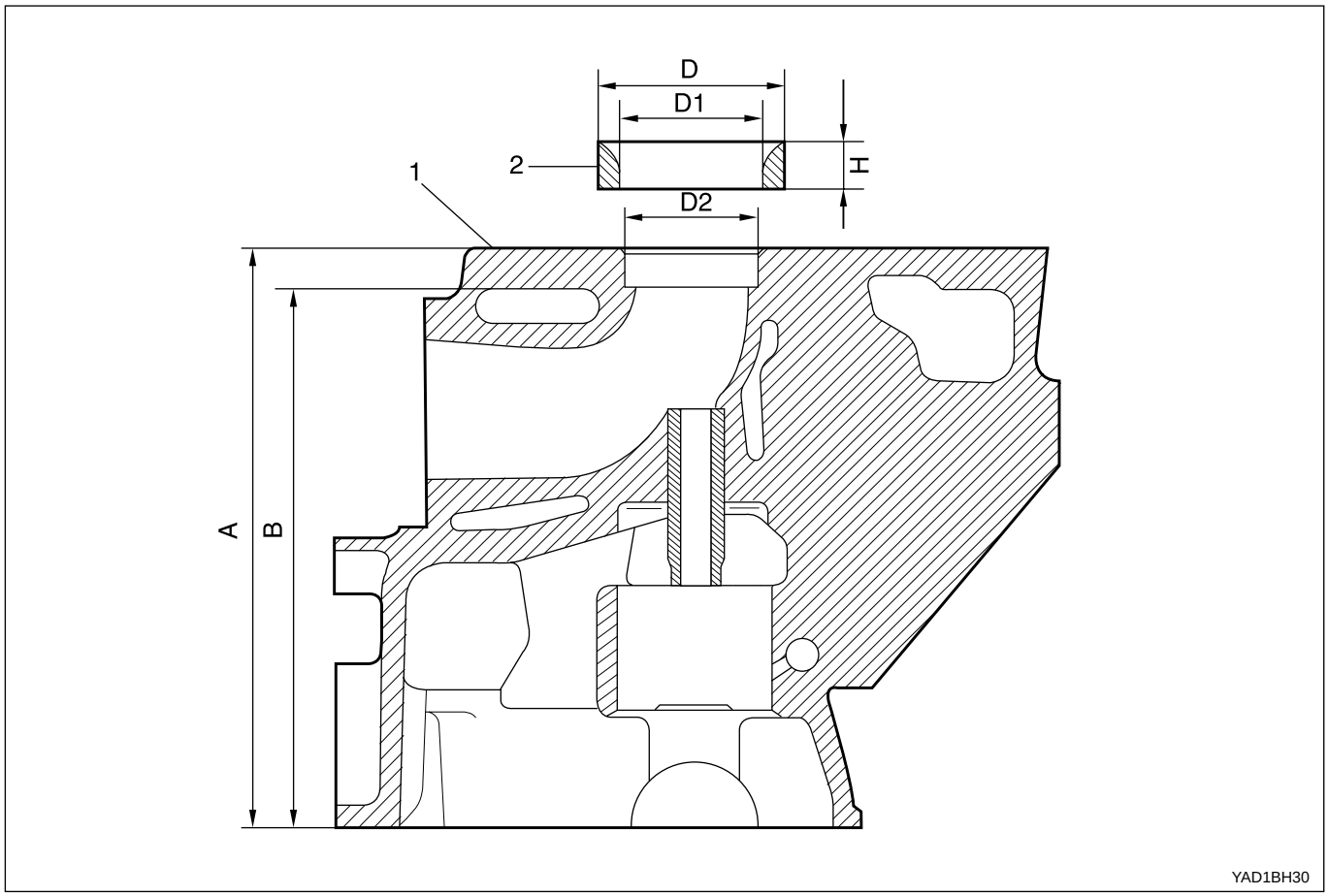
VALVE SEAT RINGS

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



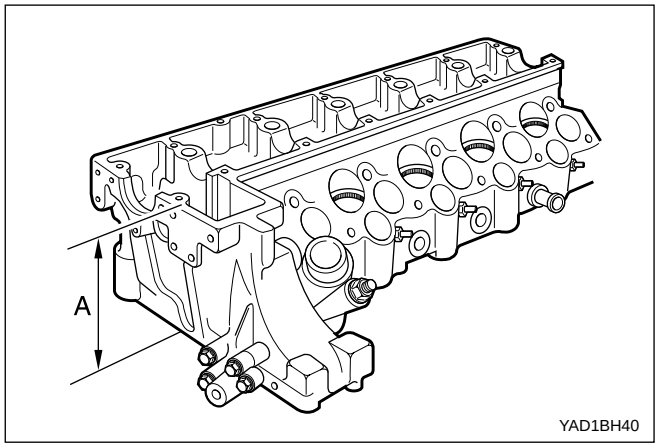
1 Cylinder Head
2 Valve Seat Ring
A Height (Cylinder Head Upper / Lower Surface)
B Height (Cylinder Head Cover Surface / Seat of Valve Seat Ring)
D Valve Seat Ring Outer Diameter
D1 Valve Seat Ring Inner Diameter
D2 Basic Bore Diameter
H Height of Valve Seat Ring

Service Data

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

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 : 8 mm, 9 mm, 14 mm)	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 - 60 mm)	Mahr D-7300 Esslingen Order No. 844
External Micrometer (Range : 25 - 60 mm)	Mahr D-7300 Esslingen Order No. 40 S
Electrically Heated Water Tank	Otto Dürr D-7123 Sachsenherm - Ochsenbach



Tools Required

115 589 34 63 00 Mounting Device

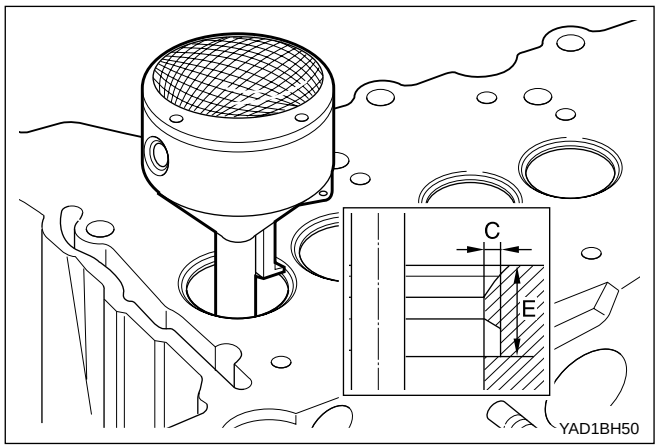
345 589 00 63 00 Super Cooling Box

Removal Procedure

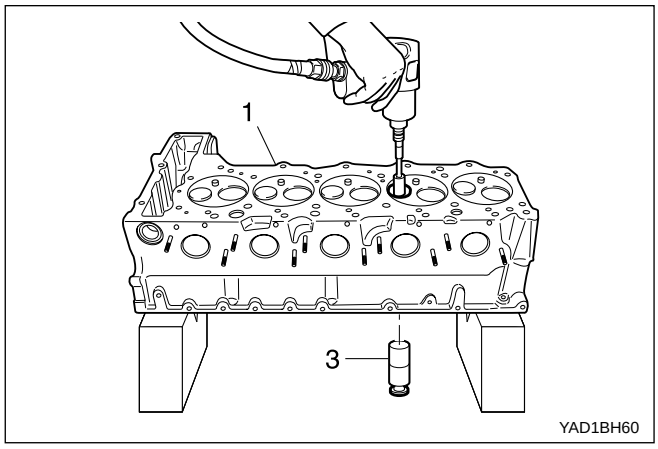
1. Measure dimension ‘A’.

Limit	142.5 mm

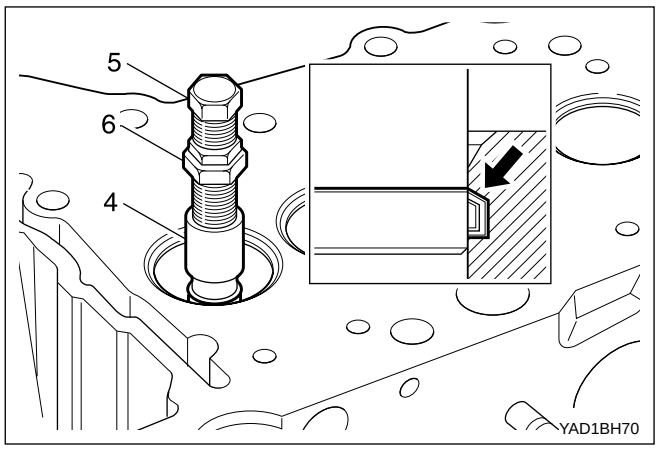
2. Clamp the cylinder head with clamping device.



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



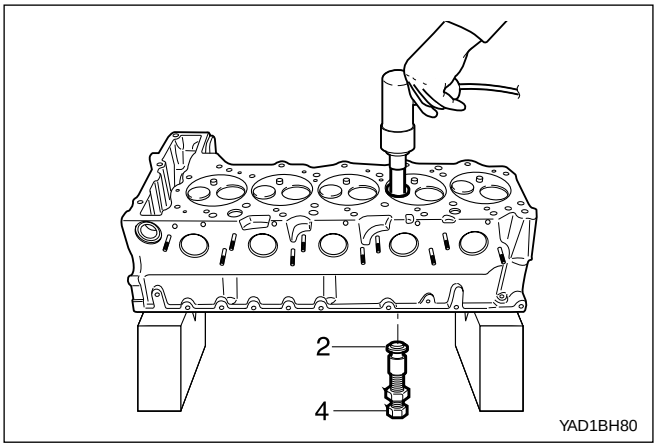
4. Remove the cylinder head from the clamping device and place it onto wooden blocks.
5. Remove the valve guide (3) by using a drift (Intake: 8 mm, Exhaust: 9 mm).



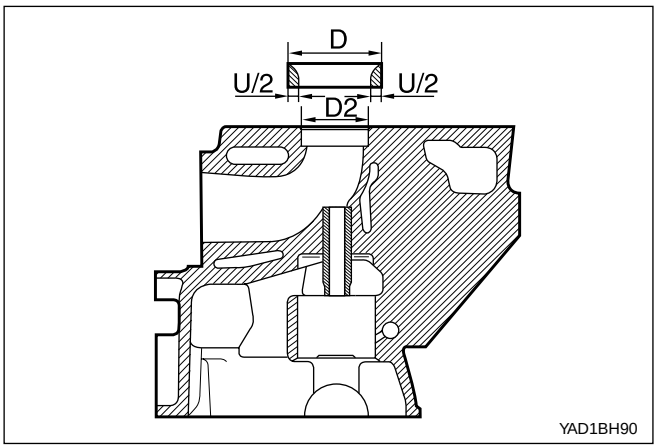
6. Insert the tensioning head (4) and extracted wedges(arrow) by turning the bolt (5).

   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 (14 mm) and removal tool.
10. Clean the basic bore of valve seat ring.

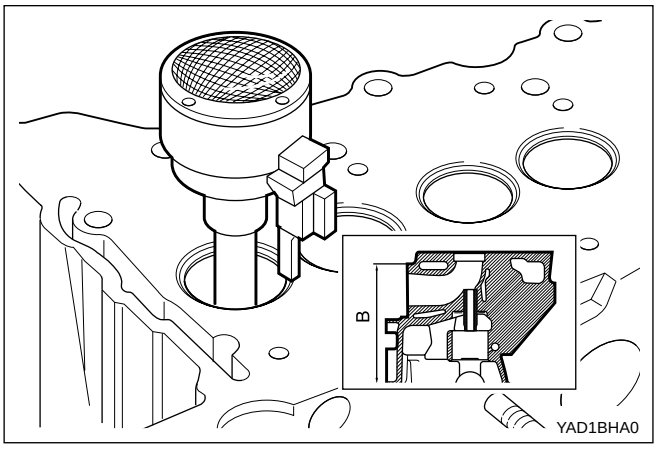


11. Measure the basic bore diameter (D2) and outer diameter (D) of the new valve seat ring (standard size).
12. Calculate the overlap value 'U' (D - D2).

Overlap Valve 'U'	0.068 - 0.100 mm

Example) Measured value D = 37.100 mm
Measured value D2 = 37.010 mm
Overlap value 'U' = 0.090 mm

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



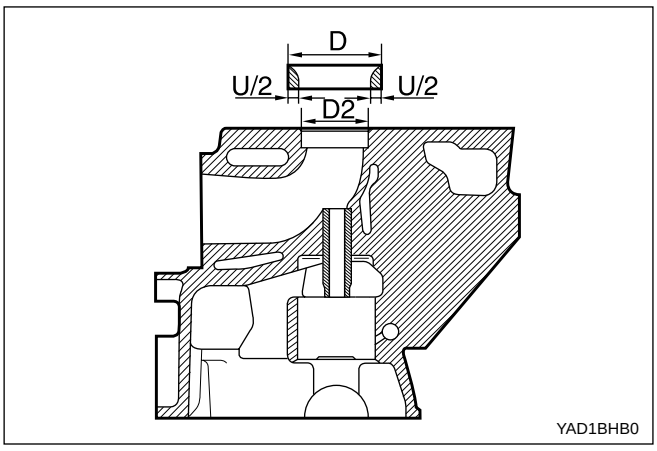
13. Clamp the cylinder head with clamping device.
14. Machining basic bore for valve seat ring (repair size).

Notice: Maintain minimum value of 'B'.

- Machine the basic bore.

Limit

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

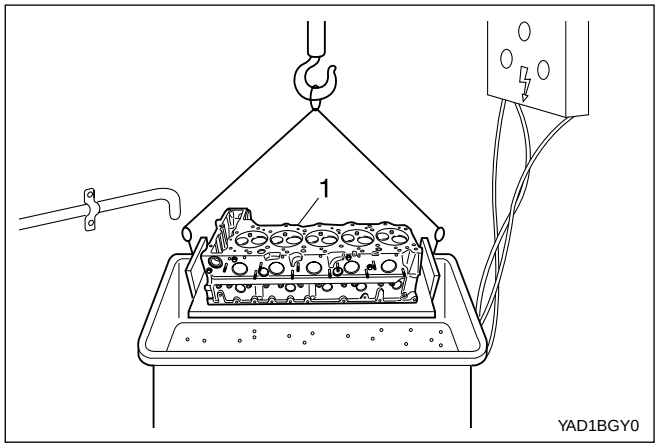


- Measure machined basic bore and outer diameter 'D' of valve seat ring (repair size).
- Measure the overlap 'U'

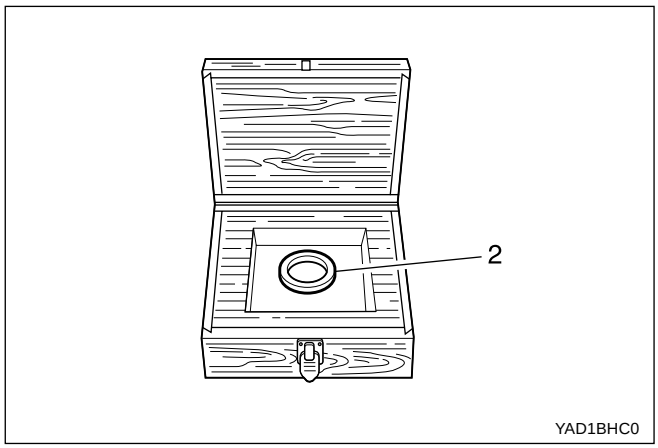
Overlap 'U' (D - D2)	0.068 - 0.100 mm

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 0.020 mm in order to get the required overlap value.

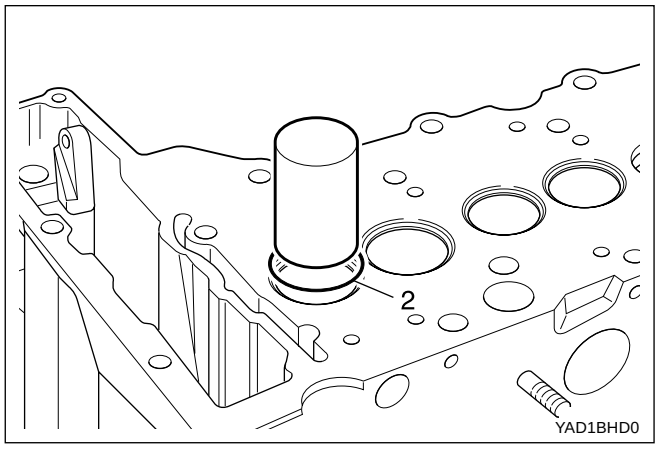


15. Hang the cylinder head (1) to the lifting device and heat in a water tank to approx. 80°C(176°F) with mounting device 115 589 34 63 00.

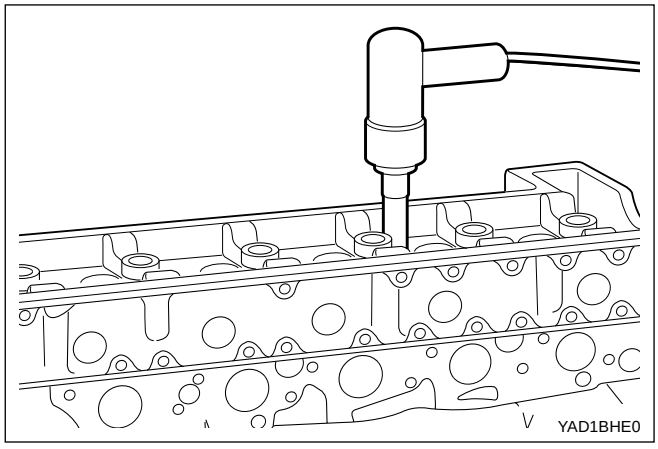


16. Cool down new valve seat ring (2) into the cooling box 345 589 00 63 00 with liquid nitrogen.

    Notice: Do not touch the cooled valve seat rings with hand.



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



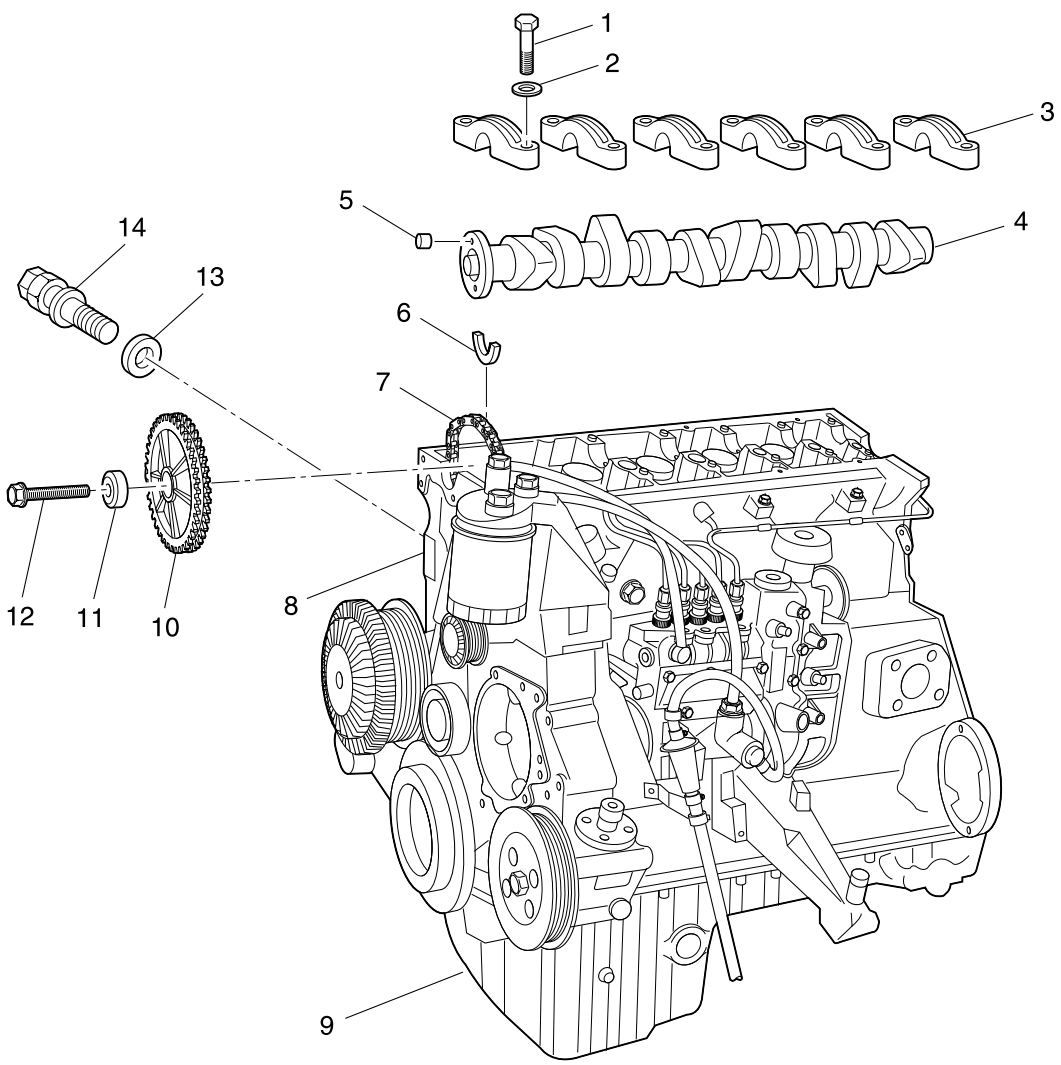
18. Install the valve guide (3) with a proper drift (Intake: 8 mm, Exhaust: 9 mm) and assembling tool.

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

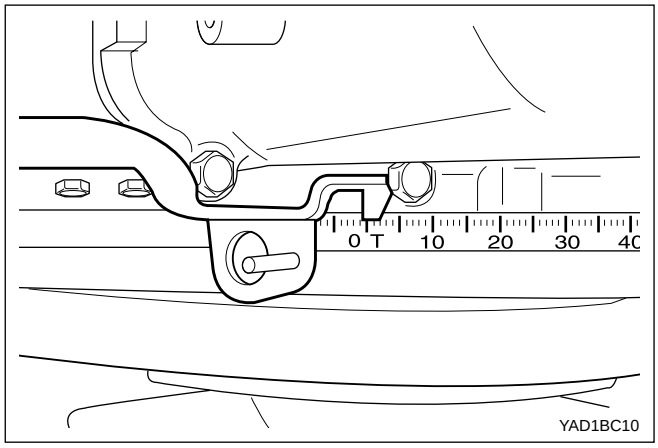
19. Machine the valve seats.

CAMSHAFT

Preceding Work: Removal of cylinder head cover



1 Bolt ..... 25 N•m (18 lb-ft)
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, 25 N•m (18 lb-ft)+ 90°
13 Gasket ..... Replace
14 Chain Tensioner ..... 80 N•m (59 lb-ft)



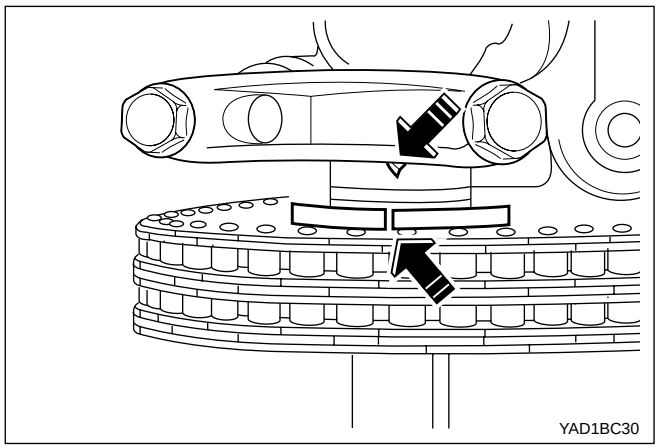
Tools Required

602 589 00 40 00 Engine Lock

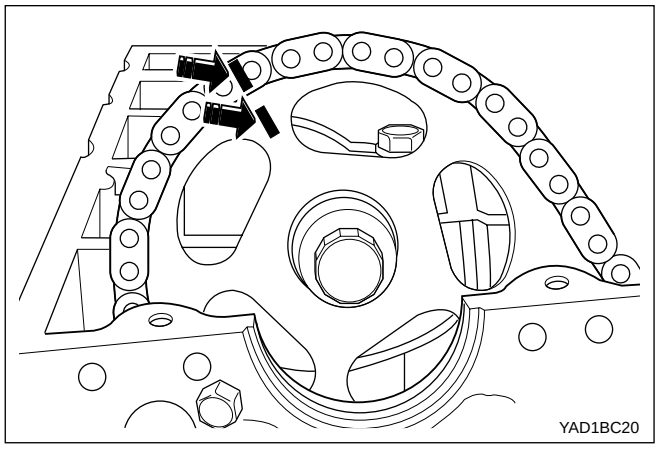
Removal Procedure

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

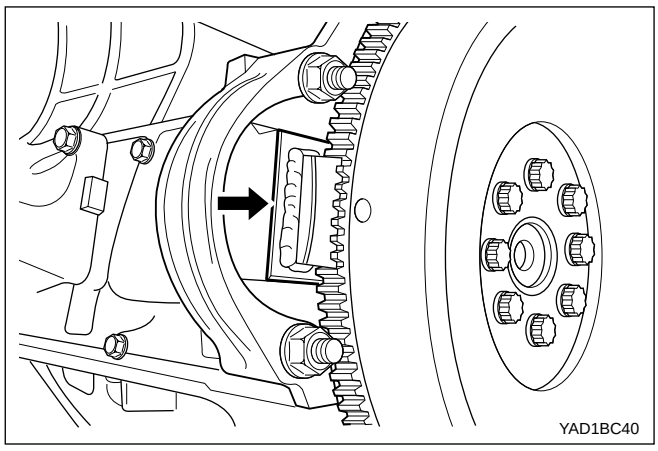
   Notice: Do not rotate the crankshaft in the opposite direction of engine rotation.



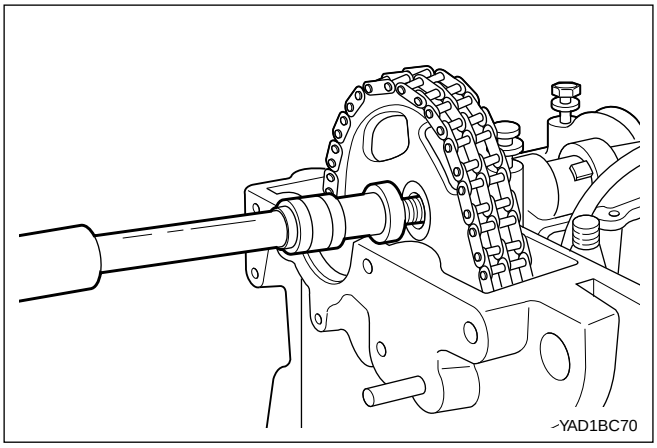
In this position, the markings of the camshaft/ camshaft bearing cap (arrow) must be aligned.



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

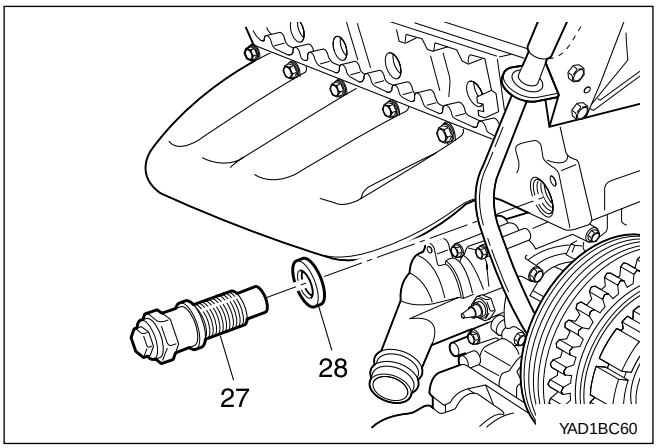


3. Remove the starter motor and install the engine lock 602 589 00 40 00.

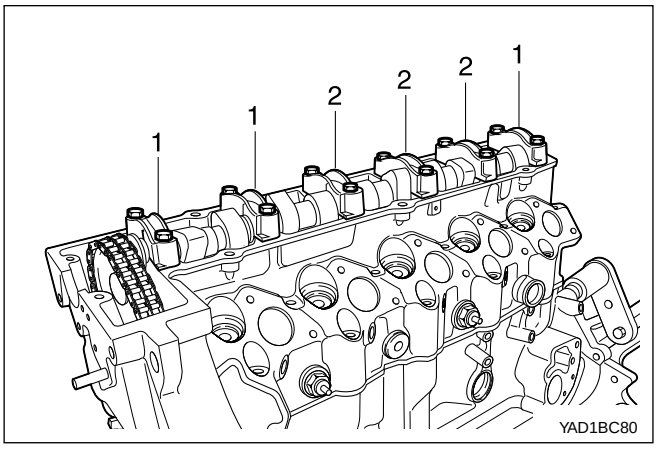


4. Remove the bolt and then remove the camshaft sprocket.

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

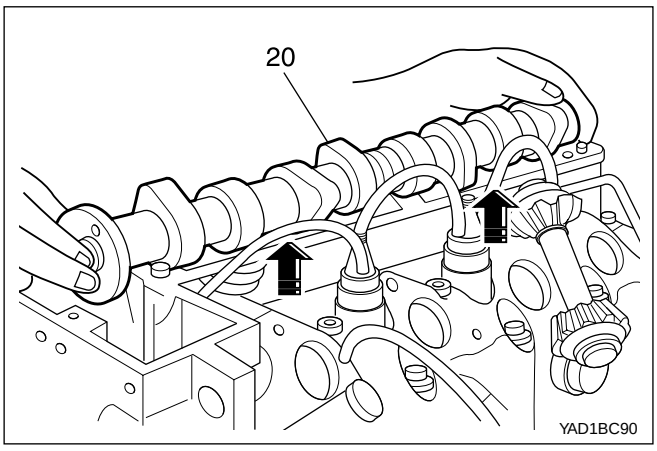


5. Remove the chain tensioner.



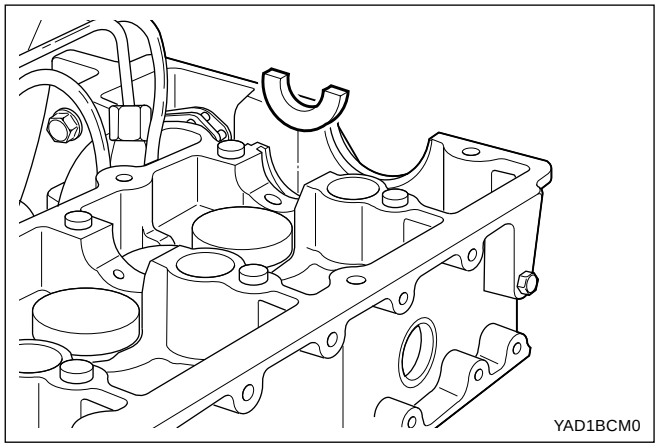
6. Remove the camshaft bearing cap bolts according to the removal order.

   Notice: Remove the camshaft bearing cap bolts of 1 first and then remove the bolts of 2 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.



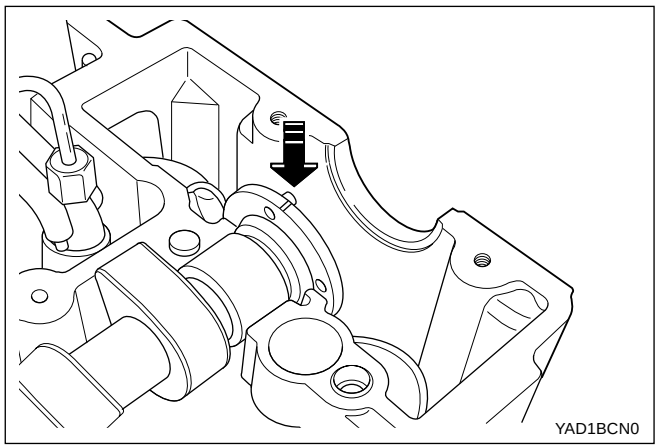
7. Remove the camshaft bearing cap.
8. Pull off the camshaft.

   Notice: Be careful not to miss front locking washer.


YAD1BCM0

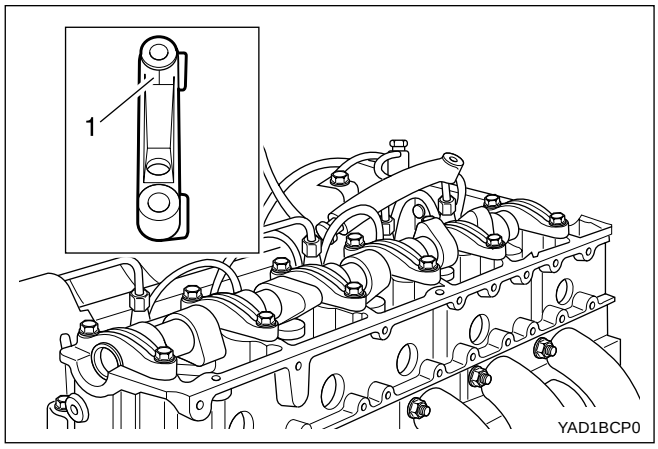
9. Pull out the locking washer.

   Notice: Check the condition of locking washer and replace if necessary.


YAD1BCN0

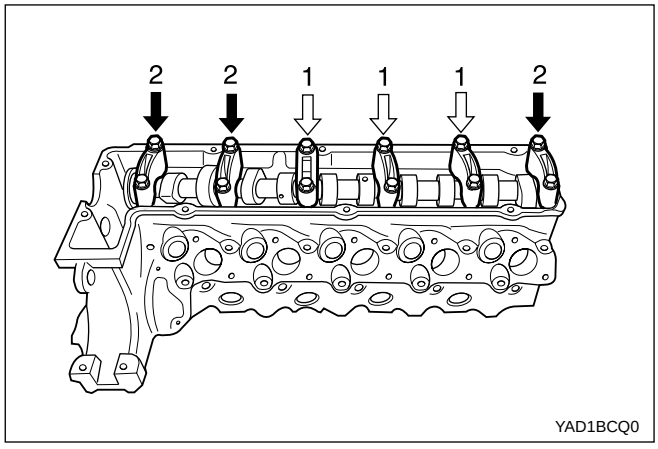
Installation Procedure

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.



YAD1BCP0

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



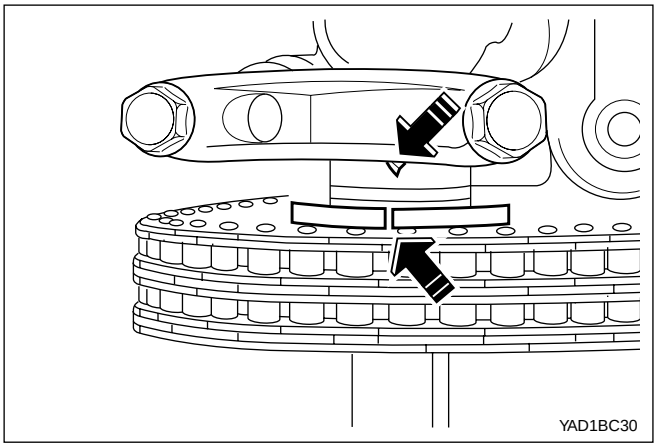
YAD1BCQ0

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

   Installation Notice

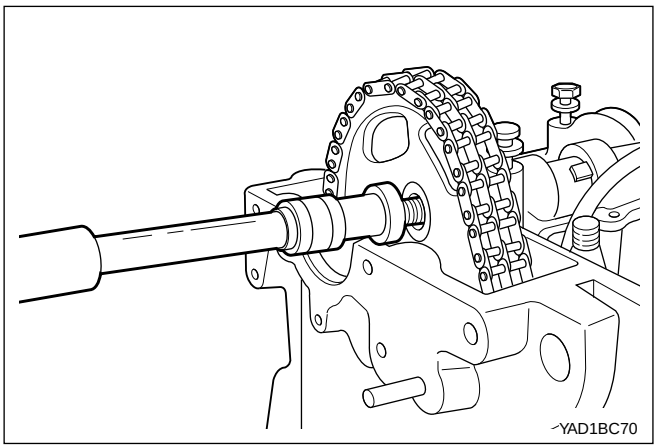
Tightening Torque	25 N•m (18 lb-ft)+ 90°

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


YAD1BC30

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

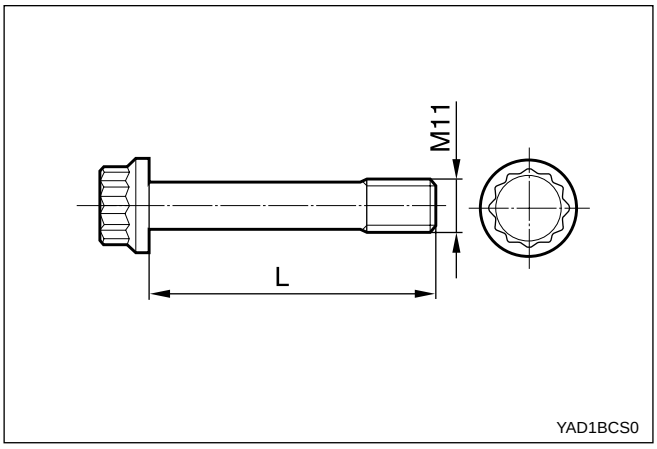
   Notice: Align the alignment marks on the timing chain and sprocket.


YAD1BC70

7. Tighten the camshaft sprocket bolt.

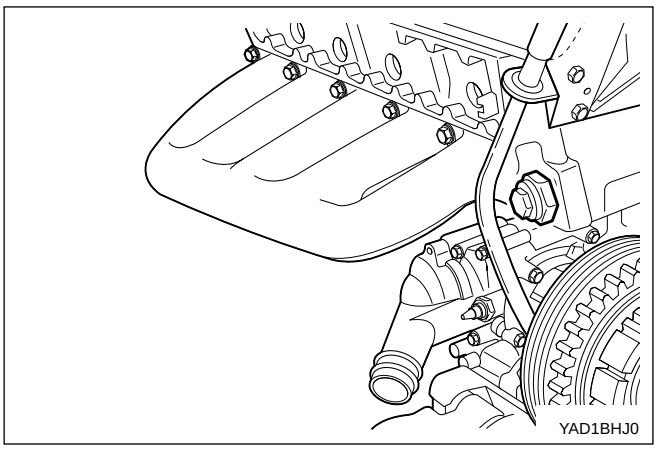
   Installation Notice

Tightening Torque	25 N•m (18 lb-ft)+ 90°



YAD1BCS0

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


YAD1BHJ0

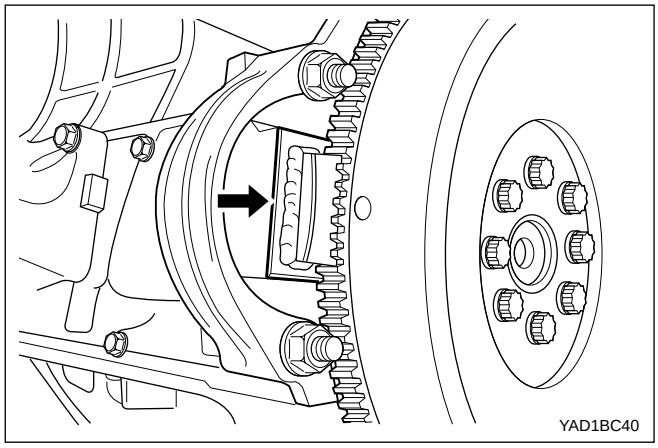
8. Install the chain tensioner.

   Installation Notice

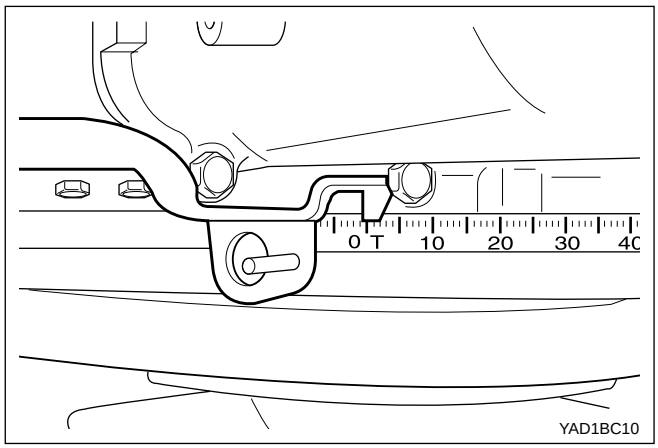
Tightening Torque	80 N•m (59 lb-ft)

   Replace the seal.

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



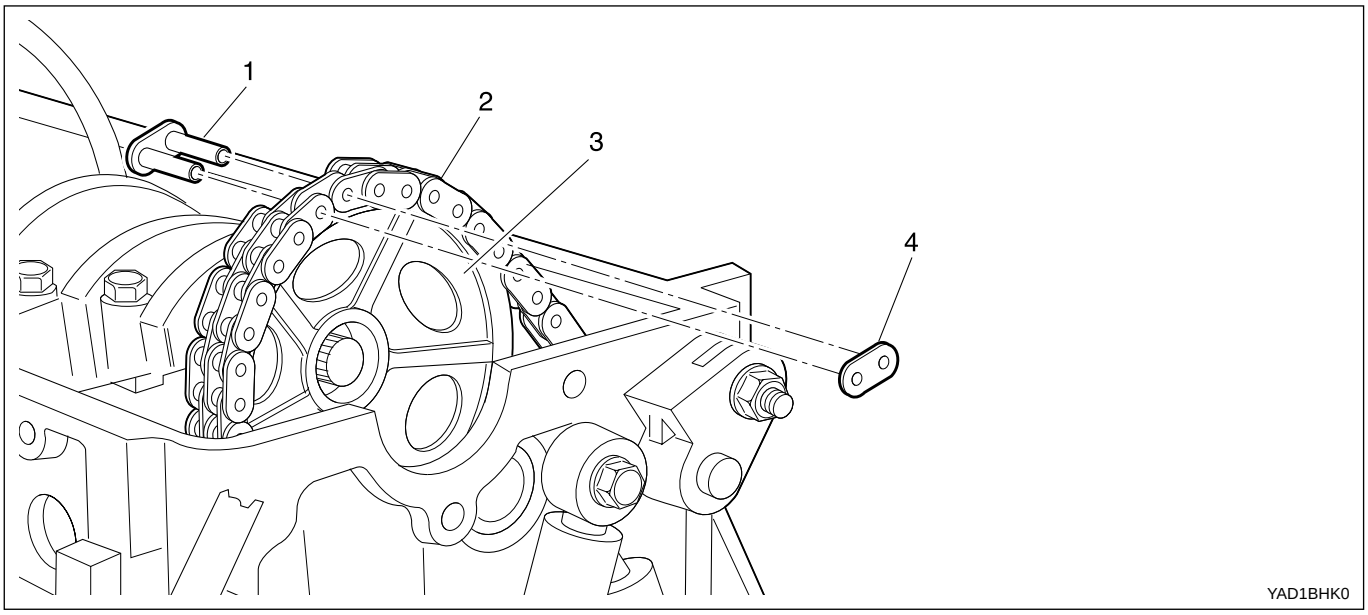
9. Remove the engine lock 602 589 00 40 00.



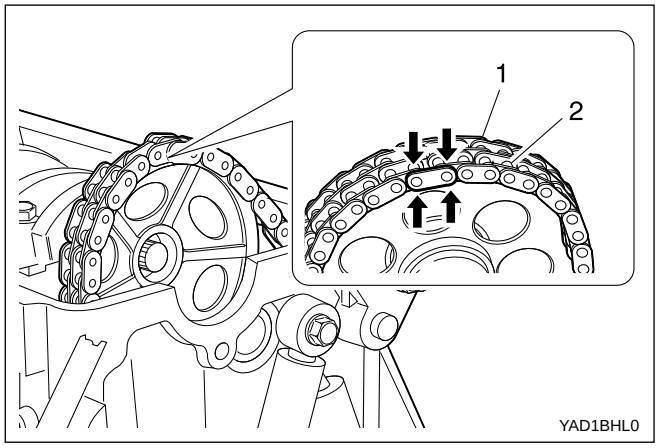
10. Check the TDC marking of OT on the crankshaft.

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

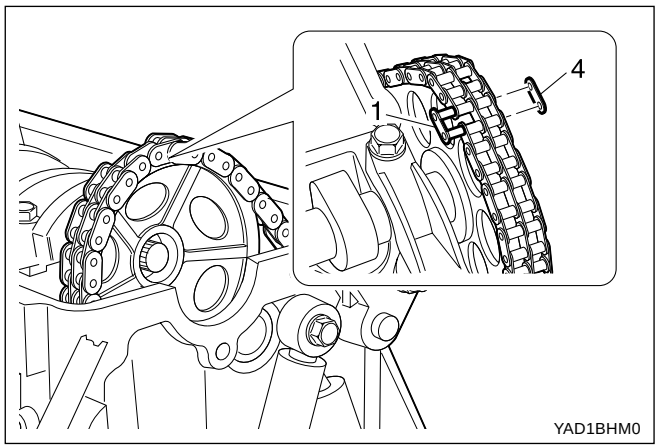


Tools Required

000 589 58 43 00 Chain Assembling Device

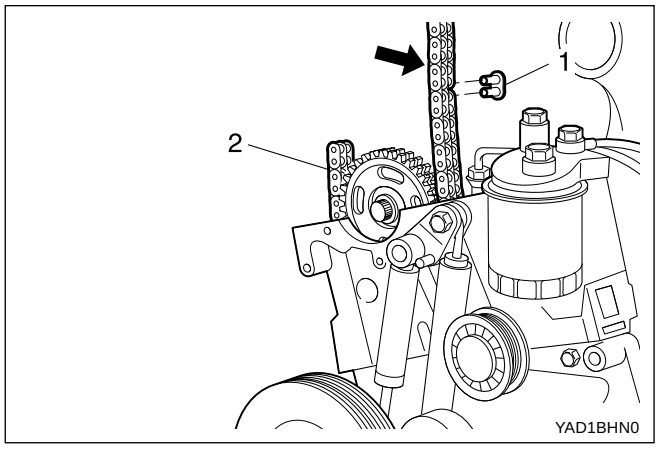
Replacement Procedure

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.

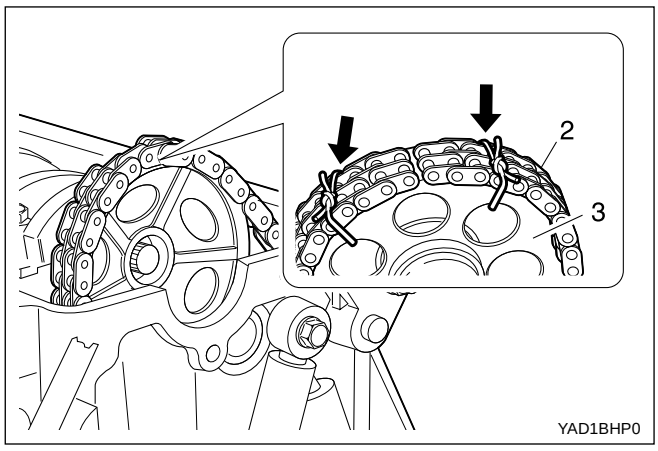


2. Remove the outer plate (4) and chain link (1).

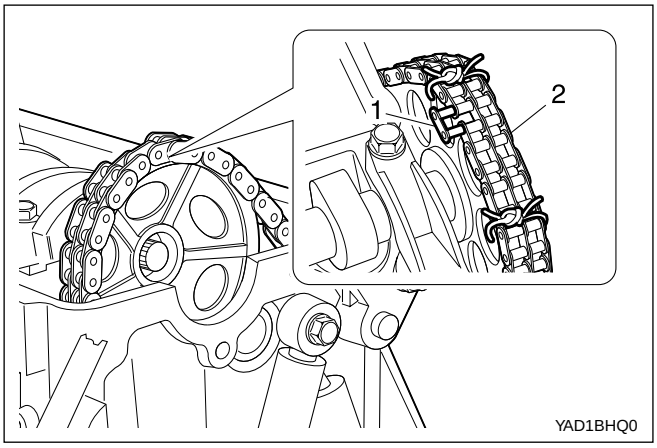
   Notice: Ensure that the ends of the timing chain do not drop into the chain box.



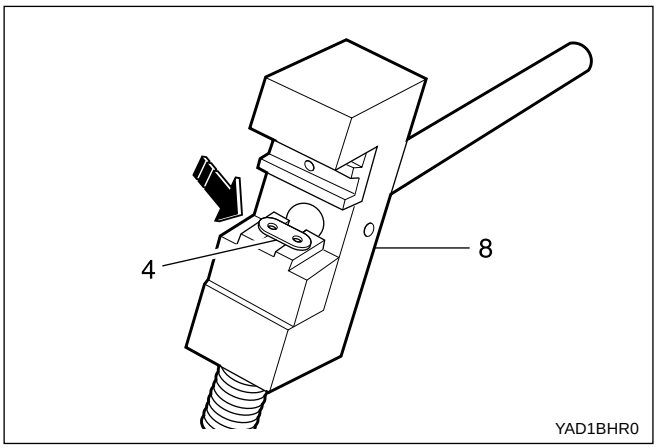
3. Loosen the chain tension with approx. 4 turns.
4. Connect the new timing chain (arrow) with chain link (1) to the old timing chain (2).



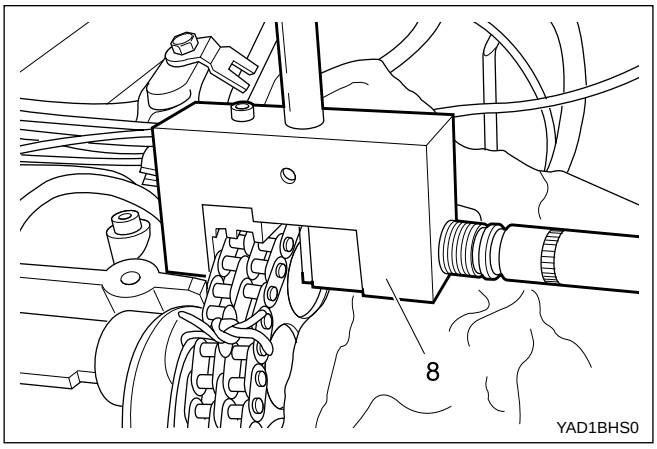
5. By rotating the crankshaft in the of engine rotation, pull out the old timing chain with installing the new timing chain.
6. Remove the old timing chain and hold the ends of the new timing chain to camshaft sprocket (3) with wire (arrow).



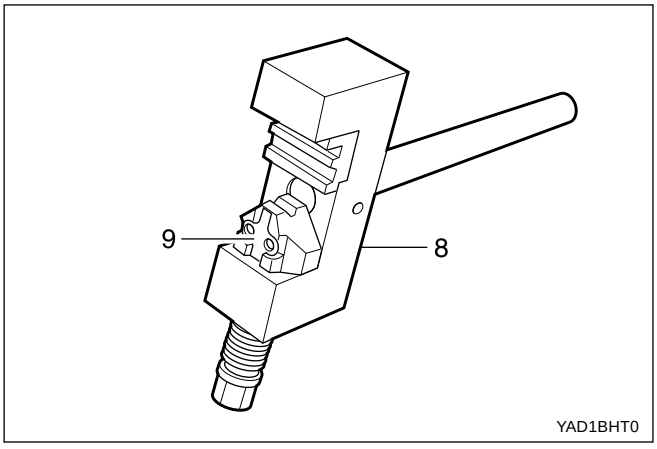
7. Insert the new chain link (1) to connect the chain.



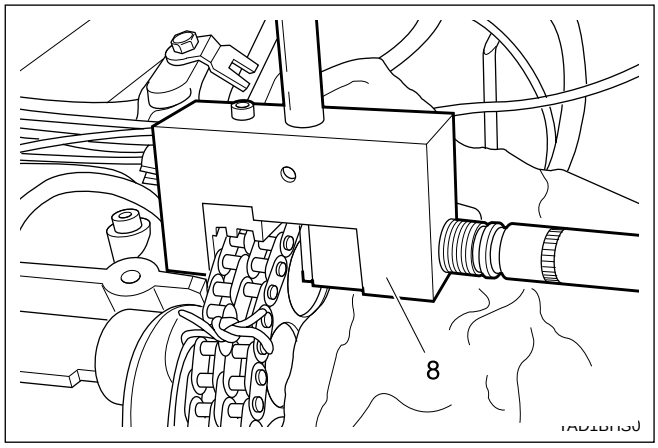
8. Insert the new outer plate (4) into the chain assembling device 000 589 58 43 00 tool (8) and then the outer plate will be held by a magnet.



9. Place the chain assembling device 000 589 58 43 00 (8) onto the chain link and press the outer plate on as far as the stop.

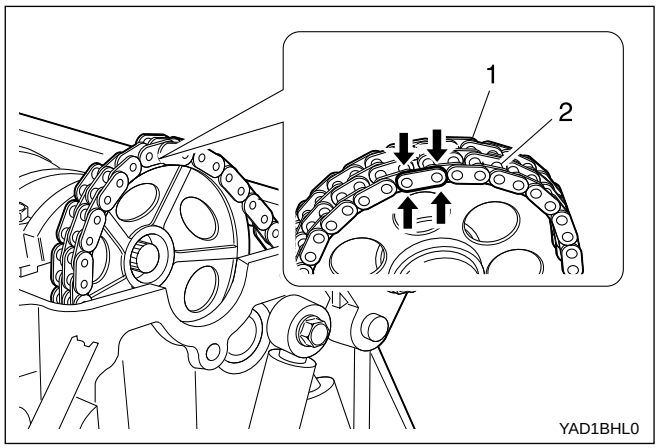


10. Switch over the die (9) of the chain assembling device 000 589 58 43 00 (8).

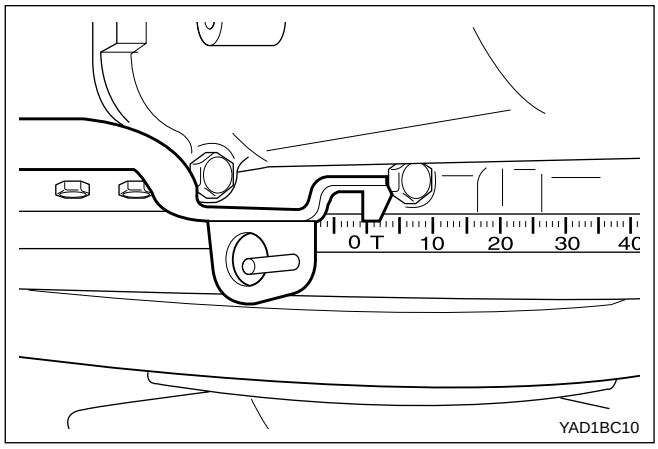


11. Place the fitting tool (8) onto the chain link and rivet the chain pins one by one.

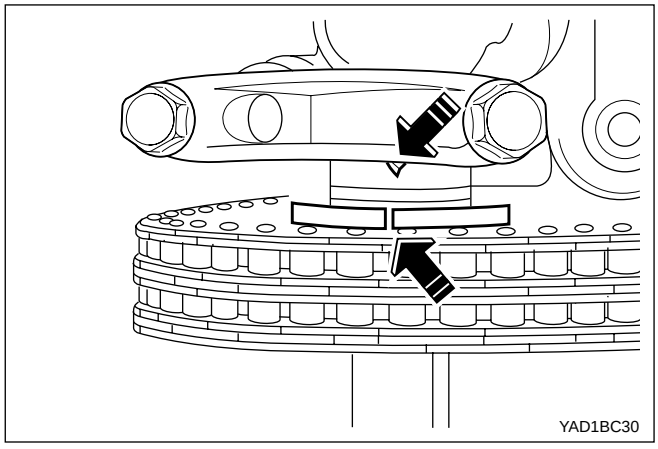
Tightening Torque	35 - 40 N•m (20 - 30 lb-ft)



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

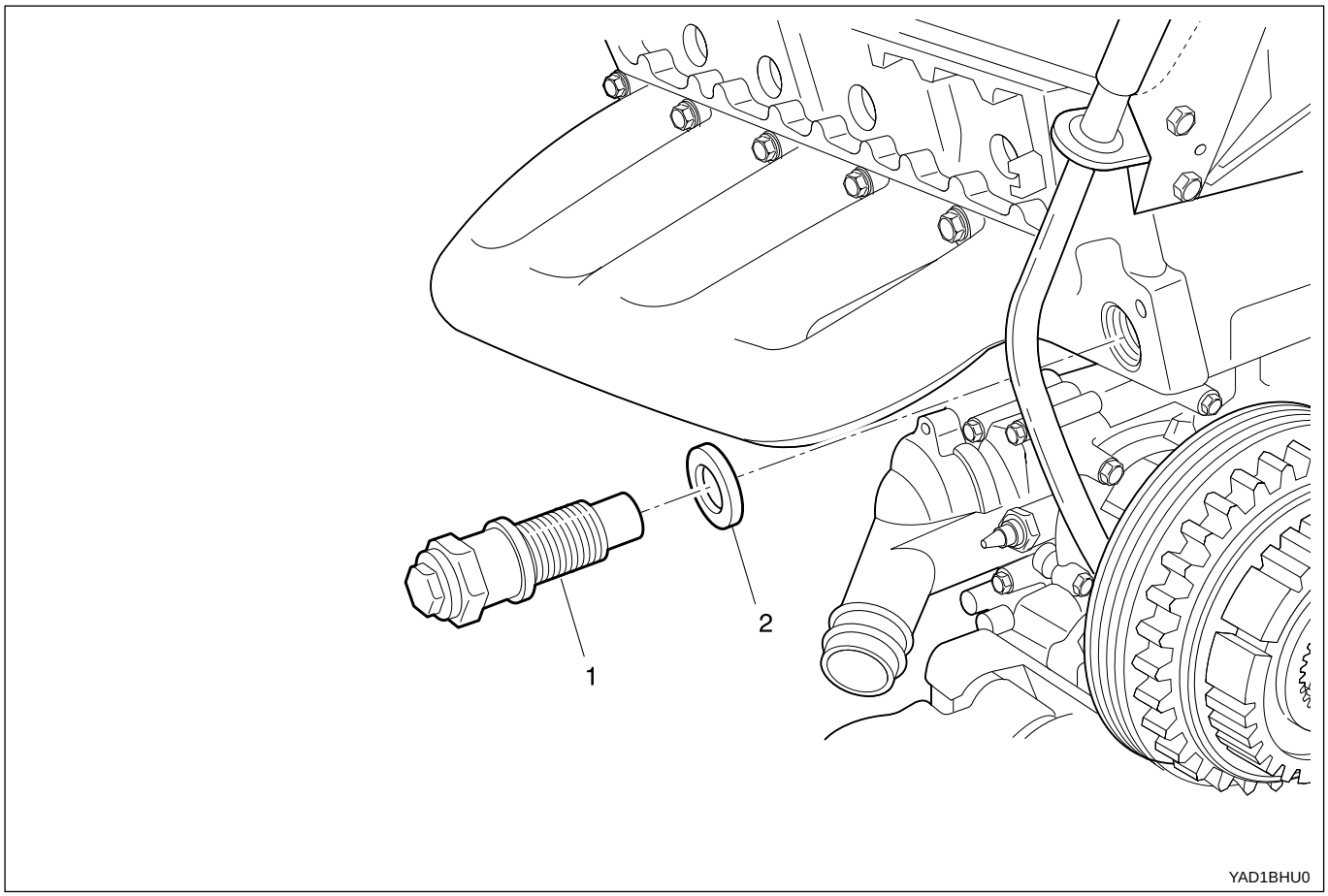


14. Position the no.1 cylinder at TDC.



Notice: 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.

CHAIN TENSIONER

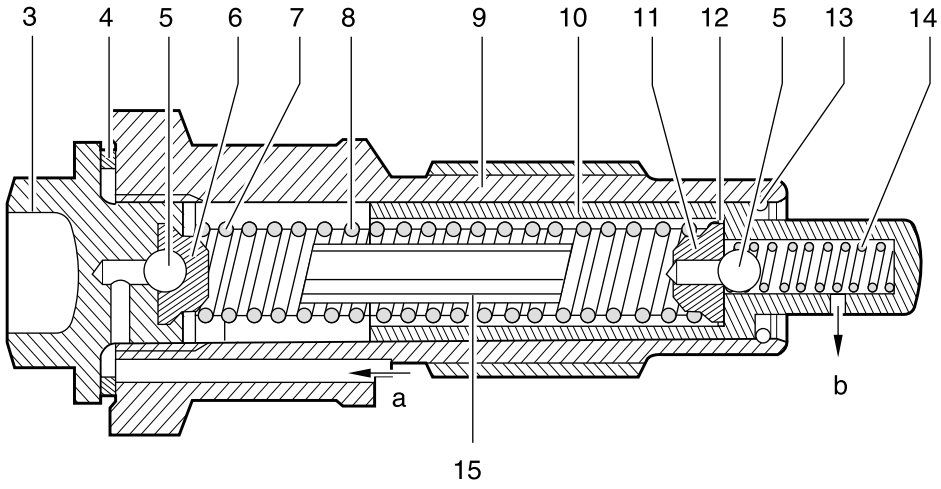


1 Chain Tensioner ..... 80 N•m (59 lb-ft)
2 Seal ..... Replace

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.

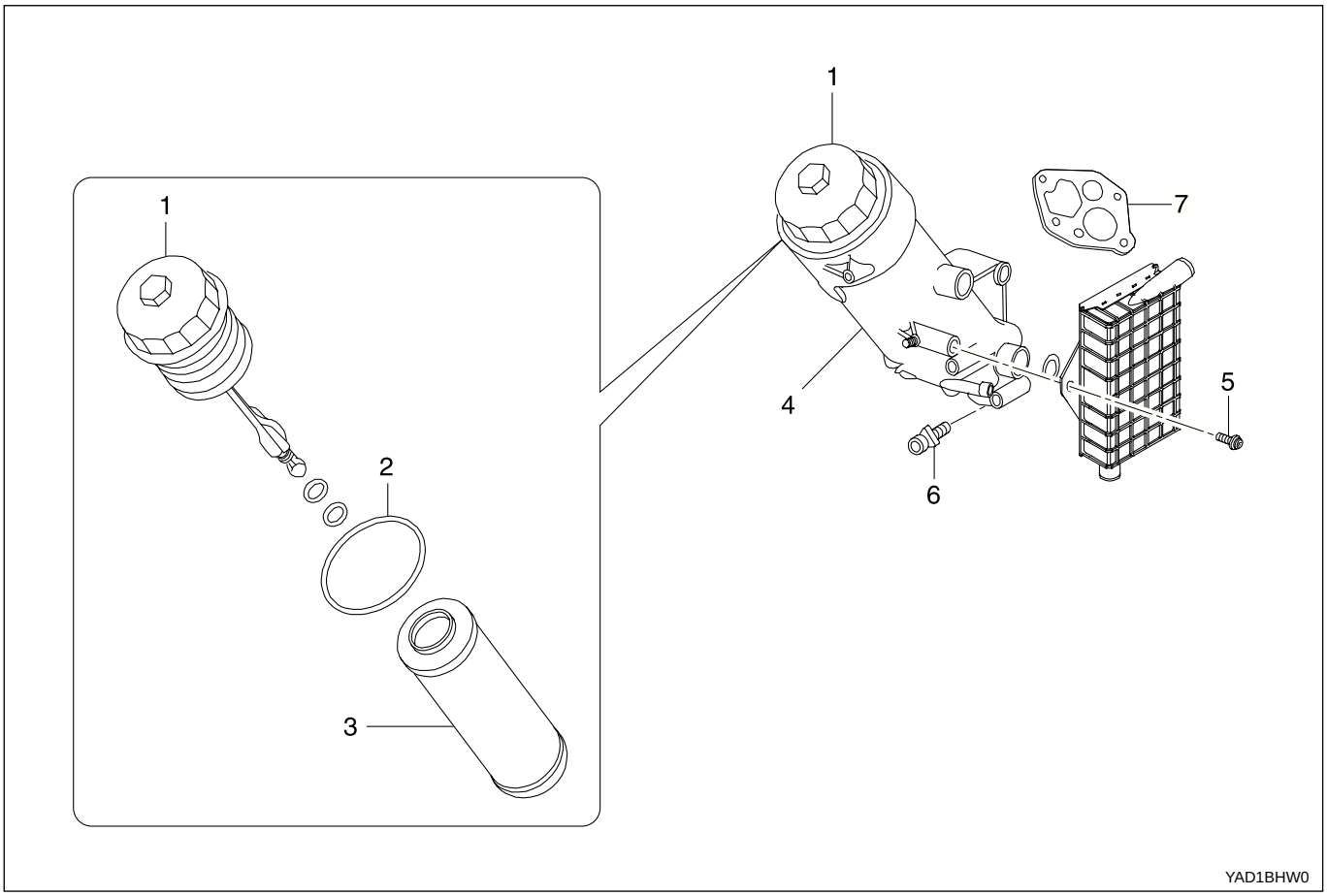


3 Screw Plug
4 Aluminum Gasket
5 Ball
6 Ball Guide
7 Compression Spring
8 Compression Spring
9 Housing
10 Thrust Pin
11 Valve Disc
12 O-Ring
13 Snap Ring
14 Compression Spring
15 Filler

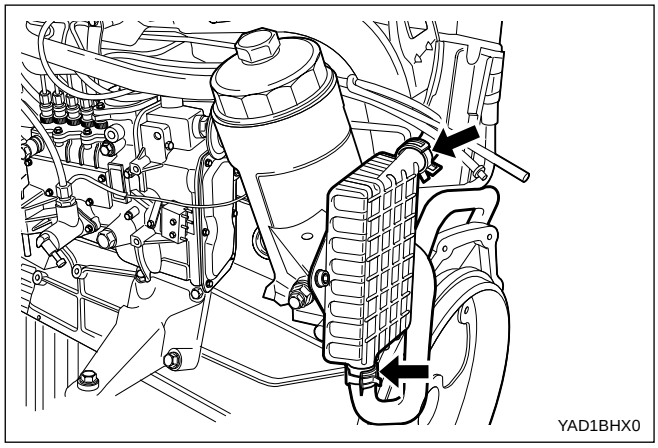
a Feed Bore from Cylinder Head
b To Oil Pan

LUBRICATION SYSTEM

OIL FILTER

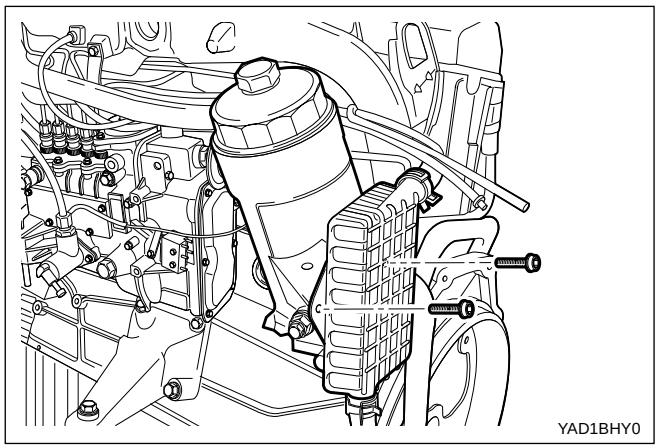


1 Housing Cap ..... 25 N•m (18 lb-ft)
2 O-Ring ..... Replace
3 Oil Filter ..... Element replace if necessary
4 Oil Filter Housing
5 Bolt ..... 25 N•m (18 lb-ft)
6 Oil Pressure Switch
7 Gasket



Removal & Installation Procedure

1. Disconnect the oil cooler inlet and outlet hoses.



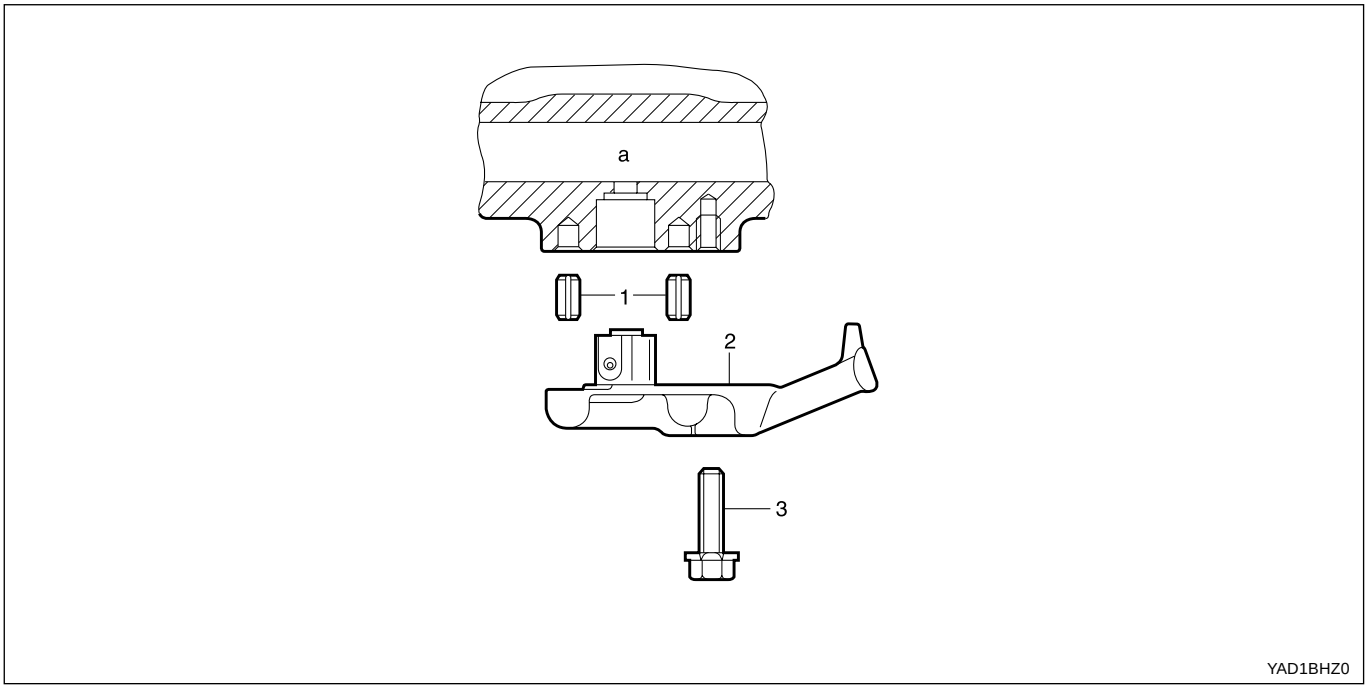
2. Remove the oil pressure switch line.
3. Remove the oil filter housing bolts and oil filter housing.

Installation Notice

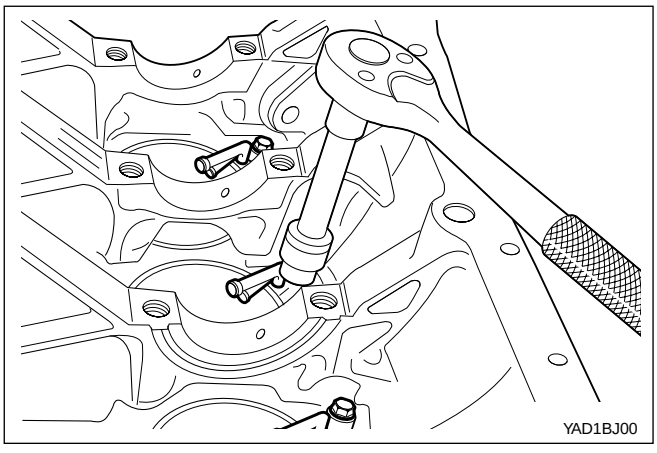
Tightening Torque	25 N•m (18 lb-ft)

4. Clean the sealing surface.
5. Installation should follow the removal procedure in the reverse order.

OIL SPRAY NOZZLE



1 Fitting Sleeve
2 Oil Spray Nozzle
3 Combination Bolt ..... 10 N•m (89 lb-in)
a Oil Duct



Removal & Installation Procedure

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

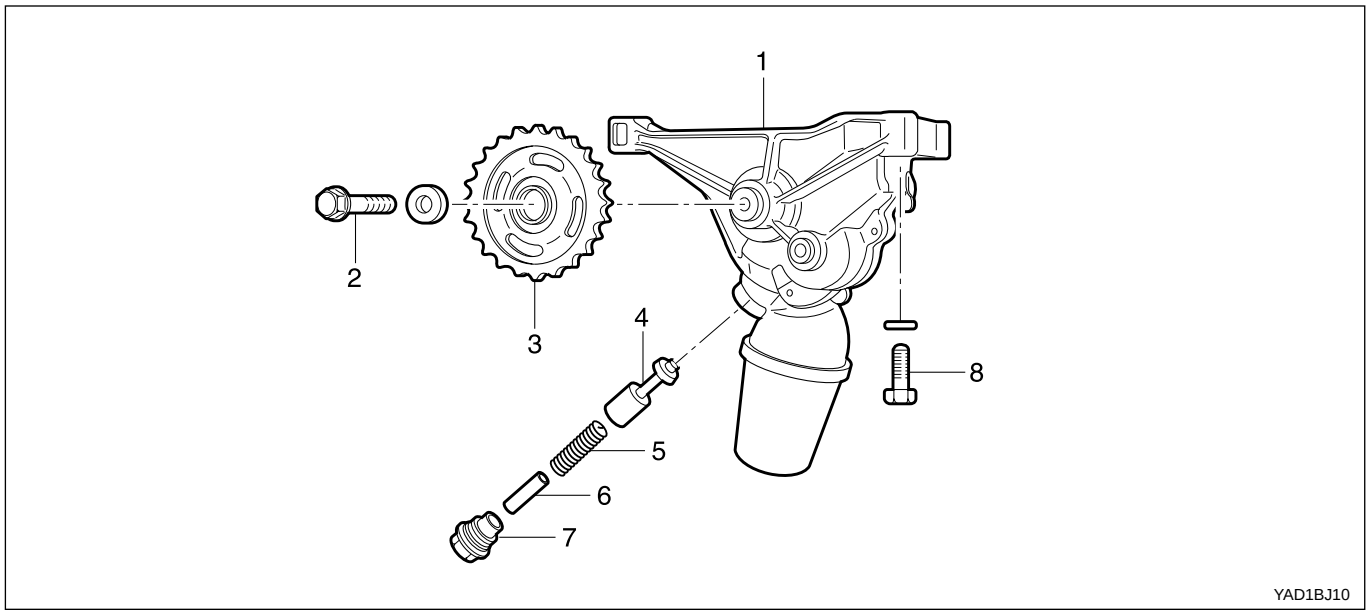
Installation Notice

Tightening Torque	10 N•m (89 lb-in)

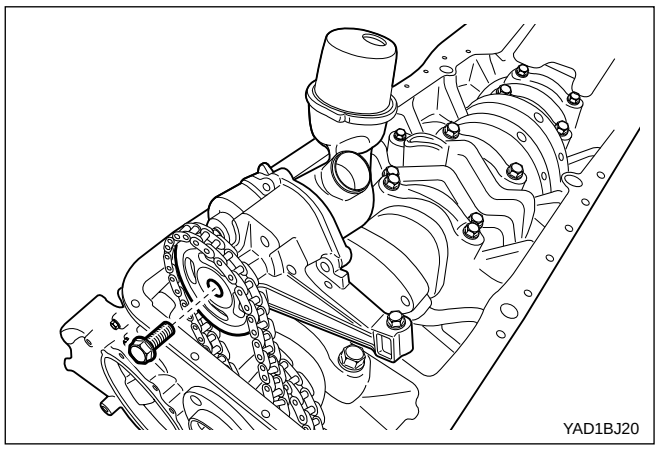
3. Installation should follow the removal procedure in the reverse order.

OIL PUMP

Preceding Work: Removal of oil pan



1 Oil Pump
2 Bolt ..... 25 N•m (18 lb-ft)
3 Sprocket
4 Poston
5 Pressure Spring
6 Guide Pin
7 Screw Plug ..... 50 N•m (37 lb-ft)
8 Bolt ..... 25 N•m (18 lb-ft)

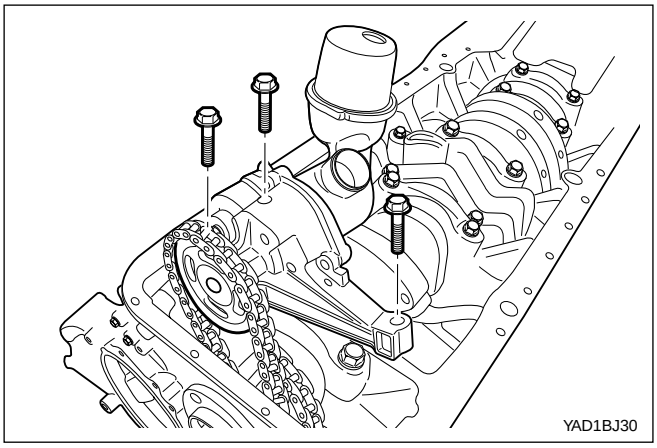


Removal & Installation Procedure

1. Removae the bolt from the oil pump drive sprocket and separate the gear and the oil pump drive chain.

Installation Notice

Tightening Torque	25 N•m (18 lb-ft)



2. Remove the oil pump mounting bolts and oil pump.

Installation Notice

Tightening Torque	25 N•m (18 lb-ft)

3. Unscrew the screw plug and remove the relief valve.

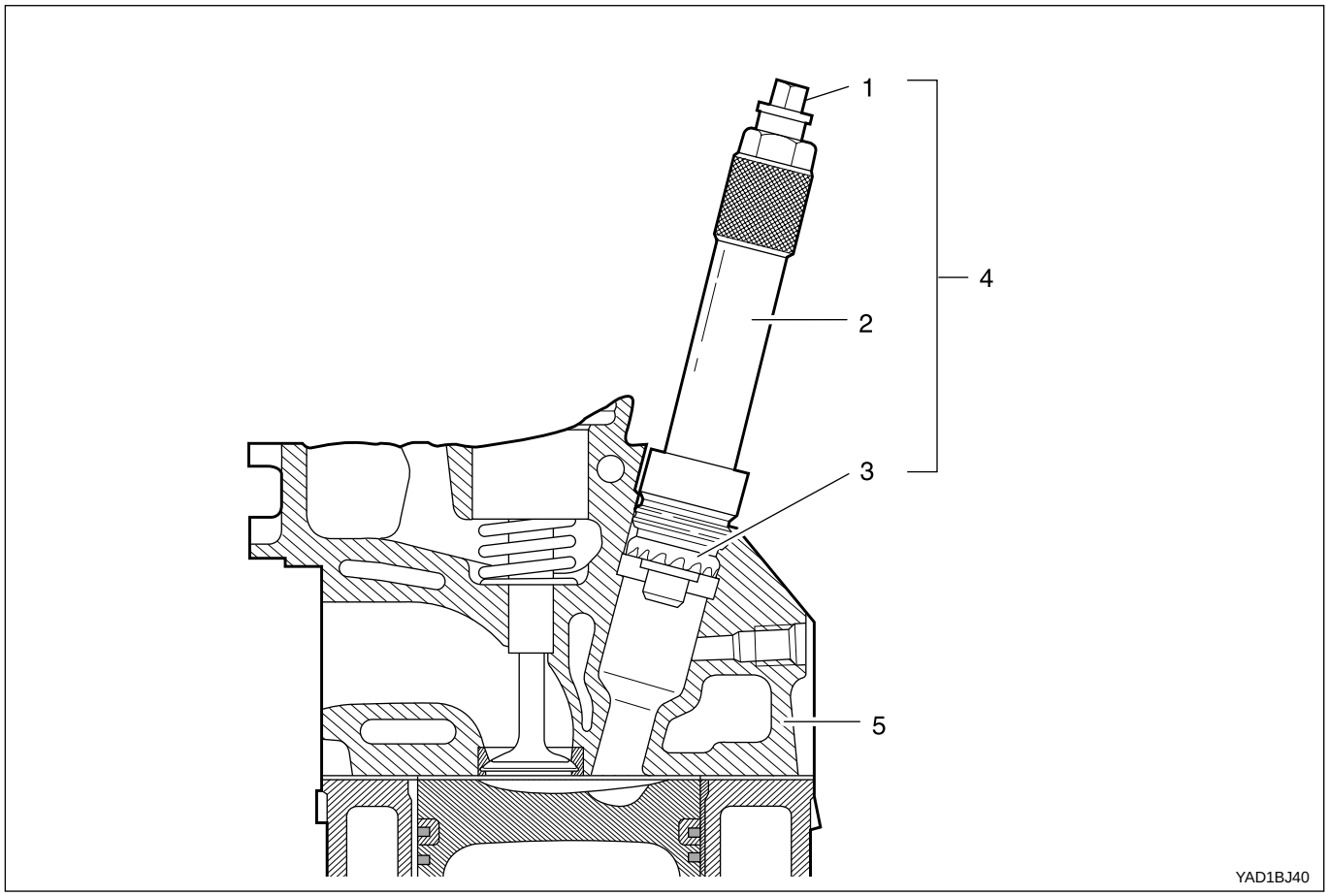
Installation Notice

Tightening Torque	50 N•m (37 lb-ft)

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

UNIT REPAIR

MILLING OF PRECHAMBER SEALING SURFACE



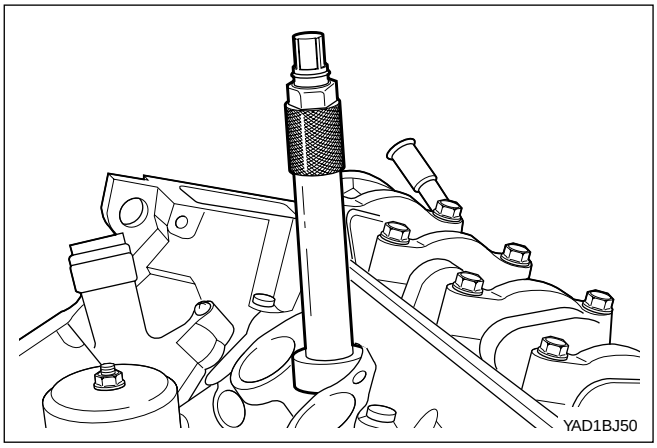
1 Drift
2 Sleeve
3 Milling Cutter
4 Counter Sink (Special Tool - 601 589 00 66 00)
5 Cylinder Head

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.

Thickness of spacers	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.



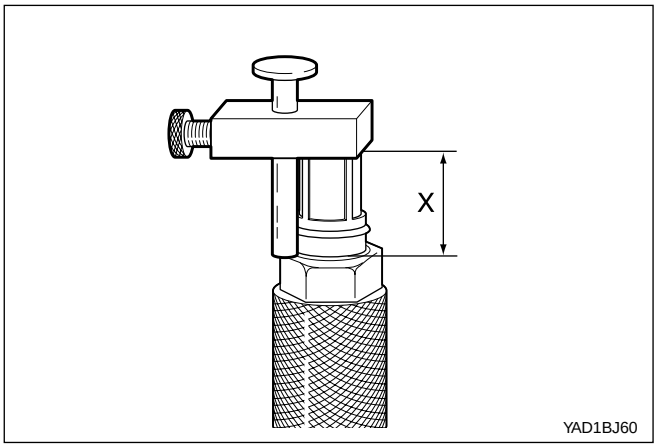
Tools Required

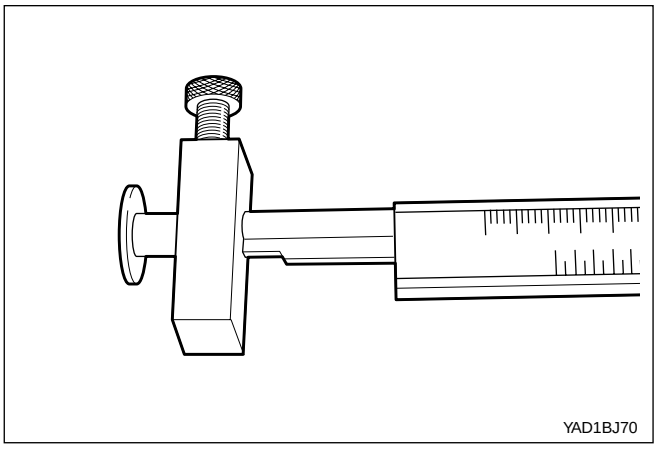
601 589 00 66 00 Counter Sink

607 589 00 23 00 Height Gauge

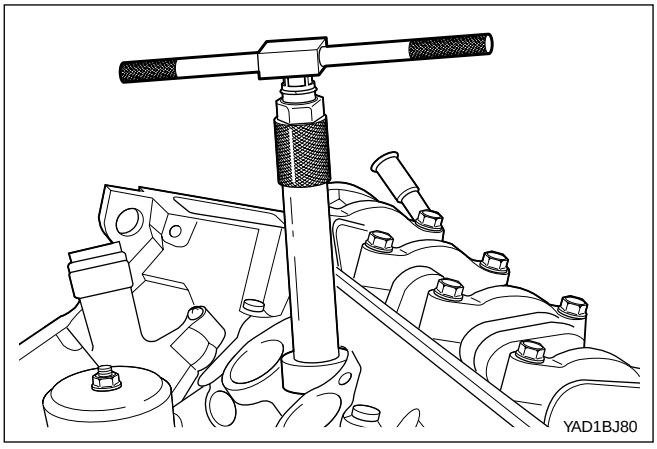
Milling of the Prechamber Sealing Surface

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 counter sink 601 589 00 60 00 and rotate the counter sink 601 589 00 60 00 into the prechamber bore to be machined as far as the stop.
5. Maintain size ‘X’ from the top edge of mandrel to the top edge of the sleeve with the height gauge 667 589 00 23 00.





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



7. Mount the turning tool onto the counter sink 601 589 00 60 00 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

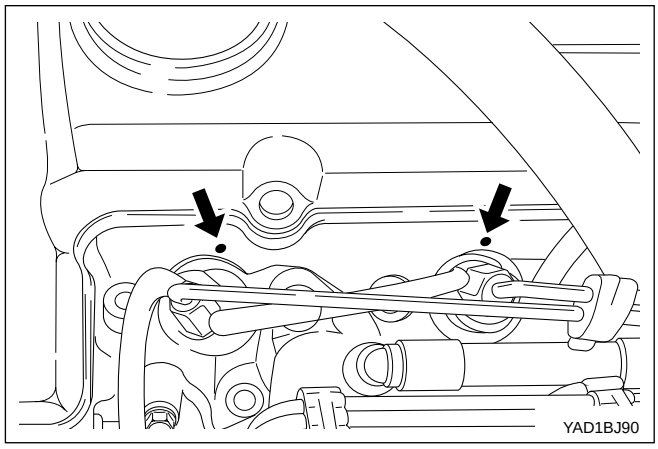
Size before machining	25.7 mm
Size after machining	25.5 mm

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

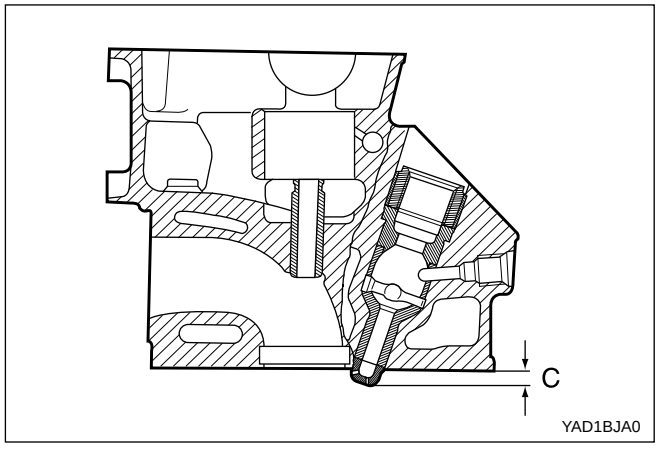
9. Remove the counter sink 601 589 00 60 00 and clean the chips.

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

10. Remove 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 - 8.1 mm