

2009 ENGINE

Mechanical - Overhaul - 2.3L (L3 With TC) Mazda 3

MECHANICAL

ENGINE OVERHAUL SERVICE WARNING

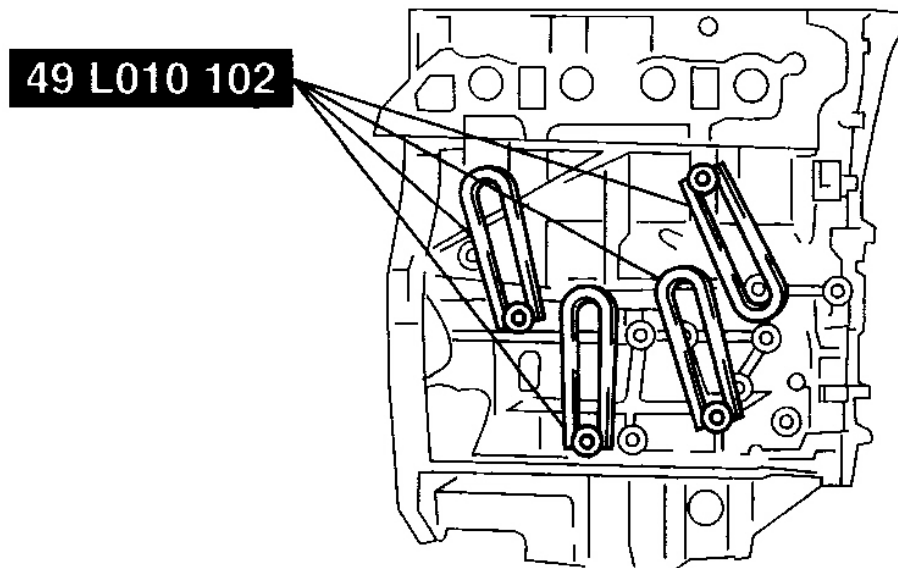
WARNING:

- Continuous exposure to USED engine oil has been shown to cause skin cancer in laboratory mice. Protect your skin by washing with soap and water immediately after performing work.

ENGINE MOUNTING/DISMOUNTING

Installation

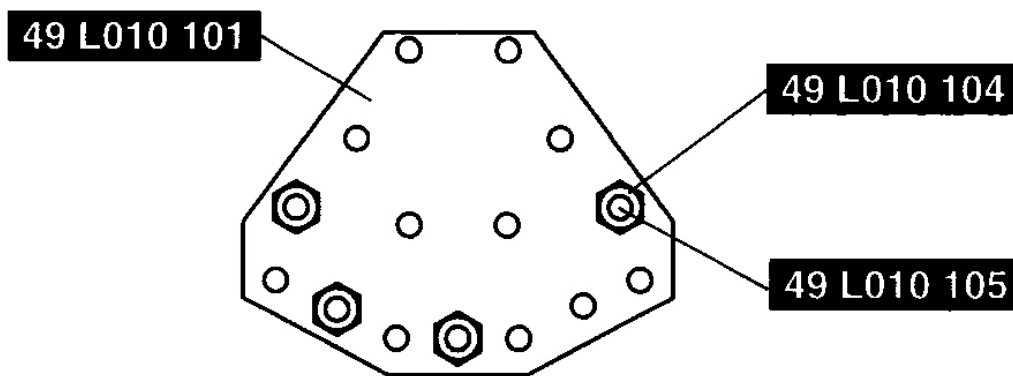
1. Install the SST (arms) to the four positions as shown in the figure and temporarily tighten the bolts (**Part No.:** 9YA20-1003) or M10 x 1.5T length 90 mm {3.55 in}.



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Fig. 1: Positions For Installing SST (Arms)
Courtesy of MAZDA MOTORS CORP.

2. Install the **SSTs** (bolts, nuts, hook, and plate) to the four positions as shown in the figure.
3. Install the **SST** (bolts, nuts, hook, and plate) set in Step 2 to the **SST** (arms and bolts) set in Step 1.
4. Adjust the bolts so that **approx. 20 mm {0.79 in}** of thread is exposed from the side of the plate.
5. Adjust the bolts and nuts so that the plate and arms are parallel.



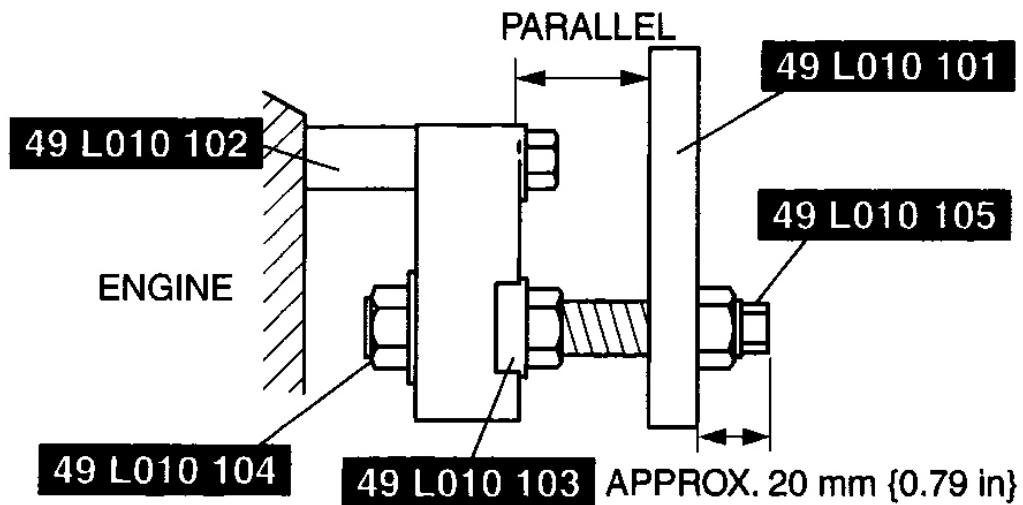
C3U0110E001

Fig. 2: Positions For Installing SSTs
Courtesy of MAZDA MOTORS CORP.

6. Install the engine to the **SST** (engine stand).
7. Remove the oil drain plug and drain the engine oil.
8. Replace the gasket with a new one and install the oil pan drain plug.

Tightening torque

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



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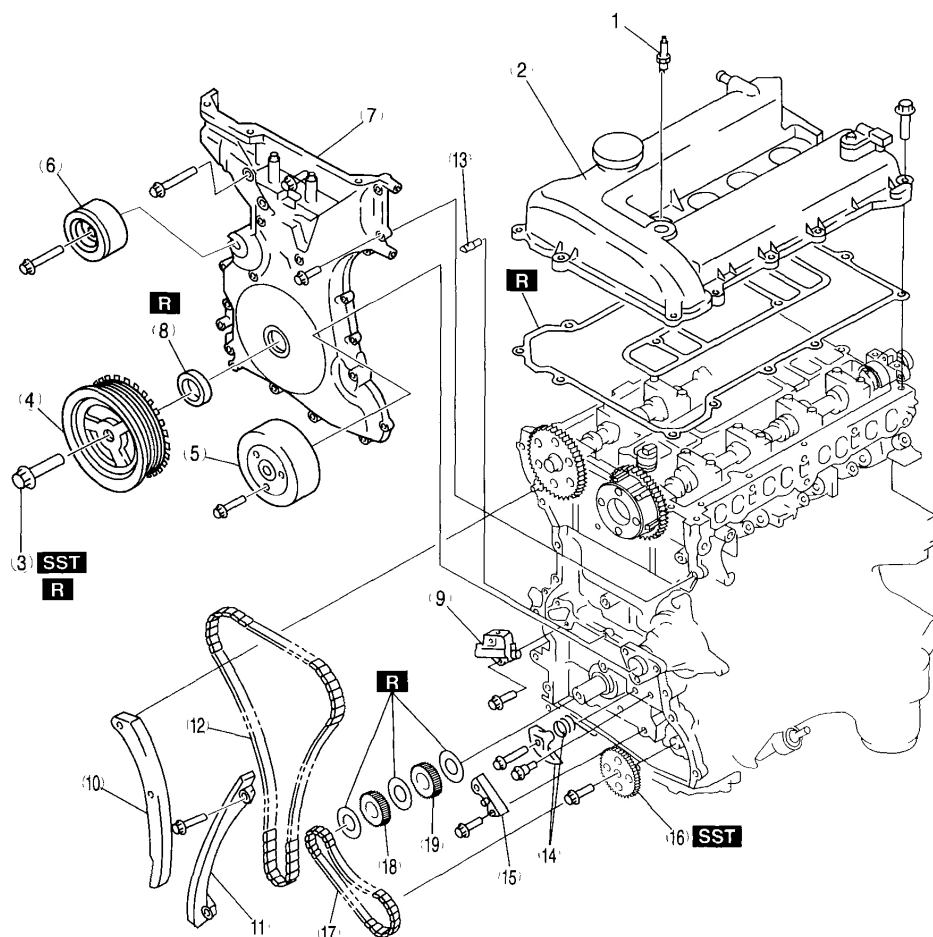
Fig. 3: Installing Engine To SST (Engine Stand)
Courtesy of MAZDA MOTORS CORP.

Removal

1. Remove in the reverse order of installation.

TIMING CHAIN DISASSEMBLY

1. Disassemble in the order indicated in the table.



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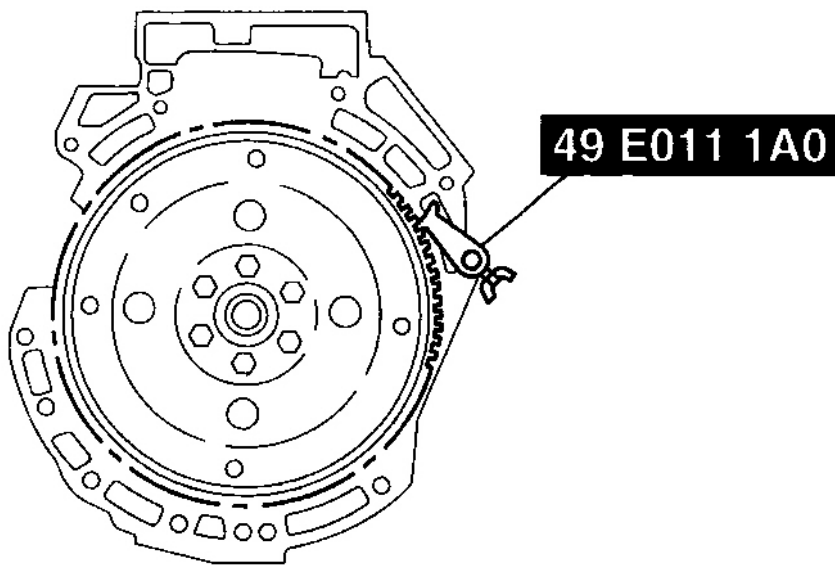
1	Spark plug
2	Cylinder head cover
3	Crankshaft pulley lock bolt
4	Crankshaft pulley
5	Water pump pulley
6	Drive belt idler pulley
7	Engine front cover
8	Front oil seal
9	Timing chain tensioner

10	Timing chain tensioner arm
11	Timing chain guide
12	Timing chain
13	Oil jet
14	Oil pump chain tensioner
15	Oil pump chain guide
16	Oil pump driven sprocket
17	Oil pump chain
18	Crankshaft sprocket
19	Oil pump drive sprocket

Fig. 4: Disassembling View Of Timing Chain
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.



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Fig. 5: Installing SST To Ring Gear
Courtesy of MAZDA MOTORS CORP.

Front Oil Seal Disassembly Note

1. Remove the oil seal using a flathead screwdriver.

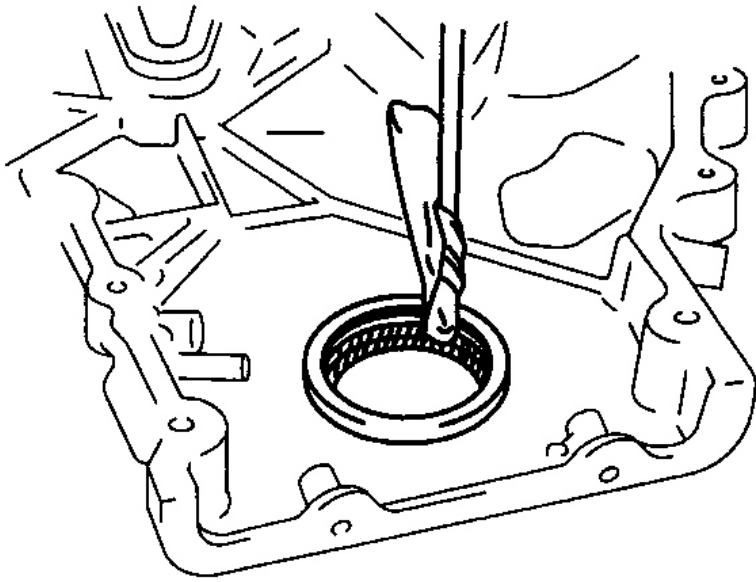
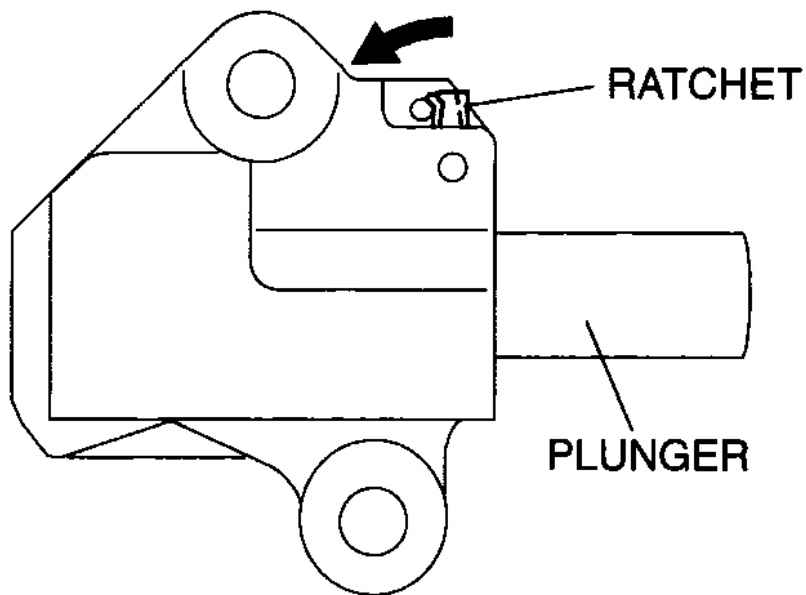
**E6U110ZWB044**

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

Timing Chain Tensioner Disassembly Note

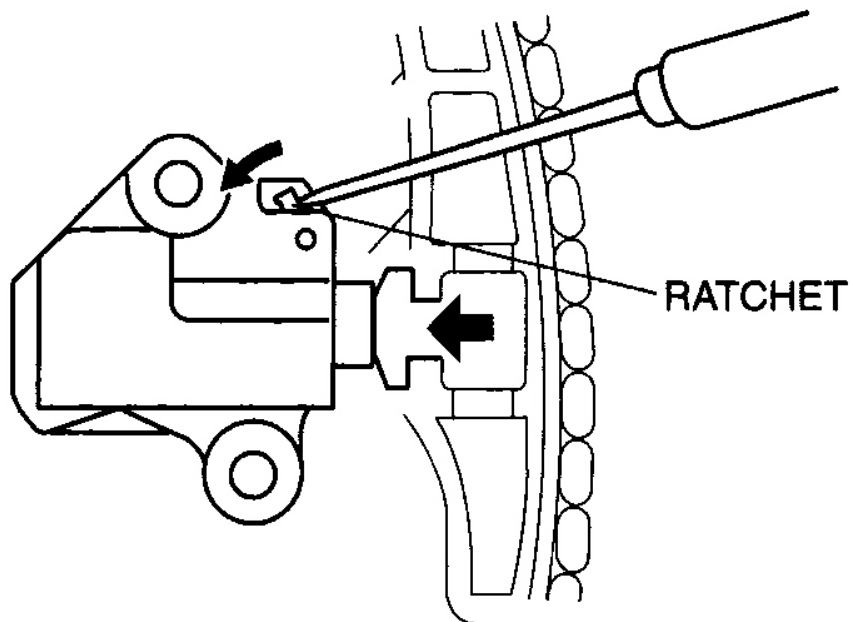
1. Press the timing chain tensioner ratchet to the left using a thin flathead screwdriver (precision screwdriver) to unlock the plunger.



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Fig. 7: Pressing Timing Chain Tensioner Ratchet To Left
Courtesy of MAZDA MOTORS CORP.

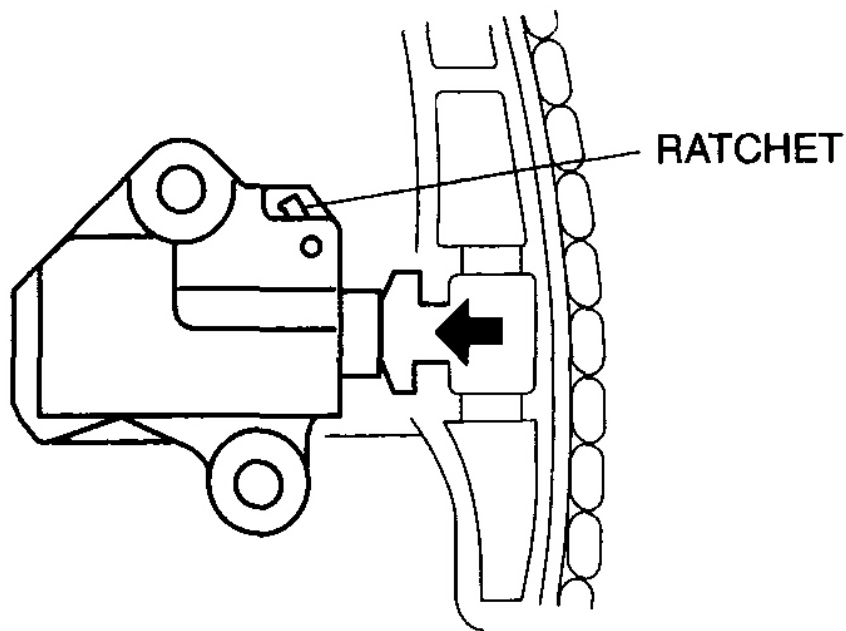
2. Slowly press the plunger back in the direction shown in the figure while pressing the ratchet.



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Fig. 8: Pressing Plunger Back
Courtesy of MAZDA MOTORS CORP.

3. Release the ratchet with the plunger still pressed down.

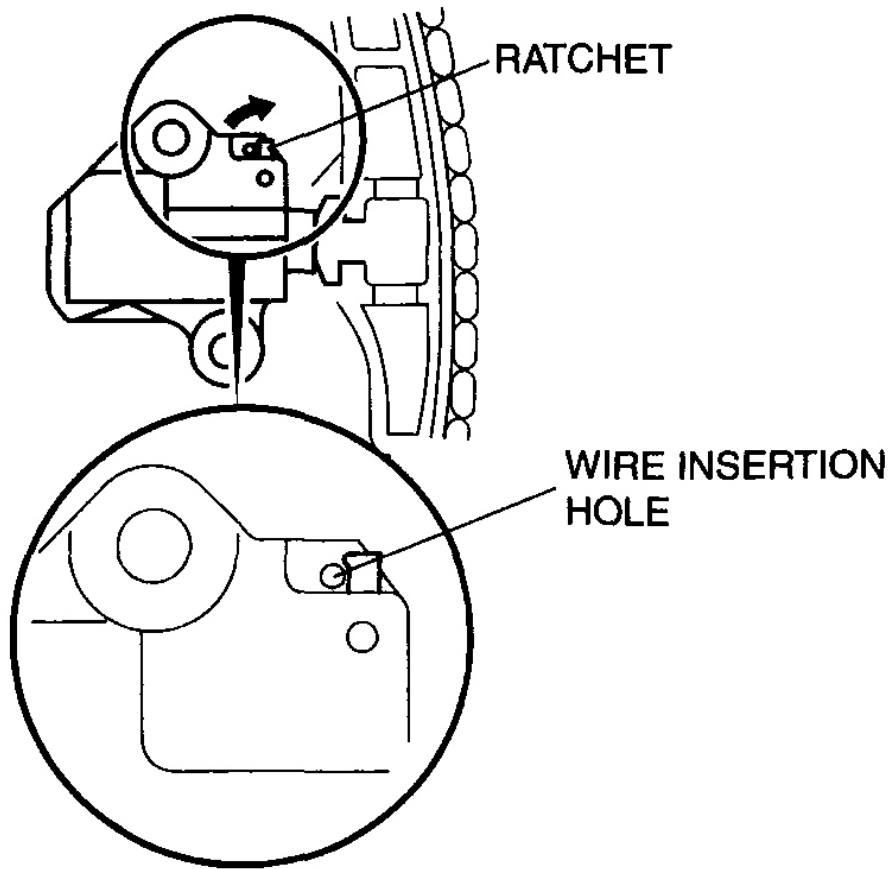


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Fig. 9: Releasing Ratchet

Courtesy of MAZDA MOTORS CORP.

4. Press-in the plunger until the ratchet position is as indicated in the figure, and then insert the wire to lock the plunger.

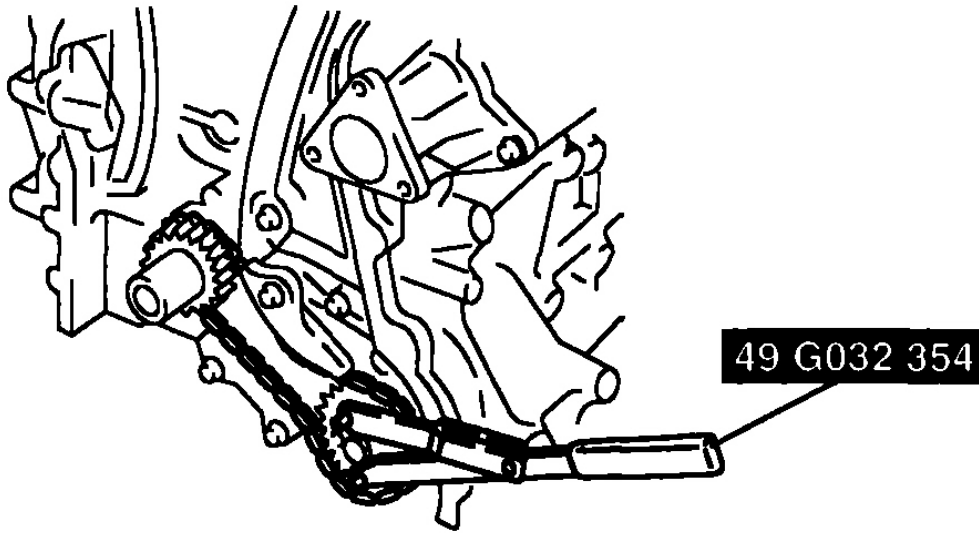


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Fig. 10: Identifying Ratchet Position For Pressing In Plunger
Courtesy of MAZDA MOTORS CORP.

Oil Pump Driven Sprocket Disassembly Note

1. Install the SST on the oil pump driven sprocket to lock the oil pump against rotation.

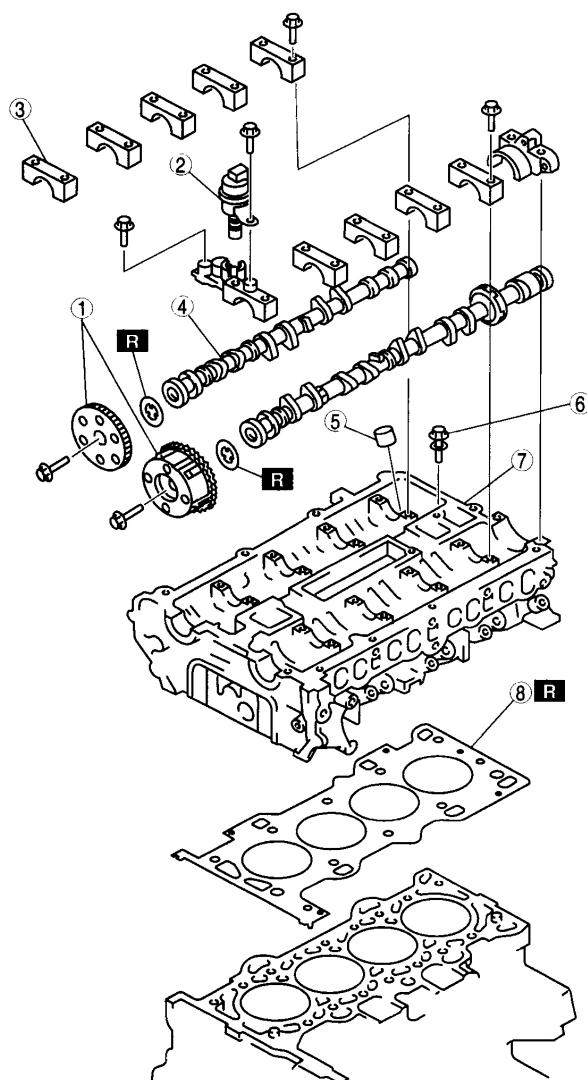


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Fig. 11: Holding Oil Pump Sprocket Using SST
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (I) DISASSEMBLY

1. Disassemble in the order indicated in the table.



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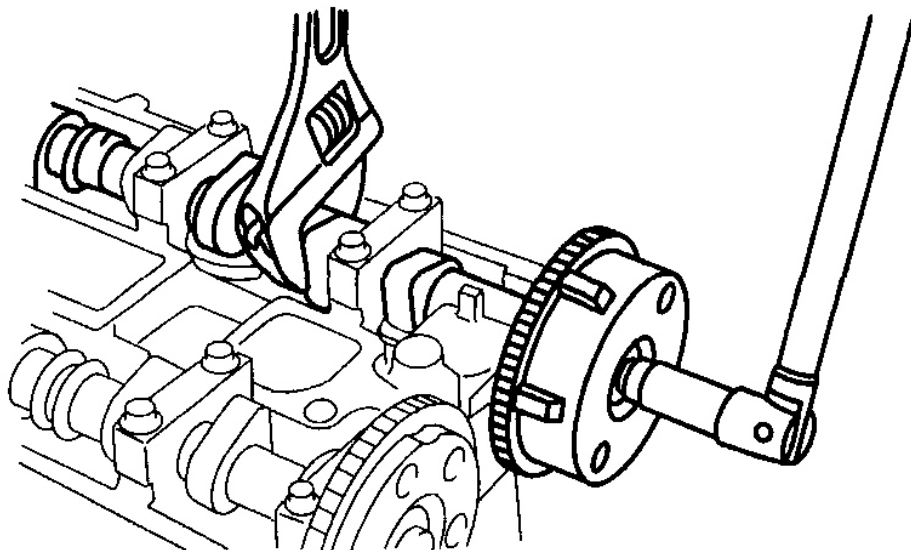
1	Camshaft sprocket, Variable valve timing actuator
2	OCV
3	Camshaft cap
4	Camshaft

5	Tappet
6	Cylinder head bolt
7	Cylinder head
8	Cylinder head gasket

Fig. 12: Disassembling View Of Cylinder Head
 Courtesy of MAZDA MOTORS CORP.

Camshaft Sprocket, Variable Valve Timing Actuator Disassembly Note

1. Before removing the camshaft, hold the camshaft using a wrench on the cast hexagon and loosen the camshaft sprocket installation bolt.



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Fig. 13: Loosening Camshaft Sprocket Bolt
Courtesy of MAZDA MOTORS CORP.

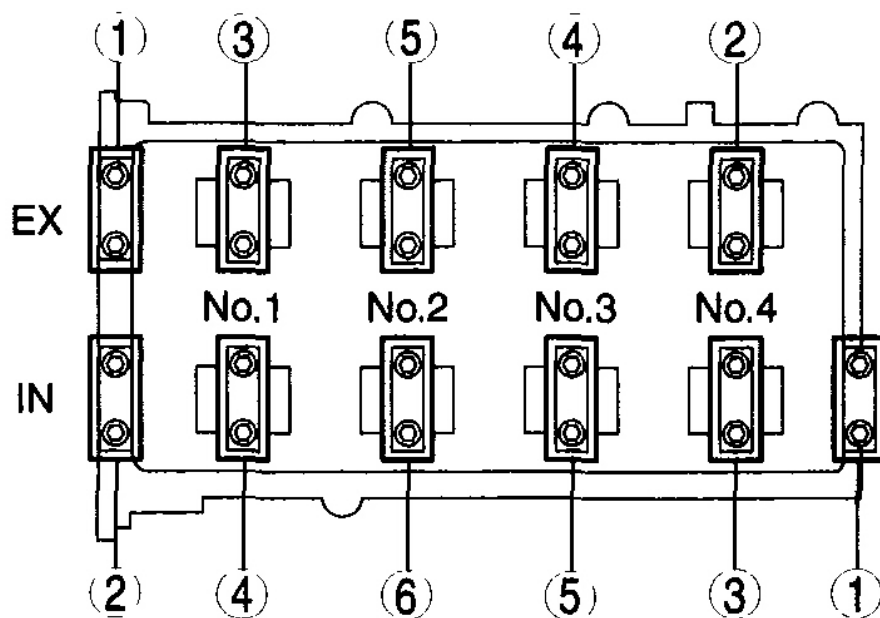
Camshaft Cap Disassembly Note

1. Before removing the camshaft cap, Inspect the camshaft end play. (See CAMSHAFT INSPECTION).

NOTE:

- Determine the position of each removed camshaft cap.

2. Loosen the camshaft cap bolts in two to three passes in the order shown in the figure and remove the camshaft caps.



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Fig. 14: Camshaft Cap Bolts Loosening Sequence
Courtesy of MAZDA MOTORS CORP.

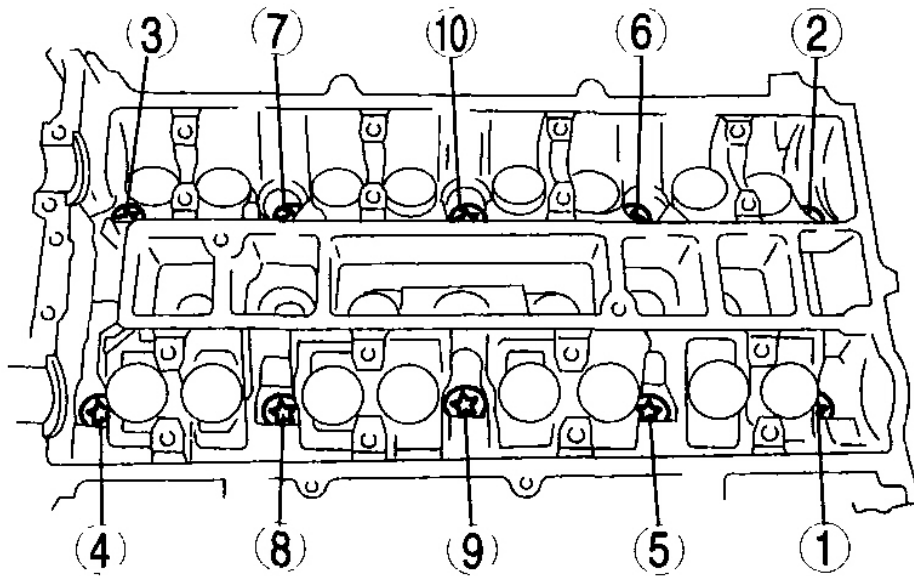
Tappet Disassembly Note

NOTE:

- Determine the position of each removed tappet.

Cylinder Head Disassembly Note

1. Loosen the cylinder head installation bolts in two to three passes in the order shown in the figure and remove them.

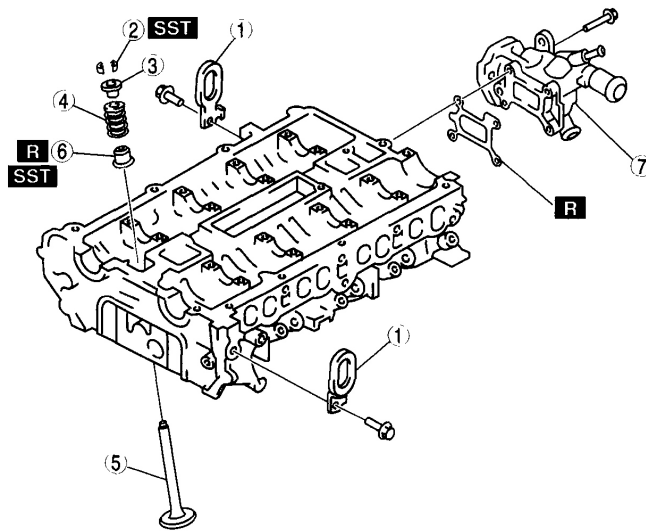


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Fig. 15: Cylinder Head Bolt Loosening Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (II) DISASSEMBLY

1. Disassemble in the order indicated in the table.



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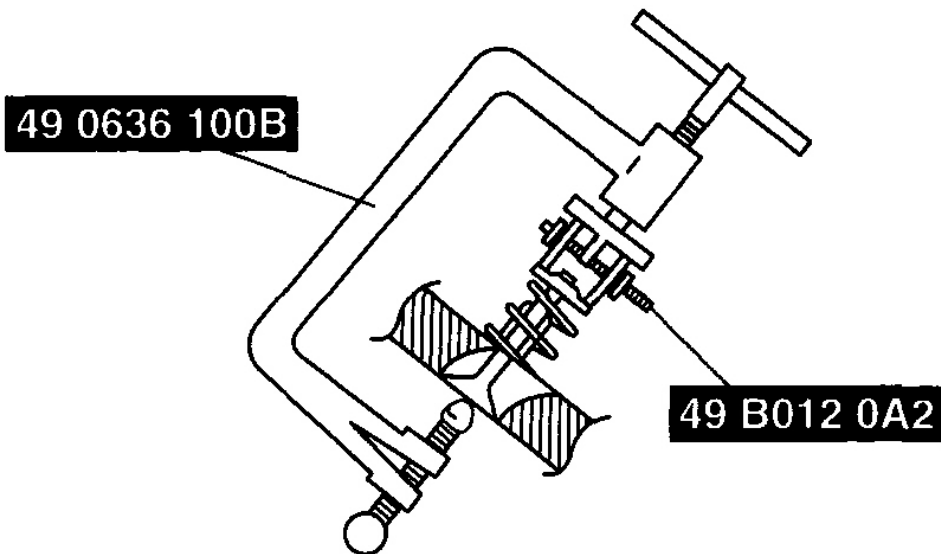
1	Engine hanger
2	Valve keeper
3	Upper valve spring seat
4	Valve spring

5	Valve
6	Valve seal
7	Water outlet case

Fig. 16: Disassembling View Of Cylinder Head (II)
 Courtesy of MAZDA MOTORS CORP.

Valve Keeper Disassembly Note

1. Remove the valve keeper using the SSTs .

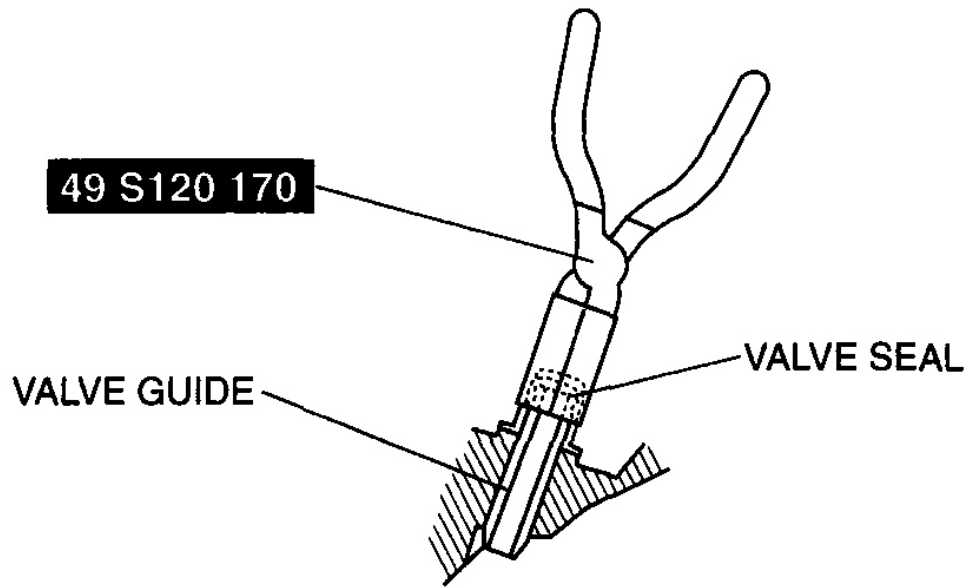


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Fig. 17: Removing Valve Keeper Using SSTs
Courtesy of MAZDA MOTORS CORP.

Valve Seal Disassembly Note

1. Remove the valve seal using the SST.

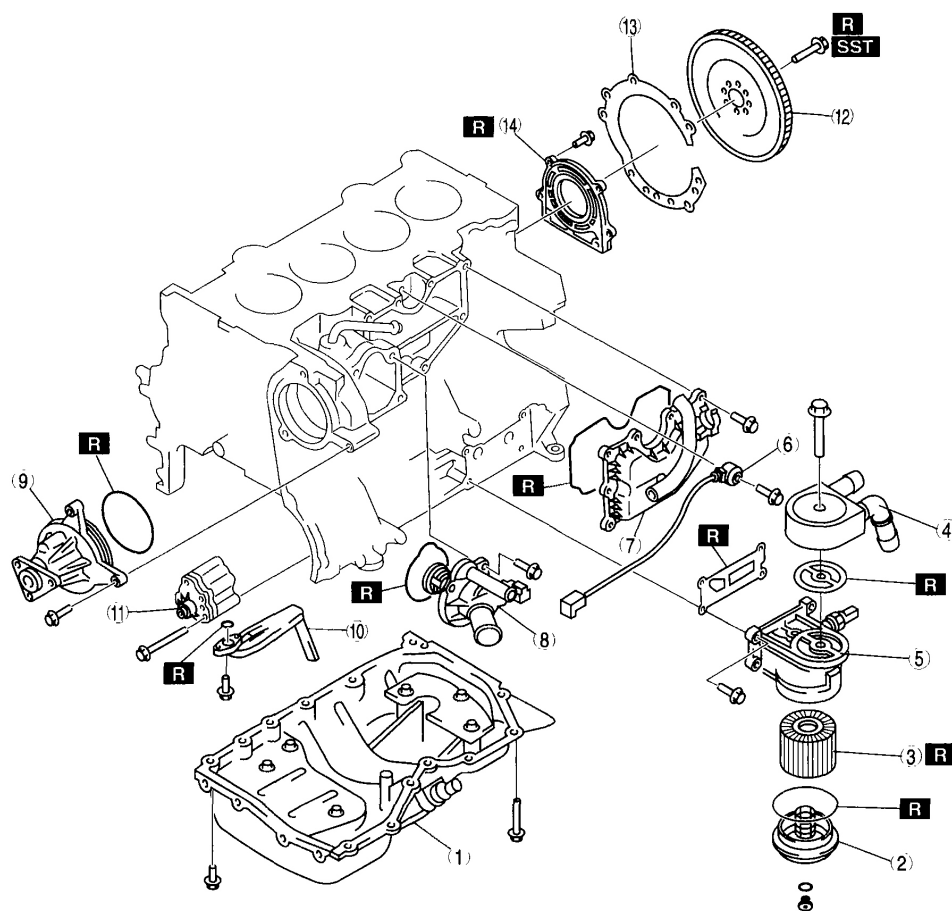


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Fig. 18: Removing Valve Seal Using SST
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (I) DISASSEMBLY

1. Disassemble in the order indicated in the table.



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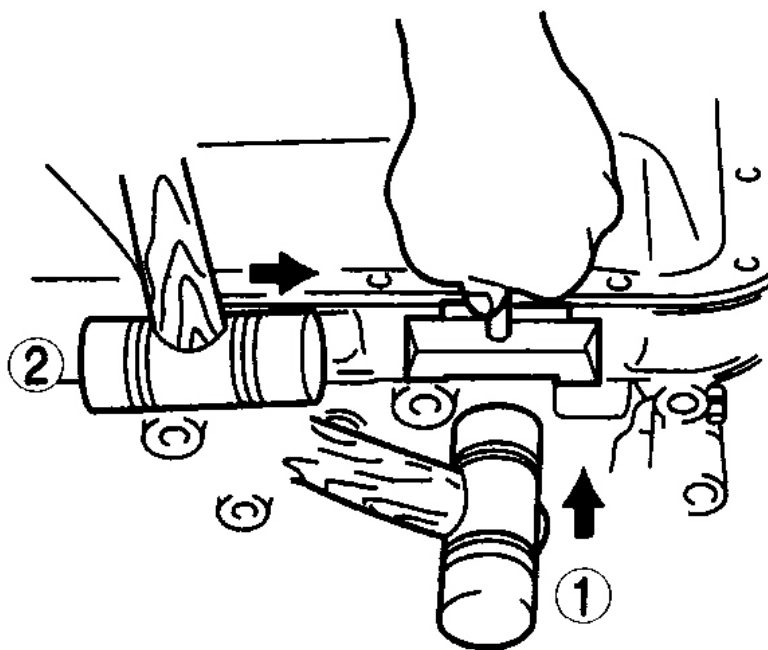
1	Oil pan
2	Oil filter cover
3	Oil filter
4	Oil cooler
5	Oil filter adapter
6	Knock sensor
7	Crankcase ventilation cover

8	Thermostat
9	Water pump
10	Oil strainer
11	Oil pump
12	Flywheel
13	End plate
14	Rear oil seal

Fig. 19: Disassembling View Of Cylinder Block (I)
 Courtesy of MAZDA MOTORS CORP.

Oil Pan Disassembly Note

1. Remove the oil pan using a oil pan seal cutter.

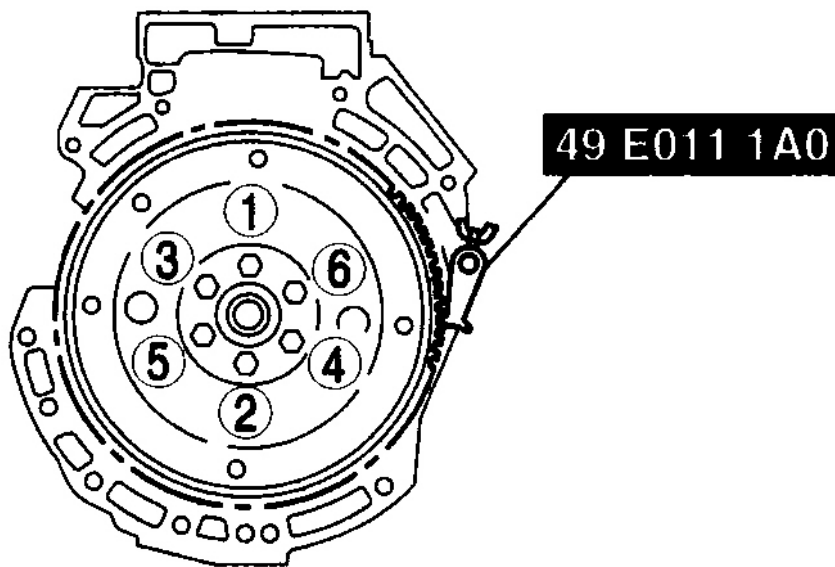


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Fig. 20: Removing Oil Pan Using Oil Pan Seal Cutter
Courtesy of MAZDA MOTORS CORP.

Flywheel Disassembly Note

1. Use the SST to lock the crankshaft against rotation.

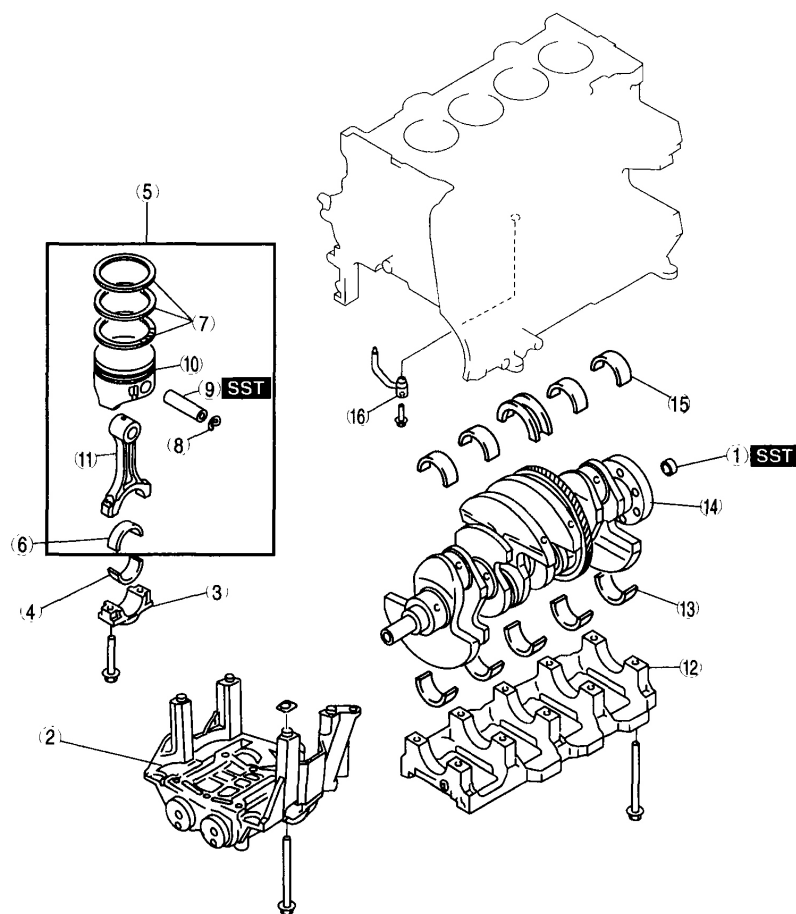


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Fig. 21: Locking Crankshaft Using SST
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (II) DISASSEMBLY

1. Disassemble in the order indicated in the table.



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1	Pilot bearing
2	Engine balancer
3	Connecting rod cap
4	Lower connecting rod bearing
5	Upper connecting rod bearing
6	Connecting rod piston
7	Piston ring
8	Snap ring

9	Piston pin
10	Piston
11	Connecting rod
12	Main bearing cap
13	Lower main bearing
14	Crankshaft
15	Upper main bearing, thrust bearing
16	Oil jet valve

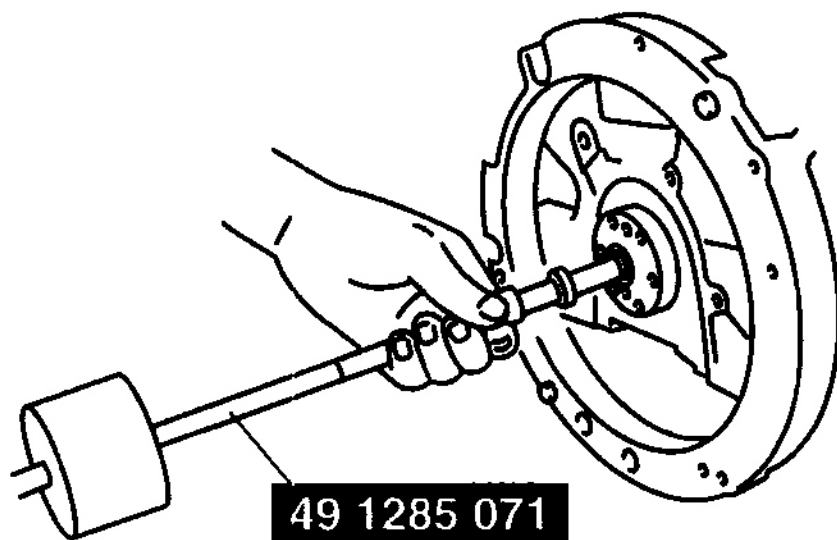
Fig. 22: Disassembling View Of Cylinder Block (II)
 Courtesy of MAZDA MOTORS CORP.

Pilot Bearing Disassembly Note

NOTE:

- The pilot bearing does not need to be removed unless you are replacing it.

1. Use the SST to remove the pilot bearing.



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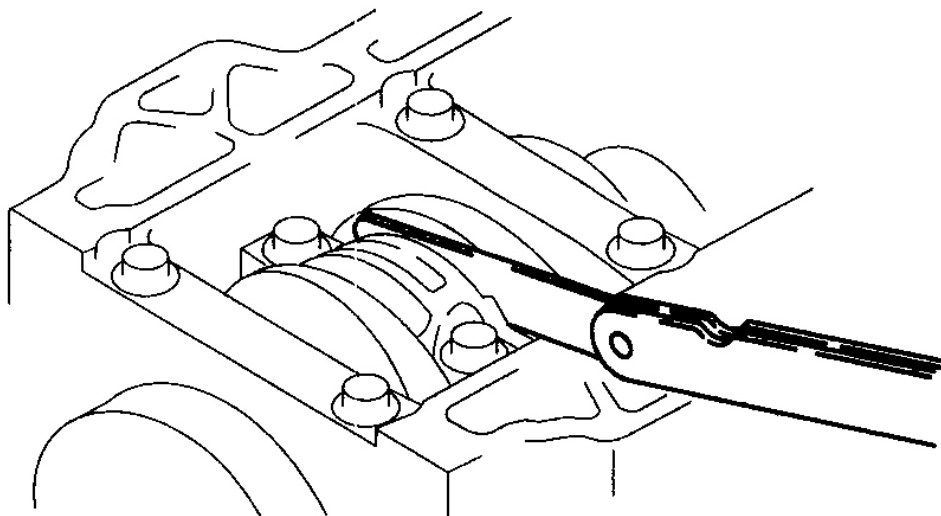
Fig. 23: Removing Pilot Bearing Using SST
Courtesy of MAZDA MOTORS CORP.

Connecting Rod Cap Disassembly Note

1. Before removing the connecting rod cap, inspect the connecting rod side clearance. (See **CONNECTING ROD CLEARANCE INSPECTION**).

NOTE:

- Determine the position of each removed connecting rod cap.



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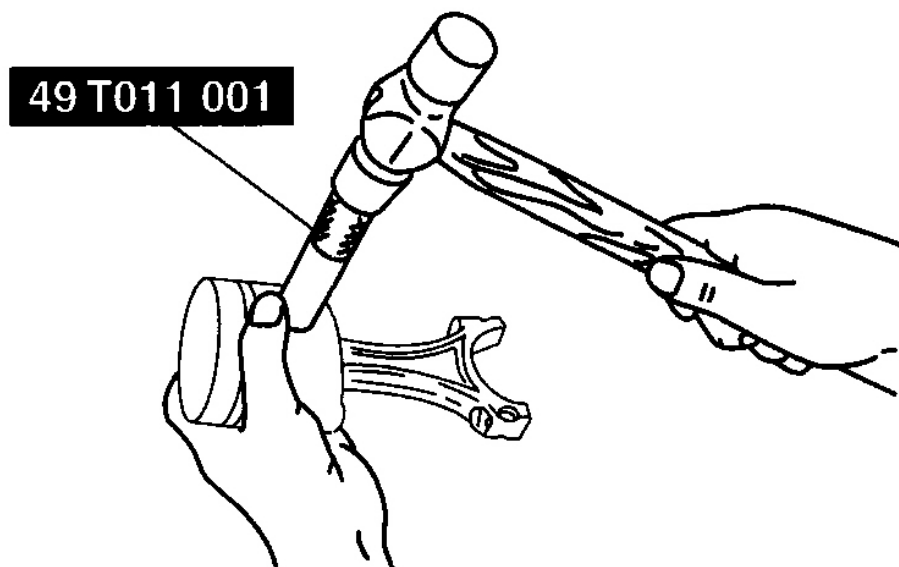
Fig. 24: Inspecting Connecting Rod Side Clearance
Courtesy of MAZDA MOTORS CORP.

Connecting Rod, Piston Disassembly Note

1. Before removing the connecting rod and piston, remove the carbon in the cylinder.
2. Before removing the connecting rod piston, inspect the oil clearance at the large end of the connecting rod. (See **CONNECTING ROD CLEARANCE INSPECTION**).

Piston Pin Disassembly Note

1. Before removing the piston pin, weigh the connecting rod. (See **PISTON, CONNECTING ROD INSPECTION**).
2. Remove the piston pin using the SST .

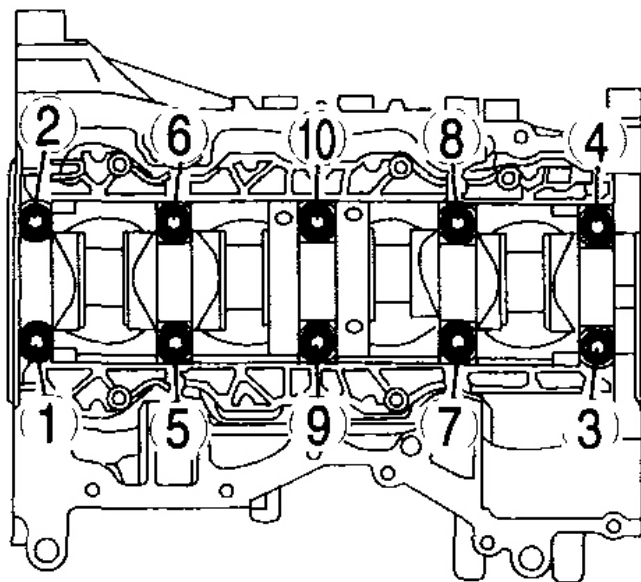


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Fig. 25: Removing Piston Pin Using SST
Courtesy of MAZDA MOTORS CORP.

Main Bearing Cap Disassembly Note

1. Before removing the main bearing cap, inspect the crankshaft end play. (See **CRANKSHAFT INSPECTION**).
2. Loosen the main bearing cap bolts in two to three passes in the order shown in the figure and remove them.



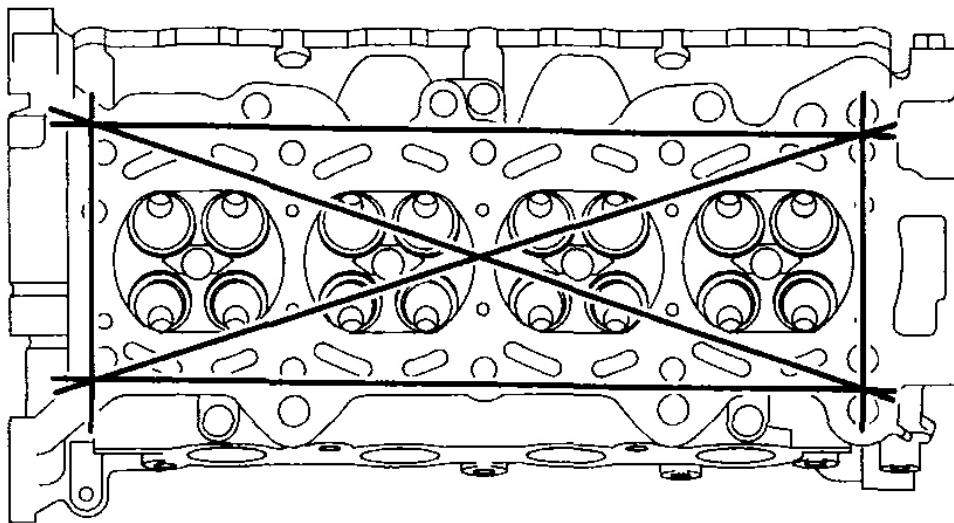
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Fig. 26: Main Bearing Cap Bolts Loosening Order
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD INSPECTION

1. Inspect the cylinder head surface for cracks and other damage using a red dye penetrant.
 - If there is a malfunction, replace the cylinder head.
2. Measure the combustion chamber side of the cylinder head for distortion in six directions as shown in the figure using a straight edge and feeler gauge.
 - If the distortion exceeds the maximum specification, replace the cylinder head.

Maximum distortion, head gasket side 0.10 mm {0.004 in}



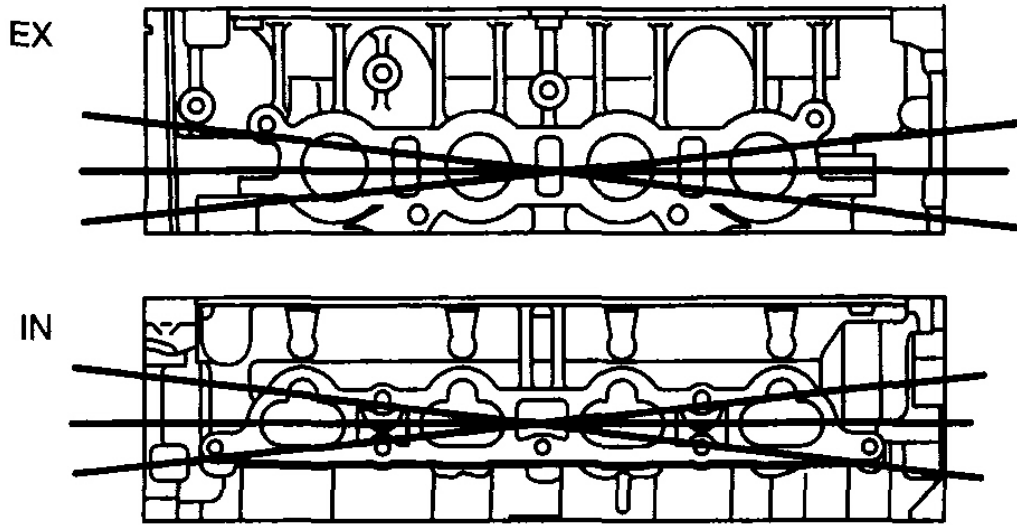
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Fig. 27: Identifying Direction For Measuring Distortion
Courtesy of MAZDA MOTORS CORP.

3. Inspect the contact surface of the exhaust manifold and the intake manifold for distortion by measuring as shown in the figure using a straight edge and feeler gauge.
 - If the distortion exceeds the maximum specification, grind the surface or replace the cylinder head.

Maximum distortion, manifold side 0.10 mm {0.004 in}

Maximum cutting length, manifold side 0.15 mm {0.006 in}



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Fig. 28: Inspecting Contact Surface Of Exhaust Manifold And Intake Manifold For Distortion
Courtesy of MAZDA MOTORS CORP.

VALVE SEAT INSPECTION/REPAIR

1. Measure the contact width of the valve face and the valve seat using the valve lapping compound.
 - If it is not within the specification, resurface the valve seat using the 45° valve seat cutter.

Standard valve seat contact width

IN: 0.7-1.3mm {0.0276-0.0511 in}

EX: 0.7-1.3mm {0.0276-0.0511 in}

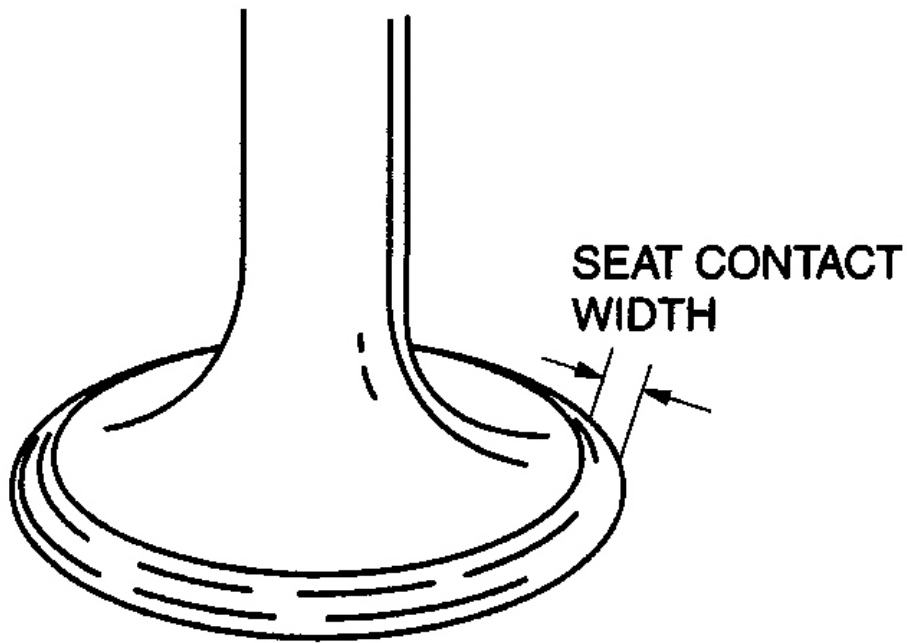
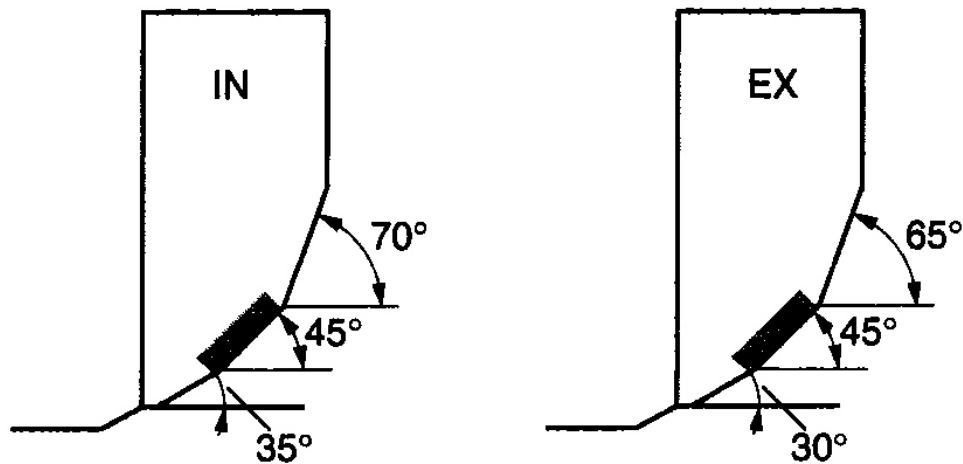
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Fig. 29: Identifying Valve Contact Width
Courtesy of MAZDA MOTORS CORP.

2. Verify that the area where the valve seat contacts the valve face is centered.
 - If the seating position is too high, resurface the valve seat using a **70° (IN) 65° (EX)** valve seat cutter and a **45°** valve seat cutter.
 - If the seating position is too low, resurface the valve seat using a **35° (IN) 30° (EX)** valve seat cutter and a **45°** valve seat cutter.

Valve seat angle**IN: 45°****EX: 45°**



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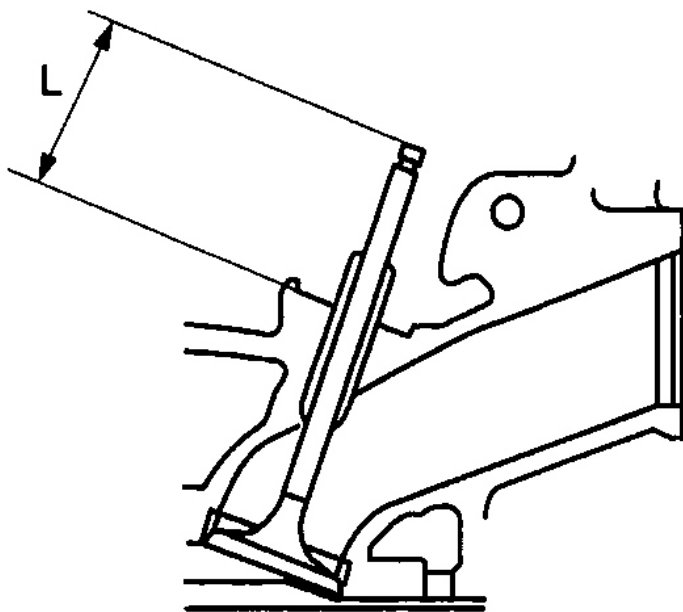
Fig. 30: Resurfacing Valve Seat
Courtesy of MAZDA MOTORS CORP.

3. Inspect the valve seat for sinkage. Measure the protruding length (dimension L) of the valve stem using a valve of standard length.
 - If it is not within the specification, replace the cylinder head.

Standard valve seat sinkage amount (Dimension L)

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

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



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Fig. 31: Identifying Valve Seat Sinkage Amount (Dimension L)
Courtesy of MAZDA MOTORS CORP.

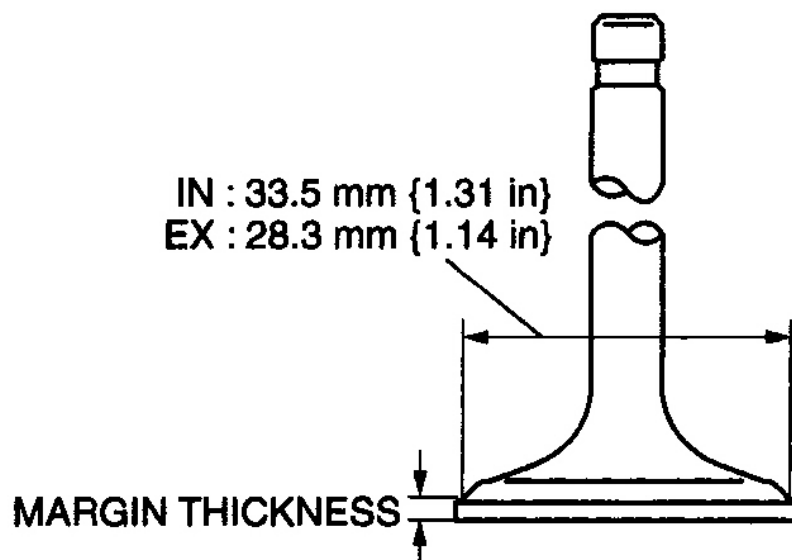
VALVE, VALVE GUIDE INSPECTION

1. Measure the valve head margin thickness using a vernier caliper.
 - If it is less than the minimum specification, replace the valve.

Minimum valve head margin thickness

IN: 1.62 mm {0.0637 in}

EX: 1.82 mm {0.0716 in}



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Fig. 32: Identifying Valve Head Margin Thickness
Courtesy of MAZDA MOTORS CORP.

2. Measure the length of the each valve using a vernier caliper.
 - If it is not within the specification, replace the valve.

Standard valve length (Dimension L)

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

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



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Fig. 33: Identifying Valve Length (Dimension L)
Courtesy of MAZDA MOTORS CORP.

3. Measure the stem diameter of each valve using the micrometer. Measurement positions total six and are in the X and Y directions, at three points (A, B, and C) as shown in the figure.
 - If it is less than the minimum specification, replace the valve.

Valve stem diameter

Standard

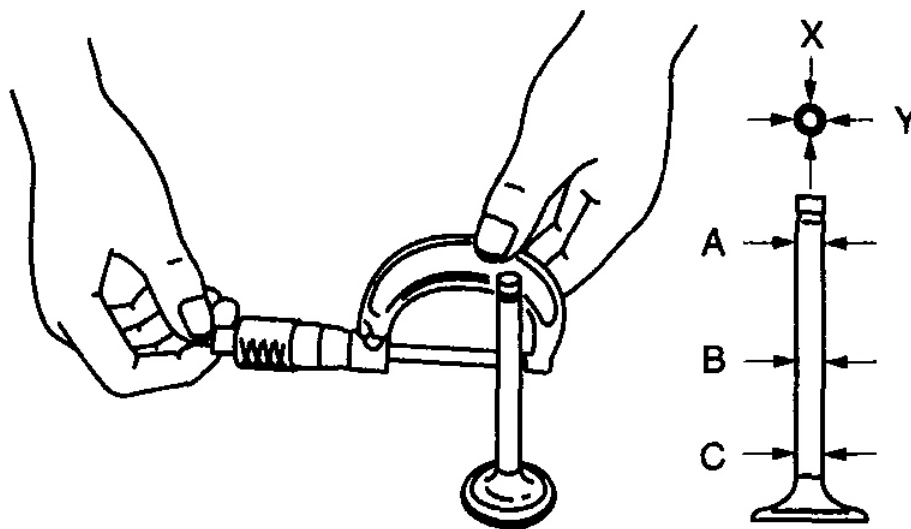
IN: 5.970-5.985 mm {0.2351-0.2356 in}

EX: 5.965-5.980 mm {0.2349-0.2354 in}

Minimum

IN: 5.940 mm {0.2339 in}

EX: 5.935 mm {0.2336 in}



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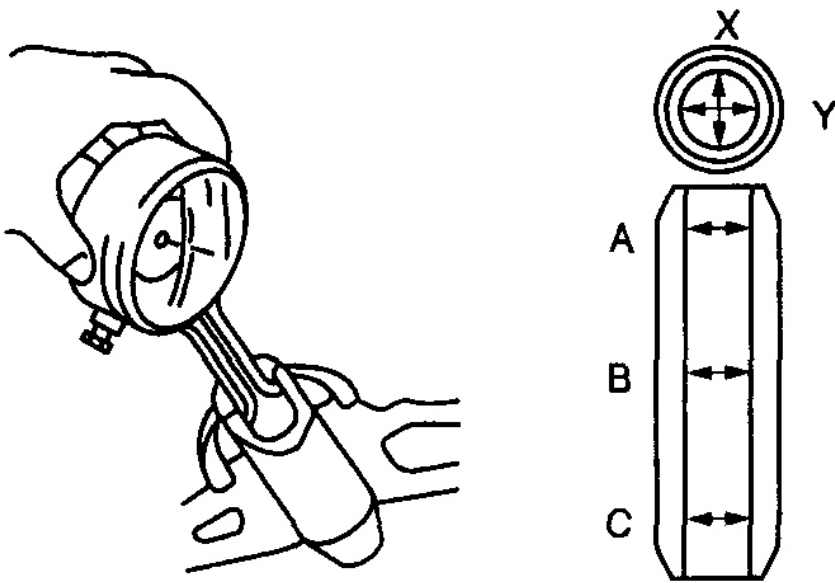
Fig. 34: Measuring Stem Diameter Of Valve Using Micrometer
Courtesy of MAZDA MOTORS CORP.

4. Measure the inner diameter of each valve guide using the caliper gauge. Measurement positions total six and are in the X and Y directions, at three points (A, B, and C) as shown in the figure.
 - If it is not within the specification, replace the valve guide.

Standard valve guide inner diameter

IN: 6.009-6.039 mm {0.2366-0.2377 in}

EX: 6.009-6.039 mm {0.2366-0.2377 in}



ADJ2224E026

Fig. 35: Measuring Inner Diameter Of Valve Guide Using Caliper Gauge
Courtesy of MAZDA MOTORS CORP.

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

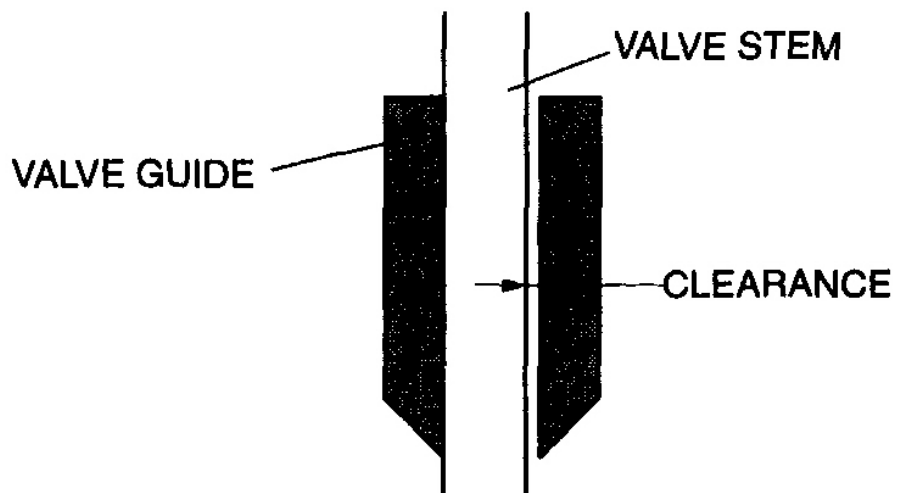
Clearance between valve stem and guide Standard

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

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

Maximum

0.10 mm {0.004 in}



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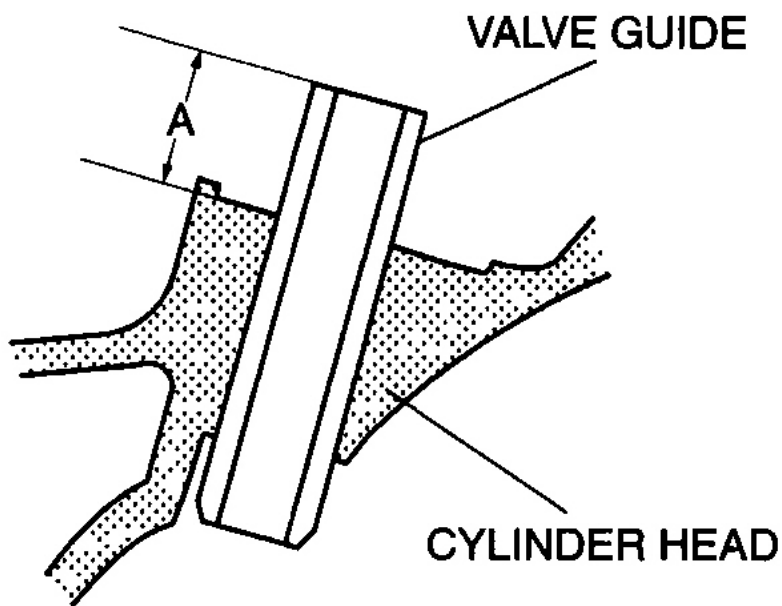
Fig. 36: Identifying Clearance Between Valve Stem And Valve Guide
Courtesy of MAZDA MOTORS CORP.

6. Measure the projection height (dimension A) of each valve guide using the vernier caliper.
 - If it is not within the specification, replace the valve guide.

Standard valve guide projection height

IN: 12.2-12.8 mm {0.481-0.503 in}

EX: 12.2-12.8 mm {0.481-0.503 in}



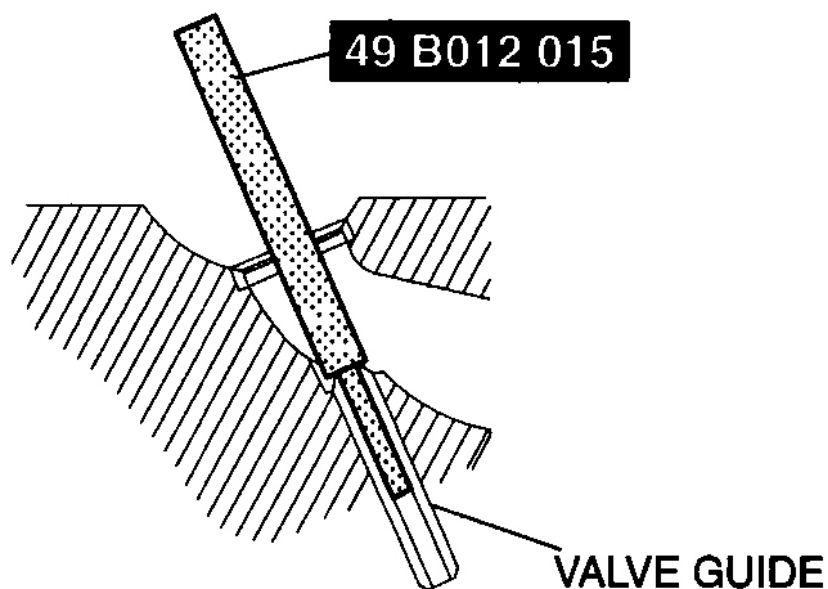
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Fig. 37: Identifying Projection Height (Dimension A)
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE REPLACEMENT

Removal

1. Tap the valve guide out from combustion chamber side using the SST.



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Fig. 38: Tapping Valve Guide Out From Combustion Chamber Side Using SST
Courtesy of MAZDA MOTORS CORP.

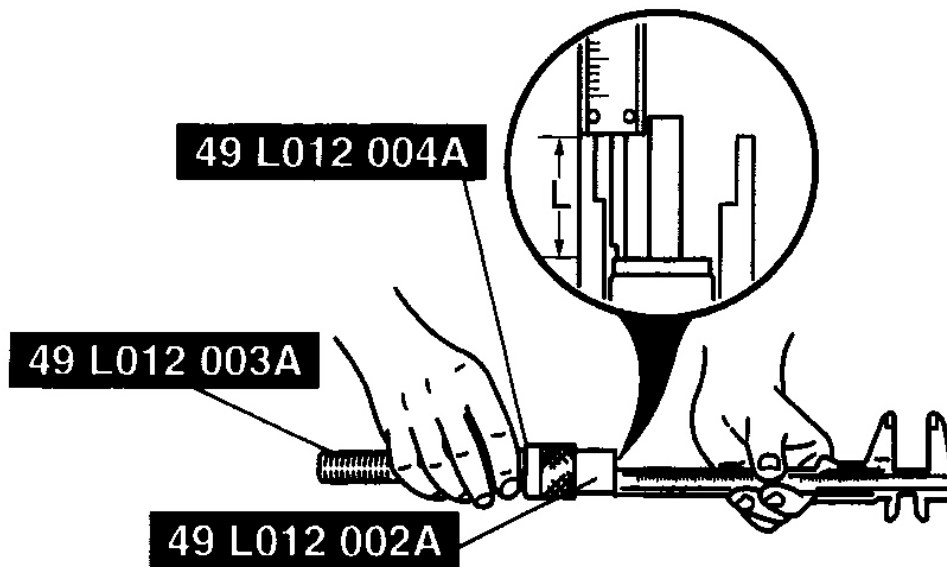
Installation

1. Assemble the SSTs so that dimension L is as specified.

Standard valve guide projection height

IN: 12.2-12.8 mm {0.481-0.503 in}

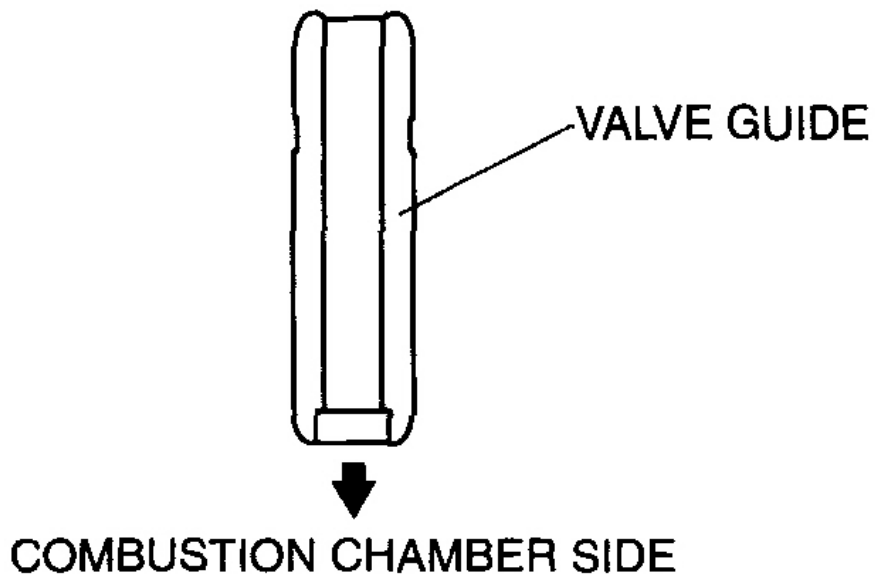
EX: 12.2-12.8 mm {0.481-0.503 in}



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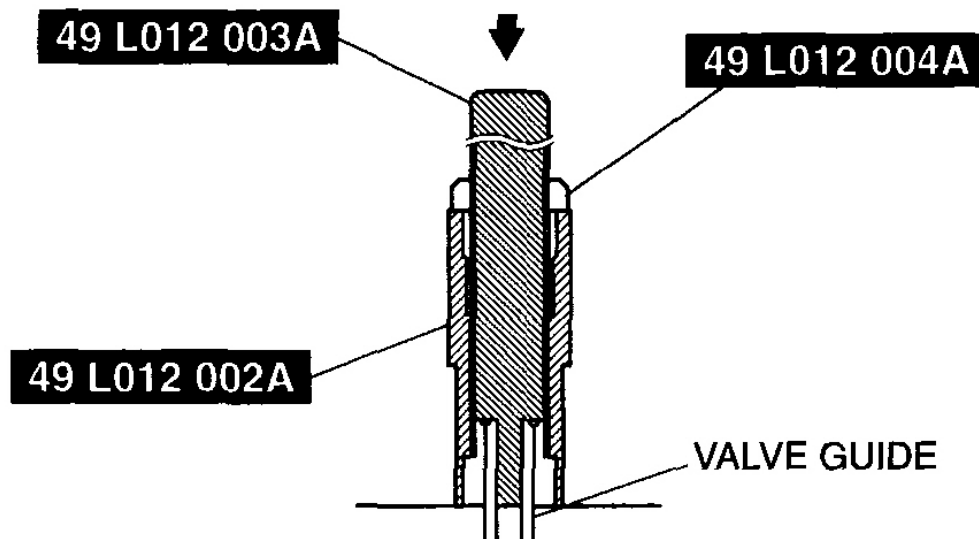
Fig. 39: Assembling SSTs
Courtesy of MAZDA MOTORS CORP.

2. Tap the valve guide in from the cam side using the SSTs assembled in Step 1.



E6U110ZWB061

Fig. 40: Identifying Valve Guide
Courtesy of MAZDA MOTORS CORP.



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Fig. 41: Tapping Valve Guide In From Cam Side Using SSTs
Courtesy of MAZDA MOTORS CORP.

VALVE SPRING INSPECTION

1. Measure the valve spring height using the spring tester.
 - If it is not within the specification, replace the valve spring.

Valve spring installation height

37.90 mm {1.492 in} (171.5 N {17.49 kgf, 38.55 lbf})

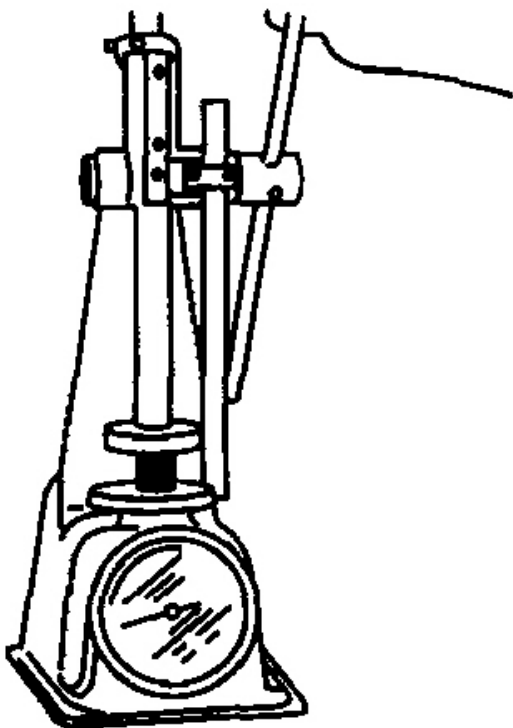
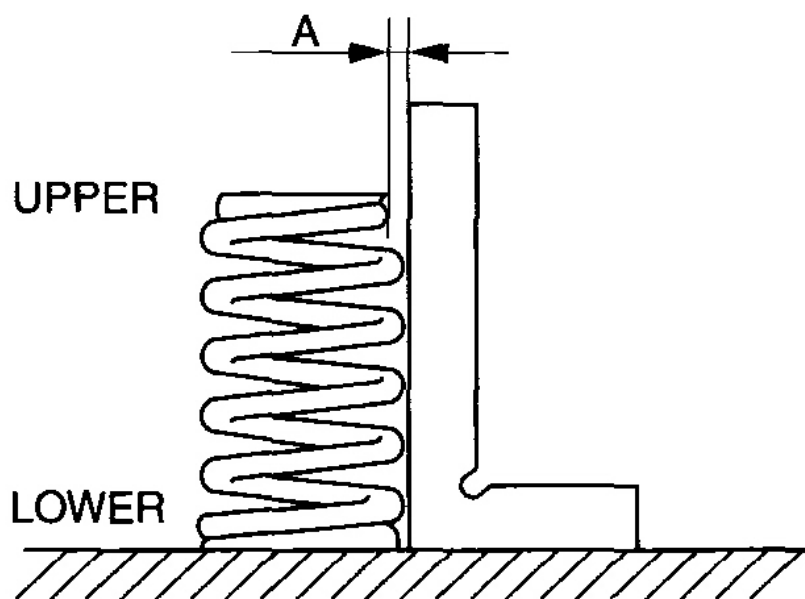
**ADJ2224E028**

Fig. 42: Measuring Valve Spring Height Using Spring Tester
Courtesy of MAZDA MOTORS CORP.

2. Measure the amount of off-square on the valve spring using a square.
1. Rotate the valve spring one full turn and measure A at the point where the gap is the largest.
 - If it exceeds the maximum specification, replace the valve spring.

Maximum valve spring off-square 2.55 mm {0.100 in}



B3E0110E073

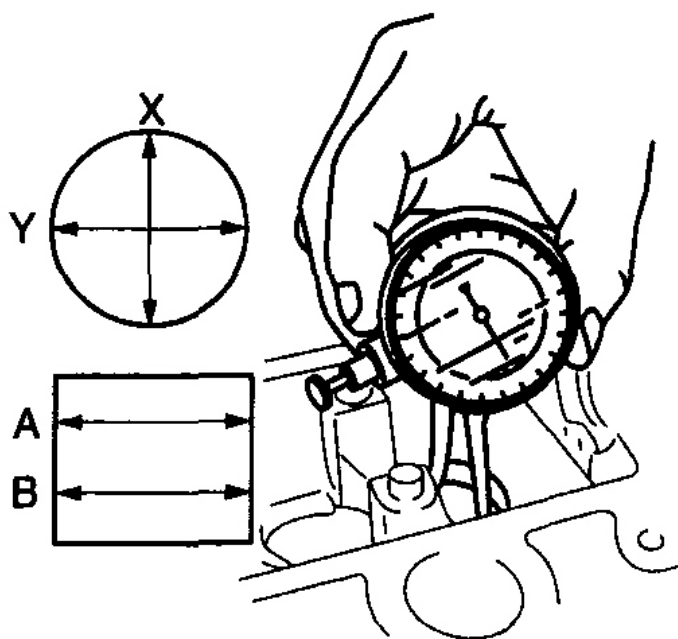
Fig. 43: Measuring Amount Of Off-Square On Valve Spring Using Square
Courtesy of MAZDA MOTORS CORP.

TAPPET INSPECTION

1. Measure the diameter of each tappet bore using the caliper gauge. Measurement positions total four and are in the X and Y directions, at two points (A and B) as shown in the figure.

Standard tappet bore diameter

31.000-31.030 mm {1.2205-1.2216 in}



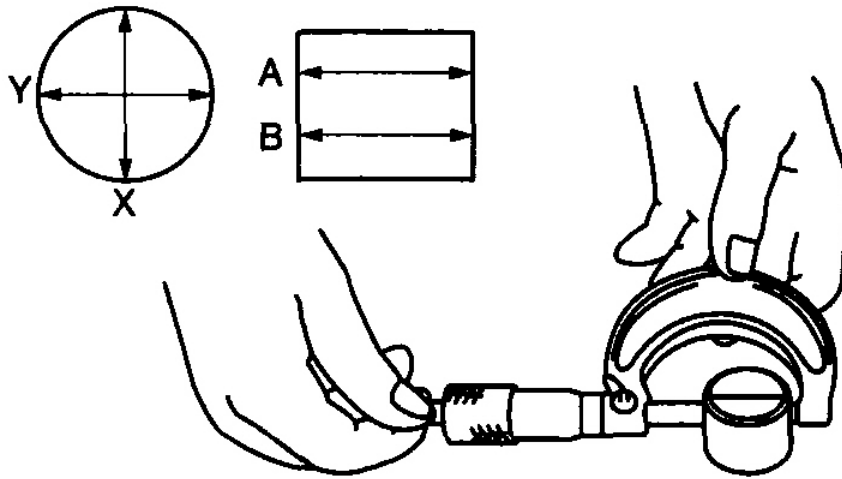
ADJ2224E023

Fig. 44: Measuring Diameter Of Tappet Bore Using Caliper Gauge
Courtesy of MAZDA MOTORS CORP.

2. Measure the tappet body outer diameter of each valve using the micrometer. Measurement positions total four and are in the X and Y directions, at two points (A and B) as shown in the figure.

Standard tappet body outer diameter

30.970-30.980 mm {1.2193-1.2196 in}



ADJ2224E029

Fig. 45: Measuring Tappet Body Outer Diameter
Courtesy of MAZDA MOTORS CORP.

3. Calculate the clearance between the tappet and the related tappet bore by subtracting the outer diameter of the tappet from the inner diameter of the tappet bore.
 - If it exceeds the maximum specification, replace the tappet or cylinder head.

Clearance between tappet and tappet bore

Standard

0.02-0.06 mm {0.0008-0.0023 in}

Maximum

0.15 mm {0.006 in}

VARIABLE VALVE TIMING ACTUATOR INSPECTION

1. Rotate the variable valve timing actuator by hand and verify that the groove of the rotor and notch of the cover on the variable valve timing actuator are aligned and fitted.

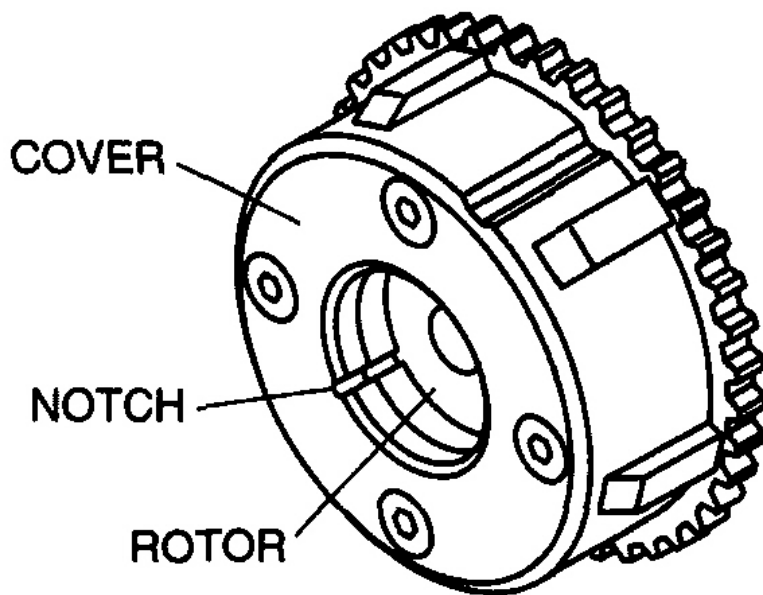
CAUTION: • If the groove and notch are not aligned, rotate the rotor toward the

valve timing retard position until a locking sound is heard and verify that they are set in place.

- If the rotor and cover are not secured even though their notch and groove are aligned, replace the variable valve timing actuator.

CAUTION:

- Due to the precision interior construction of the variable valve timing actuator, it cannot be disassembled.



B3E0110E089

Fig. 46: Identifying Rotor And Cover
Courtesy of MAZDA MOTORS CORP.

OIL CONTROL VALVE (OCV) INSPECTION

Coil Resistance Inspection

1. Measure the coil resistance between terminals A and B using a tester.
- If it is not within the specification, replace the oil control valve.

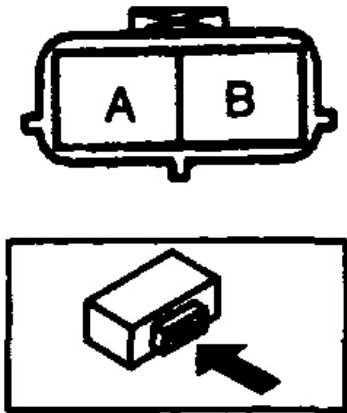
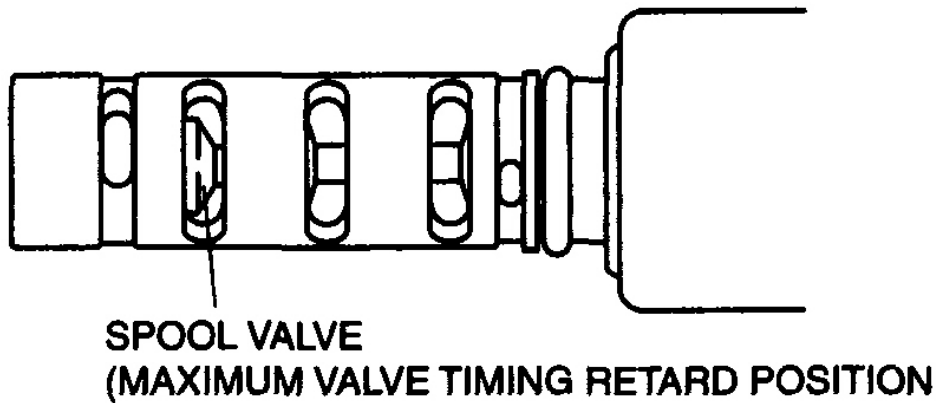
Oil control valve coil resistance**6.9-7.9 ohms [20°C {68°F}]****OIL CONTROL VALVE (OCV)****AME2226W002**

Fig. 47: Identifying Oil Control Valve (OCV) Terminals
Courtesy of MAZDA MOTORS CORP.

Spool Valve Operation Inspection

1. Verify that the spool valve inside the oil control valve is at the maximum valve timing retard position as shown in the figure.
 - If there is any malfunction, replace the oil control valve.



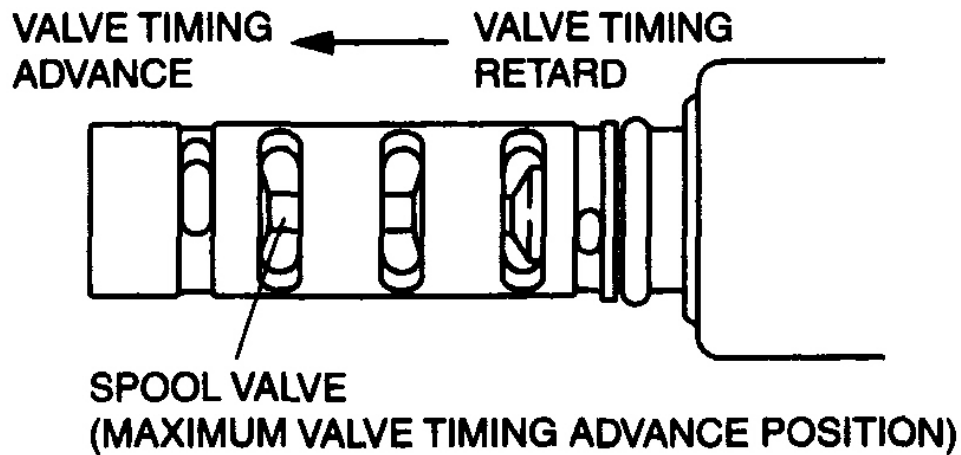
B3E0110E090

Fig. 48: Identifying Spool Valve (Maximum Valve Timing Retard Position)
Courtesy of MAZDA MOTORS CORP.

2. Apply battery positive voltage between the oil control valve terminals A and B and verify that the spool valve operates and move to the maximum valve timing retard position.
 - If there is any malfunction, replace the oil control valve.

NOTE:

- **When applying battery positive voltage between the oil control valve terminals, the connection of the positive and negative cables can be either terminal A or B.**
3. Stop applying battery positive voltage and verify that the spool valve returns to the maximum valve timing retard position.
 - If there is any malfunction, replace the oil control valve.



B3E0110E091

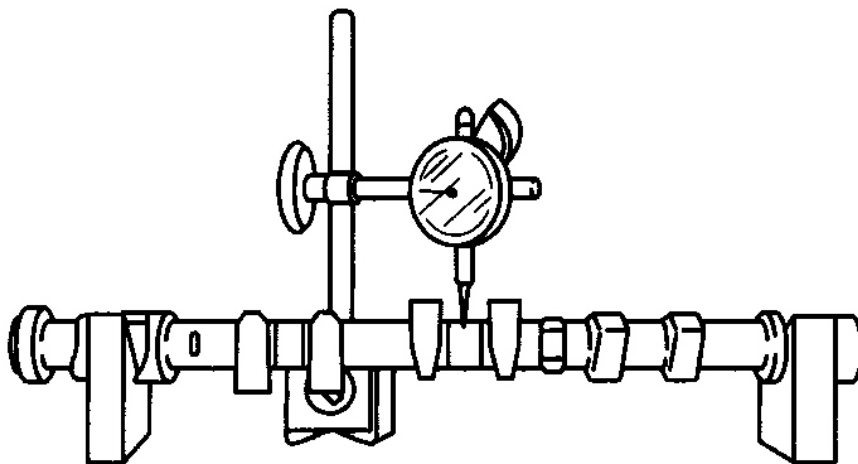
Fig. 49: Identifying Spool Valve (Maximum Valve Timing Advanced Position)
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT INSPECTION

1. Set the No. 1 and No.5 journals of the camshaft on V-blocks.
2. Measure the camshaft runout using the dial gauge.
 - If it is not within the specification, replace the camshaft.

Maximum camshaft runout

0.03 mm {0.0012 in}



B3E0110E074

Fig. 50: Measuring Camshaft Runout
Courtesy of MAZDA MOTORS CORP.

3. Measure the cam height using the micrometer as shown in the figure.
 - If it is less than the minimum specification, replace the camshaft.

Cam height

Standard

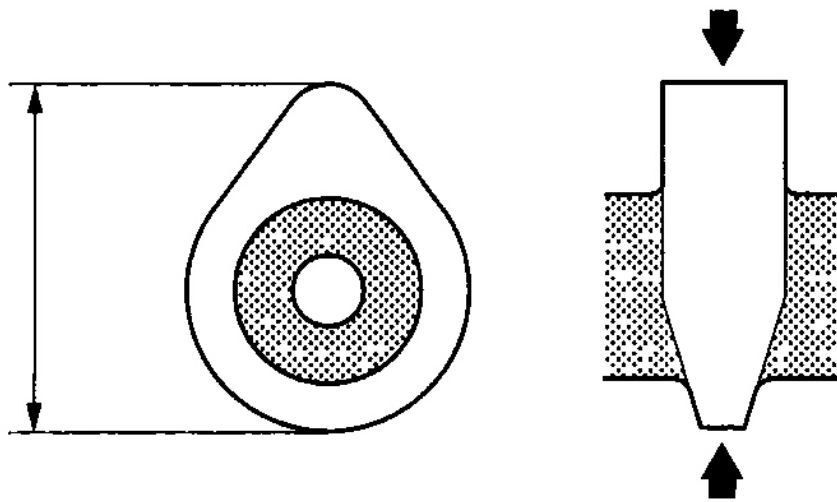
IN: 42.44 mm {1.671 in}

EX: 41.18 mm {1.622 in}

Minimum

IN: 42.34 mm {1.667 in}

EX: 41.08 mm {1.618 in}



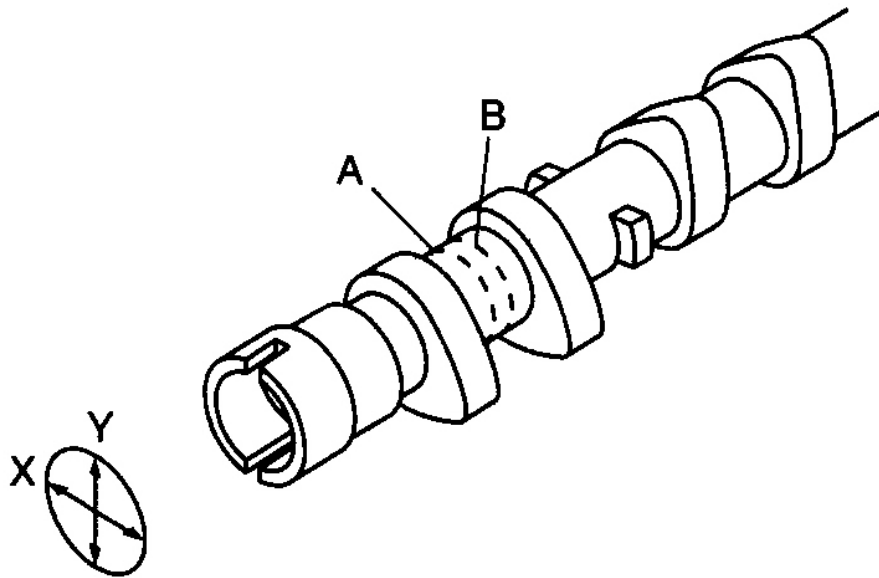
B3E0110E076

Fig. 51: Measuring Cam Height Using Micrometer

Courtesy of MAZDA MOTORS CORP.

4. Measure the journal diameter using the micrometer. Measurement positions total four and are in the X and Y directions, at two points (A and B) as shown in the figure.
 - If it is less than the minimum specification, replace the camshaft.

Camshaft journal diameter**Standard****24.96-24.98 mm {0.9827-0.9834 in}****Minimum****24.95 mm {0.982 in}**



B3E0110E075

Fig. 52: Journal Diameter Measurement Positions
Courtesy of MAZDA MOTORS CORP.

5. Measure the camshaft journal oil clearance using the plastigage with the tappet removed.
 - If it exceeds the maximum specification, replace the cylinder head.

NOTE:

- Clean the camshaft journal and the journal receptacle part.
- Cut the plastigage to the same length as the journal width and position it parallel to the camshaft.

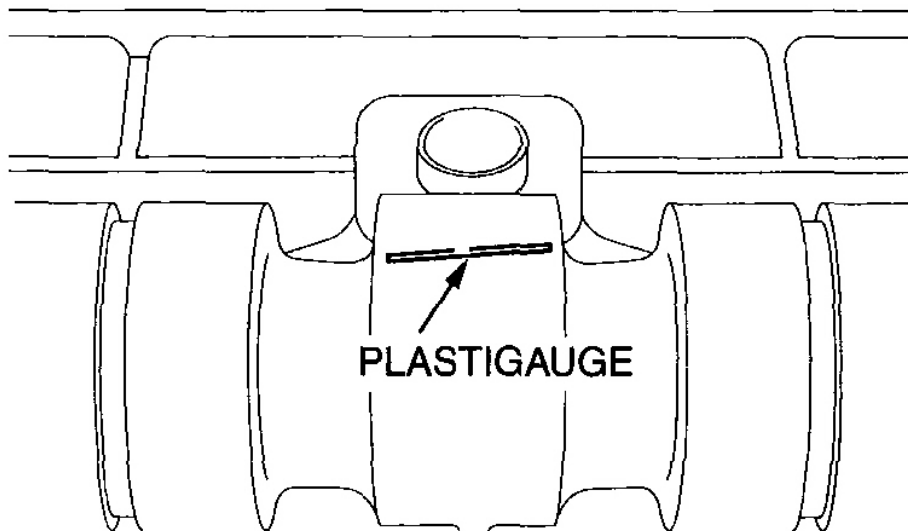
Camshaft journal oil clearance

Standard

0.04-0.08 mm {0.002-0.003 in}

Maximum

0.09 mm {0.0035 in}



B3E0110E077

Fig. 53: Measuring Camshaft Journal Oil Clearance Using Plastigage
Courtesy of MAZDA MOTORS CORP.

6. Measure the camshaft end play using a dial gauge.
 - If it exceeds the maximum specification, replace the cylinder head or camshaft.

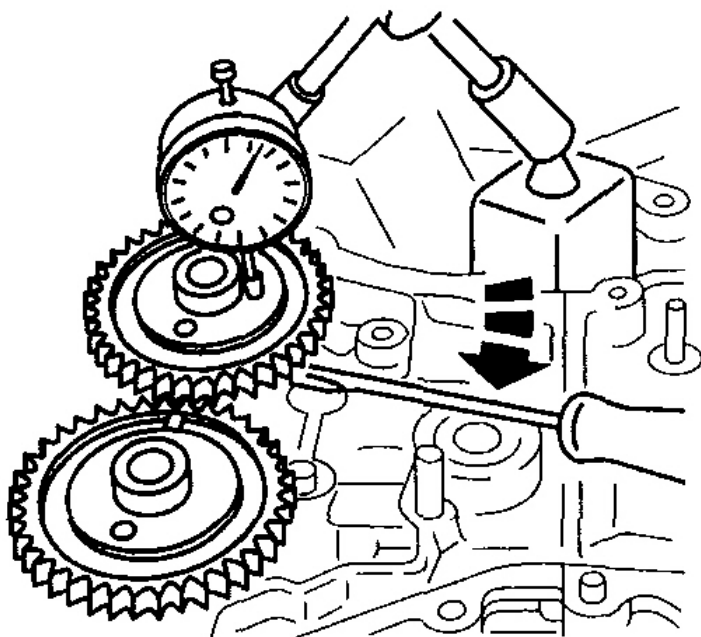
Camshaft end play

Standard

0.09-0.24 mm {0.0035-0.0094 in}

Maximum

0.25 mm {0.0099 in}



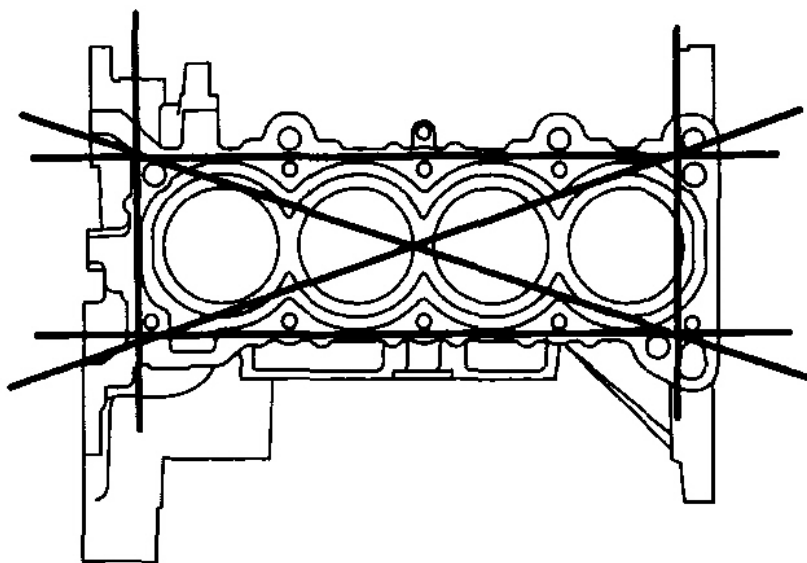
B3E0110E078

Fig. 54: Measuring Camshaft End Play Using Dial Gauge
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK INSPECTION

1. Measure the cylinder block for distortion in six directions as shown in the figure using a straight edge and feeler gauge.
 - If it exceeds the maximum specification, replace the cylinder block.

Maximum distortion, head gasket side 0.10 mm {0.004 in}

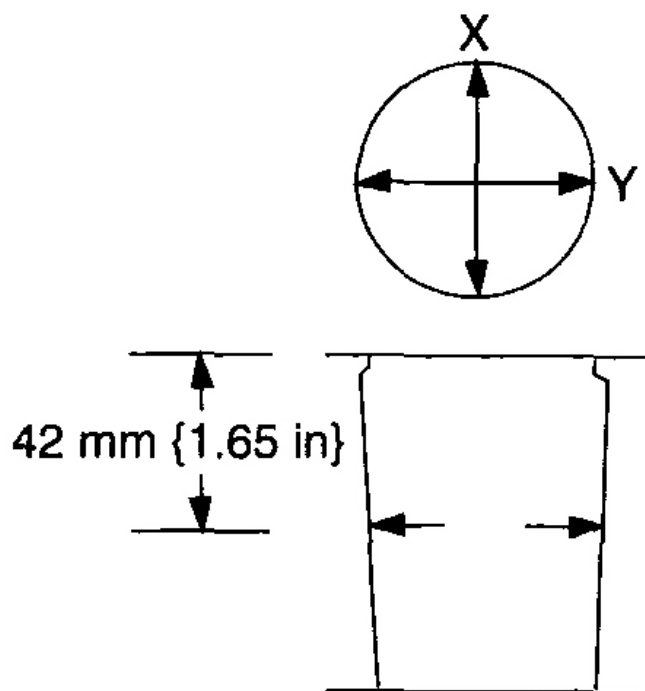


ADJ2224E089

Fig. 55: Measuring Cylinder Block Distortion In Six Directions
Courtesy of MAZDA MOTORS CORP.

2. Measure the cylinder bore diameter using the cylinder gauge. The measurement position is in the X and Y directions at a point 42 mm below the top surface of the cylinder as shown in the figure.
 - If it exceeds the maximum specification, replace the cylinder block.

Maximum bore inner diameter 87.500-87.530 mm {3.4449-3.4460 in}

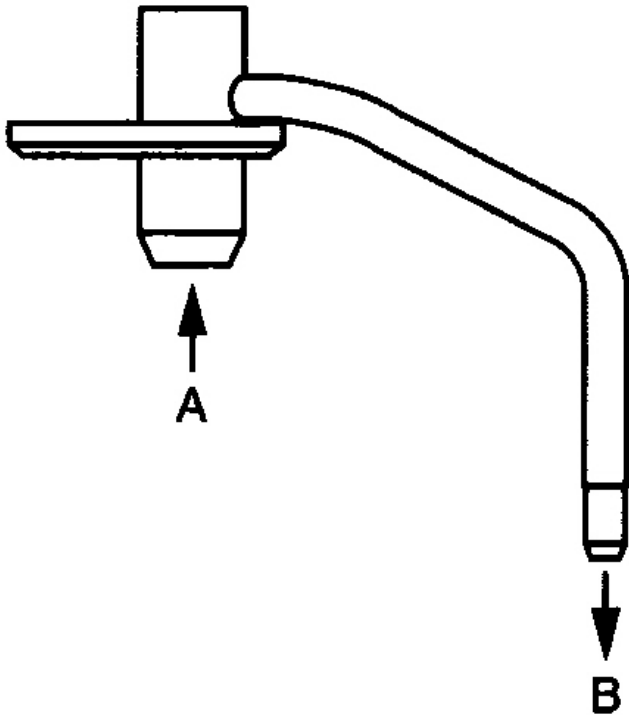


C3U0110E007

Fig. 56: Cylinder Bore Diameter Measurement Position
Courtesy of MAZDA MOTORS CORP.

OIL JET VALVE INSPECTION

1. Apply 0.17-0.23 MPa or more of compressed air to oil jet valve A and verify that air passes through oil jet valve B. If this cannot be verified, replace the oil jet valve.



E6U110ZEB003

Fig. 57: Identifying Oil Jet Valve A And B
Courtesy of MAZDA MOTORS CORP.

PISTON INSPECTION

1. Measure the piston outer diameter using the micrometer.

The measurement position is **10.0 mm {0.40 in}** from the lower end of the piston and in the thrust direction.

- If it is not within the specification, replace the piston.

Standard piston outer diameter 87.465-87.495 mm {3.4435-3.4446 in}

2. Calculate the cylinder-to-piston clearance from the cylinder bore diameter and the piston outer diameter.
 - If the clearance is at the maximum specification or more, replace the piston or cylinder block.

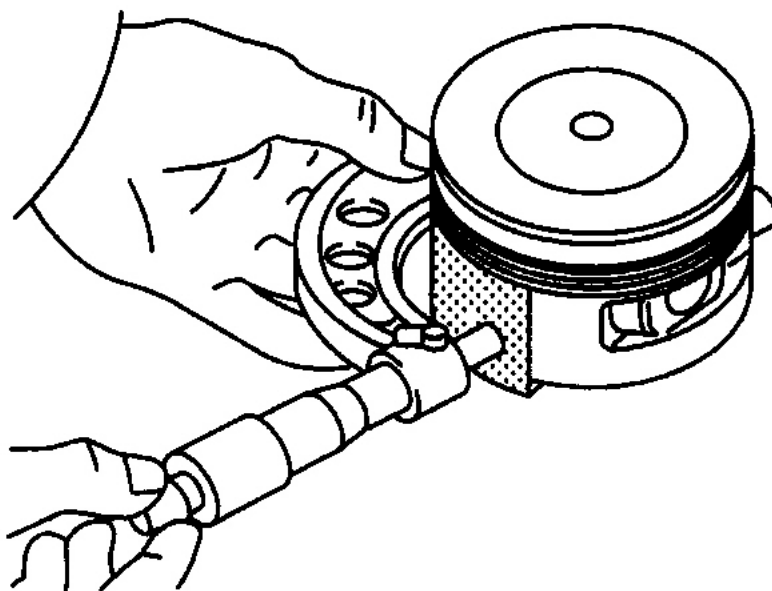
**B3E0110E080**

Fig. 58: Measuring Piston Outer Diameter Using Micrometer
Courtesy of MAZDA MOTORS CORP.

Clearance between piston and cylinder

Standard

0.025-0.045 mm {0.0010-0.0017 in}

Maximum

0.11 mm {0.0043 in}

3. Measure the piston-to-ring groove clearance along the perimeter using a feeler gauge.
 - If the clearance is at the maximum specification or more, replace the piston or piston ring.

Clearance between piston ring and ring groove

Standard

Top: 0.005-0.08 mm {0.0020-0.0031 in}

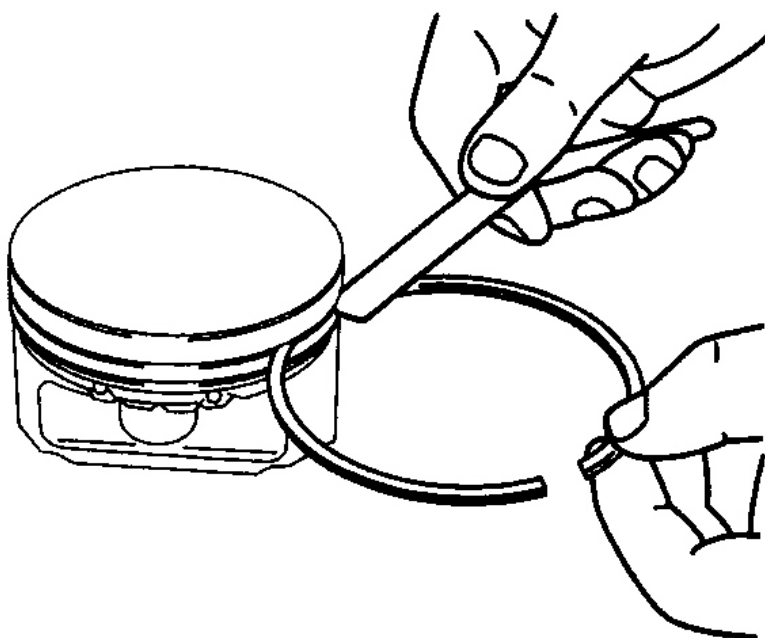
Second: 0.03-0.07 mm {0.0012-0.0027in}

Oil: 0.02-0.06 mm {0.0008-0.0023 in}

Maximum

Top: 0.17 mm {0.0067 in}

Second, Oil: 0.15 mm {0.0059 in}



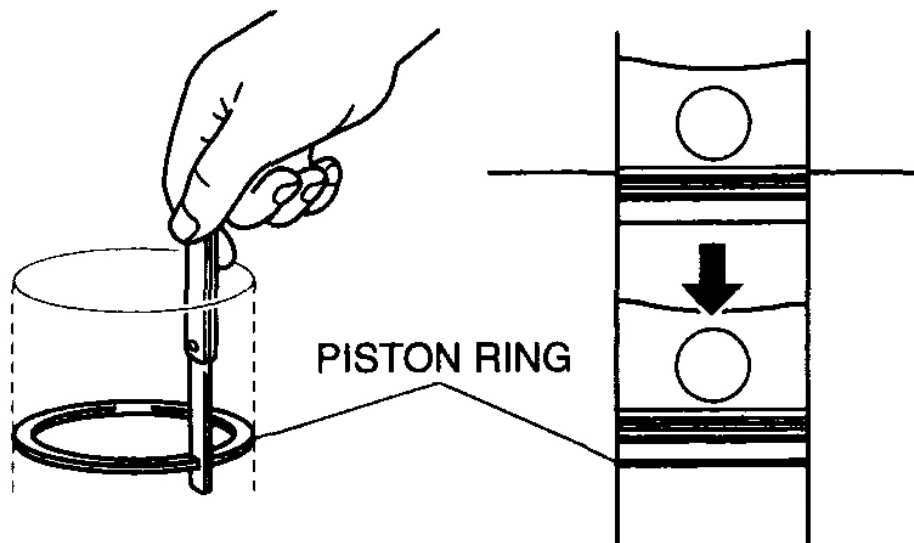
B3E0110E081

Fig. 59: Measuring Piston-To-Ring Groove Clearance

Courtesy of MAZDA MOTORS CORP.

4. Measure the piston ring end gap using a feeler gauge.
 - If it is at the maximum specification or more, replace the piston ring.

Piston ring end gap

Standard**Top: 0.14-0.24 mm {0.0056-0.0094 in}****Second: 0.34-0.44 mm {0.0134-0.0173 in}****Oil (rail): 0.15-0.40 mm {0.0060-0.0157 in}****Maximum****1.0 mm {0.0393 in}**

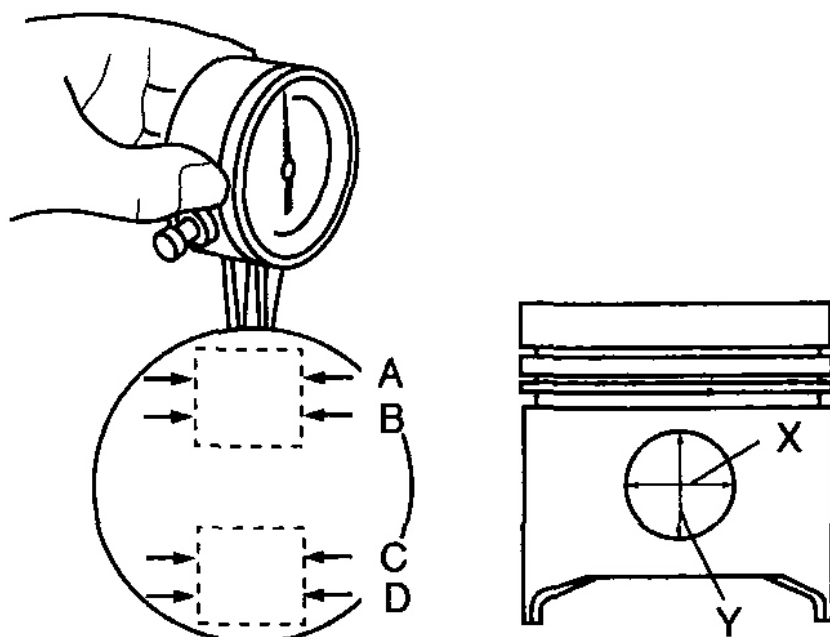
B3E0110E082

Fig. 60: Measuring Piston Ring End Gap Using Feeler Gauge
Courtesy of MAZDA MOTORS CORP.

PISTON PIN INSPECTION

1. Measure the piston pin hole diameter using the caliper gauge. Measurement positions total eight and are in the X and Y directions, at four points (A, B, C, and D) as shown in the figure.

Standard piston pin hole diameter 22.504-22.508 mm {0.8860-0.8861 in}



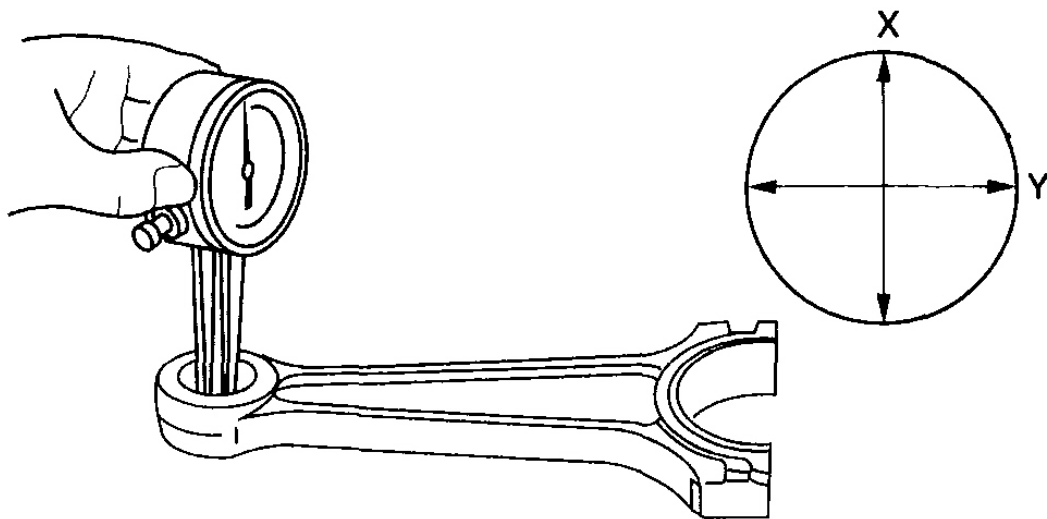
ADJ2224E253

Fig. 61: Measuring Piston Pin Hole Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure the inner diameter on the small end of the connecting rod using the caliper gauge. Measurement positions total eight and are in the X and Y directions, at four points (A, B, C, and D) as shown in the figure.

Standard connecting rod small end inner diameter

22.510-22.521 mm {0.8863-0.8866 in}



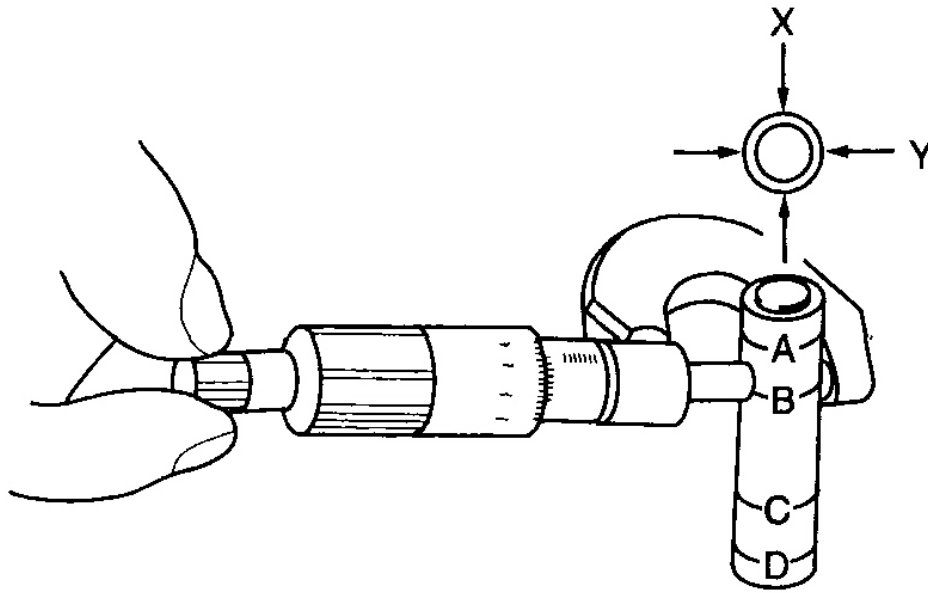
ADJ2224E254

Fig. 62: Measuring Inner Diameter On Small End Of Connecting Rod Using Caliper Gauge
Courtesy of MAZDA MOTORS CORP.

3. Measure the piston pin outer diameter using the micrometer. Measurement positions total eight and are in the X and Y directions, at four points (A, B, C, and D) as shown in the figure.

Standard piston pin outer diameter

22.495-22.500 mm {0.8857-0.8858 in}



ADJ2224E255

Fig. 63: Measuring Piston Pin Outer Diameter Using Micrometer
 Courtesy of MAZDA MOTORS CORP.

4. Calculate the clearance between the piston pin hole diameter and the piston pin outer diameter.
 - If it is not within the specification, replace the piston or the piston pin.

Standard clearance between piston pin hole diameter and piston outer diameter

0.004-0.013 mm {0.0002-0.0005 in}

5. Calculate the clearance between the inner diameter on the small end of the connecting rod and the piston pin outer diameter.
 - If it is not within the specification, replace the connecting rod or the piston pin.

Standard clearance between connecting rod small end inner diameter and piston pin outer diameter
0.010-0.026 mm {0.0004-0.0010 in}

CONNECTING ROD CLEARANCE INSPECTION

1. Measure the side clearance at the large end of the connecting rod using a feeler gauge.

- If it is at the maximum specification or more, replace the connecting rod or crankshaft.

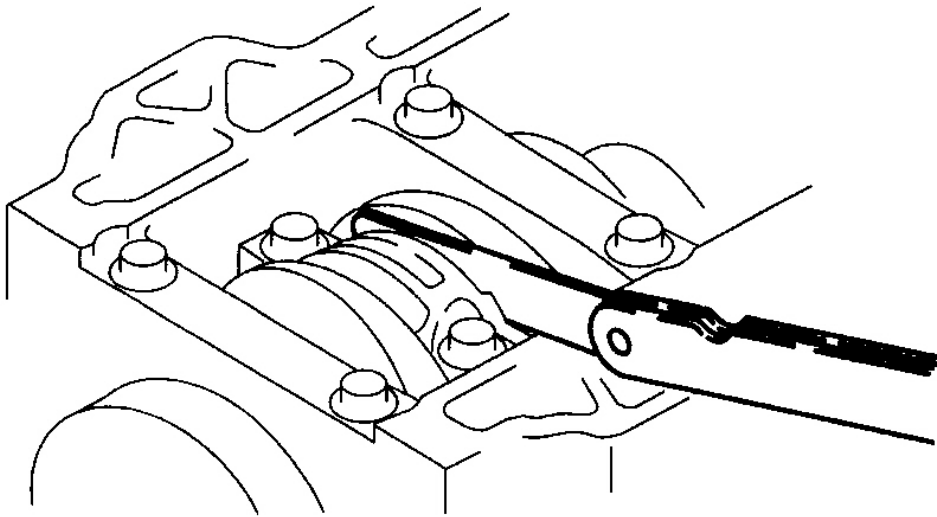
Connecting rod large end side clearance**Standard****0.14-0.36 mm {0.0056-0.0141 in}****Maximum****0.435 mm {0.0172 in}****B3E0110E087**

Fig. 64: Measuring Connecting Rod Side Clearance
Courtesy of MAZDA MOTORS CORP.

2. Using a plastigage, measure the oil clearance at the large end of the connecting rod.
 - If it is at the maximum specification or more, replace the bearing or grind the crank pin and use oversize bearings so that the specified clearance is obtained.

NOTE:

- **Cut the plastigage as wide as the connecting rod bearing width, place it parallel to the crankshaft, keeping away from the oil hole.**

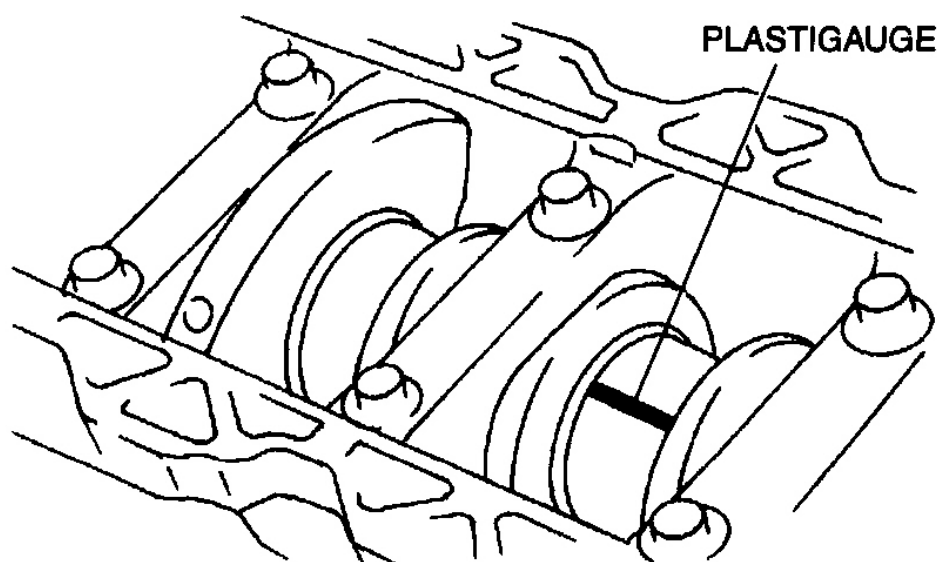
Bearing oil clearance at the large end of connecting rod**Standard****0.027-0.051 mm {0.0011-0.0020 in}****Maximum****0.1 mm {0.0039 in}****E6U110ZEB025**

Fig. 65: Measuring Oil Clearance Using Plastigage
Courtesy of MAZDA MOTORS CORP.

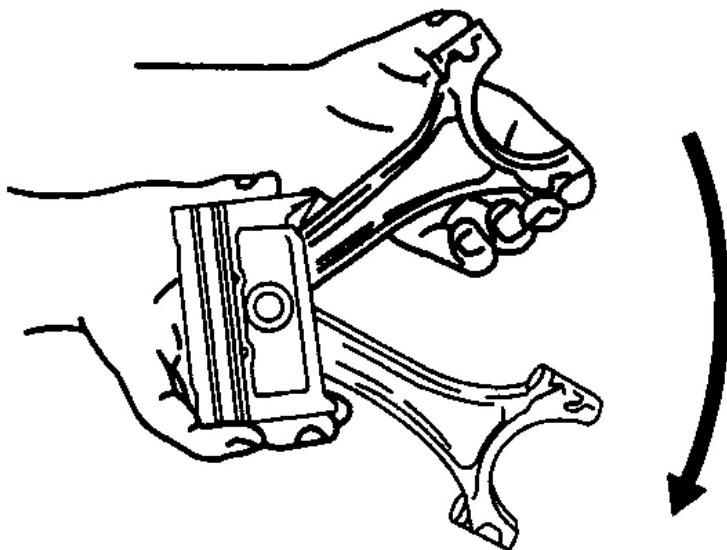
Connecting rod bearing size**STD****1.495-1.519 mm {0.0589-0.0598 in}****OS0.25****1.614-1.626 mm {0.0636-0.0640 in}**

OS0.50

1.739-1.751 mm {0.0685-0.0689 in}

PISTON, CONNECTING ROD INSPECTION

1. Check the oscillation torque as shown in the figure. Verify that the large end drops under its own weight with no resistance. If the piston shakes heavily or unsmoothly, replace the connecting rod and piston pin.



E6U110ZEB009

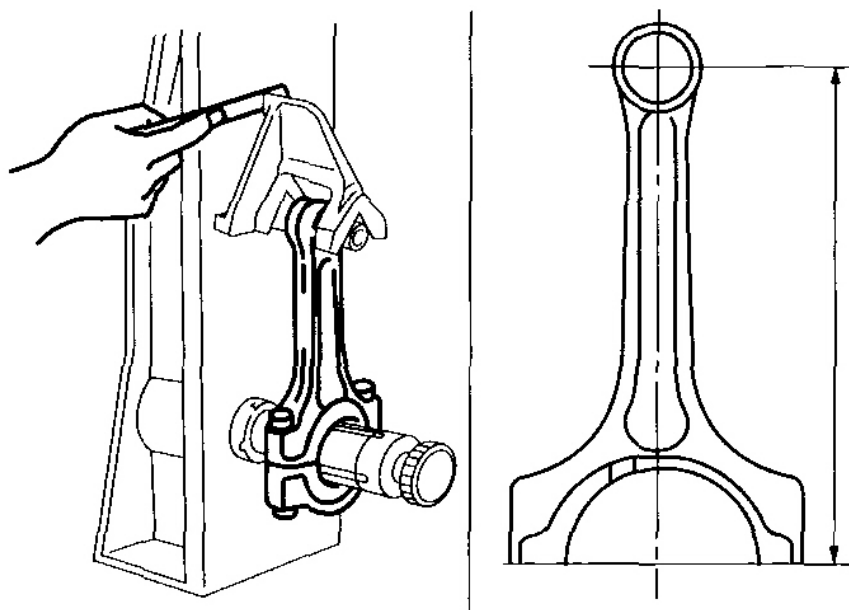
Fig. 66: Checking Oscillation Torque
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD INSPECTION

1. Inspect the connecting rod for bending and distortion using the connecting rod aligner. If it is at the maximum specification or more, replace the connecting rod.

Maximum connecting rod bending [per 50 mm {1.968 in}]

0.070 mm {0.0019 in}



AMJ2224E255

Fig. 67: Inspecting Connecting Rod For Bending And Distortion Using Connecting Rod Aligner
Courtesy of MAZDA MOTORS CORP.

Maximum connecting rod distortion [per 50 mm {1.968 in}]

0.060 mm {0.0027 in}

Connecting rod center-to-center distance

150.65-150.75 mm {5.9311-5.9350 in}

CRANKSHAFT INSPECTION

1. Measure the crankshaft end play using a dial gauge.
 - If it exceeds the maximum specification, replace the thrust bearing or crankshaft so that the specified end play is obtained.

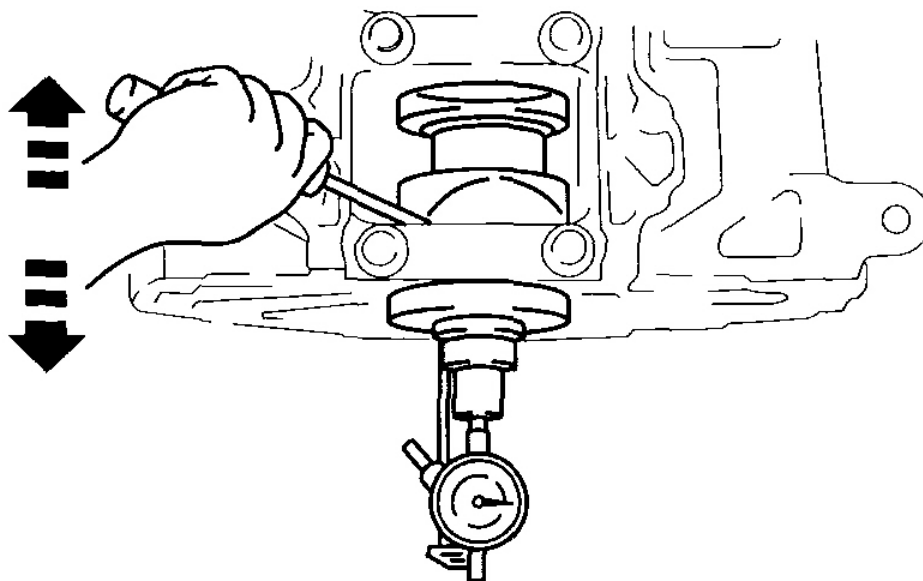
Crankshaft end play

Standard

0.22-0.45 mm {0.0087-0.0177 in}

Maximum

0.55 mm {0.021 in}

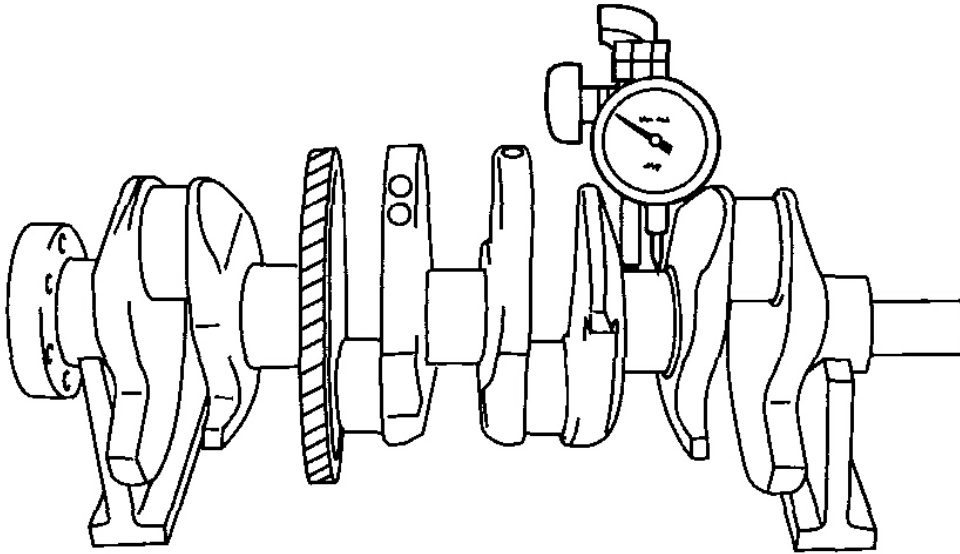


B3E0110E083

Fig. 68: Measuring Crankshaft End Play Using Dial Gauge
Courtesy of MAZDA MOTORS CORP.

2. Measure the runout of the main journal using a V-block and dial gauge.
 - If it is at the maximum specification or more, replace the crankshaft.

Maximum main journal runout 0.05 mm {0.0019 in}



AME2224E311

Fig. 69: Measuring Runout Of Main Journal
Courtesy of MAZDA MOTORS CORP.

3. Inspect the main journal diameter and crank pin diameter. Measurement positions total four and are in the X and Y directions, at two points (A and B) as shown in the figure.
 - If it is not within the specification or if it exceeds the maximum off-round, grind the journal with an oversized bearing.

Main journal diameter

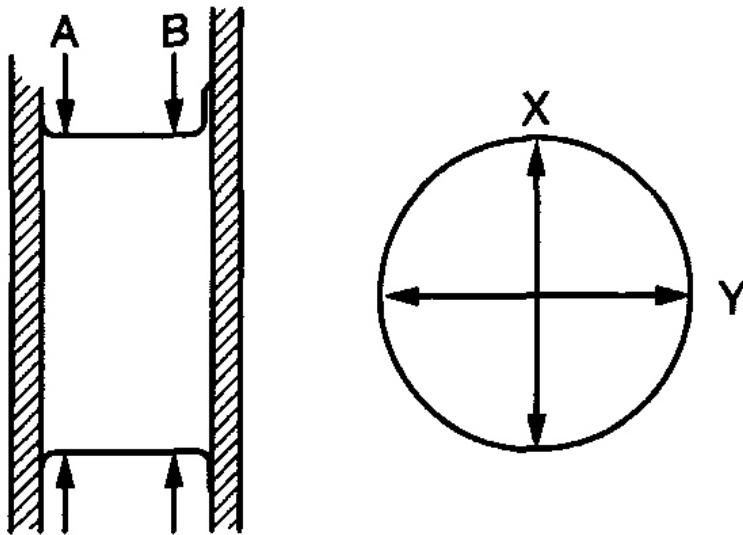
STD

51.980-52.000 mm {2.0465-2.0472 in}

OS0.25

51.730-51.750 mm {2.0367-2.0374 in}

Maximum main journal off-round 0.05 mm {0.0019 in}



B3E0110E085

Fig. 70: Main Journal And Crank Pin Diameter Measurement Positions
Courtesy of MAZDA MOTORS CORP.

Crank pin diameter

STD

51.980-52.000 mm {2.0465-2.0472 in}

OS0.25

51.730-51.750 mm {2.0367-2.0374 in}

Maximum crank pin off-round 0.05 mm {0.0019 in}

4. Inspect the main journal oil clearance using the following procedure.
 1. Install the upper main bearing and crankshaft.
 2. Position a plastigage on the journals.
 3. Install the lower main bearing and main bearing cap and tighten the bolts in the order shown in the figure.

Tightening procedure

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.lbf}
4. 38-42 N.m {3.9-4.2 kgf.m, 28.1-30.9 ft.lbf}
5. Loosen all the bolts (until bolts are torque-free).
6. 3-7 N.m {30.6-71.3 kgf.cm, 26.6-61.9 in.lbf}
7. 18-22 N.m {1.9-2.2 kgf.m, 13.3-16.2 ft.lbf}
8. 87.5°-92.5°

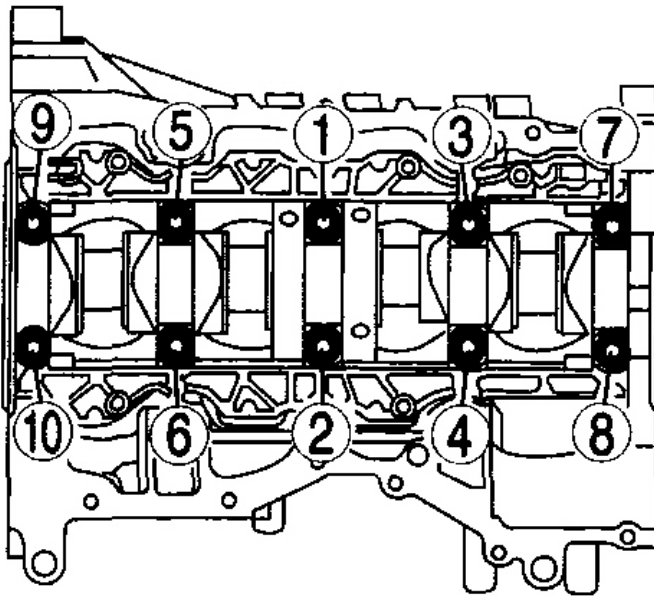
**B3E0110E267**

Fig. 71: Main Bearing Cap Bolts Tightening Order
Courtesy of MAZDA MOTORS CORP.

4. Loosen the bolts in the reverse order of tightening.
5. Measure the main journal oil clearance.

- If it is not within the specification, replace the main bearing, or grind the main journal and use oversized bearings so that the specified oil clearance is obtained.

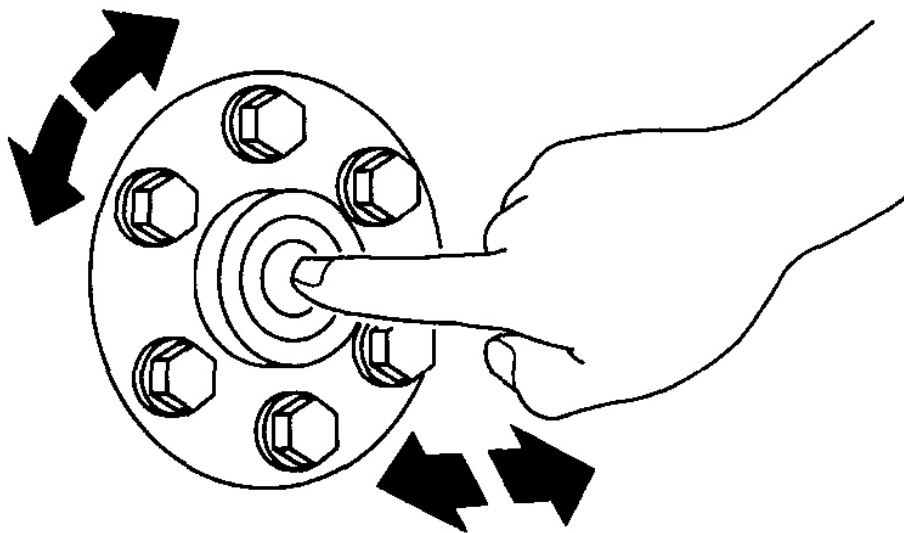
Main journal oil clearance**Standard****0.016-0.039 mm {0.0007-0.0015 in}****Maximum****0.10 mm {0.0039 in}****B3E0110E086**

Fig. 72: Measuring Main Journal Oil Clearance
Courtesy of MAZDA MOTORS CORP.

Main bearing size (UPPER)

STD**2.501-2.522 mm {0.0985-0.0992 in}****OS0.25****2.623-2.629 mm {0.1033-0.1035 in}****OS0.50****2.748-2.754 mm {0.1082-0.1084 in}****Main bearing size (LOWER)****STD****2.501-2.529 mm {0.0985-0.0995 in}****OS0.25****2.624-2.630 mm {0.1034-0.1035 in}****OS0.50****2.749-2.755 mm {0.1083-0.1084 in}****PILOT BEARING INSPECTION**

1. Without removing the pilot bearing, turn the bearing while applying force in the axial direction.
 - If there is any malfunction, replace the pilot bearing.



ADJ4920W002

Fig. 73: Inspecting Pilot Bearing
Courtesy of MAZDA MOTORS CORP.

BOLT INSPECTION

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

Cylinder head bolt length

Standard

144.7-145.3 mm {5.696-5.720 in}

Maximum

146 mm {5.748 in}

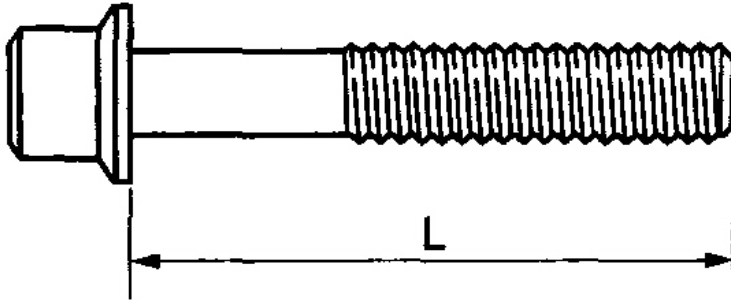
Connecting rod bolt length

Standard

43.7-44.3 mm {1.720-1.744 in}

Maximum

46 mm {1.811 in}



B3E0110E088

Fig. 74: Identifying Bolt Length
Courtesy of MAZDA MOTORS CORP.

VALVE CLEARANCE INSPECTION/ADJUSTMENT

VALVE CLEARANCE INSPECTION

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 it is not within the specification, replace the tappet and adjust the valve clearance to the standard clearance. (See **VALVE CLEARANCE ADJUSTMENT**).

Standard valve clearance [when cold]

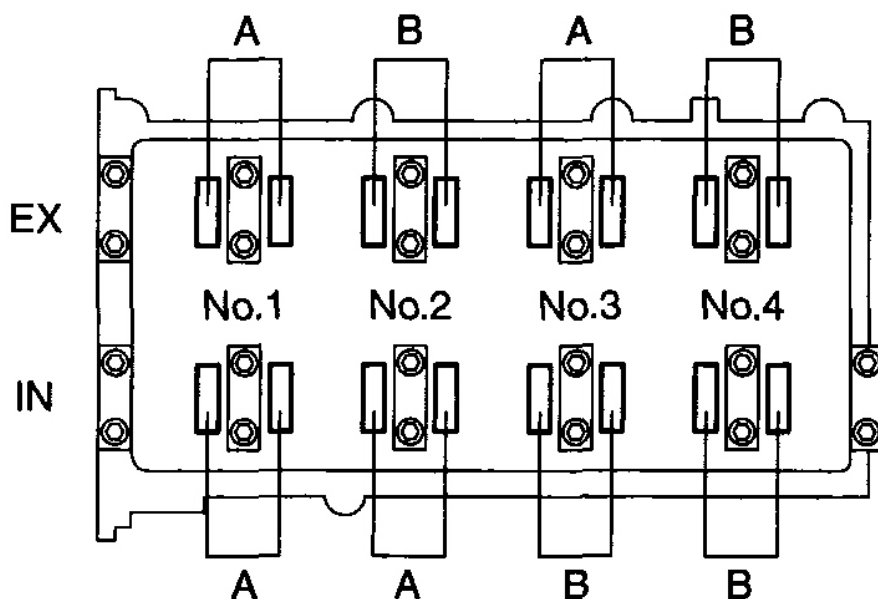
IN: 0.22-0.28 mm {0.0087-0.0110 in}

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

NOTE:

- When replacing the tappet, select the tappet according to the measured value and note down the measured value.

3. Rotate the crankshaft clockwise 360° so that the No. 4 piston is at the TDC of the compression stroke.
4. Measure the valve clearance at B in the figure.
 - If it is not within the specification, replace the tappet and adjust the valve clearance to the standard clearance. (See VALVE CLEARANCE ADJUSTMENT).



E6U110ZEB002

Fig. 75: Positions For Measuring Valve Clearance
 Courtesy of MAZDA MOTORS CORP.

Standard valve clearance [when cold]

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

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

NOTE:

- When replacing the tappet, select the tappet according to the measured value and note down the measured value.

VALVE CLEARANCE ADJUSTMENT

1. Remove the engine front cover lower blind plug.
2. Remove the engine front cover upper blind plug.

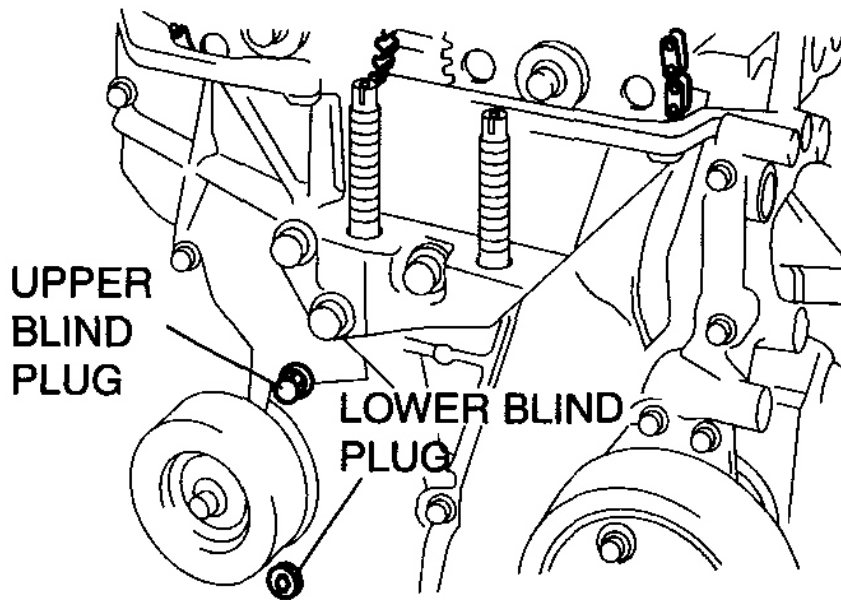
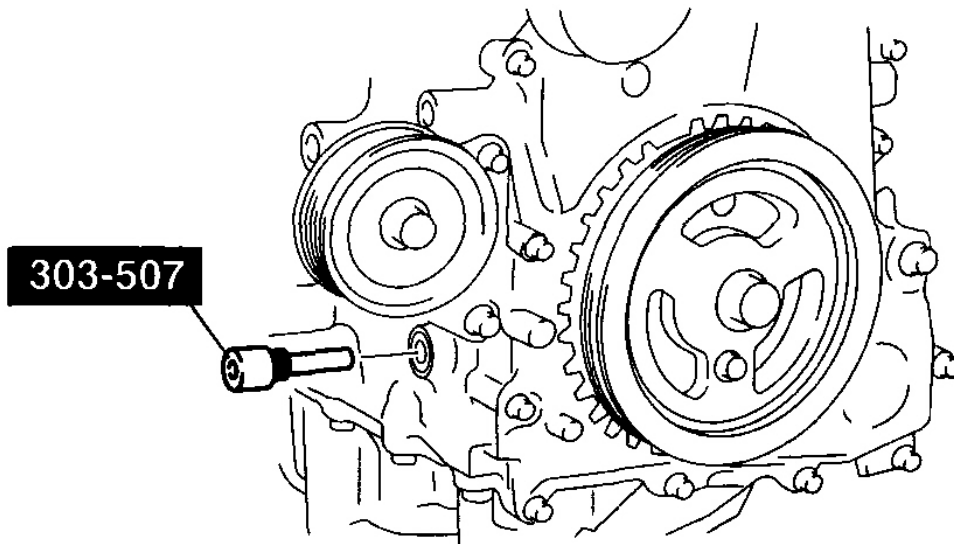
**B3E0110E093**

Fig. 76: Identifying Lower And Upper Blind Plug
Courtesy of MAZDA MOTORS CORP.

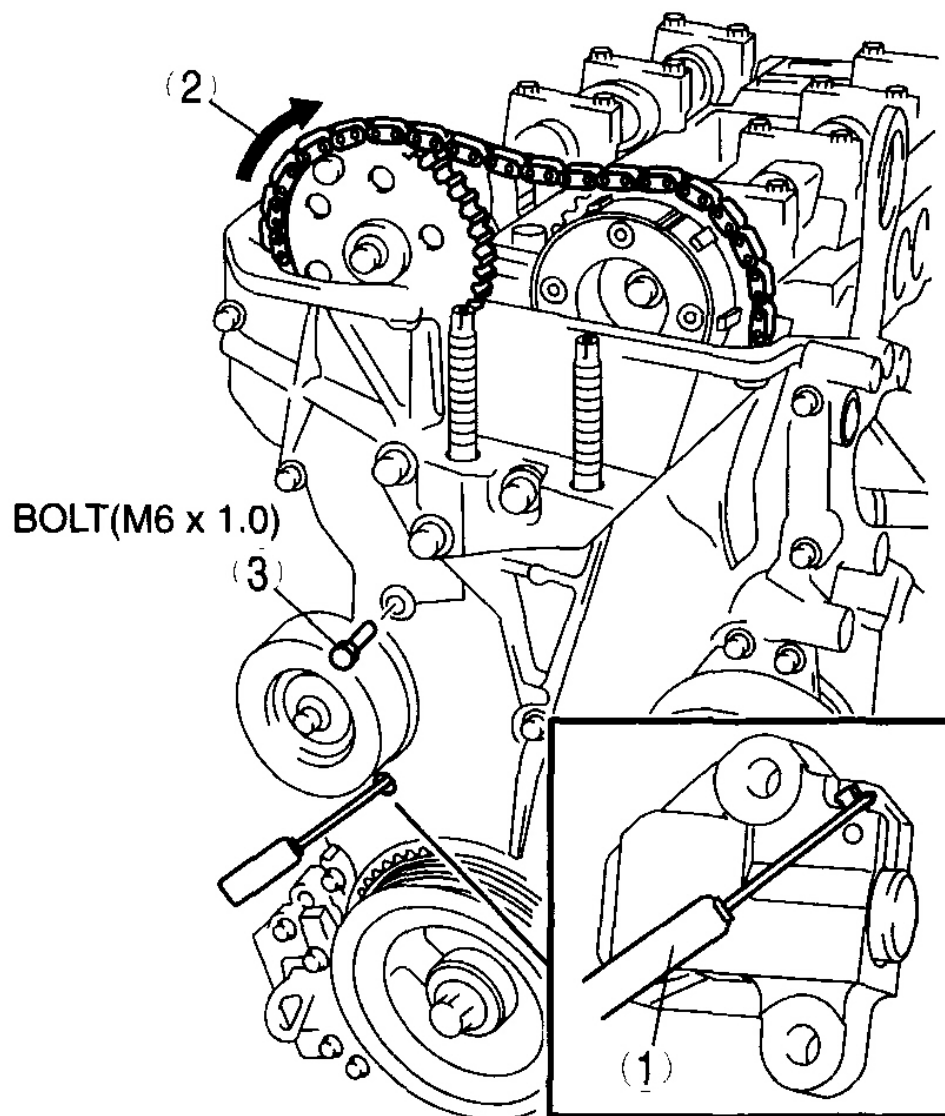
3. Remove the cylinder block lower blind plug and install the SST .
4. Rotate the crankshaft clockwise so that the No. 1 piston is at TDC of the compression stroke. (The position crank weight contacts the SST).



E6U110ZWB050

Fig. 77: Installing SST
Courtesy of MAZDA MOTORS CORP.

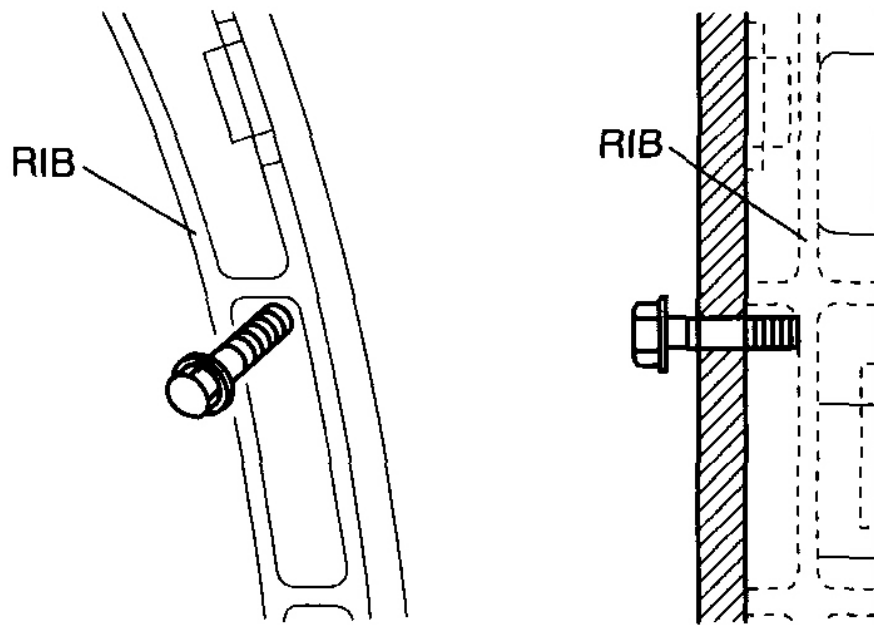
5. Loosen the timing chain.
 1. Using a suitable screwdriver or equivalent tool, unlock the timing chain tensioner ratchet.
 2. Rotate the exhaust camshaft clockwise using a suitable wrench on the cast hexagon and loosen the timing chain tensioner.



E6U110ZWB052

Fig. 78: Loosening Timing Chain
Courtesy of MAZDA MOTORS CORP.

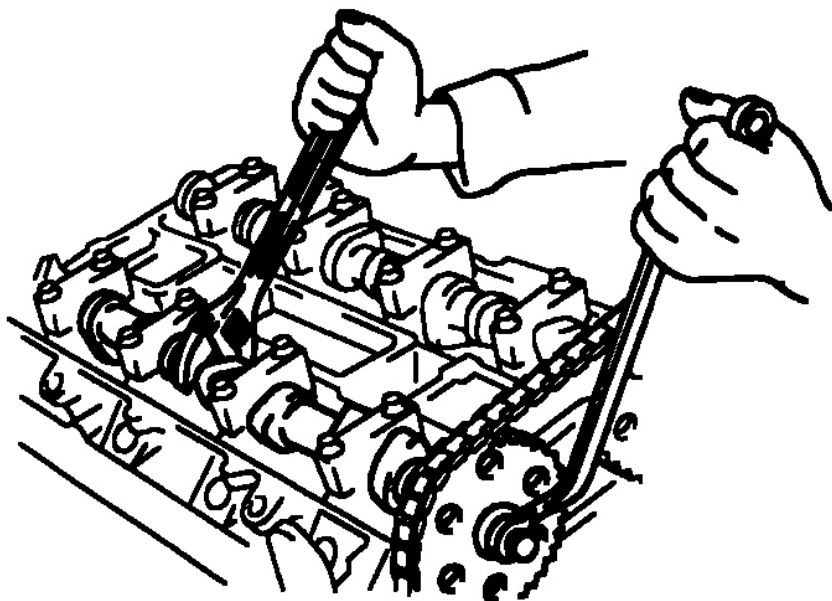
3. Using a suitable bolt (M6 X 1.0 length 25-35 mm {0.99-1.37 in}) at the engine front cover upper blind plug, secure the tensioner arm at the position where the tension is released.



E6U110ZWB045

Fig. 79: Securing Tensioner Arm Using Suitable Bolt
Courtesy of MAZDA MOTORS CORP.

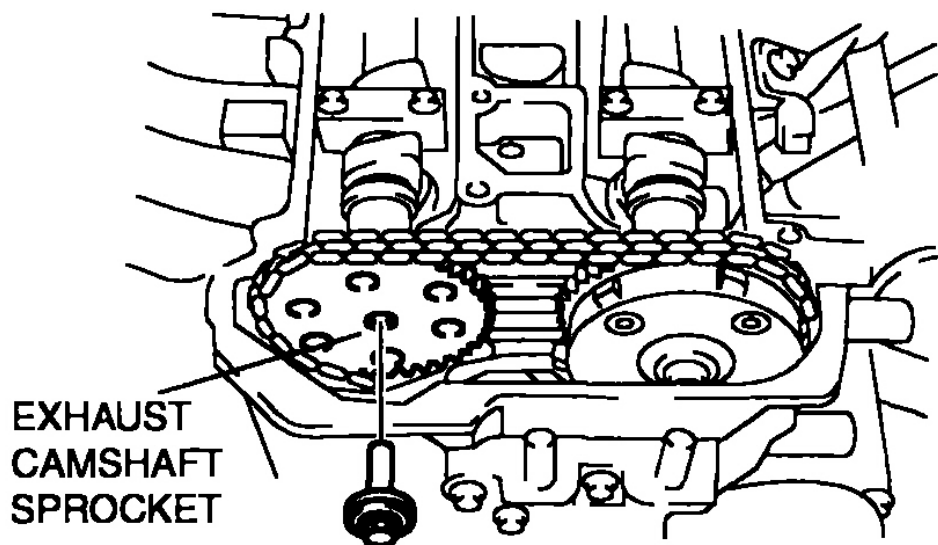
6. Secure the exhaust camshaft using a wrench on the cast hexagon and loosen the camshaft sprocket installation bolt.



B3E0110E095

Fig. 80: Holding Camshaft Using Suitable Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.

7. Remove the installation bolt and exhaust camshaft sprocket.



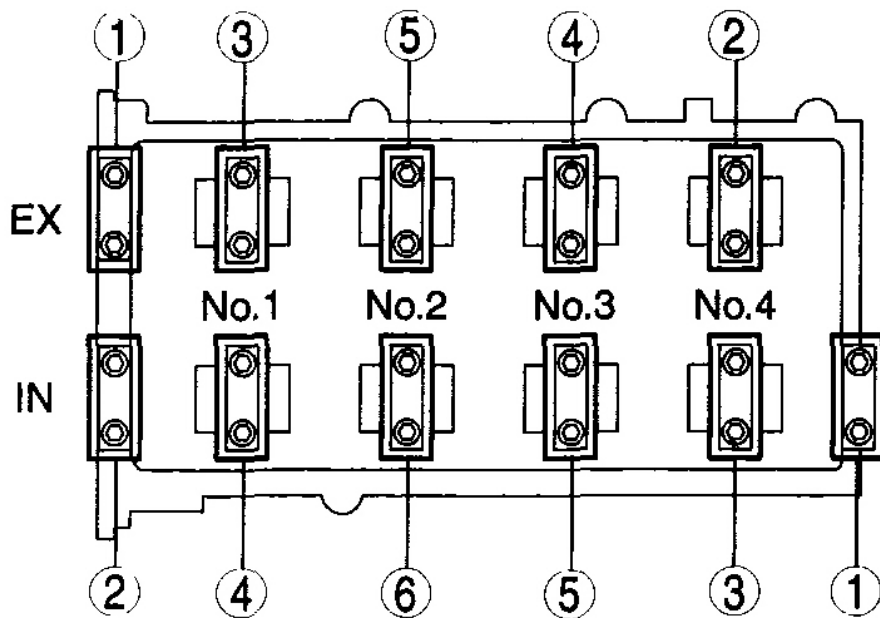
E6U110ZWB008

Fig. 81: Removing/Installing Exhaust Camshaft Sprocket
Courtesy of MAZDA MOTORS CORP.

8. Loosen the camshaft cap bolts in two or three passes in the order shown in the figure, and remove the camshaft bearing caps.

NOTE:

- The camshaft caps are to be kept ordered for correct reassembly in their original positions. Do not mix the caps.



E6U110ZEB001

Fig. 82: Camshaft Cap Bolts Loosening Sequence
 Courtesy of MAZDA MOTORS CORP.

9. Remove the camshafts for intake and exhaust sides.
10. Remove the tappet.
11. Select and install the suitable tappet according to the result of valve clearance inspection.

Selected tappet = Removed tappet thickness + Measured valve clearance - Standard valve clearance

Standard valve clearance [when cold]

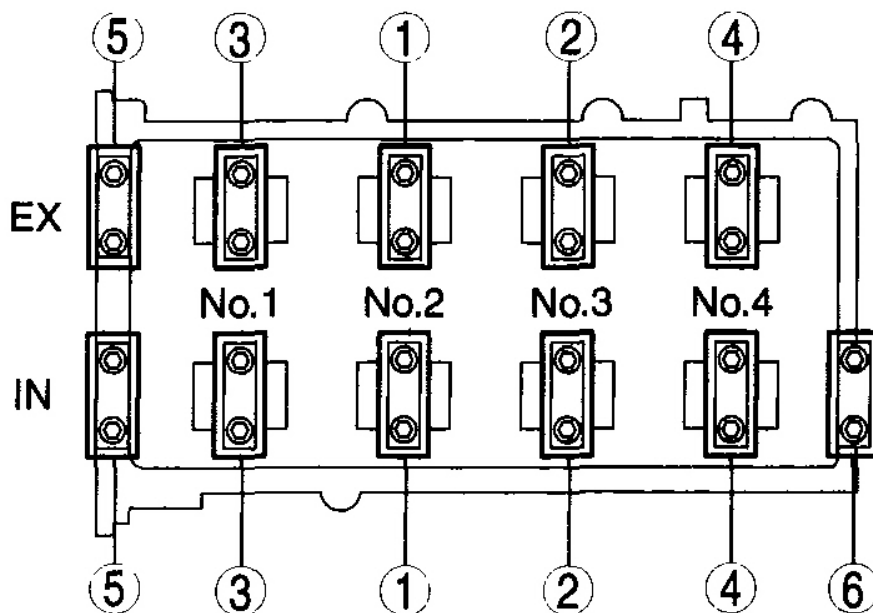
IN: 0.22-0.28 mm {0.0087-0.0110 in}

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

12. Install the camshaft with the No. 1 cylinder cam aligned at TDC of the compression stroke.
13. Install the camshaft bearing cap and tighten the camshaft bearing cap bolts in two passes in the order shown in the figure.

Tightening procedure

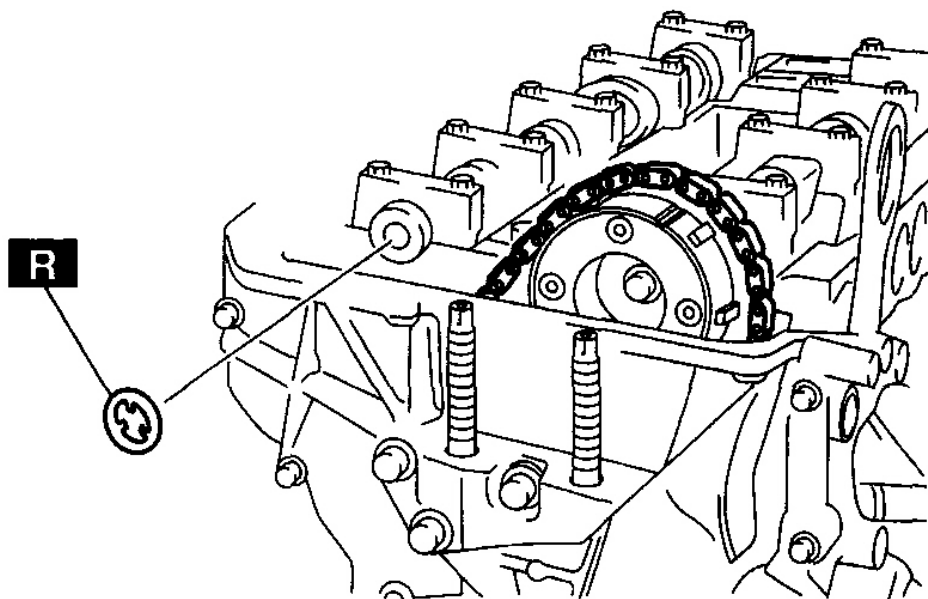
1. 5.0-9.0 N.m {51.0-91.7 kgf.cm, 44.3-79.6 in.lbf}
2. 14.0-17.0 N.m {1.5-1.7 kgf.m, 10.4-12.5 ft.lbf}



E6U110ZEB012

Fig. 83: Camshaft Cap Bolts Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

14. Install a new washer.



E6U110ZWB020

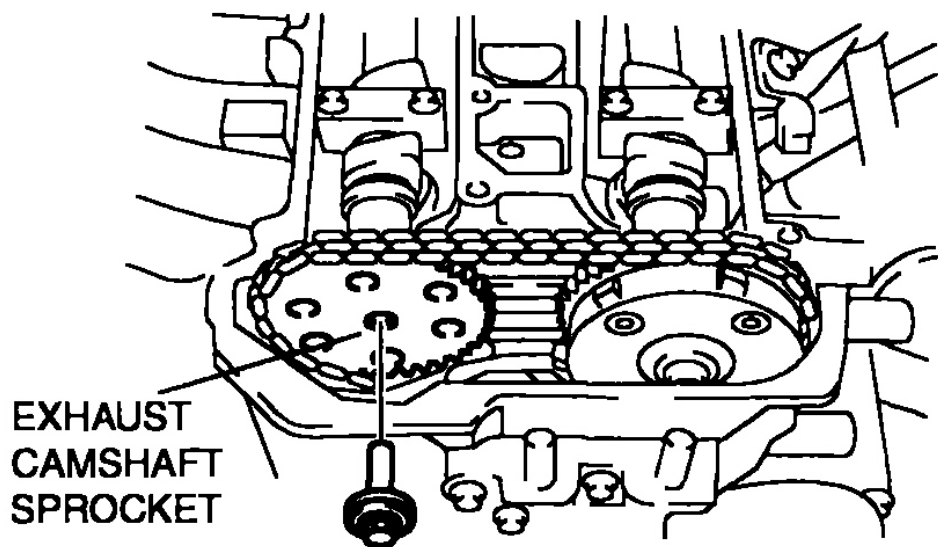
Fig. 84: Installing Washer

Courtesy of MAZDA MOTORS CORP.

15. Install the exhaust camshaft sprocket.

CAUTION:

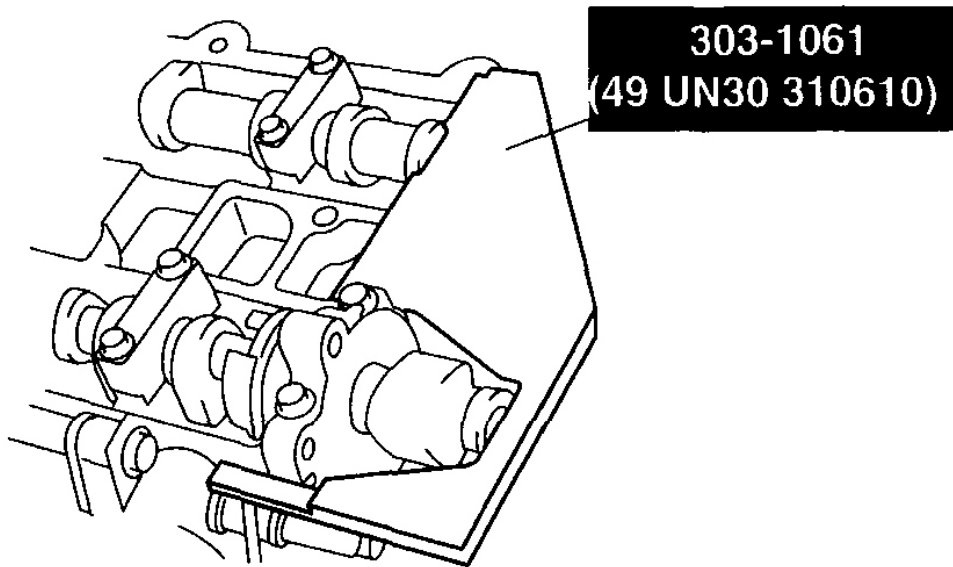
- Do not tighten the camshaft sprocket installation bolt during this step.



E6U110ZWB008

Fig. 85: Removing/Installing Exhaust Camshaft Sprocket
Courtesy of MAZDA MOTORS CORP.

16. Install the **SST** on the camshaft as shown in the figure.
17. Remove the bolt (**M6 X 1.0 length 25-35 mm {0.99-1.37 in}**) from the engine front cover upper blind plug and apply tension to the timing chain.
18. Rotate the crankshaft clockwise and verify that the No. 1 piston is at TDC of the compression stroke.



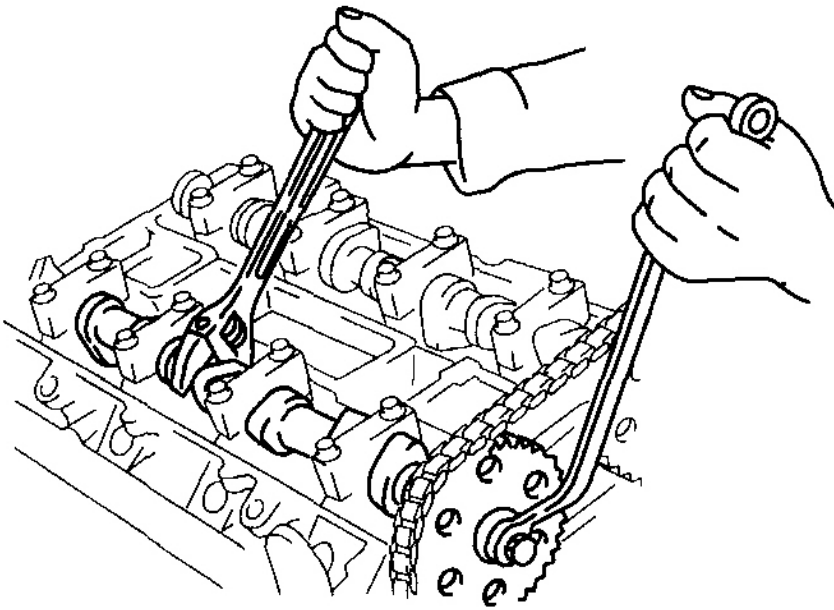
E6U110ZEB036

Fig. 86: Installing SST On Camshaft
Courtesy of MAZDA MOTORS CORP.

19. Secure the exhaust camshaft using a wrench on the cast hexagon and tighten the sprocket installation bolt.

Tightening torque

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



B3E0110E095

Fig. 87: Securing Exhaust Camshaft Using Wrench
Courtesy of MAZDA MOTORS CORP.

20. Remove the SST from the camshaft.
21. Remove the SST installed in the cylinder block lower blind plug hole.
22. Rotate the crankshaft clockwise two turns and inspect the valve timing.
23. Apply silicone sealant and install the engine front cover upper blind plug.

Tightening torque

8.0-11.5 N.m {81.6-117.2 kgf.cm, 70.9-101.7 in.lbf}

24. Install the cylinder block lower blind plug.

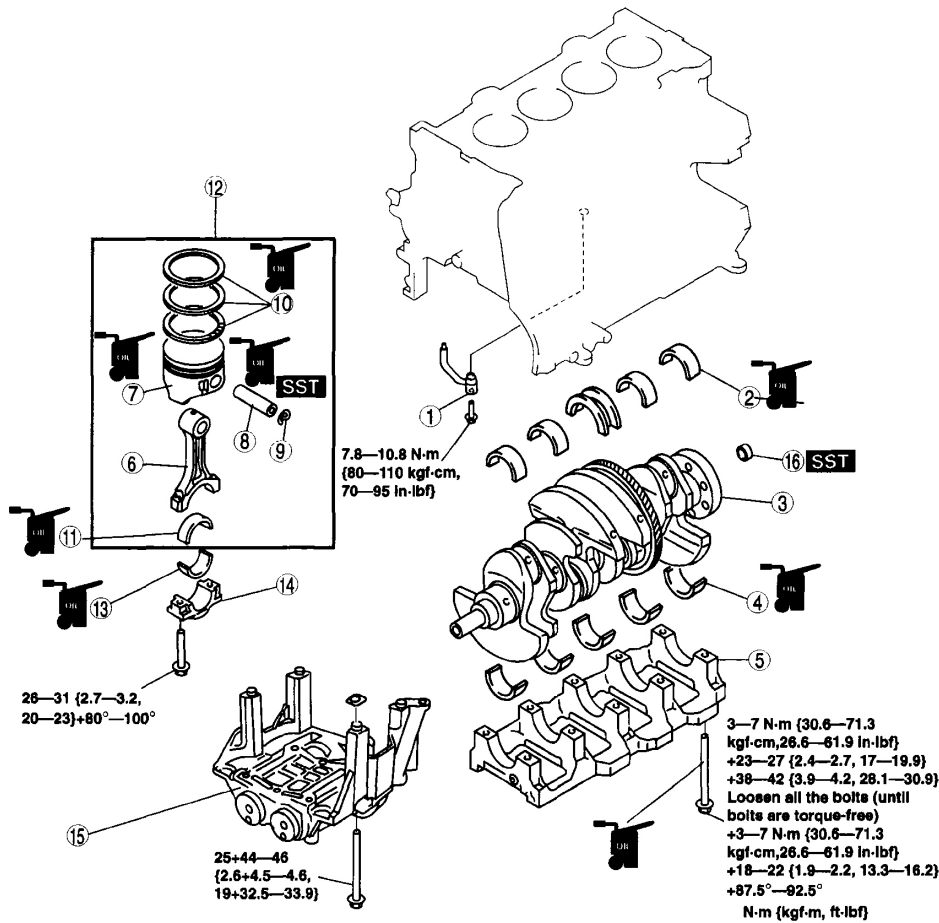
Tightening torque

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

25. Install a new engine front cover lower blind plug.

Tightening torque**10.0-14.0 N.m {102.0-142.7 kgf.cm, 88.6-123.9 in.lbf}****CYLINDER BLOCK (I) ASSEMBLY**

1. Assemble in the order indicated in the table.



E6U110ZEB018

1	Oil jet valve
2	Upper main bearing, thrust bearing
3	Crankshaft
4	Lower main bearing
5	Main bearing cap
6	Connecting rod
7	Piston
8	Piston pin
9	Snap ring
10	Piston ring
11	Upper connecting rod bearing

12	Connecting rod, piston
13	Lower connecting rod bearing
14	Connecting rod cap
15	Engine balancer
16	Pilot bearing

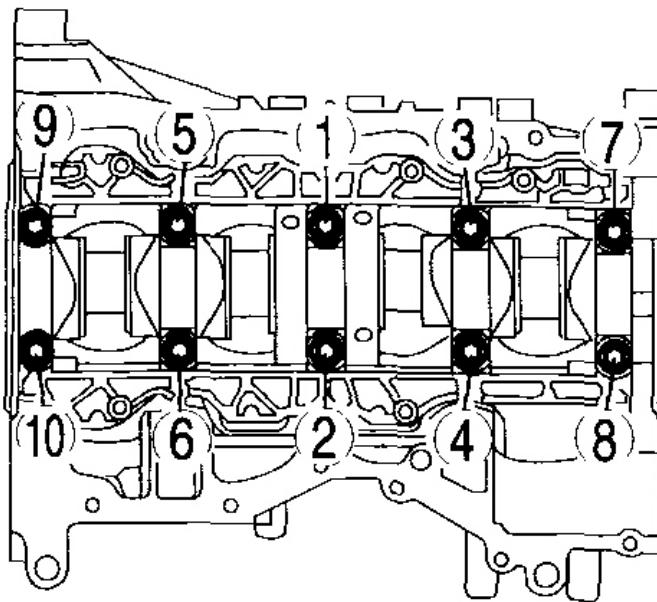
Fig. 88: Assembling Cylinder Block (I) & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Main Bearing Cap Assembly Note

1. Tighten the crank bearing caps in the order shown in the figure.

Tightening procedure

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.lbf}
4. 38-42 N.m {3.9-4.2 kgf.m, 28.1-30.9 ft.lbf}
5. Loosen all the bolts (until bolts are torque-free).
6. 3-7 N.m {30.6-71.3 kgf.cm, 26.6-61.9 in.lbf}
7. 18-22 N.m {1.9-2.2 kgf.m, 13.3-16.2 ft.lbf}
8. 87.5°-92.5°

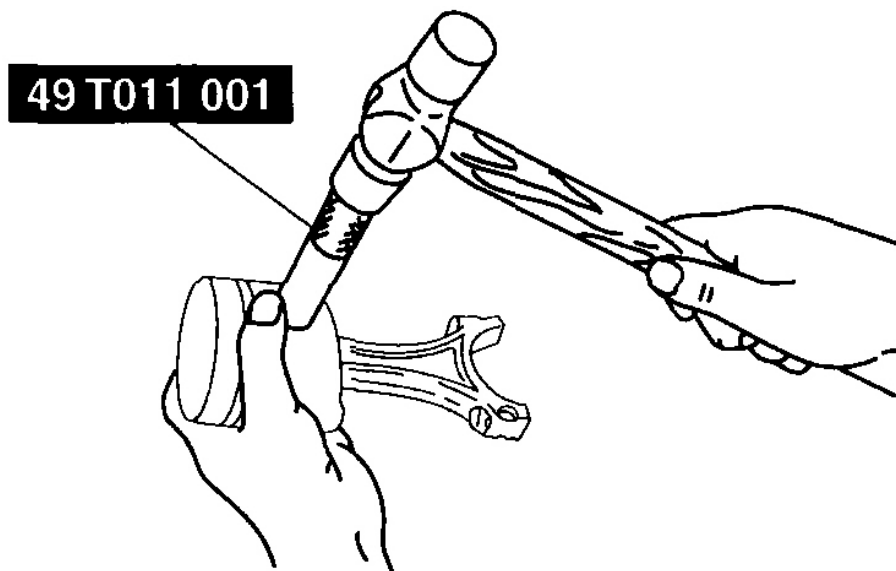


B3E0110E267

Fig. 89: Crank Bearing Cap Tightening Order
Courtesy of MAZDA MOTORS CORP.

Piston Pin Assembly Note

1. Assemble the piston pin using the SST.

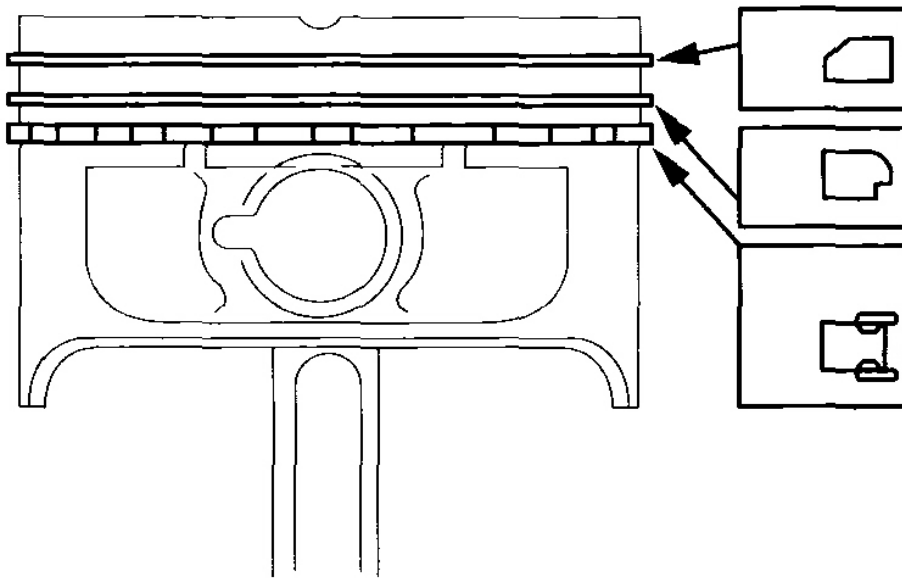


E6U110ZEB034

Fig. 90: Assembling Piston Pin Using SST
Courtesy of MAZDA MOTORS CORP.

Piston Ring Assembly Note

1. Assemble the oil ring.
2. Assemble the second ring with the notch facing downward.
3. Assemble the top ring with scraper face side upward.

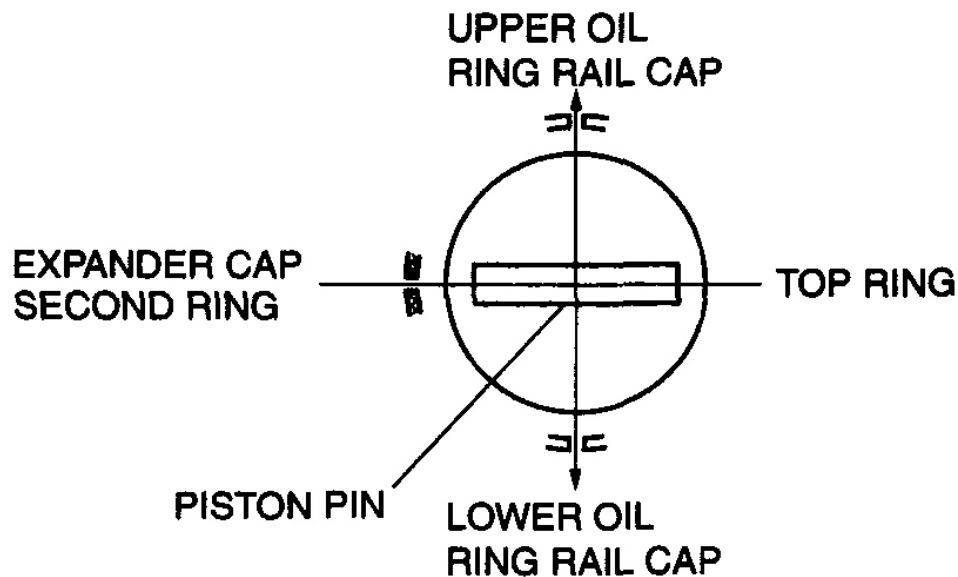


C3U0110E256

Fig. 91: Assembling Piston Ring
Courtesy of MAZDA MOTORS CORP.

Piston Assembly Note

1. Position the end gap of each ring so they are not aligned as shown in the figure.



E6U110ZEB004

Fig. 92: Positioning Ring End Gap
Courtesy of MAZDA MOTORS CORP.

2. Insert the piston into the cylinder with the arrow on top of the piston facing the front of the engine.

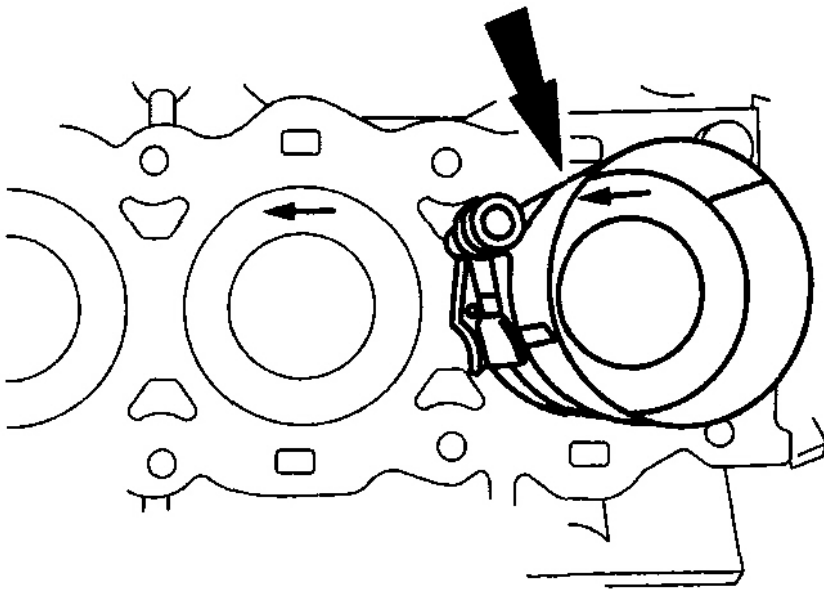
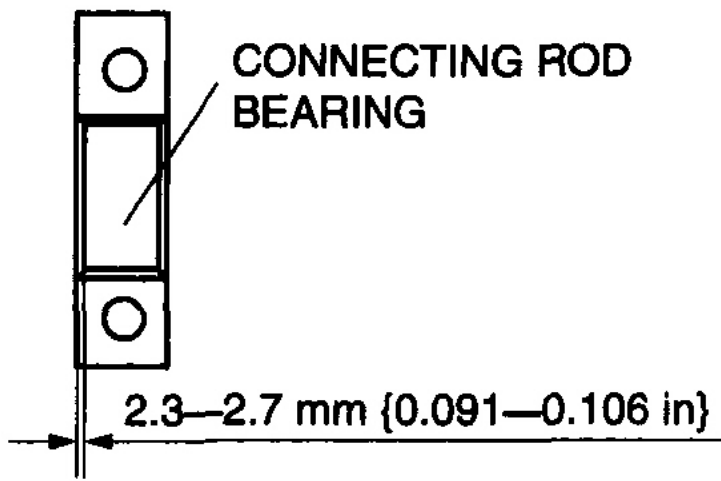
**B3E0110E108**

Fig. 93: Inserting Piston Into Cylinder
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.



B3E0110E109

Fig. 94: 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 installation bolts using the following procedure.

Tightening procedure

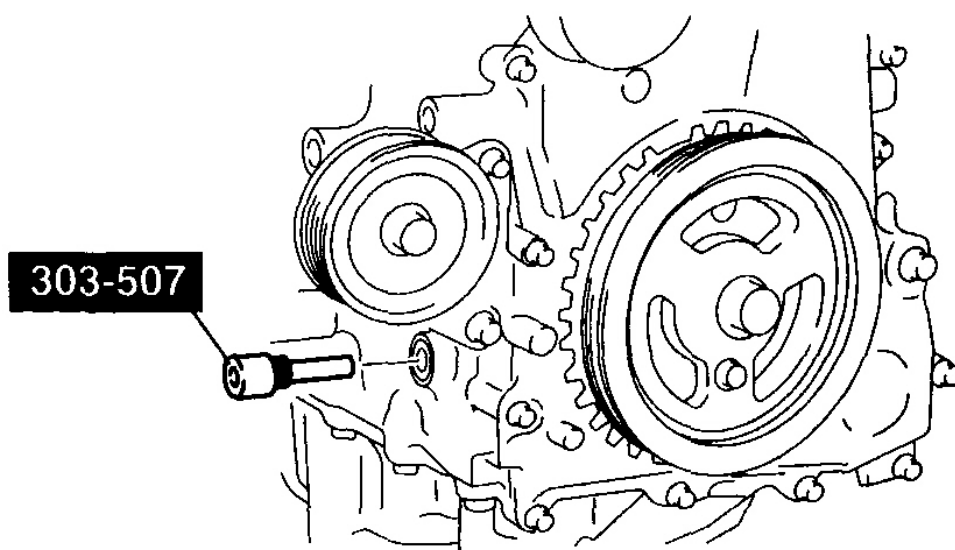
1. 26-31 N.m {2.7-3.1 kgf.m, 19.2-22.8 ft.lbf}
2. 80°-100°

Balancer Unit Assembly Note

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

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

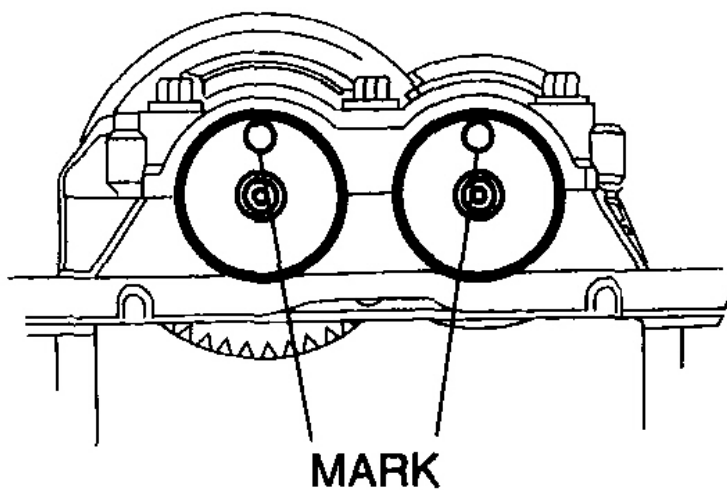
2. Remove the cylinder block lower blind plug and install the SST.
3. Rotate the crankshaft clockwise so that the No. 1 piston is at TDC of the compression stroke. (The position crank weight contacts the SST.)
4. Install the adjustment shim to the seating face of the balancer unit.



E6U110ZWB050

Fig. 95: Installing SST
Courtesy of MAZDA MOTORS CORP.

5. With the balancer unit marks at the exact top center, assemble the balancer unit to the cylinder block.



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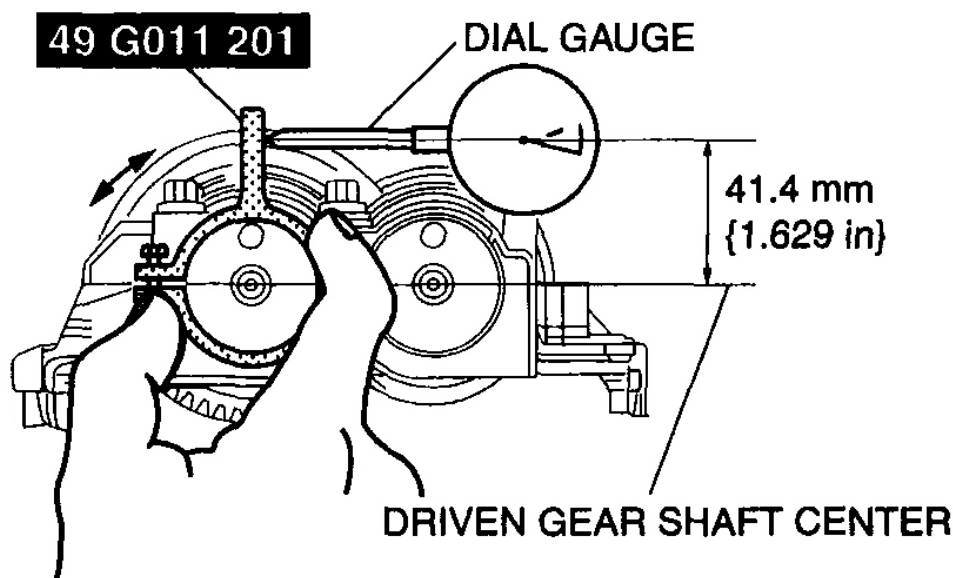
Fig. 96: Identifying Balancer Unit Marks

Courtesy of MAZDA MOTORS CORP.

6. Set the SST as shown in the figure and measure the gear backlash using a dial gauge.

NOTE:

- To measure the backlash precisely, insert a flathead screwdriver into the crankshaft No. 1 crank weight area and set both the rotation and the thrust direction with the flathead screwdriver, using a prying action, as shown in the figure.



B3E0110E112

Fig. 97: Measuring Gear Backlash Using Dial Gauge
Courtesy of MAZDA MOTORS CORP.

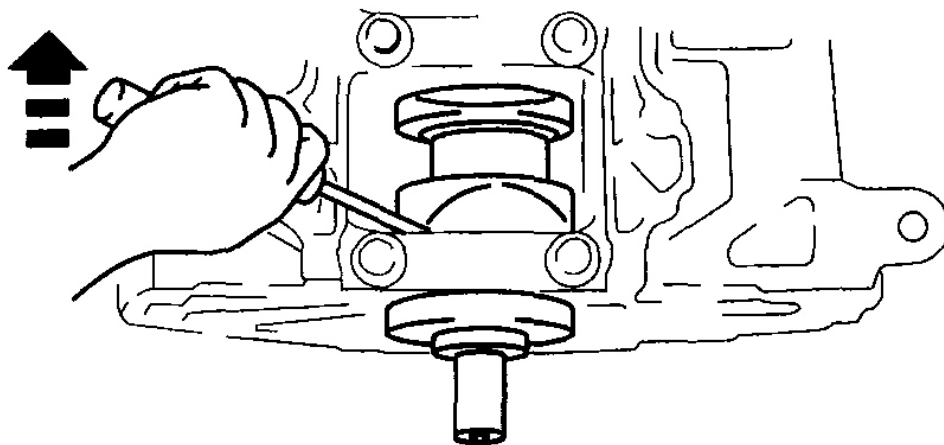
- If it exceeds the maximum specification, remeasure the backlash and, using the adjustment shim selection table, select the proper shim, according to the following procedure.

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.

Maximum gear backlash

0.005-0.101 mm {0.00019-0.0039 in}



B3E0110E113

Fig. 98: Checking Crankshaft No. 1 Backlash
 Courtesy of MAZDA MOTORS CORP.

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

Adjustment shim selection table

ADJUSTMENT SHIM SELECTION REFERENCE

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			0.106-0.112		

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{0.00968-0.00992}	18	1.18 {0.0464}	{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			0.001-0.007		

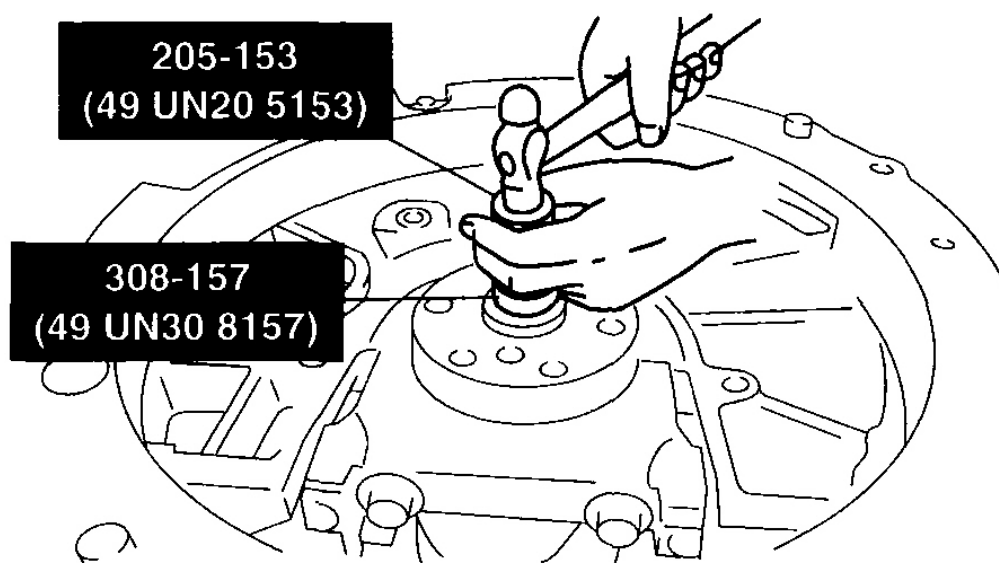
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{0.00555-0.00578}	33	1.33 {0.523}	{0.00003-0.000275}	53	1.53 {0.0602}
0.134-0.140 {0.00527-0.00551}	34	1.34 {0.527}	0.000-0.000 {0.000-0.000}	54	1.54 {0.0606}

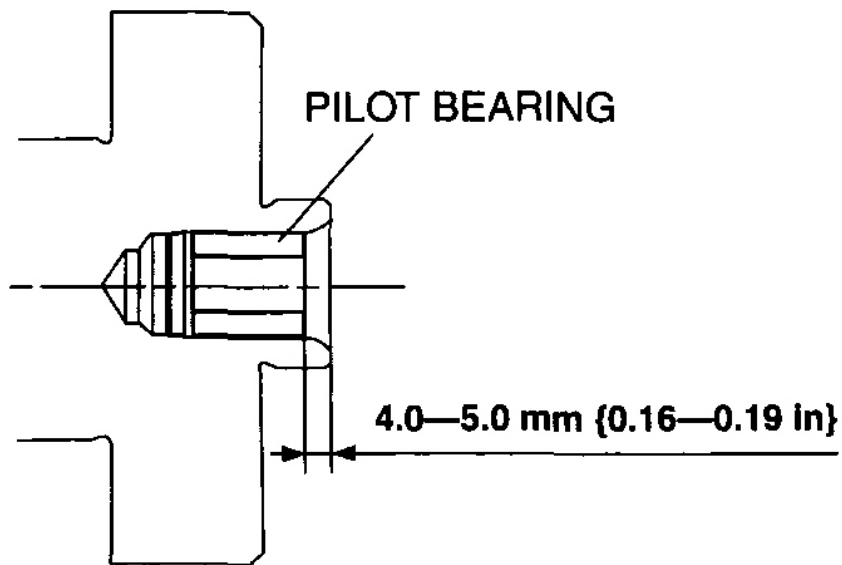
Pilot Bearing Assembly Note

1. Use the SSTs to install the pilot bearing.



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Fig. 99: Installing Pilot Bearing Using SSTs
Courtesy of MAZDA MOTORS CORP.

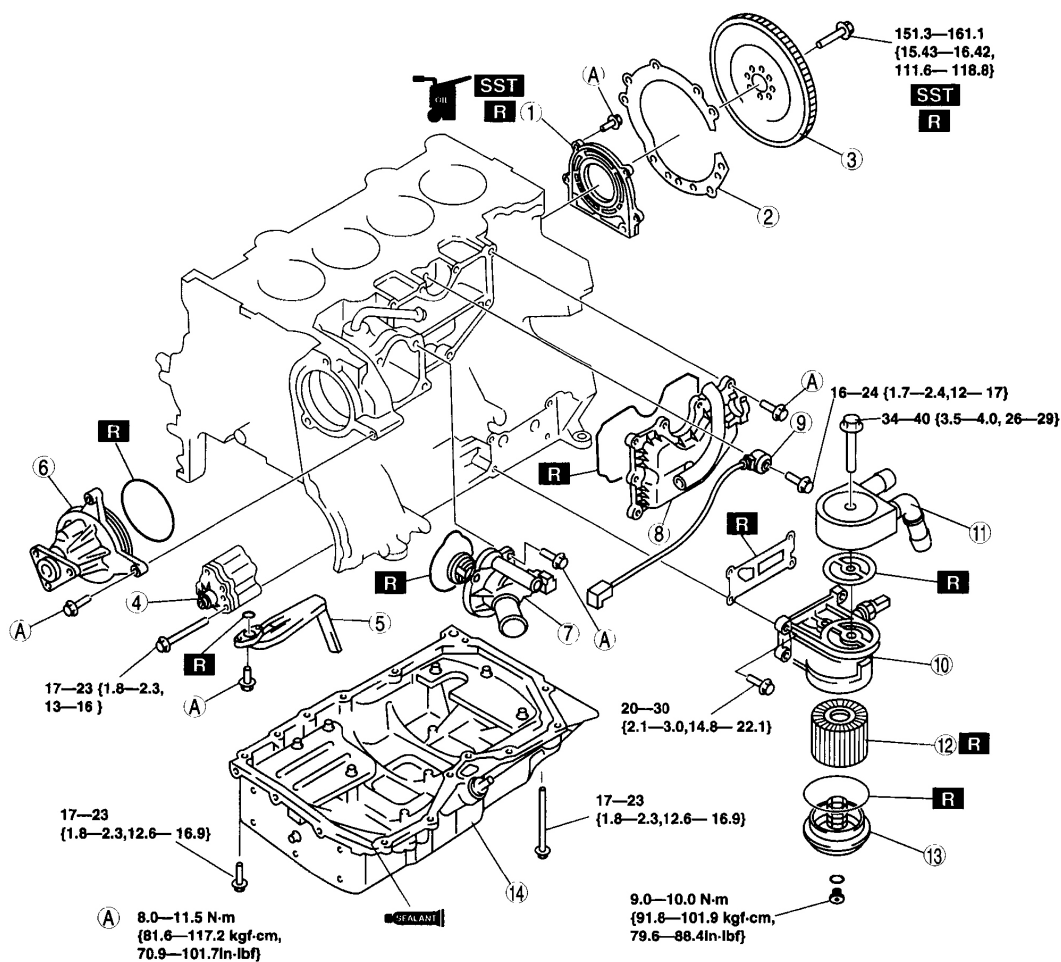


C3U0510W013

Fig. 100: Positions For Installing Pilot Bearing
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK (II) ASSEMBLY

1. Assemble in the order indicated in the table.



N·m {kgf·m, ft·lbf}

E6U110ZEB017

1	Rear oil seal
2	End plate
3	Flywheel
4	Oil pump
5	Oil strainer
6	Water pump
7	Thermostat

8	Crankcase ventilation cover
9	Knock sensor
10	Oil filter adapter
11	Oil cooler
12	Oil filter
13	Oil filter cover
14	Oil pan

Fig. 101: Assembling Cylinder Block (II) & Torque Specification
 Courtesy of MAZDA MOTORS CORP.

Rear Oil Seal Assembly Note

1. Apply clean engine oil to a new rear oil seal.
2. Install the rear oil seal using a SST .

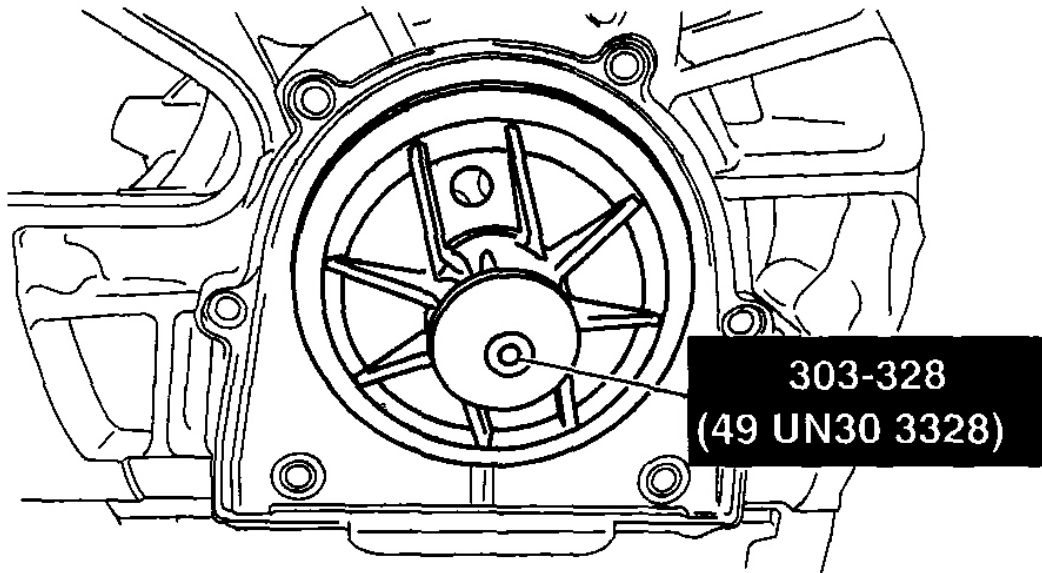
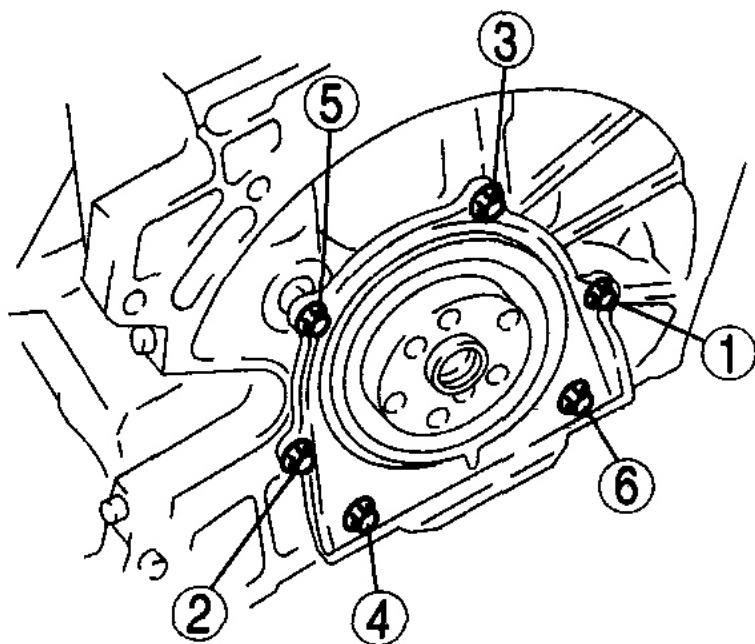


Fig. 102: Installing Rear Oil Seal Using SST
Courtesy of MAZDA MOTORS CORP.

3. Tighten the installation bolts in the order shown in the figure.

Tightening torque

8.0-11.5 N.m {81.6-117.2 kgf.cm, 70.9-101.7 in.lbf}



B3E0110E116

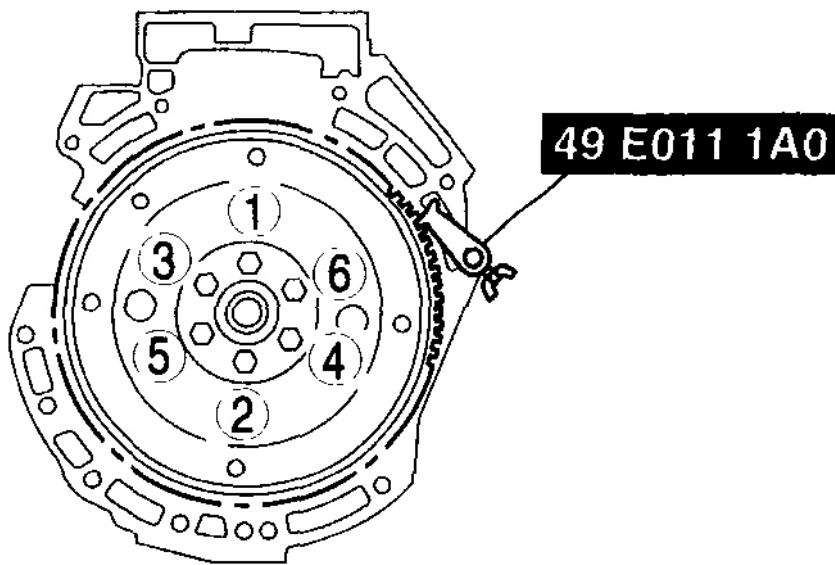
Fig. 103: Rear Oil Seal Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Flywheel Assembly Note

1. Secure the crankshaft using the SST .
2. Tighten the installation bolts in two or three passes in the order shown in the figure.

Tightening torque

151.3-161.1 N.m {15.43-16.42 kgf.m, 111.6-118.8 ft.lbf}

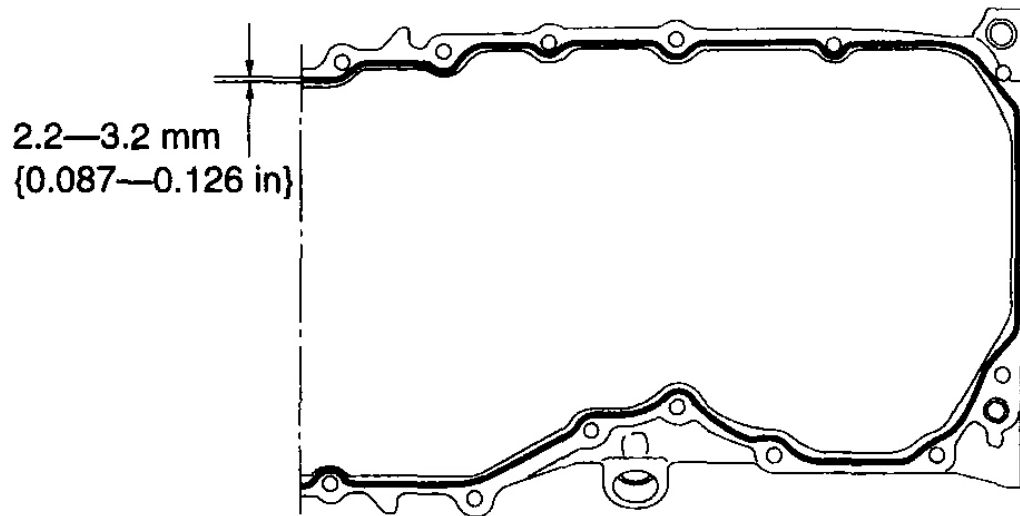


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Fig. 104: Flywheel Holding Tool And Bolt Tightening Sequence
 Courtesy of MAZDA MOTORS CORP.

Oil Pan Assembly Note

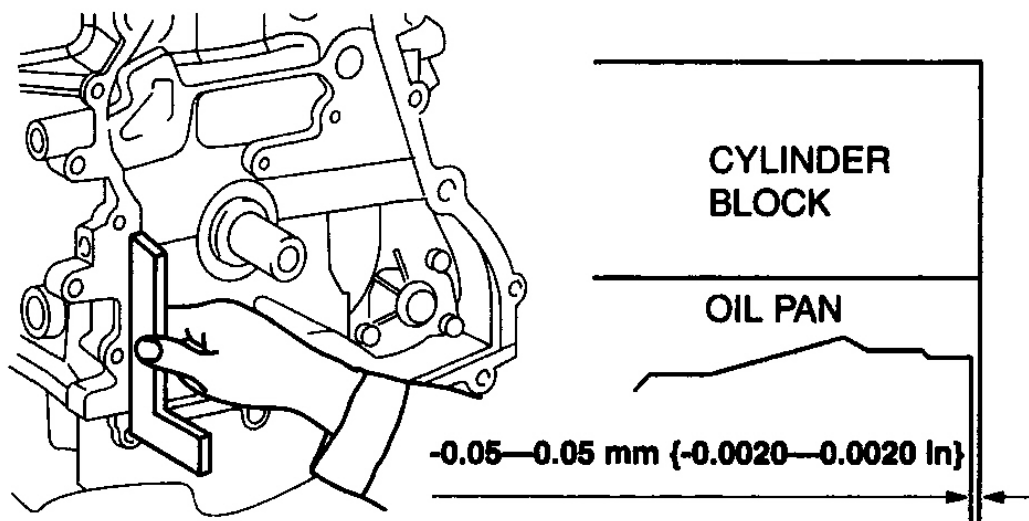
1. Apply silicone sealant to the areas shown in the figure.
2. Assemble the oil pan.



E6U111ZWB006

Fig. 105: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

3. Use a straight edge to align the junction of the oil pan and the cylinder block on the engine front cover side.



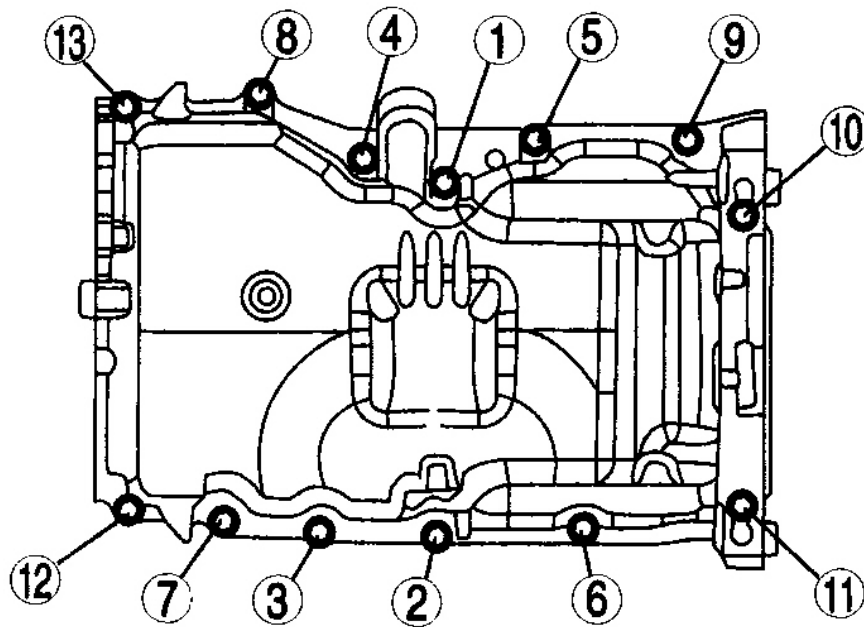
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Fig. 106: Aligning Junction Of Oil Pan And Cylinder Block Using Straight Edge
Courtesy of MAZDA MOTORS CORP.

4. Tighten the bolts in the order shown in the figure.

Tightening torque

17-23 N.m {1.8-2.3 kgf.m, 12.6-16.9 ft.lbf}

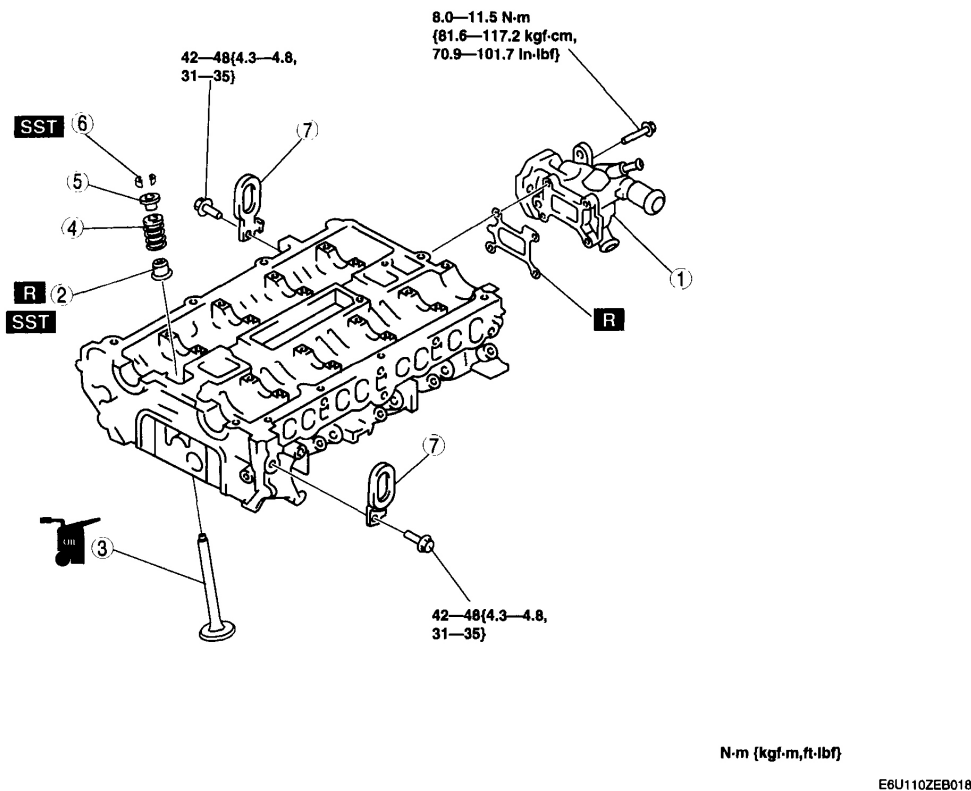


E6U110ZEB021

Fig. 107: Oil Pan Bolt Tightening Order
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (I) ASSEMBLY

1. Disassemble in the order indicated in the table.



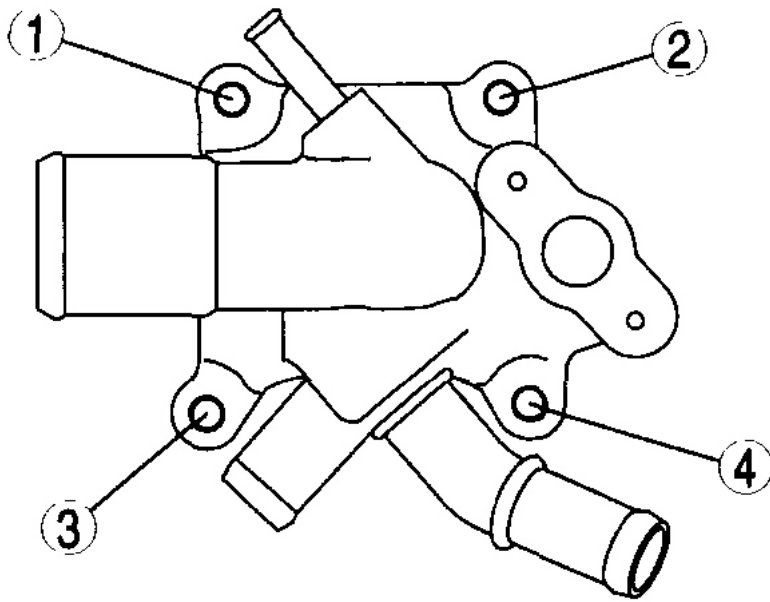
1	Water outlet case
2	Valve seal
3	Valve
4	Valve spring

5	Upper valve spring seat
6	Valve keeper
7	Engine hanger

Fig. 108: Assembling Cylinder Head (I) & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Water Outlet Case Assembly Note

1. Tighten the bolts in the order shown in the figure.

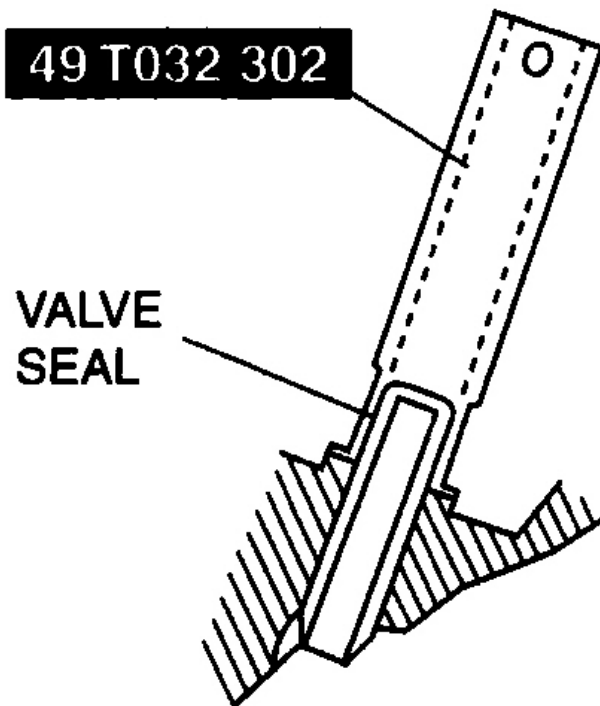


E6U110ZEB037

Fig. 109: Water Outlet Case Bolts Tightening Order
Courtesy of MAZDA MOTORS CORP.

Valve Seal Assembly Note

1. Press in the valve seal to the valve guide by hand.
2. Set the SST and tap it using a plastic hammer.

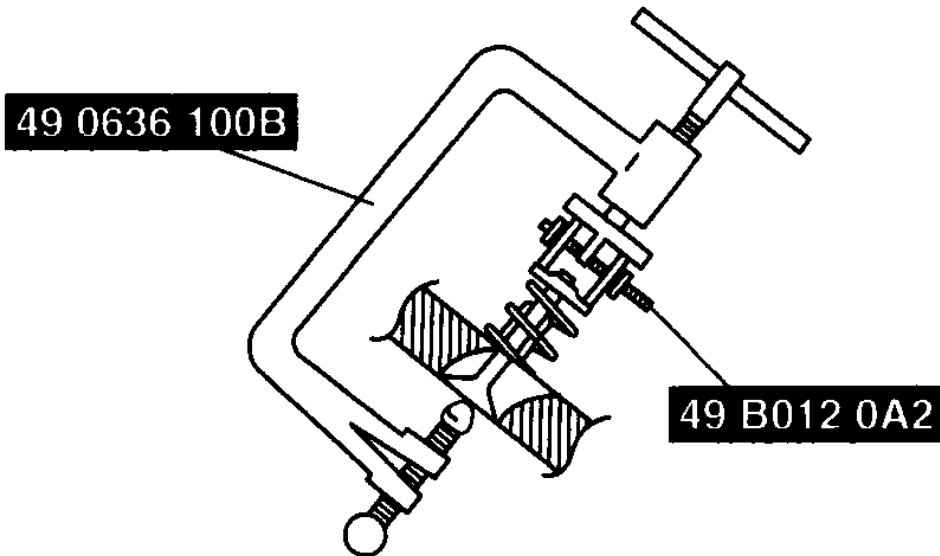


B3E0110E123

Fig. 110: Installing Valve Seal
Courtesy of MAZDA MOTORS CORP.

Valve Keeper Assembly Note

1. Assemble the valve keeper using the SST .

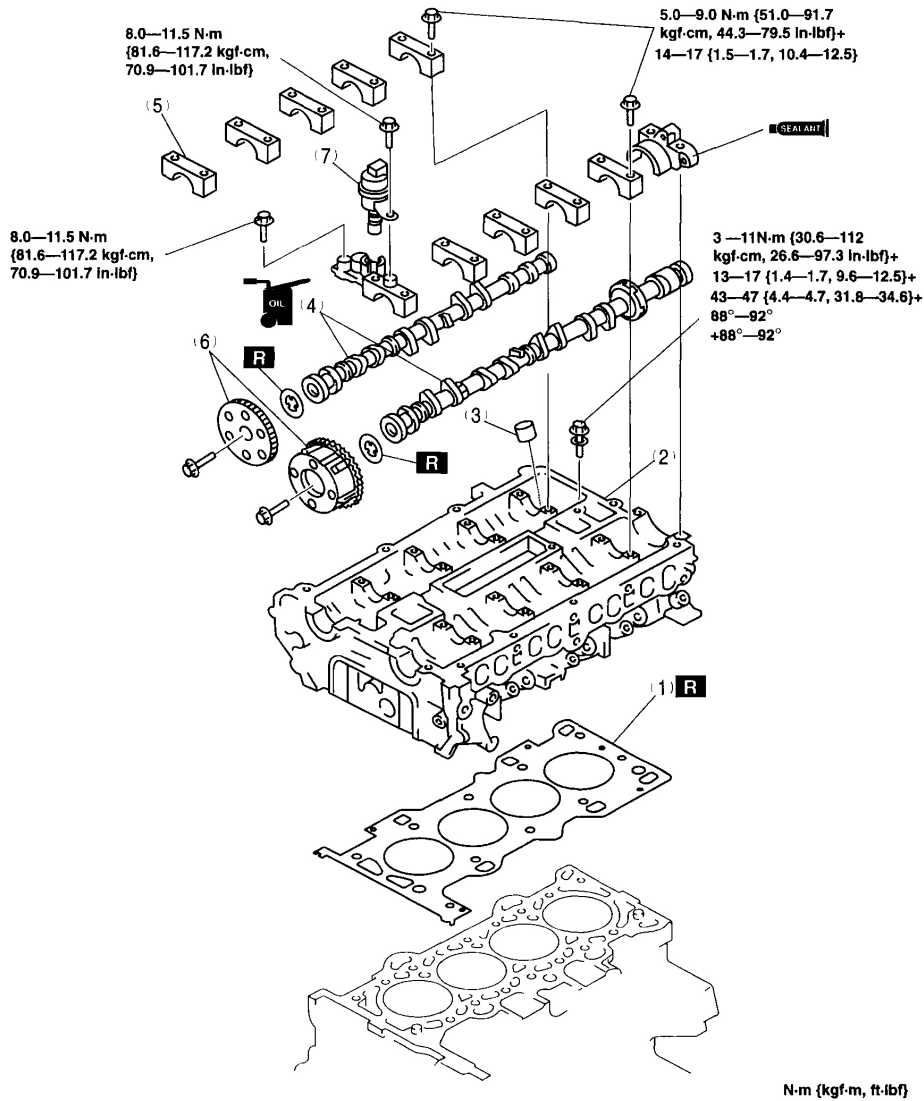


B3E0110E124

Fig. 111: Assembling Valve Keeper Using SST
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD (II) ASSEMBLY

1. Assemble in the order indicated in the table.



E6U110ZEB019

1	Cylinder head gasket
2	Cylinder head
3	Tappet
4	Camshaft

5	Camshaft cap
6	Camshaft sprocket, variable valve timing actuator
7	OCV

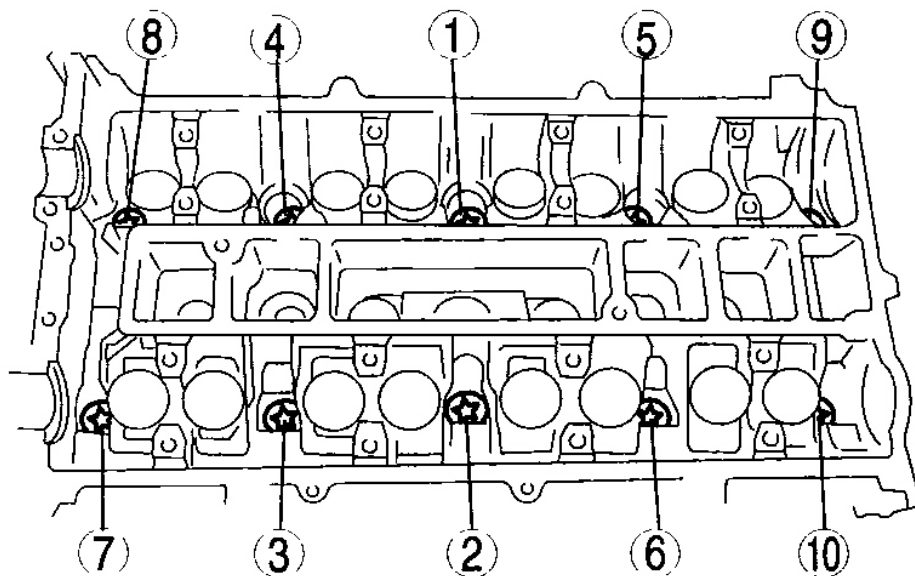
Fig. 112: Assembling Cylinder Head (II) & Torque Specification
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Assembly Note

1. Tighten the cylinder head installation bolts in five passes in the order shown in the figure.

Tightening procedure

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°



C3U0110E054

Fig. 113: Cylinder Head Bolt Tightening Order
 Courtesy of MAZDA MOTORS CORP.

Camshaft Assembly Note

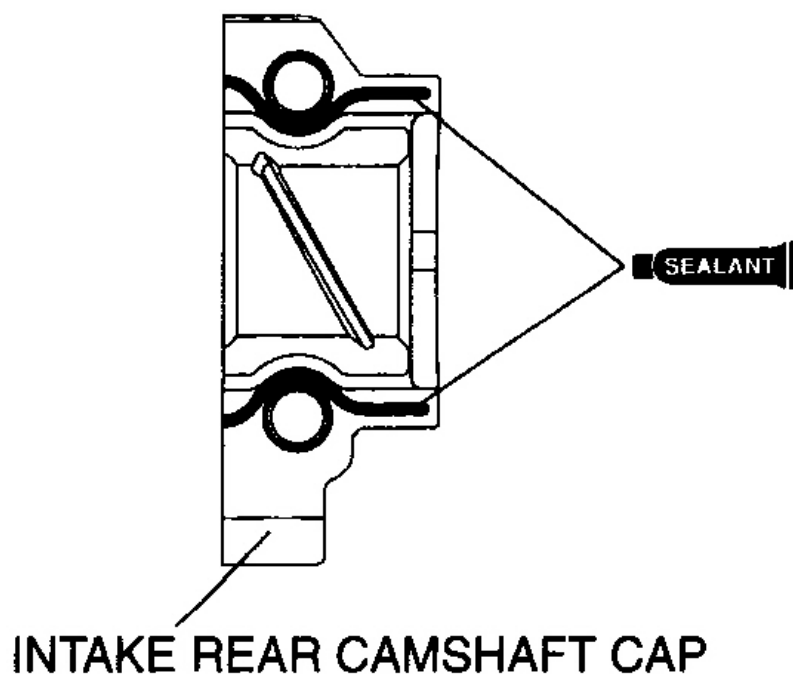
NOTE:

- Install the camshaft with the No. 1 cylinder cam aligned at TDC of the compression stroke.

1. Carefully apply adhesive agent to the area indicated in the figure so that it does not leak into the sliding part.

Thickness

1.0 mm {0.039 in}



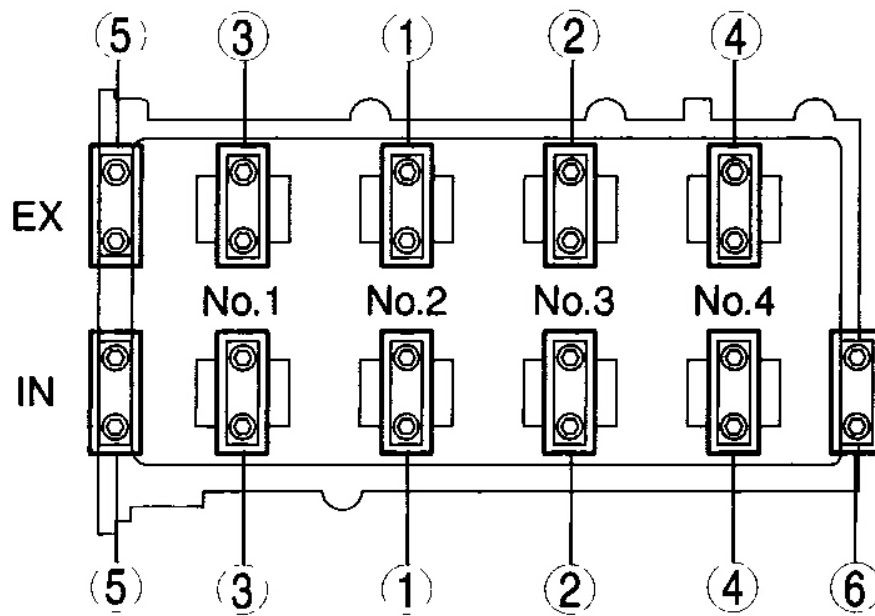
E6U110ZWB063

Fig. 114: Applying Adhesive Agent
Courtesy of MAZDA MOTORS CORP.

2. Install the camshaft caps and hand-tighten the camshaft cap bolts evenly in two or three passes, and then tighten the camshaft cap bolts in two passes, in the order shown in the figure.

Tightening procedure

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 {1.5-1.7 kgf.m, 10.4-12.5 ft.lbf}



E6U110ZEB012

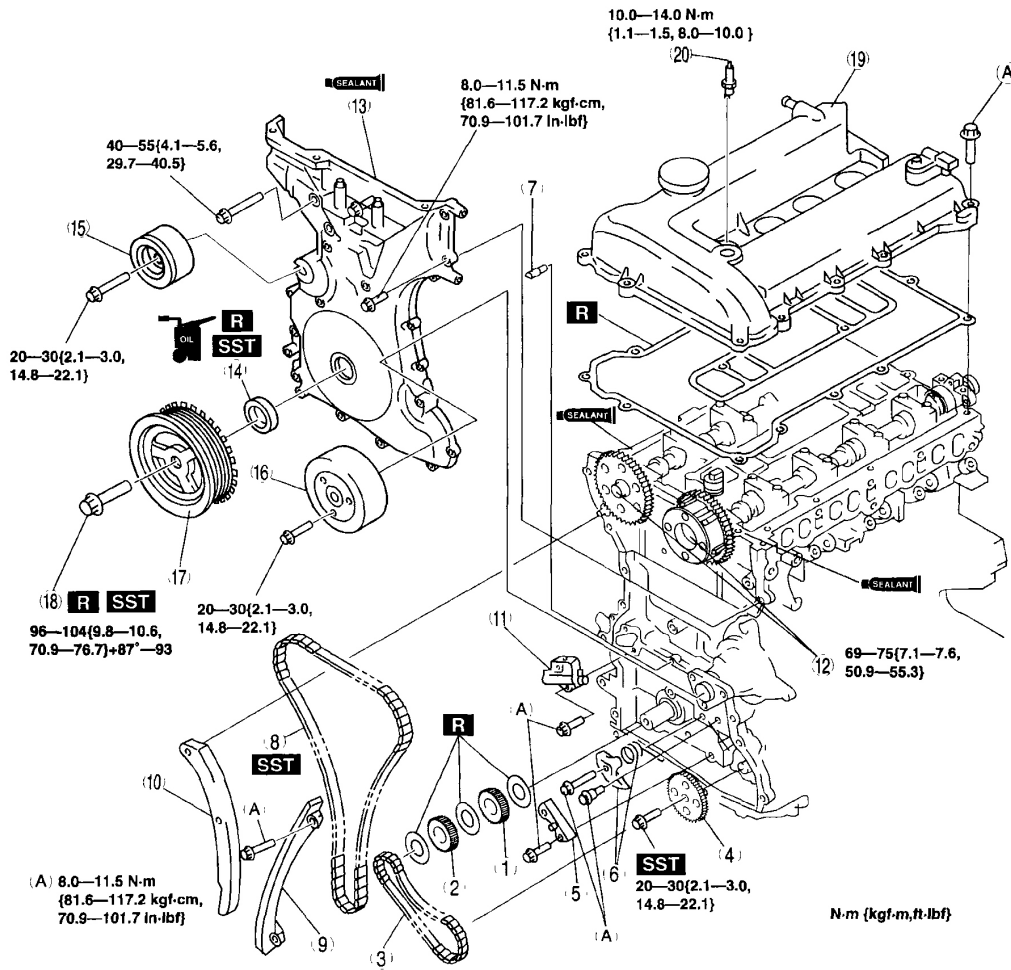
Fig. 115: Camshaft Cap Bolts Tightening Order
Courtesy of MAZDA MOTORS CORP.

Camshaft Sprocket, Variable Valve Timing Actuator Assembly Note

1. Leave the camshaft sprocket installation bolt temporarily tightened until the timing chain is installed. After the timing chain is installed, tighten it to the specified torque.

TIMING CHAIN ASSEMBLY

1. Assemble in the order indicated in the table.



E6U110ZEB020

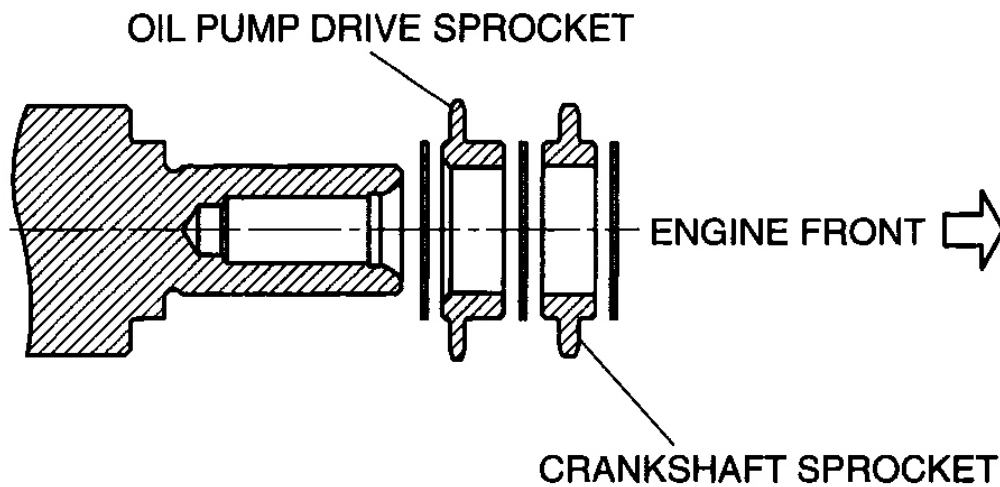
1	Oil pump drive sprocket
2	Crankshaft sprocket
3	Oil pump chain
4	Oil pump driven sprocket
5	Oil pump chain guide
6	Oil pump chain tensioner
7	Oil jet
8	Timing chain
9	Timing chain guide
10	Timing chain tensioner arm
11	Timing chain tensioner

12	Camshaft sprocket lock bolt
13	Front oil seal
14	Engine front cover
15	Drive belt idler pulley
16	Water pump pulley
17	Crankshaft pulley
18	Crankshaft pulley lock bolt
19	Cylinder head cover
20	Spark plug

Fig. 116: Timing Chain Components With Torque Specification
Courtesy of MAZDA MOTORS CORP.

Drive Sprocket Assembly Note

1. The oil pump drive sprocket has the assembly direction as shown in the figure.

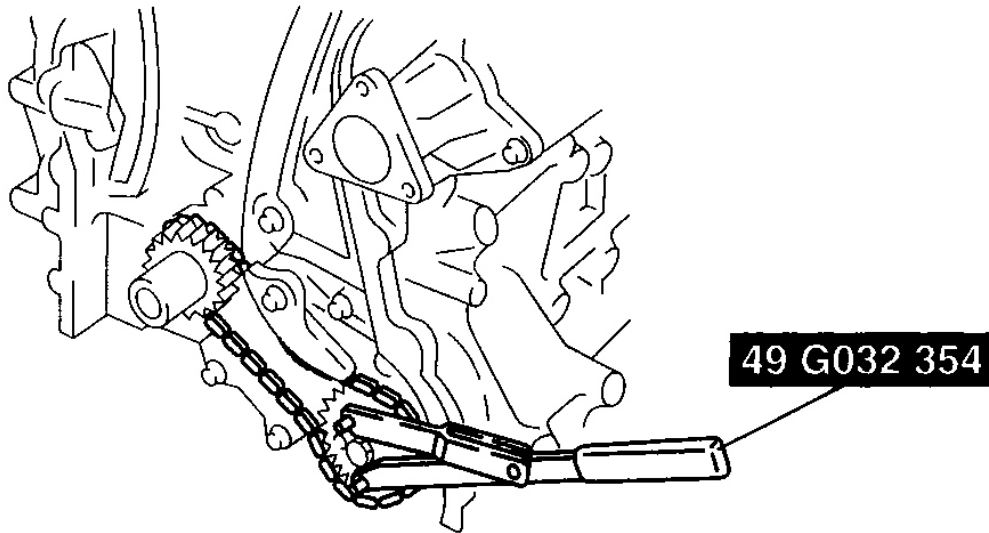


E6U110ZWB059

Fig. 117: Assembling Oil Pump Drive Sprocket
Courtesy of MAZDA MOTORS CORP.

Oil Pump Driven Sprocket Assembly Note

1. Install the **SST** on the oil pump driven sprocket to lock the oil pump against rotation.

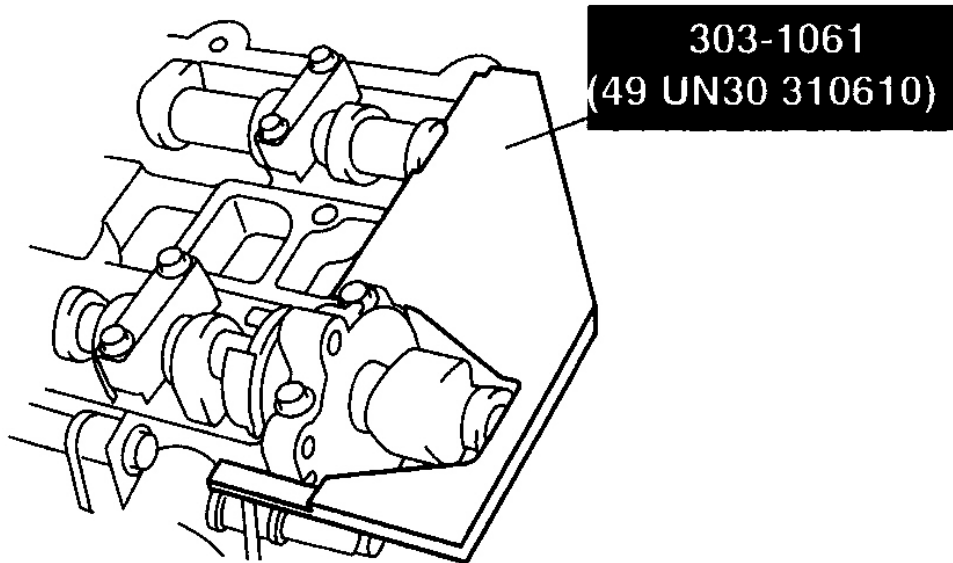


B3E0110E125

Fig. 118: Installing SST On Oil Pump Driven Sprocket
Courtesy of MAZDA MOTORS CORP.

Timing Chain Assembly Note

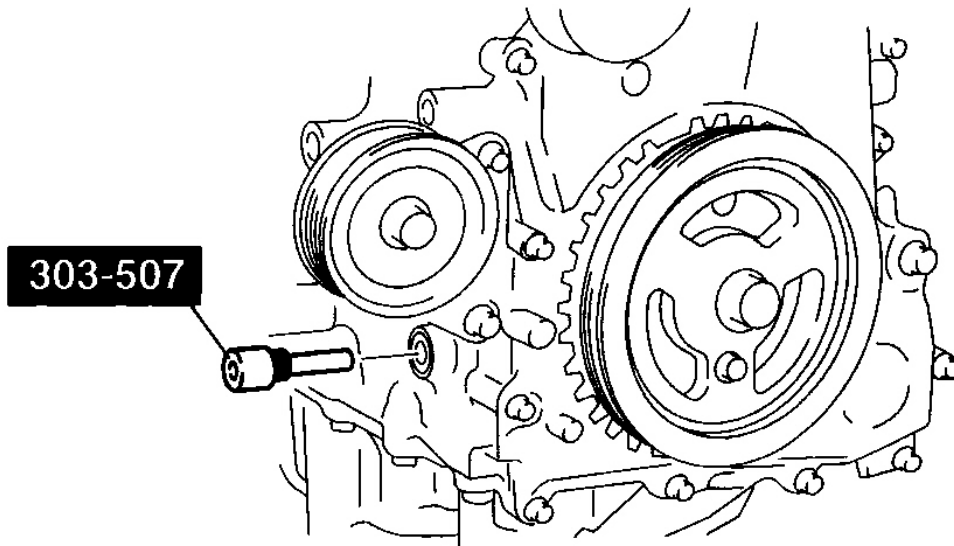
1. Install the SST on the camshaft and align the No. 1 camshaft position at TDC of the compression stroke.



E6U110ZEB036

Fig. 119: Installing SST On Camshaft
Courtesy of MAZDA MOTORS CORP.

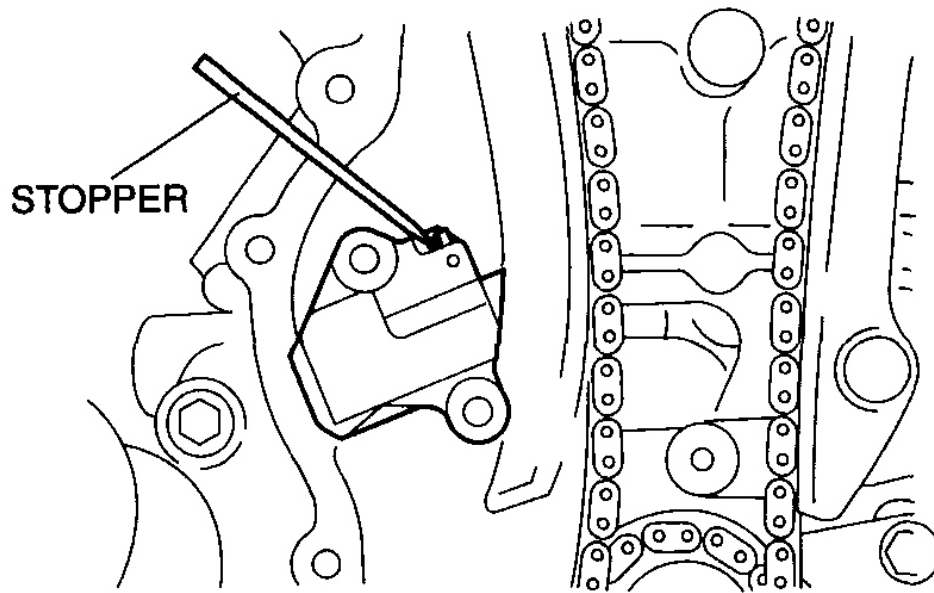
2. Remove the cylinder block lower blind plug from the cylinder block and install the SST .
3. Rotate the crankshaft clockwise so that the No. 1 piston is at TDC of the compression stroke. (The position crank weight contacts the SST).
4. Install the timing chain.



E6U110ZWB050

Fig. 120: Installing SST
Courtesy of MAZDA MOTORS CORP.

5. After the chain adjuster is installed, remove the paper clip (stopper).



E6U110ZWB057

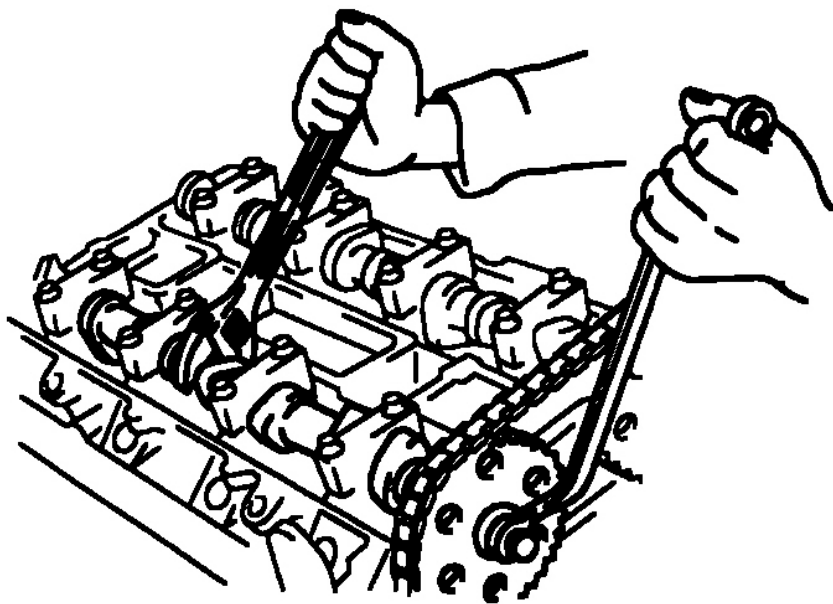
Fig. 121: Removing Paper Clip (Stopper)
Courtesy of MAZDA MOTORS CORP.

Camshaft Sprocket Lock Bolt Assembly Note

1. Lock the camshaft against rotation using a wrench on the cast hexagon.
2. Tighten the camshaft sprocket installation bolt.

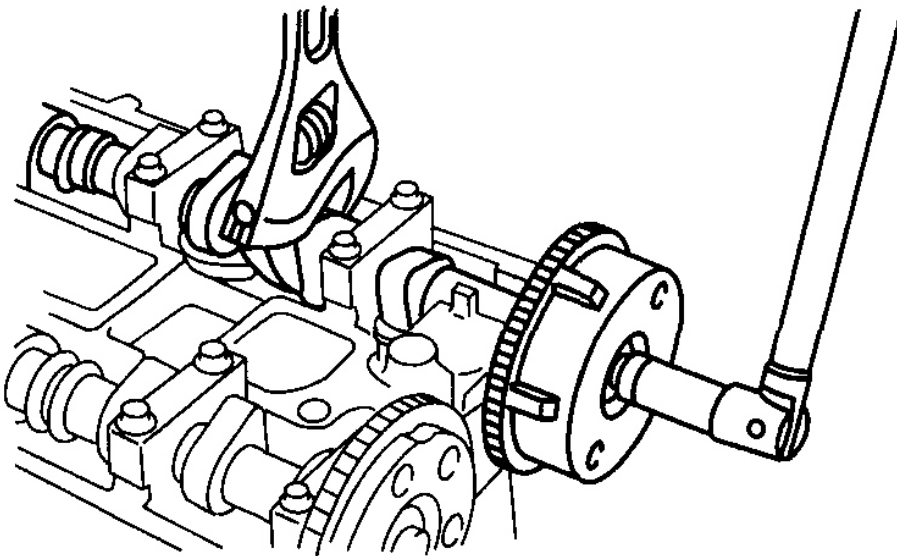
Tightening torque

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



B3E0110E095

Fig. 122: Holding Camshaft Using Suitable Wrench On Cast Hexagon
Courtesy of MAZDA MOTORS CORP.



E6U110ZWB047

Fig. 123: Holding Camshaft While Turning Camshaft Sprocket Bolt
Courtesy of MAZDA MOTORS CORP.

Engine Front Cover Assembly Note

1. Apply silicone sealant to the engine front cover.

CAUTION:

- Install the engine front cover within 10 minutes of applying the silicone sealant.
- Silicone sealant is not need in area C as indicated below due to an existing.

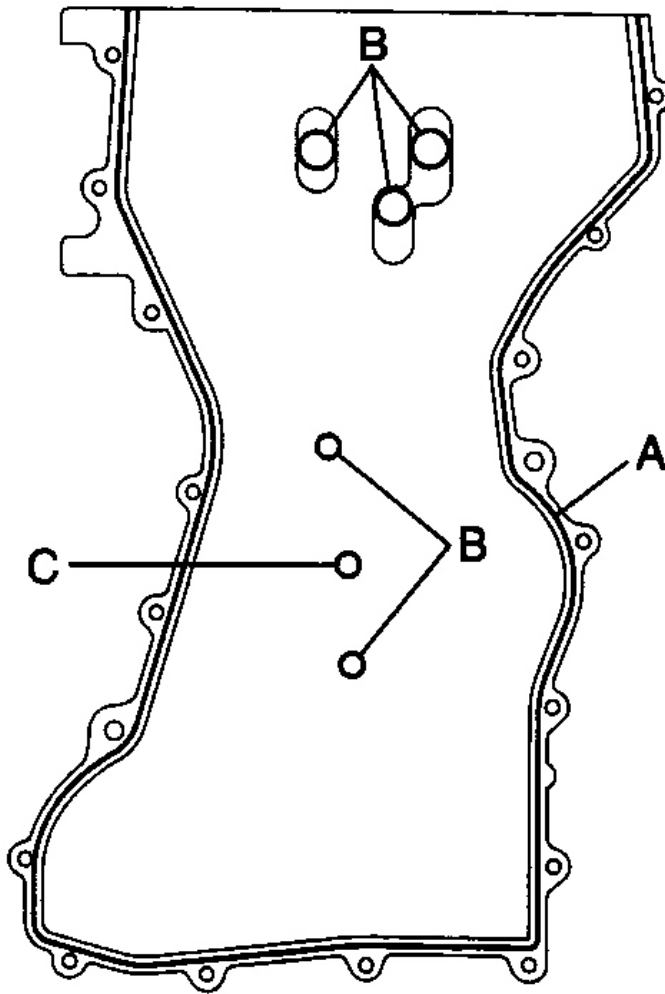
NOTE:

- Install the engine front cover within 10 min after applying the silicone sealant.

Thickness

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

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



B3E0110E129

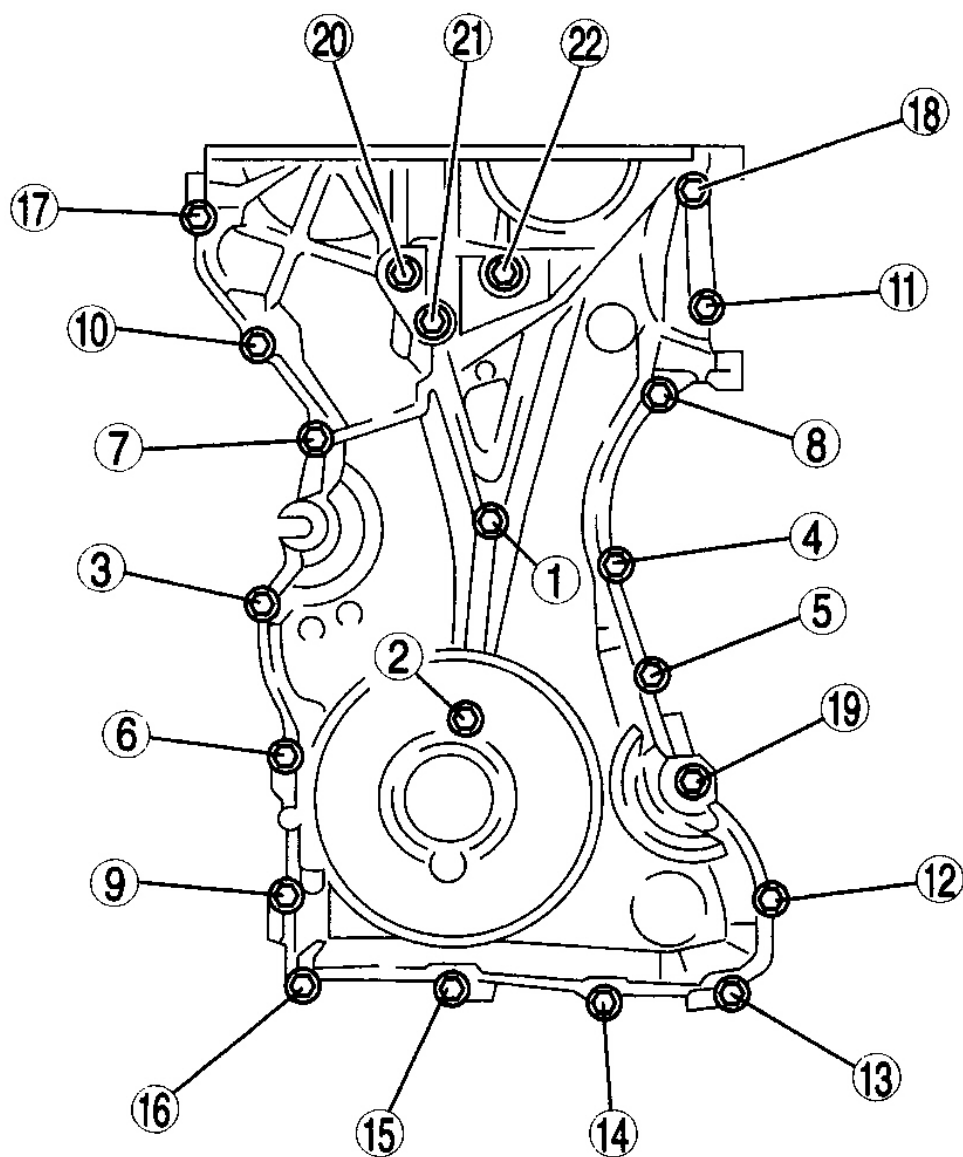
Fig. 124: Applying Silicone Sealant To Engine Front Cover
Courtesy of MAZDA MOTORS CORP.

2. Tighten the engine front cover installation bolts in the order shown in the figure.

ENGINE FRONT COVER INSTALLATION BOLTS TIGHTENING SPECIFICATIONS

Installation position	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, 29.7-40.5}



B3E0110E062

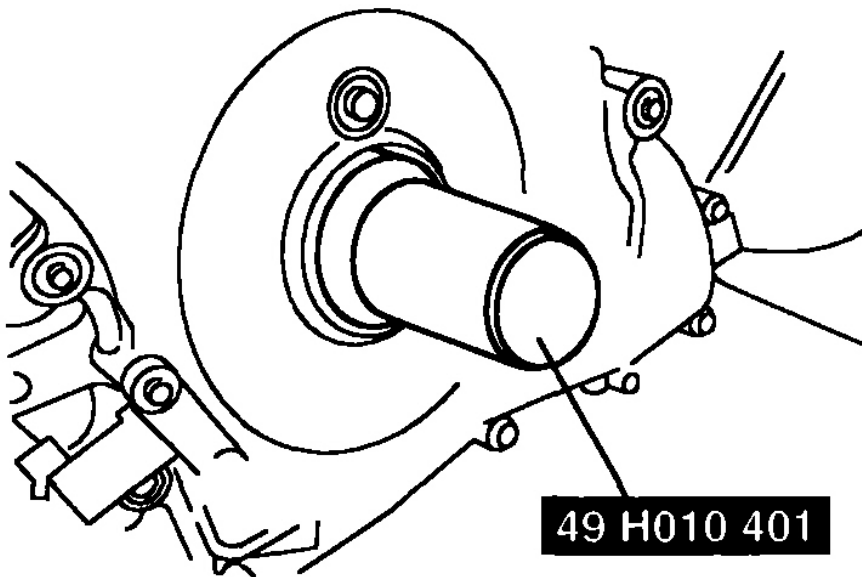
Fig. 125: Engine Front Cover Bolt Tightening Order

Courtesy of MAZDA MOTORS CORP.

3. Install the oil seal using the SST .

Front oil seal press-in amount

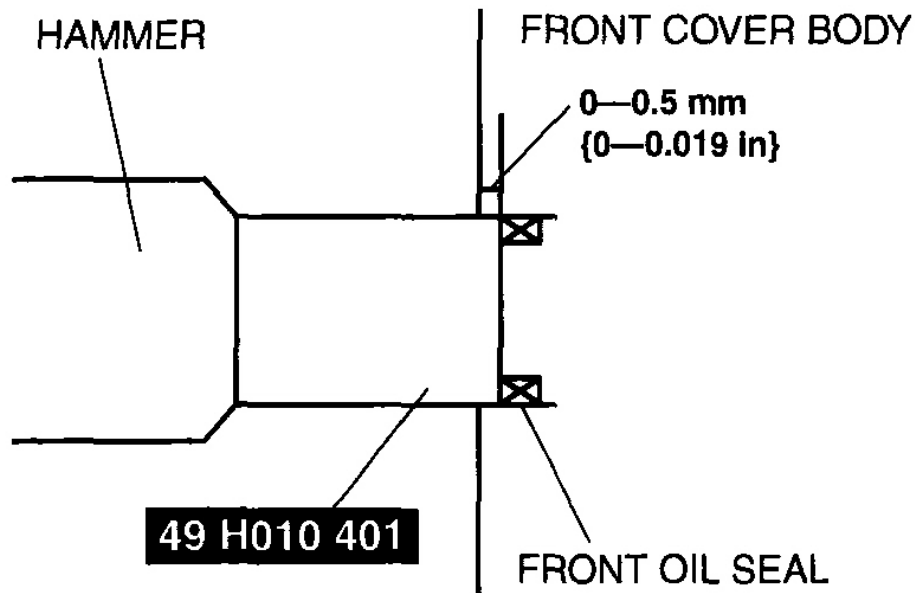
0-0.5 mm {0-0.019 in}



B3E0110E127

Fig. 126: Installing Front Oil Seal

Courtesy of MAZDA MOTORS CORP.

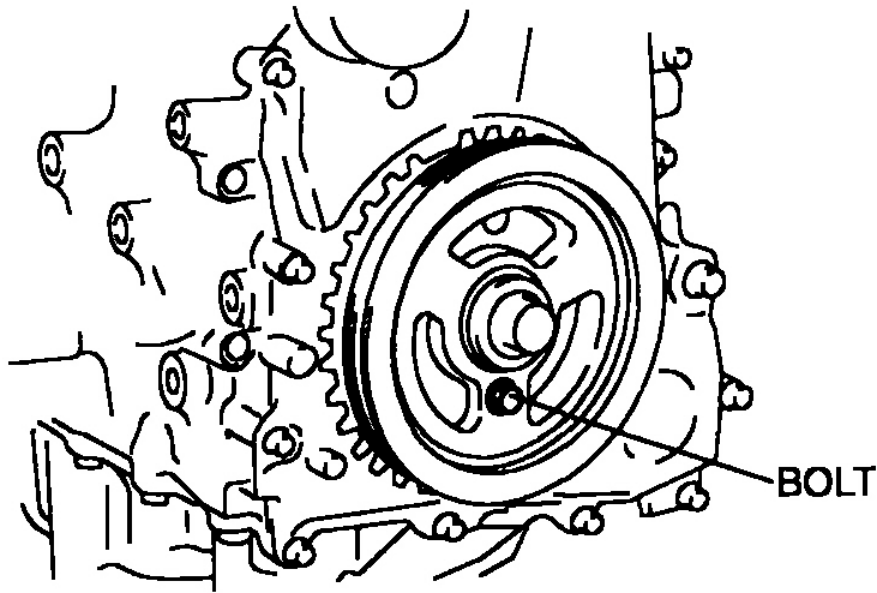


C3U0110W057

Fig. 127: Identifying Front Oil Seal Installation Recess Value
Courtesy of MAZDA MOTORS CORP.

Crankshaft Pulley Lock Bolt Assembly Note

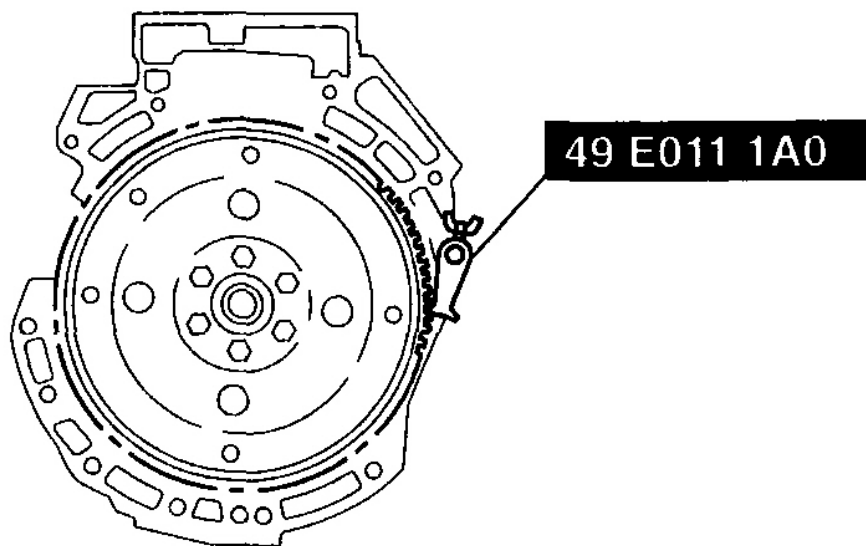
1. Install the crankshaft pulley to the front cover using a bolt (**M6 X 1.0**) . Temporarily tighten the bolt.



B3E0110E063

Fig. 128: Installing M6 X 1.0 Bolt
Courtesy of MAZDA MOTORS CORP.

2. Use the SST to lock the crankshaft against rotation.



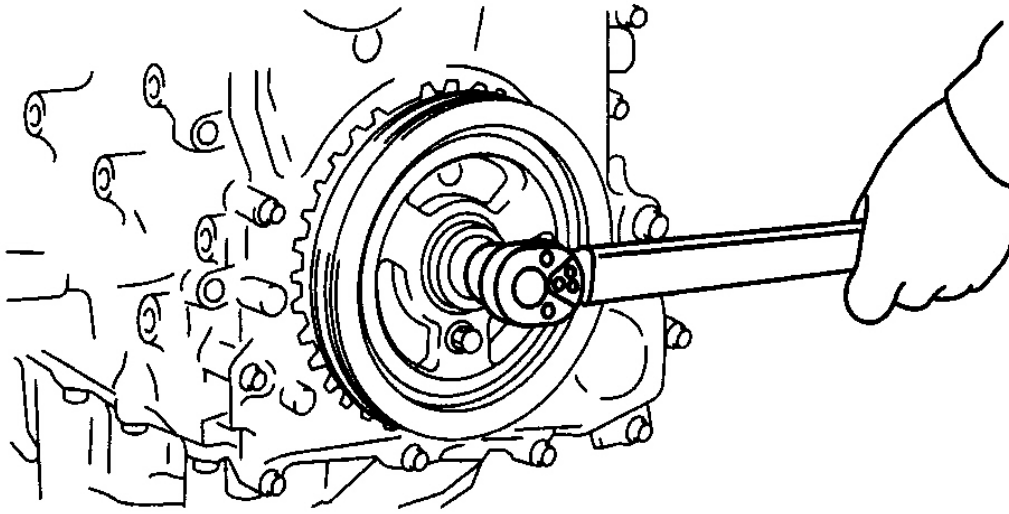
E6U110ZEB039

Fig. 129: Locking Crankshaft Using SST
Courtesy of MAZDA MOTORS CORP.

3. Tighten the pulley lock bolt.

Tightening procedure

1. 96-104 N.m {9.8-10.6 kgf.m, 70.9-76.7 ft.lbf}
2. 87°-93°
4. Remove the SST from the camshaft, and remove the bolt from the crankshaft pulley.
5. Remove the SST from the cylinder block lower blind plug, and install the cylinder block lower blind plug.



E6U110ZEB038

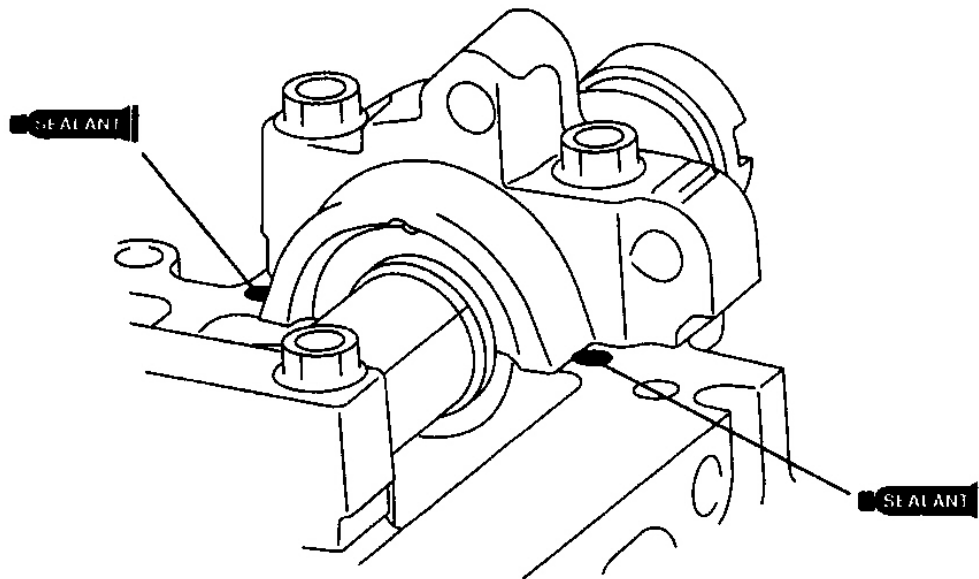
Fig. 130: Tightening Crankshaft Bolt
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Cover Assembly Note

1. Apply silicone sealant to the areas shown in the figure.

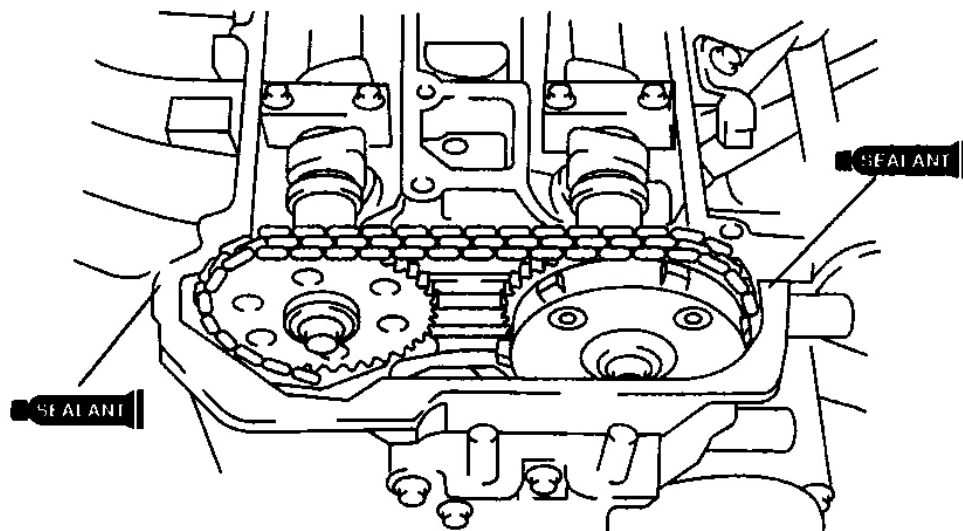
Thickness

5.0 mm {0.196 in}



E6U110ZWB058

Fig. 131: Identifying Areas For Applying Silicone Sealant (1 Of 2)
Courtesy of MAZDA MOTORS CORP.



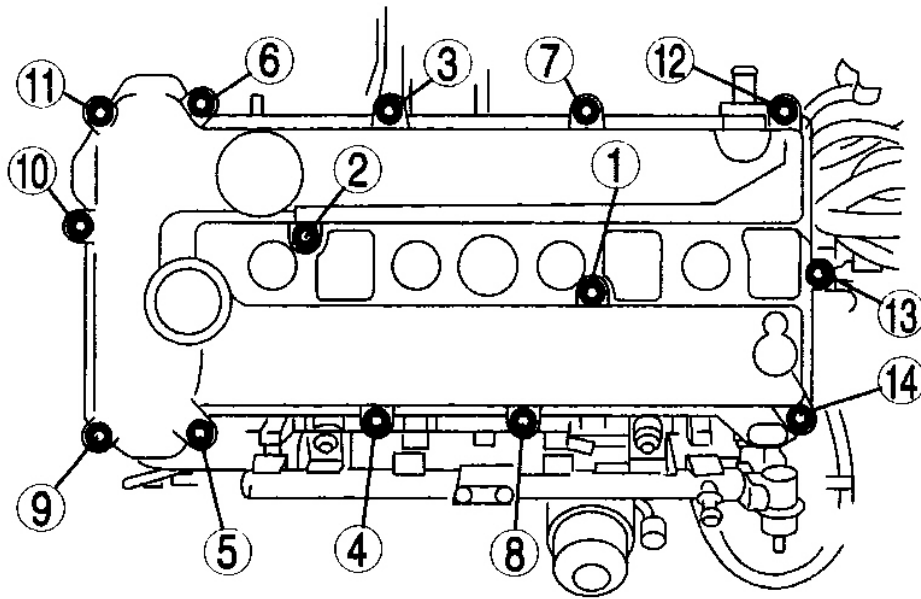
E6U110ZWB007

Fig. 132: Identifying Areas For Applying Silicone Sealant (2 Of 2)
Courtesy of MAZDA MOTORS CORP.

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

Tightening torque

8.0-10.5 N.m {81.6-107 kgf.cm, 70.9-92.9 in.lbf}



B3E0110W050

Fig. 133: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

01-50 TECHNICAL DATA

ENGINE TECHNICAL DATA

ENGINE TECHNICAL DATA

Item	Specification
Maximum distortion, head gasket side	0.10 mm {0.004 in}
Maximum distortion, manifold side	0.10 mm {0.004 in}
Maximum cutting length, manifold side	0.15 mm {0.006 in}
Standard valve seat contact width	IN: 0.7-1.3mm {0.0276-0.0511 in} EX: 0.7-1.3mm {0.0276-0.0511 in}
Valve seat angle	IN: 45° EX: 45°
Standard valve seat sinkage amount (Dimension L)	IN: 40.64-42.24 mm {1.600-1.662 in} EX: 40.50-42.10 mm {1.595-1.657 in}
Minimum valve head margin thickness	IN: 1.62 mm {0.0637 in} EX: 1.82 mm {0.0716 in}

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Standard valve length (Dimension L)	IN: 102.99-103.79 mm {4.055-4.086 in} EX: 104.25-105.05 mm {4.105-4.135 in}
Valve stem diameter	Standard IN: 5.970-5.985 mm {0.2351-0.2356 in} EX: 5.965-5.980 mm {0.2349-0.2354 in} Minimum IN: 5.940 mm {0.2339 in} EX: 5.935 mm {0.2336 in}
Standard valve guide inner diameter	IN: 6.009-6.039 mm {0.2366-0.2377 in} EX: 6.009-6.039 mm {0.2366-0.2377 in}
Clearance between valve stem and guide	Standard IN: 0.024-0.069 mm {0.0009-0.0027 in} EX: 0.029-0.074 mm {0.0012-0.0029 in} Maximum 0.10 mm {0.004 in}
Standard valve guide projection height	IN: 12.2-12.8 mm {0.481-0.503 in} EX: 12.2-12.8 mm {0.481-0.503 in}
Valve spring installation height	37.90 mm {1.492 in} (171.5 N {17.49 kgf, 38.55 lbf})
Maximum valve spring off-square	2.55 mm {0.100 in}
Standard tappet bore diameter	31.000-31.030 mm {1.2205-1.2216 in}
Standard tappet body outer diameter	30.970-30.980 mm {1.2193-1.2196 in}
Clearance between tappet and tappet bore	Standard 0.02-0.06 mm {0.0008-0.0023 in} Maximum 0.15 mm {0.006 in}
Oil control valve coil resistance	6.9-7.9 ohms [20°C {68°F}]
Maximum camshaft runout	0.03 mm {0.0012 in}
Cam height	Standard IN: 42.44 mm {1.671 in} EX: 41.18 mm {1.622 in} Minimum IN: 42.34 mm {1.667 in} EX: 41.08 mm {1.618 in}
Camshaft journal diameter	Standard 24.96-24.98 mm {0.9827-0.9834 in} Minimum 24.95 mm {0.982 in}

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Camshaft journal oil clearance	Standard 0.04-0.08 mm {0.002-0.003 in} Maximum 0.09 mm {0.0035 in}
Camshaft end play	Standard 0.09-0.24 mm {0.0035-0.0094 in} Maximum 0.25 mm {0.0099 in}
Maximum distortion, head gasket side	0.10 mm {0.004 in}
Maximum bore inner diameter	87.500-87.530 mm {3.4449-3.4460 in}
Standard piston outer diameter	87.465-87.495 mm {3.4435-3.4446 in}
Clearance between piston and cylinder	Standard 0.025-0.045 mm {0.0010-0.0017 in} Maximum 0.11 mm {0.0043 in}
Clearance between piston ring and ring groove	Standard Top: 0.005-0.08 mm {0.0020-0.0031 in} Second: 0.03-0.07 mm {0.0012-0.0027 in} Oil: 0.02-0.06 mm {0.0008-0.0023 in} Maximum Top: 0.17 mm {0.0067 in} Second, Oil: 0.15 mm {0.0059 in}
Piston ring end gap	Standard Top: 0.14-0.24 mm {0.0056-0.0094 in} Second: 0.34-0.44 mm {0.0134-0.0173 in} Oil (rail): 0.15-0.40 mm {0.0060-0.0157 in} Maximum 1.0 mm {0.0393 in}
Standard piston pin hole diameter	22.504-22.508 mm {0.8860-0.8861 in}
Standard connecting rod small end inner diameter	22.510-22.521 mm {0.8863-0.8866 in}
Standard piston pin outer diameter	22.495-22.500 mm {0.8857-0.8858 in}
Standard clearance between piston pin hole diameter and piston outer diameter	0.004-0.013 mm {0.0002-0.0005 in}
Standard clearance between connecting rod small end inner diameter and piston pin outer diameter	0.010-0.026 mm {0.0004-0.0010 in}
Connecting rod large end side clearance	Standard 0.14-0.36 mm {0.0056-0.0141 in} Maximum 0.435 mm {0.0172 in}
	Standard 0.027-0.051 mm {0.0011-0.0020 in}

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Bearing oil clearance at the large end of connecting rod	Maximum 0.1 mm {0.0039 in}
Connecting rod bearing size	STD 1.495-1.519 mm {0.0589-0.0598 in} OS0.25 1.614-1.626 mm {0.0636-0.0640 in} OS0.50 1.739-1.751 mm {0.0685-0.0689 in}
Maximum connecting rod bending [per 50 mm]	0.070 mm {0.0019 in}
Maximum connecting rod distortion [per 50 mm]	0.060 mm {0.0027 in}
Connecting rod center-to-center distance	150.65-150.75 mm {5.9311-5.9350 in}
Crankshaft end play	Standard 0.22-0.45 mm {0.0087-0.0177 in} Maximum 0.55 mm {0.021 in}
Maximum main journal runout	0.05 mm {0.0019 in}
Main journal diameter	STD 51.980-52.000 mm {2.0465-2.0472 in} OS0.25 51.730-51.750 mm {2.0367-2.0374 in}
Maximum main journal off-round	0.05 mm {0.0019 in}
Crank pin diameter	STD 51.980-52.000 mm {2.0465-2.0472 in} OS0.25 51.730-51.750 mm {2.0367-2.0374 in}
Maximum crank pin off-round	0.05 mm {0.0019 in}
Main journal oil clearance	Standard 0.016-0.039 mm {0.0007-0.0015 in} Maximum 0.10 mm {0.0039 in}
Main bearing size (UPPER)	STD 2.501-2.522 mm {0.0985-0.0992 in} OS0.25 2.623-2.629 mm {0.1033-0.1035 in} OS0.50 2.748-2.754 mm {0.1082-0.1084 in}
Main bearing size (LOWER)	STD 2.501-2.529 mm {0.0985-0.0995 in} OS0.25 2.624-2.630 mm {0.1034-0.1035 in} OS0.50 2.749-2.755 mm {0.1083-0.1084 in}
Cylinder head bolt length	Standard 144.7-145.3 mm {5.696-5.720 in} Maximum 146 mm {5.748 in}

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Connecting rod bolt length	Standard 43.7-44.3 mm {1.720-1.744 in} Maximum 46 mm {1.811 in}
Standard valve clearance [when cold]	IN: 0.22-0.28 mm {0.0087-0.0110 in} EX: 0.27-0.33 mm {0.0106-0.0130 in}
Maximum gear backlash	0.005-0.101 mm {0.00019-0.0039 in}
Front oil seal press-in amount	0-0.5 mm {0-0.019 in}

01-60 SERVICE TOOLS

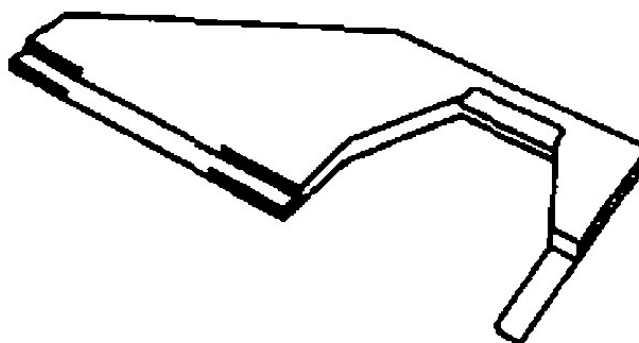
ENGINE SST [L3 WITH T/C]

1. Mazda SST number
2. Global SST number

Example

SST EXAMPLE

1: 49 UN30
310610
2: 303-1061
Camshaft alignment timing tool

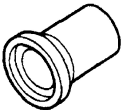
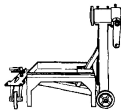
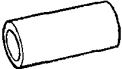
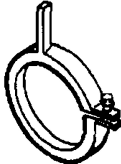
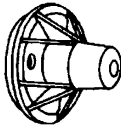
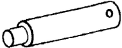


SST DESCRIPTION

1:-2: 303-507 Crankshaft TDC timing peg		1:-2: 205-072-02 Crankshaft holding tool pins		1: 49 G032 354 2:- Adjusting wrench	
1: 49 E011 1A0 2:- Ring gear brake set		1: 49 0636 100B 2:- Valve spring lifter arm		1: 49 B012 0A2 2:- Pivot	
1: 49 B012 015 2:- Valve guide		1: 49 H010 401 2:- Oil seal installer		1: 49 0107 680A 2:- Engine stand	

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installer			
1: 49 L010 1A0 2:- Engine hanger set		1: 49 S120 170 2:- Valve seal remover	
1: 49 T032 302 2:- Bearing installer		1: 49 UN30 310610 2: 303-1061 Camshaft alignment timing tool	
1: 49 UN20 5153 2: 205-153 Handle		1: 49 1285 071 2:- Bearing puller	
1: 49 T011 001 2:- Piston pin installer		1: 49 UN30 8157 2: 308-157 Pilot bearing installer	-
		