2003-08 ENGINES

Mechanical Overhaul 3.0L V6 (AJ With Variable Valve Timing)

IDENTIFICATION

MODEL APPLICATION

Model	Year
Mazda6	2003-2006

ENGINE OVERHAUL SERVICE WARNING

WARNING:

- **Continuous exposure to 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

1. Install the **SST** (engine hanger) to the cylinder block holes as indicated in the figure, and tighten the **SSTs** (bolts).
2. Mount the engine on the **SST** (engine stand).
3. Drain the engine oil into a container.
4. Inspect the seal rubber of the oil pan drain plug and make sure there are no cracks or damage.
   - If necessary, replace the oil pan drain plug.
5. Clean the flange surface (seal rubber) of the drain plug, then install the plug.

   Tightening Torque

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

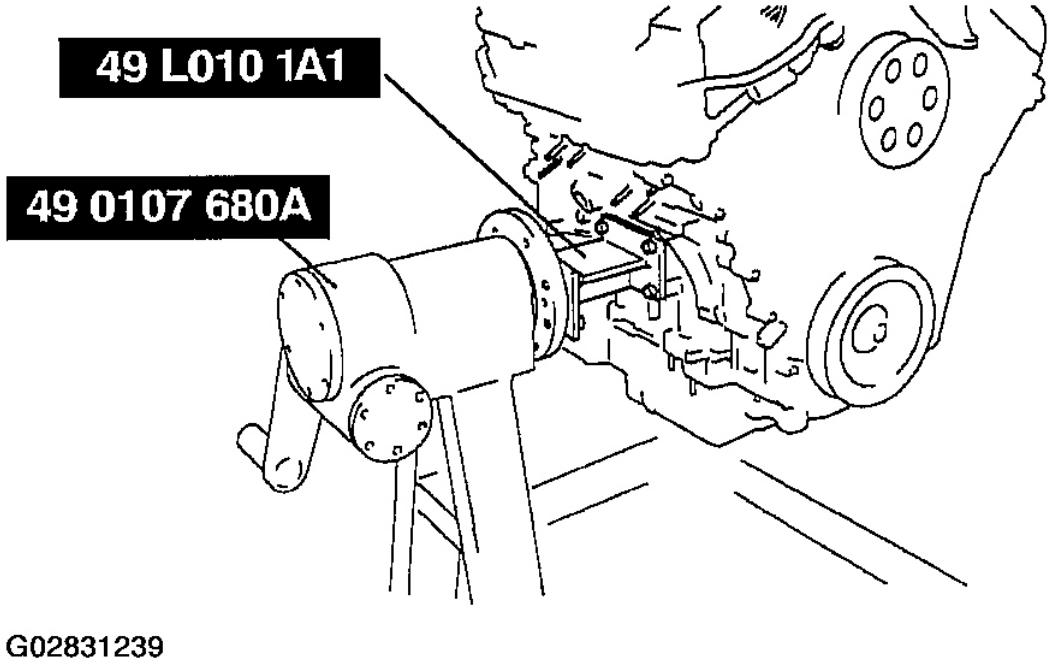


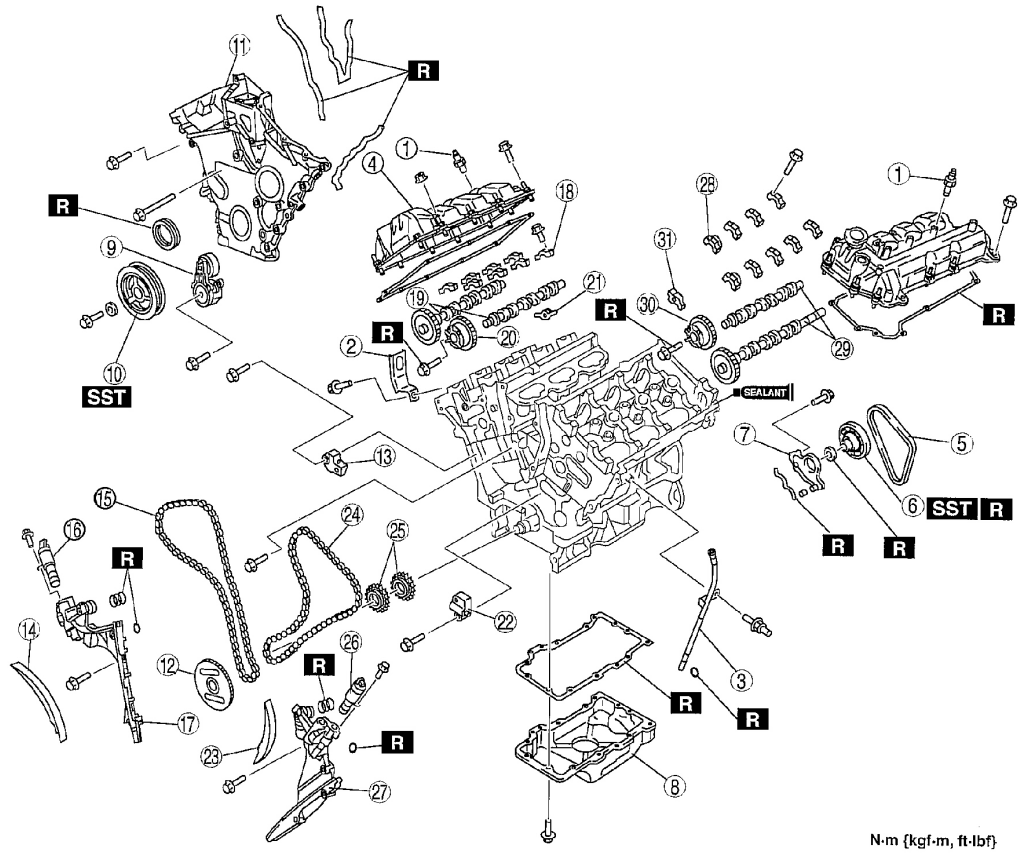
Fig. 1: Mounting Engine On Stand
Courtesy of MAZDA MOTORS CORP.

ENGINE DISMOUNTING

1. Dismount in the reverse order of mounting.

TIMING CHAIN DISASSEMBLY

1. Disassemble in the order indicated in the figure.



1	Spark plug
2	Engine hanger
3	Oil level gauge, pipe
4	Cylinder head cover (See Cylinder Head Cover Disassembly Note)
5	Water pump drive belt (See Water Pump Drive Belt Disassembly Note)
6	Water pump drive pulley (See Water Pump Drive Pulley Disassembly Note)
7	Camshaft oil seal housing (See Camshaft Oil Seal Housing Disassembly Note)
8	Oil pan (See Oil Pan Disassembly Note)
9	Auto tensioner
10	Crankshaft pulley (See Crankshaft Pulley Disassembly Note)
11	Engine front cover (See Engine Front Cover Disassembly Note)
12	CKP sensor pulse wheel
13	Chain tensioner (RH) (See Chain Tensioner (RH) Disassembly Note)
14	Tensioner arm (RH)

15	Timing chain (RH)
16	Oil control valve (OCV)
17	Chain guide (RH)
18	Camshaft cap (RH) (See Camshaft Cap (RH) Disassembly Note)
19	Camshaft (RH)
20	Variable valve timing actuator (RH) (See Variable Valve Timing Actuator Disassembly Note)
21	Rocker arm (RH)
22	Chain tensioner (LH) (See Chain Tensioner (LH) Disassembly Note)
23	Tensioner arm (LH)
24	Timing chain (LH)
25	Crankshaft timing sprocket
26	Oil control valve (OCV)
27	Chain guide (LH)
28	Camshaft cap (LH) (See Camshaft Cap (LH) Disassembly Note)
29	Camshaft (LH)
30	Variable valve timing actuator (LH) (See Variable Valve Timing Actuator Disassembly Note)
31	Rocker arm (LH)

G02831240

Fig. 2: Removing Timing Chains
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD COVER DISASSEMBLY NOTE

1. Remove the cylinder head cover bolts in the order indicated in the figure.

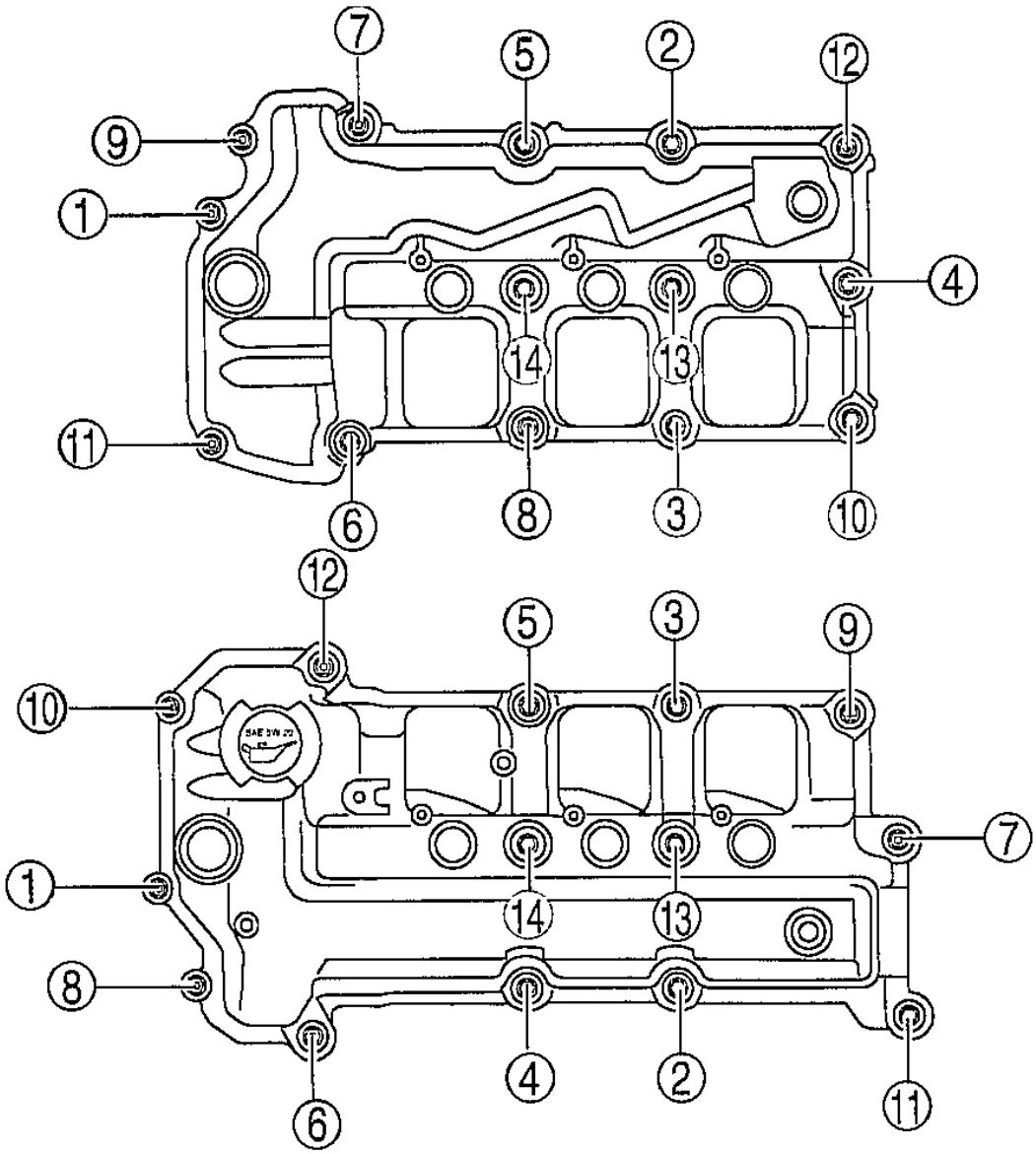


Fig. 3: Cylinder Head Cover Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

WATER PUMP DRIVE BELT DISASSEMBLY NOTE

1. Rotate the belt tensioner counterclockwise to release the drive belt tension and remove the belt.

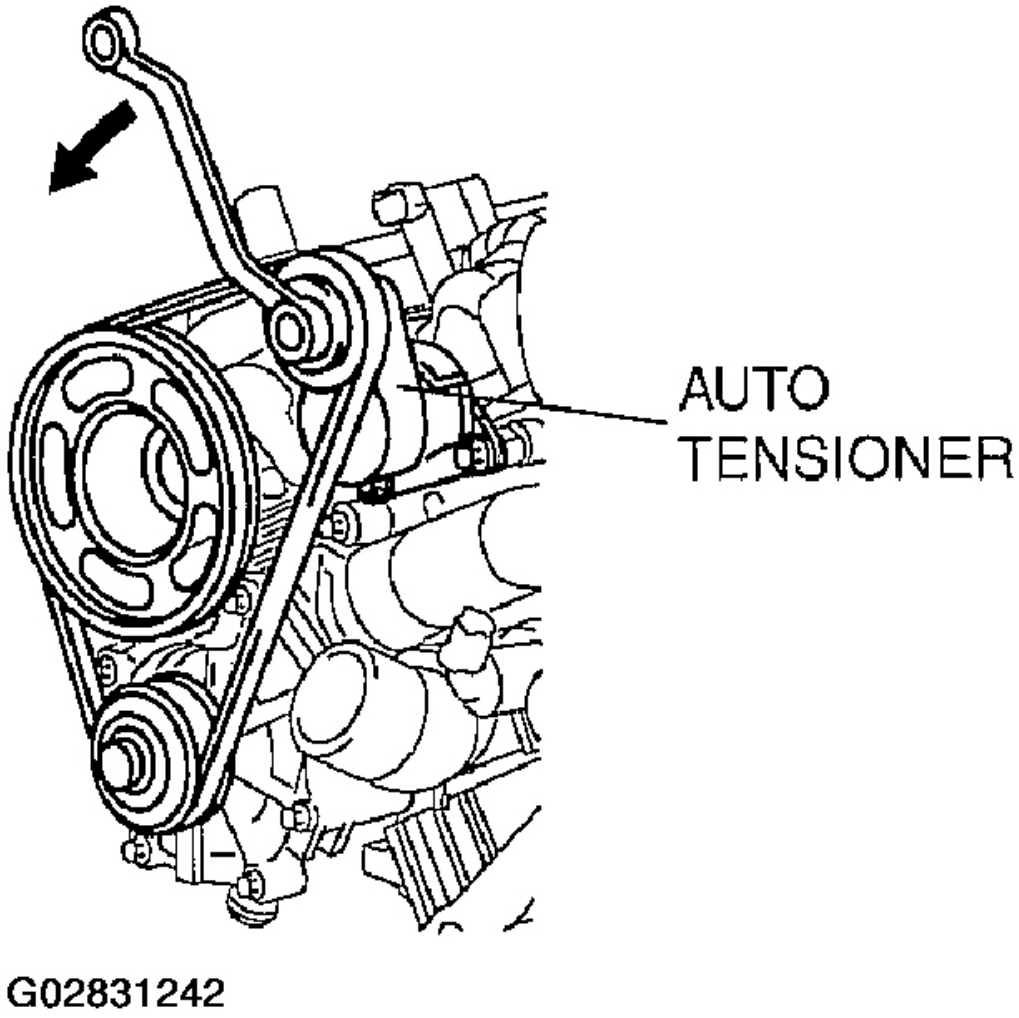


Fig. 4: Releasing Drive Belt Tension
Courtesy of MAZDA MOTORS CORP.

WATER PUMP DRIVE PULLEY DISASSEMBLY NOTE

1. Replace part A of the **SST** [303-009 (49 UN30 3009)] with the **SST** [303-457 (49 UN30 3457)].

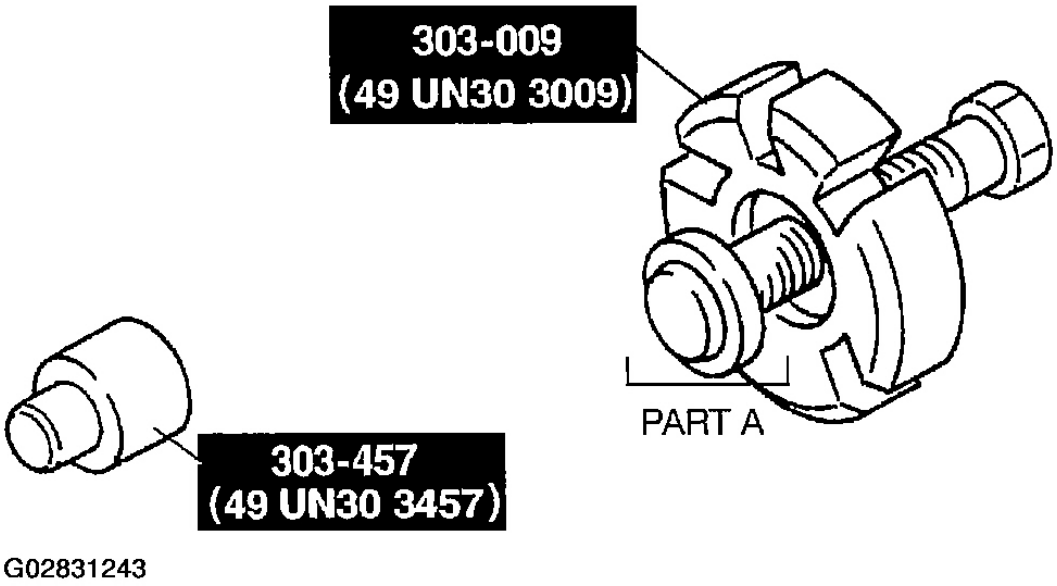
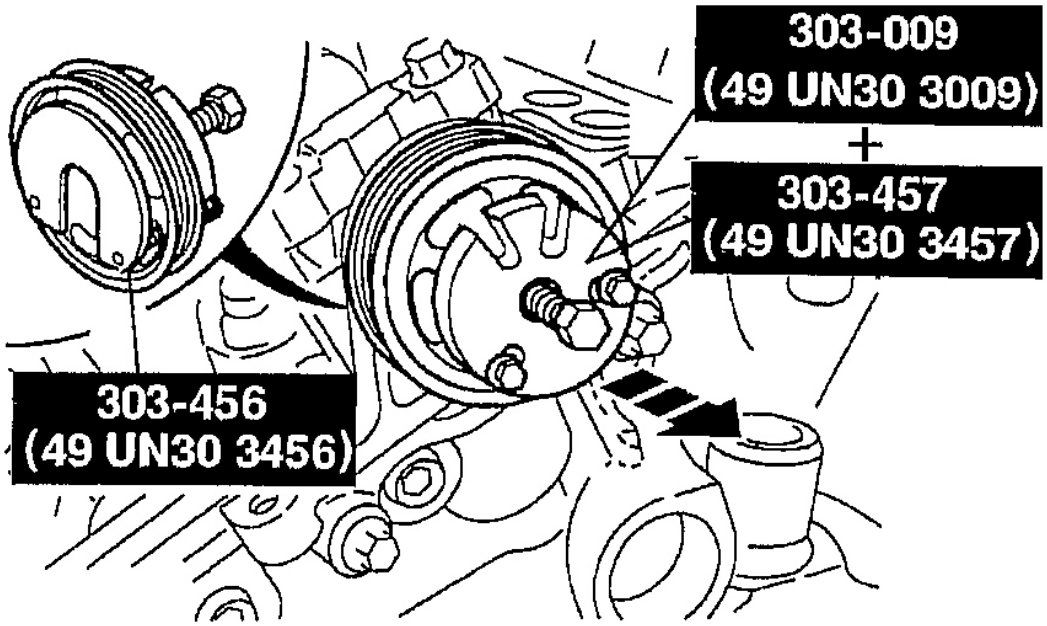


Fig. 5: Assembling SST
Courtesy of MAZDA MOTORS CORP.

2. Remove the water pump pulley using the **SSTs** .



G02831244

Fig. 6: Removing Water Pump Pulley
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT OIL SEAL HOUSING DISASSEMBLY NOTE

1. Remove the oil seal using a screwdriver.

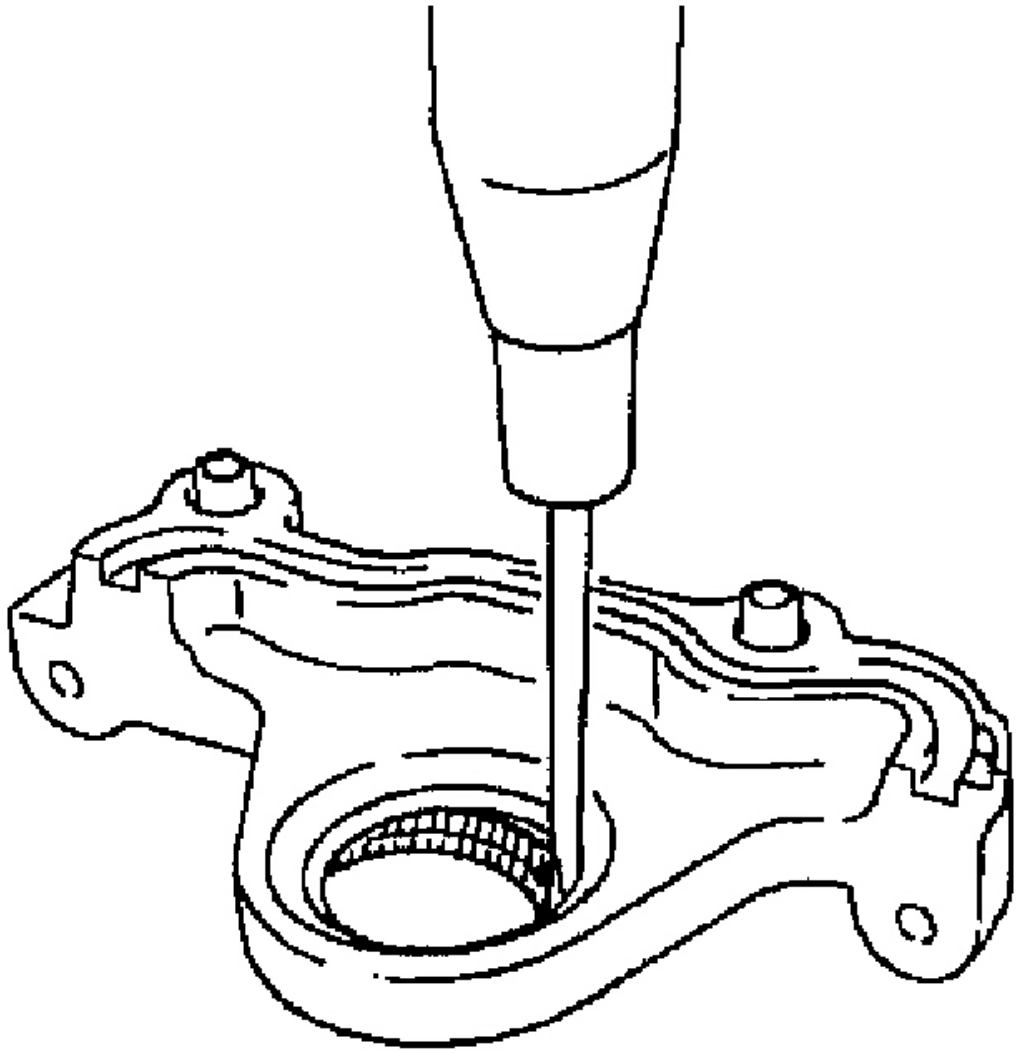


Fig. 7: Removing Oil Seal
Courtesy of MAZDA MOTORS CORP.

OIL PAN DISASSEMBLY NOTE

1. Remove the oil pan bolts and studs in the order indicated in the figure.

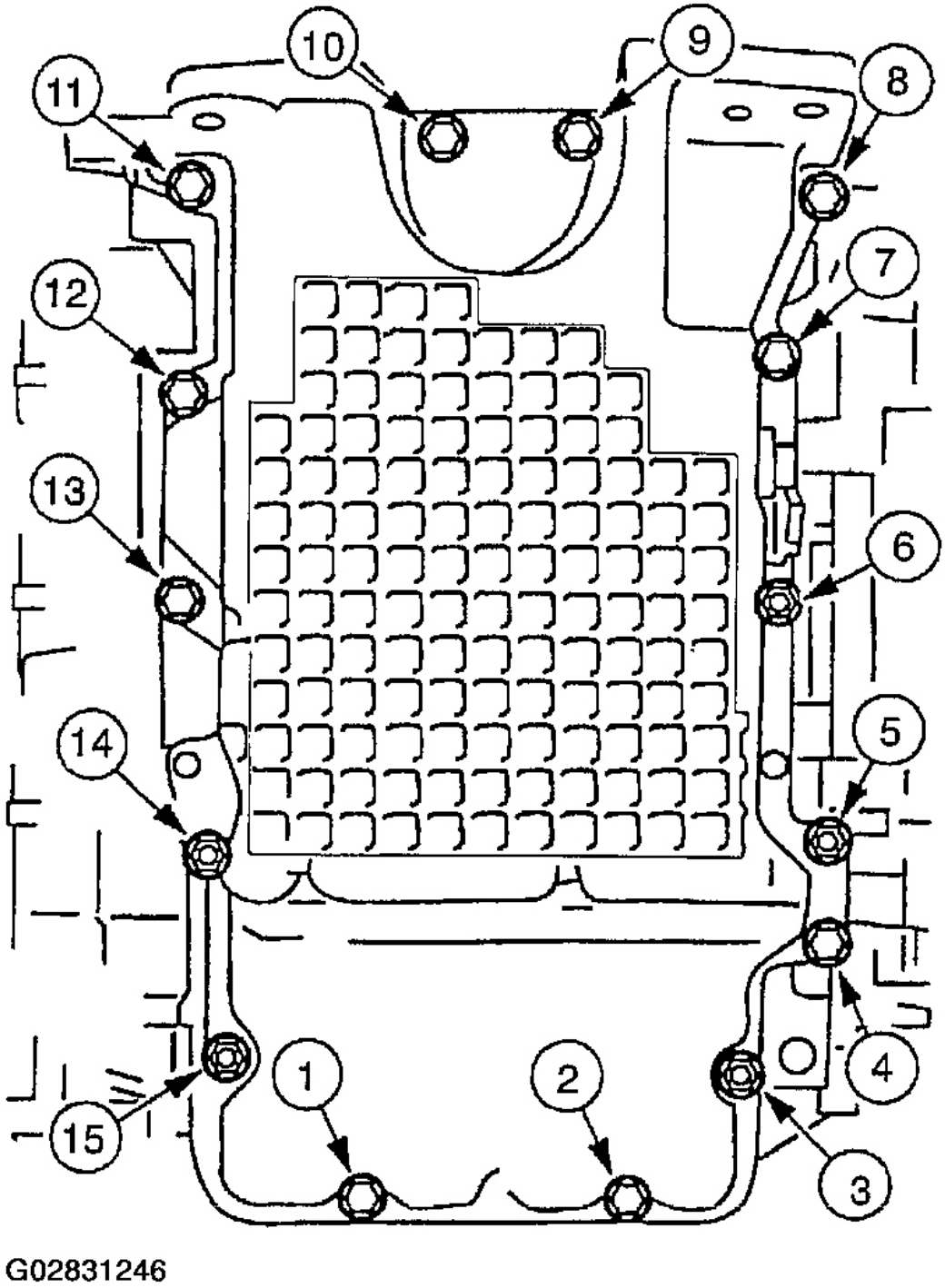


Fig. 8: Oil Pan Bolt & Stud Removal Sequence
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT PULLEY DISASSEMBLY NOTE

1. Hold the flywheel (MTX) or the drive plate (ATX) using the **SST** .

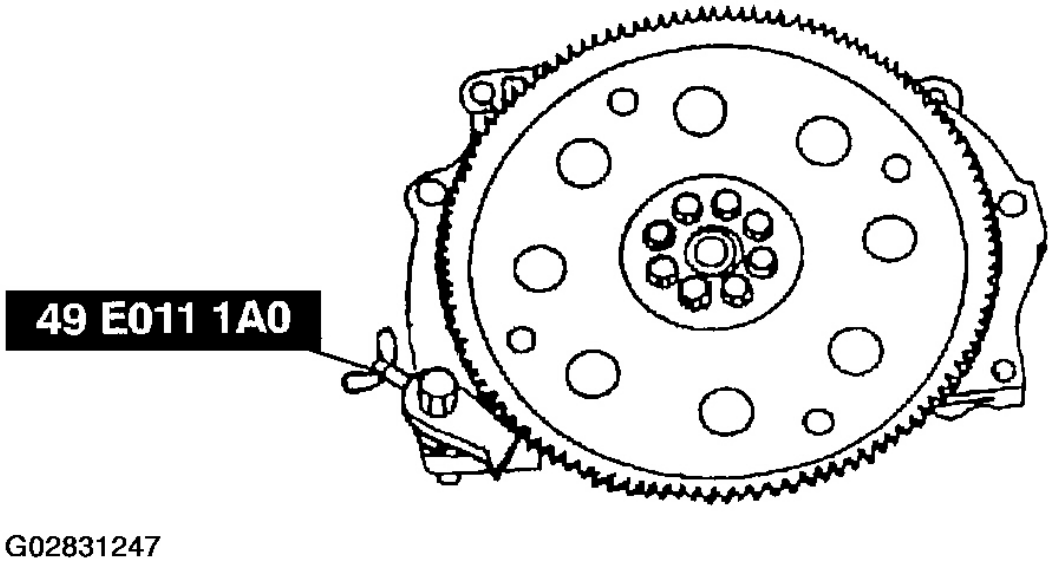


Fig. 9: Holding Flywheel (MTX) Or Drive Plate (ATX)
Courtesy of MAZDA MOTORS CORP.

2. Remove the crankshaft pulley lock bolt.
3. Remove the crankshaft pulley using the **SST** and three **(M8x 1.25x45)** bolts.

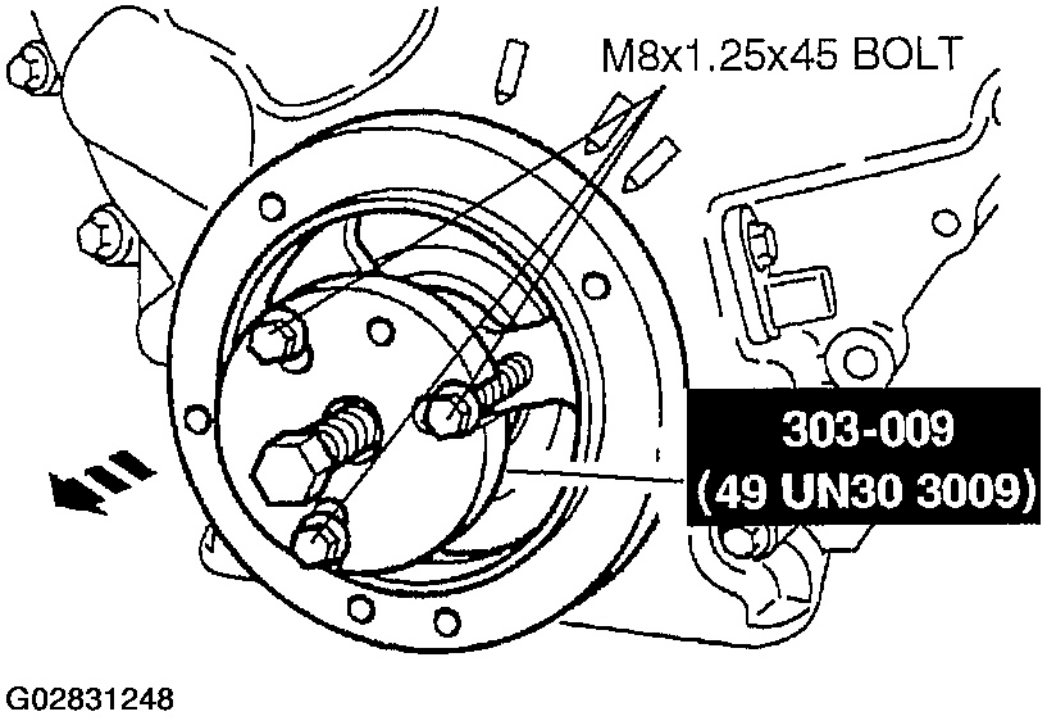


Fig. 10: Removing Crankshaft Pulley
Courtesy of MAZDA MOTORS CORP.

ENGINE FRONT COVER DISASSEMBLY NOTE

1. Remove the engine front cover bolts and studs in the order indicated in the figure.

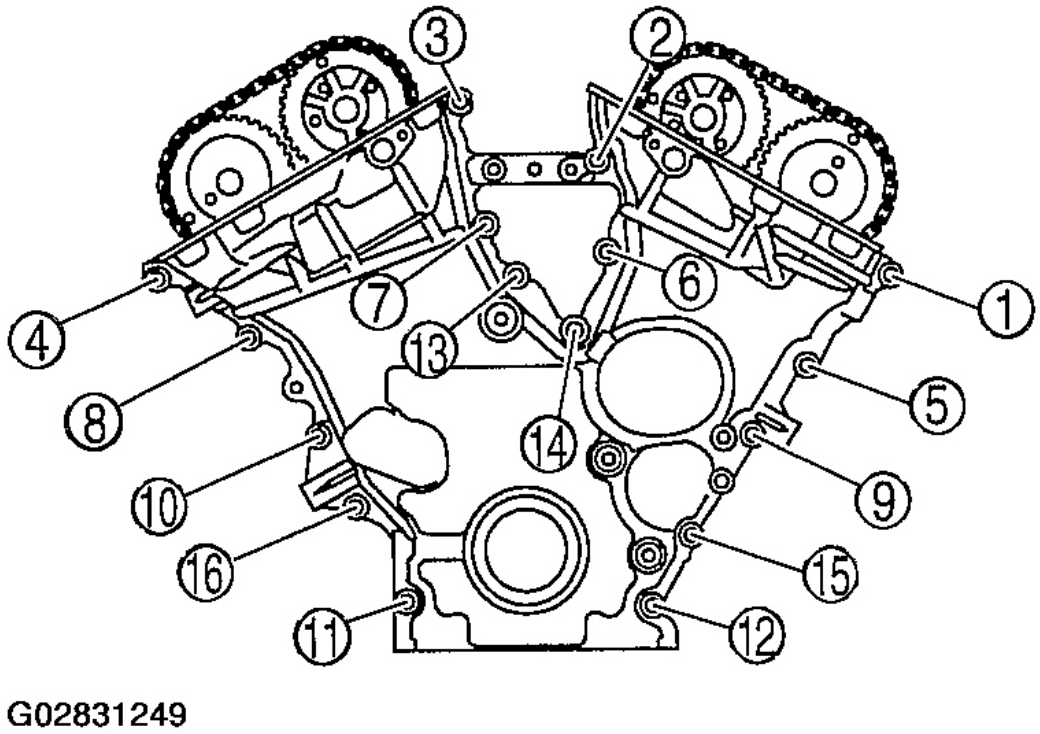


Fig. 11: Engine Front Cover Bolt & Stud Removal Sequence
Courtesy of MAZDA MOTORS CORP.

2. Remove the oil seal using a screwdriver.

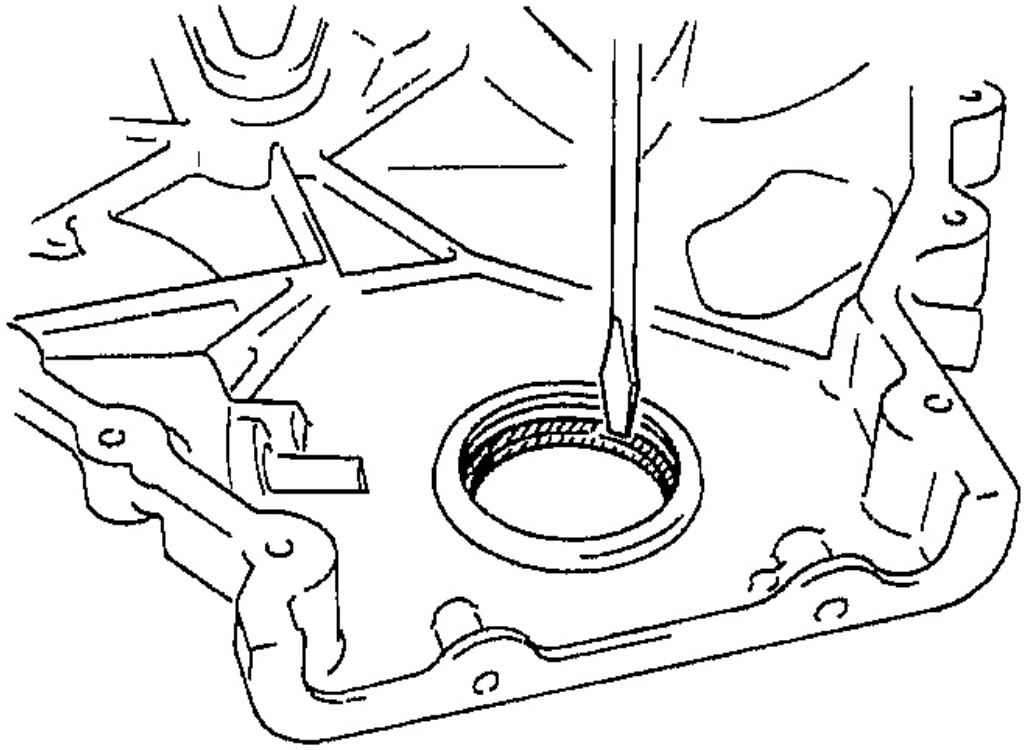


Fig. 12: Removing Oil Seal
Courtesy of MAZDA MOTORS CORP.

CHAIN TENSIONER (RH) DISASSEMBLY NOTE

1. Before removing chain tensioner (RH), turn the crankshaft clockwise to position the crankshaft keyway in the **3 o'clock** position, (camshafts (RH) are in the neutral position.)

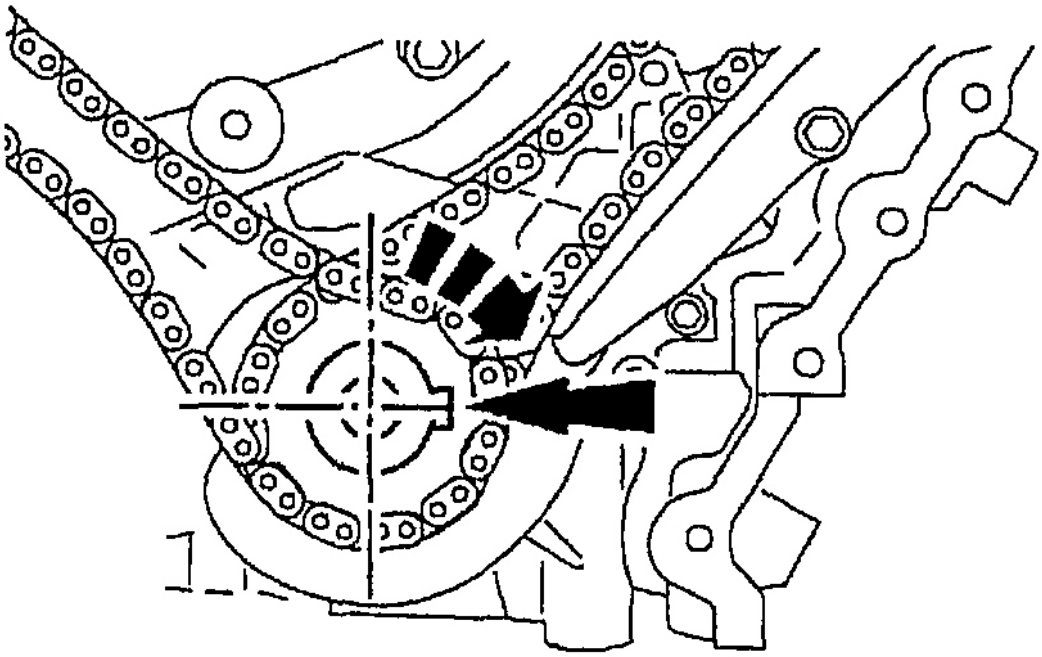


Fig. 13: Crankshaft Keyway In 3 O'clock Position
Courtesy of MAZDA MOTORS CORP.

2. Hold the timing chain tensioner ratchet lock mechanism away from the ratchet stem with a thin screwdriver.
3. Slowly press the tensioner piston.
4. Hold the tensioner piston with a **1.5 mm (0.06 in)** wire or paper clip.

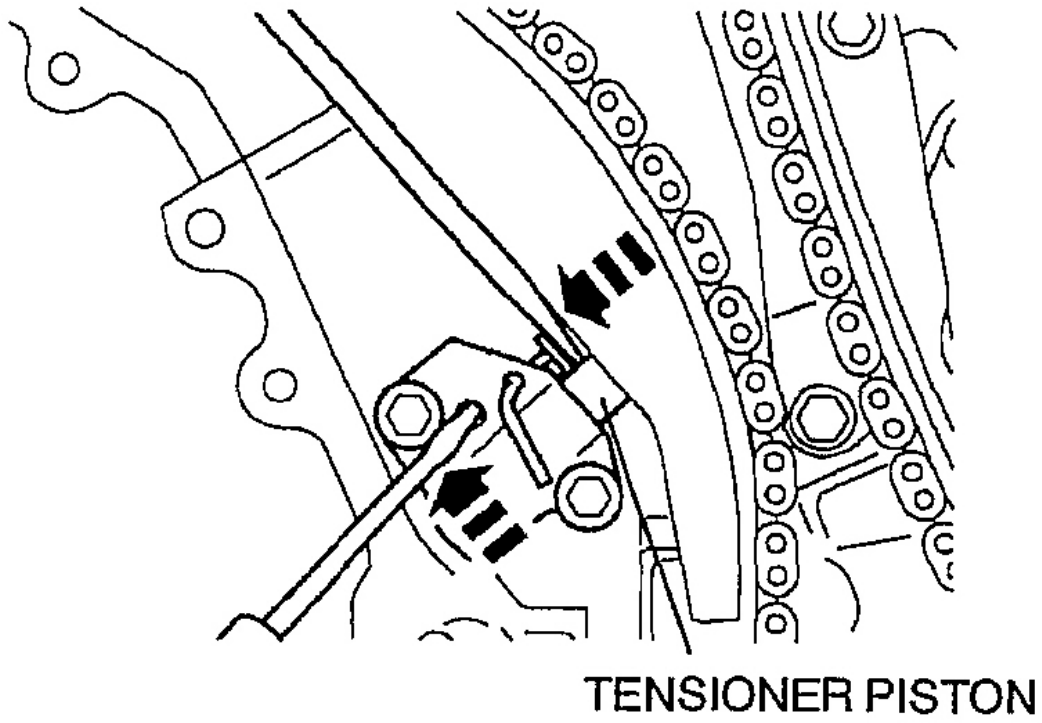


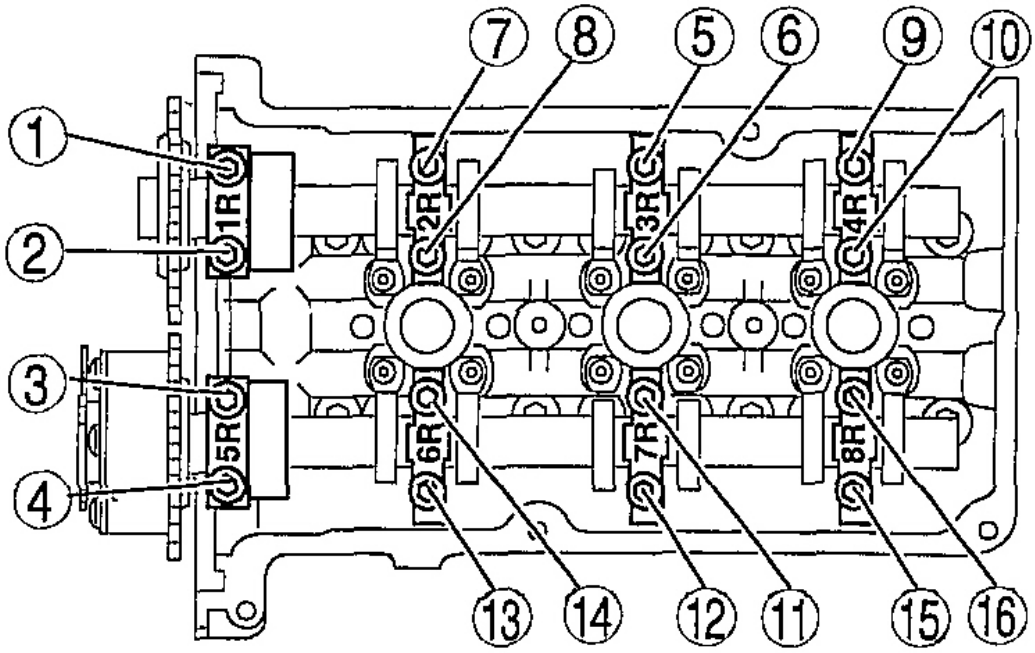
Fig. 14: Holding Tensioner Piston
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT CAP (RH) DISASSEMBLY NOTE

1. Before removing the camshaft cap, inspect the following.
    1. Camshaft end play (See **CAMSHAFT END PLAY INSPECTION**.)
    2. Camshaft journal oil clearance (See **CAMSHAFT OIL CLEARANCE INSPECTION**.)

CAUTION:
- **Remove the camshaft bearing thrust caps 1R and 5R first, Do not loosen any of the other bolts until the thrust caps are removed, or damage to the thrust caps may occur.**

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



G02831253

Fig. 15: Camshaft Cap Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

2. Remove the camshaft cap bolts in the order indicated in the figure, loosening in several passes.

VARIABLE VALVE TIMING ACTUATOR DISASSEMBLY NOTE

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

NOTE:
- **The variable valve timing actuator camshaft sprocket is integrated with the variable valve timing actuator and cannot be disassembled.**

1. Secure the camshaft sprocket in a vise using the **SST** .

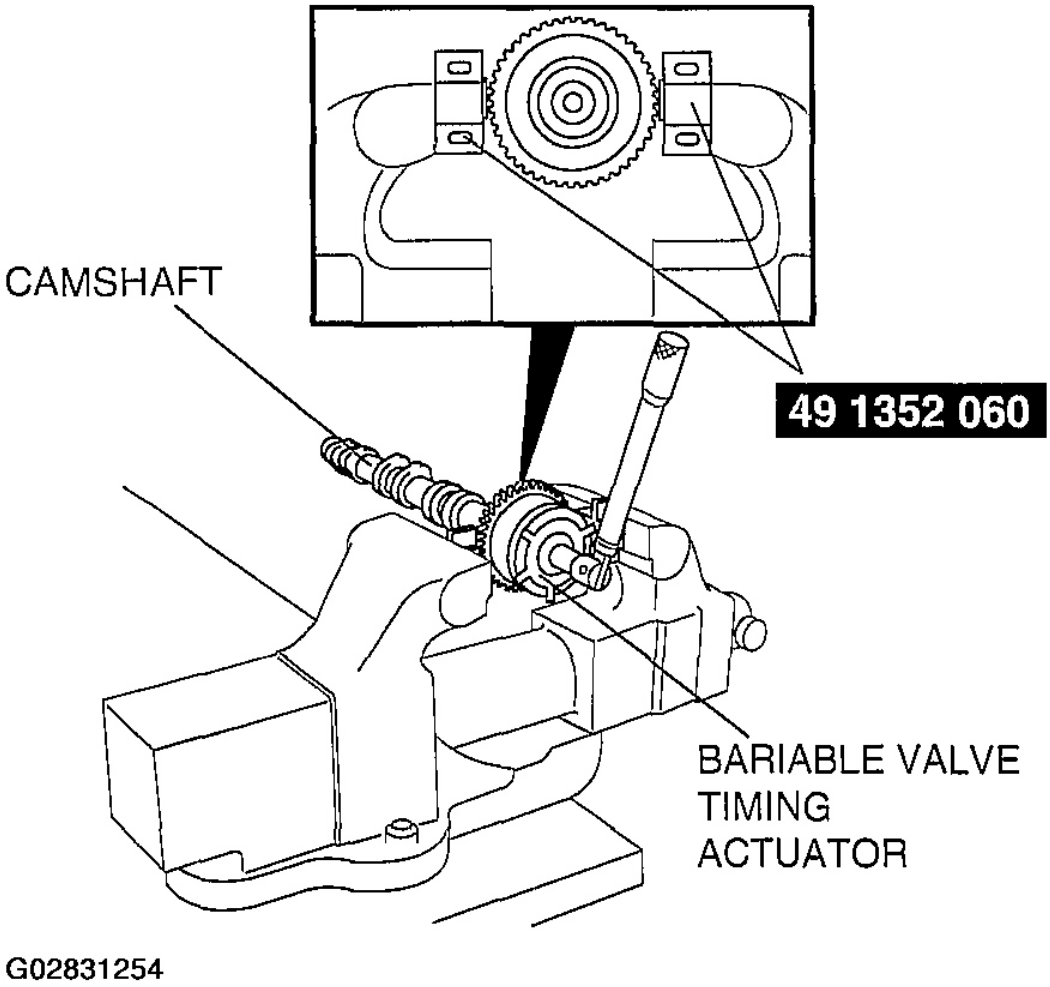


Fig. 16: Securing Camshaft Sprocket In A Vise
Courtesy of MAZDA MOTORS CORP.

2. Loosen the variable valve timing actuator tightening bolt.
3. Remove the variable valve timing actuator.

CHAIN TENSIONER (LH) DISASSEMBLY NOTE

1. Before removing chain tensioner (LH), turn the crankshaft clockwise **1 and 2/3 turns** to position the crankshaft keyway in the **11 o'clock** position, (camshafts (LH) are in the neutral position.)

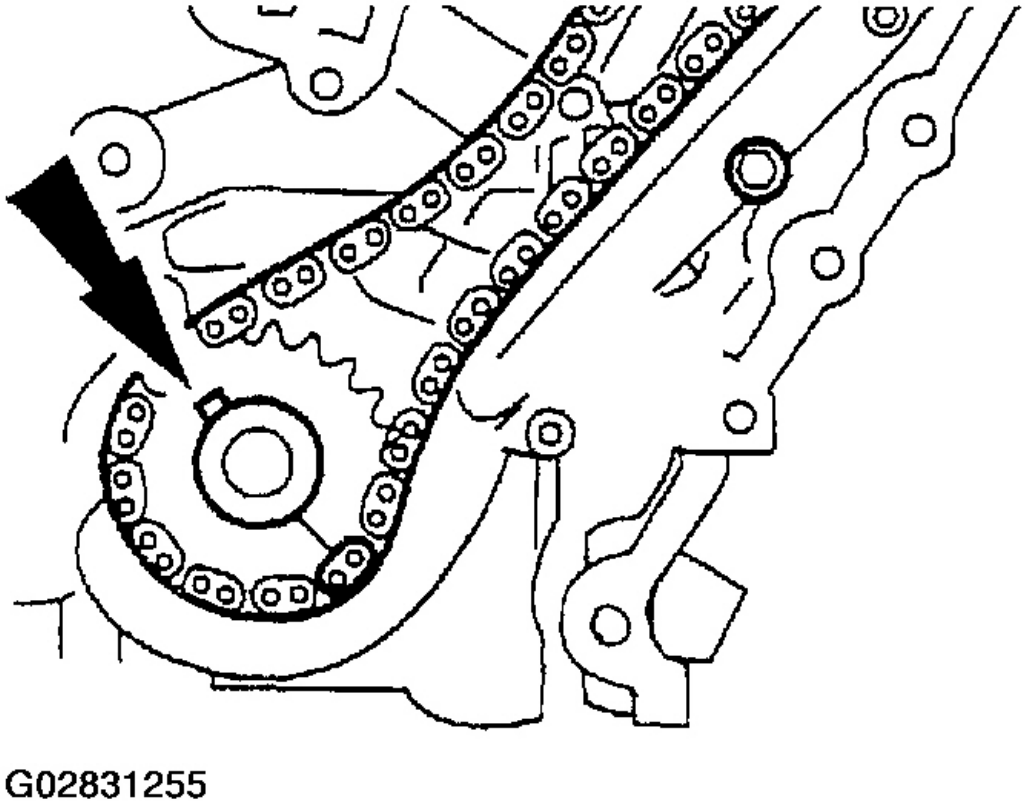


Fig. 17: Positioning Crankshaft Keyway In 11 O'clock Position
Courtesy of MAZDA MOTORS CORP.

2. Press and hold the tensioner piston by following Step 4 to 6 in Chain Tensioner (RH) Disassembly Note. (See **CHAIN TENSIONER (RH) DISASSEMBLY NOTE**.)

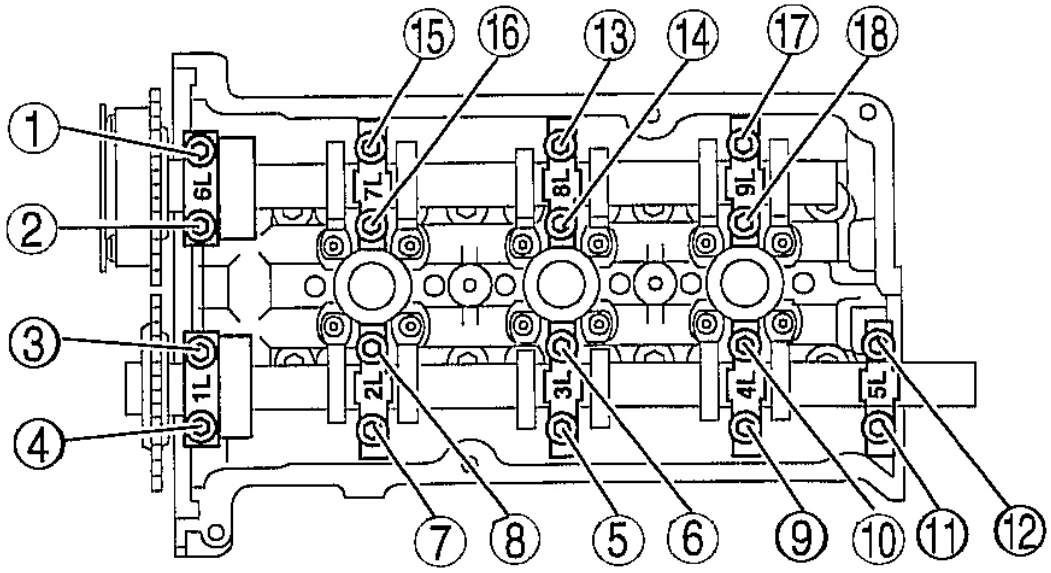
CAMSHAFT CAP (LH) DISASSEMBLY NOTE

1. Before removing the camshaft cap, inspect the following.
    1. Camshaft end play. (See **CAMSHAFT END PLAY INSPECTION**.)
    2. Camshaft journal oil clearance. (See **CAMSHAFT OIL CLEARANCE INSPECTION**.)

CAUTION:
- **Remove the camshaft bearing thrust caps 1L and 6L first. Do not loosen any of the other bolts until the thrust caps are removed, or damage to the thrust caps may occur.**

NOTE:
- **The camshaft bearing caps are numbered to make sure they are**

reassembled in their original position. When removed, keep the bearing caps with the cylinder head from where they were removed. Do not mix the caps.



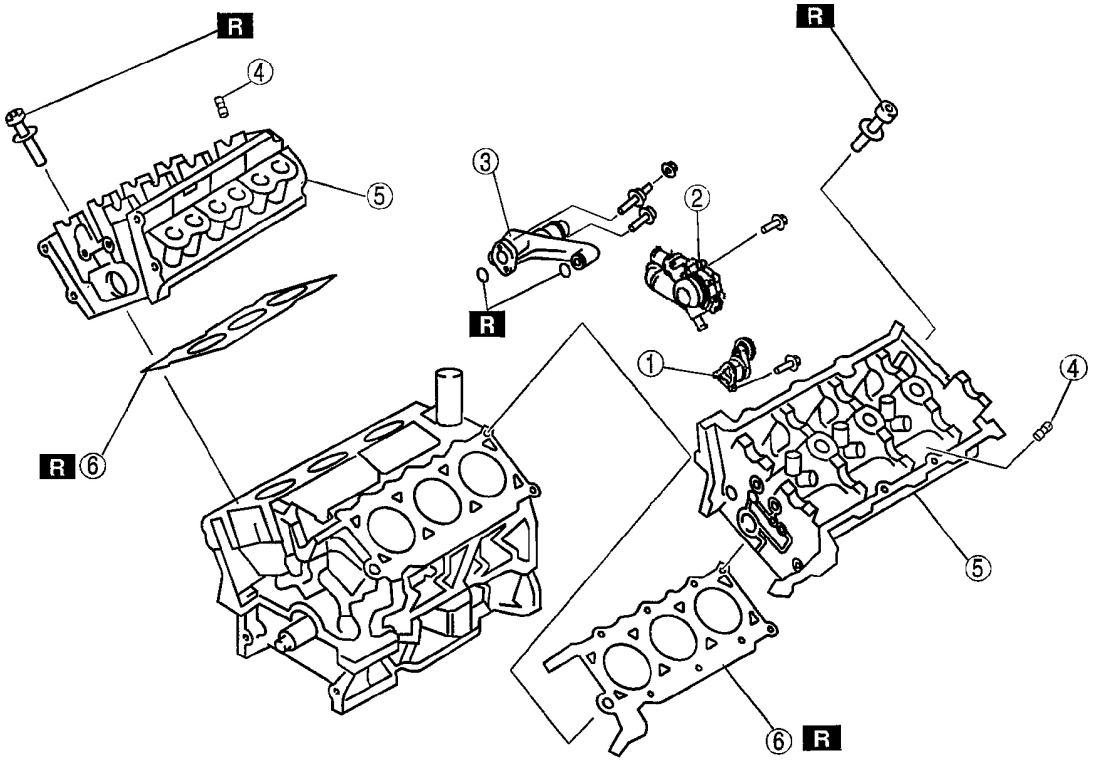
G02831256

Fig. 18: Camshaft Cap Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

2. Remove the camshaft cap bolts in the order indicated in the figure, loosening in several passes.

CYLINDER HEAD DISASSEMBLY (I)

1. Disassemble in the order indicated in the figure.



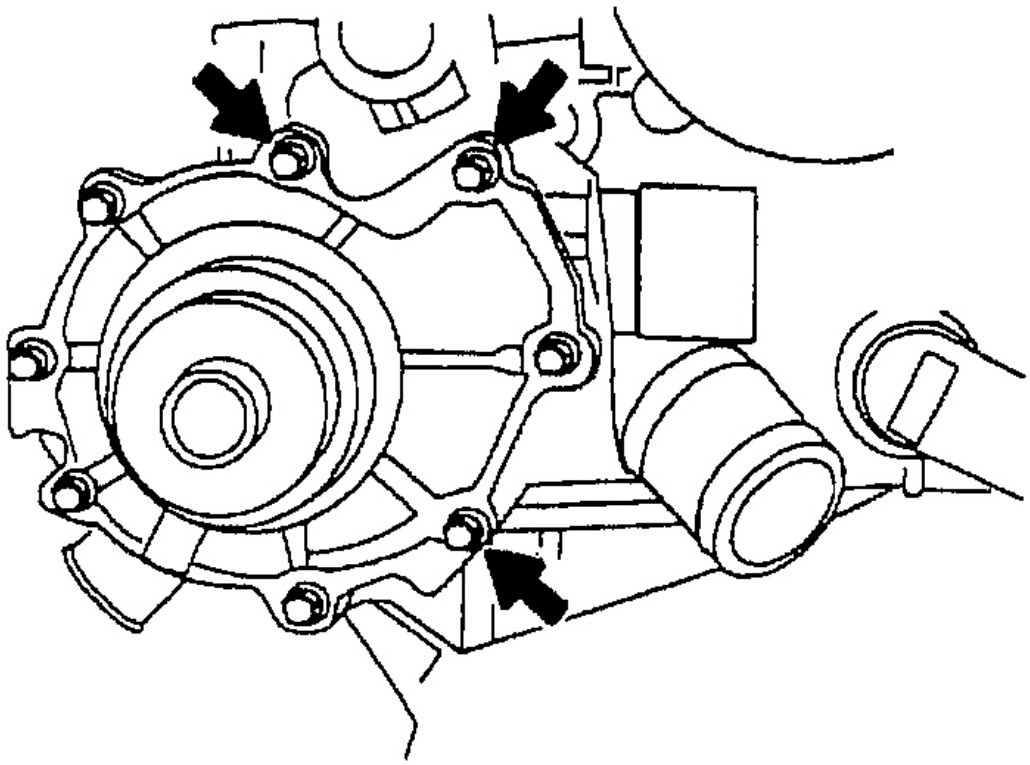
1	Water pump drive belt tensioner	4	HLA
2	Water pump (See Water Pump Disassembly Note)	5	Cylinder head (See Cylinder Head Disassembly Note)
3	Water bypass tube	6	Cylinder head gasket

G02831257

Fig. 19: Cylinder Head Disassembly (I)
Courtesy of MAZDA MOTORS CORP.

WATER PUMP DISASSEMBLY NOTE

1. Remove the water pump mounting bolts as shown.



G02831258

Fig. 20: Removing Water Pump
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD DISASSEMBLY NOTE

1. Remove the cylinder head bolts in the order indicated in the figure, loosening in several passes.

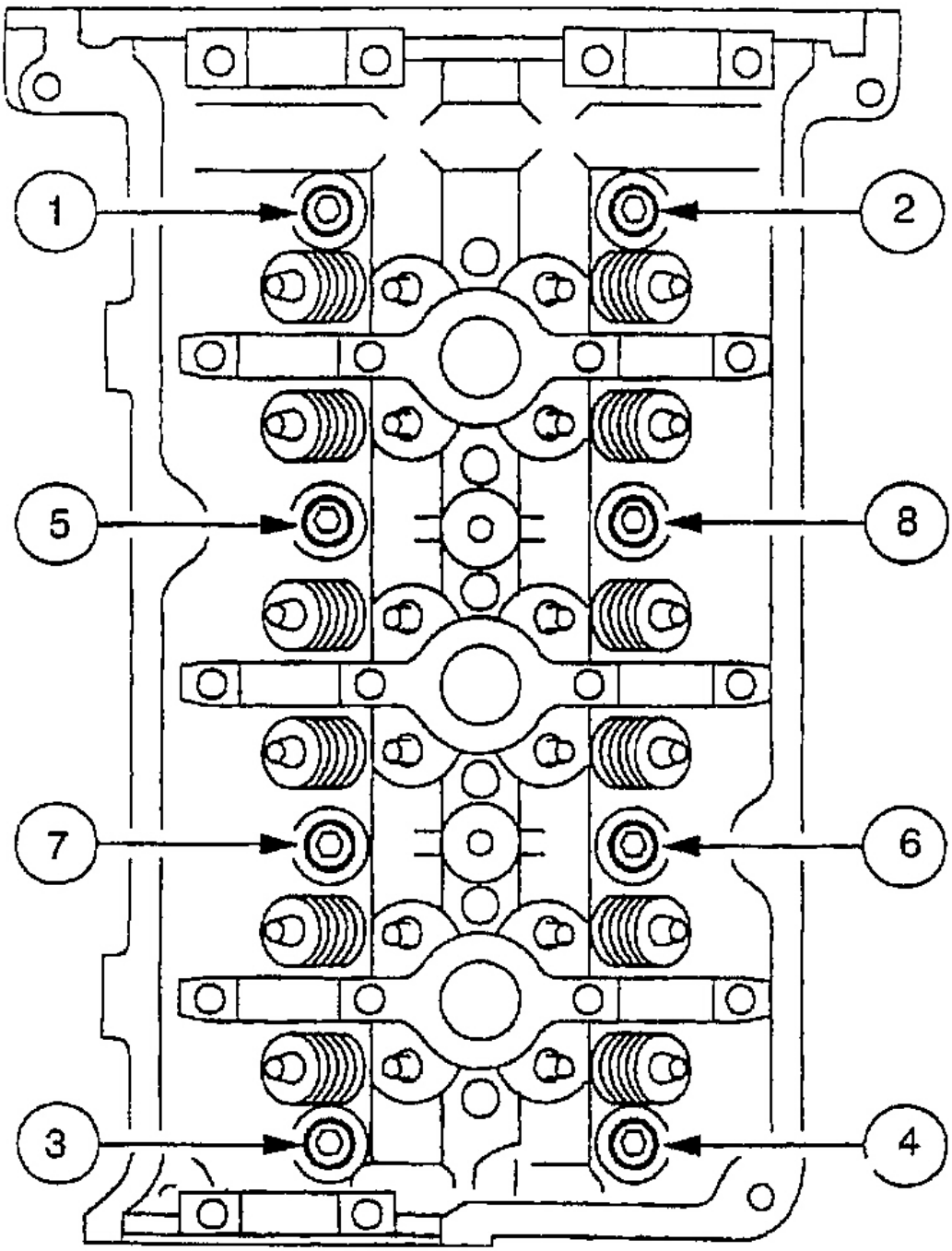


Fig. 21: Cylinder Head Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD DISASSEMBLY (II)

1. Disassemble in the order indicated in the table/figure.

CYLINDER HEAD DISASSEMBLY (II)

Component/Step No.	Component Description
1	Valve Keeper (See **VALVE KEEPER DISASSEMBLY NOTE**)
2	Upper Valve Spring Seat
3	Valve Spring
4	Valve
5	Valve Seal (See **VALVE SEAL DISASSEMBLY NOTE**)

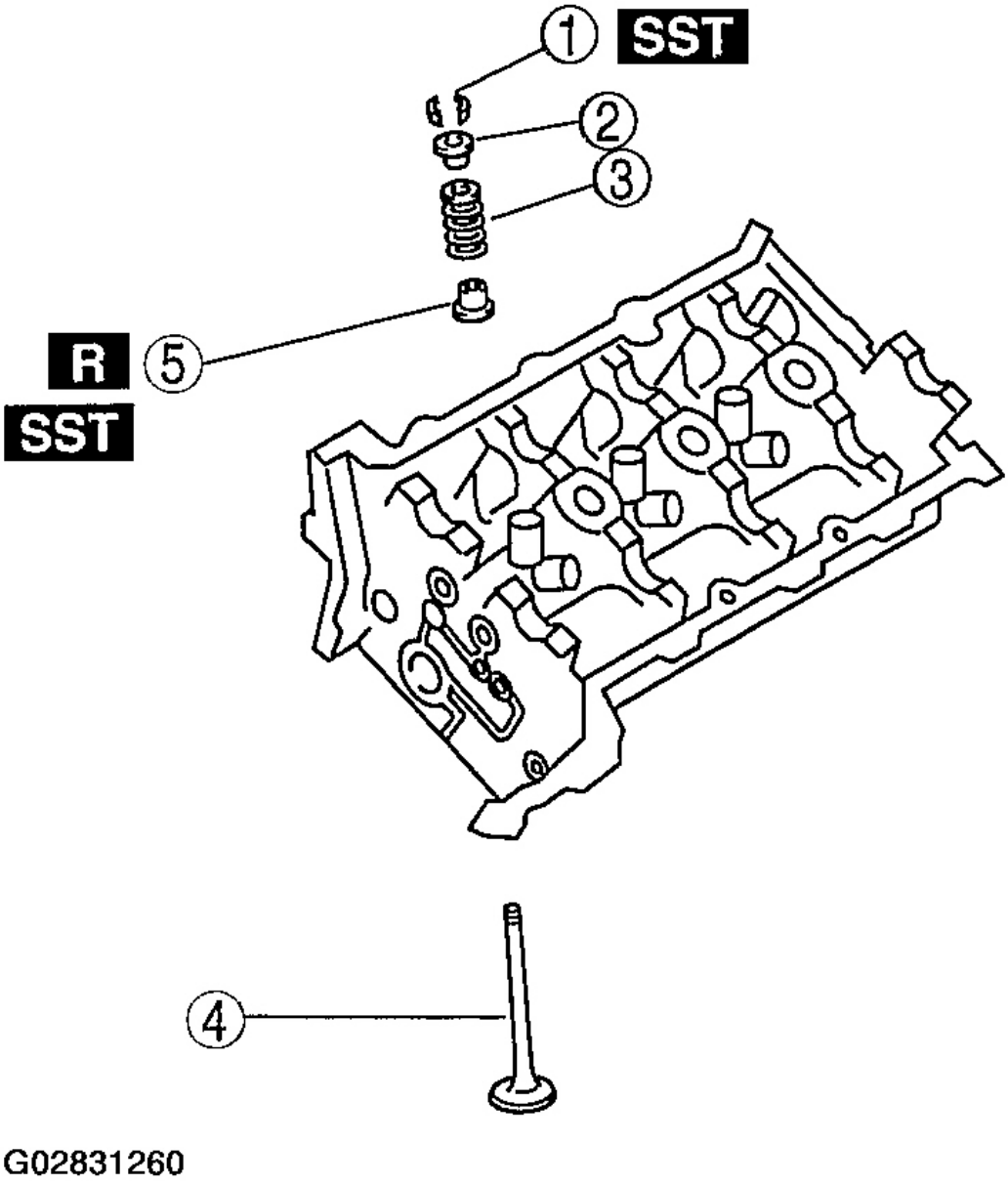


Fig. 22: Disassembling Cylinder Head (II)
Courtesy of MAZDA MOTORS CORP.

VALVE KEEPER DISASSEMBLY NOTE

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

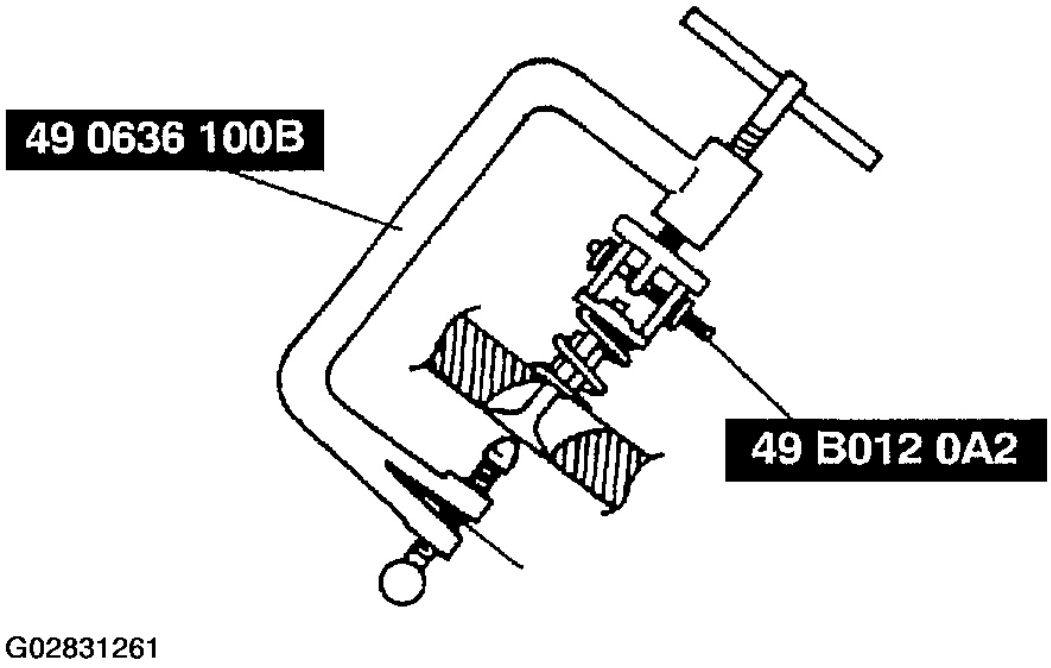


Fig. 23: Removing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

VALVE SEAL DISASSEMBLY NOTE

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

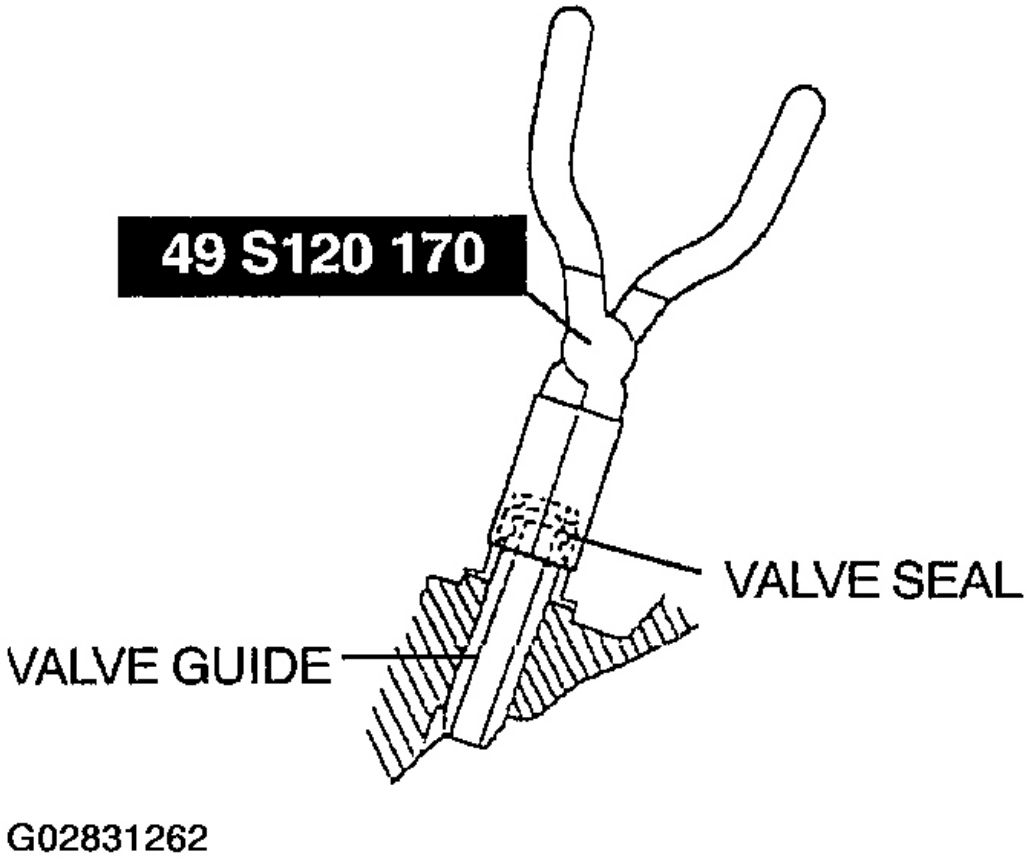
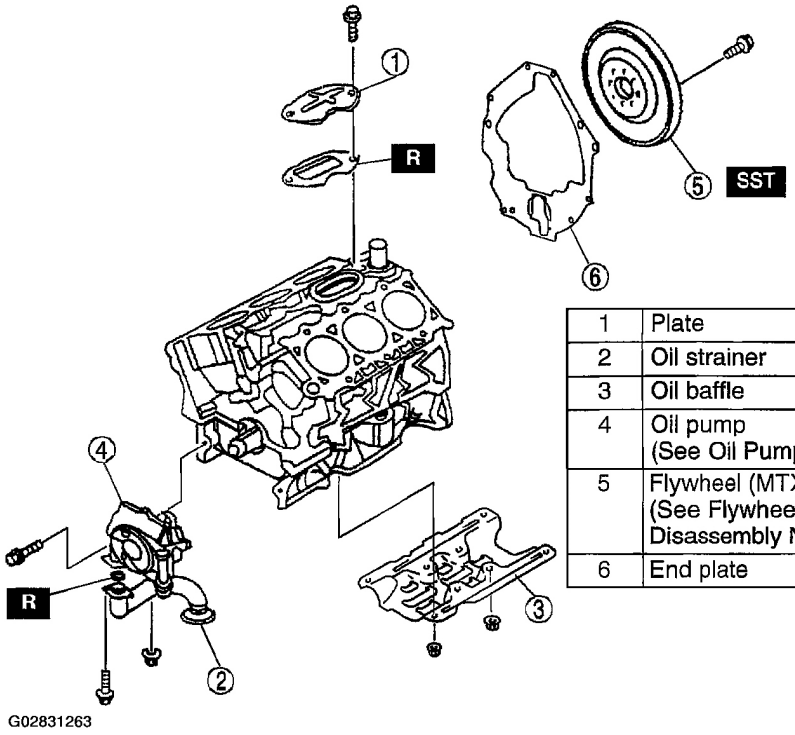


Fig. 24: Removing Valve Seal
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK DISASSEMBLY (I)

1. Disassemble in the order indicated in the figure.

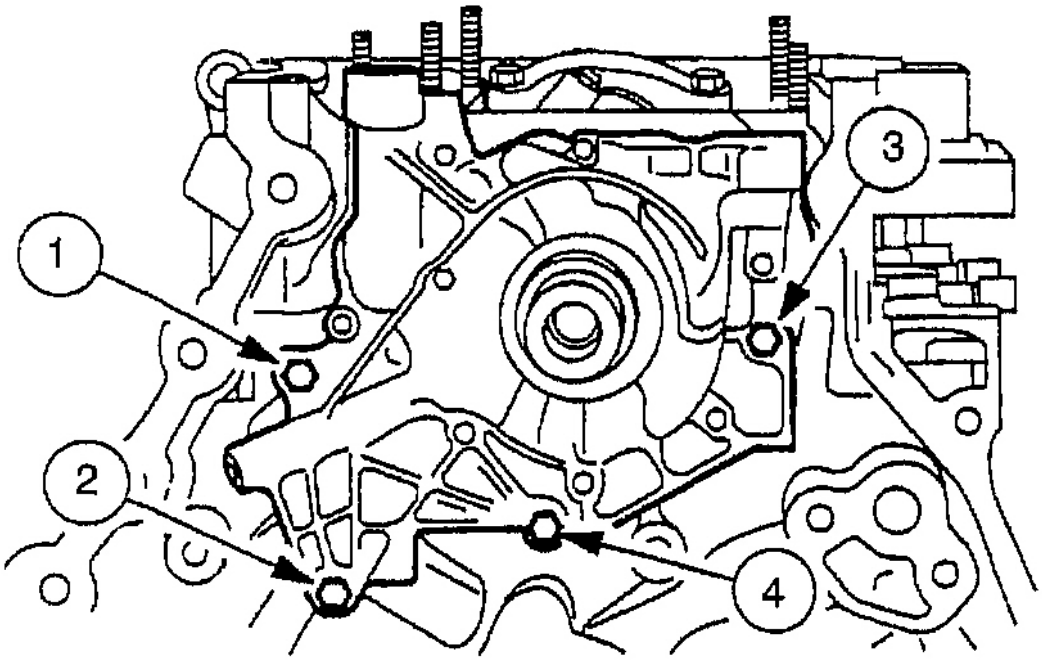


1	Plate
2	Oil strainer
3	Oil baffle
4	Oil pump (See Oil Pump Disassembly Note)
5	Flywheel (MTX), Drive plate (ATX) (See Flywheel (MTX), Drive Plate (ATX) Disassembly Note)
6	End plate

Fig. 25: Disassembling Cylinder Block (I)
Courtesy of MAZDA MOTORS CORP.

OIL PUMP DISASSEMBLY NOTE

1. Remove the bolts in the order indicated in the figure.



G02831264

Fig. 26: Oil Pump Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

FLYWHEEL (MTX), DRIVE PLATE (ATX) DISASSEMBLY NOTE

1. Hold the flywheel (MTX) or the drive plate (ATX) using the **SST** .

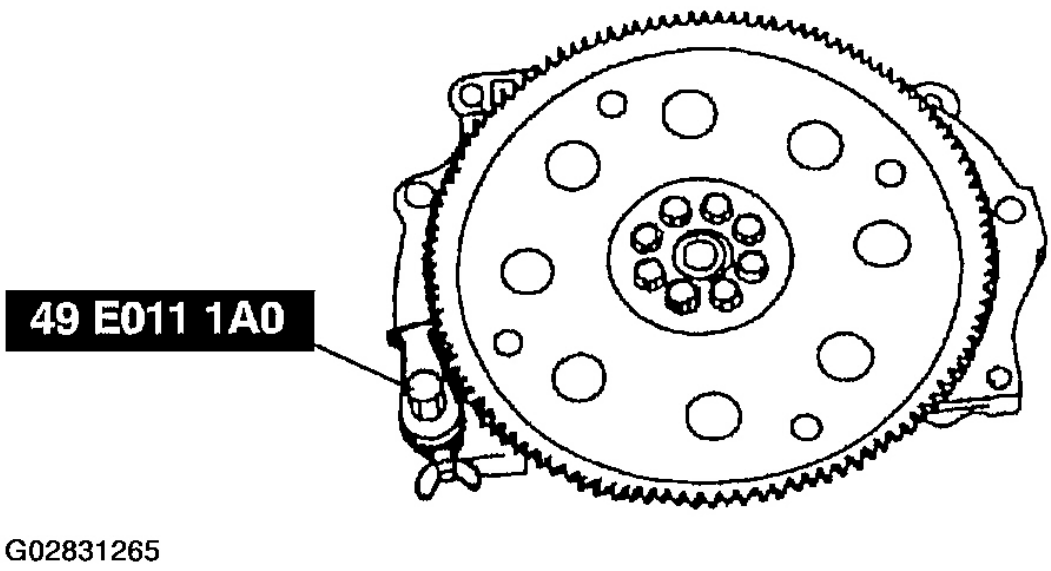
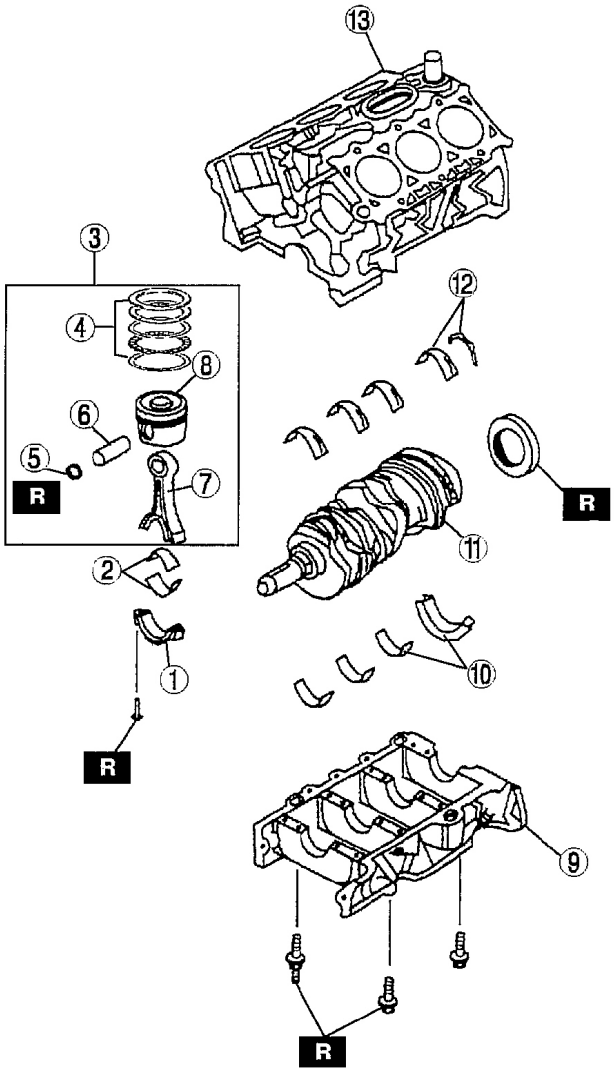


Fig. 27: Holding Flywheel (MTX) Or Drive Plate (ATX)
Courtesy of MAZDA MOTORS CORP.

2. Remove the bolts, loosening in several passes.

CYLINDER BLOCK DISASSEMBLY (II)

1. Disassemble in the order indicated in the figure.



1	Connecting rod cap (See Connecting Rod Cap Disassembly Note)
2	Connecting rod bearing
3	Connecting rod, piston (See Connecting Rod, Piston Disassembly Note)
4	Piston ring
5	Snap ring
6	Piston pin (See Piston Pin Disassembly Note)

7	Connecting rod
8	Piston
9	Lower cylinder block (See Lower Cylinder Block Disassembly Note)
10	Lower main bearing, thrust bearing
11	Crankshaft
12	Upper main bearing, thrust bearing
13	Upper cylinder block

G02831266

Fig. 28: Disassembling Cylinder Block
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 SIDE CLEARANCE INSPECTION**.)
2. Remove the connecting rod bolt from the connecting rod cap by tapping the bolt with a plastic hammer.

CONNECTING ROD, PISTON DISASSEMBLY NOTE

1. Before removing the connecting rod and piston, inspect the connecting rod oil clearance. (See **CONNECTING ROD OIL CLEARANCE INSPECTION/REPAIR**.)

PISTON PIN DISASSEMBLY NOTE

1. Remove the piston pin using the **SST** .

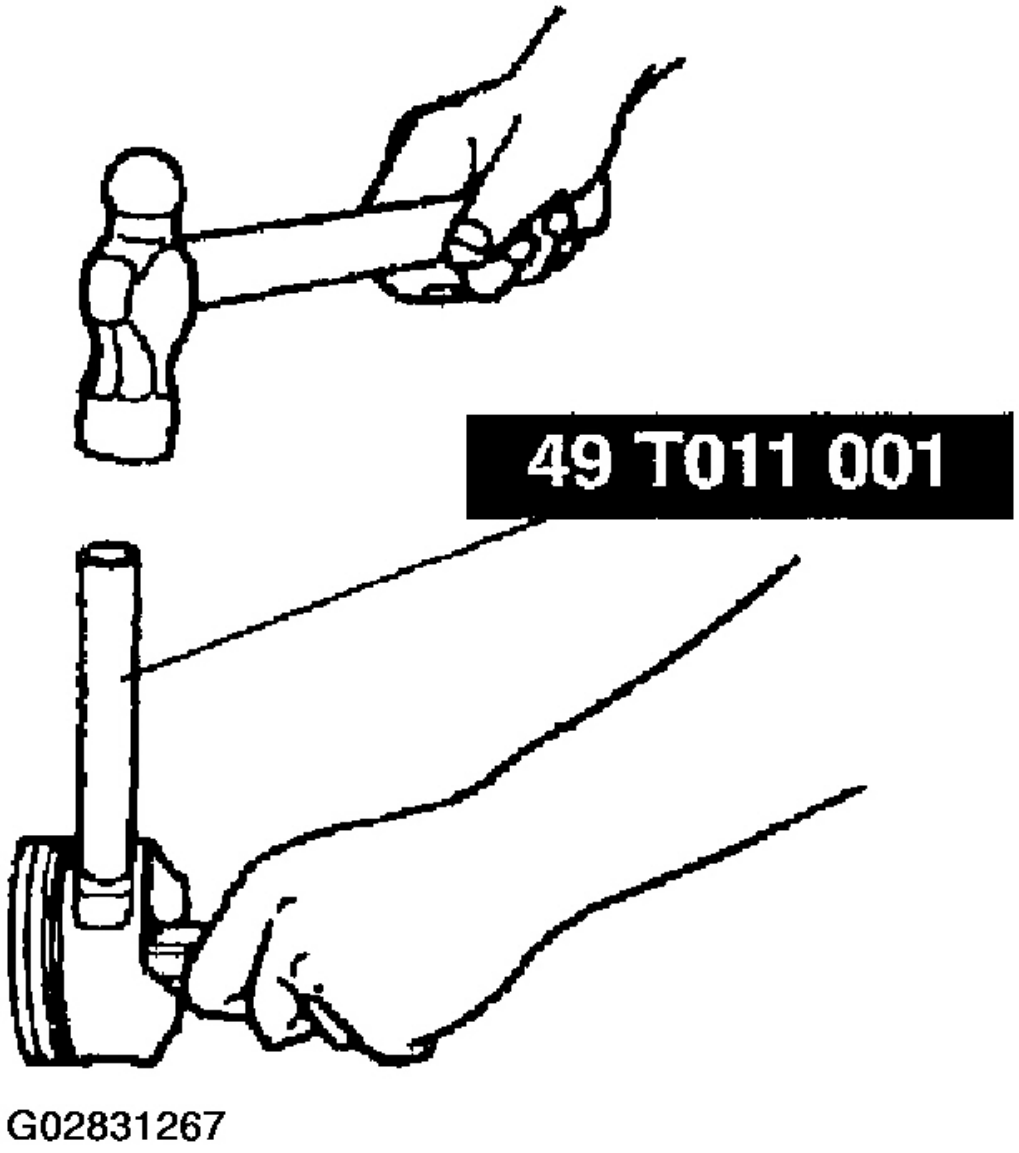


Fig. 29: Removing Piston Pin
Courtesy of MAZDA MOTORS CORP.

LOWER CYLINDER BLOCK DISASSEMBLY NOTE

1. Before removing the lower cylinder block, inspect the crankshaft end play. (See **CRANKSHAFT END PLAY INSPECTION**.)
2. Remove the lower cylinder block bolts in the order indicated in the figure in, loosening several passes.

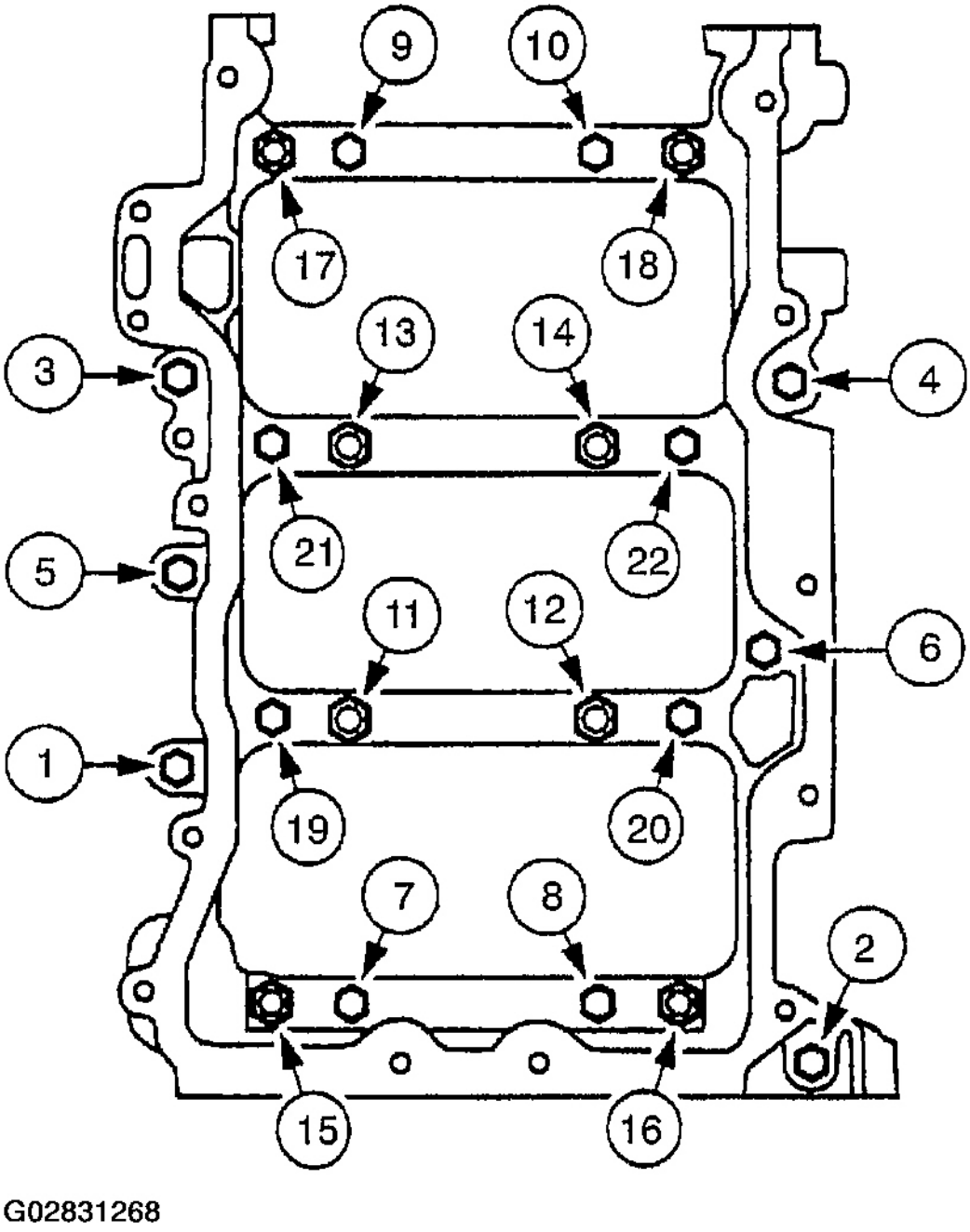
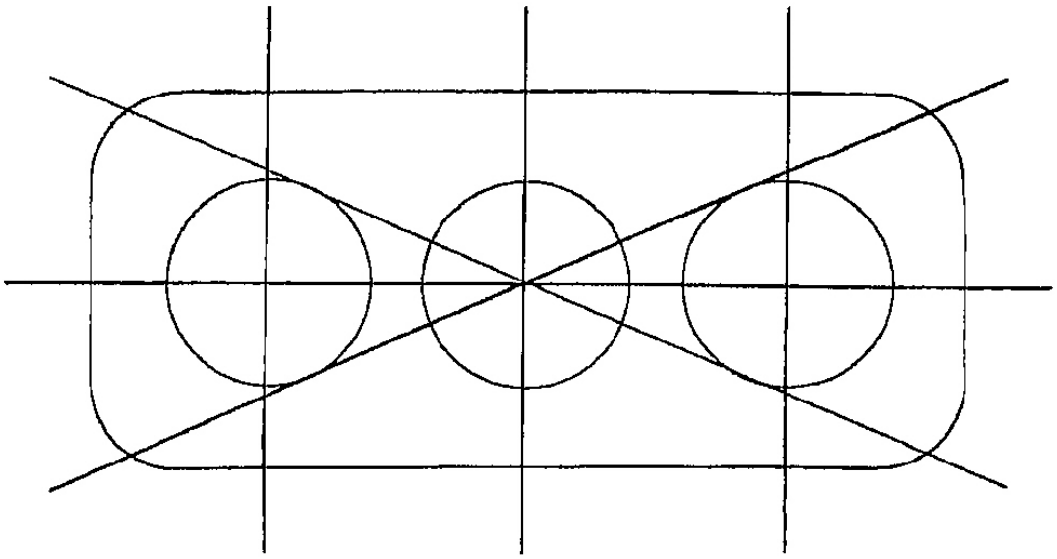


Fig. 30: Lower Cylinder Block Bolt Removal Sequence
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD INSPECTION

1. Carry out color contrast penetration examination on the cylinder head surface.
   - Replace the cylinder head if necessary.
2. Inspect for the following and replace if necessary.
   1. Camshaft end play. (See **CAMSHAFT END PLAY INSPECTION**.)
   2. Camshaft journal oil clearance. (See **CAMSHAFT OIL CLEARANCE INSPECTION**.)
3. Measure the cylinder head for distortion in the six directions as indicated in the figure.
   - If the cylinder head distortion exceeds the maximum, replace the cylinder head. Do not attempt to repair the cylinder head by milling or grinding.

Maximum Distortion 0.08 mm {0.0031 in}



G02831269

Fig. 31: Measuring Cylinder Head For Distortion
Courtesy of MAZDA MOTORS CORP.

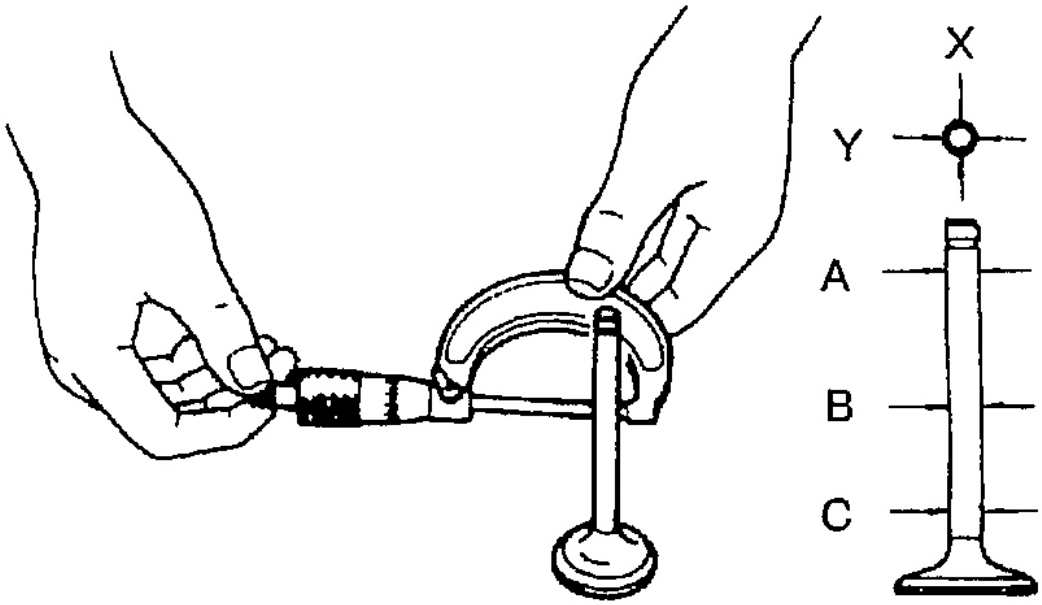
VALVE, VALVE GUIDE INSPECTION

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

     Standard Diameter

     IN: 5.975-5.995 mm {0.2352-0.2360 in}

EX: 5.950-5.970 mm {0.2343-0.2350 in}



G02831270

Fig. 32: Measuring Valve Stem Diameter
Courtesy of MAZDA MOTORS CORP.

2. Measure the inner diameter of each valve guide in X and Y directions at the three points (A, B, and C) as indicated in the figure.

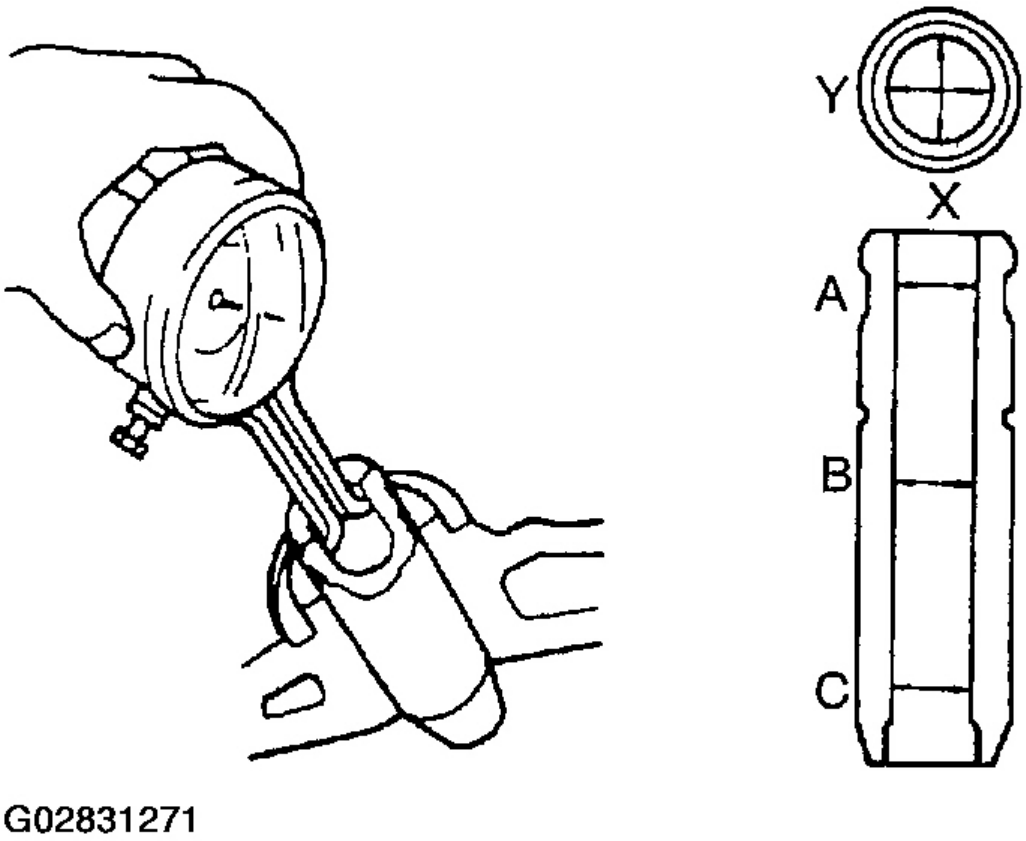


Fig. 33: Measuring Valve Guide Inner Diameter
Courtesy of MAZDA MOTORS CORP.

3. Calculate the valve stem to guide clearance by subtracting the outer diameter of the valve stem from the inner diameter of the corresponding valve guide.
   - If not as specified, replace the valve and/or the valve guide.

Standard Clearance

IN: 0.020-0.069 mm {0.0008-0.0027 in}

EX: 0.045-0.094 mm {0.0018-0.0037 in}

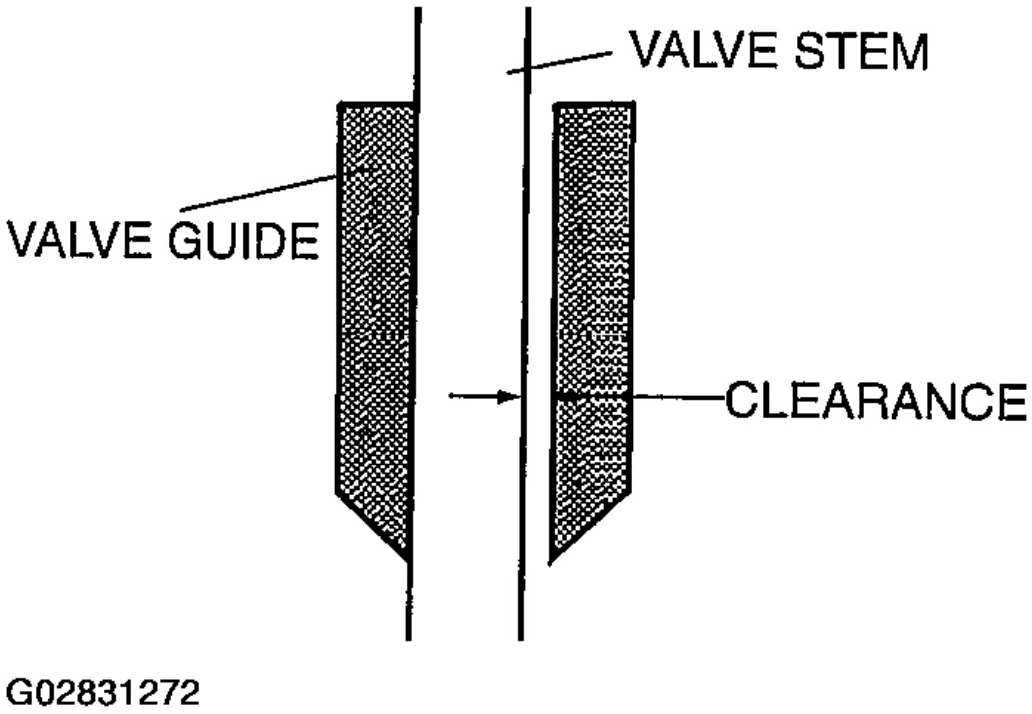


Fig. 34: Measuring Valve Stem To Guide Clearance
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE REPLACEMENT

VALVE GUIDE REMOVAL

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

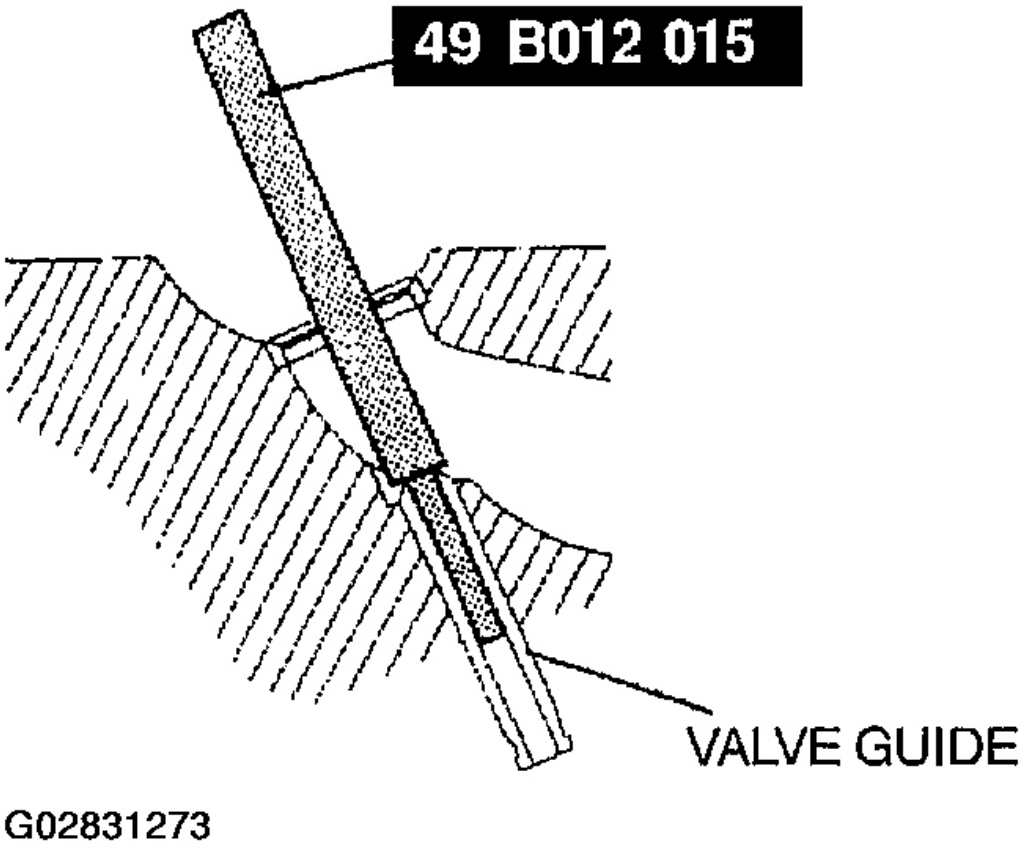


Fig. 35: Removing Valve Guide
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE INSTALLATION

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

   Depth L

   IN: 13.4-14.2 mm {0.528-0.559 in}

   EX: 13.4-14.2 mm {0.528-0.559 in}

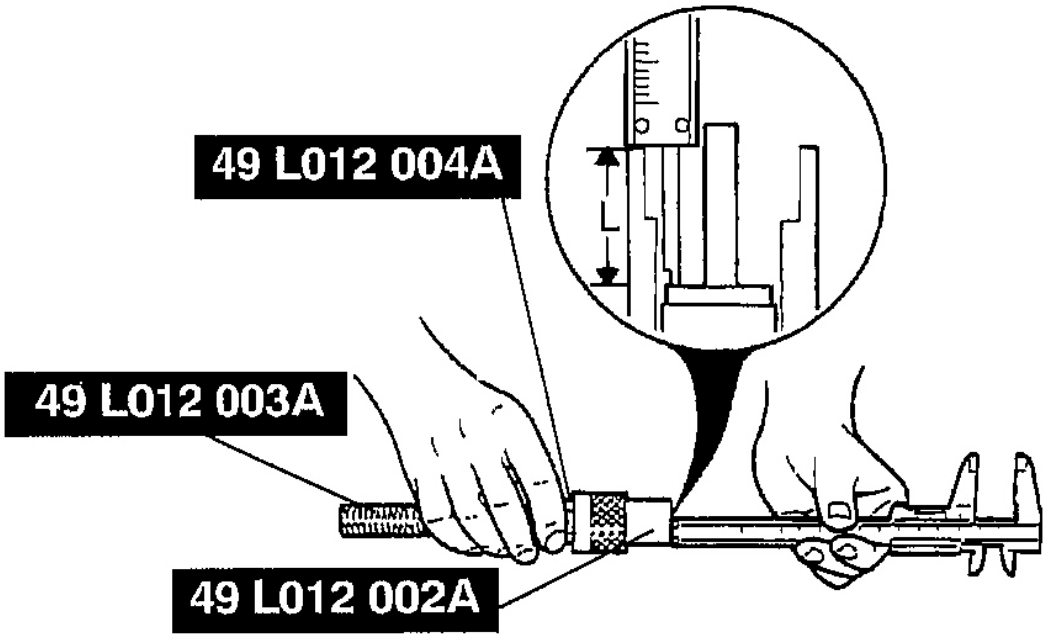


Fig. 36: Measuring Distance L
Courtesy of MAZDA MOTORS CORP.

2. Tap the valve guide in from the side opposite the combustion chamber until the **SSTs** contact the cylinder head.

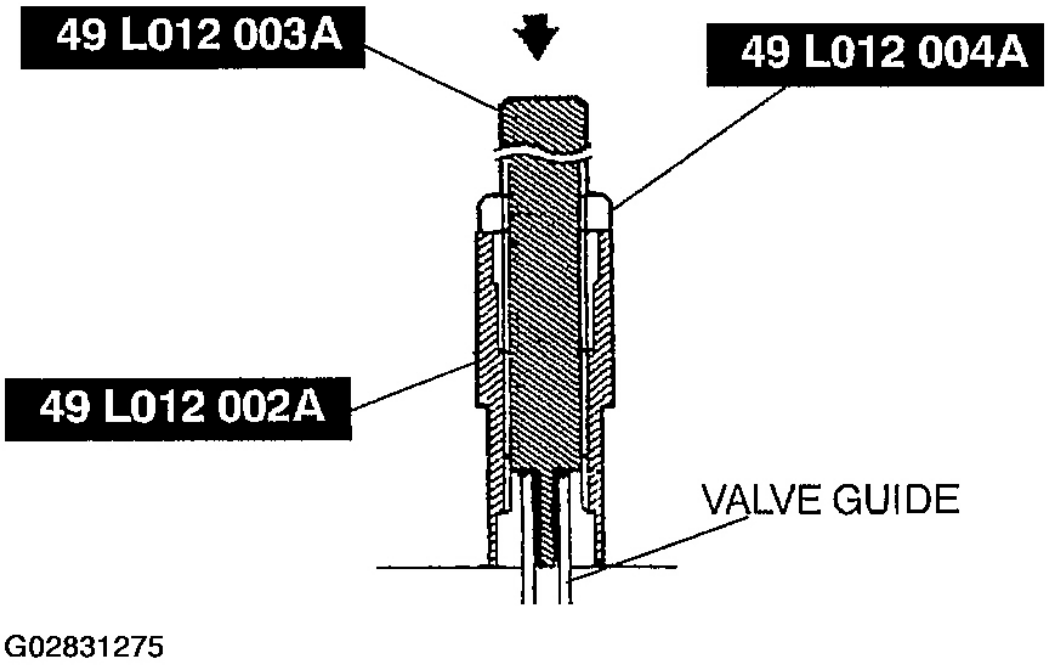


Fig. 37: Installing Valve Guide
Courtesy of MAZDA MOTORS CORP.

3. Verify that the valve guide projection height is within the specification.

Standard Height

IN: 13.4-14.2 mm {0.528-0.559 in}

EX: 13.4-14.2 mm {0.528-0.559 in}

VALVE SEAT INSPECTION/REPAIR

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

     Standard Width

     IN: 1.1-1.4 mm {0.043-0.055 in}

     EX: 1.4-1.7 mm {0.056-0.066 in}

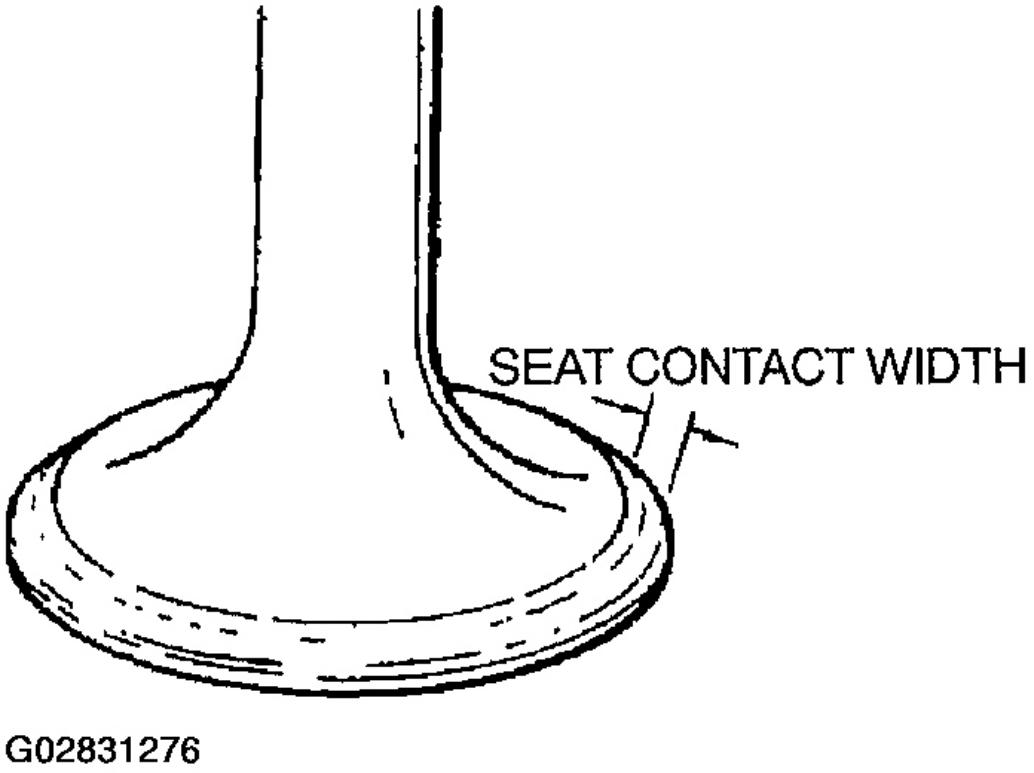


Fig. 38: Measuring Seat Contact Width
Courtesy of MAZDA MOTORS CORP.

2. Verify that the valve seating position is at the center of the valve face.
    - If the seating position is too high, correct the valve seat using a **70°** cutter, and then **45°** cutter.
    - If the seating position is too low, correct the valve seat using **30°** cutter, and then **45°** cutter.

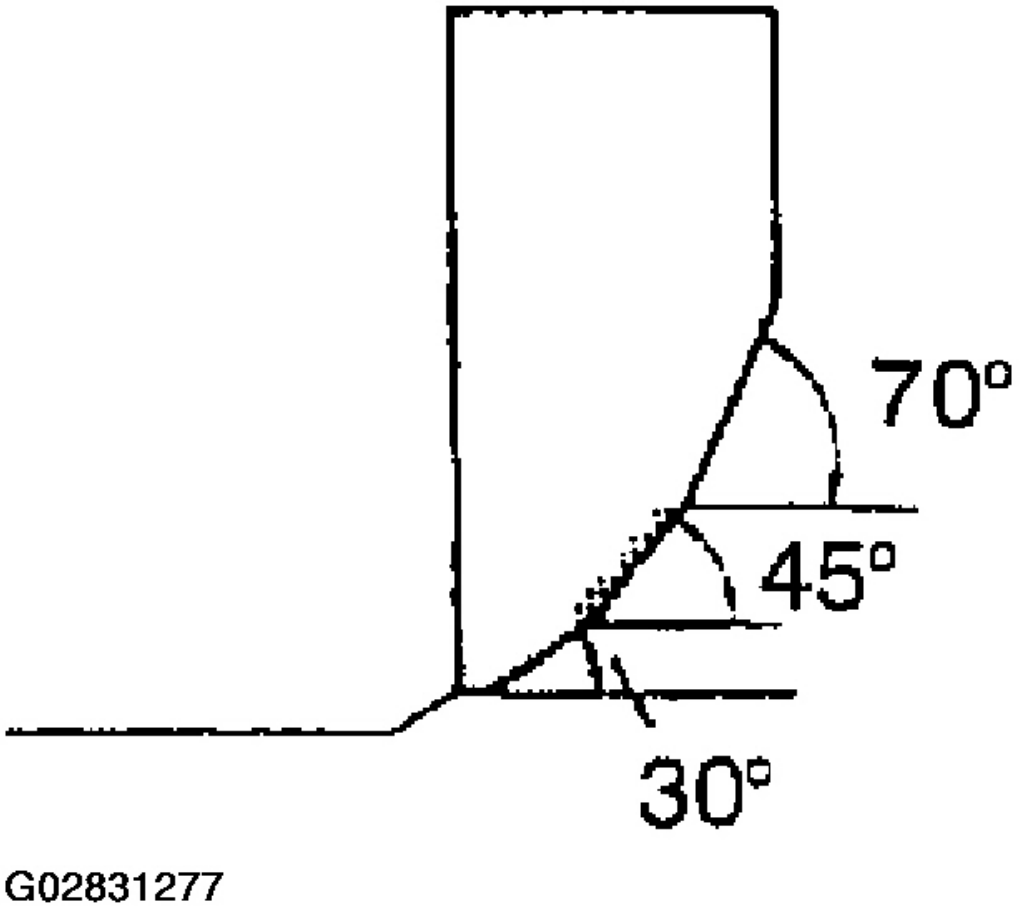


Fig. 39: Centering Valve Seating Position
Courtesy of MAZDA MOTORS CORP.

VALVE SPRING INSPECTION

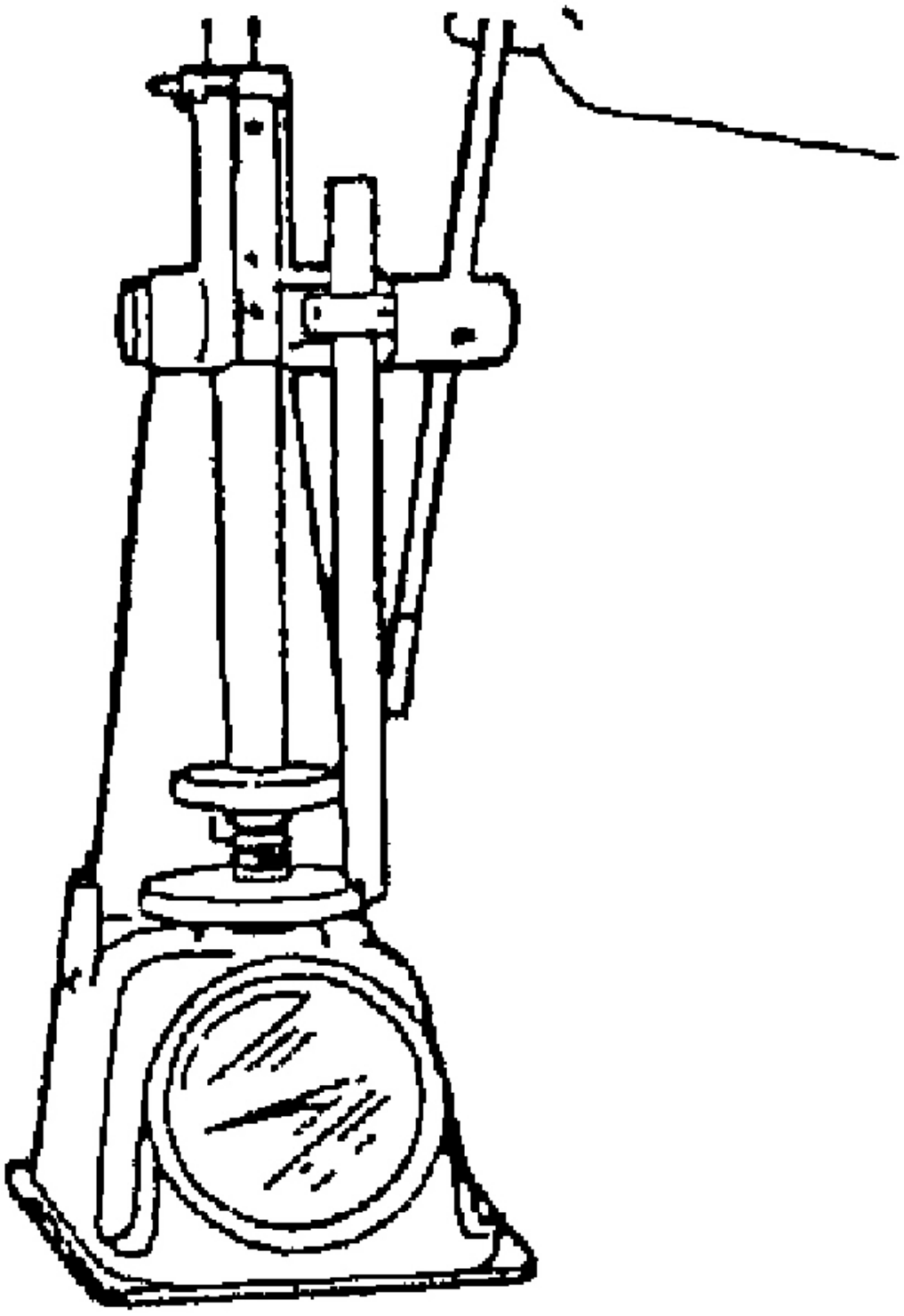
1. Apply pressing force to the pressure spring and inspect the spring height.
   - If not as specified, replace the valve spring.

   Pressing Force

   680 N {69.3 kgf, 152 lbf}

   Standard Height

   30.19 mm {1.189 in}



G02831278

Fig. 40: Applying Pressing Force
Courtesy of MAZDA MOTORS CORP.

2. Measure the amount of off-square on the valve spring.
   - If not as specified, replace the valve spring.

   Valve Spring Maximum Off-Square

   1% (0.468 mm {0.00184 in})

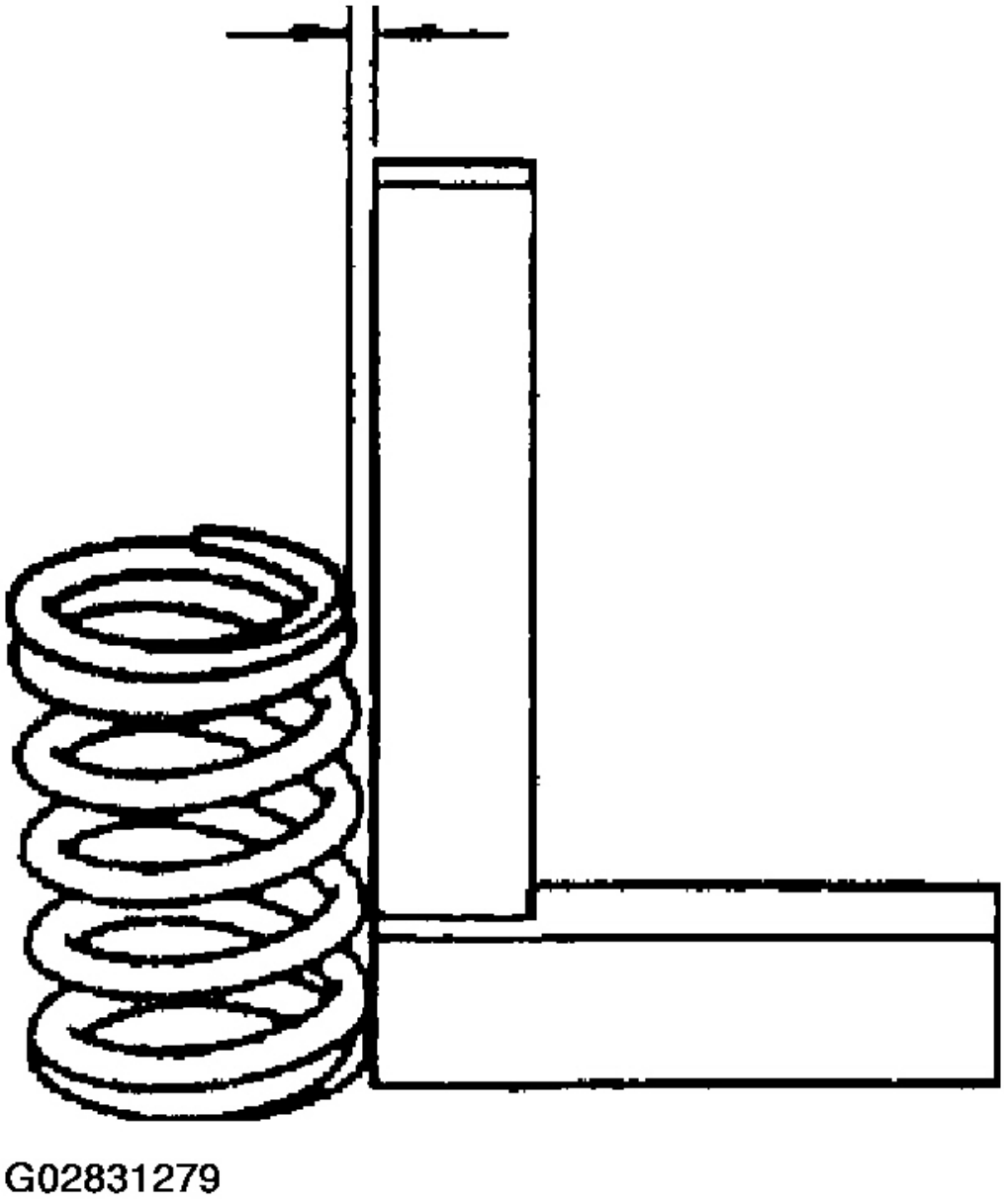


Fig. 41: Measuring Valve Spring Off-Square
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT INSPECTION

1. Measure the cam lobe height at the two points as indicated in the figure to calculate the gap between X and Y.

- If not as specified, replace the camshaft.

  Standard Height

  IN: 4.79 mm {0.189 in}

  EX: 4.79 mm {0.189 in}

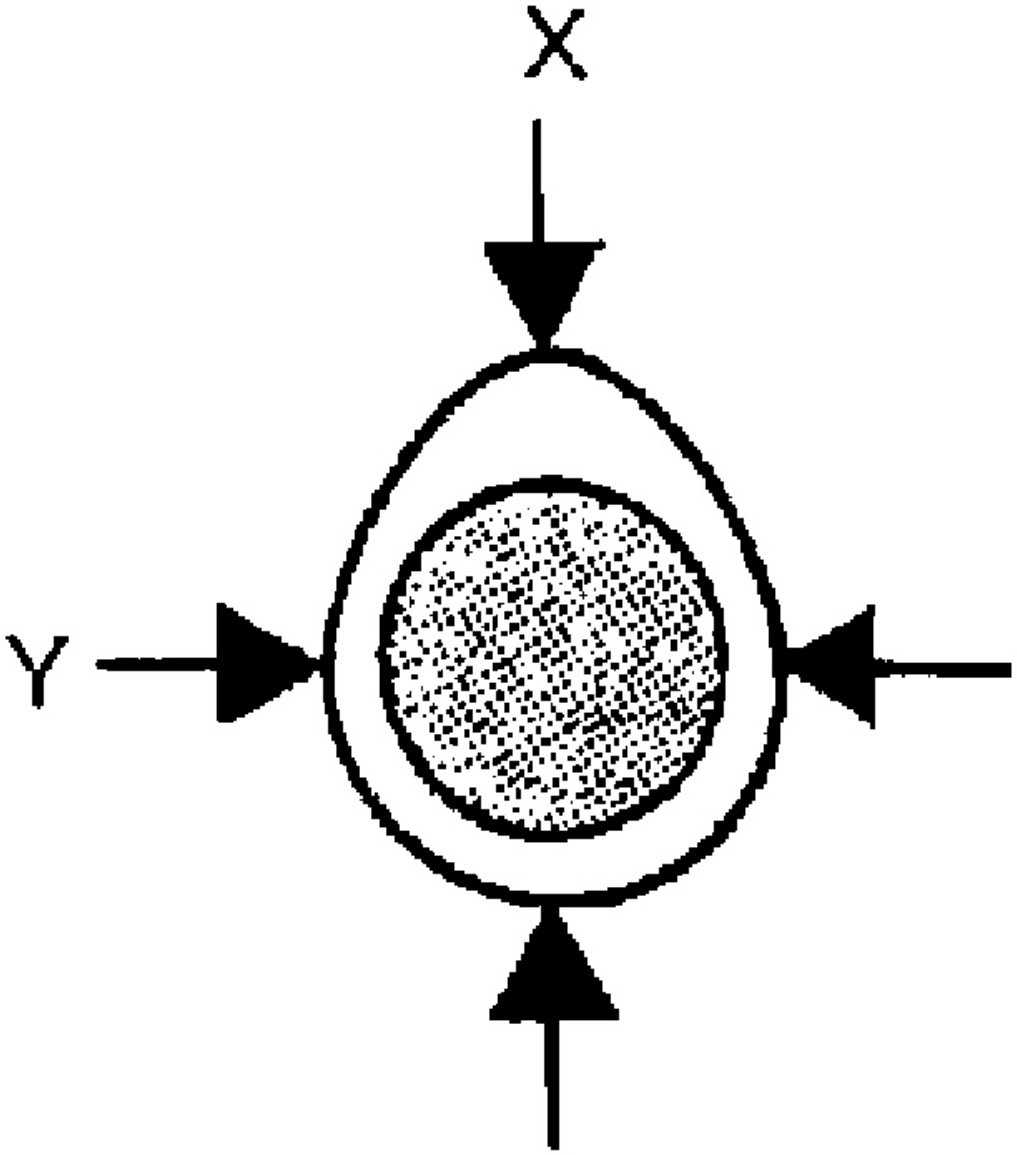


Fig. 42: Measuring Cam Lobe Height
Courtesy of MAZDA MOTORS CORP.

2. Measure the journal diameters in X and Y directions at the two points (A and B) as indicated in the figure.
    - If not as specified, replace the camshaft.

Standard Diameter

26.936-26.962 mm {1.0604-1.0615 in}

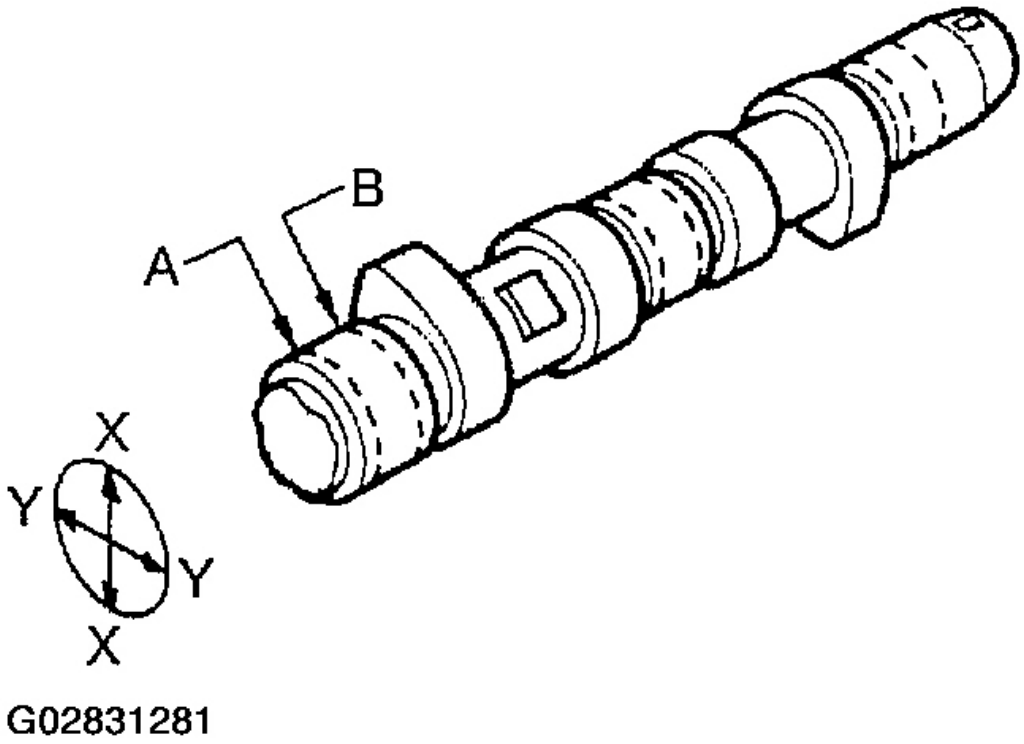


Fig. 43: Measuring Journal Diameters
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT OIL CLEARANCE INSPECTION

1. Position plastigage atop the journals in the axial direction.
2. Install the camshaft cap. (See **TIMING CHAIN (LH) ASSEMBLY NOTE**.) (See **TIMING CHAIN (RH) ASSEMBLY NOTE**.)
3. Remove the camshaft cap. (See **CAMSHAFT CAP (RH) DISASSEMBLY NOTE**.) (See **CAMSHAFT CAP (LH) DISASSEMBLY NOTE**.)
4. Measure the oil clearance.
   - If the oil clearance exceeds the maximum clearance, replace the cylinder head.

Standard Clearance

0.025-0.076 mm {0.0010-0.0029 in}

Maximum clearance

0.121 mm {0.00476 in}

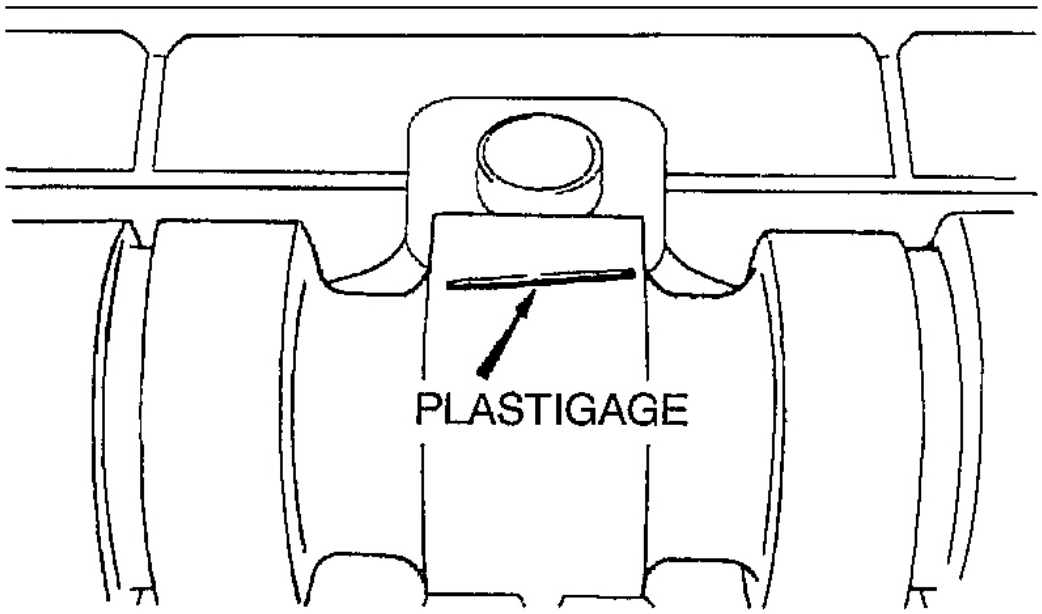


Fig. 44: Measuring Camshaft Oil Clearance Using Plastigage
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT END PLAY INSPECTION

1. Measure the camshaft end play.
   - If the camshaft end play exceeds the maximum end play, replace the cylinder head or camshaft.

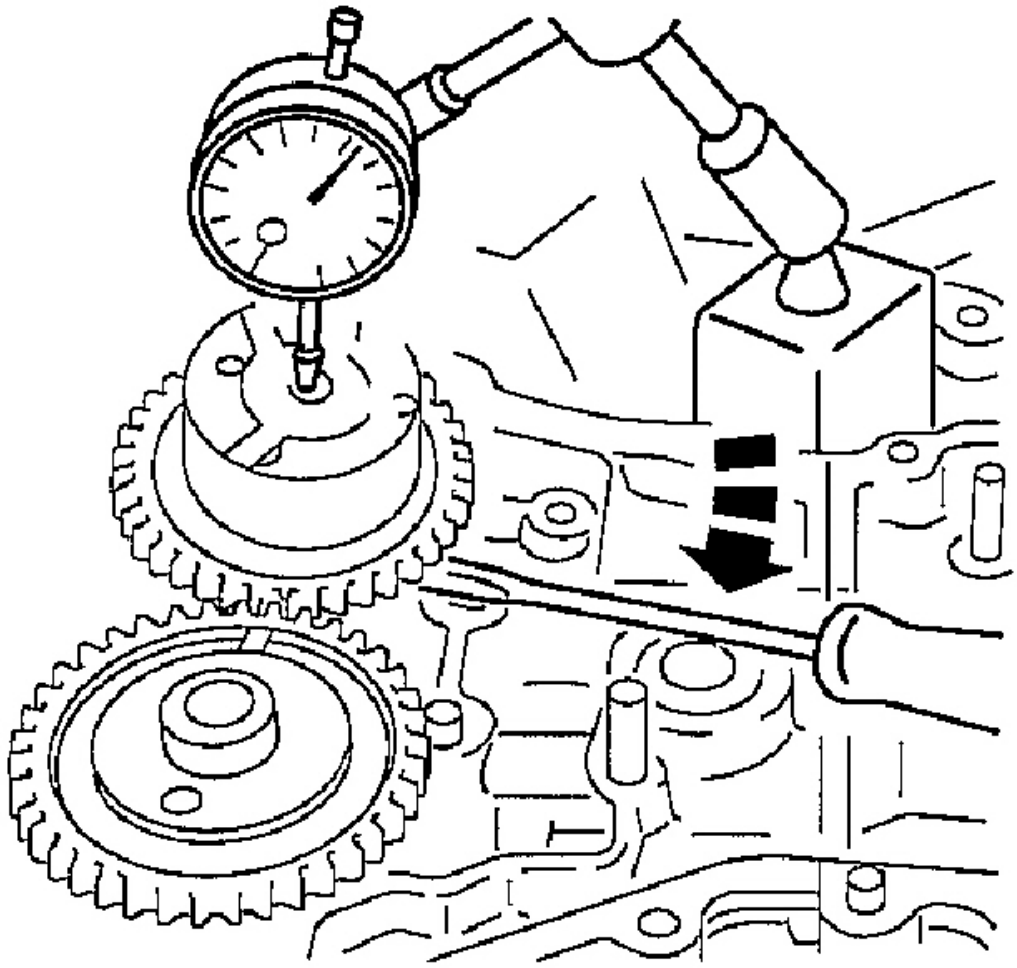
     Standard End Play

     0.025-0.165 mm {0.0010-0.0064 in}

     Maximum End Play

     0.190 mm{0.00748 in}
2. Remove the camshaft cap. (See **CAMSHAFT CAP (RH) DISASSEMBLY NOTE**.) (See **CAMSHAFT**

CAP (LH) DISASSEMBLY NOTE.)



G02831283

Fig. 45: Measuring Camshaft End Play
Courtesy of MAZDA MOTORS CORP.

HYDRAULIC LASH ADJUSTER (HLA) INSPECTION

1. Measure the diameter of each HLA bore.

Standard Diameter

16.018-16.057 mm {0.63063-0.63216 in}

2. Measure the diameter of each HLA.

   Standard Diameter

   15.988-16.000 mm {0.62945-0.62992 in}

3. Calculate the clearance between the HLA and the related HLA bores.
   - If the clearance exceeds the maximum clearance, replace the cylinder head or the HLA.

   Standard Clearance

   0.018-0.069 mm {0.0008-0.0027 in}

   Maximum Clearance

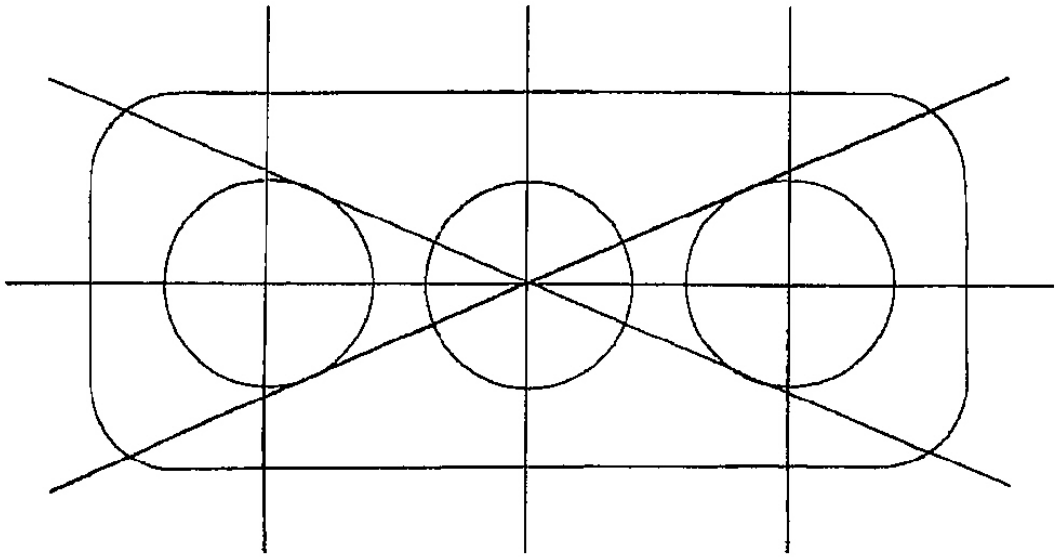
   0.16 mm {0.0063 in}

CYLINDER BLOCK INSPECTION

1. Measure the distortion of the cylinder block top surface in the six directions as indicated in the figure.
   - If not as specified, replace the cylinder block.

     Cylinder Block Maximum Distortion

     0.08 mm {0.0031 in}



G02831284

Fig. 46: Measuring Cylinder Block Distortion
Courtesy of MAZDA MOTORS CORP.

2. Measure the cylinder bores in X and Y directions at **50 mm {2.0 in}** below the top surface.
   - If the difference between measurements A and C exceeds the maximum taper, replace the cylinder block.
   - If the difference between measurements X and Y exceeds the maximum distortion, replace the cylinder block.

Cylinder Bore

89.000-89.030 mm {3.5039-3.5051 in}

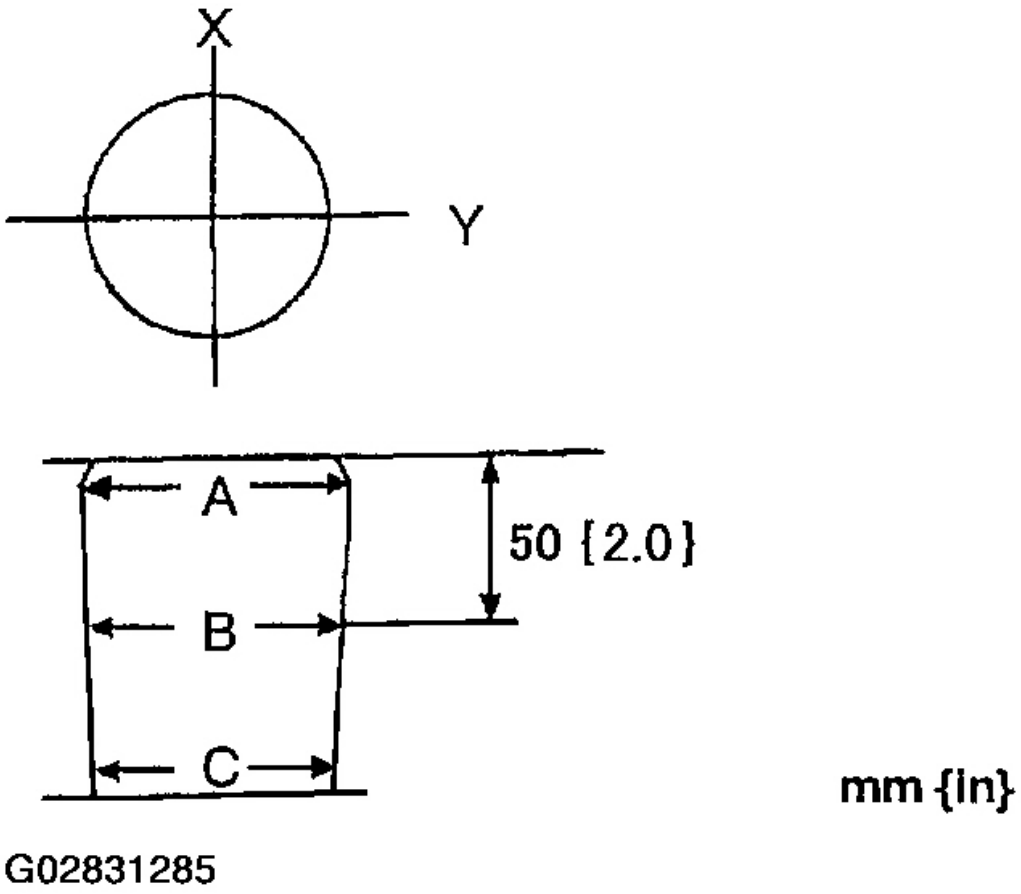


Fig. 47: Measuring Cylinder Bore Taper
Courtesy of MAZDA MOTORS CORP.

Maximum Taper

0.020 mm {0.00079 in}

Off-Round

0.020 mm {0.00079 in}

WATER INLET TUBE INSTALLATION

NOTE: When replacing a cylinder block that has no water inlet tube.

1. Apply silicone sealant to the water inlet tube as indicated in the figure.

Thickness

2.0 mm {0.079 in}

2. Install the water inlet tube using the **SST** .

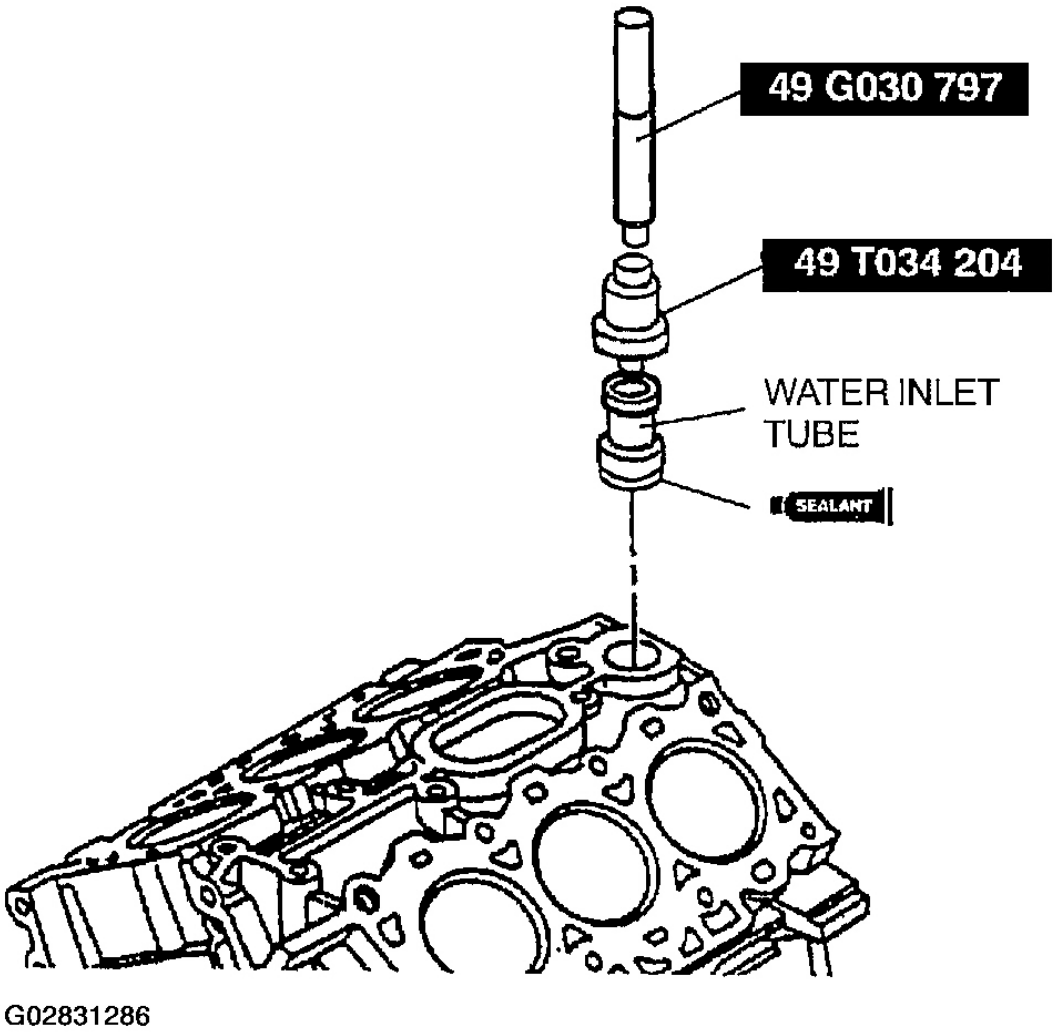


Fig. 48: Installing Water Inlet Tube
Courtesy of MAZDA MOTORS CORP.

PISTON INSPECTION

1. Measure the outer diameter of each piston at a right angle **(90°)** to the piston pin, **42.6 mm {1.68 in}** below the top of the piston.
    - If the piston diameter is below the standard diameter, replace the piston.

Piston Diameter

88.990-89.030 mm {3.5036-3.5051 in}

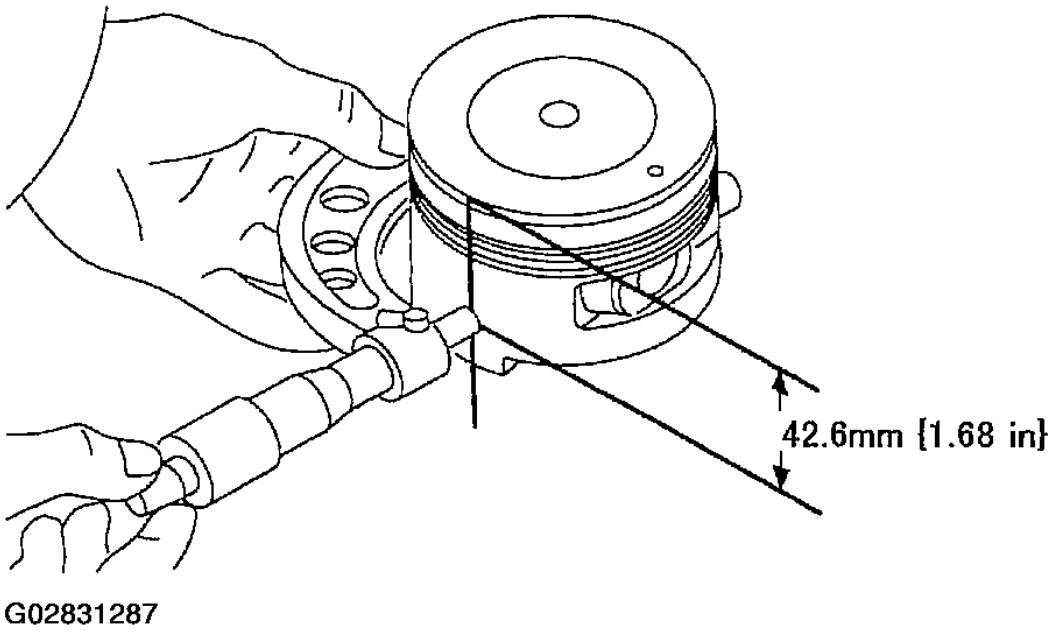


Fig. 49: Measuring Piston Outer Diameter
Courtesy of MAZDA MOTORS CORP.

PISTON CLEARANCE INSPECTION

1. Measure the piston-to-cylinder clearance.
    - If not as specified, replace the piston or the cylinder block.
        - If the piston is replaced, the piston rings must also be replaced.

Standard Clearance

0.012-0.022 mm {0.0004-0.0008 in}

PISTON RING CLEARANCE INSPECTION

1. Measure the piston ring-to-ring groove clearance around the entire circumference.
    - If the piston ring-to-ring groove clearance exceeds the maximum clearance, replace the piston and piston ring.

      Standard Clearance

Top: 0.040-0.075 mm {0.0016-0.0029 in}

Second: 0.040-0.085 mm {0.0016-0.0033 in}

Maximum Clearance

0.10 mm {0.0039 in}

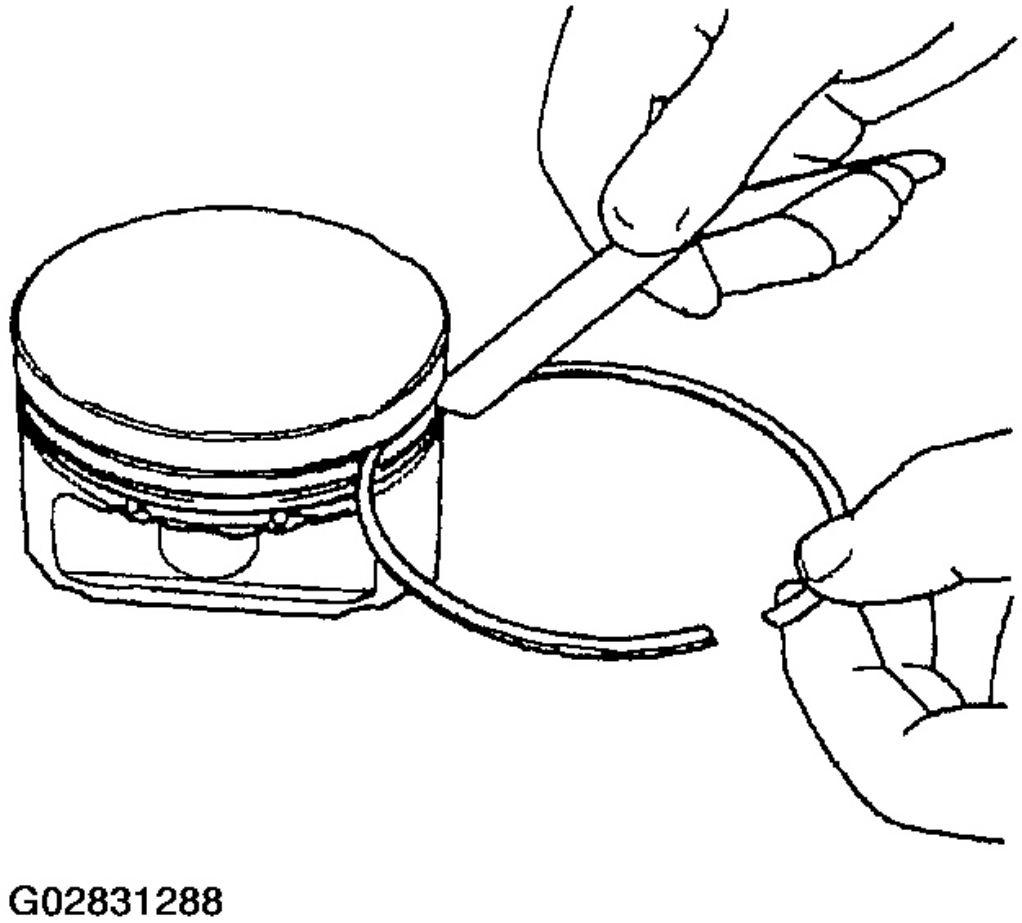


Fig. 50: Measuring Piston Ring-To-Ring Groove Clearance
Courtesy of MAZDA MOTORS CORP.

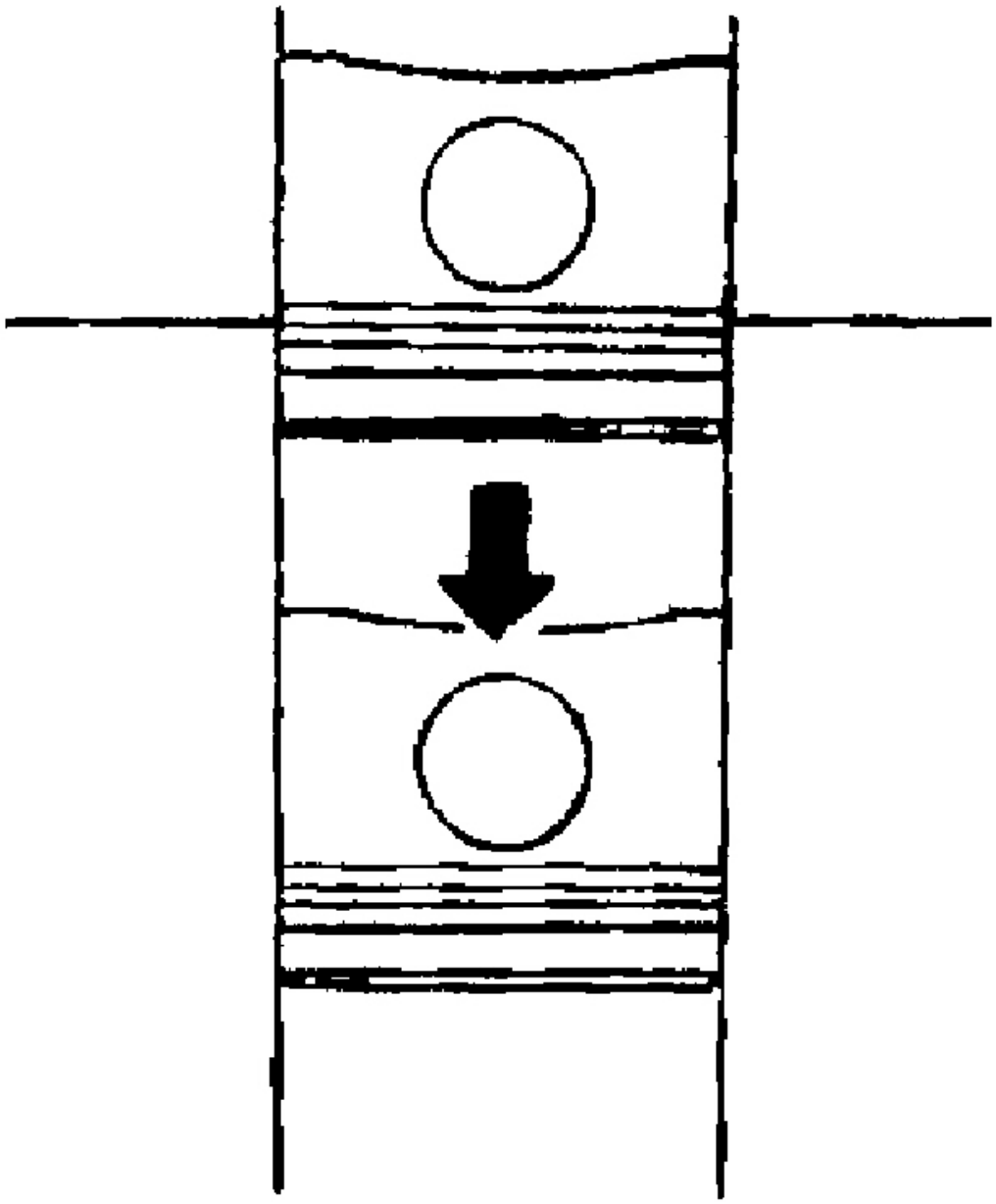
2. Insert the piston ring into the cylinder by hand and use the piston to push it to the bottom of the ring travel.
3. Measure each piston ring end gap with a feeler gauge.
    - If the piston ring end gap exceeds the maximum end gap, replace the piston ring.

Standard End Gap

Top: 0.10-0.25 mm {0.004-0.009 in}

Second: 0.27-0.42 mm {0.011-0.016 in}

Oil (side Rail): 0.15-0.65 mm {0.006-0.025 in}



G02831289

Fig. 51: Measuring Piston Ring End Gap
Courtesy of MAZDA MOTORS CORP.

Maximum End Gap

Top: 0.50 mm {0.019 in}

Second: 0.65 mm {0.025 in}

Oil (Side Rail): 0.90 mm {0.035 in}

PISTON PIN CLEARANCE INSPECTION

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

   Standard Diameter

   21.008-21.012 mm {0.82709-0.82724 in}

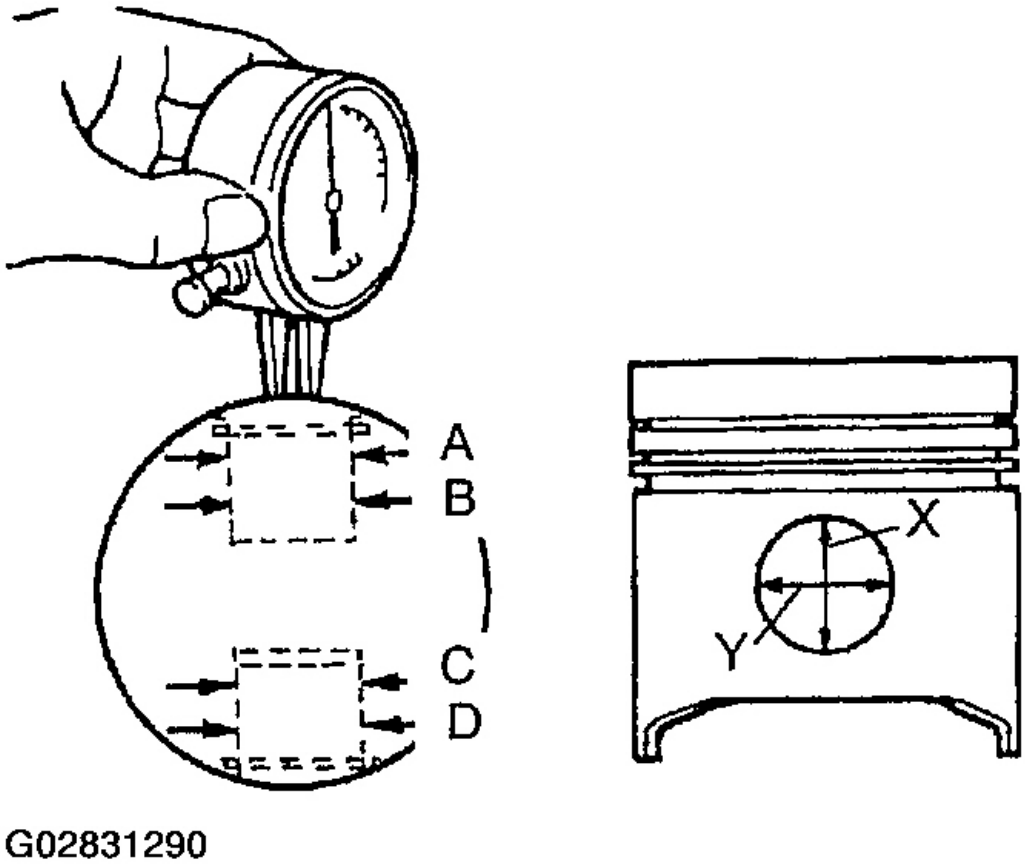


Fig. 52: Measuring Piston Pin Bore Diameter
Courtesy of MAZDA MOTORS CORP.

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

   Standard Diameter

   21.017-21.031 mm {0.82744-0.82799 in}

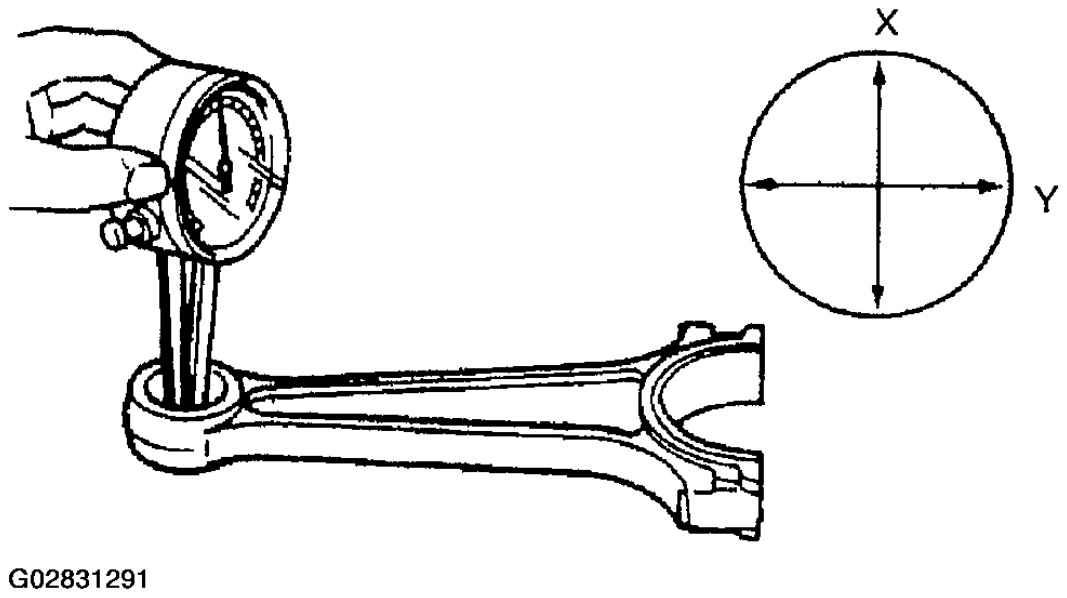


Fig. 53: Measuring Connecting Rod Small End Inner Diameter
Courtesy of MAZDA MOTORS CORP.

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

   Standard Diameter

   21.011-21.013 mm {0.82721-0.82728 in}

4. Calculate the piston pin-to-piston pin bore clearance.
   - If not as specified, replace the piston and/or piston pin.

     Standard Clearance

     -0.005-0.001 mm {-0.00019-0.00003 in}

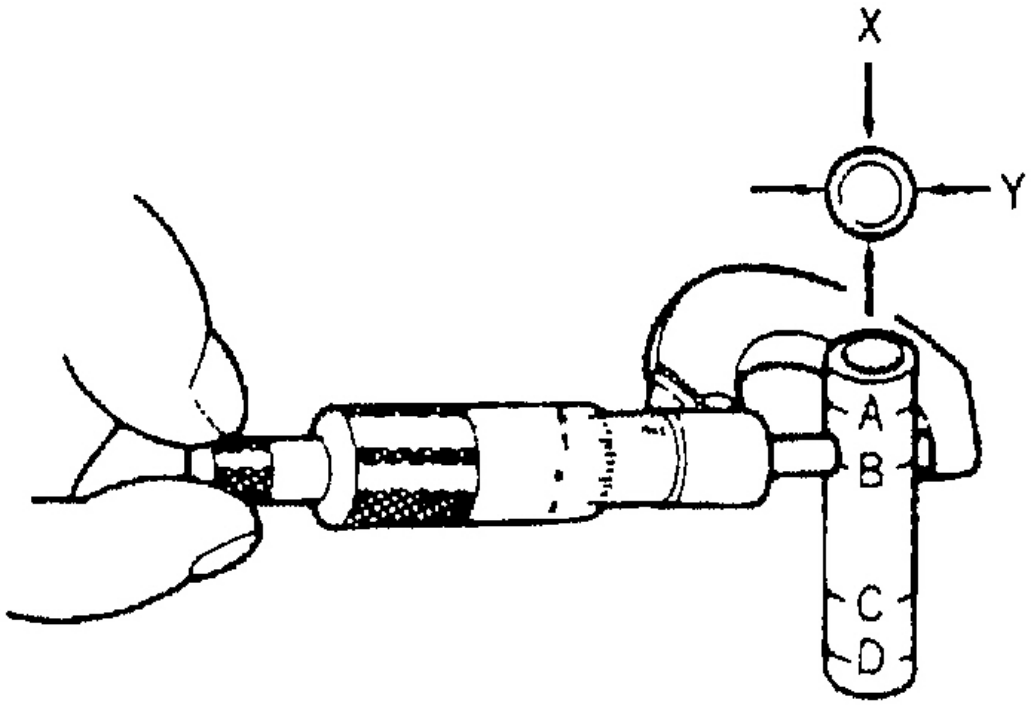


Fig. 54: Measuring Piston Pin
Courtesy of MAZDA MOTORS CORP.

5. Calculate small end-to-piston pin clearance of the connecting rod.
    - If small end-to-piston pin clearance of the connecting rod exceeds the maximum clearance, replace the connecting rod or piston pin.

Standard Clearance

0.004-0.020 mm {0.00016-0.00078 in}

Maximum Clearance

0.035 mm {0.0013 in}

CRANKSHAFT INSPECTION

1. Measure the crankshaft runout.
    - If the crankshaft runout exceeds the maximum runout, replace the crankshaft.

Maximum Runout

0.05 mm {0.0019 in}

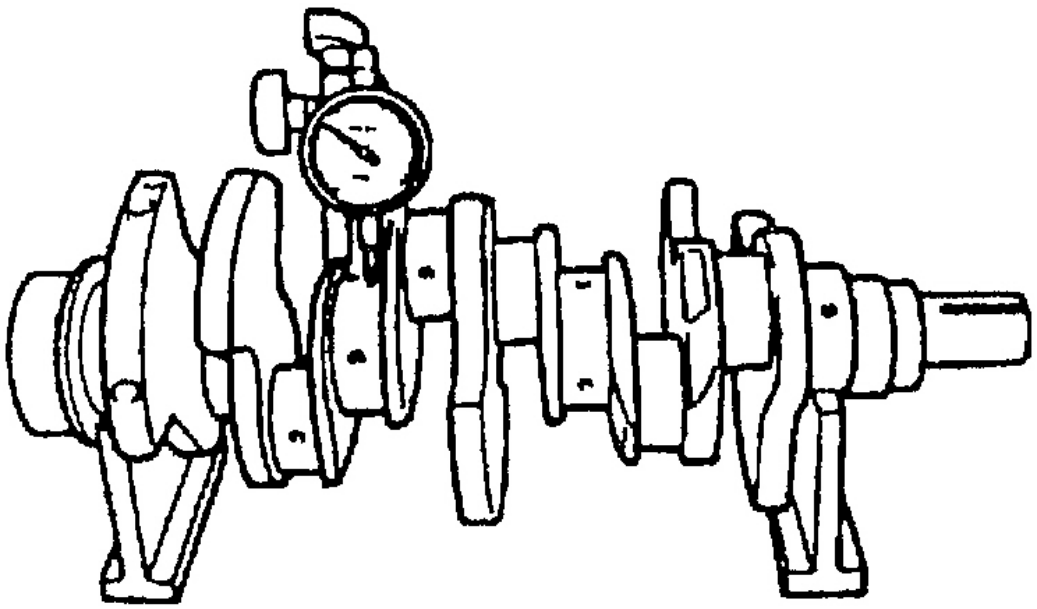


Fig. 55: Measuring Crankshaft Runout
Courtesy of MAZDA MOTORS CORP.

2. Measure the journal diameter in X and Y directions at the two points (A and B) as indicated in the figure.
    - If not as specified, replace the crankshaft or grind the journal and install the undersize bearing.

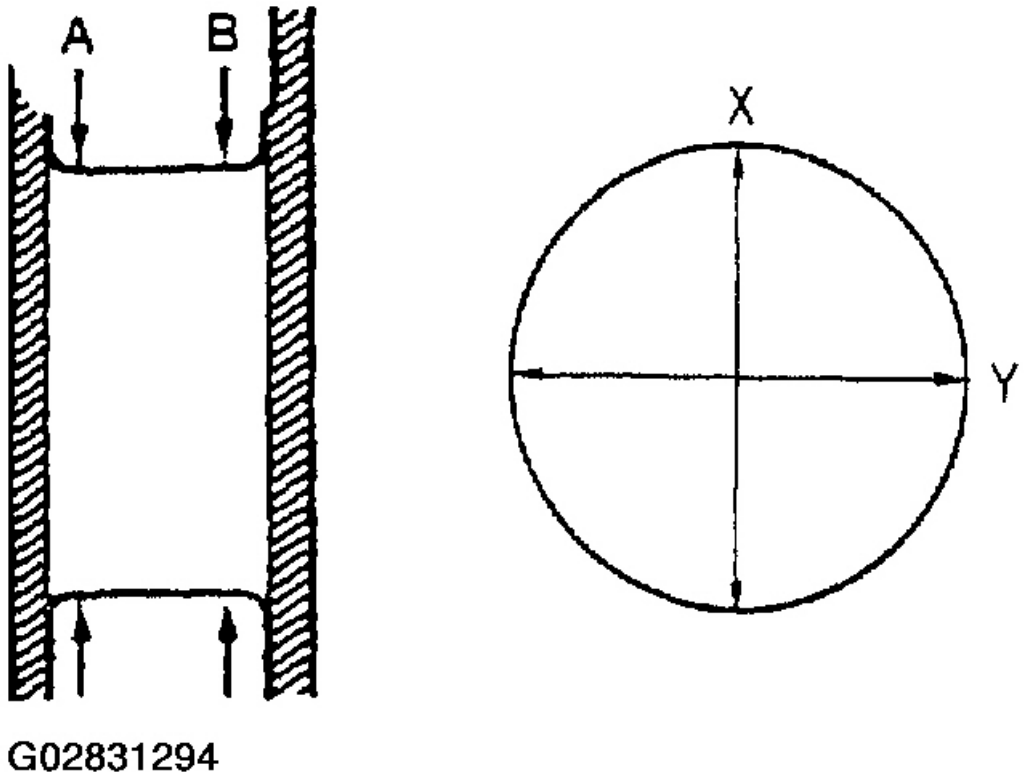


Fig. 56: Measuring Crankshaft Journal Diameter
Courtesy of MAZDA MOTORS CORP.

MAIN JOURNAL BEARING SPECIFICATIONS

Bearing Size (mm {in})	Standard Diameter (mm {in})
Standard	62,968-62.992 {2.4791-2.4799}
0.25{0.01} Undersize	62.718-62.742 {2.4693-2.4701}

CRANK PIN BEARING SPECIFICATIONS

Bearing Size (mm {in})	Standard Diameter (mm {in})
Standard	49.970-49.990 {1.9674-1.9681}
0.02 {0.0008} Undersize	49.950-49.970 {1.9666-1.9673}
0.05 {0.0020} Undersize	49.920-49.940 {1.9654-1.9661}
0.25 {0.01} Undersize	49.720-49.740 {1.9575-1.9582}

CRANKSHAFT OIL CLEARANCE INSPECTION/REPAIR

CAUTION: Because the bolts are pliant bolts, they cannot reused. Use new bolts for inspection. The bolts may be reused for assembly.

1. Install the upper main bearing and crankshaft.
2. Position a plastigage atop the journals in the axial direction.
3. Install the lower main bearing and lower cylinder block, and tighten the bolts in the order indicated in the figure.

   Tightening Torque

   37-43 N.m {3.7-4.4kgf.m, 27-31 ft.lbf}

4. Tighten the bolts by turning each **85° - 95°** in the sequence as indicated in the figure.
5. Loosen the bolts in the reverse order of tightening.

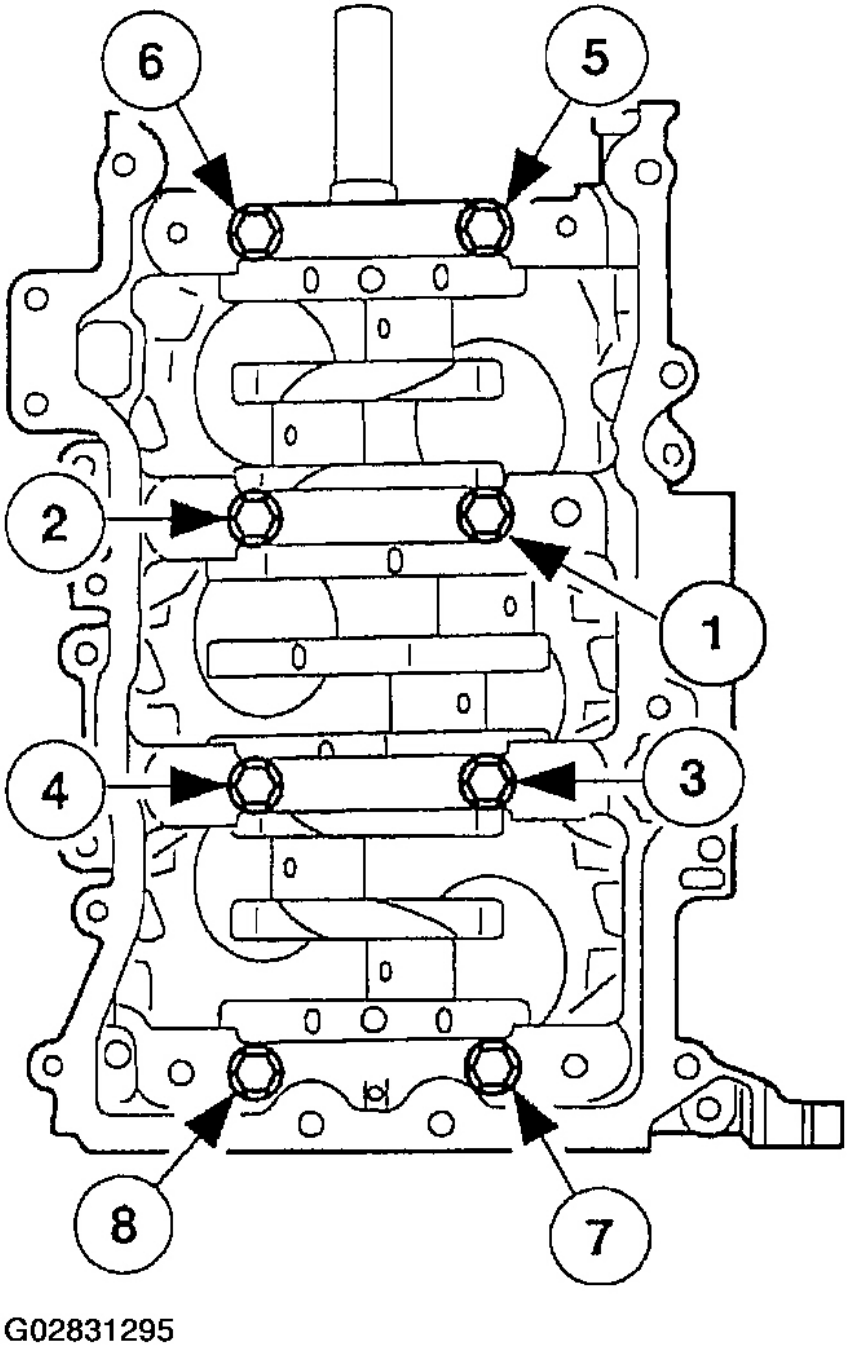


Fig. 57: Lower Cylinder Block Main Bearing Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

6. Measure the main journal oil clearance.
    - If the clearance exceeds the maximum, replace the main bearing using the main bearing selection

table or grind the main journal and install the undersize bearings so that the specified oil clearance is obtained.

Standard Clearance

0.025-0.045 mm {0.0010-0.0017 in}

Maximum Clearance

0.050 mm {0.0019 in}

mm {in}

Bearing size	Grade	Bearing thickness	
		Upper:No.1,2,3,4 Lower: No.1,2,3	Lower: No.4
Standard	1	2.494—2.500 {0.09819—0.09842}	2.492—2.498 {0.09812—0.09834}
	2	2.498—2.504 {0.09835—0.09858}	2.496—2.502 {0.09827—0.09850}
	3	2.502—2.508 {0.09851—0.09873}	2.5000—2.5006 {0.09843—0.09844}
0.25 {0.01} undersize	–	2.623—2.629 {0.10327—0.10350}	2.621—2.627 {0.10319—0.10342}

G02831296

Fig. 58: Main Journal Bearing Specifications
Courtesy of MAZDA MOTORS CORP.

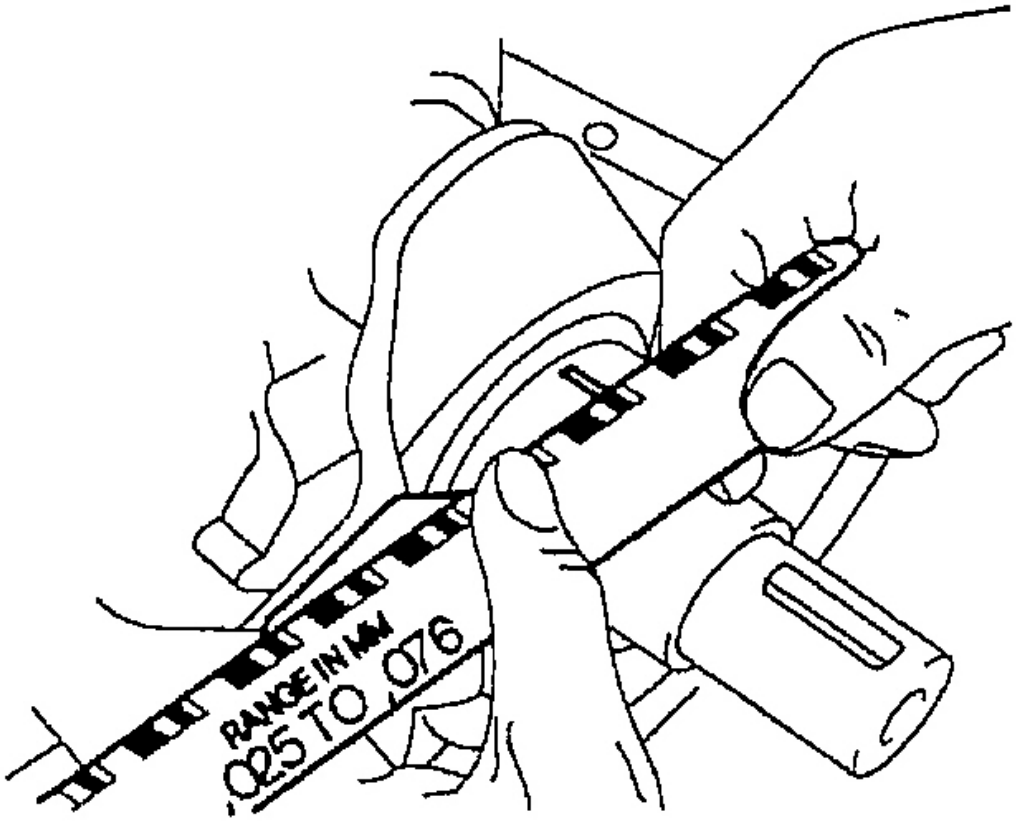


Fig. 59: Measuring Main Journal Oil Clearance Using Plastigage
Courtesy of MAZDA MOTORS CORP.

MAIN BEARING SELECTION TABLE

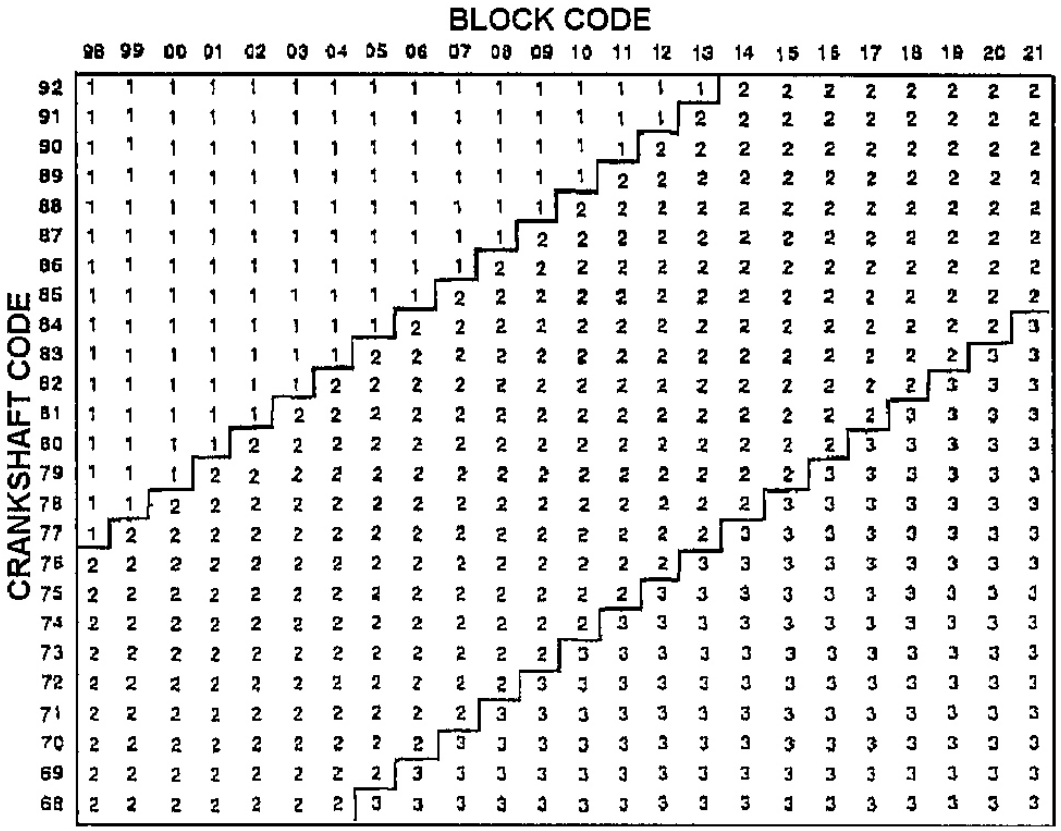


Fig. 60: Main Bearing Selection Table
Courtesy of MAZDA MOTORS CORP.

EXAMPLE OF MAIN BEARING SELECTION

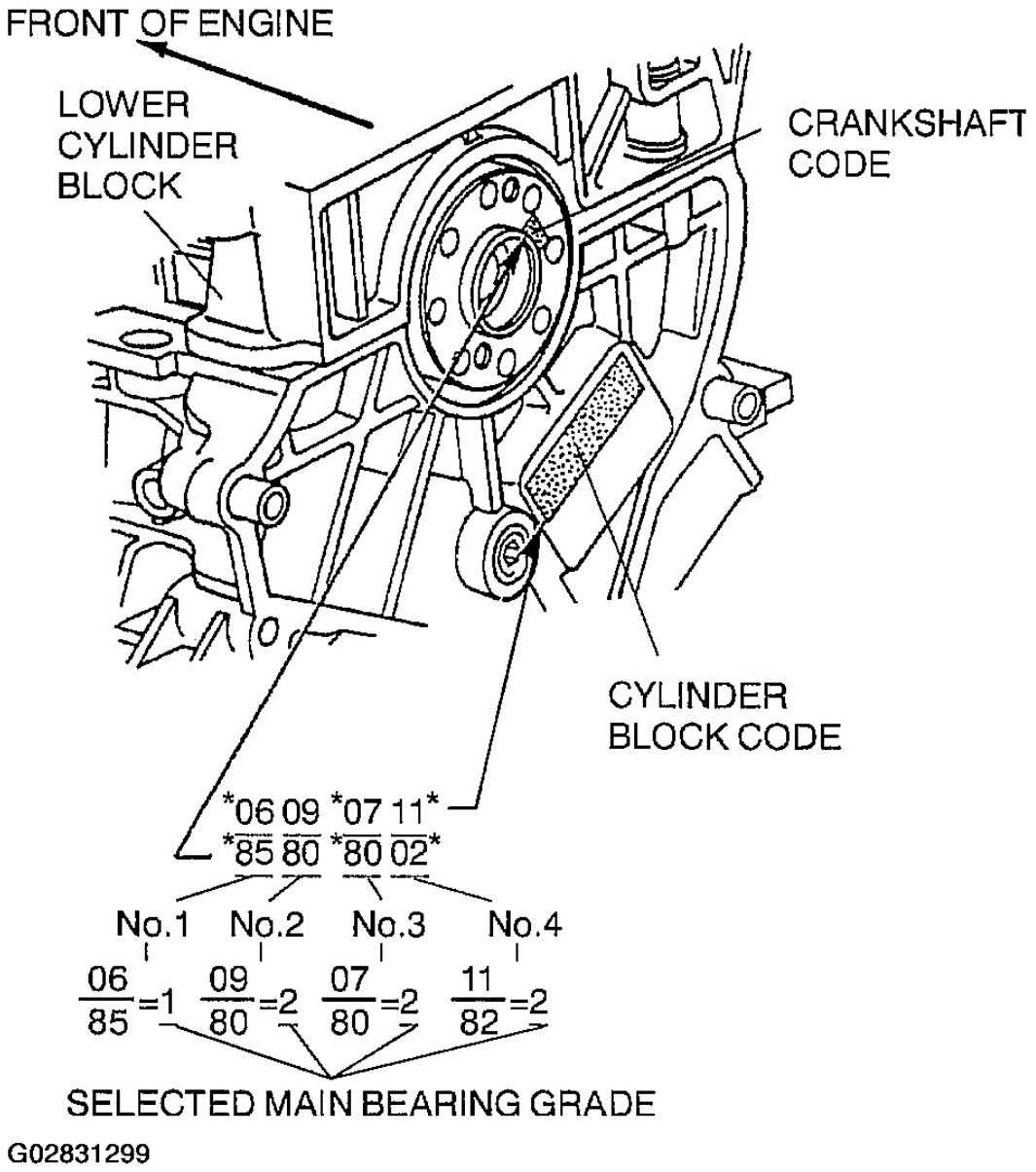


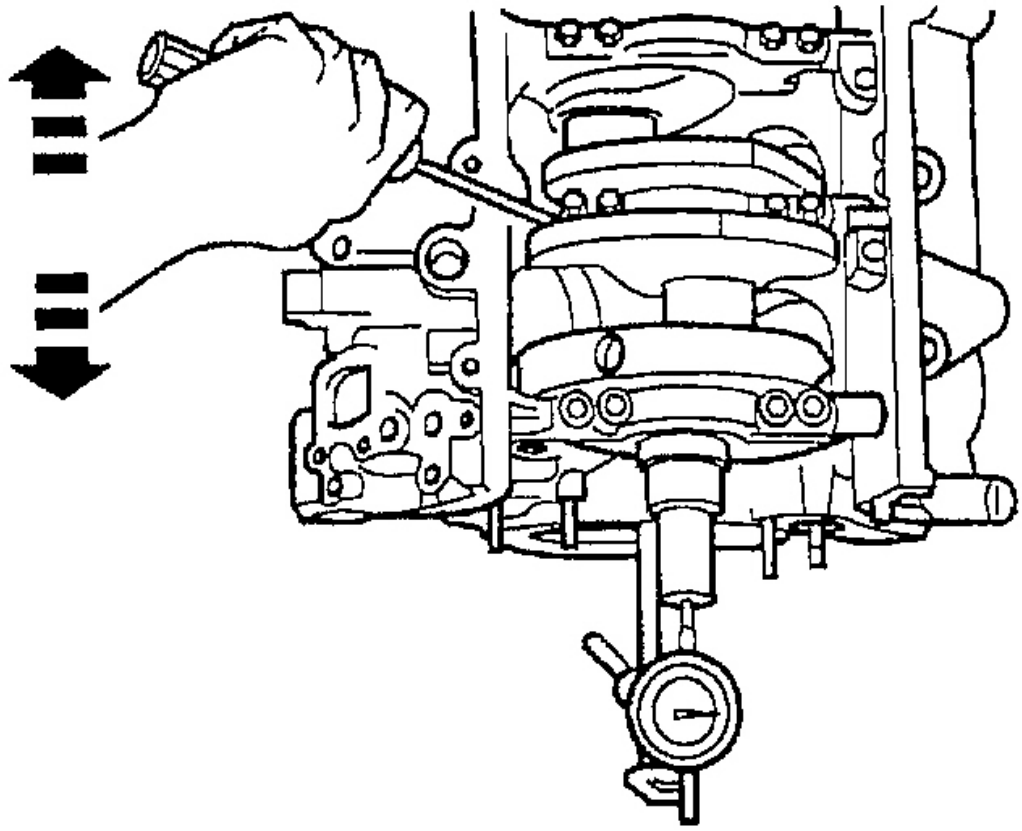
Fig. 61: Main Bearing Selection Example
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT END PLAY INSPECTION

1. Measure the crankshaft end play.
    - If not as specified, replace the thrust bearing and No.4 lower main bearing or crankshaft so that the specified end play is obtained.

Standard End Play

0.110-0.232 mm {0.00434-0.00913 in}



G02831300

Fig. 62: Measuring Crankshaft End Play
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD INSPECTION

1. Measure each connecting rod for bending and distortion.
    - If not as specified, replace the connecting rod.

Bending

0.038 mm {0.0014 in}max./25 mm {0.98 in}

Distortion

0.050 mm {0.0019 in}max./25 mm {0.98 in}

Center-to-center distance

138.06-138.14 mm {5.4355-5.4385 in}

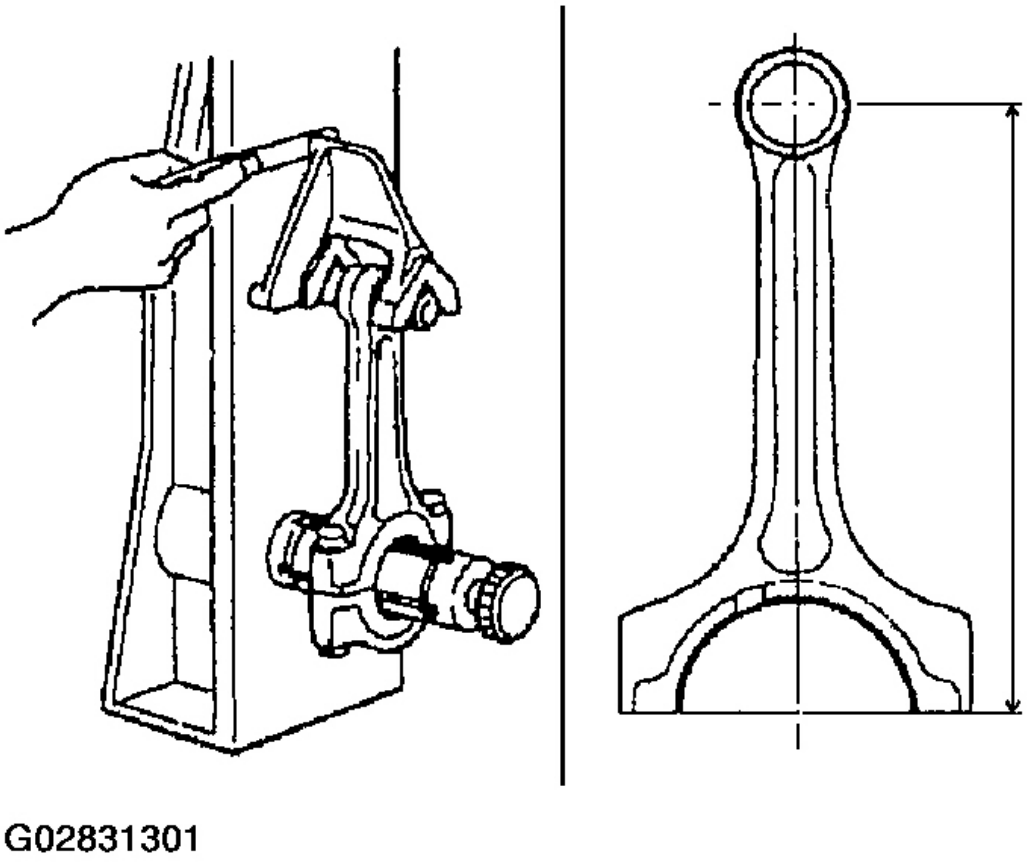


Fig. 63: Measuring Connecting Rod For Bending & Distortion
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD OIL CLEARANCE INSPECTION/REPAIR

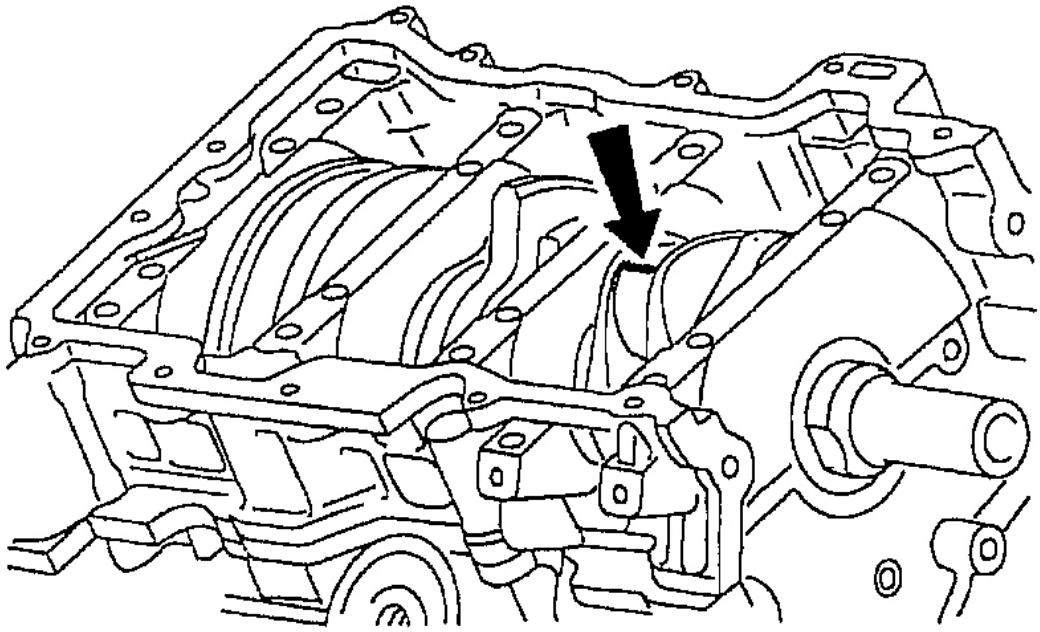
CAUTION:

Because the bolts are pliant bolts, they cannot reused. Use new bolts for inspection. The bolts may be reused for assembly.

1. Position plastigage atop the journals in the axial direction.
2. Install the connecting rod bearing and connecting rod cap. (See **CONNECTING ROD CAP ASSEMBLY NOTE**.)
3. Remove the connecting rod cap.
4. Measure the connecting rod oil clearance.
    - If not as specified, replace the connecting rod bearing or grind the crankpin and use undersize bearings so that the specified clearance is obtained.

Standard Clearance

0.028-0.066 mm {0.0012-0.0025 in}



G02831302

Fig. 64: Measuring Connecting Rod Oil Clearance Using Plastigage
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD SPECIFICATIONS

Bearing Size (mm {in})	Bearing Thickness (mm {in})
Standard	1.500-1.506 {0.0591-0.0593}
0.02 {0.0008} Undersize	1.510-1.516{0.0595-0.0596}
0.05 {0.002} Undersize	1.525-1.531{0.0601-0.0602}
0.25 {0.01} Undersize	1.625-1.631{0.0640-0.0642}

CONNECTING ROD SIDE CLEARANCE INSPECTION

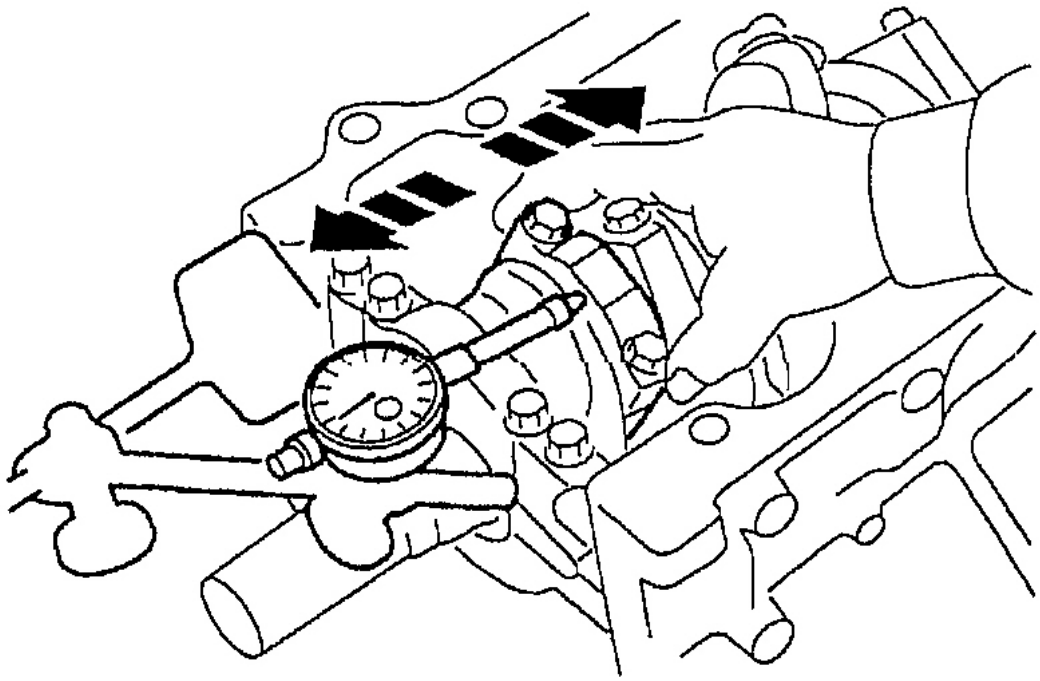
1. Measure the connecting rod large end side clearance.
    - If the connecting rod side clearance exceeds the maximum clearance, replace the connecting rod and cap.

Standard Clearance

0.10-0.30 mm {0.004-0.011 in}

Maximum Clearance

0.35 mm {0.013 in}



G02831303

Fig. 65: Measuring Connecting Rod Large End Side Clearance
Courtesy of MAZDA MOTORS CORP.

VARIABLE VALVE TIMING ACTUATOR INSPECTION

CAUTION:

The variable valve timing actuator cannot be disassembled because it is a precision unit.

1. Confirm that the key groove of the rotor and the timing mark of the sprocket at the variable valve timing actuator are aligned and fitted.
   - If the timing mark and the key groove are not aligned, rotate the rotor toward the bulb timing retard position by hand until they are in place.
   - If the rotor and sprocket are not secured even though their timing mark and the key groove are aligned, replace the variable valve timing actuator.

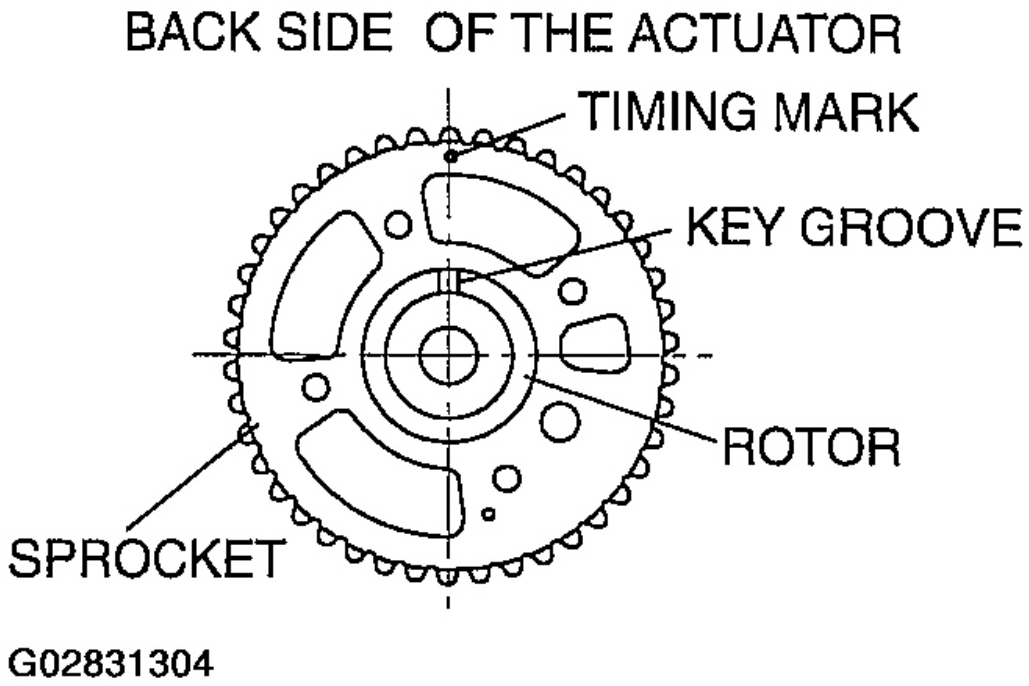


Fig. 66: Identifying Variable Valve Timing Actuator Alignment
Courtesy of MAZDA MOTORS CORP.

OIL CONTROL VALVE (OCV) INSPECTION

COIL RESISTANCE INSPECTION

1. Disconnect the negative battery cable.
2. Disconnect the Oil Control Valve (OCV) connector.
3. Measure the resistance between terminals A and B using an ohmmeter.

- If not as specified, replace the Oil Control Valve (OCV).

  Specification

  7.05-7.95 ohms

4. Connect the Oil Control Valve (OCV) connector.

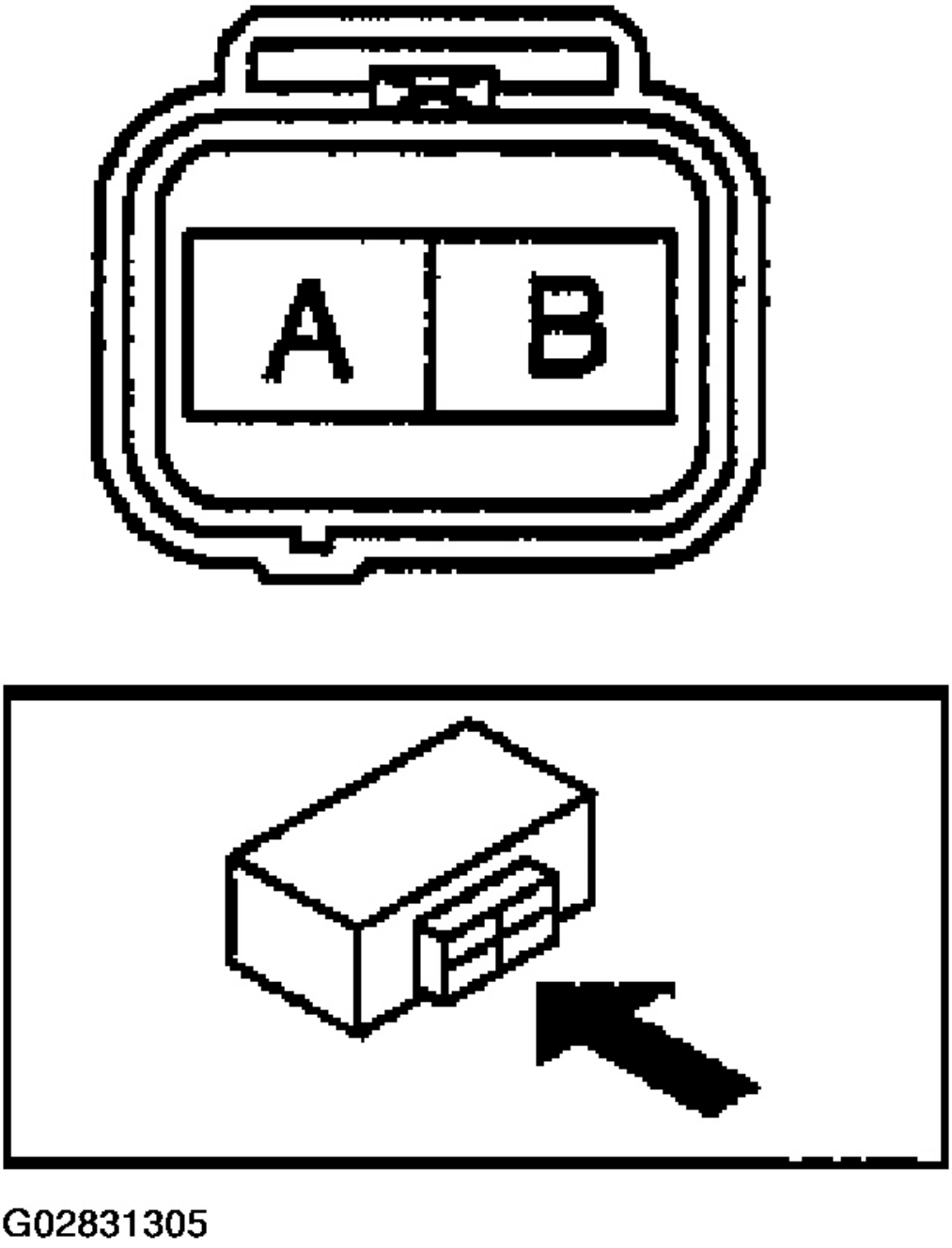


Fig. 67: Identifying OCV Connector Terminals
Courtesy of MAZDA MOTORS CORP.

SPOOL VALVE OPERATION INSPECTION

1. Disconnect the negative battery cable.
2. Remove the Oil Control Valve (OCV).
3. Verify that the spool valve in the Oil Control Valve (OCV) is in the maximum valve timing retard position as indicated in the figure.
    - If not as specified, replace the Oil Control Valve (OCV).
4. Verify that the battery is fully charged.
    - If not as specified, recharge the battery.

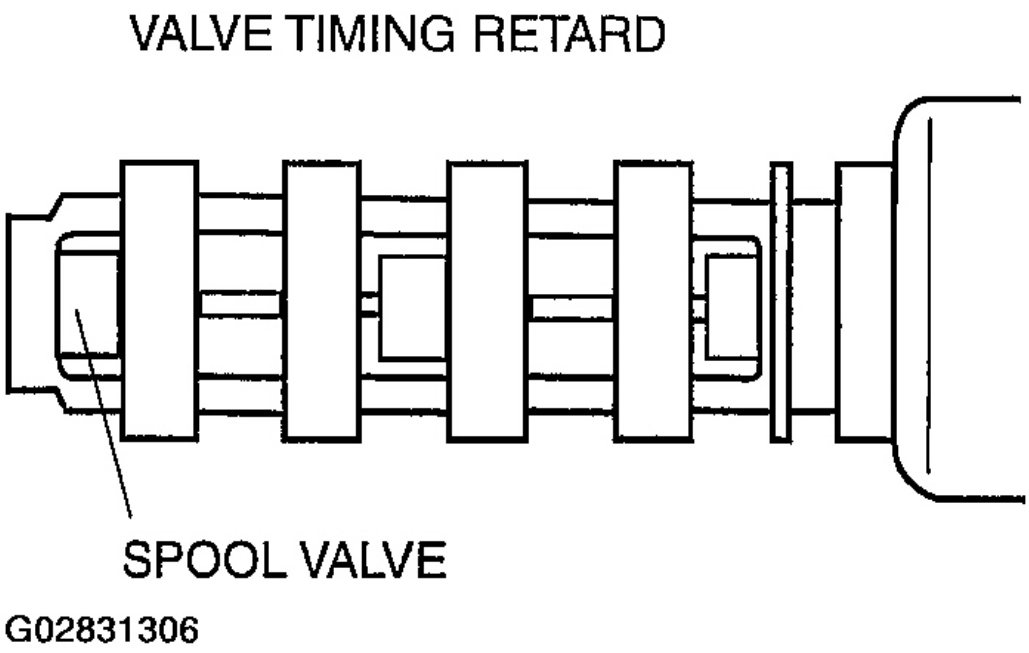


Fig. 68: OCV In Maximum Valve Timing Retard Position
Courtesy of MAZDA MOTORS CORP.

5. Apply battery positive voltage between the Oil Control Valve (OCV) terminals and verify that the spool valve operates and moves to the maximum valve timing advance position.

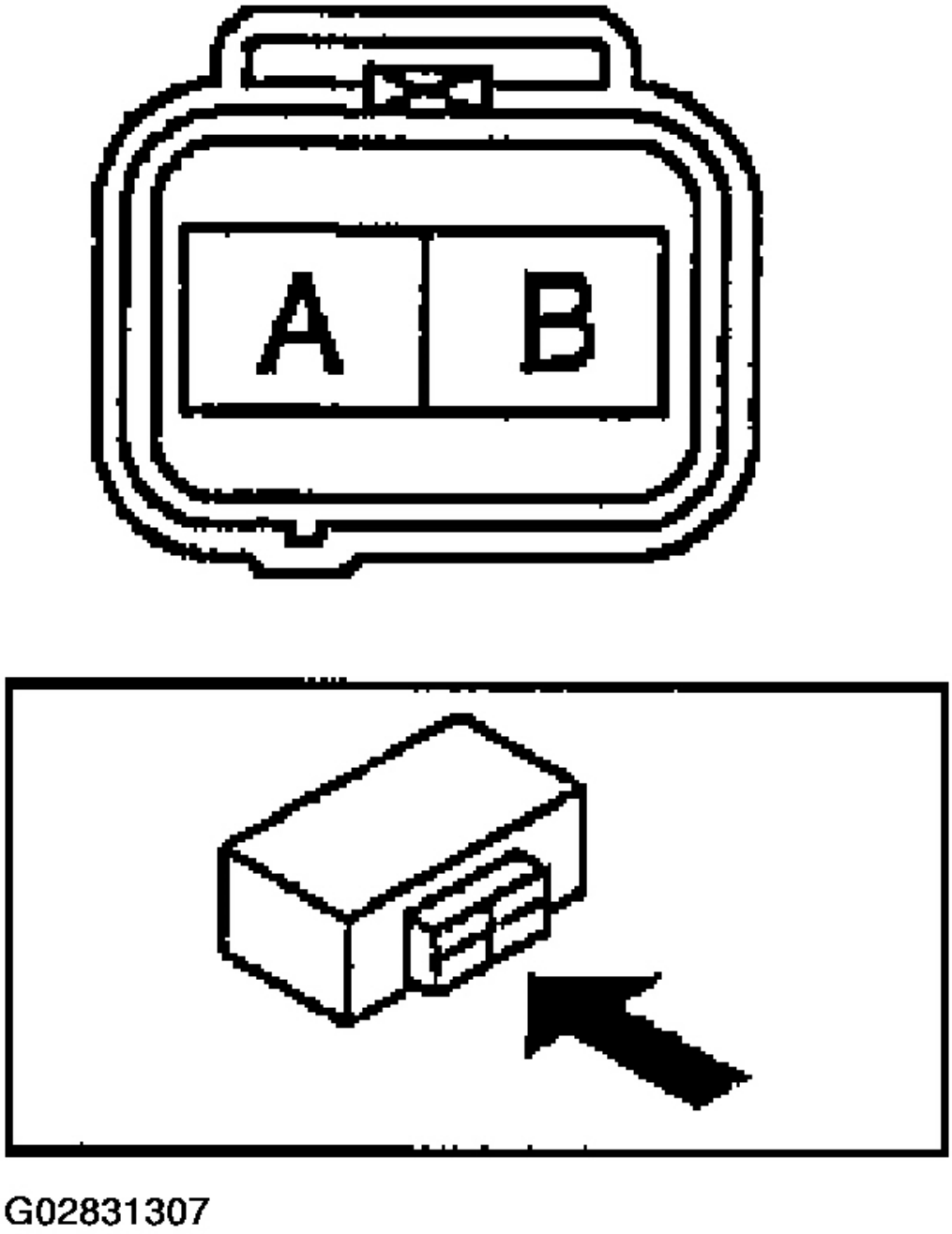


Fig. 69: Identifying OCV Connector Terminals
Courtesy of MAZDA MOTORS CORP.

- If not as specified, replace the Oil Control Valve (OCV).

NOTE:

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

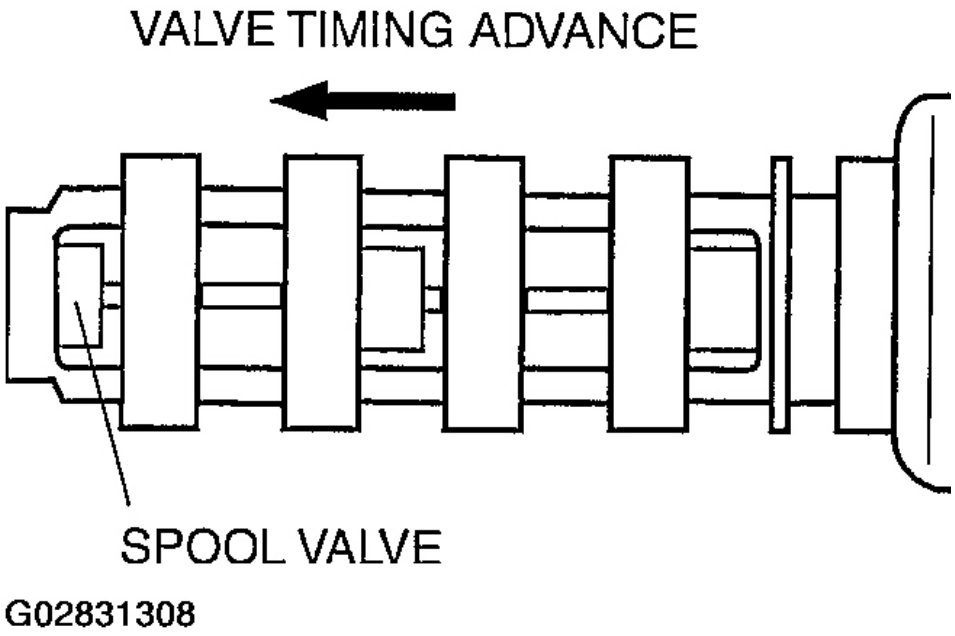
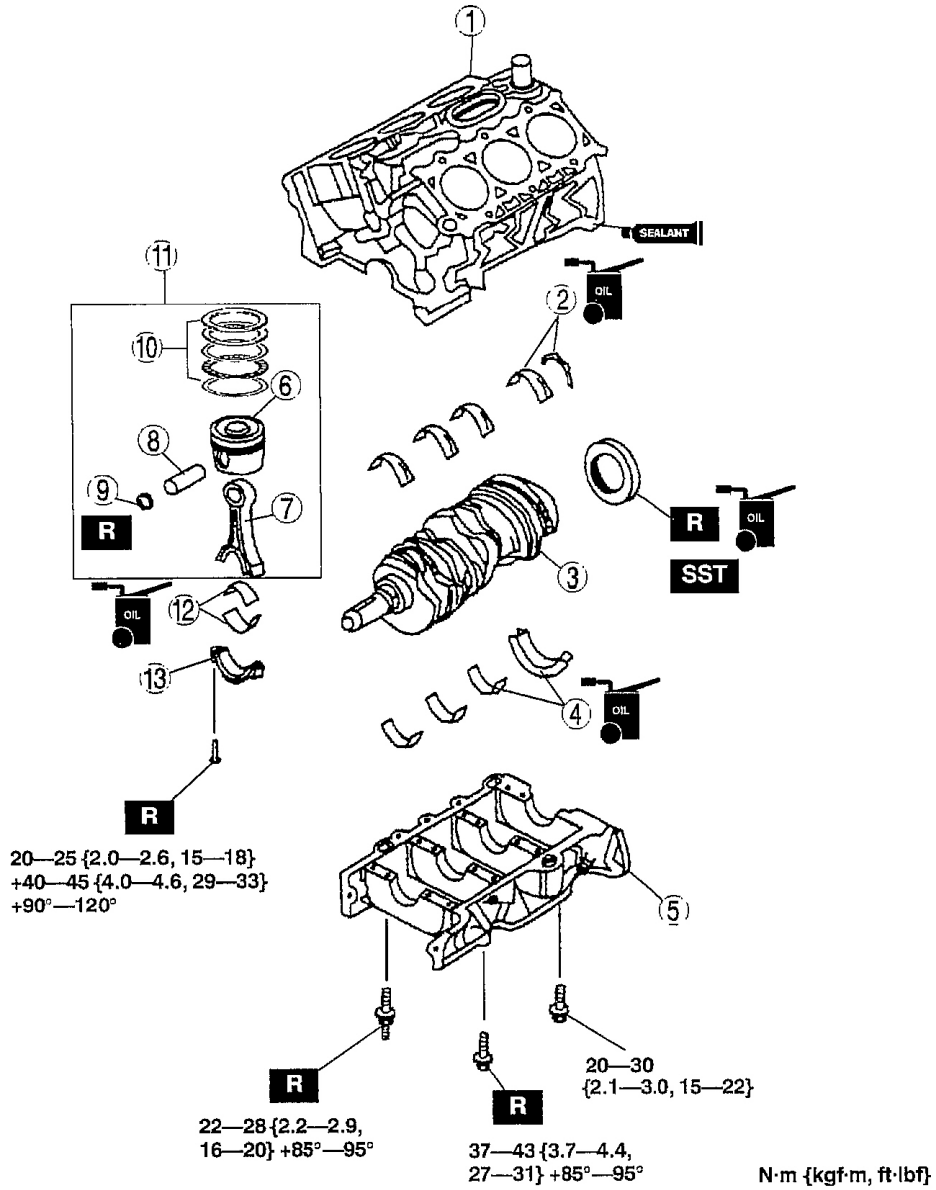


Fig. 70: OCV Spool Valve In Maximum Valve Timing Advance Posi
Courtesy of MAZDA MOTORS CORP.

6. Stop applying battery positive voltage and verify that the spool valve returns to the maximum valve timing retard position.
   - If not as specified, replace the Oil Control Valve (OCV).

CYLINDER BLOCK ASSEMBLY (I)

1. Assemble in the order indicated in the figure.



1	Upper cylinder block
2	Upper main bearing, thrust bearing
3	Crankshaft
4	Lower main bearing, thrust bearing
5	Lower cylinder block (See Lower Cylinder Block Assembly Note)
6	Piston
7	Connecting rod
8	Piston pin (See Piston Pin Assembly Note)

9	Snap ring
10	Piston ring (See Piston Ring Assembly Note)
11	Piston, connecting rod (See Piston, Connecting Rod Assembly Note)
12	Connecting rod bearing
13	Connecting rod cap (See Connecting Rod Cap Assembly Note)

G02831309

Fig. 71: Assembling Cylinder Block (I)
Courtesy of MAZDA MOTORS CORP.

LOWER CYLINDER BLOCK ASSEMBLY NOTE

1. Apply a continuous bead of silicone sealant to the upper cylinder block as indicated in the figure.

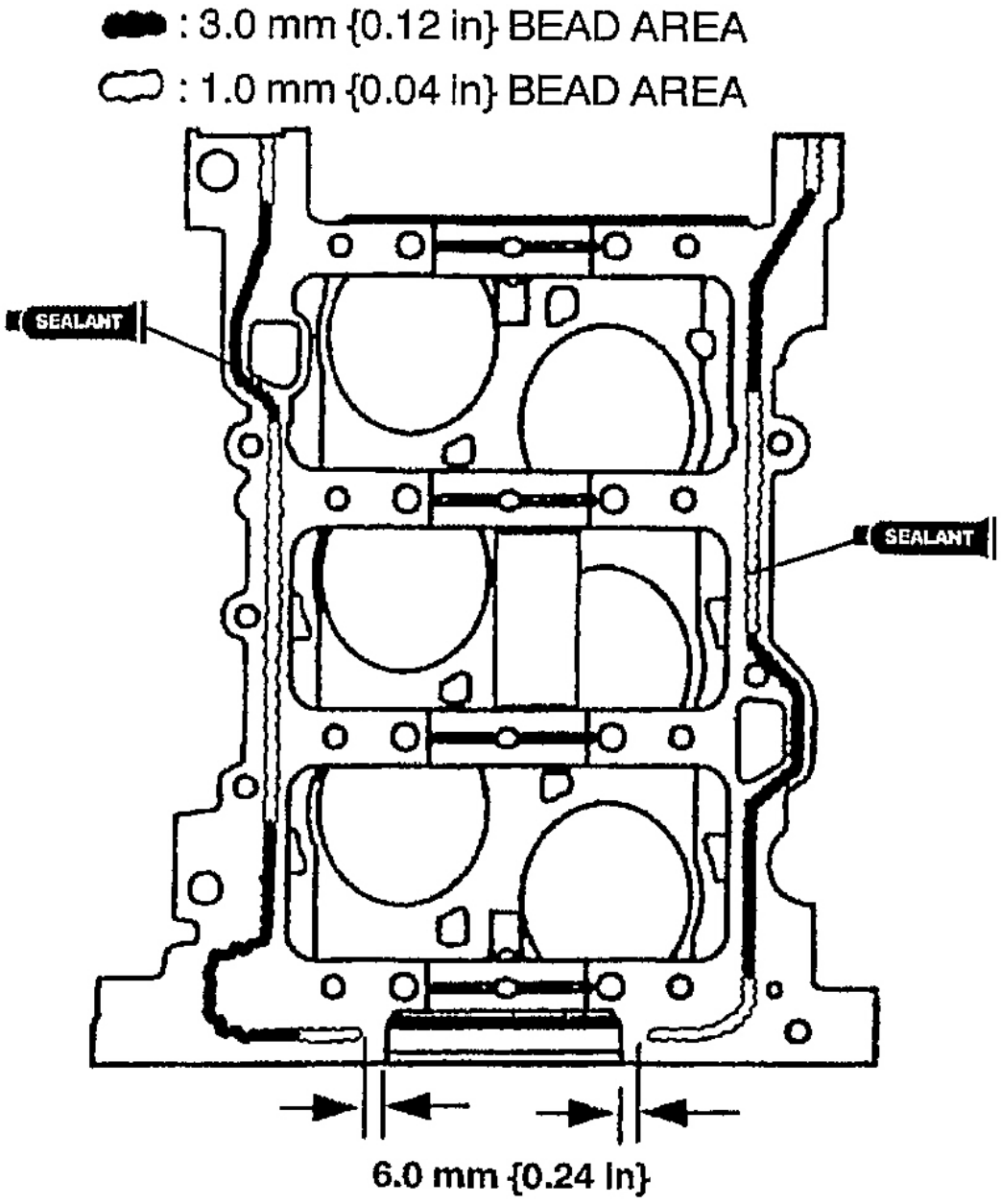
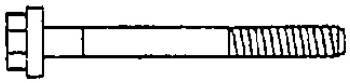
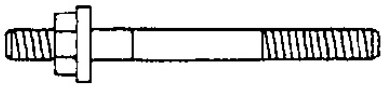
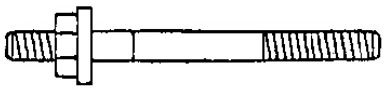


Fig. 72: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

CAUTION:

- **Because bolts 1-16 are pliant bolts, they cannot be reused. Replace bolts 1-8 with new bolts and use bolts 9-16 installed**

during inspection when assembling the lower cylinder block.

Hole No.	Bolt	Description
18, 19, 20, 21, 22		M8×1.25×79.3 bolt
1, 2, 3, 4, 17		M8×1.25×96 bolt
13, 14, 15, 16		M10×1.5×106.5 bolt
5, 6, 7, 8		M8×1.25×96 stud/M6×1.0×18
9, 10, 11, 12		M10×1.5×106.8/ M8×1.25×21.5 stud

G02831311

Fig. 73: Identifying Lower Cylinder Block Bolts
Courtesy of MAZDA MOTORS CORP.

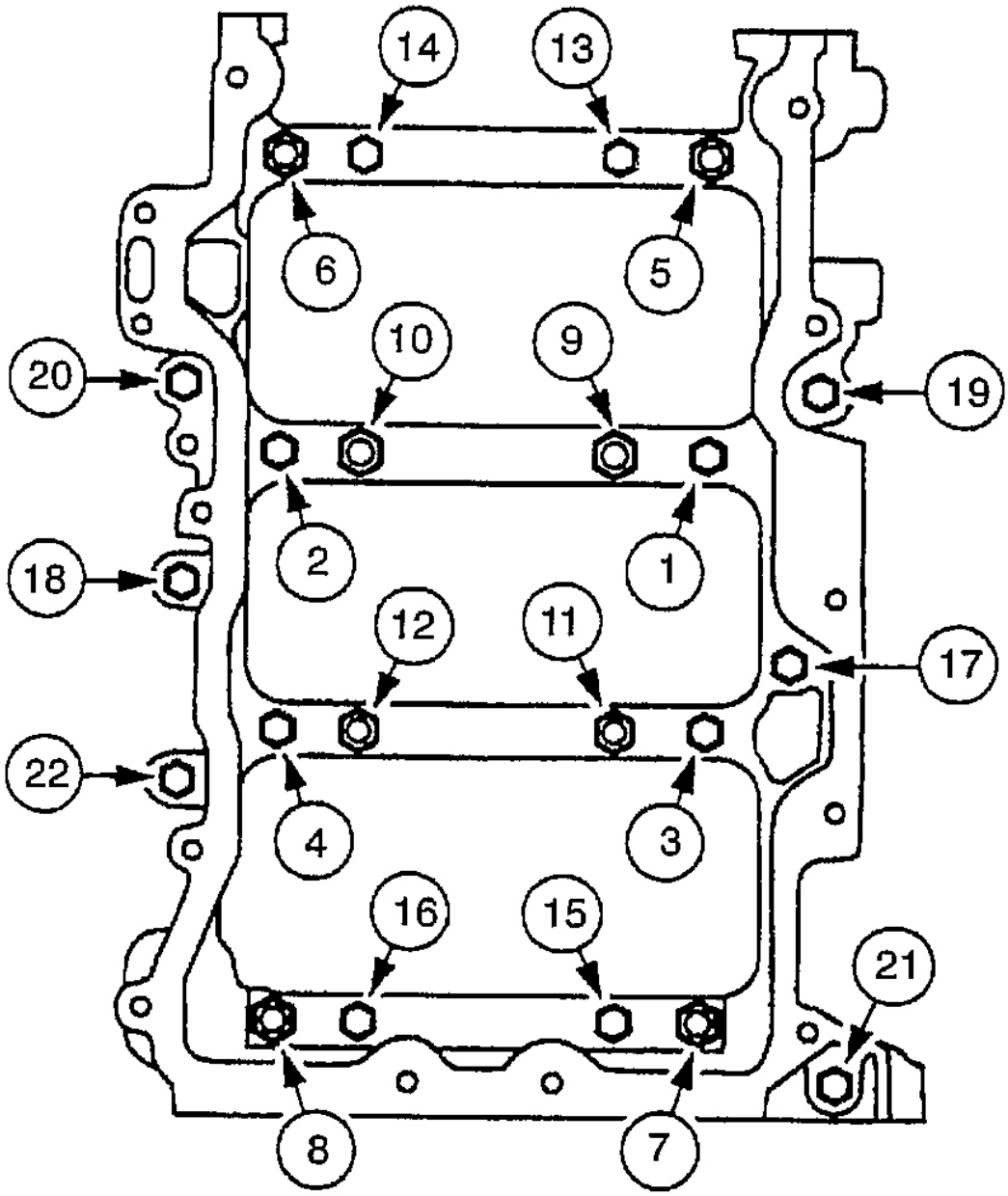


Fig. 74: Lower Cylinder Block Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

2. Install the lower cylinder block bolts in the order indicated in the figure.

Tightening Torque

3.0-5.0 N.m {30-51 kgf.cm, 27-44 in.lbf}

3. Push crankshaft forward and then rearward to seat the crankshaft thrust washer.
4. Tighten the lower cylinder block bolts in the order indicated in the figure in four steps.
    1. Bolts 1-8: tighten to **22-28 N.m {2.2-2.9 kgf.m, 16-20 ft.lbf}** .
    2. Bolts 9-16: tighten to**37-43 N.m {3.7-4.4 kgf.m, 27-31 ft.lbf}** .
    3. Bolts 1-16: tighten **85°-95°** .
    4. Bolts 17-22: tighten to **20-30 N.m {2.1-3.0 kgf.m, 15-22 ft-lbf}** .
    5. Verify that the crankshaft rotates freely.

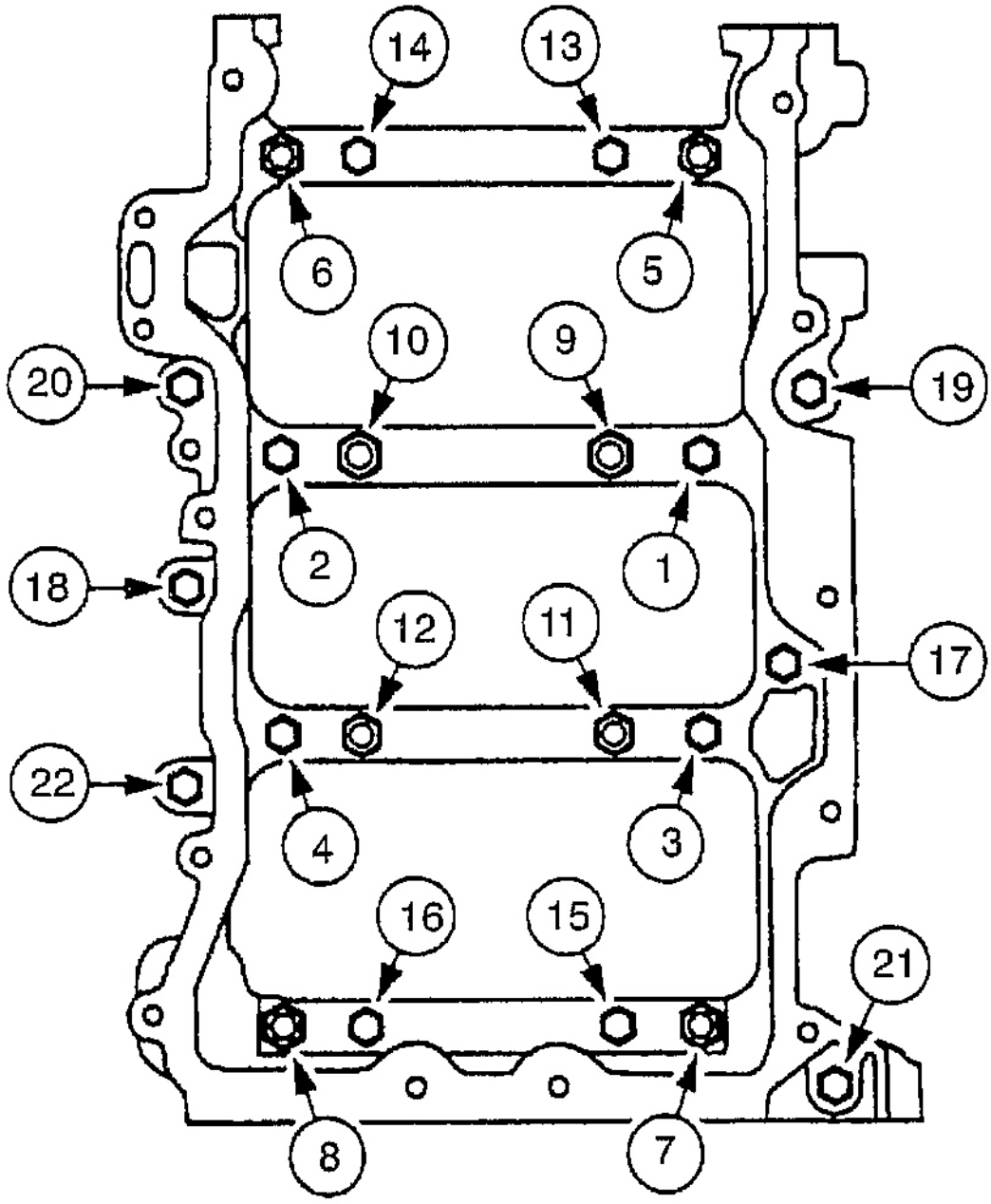


Fig. 75: Lower Cylinder Block Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

5. Assemble rear oil seal with part A of the **SST** [303-178 (49 UN01 070)] and the **SST** [303-384 (49 UN30 3384)].

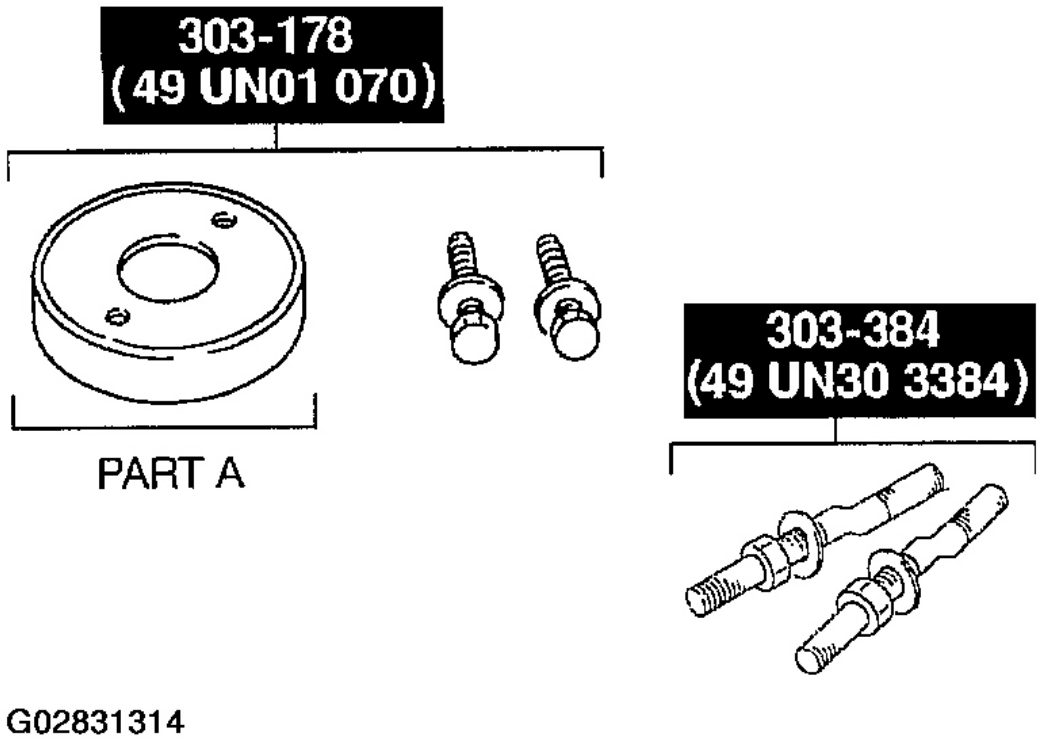


Fig. 76: Assembling SST & Oil Seal
Courtesy of MAZDA MOTORS CORP.

1. Install the studs of the **SST** as indicated in the figure.

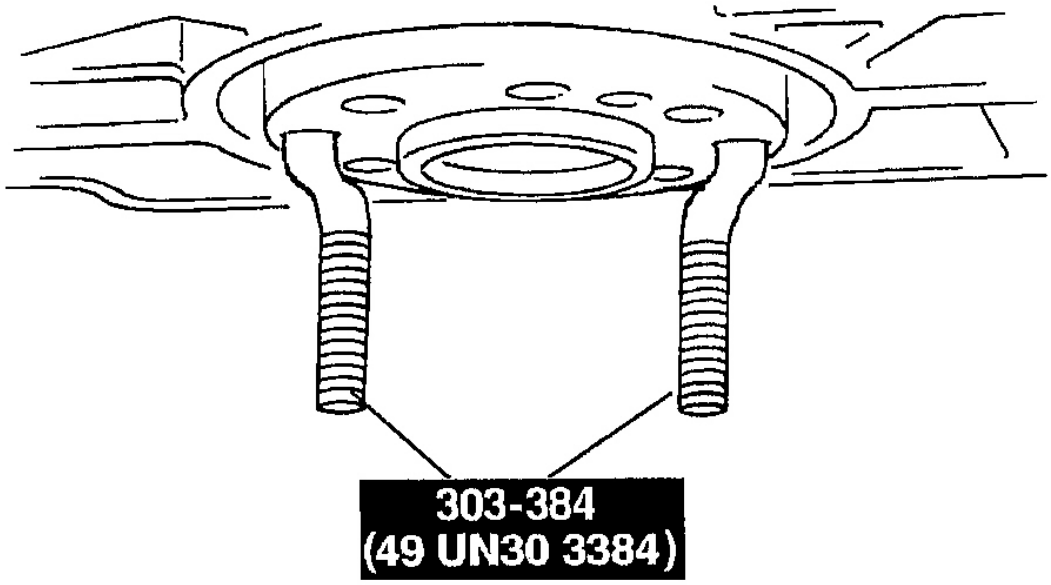


Fig. 77: Installing SST Studs
Courtesy of MAZDA MOTORS CORP.

2. Apply clean engine oil to the oil seal.
3. Push the oil seal slightly in by hand.
4. Install part A of the **SST** [303-178 (49 UN01 070)] and compress the oil seal with the nuts of the **SST** [303-384 (49 UN30 3384)].

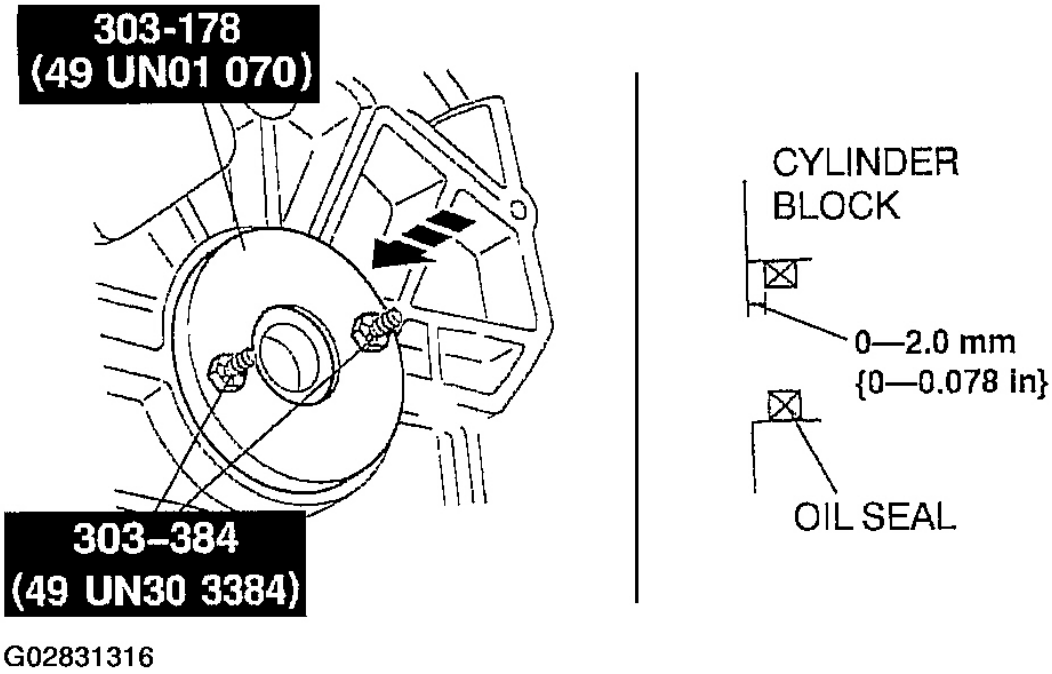


Fig. 78: Installing Oil Seal
Courtesy of MAZDA MOTORS CORP.

PISTON PIN ASSEMBLY NOTE

1. Assemble the piston pin so that connecting rod's projection for discrimination faces the opposite side of the arrow mark on the piston (rear side of the engine).
2. Apply clean engine oil to the piston pin.
3. Install the piston pin until the pin contacts the clip.
    - If the pin cannot be installed easily, heat the piston.

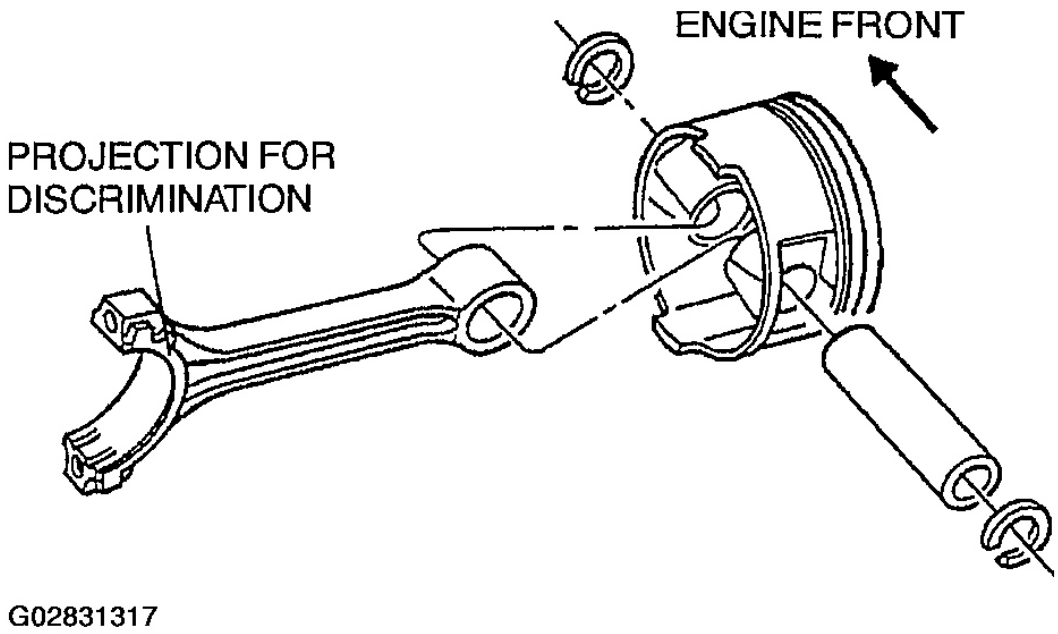
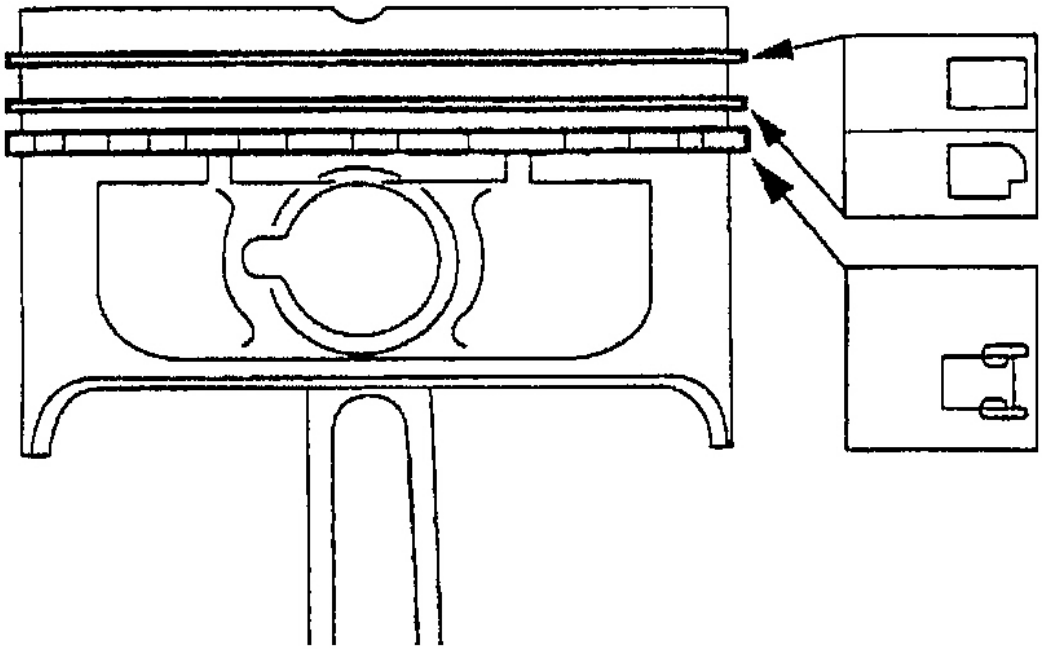


Fig. 79: Assembling Piston
Courtesy of MAZDA MOTORS CORP.

PISTON RING ASSEMBLY NOTE

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



G02831318

Fig. 80: Installing Piston Rings
Courtesy of MAZDA MOTORS CORP.

PISTON, CONNECTING ROD ASSEMBLY NOTE

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

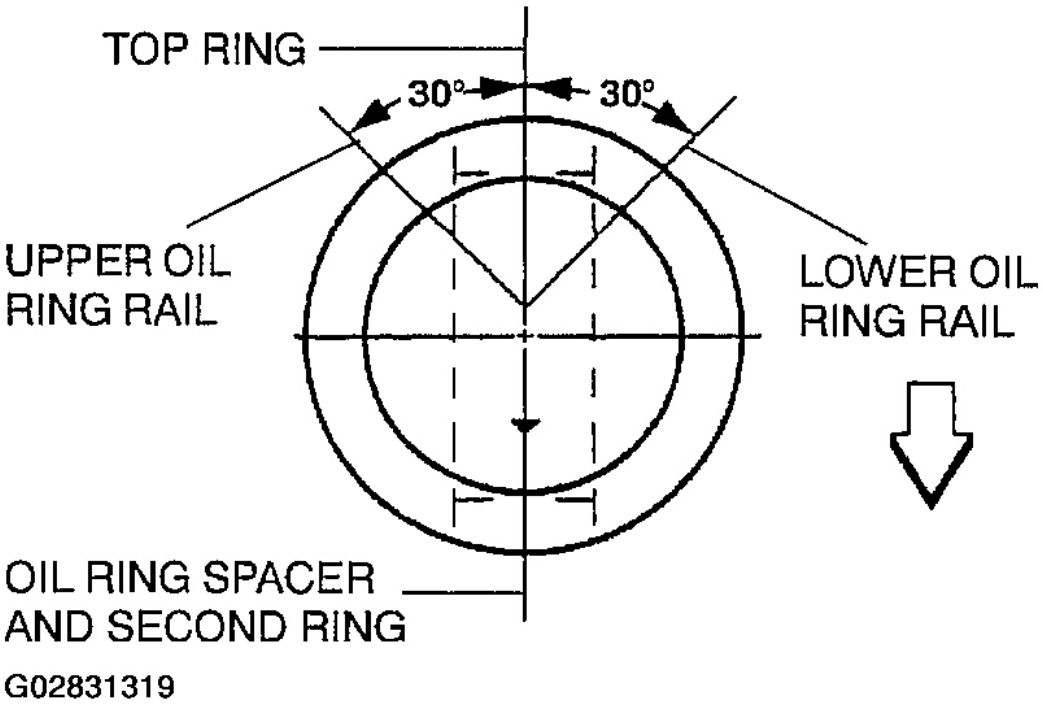


Fig. 81: Positioning Piston Ring End Gap
Courtesy of MAZDA MOTORS CORP.

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

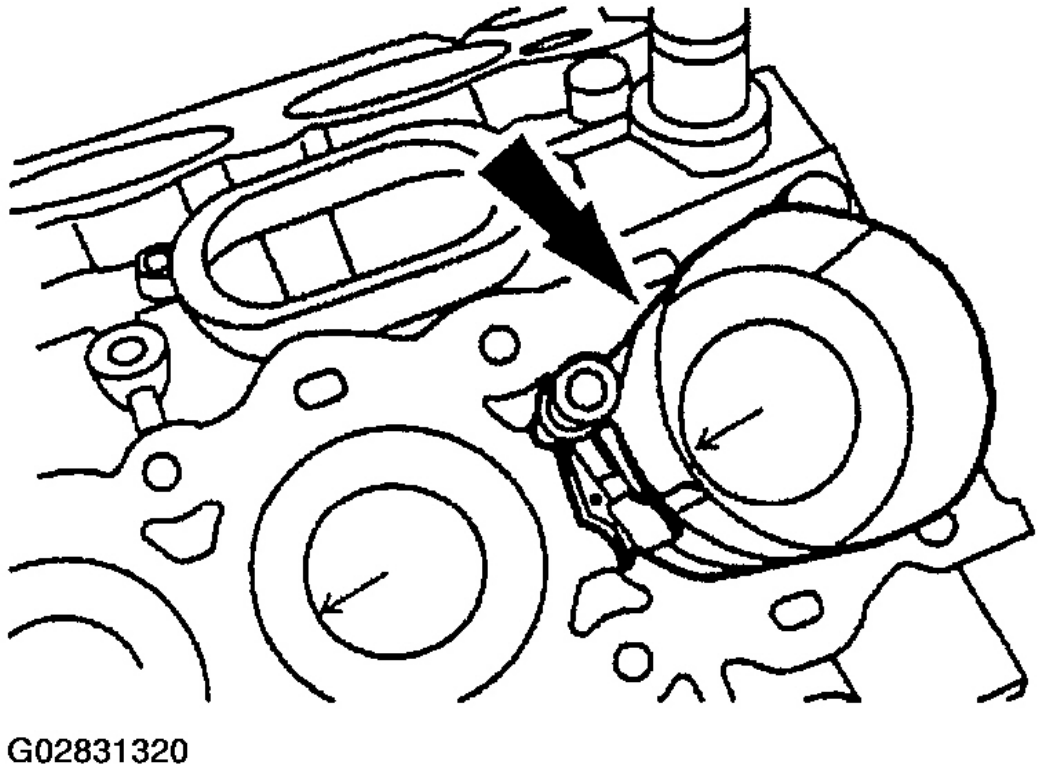


Fig. 82: Installing Piston To Cylinder Block
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD CAP ASSEMBLY NOTE

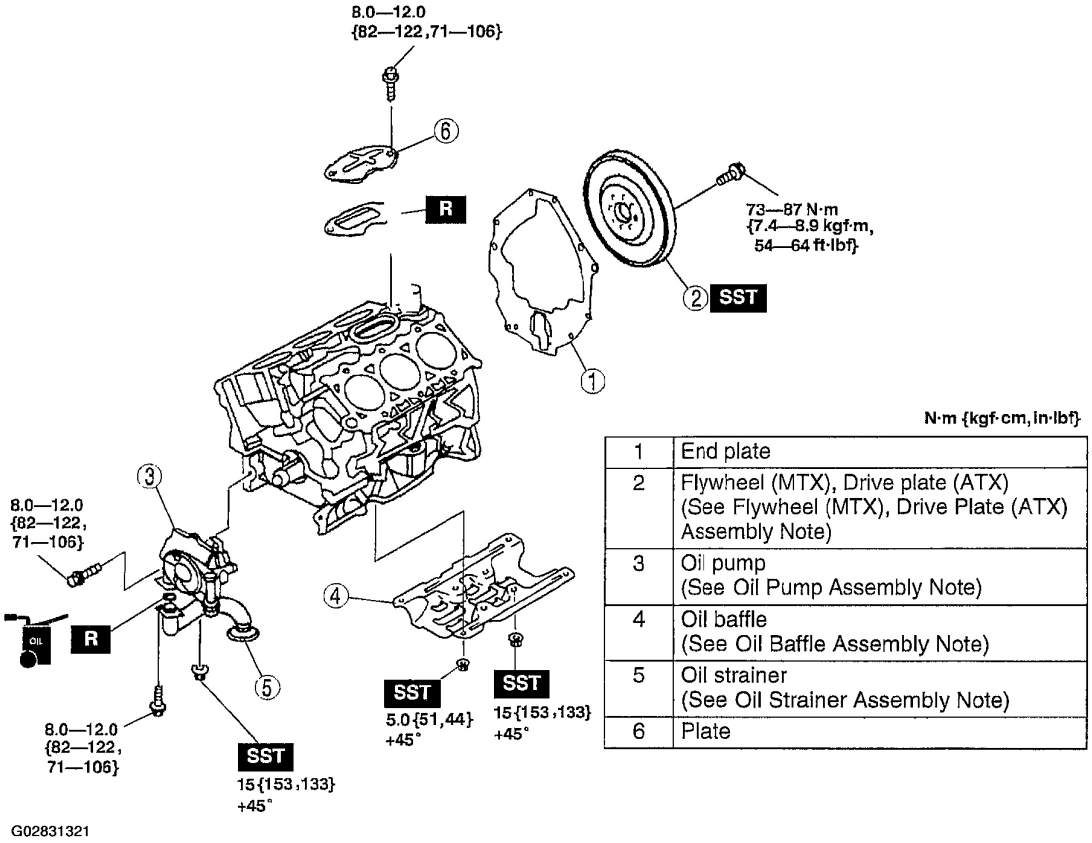
CAUTION:
- **Because the connecting rod bolts are pliant bolts, they cannot be reused. Use the bolts installed during inspection when assembling the connecting rod cap.**

NOTE:
- **When assembling the connecting rods and connecting rod caps, it is imperative that bearing slots and tangs be located on the same side of the connecting rods.**

1. Install the connecting rod bolts to the connecting rod cap by tapping the bolt with a plastic hammer.
2. Tighten the connecting rod bolts in three steps.
    1. Tighten to **20-25 N.m {2.0-2.6 kgf.m, 15-18 ft.lbf}** .
    2. Tighten to **40-45 N.m {4.0-4.6 kgf.m, 29-33 ft.lbf}** .
    3. Tighten **90°-120°** .

CYLINDER BLOCK ASSEMBLY (II)

1. Assemble in the order indicated in the figure.



N·m {kgf·cm, in·lbf}

1	End plate
2	Flywheel (MTX), Drive plate (ATX) (See Flywheel (MTX), Drive Plate (ATX) Assembly Note)
3	Oil pump (See Oil Pump Assembly Note)
4	Oil baffle (See Oil Baffle Assembly Note)
5	Oil strainer (See Oil Strainer Assembly Note)
6	Plate

Fig. 83: Assembling Cylinder Block Assembly (II)
Courtesy of MAZDA MOTORS CORP.

FLYWHEEL (MTX), DRIVE PLATE (ATX) ASSEMBLY NOTE

1. Hold the flywheel (MTX) or the drive plate (ATX) using the **SST** .

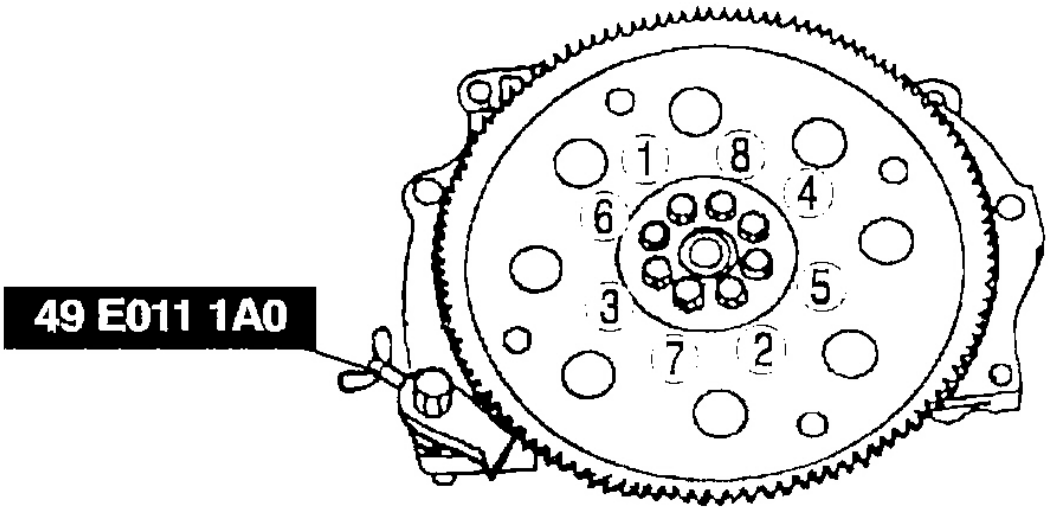


Fig. 84: Holding Flywheel (MTX) Or Drive Plate (ATX)
Courtesy of MAZDA MOTORS CORP.

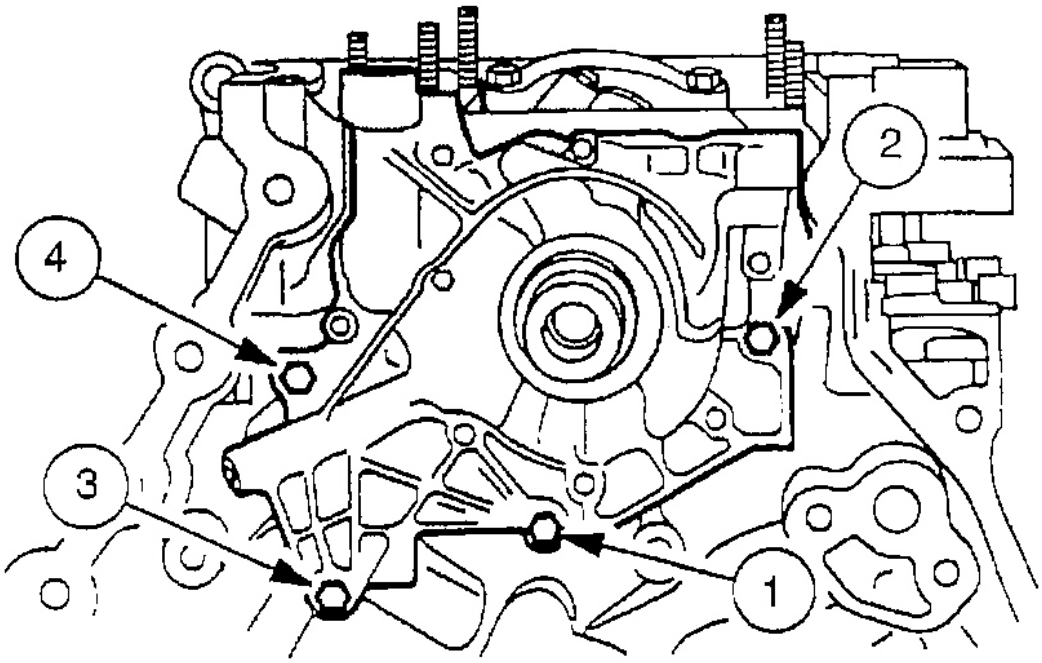
2. Tighten the bolts in the order indicated in the figure in several passes.

OIL PUMP ASSEMBLY NOTE

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

Tightening Torque

8.0-12.0 N.m {82-122 kgf.cm, 71-106 in.lbf}



G02831323

Fig. 85: Oil Pump Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

OIL BAFFLE ASSEMBLY NOTE

1. Tighten the nuts in two steps.
    1. Tighten nuts A to 5.0 N.m {51.0 kgf.cm, 44.3 in-lbf}, then nuts B to 15.0 N.m {153 kgf.cm, 133 in.lbf}.
    2. Tighten 45° using the SST.

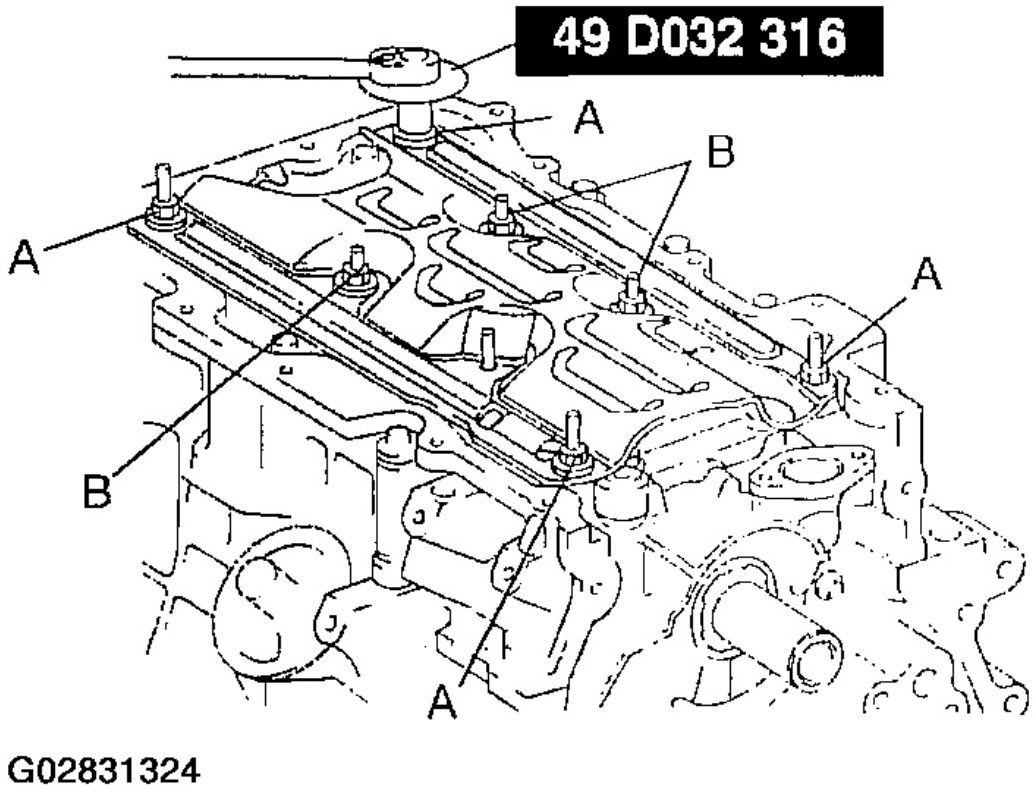


Fig. 86: Oil Baffle Bolt Identification
Courtesy of MAZDA MOTORS CORP.

OIL STRAINER ASSEMBLY NOTE

1. Tighten the bolts.
2. Tighten the nut in two steps.
    1. Tighten to **15.0 N.m {153 kgf.cm, 133 in.lbf}** .
    2. Tighten **45 °** using the SST.

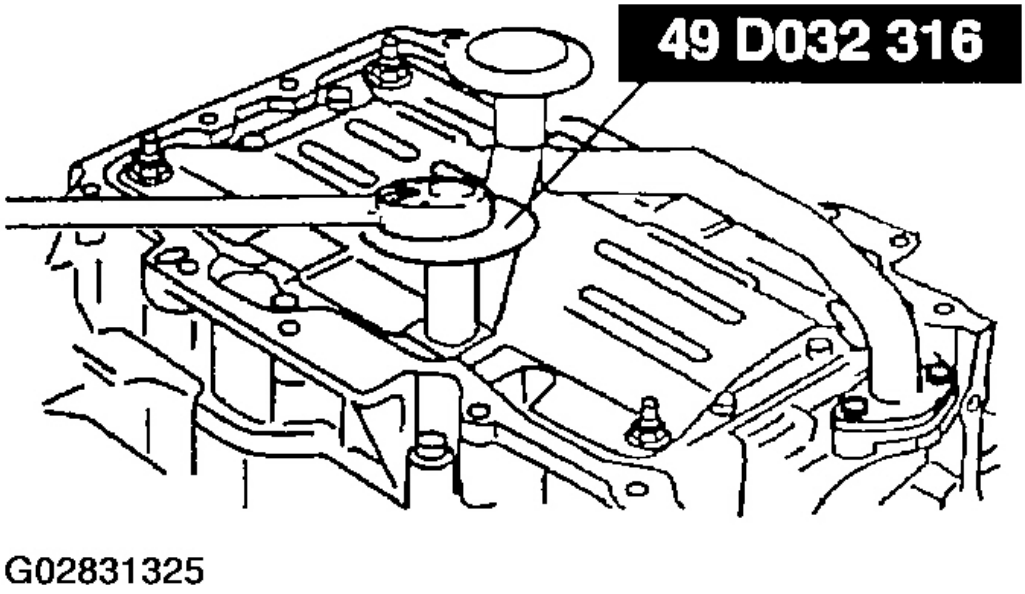


Fig. 87: Tightening Oil Strainer Nut
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD ASSEMBLY (I)

1. Assemble in the order Indicated in the table/figure.

CYLINDER HEAD ASSEMBLY (I)

Component/Step No.	Component Description
1	Valve Seal (See **VALVE SEAL ASSEMBLY NOTE**)
2	Valve
3	Valve Spring
4	Upper Valve Spring Seat
5	Valve Keeper (See **VALVE KEEPER ASSEMBLY NOTE**)

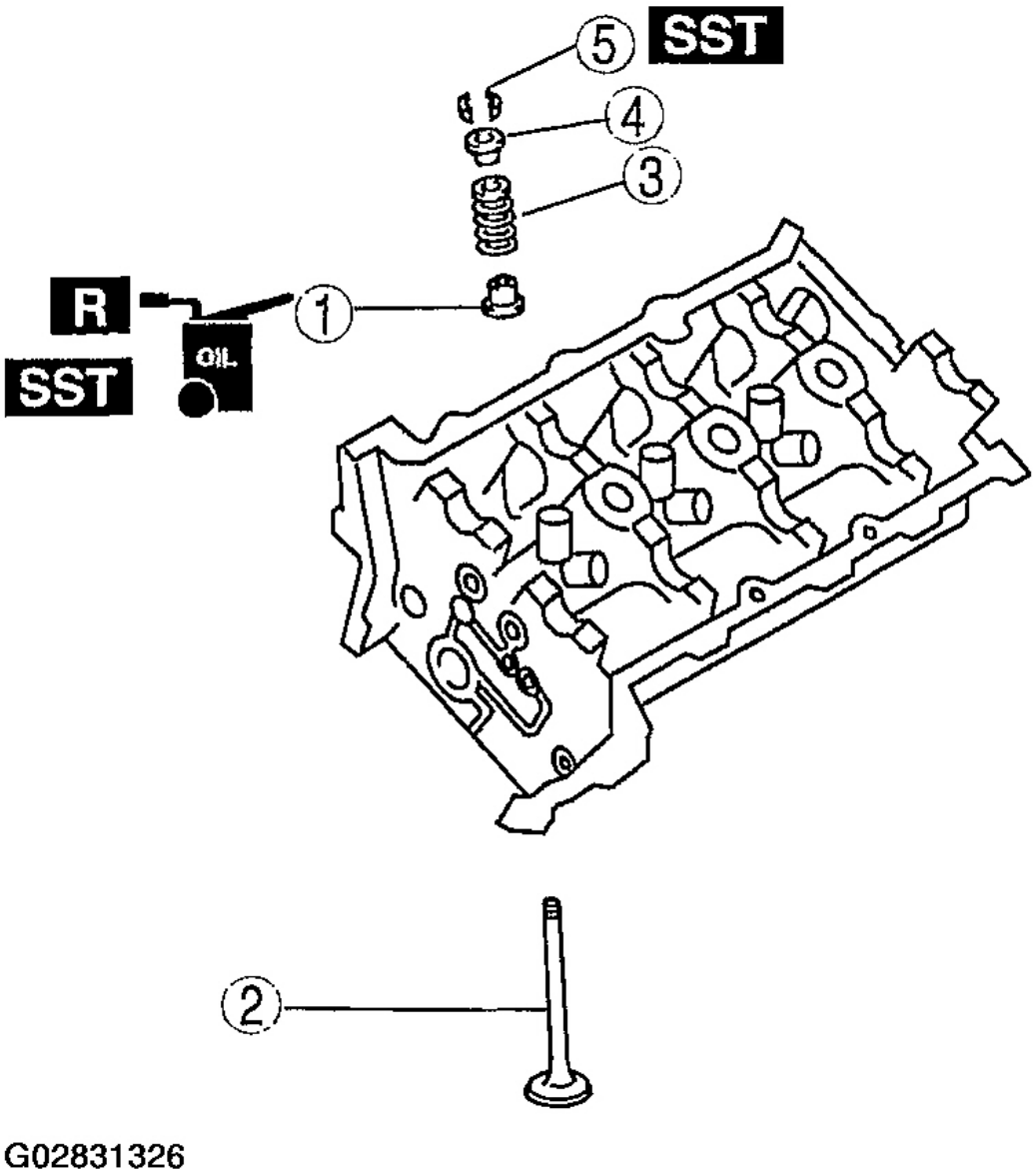


Fig. 88: Assembling Cylinder Head (I)
Courtesy of MAZDA MOTORS CORP.

VALVE SEAL ASSEMBLY NOTE

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

Fig. 89: Installing Valve Seal
Courtesy of MAZDA MOTORS CORP.

VALVE KEEPER ASSEMBLY NOTE

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

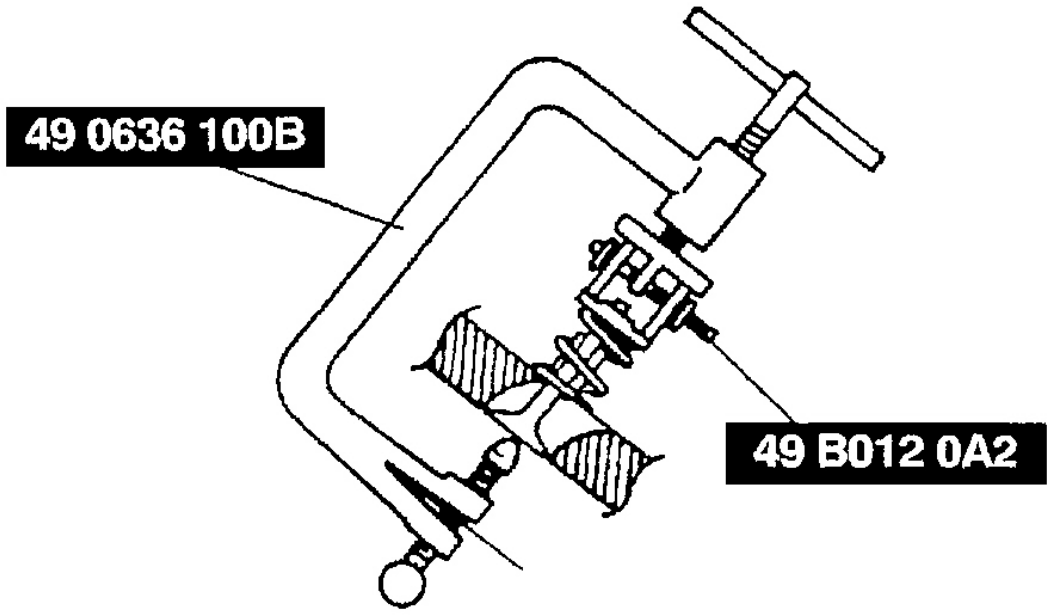
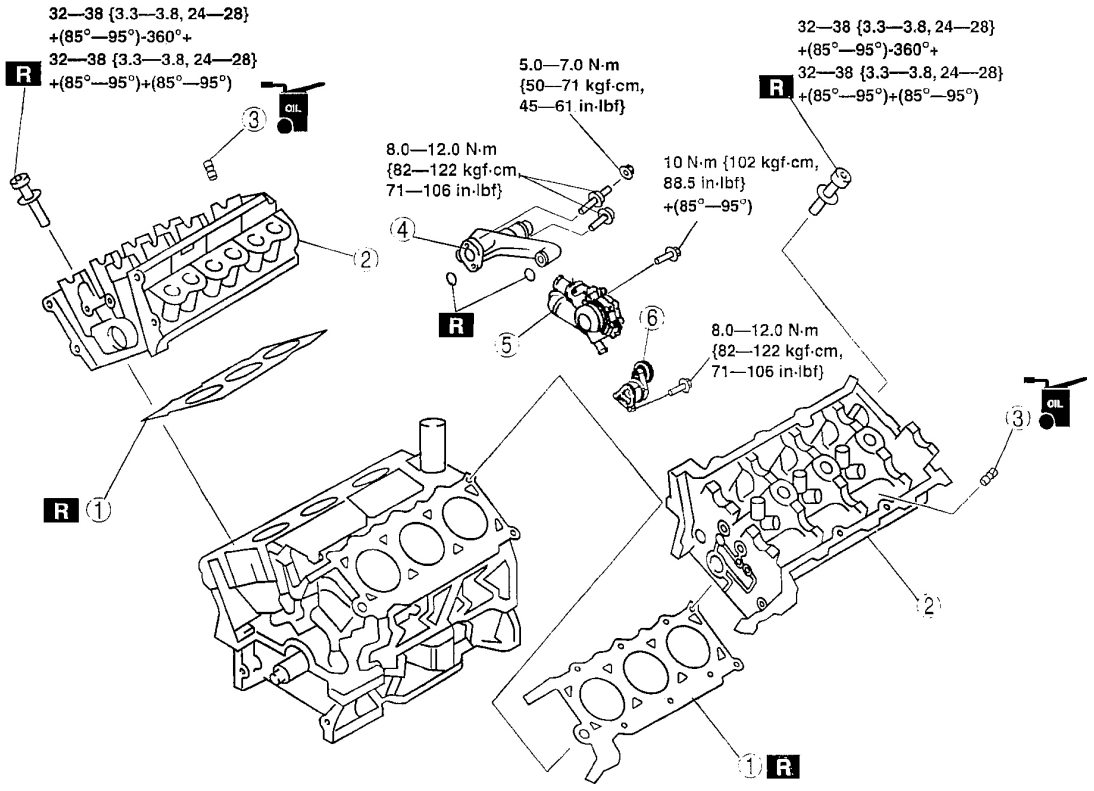


Fig. 90: Installing Valve Keeper
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD ASSEMBLY (II)

1. Assemble in the order indicated in the figure.



1	Cylinder head gasket	4	Water bypass tube
2	Cylinder head (See Cylinder Head Assembly Note)	5	Water pump (See Water Pump Assembly Note)
3	HLA	6	Water pump drive belt tensioner

G02831329

Fig. 91: Assembly Cylinder Head (II)
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD ASSEMBLY NOTE

1. Tighten the cylinder head bolts in the order indicated in the figure in six steps.
    1. Tighten to **32-38N.m {3.2 - 3.9kgf.m, 23-28 ft.lbf}** .
    2. Tighten **85°-95°** .
    3. Loosen **360°** (one full turn) in reverse order.
    4. Tighten to **32-38N.m {3.2-3.9kgf.m, 23-28 ft.lbf}** .
    5. Tighten **85°-95°** .
    6. Tighten **85°-95°** .

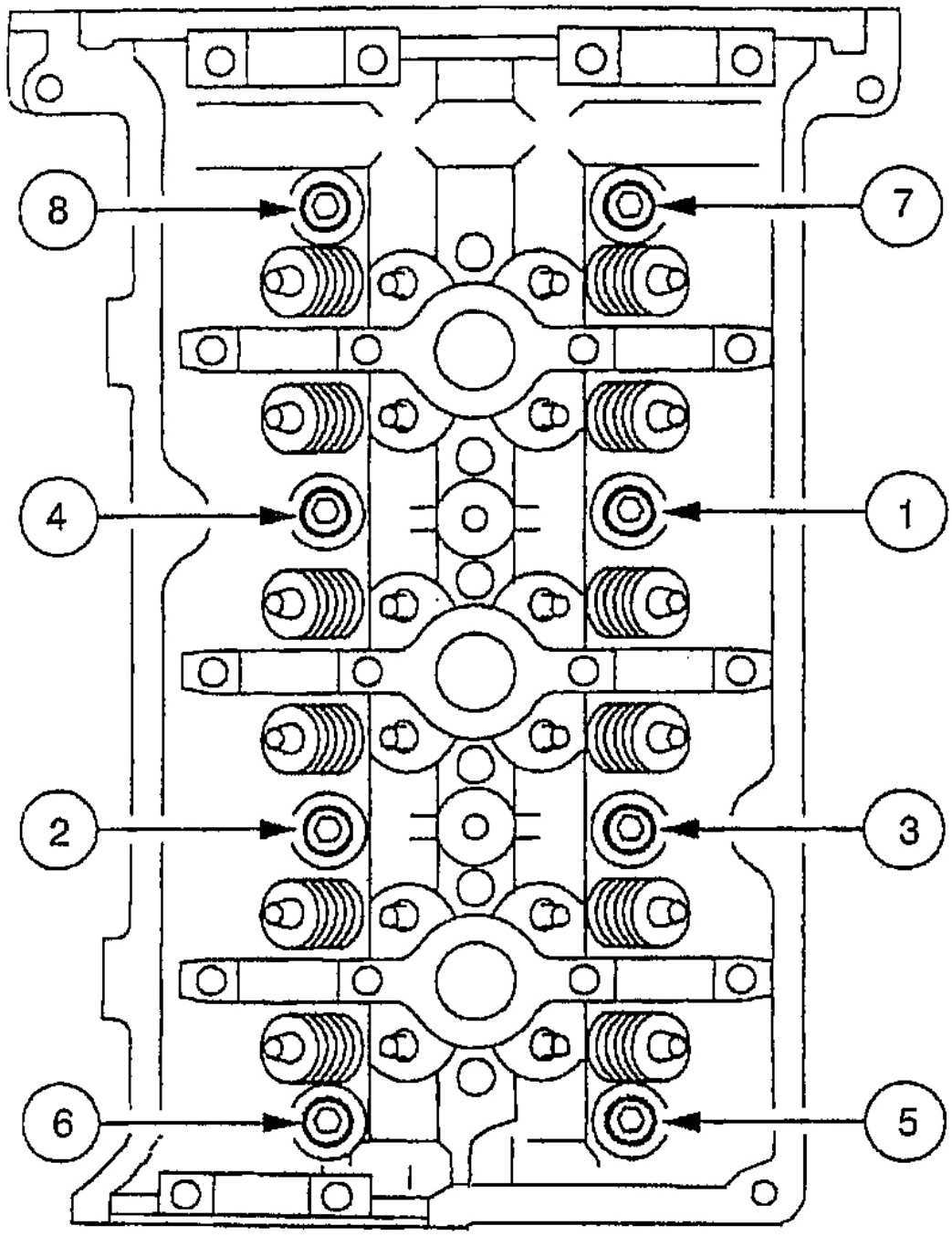
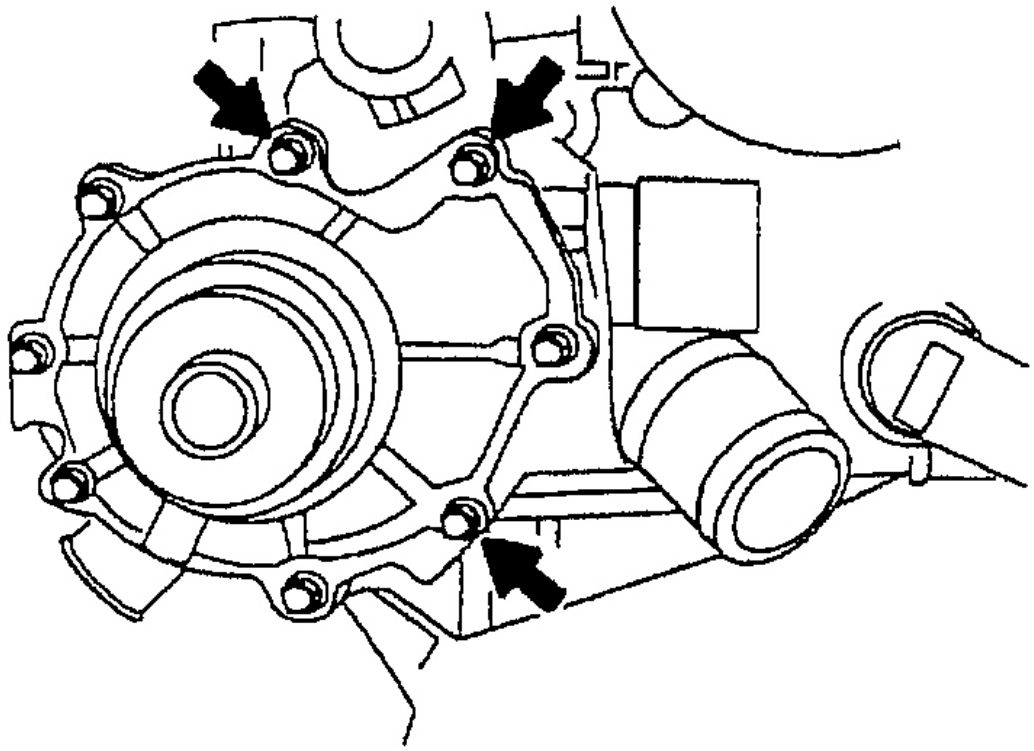


Fig. 92: Cylinder Head Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

WATER PUMP ASSEMBLY NOTE

1. Install new bolts and tighten them in two steps.
    1. Tighten to **10.0 N.m {102 kgf.cm, 88.5 in.lbf}** .
    2. Tighten **85°-95°** .

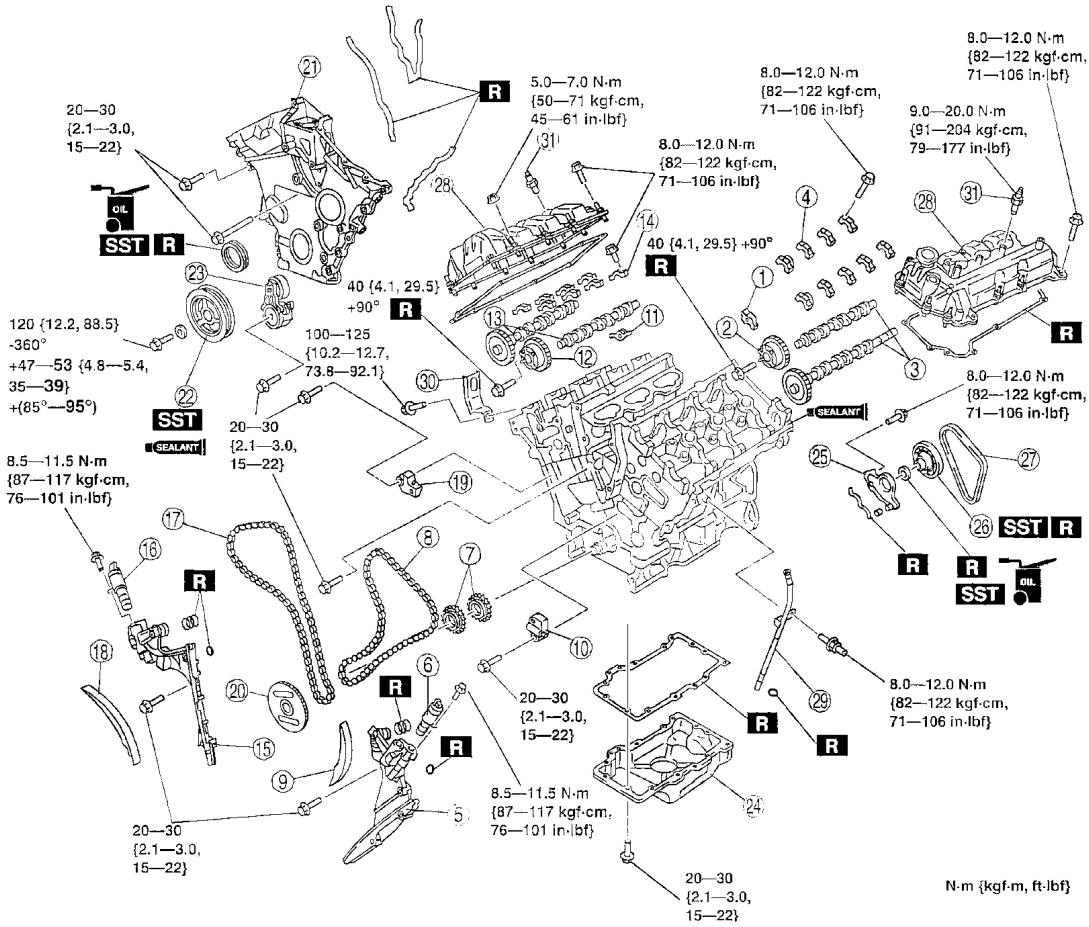


G02831331

Fig. 93: Installing Water Pump
Courtesy of MAZDA MOTORS CORP.

TIMING CHAIN ASSEMBLY

1. Assemble in the order indicated in the figure.



1	Rocker arm (LH)
2	Variable valve timing actuator (LH) (See Variable Valve Timing Actuator Assembly Note)
3	Camshaft (LH) (See Camshaft (LH) Assembly Note)
4	Camshaft cap (LH)
5	Chain guide (LH) (See Chain Guide (LH, RH) Assembly Note)
6	Oil control valve (OCV)
7	Crankshaft timing sprocket
8	Timing chain (LH) (See Timing Chain (LH) Assembly Note)
9	Tensioner arm (LH)
10	Chain tensioner (LH)
11	Rocker arm (RH)
12	Variable valve timing actuator (RH) (See Variable Valve Timing Actuator Assembly Note)
13	Camshaft (RH) (See Camshaft (RH) Assembly Note)
14	Camshaft cap (RH)
15	Chain guide (RH) (See Chain Guide (LH, RH) Assembly Note)
16	Oil control valve (OCV)

17	Timing chain (RH) (See Timing Chain (RH) Assembly Note)
18	Tensioner arm (RH)
19	Chain tensioner (RH)
20	CKP sensor pulse wheel (See Crankshaft Position (CKP) Sensor Pulse Wheel Assembly Note)
21	Engine front cover (See Engine Front Cover Assembly Note)
22	Crankshaft pulley (See Crankshaft Pulley Assembly Note)
23	Auto tensioner
24	Oil pan (See Oil Pan Assembly Note)
25	Camshaft oil seal housing (See Camshaft Oil Seal Housing Assembly Note)
26	Water pump drive pulley (See Water Pump Drive Pulley Assembly Note)
27	Water pump drive belt
28	Cylinder head cover (See Cylinder Head Cover Assembly Note)
29	Oil level gauge, pipe
30	Engine hanger
31	Spark plug

G02831332

Fig. 94: Installing Timing Chains
Courtesy of MAZDA MOTORS CORP.

VARIABLE VALVE TIMING ACTUATOR ASSEMBLY NOTE

1. Install the variable valve timing actuator using a new tightening bolt.
2. Secure the camshaft sprocket in a vise using the **SST** .

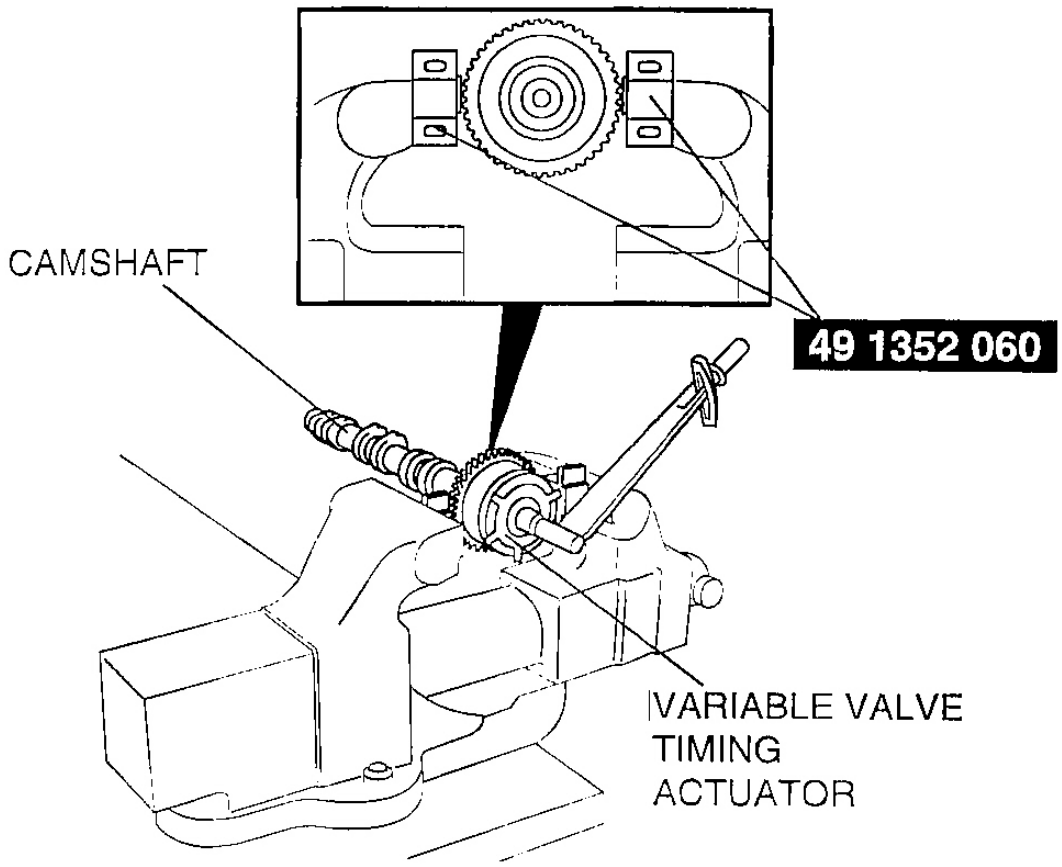


Fig. 95: Securing Camshaft Sprocket In A Vise
Courtesy of MAZDA MOTORS CORP.

3. Tighten the variable valve timing actuator tightening bolt in two steps.
    1. Tighten to **40 N.m {4.1 kgf.m, 29.5 ft.lbf}** .
    2. Tighten **90°** .

CAMSHAFT (LH) ASSEMBLY NOTE

1. Turn the crankshaft clockwise to position the crankshaft keyway in the **11 o'clock** position.

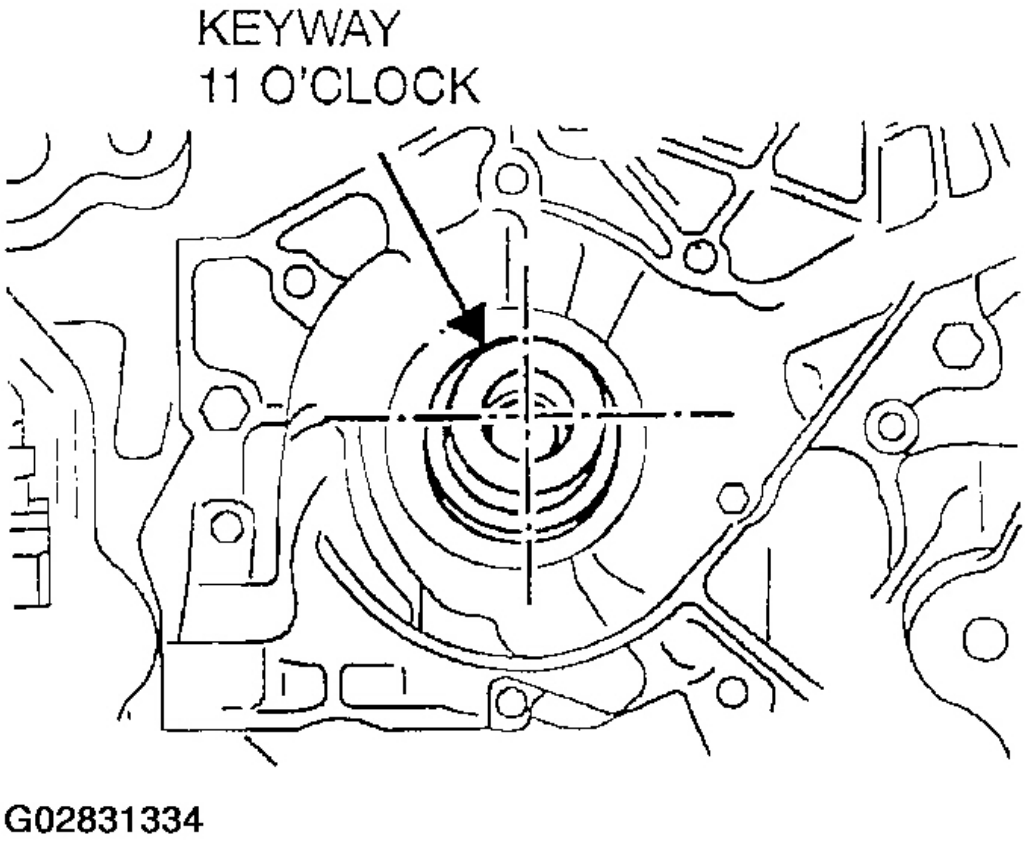


Fig. 96: Position Crankshaft Keyway In 11 O'clock Position
Courtesy of MAZDA MOTORS CORP.

2. Install the camshafts (LH).
    1. Position the intake camshaft so that the mark is at **9 o'clock** direction.
    2. Position the exhaust camshaft so that the mark is at **12 o'clock** direction.

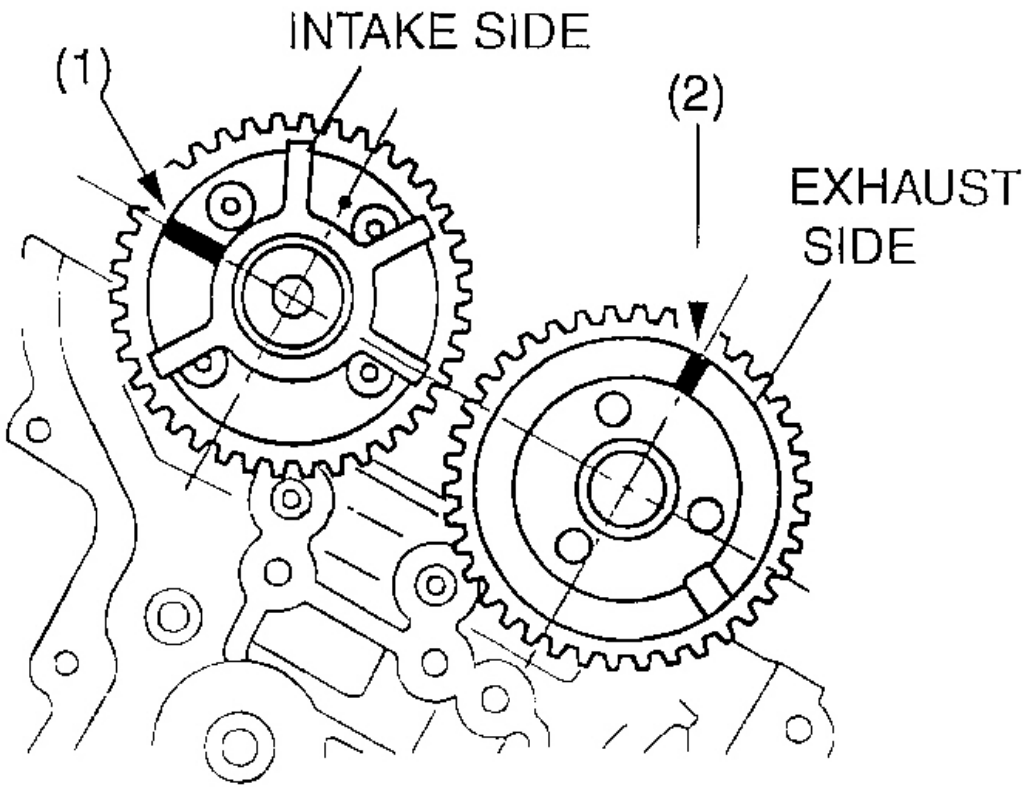


Fig. 97: Installing Camshafts
Courtesy of MAZDA MOTORS CORP.

CAUTION:
- **Do not install thrust caps 1L and 6L at this time, or damage to the thrust caps may occur.**

NOTE:
- **Tighten the camshafts caps at specified torque after assembling the timing chain.**
- **The camshaft bearing caps are numbered to make sure they are assembled in their original positions.**

3. Hand tighten the camshaft (LH) caps in their original positions.

CHAIN GUIDE (LH, RH) ASSEMBLY NOTE

1. The chain guide should be installed to the actuator and allowed to hang freely when the bolts are

installed. Do not hold the chain guide in an upward position when the bolts are installed. The actuator causes a wear O-ring and this installation method will allow that wear to continue.

TIMING CHAIN (LH) ASSEMBLY NOTE

1. Install the timing chain (LH) by aligning the colored links on the timing chain (LH) with the marks on the timing sprockets.

CAUTION:
- **Install the camshaft bearing thrust caps after installing the other bearing caps, or damage to the thrust caps may occur.**

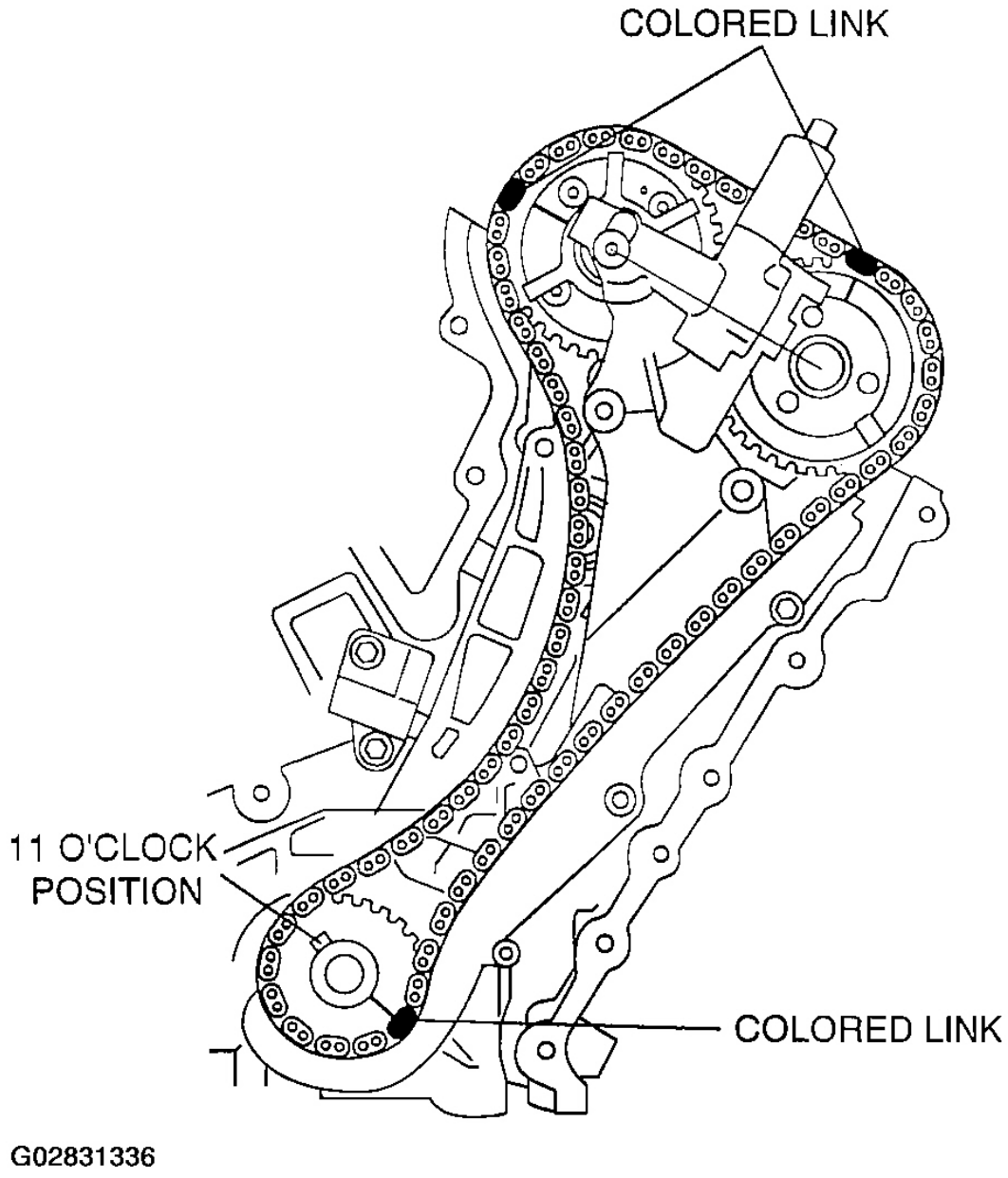
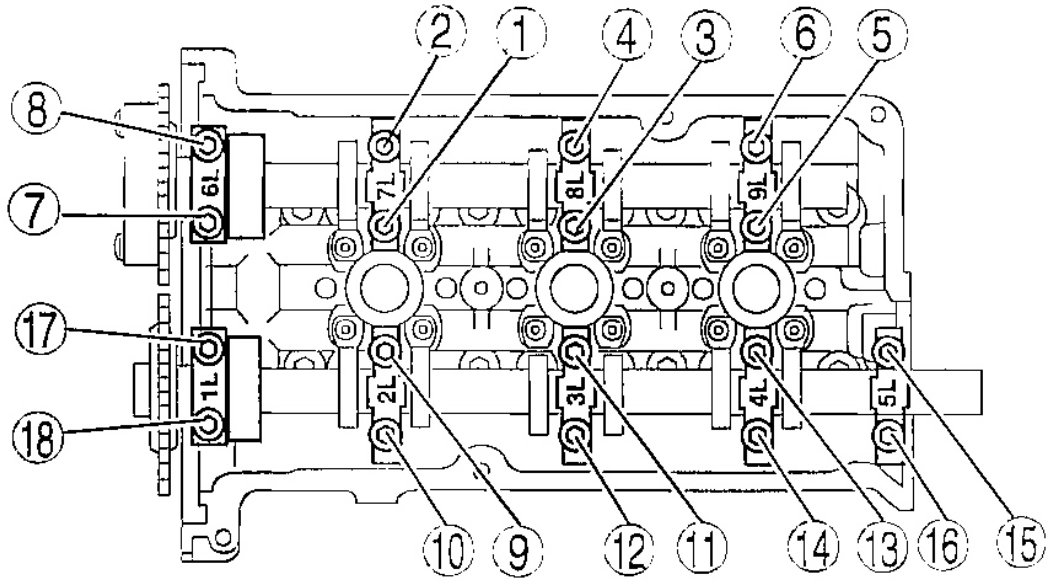


Fig. 98: Installing Timing Chain (LH)
Courtesy of MAZDA MOTORS CORP.

2. Align the camshaft end play using the camshaft bearing thrust caps 1L and 6L, and tighten the other bearing caps.
3. Tighten the bearing caps in the order indicated in the figure in several passes.



G02831337

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

CAMSHAFT (RH) ASSEMBLY NOTE

1. Turn the crankshaft clockwise to position the crankshaft keyway in the **3 o'clock** position.

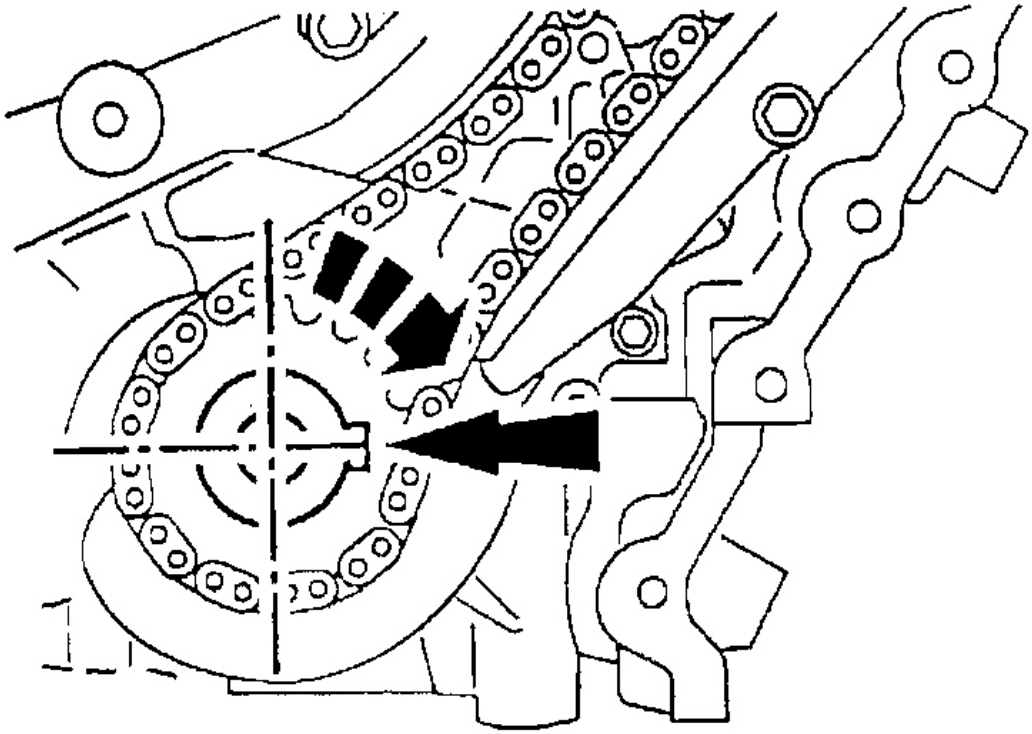


Fig. 100: Positioning Crankshaft Keyway In 3 O'clock Position
Courtesy of MAZDA MOTORS CORP.

2. Install the camshafts (RH).
    1. Position the exhaust camshaft so that the mark is at **12 o'clock** direction.
    2. Position the intake camshaft so that the mark is at **3 o'clock** direction.

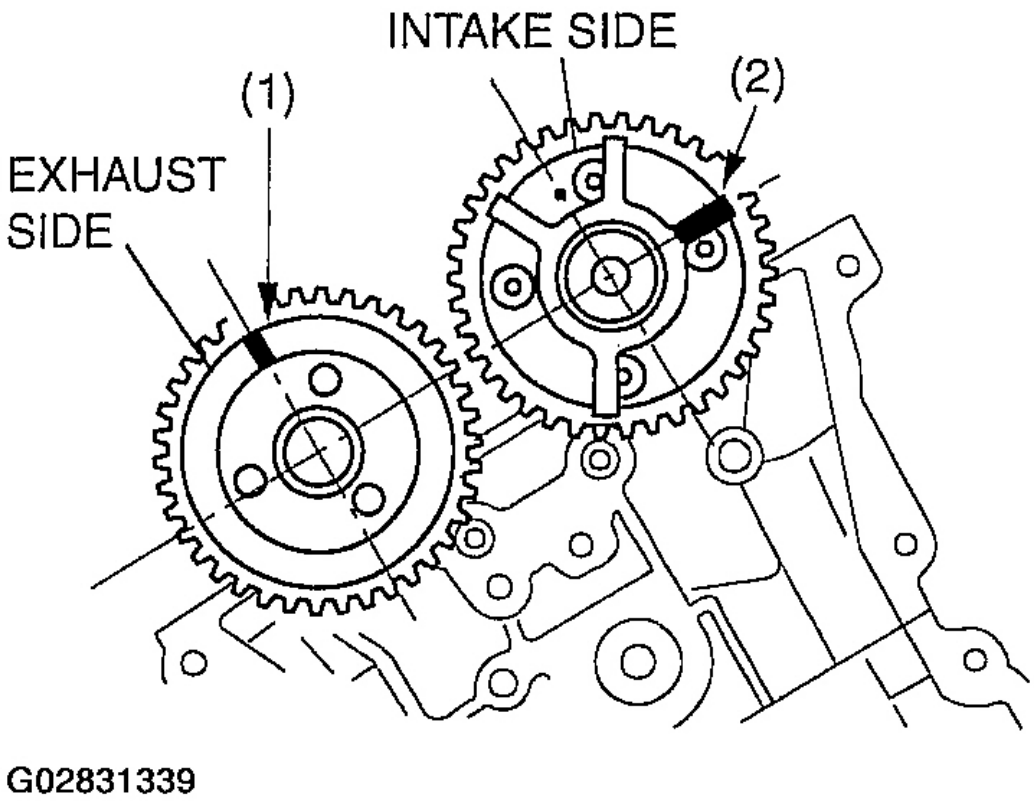


Fig. 101: Installing Camshafts (RH)
Courtesy of MAZDA MOTORS CORP.

CAUTION:
- **Do not install thrust caps 1R and 5R at this time, or damage to the thrust caps may occur.**

NOTE:
- **Tighten the camshafts caps at specified torque after assembling the timing chain.**
- **The camshaft bearing caps are numbered to make sure they are assembled in their original positions.**

3. Hand tighten the camshaft caps (RH) in their original positions.

TIMING CHAIN (RH) ASSEMBLY NOTE

1. Install the timing chain (RH) by aligning the colored links on the timing chain (RH) with the marks on the timing sprockets.

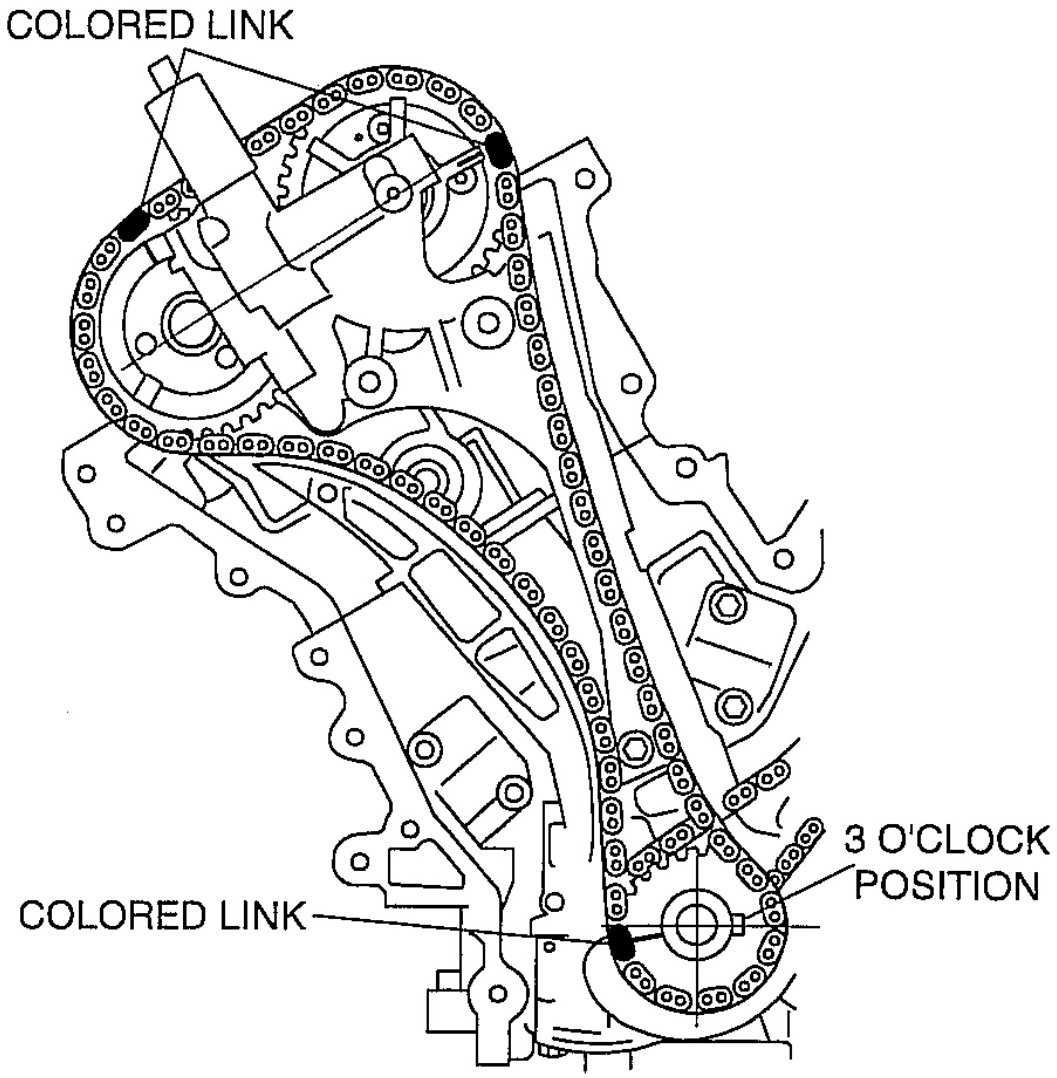
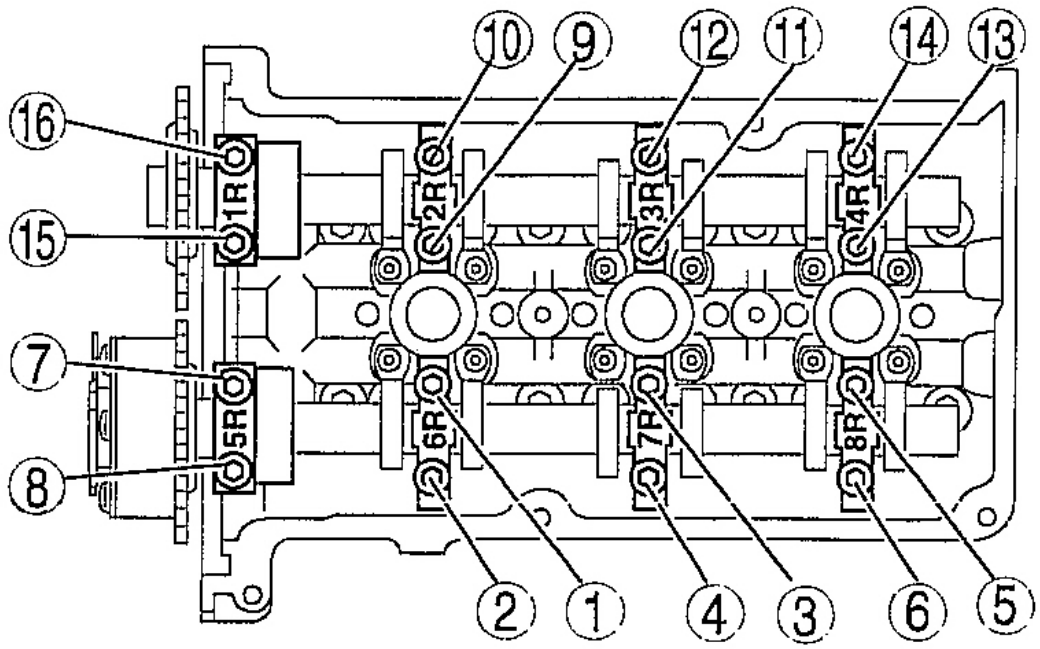


Fig. 102: Installing Timing Chain (RH)
Courtesy of MAZDA MOTORS CORP.

CAUTION:
- **Install the camshaft bearing thrust caps after installing the other bearing caps, or damage to the thrust caps may occur.**

2. Align the camshaft end play using the camshaft bearing thrust caps 1R and 5R, and tighten the other bearing caps.
3. Tighten the bearing caps in the order indicated in the figure in several passes.



G02831341

Fig. 103: Bearing Cap Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

4. Install the chain tensioner and remove the retaining wire.

CRANKSHAFT POSITION (CKP) SENSOR PULSE WHEEL ASSEMBLY NOTE

1. With the "FRONT" mark of the pulse wheel facing you, install the crankshaft position (CKP) sensor pulse wheel using the keyway on the same side as the empty space shown in figure.

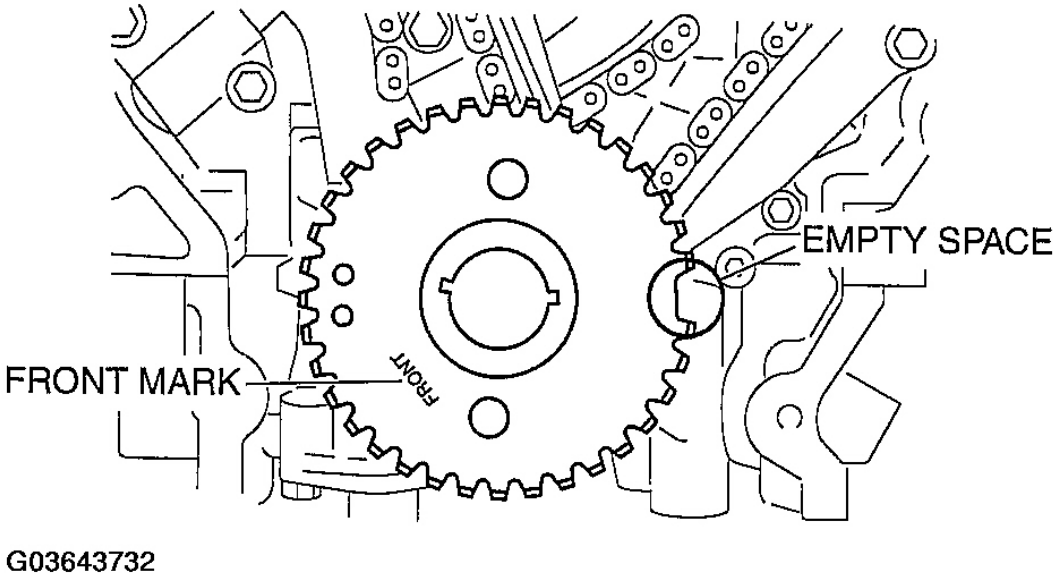
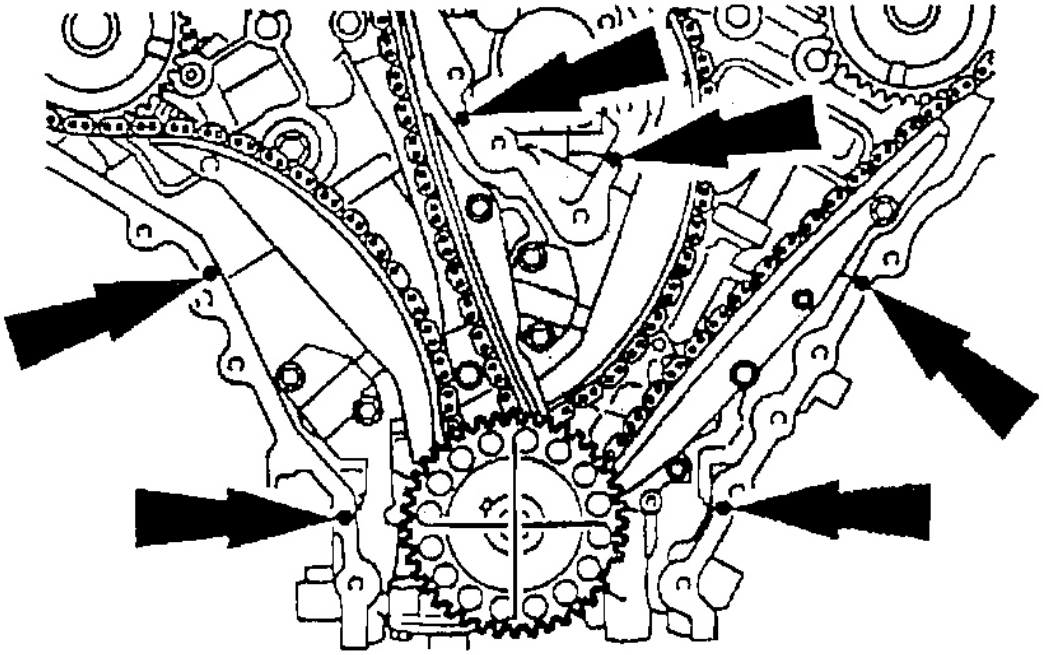


Fig. 104: Installing Crankshaft Position (CKP) Sensor Pulse Wheel
Courtesy of MAZDA MOTORS CORP.

ENGINE FRONT COVER ASSEMBLY NOTE

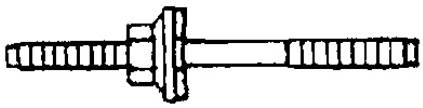
1. Apply a **6 mm {0.24 in}** dot of silicon sealant as indicated in the figure (mating faces).



G02831344

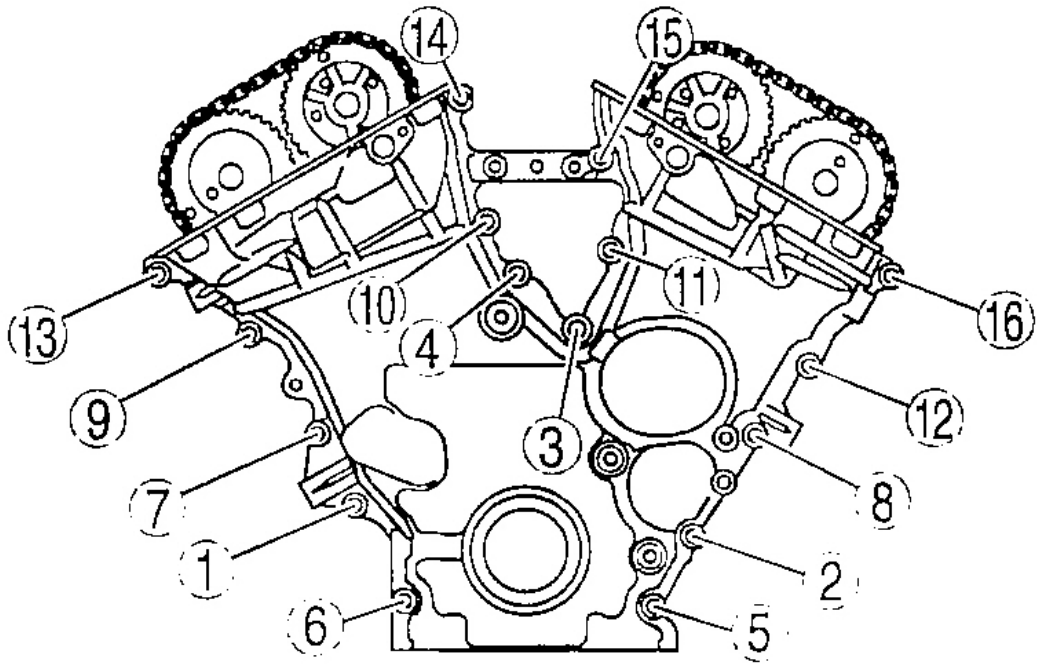
Fig. 105: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

2. Tighten the bolts and studs in the order indicated in the figure.

Hole No.	Bolt	Description
2, 5, 6, 7, 9, 12,		M8×1.25×51.8 bolt
3, 4, 14		M8×1.25×64 stud
1, 8, 13, 16		M6×1.0×20/ M8×1.25 stud
10, 11, 15,		M8×1.25×115 bolt

G02831342

Fig. 106: Identifying Engine Front Cover Bolts & Studs
Courtesy of MAZDA MOTORS CORP.



G02831345

Fig. 107: Engine Front Cover Bolt & Stud Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

3. Assemble the front oil seal using part A of the **SST** [303-335 (49 UN30 3335)] and the **SST** [303-102 (49 UN01 002)] in the following order.

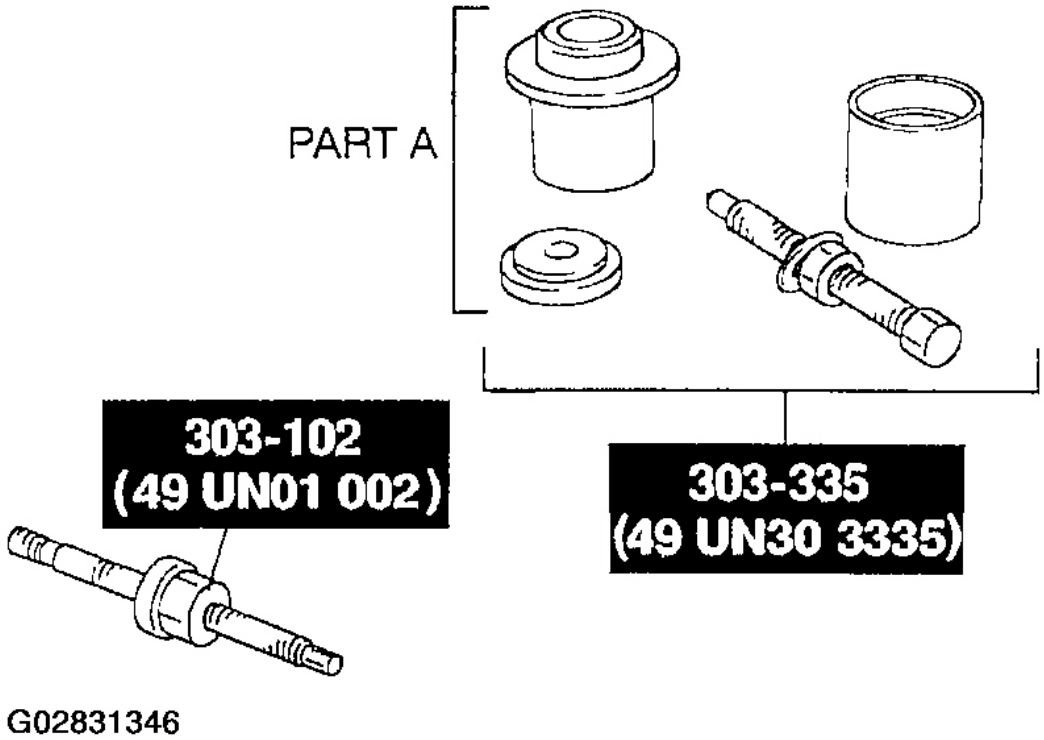


Fig. 108: Assembling SST & Oil Seal
Courtesy of MAZDA MOTORS CORP.

1. Apply clean engine oil to the new oil seal.
2. Push the oil seal slightly in by hand.
3. Compress the oil seal using the **SSTs** .

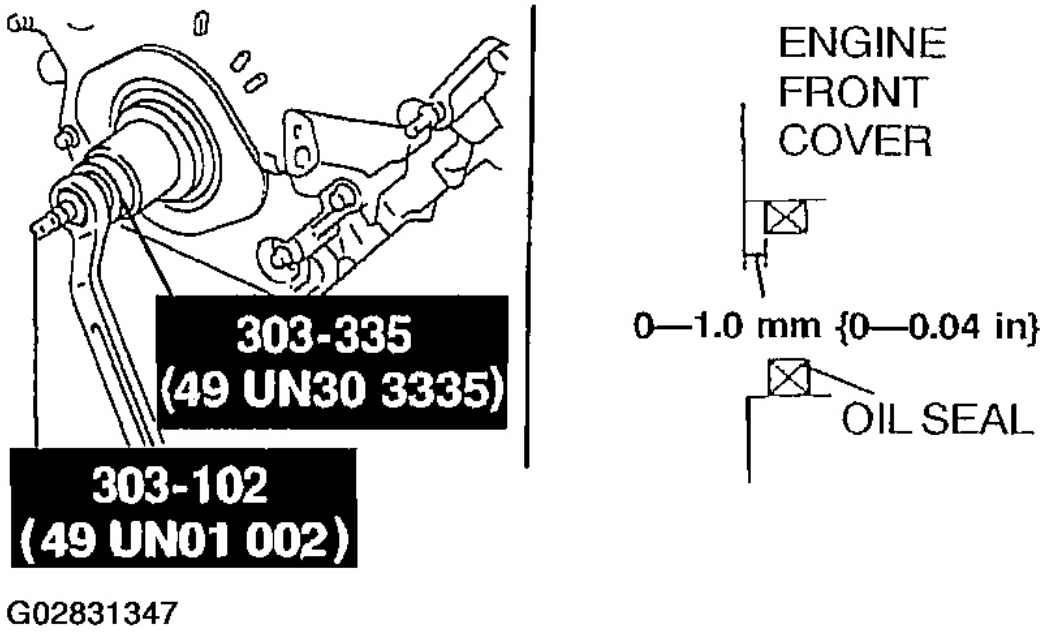


Fig. 109: Installing Oil Seal
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT PULLEY ASSEMBLY NOTE

1. Using the silicone sealant, seal the keyway in the crankshaft pulley.
2. Install the crankshaft pulley using the **SST** and washer of crankshaft pulley lock bolt washer.

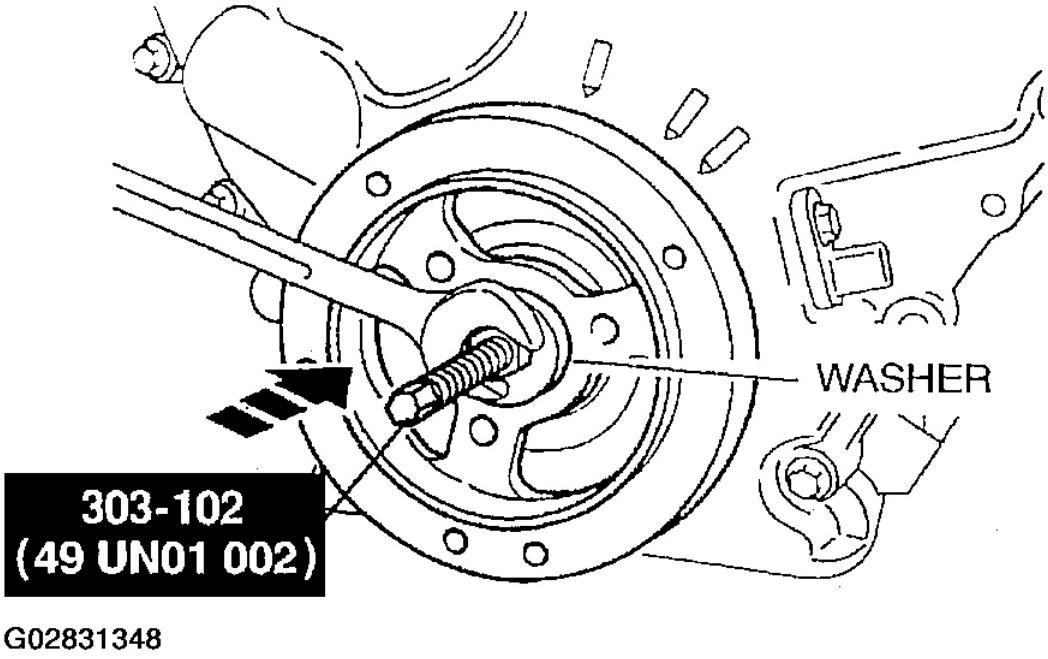


Fig. 110: Installing Crankshaft Pulley
Courtesy of MAZDA MOTORS CORP.

3. Hold the flywheel (MTX) or the drive plate (ATX) using the **SST** .

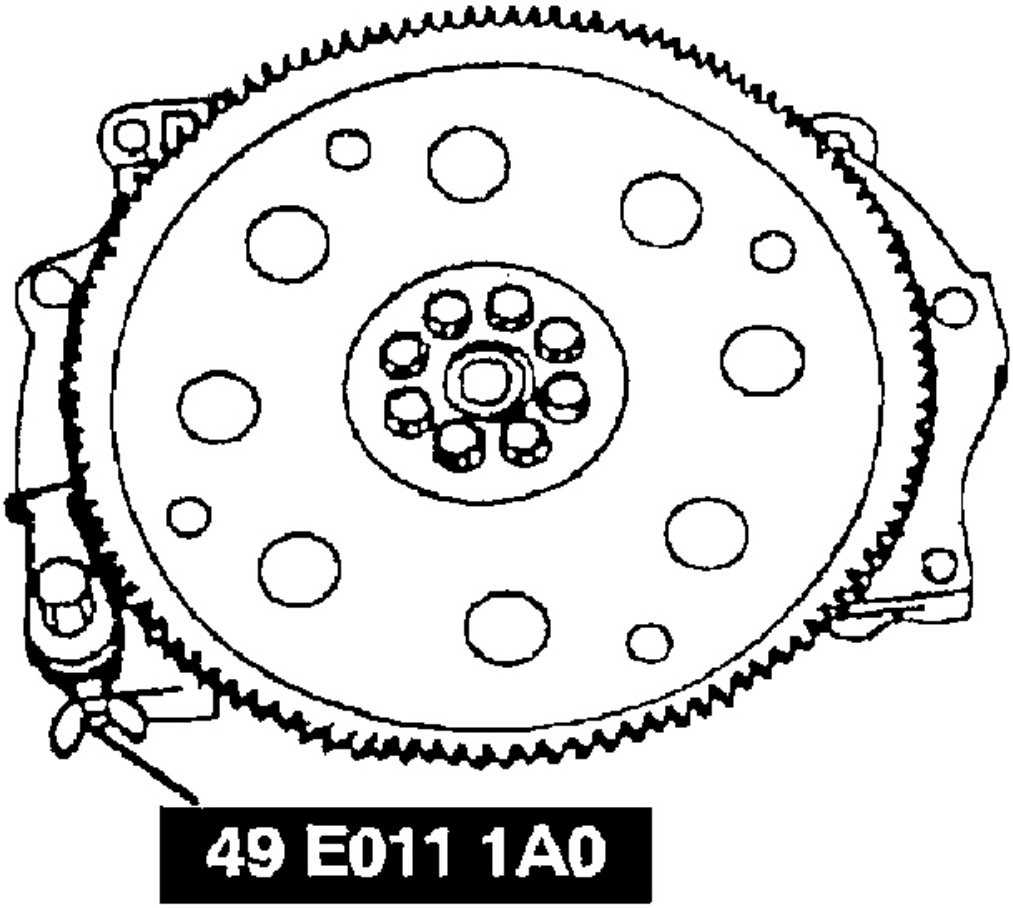
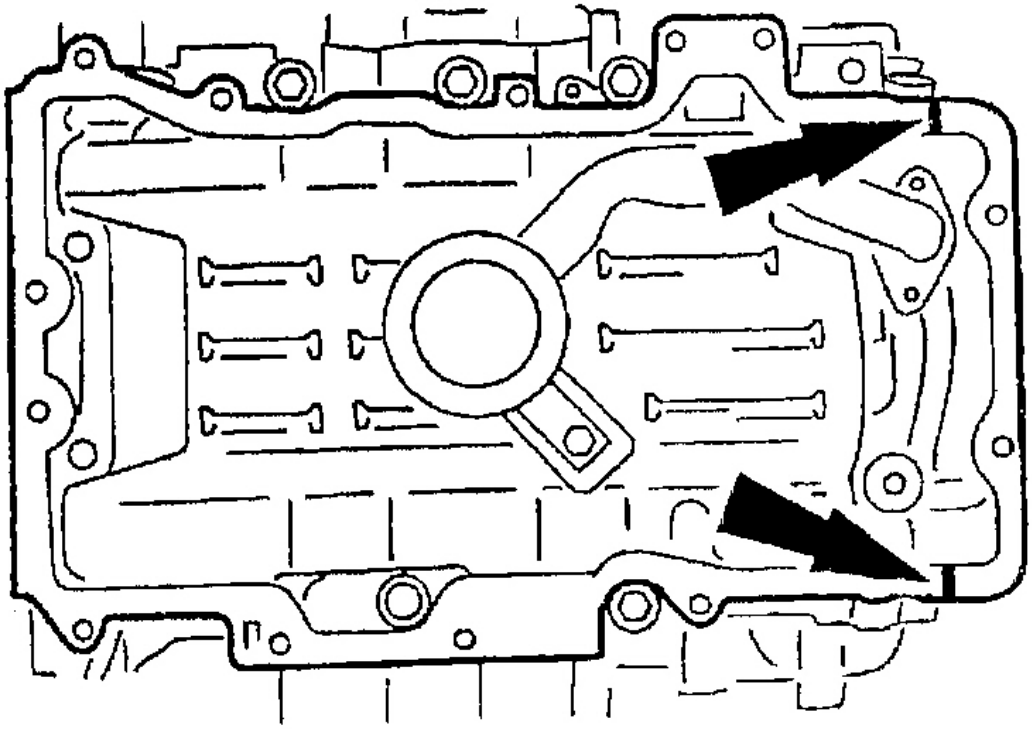


Fig. 111: Holding Flywheel (MTX) Or Drive Plate (ATX)
Courtesy of MAZDA MOTORS CORP.

4. Tighten the crankshaft pulley lock bolt in four steps.
    1. Tighten to **120 N.m {12.2 kgf.m, 88.5 ft.lbf}** .
    2. Loosen **360°** (one full turn) in reverse order.
    3. Tighten **47-53 N.m {4.8-5.4 kgf.m, 35-39 ft.lbf}** .
    4. Tighten **85°-95°** .

OIL PAN ASSEMBLY NOTE

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



G02831350

Fig. 112: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

Dot Diameter

10 mm {0.39 in}

2. Install the oil pan with a new gasket.
3. Install the bolts and studs as indicated in the figure.

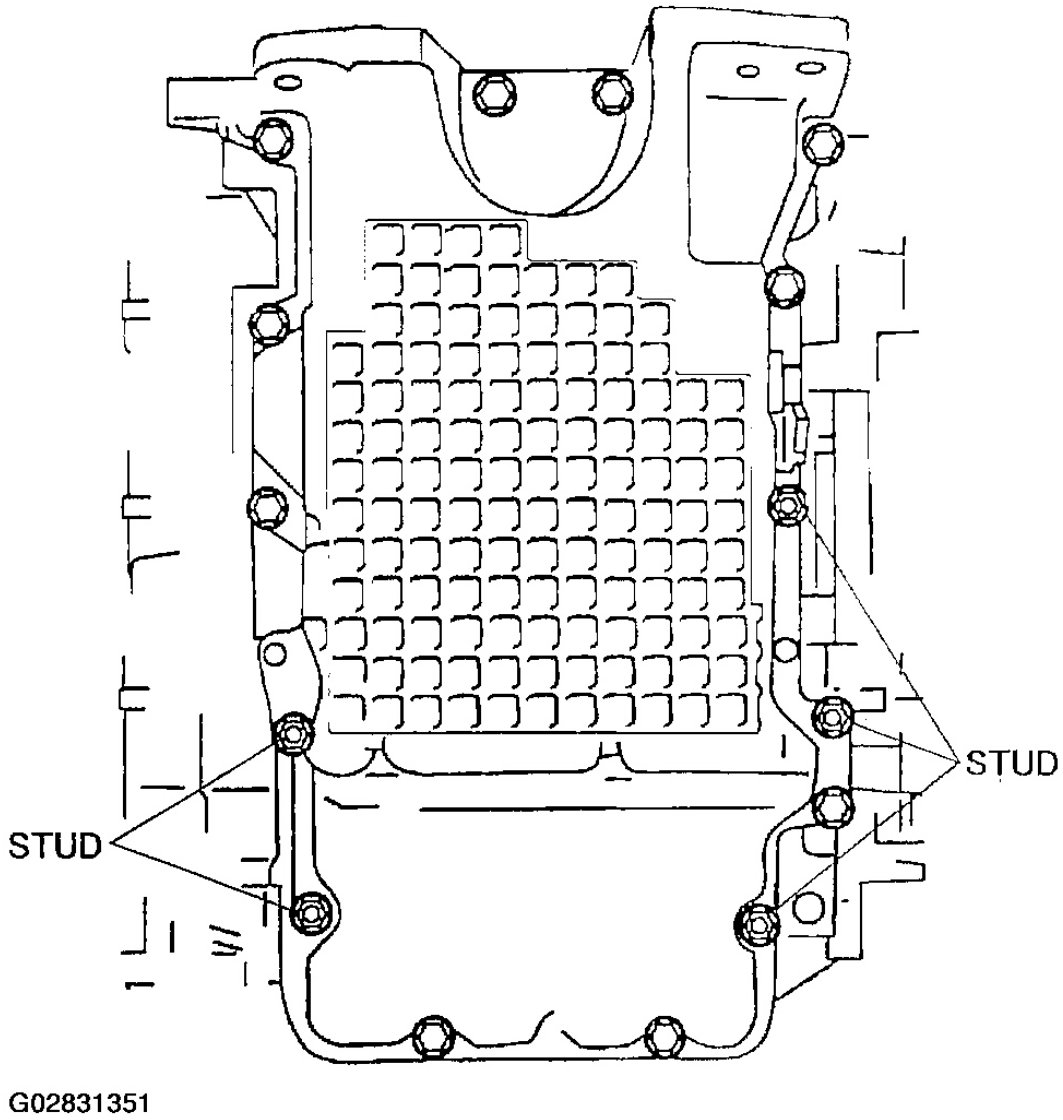


Fig. 113: Identifying Oil Pan Bolt & Stud Locations
Courtesy of MAZDA MOTORS CORP.

4. Align the cylinder block and the rear face of the oil pan using the straight edge.

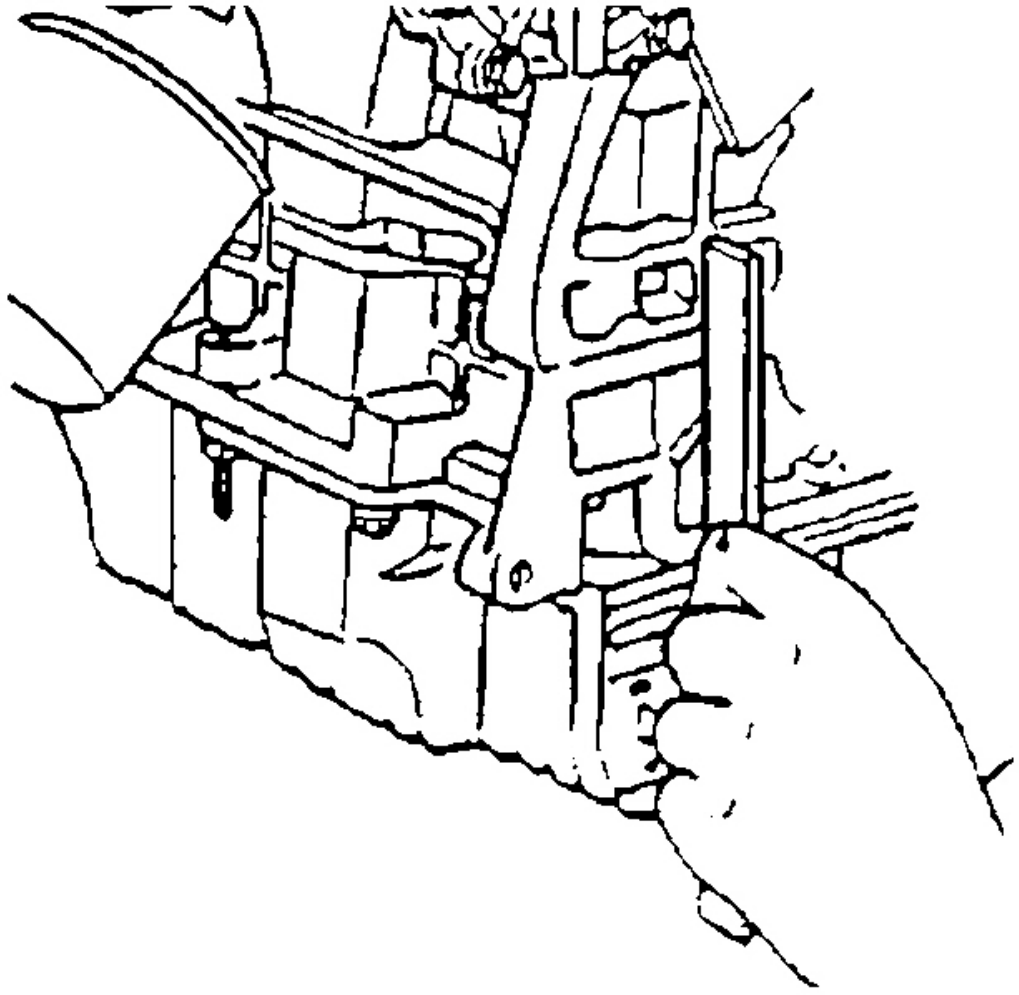


Fig. 114: Aligning Cylinder Block & Rear Face Of Oil Pan
Courtesy of MAZDA MOTORS CORP.

5. Tighten the bolts and studs in the order indicated in the figure.

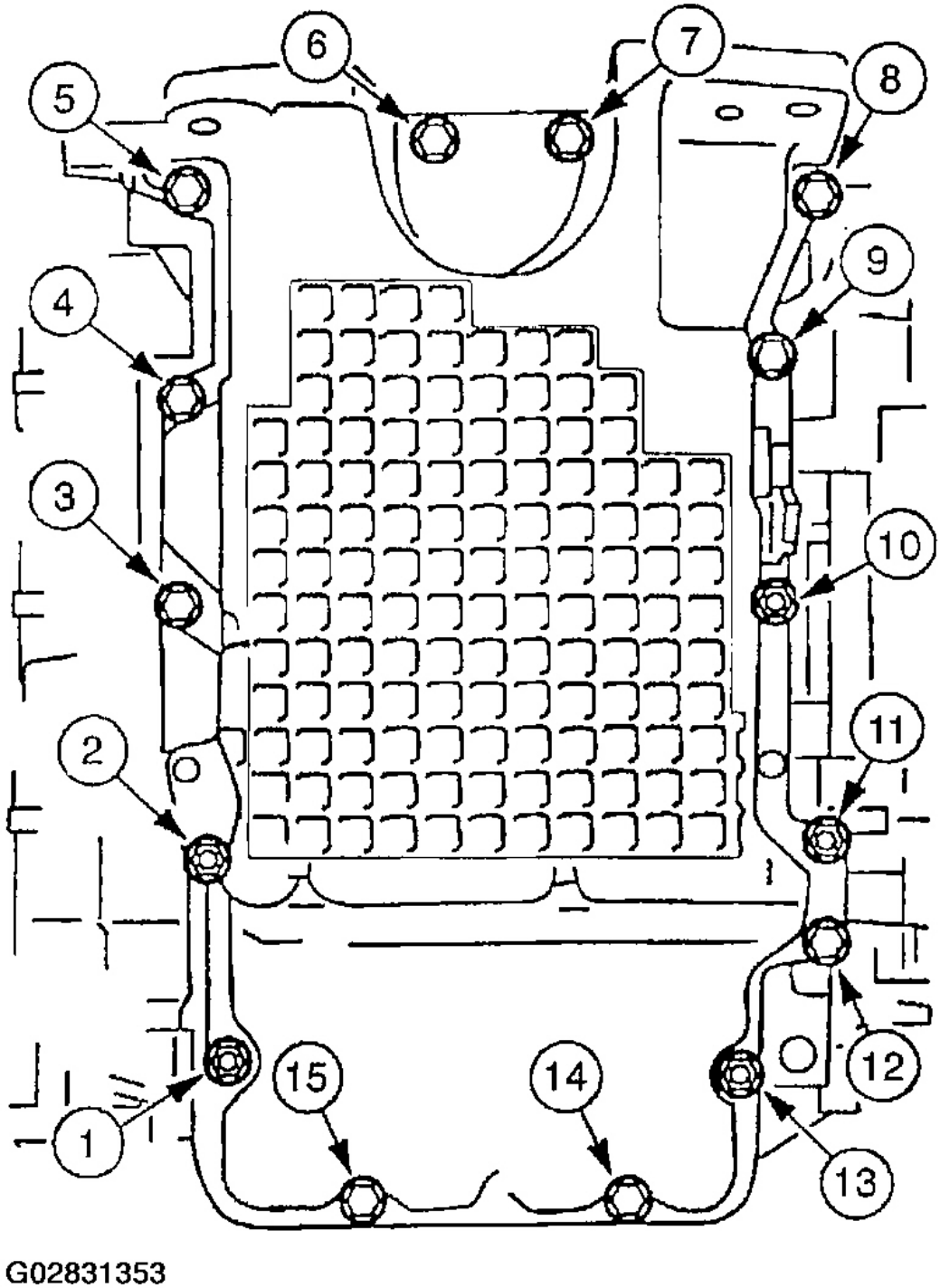


Fig. 115: Oil Pan Bolt & Stud Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

CAMSHAFT OIL SEAL HOUSING ASSEMBLY NOTE

1. Apply clean engine oil to the oil seal.
2. Install the camshaft oil seal using the **SSTs** .

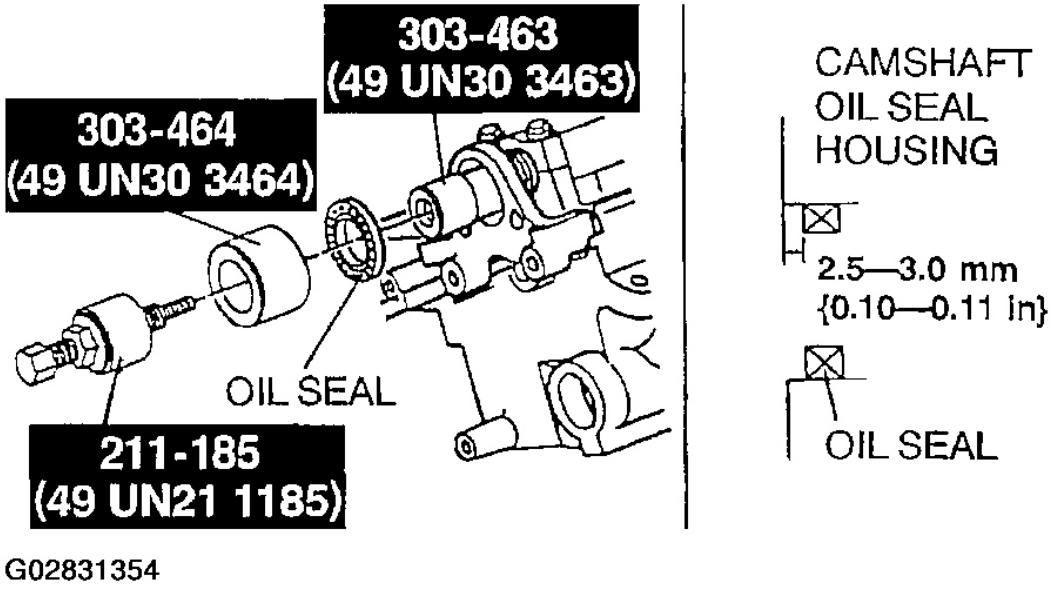


Fig. 116: Installing Camshaft Oil Seal
Courtesy of MAZDA MOTORS CORP.

WATER PUMP DRIVE PULLEY ASSEMBLY NOTE

1. Install the new water pump pulley using the **SST** .

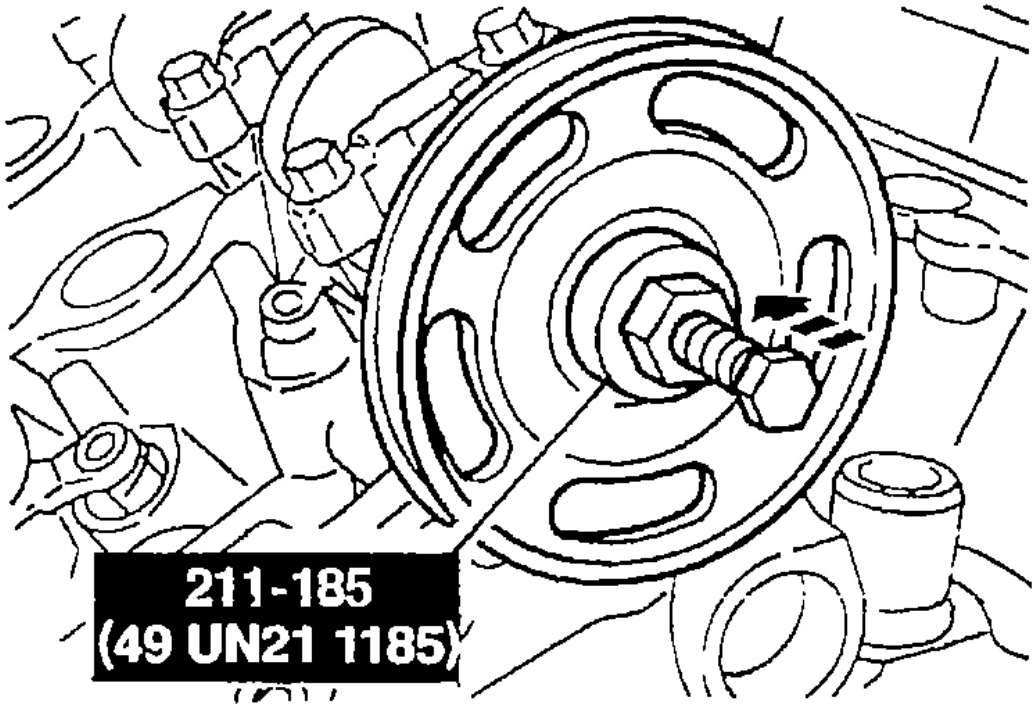


Fig. 117: Installing Water Pump Pulley
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD COVER ASSEMBLY NOTE

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

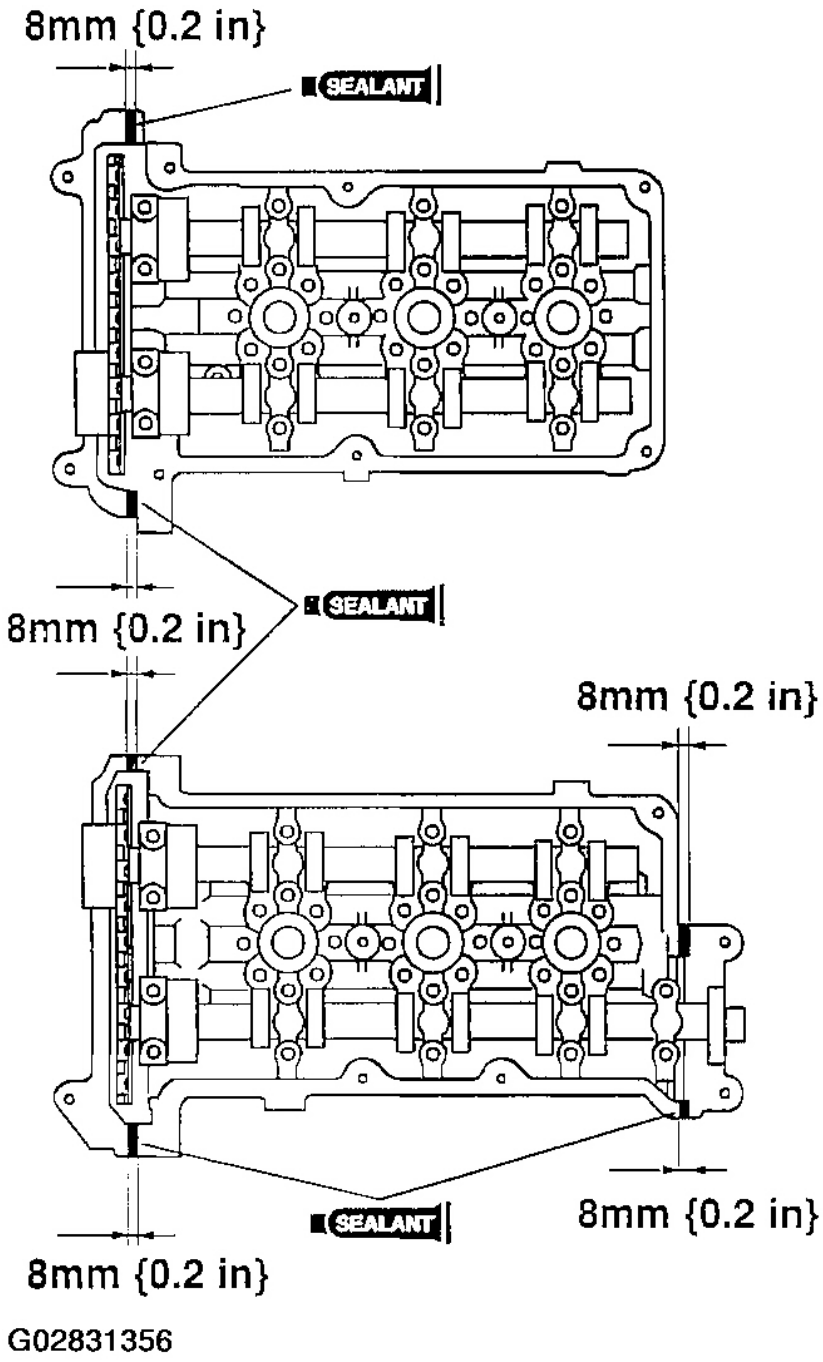


Fig. 118: Applying Silicone Sealant
Courtesy of MAZDA MOTORS CORP.

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

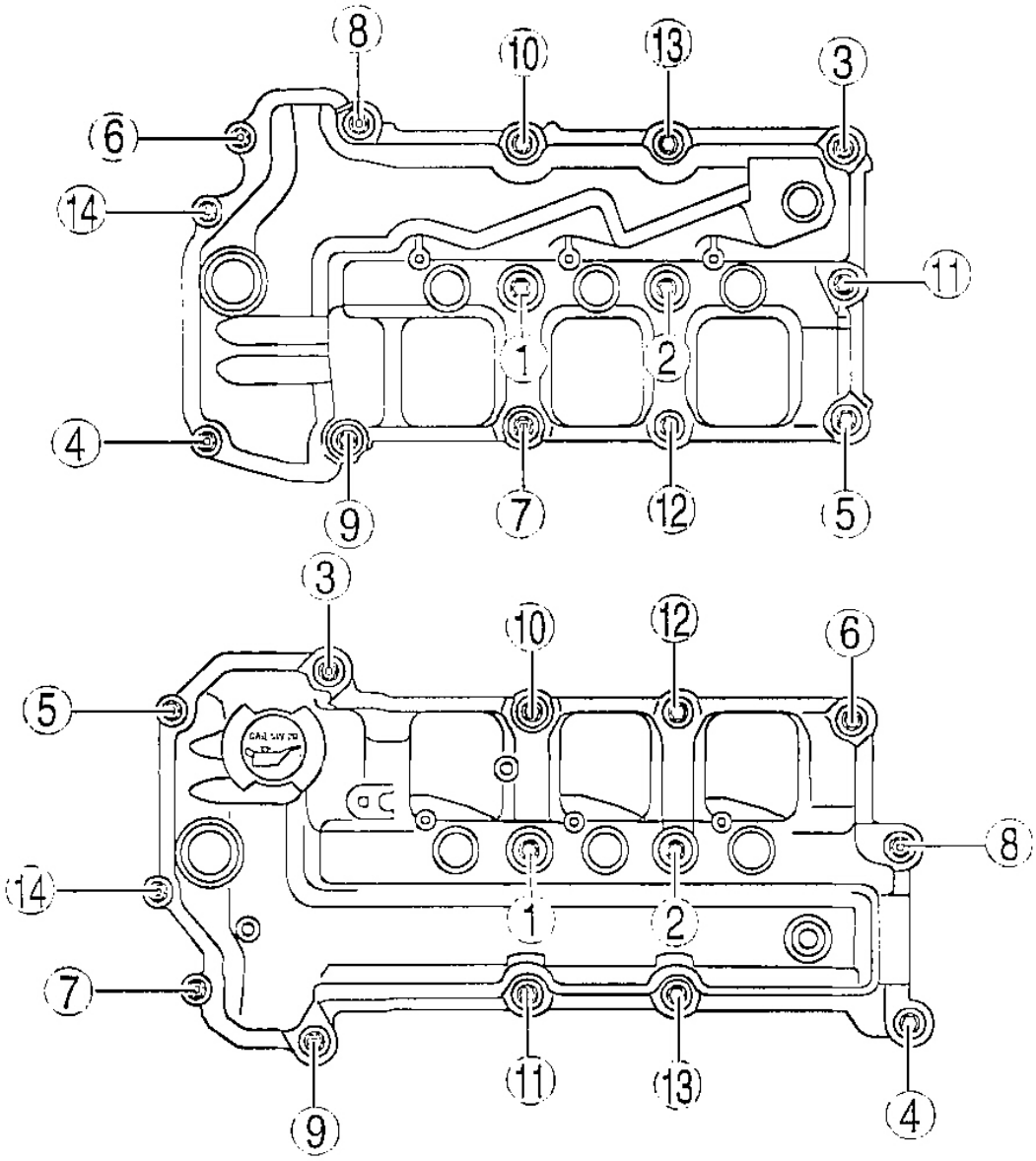


Fig. 119: Cylinder Head Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Connector Rod Cap Nuts	(1)

Crankshaft Damper Bolt	
Step 1	88 (120)
Step 2	Loosen One Full Turn
Step 3	35-39 (47-53)
Step 4	Additional 85-95 Degrees
Crankshaft Main Bearing Cap Bolts	(2)
Cylinder Head Bolts (3)	
Step 1	24-28 (32-38)
Step 2	Additional 85-95 Degrees
Step 3	Loosen One Full Turn
Step 4	24-28 (32-38)
Step 5	Additional 85-95 Degrees
Step 6	Additional 85-95 Degrees
Drive Belt Tensioner	15-22 (20-30)
EGR Pipe Nuts	26-33 (35-45)
EGR Valve Bolts	14-19 (19-26)
Engine Front Cover Bolts (4)	15-22 (20-30)
Engine Hanger Bolt	73-92 (100-125)
Engine Mount Nuts	50-67(67-93)
Engine Mount Through Bolts	63-86 (85-116)
Exhaust Manifold Nuts (5)(6)	15-18 (20-25)
Flex Plate Bolts (7)	54-64 (73-87)
Generator Bolts	29-24 (40-55)
Generator Bracket Bolts	15-22 (20-30)
Heated Oxygen Sensor	22-36 (29-49)
Knock Sensor	15-22 (20-30)
Oil Pan Drain Plug	16-22 (22-30)
Oil Pan Bolts (8)	15-22 (20-30)
Oil Pressure Switch	9-12 (12-16)
Spark Plug	7-15 (9-20)
Starter Motor Bolts	28-38 (38-51)
Transmission-To-Engine Bolts	28-38 (38-51)
	INCH Lbs. (N.m)
A/C Pipe Stay Nut	80-115 (9-13)
Battery Clamp Nuts	35-62 (4-7)

Battery Tray Bolts & Nut	71-106 (8-12)
Camshaft Bearing Cap Bolts	71-106 (8-12)
Camshaft Position Sensor	71-106 (8-12)
Crankshaft Position Sensor	71-106 (8-12)
Ignition Coil Bolts	53-70 (6-8)
Intake Manifold Bolts (Lower) (9)	71-106 (8-12)
Intake Manifold Bolts (Upper) (10)	71-106 (8-12)
Oil Level Indicator Tube Bolt	71-106 (8-12)
Oil Pump Bolts (11)	71-106 (8-12)
Oil Strainer Bolts	71-106 (8-12)
Oil Strainer Stay Nut	
Step 1	133 (15)
Step 2	Additional 45 Degrees
PCM Connector Bolt	26-44 (3-5)
PCM Bracket Nuts	80-115 (9-13)
Radiator Bracket Bolts	71-106 (8-12)
Starter Motor Terminal Nuts	89-106 (10-12)
Thermostat Cover Bolts	71-106 (8-12)
Valve Cover Bolts (12)(13)	71-106 (8-12)
Water Bypass Tube Bolts	71-106 (8-12)
Water Pump Bolt	89 (10)
Water Pump Drive Belt Tensioner Bolt	71-106 (8-12)

(1) Specification not provided from manufacturer.

(2) Tighten bolts in sequence. See **Fig. 71**.

(3) Tighten bolts in sequence. See **Fig. 120**.

(4) Tighten bolts in sequence. See **Fig. 121**.

(5) Tighten bolts in sequence. See **Fig. 122**.

(6) Tighten bolts in sequence. See **Fig. 123**.

(7) Tighten bolts in sequence. See **Fig. 124**.

(8) Tighten bolts in sequence. See **Fig. 125**.

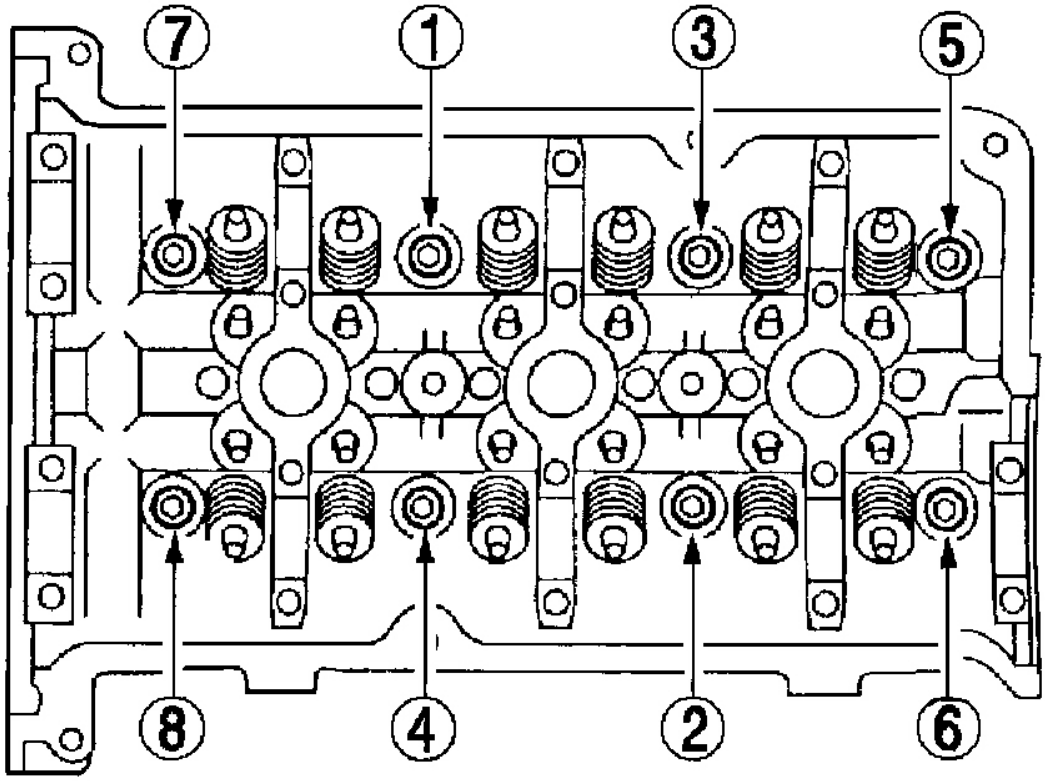
(9) Tighten bolts in sequence. See **Fig. 126**.

(10) Tighten bolts in sequence. See **Fig. 127**.

(11) Tighten bolts in sequence. See **Fig. 128**.

(12) Tighten bolts in sequence. See **Fig. 129**.

(13) Tighten bolts in sequence. See **Fig. 130**.



G00354553

Fig. 120: Cylinder Head Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

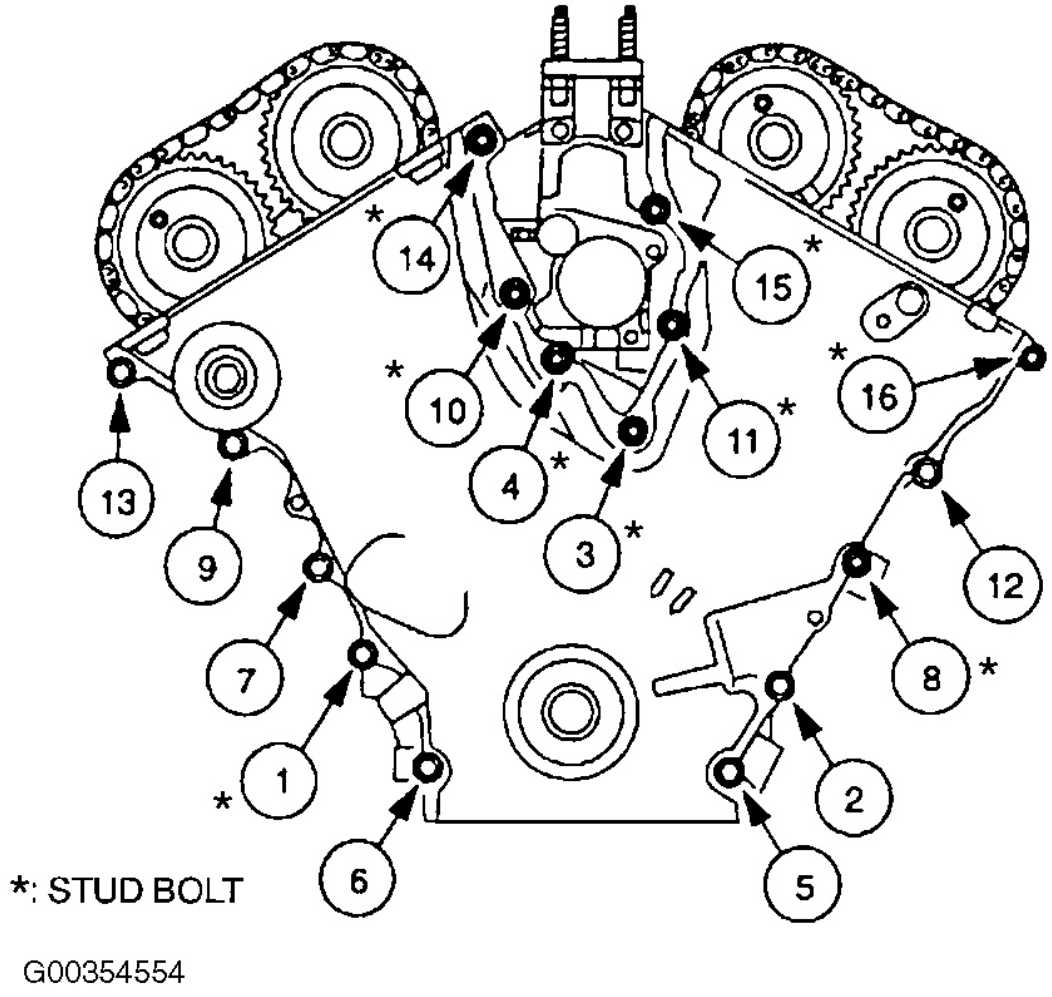


Fig. 121: Engine Front Cover Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

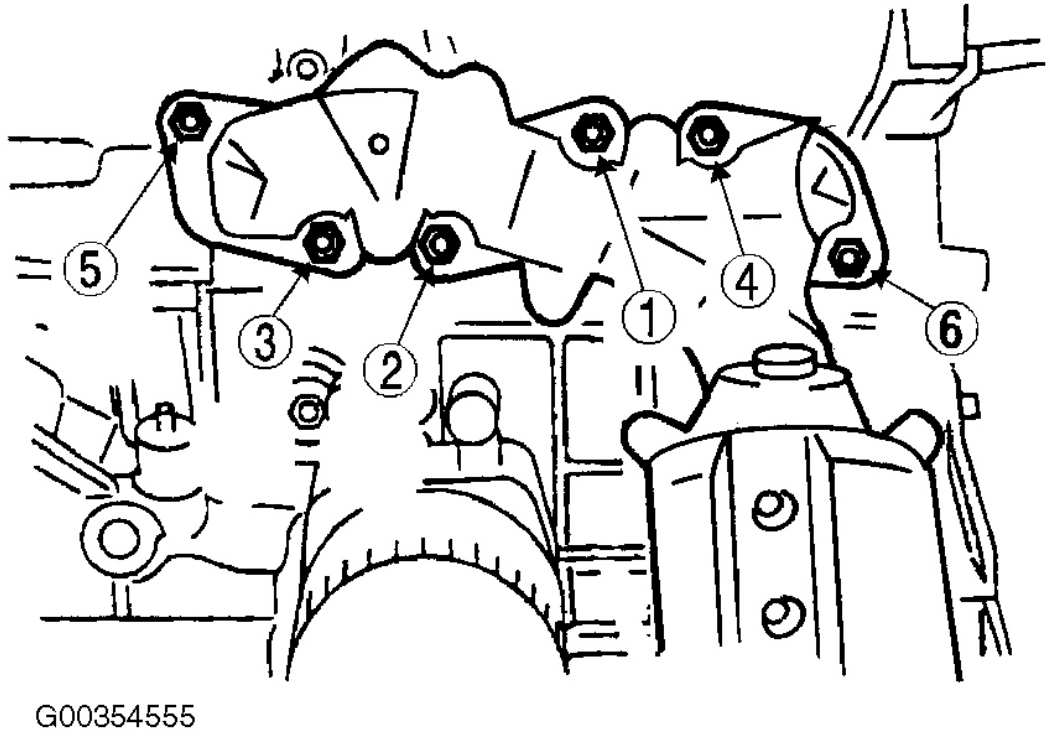


Fig. 122: Exhaust Manifold Nut Tightening Sequence (Left)
Courtesy of MAZDA MOTOR CORP.

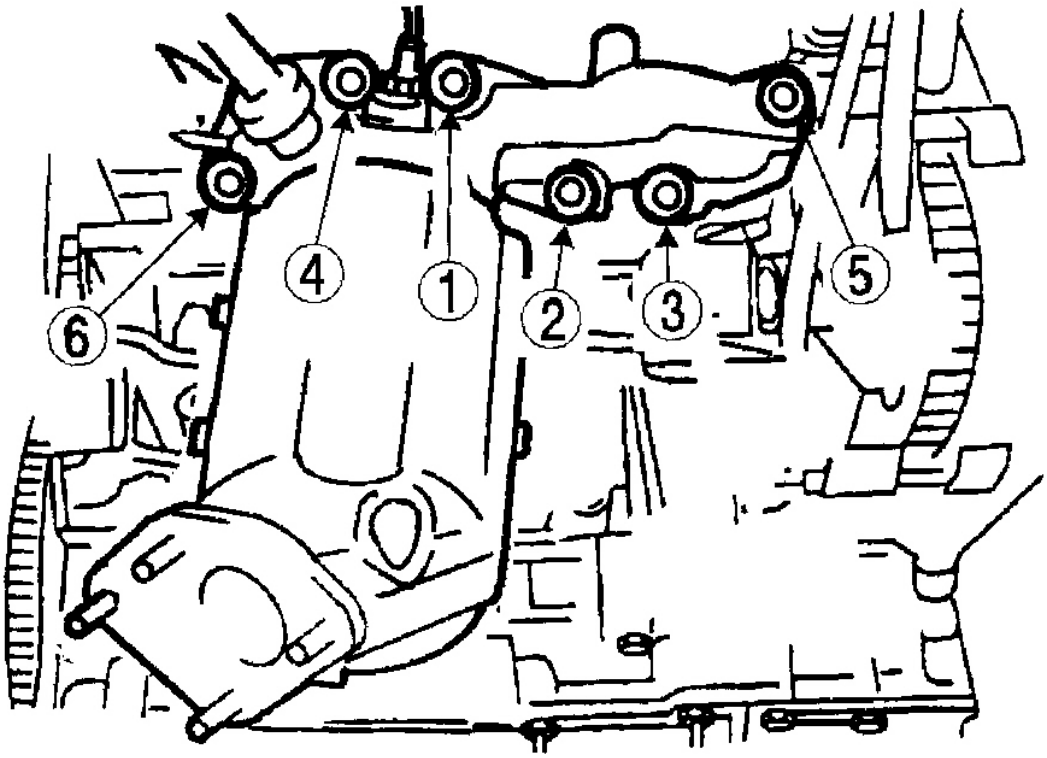
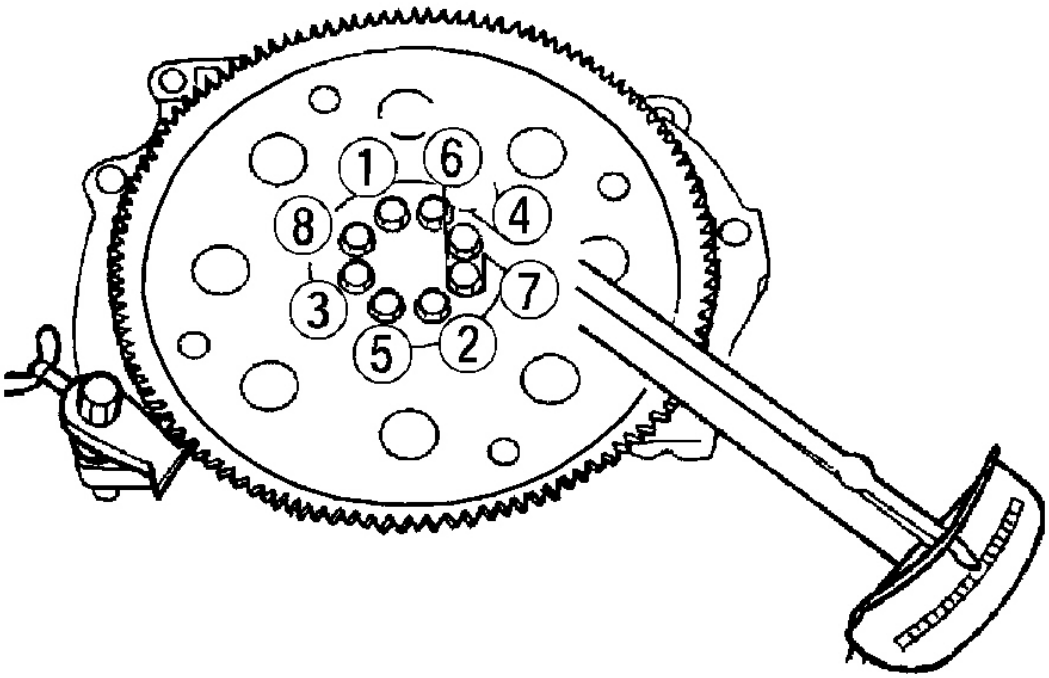


Fig. 123: Exhaust Manifold Nut Tightening Sequence (Right)
Courtesy of MAZDA MOTOR CORP.



G00354558

Fig. 124: Flex Plate Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

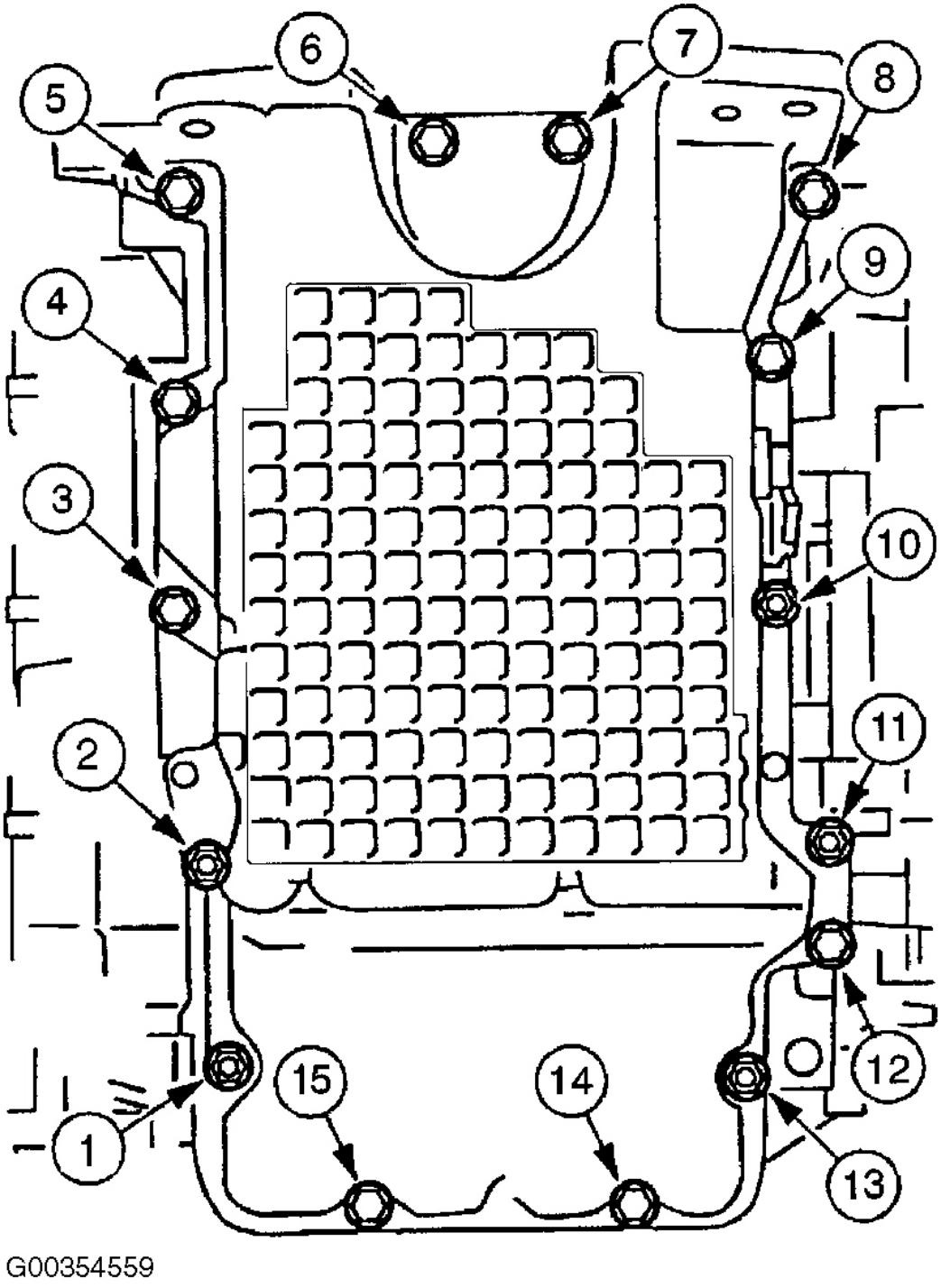


Fig. 125: Oil Pan Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

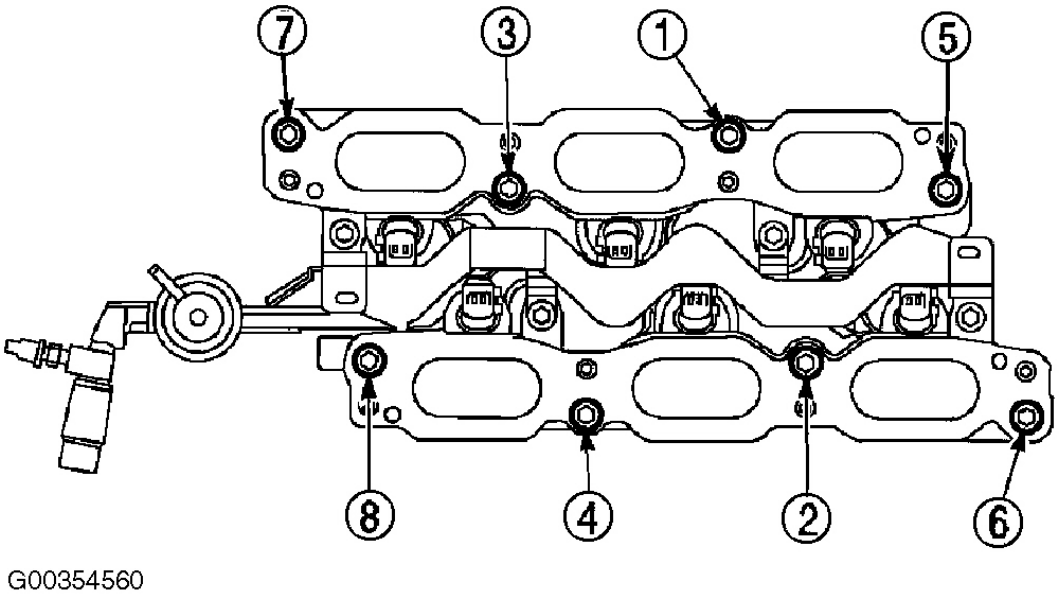
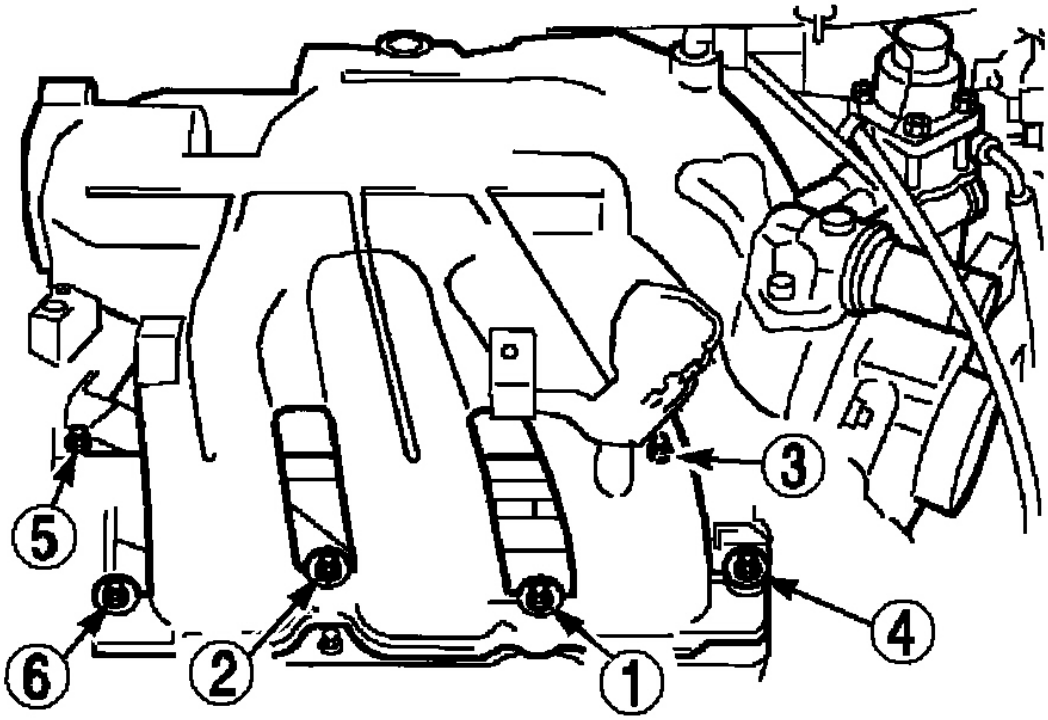
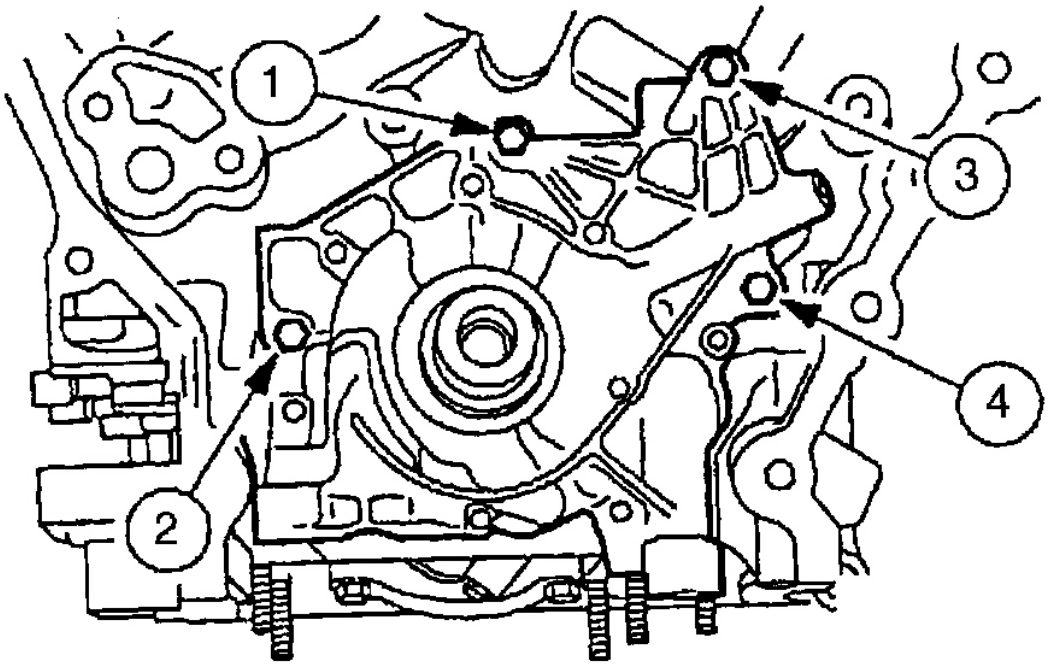


Fig. 126: Intake Manifold Bolt Tightening Sequence (Lower)
Courtesy of MAZDA MOTOR CORP.



G00354563

Fig. 127: Intake Manifold Bolt Tightening Sequence (Upper)
Courtesy of MAZDA MOTOR CORP.



G00354564

Fig. 128: Oil Pump Bolt Tightening Sequence
Courtesy of MAZDA MOTOR CORP.

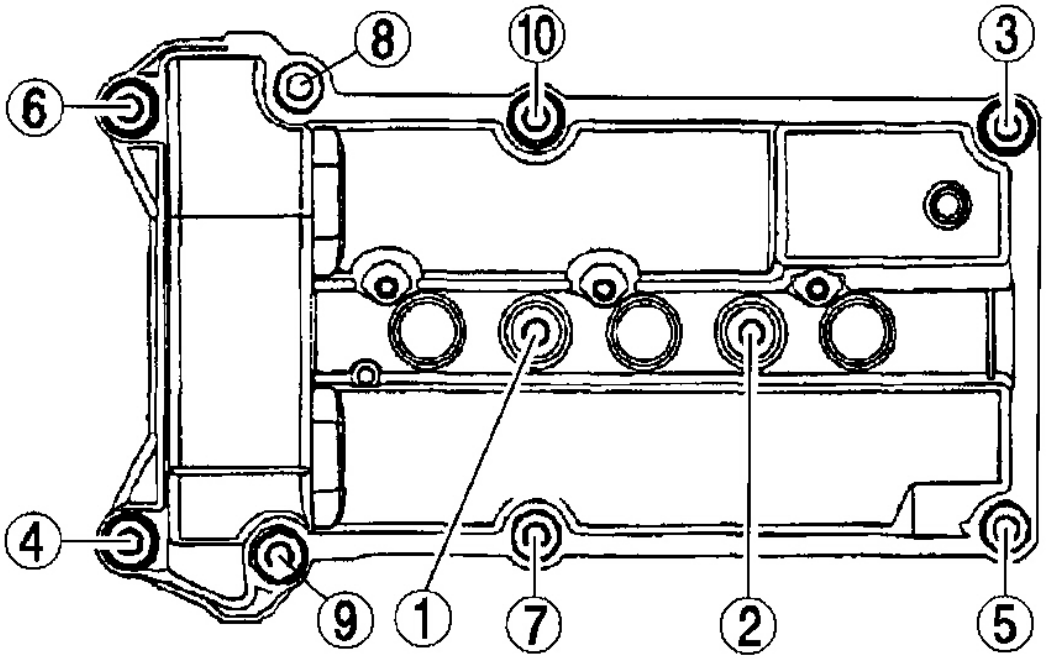


Fig. 129: Valve Cover Bolt Tightening Sequence (Right)
Courtesy of MAZDA MOTORS CORP.

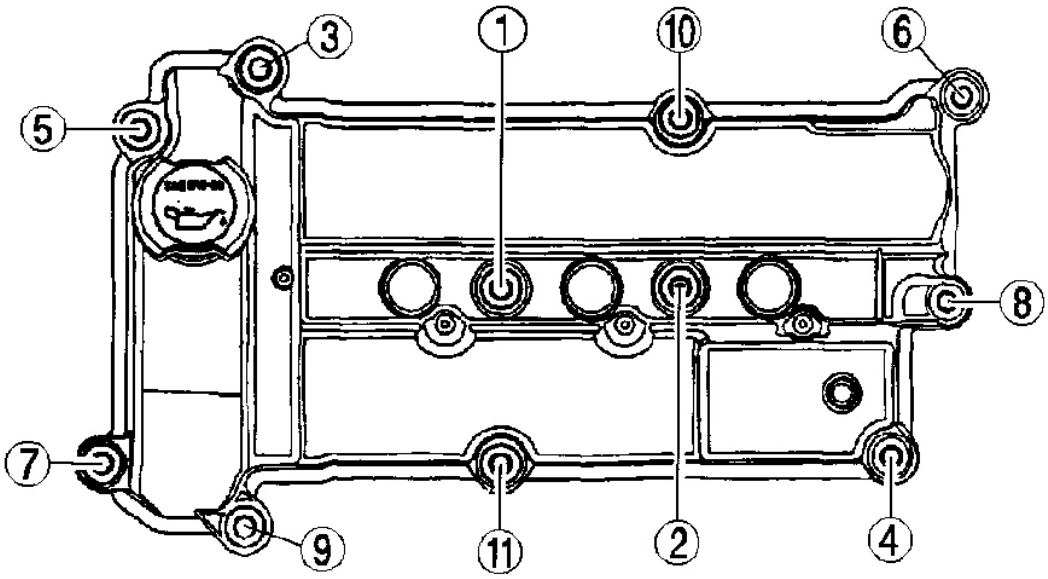


Fig. 130: Valve Cover Bolt Tightening Sequence (Left)
Courtesy of MAZDA MOTORS CORP.

ENGINE TECHNICAL DATA

Item				Engine
				AJ
Cylinder head				
Cylinder head gasket contact surfaces distortion	(mm {in})	Maximum		0.08 {0.0031}
Valve and valve guide				
Valve stem diameter	(mm {in})	Standard	IN	5.975—5.995 {0.2352—0.2360}
			EX	5.950—5.970 {0.2343—0.2350}
Valve stem to guide clearance	(mm {in})	Standard	IN	0.020—0.069 {0.0008—0.0027}
			EX	0.045—0.094 {0.0018—0.0037}
Valve guide projection height	(mm {in})	Standard	IN	13.4—14.2 {0.528—0.559}
			EX	13.4—14.2 {0.528—0.559}
Valve seat				
Valve seat contact width	(mm {in})	Standard	IN	1.1—1.4 {0.043—0.055}
			EX	1.4—1.7 {0.056—0.066}
Valve seat angle	(°)		IN	45
			EX	45
Valve spring				
Pressing force at valve spring height H	(mm {in})	680 N {69.3 kgf, 152 lbf}		30.19 {1.189}
Off-square	(mm {in})	Maximum		1% (0.468 {0.00184})
Camshaft				
Cam lobe height	(mm {in})	Standard	IN	4.79 {0.189}
			EX	4.79 {0.189}
Journal diameter	(mm {in})	Standard		26.936—26.962 {1.0604—1.0615}
Journal oil clearance	(mm {in})	Standard		0.025—0.076 {0.0010—0.0029}
		Maximum		0.121 {0.00476}
End play	(mm {in})	Standard		0.025—0.165 {0.0010—0.0064}
		Maximum		0.190 {0.00748}
HLA				
HLA bore diameter	(mm {in})	Standard		16.018—16.057 {0.63063—0.63216}
HLA diameter	(mm {in})	Standard		15.988—16.000 {0.62945—0.62992}
HLA-to-HLA bore oil clearance	(mm {in})	Standard		0.018—0.069 {0.0008—0.0027}
		Maximum		0.16 {0.0063}
Cylinder block				
Distortion	(mm {in})	Maximum		0.08 {0.0031}
Cylinder bore diameter [Measure the cylinder bore at 50 mm {2.0 in} below the top surface]	(mm {in})	Standard		89.000—89.030 {3.5039—3.5051}
Taper	(mm {in})	Maximum		0.020 {0.00079}
Off-round	(mm {in})	Maximum		0.020 {0.00079}
Piston				
Piston diameter [Measured at 90° to pin bore axis and 42.6 mm{1.68 in} below the top of piston]	(mm {in})	Standard		88.990—89.030 {3.5036—3.5051}
Piston-to-cylinder clearance	(mm {in})	Standard		0.012—0.022 {0.0004—0.0008}

G02831358

Fig. 131: Engine Technical Data (1 Of 3)
Courtesy of MAZDA MOTORS CORP.

Item				Engine
				AJ
Piston ring				
Piston ring-to-ring groove clearance	(mm {in})	Standard	Top	0.040—0.075 {0.0016—0.0029}
			Second	0.040—0.085 {0.0016—0.0033}
		Maximum		0.10 {0.0039}
End gap (measured in cylinder)	(mm {in})	Standard	Top	0.10—0.25 {0.004—0.009}
			Second	0.27—0.42 {0.011—0.016}
			Oil (rail)	0.15—0.65 {0.006—0.025}
		Maximum	Top	0.50 {0.019}
			Second	0.65 {0.025}
			Oil (rail)	0.90 {0.035}
Piston pin				
Piston pin diameter	(mm {in})	Standard		21.011—21.013 {0.82721—0.82728}
Piston pin bore diameter	(mm {in})	Standard		21.008—21.012 {0.82709—0.82724}
Connecting rod-to-piston pin clearance	(mm {in})	Standard		0.004—0.020 {0.00016—0.00078}
		Maximum		0.035 {0.0013}
Piston pin bore-to-piston pin clearance	(mm {in})	Standard		-0.005—0.001 {-0.00019—0.00003}
Connecting rod and connecting rod bearing				
Length (center to center)	(mm {in})	Standard		138.06—138.14 {5.4355—5.4385}
Bending	(mm {in})	Maximum		0.038 {0.0014}/25 {0.98}
Distortion	(mm {in})	Maximum		0.050 {0.0019}/25 {0.98}
Connecting rod small end inner diameter	(mm {in})	Standard		21.017—21.031 {0.82744—0.82799}
Connecting rod side clearance	(mm {in})	Standard		0.10—0.30 {0.004—0.011}
		Maximum		0.35 {0.013}
Connecting rod bearing size	(mm {in})	Standard		1.500—1.506 {0.0591—0.0593}
		0.02 {0.0008} undersize		1.510—1.516 {0.0595—0.0596}
		0.05 {0.0020} undersize		1.525—1.531 {0.0601—0.0602}
		0.25 {0.0100} undersize		1.625—1.631 {0.0640—0.0642}
Connecting rod bearing oil clearance	(mm {in})	Standard		0.028—0.066 {0.0012—0.0025}
Crankshaft				
Crankshaft runout	(mm {in})	Maximum		0.05 {0.0019}
Main journal diameter	(mm {in})	Standard		62.968—62.992 {2.4791—2.4799}
		0.25 {0.01} undersize		62.718—62.742 {2.4693—2.4701}
Main journal oil clearance	(mm {in})	Standard		0.025—0.045 {0.0010—0.0017}
		Maximum		0.050 {0.0019}
Main bearing size	(mm {in})	Standard	Grade 1	Upper No.1,2,3,4; Lower No.1,2,3: 2.494—2.500 {0.09819—0.09842} Lower No.4: 2.492—2.498 {0.09812—0.09834}
			Grade 2	Upper No.1,2,3,4; Lower No.1,2,3: 2.498—2.504 {0.09835—0.09858} Lower No.4: 2.496—2.502 {0.09827—0.09850}
			Grade 3	Upper No.1,2,3,4; Lower No.1,2,3: 2.502—2.508 {0.09851—0.09873} Lower No.4: 2.5000—2.5006 {0.09843—0.09844}
		0.25 {0.01} undersize		Upper No.1,2,3,4; Lower No.1,2,3: 2.623—2.629 {0.10327—0.10350} Lower No.4: 2.621—2.627 {0.10319—0.10342}

G02831359

Fig. 132: Engine Technical Data (2 Of 3)
Courtesy of MAZDA MOTORS CORP.

Item			Engine
			AJ
Crank pin journal diameter	(mm {in})	Standard	49.970—49.990 {1.9674—1.9681}
		0.02 {0.0008} undersize	49.950—49.970 {1.9666—1.9673}
		0.05 {0.0020} undersize	49.920—49.940 {1.9654—1.9661}
		0.25 {0.0100} undersize	49.720—49.740 {1.9575—1.9582}
Crankshaft end play	(mm {in})	Standard	0.110—0.232 {0.00434—0.00913}
Camshaft oil seal			
Pushing distance of the camshaft oil seal [from the edge of the oil seal housing]		(mm {in})	2.5—3.0 {0.10—0.11}
Front oil seal			
Pushing distance of the front oil seal [from the edge of the engine front cover]		(mm {in})	0—1.0 {0—0.04}
Rear oil seal			
Pushing distance of the rear oil seal [from the edge of the cylinder block]		(mm {in})	0—2.0 {0—0.08}
Oil control valve (OCV)			
Resistance		(ohm)	7.05—7.95

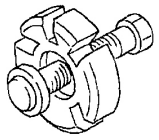
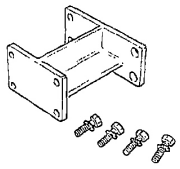
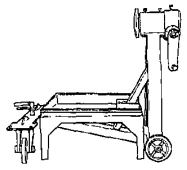
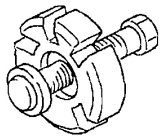
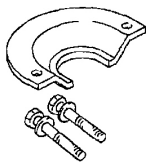
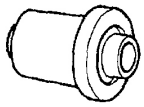
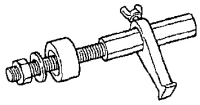
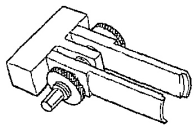
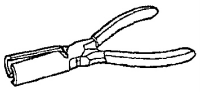
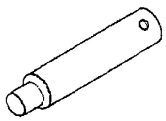
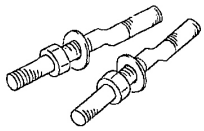
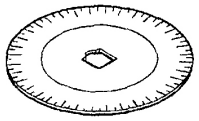
G02831360

Fig. 133: Engine Technical Data (3 Of 3)
Courtesy of MAZDA MOTORS CORP.

ENGINE SST

ENGINE SST

1: Mazda SST number
2: Global SST number
Example

1:49 UN30 3009 2:303-009 Crankshaft damper remover 		
1.49 L010 1A1 2. – Engine hanger set 	1.49 0107 680A 2. – Engine stand 	1.49 UN30 3009 2.303-009 Crankshaft damper remover 
1.49 UN30 3457 2.303-457 Shaft protector 	1.49 UN30 3456 2.303-456 Water pump pulley plate 	1.49 T034 204 2. – Attachment (Part of 49 T034 2A1) 
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 S120 170 2. – Valve seal remover 	1.49 T011 001 2. – Piston pin installer 	1.49 G030 797 2. – Handle (Part of 49 G030 795) 
1.49 UN01 070 2.303-178 Crankshaft seal installer 	1.49 UN30 3384 2.303-384 Rear crankshaft adapter bolts 	1.49 D032 316 2. – Protractor 

G02831361

Fig. 134: Identifying Engine SSTs (1 Of 2)
Courtesy of MAZDA MOTORS CORP.

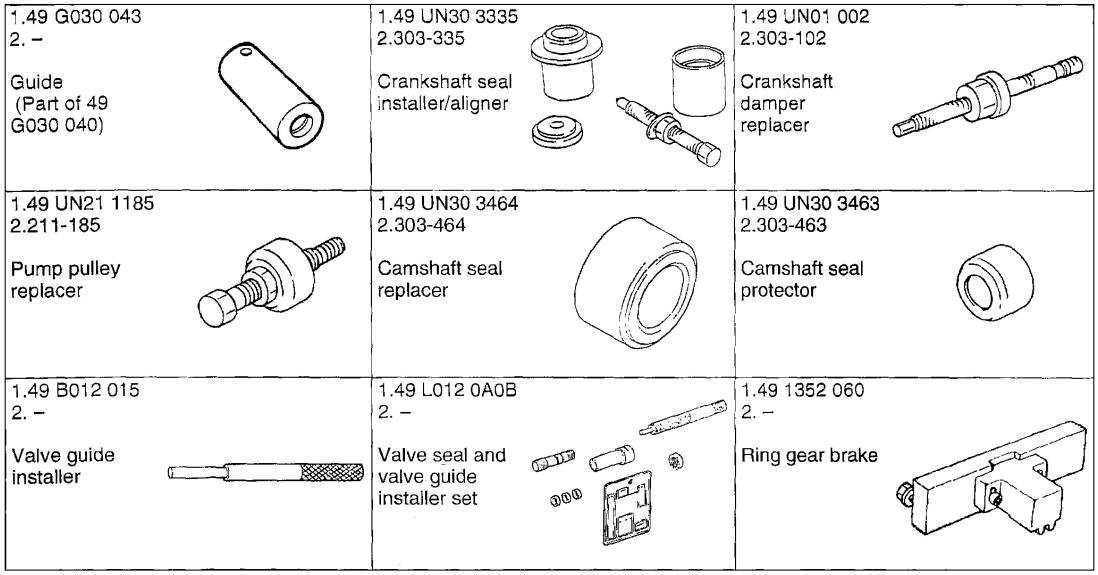


Fig. 135: Identifying Engine SSTs (2 Of 2)
Courtesy of MAZDA MOTORS CORP.

