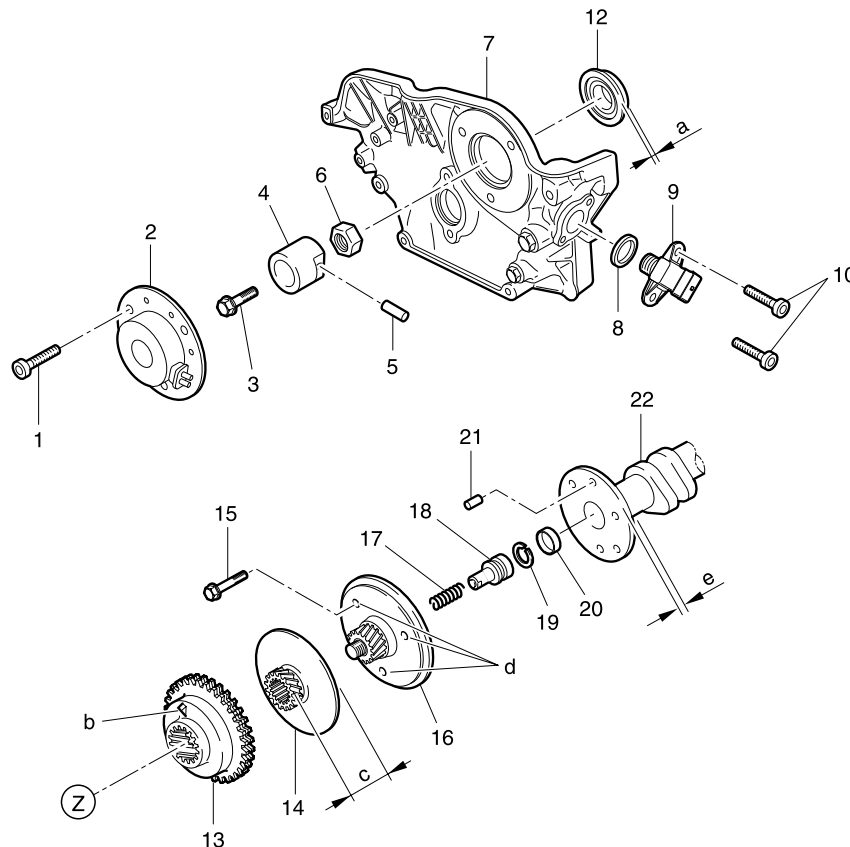


TIMING DEVICE AND VALVE

CAMSHAFT ADJUSTER

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover



YAD1B0B0

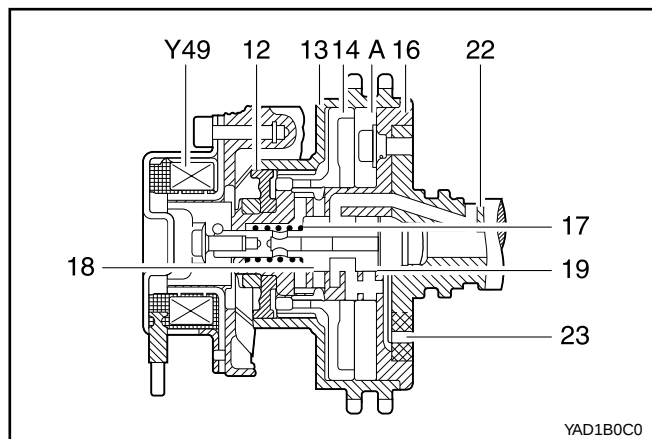
- | | |
|---|---|
| 1 Bolt (M6 x 16, 3 pieces)
..... 9-11 N•m (80-97 lb-in) | 12 Seal Cover |
| 2 Camshaft Actuator (2 Pin Connector) | 13 Camshaft Sprocket and Position Indicator (b) |
| 3 Bolt 35 N•m (26 lb-ft) | 14 Adjuster Piston |
| 4 Armature | 15 Flange Bolt (M7 x 13, 3 pieces)
..... 1st step 18-22 N•m (13-16 lb-ft)
2nd step 90° ± 5° |
| 5 Roll Pin | 16 Flange Shaft |
| 6 Nut (M20 x 1.5) 60-70 N•m (44-52 lb-ft) | 17 Compression Spring |
| 7 Front Cover | 18 Control Piston |
| 8 Seal | 19 Circlip |
| 9 Camshaft Position Sensor | 20 Oil Gallery |
| 10 Bolt (M6 x 16, 2 pieces)
..... 9-11 N•m (80-97 lb-in) | 21 Pin |
| 11 - | 22 Intake Camshaft |

Functions

When the engine is running, the camshaft rotates the intake camshaft hydraulically/mechanically relative to the camshaft sprocket by 34° crankangle to the 'advanced' position and back to the 'retarded' position.

The camshaft adjuster is actuated electromechanically by the ECU. The positioning time of approx. 1 second is dependent on the engine oil pressure at the camshaft adjuster and on the oil viscosity and oil temperature, respectively. The position indicator (b) on the camshaft sprocket (13) provides the camshaft rotational speed to the position sensor (9) as an input parameter for the engine ignition control unit.

"Retarded" Position



- 12 Seal Cover
- 13 Camshaft Sprocket
- 14 Adjust Piston (Stops Towards The Front)
- 16 Flange Shaft
- 17 Compression Spring
- 18 Control Piston (Stops Towards The Rear)
- 19 Circlip
- 22 Intake Camshaft
- 23 Oil Outlet Drilling
- A Working Chamber (Oil Pressure)
- Y49 Electromagnetic Actuator (Not Functioning)

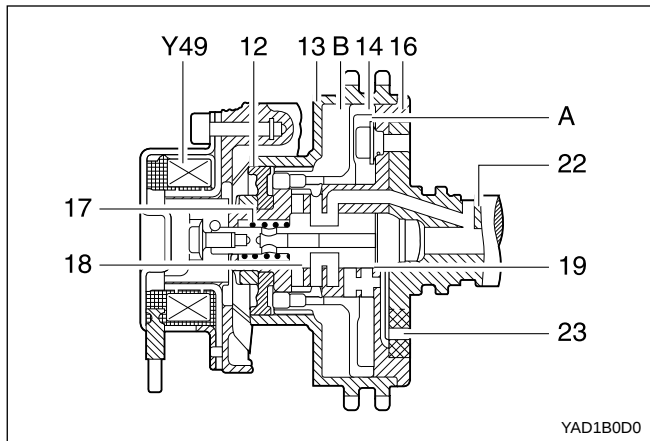
1. Ignition switch OFF ('retarded')

The compression spring (17) pushes the control piston (18) against the circlip (19). The engine oil pressure in the camshaft is eliminated.

2. From 0 to 1000 - 2000 rpm ('retarded')

The torque of the internally helically toothed camshaft sprocket (13) acting in the direction of rotation of the engine pushes the externally helically toothed positioning piston (14) against the cover (12) as a result of the screw action. Consequently, the likewise internally helically toothed positioning piston (14) holds the externally helically toothed flanged shaft (16) together with the bolted-on camshaft (22) in the 'retarded position'. The compressing spring (17) pushes the control piston (18) against the circlip (19). The engine oil flows through 2 oblique drillings in the camshaft flange and in the flanged shaft (16) into the working chamber (A) and holds the positioning piston (14) additionally in the 'retarded' position with the available engine oil pressure.

Leak oil flows off over control and positioning piston surface, through the control piston drilling and 2 drillings (23) in the camshaft flange.

"Advanced" Position

- 12 Seal Cover
- 13 Camshaft Sprocket
- 14 Adjust Piston (Stops Towards The Front)
- 16 Flange Shaft
- 17 Compression Spring
- 18 Control Piston (Stops Towards The Rear)
- 19 Circlip
- 22 Intake Camshaft
- 23 Oil Outlet Drilling

A Working Chamber (Oil Pressure)

Y49 Electromagnetic Actuator (Not Functioning)

3. From 1000 - 2000 to 4000 rpm ('advanced')

The control piston (18) is pulled forward as far as the stop in the flanged shaft (16) by the actuator (Y49) against the force of the compression spring (17).

The control piston (18) closes the oil feed to the working chamber 'A' and at the same time allows oil to flow to the working chamber 'B' through 2 drillings each in the flanged shaft (16) and adjusting piston (14). The engine oil pressure moves the adjusting piston (14) as far as the stop on the flanged shaft (16). As a result of the axial movement of the flanged shaft (16) is turned into the 'advanced' position. The turning action is achieved as a result of the effect of the helical teeth on the camshaft sprocket (13), positioning piston (14) and flanged shaft (16). The engine oil in working chamber 'A' flows off, assisted by the pushing action of the adjusting piston (14), over the flanged shaft (16) and through 2 drillings (23) in the camshaft flange.

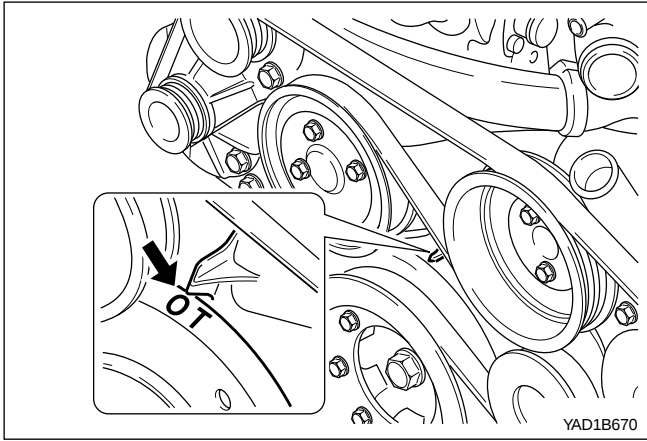
4. From 4000 rpm ('retarded')

The electromagnetic actuator (Y49) is not actuated and allows the control piston to move. The compression spring (17) pushes the control piston (18) against the circlip (19). The oil feed to the working chamber 'B' is closed off and oil is able to flow to working chamber 'A' along 2 drillings in the flanged shaft (16). As a result of the engine oil pressure, the control piston (18) is moved as far as the cover (12).

This axial movement of the adjusting piston (14) rotates the camshaft (22) bolted to the flanged shaft (16) in to the 'retarded' position.

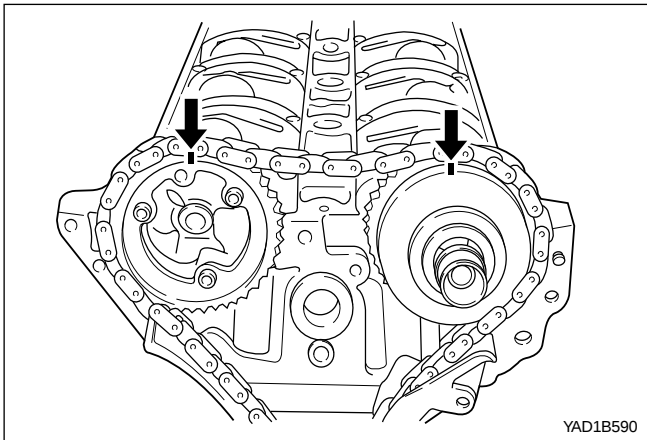
The rotational movement is a result of the screw effect of the helical teeth on the camshaft sprocket (13), positioning piston (14) and flanged shaft (16). The engine oil in the working chamber (B) flows off, assisted by the pushing action of the adjusting piston (14), through 2 drillings each in the adjusting piston (14), flanged shaft (16) and control piston (18) through the control piston (18) and 2 drillings in the camshaft flange (23).

Leak oil flows off over the control and adjusting piston surfaces through the control piston drilling and 2 drillings in the camshaft flange (23).

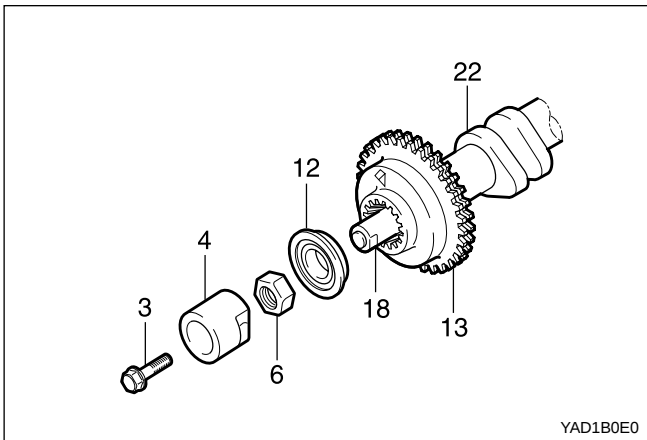


Removal & Installation Procedure

1. Turn the crankshaft to the direction of engine rotation and position the no.1 cylinder piston at TDC which the camshaft is positioned at OT.



2. Remove the cylinder head front cover. Refer to "Cylinder Head Front Cover" in this section.
3. Paint the alignment marks (arrows) on the intake and exhaust camshaft sprocket and the timing chain.



4. Unscrew the bolt (3) from the armature (4) and remove the armature.

Installation Notice

Tightening Torque	35 N•m (26 lb-ft)
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5. Unscrew the nut (6) and remove the ring and seal cover (11).

Installation Notice

Tightening Torque	60 - 70 N•m (44 - 52 lb-ft)
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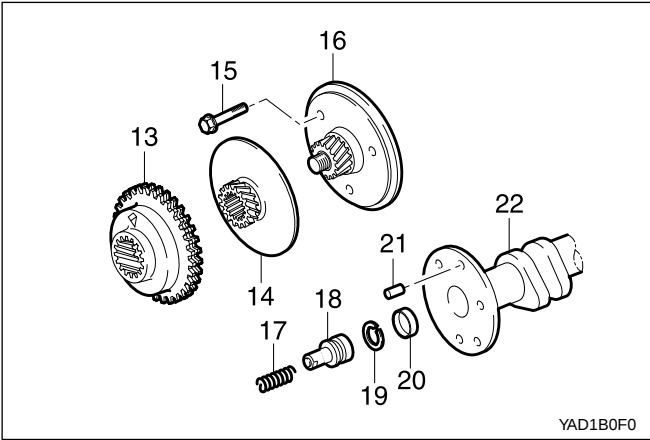
- | | |
|-------------------|----------------------|
| 3 Bolt | 13 Camshaft Sprocket |
| 4 Amarture | 18 Control Piston |
| 6 Nut (M20 x 1.5) | 22 Intake Camshaft |
| 12 Seal Cover | |

6. Unscrew the sprocket bolt from the exhaust camshaft and remove the sprocket.

Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

The sprocket bolt is designed to be used only once, so always replace with new one.



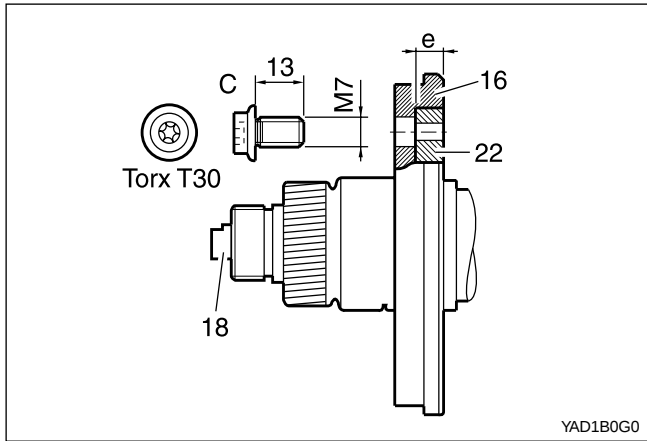
7. Remove the camshaft sprocket (13) and adjust piston (14), and remove the flange shaft (16) from the intake camshaft (22) after removing the bolt (15).

Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

The sprocket bolt is designed to be used only once, so always replace with new one.

8. Installation should follow the removal procedure in the reverse order.
9. Adjust the camshaft timing.



- C M7 x 13 Collar Bolt Torx-T30
 e 6.8 mm
 16 Flange Shaft
 18 Control Piston
 22 Intake Camshaft

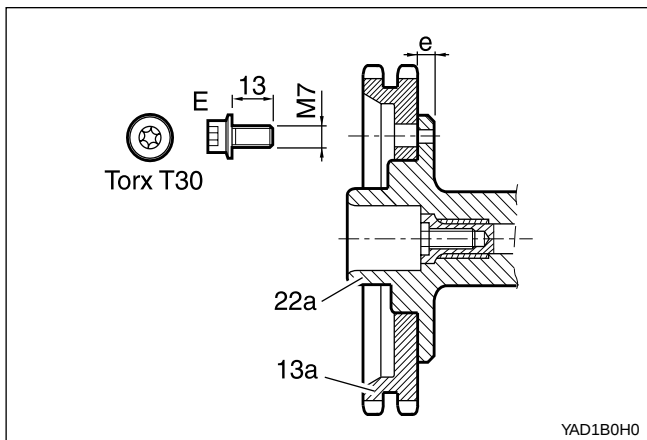
CAMSHAFT SPROCKET BOLT

Intake Flange Shaft Bolt

Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

The sprocket bolts are designed to be used only once, so always replace with new one.



- E M7 x 13 Collar Bolt Torx-T30
 e 6.8 mm
 13a Camshaft Sprocket
 22a Exhaust Camshaft

Exhaust Camshaft Sprocket Bolt

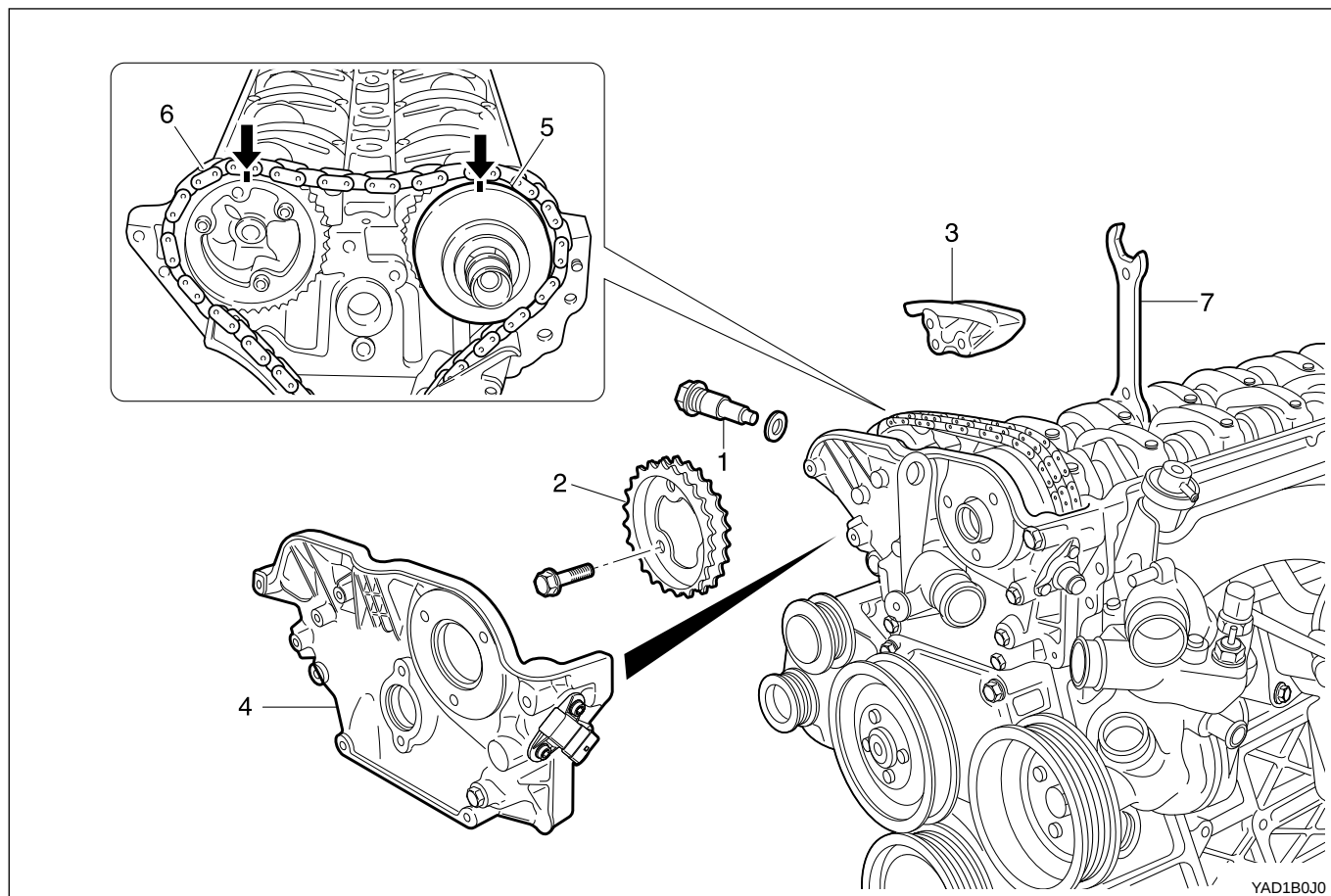
Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

The sprocket bolts are designed to be used only once, so always replace with new one.

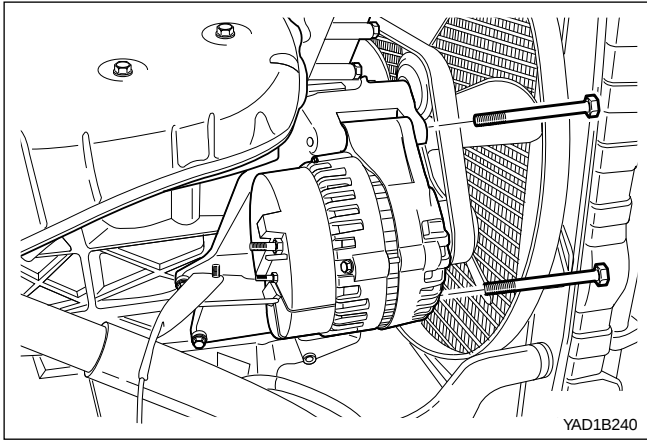
CAMSHAFT

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover
Removal of coolant connection fitting



- | | | |
|---|---------------------------|-------------------------|
| 1 | Chain Tensioner Assembly | |
| | | 72-88 N•m (53-65 lb-ft) |
| 2 | Exhaust Camshaft Sprocket | |
| 3 | Upper Guide Rail | |

- | | |
|---|---------------------------|
| 4 | Cylinder Head Front Cover |
| 5 | Intake Camshaft Sprocket |
| 6 | Chain |
| 7 | Wrench |

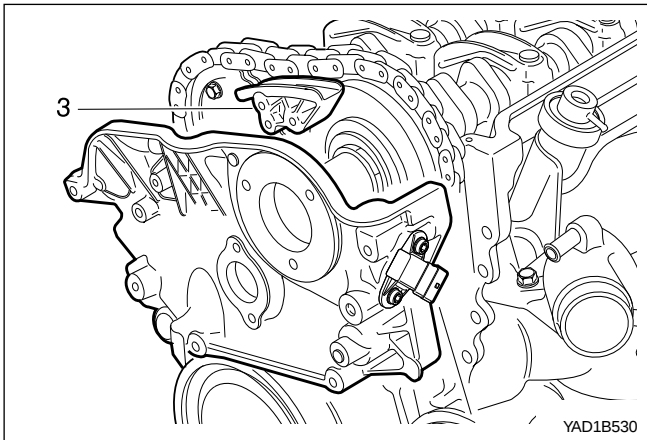


Tools Required

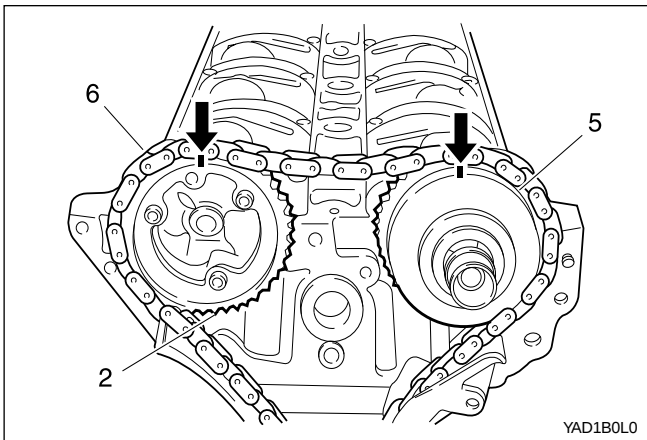
DW 110-120 Holding Pin

Removal Procedure

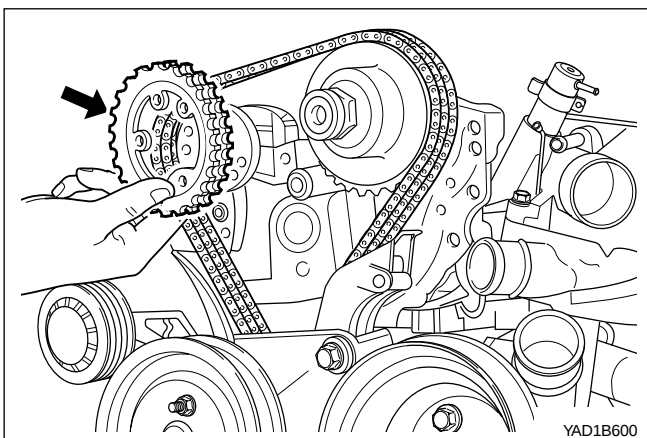
1. Turn the crankshaft and position the No. 1 cylinder piston at BTDC 30°.
2. Remove the generator.
3. Remove the chain tensioner. Refer to "Chain Tensioner" in this section.



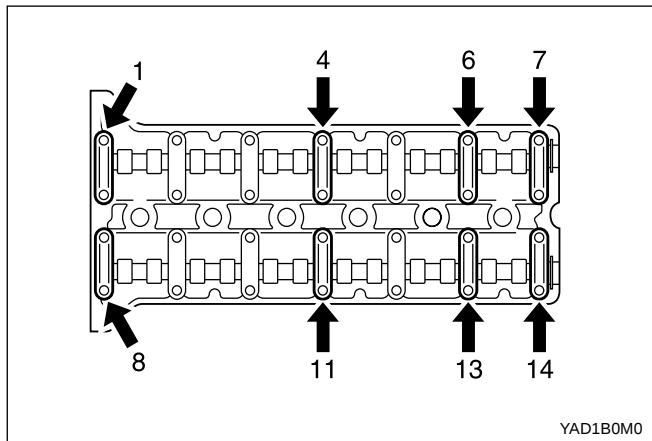
4. Remove the cylinder head front cover and the upper guide rail.



5. Put the alignment marks (arrows) on the camshaft sprocket (2, 5) and the timing chain (6).



6. Unscrew the exhaust camshaft sprocket bolt and remove the sprocket.
7. Separate the chain from the intake camshaft sprocket and put the chain not to be dropped into timing case.

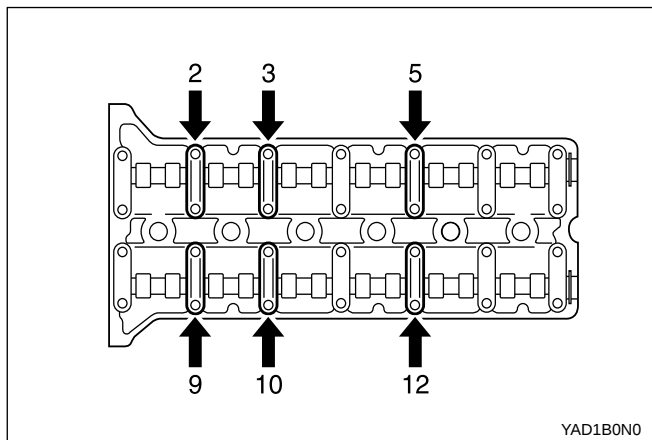


8. Unscrew the intake side bolts (8, 11, 13, 14) and the exhaust side bolts (1, 4, 6, 7).
 9. Loosen the remaining bolts and unscrew the intake and exhaust side camshaft bearing cap bolts.
- Notice:** Number the camshaft bearing cap bolts when removing them, so that they don't get mixed up.
10. Remove the intake and exhaust camshafts.

Installation Procedure

1. Turn the crankshaft and position the No. 1 cylinder piston at BTDC 30°.

Notice: Turn the crankshaft in the direction of engine rotation.

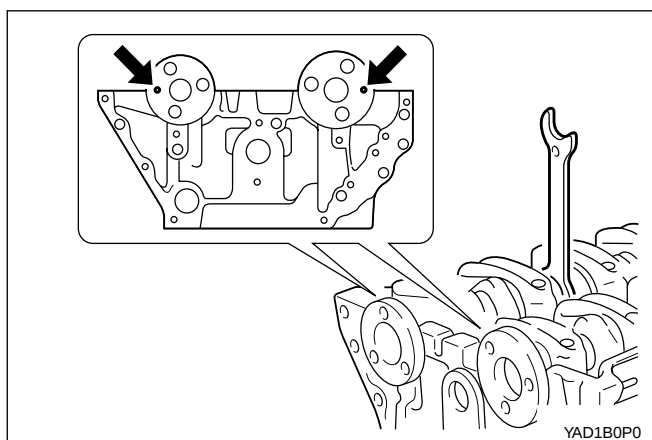


2. Install the exhaust camshaft bearing caps (2, 3, 5) and the intake camshaft bearing caps (9, 10, 12). Tighten the bolts with specified torque and install the remaining bearing caps.

Installation Notice

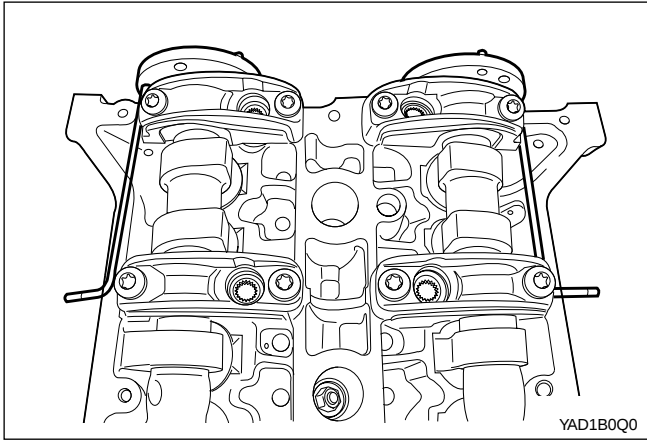
Tightening Torque	22.5 - 27.5 N•m (16.6 - 20.3 lb-ft)
-------------------	--

Install the bearing caps according to the numbers on the bearing caps.

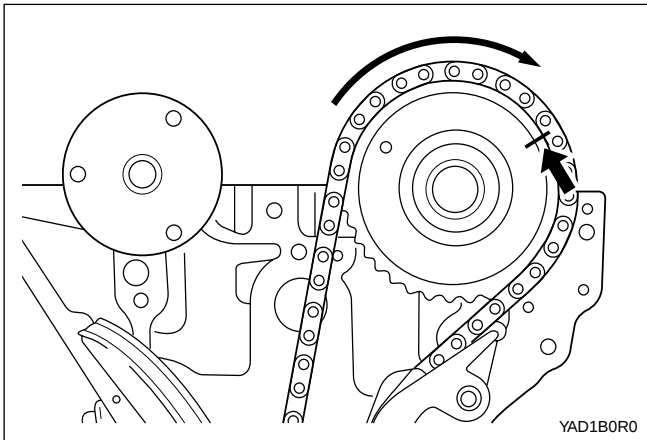


3. Turn the camshaft using the wrench so that the intake camshaft adjustment hole lines up with the cylinder head upper side (3 o'clock direction at the intake, 9 o'clock direction at the exhaust).

Notice: Turn the crankshaft and adjust it to OT so that No. 1 cylinder's piston would be at TDC.



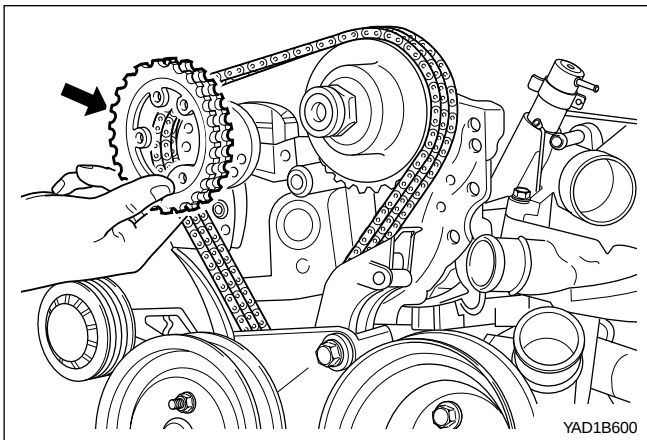
4. Align the holes on intake and exhaust camshaft to the hole on cylinder head. Insert the holding pin DW 110-120 into the holes.



5. Turn the intake camshaft adjuster to the direction of camshaft rotation by hand until it stops and then install the chain.

Notice:

- Make sure that the camshaft sprocket and timing chain are aligned with marks.
- Intake camshaft adjuster should be in retarded position.

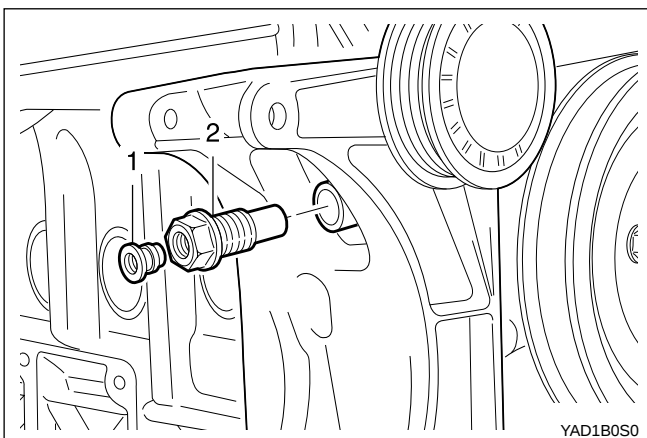


6. Install the chain on the exhaust sprocket and tighten the sprocket bolts.

Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

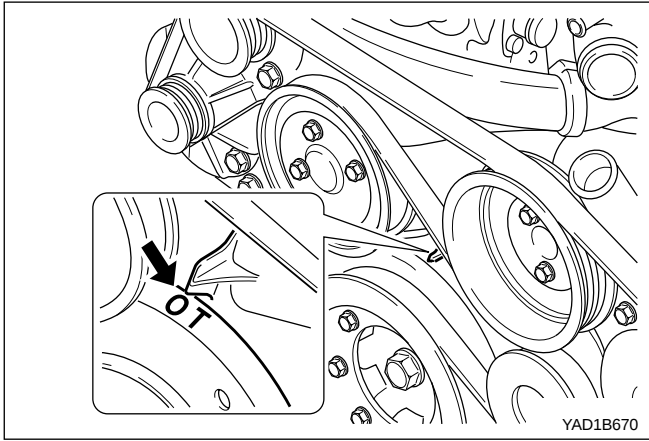
- Make sure that the camshaft sprocket and timing chain are aligned with marks.
- Replace the sprocket bolt with new one.



7. Install the chain tensioner screw plug (1) and chain tensioner assembly (2) and tighten it as specified.

Installation Notice

Tightening Torque	(1) : 40 N•m (30 lb-ft)
	(2) : 72 - 88 N•m (53 - 65 lb-ft)

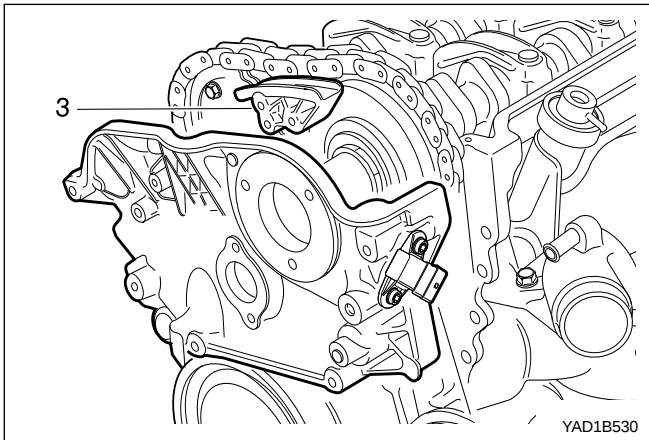


8. Rotate the crankshaft 2 revolutions and check followings:

- TDC of no. 1 cylinder : OT
- Alignment between camshaft adjustment hole and cylinder head surface.
- Alignments between timing chain and sprocket marks.

Notice:

- Turn the crankshaft in the direction of engine rotation.
- Read just if not aligned.



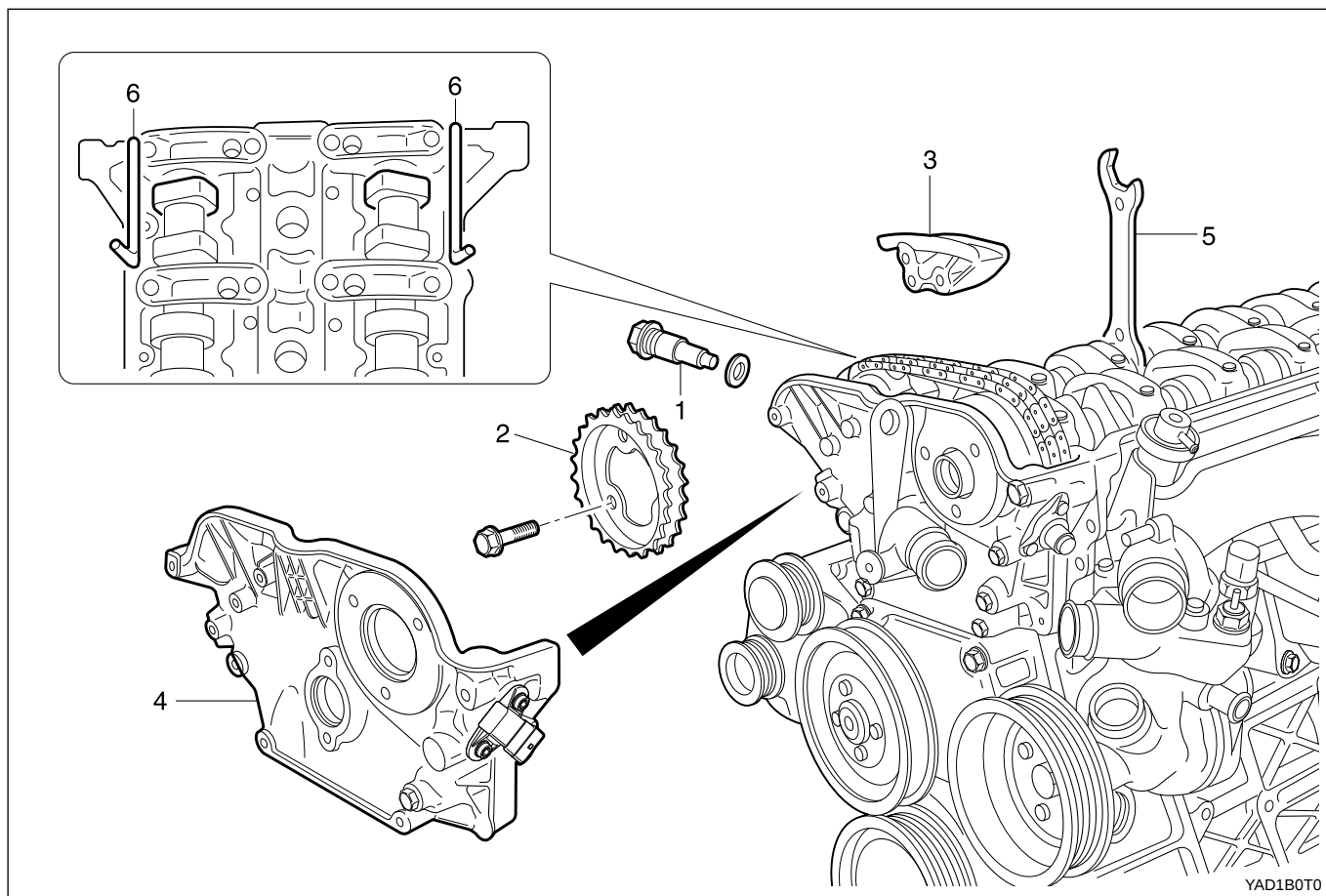
9. Install the upper guide rail and cylinder head front cover.

10. Install the generator.

CAMSHAFT TIMING POSITION

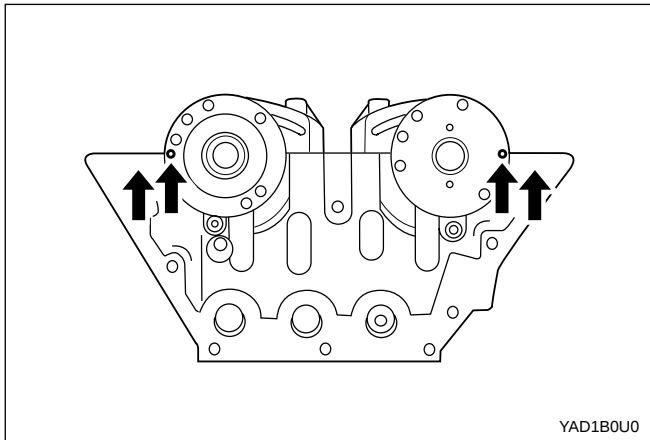
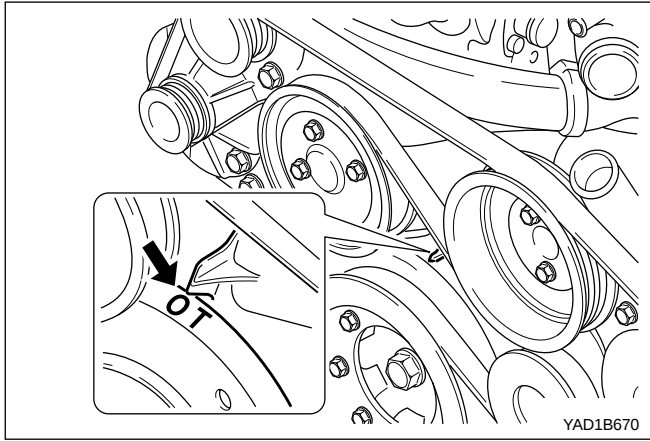
Preceding Work : Removal of cylinder head cover

Removal of cylinder head front cover



- 1 Chain Tensioner Assembly
- 2 Exhaust Camshaft Sprocket
- 3 Upper Guide Rail

- 4 Cylinder Head Front Cover
- 5 Wrench
- 6 Holding Pin DW 110-120



Tools Required

DW 110-120 Holding Pin

Inspection

1. Position the No.1 cylinder piston to TDC (OT) by turning the crankshaft.

Notice: When the OT mark on vibration damper is aligned with timing gear case cover, the intake and exhaust cam of cylinder will make the slope to the center and will face up. In this way, the adjustment hole of the intake and exhaust camshaft will match in line with the cylinder head upper end, at 3 o'clock, and 9 o'clock direction each other.

2. Check the timing as below procedure;
 - Check if the camshaft adjustment hole is positioned to 3 o'clock direction at the intake side and to 9 o'clock direction at the exhaust side, respectively and align with the cylinder head mating surface.
 - At this condition, check if the OT mark on vibration damper aligns with the marker on the timing gear case.

Adjustment Procedure

1. Position the No.1 cylinder to BTDC 30° .
2. Remove the chain tensioner.
3. Remove the exhaust camshaft sprocket.
4. Align the intake and exhaust camshaft flange hole with the cylinder head upper surface.
 - Intake Side : 3 o'clock direction
 - Exhaust Side : 9 o'clock direction
5. Align the holes on intake and exhaust camshaft to the hole on cylinder head. Insert the holding pin DW 110-120 into the hole.
6. Secure the intake and exhaust camshaft.
7. Position the piston of No.1 cylinder at TDC (OT) by turning the crankshaft.
8. Turn the camshaft adjuster of the intake camshaft to the left as much as possible (cam adjuster 'retarded' position).
9. Install the chain to the intake camshaft sprocket.

Notice: Timing chain must be placed on the guide rail in gear case cover.

10. Install the chain to the exhaust camshaft sprocket and install it to the camshaft.

Installation Notice

Tightening Torque	1st step: 18 - 22 N•m (13 - 16 lb-ft)
	2nd step: 90° ± 5°

The sprocket bolt is designed to be used only once, so replace with new one.

11. Install the chain tensioner.

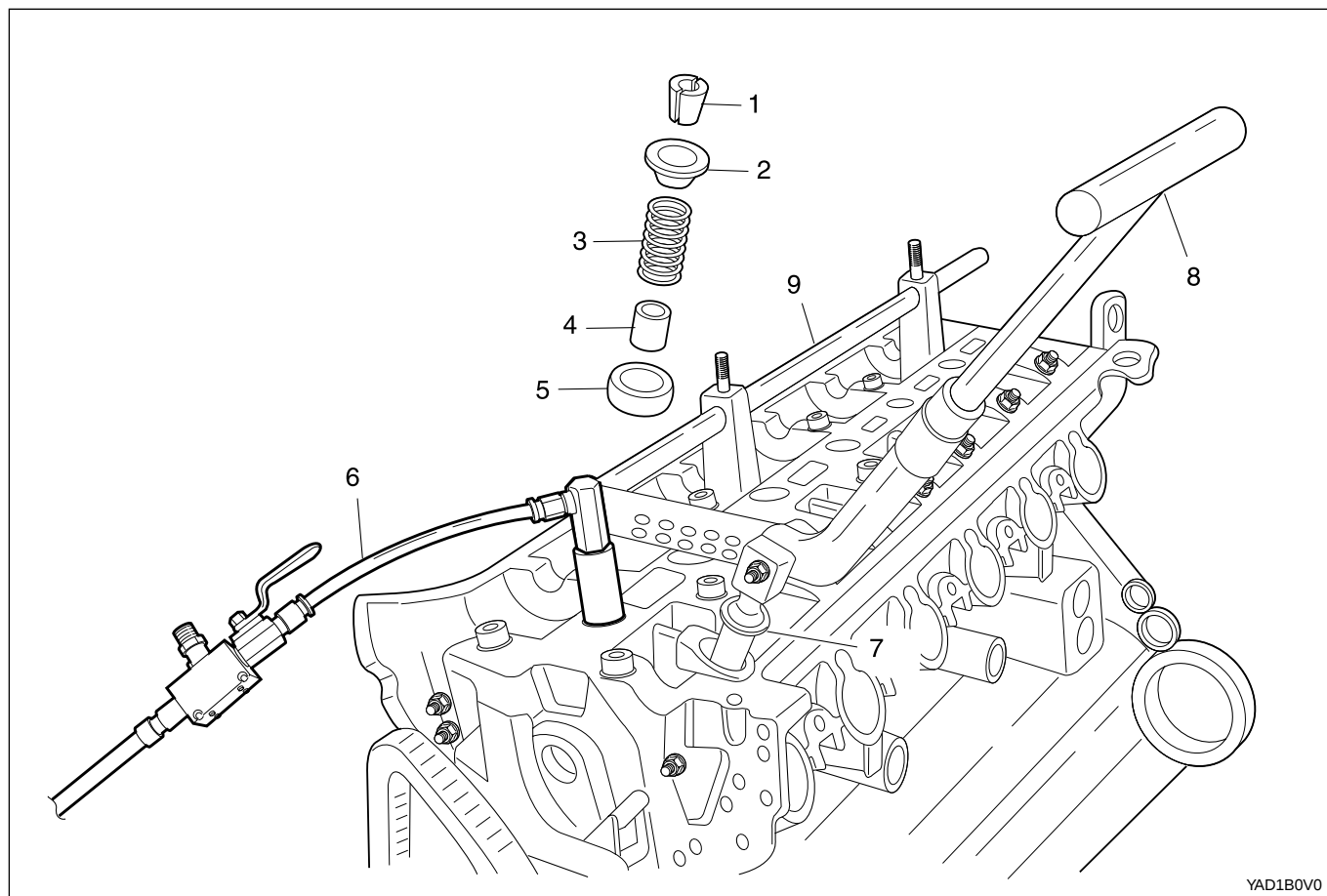
Installation Notice

Tightening Torque	Screw Plug	40 N•m (30 lb-ft)
	Tensioner Assembly	72 - 88 N•m (53 - 65 lb-ft)

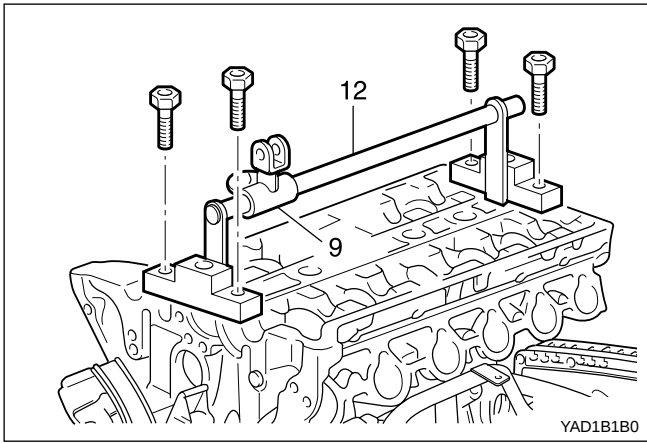
12. Check the camshaft timing.

VALVE SPRING

Preceding Work : Removal of camshaft
Removal of spark plug



- | | | |
|--|-------------------|------------------|
| 1 Valve Cotter | 6 Connecting Hose | DW 110-090 |
| 2 Upper Retainer | 7 Thrust Piece | 111 589 25 63 00 |
| 3 Valve Spring Check, Replace if necessary | 8 Lever Pusher | 111 589 18 61 00 |
| 4 Valve Stem Seal | 9 Supporting Bar | 111 589 01 59 00 |
| 5 Lower Retainer | | |



Tools Required

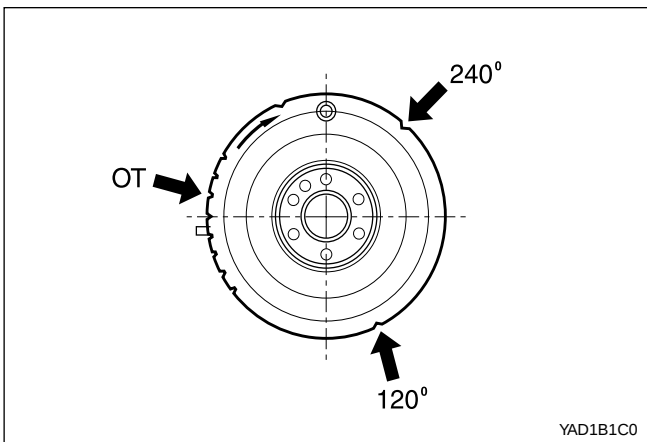
111 589 01 59 00	Supporting Bar
111 589 18 61 00	Lever Pusher
111 589 25 63 00	Thrust Piece
602 589 00 40 00	Engine Lock
DW 110-090	Connecting Hose
DW 110-100	Valve Tappet Remover

Removal & Installation Procedure

1. Place the supporting bar 111 589 01 59 00 (12) at the camshaft bearing cap and tighten them with the bearing cap bolt.

Installation Notice

Tightening Torque	22.5 - 27.5 N•m (16.6 - 20.3 lb-ft)
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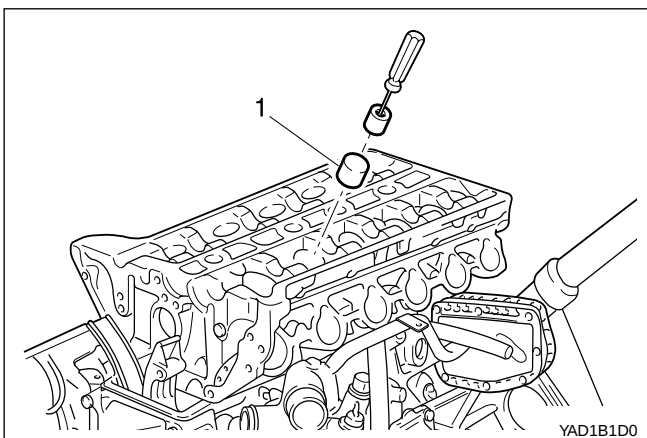
2. Turn the crankshaft to position the each cylinder piston at TDC.

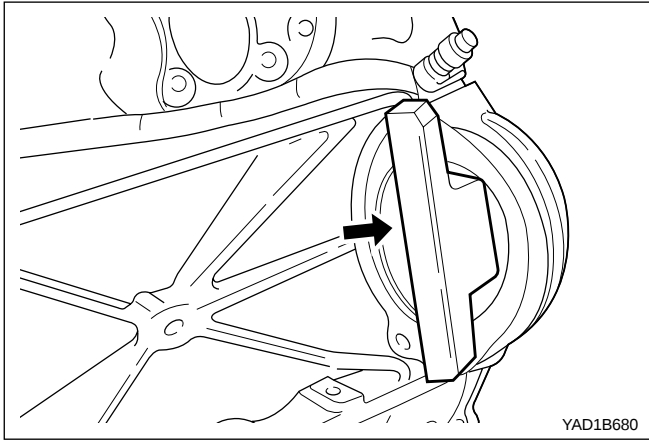
Mark on The Vibration Damper	Cylinder
OT	1, 6
120°	2, 5
240°	3, 4

Notice:

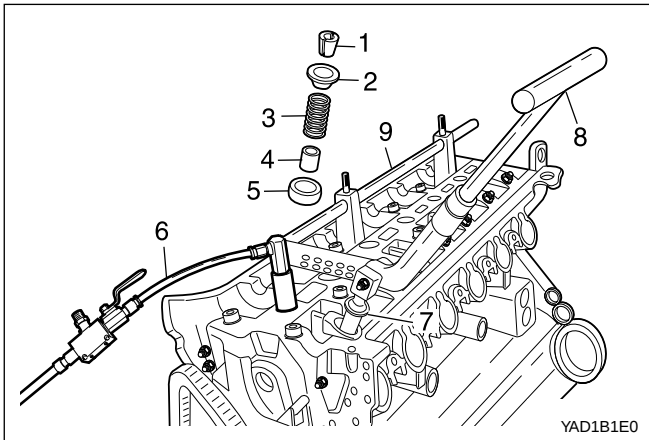
- Remove the valve spring only at TDC.
- Always rotate the crankshaft by holding the chain to prevent from timing chain damage and tangling, and for smooth rotation.

3. Remove the valve tappet (1) using the valve tappet remover DW 110-100.
4. Install the connecting hose DW 110-090 to the spark plug hole.

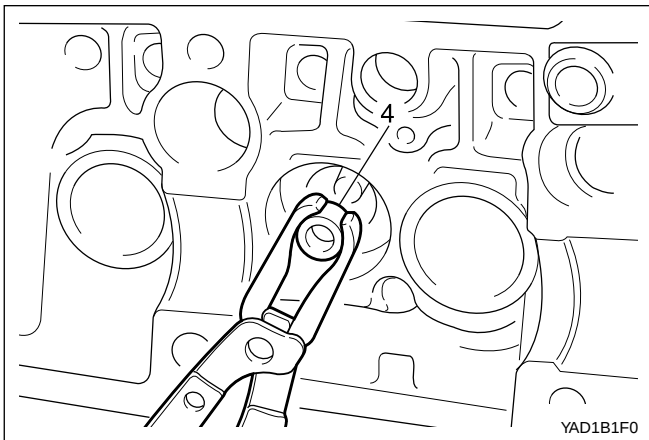




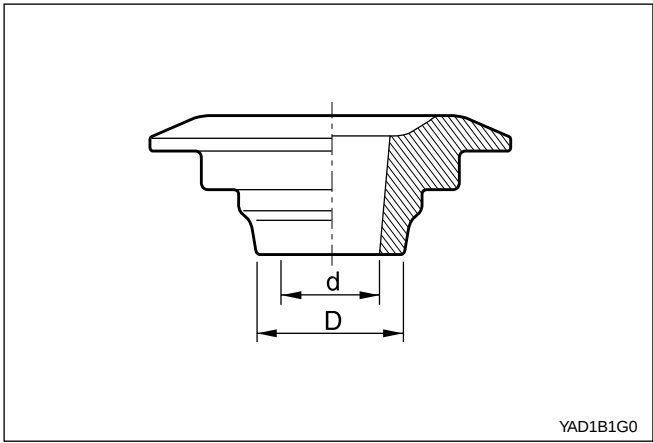
5. Install the engine lock to the ring gear to prevent the crankshaft from rotating.
6. Blow up with compressed air.



7. Install the lever pusher 111 589 18 61 00 (8) and the thrust piece 111 589 25 63 00 (7).
8. Mount the thrust piece 111 589 25 03 00 (7) vertically to the valve spring retainer (2).
9. Press the valve spring (3) by using the lever pusher 111 589 18 61 00 (8).
10. Remove the valve cotter (1) using the pincette.
11. Remove the upper retainer (2) and the valve spring (3).



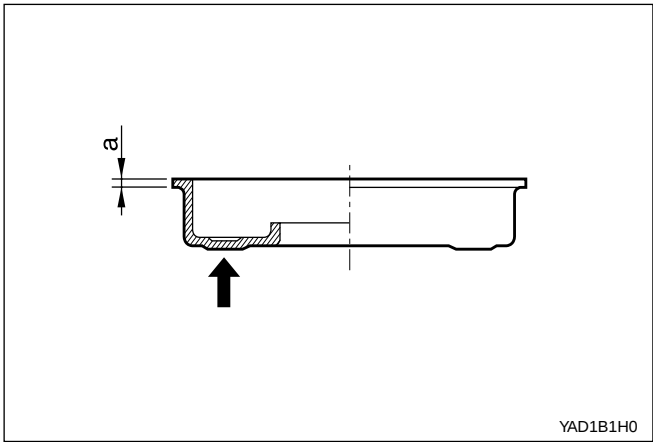
12. Remove the valve stem seal (4).
Notice: Check the valve stem seal for damage and replace if necessary.
13. Remove the lower retainer (5).
Notice: Check the retainer for damages and replace with a new one if necessary.
14. Installation should follow the removal procedure in the reverse order.



Test (Upper and Lower Valve Tappet and Valve Cotter)

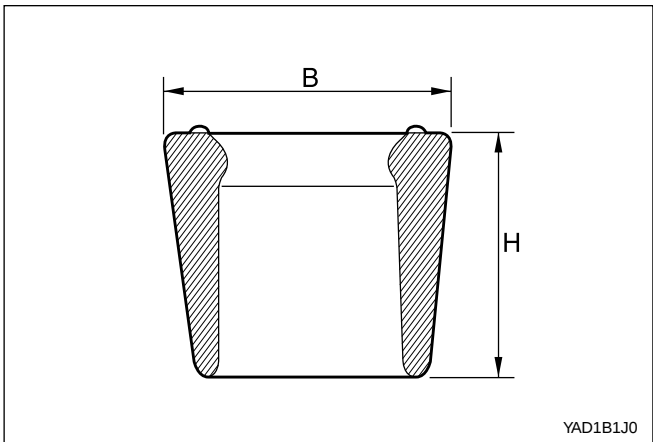
- Upper Valve Spring Retainer

Size (mm)	(d)	8.5
	(D)	12.3



- Lower Valve Spring Retainer

Thickness (mm)	(a)	0.8 - 1.0
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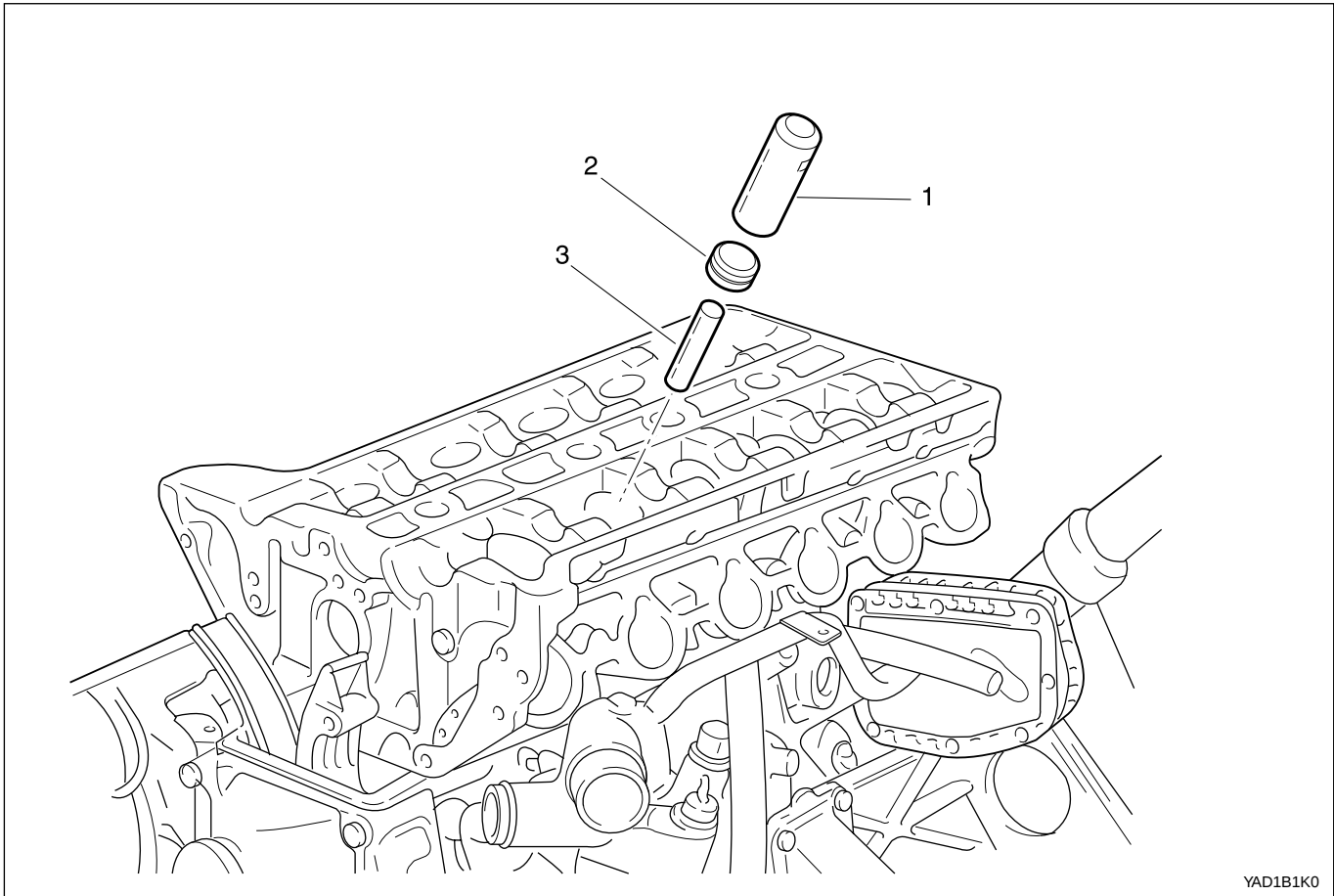


- Valve Cotter

Size (mm)	(B)	9.0
	(H)	9.2 - 9.8

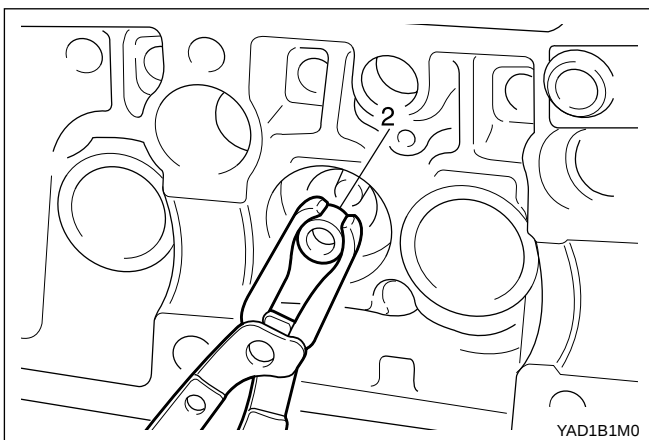
VALVE STEM SEAL

Preceding Work : Removal of valve spring



- 1 Drift 119 589 00 43 00
- 2 Valve Stem Seal

- 3 Protective Sleeve



Tools Required

119 589 00 43 00 Drift

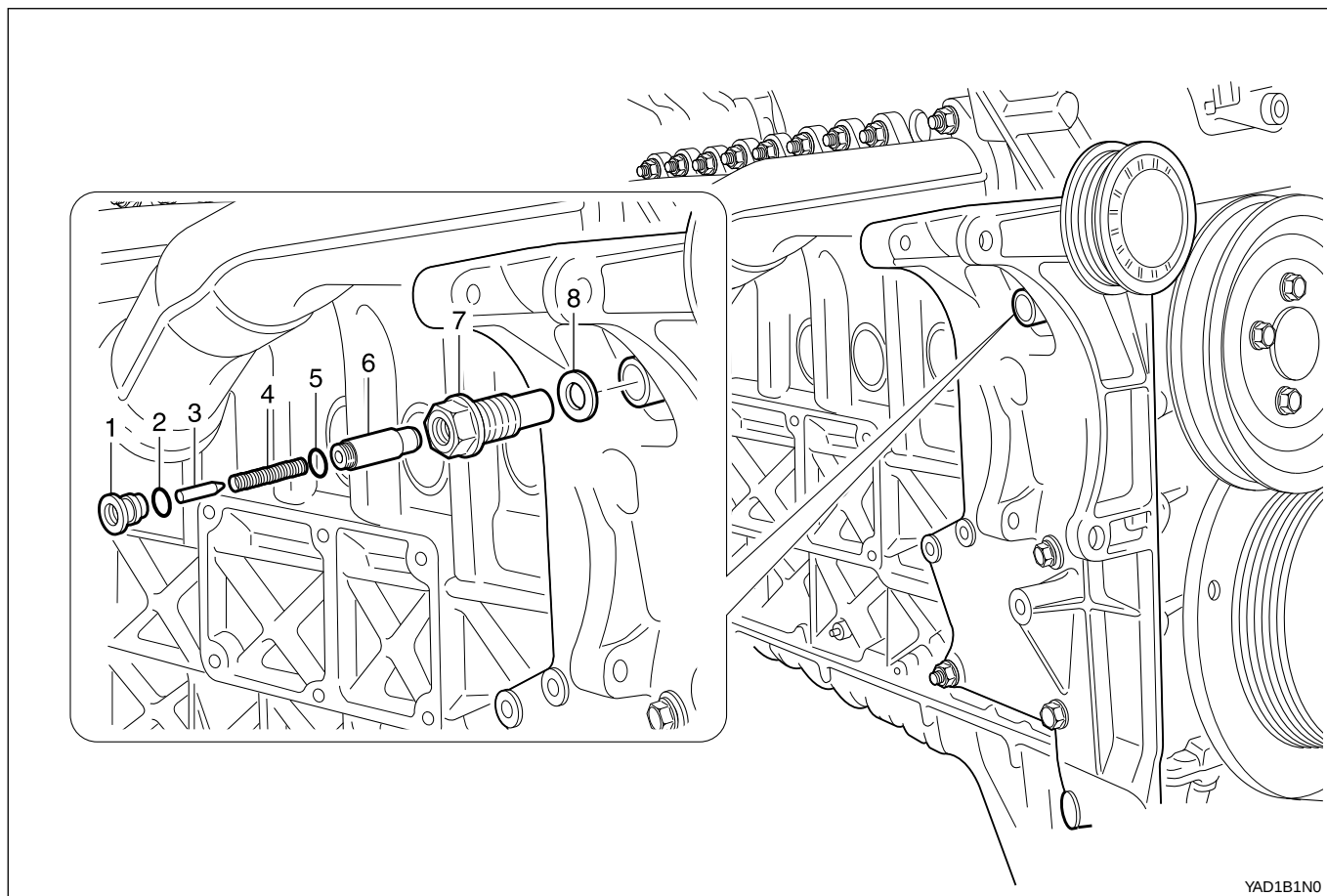
Replacement Procedure

1. Remove the valve stem seal (2) using the pliers.

Notice: Check the valve stem seal for damage and replace if necessary.

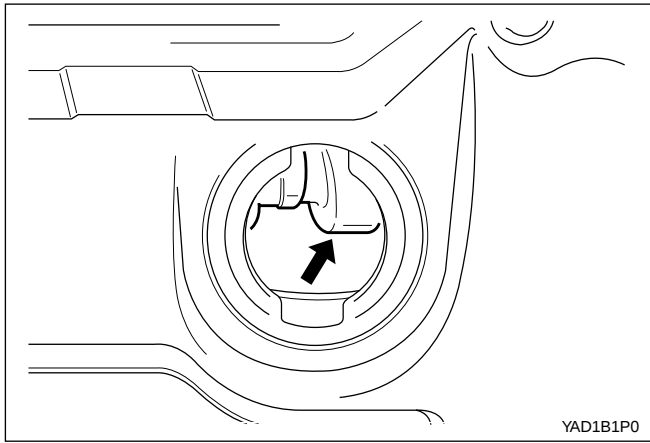
2. Coat the valve stem seal with oil and assemble it with the protective sleeve.
3. Insert the valve stem seal by pressing it with the drift 119 589 00 43 00.

CHAIN TENSIONER



YAD1B1N0

- | | |
|--------------------------------------|-------------------------------|
| 1 Screw Plug 40 N•m (30 lb-ft) | 6 Thrust Pin |
| 2 Seal | 7 Chain Tensioner Housing |
| 3 Filler Pin | 72-88 N•m (53-65 lb-ft) |
| 4 Compression Spring | 8 Seal |
| 5 Snap Ring | |



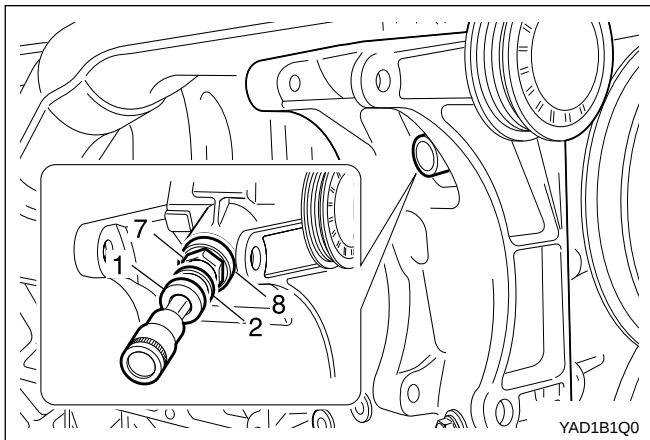
Removal Procedure

1. Position the No.1 cylinder to TDC (OT).

Notice: Remove the oil filler cap at adjustment position, and check whether the intake camshaft cam's lobe (arrow) stays in the upper side.

2. Cover the generator with a clean cloth.
3. Release the tension by unscrewing the screw plug once.

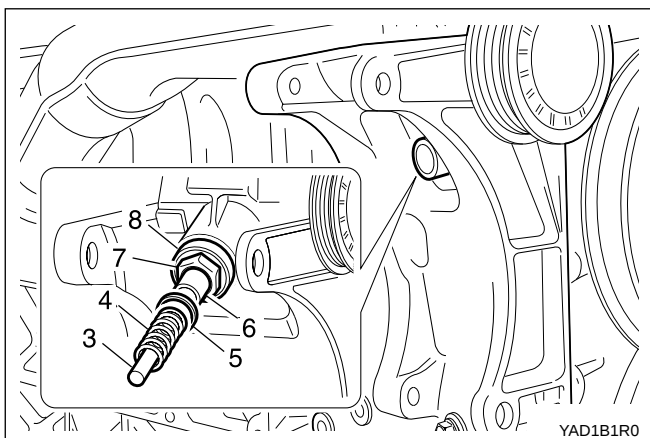
Notice: In case that the tension is reduced by unscrewing the screw plug, reinstall after completely removing the chain tensioner. If the chain tensioner is tightened again without completely reducing its tension, then the detent spring doesn't return to the original position and the tension gets exceeded.



4. Carefully unscrew the screw plug (1), and remove the seal (2).

Notice:

- For the removal of screw plug, be careful that it can be jumped out due to the force of compression spring.
- Remove the screw plug only when the seal and compression spring are damaged.

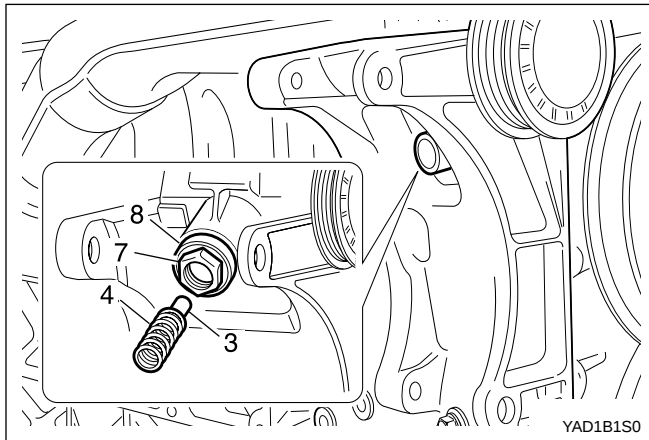


5. Carefully remove the filler pin (3), compression spring (4), snap ring (5), and the thrust pin (6).
6. Remove the chain tensioner housing (7) and the seal (8).

Installation Procedure

1. Connect the thrust pin (6) and the snap ring (5) to the chain tensioner housing (7).

Notice: When connecting the thrust pin, push in the thrust pin far enough so that it doesn't protrude at the chain tensioner housing.

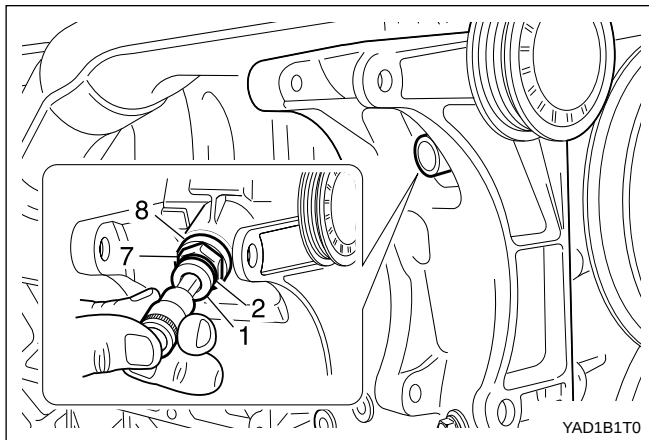


2. Install the chain tensioner housing (7), thrust pin (6), snap ring (5), and the seal (8).

Installation Notice

Tightening Torque	72 - 88 N•m (53 - 65 lb-ft)
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3. Insert the compression spring (4) with the filler pin (3) into chain tensioner housing.



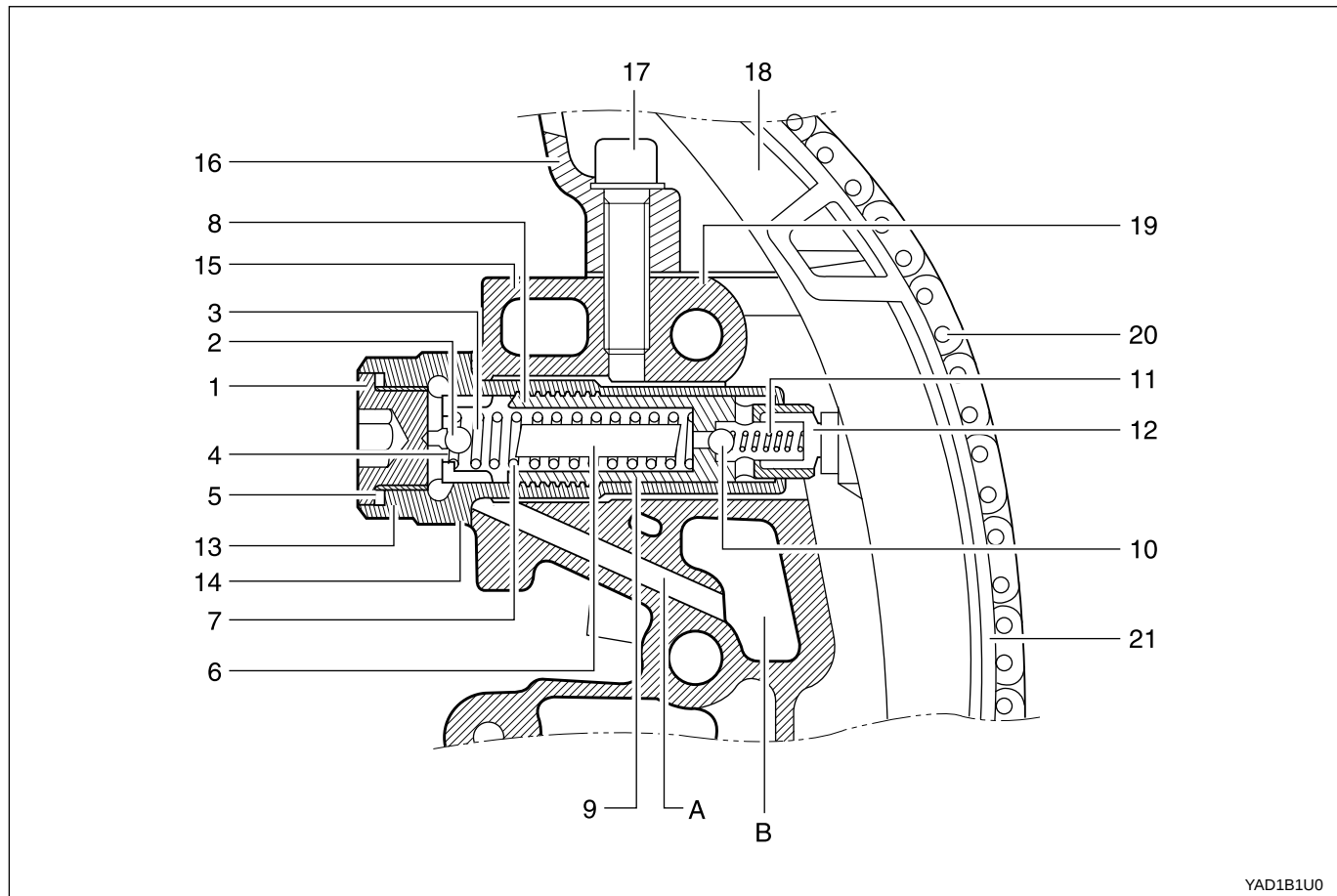
4. Lightly apply the grease to the seal (2) and install the screw plug (1).

Installation Notice

Tightening Torque	40 N•m (30 lb-ft)
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5. Check for leaks by operating the engine.

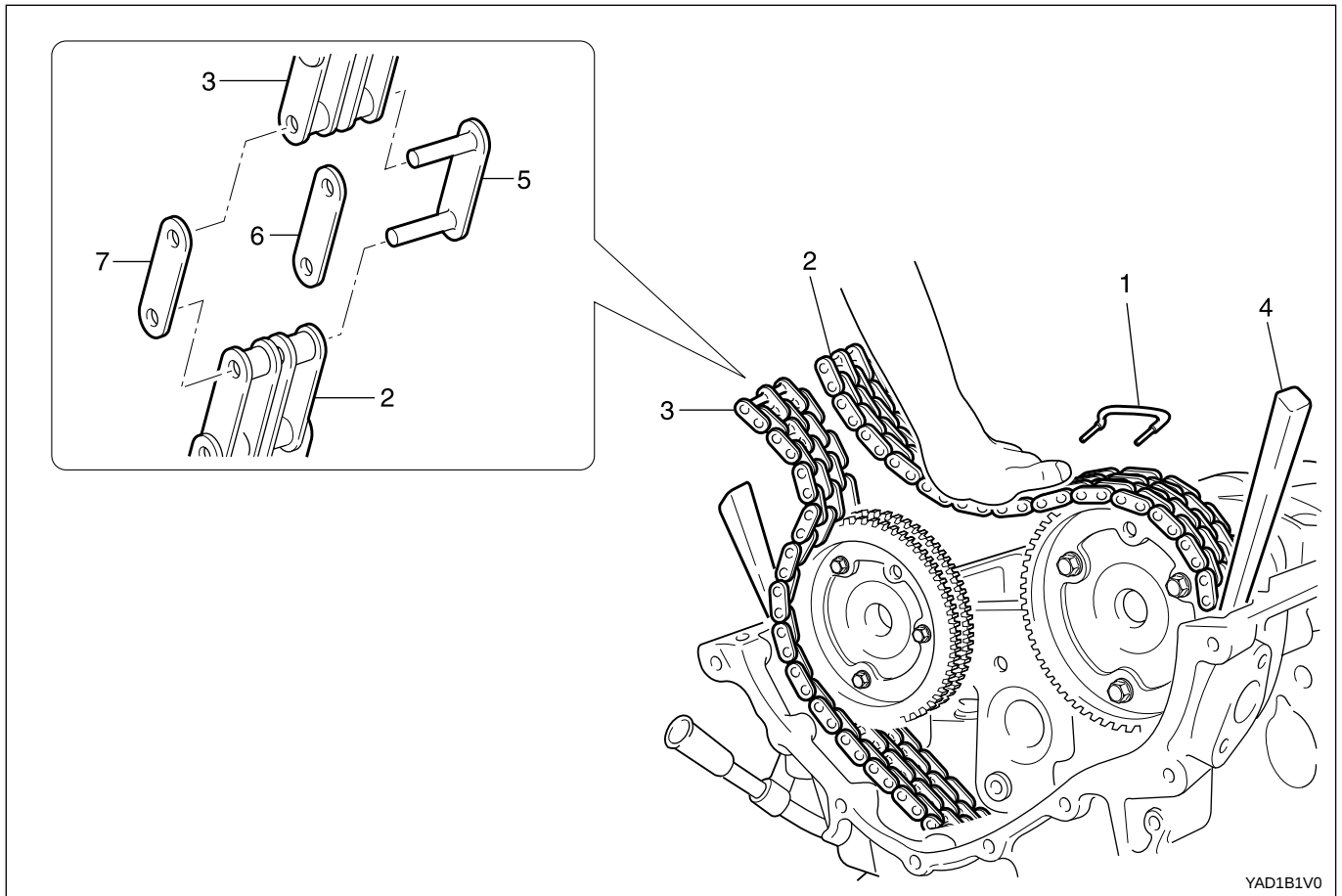
Sectional View



- | | |
|---------------------------|---|
| 1 Screw Plug | 13 Chain Tensioner Housing |
| 2 Ball (Nonreturn Valve) | 14 Seal |
| 3 Compression Spring | 15 Timing Gear Case Cover |
| 4 Ball Guide | 16 Cylinder Head |
| 5 Seal (Aluminum) | 17 Bolt / Washer |
| 6 Filler Pin | 18 Tensioning Rail |
| 7 Compression Spring | 19 Cylinder Head Gasket |
| 8 Snap Ring | 20 Timing Chain |
| 9 Thrust Pin | 21 Tensioning Rail Base (Sliding Surface) |
| 10 Ball (Nonreturn Valve) | A Oil Supply Hole |
| 11 Compression Spring | B Chain Tensioner Oil Storage Hole |
| 12 Thrust Piece | |

TIMING CHAIN

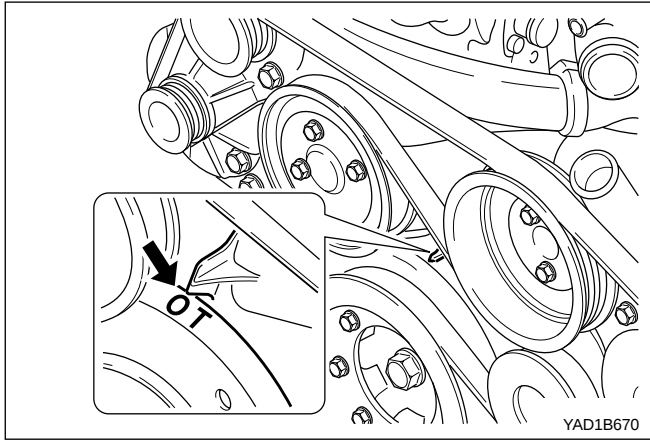
Preceding Work : Removal of cylinder head cover
Removal of spark plug



- 1 Pin
- 2 New Timing Chain
- 3 Timing Chain (Used)
- 4 Wedge

- 5 Link
- 6 Center Plate
- 7 Outer Plate

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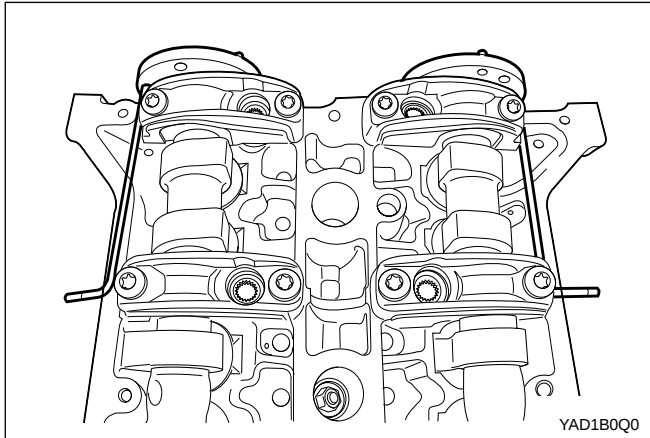
Tools Required

000 589 58 43 00 Chain Assembly

DW 110-120 Holding Pin

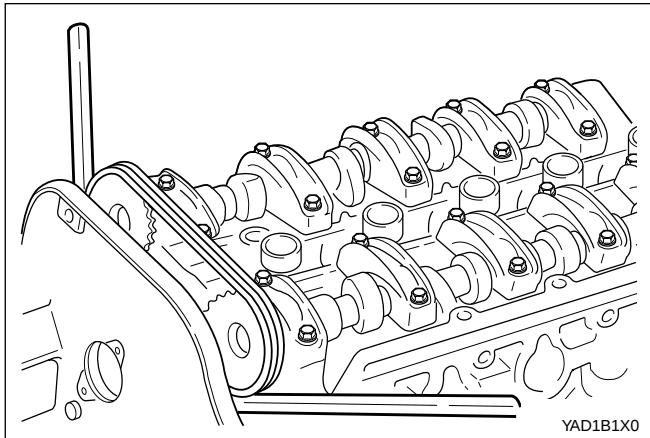
Replacement Procedure

1. Position the No.1 cylinder to TDC (OT).

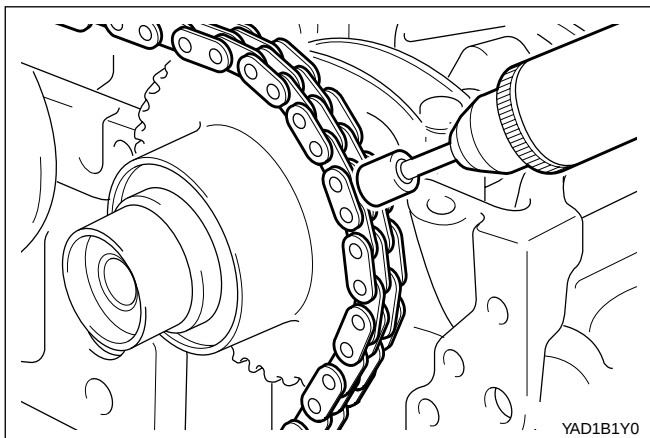


2. Insert the holding pin DW 110-120 to the intake and exhaust camshaft flange not to rotate camshaft.

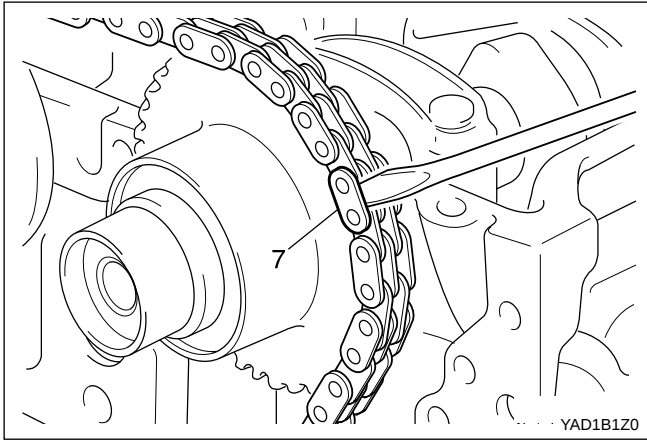
3. Remove the chain tensioner.



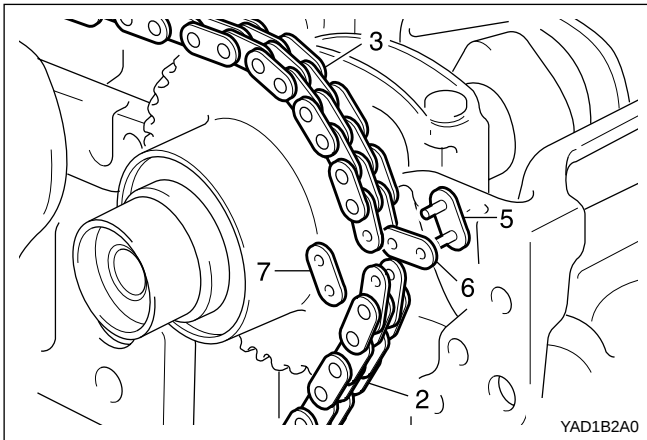
4. Mount the wedges to both sides of the camshaft sprocket as shown in the figure.



5. Cover the chain housing with a clean cloth, and grind off the timing chain pin from the intake camshaft sprocket with the grinder.



6. Remove the outer plate (7) with the screw driver and remove the link.

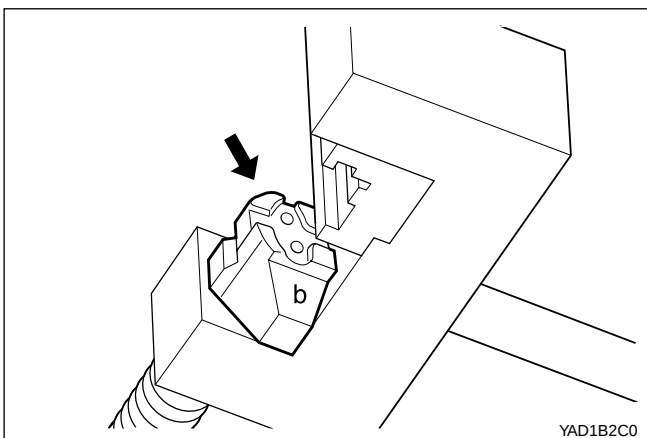
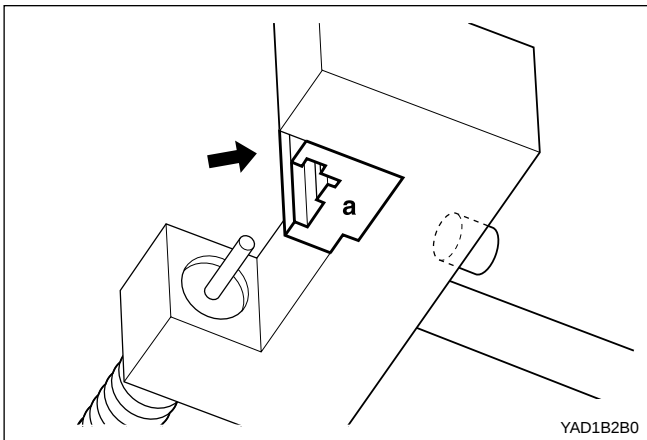


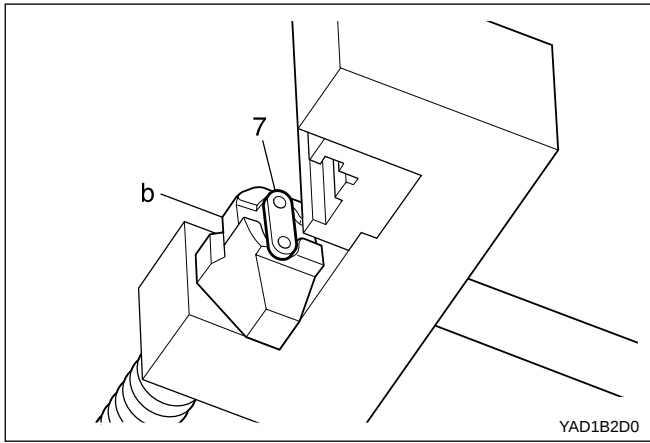
7. Connect the new timing chain (2) to the used timing chain (3) with the link (5), center plate (6, thickness 1.6 mm), and the outer plate (7).

8. Rotate the crankshaft in the direction of engine revolution by pressing the new timing chain against the exhaust camshaft sprocket to prevent it to be tangled.

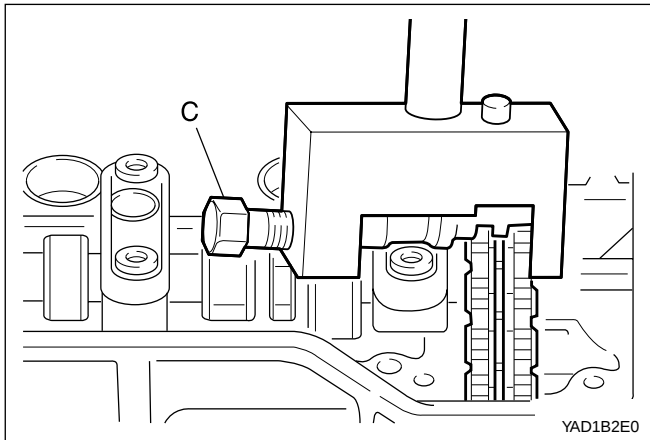
Notice: Be sure to remove the wedge before cranking the engine.

9. Take out the used timing chain out from the chain housing.
10. Connect both separators of the new timing chain with the link (5) and the center plate (6).
11. Install the jaw (a) and the thrust piece (b) to the assembly tool as shown in the figures.

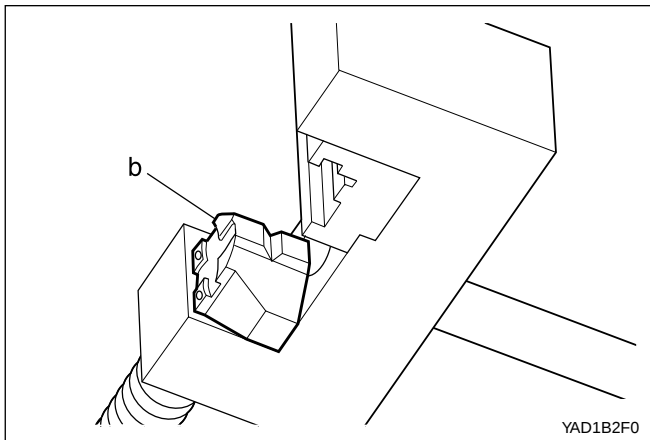




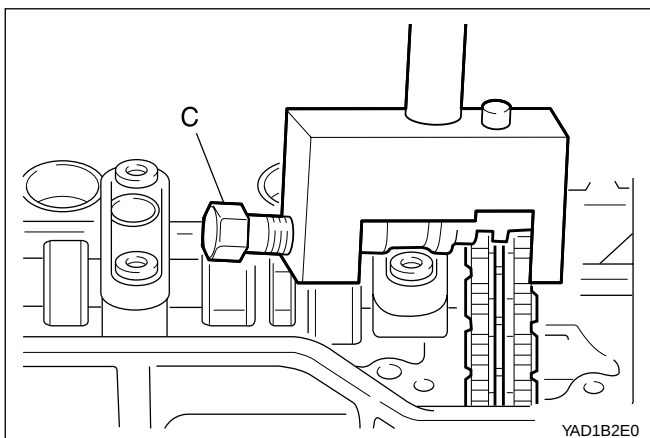
12. Place the outer plate (7, thickness 1.2 mm) inside the thrust piece (b).



13. Install the chain assembly 000 589 58 43 00 above the link and tighten the spindle (c) until a block is felt.
14. Place the chain assembly 000 589 58 43 00.



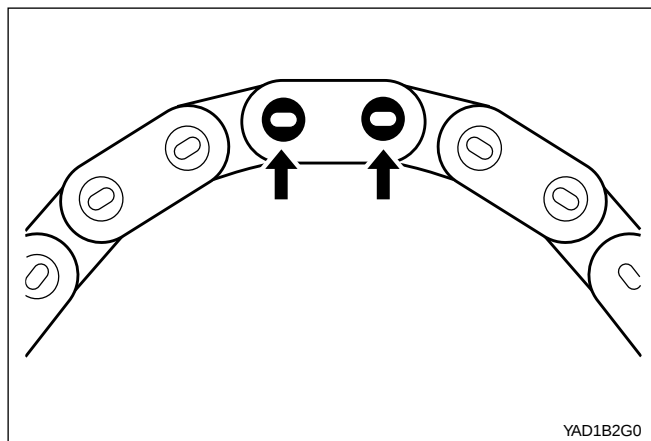
15. Replace the thrust piece (b) as shown in the figure.



16. Install the chain assembly 000 589 58 43 00 to the link pin and tighten the spindle (c).

Tightening Torque

30 N•m (22 lb-ft)



17. Rivet the link pin.
Check the condition and it again if necessary.
18. Install the chain tensioner.

Installation Notice

Tightening Torque	Screw Plug	40 N•m (30 lb-ft)
	Tensioner Assembly	72 - 88 N•m (53 - 65 lb-ft)

19. Check the camshaft timing position.