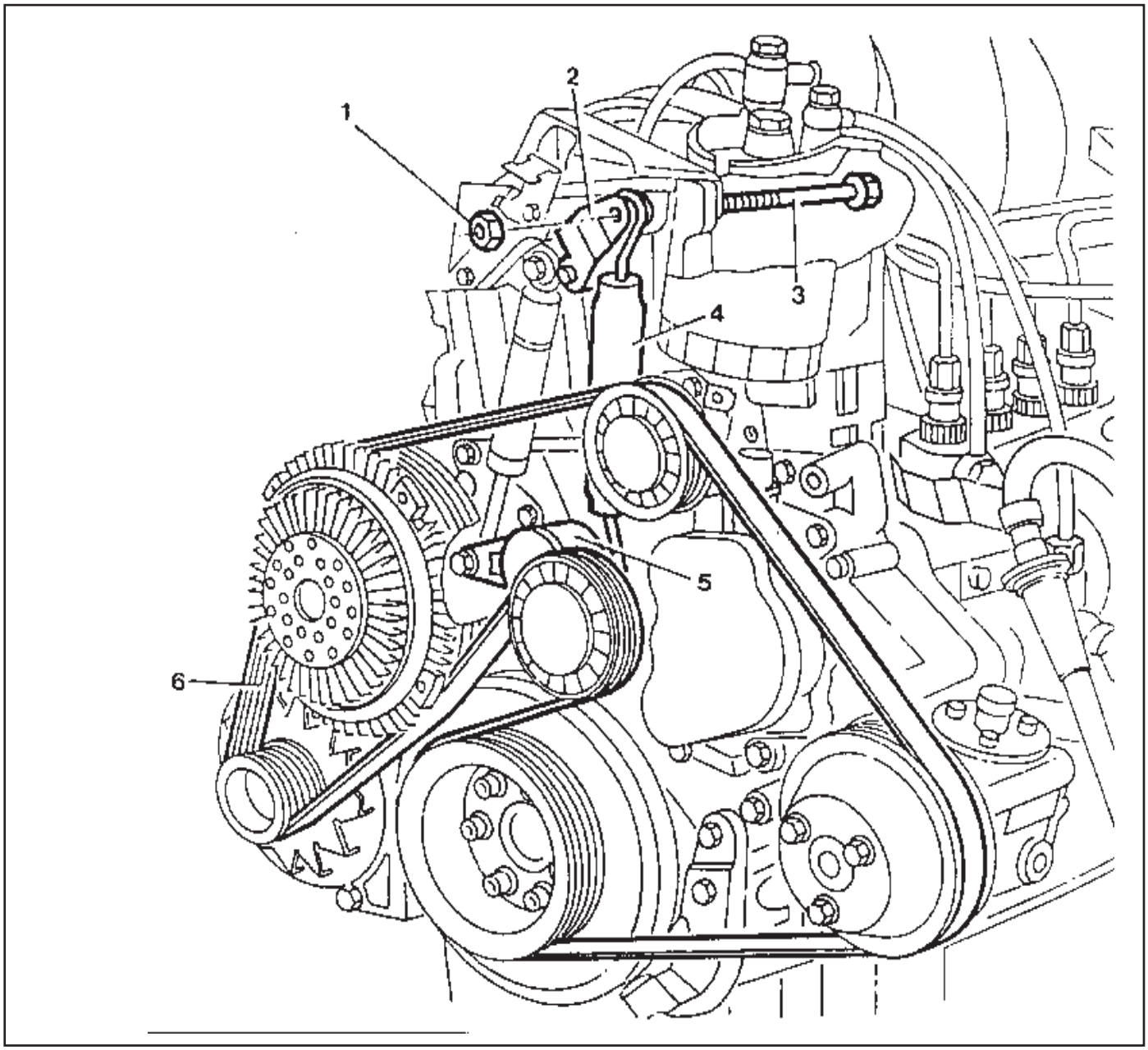
Tightening Torque	50 - 75 Nm

38. Remove the engine assembly from the vehicle by using a hoist or crane.



39. Installation should follow the removal procedure in the reverse order.

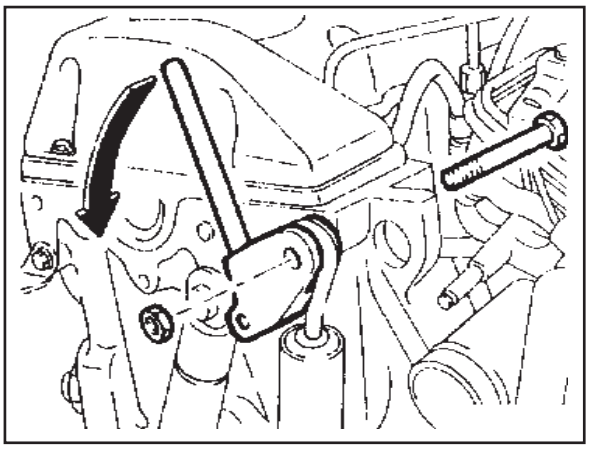
POLY V-BELT



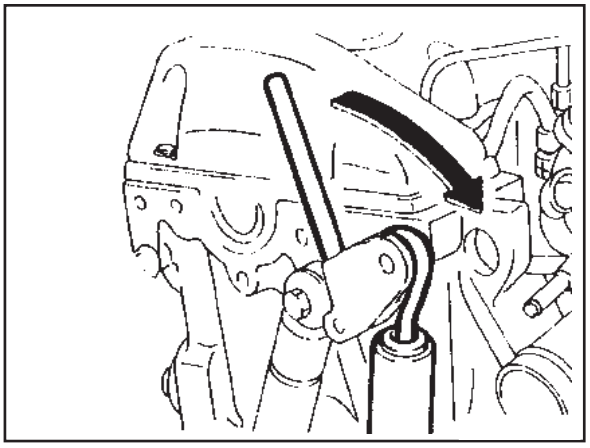
1 Nut 23Nm
2 Tensioning Lever
3 Bolt
4 Spring
5 Tensioning Lever
6 Poly V-Belt

Removal & Installation Procedure

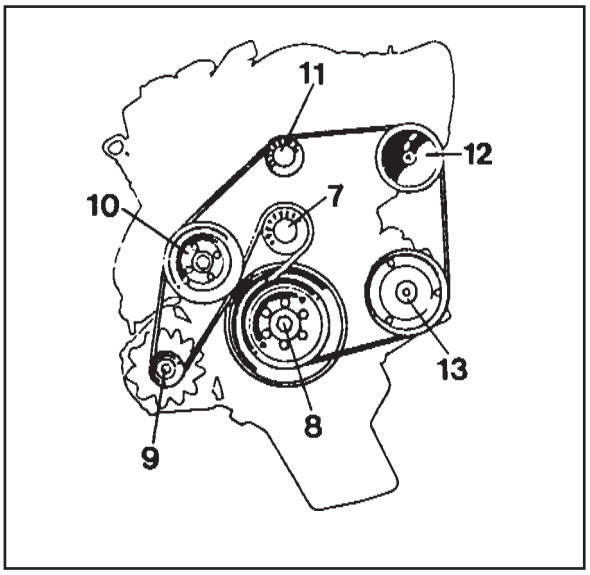
1. Remove the nut.
2. Push the tensioning lever in direction of arrow with a rod (F12 ´ 180mm) and pull out the bolt to the rear.



3. Push back the tensioning lever (arrow direction) to release the spring tension and remove the belt.



4. Install the poly V-belt beginning at the tensioning pulley (7).



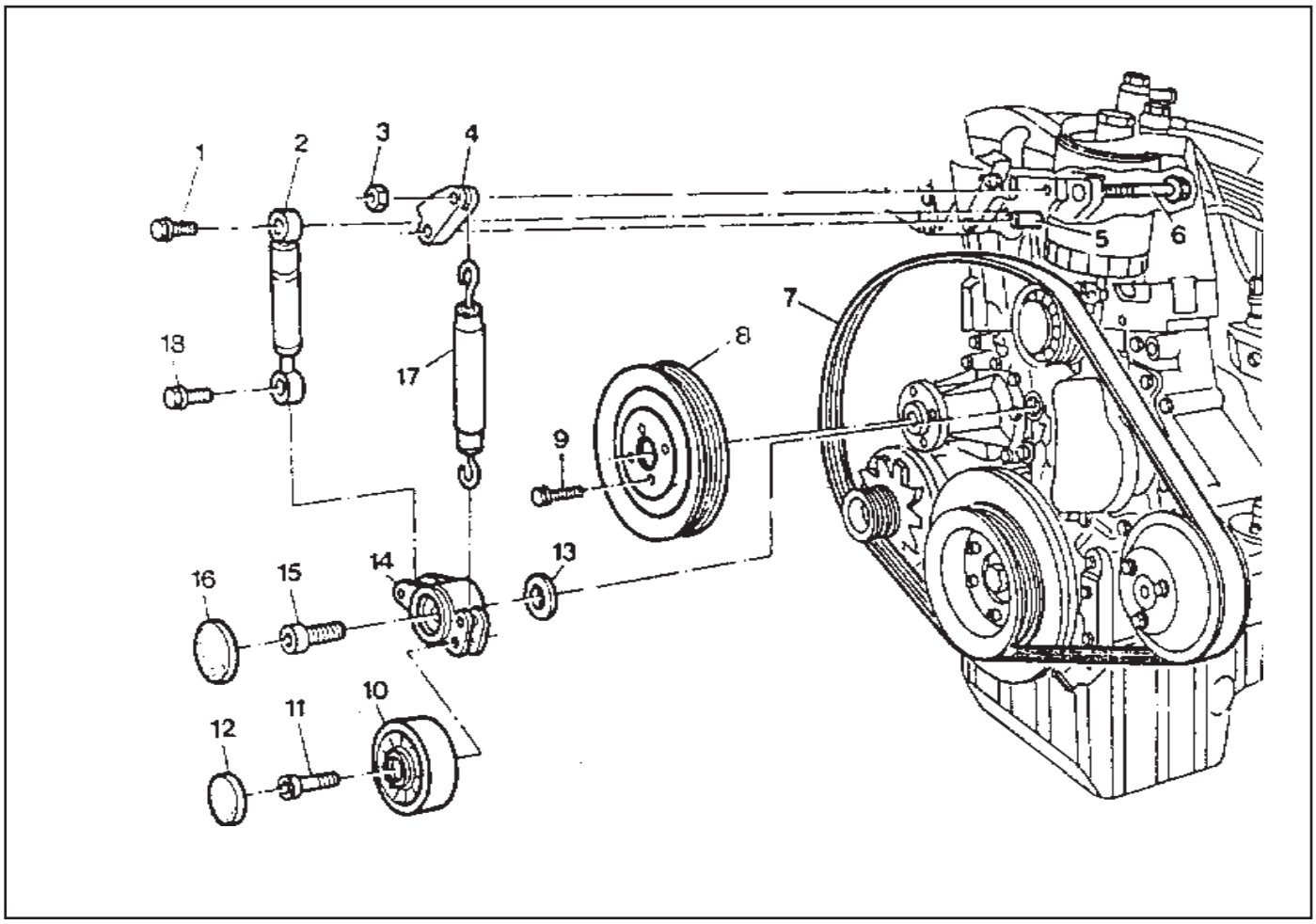
7 Tensioning Pulley
8 Crankshaft
9 Alternator
10 Coolant Pump
11 Guide Pulley
12 Power Steering Pump
13 Aircon. Compressor

Lengthe of Belt

Length (L)	With Air Conditioner	2,100 mm
	Without Air Conditioner	2,040 mm

TENSIONING DEVICE

Preceding Work : Removal of cooling fan



1 Bolt 21Nm
2 Damper
3 Nut 21Nm
4 Tensioning Lever
5 Guide Rail Pin
6 Bolt
7 Poly V-Belt
8 Belt Pulley
9 Bolt 10Nm
10 Tensioning Pulley
11 Socket Bolt 29Nm
12 Closing Cover
13 Washer
14 Tensioning Lever
15 Fit Bolt 100Nm
16 Closing Cover
17 Spring
18 Bolt 20Nm

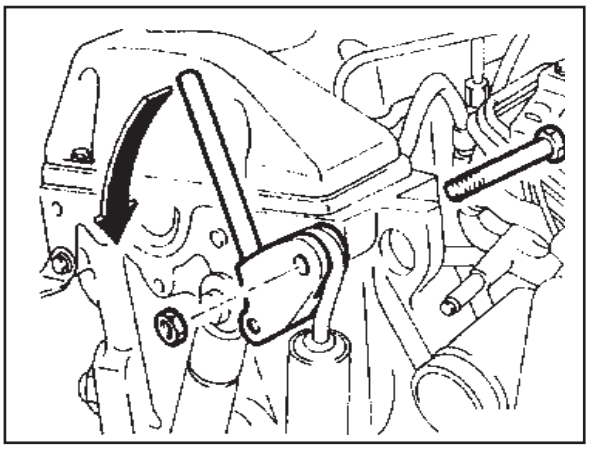
Removal & Installation Procedure

1. Remove the nut.

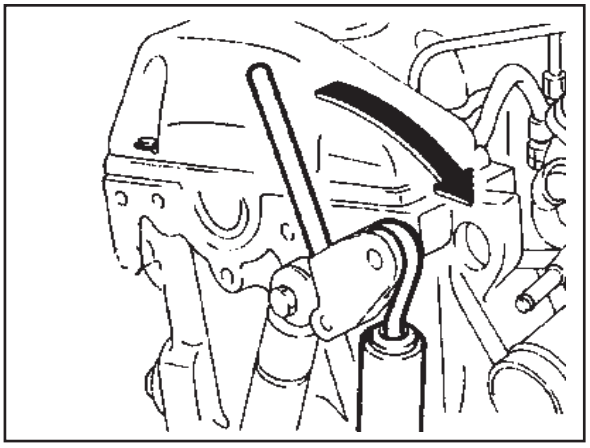
   Installation Notice

Tightening Torque	10 Nm

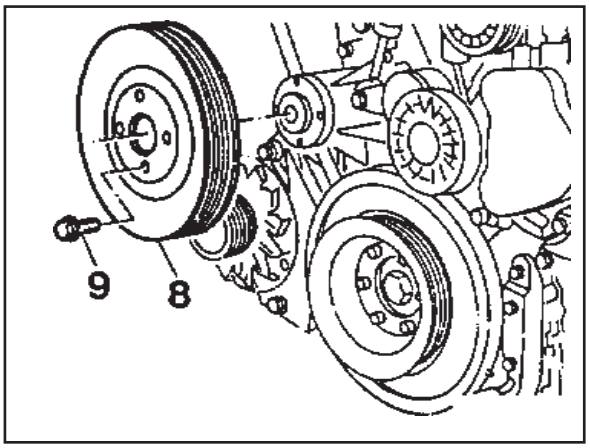
2. Push the tensioning lever in direction of arrow with a rod (F12 ´ 180mm) and push out the bolt to the rear.



3. Push back the tensioning lever to release the spring tension and remove the belt.



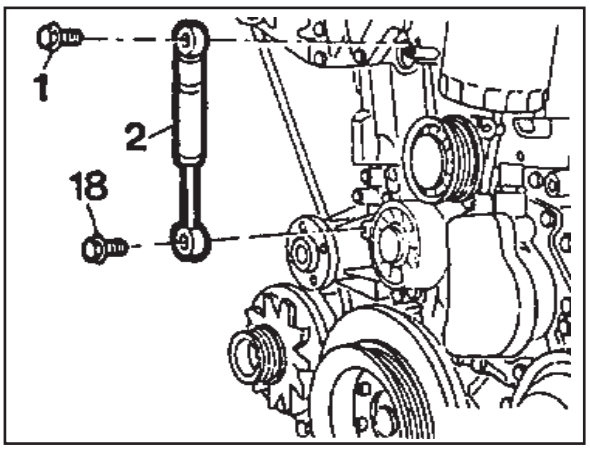
4. Remove the bolt (9) and then remove the belt pulley (8).



5. Remove the bolt (1, 18) and take off the damper (2).

   Notice

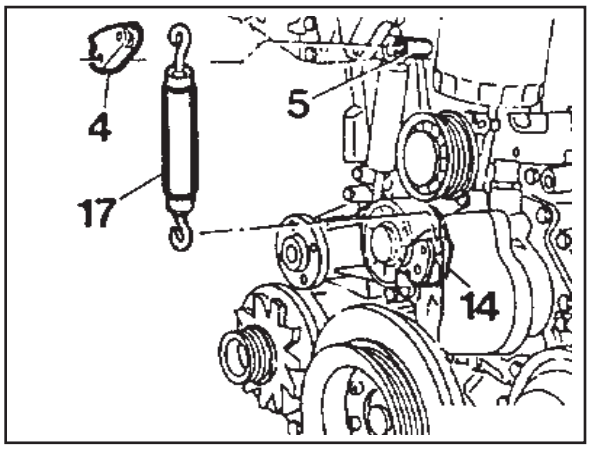
   Pay attention to installation position of the damper.



6. Pull off the tensioning lever (4) from guide rail pin.
7. Remove the spring (17).

Installation Notice

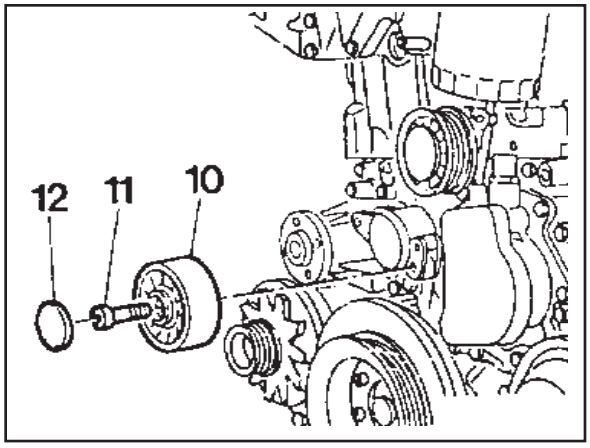
Insert spring (17) with color coding (blue/violet) facing up.



8. Pry off the closing cover (12) and remove the socket bolt (11) and then remove the tensioning pulley (10).

Installation Notice

Tightening Torque	29 Nm

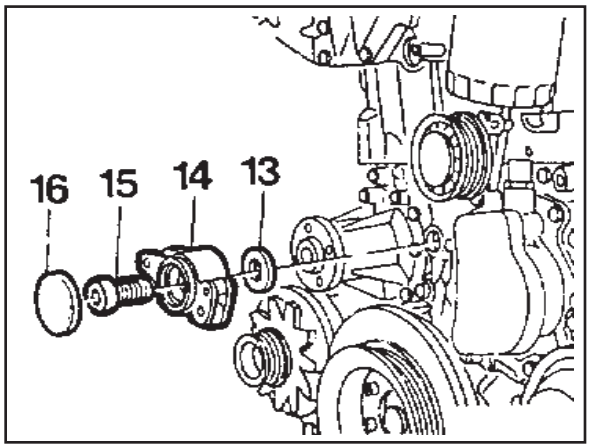


9. Pry off the closing cover (16) and remove the fit bolt (15).
10. Remove the tensioning lever (14) and washer (13).
11. Clean thread in the timing case cover and fit bolt.

Installation Notice

Apply Loctite on thread of fit bolt.

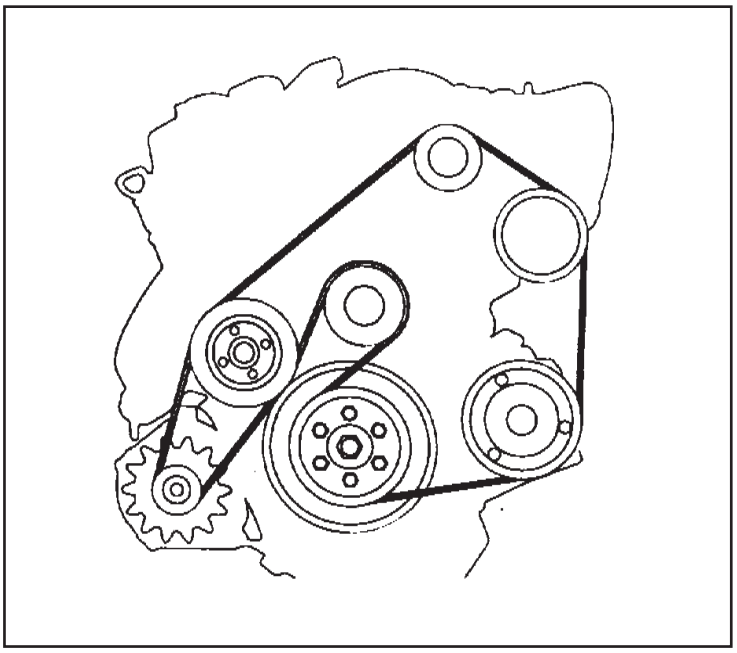
Tightening Torque	100 Nm



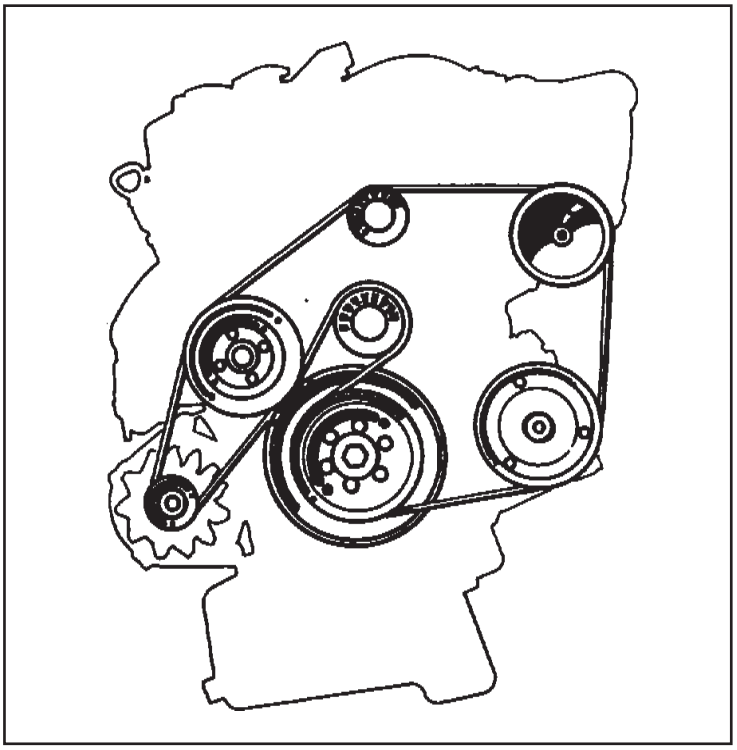
12. Installation should follow the removal procedure in the reverse order.

POLY V-BELT ALIGNMENT & INSPECTION

Without Air Conditioner



With Air Conditioner

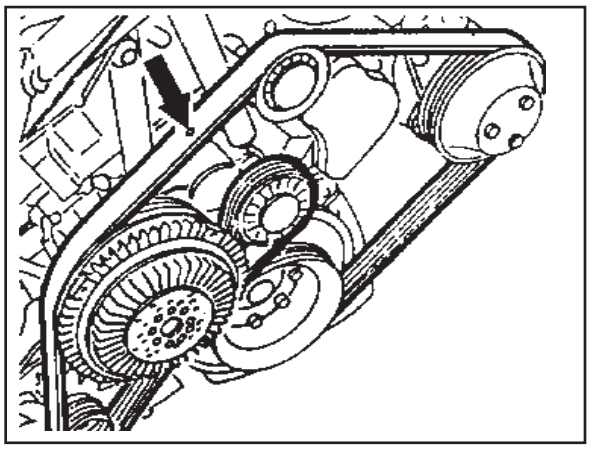


Inspection Procedure

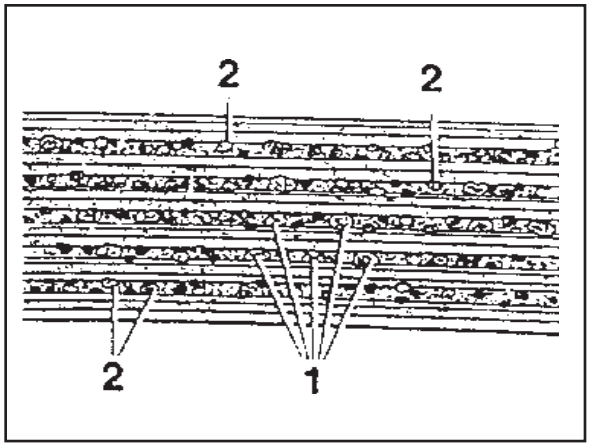
- Mark poly V-belt at a clearly visible point with chalk.
- Rotate the engine and check the belt.

Notice

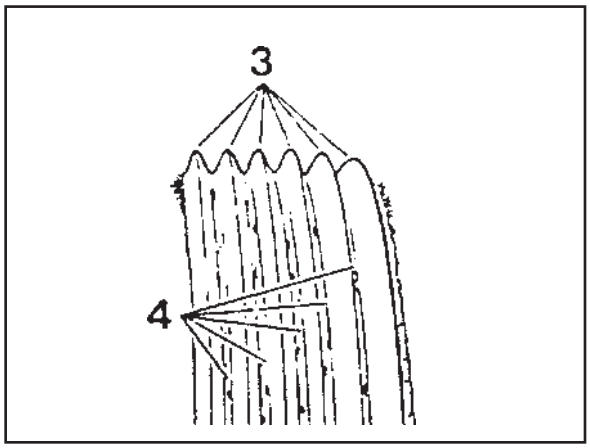
If one of the following types of damage is found, replace the belt.



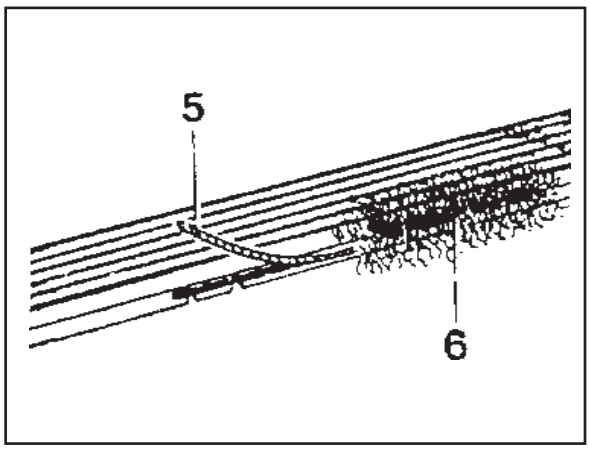
1. Rubber lumps in the base of rips.
2. Dirt or grit ingrained.



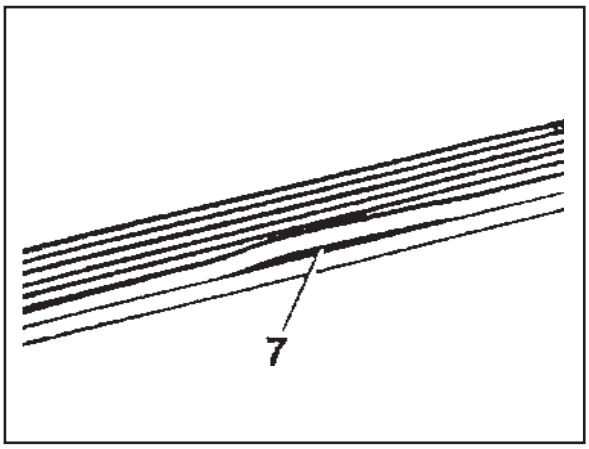
3. Pointed rips.
4. Belt cord visible in the base of rips.



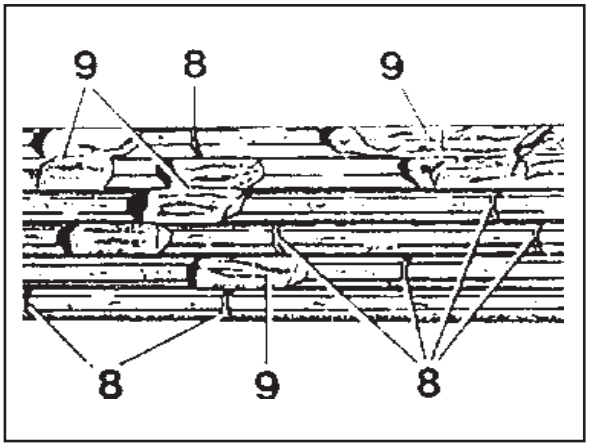
5. Cord torn out at the side.
6. Outer cords frayed.



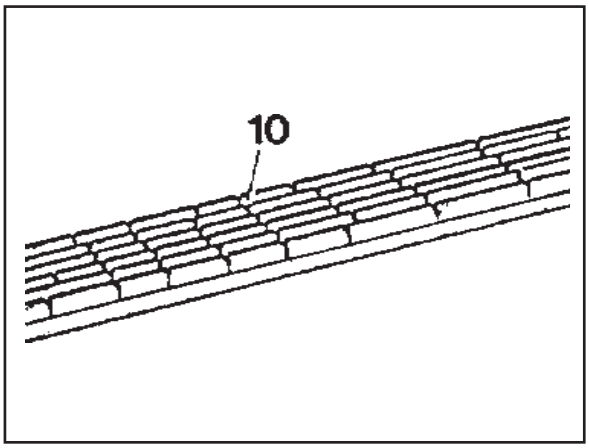
7. Belt detached from the base of rip.



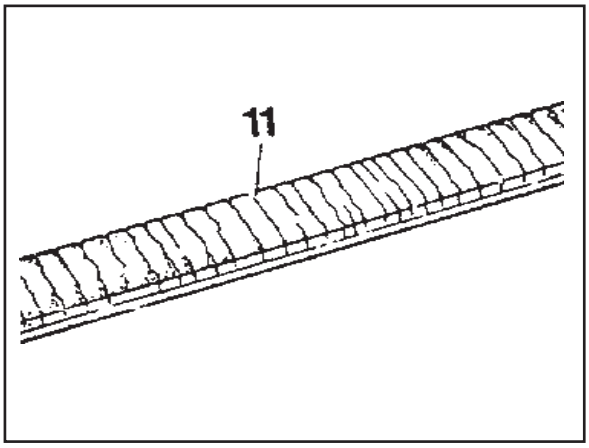
8. Splits across the rips.
9. Sections of rip torn out.



10. Splits across several rips.

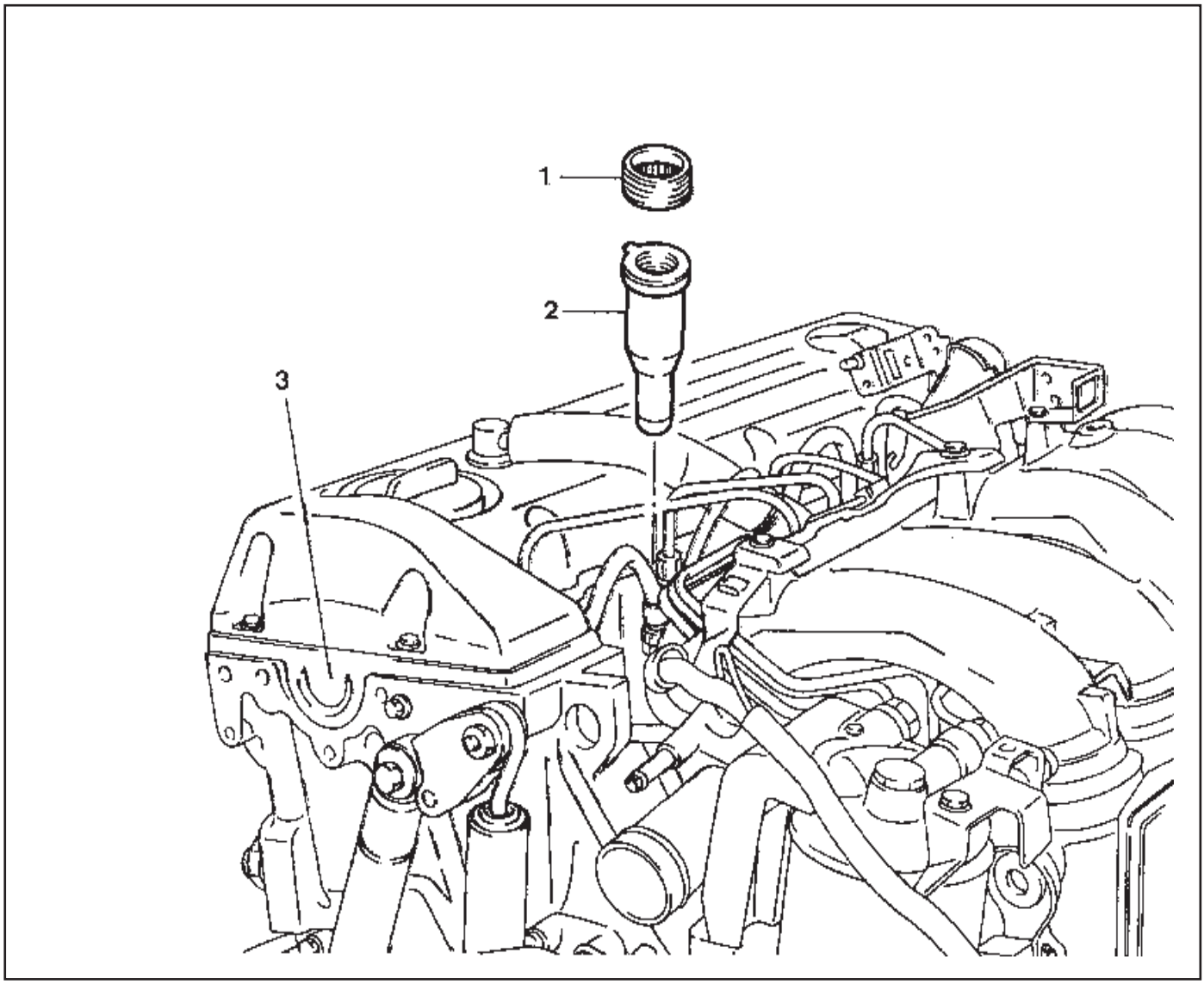


11. Splits across the back.



PRECHAMBER

Preceding Work : Removal of glow plug
Removal of fuel injection nozzle



1 Threaded Ring ..... 130 Nm
2 Prechamber
3 Cylinder Head

Tools Required

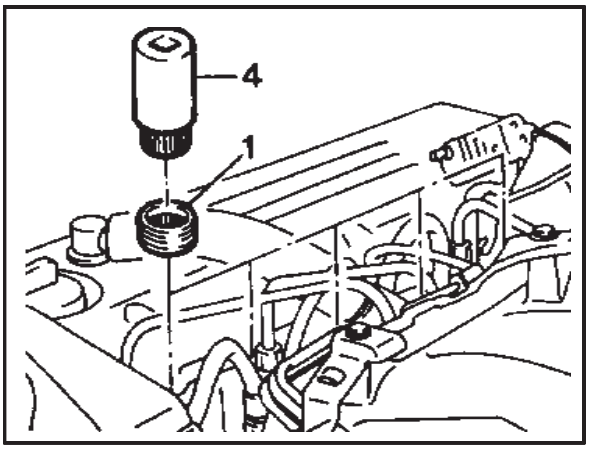
603 589 00 09 00 Serration Wrench

667 589 03 63 00 Sliding Hammer

Removal & Installation Procedure

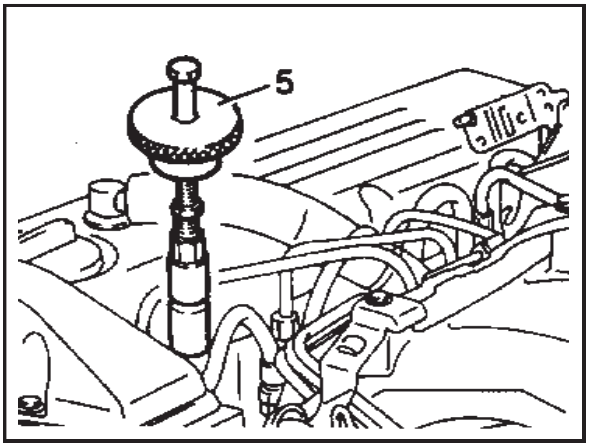
1. Using the serration wrench (4), remove the threaded ring (1).

Serration Wrench 603 589 00 09 00



2. Install the sliding hammer into the prechamber.

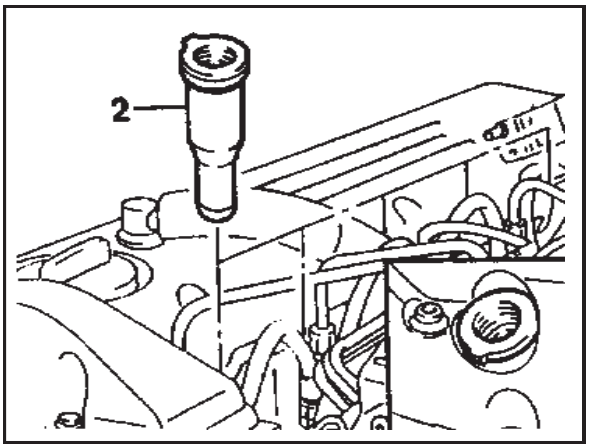
Sliding Hammer 667 589 03 63 00



3. Remove the perchamber (2).

Notice

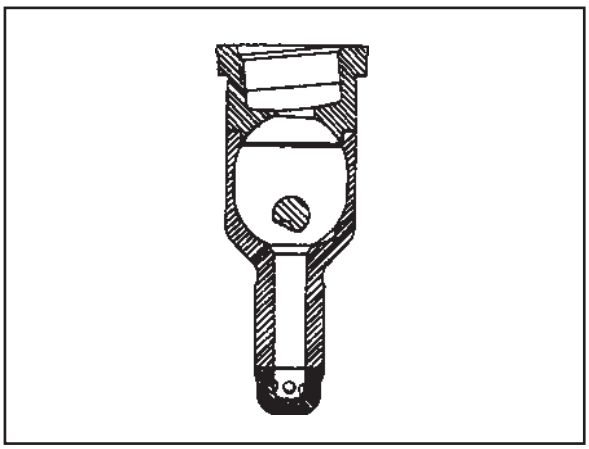
After removing the prechamber, cover over the bores with clean rag.



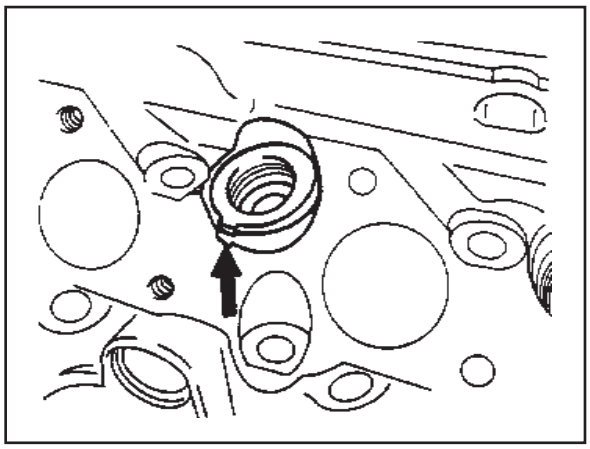
4. Inspect the prechamber.

Notice

If the prechamber seats in the cylinder head are leaking or if the prechambers are replaced, the sealing surfaces in the cylinder head must be remachined.



Assembly Procedure



Notice

In case the prechambers are reused, inspect the prechambers thoroughly, if the ball pin by heat and fire is broken, it can not be used.

1. Clean the sealing surface of the prechamber.
2. Insert the prechamber into the cylinder head at the same time aligning the cam on the collar of the prechambers with the slots in the cylinder head.

Notice

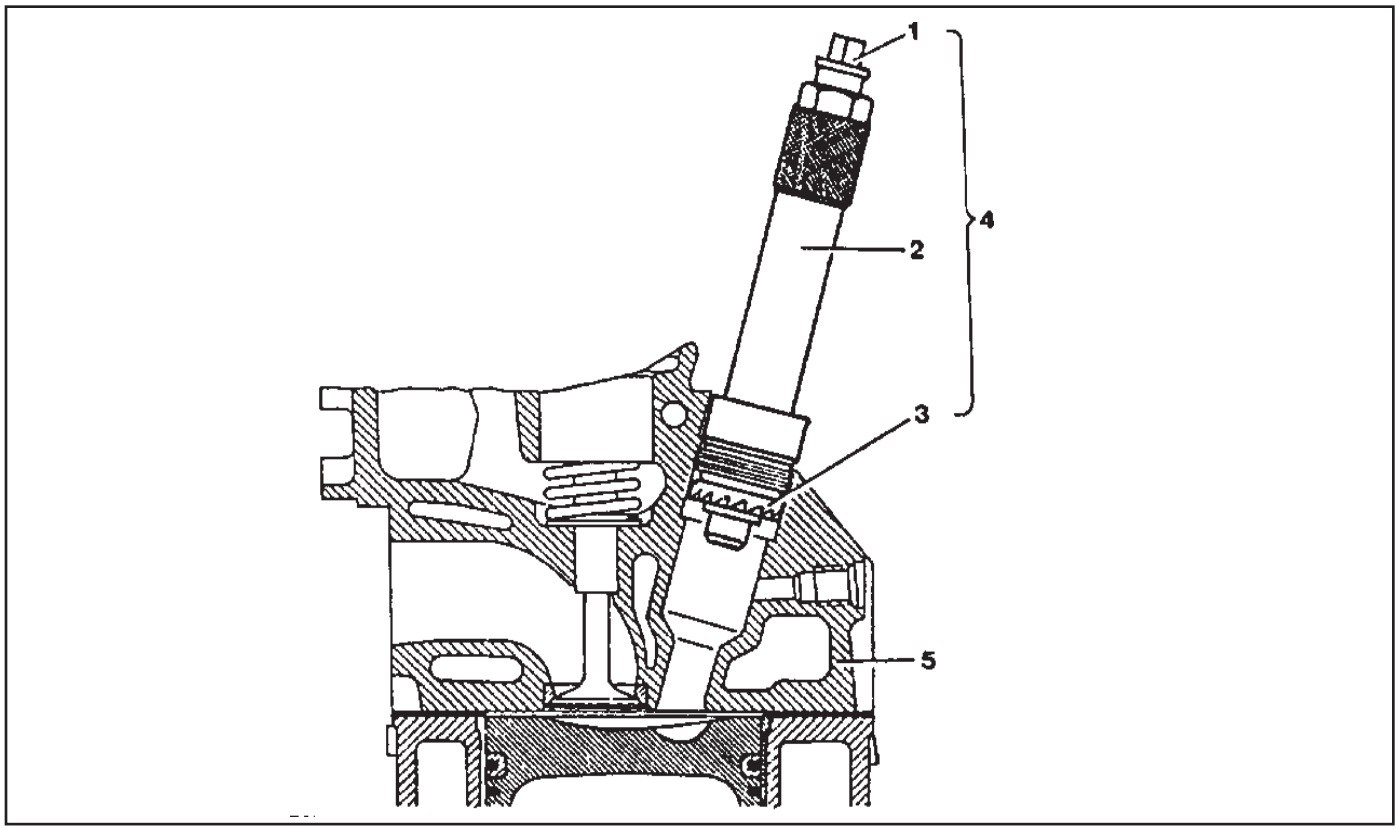
If the spacer rings are fitted to the prechambers, the spacer rings should be replaced with rings of the same thickness.

Thickness of Spacer Ring	0.3, 0.6, 1.0 mm

3. Coat the threaded ring with oil and assemble the ring by using the serration wrench.

Tightening Torque	130 Nm

MILLING OF PRECHAMBER SEALING SURFACE



1 Drift
2 Sleeve
3 Milling Cutter
4 Counter Sink (Special Tool - 601 589 00 66)
5 Cylinder Head

Tools Required

601 589 00 66 00 Counter Sink
667 589 00 23 00 Height Gauge

Milling of the Prechamber Sealing Surface

Notice

The prechamber sealing surface may only be remachined once with the cylinder head fitted. It is essential to adhere to the specified projection ‘C’ of the prechamber of 7.6 - 8.1mm.

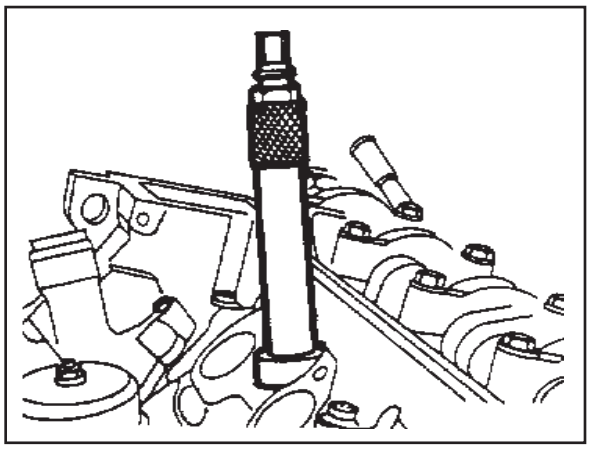
This ensures that the required clearance exists between prechamber and piston crown with the piston in TDC. For this reason, spacer rings should be inserted on remachined sealing surfaces.

Tightening Torque	0.3, 0.6, 1.0 mm

If a spacer ring is already fitted, or a marking is made on the cylinder head, the cylinder head must be removed and size ‘C’ measured if further remachining is necessary on a prechamber sealing surface.

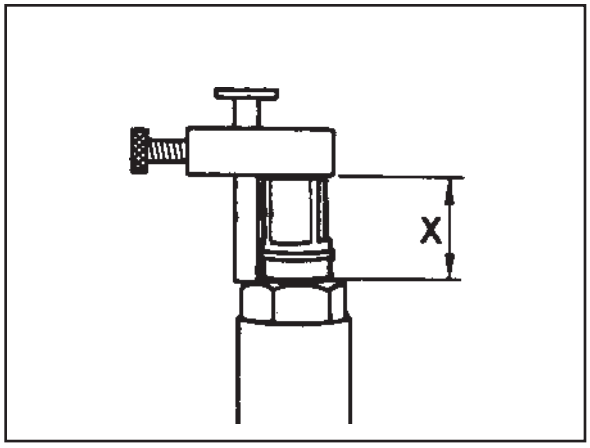
1. Remove the injection nozzle.
2. Remove the prechamber.
3. Cover the prechamber bore to avoid any chips dropping into the combustion chamber.
4. Remove the protective sleeve from the countersink and rotate the countersink into the prechamber bore to be machined as far as the stop.

Counter Sink 601 589 00 66 00

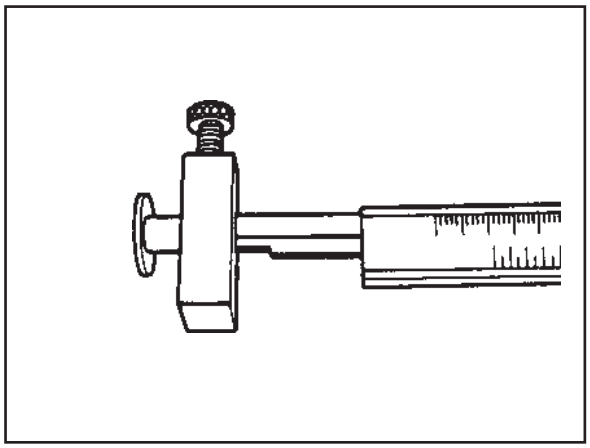


5. Maintain size ‘X’ from the top edge of mandrel to the top edge of the sleeve with the gauge.

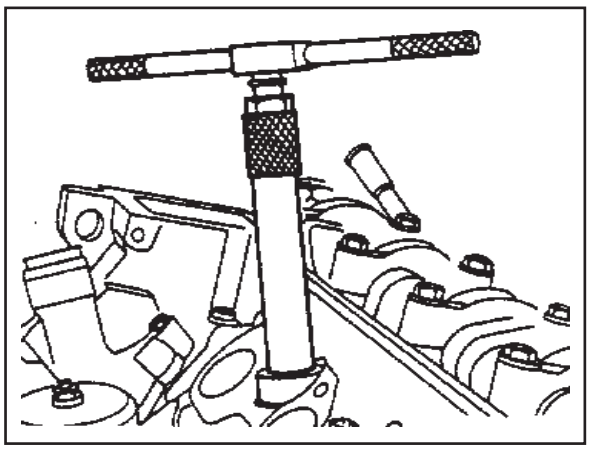
Height Gauge 667 589 00 23 00



6. Measure the ‘X’ by using a vernier caliper.



7. Mount the turning tool onto the countersink tool and rotate to the right approx. 5 revolutions by applying slight pressure.



8. Remeasure size ‘X’ and compare it with the first measurement and determine the thickness of spacer ring.

Ex

Size before machining	25.7 mm
Size after machining	25.5 mm

The spacer ring should be selected so that it is at least 0.1mm and not more than 0.3mm thicker than the measured on the sealing surface. In this example, the necessary thickness of spacer ring should be within 0.3 ~ 0.5mm and the thickness of spacer ring to be installed is 0.3mm.

9. Remove the countersink tool and clean the chips.

Notice

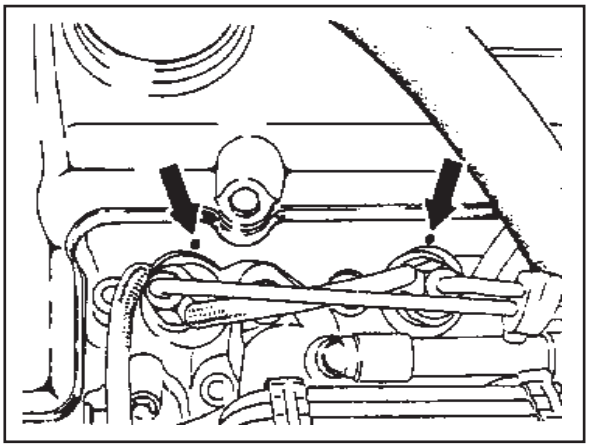
If the sealing surface is not completely flat, remachine the sealing surface.

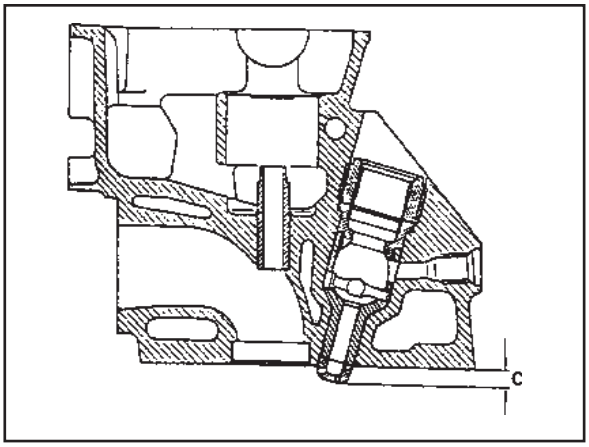
10. emove rag from the prechamber bore and crank the engine with starter motor to threw out any chips which may have got into the combustion chamber.
11. Insert the proper spacer ring into the prechamber sealing surface.
12. Punch a mark on the cylinder head above the prechamber sealing surface which has been machined.
13. Install the prechambers.

Notice

If the cylinder head is removed, the projection ‘C’ is measured in place of size ‘X’ and the appropriate size of spacer ring selected.

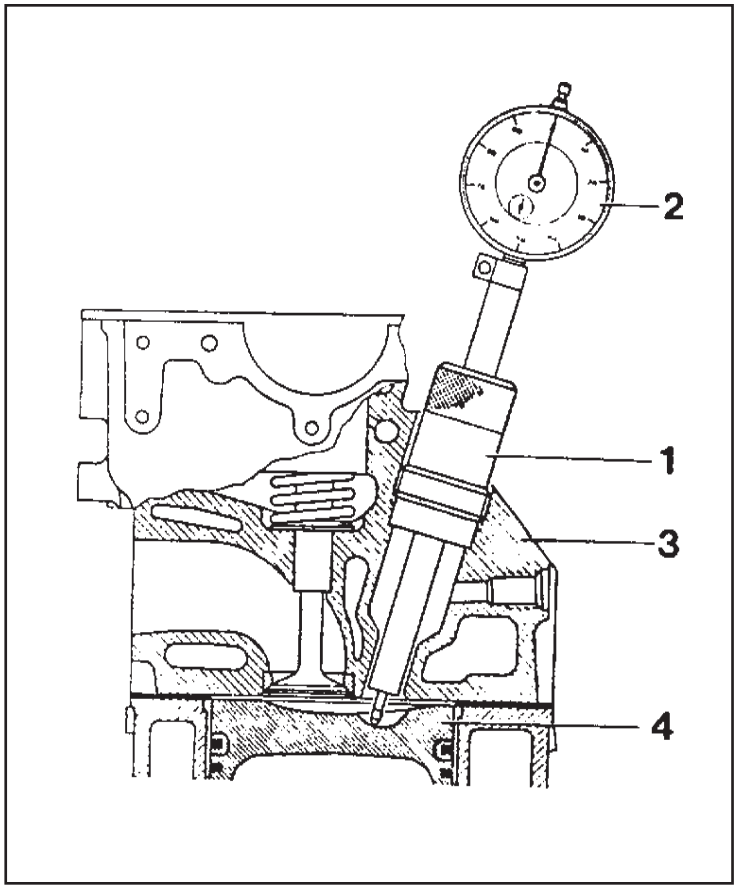
Normal Projection (c)	7.6 - 8.1mm





TDC (TDC SENSOR BRACKET) SETTING

Preceding Work : Removal of No.1 cylinder prechamber



1 Measuring Device
2 Dial Gauge
3 Cylinder Head
4 Piston ..... Set at TDC

Tools Service

001 589 32 21 00 Dial Gauge
601 589 07 21 00 Deqth Gauge
667 589 01 21 00 Fixing Device

Notice

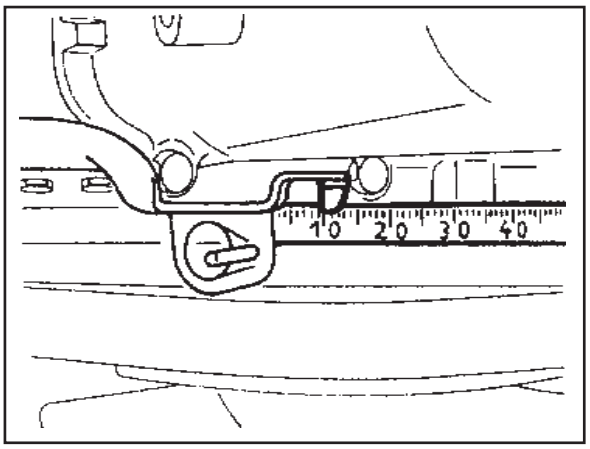
- The TDC sensor bracket must be adjusted in case of followings.
- When replacing the TDC sensor bracket.
- When replacing the crankshaft, the hub or the vibration damper.
- When replacing or installing the timing case cover.
- After engine overhauling.

* If the cylinder head is removed, the measuring pin of the dial gauge can be positioned on the piston crown.

  This is done by placing the magnetic dial holder on the mating surface of the crankcase.

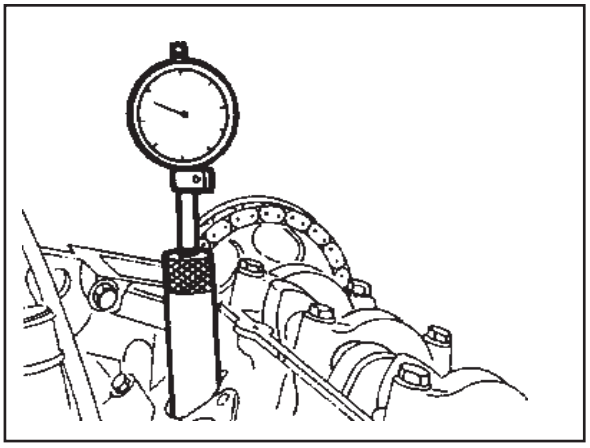
Setting (with cylinder head installed)

1. Remove the prechamber of No. 1 cylinder.
2. Position the piston of No.1 cylinder at BTDC 10.



3. Install the measuring device into the prechamber bore and position the dial gauge with a preload of 5mm.

   Dial Gauge 001 589 53 21 00
   Depth Gauge 601 589 07 21 00



4. Slowly rotate the crankshaft in the direction of engine rotation until the large pointer on the dial gauge stops (TDC position).

   Notice

   The position of TDC is when the large pointer on the dial gauge is stopped before moving back.

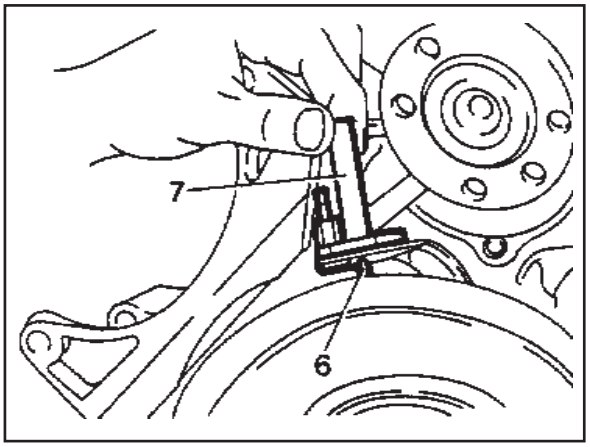
5. remove the reinstall the measuring device and position the dial gauge scale at '0'.
6. Slowly rotate the crankshaft in the direction of engine rotation until the dial gauge has moved back (counterclockwise) by 3.65mm.

7. Insert fixing device into the sensor bracket.

   Notice

   The pin on the vibration damper must engage into the slot of the fixing device.

   Fixing Device 667 589 01 21 00



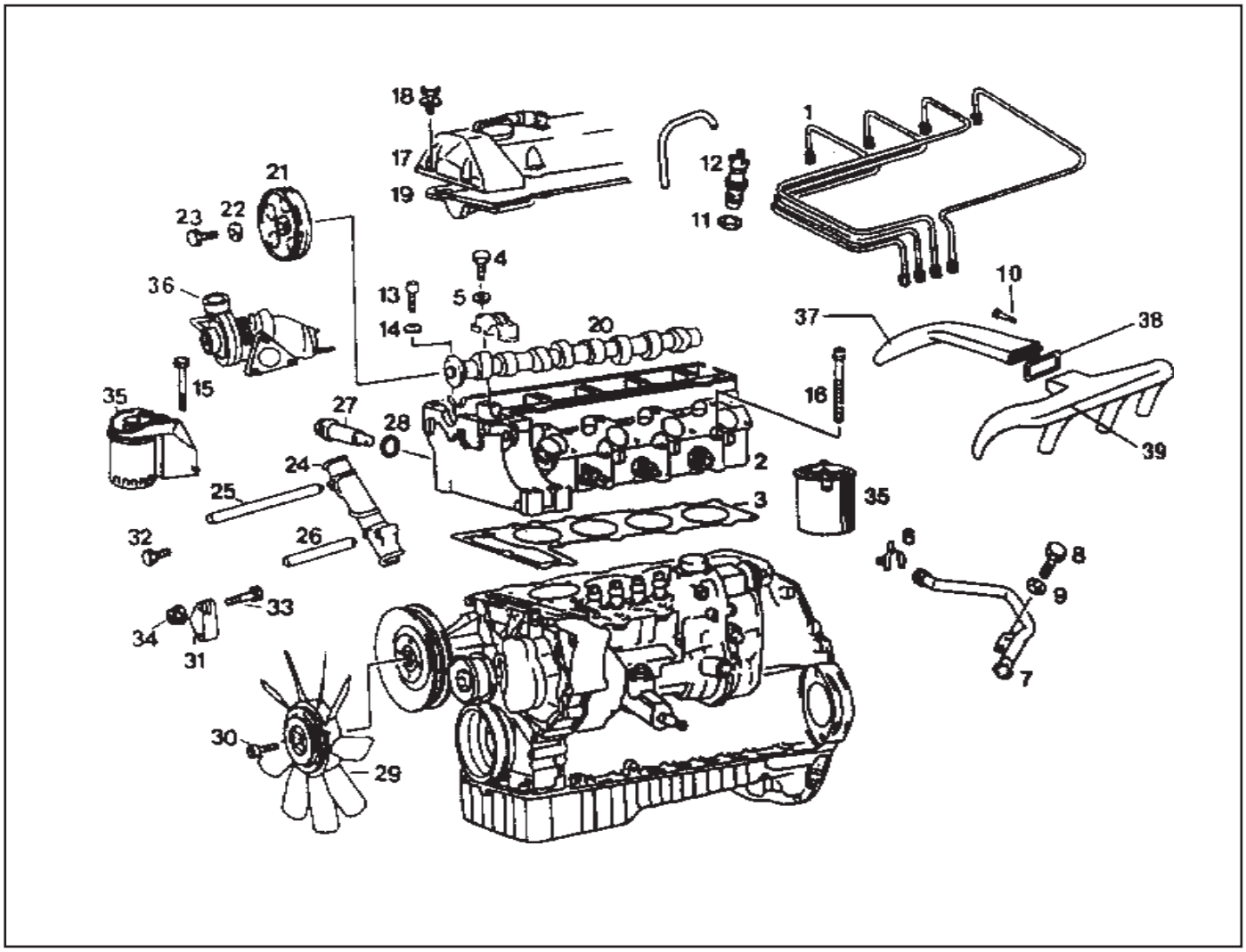
8. If the pin does not engage, adjust the setting of the sensor bracket by removing and tightening of the sensor bracket bolts.

Tightening Torque	10 Nm

   Notice

   The timing mark on the damper must be positioned at ATDC 20.

CYLINDER HEAD



1 Fuel Injection Pipe 18Nm
2 Cylinder Head
3 Gasket ..... Replace
4 Bolt 25Nm
5 Washer
6 Clamp
7 Heater Feed Pipe
8 Bolt
9 Washer
10 Bolt
11 Nozzle Washer ..... Replace
12 Fuel Injection Nozzle ..... 35-40 Nm
13 Hexagon Socket Bolt ..... 25 Nm
14 Washer
15 Bolt ..... 25 Nm
16 Cylinder Head Bolt ..... See Table
17 Cylinder Head Cover
18 Bolt ..... 10 Nm
19 Gasket
20 Camshaft
21 Camshaft Drive Sprocket ..... Replace
22 Washer
23 Bolt(12-Sided) ..... 25Nm + 90°
24 Sliding Rail
25 Sliding Rail Pin
26 Sliding Rail Pin
27 Chain Tensioner ..... 80 Nm
28 Gasket ..... Replace
29 Cooling Fan ..... Check
30 Hexagon Socket Bolt ..... 45 Nm
31 Tensioning Lever
32 Bolt ..... 25 Nm
33 Bolt
34 Nut ..... 23 Nm
35 Fuel Filter
36 Turbo Charger
37 Intake Duct
38 Gasket ..... Replace
39 Intake Manifold

Tightening Torque

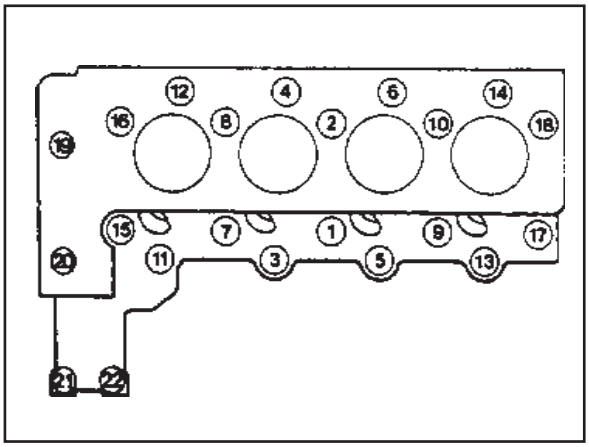
Cylinder Bolts (12-sided socket head) (Engine cold)	stage1	10 Nm
	stage2	35 Nm
	stage3	180°
M8 Cylinder Head Bolts		25 Nm

Tools Required

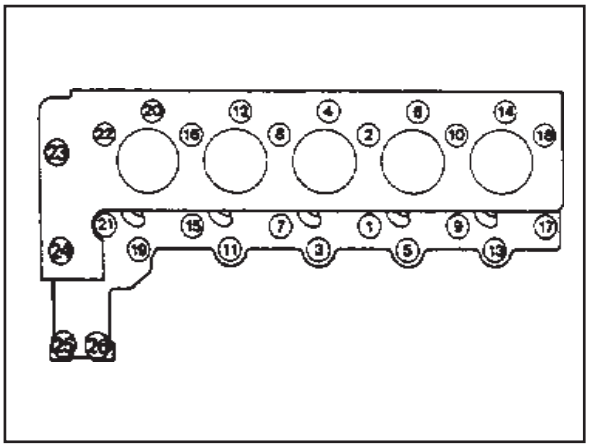
000 589 77 03 00 Box Wrench Insert
001 589 65 09 00 Socket Wrench Insert
102 589 03 40 00 Magnetic Bar
116 589 02 34 00 Threaded Pin
116 589 03 07 00 T Type Socket Wrench
116 589 20 33 00 Sliding Hammer
601 589 00 10 00 Cylinder Head Bolt Wrench
602 589 00 40 00 Engine Lock
603 589 00 40 00 Counter Holder

Tightening Sequence for Cylinder Head Bolts

OM 662LA Engine



OM 661LA Engine



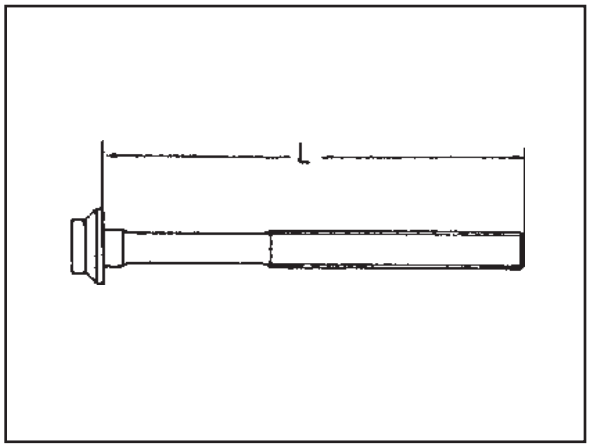
Notice

The cylinder head may only be removed when the engine has cooled down. The cylinder head is removed together with the exhaust manifold. As the cylinder head bolts undergo a permanent tightening. They require to be replaced if they exceed the maximum lengthes indicated in the table.

Thread Dia.	Length(L) When New	Max. Length(L)
M10	80mm	82mm
M10	102mm	104mm
M10	115mm	117mm

The twelve-sided socket head bolts are tightened with each stages of torque and torque angle.

It is not necessary to retighten the cylinder head bolts at the 1000~1500km inspection or after 1000~1500km of repairs.



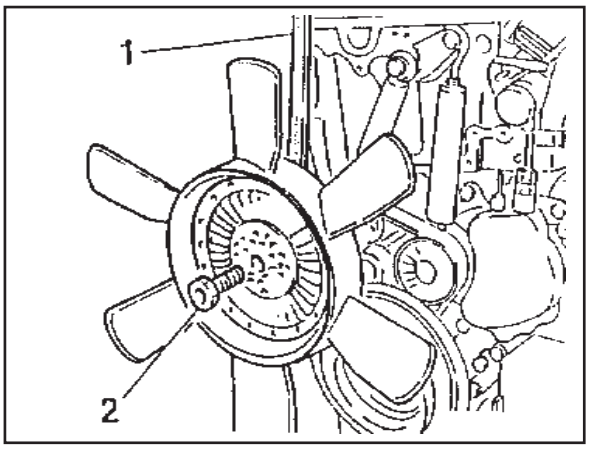
Disassembly Procedure

1. Completely drain the coolant from the radiator and cylinder block.
2. Remove the cooling fan shroud.
3. Hold the fan with counter holder and remove the bolt and then remove the cooling fan.

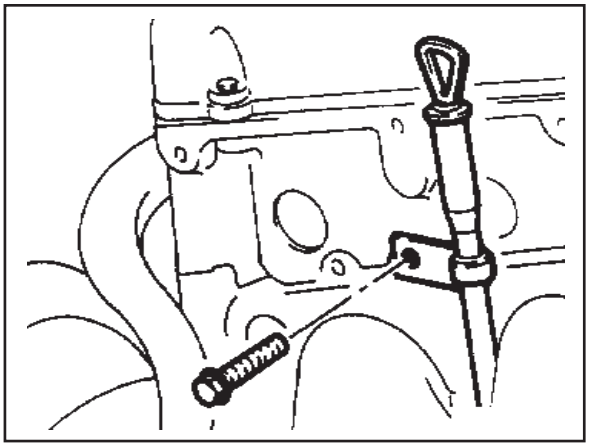
   Notice

   Keep the fan in vertical position.

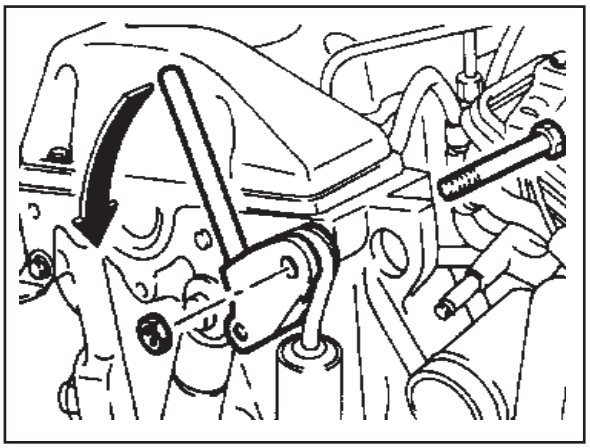
Counter Holder 603 589 00 40 00



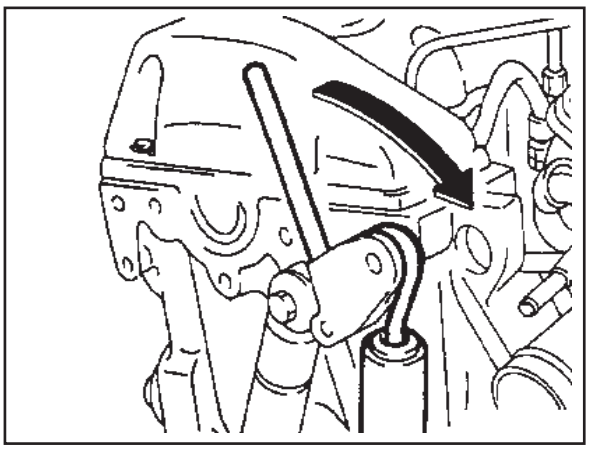
4. Remove the bracket oil dipstick tube.



5. Remove the nut.
6. Remove the nut on the tensioning lever and insert the rod(F12´180mm). By pushing the rod to the arrow direction, pull back the bolt.



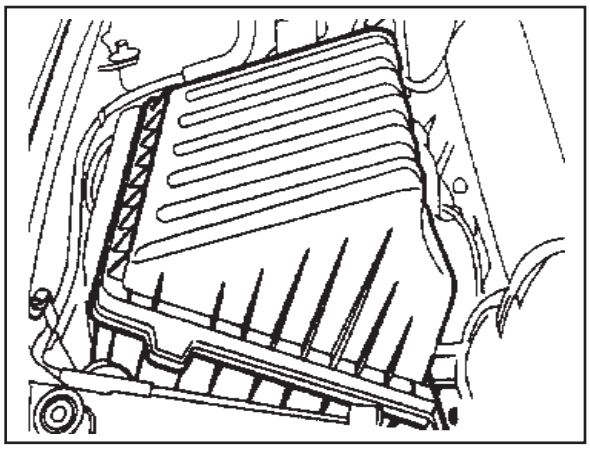
7. Push the tensioning lever to the opposite direction to release the spring tension and remove the poly V-belt.



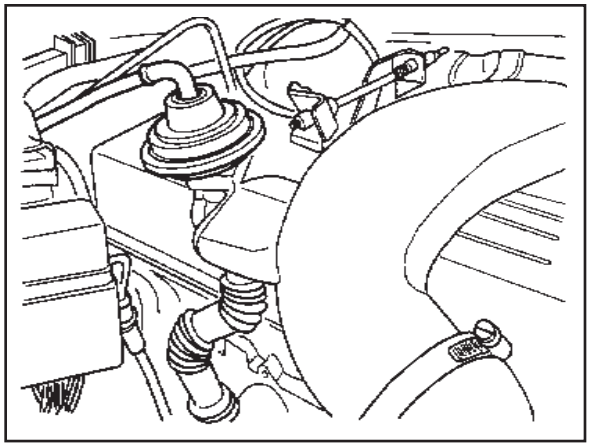
8. Remove the air cleaner cover and element and then remove the air cleaner housing.
9. Remove the oil return hose and plug.

   Notice

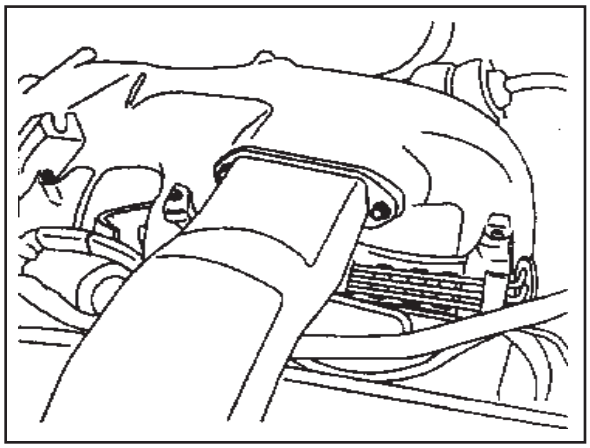
   Cover them to prevent chips from coming into.



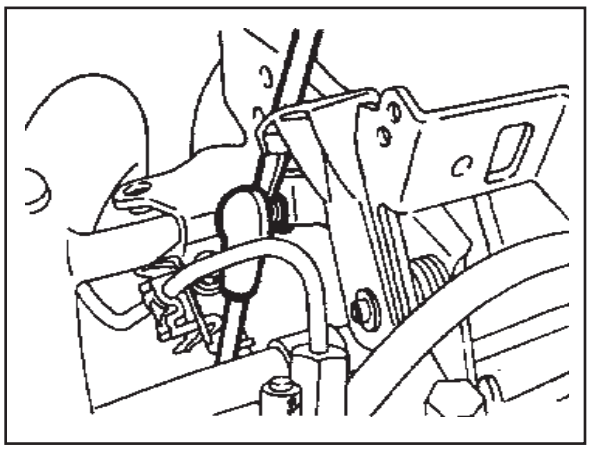
10. Unscrew the EGR pipe mounting bolts onto the exhaust manifold.
11. Remove the duct bracket from the cylinder head.



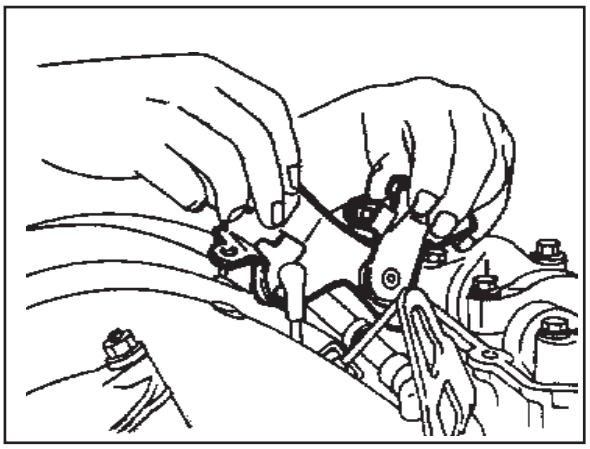
12. Unscrew the intake duct mounting bolts onto the intake manifold.



13. Separate the connecting rod from the control lever.

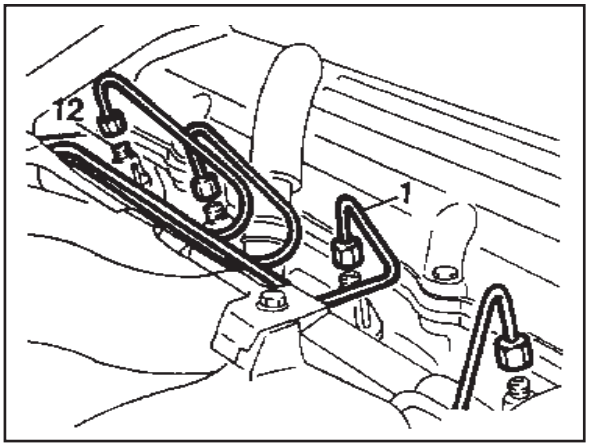


14. Pull out the accelerator control linkage.



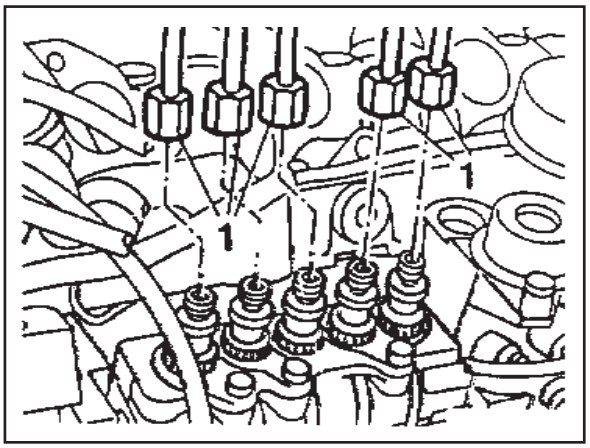
15. Remove the fuel injection line(1) from the fuel injection nozzle(12).

Box Wrench Inset 000 589 77 03 00

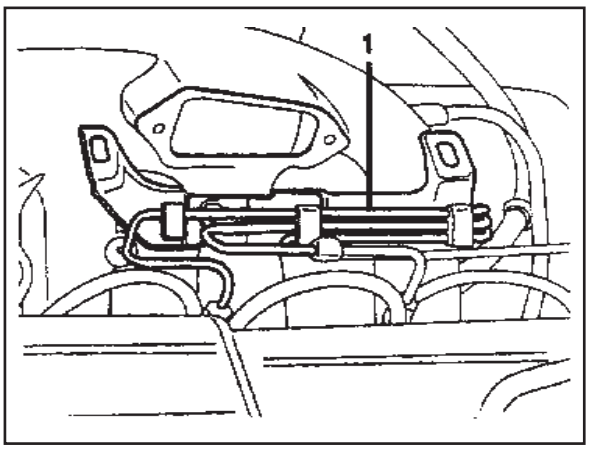


16. Remove the fuel injection line from the fuel injection pump.

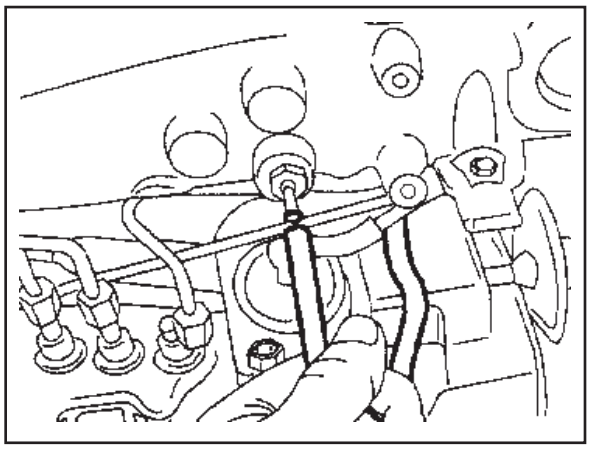
Box Wrench Insert 000 589 77 03 00



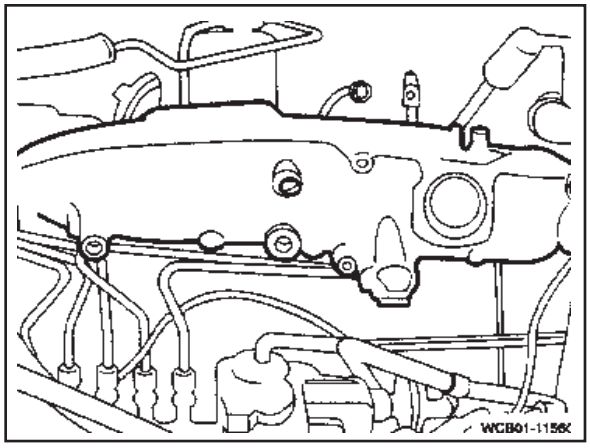
17. Remove the bracket mounting bolts and then remove the fuel injection line(1).



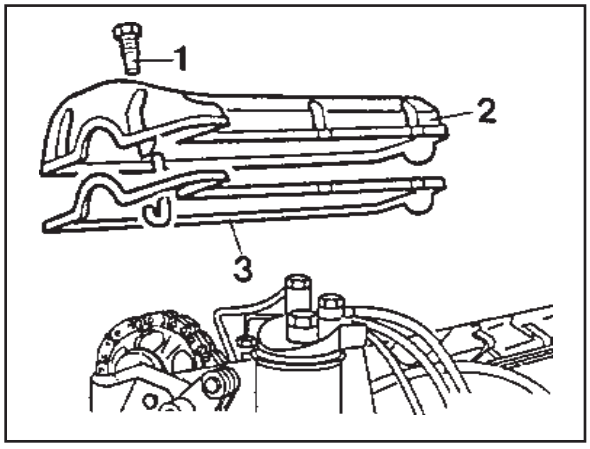
18. Disconnect the booster hose connected to intake manifold.



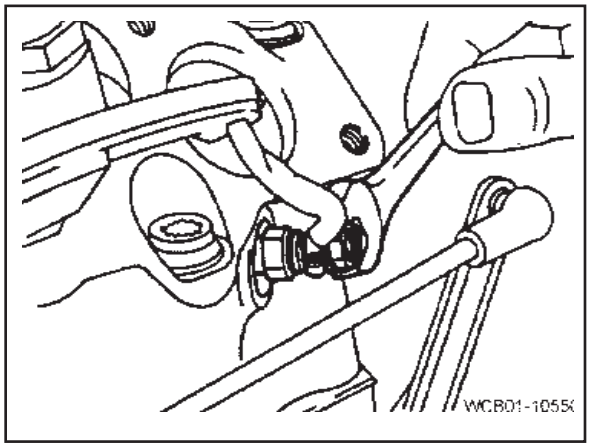
19. Remove the intake manifold and gasket.



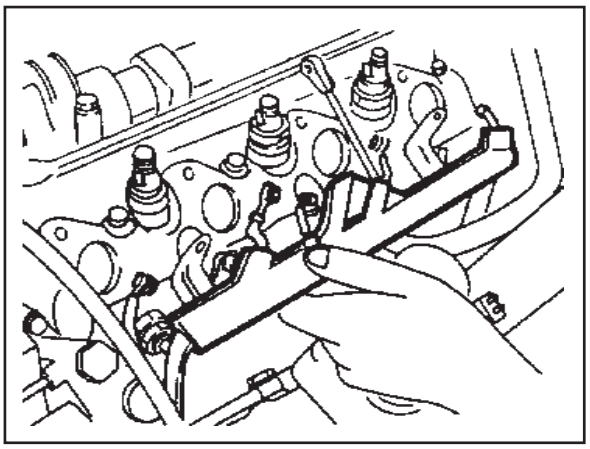
20. Remove the cylinder head cover and gasket with the blow-by gas hose.



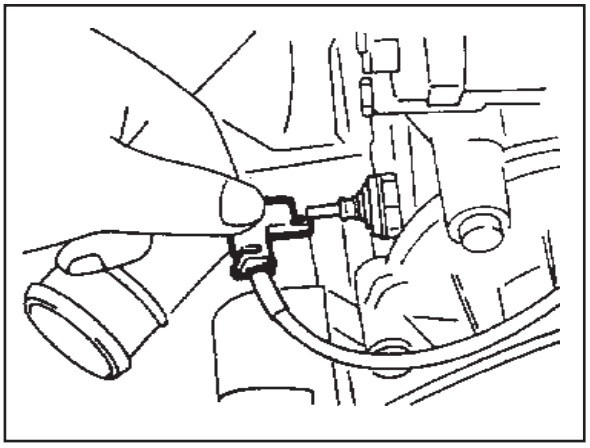
21. Disconnect the glow plug cables.



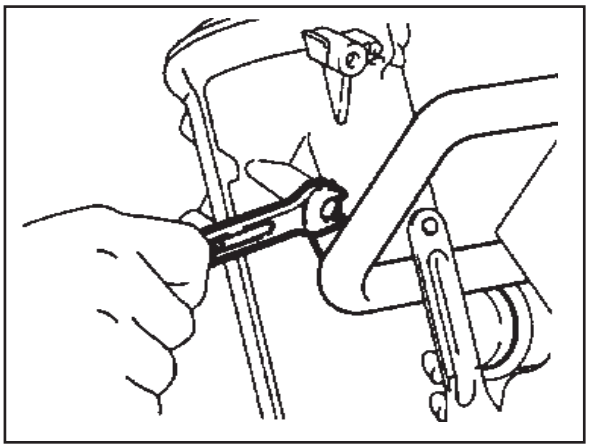
22. Remove the cable channel.



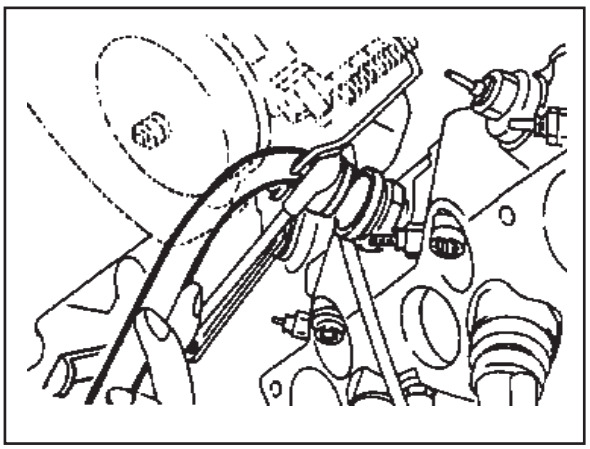
23. Disconnect the cables from the glow plug sensor and coolant temperature sensor.



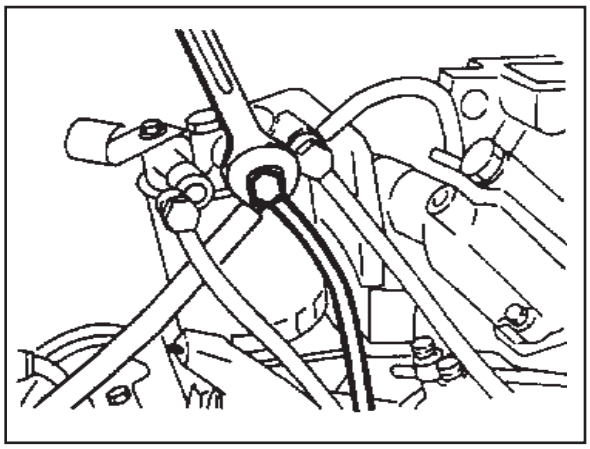
24. Remove the heater pipe bracket from the oil filter.



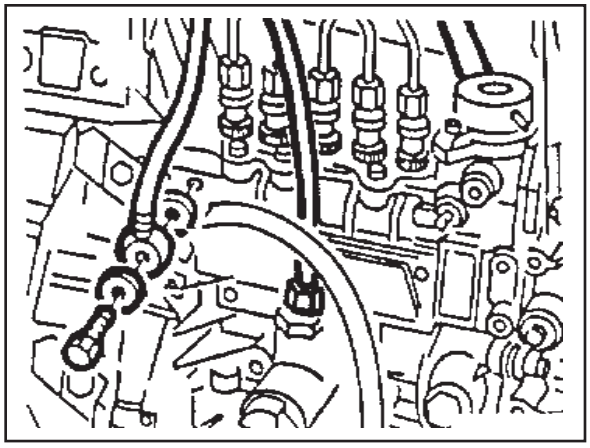
25. Pry off the clamp and push the heater feed pipe forward and then pull out the pipe.



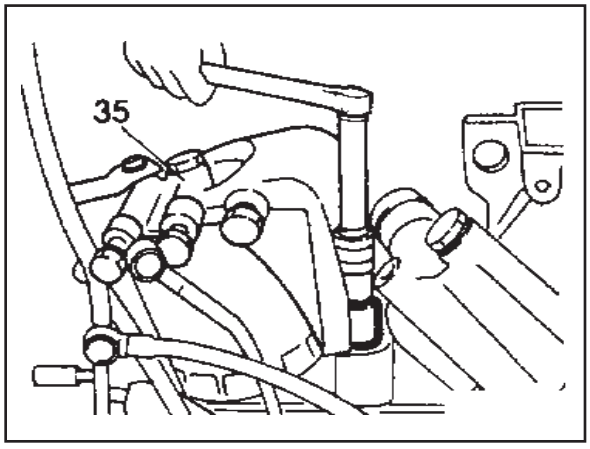
26. Disconnect the fuel lines from the fuel filter.



27. Disconnect the fuel lines from the injection pump.

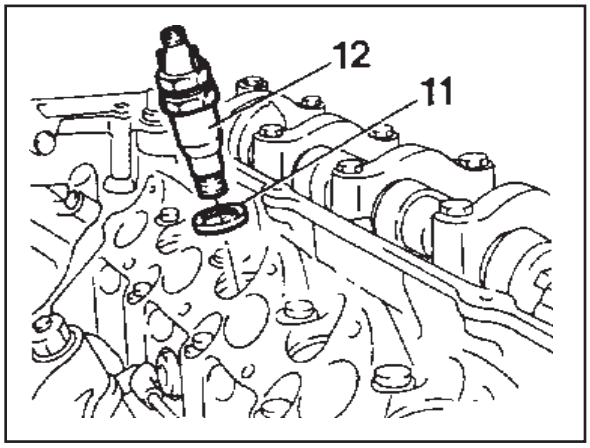


28. Remove the fuel filter(35).



29. Remove the fuel injection nozzle(12) and nozzle washer(11).

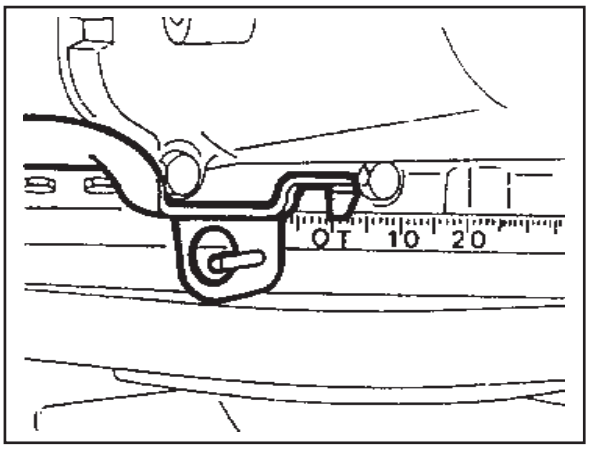
Socket Wrench Insert 001 589 65 09 00



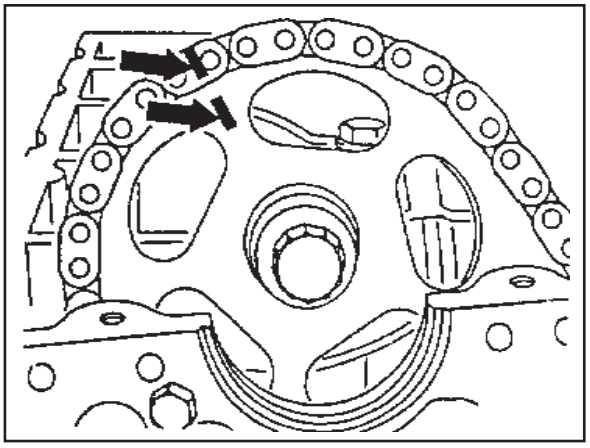
30. Rotate the crankshaft and set the no.1 cylinder at TDC.

    Notice

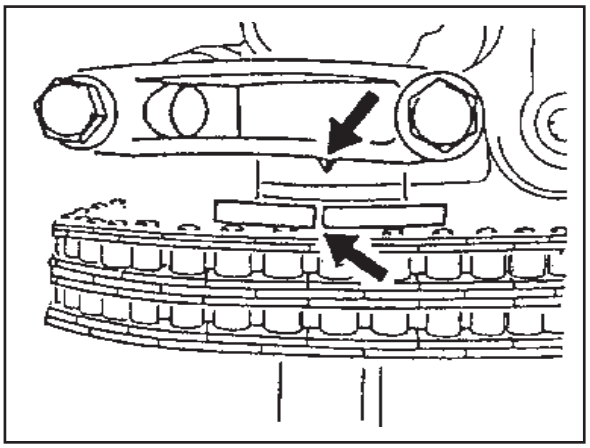
    Do not rotate the crankshaft to the opposite direction of engine revolution.



31. Place alignment marks on the camshaft gear and timing chain.

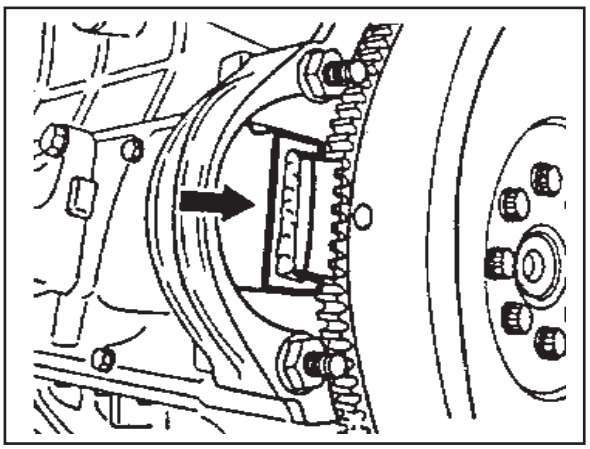


32. Ensure that the camshaft and the bearing cap marking are aligned.

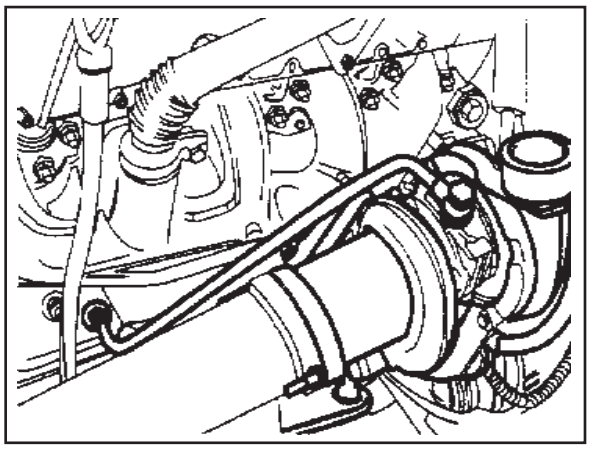


33. Remove the starter motor and install the engine lock onto the flywheel ring gear.

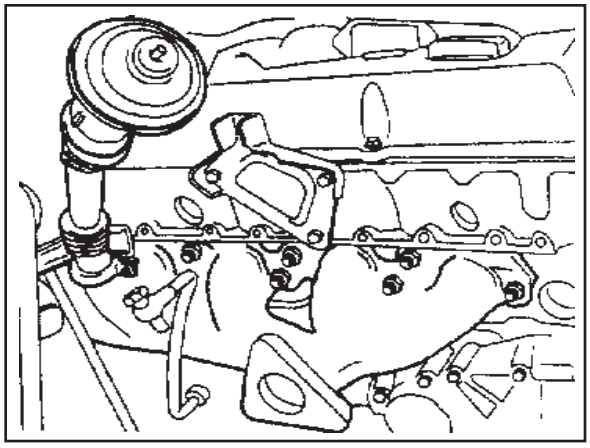
    Engine Lock 602 589 00 40 00



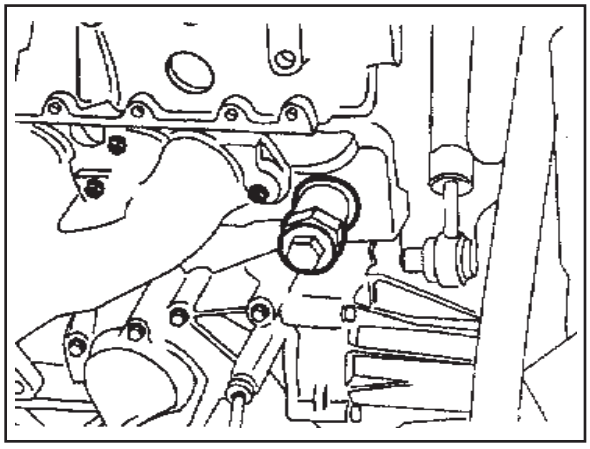
34. Remove the turbocharger.



35. Remove the exhaust manifold and gasket.



36. Remove the chain tensioner and seal.

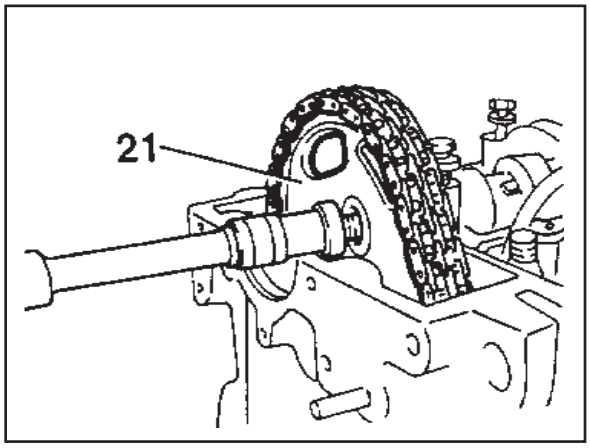


37. Remove the bolt and separate the drive sprocket(21).

Notice

During removal, be careful not to drop the sprocket and chain into the timing case.

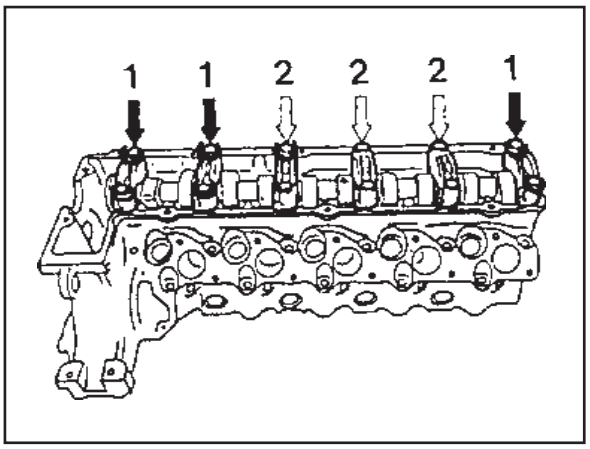
Carefully pull off the chain and then pull out the sprocket.



38. Remove the camshaft bearing cap bolts according to the numerical sequence.

Notice

Remove the No.1 bolts first and then remove the No. 2 bolts. Do not remove the bolts at a time completely but remove them step by step evenly or camshaft can be seriously damaged.



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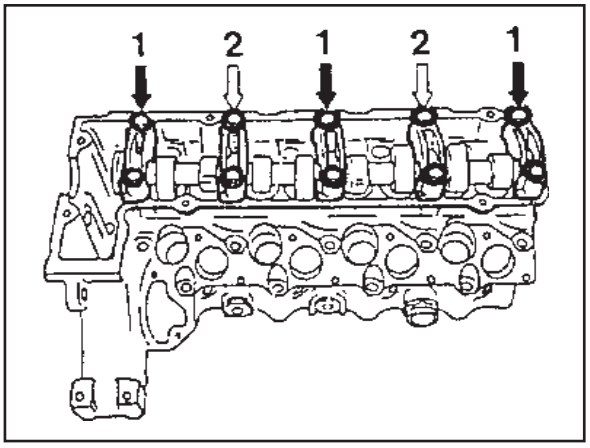
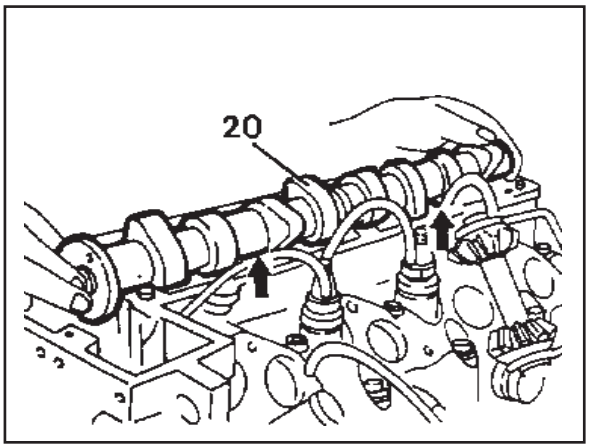


OM661LA

39. Remove the bearing caps and then pull out the camshaft(20) upward.

Notice

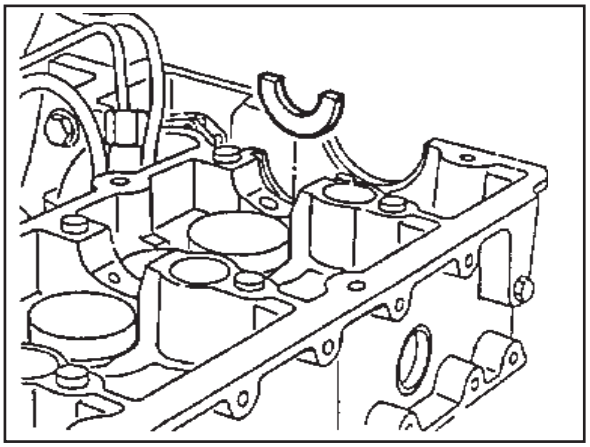
Be careful not to miss the locking washer.



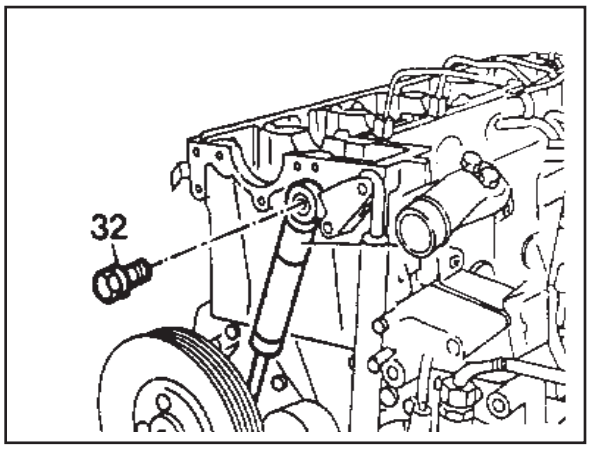
40. Remove the locking washer.

Notice

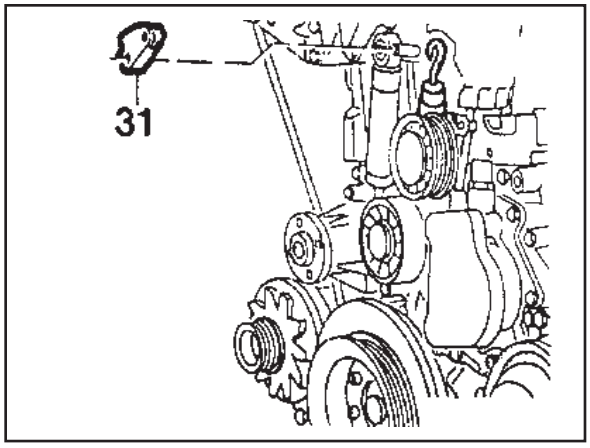
Check the locking washer and replace if necessary.



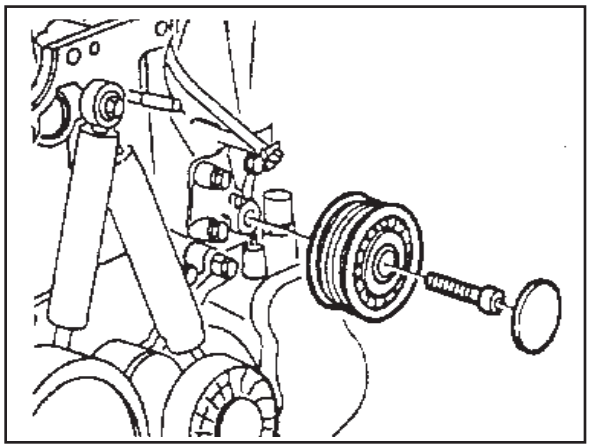
41. Remove the bolt(32).



42. Separate the spring and pull out the tensioning lever(31).

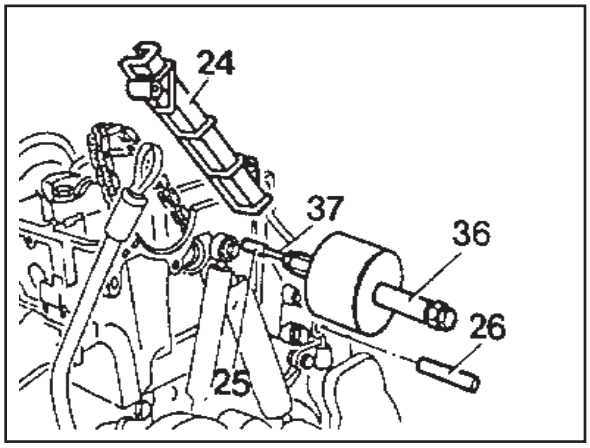


43. Pry off the closing cover. Remove the bolt and then remove the idle pulley.

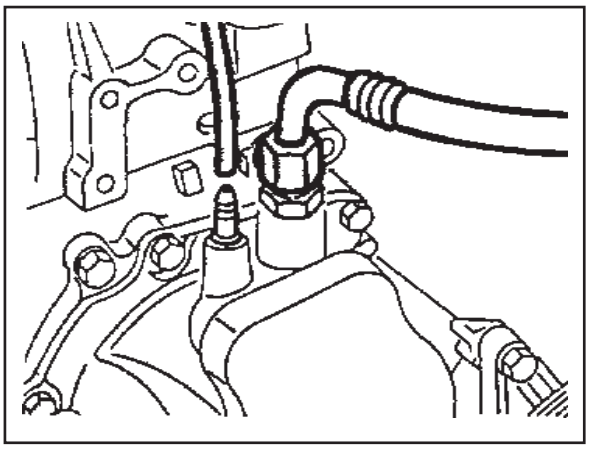


44. Using the sliding hammer(36) and the threaded pin(37), pull out the sliding rail pins(25, 26) and remove the sliding rail(24).

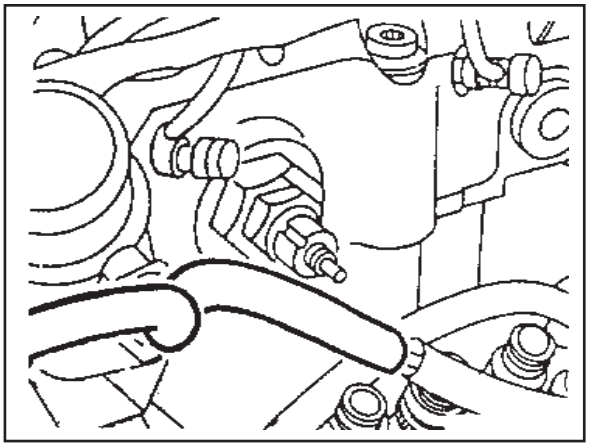
Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00



45. Remove the vacuum line from the vacuum pump.

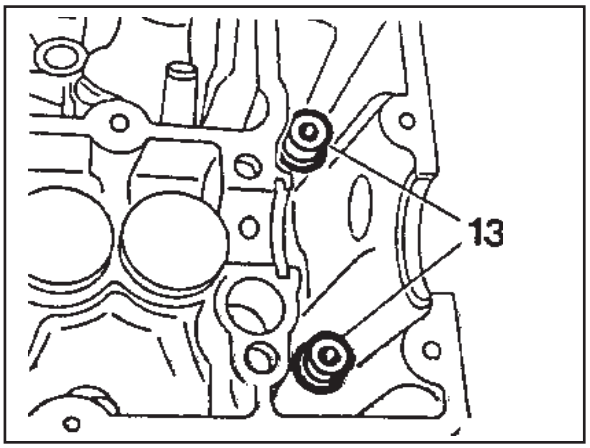


46. Disconnect the vacuum pipe from thermo valve.



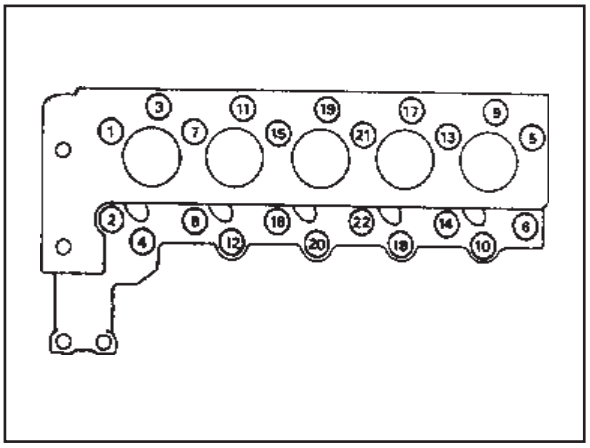
47. Remove the socket bolts(13) of the chain box.

T Type Socket Wrench 116 589 03 07 00
Magnetic Bar 102 589 03 40 00

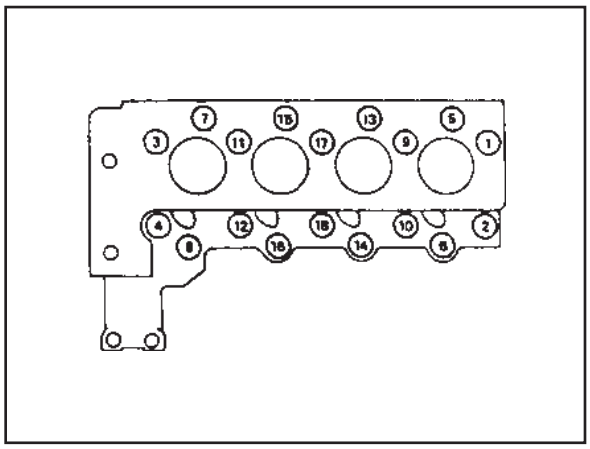


48. Remove the cylinder head bolts in numerical se-quence.

Cylinder Head Bolt Wrench 601 589 00 10 00

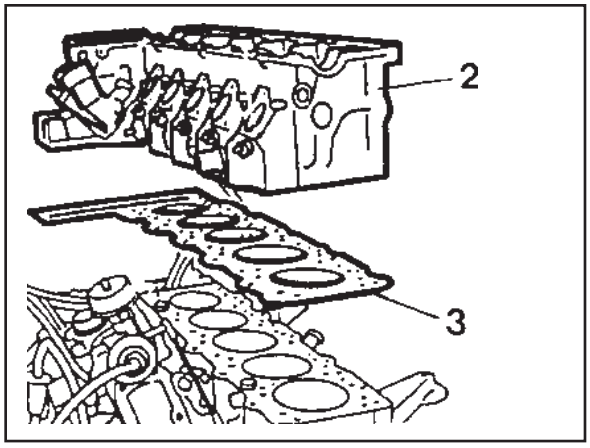


OM 662LA



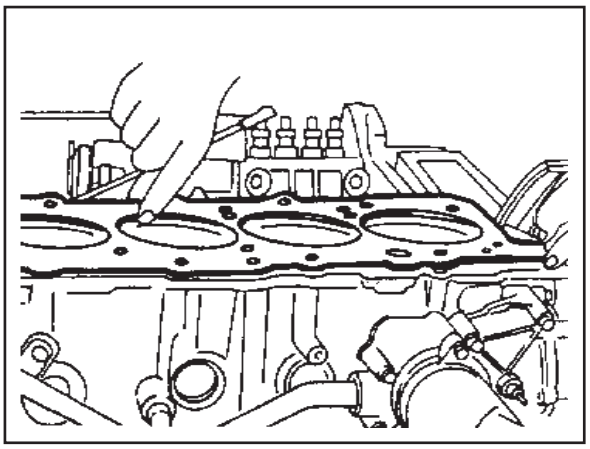
OM 661LA

49. Remove the cylinder head(2) and gasket(3).



Assembly Procedure

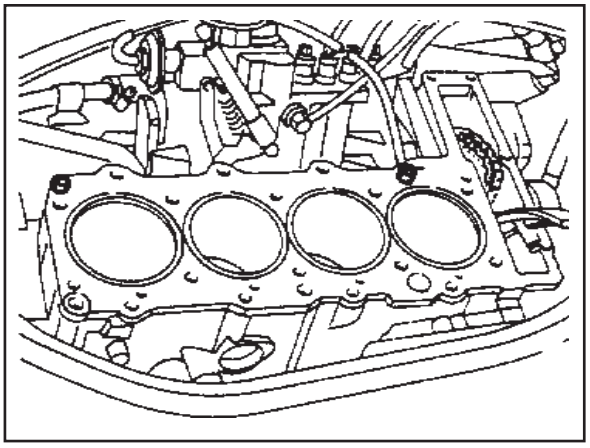
1. Replace the cylinder head gasket.



2. Install the cylinder head onto the crankcase.

   Notice

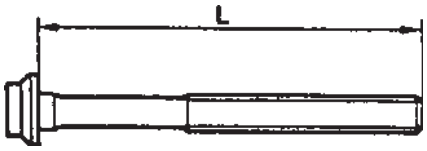
   Align the cylinder head holes with the guide pins.



3. Measure the length(L) of cylinder head bolts.

   Notice

   If the max. length is exceeded, replace the bolts.



Thread Dia.	Length(L) when new	Max. Limit(L)
M10	80mm	82mm
M10	102mm	104mm
M10	115mm	117mm

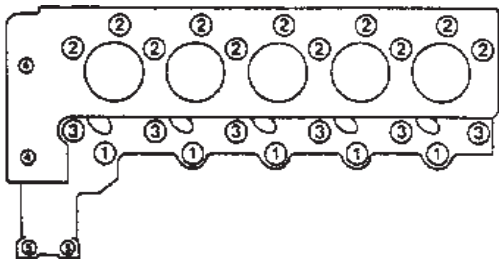
4. Coat the head contact surface of bolts and thread with oil and insert them as shown.

   - Cylinder head bolts arrangement

   Bore

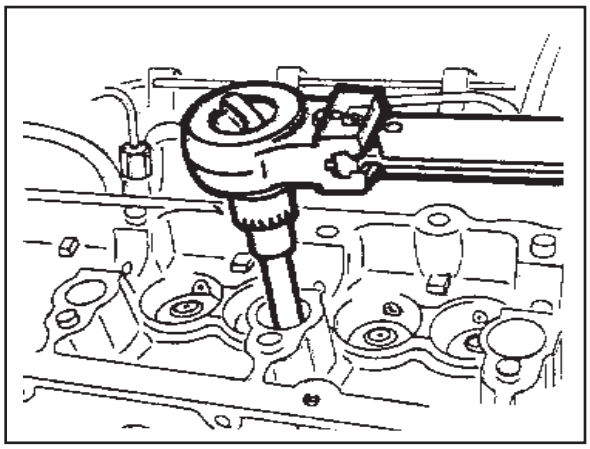
   1 ..... M10 × 80
   2 ..... M10 × 102
   3 ..... M10 × 115
   4 ..... M 8 × 50
   5 ..... M 8 × 80

OM662LA

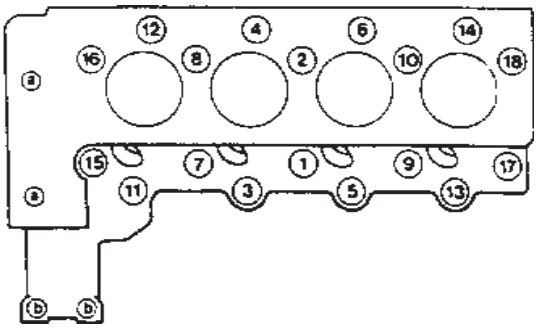


5. Tighten the cylinder head bolts to specified torque and torque angle.

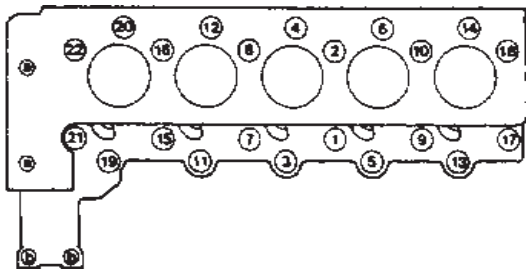
Stage 1	15 Nm
Stage 2	35 Nm
Torque angle	90°
Wait for	10 minutes
Torque angle	90°



OM 661LA

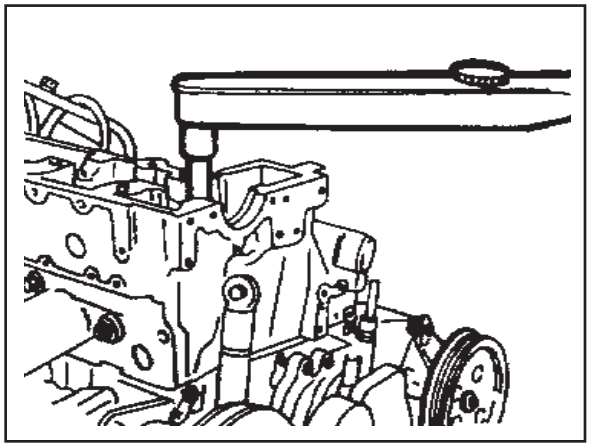


OM 662LA

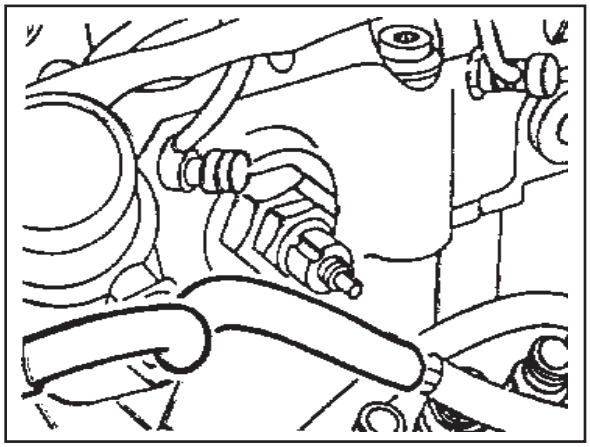


6. Install the socket bolts in the chain box.

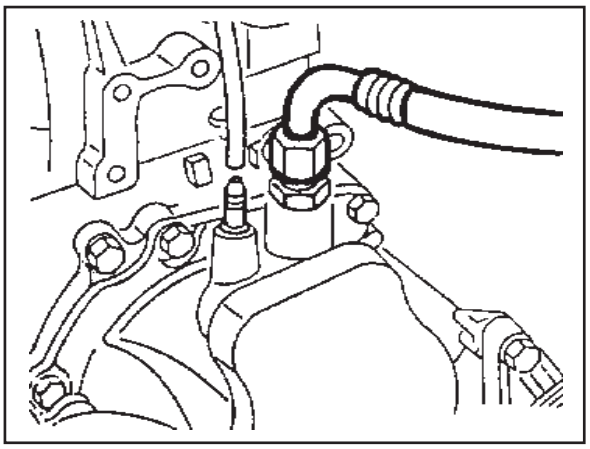
Tightening Torque	25 Nm



7. Connect the vacuum pipe to the thermo valve.



8. Connect the vacuum lines to the vacuum pump.

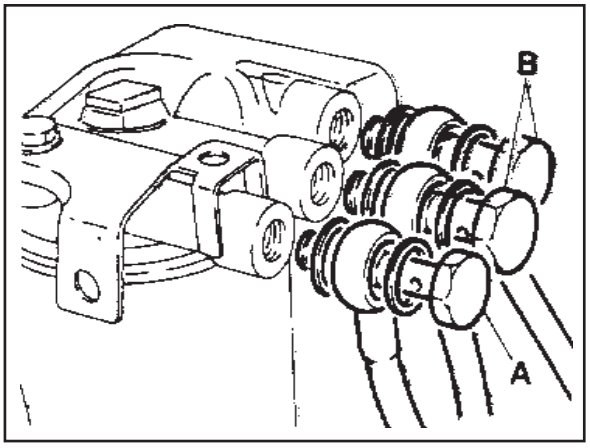


9. Install the fuel filter and connect the pipe.

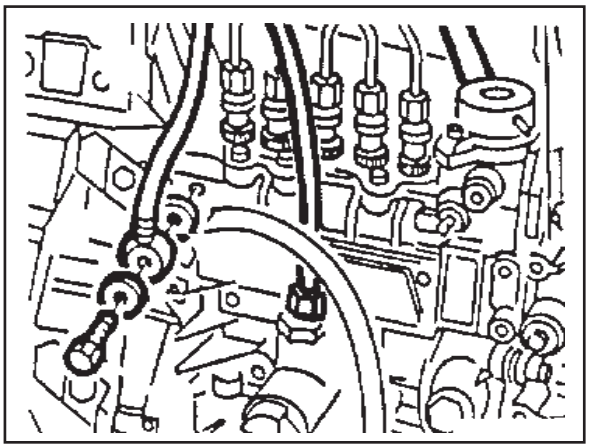
Tightening Torque	25 Nm

Notice

Be careful not to be confused the connections and hoses.



10. Connect the fuel pipe to the injection pump.

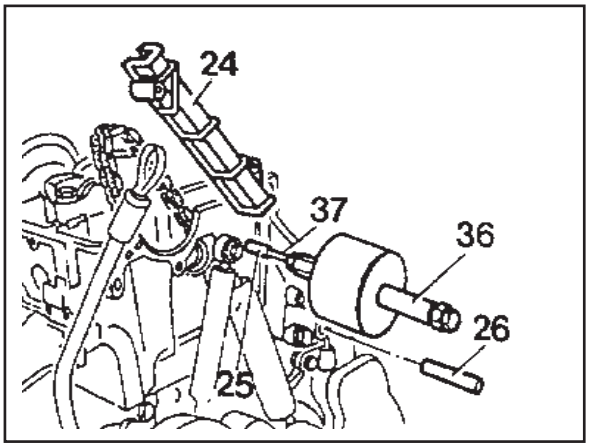


11. Install the sliding rail(24) and insert the sliding rail pins(25, 26).

Notice

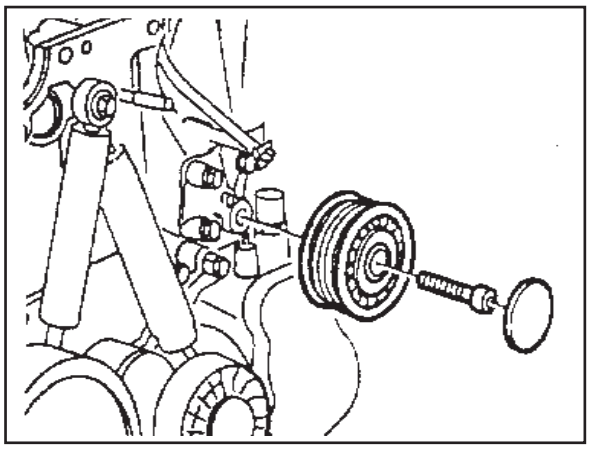
Apply sealing compound on the each collar of the sliding rail pins.

Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00

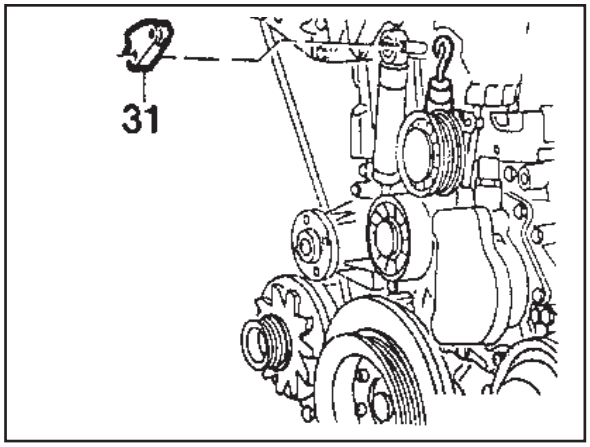


12. Install the idle pulley and fit the closing cover.

Tightening Torque	25 Nm



13. Insert the tensioning lever(31) and install the spring.

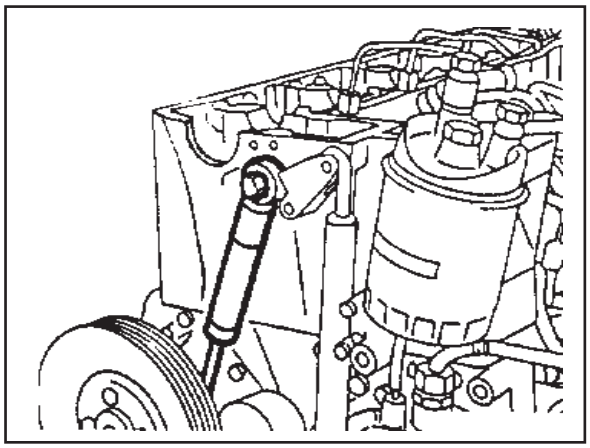


14. Install the damper.

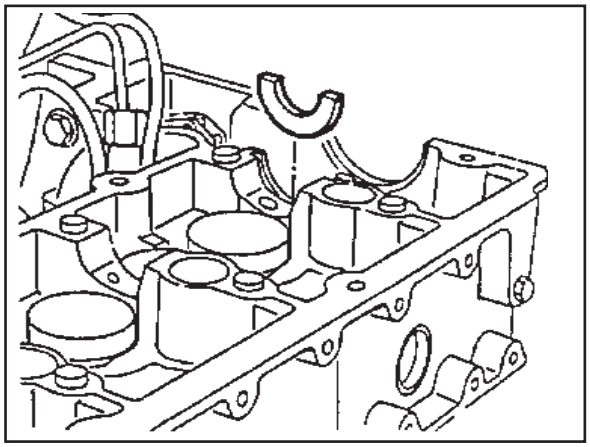
Tightening Torque	23 Nm

Notice

Insert the tensioning lever bolts onto the mounting hole.



15. Insert the locking washer.
16. Inspect the valve tappet and check that the tappet moves smoothly.

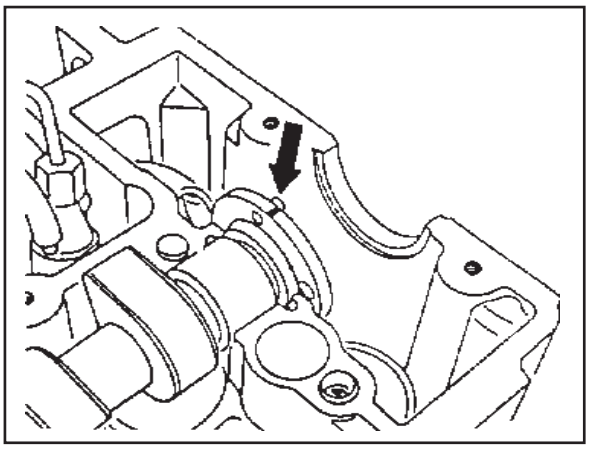


17. Coat the camshaft with oil and install the camshaft on the cylinder head to be TDC mark(arrow) upward.
18. Measure the axial end play of the camshaft.

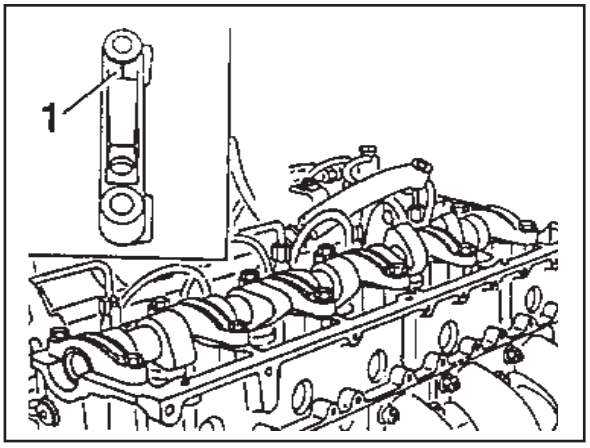
End Play	0.06 - 0.21mm

Notice

If out of standard, adjust it with the proper thickness of locking washer.



19. Install the bearing caps on the camshaft according to the number on the caps.

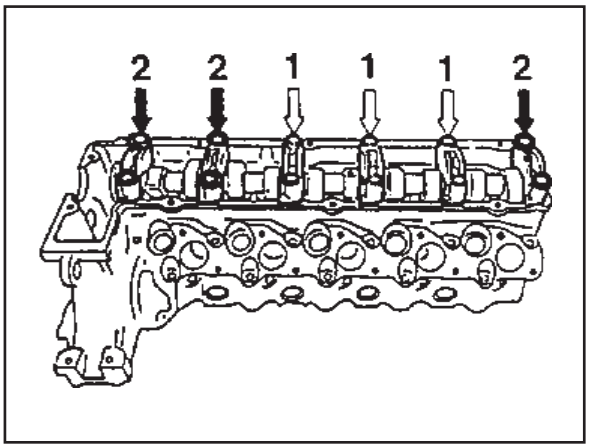


20. Tighten the bearing cap bolts according to the numerical sequence.

Tightening Torque	25 Nm

Notice

Tighten the No. 1 bolts(light arrow) first and then tighten the No. 2 bolts(dark arrow) stage by stage.



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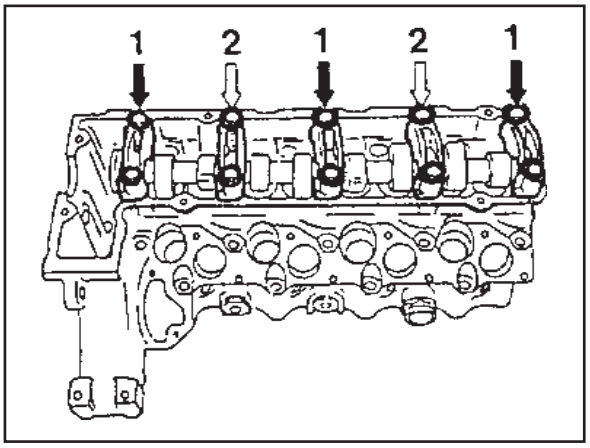

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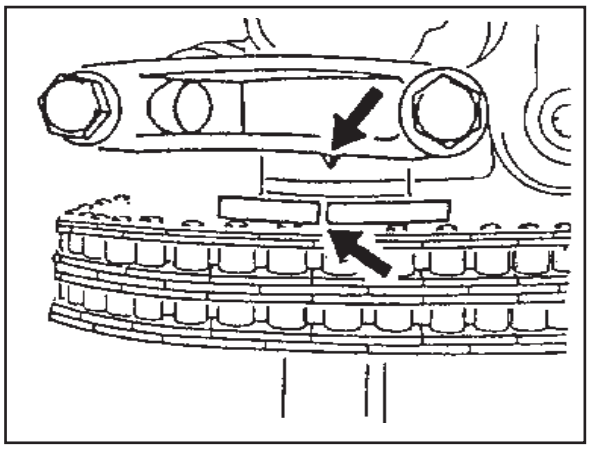
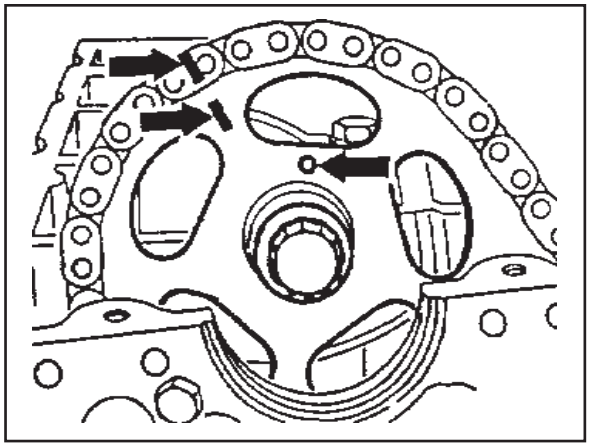
21. Position the camshaft on marking and install the camshaft sprocket.

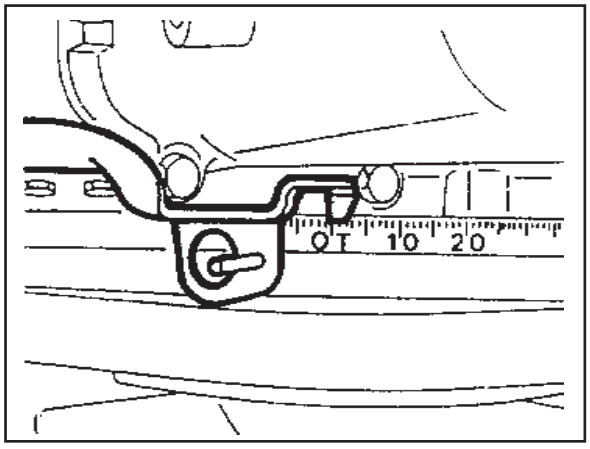
    Notice

    Align the alignment marks on the chain and sprocket.



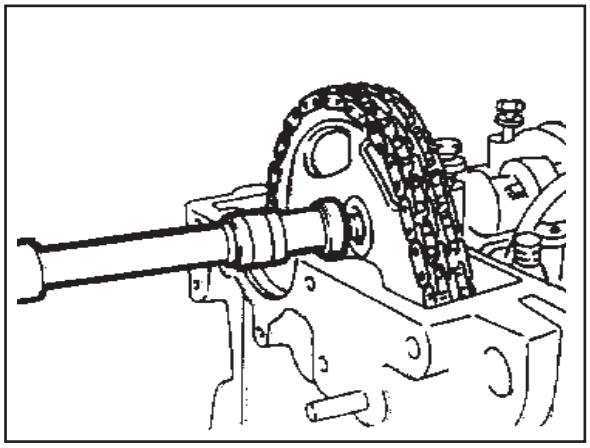


22. Check the TDC position of the crankshaft.



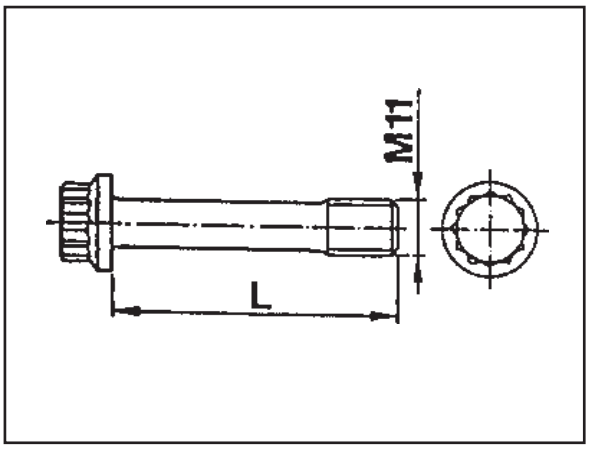
23. Install the camshaft sprocket bolt.

Tightening Torque	25 Nm + 90°

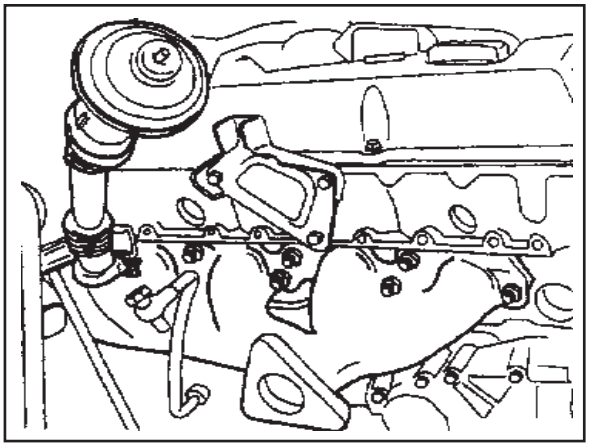


Notice

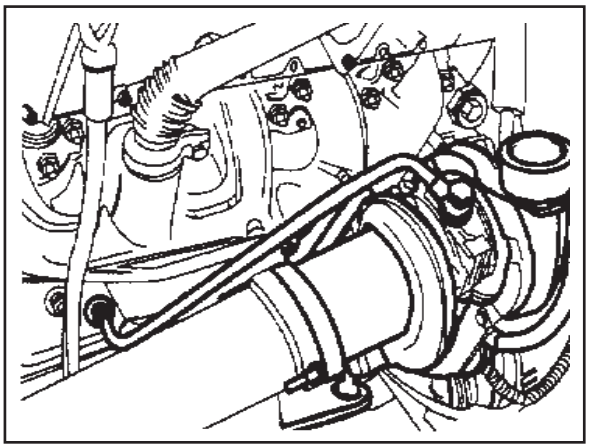
Measure the max. length 'L' and replace the bolt if it exceeds 53.6mm.



24. Install the exhaust manifold and gasket.

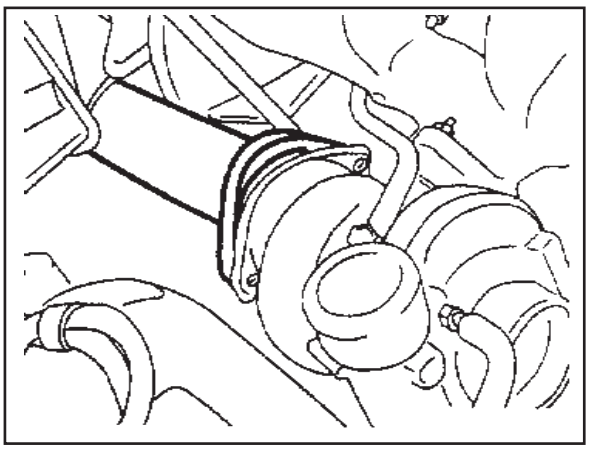


25. Install the turbocharger.



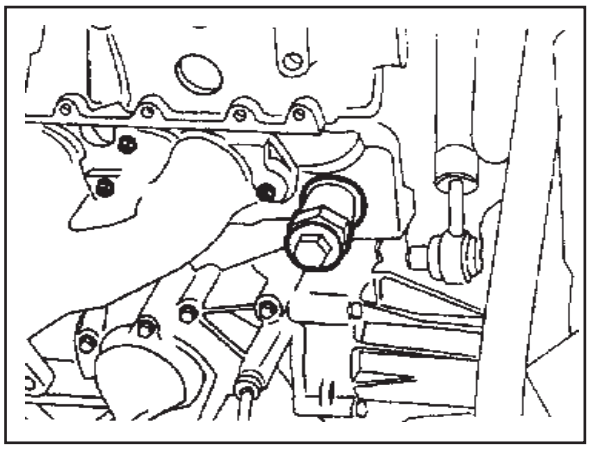
26. Install the exhaust pipe onto the turbocharger.

Tightening Torque	25 Nm

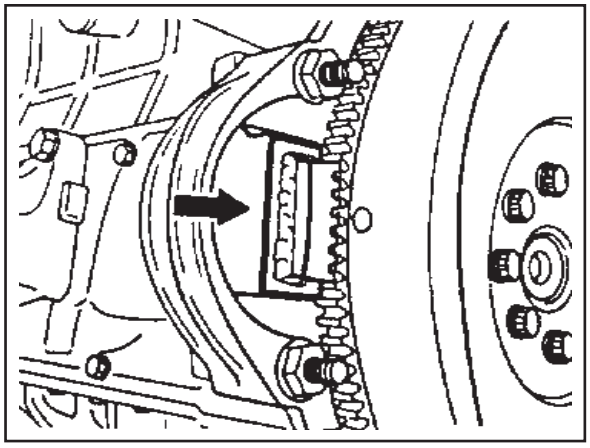


27. Replace the seal and then install the chain tensioner.

Tightening Torque	80 Nm

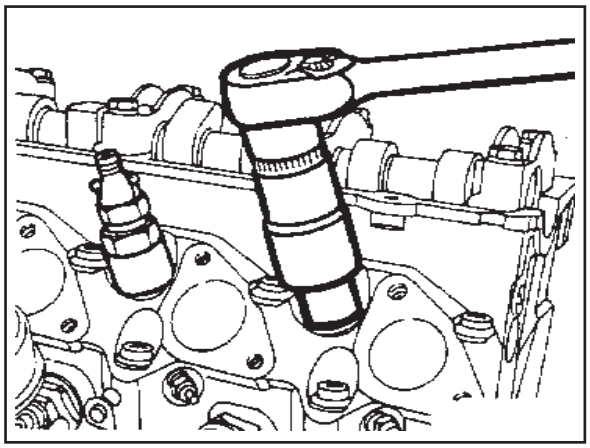


28. Remove the engine lock.

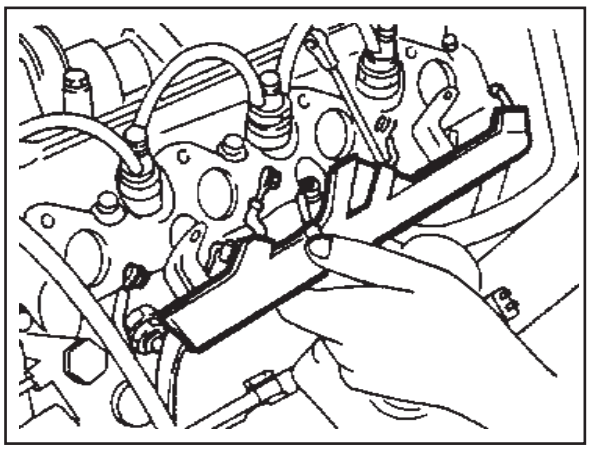


29. Insert the nozzle washer into the hole to face round part downward.
30. Install the fuel injection nozzle.

Tightening Torque	40 Nm

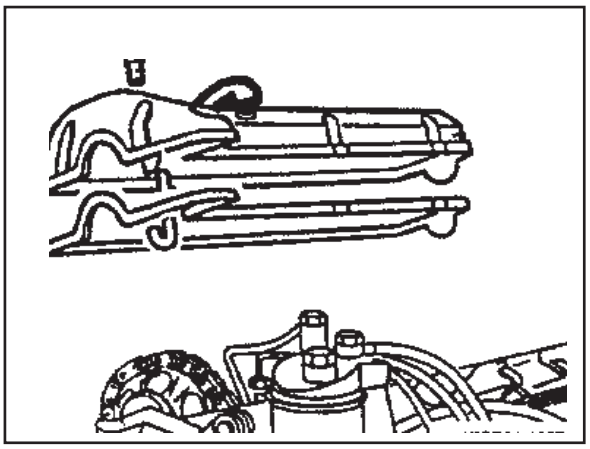


31. Connect the fuel hose.
32. Install the cable channel and connect the cables to glow plugs.



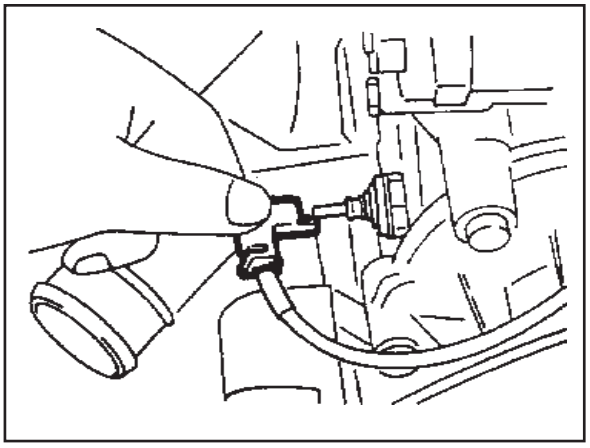
33. Replace the gasket and install the cylinder head cover.

Tightening Torque	10 Nm

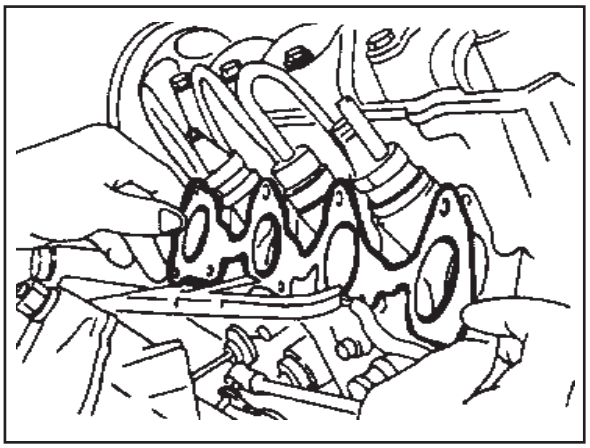


34. Install the blow-by hose.

35. Connect the wires to the coolant temperature sensor and the glow plug sensor.

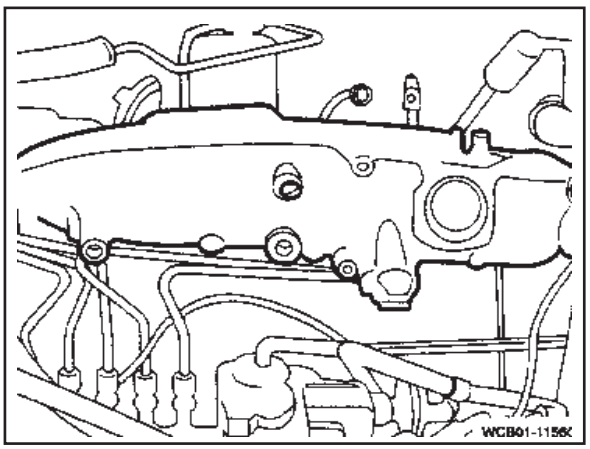


36. Replace the intake manifold gasket.



37. Install the intake manifold.

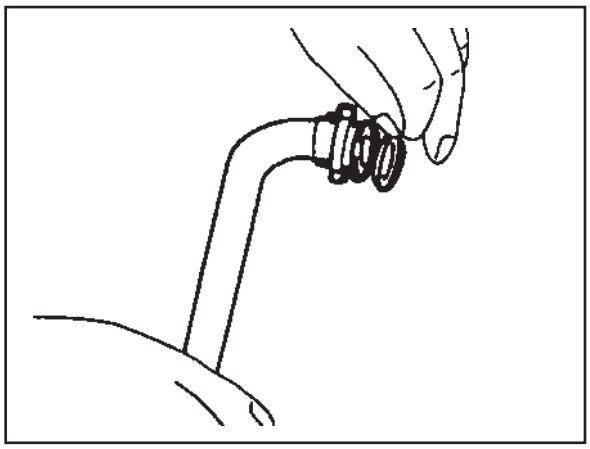
Tightening Torque	25 Nm



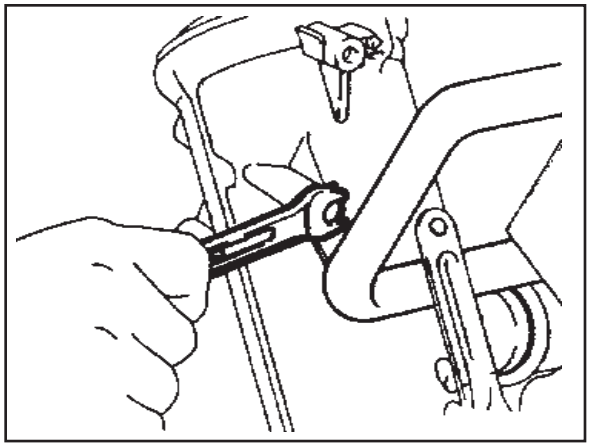
38. Replace the O-ring of heater feed pipe and install it to the cylinder head.

    Notice

    For installation, clean the hole.

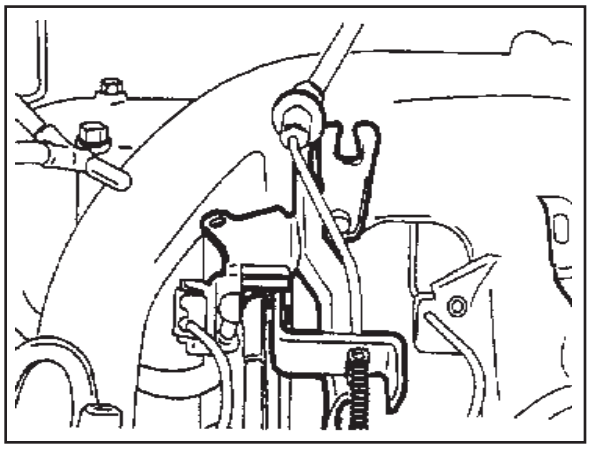


39. Install the bracket of heater feed pipe to the oil filter.

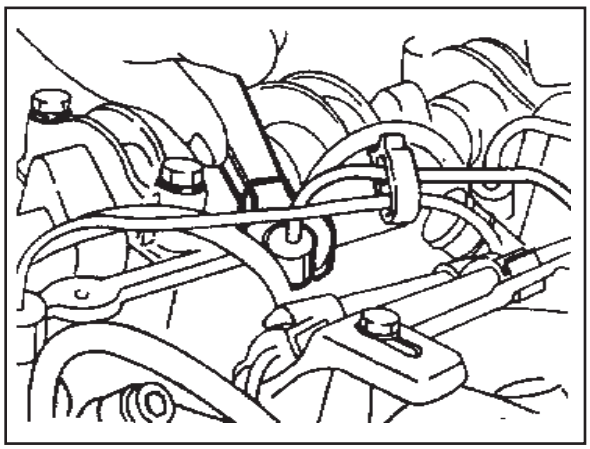


40. Install the fuel pipe and the accelerator control linkage.
41. Connect the fuel lines to the injection nozzles and to the injection pump.

    Box Wrench Insert 000 589 77 03 00



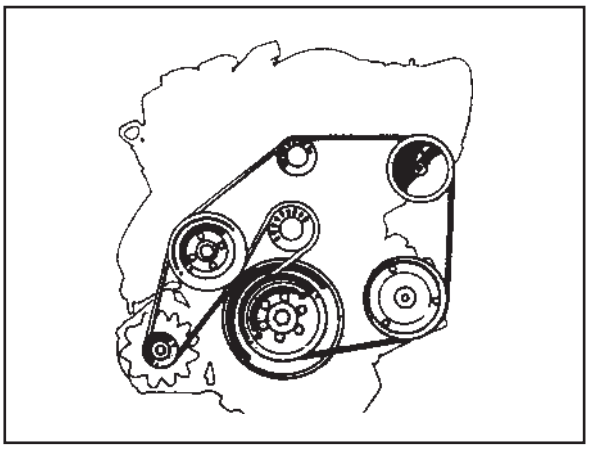
Tightening Torque	18 Nm



42. Install the poly V-belt.

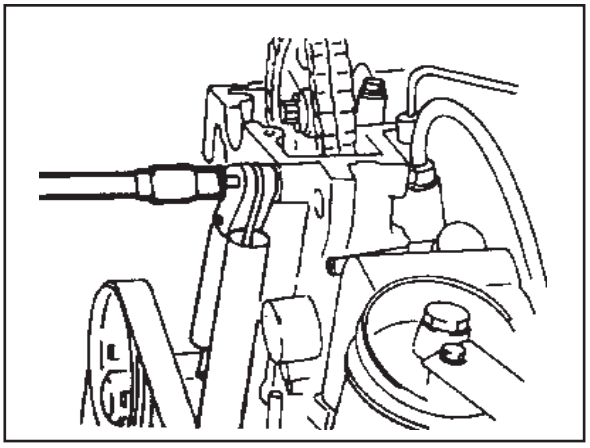
Notice

Be careful not to contaminate the belt.



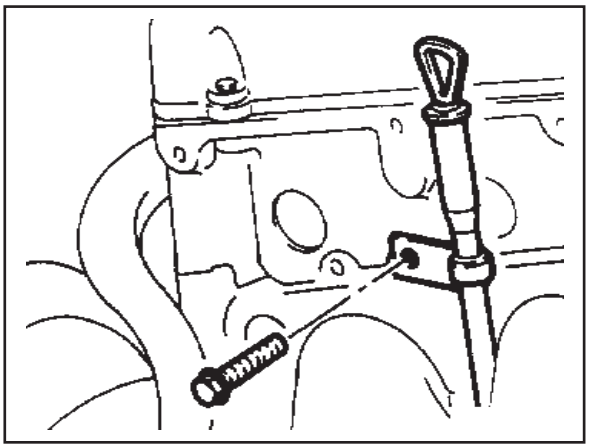
43. By inserting a rod into the tensioning lever upper hole and pulling the rod, install the bolt and then tighten the nut.

Tightening Torque	23 Nm

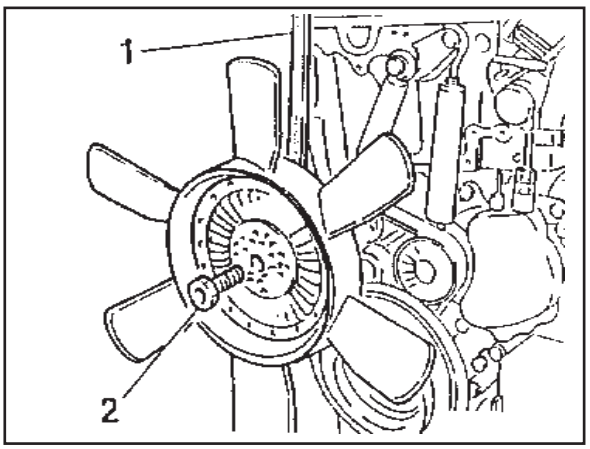


44. Install the oil dipstick tube bracket.

Tightening Torque	10 Nm

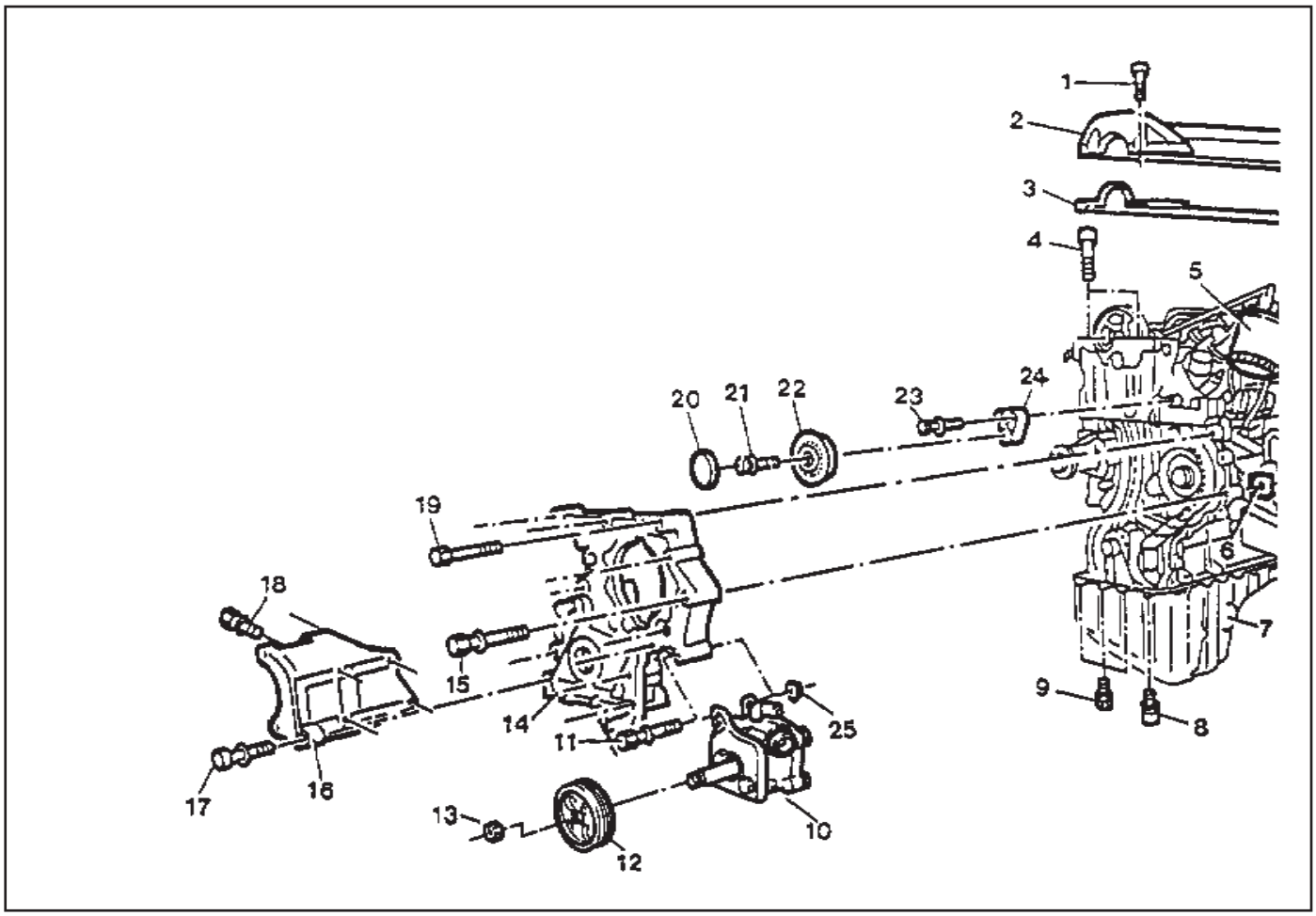


45. Hold the cooling fan with the counter holder and tighten the bolt.



TIMING CASE COVER

Preceding Work : Removal of the cooling fan
Rmoval of the V-belt tensioning device
Removal of the vibration damper and hub
Removal of the alternator



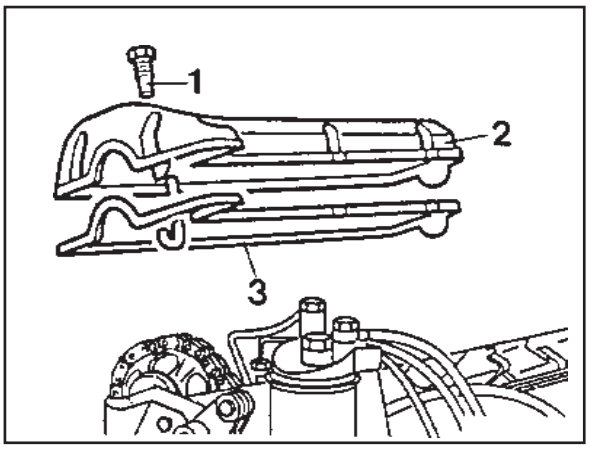
1 Bolt 10Nm
2 Cylinder Head Cover
3 Gasket ..... Replace
4 Socket Bolt 25Nm
5 Fuel Filter
6 Square Nut
7 Oil Pan
8 Socket Bolt 10Nm
9 Bolt ..... M6 : 10Nm
M8 : 23Nm
10 Power Steering Pump
11 Bolt
12 Belt Pulley
13 Bolt 32Nm
14 Timing Case Cover
15 Bolt 23Nm
16 Alternator Bracket
17 Bolt 45Nm
18 Bolt 25Nm
19 Bolt 10Nm
20 Closing Cover
21 Socket Bolt 23Nm
22 Guide Pulley
23 Bolt 9Nm
24 Guide Pulley Bracket
25 Nut 23Nm

Tools Required

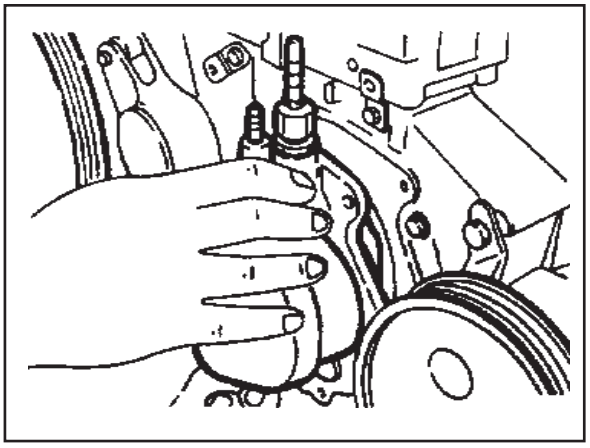
116 589 03 07 00 Socket Wrench

Removal Procedure

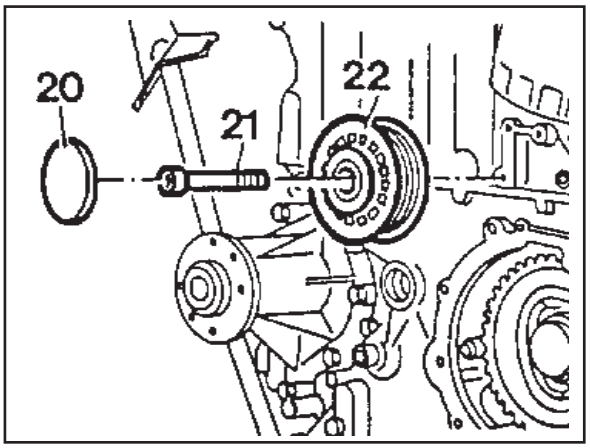
1. Remove the fan clutch and cooling fan belt pulley.
2. Drain the engine oil completely.
3. Remove the oil dipstick tube bracket bolts.
4. Remove the crankshaft pulley.
5. Loosen the bolt (1) and then remove the cylinder head cover (2) and gasket.



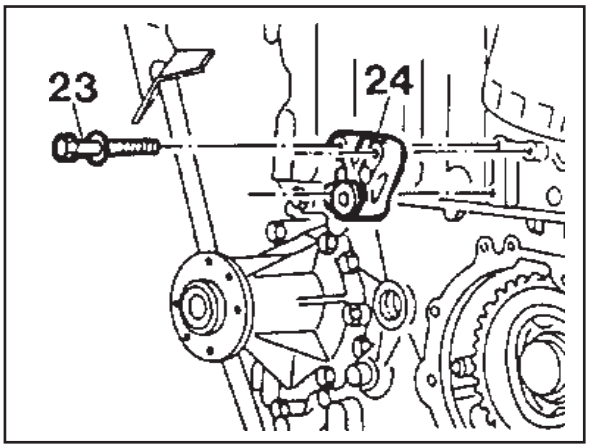
6. Remove the vacuum pump.



7. Detach the closing cover (20). Remove the bolts(21) and then remove the guide pulley (22).



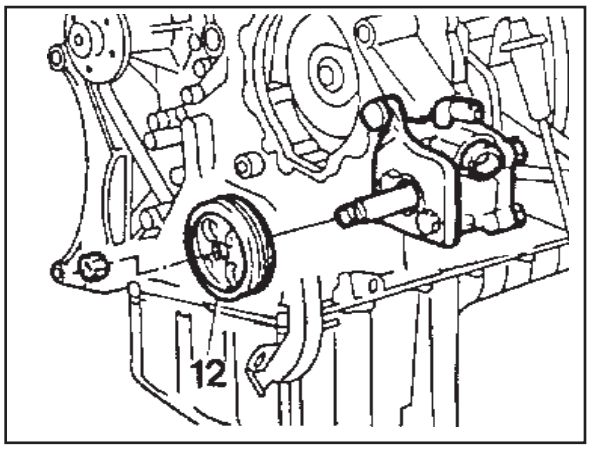
8. Remove the guide pulley bracket (24).



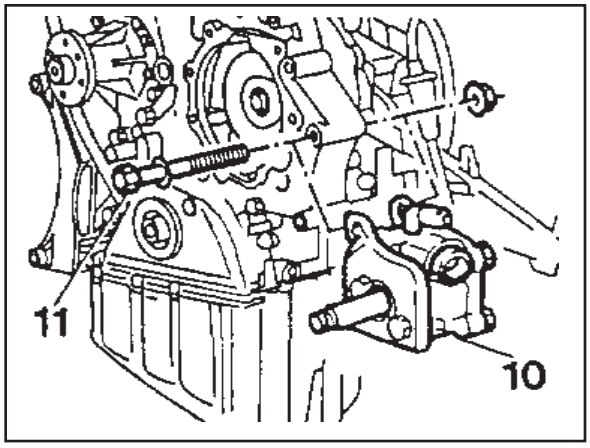
9. Disconnect the pipes of power steering pump and remove the belt pulley.

   Notice

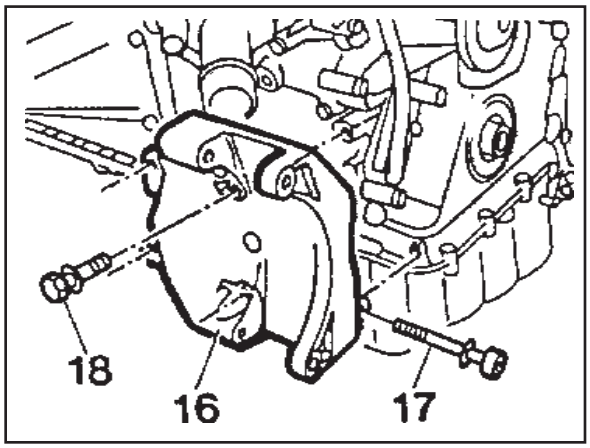
   Be careful not to lose the key.



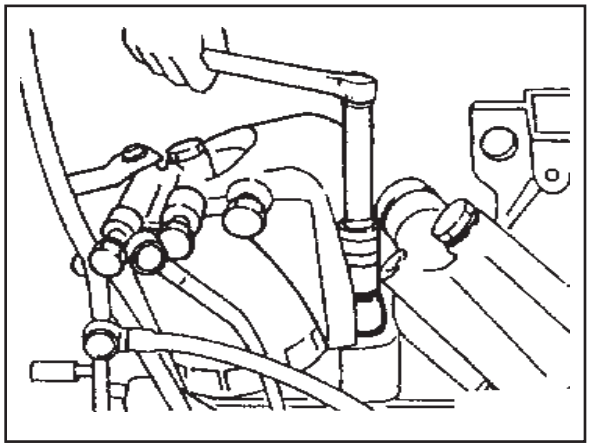
10. Remove the nut and pull out the bolt and then remove the power steering pump.



11. Remove the alternator bracket (16).

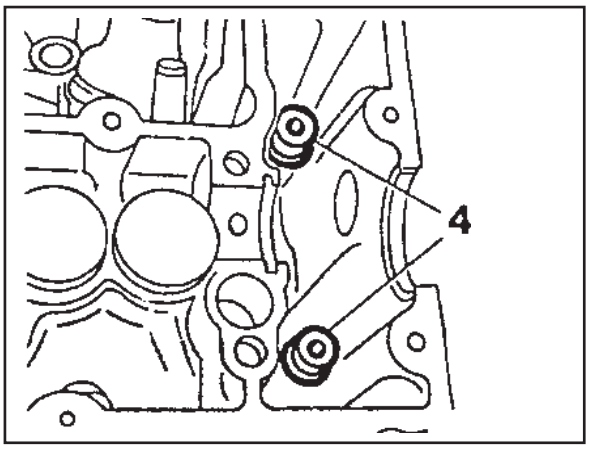


12. Remove the fuel filter.



13. Remove the camshaft.
14. Remove the socket bolts(4) in the chain box.

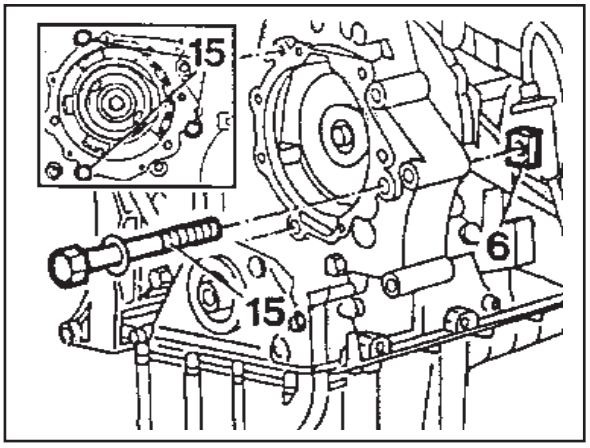
Socket Wrench 115 589 03 07 00



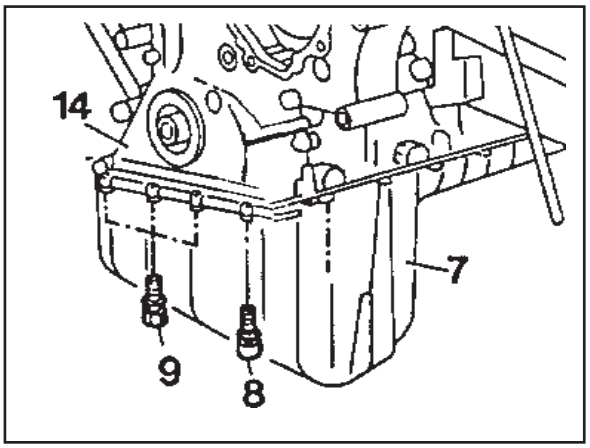
15. Remove the injection pump.

Notice

See the 'Removal of fuel injection pump'.



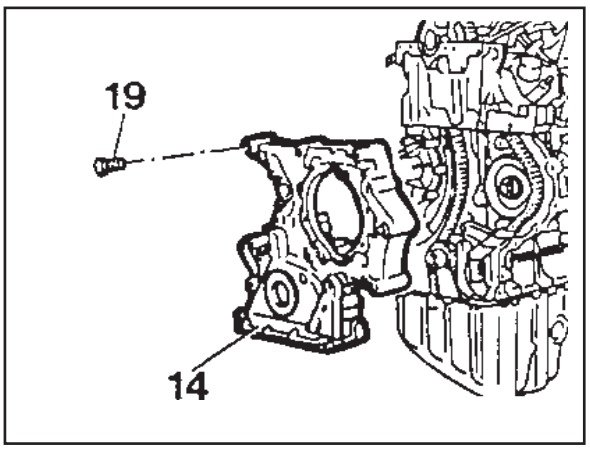
16. Remove the oil pan bolts (8, 9) in the area of the timing case cover (14).
17. Slightly loosen the remaining oil pan bolts.



18. Remove the timing case cover (19) bolts and then remove the timing case cover (14).

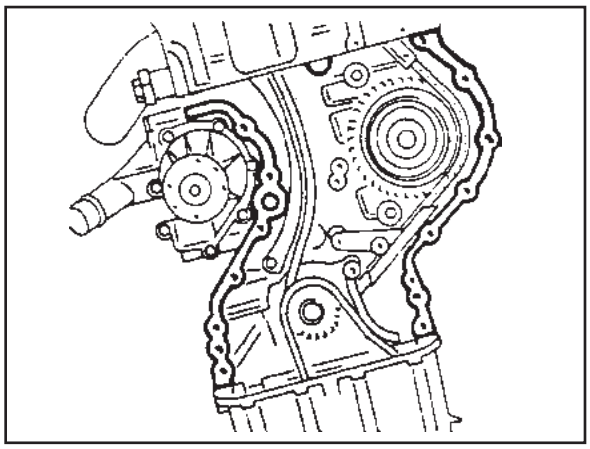
Notice

Be careful not to damage the cylinder head gasket or oil pan gasket.



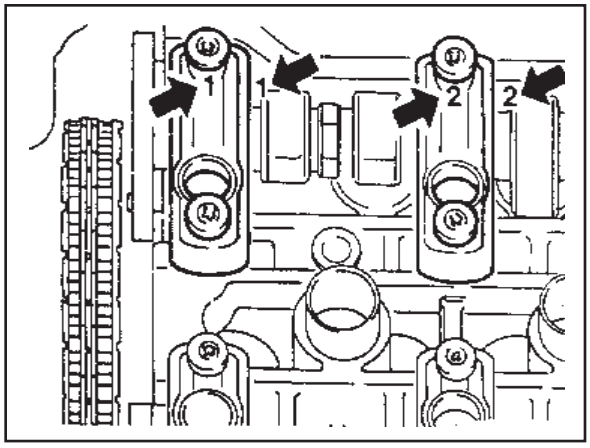
Installation Procedure

1. Thoroughly clean the sealing surface and apply sealant.



2. Install the timing case cover.

Tightening Torque	10 Nm



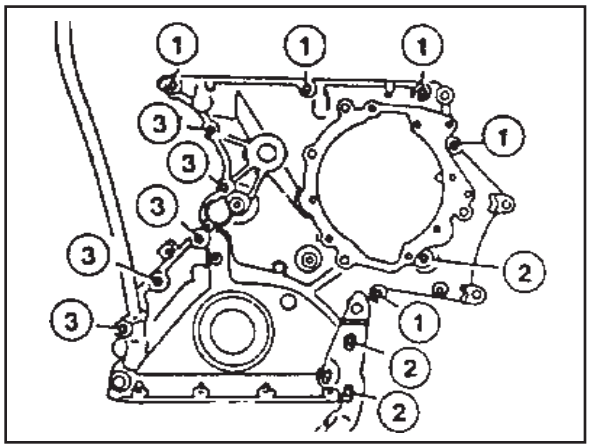
Notice

Bolts arrangement

1.M6 x 60

2.M6 x 70

3.M6 x 40

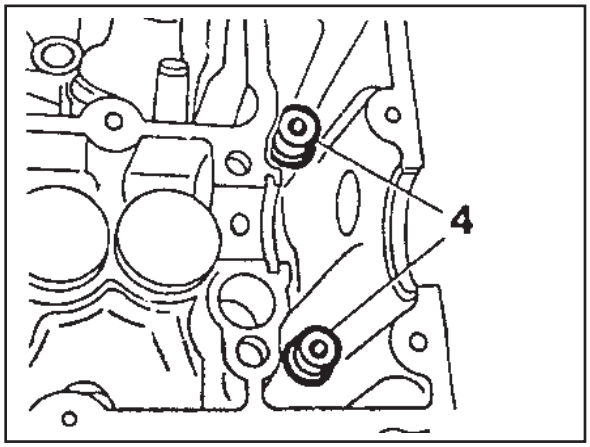


3. Tighten the socket bolts in the chain box.

Tightening Torque	23 Nm

4. Tighten the oil pan bolts.

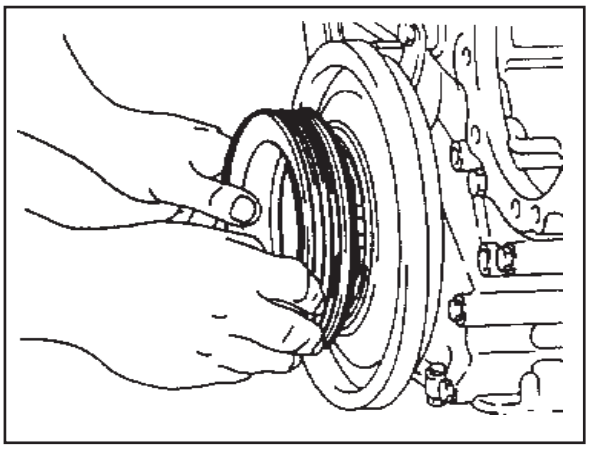
Tightening Torque	Socket bolt	10 Nm
	M6 bolt	10 Nm
	M8 bolt	23 Nm



5. Install the flange, vibration damper and crankshaft belt pulley.

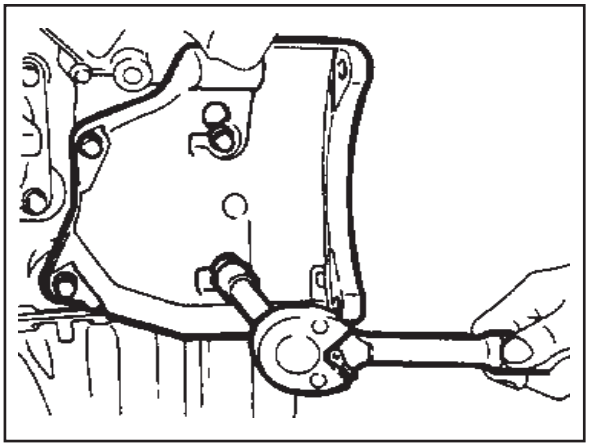
   Notice

   Replace front radial seal if necessary.



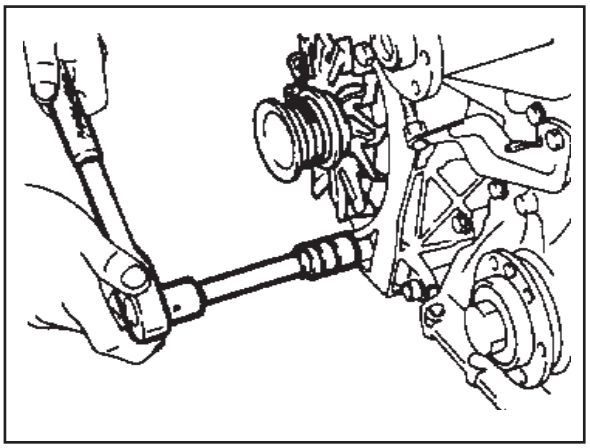
6. Install the alternator bracket.

Tightening Torque	Front	25 Nm
	Side	25 Nm



7. Install the alternator

Tightening Torque	Upper - 25 Nm
	Low - 25 Nm

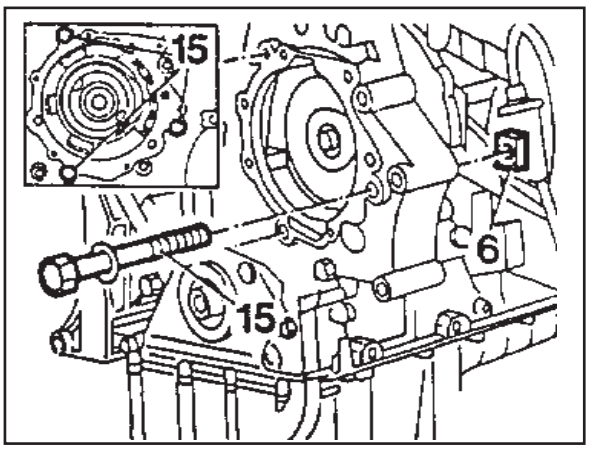


8. Install the cylinder head cover.

Tightening Torque	10 Nm

9. Tighten the injection pump mounting bolts.

Tightening Torque	23 Nm

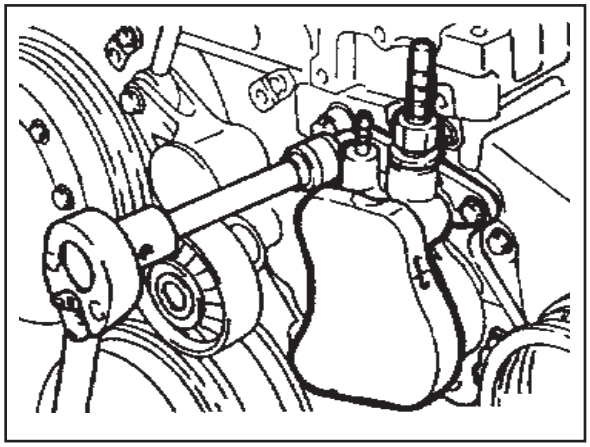


10. Install the fuel filter.

Tightening Torque	25 Nm

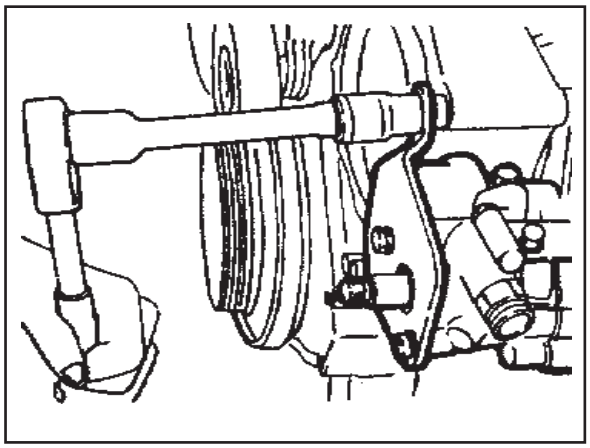
11. Install the vacuum pump.

Tightening Torque	10 Nm



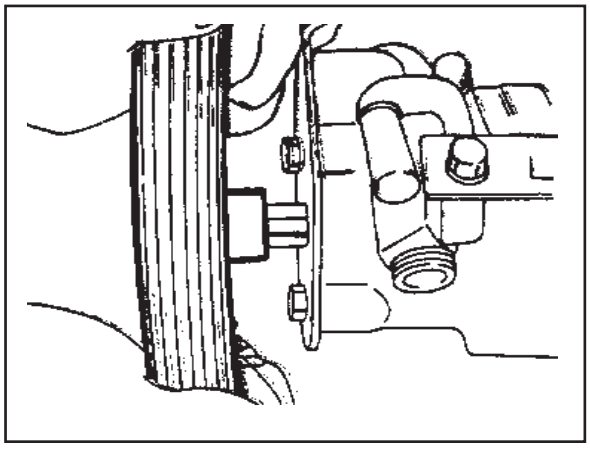
12. Install the power steering pump.

Tightening Torque	23 Nm



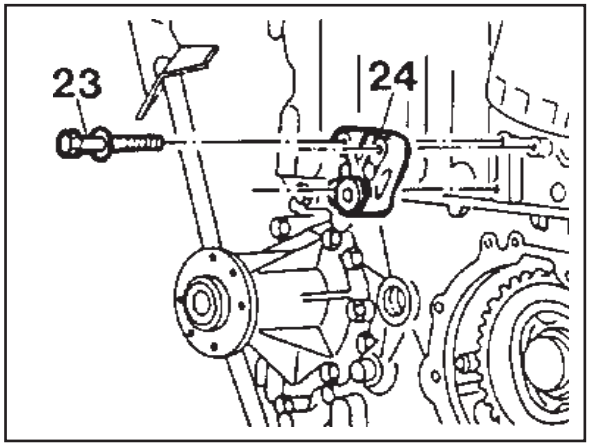
13. Install the power steering pump pulley.

Tightening Torque	32 Nm



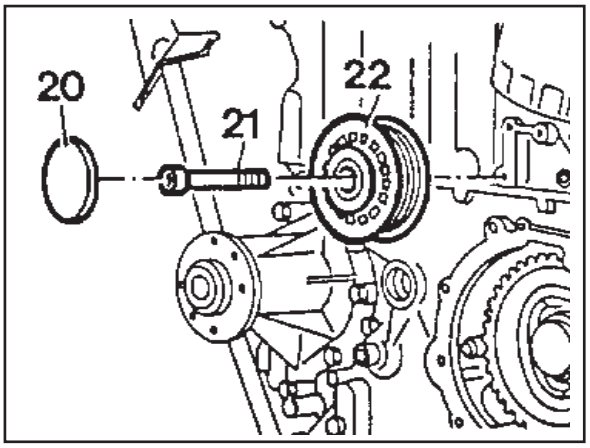
14. Install the guide pulley bracket.

Tightening Torque	9 Nm



15. Install the guide pulley (22) and fit the closing cover (20).

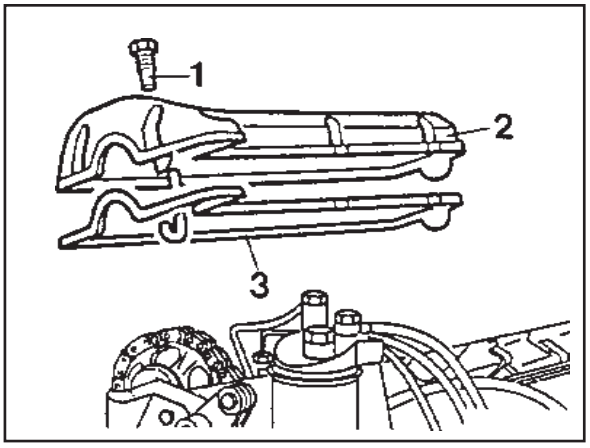
Tightening Torque	23 Nm



16. Replace the gasket (3) and install the cylinder head cover (2).

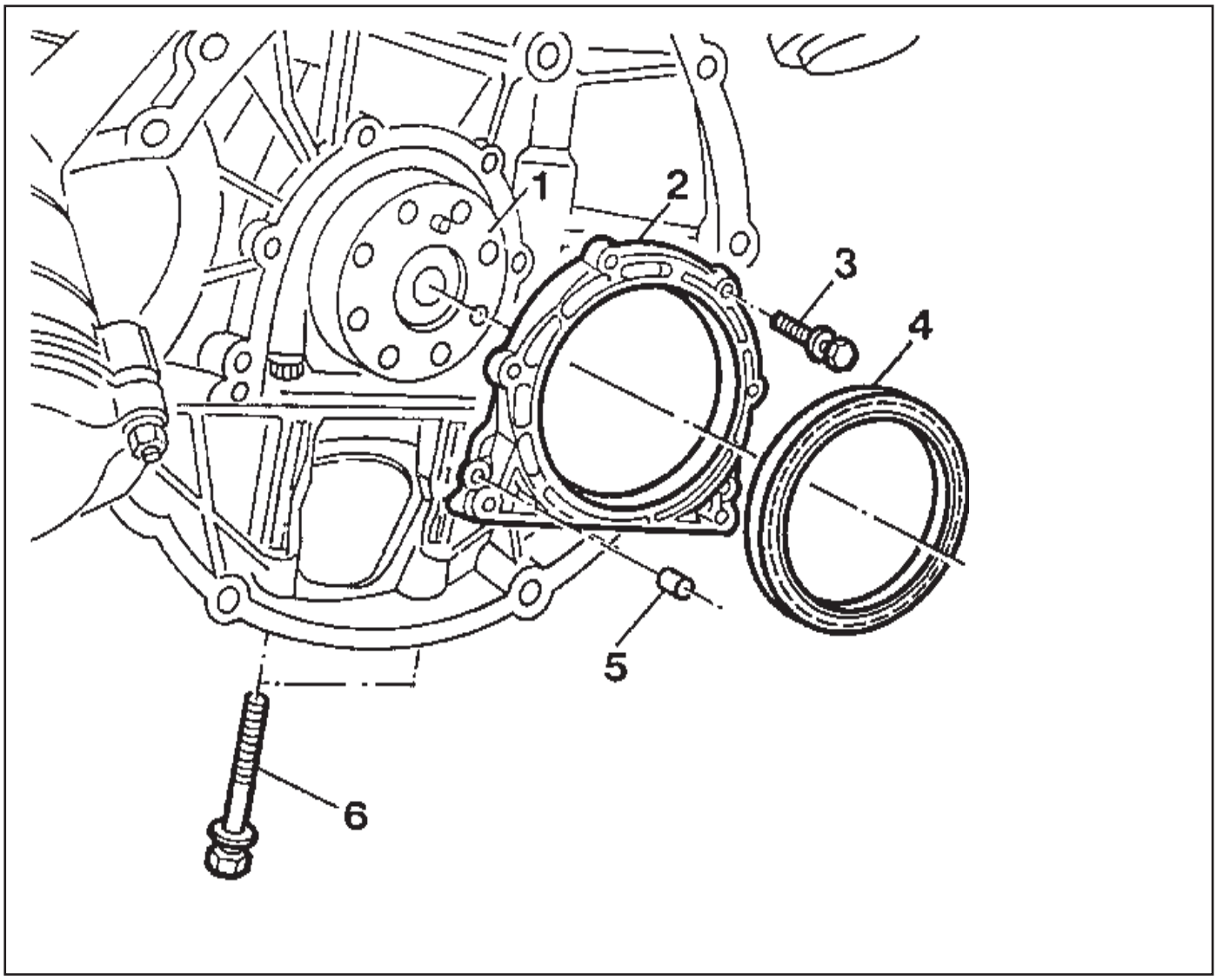
Tightening Torque	10 Nm

17. Install the cooling fan belt pulley and fan clutch.
18. Install the belt tensioning device and then install the belt.
19. Install the cooling fan.
20. Fill the engine oil and check oil leaks by running the engine.



CRANKSHAFT END COVER

Preceding Work : Removal of flywheel and driven plate.



1	Crankshaft Flange	4	Radial Seal ..... Replace
2	End Cover ..... Clean, Loctite 573	5	Dowel Sleeve
3	Bolt ..... 10Nm, Loctite 573	6	Bolt ..... 10Nm, Loctite 573

Tools Required

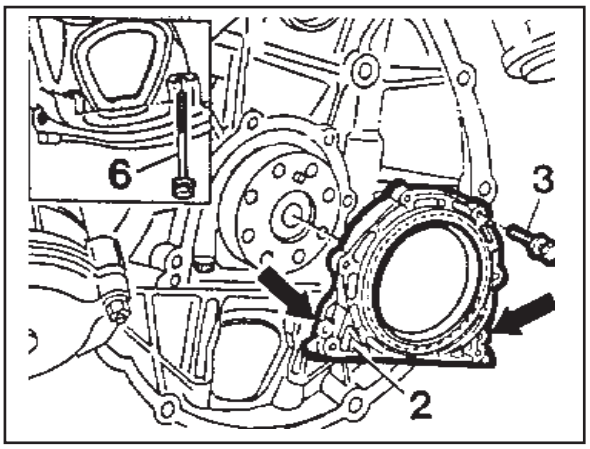
601 589 03 43 00 Oil Seal Assmbler

Removal Procedure

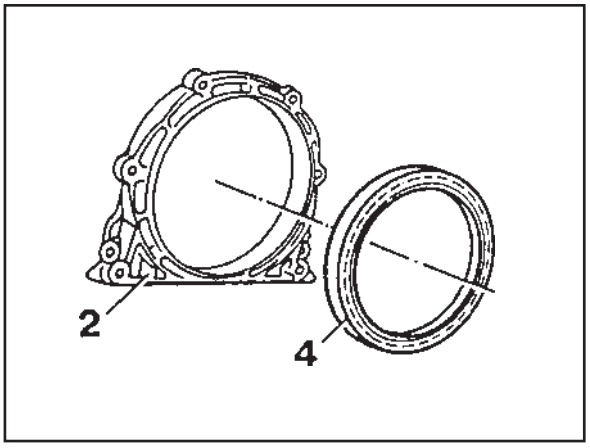
1. Remove the bolts (3, 6) from end cover, By pulling out the lugs (arrow), remove the cover.

   Notice

   Be careful not to damage the oil pan gasket.



2. Remove the radial seal (4) with care not to damage the sealing surface.



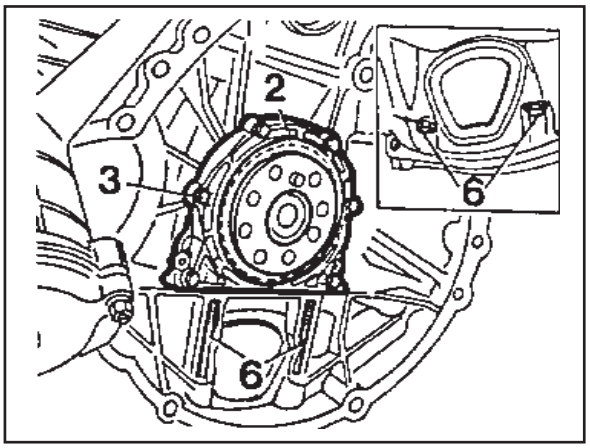
Installation Procedure

1. Thoroughly clean the sealing surface of end cover and apply Loctite 573.
2. Clean the groove of radial seal.
3. Apply Loctite 573 on the bolts and install the end cover.

Tightening Torque	10 Nm

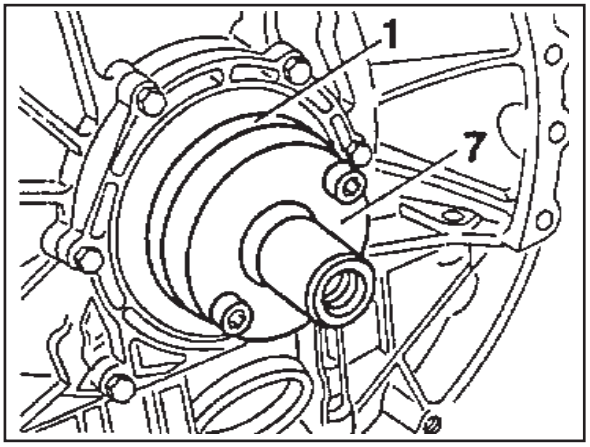
   Notice

   Be careful not to damage the oil pan gasket.

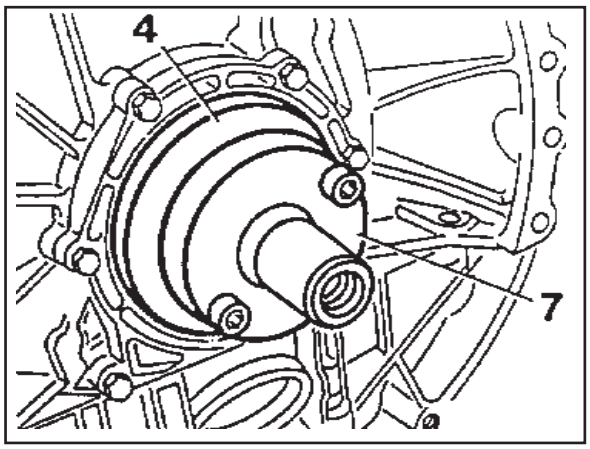


4. Install the inner oil seal assembler to the crankshaft flange.

   Oil Seal Assembler 601 589 03 43 00



5. Coat a little oil on the sealing lip of new radial seal and contacting surface.



Notice

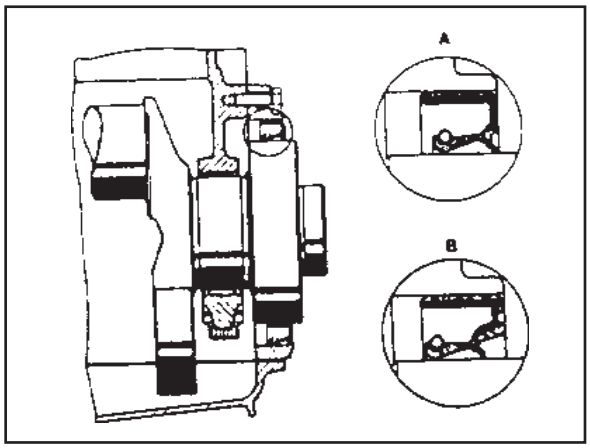
Don't use grease.

6. Insert the new radial seal (4) onto the oil seal assembler (7).

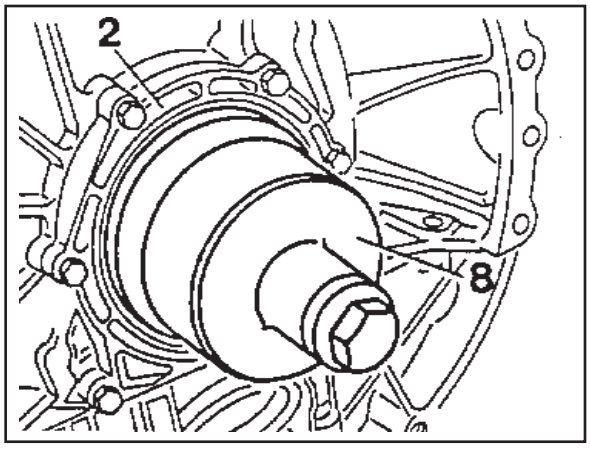
Notice

The sealing lip of the repair radial seal is offset to the inside by 3mm to ensure that it does not run in any groove which the standard radial seal may have left on the crankshaft flange.

A Standard Radial Seal
B Repair Radial Seal



7. Install the outer oil seal assembler on he seal and by tightening the bolts, press the radial seal into the end cover as far as the stop.



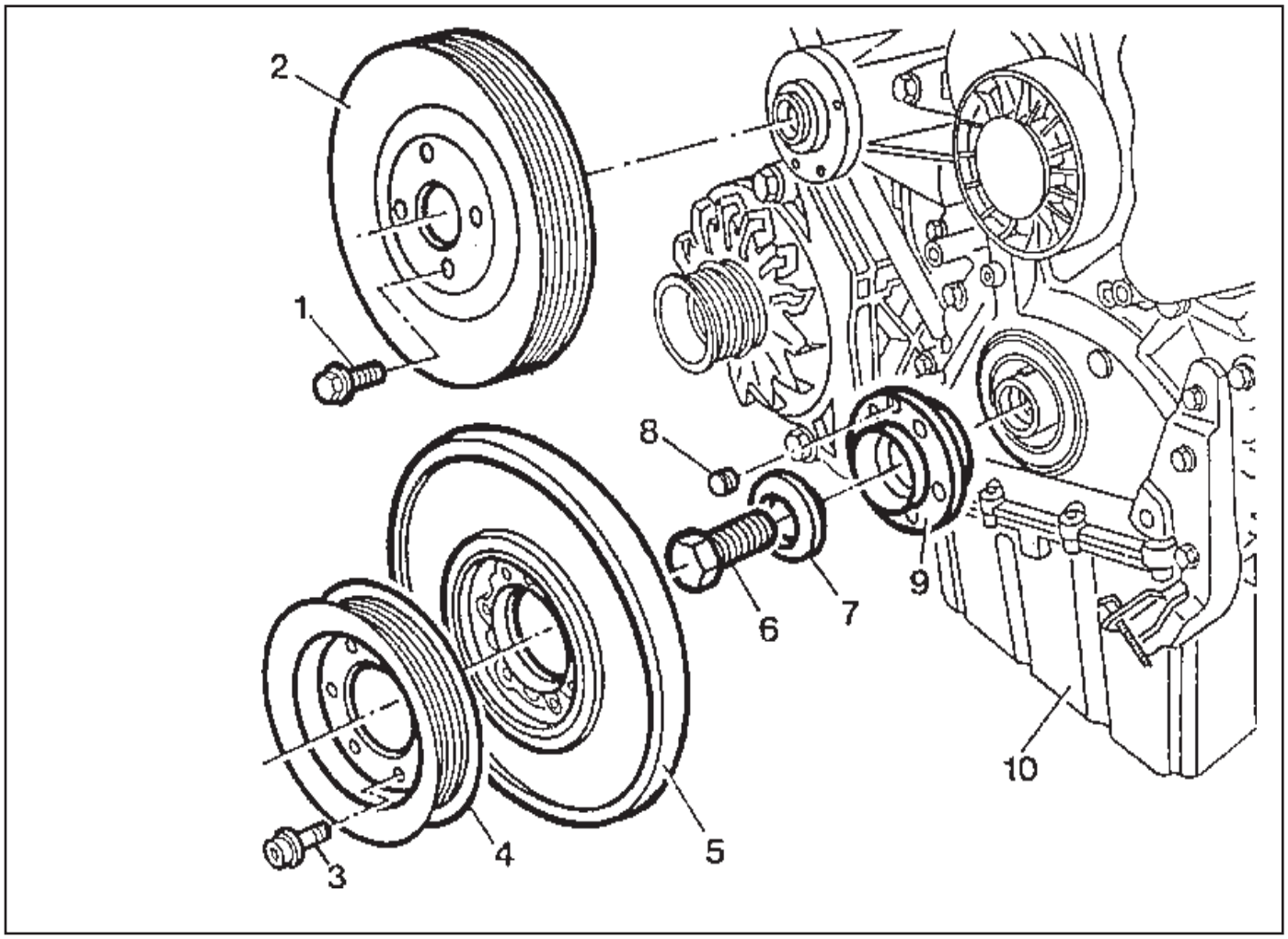
Notice

The seal must be positioned exactly at right angles in the end cover to ensure that it provides a proper seal.

Oil Seal Assembler 601 589 03 43 00

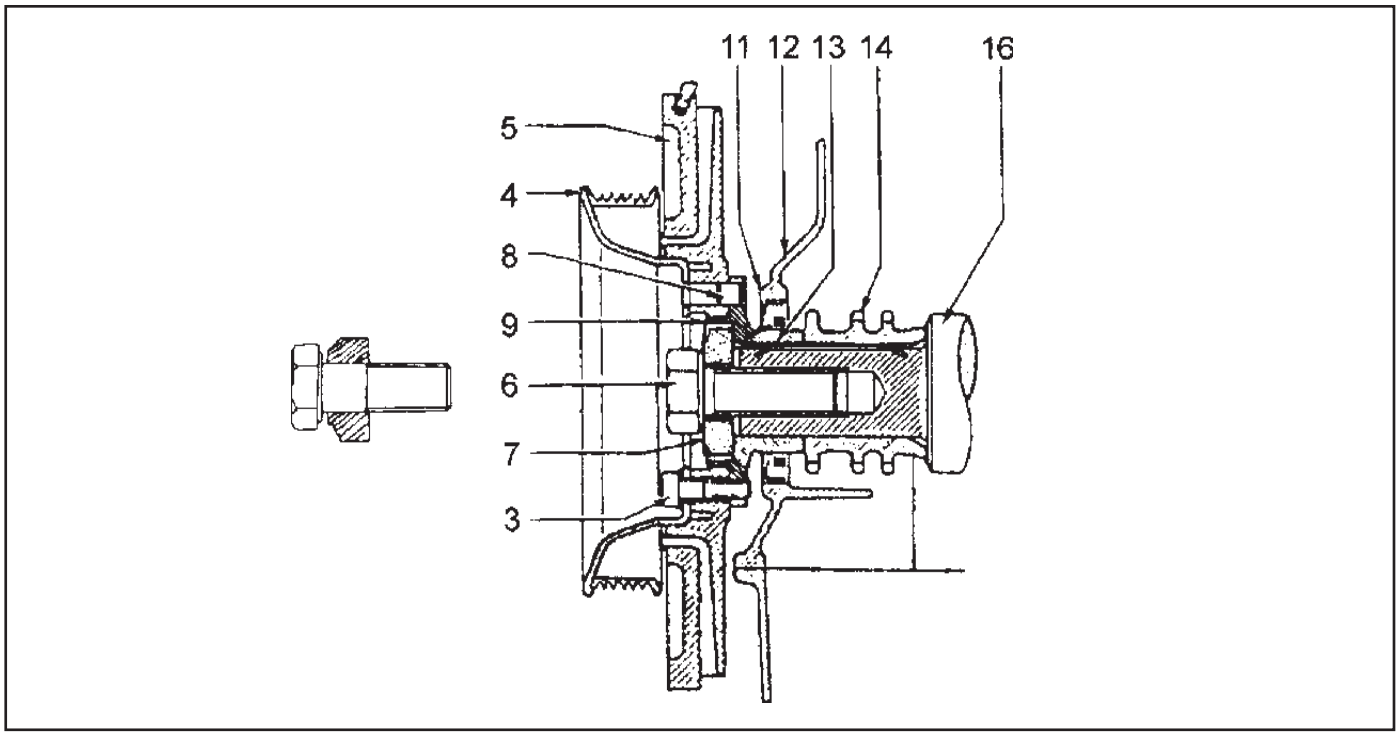
VIBRATION DAMPER AND HUB

Preceding Work : Removal of the cooling fan
Removal of poly V-belt



1 Bolt 10Nm
2 Cooling Fan Belt Pulley
3 Socket Bolt 23Nm
4 Crankshaft Belt Pulley
5 Vibration Damper
6 Bolt ..... 200Nm + 90°
7 Washer
8 Straight Pin
9 Hub
10 Oil Pan

Sectional View



3 Socket Bolt
4 Crankshaft Belt Pulley
5 Vibration Damper
6 Bolt
7 Washer
8 Straight Pin
9 Hub
11 Radial Seal
12 Timing Gear Case Cover
13 Key
14 Crankshaft Sprocket
16 Crankshaft

Notice

The mounting position of vibration damper is fixed by straight pin (8).

Tools Required

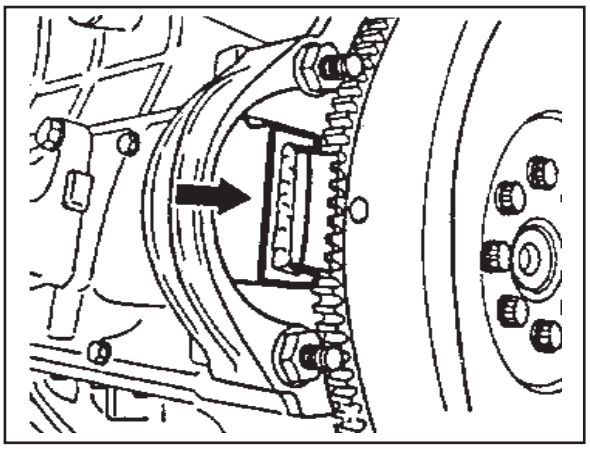
602 589 00 40 00 Engine Lock

103 589 00 30 00 Puller

Removal Procedure

1. Remove the starter motor and install the engine lock into the wheel ring gear.

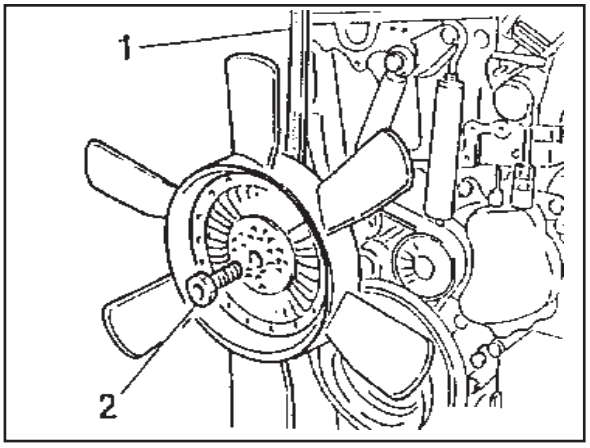
Engine Lock 602 589 00 40 00



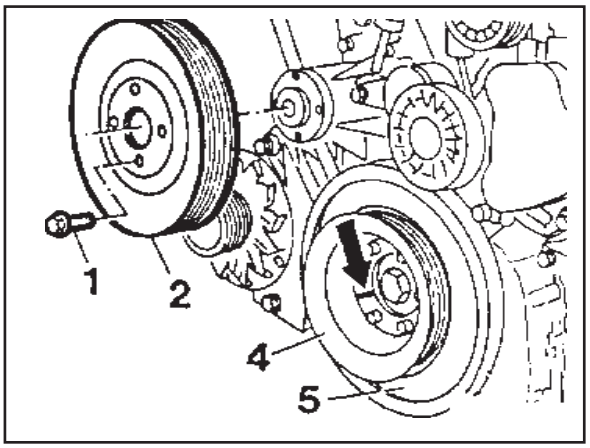
2. Remove the poly V-belt.
3. Remove the cooling fan.

Notice

Keep the fan in vertical position.



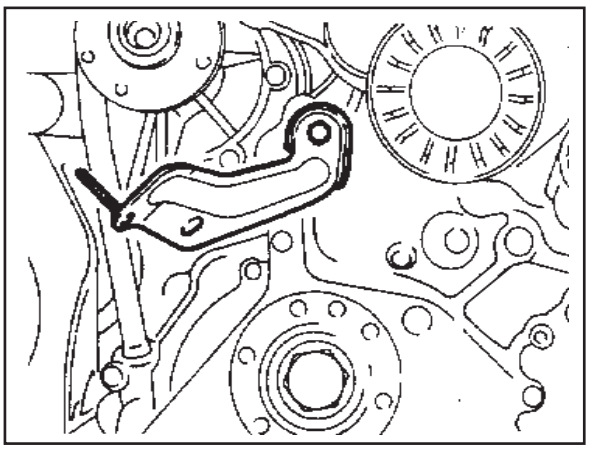
4. Remove the cooling fan belt pulley (2).
5. Place alignment marks (arrow) on the vibration damper (5) and crankshaft belt pulley (4).



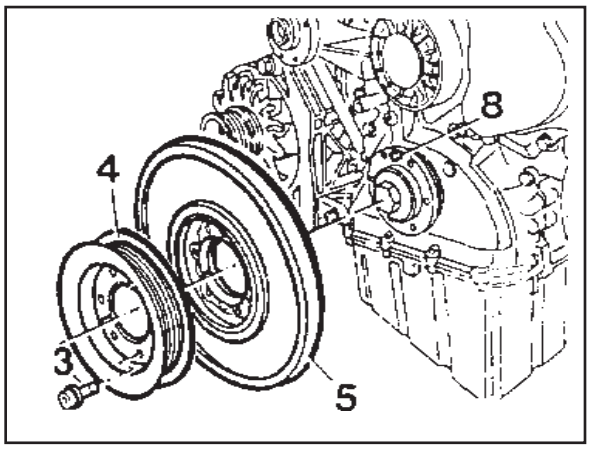
6. Remove the timing sensor bracket.

Notice

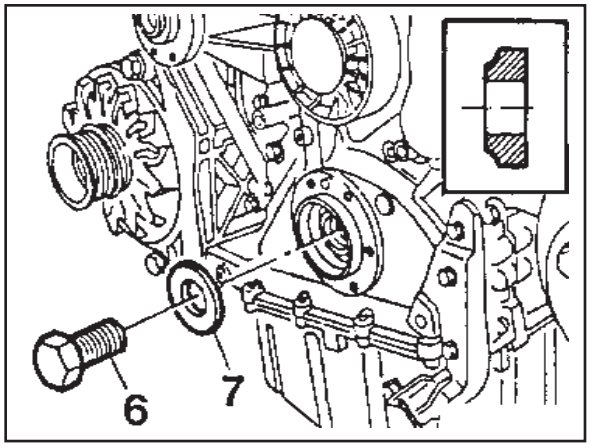
Remove if necessary.



7. Remove the socket bolts (3) and then remove the belt pulley (4) and vibration damper (5).



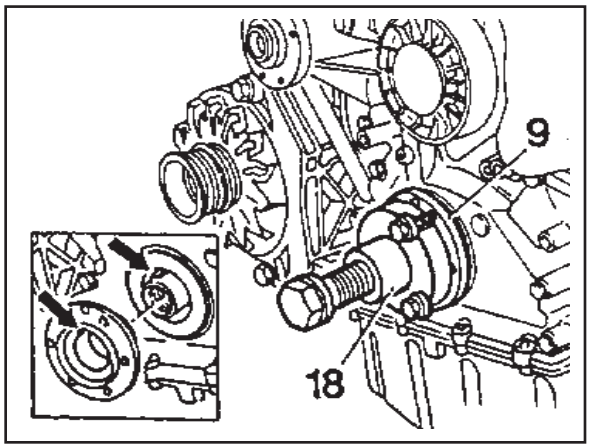
8. Remove the washer and bolt.



9. Remove the hub by using a puller.

Puller 103 589 00 33 00

10. Replace the radial seal.

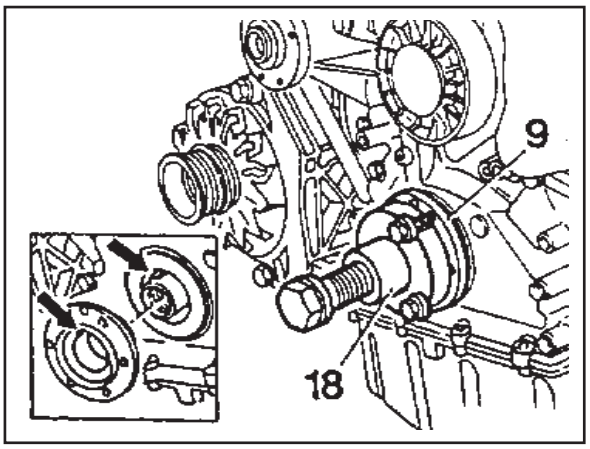


Installation Procedure

1. Install the hub.

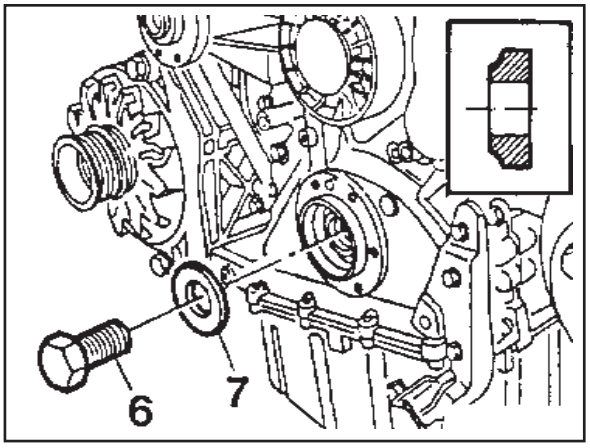
   Notice

   Exactly align the woodruff key and the groove of hub (arrow).



2. Install the washer (7) and tighten the bolt (6).

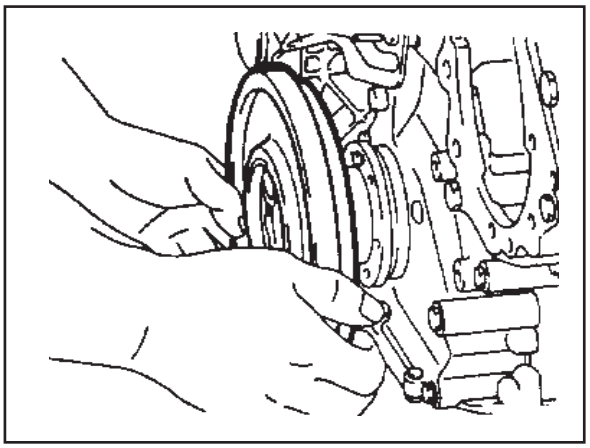
Washer (new) : 1 EA	200 Nm + 90°



3. Install the vibration damper.

   Notice

   Exactly align and insert onto the straight pin.

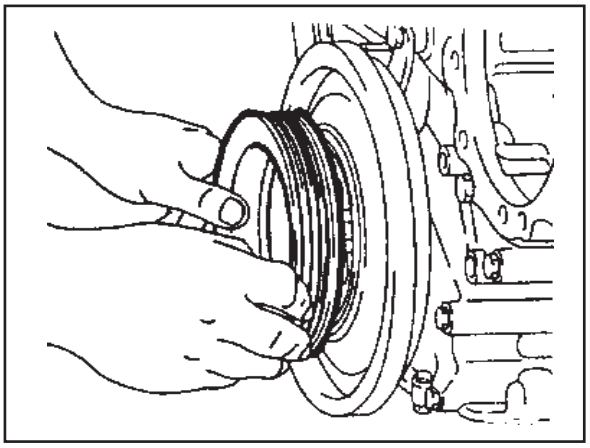


4. Install the belt pulley.

Tightening Torque	25 Nm

   Notice

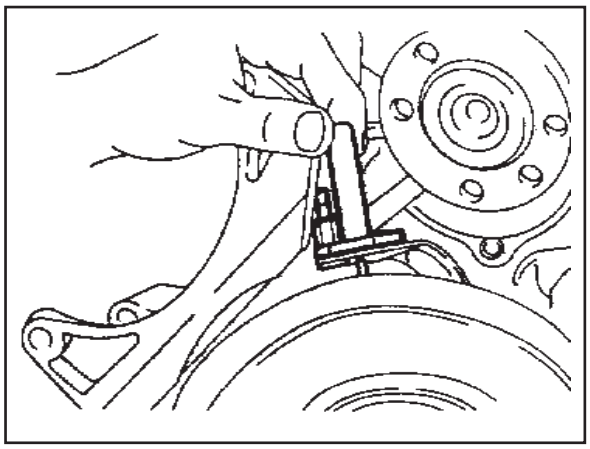
   Align the alignment marks.



5. Install the timing sensor bracket.

   Notice

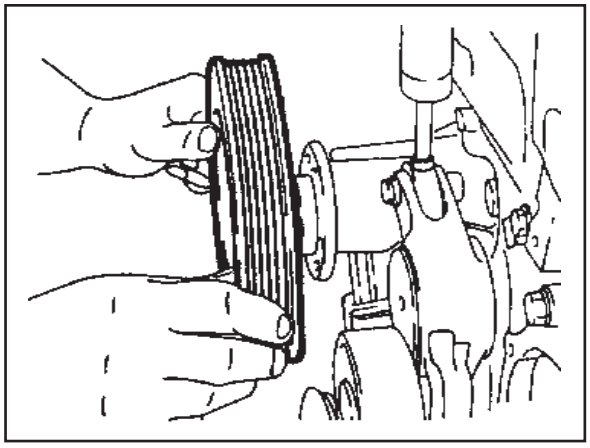
   See the 'TDC setting'.



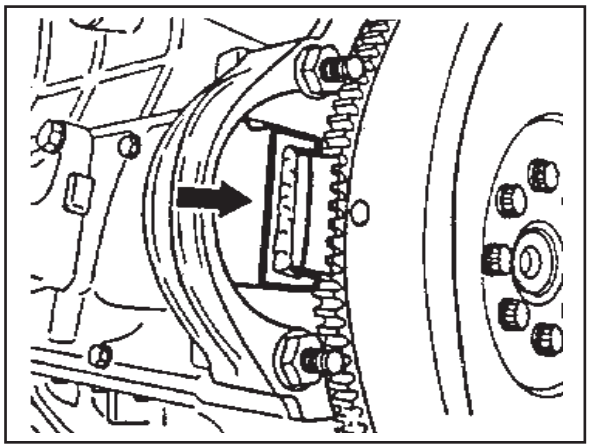
6. Install the cooling fan pulley.

Tightening Torque	10 Nm

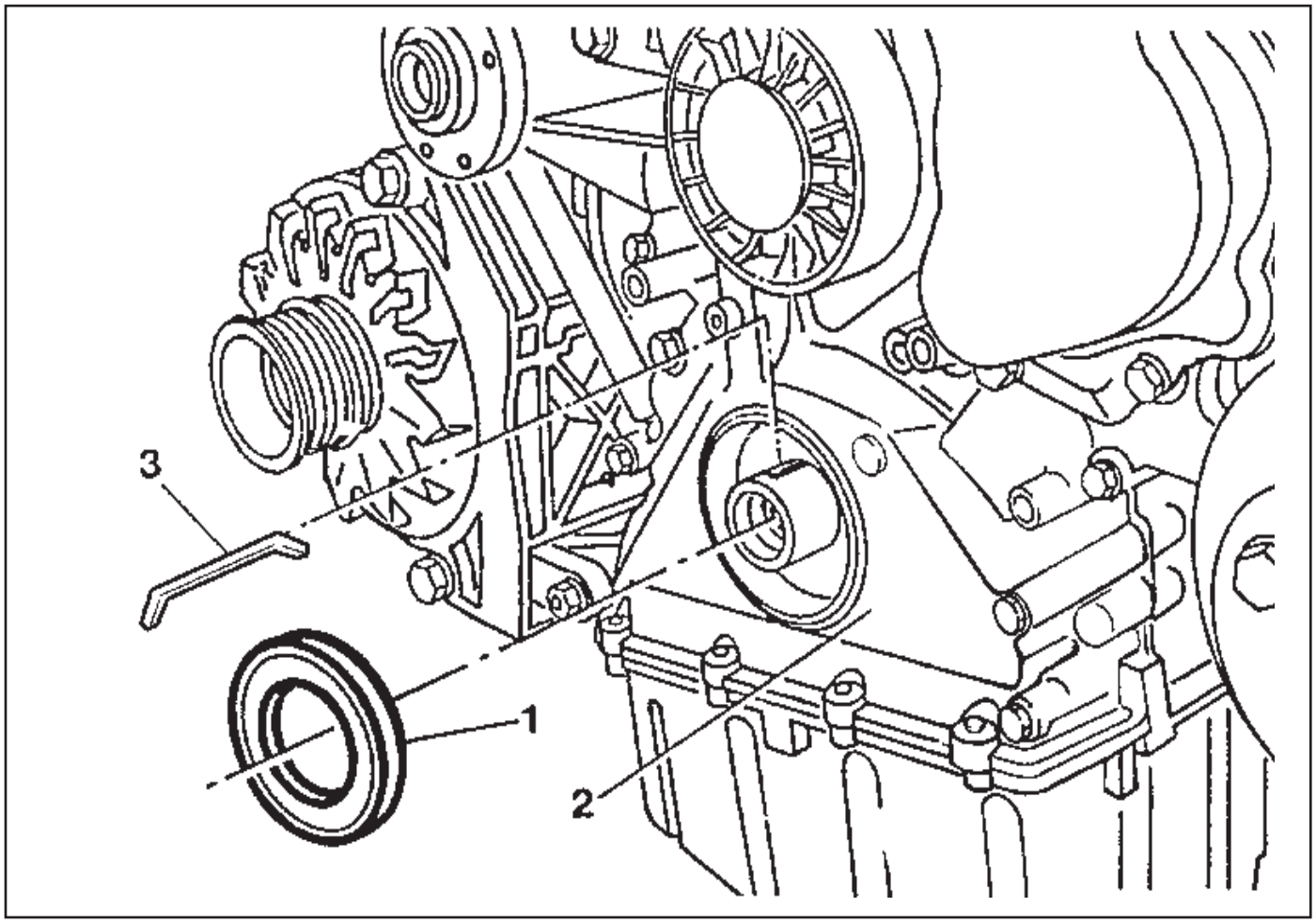
7. Install the cooling fan.
8. Install the fan belt.



9. Remove the engine lock.



CRANKSHAFT FRONT RADIAL SEAL



1 Radial Seal
2 Timing Case Cover
3 Woodruff Key

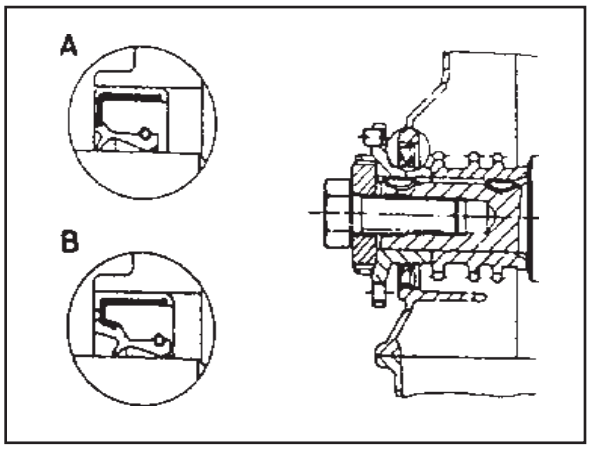
Tools Required

601 589 03 14 00 Sleeve

Notice

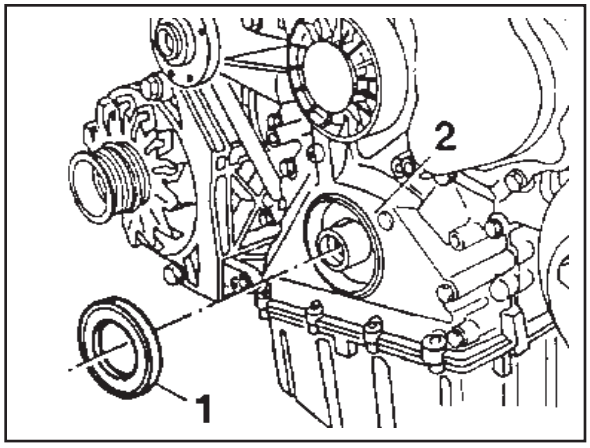
The sealing lip of the repair radial seal is offset to the inside by 2mm to ensure that is does not run in any groove which the standard radial seal may have left on the crankshaft flange.

A Standard Radial Seal
B Repair Radial Seal



Replacement Procedure

1. Pull out the radial seal (1) and be careful not to damage the sealing surface of timing case cover.
2. Thoroughly clean the mounting bore of the radial seal.



3. Coat a little oil on the sealing lip of new radial (1) and contact surface.

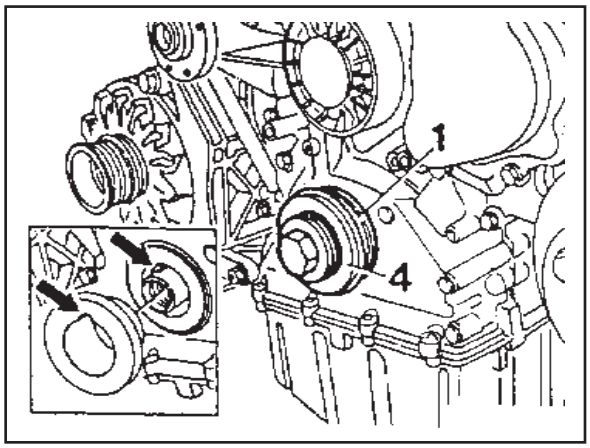
   Notice

   Don't use grease.
4. Install the radial seal (1) by using a sleeve (4).

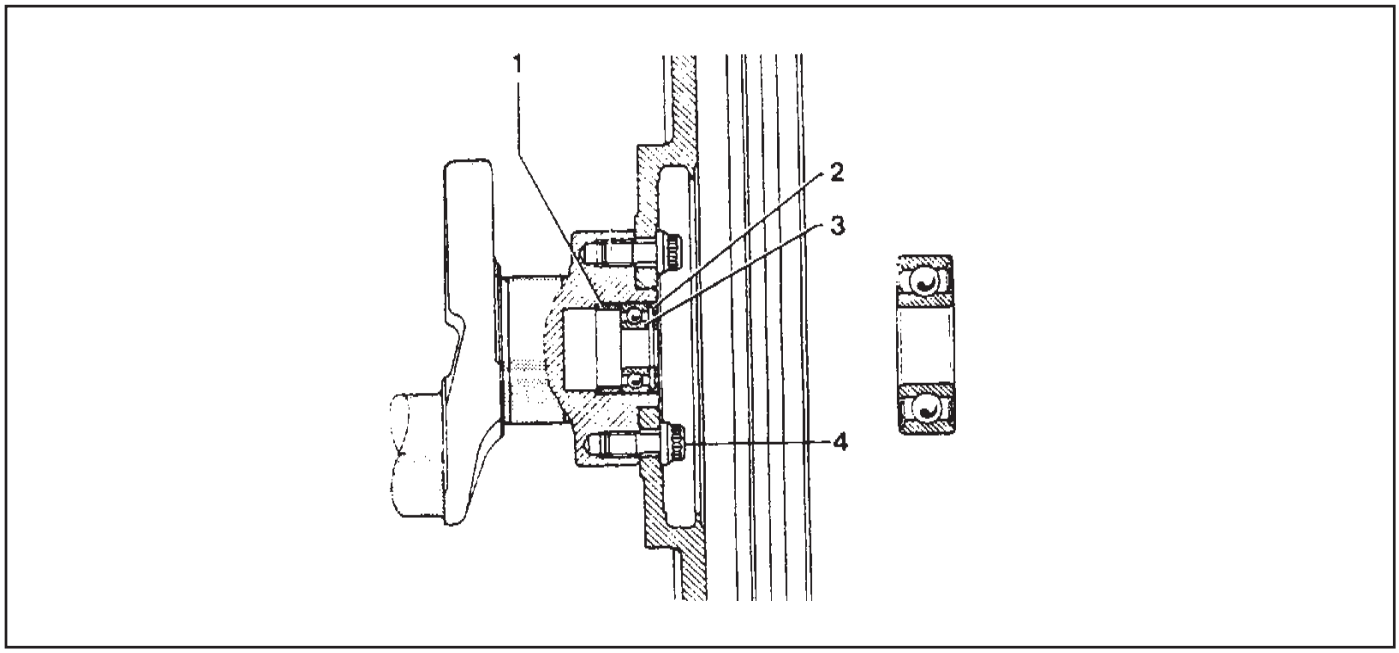
   Notice

   Align the groove of sleeve and woodruff key(arrow).

Sleeve 601 589 03 14



CRANKSHAFT BALL BEARING



1 Spacer
2 Cover ..... Replace
3 Ball Bearing
4 Bolt ..... 45Nm + 90°

Notice

Manual transmission only.

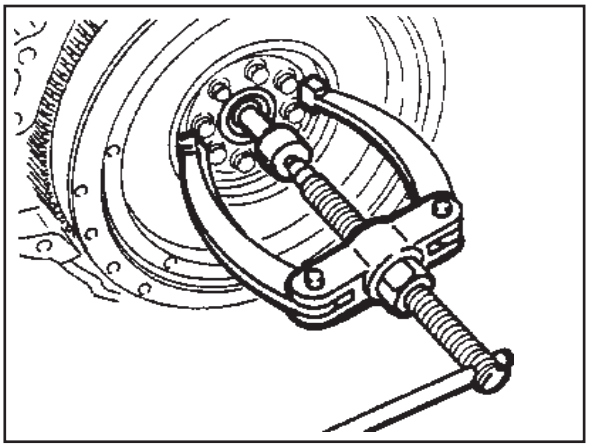
Tools Required

000 589 33 33 00 Counter Support
000 589 25 33 00 Internal Extractor

Removal & Installation Procedure

1. Remove the manual transmission.
2. Using a puller, pull out the locking ring and ball bearing together.

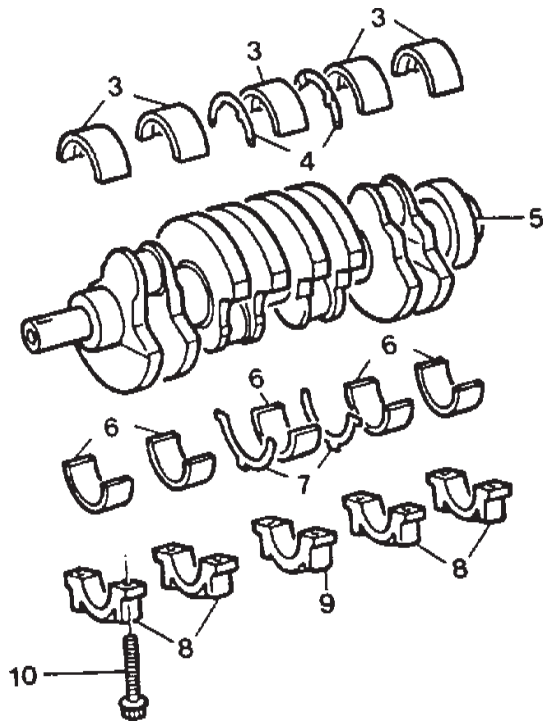
Counter Support 000 589 33 33 00
Internal Extractor 000 589 25 33 00



3. Apply Loctite 241 on the new ball bearing and then insert the ball bearing to be stopped at the spacer ring by using a proper mandrel.

CRANKSHAFT

Preceding Work : Removal of the end cover
Removal of the piston
Removal of the crankshaft sprocket



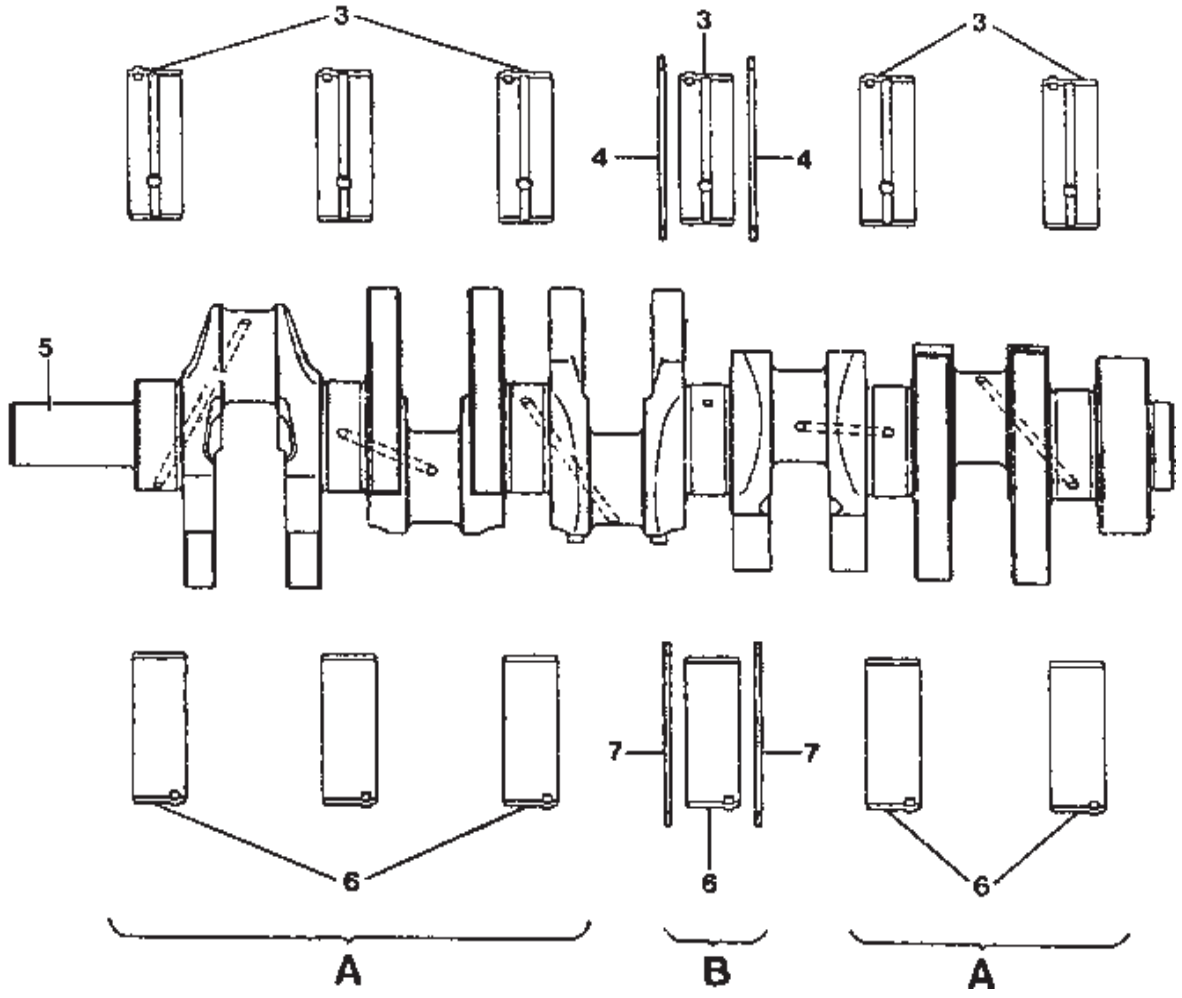
3 Crankshaft Main Bearing Shells (Upper)
4 Trust Bearings (Upper)
5 Crankshaft
6 Crankshaft Main Bearing Shells (Lower)
7 Thrust Bearings (Lower)
8 Crankshaft Bearing Cap
9 Crankshaft Bearing Cap (Fit Bearing)
10 12-sided Stretch Bolts ..... 55Nm + 90°

Tools Required

001 589 53 21 00 Dial Gauge
363 589 02 21 00 Dial Gauge Holder
366 589 00 21 05 Extension

Thrust Washer and Bearing Arrangement

OM662LA Engine



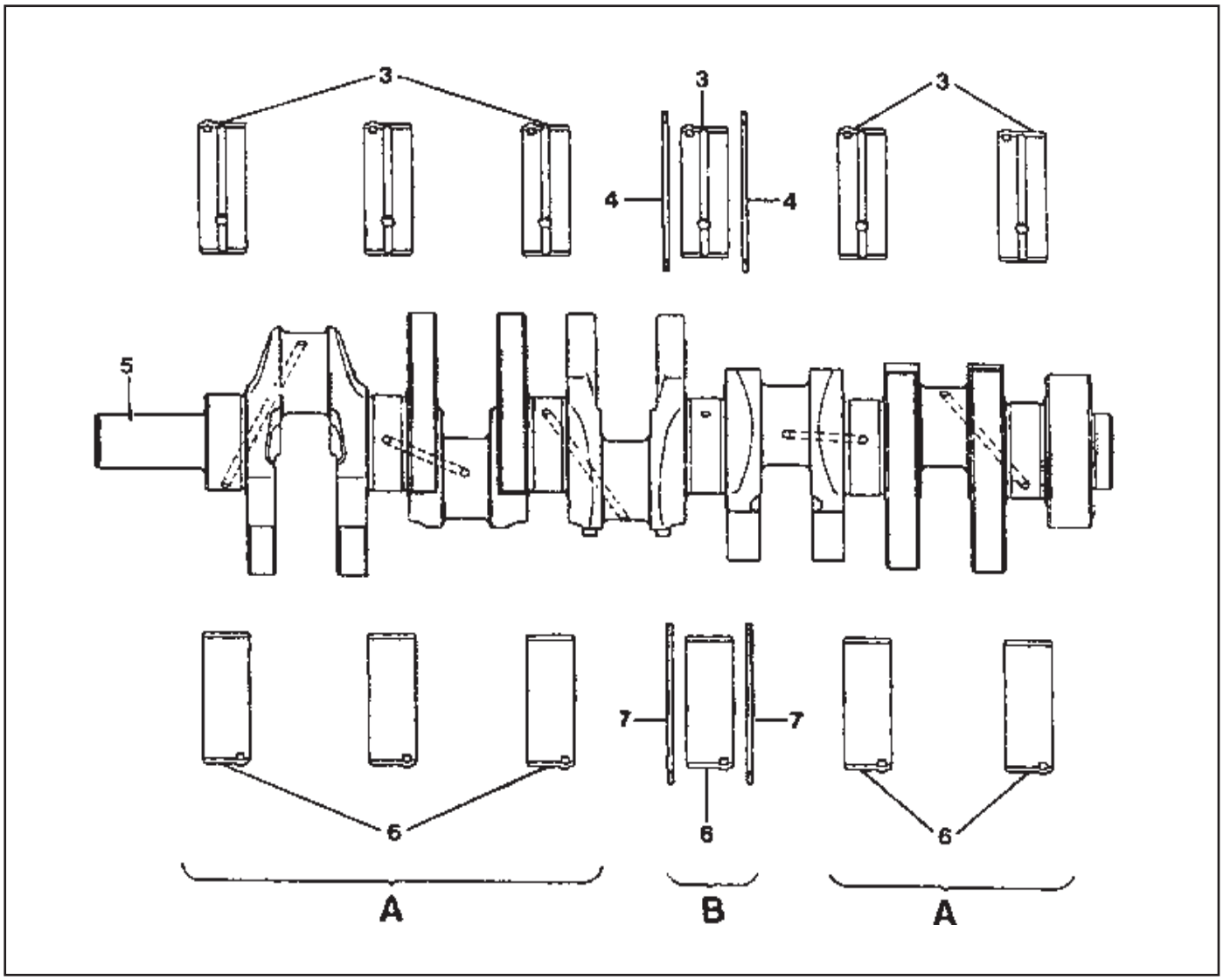
3 Crankshaft Main Bearing Shells (Upper)
4 Thrust Bearings (Upper)
5 Crankshaft
6 Crankshaft Main Bearing Shells (Lower)
7 Thrust Bearings (Lower)

A Radial Bearings
B Radial and Axial Bearings (Thrust Bearing)

Notice

The gaps between the bearing shell and bore and between the bearing shell and journal are different each other. Refer to service data.

OM661LA Engine



3 Crankshaft Main Bearing Shells (Upper)
4 Thrust Bearings (Upper)
5 Crankshaft
6 Crankshaft Main Bearing Shells (Lower)
7 Thrust Bearings (Lower)

A Radial Bearings
B Radial and Axial Bearings (Thrust Bearing)

Notice

The gaps between the bearing shell and bore and between the bearing shell and journal are different each other. Refer to service data.

Crankshaft Standard and Repair Sizes

mm

	Crankshaft bearing journal diameter	Thrust bearing journal width	Thrust bearing journal diameter
Standard size	50.950 - 57.965	24.500 - 24.533	47.950 - 47.965
		24.600 - 24.633	
Repair size 1	57.500 - 57.715	24.700 - 24.733	47.700 - 47.715
Repair size 2	57.450 - 57.465	24.900 - 24.933	47.450 - 47.650
Repair size 3	57.200 - 57.215	25.000 - 25.033	47.200 - 47.215
Repair size 4	56.950 - 56.965	-	46.950 - 46.965

Bearing Clearances

mm

		Thrust bearing	Crankshaft bearing
Radial clearances	New	0.027 - 0.051	0.026 - 0.068
	Limit	Max. 0.070	Max. 0.080
Axial clearances	New	0.100 - 0.254	-
	Limit	Max. 0.300	-

Matching Fit Bearing Journal Width to Thrust Bearings

mm

Fit bearing journal width	Thrust bearings thickness
24.500 - 24.533	2.15
24.600 - 24.633	2.20
24.700 - 24.733	2.25
24.900 - 24.933	2.35
25.000 - 25.033	2.40

Notice

- Measure crankshaft axial clearance and adjust with proper thrust Bearing.
- The same thickness of washer must be installed on both sides of the fit bearing.

Matching Crankshaft Bearing Shells to Basic Bearing Bore in Crankshaft

Marking of basic bearing bore in lower parting surface	Color code of relevant crankshaft bearing shell
1 punch mark or blue	Blue or white-blue
2 punch marks or yellow	Yellow or white-yellow
3 punch marks or red	Red or white-red

Matching Crankshaft Bearing Shells to Basic Bearing Journal of Crankshaft

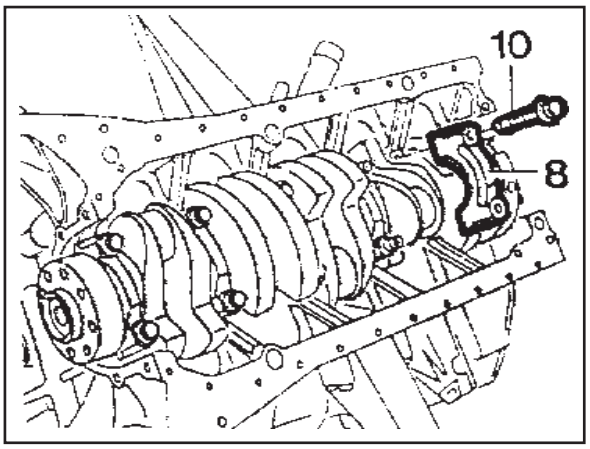
Marking of bearing journals on crank webs	Color code of relevant crankshaft bearing shell
Blue or white-blue	Blue or white-blue
Yellow or white-blue	Yellow or white-yellow
Red or white-blue	Red or white-red

Removal & Installation Procedure

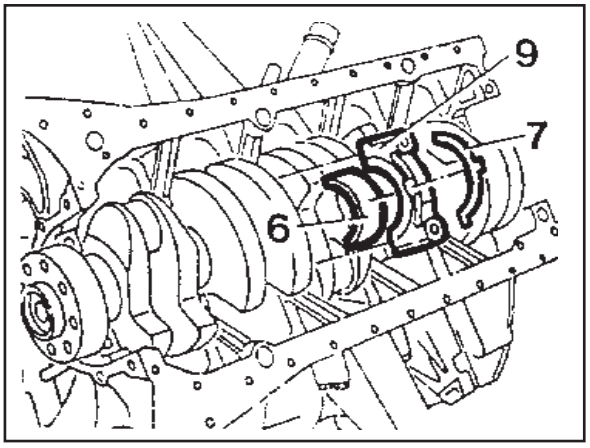
1. Remove the bearing cab bolt.
2. Remove the bearing caps (8).

Notice

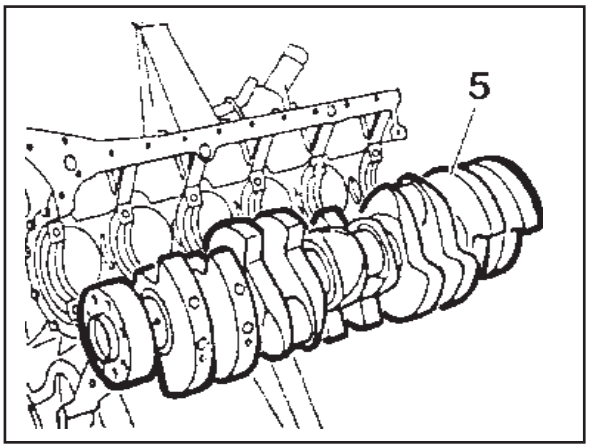
The crankshaft bearing caps are marked with stamped numbers. Remove the bearing cap from the vibration damper side.



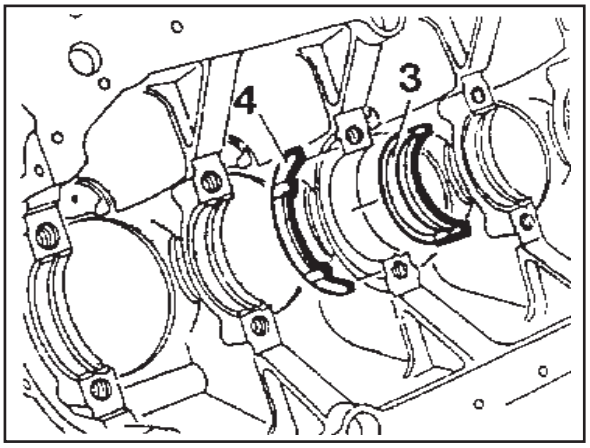
3. Remove the crankshaft bearing caps (9) and lower thrust bearings (7).
4. Remove the lower thrust bearings (6) from the bearing cap (9).



5. Remove the crankshaft (5).



6. Remove the upper thrust bearings(4).
7. Remove the upper bearing shells (3) from crankcase.



8. Thoroughly clean the oil gallery.
9. Select a proper new bearing shells with reference to table.
10. Coat the new bearing shells with oil and insert into the crankcase and into the crankshaft bearing caps.

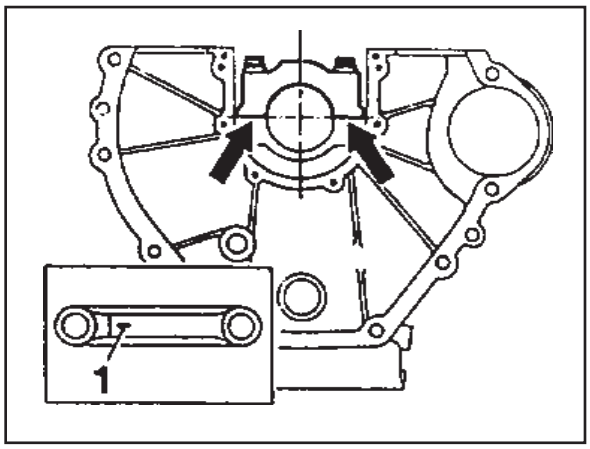
    Notice

    Do not mix up upper and lower crankshaft bearing shells.
11. Install the bearing caps according to marking and tighten the 12-sided stretch bolts.

Tightening Torque	35 - 40 Nm

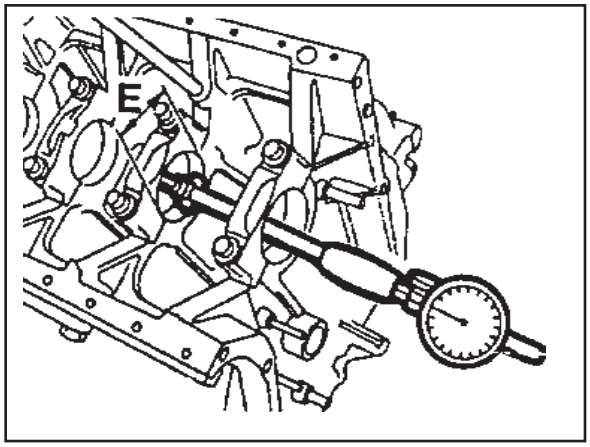
    Notice

    No. 1 is vibration damper side.

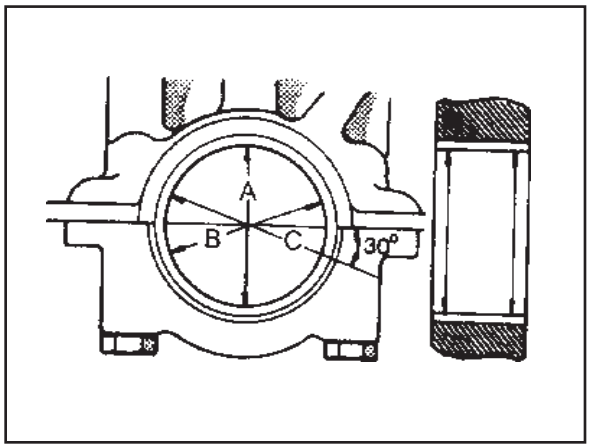


12. Measure crankshaft bearing diameters (E).

Extension 366 589 00 21 05



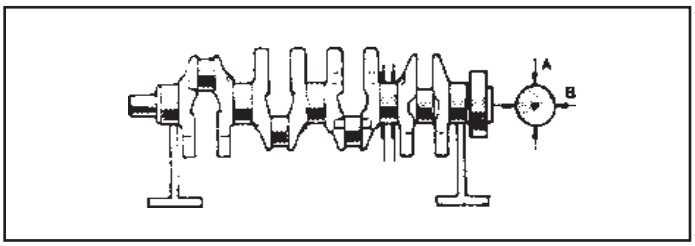
13. Measure at 3 points (A, B and C) and if the average value of B and C is less than A' s value, the average value of B and C is the mean value and if more than A' s value, A' s value is the mean value.

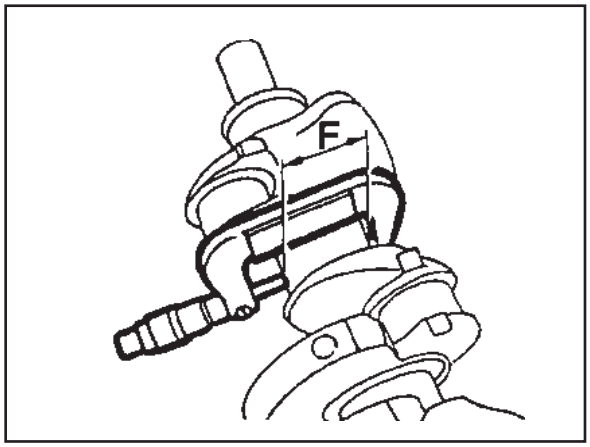


14. Measure crankshaft bearing journal diameter (F).

    Notice

    When measured in A and B, the runout should not exceed 0.010mm.





15. Measure radial clearance of crankshaft bearing (G).

Clearance 'G'	0.027 - 0.051mm

Notice

If 'G' is out of standard, replace the bearing shells and adjust the radial clearance of crankshaft bearing.

Example) Measured value 'E' = 57.700mm
Measured value 'F' = 57.659mm

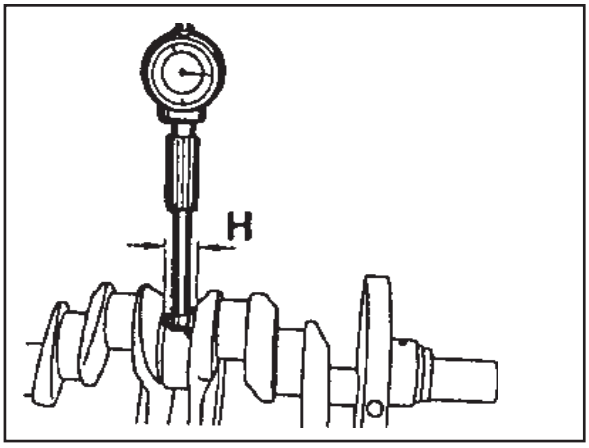
Clearance 'G' = 0.041mm

16. Remove the crankshaft bearing cap.

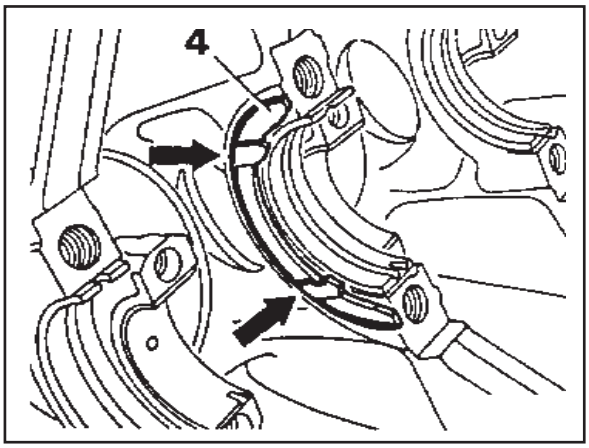
17. Measure width of thrust bearing journal (H) and adjust with proper thrust bearings (see table).

Notice

The same thickness of thrust washers should be installed on both sides of the thrust bearing.



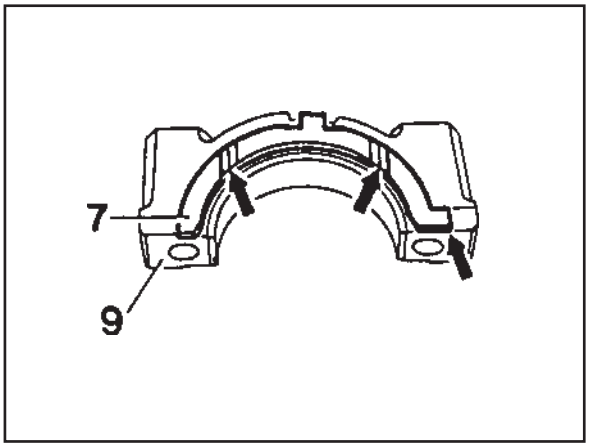
18. Coat the upper thrust bearing (4) with oil and insert into the crankcase so that the oil grooves are facing the crank webs (arrow).



19. Coat the lower thrust bearing (7) with oil and insert into the crankshaft bearing cap so that the oil grooves are facing the crank webs (arrow).

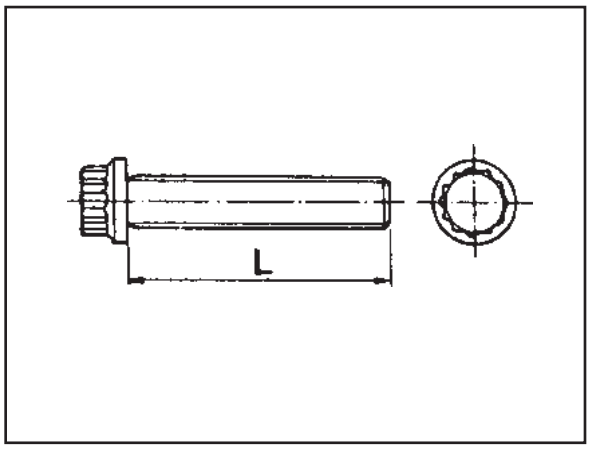
Notice

The retaining lugs should be positioned in the grooves (arrow).



Notice

If the max. length of bolts(L) exceed 63.8mm, replace them.

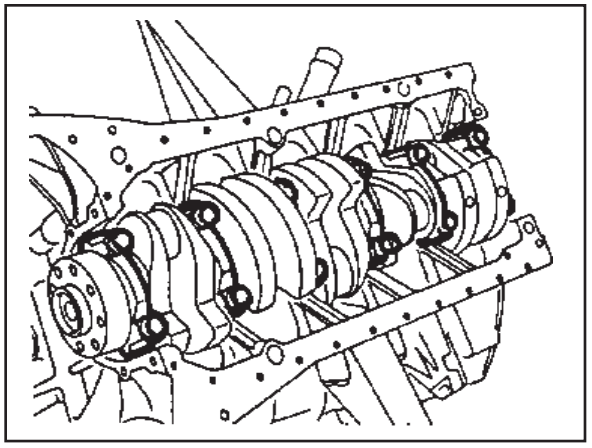


19. Coat the new crankshaft with engine oil and place it on the crankcase.
20. Install the crankshaft bearing caps according to marking and tighten the bolts.

Tightening Torque	55 Nm + 90°

Notice

Install from No. 1 cap.



22. Rotate the crankshaft with hand and check whether it rotates smoothly.
23. Measure crankshaft bearing axial clearance.

Clearance	0.100 - 0.245mm

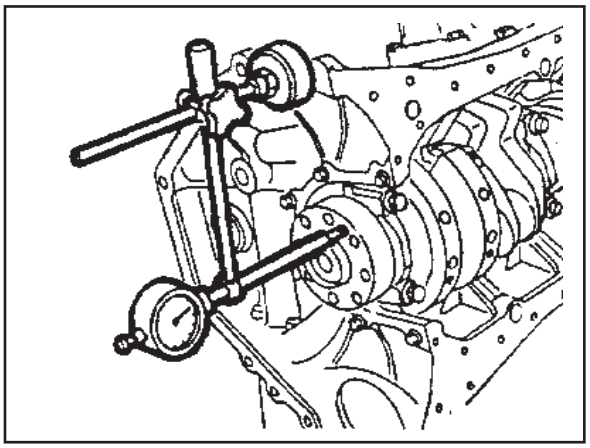
Notice

If the clearance is out of standard, adjust the axial clearance of crankshaft bearing by replacing the thrust washers.

Dial Gauge 001 589 53 21 00
Dial Gauge Holder 363 589 02 21 00

Notice

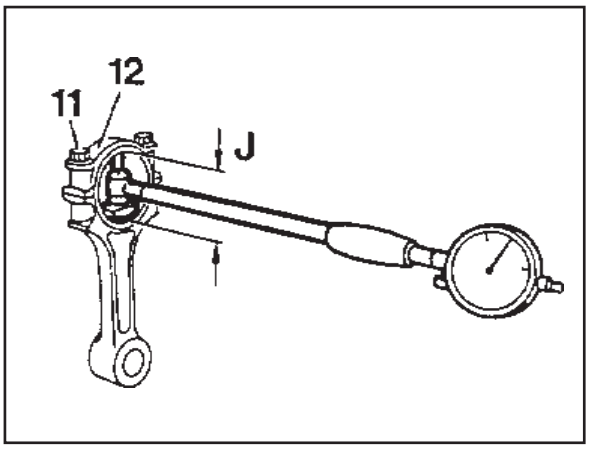
The same thickness of thrust washers should be installed on both sides of the thrust bearing.



24. Insert the new connecting rod bearing shells into the connecting rod and connecting rod bearing cap and tighten the 12-sided stretch bolts (11).

Tightening Torque	40 Nm + 90°

25. Measure inner diameter of connecting rod bearing.



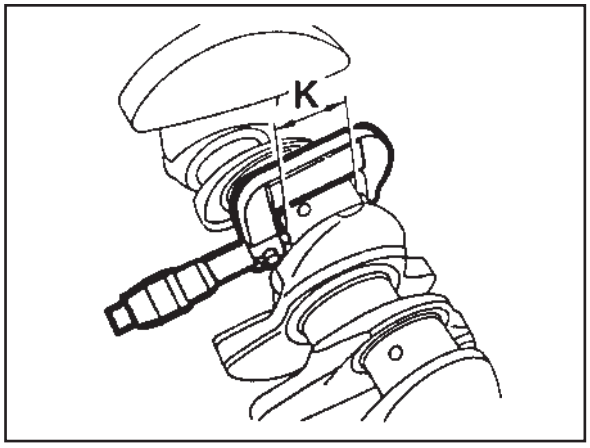
26. Measure connecting rod bearing journal diameter (K).

Notice

Refer to measurement of the crankshaft bearing journal diameter.

27. Measure the radial clearance (L) of the connecting rod bearing.

Example) Measured value 'J' = 47.700mm
Measured value 'K' = 47.653mm
Clearance 'L' = 0.047mm



Radial Clearance 'L'	0.026 - 0.068mm

Notice

If the clearance is out of standard, adjust the radial clearance of connecting rod bearing by replacing the connecting rod bearing shells.

28. Remove the connecting rod bearing cap.
29. Install the piston.
30. Rotate the crankshaft by hand and check whether it rotates smoothly.
31. If the bearings are damaged,

- replace the oil presser relief valve.
- clean the oil pump and oil filter housing carefully and replace the hose if necessary.

Notice

After assembling the engine, check the camshaft timing, adjust the start of fuel injection and check the TDC sensor bracket setting.

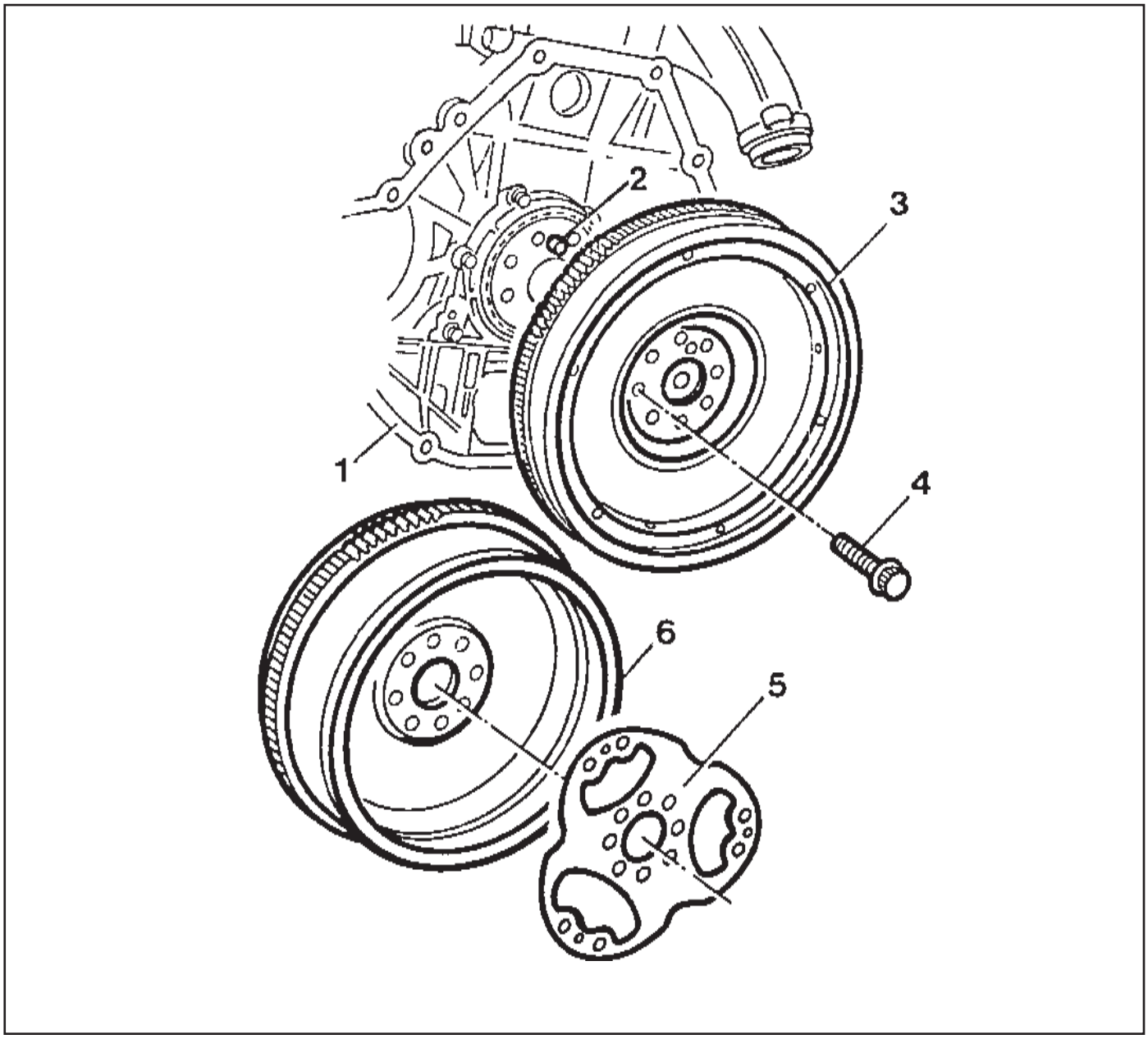
32. Fill oil and run the engine and then check the oil pressure and oil level.

Notice

Install the original oil filter element and then change the engine oil and oil filter element after 1,000 - 1,500km.

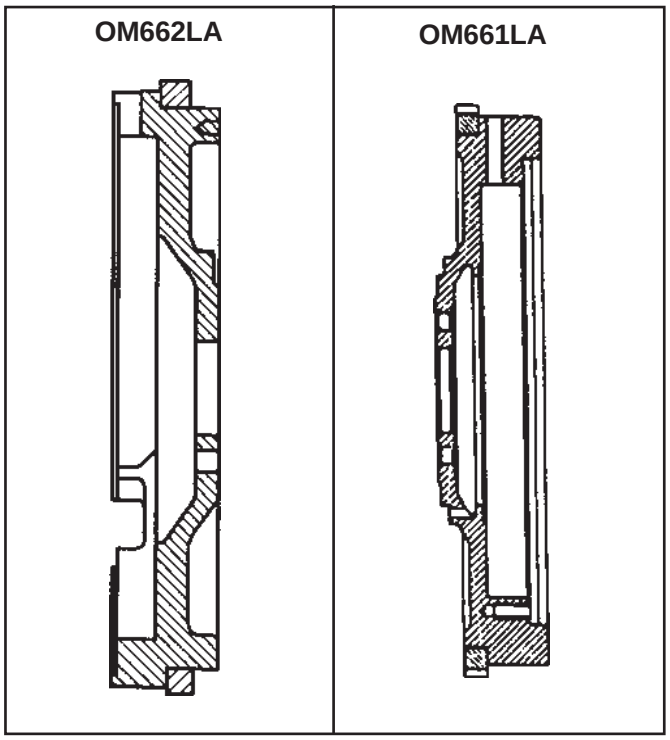
FLYWHEEL

Preceding Work : Removal of the transmission
Removal of the clutch

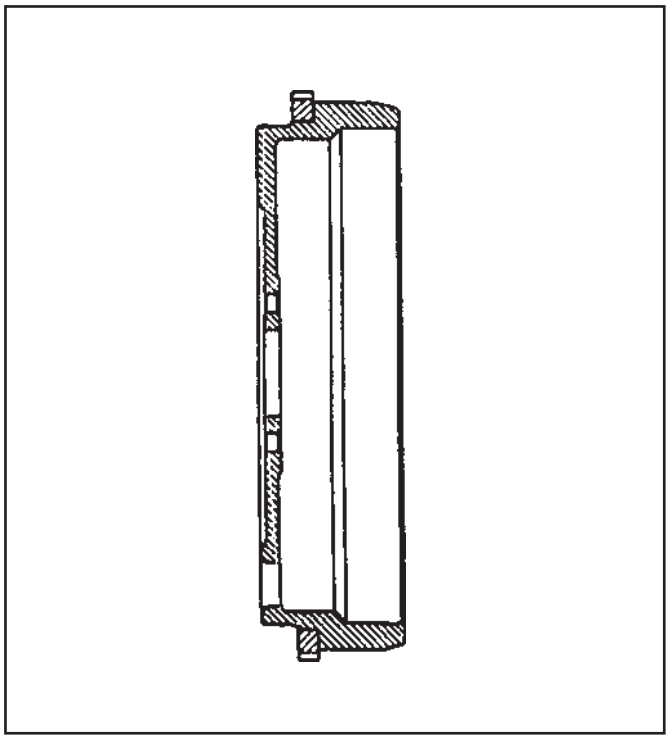


1 Oil Pan
2 Straight Pin
3 Flywheel
4 12-Sided Stretch Bolt ..... Check, 45Nm + 90°
5 Drive Plate (Automatic Transmission)
6 Flywheel (Automatic Transmission)

- Manual transmission flywheel



- Automatic transmission flywheel



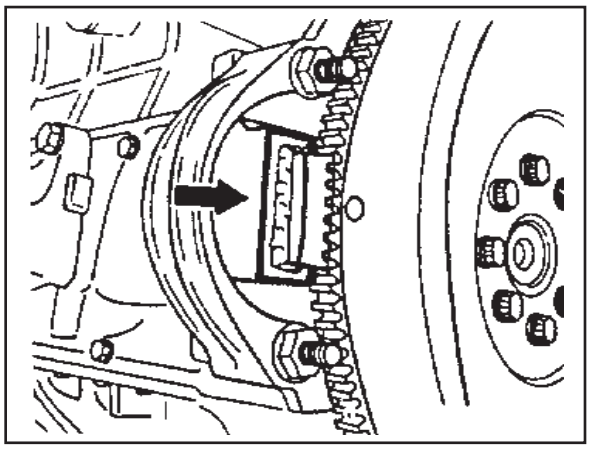
Tools Required

602 589 00 40 00 Engine Lock

Removal & Installation Procedure

1. Install the engine lock.

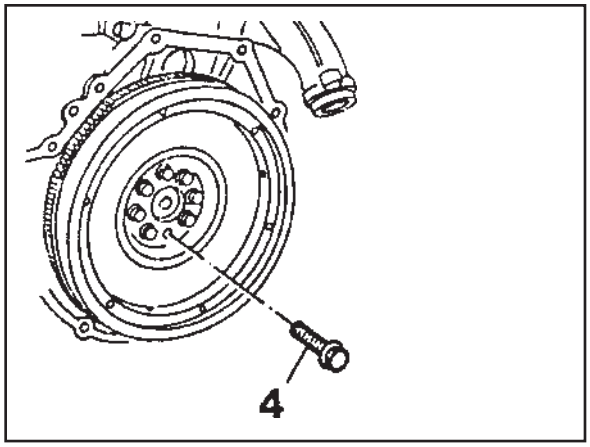
Engine Lock 602 589 02 40 00



2. Remove the 12-sided stretch bolts (4).

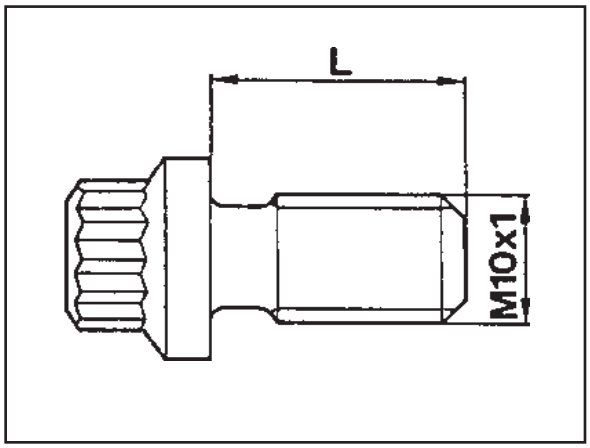
Installation Notice

Tightening Torque	45 Nm + 90°



Notice

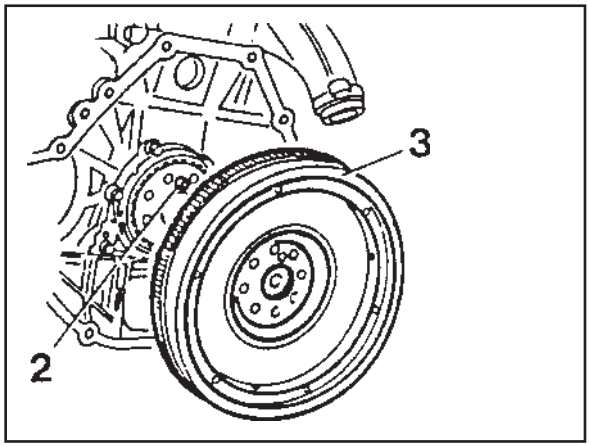
If the length 'L' of bolts exceeds 22.5mm, replace the bolts.



3. Remove the flywheel (3), if equipped with manual transmission.

Installation Notice

Correctly align the position of dowel pin (2).

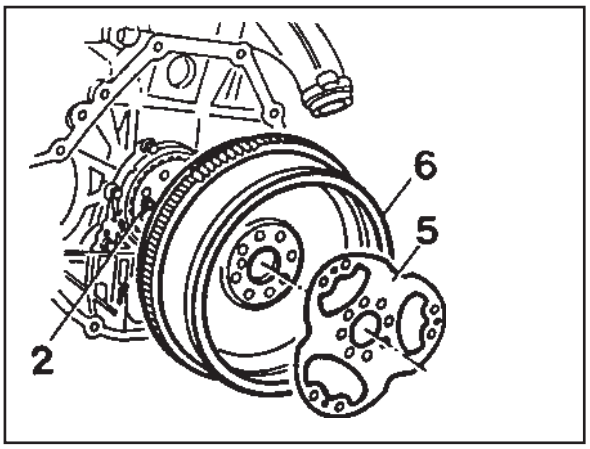


4. Remove the flywheel (6) and driven plate (5), if equipped with automatic transmission.

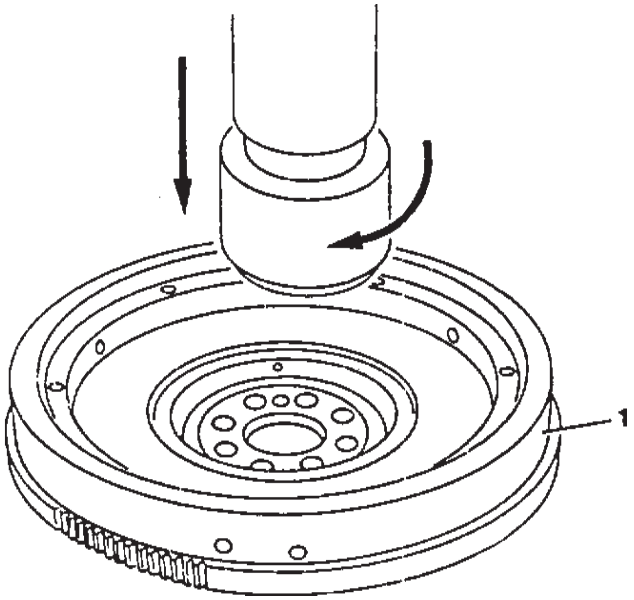
   Installation Notice

   Correctly align the position of dowel pin (2).

5. Installation should follow the removal procedure in the reverse order.



MACHINING OF FLYWHEEL



1 Flywheel

Machining of Flywheel

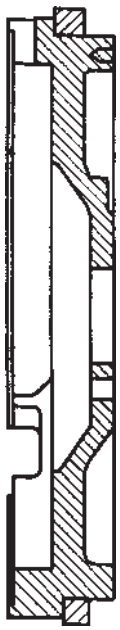
Notice

Flywheels which have scorch marks, scoring or cracks in the clutch surface should be machined by grinding or precision-turning. If the scores or cracks are severe than permissible specifications, replace the flywheel.

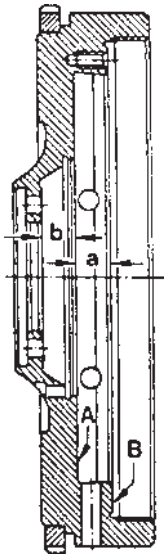
Distance 'a'	19.3 - 19.5 mm	
Distance 'b'	New	16.6 mm
	Repair up to	15.6 mm
Max. axial runout		0.05 mm

- When machining the clutch surface 'A', the mounting surface (B) for the clutch pressure plate should also be machined in accordance with 'A' to keep the distance 'a'.
- Do not machine under 'b' value.
- When machining, fix the flywheel exactly not to exceed the standard runout.

OM662LA

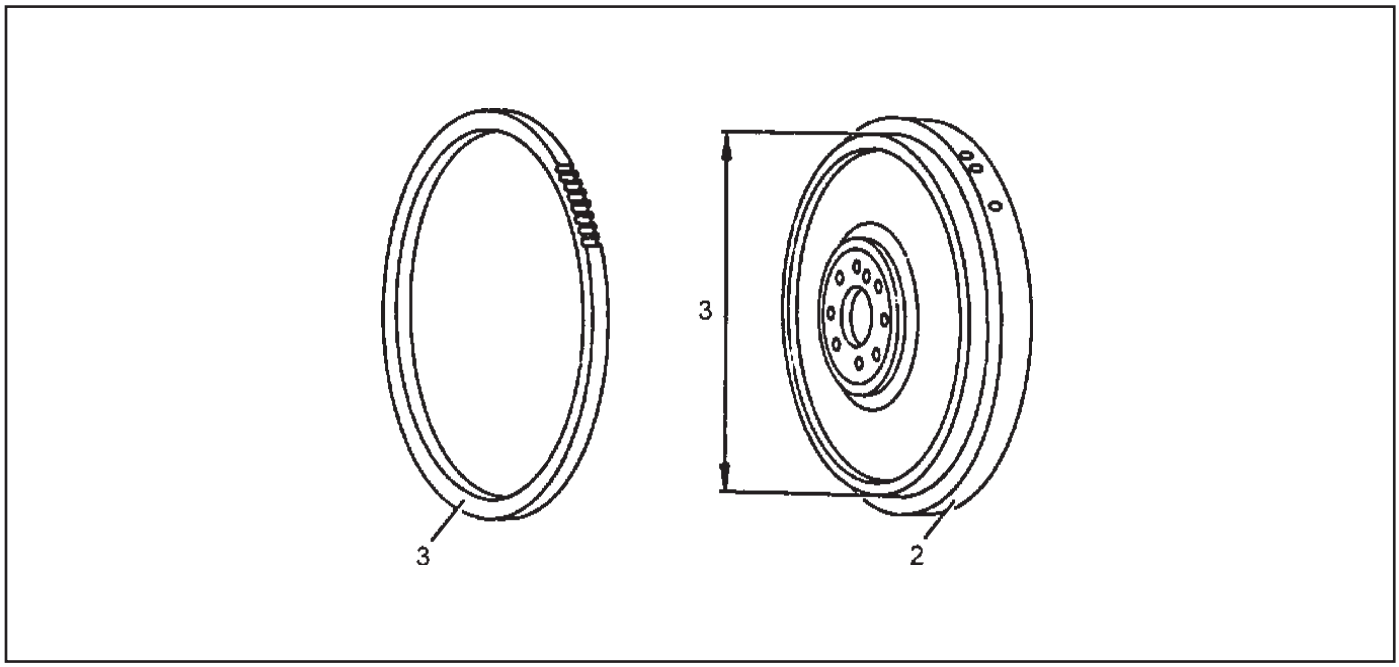


OM662LA



FLYWHEEL RING GEAR

Preceding Work : Removal of flywheel



1 Ring Gear
2 Flywheel
3 Centering Collar Diameter

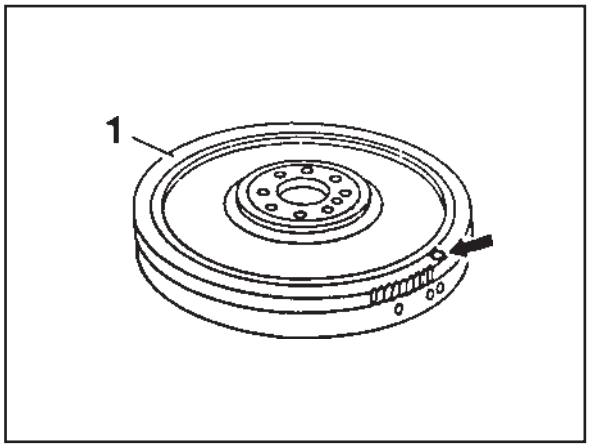
Tools Required

001 589 53 21 00 Dial Gauge

363 589 02 21 00 Dial Gauge Holder

Replacement Procedure

1. Drill a hole into the ring gear (1) (arrow) and snap with a chisel.
2. Thoroughly clean the collar surfaces of ring gear.

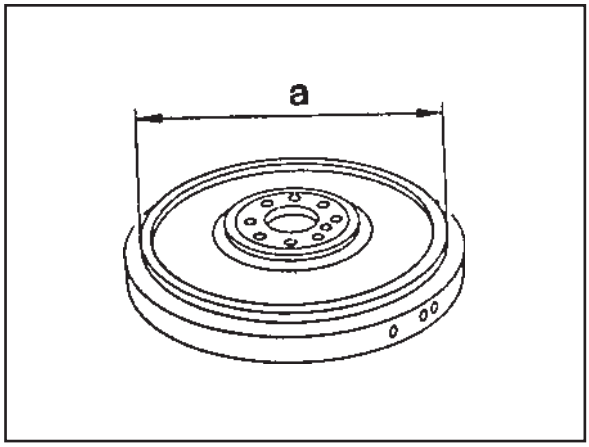


3. Measure diameter (a) of centering collar.

Diameter 'a'	275 + 0.5mm

Notice

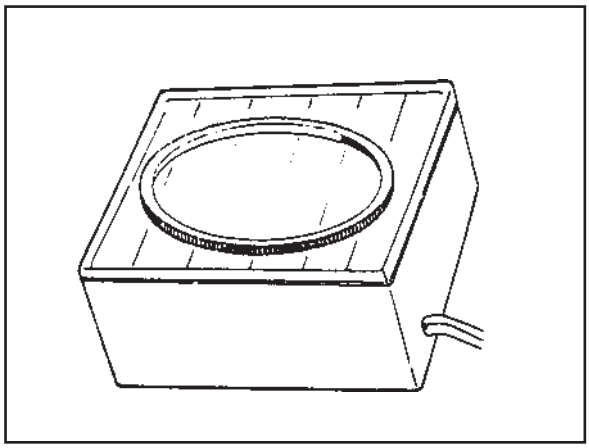
If out of standard, replace the flywheel.



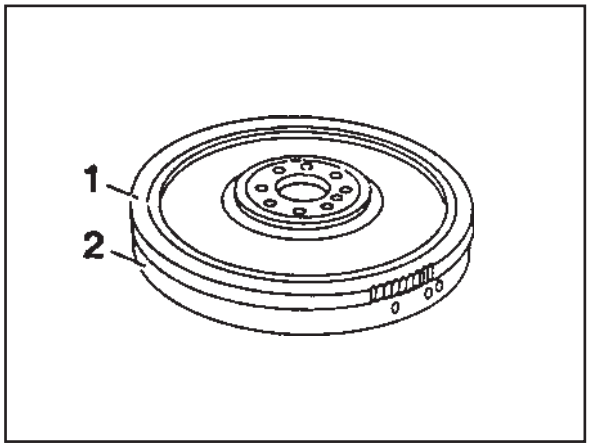
4. Heat up the new ring gear up to 220°C by using a heating device.

Notice

Use temperature measuring chalk.



5. Install the new ring gear (1) onto the flywheel by using a drift.



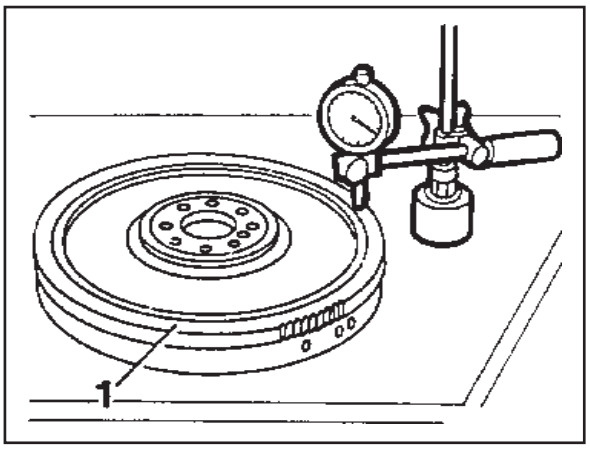
6. Measure axial runout of ring gear (1) on a surface plate.

Limit	Max. 0.4mm

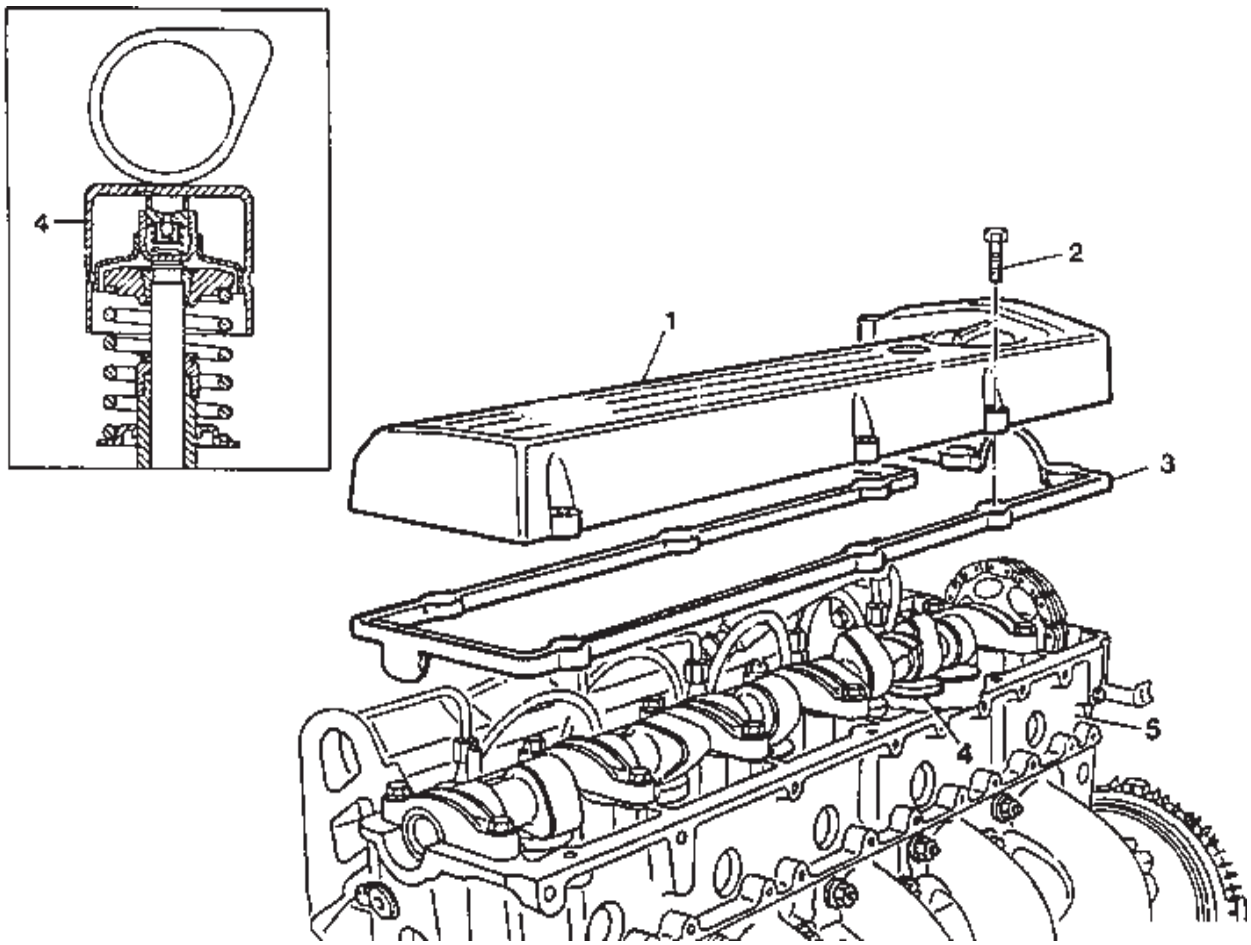
Notice

For correct measurement, put the flywheel on the flat measuring board.

Dial Gauge 001 589 53 21 00
Dial Gauge Holder 363 589 02 21 00

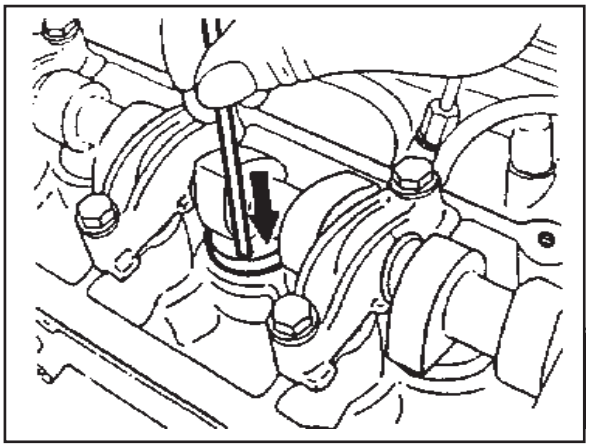


HYDRAULIC VALVE CLEARANCE COMPENSATION ELEMENT CHECK



1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Valve Tappet
5 Cylinder Head

Checking



Notice

The noise which continues short time during short travel (frequent starting of the engine) or engine starting after a long time storage is normal operating conditions. So, it does not need to be repaired. Determine the malfunctions in valve clearance compensation device with noise through following tests. If defective, replace as respectively.

1. Run the engine at more than 3000rpm for approx. 4 minutes.
2. Stop the engine. After 5minutes, check the engine oil level and adjust if necessary.
3. Remove the cylinder head cover.
4. Check the valve tappets at TDC position of each cylinders.
5. Using a drift, lightly press the valve tappet and measure clearance between the cam and valve tappet.

Notice

If the clearance exceeds 0.4mm, replace the valve tappet.

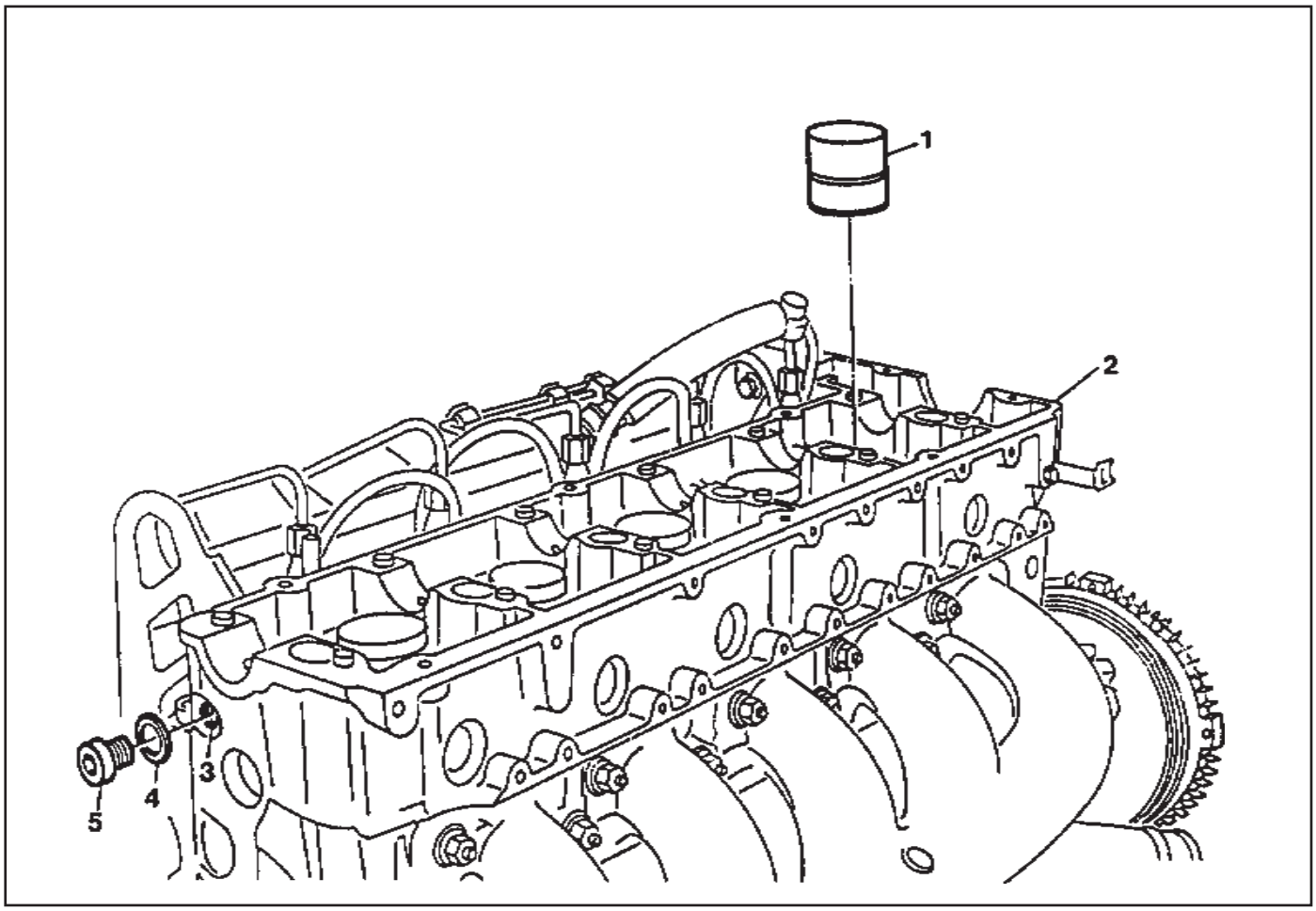
6. If a valve tappet moves down too far in comparison to the others, replace the valve tappet.
7. Rotate the engine and check the remaining valve tappets.

Notice

- Unnecessary rotation of the engine will damage the valve tappets.
- Do not rotate the engine by using the camshaft sprocket bolt or to the opposite direction of the engine rotation.

VALVE TAPPETS

Preceding Work : Removal of camshaft



1 Valve Tappet
2 Cylinder Head
3 Oil Gallery
4 Seal ..... Replace
5 Screw Plug

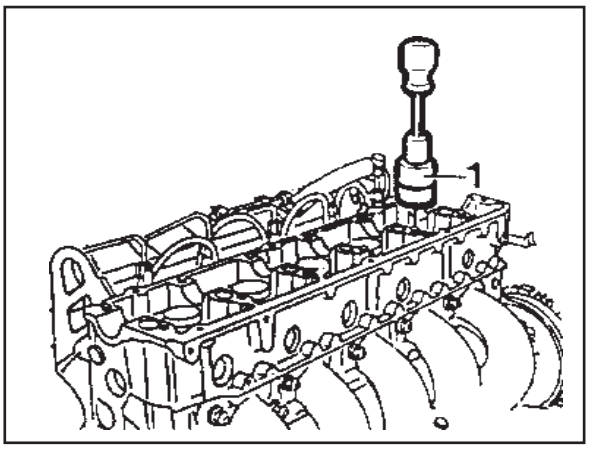
Tools Required

102 589 03 40 00 Magnetic Bar

Replacement Procedure

1. Pull out the valve tappet (1).

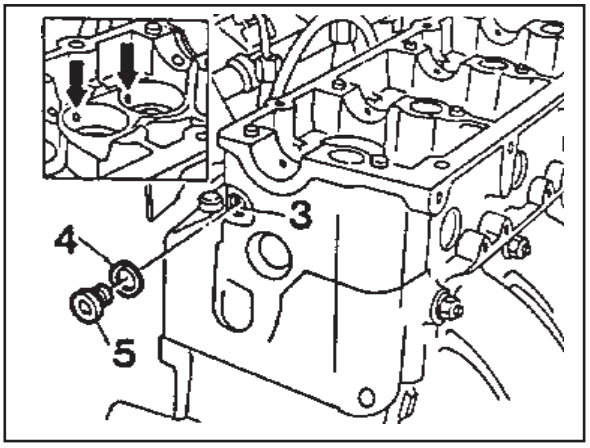
Magnetic Bar 102 589 03 40 00



2. Remove the plug (5) and blow compressed air into the oil gallery (3). At this time, check that the outlet bores(arrow) at the seat of the valve tappet are clear.
3. Replace the seal (4) and tighten the plug (5).
4. Insert the new valve tappet.

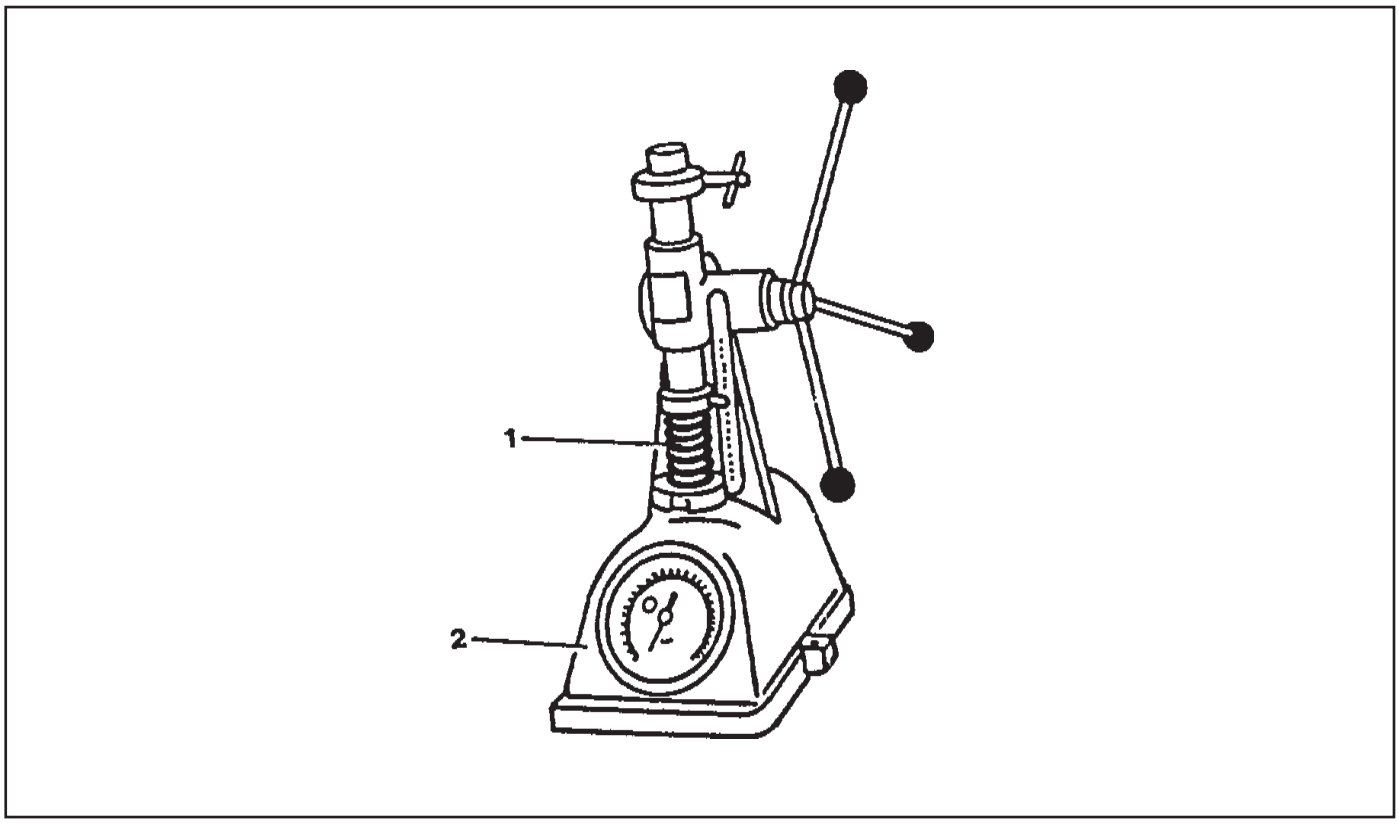
   Notice

   Coat the valve tappet with oil.



VALVE SPRINGS CHECK

Preceding Work : Removal of valve spring



1 Valve Spring

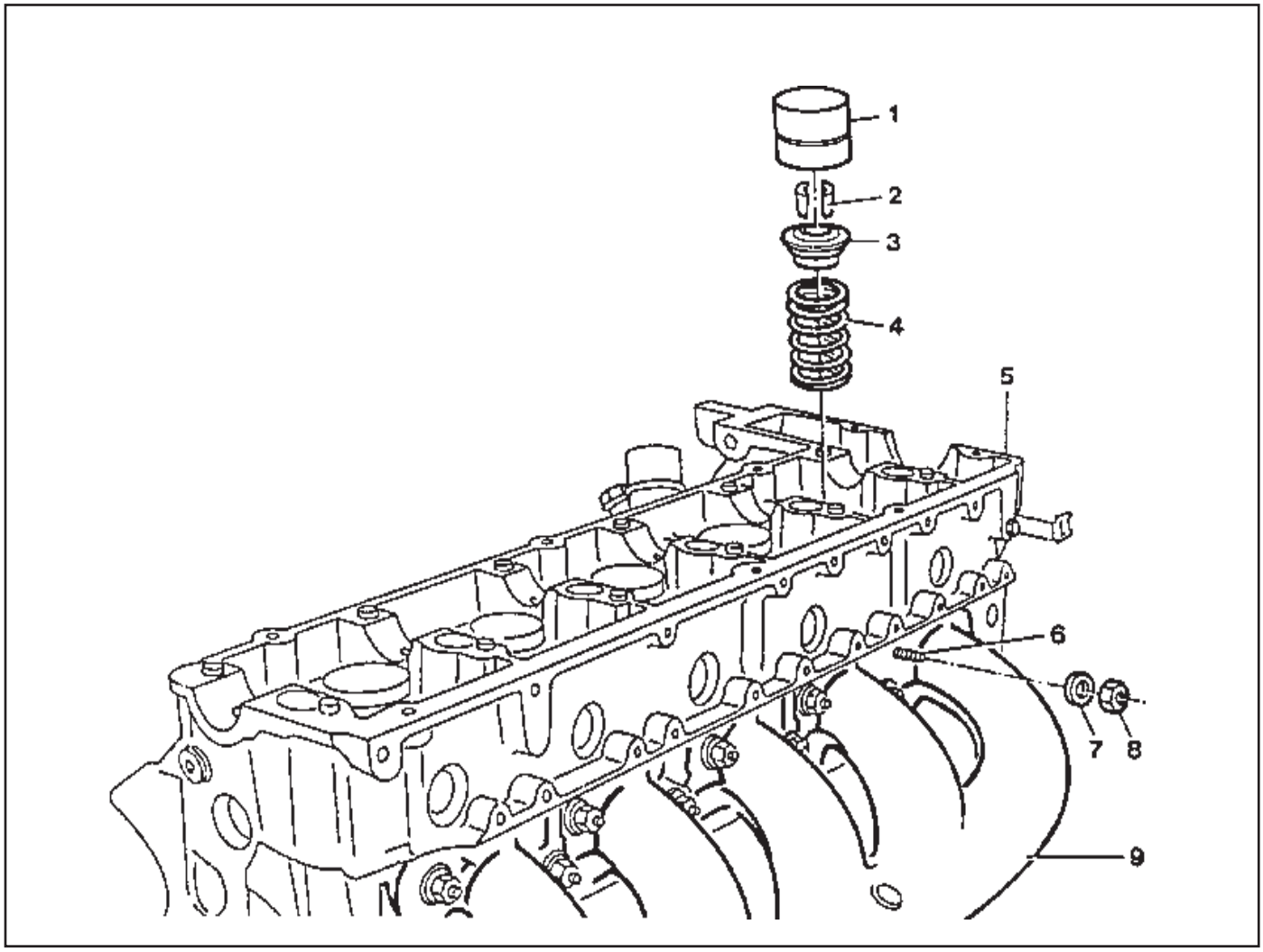
2 Spring Scale

Service Data

Outer diameter	Wire diameter	Free length	At preloaded		
			Length	Tension (new)	Limit
33.1mm	4.20mm	50.0mm	27mm	680 - 740N	612N

VALVE SPRINGS (CYLINDER HEAD REMOVED)

Cylinder Head Removed



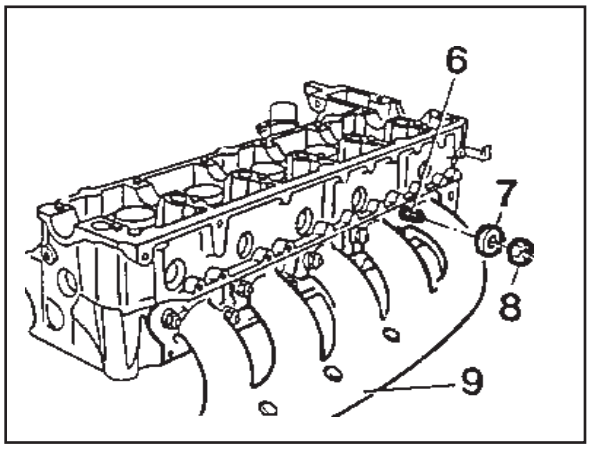
1 Valve Tappet
2 Valve Cotters
3 Spring Retainer
4 Valve Spring ..... Check, replace if necessary
5 Cylinder Head
6 Stud Bolt 12Nm
7 Washer
8 Nut ..... Replace, 25Nm
9 Exhaust Manifold

Tools Required

102 589 03 40 00 Magnetic Bar
116 589 06 63 00 Magnetic Finger
601 589 01 59 00 Assembling Board
601 589 02 59 00 Supporting Bridge
667 589 00 31 00 Press Lever

Removal & Installation Procedure

1. Remove the nuts (8) uniformly and then remove the washer (7), exhaust manifold (9) and gasket.



Installation Notice

Check the stud bolt (6) for damage and replace if necessary.

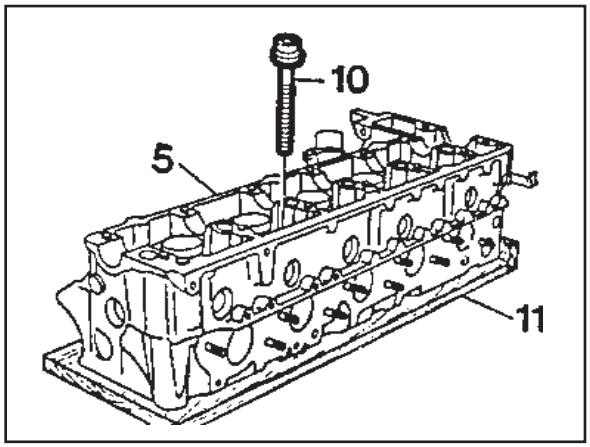
Tighten Torque	12 Nm

Replace the gasket and tighten the nuts (8).

Tighten Torque	25 Nm

2. Install the assembling board (11) to the cylinder head with 4 cylinder head blots (10).

Assembling Board 601 589 01 59 00

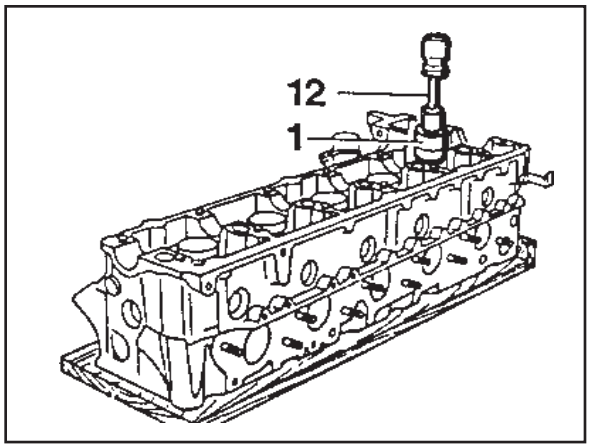


3. Pull out the valve tappet (1) with magnetic bar (12).

Notice

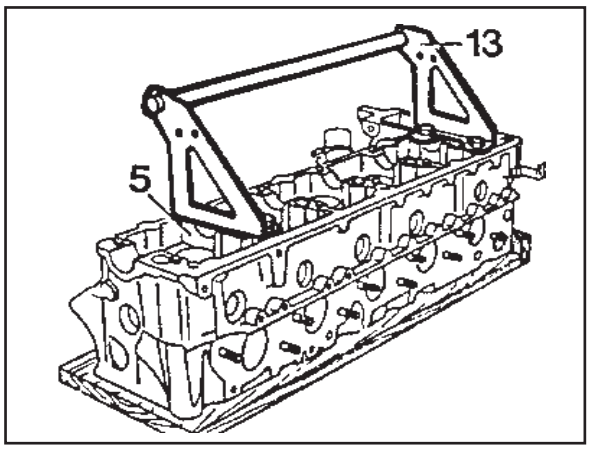
Place the valve tappets upside down (open end upward).

Magnetic Bar 102 589 03 40 00



4. Install the supporting bridge (13) on the cylinder head (5).

Supporting Bridge 601 589 02 59 00

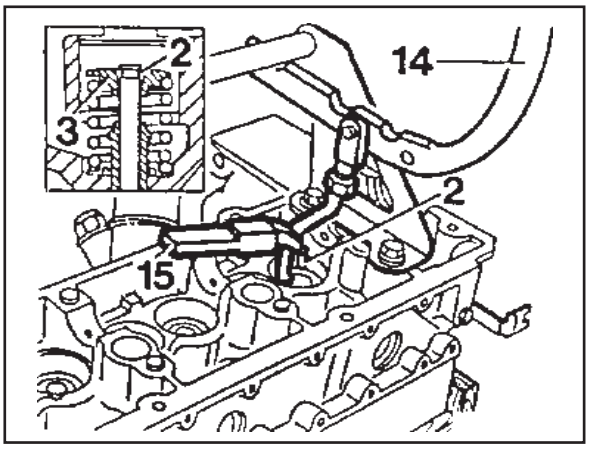


5. Using the press lever (14), press the spring retainer downward and remove the valve cotters (2) with magnetic finger (15).

   Notice

   Be careful not to damage guide bore of the valve tappet.

   Press Lever 667 589 00 31 00
   Magnetic Finger 116 589 06 63 00

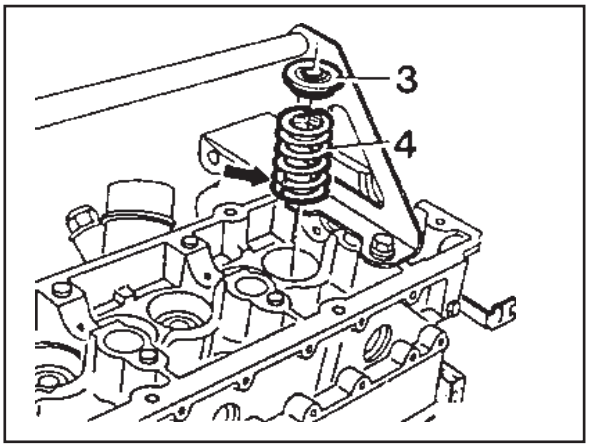


6. Remove the spring retainer (3) and spring (4).

   Installation Notice

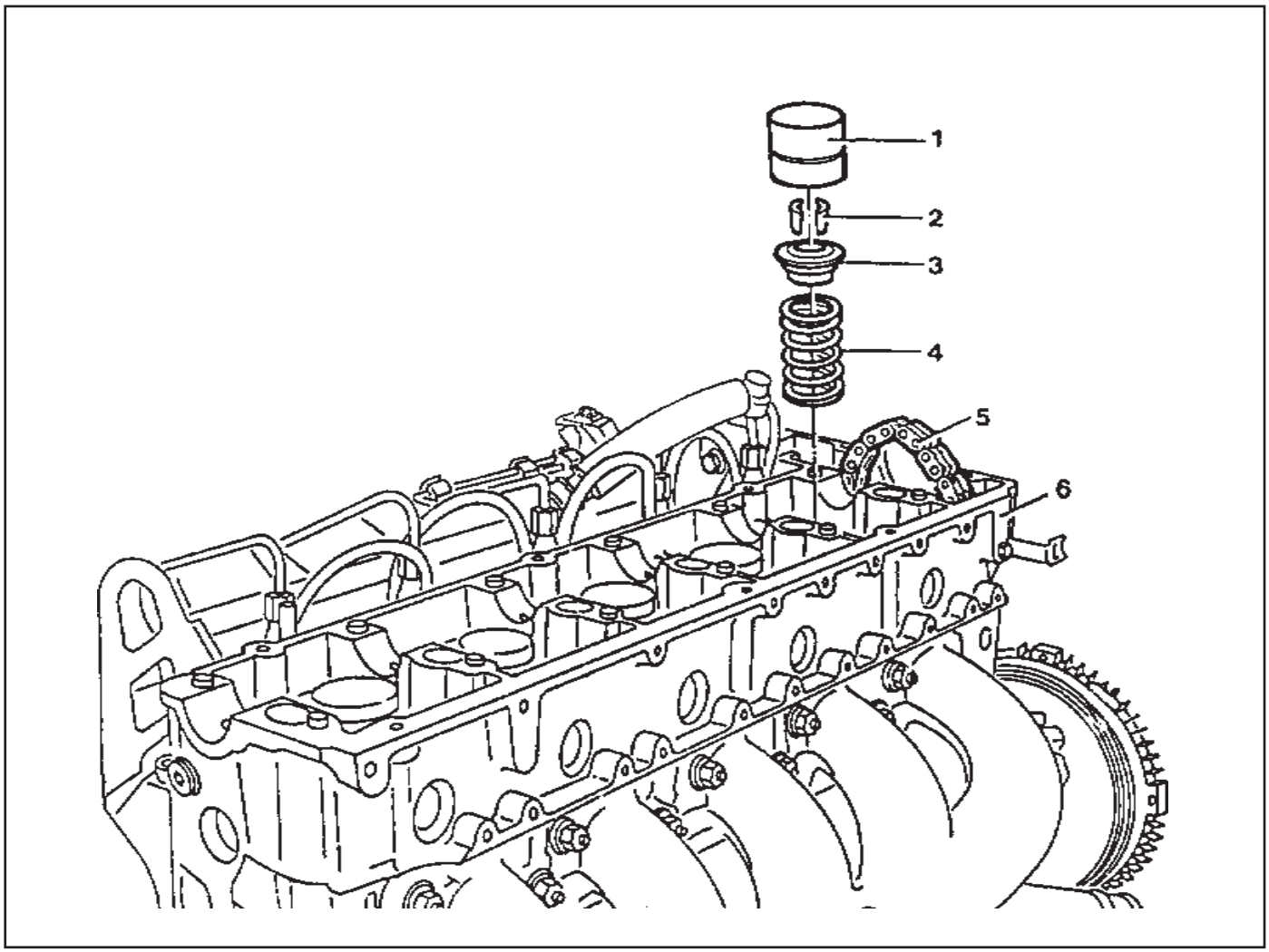
   Install the valve spring with the color coding (arrow) facing down.

7. Check the valve spring and replace if necessary.
8. Installation should follow the removal procedure in the reverse order.



VALVE SPRINGS (CYLINDER HEAD INSTALLED)

Preceding Work : Removal of camshaft



1 Valve Tappet
2 Valve Cotters
3 Spring Retainer
4 Valve Spring ..... Check, replace if necessary
5 Timing Chain
6 Cylinder Head

Notice

Remove the valve springs only when the piston is at TDC.

Tools Required

102 589 03 40 00 Magnetic Bar
116 589 06 63 00 Magnetic Finger
603 589 01 40 00 Holding Wheel
667 589 00 31 00 Press Lever
667 589 02 63 00 Supporting Bar

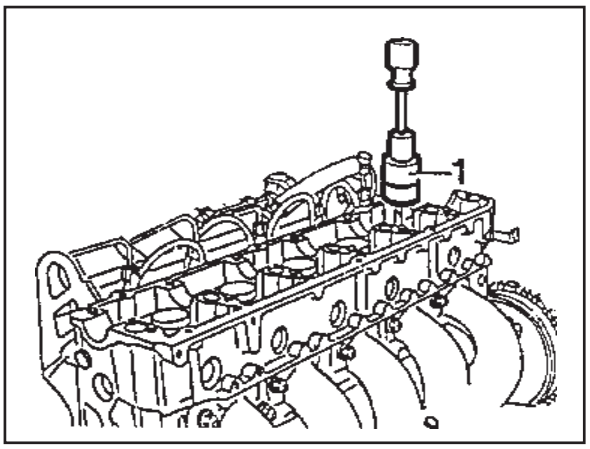
Removal & Installation Procedure

1. Remove the valve tappet (1) with magentic lifter.

   Notice

   Place the valve tappets upside down (open end upward)

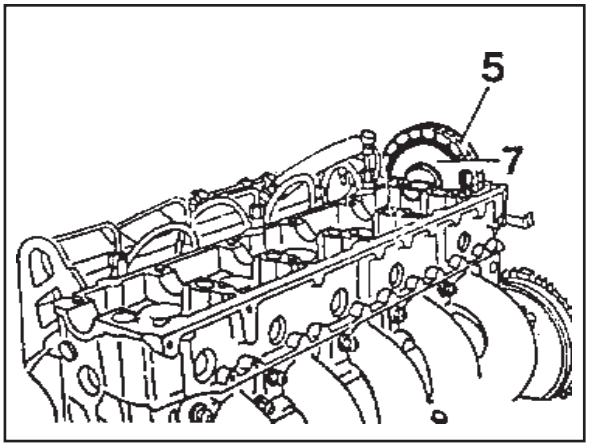
   Magentic Liter 102 589 03 40 00



2. Install the holding wheel (7) into the timing chain of camshaft sprocket piston.

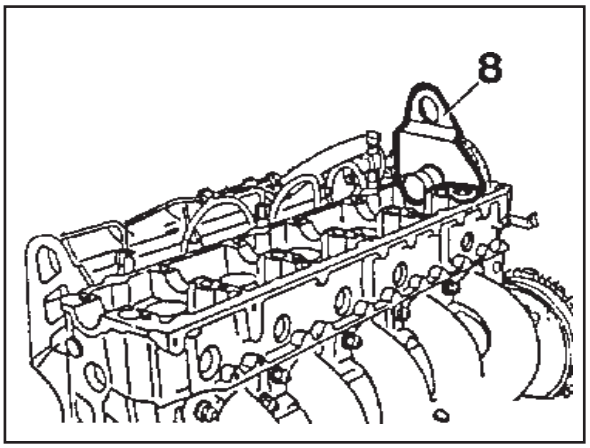
   Holding Wheel 603 589 01 40 00

3. Position the piston of relevant cylinder at TDC.



4. Install the supporting bar (8).

   Supporting Bar 667 589 02 63 00

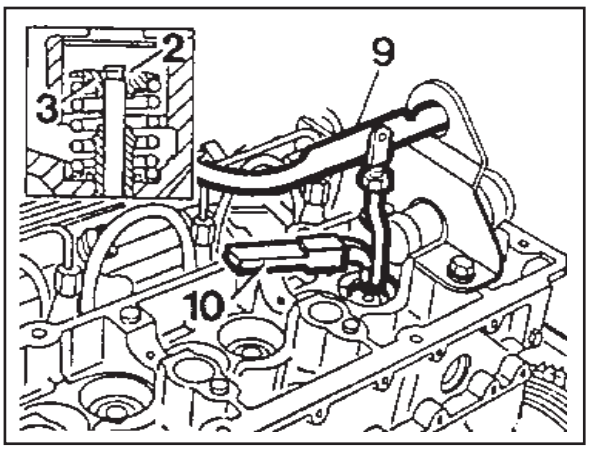


5. Using the press lever (9), press the spring retainer(3) downward and remove the valve cotters (2) with magnetic finger (10).

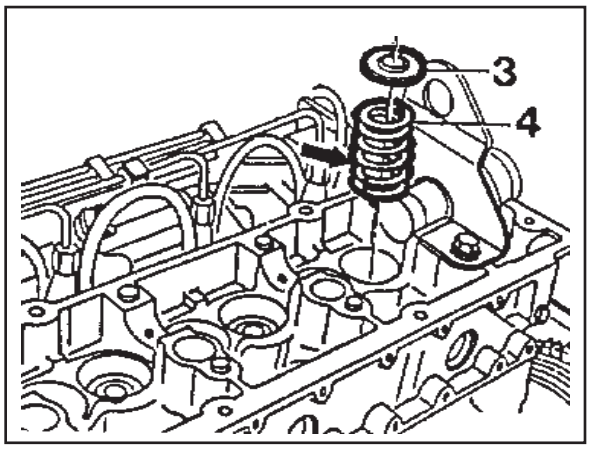
   Notice

   Be careful not to damage guide bore of the valve tappet.

   Press Lever 667 589 00 31 00
   Magnetic Finger 116 589 06 63 00

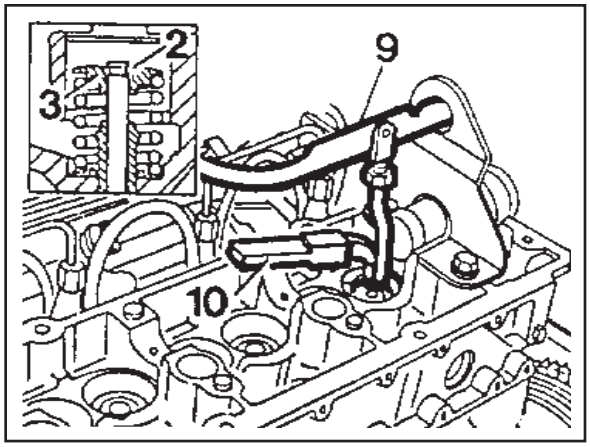


6. Remove the spring retainer(3) and spring (4).
7. Check the valve spring and replace if necessary.
8. Insert valve spring (4) with the color coding (arrow) facing down and insert valve spring Retainer(3).



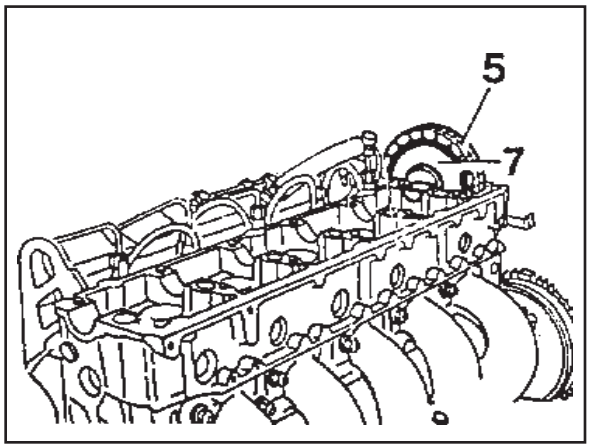
9. By press the spring retainer(3) with press lever (90), install the valve cotters with magnetic finger (10).

Press Lever 667 589 00 31 00
Magnetic Finger 116 589 06 63 00



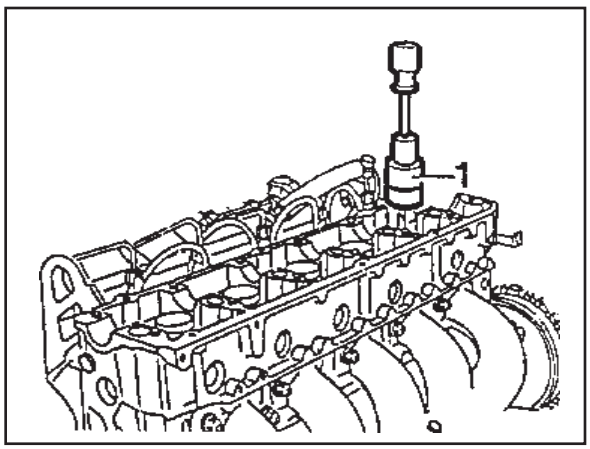
10. Remove the supporting bar.
11. Remove the holding wheel (7) from the timing chain (5).

Holding Wheel 603 589 01 40 00



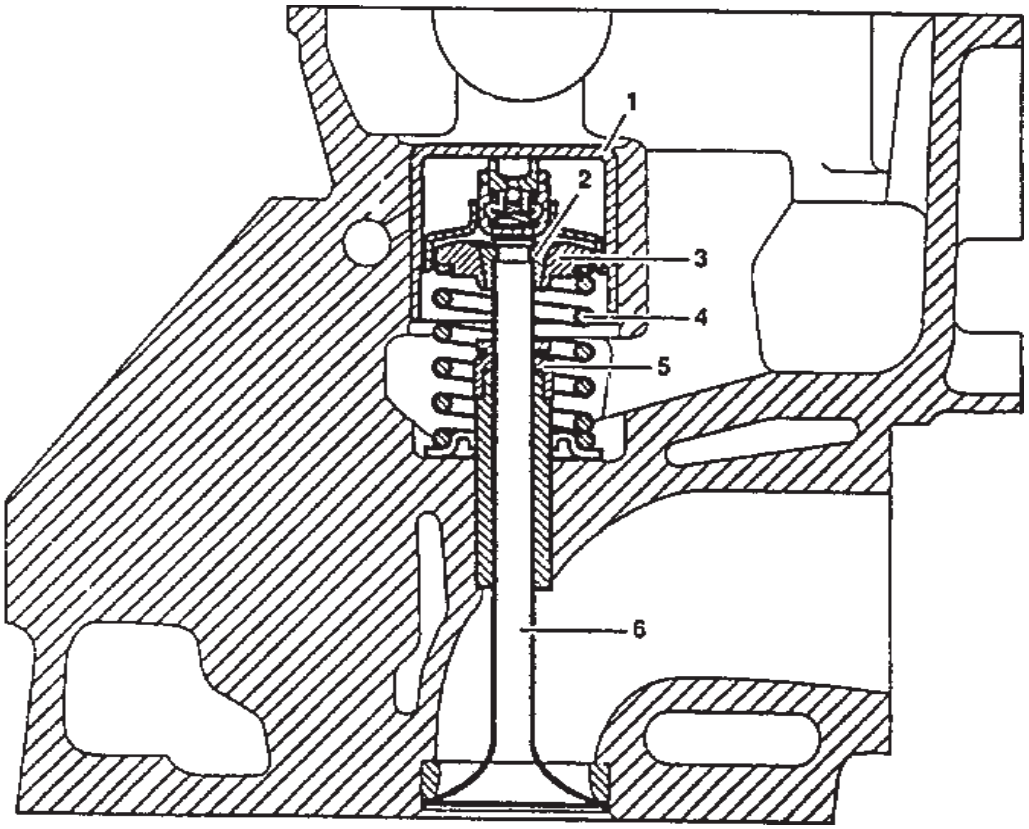
13. Coat the valve tappet with oil and install it.

Magnetic Bar 102 589 03 40 00



VALVE STEM SEALS

Preceding Work : Removal of camshaft.



1 Valve Tappet
2 Valve Cotters
3 Spring Retainer
4 Valve Spring ..... Check, replace if necessary
5 Valve Stem Seal
6 Valve

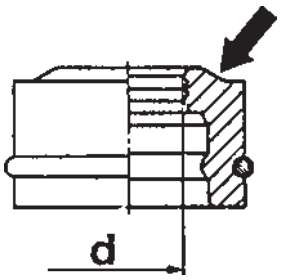
Notice

Remove the valve stem seals when the piston is positioned at TDC.

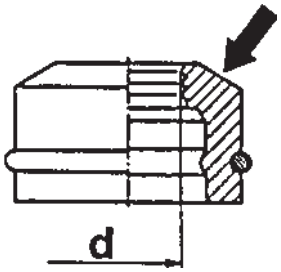
Tools Required

667 589 00 31 00 Press Lever
104 589 00 37 00 Pliers
102 589 03 40 00 Magnetic Lifter
603 589 01 40 00 Holding Wheel
601 589 02 43 00 Drift
116 589 06 63 00 Magnetic Finger
667 589 02 63 00 Supporting Bar

A : Intake valve stem seal



B : Exhaust valve stem seal



	Intake valve stem seal	Exhaust valve stem seal
Chamfer	Offset	All round
Inner diameter ‘d’	7.3mm	8.2mm
Color	Brown	Green
Wire ring	Black	Yellow

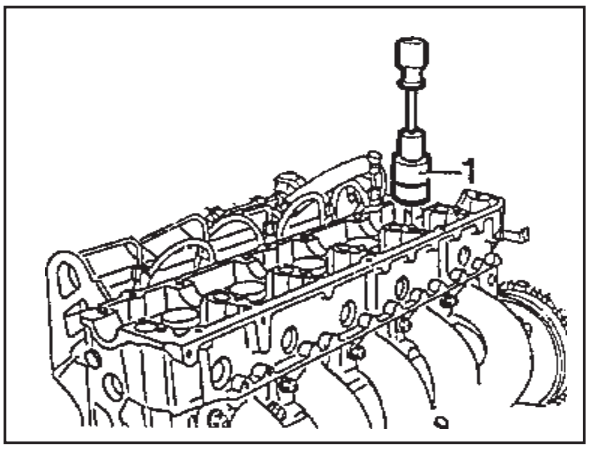
Replacement Procedure

1. Remove the valve tappet (1) with magnetic lifter.

   Notice

   Place the valve tappets upside down (open end upward).

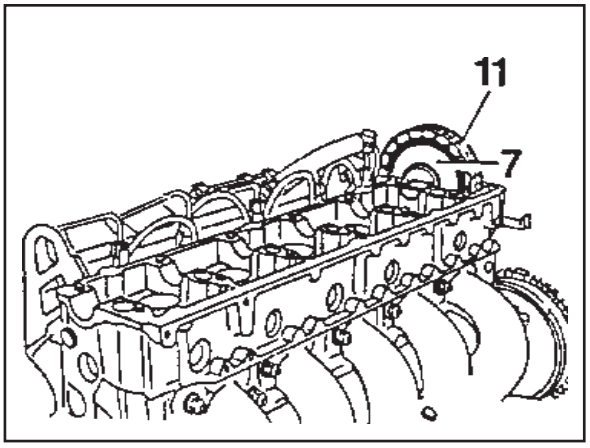
   Magnetic Lifter 102 589 03 40 00



2. Install the holding wheel (7) into the timing chain (11).

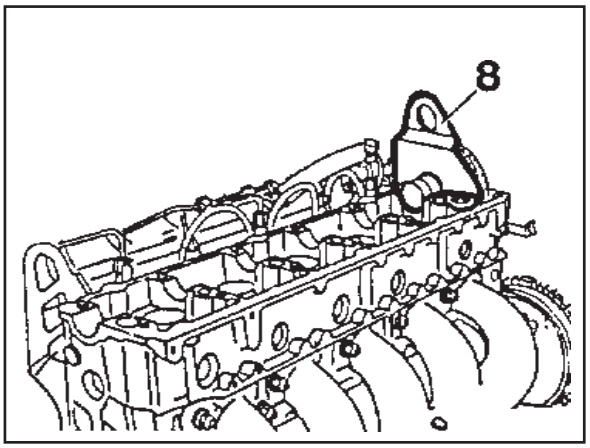
   Holding Wheel 603 589 01 40 00

3. Position the piston of relevant cylinder at TDC.



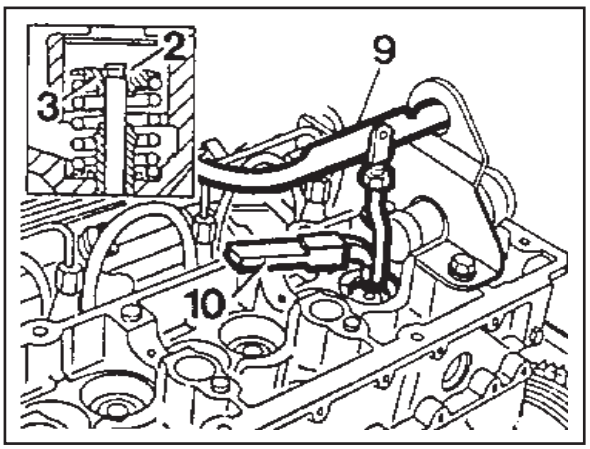
4. Install the supporting bar (8).

   Supporting Bar 667 589 02 63 00

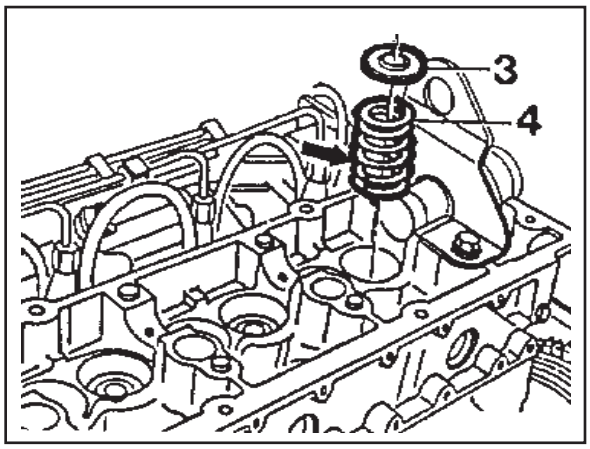


5. Using press lever (9), press the spring retainer(3) downward and remove the valve collets with magnetic finger (10).

   Press Lever 667 589 00 31 00
   Magnetic Finger 116 589 06 63 00

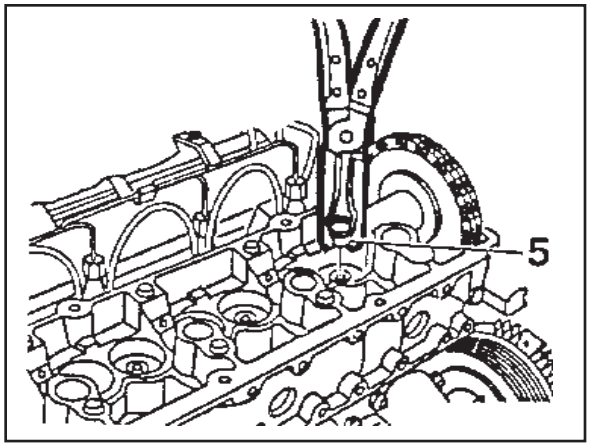


6. Remove the spring retainer(3) and valve spring (4).



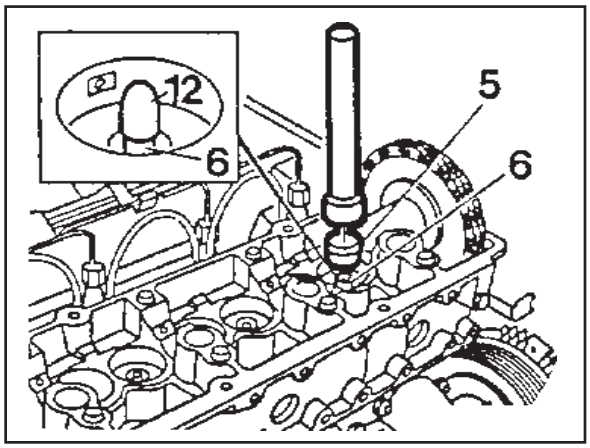
7. Remove the valve stem seal (5).

Pliers 104 589 00 37 00



8. Insert the cap (12) onto the valve (6) and install the new valve stem seal (5) and then remover the cap.

Drift 601 589 02 43 00

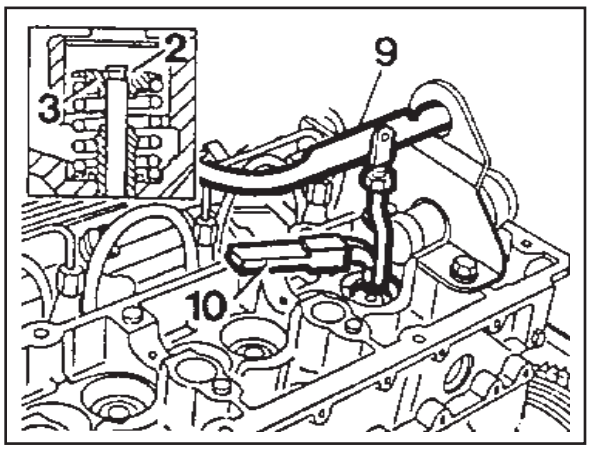


9. By pressing the spring seat with press lever (9), install the valve cotters(2) with magnetic finger (10).

Notice

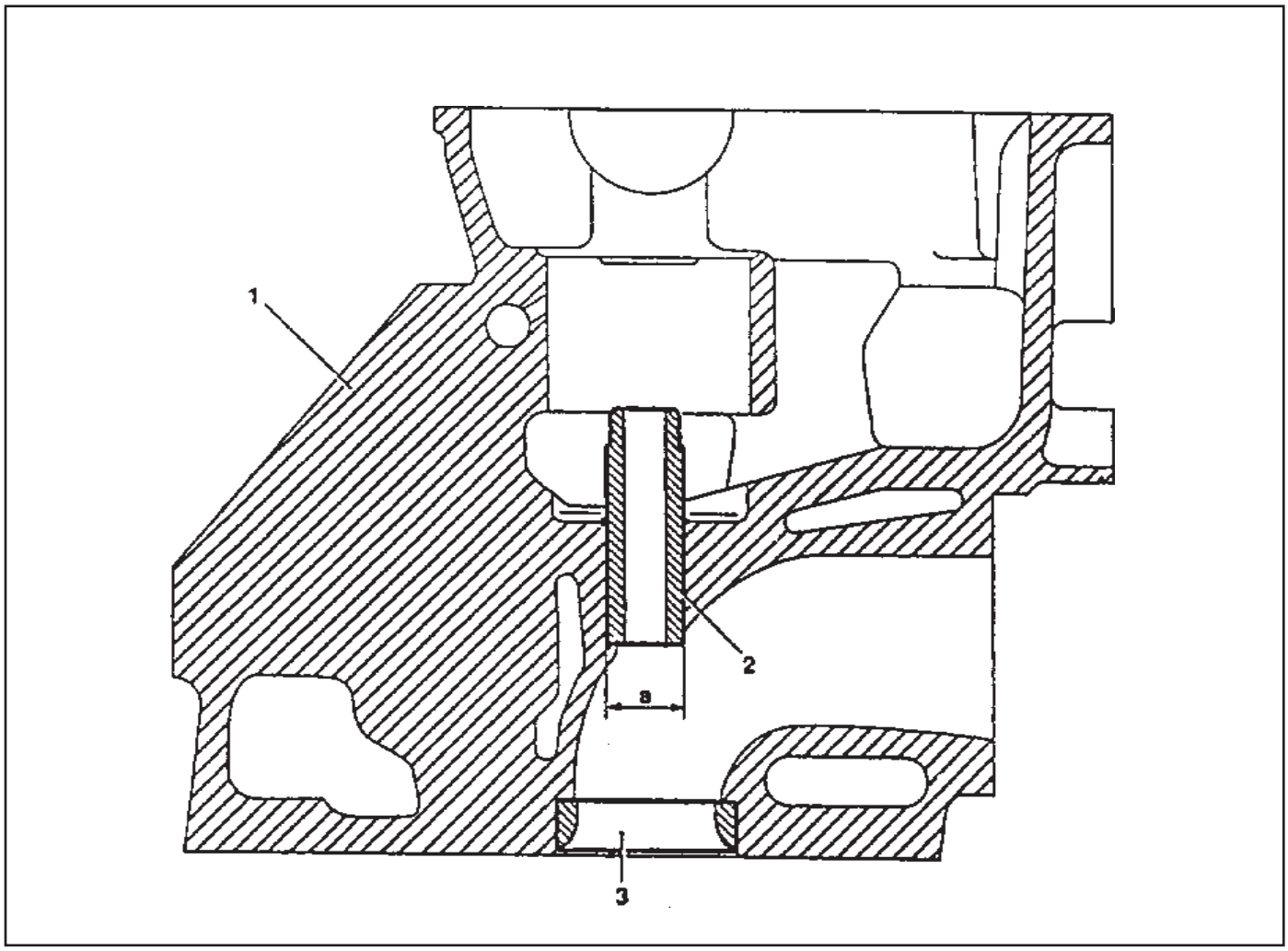
Be careful not to damage guide bore of the valve tappet.

Press Lever 667 589 00 31 00
Magnetic Finger 116 589 06 63 00



CHECK AND REPLACEMENT OF VALVE GUIDES

Preceding Work : Removal of cylinder head
Removal of valve spring
Removal of valve



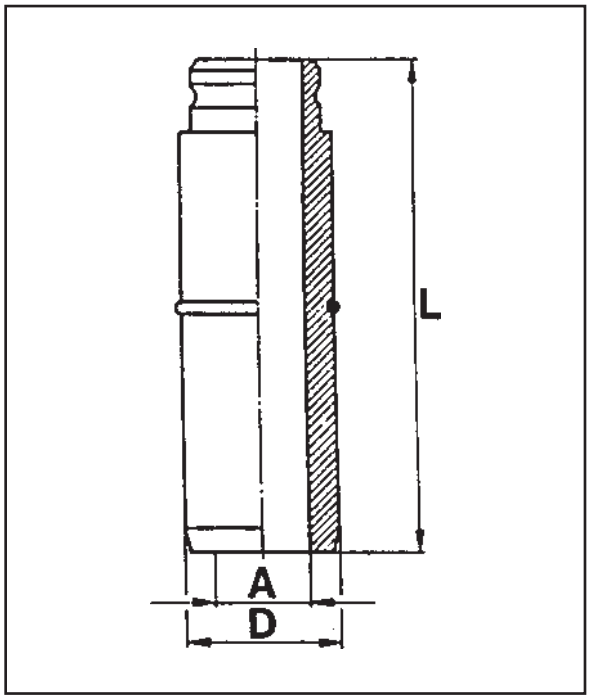
1 Cylinder Head
2 Valve Guide
3 Valve Seat Ring
a Basic Bore Diameter

Service Data

	Item	Outer Diameter 'D'	Color Code	Basic Bore Diameter 'a'	Overlap 'D' - 'a'	Valve Guide Inner Diameter 'A'	Length 'L'
Intake	Repair size 1	14.251	Red	14.200 - 14.211	0.029	8.000	39.5
	Repair size 2	14.440 - 14.451	White	14.400 - 14.411	- 0.051	- 8.030	
Exhaust	Repair size 1	14.240 - 14.251	Red	14.200 - 14.211	0.029	9.000	37.7
	Repair size 2	14.440 - 14.451	White	14.400 - 14.411	- 0.051	- 9.050	

Notice

Measure center (arrow) of the valve guide and if the inner diameter 'A' exceeds standard value, replace the guide.



Tools Required

000 589 10 53 00 Reamer (for Exhaust)
000 589 10 68 00 Cylinder Brush
000 589 21 53 00 Reamer (for Intake)
102 589 00 23 00 GO / NO GO Gauge (for Intake)
103 589 02 15 00 Drift (for Exhaust)
103 589 03 15 00 Drift (for Intake)
117 589 03 25 00 GO / NO GO Gauge (for Exhaust)
346 589 00 63 00 Super Cooling Box
601 589 02 23 00 GO/NO GO Gauge
601 589 05 15 00 Drift (for Intake)
601 589 06 15 00 Drift (for Exhaust)

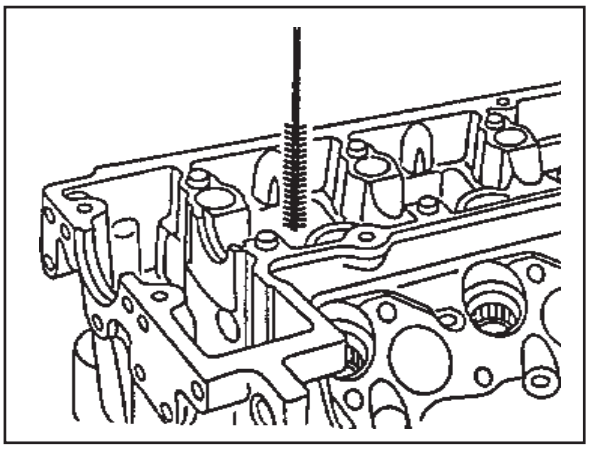
Matching Valve Seat - Broaching Tools - Guide Sleeves

Valve Seat	Broaching Tool No.	Guide Sleeve Tool No.	Guide Sleeve Side
Intake	115 589 00 53 00 (14.2mm)	102 589 00 63 00	B
Exhaust		102 589 08 63 00	B
Intake	115 589 01 53 00 (14.4mm)	601 589 15 63 00	A
Exhaust			B

Checking

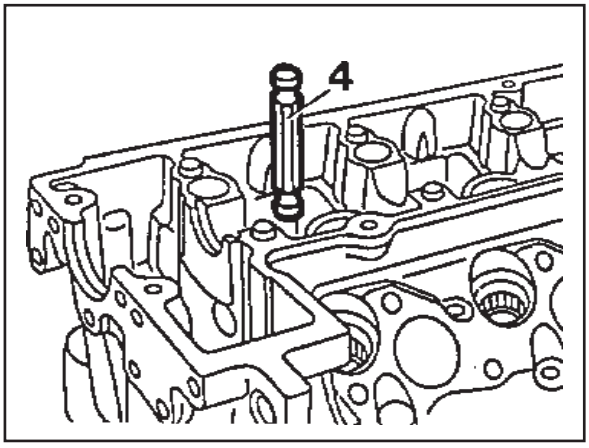
1. Thoroughly clean the valve guide bore using a cylinder brush.

Cylinder Brush 000 589 10 68 00



2. Insert the GO/NO GO gauge into the valve guide bore. If the NO GO side is inserted fully, replace the valve guide (Intake 8mm, Exhaust 9mm).

GO/NO GO Gauge 601 589 02 23 00



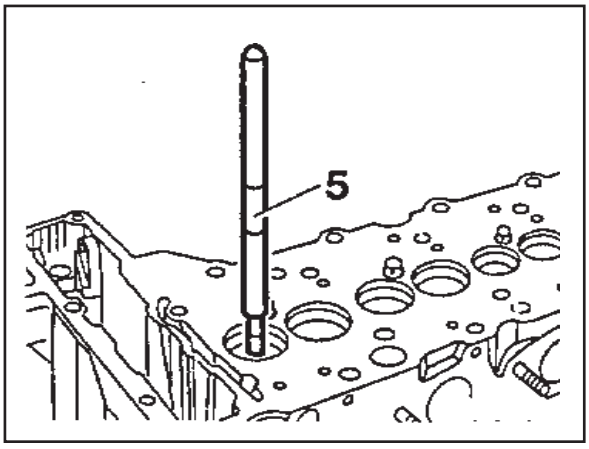
Replacement Procedure

1. Drive out the valve guide (2) by using a drift (5).

   Notice

   The valve guide must be driven out upward of the cylinder head.

Drift (for Intake) 103 589 03 15 00
Drift (for Exhaust) 103 589 02 15 00



2. Thoroughly clean the basic bore by using a cylinder brush.

Cylinder Brush 000 589 10 68 00

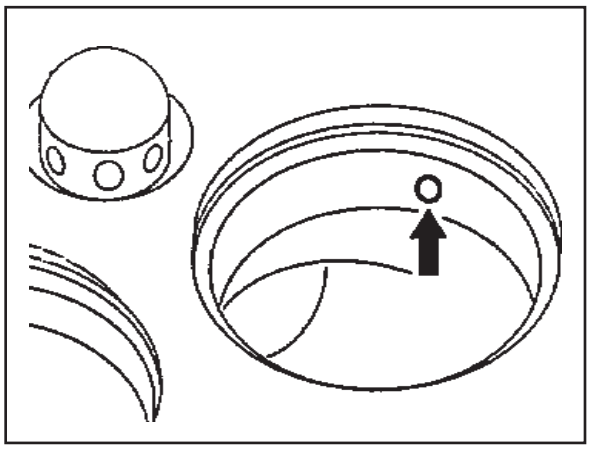
3. Check the basic bore in cylinder head for scoring marks and ream to next repair size if necessary.

4. Reaming basic bore in cylinder head (repair size).
   - Thoroughly remove carbon deposits in cylinder head.

     Notice

     Particularly remove the insides of the valve seat rings.

   - Remove the elevation (arrow) of intake valve seat rings.



   - Select correct broaching tool and guide sleeve (refer to the table).

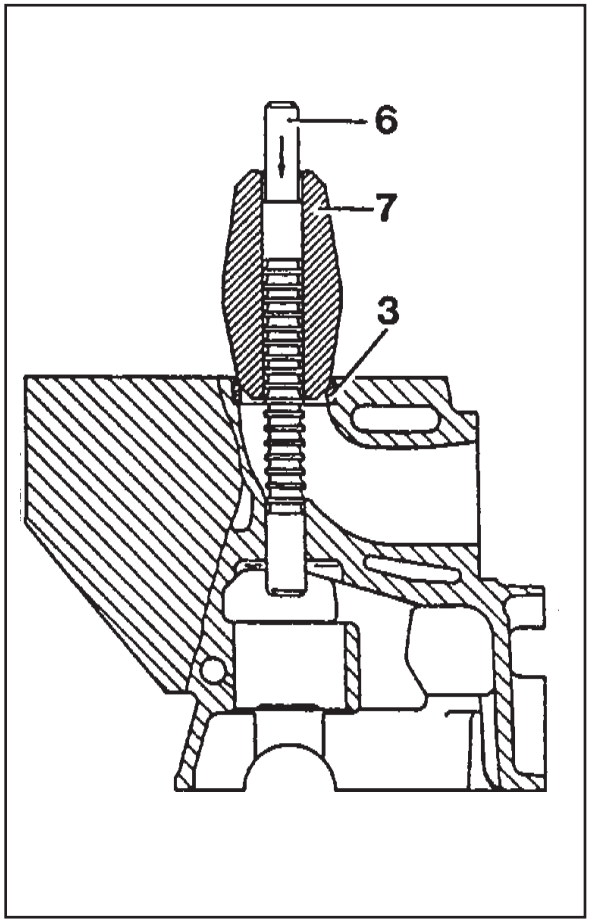
     Notice

     Before broaching work, the broaching tool must be cleared of swarf with a stiff plastic brush.

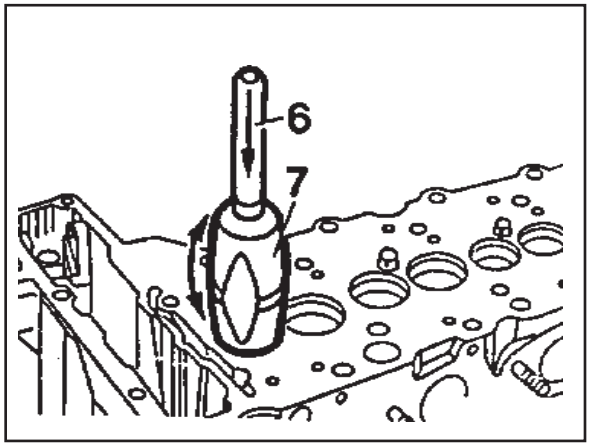
   - Lubricate the basic bore, guide sleeve and broaching tool with petroleum.
   - Push broaching tool (6) in broaching direction (arrow) into the guide sleeve (7) far enough so that the first cut of the broaching tool is positioned in the basic bore when guide sleeve is fitted onto the valve seat ring (3).

6. Broaching tool
7. Guide sleeve

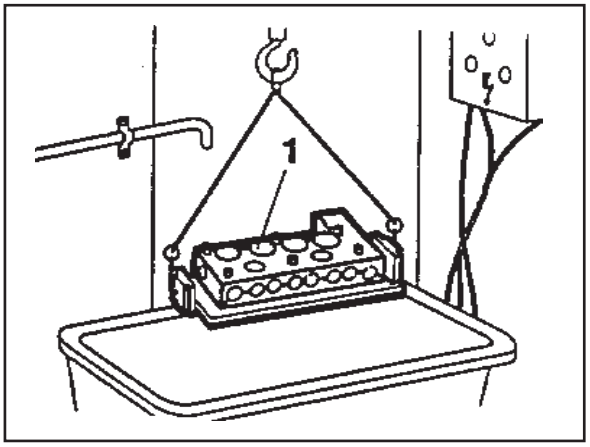
See the 'standard data'



   - Center the guide sleeve (7) in the valve seat ring (3) by turning.
   - Knock through the broaching tool (6) with a plastic hammer (approx. 25g). and aluminum drift.



5. Heat the cylinder head (1) in a wear tank to approx. 80°C.

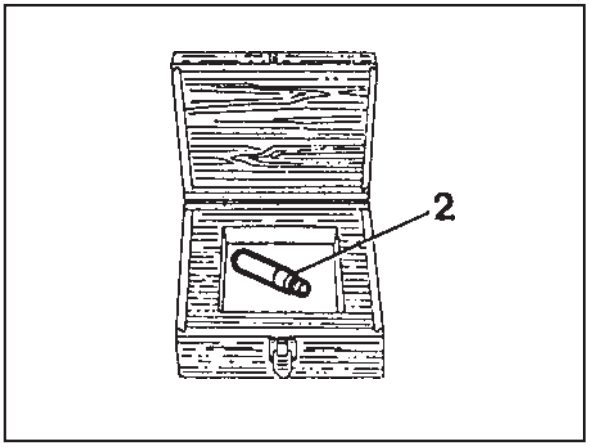


6. Cool down the new valve guide (2) with liquid nitrogen.

Notice

Do not touch the cooled valve guide by hand.

Super Cooling box 346 589 00 63 00

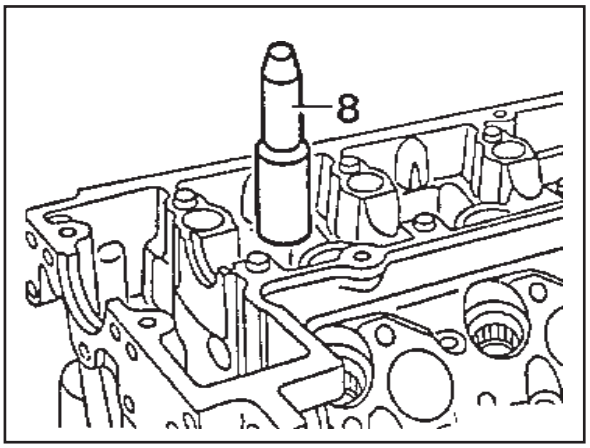


7. Drive in new valve guide with drift (8) until the wire ring makes contact.

Notice

The valve guide must be driven in from the cylinder head cover.

Drift (for Intake) 601 589 05 15 00
Drift (for Exhaust) 601 589 06 15 00



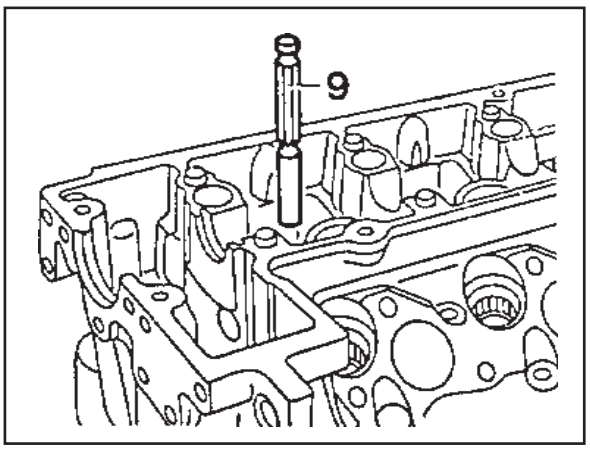
8. Check the valve guide bore with GO / NO GO gauge (9).

The GO side (marked '0') should just still drop. If the GO side cannot be inserted, the bore of valve guide should be reamed.

Notice

Perform the check only on cooled down cylinder head.

GO / NO GO Gauge (for Intake) 102 589 00 23 00
GO / NO GO Gauge (for Exhaust) 117 589 03 23 00

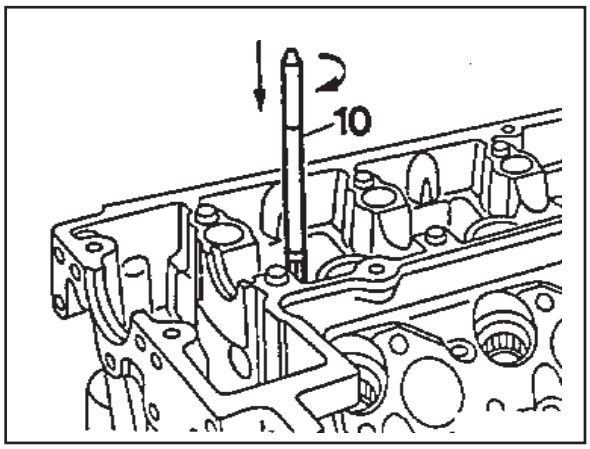


9. If necessary, ream the valve guide bore evenly.

Notice

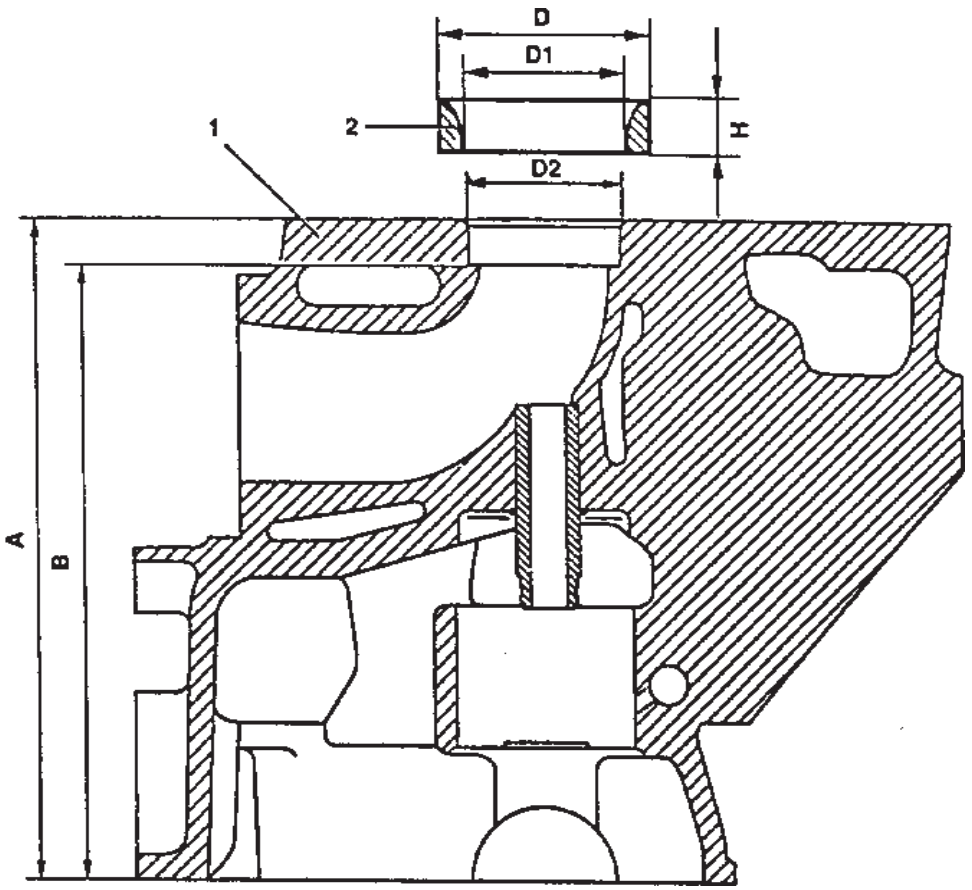
Never turn the reamer against the direction of rotation.

Reamer (for Exhaust) 000 589 10 53 00
Reamer (for Intake) 000 589 21 53 00



VALVE SEAT RINGS

Preceding Work : Removal of valve
Checking of valve guide, replace if necessary
Removal of prechamber



1 Cylinder Head
2 Valve Seat Ring
3 Valve Guide
A Height (Cylinder Head Upper / Lower Surface)
B Height (cylinder Head Cover Surface - Seat of Valve Seat Ring)
D Valve Seat Ring Outer Diameter
D1 Valve Seat Ring Inner Diameter
D2 Basic Bore Diameter
H Height of Valve Seat Ring

Service Data

Item	Intake	Exhaust
D2	40.000 - 40.016mm	37.000 - 37.016mm
D	40.084 - 40.100mm	37.084 - 37.100mm
D1	33.400 - 33.600mm	30.400 - 30.600mm
H	6.955 - 7.045mm	6.955 - 7.045mm
Overlap U=D-D2	0.068 - 0.100mm	0.068 - 0.100mm
B	133.4mm	133.4mm
A	142.5mm	142.5mm

Commercial Tools

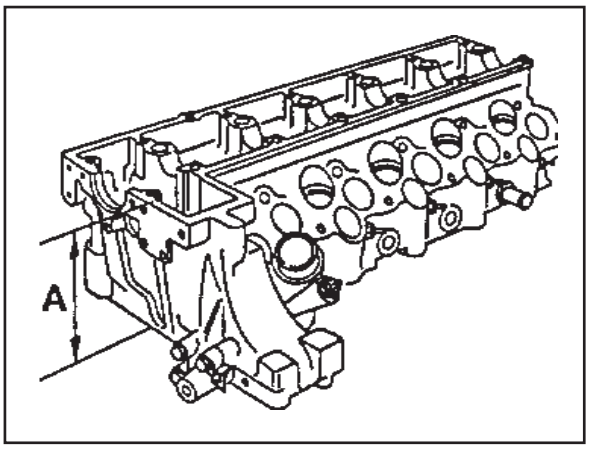
Cylinder Head Clamping Device	Hunger D-8000 München 70 Type Ventilknecht K2000 Order No. 221 00 100
Valve Seat Turning Tool	Hunger D-8000 München 70 Type VDS 1A Order No. 236 03 308
Ring Seat Turning Tool	Hunger D-8000 München 70 Type RDS 1 Order No. 219 00 100
Pneumatic Removal / Installation Device (Drift : 8mm, 9mm, 14mm)	Hunger D-8000 München 70 Type PVM 1
Tensioning Head	Hunger D-8000 München 70 Order No. 250 15 250
Cutting Tool for Recessing Grooves	Hunger D-8000 München 70 Order No. 217 93 601
Test Set for Valves	Hunger D-8000 München 70 Order No. 216 69 210
Internal Dial Gauge (Range : 25 - 60mm)	Mahr D-7300 Esslingen Order No. 844
External Micrometer (Range : 25 - 60mm)	Mahr D-7300 Esslingen Order No. 40 S
Electrically Heated Water Tank	Otto Dürr D-7123 Sachsenherm - Ochsenbach

Removal Procedure

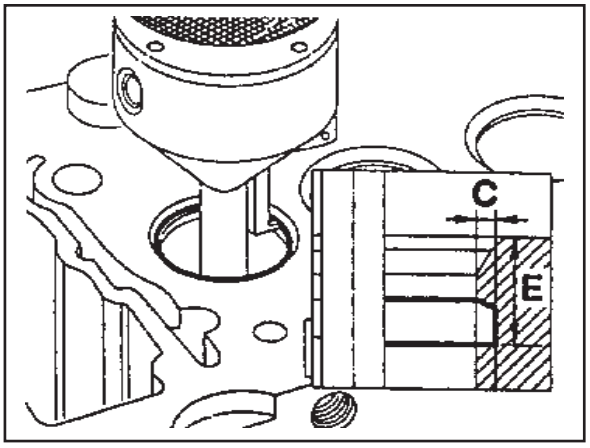
1. Measure dimension ‘A’ .

Limit	142.5mm

2. Clamp the cylinder head with clamping device.

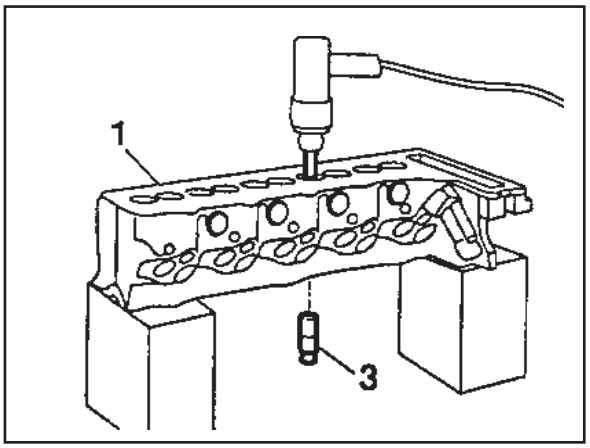


3. Cut groove into the valve seat ring so that dimension ‘C’ is approx. 2mm and dimension ‘E’ is approx. 6mm.



4. Remove the cylinder head from the clamping device and place it onto wooden blocks.
5. Remove the valve guide (3).

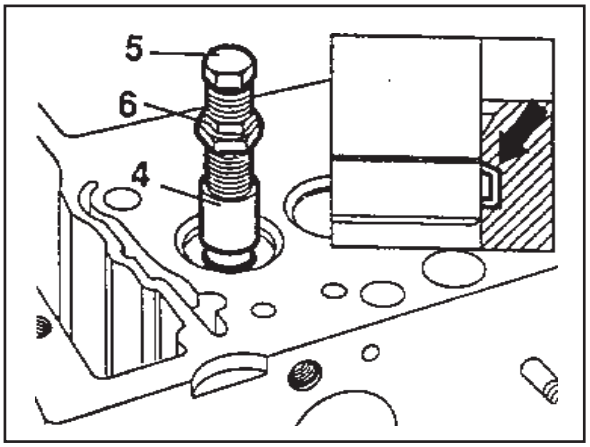
Drift (Intake) 8mm
Drift (Exhaust) 9mm



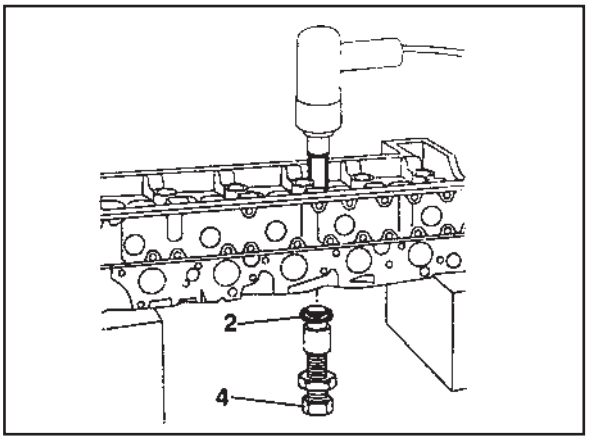
6. Insert the tensioning head (4) and extracted wedges(arrow) by turning the bolt (5).

   Notice

   Carefully tighten the bolt (5) otherwise the valve seat ring in the cylinder head will be excessively tensioned.
7. Lock the bolt (5) with nut (6).



8. Turn over the cylinder head.
9. Remove the tensioning head (4) and valve seat ring (2) with drift (14mm) and removal tool.
10. Clean the basic bore of valve seat ring.



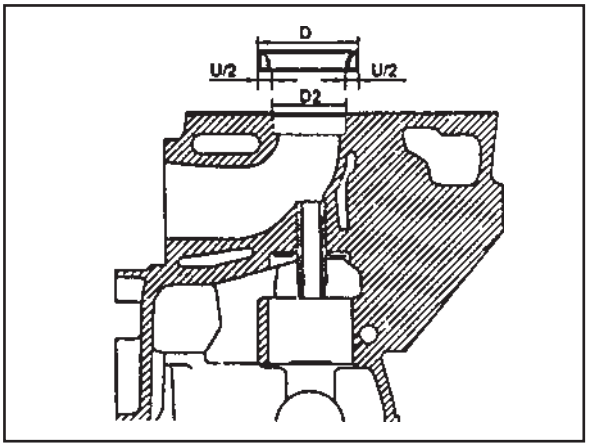
11. Measure the basic bore diameter (D2) and outer diameter (D) of the new valve seat ring (standard size).
12. Calculate the overlap value 'U' (D - D2).

Overlap Value 'U'	0.068 - 0.100mm

Example) Measured value D = 37.100mm
Measured value D2 = 37.010mm

Overlap value 'U' = 0.090mm

If overlap value 'U' is out of standard, machine the basic bore for the valve seat ring.



13. Clamp the cylinder head with clamping device.
14. Machining basic bore for valve seat ring (repair size).

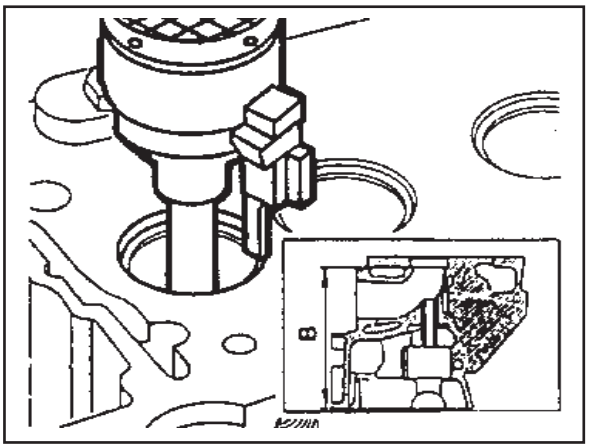
Notice

Maintain minimum value of 'B'.

- Machine the basic bore.

Limit

Max. D2	Intake	40.516mm
	Exhaust	37.516mm
Min. B		133.4mm



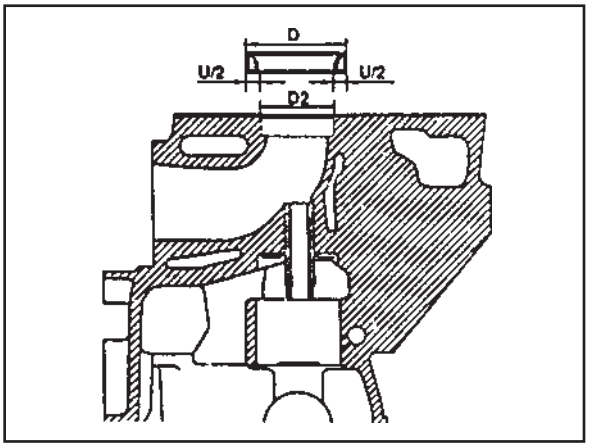
- Measure machined basic bore and outer diameter 'D' of valve seat ring (repair size).
- Measure the overlap 'U'

Overlap 'U' (D - D2)	0.068 - 0.100 mm

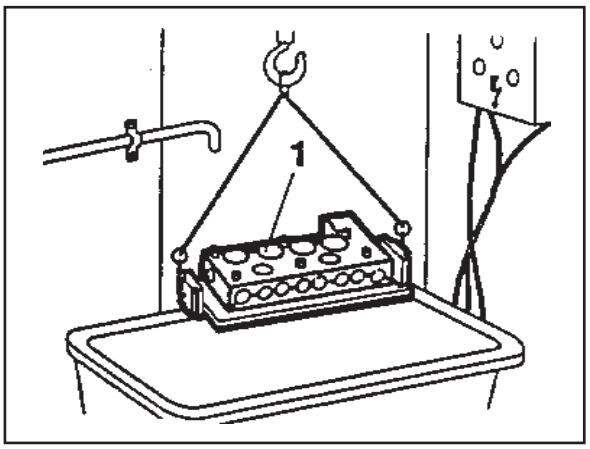
Example) Measured value D = 37.600 mm
Measured value D2 = 37.480 mm

Overlap U = 0.120 mm

The basic diameter D2 must be machined by 0.020mm in order to get the required overlap value.



15. Hang the cylinder head (1) to the lifting device and heat in a water tank to approx. 80°C.

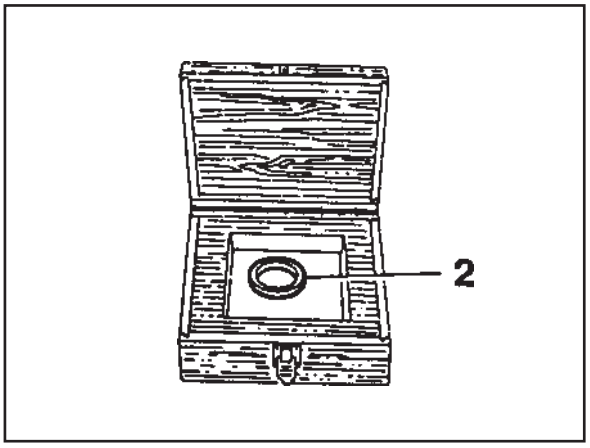


16. Cool down new valve seat ring (2) into the cooling box with liquid nitrogen.

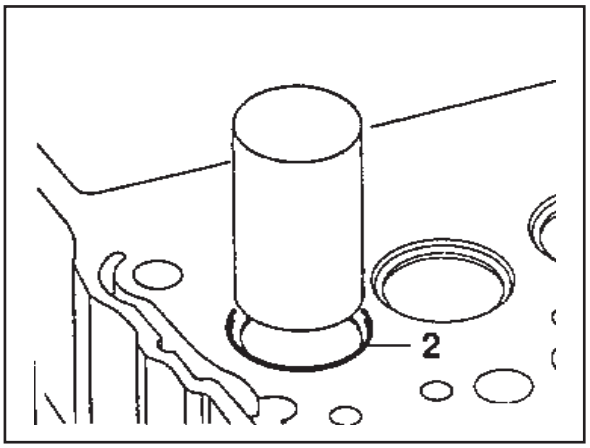
Notice

Do not touch the cooled valve seat rings with hand.

Super Cooling Box 345 589 00 63 00



17. Drive in new valve seat ring (2) with a proper wooden drift.

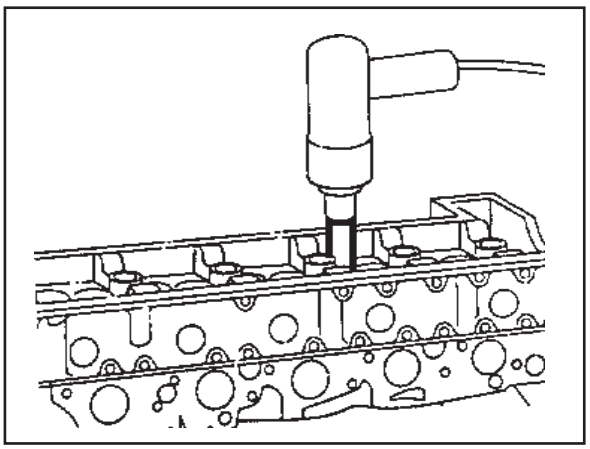


18. Install the valve guide (3) with a proper drift and assembling tool.

Notice

The valve guide must be driven in from the cylinder head cover.

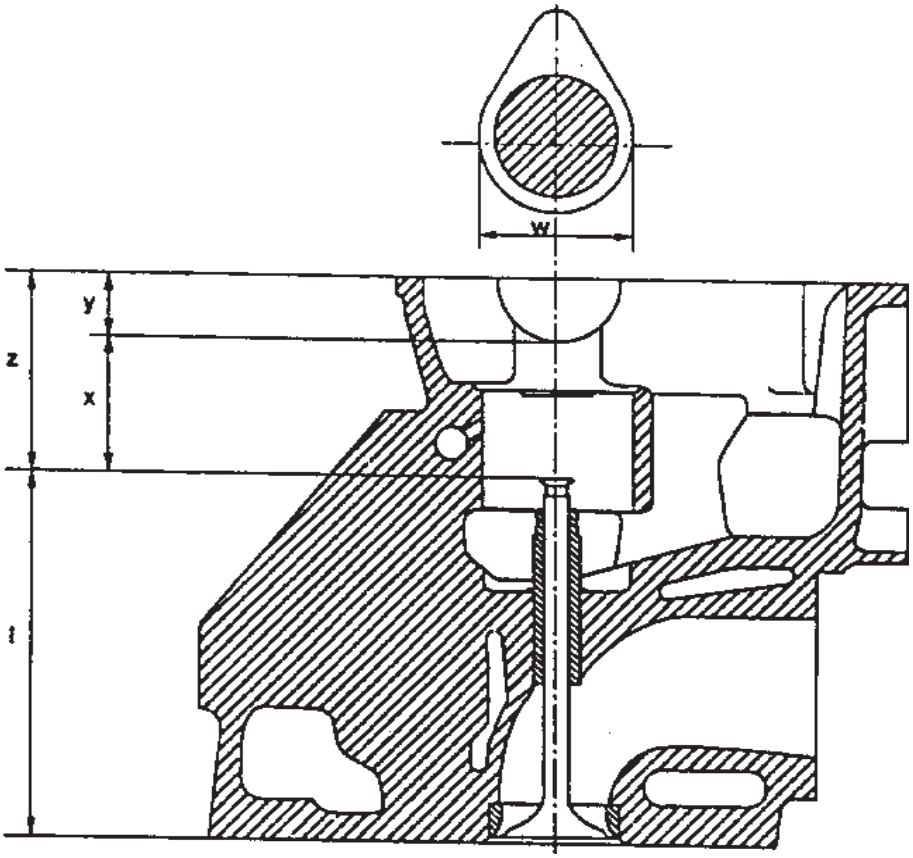
Drift (Intake) 8mm
Drift (Exhaust) 9mm



19. Machine the valve seats.

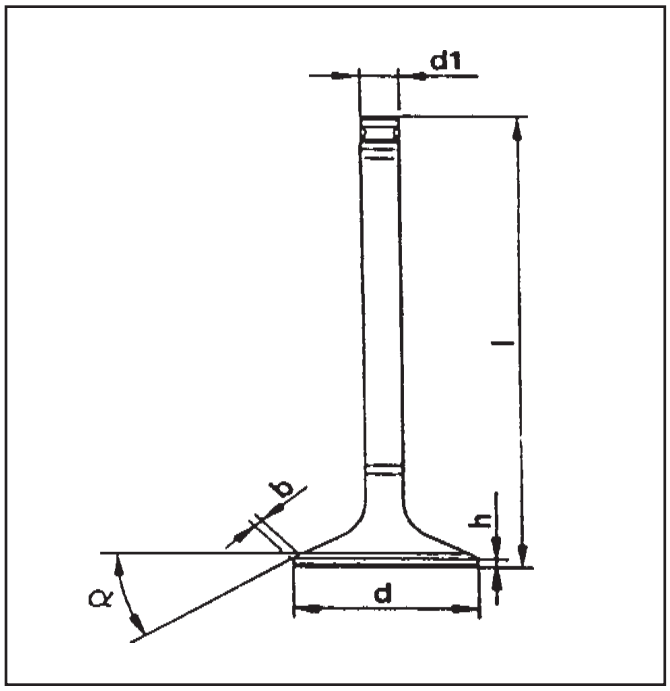
CHECK AND MACHINING OF VALVES

Preceding Works : Removal of cylinder head
Removal of the vale spring
Removal of the valve

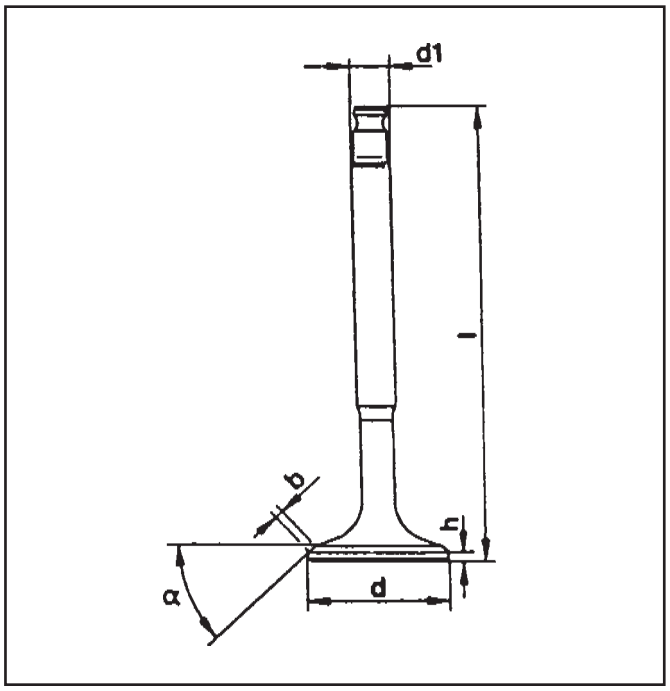


- I Valve Length
- W Camshaft Cam Basic Diameter
- X Distance (Camshaft Basic Bore - Valve Stem)
- Y Half Camshaft Basic Bore Diameter
- Z Distance (Cylinder Head Cover Parting Surface - Valve Stem)

Intake Valve



Exhaust Valve



Item		Intake Valve	Exhaust Valve
Valve Disc Diameter 'd'		37.90 - 38.10 mm	34.90 - 35.10 mm
Valve Disc Height 'h'		1.7 mm	1.7 mm
Setting Angle "α" or Machining the Valve		45°	45°
Valve Stem Diameter 'd1'		7.955 - 7.970 mm	9.945 - 8.960 mm
Valve Length 'l'	Standard	106.20 - 106.60 mm	106.20 - 106.60 mm
	Repair	105.30 - 105.70	105.30 - 105.70 mm
Max. Permis Sible Runout at Valve Stem and Valve Seat		0.03 mm	0.03 mm

Matching Valves

	Camshaft Cam Basic Dia. W = 38.0 ± 0.2mm	Camshaft Cam Basic Dia. W = 36.6 ± 0.2mm	Valve to be Used
Size (x)	19.5 - 20.3mm	19.5 - 20.1mm	Use machined valve, if needed new repair valve l = 105.5 ± 0.2mm
Size (x)	20.4 - 21.4mm	20.2 - 21.2mm	Reuse valve
Size (x)	21.4 - 21.97mm	21.2 - 21.97mm	Use standard size valve l = 106.4 ± 0.2mm

Tools Required

001 589 32 21 00 Dial Gauge

Commercial Tool

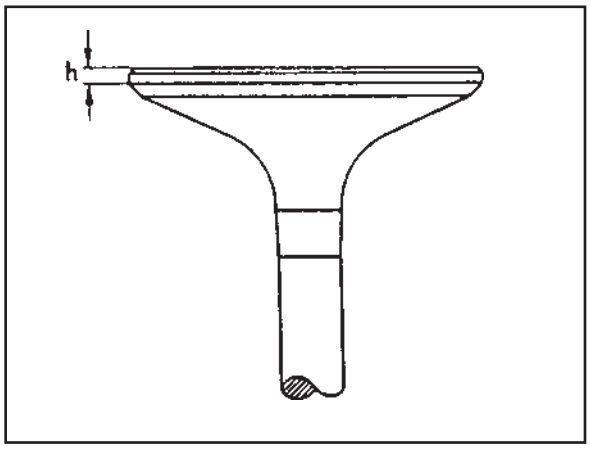
Valve corn grinding machine

Checking and Machining

1. Clean the valves and do visual check.

   Valves with wobbled valve disc, with worn or scored valve stem should be replaced.

2. Measure valve disc height 'h'.

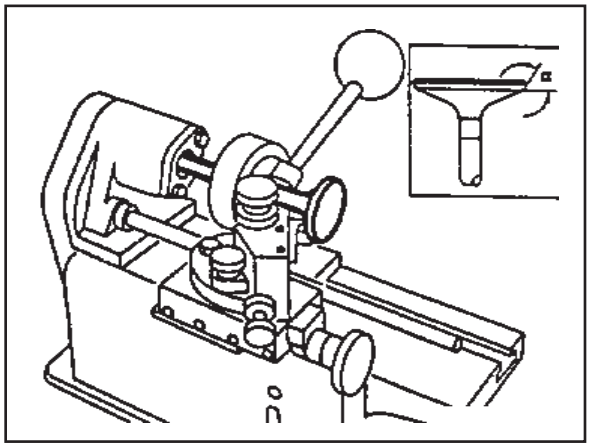


Service data	Intake	1.7 ± 0.15 mm
	Exhaust	1.7 ± 0.15 mm

3. Machine the valve.

   Notice

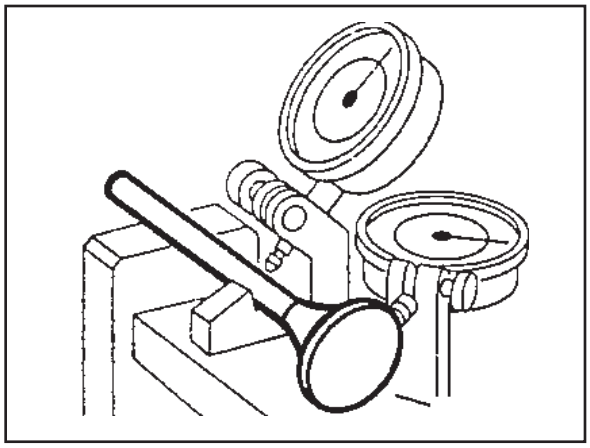
   Pay attention to setting angle 'α' .



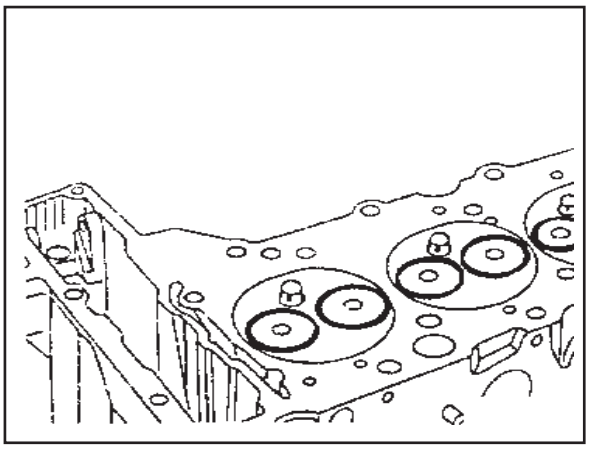
4. Measure radial runout between valve stem and valve seat.

Limit	Max. 0.03mm

Dial Gauge 001 589 32 21 00



5. Clean the vales, valve seats and valve guides.
6. Coat the valve stem with oil and insert it into valve guide.

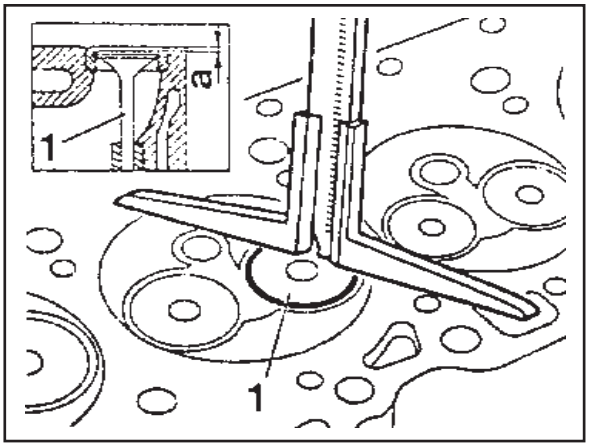


7. Insert the valves (1) into the valve guides according to marking.
8. Measure amount by which the valve arrears ‘a’.

Arrears ‘a’	0.1 - 0.7 mm

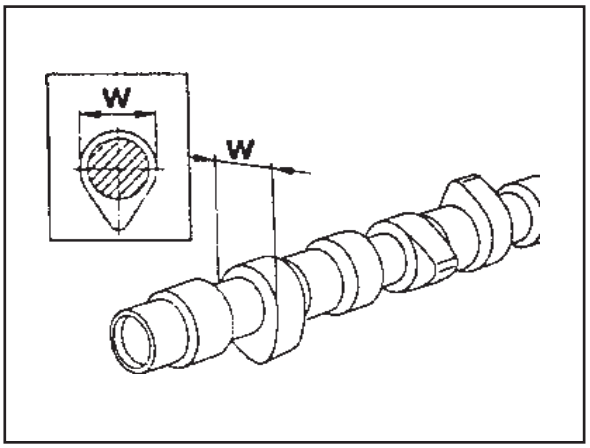
Notice

If out of standard, replace the valve seat ring.

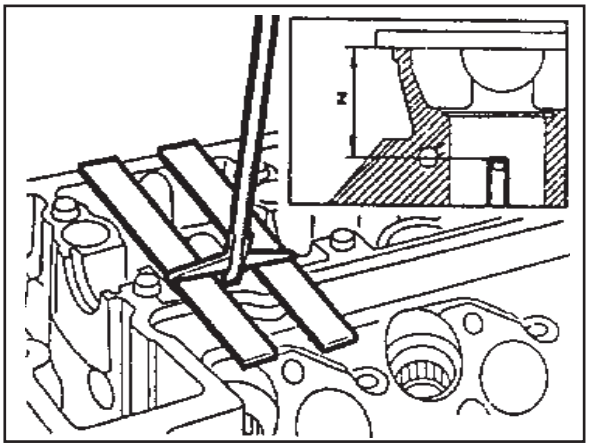


9. Measure camshaft cam basic diameter (w).

Diameter ‘w’	38 ± 0.2 mm or 37.6 ± 0.2 mm



10. Measure distance ‘z’ (cylinder head cover parting surface - valve stem).



11. The distance ‘x’ (camshaft basic bore - valve stem).

    ‘x’ = ‘z’ - ‘y’.

    Determine the valve to use according to this measurement (See ‘matching valves’)

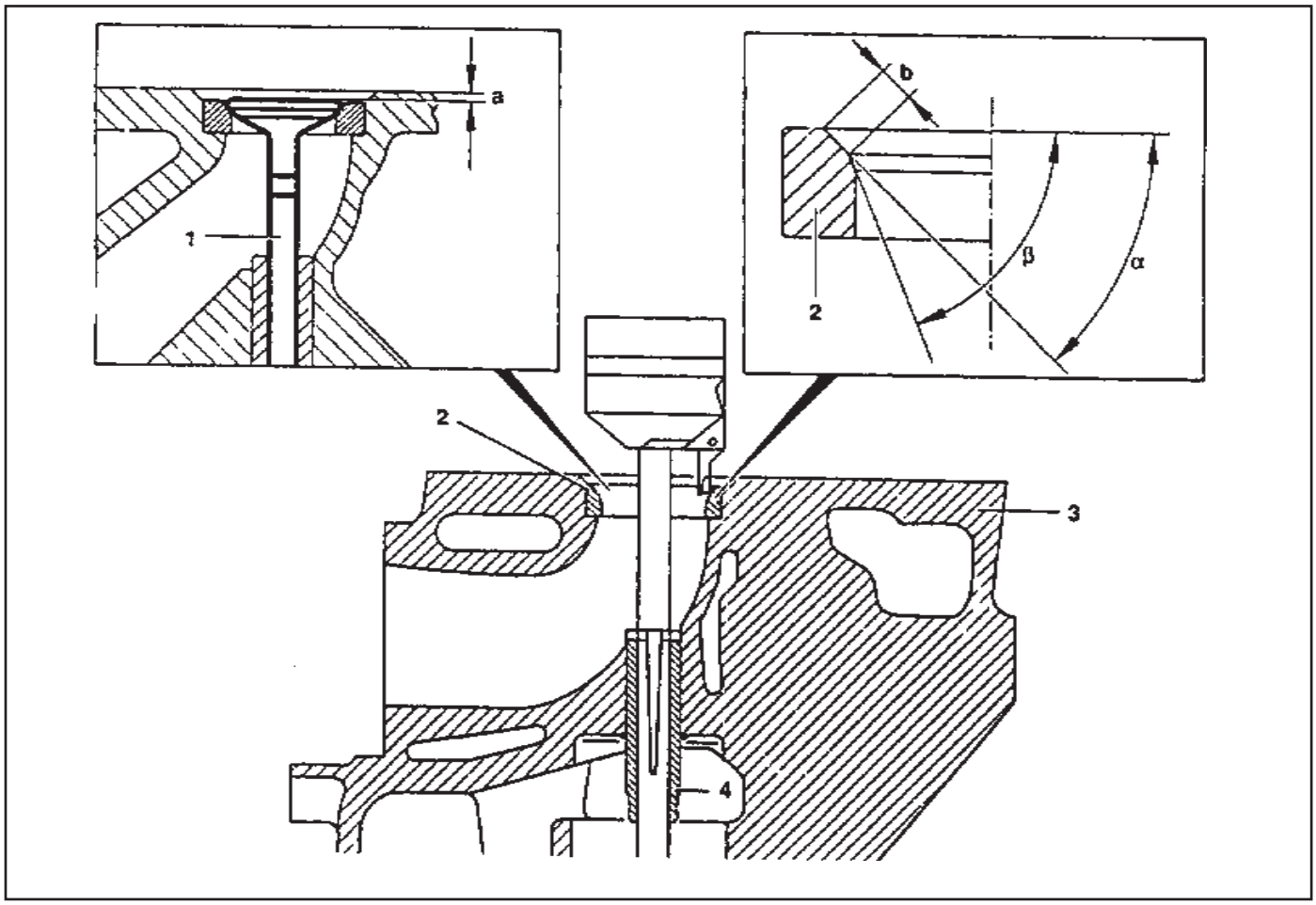
    Example) Measured value ‘w’ = 38.2 mm
    Measured value ‘z’ = 36.5 mm
    Value ‘y’ = 15.5 mm

    ‘x’ = 36.5 - 15.5 = 21.0mm

    In this case according to ‘Matching valves’ table, the installed valve may be used.

MACHINING OF VALVE SEAT

Preceding Work : Removal of prechamber
Removal and inspection of valve, replace if necessary
Inspection of valve guide, replace if necessary



1 Valve
2 Valve Seat Ring
3 Cylinder Head
4 Valve Guide

a Valve Seat Angle
b Valve Seat Free Angle

Service Data

Item		Intake	Exhaust
Valve Arrears 'a'		0.1 - 0.7 mm	0.1 - 0.7 mm
Valve Seat Width 'b'		1.2 - 1.7 mm	1.5 - 2.0 mm
Valve Seat Angle 'α'		45°	45°
Valve Seat Free Angle 'β'		65°	65°
Permissible Radial Runout		0.03 mm	0.03 mm
Valve Length 'l'	Standard	106.20 - 106.60 mm	106.20 - 106.60 mm
	Repair	105.30 - 105.70 mm	105.30 - 105.70 mm

Matching Valves

	Camshaft cam basic dia. w = 38.0 ± 0.2 mm	Camshaft cam basic dia. w = 37.6 ± 0.2 mm	Valve to be used
Size (x)	19.5 - 20.3mm	19.5 - 20.1mm	Use machined valve, if needed use pair valve 1 = 105.5 ± 0.2mm
Size (x)	20.4 - 21.4mm	20.2 - 21.2mm	Reuse valve
Size (x)	21.4 - 21.97mm	21.2 - 21.97mm	Use standard size valve l = 106.4 ± 0.2mm

Commercial Tools

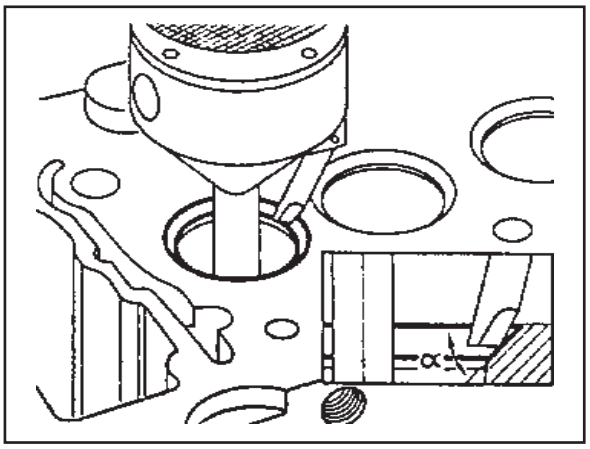
Cylinder Head Clamping Devie	Hunger D-8000 München 70 Type Ventilknecht K2000 Order No. 221 00 100
Valve Seat Turning Tool	Hunger D-8000 München 70 Type VDS 1A Order No. 236 03 308
Test Sat for Valves	Hunger D-8000 München 70 Order No. 217 93 601

Machining Procedure

Valve machining is required :

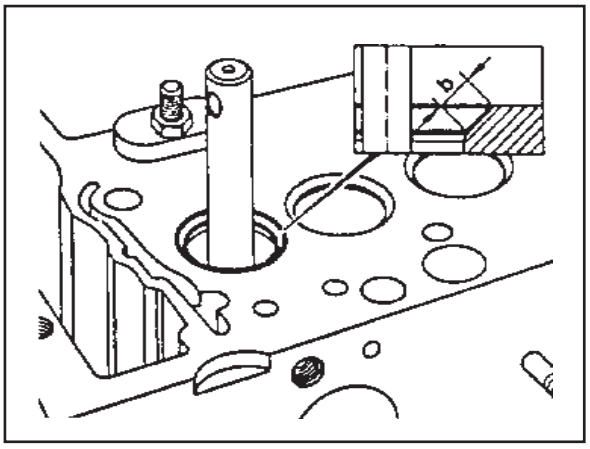
- When the valve is leaking.
- When replacing the valve.
- When replacing the valve guide.
- When replacing the valve seat or valve seat ring.

1. Machine the valve seat (a=45°).

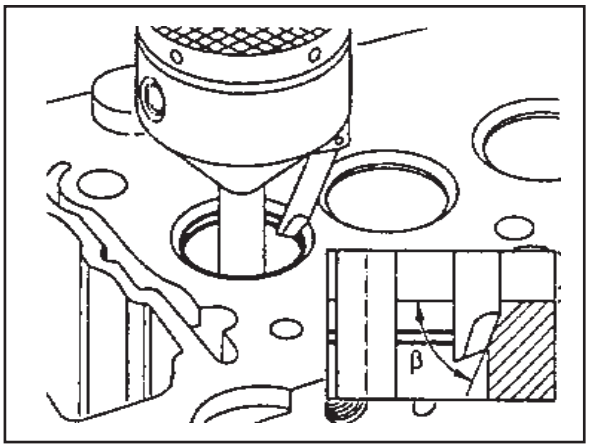


2. Measure valve seat width ‘b’.

Valve seat width ‘b’	Intake	1.2 - 1.7 mm
	Exhaust	1.5 - 2.0 mm

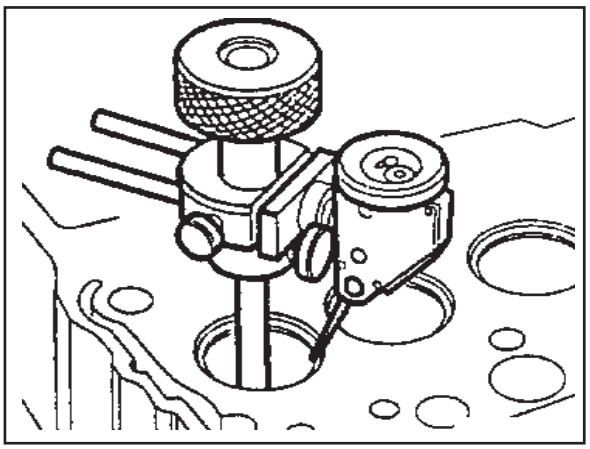


3. If the specification is exceeded, the valve seat width has to be corrected at the lower free angle of ‘β’=65°.



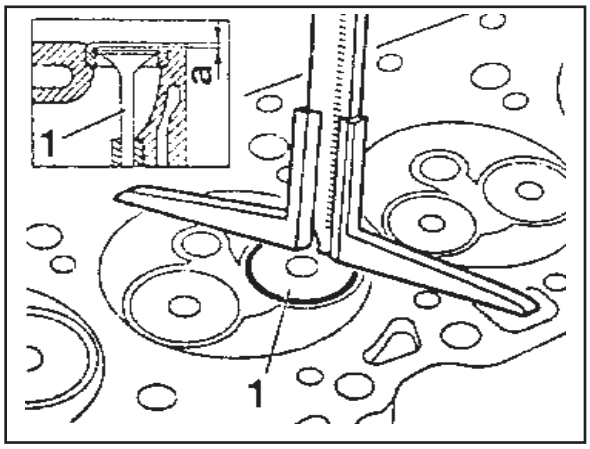
4. Measure radial runout.

Runout	Max. 0.03mm



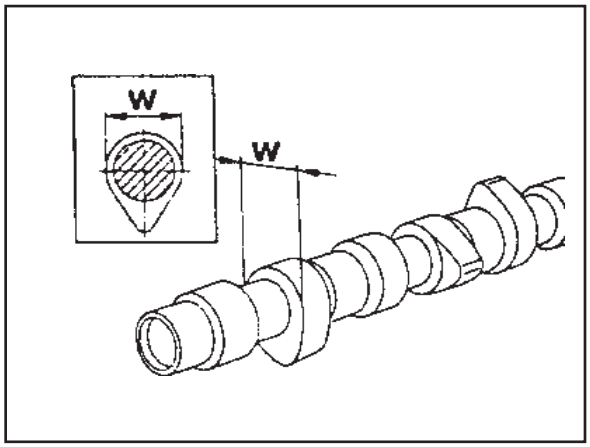
5. Insert the valve (1) into the valve guide according to marking and measure amount by which the valve arrears ‘a’.

Arrears ‘a’	0.1 - 0.7mm

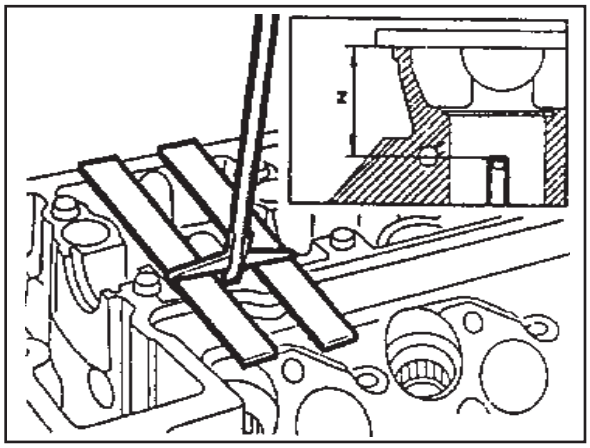


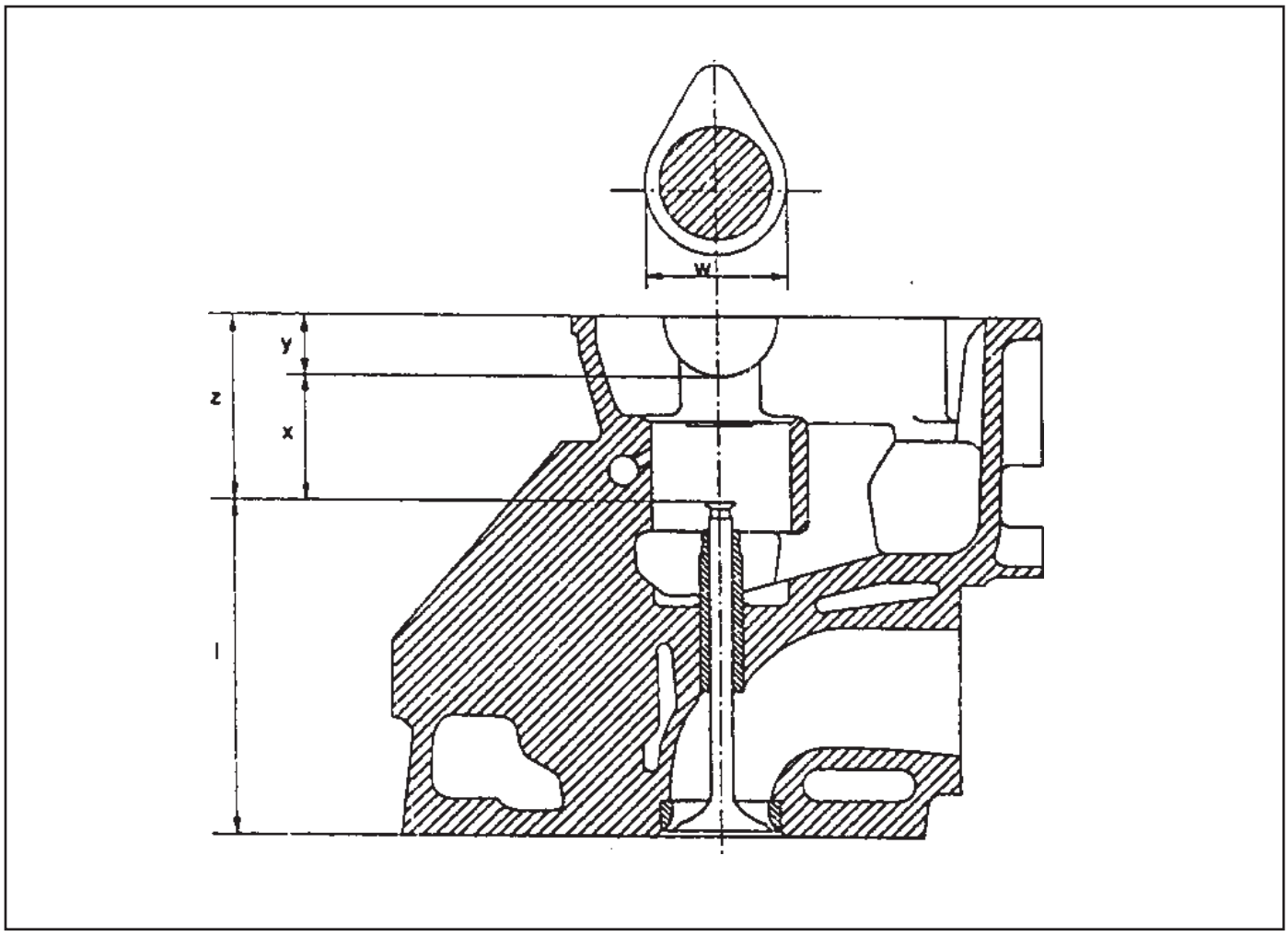
6. Measure camshaft cam basic circle diameter (w).

Diameter ‘w’	38 ± 0.2mm or 37.6 ± 0.2mm



7. Measure distance ‘z’ (cylinder head cover parting surface - valve stem).



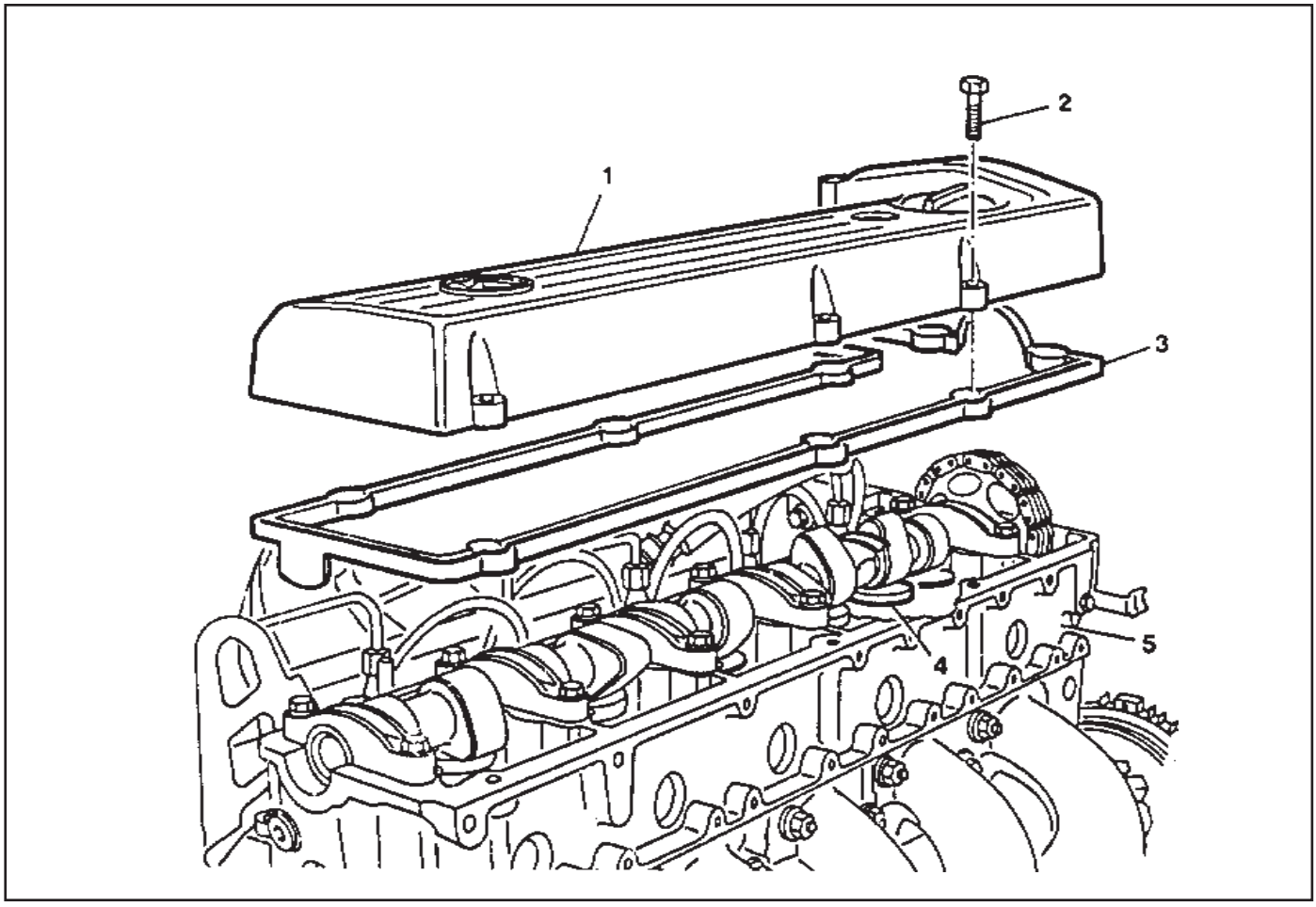


l Length of Valve
w Camshaft Cam Basic Circle Diameter
x Distance (Camshaft basic bore - valve stem)
y Half Camshaft Basic Bore Diameter
z Distance (Cylinder head cover parting surface -. valve stem)

8. Measure ‘x’ (Camshaft basic bore - valve stem).
   ‘x’ = ‘z’ - ‘y’
9. Determine the valve to be used.
   (See ‘Matching valves’)
   Example) Measured value ‘w’ = 38.2 mm
   Measured value ‘z’ = 36.5 mm
   Value ‘y’ = 15.5 mm
   ‘x’ = 36.5 - 15.5 = 21.0 mm
   In the case of a camshaft cam basic circle diameter ‘w’ = 38.2mm and a distance ‘x’ = 21.0mm, the installed valve may be used.

CAMSHAFT TIMING TEST

Preceding Work : Removal of glow plug



1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Valve Tappet
5 Cylinder Head

Timing

Condition of camshaft	Intake valve		Exhaust valve	
	Open	Close	Open	Close
New	ATDC 11.33°	ABDC 17°	BBDC 28°	BTDC 15.25°
After approx. 20,000km	ATDC 12°	ABDC 18°	BBDC 27°	BTDC 14°

*At 2mm of valve lifting stroke.

Tools Required

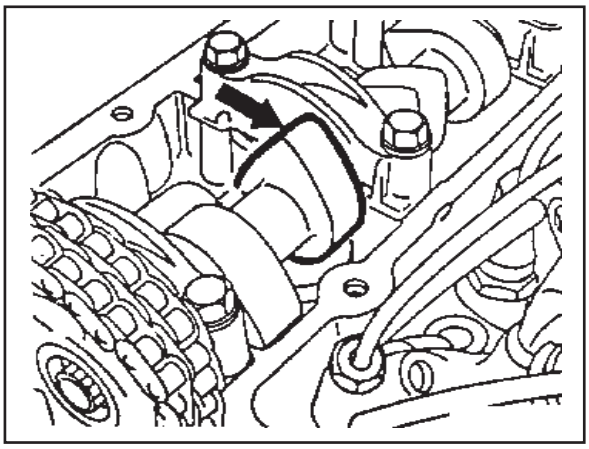
001 589 53 21 00 Dial Gauge

363 589 02 21 00 Dial Gauge Holder

366 589 00 21 05 Extension

Measurement Procedure

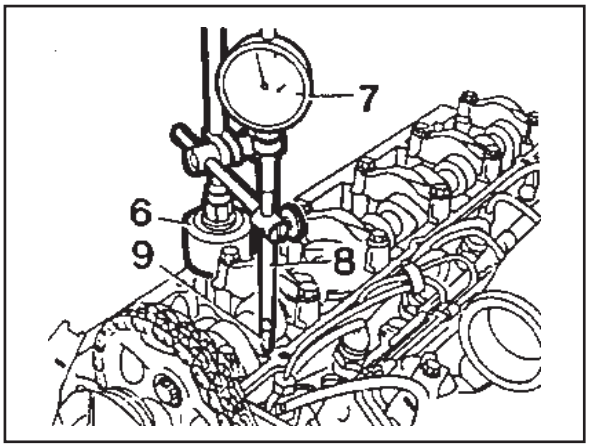
1. Remove the cylinder head cover.
2. Rotate the engine in the direction of engine rotation until the intake valve of NO. 1 cylinder is completely closed. The cam lobe faces up (arrow).



Notice

Do not rotate the engine at the bolt of the crankshaft sprocket. Do not rotate the engine in the opposite direction of engine rotation. If do, this will cause serious measuring errors.

3. Install the dial gauge holder and dial gauge (7) with the extension (8) to the cylinder head and position the tracer pin (9) onto the valve tappet (intake valve of cylinder NO.1) with a preload of min. 3mm.

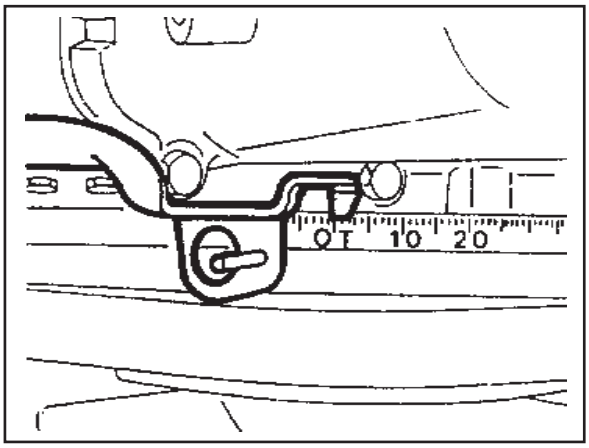


Notice

The tracer pin should be positioned exactly vertical.

Dial gauge Holder 363 589 02 21 00
Dial Gauge 001 589 53 21 00
Extension 366 589 00 21 05

4. Set the dial gauge to '0'.
5. Rotate the engine further in direction of rotation until the dial gauge has moved back by 2mm (valve lift) to 1mm.
6. Check the timing.



New	ATDC 11.33°
After approx. 20,000km	ATDC 12°

Notice

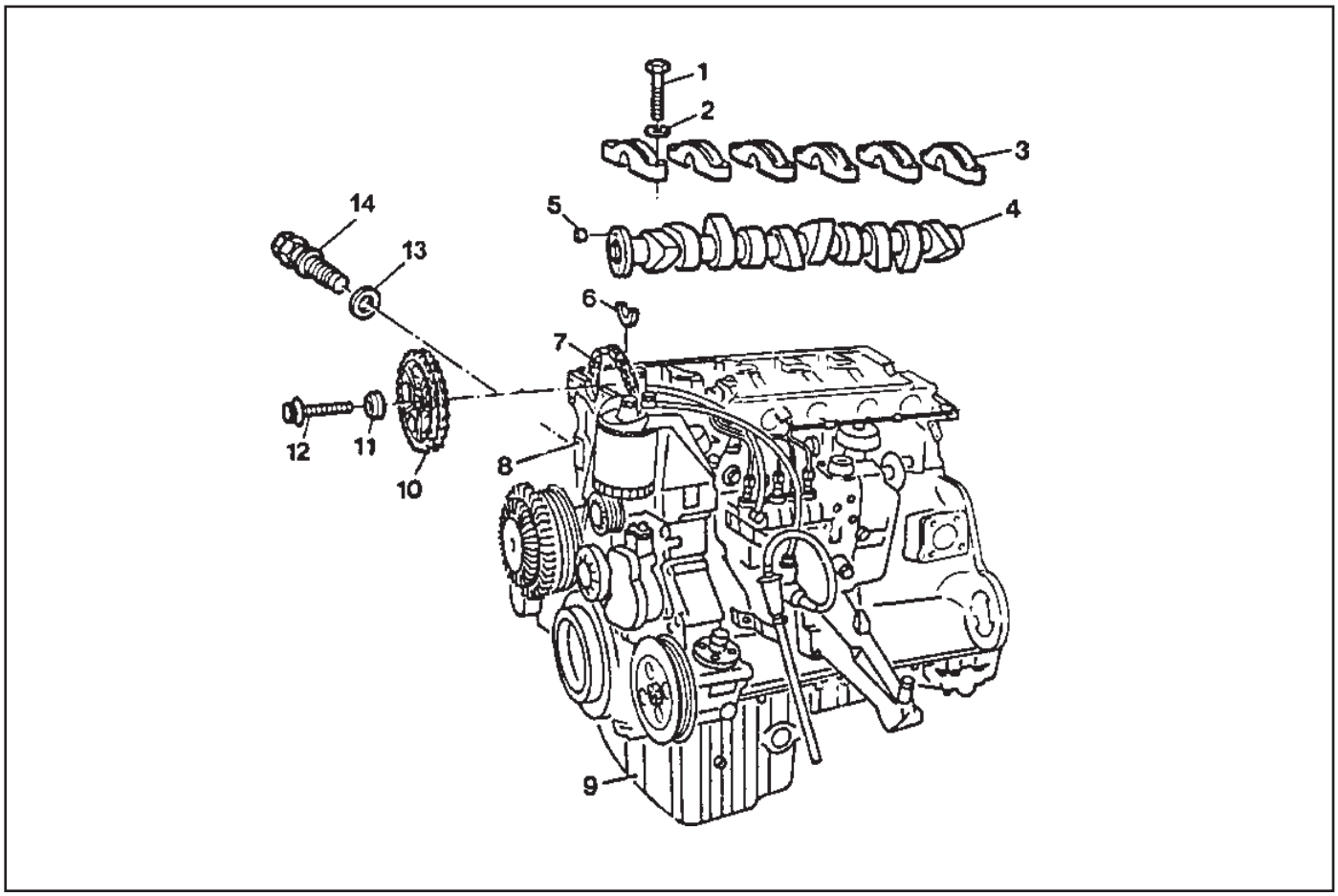
If timing is out standard, the camshaft should be checked for wear and the timing chain for stretch. If a difference of more than 4° exists, the timing chain should be replaced.

7. Replace the gasket and install the cylinder head cover.

Tightening Torque	10 Nm

CAMSHAFT

Preceding Work : Removal of cylinder head cover



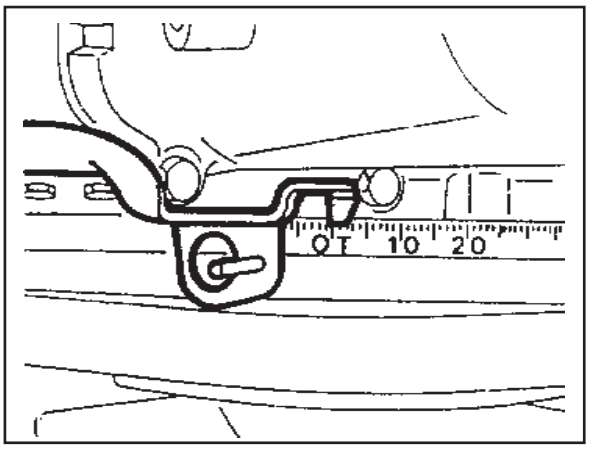
1 Bolt 25Nm
2 Washer
3 Camshaft Bearing Cap
4 Camshaft
5 Dowel Pin
6 Locking Washer
7 Timing Chain
8 Cylinder Head
9 Oil Pan
10 Camshaft Sprocket
11 Washer
12 12-Sided Bolt (M11) ..... Check, 25Nm + 90°
13 Gasket ..... Replace
14 Chain Tensioner 80Nm

Tools Required

602 589 00 40 00 Engine Lock

Removal Procedure

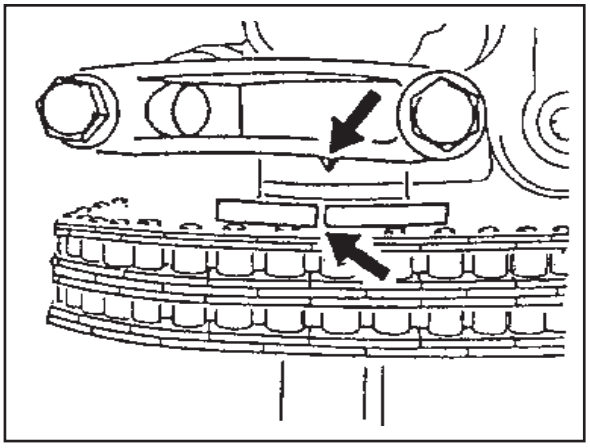
1. Rotate the crankshaft and position the piston of no.1 cylinder at TDC.



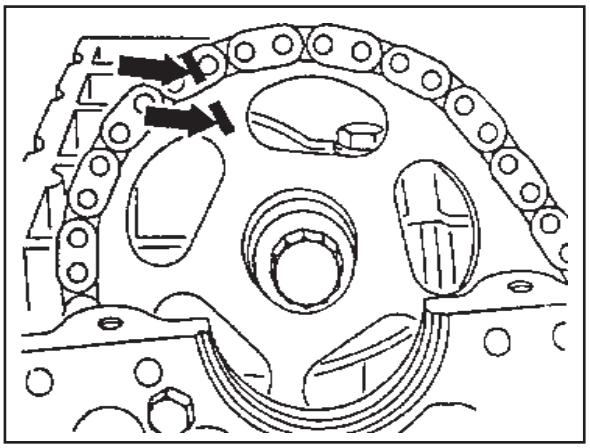
Notice

Do not rotate the crankshaft in the opposite direction of engine rotation.

In this position, the markings of the camshaft/camshaft bearing cap (arrow) must be aligned.

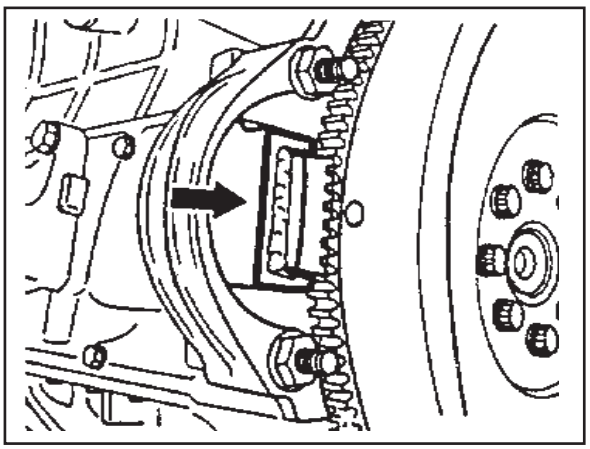


2. Place alignment marks on the camshaft sprocket and timing chain.



3. Remove the starter motor and install the engine lock.

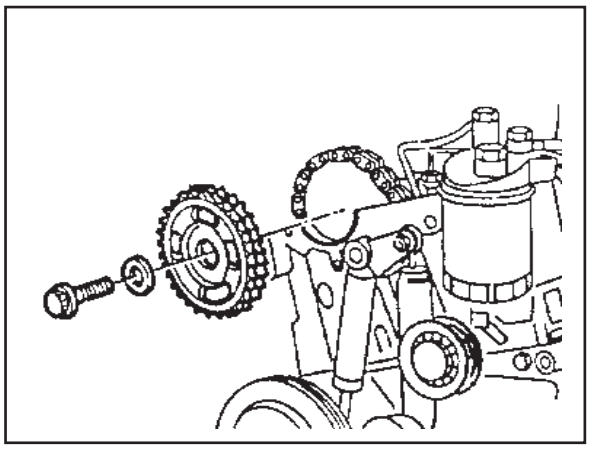
Engine Lock 602 589 00 40 00



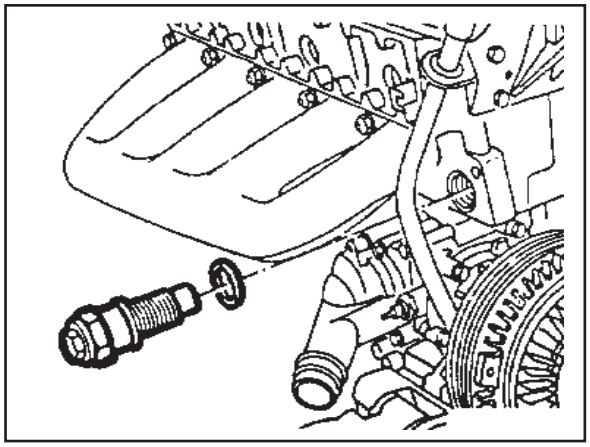
4. Remove the bolt and then remove the camshaft sprocket.

   Notice

   During removal, be careful not to drop the sprocket with chain. Remove the chain carefully and then pull out the sprocket.



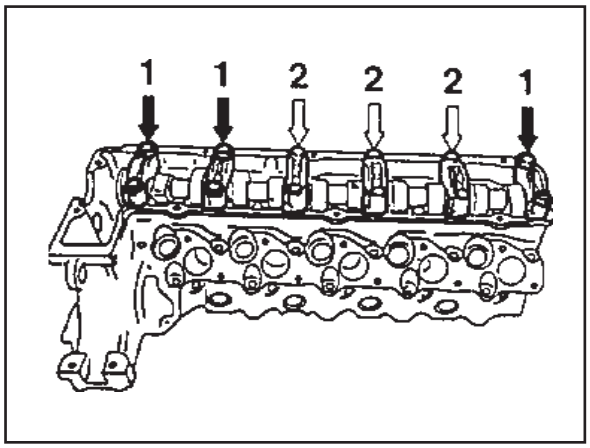
5. Remove the chain tensioner.



6. Remove the camshaft bearing cap bolts according to the removal order.

   Notice

   Remove the camshaft bearing cap bolts of 1(dark arrow) first and then remove the bolts of 2 (light arrow) one revolution in stages until the counter-pressure is released. In order to avoid damaging the camshaft, it is essential to adhere to the removal order for the camshaft bearing caps.



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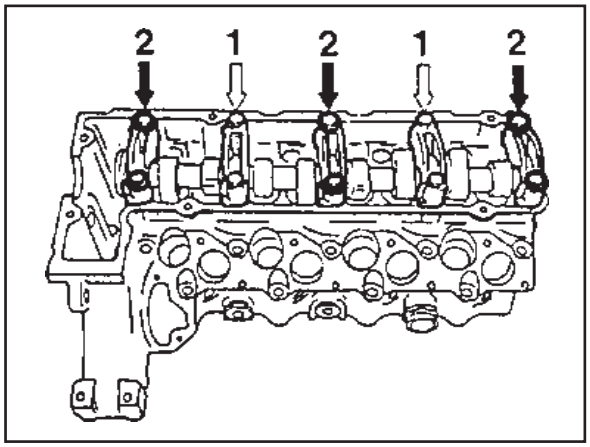
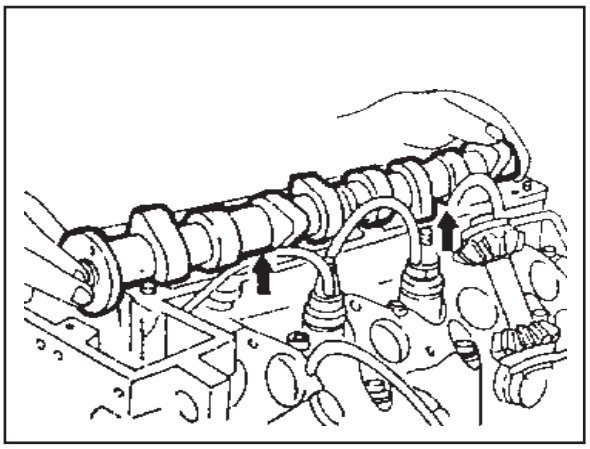


OM 661LA

7. Remove the camshaft bearing cap.
8. Pull off the camshaft.

Notice

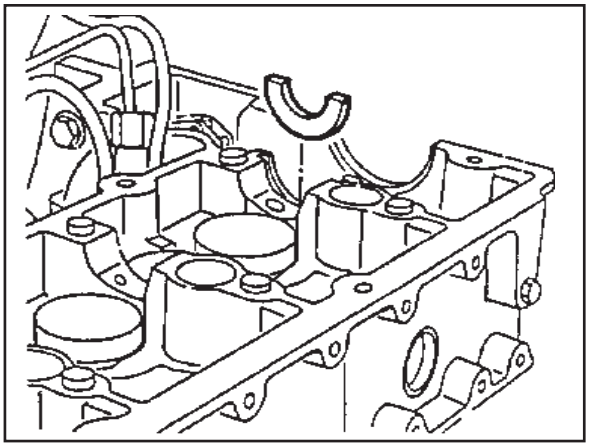
Be careful not to miss front locking washer.



9. Pull out the locking washer.

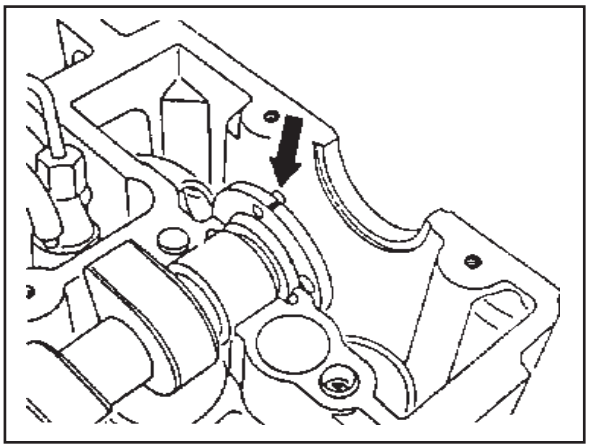
Notice

Check the condition of locking washer and replace if necessary.

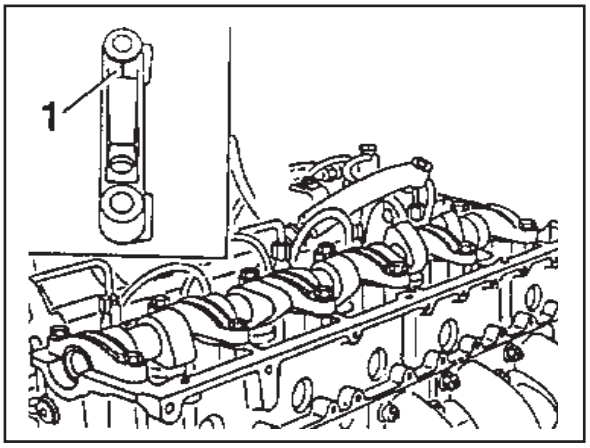


Installation Procedure

1. Insert the locking washer.
2. Check the valve tappet and ensure that tappet moves smoothly.
3. Coat the camshaft with oil and install the camshaft onto the cylinder head so that the TDC marking (arrow) is positioned upward vertically.



4. Install the camshaft bearing caps according to markings(1, 2, 3 etc.).

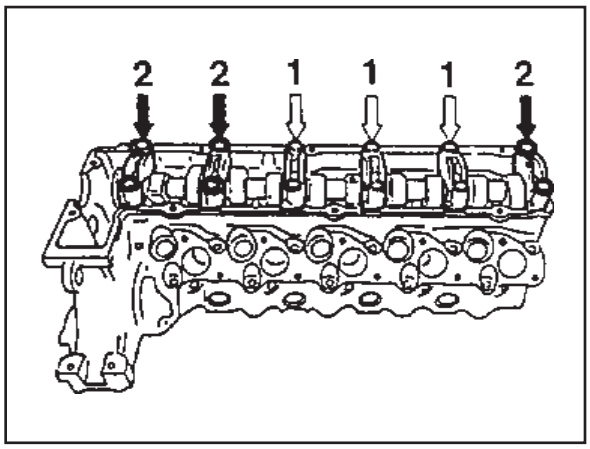


5. Tighten the camshaft bearing cap bolts acccording to installation order.

Tightening Torque	25 Nm

Notice

Tighten the No. 1 bolts (light arrow) by one revolution in stages first and then tighten the No.2 bolts (dark arrow).



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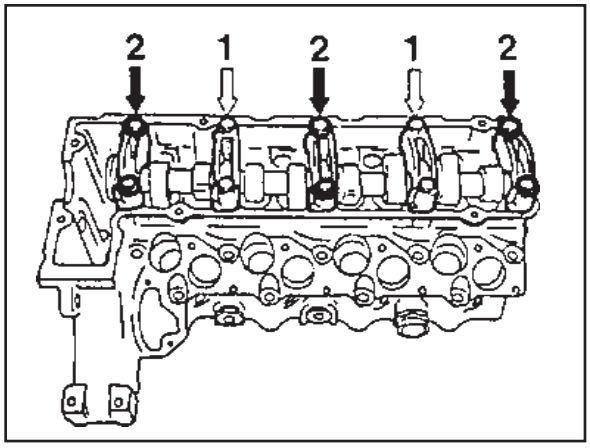
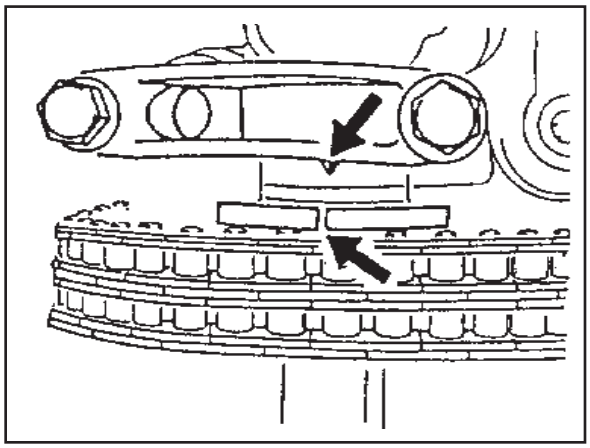


OM 661LA

6. Install the camshaft sprocket to be aligned the markings of the camshaft / camshaft bearing cap (arrow).

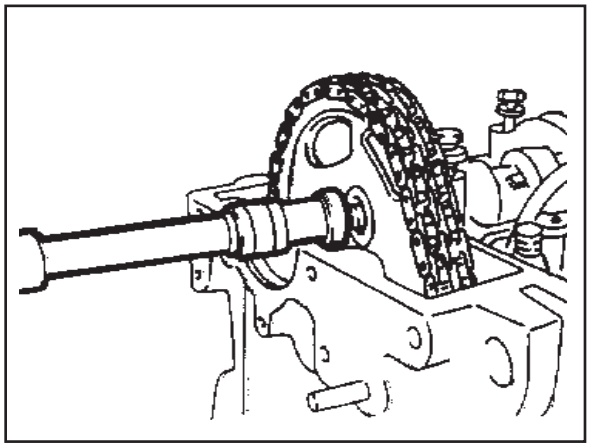
Notice

Align the alignment marks on the timing chain and sprocket.



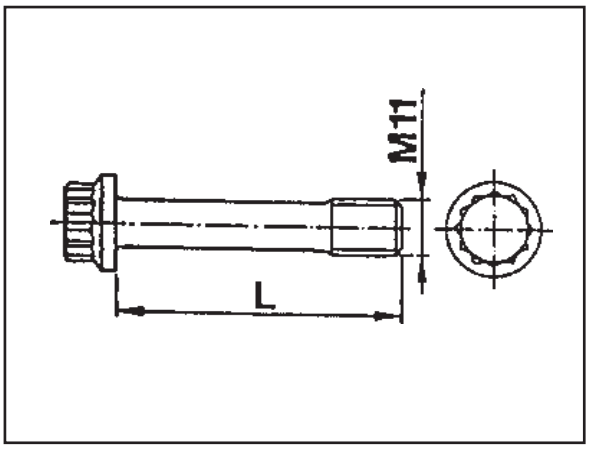
7. Tighten the camshaft sprocket bolt.

Tightening Torque	25Nm + 90°



Notice

If max. length 'L' of the 12-sided bolt exceeds 53.6mm, replace it.



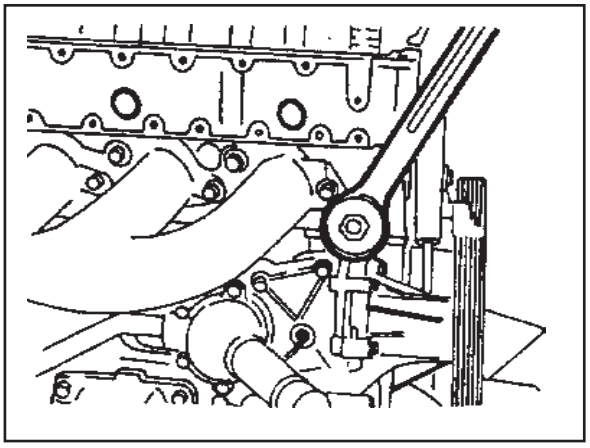
8. Install the chain tensioner.

Tightening Torque	80 Nm

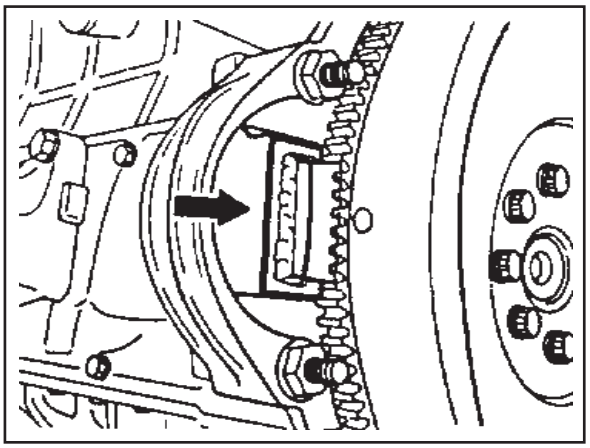
Notice

Replace the seal.

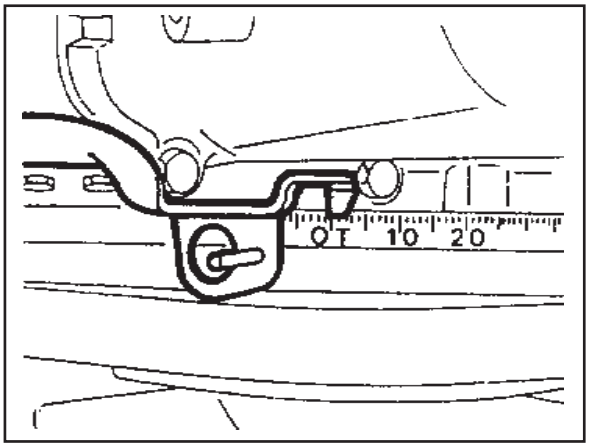
Before installation, by pumping in the oil approx. 10 times, fill the oil.



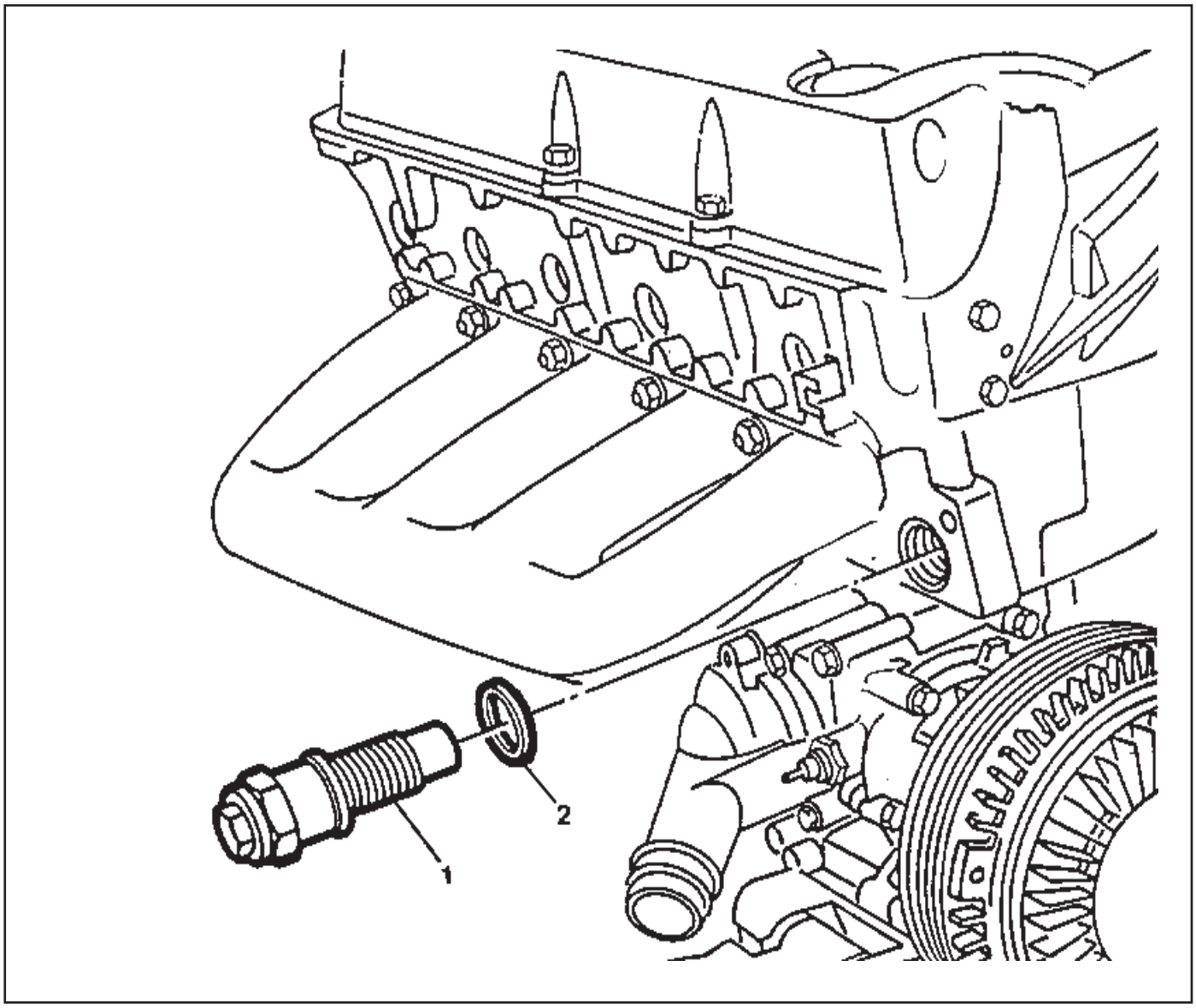
9. Remove the engine lock.



10. Check the TDC marking of OT on the crankshaft.



CHAIN TENSIONER



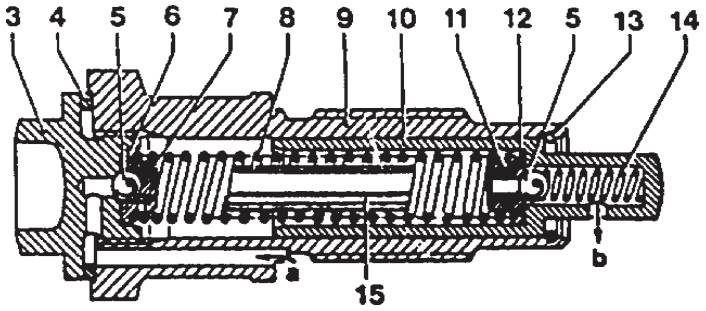
1 Chain Tensioner 80Nm
2 Seal ..... Replace

Notice

Always install the chain tensioner to be filled with oil.

Place the chain tensioner in engine oil up to over the collar on the hexagon head with the thrust pin facing up. Slowly push down the thrust pin as far as the stop 7~10 times with the aid of a press or a column drill

Faulty chain tensioners should be replaced completely.

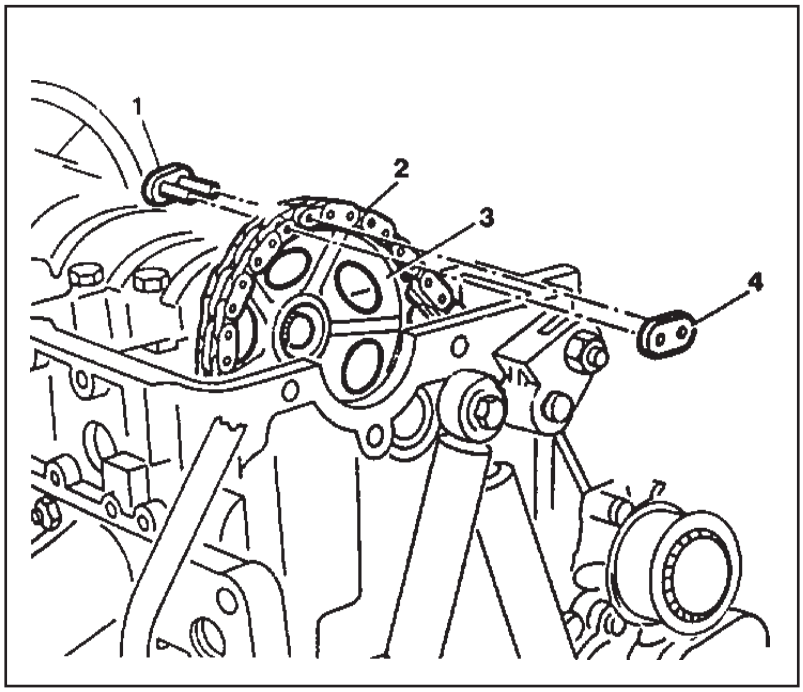


3 Screw Plug
4 Aluminum Gasket
5 Ball
6 Ball Guide
7 Compression Spring
8 Compression Spring
9 Housing
10 Thrust Pin
11 Valve Disc
12 O-Ring
13 Snap Ring
14 Compression Spring
15 Filler

A Feed Bore from Cylinder Head
B To Oil Pan

TIMING CHAIN

Preceding Work : Removal of glow plug
Removal of chain tensioner
Removal of cooling fan
Removal of cylinder head cover



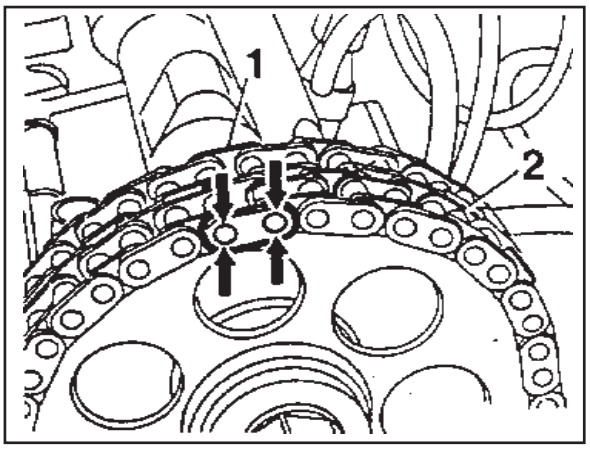
1 Chain Link
2 Timing Chain
3 Camshaft Sprocket
4 Outer Plate

Tools Required

000 589 58 43 00 Chain Assembling Device

Replacement Procedure

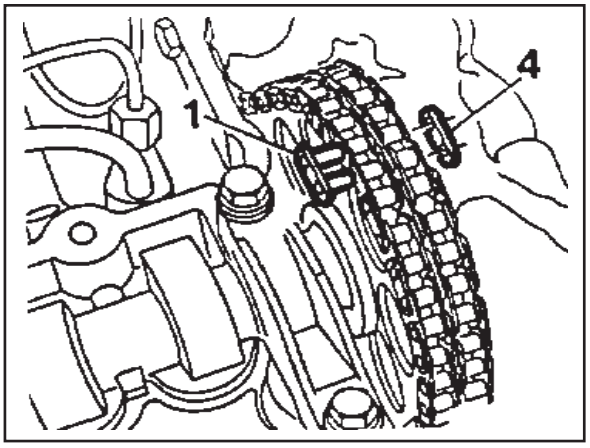
1. Cover over the chain box with cleaning rag and grind off both chain pins (arrow) at a chain link (1) of the timing chain.



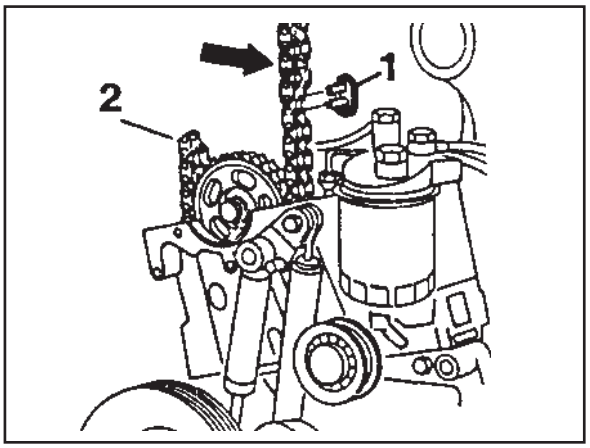
2. Remove the outer plate (4) and chain link (1).

   Notice

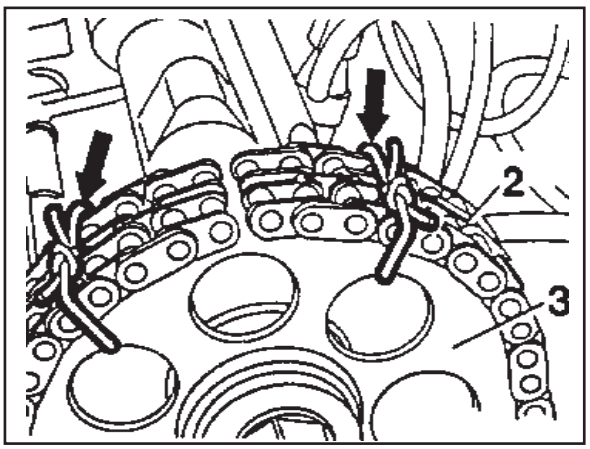
   Ensure that the ends of the timing chain do not drop into the chain box.



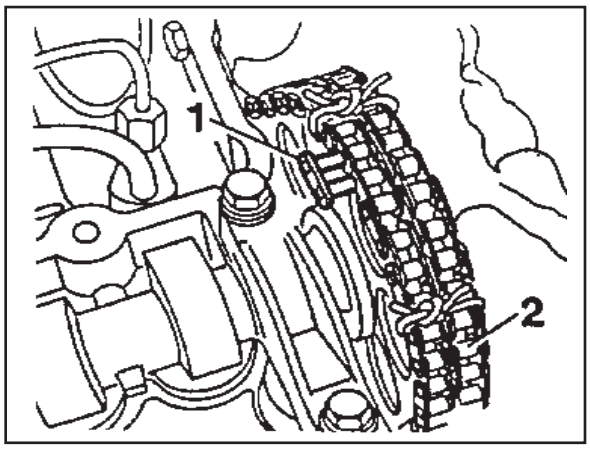
3. Loosen the chain tension with approx. 4 turns.
4. Connect the new timing chain (arrow) with chain link (1) to the old timing chain (2).



5. By rotating the crankshaft in the of engine rotation, pull out the old timing chain with installing the new timing chain.
6. Remove the old timing chain and hold the ends of the new timing chain to camshaft sprocket (3) with wire (arrow).

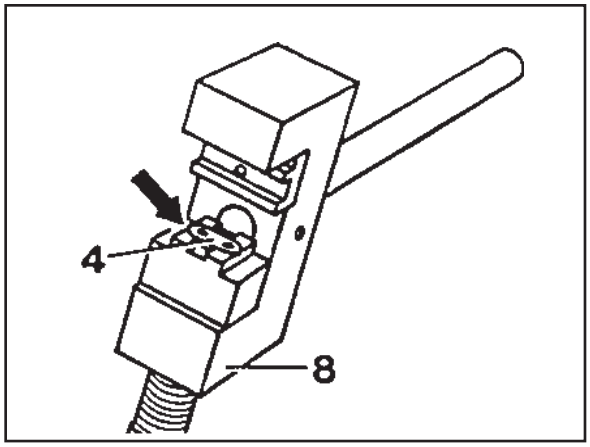


7. Insert the new chain link (1) to connect the chain.

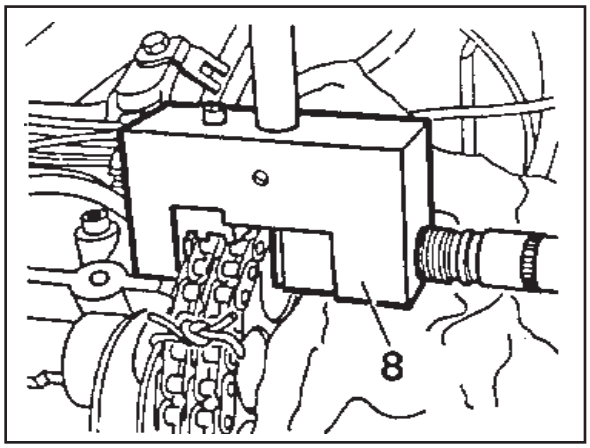


8. Insert the new outer plate (4) into the fitting tool (8) and then the outer plate will be held by a magnet.

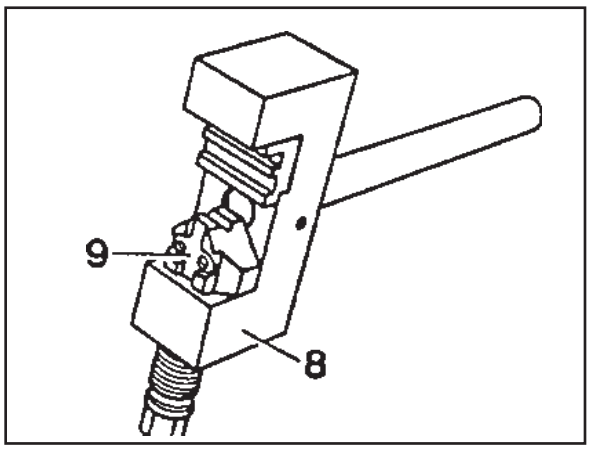
Chain Assembling Device 000 589 58 43 00



9. Place the fitting tool (8) onto the chain link and press the outer plate on as far as the stop.

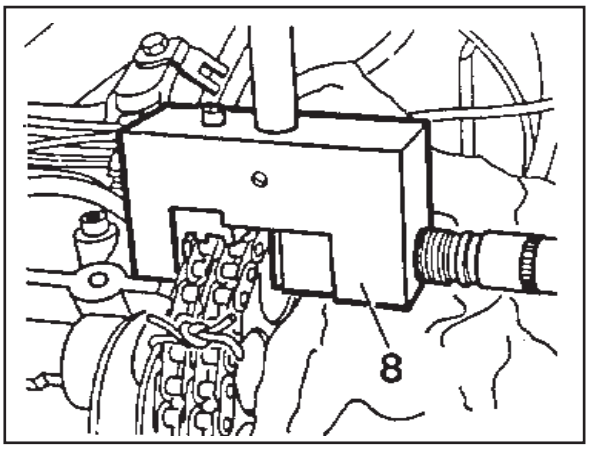


10. Switch over the die (9) of the fitting tool (8).

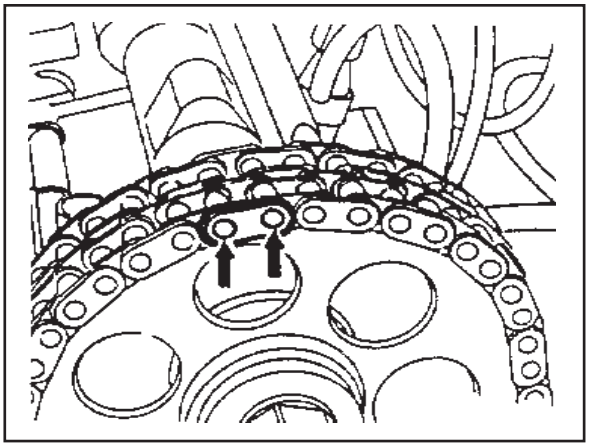


11. Place the fitting tool (8) onto the chain link and rivet the chain pins one by one.

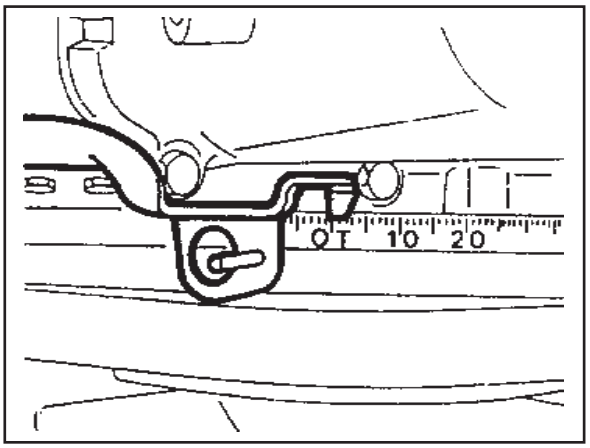
Tightening Torque	35 - 40 Nm



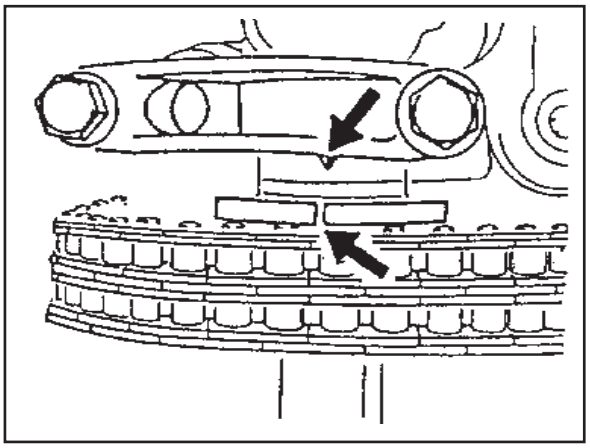
12. Check the riveting of chain pins and re-rivet if necessary.
13. Remove the wire.



14. Position the no.1 cylinder at TDC.

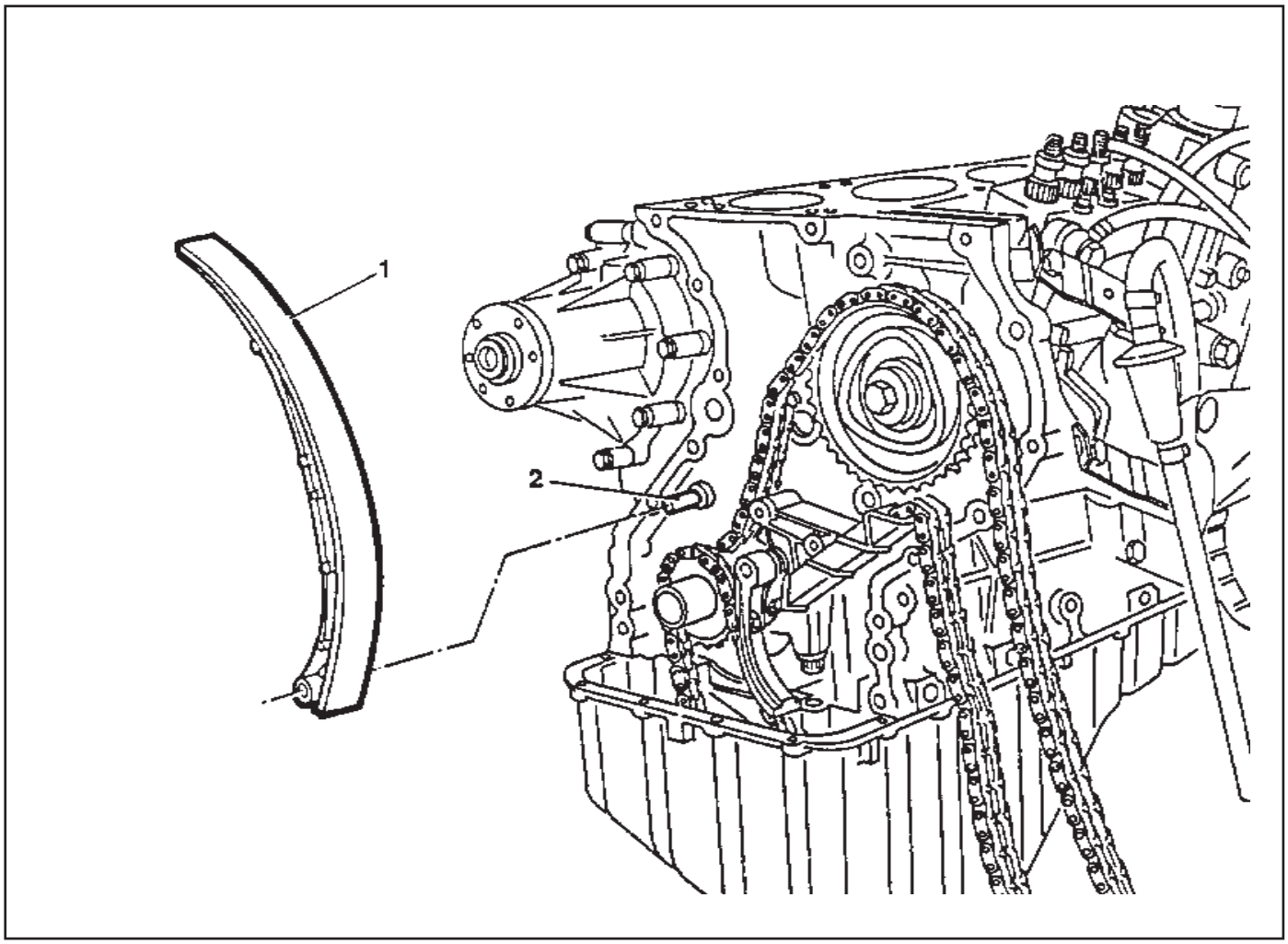


In this position, the marking on camshaft / camshaft bearing cap (arrow) must also be aligned. If the markings are not aligned, the timing chain must be re-set and the injection pump timing has to be set.



TENSIONING RAIL

Preceding Work : Removal of cylinder head
Removal of timing case cover



1 Tensioning Rail

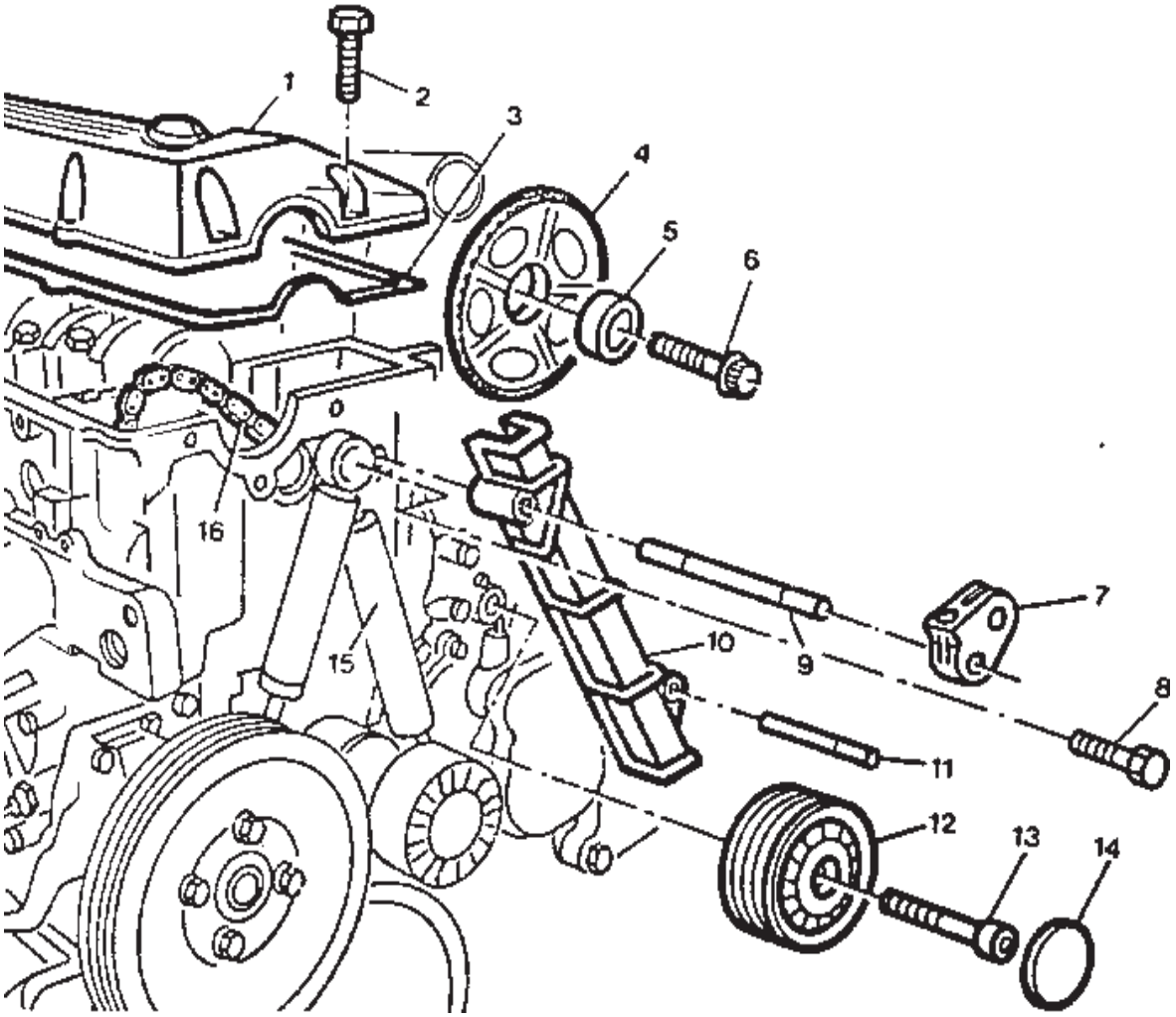
2 Bearing Pin

Notice

The plastic coating of the tensioning rail can not be replaced.

CYLINDER HEAD GUIDE RAIL

Preceding Work : Removal of the cooling fan
Removal of poly V-belt
Removal of chain tensioner



1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Camshaft Sprocket
5 Washer
6 12-Sided Bolt (M11) ..... Inspect, 25Nm + 90°
7 Tensioning Lever
8 Bolt 23Nm
9 Bearing Pin ..... Sealing Compound
10 Guide Rail
11 Bearing Pin
12 Guide Pulley
13 Socket Bolt 23Nm
14 Closing Cover
15 Spring
16 Timing Chain

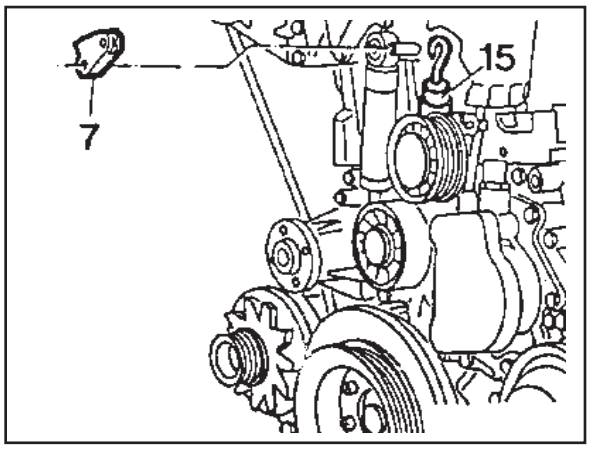
Tools Required

115 589 02 34 00 Sliding Hammer

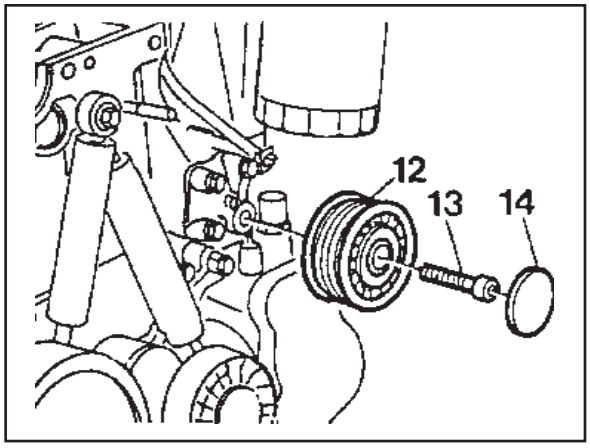
116 589 20 33 00 Threaded Pin

Removal Procedure

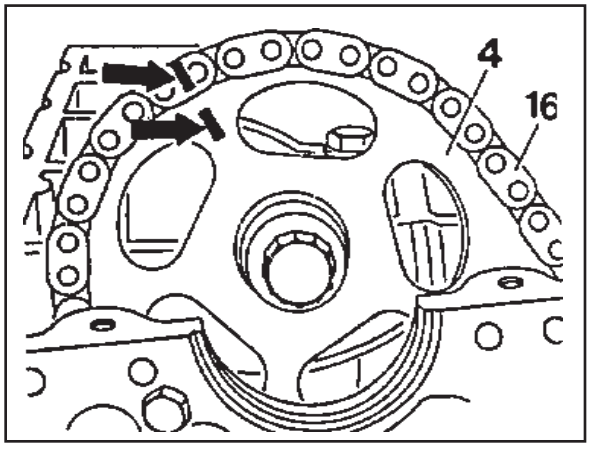
1. Removal the cylinder head cover.
2. Pull off the tensioning lever (7) and remove from the spring (15).



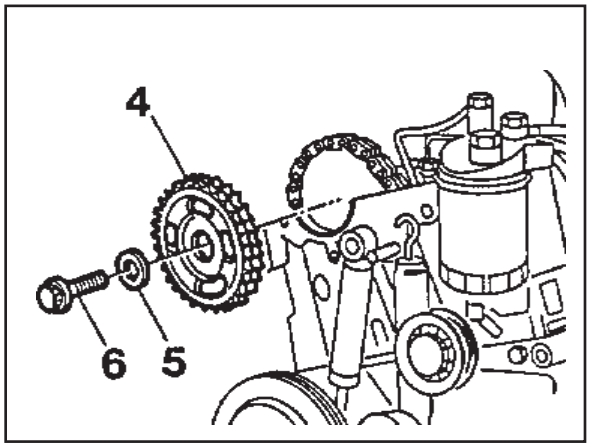
3. Pry off the closing cover (14) and remove the bolt (13) and then remove the guide pulley (12).



4. Place alignment marks (arrow) on the timing chain (16) and camshaft sprocket (4).

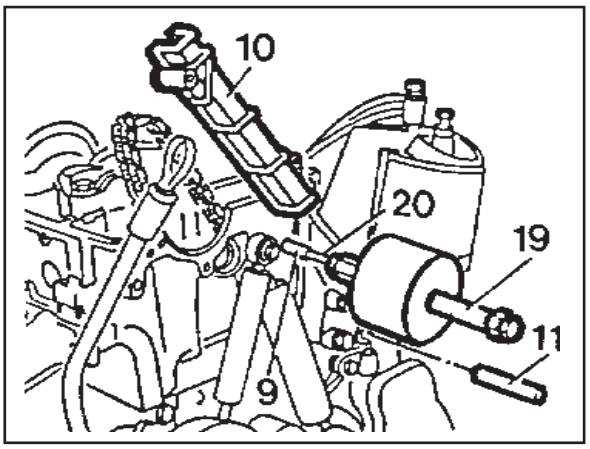


5. Remove the camshaft sprocket.



6. Pull out the bearing pins (9, 11) with sliding hammer and remove the guide rail 10.

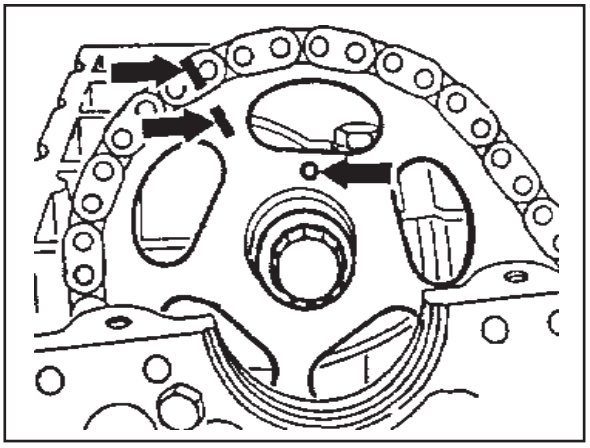
Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00



Installation Procedure

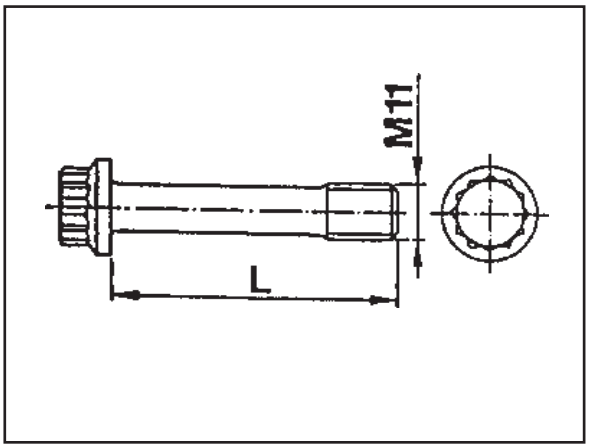
1. Apply collar of both bearing pins with sealing compound.
2. Position the guide rail and insert the bearing pins.
3. Install the camshaft sprocket.

Tightening Torque	10 Nm

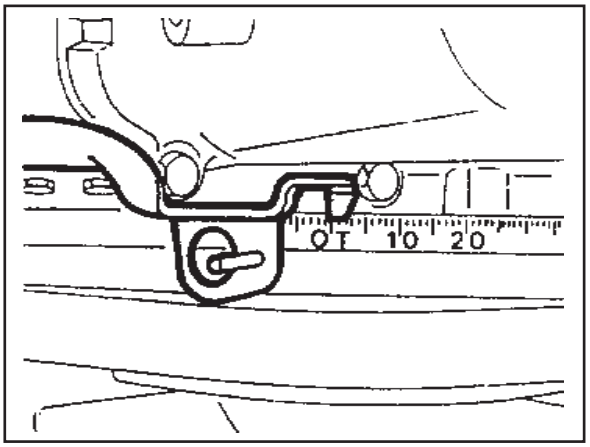


Notice

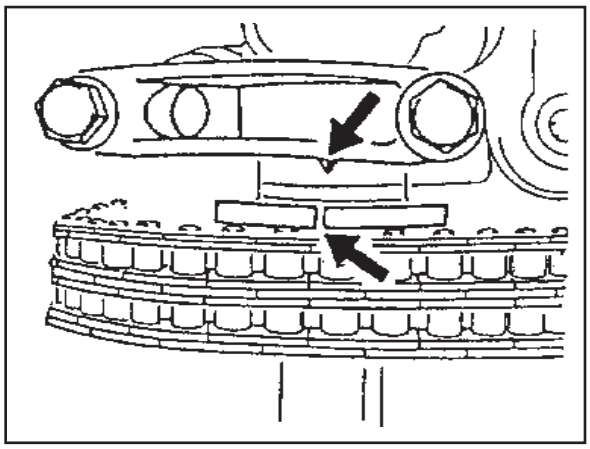
If the max. length 'L' of the 12-sided bolt exceeds 53.6mm, replace it.



4. Position the no. 1 cylinder at the TDC of OT.



In this position, the marking on the camshaft / camshaft bearing cap (arrow) must also be aligned.



5. Install the guide pulley (12).

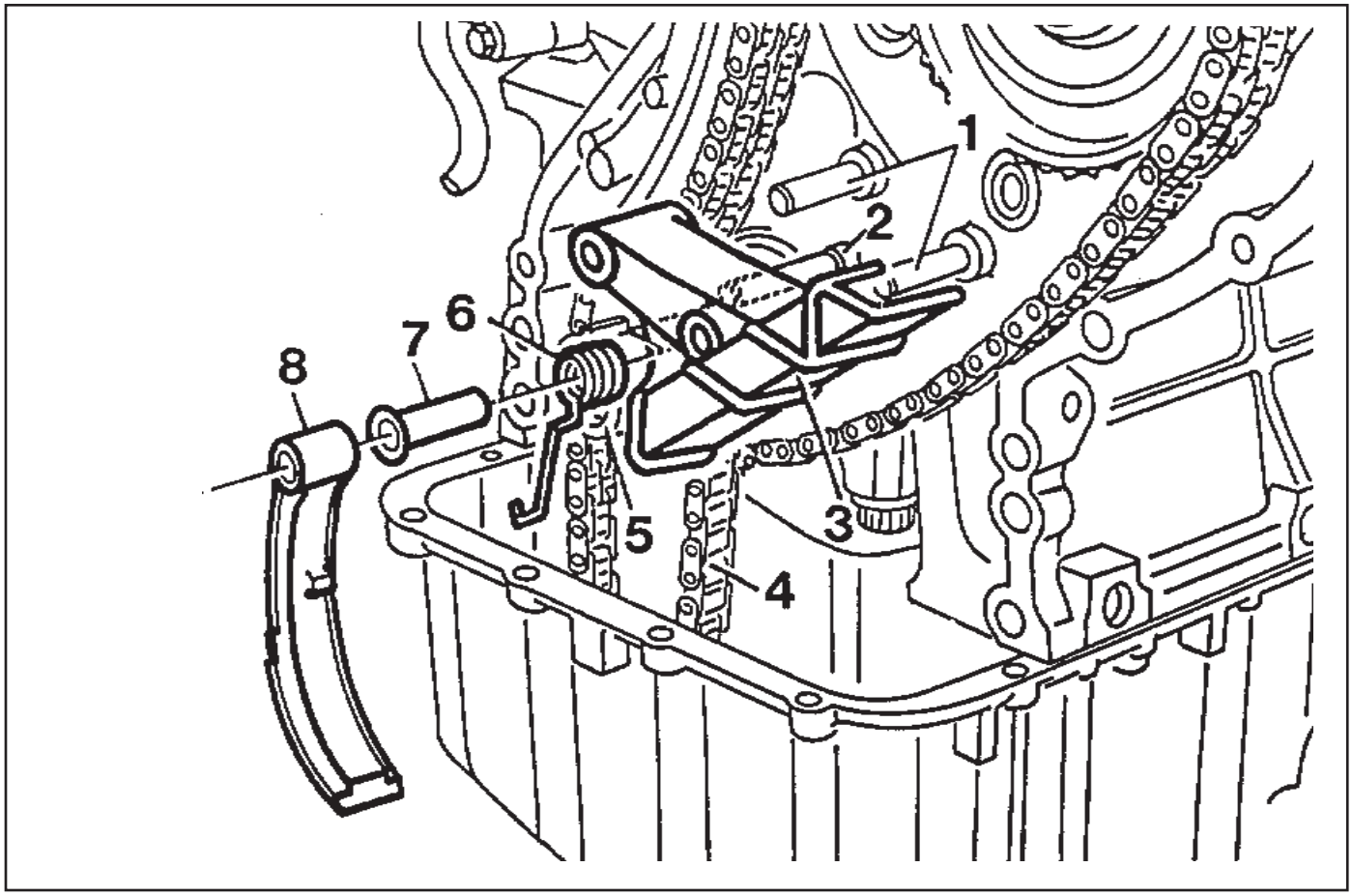
Tightening Torque	23 Nm

6. Attach the tensioning lever (7) to the spring (15) and install.
7. Replace the gasket and install the cylinder head cover.

Tightening Torque	10 Nm

TIMING CASE COVER GUIDE RAIL

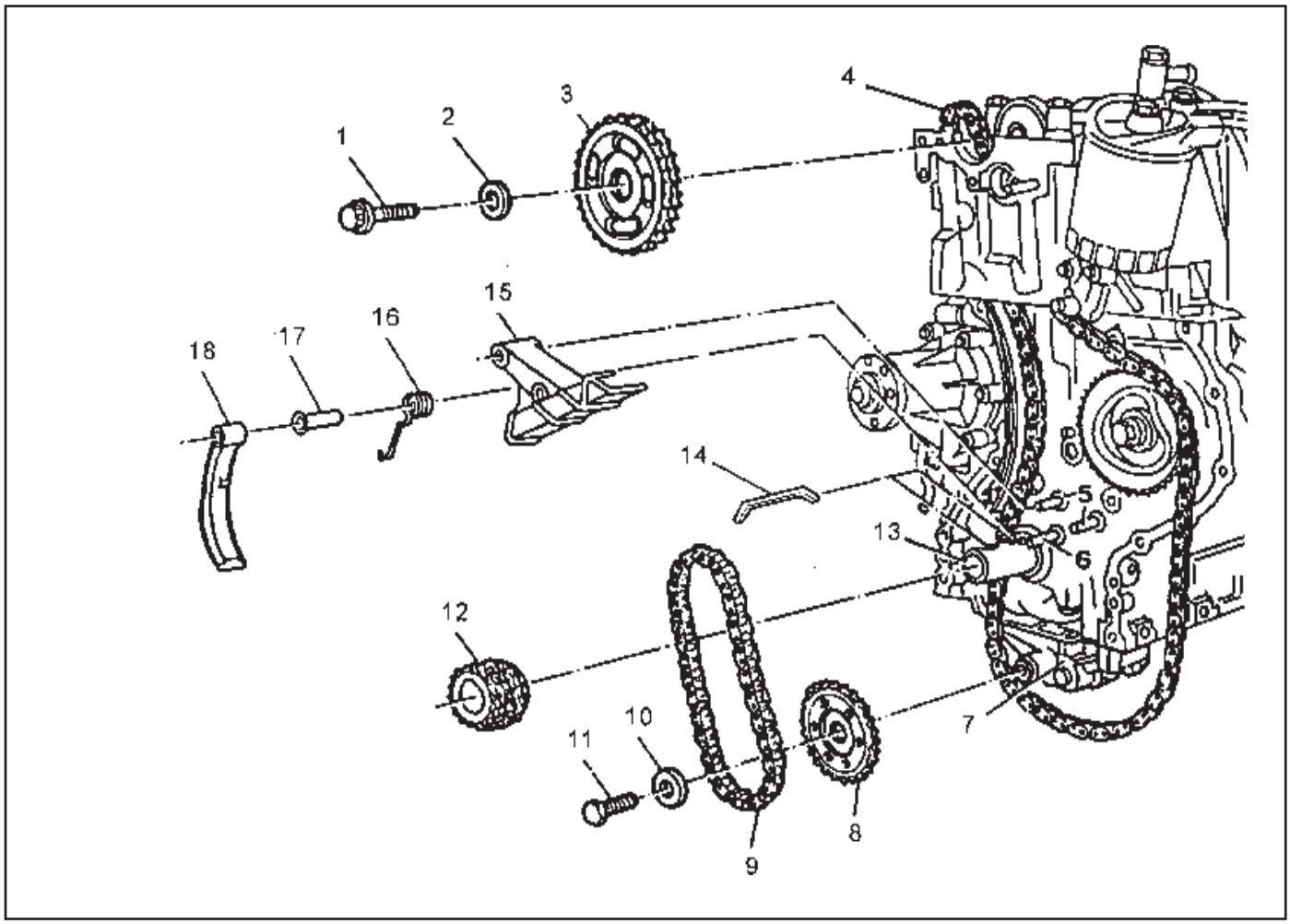
Preceding Work : Removal of cylinder head cover



1 Bearing Pin
2 Bearing Pin
3 Guide Rail
4 Oil Pump Chain
5 Crankshaft
6 Spring
7 Bushing
8 Tensioning Lever

CRANKSHAFT SPROCKET

Preceding Work : Removal of oil pan
Removal of timing case cover



1 12-Sided Stretch Bolt (M11) .. Check, 25Nm + 90°
2 Washer
3 Camshaft Sprocket
4 Timing Chain
5 Bearing Pin
6 Bearing Pin
7 Oil Pump
8 Oil Pump Sprocket
9 Oil Pump Chain
10 Washer
11 Bolt 25Nm
12 Crankshaft Sprocket
13 Crankshaft
15 Key
16 Guide Rail
17 Spring
18 Bushing
19 Tensioning Lever

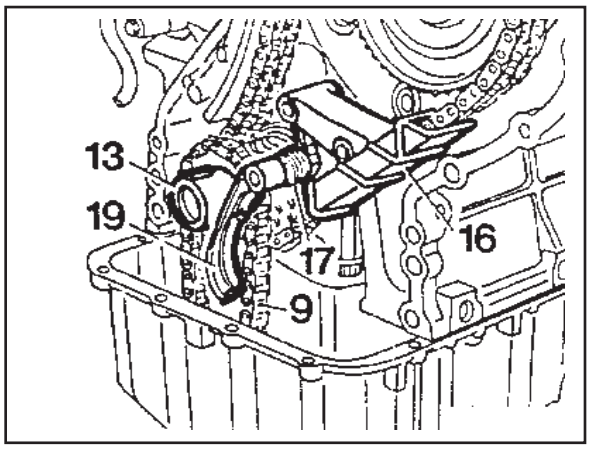
Special Tools

116 589 07 15 00 Drift

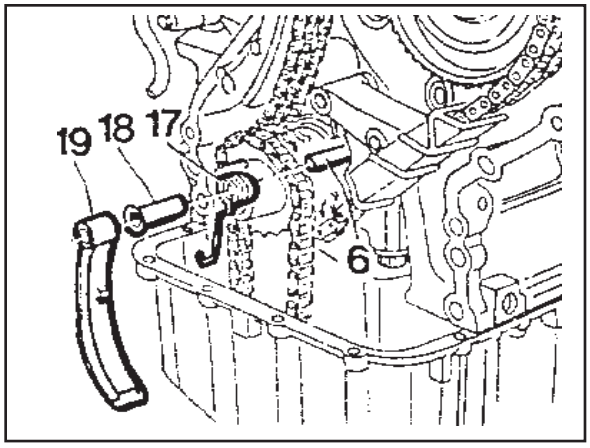
102 589 05 33 00 Puller

Removal Procedure

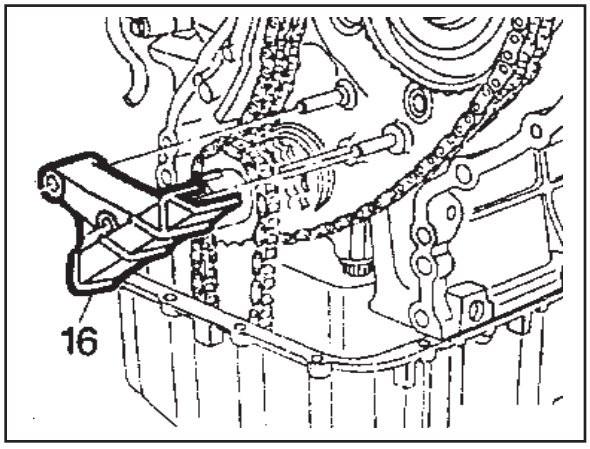
1. Pull out the tensioning lever (19) together with the spring (17) and guide rail (16) far enough until the tensioning lever has passed the oil pump chain (9) and is resting against the crankshaft (13).



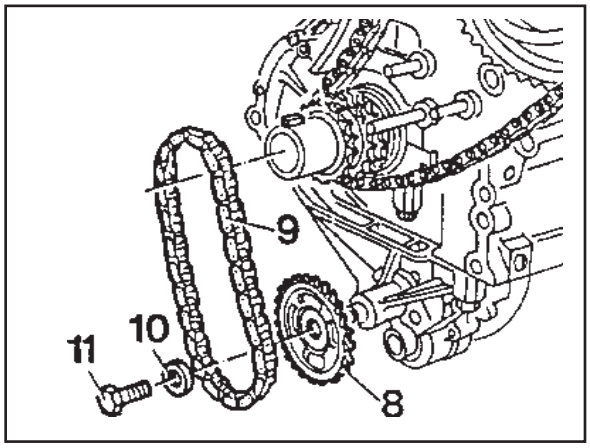
2. Pull out tensioning lever (19), spring (17) and bushing (18) from the bearing pin (6).



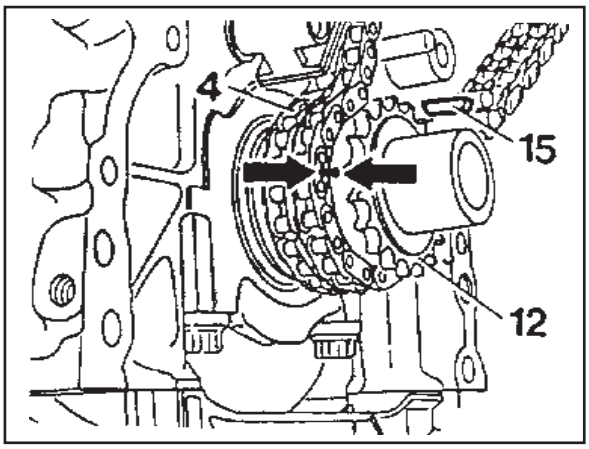
3. Pull out the guide rail (16).



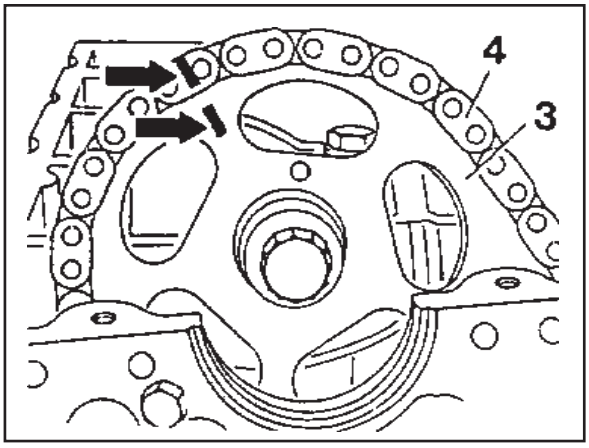
4. Remove the bolt(11) and then remove the washer (10), oil pump chin (9) and sprocket (8).



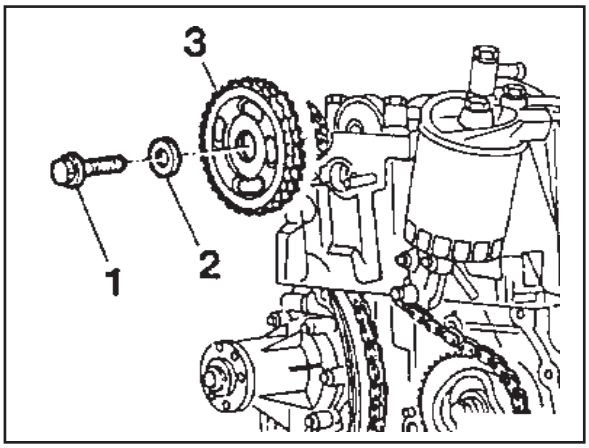
5. Place alignment marks (arrow) on the timing chain (4) and crankshaft sprocket (12).
6. Remove the woodruff key(15).



7. Place alignment marks (arrow) on the timing chain (4) and camshaft sprocket (3).

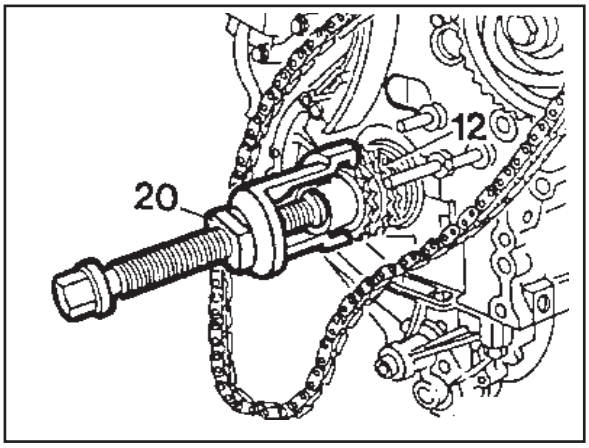


8. Remove the chain tensioner.
9. Remove the bolt (1) and then remove the washer (2) and camshaft sprocket (3).



10. Remove the crankshaft sprocket (12) by using a puller (20).

Puller 102 589 05 33 00

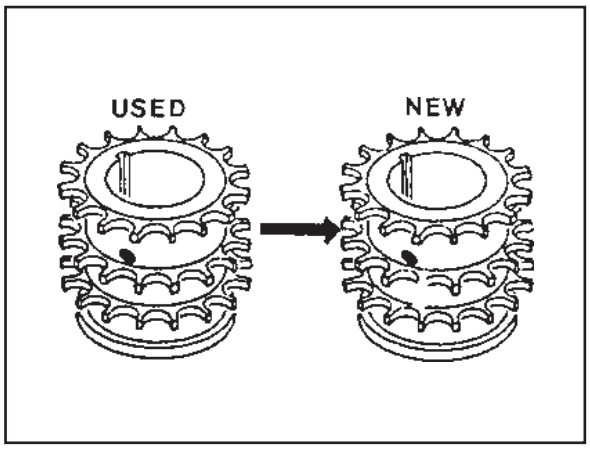


Installation Procedure

1. Put the same alignment mark on the new crankshaft sprocket as in the old sprocket.

   Notice

   Check the timing chain, camshaft sprocket, injection pump timing sprocket, oil pump chain and oil pump sprocket for wear and replace if necessary.

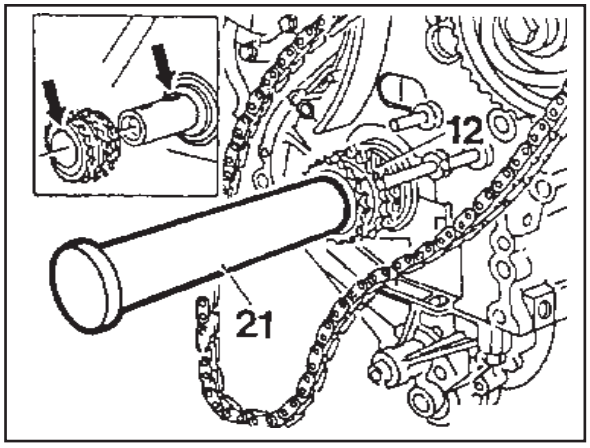


2. Install the new crankshaft sprocket (12) by using a drift (21).

   Notice

   Align the groove of sprocket and woodruff key (arrow) exactly.

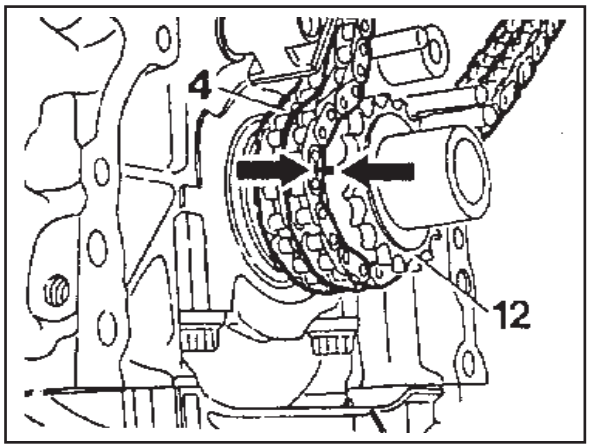
   Drift 116 589 07 15 00



3. Fit the timing chain (4) on the crankshaft sprocket (12).

   Notice

   Align the alignment marks (arrow) on the chain and sprocket.

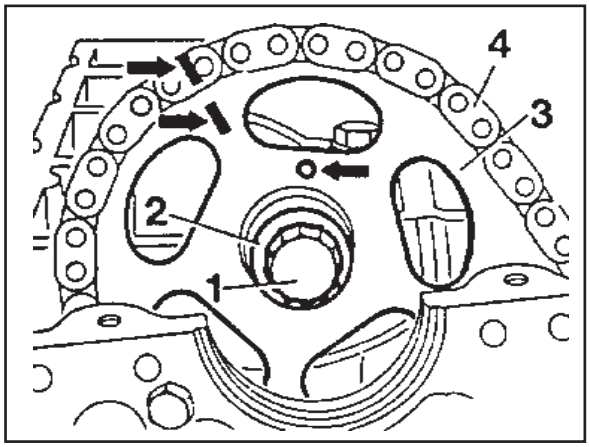


4. Install the camshaft sprocket (3).

Tightening Torque	25 Nm + 90°

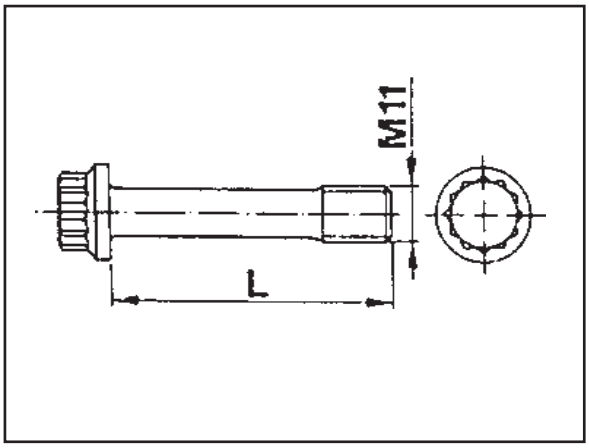
   Notice

   Pay attention on the alignment marks and dowel pin (arrow).



Notice

If the max. length 'L' of the stretch bolt exceeds 53.6mm, replace it.

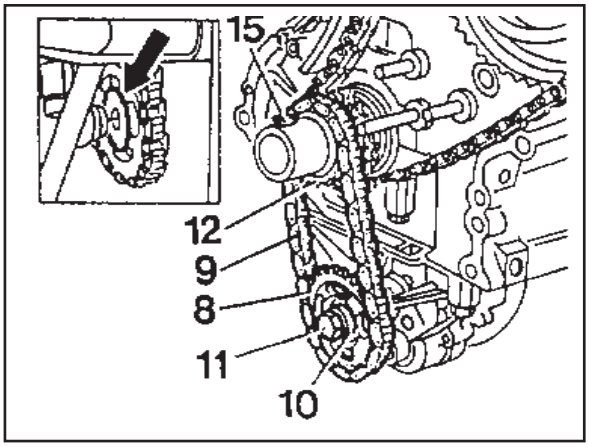


5. Fit the oil pump chain (9) on the crankshaft sprocket (12) and insert the oil pump sprocket (8) into the oil pump chain and then install it on the oil pump.

   Notice

   The curved side of the oil pump sprocket should face the oil pump.

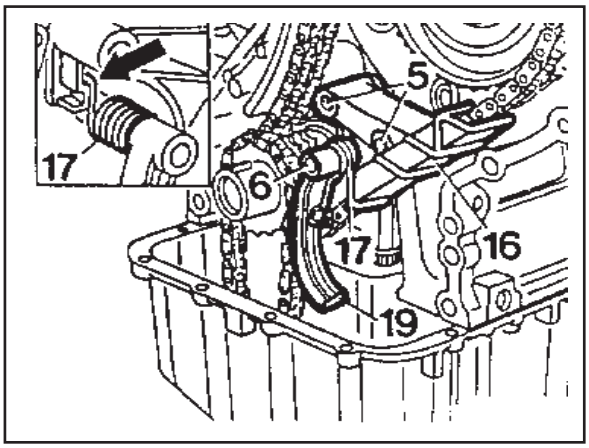
6. Insert the woodruff key (15).



7. Install the guide rail (16). Attach the spring (17) to guide rail and to tensioning lever together onto the bearing pins (5,6).

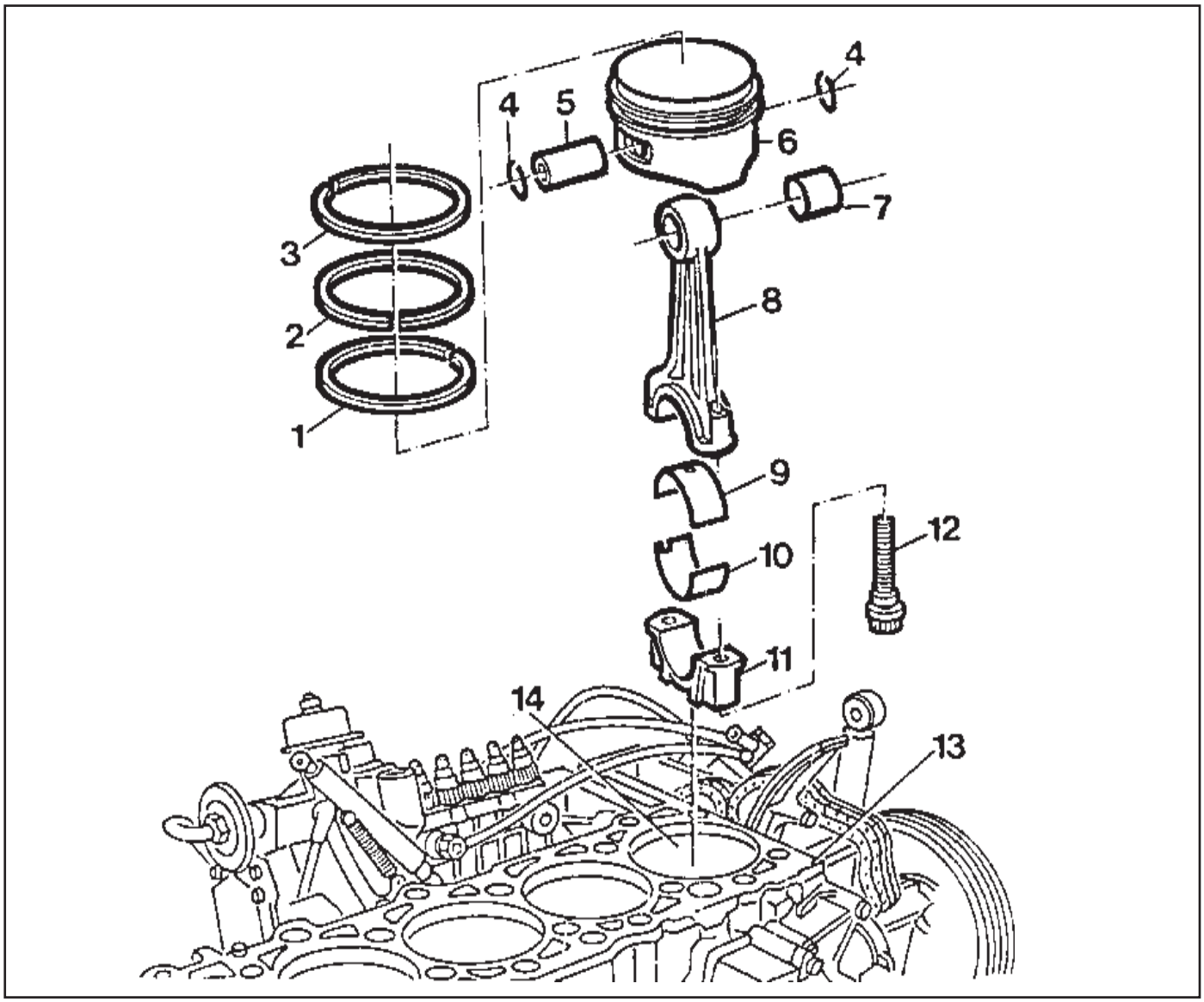
   Notice

   Ensure that the spring is correctly located in the guide rail (arrow).



PISTON

Preceding Work : Removal of the cylinder head
Removal of the oil pump



1 Oil Ring
2 2nd Ring
3 Top Ring
4 Snap Ring ..... Replace
5 Piston Pin
6 Piston
7 Connecting Rod Bushing ..... Check
8 Connecting Rod
9 Connecting Rod Upper Bearing Shell
10 Connecting Rod Lower Bearing Shell
11 Connecting Rod Bearing Cap
12 Connecting Rod Bolt ..... 35Nm + 90°
13 Crankcase
14 Cylinder Bore

Notice

There are two kinds of connecting rods (for machining) and they are different in weight approx. 15g. When replacing the connecting rod, measure its weight and ensure that a engine has the same weight of connecting rods. If not, there would be a unbalancing of engine.

Service Data

Piston clearance	Max. 0.12 mm
Piston crown protrusion in TDC position	0.735 - 0.965 mm
Connecting rod bushing diameter	26.012 - 26.018 mm

Connecting Rod Bolt Dimensions

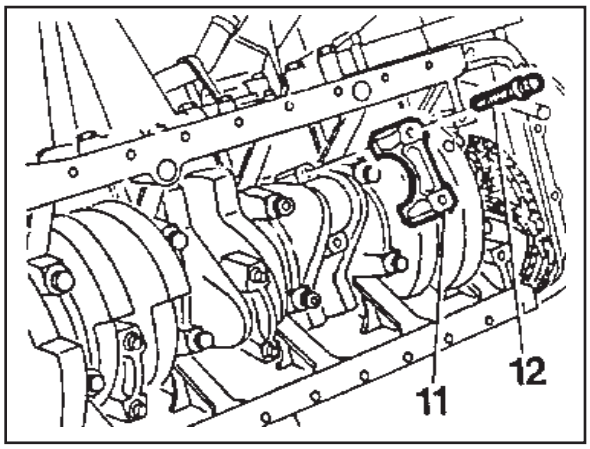
Thread	M9 x 1
Stretch shaft(C) diameter (new)	$7.4^{-0.1}$mm
Minimum stretch shaft diameter (C)	7.1 mm
Length(L)(new)	$52^{-0.3}$mm

Tools Required

000 589 04 14 00 Tensioning Strap
001 589 53 21 00 Dial Gauge
363 589 02 21 00 Dial Gauge Holder

Removal Procedure

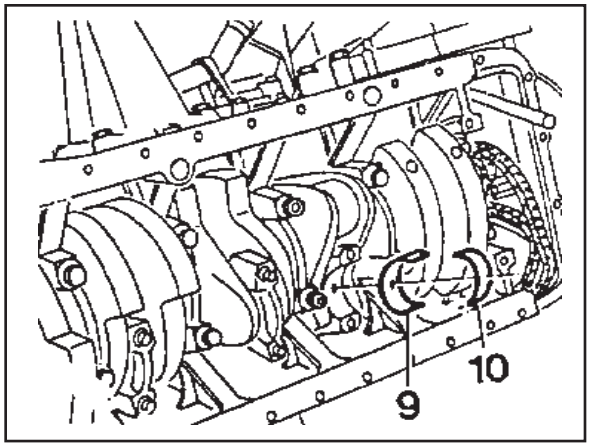
1. Remove combustion residues from the cylinder bores.
2. Remove the connecting rod bolts (12) and then remove the connecting rod bearing caps(11).



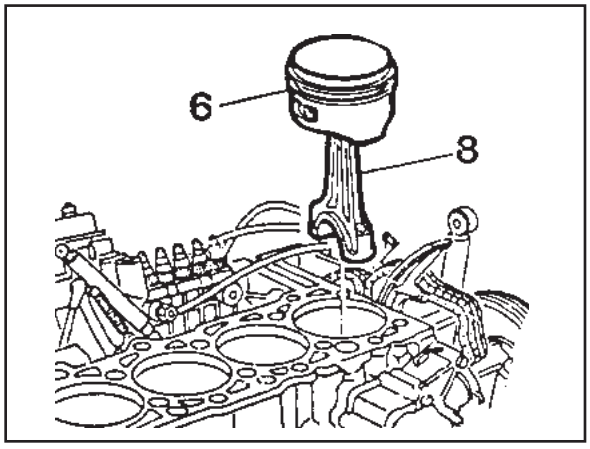
3. Remove the connecting rod bearing shells (9, 10).

   Notice

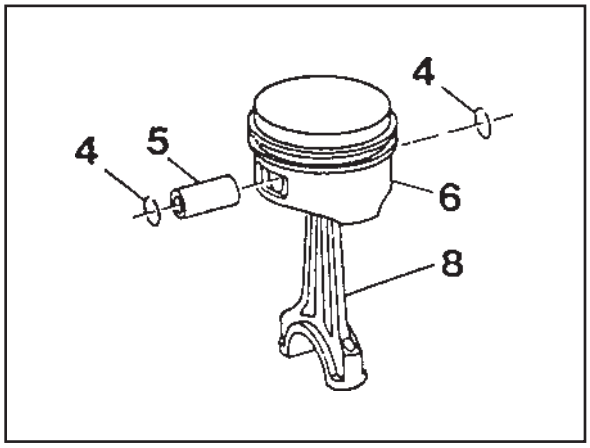
   Be careful not mix the bearing caps and shells each other.



4. Remove the piston (6) and connecting rod (8).

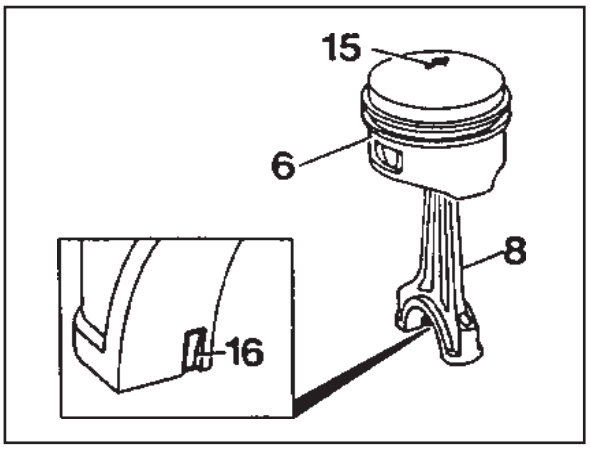


5. Remove the snap ring (4) and pull out the piston pin (5).
6. Separate the piston and connecting rod.



Installation Procedure

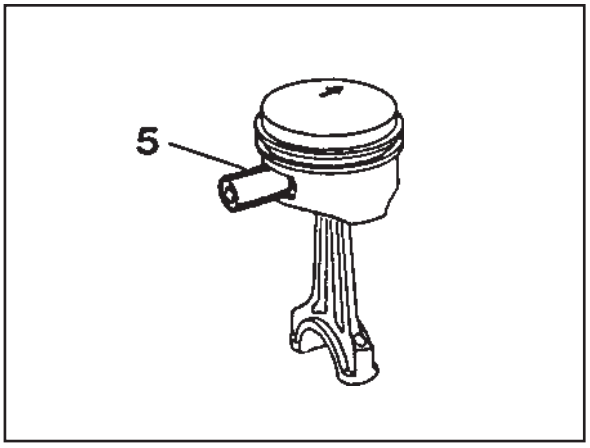
1. Fit the piston onto the connecting rod so that the arrow (15) and the locking slot (16) are facing in direction of the vehicle.



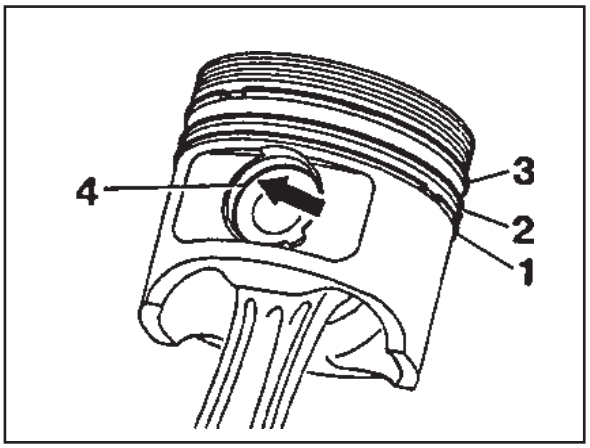
2. Coat the piston pin (15) with engine oil and insert it by hand.

   Notice

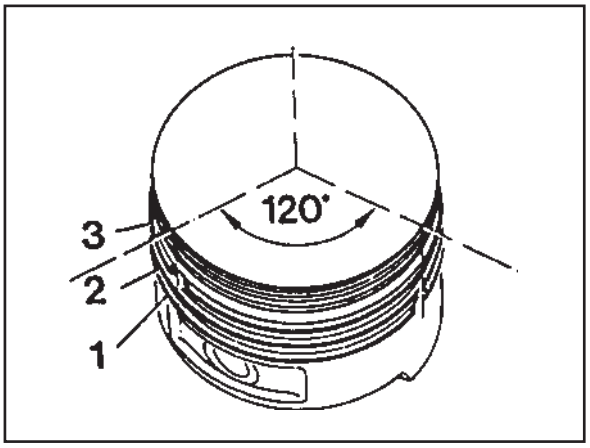
   Do not heat up the piston.



3. Install the new snap ring (4) into the grooves (arrow).
4. Check the piston rings (1, 2, 3) and replace them if necessary.

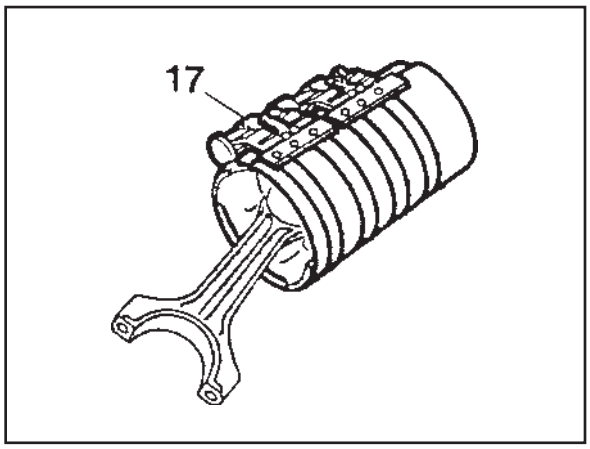


5. Install and arrange the piston rings to be evenly 120° from each ends gap.



6. Coat the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and piston with oil.
7. Compress the piston rings with a tensioning strap (7).

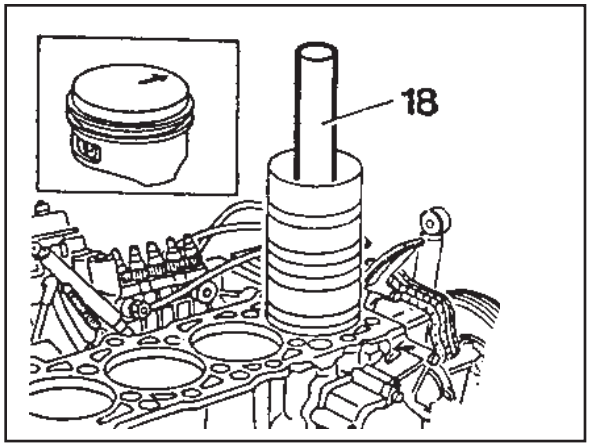
Tensioning Strap 000 589 04 14 00



8. Insert the piston assembly into the cylinder with a wooden stick (18).

Notice

The arrow on the piston crown must point toward the front of vehicle.



9. Insert the connecting rod bearing shells (9, 10).

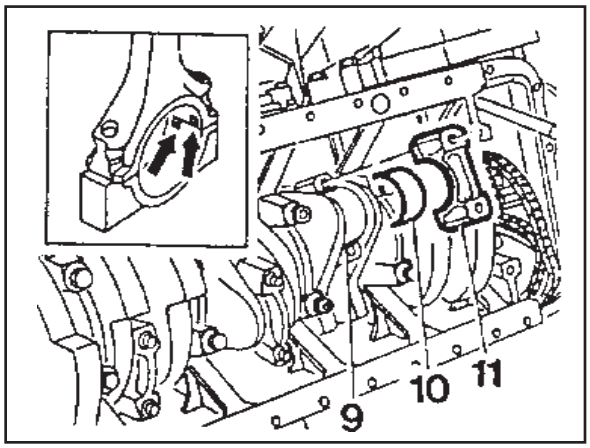
Notice

Be careful of the difference in upper and lower bearing shells and not to be changed.

10. Position the connecting rod bearings caps.

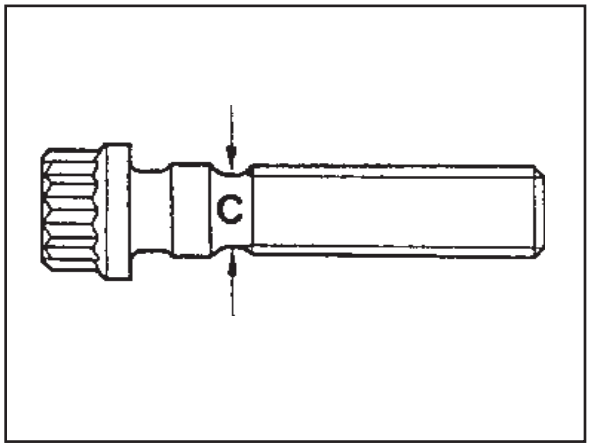
Notice

Position so that the retaining lugs are on the same side of the connecting rod bearing(arrow).



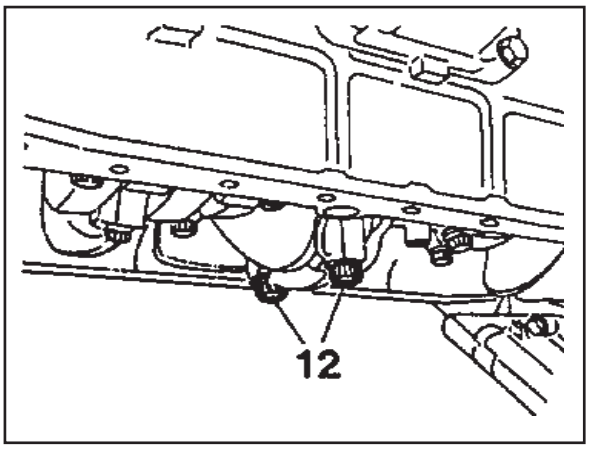
11. Measure stretch shaft diameter (C) of the connecting rod bolts.

Limit 'C'	7.1mm



12. Coat the bolts (12) with oil and then tighten the bolts.

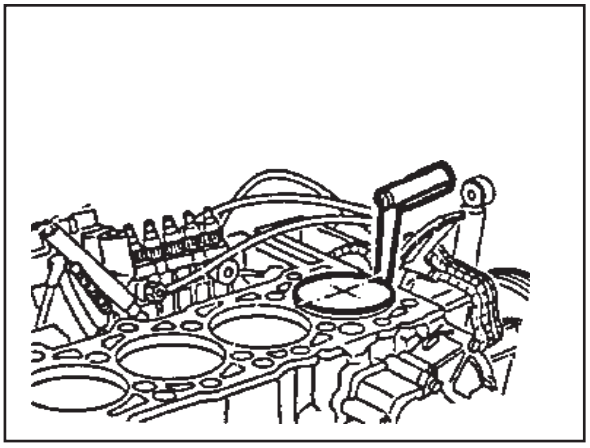
Tightening Torque	40Nm + 90°



13. Rotate the crankshaft and check axial clearance between the connecting rod and crankshaft.

14. Measure clearance between the piston crown and cylinder

Standard	Max. 0.12mm



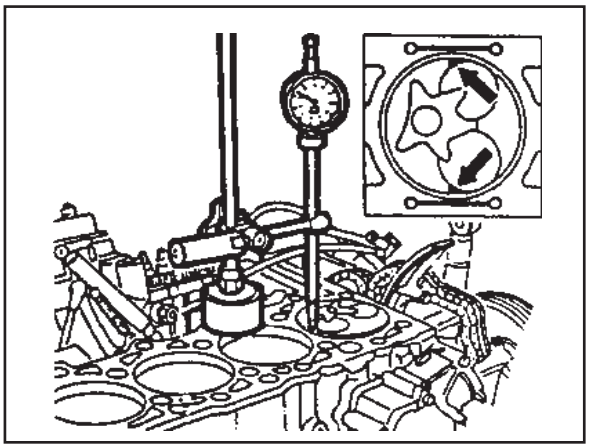
15. Position the piston at TDC and measure the distance between the piston crown and the crankcase surface.

Standard	Max. 0.965 mm

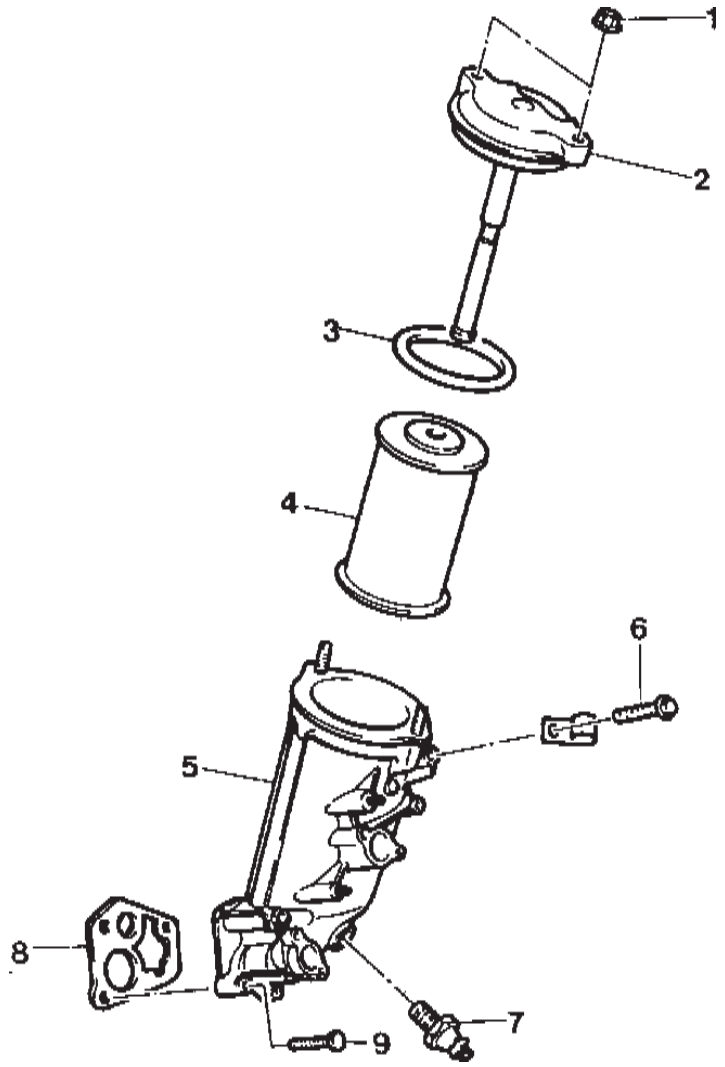
Notice

Measure at points marked.

Dial Gauge 001 589 00 53 21
Dial Gauge Holder 363 589 02 21 00



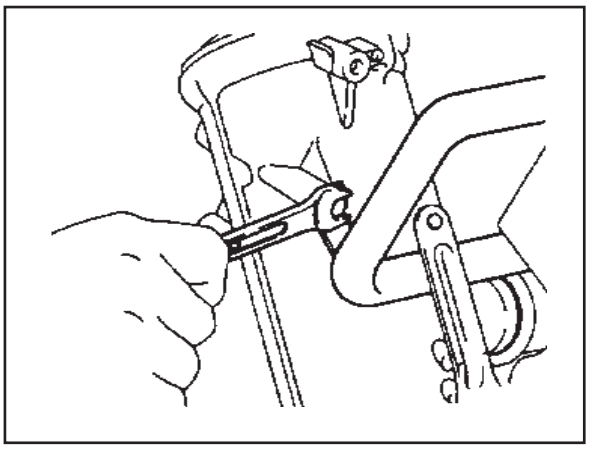
OIL FILTER



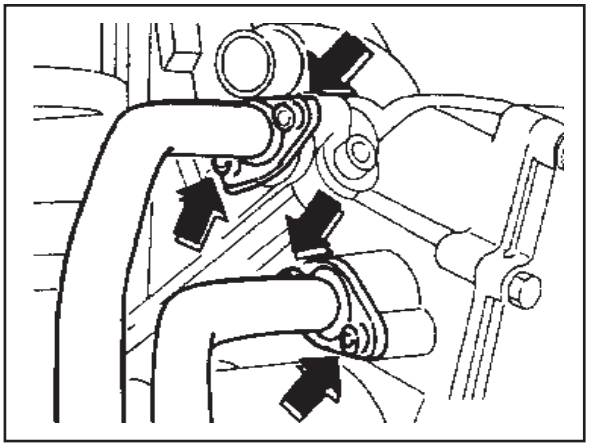
1 Nut ..... 25 Nm
2 Oil Filter ..... Cover
3 O-Ring ..... Replace
4 Oil Filter ..... Element Replace If necessary
5 Oil Filter Housing
6 Bolt (M8) 10Nm
7 Oil Pressure Switch
8 Gasket
9 Bolt ..... 25 Nm

Removal & Installation Procedure

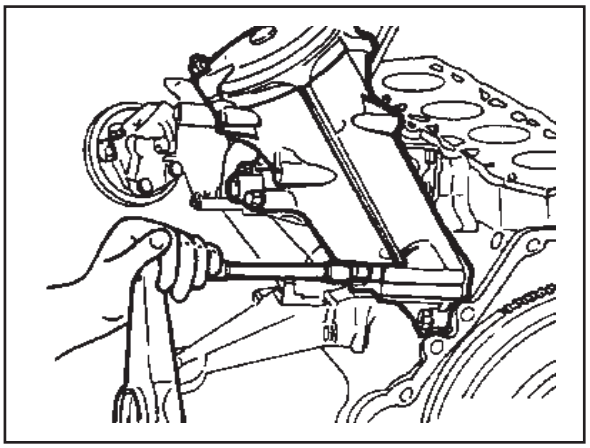
1. Remove the oil filter cover and then drain the oil.



2. Remove the oil pressure switch line.

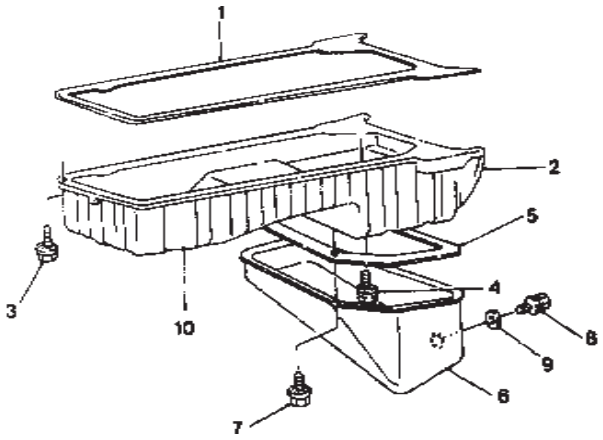


3. Remove the oil filter housing.
4. Clean the sealing surface.
5. Installation should follow the removal procedure in the reverse order.

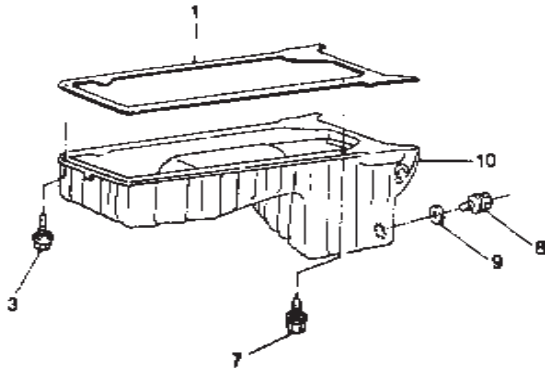


OIL PAN

OM662LA



OM661LA



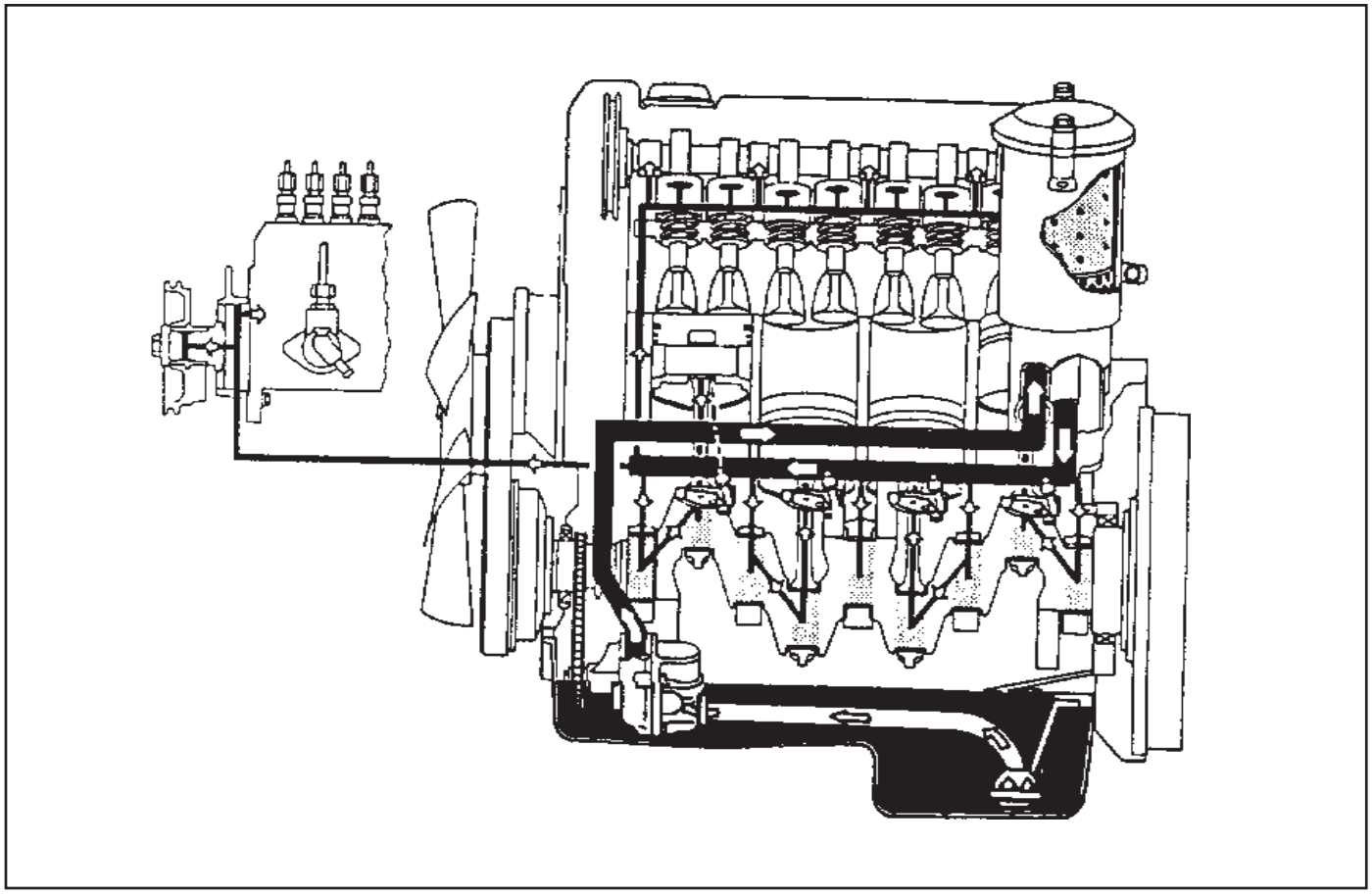
1	Gasket ..... Replace	6	Lower Oil Pan
2	Upper Oil Pan	7	Combination Bolt ..... 25 Nm
3	Combination Bolt ..... 10 Nm	8	Drain Plug ..... 25 Nm
4	Combination Bolt ..... 10 Nm	9	Washer Seal ..... Replace
5	Gasket ..... Replace	10	Oil Pan

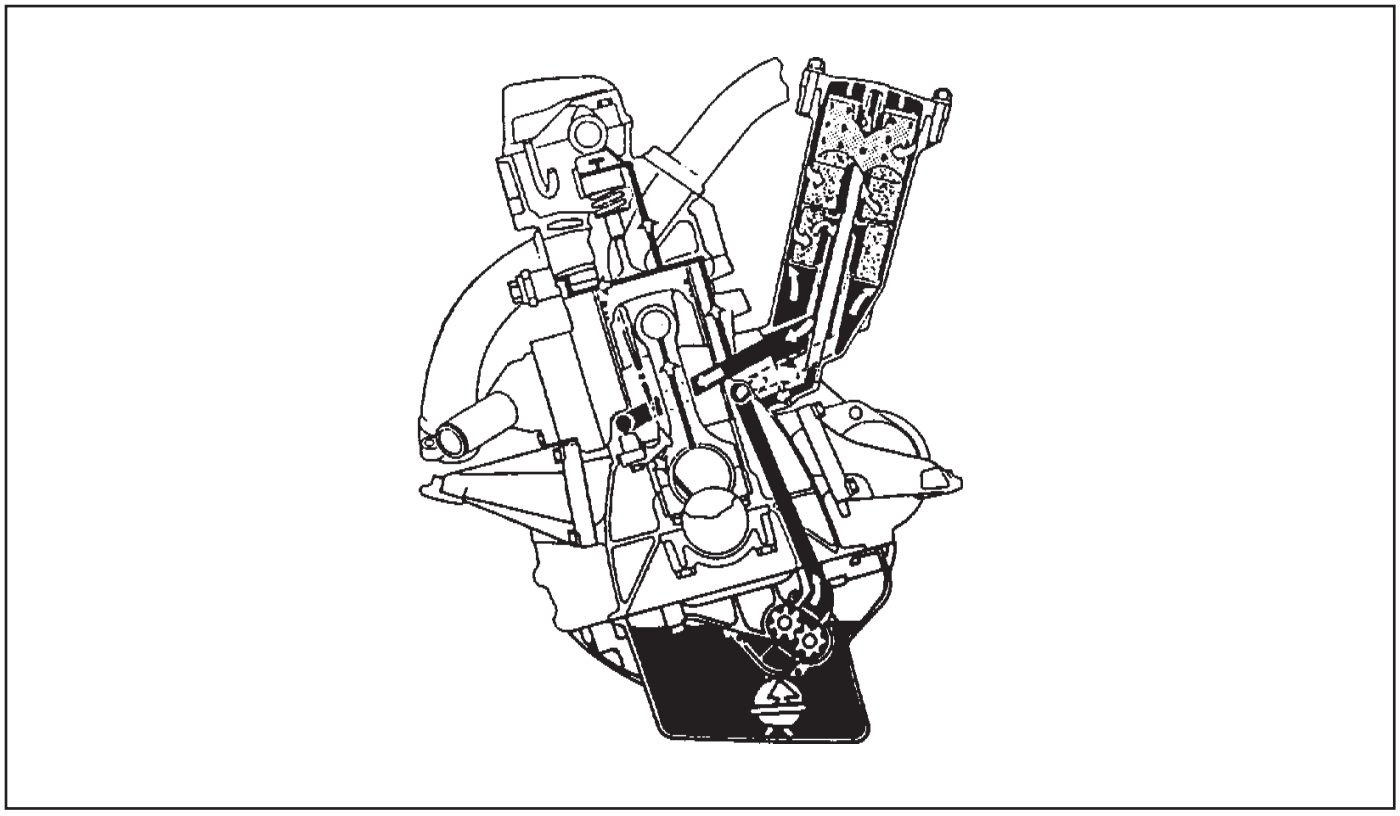
*Remove and install as numerical sequence.

Notice

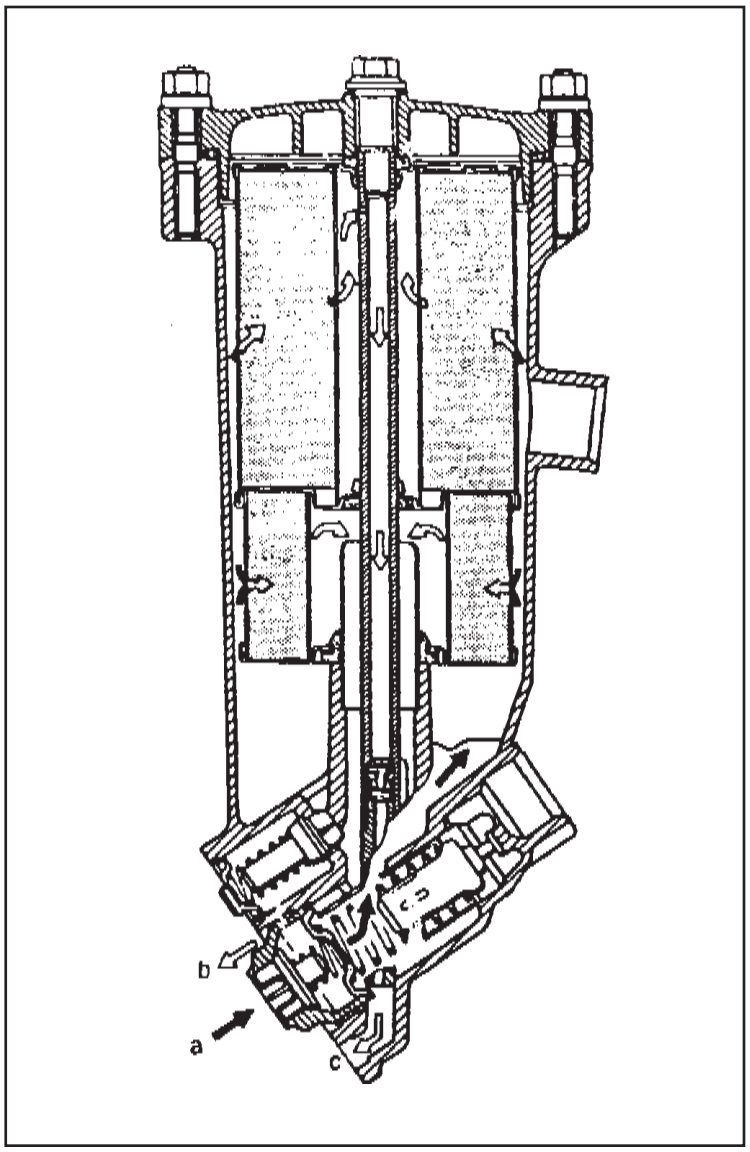
Replace the washer seal with new one.

Oil Circulation



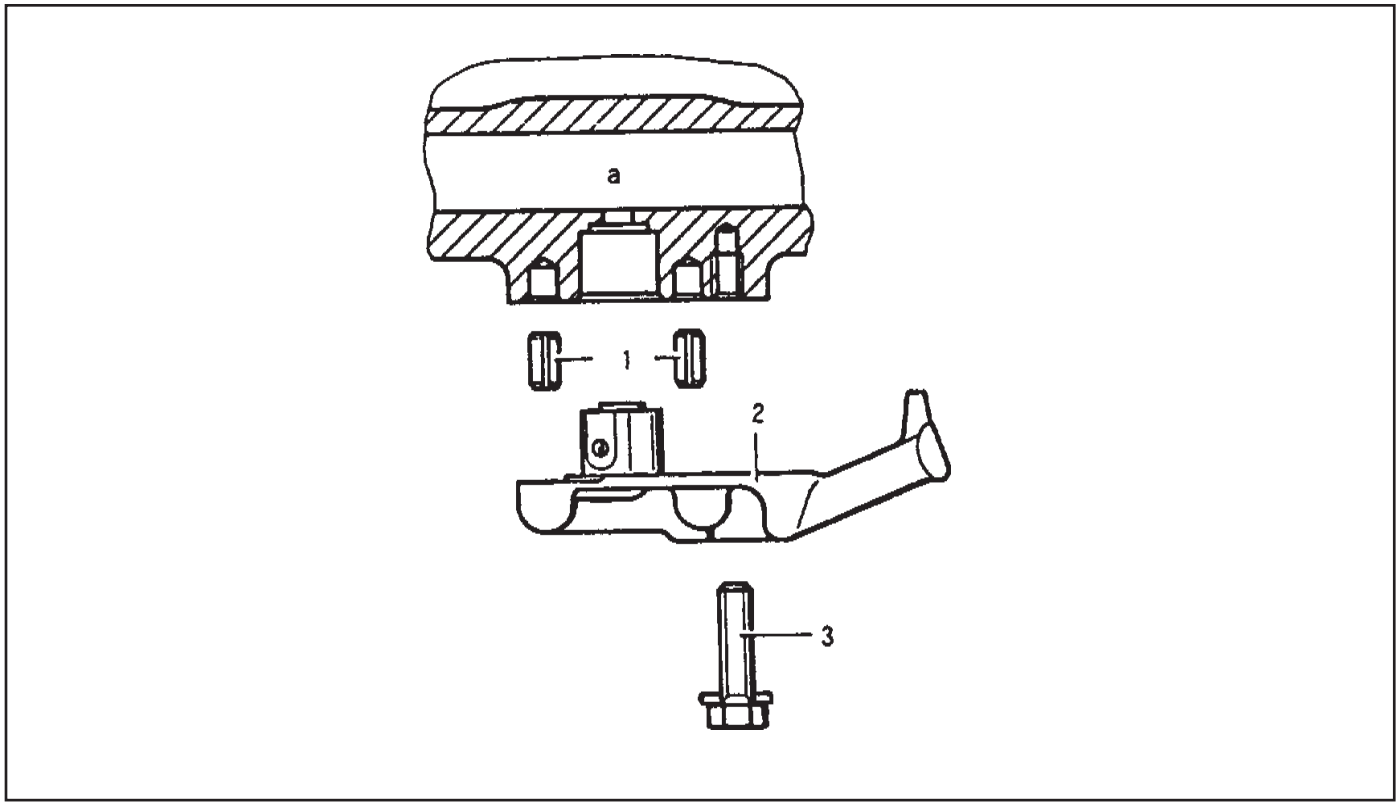


Oil Filter



a From Oil Pump
b To Main Oil Gallery
c To Oil Pan

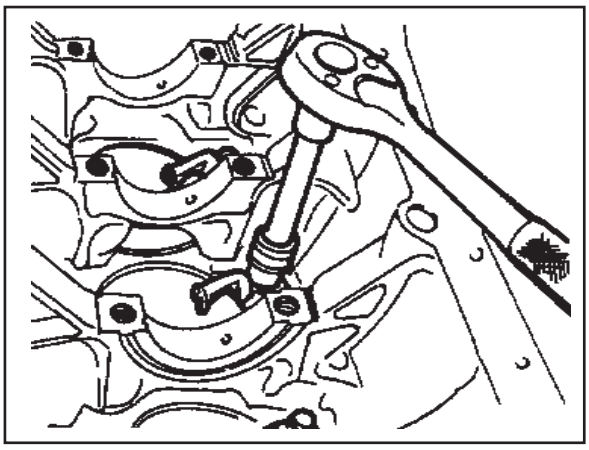
OIL SPRAY NOZZLE



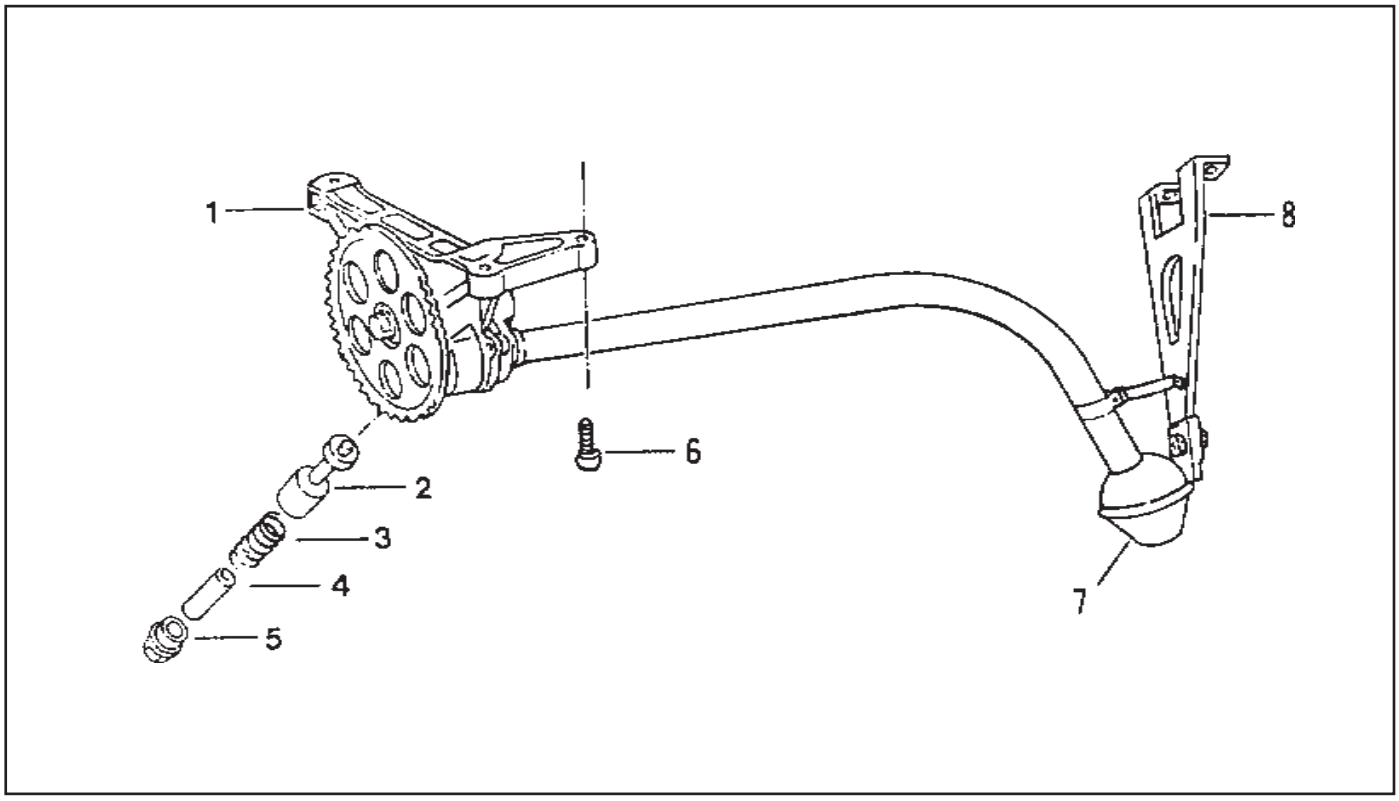
1 Fitting Sleeve
2 Oil Spray Nozzle
3 Combination Bolt ..... 10 Nm
A Oil Duct

Disassembly Procedure

1. Remove oil pan or crankshaft.
2. Loose the bolt and then remove the nozzle.



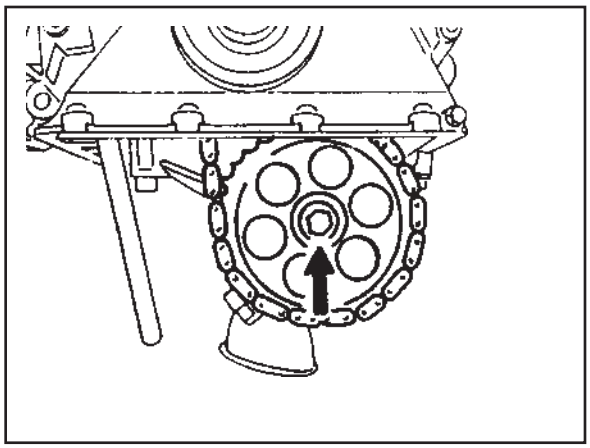
OIL PUMP



1 Oil Pump
2 Piston
3 Pressure Spring
4 Guide Pin
5 Screw Plug ..... 50 Nm
6 Combination Bolt ..... 25 Nm
7 Oil Strainer
8 Bracket

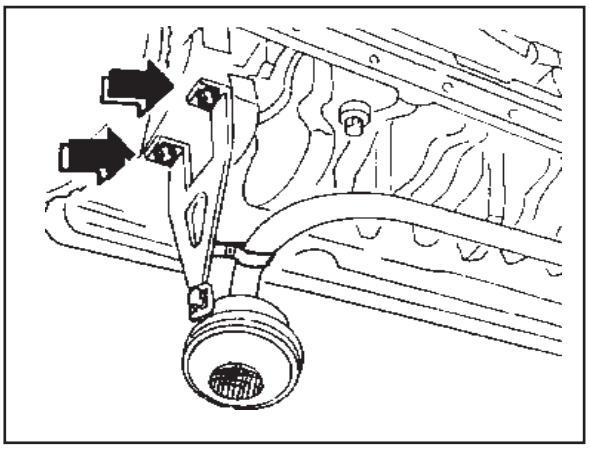
Disassembly Procedure

1. Remove the oil pan.
2. Unscrew the mounting bolt of spracket.

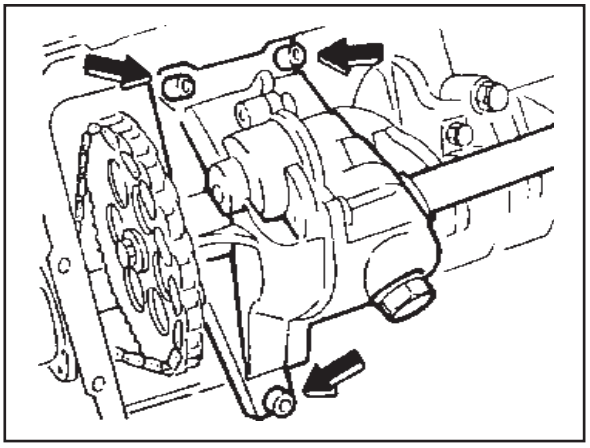


3. Unscrew the oil strainer bracket bolt.

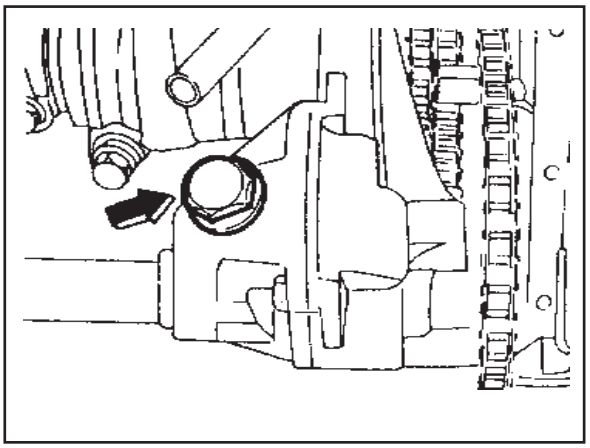
Tightening Torque	10 Nm



4. Remove the oil pump.



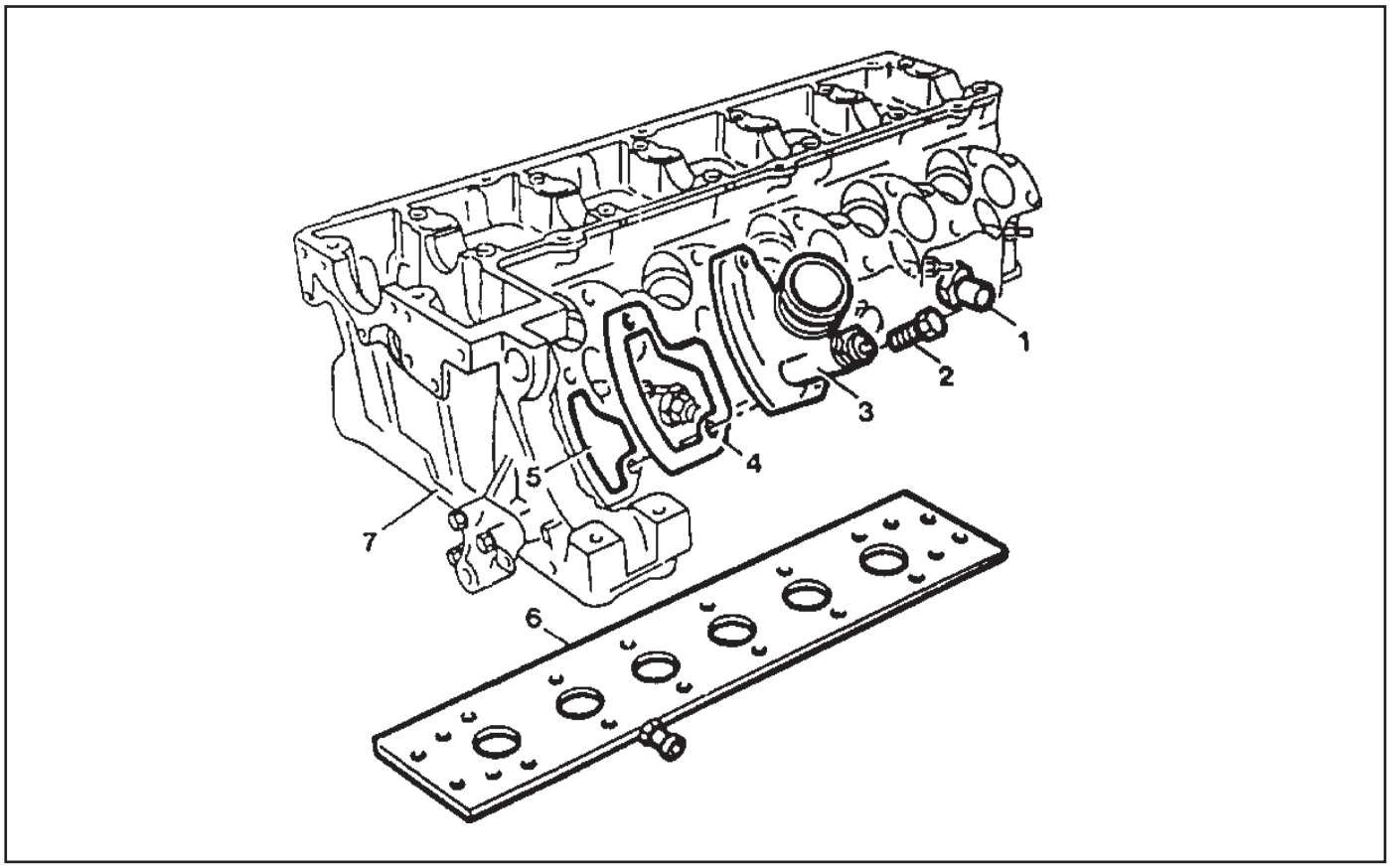
5. Unscrew the screw plug and remove the relief valve.
6. Installation should follow the removal procedure in the reverse order.



UNIT REPAIR

CYLINDER HEAD PRESSURE LEAKAGE TEST

Preceding Work : Removal of the cylinder head
Removal of the exhaust manifold
Removal of the valve



1 Feed Pipe
2 Bolt
3 Return Connection
4 Gasket ..... Replace
5 Coolant Gallery ..... Sealing
6 Pressure Measuring Plate ..... Completely tight to the cylinder head
7 Cylinder Head .....
Immerse with pressure measuring plate into warm water of approx. 60°C and pressurize with compressed airof 2 bar.

Notice

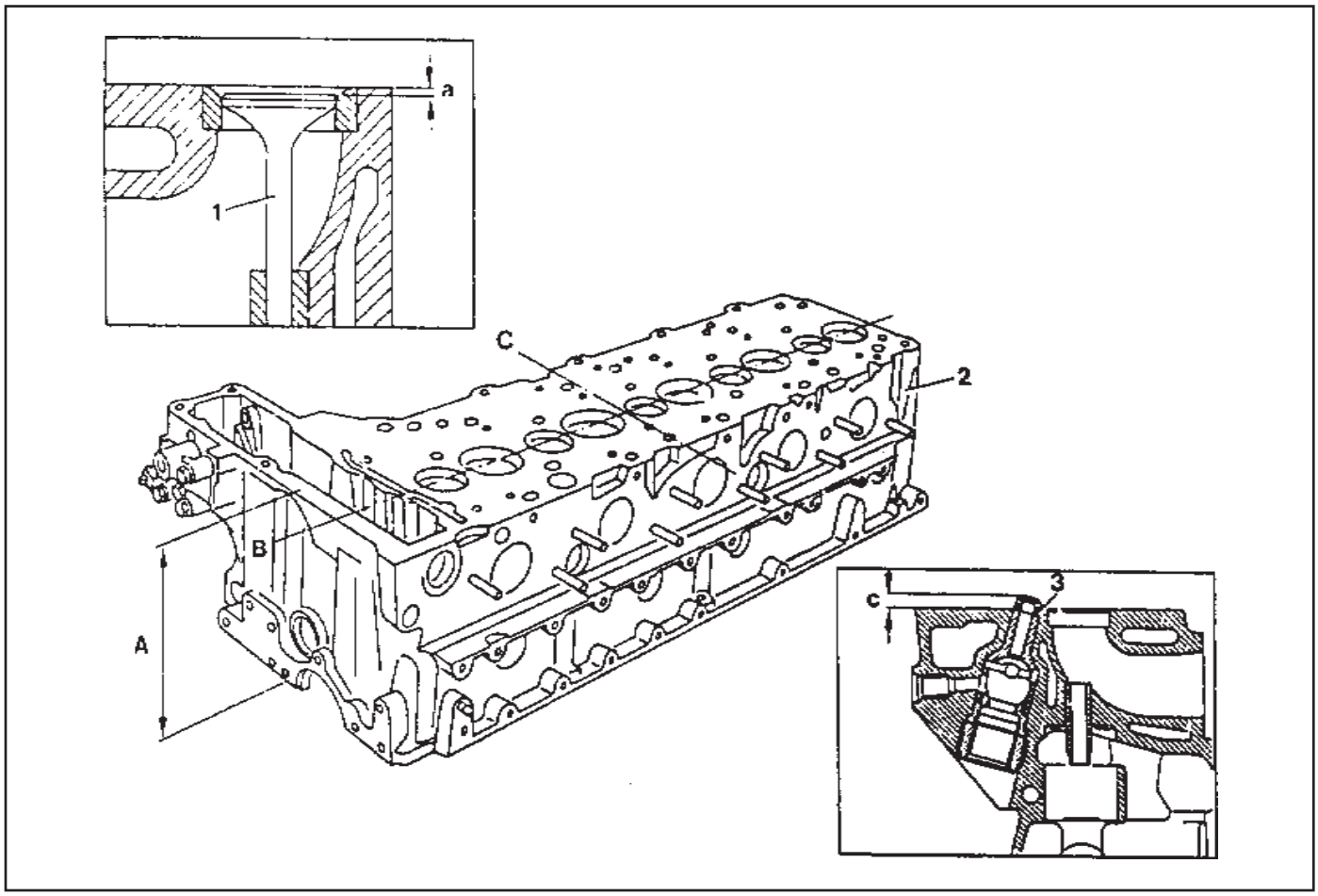
If air bubbles are seen, replace the cylinderhead.

Tools Required

115 589 34 63 00 Pressure Measuring Plate
601 589 00 25 00 Suspension Device

FACING CYLINDER HEAD MATING SURFACE

Preceding Work : Removal of prechamber
Cylinder head pressure leakage test



1 Valve
2 Cylinder Head
3 Prechamber
A Height of Cylinder Head
B Longitudinal Direction
C Transverse Direction
a Valve Arrears
b Prechamber Protrusion

Service Data

Height 'A' (cylinder head surface - cylinder head cover surface)		142.9 - 143.1mm
Minimum height after machining		142.5mm
Permissible unevenness of parting surface	In longitudinal direction	0.08mm
	In transverse direction	0.0mm
Permissible variation of parallelism (longitud. Direction)		Max. 0.1mm
Peak-to-valley height		0.0017mm
Valve arrears 'a'	Intake valve	0.1 - 0.7mm
	Exhaust valve	0.1 - 0.7mm
Prechamber protrusion		7.6 - 8.1mm

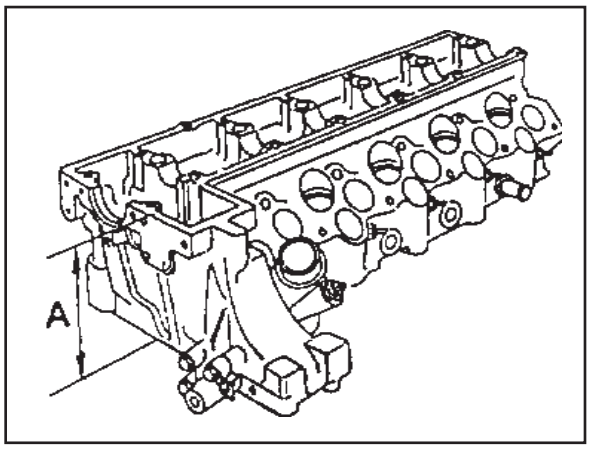
Measurement Procedure

1. Measure height 'A' .

Limit	142.5 mm

Notice

If the height is less than 142.5mm, replace the cylinder head.

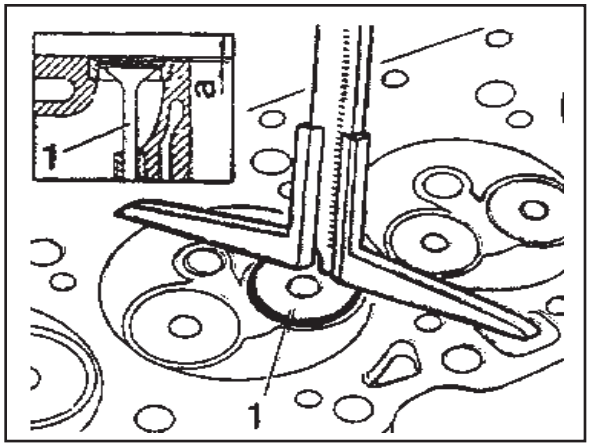


2. Insert the valve (1) and measure valve arrears 'a'.

Valve Arrears 'a'	0.1 - 0.7 mm

Notice

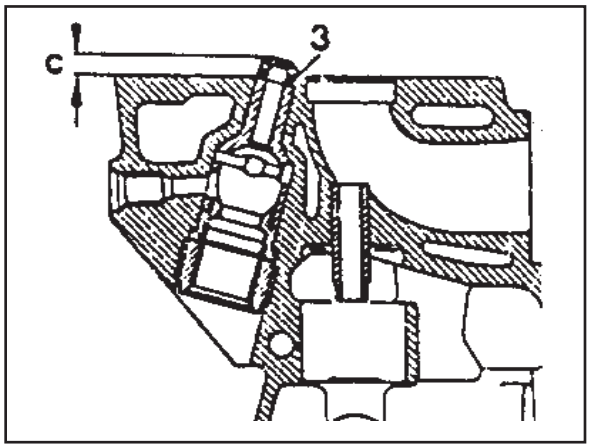
If out of standard, machine the valve seat.



3. Install the prechamber and measure protrusion 'C'.

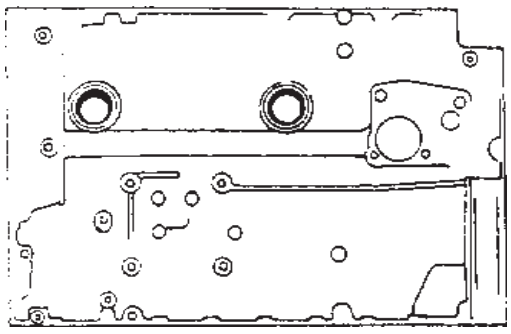
Protrusion 'C'	7.6 - 8.1mm

4. Assemble the engine and check the valve timing.



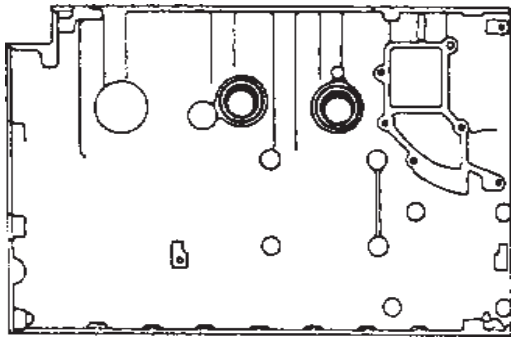
REPLACEMENT OF CRANKCASE CORE PLUG

Left



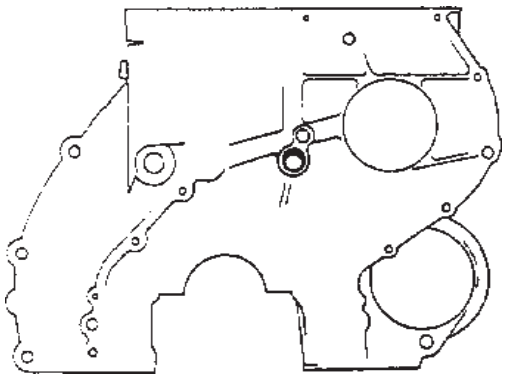
Core plug ϕ34mm
OM661LA - 2EA
OM662LA - 3EA

Right



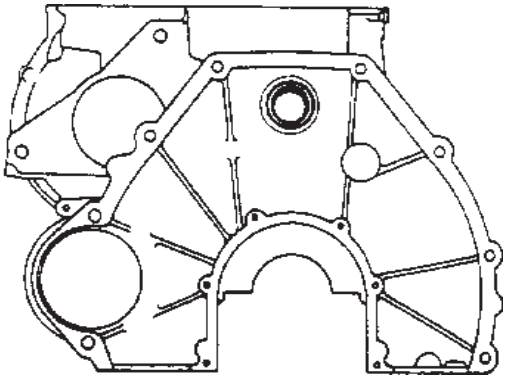
Core plug ϕ34mm
OM661LA - 2EA
OM662LA - 3EA

Left



Core plug ϕ17mm
OM661LA - 1EA
OM662LA - 1EA

Right



Core plug ϕ34mm
OM661LA - 1EA
OM662LA - 1EA

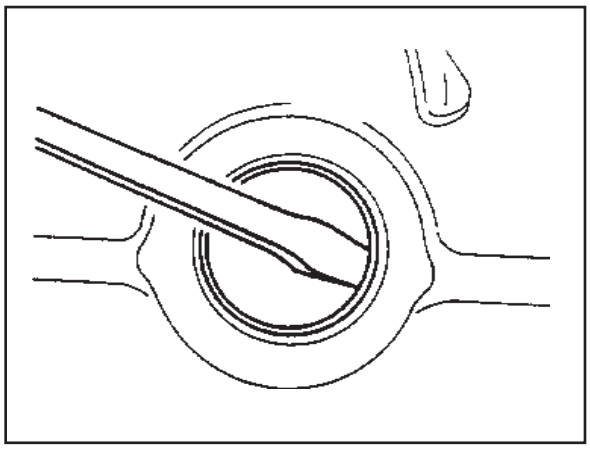
Tools Required

102 589 00 15 00 Drift

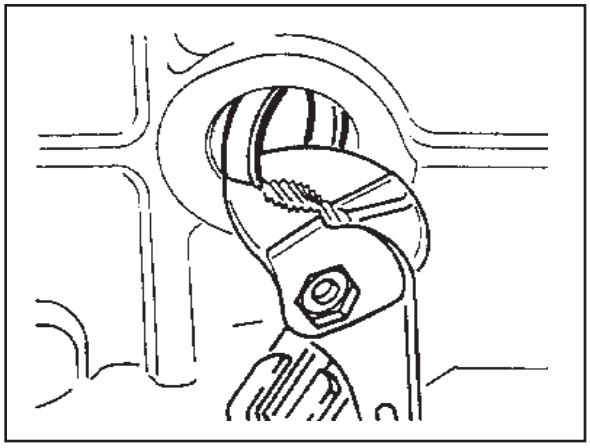
102 589 12 15 00 Drift

Replacement Procedure

1. Completely drain the coolant.
2. Remove any parts which impede access.
   (Example : transmission, injection pump)
3. Place the screwdriver to the deepdrawn edge of the core plug and pull forward and then rotate 90°.

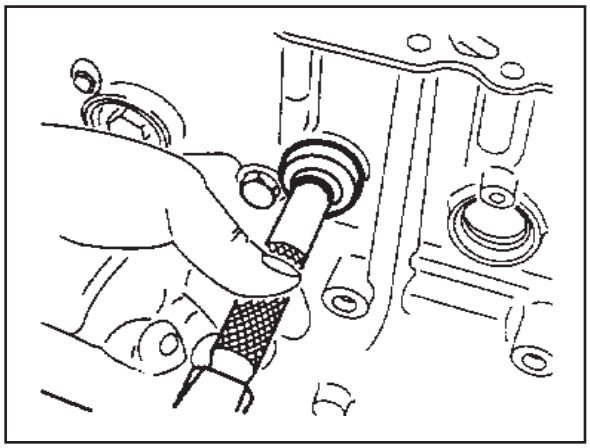


4. Pull out the core plug with pliers.



5. Thoroughly clean the sealing surface and apply Loctite 241.
6. Install the new core plug by using a drift.

Drift 102 589 00 15 00 (F34)
Drift 102 589 12 15 00 (F17)

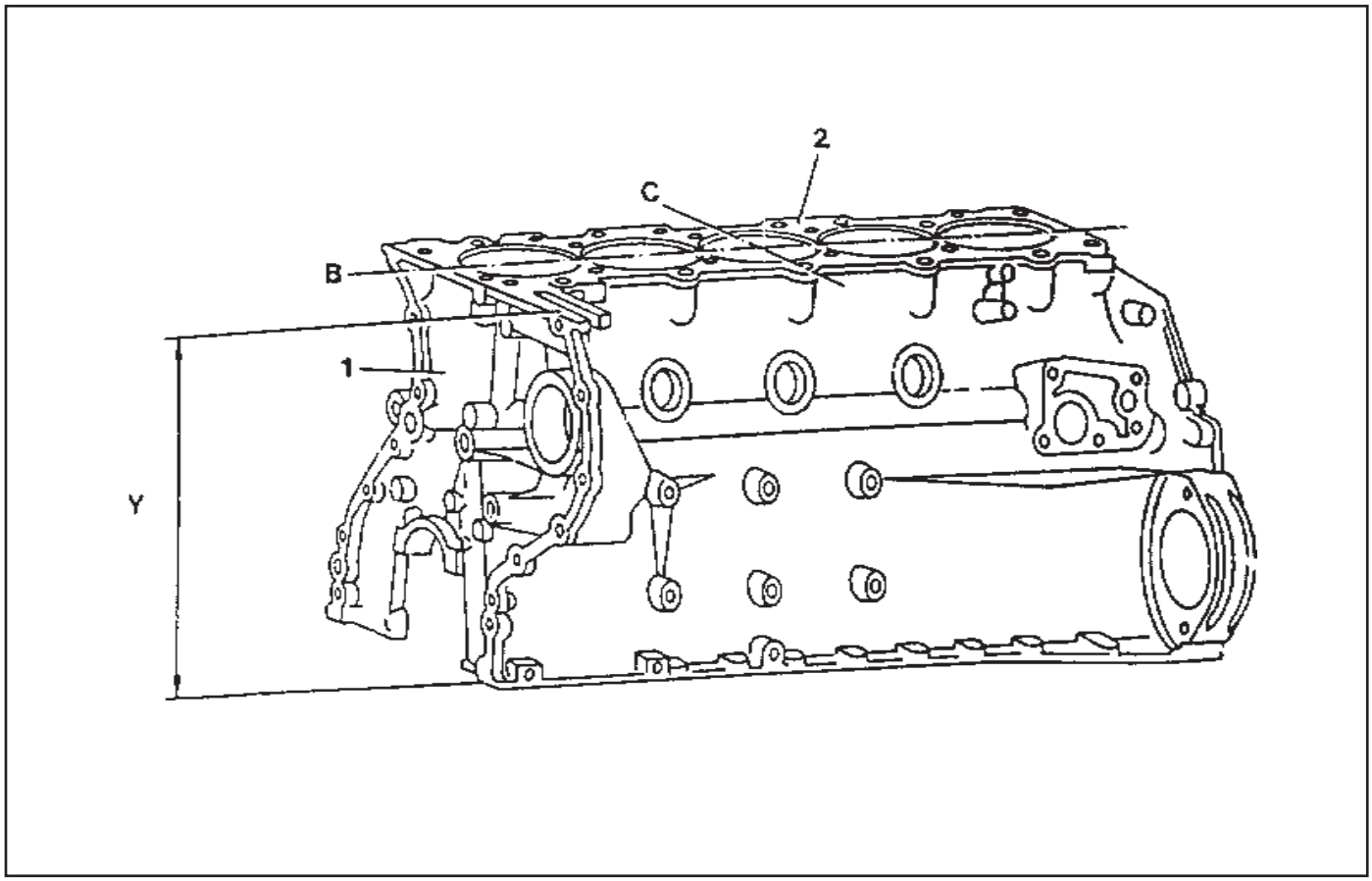


7. Install the removed parts and fill the coolant.

   Notice

   The adhesive must be allowed to harden for about 45 minutes before filling of coolant.
8. Warm up the engine and check the coolant for leaks.

FACING CRANKCASE CONTACTING SURFACE



1 Crankcase
2 Crankcase Contacting Surface

Y Height (crankcase upper surface - crankcase lower surface)

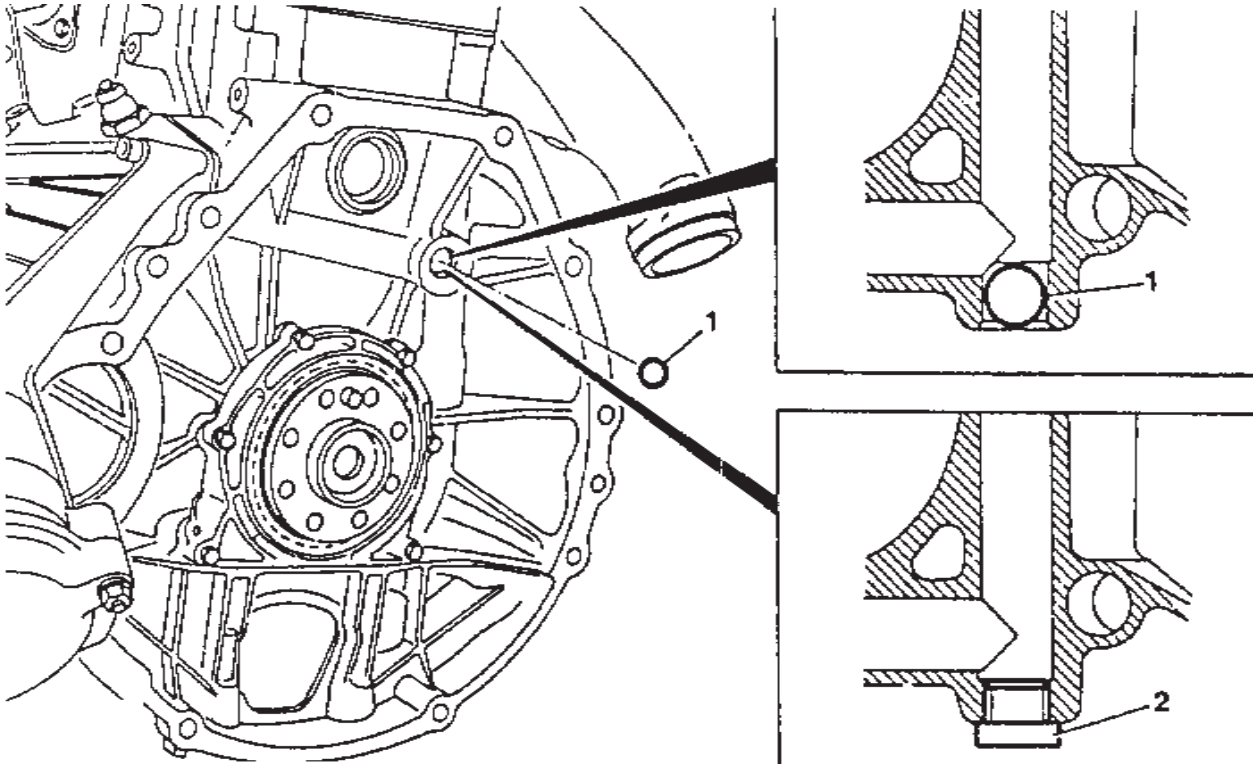
B Longitudinal Direction
C Transverse Direction
H Chamfer Height
b Chamfer Angle

Service Data

Height 'Y'		Min. 299.62 mm
Permissible unevenness of contacting surface	In longitudinal direction (B)	0.06 mm
	In transverse direction (C)	0.06 mm
Permissible roughness upper contacting surface		0.0006 - 0.0016 mm
Permissible variation of parallelism of crankcase upper surface to lower surface in longitudinal direction		0.05 mm
Piston protrusion at TDC to crankcase upper surface	Max.	0.965 mm
	Min.	0.735 mm

OIL GALLERY STEEL BALL

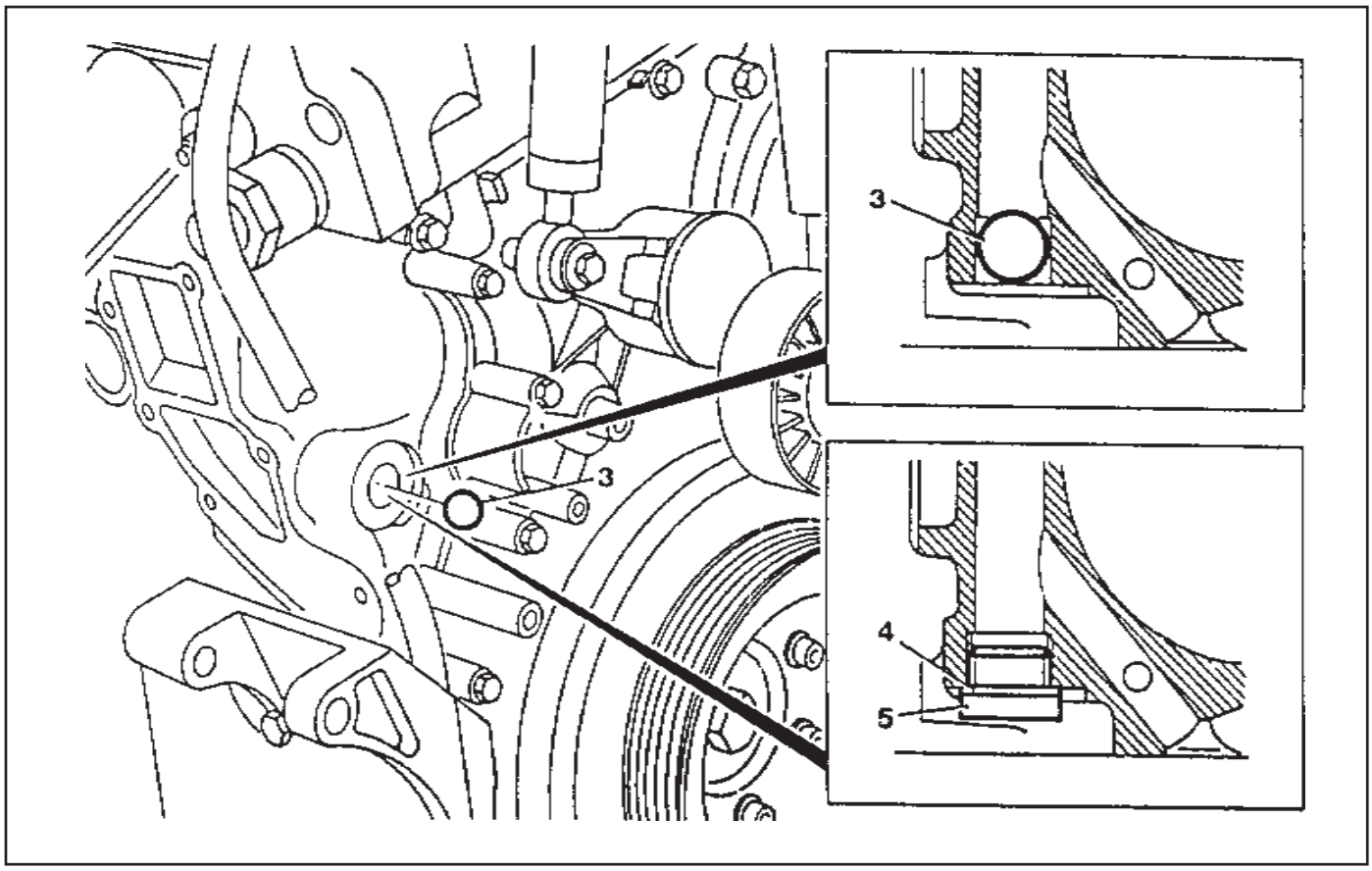
Preceding Work : Removal of cooling fan
Removal of the coolant pump housing
Removal of the flywheel and driven plate



1 Steel Ball ..... ϕ15mm 2 Screw Plug ..... Loctite 241,50Nm

Notice

The screw plug (2) has to be installed as a repair solution if the steel ball (1) is leaking.



3 Steel Ball ϕ17mm
4 Seal
5 Screw Plug 50Nm

Notice

The seal (4) and screw plug (5) have to be installed as a repair solution if the steel ball (3) is leaking.

Tools Required

601 589 08 15 00 Drift

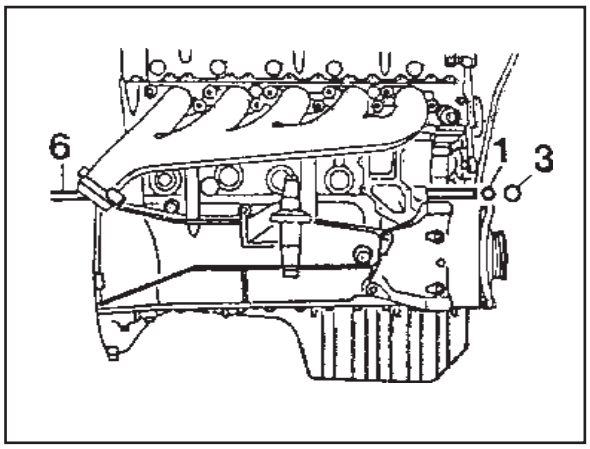
Removal & Installation Procedure

1. Remove the timing case cover.
2. By inserting a round bar (6) approx. 0.7m from the back to the front side through the oil gallery, knock out the steel balls (1,3).

   Notice

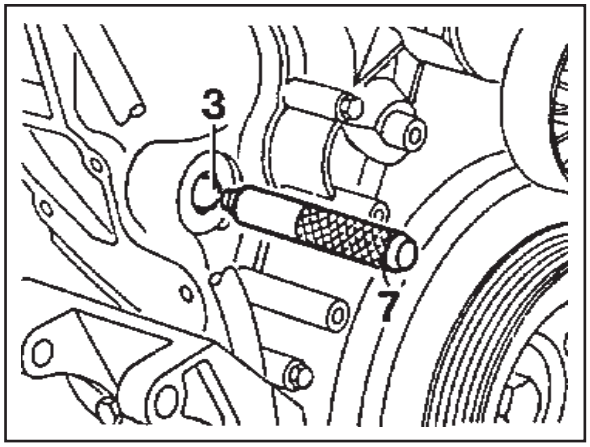
   Be careful not to damage the bores of the steel balls.

   6 Shop-made tool



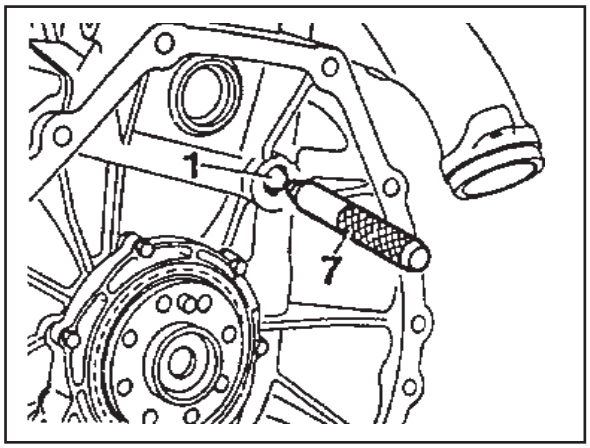
3. Thoroughly clean the bores of steel balls.
4. Place the steel ball (3) onto the drift (7) with a little grease and position to the bore and then tap until the drift stops.

   Drift 601 589 08 15 00



5. Place the steel ball (1) onto the drift (7) with a little grease and position to the bore and then tap until the drift stops.

   Drift 601 589 08 1500



6. Warm up the engine and check the oil for leaks.

Installation of Screw Plug

Notice

If steel ball leaks again, install the screw plug.

1. Remove the steel ball.
2. Tap thread into the bores of the oil gallery.

Notice

Front bore : M18 ´ 1.5, depth 10mm

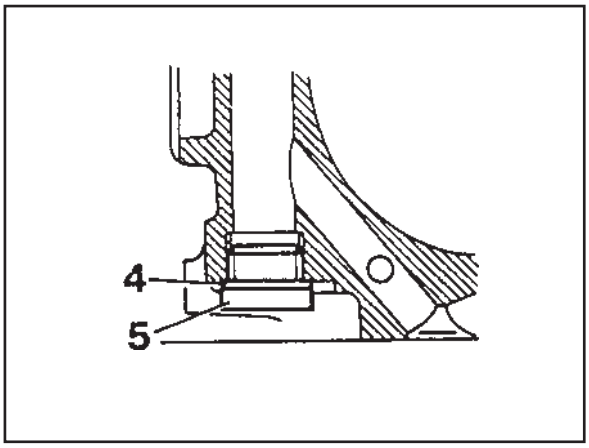
Rear bore : M16 ´ 1.5, depth 14mm

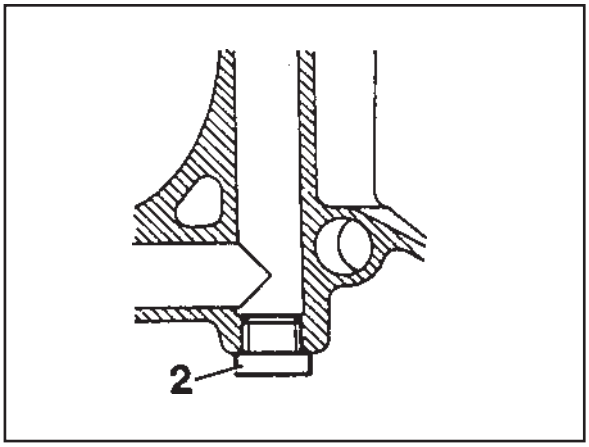
3. Thoroughly clean the oil gallery.
4. Tighten the front plug (5) with seal (4).

Tightening Torque	50 Nm

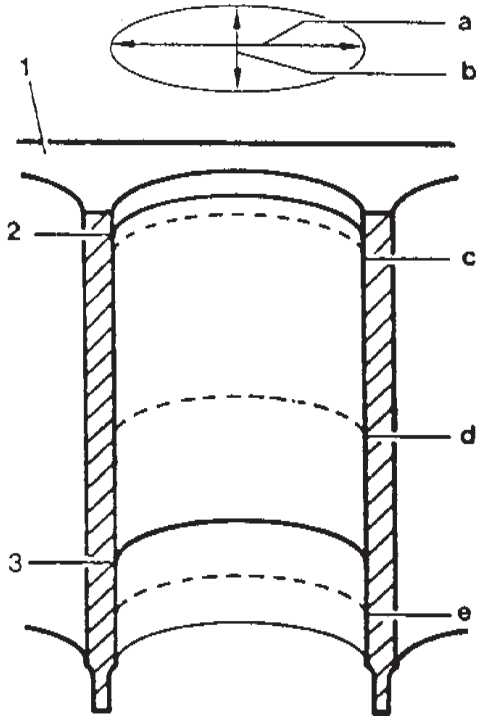
5. Apply Loctite 241 and then tighten the rear plug (2).

Tightening Torque	50 Nm





CYLINDER BORE MEASUREMENT



a Longitudinal Direction
b Transverse Direction
c, d, e. Measuring Point

1 Crankcase Contacting Surface
2 TDC of 1st Piston Ring
4 BDC of Ring

Service Data

Standard size	Code letter 'A'	89.000 - 89.006mm
	Code letter 'X'	89.006 - 89.012mm
	Code letter 'B'	89.012 - 89.018mm
Wear limit in direction of travel and in transverse direction		Max. 0.20mm
	When new	0.01mm
Permissible deviation of cylinder shape	Wear limit	0.05mm
Honing angle		50° ± 10°