2006-08 ENGINE

Mechanical - Overhaul - 2.0L (LF) & 2.3L (L3) - Mazda6 & MX-5 Miata

ENGINE IDENTIFICATION

Engine can be identified by engine model and number

ENGINE IDENTIFICATION CODE

Engine	Code
2.0L 4-Cylinder	LF
2.3L 4-Cylinder	L3

MECHANICAL

ENGINE OVERHAUL SERVICE WARNING

WARNING:

- **Continuous exposure with USED engine oil has caused skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after this work.**

ENGINE MOUNTING/DISMOUNTING

1. Install the **SSTs** (arms) to the cylinder block holes as shown, and hand-tighten the bolts **(part No.: 9YA20-1003) or M10 x 1.5T length 90 mm {3.55 in}.**

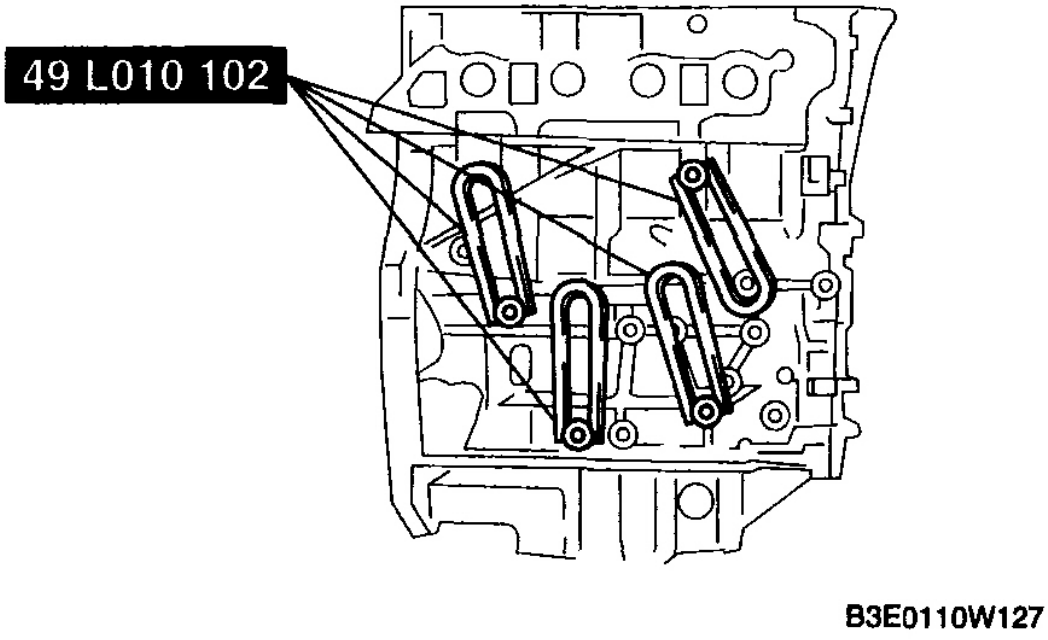


Fig. 1: Installing SST (Arms) To Cylinder Block Holes
Courtesy of MAZDA MOTORS CORP.

2. Assemble the **SSTs** (bolts, nuts and plate) to the specified positions.
3. Adjust the **SSTs** (bolts) so that less than **20 mm {0.79 in}** of thread is exposed.
4. Make the **SSTs** (arms and plate) parallel by adjusting the **SSTs** (bolts and nuts).

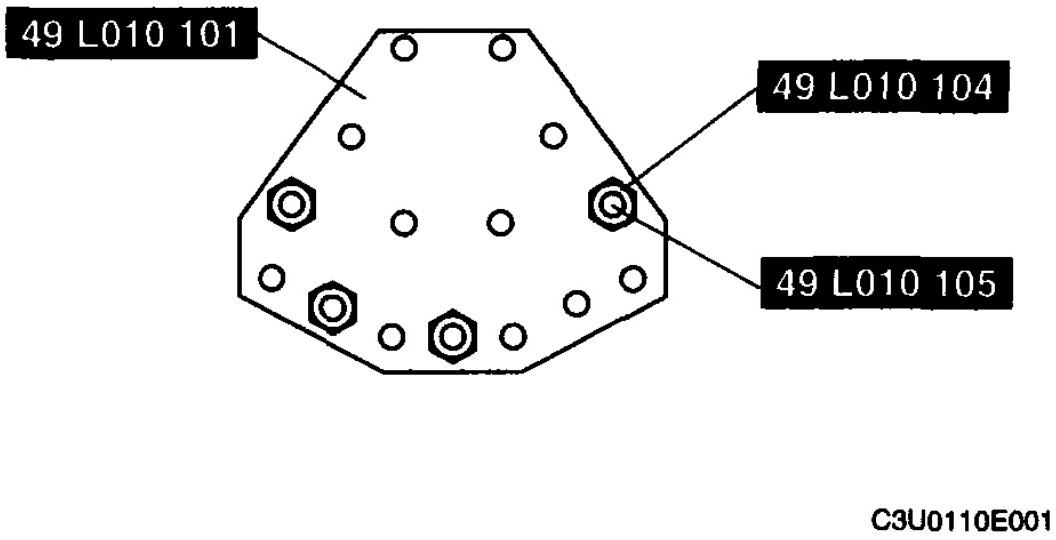


Fig. 2: Assembling SSTs (Bolts, Nuts And Plate) To Positions
Courtesy of MAZDA MOTORS CORP.

5. Tighten the **SSTs** (bolts and nuts) to affix the **SSTs** firmly.

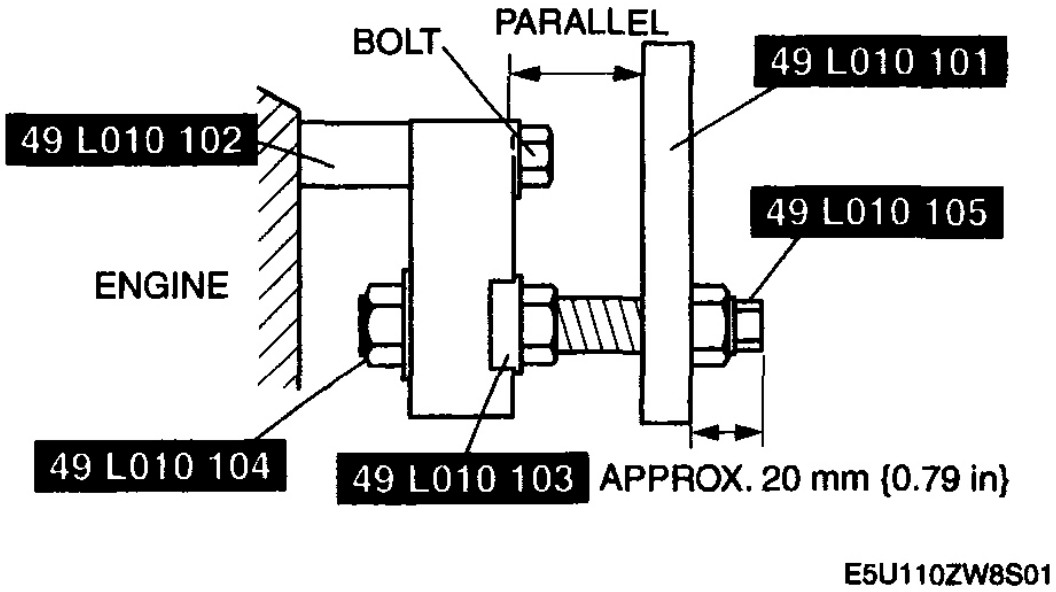


Fig. 3: Identifying SST Bolts, Nuts & Parallel Plates

Courtesy of MAZDA MOTORS CORP.

WARNING:

- **Self-locking brake system of the engine stand may not be effective when the engine is held in an unbalanced position. This could lead to sudden, rapid movement of the engine and mounting stand handle and cause serious injury. Never keep the engine in an unbalanced position, and always hold the rotating handle firmly when turning the engine.**

6. Mount the engine on the **SST** (engine stand).
7. Drain the engine oil into a container.
8. Install the oil pan drain plug.
    - With washer
        1. Install the oil pan drain plug with a new washer.

        Tightening torque

        30-41 N.m {3.1-4.1 kgf.m, 23-30 ft.lbf}

    - Without washer
        1. Inspect the seal rubber of the oil pan drain plug and make sure there are no cracks or damage. - If necessary, replace the oil pan drain plug.
        2. Clean the flange surface (seal rubber) on the oil pan drain plug, then install the oil pan drain plug.

    Tightening torque

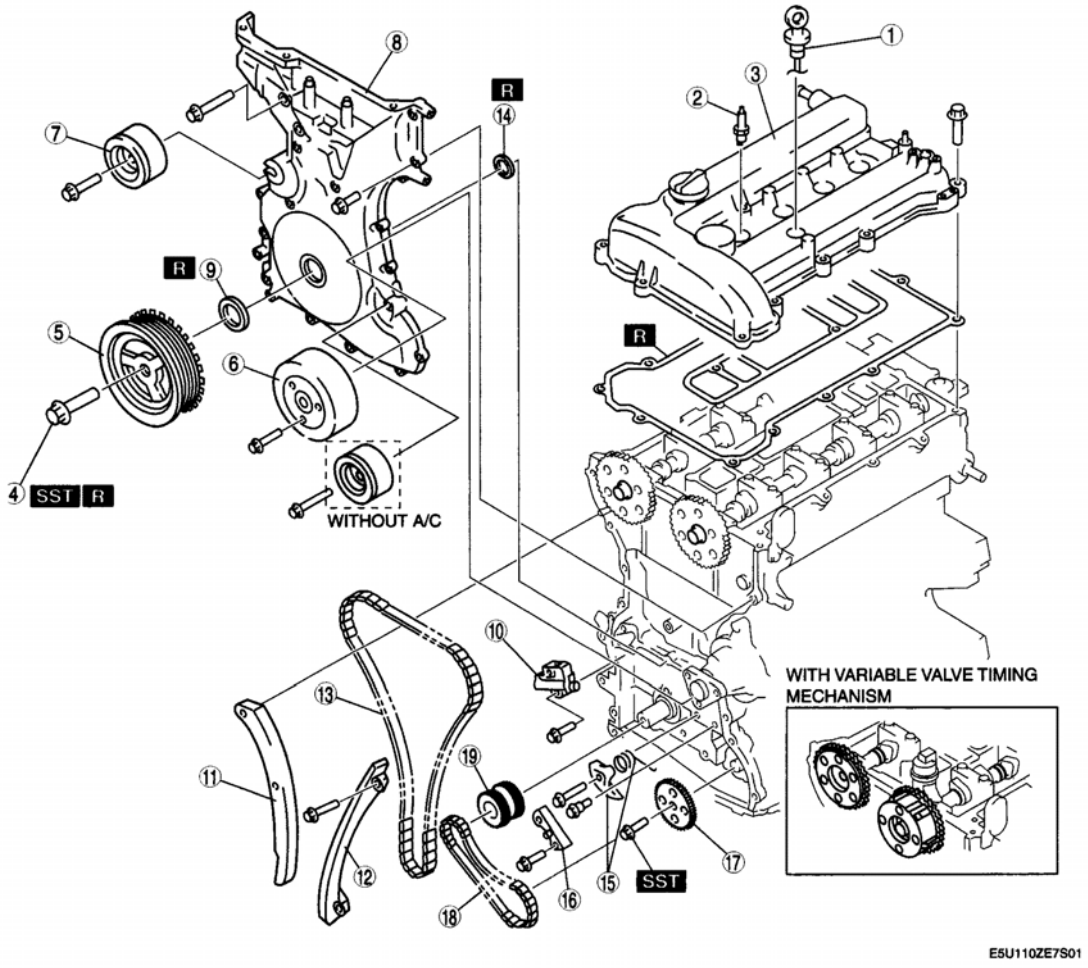
    22-30 N.m {2.2-3.1 kgf.m, 16-22 ft.lbf}

DISMOUNTING

- Dismount in the reverse order of mounting.

TIMING CHAIN DISASSEMBLY

1. Disassemble in the order indicated in the table.



1	Oil level gauge (if equipped)
2	Spark plug
3	Cylinder head cover
4	Crankshaft pulley lock bolt
5	Crankshaft pulley
6	Water pump pulley
7	Drive belt idler pulley (Without stretch-type A/C drive belt)
8	Engine front cover
9	Front oil seal

10	Chain tensioner
11	Tensioner arm
12	Chain guide
13	Timing chain
14	Seal (With variable valve timing mechanism)
15	Oil pump chain tensioner
16	Oil pump chain guide
17	Oil pump sprocket
18	Oil pump chain
19	Crankshaft sprocket

Fig. 4: Exploded View Of Timing Chain Components
Courtesy of MAZDA MOTORS CORP.

Crankshaft Pulley Lock Bolt Disassembly Note

1. Install the **SST** to the ring gear to lock the crankshaft against rotation.

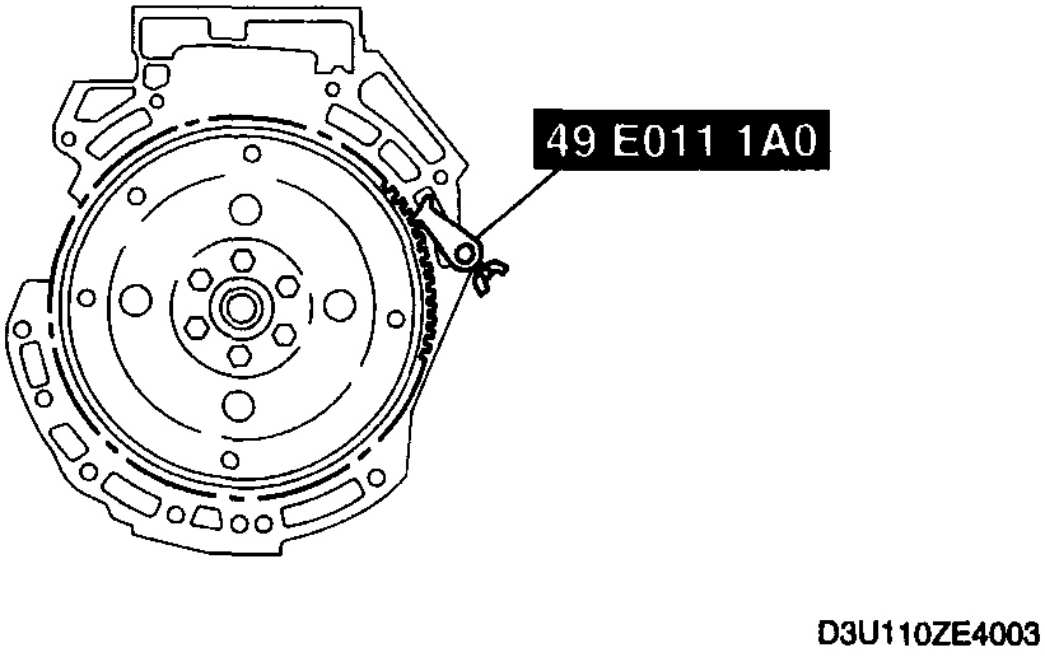


Fig. 5: Installing SST Ring Gear To Lock Crankshaft Against Rotation
Courtesy of MAZDA MOTORS CORP.

Front Oil Seal Disassembly Note

1. Remove the oil seal using a screwdriver.

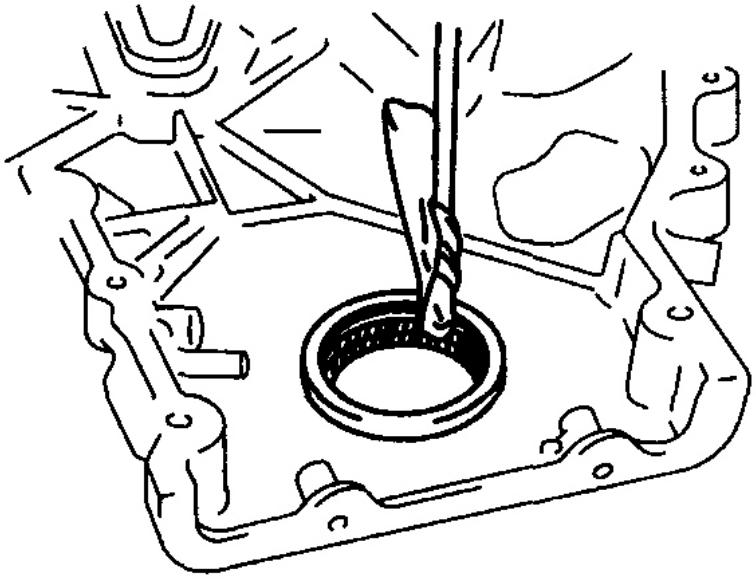


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Fig. 6: Removing Oil Seal
Courtesy of MAZDA MOTORS CORP.

Chain Tensioner Disassembly Note

1. Unlock the chain tensioner ratchet using a suitable screw driver or equivalent tool.
2. Slowly press the tensioner piston.
3. Hold the chain tensioner piston with a **1.5 mm {0.06 in}** wire or paper clip.

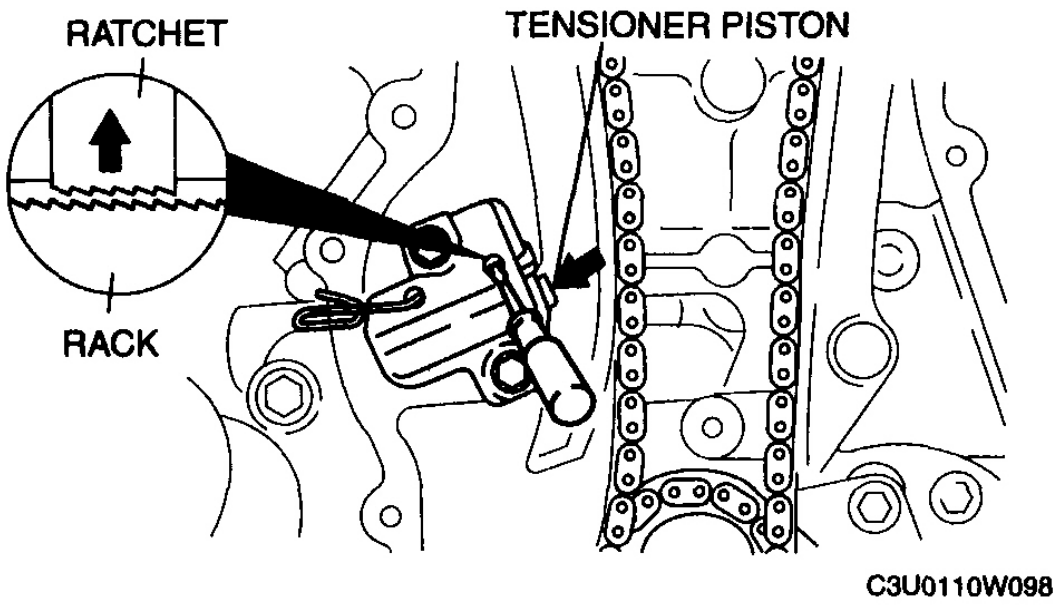


Fig. 7: Disassembling Chain Tensioner
Courtesy of MAZDA MOTORS CORP.

Oil Pump Sprocket Disassembly Note

1. Hold the oil pump sprocket using the **SST** .

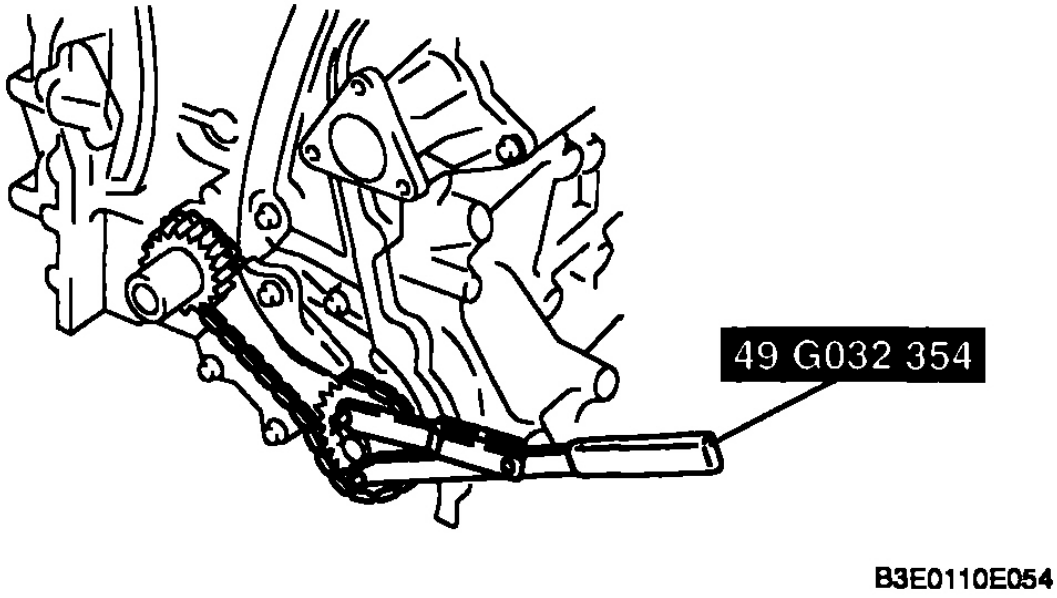
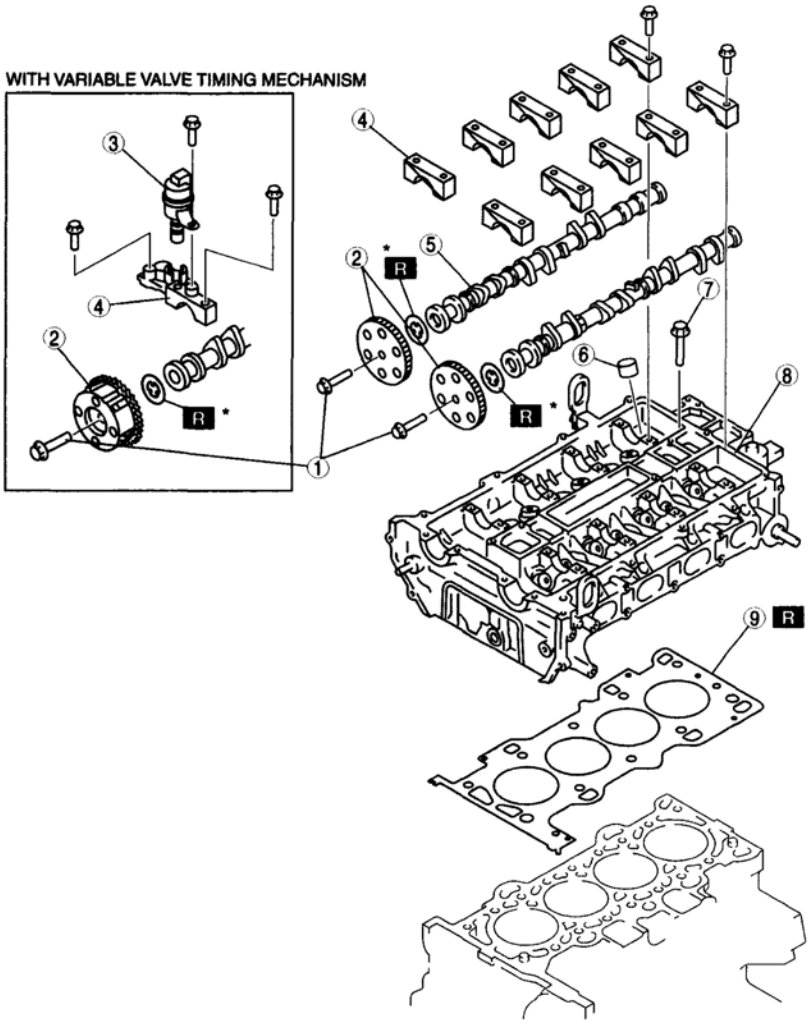


Fig. 8: Holding Oil Pump Sprocket Using SST
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (I) DISASSEMBLY

1. Disassemble in the order indicated in the table.



*:EXCEPT FOR MAZDA6 ARE EQUIPPED. IF WASHER IS NOT INSTALLED TO THE ENGINE, INSTALL A NEW WASHER.

E5U110ZE7S02

1	Camshaft sprocket lock bolt, variable valve timing actuator lock bolt (With variable valve timing mechanism)
2	Camshaft sprocket, variable valve timing actuator (With variable valve timing mechanism)
3	Oil control valve (OCV) (with variable valve timing mechanism)
4	Camshaft cap
5	Camshaft
6	Tappet
7	Cylinder head bolt
8	Cylinder head
9	Cylinder head gasket

Fig. 9: Exploded View Of Cylinder Head (I) Disassembly
Courtesy of MAZDA MOTORS CORP.

Camshaft Sprocket Lock Bolt, Variable Valve Timing Actuator Lock Bolt Disassembly Note

1. Hold the camshaft by using a wrench on the cast hexagon as shown, and loosen the camshaft sprocket

installation bolt or variable valve timing actuator installation bolt (With variable valve timing mechanism).

Without variable valve timing mechanism

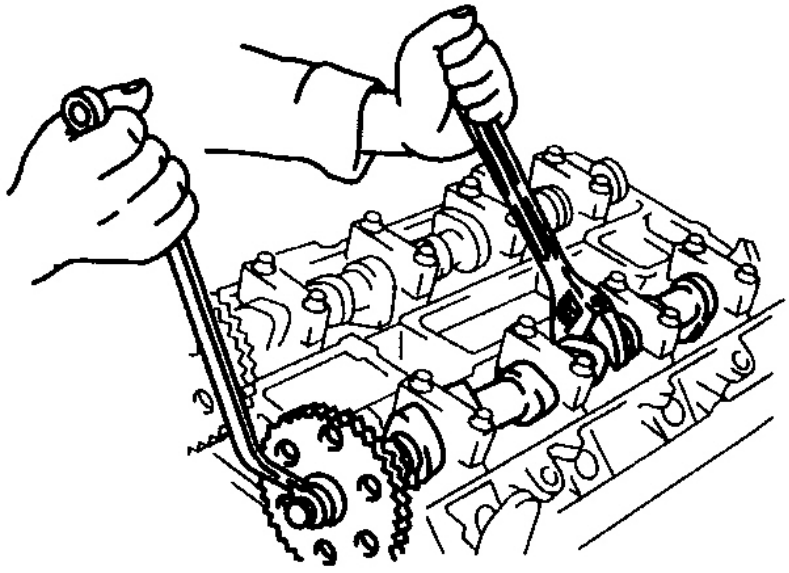


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Fig. 10: Using Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

With variable valve timing mechanism

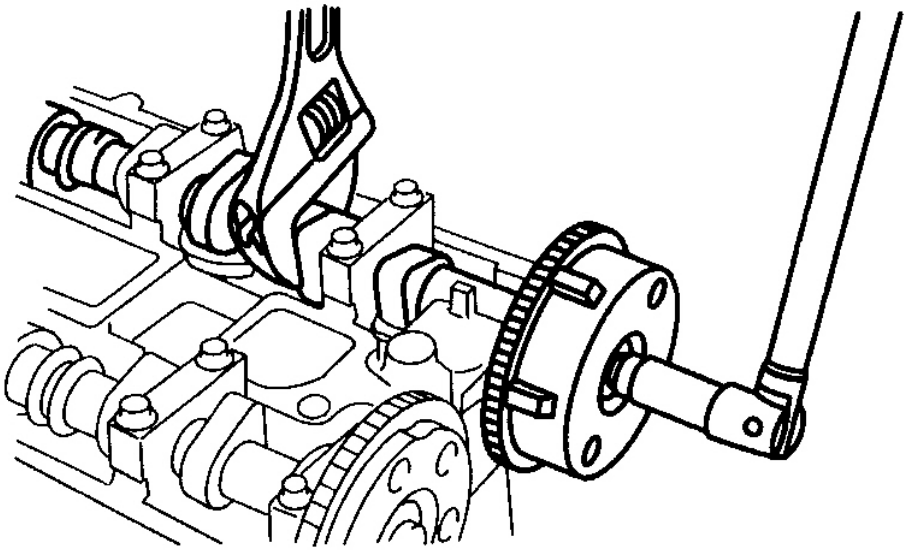

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Fig. 11: Using Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

Camshaft Cap Disassembly Note

1. Before removing the camshaft caps, inspect the following:
   - Camshaft end play and camshaft journal oil clearance (See **CAMSHAFT INSPECTION**).

NOTE:

- **The camshaft caps are numbered to make sure they are assembled in their original positions. When removed, keep the caps with the cylinder head they were removed from. Do not mix the caps.**

2. Loosen the camshaft caps bolts in 2--3 steps in the order shown in the figure.

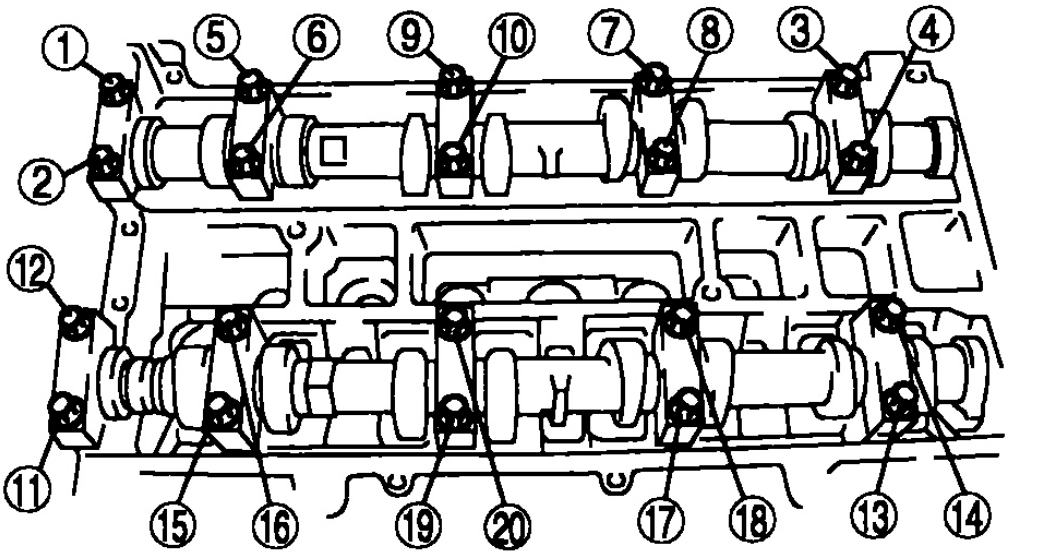


Fig. 12: Identifying Loosening Sequence Of Camshaft Cap Bolts
Courtesy of MAZDA MOTORS CORP.

Tappet Disassembly Note

NOTE:

- **The tappets are numbered to make sure they are assembled in their original positions. When removed, keep the tappets with the cylinder head they were removed from. Do not mix the tappets.**

Cylinder Head Bolt Disassembly Note

1. Loosen the cylinder head bolts in 2-3 steps in the order shown in the figure.

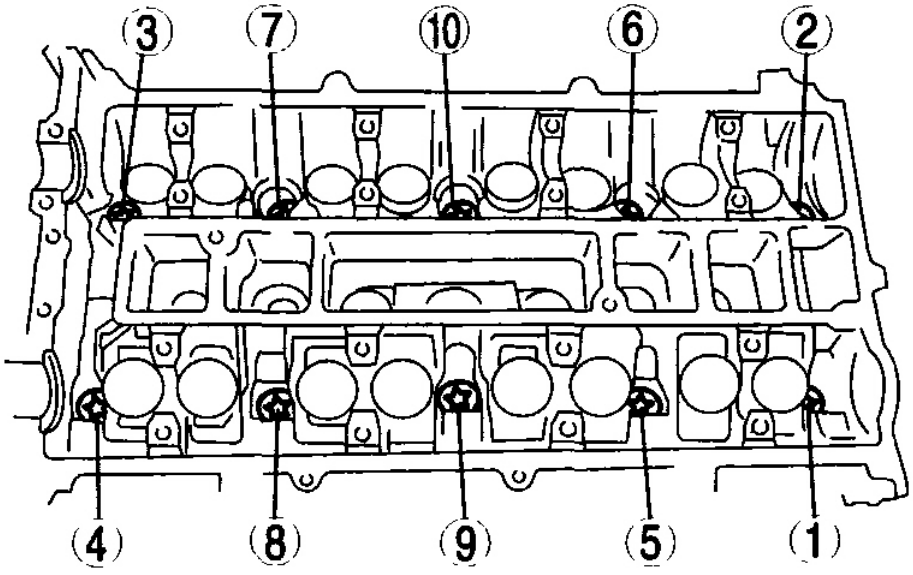
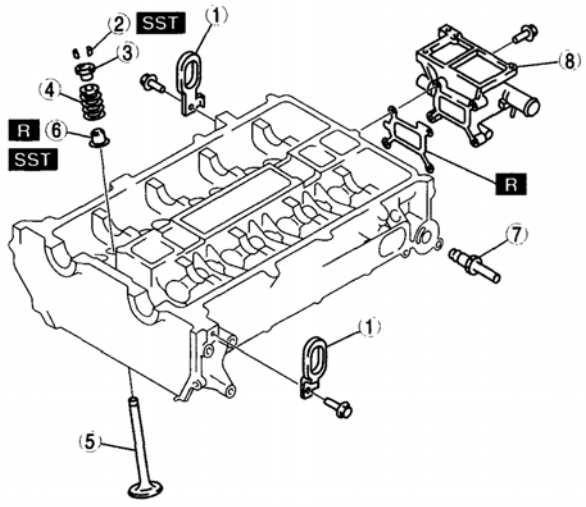


Fig. 13: Loosening Cylinder Head Bolts
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (II) DISASSEMBLY

1. Disassemble in the order indicated in the table.



1	Engine hanger	5	Valve
2	Valve keeper	6	Valve seal
3	Upper valve spring seat	7	EGR pipe
4	Valve spring	8	Water outlet

Fig. 14: Exploded View Of Cylinder Head (II) Disassembly
Courtesy of MAZDA MOTORS CORP.

Valve Keeper Disassembly Note

1. Remove the valve keeper using the **SSTs** .

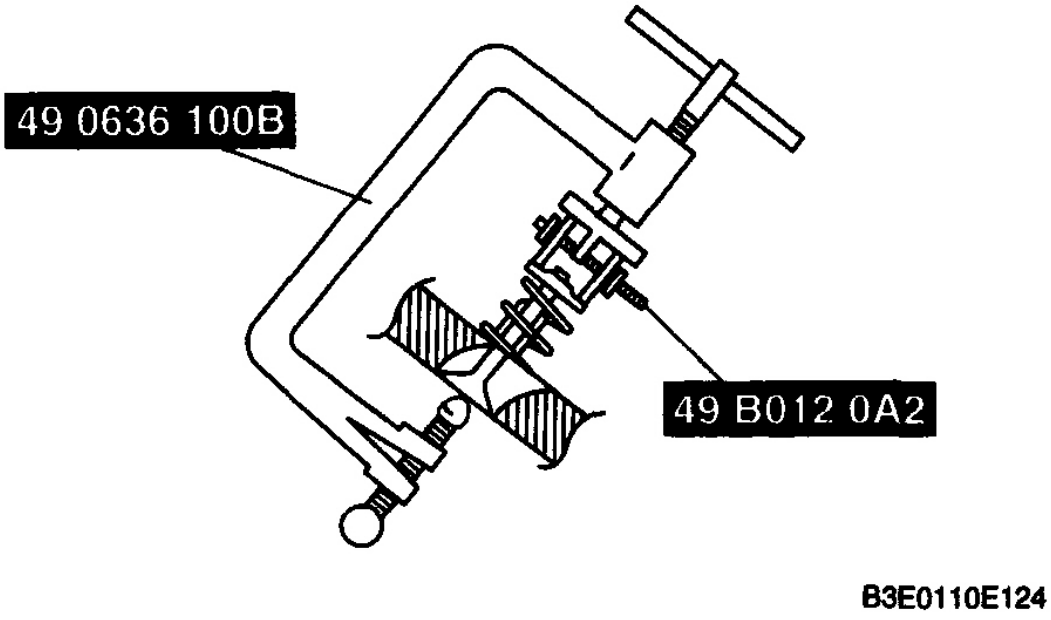


Fig. 15: Removing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

Valve Seal Disassembly Note

1. Remove the valve seal using the **SST.**

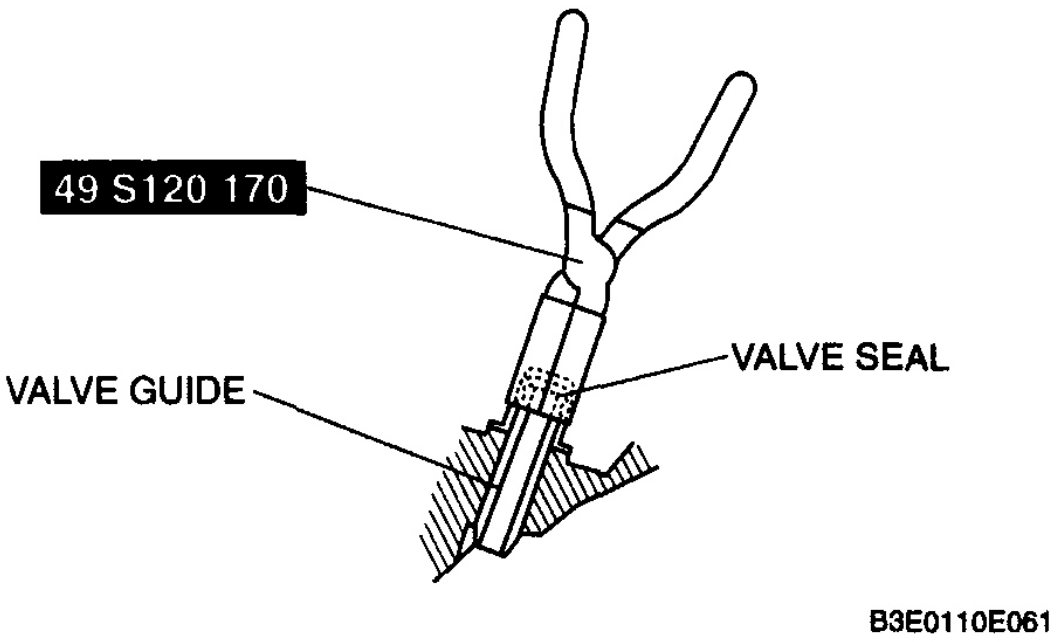
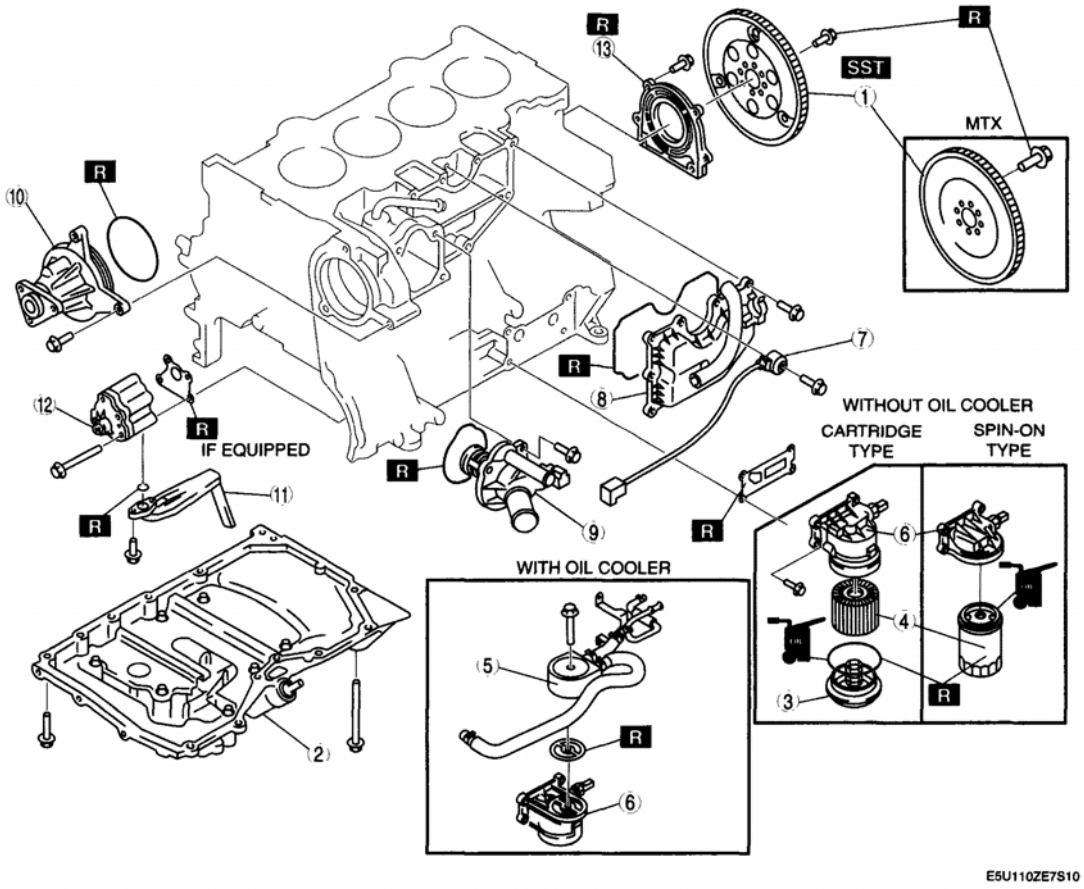


Fig. 16: Removing Valve Seal
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (I) DISASSEMBLY

1. Disassemble in the order indicated in the table.



1	Flywheel (MTX), Drive plate (ATX)
2	Oil pan
3	Oil filter cover (cartridge type)
4	Oil filter
5	Oil cooler
6	Oil filter adapter

7	Knock sensor
8	Oil separator
9	Thermostat
10	Water pump
11	Oil strainer
12	Oil pump
13	Rear oil seal

Fig. 17: Exploded View Of Cylinder Block (I) Disassembly
Courtesy of MAZDA MOTORS CORP.

Drive Plate (ATX), Flywheel (MTX) Disassembly Note

1. Hold the crankshaft using the **SST.**
2. Remove the bolts in several passes.

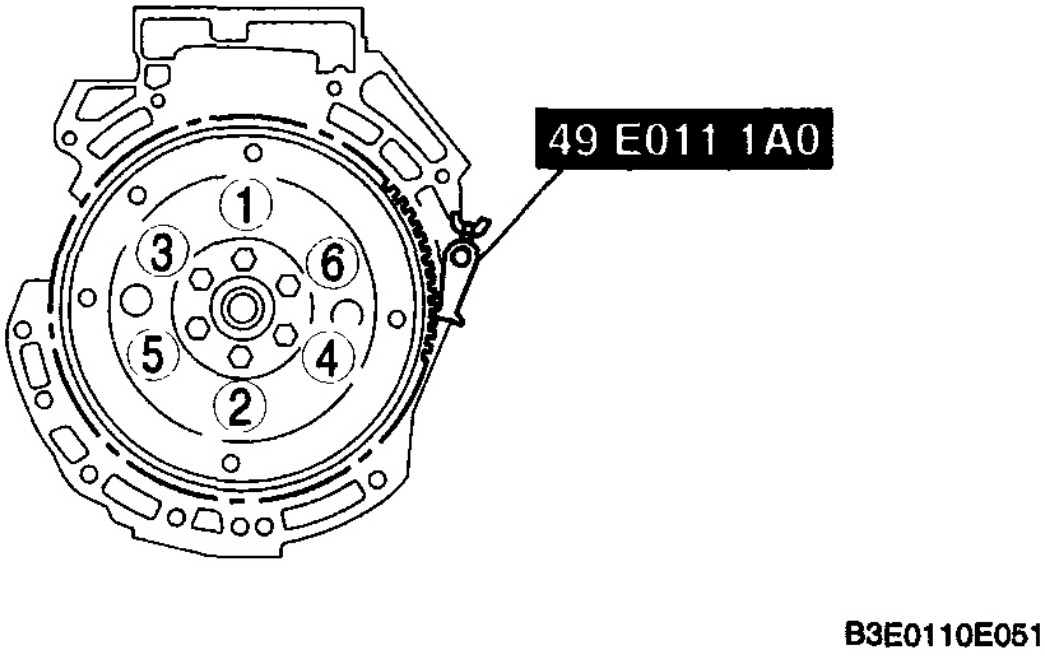
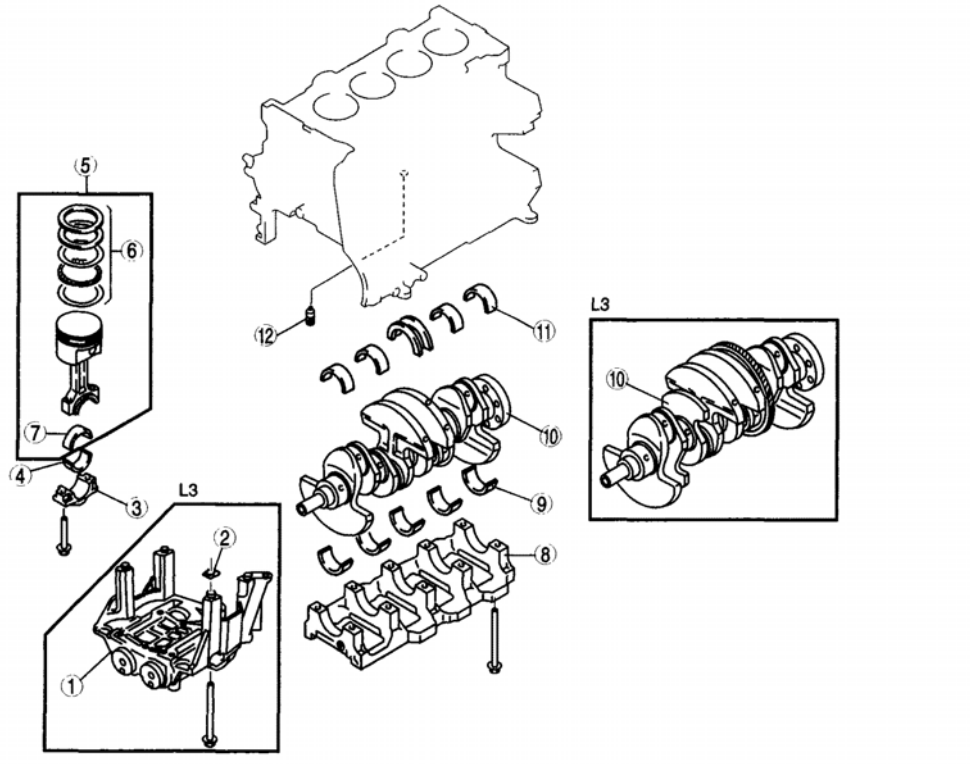


Fig. 18: Removal Sequence Of Drive Plate Or Flywheel Bolts
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (II) DISASSEMBLY

1. Disassemble in the order indicated in the table.



1	Balancer unit
2	Adjustment shim
3	Connecting rod cap
4	Lower connecting rod bearing
5	Connecting rod, Piston component
6	Piston ring

7	Upper connecting rod bearing
8	Main bearing cap
9	Lower main bearing, thrust bearing
10	Crankshaft
11	Upper main bearing, thrust bearing
12	Oil jet valve

Fig. 19: Exploded View Of Cylinder Block (II) Disassembly
Courtesy of MAZDA MOTORS CORP.

Connecting Rod Cap Disassembly Note

1. Before removing connecting rod inspect the connecting rod side clearance. (See **CONNECTING ROD INSPECTION**).
2. Remove the connecting rod bolt from the connecting rod cap by tapping the bolt with a plastic hammer.

NOTE:

- **The tappets are numbered to make sure they are assembled in their original positions. When removed, keep the tappets with the cylinder head they were removed from. Do not mix the tappets.**

Main Bearing Cap Disassembly Note

1. Before removing main bearing cap inspect the crankshaft end play. (See **CRANKSHAFT**

INSPECTION).

2. Loosen the main bearing cap bolts in two or three steps in the order shown in the figure.

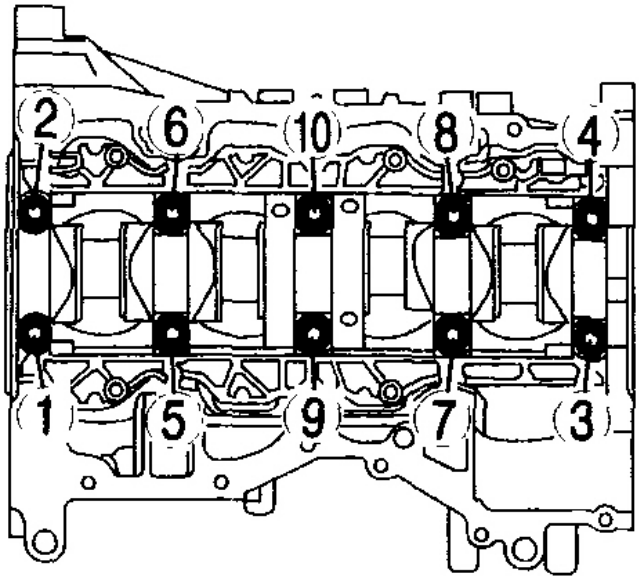


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Fig. 20: Loosening Main Bearing Cap Bolts
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD INSPECTION

1. Perform color contrast penetrate examination on the cylinder head surface.
   - Replace the cylinder head if necessary.
2. Inspect for the following and repair or replace if necessary.
   1. Sunken valve seats
   2. Excessive camshaft oil clearance and end play
3. Measure the cylinder head for distortion in six directions as shown in the figure.
   - If it exceeds the maximum specification, replace the cylinder head.

Cylinder head gasket contact surface distortion (Maximum)

0.10 mm {0.004 in}

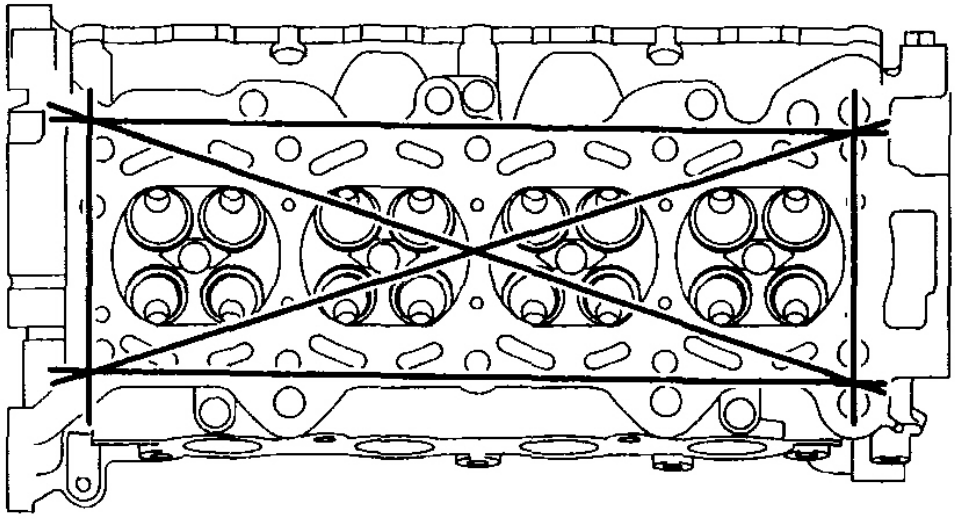

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Fig. 21: Measuring Cylinder Head For Distortion
Courtesy of MAZDA MOTORS CORP.

4. Measure the manifold contact surface distortion as shown in the figure.

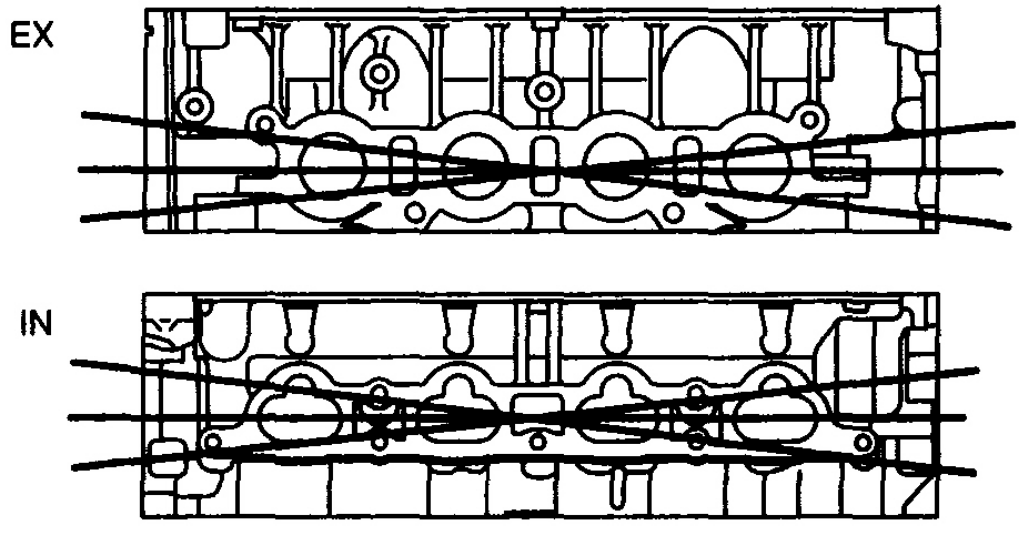

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Fig. 22: Measuring Manifold Contact Surface Distortion
Courtesy of MAZDA MOTORS CORP.

- If it exceeds the maximum specification, grind the surface or replace the cylinder head.

Manifold contact surfaces distortion (Maximum)

0.10 mm {0.004 in}

Manifold contact surfaces distortion (Maximum grinding)

0.15 mm {0.006 in}

VALVE, VALVE GUIDE INSPECTION

1. Measure the valve head margin thickness of each valve.
   - If it is less than the specification, replace the valve.

Valve head margin thickness (Minimum)

IN: 1.62 mm {0.0637 in}

EX: 1.82 mm {0.0716 in}

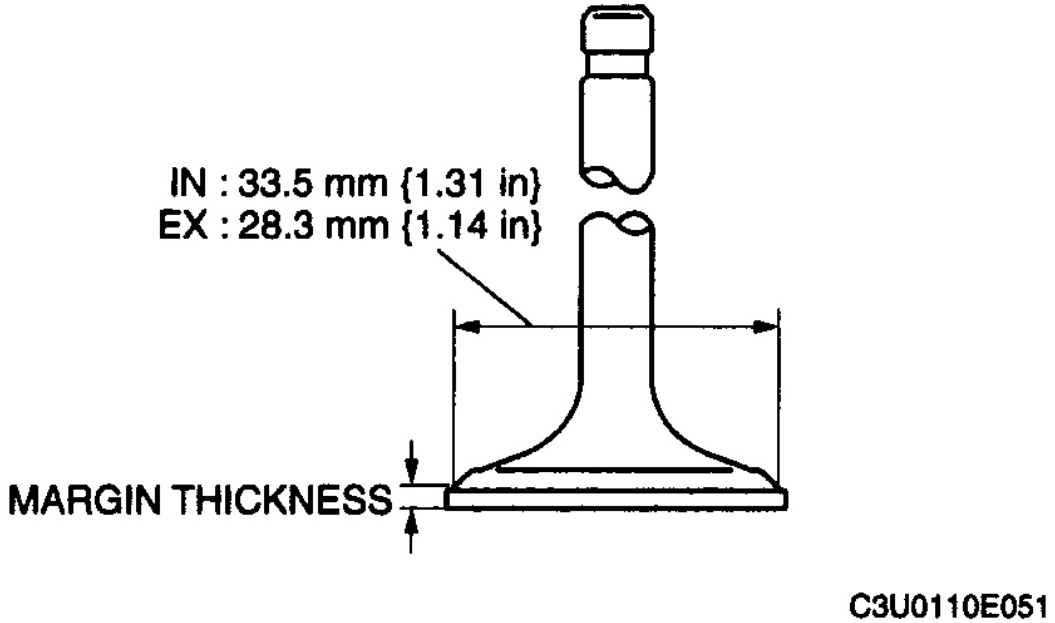

Fig. 23: Measuring Valve Head Margin Thickness Of Each Valve
Courtesy of MAZDA MOTORS CORP.

2. Measure the length of each valve. Replace the valve if necessary.
   - If it is less than the specification, replace the valve.

Valve length (Standard)

IN: 102.99-103.79 mm {4.055-4.086 in}

EX: 104.25-105.05 mm {4.105-4.135 in}

Valve length (Minimum)

IN: 102.99 mm {4.055 in}

EX: 104.25 mm {4.104 in}

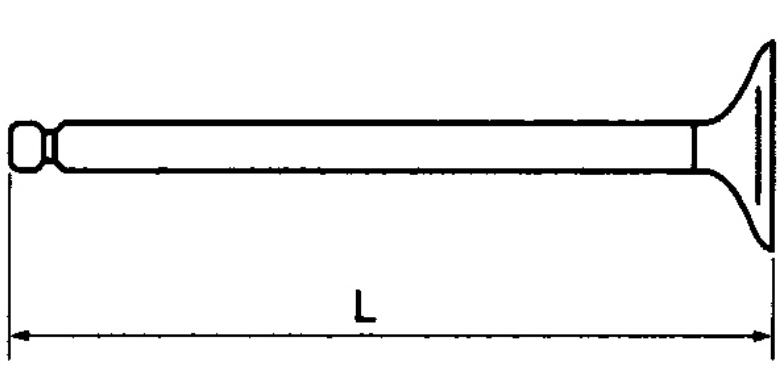

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Fig. 24: Measuring Length Of Each Valve
Courtesy of MAZDA MOTORS CORP.

3. Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) as indicated in the figure.
   - If it exceeds the specification, replace the valve.

Valve stem diameter (Standard)

IN: 5.470-5.485 mm {0.2154-0.2159 in}

EX: 5.465-5.480 mm {0.2152-0.2157 in}

Valve stem diameter (Minimum)

IN: 5.440 mm {0.2142 in}

EX: 5.435 mm {0.2140 in}

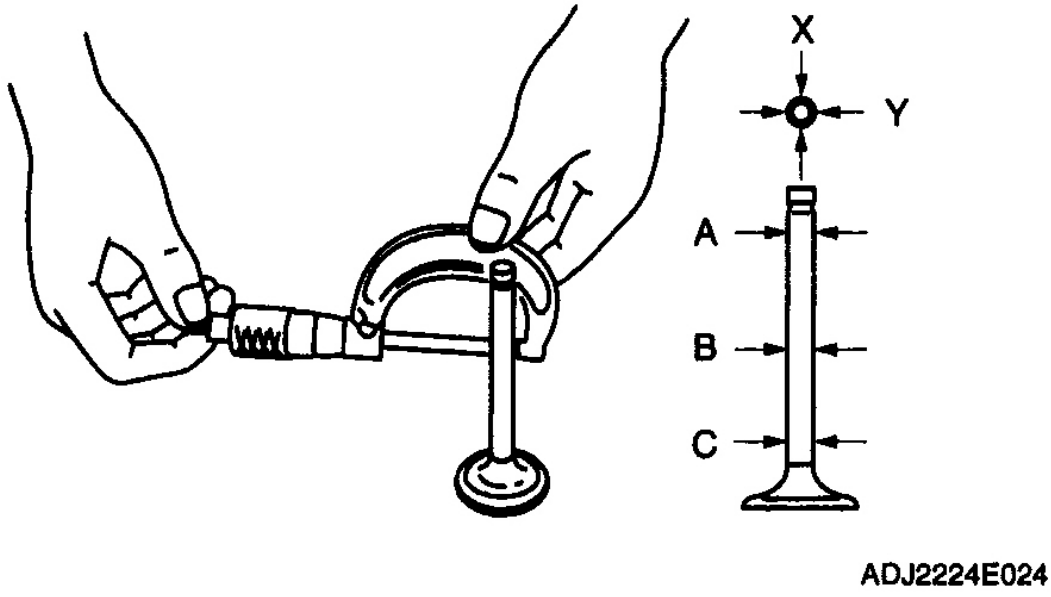

Fig. 25: Measuring Stem Diameter
Courtesy of MAZDA MOTORS CORP.

4. Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) as indicated in the figure.
   - If not as specified, replace the valve guide.

Valve guide inner diameter (Standard)

5.509-5.539 mm {0.2169-0.2180 in}

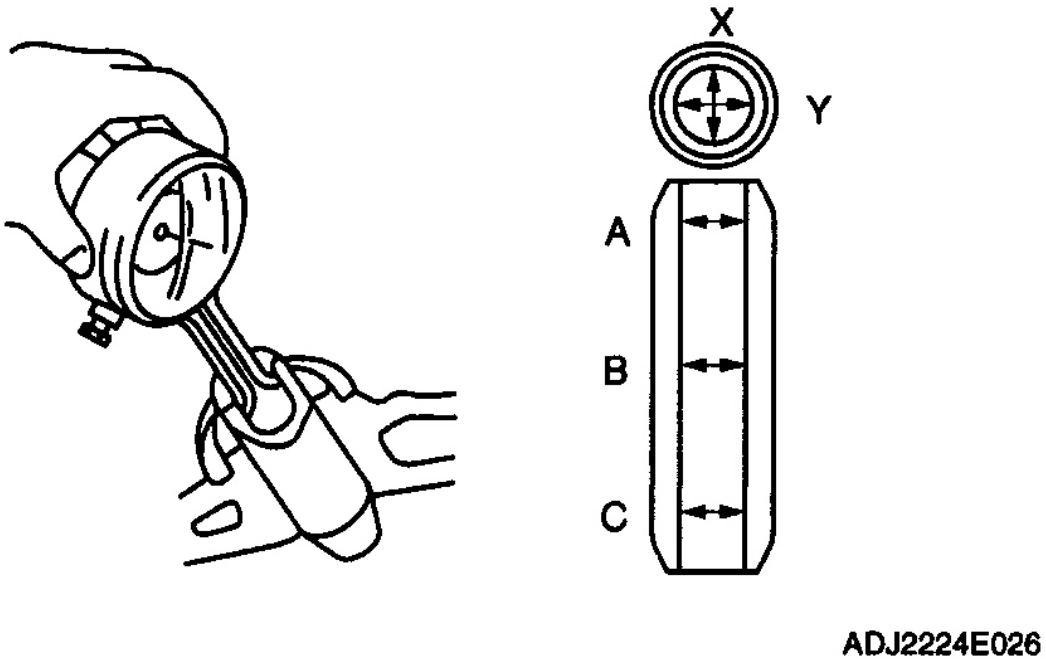

Fig. 26: Measuring Valve Guise Inner Diameter
Courtesy of MAZDA MOTORS CORP.

5. Calculate the valve stem to guide clearance by subtracting the outer diameter of the valve stem from the inner diameter of the corresponding valve guide.
    - If it exceeds the specification, replace the valve and/or the valve guide.

Valve stem to guide clearance (Standard)

IN: 0.024-0.069 mm {0.0009-0.0027 in}

EX: 0.029-0.074 mm {0.0012-0.0029 in}

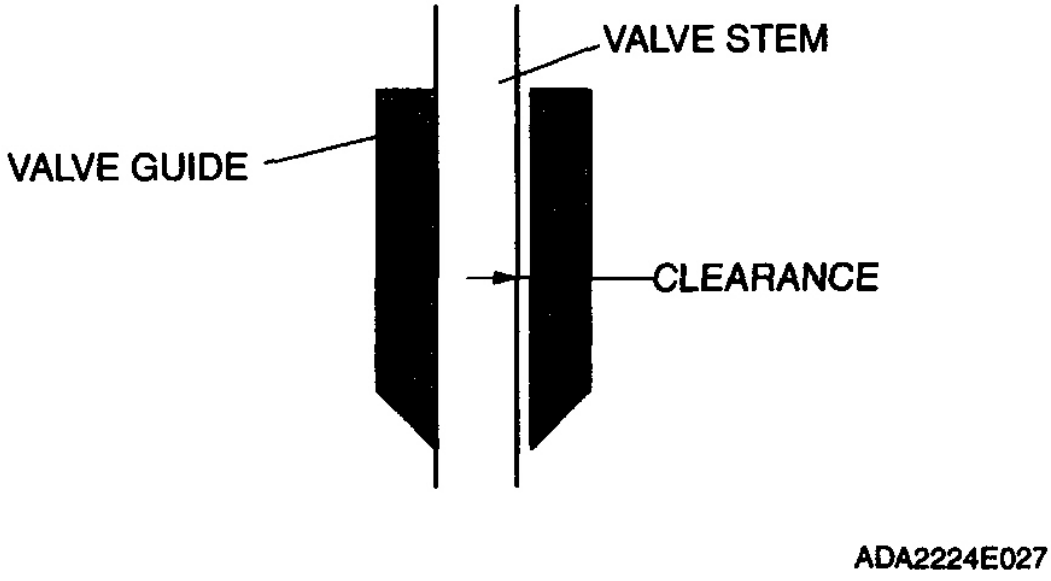

Fig. 27: Calculating Valve Stem To Guide Clearance
Courtesy of MAZDA MOTORS CORP.

Valve stem to guide clearance (Maximum) 0.10 mm {0.004 in}

6. Measure the protrusion height (dimension A) of each valve guide without lower valve spring seat.
    - If not within the specified, replace the valve guide.

Valve guide protrusion height (standard) 12.2-12.8 mm {0.481-0.503 in}

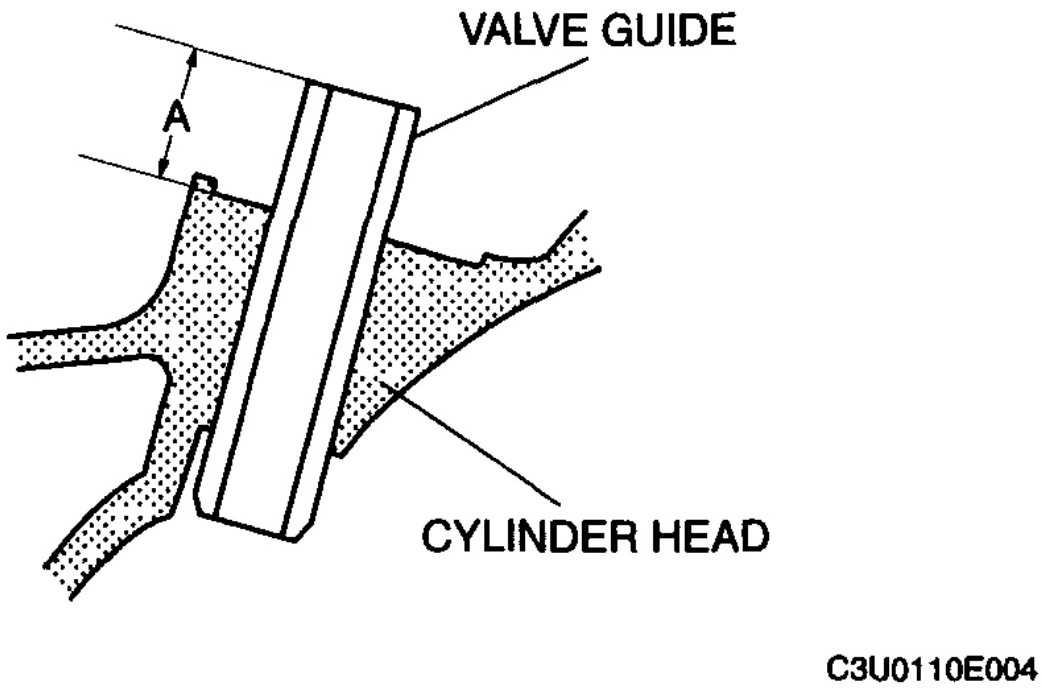

Fig. 28: Measuring Protrusion Height (Dimension A) Of Each Valve Guide
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE REPLACEMENT

Valve Guide Removal

1. Remove the valve guide from the combustion chamber side using the **SST** .

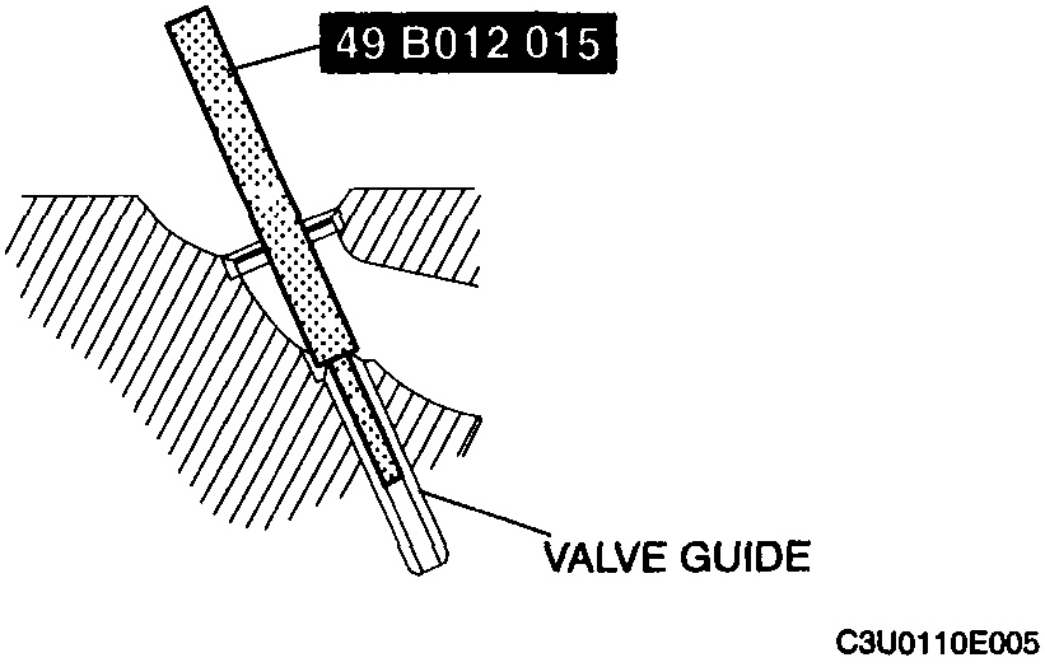

Fig. 29: Removing Valve Guide From Combustion Chamber Side
Courtesy of MAZDA MOTORS CORP.

Valve Guide Installation

1. Assemble the **SSTs** so that depth L is as specified.

   Valve guide protrusion height (standard)

   12.2-12.8 mm {0.481-0.503 in}

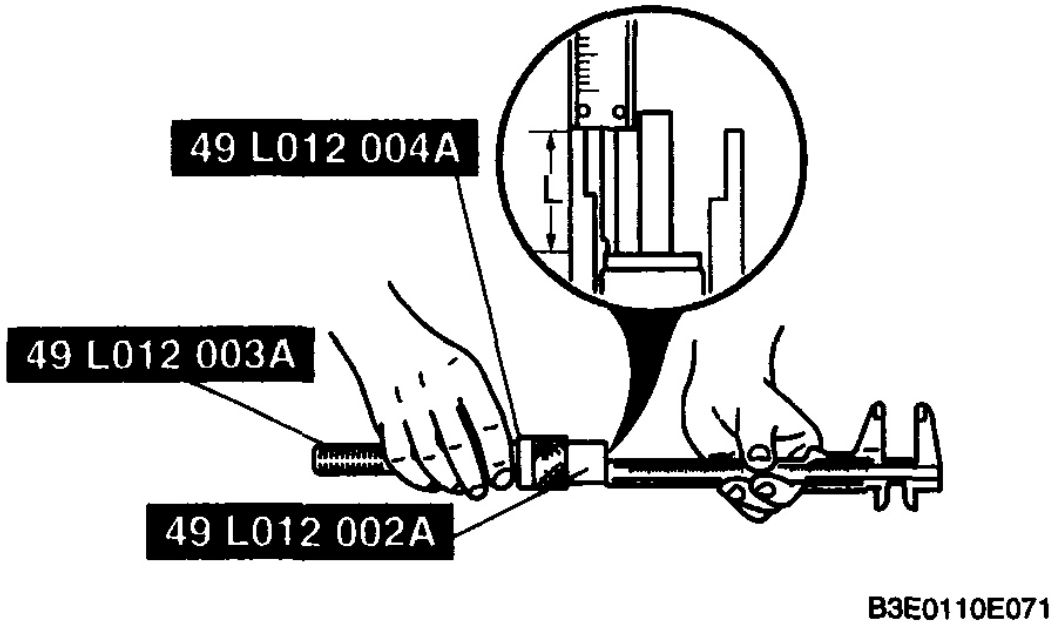

Fig. 30: Measuring Valve Guide Protrusion Height
Courtesy of MAZDA MOTORS CORP.

2. Tap the valve guide in from the top of the cylinder head until the **SSTs** contacts the cylinder head.

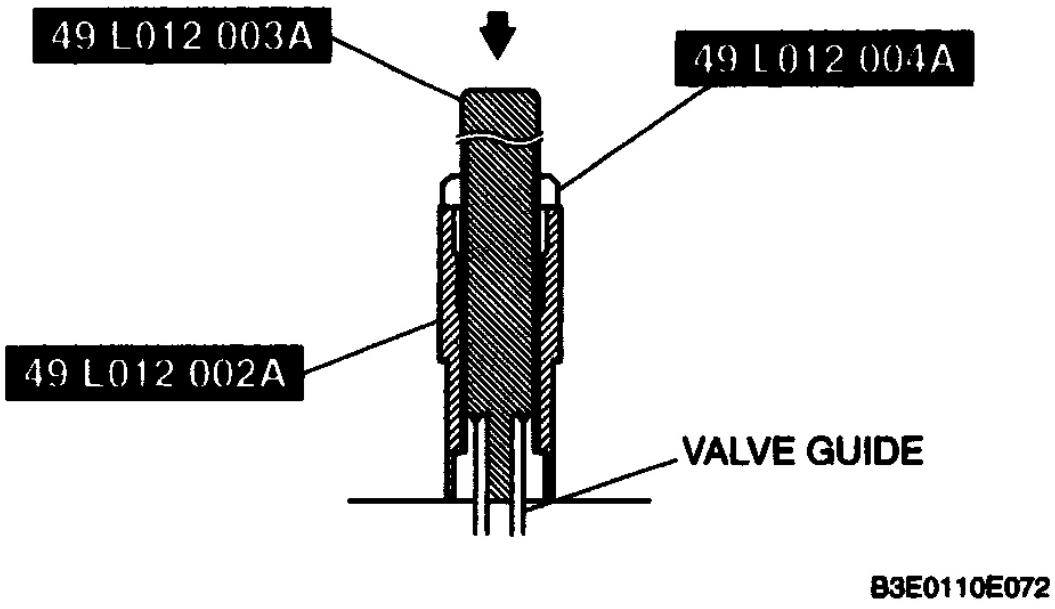

Fig. 31: Installing Valve Guide
Courtesy of MAZDA MOTORS CORP.

3. Verify that the valve guide protrusion height (dimension A) is within the specification.

   Valve guide protrusion height (standard)

   12.2-12.8 mm {0.481-0.503 in}

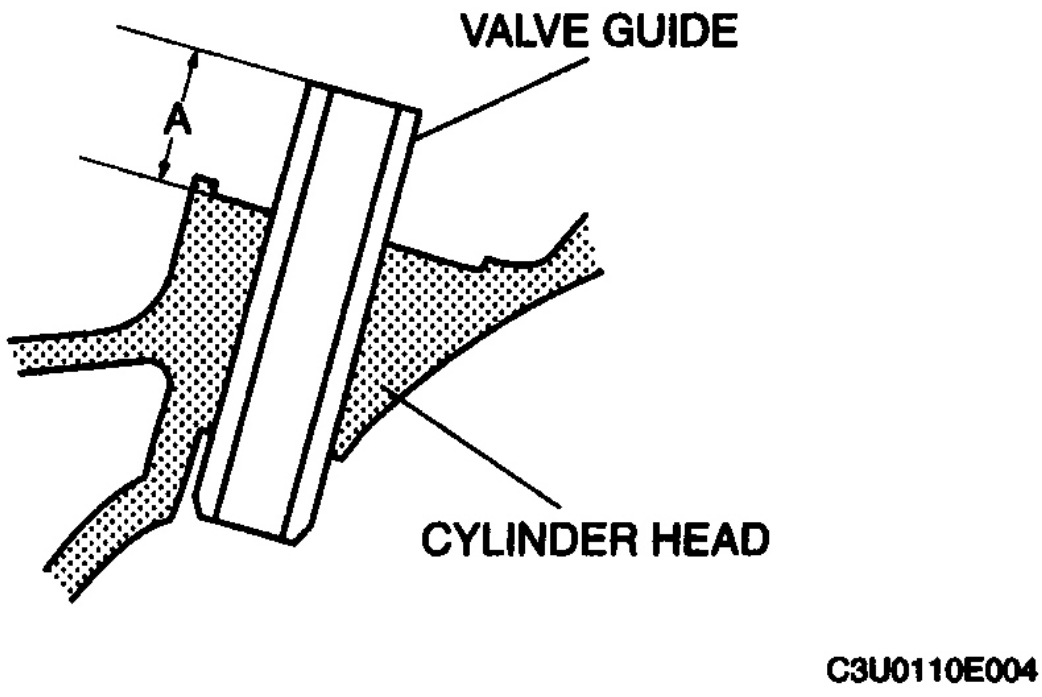

Fig. 32: Verifying Valve Guide Height
Courtesy of MAZDA MOTORS CORP.

VALVE SEAT INSPECTION/REPAIR

1. Measure the seat contact width.
    - If not within the specification, resurface the valve seat using a **45°** valve seat cutter and/or resurface the valve face.

Valve seat contact width (Standard)

1.2-1.6 mm {0.048-0.062 in}

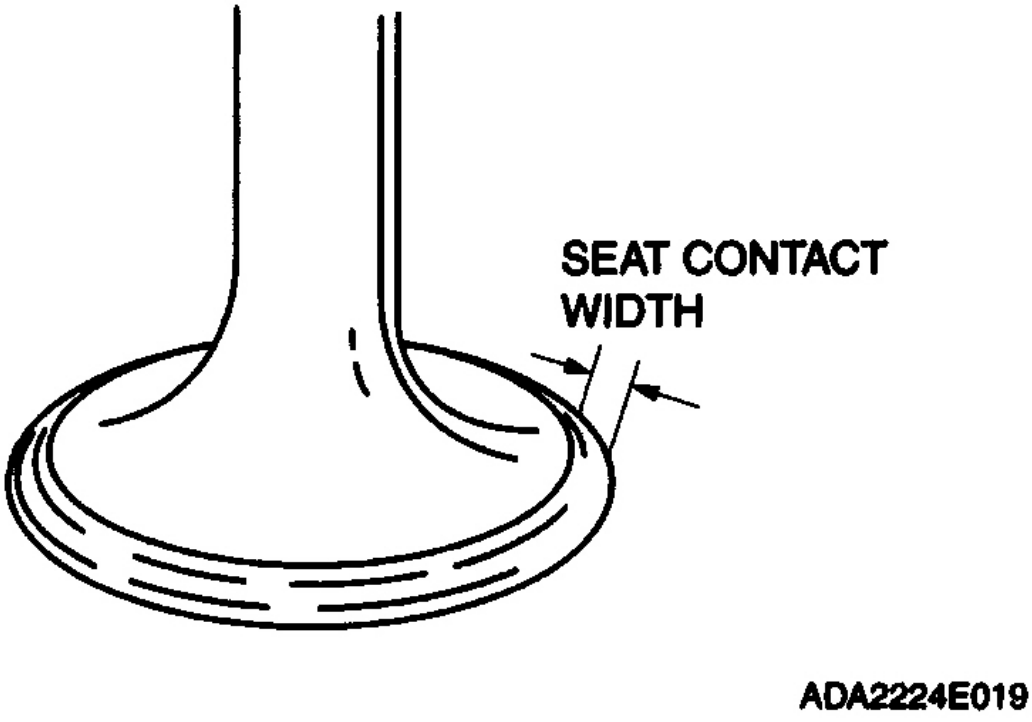

Fig. 33: Measuring Seat Contact Width
Courtesy of MAZDA MOTORS CORP.

2. Verify that the valve seating position is at the center of the valve face.
    1. If the seating position is too out side, correct the valve seat using a **70°** (IN) or **65°** (EX) cutter, and a **45°** cutter.
    2. If the seating position is too inner side, correct the valve seat using a **35°** (IN) cutter, and a **30°** (EX) cutter, and a **45°** cutter.

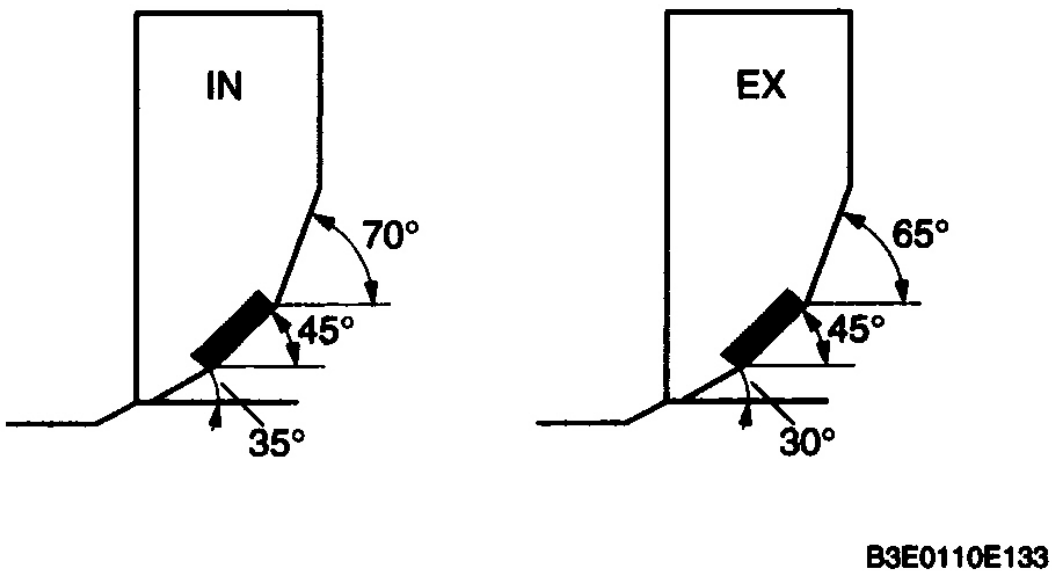

Fig. 34: Positioning Center Of Valve Face
Courtesy of MAZDA MOTORS CORP.

3. Inspect the sinking of the valve seat. Measure the protruding length (dimension L) of the valve stem.
   - If not specified, replace the cylinder head.

Valve protrusion height (Standard)

IN: 40.64-42.24 mm {1.600-1.662 in}

EX: 40.50-42.10 mm {1.595-1.657 in}

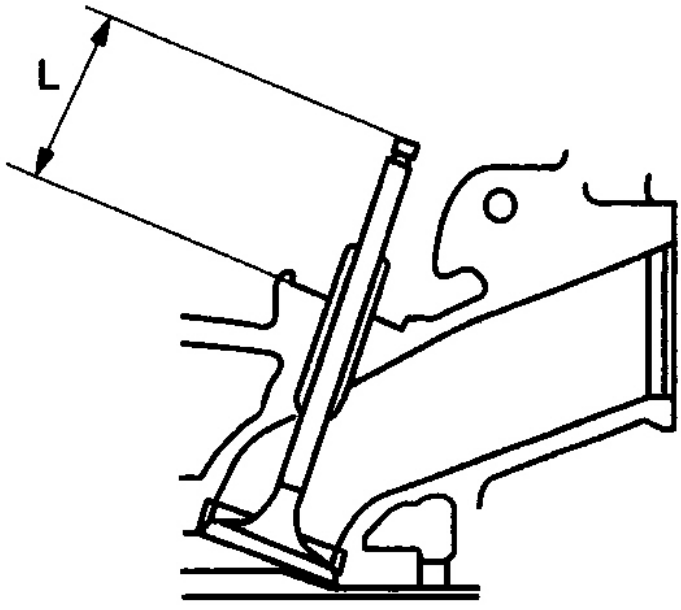

Fig. 35: Measuring Protruding Length (Dimension L) Of Valve Stem
Courtesy of MAZDA MOTORS CORP.

VALVE SPRING INSPECTION

1. Apply pressing force to the pressure spring and inspect the spring height.
   - If it is less than the specification, replace the valve spring.

Valve spring pressing force

390 N {39.76 kgf, 87.67 lbf}

Valve spring standard height H

28.68 mm {1.129 in}

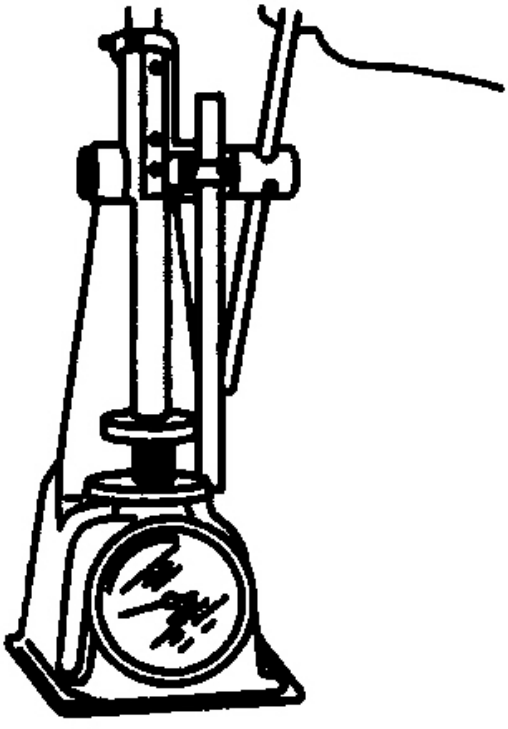

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Fig. 36: Performing Valve Spring Inspection
Courtesy of MAZDA MOTORS CORP.

2. Measure the out-of-square of the valve spring, using a square, as shown in the figure.
    1. Rotate the valve spring one full turn and measure "A" at the point where the gap is the largest.
        - If it exceeds the specification, replace the valve spring.

Valve spring out-of-square (Maximum)

1.95 mm {0.0767 in}

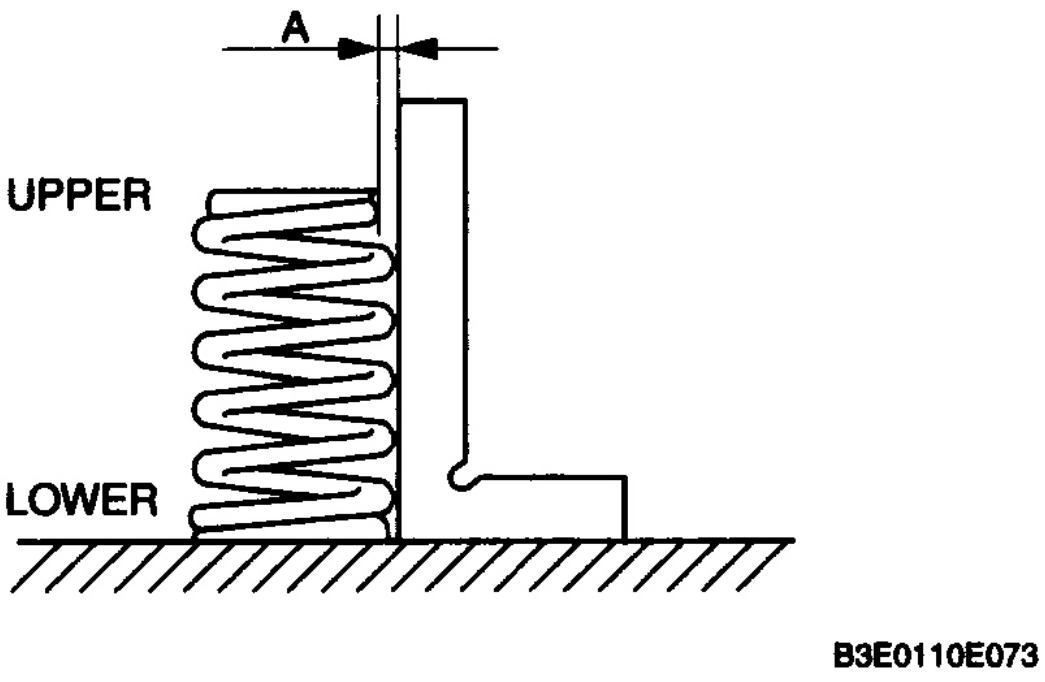

Fig. 37: Measuring Valve Spring Out-Of-Square
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT INSPECTION

1. Set the No. 1 and No.5 journals on V-blocks.
2. Measure the camshaft runout.
   - If it exceeds the specification, replace the camshaft.

Maximum runout (Maximum)

0.03 mm {0.0012 in}

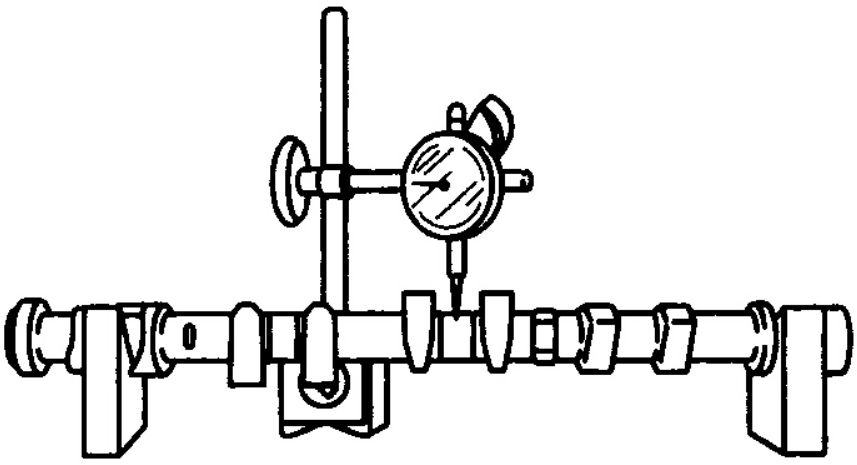

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Fig. 38: Measuring Camshaft Runout
Courtesy of MAZDA MOTORS CORP.

3. Measure the cam lobe height at the two points as shown in the figure.
   - If it is less than the specification, replace the camshaft.

Camshaft standard height (mm {in})

With variable valve timing mechanism

IN: 42.44 {1.671}

EX: 41.18 {1.621}

Without variable valve timing mechanism

IN: 42.12 {1.659}

EX: 41.08 {1.618}

Camshaft minimum height (mm {in})

With variable valve timing mechanism

IN: 42.33 {1.666}

EX: 41.06 {1.616}

Without variable valve timing mechanism

IN: 42.01 {1.653}

EX: 40.96 {1.612}

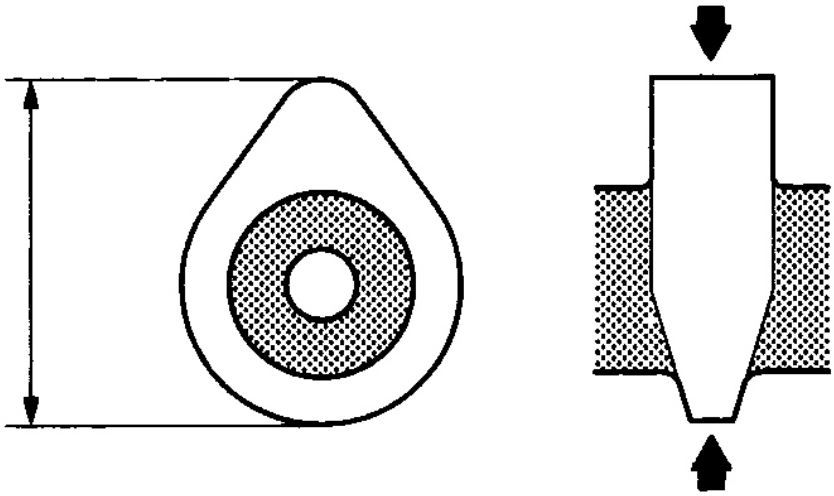

Fig. 39: Measuring Cam Lobe Height At Two Points
Courtesy of MAZDA MOTORS CORP.

4. Measure the journal diameters in X and Y directions at the two points (A and B) as indicated in the figure.
    - If it is less than the specification, replace the camshaft.

Camshaft journal diameter (Standard)

24.96-24.98 mm {0.9827-0.9834 in}

Camshaft journal diameter (Minimum)

24.95 mm {0.982 in}

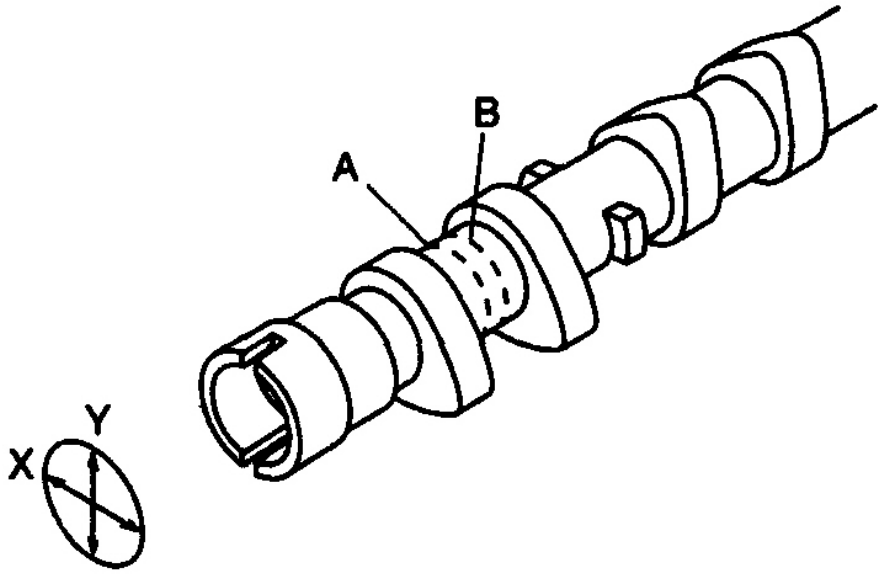

Fig. 40: Measuring Journal Diameters In X And Y Directions At Two Points (A And B)
Courtesy of MAZDA MOTORS CORP.

5. Remove the tappet.
6. Position a plastigage atop the journals in the axial direction.
7. Install the camshaft cap. (See **CAMSHAFT ASSEMBLY NOTE**).
8. Remove the camshaft cap. (See **CAMSHAFT CAP DISASSEMBLY NOTE**).
9. Measure the oil clearance.
    - If it exceeds the specification, replace the cylinder head.

Camshaft journal oil clearance (Standard)

0.035-0.080 mm {0.0014-0.0031 in}

Camshaft journal oil clearance (Maximum)

0.09 mm {0.0035 in}

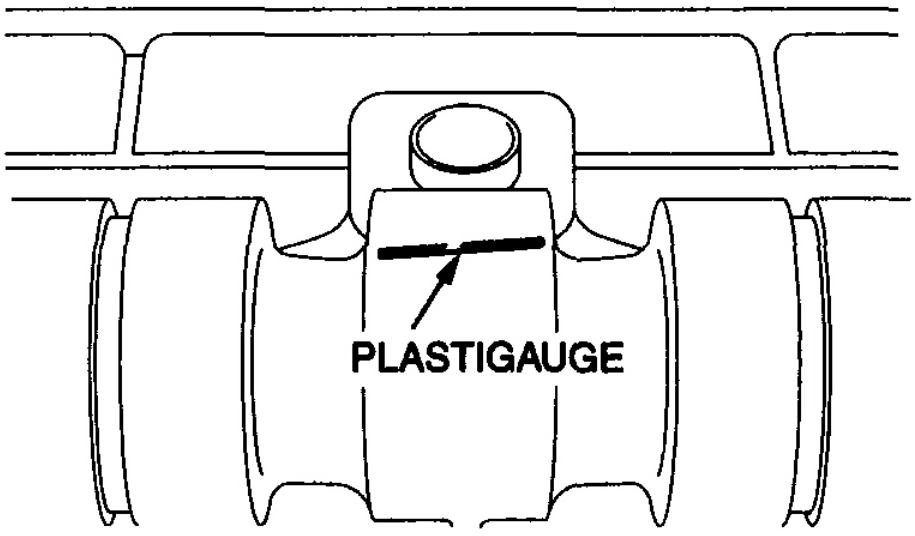

Fig. 41: Measuring Oil Clearance Using Plastigauge
Courtesy of MAZDA MOTORS CORP.

10. Install the camshaft cap. (See **CAMSHAFT ASSEMBLY NOTE**).
11. Measure the camshaft end play.
    - If it exceeds the specification, replace the cylinder head or camshaft.

    Camshaft end play (Standard)

    0.09-0.24 mm {0.0035-0.0094 in}

    Camshaft end play (Maximum)

    0.25 mm {0.0098 in}

12. Remove the camshaft cap. (See **CAMSHAFT CAP DISASSEMBLY NOTE**).

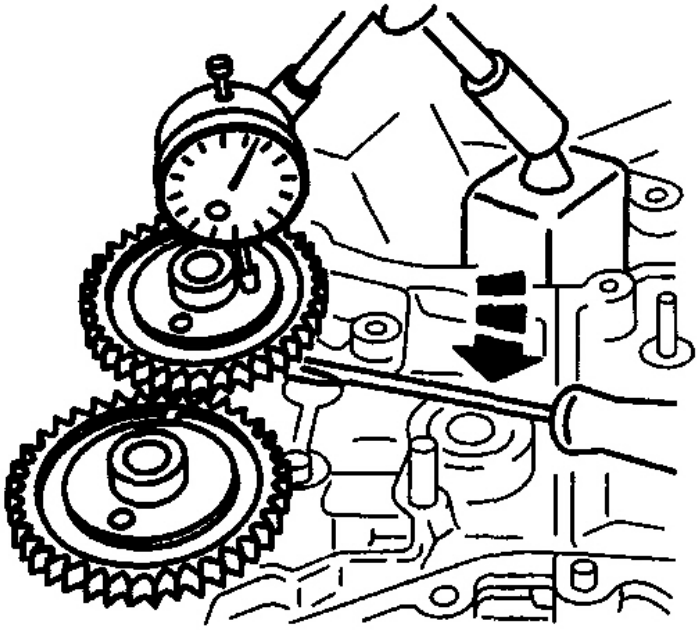

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Fig. 42: Measuring Camshaft End Play
Courtesy of MAZDA MOTORS CORP.

TAPPET INSPECTION

1. Measure the tappet hole inner diameter in X and Y directions at the two points (A and B) shown in the figure.

   Tappet bore diameter (Standard)

   31.000-31.030 mm {1.2205-1.2216 in}

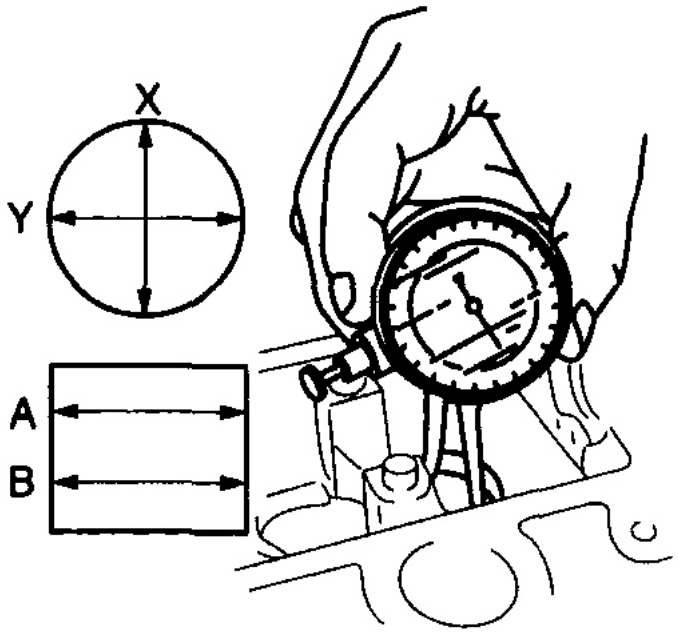

Fig. 43: Measuring Tappet Hole Inner Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure the tappet body outer diameter in X and Y directions at the two points (A and B) shown in the figure.

   Tappet diameter (Standard)

   30.970-30.980 mm {1.2193-1.2196 in}

3. Subtract the tappet body outer diameter from the tappet hole inner diameter.
   - If it exceeds the specification, replace the tappet or cylinder head.

   Tappet-to-Tappet bore oil clearance (Standard)

   0.02-0.06 mm {0.0008-0.0023 in}

   Tappet-to-Tappet bore oil clearance (Maximum)

   0.15 mm {0.006 in}

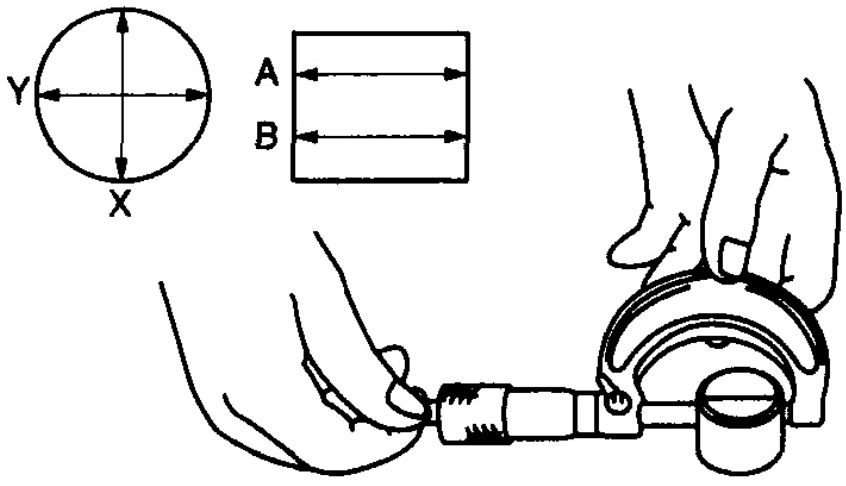

Fig. 44: Measuring Tappet Body Outer Diameter In X And Y Directions At Two Points (A And B)
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK INSPECTION

1. Measure the distortion of the cylinder block top surface in six directions as indicated in the figure.
   - If it exceeds the maximum, replace the cylinder block.

   Cylinder head gasket contact surfaces distortion (Maximum)

   0.10 mm {0.004 in}

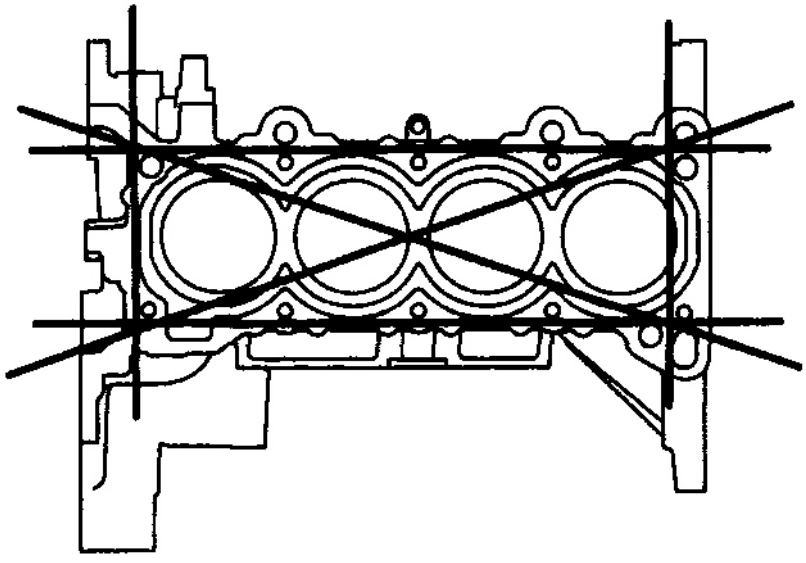

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Fig. 45: Measuring Distortion Of Cylinder Block Top Surface In Six Directions
Courtesy of MAZDA MOTORS CORP.

2. Measure the cylinder bores in X and Y directions at 42 mm {1.65 in} below the top surface.
   - If not within the specification, replace the cylinder block.

Cylinder bore diameter (Standard)

87.500-87.530 mm {3.4449-3.4460 in}

Minimum / maximum bore diameter limit

87.440-87.590 mm {3.4425-3.4484 in}

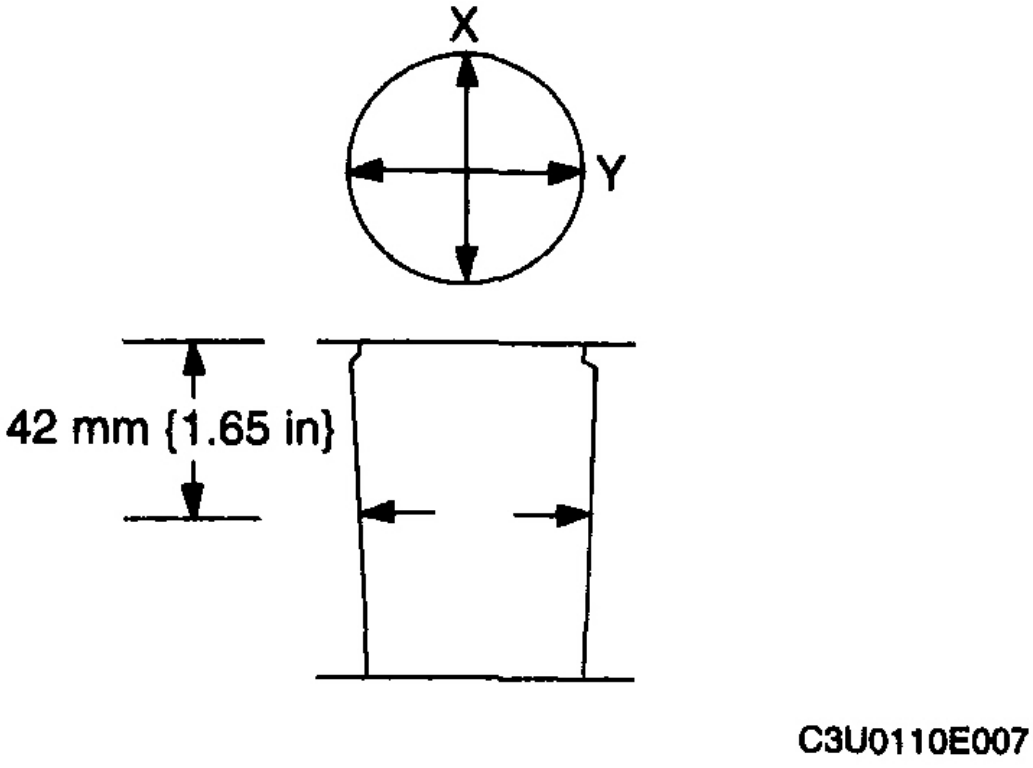

Fig. 46: Measuring Cylinder Bores In X And Y Directions At Below Top Surface
Courtesy of MAZDA MOTORS CORP.

OIL JET VALVE INSPECTION

1. Apply compressed air to oil jet valve A and verify that air passes through oil jet valve B.
   - If air does not flow, replace the oil jet valve.

Oil jet valve air pressure

216-274 kPa {2.2-2.7 kgf.cm^2 31.4-39.7 psi}

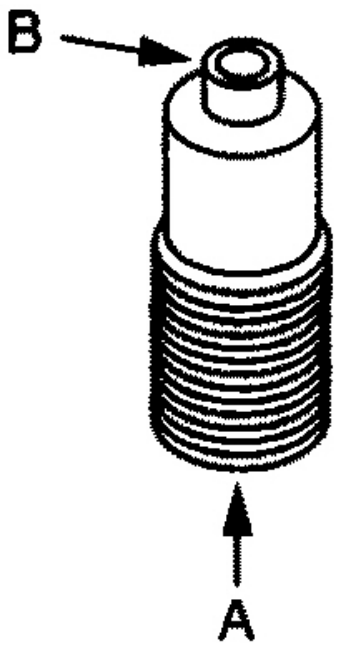

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Fig. 47: Inspecting Oil Jet Valve
Courtesy of MAZDA MOTORS CORP.

PISTON INSPECTION

CAUTION:
- **The piston and connecting rod cannot be disassembled.**
- **When replacing the piston, piston pin, piston ring and connecting rod, replace them together as a single unit.**

1. Measure the outer diameter of each piston at right angle 90° to the piston pin, 10.0 mm {0.40 in} above the under of the piston.
   - If not within the specification, replace the piston, piston pin, piston ring and connecting rod as a single unit.

Piston diameter (Standard)

87.465-87.495 mm {3.4435-3.4446 in}

2. Measure the piston-to-cylinder clearance.
   - If not within the specification, replace the piston, piston pin, piston ring and connecting rod as a single unit.

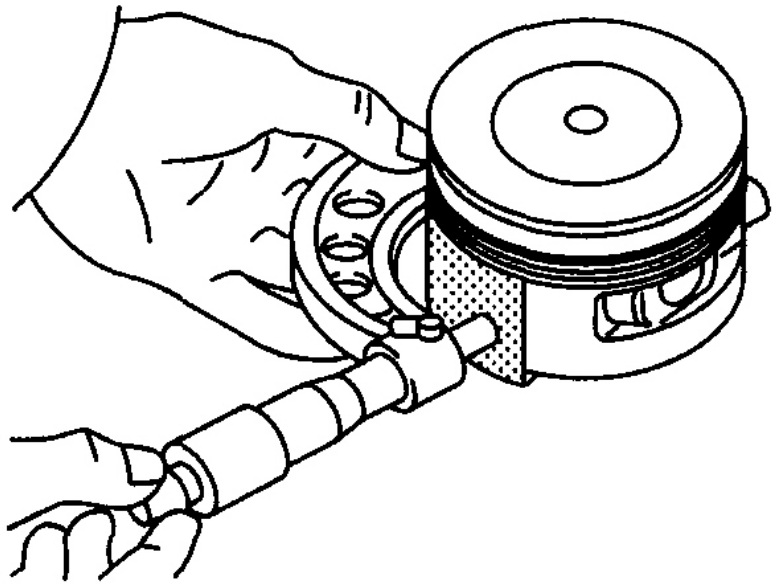

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Fig. 48: Measuring Piston-To-Cylinder Clearance
Courtesy of MAZDA MOTORS CORP.

Piston-to-cylinder clearance (Standard)

0.025-0.045 mm {0.0010-0.0017 in}

Piston-to-cylinder clearance (Maximum)

0.11 mm {0.0043 in}

3. Measure the piston ring-to-ring groove clearance around the entire circumference.
   - If it exceeds the specification, replace the piston, piston pin, piston ring and connecting rod as a single unit.

Piston ring-to-ring groove clearance (Standard)

Top: 0.03-0.08 mm {0.0012-0.0031 in}

Second: 0.03-0.07 mm {0.0012-0.0027 in}

Oil: 0.03-0.07 mm {0.0012-0.0027 in}

Piston ring-to-ring groove clearance (Maximum)

Top: 0.17 mm {0.0067 in}

Second, Oil: 0.15 mm {0.0059 in}

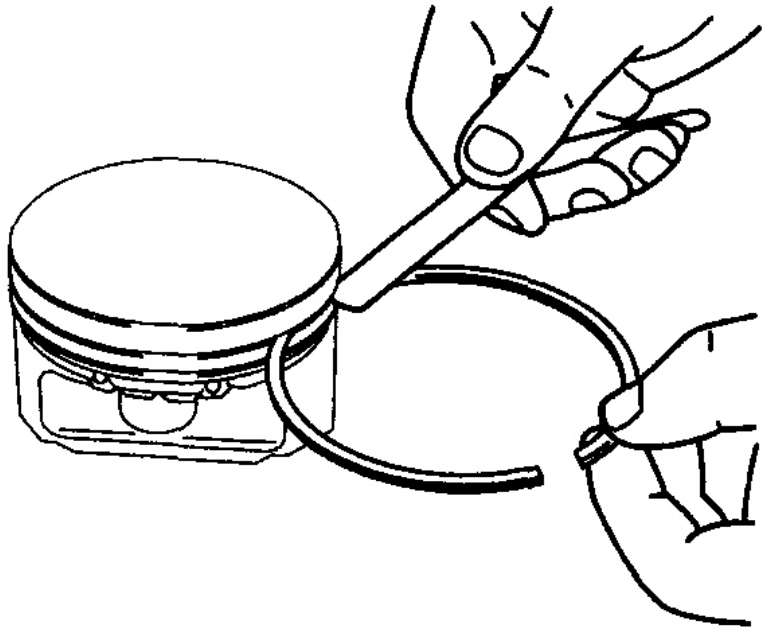

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Fig. 49: Measuring Piston Ring-To-Ring Groove Clearance
Courtesy of MAZDA MOTORS CORP.

4. Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
5. Measure each piston ring end gap with a feeler gauge.
    - If it exceeds the specification, replace the piston, piston pin, piston ring and connecting rod as a single unit.

Piston end gap (Standard)

Top: 0.16-0.31 mm {0.0063-0.0122 in}

Second: 0.33-0.48 mm {0.0130-0.0189 in}

Oil (rail): 0.20-0.70 mm {0.0079-0.0275 in}

Piston end gap (Maximum)

1.0 mm {0.0393 in}

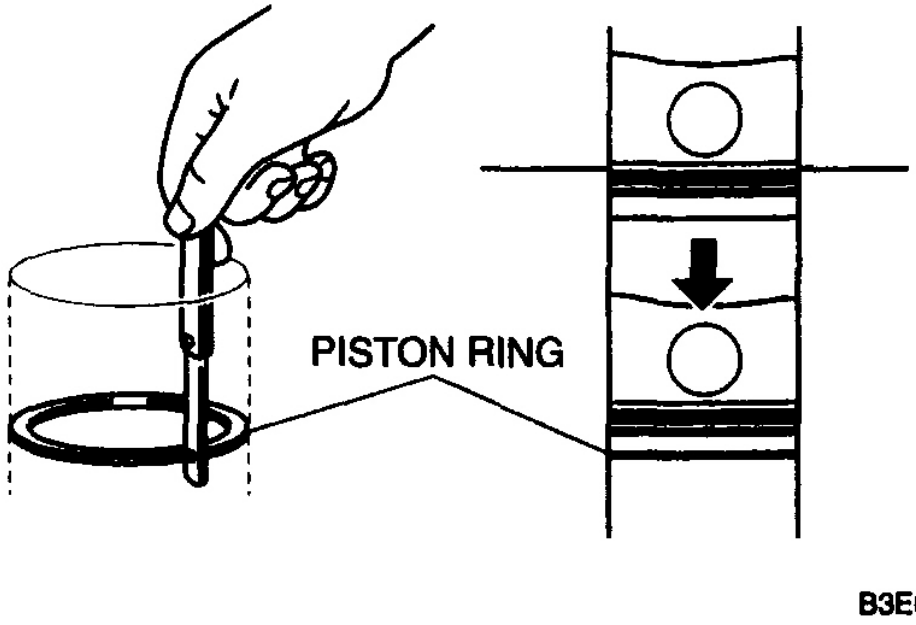

Fig. 50: Measuring Each Piston Ring End Gap With Feeler Gauge
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT INSPECTION

1. Install the main bearing cap. (See **MAIN BEARING CAP ASSEMBLY NOTE**).
2. Measure the crankshaft end play.
   - If it exceeds the specification, replace the thrust bearing or crankshaft so that the specified end play is obtained.

Crankshaft end play (Standard)

0.22-0.45 mm {0.0087-0.0177 in}

Crankshaft end play (Maximum)

0.55 mm {0.0216 in}

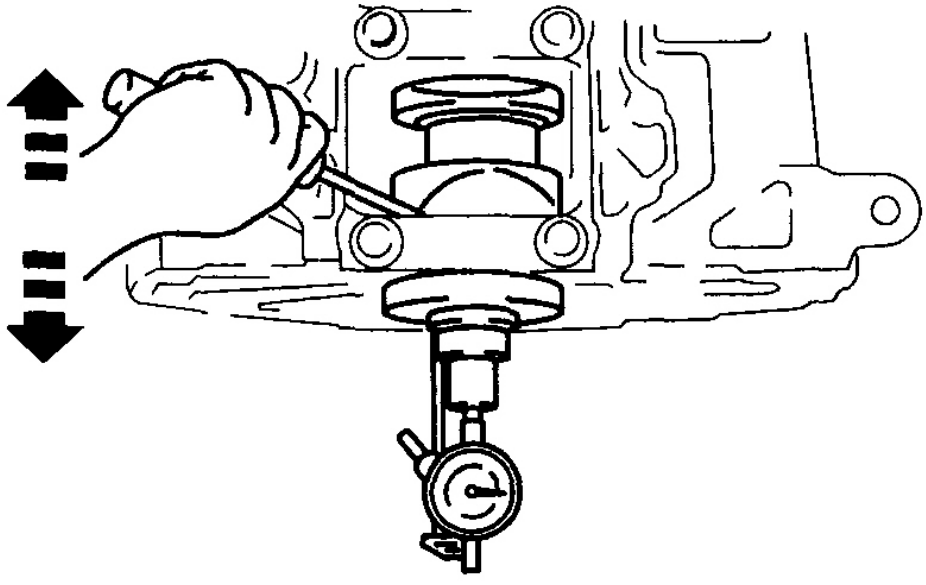

Fig. 51: Measuring Crankshaft End Play
Courtesy of MAZDA MOTORS CORP.

3. Remove the main bearing cap. (See **MAIN BEARING CAP DISASSEMBLY NOTE**).
4. Measure the crankshaft runout.
   - If it exceeds the specification, replace the crankshaft.

Crankshaft runout (Maximum)

0.05 mm {0.0019 in}

5. Measure the journal diameter in X and Y directions at the two points (A and B) as indicated in the figure.
   - If it exceeds the specification, replace the crankshaft or grind the journal and install the undersize bearing.

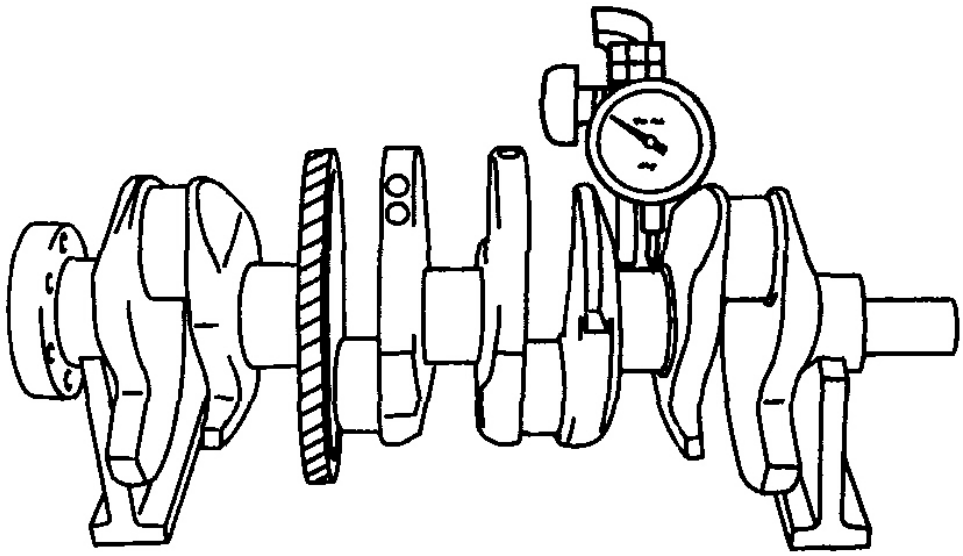

Fig. 52: Measuring Crankshaft Runout
Courtesy of MAZDA MOTORS CORP.

Main journal bearing size

STD: 51.980-52.000 mm {2.0464-2.0472 in}

US0.25: 51.730-51.750 mm {2.0366-2.0373 in}

Main journal out of round (Maximum)

0.05 mm {0.0019 in}

Crank pin journal diameter [LF]

STD: 46.980-47.000 mm {1.8497-1.8503 in}

US0.25: 46.730-46.750 mm {1.8398-1.8405 in}

Crank pin journal diameter [L3]

STD: 49.980-50.000 mm {1.9677-1.9685 in}

US0.25: 49.730-49.750 mm {1.9579-1.9586 in}

Crank pin out of round (Maximum)

0.05 mm {0.0019 in}

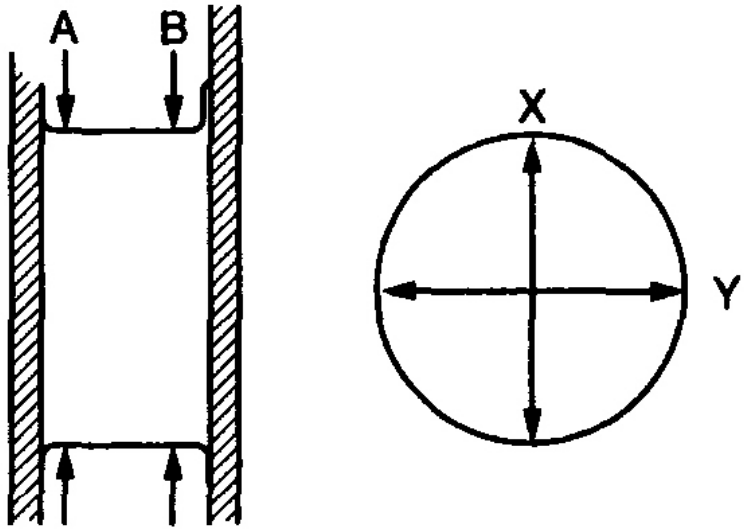

Fig. 53: Measuring Journal Diameter In X And Y Directions At Two Points (A And B)
Courtesy of MAZDA MOTORS CORP.

6. Install the main bearing caps and crankshaft.
7. Position a plastigage atop the journals in the axial direction.
8. Install the main bearing caps and cylinder block. (See **MAIN BEARING CAP ASSEMBLY NOTE**).
9. Remove the main bearing caps. (See **MAIN BEARING CAP DISASSEMBLY NOTE**).
10. Measure the main journal oil clearance.
    - If it exceeds the specification, replace the main bearing using the main bearing selection table or grind the main journal and install the oversize bearings so that the specified oil clearance is obtained.

Main journal oil clearance (Standard)

0.019-0.035 mm {0.0007-0.0013 in}

Main journal oil clearance (Maximum)

0.10 mm {0.0039 in}

Main bearing size

STD: 2.506-2.509 mm {0.0987-0.0988 in}

OS0.25: 2.628-2.634 mm {0.1034-0.1037 in}

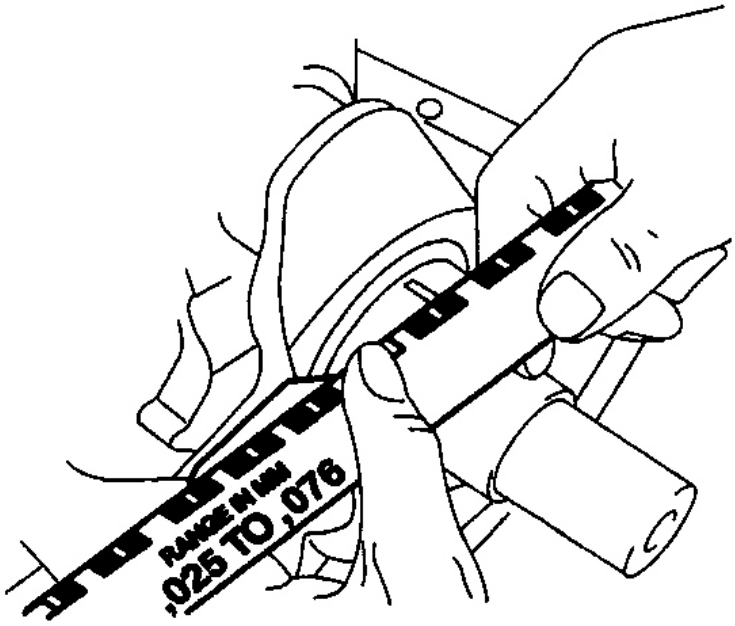

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Fig. 54: Measuring Main Journal Oil Clearance
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD INSPECTION

CAUTION:
- **The piston and connecting rod cannot be disassembled.**
- **When replacing the piston, piston pin, piston ring and connecting rod, replace them together as a single unit.**

1. Install the connecting rod cap. (See **CONNECTING ROD CAP ASSEMBLY NOTE**).
2. Measure the connecting rod large end side clearance.
   - If it exceeds the specification, replace the piston, piston pin, piston ring and connecting rod as a

single unit.

Connecting rod side clearance (Standard)

0.14-0.36 mm {0.0056-0.0141 in}

Connecting rod side clearance (Maximum)

0.435 mm {0.0172 in}

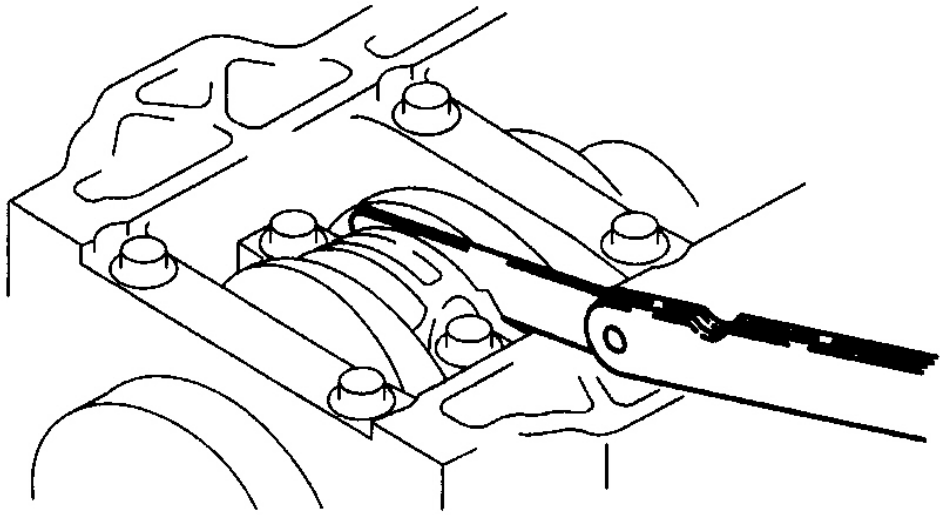

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Fig. 55: Measuring Connecting Rod Large End Side Clearance
Courtesy of MAZDA MOTORS CORP.

3. Remove the connecting rod cap.
4. Position plastigage atop the journals in the axial direction.
5. Install the connecting rod bearing and connecting rod cap. (See **CONNECTING ROD CAP ASSEMBLY NOTE**).
6. Remove the connecting rod cap.
7. Measure the connecting rod oil clearance.
   - If it exceeds the specification, replace the connecting rod bearing or grind the crank pin and use oversize bearings so that the specified clearance is obtained.

Connecting rod bearing oil clearance (Standard)

0.026-0.052 mm {0.0011-0.0020 in}

Connecting rod bearing oil clearance (Maximum)

0.1 mm {0.0039 in}

Connecting rod bearing size [LF]

STD: 1.498-1.504 mm {0.0589-0.0592 in}

OS0.25: 1.623-1.629 mm {0.0639-0.0641 in}

Connecting rod bearing size [L3]

STD: 1.496-1.502 mm {0.0589-0.0591 in}

OS0.25: 1.621-1.627 mm {0.0639-0.0641 in}

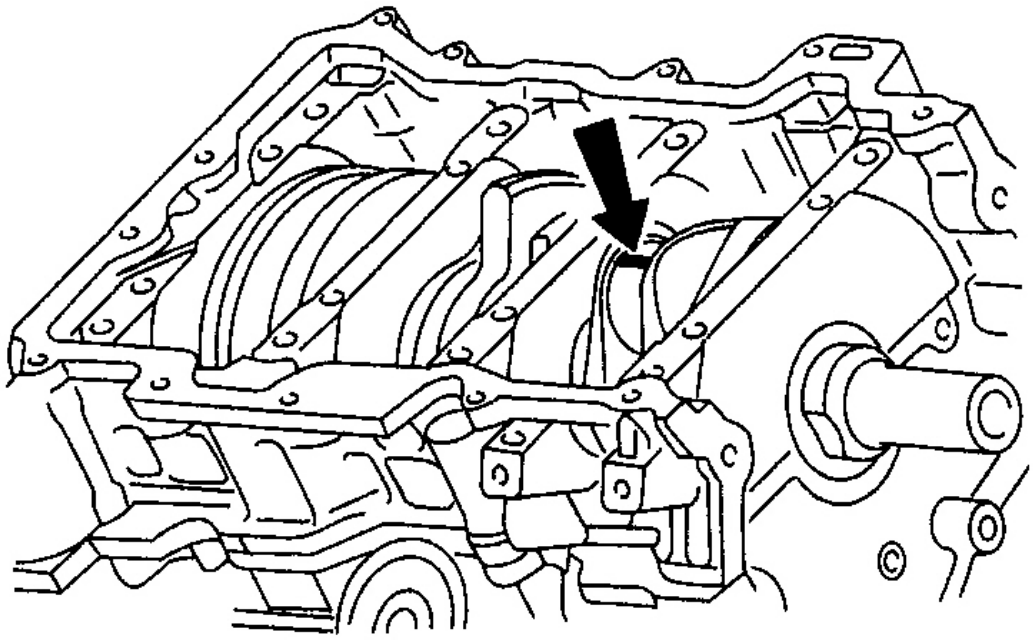

Fig. 56: Measuring Connecting Rod Oil Clearance
Courtesy of MAZDA MOTORS CORP.

BOLT INSPECTION

1. Measure the length of each bolt.
   - If it exceeds the specification, replace the bolt.

Bolt length (mm {in})

Cylinder head bolt (With washer)

Standard: 149.2-149.8 {5.87-5.90}

Maximum: 150.5 {5.91}

Cylinder head bolt (Without washer)

Standard: 145.2-145.8 {5.72-5.74}

Maximum: 146.5 {5.77}

Connecting rod bolt

Standard: 44.7-45.3 {1.75-1.78}

Maximum: 46.0 {1.81}

Main bearing cap bolt (Plastic region tightening bolt only)

Standard: 110.0-110.6 {4.33-4.35}

Maximum: 111.3 {4.38}

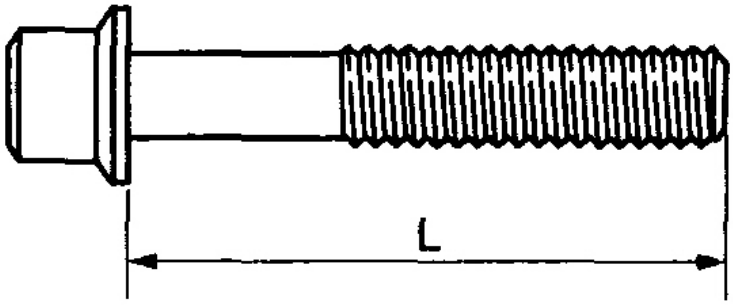

Fig. 57: Measuring Length Of Each Bolt
Courtesy of MAZDA MOTORS CORP.

VARIABLE VALVE TIMING ACTUATOR INSPECTION [WITH VARIABLE VALVE TIMING MECHANISM]

CAUTION:
- **Variable valve timing actuator cannot be disassembled because it is a precision unit.**

1. Confirm that the groove of the rotor and notch of the cover at the variable valve timing actuator are aligned and fixed.
   - If the notch and the bump are not aligned, rotate the rotor toward the valve timing retard position by hand until they are in place.
   - If the rotor and cover are not fixed even though their notch and groove are aligned, replace the variable valve timing actuator.

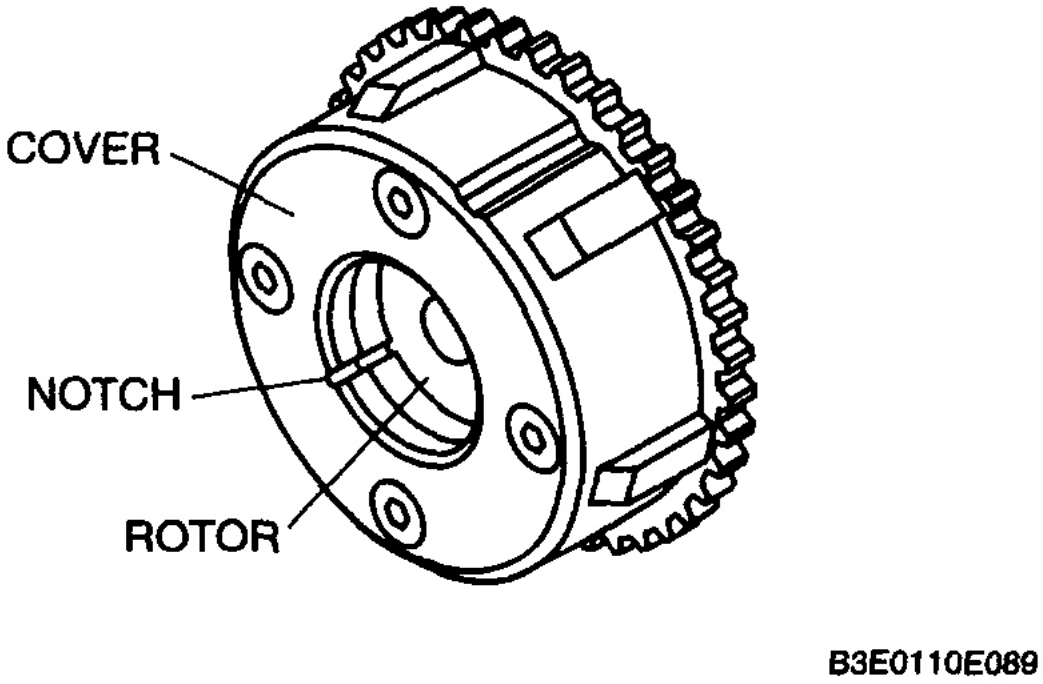

Fig. 58: Aligning Actuator Rotor Groove & Notch
Courtesy of MAZDA MOTORS CORP.

OIL CONTROL VALVE (OCV) INSPECTION [WITH VARIABLE VALVE TIMING MECHANISM]

Coil Resistance Inspection

1. Disconnect the negative battery cable.
2. Disconnect the oil control valve (OCV) connector.
3. Measure the resistance between terminals A and B using an ohmmeter.
   - If not as specified, replace the oil control valve (OCV).

Specification

6.9-7.9 ohms [20 °C {68 °F}]

4. Connect the oil control valve (OCV) connector.

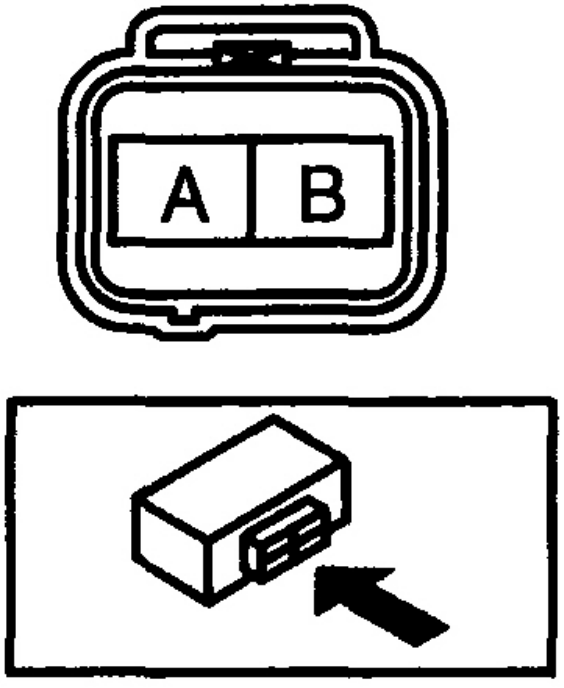

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Fig. 59: Identifying Coil Control Valve Connector Terminals
Courtesy of MAZDA MOTORS CORP.

Spool Valve Operation Inspection

1. Disconnect the negative battery cable.
2. Remove the oil control valve (OCV).
3. Verify that the spool valve in the oil control valve (OCV) is in the maximum valve timing retard position as indicated in the figure.
    - If it exceeds the specification, replace the oil control valve (OCV).
4. Verify that the battery is fully charged.
    - If it is less than specification, recharge the battery.

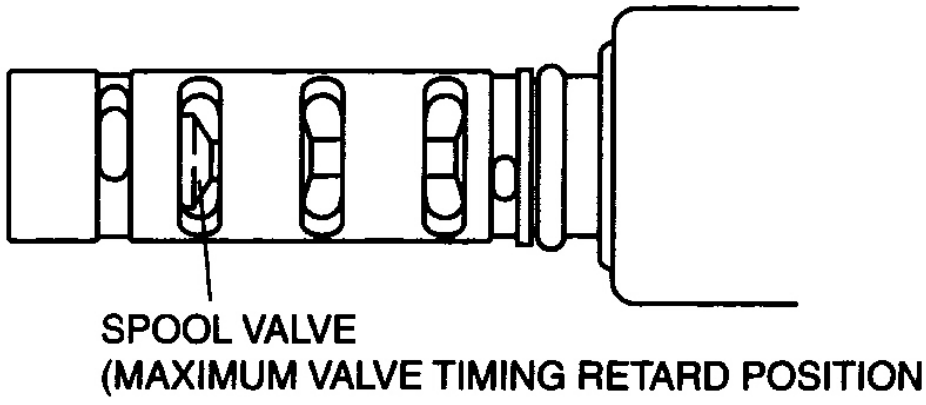

Fig. 60: Identifying Spool Valve
Courtesy of MAZDA MOTORS CORP.

5. Apply battery positive voltage between the oil control valve (OCV) terminals and verify that the spool valve operates and moves to the maximum valve timing advance position.
   - If it exceeds the specification, replace the oil control valve (OCV).

NOTE:

- **When applying battery positive voltage between the oil control valve (OCV) terminals, the connection can be either of the following:**
  - **Positive battery cable to terminal A, negative battery cable to terminal B**
  - **Positive battery cable to terminal B, negative battery cable to terminal A**

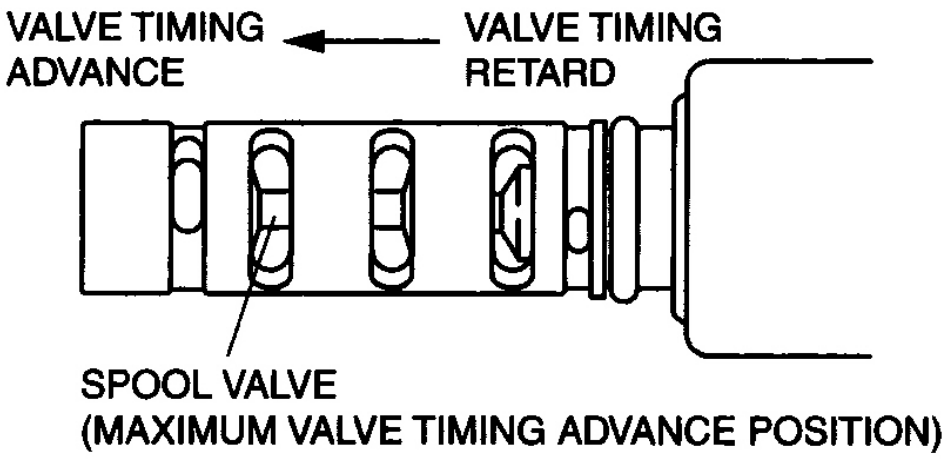

Fig. 61: Positioning Spool Valve Operates And Moves To Maximum Valve Timing Advance
Courtesy of MAZDA MOTORS CORP.

6. Stop applying battery positive voltage and verify that the spool valve returns to the maximum valve timing retard position.
    - If it exceed the specification, replace the oil control valve (OCV).

VALVE CLEARANCE INSPECTION

1. Measure the valve clearance as follows.
    1. Turn the crankshaft clockwise so that the No. 1 piston is at TDC of the compression stroke.
    2. Measure the valve clearance at A in the figure.
        - If the valve clearance exceeds the standard, replace the tappet. (See **VALVE CLEARANCE ADJUSTMENT**).

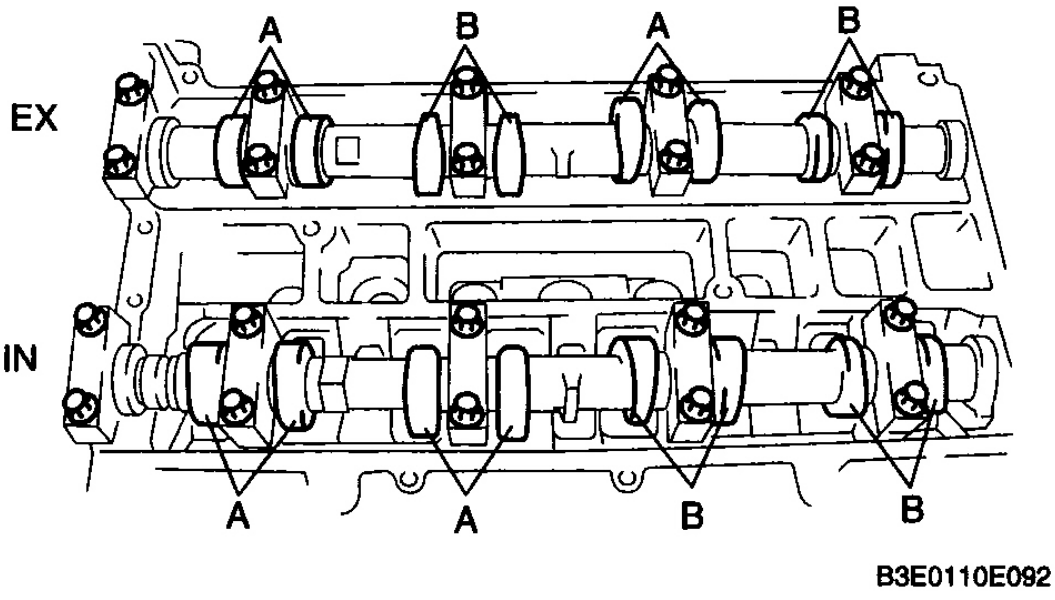

Fig. 62: Measuring Valve Clearance At Point A
Courtesy of MAZDA MOTORS CORP.

NOTE:
- **Make sure to note the measured values for choosing the suitable replacement tappets.**

Valve clearance [Engine cold]

IN: 0.22-0.28 mm {0.0087-0.0110 in}

EX: 0.27-0.33 mm {0.0106-0.0130 in}

3. Turn the crankshaft **360°** clockwise so that the No.4 piston is at TDC of the compression stroke.
4. Measure the valve clearance at B in the figure.
   - If the valve clearance exceeds the standard, replace the tappet. (See **VALVE CLEARANCE ADJUSTMENT**).

NOTE:
- **Make sure to note the measured values for choosing the suitable replacement tappets.**

Valve clearance [Engine cold]

IN: 0.22-0.28 mm {0.0087-0.0110 in}

EX: 0.27-0.33 mm {0.0106-0.0130 in}

VALVE CLEARANCE ADJUSTMENT

1. Remove the engine front cover lower blind plug.
2. Remove the engine front cover upper blind plug.
3. Remove the cylinder block lower blind plug.
4. Install the SST as shown in the figure.

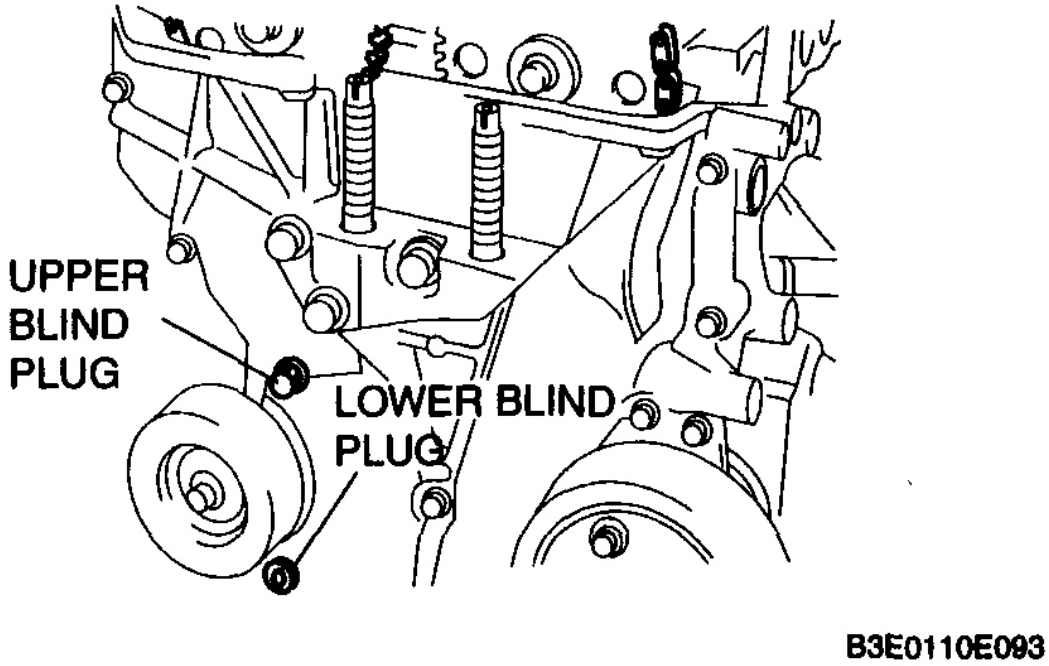

Fig. 63: Locating Engine Front Cover Upper & Lower Blind Plug
Courtesy of MAZDA MOTORS CORP.

CAUTION:
- **Removal of this SST is extremely important. If you crank the engine with this SST installed, the cylinder block will be damaged.**

5. Turn the crankshaft clockwise so that the crankshaft is in the No. 1 cylinder TDC position.

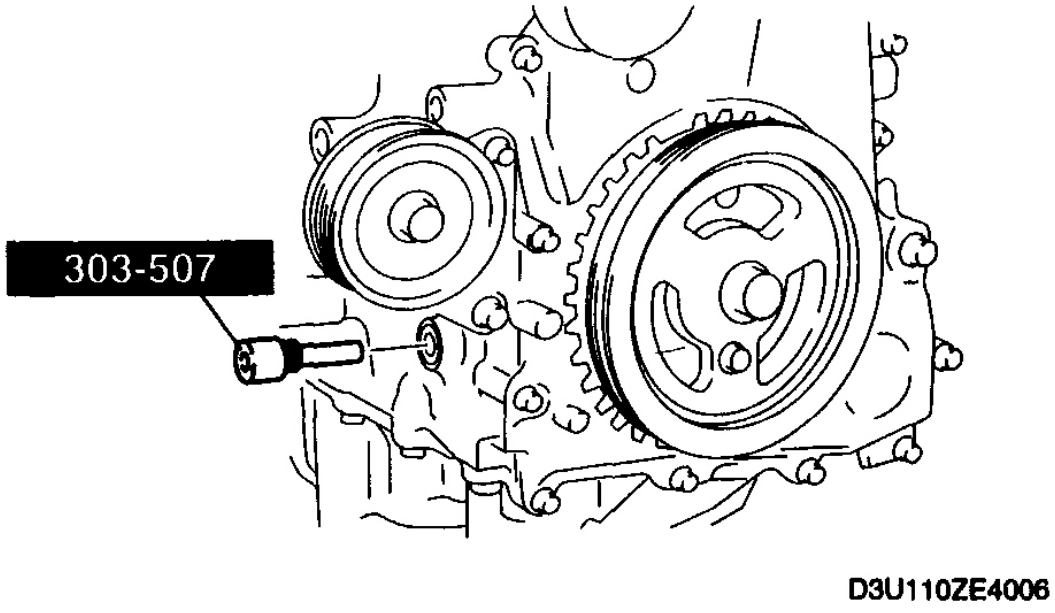

Fig. 64: Locating Cylinder Block SST
Courtesy of MAZDA MOTORS CORP.

6. Loosen the timing chain.
    1. Using a suitable screwdriver or equivalent tool, unlock the chain tensioner ratchet.
    2. Turn the exhaust camshaft clockwise using a suitable wrench on the cast hexagon and loosen the timing chain.
    3. Placing the suitable bolt **(M6 x 1.0 Length 25-35 mm {0.9-1.3 in})** at the engine front cover upper blind plug, secure the chain guide at the position where the tension is released.

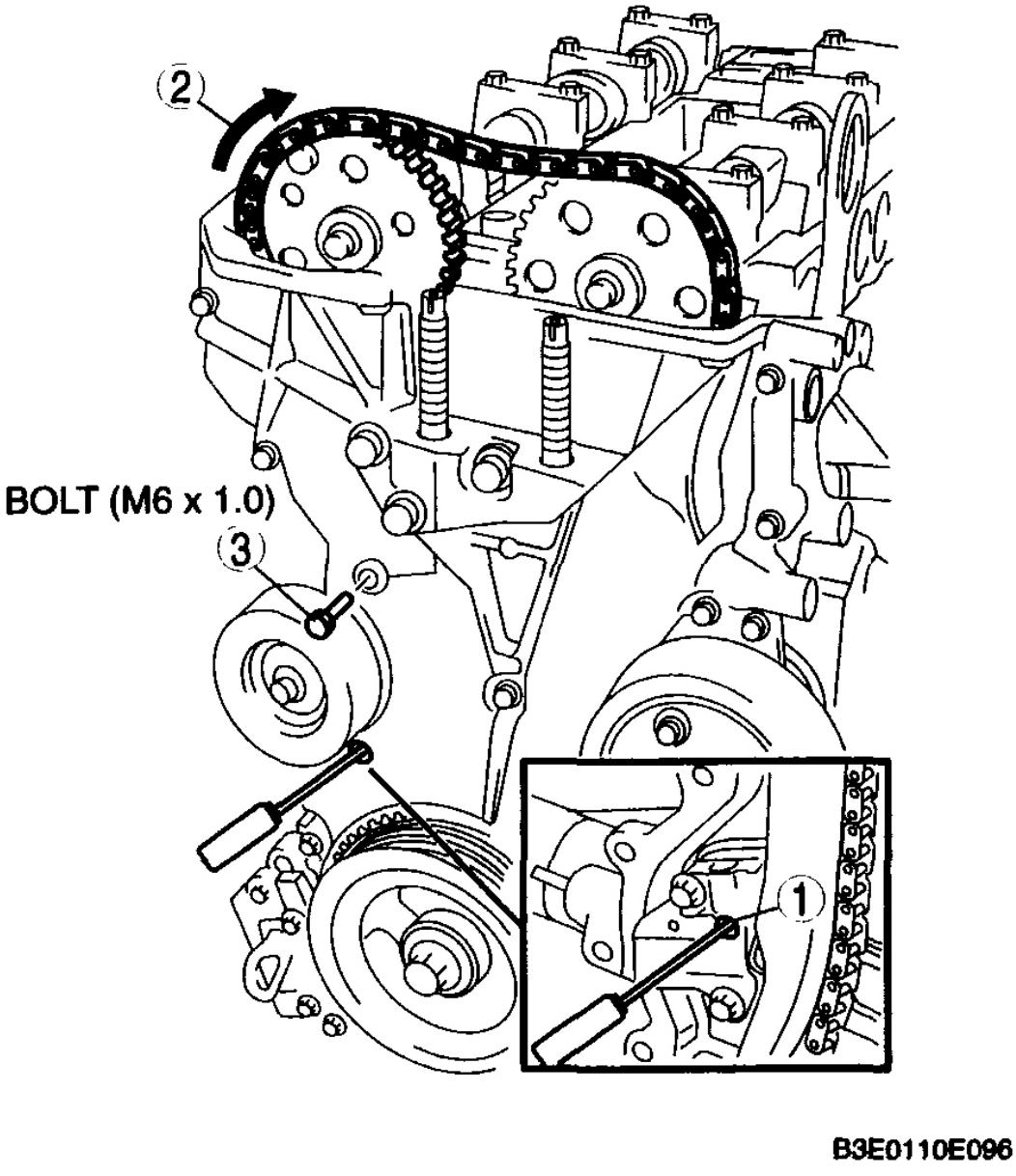

Fig. 65: Loosening Timing Chain
Courtesy of MAZDA MOTORS CORP.

7. Hold the exhaust camshaft using a suitable wrench on the cast hexagon as shown in the figure.

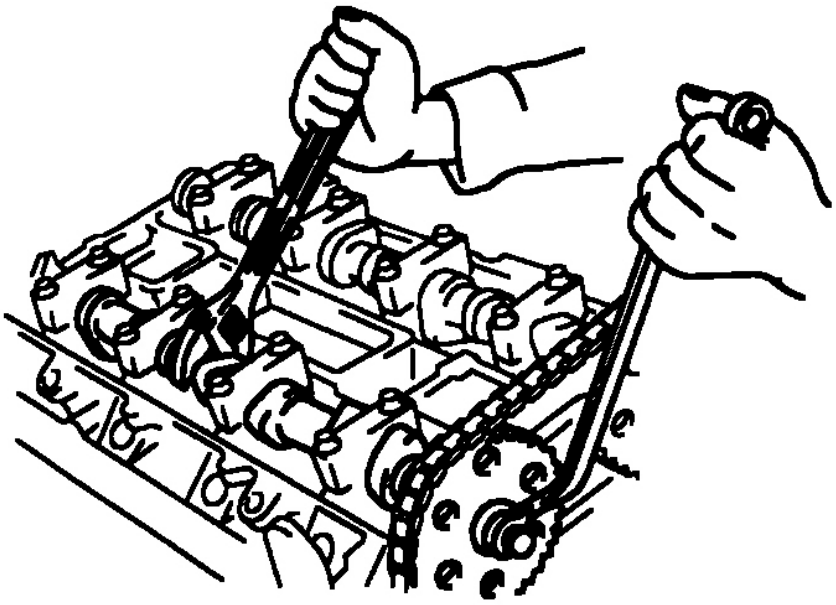

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Fig. 66: Holding Camshaft Using Suitable Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

8. Remove the exhaust camshaft sprocket.

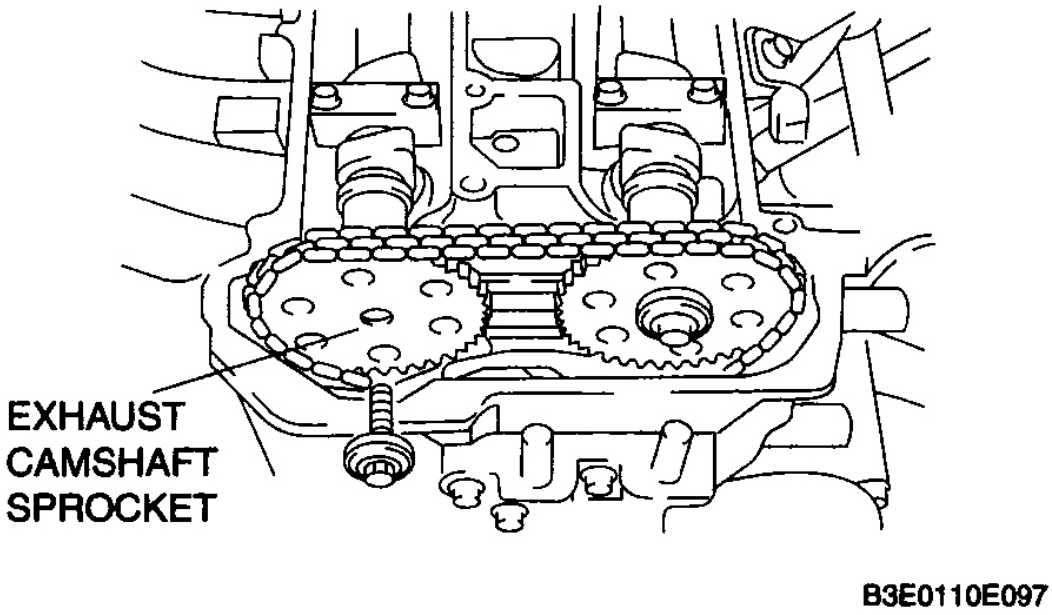

Fig. 67: Removing Exhaust Camshaft Sprocket
Courtesy of MAZDA MOTORS CORP.

9. Loosen the camshaft cap bolts in several passes in the order shown in the figure.

NOTE:

- **The cylinder head and the camshaft caps are numbered to make sure they are reassembled in their original position. When removed, keep the caps with the cylinder head they were removed from. Do not mix the caps.**

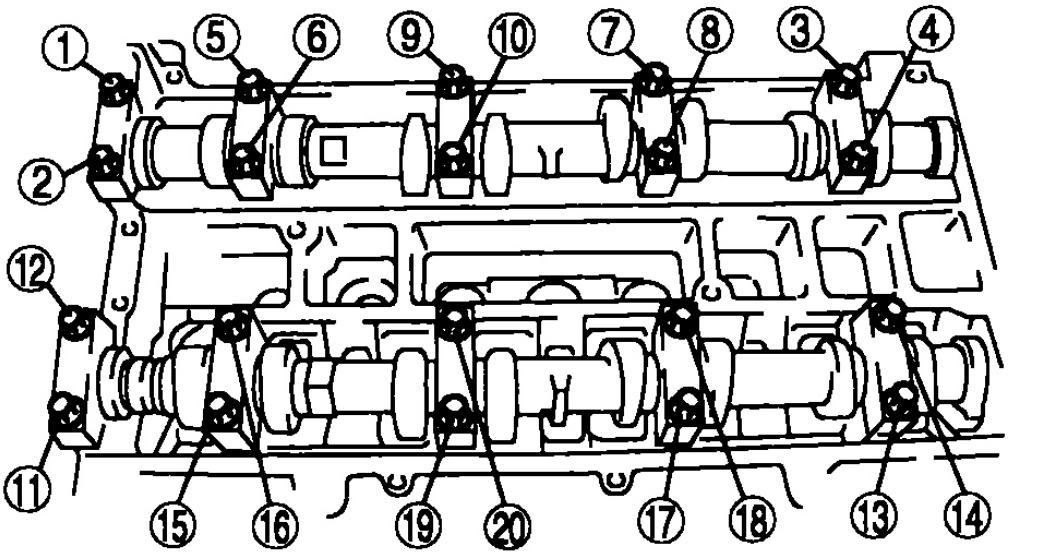

Fig. 68: Identifying Loosening Sequence Of Camshaft Cap Bolts
Courtesy of MAZDA MOTORS CORP.

10. Remove the camshaft.
11. Remove the tappet.
12. Select proper adjustment shim.

    New adjustment shim

    = Removed shim thickness + Measured valve clearance - Standard valve clearance (IN: 0.25 mm {0.0098 in}, EX: 0.30 mm {0.0118 in})

    Valve clearance [Engine cold]

    IN: 0.22-0.28 mm {0.0087-0.0110 in}

    EX: 0.27-0.33 mm {0.0106-0.0130 in}

13. Install the camshaft with No. 1 cylinder aligned with the TDC position.
14. Tighten the camshaft cap bolt using the following two steps.

    Tightening torque

    1. **5.0-9.0 N.m**

{51.0-91.7 kgf.cm, 44.3-79.5 in.lbf}

2. **14.0-17.0 N.m**

   {1.43-1.73 kgf.m, 10.4-12.5 ft.lbf}

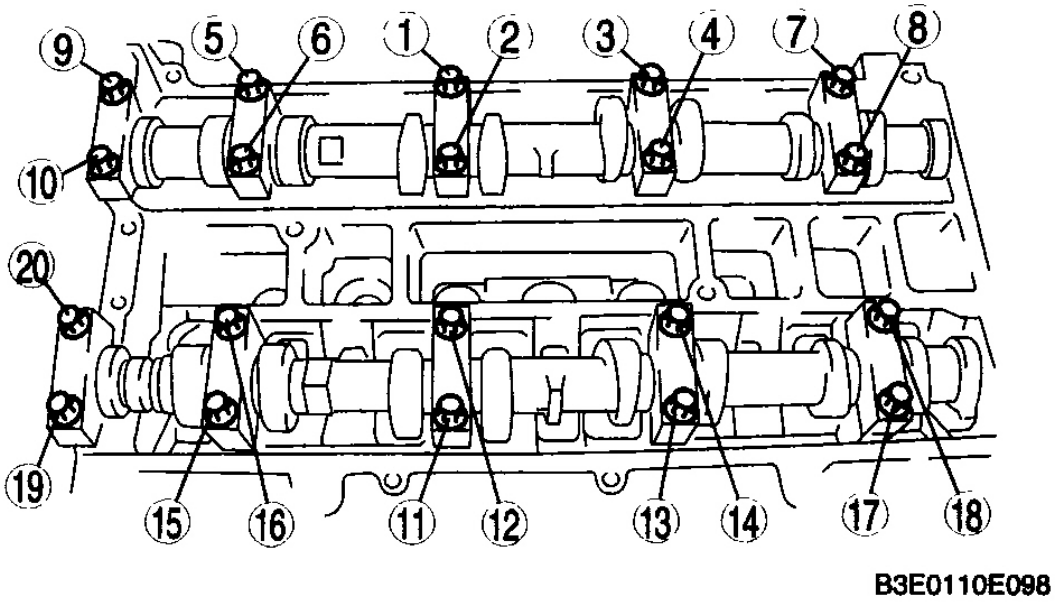

Fig. 69: Camshaft Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

15. Install a new washer (except for Mazda6).

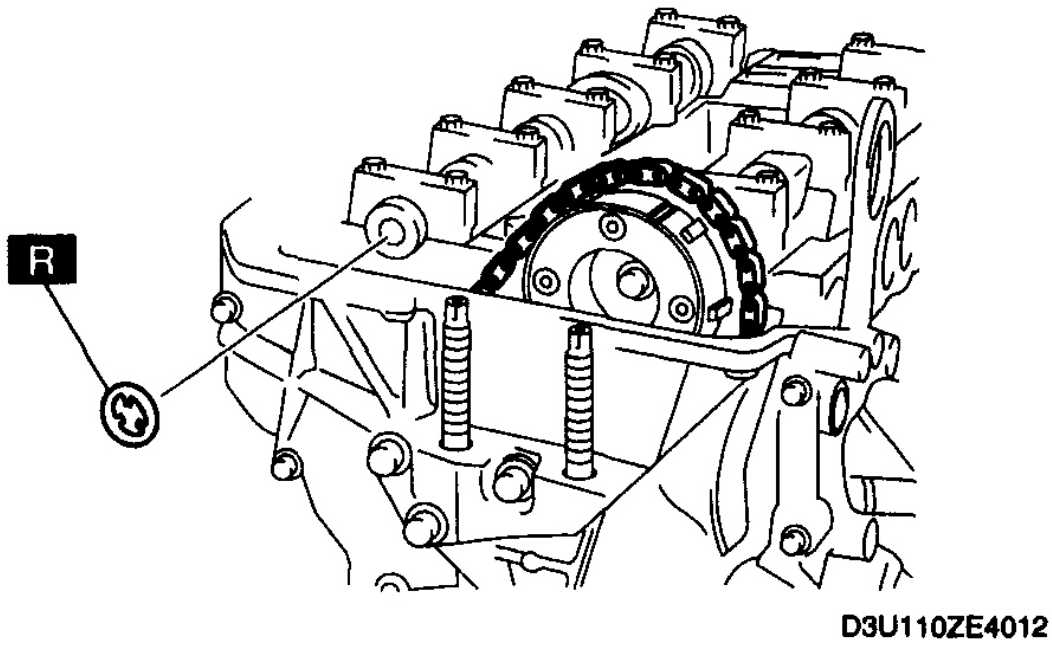

Fig. 70: Camshaft Sprocket Washer
Courtesy of MAZDA MOTORS CORP.

16. Install the exhaust camshaft sprocket.

NOTE:

- **Do not tighten the bolt for the camshaft sprocket during this step. First confirm the valve timing, then tighten the bolt.**

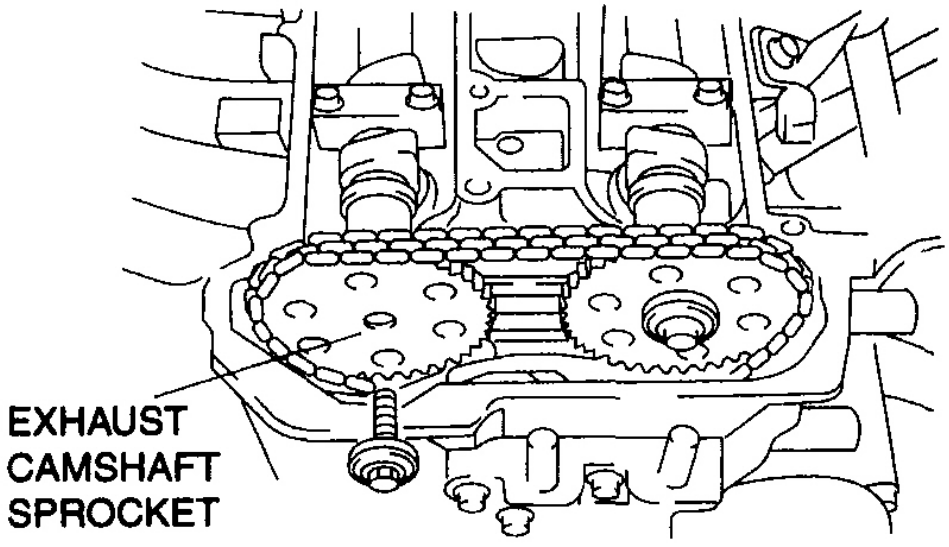

Fig. 71: Exhaust Camshaft Sprocket
Courtesy of MAZDA MOTORS CORP.

17. Install the **SST** to the camshaft as shown in the figure.
18. Remove the M6 x 1.0 bolt from the engine front cover to apply tension to the timing chain.
19. Turn the crankshaft clockwise so that the crankshaft is in the No. 1 cylinder TDC position.

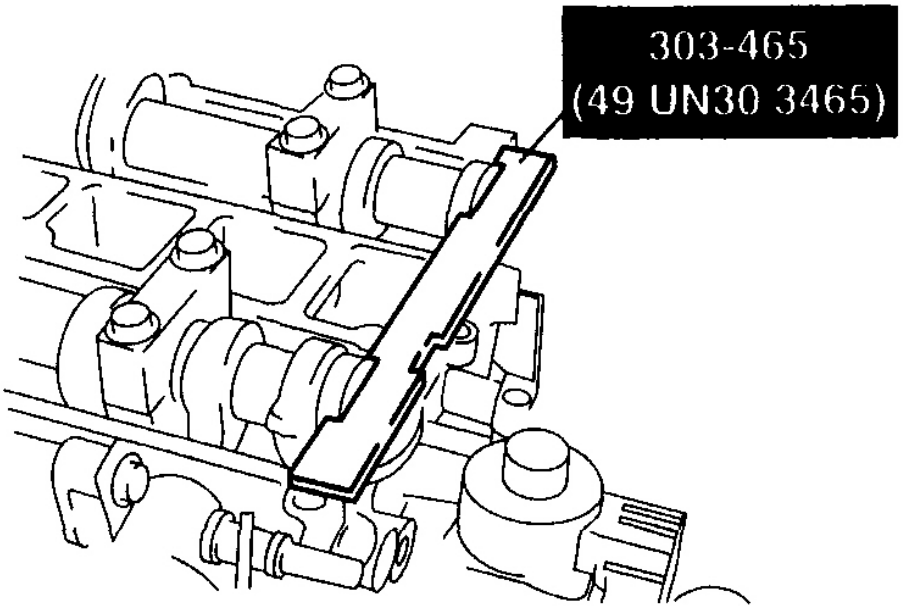

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Fig. 72: Installing SST To Camshaft
Courtesy of MAZDA MOTORS CORP.

20. Hold the exhaust camshaft using a suitable wrench on the cast hexagon as shown in the figure.
21. Tighten the exhaust camshaft sprocket lock bolt.

Tightening torque

69-75 N.m {7.1-7.6 kgf.m, 50.9-55.3 ft.lbf}

22. Remove the **SST** from the camshaft.
23. Remove the **SST** from the block lower blind plug.
24. Rotate the crankshaft clockwise two turns until the TDC position.
    - If not aligned, loosen the camshaft sprocket lock bolt and repeat from Step 17.

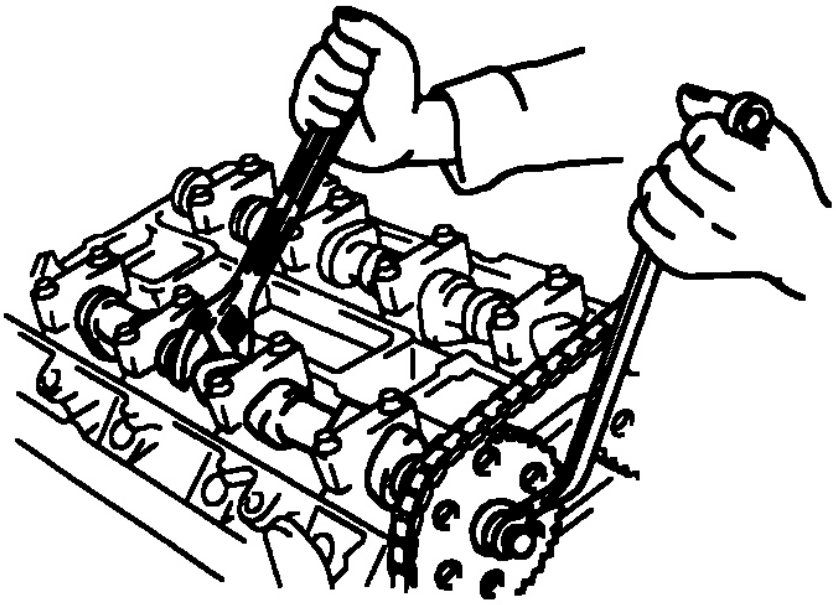

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Fig. 73: Holding Camshaft Using Suitable Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

25. Install the new engine front cover upper blind plug.

Tightening torque

8.0-11.5 N.m {82-117 kgf.cm, 71-101 in.lbf}

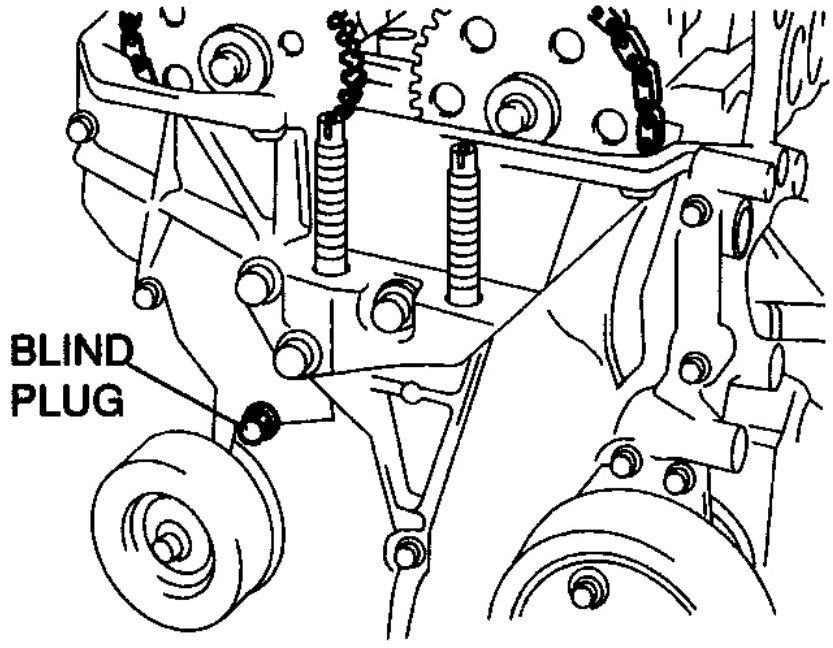


Fig. 74: Installing Engine Front Cover Upper Blind Plug
Courtesy of MAZDA MOTORS CORP.

26. Install the cylinder block lower blind plug.

Tightening torque

18-22 N.m {1.9-2.2 kgf.m, 13.3-16.2 ft.lbf}

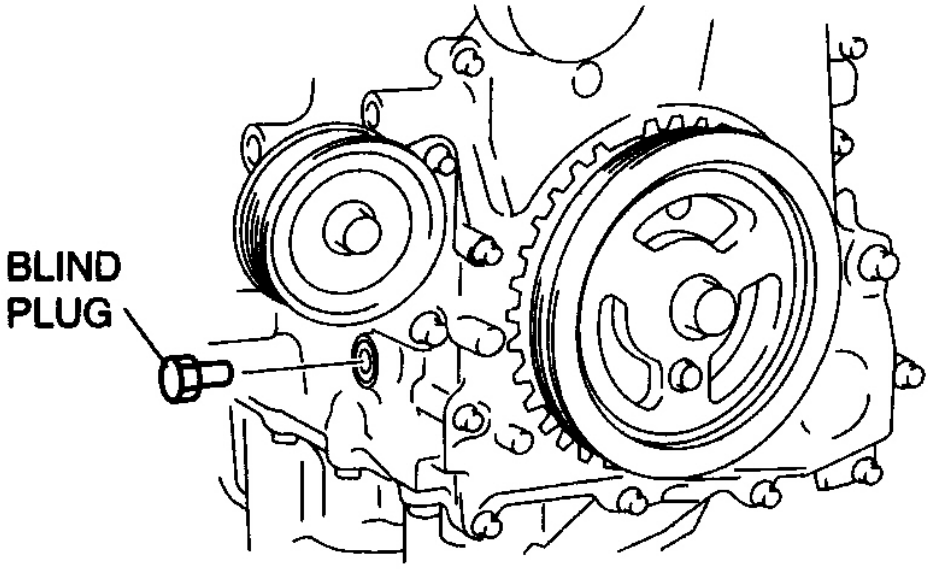


Fig. 75: Installing Cylinder Block Lower Blind Plug
Courtesy of MAZDA MOTORS CORP.

27. Install the new engine front cover lower blind plug.

Tightening torque

10-14 N.m {102-142 kgf.cm, 89-123 in.lbf}

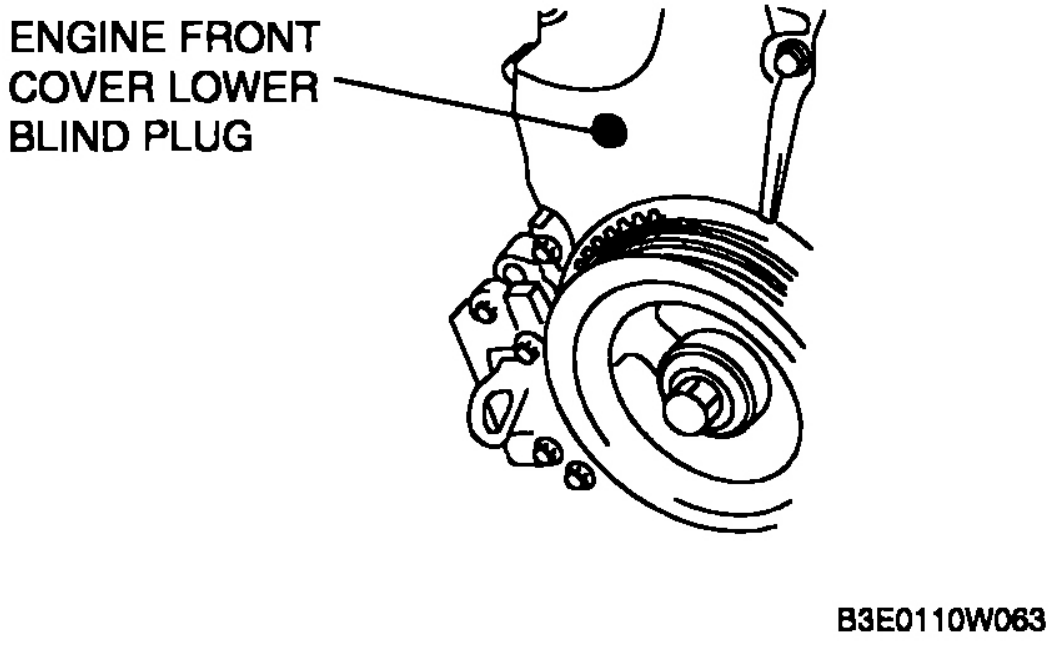
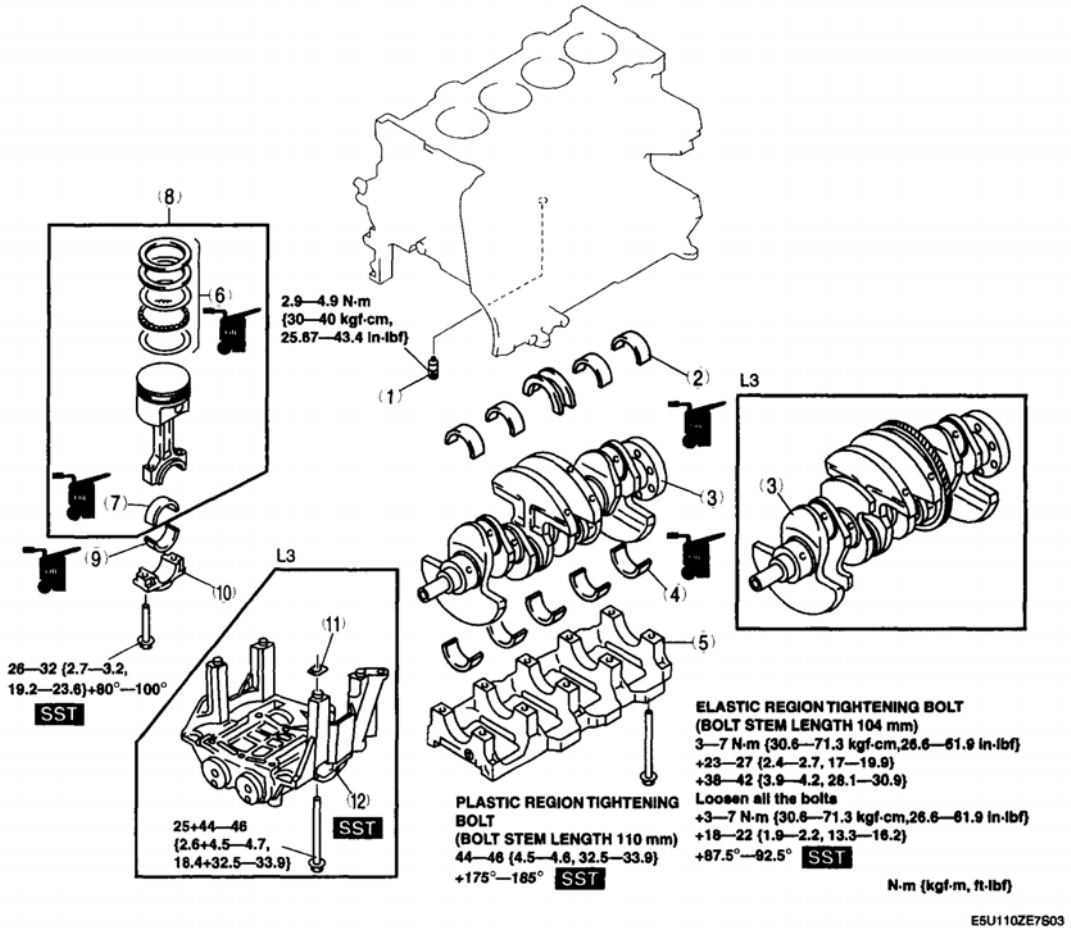


Fig. 76: Identifying Engine Front Cover Lower Blind Plug
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (I) ASSEMBLY

1. Assemble in the order indicated in the table.



1	Oil jet valve
2	Upper main bearing, thrust bearing
3	Crankshaft
4	Lower main bearing, thrust bearing
5	Main bearing cap
6	Piston ring
7	Upper connecting rod bearing

8	Connecting rod, piston assembly
9	Lower connecting rod bearing
10	Connecting rod cap
11	Adjustment shim
12	Balancer unit

Fig. 77: Exploded View Of Cylinder Block (I) Assembly & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Main Bearing Cap Assembly Note

1. Install the main bearing caps in the order indicated in the figure.
2. Tighten the main bearing cap bolts using the **SST (49 D032 316).**

Tightening torque

Plastic region tightening bolt (Bolt stem length 110 mm)

1. **44-46 N.m {4.5-4.6 kgf.m, 32.5-33.9 ft.lbf}**
2. **175°-185°**

Elastic region tightening bolt (Bolt stem length 104 mm)

1. **Apply engine oil to all bolts.**
2. **3-7 N.m {30.6-71.3 kgf.cm, 26.6-61.9 in.lbf}**
3. **23-27 N.m {2.4-2.7 kgf.m, 17-19.9 ft.lbt}**
4. **38-42 N.m {3.9-4.2 kgf.m, 28.1-30.9 ft.lbt}**
5. **Loosen all the bolts. (no remaining torque).**
6. **3-7 N.m {30.6-71.3 kgf.cm, 26.6-61.9 in.lbt}**
7. **18-22 N.m {1.9-2.2 kgf.m, 13.3-16.2 ft.lbt}**
8. **87.5°-92.5°**

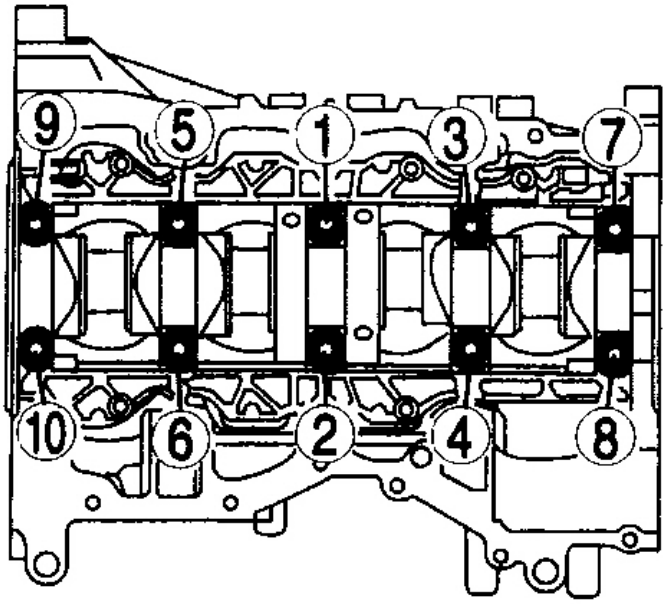


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Fig. 78: Tightening Sequence Of Main Bearing Cap Bolts
Courtesy of MAZDA MOTORS CORP.

Piston Ring Assembly Note

1. Install the two oil control ring segments and spacer.
2. Verify that the second ring is installed with scraper face side downward.
3. Verify that the top ring is installed with scraper face side inner of upper.

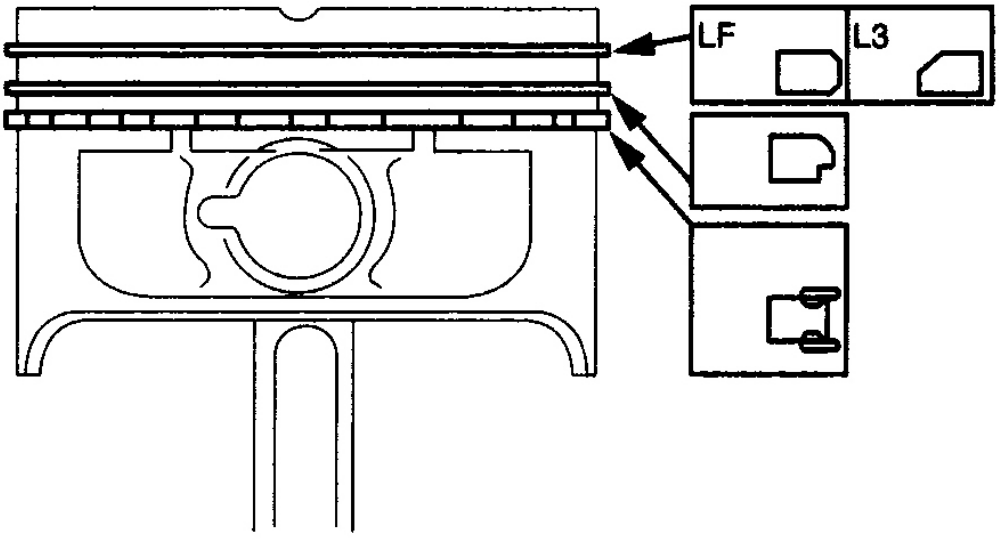

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Fig. 79: Identifying Piston Rings
Courtesy of MAZDA MOTORS CORP.

Piston Assembly Note

1. Position the end gap of each ring as indicated in the figure.

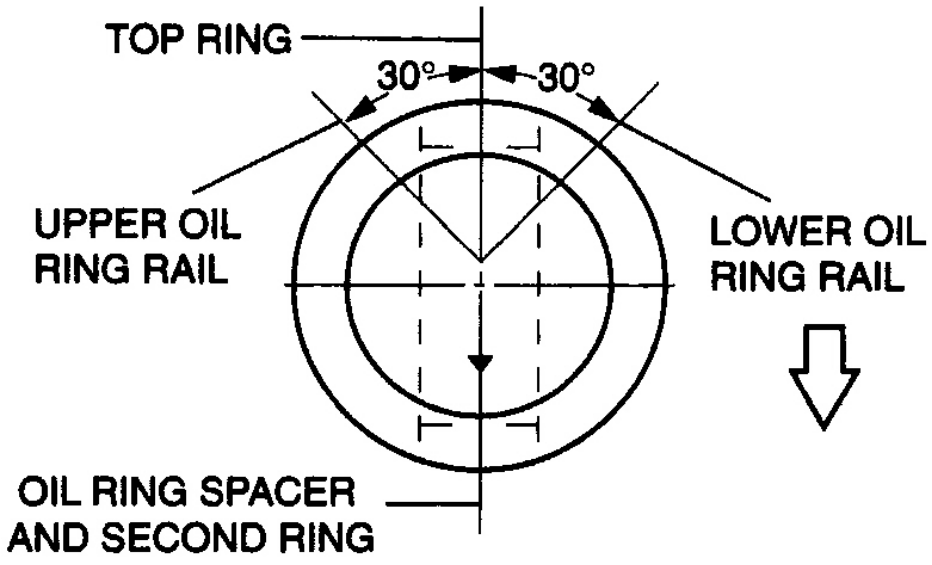

Fig. 80: Positioning End Gap Of Each Ring
Courtesy of MAZDA MOTORS CORP.

2. Insert the piston and connecting rod into the cylinder with the arrow mark to front of the engine.

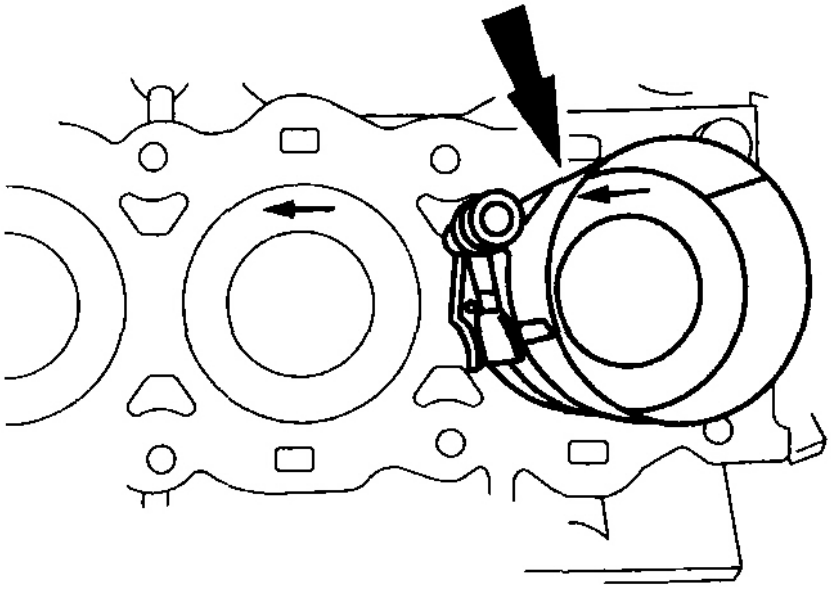

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Fig. 81: Inserting Piston And Connecting Rod Into Cylinder Bore
Courtesy of MAZDA MOTORS CORP.

Connecting Rod Bearing Assembly Note

1. Install the connecting rod bearing to the connecting rod and connecting rod caps, as shown in the figure.

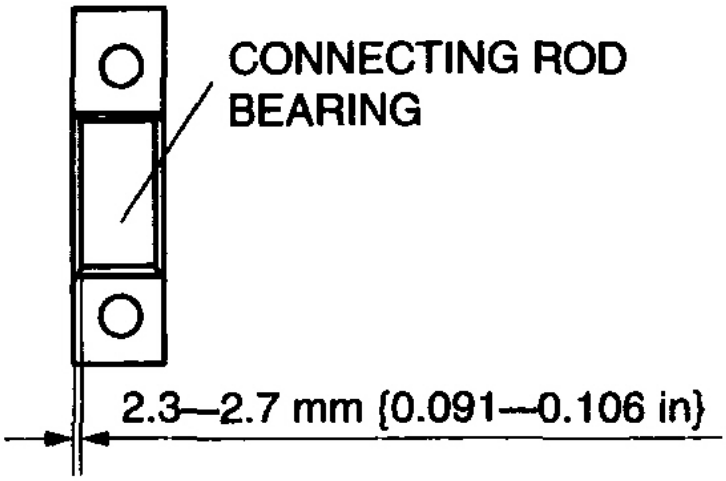

Fig. 82: Installing Connecting Rod Bearing
Courtesy of MAZDA MOTORS CORP.

Connecting Rod Cap Assembly Note

CAUTION:
- **When assembling the connecting rod caps, align the broken, rough faces of the connecting rods and connecting rod caps.**

1. Tighten the connecting rod bolts in two steps using the **SST (49 D032 316).**

   Tightening torque

   1. **26-32 N.m**

      {2.7-3.2 kgf.m, 19.2-23.6 ft.lbf}

   2. **80°-100°**

Balancer Unit Assembly Note

1. Confirm by visual inspection that there is no damage to the balancer unit gear and verify that the shaft turns smoothly.
   - If there is any damage or malfunction, replace the balancer unit.

CAUTION:
- **Due to the precision interior construction of the balancer unit, it cannot be disassembled.**

2. Install the **SST** as shown in the figure.

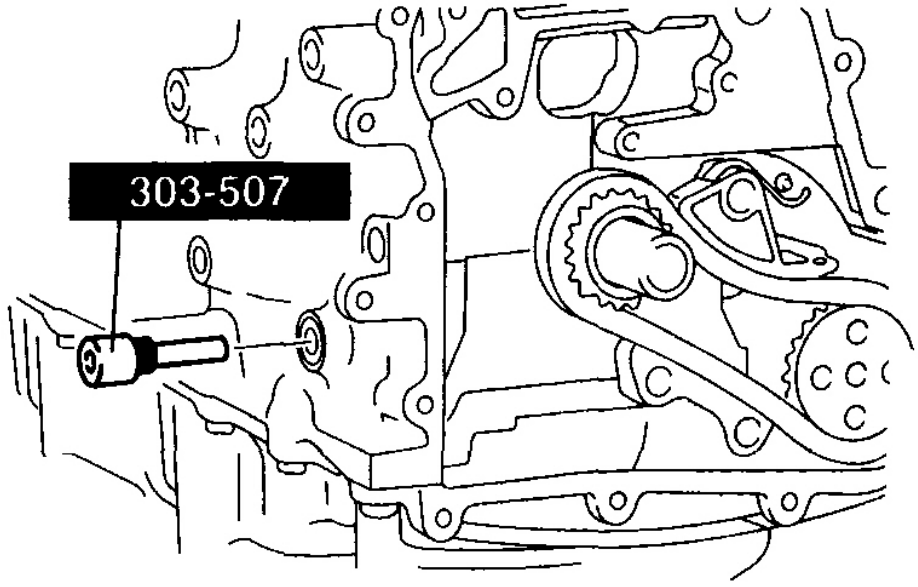

Fig. 83: Attaching SST To Balancer
Courtesy of MAZDA MOTORS CORP.

3. Turn the crankshaft clockwise the crankshaft is in the No. 1 cylinder TDC position (until the balance weight is attached to the **SST**).
4. Install the adjustment shim to the seat face of the balancer unit.
5. With the balancer unit marks at the exact top center, assemble the unit to the cylinder block.

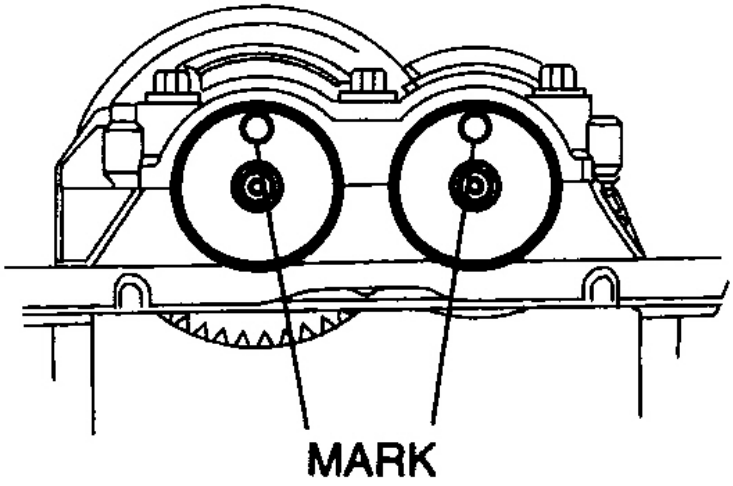

Fig. 84: Identifying Marks At Exact Top Center
Courtesy of MAZDA MOTORS CORP.

6. Set the **SST** as shown, then measure the gear backlash using a dial gauge.

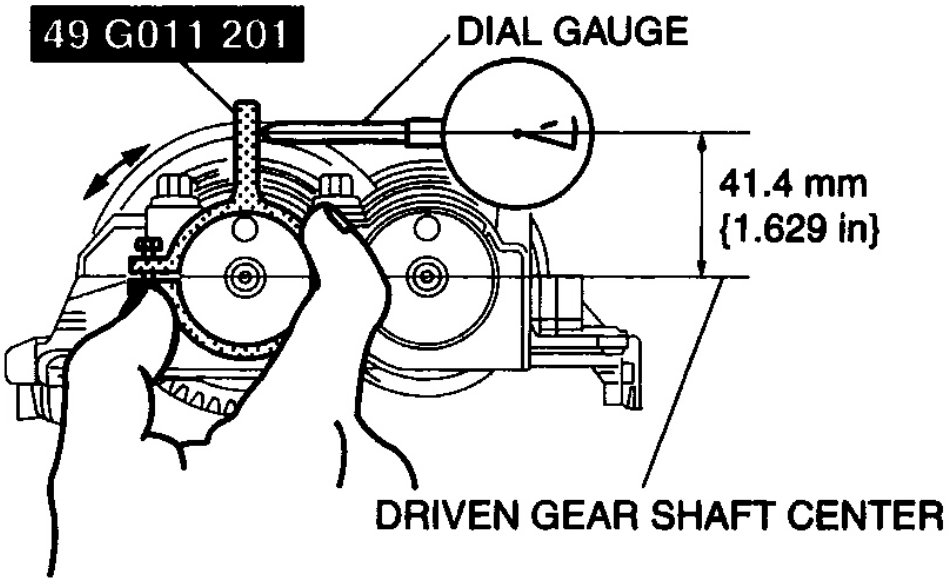

Fig. 85: Measuring Gear Backlash Using Dial Gauge
Courtesy of MAZDA MOTORS CORP.

NOTE:

- **For an accurate measurement of gear backlash, insert a screwdriver into the crankshaft No. 1 balance weight area and set both the rotation and the thrust direction with the screwdriver, using a prying action, as shown in the figure.**

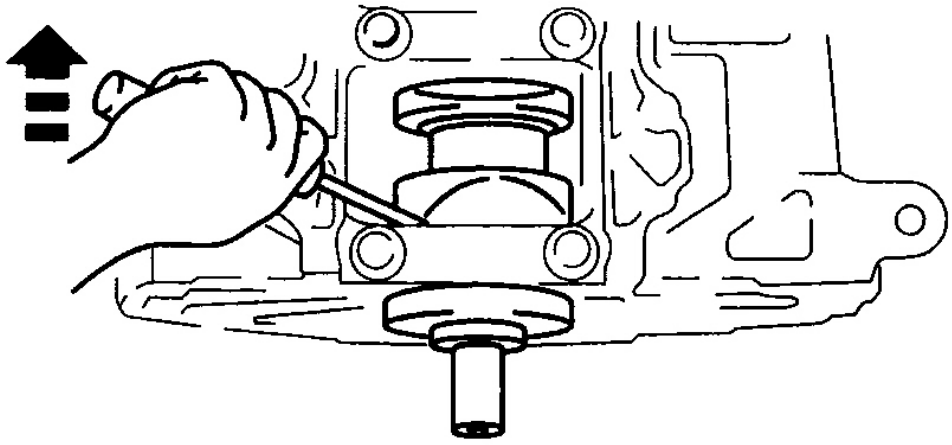

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Fig. 86: Measuring Gear Backlash
Courtesy of MAZDA MOTORS CORP.

- **If the backlash exceeds the specified range, remeasure the backlash and, using the adjustment shim selection table, select the proper shim, according to the following procedure.**

CAUTION:
- **When measuring the backlash, rotate the crankshaft one full rotation and verify that it is within the specified range at all of the following six positions: 10°, 30°, 100°, 190°, 210°, 280° ATDC.**

Value range

0.005-0.101 mm {0.00019-0.0039 in}

1. Using master adjustment shim (No.50), assemble the balancer unit to the cylinder block, then measure the backlash.
2. Select the proper adjustment shim according to the measured value.
3. Install the selected adjustment shim to the balancer unit, then assemble the balancer unit to the cylinder block.

Adjustment shim selection table

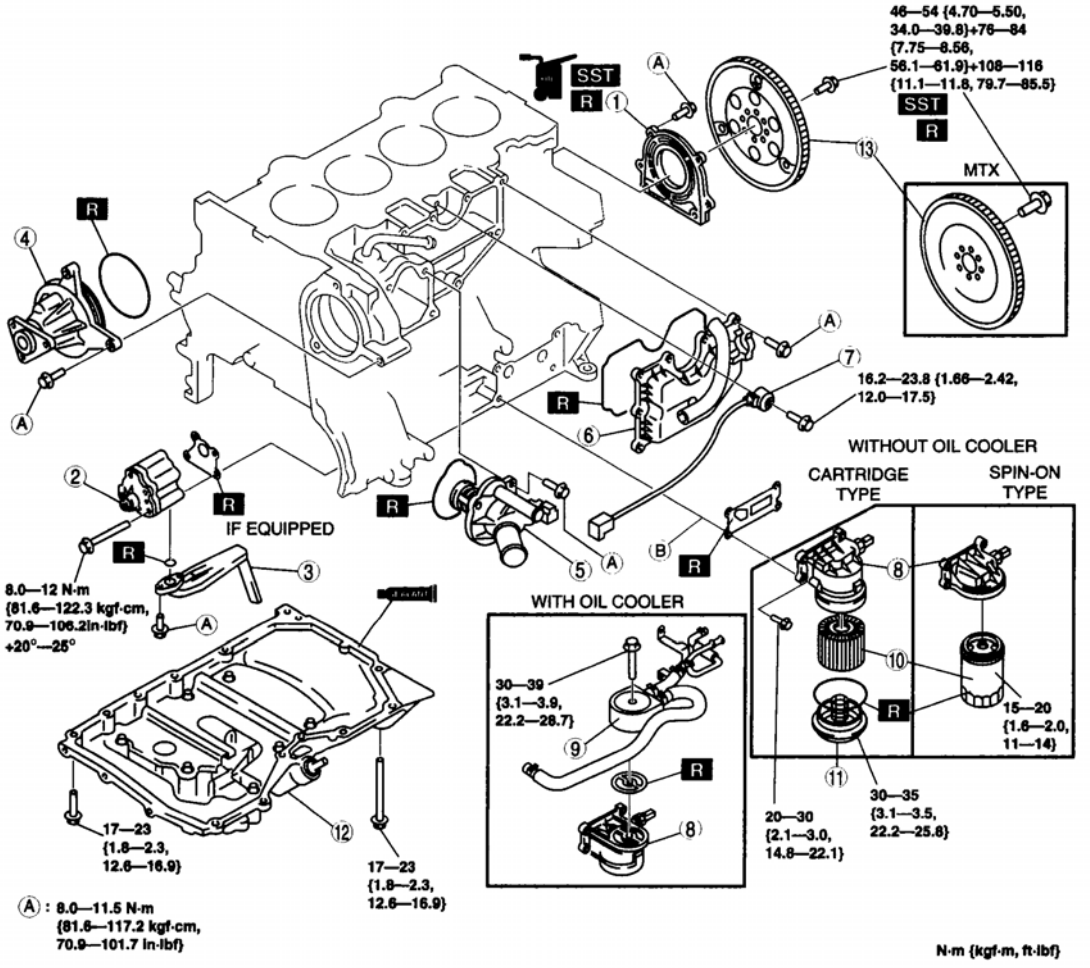
ADJUSTMENT SHIM SELECTION CHART

Backlash mm {in}	Selection shim (No).	Shim thickness mm {in}	Backlash mm {in}	Selection shim (No).	Shim thickness mm {in}
0.267-0.273 {0.01051-0.01074}	15	1.15 {0.0452}	0.127-0.133 {0.00500-0.00523}	35	1.35 {0.0531}
0.260-0.266 {0.01023-0.01047}	16	1.16 {0.0456}	0.120-0.126 {0.00472-0.00496}	36	1.36 {0.0535}
0.253-0.259 {0.00996-0.01019}	17	1.17 {0.0460}	0.113-0.119 {0.00444-0.00468}	37	1.37 {0.0539}
0.246-0.252 {0.00968-0.00992}	18	1.18 {0.0464}	0.106-0.112 {0.00417-0.00440}	38	1.38{0.0543}
0.239-0.245 {0.00940-0.00964}	19	1.19 {0.0468}	0.099-0.105 {0.00389-0.00413}	39	1.39 {0.0547}
0.232-0.238 {0.00913-0.00937}	20	1.20 {0.0472}	0.092-0.098 .087 {0.00362-0.00385}	40	1.40 {0.0551}
0.225-0.231 {0.00885-0.00909}	21	1.21 {0.0476}	0.085-0.091 {0.00334-0.00358}	41	1.41 {0.0555}
0.218-0.224 {0.00858-0.00881}	22	1.22 {0.0480}	0.078-0.084 {0.00307-0.00330}	42	1.42 {0.0559}
0.211-0.217 {0.00830-0.00854}	23	1.23 {0.0484}	0.071-0.077 {0.00279-0.00303}	43	1.43 {0.0562}
0.204-0.210 {0.00803-0.00826}	24	1.24 {0.0488}	0.064-0.070 {0.00251-0.00275}	44	1.44 {0.0566}
0.197-0.203 {0.00775-0.00799}	25	1.25 {0.492}	0.057-0.063 {0.00224-0.00248}	45	1.45 {0.0570}
0.190-0.196 {0.00748-0.00771}	26	1.26 {0.496}	0.050-0.056 {0.00196-0.00220}	46	1.46 {0.0574}
0.183-0.189 {0.00720-0.00744}	27	1.27 {0.499}	0.043-0.049 {0.00169-0.00192}	47	1.47 {0.0578}
0.176-0.182 {0.00692-0.00716}	28	1.28 {0.503}	0.036-0.042 {0.00141-0.00165}	48	1.48 {0.0582}

0.169-0.175 {0.00665-0.00688}	29	1.29 {0.507}	0.029-0.035 {0.00114-0.00137}	49	1.49 {0.0586}
0.162-0.168 {0.00637-0.00661}	30	1.30 {0.511}	0.022-0.028 {0.000866-0.00110}	50 (master)	1.50 {0.0590}
0.155-0.161 {0.00610-0.00633}	31	1.31 {0.515}	0.015-0.021 {0.00059-0.000826}	51	1.51 {0.0594}
0.148-0.154 {0.00582-0.00606}	32	1.32 {0.519}	0.008-0.014 {0.000314-0.000551}	52	1.52 {0.0598}
0.141-0.147 {0.00555-0.00578}	33	1.33 {0.523}	0.001-0.007 {0.00003-0.000275}	53	1.53 {0.0602}
0.134-0.140 {0.00527-0.00551}	34	1.34 {0.527}	0.000-0.000 {0.000-0.000}	54	1.54 {0.0606}

CYLINDER BLOCK (II) ASSEMBLY

1. Assemble in the order indicated in the table.



1	Rear oil seal
2	Oil pump
3	Oil strainer
4	Water pump
5	Thermostat
6	Oil separator
7	Knock sensor

8	Oil filter adapter
9	Oil cooler
10	Oil filter
11	Oil filter cover (cartridge type)
12	Oil pan
13	Flywheel (MTX), Drive plate (ATX)

Fig. 87: Exploded View Of Cylinder Block (II) Assembly & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Rear Oil Seal Assembly Note

1. Apply clean engine oil to the new oil seal lip.
2. Install the rear oil seal using the **SST** as shown in the figure.

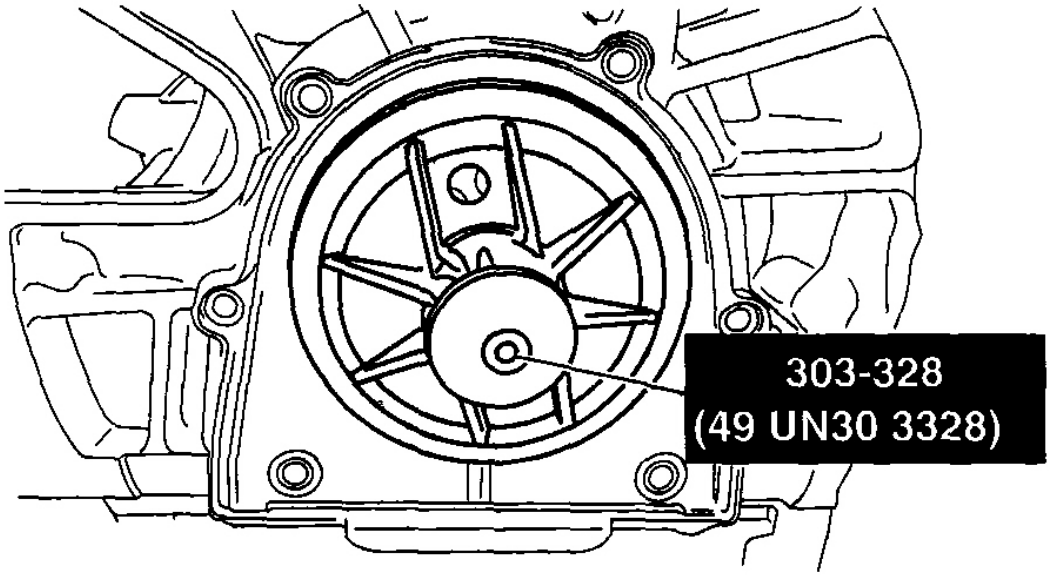


Fig. 88: Installing Rear Oil Seal Using SST
Courtesy of MAZDA MOTORS CORP.

3. Tighten the rear oil seal bolts in the order as shown in the figure.

Tightening torque

8.0-11.5 N.m

{81.6-117.2 kgf.cm, 70.9-101.7 in.lbf}

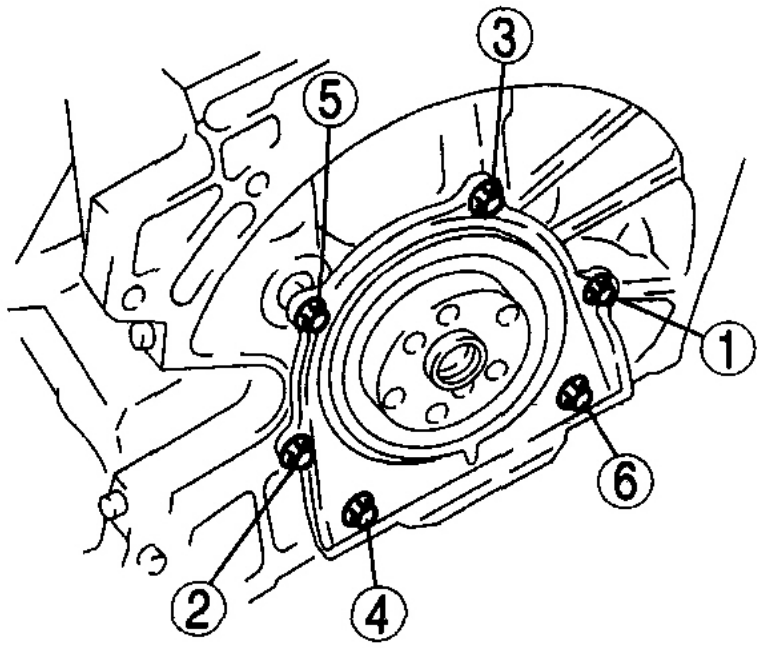


Fig. 89: Rear Oil Seal Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Drive Plate (ATX), Flywheel (MTX) Assembly Note

1. Hold the crankshaft using the **SST** .
2. Tighten the bolts in the 3 steps in the figure.

Tightening torque

1. **46-54 N.m**

   {4.70-5.50 kgf.m, 34.0-39.8 ft.lbf

2. **76-84 N.m**

   {7.75-8.56 kgf.m, 56.1-61.9 ft.lbf

3. **108-116 N.m**

   {11.1-11.8 kgf.m, 79.7-85.5 ft.lbf

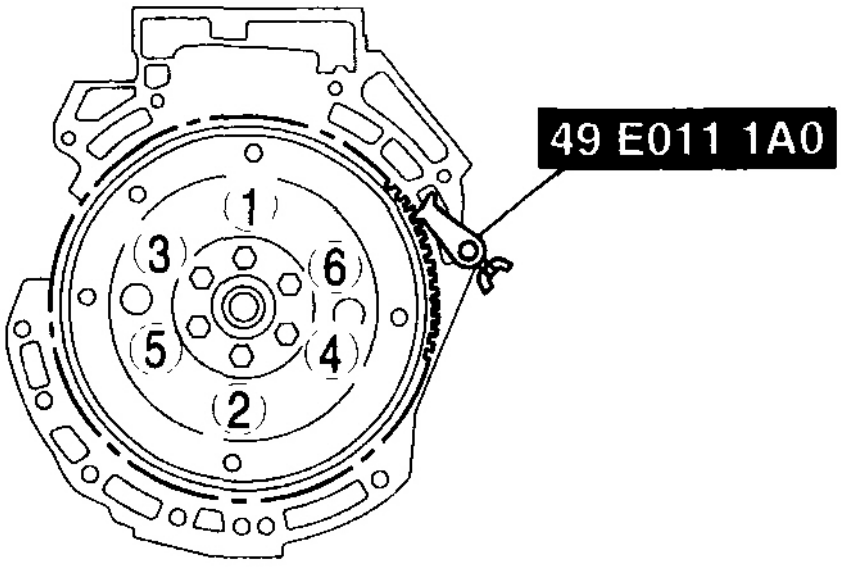


Fig. 90: Tightening Sequence Of Drive Plate Or Flywheel Bolts (Performed In 3 Steps)
Courtesy of MAZDA MOTORS CORP.

Oil pan Assembly Note

1. Apply a continuous bead of silicone sealant to the oil pan as indicated in the figure.

CAUTION:
- **Install the oil pan within 10min of applying the silicone sealant**
- **Make sure that there is no oil or dust on the seal side of oil pan.**

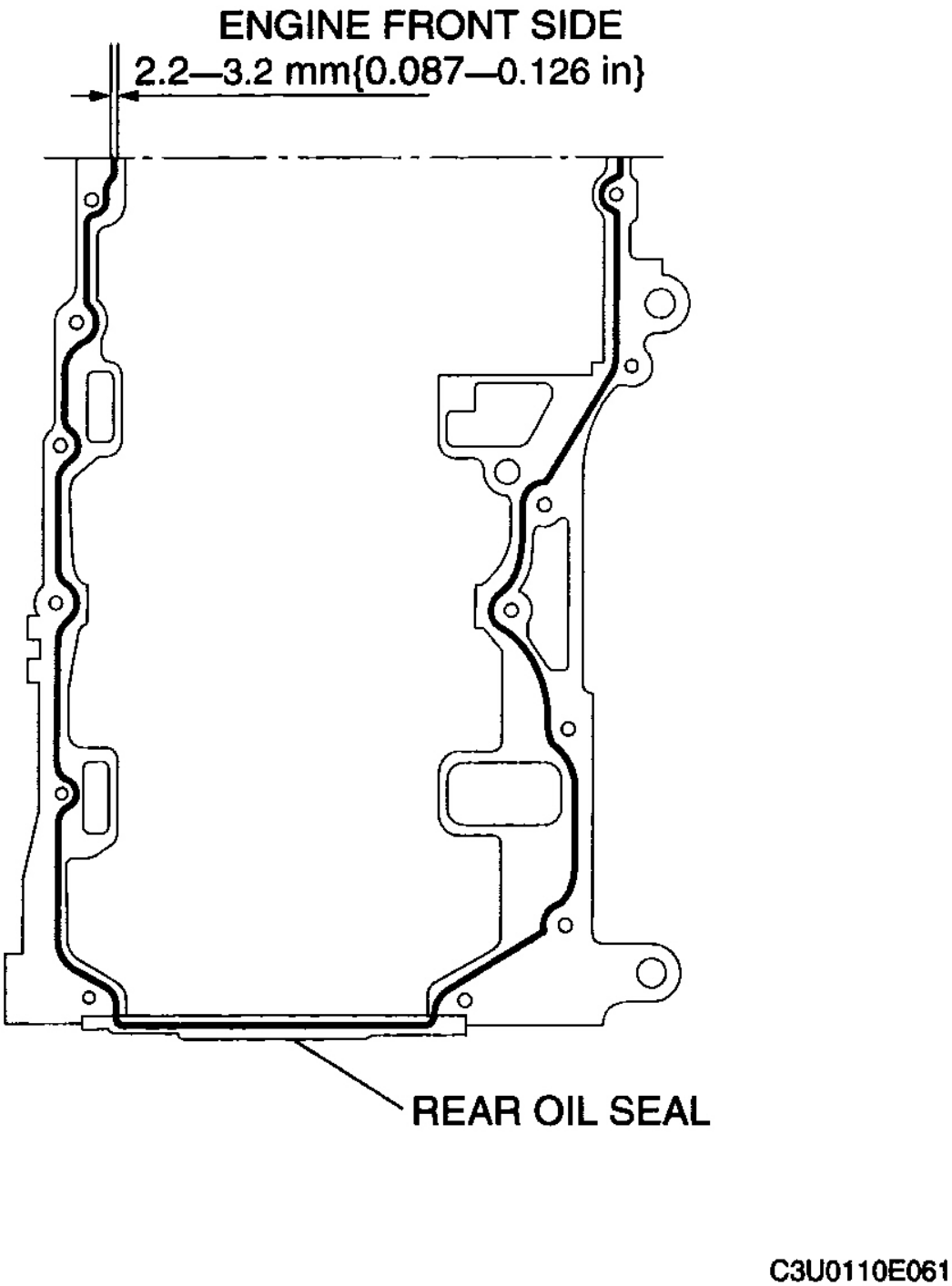


Fig. 91: Installing Silicone Sealant To Oil Pan
Courtesy of MAZDA MOTORS CORP.

2. Use a square ruler to unite the oil pan and the cylinder block junction side on the engine front cover side.

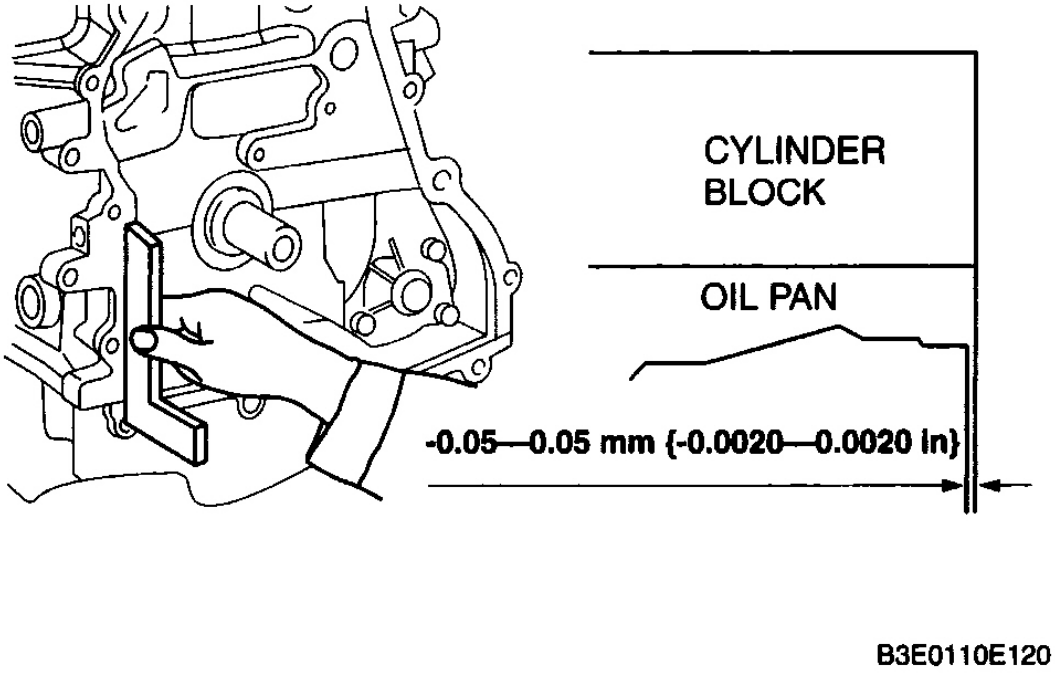


Fig. 92: Using Square Ruler To Align Oil Pan & Cylinder Block
Courtesy of MAZDA MOTORS CORP.

3. Tighten the rear oil pan bolts in the order as shown in the figure.

Tightening torque

17-23 N.m

{1.8-2.3 kgf.m, 12.6-16.9 ft.lbf}

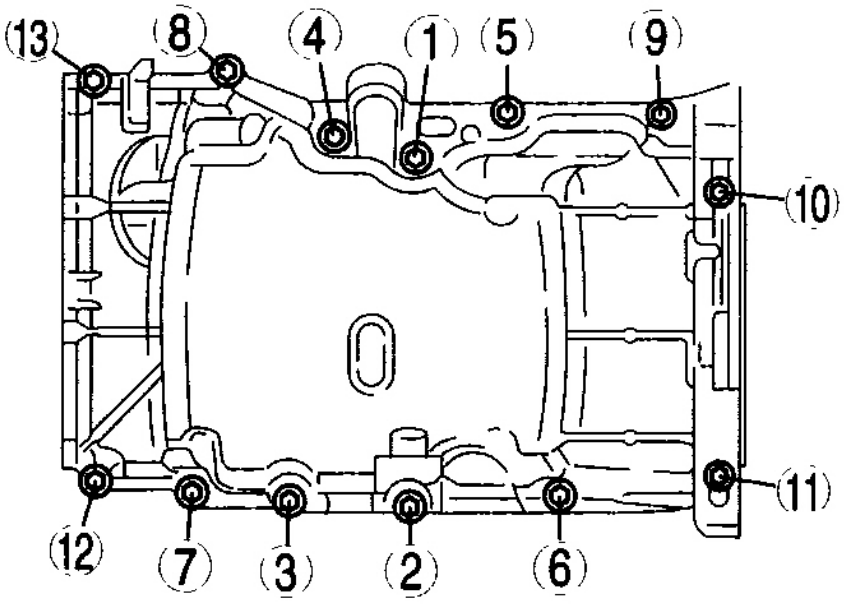


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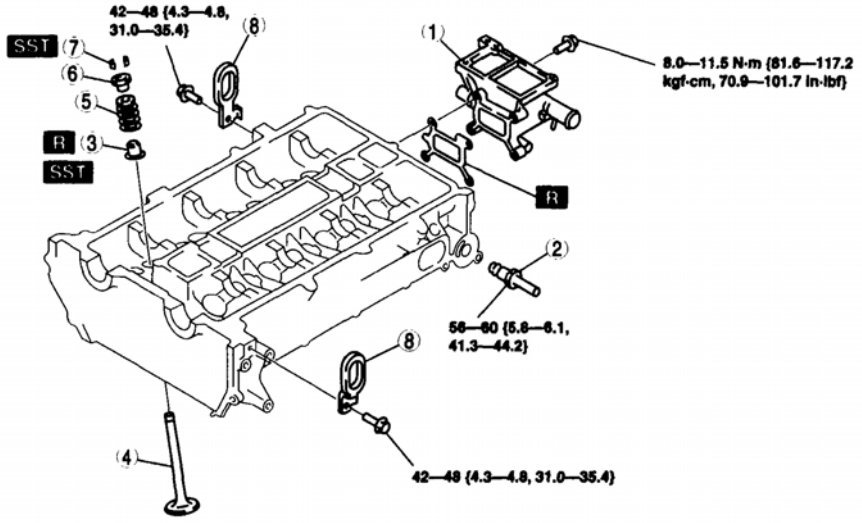
Fig. 93: Rear Oil Pan Bolts Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (I) ASSEMBLY

1. Assemble in the order indicated in the table.



1	Water outlet	5	Valve spring
2	EGR pipe	6	Upper valve spring seat
3	Valve seal	7	Valve keeper
4	Valve	8	Engine hanger

Fig. 94: Exploded View Of Cylinder Head (I) Assembly & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Valve Seal Assembly Note

1. Press the valve seal onto the valve guide by hand.
2. Lightly tap the **SST** using a plastic hammer.

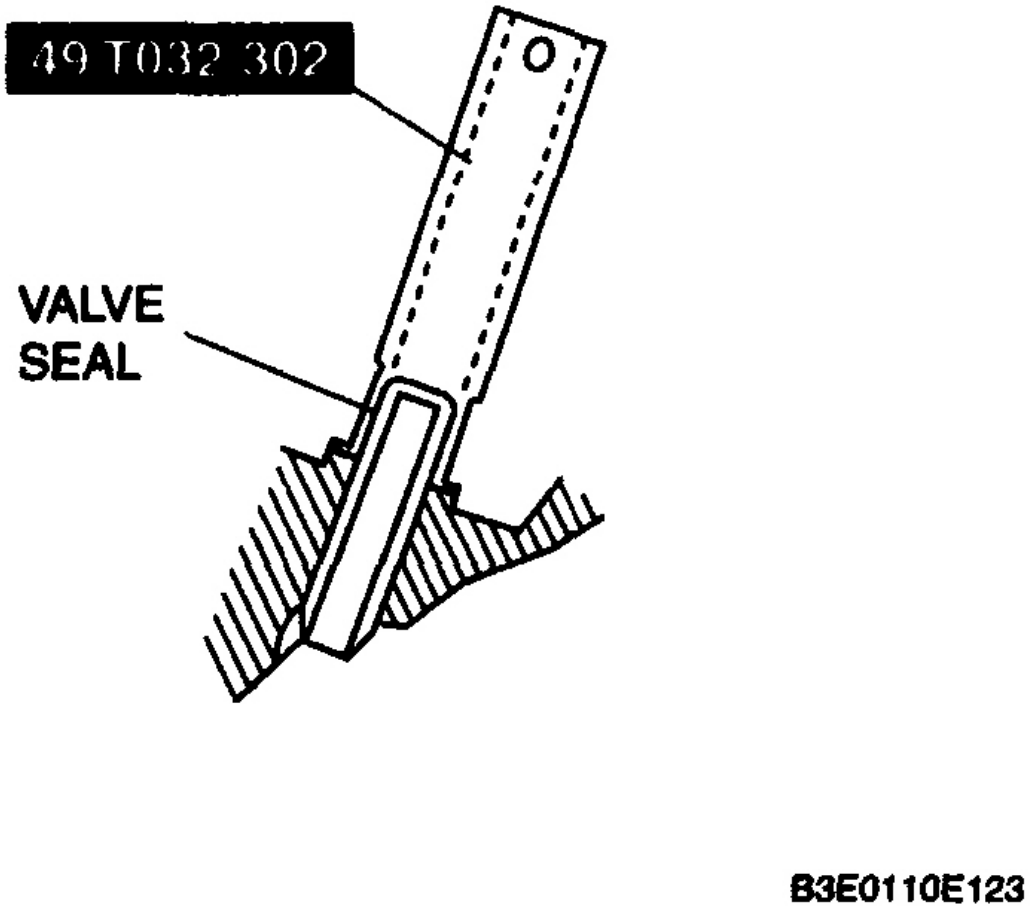


Fig. 95: Pressing Valve Seal
Courtesy of MAZDA MOTORS CORP.

Valve Keeper Assembly Note

1. Install the valve keeper using the **SSTs** .

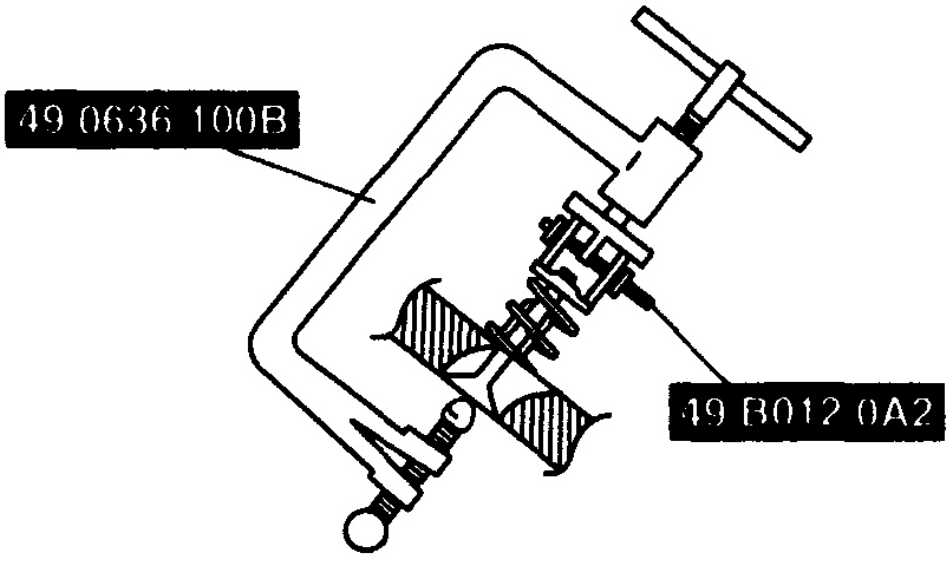
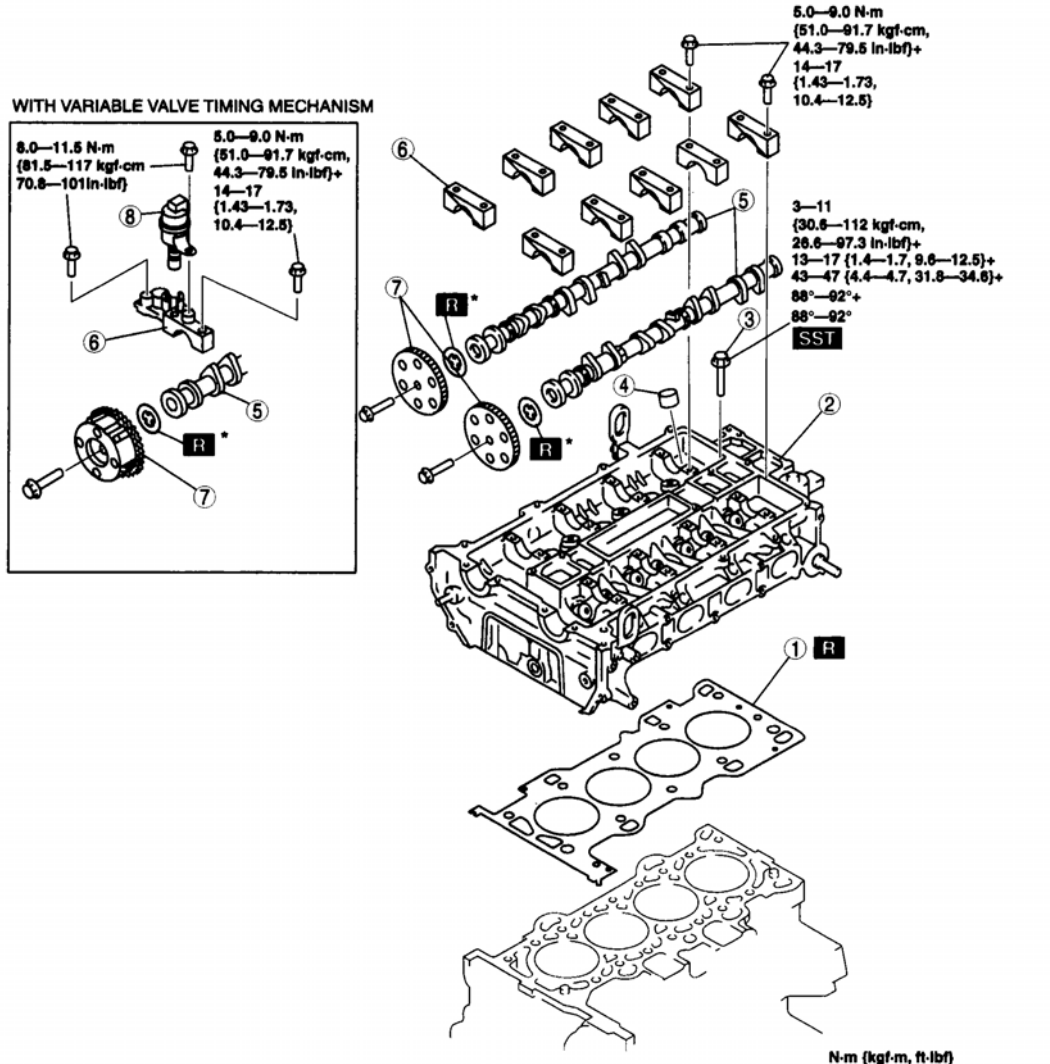


Fig. 96: Installing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (II) ASSEMBLY

1. Assemble in the order indicated in the table.



*:EXCEPT FOR MAZDA6 ARE EQUIPPED. IF WASHER IS NOT INSTALLED TO THE ENGINE, INSTALL A NEW WASHER.

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1	Cylinder head gasket
2	Cylinder head
3	Cylinder head bolt
4	Tappet
5	Camshaft

6	Camshaft cap
7	Camshaft sprocket, variable valve timing actuator
8	Oil control valve (OCV) (With variable valve timing mechanism)

Fig. 97: Exploded View Of Cylinder Head (II) Assembly & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Bolt Assembly Note

1. Tighten the cylinder head bolts in the order indicated in the figure in 5 steps using the **SST (49 D032 316).**

Tightening torque

1. **3-11 N.m**

   {30.6-112 kgf.cm, 26.6-97.3 in.lbf}

2. **13-17 N.m**

   {1.4-1.7 kgf.m, 9.6-12.5 ft.lbf}

3. **43-47 N.m**

   {4.4-4.7 kgf.m, 31.8-34.6 ft.lbf}

4. **88°-92°**
5. **88°-92°**

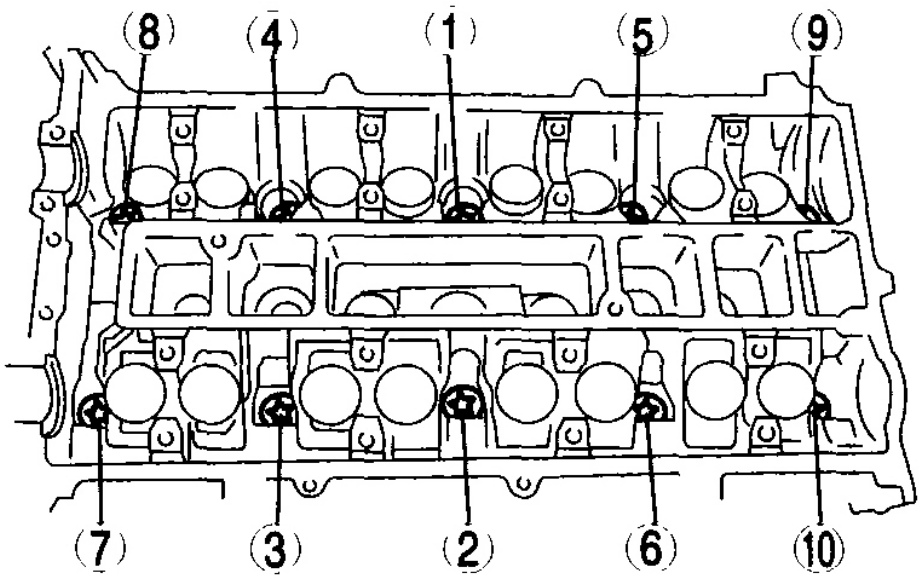


Fig. 98: Cylinder Head Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Camshaft Assembly Note

1. Set the cam position of No. 1 cylinder at the top dead center (TDC) and install the camshaft.
2. Temporarily tighten the camshaft bearing caps evenly in 2-3 steps.
3. Tighten the camshaft cap bolt in the order shown two steps.

Tightening torque

1. **5.0-9.0 N.m**

   {51.0-91.7 kgf.cm, 44.3-79.5 in.lbf}

2. **14-17 N.m**

   {1.43-1.73 kgf.m, 10.4-12.5 ft.lbf}

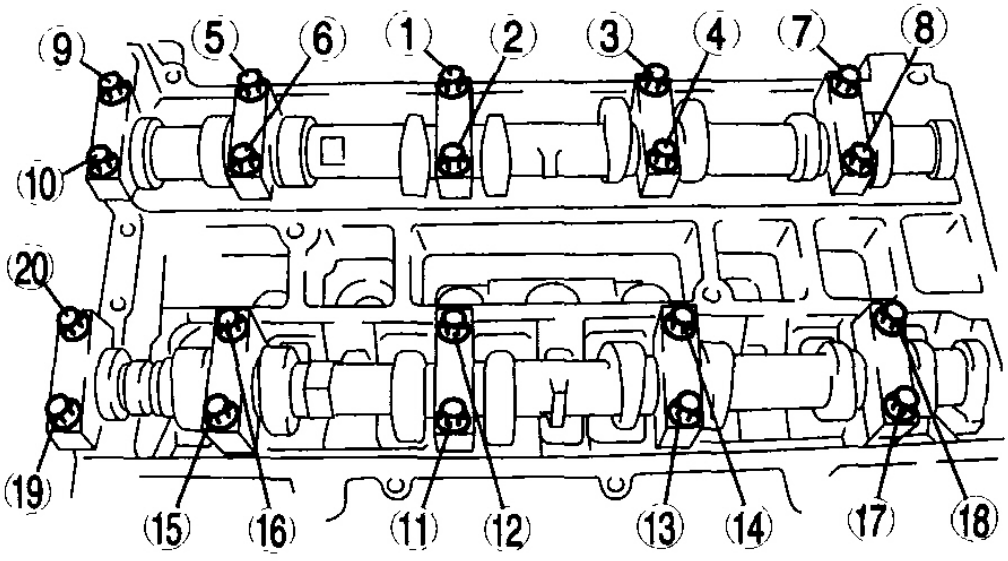


Fig. 99: Camshaft Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

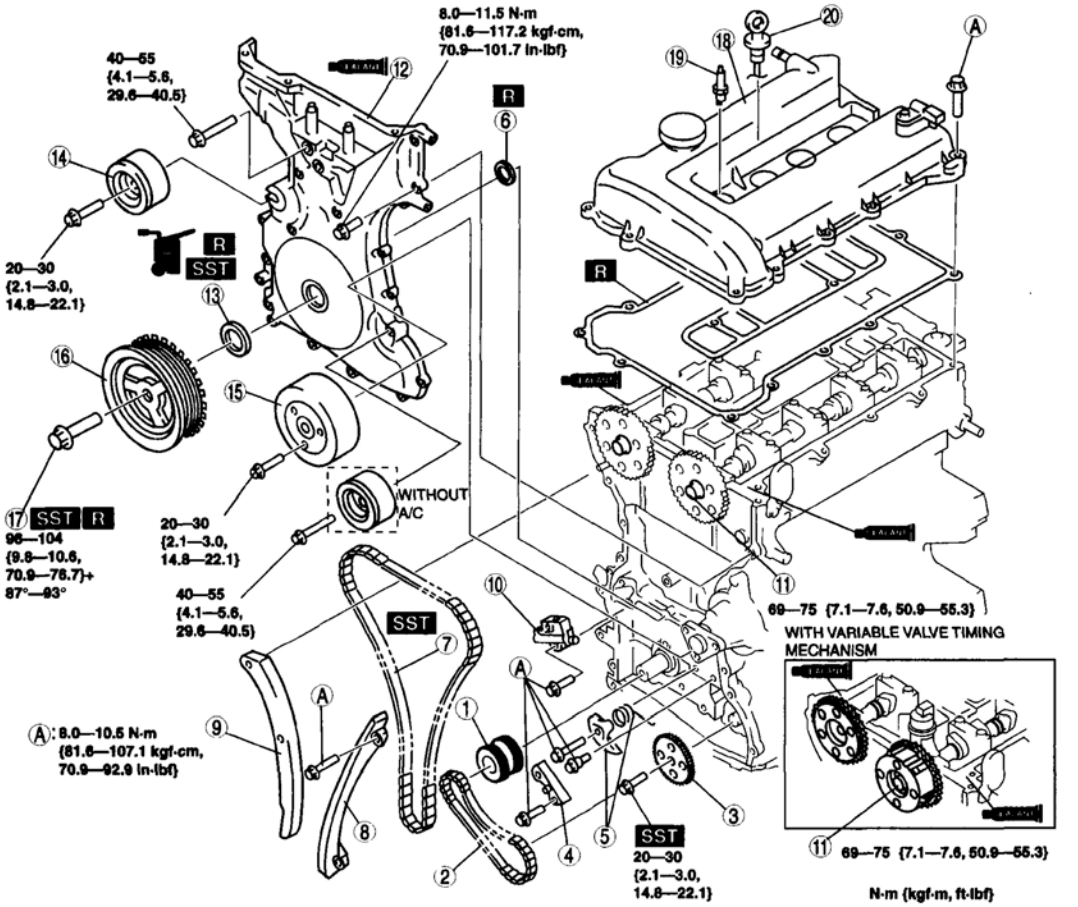
Camshaft Sprocket, Variable Valve Timing Actuator Assembly Note

1. Temporarily tighten the camshaft sprocket or variable valve timing actuator installation bolts by hand until the timing chain is installed.
2. Fully tighten the camshaft sprocket or variable valve timing actuator installation bolts after timing chain

installation.

TIMING CHAIN ASSEMBLY

1. Assemble in the order indicated in the table.



1	Crankshaft sprocket
2	Oil pump chain
3	Oil pump sprocket
4	Oil pump chain guide
5	Oil pump chain tensioner
6	Seal (With variable valve timing mechanism)
7	Timing chain
8	Chain guide
9	Tensioner arm
10	Chain tensioner
11	Camshaft sprocket, variable valve timing actuator

12	Engine front cover
13	Front oil seal
14	Drive belt idler pulley (Without stretch-type A/C drive belt)
15	Water pump pulley
16	Crankshaft pulley
17	Crankshaft pulley lock bolt
18	Cylinder head cover
19	Spark plug
20	Dipstick (if equipped)

Fig. 100: Exploded View Of Timing Chain Assembly & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Oil Pump Sprocket Assembly Note

1. Hold the oil pump sprocket using the **SST** .

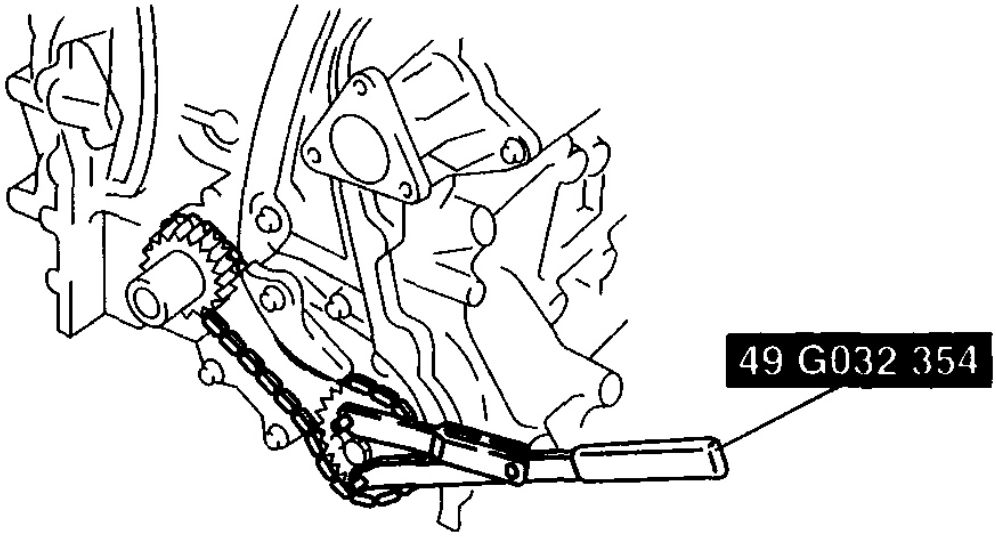


Fig. 101: Assembling Oil Pump Sprocket
Courtesy of MAZDA MOTORS CORP.

Timing Chain Assembly Note

1. Install the **SST** to the camshaft, then align the No. 1 camshaft position with the TDC.

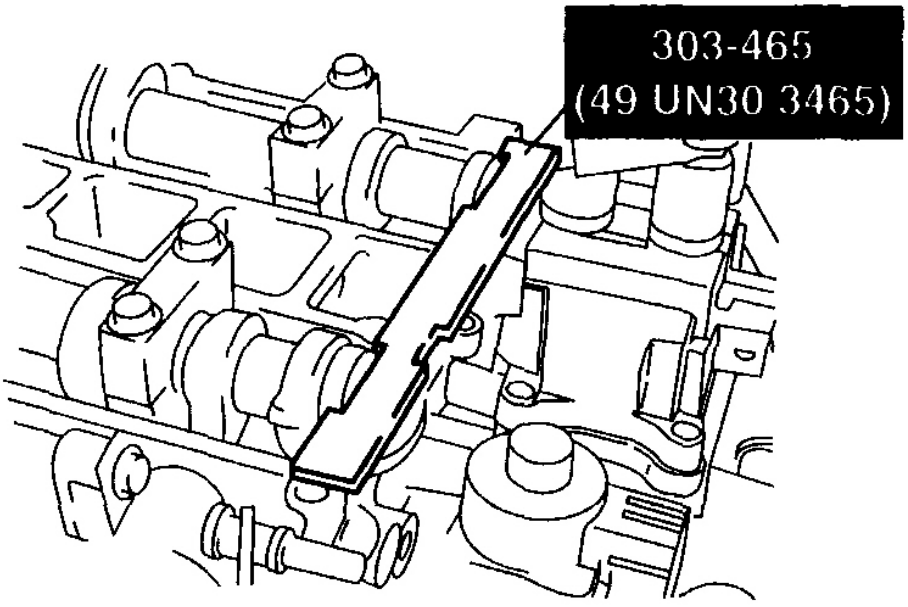


Fig. 102: Installing SST To Camshaft
Courtesy of MAZDA MOTORS CORP.

2. Remove the cylinder block lower blind plug.
3. Install the **SST** as shown in the figure.

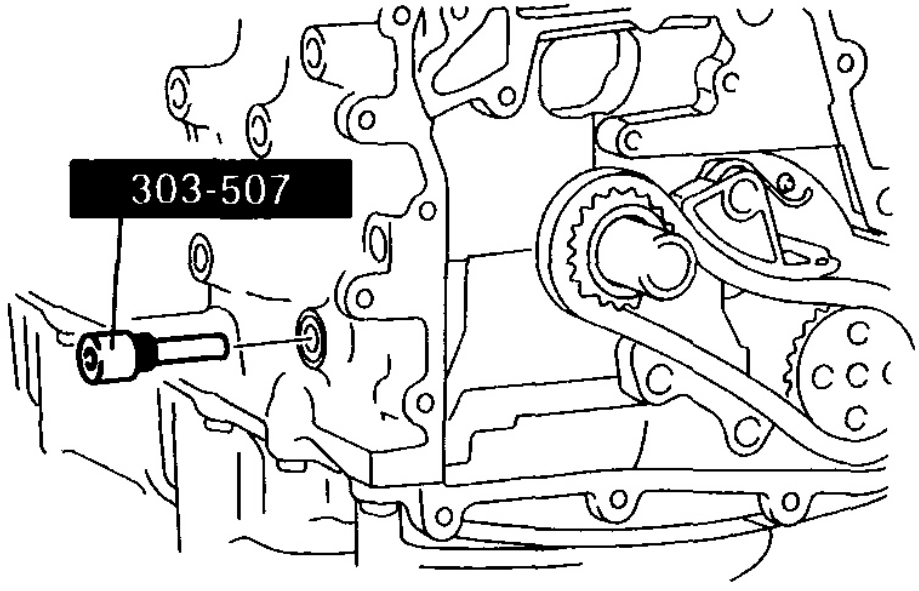


Fig. 103: Installing SST In Place Of Cylinder Block Lower Blind Plug
Courtesy of MAZDA MOTORS CORP.

4. Turn the crankshaft clockwise so that the crankshaft is in the No. 1 cylinder TDC position.
5. Install the timing chain.
6. Install the chain tensioner and remove the retaining wire.

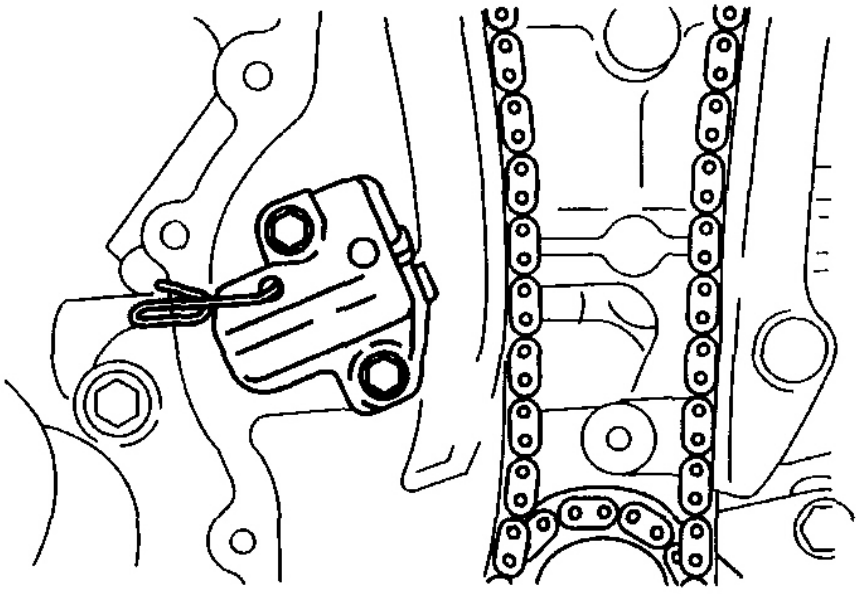


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Fig. 104: Chain Tensioner Retaining Wire
Courtesy of MAZDA MOTORS CORP.

Camshaft Sprocket, Variable Valve Timing Actuator Assembly Note

1. Hold the camshaft using a suitable wrench on the cast hexagon as shown in the figure.
2. Tighten the camshaft sprocket lock bolt.

Tightening torque

69-75 N.m {7.1-7.6 kgf.m, 50.9-55.3 ft.lbf}

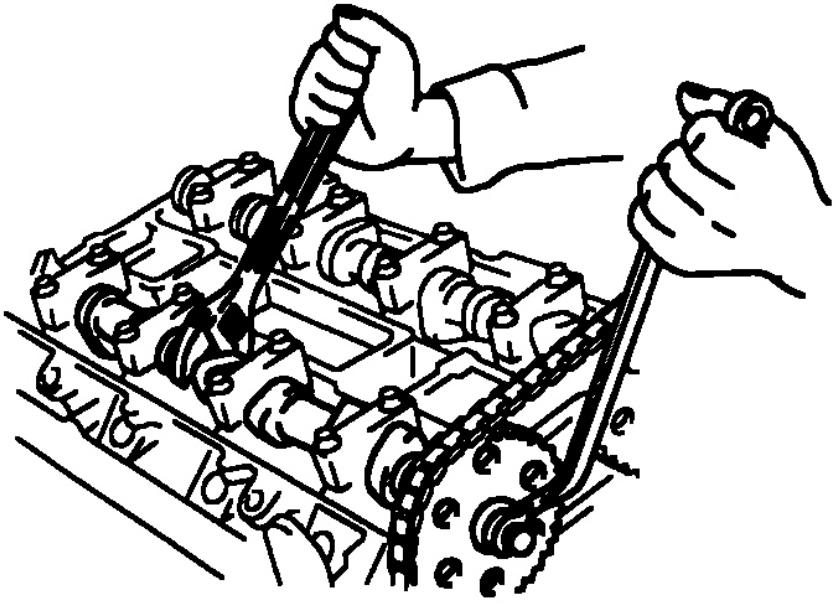

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Fig. 105: Holding Camshaft Using Suitable Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

Front Oil Seal Assembly Note

1. Apply clean engine oil to the oil seal.
2. Push the oil seal slightly in by hand.
3. Compress the oil seal using the **SST** and a hammer.

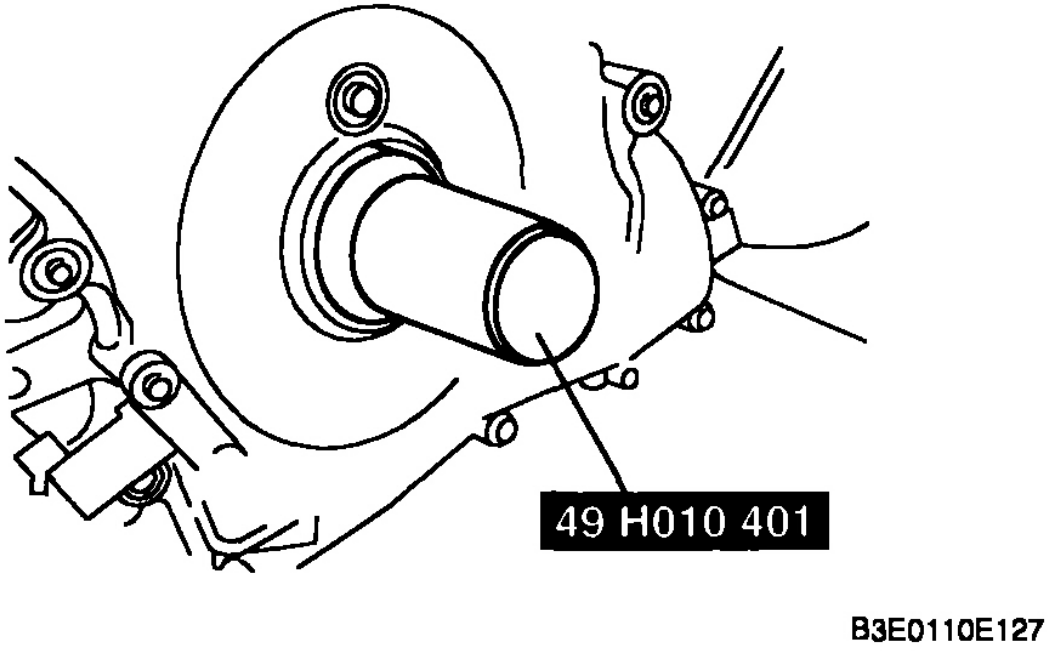

Fig. 106: Installing Front Oil Seal
Courtesy of MAZDA MOTORS CORP.

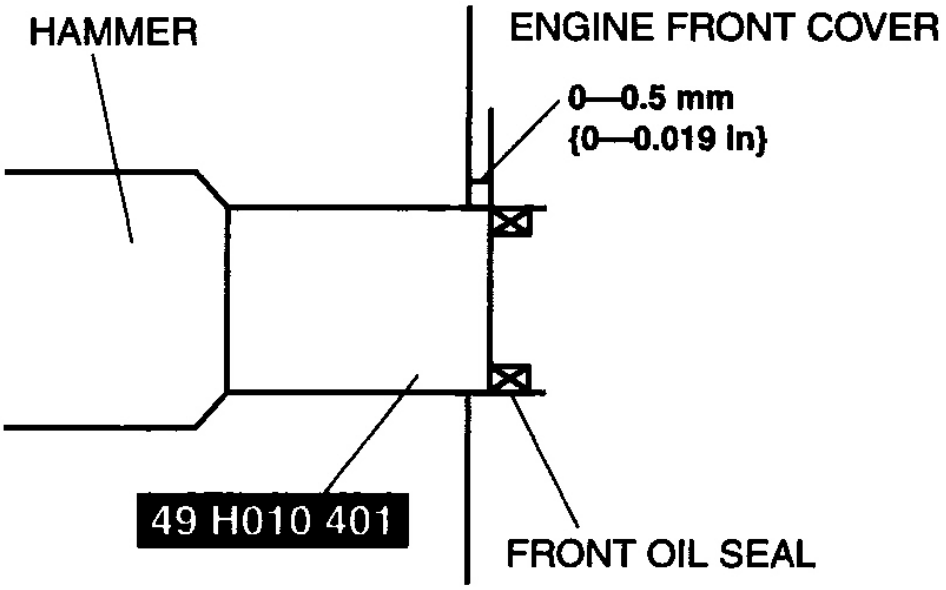

Fig. 107: Using SST And Hammer
Courtesy of MAZDA MOTORS CORP.

Engine Front Cover Assembly Note

1. Apply silicone sealant to the engine front cover as shown in the figure.

CAUTION:
- **Install the cylinder head cover within 10 min of applying the silicone sealant.**
- **Silicone sealant is not need in area C as indicated below due to an existing. (With variable valve timing mechanism)**
- **Make sure that there is no oil or dust on the seal side of oil pan.**

Thickness

A: 2.2-3.2 mm {0.087-0.125 in}

B: 1.5-2.5 mm {0.059-0.098 in}

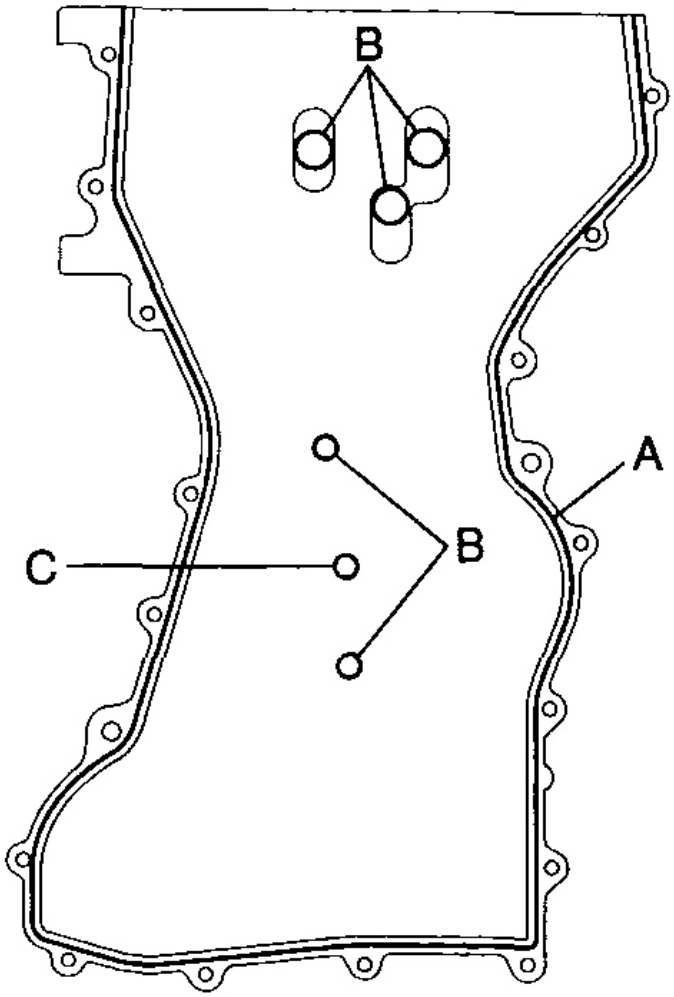

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Fig. 108: Applying Silicone Sealant To Engine Front Cover
Courtesy of MAZDA MOTORS CORP.

2. Install the cylinder head cover bolts in the order as shown in the figure.

CYLINDER HEAD COVER BOLTS SPECIFICATION

Bolt No.	Tightening torque N.m {kgf.m, ft.lbf}

1-18	8.0-11.5 N.m {81.6-117.2 kgf.cm, 70.9-101.7 in.lbf}
19-22	40-55 {4.1-5.6, 29.6-40.5}

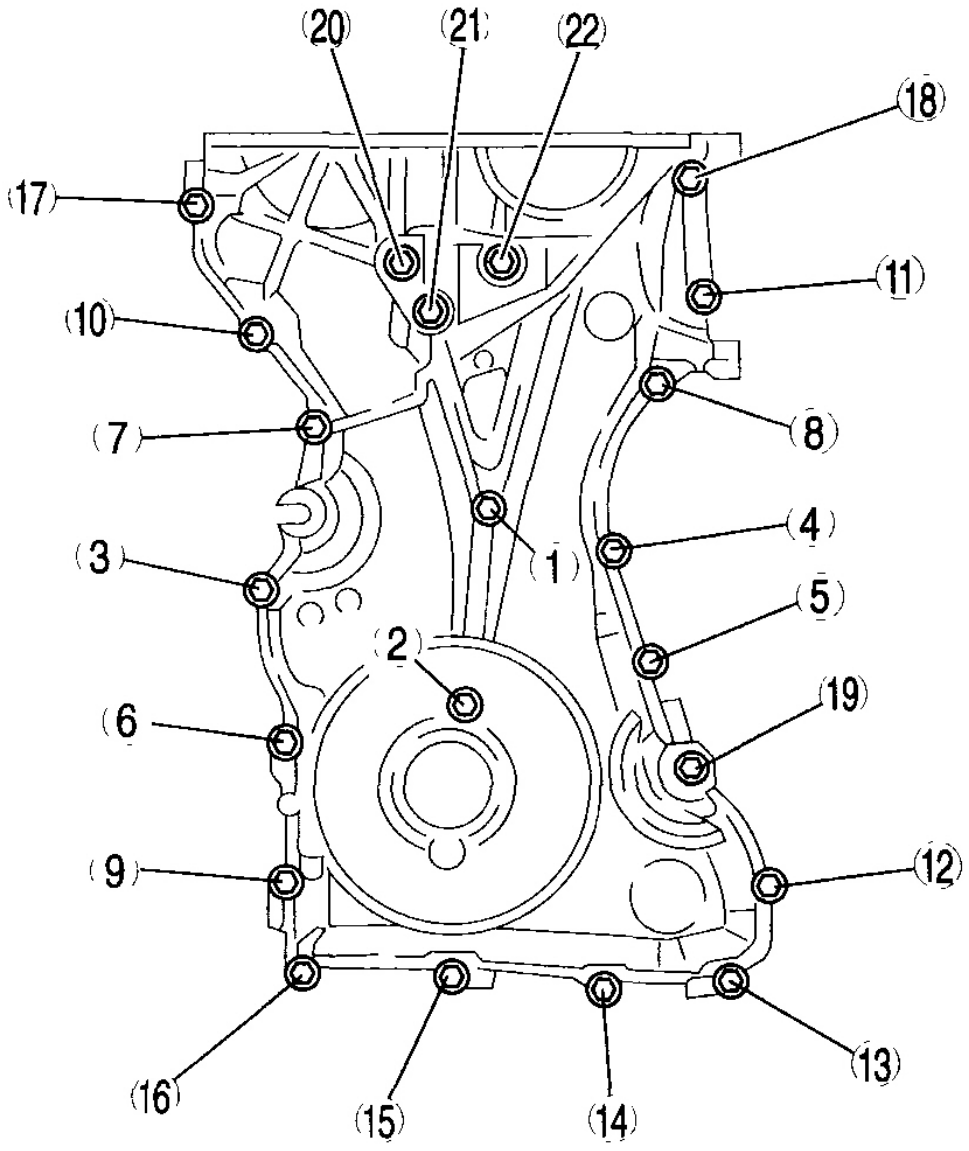


Fig. 109: Engine Front Cover Bolt Tightening Sequence

Courtesy of MAZDA MOTORS CORP.

Crankshaft Pulley Lock Bolt Assembly Note

1. Install the **SST** to the camshaft as shown in the figure.

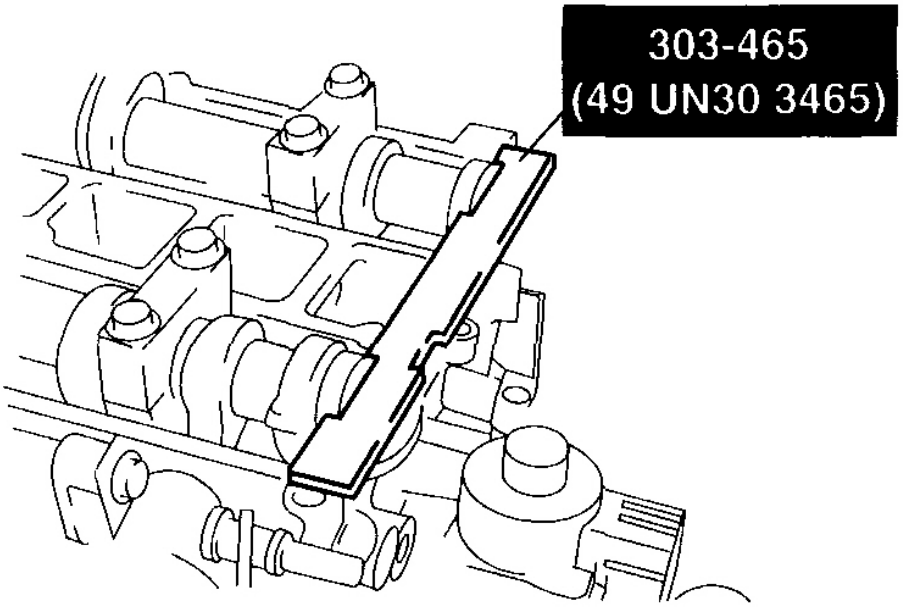


Fig. 110: Installing SST To Camshaft
Courtesy of MAZDA MOTORS CORP.

2. Install the M6 x 1.0 bolt in by hand.
3. Turn the crankshaft clockwise so that the crankshaft is in the No. 1 cylinder TDC position.

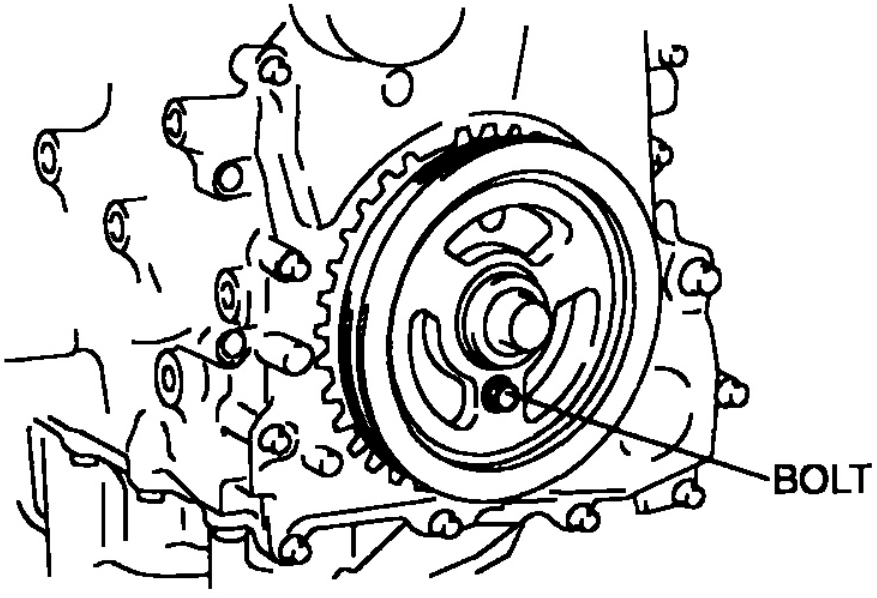


Fig. 111: Installing M6 X 1.0 Bolt On Crankshaft Pulley
Courtesy of MAZDA MOTORS CORP.

4. Hold the crankshaft pulley using the **SST** .
5. Tighten the crankshaft pulley lock bolt in the order shown following two steps using the **SST (49 D032 316).**

   Tightening torque

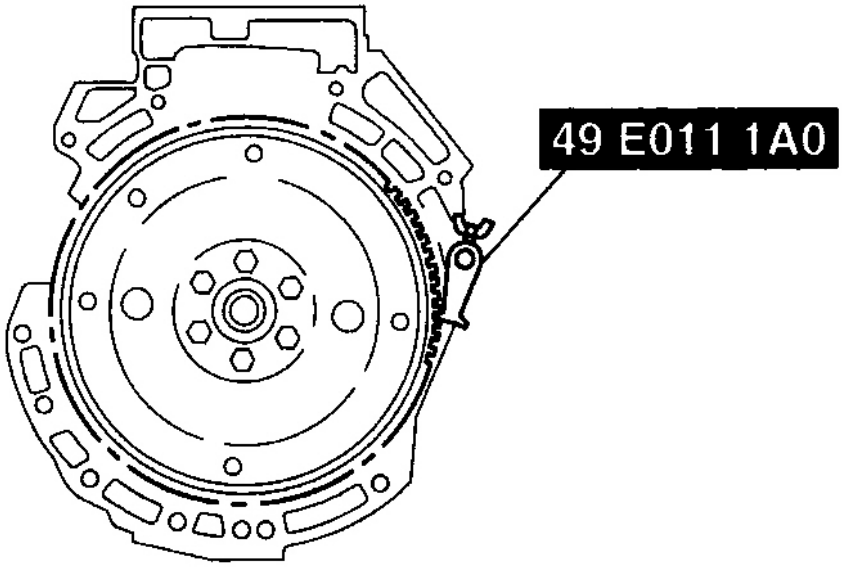
   1. **96-104 N.m**

      {9.8-10.6 kgf.m, 70.9-76.7 ft.lbf}

   2. **87°-93°**
6. Remove the M6 x 1.0 bolt.
7. Remove the **SST** from the camshaft.
8. Remove the **SST** from the block lower blind plug.
9. Rotate the crankshaft clockwise two turns until the TDC position.
   - If not aligned, loosen the crankshaft pulley lock bolt and repeat from Step 1.
10. Install the cylinder block lower blind plug.

    Tightening torque

18-22 N.m {1.9-2.2 kgf.m, 13.3-16.2 ft.lbf}



E5U110ZE7S11

Fig. 112: Locking Flywheel Using SST
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Cover Assembly Note

1. Apply silicone sealant to the mating faces as shown in the figure.

CAUTION:
- **Install the cylinder head cover within 10 min of applying the silicone sealant.**

Dot diameter

4.0-6.0 mm {0.16-0.23 in}

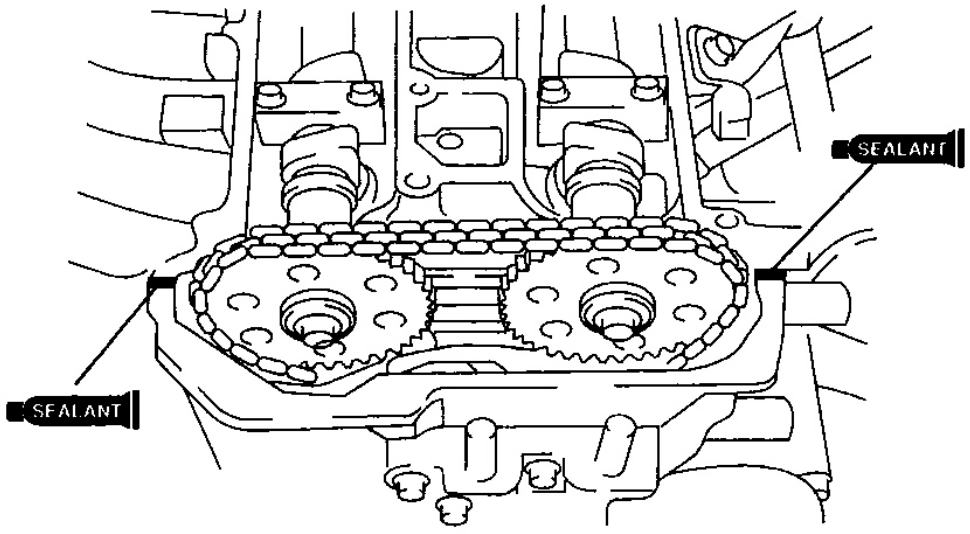


Fig. 113: Applying Silicone Sealant To Mating Faces
Courtesy of MAZDA MOTORS CORP.

2. Install the cylinder head cover with a new gasket.
3. Tighten the bolts in the order shown in the figure.

Tightening torque

8.0-10.5 N.m

{81.6-107.1 kgf.cm, 70.9-92.9 in.lbf}

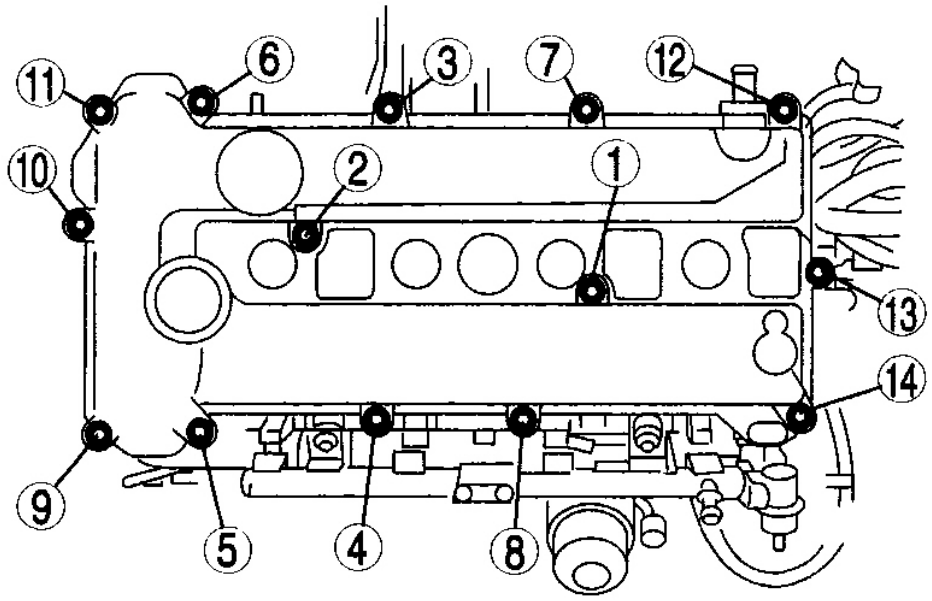


Fig. 114: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

01-50 TECHNICAL DATA

ENGINE TECHNICAL DATA

ENGINE TECHNICAL DATA SPECIFICATION

Item	Specification
Cylinder head gasket contact surface distortion (Maximum)	0.10 mm {0.004 in}
Manifold contact surfaces distortion (Maximum)	0.10 mm {0.004 in}
Manifold contact surfaces distortion (Maximum grinding)	0.15 mm {0.006 in}
Valve head margin thickness (Minimum)	IN: 1.62 mm {0.0637 in} EX: 1.82 mm {0.0716 in}
Valve length (Standard)	IN: 102.99-103.79 mm {4.055-4.086 in} EX: 104.25-105.05 mm {4.105-4.135 in}
Valve length (Minimum)	IN: 102.99 mm {4.055 in} EX: 104.25 mm {4.104 in}

Valve stem diameter (Standard)	IN: 5.470-5.485 mm {0.2154-0.2159 in} EX: 5.465-5.480 mm {0.2152-0.2157 in}
Valve stem diameter (Minimum)	IN: 5.440 mm {0.2142 in} EX: 5.435 mm {0.2140 in}
Valve guide inner diameter (Standard)	5.509-5.539 mm {0.2169-0.2180 in}
Valve stem to guide clearance (Standard)	IN: 0.024-0.069 mm {0.0009-0.0027 in} EX: 0.029-0.074 mm {0.0012-0.0029 in}
Valve stem to guide clearance (Maximum)	0.10 mm {0.004 in}
Valve guide protrusion height (standard)	12.2-12.8 mm {0.481-0.503 in}
Valve seat contact width (Standard)	1.2-1.6 mm {0.048-0.062 in}
Valve protrusion height (Standard)	IN: 40.64-42.24 mm {1.600-1.662 in} EX: 40.50-42.10 mm {1.595-1.657 in}
Valve spring pressing force	390 N {39.76 kgf, 87.67 lbf}
Valve spring standard height H	28.68 mm {1.129 in}
Valve spring out-of-square (Maximum)	1.95 mm {0.0767 in}
Maximum runout (Maximum)	0.03 mm {0.0012 in}
Camshaft standard height (mm {in})	With variable valve timing mechanism IN: 42.44 {1.671} EX: 41.18 {1.621} Without variable valve timing mechanism IN: 42.12 {1.659} EX: 41.08 {1.618}
Camshaft minimum height (mm {in})	With variable valve timing mechanism IN: 42.33 {1.666} EX: 41.06 {1.616} Without variable valve timing mechanism IN: 42.01 {1.653} EX: 40.96 {1.612}
Camshaft journal diameter (Standard)	24.96-24.98 mm {0.9827-0.9834 in}
Camshaft journal diameter (Minimum)	24.95 mm {0.982 in}
Camshaft journal oil clearance (Standard)	0.035-0.080 mm {0.0014-0.0031 in}
Camshaft journal oil clearance (Maximum)	0.09 mm {0.0035 in}
Camshaft end play (Standard)	0.09-0.24 mm {0.0035-0.0094 in}
Camshaft end play (Maximum)	0.25 mm {0.0098 in}
Tappet bore diameter (Standard)	31.000-31.030 mm {1.2205-1.2216 in}
Tappet diameter (Standard)	30.970-30.980 mm {1.2193-1.2196 in}
Tappet-to-Tappet bore oil clearance (Standard)	0.02-0.06 mm {0.0008-0.0023 in}
Tappet-to-Tappet bore oil clearance (Maximum)	0.15 mm {0.006 in}
Cylinder head gasket contact surfaces distortion (Maximum)	0.10 mm {0.004 in}
Cylinder bore diameter (Standard)	87.500-87.530 mm {3.4449-3.4460 in}
Minimum / maximum bore diameter limit	87.440-87.590 mm {3.4425-3.4484 in}
Oil jet valve air pressure	216-274 kPa {2.2-2.7 kgf.cm^2 31.4-39.7 psi}

Piston diameter (Standard)	87.465-87.495 mm {3.4435-3.4446 in}
Piston-to-cylinder clearance (Standard)	0.025-0.045 mm {0.0010-0.0017 in}
Piston-to-cylinder clearance (Maximum)	0.11 mm {0.0043 in}
Piston ring-to-ring groove clearance (Standard)	Top: 0.03-0.08 mm {0.0012-0.0031 in} Second: 0.03-0.07 mm {0.0012-0.0027 in} Oil: 0.03-0.07 mm {0.0012-0.0027 in}
Piston ring-to-ring groove clearance (Maximum)	Top: 0.17 mm {0.0067 in} Second, Oil: 0.15 mm {0.0059 in}
Piston end gap (Standard)	Top: 0.16-0.31 mm {0.0063-0.0122 in} Second: 0.33-0.48 mm {0.0130-0.0189 in} Oil (rail): 0.20-0.70 mm {0.0079-0.0275 in}
Piston end gap (Maximum)	1.0 mm {0.0393 in}
Crankshaft end play (Standard)	0.22-0.45 mm {0.0087-0.0177 in}
Crankshaft end play (Maximum)	0.55 mm {0.0216 in}
Crankshaft runout (Maximum)	0.05 mm {0.0019 in}
Main journal bearing size	STD: 51.980-52.000 mm {2.0464-2.0472 in} US0.25: 51.730-51.750 mm {2.0366-2.0373 in}
Main journal out of round (Maximum)	0.05 mm {0.0019 in}
Crank pin journal diameter [LF]	STD: 46.980-47.000 mm {1.8497-1.8503 in} US0.25: 46.730-46.750 mm {1.8398-1.8405 in}
Crank pin journal diameter [L3]	STD: 49.980-50.000 mm {1.9677-1.9685 in} US0.25: 49.730-49.750 mm {1.9579-1.9586 in}
Crank pin out of round (Maximum)	0.05 mm {0.0019 in}
Main journal oil clearance (Standard)	0.019-0.035 mm {0.0007-0.0013 in}
Main journal oil clearance (Maximum)	0.10 mm {0.0039 in}
Main bearing size	STD: 2.506-2.509 mm {0.0987-0.0988 in} OS0.25: 2.628-2.634 mm {0.1034-0.1037 in}
Connecting rod side clearance (Standard)	0.14-0.36 mm {0.0056-0.0141 in}
Connecting rod side clearance (Maximum)	0.435 mm {0.0172 in}
Connecting rod bearing oil clearance (Standard)	0.026-0.052 mm {0.0011-0.0020 in}
Connecting rod bearing oil clearance (Maximum)	0.1 mm {0.0039 in}
Connecting rod bearing size [LF]	STD: 1.498-1.504 mm {0.0589-0.0592 in} OS0.25: 1.623-1.629 mm {0.0639-0.0641 in}
Connecting rod bearing size [L3]	STD: 1.496-1.502 mm {0.0589-0.0591 in} OS0.25: 1.621-1.627 mm {0.0639-0.0641 in}
Bolt length (mm {in})	Cylinder head bolt (With washer) Standard: 149.2-149.8 {5.87-5.90} Maximum: 150.5 {5.91} Cylinder head bolt (Without washer) Standard: 145.2-145.8 {5.72-5.74} Maximum: 146.5 {5.77} Connecting rod bolt Standard: 44.7-45.3 {1.75-1.78}

	Maximum: 46.0 {1.81} Main bearing cap bolt (Plastic region tightening bolt only) Standard: 110.0-110.6 {4.33-4.35} Maximum: 111.3 {4.38}
Valve clearance [Engine cold]	IN: 0.22-0.28 mm {0.0087-0.0110 in} EX: 0.27-0.33 mm {0.0106-0.0130 in}
Value range	0.005-0.101 mm {0.00019-0.0039 in}

01-60 SERVICE TOOLS

ENGINE SST

1. Mazda **SST** number
2. Global **SST** number

Example

1. 49 UN20 5072
2. 205-072

Holder

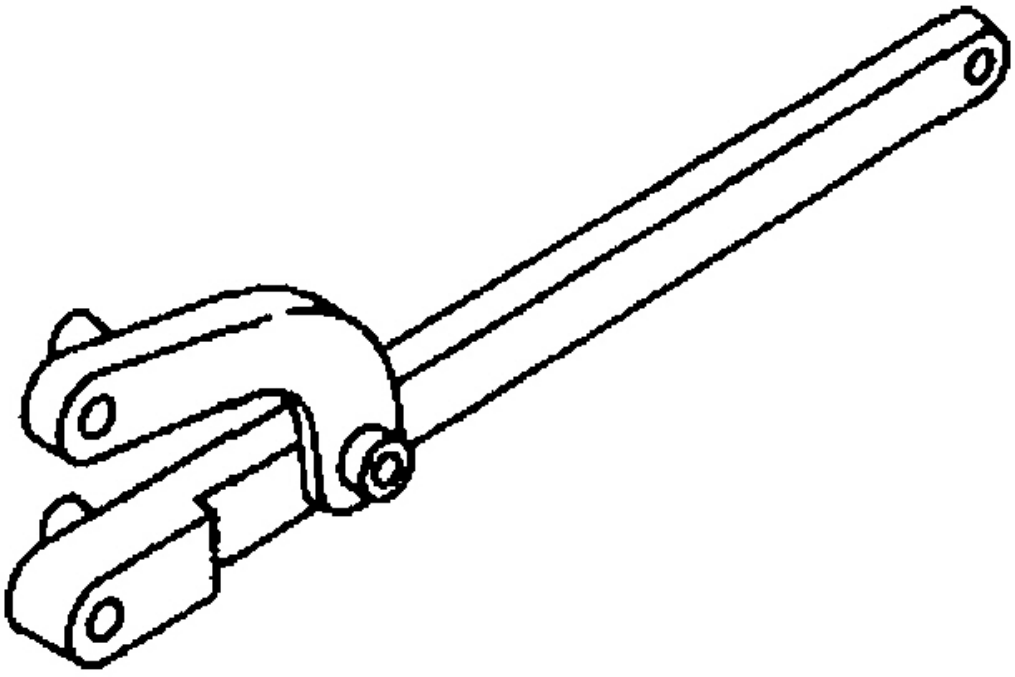
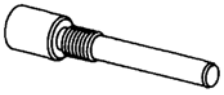
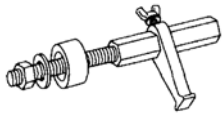
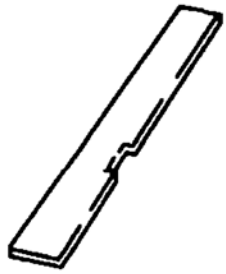
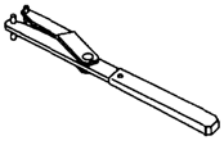
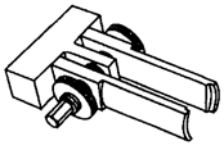
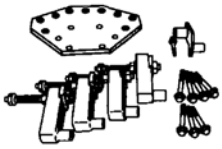
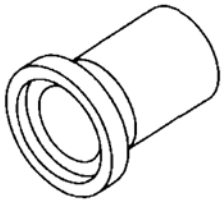
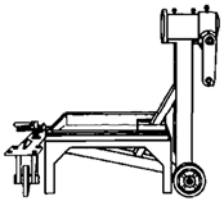
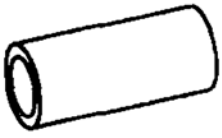
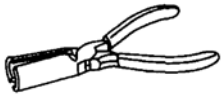
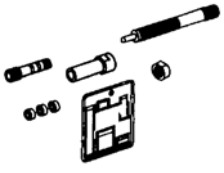
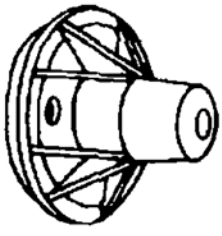
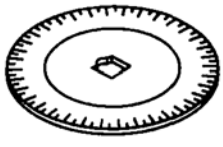
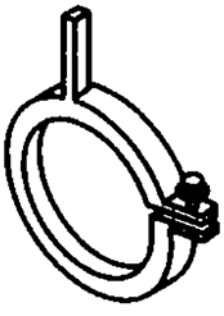


Fig. 115: Identifying Engine SST Holder
Courtesy of MAZDA MOTORS CORP.

ENGINE SERVICE TOOLS SPECIFICATION

1: - 2: 303-507 Crankshaft TDC setting peg 	1: 49 E011 1A0 2:- Ring gear brake set 	1: 49 UN30 3465 2: 303-465 Camshaft Alignment timing Tool 
1: 49 G032 354 2:- Adjusting wrench 	1: 49 B012 015 2:- Valve guide installer 	1: 49 0636 100B 2:- Valve spring lifter arm 
	1: 49 L010	

1: 49 B012 0A2 2:- Pivot		1A0 2:- Engine hanger set		1: 49 H010 401 2:- Oil seal installer	
1: 49 0107 680A 2:- Engine stand		1: 49 T032 302 2:- Bearing installer		1: 49 S120 170 2:- Valve seal remover	
1: 49 L012 0A0B 2:- Valve seal and valve guide installer set		1: 49 UN30 3328 2: 303-328 Rear oil seal replacer		1: 49 D032 316 2:- Protractor	
1: 49 G011 201 2:- Attachment		-		-	