

2003-07 ENGINE

Overhaul - 3.0L - B3000

ENGINE OVERHAUL SERVICE WARNING

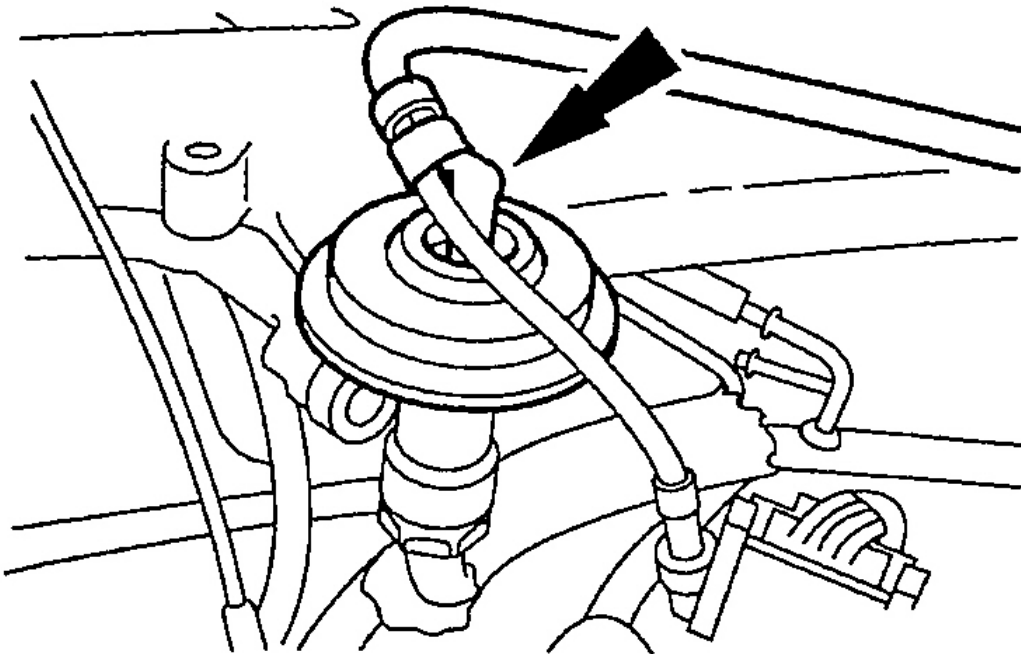
WARNING:

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

ENGINE DISASSEMBLY/ASSEMBLY

DISASSEMBLY NOTE

1. Disconnect the spark plug wires.
2. Disconnect the vacuum line.

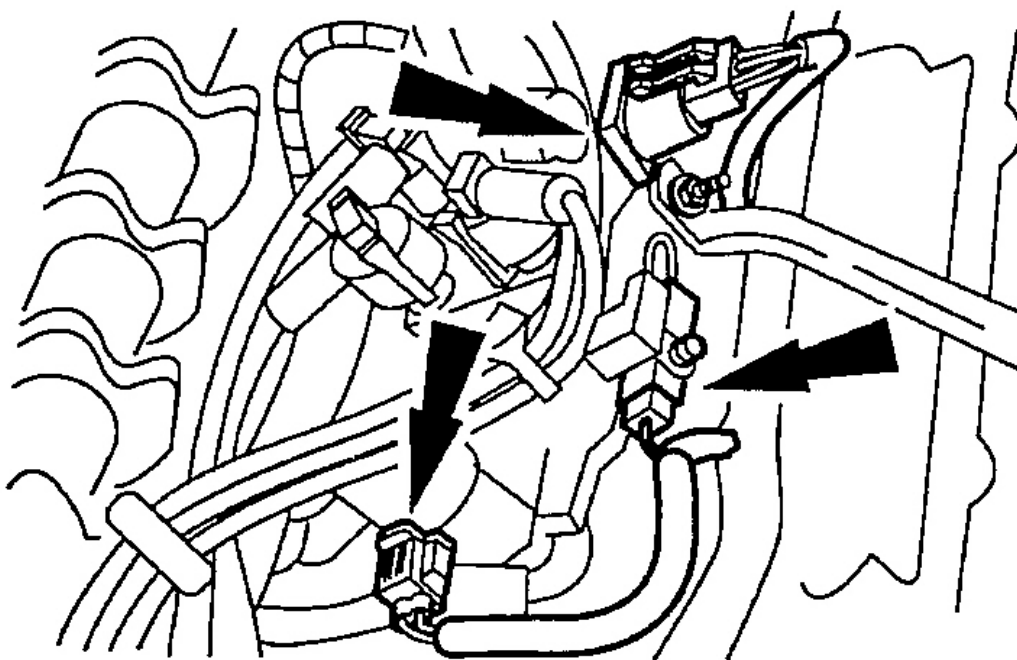


G03312191

Fig. 1: Disconnecting Vacuum Line
Courtesy of MAZDA MOTORS CORP.

3. Disconnect the engine harness from:

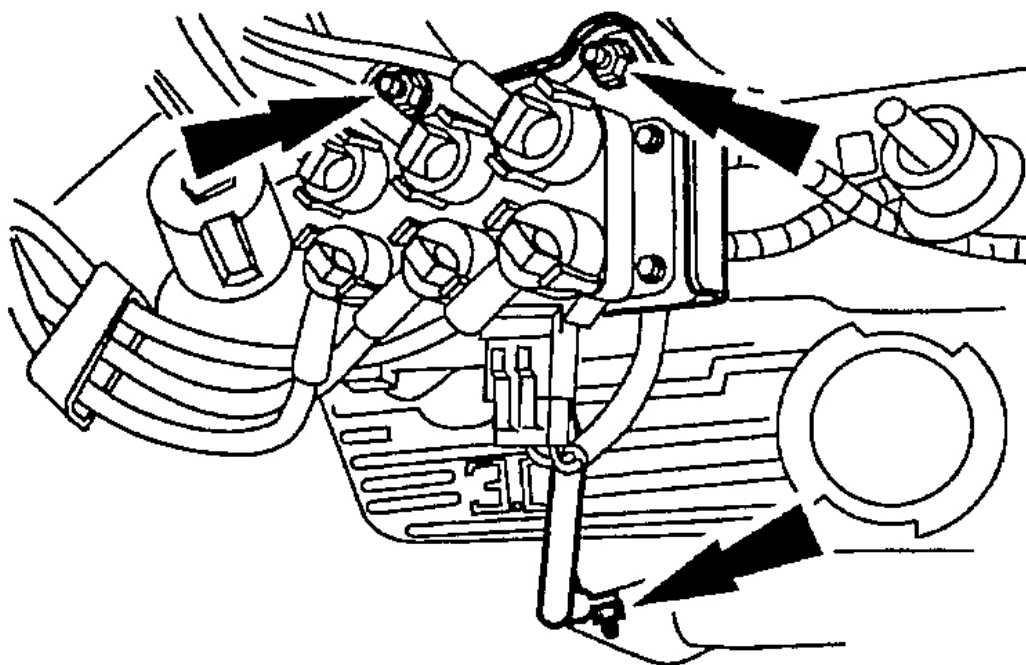
- The ignition coil.
- The radio ignition interference capacitor.
- The EGR vacuum regulator solenoid.
- The vacuum line from the EGR vacuum regulator solenoid.



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Fig. 2: Disconnecting Engine Harness
Courtesy of MAZDA MOTORS CORP.

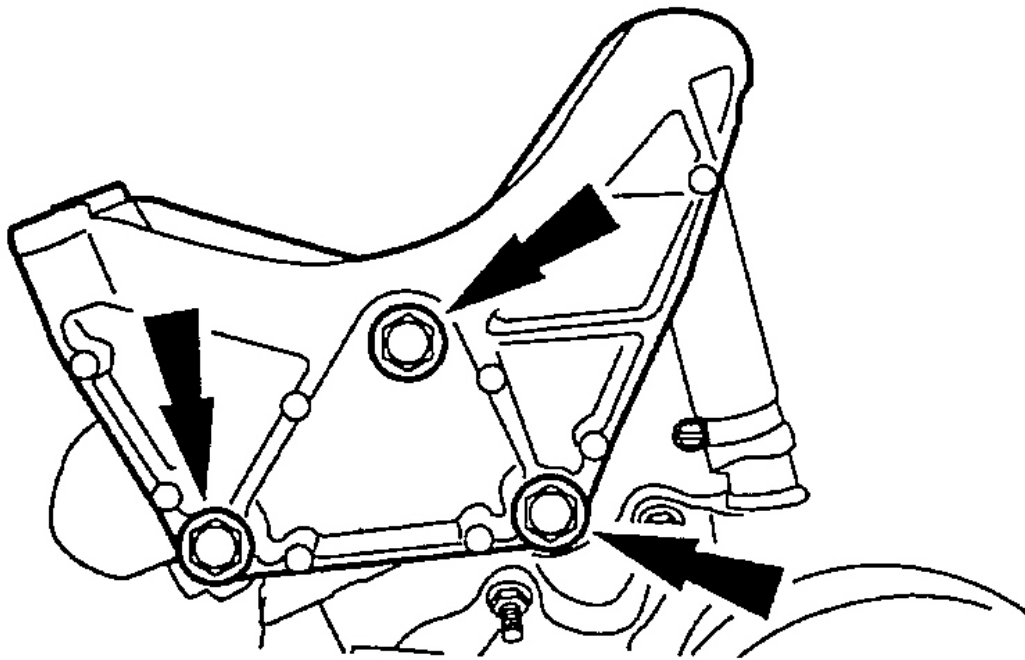
4. Remove the nuts.



G03312193

Fig. 3: Removing Coil Mounting Bracket Nuts
Courtesy of MAZDA MOTORS CORP.

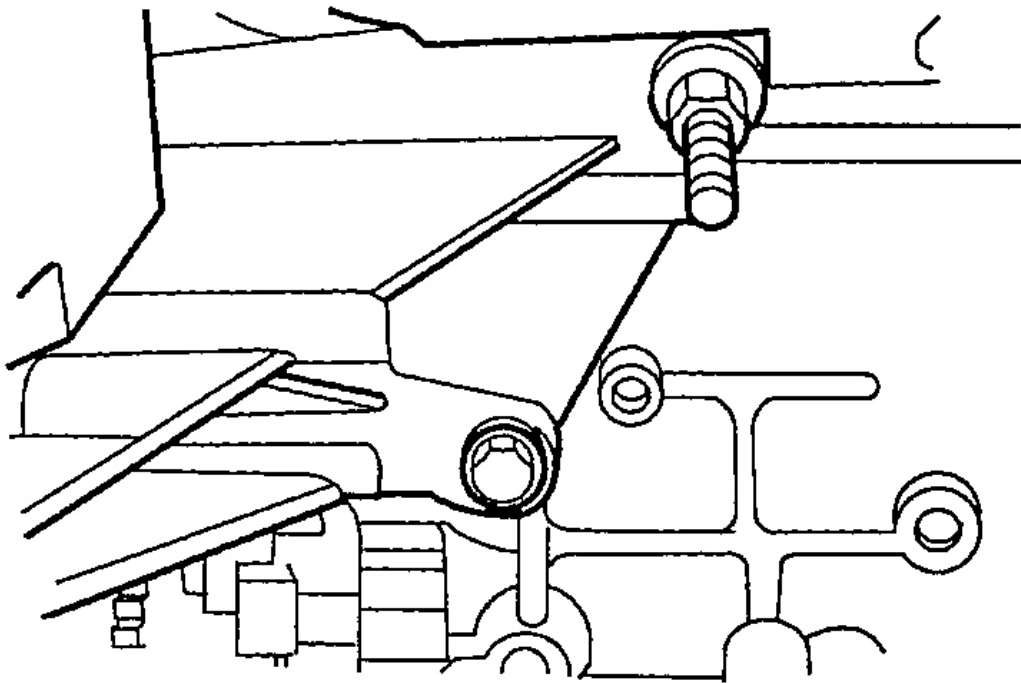
5. Remove the bolts and the generator mounting bracket.



G03312194

Fig. 4: Removing Generator Mounting Bracket Bolts
Courtesy of MAZDA MOTORS CORP.

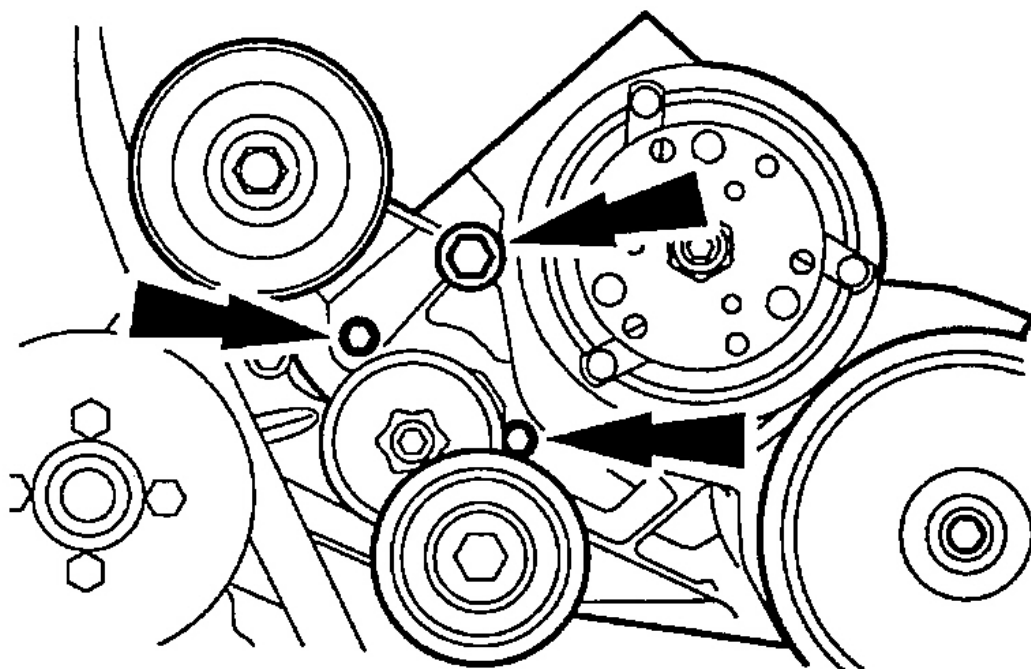
6. Remove the bolt and nut.



G03312195

Fig. 5: Removing Bolt & Nut
Courtesy of MAZDA MOTORS CORP.

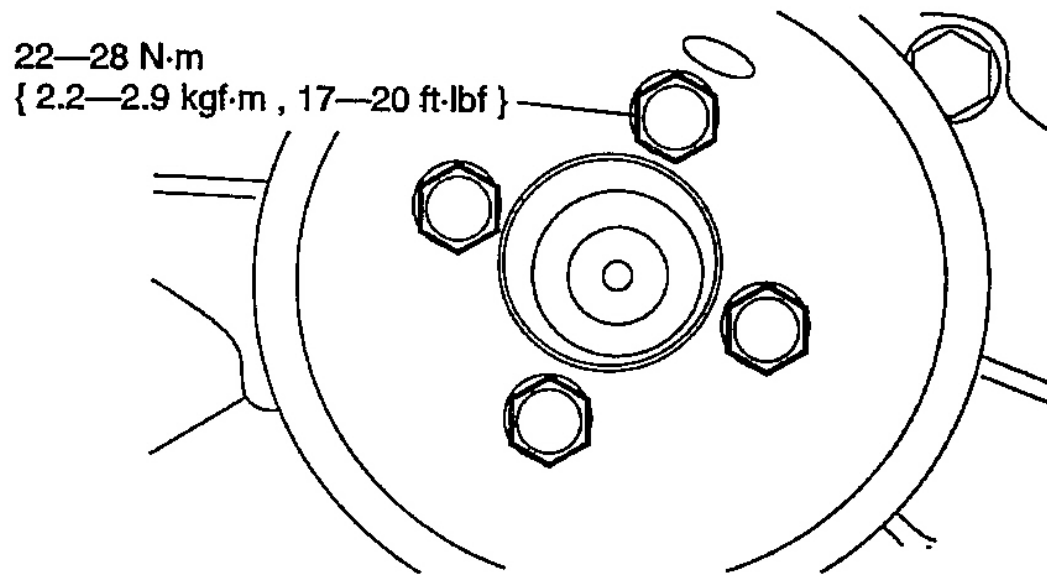
7. Remove the bolts and the A/C compressor mounting bracket.



G03312196

Fig. 6: Removing A/C Compressor Mounting Bracket
Courtesy of MAZDA MOTORS CORP.

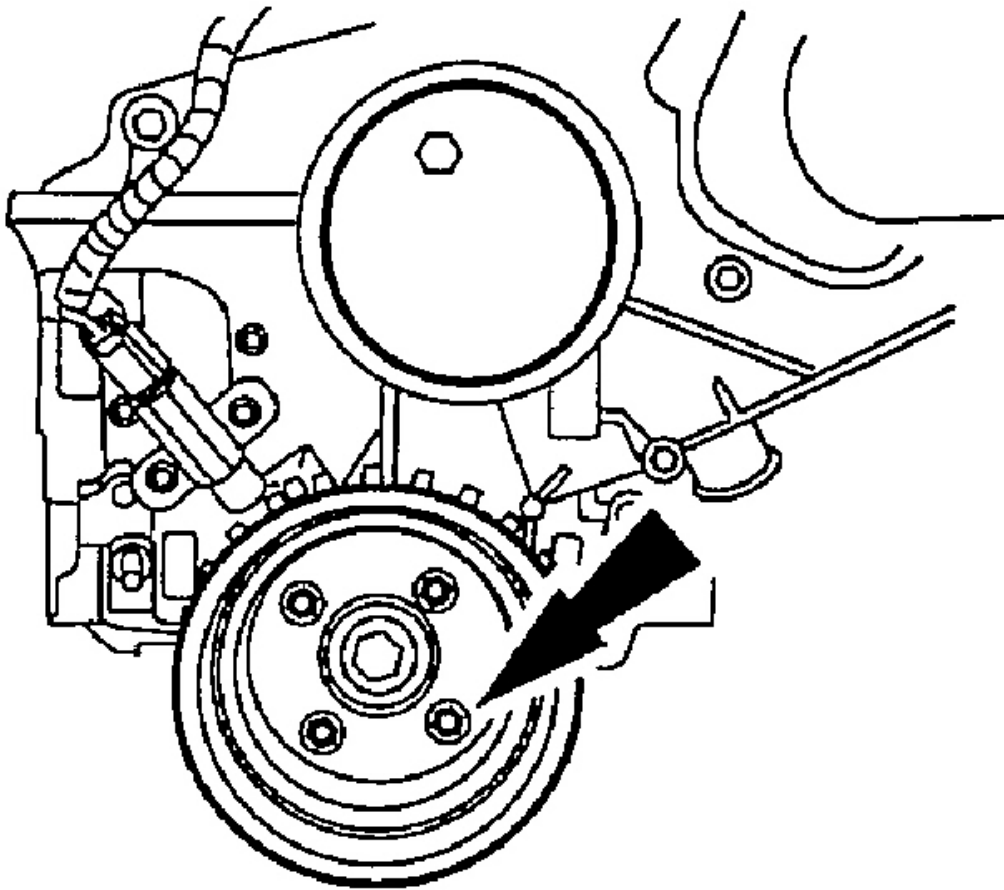
8. Remove the bolts and the water pump pulley.



G03312197

Fig. 7: Removing Water Pump Pulley (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

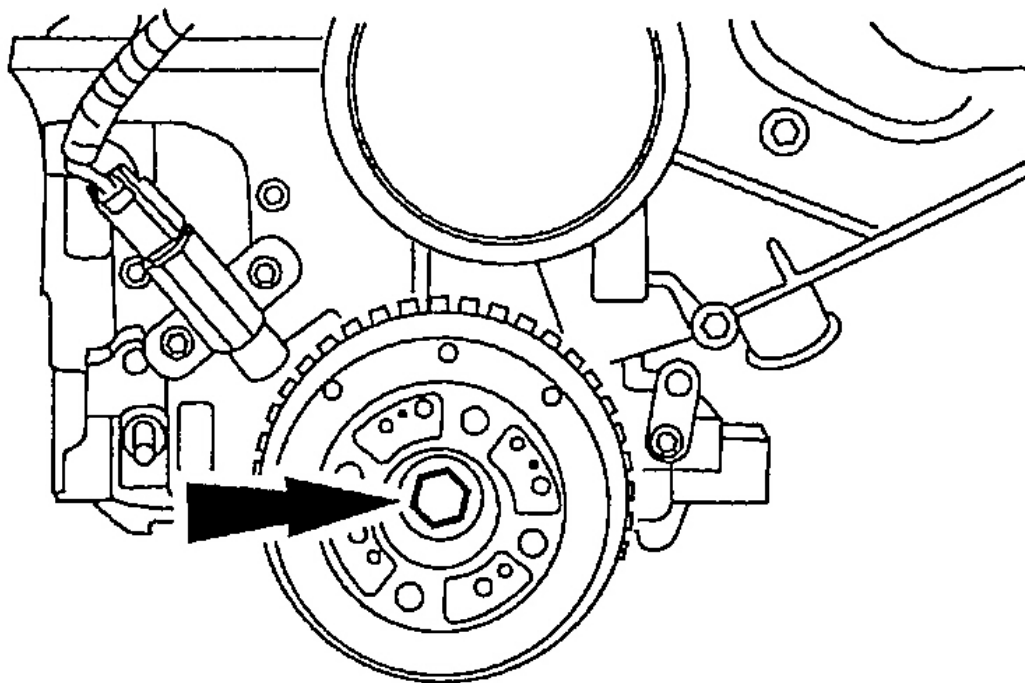
9. Remove the bolts and the crankshaft pulley.



G03312198

Fig. 8: Removing Crankshaft Pulley
Courtesy of MAZDA MOTORS CORP.

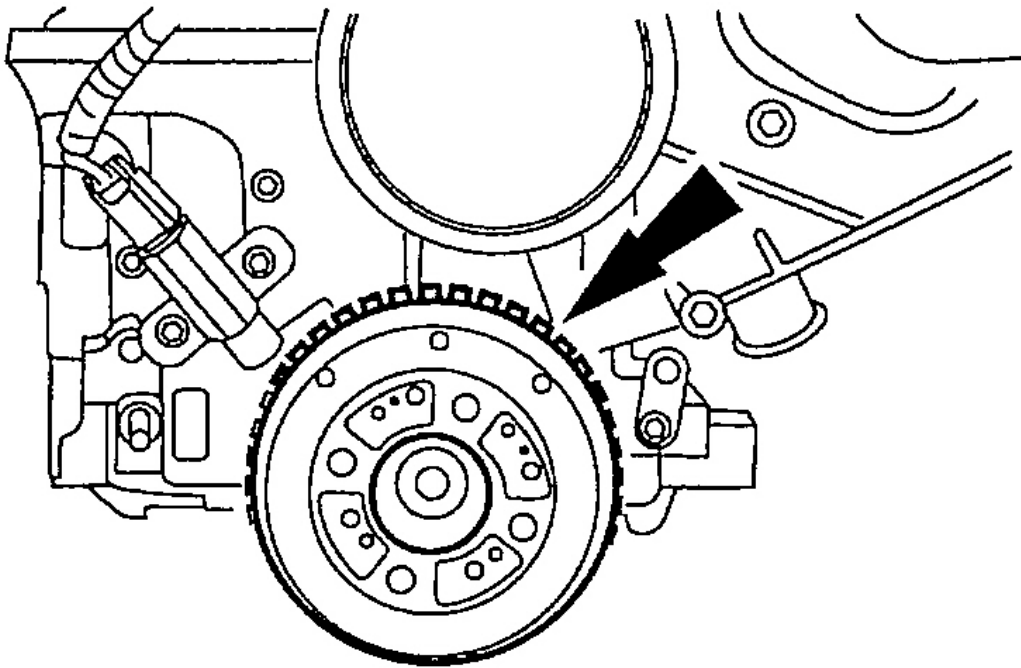
10. Remove the crankshaft damper bolt.



G03312199

Fig. 9: Removing Crankshaft Damper Bolt
Courtesy of MAZDA MOTORS CORP.

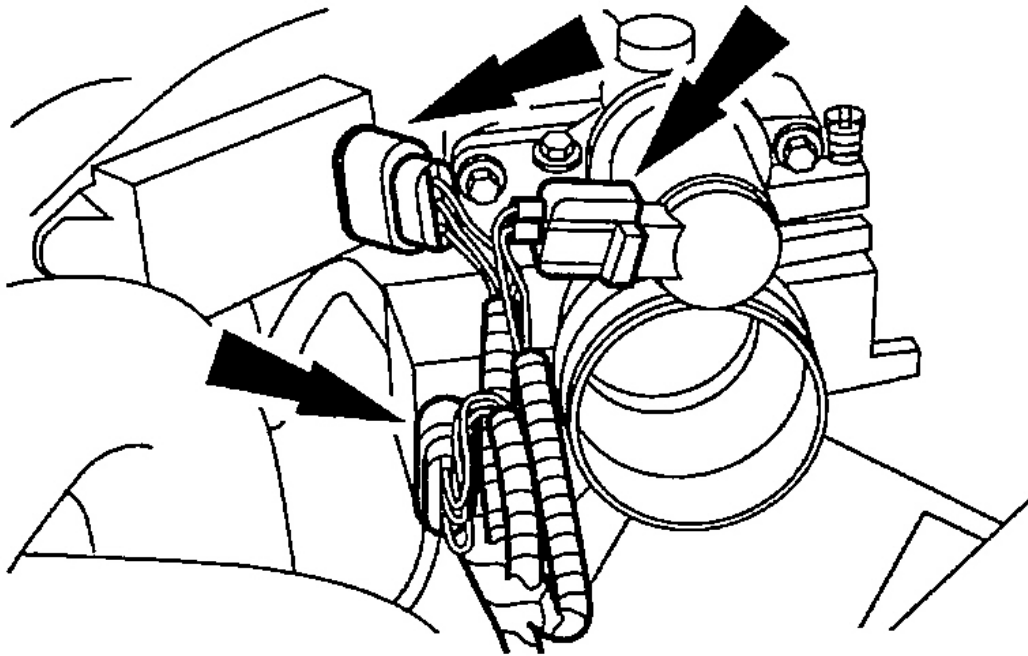
11. Using Crankshaft Damper Remover SST 303-009 (T58P-6316-D) or equivalent, remove the crankshaft damper.



G03312200

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

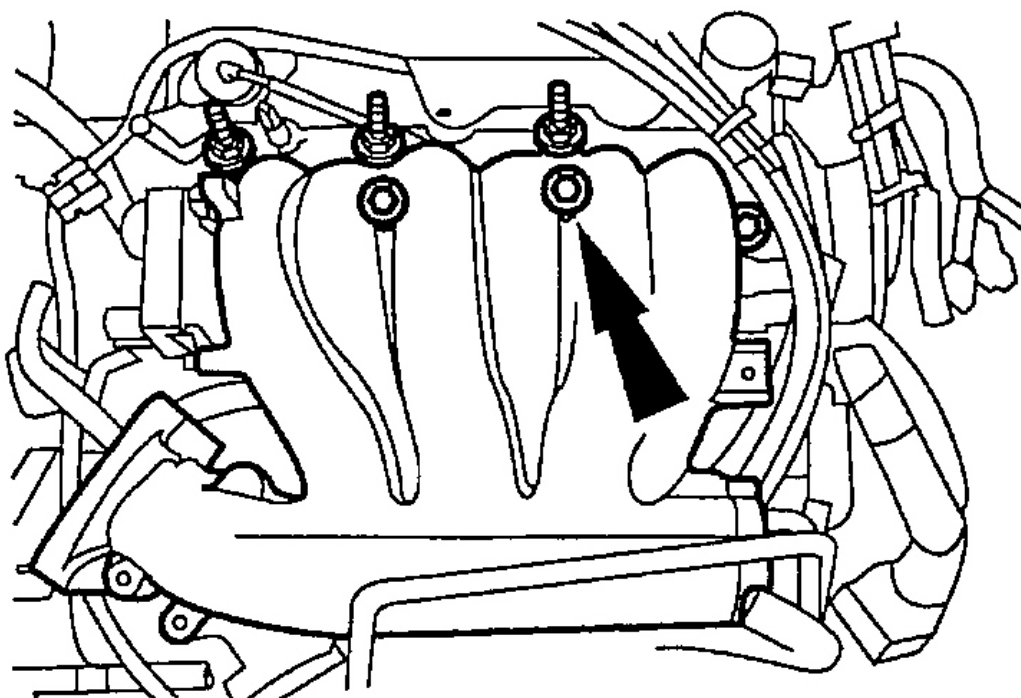
12. Disconnect the engine harness from:
 - The Idle Air Control (IAC) valve.
 - The Throttle Position (TP) sensor.
 - The DPFE sensor.



G03312201

Fig. 11: Disconnecting IAC Valve, TP Sensor & DPFE Sensor Connectors
Courtesy of MAZDA MOTORS CORP.

13. Remove the six bolts and upper intake manifold.

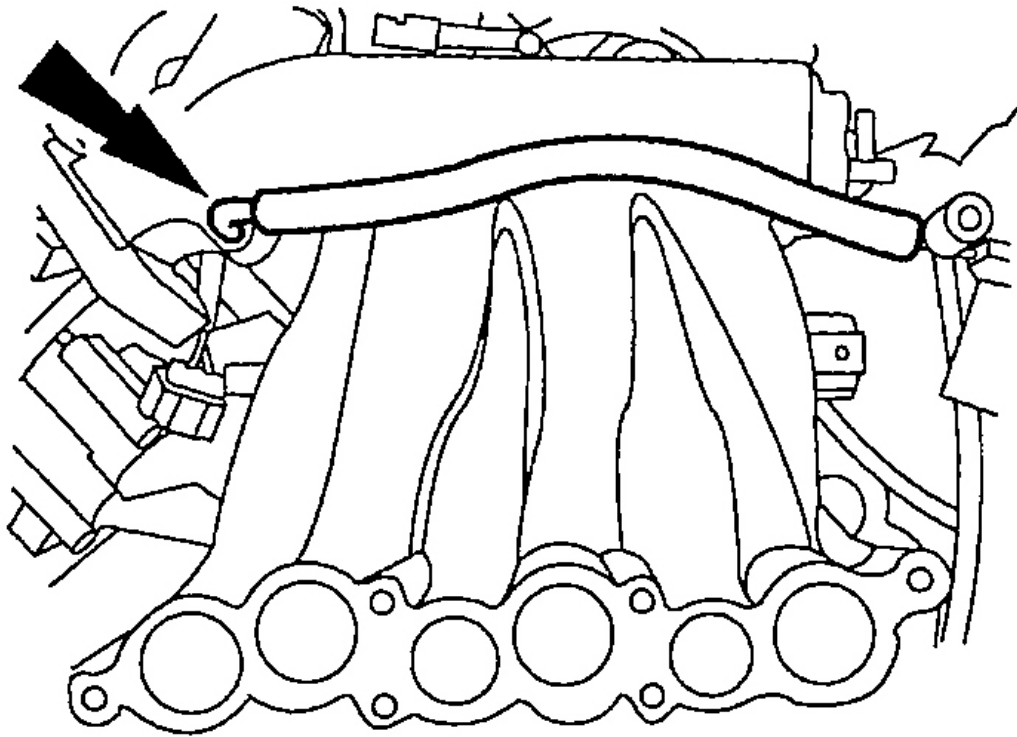


G03312202

Fig. 12: Removing Upper Intake Manifold

Courtesy of MAZDA MOTORS CORP.

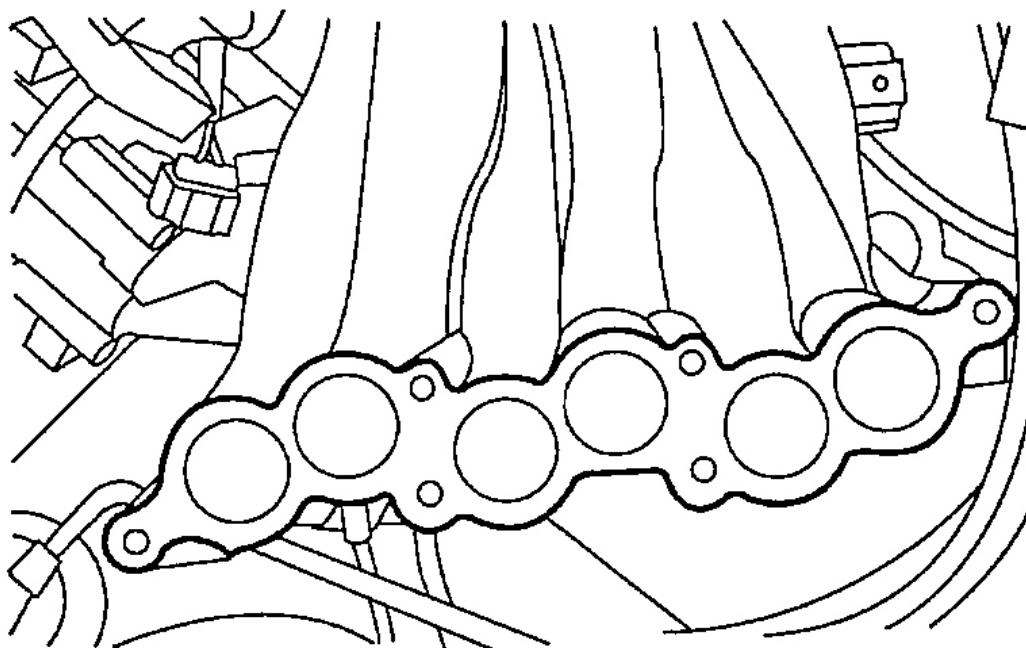
14. Remove the Positive Crankcase Ventilation (PCV) valve.



G03312203

Fig. 13: Removing PCV Valve
Courtesy of MAZDA MOTORS CORP.

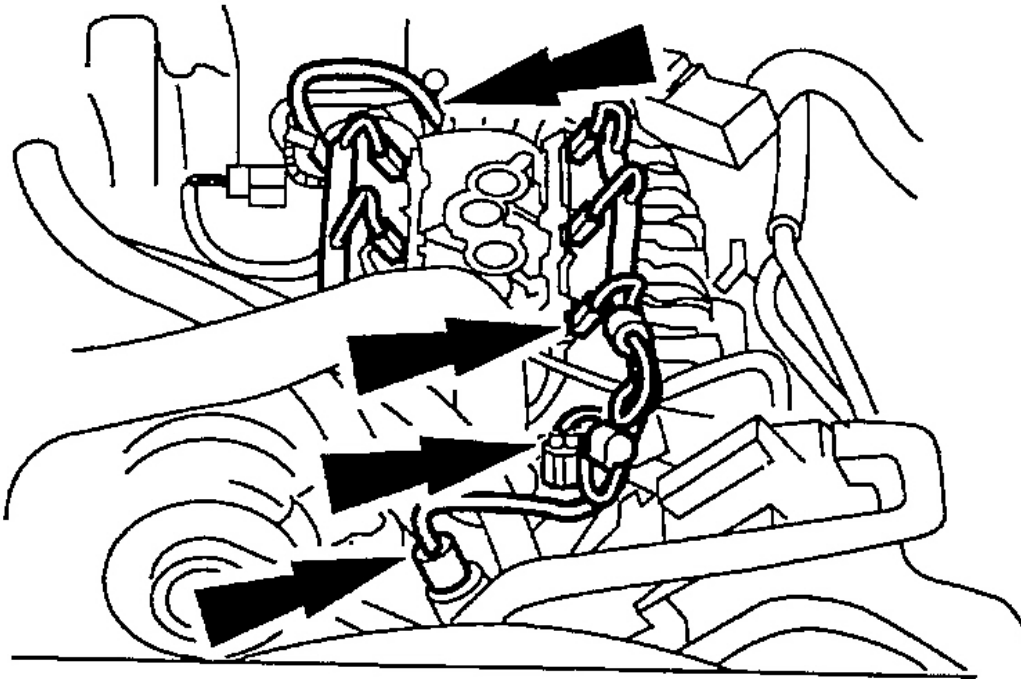
15. Remove the intake manifold upper gasket.



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Fig. 14: Removing Intake Manifold Upper Gasket
Courtesy of MAZDA MOTORS CORP.

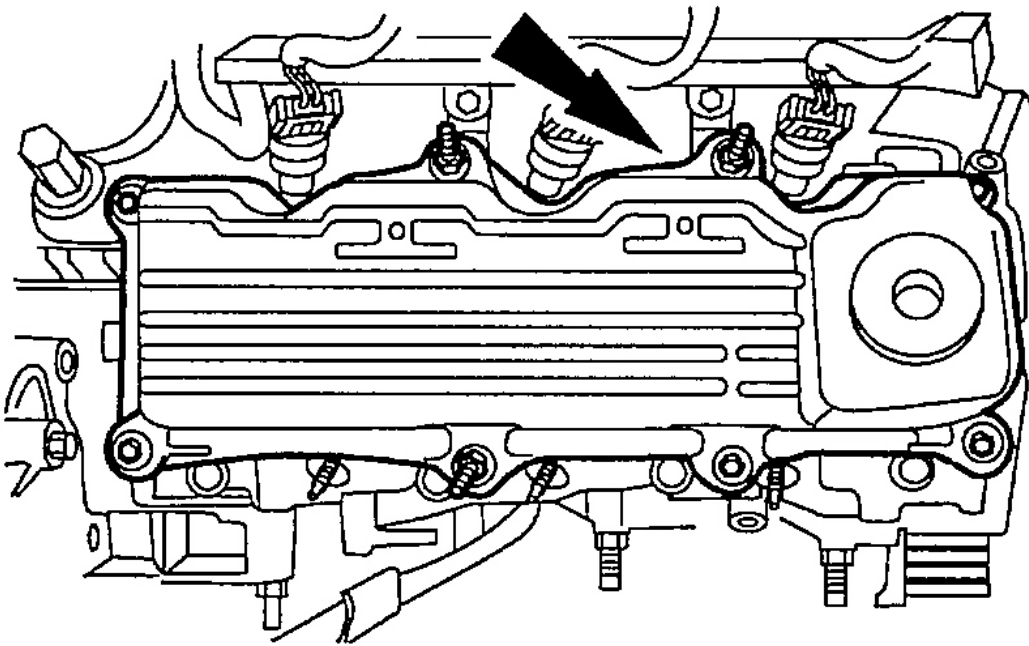
16. Disconnect the engine harness from:
- The Engine Coolant Temperature (ECT) sensor.
 - The water temperature indicator sender unit.
 - The fuel injectors.
 - The camshaft synchronizer.



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Fig. 15: Disconnecting Engine Harness
Courtesy of MAZDA MOTORS CORP.

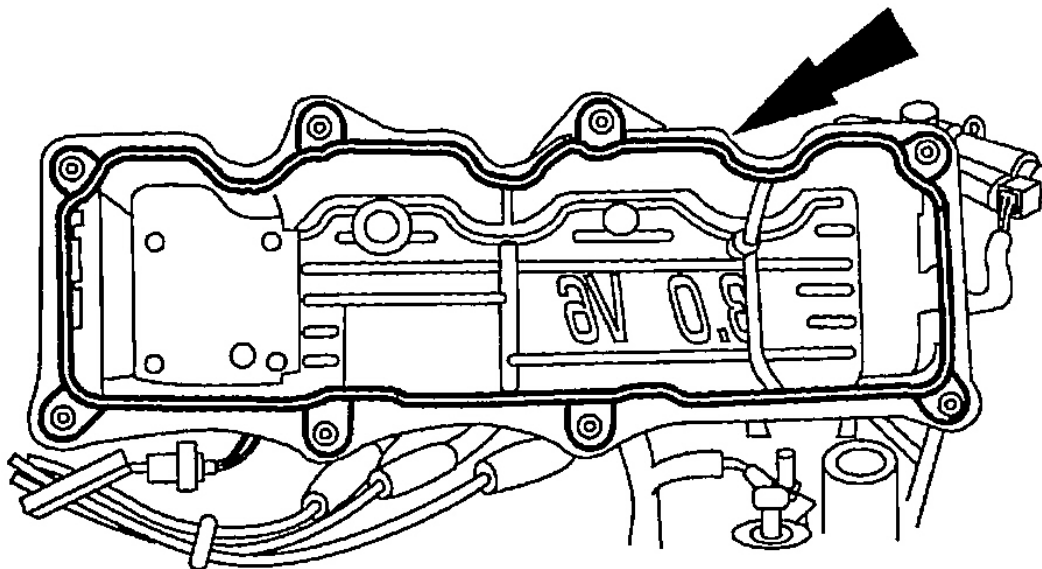
17. Remove the valve covers.



G03312206

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

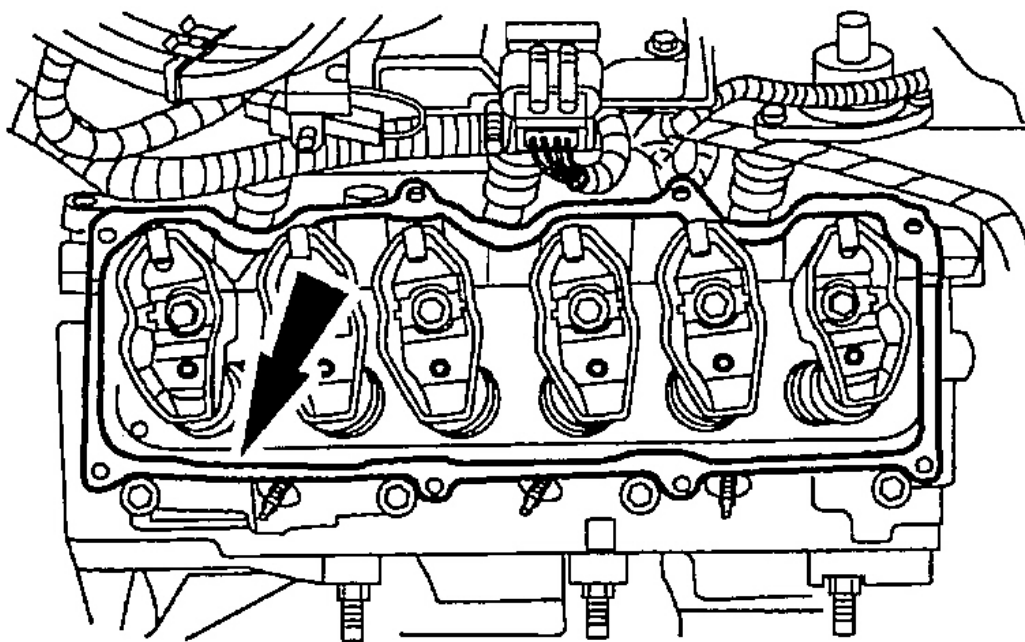
18. If required, remove the valve cover gaskets.



G03312207

Fig. 17: Removing Valve Cover Gaskets
Courtesy of MAZDA MOTORS CORP.

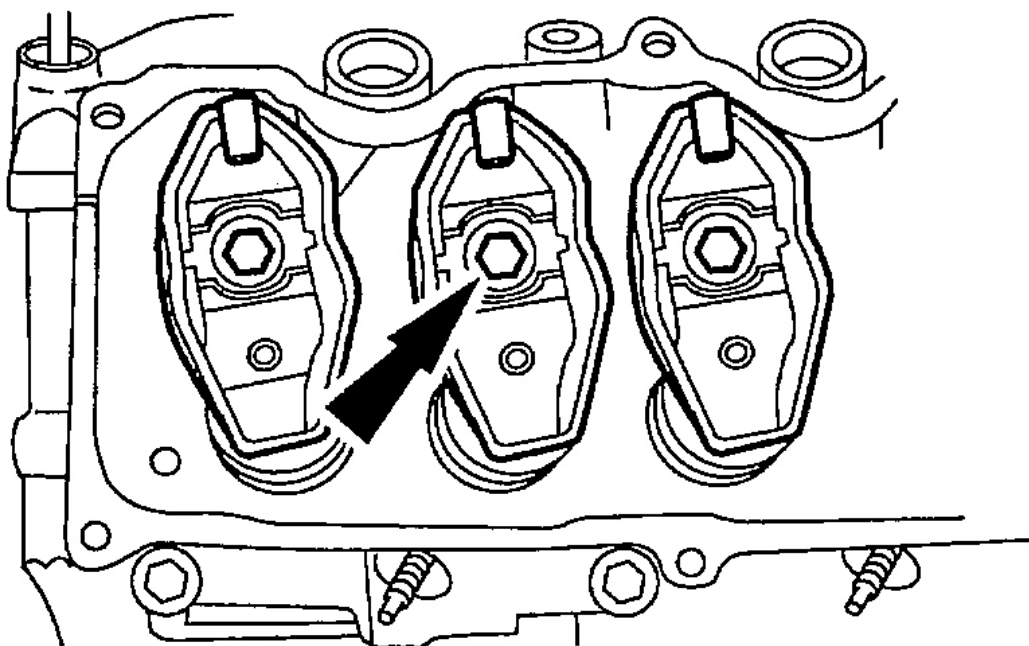
19. Clean the sealing surfaces.



G03312208

Fig. 18: Identifying Sealing Surfaces
Courtesy of MAZDA MOTORS CORP.

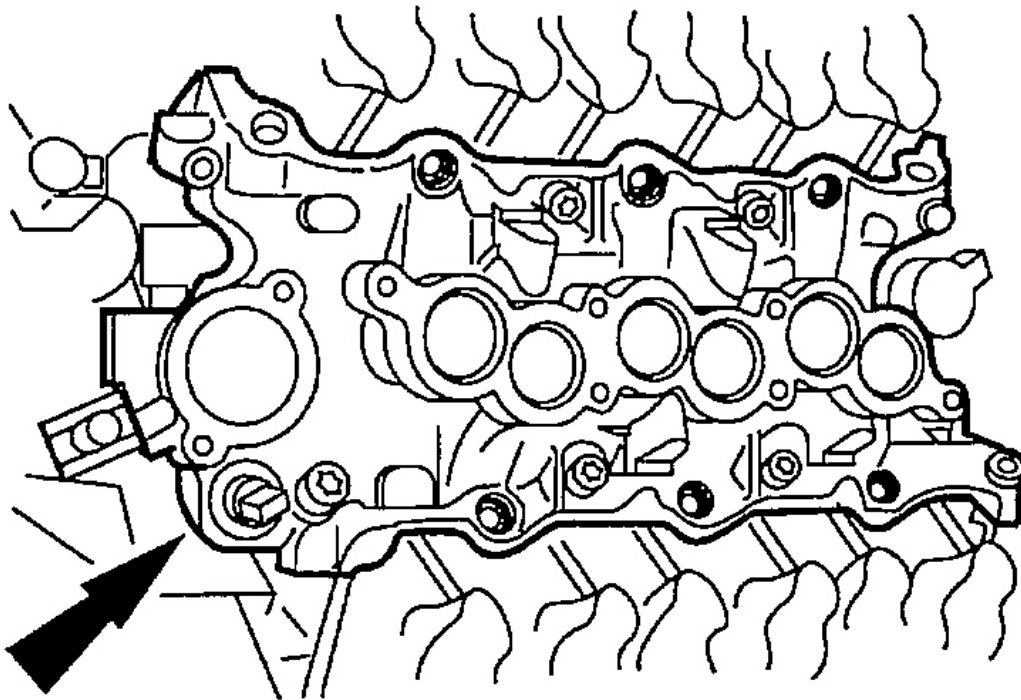
20. Remove the rocker arms and the push rods.



G03312209

Fig. 19: Removing Rocker Arms
Courtesy of MAZDA MOTORS CORP.

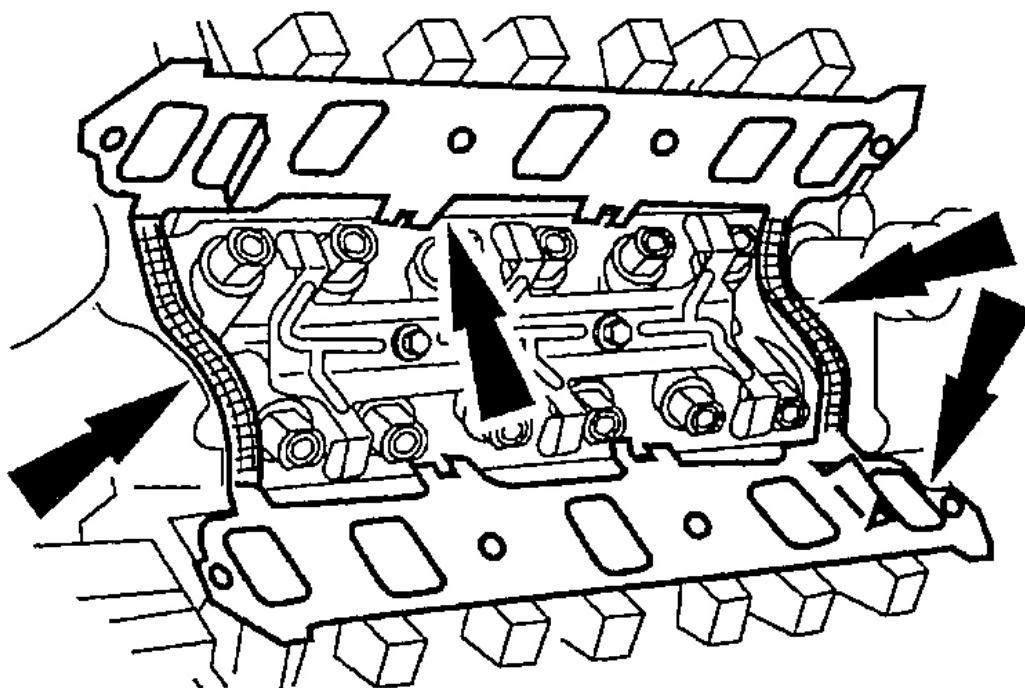
21. Remove the eight bolts and lower intake manifold.



G03312210

Fig. 20: Removing Lower Intake Manifold
Courtesy of MAZDA MOTORS CORP.

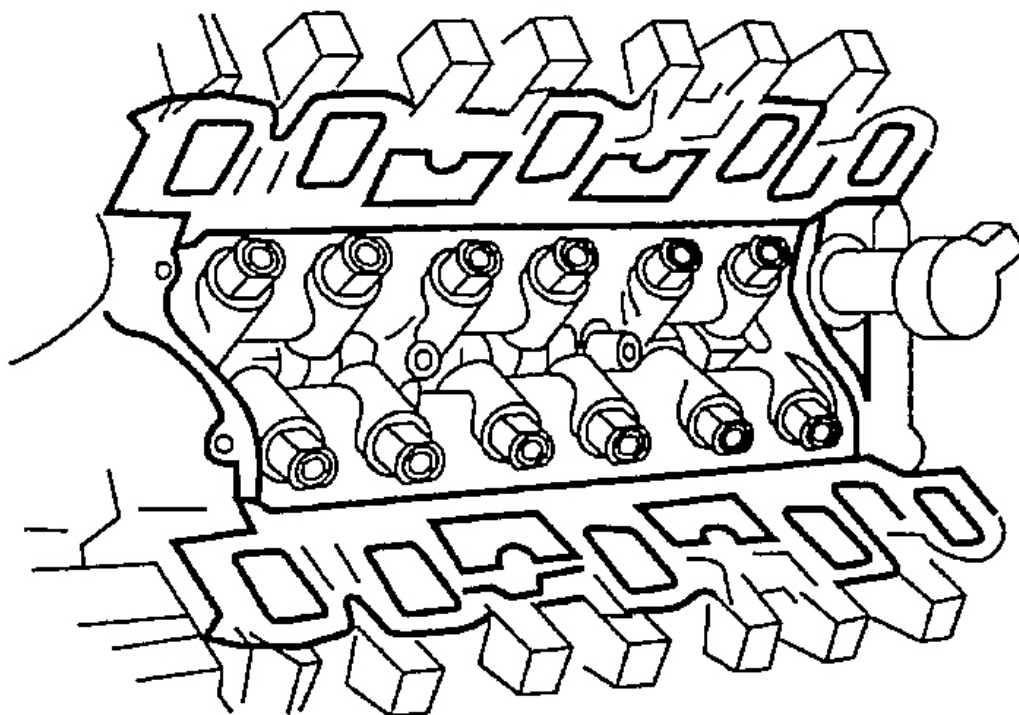
22. Remove the intake manifold gaskets and end seals.



G03312211

Fig. 21: Removing Intake Manifold Gaskets & End Seals
Courtesy of MAZDA MOTORS CORP.

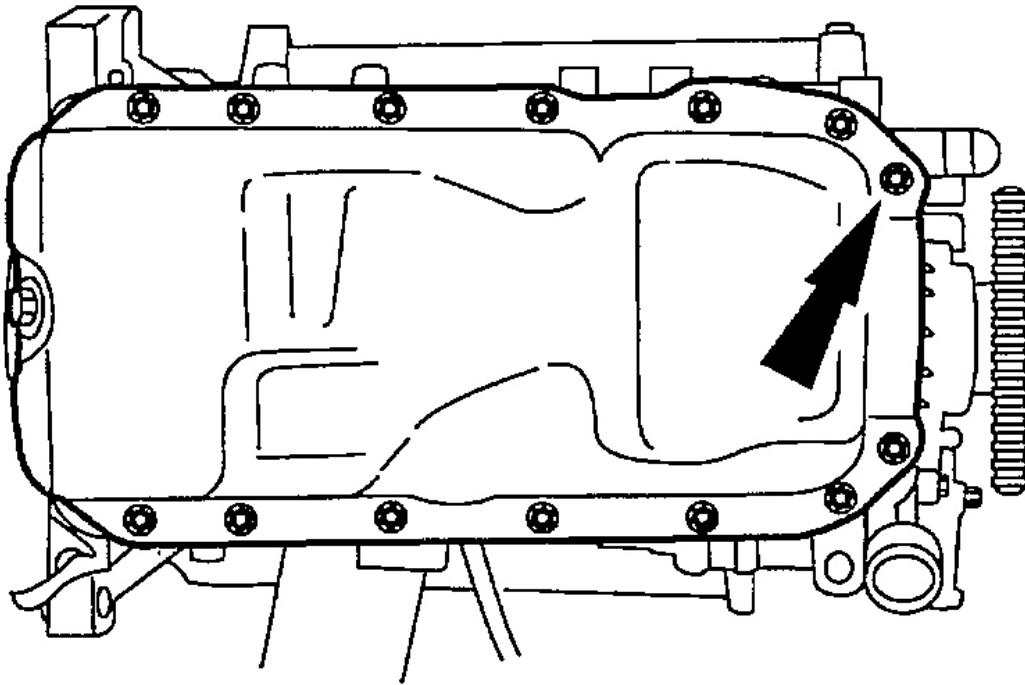
23. Clean the surface.



G03312212

Fig. 22: Cleaning Gasket & Seal Surfaces
Courtesy of MAZDA MOTORS CORP.

24. Remove the camshaft synchronizer. Refer to CAMSHAFT.
25. Remove the bolts and oil pan.

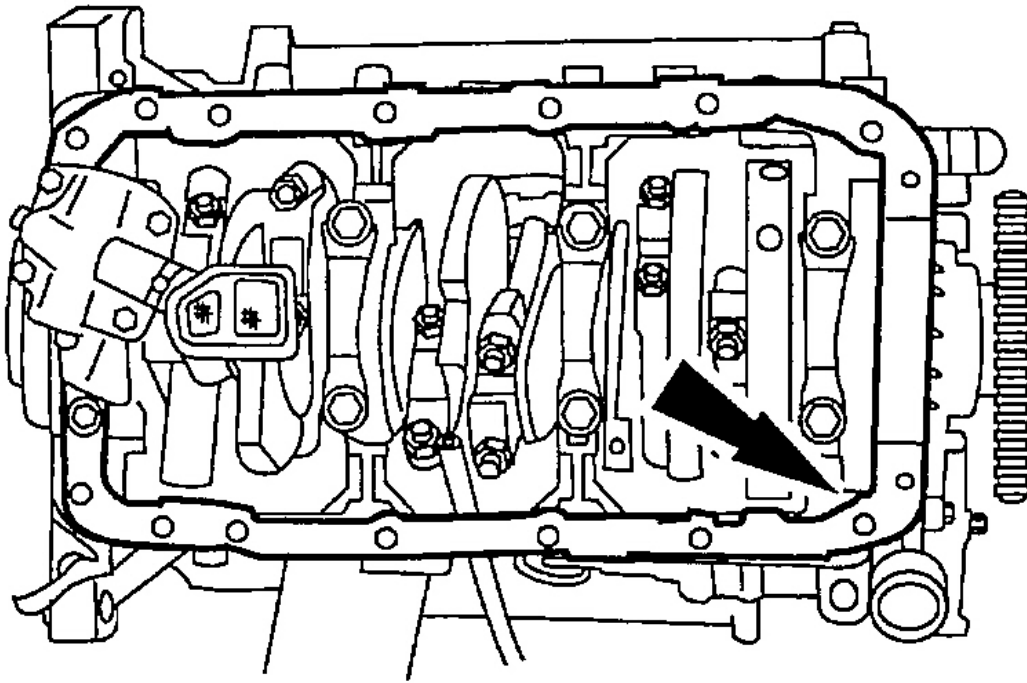


G03312213

Fig. 23: Removing Oil Pan

Courtesy of MAZDA MOTORS CORP.

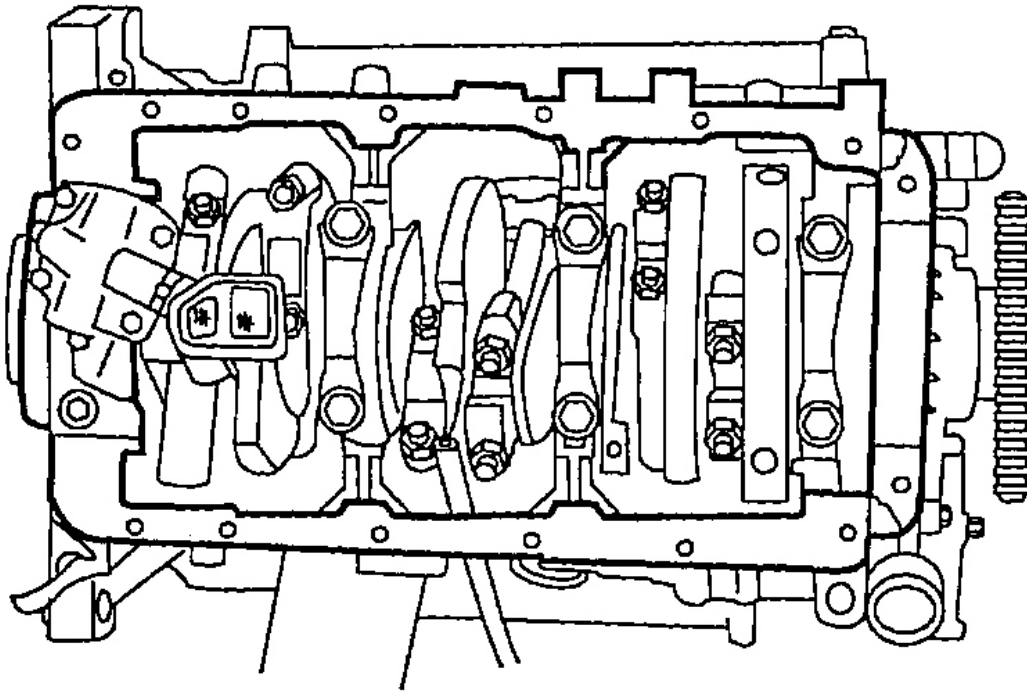
26. Remove the oil pan gasket.



G03312214

Fig. 24: Removing Oil Pan Gasket
Courtesy of MAZDA MOTORS CORP.

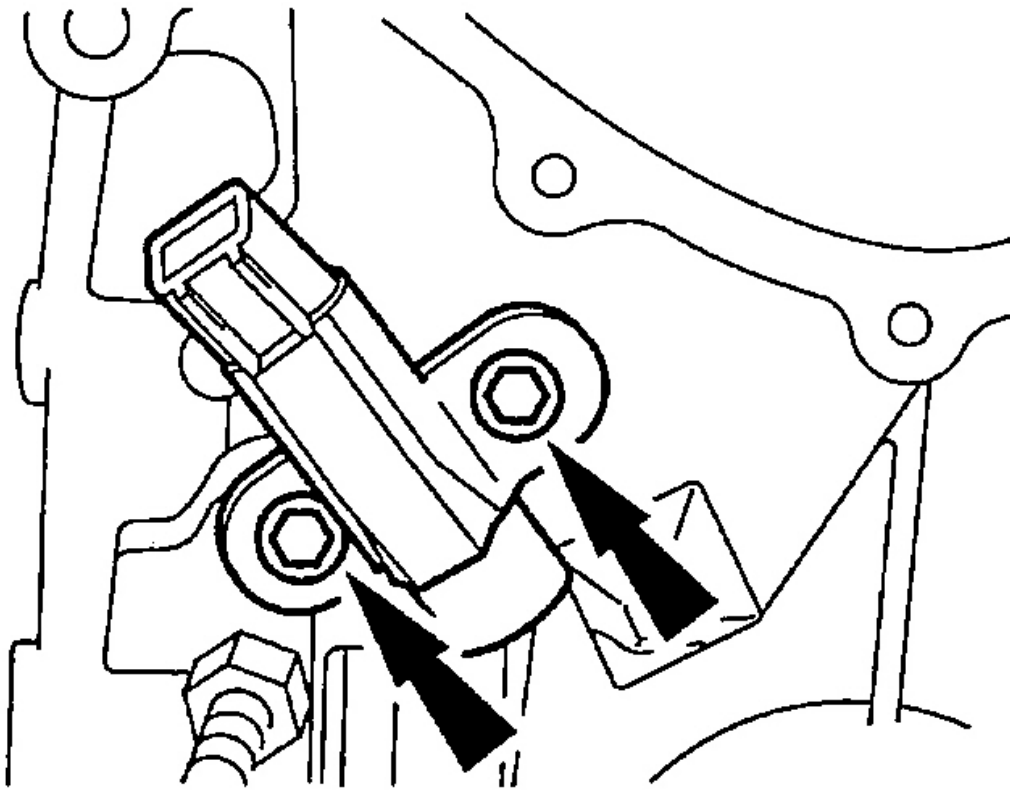
27. Clean the surfaces.



G03312215

Fig. 25: Cleaning Oil Pan Sealing Surfaces
Courtesy of MAZDA MOTORS CORP.

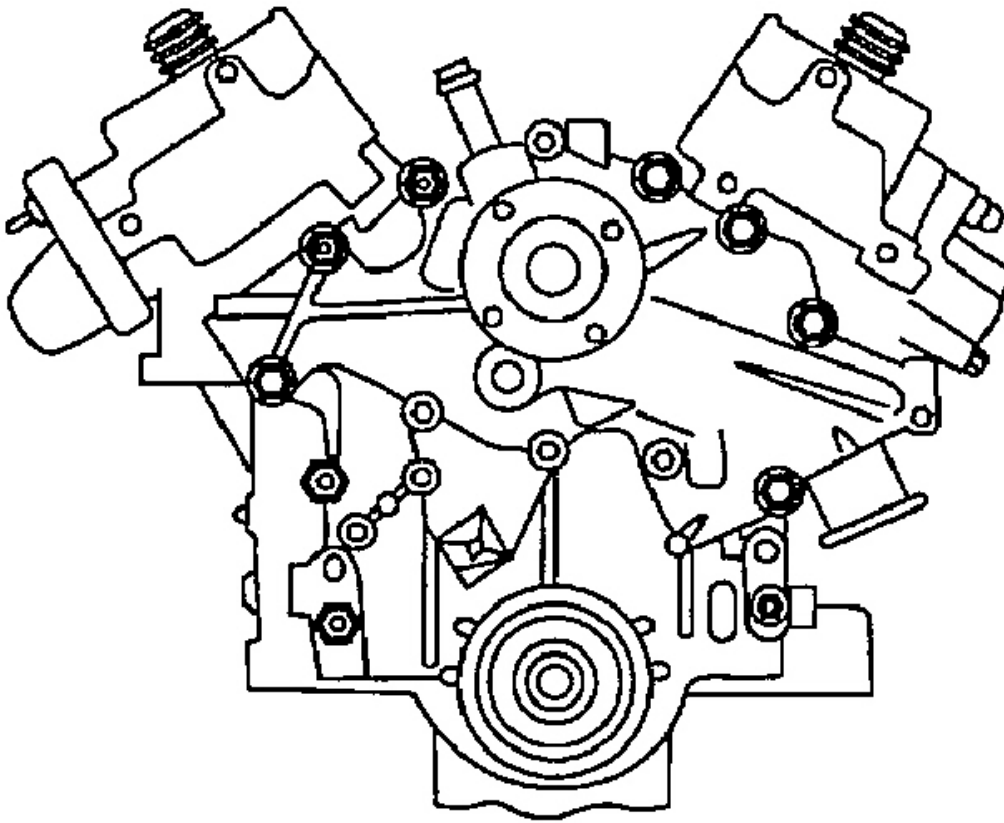
28. Remove the Crankshaft Position (CKP) sensor.



G03312216

Fig. 26: Removing CKP sensor
Courtesy of MAZDA MOTORS CORP.

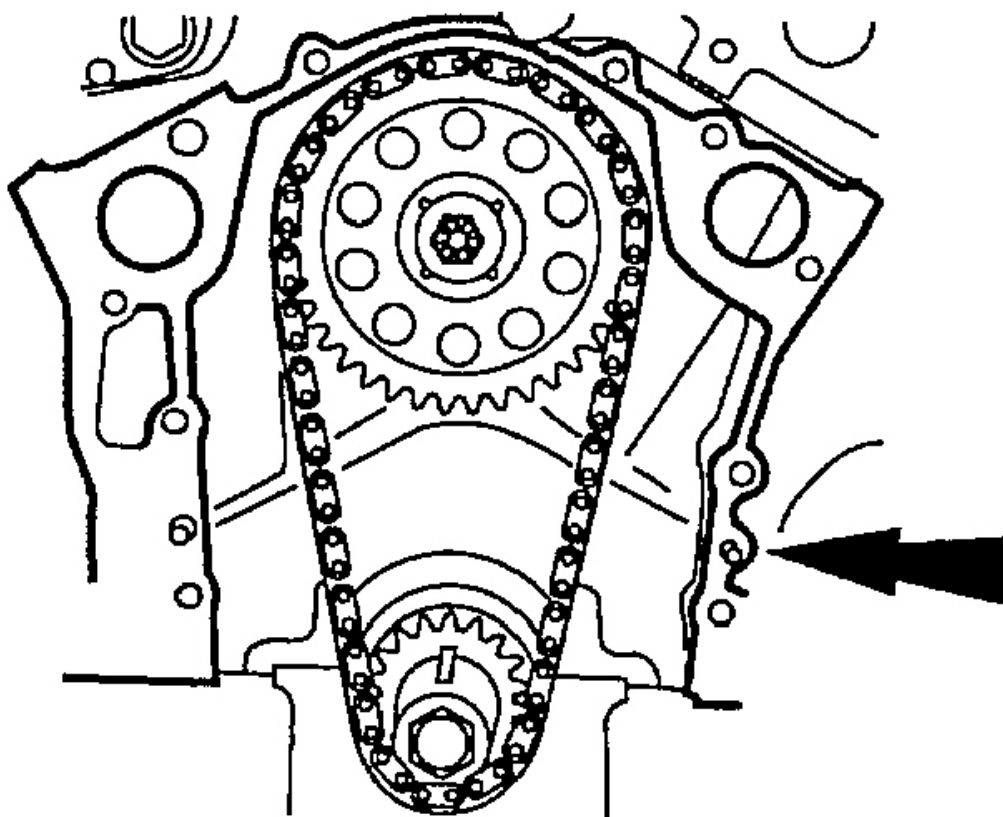
29. Remove the front cover bolts and engine front cover.



G03312217

Fig. 27: Removing Engine Front Cover
Courtesy of MAZDA MOTORS CORP.

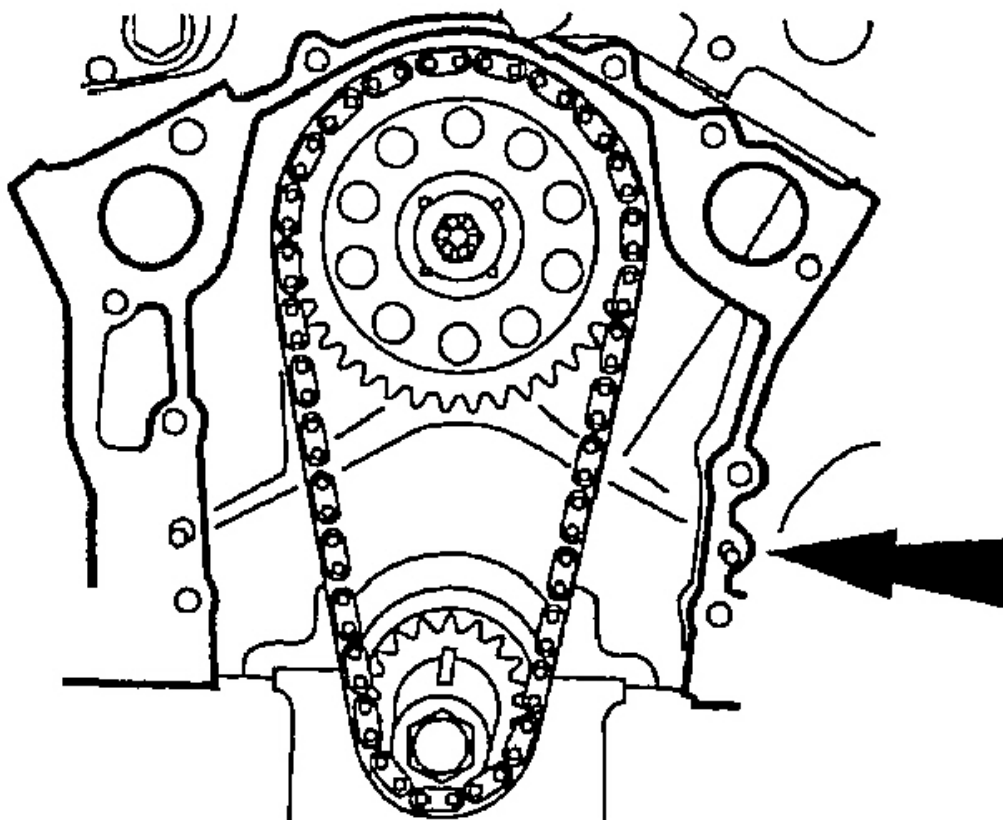
30. Remove the engine front cover gasket.



G03312218

Fig. 28: Removing Engine Front Cover Gasket
Courtesy of MAZDA MOTORS CORP.

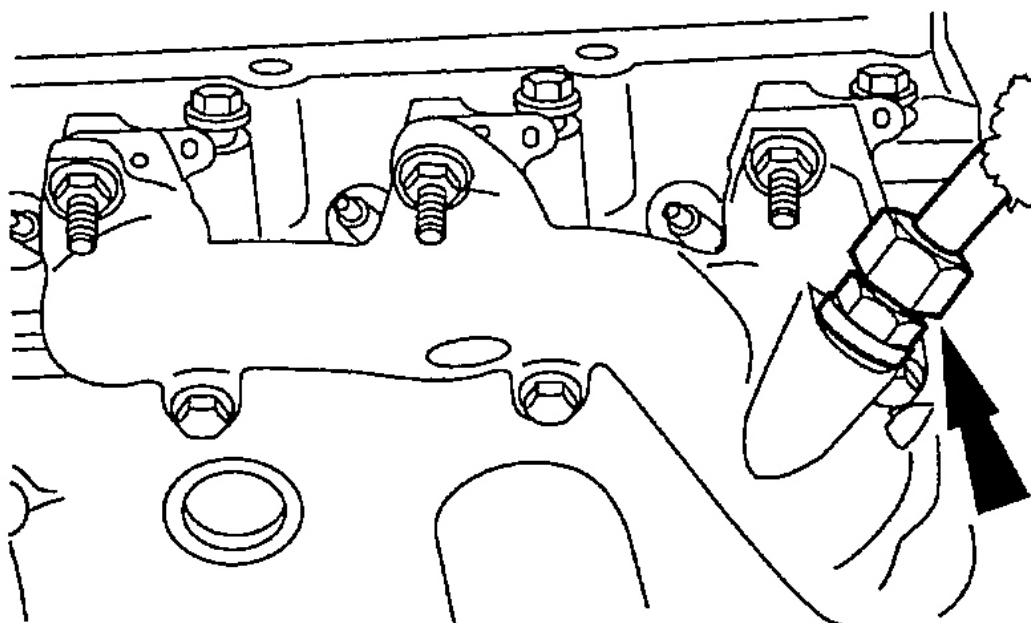
31. Clean the sealing surfaces.



G03312219

Fig. 29: Cleaning Engine Front Cover Sealing Surfaces
Courtesy of MAZDA MOTORS CORP.

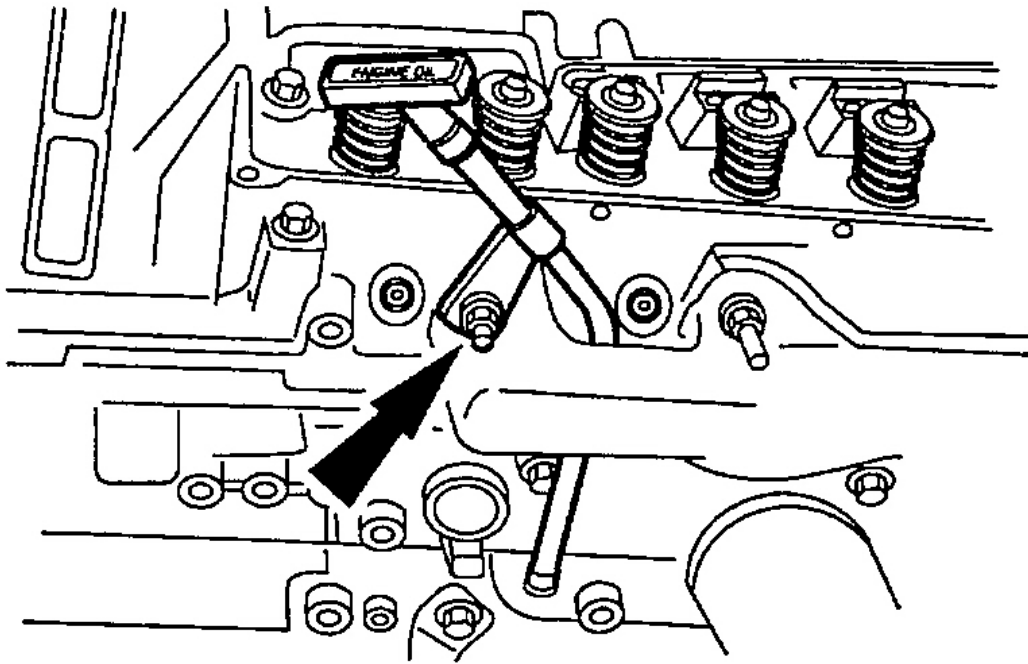
32. Remove the EGR valve to exhaust manifold tube.



G03312220

Fig. 30: Removing EGR Valve To Exhaust Manifold Tube
Courtesy of MAZDA MOTORS CORP.

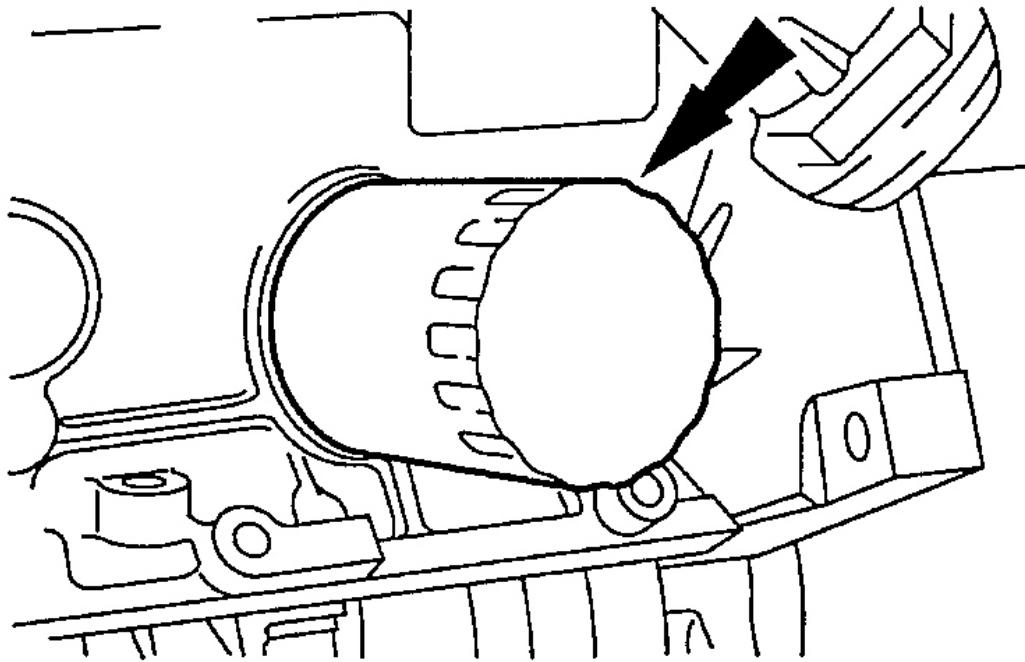
33. Remove the oil level indicator tube.



G03312221

Fig. 31: Removing Oil Level Indicator Tube
Courtesy of MAZDA MOTORS CORP.

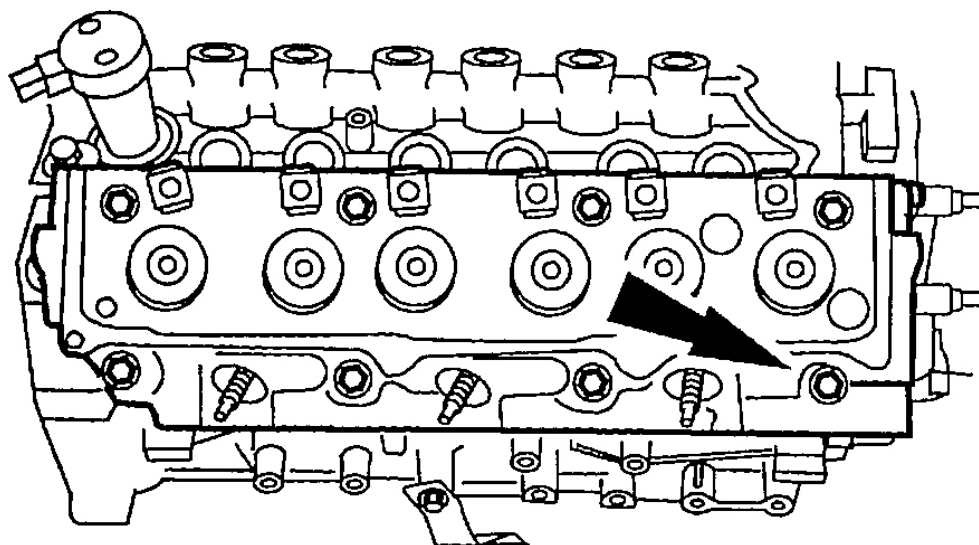
34. Remove the oil filter.



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Fig. 32: Removing Oil Filter
Courtesy of MAZDA MOTORS CORP.

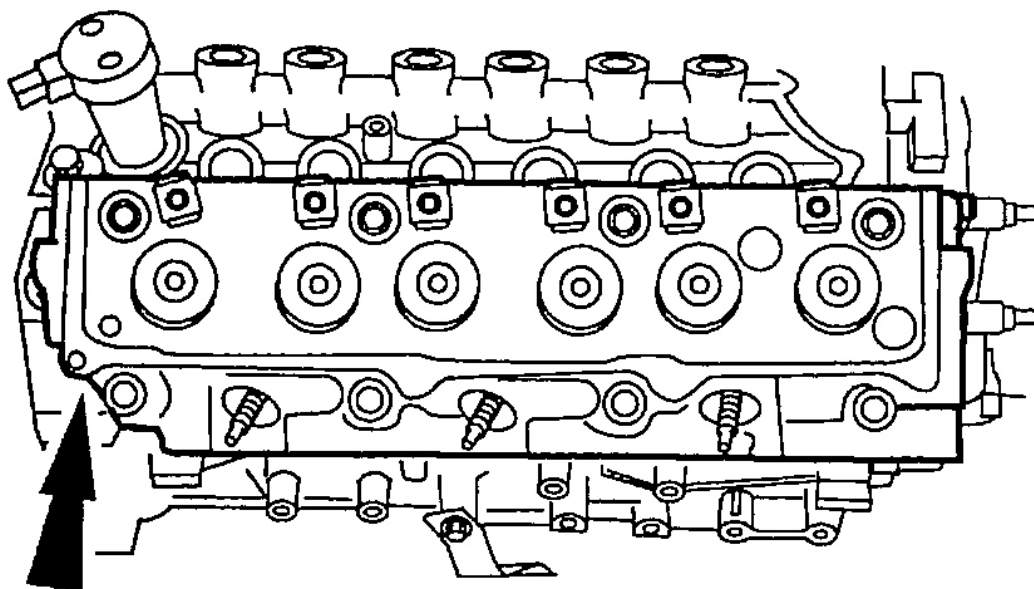
35. Remove the bolts.



G03312223

Fig. 33: Removing Cylinder Head Bolts
Courtesy of MAZDA MOTORS CORP.

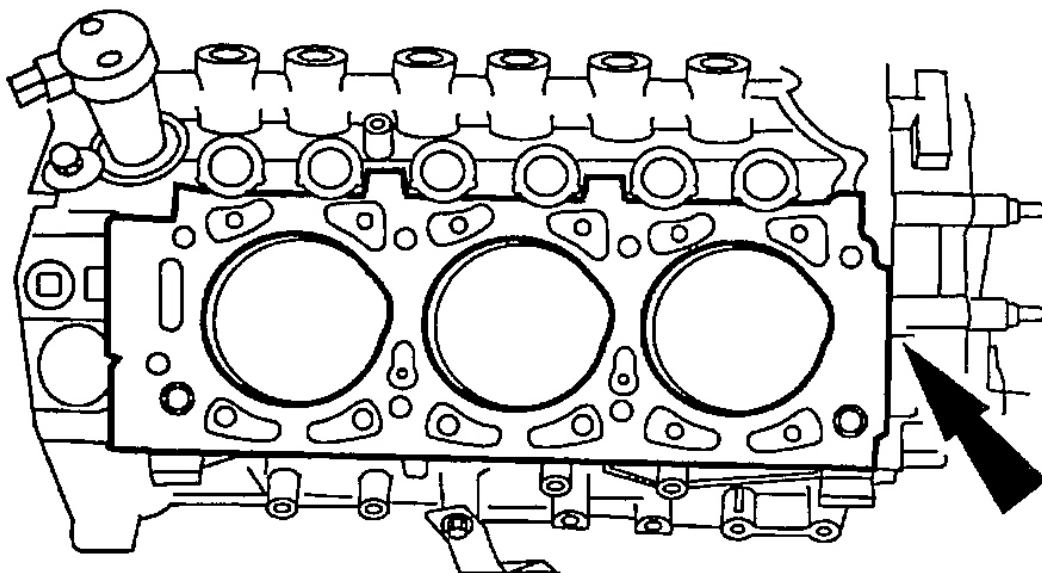
36. Remove the cylinder heads.



G03312224

Fig. 34: Removing Cylinder Heads
Courtesy of MAZDA MOTORS CORP.

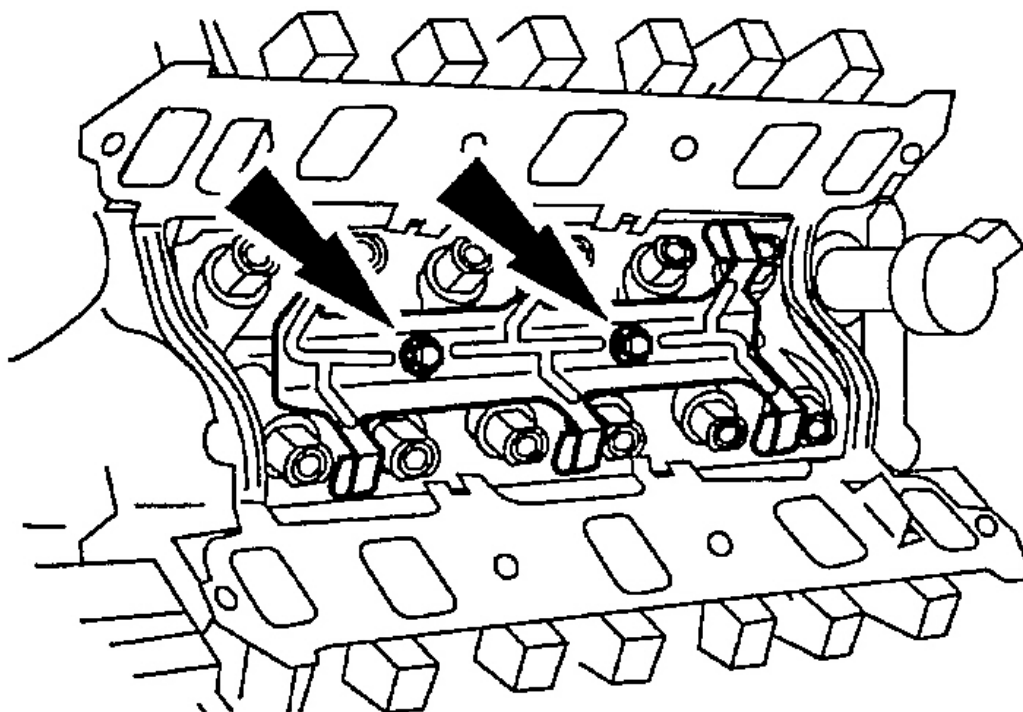
37. Remove the cylinder head gaskets.



G03312225

Fig. 35: Removing Cylinder Head Gasket
Courtesy of MAZDA MOTORS CORP.

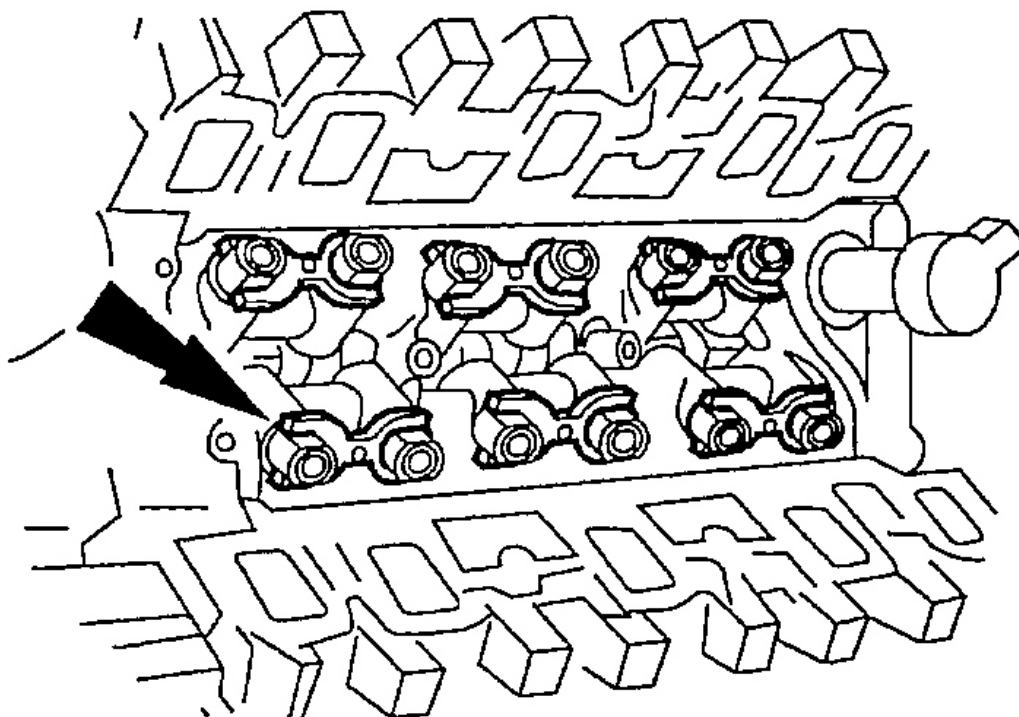
38. Remove the valve tappet guide plate retainer.



G03312226

Fig. 36: Removing Valve Tappet Guide Plate Retainer
Courtesy of MAZDA MOTORS CORP.

39. Remove the valve tappet guide plates.



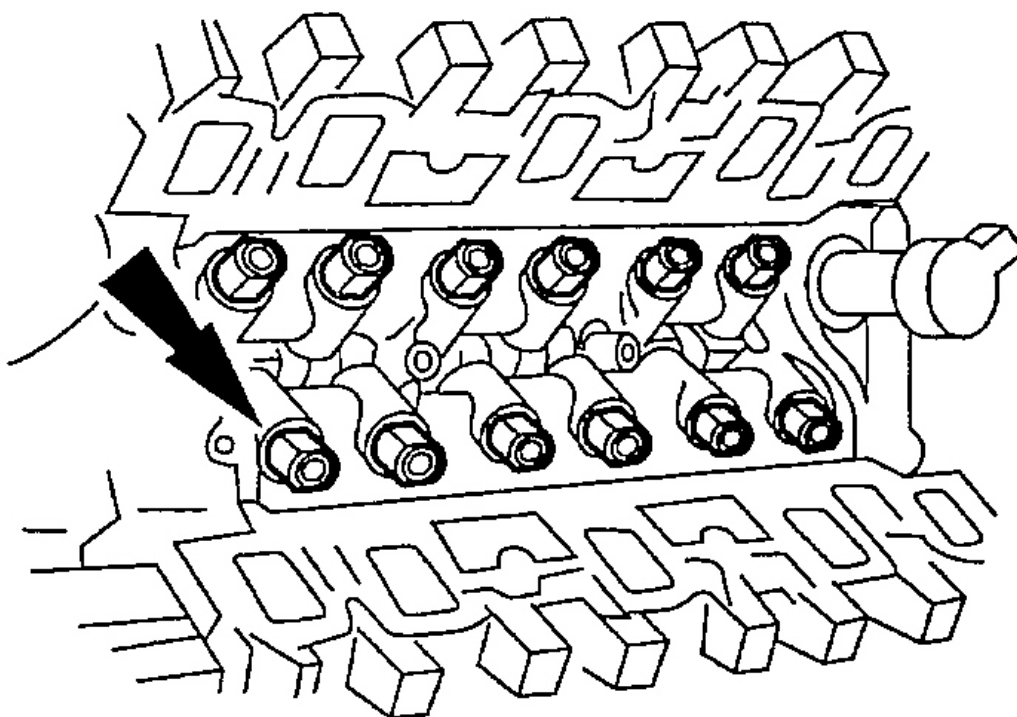
G03312227

Fig. 37: Removing Valve Tappet Guide Plates

Courtesy of MAZDA MOTORS CORP.

NOTE:

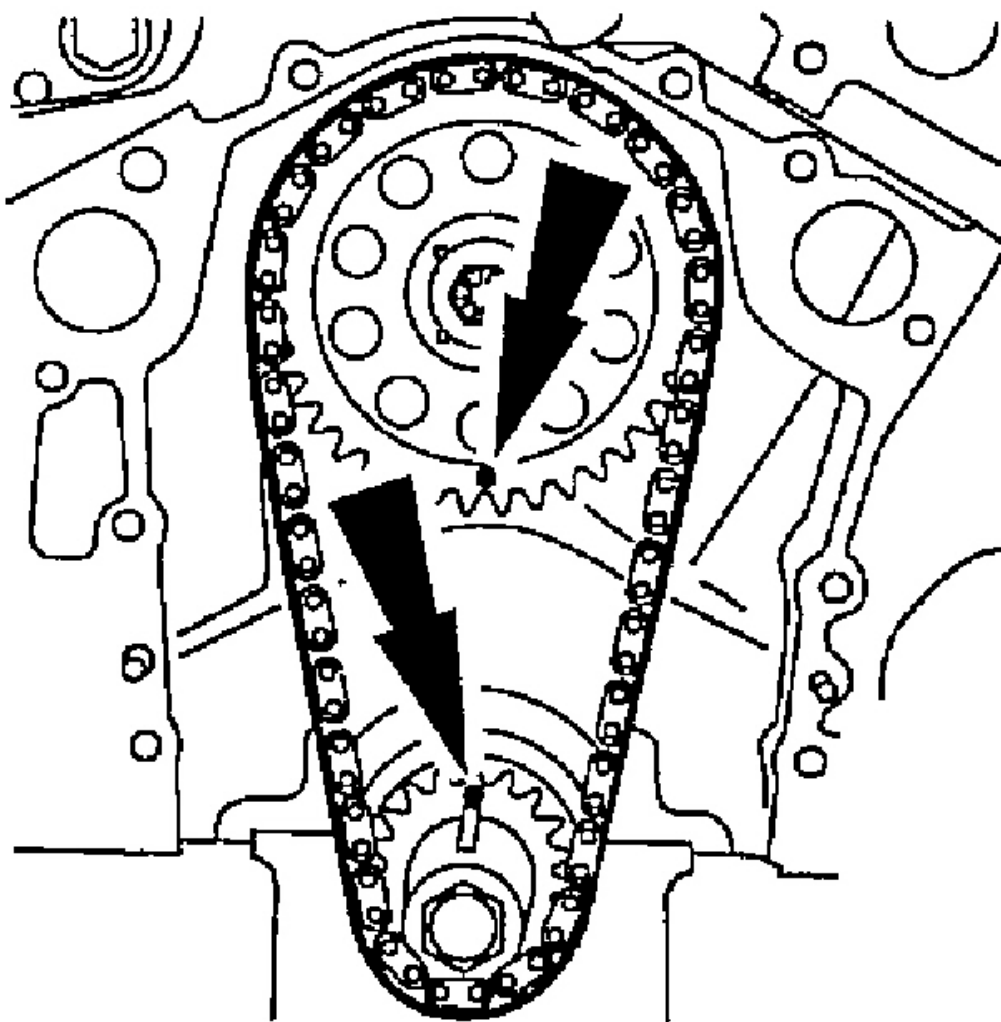
- The valve tappets are positional. Identify each valve tappet for installation in the original position.



G03312228

Fig. 38: Removing Valve Tappets
Courtesy of MAZDA MOTORS CORP.

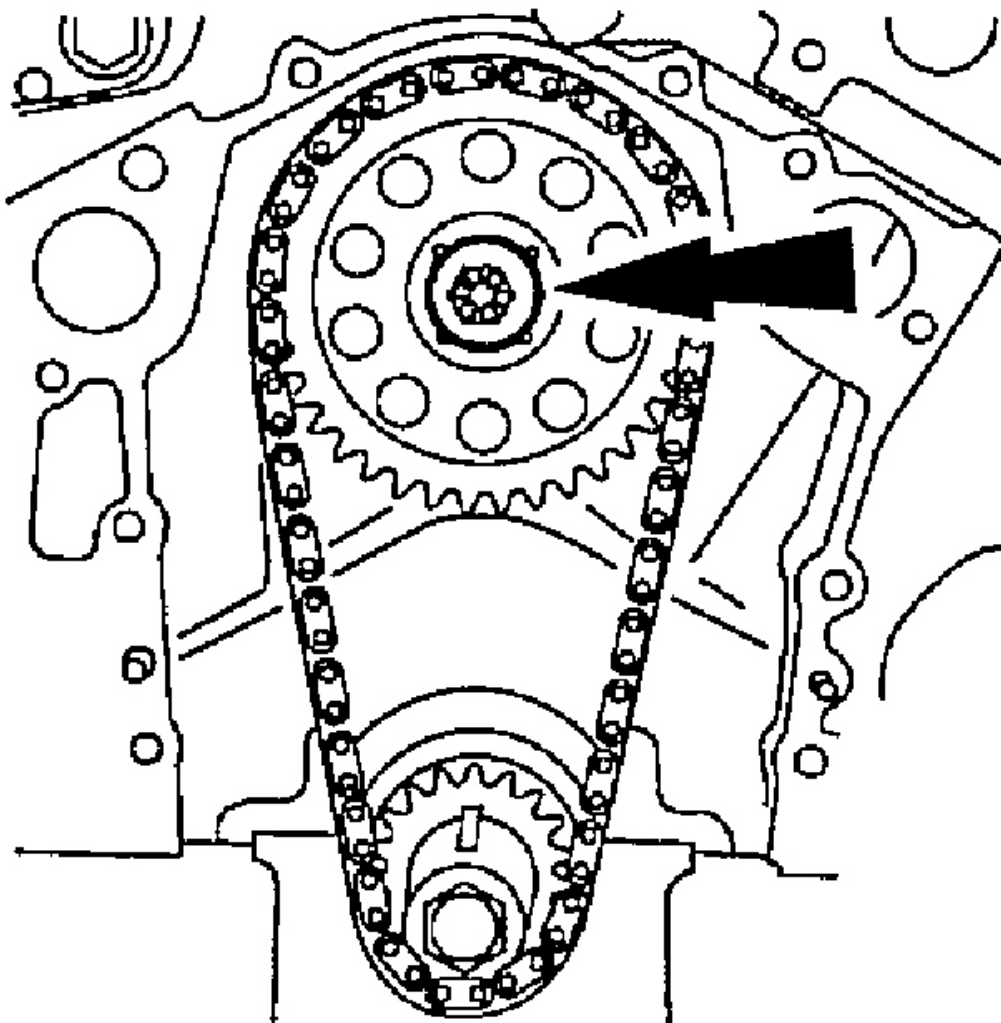
40. Remove the valve tappets.
41. Align the timing marks.



G03312229

Fig. 39: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

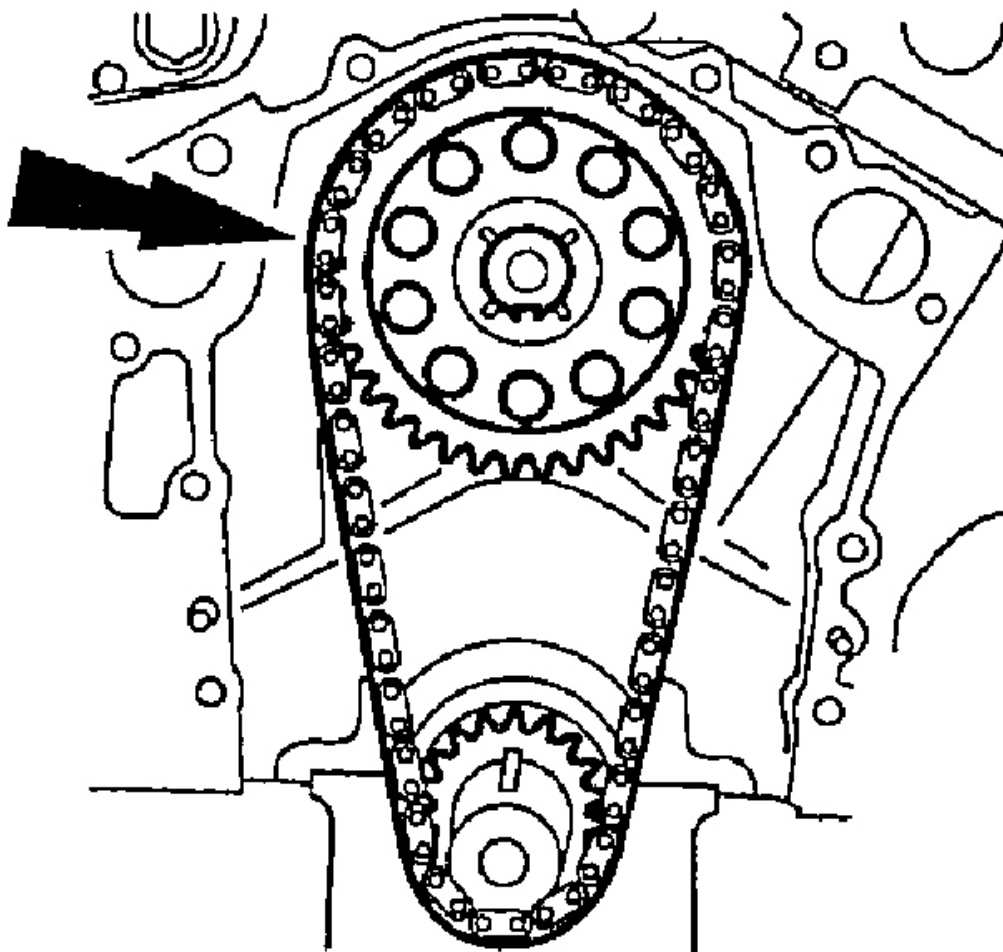
42. Remove the bolt.



G03312230

Fig. 40: Removing Camshaft Pulley Bolt
Courtesy of MAZDA MOTORS CORP.

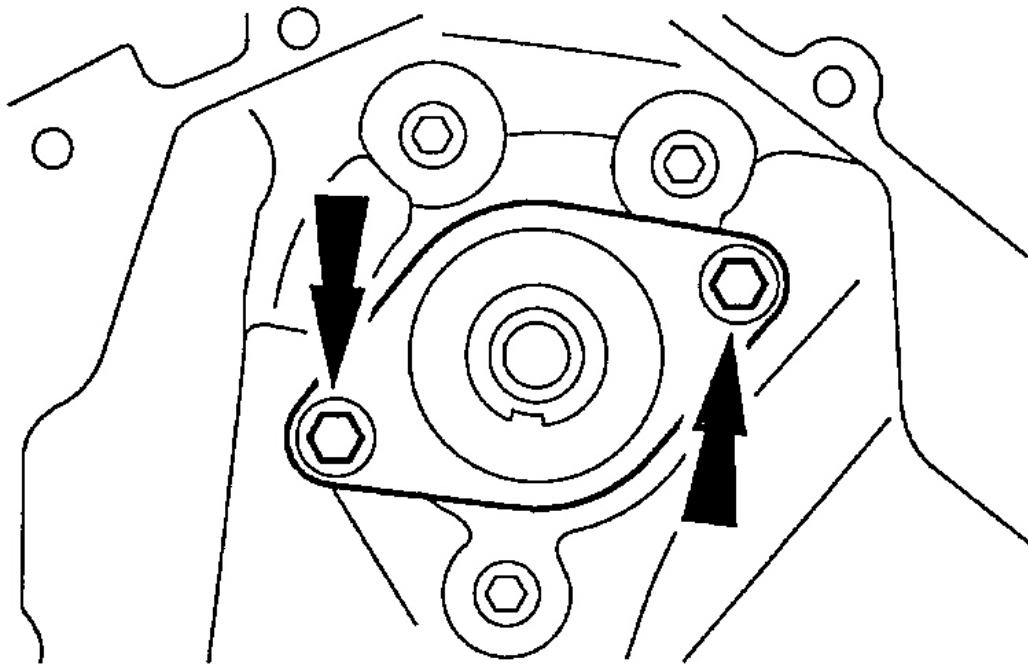
43. Remove the timing sprockets and timing chain as an assembly.



G03312231

Fig. 41: Removing Timing Sprockets & Timing Chain
Courtesy of MAZDA MOTORS CORP.

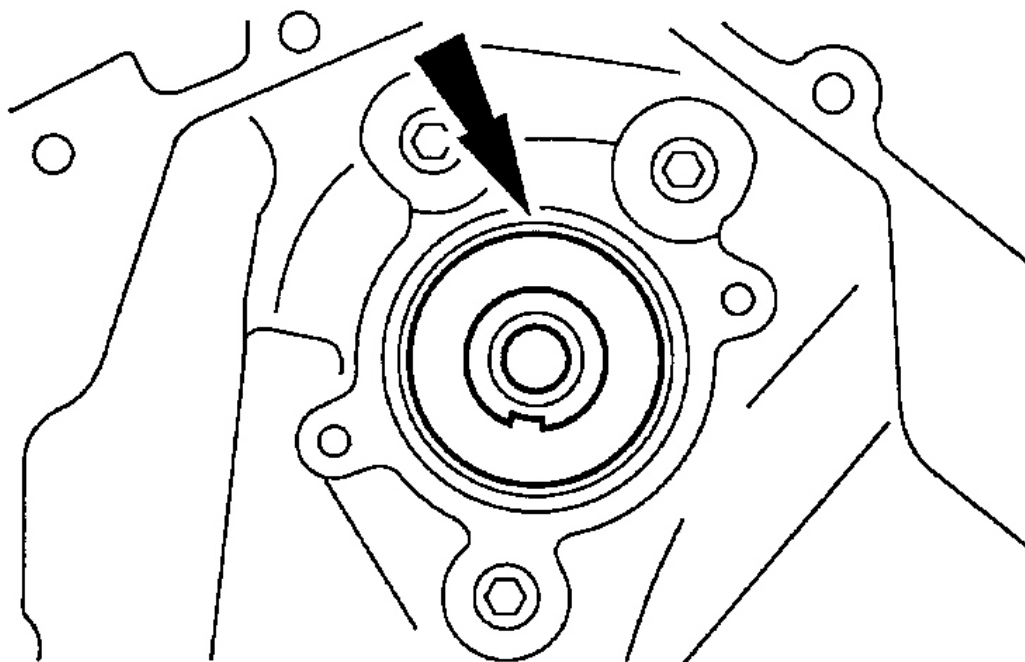
44. Remove the camshaft retainer.



G03312232

Fig. 42: Removing Camshaft Retainer
Courtesy of MAZDA MOTORS CORP.

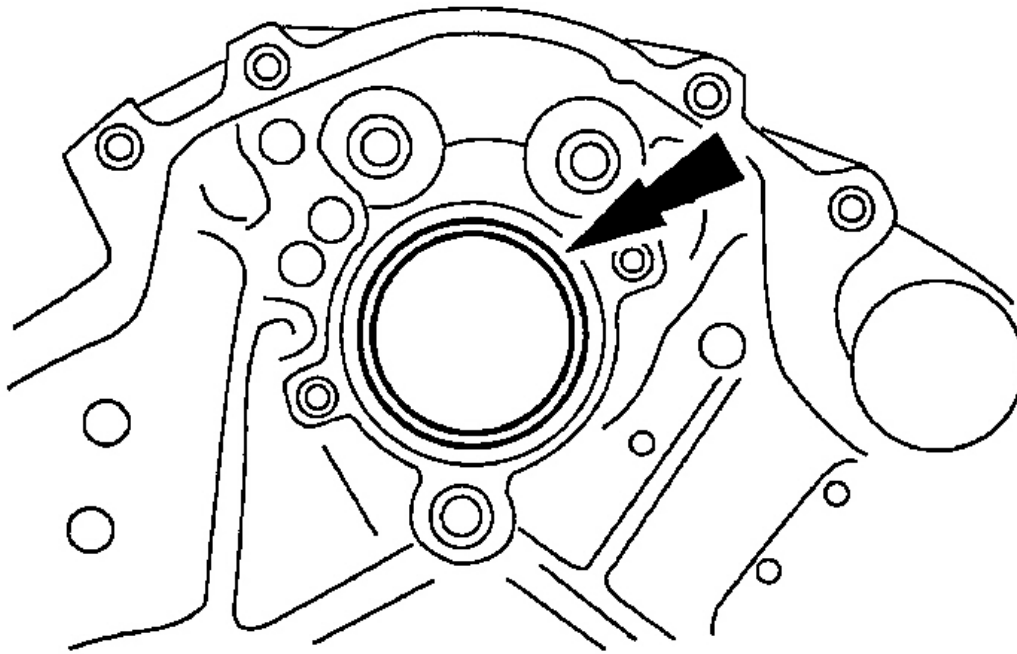
45. Remove the camshaft.



G03312233

Fig. 43: Removing Camshaft
Courtesy of MAZDA MOTORS CORP.

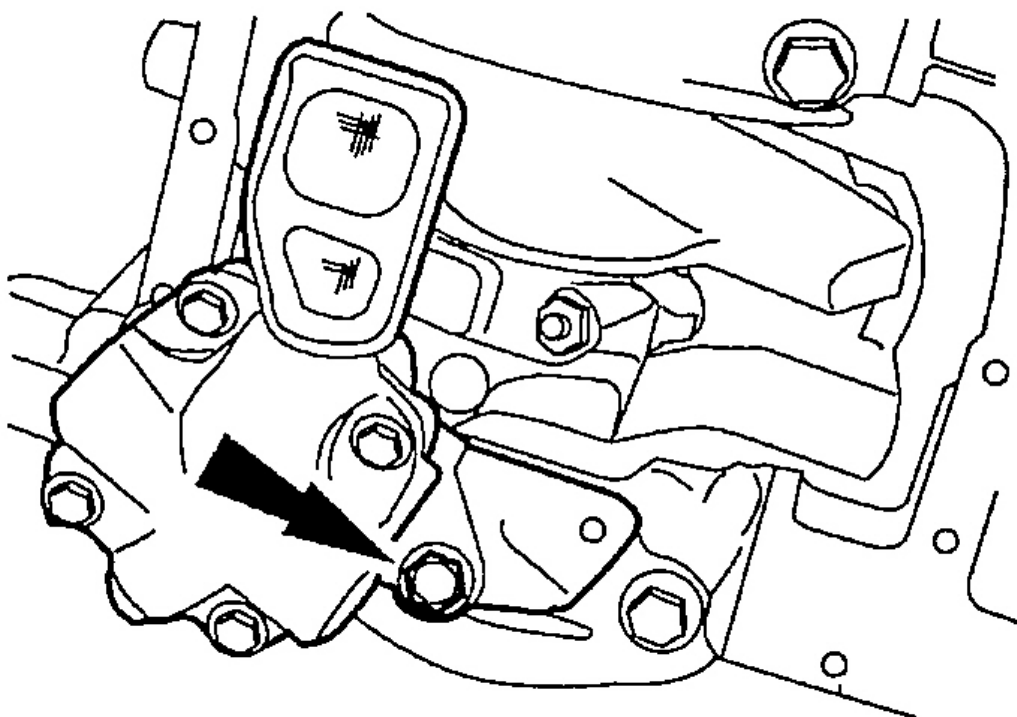
46. If required, remove the camshaft bearings.
- Use the Camshaft Bearing Set SST 303-017 (T65L-6250-A) or equivalent.



G03312234

Fig. 44: Removing Camshaft Bearings
Courtesy of MAZDA MOTORS CORP.

47. Remove the oil pump.



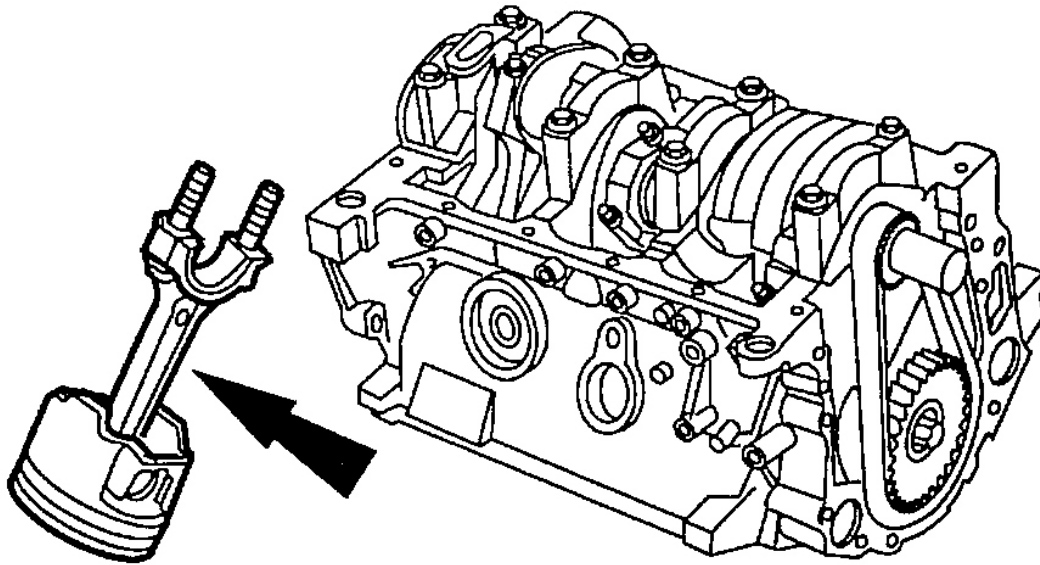
G03312235

Fig. 45: Removing Oil Pump

Courtesy of MAZDA MOTORS CORP.

NOTE:

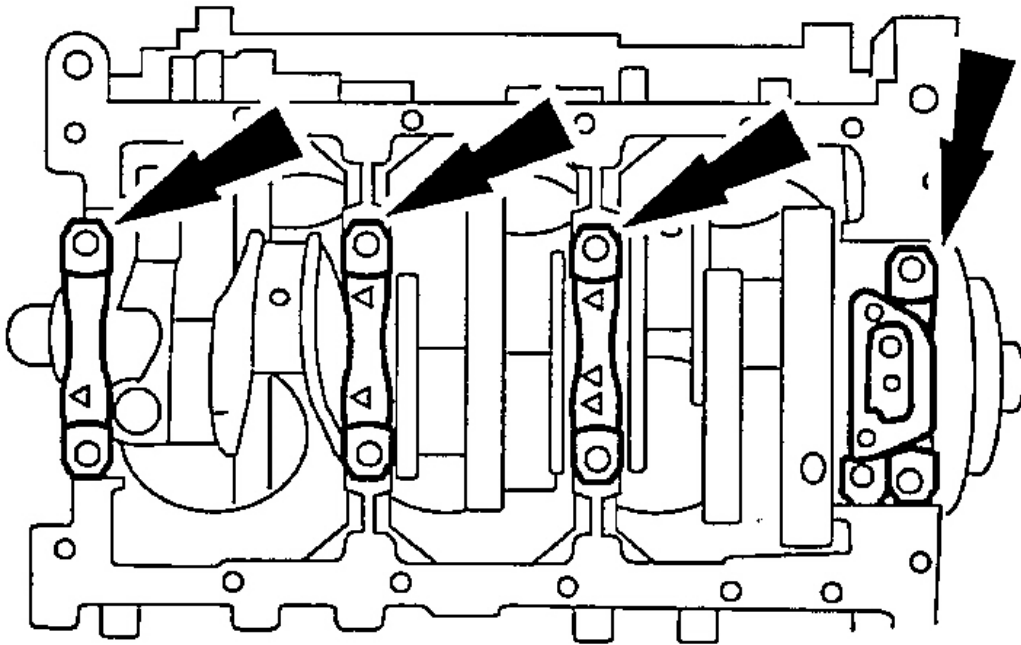
- Before removing the piston and connecting rod assemblies, inspect the top of the cylinder bores. If required, remove the cylinder ridge.



G03312236

Fig. 46: Removing Piston & Connecting Rod Assemblies
Courtesy of MAZDA MOTORS CORP.

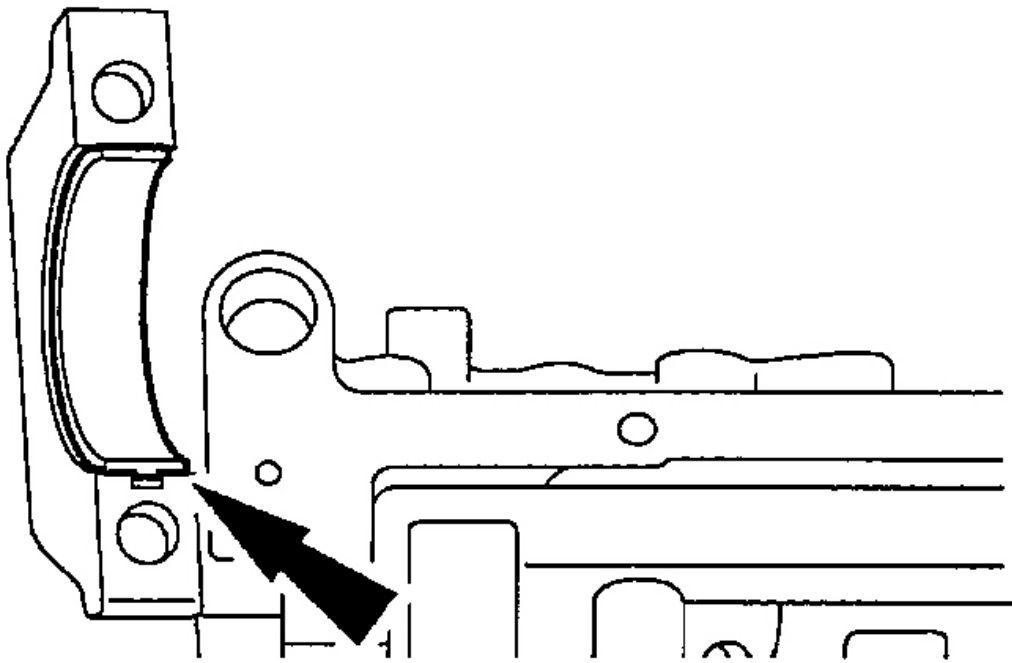
48. Remove the piston and connecting rod assemblies one at a time.
 1. Remove the connecting rod nuts in pairs.
 2. Remove the connecting rod cap.
 3. Remove the piston and connecting rod assembly.
49. Remove the bolts and main bearing caps.



G03312237

Fig. 47: Removing Main Bearing Caps
Courtesy of MAZDA MOTORS CORP.

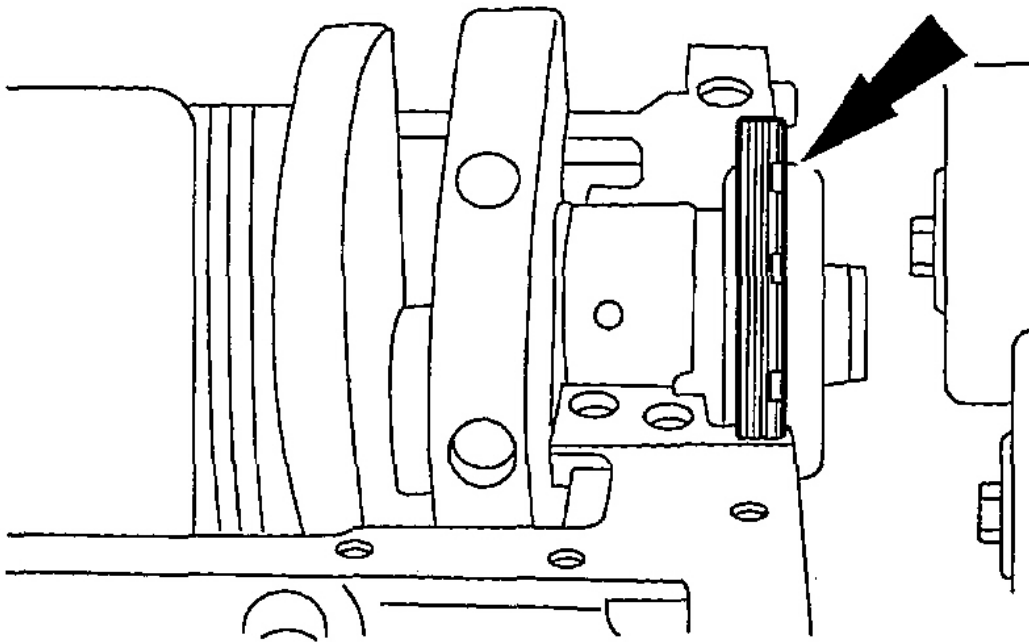
50. Remove the lower crankshaft main bearings.



G03312238

Fig. 48: Removing Lower Crankshaft Main Bearings
Courtesy of MAZDA MOTORS CORP.

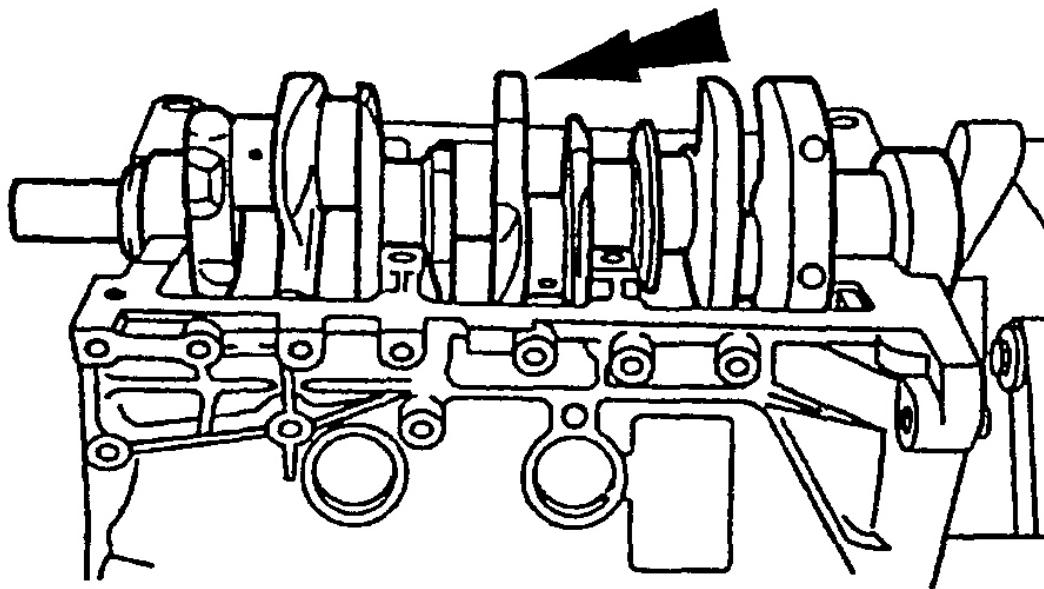
51. Remove the crankshaft rear oil seal.



G03312239

Fig. 49: Removing Crankshaft Rear Oil Seal
Courtesy of MAZDA MOTORS CORP.

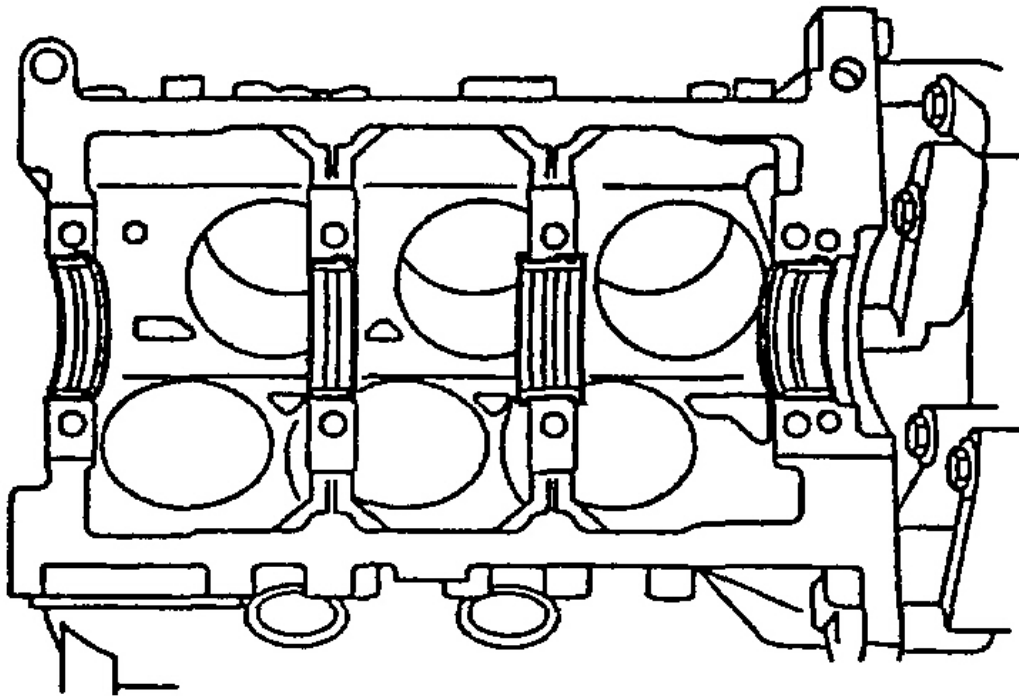
52. Remove the crankshaft.



G03312240

Fig. 50: Removing Crankshaft
Courtesy of MAZDA MOTORS CORP.

53. Remove the upper crankshaft main bearings.

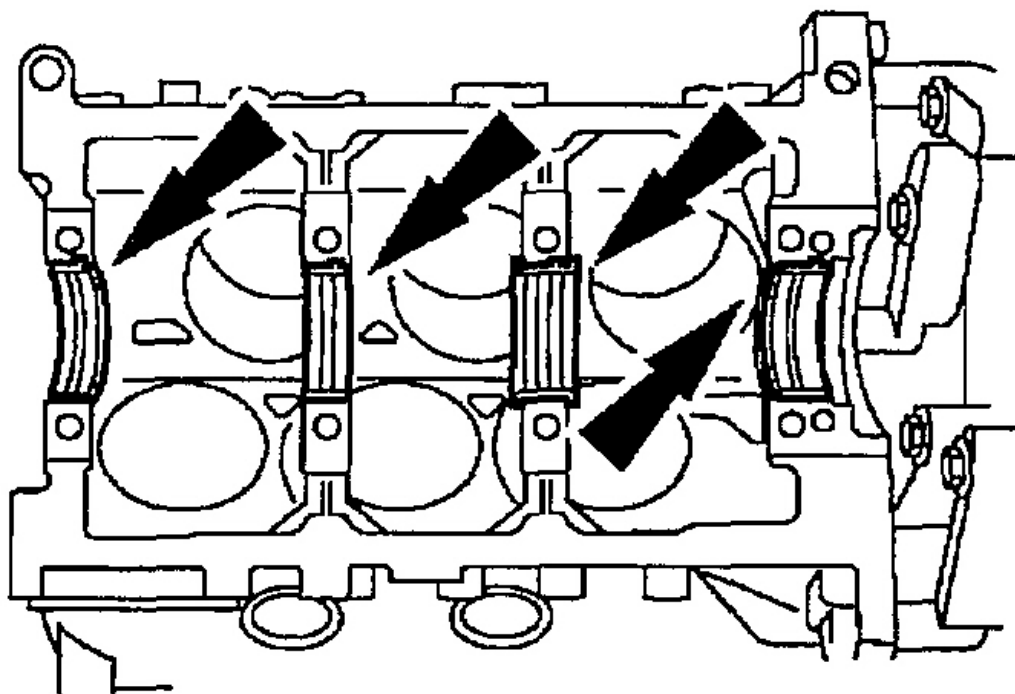


G03312241

Fig. 51: Removing Upper Crankshaft Main Bearings
Courtesy of MAZDA MOTORS CORP.

ASSEMBLY NOTE

1. Install the upper crankshaft main bearings.

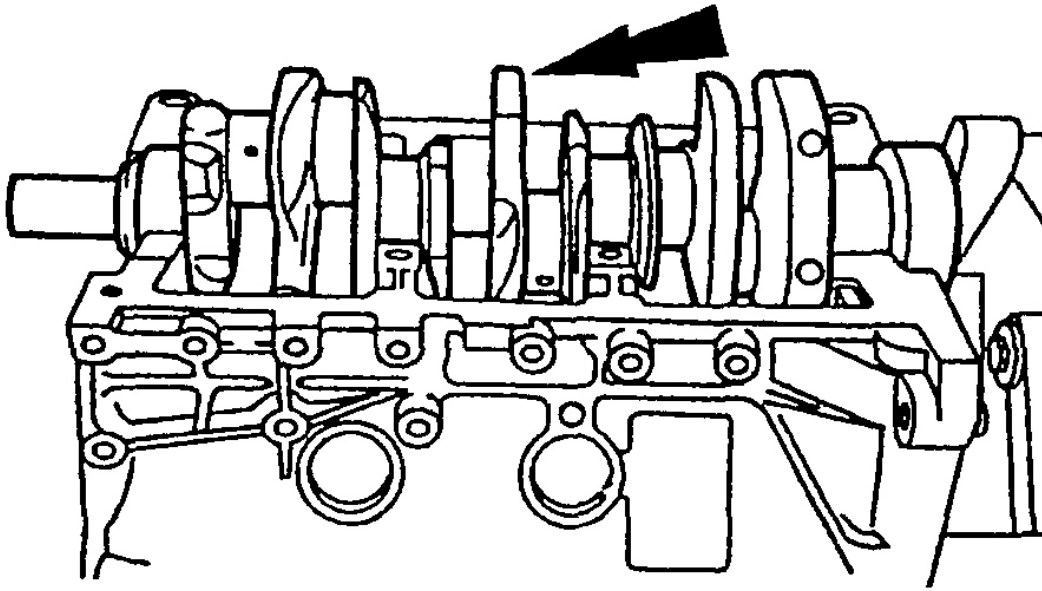


G03312242

Fig. 52: Installing Upper Crankshaft Main Bearings
Courtesy of MAZDA MOTORS CORP.

NOTE:

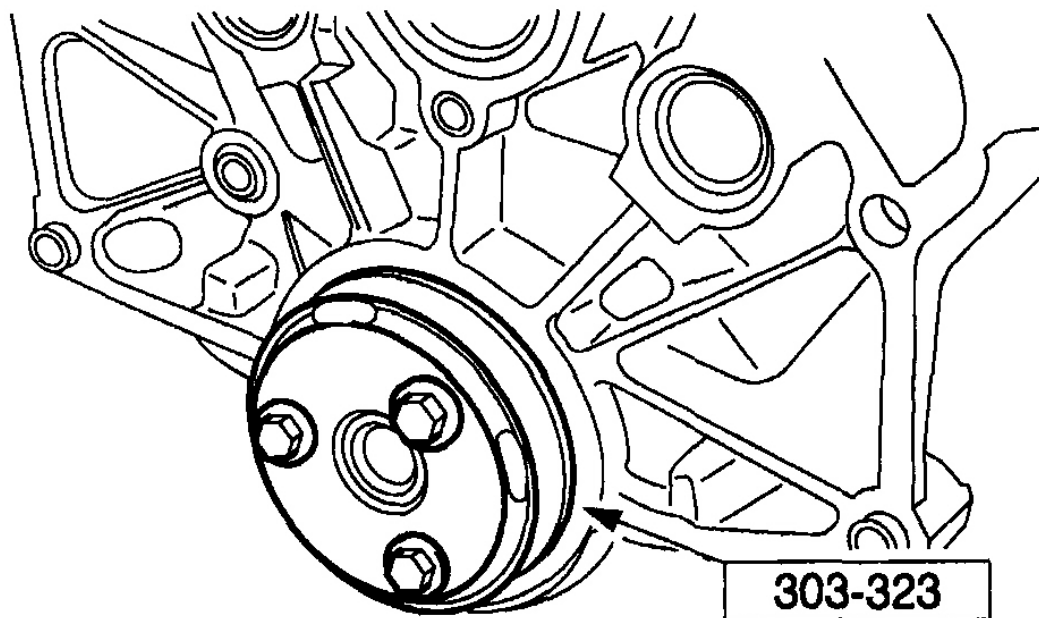
- Lubricate the crankshaft journals and the crankshaft main bearings with clean engine oil.



G03312243

Fig. 53: Installing Crankshaft
Courtesy of MAZDA MOTORS CORP.

2. Install the crankshaft.
3. Install the crankshaft rear main oil seal.
 1. Lubricate the outer lips and the inner seal on the crankshaft rear oil seal.
 2. Install the crankshaft rear oil seal using Rear Main Seal Installer **SST 49 UN01 064** . Alternate bolt tightening to seat seal properly.



AA5168-A

Fig. 54: Installing Crankshaft Rear Oil Seal

4. Apply two dots of gasket eliminator or equivalent between the rear bearing cap and the cylinder block.

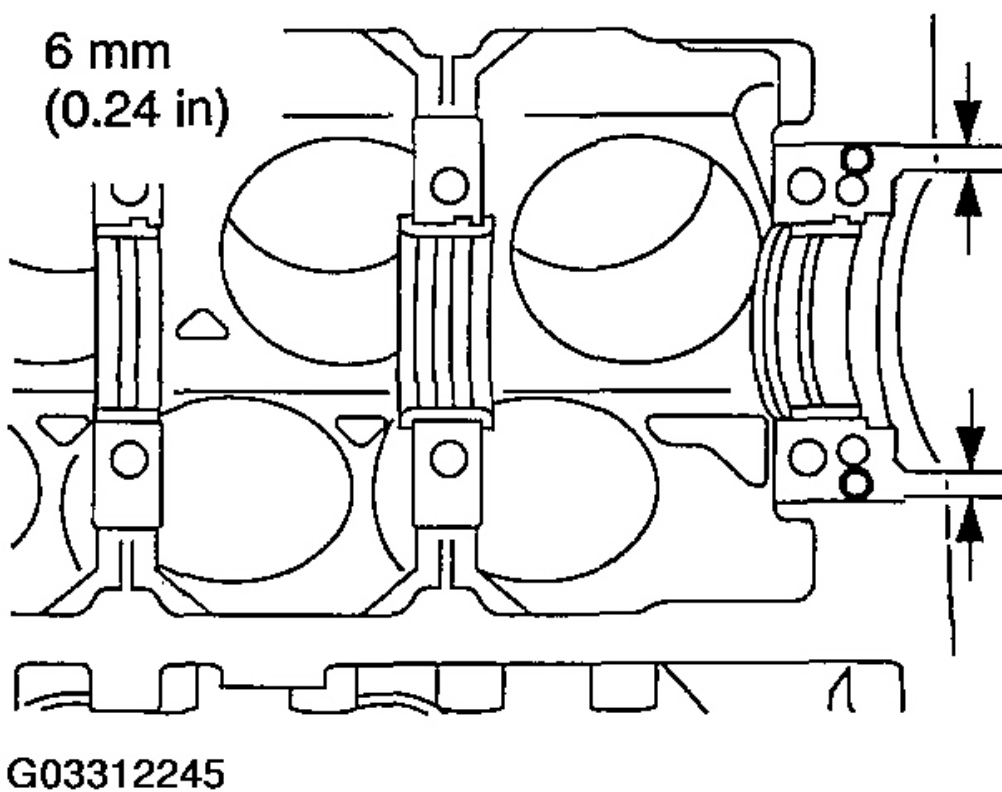
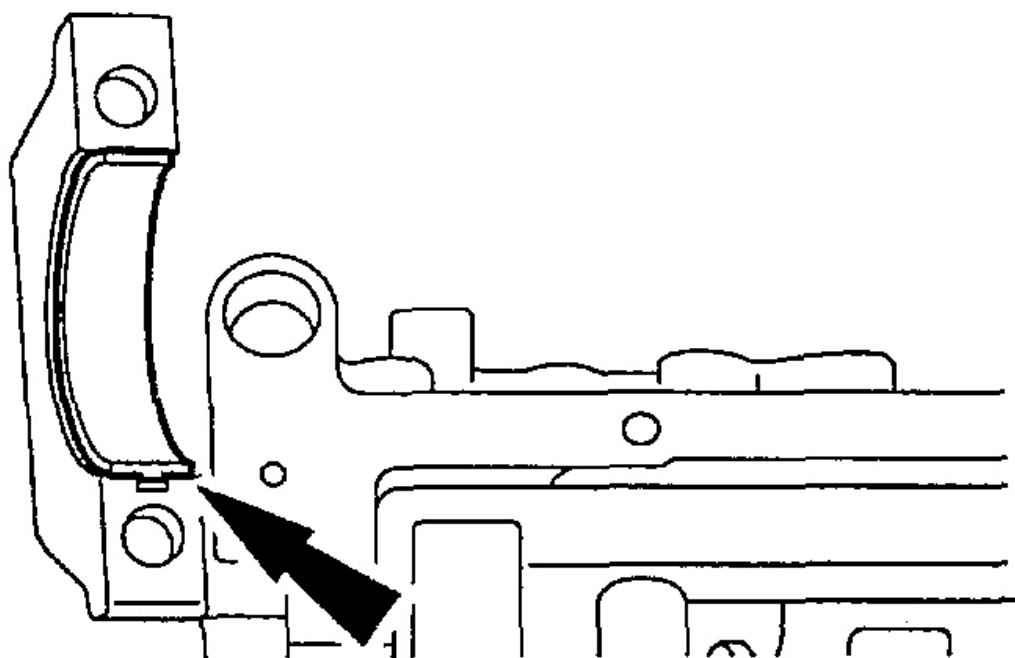


Fig. 55: Applying Two Dots Of Gasket Eliminator
 Courtesy of MAZDA MOTORS CORP.

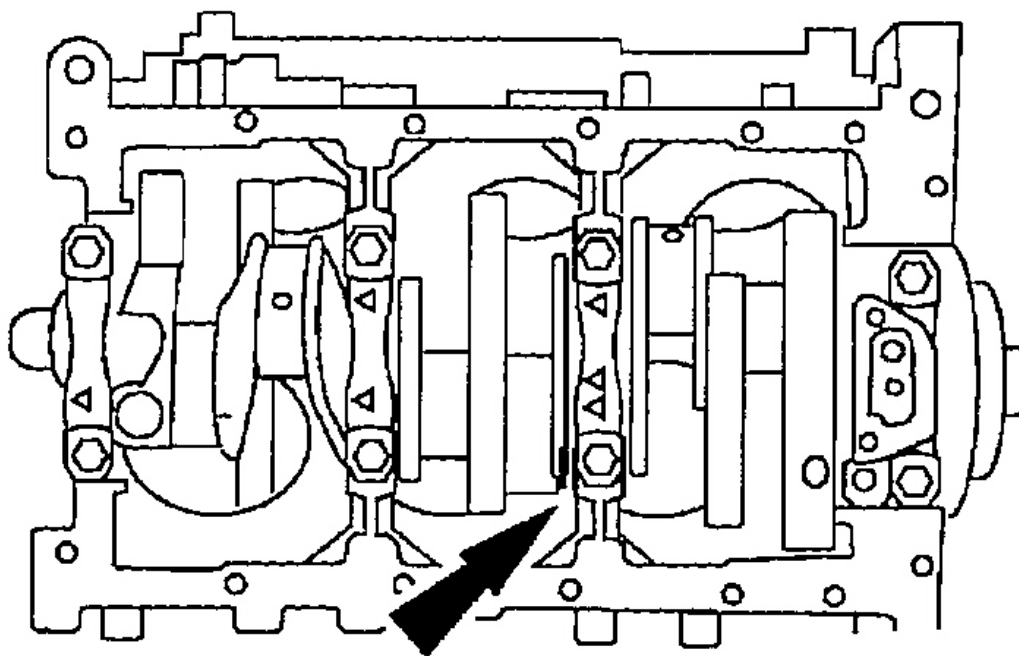
5. Install the lower crankshaft main bearings.



G03312246

Fig. 56: Installing Lower Crankshaft Main Bearings
Courtesy of MAZDA MOTORS CORP.

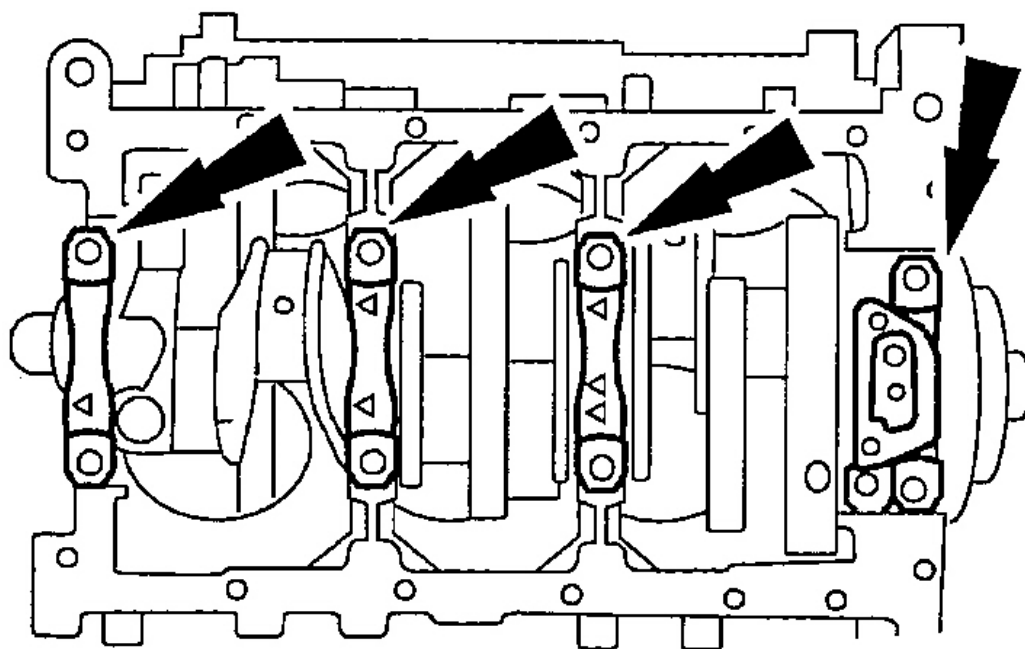
6. Wedge a large screwdriver at the location shown to hold the crankshaft forward until all the bolts are tightened.



G03312247

Fig. 57: Locating Screwdriver Insertion Location
Courtesy of MAZDA MOTORS CORP.

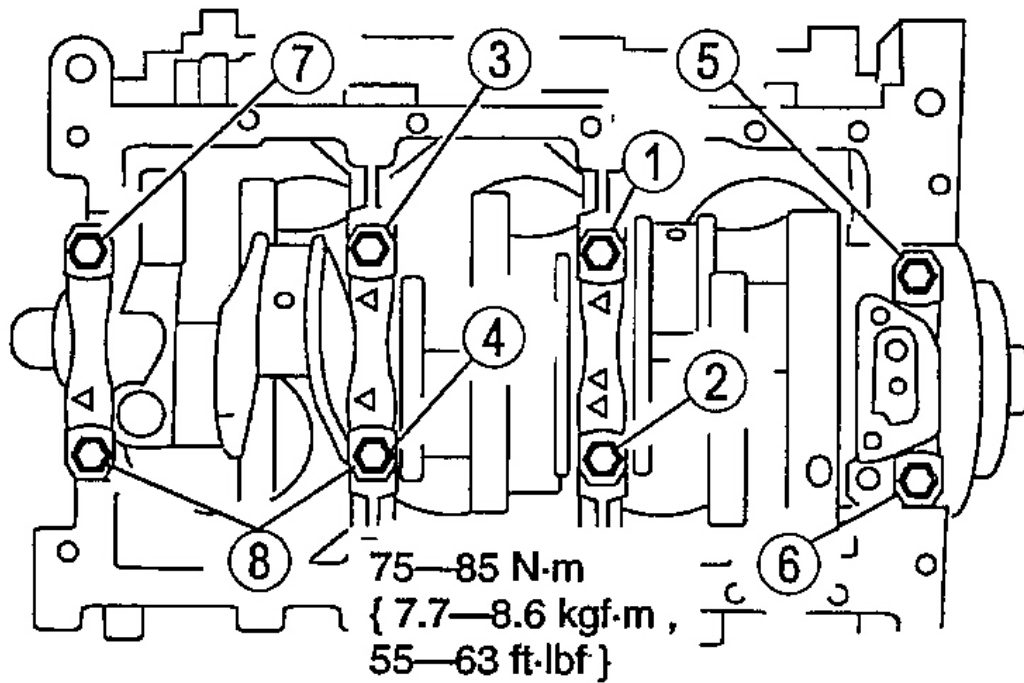
7. Install the main bearing caps.



G03312248

Fig. 58: Installing Main Bearing Caps
Courtesy of MAZDA MOTORS CORP.

8. Install the bolts.
 1. Tighten the bolts in pairs.
 2. For crankshaft and crankshaft bearing component tests, refer to **CRANKSHAFT INSPECTION** and **BEARING INSPECTION**.

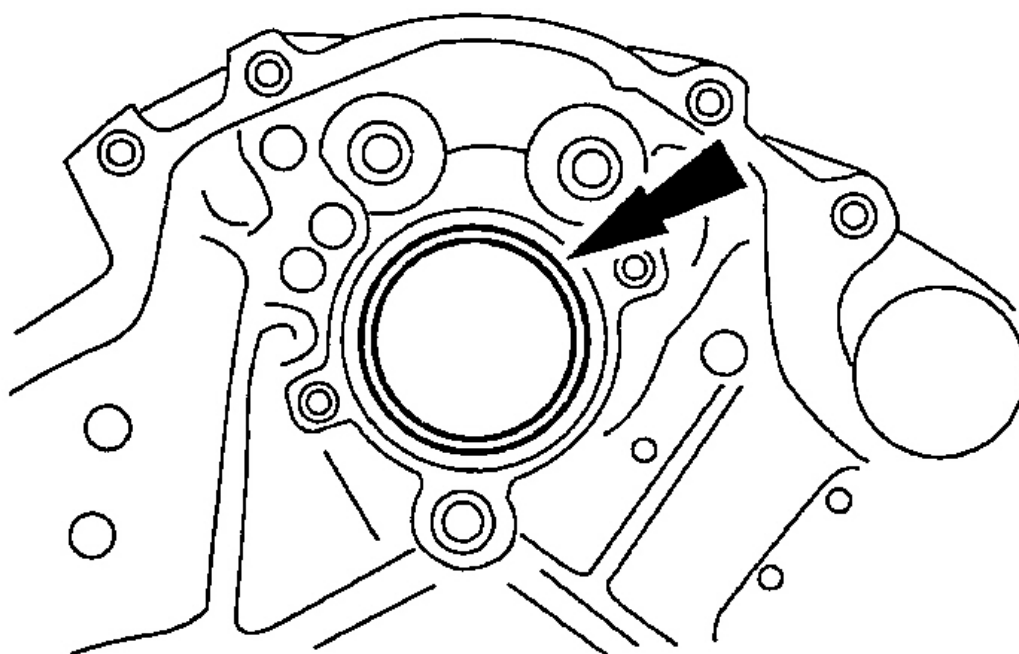


G03312249

Fig. 59: Installing Main Bearing Cap Bolts (With Torque Specifications)

Courtesy of MAZDA MOTORS CORP.

9. If removed, install the camshaft bearings.
 - Use the Cam Bearing Service Set SST 303-017 (T65L-6250-A) or equivalent.

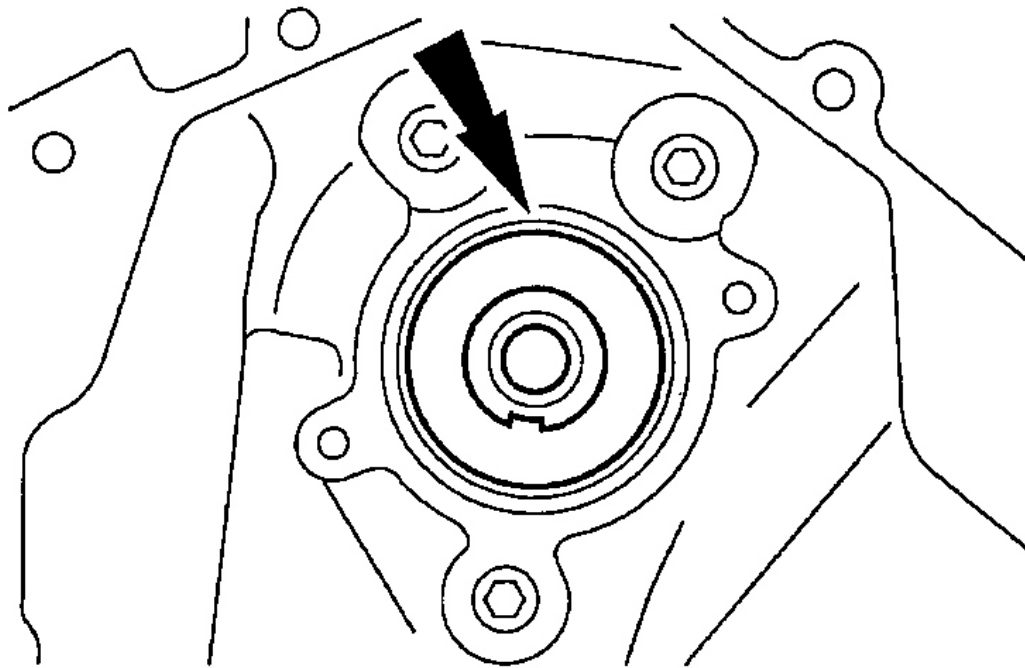


G03312250

Fig. 60: Installing Camshaft Bearings
Courtesy of MAZDA MOTORS CORP.

NOTE:

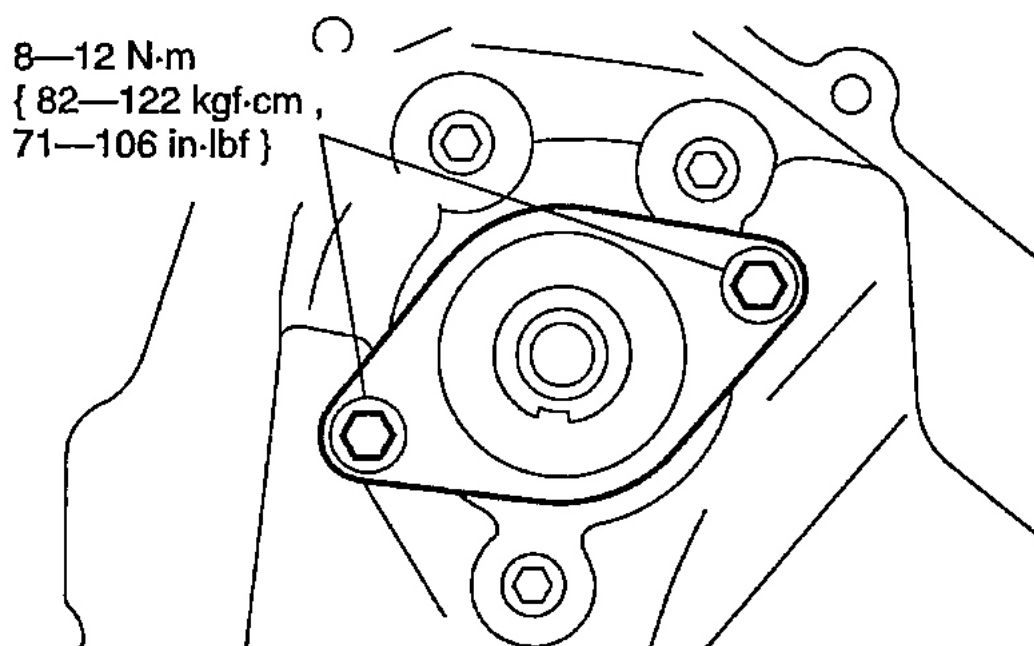
- Lubricate the camshaft and the camshaft bearings with clean engine oil.



G03312251

Fig. 61: Installing Camshaft
Courtesy of MAZDA MOTORS CORP.

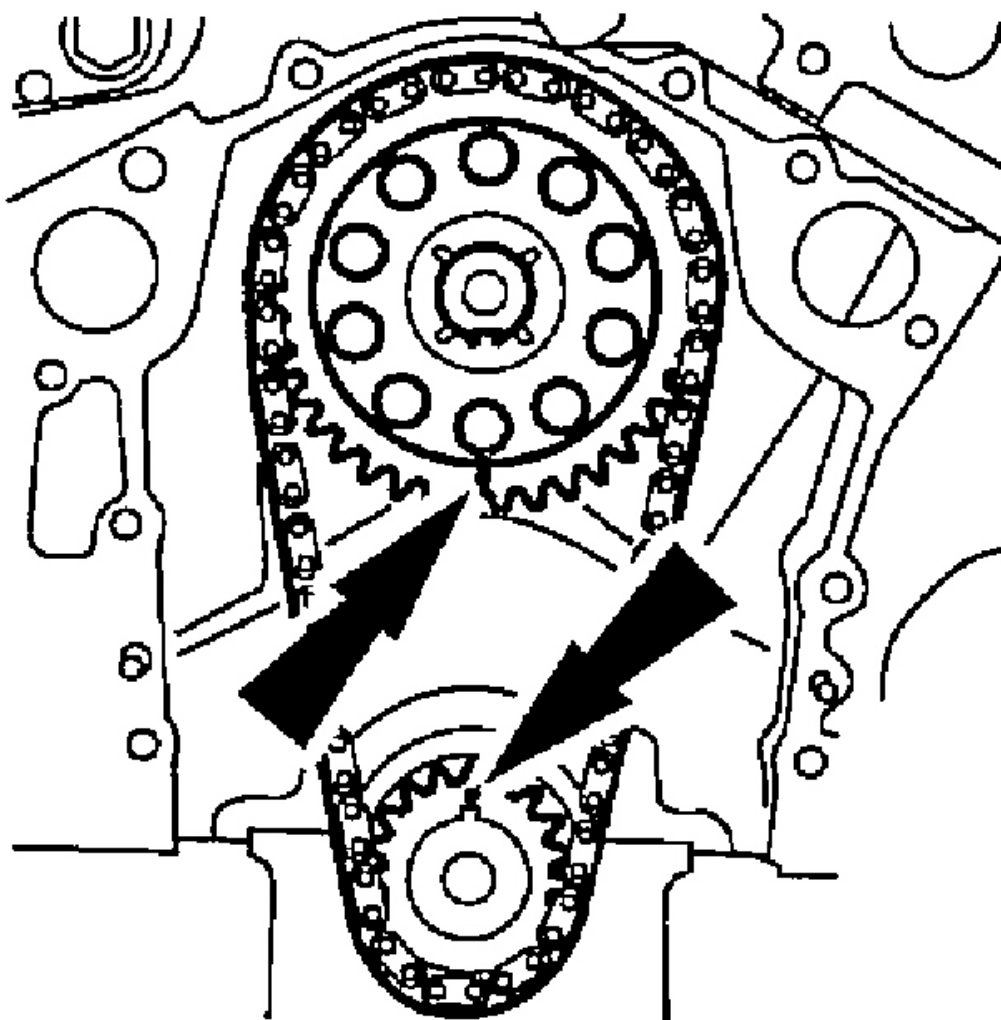
10. Install the camshaft.
11. Install the camshaft retainer.



G03312252

Fig. 62: Installing Camshaft Retainer (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

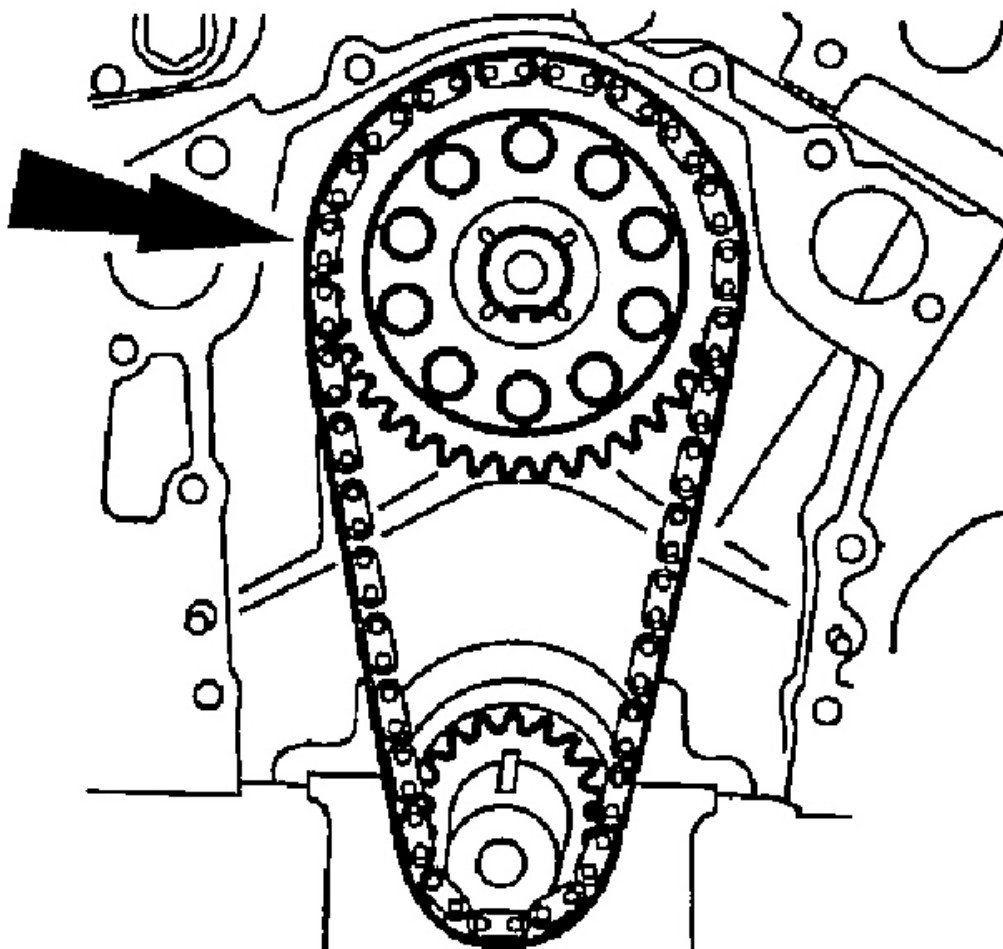
12. Inspect camshaft endplay. Refer to CAMSHAFT INSPECTION.
13. Align timing marks.



G03312253

Fig. 63: Aligning Timing Marks
Courtesy of MAZDA MOTORS CORP.

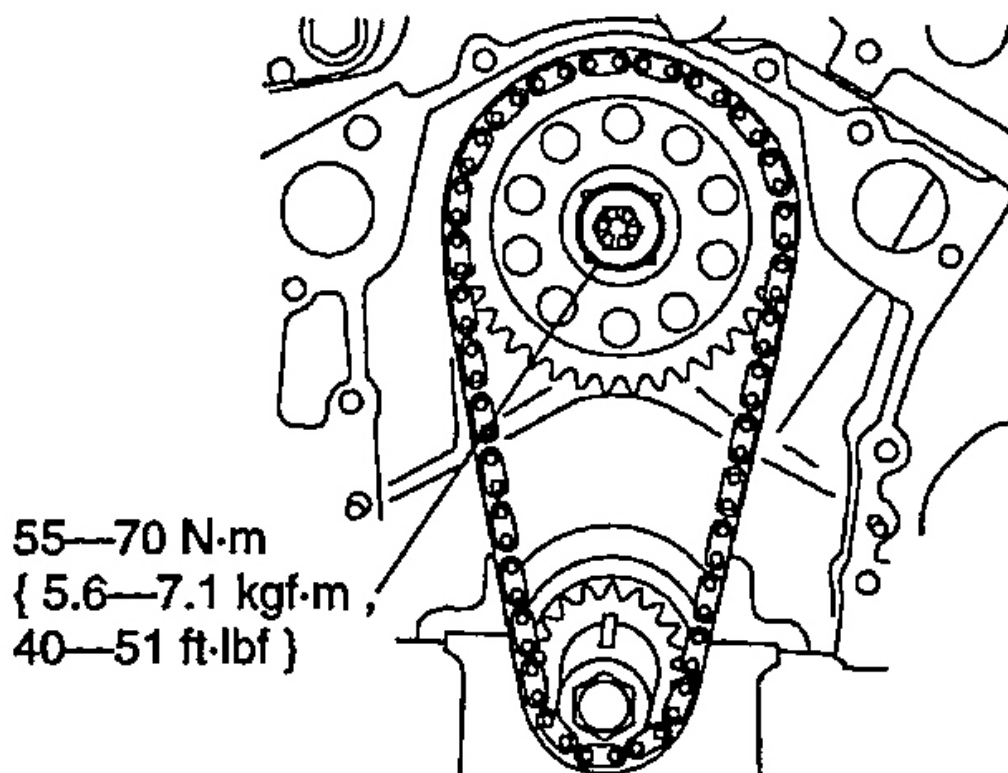
14. Install the timing chain, the camshaft sprocket and the crankshaft sprocket as an assembly.



G03312254

Fig. 64: Installing Timing Chain, Camshaft Sprocket & Crankshaft Sprocket Assembly
Courtesy of MAZDA MOTORS CORP.

15. Install the bolt.

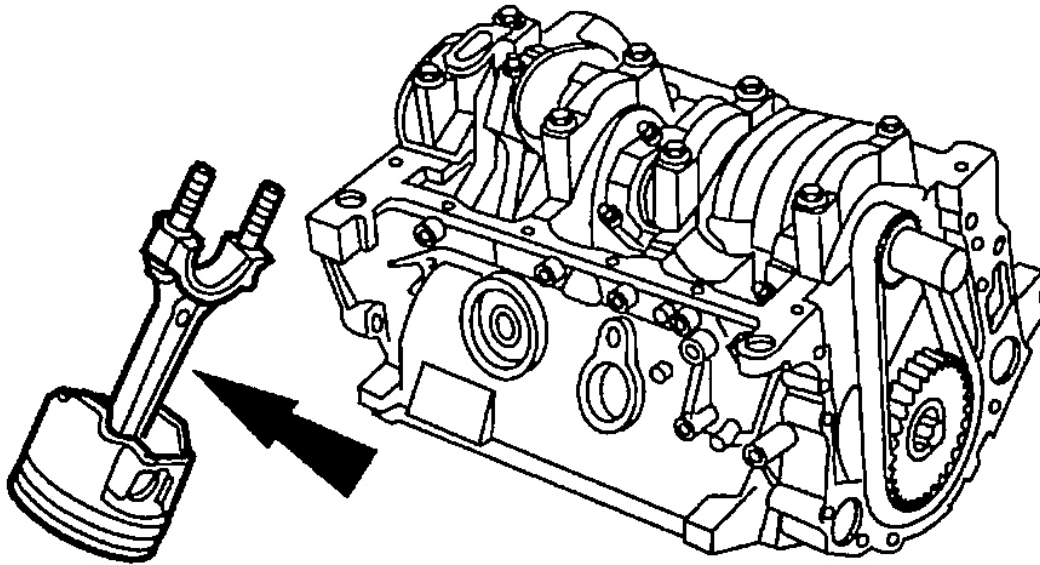


G03312255

Fig. 65: Installing Camshaft Sprocket Bolt (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

NOTE:

- Lubricate the piston and connecting rod assemblies with clean engine oil.



G03312256

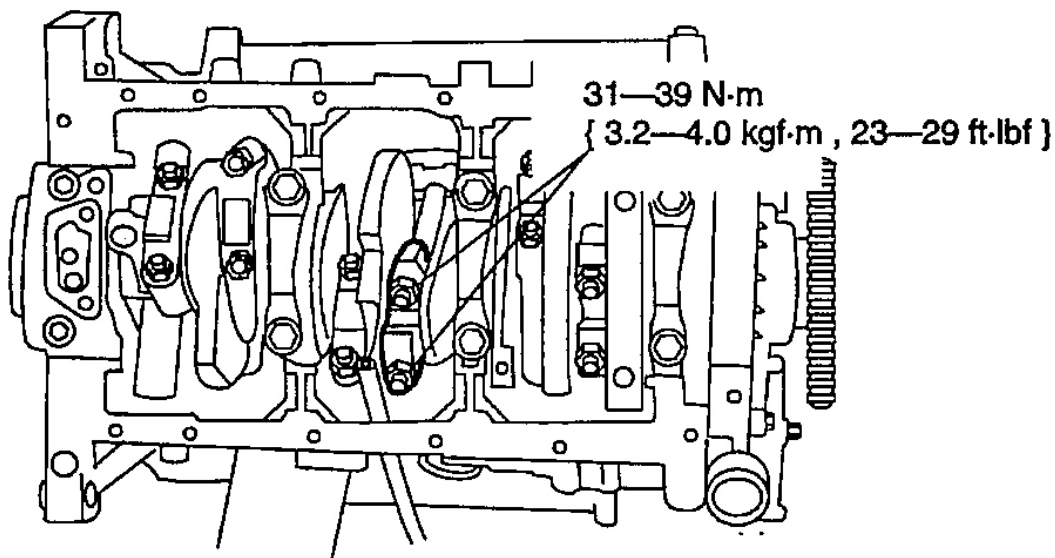
Fig. 66: Installing Piston & Connecting Rod Assemblies
Courtesy of MAZDA MOTORS CORP.

16. Install the piston and connecting rod assemblies.
 - Use a piston ring compressor.

NOTE:

- Lubricate the connecting rod bearings with clean engine oil.

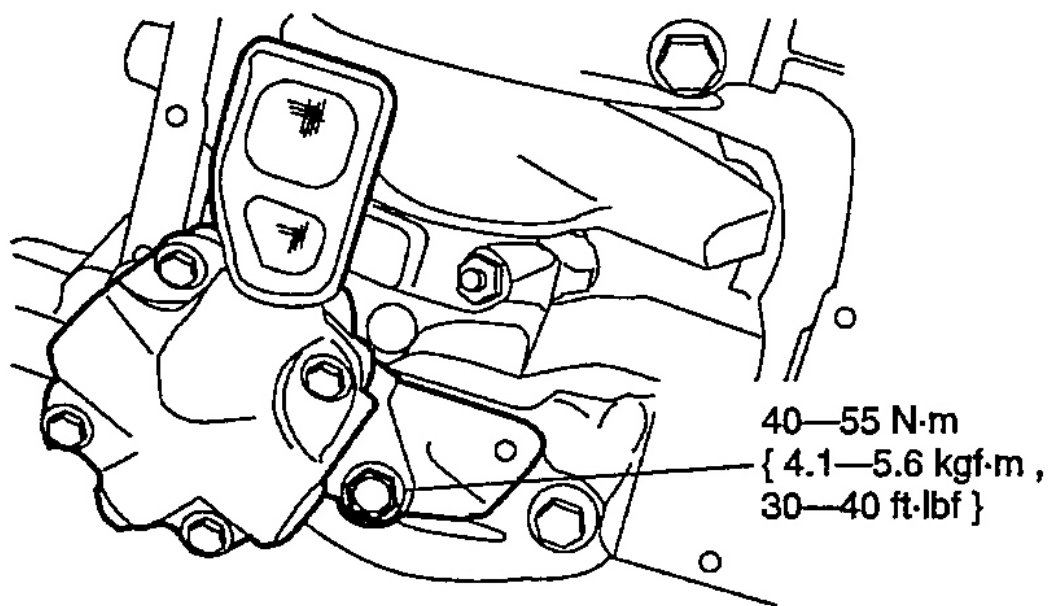
17. Install the connecting rod bearings.
18. Install the connecting rod caps and nuts.
 1. Tighten the nuts in pairs.



G03312257

Fig. 67: Installing Connecting Rod Caps & Nuts (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

19. Install the oil pump.

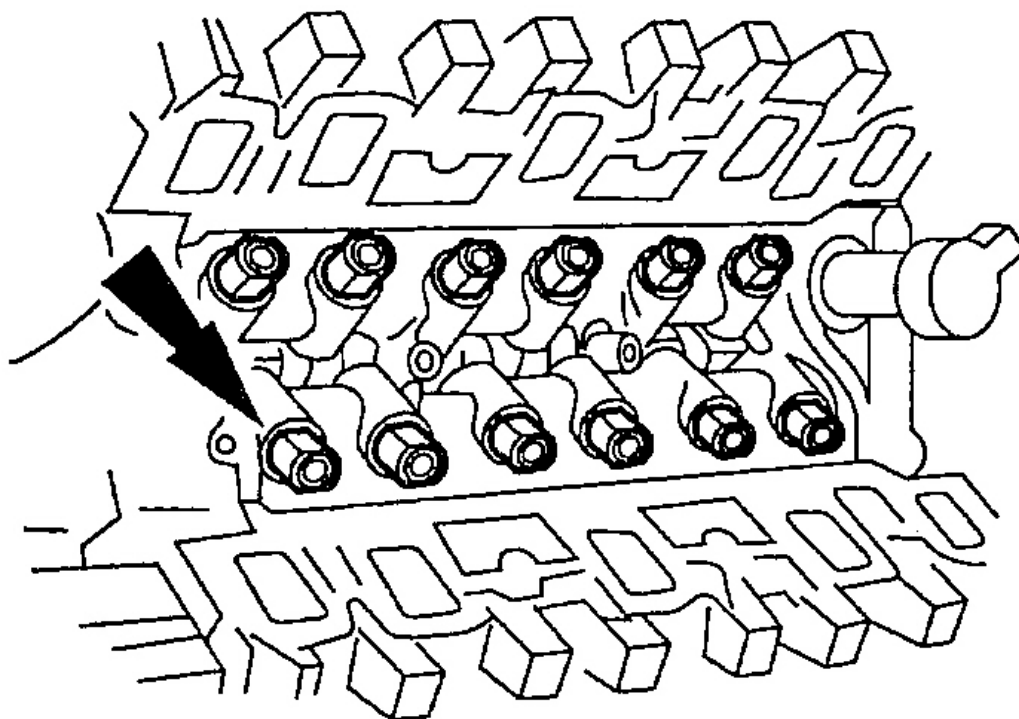


G03312258

Fig. 68: Installing Oil Pump (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

NOTE:

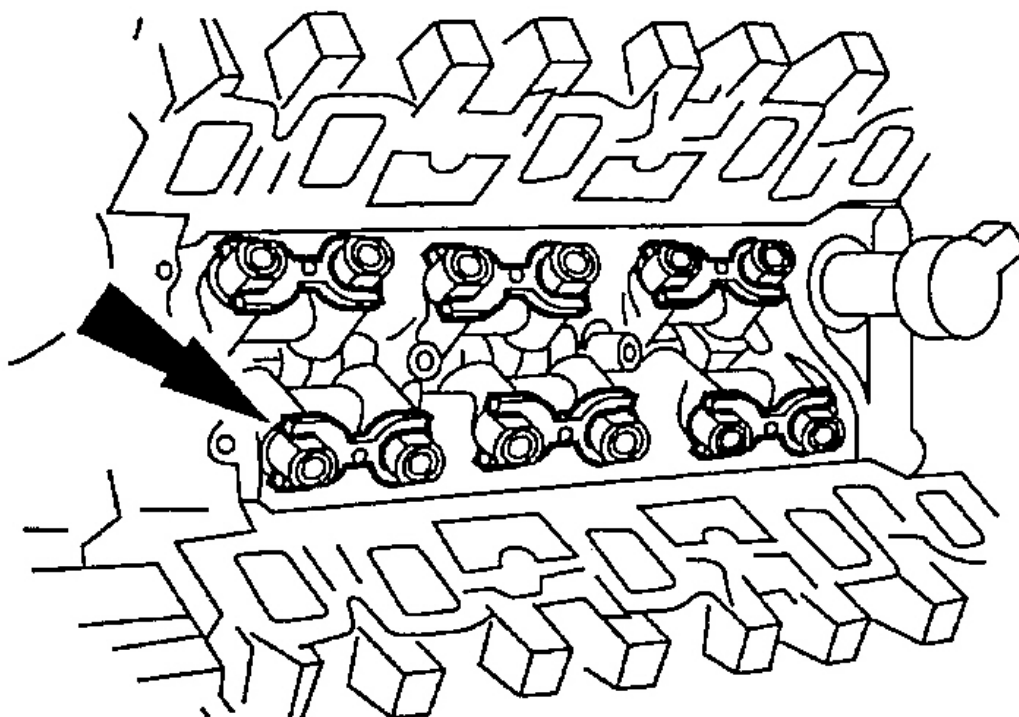
- Lubricate the valve tappets with clean engine oil.



G03312259

Fig. 69: Installing Valve Tappets
Courtesy of MAZDA MOTORS CORP.

20. Install the valve tappets.
21. Install the valve tappet guide plates.



G03312260

Fig. 70: Installing Valve Tappet Guide Plates
Courtesy of MAZDA MOTORS CORP.

22. Install the valve tappet guide plate retainer.

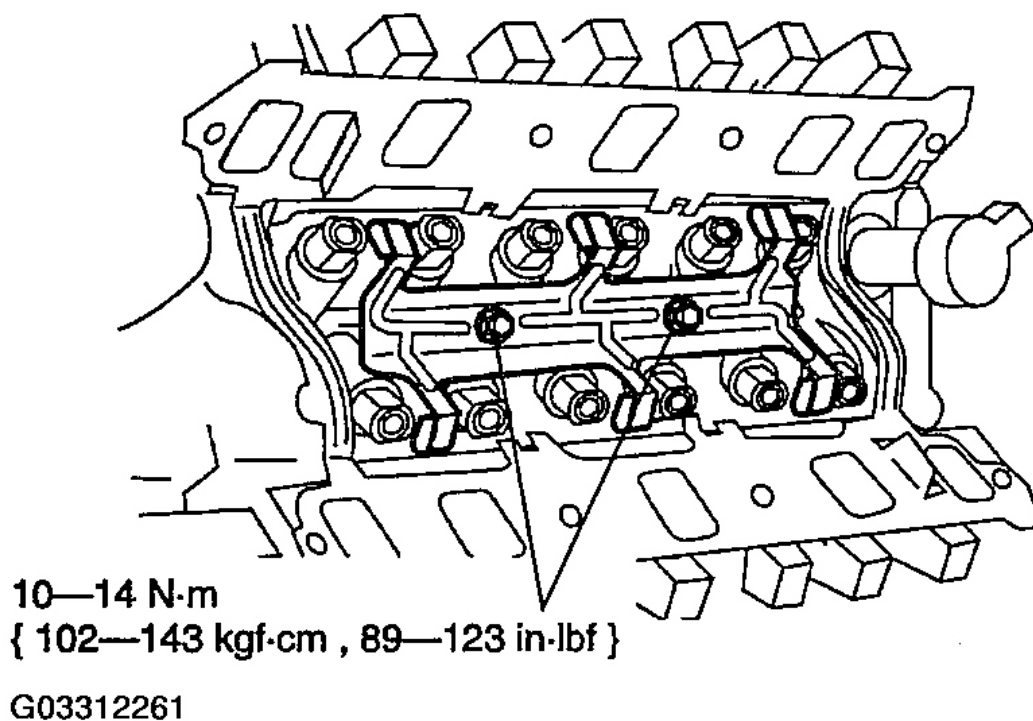
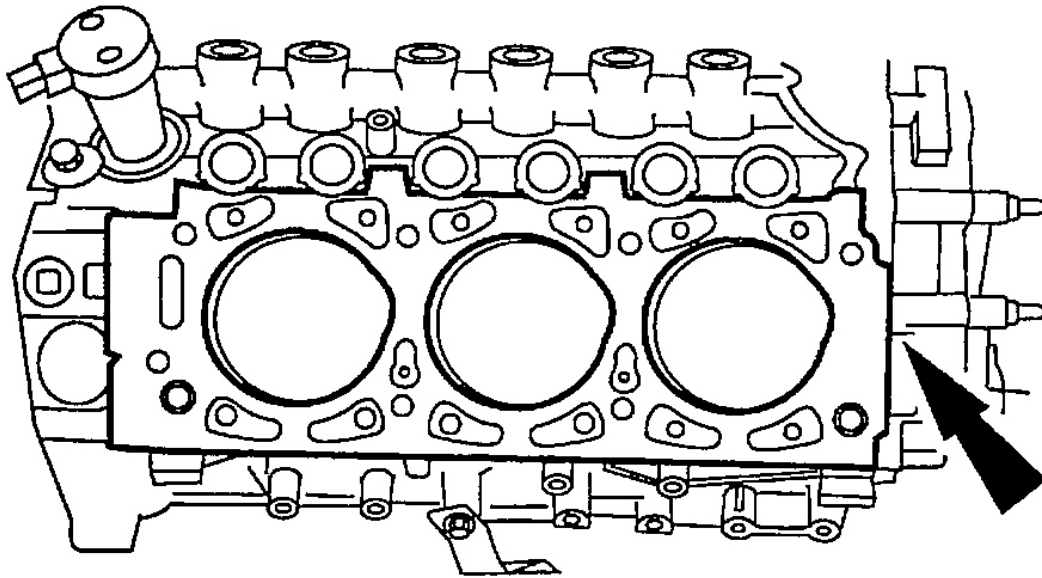


Fig. 71: Installing Valve Tappet Guide Plate Retainer (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

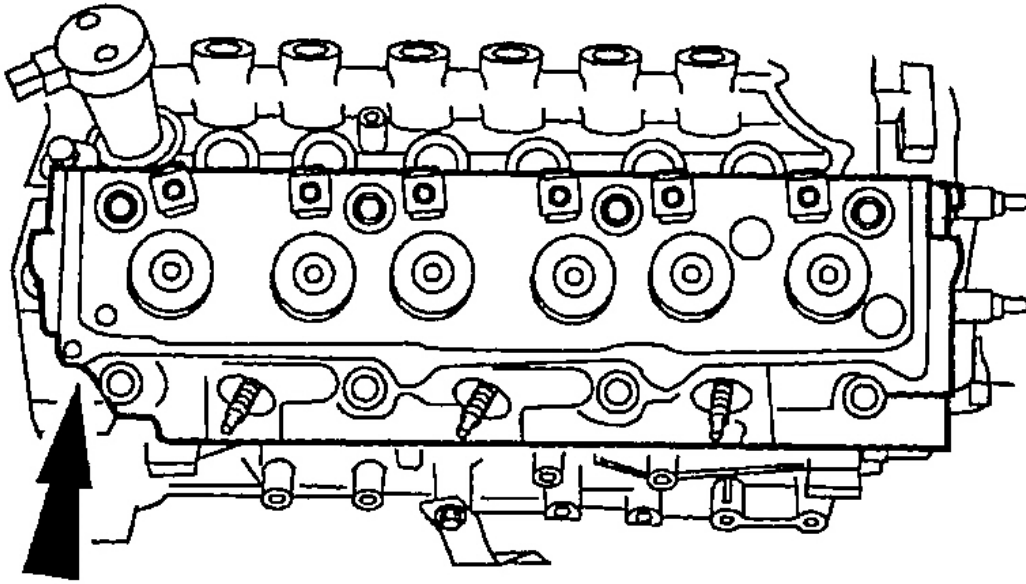
23. Install the cylinder head gaskets.



G03312262

Fig. 72: Installing Cylinder Head Gaskets
Courtesy of MAZDA MOTORS CORP.

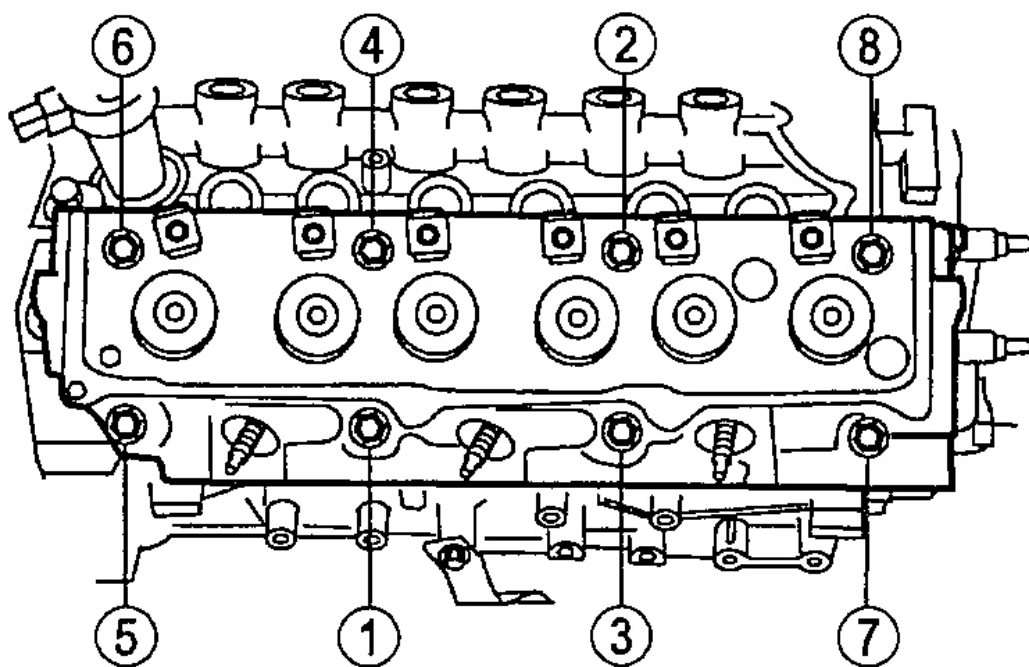
24. Install the cylinder heads.



G03312263

Fig. 73: Installing Cylinder Head
Courtesy of MAZDA MOTORS CORP.

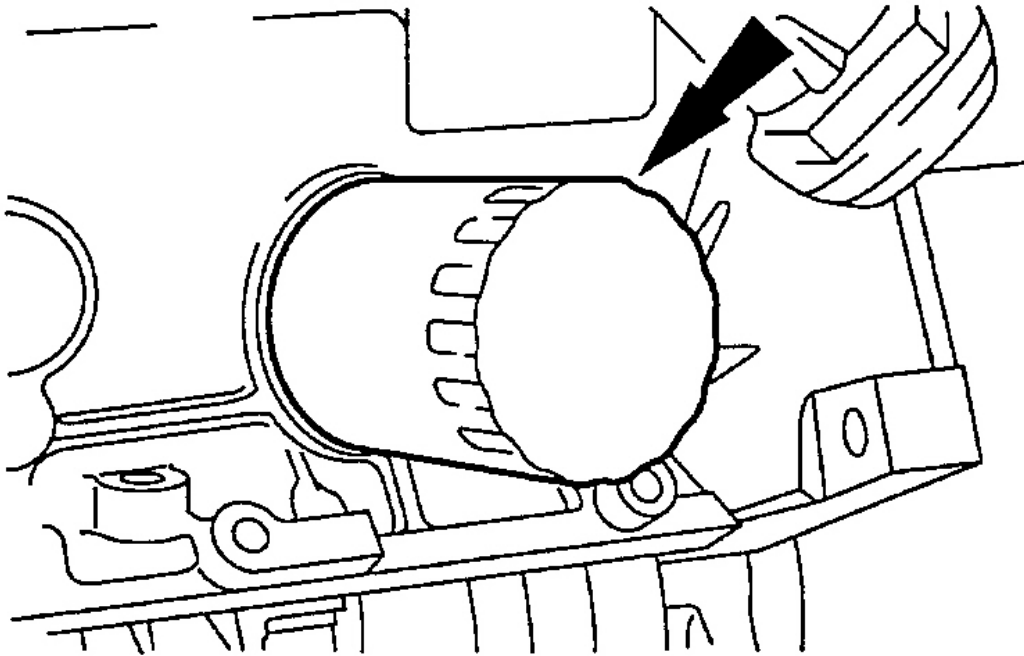
25. Install the bolts. Tighten the bolts in the sequence shown in four steps.
 1. Tighten the bolts to 80 N.m (59 ft.lbf).
 2. Loosen the bolts one full turn.
 3. Tighten to 45-55 N.m (34-40 ft.lbf).
 4. Tighten to 85-99 N.m (63-73 ft.lbf).



G03312264

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

26. Install the oil filter.



G03312265

Fig. 75: Installing Oil Filter
Courtesy of MAZDA MOTORS CORP.

27. Install the oil level indicator tube.

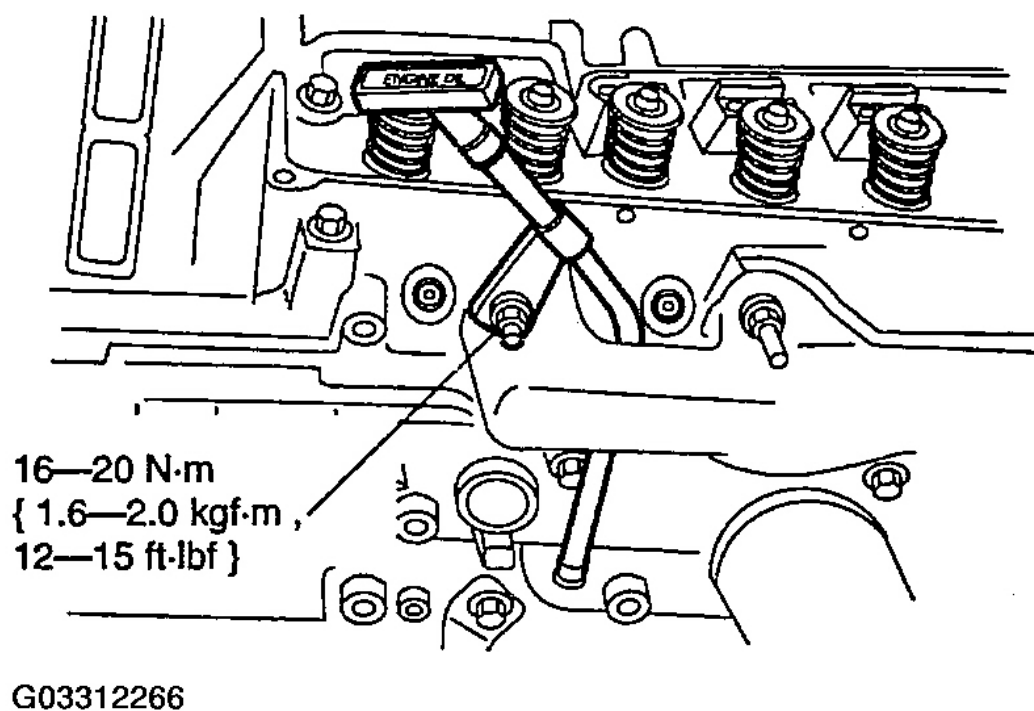
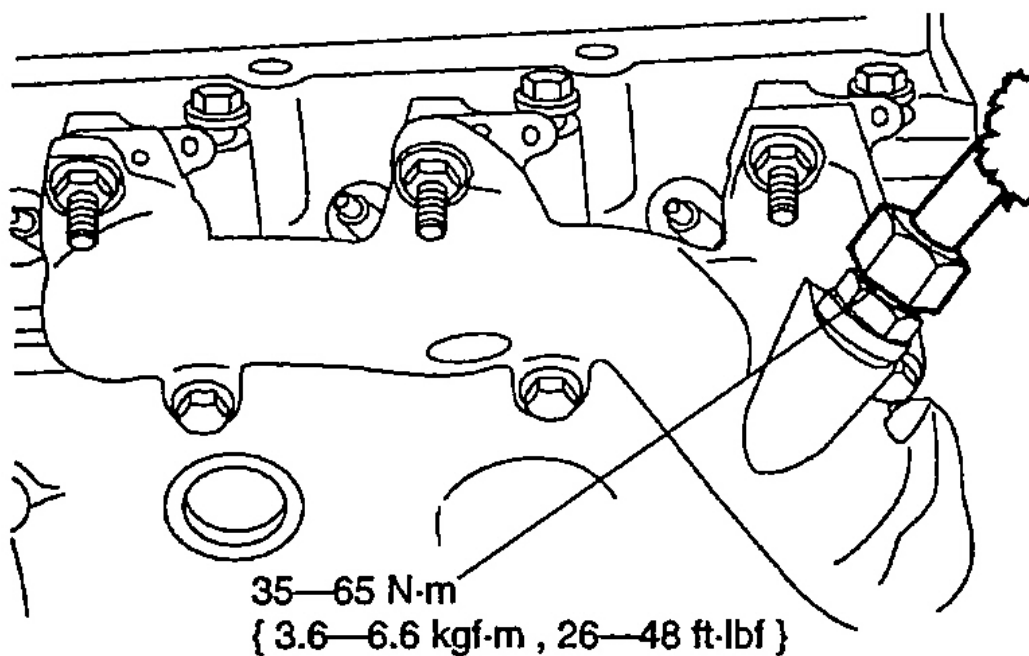


Fig. 76: Installing Oil Level Indicator Tube (With Torque Specifications)
 Courtesy of MAZDA MOTORS CORP.

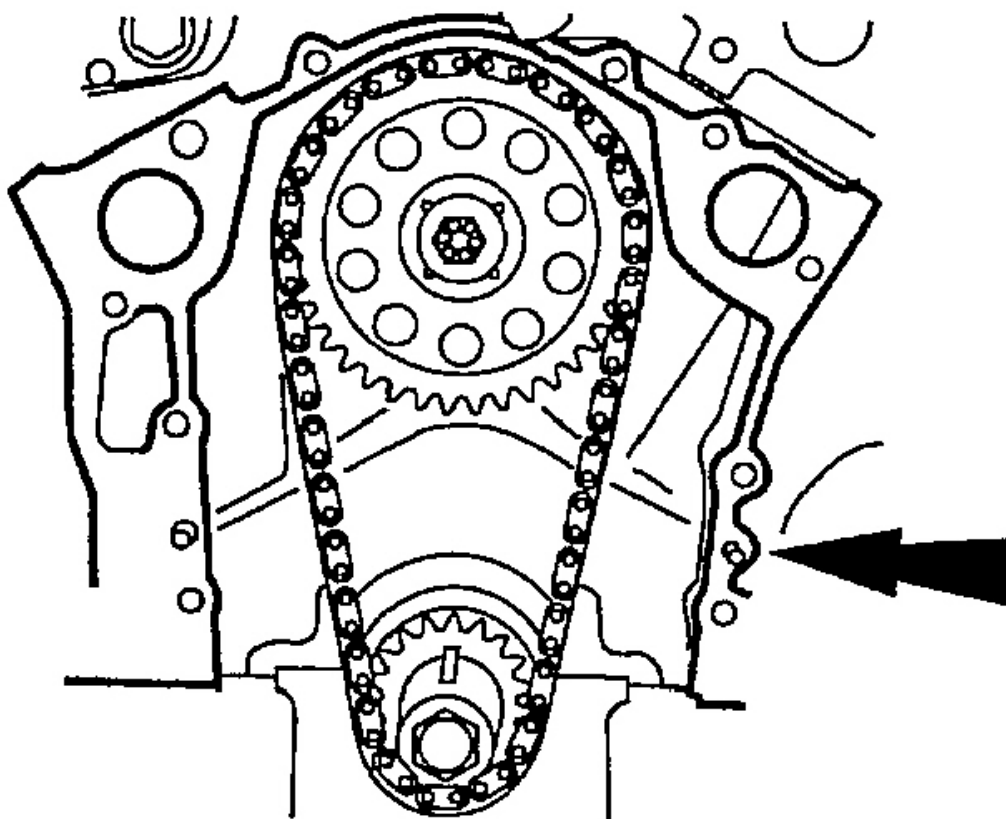
28. Install the EGR valve to exhaust manifold tube.



G03312267

Fig. 77: Installing EGR Valve To Exhaust Manifold Tube (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

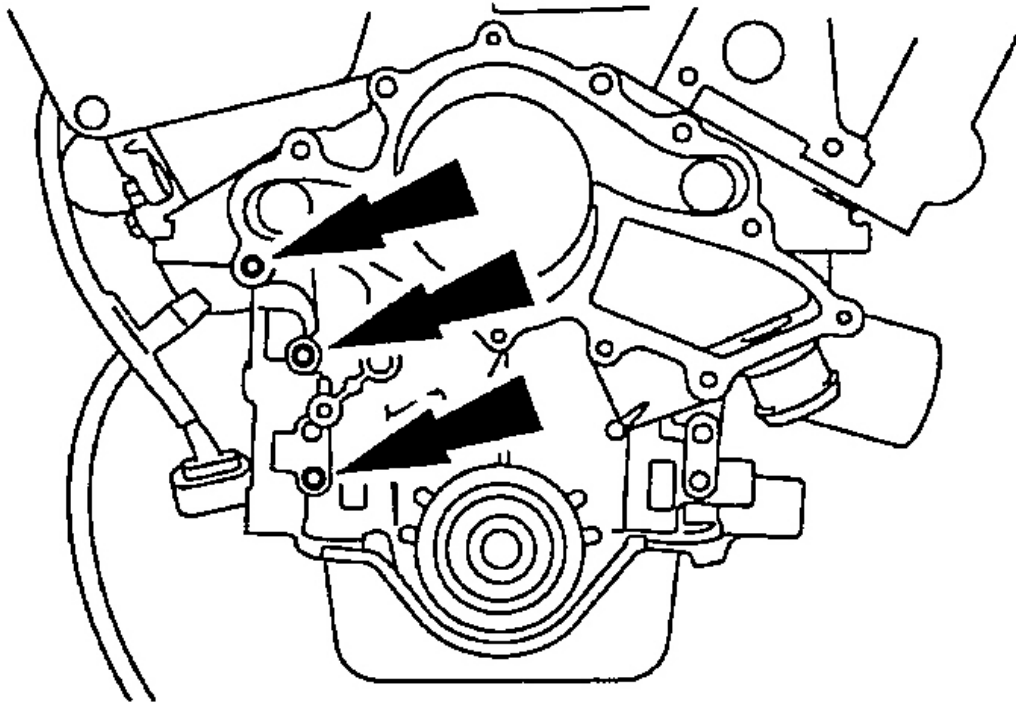
29. Install the engine front cover gasket and the engine front cover.



G03312268

Fig. 78: Installing Engine Front Cover Gasket
Courtesy of MAZDA MOTORS CORP.

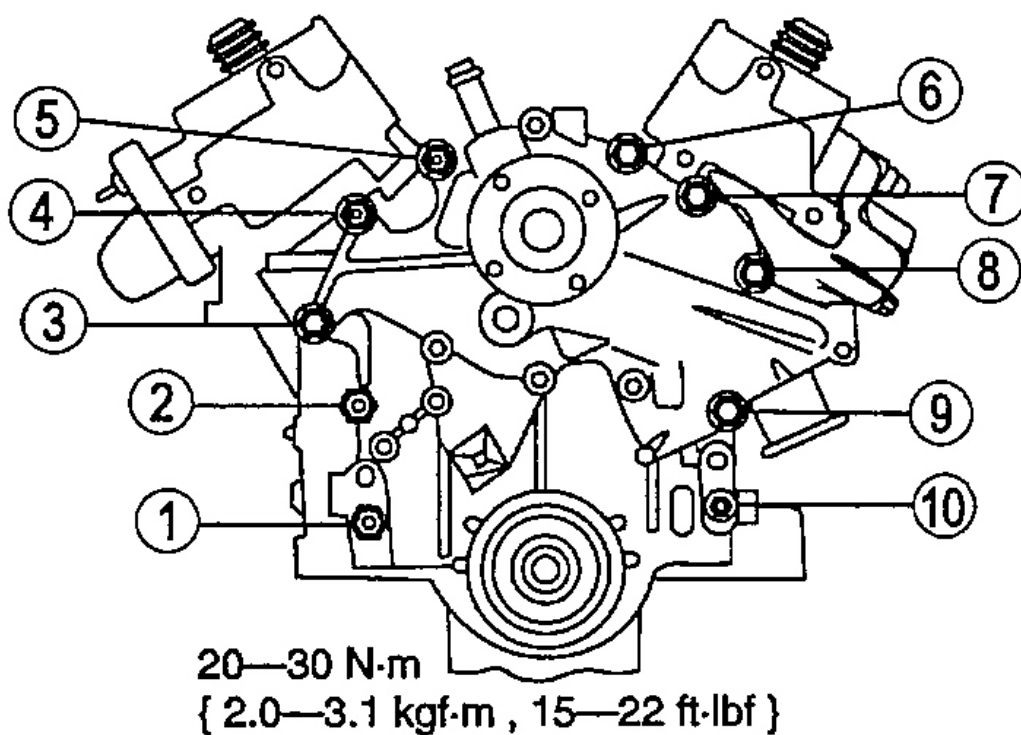
30. Apply pipe sealant with on the bolts to be installed in the locations shown.



G03312269

Fig. 79: Applying Pipe Sealant
Courtesy of MAZDA MOTORS CORP.

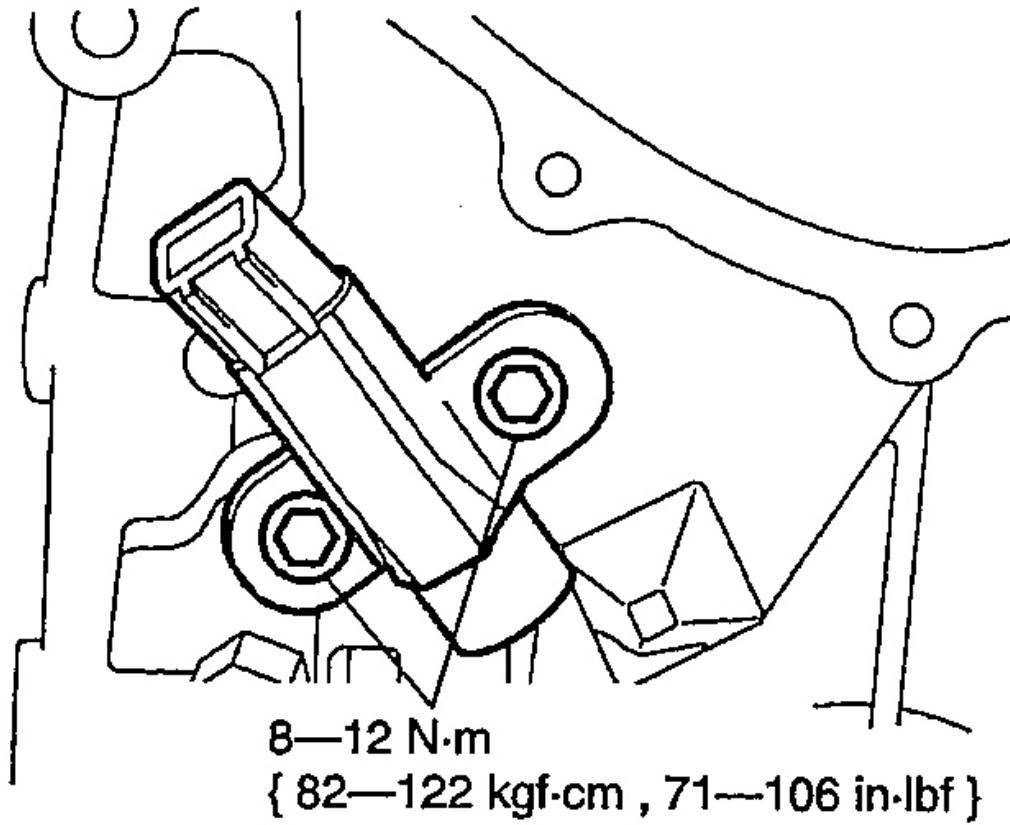
31. Install the bolts.
 1. Tighten the bolts in the sequence shown.



G03312270

Fig. 80: Installing Engine Front Cover Bolts (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

32. Install the CKP sensor.

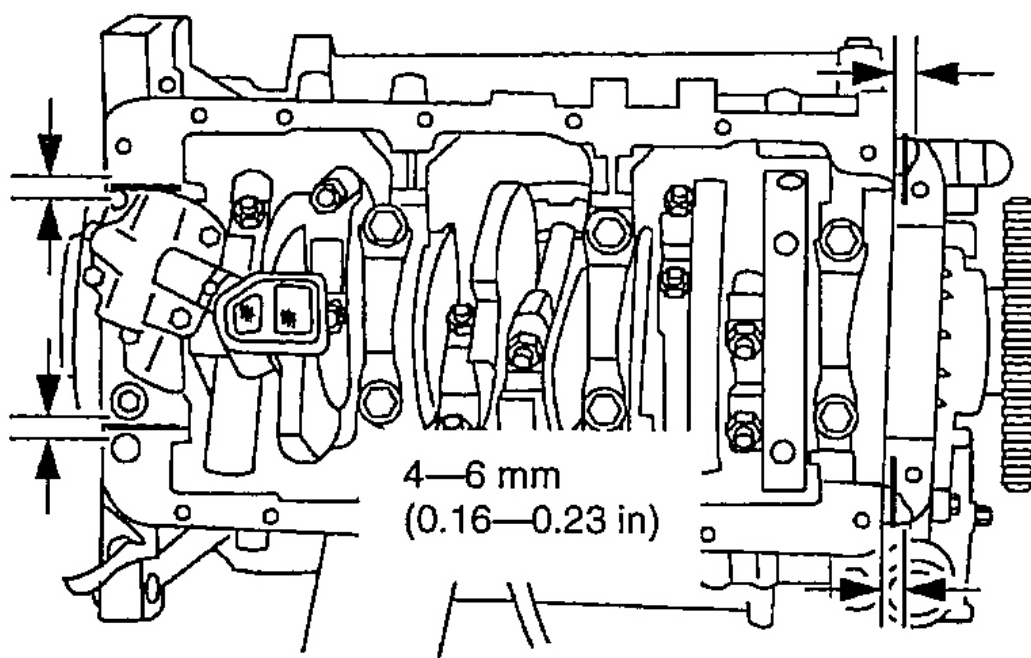


G03312271

Fig. 81: Installing CKP Sensor (With Torque Specifications)

Courtesy of MAZDA MOTORS CORP.

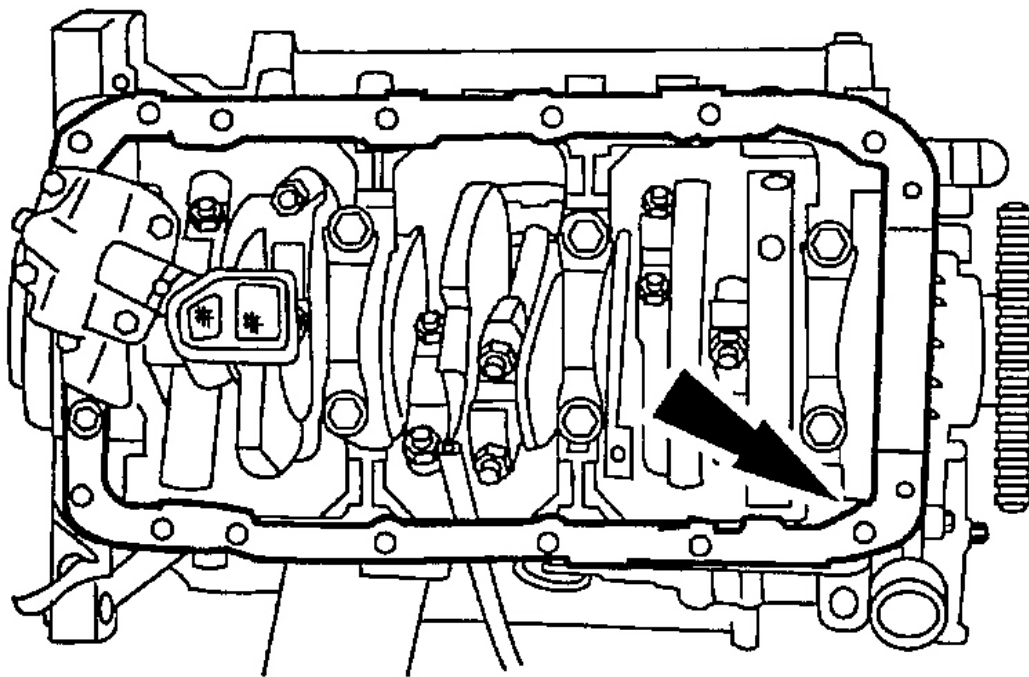
33. Apply four beads of silicone as shown.



G03312272

Fig. 82: Silicone Application Areas
Courtesy of MAZDA MOTORS CORP.

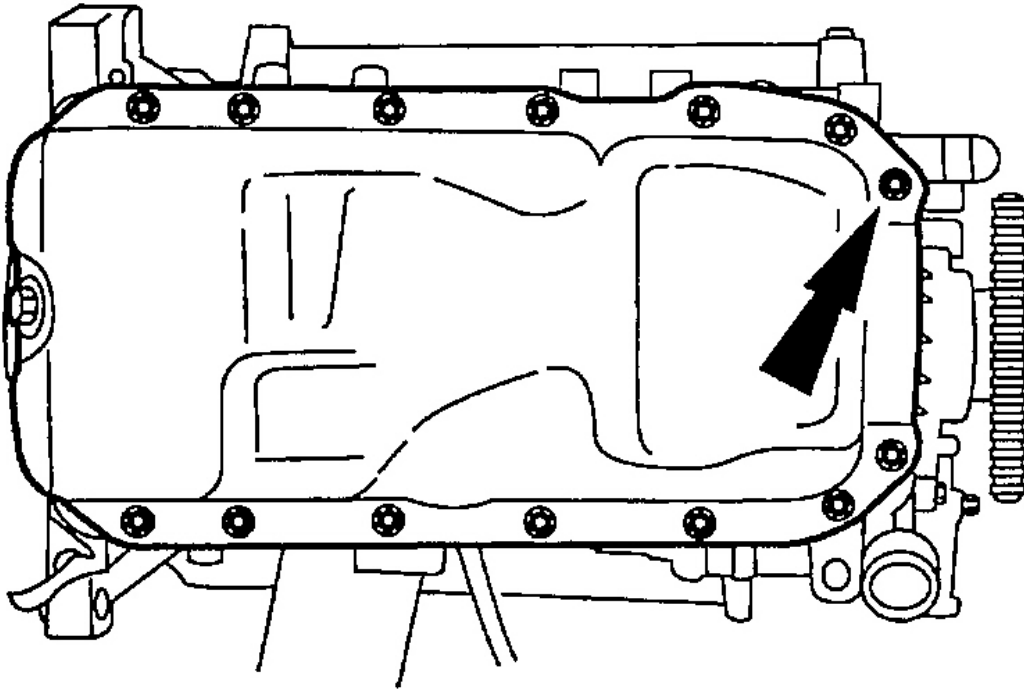
34. Install the oil pan gasket.



G03312273

Fig. 83: Installing Oil Pan Gasket
Courtesy of MAZDA MOTORS CORP.

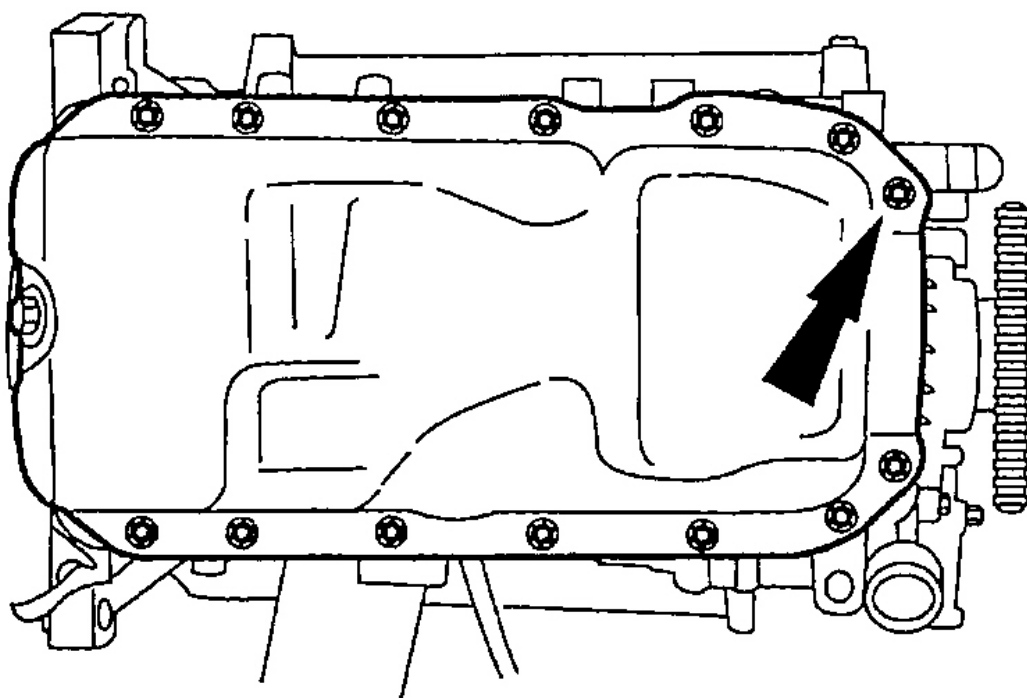
35. Install the oil pan and hand-start the bolts.



G03312274

Fig. 84: Installing Oil Pan**Courtesy of MAZDA MOTORS CORP.**

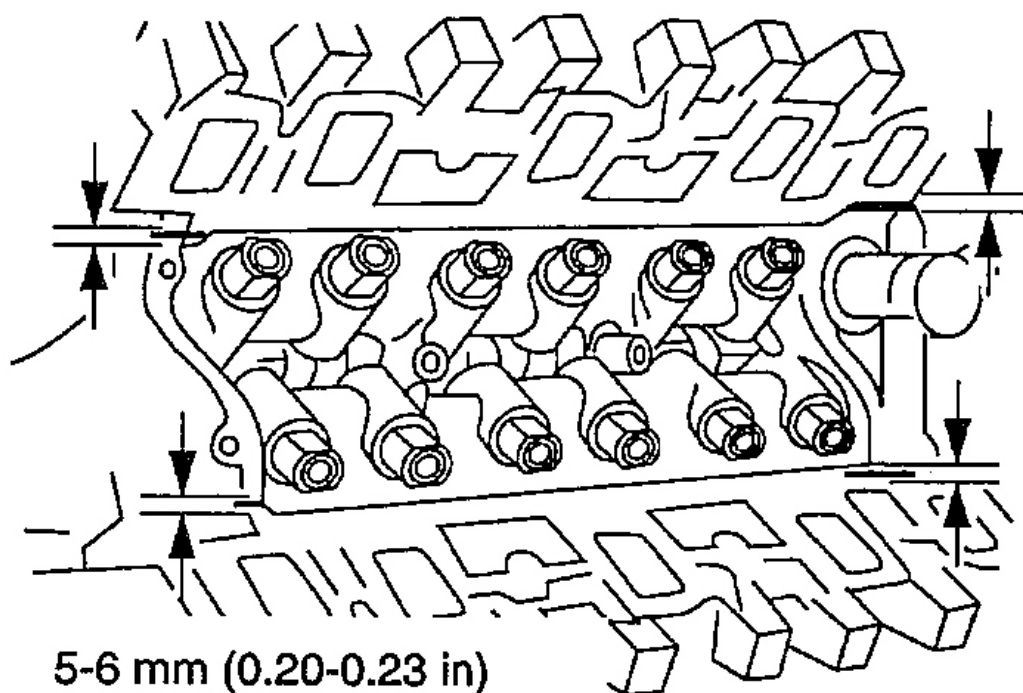
36. Install the oil pan bolts.
 1. Tighten the bolts in four steps.
 - Tighten the four corner bolts to 10-14 N.m (89-123 in.lbf).
 - Tighten the remaining bolts to 10-14 N.m (89-123 in.lbf).
 - Loosen all the bolts one turn.
 - Tighten all the bolts to 10-14 N.m (89-123 in.lbf).



G03312275

Fig. 85: Tightening Oil Pan Bolts
Courtesy of MAZDA MOTORS CORP.

37. Install the camshaft synchronizer. Refer to **CAMSHAFT**.
38. Apply four beads of Silicone Rubber.

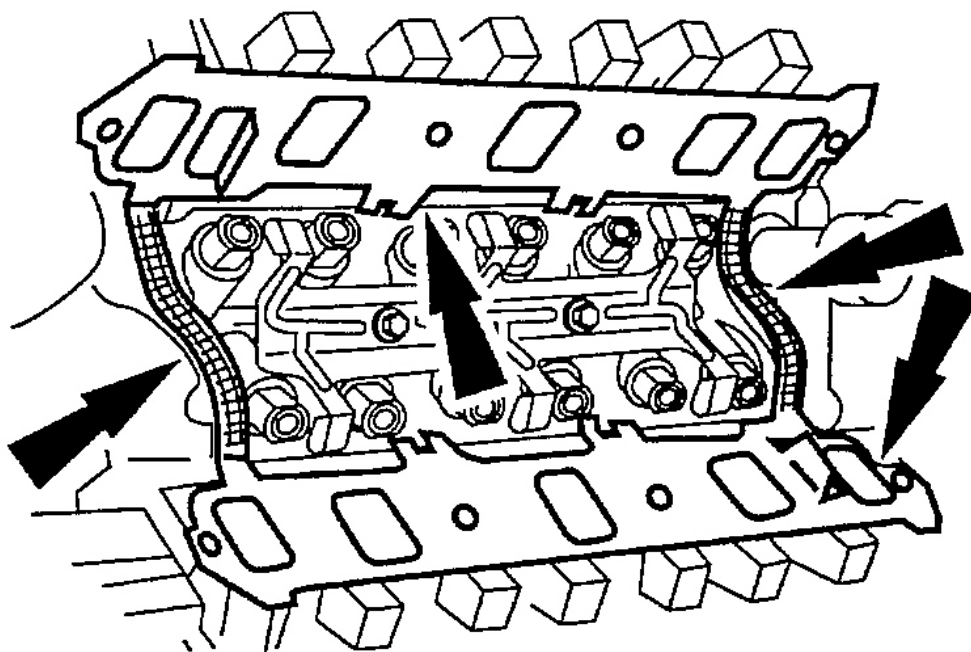


G03312276

Fig. 86: Silicone Rubber Application Areas

Courtesy of MAZDA MOTORS CORP.

39. Install the intake manifold gaskets and end seals.



G03312277

Fig. 87: Installing Intake Manifold Gaskets & End Seals
Courtesy of MAZDA MOTORS CORP.

40. Install the lower intake manifold.
 1. Tighten the bolts in the sequence shown.

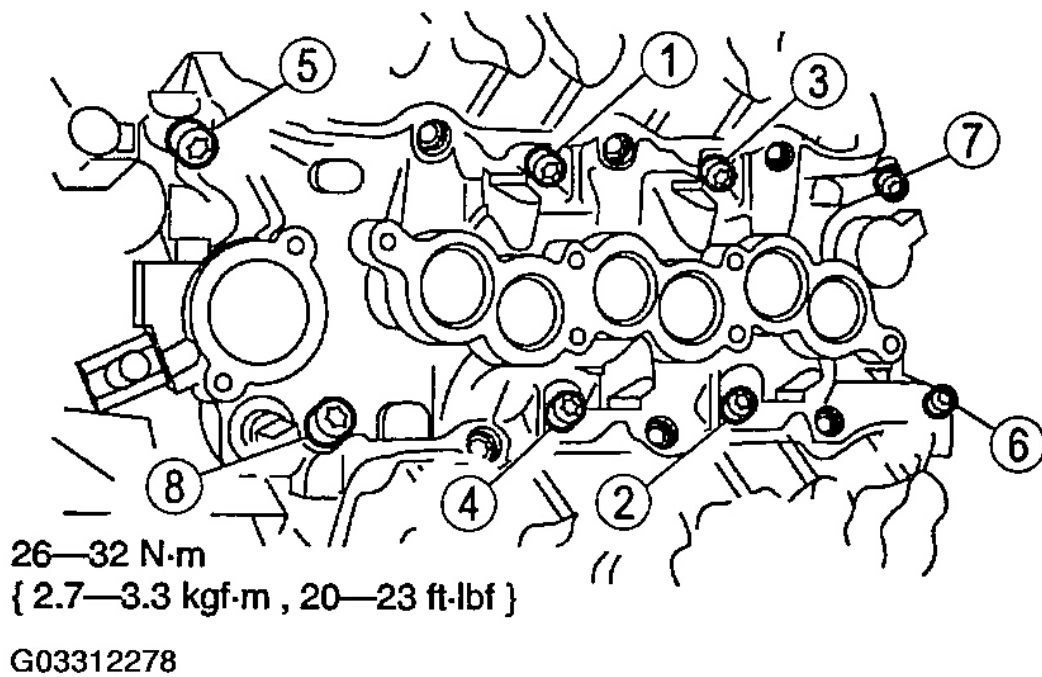
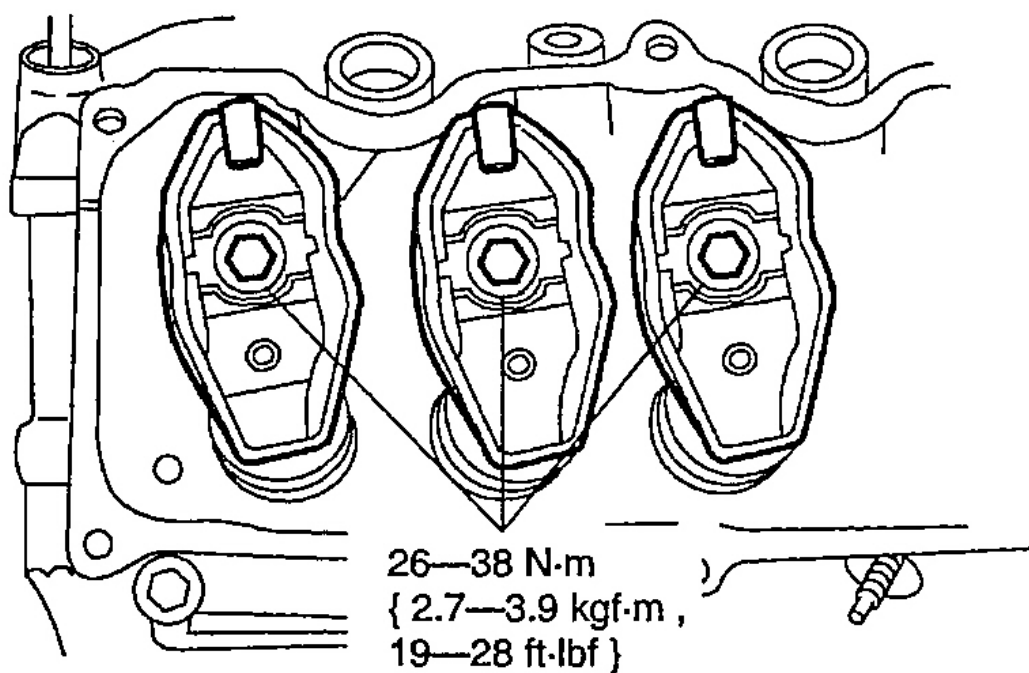


Fig. 88: Intake Manifold Torque Sequence (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

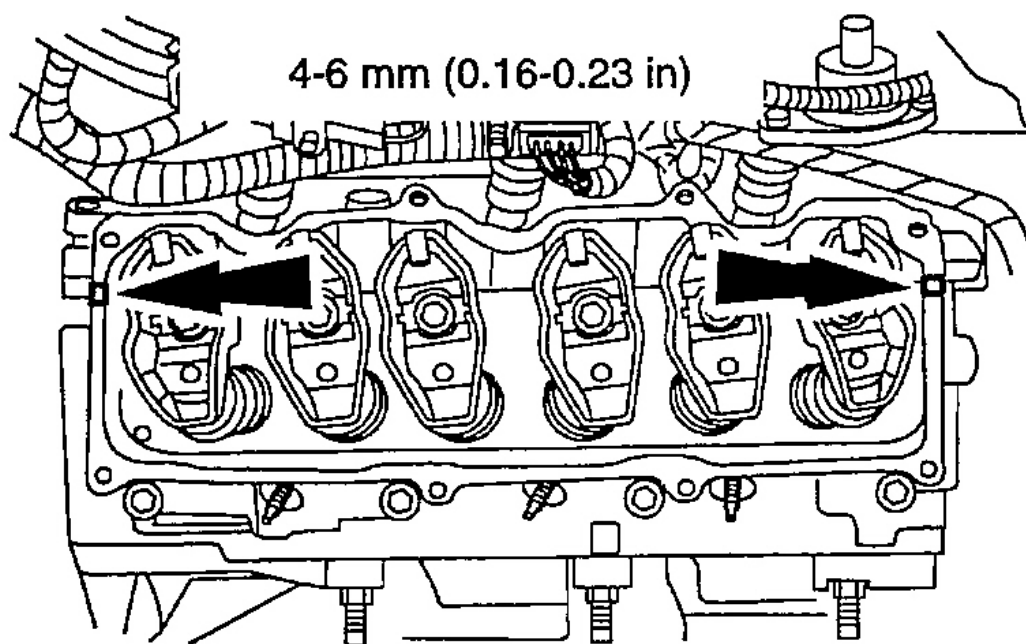
41. Install the push rods and the rocker arms.
 1. Install the push rods.
 2. Install the rocker arms.
 3. Tighten the rocker arm bolts.



G03312279

Fig. 89: Installing Push Rods & Rocker Arms (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

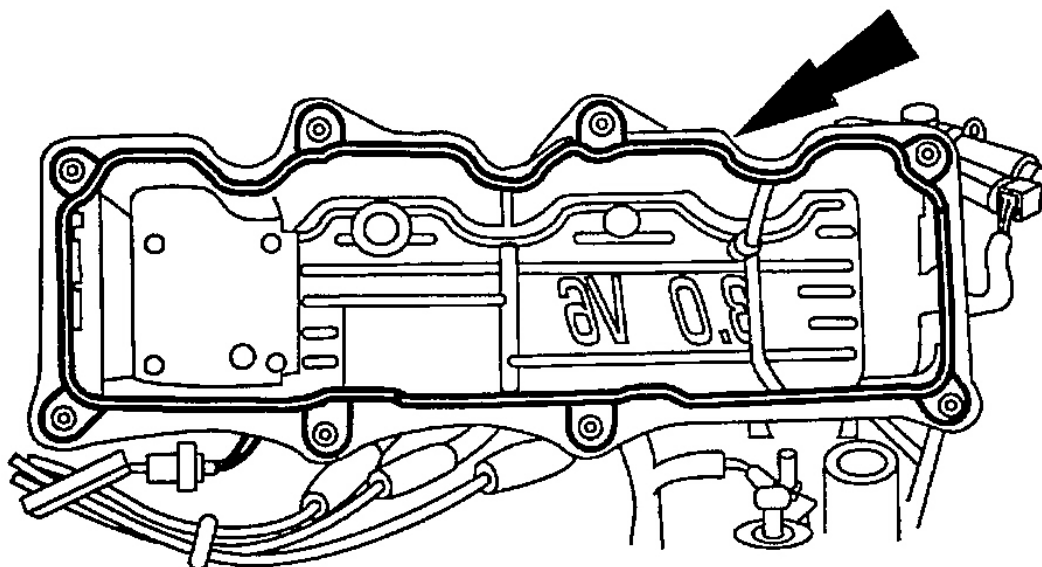
42. Apply a bead of silicone to the four intake-to-cylinder head seams.



G03312280

Fig. 90: Applying Silicone To Intake-To-Cylinder Head Seams
Courtesy of MAZDA MOTORS CORP.

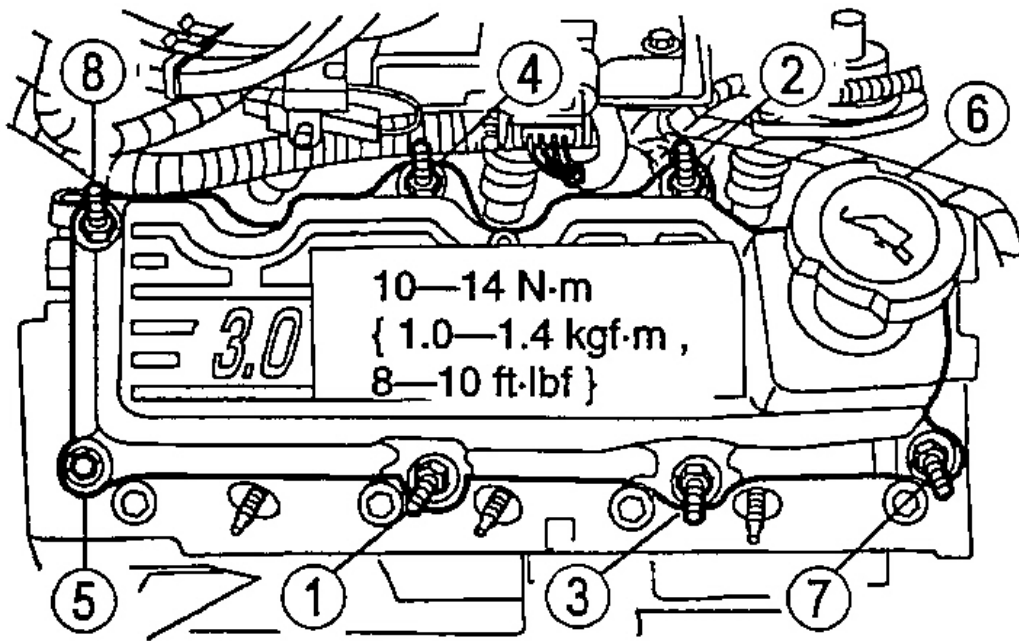
43. If removed, install the valve cover gaskets.



G03312281

Fig. 91: Installing Valve Cover Gaskets
Courtesy of MAZDA MOTORS CORP.

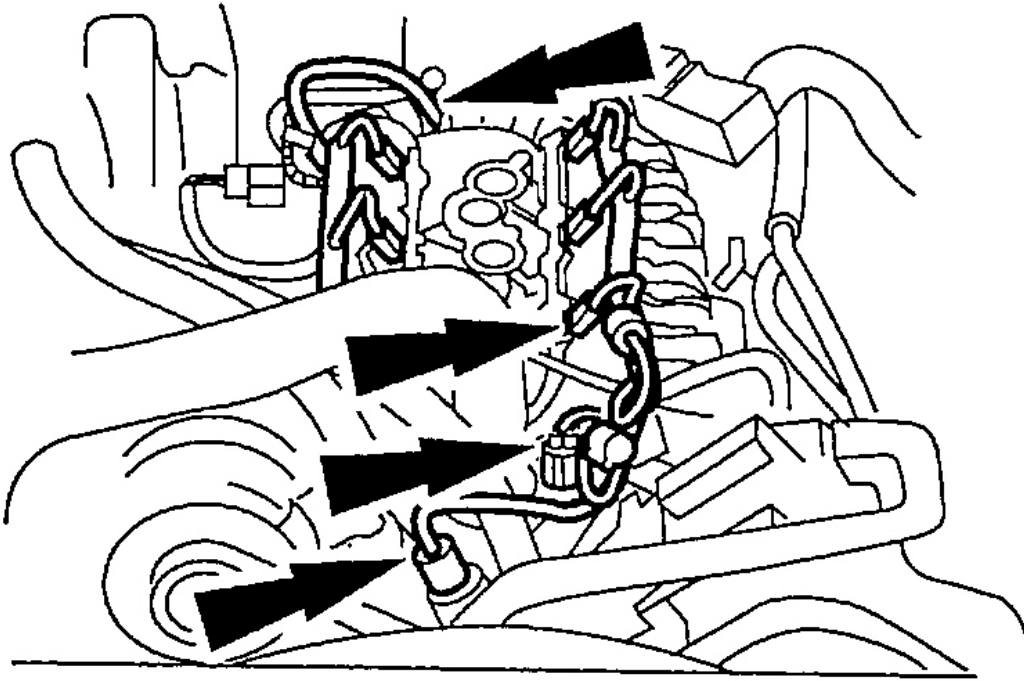
44. Install the valve covers.
 1. Tighten the bolts in the sequence shown.



G03312282

Fig. 92: Installing Valve Covers (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

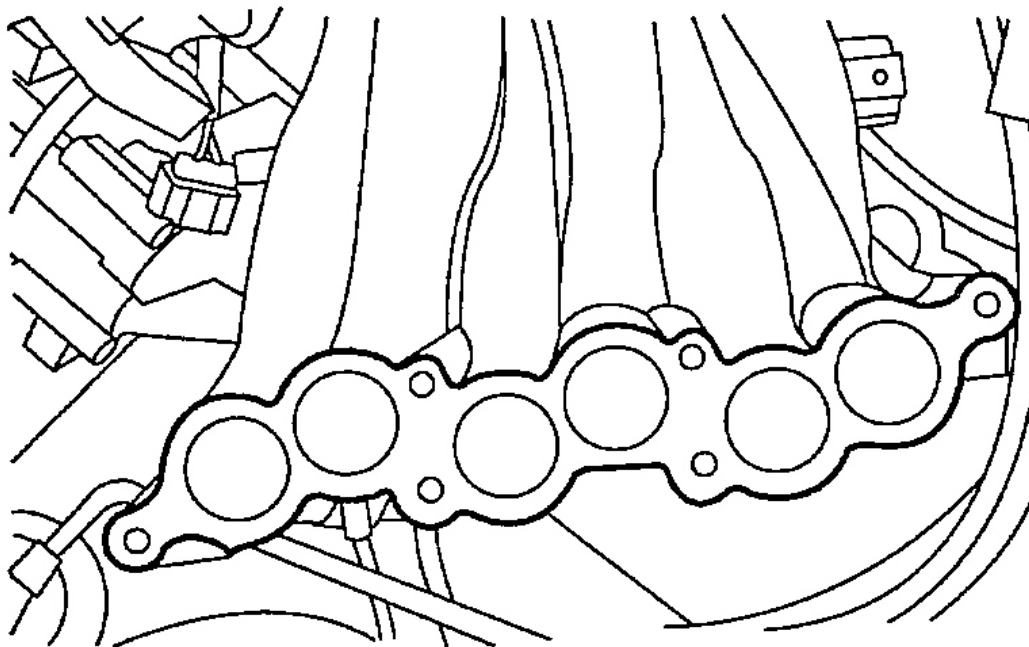
45. Position the engine harness and connect:
- The camshaft synchronizer.
 - The fuel injectors.
 - The water temperature indicator sender unit.
 - The engine harness.



G03312283

Fig. 93: Connecting Engine Harness Connectors
Courtesy of MAZDA MOTORS CORP.

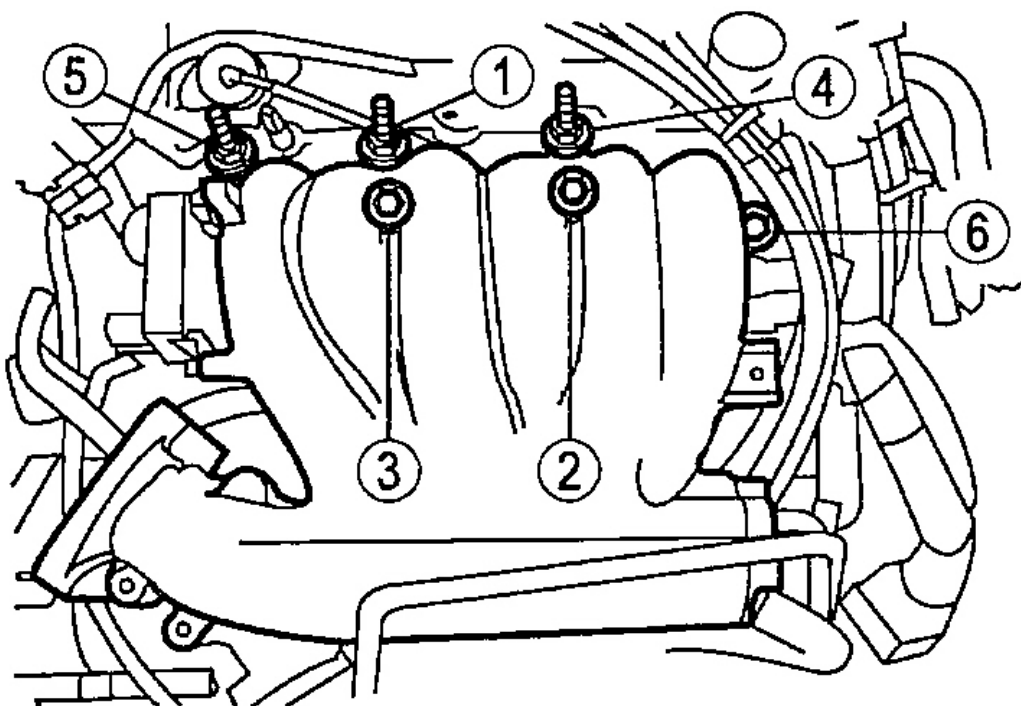
46. Install the intake manifold upper gasket.



G03312284

Fig. 94: Installing Intake Manifold Upper Gasket
Courtesy of MAZDA MOTORS CORP.

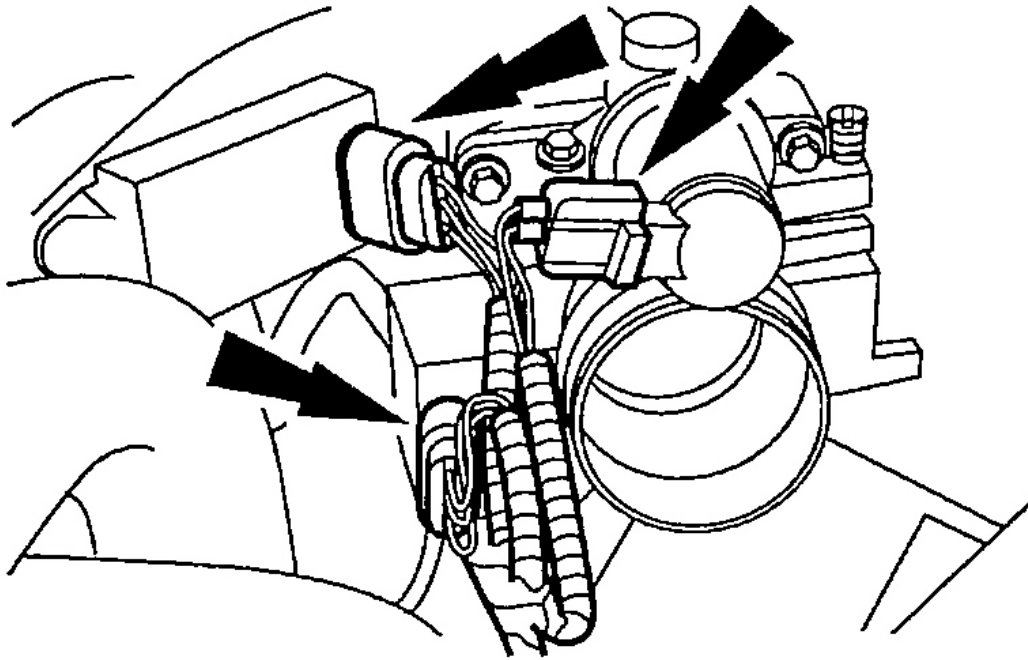
47. Install the PCV valve.
48. Install the upper intake manifold.
 1. Install the three bolts and the three stud bolts.
 2. Tighten the bolts in the sequence shown in two steps.
 3. Tighten to 20 N.m (14 ft.lbf)
 4. Tighten to 25 N.m (18 ft.lbf)



G03312285

Fig. 95: Upper Intake Manifold Bolt Tightening Sequence
Courtesy of MAZDA MOTORS CORP.

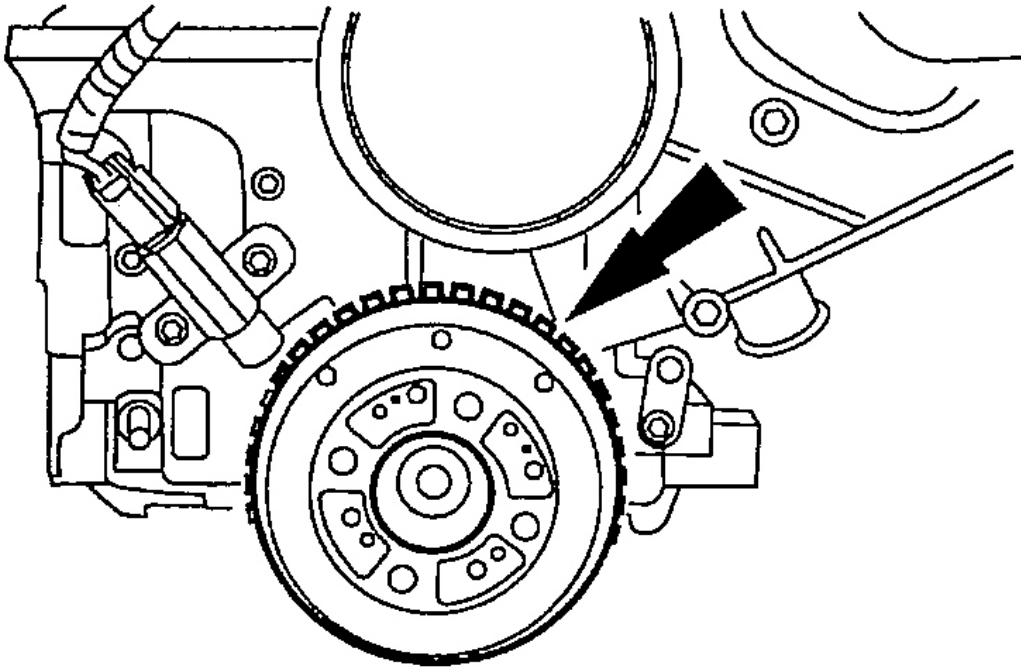
49. Connect the engine harness to:
- The Idle Air Control (IAC) valve.
 - The Throttle Position (TP) sensor.
 - The DPFE transducer.



G03312286

Fig. 96: Connecting IAC valve, TP Sensor & DPFE Transducer Connectors
Courtesy of MAZDA MOTORS CORP.

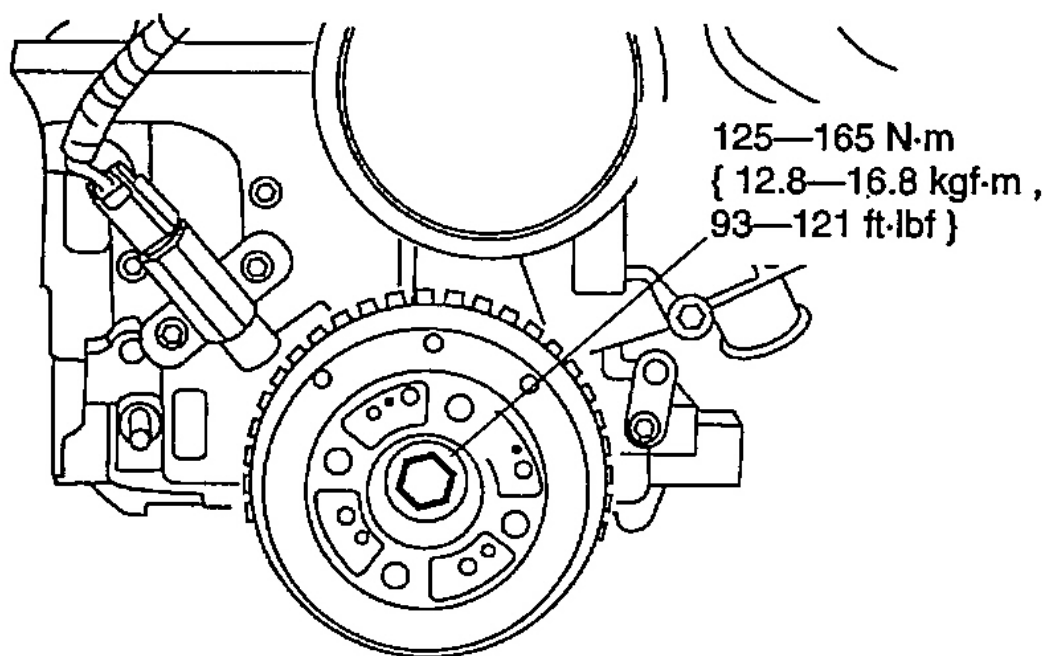
50. Using the Vibration Damper and Seal Replacer SST 303-175 (T82L-6316-A) or equivalent, install the crankshaft damper.



G03312287

Fig. 97: Installing Crankshaft Damper
Courtesy of MAZDA MOTORS CORP.

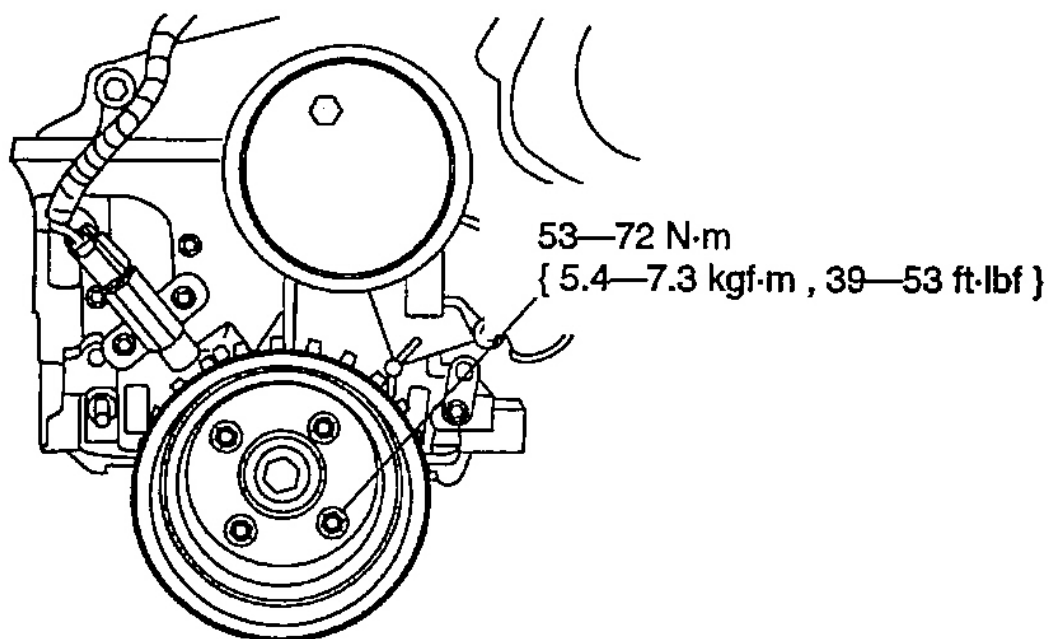
51. Install the bolt.



G03312288

Fig. 98: Installing Crankshaft Damper Bolt (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

52. Install the crankshaft vibration damper and the bolts.



G03312289

Fig. 99: Installing Crankshaft Vibration Damper (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

53. Install the water pump pulley and the bolts.

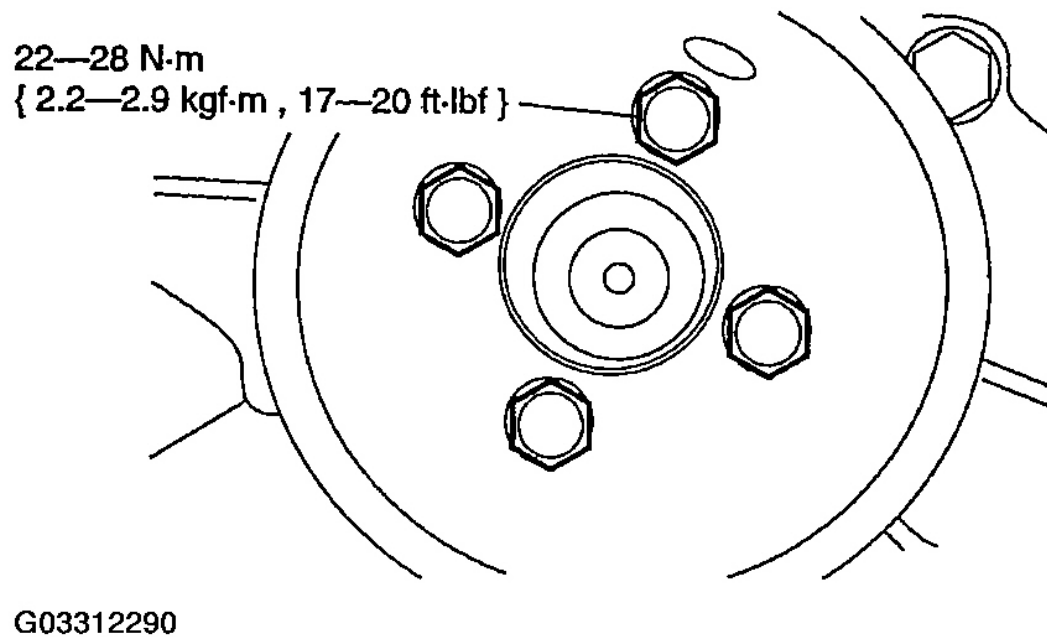
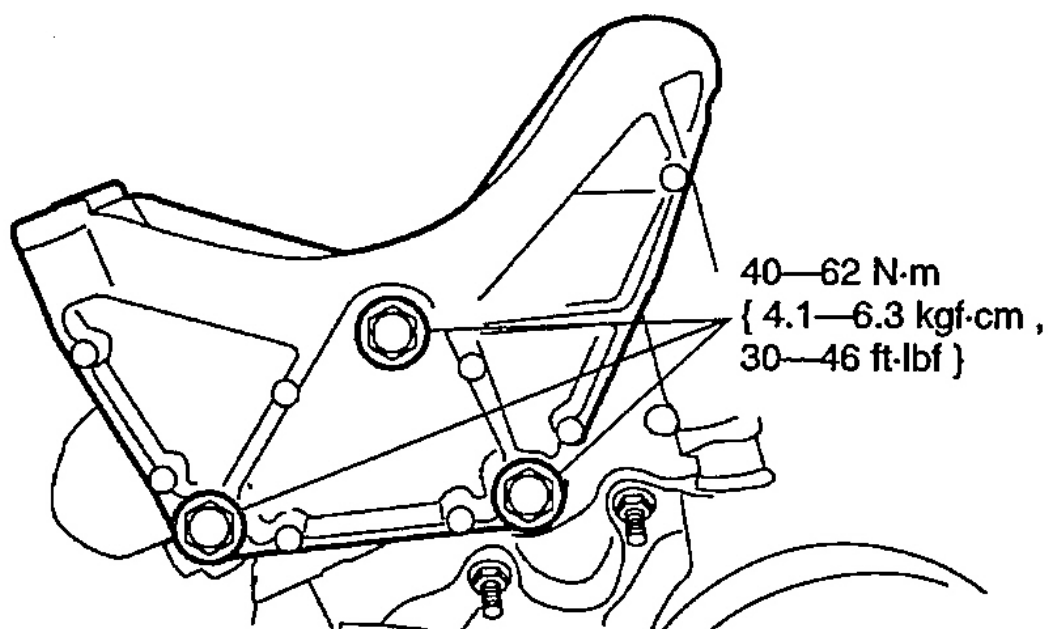


Fig. 100: Installing Water Pump Pulley (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

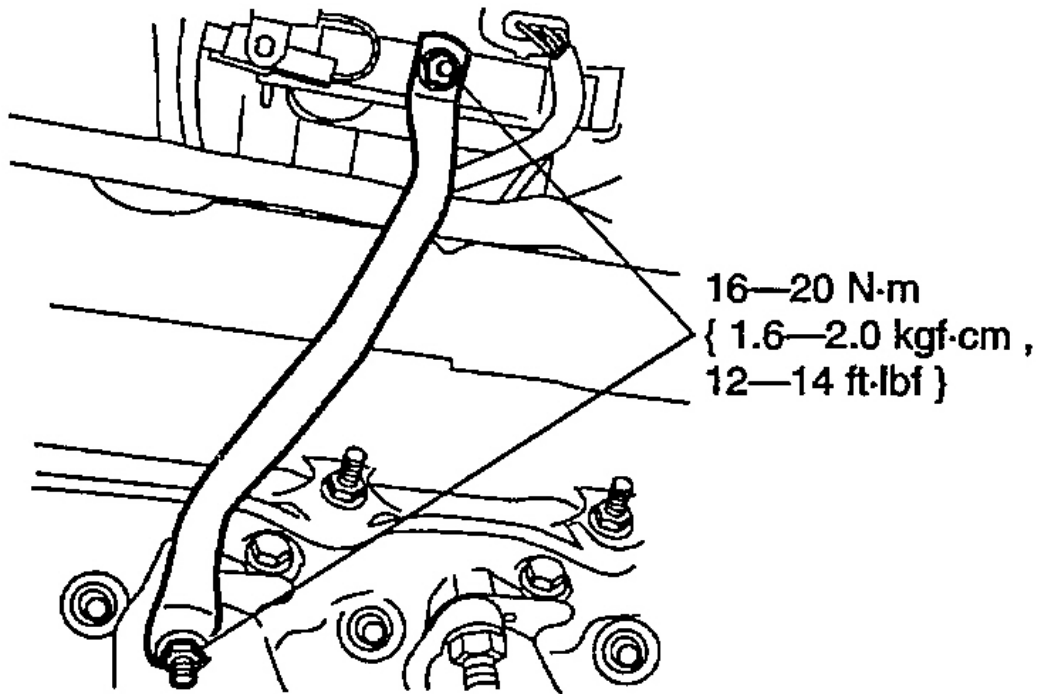
54. Install the generator mounting bracket and the bolts.



G03312291

Fig. 101: Installing Generator Mounting Bracket (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

55. Install the nuts.

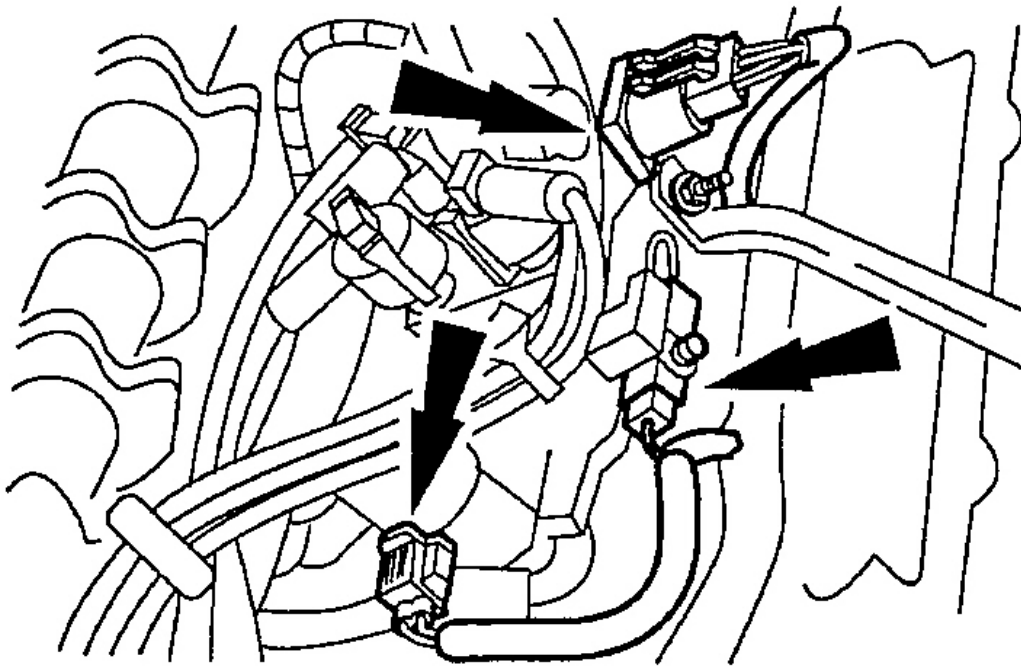


G03312292

Fig. 102: Installing Support Bracket Nuts (With Torque Specifications)
 Courtesy of MAZDA MOTORS CORP.

56. Connect the engine harness to:

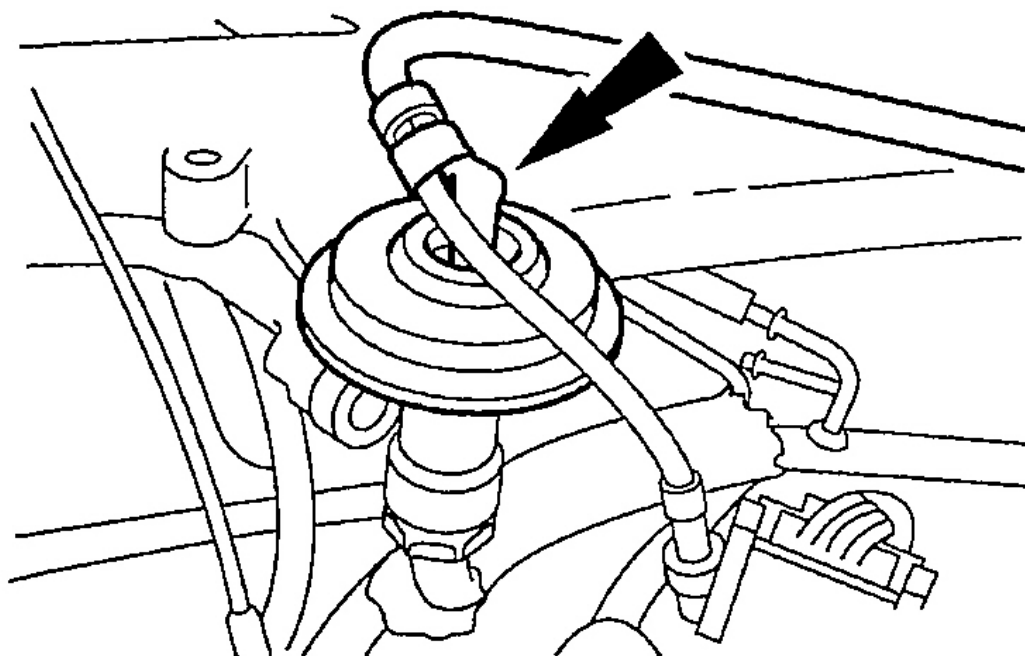
- The ignition coil.
- The radio ignition interference capacitor.
- The EGR vacuum regulator solenoid.
- The vacuum line from the EGR vacuum regulator solenoid.



G03312293

Fig. 103: Connecting Engine Harness Connectors
Courtesy of MAZDA MOTORS CORP.

57. Connect the vacuum line.



G03312294

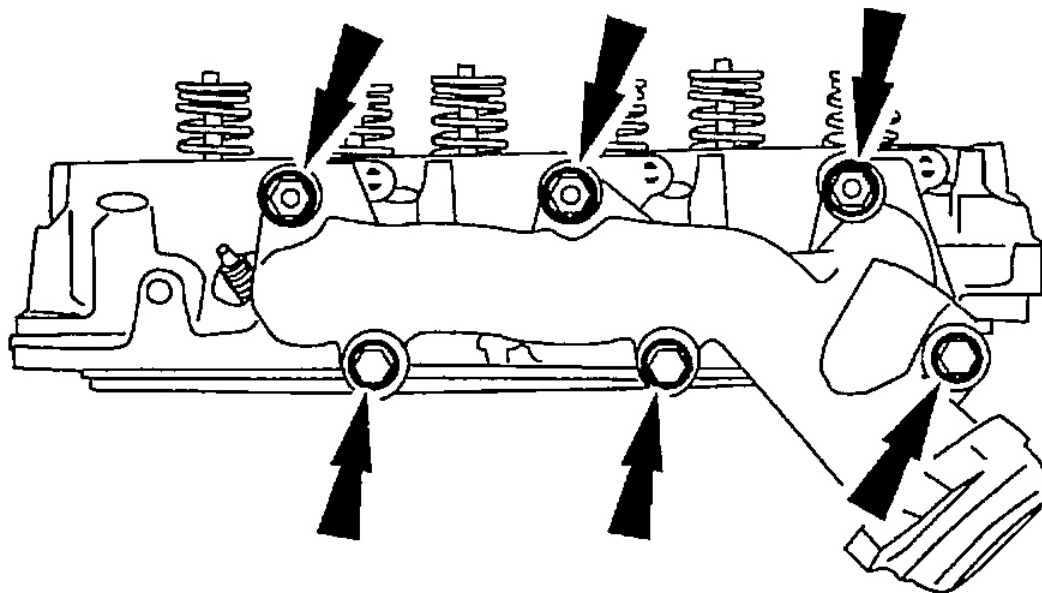
Fig. 104: Connecting Vacuum Line
Courtesy of MAZDA MOTORS CORP.

58. Connect the spark plug wires.

CYLINDER HEAD DISASSEMBLY/ASSEMBLY

DISASSEMBLY NOTE

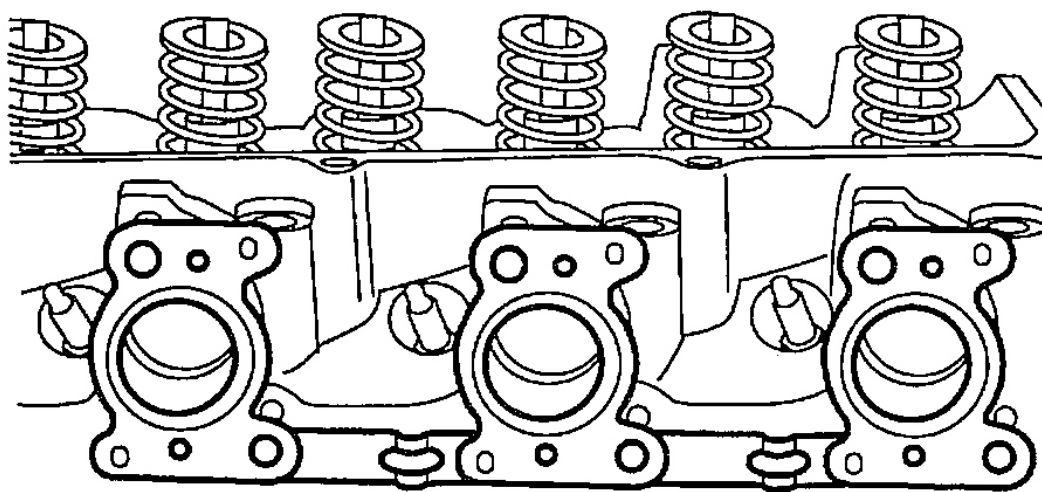
1. Remove the exhaust manifold.
 1. Remove the bolts.
 2. Remove the exhaust manifold.



G03312295

Fig. 105: Removing Exhaust Manifold
 Courtesy of MAZDA MOTORS CORP.

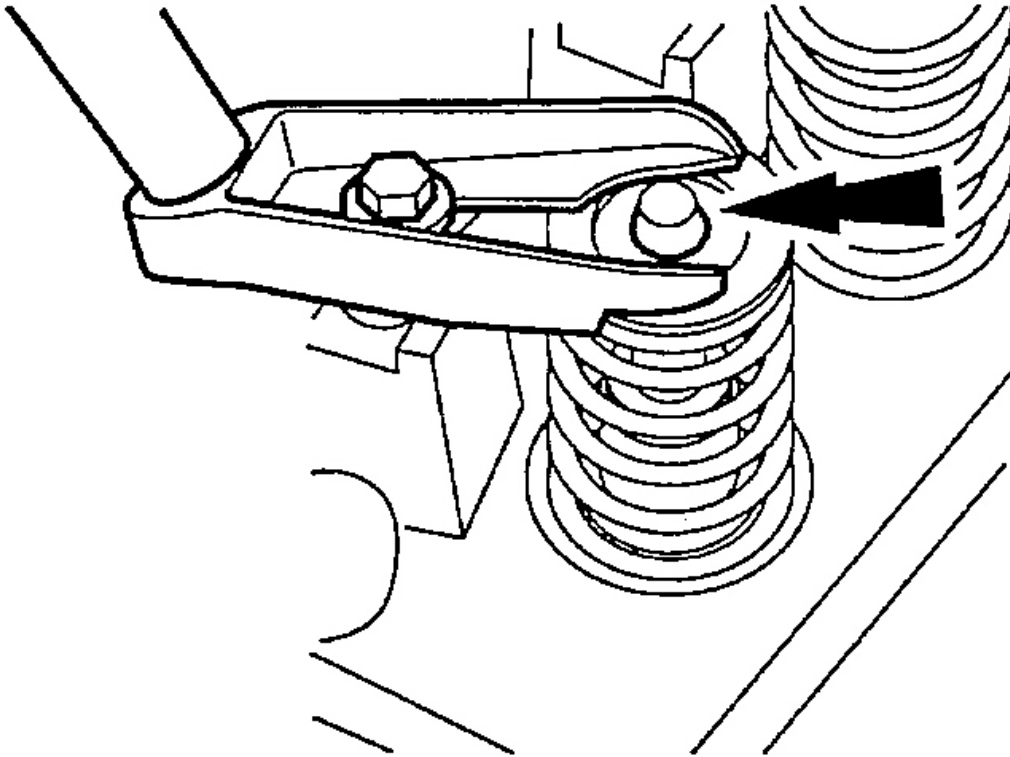
2. Remove the exhaust manifold gasket.



G03312296

Fig. 106: Removing Exhaust Manifold Gasket
Courtesy of MAZDA MOTORS CORP.

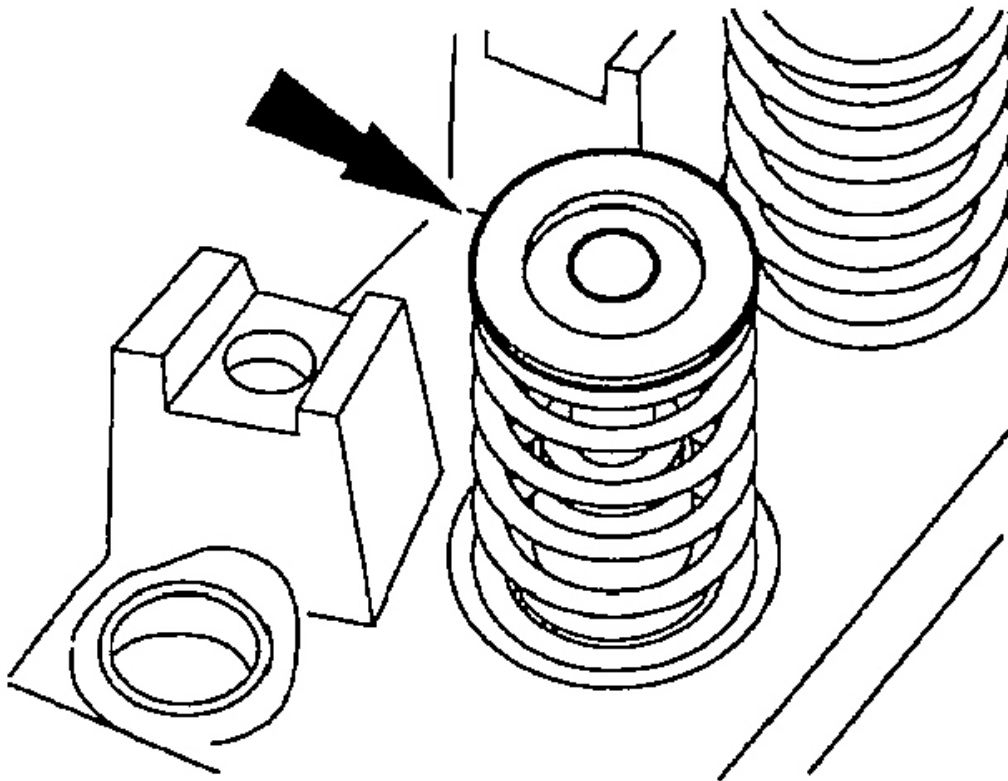
3. Using a Valve Spring Compressor SST 303-163 (T81P-6513-A) or equivalent, remove the valve spring retainer key.



G03312297

Fig. 107: Removing Valve Spring Retainer Key
Courtesy of MAZDA MOTORS CORP.

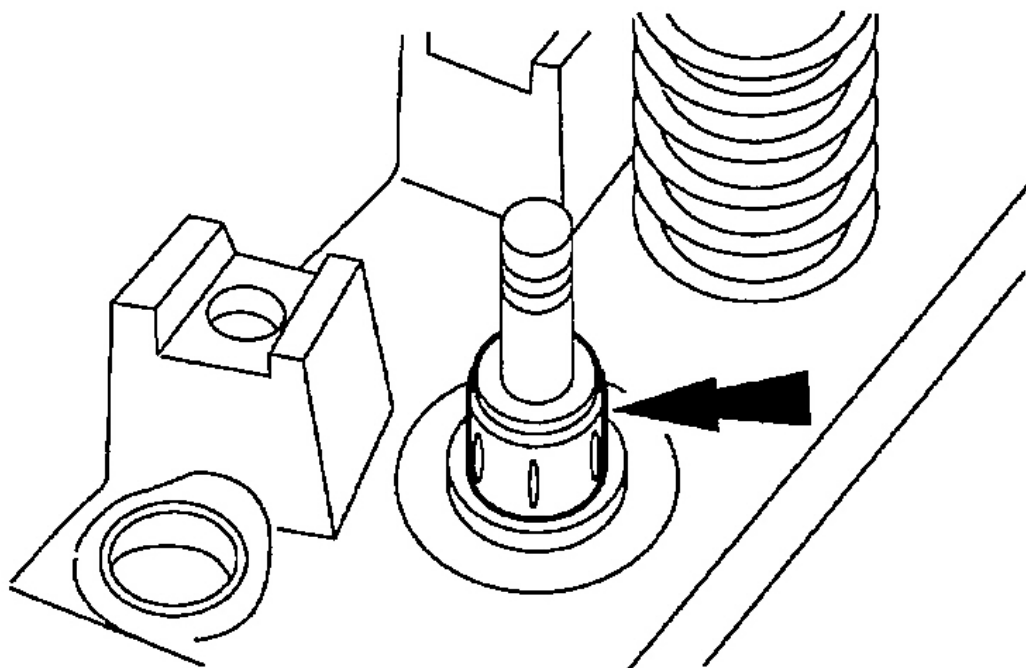
4. Remove the valve spring retainer.
 - For component tests for the valve spring retainer, refer to **VALVE SPRING INSPECTION**.



G03312298

Fig. 108: Removing Valve Spring Retainer
Courtesy of MAZDA MOTORS CORP.

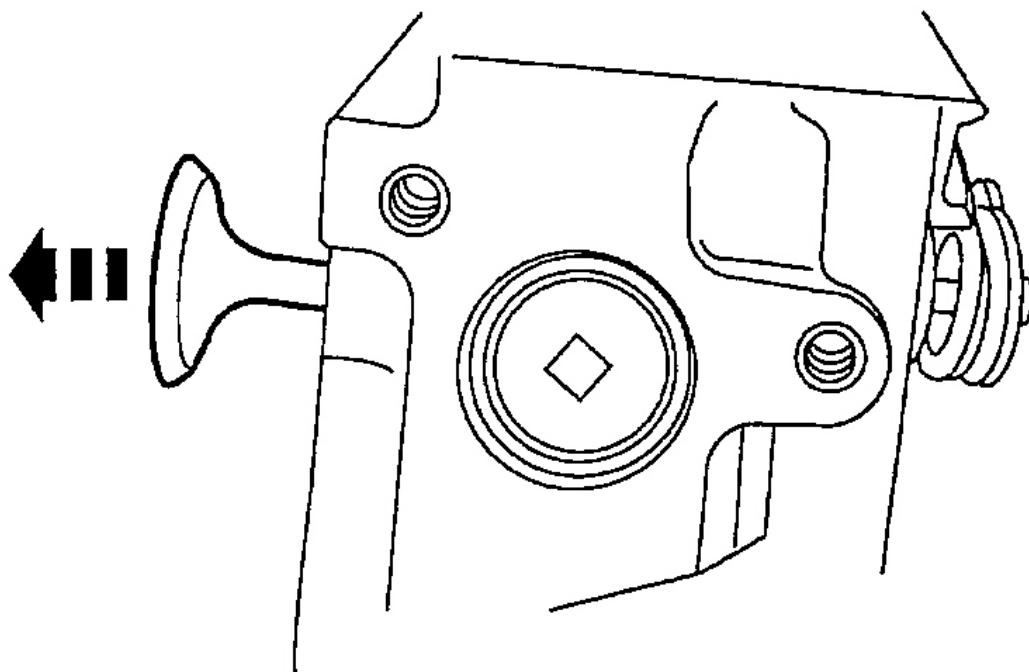
5. Remove the valve stem seal.



G03312299

Fig. 109: Removing Valve Stem Seal
Courtesy of MAZDA MOTORS CORP.

6. Remove the valve.
 - For component tests for the valve, refer to **VALVE INSPECTION**.
 - For component tests for the cylinder head, refer to **CYLINDER HEAD INSPECTION**.

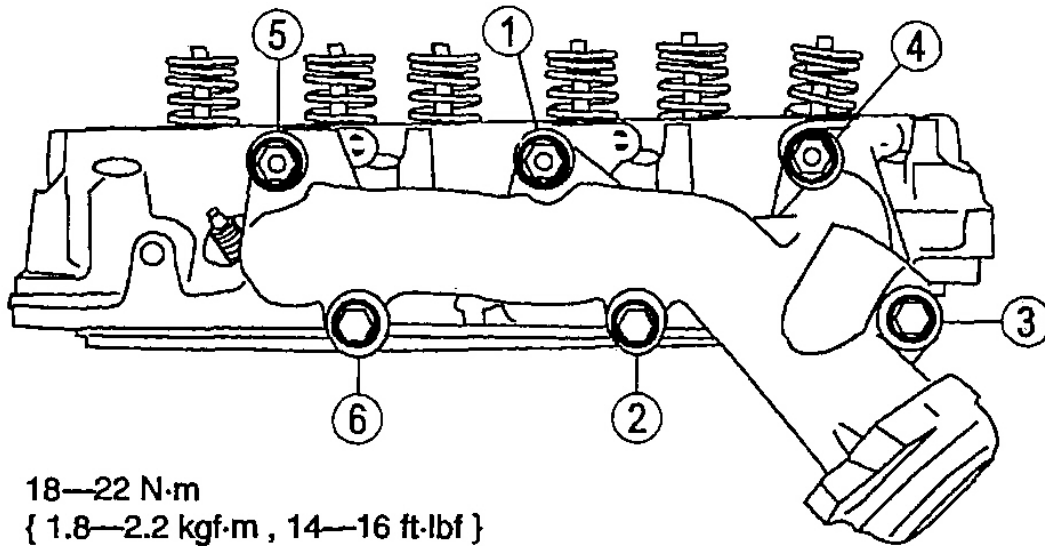


G03312300

Fig. 110: Removing Valve
Courtesy of MAZDA MOTORS CORP.

ASSEMBLY NOTE

1. Assemble in reverse order of disassembly.
 1. Lubricate the valve stem and the valve stem seal with clean engine oil.



G03312301

Fig. 111: Exhaust Manifold Bolt Tightening Sequence (With Torque Specifications)
 Courtesy of MAZDA MOTORS CORP.

PISTON & CONNECTING ROD DISASSEMBLY/ASSEMBLY

DISASSEMBLY NOTE

NOTE:

- Use a suitable ring expander to remove piston rings to prevent damage.

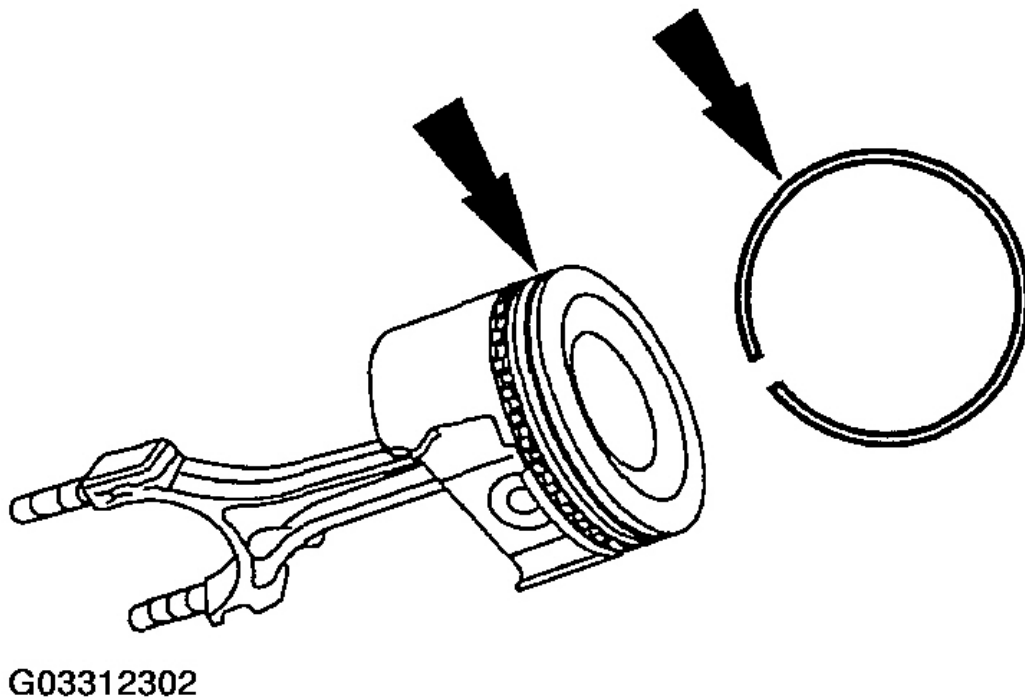
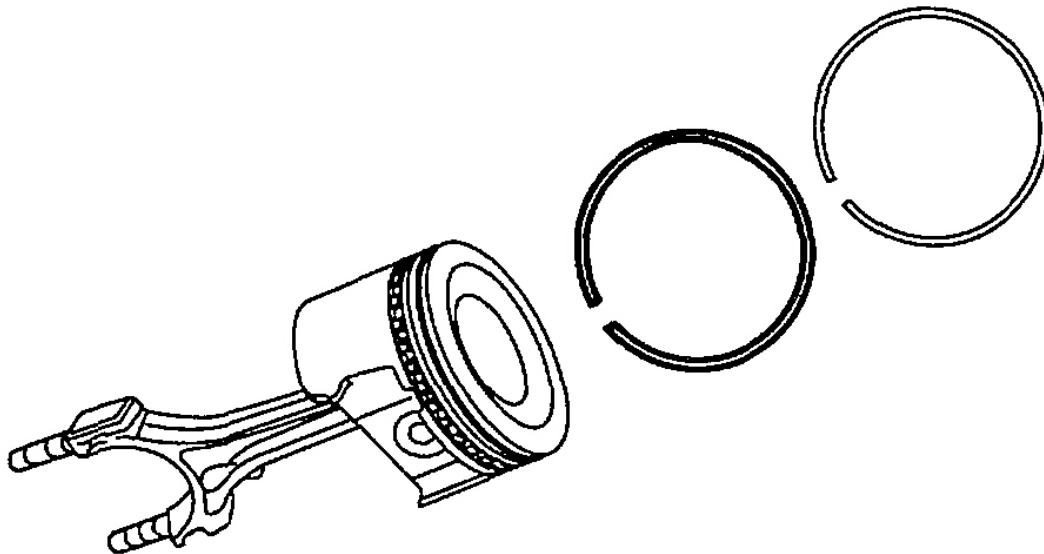


Fig. 112: Removing Top Compression Ring
Courtesy of MAZDA MOTORS CORP.

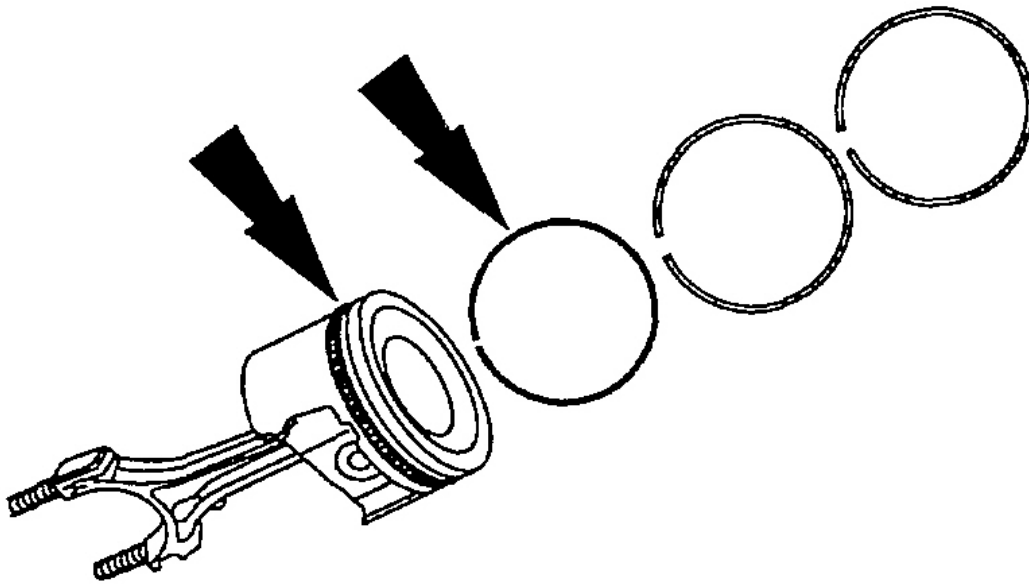
1. Remove the top compression ring.
2. Remove the second compression ring.



G03312303

Fig. 113: Removing Second Compression Ring
Courtesy of MAZDA MOTORS CORP.

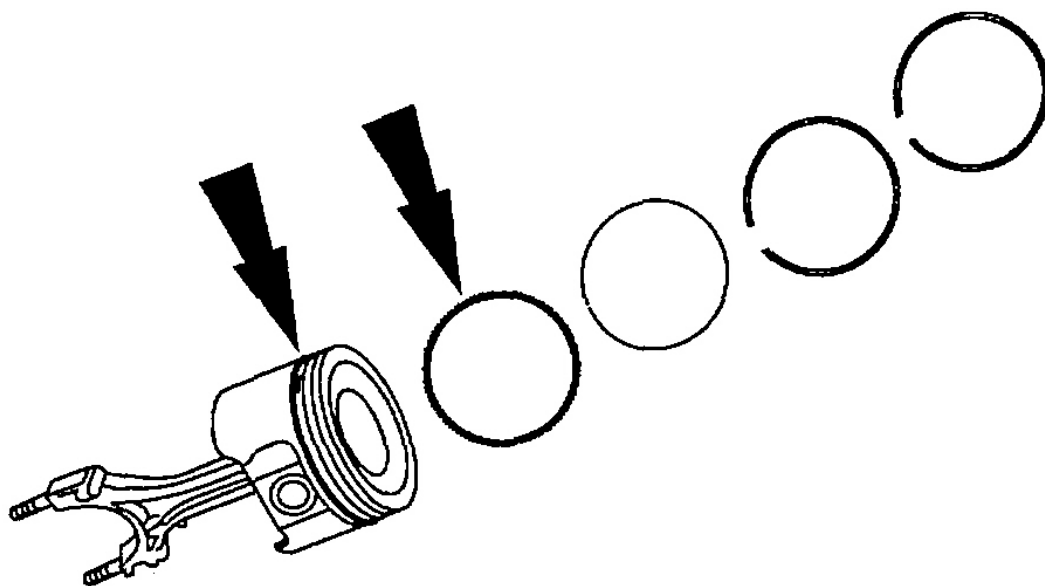
3. Remove the first oil control ring.



G03312304

Fig. 114: Removing First Oil Control Ring
Courtesy of MAZDA MOTORS CORP.

4. Remove the oil control spacer ring.



G03312305

Fig. 115: Removing Oil Control Spacer Ring
Courtesy of MAZDA MOTORS CORP.

5. Remove the second oil control ring.

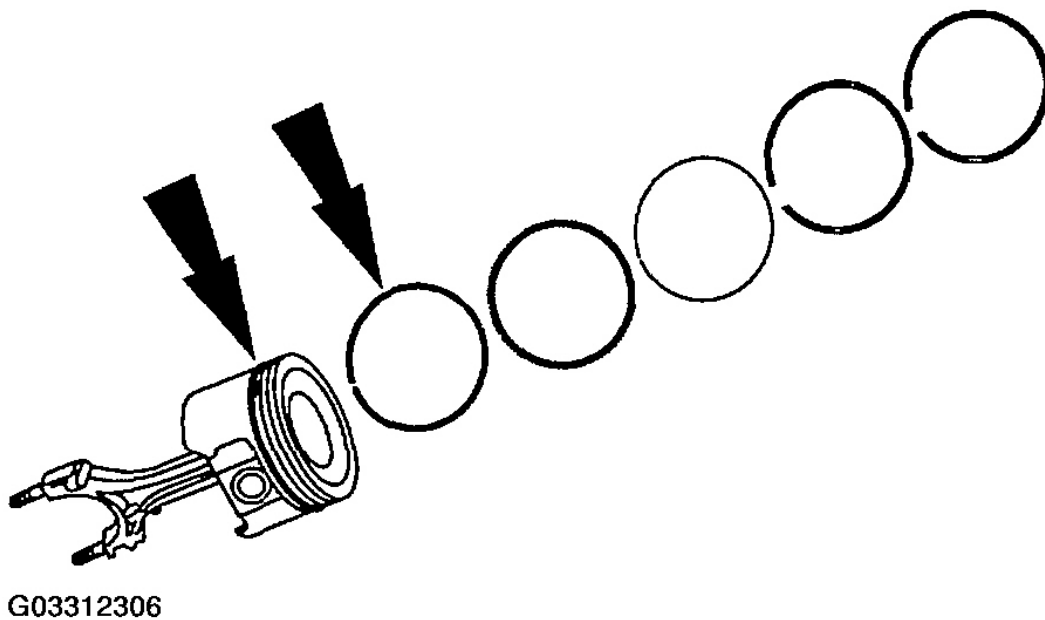
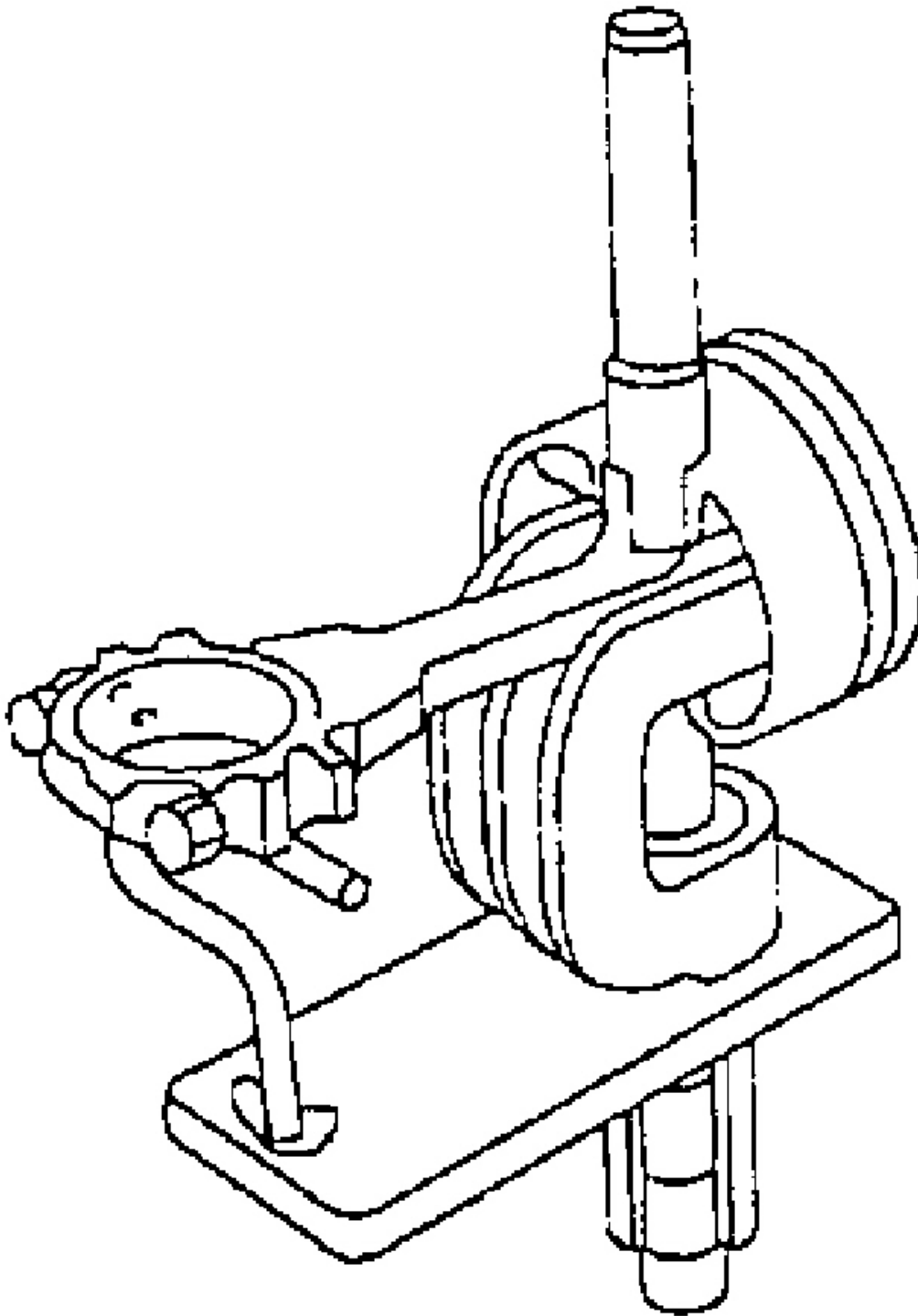


Fig. 116: Removing Second Oil Control Ring
Courtesy of MAZDA MOTORS CORP.

NOTE:

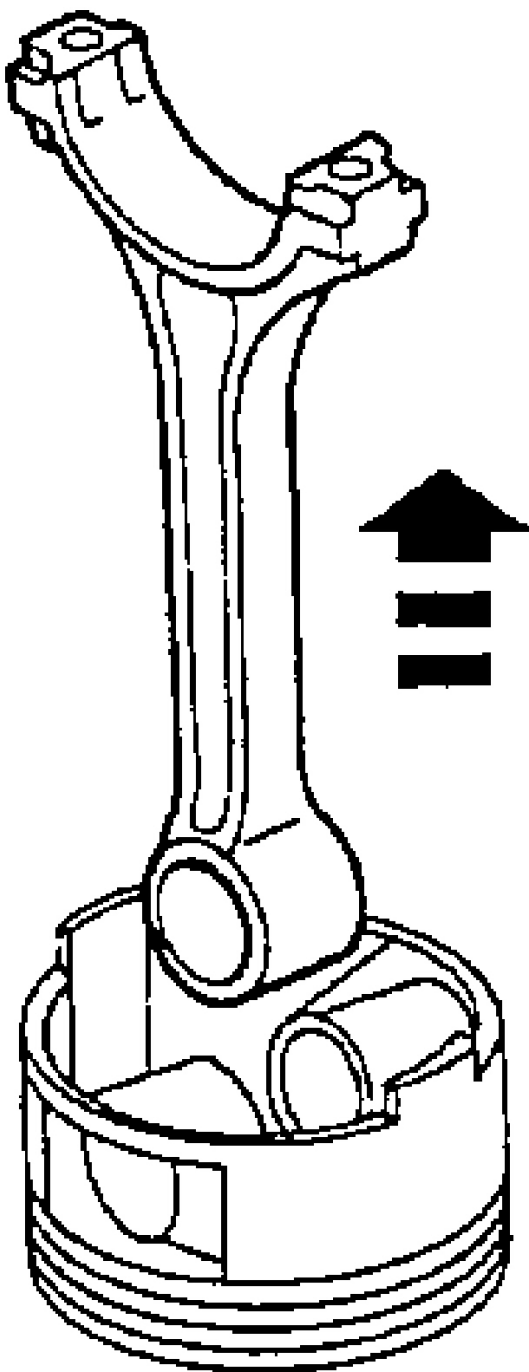
- Take note of piston connecting rod assembly and mark the connecting rod and the piston to ensure proper orientation during reassembly.



G03312307

Fig. 117: Removing Piston Pin From Piston Connecting Rod Assembly
Courtesy of MAZDA MOTORS CORP.

6. Use a suitable piston pin tool to press the piston pin out of the piston connecting rod assembly.
7. Remove the connecting rod from the piston.



G03312308

Fig. 118: Removing Connecting Rod From Piston
Courtesy of MAZDA MOTORS CORP.

8. Clean and inspect the connecting rod and the piston. Refer to **PISTON INSPECTION** and **CONNECTING ROD INSPECTION**.

ASSEMBLY NOTE

1. Lubricate the piston pin and piston pin bore.
 - Use clean engine oil.

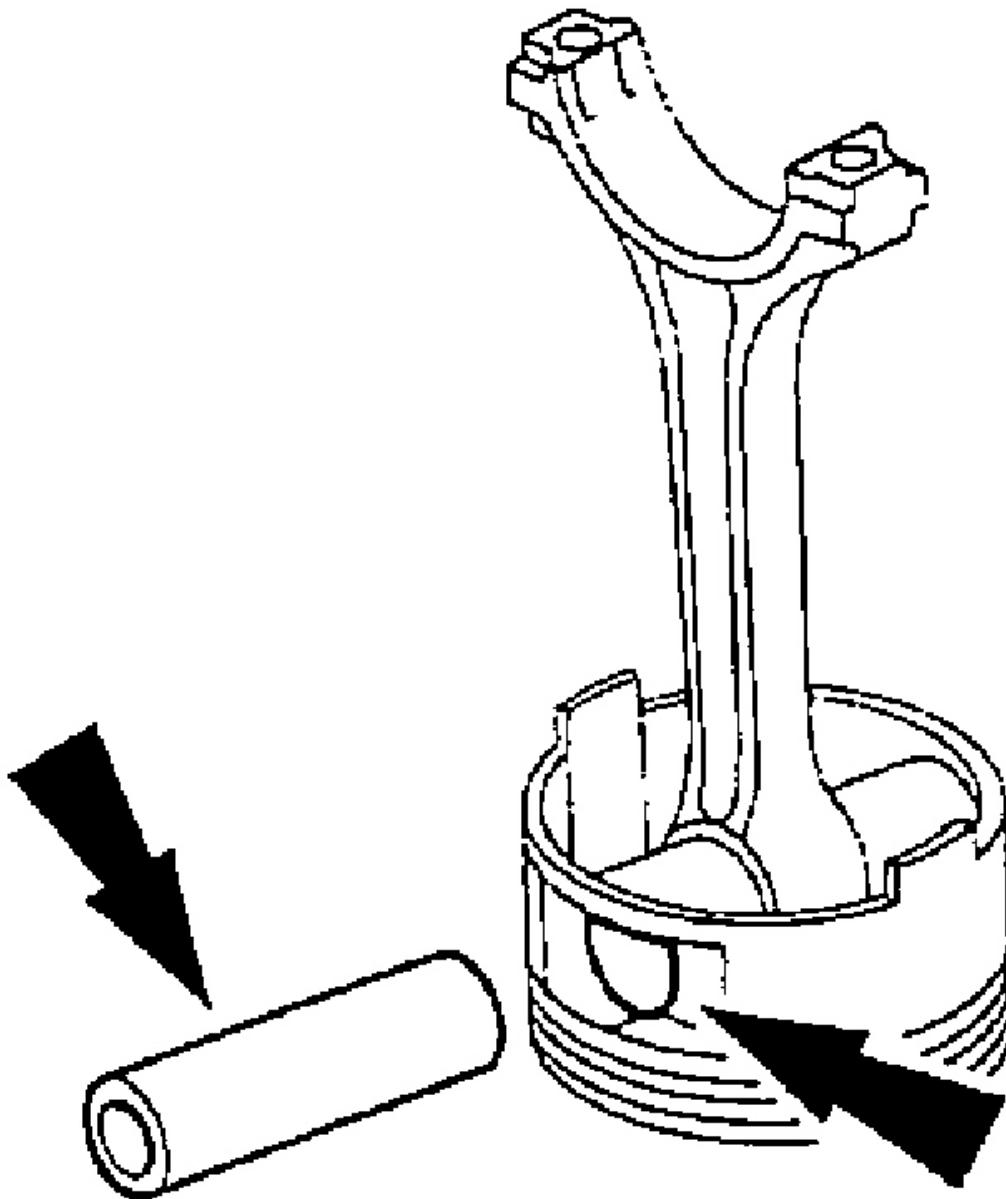
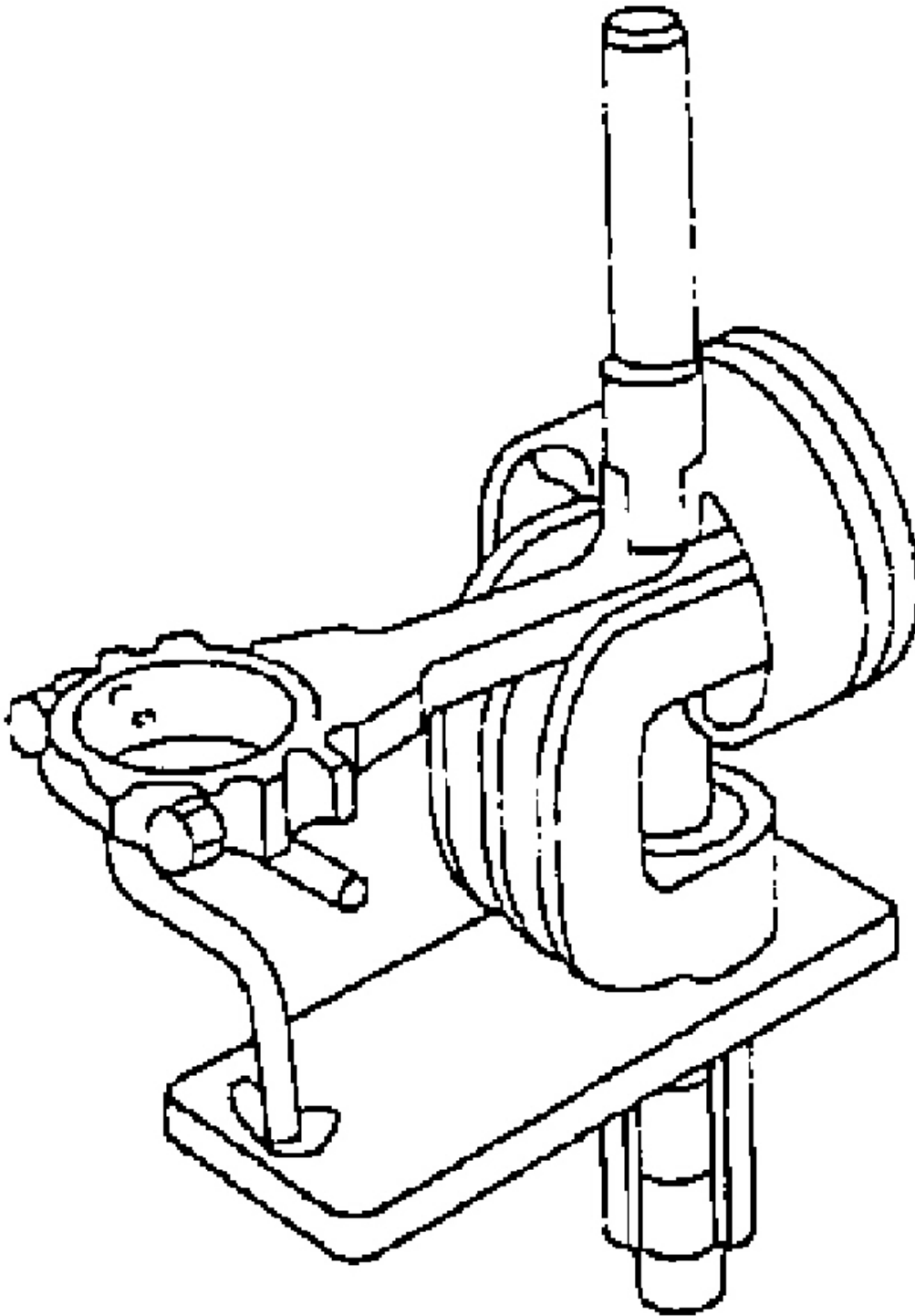
**G03312309**

Fig. 119: Lubricating Piston Pin & Piston Pin Bore
Courtesy of MAZDA MOTORS CORP.

NOTE:

- During assembly the small end of the connecting rod must be heated to 232°-316°C (450°-600° F).



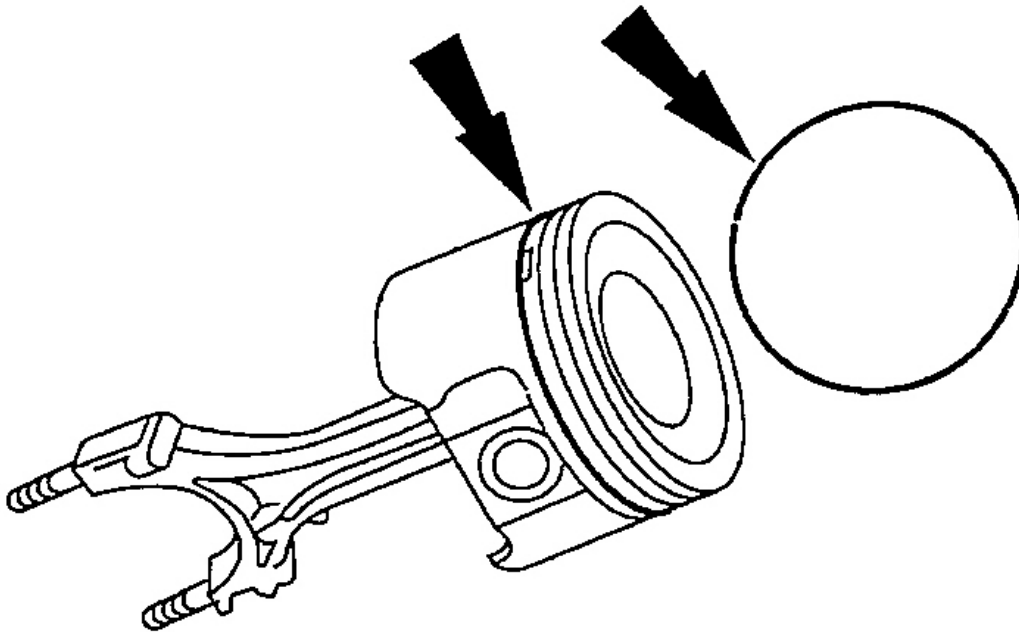
G03312310

Fig. 120: Installing Piston Pin Into Piston & Connecting Rod
Courtesy of MAZDA MOTORS CORP.

2. Use a suitable piston pin tool to press the piston pin into the piston and the connecting rod.

NOTE:

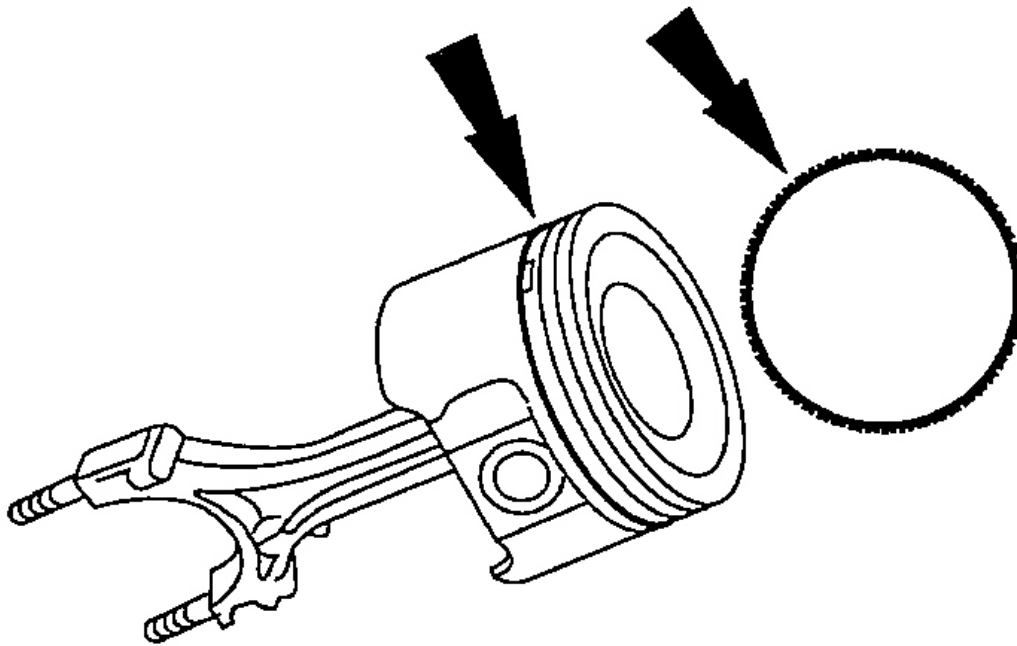
- Lubricate the piston and the piston rings with clean engine oil.
- Use a suitable ring expander to install the piston rings. Ensure ring end gaps are equally spaced around the circumference of the piston for all piston rings.



G03312311

Fig. 121: Installing Second Oil Control Ring
Courtesy of MAZDA MOTORS CORP.

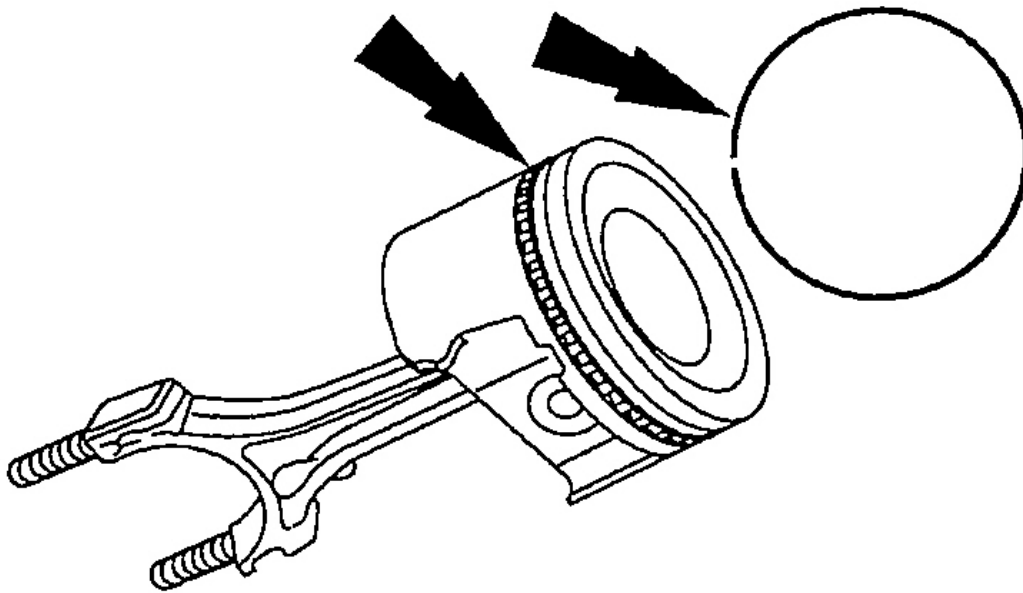
3. Install the second oil control ring.
4. Install the oil control spacer ring.



G03312312

Fig. 122: Installing Oil Control Spacer Ring
Courtesy of MAZDA MOTORS CORP.

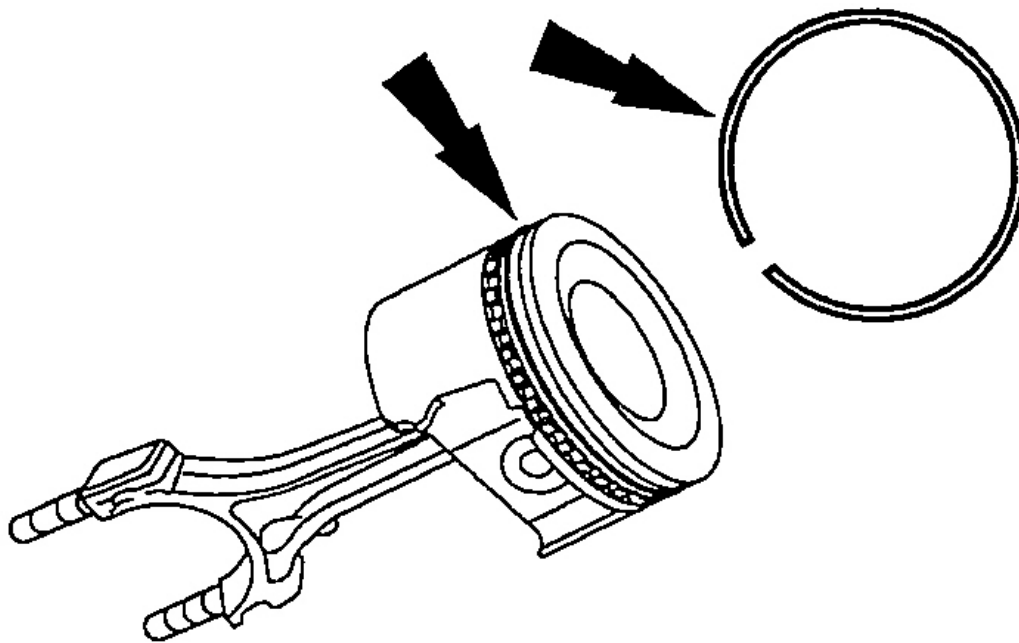
5. Install the first oil control ring.



G03312313

Fig. 123: Installing First Oil Control Ring
Courtesy of MAZDA MOTORS CORP.

6. Install the second compression ring.



G03312314

Fig. 124: Installing Second Compression Ring
Courtesy of MAZDA MOTORS CORP.

7. Install the top compression ring.

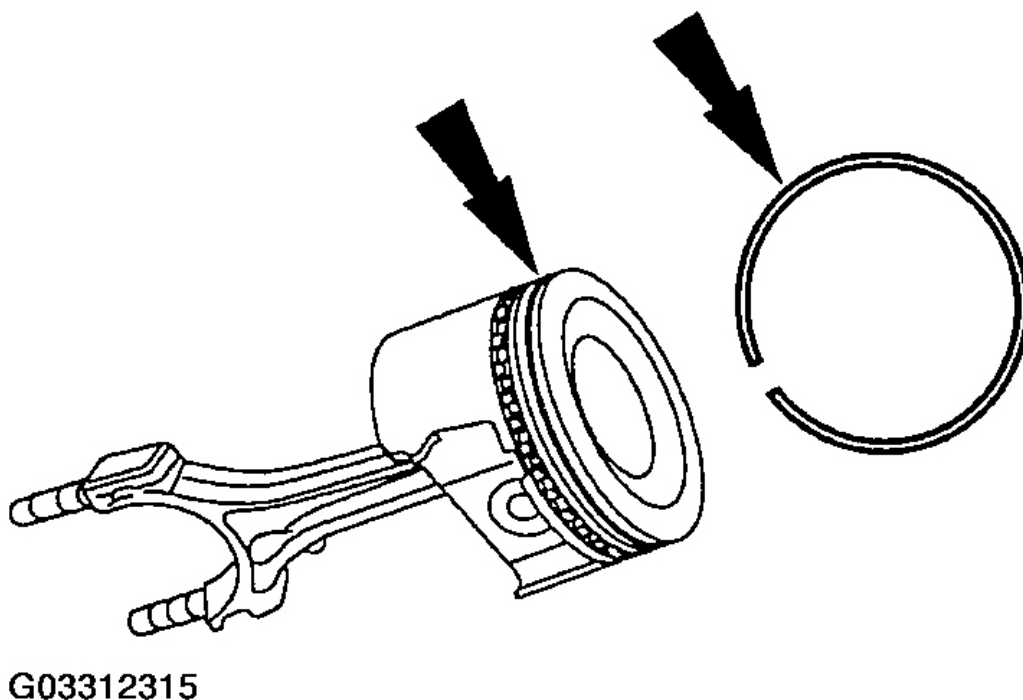


Fig. 125: Installing Top Compression Ring
Courtesy of MAZDA MOTORS CORP.

8. Check piston ring end gap and ring-to-groove side clearance. Refer to **PISTON INSPECTION**.

SPROCKET INSPECTION

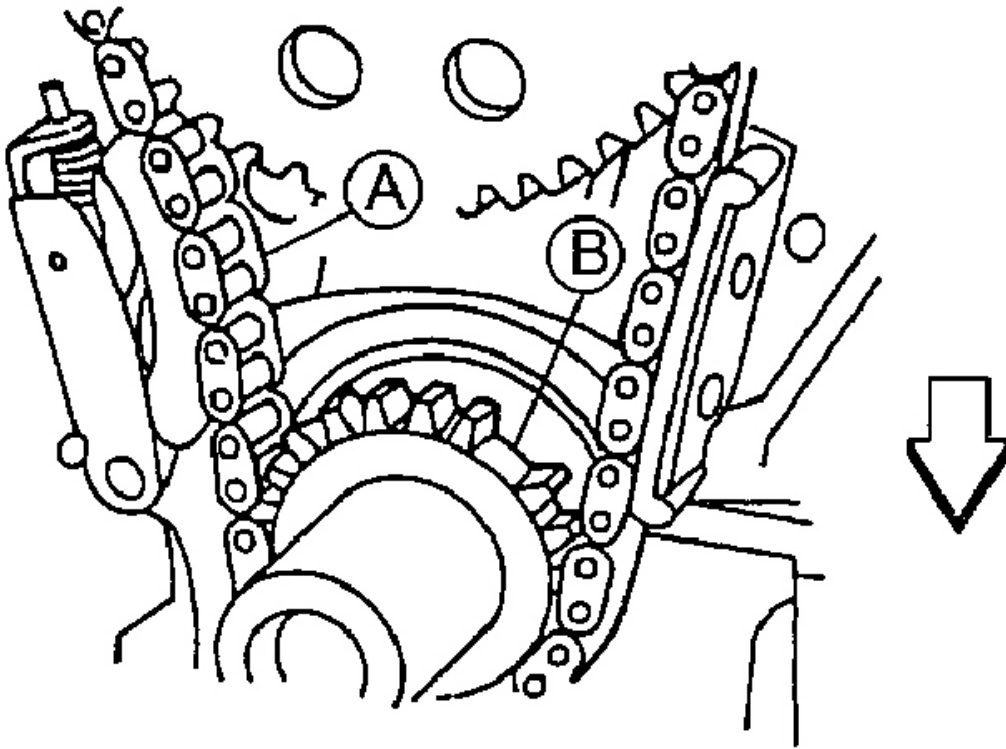
WARNING:

- To avoid the possibility of personal injury or damage to the vehicle, do not operate the engine with the hood open until the fan blade has been examined for possible cracks and separation.

NOTE:

- Specifications show the expected minimum or maximum condition.
- If a component fails to meet the specifications, it is necessary to replace or refinish. If the component can be refinished, wear limits are provided as an aid to making a decision. Any component that fails to meet specifications and cannot be refinished must be replaced.

1. Inspect the (A) timing chain/belt and the (B) sprockets.
 - Replace as necessary.



G03312316

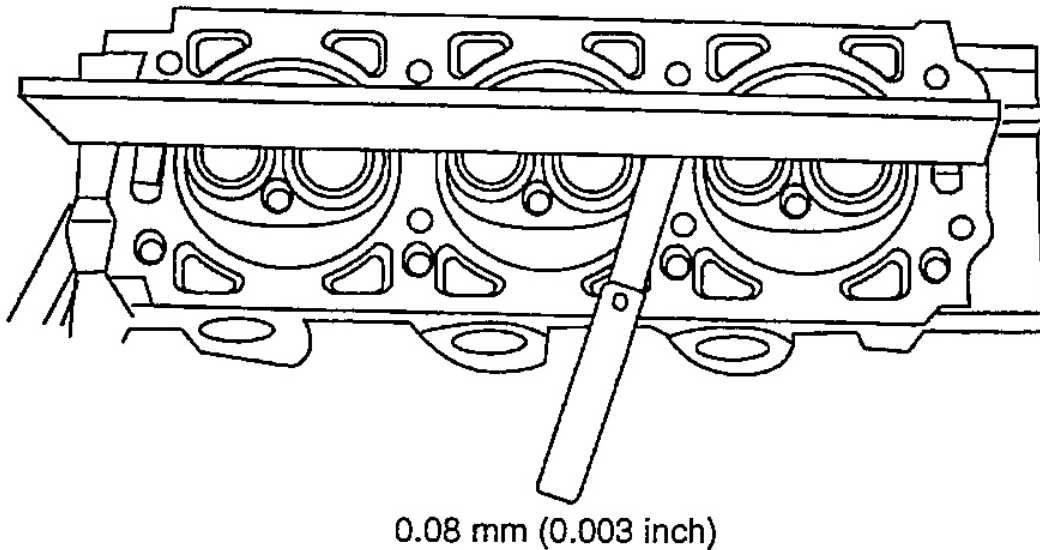
Fig. 126: Inspecting (A) Timing Chain/Belt & (B) Sprockets
Courtesy of MAZDA MOTORS CORP.

CYLINDER HEAD INSPECTION

NOTE:

- Do not remove more than 0.25 mm (0.010) of material from cylinder head.

1. Inspect the cylinder head for flatness using a flat edge and a feeler gauge. If the cylinder head is distorted, resurface the cylinder head within specification.

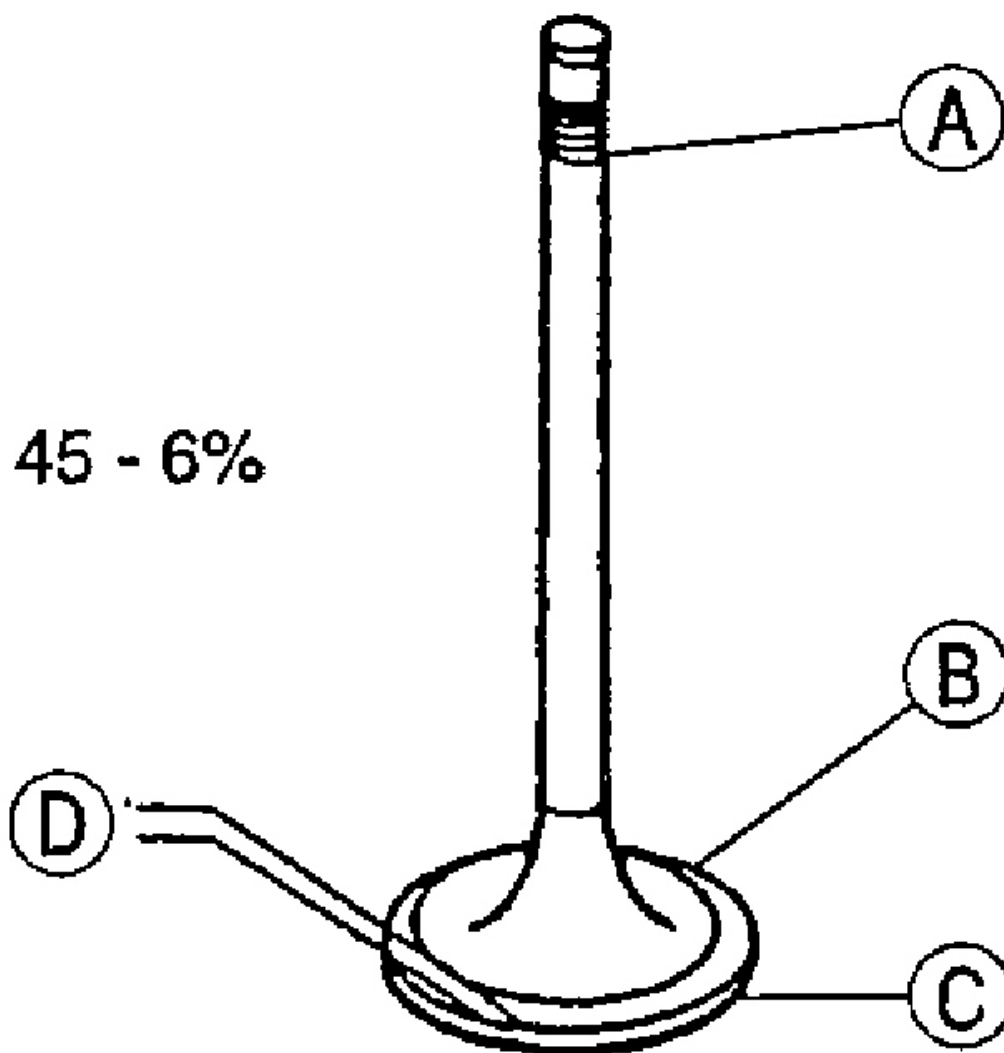


G03312317

Fig. 127: Checking Cylinder Head Flatness
Courtesy of MAZDA MOTORS CORP.

VALVE INSPECTION

1. Inspect the following valve areas:
 - The (A) end of the stem for grooves or scoring.
 - The (B) valve face for pits, grooves or scores.
 - The (C) valve head for signs of burning, erosion, warpage and cracking. Minor pits, grooves and other abrasions may be removed.
 - The (D) valve face angle for wear.



G03312318

Fig. 128: Inspecting Valves

Courtesy of MAZDA MOTORS CORP.

VALVE STEM DIAMETER

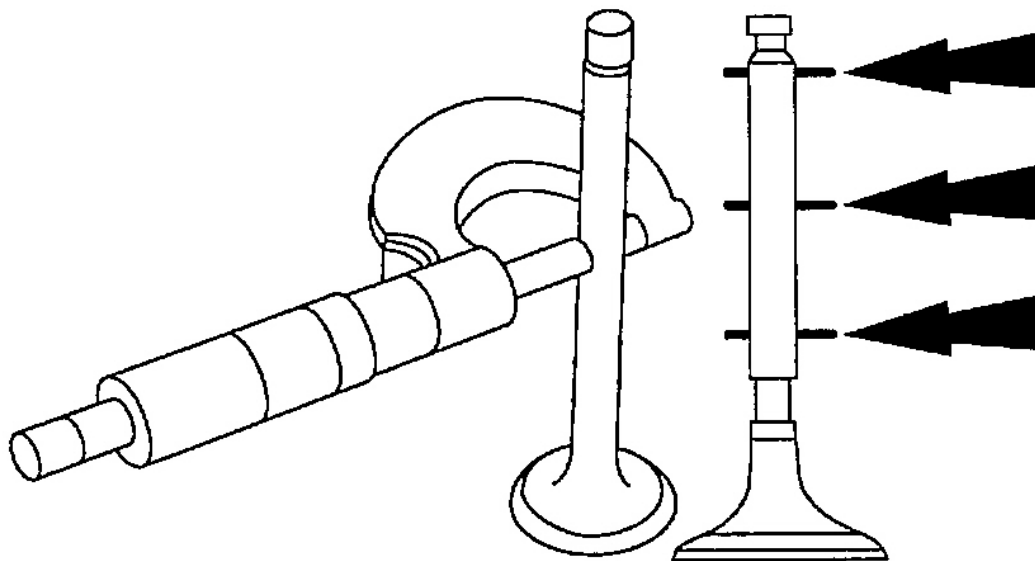
1. Measure the diameter of each intake valve stem at the points shown. Verify the diameter is within specification.

Intake (STD.)

7.960-7.940 mm (0.3134-0.3126 in.)

Exhaust (STD.)

7.948-7.928 mm (0.3129-0.3121 in.)



G03312319

Fig. 129: Measuring Intake Valve Stem Diameter
Courtesy of MAZDA MOTORS CORP.

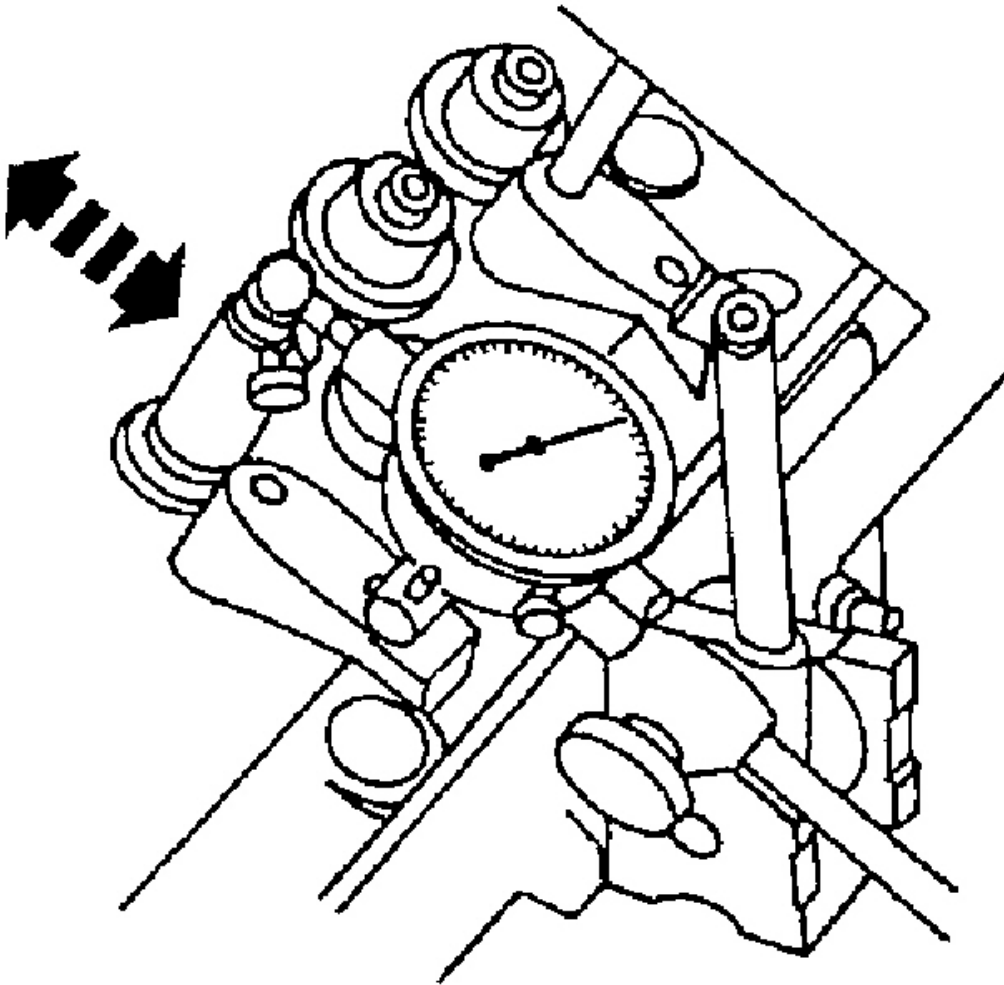
2. Measure the diameter of each exhaust valve stem at the points shown. Verify the diameter is within specification.

VALVE STEM OIL CLEARANCE

NOTE:

- The valve stem diameter must be within specification before checking valve stem-to-valve guide clearance.

1. Install the Valve Stem Clearance Tool SST 303-004 (TOOL-6505-E) or equivalent on the valve stem and install Dial Indicator With Bracketry. Lower the valve until the Valve Stem Clearance Tool SST 303-004 (TOOL-6505-E) or equivalent contacts the upper surface of the valve guide.
2. Move the Valve Stem Clearance Tool toward the Dial Indicator and zero the Dial Indicator. Move the Valve Stem Clearance Tool away from the Dial Indicator and note the reading. The reading will be double the valve stem-to-valve guide clearance. Valves with oversize stems will need to be installed if out of specification.



G03312320

Fig. 130: Measuring Valve Stem Clearance
Courtesy of MAZDA MOTORS CORP.

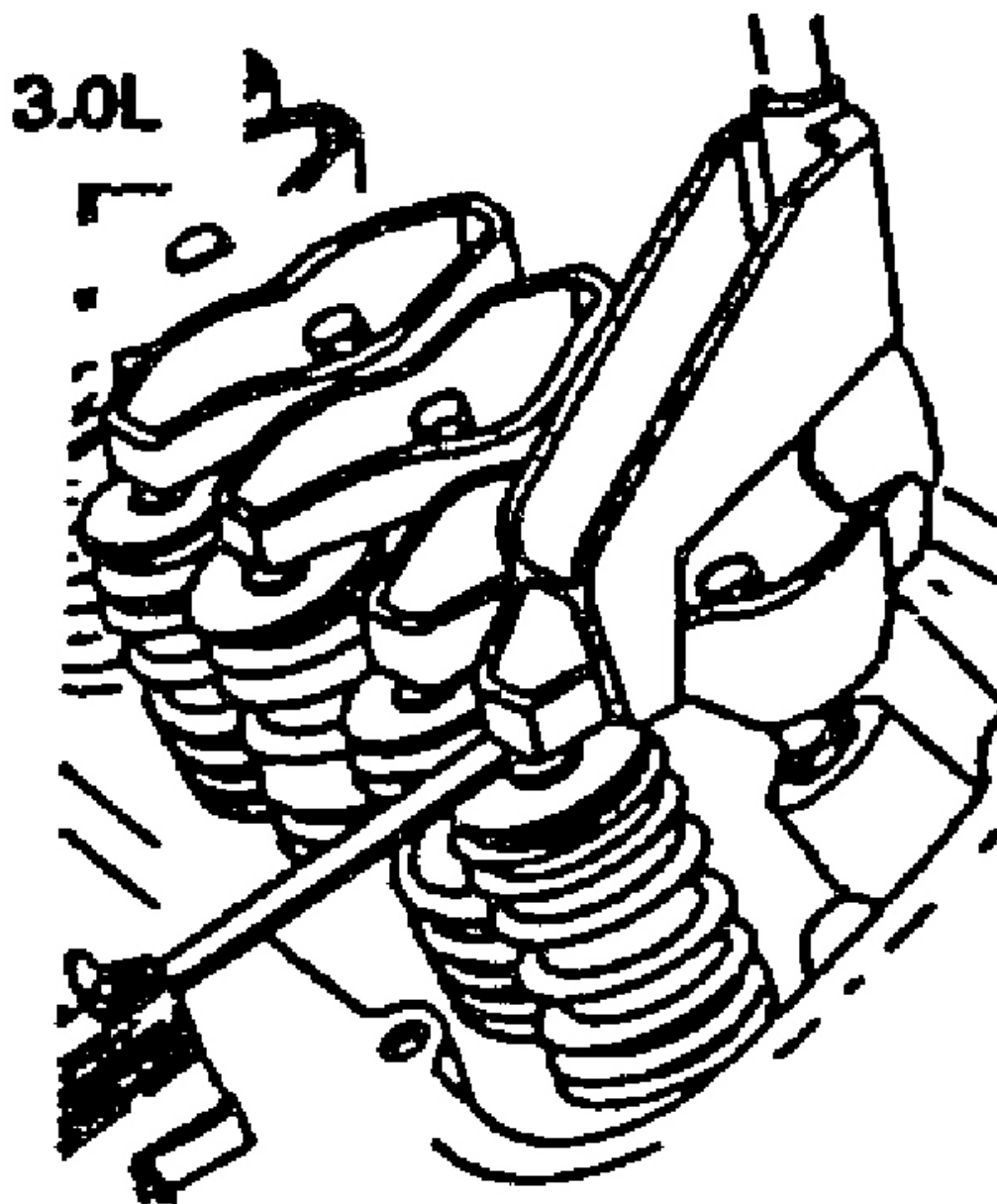
Valve Clearance Inspection

NOTE:

- Valve stem-to-valve rocker arm clearance should be within specification with the hydraulic valve tappet completely collapsed. Repeated valve reconditioning operations (valve and/or valve seat refacing) will decrease the clearance to the point that if it is not compensated for, the hydraulic valve tappet will cease to function and the valve will be held open.

- The positive stop rocker arm bolts eliminate the necessity to adjust the valve clearance. However, to obtain the specified valve clearance, it is important that all valve components be in a serviceable condition and installed and tightened properly.
- To determine whether a shorter or a longer push rod is necessary, make the following check.

1. Position **SST T71P-6513-B** or equivalent on the rocker arm.
2. Slowly apply pressure to bleed down the valve tappet until the plunger is completely bottomed. Hold the valve tappet in this position and check the available clearance between the rocker arm and the valve stem tip with a feeler gauge.

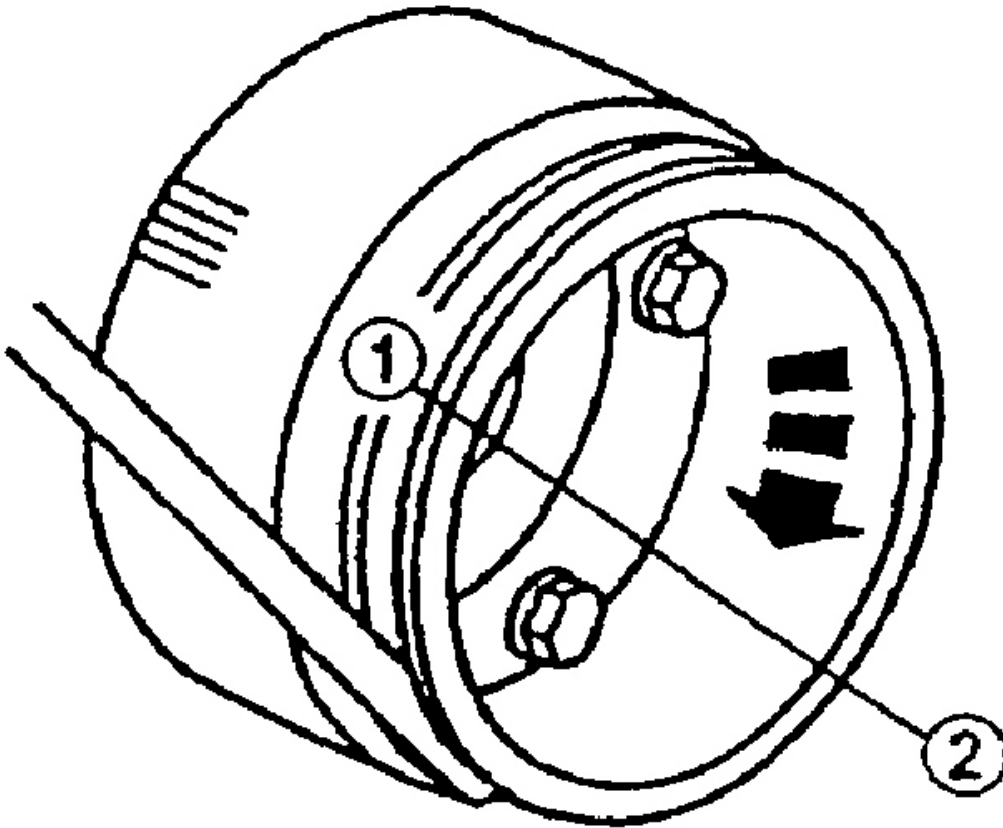


G03312321

Fig. 131: Checking Clearance Between Rocker Arm & The Valve Stem Tip
Courtesy of MAZDA MOTORS CORP.

3. If the clearance is less than specification, install a shorter push rod. If the clearance is greater than specification, install a longer push rod.

4. With No. 1 piston on TDC at the end of compression stroke check the following valves:
 - No. 1 exhaust valve No. 1 intake valve
 - No. 3 exhaust valve No. 2 intake valve
 - No. 6 exhaust valve No. 4 intake valve
5. Rotate crankshaft 360 degrees to position No. 2 and check the following valves:
 - No. 2 exhaust valve No. 3 intake valve
 - No. 4 exhaust valve No. 5 intake valve
 - No. 5 exhaust valve No. 6 intake valve



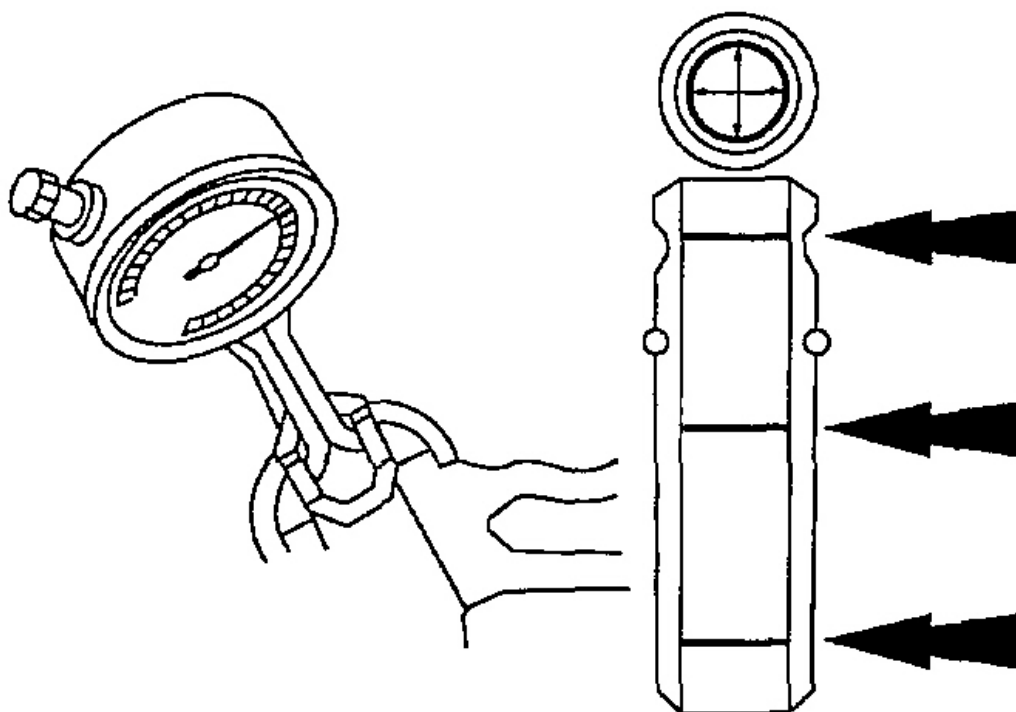
G03312322

Fig. 132: Rotating Crankshaft
Courtesy of MAZDA MOTORS CORP.

VALVE GUIDE INSPECTION/REPAIR

VALVE GUIDE INSPECTION

1. Measure the inner diameter of the valve guides in two directions where indicated. Verify the diameter is within specification. Refer to **SPECIFICATIONS**.



G03312323

Fig. 133: Measuring Valve Guide Inner Diameter
Courtesy of MAZDA MOTORS CORP.

2. If the valve guide is not within specifications, ream the valve guide and install a valve with an oversize stem or remove the valve guide and install a new valve guide.

VALVE GUIDE REPAIR

CAUTION:

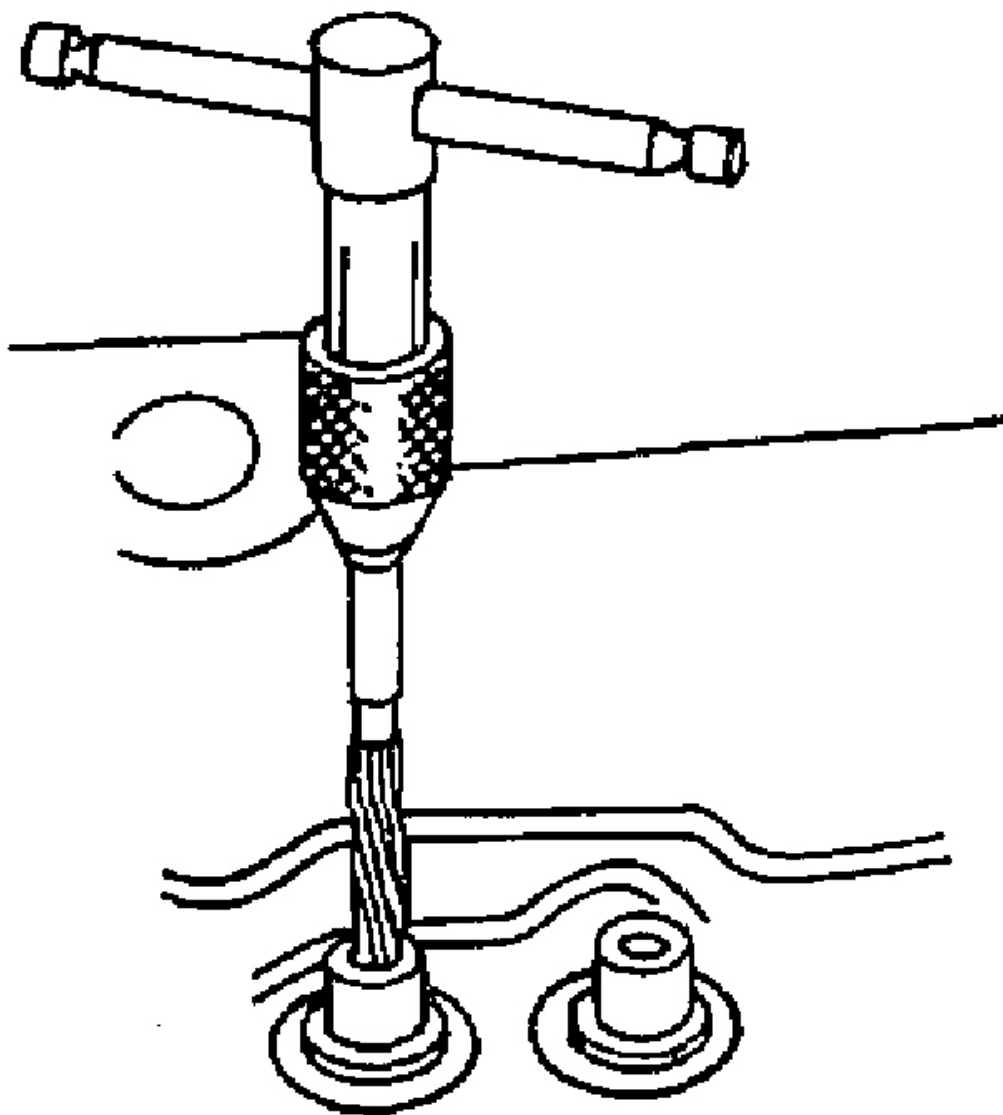
- Always reface the valve seat after the valve guide has been reamed, and use a suitable scraper to break the sharp corner (ID) left by the reamer at the top of the valve guide.
- The interference angle of the valve and seat should not be lapped out. Remove grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.254mm

(0.010 in) from the end of the valve stem.

NOTE:

- **If oversize valve stems and oversize stem seals are not available, bore out original guide and install service bushing. Ream ID for specified clearance for standard size valve. Reface valve seat as required. Install standard size valve stem seal.**

1. Use a hand-reaming kit to ream the valve guide.



G03312324

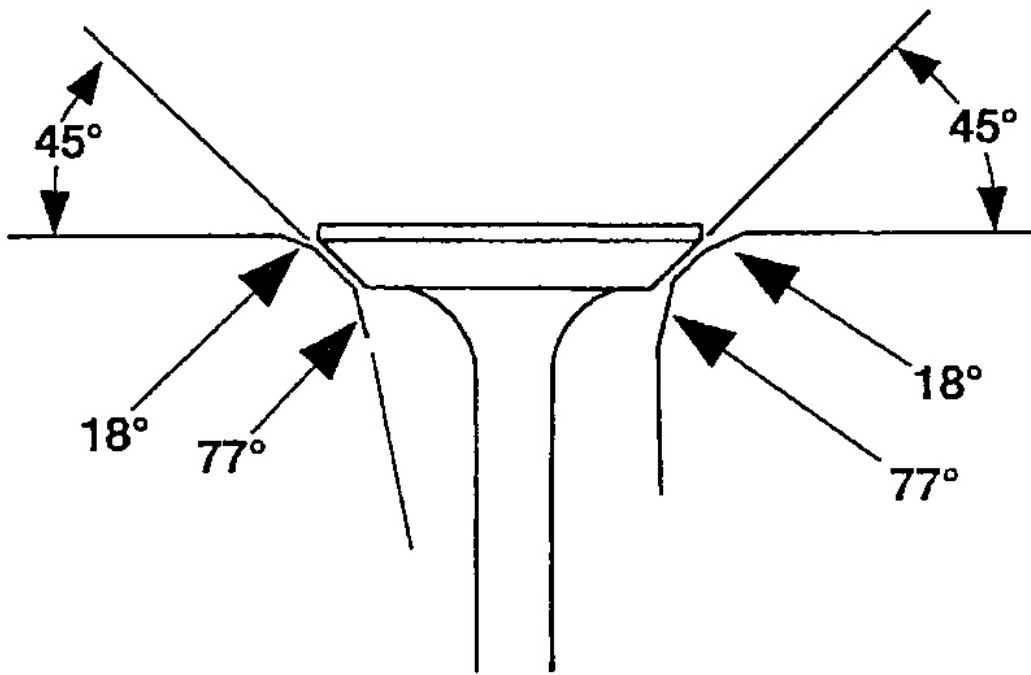
Fig. 134: Reaming Valve Guide
Courtesy of MAZDA MOTORS CORP.

2. Reface the valve seat.
3. Clean the sharp edges of the valve guide inner diameter left by reaming.

VALVE SEAT INSPECTION

CAUTION: • After grinding valves or valve seats, check valve clearance.

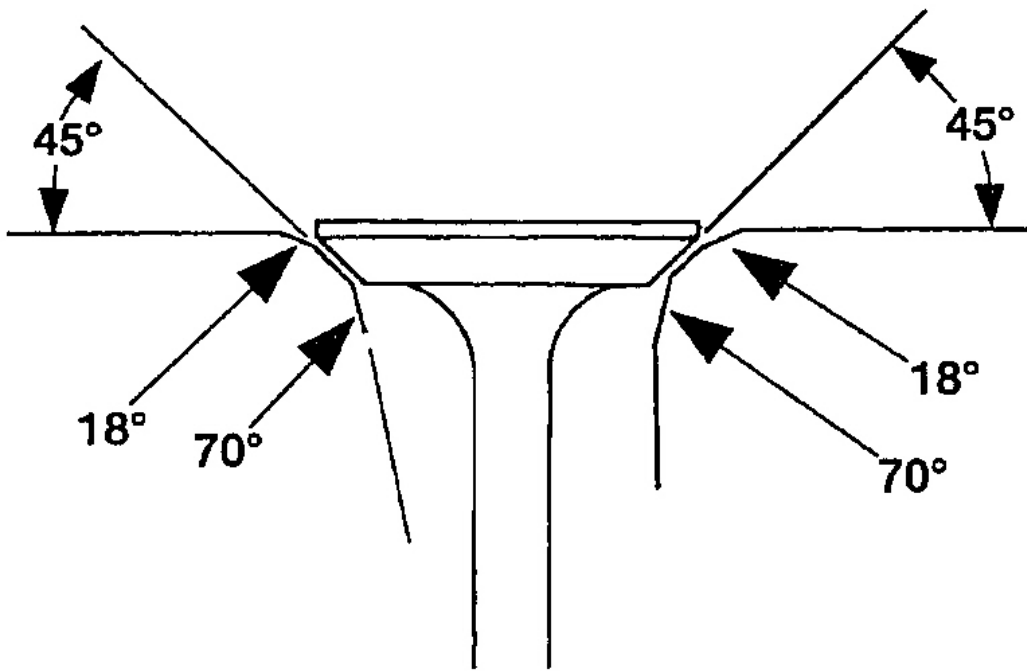
NOTE: • The finished valve seat should contact the approximate center of the valve face.



G03312325

Fig. 135: Checking Intake Valve Seat & Intake Valve Angles
Courtesy of MAZDA MOTORS CORP.

1. Check intake valve seat and intake valve angles.
2. Check exhaust valve seat and exhaust valve angles.



G03312326

Fig. 136: Check Exhaust Valve Seat & Exhaust Valve Angles
Courtesy of MAZDA MOTORS CORP.

3. Measure the valve seat width. If necessary, grind the valve seat to specification.
 1. Measure the intake valve seat width.
 2. Measure the exhaust valve seat width.
 3. Recheck the valve spring installed length after the seats have been ground, and shim the valve springs as necessary to achieve the correct installed spring length.

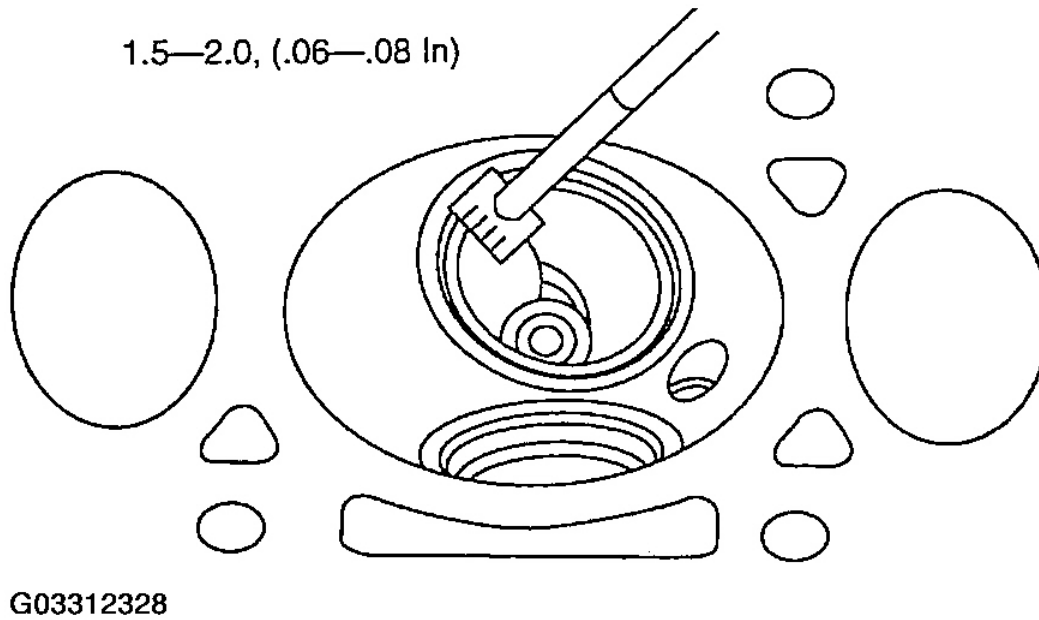
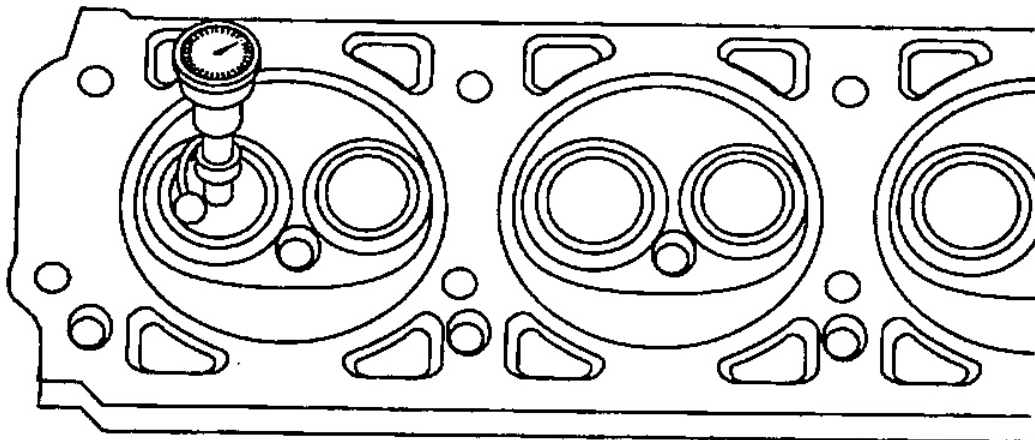


Fig. 137: Measuring Valve Seat Width
 Courtesy of MAZDA MOTORS CORP.

4. Check that the finished valve seat contacts the approximate center of the valve face.
 1. Coat the valve seat with Prussian Blue.
 2. Set the valve in place.
 3. Rotate the valve with light pressure.
 4. Inspect the Prussian Blue transferred to the valve and grind the valve or valve seat as necessary.
5. Use a valve seat runout gauge to check valve seat runout.

0.076 mm (0.003 in.)

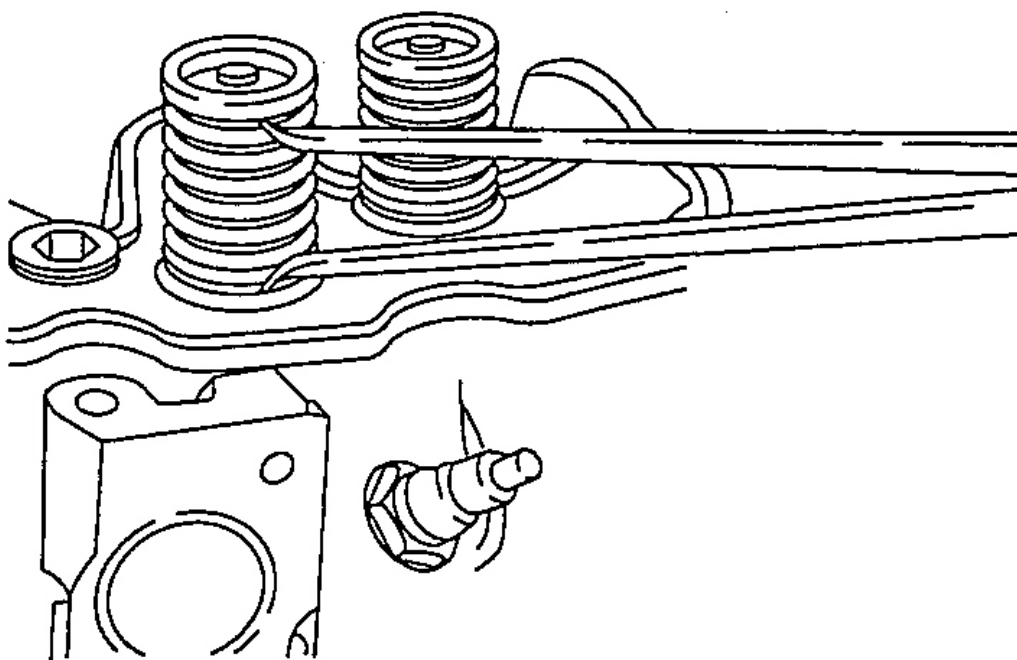


G03312329

Fig. 138: Measuring Valve Seat Width
Courtesy of MAZDA MOTORS CORP.

VALVE SPRING INSPECTION

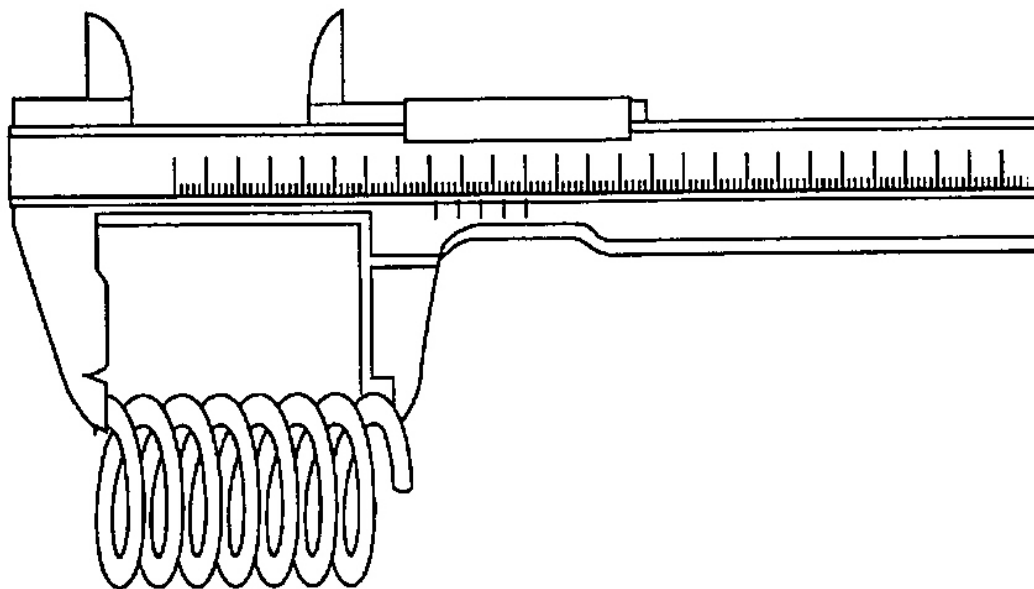
1. Measure the installed length of each valve spring. Verify the length is within specification. Refer to **SPECIFICATIONS**.



G03312327

Fig. 139: Measuring Valve Spring Installed Length
Courtesy of MAZDA MOTORS CORP.

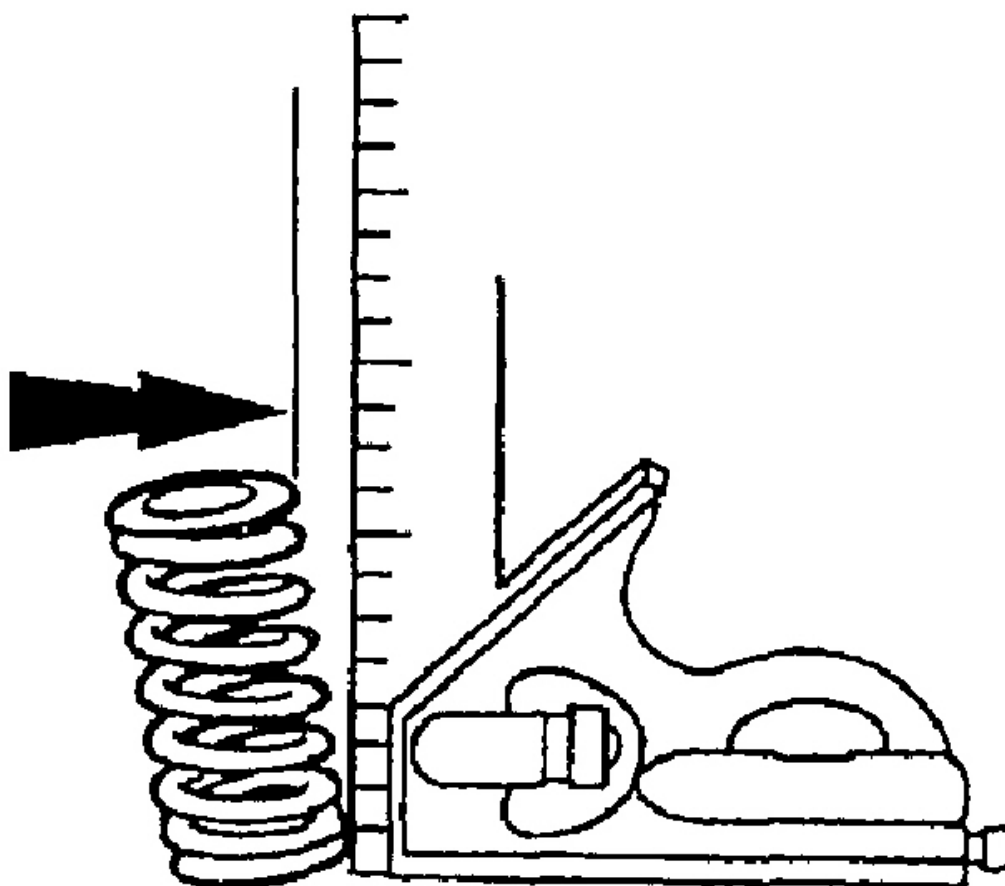
2. Measure the free length of each valve spring. Verify the length is within specification. Refer to **SPECIFICATIONS**.



G03312330

Fig. 140: Measuring Valve Spring Free Length**Courtesy of MAZDA MOTORS CORP.**

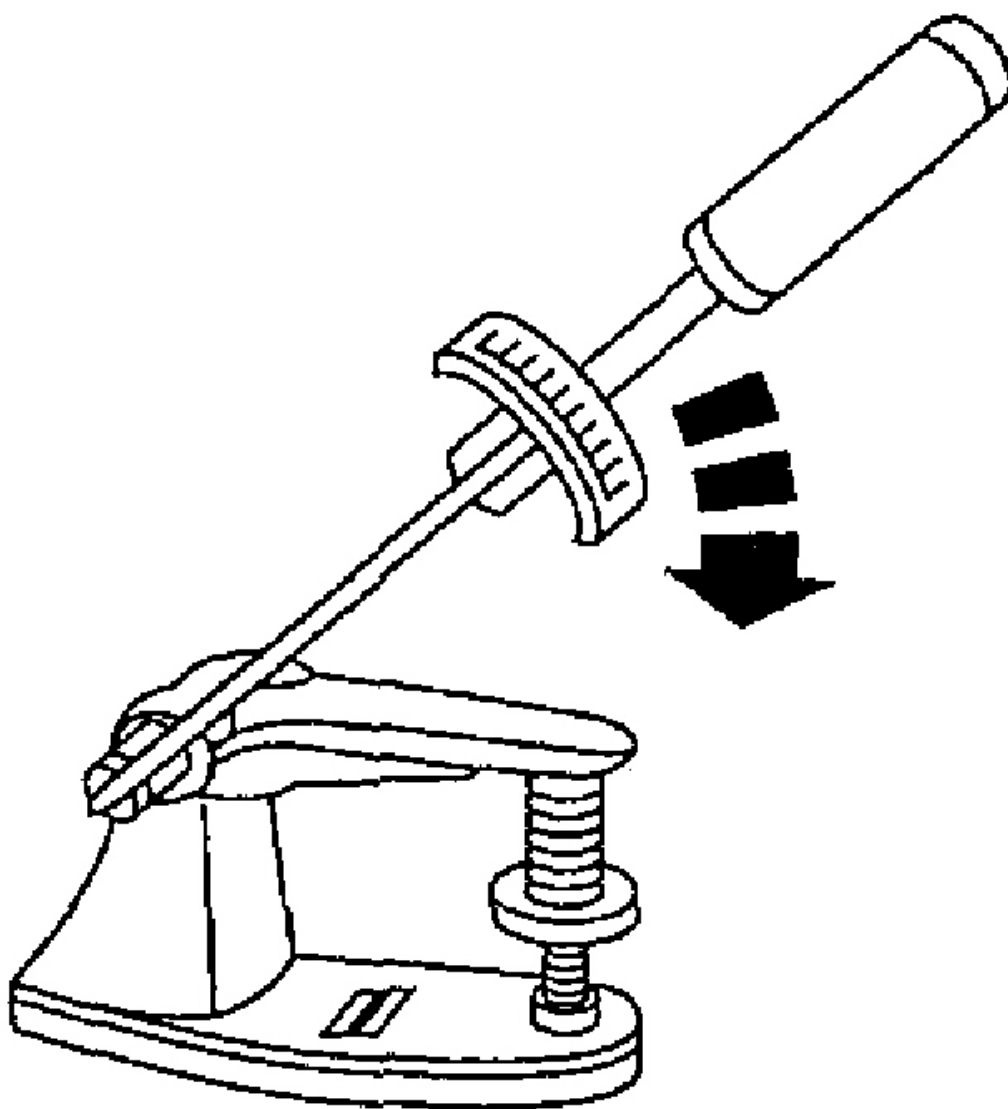
3. Measure the out-of-square on each valve spring.
 1. Turn the valve spring and observe the space between the top of the valve spring and the square. Replace the valve spring if out of specification. Refer to **SPECIFICATIONS**.



G03312331

Fig. 141: Measuring Valve Spring Out-Of-Square
Courtesy of MAZDA MOTORS CORP.

4. Using Valve/Clutch Spring Tester SST 303-006 (TOOL-6573-DD) or equivalent, check the valve springs for proper strength at the specified valve spring length.



G03312333

Fig. 142: Measuring Valve Spring Strength
Courtesy of MAZDA MOTORS CORP.

SPARK PLUG HOLE THREAD REPAIR

CAUTION:

- The cylinder head must be removed from the engine before installing a tapersert. If this procedure is done with the cylinder head on the

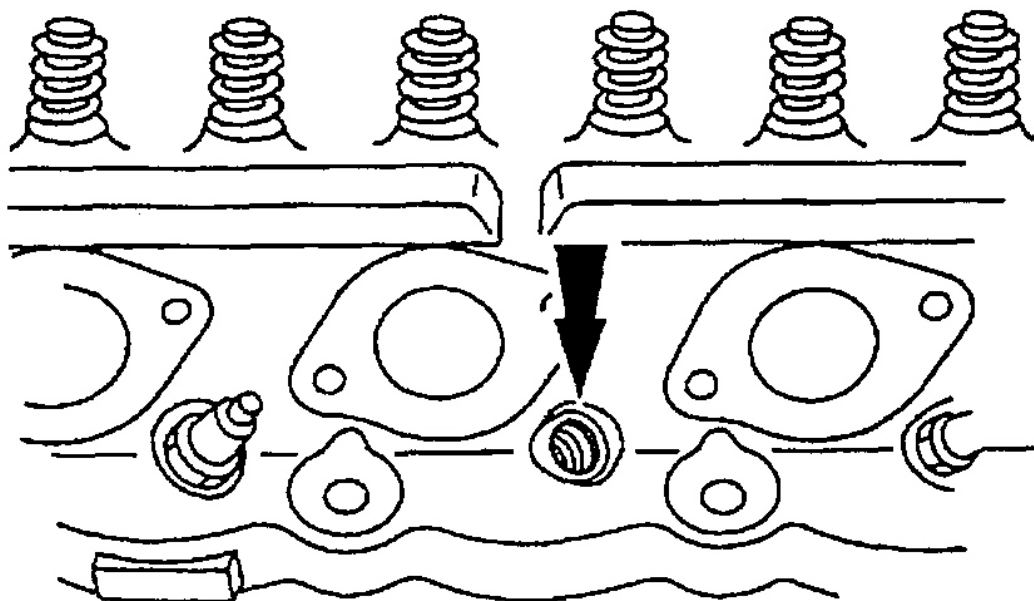
engine, the cylinder walls can be damaged by metal chips produced by the thread-cutting process.

- Do not use power or air-driven tools for installing taperserts. Cylinder head damage may occur.

NOTE:

- This repair is permanent and will have no effect on the cylinder block or spark plug life.

1. Clean the spark plug seat and threads.

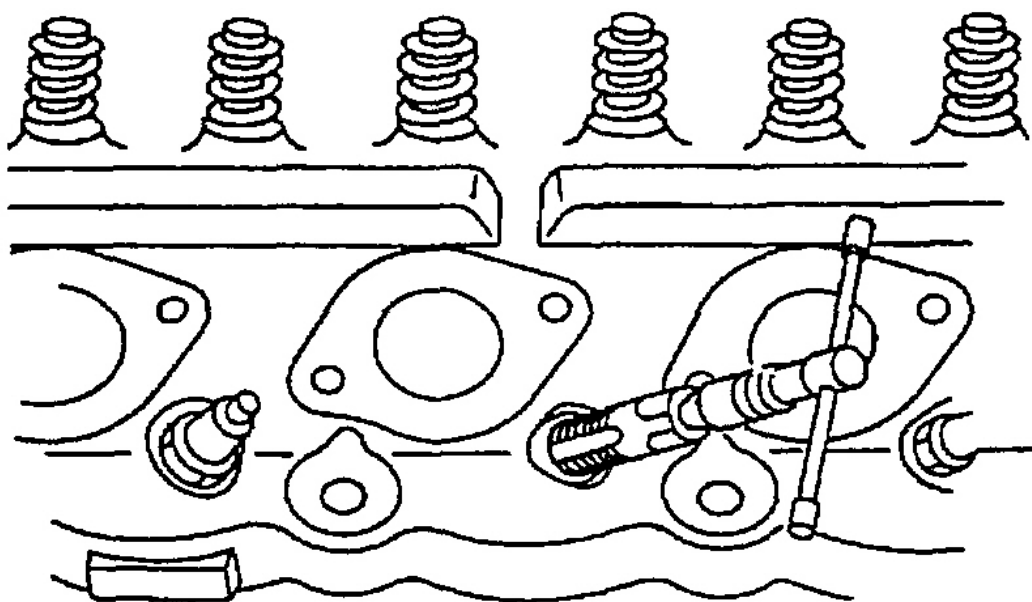


G03312332

Fig. 143: Cleaning Spark Plug Seat & Threads

Courtesy of MAZDA MOTORS CORP.

2. Start the tap into the spark plug hole, being careful to keep it properly aligned. As the tap begins to cut new threads, apply aluminum cutting oil.



G03312334

Fig. 144: Tapping Spark Plug Hole
Courtesy of MAZDA MOTORS CORP.

3. Continue cutting the threads and applying oil until the stop ring bottoms against the spark plug seat.
4. Remove the tap and metal chips.
5. Coat the threads of the mandrel with cutting oil.

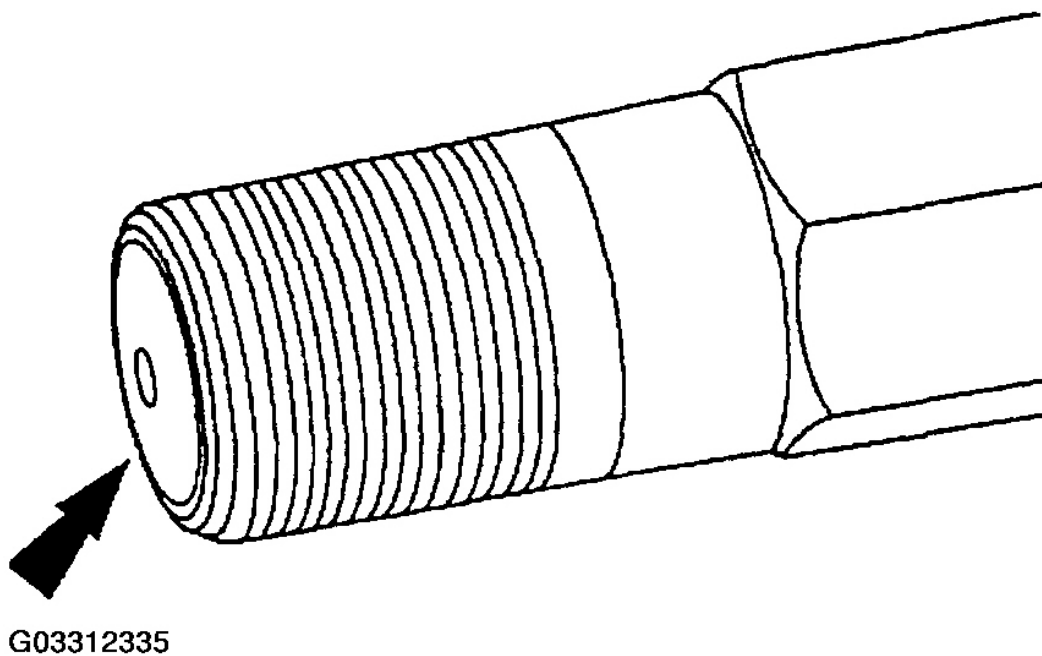


Fig. 145: Coating Threads Of Mandrel With Cutting Oil
Courtesy of MAZDA MOTORS CORP.

6. Thread the tapersert onto the mandrel until one thread of the mandrel extends beyond the tapersert.

NOTE:

- A properly installed tapersert will be either flush with or 1.0 mm (0.039 in) below the spark plug gasket seat.

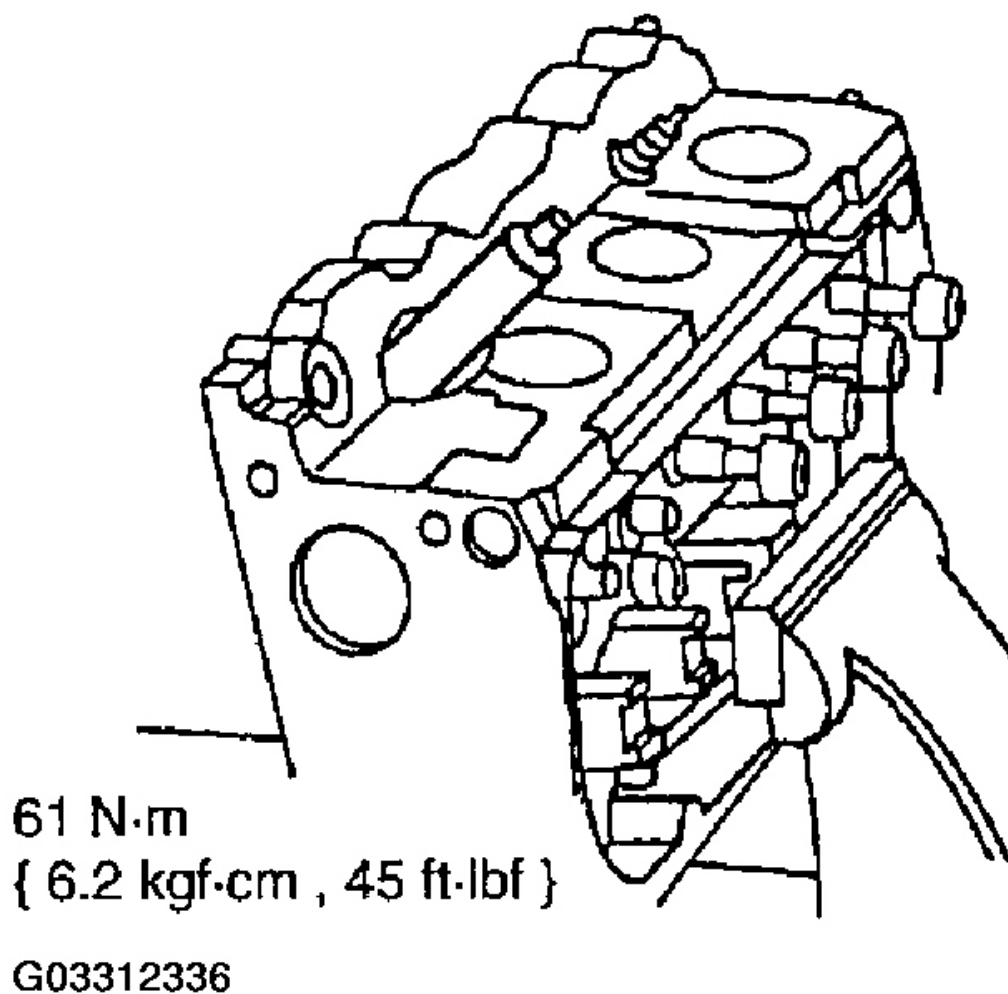
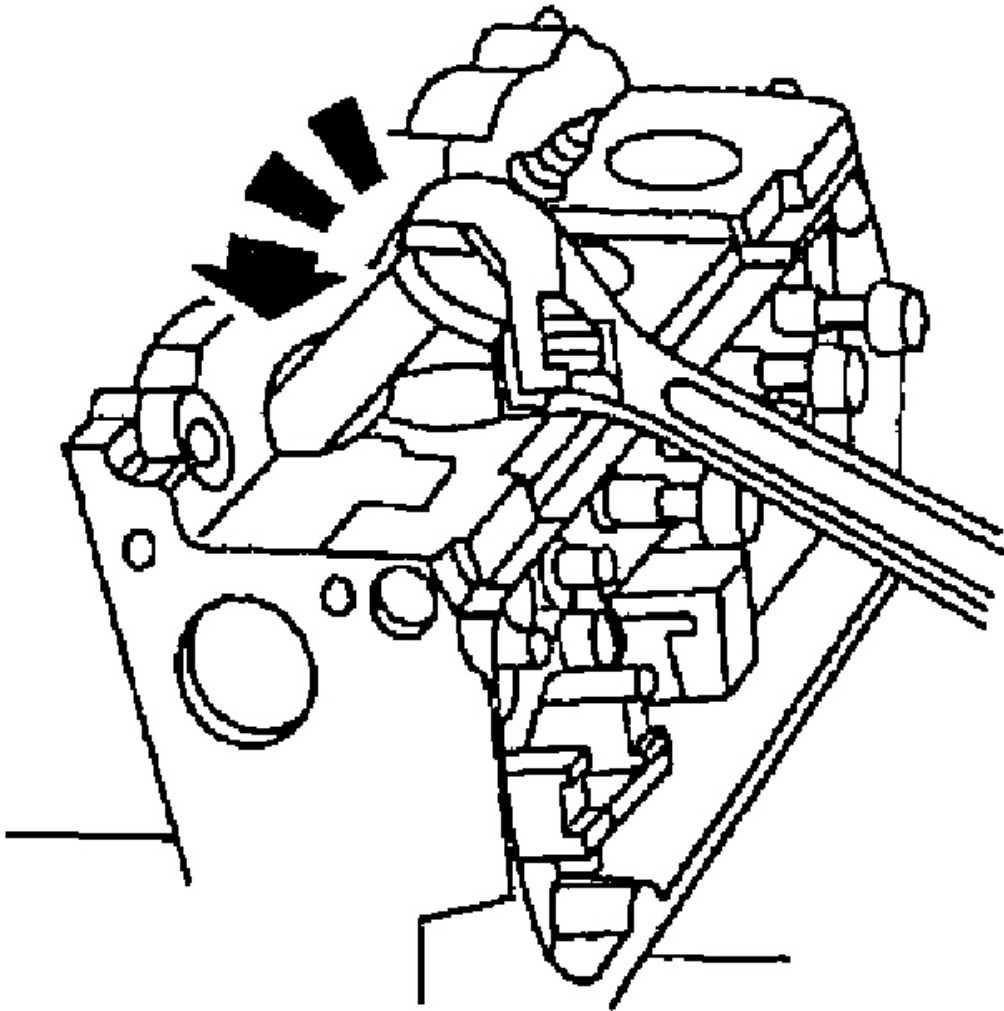


Fig. 146: Tightening Tapersert (With Torque Specifications)
Courtesy of MAZDA MOTORS CORP.

7. Tighten the tapersert into the spark plug hole.
8. Turn the mandrel body approximately one-half turn counterclockwise and remove.



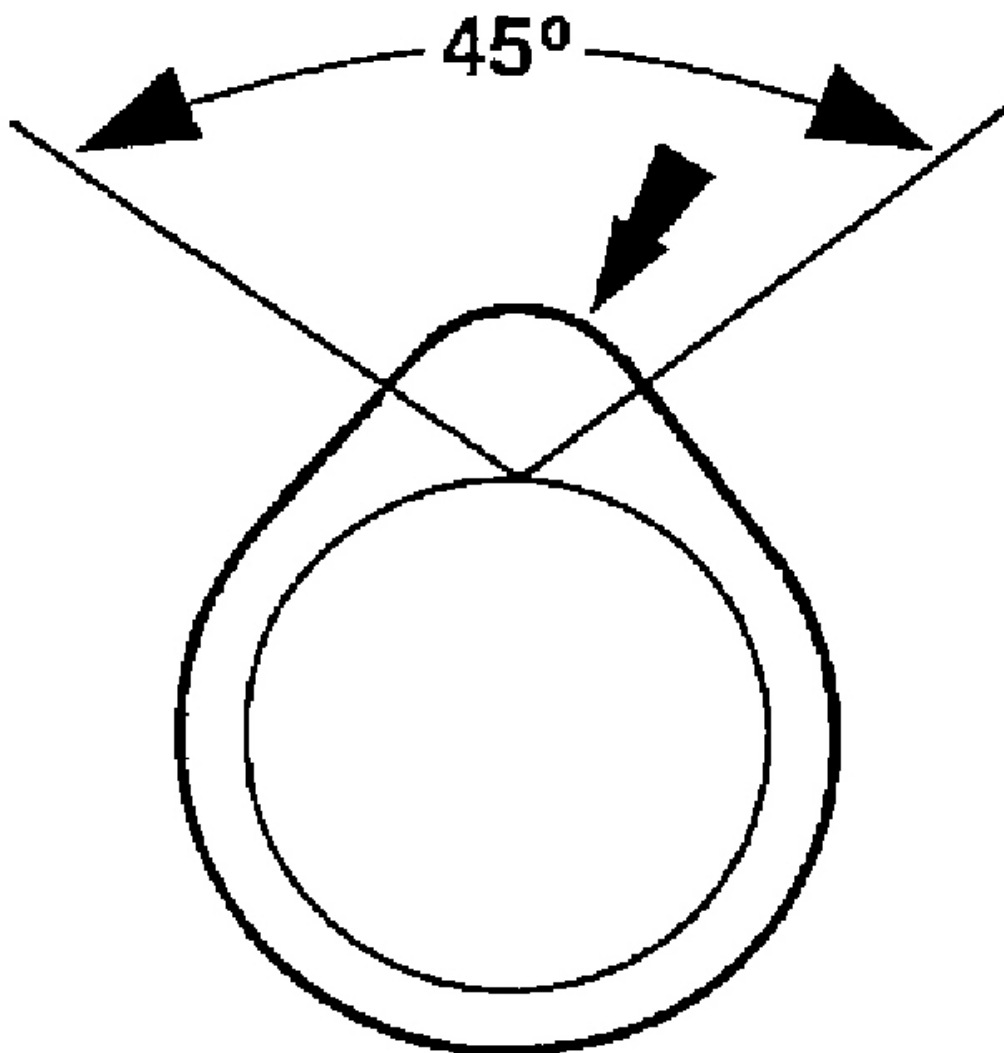
G03312339

Fig. 147: Removing Mandrel Body
Courtesy of MAZDA MOTORS CORP.

9. Use a feeler gauge and straight edge to check for cylinder head flatness. Refer to **CYLINDER HEAD INSPECTION**.

CAMSHAFT INSPECTION

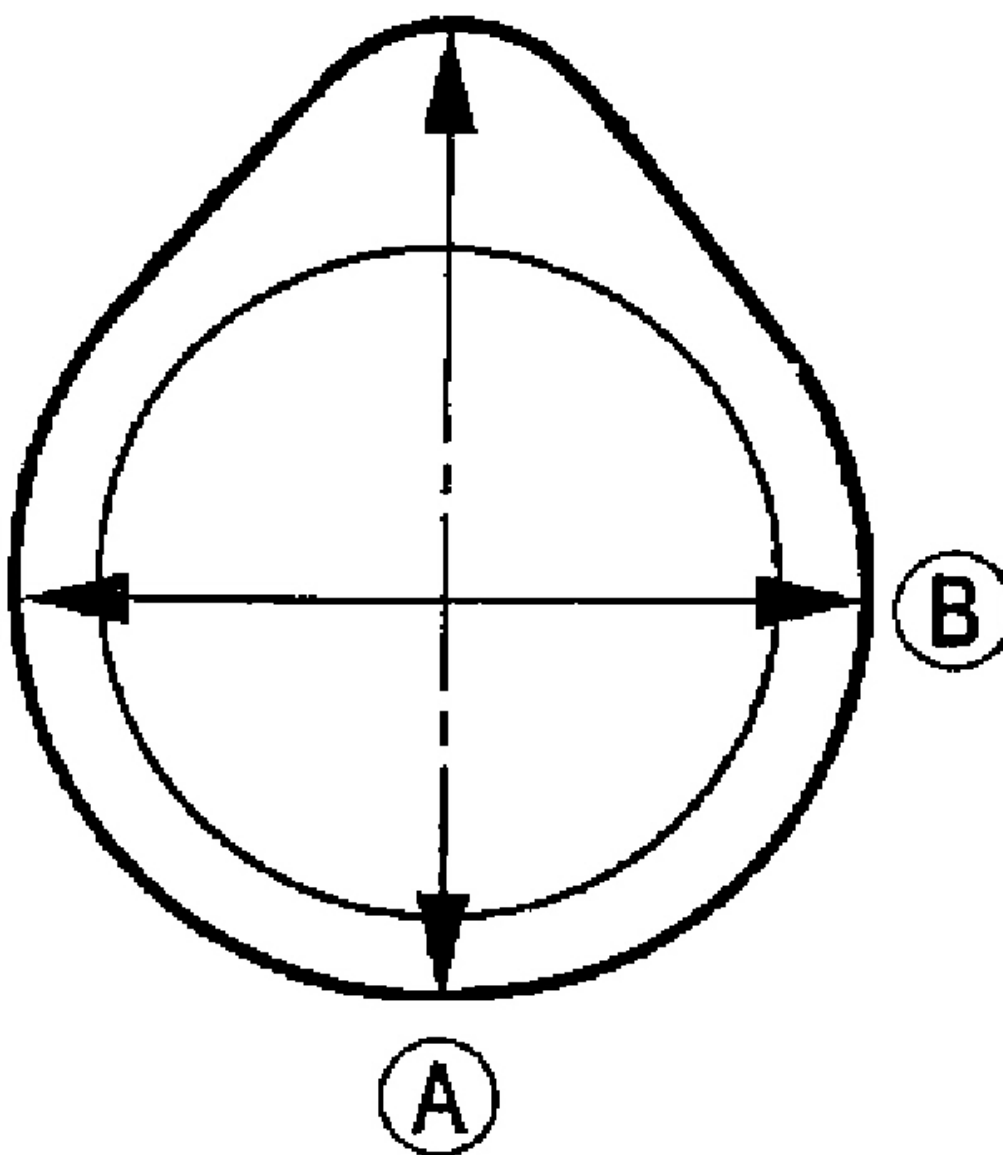
1. Inspect camshaft lobes for pitting or damage in the active area. Minor pitting is acceptable outside the active area.



G03312337

Fig. 148: Inspecting Camshaft Lobes
Courtesy of MAZDA MOTORS CORP.

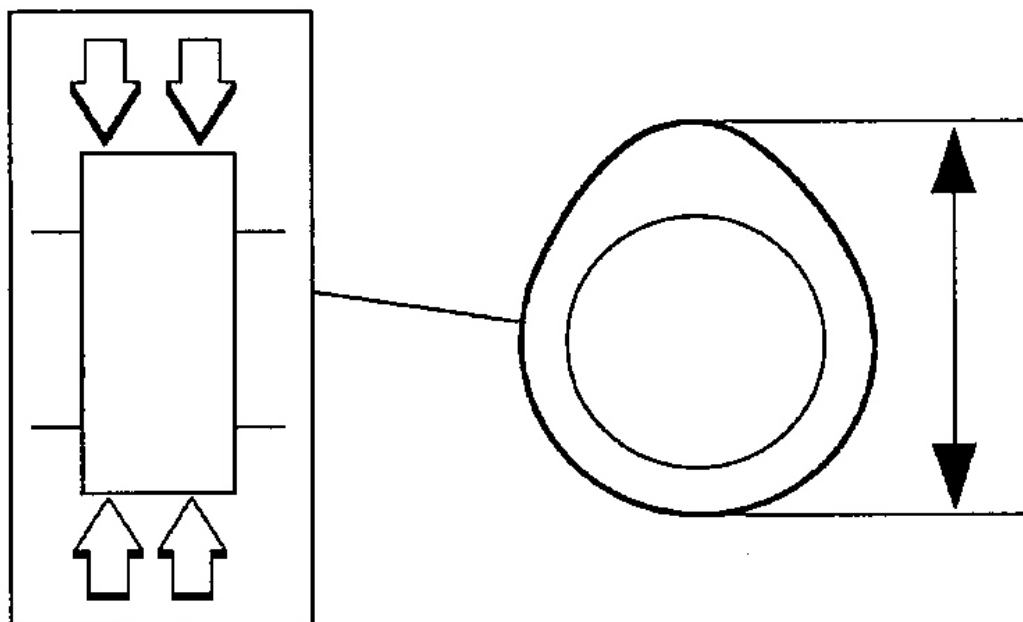
2. Measure diameter (A) and diameter (B) with a vernier caliper. The difference in measurements is the lobe lift.



G03312338

Fig. 149: Measuring Camshaft Lobes
Courtesy of MAZDA MOTORS CORP.

3. Measure each side of the lobe for even wear.

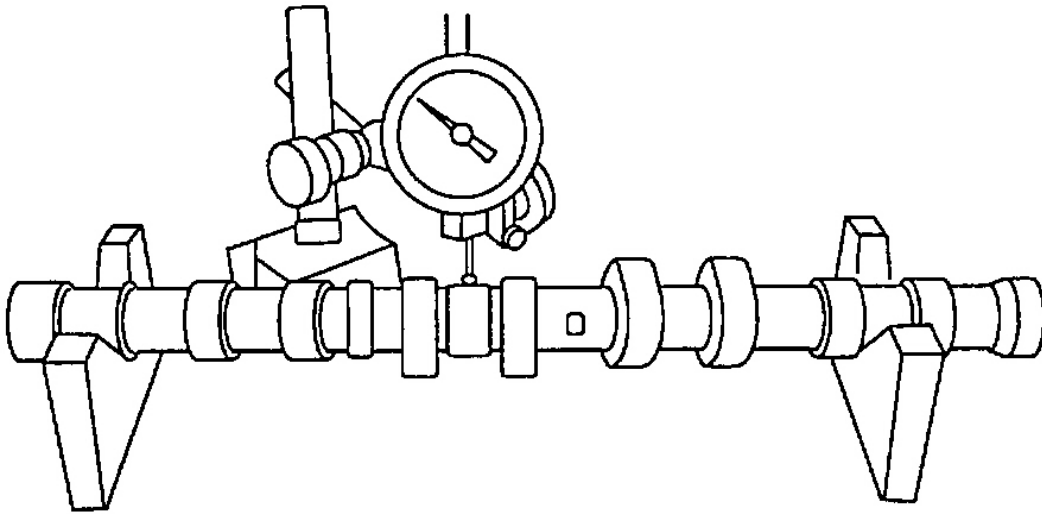


G03312340

Fig. 150: Measuring Each Side Of Lobe
 Courtesy of MAZDA MOTORS CORP.

NOTE:

- Camshaft journals must be within specifications before checking runout.



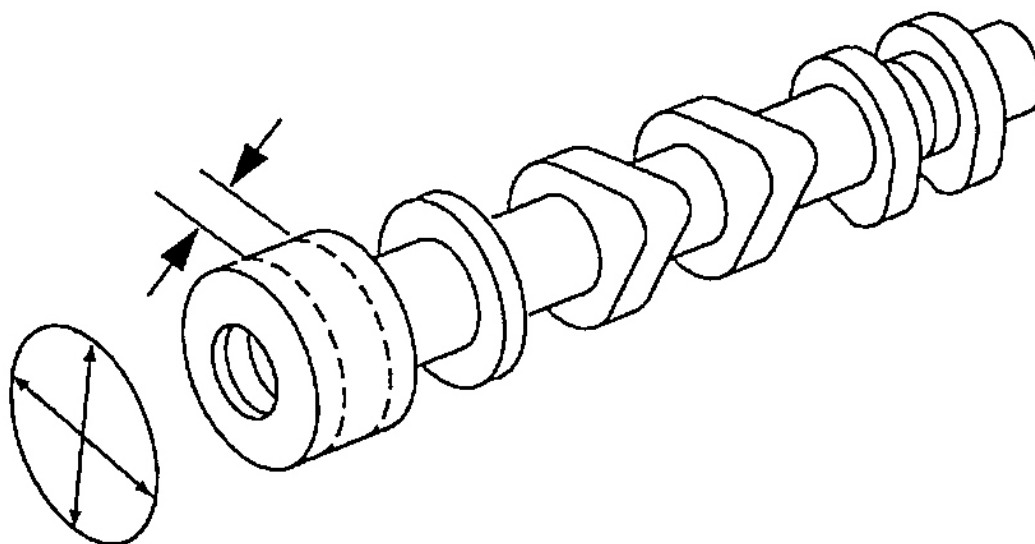
G03312341

Fig. 151: Measuring Camshaft Runout
Courtesy of MAZDA MOTORS CORP.

4. Use the Dial Indicator With Bracketry to measure the camshaft runout.
 1. Rotate the camshaft and subtract the lowest dial indicator reading from the highest dial indicator reading. Refer to **SPECIFICATIONS**.

CAMSHAFT OIL CLEARANCE INSPECTION

1. Measure each camshaft journal diameter in two directions. Verify journal diameter is within specifications. Refer to **SPECIFICATIONS**.
 1. If out of specification, replace as necessary.

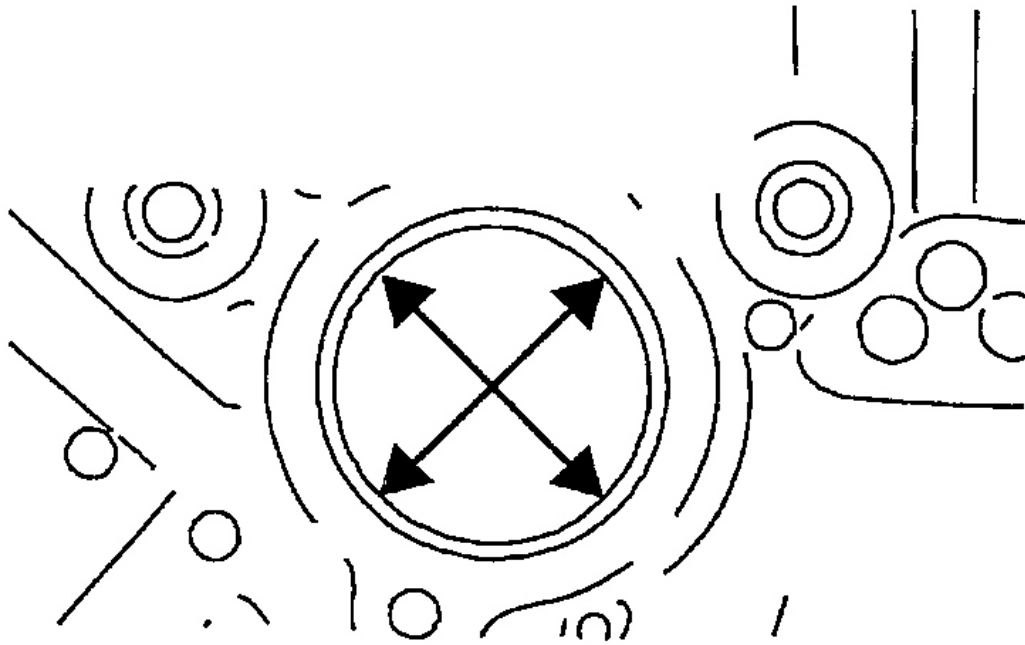


G03312342

Fig. 152: Measuring Camshaft Journal Diameter In Two Directions
Courtesy of MAZDA MOTORS CORP.

NOTE:

- The camshaft journals must meet specification before checking camshaft journal clearance.



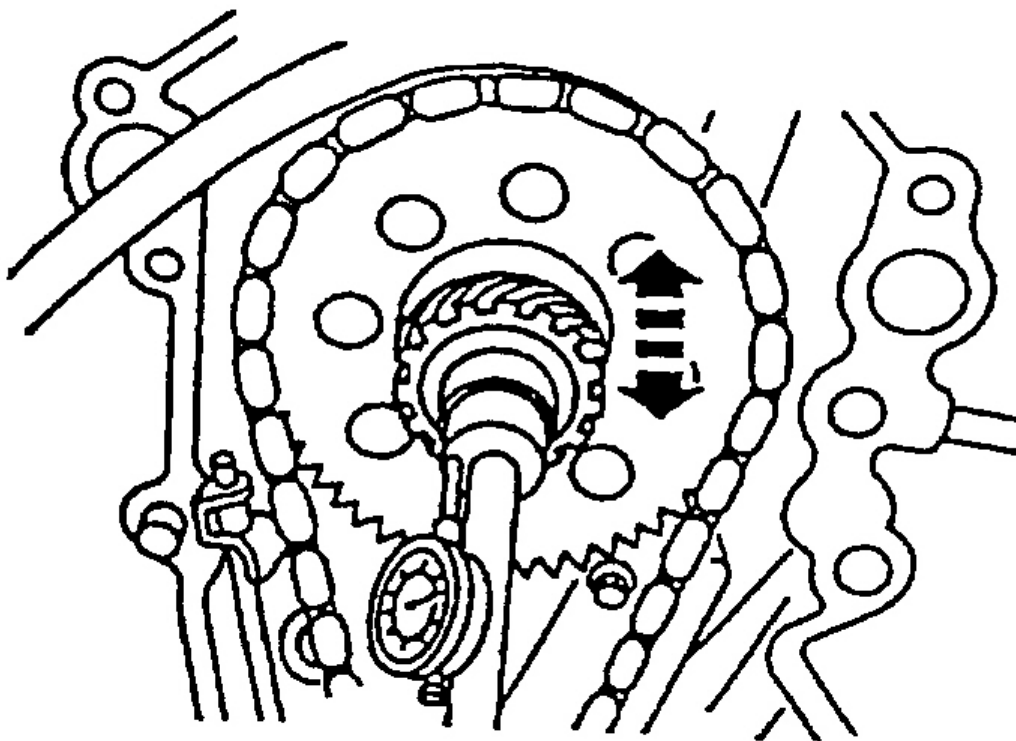
G03312343

Fig. 153: Measuring Camshaft Bearings
Courtesy of MAZDA MOTORS CORP.

2. Measure the camshaft bearings in two directions.
 1. Subtract the camshaft journal diameter from the camshaft bearing diameter.

CAMSHAFT END PLAY INSPECTION

1. Remove the valve tappets. Refer to **ENGINE DISASSEMBLY/ASSEMBLY**.
2. Use a suitable Dial Indicator With Bracketry to measure the camshaft end play.
3. Position the camshaft to the rear of the cylinder block.
4. Zero the Dial Indicator With Bracketry.
5. Move the camshaft to the front of the cylinder block. Note and record the camshaft end play.
 1. Refer to **SPECIFICATIONS**. If the camshaft end play exceeds specification, replace the camshaft thrust plate. Refer to **ENGINE DISASSEMBLY/ASSEMBLY**.

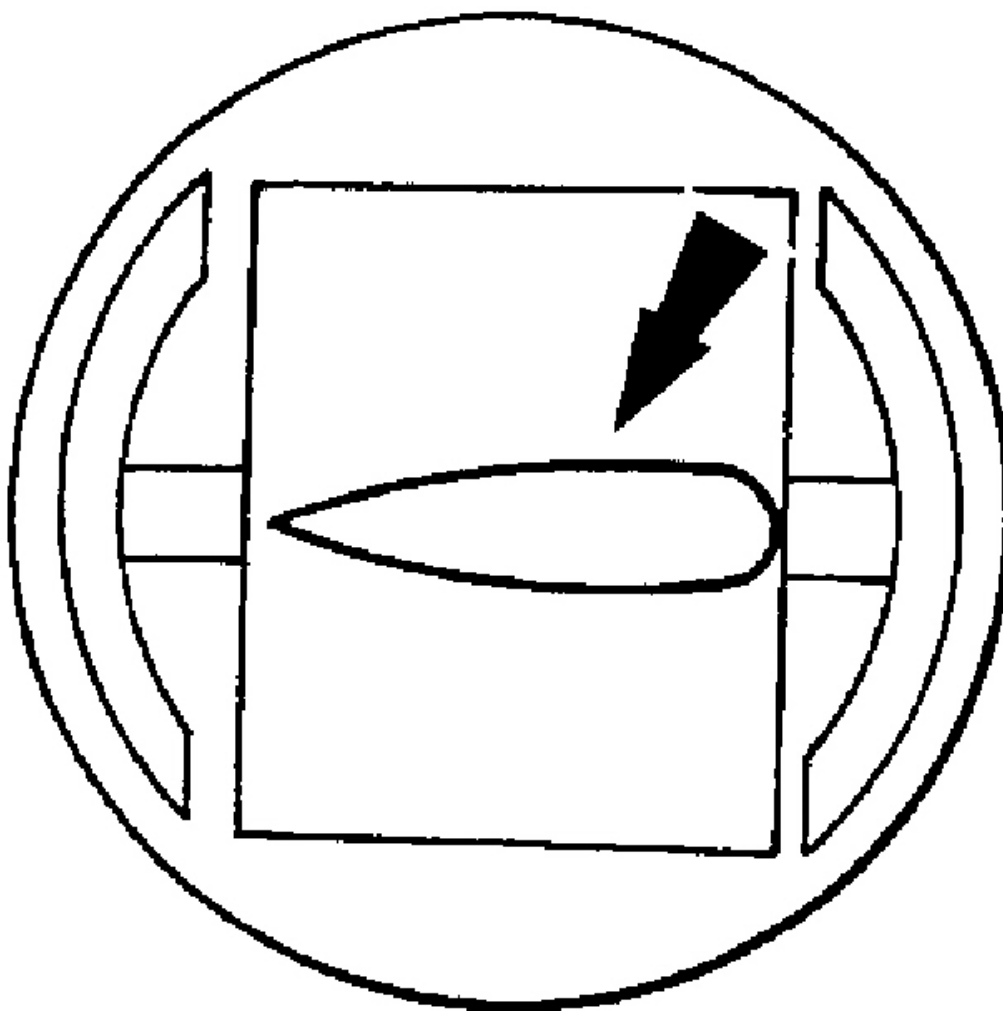


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Fig. 154: Measuring Camshaft End Play
Courtesy of MAZDA MOTORS CORP.

TAPPET INSPECTION

1. Inspect the valve tappet for damage. If any damage is found, inspect the camshaft lobes and valves for damage. Refer to CAMSHAFT INSPECTION.



G03312344

Fig. 155: Inspecting Valve Tappet
Courtesy of MAZDA MOTORS CORP.

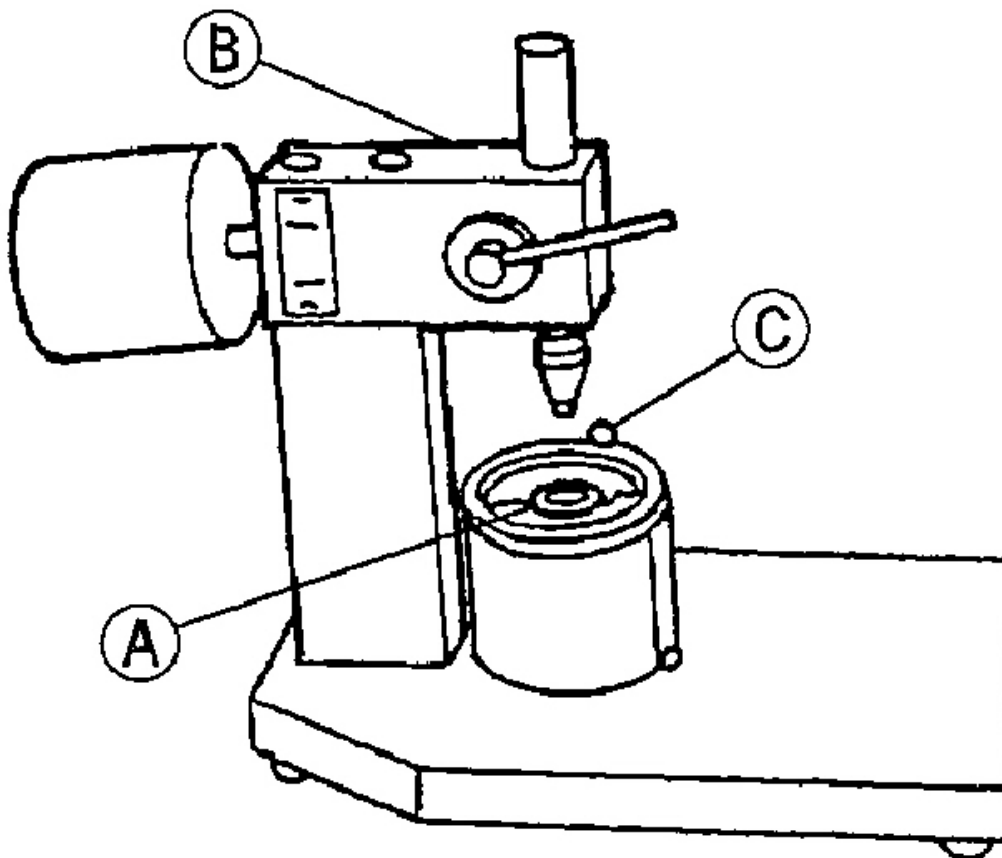
2. Replace parts as necessary.

TAPPET LEAKDOWN TEST

NOTE:

- This test will not be accurate if it is done with engine oil in the hydraulic valve tappet. Use testing fluid. New hydraulic valve tappets are already filled with testing fluid.

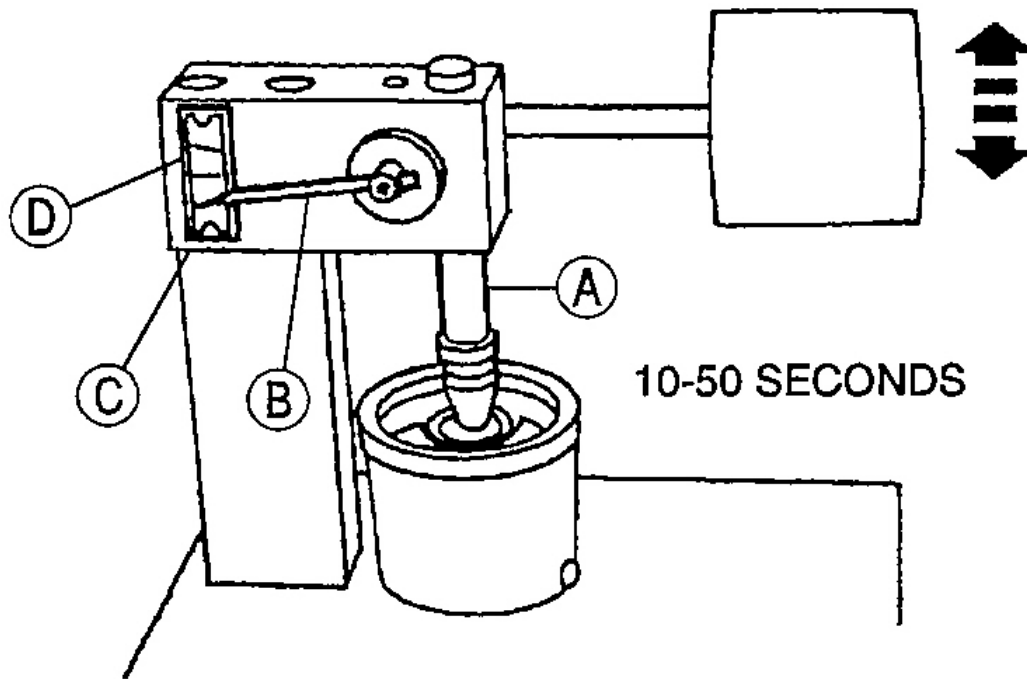
1. Compress the hydraulic valve tappet to remove the engine oil, if necessary.
2. Place the (A) hydraulic valve tappet in a (B) commercially available hydraulic tappet leakdown tester. Position the (C) steel ball provided in the plunger cap. Add testing fluid to cover the hydraulic tappet and compress hydraulic tappet leakdown tester until the hydraulic valve tappet is filled with testing fluid.



G03312346

Fig. 156: Placing (A) Hydraulic Valve Tappet In (B) Hydraulic Tappet Leakdown Tester
Courtesy of MAZDA MOTORS CORP.

3. Adjust the length of the (A) ram so that the (B) pointer is just below the (C) Start Timing mark when the ram contacts the hydraulic valve tappet. Start timing as the pointer passes the (C) Start Timing mark and end timing as the pointer reaches the (D) center mark.



G03312349

Fig. 157: Compressing Hydraulic Valve Tappet
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK INSPECTION/REPAIR

CYLINDER BLOCK INSPECTION

1. Measure the cylinder bore at the top and bottom. Verify the cylinder bore is within the wear limit. The difference indicates the cylinder taper; bore the cylinder to the next oversize.

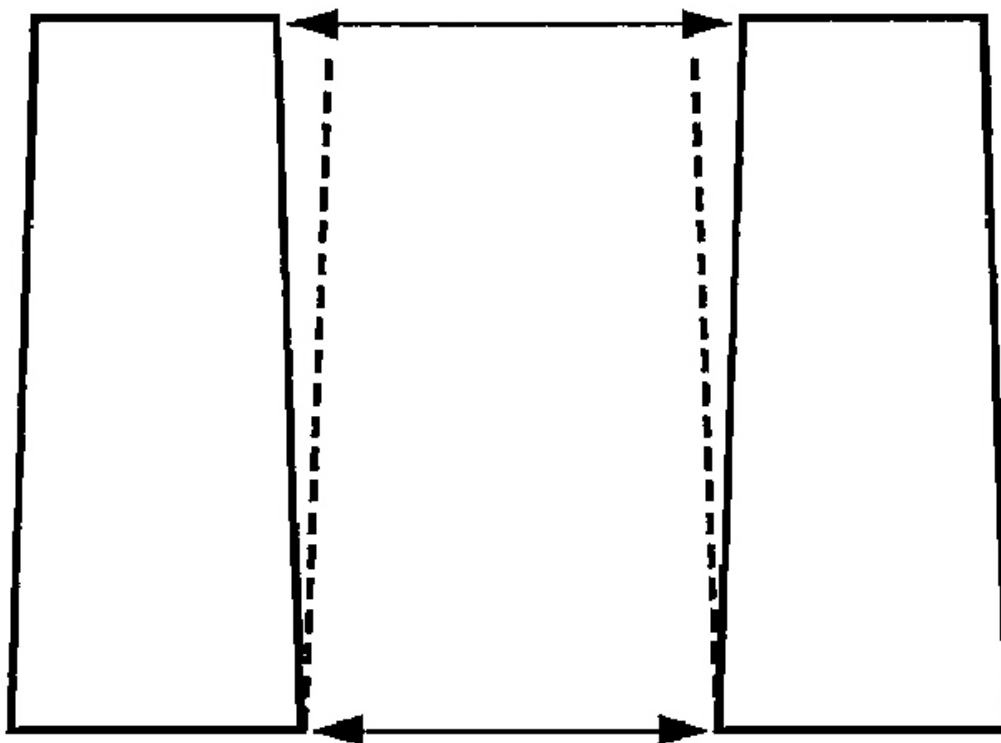
**G03312347**

Fig. 158: Measuring Cylinder Bore
Courtesy of MAZDA MOTORS CORP.

2. Measure the cylinder bore in two directions. The difference is the out-of-round. Verify the out-of-round is within the wear limit and bore the cylinder to the next oversize limit.

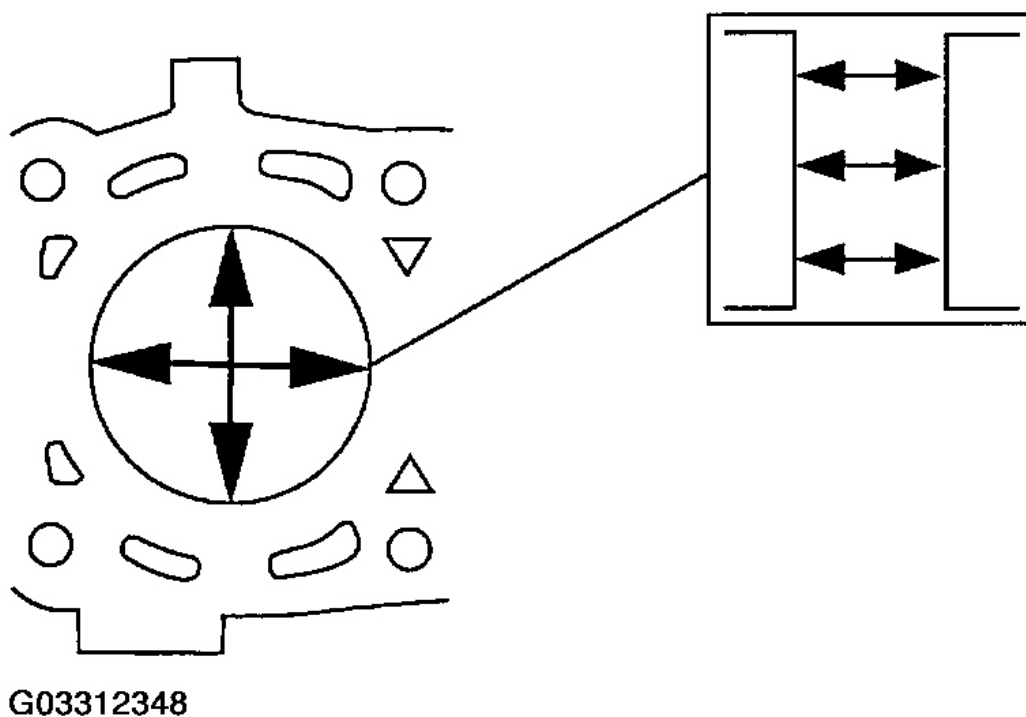
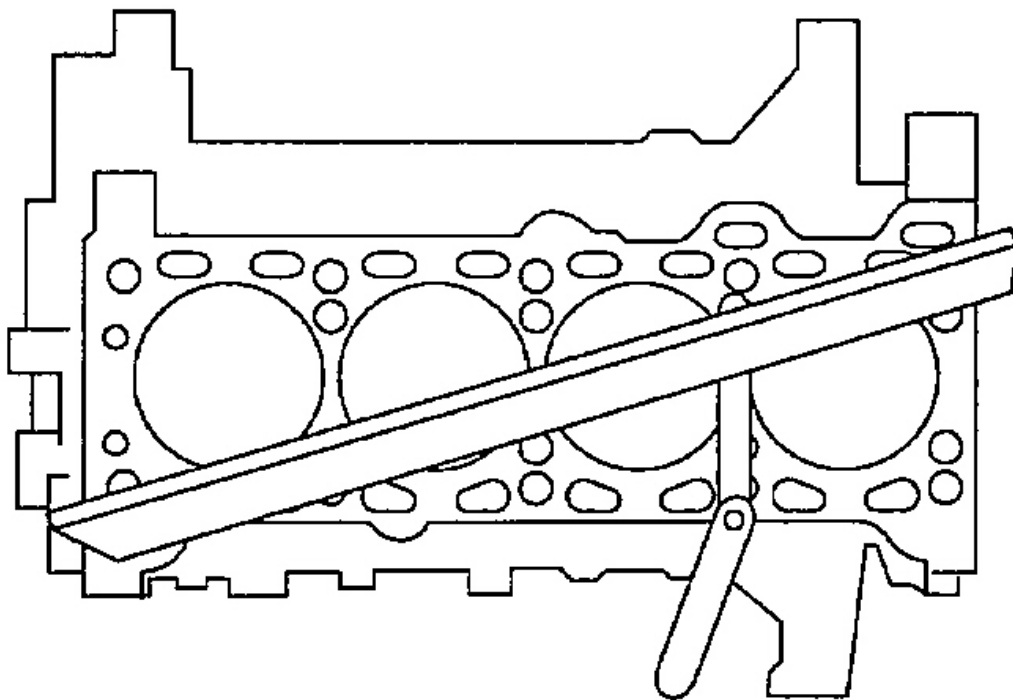


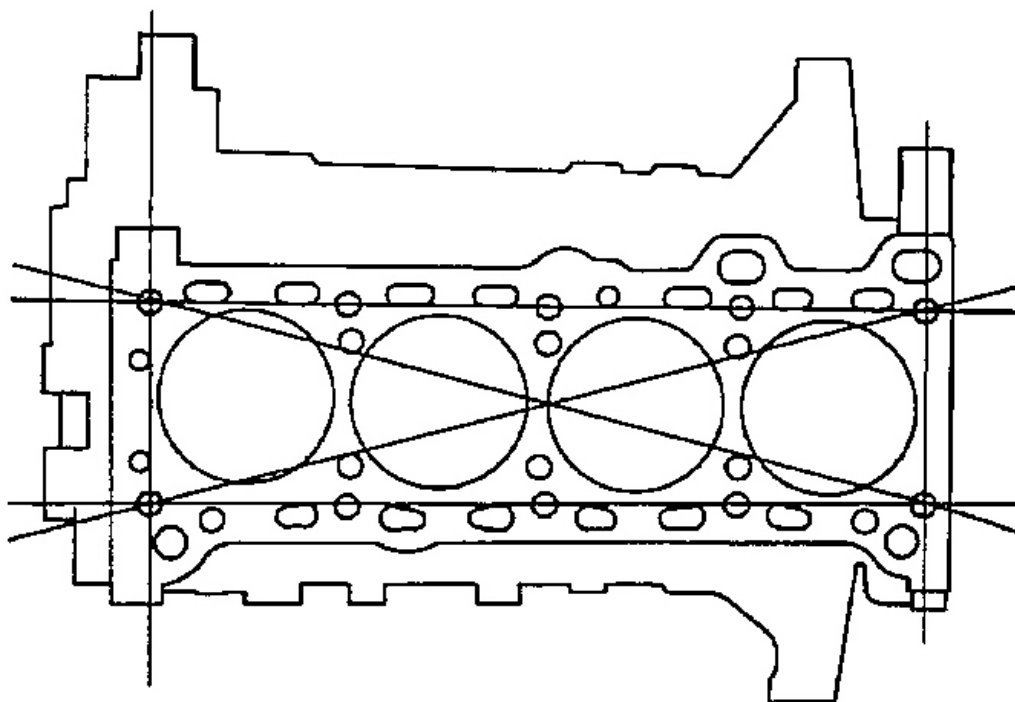
Fig. 159: Measuring Cylinder Out-Of-Round
Courtesy of MAZDA MOTORS CORP.

3. Use the Straight Edge and the Feeler Gauge to inspect the head gasket surface for flatness. If the cylinder block is distorted, resurface the cylinder block within specification. Refer to **SPECIFICATIONS**.
 - The head gasket surface is measured in six straight line directions for flatness.



G03312350

Fig. 160: Inspecting Head Gasket Surface For Flatness
Courtesy of MAZDA MOTORS CORP.



G03312351

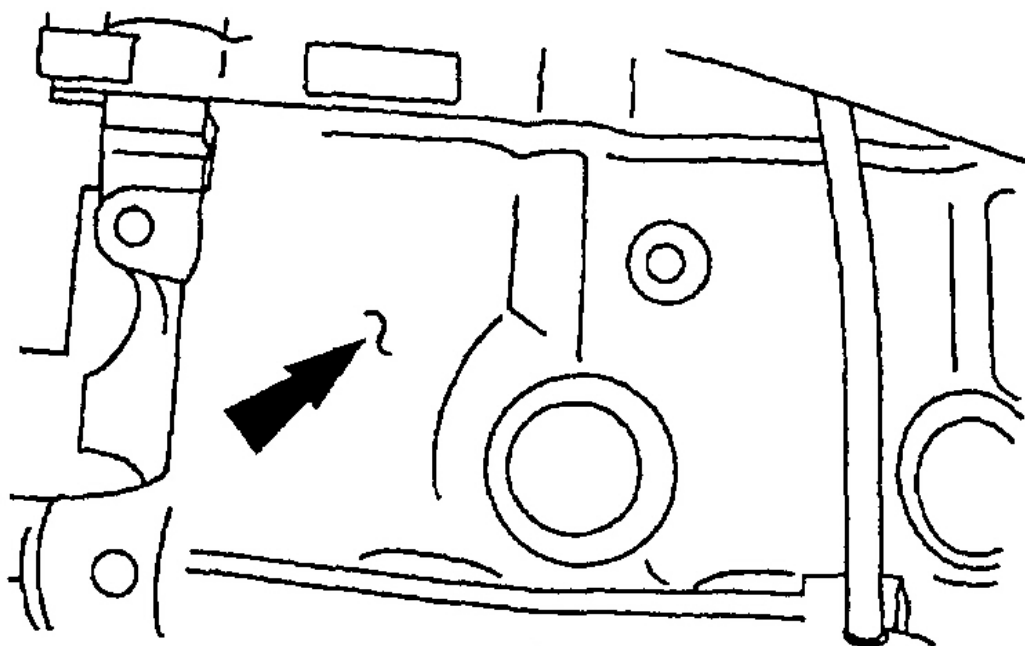
Fig. 161: Measuring In Six Straight Line Directions For Flatness
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK REPAIR

CAUTION:

- Do not attempt to repair cracks.
- Do not attempt to repair areas where temperature will exceed 260°C (500°F).

1. Repair porosity defects with an epoxy sealer.
 1. Clean the surface to be repaired to a bright, oil-free metal surface.
 2. Chamfer or undercut the repair area to a greater depth than the rest of the cleaned surface. Solid metal must surround the area to be repaired.
 3. Apply the epoxy sealer and heat-cure with a 250 watt lamp placed 254 mm (10 in) from the repaired surface or air dry for 10-12 hours at a temperature above 10°C (50°F).
 4. Sand or grind the repaired area to blend with the general contour of the surface.
 5. Paint the surface to match the rest of the cylinder block.



G03312352

Fig. 162: Identifying Porosity Defect
Courtesy of MAZDA MOTORS CORP.

CYLINDER BLOCK HONING

CAUTION:

- After the final honing and prior to checking the piston fit, thoroughly clean the cylinder bore with a detergent and water solution. Then lightly coat the cylinder bore with Premium SAE 10W-30 Motor Oil.
- When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and Premium SAE 10W-30 Motor Oil.

NOTE:

- Before any cylinder bore is honed, all main bearing caps must be installed so that the crankshaft bearing bores will not become distorted.
- To correct taper out-of-round, bore the cylinder block.
- Honing should be done when fitting new piston rings or removing minor surface imperfections.

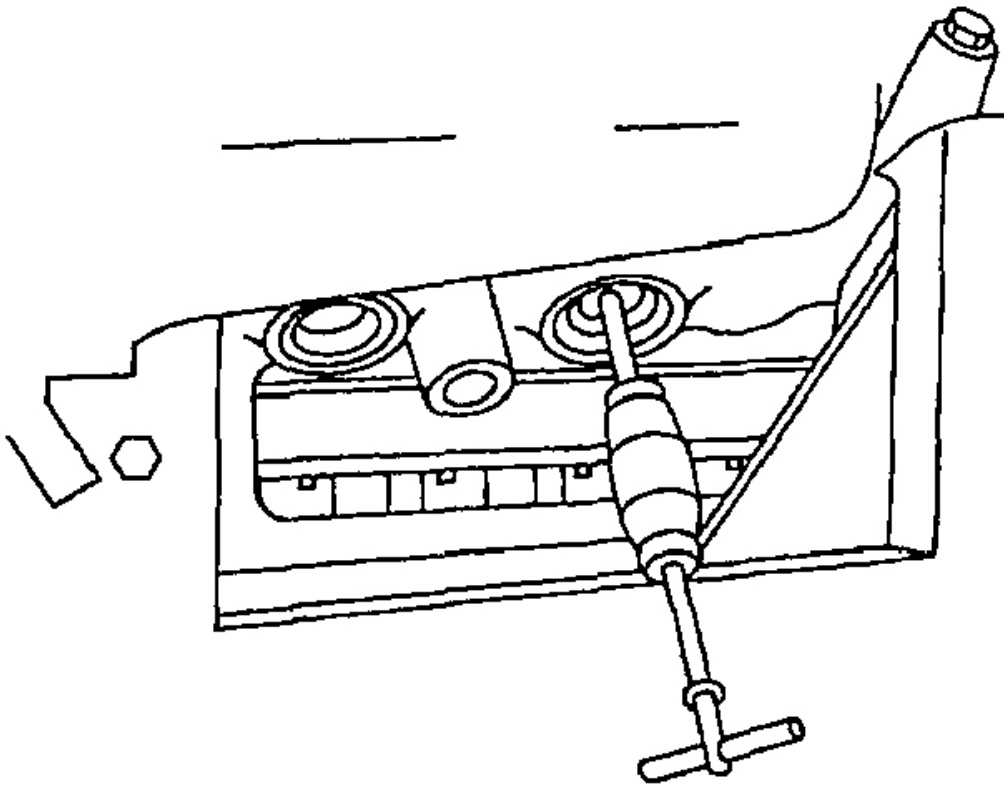
CAUTION:

- If these procedures are not followed, rusting of the cylinder bores may occur.

1. Hone with **SST T73L-6011-A** or equivalent, at a speed of 300-500 RPM and a hone grit of 180-200, to provide the desired cylinder bore surface finish of 18-38 AA.
2. Clean the cylinder bores with soap or detergent and water.
3. Thoroughly rinse with clean water and wipe dry with a clean, lint-free cloth.
4. Use a clean, lint-free cloth and lubricate the cylinder bores.
 - Use Super Premium 5W-30 SAE Motor Oil.

CYLINDER BLOCK CORE PLUG REPLACEMENT

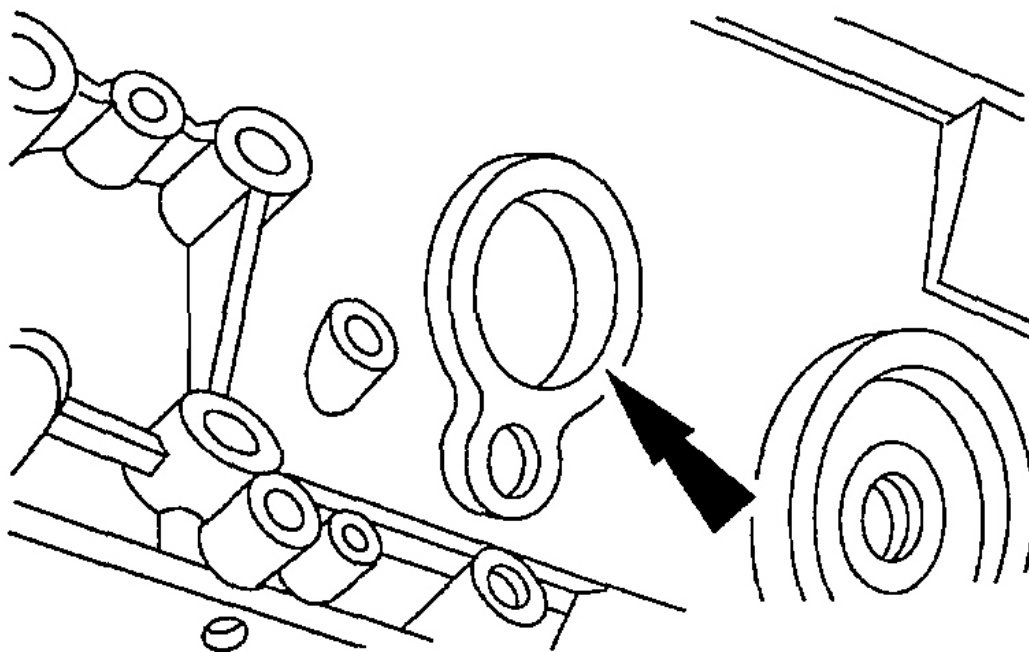
1. Drill a small hole in the center of the engine block, then use **SST T78P-3504-N** or equivalent to remove the engine block plug.



G03312353

Fig. 163: Removing Engine Block Plug
Courtesy of MAZDA MOTORS CORP.

2. Inspect the cylinder block plug bore for any damage that would interfere with the proper sealing of the plug. If the cylinder block plug bore is damaged, bore for the next oversize plug.



G03312354

Fig. 164: Inspecting Cylinder Block Plug Bore
Courtesy of MAZDA MOTORS CORP.

NOTE:

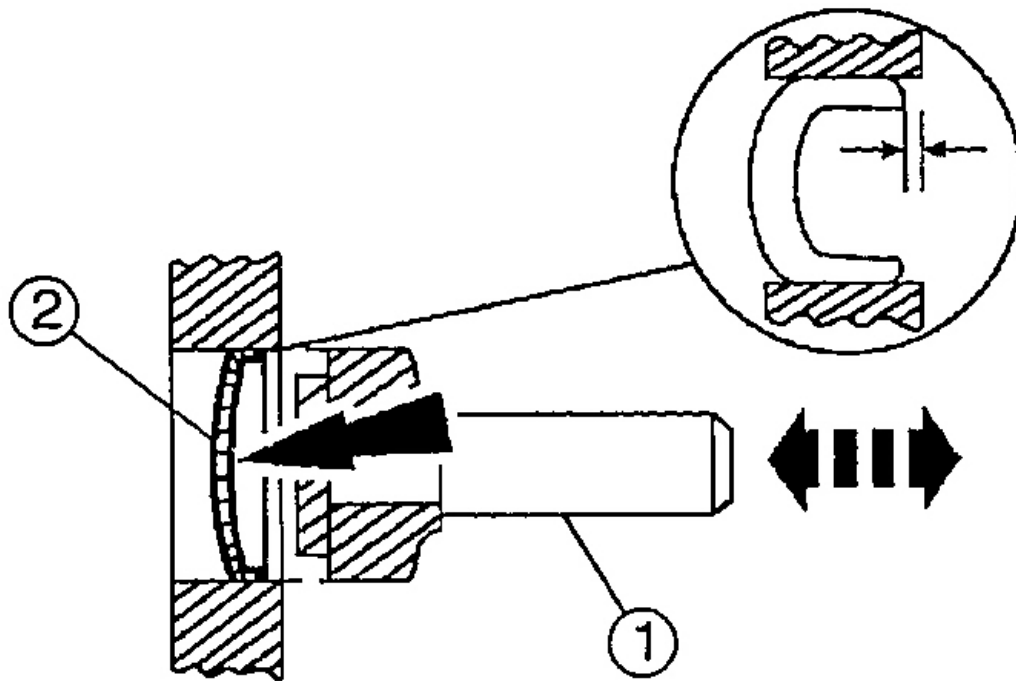
- Oversize plugs are identified by the "OS" stamped in the flat located on the cup side of the plug.

3. Coat the engine block plug and bore lightly with an oil-resistant (oil galley) Stud and Bearing Mount Sealer and install the engine block plug.

CYLINDER CORE PLUG INSTALLATION (CUP-TYPE)**CAUTION:**

- Use care during this procedure so as not to disturb or distort the cup sealing surface.
- When installed, the flanged edge must be below the chamfered edge of the bore to effectively seal the bore.

1. Use a (1) cup-type core plug replacer tool to seat the (2) cup-type engine block plug.



G03312355

Fig. 165: Installing Cup-Type Core Plug
Courtesy of MAZDA MOTORS CORP.

CYLINDER CORE PLUG INSTALLATION (EXPANSION TYPE)

CAUTION:

- Do not contact the crown when installing a cup-type engine block plug. This could expand the plug before seating and result in leakage.

1. Use an (1) expansion-type core plug replacer tool to seat the (2) expansion-type engine block plug.

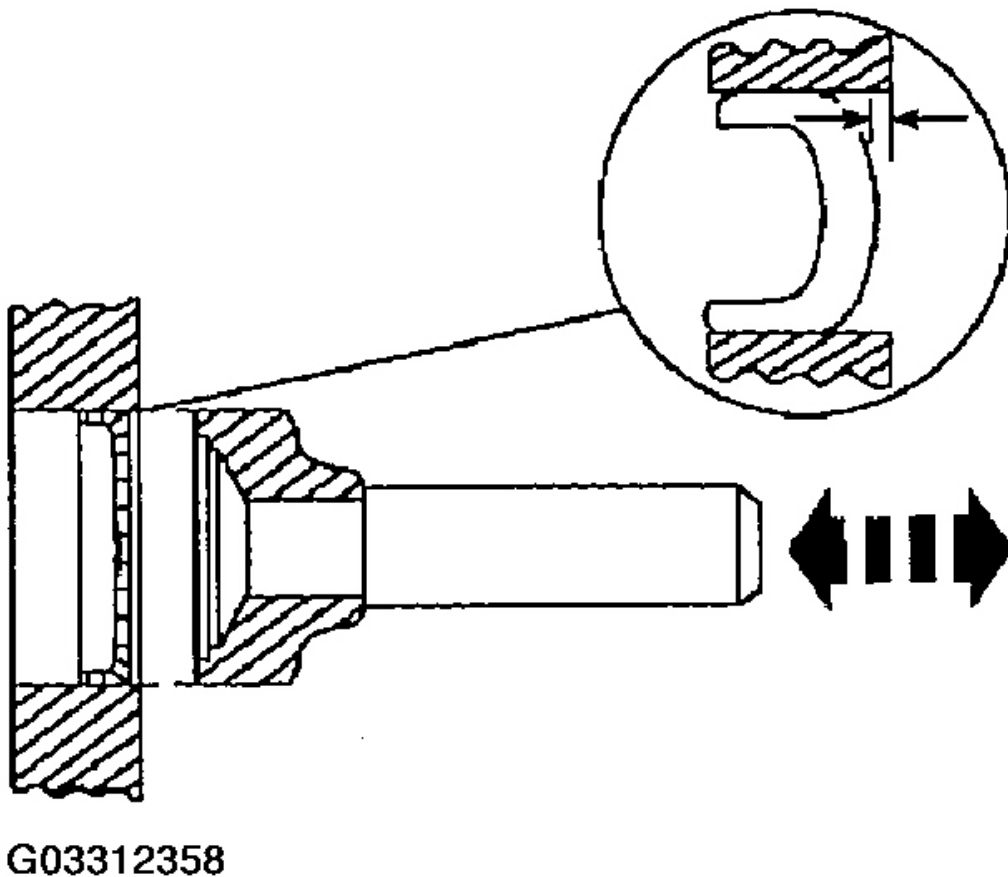


Fig. 166: Installing Expansion-Type Engine Block Plug
Courtesy of MAZDA MOTORS CORP.

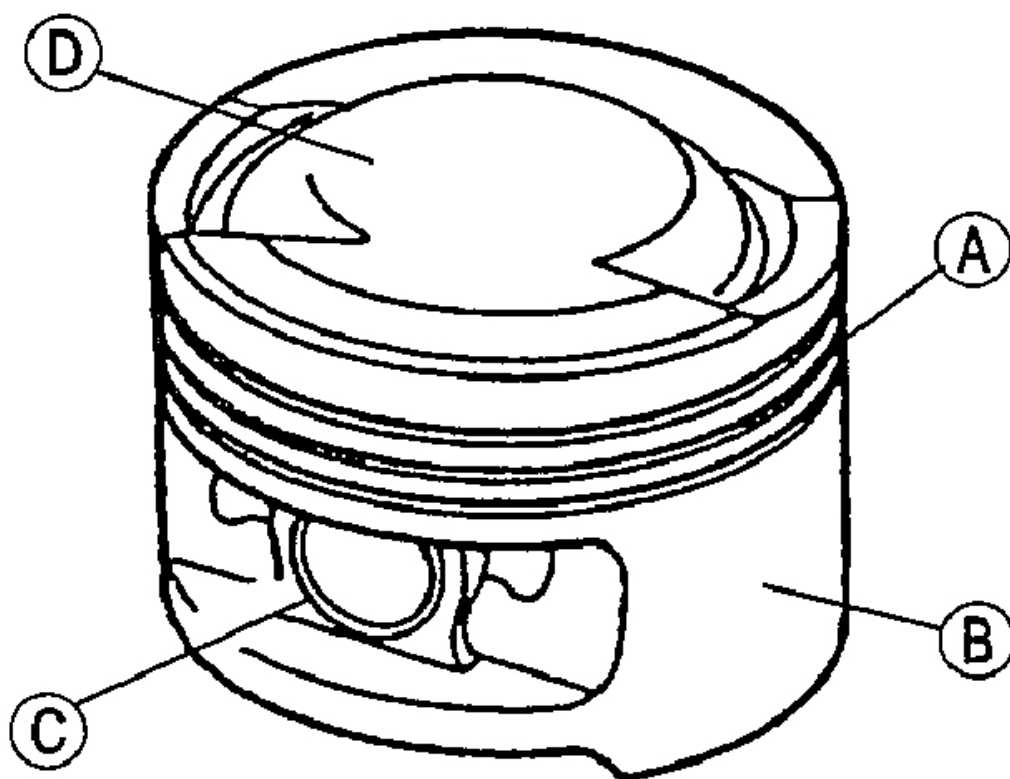
PISTON INSPECTION

PISTON INSPECTION

CAUTION:

- Do not use a caustic cleaning solution or a wire brush to clean the pistons or damage may occur.

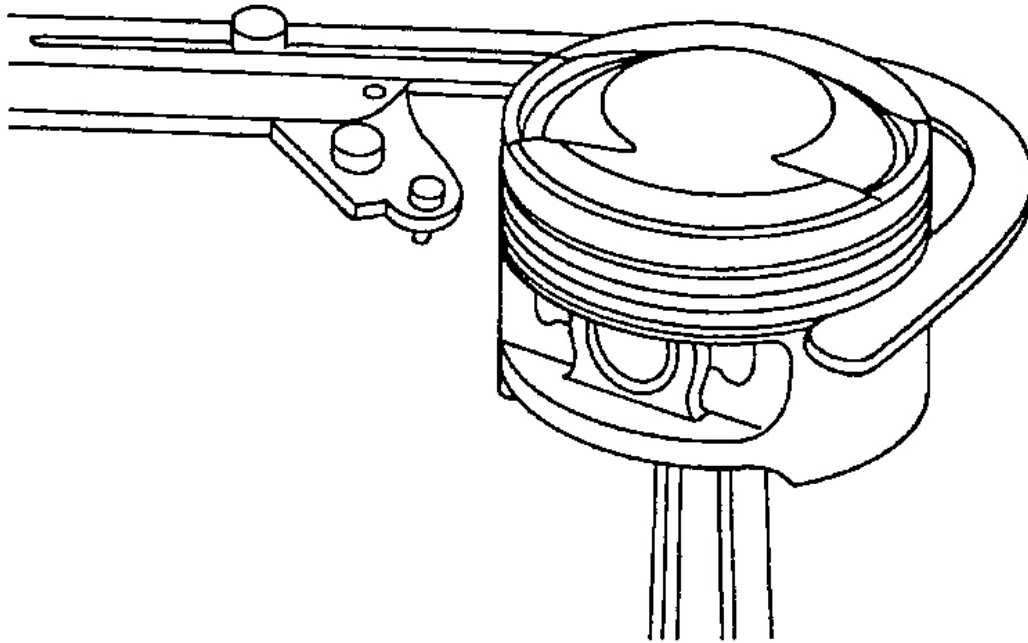
1. Clean and inspect the (A) ring lands, (B) skirts, (C) pin bosses, and the (D) top of the pistons. If wear marks or polishing are found on the piston skirt, check for a bent or twisted connecting rod.



G03312356

Fig. 167: Cleaning & Inspecting Piston
Courtesy of MAZDA MOTORS CORP.

2. Clean the piston ring grooves.
 - Make sure the oil ring holes are clean.

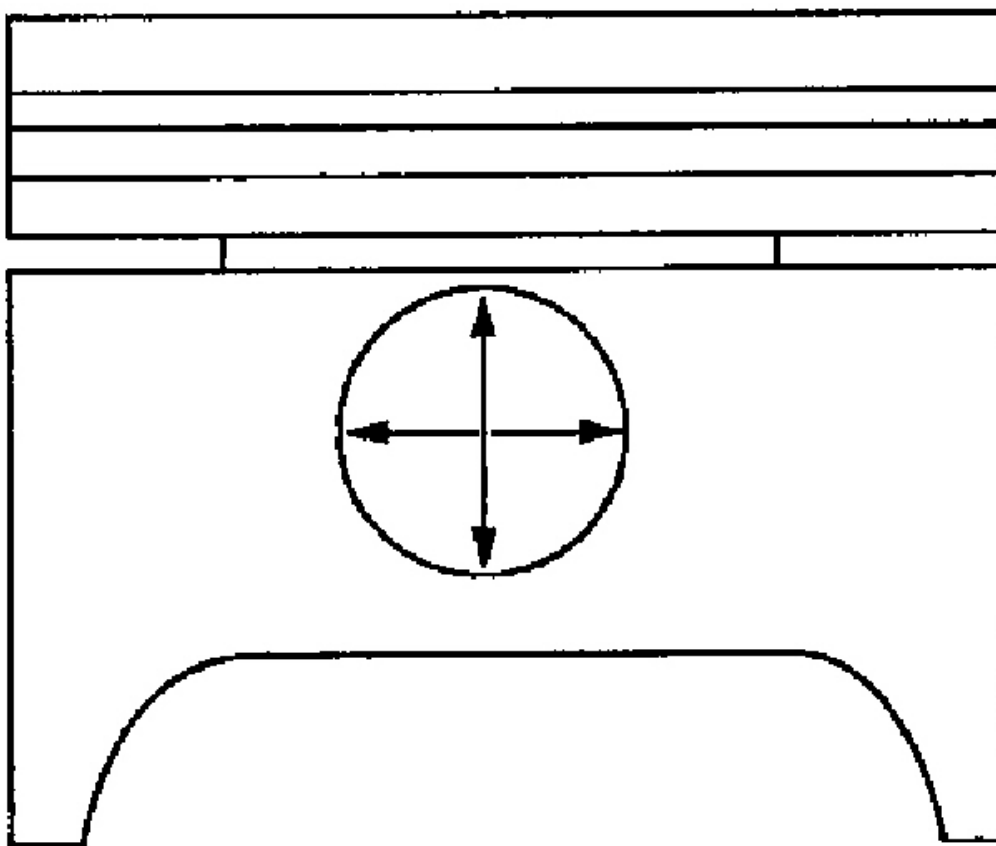


G03312357

Fig. 168: Cleaning Piston Ring Grooves
Courtesy of MAZDA MOTORS CORP.

NOTE:

- Piston and piston pins are a matched set and cannot be interchanged.



G03312359

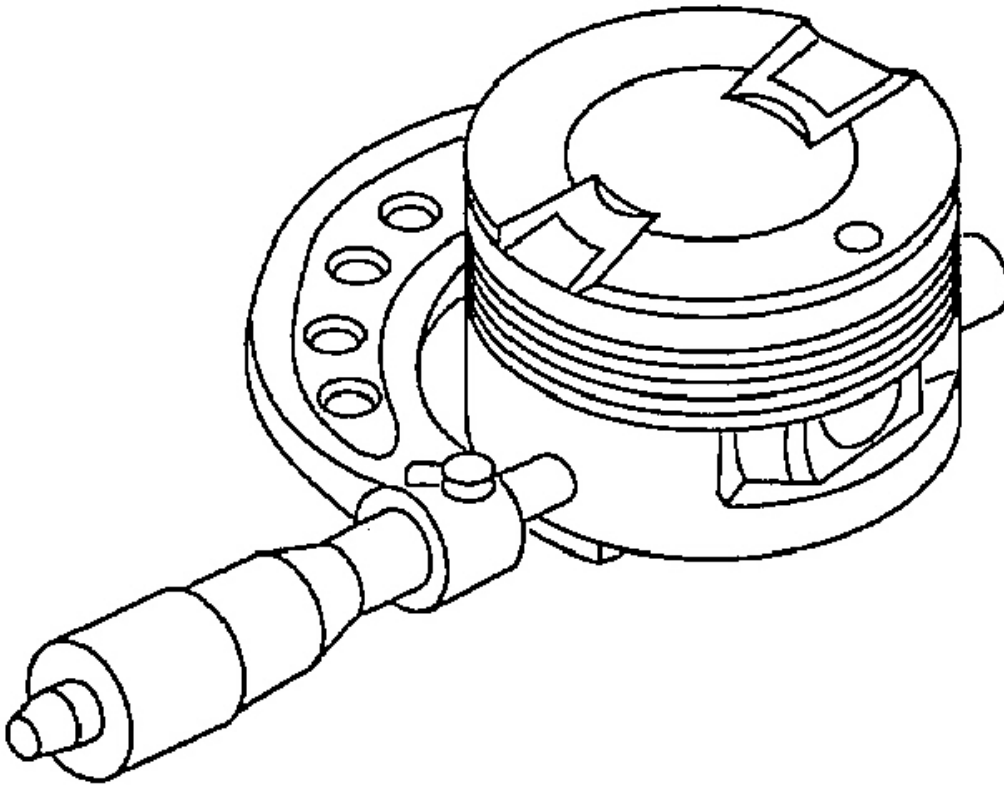
Fig. 169: Measuring Piston Pin Bore Diameter

Courtesy of MAZDA MOTORS CORP.

3. Measure the piston pin bore diameter in two directions on each side. Verify the diameter is within specification. Refer to **SPECIFICATIONS**.

NOTE:

- Always install the piston in the same cylinder bore from which it was removed.



G03312360

Fig. 170: Measuring Piston Bore & Skirt Diameter
Courtesy of MAZDA MOTORS CORP.

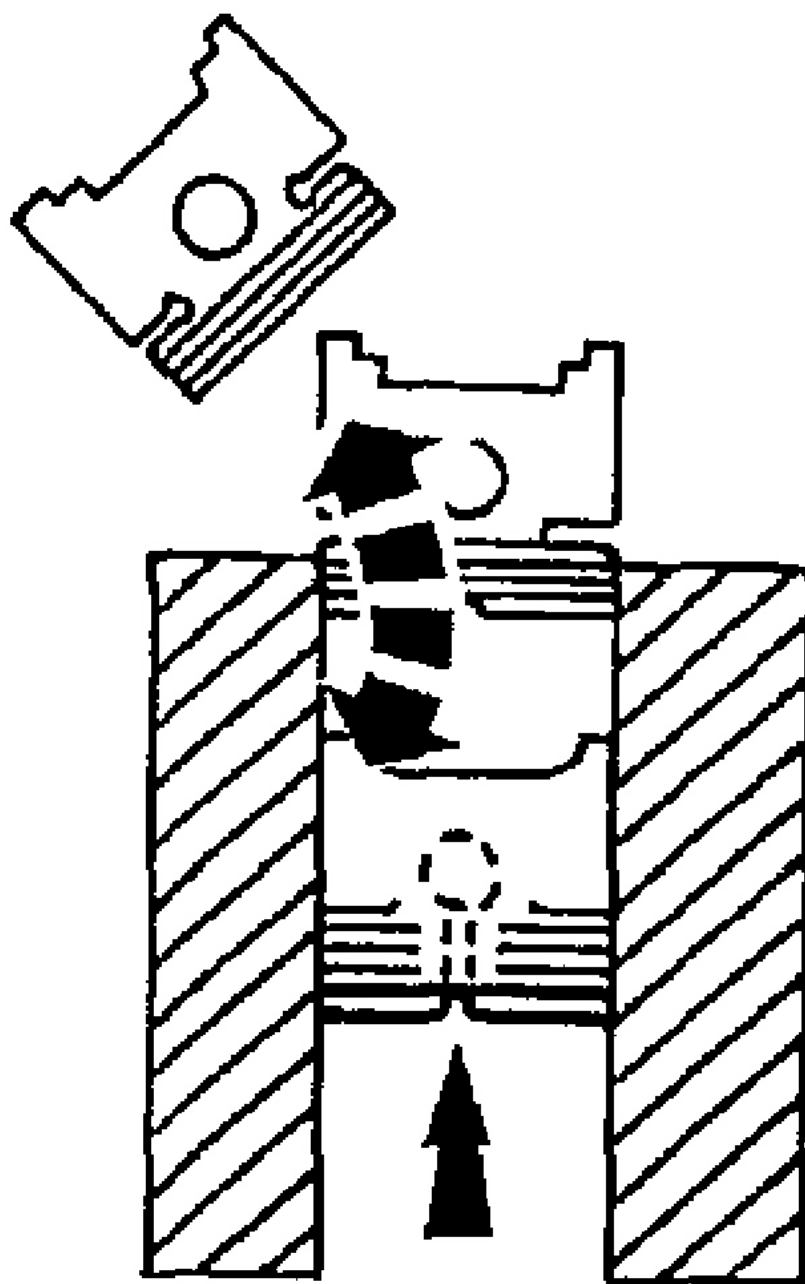
CAUTION:

- Use care when fitting piston rings to avoid possible damage to the piston ring or the cylinder bore.
- Piston rings should not be transferred from one piston to another.

4. Measure the piston bore and skirt diameter 90 degrees from the piston pin as indicated.

NOTE:

- Cylinder bore must be within specification for taper and out-of-round to fit piston rings.

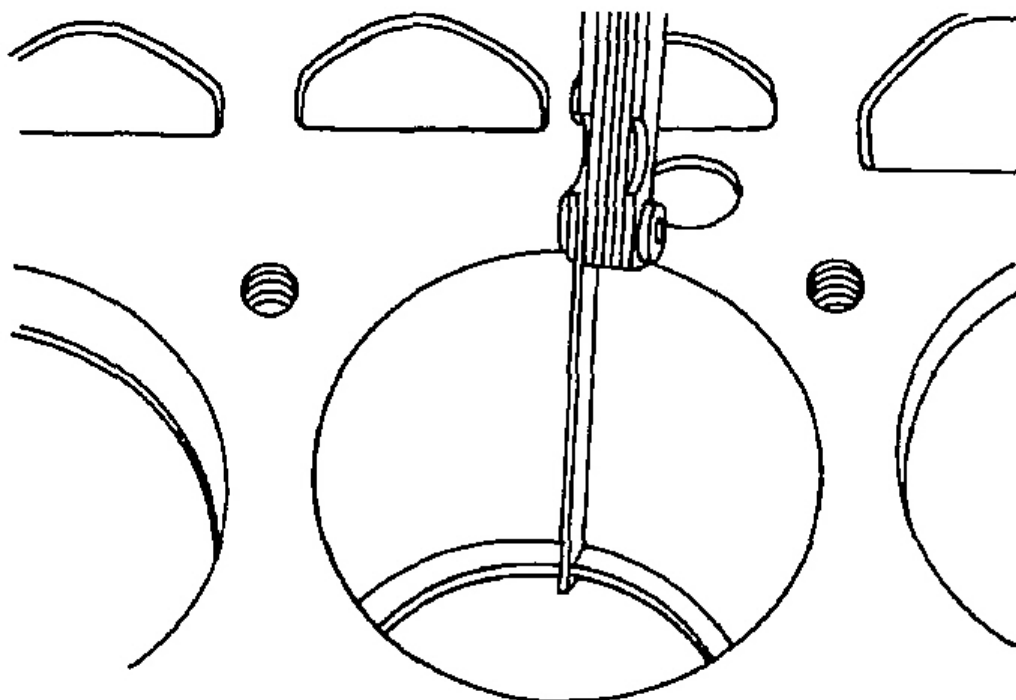


G03312361

Fig. 171: Pushing Piston Into A Cylinder To Bottom Of Ring Travel
Courtesy of MAZDA MOTORS CORP.

5. Push a piston into a cylinder to the bottom of ring travel using a piston without rings.

6. Measure the top piston ring end gap and second ring end gap using feeler gauge.



G03312362

Fig. 172: Measuring Piston Ring End Gap At Top & Bottom Of Ring Travel
Courtesy of MAZDA MOTORS CORP.

PISTON REPLACEMENT INSPECTION

NOTE:

- The cylinder bore must be within specifications for taper and out-of-round before fitting a piston.

1. Select a piston size based on the cylinder bore.

NOTE:

- For precision fit, new pistons are divided into three categories within each size range based on their relative position within the range. A paint spot on the new pistons indicates the position within the size range.

2. Choose the piston with the proper paint color.

- Red - in the lower third of the size range.
- Blue - in the middle third of the size range.
- Yellow - in the upper third of the size range.

PISTON CLEARANCE INSPECTION

1. Subtract the piston diameter from the cylinder bore diameter to find the piston-to-cylinder bore clearance.

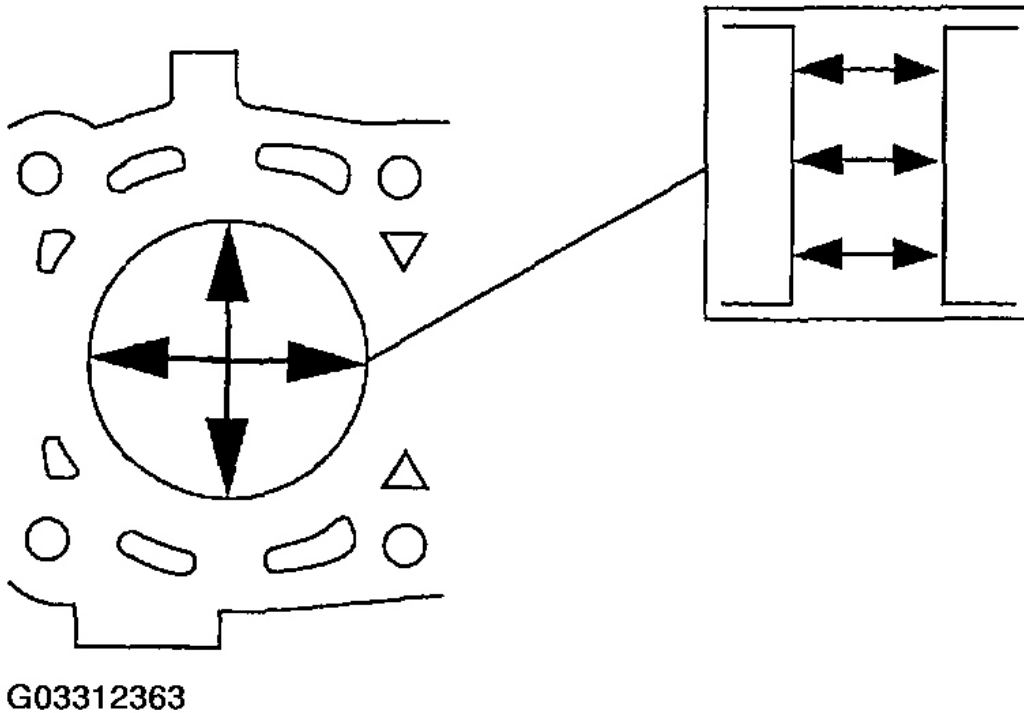
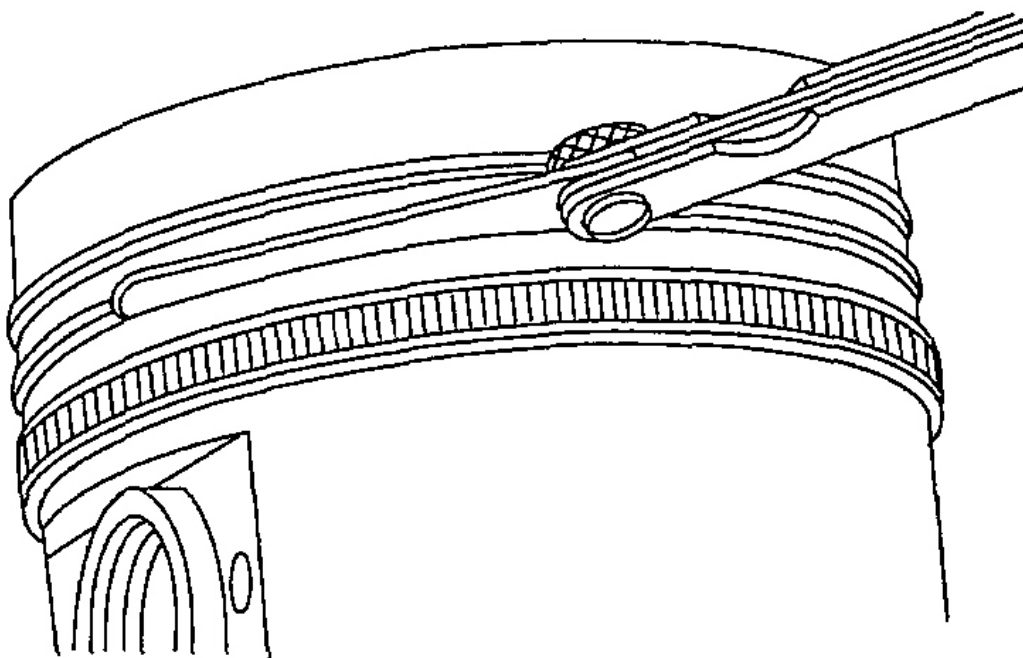


Fig. 173: Cylinder Bore Diameter Measuring Points
Courtesy of MAZDA MOTORS CORP.

PISTON RING CLEARANCE INSPECTION

1. Inspect for a step in the grooves.
2. Measure the piston ring-to-groove clearance all the way around the piston.

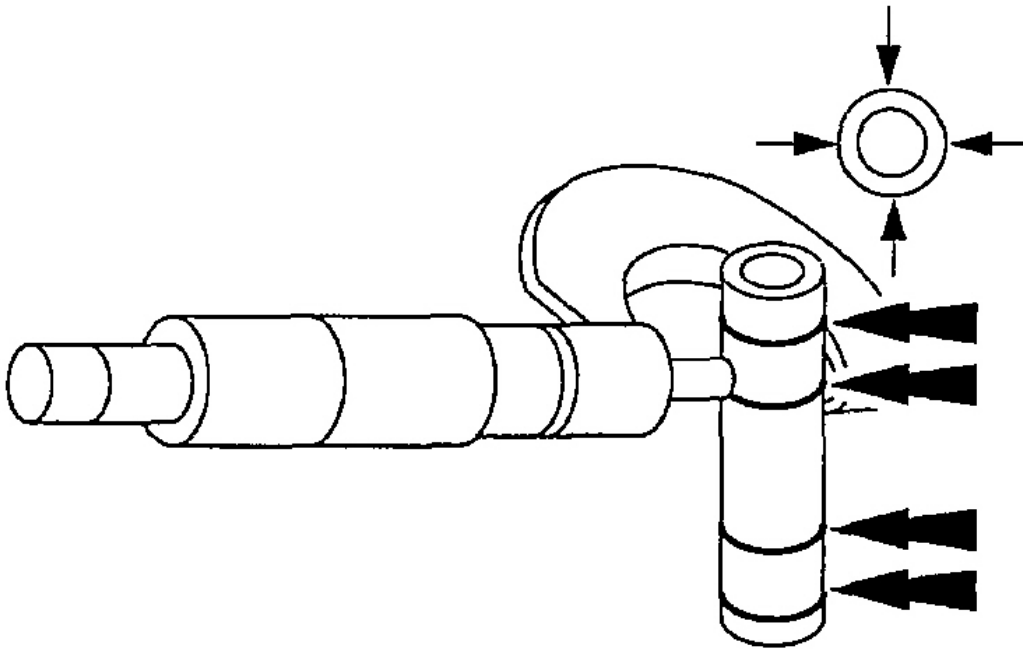


G03312364

Fig. 174: Measuring Piston Ring-To-Groove Clearance
Courtesy of MAZDA MOTORS CORP.

PISTON PIN INSPECTION

1. Measure the piston pin diameter in two directions at points shown. Verify the diameter is within specification. Refer to **SPECIFICATIONS**.



G03312365

Fig. 175: Measuring Piston Pin Diameter
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD INSPECTION

CONNECTING ROD CLEANING

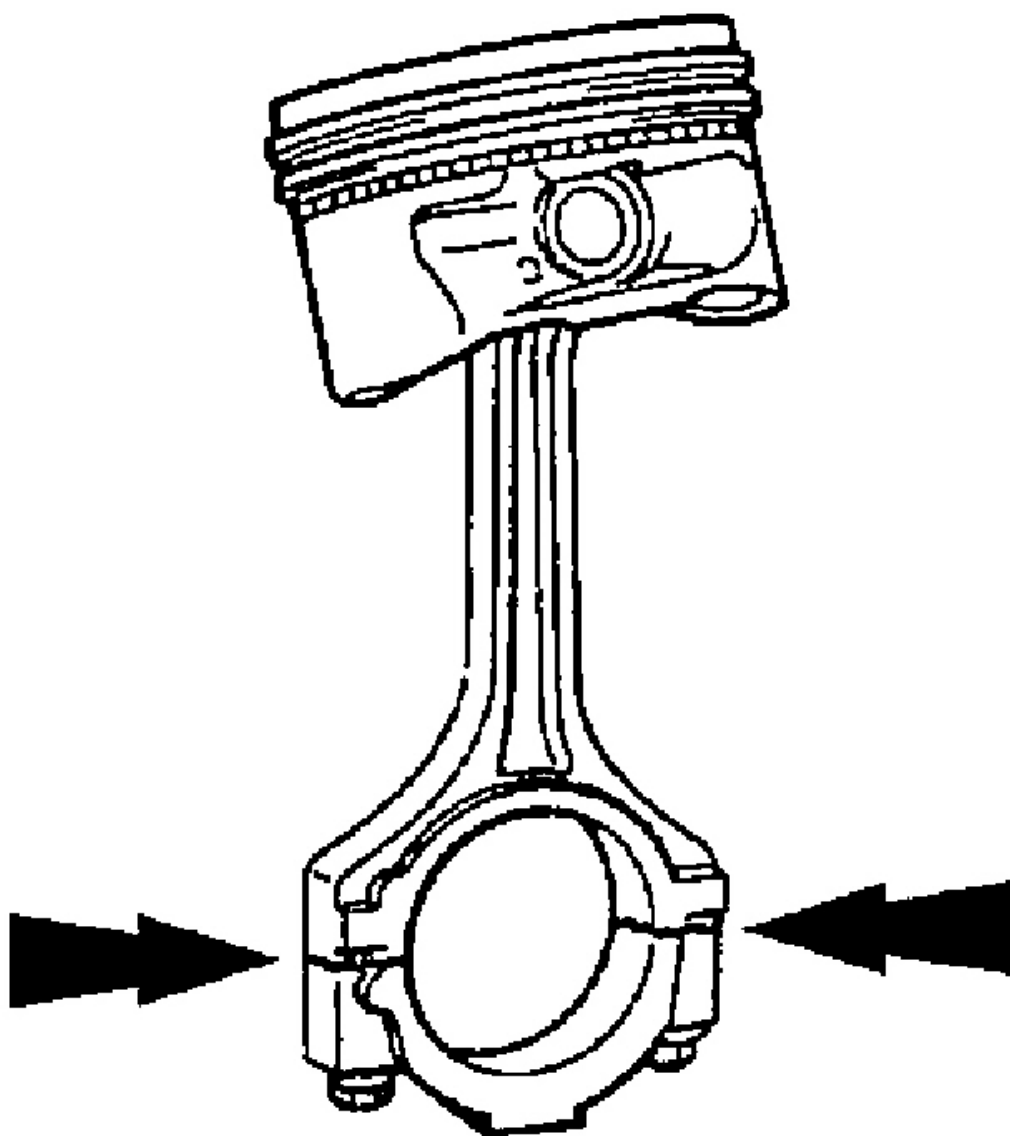
CAUTION:

- Do not use a caustic cleaning solution or damage to the connecting rods may occur.

NOTE:

- If the connecting rod large end is mechanically split or cracked to produce a unique parting face, a locking joint is produced. Parts are not interchangeable.

1. Mark and separate the parts and clean with solvent. Clean the oil passages.

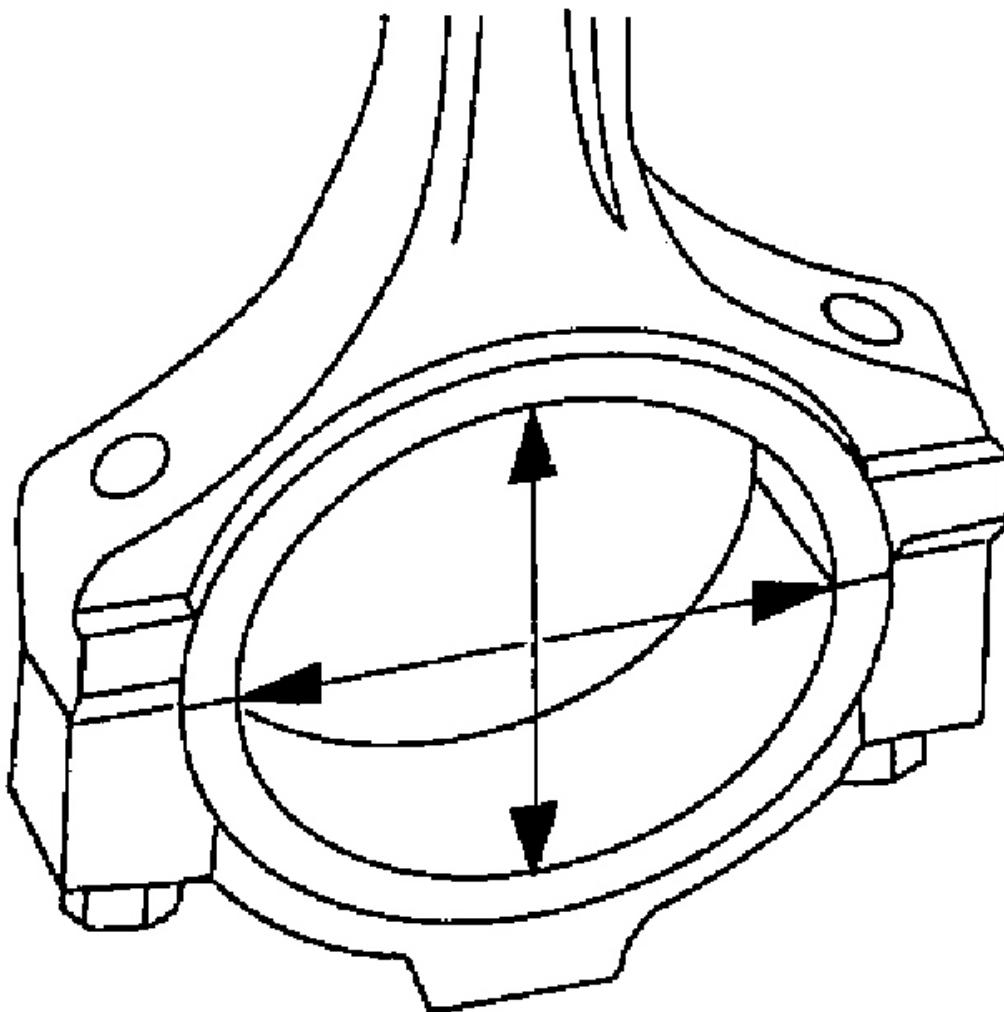


G03312366

Fig. 176: Marking Connecting Rod Caps
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD INSPECTION

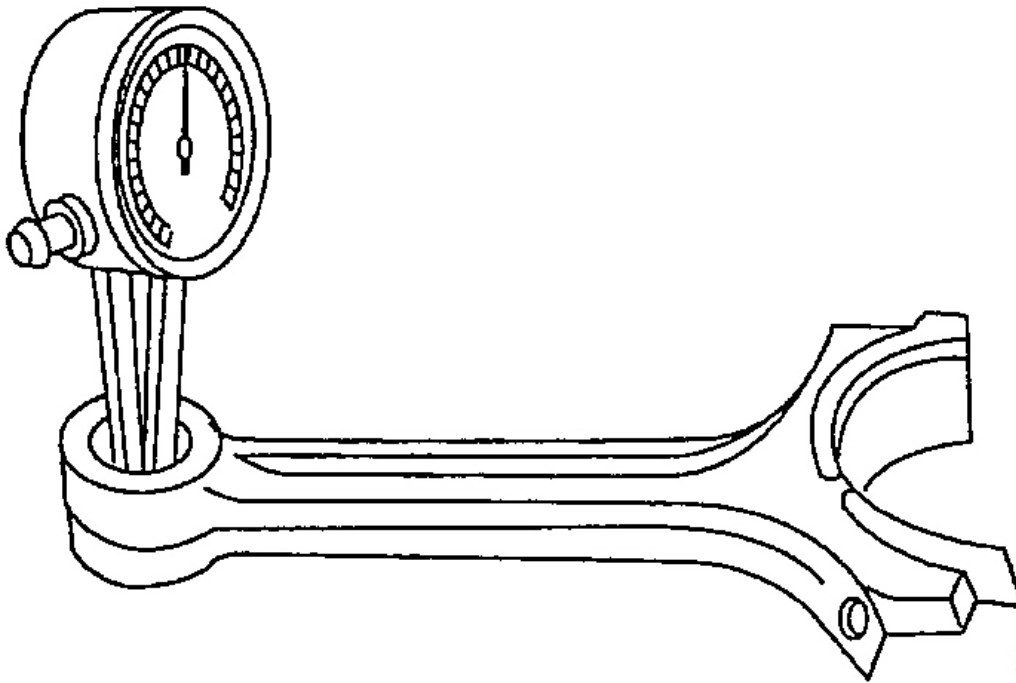
1. Measure the bearing bore in two directions. The difference is the connecting rod bore out-of-round. Verify the out-of-round is within specification. Refer to **SPECIFICATIONS**



G03312367

Fig. 177: Measuring Connecting Rod Bearing Bore
Courtesy of MAZDA MOTORS CORP.

2. Measure the bushing bore diameter of the connecting rod. Verify the diameter is within specification. Refer to **SPECIFICATIONS**.



G03312368

Fig. 178: Measuring Bushing Bore Diameter
Courtesy of MAZDA MOTORS CORP.

3. Measure the connecting rod bend on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. Verify the bend measurement is within specification. Refer to **SPECIFICATIONS**.
4. Measure the connecting rod twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. Verify the measurement is within specification. Refer to **SPECIFICATIONS**.

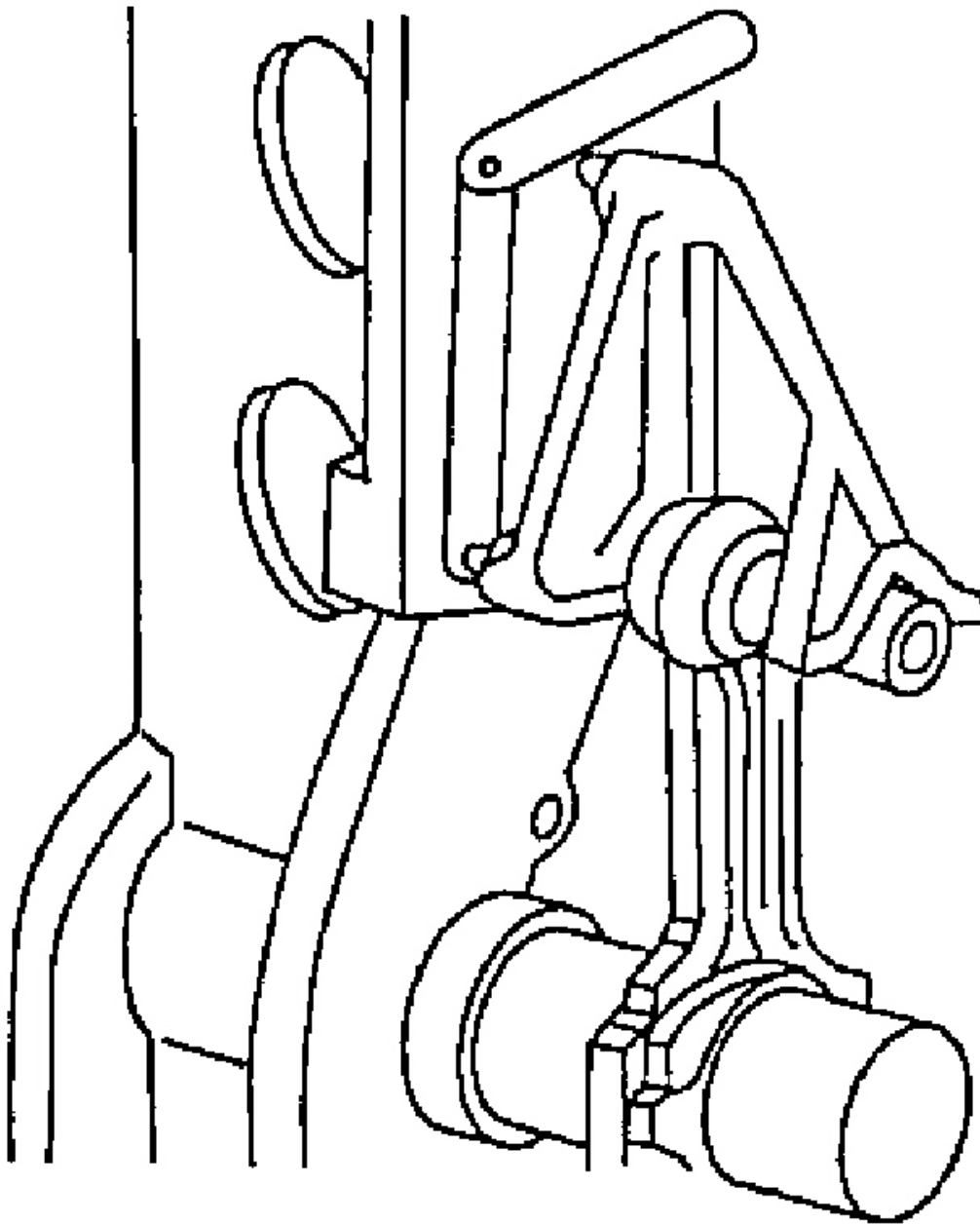
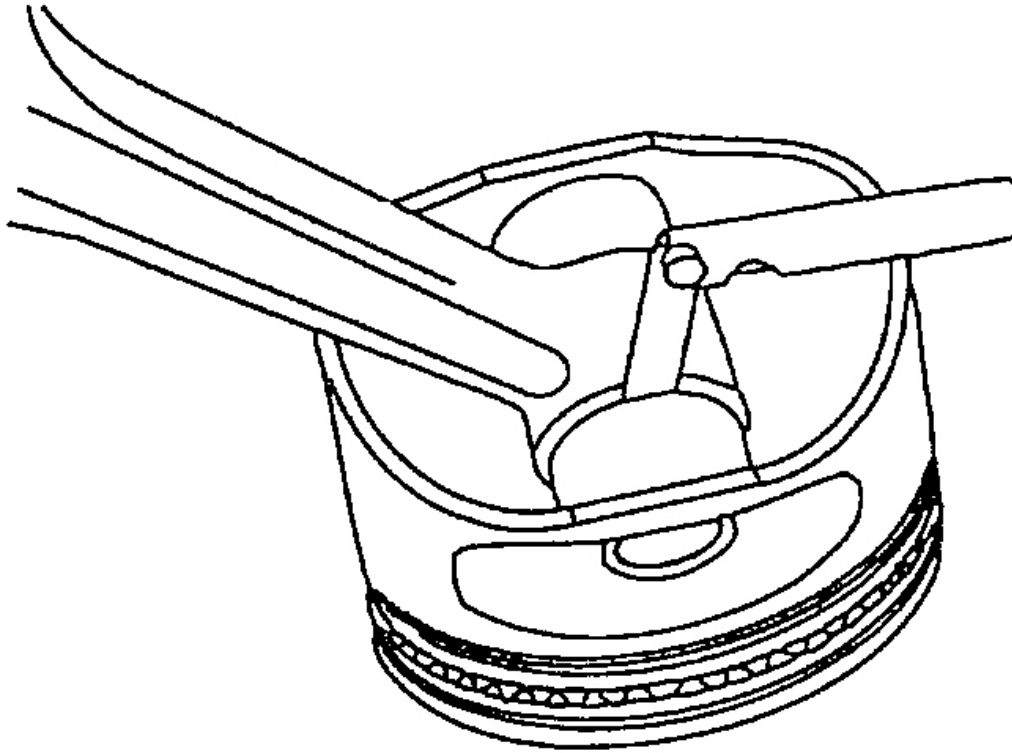


Fig. 179: Measuring Connecting Rod Twist
Courtesy of MAZDA MOTORS CORP.

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1. Measure the clearance between the connecting rod and the piston. Verify the measurement is within specification. Refer to **SPECIFICATIONS**.



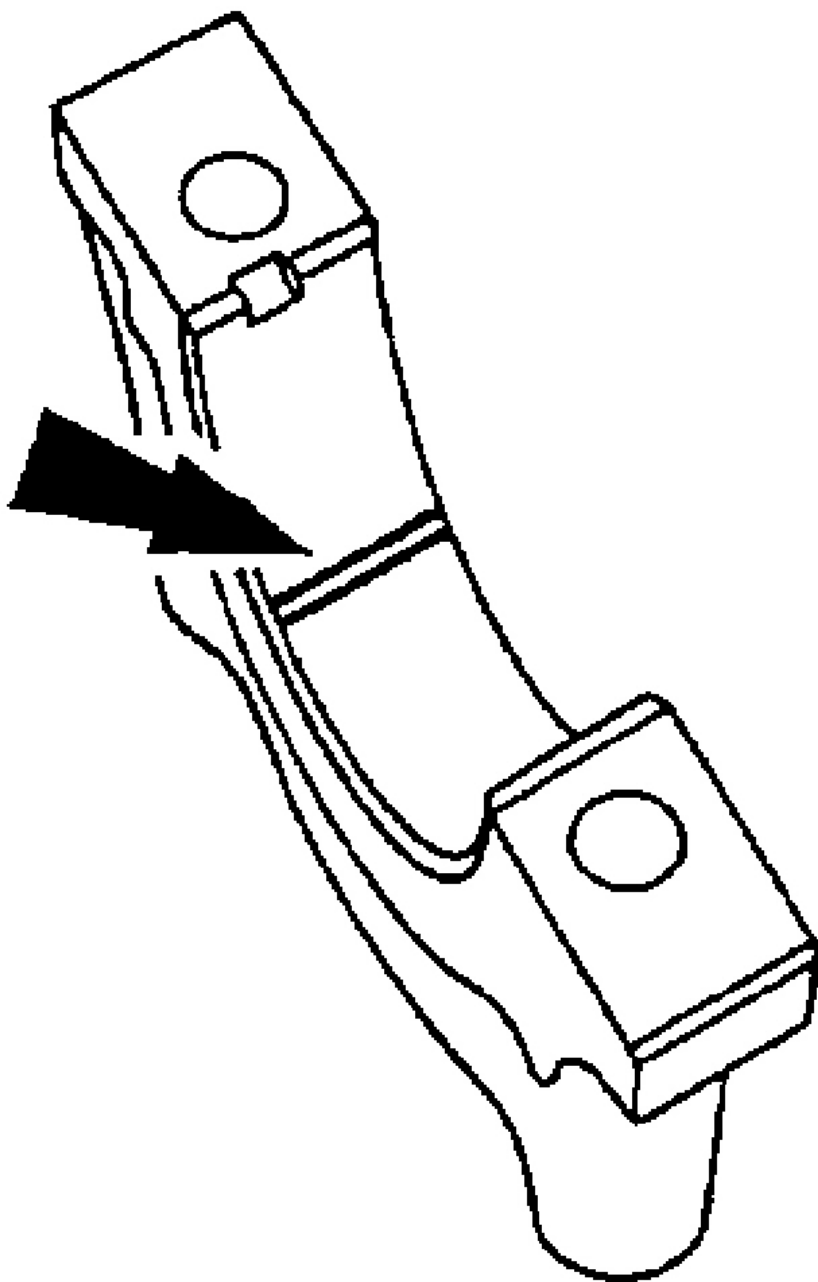
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Fig. 180: Measuring Clearance Between Connecting Rod & Piston
Courtesy of MAZDA MOTORS CORP.

CONNECTING ROD OIL CLEARANCE INSPECTION

NOTE:

- The crankshaft connecting rod journals must be within specification to check the connecting rod bearing journal clearance.



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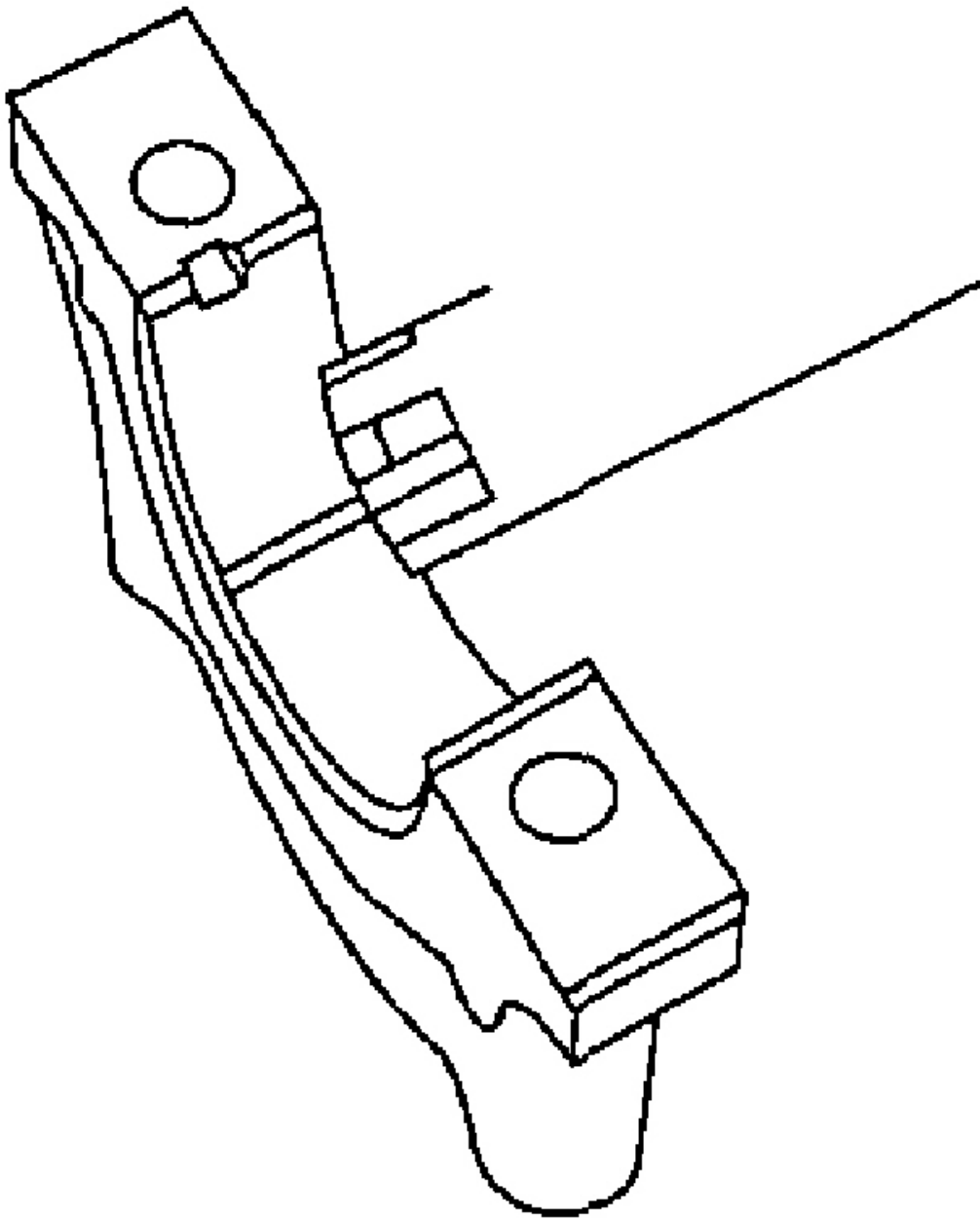
Fig. 181: Positioning Plastigage Across Bearing Surface
Courtesy of MAZDA MOTORS CORP.

1. Position a piece of Plastigage across the bearing surface.

NOTE:

- **Do not turn the crankshaft during this step.**

2. Install and tighten to specification, then remove the connecting rod bearing cap. Refer to **ENGINE DISASSEMBLY/ASSEMBLY**.
3. Measure the Plastigage to get the connecting rod bearing journal clearance. The Plastigage should be smooth and flat. A changing width indicates a tapered or damaged crankshaft main bearing or connecting rod. Refer to **SPECIFICATIONS**.



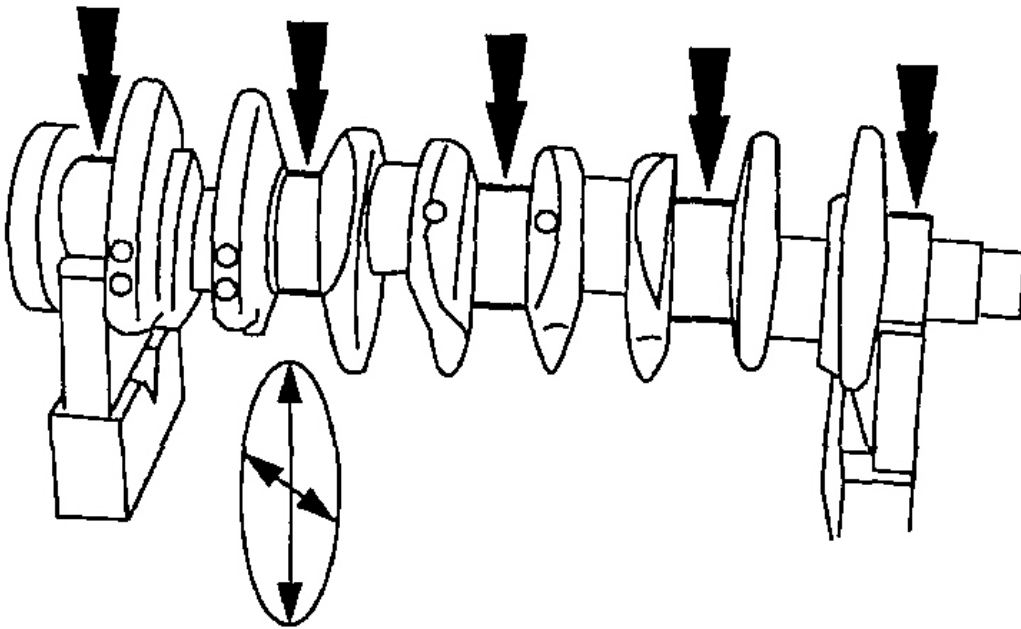
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Fig. 182: Measuring Plastigage
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT INSPECTION

CRANKSHAFT INSPECTION

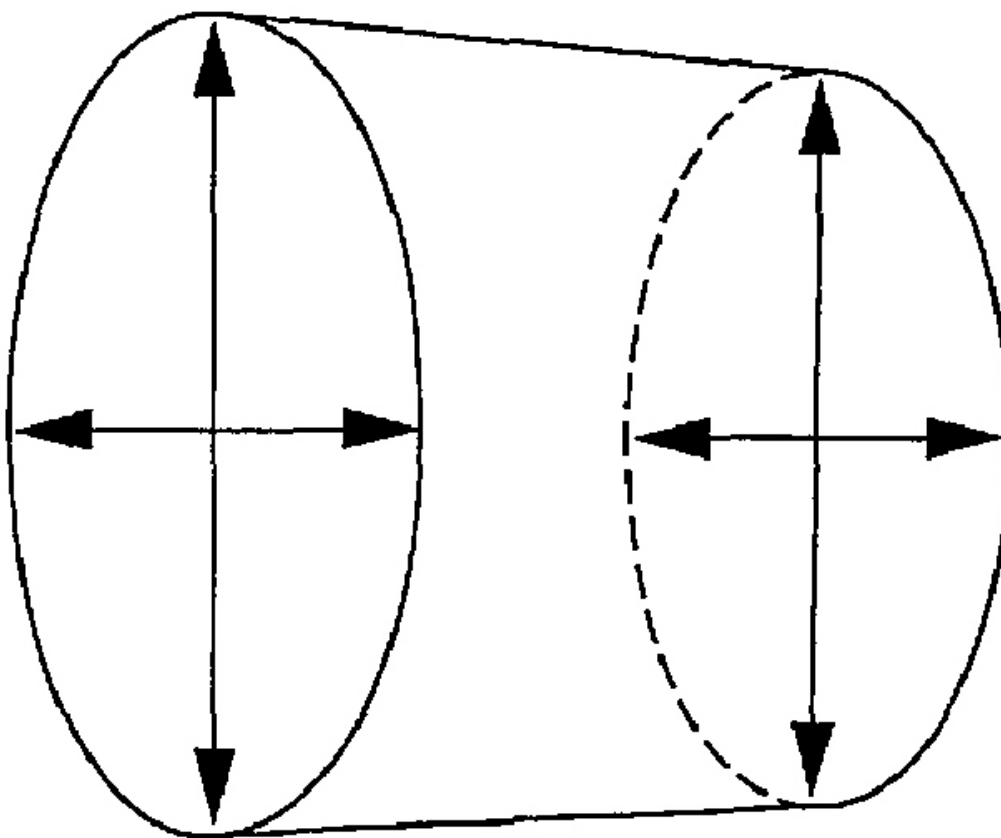
1. Measure each of the crankshaft main bearing journal diameters in at least two directions. Refer to **SPECIFICATIONS**. If out of specification, replace as necessary.



G03312372

Fig. 183: Measuring Crankshaft Main Bearing Journal Diameters
Courtesy of MAZDA MOTORS CORP.

2. Measure each of the crankshaft main bearing journal diameters in at least two directions at each end of the main bearing journal. Refer to **SPECIFICATIONS**. If out of specification, replace as necessary

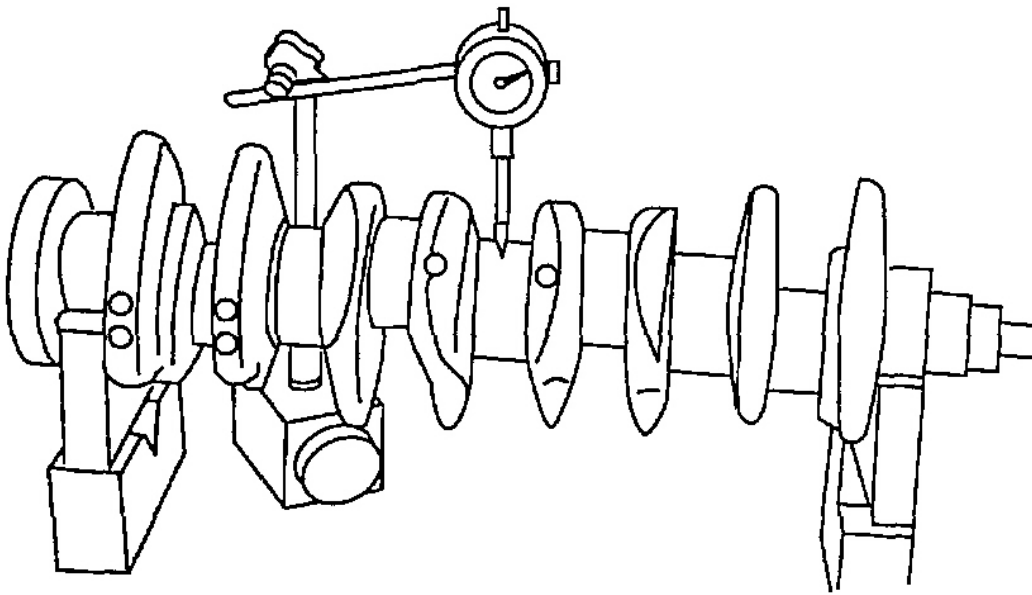


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Fig. 184: Measuring Crankshaft Main Bearing Journal Diameters In Two Directions
Courtesy of MAZDA MOTORS CORP.

NOTE:

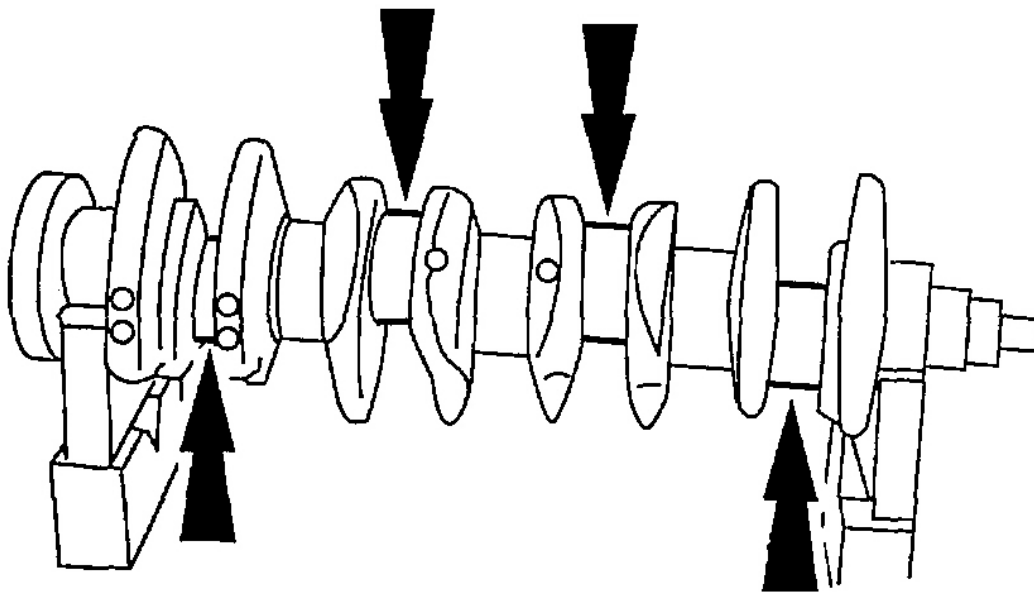
- Crankshaft main bearing journals must be within specifications before checking runout.



G03312375

Fig. 185: Measuring Crankshaft Runout
Courtesy of MAZDA MOTORS CORP.

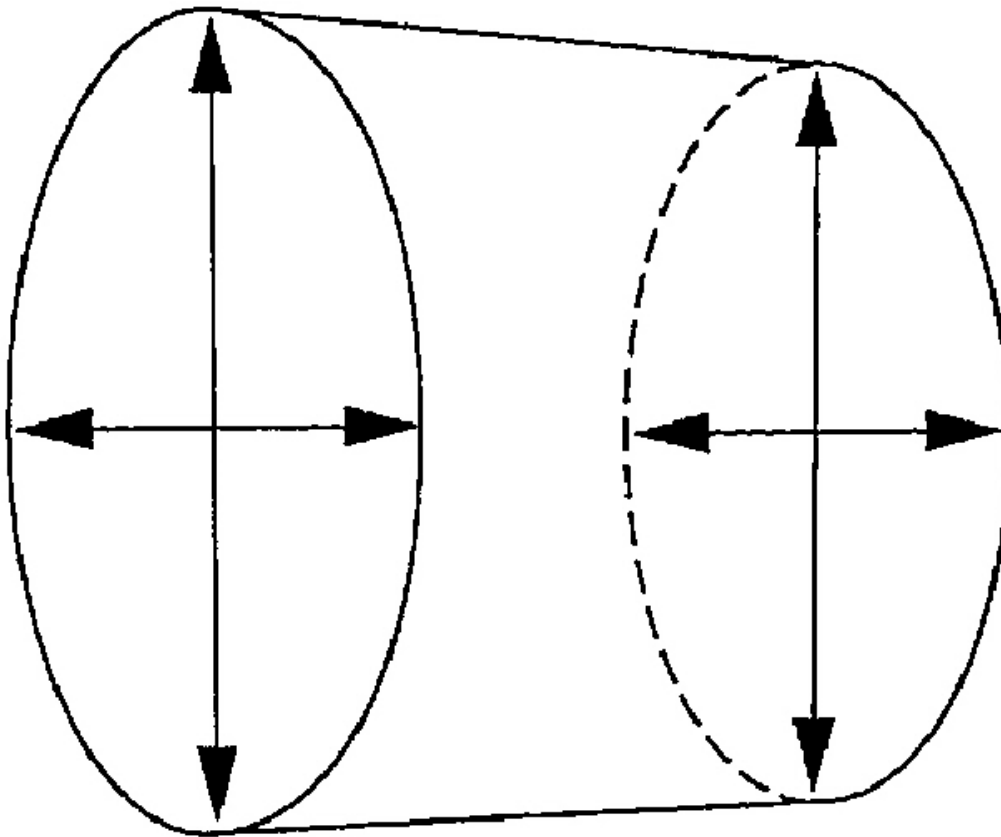
3. Use the Dial Indicator With Bracketry to measure the crankshaft runout.
 1. Rotate the crankshaft and subtract the lowest dial indicator reading from the highest dial indicator reading to figure the crankshaft runout. Verify the runout is within specification. Refer to **SPECIFICATIONS**. If it is out of specification, replace as necessary.
4. Measure the crankshaft connecting rod journal diameters in at least two directions perpendicular to one another. Verify the journal is within specification. Refer to **SPECIFICATIONS**.



G03312376

Fig. 186: Measuring Crankshaft Connecting Rod Journal Diameters
Courtesy of MAZDA MOTORS CORP.

5. Measure the crankshaft connecting rod journal diameters in two directions perpendicular to one another at each end of the connecting rod journal. The difference in the measurements from one end to the other is the taper. Verify the taper is within the wear limit. Refer to **SPECIFICATIONS**.



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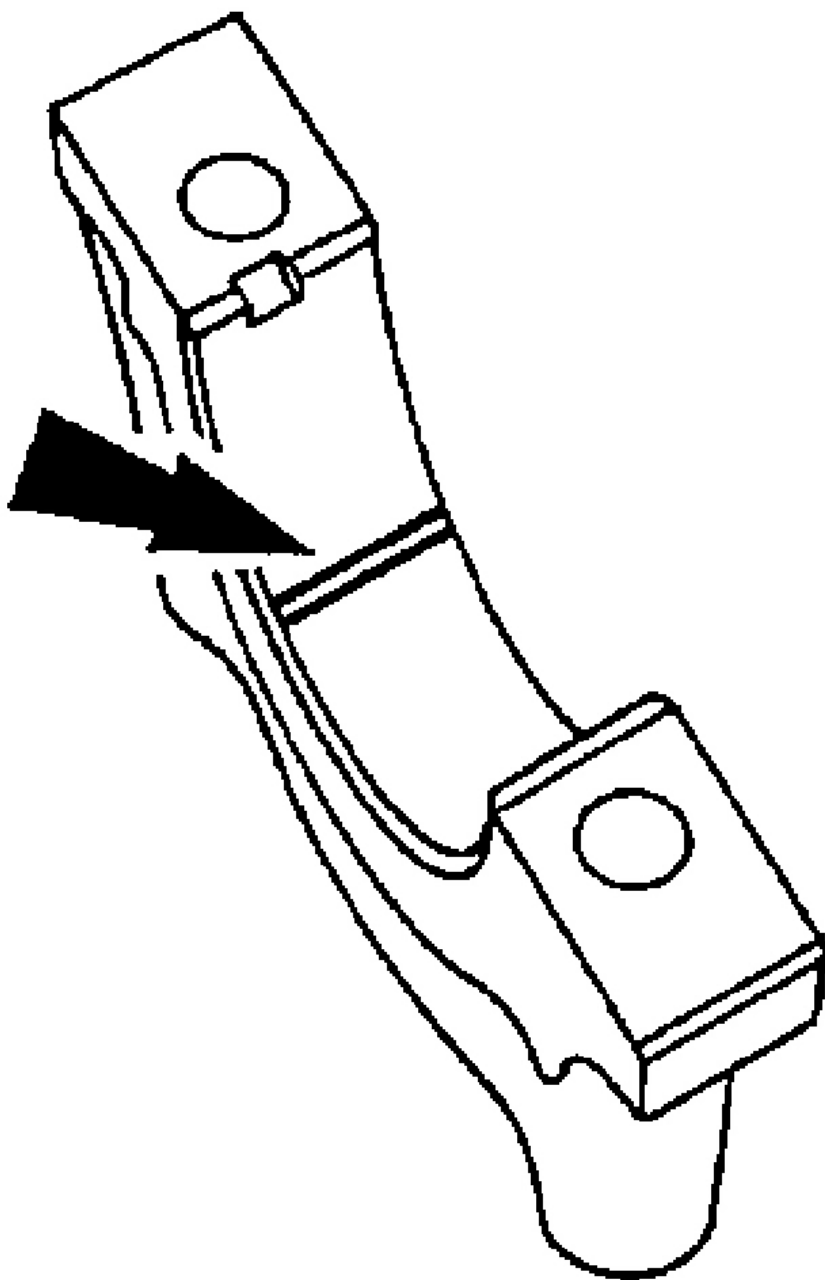
Fig. 187: Measuring Crankshaft Connecting Rod Journal Diameters In Two Directions
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT OIL CLEARANCE INSPECTION/REPAIR

NOTE:

- Crankshaft main bearing journals must be within specification before checking journal clearance.

1. Remove the crankshaft main bearing caps and bearings. Refer to **ENGINE DISASSEMBLY/ASSEMBLY**.
2. Lay a piece of Plastigage off-center and fully across the face of each crankshaft main bearing surface.



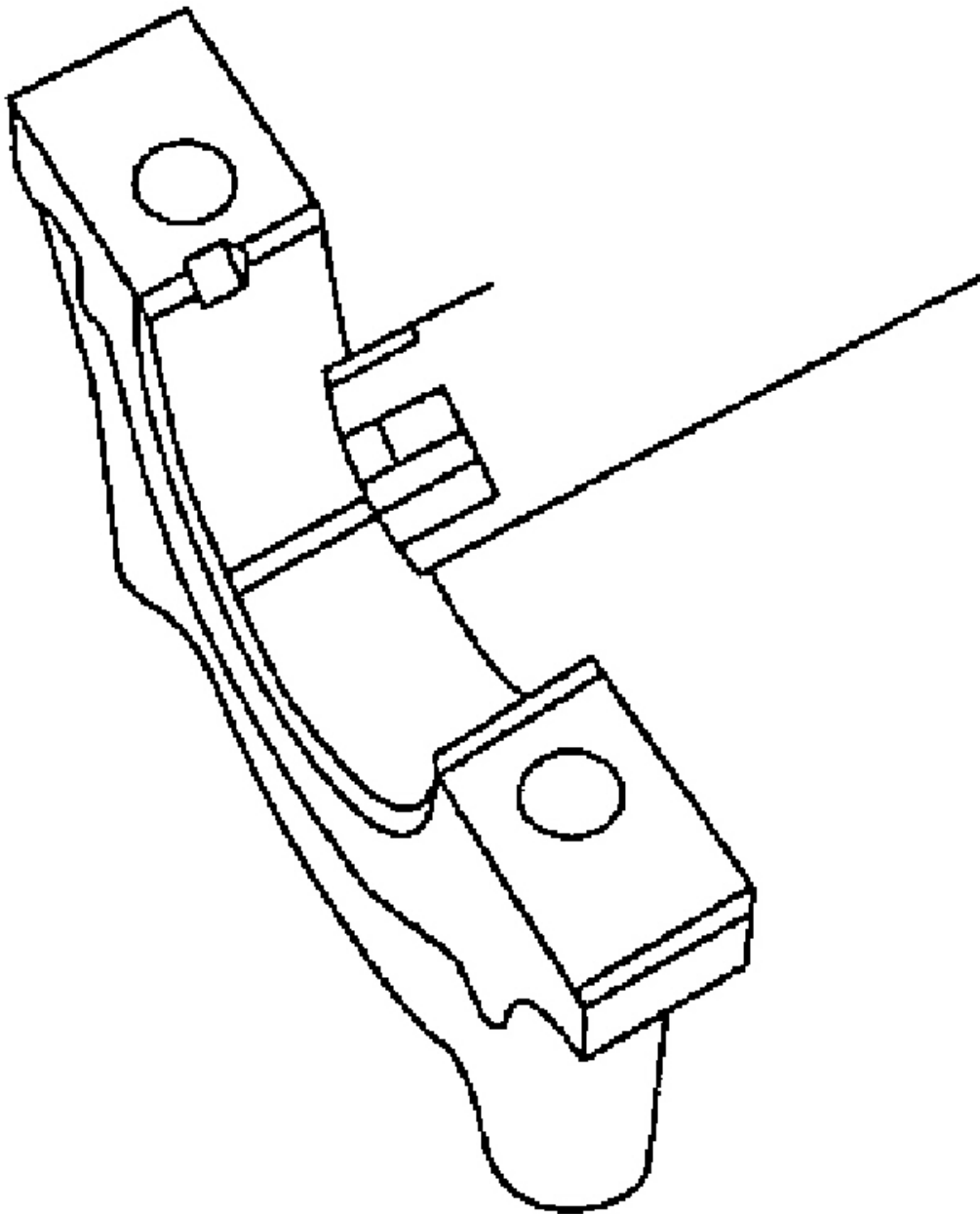
G03312378

Fig. 188: Laying Plastigage Off-Center & Across Face Of Crankshaft Main Bearing Surface
Courtesy of MAZDA MOTORS CORP.

NOTE:

- Do not turn the crankshaft while doing this procedure.

3. Install and remove the crankshaft main bearing cap. Refer to **ENGINE DISASSEMBLY/ASSEMBLY** .
4. Verify the crankshaft journal clearance. Refer to **SPECIFICATIONS**.
 1. If it is out of specification, replace as necessary.



G03312379

Fig. 189: Measuring Plastigage
Courtesy of MAZDA MOTORS CORP.

CRANKSHAFT END PLAY INSPECTION

1. Use the Dial Indicator With Bracketry to measure crankshaft end play.
2. Position the crankshaft to the rear of the cylinder block.

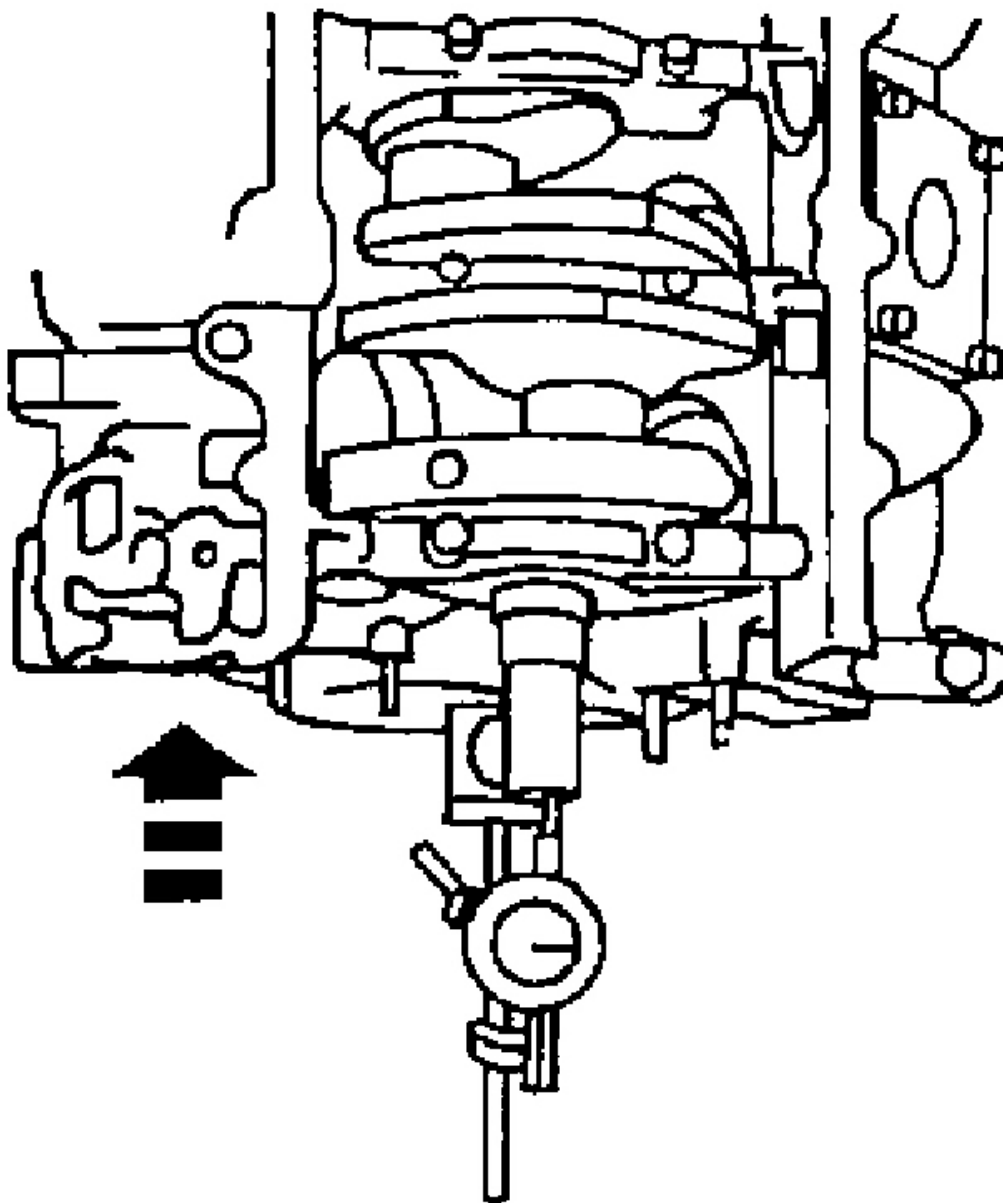
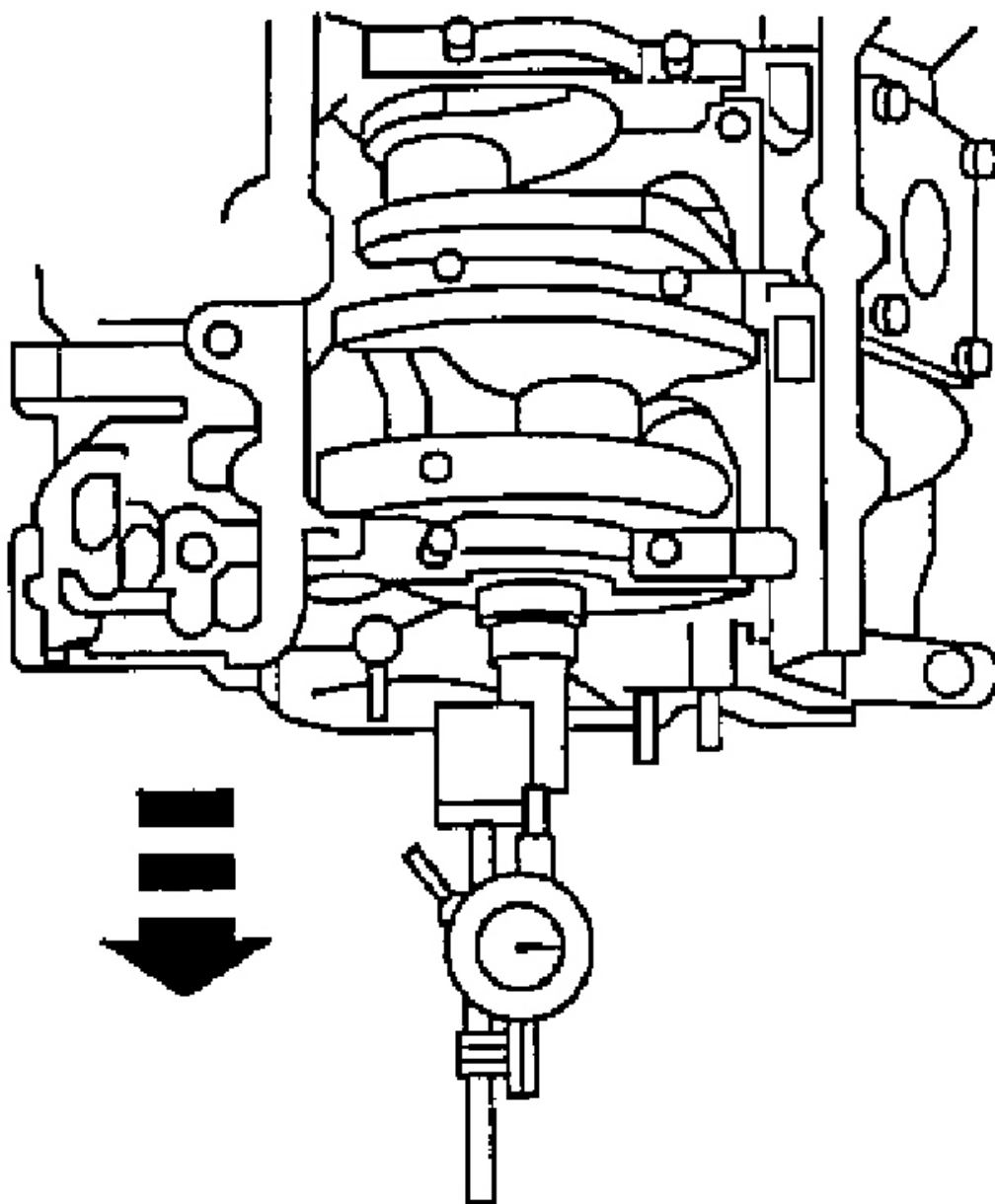
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Fig. 190: Zeroing Dial Indicator
Courtesy of MAZDA MOTORS CORP.

3. Zero the Dial Indicator With Bracketry.
4. Move the crankshaft to the front of the cylinder block. Note and record the crankshaft end play. Verify the end play is within specifications. Refer to **SPECIFICATIONS**.
 1. If crankshaft end play exceeds specifications, replace the crankshaft thrust washers or thrust bearing. Refer to **SPECIFICATIONS**.



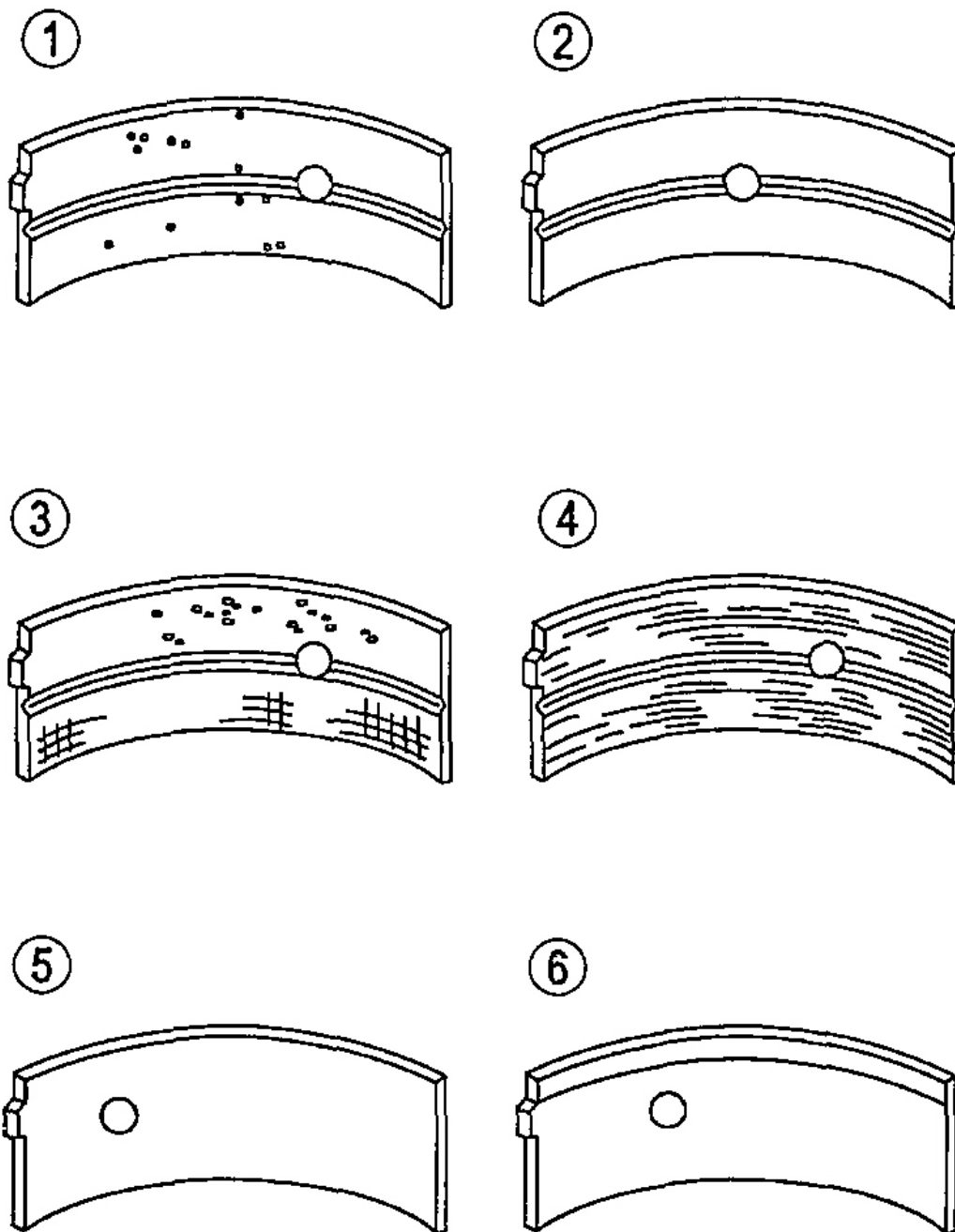
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Fig. 191: Measuring Crankshaft End Play
Courtesy of MAZDA MOTORS CORP.

BEARING INSPECTION

1. Inspect the bearings for the following defects. Possible causes are shown:

- Cratering - fatigue failure (1)
- Spot polishing - improper seating (2)
- Scratching - dirty (3)
- Base exposed - poor lubrication (4)
- Both edges worn - journal damaged (5)
- One edge worn - journal tapered or bearing not seated (6)



G03312382

Fig. 192: Identifying Bearing Defects
 Courtesy of MAZDA MOTORS CORP.

SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Item	Specification
Displacement	3.0L
Number Of Cylinders	6
Bore & Stroke	
Bore	89.00 mm (3.50 In.)
Stroke	80.00 mm (3.14 In.)
Firing Order	1-4-2-5-3-6
Oil Pressure (Hot 2500 RPM)	40-60 PSI
Drive Belt Tension	(1)
(1) Refer to SPECIFICATIONS & DRIVE BELT ROUTING	

CYLINDER HEAD & VALVE TRAIN

CYLINDER HEAD & VALVE TRAIN SPECIFICATIONS

Item	Specification
Combustion Chamber Volume (cc)	50.1-47.1
Valve Guide Bore Diameter	
Intake & Exhaust	8.745-8.720 mm (0.3443-0.3443 In.)
Valve Seats	
Width - Intake & Exhaust	1.5-2.0, (.06-.08 In.)
Angle	45°
Runout (T.I.R.)	0.076 mm (0.003 In.)
Bore Diameter (Insert Counterbore Diameter)	47.097 mm (1.8542 In.) Max.
Intake	47.072 mm (1.8532 In.) Max.
Exhaust	39.730 mm (1.5645 In.) Max.
Gasket Surface Flatness	0.08 mm (0.003 In.) Over 152.0 mm (6.00 In.)
Valve Stem To Guide Clearance	
Intake	0.026-0.068 mm (.001-0.0027 In.)
Exhaust	0.038-0.081 mm (0.0015-0.0032 In.)
Valve Head Diameter	
Intake	40.0 mm (1.57 In.)
Exhaust	33.0 mm (1.30 In.)
Valve Face Runout Limit	0.05 mm (0.002 In.)
Valve Face Angle	44°
Valve Stem Diameter (Standard)	
Intake	7.960-7.940 mm (0.3134-0.3126 In.)

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Exhaust (Oversize)	7.948-7.928 mm (0.3129-0.3121 In.)
Intake	8.340-8.320 mm (0.3283-0.3276 In.)
Exhaust (Oversize)	8.328-8.308 mm (0.3279-0.3271 In.)
Intake	8.720-8.700 mm (0.3433-0.3425 In.)
Exhaust	8.708-8.688 mm (0.3428-0.3420 In.)
Valve Springs	
Compression Pressure	N [Lbf.] @ Spec. Length)
Valve Open To Maximum Lift	800.6N (180 Lbs.) 29.5 mm (1.16 In.)
Valve Closed	288.1N (65 Lbs.) 40.1 mm (1.58 In.)
Free Length (Approximate)	46.7 mm (1.84 In.)
Installed Spring Height	44.17-41.98 mm (1.736-1.650 In.)
Service Limit	10% Force Loss @ Specified Height
Rocker Arm Ratio	1.61
Valve Tappet, Hydraulic	
Diameter (Std.)	22.206 mm (0.874 In.)
Clearance To Bore	0.018-0.069 mm (0.0007-0.0027 In.)
Service Limit	0.127 mm (0.005 In.)
Hydraulic Leak-Down Rate Collapsed Tappet Gap (Nominal)	(1)
Intake	2.23-4.77 mm (0.088-0.189 In.)
Exhaust	2.23-4.77 mm (0.088-0.189 In.)
Distributor Shaft Bearing Bore Diameter	22.268-22.230 mm
Tappet Bore Diameter	0.08767-0.8752 In.)
Camshaft Bore Inside Diameter	
No. 1	54.688-54.713 mm (2.1531-2.1541 In.)
No. 2	54.188-54.213 mm (2.1334-2.1344 In.)
No. 3	54.188-54.213 mm (2.1334-2.1344 In.)
No. 4	54.688-54.713 mm (2.1531-2.1541 In.)
(1) 20-200 seconds to leak-down 3.18 (0.125 in.) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.	

CAMSHAFT SPECIFICATIONS**CAMSHAFT SPECIFICATIONS**

Item	Specification
Lobe Lift	
Intake	6.604 mm (0.260 In.)
Exhaust	6.604 mm (0.260 In.)
Allowable Lobe Lift Loss	0.127 mm (0.005 In.)
Theoretical Valve Lift @ Zero Lash	
Intake	10.65 mm (0.419 In.)

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Exhaust	10.65 mm (0.419 In.)
End Play	
Service Limit	0.003 mm (.007 In.)
Journal to Bearing Clearance	0.025-0.076 mm (0.001-0.003 In.)
Journal Diameter	
All	50.987-51.013 (2.0074-2.0084 In.)
Cam Bearing I.D.	51.038-51.063 mm (2.0094-2.0104 In.)
Runout Limit	0.05 mm (0.002 In.) Runout Of No. 2 or No. 3 Relative To No. 1 & No. 4
Out-of-Round Limit	0.025 mm (0.001 In.)

CYLINDER BLOCK SPECIFICATIONS**CYLINDER BLOCK SPECIFICATIONS**

Item	Specification
Head Gasket Surface Flatness	0.08 mm (0.003 In.) in 152.0 mm (6.00 In.)
Head Gasket Surface Finish (RMS)	1.0-3.3 Micrometers
Cylinder Bore	
Diameter	89.00 mm (3.504 In.)
Surface Finish (RMS)	0.45-0.96
Out-of-Round Limit	0.025 mm (0.001 In.)
Out-of-Round Service Limit	0.050 mm (0.002 In.)
Taper Service Limit	0.050 mm (0.002 In.)
Main Bearing Bore Diameter	68.905 mm (2.713 In.) 68.885 mm (2.712 In.)

CRANKSHAFT & FLYWHEEL SPECIFICATIONS**CRANKSHAFT & FLYWHEEL SPECIFICATIONS**

Item	Specification
Main Bearing Journal Diameter	63.983-64.003 mm (2.5190-2.5198 In.)
Out-of-Round Limit	0.008 mm (0.0003 In.)
Taper Limit	0.06 mm (0.0006 In.) Total 0.013 mm (0.0003 In.) Per 25 mm (1 In.)
Journal Runout Limit	0.05 mm (0.002 In.), 0.05 mm (0.002 In.)

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Surface Finish (RMS)	0.25 Micrometers (10.0 Micro In.)
Thrust Bearing Journal	
Length	25.775-25.825 mm (1.0148-1.067 In.)
Connecting Rod Journal	
Diameter	53.983-54.003 mm (2.1253-2.1261 In.)
Out-of-Round Limit	0.006 mm (0.0003 In.) Max.
Taper Limit	0.0150 mm (0.0006 In.) Total 0.008 mm per 25 mm (0.0003 In. Per In.)
Surface Limit (RMS)	0.25 Micrometers (10.0 Micro In.)
Main Bearing Thrust Face	
Surface Finish (RMS)	0.4 Micrometers (0.157 Micro In.) Front; 0.4 Micrometers (0.157 Micro In.) Rear
Runout Limit	0.025 mm (0.001 In.)
Flywheel Ring Gear Lateral Runout (T.I.R.) Automatic Transmission	1.778 mm (0.07 In.)
Crankshaft End Play	0.10-0.20 mm (0.004-0.008 In.)
Connecting Rod Bearings	
Clearance to Crankshaft	
Desired	0.025-0.035 mm (0.001-0.0014 In.)
Allowable	0.020-0.066 mm (0.00086-0.0027 In.)
Bearing Wall Thickness (Std.)	1.557-1.570 mm (0.0612-0.0618 In.)
Main Bearings	
Clearance to Crankshaft	
Desired	0.25-0.035 mm (0.001-0.0014 In.)
Allowable	0.020-0.066 mm (0.0005-0.0023 In.)
Bearing Wall Thickness (Std.)	2.444-2.481 mm 1st and 2nd 2.491-2.427 3rd and Rear

CONNECTING ROD, PISTON & RINGS SPECIFICATIONS**CONNECTING ROD, PISTON & RINGS SPECIFICATIONS**

Item	Specification
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Connecting Rod

Piston Pin Bore Diameter	23.105-23.145 mm (0.9096-0.9112 In.)
Crankshaft Bearing Bore Diameter	5.15-57.17 mm (2.250-2.251 In.)
Length (Center-to-Center)	140.46-140.54 mm (5.530-5.533 In.)
Alignment (Bore-to-Bore Max Diff.)	
Twist	0.075 per 25 mm (0.003 per In.)
Bend	0.04 per 25 mm (0.0016 per In.)
Side Clearance (Assembled to Crank)	
Standard	0.15-0.35 mm (0.006-0.014 In.)
Service Limit	0.36 mm Max. (0.014 In. Max.)

PISTON SPECIFICATIONS**PISTON SPECIFICATIONS**

Item	Specification
Diameter	
Coded Red	88.962-88.978 mm (3.5024-3.5031 In.)
Coded Blue	88.988-89.004 mm (3.5035-3.5041 In.)
Coded Yellow	89.014-89.030 mm (3.5045-3.5051 In.)
Piston-To-Bore Clearance	0.030-0.056 mm (0.0012-0.0022 In.)
Service Limit	0.081 mm Max.
Service Piston Selection ⁽¹⁾	
Piston Bore Diameter	Service Piston Grade Required
89.009-89.035 mm (3.5043-3.05053 In.)	RED
89.035-89.060 mm (3.5053-3.5063 In.)	BLUE
89.060-89.086 mm (3.5063-3.5073 In.)	YELLOW
Ring Groove Width	
Compression (Top)	1.530-1.555 mm (0.0602-0.0612 In.)
Compression (Bottom)	4.030-4.055 mm (0.1587-0.1596 In.)
Piston Pin	
Length	76.5-77.2 mm (3.012-3.039 In.)
Diameter	23.162-23.175 mm (0.9119-0.9124 In.)
Pin to Piston Clearance	0.005-0.012 mm (0.002-0.0005 In.)
Pin to Rod Clearance	Press Kit 4 KiloNewtons (900 Lbs.)
Piston Pins	

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Ring Width

Compression (Top)	1.460-1.490 mm (0.0575-0.0587 In.)
Compression (Bottom)	1.460-1.490 mm (0.0575-0.0587 In.)
Oil Ring	Side Seal - Snug Fit
Service Limit	Side Clearance 0.15 mm Max. (0.0006 In. Max.)

Ring Gap

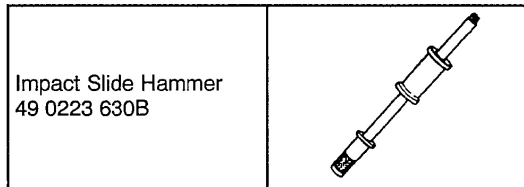
Compression (Top) (In Gauge)	0.25-0.50 mm (0.01-0.02 In.)
Compression (Bottom) (In Gauge)	0.25-0.50 mm (0.01-0.02 In.)
Oil Ring (Steel Rail) (In Gauge)	0.25-1.25 mm (0.010-0.049 In.)

Side Clearance

1st Ring	0.040-0.095 mm (0.0016-0.0037 In.)
2nd Ring	0.040-0.095 mm (0.0016-0.0037 In.)

(1) When replacing pistons, measure the cylinder bore as described, and install the indicated service piston.

SPECIAL SERVICE TOOLS



G03312383

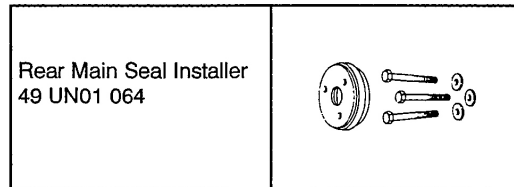


Fig. 193: Identifying Special Tools
Courtesy of MAZDA MOTORS CORP.