

2003-05 ENGINE

Overhaul - 1.8L (BP) 4-Cylinder - MX-5 Miata

ENGINE OVERHAUL SERVICE WARNING

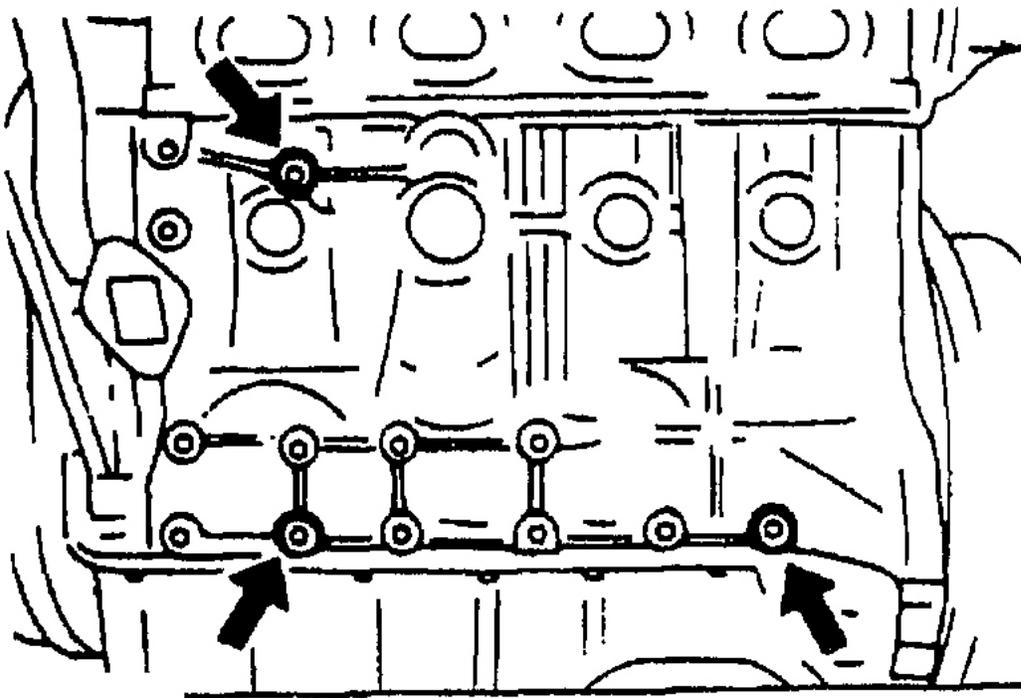
WARNING:

- 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

MOUNTING

1. Use the holes shown in the figure.



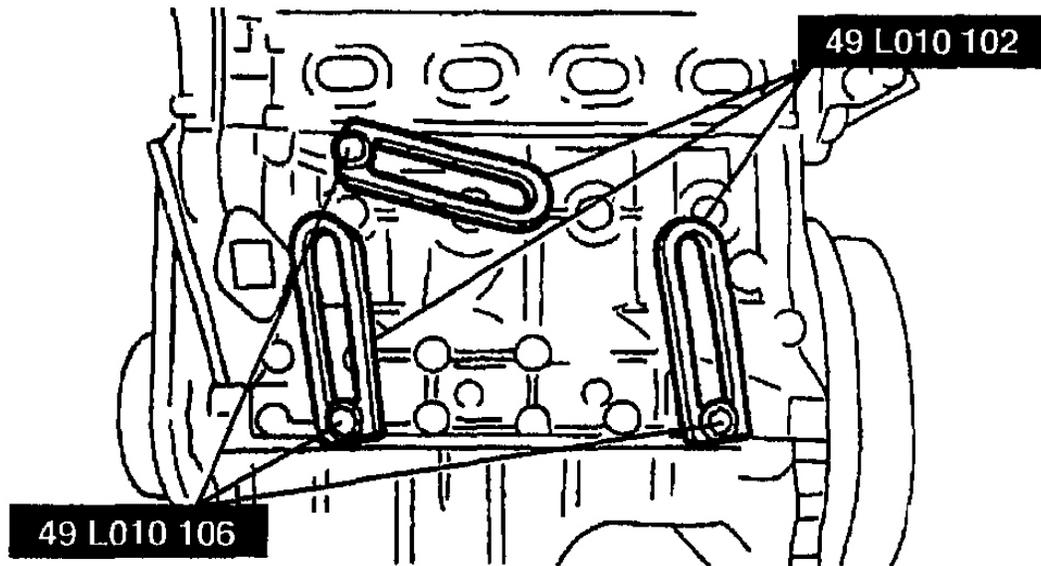
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Fig. 1: Identifying SST Mounting Holes
Courtesy of MAZDA MOTORS CORP.

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2. Install the **SST** (arms) to the cylinder block holes as shown, and hand-tighten the **SST** (bolts).



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Fig. 2: Installing SST Arms To Cylinder Block
Courtesy of MAZDA MOTORS CORP.

3. Assemble the **SST** (bolts, nuts, and plate) in the specified positions.

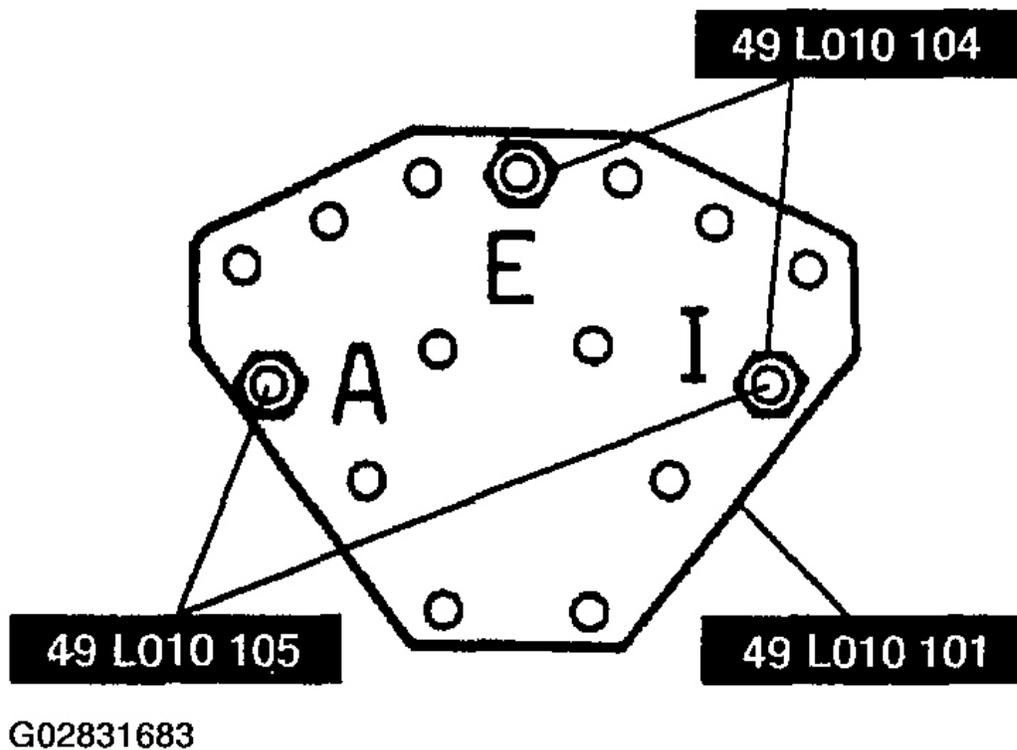
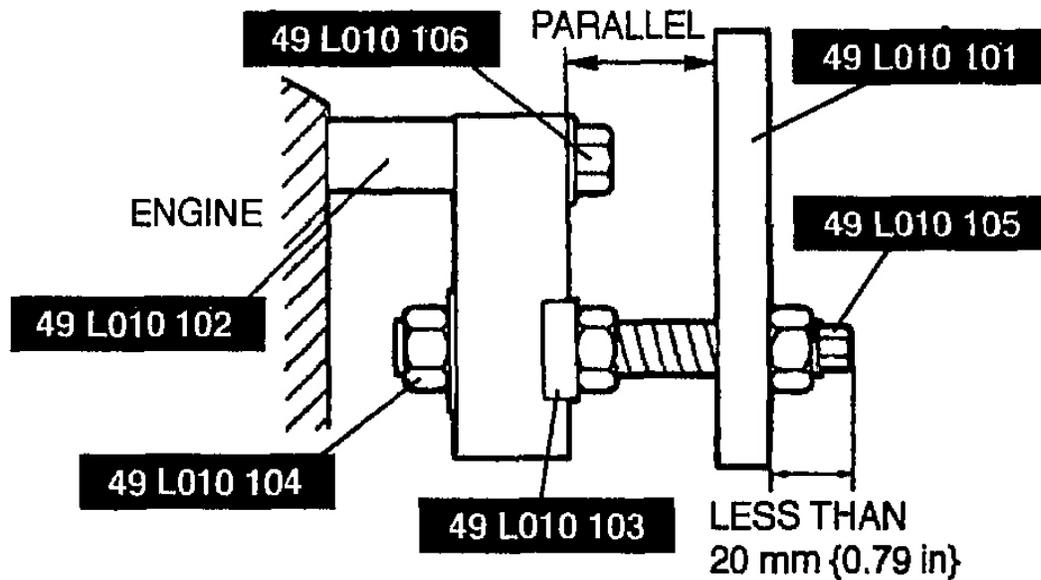


Fig. 3: Identifying SST Mounting Positions
Courtesy of MAZDA MOTORS CORP.

4. Install the SST assembled in step 3 to the respective arms.
5. Adjust the SST (bolts) so that less than **20 mm {0.79 in}** of thread is exposed.
6. Make the SST (plate and arms) parallel by adjusting the SST (bolts and nuts).



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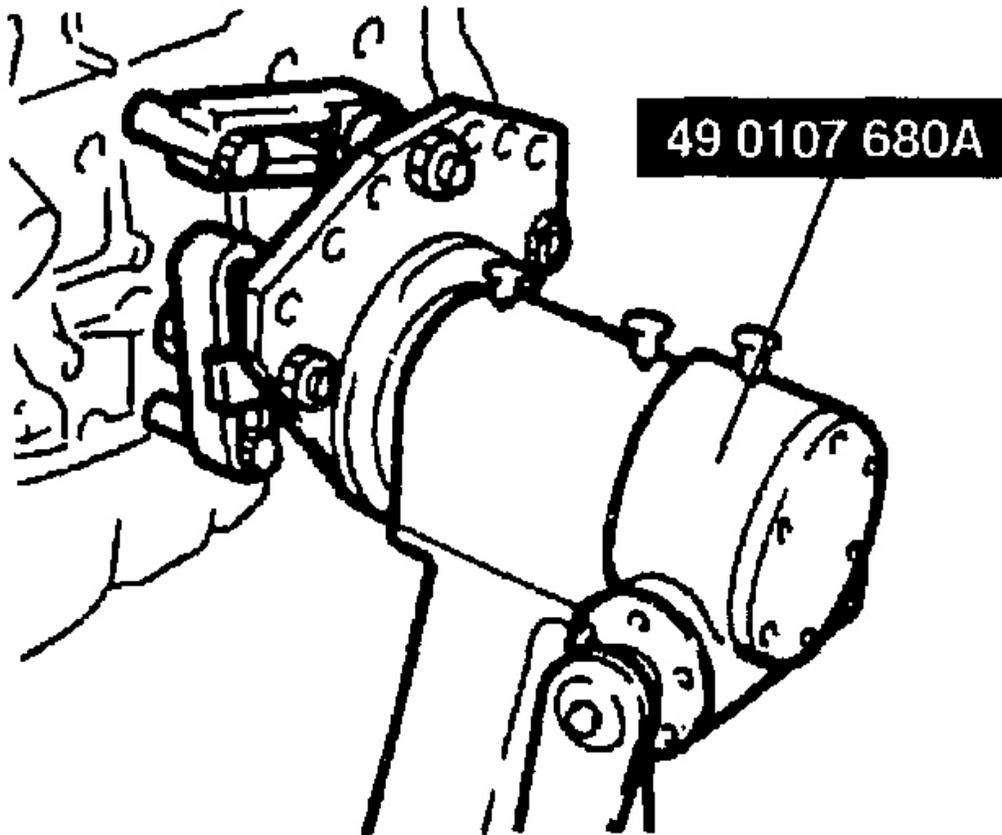
Fig. 4: Adjusting SST Plate & Arms
 Courtesy of MAZDA MOTORS CORP.

7. Tighten the SST (bolts and nuts) to affix the SST firmly.

WARNING:

- The 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 rotation handle firmly turning the engine.

8. Mount the engine on the SST (engine stand).



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Fig. 5: Mounting Engine To Engine Stand
Courtesy of MAZDA MOTORS CORP.

9. Drain the engine oil.
10. Install the oil drain plug.

Tightening Torque

30-41 N.m {3.0-4.2 kgf.m, 22-30 ft.lbf}

DISMOUNTING

- Dismount in the reverse order of mounting.

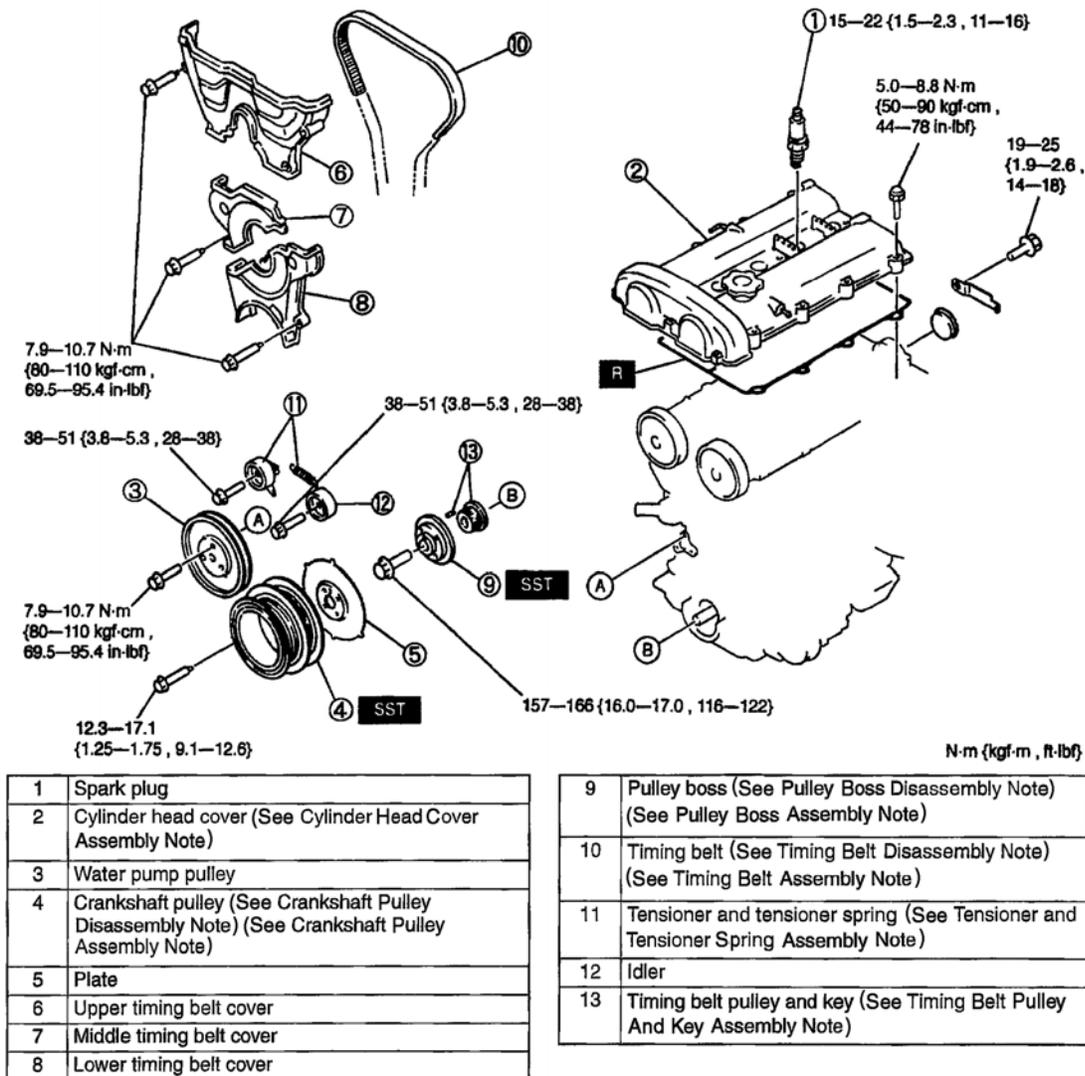
ENGINE DISASSEMBLY/ASSEMBLY

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TIMING BELT DISASSEMBLY/ASSEMBLY

1. Disassemble in the order indicated in the figure.



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Fig. 6: Disassembling/Assembling Timing Belt
Courtesy of MAZDA MOTORS CORP.

2. Assemble in the reverse order of disassembly.

Crankshaft Pulley Disassembly Note

- Hold the crankshaft using the SST .

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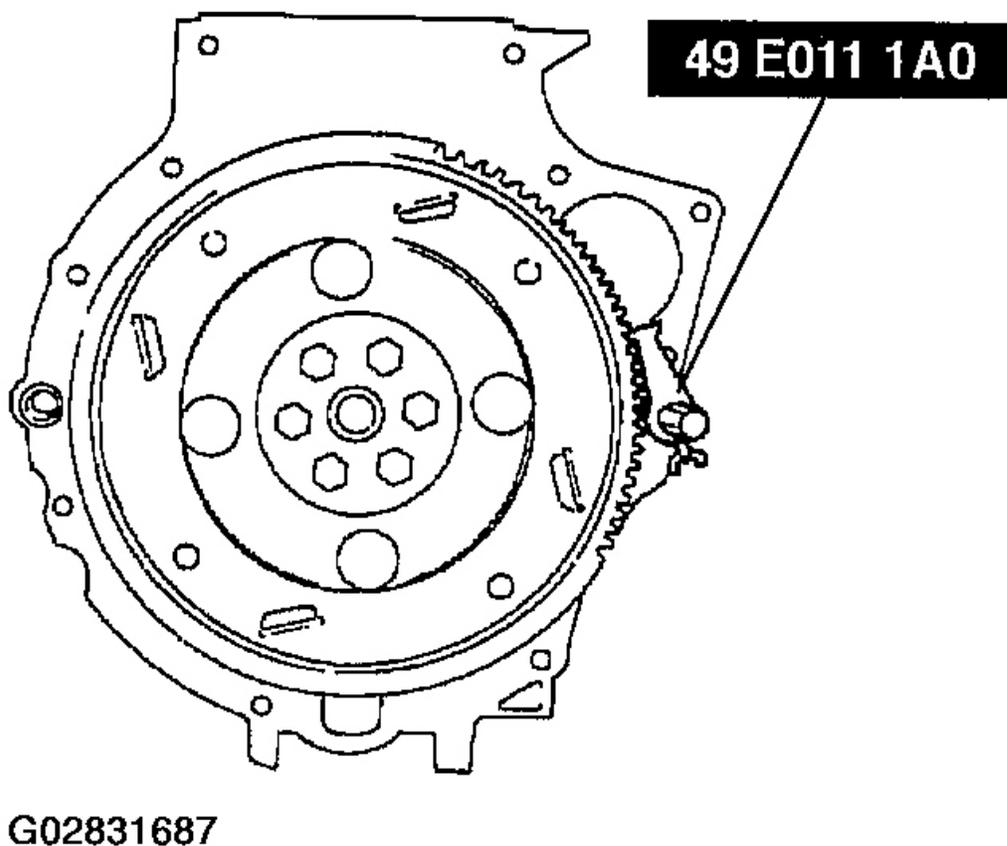


Fig. 7: Holding Crankshaft
Courtesy of MAZDA MOTORS CORP.

Pulley Boss Disassembly Note

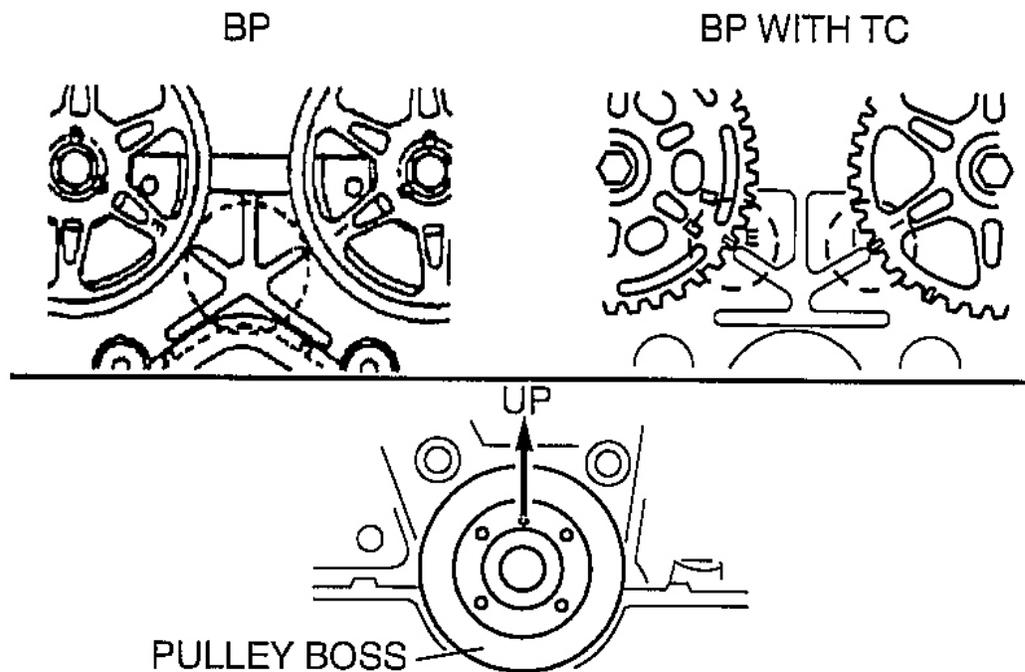
1. Turn the crankshaft clockwise and align the timing marks of the pulleys.

NOTE:

- For the crankshaft side, face the locating pin on the pulley boss straight up.

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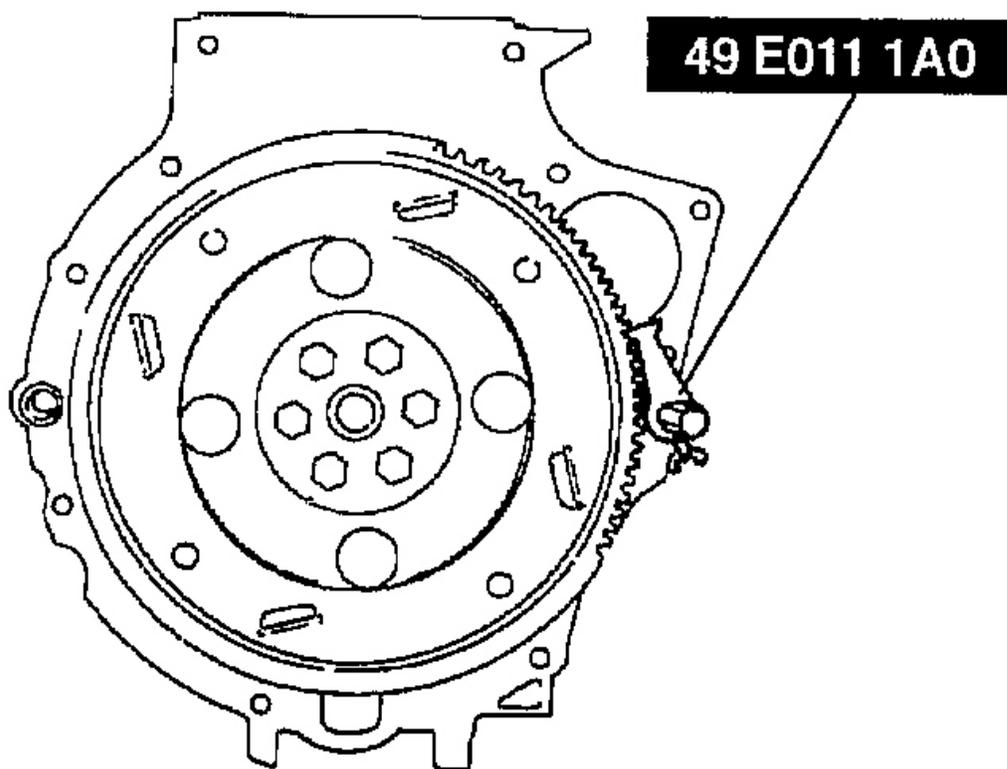
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Fig. 8: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

2. Hold the crankshaft using the SST .

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Fig. 9: Holding Crankshaft
Courtesy of MAZDA MOTORS CORP.

Timing Belt Disassembly Note

CAUTION: • The following will damage the belt and shorten its life; Forcefully twisting it, turning it inside out, or allowing oil or grease on it.

1. Mark the timing belt rotation on the belt for proper reinstallation.

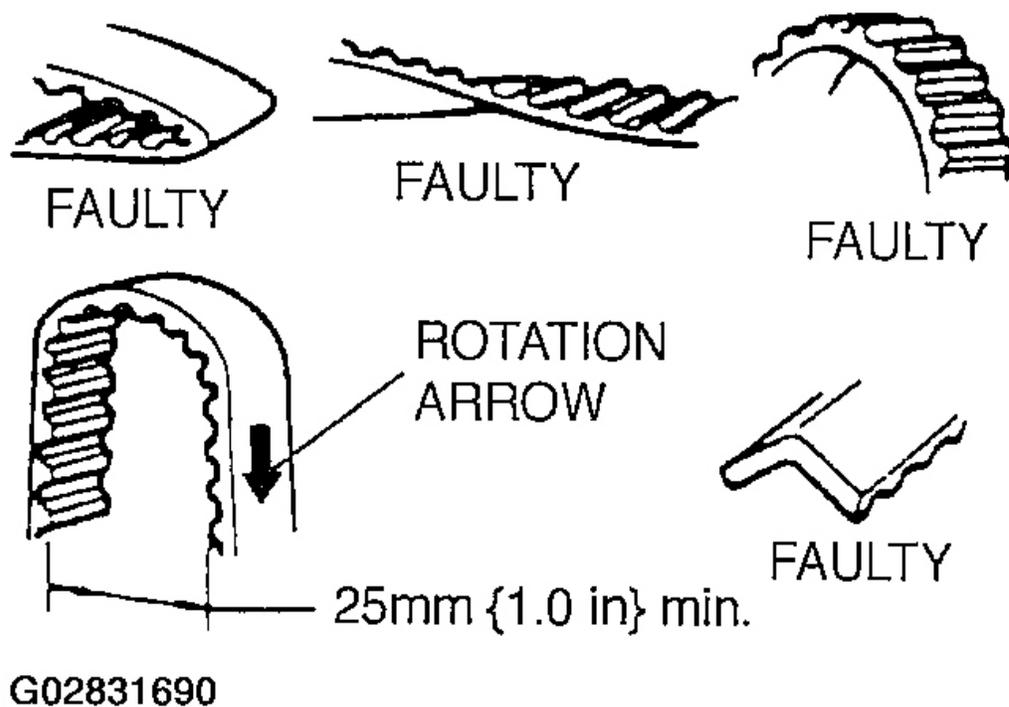
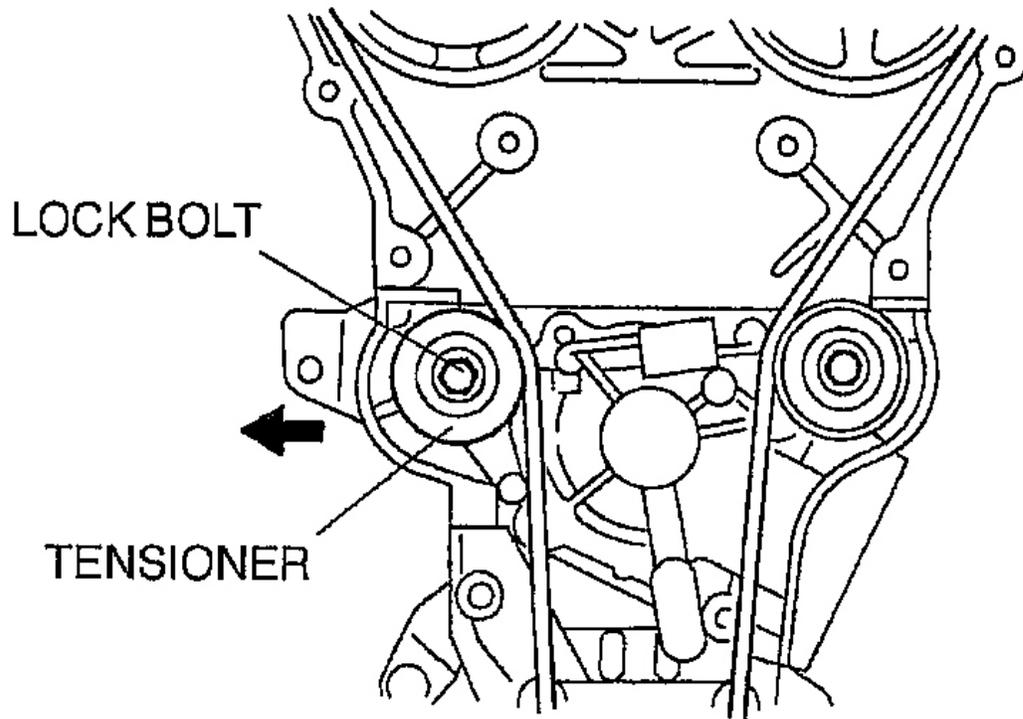


Fig. 10: Marking Timing Belt & Identifying Faulty Belts
Courtesy of MAZDA MOTORS CORP.

2. Loosen the tensioner lock bolt.
3. Push the tensioner in the direction of the arrow and hand-tighten the lock bolt.



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Fig. 11: Identifying Tensioner & Lock Bolt
Courtesy of MAZDA MOTORS CORP.

4. Remove the timing belt.

Timing Belt Pulley And Key Assembly Note

- Insert the key into the timing belt pulley, facing the tapered side downward. Push the key until it stops.

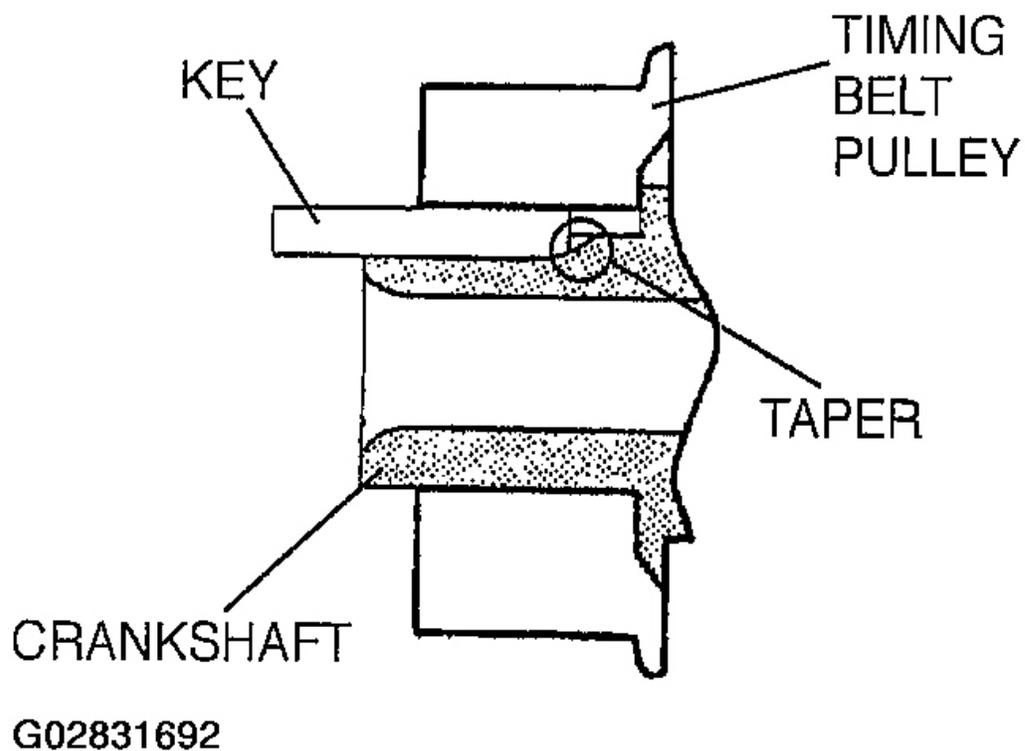


Fig. 12: Installing Timing Belt Pulley Key
Courtesy of MAZDA MOTORS CORP.

Tensioner And Tensioner Spring Assembly Note

1. Install the tensioner spring so that the chamfer of dumping rubber faces the right side as shown.
2. Push the tensioner in the direction of the arrow and hand-tighten the lock bolt.

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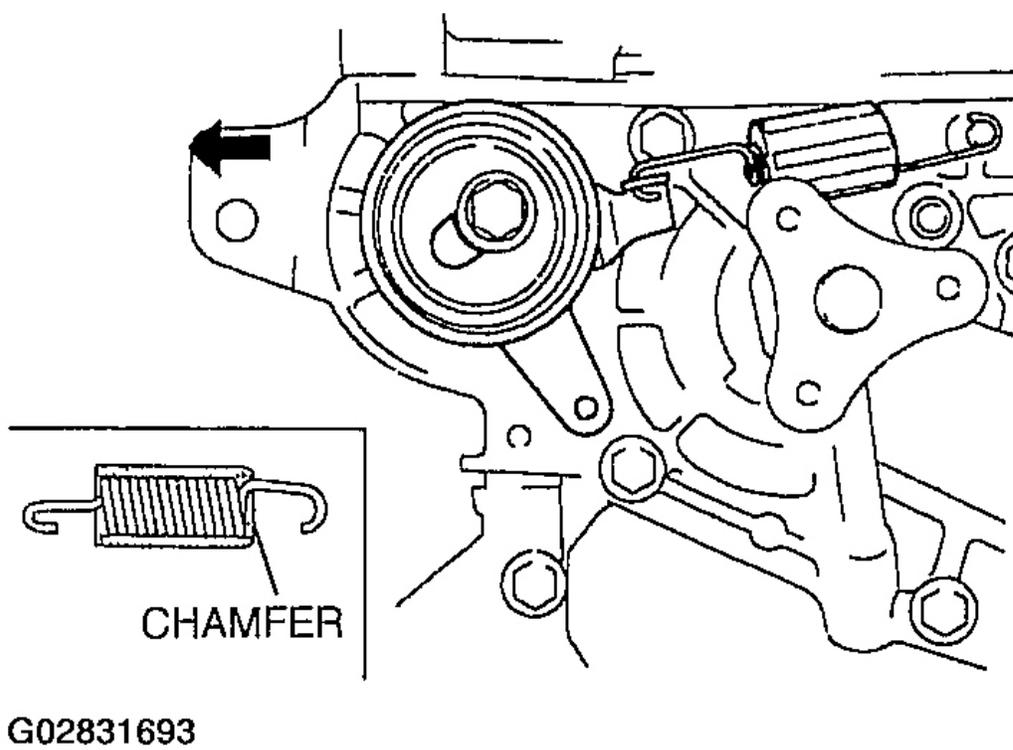


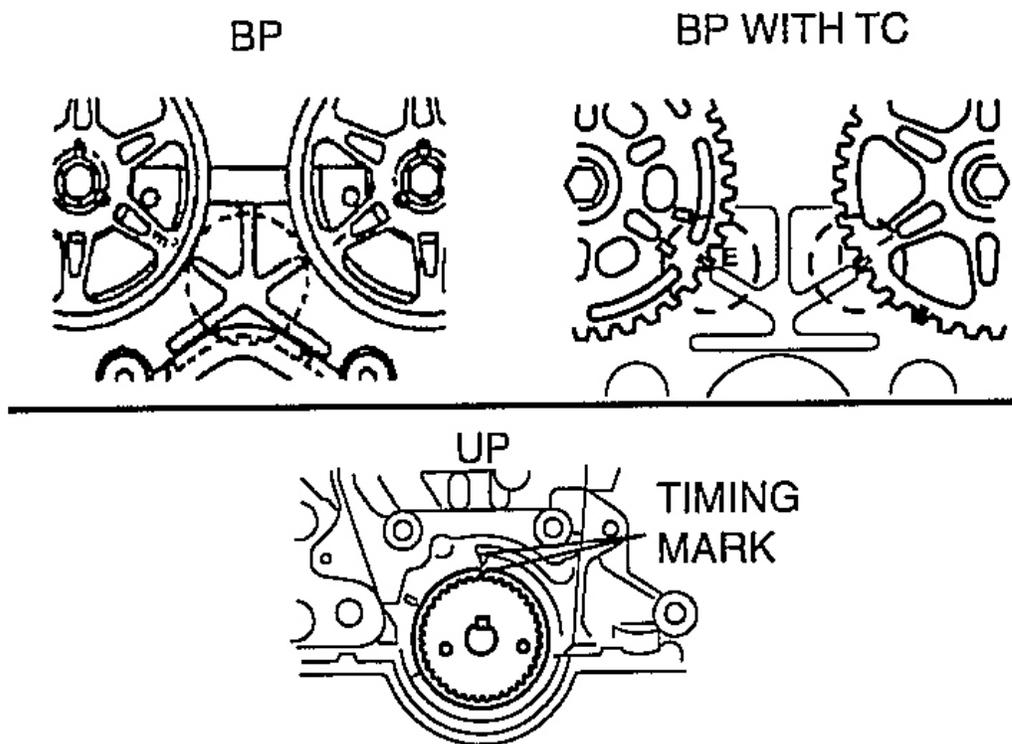
Fig. 13: Pushing Tensioner Outward
Courtesy of MAZDA MOTORS CORP.

Timing Belt Assembly Note

- Verify that all timing marks are correctly aligned.

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Fig. 14: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

Pulley Boss Assembly Note

1. Install the pulley boss and pulley lock bolt. Turn the crankshaft clockwise 1 and 5/6 times, and verify that the timing mark and the tension set mark A are aligned.

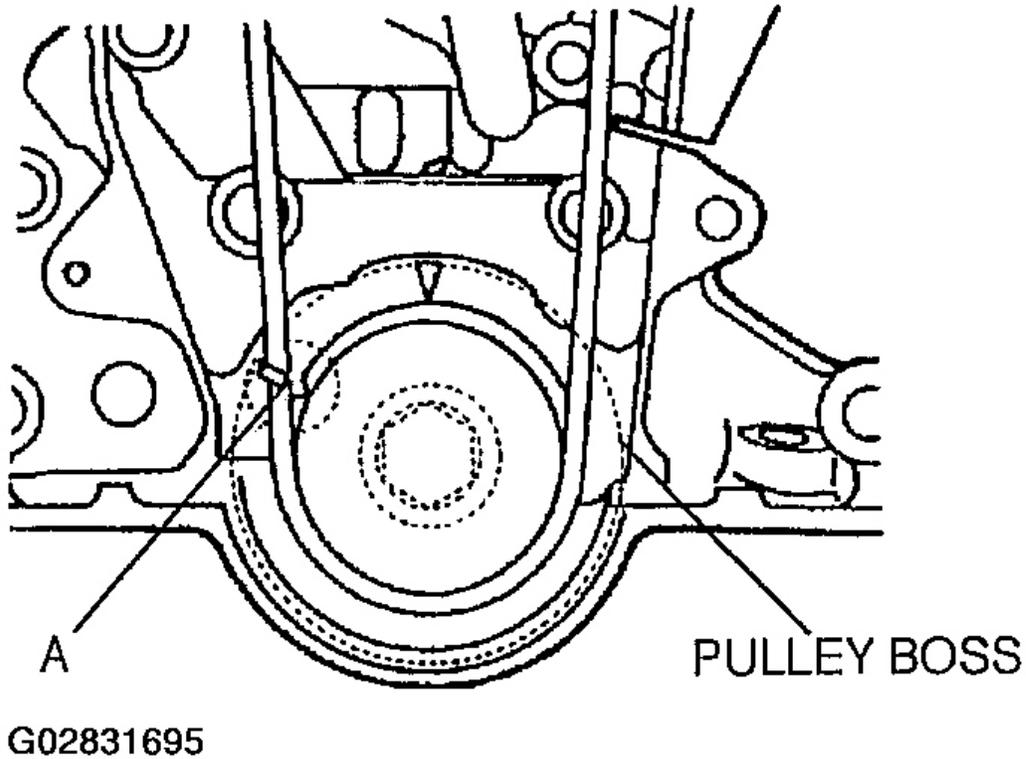
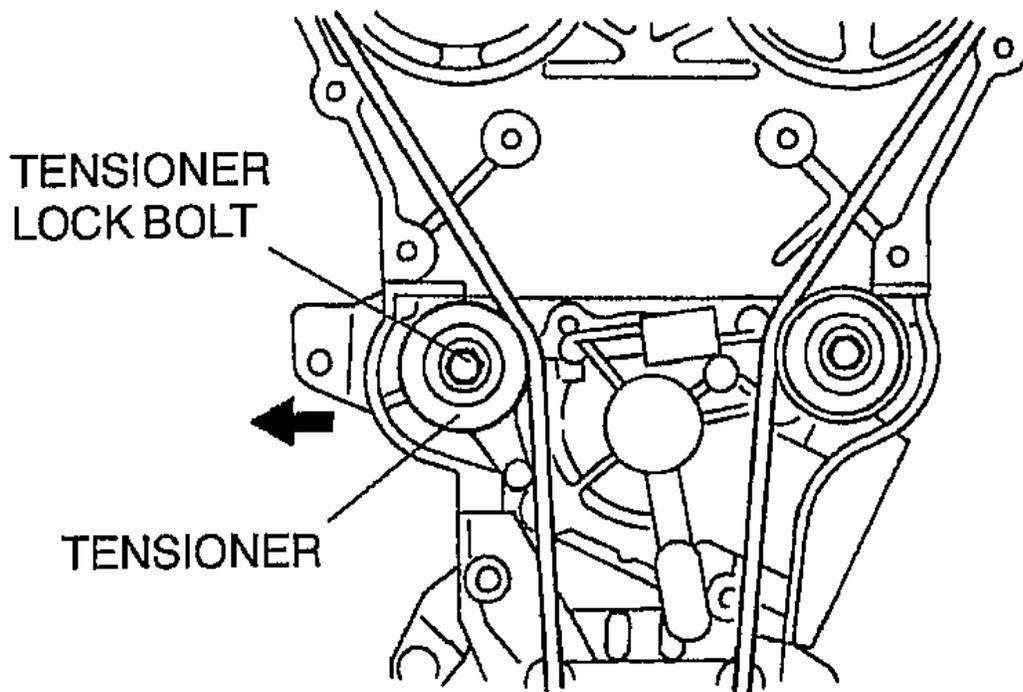


Fig. 15: Aligning Timing Mark & Tension Set Mark
Courtesy of MAZDA MOTORS CORP.

2. Loosen the tensioner lock bolt to apply tension to the timing belt. Do not apply tension other than that of the tensioner spring.
3. Tighten the tensioner lock bolt.



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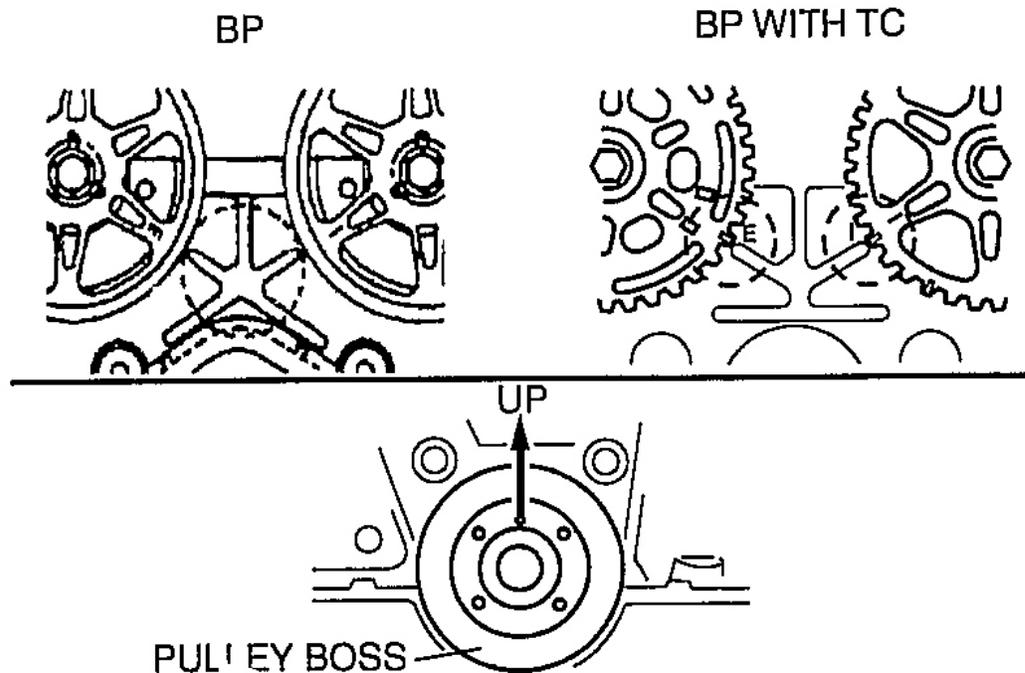
Fig. 16: Identifying Tensioner Lock Bolt
Courtesy of MAZDA MOTORS CORP.

NOTE:

- For the crankshaft side, face the locating pin on the pulley boss straight up.

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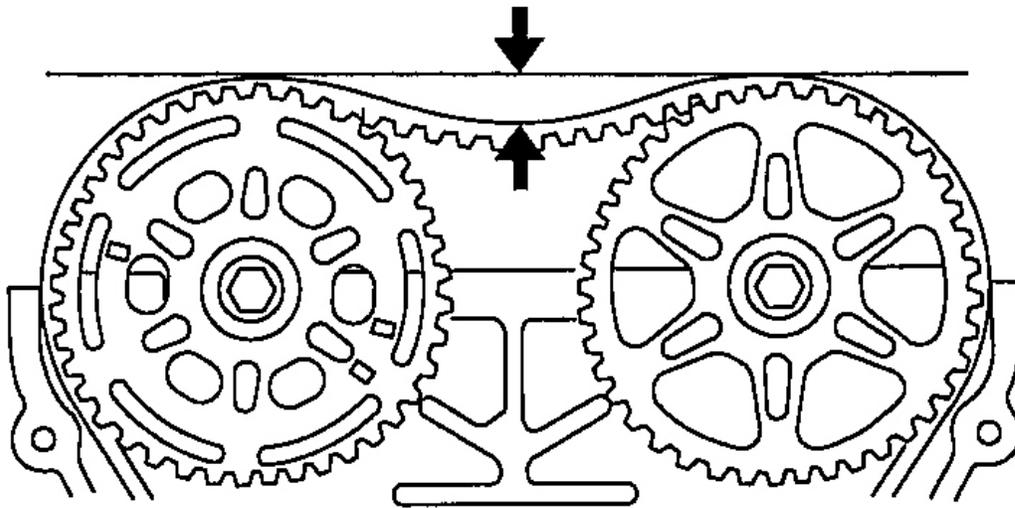
Fig. 17: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

4. Turn the crankshaft clockwise 2 and 1/6 times, and verify that all timing marks are correctly aligned.
5. Inspect for the belt deflection at the point indicated by applying moderate pressure **98 N {10 kgf, 22 lbf}**.

Timing Belt Deflection

8.5-11.5 mm {0.34-0.45 in}

6. If the timing belt deflection is not as specified, remove the timing belt and repeat from **TIMING BELT ASSEMBLY NOTE**.



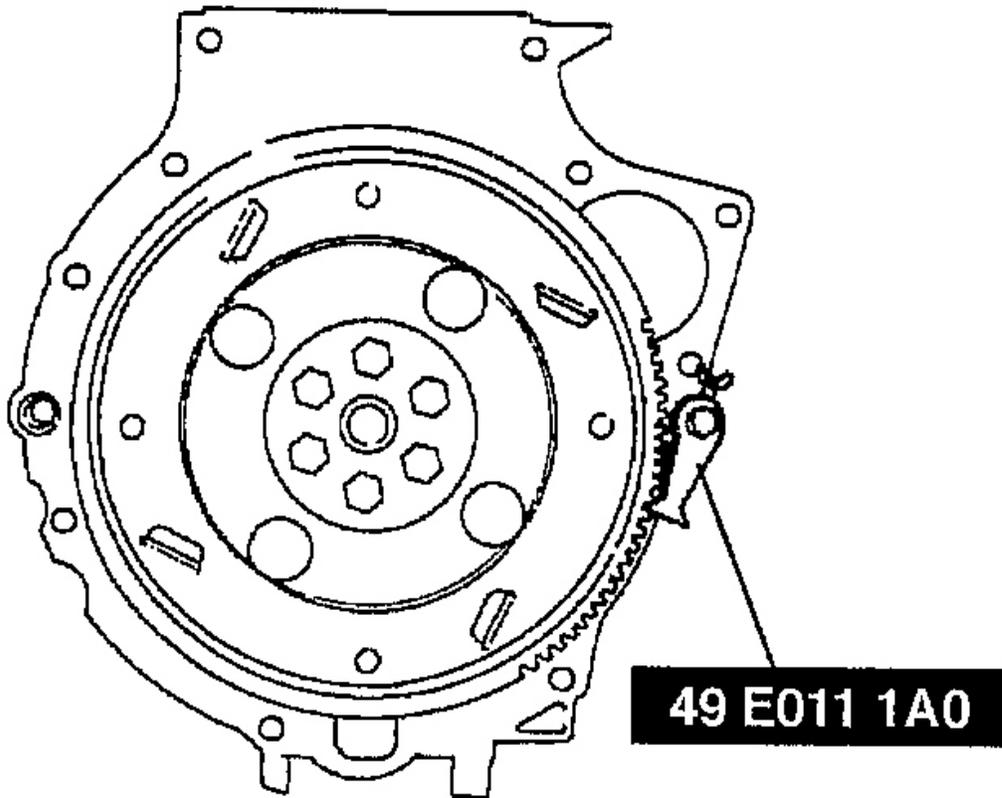
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Fig. 18: Checking Timing Belt Deflection
Courtesy of MAZDA MOTORS CORP.

7. Hold the crankshaft by using the SST .

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Fig. 19: Holding Crankshaft
Courtesy of MAZDA MOTORS CORP.

Crankshaft Pulley Assembly Note

- Hold the crankshaft by using the SST .

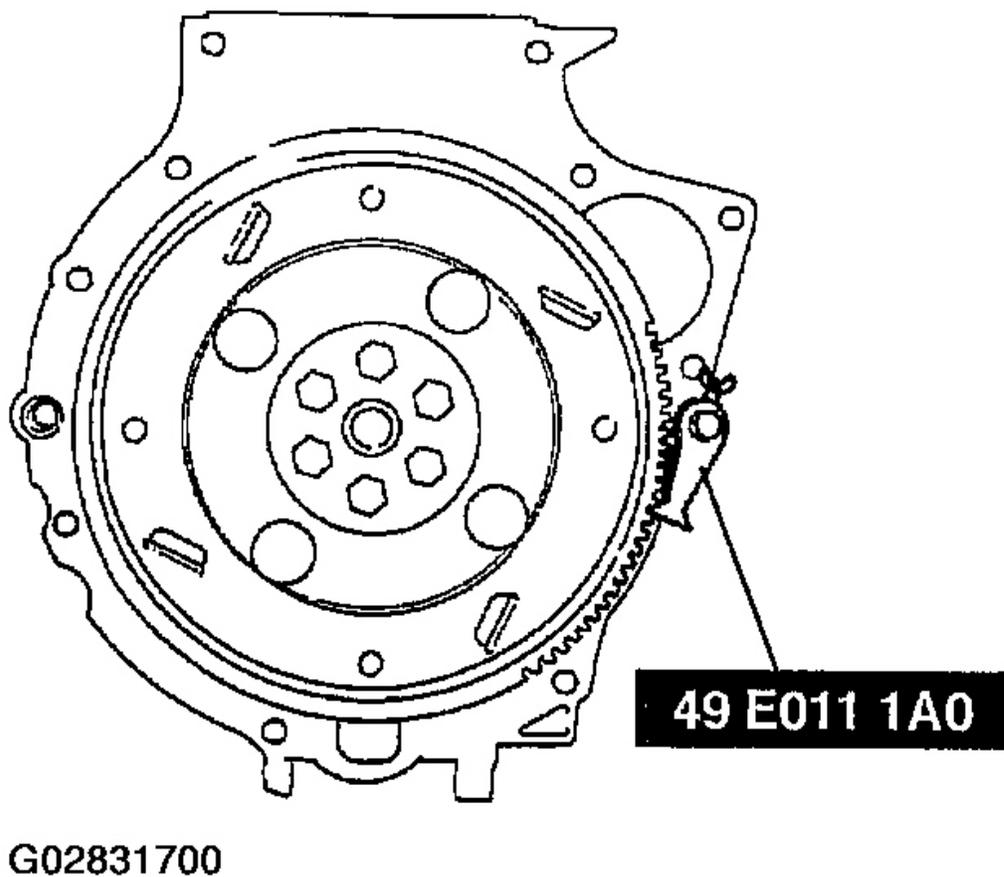


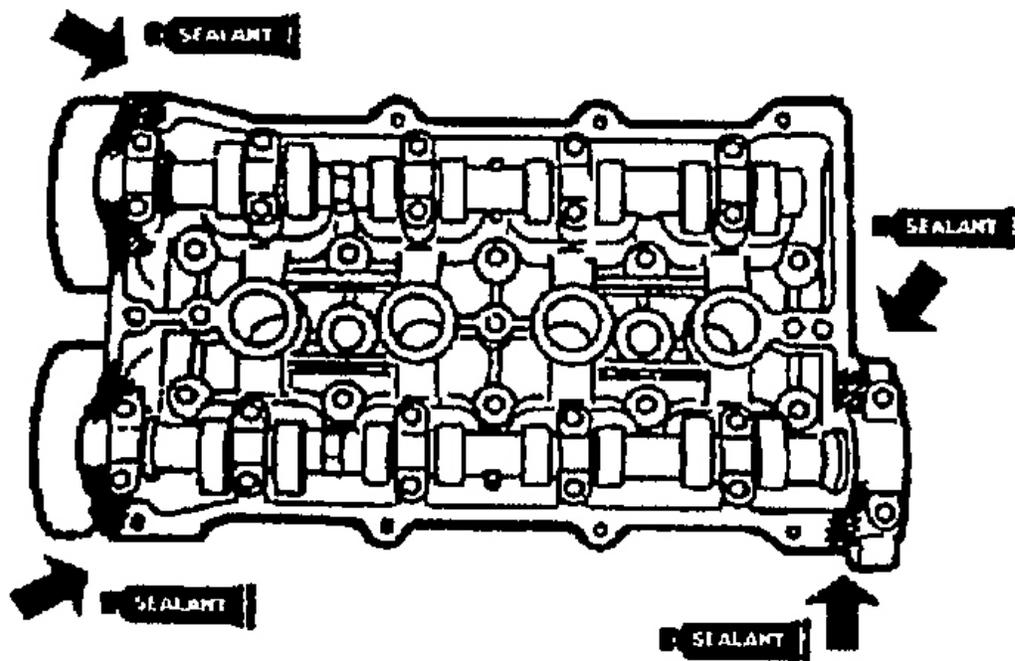
Fig. 20: Holding Crankshaft
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Cover Assembly Note

1. Verify that the grooves on the cylinder head cover are free of oil, water and other foreign material.
2. Install the cylinder head cover gasket into the cylinder head cover.
3. Apply silicone sealant to the cylinder head as shown.

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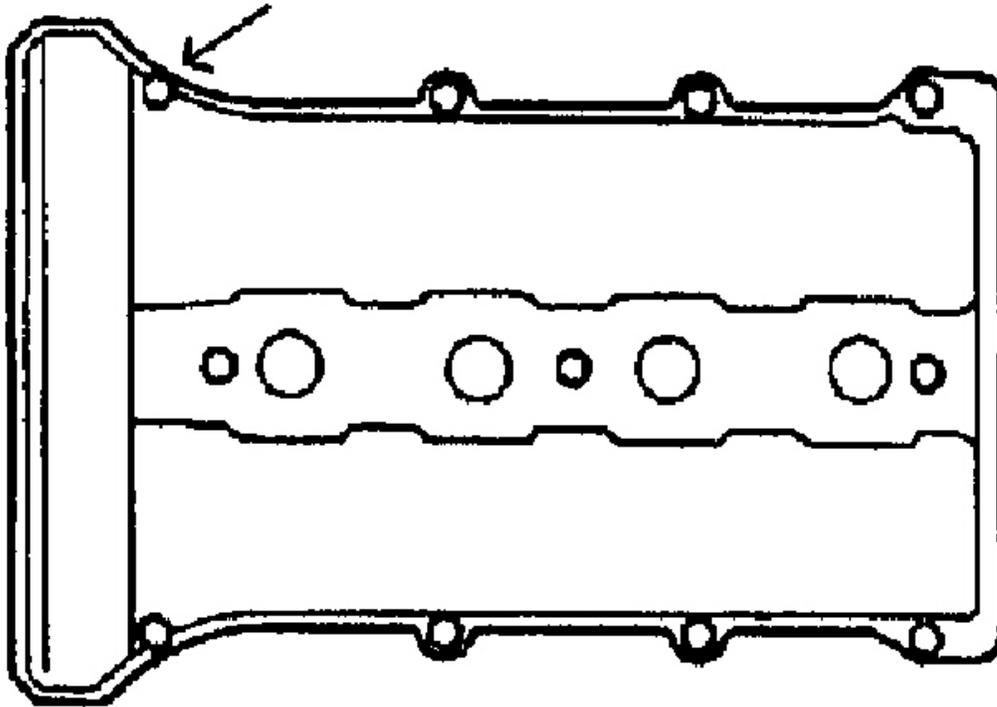
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Fig. 21: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

4. Hand-tighten the cylinder head cover bolt as shown.

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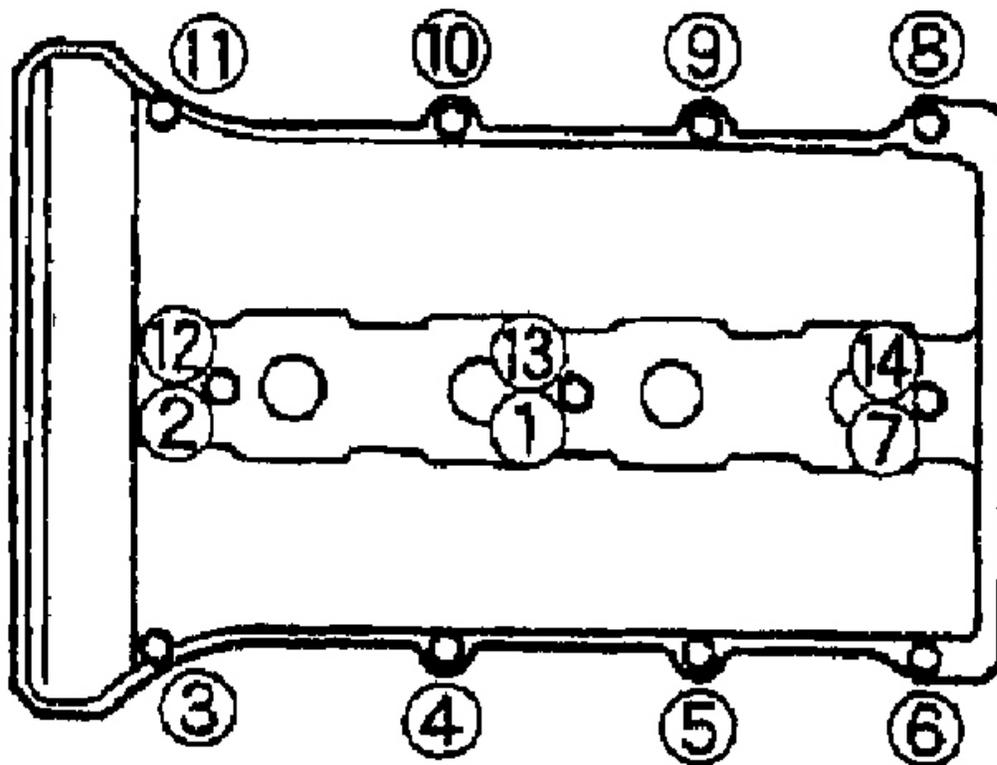
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Fig. 22: Identifying Cylinder Head Cover Bolt
Courtesy of MAZDA MOTORS CORP.

5. Tighten the cylinder head cover bolts in two or three step in the order shown.



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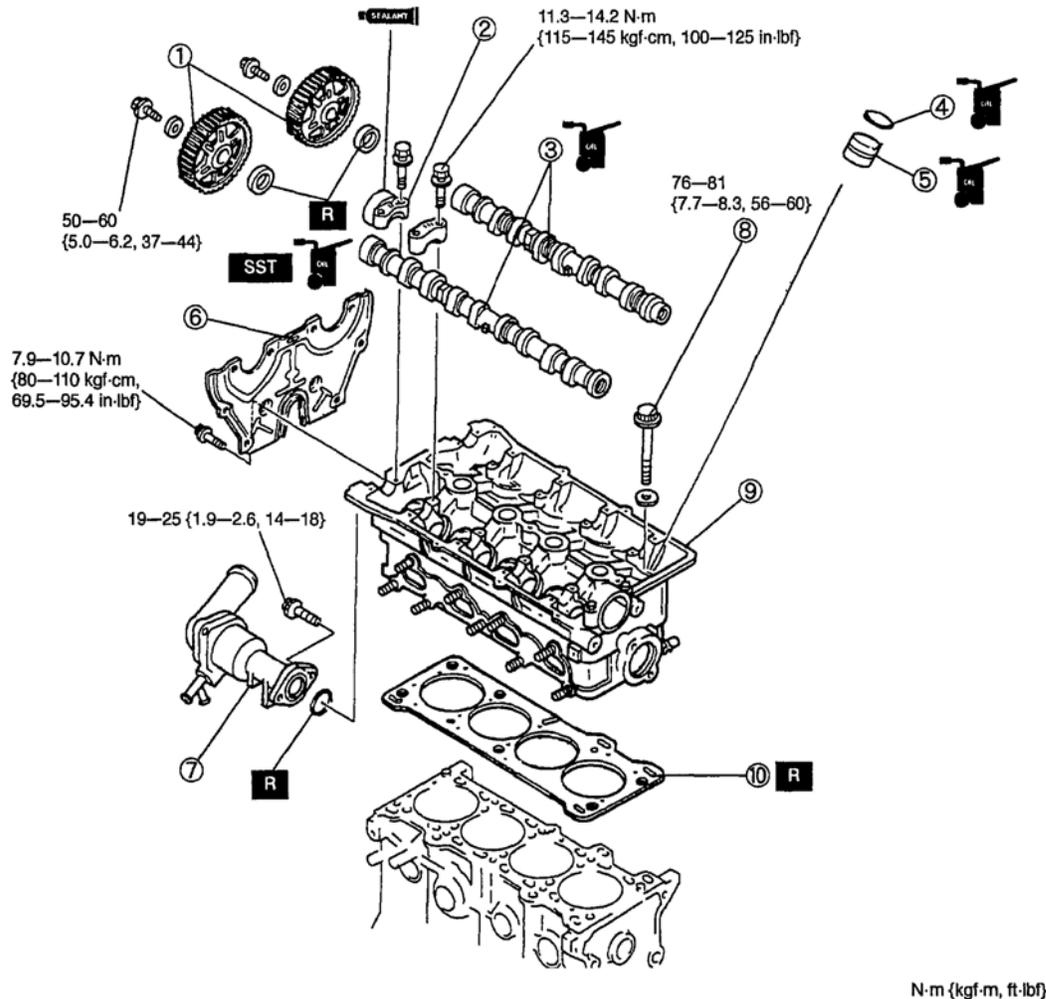
Fig. 23: Identifying Cylinder Head Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD DISASSEMBLY/ASSEMBLY (I)

1. Disassemble in the order indicated in the figure.

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N·m {kgf·m, ft·lbf}

1	Camshaft pulley (See Camshaft Pulley Disassembly Note) (See Camshaft Pulley Assembly Note)	6	Seal plate
2	Camshaft cap (See Camshaft Cap Disassembly Note) (See Camshaft Cap Assembly Note)	7	Thermostat housing
3	Camshaft (See Camshaft Disassembly Note) (See Camshaft Assembly Note)	8	Cylinder head bolt (See Cylinder Head Bolt Disassembly Note) (See Cylinder Head Bolt Assembly Note)
4	Adjustment shim	9	Cylinder head (See Cylinder Head Disassembly Note) (See Cylinder Assembly Note)
5	Tappet	10	Cylinder head gasket

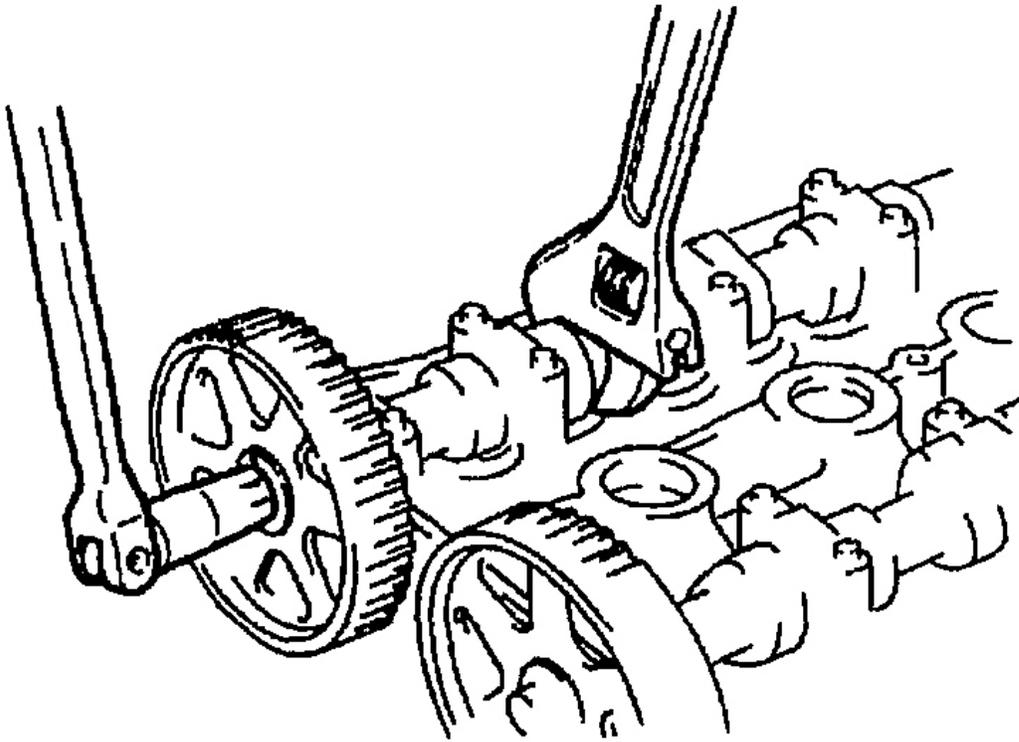
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Fig. 24: Disassembling/Assembling Cylinder Head
 Courtesy of MAZDA MOTORS CORP.

2. Assemble in the reverse order of disassembly.

Camshaft Pulley Disassembly Note

- Hold the camshaft by using a wrench on the cast hexagon as shown, and loosen the camshaft pulley lock bolt.



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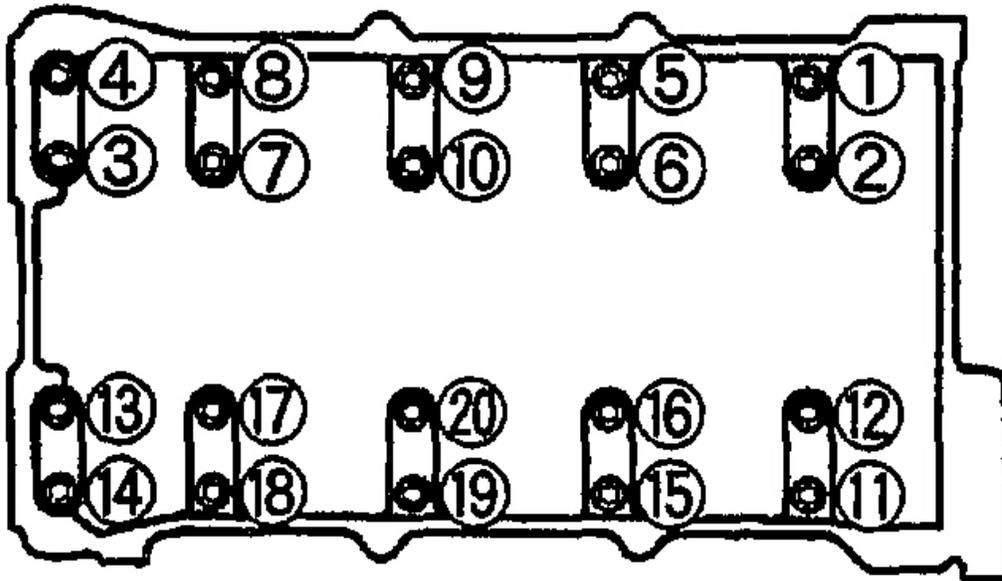
Fig. 25: Holding Camshaft
Courtesy of MAZDA MOTORS CORP.

Camshaft Cap Disassembly Note

- Loosen the camshaft cap bolts in two or three steps in the order shown.

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Fig. 26: Camshaft Cap Bolt Loosening Sequence
Courtesy of MAZDA MOTORS CORP.

Camshaft Disassembly Note

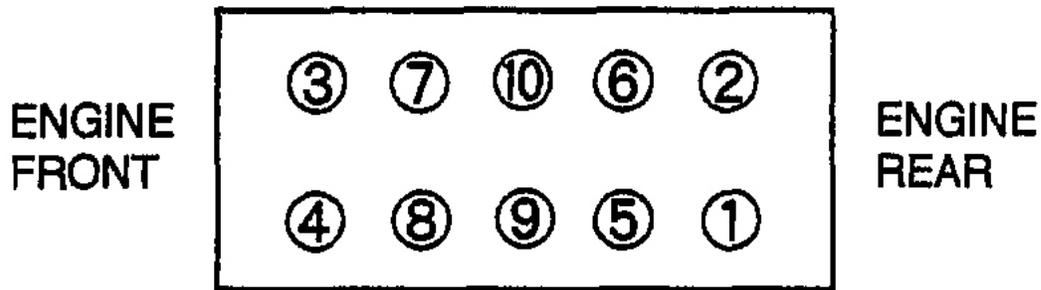
- Inspect the camshaft end play. (Refer to ENGINE INSPECTION/REPAIR , CAMSHAFT END PLAY INSPECTION .)

Cylinder Head Disassembly Note

- Loosen the cylinder head bolts in two or three steps in the order shown.

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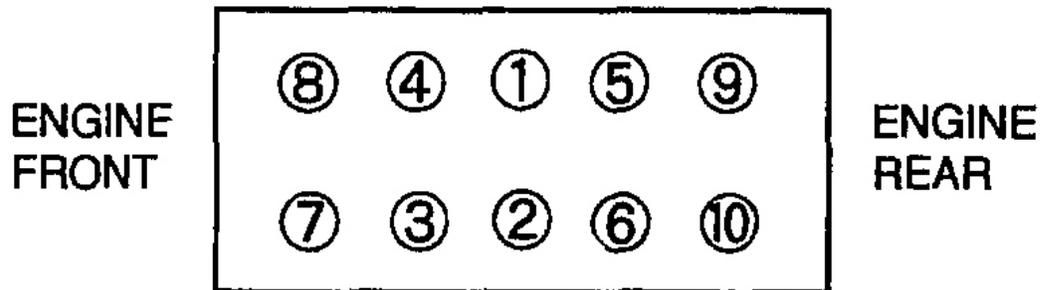


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Fig. 27: Cylinder Head Bolt Loosening Sequence
Courtesy of MAZDA MOTORS CORP.

Cylinder Head Assembly Note

- Install the bolts and tighten them in two or three steps in the order shown.



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Fig. 28: Cylinder Head Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Camshaft Assembly Note

CAUTION:

- Because there is little camshaft thrust clearance, the camshaft must be held horizontally while it is installed. Otherwise, excessive force will be applied to the thrust area, causing burr on the thrust receiving area of the cylinder head journal. To avoid this, the following

procedure must be observed.

- Assemble the camshaft onto the cylinder head, facing the cam noses at No.1 and No.3 cylinders as shown.

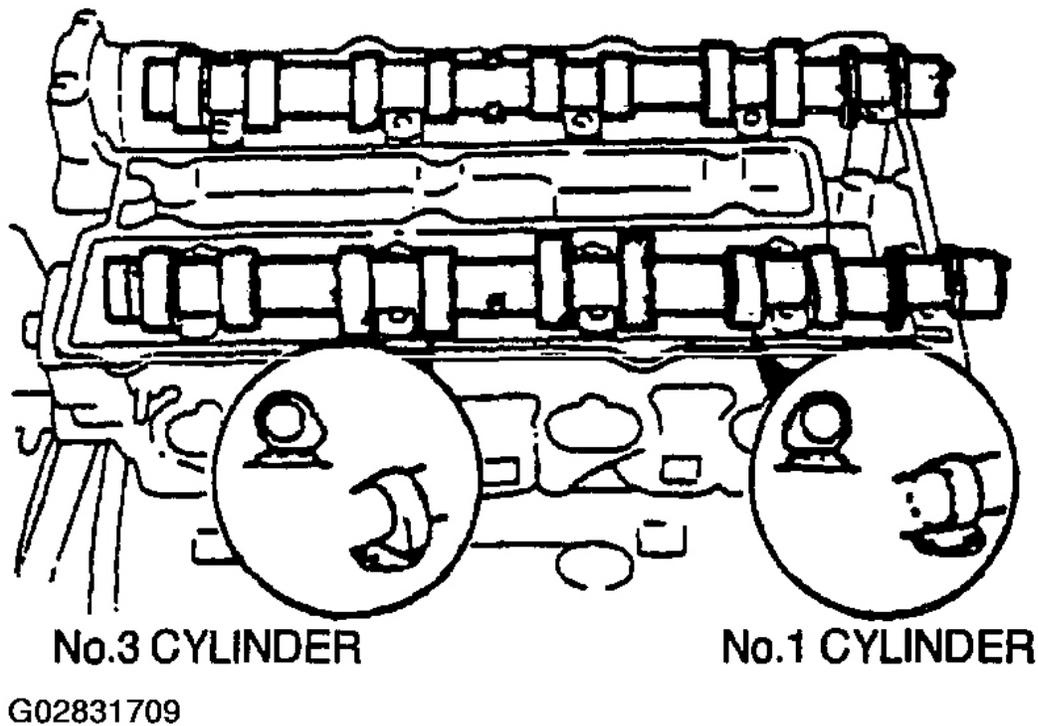
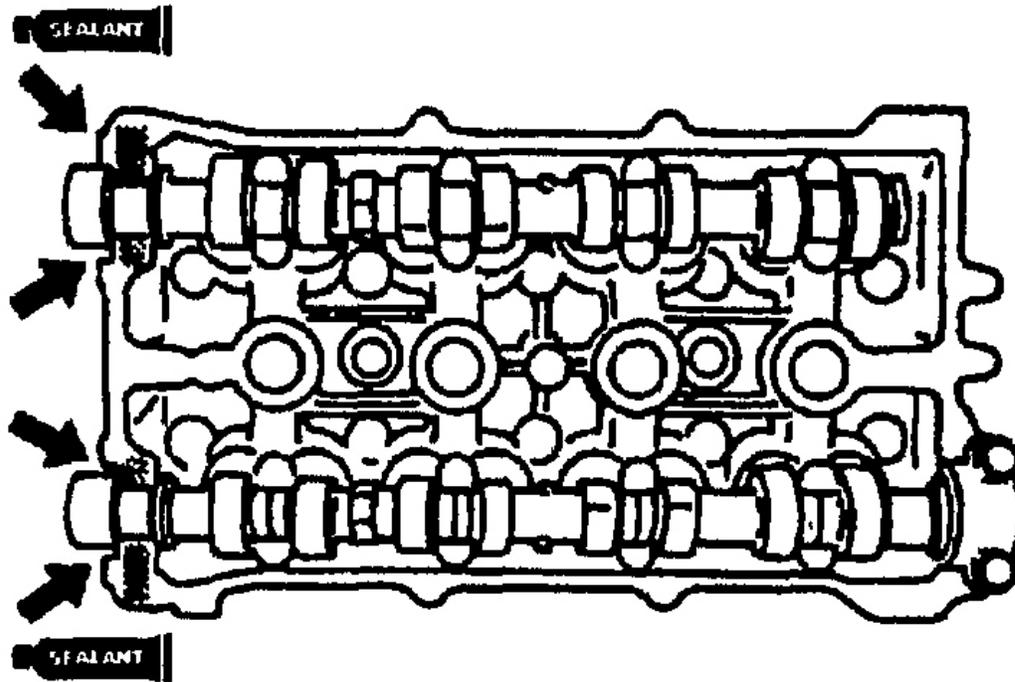


Fig. 29: Installing Camshaft
Courtesy of MAZDA MOTORS CORP.

Camshaft Cap Assembly Note

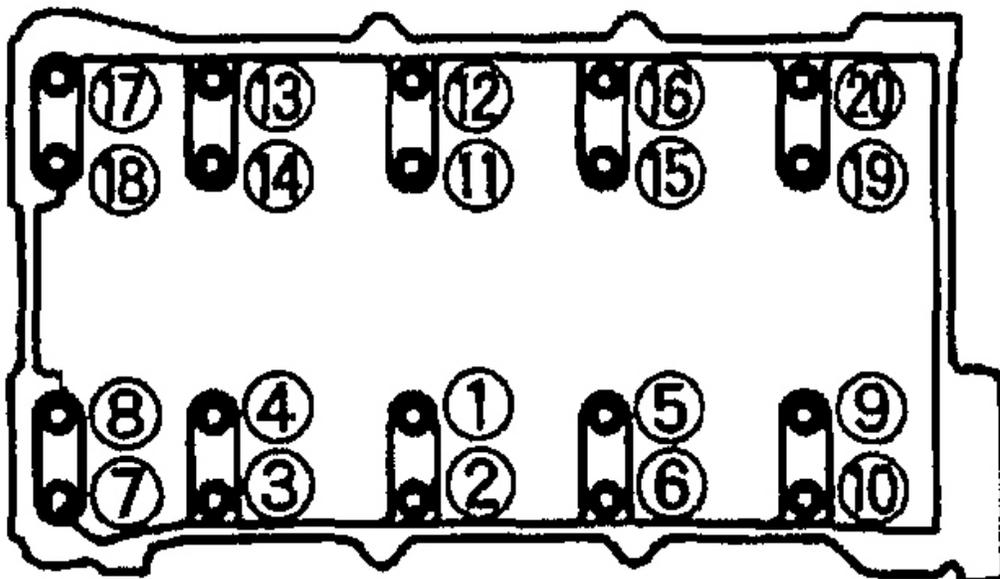
1. Apply silicone sealant to the shaded areas shown in the figure.



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Fig. 30: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

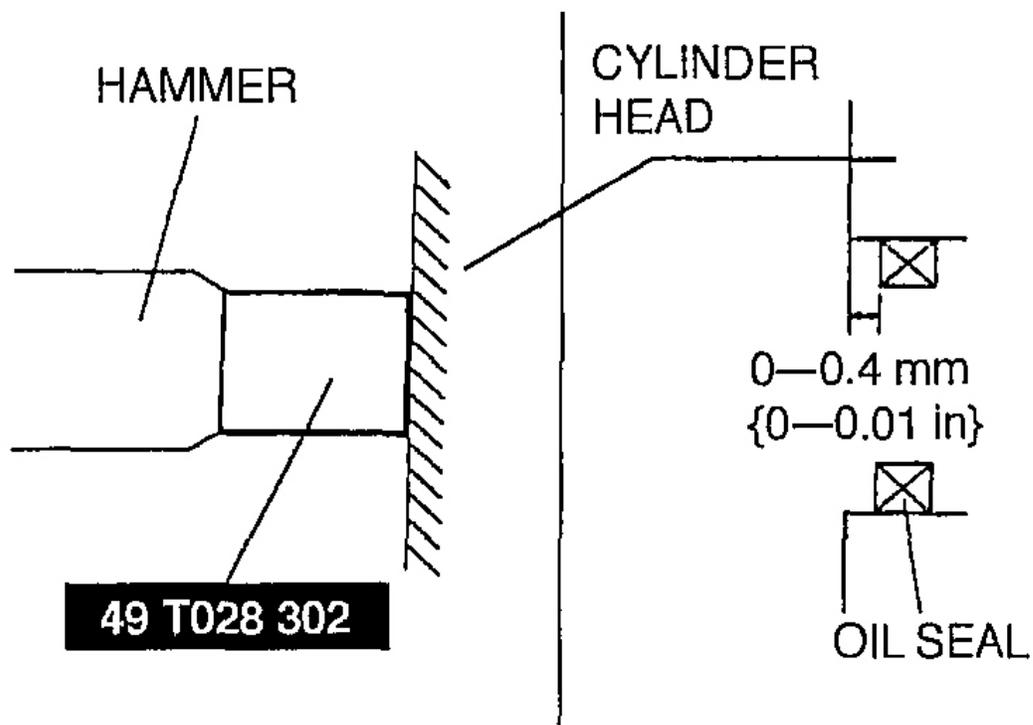
2. Install the camshaft caps to the positions from which they were removed.
3. Tighten the camshaft cap bolts in two or three steps in the order shown.



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Fig. 31: Camshaft Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

4. Apply clean engine oil to the lip of the new camshaft oil seal.
5. Push the oil seal slightly in by hand.
6. Press the oil seal in evenly by using the SST .

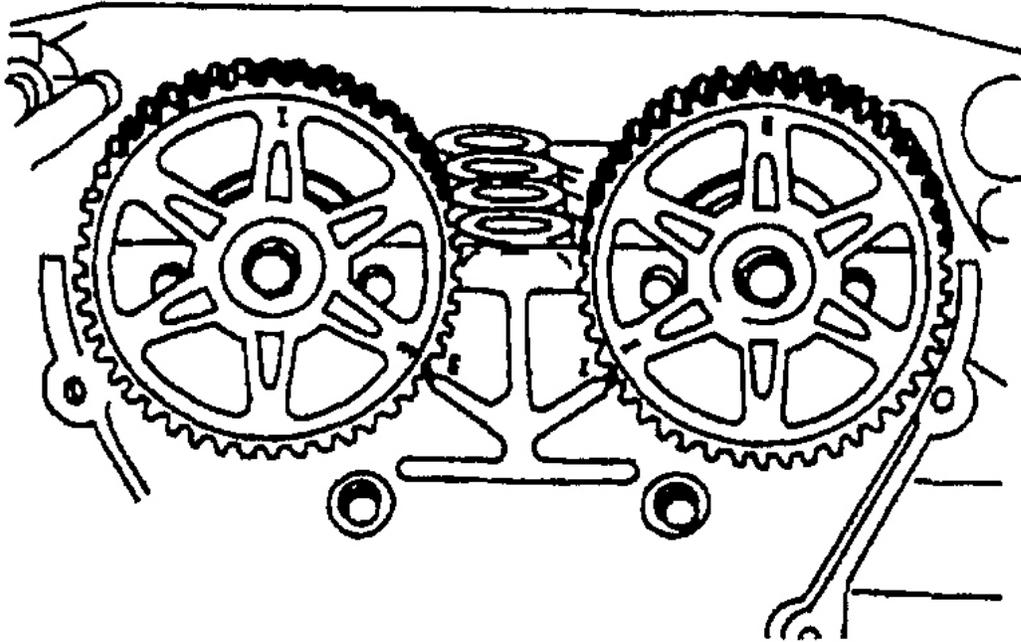


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Fig. 32: Installing Oil Seal
 Courtesy of MAZDA MOTORS CORP.

Camshaft Pulley

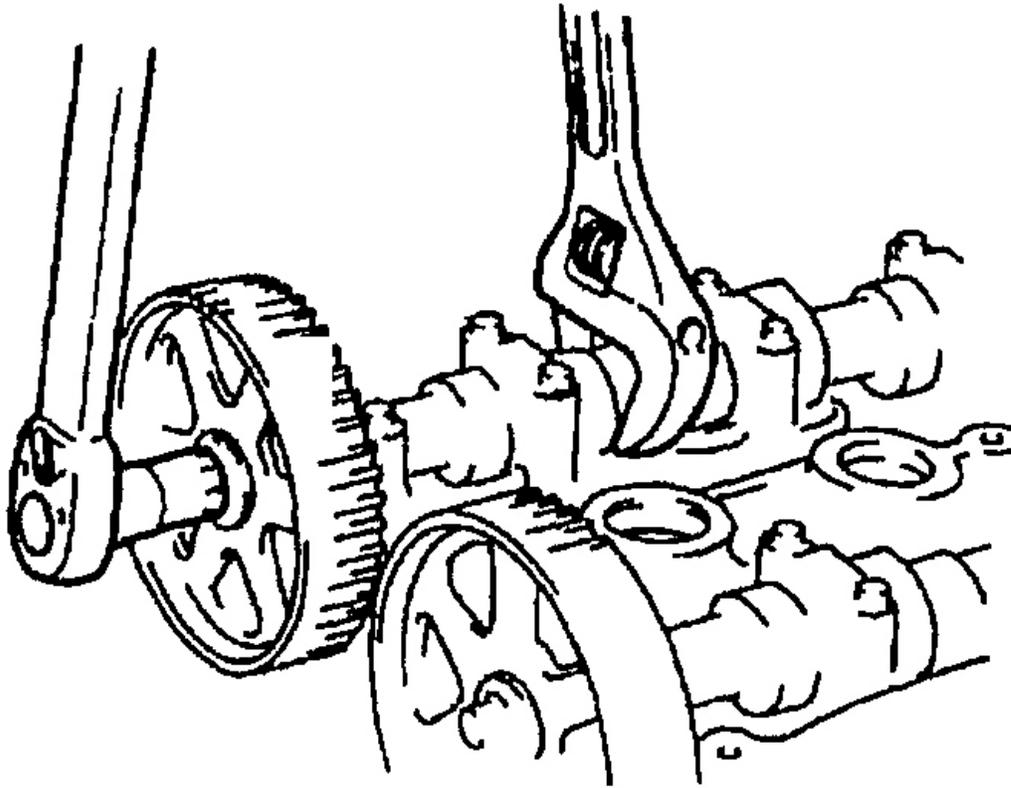
1. Install the camshaft pulleys with the "I" mark (intake side) or the "E" mark (exhaust side) straight up.



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Fig. 33: Identifying Camshaft Pulley Marks
Courtesy of MAZDA MOTORS CORP.

2. Hold the camshaft by using a wrench on the cast hexagon, and tighten the camshaft pulley lock bolt.



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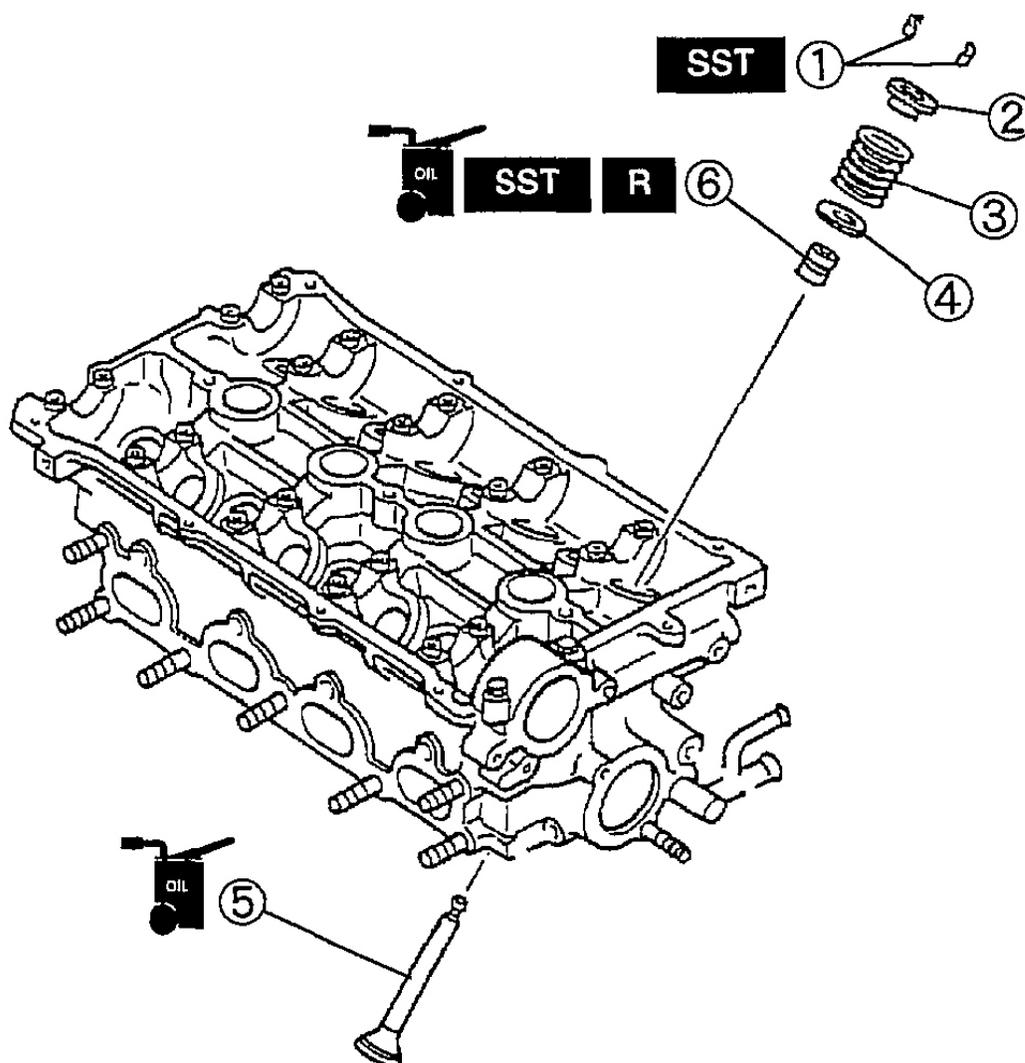
Fig. 34: Holding Camshaft
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II)

1. Disassemble in the order indicated in the figure.

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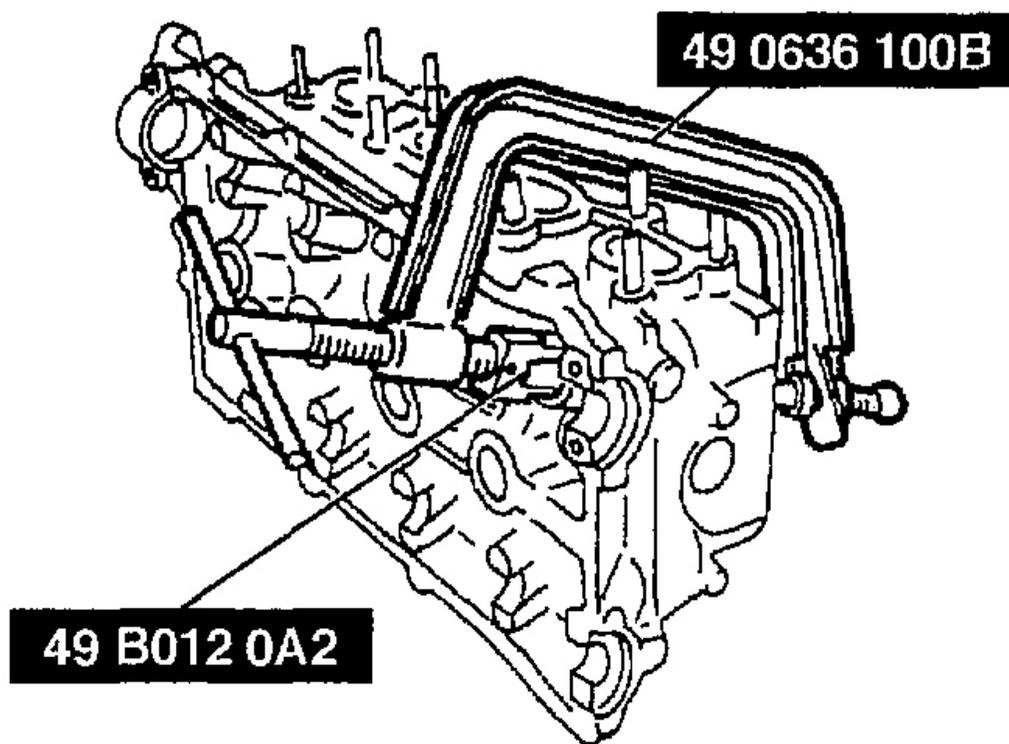
1	Valve keeper (See Valve Keeper Disassembly Note) (See Valve Keeper Assembly Note)
2	Valve spring seat, upper
3	Valve spring (See Valve Spring Assembly Note)
4	Valve spring seat, lower
5	Valve
6	Valve seal (See Valve Seal Disassembly Note) (See Valve Seal Assembly Note)

Fig. 35: Disassembling/Assembling Cylinder Head
Courtesy of MAZDA MOTORS CORP.

2. Assemble in the reverse order of disassembly.

Valve Keeper Disassembly Note

- Remove the valve keeper using the SST.



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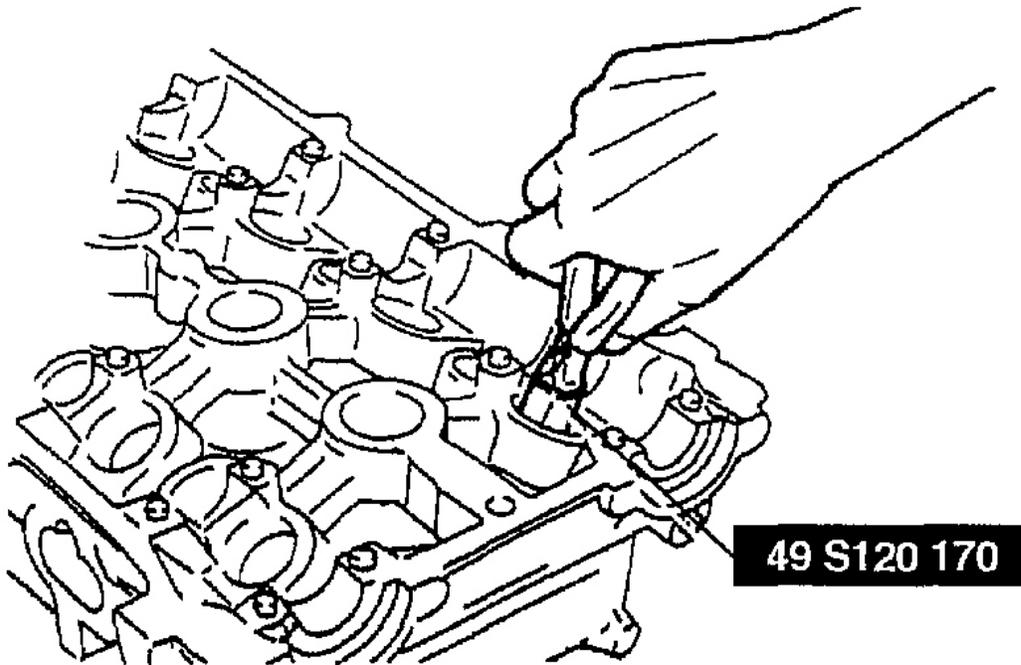
Fig. 36: Removing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

Valve Seal Disassembly Note

- Remove the valve seal using the SST.

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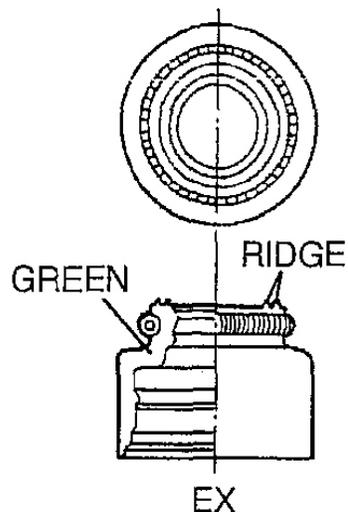
Fig. 37: Removing Valve Seal
Courtesy of MAZDA MOTORS CORP.

Valve Seal Assembly Note

- NOTE:**
- The intake and exhaust valve seals are different as shown.

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	Ridge		Color
	BP	BP with TC	
Intake	One	Non	Gray
Exhaust	Two		Green

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Fig. 38: Identifying Intake & Exhaust Valve Seals
 Courtesy of MAZDA MOTORS CORP.

1. Assemble the SST so that depth L is as specified.

Depth L

19.9 mm {0.783 in}

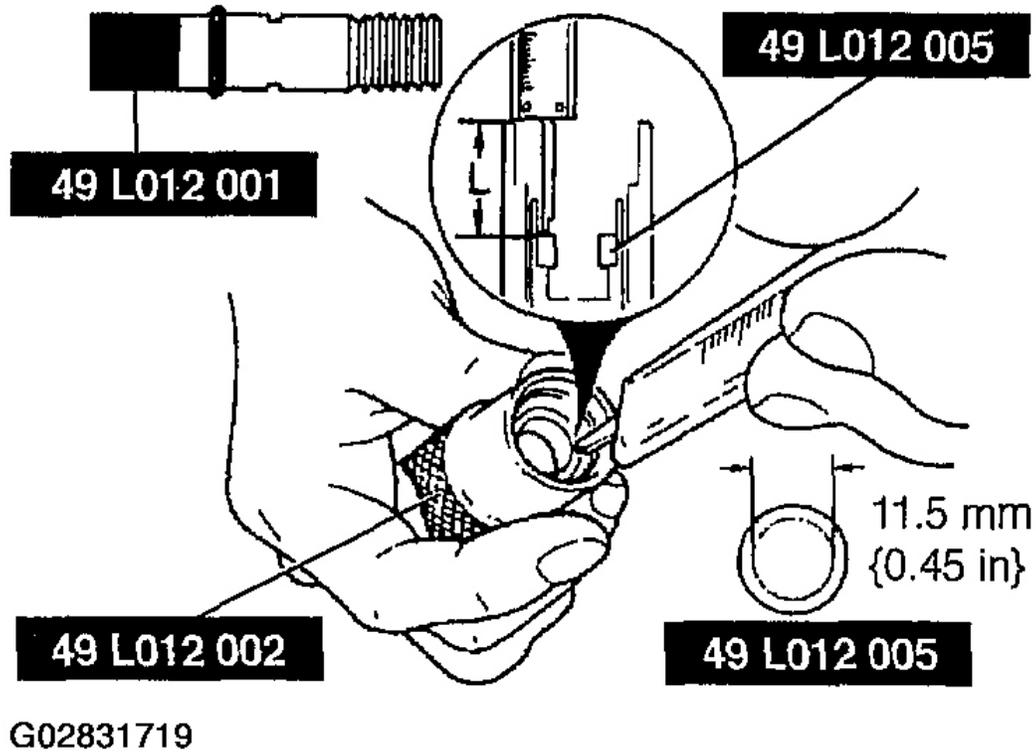
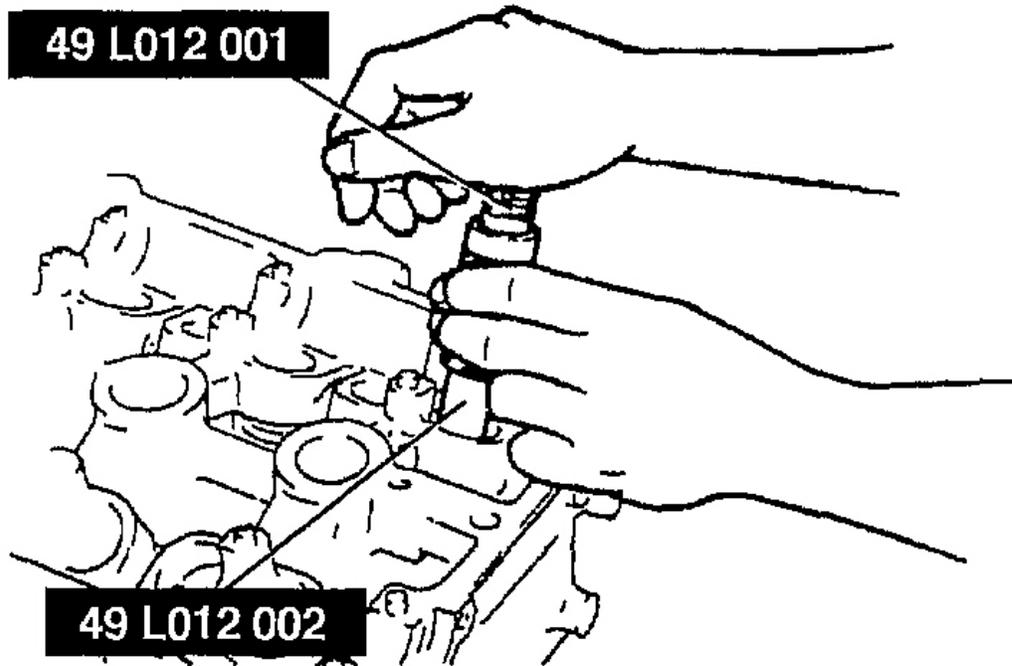


Fig. 39: Adjusting SST For Depth L
Courtesy of MAZDA MOTORS CORP.

2. Press the valve seal onto the valve guide by hand.
3. Tap the SST by using a plastic hammer until its lower end touches the cylinder head.



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Fig. 40: Installing Valve Seal
Courtesy of MAZDA MOTORS CORP.

Valve Spring Assembly Note

1. Install the valve spring with the closer pitch toward the cylinder head.

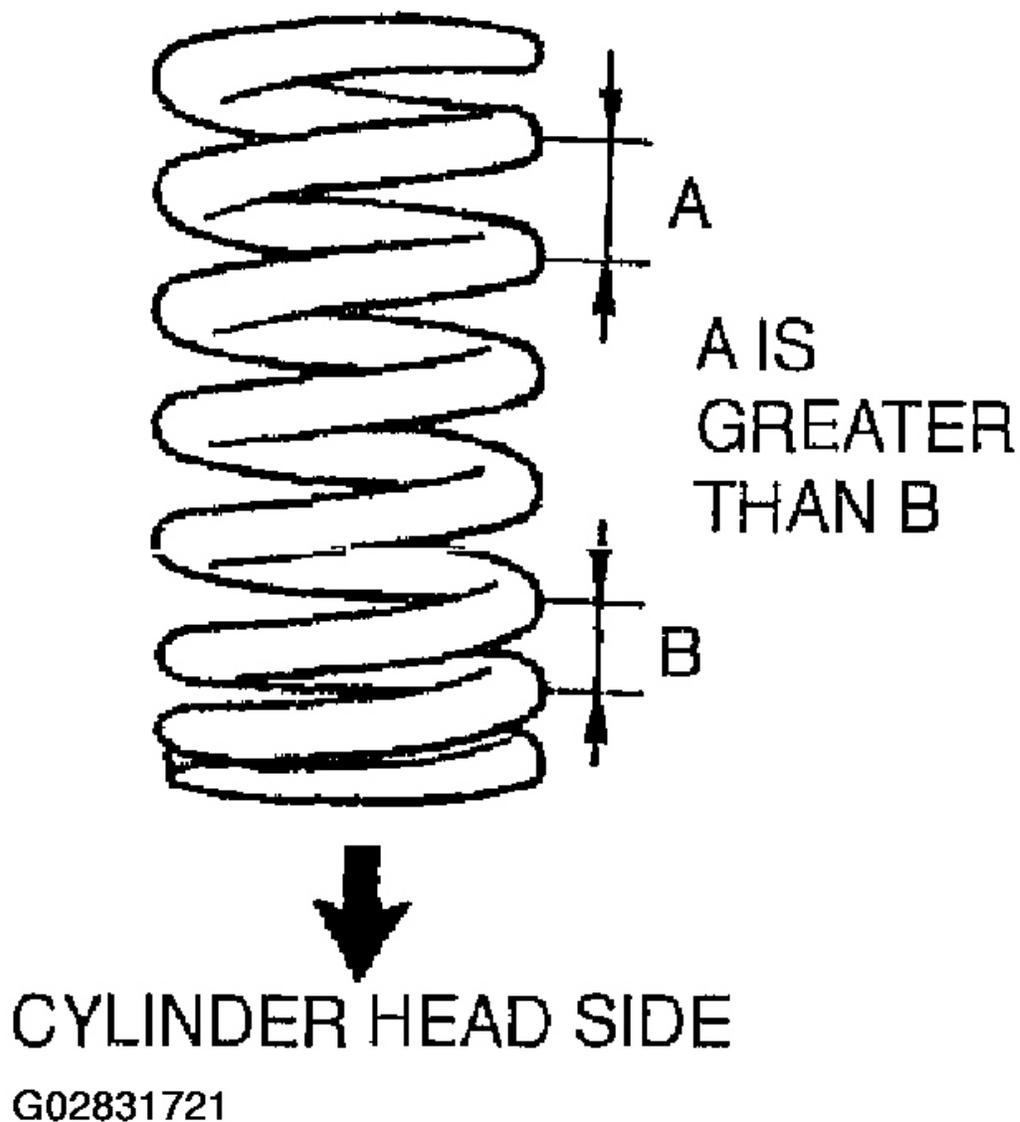
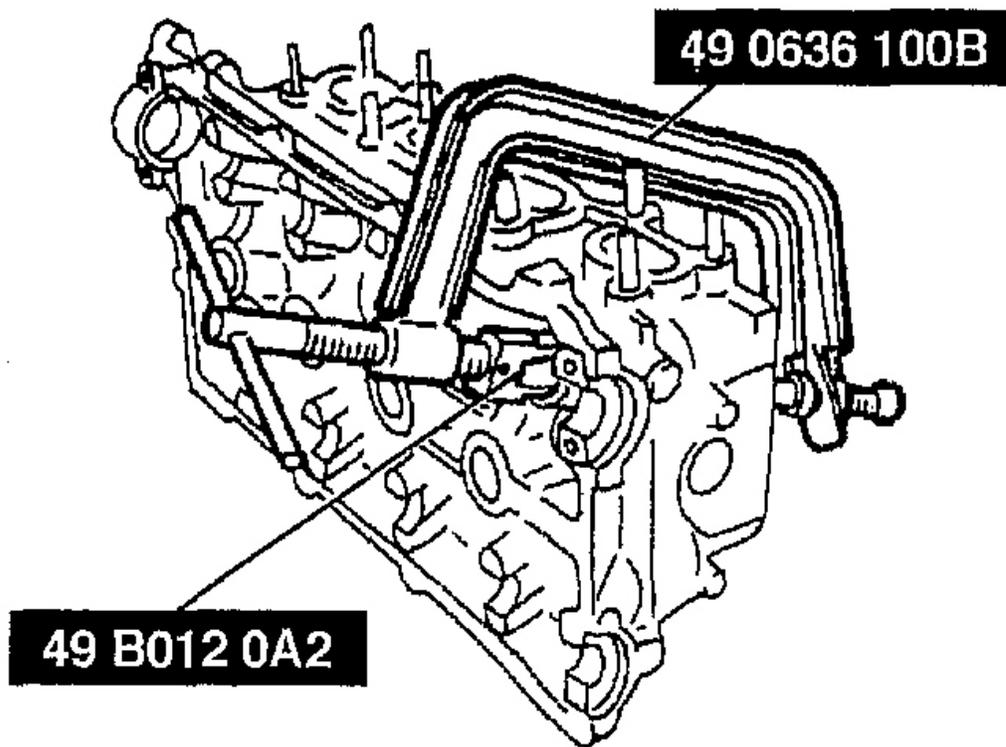


Fig. 41: Identifying Valve Spring Pitch
Courtesy of MAZDA MOTORS CORP.

Valve Keeper Assembly Note

1. Install the valve keeper by using the SST .



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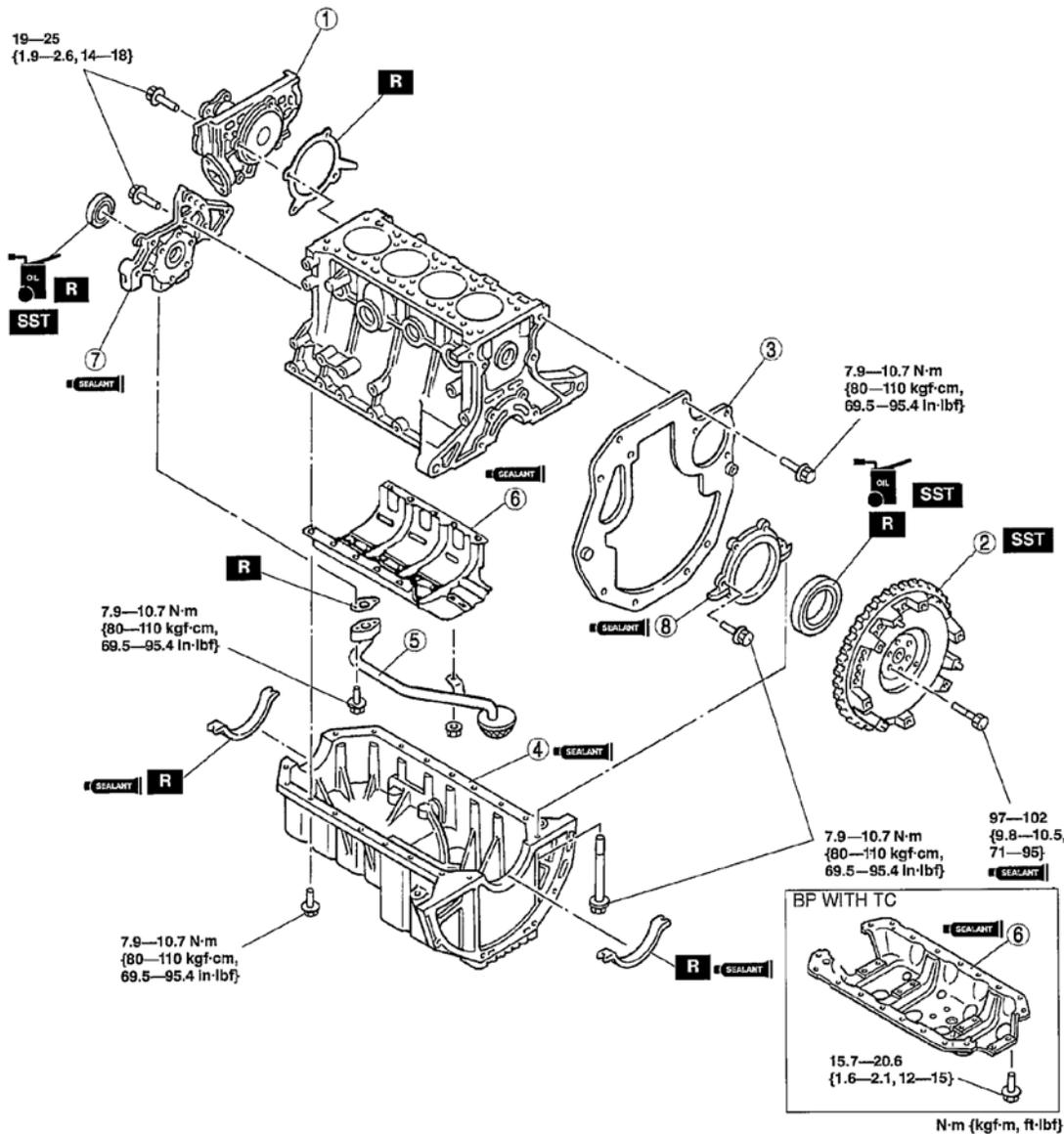
Fig. 42: Installing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (I)

1. Disassemble in the order indicated in the figure.

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1	Water pump
2	Flywheel (MT), drive plate (AT) (See Flywheel (MT), Drive Plate (AT) Disassembly Note (See Flywheel (MT), Drive Plate (AT) Assembly Note
3	End plate
4	Oil pan (See Oil Pan Disassembly Note) (See Oil Pan Assembly Note)
5	Oil strainer (See Oil Strainer Assembly Note)

6	Oil baffle (See Oil Baffle (BP), MBSP (BP With TC) Disassembly Note) (See Oil Baffle (BP), MBSP (BP With TC) Assembly Note)
7	Oil pump (See Oil Pump Disassembly Note) (See Oil Pump Assembly Note)
8	Rear cover (See Rear Cover Disassembly Note) (See Rear Cover Assembly Note)

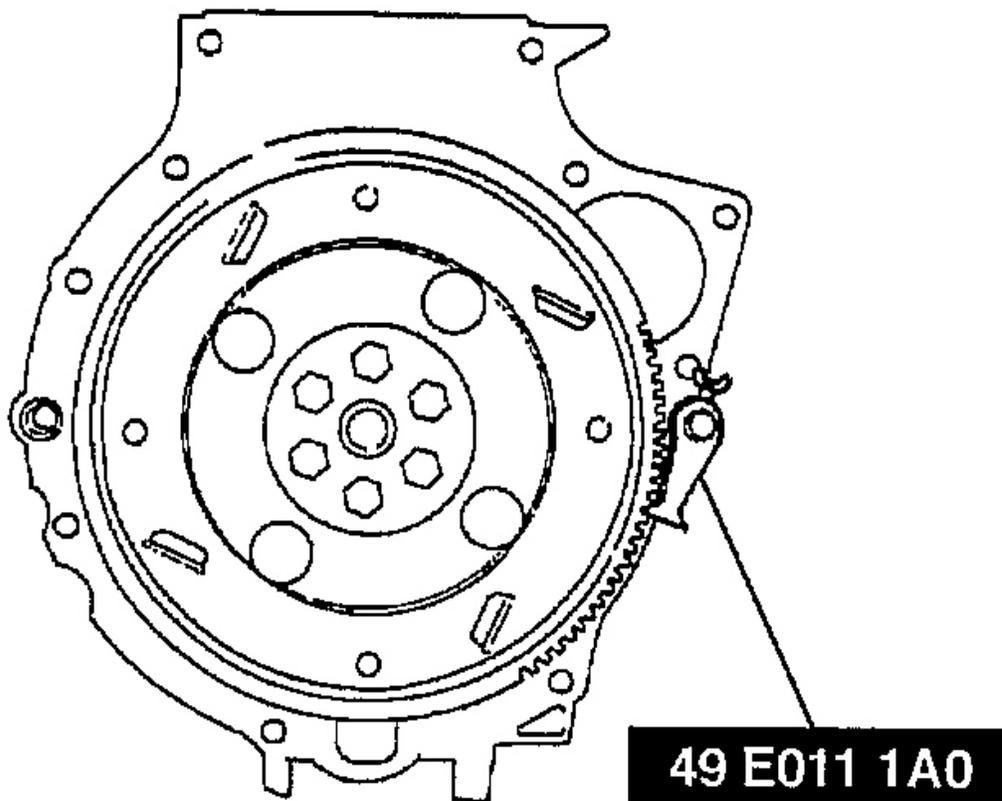
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Fig. 43: Disassembling/Assembling Cylinder Block
 Courtesy of MAZDA MOTORS CORP.

2. Assemble in the reverse order of disassembly.

Flywheel (MT), Drive Plate (AT) Disassembly Note

- Hold the crankshaft by using the SST .



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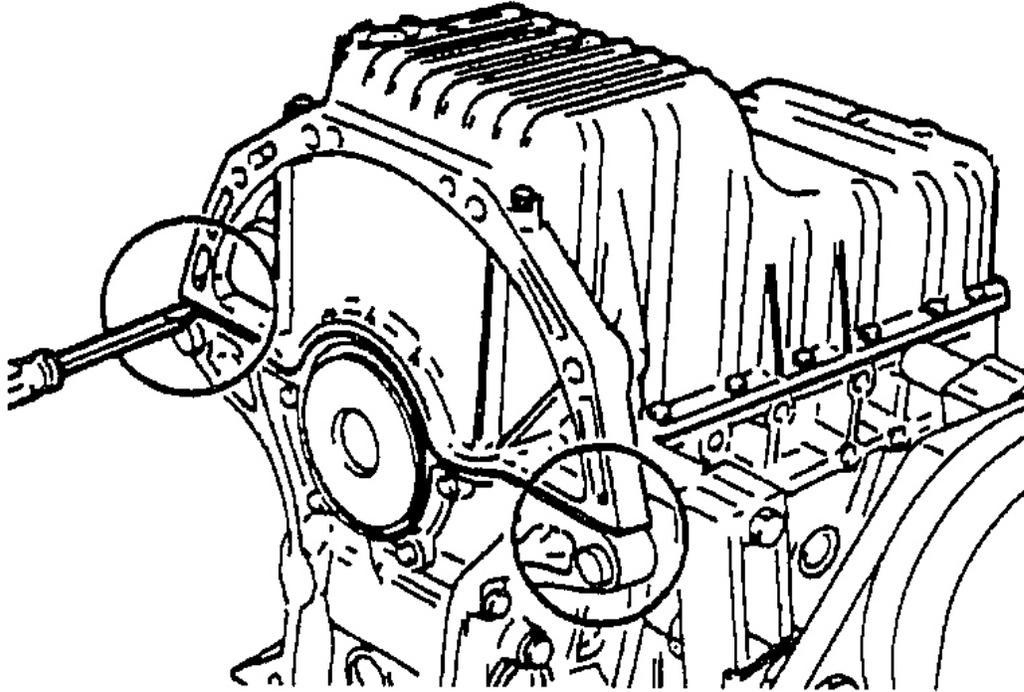
Fig. 44: Holding Crankshaft
Courtesy of MAZDA MOTORS CORP.

Oil Pan Disassembly Note

1. Remove the oil pan mounting bolts.

CAUTION:

- Pry tools can easily scratch the cylinder block and oil pan contact surfaces.



G02831725

Fig. 45: Identifying Screwdriver Insertion Points
Courtesy of MAZDA MOTORS CORP.

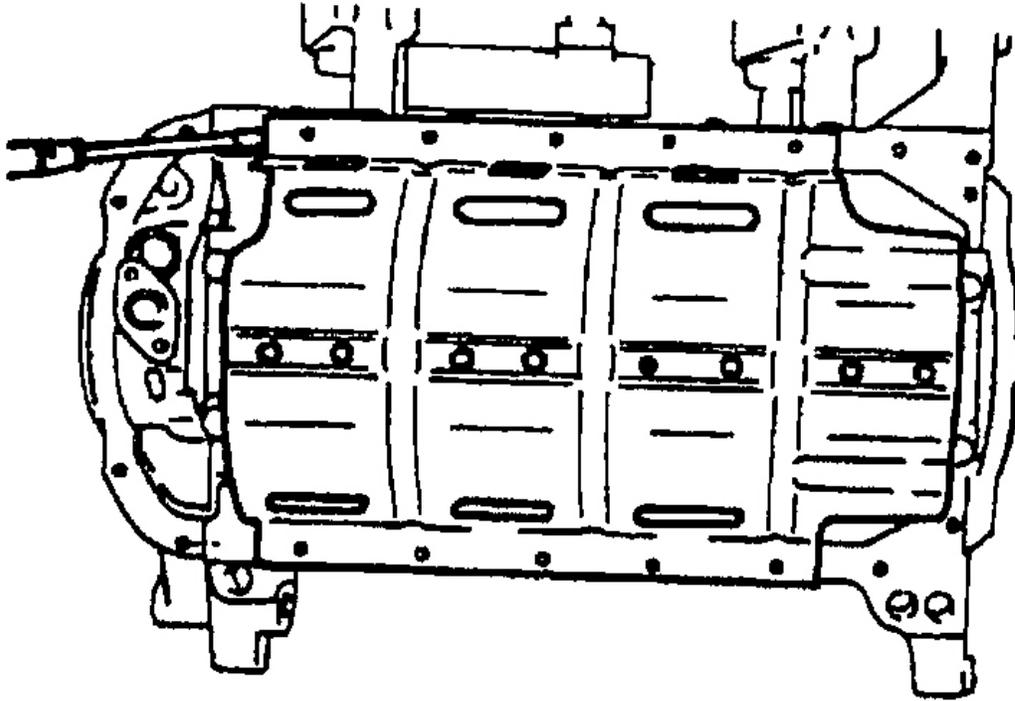
2. Insert a screwdriver only at the points shown.

Oil Baffle Disassembly Note

1. Insert a screwdriver between the cylinder block and the oil baffle to separate them.
2. Remove the oil baffle.

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G02831726

Fig. 46: Removing Oil Baffle
Courtesy of MAZDA MOTORS CORP.

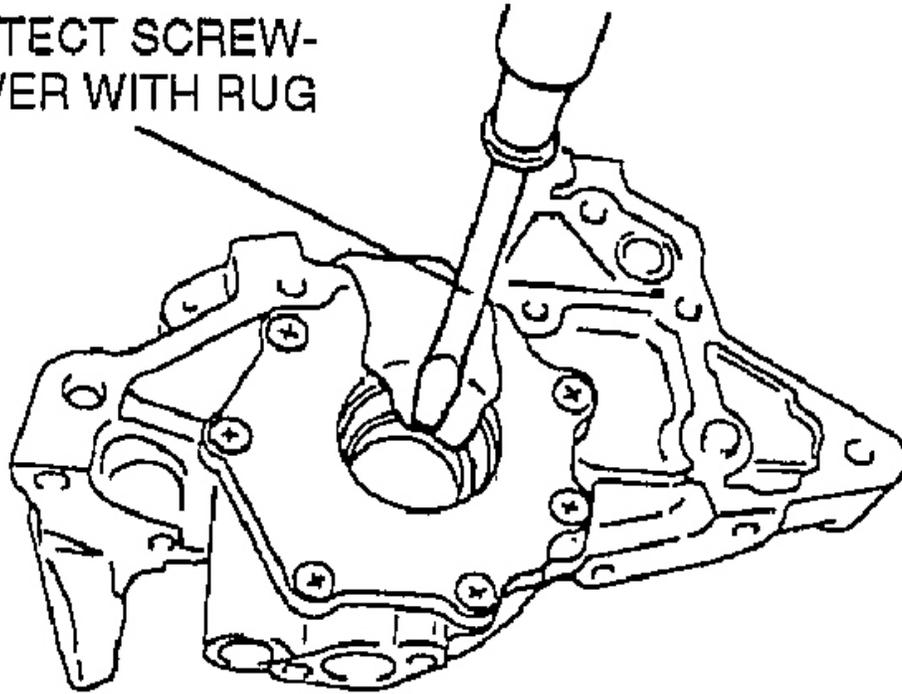
Oil Pump Disassembly Note

- Remove the oil seal by using a screwdriver protected with a rag.

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**PROTECT SCREW-
DRIVER WITH RUG**

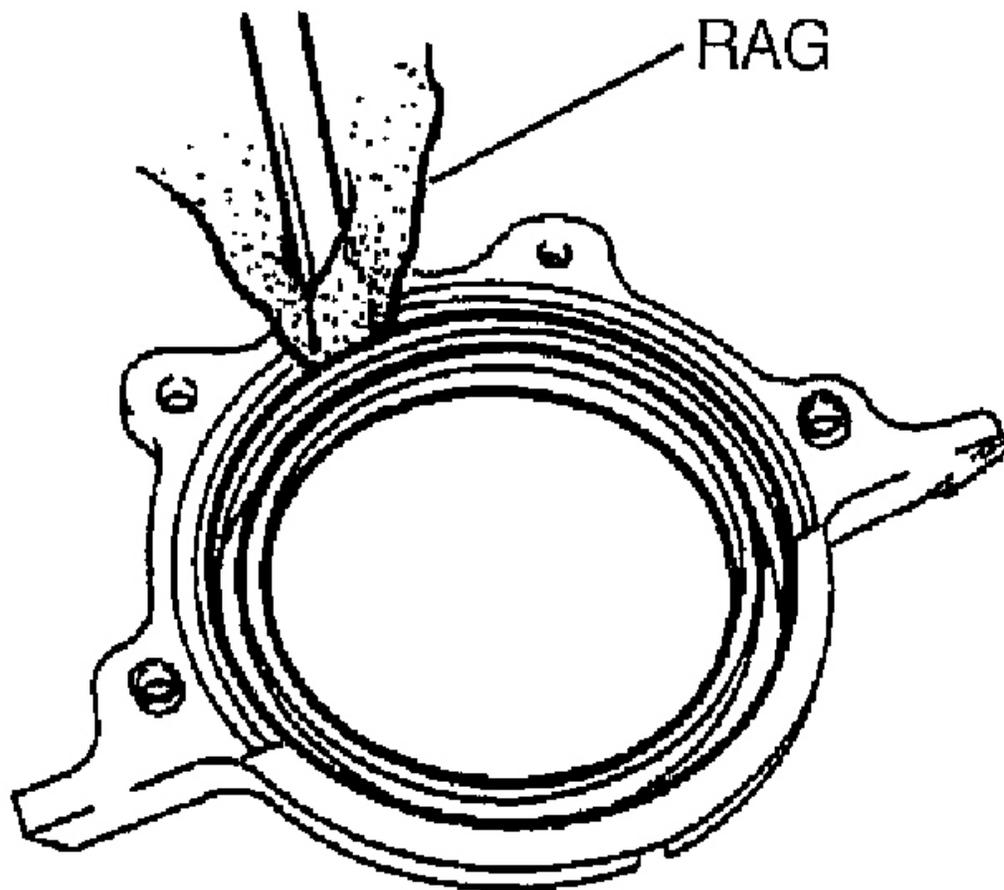


G02831727

Fig. 47: Removing Oil Pump Oil Seal
Courtesy of MAZDA MOTORS CORP.

Rear Cover Disassembly Note

- Remove the oil seal by using a screwdriver protected with a rag.



G02831728

Fig. 48: Removing Rear Cover Oil Seal
Courtesy of MAZDA MOTORS CORP.

Rear Cover Assembly Note

1. Apply clean engine oil to the new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly by using the **SST** .

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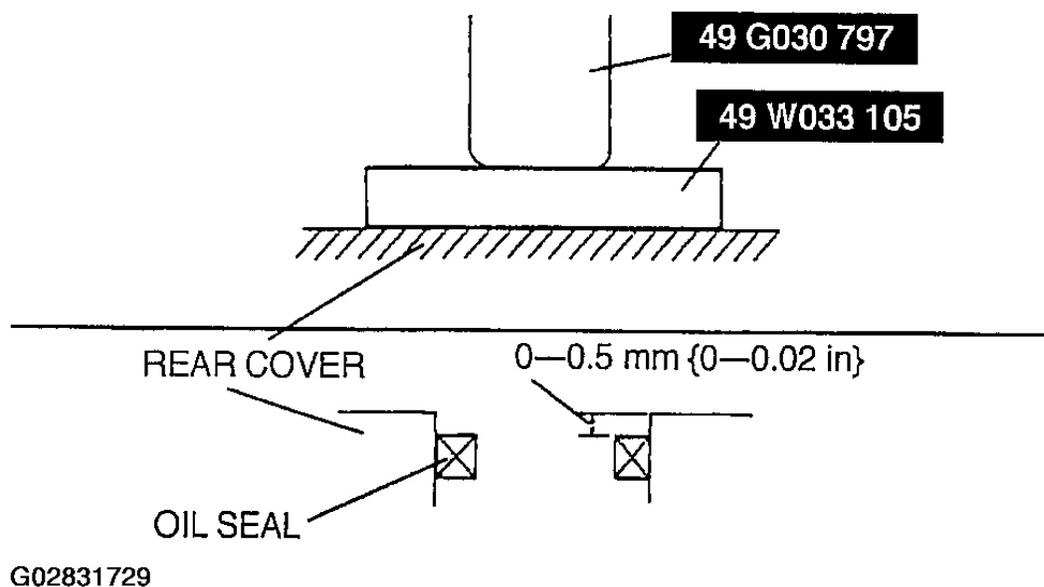
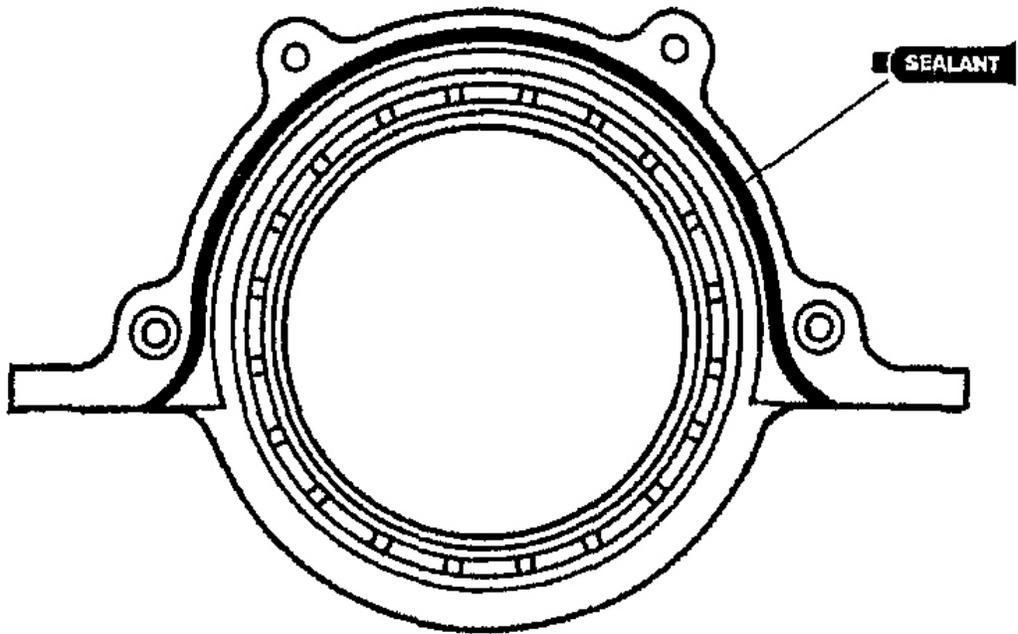


Fig. 49: Installing Rear Cover Oil Seal
Courtesy of MAZDA MOTORS CORP.

4. Apply silicone sealant to the rear cover as shown.

Thickness

2 mm {0.079 in}



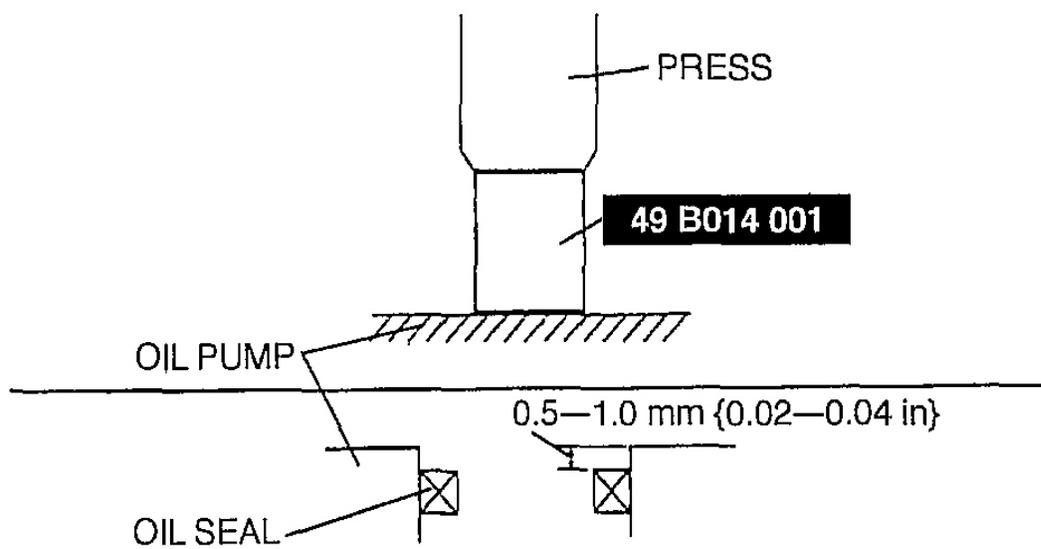
G02831730

Fig. 50: Applying Silicone Sealant To Rear Cover
Courtesy of MAZDA MOTORS CORP.

5. Install the rear cover.
6. Cut away the portion of the silicone sealant that projects from the rear cover toward the oil pan side.

Oil Pump Assembly Note

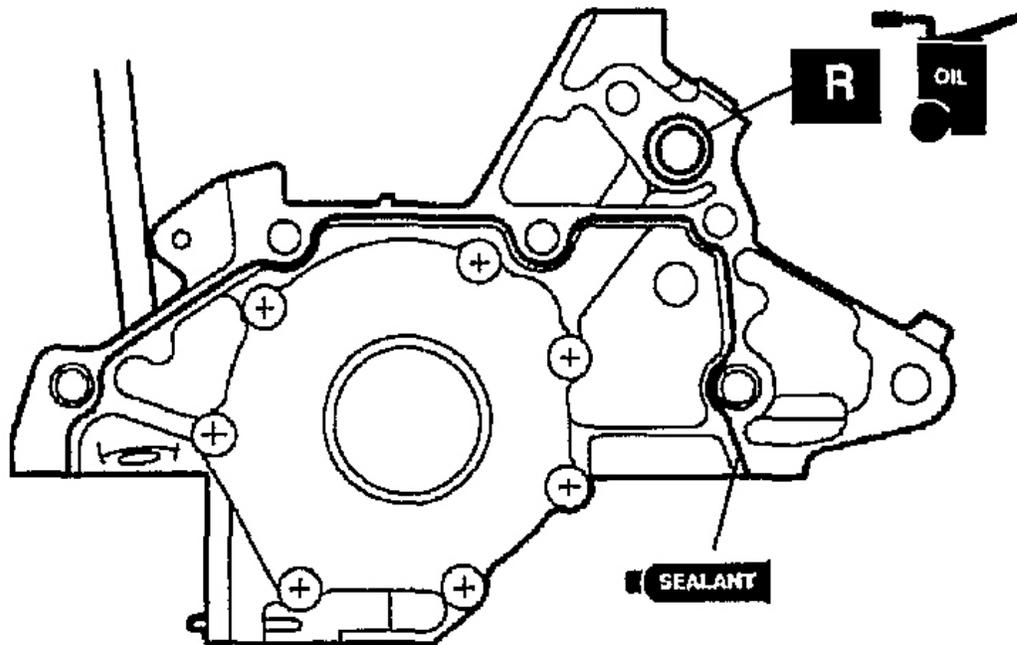
1. Apply clean engine oil to a new oil seal.
2. Push the oil seal slightly in by hand.
3. Press the oil seal in evenly using the **SST** .



G02831731

Fig. 51: Installing Oil Pump Seal
Courtesy of MAZDA MOTORS CORP.

4. Install the new O-ring.
5. Apply silicone sealant to the oil pump as shown.



G02831732

Fig. 52: Applying Silicone Sealant To Oil Pump
Courtesy of MAZDA MOTORS CORP.

Thickness

1-2 mm {0.040-0.078 in}

6. Install the oil pump.
7. Cut away the portion of the silicone sealant that projects from the body toward the oil pan side.

Oil Baffle Assembly Note (BP)

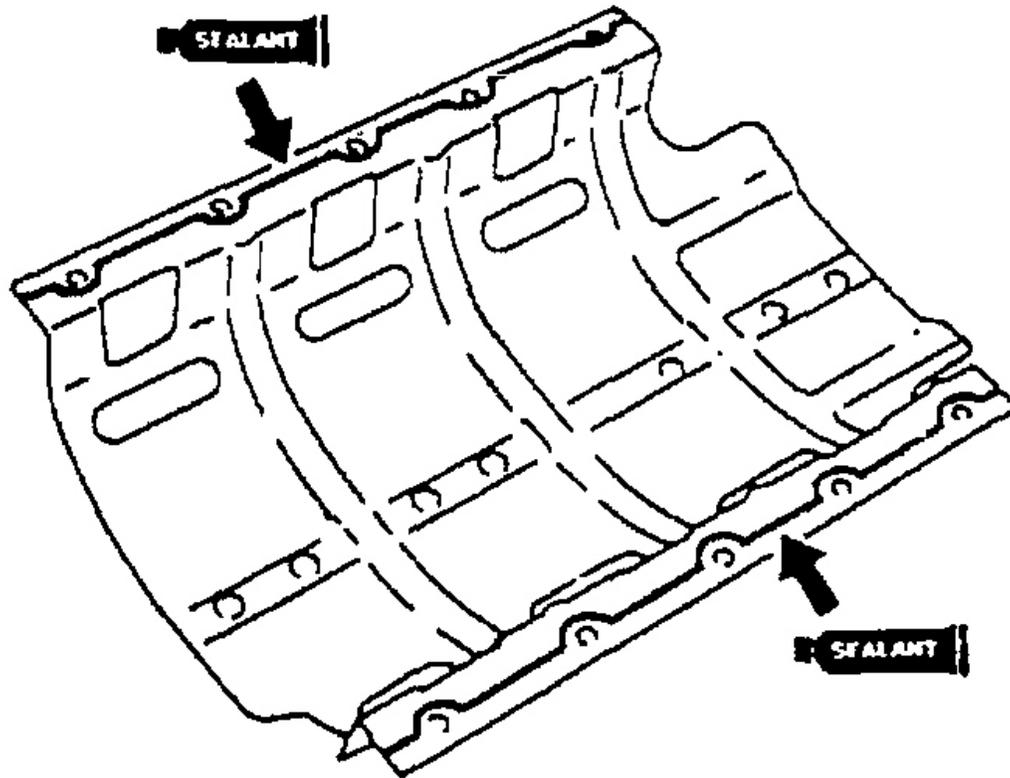
1. Remove all foreign material from the contact surfaces.
2. Apply silicone sealant to the oil baffle along the inside of the bolt holes, and install within five minutes.

Thickness

2.5-3.5 mm {0.099-0.137 in}

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G02831733

Fig. 53: Applying Silicone Sealant To Oil Baffle
Courtesy of MAZDA MOTORS CORP.

MBSP Assembly Note (BP With TC)

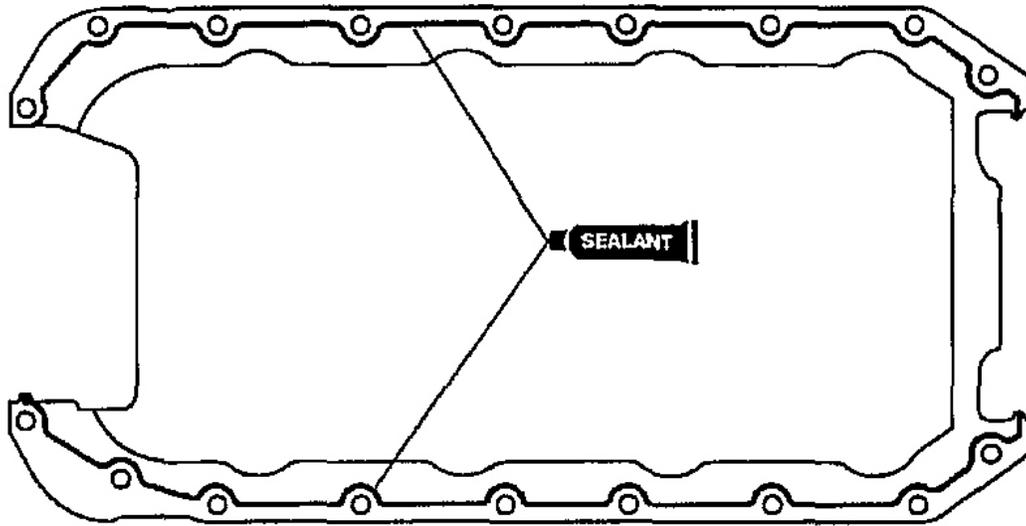
1. Apply silicone sealant to the MBSP along the inside of the bolt holes, and install within five minutes.

Thickness

2.5-3.5 mm {0.099-0.137 in}

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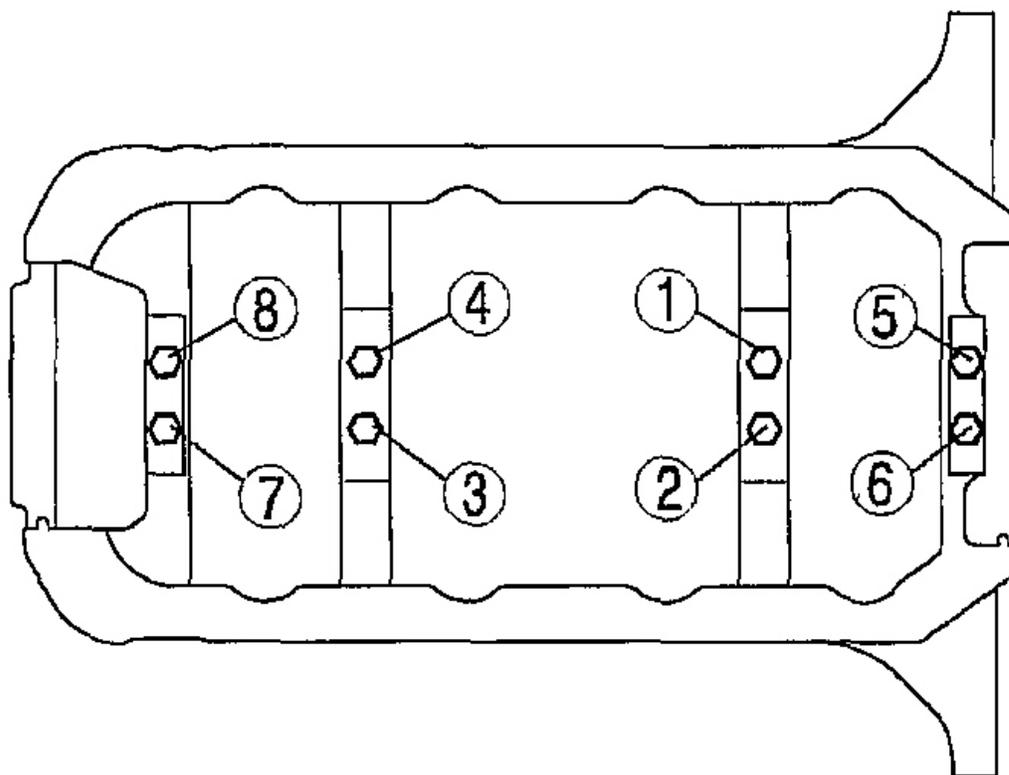
G02831734

Fig. 54: Applying Silicone Sealant To MBSP
Courtesy of MAZDA MOTORS CORP.

2. Tighten the MBSP bolts in two or three steps in the order shown.

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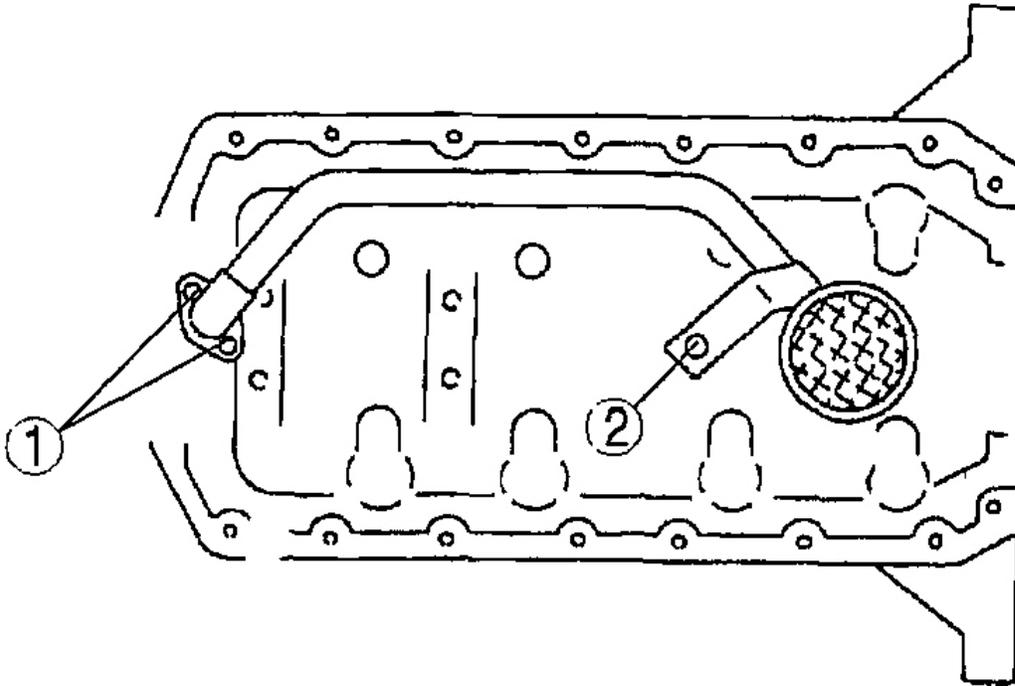
Fig. 55: MBSP Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Oil Strainer Assembly Note (BP With TC)

1. Install a new oil strainer gasket onto the oil pump body.
2. Tighten the oil strainer bolts in the order shown.

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G02831736

Fig. 56: Oil Strainer Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Oil Pan Assembly Note (BP)

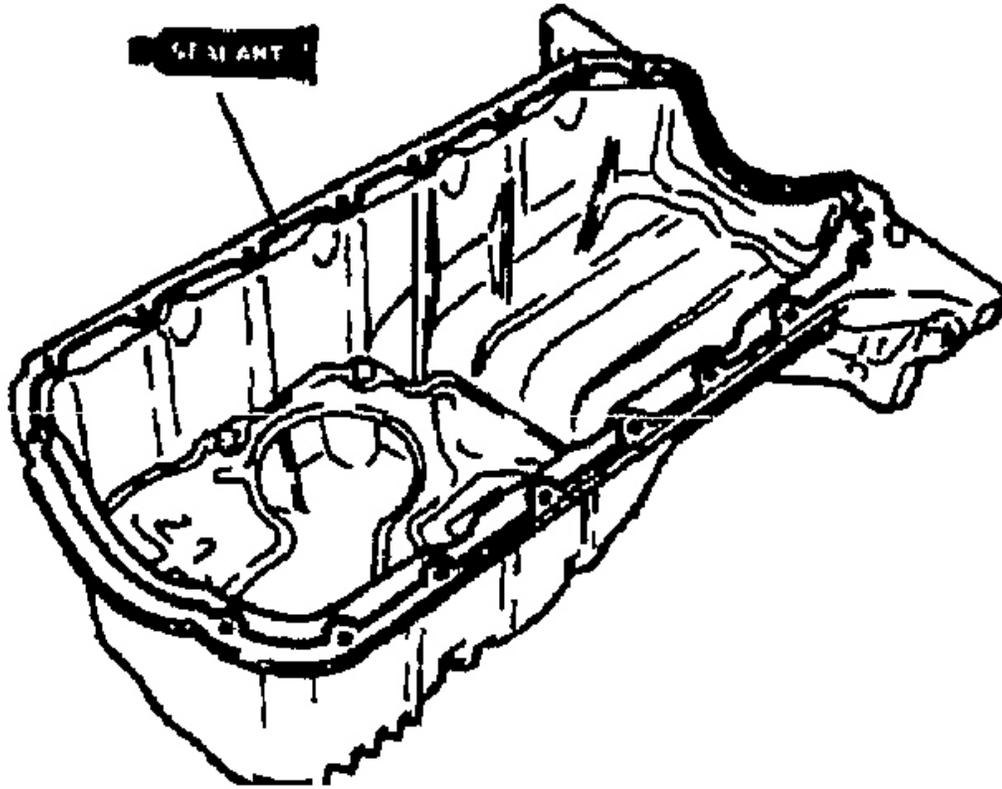
1. Apply silicone sealant to the oil pan as shown.

Thickness

2.5-3.5 mm {0.099-0.137 in}

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G02831737

Fig. 57: Applying Silicone Sealant To Oil Pan
Courtesy of MAZDA MOTORS CORP.

Oil Pan Assembly Note (BP With TC)

- CAUTION:**
- If the bolts are reused, remove the old sealant from the bolt threads. Tightening a bolt that has old sealant on it can cause bolt hole damage.

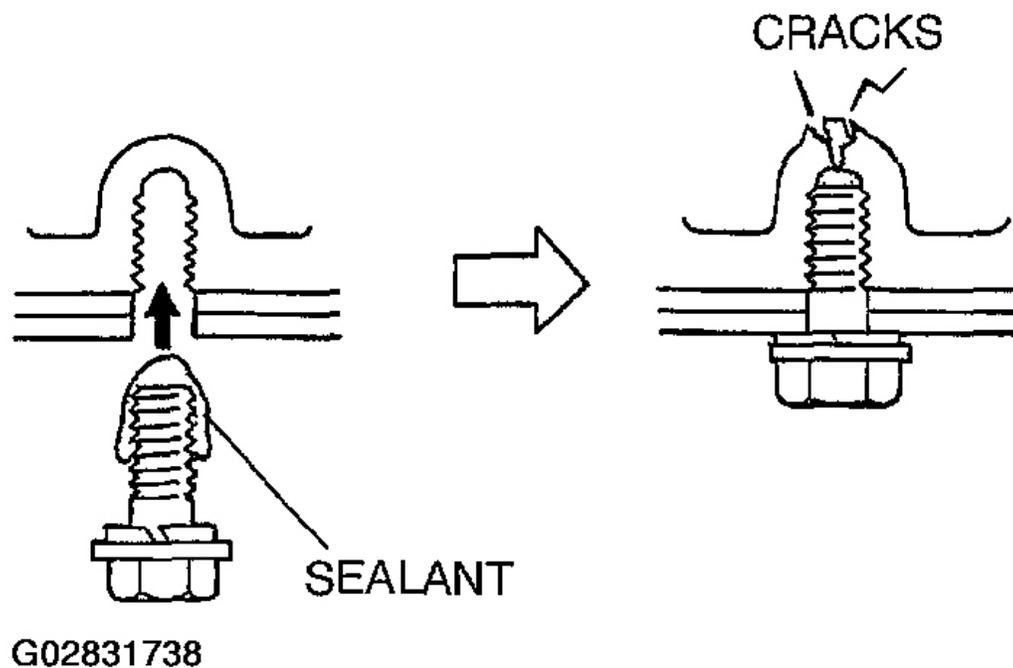


Fig. 58: Identifying Old Sealant & Possible Damage
Courtesy of MAZDA MOTORS CORP.

1. Apply silicone sealant to oil pan gasket as shown.

Thickness

2.0 mm {0.079 in}

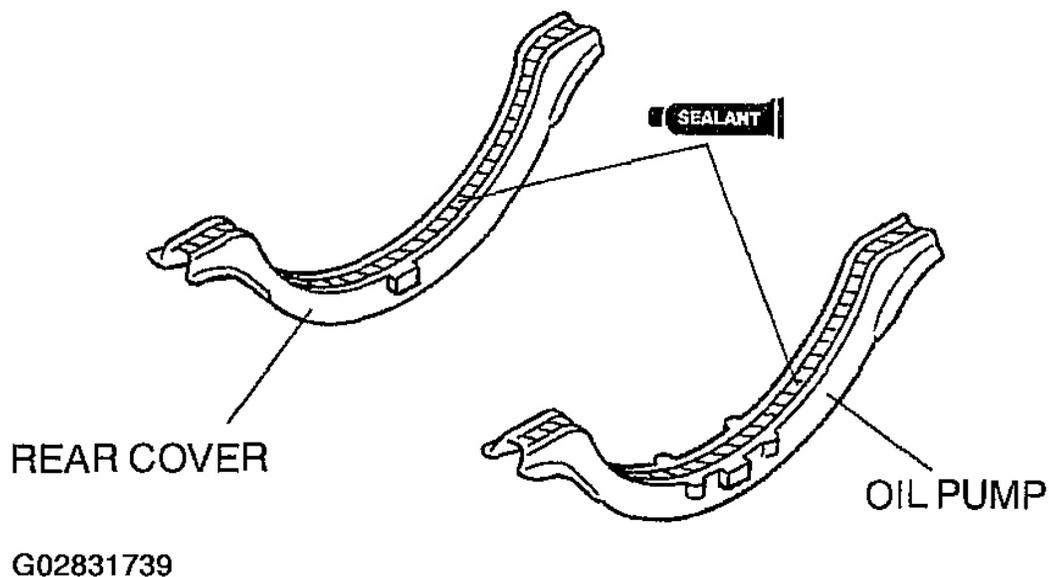


Fig. 59: Applying Silicone Sealant To Oil Pan Gaskets
Courtesy of MAZDA MOTORS CORP.

2. Install oil pan gaskets onto the oil pump body and the rear cover with the projections in the notches as shown.

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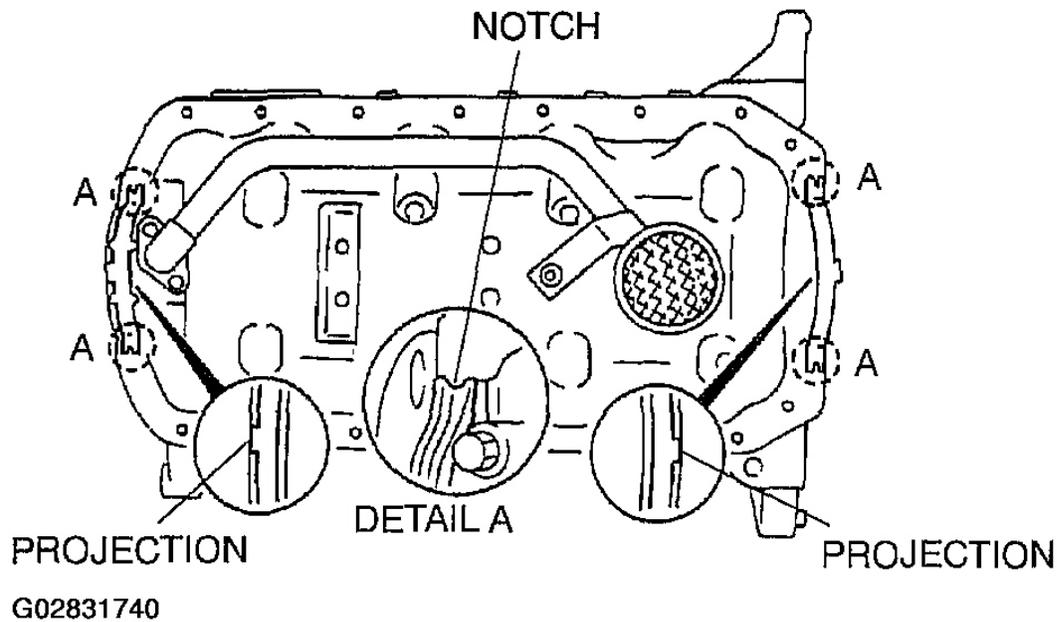


Fig. 60: Identifying Oil Pump/Rear Cover Body Notches
Courtesy of MAZDA MOTORS CORP.

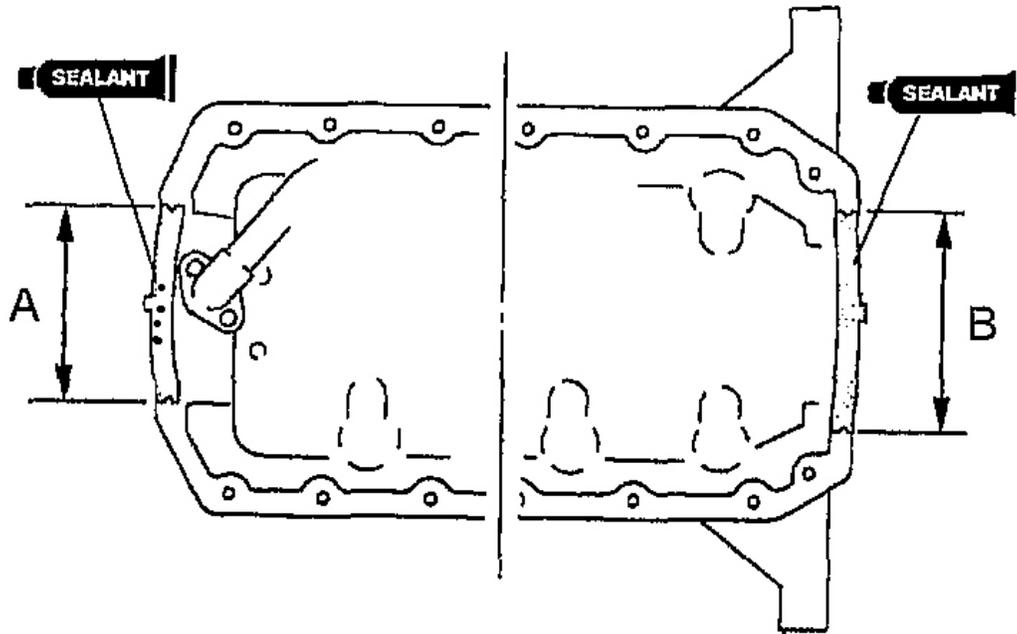
3. Apply silicone sealant onto the area of oil pan gasket indicated by A and B.

Thickness

2.0 mm {0.079 in}

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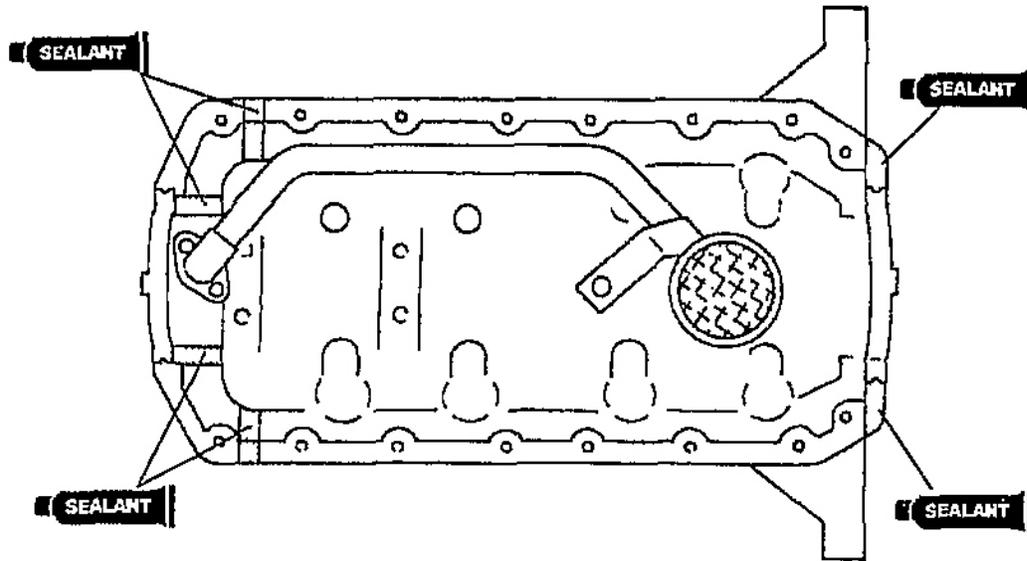
G02831741

Fig. 61: Applying Silicone Sealant To Oil Pan Gasket
Courtesy of MAZDA MOTORS CORP.

4. Apply silicone sealant to the shaded areas shown.

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G02831742

Fig. 62: Applying Silicone Sealant To Shaded Areas
Courtesy of MAZDA MOTORS CORP.

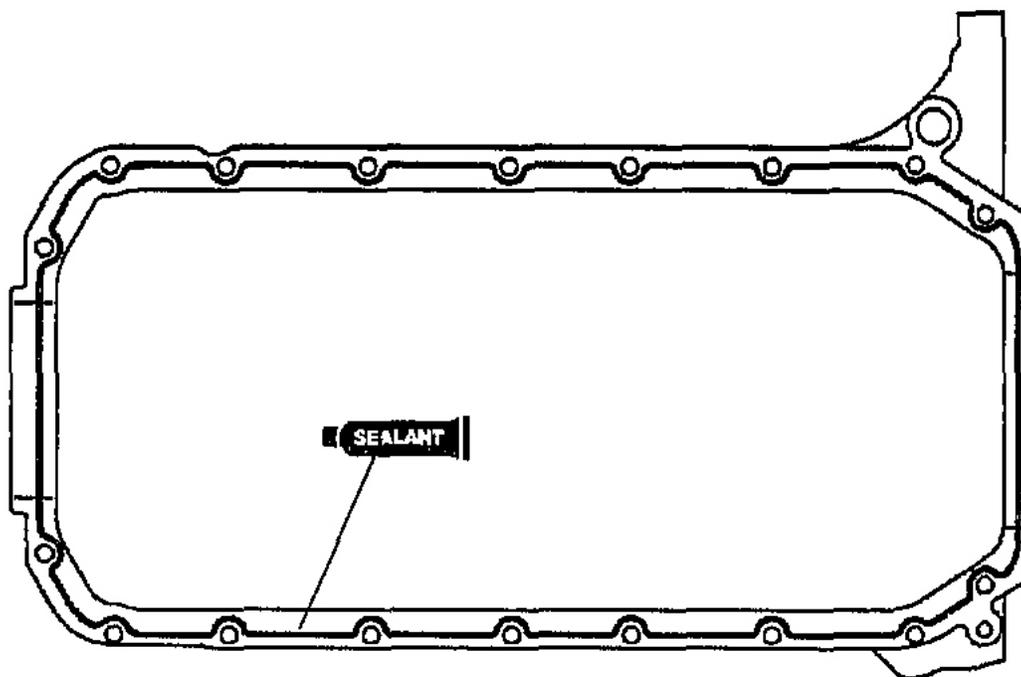
5. Apply silicone sealant to the oil pan along the inside of the bolt holes, and install within five minutes.

Thickness

2.5-3.5 mm {0.099-0.137 in}

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G02831743

Fig. 63: Applying Silicone Sealant To Oil Pan
Courtesy of MAZDA MOTORS CORP.

Flywheel (MT), Drive Plate (AT) Assembly Note

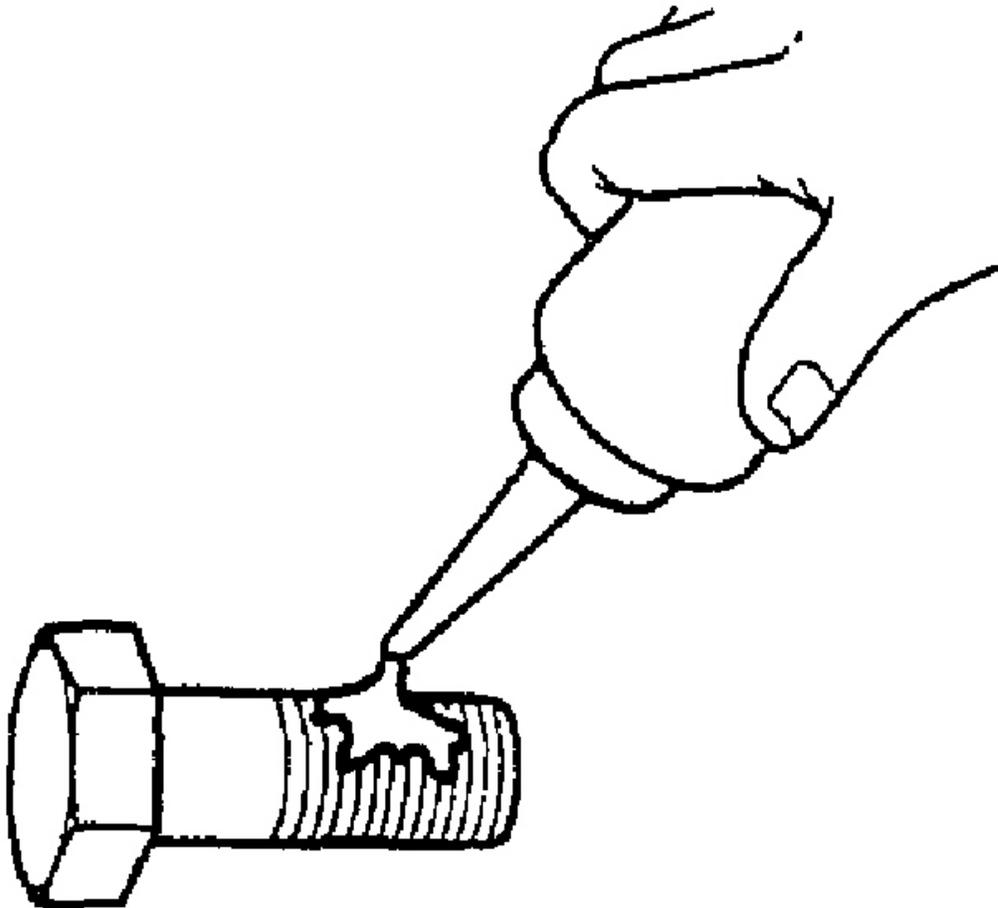
CAUTION:

- If all of the old thread locking sealant cannot be removed from the bolt, it will not torque properly. Replace the bolt.

NOTE:

- If a new bolt is used, do not apply thread locking sealant. New bolts have sealant on them.

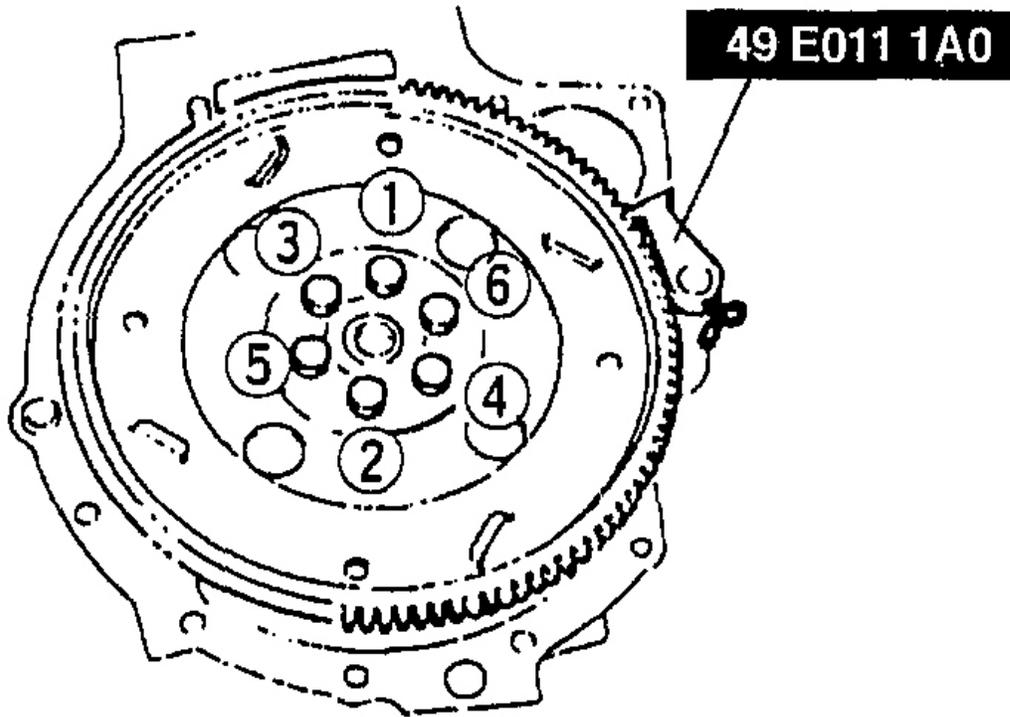
1. Remove the sealant from the bolt holes in the crankshaft and from the bolts.
2. Set the flywheel or drive plate onto the crankshaft.
3. Apply sealant to the flywheel bolts and install them.



G02831744

Fig. 64: Applying Sealant To Flywheel Bolts
Courtesy of MAZDA MOTORS CORP.

4. Hold the flywheel or drive plate using the SST .
5. Tighten the bolts in two or three steps in the order shown.

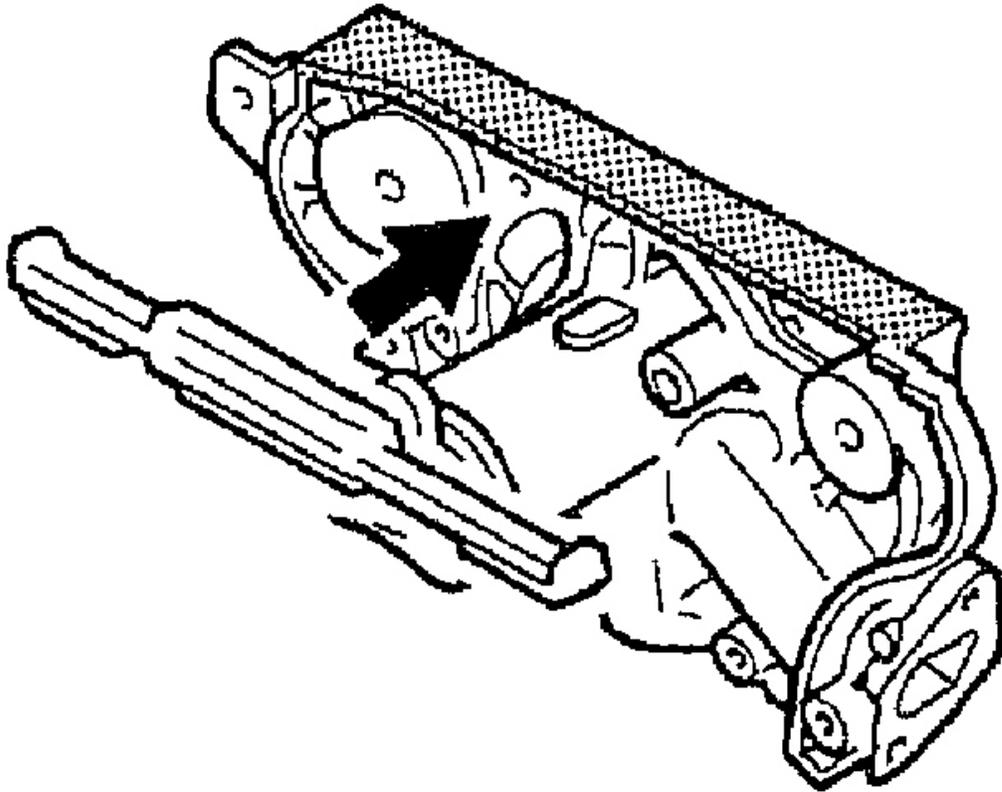


G02831745

Fig. 65: Flywheel Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

Water Pump Assembly Note

1. Verify that the rubber seal is securely fixed onto the water pump.



G02831746

Fig. 66: Installing Rubber Seal To Water Pump
Courtesy of MAZDA MOTORS CORP.

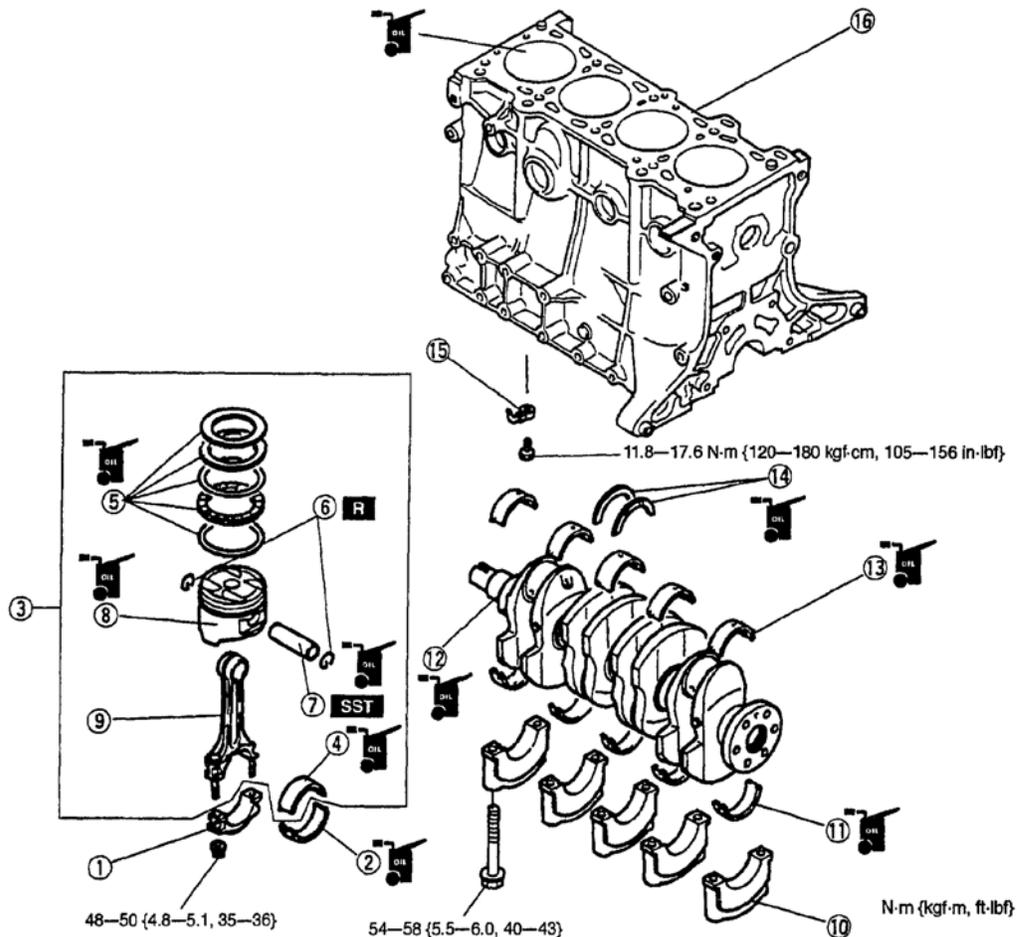
2. If not as specified, remove the rubber seal and reinstall it with the bonding agent.

CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (II)

1. Disassemble in the order indicated in the figure.

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1	Connecting rod cap (See Connecting Rod Cap Assembly Note)
2	Lower connecting rod bearing
3	Piston and connecting rod (See Piston And Connecting Rod Disassembly Note) (See Piston And Connecting Rod Assembly Note)
4	Upper connecting rod bearing
5	Piston ring
6	Piston pin clip
7	Piston pin
8	Piston

9	Connecting rod
10	Main bearing cap (See Main Bearing Cap Disassembly Note) (See Main Bearing Cap Assembly Note)
11	Lower main bearing
12	Crankshaft
13	Upper main bearing
14	Thrust bearing
15	Oil jet
16	Cylinder block

G02831747

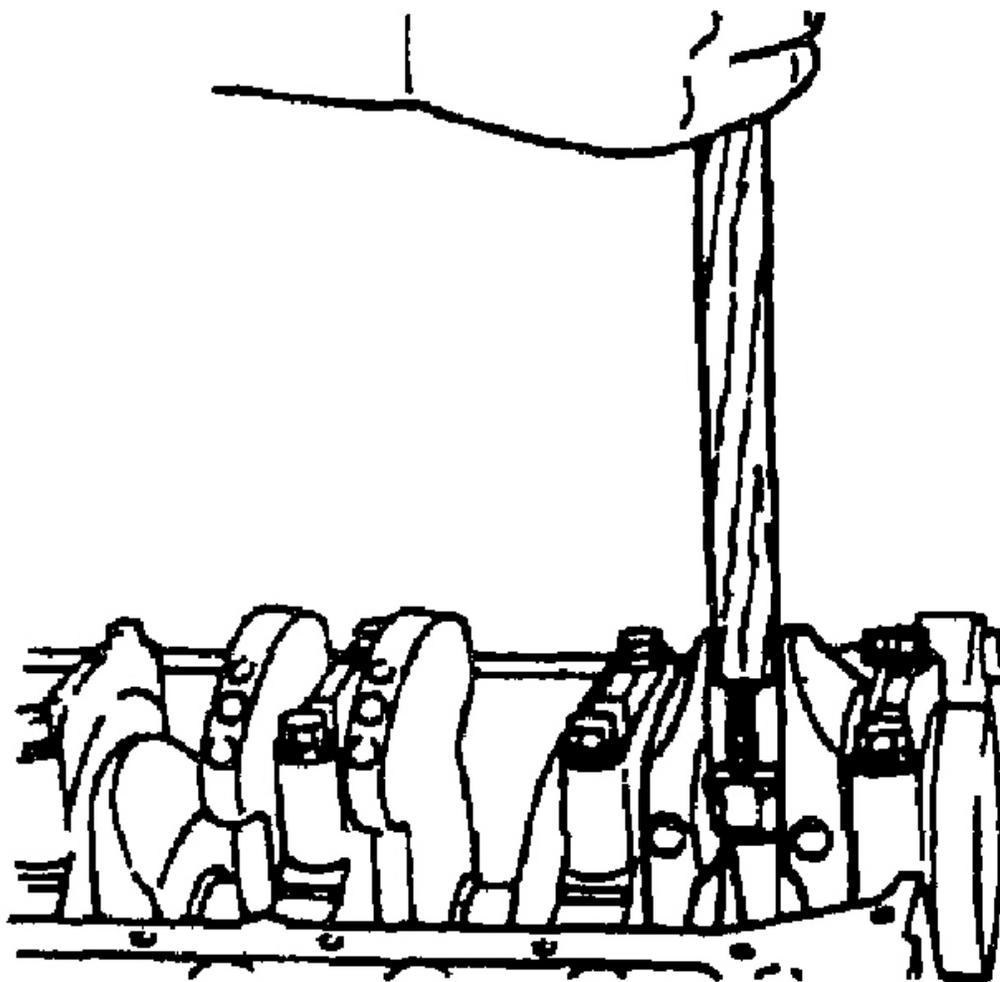
Fig. 67: Disassembling/Assembling Cylinder Block
 Courtesy of MAZDA MOTORS CORP.

2. Assemble in the reverse order of disassembly.

Piston And Connecting Rod Disassembly Note

1. Inspect the connecting rod side clearance. (Refer to **ENGINE INSPECTION/REPAIR , CONNECTING ROD SIDE CLEARANCE INSPECTION .**)

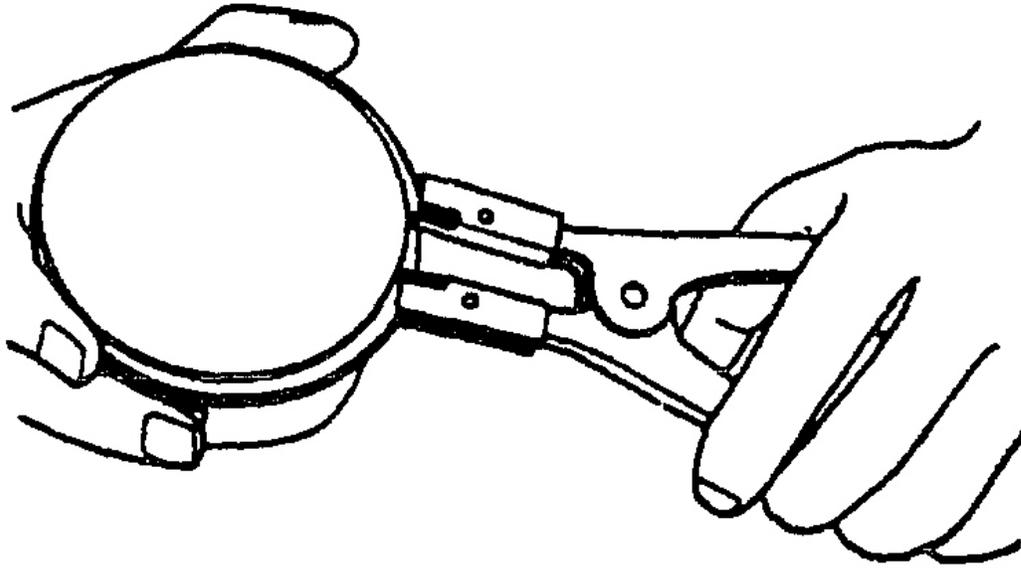
2. Use the handle of a hammer to remove the piston and connecting rod through the top of the cylinder block.



G02831748

Fig. 68: Removing Piston & Connecting Rod
Courtesy of MAZDA MOTORS CORP.

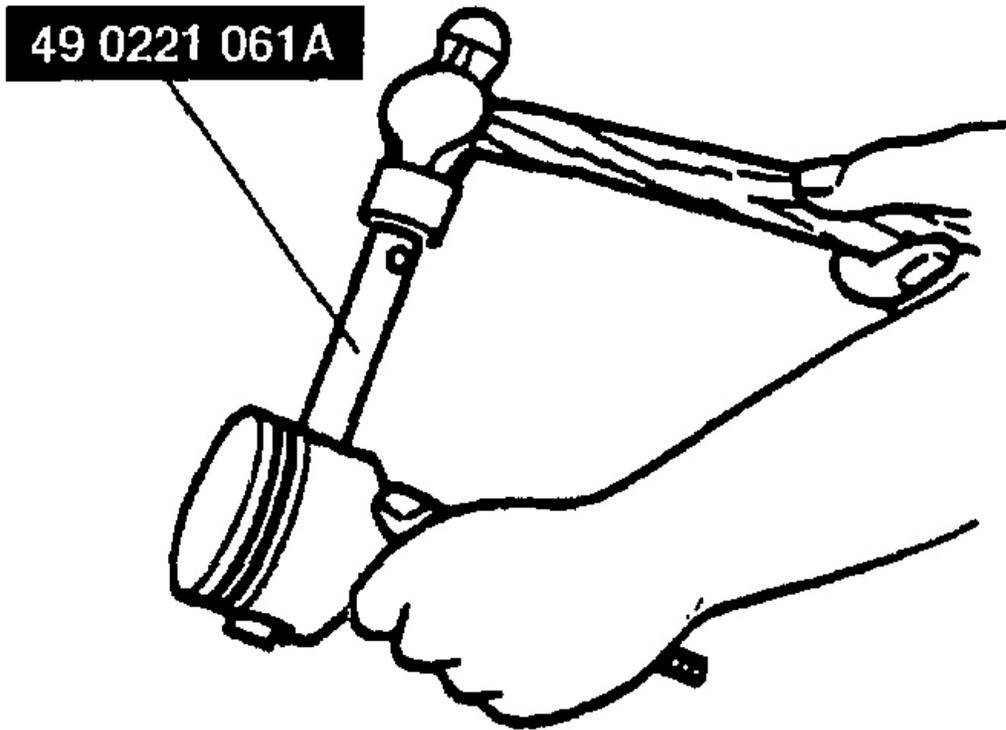
3. Inspect the piston and connecting rod. (Refer to ENGINE INSPECTION/REPAIR , PISTON AND CONNECTING ROD INSPECTION .)
4. Remove the piston rings by using a piston ring expander.



G02831749

Fig. 69: Removing Piston Rings
Courtesy of MAZDA MOTORS CORP.

5. Remove the piston pin by using the SST .



G02831750

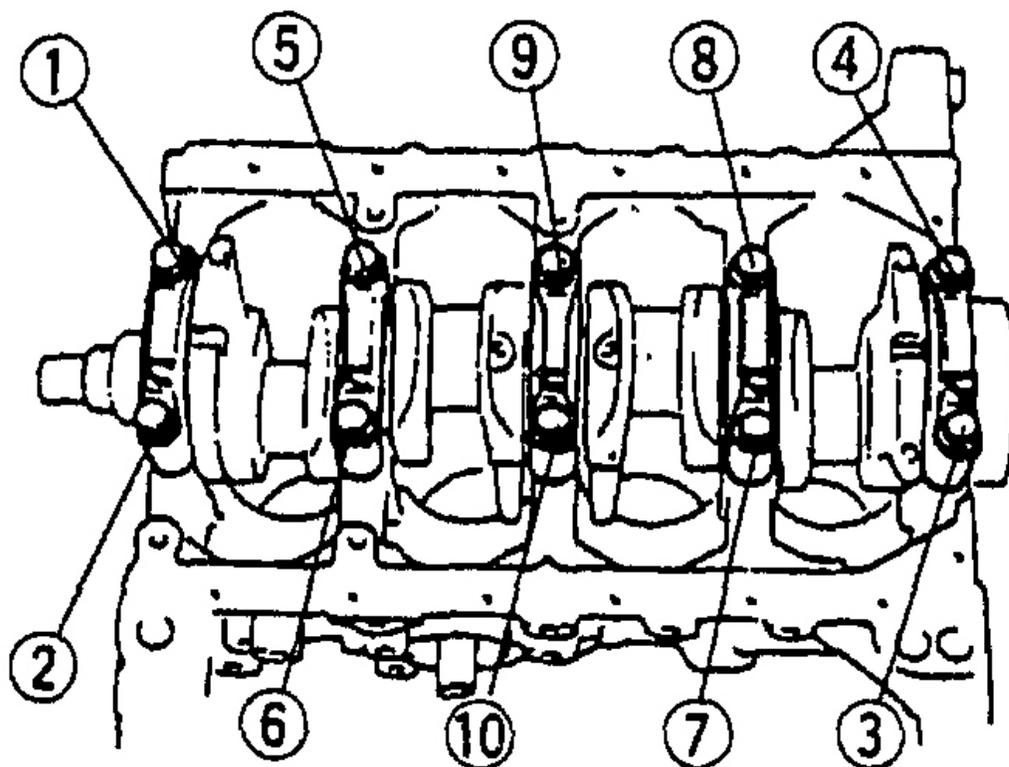
Fig. 70: Removing Piston Pins
Courtesy of MAZDA MOTORS CORP.

Main Bearing Cap Disassembly Note

1. Inspect the crankshaft end play. (Refer to **ENGINE INSPECTION/REPAIR , CRANKSHAFT END PLAY INSPECTION** .)
2. Loosen the main bearing cap bolts in two or three steps in the order shown.

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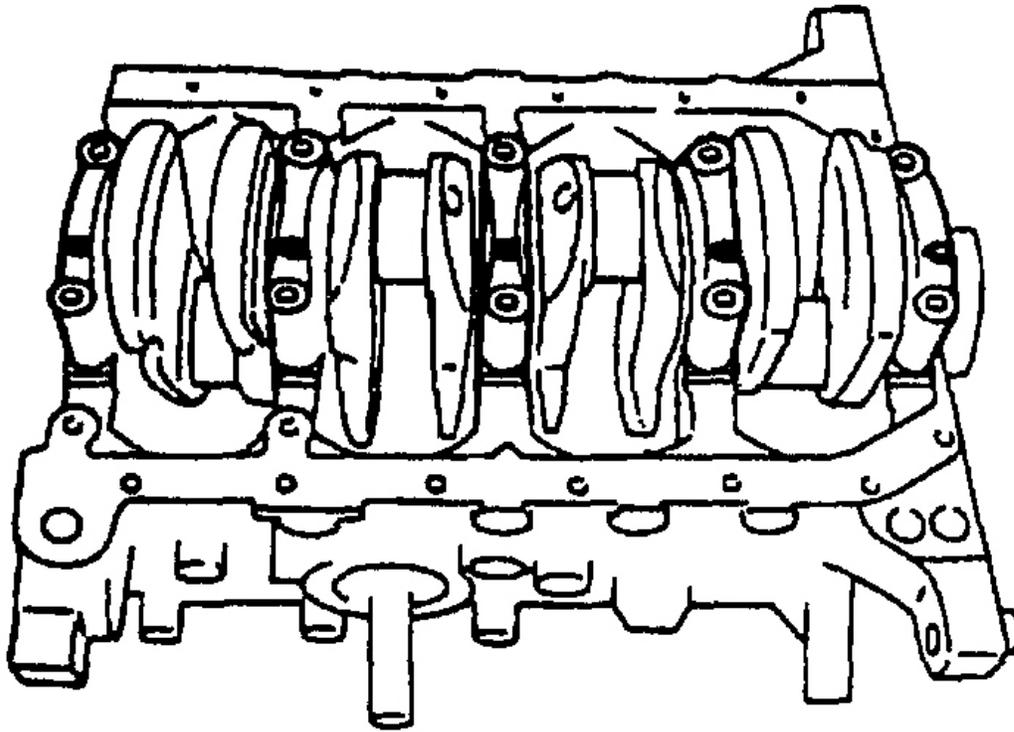
G02831751

Fig. 71: Main Bearing Cap Bolt Loosening Sequence
Courtesy of MAZDA MOTORS CORP.

3. Remove the main bearing caps.

Main Bearing Cap Assembly Note

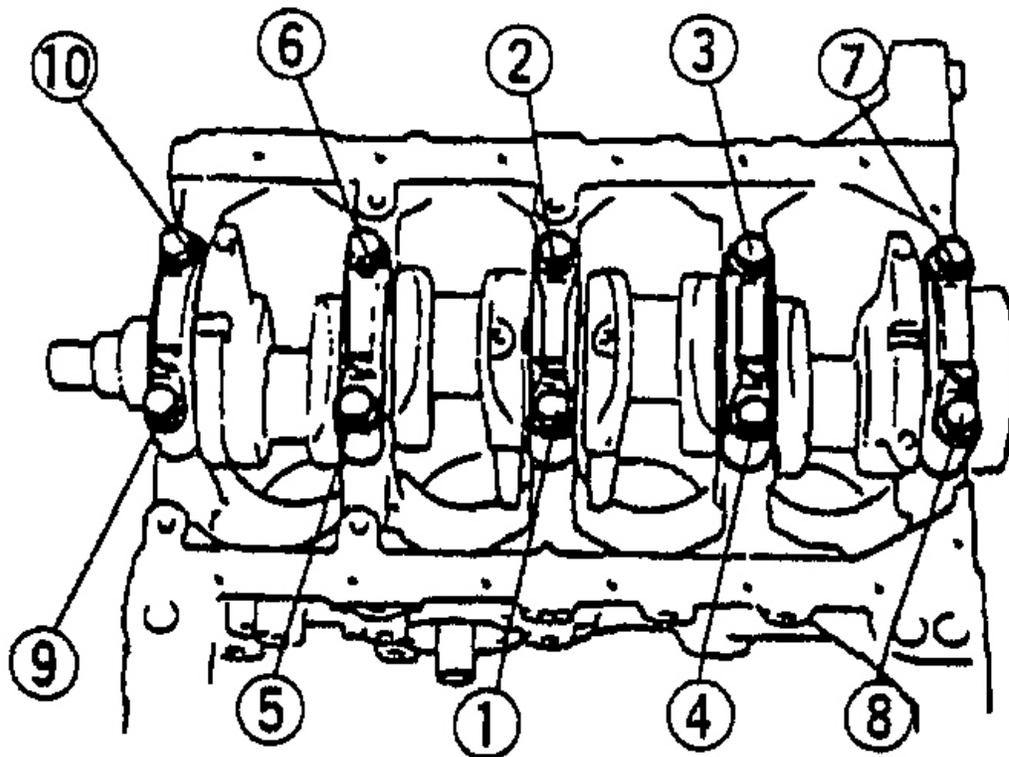
1. Install the crankshaft and the main bearing caps according to the cap number and "<=" mark which indicates front side.



G02831752

Fig. 72: Installing Crankshaft & Main Bearing Caps
Courtesy of MAZDA MOTORS CORP.

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

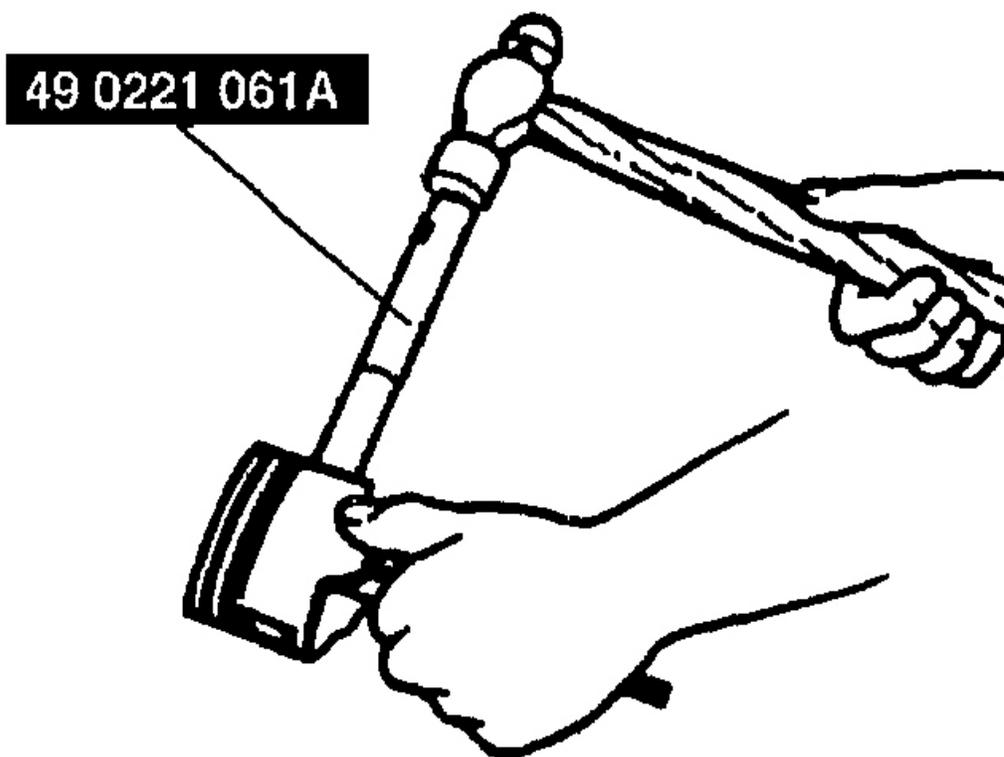


G02831753

Fig. 73: Main Bearing Cap Bolt Tightening Sequence
 Courtesy of MAZDA MOTORS CORP.

Piston And Connecting Rod Assembly Note

1. Install one piston pin clip into the clip groove in the piston.
2. Assemble the piston and the connecting rod.
3. Apply clean engine oil to the piston pin.
4. Install the piston pin from the side opposite the clip.
5. Tap the piston pin in with the **SST** until the pin contacts the clip. If the pin cannot be installed easily, replace the connecting rod.



G02831754

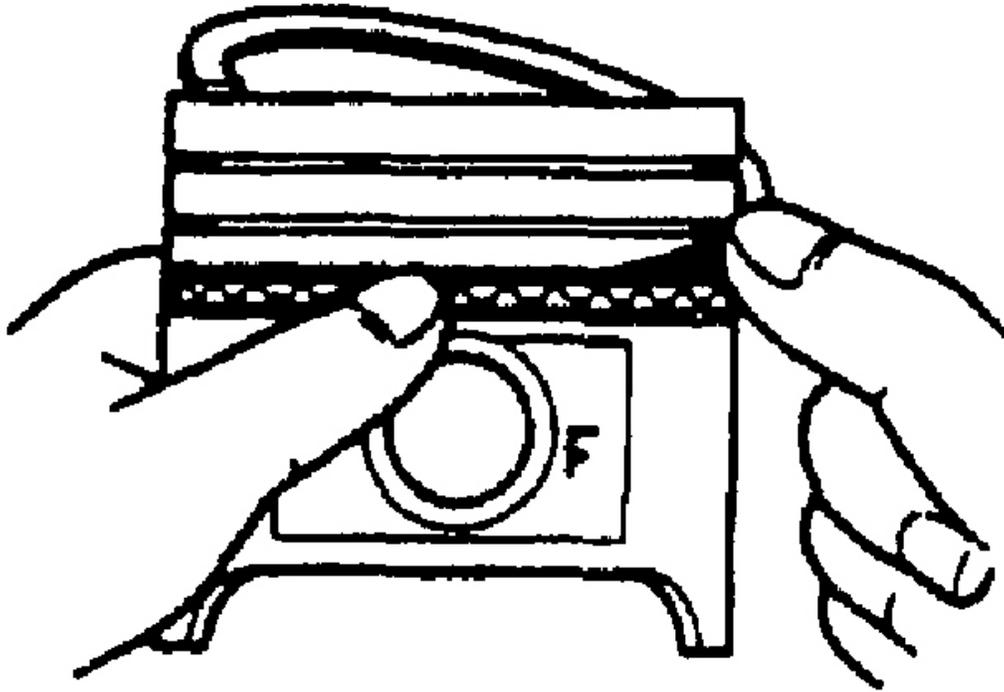
Fig. 74: Installing Piston Pin
Courtesy of MAZDA MOTORS CORP.

6. Install the second clip into the clip groove in the piston.

NOTE:

- The upper and lower rails are the same. They can be installed with either face upward.

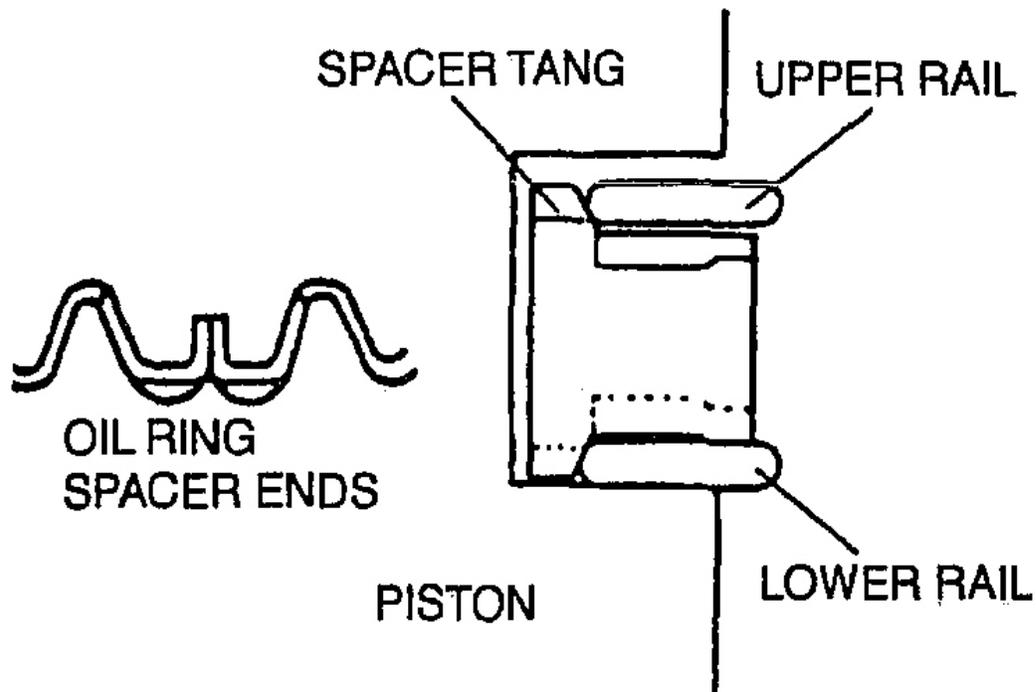
7. Install the three-piece oil rings on the pistons.
 1. Apply clean engine oil to the oil ring spacer and rails.
 2. Install the oil ring spacer with the ends upward.
 3. Install the upper and lower rails.



G02831755

Fig. 75: Installing Three-Piece Oil Rings
Courtesy of MAZDA MOTORS CORP.

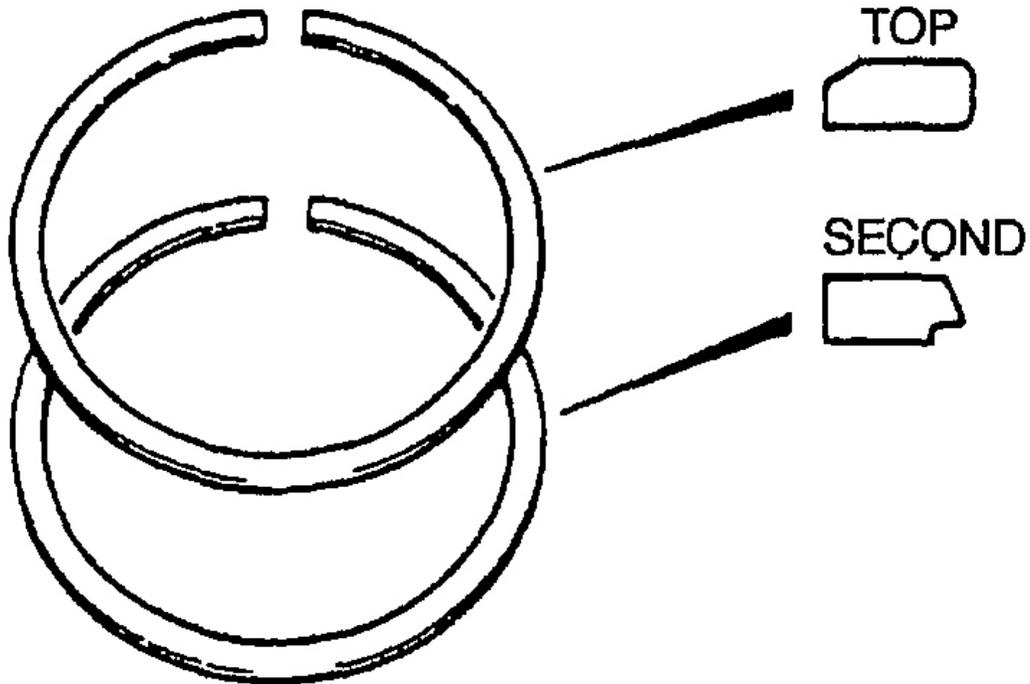
8. Verify that the spacer tang separates the rails, and that the rails turn smoothly in both directions.



G02831756

Fig. 76: Checking Oil Ring Installation
Courtesy of MAZDA MOTORS CORP.

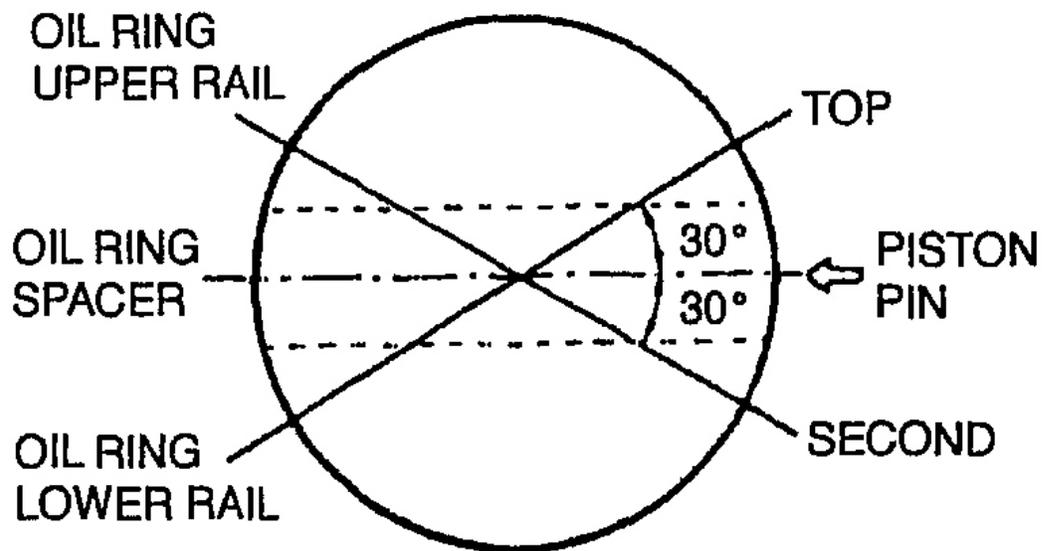
9. Using a piston ring expander, install the second ring with the scraper face downward.



G02831757

Fig. 77: Installing Second Ring
Courtesy of MAZDA MOTORS CORP.

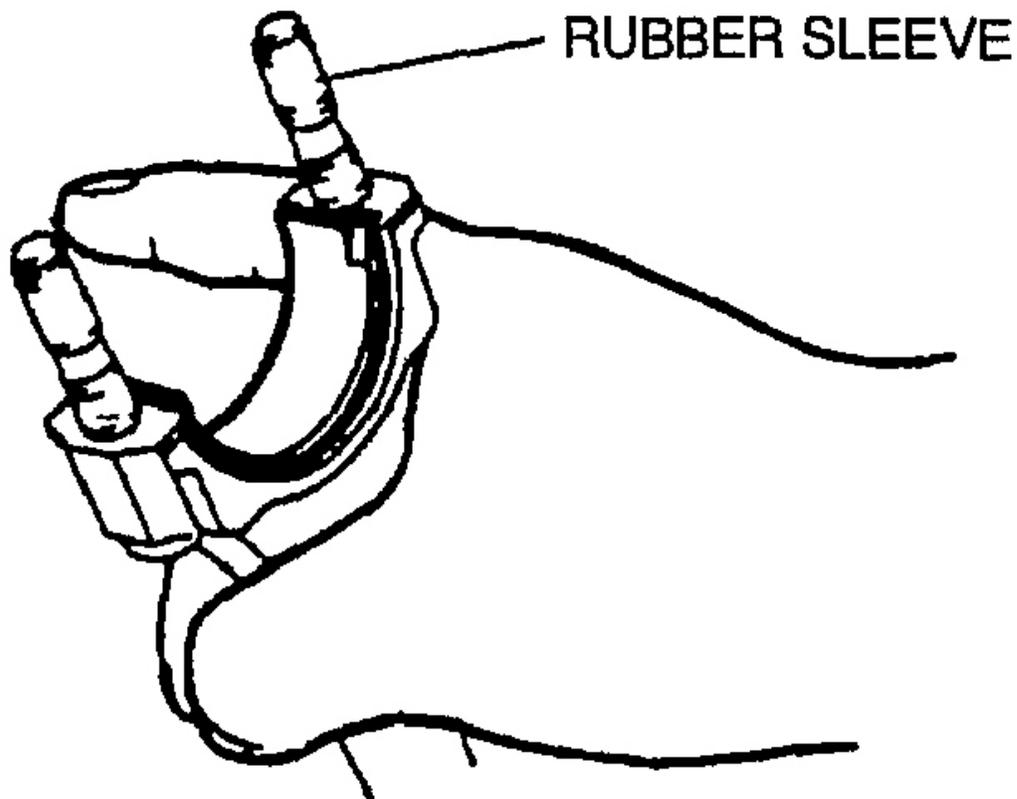
10. Using a piston ring expander, install the top ring with the chamfer facing upward.
11. Apply clean engine oil to the top and second piston rings.
12. Position the end gaps of the rings as shown.



G02831758

Fig. 78: Positioning Piston Ring End Gaps
Courtesy of MAZDA MOTORS CORP.

13. Protect the connecting rod bolts with rubber sleeves.



G02831759

Fig. 79: Installing Rubber Sleeves On Connecting Rod Bolts
Courtesy of MAZDA MOTORS CORP.

14. Apply clean engine oil to the cylinder walls, pistons, and piston rings.
15. Inspect the piston rings for correct end gap alignment.
16. Insert each piston into the cylinder block with the **F** mark facing the front of the engine. Use a piston ring compressor.

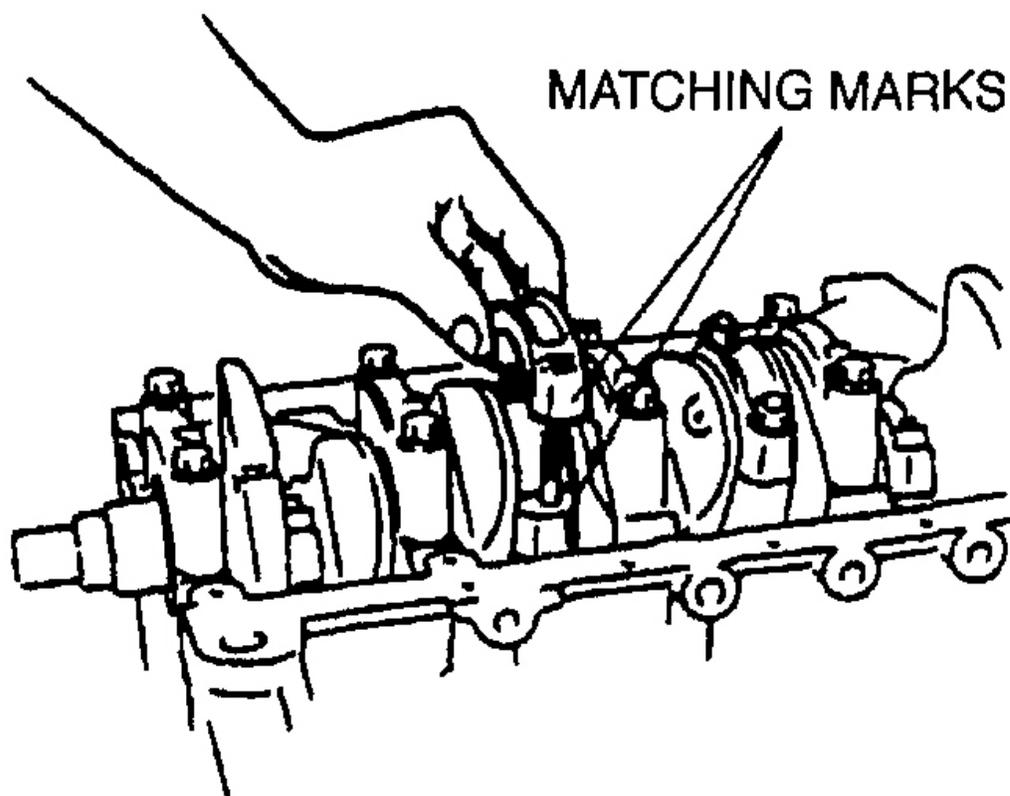


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Fig. 80: Installing Piston & Connecting Rod
Courtesy of MAZDA MOTORS CORP.

Connecting Rod Cap Assembly Note

1. Align the matching marks on the cap and the connecting rod and install the connecting rod cap.



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Fig. 81: Aligning Connecting Rod Cap Matching Marks
Courtesy of MAZDA MOTORS CORP.

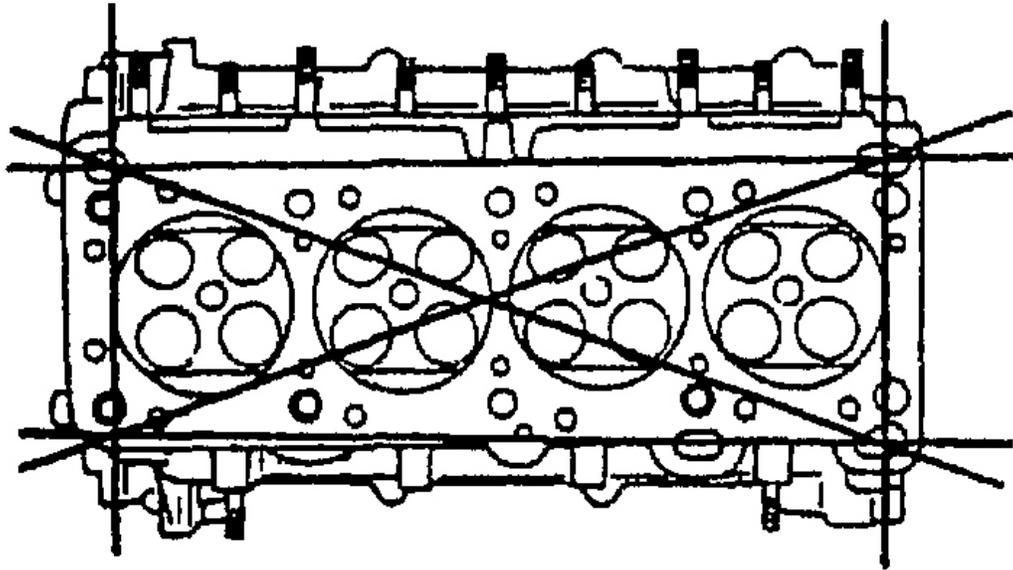
ENGINE INSPECTION/REPAIR

CYLINDER HEAD INSPECTION/REPAIR

1. Carry out cooling flaw detection on the cylinder head surface. Replace the cylinder head as necessary.
2. Inspect for the following and repair or replace as necessary.
 1. Sunken valve seats.
 2. Excessive camshaft oil clearance and end play.
3. Measure the cylinder head for distortion in the six directions as shown.

Distortion

0.10 mm {0.004 in} max.



G02831762

Fig. 82: Cylinder Head Distortion Measurement Directions
Courtesy of MAZDA MOTORS CORP.

4. If the cylinder head distortion exceeds the maximum, repair by grinding height or replace the cylinder head. If the cylinder head height is not as specified, replace it.

Standard Height

133.8-134.0 mm {5.268-5.275 in}

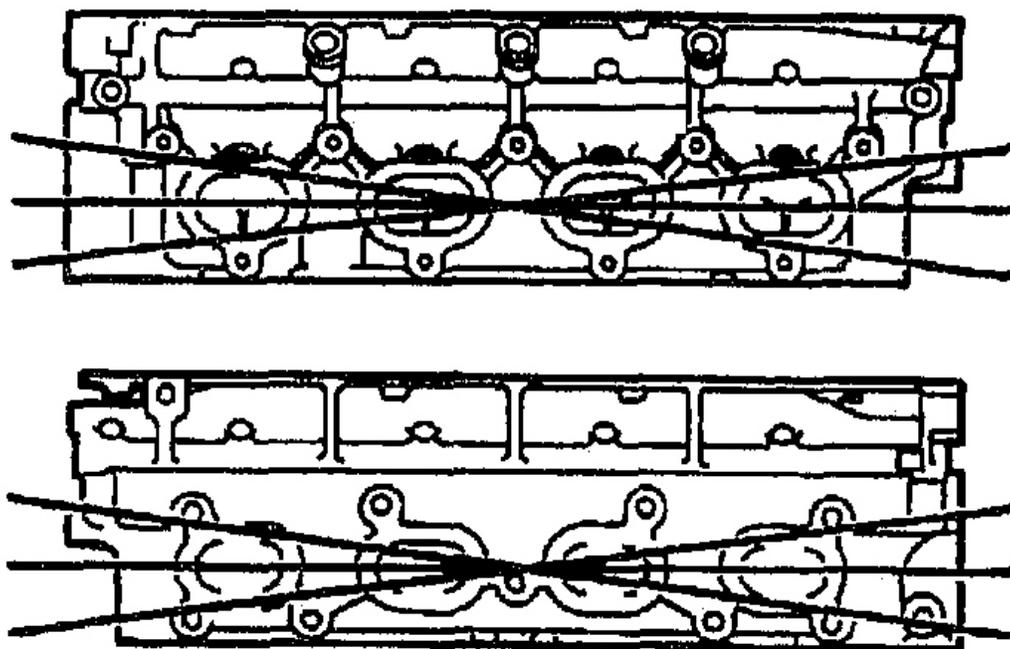
Grinding

0.10 mm {0.004 in} max.

5. Measure the manifold contact surface distortion as shown.

Distortion

0.15 mm {0.006 in} max.



G02831763

Fig. 83: Manifold Contact Surface Distortion Measurements
Courtesy of MAZDA MOTORS CORP.

6. If the distortion exceeds the specification, grind the surface or replace the cylinder head.

Grinding

0.20 mm {0.008 in} max.

VALVE INSPECTION

1. Measure the valve head margin thickness of each valve. Replace the valve as necessary.

Margin Thickness

IN: 0.9 mm {0.035 in} min.

EX: 1.0 mm {0.039 in} min.

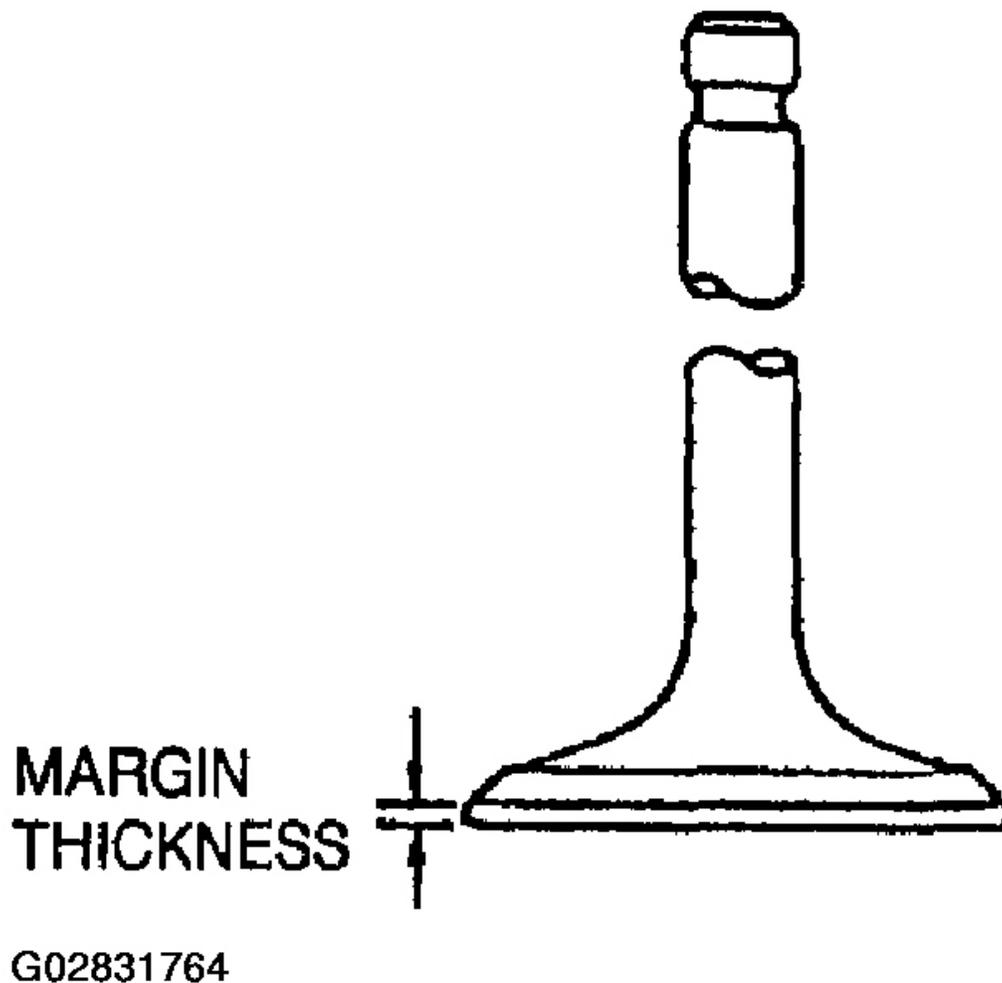


Fig. 84: Measuring Margin Thickness
Courtesy of MAZDA MOTORS CORP.

2. Measure the length of each valve. Replace the valve as necessary.

Standard Length

IN: 101.71-102.31 mm {4.0044-4.0279 in}

EX: 101.71-102.31 mm {4.0044-4.0279 in}

Minimum Length

IN: 101.61 mm {4.0004 in}

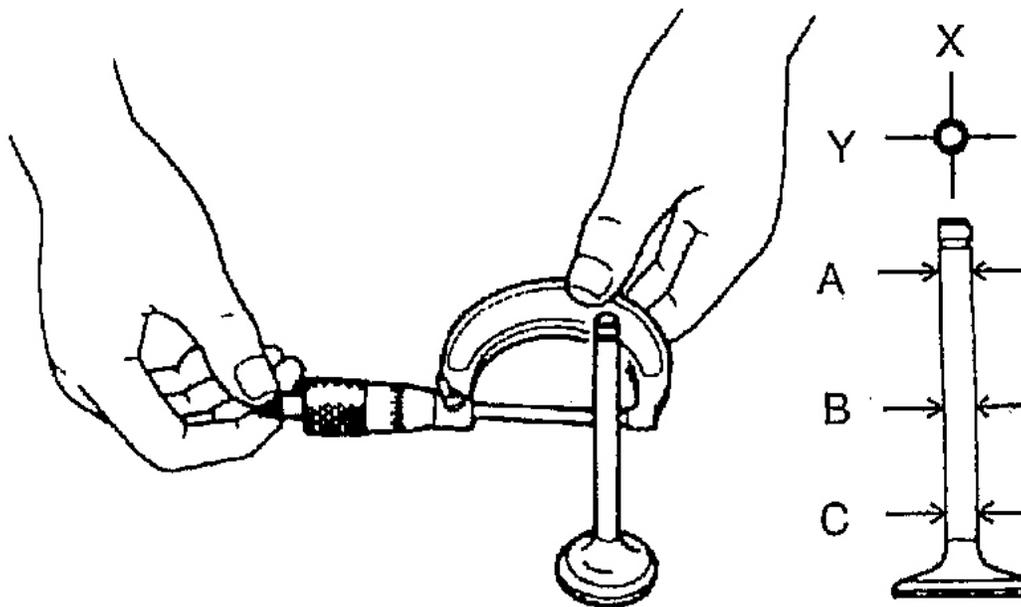
EX: 101.61 mm {4.0004 in}

3. Measure the stem diameter of each valve in X and Y directions at the three points (A, B, and C) shown. Replace the valves as necessary.

Standard Diameter

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

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



G02831765

Fig. 85: Measuring Valve Stem Diameter
Courtesy of MAZDA MOTORS CORP.

Minimum Diameter

IN: 5.920 mm {0.2331 in}

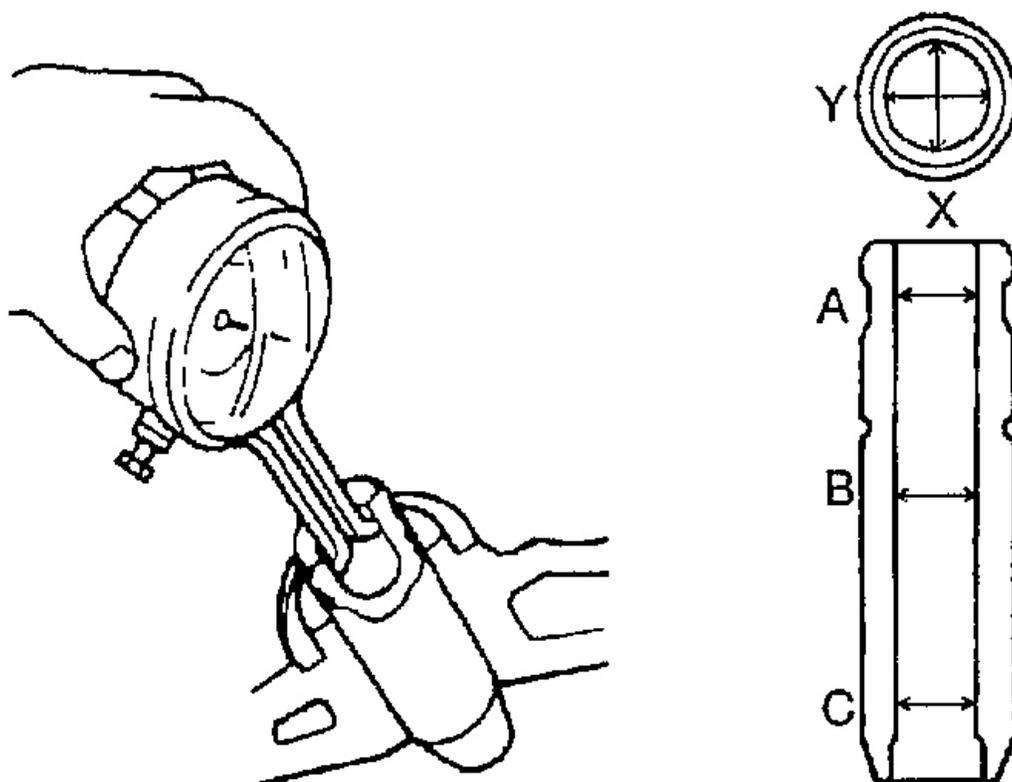
EX: 5.915 mm {0.2329 in}

VALVE GUIDE INSPECTION

1. Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) shown. Replace the valve guide as necessary.

Standard Inner Diameter

6.02-6.04 mm {0.2371-0.2377 in}



G02831766

Fig. 86: Measuring Valve Guide Inner Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure the protrusion height (dimension A) of each valve guide without the lower valve spring seat. Replace the valve guide as necessary.

Standard Height

18.3-18.9 mm {0.721-0.744 in}

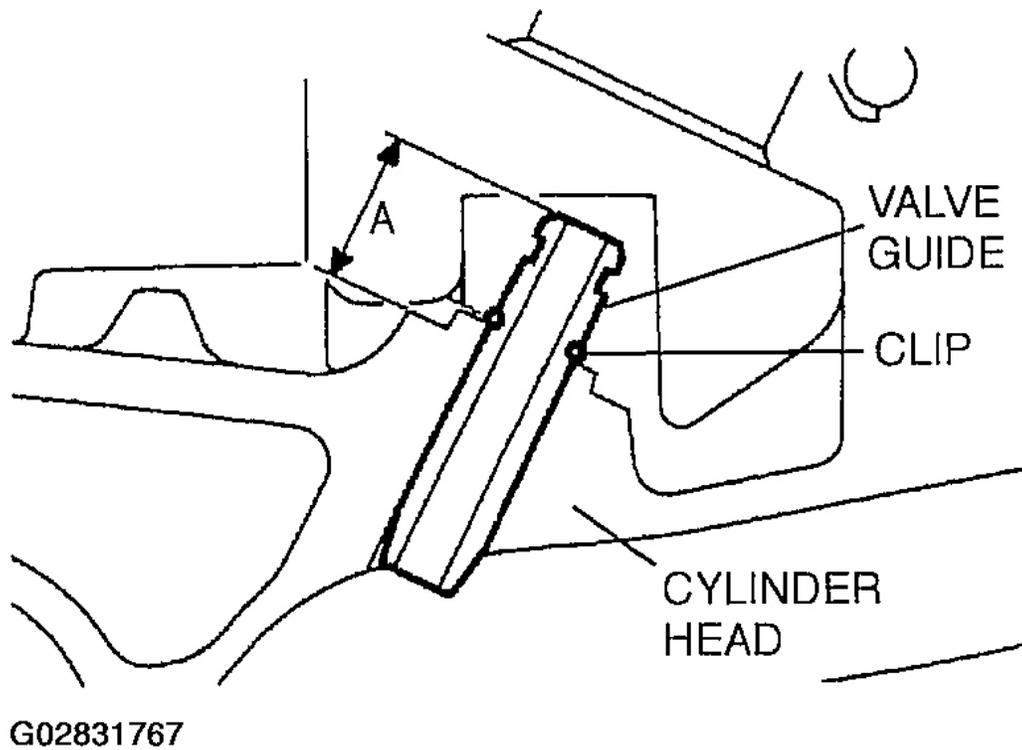


Fig. 87: Measuring Valve Guide Protrusion Height
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE REPLACEMENT

- NOTE:**
- Intake and exhaust valve guides are different.

Valve Guide Removal

- Remove the valve guide from the combustion chamber side by using the SST .

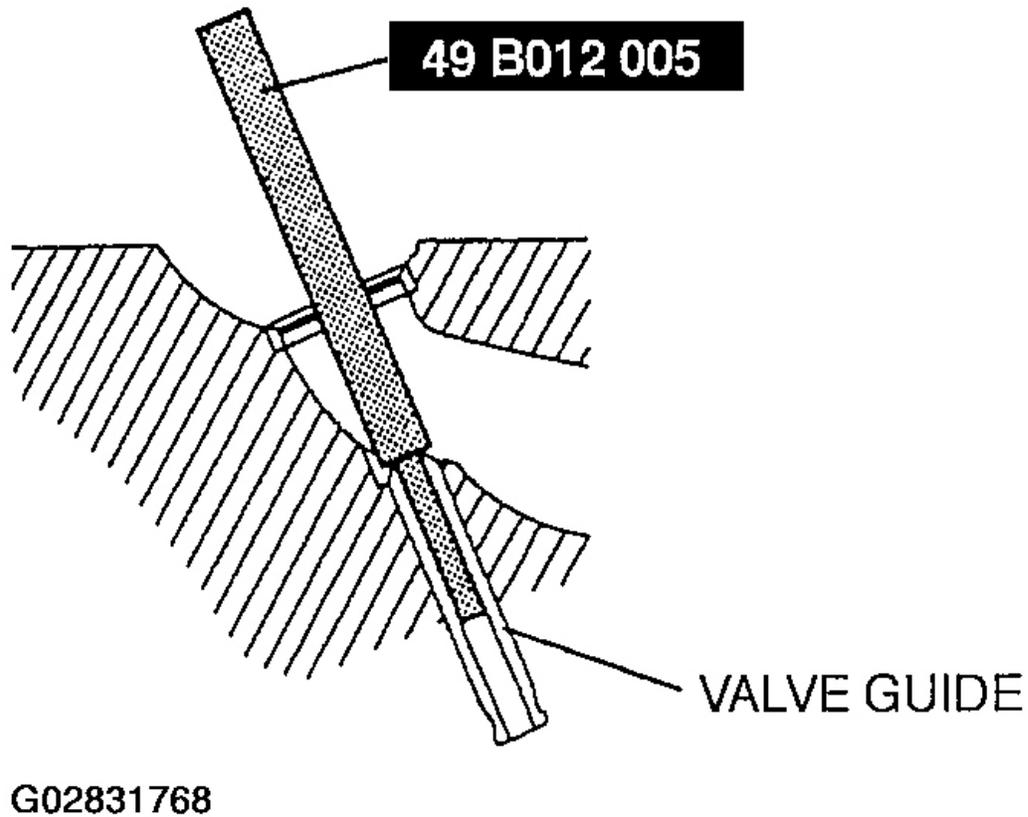


Fig. 88: Removing Valve Guide
Courtesy of MAZDA MOTORS CORP.

Valve Guide Installation

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

Depth L

18.3-18.9 mm {0.721-0.744 in}

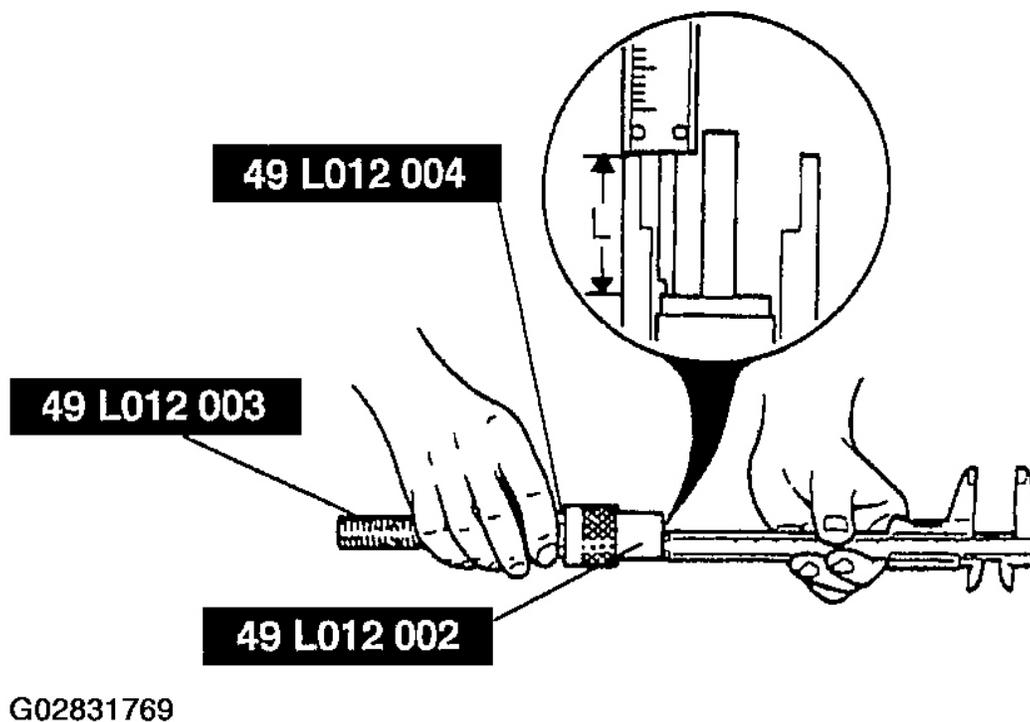
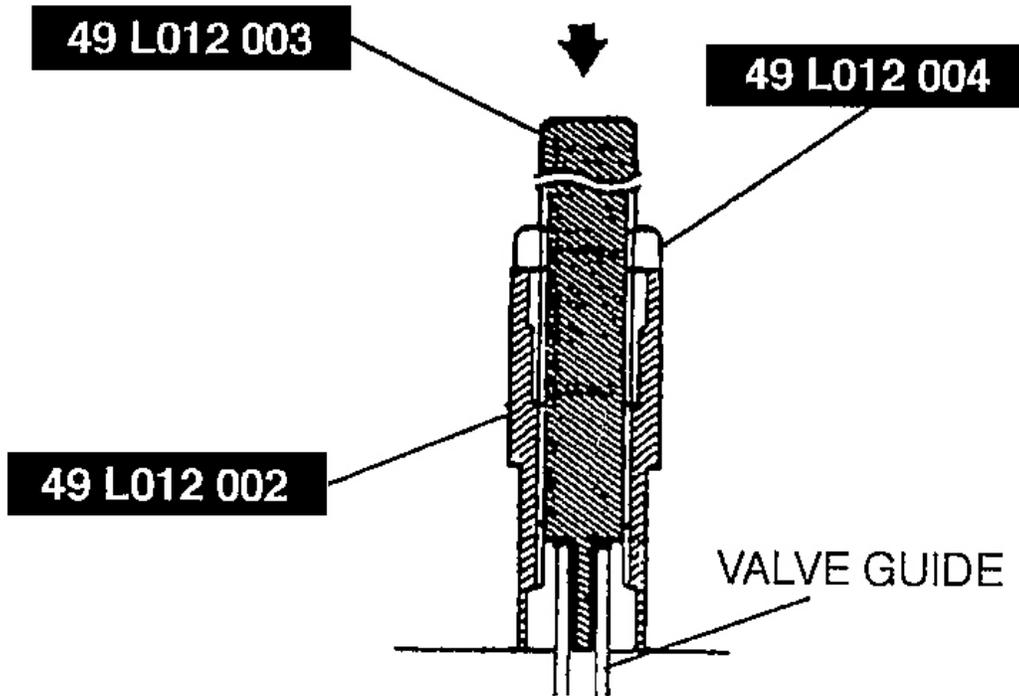


Fig. 89: Assembling SST To Depth L
Courtesy of MAZDA MOTORS CORP.

2. Tap the valve guide in from the side opposite the combustion chamber until the SST contacts the cylinder head.
3. Verify that the valve guide projection height (dimension) is as specified.

Standard Height

18.3-18.9 mm {0.721-0.744 in}



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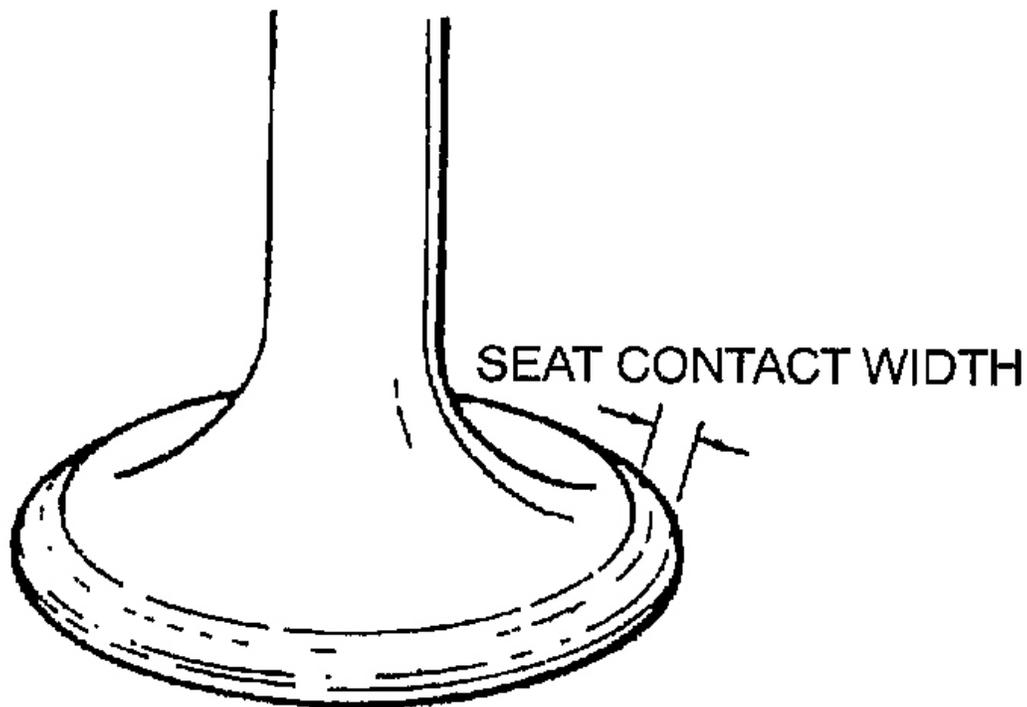
Fig. 90: Measuring Valve Guide Projection Height
Courtesy of MAZDA MOTORS CORP.

VALVE SEAT INSPECTION/REPAIR

1. Measure the seat contact width. As necessary, resurface the valve seat using a 45° valve seat cutter and/or resurface the valve face.

Standard Width

0.8-1.4 mm {0.032-0.055 in}



G02831771

Fig. 91: 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 high, correct the valve seat using a 70° cutter, and a 45° cutter.
 2. If the seating position is too low, correct the valve seat using a 45° cutter.

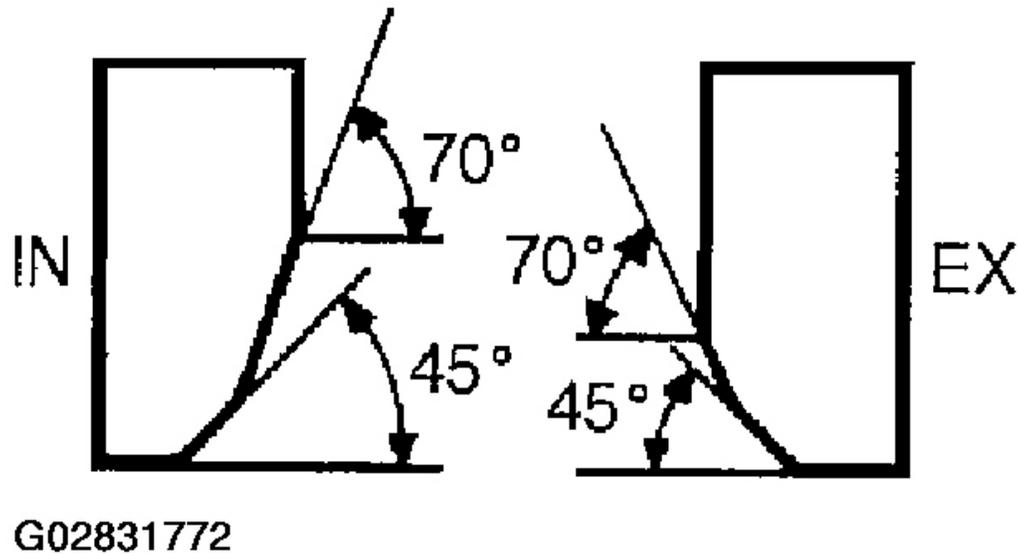


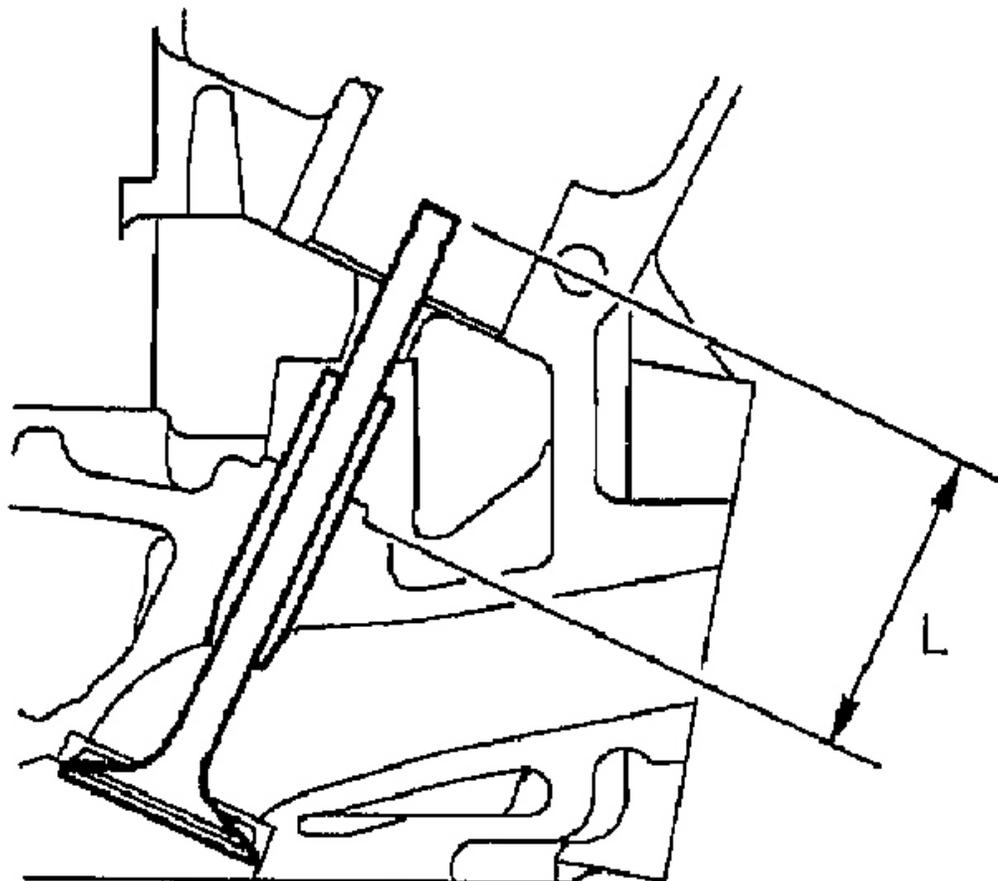
Fig. 92: Centering Valve Seating Position
Courtesy of MAZDA MOTORS CORP.

3. Inspect the sinking of the valve seat. Measure the protruding length (dimension L) of the valve stem. Replace the cylinder head as necessary.

Standard Dimension L

IN: 45.0 mm {1.772 in}

EX: 45.0 mm {1.772 in}



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Fig. 93: Measuring Protruding Length
Courtesy of MAZDA MOTORS CORP.

Maximum Dimension L

IN: 45.6 mm {1.795 in}

EX: 45.6 mm {1.795 in}

VALVE SPRING INSPECTION

1. Apply pressing force to the pressure spring and measure the spring height. Replace the valve spring as necessary.

Pressing Force

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IN: 172.60-195.15 N

{17.6-19.9 kgf, 38.72-43.78 lbf}

EX: 172.60-195.15 N

{17.6-19.9 kgf, 38.72-43.78 lbf}

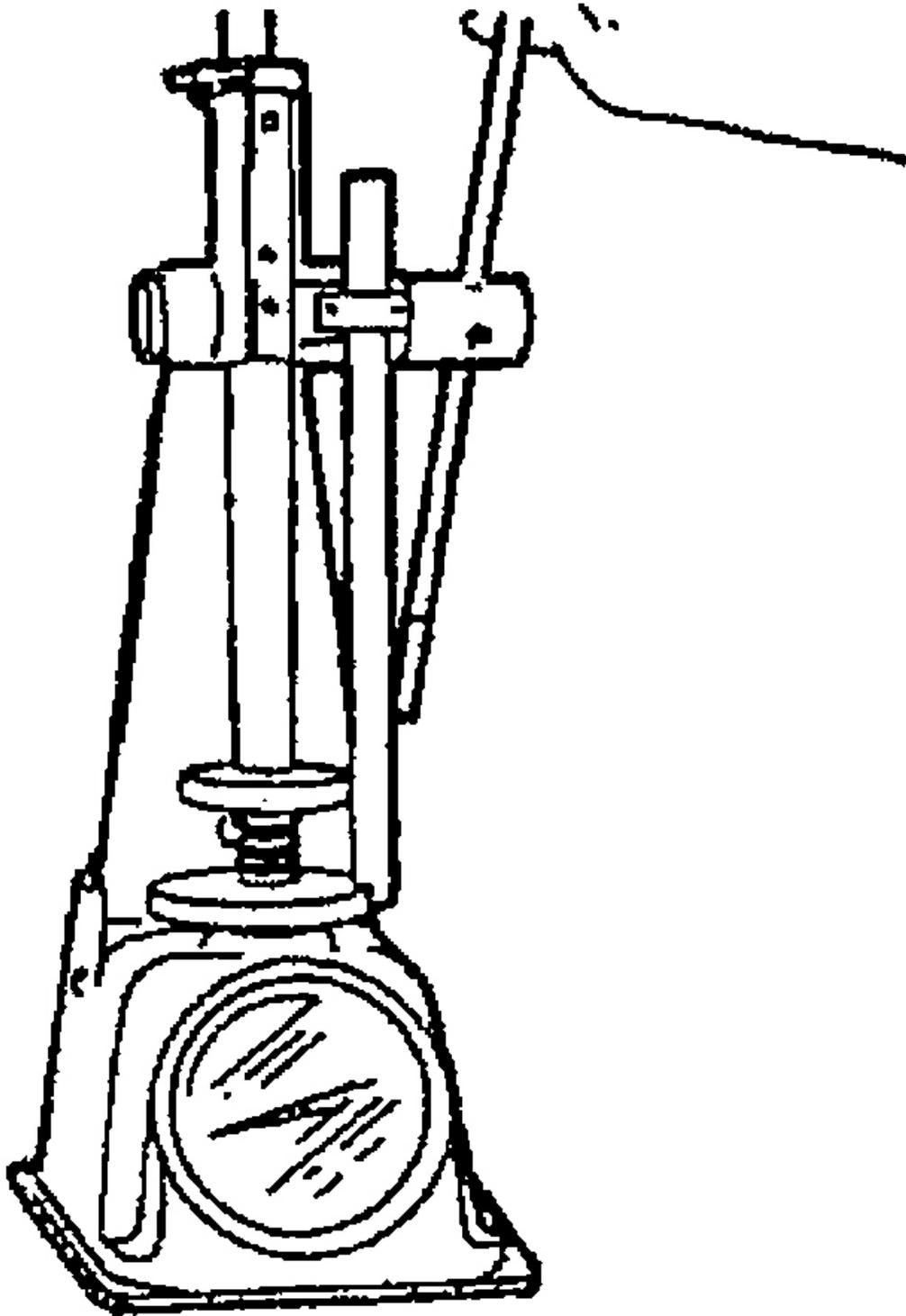
Standard Height

IN: 39.5 mm {1.56 in}

EX: 39.5 mm {1.56 in}

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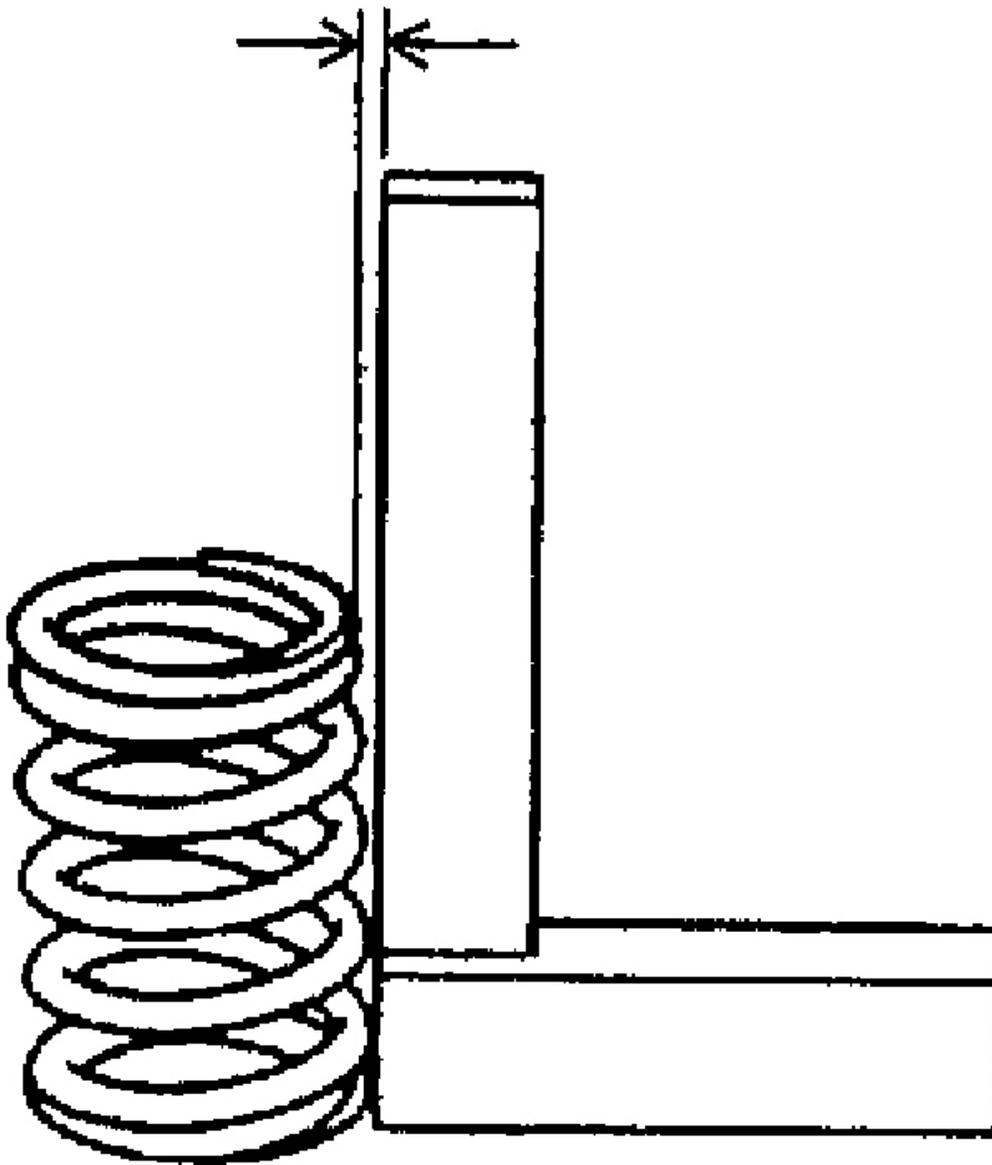
2003-05 ENGINE Overhaul - 1.8L (BP) 4-Cylinder - MX-5 Miata



G02831774

Fig. 94: Measuring Spring Height Under Pressing Force
Courtesy of MAZDA MOTORS CORP.

2. Measure the out-of-square of the valve spring. Replace the valve spring as necessary.



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Fig. 95: Measuring Valve Spring Out-Of-Square

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2003-05 ENGINE Overhaul - 1.8L (BP) 4-Cylinder - MX-5 Miata

Courtesy of MAZDA MOTORS CORP.

VALVE SPRING OUT-OF-SQUARE SPECIFICATIONS

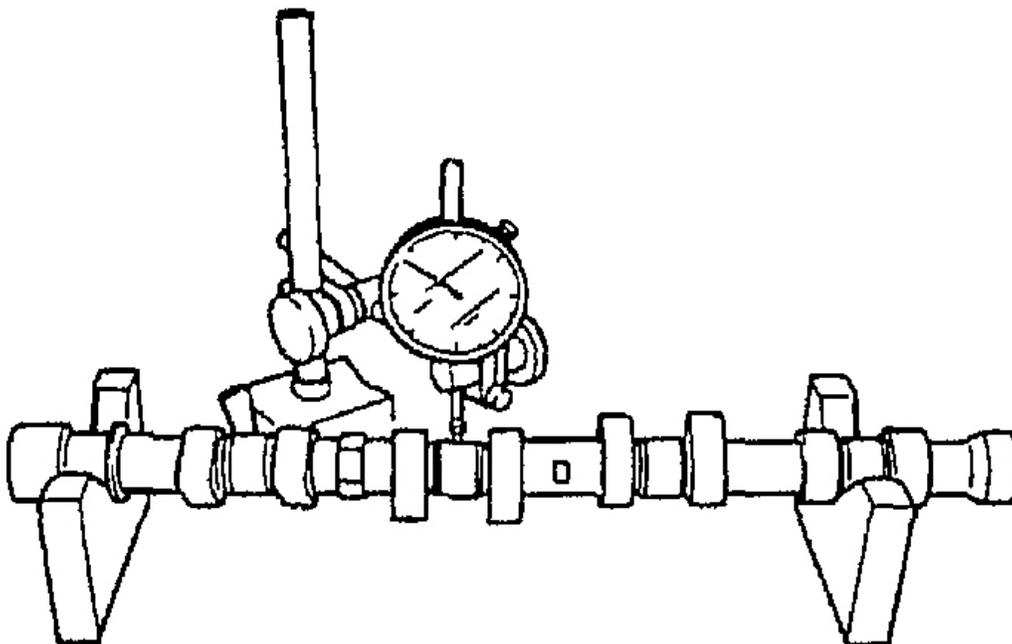
Valve Spring	BP - mm {in}	BP with TC - mm {in}
IN	1.63 {0.064} max.	1.58 {0.062} max.
EX	1.63 {0.064} max.	

CAMSHAFT INSPECTION

1. Set the No.1 and No.5 journals on V-blocks. Measure the camshaft runout. Replace the camshaft as necessary.

Runout

0.03 mm {0.0012 in} max.



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Fig. 96: Measuring Camshaft Runout
Courtesy of MAZDA MOTORS CORP.

2. Measure the cam lobe height at the two points as shown. Replace the camshaft as necessary.

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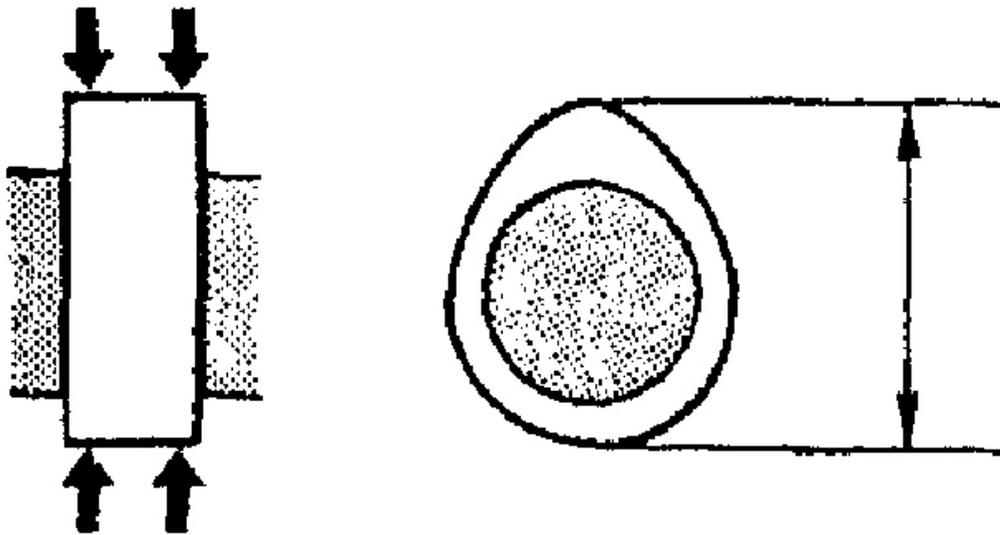
2003-05 ENGINE Overhaul - 1.8L (BP) 4-Cylinder - MX-5 Miata

CAM LOBE STANDARD HEIGHT SPECIFICATIONS

Camshaft	BP - mm {in}	BP with TC - mm {in}
IN	44.3 {1.744}	44.8 {1.764}
EX	44.9 {1.768}	

CAM LOBE MINIMUM HEIGHT SPECIFICATIONS

Camshaft	BP - mm {in}	BP with TC - mm {in}
IN	44.1 {1.736}	44.6 {1.756}
EX	44.7 {1.760}	



G02831777

Fig. 97: Measuring Camshaft Lobe Height
Courtesy of MAZDA MOTORS CORP.

3. Measure the journal diameters in X and Y directions at the two points (A and B) as shown. Replace the camshaft as necessary.

Standard Diameter

25.940-25.965 mm {1.0213-1.0222 in}

Minimum Diameter

25.910 mm {1.0201 in}

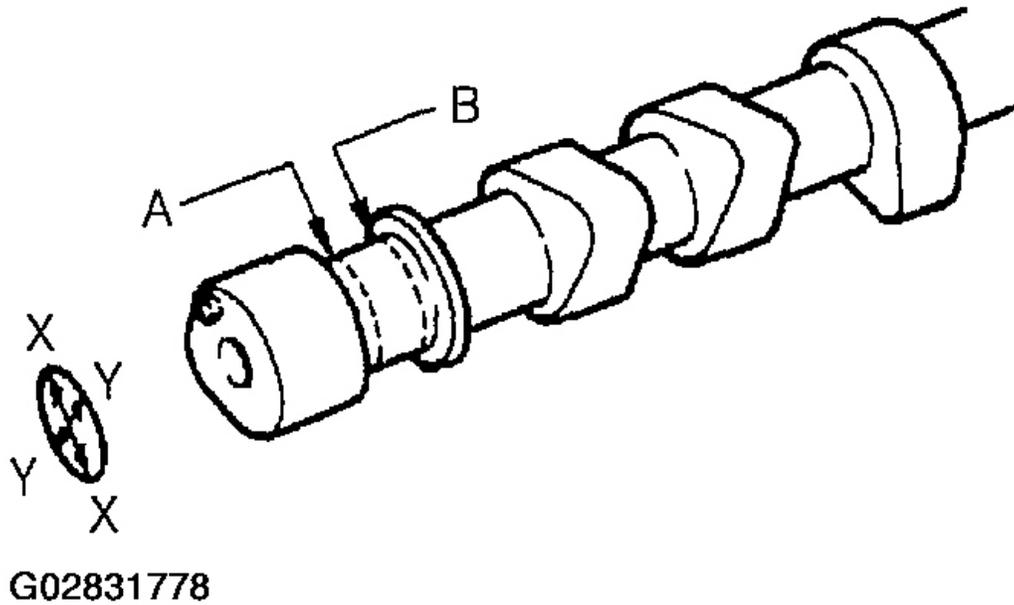
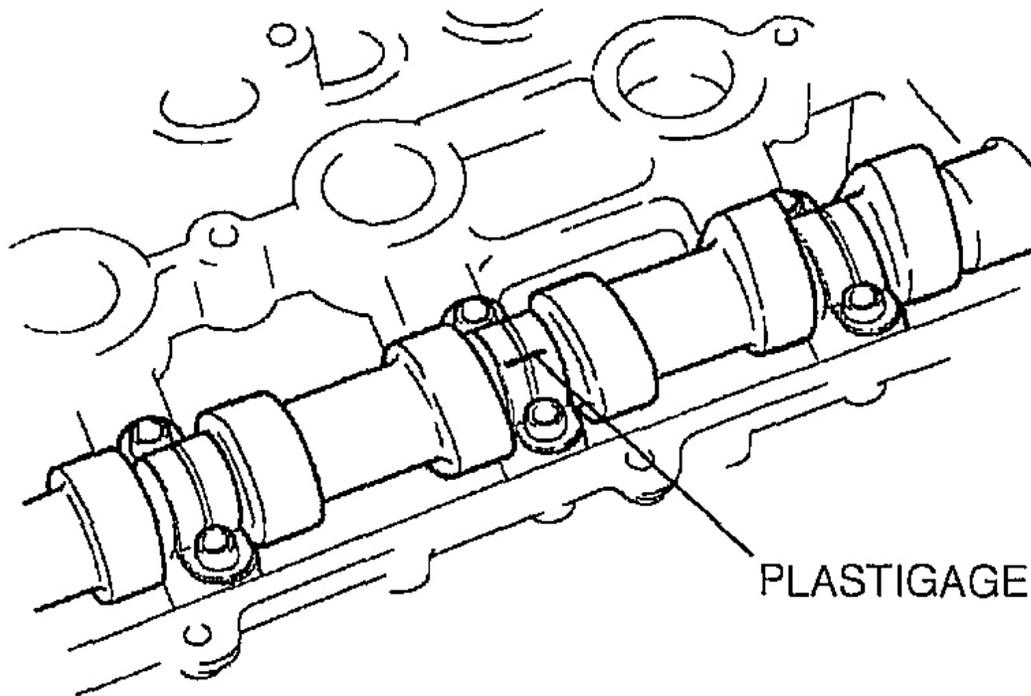


Fig. 98: Measuring Journal Diameter
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT OIL CLEARANCE INSPECTION

1. Position a plastigage on the top of the journals in the axial direction.



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Fig. 99: Positioning Plastigage On Camshaft Journal
Courtesy of MAZDA MOTORS CORP.

2. Install the camshaft cap. (Refer to ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II) , CAMSHAFT DISASSEMBLY NOTE .)
3. Remove the camshaft cap. (Refer to ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II) , CAMSHAFT DISASSEMBLY NOTE .)
4. Measure the oil clearance. Replace the cylinder head as necessary.

Standard Clearance

0.035-0.081 mm {0.0014-0.0031 in}

Maximum Clearance

0.15 mm {0.006 in}

CAMSHAFT END PLAY INSPECTION

1. Install the camshaft cap. (Refer to ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II) , CAMSHAFT DISASSEMBLY NOTE .)

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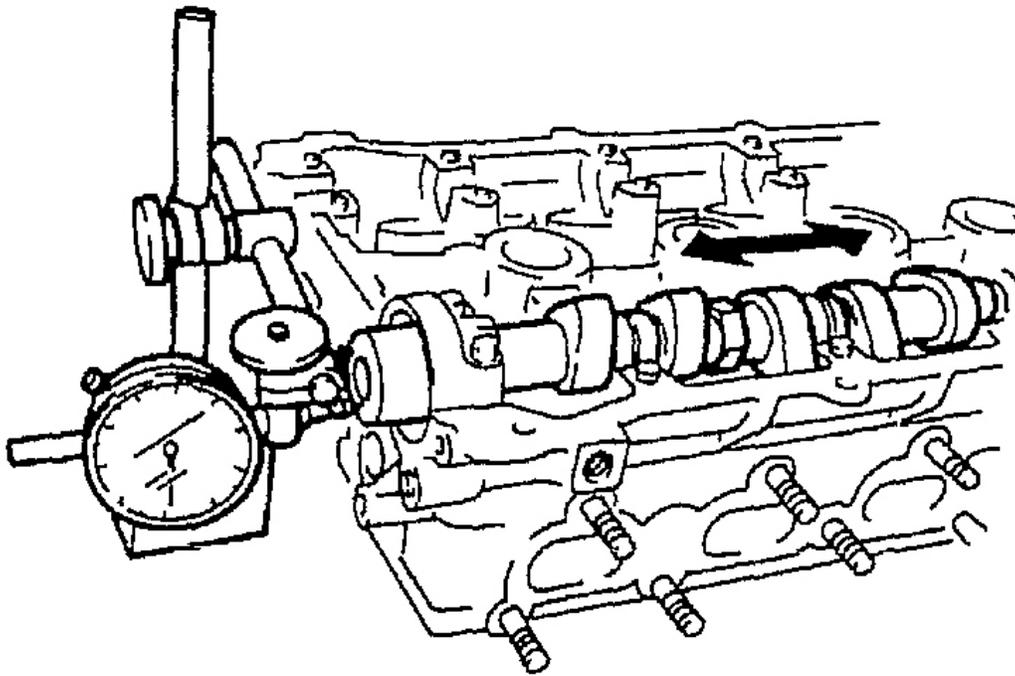
2. Measure the camshaft end play. Replace the cylinder head or camshaft as necessary.

Standard End Play

0.057-0.127 mm {0.0023-0.0049 in}

Maximum End Play

0.20 mm {0.008 in}



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Fig. 100: Measuring Camshaft End Play
Courtesy of MAZDA MOTORS CORP.

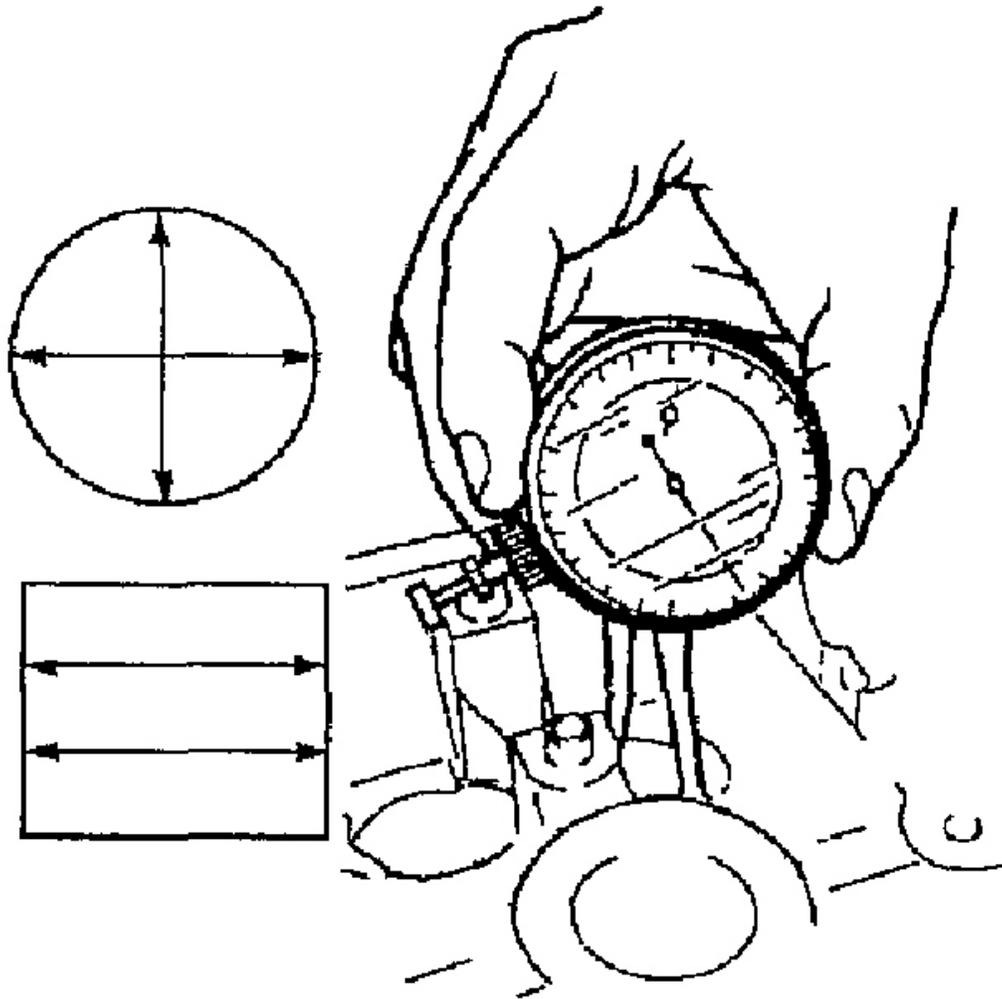
3. Remove the camshaft cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY** , **CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II)** , **CAMSHAFT DISASSEMBLY NOTE** .)

TAPPET INSPECTION

1. Measure the diameter of each tappet bore.

Standard Diameter

30.000-30.025 mm {1.1811-1.1820 in}



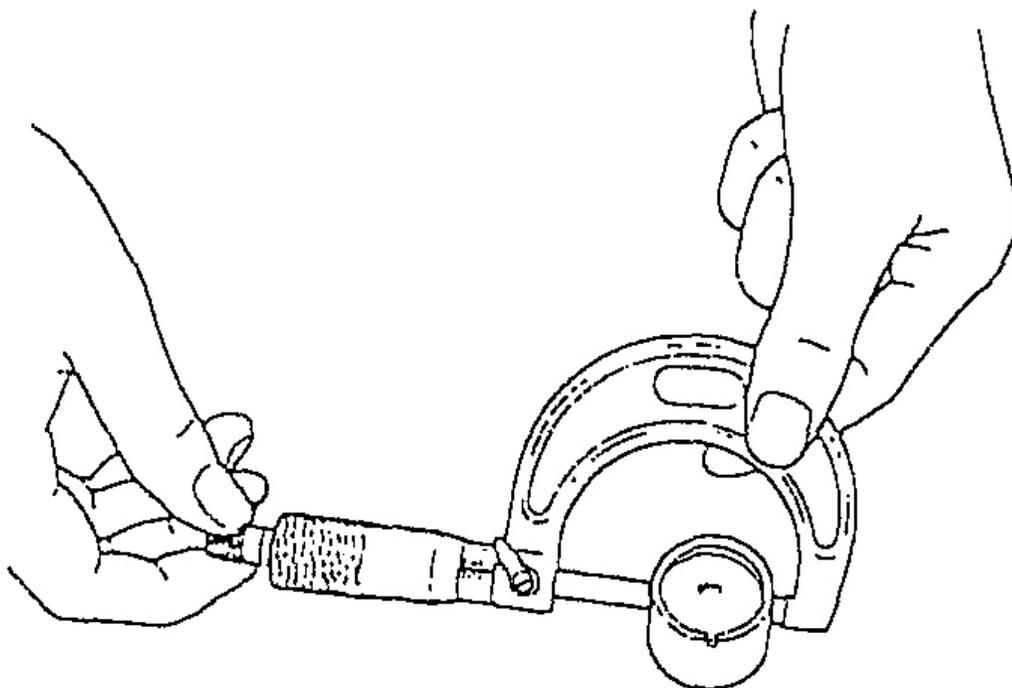
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Fig. 101: Measuring Tappet Bore Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure the diameter of each tappet.

Standard Diameter

29.959-29.975 mm {1.1795-1.1801 in}



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Fig. 102: Measuring Tappet Diameter
Courtesy of MAZDA MOTORS CORP.

3. Calculate the clearance between the tappet and the related tappet bore. Replace the tappet or cylinder head as necessary.

Standard Clearance

0.025-0.066 mm {0.00099-0.00259 in}

Maximum Clearance

0.180 mm {0.0071 in}

CYLINDER BLOCK INSPECTION/REPAIR

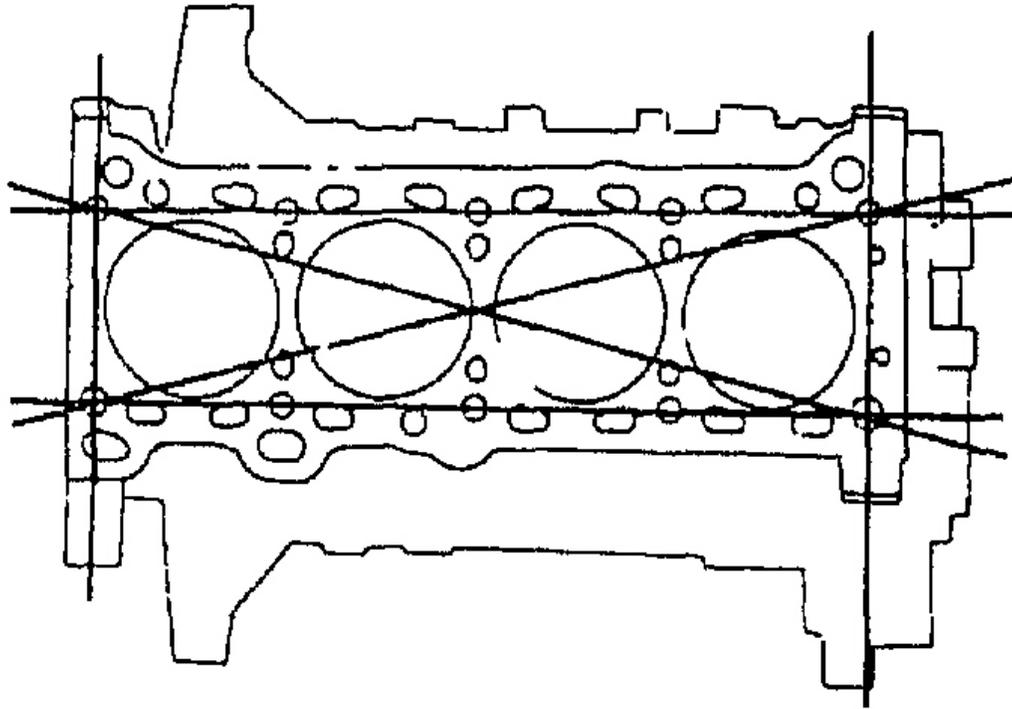
1. Measure the distortion of the cylinder block top surface in the six directions as shown. Repair by grinding or replace as necessary.

Cylinder Block Distortion

0.15 mm {0.006 in} max.

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Fig. 103: Cylinder Block Top Surface Distortion Measurement Directions
Courtesy of MAZDA MOTORS CORP.

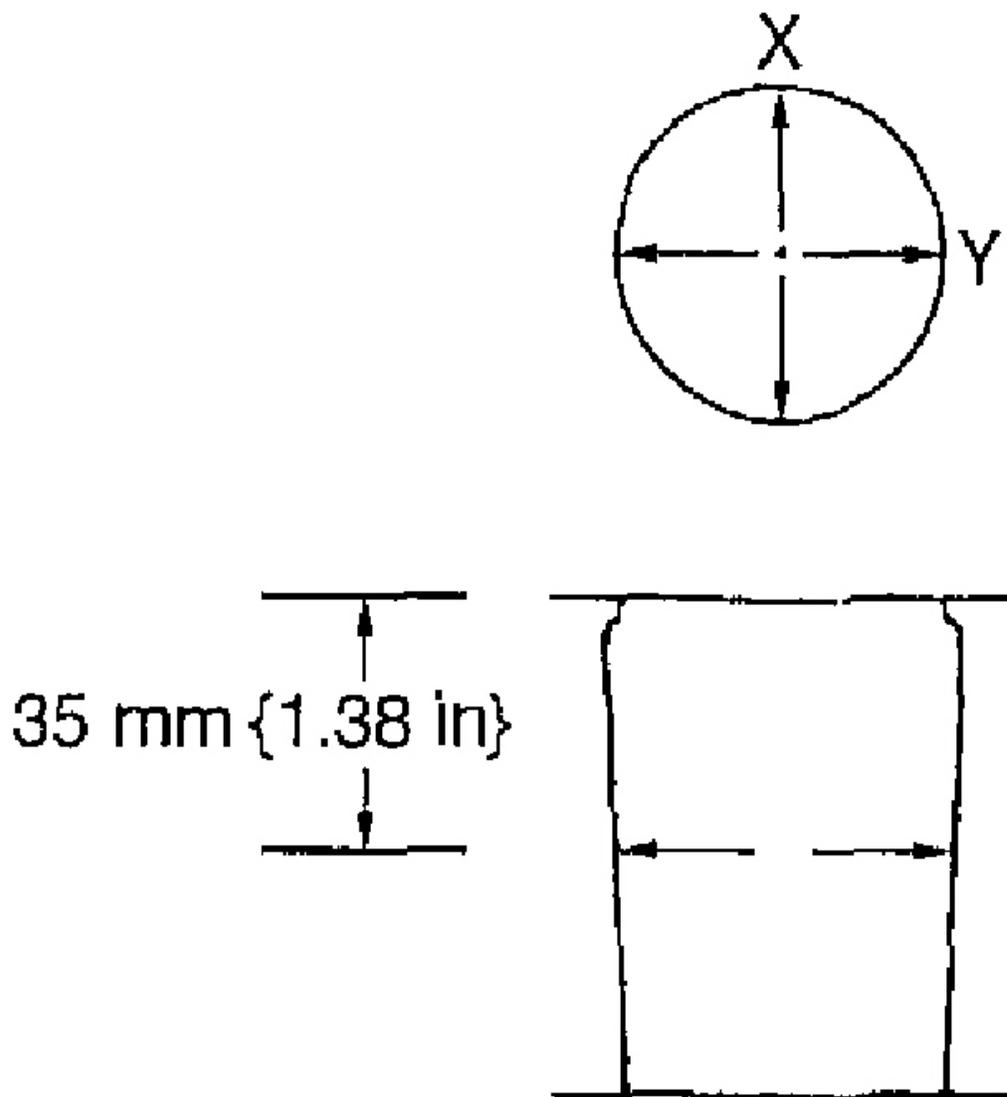
Cylinder Block Height

221.5 mm {8.720 in}

Grinding

0.20 mm {0.008 in} max.

2. Measure the cylinder bores in X and Y directions at **35 mm {1.38 in}** below the top surface.



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Fig. 104: Measuring Cylinder Bores
Courtesy of MAZDA MOTORS CORP.

NOTE:

- Base the boring diameter on the diameter of an oversize piston. All cylinders must be the same diameter.

3. If the cylinder bore exceeds the wear limit, replace the cylinder block or bore the cylinder and install

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the oversize pistons so that the specified piston-to-cylinder clearance is obtained.

CYLINDER BORE

CYLINDER BORE SPECIFICATIONS

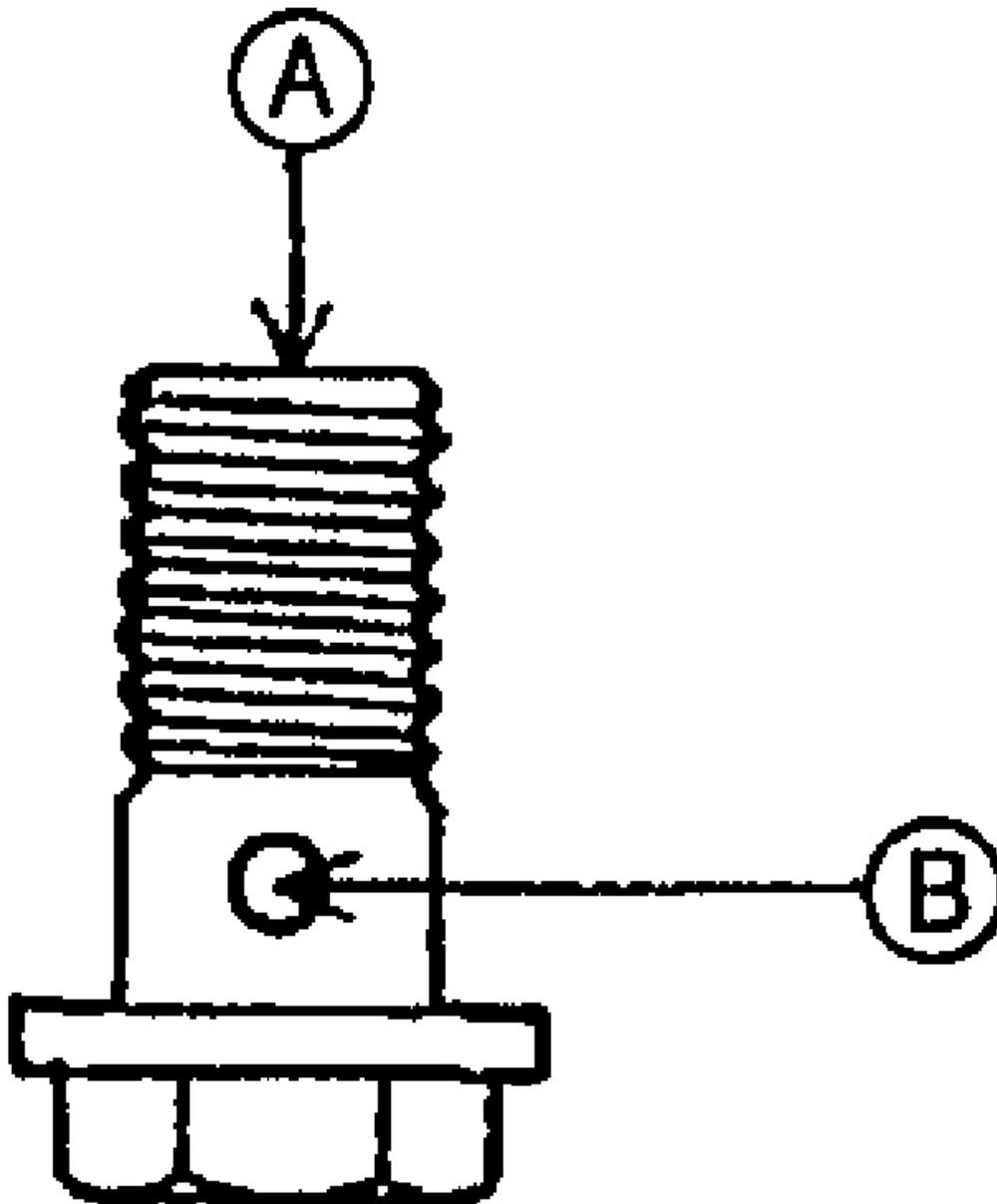
Size - mm {in}	Diameter - mm {in}
Standard	83.000-83.019 {3.2678-3.2684}
0.25 {0.01} oversize	83.250-83.269 {3.2776-3.2783}
0.50 {0.02} oversize	83.500-83.519 {3.2874-3.2881}

Wear Limit

0.15 mm {0.006 in}

OIL JET INSPECTION

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



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Fig. 105: Identifying Oil Jet Valve Ports
Courtesy of MAZDA MOTORS CORP.

Air Pressure

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167-225 kPa {1.7-2.3 kgf/cm² , 25-32 psi}

2. Inspect the oil jet nozzle for clogs. Replace the nozzle as necessary.

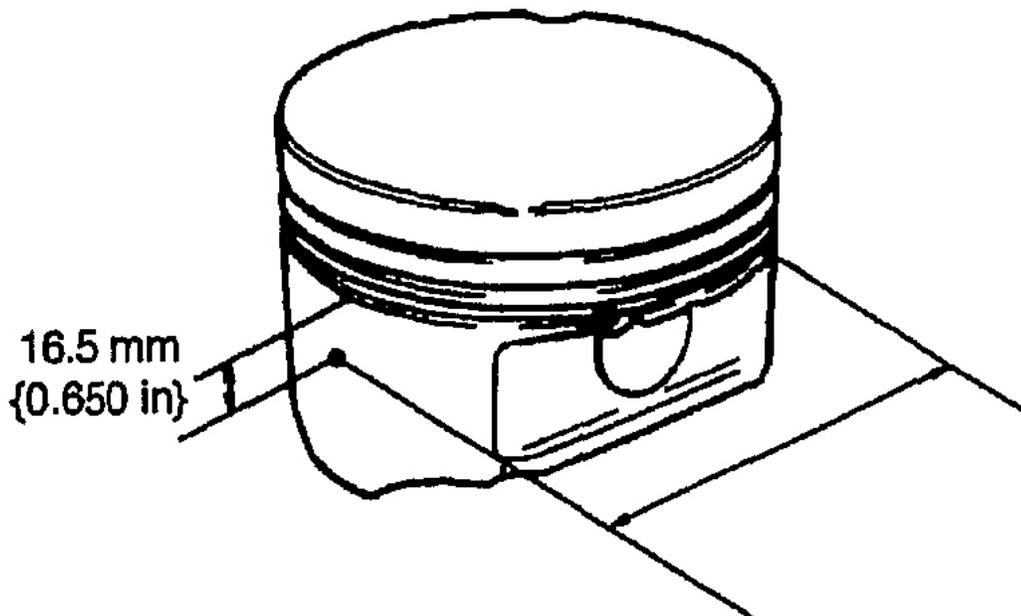
PISTON INSPECTION

- Measure the outer diameter of each piston at right angle (90 °) to the piston pin, **16.5 mm {0.650 in}** below the oil ring groove lower edge.

Piston Diameter

PISTON DIAMETER SPECIFICATIONS

Size - mm {in}	Diameter - mm {in}
Standard	82.953-82.975 {3.2659-3.2667}
0.25 {0.01} oversize	83.203-83.225 {3.2758-3.2765}
0.50 {0.02} oversize	83.453-83.475 {3.2856-3.2864}



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Fig. 106: Measuring Piston Diameter
Courtesy of MAZDA MOTORS CORP.

PISTON CLEARANCE INSPECTION/REPAIR

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1. Calculate the piston-to-cylinder clearance.

Replace the piston or rebore the cylinders to fit oversize piston as necessary.

Standard Clearance

0.025-0.066 mm {0.0010-0.0025 in}

Maximum Clearance

0.15 mm {0.006 in}

2. If the piston is replaced, the piston rings must also be replaced.

PISTON RING CLEARANCE INSPECTION

1. Measure the piston ring-to-ring land clearance around the entire circumference. Replace the piston and piston ring as necessary.

Standard Clearance

Top : 0.030-0.065 mm {0.0012-0.0025 in}

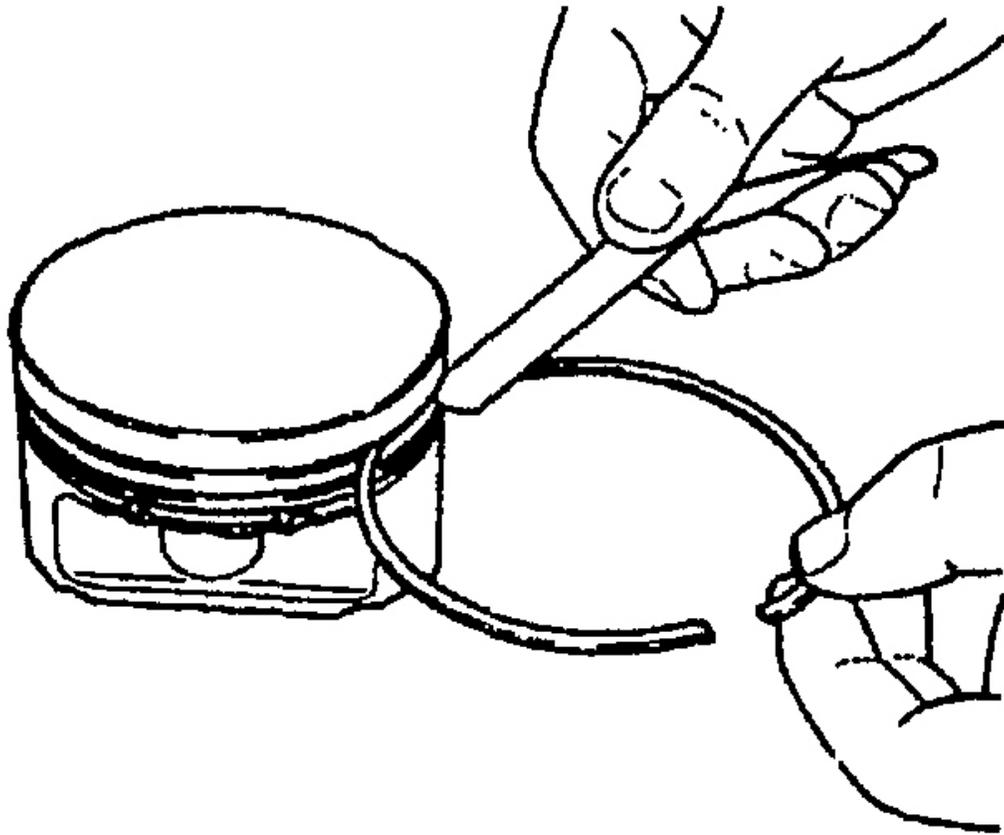
Second : 0.030-0.070 mm {0.0012-0.0027 in}

Oil : 0.07-0.16 mm {0.003-0.006 in}

Maximum Clearance

Top, Second : 0.15 mm {0.006 in}

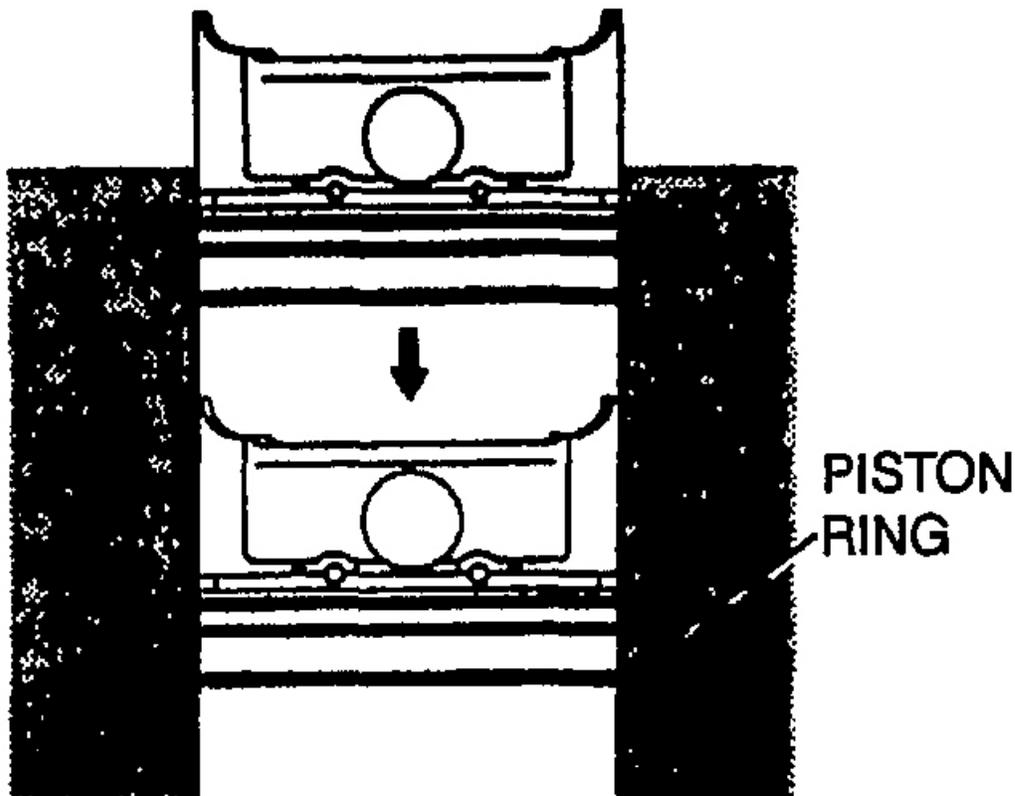
Oil : 0.20 mm {0.008 in}



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Fig. 107: Measuring Piston Ring-To-Ring Land Clearance
Courtesy of MAZDA MOTORS CORP.

2. Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.



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Fig. 108: Pushing Ring To Bottom Of Ring Travel
Courtesy of MAZDA MOTORS CORP.

3. Measure each piston ring end gap by using a feeler gauge. Replace the piston ring as necessary.

Standard End Gap

- Top : 0.15-0.30 mm {0.006-0.011 in}
- Second : 0.30-0.45 mm {0.012-0.017 in}
- Oil rail : 0.20-0.70 mm {0.008-0.027 in}

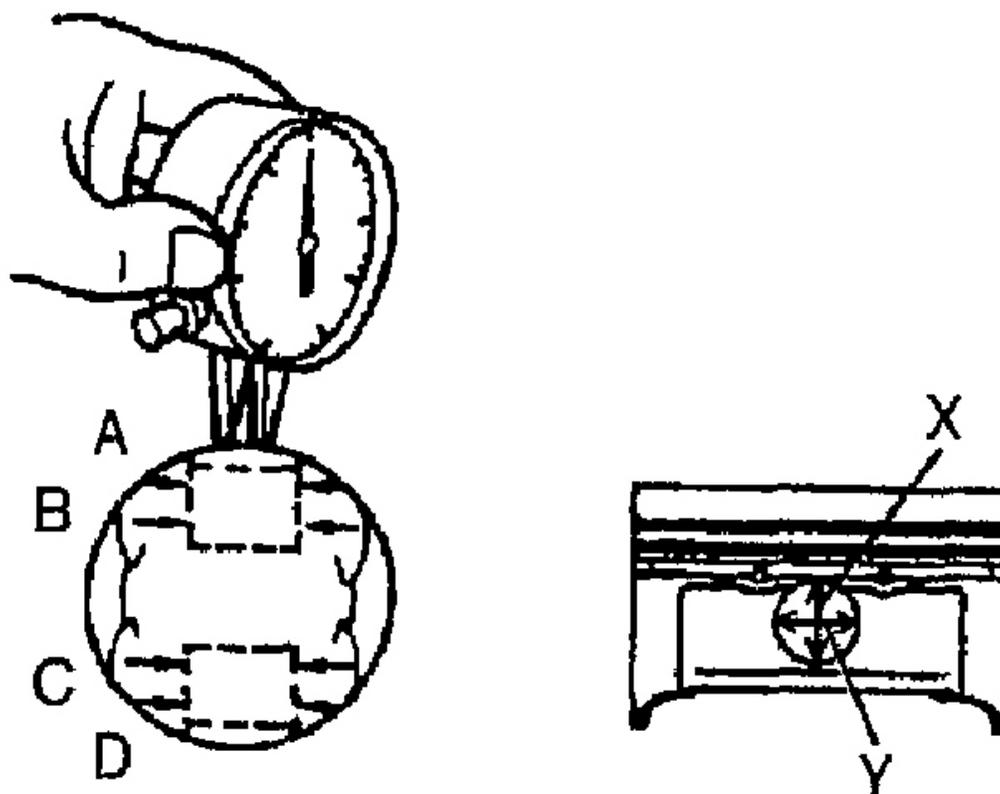
Maximum End Gap

- 1.0 mm {0.039 in}

1. Measure each piston pin hole diameter in X and Y directions at the four points (A, B, C, and D) as shown.

Standard Diameter

19.988-20.000 mm {0.7870-0.7874 in}



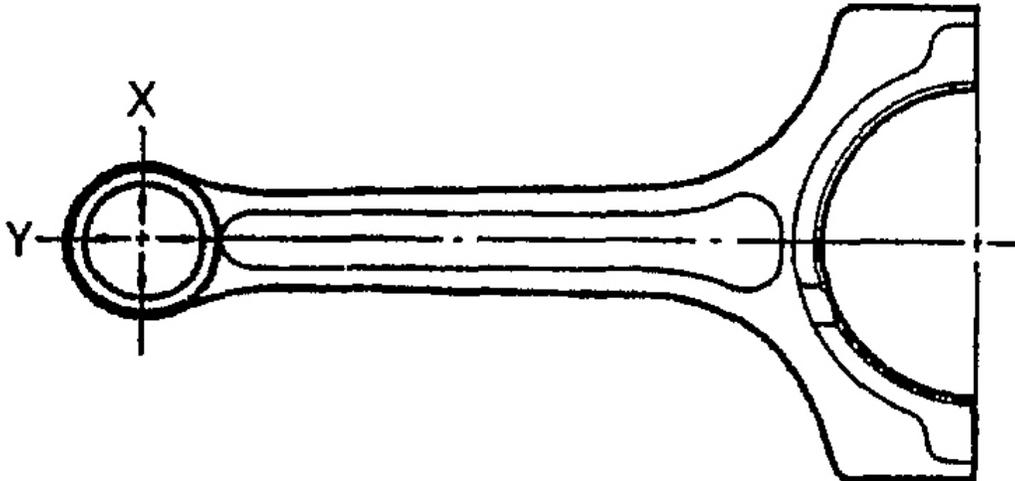
G02831789

Fig. 109: Measuring Piston Pin Hole Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure each connecting rod small end inner diameter in X and Y directions as shown.

Standard Diameter

20.003-20.014 mm {0.7876-0.7879 in}



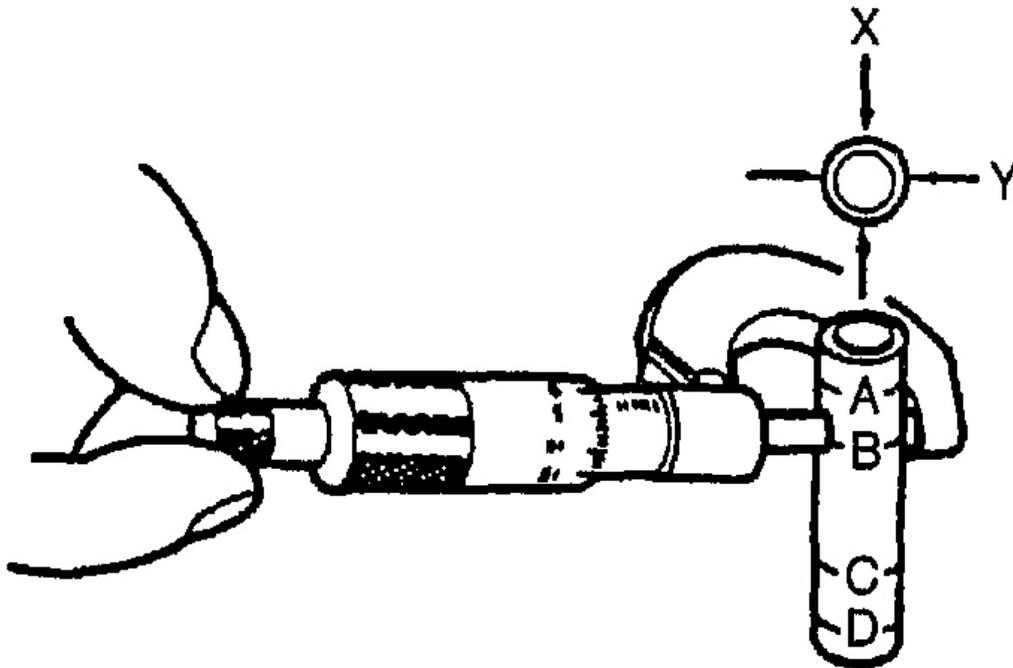
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Fig. 110: Measuring Connecting Rod Small End Inner Diameter
Courtesy of MAZDA MOTORS CORP.

3. Measure each piston pin diameter in X and Y directions at the four points (A, B, C, and D) as shown.

Standard Diameter

19.987-19.993 mm {0.7869-0.7871 in}



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Fig. 111: Measuring Piston Pin Diameter
Courtesy of MAZDA MOTORS CORP.

4. Calculate the piston pin-to-piston pin bore clearance. Replace the piston and/or piston pin as necessary.

Standard Clearance

-0.005-0.013 mm {-0.0002-0.0005 in}

5. Calculate the connecting rod small end-to-piston pin clearance. Replace the connecting rod or piston pin.

Standard Clearance

0.010-0.027 mm {0.004-0.0010 in}

CRANKSHAFT INSPECTION

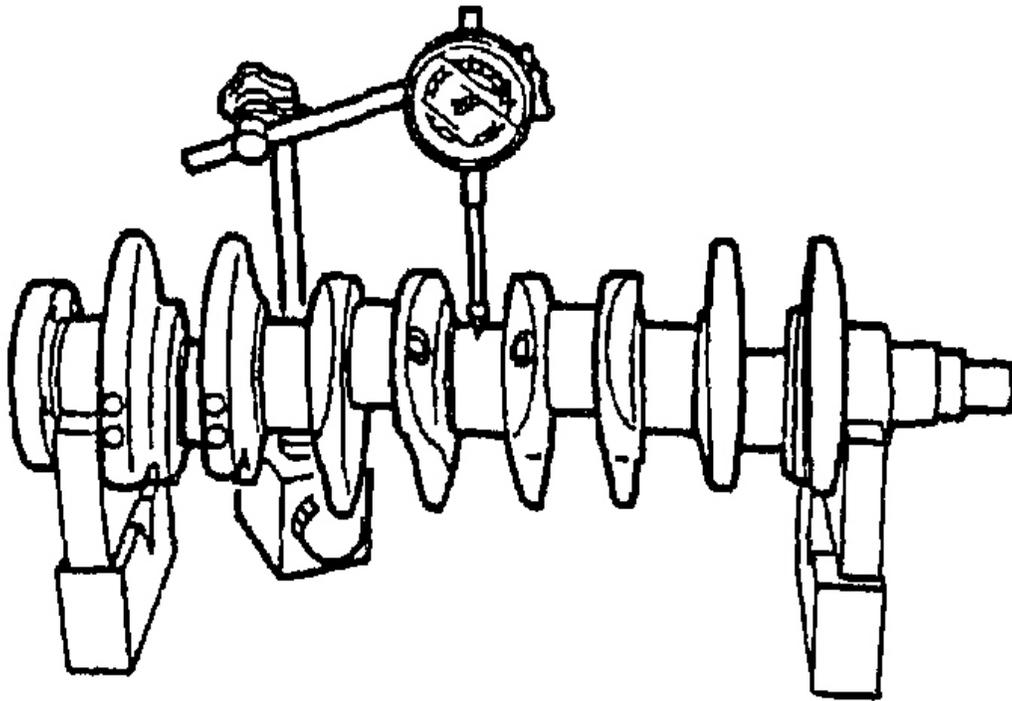
1. Measure the crankshaft runout. Replace the crankshaft as necessary.

Runout

0.04 mm {0.0016 in} max.

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Fig. 112: Measuring Crankshaft Runout
Courtesy of MAZDA MOTORS CORP.

2. Measure the journal diameter in X and Y direction at the two points (A and B) as shown. Replace the crankshaft or grind the journal and install the undersize bearing as necessary.

Main Journal

MAIN JOURNAL BEARING SPECIFICATIONS

Bearing Size - mm {in}	Diameter - mm {in}
Standard	49.938-49.956 {1.9661-1.9667}
0.25 {0.01} Undersize	49.688-49.706 {1.9563-1.9569}
0.50 {0.02} Undersize	49.438-49.456 {1.9464-1.9470}
0.75 {0.03} Undersize	49.188-49.206 {1.9366-1.9372}

Out-of-Round

0.05 mm {0.002 in} max.

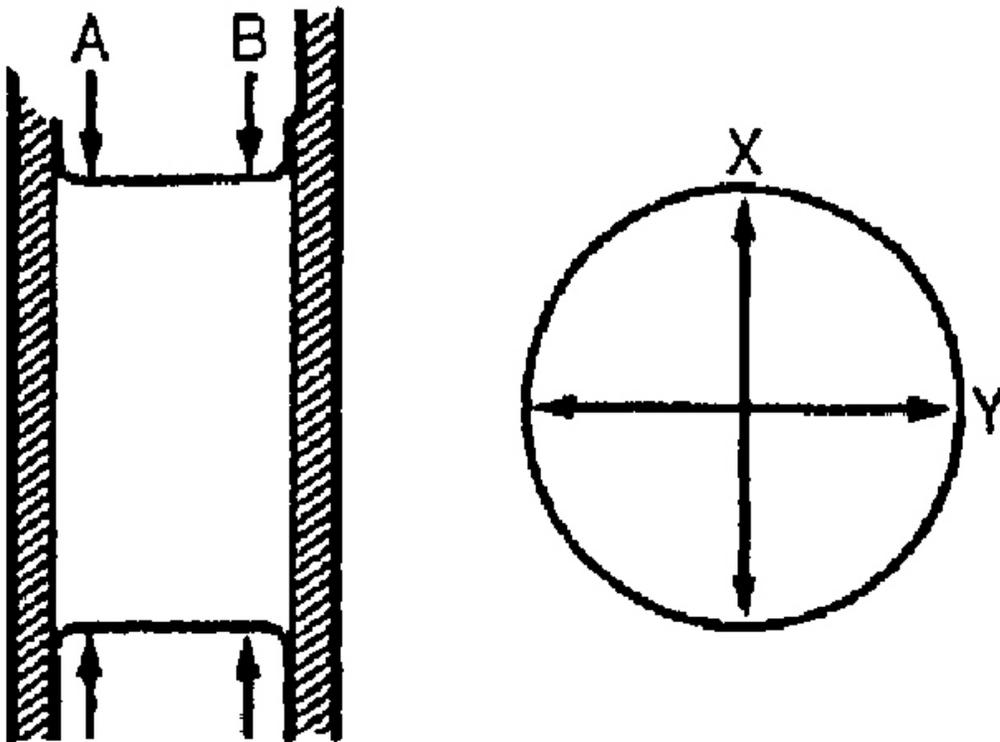
Crank Pin

CRANK PIN BEARING SPECIFICATIONS

Bearing Size - mm {in}	Diameter - mm {in}
Standard	44.940-44.956 {1.7693-1.7699}
0.25 {0.01} Undersize	44.690-44.706 {1.7595-1.7600}
0.50 {0.02} Undersize	44.440-44.456 {1.7497-1.7502}
0.75 {0.03} Undersize	44.190-44.206 {1.7398-1.7403}

Out-of-Round

0.05 mm {0.002 in} max.



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Fig. 113: Measuring Journal Out Of Round
 Courtesy of MAZDA MOTORS CORP.

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CRANKSHAFT OIL CLEARANCE INSPECTION/REPAIR

1. Position plastigage on the top of the journals in the axial direction.
2. Install the main bearing cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY** , **CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II)** , **CAMSHAFT DISASSEMBLY NOTE** .)
3. Remove the main bearing cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY** , **CYLINDER HEAD DISASSEMBLY/ASSEMBLY (II)** , **CAMSHAFT DISASSEMBLY NOTE** .)
4. Measure the main journal oil clearance. If the clearance exceeds the maximum, replace the main bearing or grind the main journal and install the undersize bearings so that the specified oil clearance is obtained.

Standard Clearance

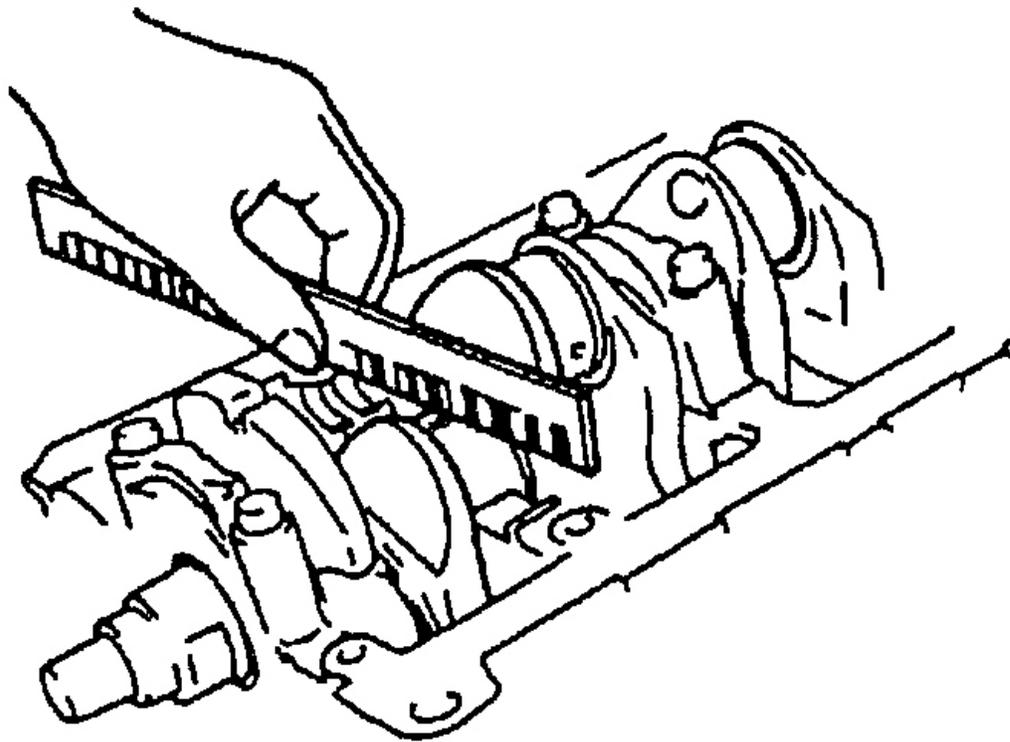
0.018-0.036 mm {0.0008-0.0014 in}

Maximum Clearance

0.10 mm {0.0039 in}

MAIN JOURNAL BEARING SPECIFICATION

Bearing Size - mm {in}	Bearing Thickness - mm {in}
Standard	2.007-2.025 {0.0791-0.0797}
0.25 {0.01} Undersize	2.133-2.137 {0.0840-0.0841}
0.50 {0.02} Undersize	2.258-2.262 {0.0889-0.0890}
0.75 {0.03} Undersize	2.383-2.387 {0.0938-0.0940}



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Fig. 114: Measuring Main Journal Oil Clearance
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT END PLAY INSPECTION/REPAIR

1. Install the main bearing cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (II) , MAIN BEARING CAP ASSEMBLY NOTE** .)
2. Measure the crankshaft end play. If the end play exceeds the maximum, replace the thrust bearing or grind the crankshaft and install an undersize bearing so that the specified end play is obtained.

Standard End Play

0.080-0.282 mm {0.0032-0.0111 in}

Maximum End Play

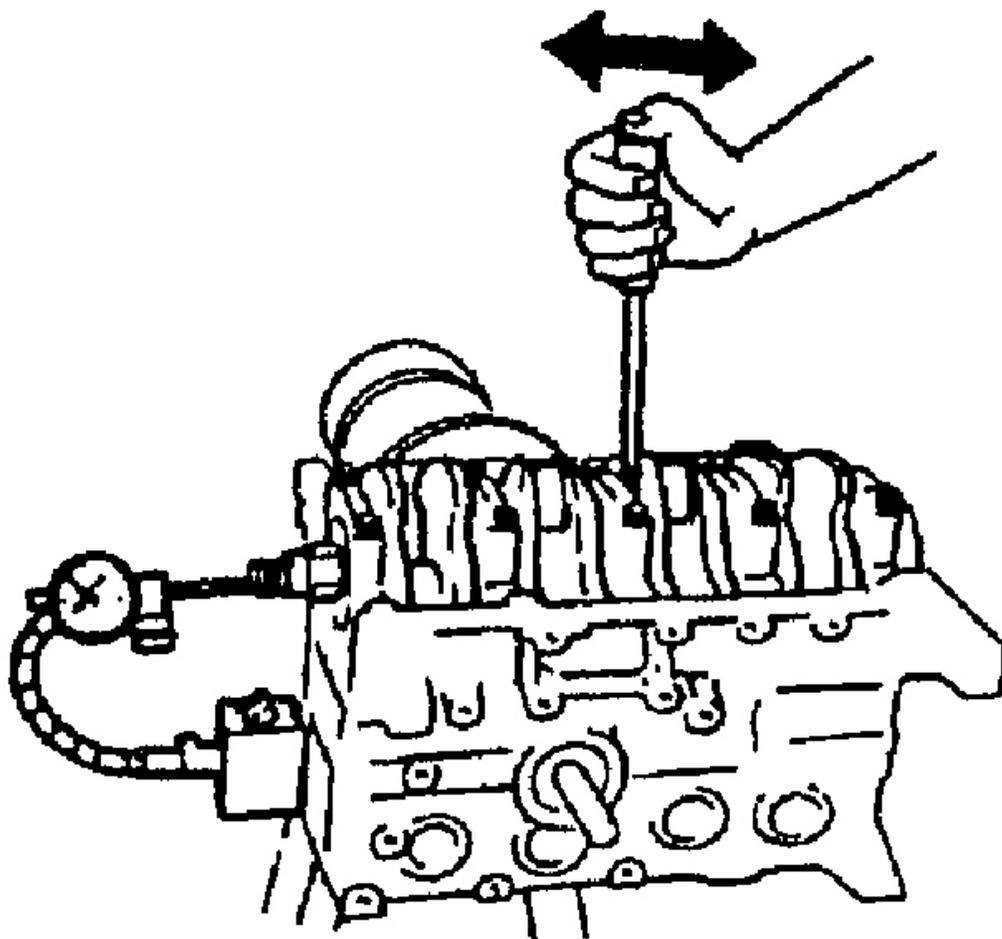
0.30 mm {0.012 in}

THRUST BEARING SPECIFICATION

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2003-05 ENGINE Overhaul - 1.8L (BP) 4-Cylinder - MX-5 Miata

Bearing Size - mm {in}	Bearing Thickness - mm {in}
Standard	2.500-2.550 {0.0985-0.1003}
0.25 {0.01} Undersize	2.625-2.675 {0.1034-0.1053}
0.50 {0.02} Undersize	2.750-2.800 {0.1083-0.1102}
0.75 {0.03} Undersize	2.875-2.925 {0.1132-0.1151}



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Fig. 115: Measuring Crankshaft End Play
Courtesy of MAZDA MOTORS CORP.

3. Remove the main bearing cap. (Refer to ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (II) , MAIN BEARING CAP DISASSEMBLY NOTE .)

CONNECTING ROD INSPECTION

- Measure each connecting rod for bending and distortion. Replace the connecting rod as necessary.

Bending

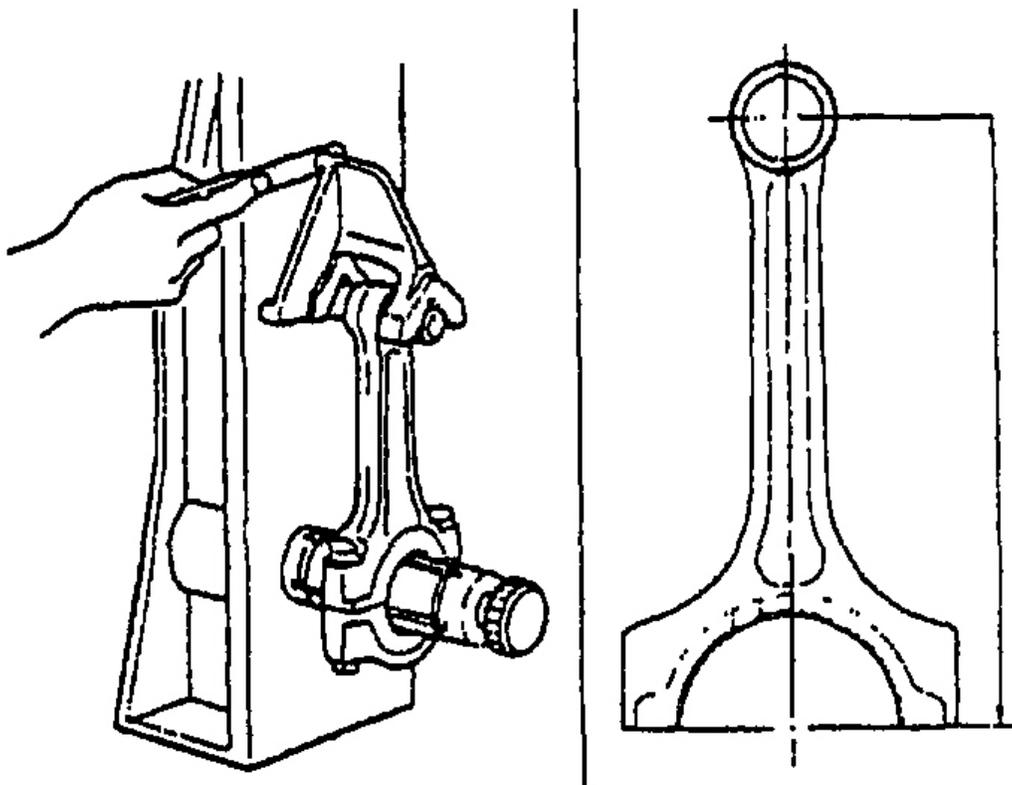
0.05 mm {0.0020 in} max. /50 mm {1.97 in}

Distortion

0.07 mm {0.0028 in} max. /50 mm {1.97 in}

Center-to-Center Distance

132.85-132.95 mm {5.2304-5.2342 in}



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Fig. 116: Measuring Connecting Rod For Bending & Distortion
Courtesy of MAZDA MOTORS CORP.

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CONNECTING ROD OIL CLEARANCE INSPECTION/REPAIR

1. Position a plastigage on the top of the journals in the axial direction.
2. Install the connecting rod cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (II) , PISTON AND CONNECTING ROD ASSEMBLY NOTE .**)
3. Remove the connecting rod cap.
4. Measure the crankpin oil clearance. If the clearance exceeds the maximum, replace the connecting rod bearing or grind the crankpin and use undersize bearings so that the specified clearance is obtained.

Standard Clearance

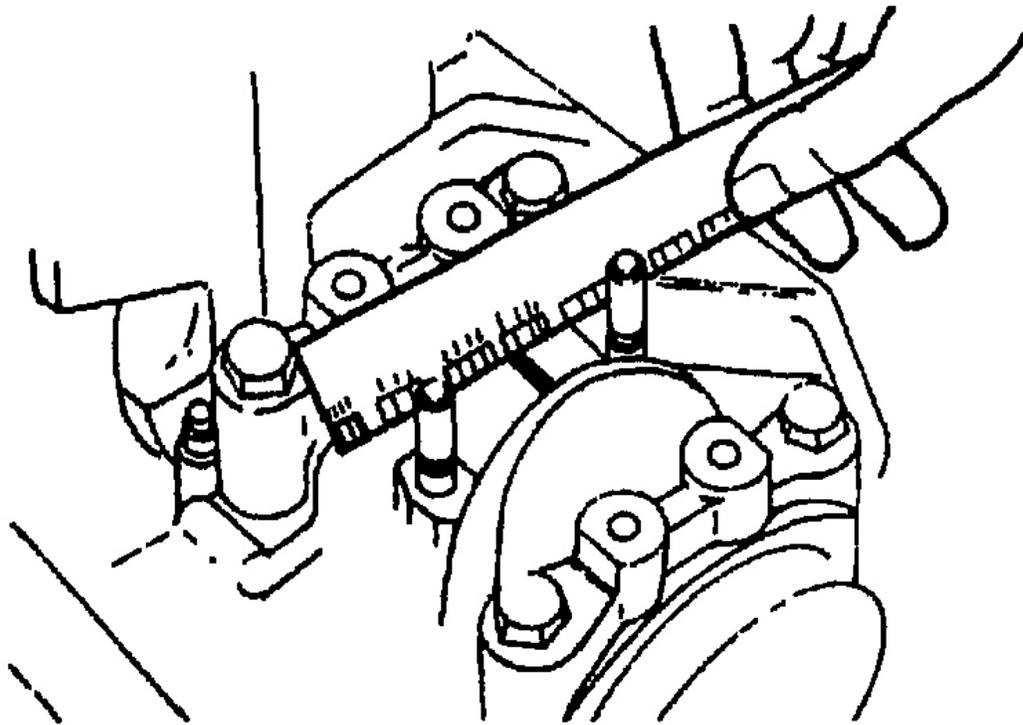
0.028-0.048 mm {0.0012-0.0018 in}

Maximum Clearance

0.10 mm {0.0039 in}

CONNECTING ROD BEARING SPECIFICATIONS

Bearing Size - mm {in}	Bearing Thickness - mm {in}
Standard	1.504-1.520 {0.05922-0.05984}
0.25 {0.01} Undersize	1.631-1.635 {0.06422-0.06436}
0.50 {0.02} Undersize	1.756-1.760 {0.06914-0.06929}
0.75 {0.03} Undersize	1.881-1.885 {0.07406-0.07421}



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Fig. 117: Measuring Crank Pin Rod Oil Clearance
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD SIDE CLEARANCE INSPECTION

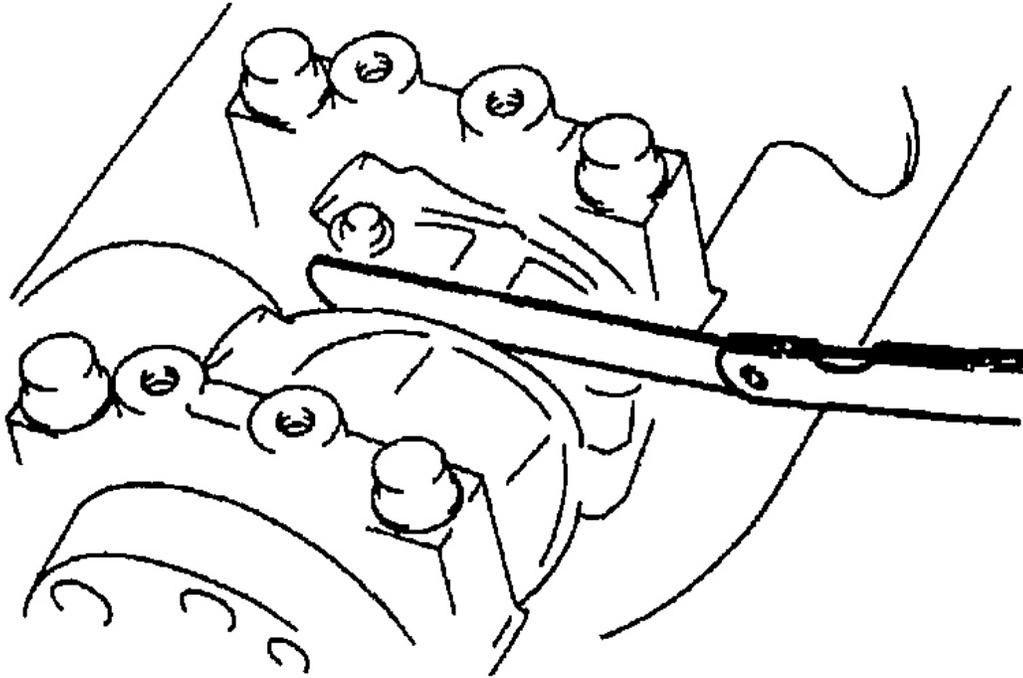
1. Install the connecting rod cap. (Refer to **ENGINE DISASSEMBLY/ASSEMBLY , CYLINDER BLOCK DISASSEMBLY/ASSEMBLY (II) , PISTON AND CONNECTING ROD ASSEMBLY NOTE .**)
2. Measure the connecting rod large end side clearance. Replace the connecting rod and cap as necessary.

Standard Clearance

0.110-0.262 mm {0.005-0.010 in}

Maximum Clearance

0.30 mm {0.012 in}



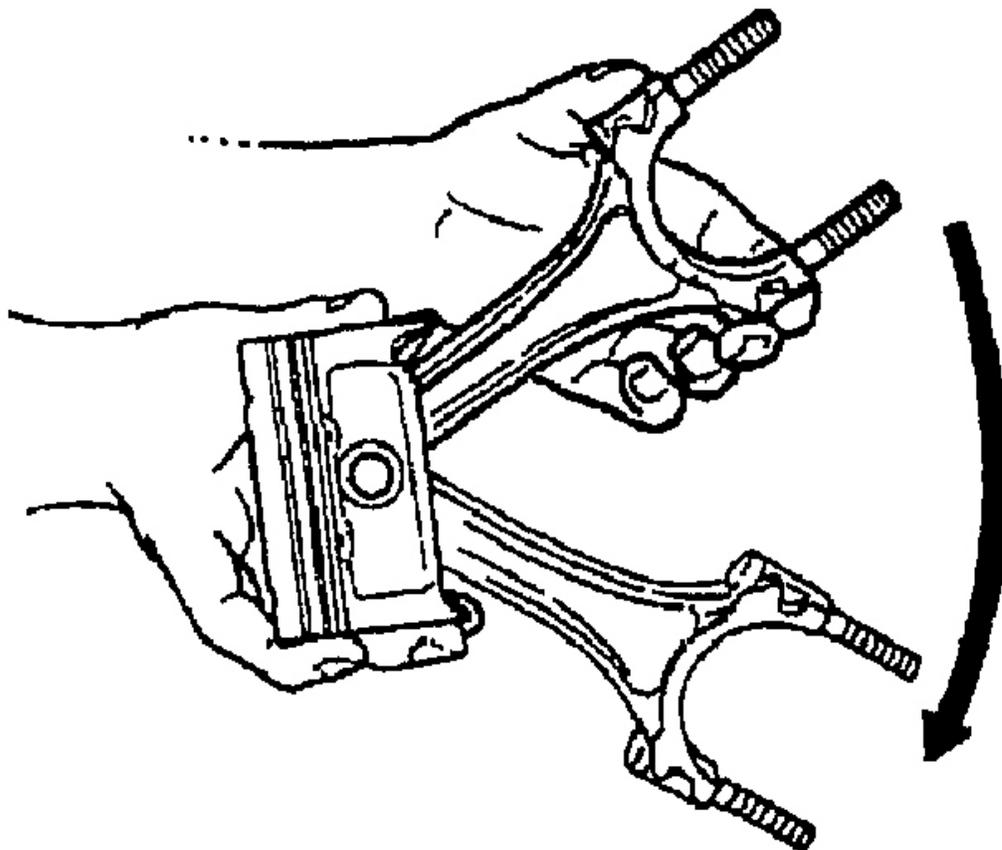
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Fig. 118: Measuring Connecting Rod Clearance
Courtesy of MAZDA MOTORS CORP.

3. Remove the connecting rod cap.

PISTON AND CONNECTING ROD INSPECTION

- Inspect the oscillation torque as shown. If the large end does not drop by its own weight, replace the piston or the piston pin.



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Fig. 119: Inspecting Oscillation Torque
Courtesy of MAZDA MOTORS CORP.

TENSIONER SPRING INSPECTION

- Measure the free length of the tensioner spring. Replace the tensioner spring as necessary.

Free Length

59.2 mm {2.331 in}

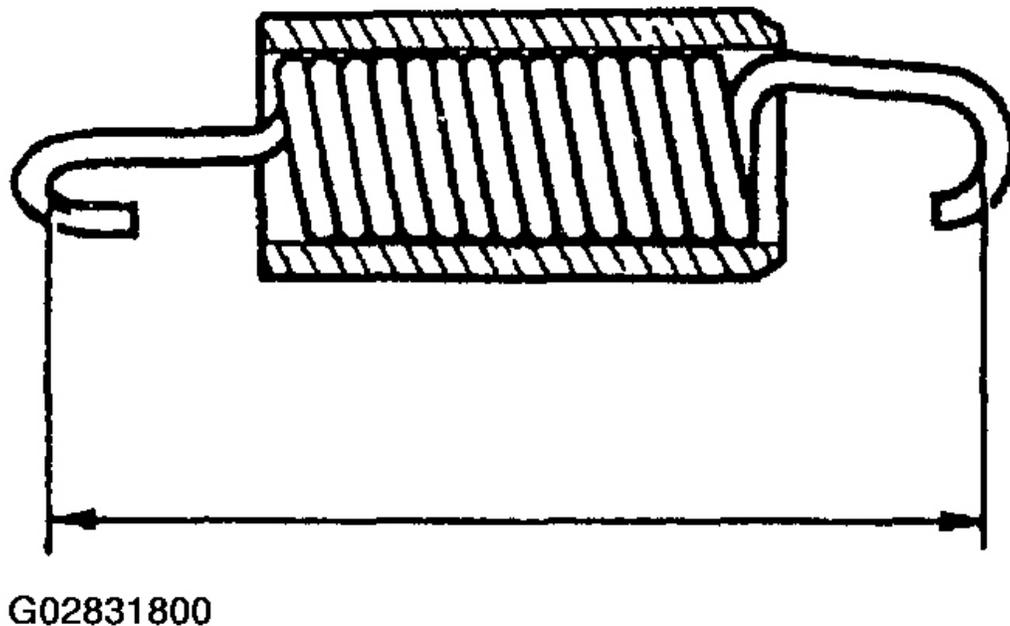


Fig. 120: Measuring Tensioner Spring Free Length
Courtesy of MAZDA MOTORS CORP.

VALVE CLEARANCE INSPECTION

1. Remove the cylinder head cover.
2. Verify that the engine is in cold condition.
3. Measure the valve clearance.
 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.

Standard Valve Clearance [Engine Cold]

IN: 0.18-0.24 mm {0.0071-0.0094 in}

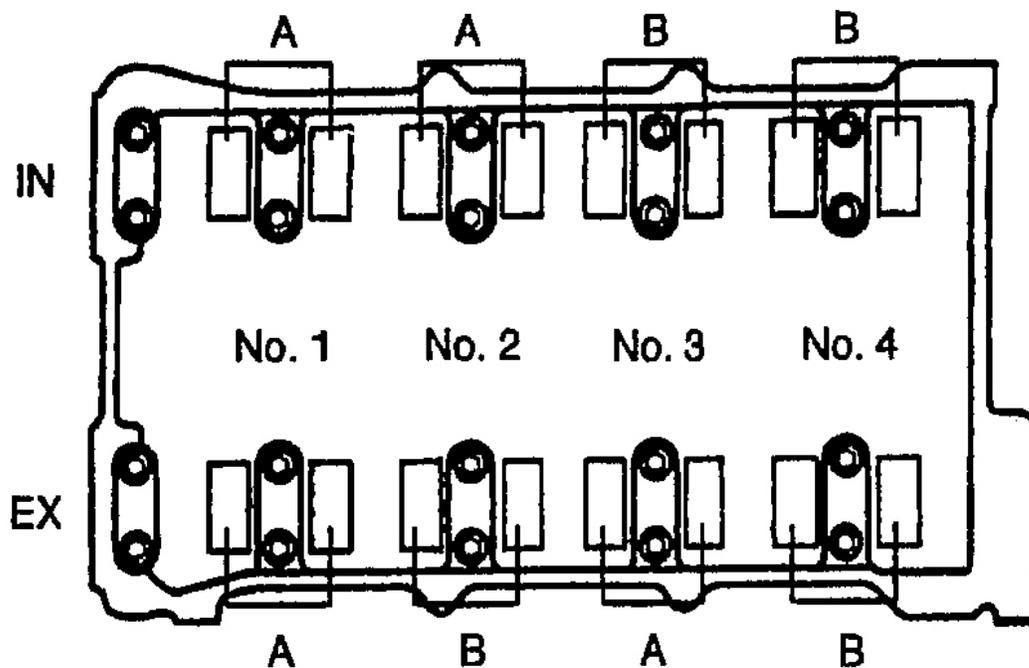
(0.21 +/- 0.03 mm {0.0083 +/- 0.0012 in})

EX: 0.28-0.34 mm {0.0111-0.0133 in}

(0.31 +/- 0.03 mm {0.0122 +/- 0.0012 in})

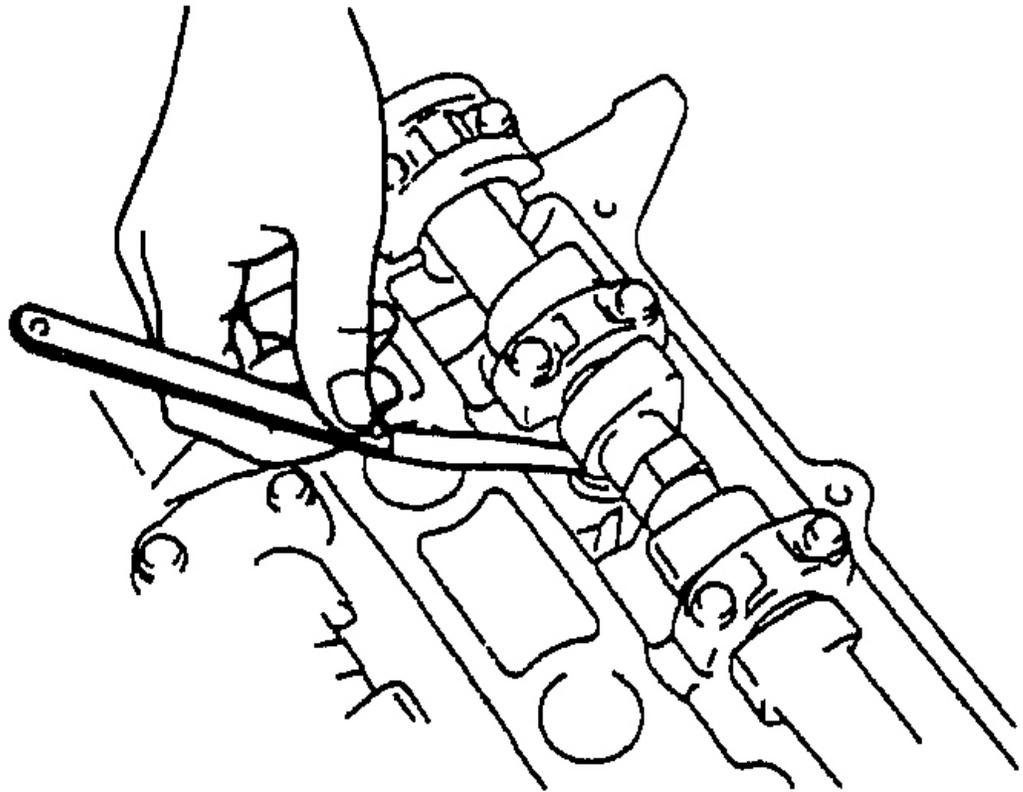
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G02831801

Fig. 121: Identifying Measurement Points
Courtesy of MAZDA MOTORS CORP.



G02831802

Fig. 122: Measuring Valve Clearance
Courtesy of MAZDA MOTORS CORP.

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

Standard Valve Clearance [Engine Cold]

IN: 0.18-0.24 mm {0.0071-0.0094 in}

(0.21 +/- 0.03 mm {0.0083 +/- 0.0012 in})

EX: 0.28-0.34 mm {0.0111-0.0133 in}

(0.31 +/- 0.03 mm {0.0122 +/- 0.0012 in})

6. If the valve clearance exceeds the standard, replace the adjustment shim. (Refer to **VALVE**

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CLEARANCE ADJUSTMENT .)

4. Install the cylinder head cover.

VALVE CLEARANCE ADJUSTMENT

Perform this same procedure for all camshafts requiring valve clearance adjustment.

1. Turn the crankshaft clockwise so that the cams on the camshafts requiring valve clearance adjustment are positioned straight up.
2. Remove the camshaft cap bolts as necessary.

Remove only one pair of cap bolts at a time.

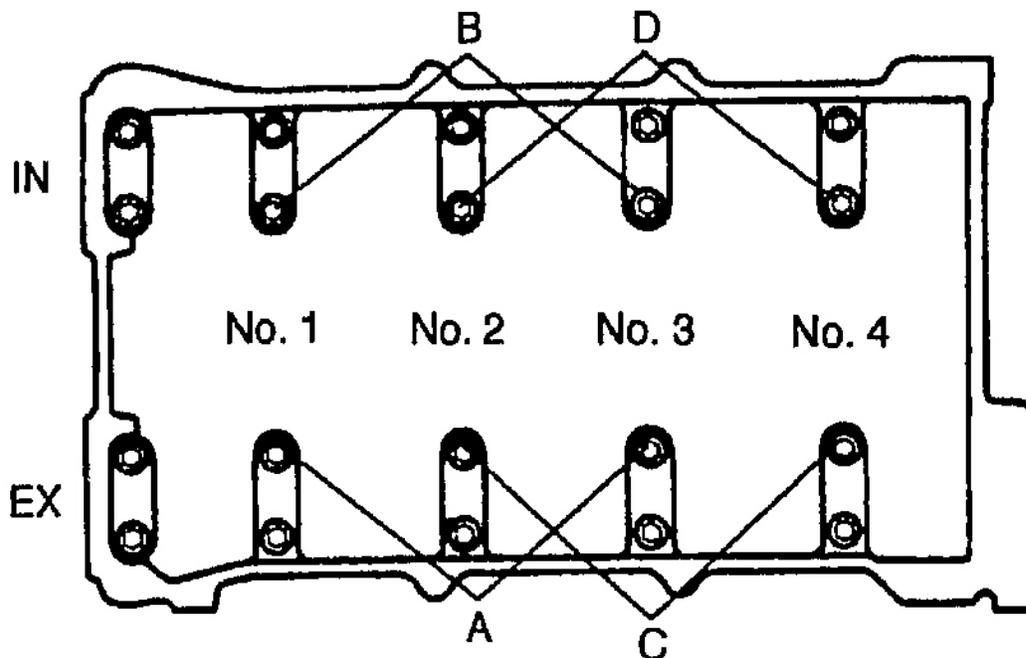
Reinstall the cap bolts before removing the next pair.

A: For EX side No. 1, 2, 3 cylinder adjustment shim removal.

B: For IN side No. 1, 2, 3 cylinder adjustment shim removal.

C: For EX side No. 2, 3, 4 cylinder adjustment shim removal.

C: For IN side No. 2, 3, 4 cylinder adjustment shim removal.



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Fig. 123: Valve Adjustment Identification
Courtesy of MAZDA MOTORS CORP.

NOTE:

- For EX side No.2, 3 cylinder adjustment shim removal, remove bolts either A or C.
- For IN side No.2, 3 cylinder adjustment shim removal, remove bolts either B or D.

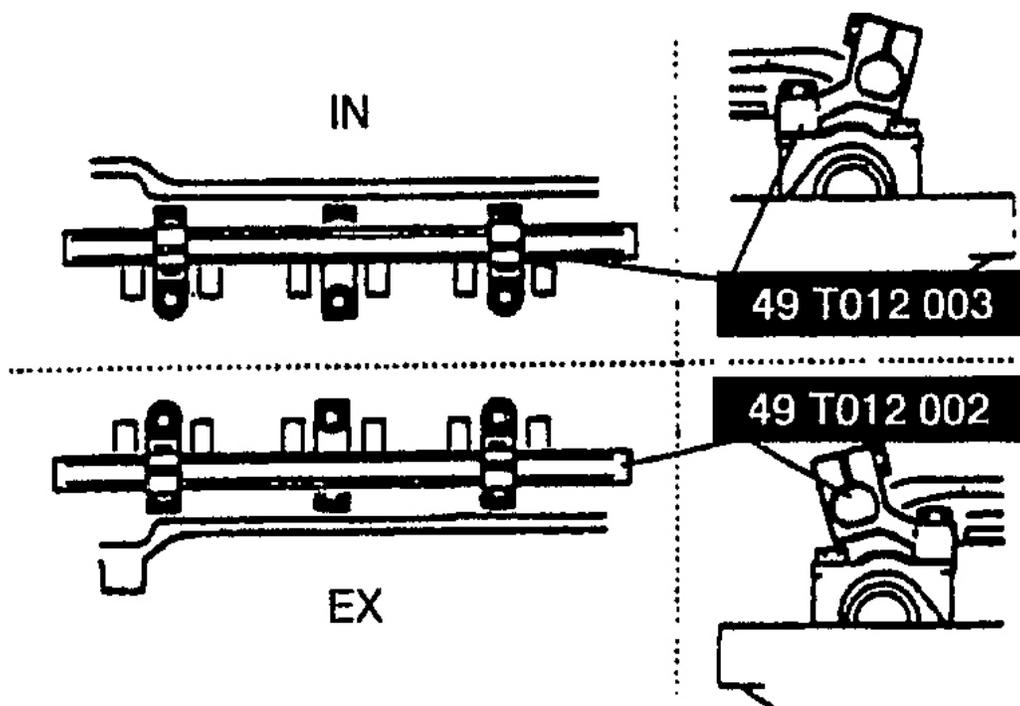
3. Install the SSTs on the camshaft using the camshaft cap bolt holes.

Tightening Torque

11.3-14.2 N.m {115-145 kgf.cm, 100-125 in.lbf}

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Fig. 124: Installing Camshaft SSTs
Courtesy of MAZDA MOTORS CORP.

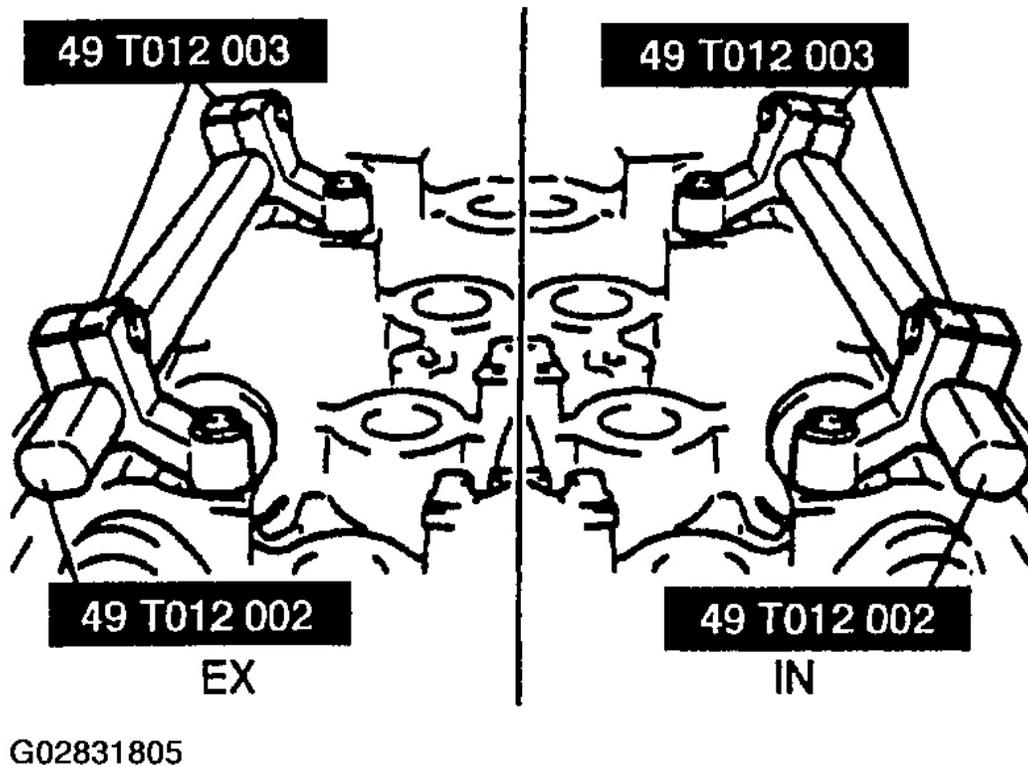
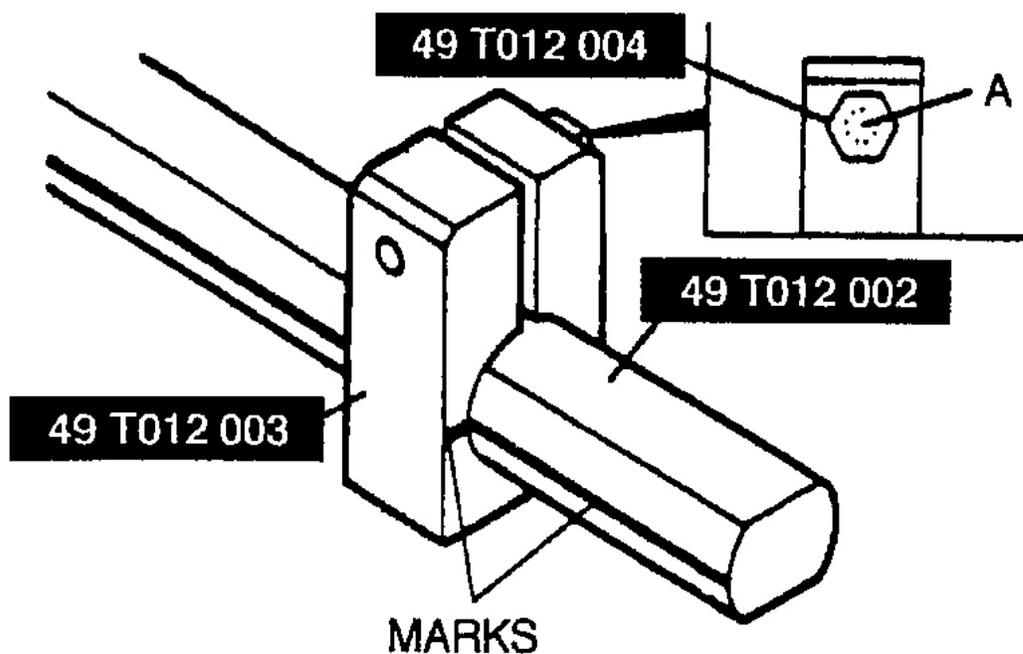


Fig. 125: Installing Camshaft SSTs
Courtesy of MAZDA MOTORS CORP.

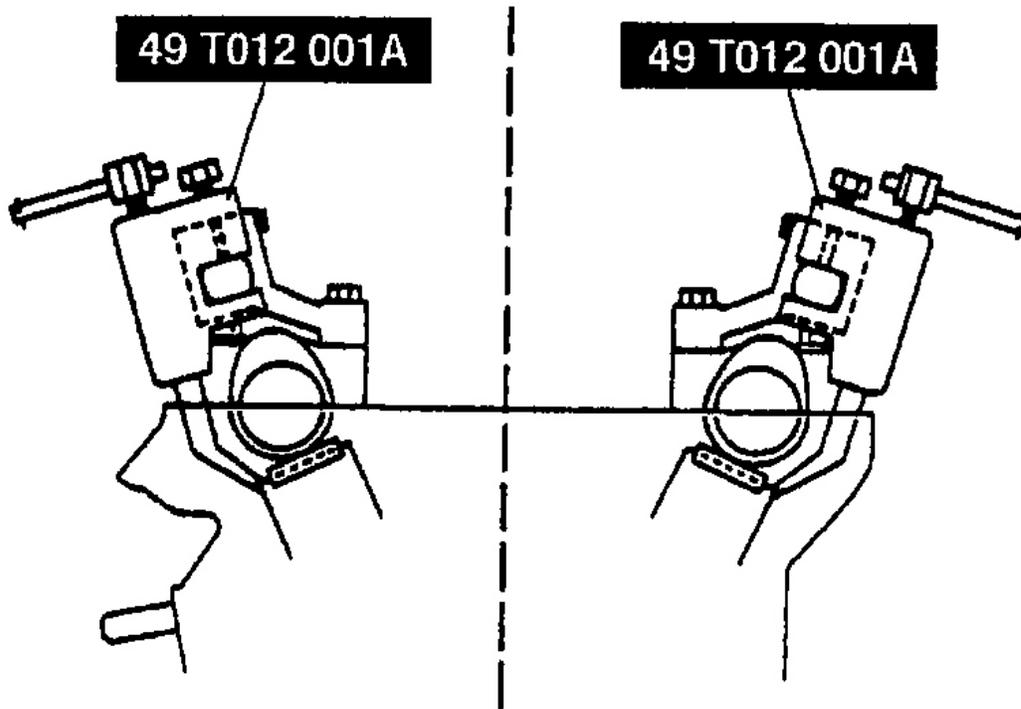
4. Align the marks on the SSTs (shaft and shaft clamp).
5. Tighten bolts A to secure the SST (shaft).



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Fig. 126: Identifying SST Bolt A
Courtesy of MAZDA MOTORS CORP.

6. Face the SST (body) outside of the cylinder head, and mount it on the SST (shaft) at the point of the adjustment shim to be replaced.



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Fig. 127: Mounting SST
Courtesy of MAZDA MOTORS CORP.

7. Face the notch of the tappet so that a fine screwdriver can be installed.

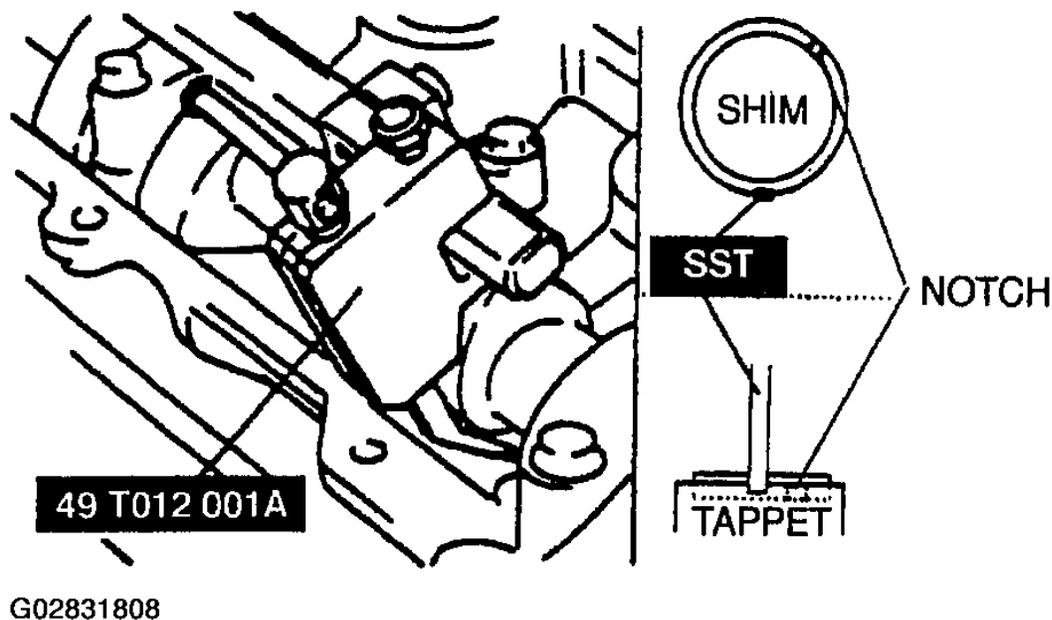
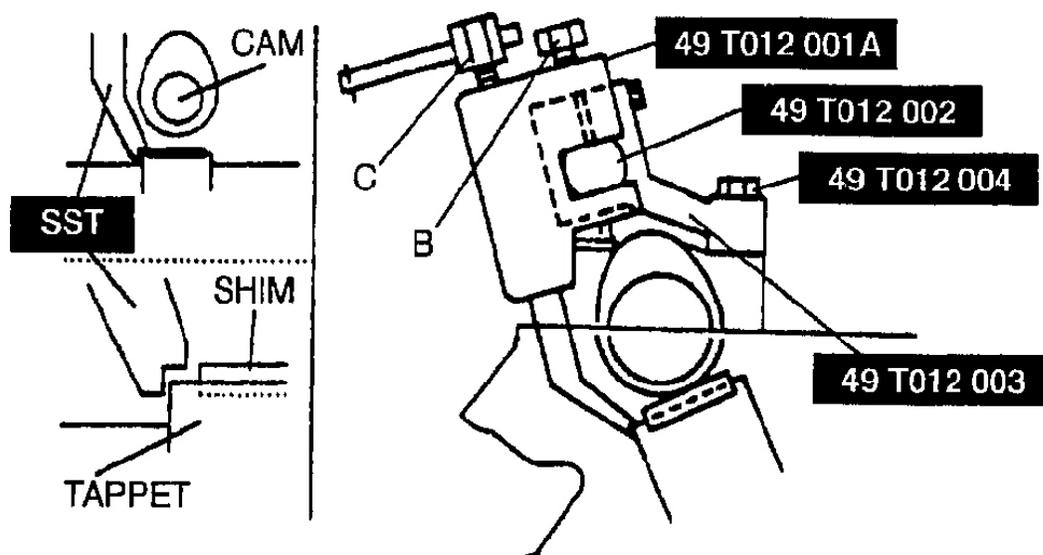


Fig. 128: Identifying Tappet Notch
Courtesy of MAZDA MOTORS CORP.

8. Set the **SST** on the tappet by its notch.
9. Tighten bolt B to secure the **SST** (body).

CAUTION:

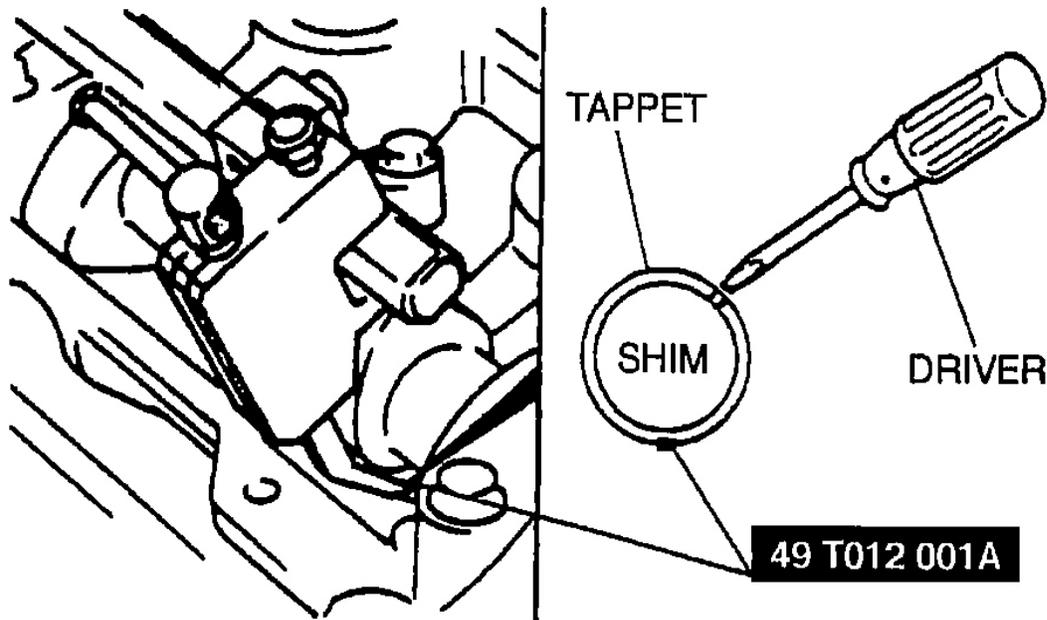
- Cylinder head can be damaged when the tappet is pressed down.



G02831809

Fig. 129: Identifying SST Bolts
 Courtesy of MAZDA MOTORS CORP.

10. Tighten bolt C, and press down the tappet.
11. Using a fine screwdriver, pry up the adjustment shim through the notch on the tappet. Remove the shim by using a magnet.



G02831810

Fig. 130: Prying Up Adjustment Shim
 Courtesy of MAZDA MOTORS CORP.

12. Select proper adjustment shim.

New Adjustment Shim

= Removed Shim Thickness + Measured Valve Clearance - Standard Valve Clearance (IN:
 0.21 mm {0.0111 in}, EX: 0.31 mm {0.0122 in})

13. Push the selected shim into the tappet.
14. Loosen bolt C to allow the tappet to move up.
15. Loosen bolt B and remove the SST (body).
16. Remove the SSTs and tighten the camshaft cap bolts.

Tightening Torque

11.3-14.2 N.m {115-145 kgf.cm, 100-125 in.lbf}

17. Inspect for the valve clearance. (Refer to VALVE CLEARANCE ADJUSTMENT , VALVE CLEARANCE INSPECTION .)

TORQUE SPECIFICATIONS

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TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Pulley Bolt	
Without Variable Valve Timing Actuator	37-44 (50-60)
With Variable Valve Timing Actuator	47-61 (63-83)
Connecting Rod Nuts	35-37 (48-50)
Crankshaft Pulley Bolts	9.1-12.6 (12.3-17.1)
Crankshaft Pulley Boss Bolt	116-122 (157-166)
Cylinder Head Bolts ^{(1) (2)}	56-60 (76-81)
Drive Plate/Flywheel Bolts	72-75 (97-102)
Intake Manifold Nuts	14-18 (19-25)
Lower Oil Control Valve Pipe Bolts ⁽³⁾	
Bolt 1	12-17 (16-23)
Bolt 2	26-35 (35-47)
Bolt 3	(4)
Main Bearing Cap Bolts ^{(1) (5)}	40-43 (54-58)
MBSP Bolts	12-15 (16-21)
Oil Jet Bolt	8.7-12.9 (11.8-17.6)
Oil Pressure Switch	9-13 (11.8-17.6)
Oil Pump Bolts	14-18 (19-25)
Pulley Boss Bolt	116-122 (157-166)
Spark Plug	11-16 (15-22)
Thermostat Housing Bolts	14-18 (19-25)
Timing Belt Pulley Bolt	28-38 (38-51)
Timing Belt Tensioner Bolt	28-38 (38-51)
Water Pump Bolts	14-18 (19-25)
	INCH Lbs. (N.m)
Camshaft Cap Bolts ⁽⁶⁾	100-125 (11.3-14.2)
Cylinder Head Cover Bolts ⁽⁷⁾	44-78 (5-8.8)
End Plate Bolts	69.5-95.4 (7.9-10.7)
Dipstick Tube Bolt	71-97 (8-11)
Oil Control Valve Adapter Bolt	70.8-97.3 (8-11)
Oil Control Valve Case Bolts ⁽⁸⁾	70.8-97.3 (8-11)
Oil Pan Bolts	71-97 (8-11)
Oil Pump Cover Bolts	52.2-77.8 (5.9-8.8)
Oil Strainer Bolts/Nut	69.5-95.4 (7.9-10.7)
Rear Cover Bolt	69.5-95.4 (7.9-10.7)
Seal Plate Bolts ⁽⁹⁾	69.5-95.4 (7.9-10.7)
Timing Case Cover Bolts ⁽¹⁰⁾	69.5-95.4 (7.9-10.7)

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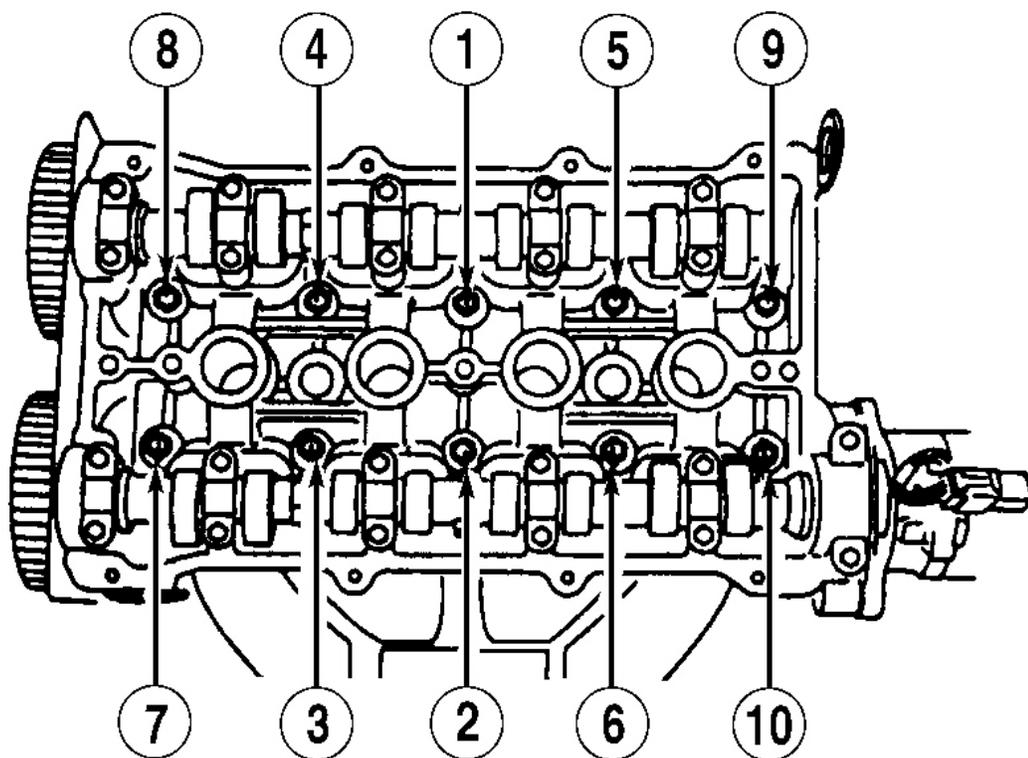
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Upper Oil Control Valve Pipe Bolts ⁽¹¹⁾	69.5-95.4 (7.9-10.7)
Variable Tumble Control System Shutter Valve Bolt	69.5-95.4 (7.9-10.7)
Variable Valve Timing Actuator Cover Bolts	35-53 (4-6)
Water Pump Pulley Bolts	69.5-94.7 (7.9-10.7)

- (1) Tighten to specification in 2 or 3 steps.
- (2) Tighten cylinder head bolts in sequence. See **Fig. 131** .
- (3) Tighten lower oil control valve pipe bolts in sequence. See **Fig. 132** .
- (4) Tighten to 71-97 INCH Lbs. (8-11 N.m).
- (5) Tighten main bearing bolts in sequence. See **Fig. 133** .
- (6) Tighten camshaft cap bolts in sequence. See **Fig. 134** .
- (7) Tighten cylinder head cover bolts in sequence. See **Fig. 135** .
- (8) Tighten oil control valve case assembly bolts in sequence. See **Fig. 136** .
- (9) Tighten seal plate bolts in sequence. See **Fig. 137** .
- (10) Tighten timing case cover bolts in sequence. See **Fig. 138** .
- (11) Tighten upper oil control valve pipe bolts in sequence. See **Fig. 139** .

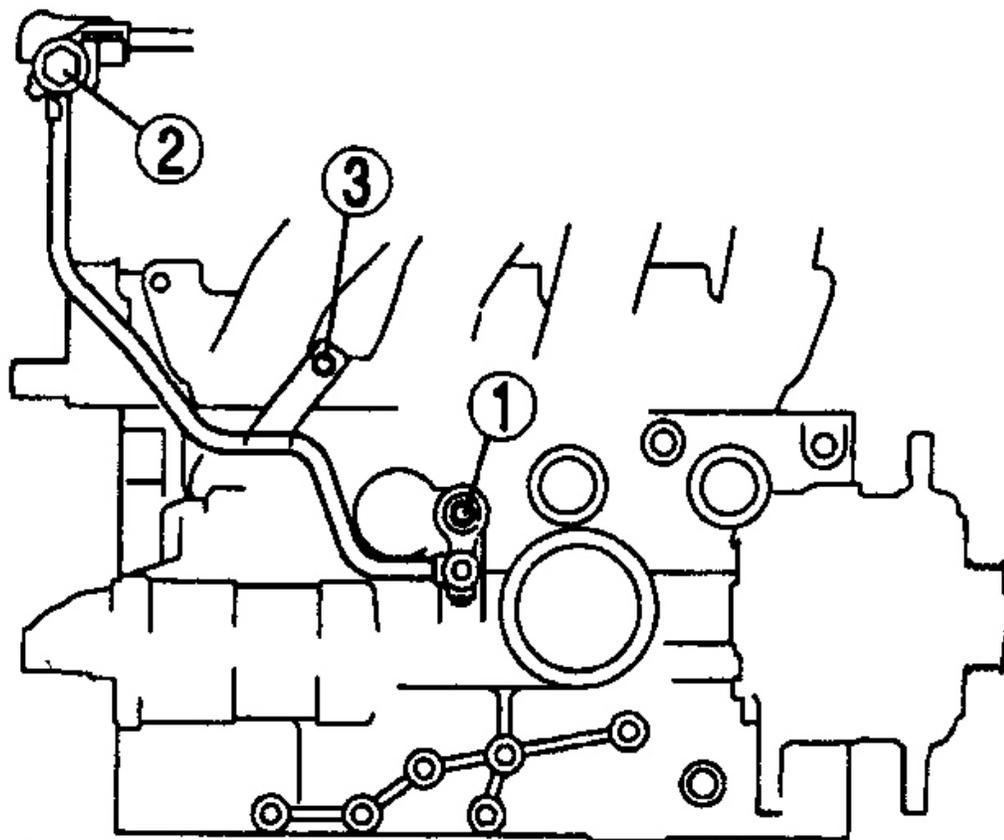
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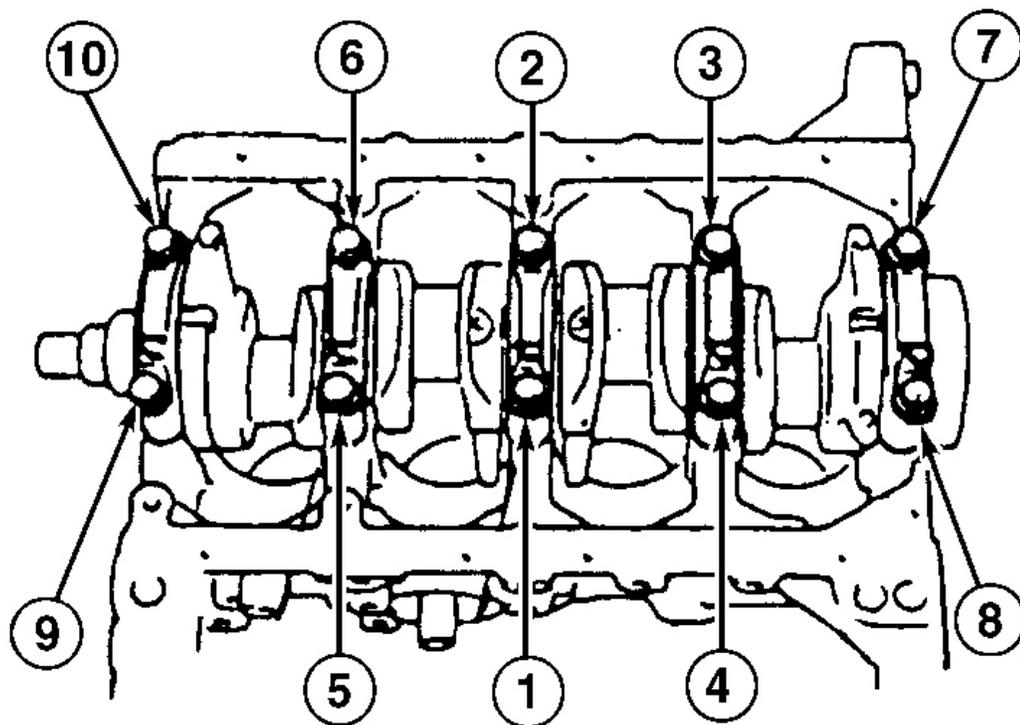
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Fig. 131: Cylinder Head Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.



G00257998

Fig. 132: Lower Oil Control Valve Pipe Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

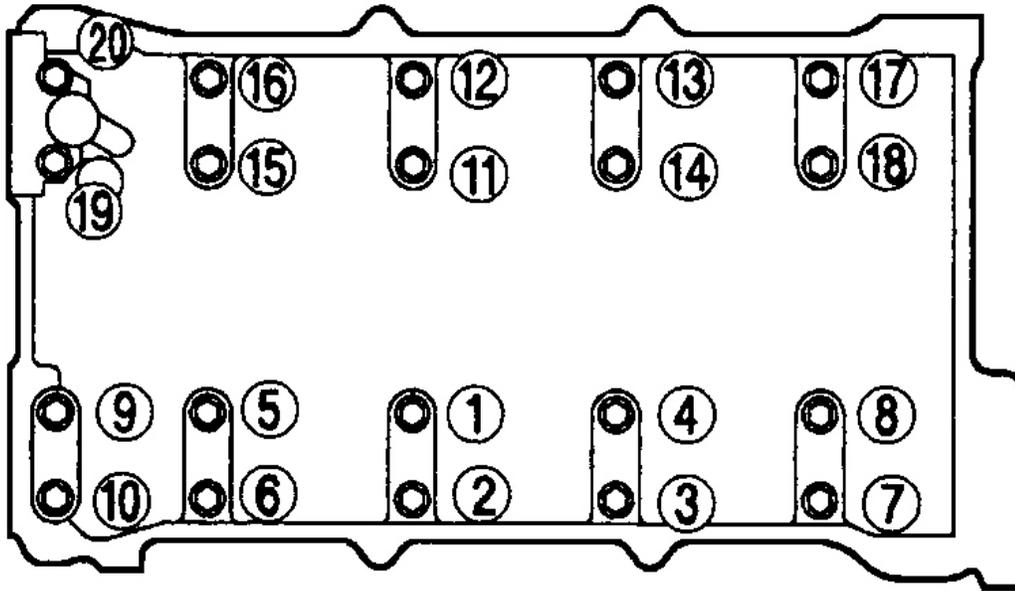


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Fig. 133: Main Bearing Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

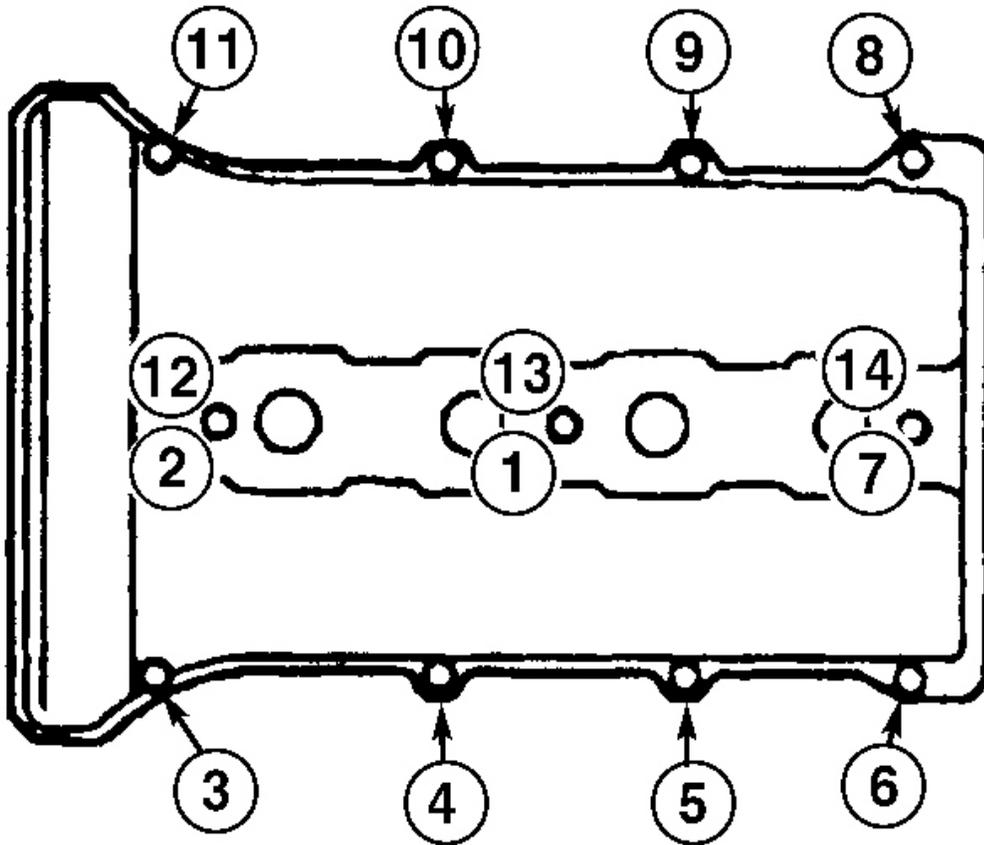
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G00257995

Fig. 134: Camshaft Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.



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Fig. 135: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

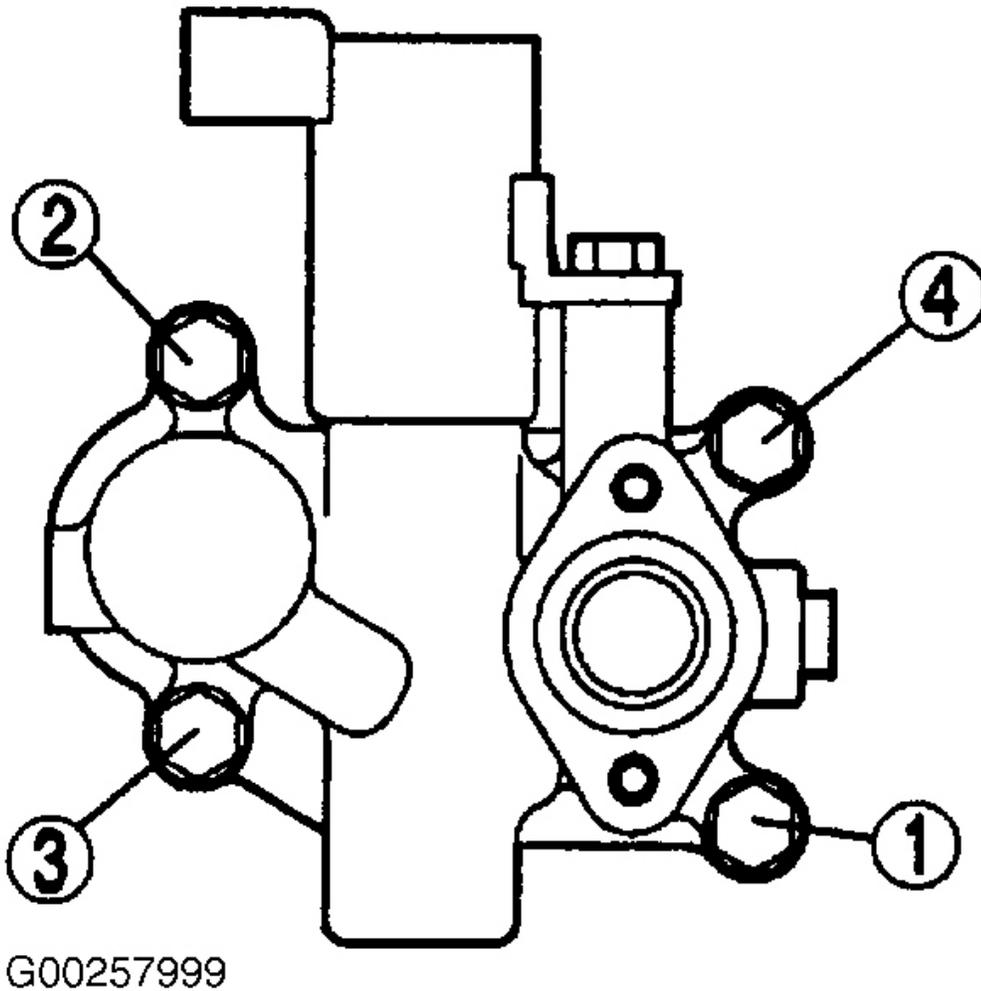
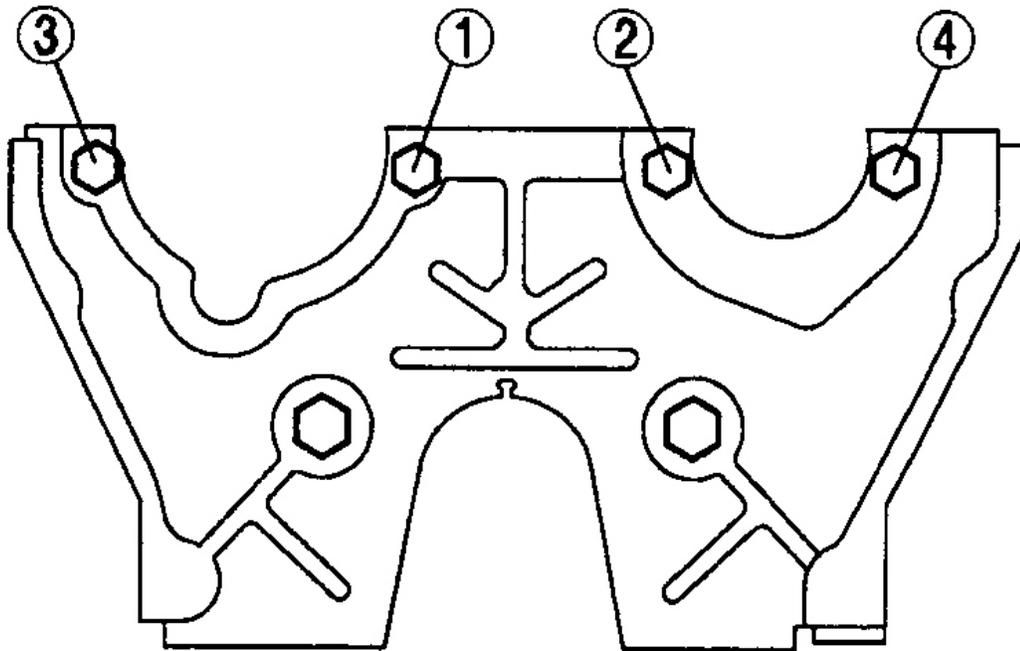


Fig. 136: Oil Control Valve Case Assembly Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

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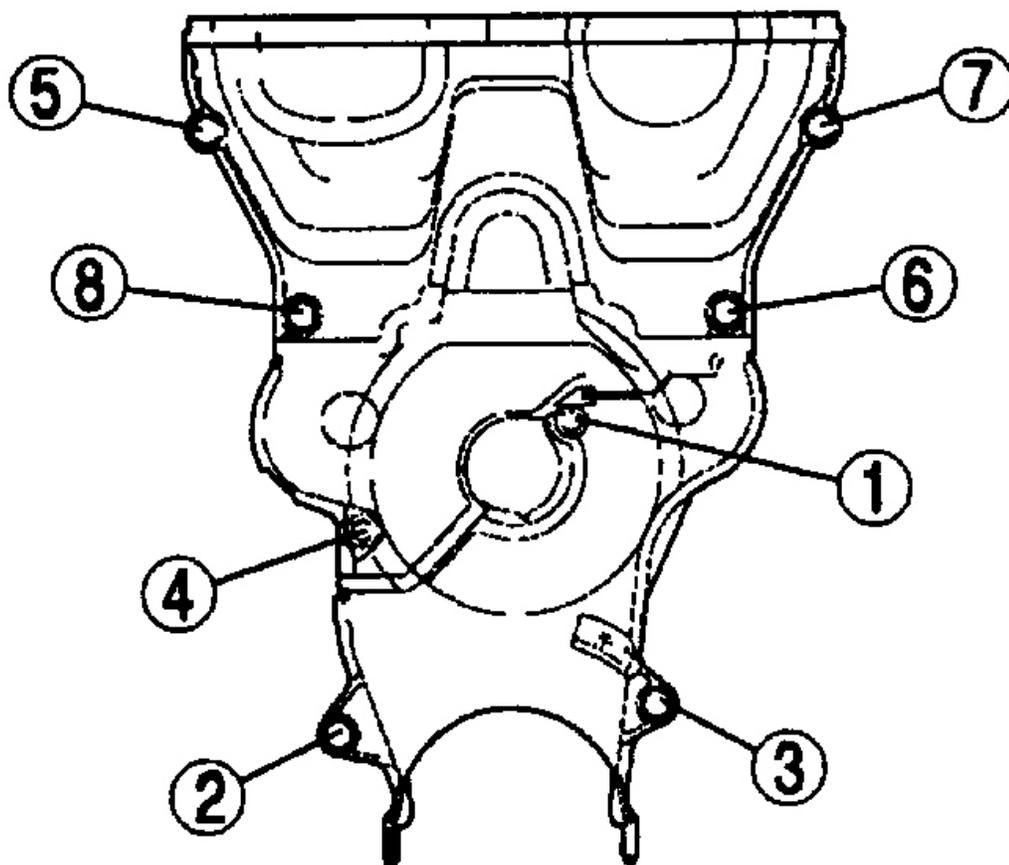


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Fig. 137: Seal Plate Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

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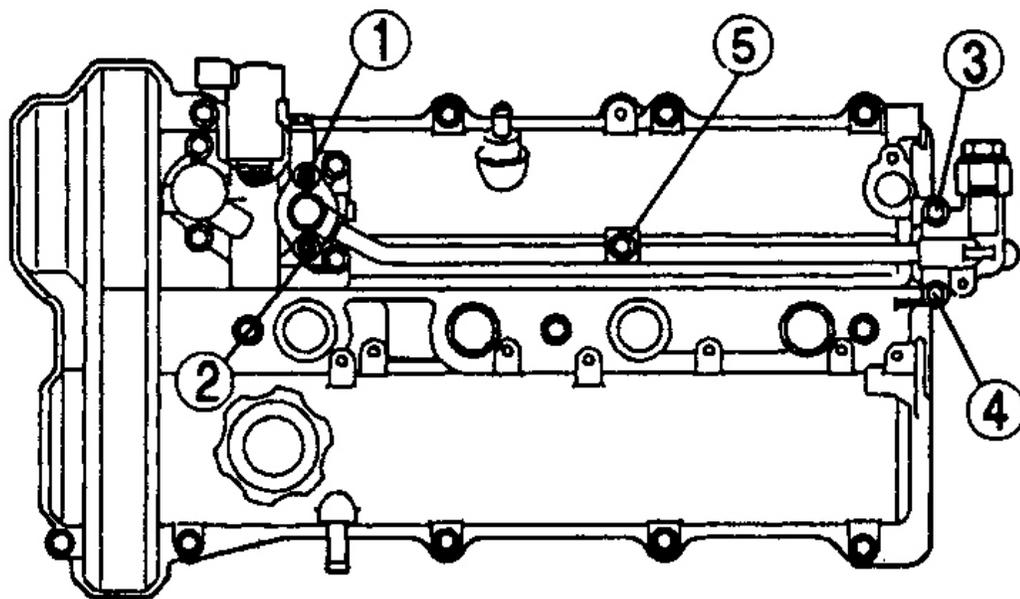


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Fig. 138: Timing Case Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

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Fig. 139: Upper Oil Control Valve Pipe Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.