2012 ENGINE

Engine Mechanical Overhaul - Mazda3

ELECTRIC VARIABLE VALVE TIMING MOTOR/DRIVER INSPECTION

CAUTION:
- **Do not disassemble the electric variable valve timing motor/driver because it is a precision unit.**
- **Do not apply e cessive force when rotating the electric variable valve timing motor joint. If it is rotated with e cessive force, the electric variable valve timing motor could be damaged.**

1. Rotate the electric variable valve timing motor joint to the left and right by your fingers and verify that it rotates smoothly in 15° increments.

NOTE:
- **Rotate the joint area smoothly using only the tips of your fingers.**
- **The electric variable valve timing motor joint moves in 15° increments, and if the joint is moved 24 times, it rotates one full rotation.**
- **If it does not rotate smoothly, replace the electric variable valve timing motor/driver.**

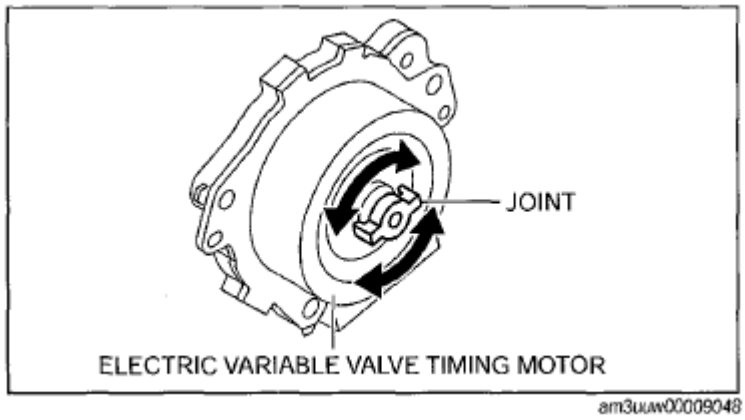


Fig. 1: Rotating Electric Variable Valve Timing Motor Joint

HYDRAULIC VARIABLE VALVE TIMING ACTUATOR INSPECTION

CAUTION:
- **Do not disassemble the hydraulic variable valve timing actuator because it is a precision unit.**

1. Verify that the notch of the rotor and projection of the cover on the hydraulic variable valve timing actuator are aligned and fitted.

- If the projection and notch are not aligned, rotate the rotor (camshaft installation) until a click is heard and verify that they are aligned and fixed in place.
    - If the projection and notch are not aligned or the rotor and cover are not secured even if their projection and notch are aligned, replace the hydraulic variable valve timing actuator.

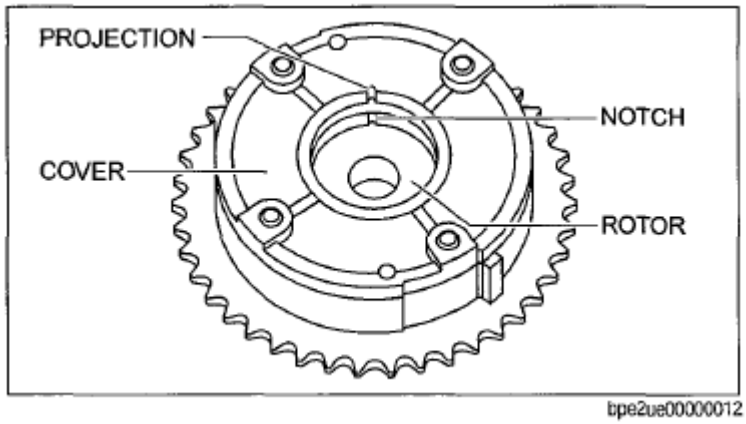


Fig. 2: Identifying Hydraulic Variable Valve Timing Actuator Rotor, Cover, Projection And Notch

ELECTRIC VARIABLE VALVE TIMING ACTUATOR INSPECTION

CAUTION:
- **Do not disassemble the electric variable valve timing actuator because it is a precision unit.**

1. Rotate the eccentric shaft of the electric variable valve timing actuator to the left and right by hand and verify that it rotates smoothly.
    - If it does not rotate smoothly, replace the electric variable valve timing actuator.

NOTE:
- **Hook a finger onto the joint groove of the eccentric shaft to rotate the shaft easily.**
- **The eccentric shaft stops rotating at the maximum retard position when it is rotated counterclockwise as viewed from the front, and at the maximum advance position when rotated clockwise.**
- **The eccentric shaft rotates 15.8 turns from the maximum retard position to the maximum advance position.**

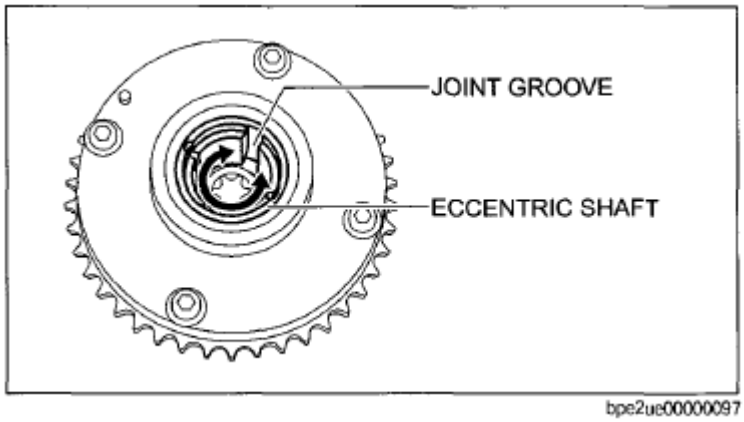


Fig. 3: Rotating Eccentric Shaft Of Electric Variable Valve Timing Actuator

OIL CONTROL VALVE (OCV) INSPECTION

COIL RESISTANCE INSPECTION

1. Measure the resistance between terminals A and B using an ohmmeter.

   OCV coil resistance

   6.9-7.5 ohms 20°C{68°F}

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

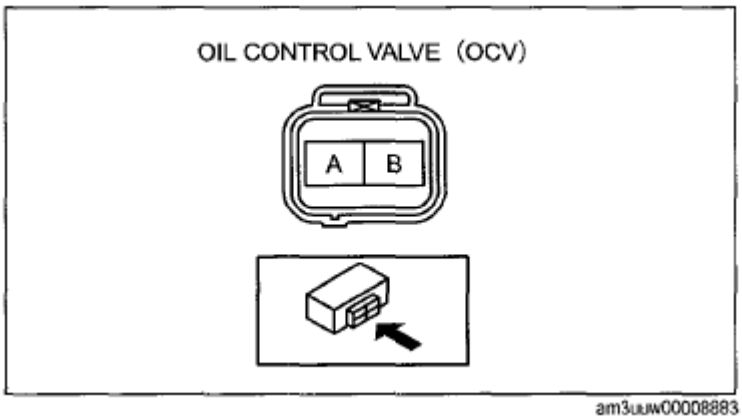


Fig. 4: Identifying Oil Control Valve (OCV) Connector Terminals

SPOOL VALVE OPERATION INSPECTION

1. Verify that the spool valve in the OCV is in the maximum valve timing advance position as indicated in the figure.

- If there is any malfunction, replace the OCV.

NOTE:

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

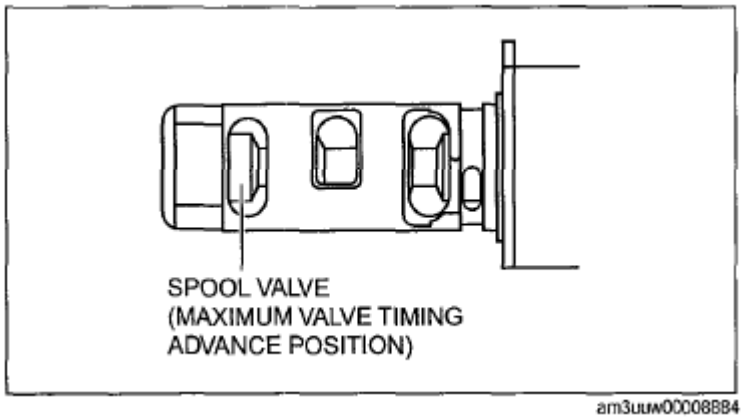


Fig. 5: Identifying Spool Valve (Maximum Valve Timing Advance Position)

2. Apply battery positive voltage between the OCV terminals and verify that the spool valve operates and moves to the maximum valve timing retard position.

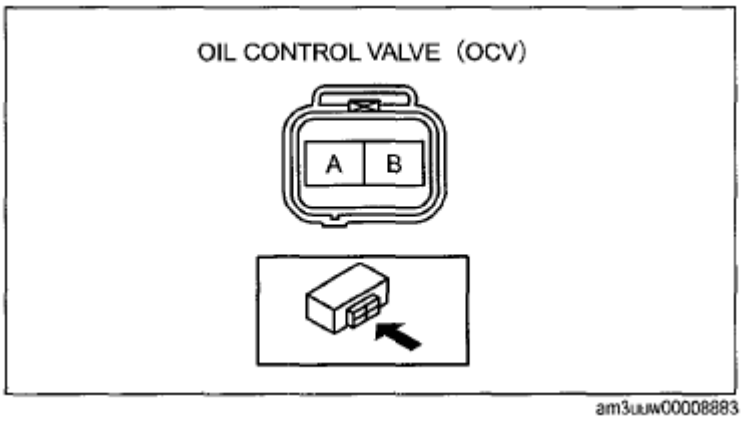


Fig. 6: Identifying Oil Control Valve (OCV) Connector Terminals

- If there is any malfunction, replace the OCV.

3. Stop applying battery positive voltage and verify that the spool valve returns to the maximum valve timing advance position.

- If there is any malfunction, replace the OCV.

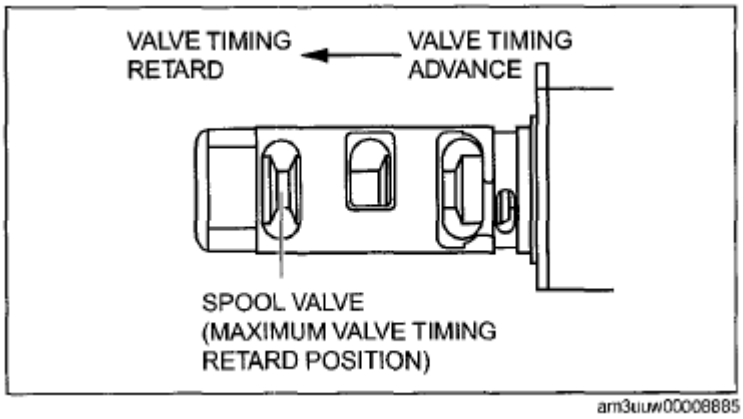


Fig. 7: Identifying Spool Valve (Valve Timing Advance To Retard Position)

HYDRAULIC LASH ADJUSTER (HLA) INSPECTION

1. Visually inspect the HLA surface where it contacts the rocker arm for wear or damage.
   - If there is any malfunction, replace the HLA.

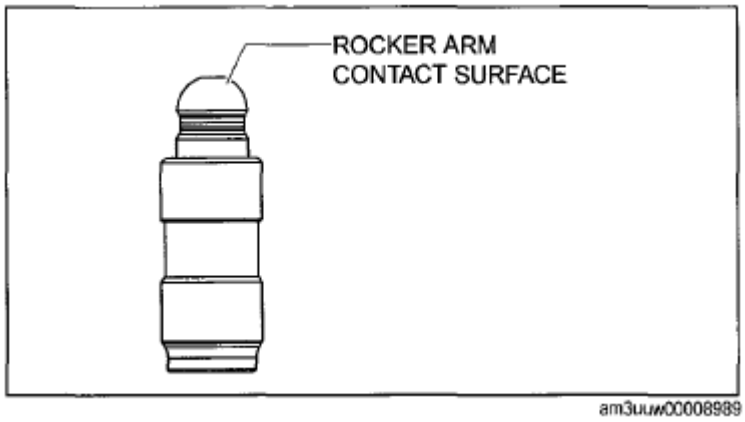


Fig. 8: Identifying Rocker Arm Contact Surface

ROCKER ARM INSPECTION

1. Rotate the roller or the rocker arm by hand and verify that rotates smoothly.
   - If it does not rotate smoothly, replace the rocker arm.
2. Visually inspect the rocker arm surface where it contacts the HLA and valve stem for wear or damage.
   - If there is any malfunction, replace the rocker arm.

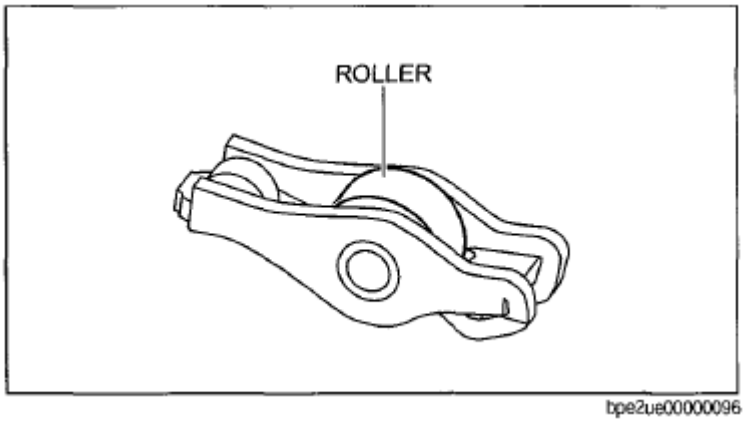


Fig. 9: Identifying Roller

ENGINE OVERHAUL SERVICE WARNING

WARNING:

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

ENGINE MOUNTING/DISMOUNTING

MOUNTING

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

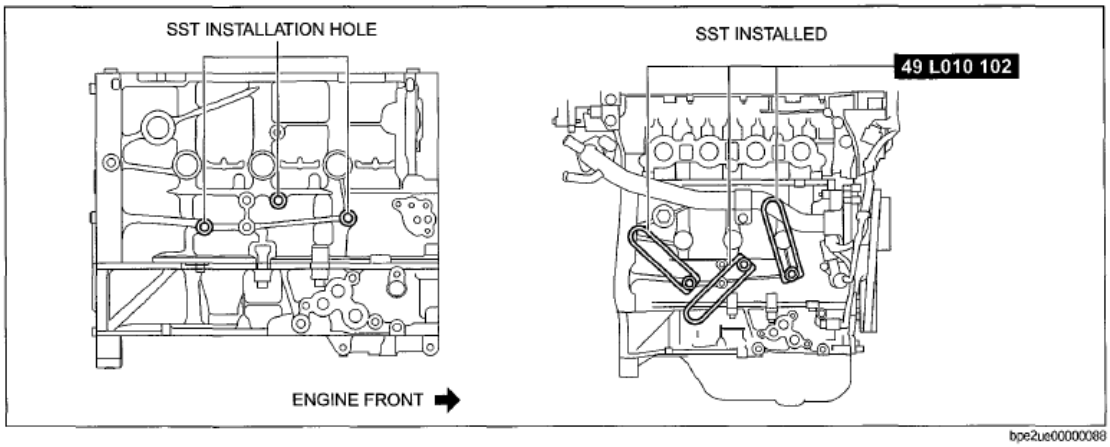


Fig. 10: Identifying SST Arm Installation Positions

2. Install the SSTs (bolts and nuts) to the three positions of the SST (plate) as shown in the figure.

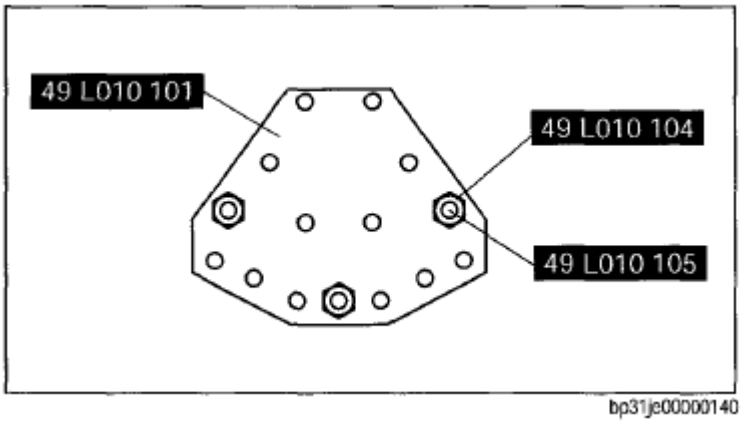


Fig. 11: Identifying SST Plate, Nuts And Bolts

3. Install the SST (bolts, nuts and plate) set in Step 2 to the SST (arms) set in Step 1 using the SSTs (hook and nuts).
4. Adjust the bolts so that approx. 20 mm {0.79 in} of thread is exposed from the side of the plate.
5. Adjust the bolts and nuts so that the plate and arms are parallel.
6. Tighten the SSTs (bolts and nuts) to affix the SST firmly.
7. Install the engine to the SST (engine stand).
8. Remove the oil drain plug and drain the engine oil.
9. Replace the gasket with a new one and install the oil pan drain plug.

   Tightening torque

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

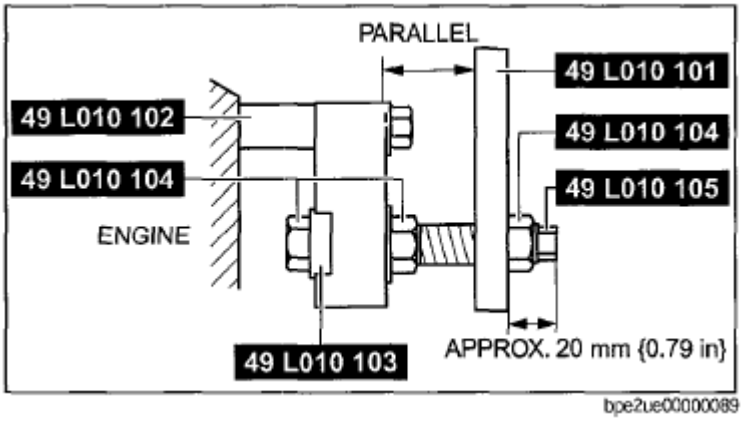


Fig. 12: Identifying Engine Mount Nuts, Bolts, Plate And Arms

DISMOUNTING

1. Dismount in the reverse order of mounting.

TIMING CHAIN DISASSEMBLY

CAUTION:

- **If the camshaft is rotated with the timing chain removed and the piston at the top dead center position, the valve may contact the piston and the engine could be damaged. When rotating the camshaft with the timing chain removed, rotate it after lowering the piston from the top dead center position.**
- **When rotating the camshaft using a wrench on the cast he agon, the wrench may contact the rocker arm and damage the rocker arm. To prevent damage to the rocker arm when holding the camshaft on the cast he agon, use the wrench at engine rear side as shown in the figure to secure a clearance between the cam.**

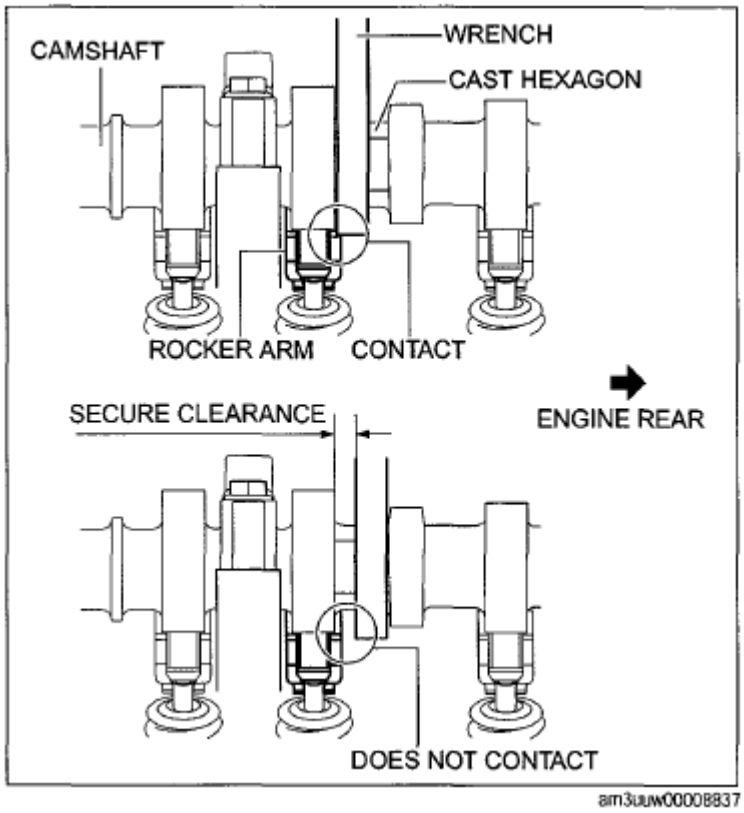


Fig. 13: Securing Clearance Between Cam And Rocker Arm

NOTE:

- **Width at the cast hexagon of the camshaft is 22-24 mm 0.87-0.94 in.**

1. Disassemble in the order indicated in the table.

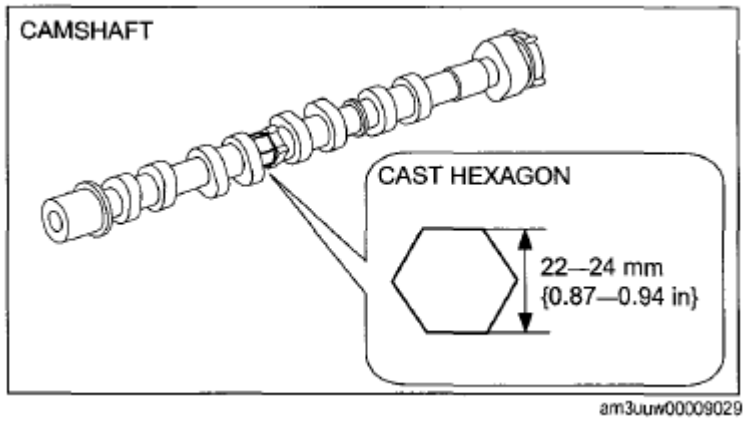
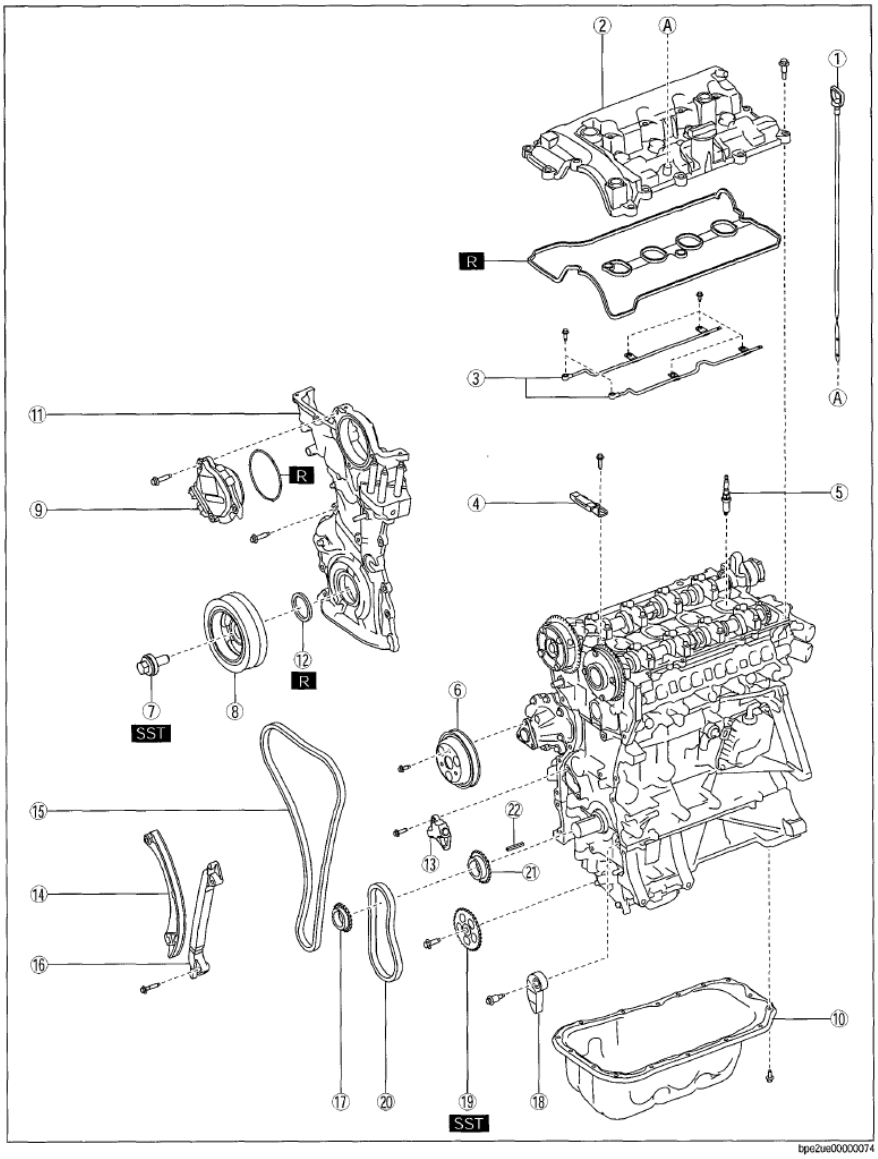


Fig. 14: Identifying Camshaft Cast Hexagon



1	Dipstick
2	Cylinder head cover
5	Spark plug
6	Water pump pulley (See Water Pump Pulley Disassembly Note.)
7	Crankshaft pulley lock bolt (See Crankshaft Pulley Lock Bolt Disassembly Note.)
8	Crankshaft pulley
9	Electric variable valve timing motor/driver
10	Oil pan (See Oil Pan Disassembly Note.)
11	Engine front cover (See Engine Front Cover Disassembly Note.)
12	Front oil seal (See Front Oil Seal Disassembly Note.)

3	Oil shower pipe
4	Chain guide (No.1)
13	Chain tensioner (See Chain Tensioner Removal Note.)
14	Tensioner arm
15	Timing chain
16	Chain guide (No.2)
17	Crankshaft sprocket
18	Oil pump chain tensioner
19	Oil pump driven sprocket (See Oil Pump Driven Sprocket Disassembly Note.)
20	Oil pump chain
21	Oil pump drive sprocket
22	Key

Fig. 15: Identifying Engine Disassembly Order

WATER PUMP PULLEY DISASSEMBLY NOTE

CAUTION:

- **Be careful not to damage the belt groove and surface of the water pump pulley when using tools, otherwise it will cause wear, breakage, abnormal noise of the drive belt (stretch belt), damage to the pulley, and rust.**

1. Align the water pump pulley hole with the water pump hole as shown in the figure.

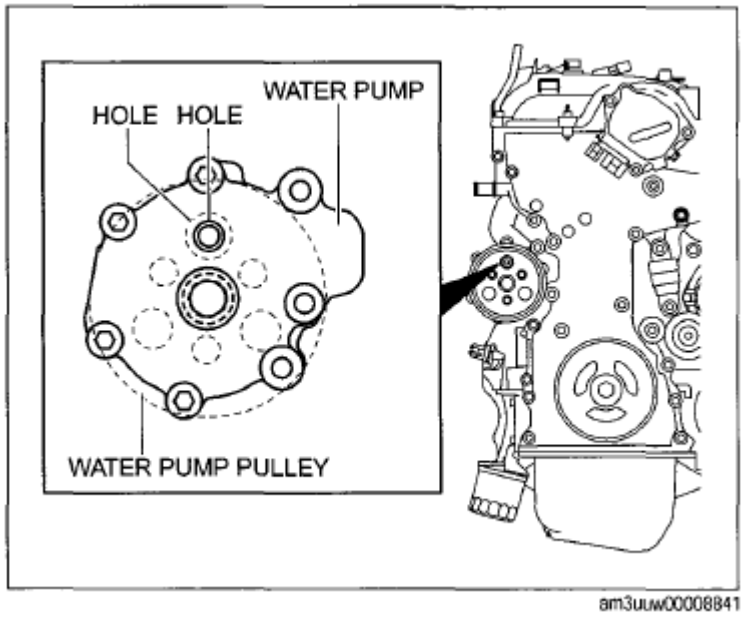


Fig. 16: Aligning Water Pump Pulley Hole With Water Pump Hole

2. Insert an appropriate bolt (length appro. 70 mm {2.8 in}) into the water pump hole as shown in the figure, and lock the water pump pulley against rotation.
3. Remove the water pump pulley.
4. Remove the bolt used for locking the water pump pulley against rotation.

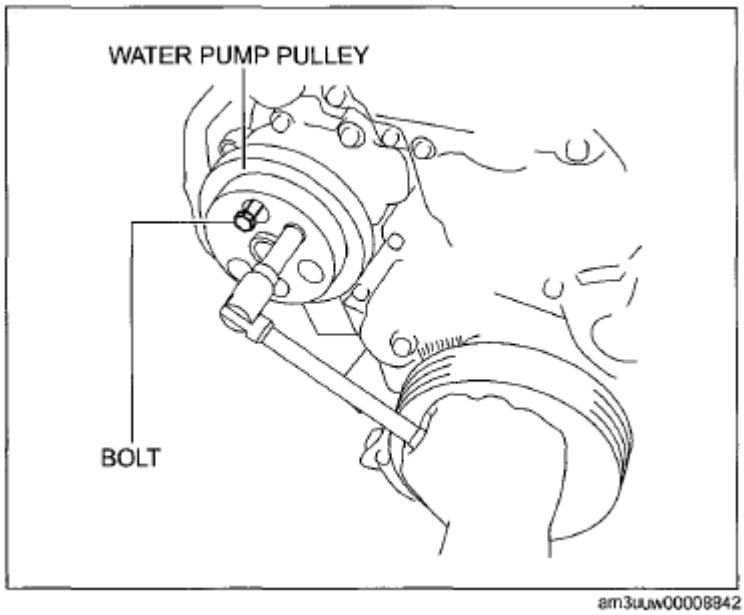


Fig. 17: Inserting Bolt Into Water Pump Hole To Lock Water Pump Pulley Against Rotation

CRANKSHAFT PULLEY LOCK BOLT DISASSEMBLY NOTE

1. Hold the crankshaft using the SST.
2. Remove the crankshaft pulley lock bolt.

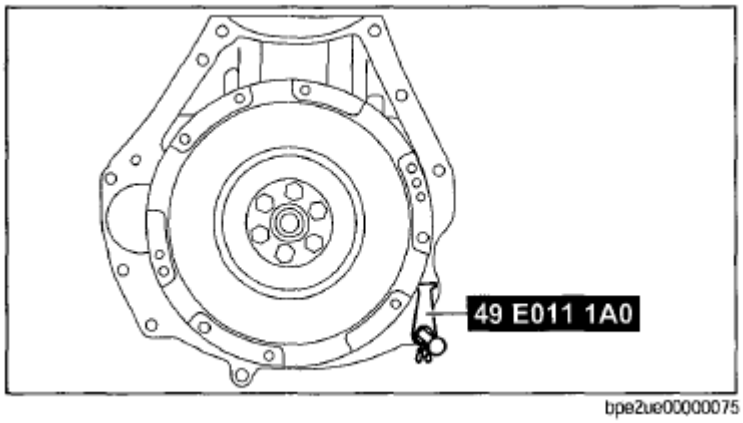


Fig. 18: Identifying Crankshaft Pulley Lock Bolt

OIL PAN DISASSEMBLY NOTE

1. Remove the oil pan using a separator tool.

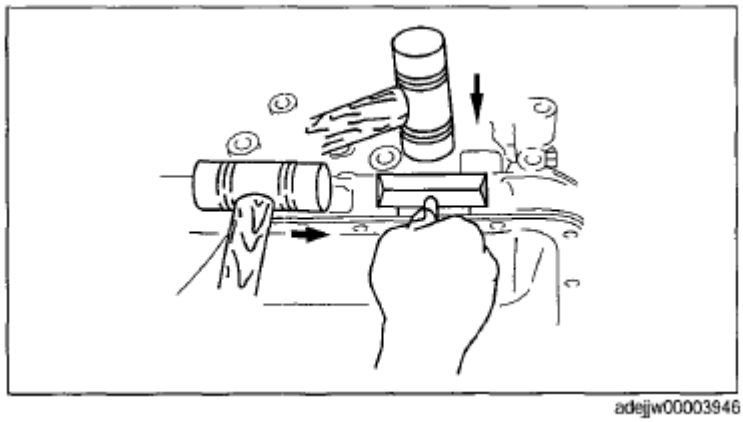


Fig. 19: Removing Oil Pan Using Separator Tool

ENGINE FRONT COVER DISASSEMBLY NOTE

1. Remove the engine front cover Bolts.
2. Using a screwdriver wrapped in a cloth, peel the sealant away a little at a time, and remove the engine front cover.

CAUTION:

- **Do not apply e cessive force to the screwdriver. Otherwise, the engine front cover could be damaged.**
- **Be careful not to scratch or damage the seal surface. Otherwise, it could cause oil leakage.**

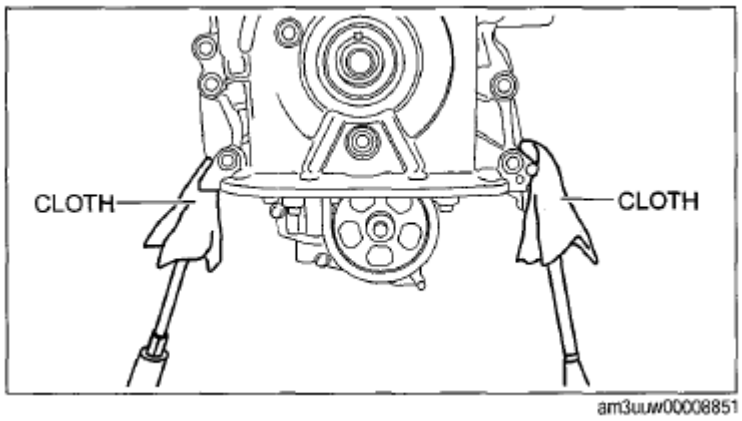


Fig. 20: Peeling Sealant Away Using Cloth Wrapped Screwdriver

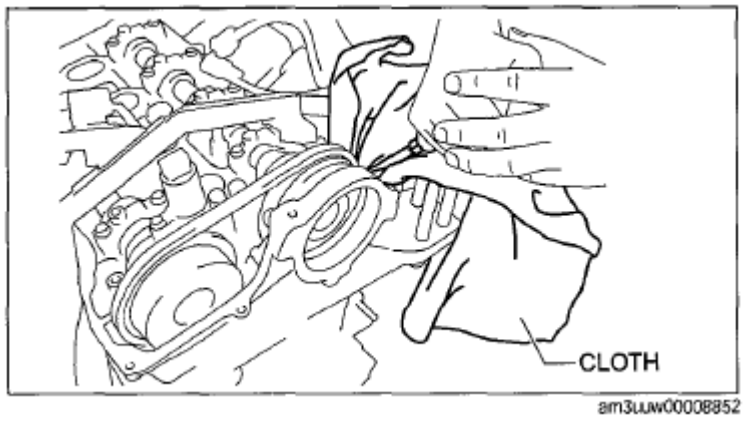


Fig. 21: Precaution For Removing Engine Front Cover Using Screwdriver

FRONT OIL SEAL DISASSEMBLY NOTE

1. Remove the oil seal using a flathead screwdriver with the tip protected by a clean cloth.

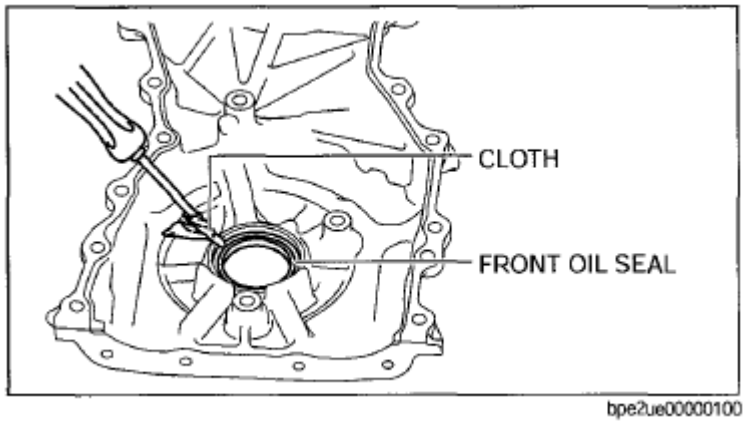


Fig. 22: Removing Oil Seal Using Flathead Screwdriver

CHAIN TENSIONER REMOVAL NOTE

1. While moving the exhaust camshaft back and forth in the direction of the arrow using a wrench on the cast hexagon, press down the link plate of the timing chain tensioner using a precision screwdriver and release the plunger lock.

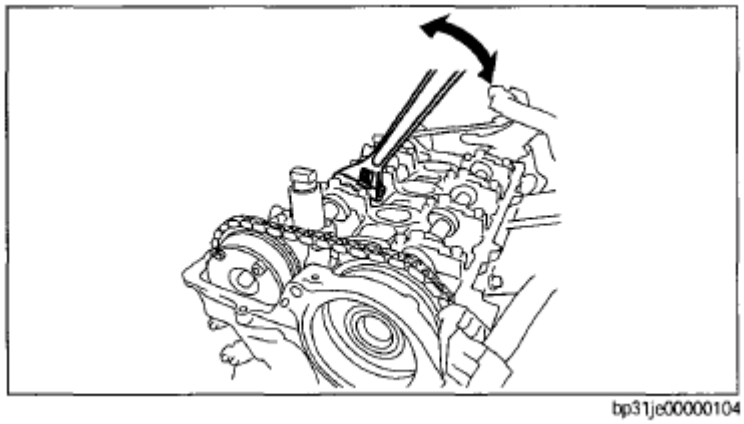


Fig. 23: Moving Exhaust Camshaft Back And Forth Using Wrench

NOTE:

- **When moving the exhaust camshaft back and forth, the timing chain pushes the plunger in the chain tensioner making it easier to operate the link plate.**

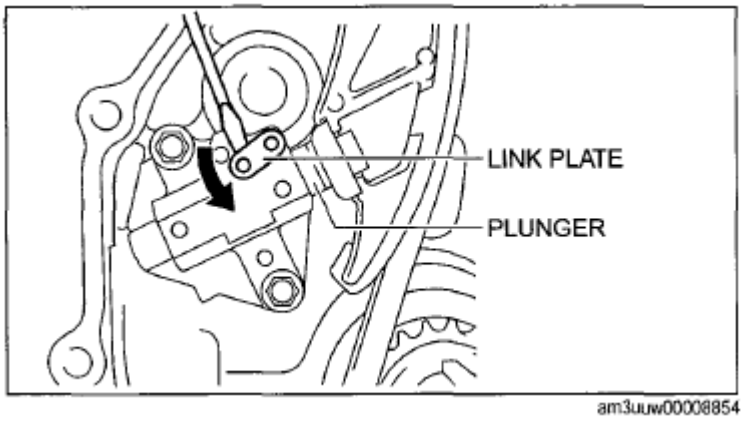


Fig. 24: Pushing Plunger Into Chain Tensioner

2. Push back the plunger slowly in the direction shown in the figure with the link plate still pushed down.
3. Remove the screwdriver from the link plate with the plunger still pushed down.
4. Release the force slightly from the plunger, and move it back and forth 2-3 mm {0.08-0.11 in}.

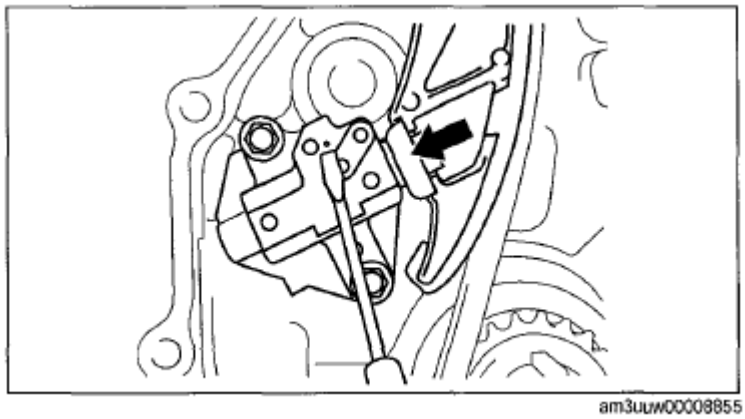


Fig. 25: Pushing Back Plunger Slowly Using Screwdriver

5. Insert a wire with an appro. diameter of 1.5 mm {0.059 in} or a paper clip where the link plate hole and the tensioner body hole overlap to secure the link plate and lock the plunger.
6. Remove the chain tensioner.

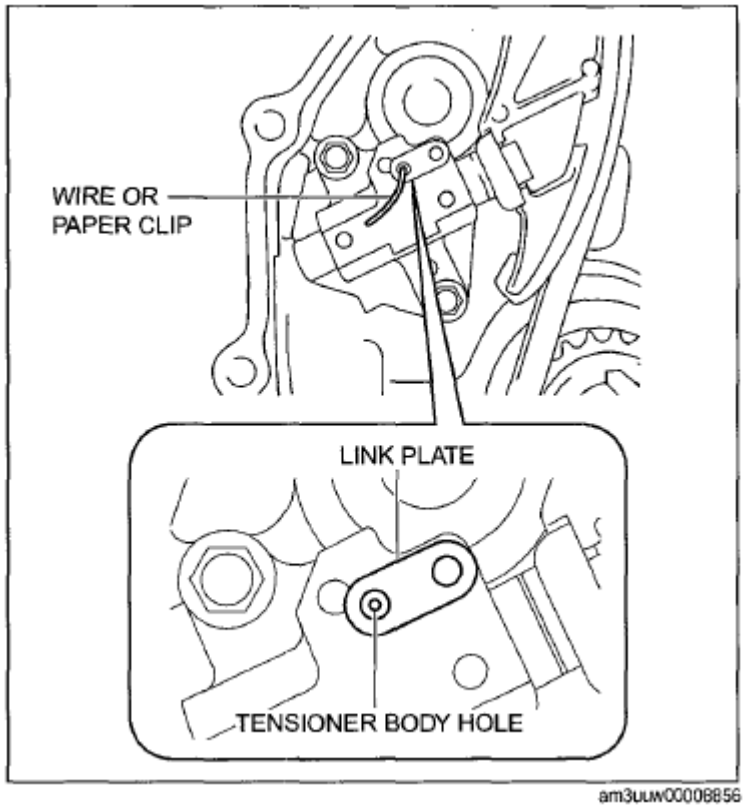


Fig. 26: Identifying Link Plate, Tensioner Body Hole And Wire

OIL PUMP DRIVEN SPROCKET DISASSEMBLY NOTE

1. Hold the crankshaft using the SST.

2. Remove the oil pump driven sprocket.

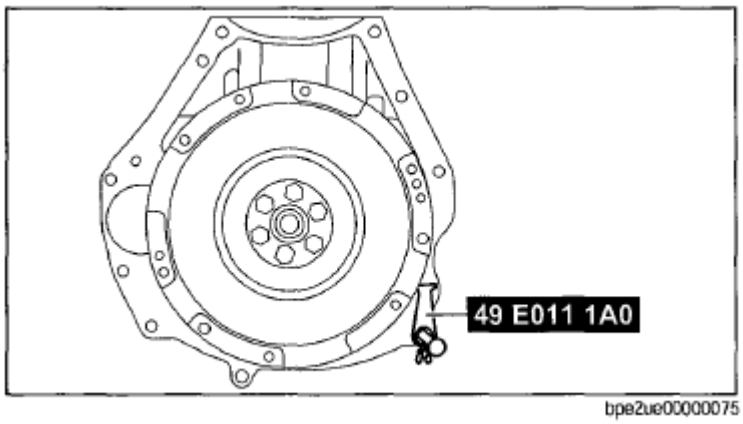


Fig. 27: Flywheel Holding Tool

CYLINDER HEAD DISASSEMBLY (I)

CAUTION:

- **If the camshaft is rotated with the timing chain removed and the piston at the top dead center position, the valve may contact the piston and the engine could be damaged. When rotating the camshaft with the timing chain removed, rotate it after lowering the piston from the top dead center position.**
- **When rotating the camshaft using a wrench on the cast he agon, the wrench may contact the rocker arm and damage the rocker arm. To prevent damage to the rocker arm when holding the camshaft on the cast he agon, use the wrench at engine rear side as shown in the figure to secure a clearance between the cam.**

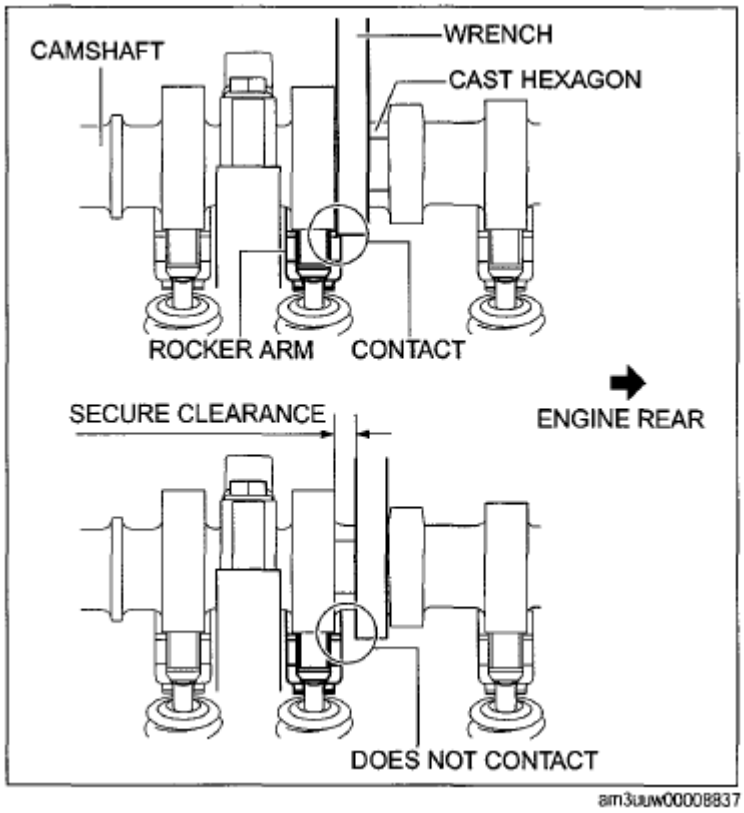


Fig. 28: Securing Clearance Between Cam Using Wrench

NOTE:

- **Width at the cast hexagon of the camshaft is 22-24 mm 0.87-0.94 in.**

1. Disassemble in the order indicated in the table.

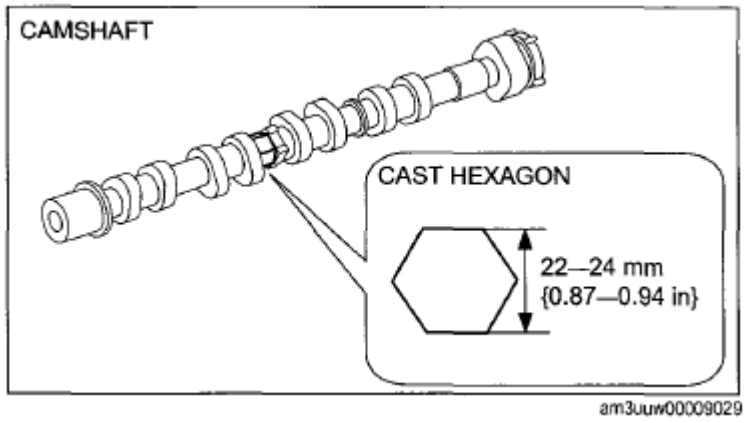
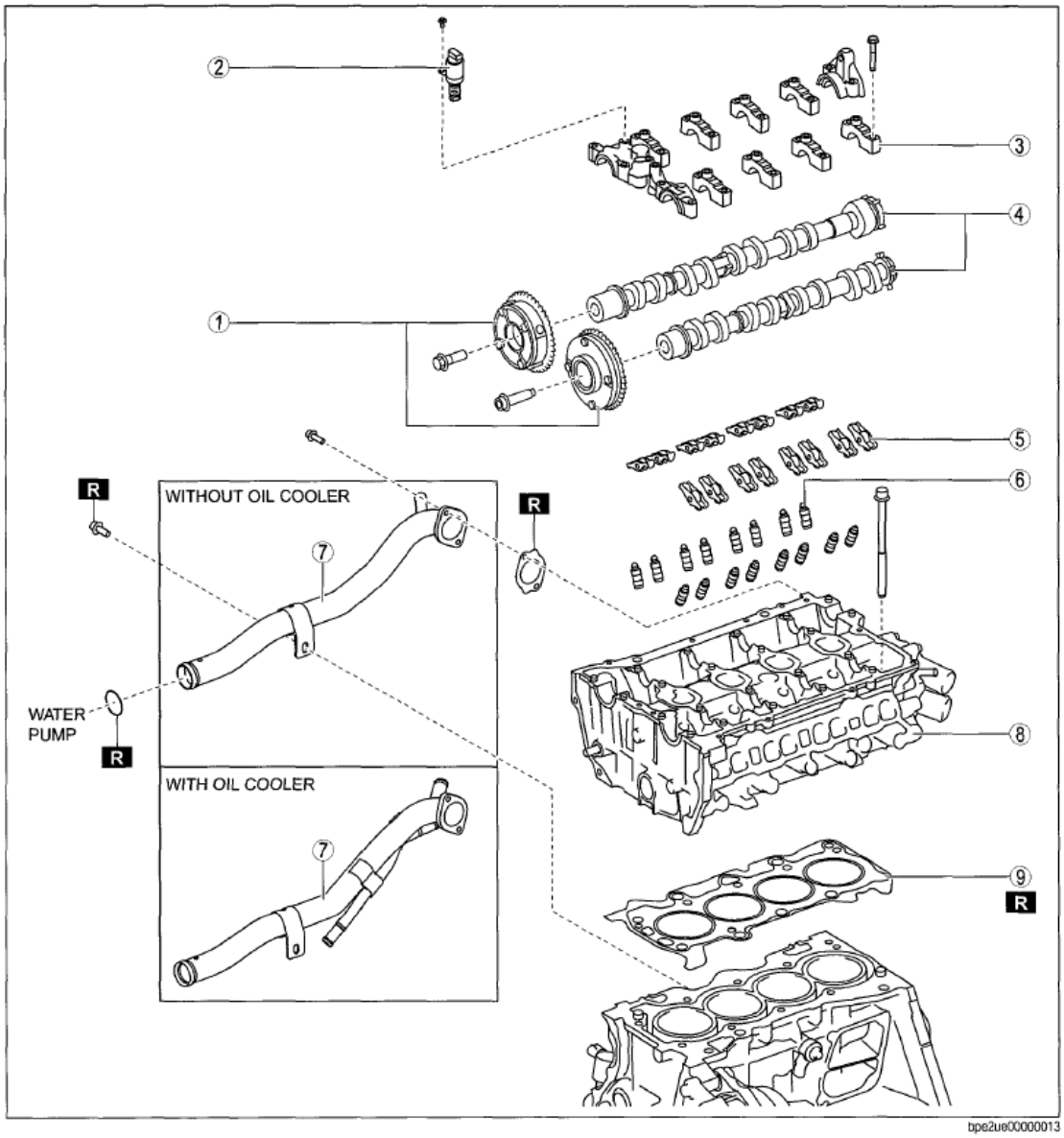


Fig. 29: Identifying Camshaft Cast Hexagon



1	Electric variable valve timing actuator, hydraulic variable valve timing actuator (See Electric Variable Valve Timing Actuator, Hydraulic Variable Valve Timing Actuator Disassembly Note.)
2	OCV
3	Camshaft cap (See Camshaft Cap Disassembly Note.)
4	Camshaft

5	Rocker arm (See Rocker Arm Disassembly Note.)
6	HLA (See HLA Disassembly Note.)
7	Water inlet pipe
8	Cylinder head (See Cylinder Head Disassembly Note.)
9	Cylinder head gasket

Fig. 30: Identifying Variable Valve Timing Actuator Components (With And Without Oil Cooler)

ELECTRIC VARIABLE VALVE TIMING ACTUATOR, HYDRAULIC VARIABLE VALVE TIMING ACTUATOR DISASSEMBLY NOTE

1. Hold the camshaft using a wrench on the cast hexagon and loosen the actuator installation bolt.

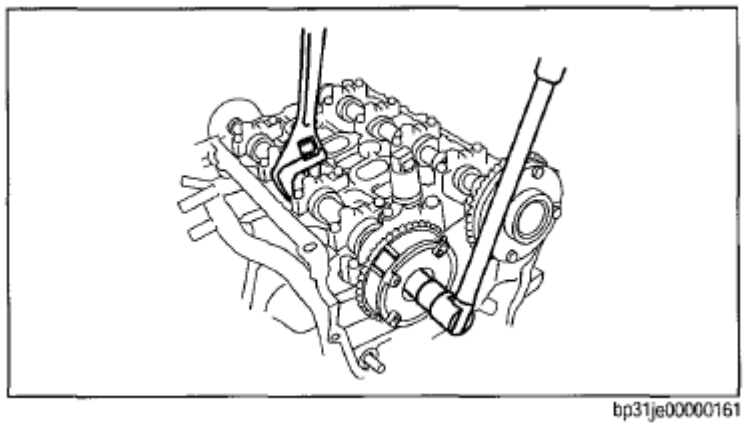


Fig. 31: Holding Camshaft And Rotating Actuator Bolt Using Tool

CAMSHAFT CAP DISASSEMBLY NOTE

1. Before removing the camshaft cap, Inspect the camshaft end play. (See **CAMSHAFT INSPECTION**.)
2. Loosen the camshaft cap Bolts in two or three passes in the order shown in the figure and remove the camshaft caps.

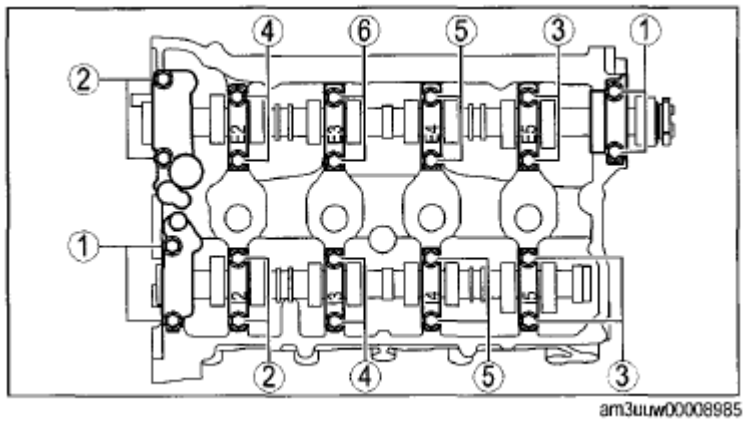


Fig. 32: Identifying Camshaft Cap Bolt Loosening Sequence

ROCKER ARM DISASSEMBLY NOTE

1. Keep the rocker arms in the order of removal to enable reassembly in their original positions.

HLA DISASSEMBLY NOTE

1. Keep the HLAs in the order of removal to enable reassembly in their original positions.

CYLINDER HEAD DISASSEMBLY NOTE

1. Loosen the cylinder head Bolts in two or three passes in the order shown in the figure and remove them.

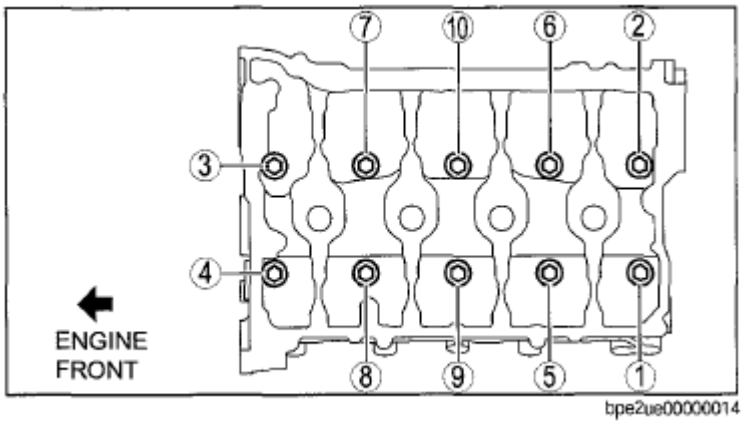
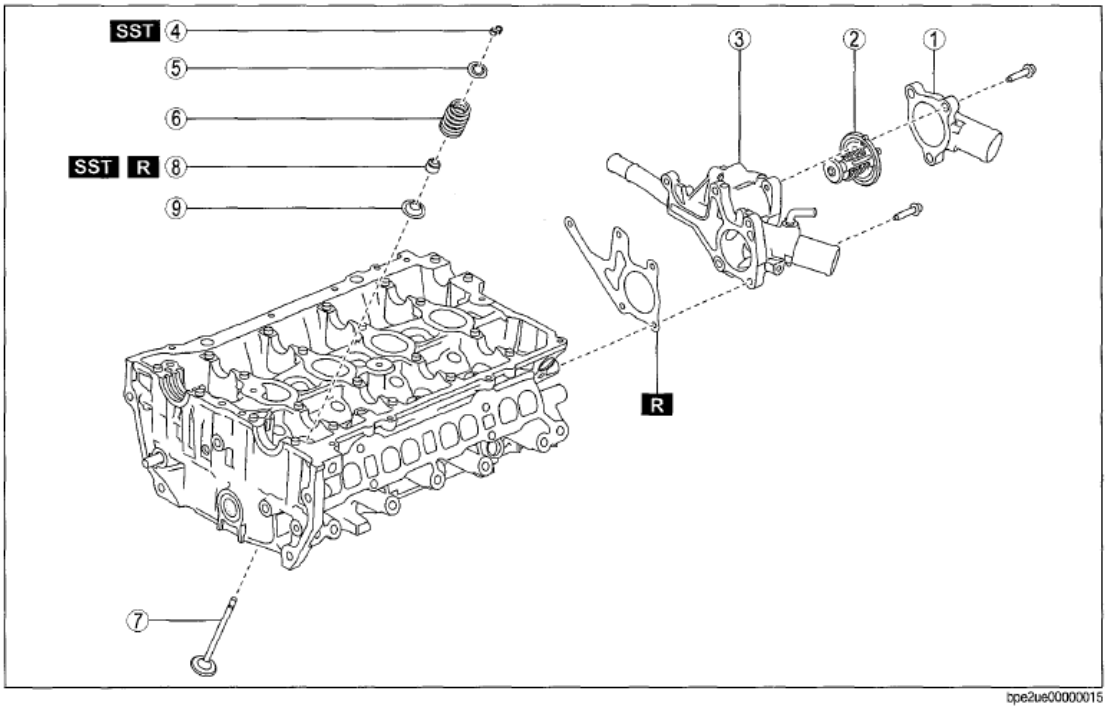


Fig. 33: Identifying Cylinder Head Bolt Loosening Sequence

CYLINDER HEAD DISASSEMBLY (II)

1. Disassemble in the order indicated in the table.



1	Thermostat cover
2	Thermostat
3	Water outlet
4	Valve keeper (See Valve Keeper Disassembly Note.)
5	Upper valve spring seat
6	Valve spring
7	Valve
8	Valve seal (See Valve Seal Disassembly Note.)
9	Lower valve spring seat

Fig. 34: Disassembling Order Of Cylinder Head

VALVE KEEPER DISASSEMBLY NOTE

1. Remove the valve keeper using the SSTs.

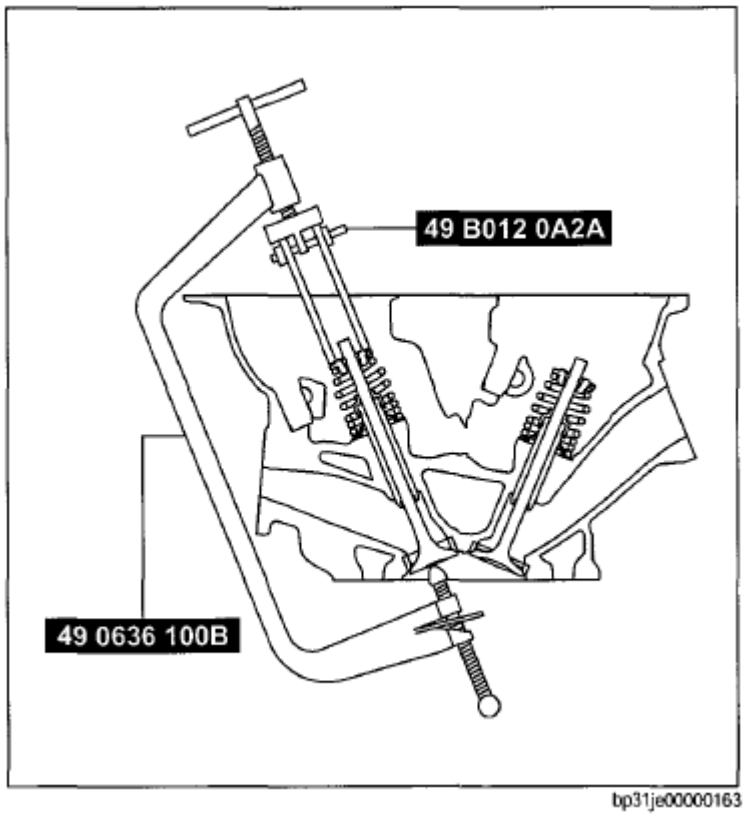


Fig. 35: Removing Valve Keeper

VALVE SEAL DISASSEMBLY NOTE

1. Remove the valve seal using the SST or pliers, etc.

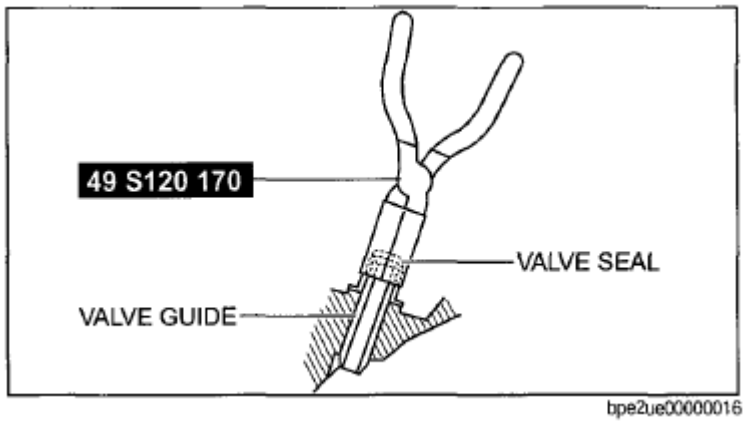


Fig. 36: Removing Valve Seal From Valve Guide Using Pliers

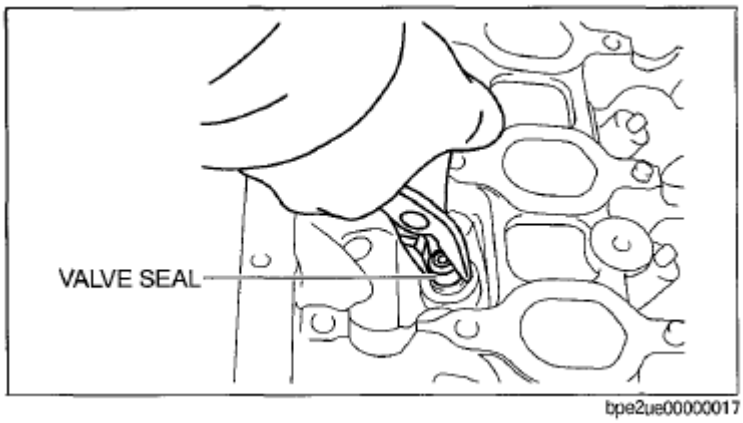
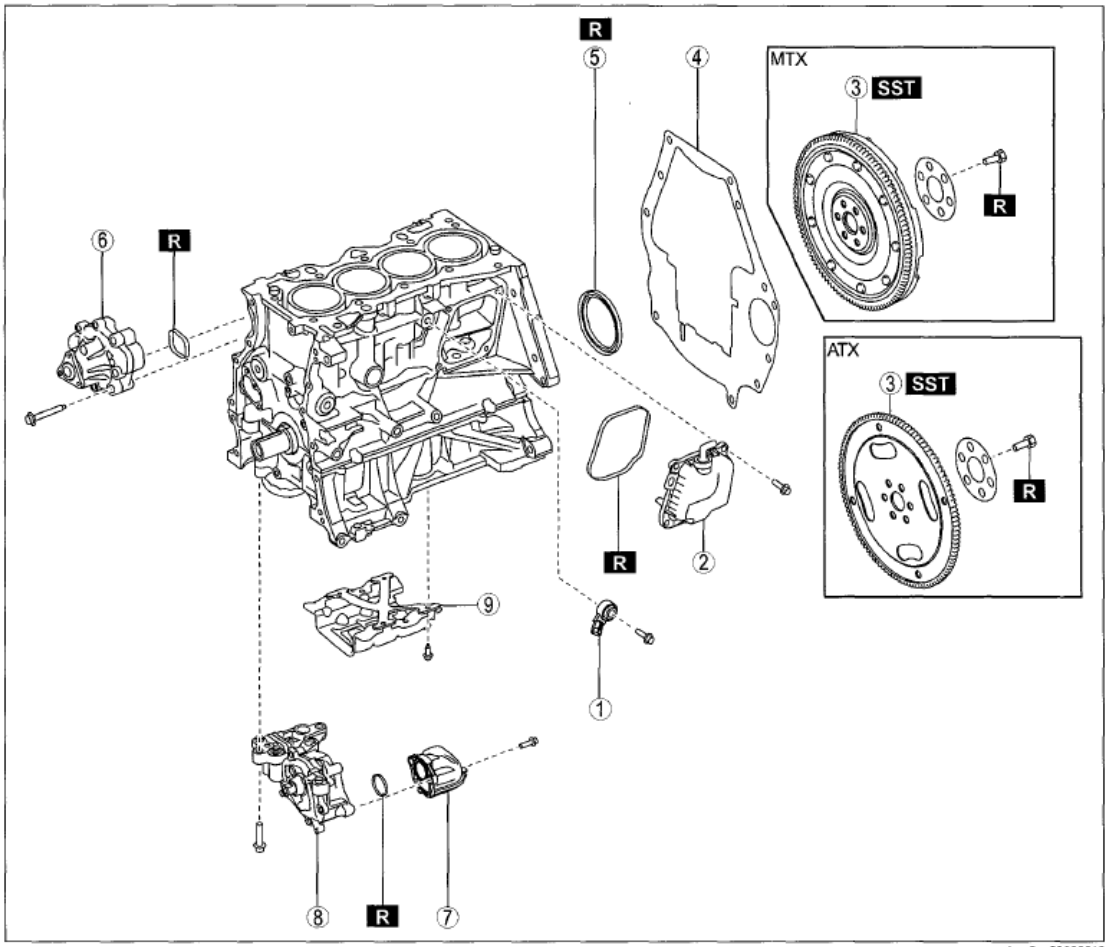


Fig. 37: Removing Valve Seal Using Pliers

CYLINDER BLOCK DISASSEMBLY ELECTRICAL (I)

CAUTION:
- **Do not disassemble the oil pump and water pump because it is a precision unit.**

1. Disassemble in the order indicated in the table.



1	Knock sensor
2	Oil separator
3	Flywheel (MTX), Drive plate (ATX) (See Flywheel (MTX), Drive Plate (ATX) Disassembly Note.)
4	End plate

5	Rear oil seal (See Rear Oil Seal Removal Note.)
6	Water pump
7	Oil strainer
8	Oil pump
9	Oil baffle plate

Fig. 38: Disassembling Order Of Cylinder Block Assembly (I)

FLYWHEEL (MT), DRIVE PLATE (AT) DISASSEMBLY NOTE

1. Hold the crankshaft using the SST.

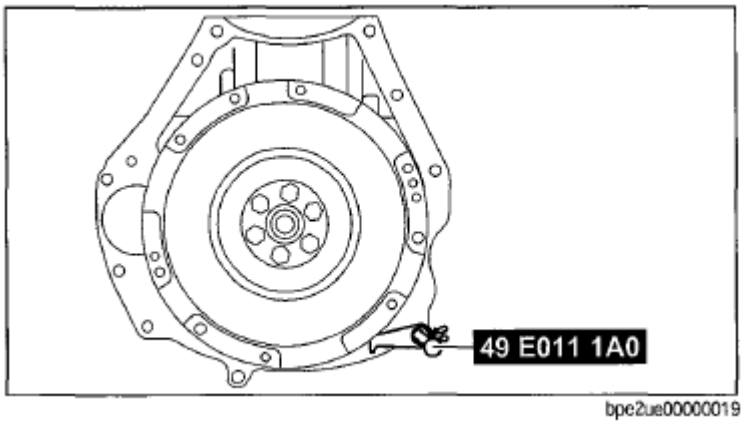


Fig. 39: Holding Flywheel Using Special Tool

REAR OIL SEAL REMOVAL NOTE

1. Cut the oil seal lip using a utility knife.
2. Remove the oil seal using a flathead screwdriver with the tip protected by a clean cloth to prevent damage to the oil seal sliding part of the crankshaft.

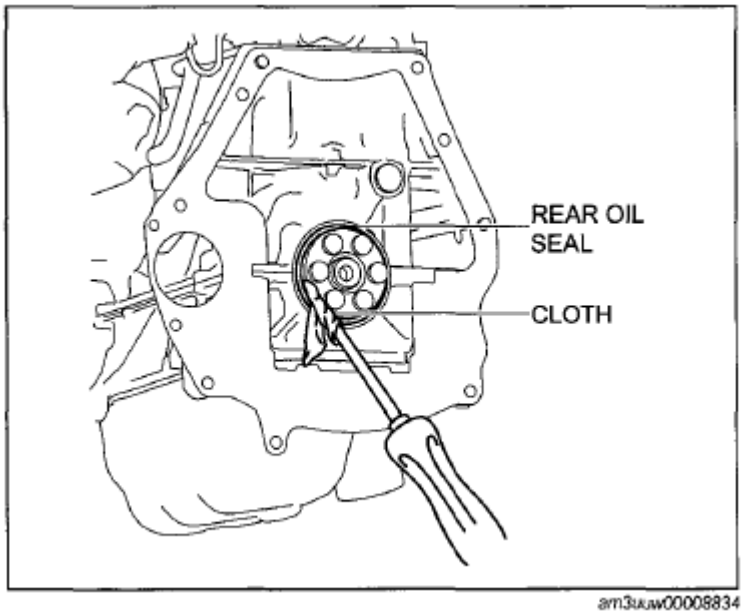
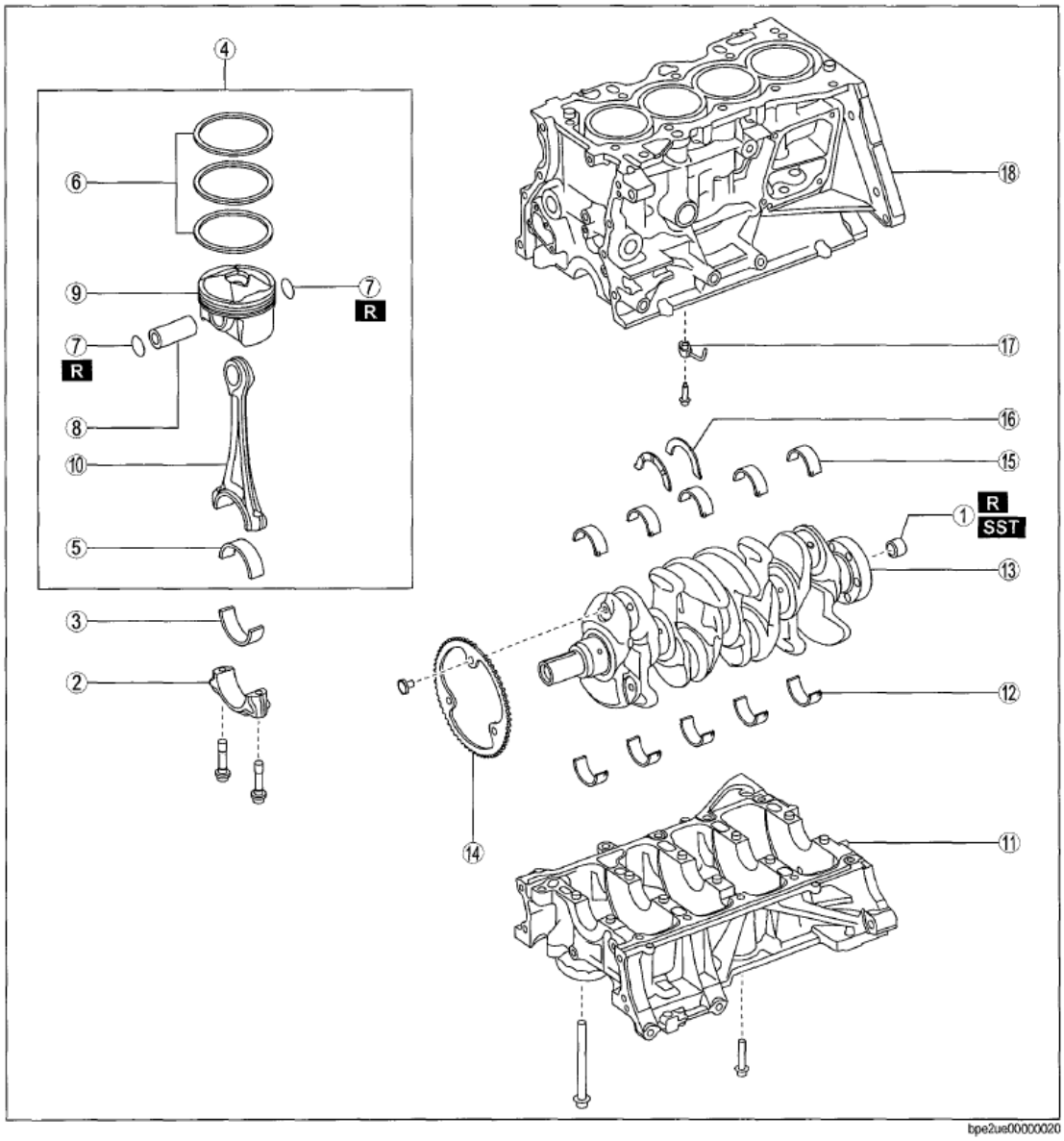


Fig. 40: Removing Rear Oil Seal Using Cloth Wrapped Screwdriver

CYLINDER BLOCK DISASSEMBLY (II)

1. Disassemble in the order indicated in the table.



1	Pilot bearing (MTX) (See Pilot Bearing Disassembly Note.)
2	Connecting rod cap (See Connecting Rod Cap Disassembly Note.)
3	Lower connecting rod bearing (See Connecting Rod Bearing Disassembly Note.)
4	Piston, connecting rod (See Piston, Connecting Rod Disassembly Note.)
11	Lower cylinder block (See Lower Cylinder Block Disassembly Note.)
12	Lower main bearing (See Thrust Bearing And Main Bearing Disassembly Note.)
13	Crankshaft (See Crankshaft Disassembly Note.)
14	Plate

5	Upper connecting rod bearing (See Connecting Rod Bearing Disassembly Note.)
6	Piston ring
7	Snap ring (See Snap Ring Disassembly Note.)
8	Piston pin
9	Piston
10	Connecting rod
15	Upper main bearing (See Thrust Bearing And Main Bearing Disassembly Note.)
16	Thrust bearing (See Thrust Bearing And Main Bearing Disassembly Note.)
17	Oil jet valve
18	Upper cylinder block

Fig. 41: Disassembling Order Of Cylinder Block Assembly (II)

PILOT BEARING DISASSEMBLY NOTE

NOTE:

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

1. Use the SST to remove the pilot bearing.

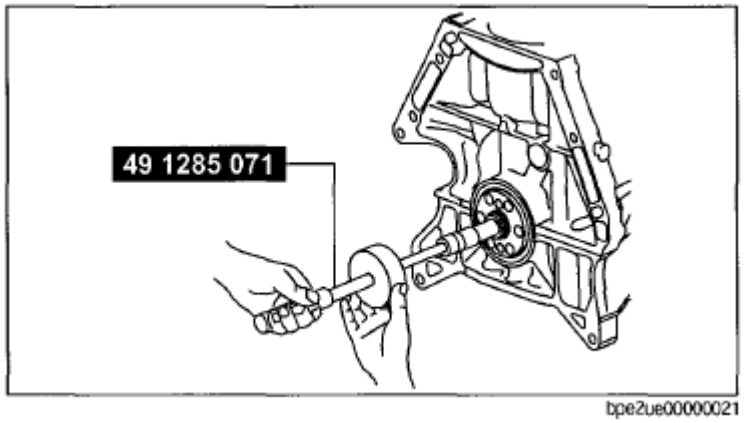


Fig. 42: Removing Pilot Bearing

CONNECTING ROD CAP DISASSEMBLY NOTE

1. Before removing the connecting rod cap, inspect the connecting rod side clearance. (See **CONNECTING ROD CLEARANCE INSPECTION**.)
2. The removed connecting rod caps are to be kept so that they can be assembled to the same positions and in the direction as before removal.

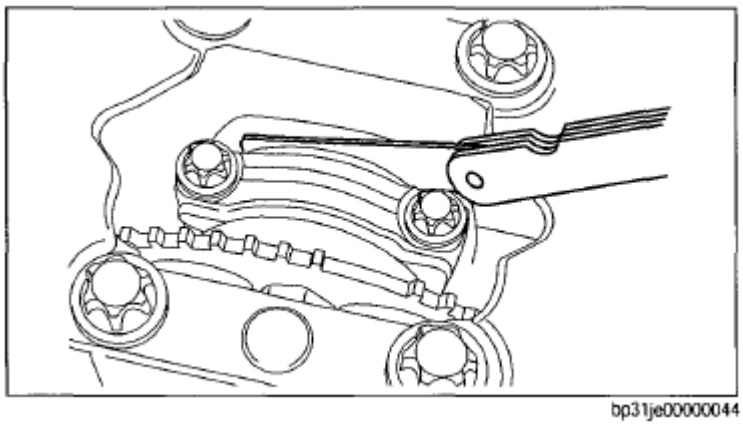


Fig. 43: Inspecting Connecting Rod Clearance Using Feeler Gauge

CONNECTING ROD BEARING DISASSEMBLY NOTE

1. The removed connecting rod bearings are to be kept so that they can be assembled to the same positions and in the direction as before removal.

PISTON, CONNECTING ROD DISASSEMBLY NOTE

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

SNAP RING DISASSEMBLY NOTE

1. Before removing the snap ring, inspect that the large end of connecting rod drops under its own weight with no resistance. (See **PISTON AND CONNECTING ROD INSPECTION**.)
2. Remove the snap ring using a flathead screwdriver.

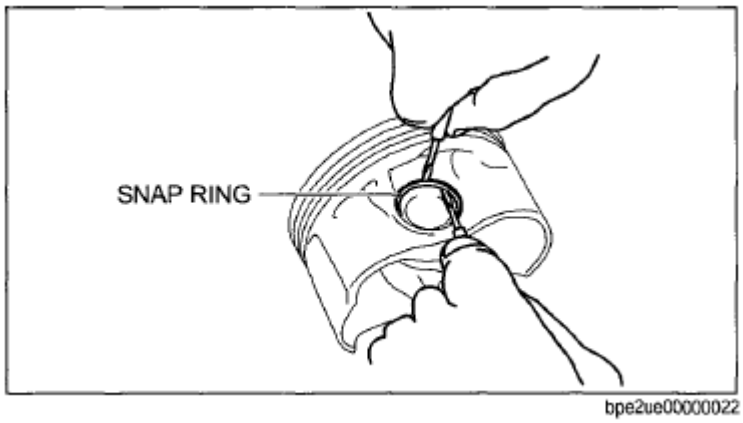


Fig. 44: Removing Snap Ring Using Flathead Screwdriver

LOWER CYLINDER BLOCK DISASSEMBLY NOTE

1. Before removing the lower cylinder block, inspect the crankshaft end play. (See **CRANKSHAFT INSPECTION**.)
2. Loosen the lower cylinder block A bolts A in two or three passes in the order shown in the figure and remove them.

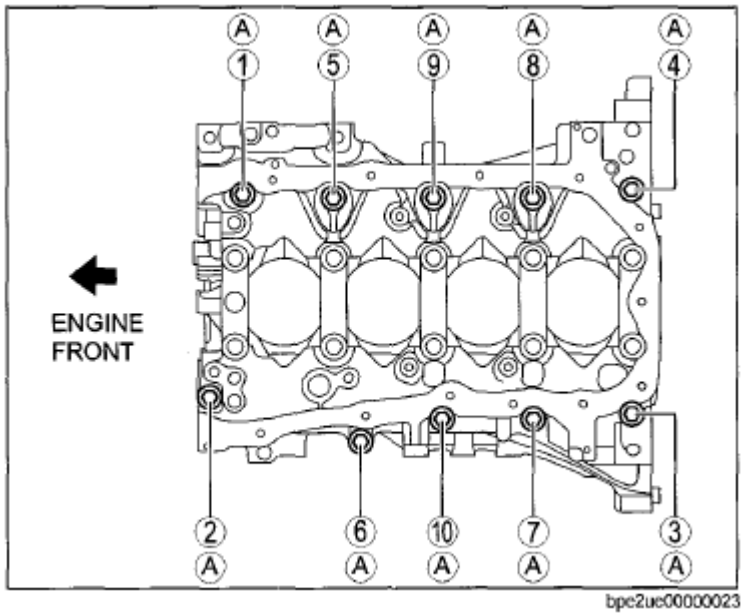


Fig. 45: Identifying Lower Cylinder Block A Bolts Loosening Sequence

3. Loosen the lower cylinder block Bolt B in two or three passes in the order shown in the figure and remove them.

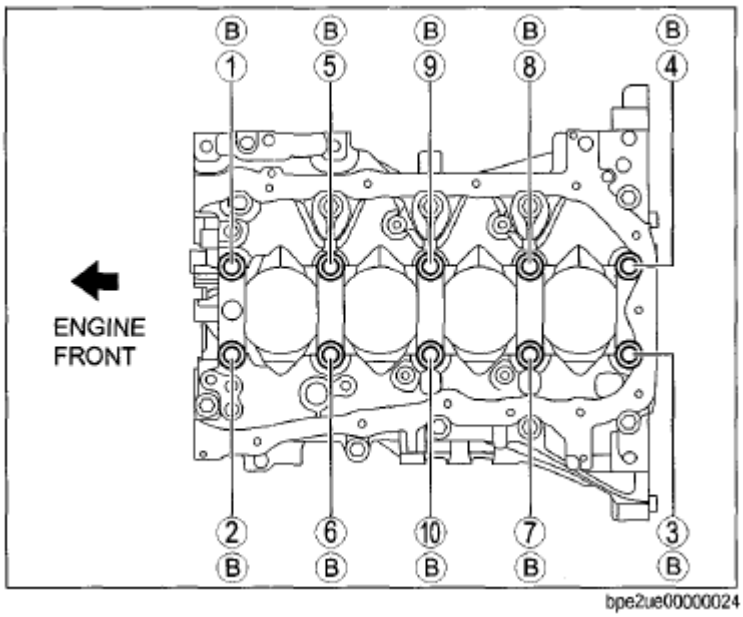


Fig. 46: Identifying Lower Cylinder Block B Bolts Loosening Sequence

4. Using a screwdriver wrapped in a cloth, peel the sealant away a little at a time, and remove the lower cylinder block.

CAUTION:
- **Do not apply e cessive force to the screwdriver. Otherwise, the**

lower cylinder block could be damaged.

- **Be careful not to scratch or damage the seal surface. Otherwise, it could cause oil leakage.**

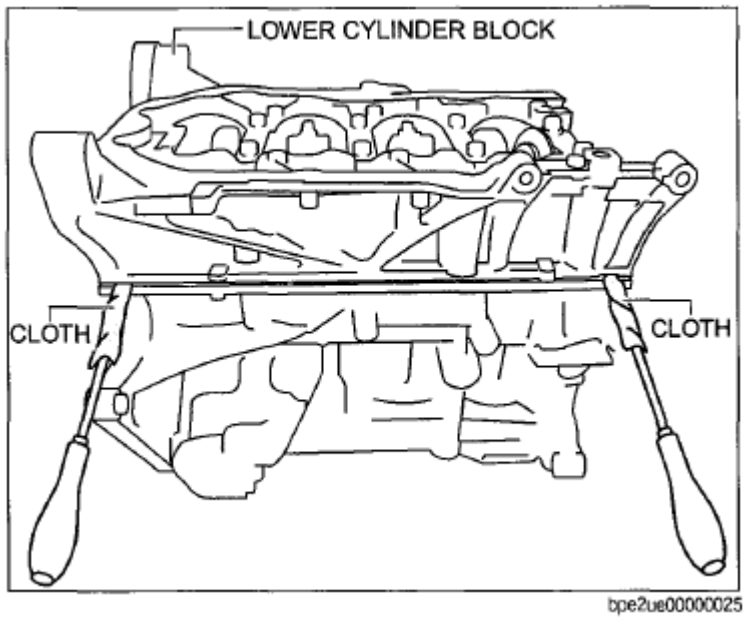


Fig. 47: Peeling Sealant Away From Lower Cylinder Block Using Cloth Wrapped Screwdriver

THRUST BEARING AND MAIN BEARING DISASSEMBLY NOTE

1. The removed thrust bearings and main bearings are to be kept so that they can be assembled to the same positions and in the direction as before removal.

CRANKSHAFT DISASSEMBLY NOTE

CAUTION:

- **Placing the crankshaft on a disassembly bench will deform or damage it because the plate for the crankshaft position sensor signal detection installed to the crankshaft is larger than the counterweight. Therefore, set wood blocks or similar objects on the both sides of the crankshaft so that the plate does not contact the disassembly bench directly when placing the crankshaft on it bench.**

CYLINDER HEAD INSPECTION

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

Ma imum distortion, head gasket side of the cylinder head 0.05 mm {0.002 in}

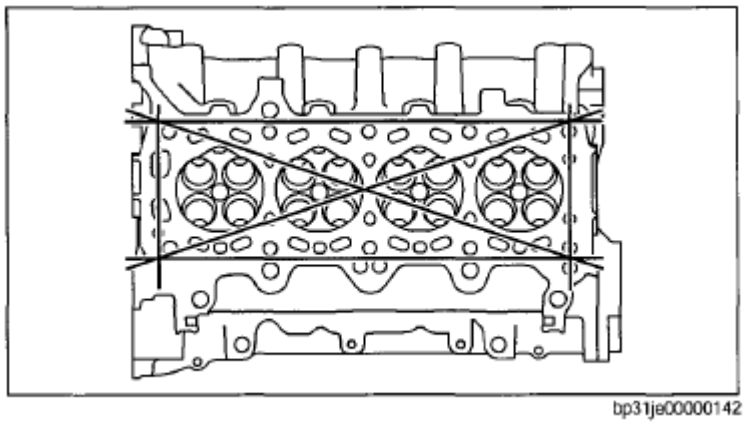


Fig. 48: Measuring Combustion Chamber Side Of Cylinder Head For Distortion Using Straight Edge And Feeler Gauge

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

    Ma imum distortion, manifold side

    IN 0.10 mm {0.0039 in}

    E 0.05 mm {0.002 in}

    Ma imum cutting length, manifold side

    IN Cutting not authori ed

    E 0.20 mm {0.0079 in}

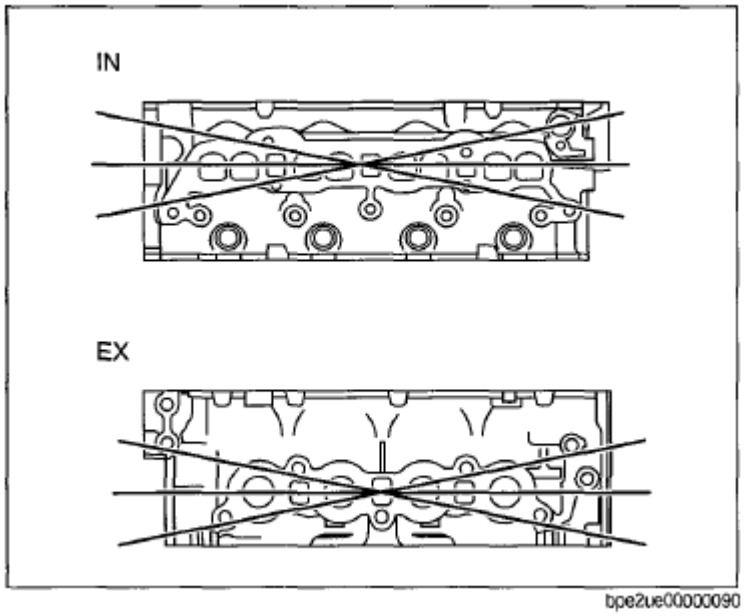


Fig. 49: Measuring Contact Surface Of Exhaust And Intake Manifold For Distortion Using Straight Edge And Feeler Gauge

VALVE SEAT INSPECTION/REPAIR

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

   Standard valve seat contact width

   1.41 mm {0.0555 in}

   Valve seat angle 45°

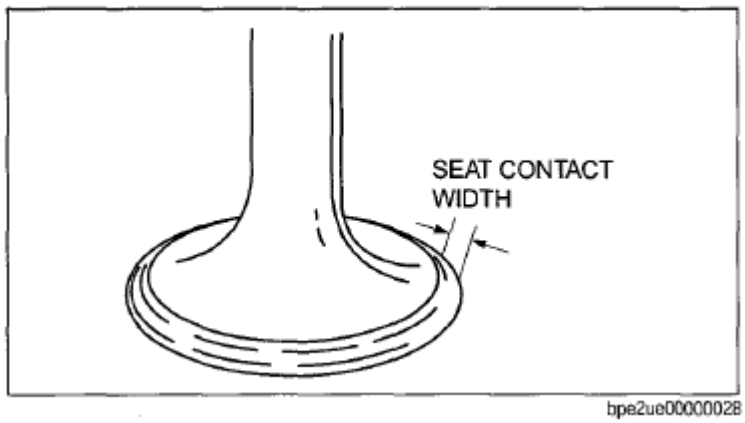


Fig. 50: Identifying Valve Seat Contact Width

2. Verify that the area where the valve seat contacts the valve face is centered.
    - If the seating position is too high, correct the valve seat using a 70° (IN) 70° (EX) valve seat cutter and a 45° valve seat cutter.
    - If the seating position is too low, correct as follows:
        - IN: Correct the valve seat using a 20° valve seat cutter and then using a 45° valve cutter.
        - EX: Correct the valve seat using a 45° valve seat cutter.

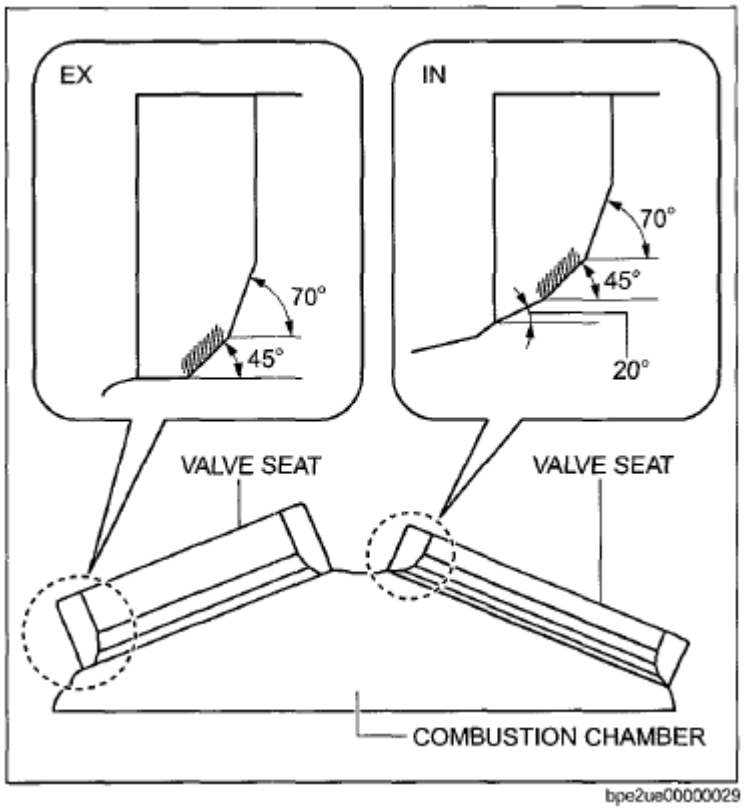


Fig. 51: Identifying Valve Seat Contact Areas

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

    Standard valve seat sinkage amount

    (Dimension L)

    IN 48.73-50.27 mm {1.919-1.979 in}

    E 48.73-50.27 mm {1.919-1.979 in}

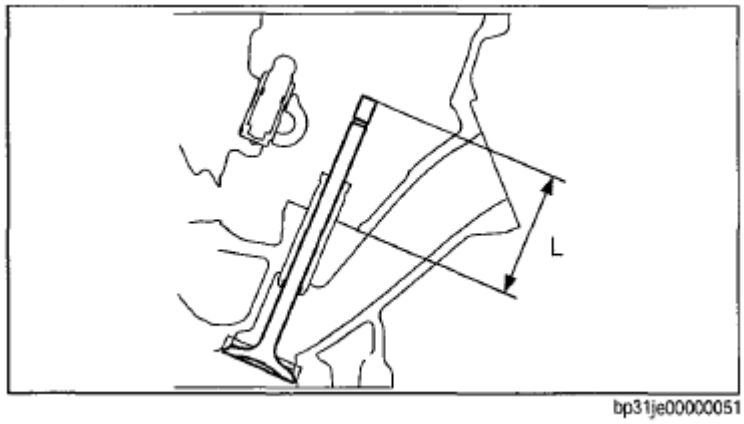


Fig. 52: Identifying Valve Stem Protruding Length

VALVE, VALVE GUIDE INSPECTION

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

   Standard valve head margin thickness

   IN 1.75-1.95 mm {0.0689-0.0767 in}

   E 1.95-2.15 mm {0.0768-0.0846 in}

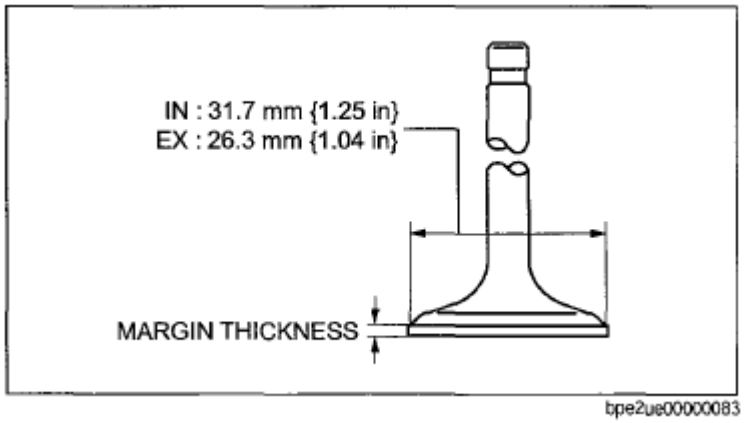


Fig. 53: Identifying Valve Head Margin Thickness

2. Measure the length of the each valve using a vernier caliper.
   - If it is less than the minimum specification, replace the valve.

   Standard valve length

   IN 106.55-107.15 mm {4.1949-4.2185 in}

E 116.55-117.15 mm {4.5886-4.6122 in}

Minimum valve length

IN 106.33 mm {4.1862 in}

E 116.33 mm {4.5799 in}

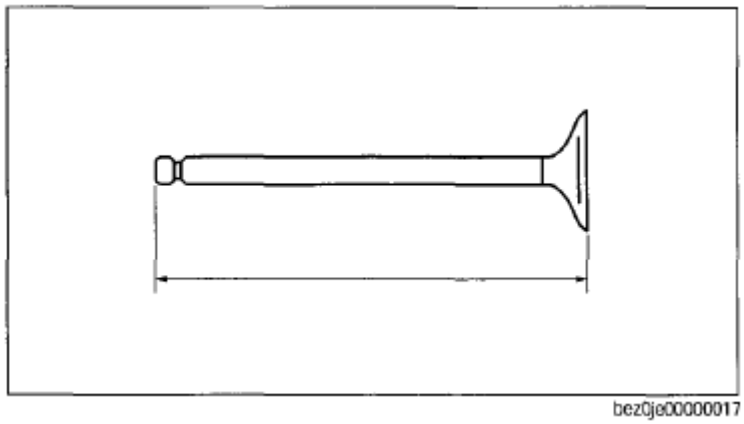


Fig. 54: Identifying Valve Length

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

   Standard valve stem diameter

   IN 5.470-5.485 mm {0.2154-0.2159 in}

   E 5.465-5.480 mm {0.2152-0.2157 in}

   Minimum valve stem diameter

   IN 5.424 mm {0.2135 in}

   E 5.419 mm {0.2133 in}

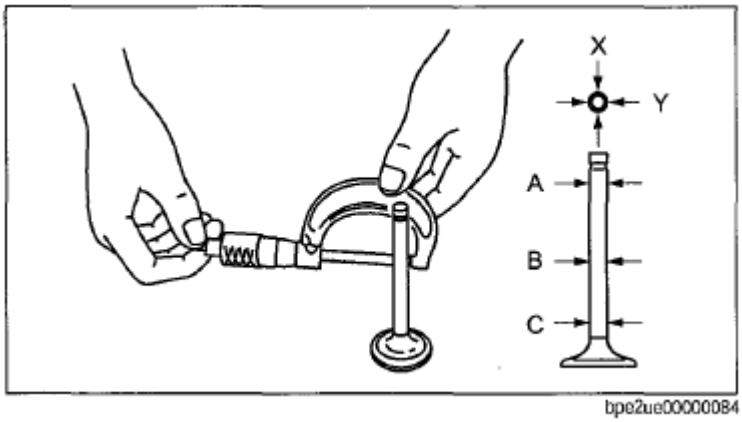


Fig. 55: Measuring Valve Stem Diameter Using Micrometer

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

   Standard valve guide inner diameter

   IN 5.510-5.530 mm {0.2170-0.2177 in}

   E 5.510-5.530 mm {0.2170-0.2177 in}

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

   Standard clearance between valve stem and guide

   IN 0.025-0.060 mm {0.0010-0.0023 in}

   E 0.030-0.065 mm {0.0012-0.0025 in}

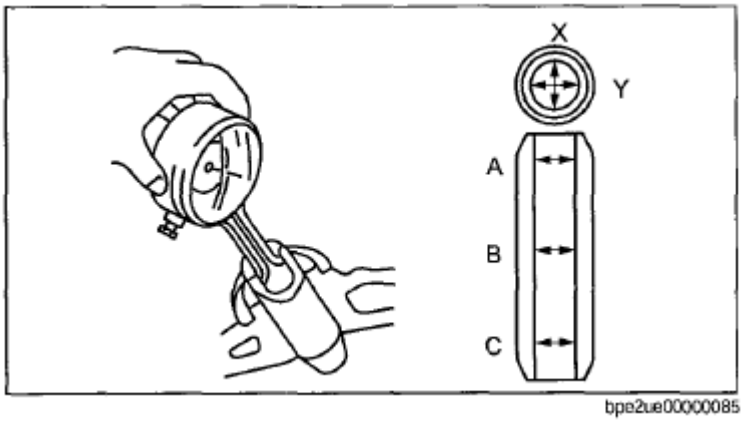


Fig. 56: Measuring Valve Guide Inner Diameter Using Caliper Gauge

Ma imum clearance between valve stem and guide

0.10 mm {0.0039 in}

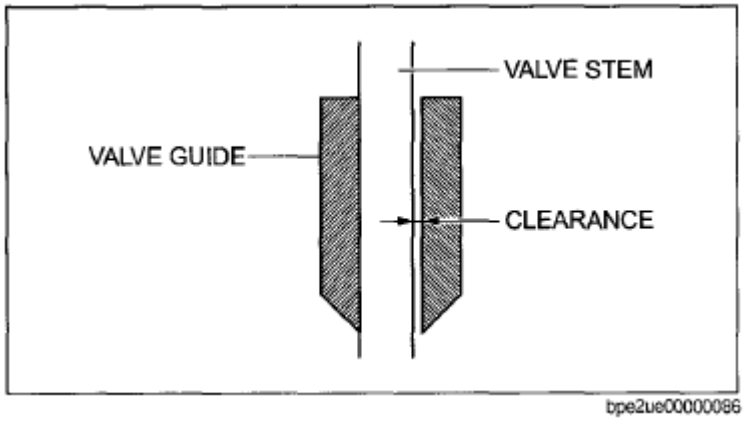


Fig. 57: Measuring Clearance Between Valve Stem And Guide

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

Standard valve guide projection height

IN 16.4-17.0 mm {0.646-0.669 in}

E 16.4-17.0 mm {0.646-0.669 in}

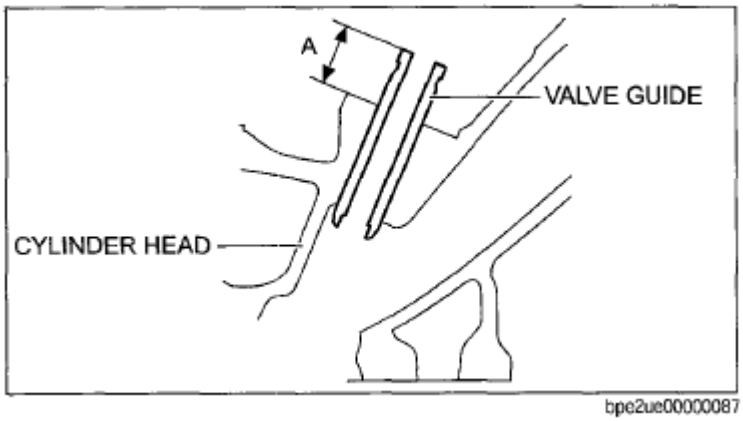


Fig. 58: Identifying Valve Guide Projection Height

VALVE GUIDE REPLACEMENT

REMOVAL

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

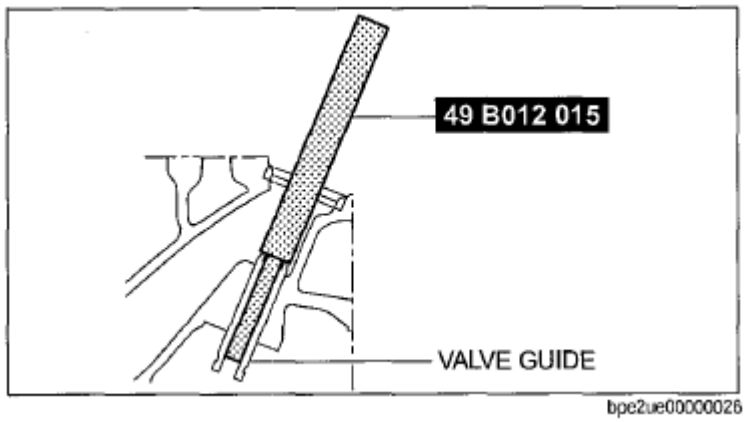


Fig. 59: Tapping Valve Guide Out From Combustion Chamber Side

INSTALLATION

1. Apply clean engine oil to the valve guide.
2. Tap the valve guide from the camshaft side using the SST so that the projection height (dimension A) is within the specification,

   Standard valve guide projection height

   IN 16.4-17.0 mm {0.646-0.669 in}

   E 16.4-17.0 mm {0.646-0.669 in}

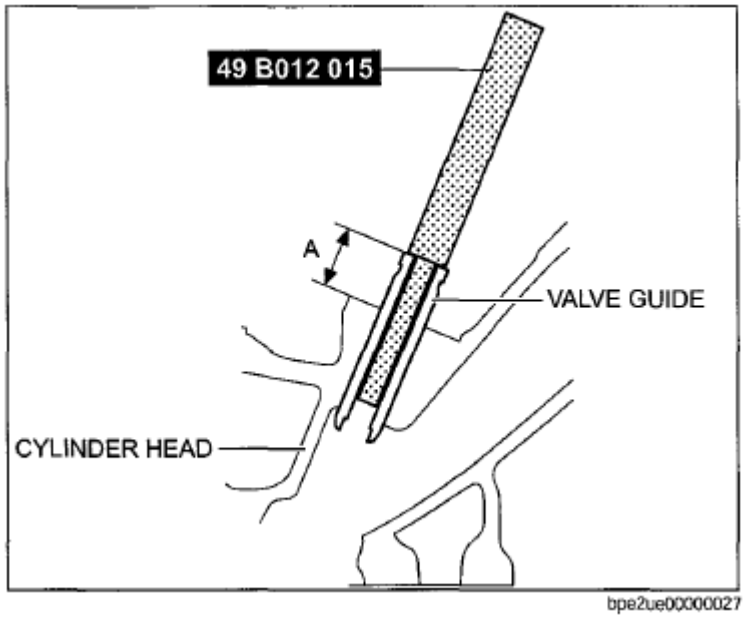


Fig. 60: Tapping Valve Guide To Projection Height

VALVE SPRING INSPECTION

CAUTION: The valve springs differ depending on the IN and E sides. Therefore, verify the free length or identification paint beforehand and inspect the valve springs.

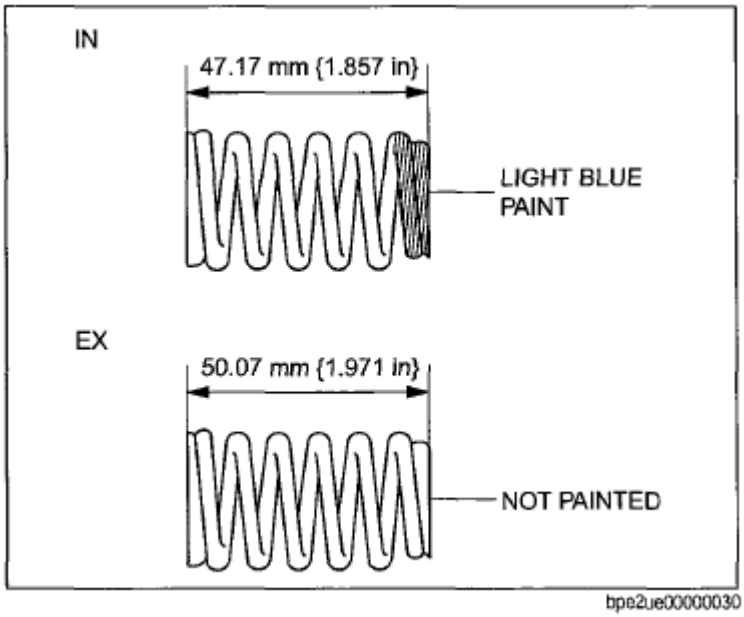


Fig. 61: Identifying Valve Spring Free Length

1. Measure the valve spring height using the spring tester.

- If it is not within the specification, replace the valve spring.

Valve spring installation height

IN When pressuri ed with spring force of 190-210 N {19.4-21.4 kgf, 42.8-47.2 lbf}, spring height is 38.0 mm {1.50 in}

E When pressuri ed with spring force of 228-252 N {23.3-25.6 kgf, 51.3-56.6 lbf}, spring height is 38.0 mm {1.50 in}

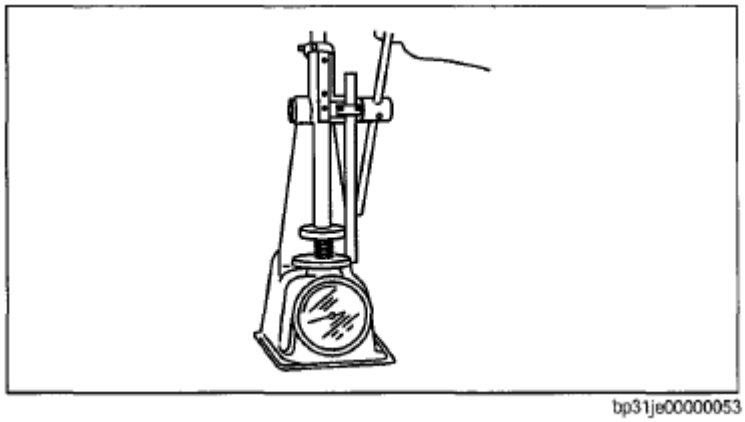


Fig. 62: Measuring Valve Spring Height Using Spring Tester

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

Ma imum valve spring off-square

IN 2.0 (1.6 mm {0.063 in})

E 2.0 (1.7 mm {0.067 in})

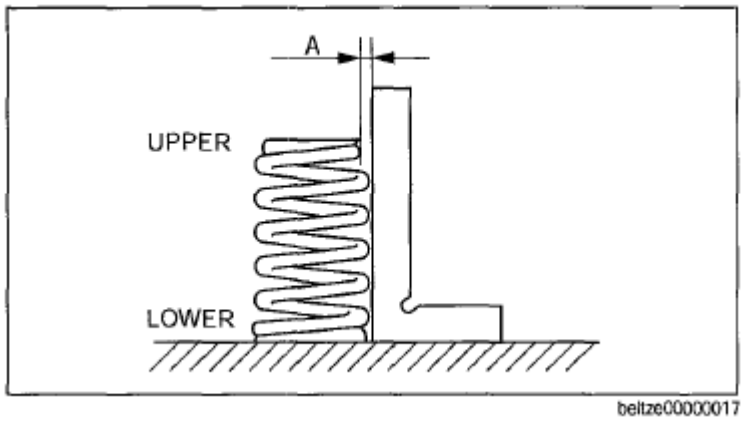


Fig. 63: Measuring Amount Of Off-Square On Valve Spring Using Square

CAMSHAFT INSPECTION

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

   Ma imum camshaft runout 0.030 mm {0.0012 in}

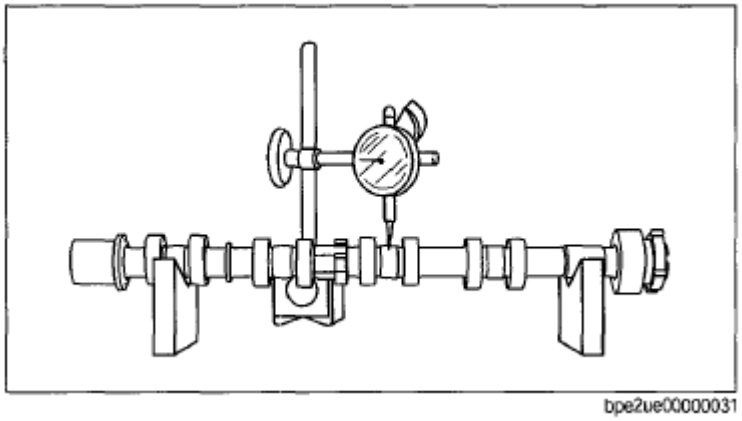


Fig. 64: Measuring Camshaft Runout Using Dial Gauge

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

   Standard cam height

   IN 41.57 mm {1.637 in}

   E 40.37 mm {1.589 in}

Minimum cam height

IN 41.50 mm {1.634 in}

E 40.30 mm {1.587 in}

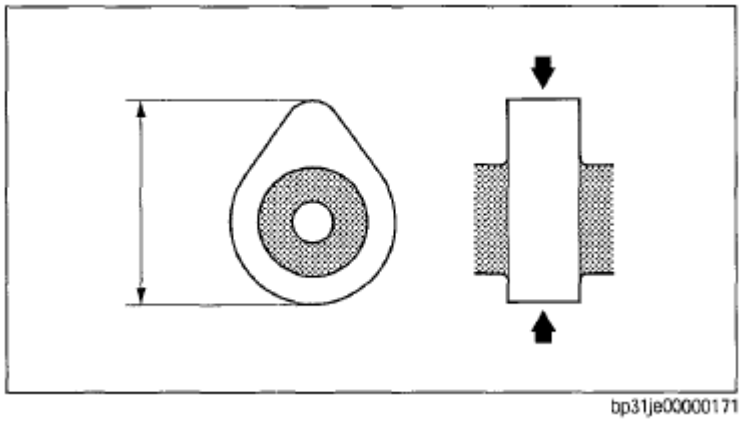


Fig. 65: Identifying Camshaft Lobe Height

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

Standard camshaft journal diameter

24.96-24.98 mm {0.9827-0.9834 in}

Minimum camshaft journal diameter

24.93 mm {0.9815 in}

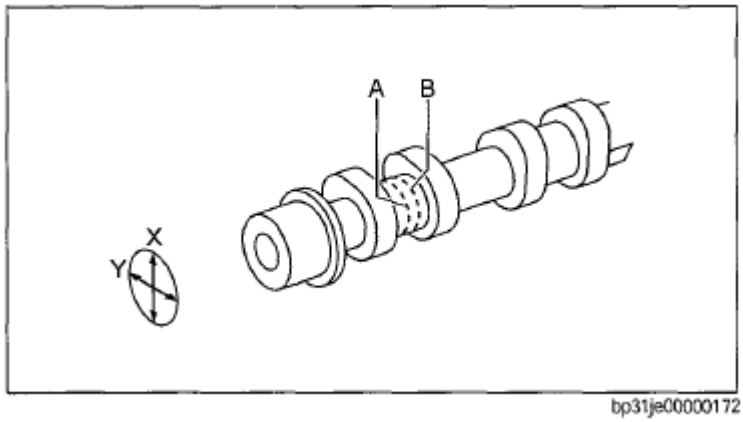


Fig. 66: Identifying Camshaft Journal Diameter Measurement Positions A And B

5. Measure the camshaft journal oil clearance using the following procedure:
    1. Clean the camshaft journal and the journal receptacle part.
    2. Put the camshaft on the cylinder head with the rocker arm detached.
    3. Cut the plastigauge to the same length as the journal width and position it parallel to the camshaft.
    4. Install the camshaft caps. (See **CYLINDER HEAD ASSEMBLY (II)**.)
    5. Remove the camshaft caps. (See **CYLINDER HEAD DISASSEMBLY (I)**.)
    6. Measure the camshaft journal oil clearance.
        - If it exceeds the maximum specification, replace the cylinder head.

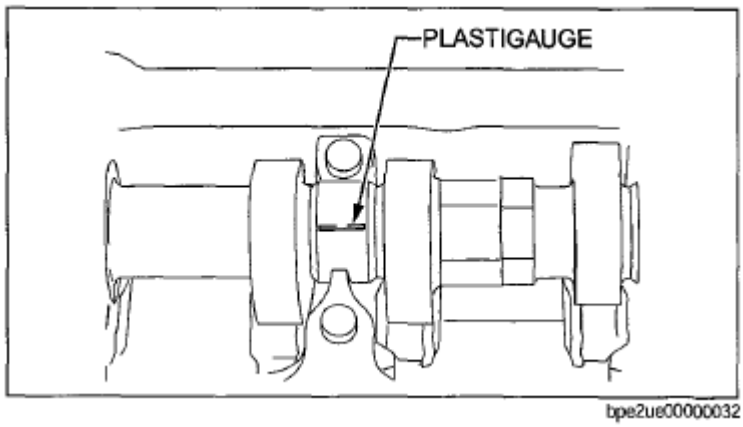


Fig. 67: Measuring Camshaft Journal Oil Clearance Using Plastigauge

Standard camshaft journal oil clearance 0.035-0.080 mm {0.0014-0.0031 in}

Ma imum camshaft journal oil clearance 0.090 mm {0.0035 in}

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

Standard camshaft end play 0.07-0.22 mm {0.003-0.008 in}

Ma imum camshaft end play 0.23 mm {0.0091 in}

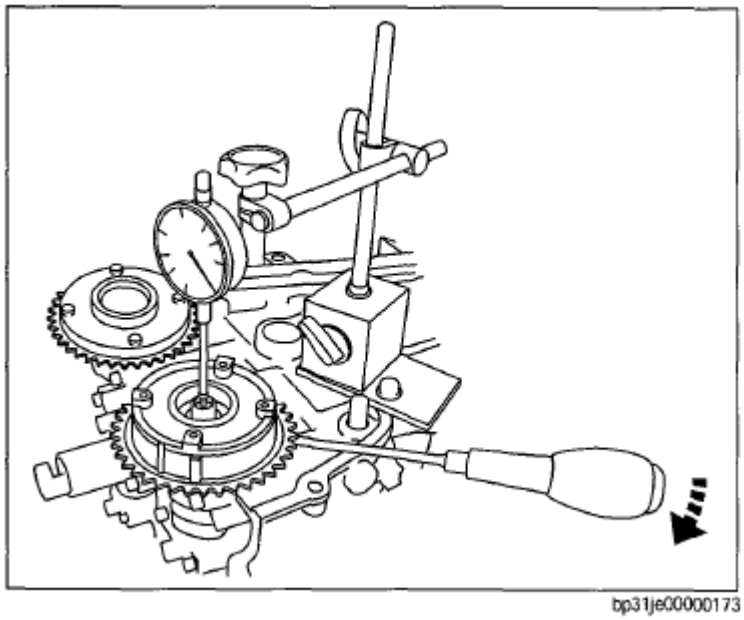


Fig. 68: Measuring Camshaft End Play Using Dial Gauge

CYLINDER BLOCK INSPECTION

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

   Ma imum distortion, head gasket side of the cylinder block

   0.10 mm {0.0039 in}

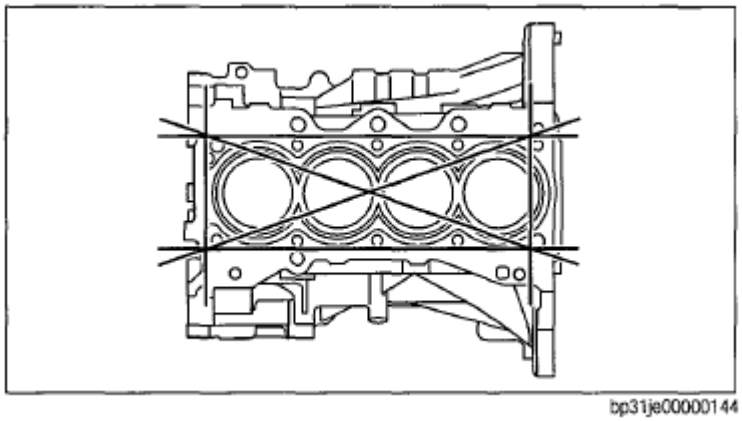


Fig. 69: Measuring Cylinder Block For Distortion Using Straight Edge And Feeler Gauge

2. Measure the cylinder bore diameter using the cylinder gauge. The measurement position is in the X and Y directions at a point 43.9 mm {1.73 in} below the top surface of the cylinder as shown in the figure.

- If it is not within the specification, replace the cylinder block.

Standard cylinder bore diameter 83.50-83.53 mm {3.2875-3.2885 in}

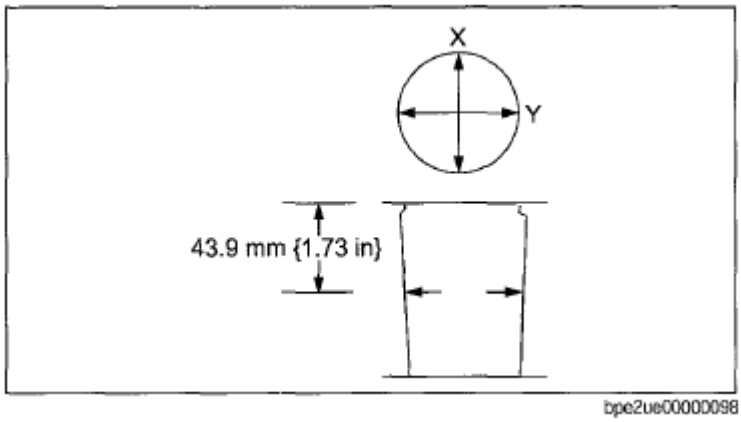


Fig. 70: Identifying Cylinder Bore Diameter Measurements Positions

OIL JET VALVE INSPECTION

1. Apply compressed air to oil jet valve A and verify that air passes through oil jet valve B.
   - If air does not flow, replace the oil jet valve.
   - If there is air flow with air compressor of less than 180 kPa {1.84 kgf/cm^2 , 26.1 psi}, replace the oil jet valve.

   Air pressure

   180-220 kPa {1.84-2.24 kgf/cm^2 , 26.2-31.9 psi}

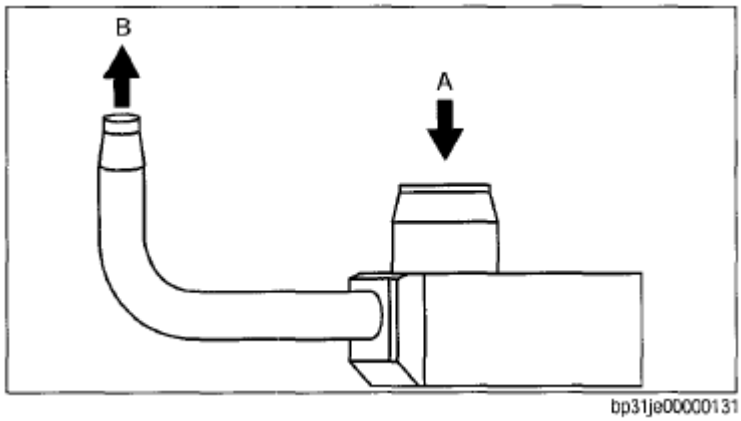


Fig. 71: Inspecting Oil Jet Valve

PISTON INSPECTION

CAUTION:
- **If the piston is replaced, replace the piston, piston pin, and the snap ring as a single component.**

1. Measure the piston outer diameter using the micrometer. The measurement position is 8.0 mm {0.31 in} from the lower end of the piston (area with no coating on the piston skirt) and in the thrust direction.
   - If it is not within the specification, replace the piston.

   Standard piston outer diameter 83.465-83.495 mm {3.2861-3.2872 in}

2. Measure the cylinder bore diameter. (See **CYLINDER BLOCK INSPECTION**.)

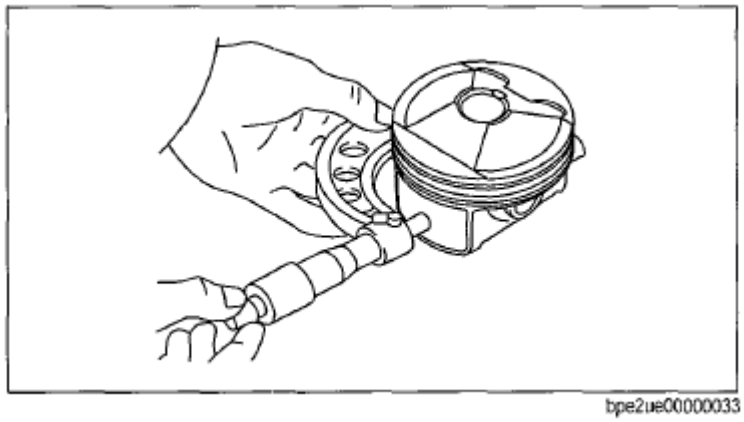


Fig. 72: Measuring Piston Outer Diameter Using Micrometer

3. Calculate the cylinder-to-piston clearance from the cylinder bore diameter and the piston outer diameter.
   - If the clearance exceeds the maximum specification, replace the piston or cylinder block.

   Standard clearance between piston and cylinder 0.025-0.045 mm {0.0010-0.0017 in}

   Ma imum clearance between piston and cylinder 0.063 mm {0.0025 in}

4. Measure the piston-to-ring groove clearance along the perimeter using a feeler gauge. For the O-ring, measure the clearance with the O-ring assembled to the piston.
   - If the clearance exceeds the maximum specification, replace the piston or piston ring.

   Standard clearance between piston ring and ring groove

   Top 0.04-0.08 mm {0.002-0.003 in}

   Second 0.03-0.07 mm {0.0012-0.0027 in}

   Oil 0.04-0.12 mm {0.002-0.004 in}

   Ma imum clearance between piston ring and ring groove

Top 0.12 mm {0.0047 in}

Second 0.10 mm {0.0039 in}

Oil 0.17 mm {0.0067 in}

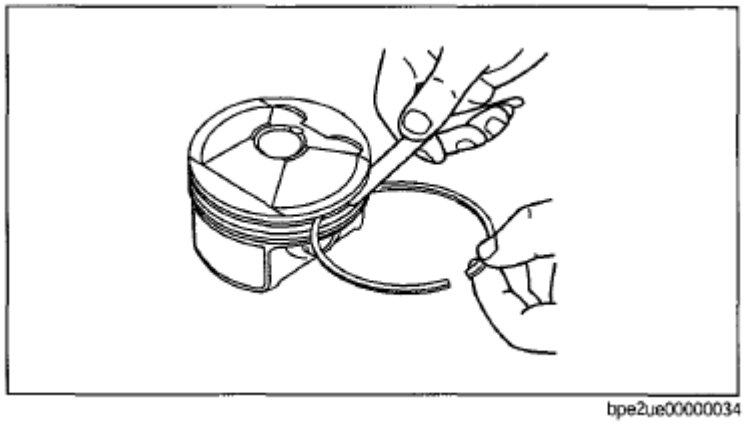


Fig. 73: Measuring Clearance Between Piston Ring And Ring Groove Using Feeler Gauge

PISTON RING INSPECTION

1. Using the piston, press the piston ring parallel into the cylinder to 43.9 mm {1.73 in} from the upper end of the cylinder block.

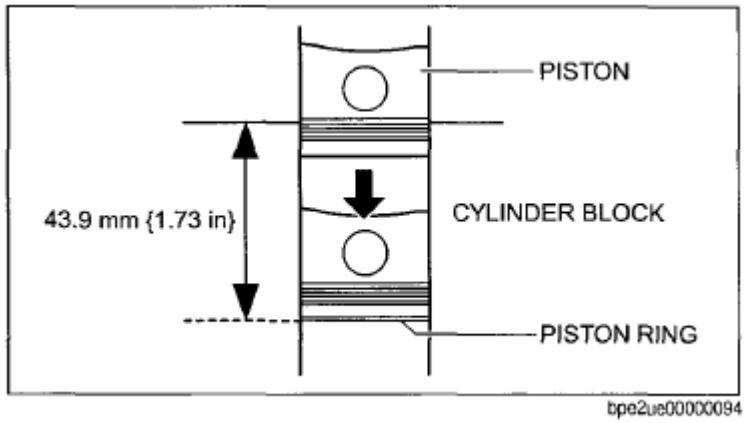


Fig. 74: Pressing Piston Ring Parallel Into Cylinder Using Piston

2. Measure the piston ring end gap using a feeler gauge.
   - If it exceeds the maximum specification, replace the piston ring.

Standard piston ring end gap

Top 0.13-0.18 mm {0.0052-0.0070 in}

Second 0.18-0.28 mm {0.008-0.011 in}

Oil 0.10-0.35 mm {0.004-0.013 in}

Ma imum piston ring end gap

Top 0.35 mm {0.014 in}

Second 0.45 mm {0.018 in}

Oil 0.52 mm {0.020 in}

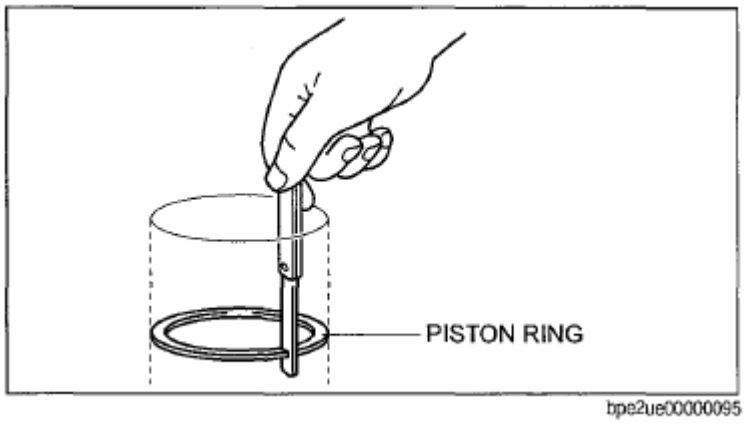


Fig. 75: Measuring Piston Ring End Gap Using Feeler Gauge

PISTON PIN INSPECTION

CAUTION:
- **If the piston or piston pin is replaced, replace the piston, piston pin and the snap ring as a single component.**

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

   Standard piston pin outer diameter 20.995-21.000 mm {0.82658-0.82677 in}

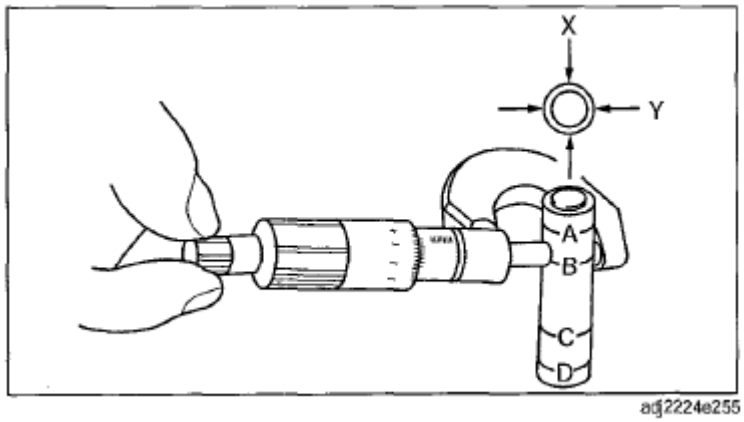


Fig. 76: Measuring Piston Pin Outer Diameter Using Micrometer

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

   Standard piston pin hole diameter 21.004-21.008 mm {0.82693-0.82708 in}

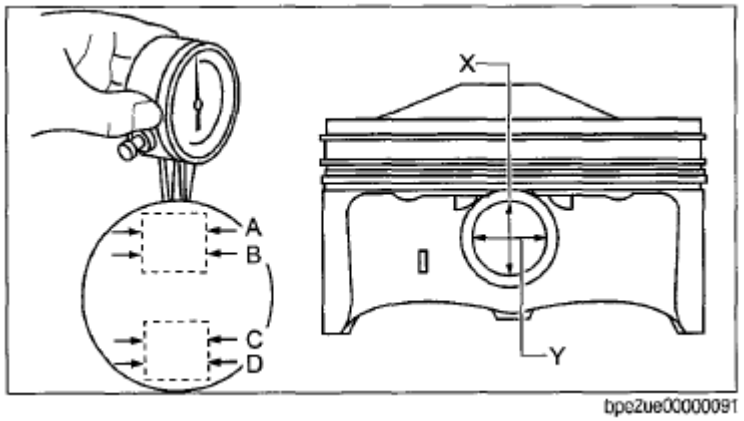


Fig. 77: Measuring Piston Pin Hole Diameter Using Caliper Gauge

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

   Standard clearance between piston pin hole diameter and piston pin outer diameter 0.004-0.013 mm {0.0002-0.0005 in}

4. Measure the inner diameter on the small end of the connecting rod using the caliper gauge in the X and Y directions as shown in the figure.

   Standard connecting rod small end inner diameter 21.006-21.017 mm {0.82701-0.82744 in}

5. Calculate the clearance between the inner diameter on the small end of the connecting rod and the piston pin outer diameter.

- If it is not within the specification, replace the connecting rod or the piston pin.

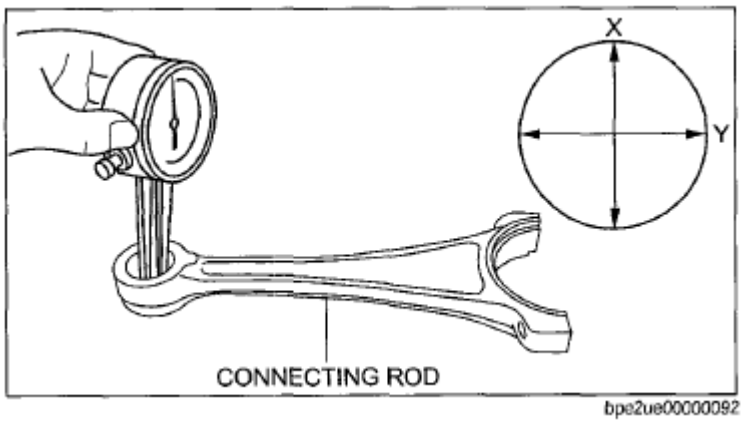


Fig. 78: Measuring Inner Diameter On Small End Of Connecting Rod Using Caliper Gauge

Standard clearance between connecting rod small end inner diameter and piston pin outer diameter 0.006-0.022 mm {0.0003-0.0008 in}

PISTON AND CONNECTING ROD INSPECTION

1. Check the oscillation torque as shown in the figure. Verify that the large end drops under its own weight with no resistance.
   - If the piston shakes heavily or unsmoothly, disassemble the piston and connecting rod, then inspect the following: (See **PISTON PIN INSPECTION**.)
     - Clearance between piston pin outer diameter and piston pin hole diameter.
     - Clearance between piston pin outer diameter and connecting rod small end inner diameter.

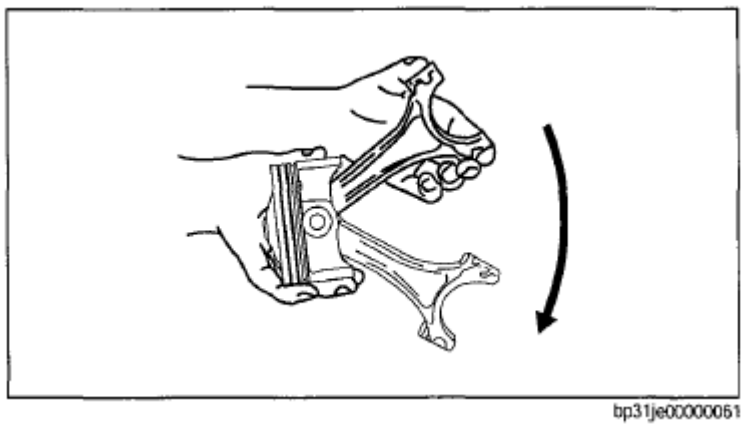


Fig. 79: Inspecting Piston And Connecting Rod

CONNECTING ROD INSPECTION

1. Inspect the connecting rod for bending and distortion using the connecting rod aligner.
   - If it exceeds the maximum specification, replace the connecting rod.

Ma imum connecting rod bending 0.050 mm {0.0020 in}

Ma imum connecting rod distortion 0.050 mm {0.0020 in}

Connecting rod center-to-center distance 155.2 mm {6.110 in}

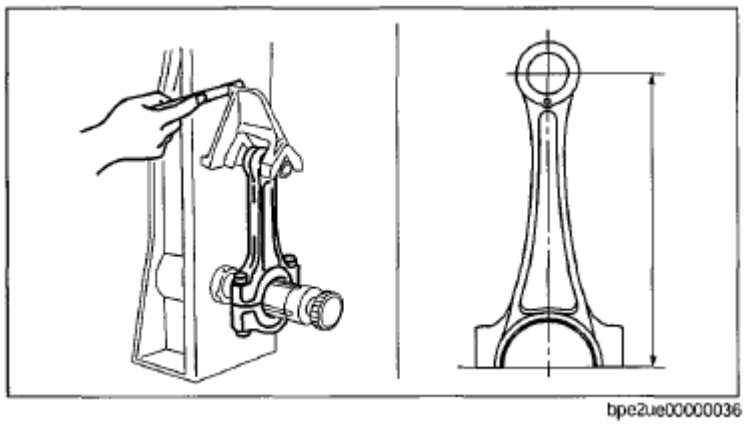


Fig. 80: Inspecting Connecting Rod For Bending And Distortion Using Connecting Rod Aligner

CONNECTING ROD CLEARANCE INSPECTION

1. Measure the side clearance at the large end of the connecting rod using a feeler gauge.
   - If it exceeds the maximum specification, replace the connecting rod or crankshaft.

Standard side clearance at the large end of connecting rod 0.14-0.36 mm {0.006-0.014 in}

Ma imum side clearance at the large end of connecting rod 0.465 mm {0.0183 in}

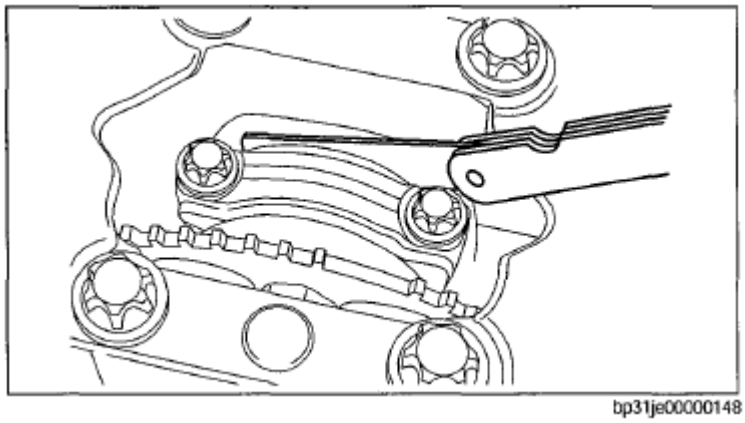


Fig. 81: Measuring Side Clearance At Large End Of Connecting Rod Using Feeler Gauge

2. Measure the oil clearance at the large end of the connecting rod using the following procedure:
    1. Cut the plastigauge as wide as the connecting rod bearing width, place it parallel to the crankshaft, keeping away from the oil hole.
    2. Install the lower connecting rod bearing and connecting rod cap. (See **CYLINDER BLOCK ASSEMBLY (I)**.)
    3. Remove the connecting rod cap. (See **CYLINDER BLOCK DISASSEMBLY (II)**.)
    4. Measure the oil clearance at the large end of the connecting rod.
        - If it exceeds the maximum specification, replace the bearing or grind the crank pin and use oversize bearings so that the specified clearance is obtained.

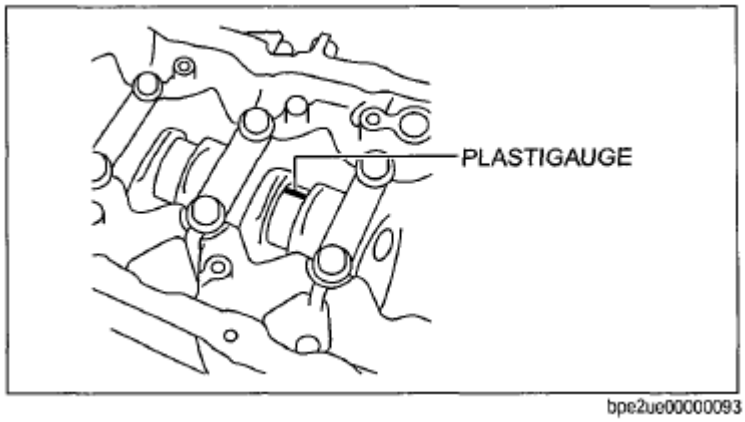


Fig. 82: Measuring Oil Clearance At Large End Of Connecting Rod Using Plastigauge

Standard bearing oil clearance at the large end of the connecting rod 0.026-0.052 mm {0.0011-0.0020 in}

Ma imum bearing oil clearance at the large end of the connecting rod 0.10 mm {0.0039 in}

Connecting rod bearing si e

STD 1.503-1.520 mm {0.05918-0.05984 in}

OS 0.25 1.628-1.631 mm {0.06410-0.06421 in}

OS 0.50 1.753-1.756 mm {0.06902-0.06913 in}

CRANKSHAFT INSPECTION

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

    Standard crankshaft end play 0.08-0.29 mm {0.004-0.011 in}

    Ma imum crankshaft end play 0.30 mm {0.012 in}

Thrust bearing si e

STD 2.500-2.550 mm {0.0985-0.1003 in}

OS0.25 2.625-2.675 mm {0.1034-0.1053 in}

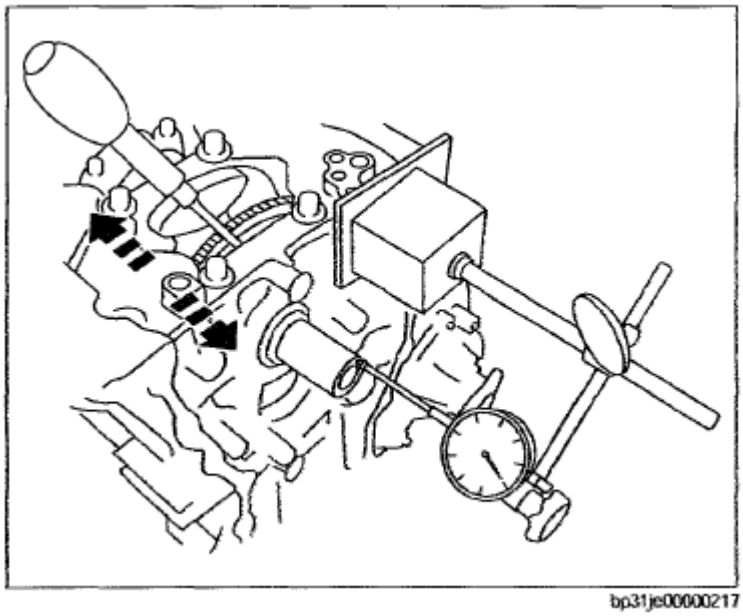


Fig. 83: Measuring Crankshaft End Play Using Dial Gauge

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

   Ma imum main journal runout 0.10 mm {0.0039 in}

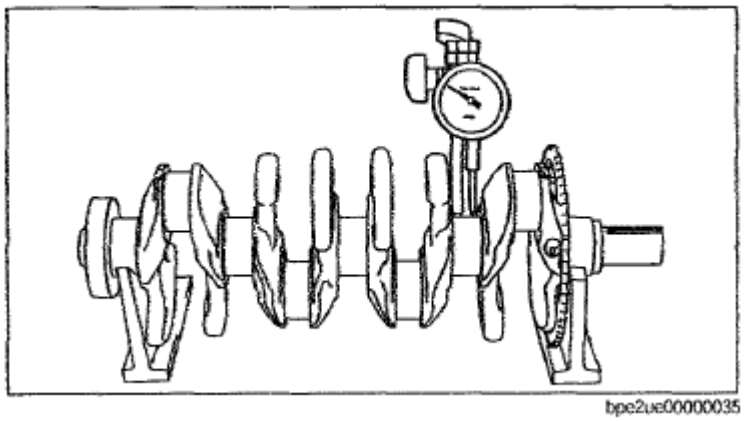


Fig. 84: Measuring Main Journal Runout Using Dial Gauge

3. Inspect the main journal diameter and crank pin diameter. Measurement positions total four and are in the

X and Y directions, at two points (A and B) as shown in the figure.

- If it is not within the specification or if it exceeds the maximum off-round, grind the journal with an oversized bearing.

Standard main journal diameter 46.980-47.000 mm {1.8497-1.8503 in}

Ma imum main journal off-round 0.005 mm {0.0002 in}

Standard crank pin diameter 46.980-47.000 mm {1.8497-1.8503 in}

Ma imum crank pin off-round 0.005 mm {0.0002 in}

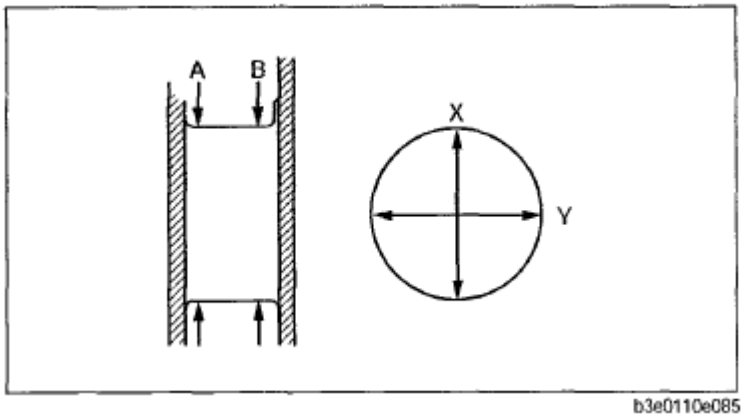


Fig. 85: Identifying Main Journal Diameter

4. Inspect the main journal oil clearance using the following procedure:
    1. Install the thrust bearing, upper main bearing and crankshaft.
    2. Position a plastigauge on the journals.
    3. Install the lower main bearing and lower cylinder block. (See **CYLINDER BLOCK ASSEMBLY (I)**.)
    4. Remove the lower cylinder block. (See **CYLINDER BLOCK DISASSEMBLY (II)**.)
    5. Measure the main journal oil clearance.
        - If it exceeds the maximum specification, replace the main bearing, or grind the main journal and use oversized bearings so that the specified oil clearance is obtained.

        Standard main journal oil clearance 0.016-0.039 mm {0.0007-0.0015 in}

        Ma imum main journal oil clearance 0.084 mm {0.0033 in}

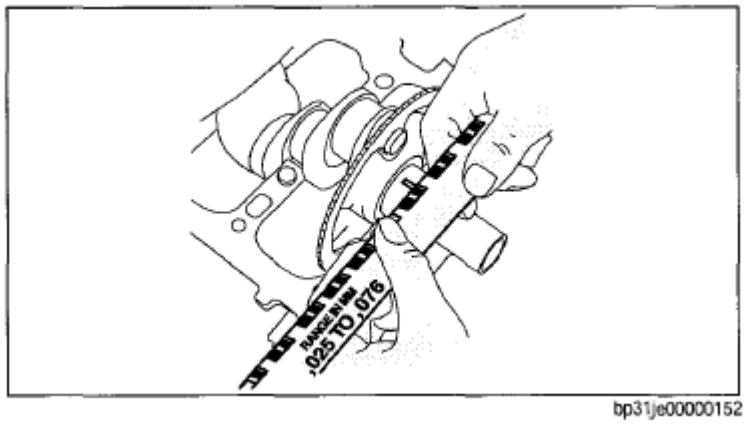


Fig. 86: Measuring Main Journal Oil Clearance Using Plastigauge

Main bearing si e

STD 2.489-2.510 mm {0.0980-0.0988 in}

OS 0.25 2.614-2.617 mm {0.10292-0.10303 in}

OS 0.50 2.739-2.742 mm {0.10784-0.10795 in}

FLYWHEEL INSPECTION

1. Perform the following procedures to inspect the flywheel.
   - If there is any malfunction or it exceeds the maximum specification, replace the flywheel.
   1. Inspect the surface that contacts the clutch disc for scratches, nicks, and discoloration.
      - Correct slight scratches and discoloration using sandpaper.
   2. Inspect the ring gear teeth for damage and wear.

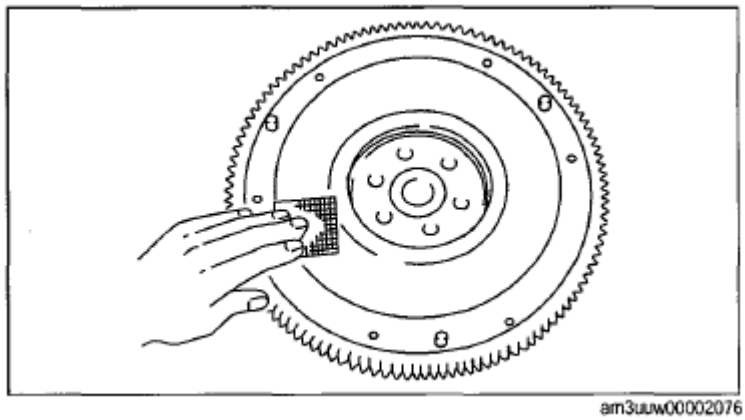


Fig. 87: Removing Slight Scratches And Discoloration Using Sandpaper

3. Measure the runout of the surface that contacts the clutch disc using a dial gauge.

Flywheel ma imum runout 0.10 mm {0.0039 in}

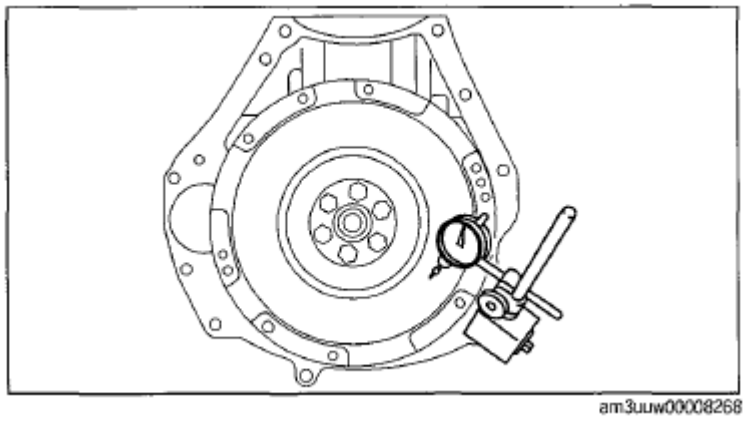


Fig. 88: Measuring Surface Clutch Disc Runout Using Dial Gauge

PILOT BEARING INSPECTION

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

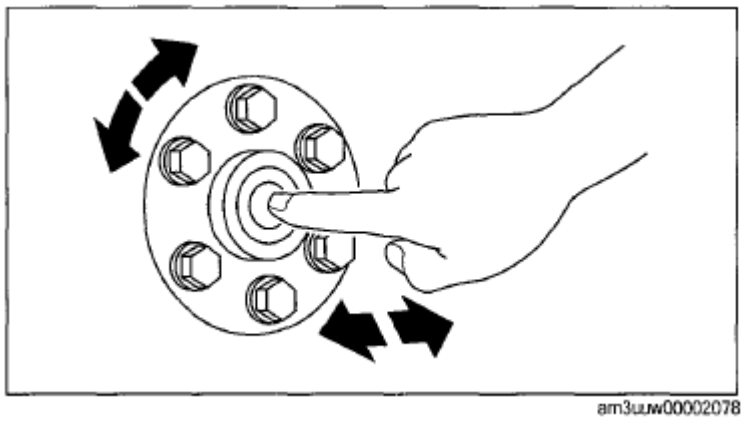


Fig. 89: Applying Force In Pilot Bearing Axial Direction

BOLT INSPECTION

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

Standard cylinder head bolt length 145.2-145.8 mm {5.717-5.740 in}

Ma imum cylinder head bolt length 146.5 mm {5.768 in}

Standard connecting rod bolt length 43.7-44.3 mm {1.73-1.74 in}

Ma imum connecting rod bolt length 45.0 mm {1.77 in}

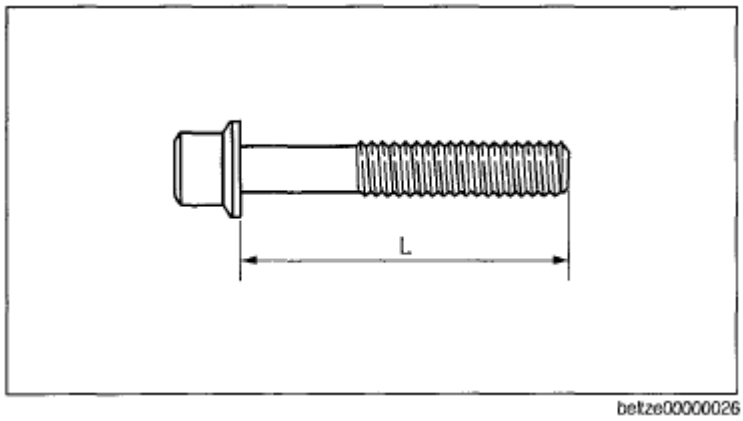
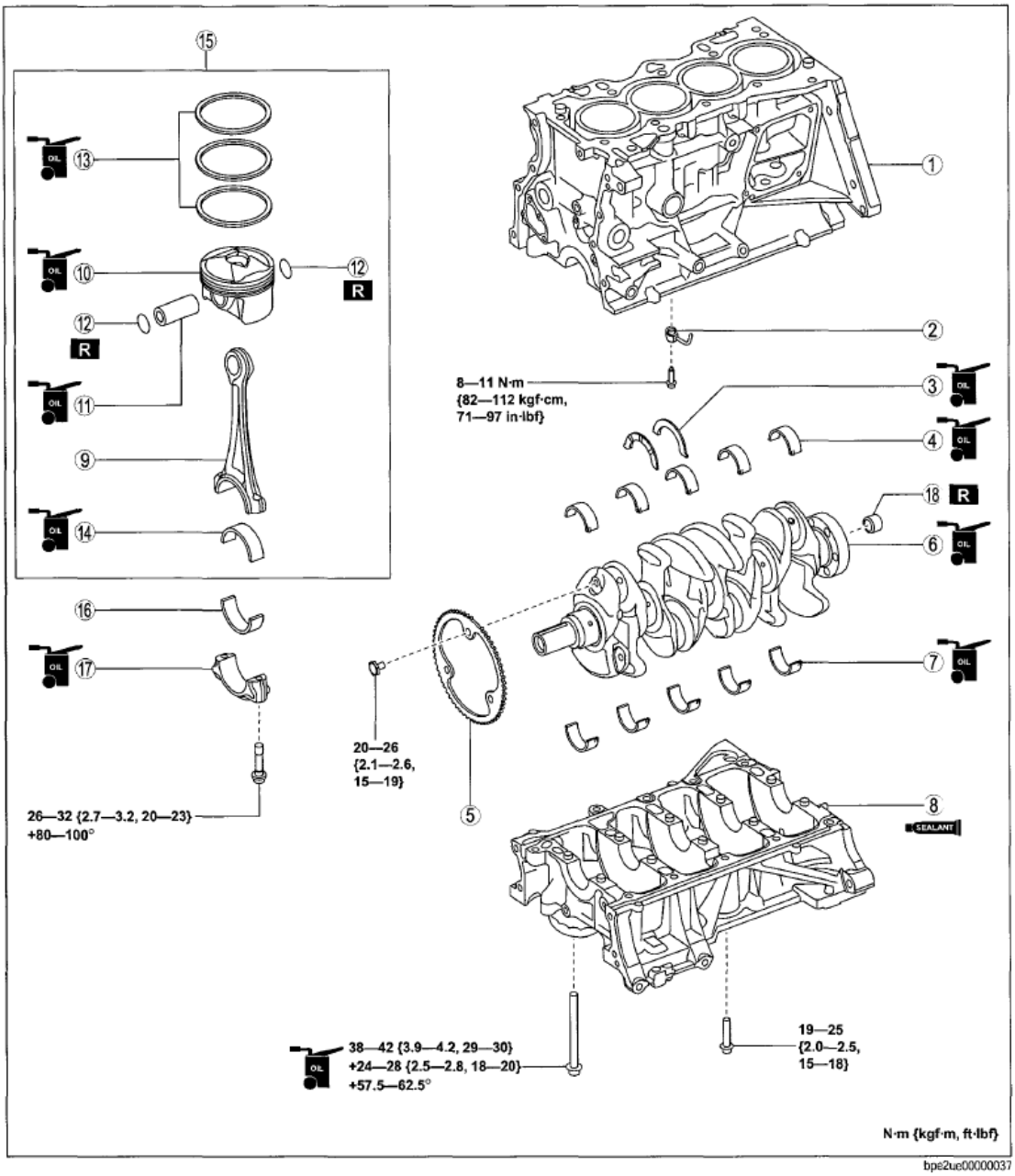


Fig. 90: Identifying Bolt Measurement Points

CYLINDER BLOCK ASSEMBLY (I)

1. Assemble in the order indicated in the table.



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1	Upper cylinder block
2	Oil jet valve
3	Thrust bearing (See Thrust Bearing And Main Bearing Assembly Note.)
7	Lower main bearing (See Thrust Bearing And Main Bearing Assembly Note.)
8	Lower cylinder block (See Lower Cylinder Block Assembly Note.)
9	Connecting rod
10	Piston
11	Piston pin (See Piston Pin Assembly Note.)
12	Snap ring (See Snap Ring Assembly Note.)

4	Upper main bearing (See Thrust Bearing And Main Bearing Assembly Note.)
5	Plate (See Plate Assembly Note.)
6	Crankshaft
14	Upper connecting rod bearing (See Connecting Rod Bearing Assembly Note.)
15	Piston, connecting rod (See Piston, Connecting Rod Assembly Note.)
16	Lower connecting rod bearing (See Connecting Rod Bearing Assembly Note.)
17	Connecting rod cap (See Connecting Rod Cap Assembly Note.)

Fig. 91: Assembling Order Of Cylinder Block Assembly (I) With Torque Specification

THRUST BEARING AND MAIN BEARING ASSEMBLY NOTE

CAUTION:
- **If the thrust bearings and main bearings are reused, assemble the bearings to the same positions and in the direction as before removal to prevent engine damage due to sei ure or burning of the bearing.**
- **To prevent engine damage due to sei ure or burning of the bearing, apply engine oil to the sliding part when assembling.**

PLATE ASSEMBLY NOTE

CAUTION:
- **Placing the crankshaft on a disassembly bench will deform or damage it because the plate for the crankshaft position sensor signal detection installed to the crankshaft is larger than the counterweight. Therefore, set wood blocks or similar objects on the both sides of the crankshaft so that the plate does not contact the disassembly bench directly when placing the crankshaft on it bench.**

1. Install the plate using the following procedure:
    1. Install the groove of the plate tooth to the position shown in the figure and temporarily tighten bolt A.
    2. Temporarily tighten the bolt B.
    3. Install bolt C and tighten the bolts to the specified tightening torque in the order of C, B, and A.

    Tightening torque

    20-26 N.m {2.1-2.6 kgf.m, 15-19 ft.lbf}

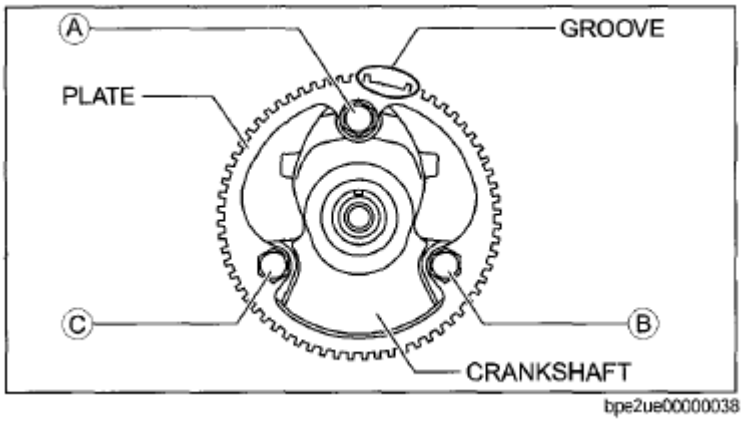


Fig. 92: Identifying Crankshaft, Plate, Groove And Mounting Bolts

LOWER CYLINDER BLOCK ASSEMBLY NOTE

1. Completely clean and remove any oil, dirt, sealant or other foreign material that may be adhering to the lower cylinder block and cylinder block.
2. When reusing the lower cylinder block Bolt, clean any old sealant from the bolts.

CAUTION:
- **Apply silicon sealant in a single, unbroken line.**
- **To prevent silicon sealant from hardening, adhere the engine front cover and the cylinder block firmly within 10 min. after applying silicon sealant. After adhering them, tighten the Bolt immediately.**
- **Using bolts with the old seal adhering could cause cracks in the cylinder block, etc.**

3. Apply silicon sealant to the lower cylinder block shown in the figure.

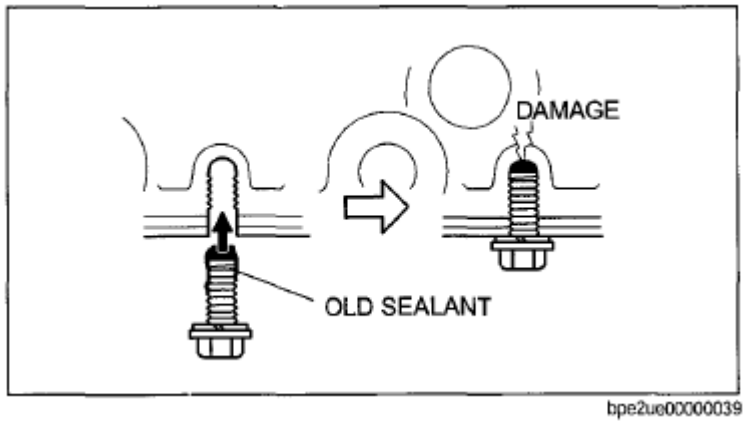


Fig. 93: Identifying Cylinder Block Damages (Old Seal Adhering Bolt)

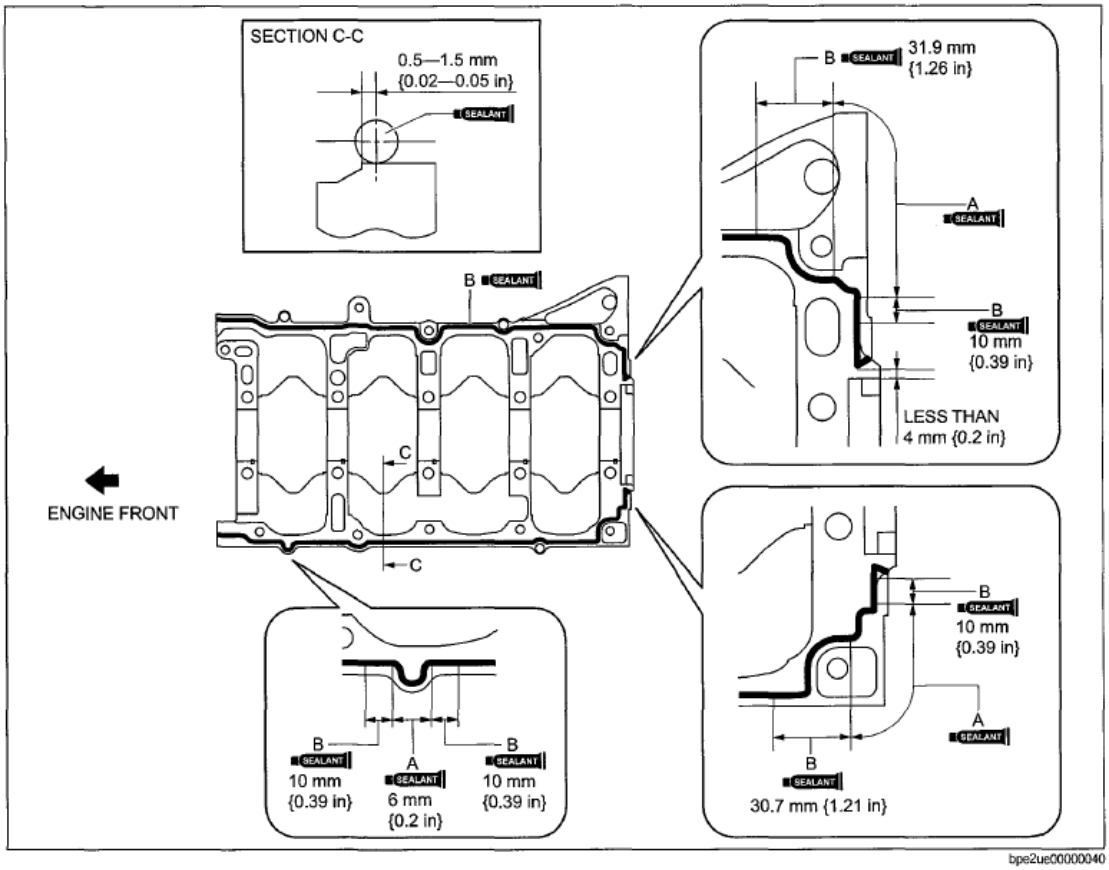


Fig. 94: Applying Silicon Sealant To Lower Cylinder Block

Bead thickness

A 3-7 mm {0.12-0.27 in}

B 2-6 mm {0.1-0.2 in}

4. Install the lower cylinder block.
5. Tighten the lower cylinder block Bolt using the following procedure:
    1. Apply clean engine oil to seating surface and thread of the lower cylinder block Bolt A.
    2. Tighten the lower cylinder block Bolt A in the order shown in the figure using the following procedure:

        Tightening procedure

        1. 38-42 N.m {3.9-4.2 kgf.m, 29-30 ft.lbf}
        2. Loosen all the bolts (until bolts are torque-free).
        3. 24-28 N.m {2.5-2.8 kgf.m, 18-20 ft.lbf}
        4. 57.5-62.5°

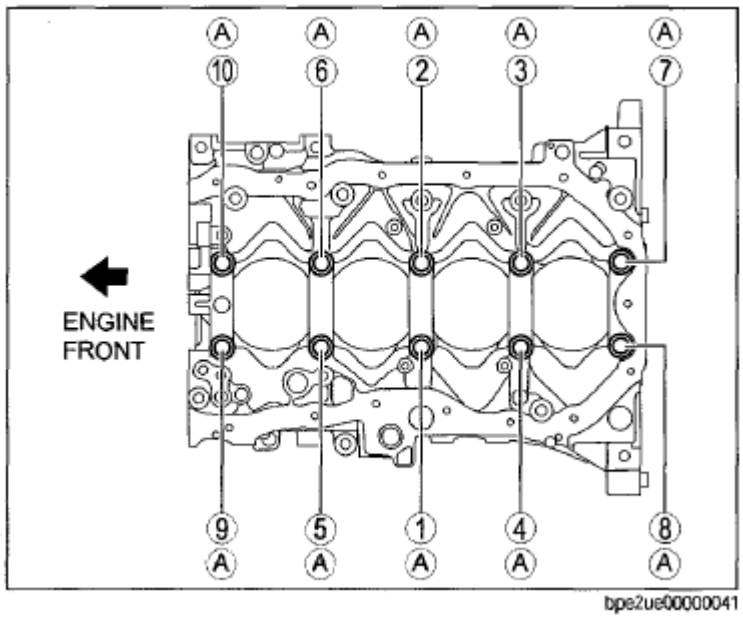


Fig. 95: Identifying Lower Cylinder Block A Bolt Tightening Sequence

3. Tighten the lower cylinder block Bolt B in the order shown in the figure.

   Tightening torque

   19-25 N.m {2.0-2.5 kgf.m, 15-18 ft.lbf}

6. After verifying that silicone sealant protrudes to the rear oil seal press-in part, wipe away the excess silicone sealant.
   - If silicone sealant does not protrude to the rear oil sea! press-in part, remove the lower cylinder block and apply silicone sealant again.

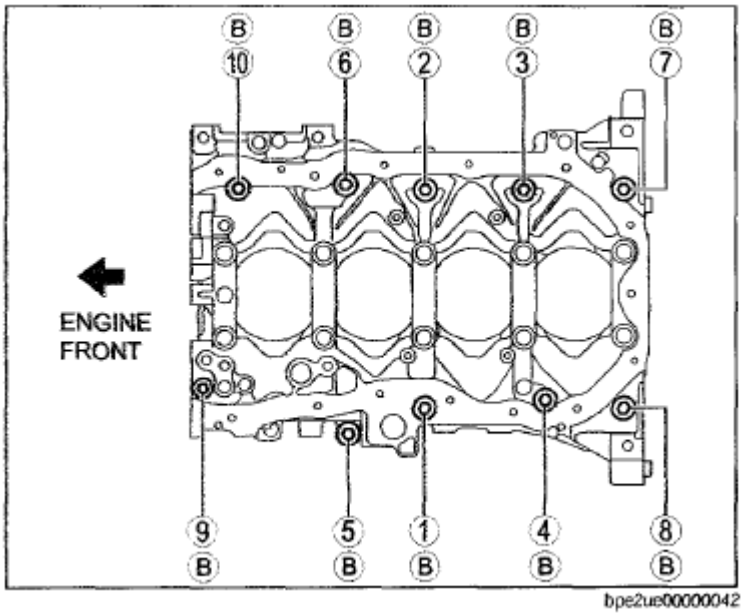


Fig. 96: Identifying Lower Cylinder Block B Bolt Tightening Sequence

PISTON PIN ASSEMBLY NOTE

1. Apply clean engine oil to the piston pin.
2. Insert the piston pin to the piston and connecting rod.

NOTE:

- **When assembling the piston to the connecting rod, each one can be assembled in either direction.**

Snap Ring Assembly Note

CAUTION:

- **Do not compress the outer diameter of the snap ring more than necessary when assembling the snap ring (reference 20.66 mm {0.8134 in} or less).**

1. Insert a new snap ring using a thin plier.

PISTON RING ASSEMBLY NOTE

NOTE:

- **It is not required to position the end gap between the top ring and second ring.**

1. Assemble the piston ring so that the end gap of each oil ring does not overlap as shown in the figure.

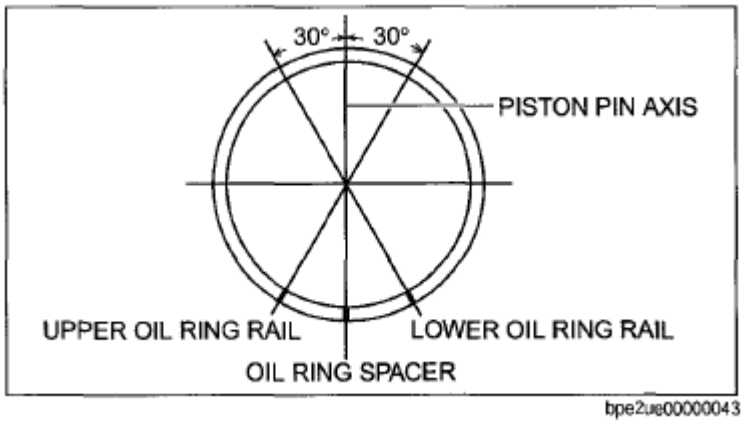


Fig. 97: Identifying Piston Ring Installation Position

2. Install the second ring with the notch facing downward.
3. Install the top ring with the notch facing upward.

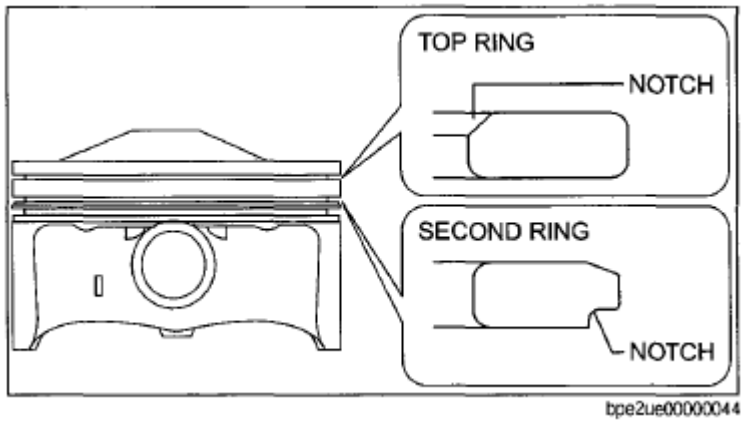


Fig. 98: Identifying Top And Second Ring Installation Position

CONNECTING ROD BEARING ASSEMBLY NOTE

CAUTION:
- **If a connecting rod bearing is reused, assemble it to the same position and in the direction as before removal to prevent engine damage due to sei ure or burning of the bearing.**
- **To prevent engine damage due to sei ure or burning of the bearing, apply engine oil to the sliding part when assembling.**

PISTON, CONNECTING ROD ASSEMBLY NOTE

1. Insert the piston into the cylinder with the mark on top of the piston facing the intake side.

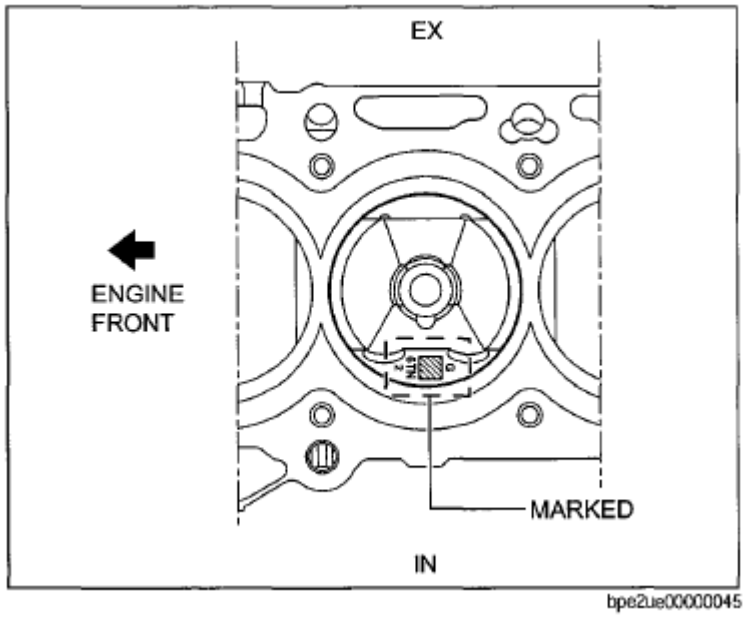


Fig. 99: Identifying Cylinder And Piston With Top Mark

CONNECTING ROD CAP ASSEMBLY NOTE

CAUTION:
- **When assembling the connecting rod caps, align the broken, rough faces of the connecting rods and connecting rod caps.**
- **If the following condition is met, replace the connecting rod cap bolts.**
  - **Length e ceeds ma imum specification**

Standard connecting rod cap bolt length 43.7-44.3 mm {1.73-1.74 in}

Ma imum connecting rod cap bolt length 45.0 mm {1.77 in}

1. Position so that the broken, rough faces of the connecting rods and connecting rod caps are aligned exactly, and assemble the connecting rod caps.
2. Tighten the connecting rod cap bolts in the following two steps.

   Tightening procedure

   Step 1 26-32 N.m {2.7-3.2 kgf.m, 20-23 ft.lbf} Step 2 80-100°

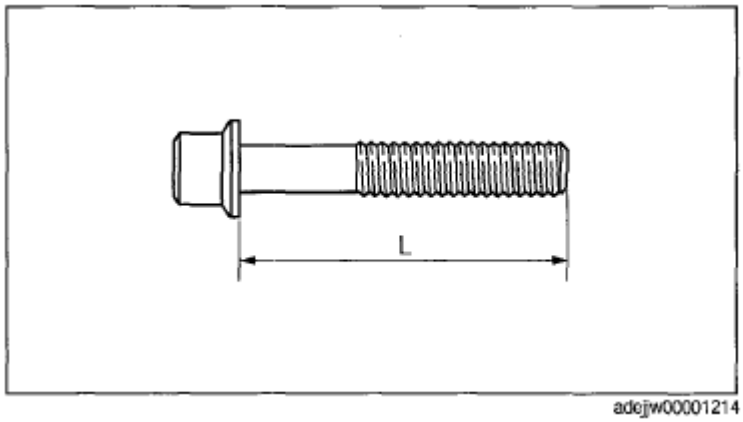


Fig. 100: Identifying Connecting Rod Cap Bolt Measurement Length

PILOT BEARING ASSEMBLY NOTE

1. Install new pilot bearing to the specified position using the following tools.

   Tool

   Snap-on brand millimeter si e bushing driver set (A160M) adapter A160M7 (20- 22 mm {0.79-0.86 in})

   - Use the adapter with the 20 mm {0.79 in} side of the A160M7 (20-22 mm {0.79- 0.86 in}) facing the pilot bearing side.

   Substitution tool

   Outer diameter 21 mm {0.83 in}

   Inner diameter 19 mm {0.75 in}

   Standard pilot bearing position

   Distance A of pilot bearing from crankshaft end 1.5-2.5 mm {0.060-0.098 in}

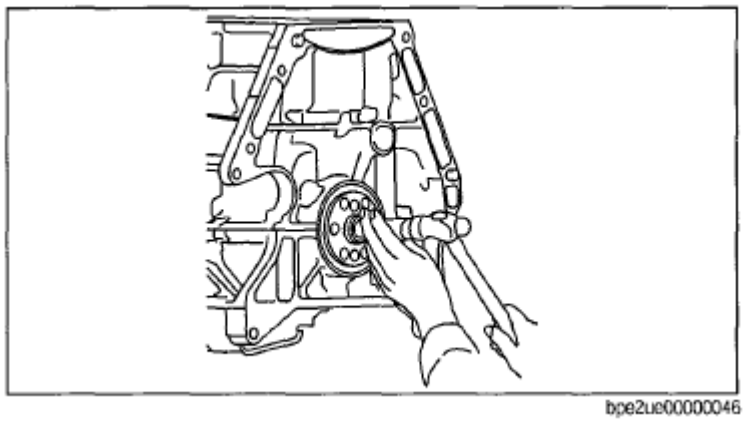


Fig. 101: Installing Pilot Bearing Using Tool

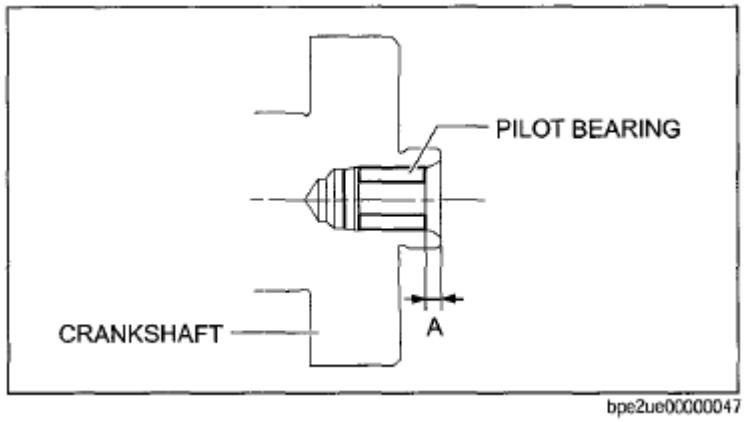
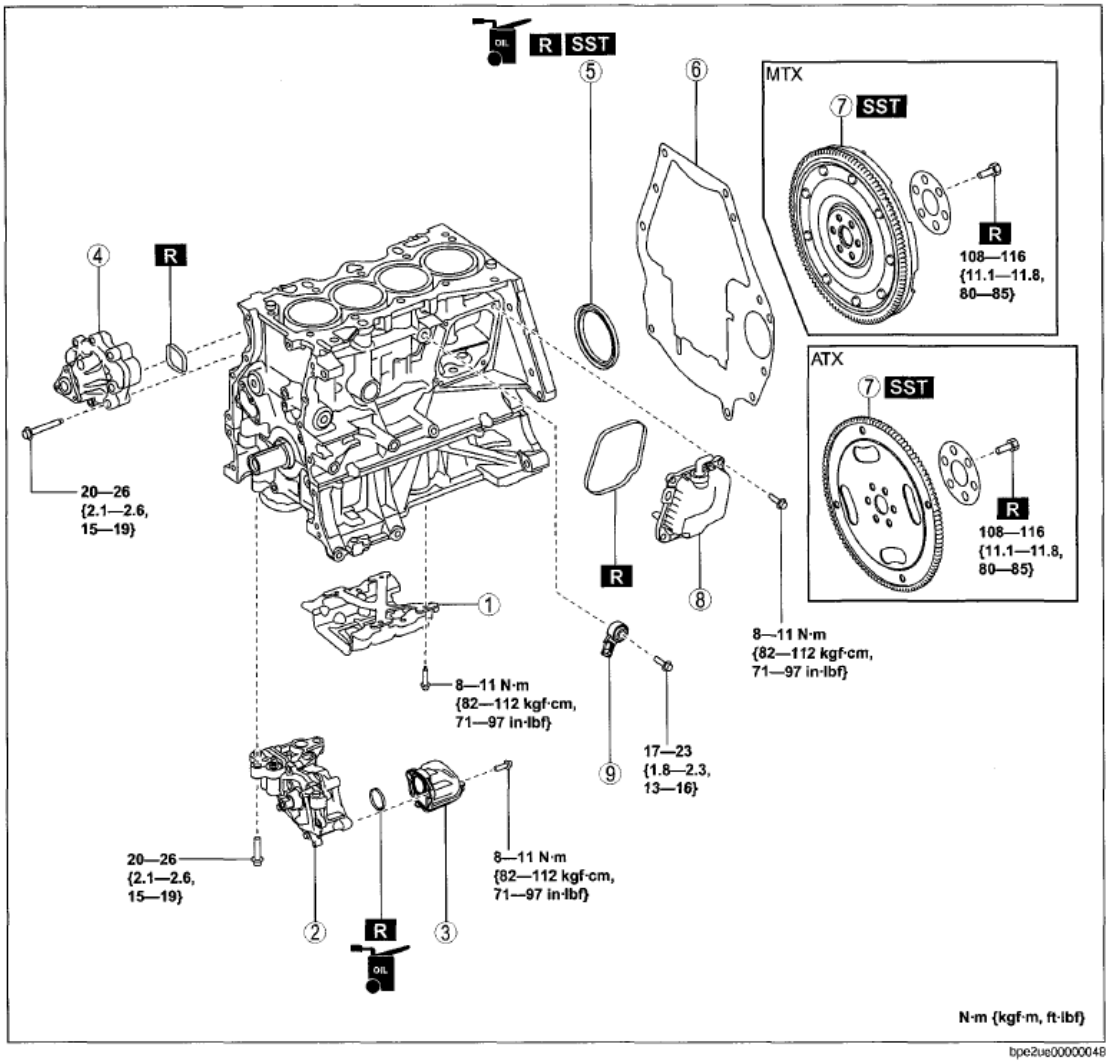


Fig. 102: Identifying Pilot Bearing Position

CYLINDER BLOCK ASSEMBLY (II)

1. Assemble in the order indicated in the table.



1	Oil baffle plate (See Oil Baffle Plate Assembly Note.)	6	End plate (See End Plate Assembly Note.)
2	Oil pump (See Oil Pump Assembly Note.)	7	Flywheel (MTX), drive plate (ATX) (See Flywheel (MTX), Drive Plate (ATX) Assembly Note.)
3	Oil strainer	8	Oil separator
4	Water pump (See Water Pump Assembly Note.)	9	Knock sensor
5	Rear oil seal (See Rear Oil Seal Assembly Note.)		

Fig. 103: Assembling Order Of Cylinder Block Assembly (II) With Torque Specification

OIL BAFFLE PLATE ASSEMBLY NOTE

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

   Tightening torque 8-11 N.m {82-112 kgf.cm, 71-97 in.lbf}

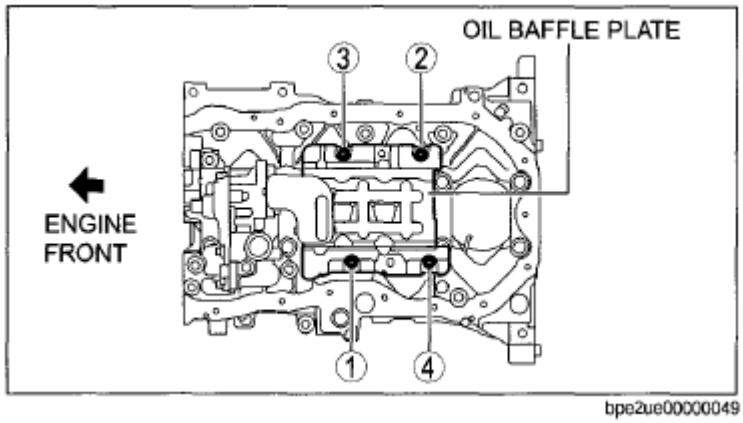


Fig. 104: Identifying Oil Baffle Plate Mounting Bolt Tightening Sequence

OIL PUMP ASSEMBLY NOTE

1. Tighten the oil pump using the following procedure:
    1. Temporarily tighten the three bolts shown in the figure.

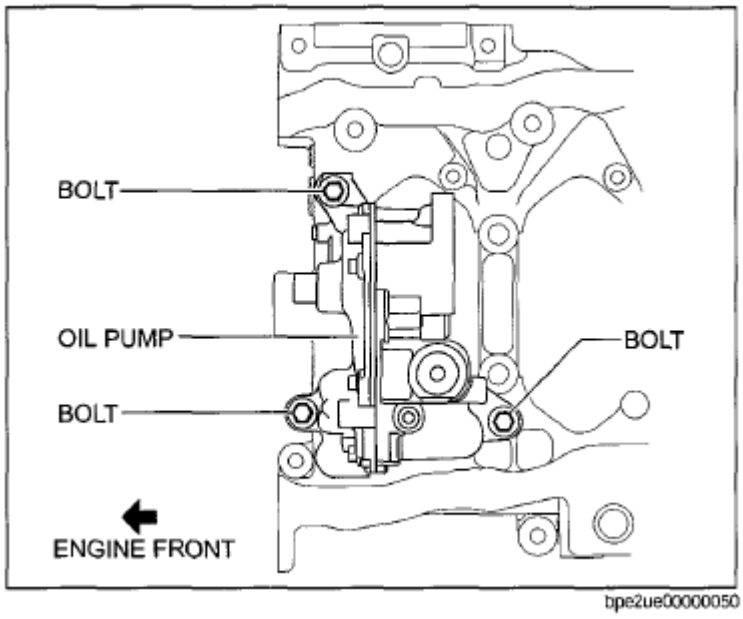


Fig. 105: Identifying Oil Pump Assembly And Mounting Bolts

    2. Tighten the two bolts shown in the figure to specified torque.
        - The tightening order for the two bolts is optional.

    Tightening torque 20-26 N.m {2.1-2.6 kgf.m, 15-19 ft.lbf}

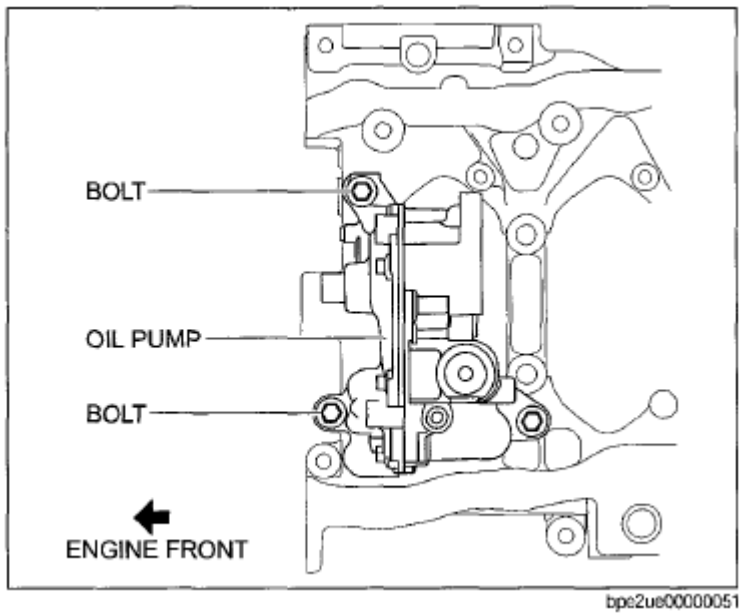


Fig. 106: Identifying Oil Pump Assembly And Mounting Bolts

3. Finally, tighten the bolt shown in the figure to the specified torque.

Tightening torque 20-26 N.m {2.1-2.6 kgf.m, 15-19 ft.lbf}

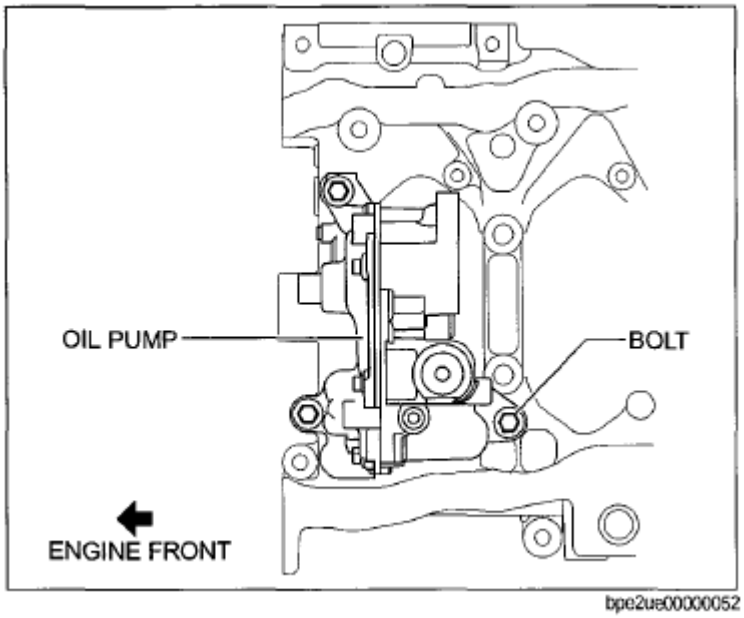


Fig. 107: Identifying Oil Pump Assembly And Mounting Bolt

WATER PUMP ASSEMBLY NOTE

CAUTION:
- **Assemble the water pump gasket to the correct direction shown in the**

figure. Otherwise, it could leak engine coolant and damage the engine.

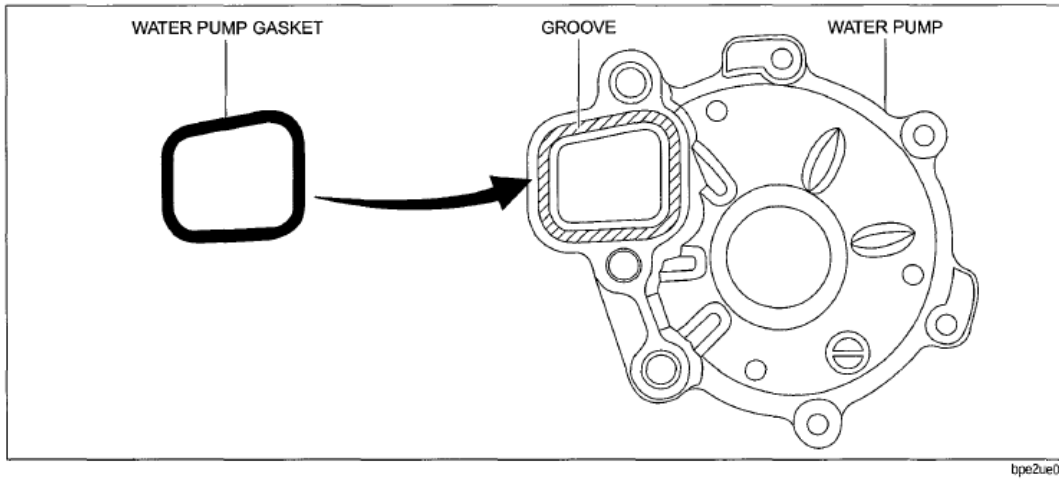


Fig. 108: Identifying Water Pump Gasket Proper Assembling Position

1. Insert a new water pump gasket into the water pump groove.
2. Install the water pump.
3. Tighten the bolts in the order shown in the figure.

   Tightening torque 20-26 N.m {2.1-2.6 kgf.m, 15-19 ft.lbf}

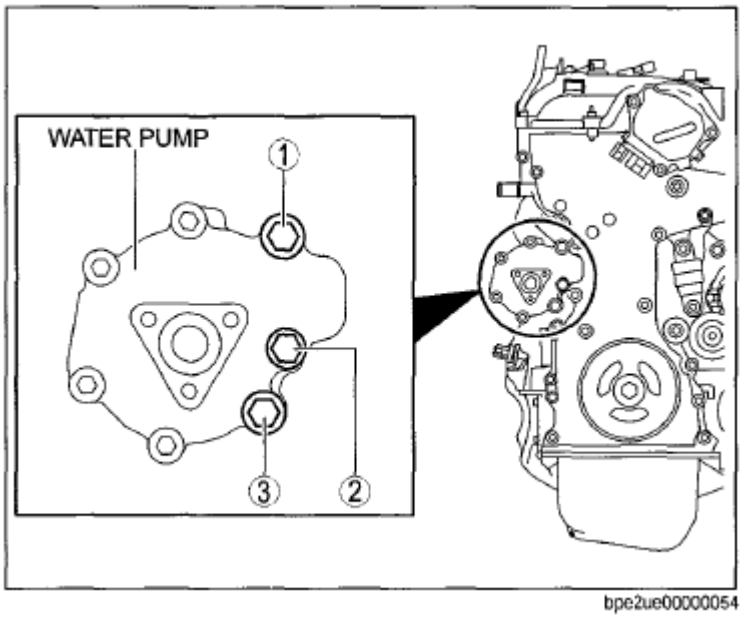


Fig. 109: Identifying Water Pump Mounting Bolt Tightening Sequence

REAR OIL SEAL ASSEMBLY NOTE

1. Apply clean engine oil to the inner surface of a new rear oil seal.
2. Insert the rear oil seal into the cylinder block by hand.
3. Tap the oil seal in evenly using the SST and a hammer.

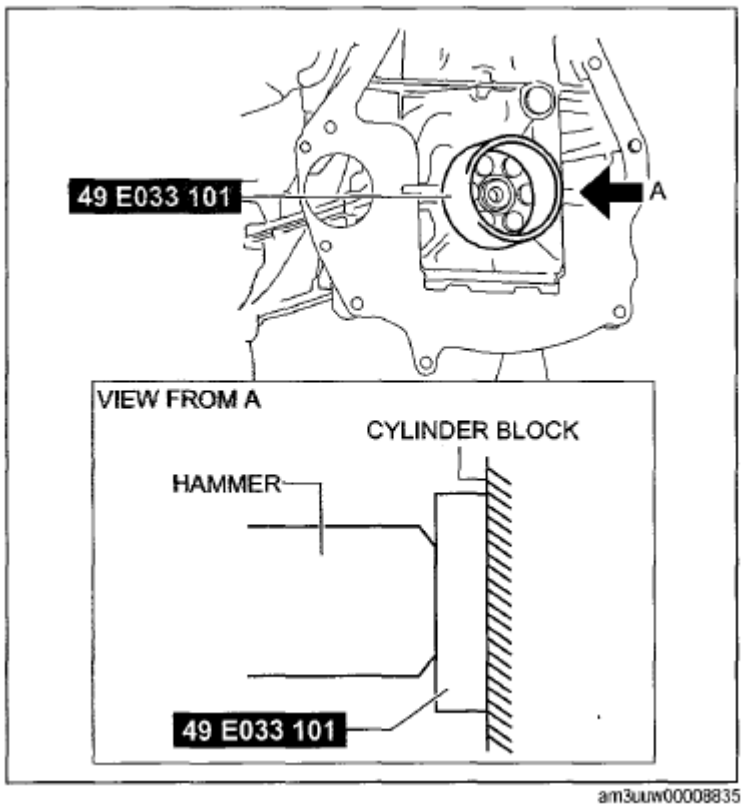


Fig. 110: Tapping Oil Seal Using SST And Hammer

Rear oil seal press-in amount 0-0.5 mm {0-0.019 in}

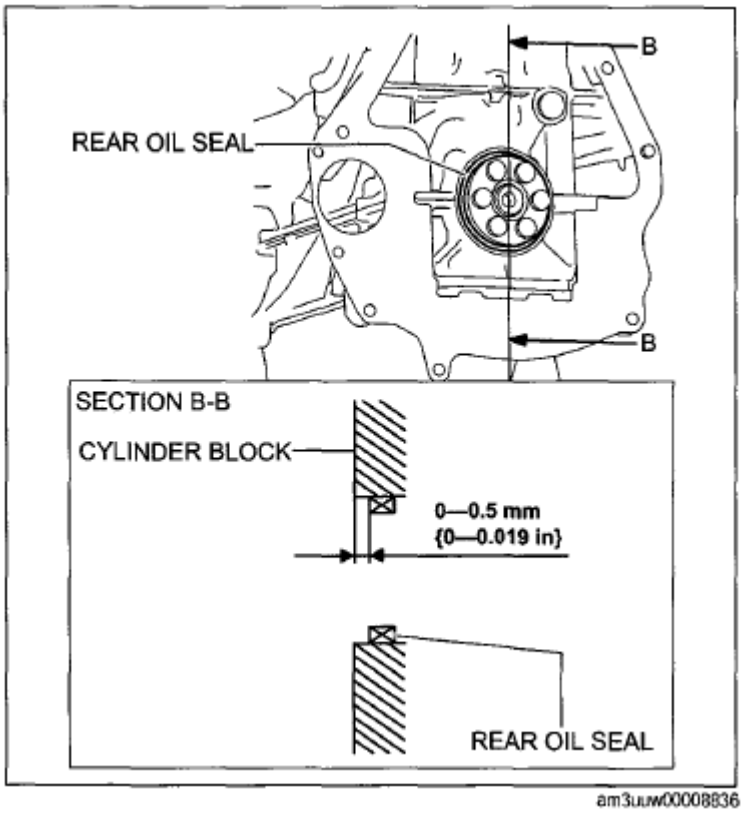


Fig. 111: Identifying Rear Oil Seal Press-In Dimension

END PLATE ASSEMBLY NOTE

1. After end plate assembly, crimp the parts A and B shown in the figure.

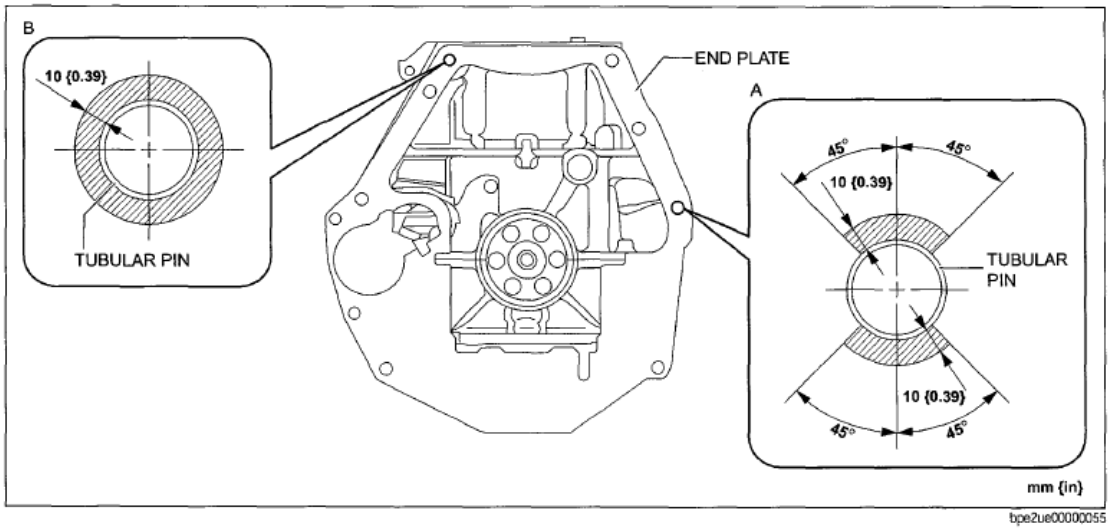


Fig. 112: Identifying End Plate Assembly Crimp Dimension

Crimp procedure

Crimp depth 0.1-1.0 mm {0.004-0.039 in}

Crimp width 0.5-10.0 mm {0.02-0.39 in}

Crimp locations Part A is 1 or more on one-side within shaded area and part B is 2 or more within shaded areas

2. After crimping, verify that there is no damage and removal of the end plate.

FLYWHEEL (MT), DRIVE PLATE (AT) ASSEMBLY NOTE

1. Hold the crankshaft using the SST.
2. Tighten the new Bolt in two or three passes in the order shown in the figure.

Tightening torque 108-116 N.m {11.1-11.8 kgf.m, 80-85 ft.lbf}

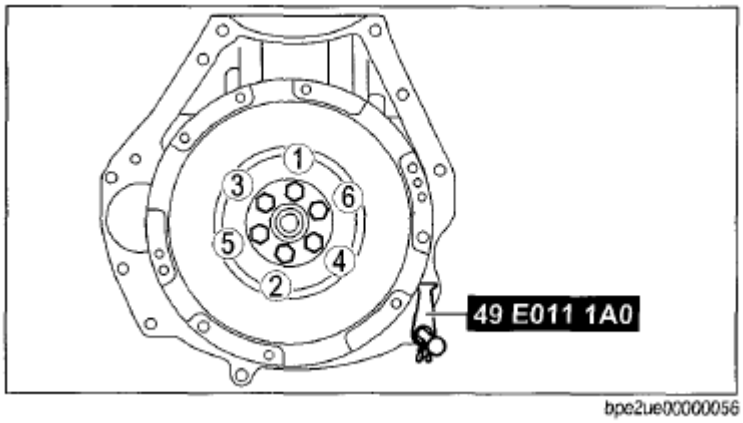
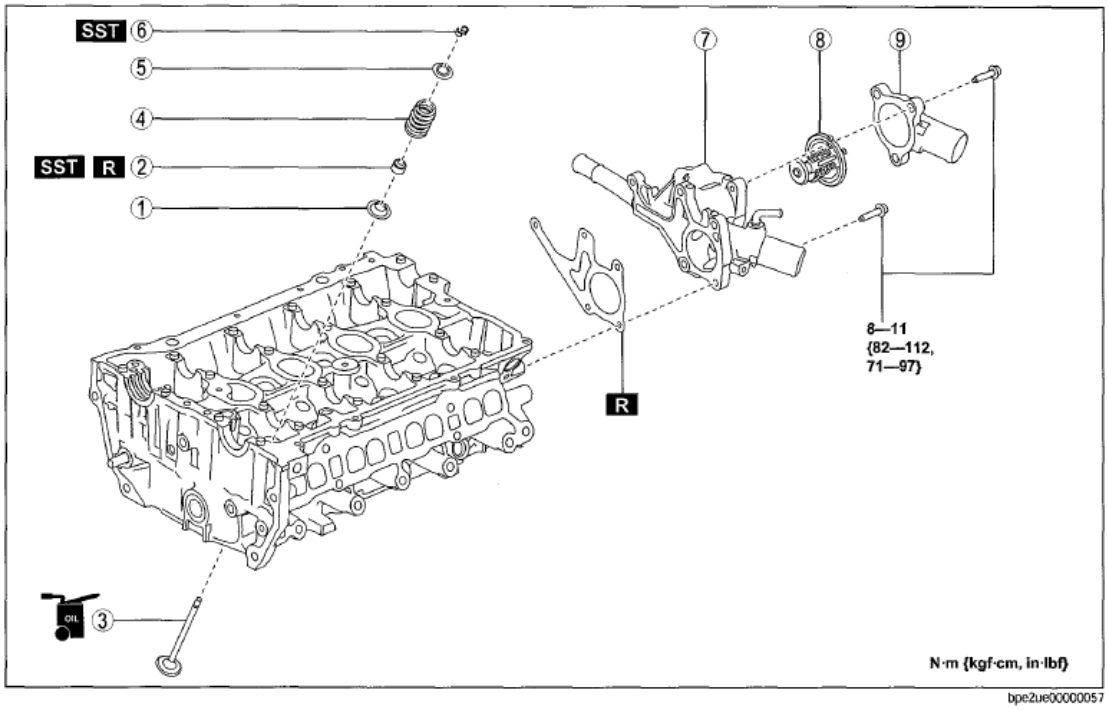


Fig. 113: Identifying Crankshaft Mounting Bolt Tightening Sequence

CYLINDER HEAD ASSEMBLY (I)

1. Assemble in the order indicated in the table.



1	Lower valve spring seat
2	Valve seal (See Valve Seal Assembly Note.)
3	Valve
4	Valve spring (See Valve Spring Assembly Note.)
5	Upper valve spring seat

6	Valve keeper (See Valve Keeper Assembly Note.)
7	Water outlet (See Water Outlet Assembly Note.)
8	Thermostat (See Thermostat Assembly Note.)
9	Thermostat cover

Fig. 114: Assembling Order Of Cylinder Head Assembly (I) With Torque Specification

VALVE SEAL ASSEMBLY NOTE

1. Press in the valve seal to the valve guide using the SST by hand.

   Valve seal identification color

   IN GREEN

   E GRAY

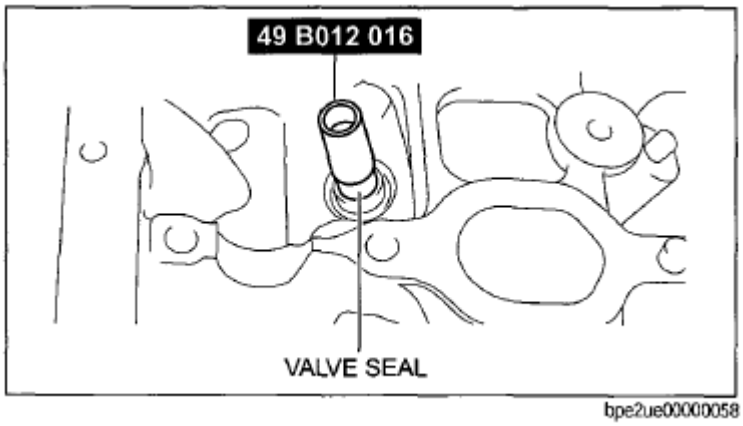


Fig. 115: Pressing In Valve Seal To Valve Guide

VALVE SPRING ASSEMBLY NOTE

CAUTION:
- **The valve springs differ depending on IN and E sides. Therefore, verify the free length or identification paint beforehand and assemble the valve springs correctly.**

1. Assemble the valve spring with the small diameter side of the valve spring facing upward.

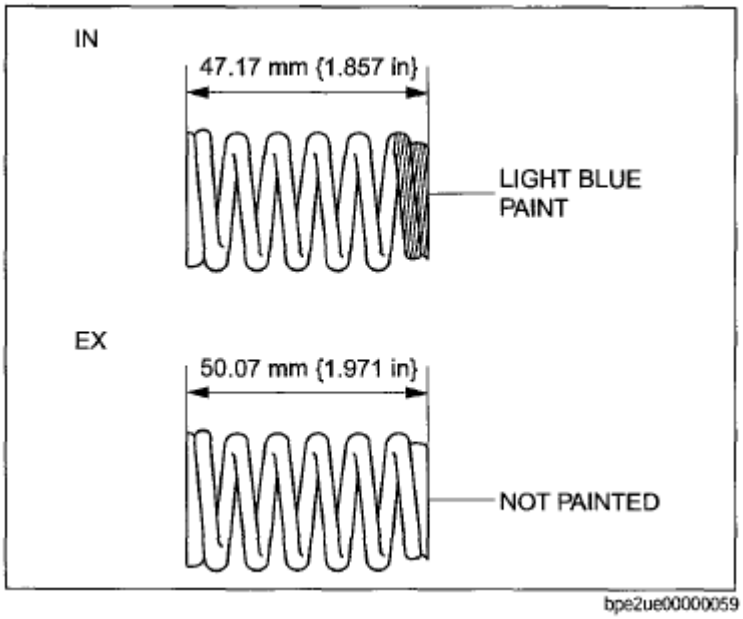


Fig. 116: Identifying Valve Spring Free Length

VALVE KEEPER ASSEMBLY NOTE

1. Install the valve keeper using the SST.

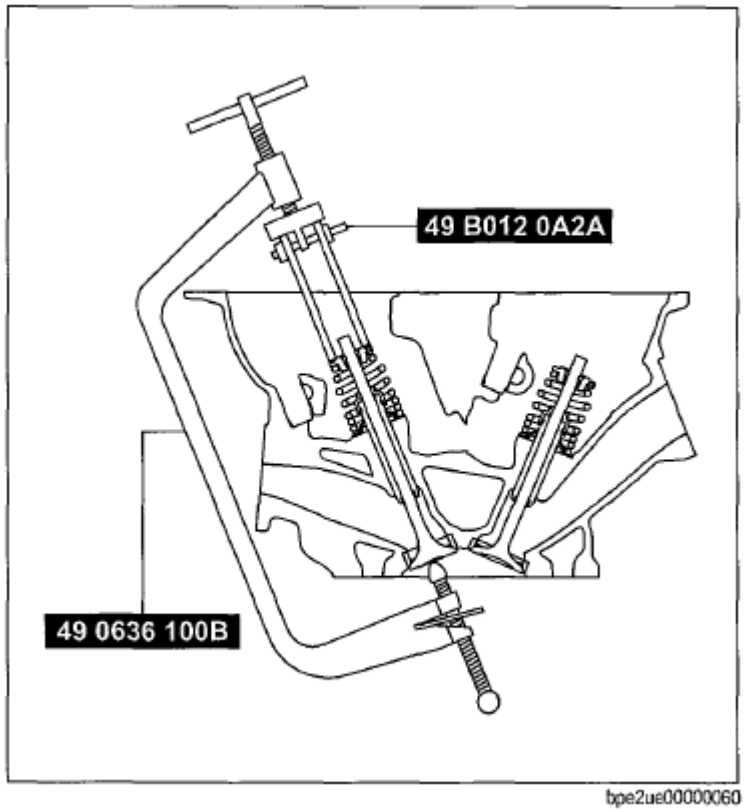


Fig. 117: Installing Valve Keeper

WATER OUTLET ASSEMBLY NOTE

1. Install the water outlet gasket with the bead of gasket facing the direction shown in the figure.
2. Temporarily tighten the water outlet Bolt.

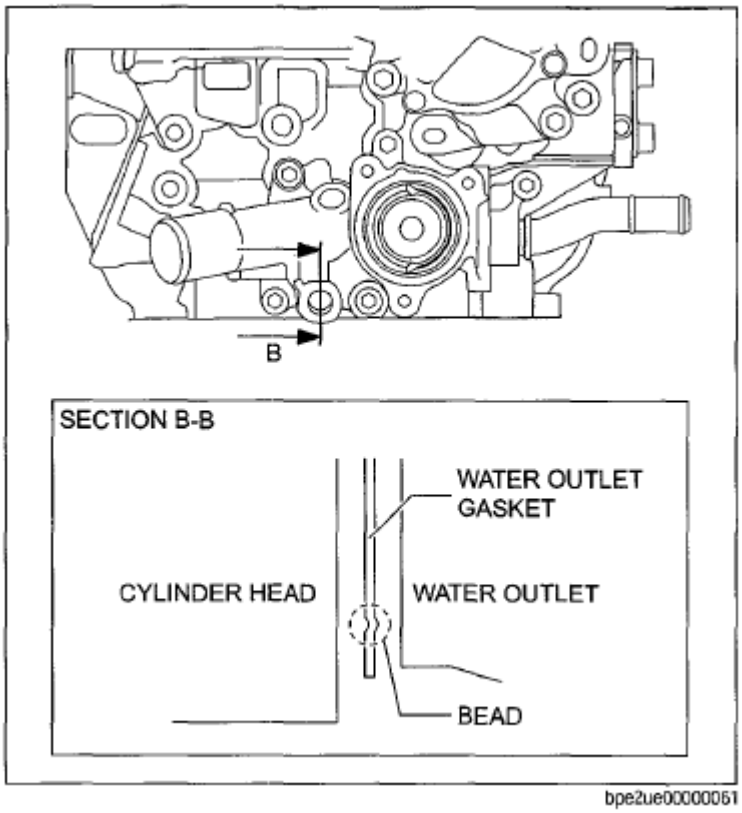


Fig. 118: Identifying Water Outlet, Gasket, Cylinder Head And Gasket Bead

3. Tighten bolt A of the 5 bolts shown in the figure to the specified torque first.

   Tightening torque 8-11 N.m {82-112 kgf.cm, 71-97 in.lbf}

NOTE:

- **The tightening order for the remaining 3 bolts is optional.**

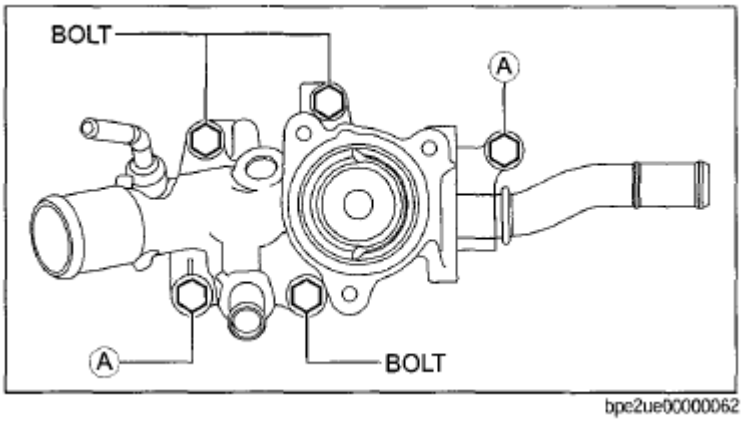


Fig. 119: Identifying Water Outlet Assembly Mounting Bolts

THERMOSTAT ASSEMBLY NOTE

1. Install the thermostat with the jiggle pin aligned with the notch of the water outlet.

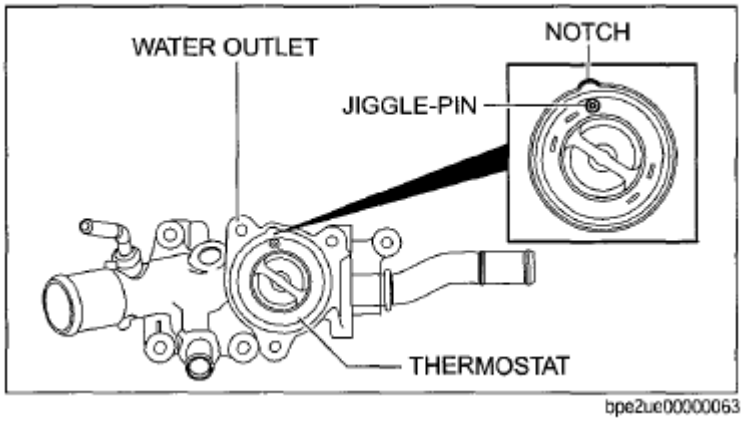


Fig. 120: Identifying Alignment Position Of Thermostat Jiggle Pin With Water Outlet Notch

CYLINDER HEAD ASSEMBLY (II)

CAUTION:

- **If the camshaft is rotated with the timing chain removed and the piston at the top dead center position, the valve may contact the piston and the engine could be damaged. When rotating the camshaft with the timing chain removed, rotate it after lowering the piston from the top dead center position.**
- **When rotating the camshaft using a wrench on the cast hexagon, the wrench may contact the rocker arm and damage the rocker arm. To prevent damage to the rocker arm when holding the camshaft on the cast he agon, use the wrench at engine rear side as shown in the figure to secure a clearance between the cam.**

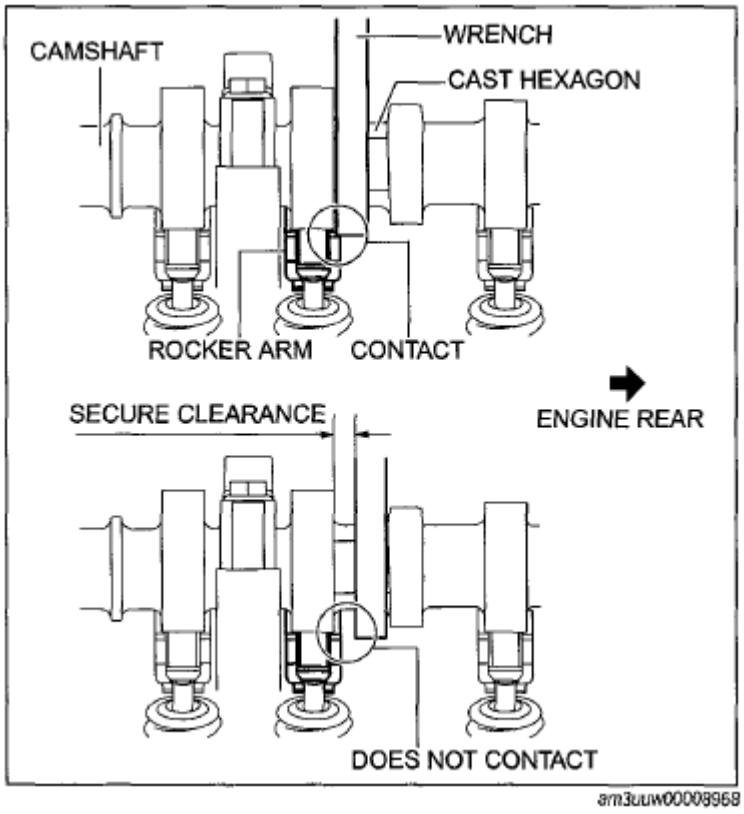


Fig. 121: Ensuring Clearance Between Cam/Rocker Arm And Wrench

NOTE:

- **Width at the cast hexagon of the camshaft is 22-24 mm 0.87-0.94 in.**

1. Assemble in the order indicated in the table.

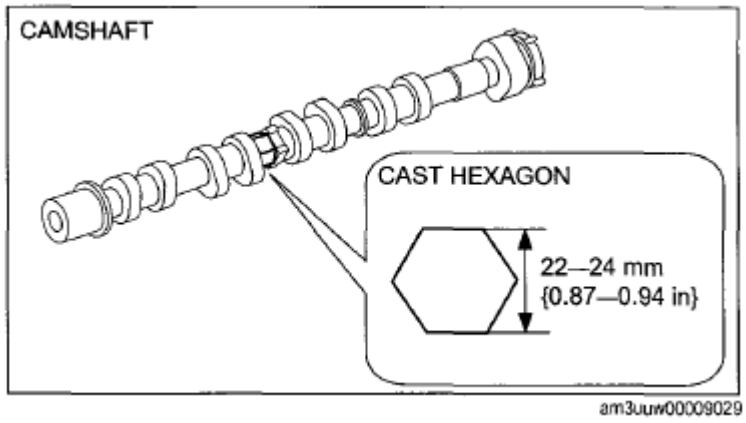
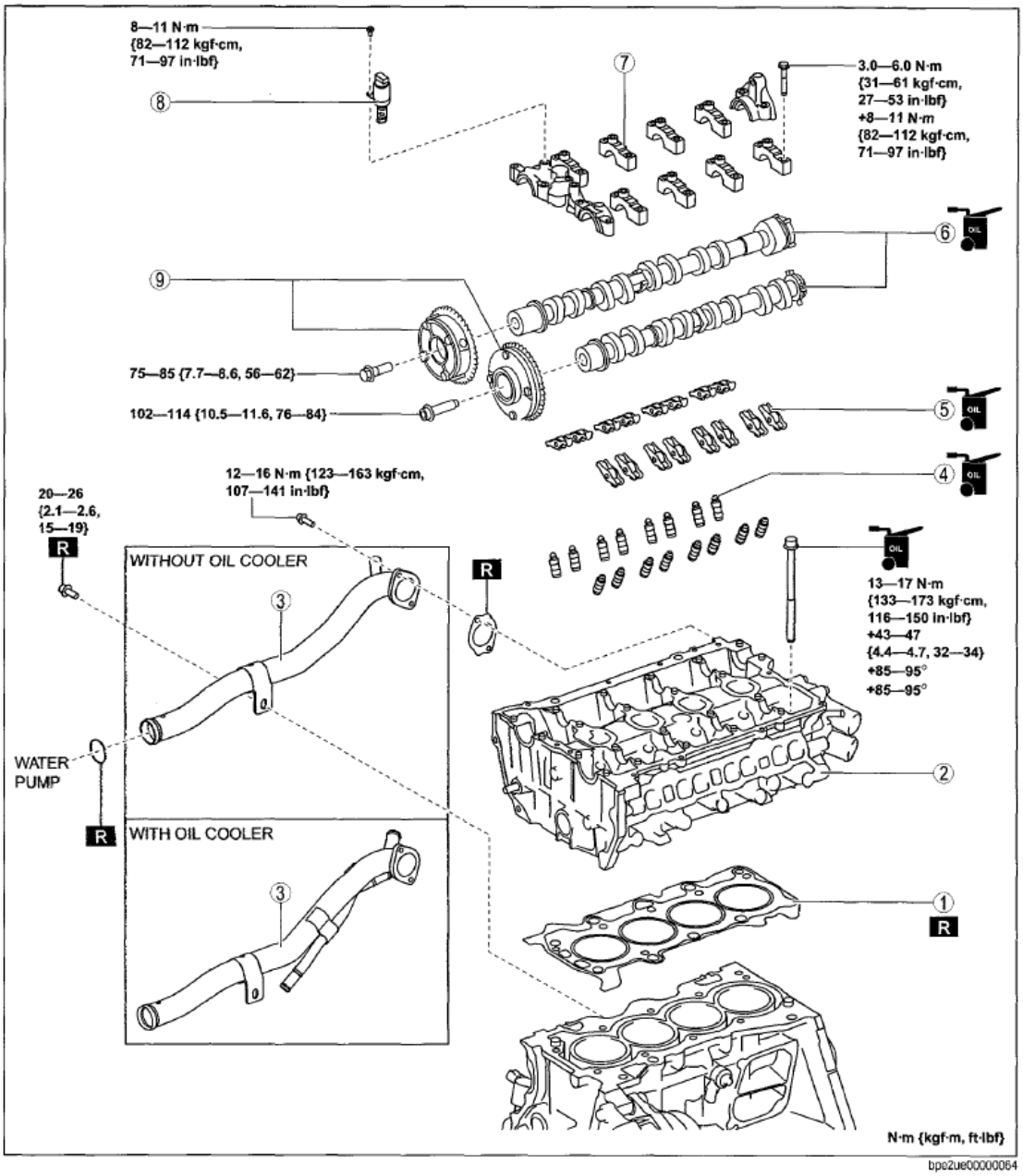


Fig. 122: Identifying Camshaft Cast Hexagon



1	Cylinder head gasket
2	Cylinder head (See Cylinder Head Assembly Note.)
3	Water inlet pipe (See Water Inlet Pipe Assembly Note.)
4	HLA (See HLA Assembly Note.)
5	Rocker arm (See Rocker Arm Assembly Note.)

6	Camshaft (See Camshaft Assembly Note.)
7	Camshaft cap (See Camshaft Assembly Note.)
8	OCV
9	Electric variable valve timing actuator, hydraulic variable valve timing actuator (See Electric Variable Valve Timing Actuator, Hydraulic Variable Valve Timing Actuator Assembly Note.)

Fig. 123: Identifying Variable Valve Timing Actuator Components (With And Without Oil Cooler)

CYLINDER HEAD ASSEMBLY NOTE

CAUTION:
- **If the following condition is met, replace the cylinder head bolts**
  - **Length e ceeds ma imum specification**

Standard cylinder head bolt length L 145.2-145.8 mm {5.717-5.740 in}

Ma imum cylinder head bolt length L 146.5 mm {5.767 in}

1. When a cylinder head bolt is reused, apply engine oil to any part of the following:
   - Bolt seating surface
   - Bolt thread
   - Cylinder head seating surface

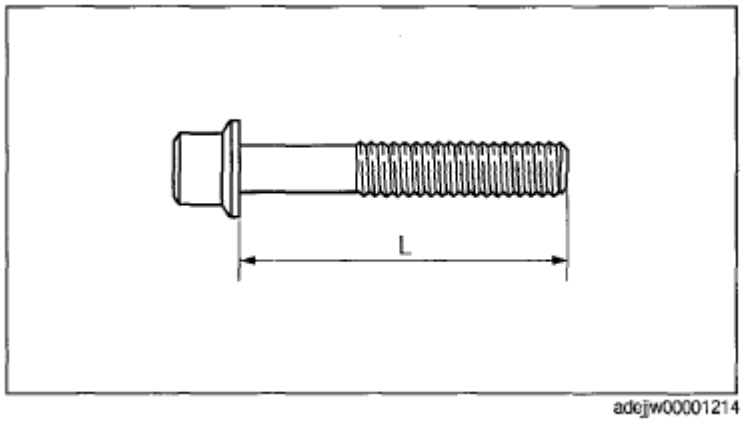


Fig. 124: Identifying Cylinder Head Bolt Length

2. Tighten the cylinder head bolts in the order shown in the following four steps.

   Tightening procedure Step 1 13-17 N.m {133-173 kgf.cm, 116-150 in.lbf}

   Step 2 43-47 N.m {4.4-4.7 kgf.m, 32-34 ft.lbf}

   Step 3 85-95°

   Step 4 85-95°

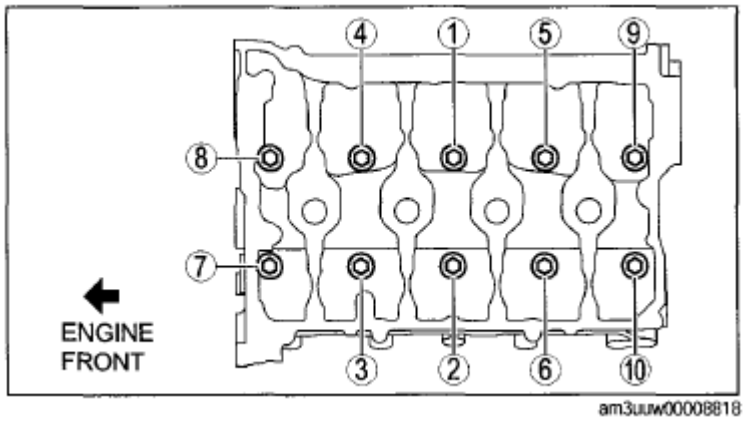


Fig. 125: Identifying Cylinder Head Mounting Bolt Tightening Sequence

WATER INLET PIPE ASSEMBLY NOTE

CAUTION:
- **Do not apply oil (engine oil, ATF etc.) to the O-ring of the water inlet pipe. Otherwise, the O-ring could swell causing a seal malfunction.**

1. Clean away the sealant adhering to the bolt hole on the cylinder block side of the water inlet pipe stay.
2. Apply engine coolant to the O-ring.
3. Install the O-ring to the water inlet pipe.
4. Insert the water inlet pipe into the water pump being careful not to damage the O-ring.
5. Install the water inlet pipe gasket with the gasket projection facing the direction shown in the figure.

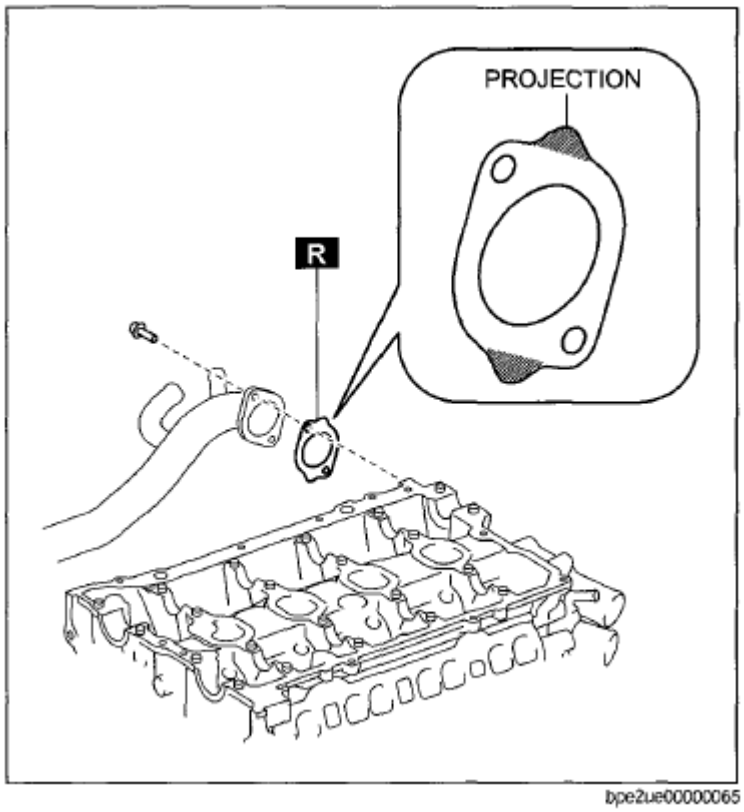


Fig. 126: Identifying Water Inlet Pipe Gasket With Gasket Projection

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

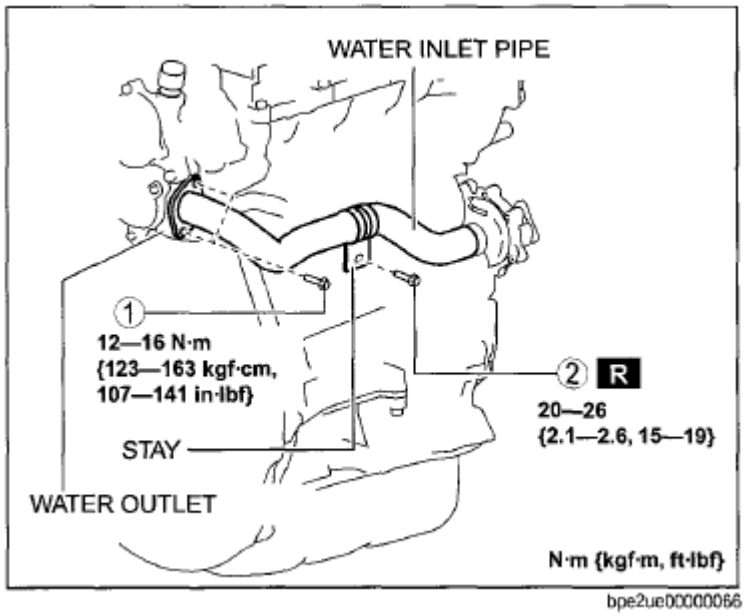


Fig. 127: Identifying Water Inlet Pipe Mounting Bolt Tightening Sequence With Torque Specifications

HLA ASSEMBLY NOTE

1. Perform HLA air bleeding using the following procedure:
    1. Put the HLA in a container filled with engine oil.

CAUTION:
- **Do not insert the round bar firmly because the check bail spring force is e tremely weak.**

    2. While lightly pressing the check ball using a round bar (appro. 1.0 mm {0.039 in} diameter), bleed air by moving the plunger up and down.
    3. Press the end of the plunger in the oil and verify that there is no rebounding feel.
        - If rebounding feel cannot be eliminated, replace the HLA.
2. Install the HLAs to their original positions as before removal.

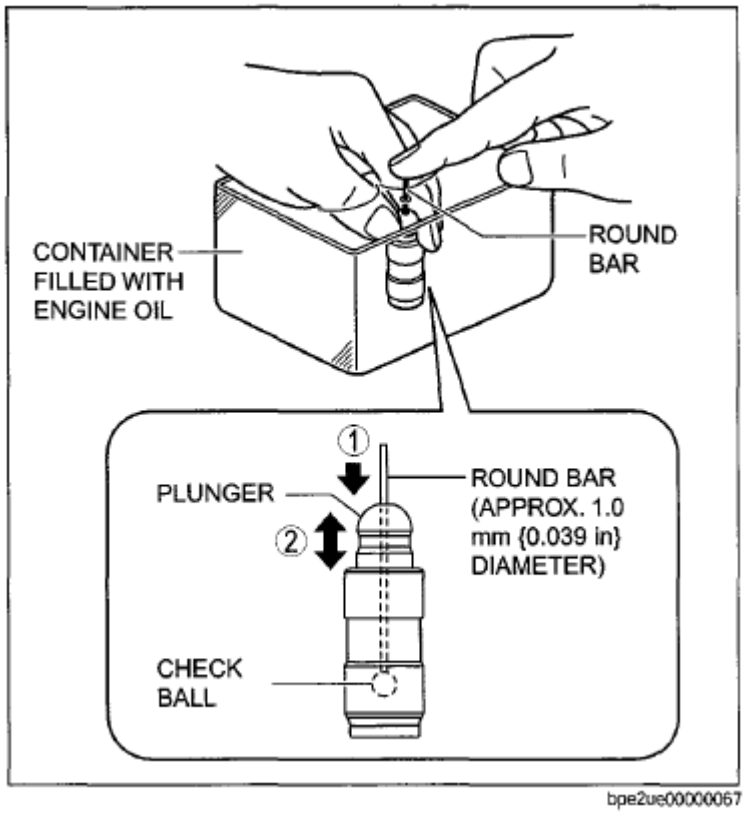


Fig. 128: Pressing Plunger End In Oil

ROCKER ARM ASSEMBLY NOTE

1. Apply engine oil to the HLAs and the end of the valve stems.
2. Install the rocker arms to their original positions as before removal.

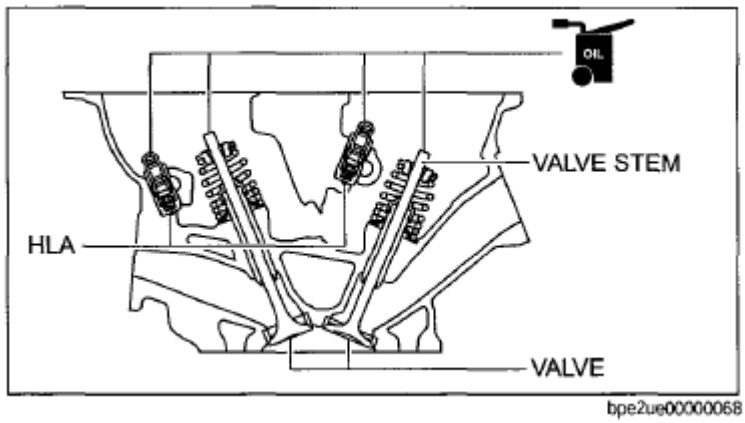


Fig. 129: Applying Engine Oil Applying Areas To HLA And End Of Valve Stems

CAMSHAFT ASSEMBLY NOTE

1. As shown in the figure, apply gear oil (SAE No. 90 or equivalent) or engine oil to the center area of each journal of the cylinder head.

CAUTION:
- **Apply 0.05 ml {0.05 cc, 0.003 in^3 } or less of oil to journal No.6.**

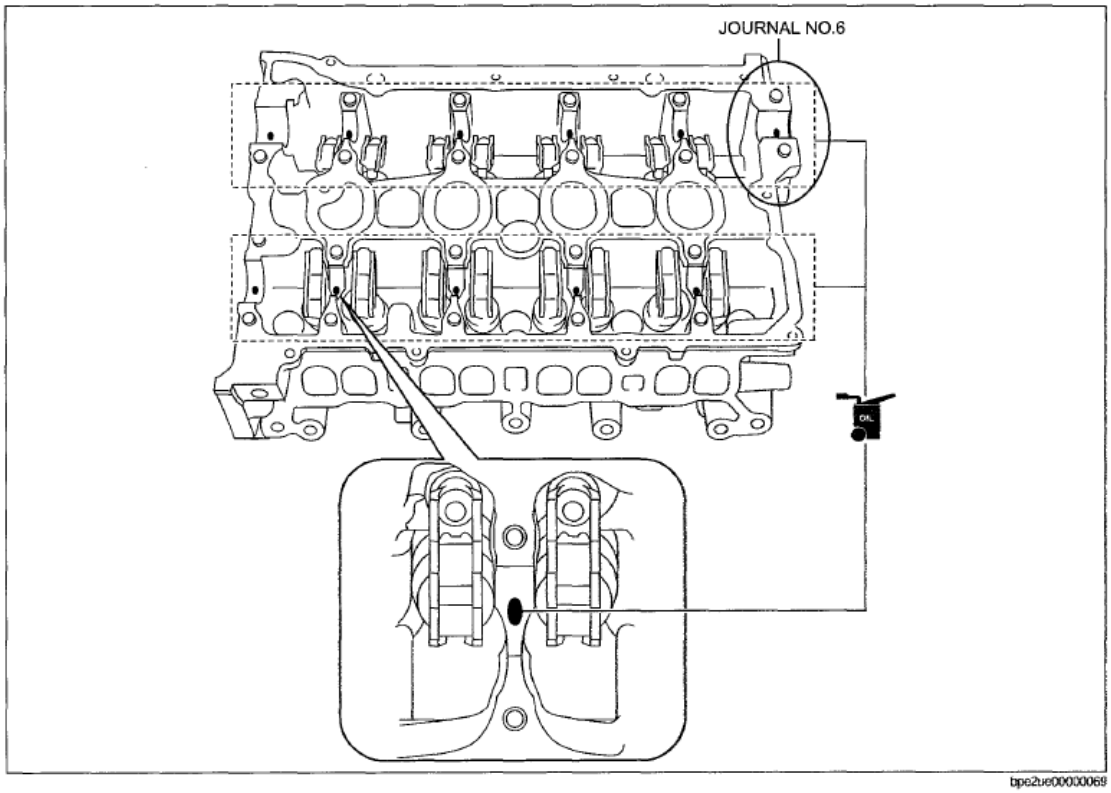


Fig. 130: Identifying Gear Oil Applying Areas To Center Area Of Cylinder Head Journal

2. As shown in the figure, align the cam position of cylinder No.1 around top dead center (TDC) and place the camshafts on the cylinder head.

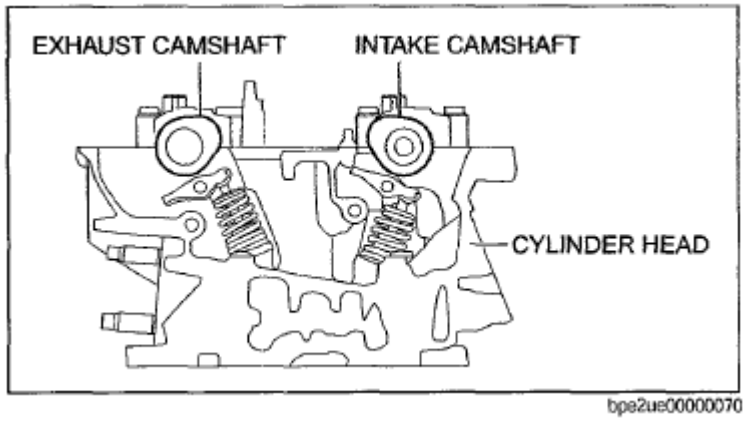


Fig. 131: Identifying Cylinder Head, Intake And Exhaust Camshaft

3. As shown in the figure, apply gear oil (SAE No. 90 or equivalent) or engine oil to the center area of each journal of the camshaft.

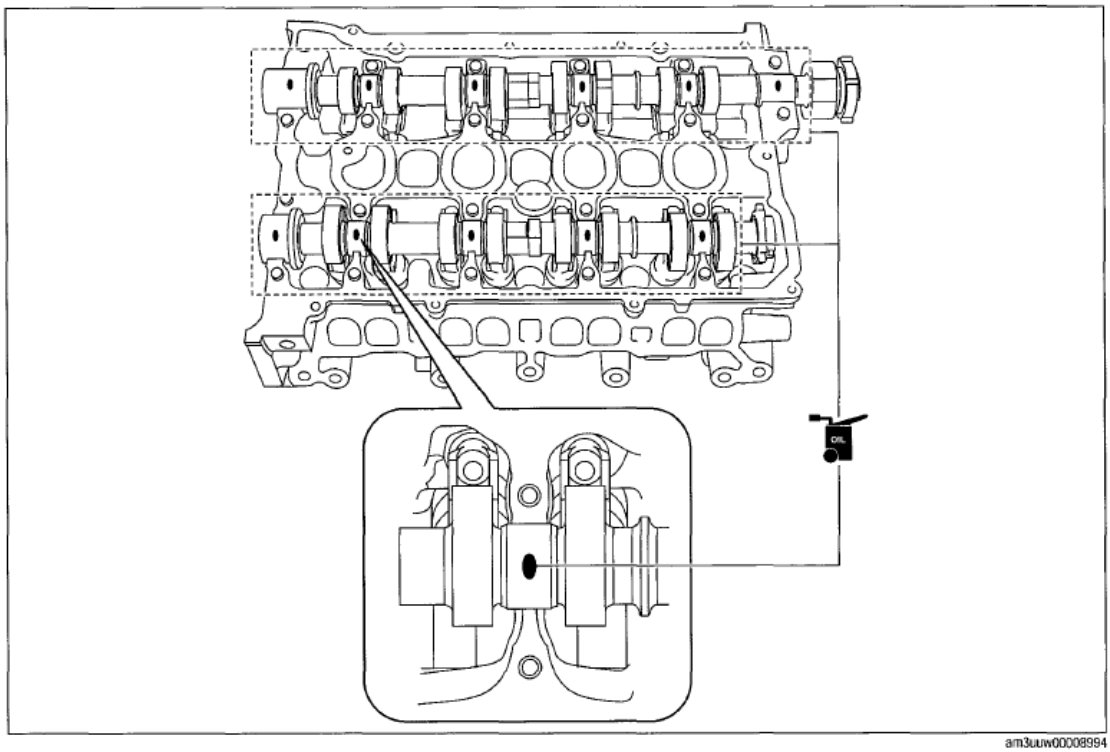


Fig. 132: Identifying Gear Oil Applying Areas To Center Area Of Camshaft Journal

4. Apply adhesive agent (Loctite 962T) around journal No.6 of the cylinder head or the exhaust-side rear camshaft cap.

CAUTION:
- **Verify that there is no adhesive agent on the journal.**

Adhesive agent bead width 0.5-1.5 mm {0.02-0.05 in}

5. Install the camshaft caps in the marked number order, and temporarily tighten the camshaft cap Bolt in two or three passes evenly.

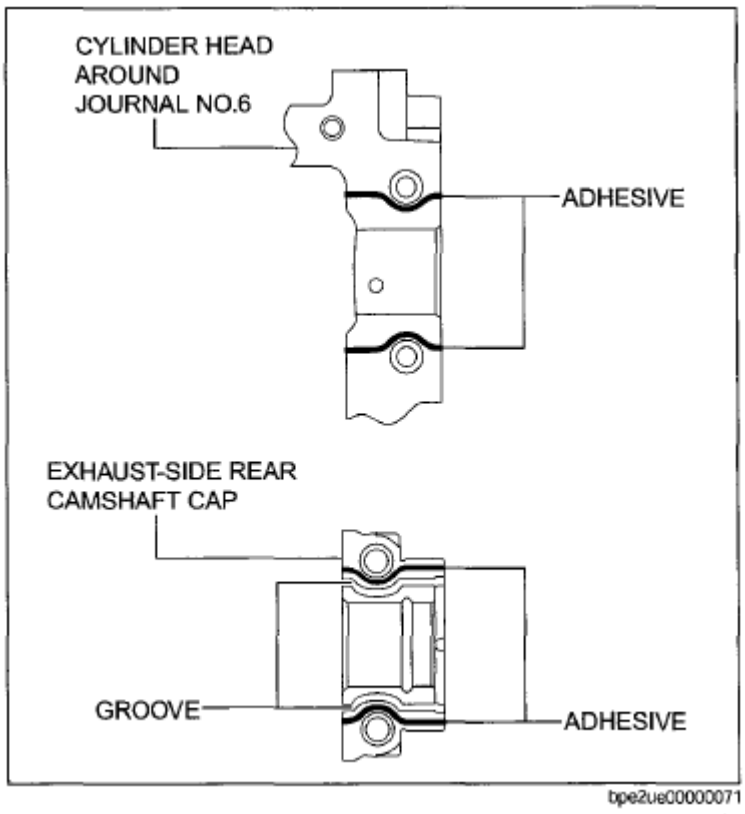


Fig. 133: Identifying Adhesive Applying Areas On Journal No.6 Of Cylinder Head And Exhaust-Side Rear Camshaft Cap

6. Tighten the camshaft cap Bolt in two steps in the order shown in the figure.

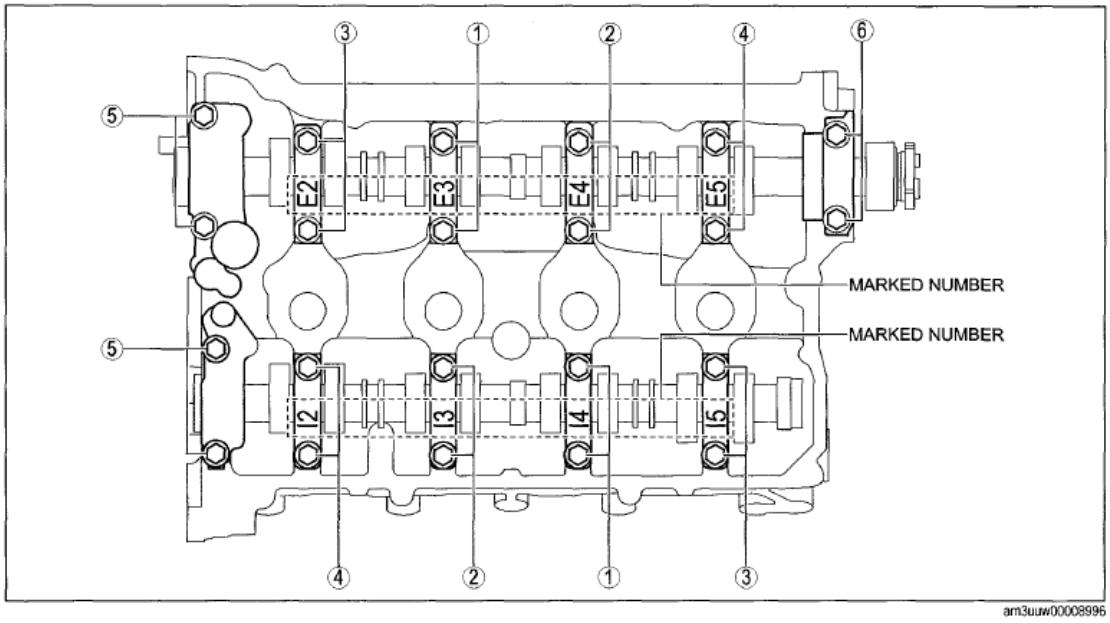


Fig. 134: Identifying Camshaft Cap Bolt Tightening Sequence

Tightening torque

Step 1 3.0-6.0 N.m {31-61 kgf.cm, 27-53 in.lbf}

Step 2 8-11 N.m {82-112 kgf.cm, 71-97 in.lbf}

ELECTRIC VARIABLE VALVE TIMING ACTUATOR, HYDRAULIC VARIABLE VALVE TIMING ACTUATOR ASSEMBLY NOTE

1. Align the knock pin on the end of the camshaft with the notch on the actuator (intake side) or knock pin installation hole (exhaust side), then install the actuator to the camshaft.

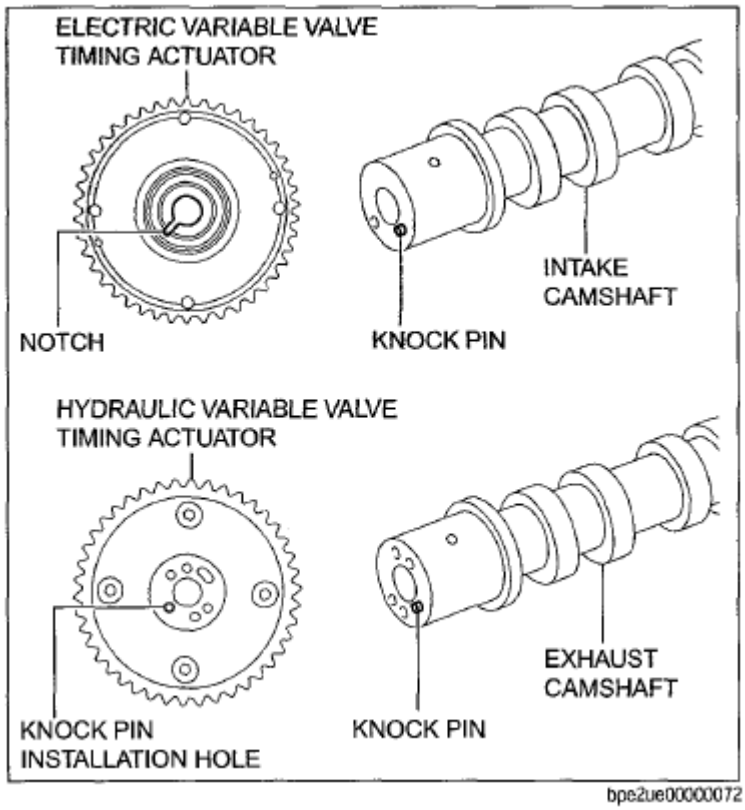


Fig. 135: Identifying Alignment Mark On Electric/Hydraulic Variable Valve Timing Actuator With Camshaft

2. Hold the camshaft using a wrench on the cast hexagon, and tighten the actuator Bolt.

   Tightening torque

   Electric variable valve timing actuator (intake side) 102-114 N.m {10.5-11.6 kgf.m, 76-84 ft.lbf}

   Hydraulic variable valve timing actuator (e haust side) 75-85 N.m {7.7-8.6 kgf.m, 56-62 ft.lbf}

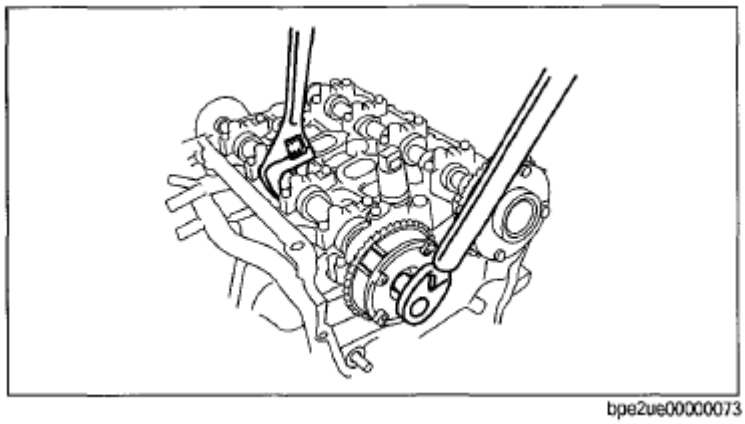


Fig. 136: Tightening Variable Valve Timing Actuator Bolt

TIMING CHAIN ASSEMBLY

CAUTION:

- **If the camshaft is rotated with the timing chain removed and the piston at the top dead center position, the valve may contact the piston and the engine could be damaged. When rotating the camshaft with the timing chain removed, rotate it after lowering the piston from the top dead center position.**
- **When rotating the camshaft using a wrench on the cast he agon, the wrench may contact the rocker arm and damage the rocker arm. To prevent damage to the rocker arm when holding the camshaft on the cast he agon, use the wrench at engine rear side as shown in the figure to secure a clearance between the cam.**

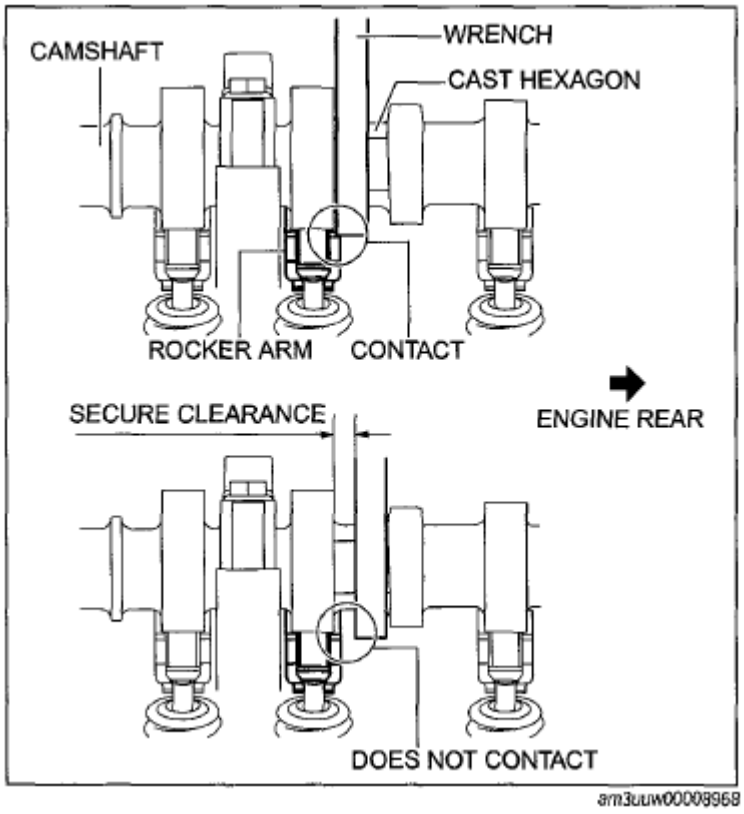


Fig. 137: Ensuring Clearance Between Cam/Rocker Arm And Wrench

NOTE:

- **Width at the cast hexagon of the camshaft is 22-24 mm 0.87-0.94 in.**

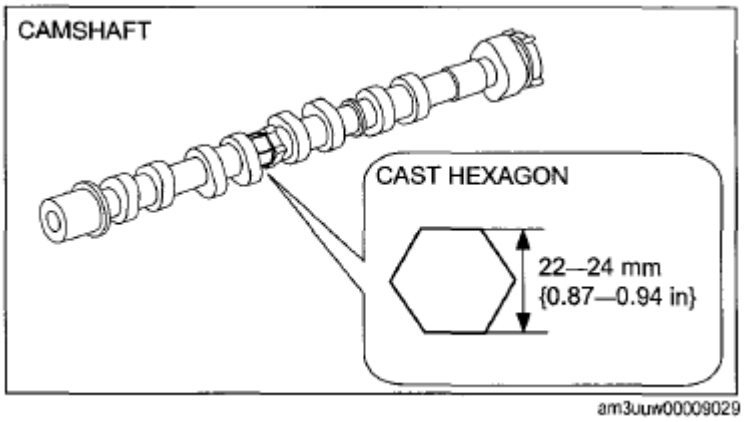
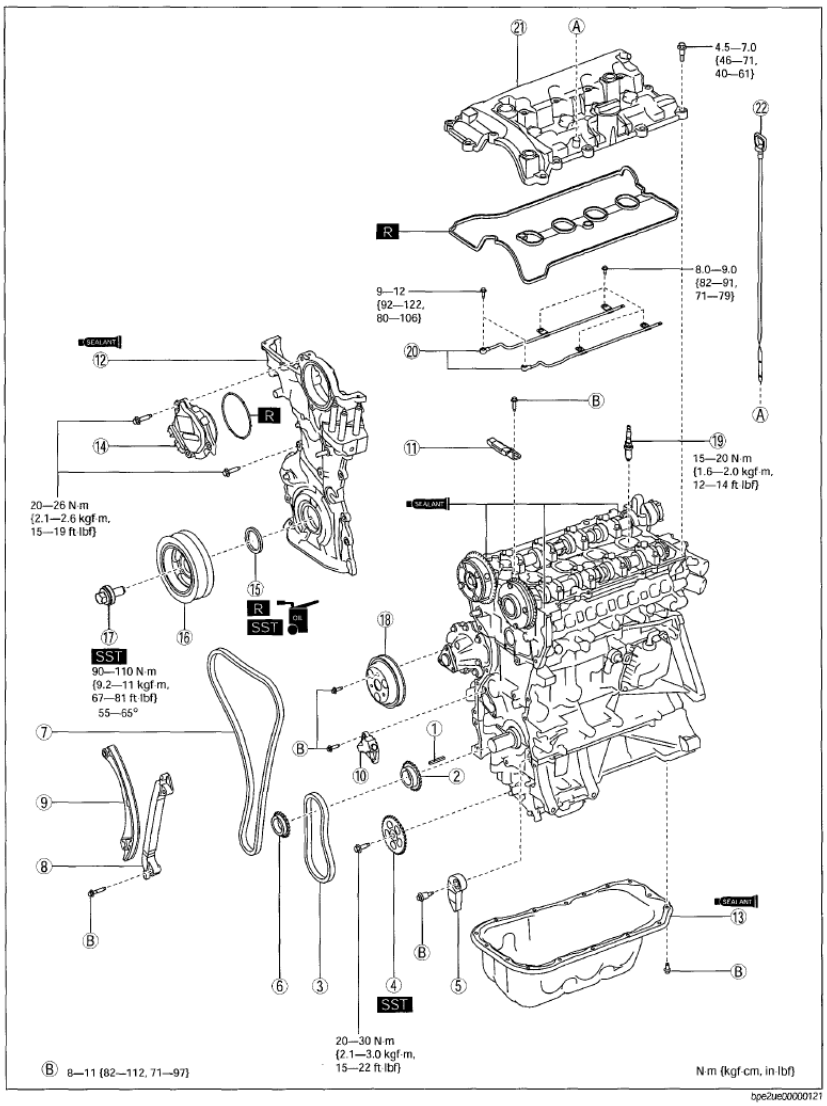


Fig. 138: Identifying Camshaft Cast Hexagon

1. Assemble in the order indicated in the table.



1	Key
3	Oil pump chain
4	Oil pump driven sprocket (See Oil Pump Driven Sprocket Assembly Note.)
5	Oil pump chain tensioner
6	Crankshaft sprocket
7	Timing chain (See Timing Chain Assembly Note.)
8	Chain guide (No.2) (See Timing Chain Assembly Note.)
9	Tensioner arm (See Timing Chain Assembly Note.)
10	Chain tensioner (See Timing Chain Assembly Note.)
11	Chain guide (No.1) (See Timing Chain Assembly Note.)
12	Engine front cover (See Engine Front Cover Assembly Note.)
13	Oil pan (See Oil Pan Assembly Note.)

2	Oil pump drive sprocket
14	Electric variable valve timing motor/driver (See Electric Variable Valve Timing Motor/Driver Assembly Note.)
15	Front oil seal (See Front Oil Seal Assembly Note.)
16	Crankshaft pulley
17	Crankshaft pulley lock bolt (See Crankshaft Pulley Lock Bolt Assembly Note.)
18	Water pump pulley (See Water Pump Pulley Assembly Note.)
19	Spark plug
20	Oil shower pipe (See Oil Shower Pipe Installation Note.)
21	Cylinder head cover (See Cylinder Head Cover Installation Note.)
22	Dipstick

Fig. 139: Assembling Order Of Engine Components With Torque Specifications

OIL PUMP DRIVEN SPROCKET ASSEMBLY NOTE

1. Hold the crankshaft using the SST.

2. Install the oil pump driven sprocket.

   Tightening torque 20-30 N.m {2.1-3.0 kgf.m, 15-22 ft.lbf)

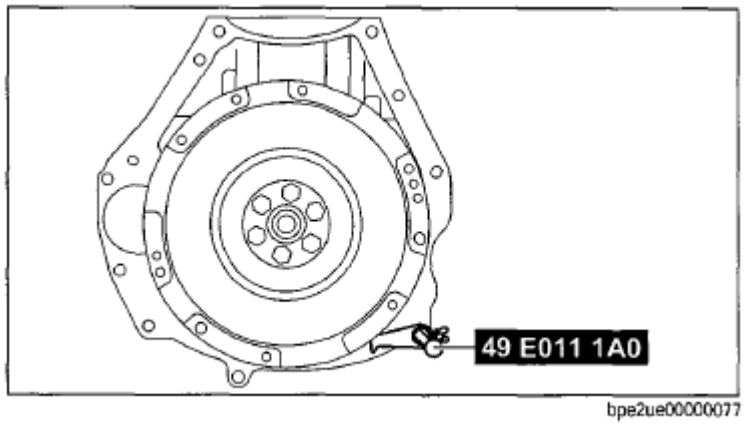


Fig. 140: Installing Oil Pump Driven Sprocket

TIMING CHAIN ASSEMBLY NOTE

1. Verify that the timing marks and the key are aligned to the position shown in the figure.

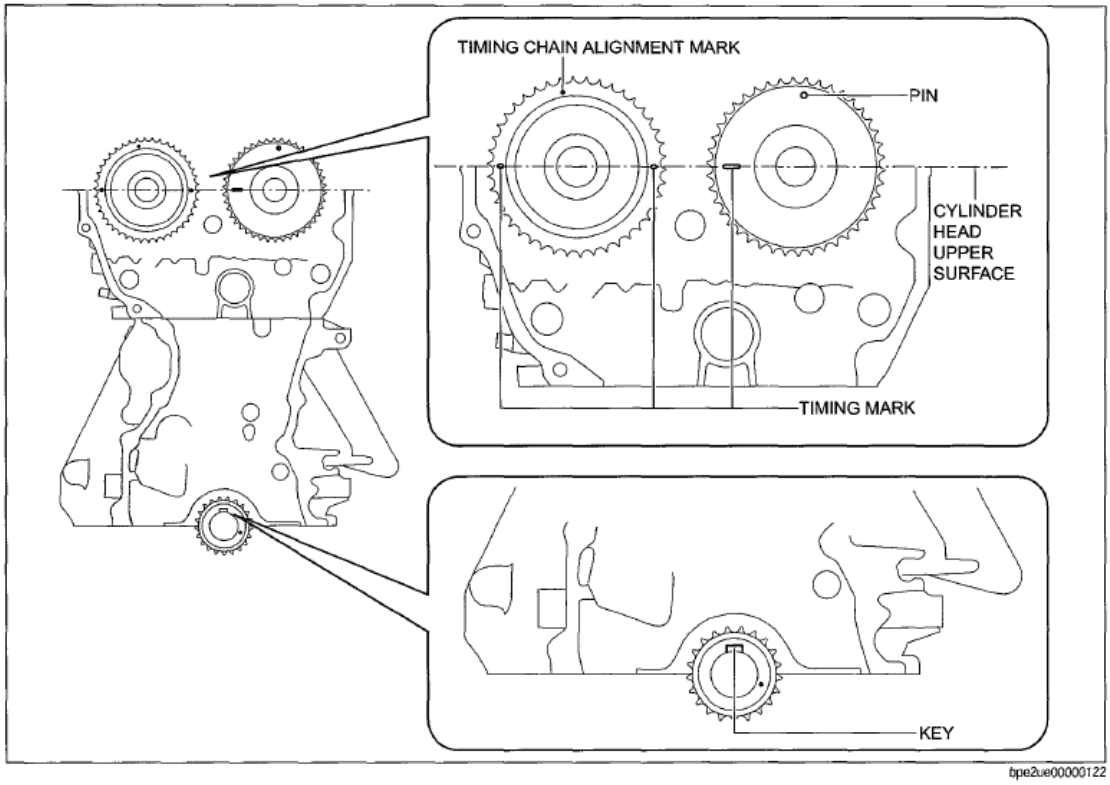


Fig. 141: Identifying Timing Chain Alignment Marks And Key Aligned Position

- If they are not in the position shown in the figure, rotate the camshaft and crankshaft to set the cylinder No.1 top dead center (TDC).

2. Install the timing chain while aligning the marks on each sprocket and the timing chain as shown in the figure.

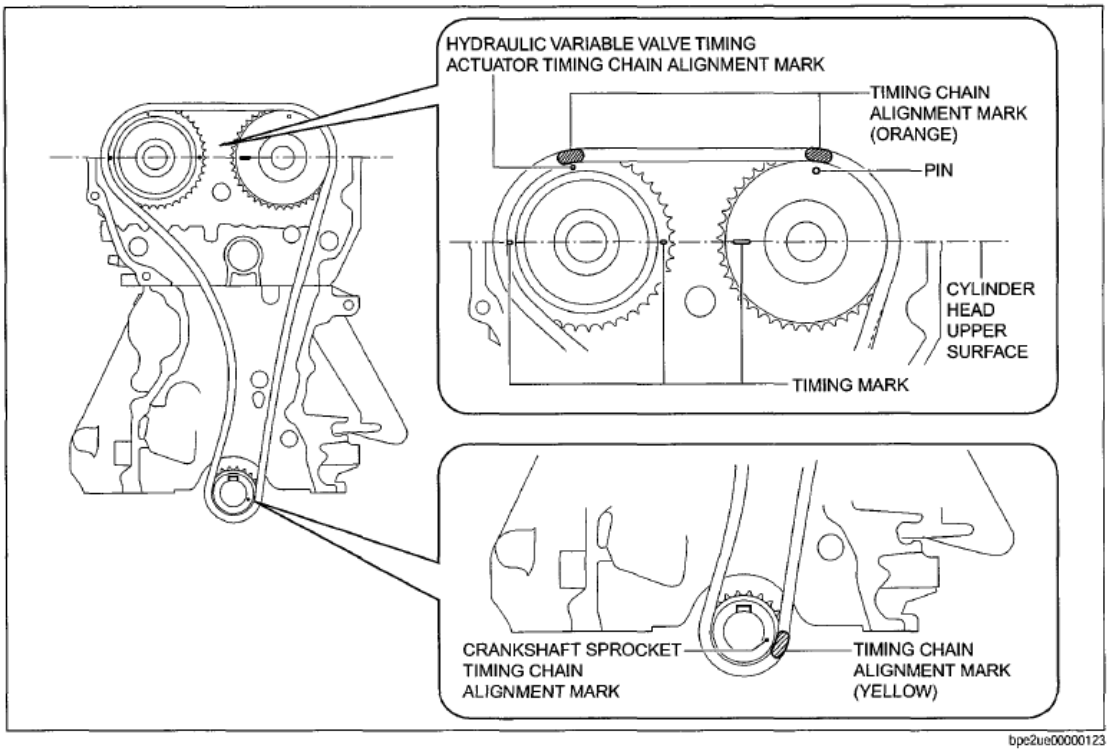


Fig. 142: Identifying Timing Chain Alignment Marks On Sprocket And Timing Chain

3. Install the chain guide (No.2).
4. Install the tensioner arm.
5. Install the chain tensioner.
6. After installing the chain tensioner, remove the installed wire or paper clip, and then apply tension to the timing chain.
    - If a new chain tensioner is used, remove the installed stopper.
7. Install the chain guide (No.1).
8. Verify that there is no looseness in the timing chain, and re-verify that each sprocket is in the specified location.

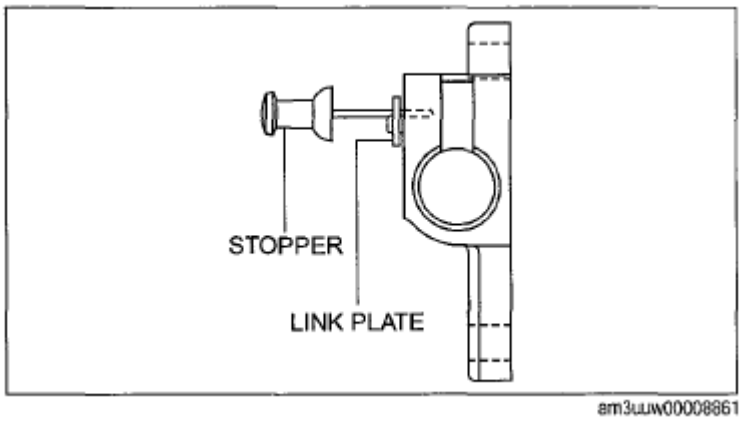


Fig. 143: Identifying Link Plate And Stopper

9. Rotate the crankshaft clockwise two turns and inspect the valve timing.

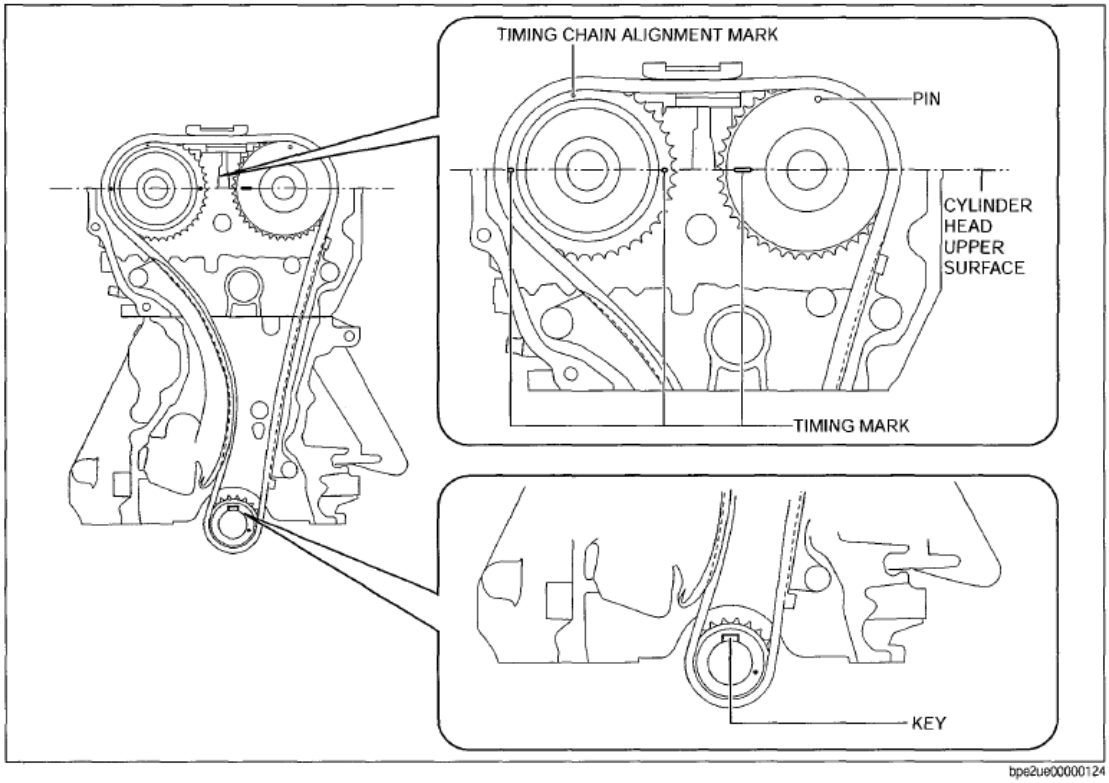


Fig. 144: Identifying Timing Chain Alignment Marks On Cylinder Head Upper Surface

ENGINE FRONT COVER ASSEMBLY NOTE

NOTE:

- **For a new engine front cover, the positioning pins in the two locations shown in the figure project to the outside of the engine.**

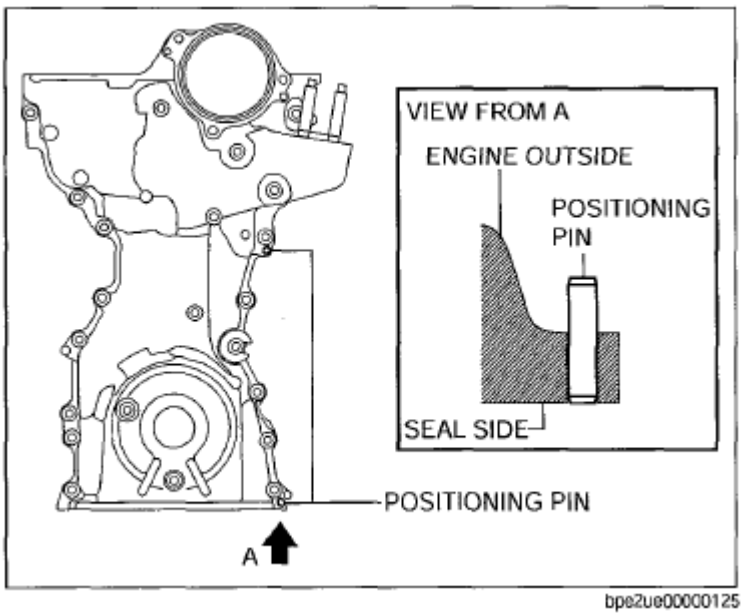


Fig. 145: Locating Positioning Pins On Engine Front Cover

1. If the engine front cover is newly replaced, tap the positioning pins in the two locations to the seal surface side.
2. Completely clean and remove any oil, dirt, sealant or other foreign material that may be adhering to the engine front cover, cylinder head, and cylinder block.
3. When reusing the engine front cover Bolts, clean any old sealant from the bolts.

CAUTION:
- **Apply the silicon sealant in a single, unbroken line.**
- **To prevent silicone sealant from hardening, adhere the engine front cover to the cylinder block within 10 min. after silicone sealant is applied. Tighten the Bolts completely soon after adhering.**
- **Using bolts with the old seal adhering could cause cracks in the cylinder head and cylinder block.**

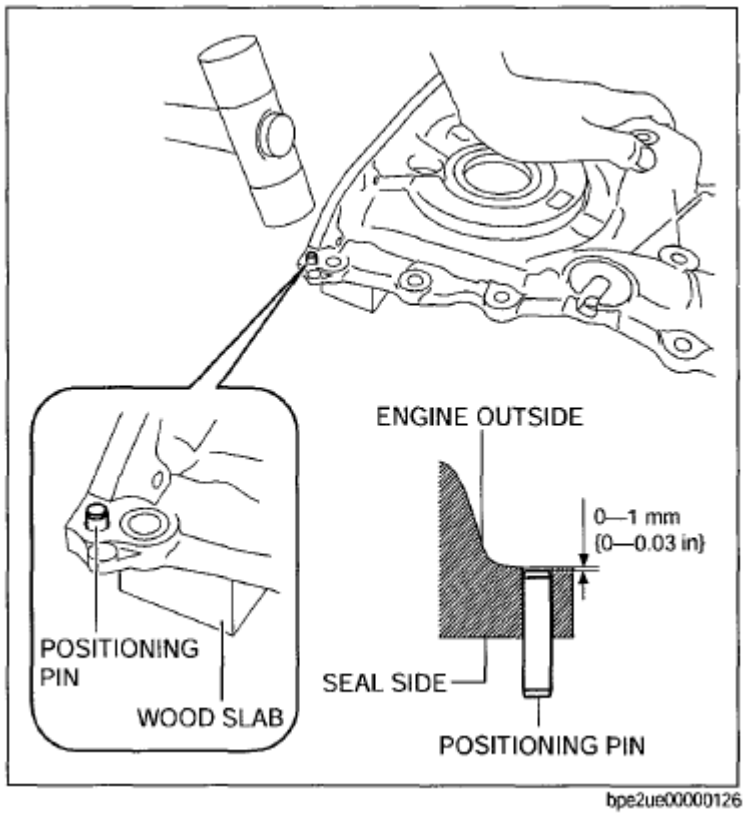


Fig. 146: Tapping Positioning Pin On Seal Surface Side Using Tool

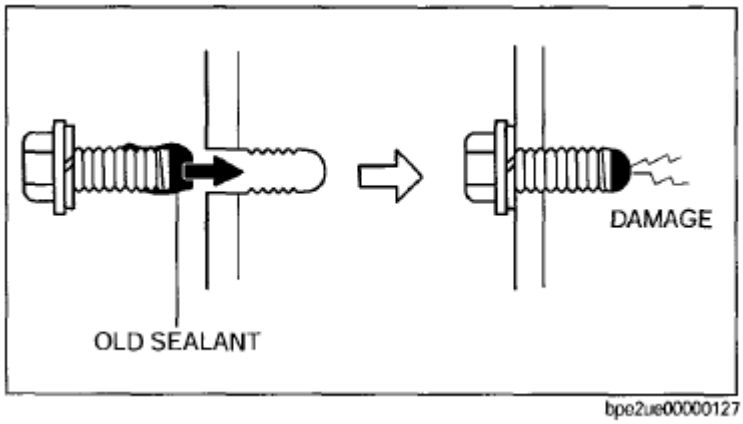


Fig. 147: Identifying Cylinder Block Damages (Old Seal Adhering Bolt)

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

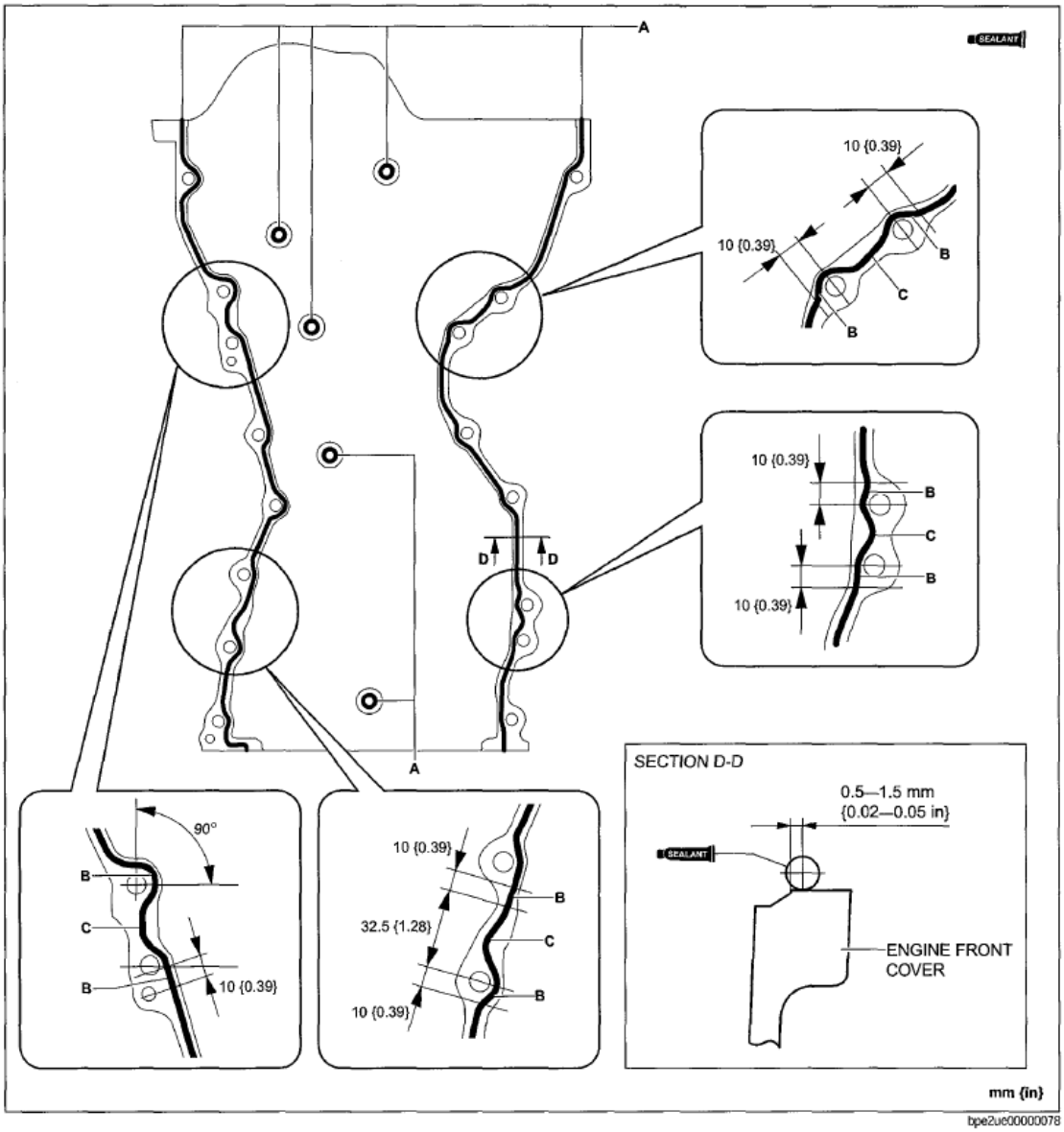


Fig. 148: Identifying Silicone Sealant Applying Areas On Engine Front Cover

Bead thickness

A. 2-6 mm {0.1-0.2 in}
B. 4-6 mm {0.16-0.23 in}
C. 4-8 mm {0.2-0.3 in}

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

CAUTION:
- **Apply the silicone sealant so that it goes into the cylinder head gasket.**

6. Install the engine front cover to the engine.

NOTE:

- **Temporarily install an appropriate bolt to the drive belt auto tensioner Bolt hole to prevent:**
  - **A silicone sealant adhesion malfunction in the drive belt auto tensioner Bolt hole.**
  - **A bolt mis-installation due to silicone sealant hardening.**

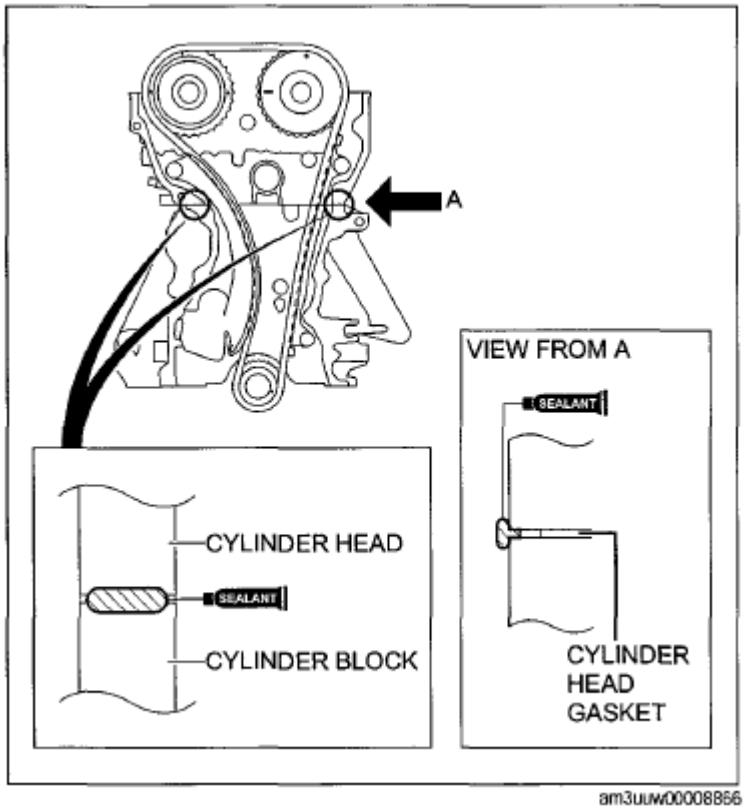


Fig. 149: Identifying Silicone Sealant Applying Areas On Cylinder Head Gasket

7. Prepare an appropriate M8 1.25 bolt (length 40 mm {1.6 in}).

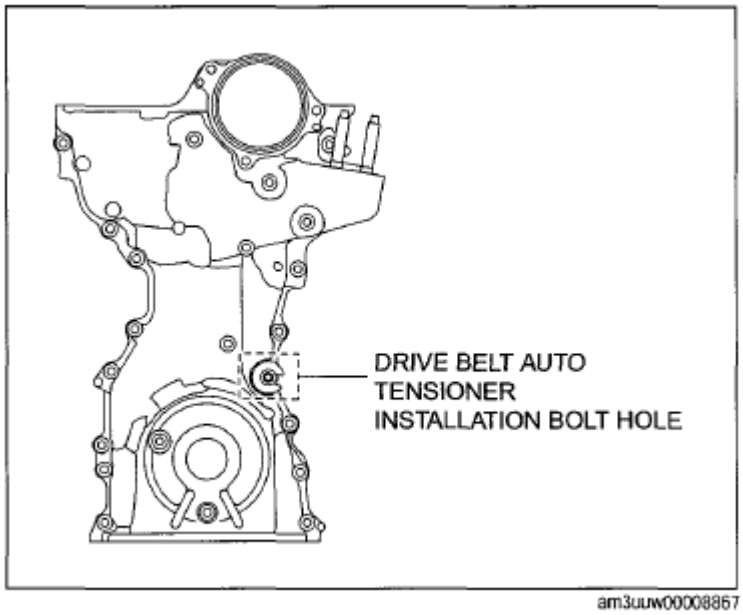


Fig. 150: Identifying Drive Belt Auto Tensioner Bolt Hole

8. Tighten the engine front cover Bolts in the order shown in the figure.

   Tightening torque 20-26 N.m {2.1-2.6 kgf.cm, 15-19 in.lbf}

9. Remove the bolt installed to the drive belt auto tensioner Bolt hole when installing the drive belt auto tensioner.

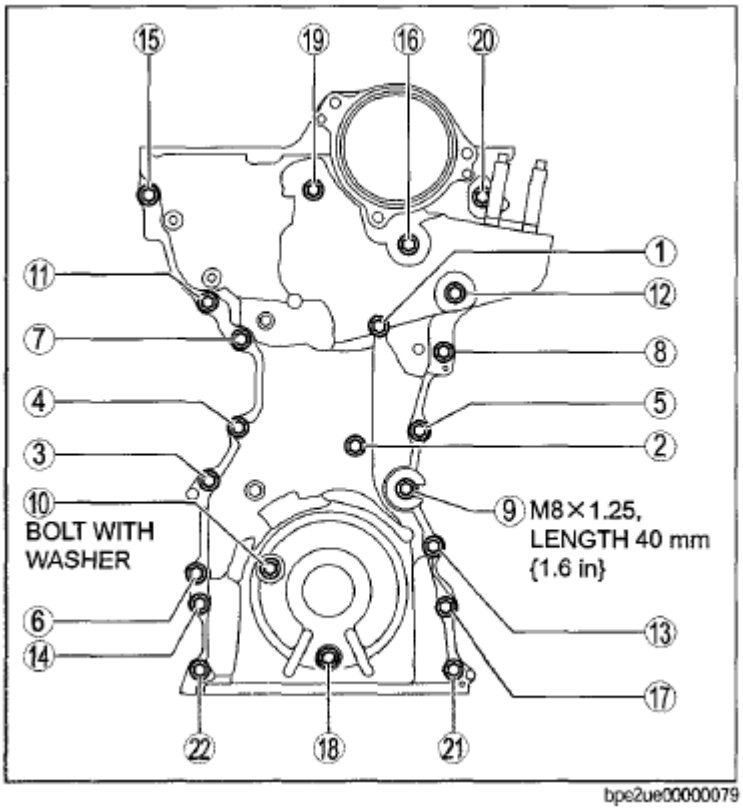


Fig. 151: Identifying Engine Front Cover Bolt Tightening Sequence

OIL PAN ASSEMBLY NOTE

1. Completely clean and remove any oil, dirt, sealant or other foreign material that may be adhering to the cylinder block and oil pan.
2. When reusing the oil pan Bolts, clean any old sealant from the bolts.

CAUTION:

- **Apply the silicon sealant in a single, unbroken line around the whole perimeter.**
- **To prevent silicone sealant from hardening, adhere the oil pan to the cylinder block within 10 min. after silicone sealant is applied. Tighten the Bolts completely soon after adhering.**
- **Using bolts with the old seal adhering could cause cracks in the cylinder block, etc.**

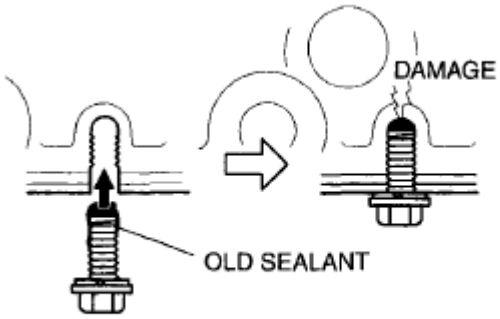


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Fig. 152: Identifying Possible Cylinder Block Damage Caused By Old Sealant Adhering To Bolt

3. Apply silicone sealant to the oil pan along the inside of the bolt holes as shown in the figure.

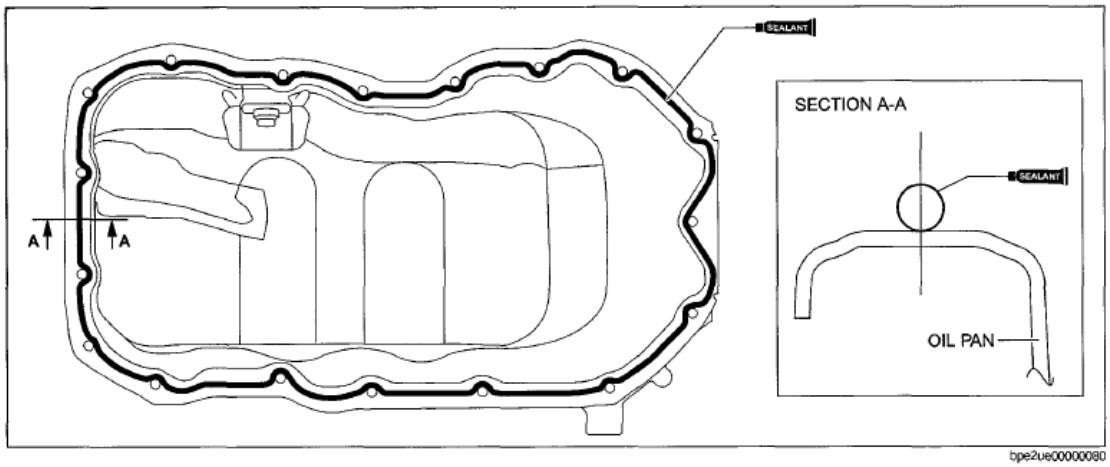

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Fig. 153: Applying Silicone Sealant To Oil Pan

Thickness 2.0-6.0 mm {0.08-0.23 in}

4. Install the oil pan to the cylinder block.
5. Tighten the bolts in the order shown in the figure.

Tightening torque 8-11 N.m {82-112 kgf.cm, 71-97 in.lbf}

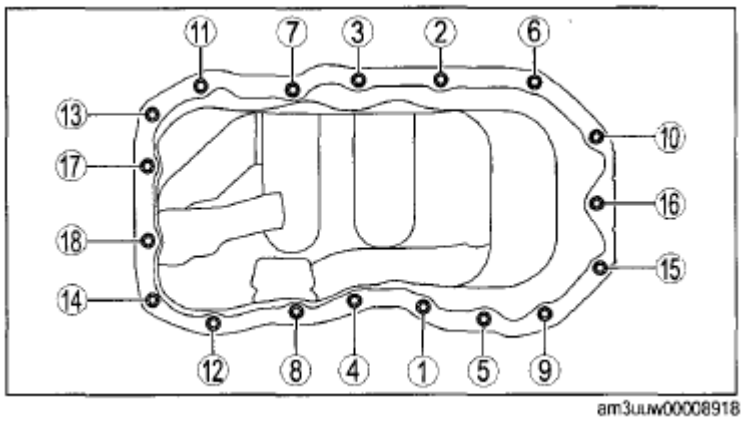


Fig. 154: Identifying Oil Pan Mounting Bolt Tightening Sequence

ELECTRIC VARIABLE VALVE TIMING MOTOR/DRIVER ASSEMBLY NOTE

1. Install a new O-ring to the O-ring installation groove of the engine front cover.

CAUTION:
- **To prevent damage to the electric variable valve timing motor/driver, do not apply e cessive force (force of 100 N {10.2 kgf, 22.5 lbf} or more) to the shaded areas shown in the figure.**

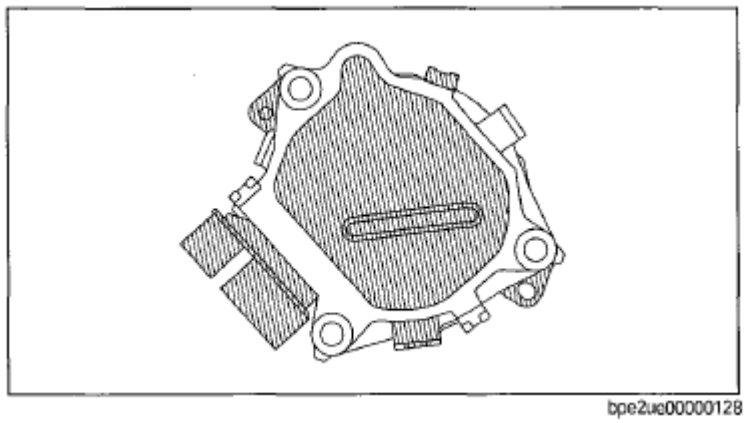


Fig. 155: Identifying Electric Variable Valve Timing Motor/Driver Force Applying Areas

2. Install the electric variable valve timing motor/driver using the following procedures.

NOTE:
- **The eccentric shaft on the electric variable valve timing actuator side can be rotated to the left and right.**
- **The electric variable valve timing motor/driver can be assembled with the joint groove of the eccentric shaft in any position, and it will not lead to vehicle damage or performance reduction.**

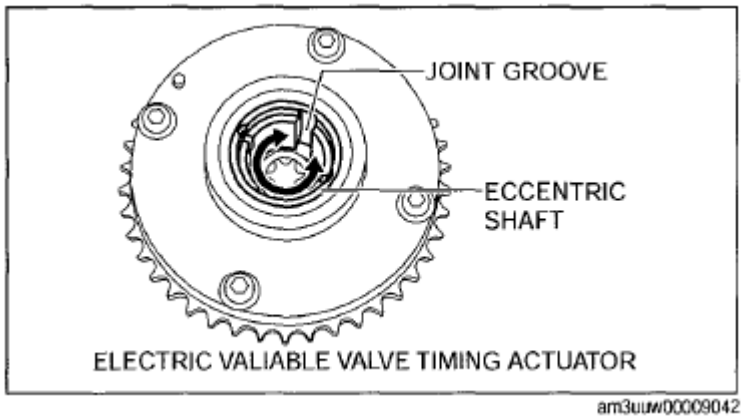


Fig. 156: Rotating Electric Variable Valve Timing Actuator Side Eccentric Shaft

1. Before installation, rotate the joint of the end of the electric variable valve timing motor so that it is aligned to the joint groove on the electric variable valve timing actuator side.
2. Engage the joint on the end of the electric variable valve timing motor with the joint groove on the electric variable valve timing actuator side.
3. Attach the seal surface.
4. Tighten the electric variable valve timing motor/driver Bolts.

Tightening torque 20-26 N.m {2.1-2.6 kgf.m, 15-19 ft.lbf}

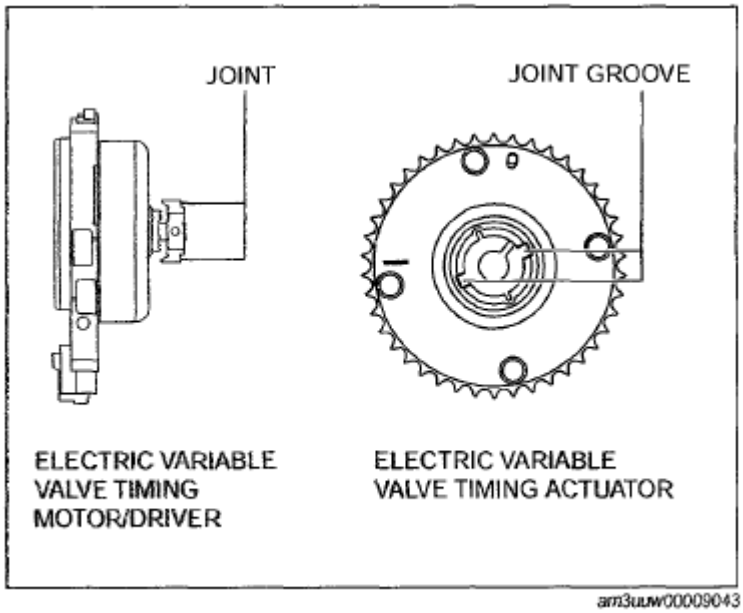


Fig. 157: Identifying Electric Variable Valve Timing Motor Joint And Electric Variable Valve Timing Actuator Side Joint Groove

FRONT OIL SEAL ASSEMBLY NOTE

1. Apply clean engine oil to the inner surface of a new front oil seal.
2. Insert the front oil seal into the engine front cover by hand.
3. Tap the oil seal in evenly using the SST and a hammer.

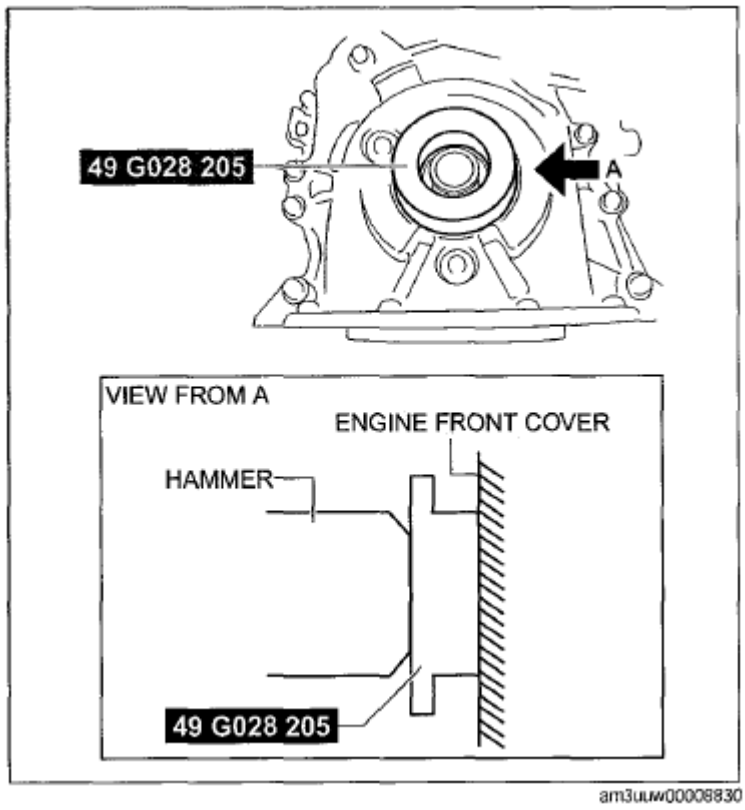


Fig. 158: Tapping Oil Seal

Front oil seal press-in amount 0-0.5 mm {0-0.019 in}

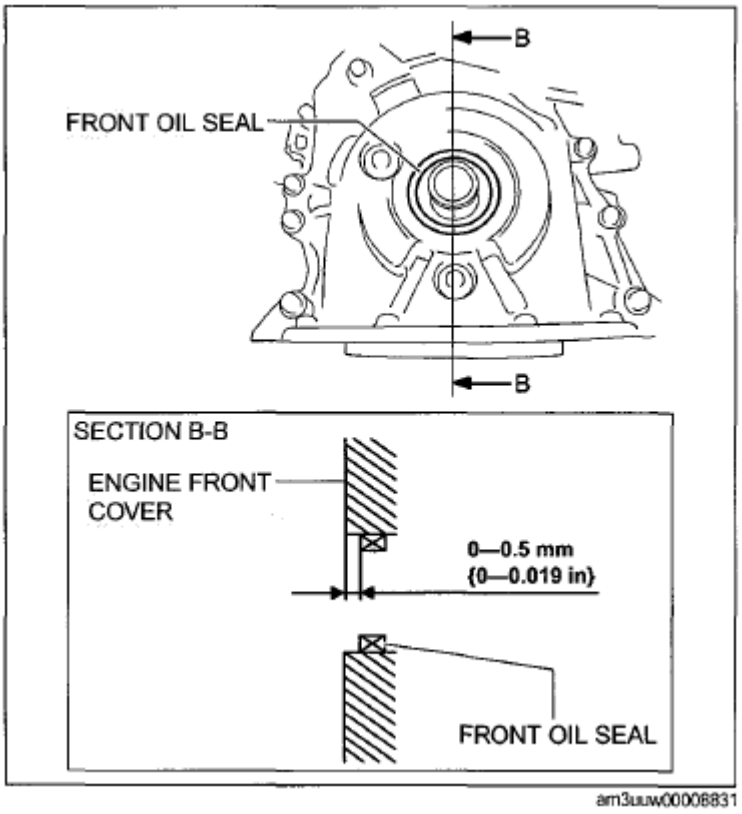


Fig. 159: Identifying Front Oil Seal Press-In Dimension

CRANKSHAFT PULLEY LOCK BOLT ASSEMBLY NOTE

1. Hold the crankshaft using the SST.
2. Tighten the crankshaft pulley lock bolt in the order shown in the following two steps.

   Tightening procedure

   Step 1 90-110 N.m {9.2-11 kgf.m, 67-81 ft.lbf}

   Step 2 55-65°

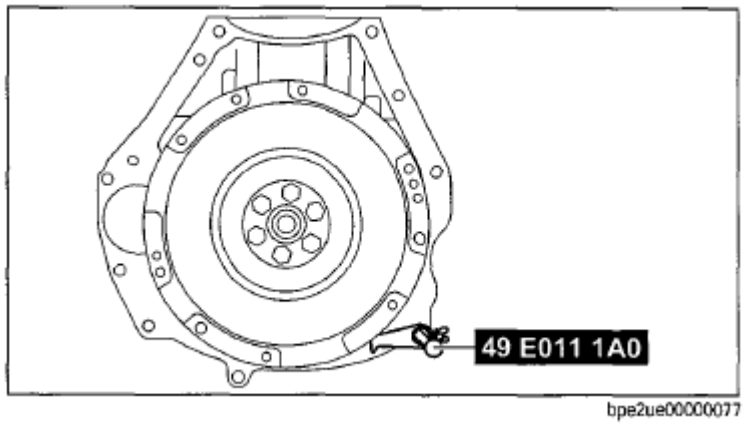


Fig. 160: Flywheel Holding Tool

WATER PUMP PULLEY ASSEMBLY NOTE

CAUTION:
- **Be careful not to damage the belt groove and surface of the water pump pulley when using tools, otherwise it will cause wear, breakage, abnormal noise of the drive belt (stretch belt), damage to the pulley, and rust.**

1. Install the water pump pulley to the water pump and temporarily tighten the bolt.
2. Align the water pump pulley hole with the water pump hole as shown in the figure.

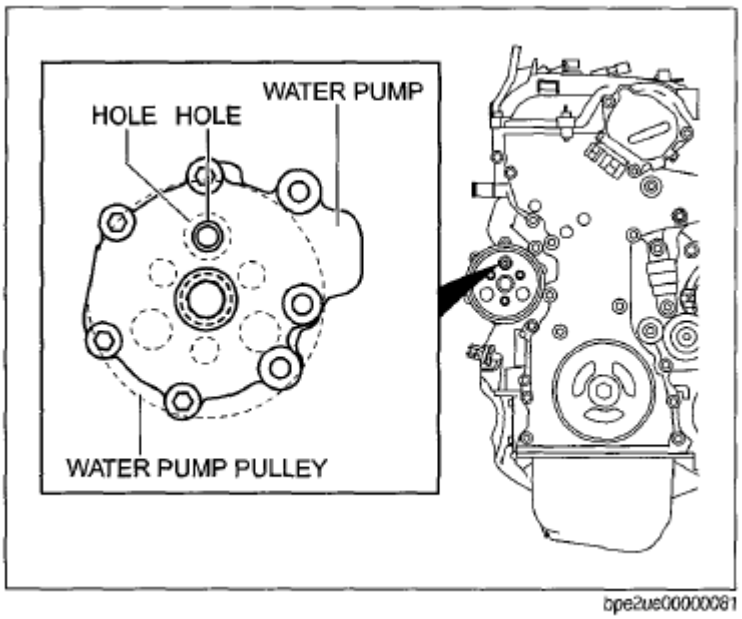


Fig. 161: Identifying Alignment Marks On Water Pump Pulley Hole With Water Pump Hole

3. Insert an appropriate bolt (length 70 mm {2.8 in}) into the water pump hole shown in the figure and lock the water pump pulley against rotation.

4. Completely tighten the water pump pulley bolt to the specified torque.

   Tightening torque 8-11 N.m {82-112 kgf.cm, 71-97 in.lbf}

5. Remove the bolt used for locking the water pump pulley against rotation.

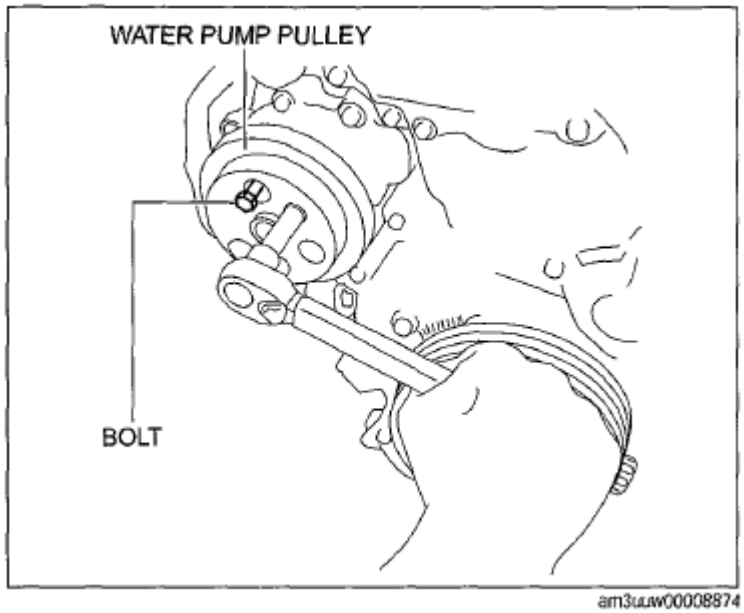


Fig. 162: Locking Water Pump Pulley To Prevent Rotation

OIL SHOWER PIPE INSTALLATION NOTE

CAUTION:

- **If the bolt is tightened with oil adhering to the bolt and the oil shower pipe connector seat shown in the figure, the a ial force of the bolt will strengthen and could cause the connector seat to deform. Before installing, remove oil from the bolt and the oil shower pipe connector seat.**

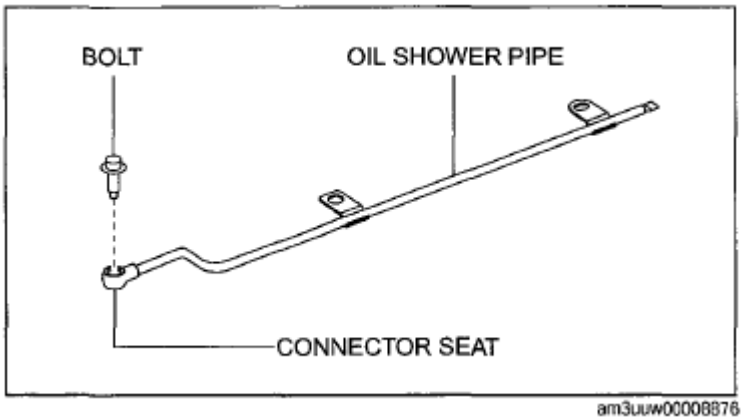


Fig. 163: Identifying Oil Shower Pipe, Connector Seat And Mounting Bolts

1. Install the oil shower pipe in the order shown in the figure.

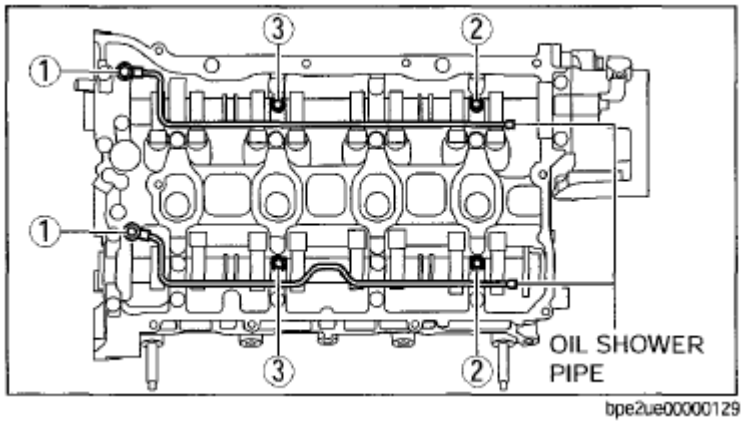


Fig. 164: Identifying Oil Shower Pipe Mounting Bolt Tightening Sequence

TIGHTENING TORQUE

Installation position	Tightening torque
1	9-12 N.m 92-122 kgf.cm, 80-106 in.lbf
2,3	8.0-9.0 N.m 82-91 kgf.cm, 71-79 in.lbf

CYLINDER HEAD COVER INSTALLATION NOTE

CAUTION:
- **To assure the sealing performance of the cylinder head cover, be careful of the following**
  - **Verify that the cylinder head cover gasket is inserted into the cylinder head cover groove and install the cylinder head cover.**
  - **Completely clean and remove any oil, dirt, sealant or other foreign material from the seal surface.**
- **To prevent silicone sealant from hardening, adhere the cylinder head cover and the cylinder head within 10 min. after silicone sealant is applied. Tighten the Bolts completely soon after adhering.**

1. Insert a new cylinder head cover gasket into the cylinder head cover groove.
2. Apply silicone sealant to the areas shown in the figure.

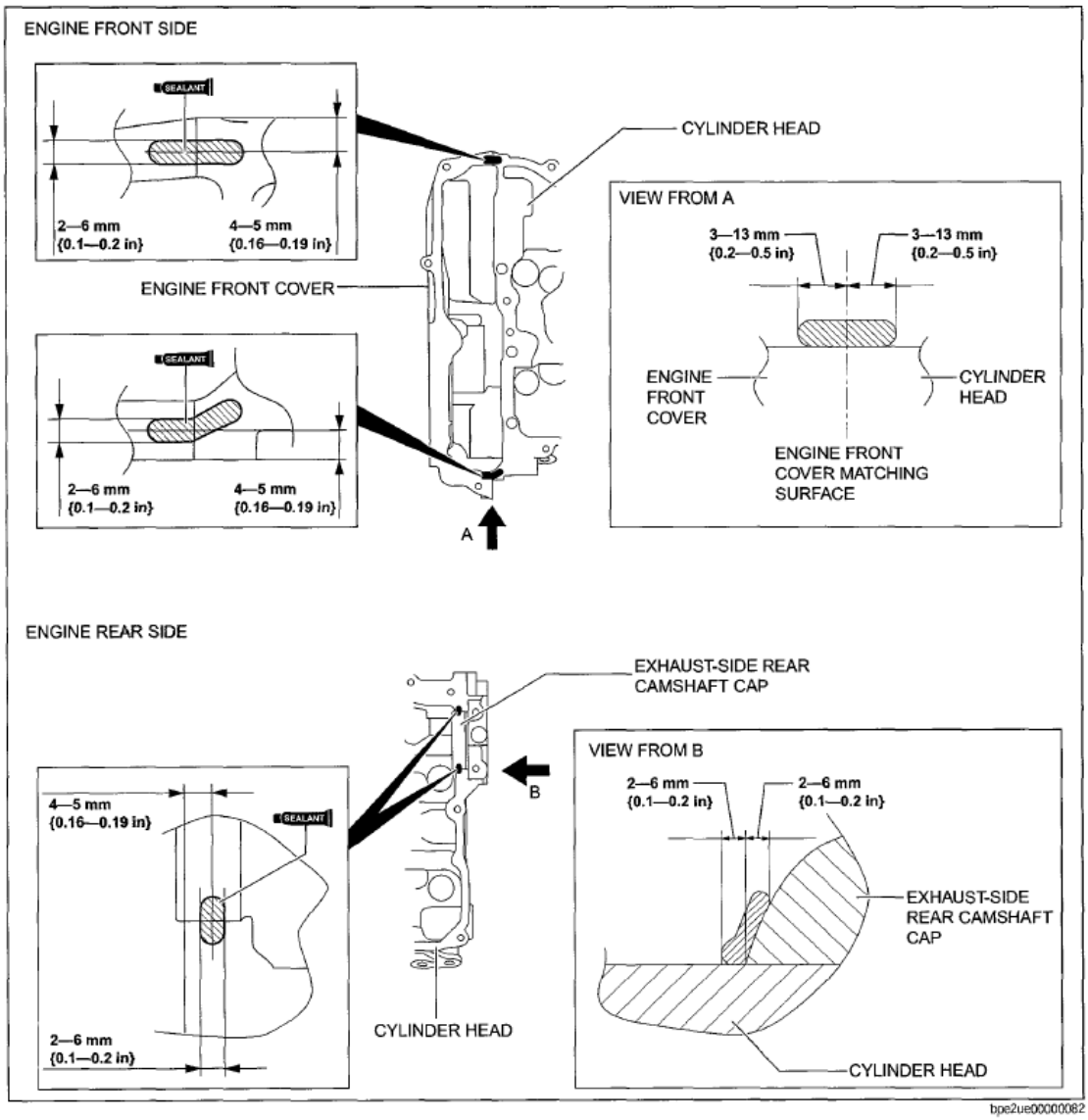


Fig. 165: Identifying Silicone Sealant Applying Areas On Cylinder Head And Exhaust Side Rear Camshaft Cap

3. Tighten the cylinder head cover bolts in the order shown in the figure.

   Tightening torque 4.5-7.0 N.m {46-71 kgf.cm, 40-61 in.lbf}

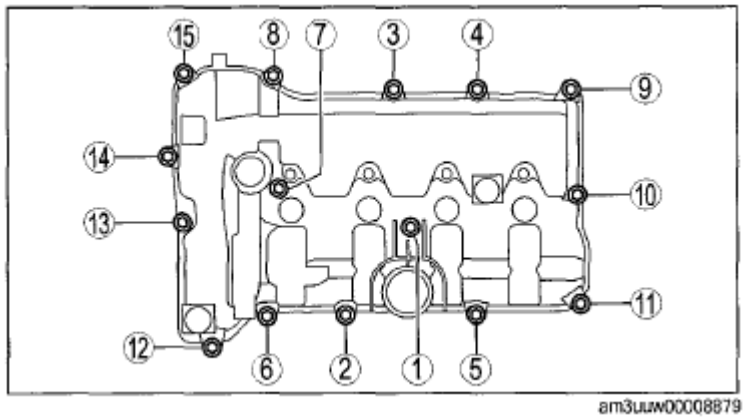


Fig. 166: Identifying Cylinder Head Cover Bolt Tightening Sequence

ENGINE TECHNICAL DATA

Item	Specification
OCV coil resistance	6.9-7.5 ohms [20 °C 68 °F]
Maximum distortion, head gasket side of the cylinder head	0.05 mm 0.002 in
Maximum distortion, manifold side	IN: 0.10 mm 0.0039 in EX: 0.05 mm 0.002 in
Maximum cutting length, manifold side	IN: Cutting not authorized EX: 0.20 mm 0.0079 in
Standard valve seat contact width	1.41 mm 0.0555 in
Valve seat angle	45
Standard valve seat sinkage amount (Dimension L)	IN: 48.73-50.27 mm 1.919-1.979 in EX: 48.73-50.27 mm 1.919-1.979 in
Standard valve head margin thickness	IN: 1.75-1.95 mm 0.0689-0.0767 in EX: 1.95-2.15 mm 0.0768-0.0846 in
Standard valve length	IN: 106.55-107.15 mm 4.1949-4.2185 in EX: 116.55-117.15 mm 4.5886-4.6122 in
Minimum valve length	IN: 106.33 mm 4.1862 in EX: 116.33 mm 4.5799 in
Standard valve stem diameter	IN: 5.470-5.485 mm 0.2154-0.2159 in EX: 5.465-5.480 mm 0.2152-0.2157 in
Minimum valve stem diameter	IN: 5.424 mm 0.2135 in EX: 5.419 mm 0.2133 in
Standard valve guide inner diameter	IN: 5.510-5.530 mm 0.2170-0.2177 in EX: 5.510-5.530 mm 0.2170-0.2177 in
Standard clearance between valve stem and guide	IN: 0.025-0.060 mm 0.0010-0.0023 in EX: 0.030-0.065 mm 0.0012-0.0025 in
Maximum clearance between valve stem and guide	0.10 mm 0.0039 in

Standard valve guide projection height	IN: 16.4-17.0 mm 0.646-0.669 in EX: 16.4-17.0 mm 0.646-0.669 in
Valve spring installation height	IN: When pressurized with spring force of 190-210 N 19.4-21.4 kgf, 42.8-47.2 lbf, spring height is 38.0 mm 1.50 in EX: When pressurized with spring force of 228-252 N 23.3-25.6 kgf, 51.3-56.6 lbf, spring height is 38.0 mm 1.50 in
Maximum valve spring off-square	IN: 2.0 (1.6 mm 0.063 in) EX: 2.0 (1.7 mm 0.067 in)
Maximum camshaft runout	0.030 mm 0.0012 in
Standard cam height	IN: 41.57 mm 1.637 in EX: 40.37 mm 1.589 in
Minimum cam height	IN: 41.50 mm 1.634 in EX: 40.30 mm 1.587 in
Standard camshaft journal diameter	24.96-24.98 mm 0.9827-0.9834 in
Minimum camshaft journal diameter	24.93 mm 0.9815 in
Standard camshaft journal oil clearance	0.035-0.080 mm 0.0014-0.0031 in
Maximum camshaft journal oil clearance	0.090 mm 0.0035 in
Standard camshaft end play	0.07-0.22 mm 0.003-0.008 in
Maximum camshaft end play	0.23 mm 0.0091 in
Maximum distortion, head gasket side of the cylinder block	0.10 mm 0.0039 in
Standard cylinder bore diameter	83.50-83.53 mm 3.2875-3.2885 in
Air pressure	180-220 kPa 1.84-2.24 kgf/cm^2 , 26.2-31.9 psi
Standard piston outer diameter	83.465-83.495 mm 3.2861-3.2872 in
Standard clearance between piston and cylinder	0.025-0.045 mm 0.0010-0.0017 in
Maximum clearance between piston and cylinder	0.063 mm 0.0025 in
Standard clearance between piston ring and ring groove	Top: 0.04-0.08 mm 0.002-0.003 in Second: 0.03-0.07 mm 0.0012-0.0027 in Oil: 0.04-0.12 mm 0.002-0.004 in
Maximum clearance between piston ring and ring groove	Top: 0.12 mm 0.0047 in Second: 0.10 mm 0.0039 in Oil: 0.17 mm 0.0067 in
Standard piston ring end gap	Top: 0.13-0.18 mm 0.0052-0.0070 in Second: 0.18-0.28 mm 0.008-0.011 in Oil: 0.10-0.35 mm 0.004-0.013 in
Maximum piston ring end gap	Top: 0.35 mm 0.014 in Second: 0.45 mm 0.018 in Oil: 0.52 mm 0.020 in
Standard piston pin outer diameter	20.995-21.000 mm 0.82658-0.82677 in
Standard piston pin hole diameter	21.004-21.008 mm 0.82693-0.82708 in
Standard clearance between piston pin hole	

diameter and piston pin outer diameter	0.004-0.013 mm 0.0002-0.0005 in
Standard connecting rod small end inner diameter	21.006-21.017 mm 0.82701-0.82744 in
Standard clearance between connecting rod small end inner diameter and piston pin outer diameter	0.006-0.022 mm 0.0003-0.0008 in
Maximum connecting rod bending	0.050 mm 0.0020 in
Maximum connecting rod distortion	0.050 mm 0.0020 in
Connecting rod center-to-center distance	155.2 mm 6.110 in
Standard side clearance at the large end of connecting rod	0.14-0.36 mm 0.006-0.014 in
Maximum side clearance at the large end of connecting rod	0.465 mm 0.0183 in
Standard bearing oil clearance at the large end of the connecting rod	0.026-0.052 mm 0.0011-0.0020 in
Maximum bearing oil clearance at the large end of the connecting rod	0.10 mm 0.0039 in
Connecting rod bearing size	STD: 1.503-1.520 mm 0.05918-0.05984 in OS 0.25:1.628-1.631 mm 0.06410-0.06421 in OS 0.50:1.753-1.756 mm 0.06902-0.06913 in
Standard crankshaft end play	0.08-0.29 mm 0.004-0.011 in
Maximum crankshaft end play	0.30 mm 0.012 in
Thrust bearing size	STD: 2.500-2.550 mm 0.0985-0.1003 in OS 0.25: 2.625-2.675 mm 0.1034-0.1053 in
Maximum main journal runout	0.10 mm 0.0039 in
Standard main journal diameter	46.980-47.000 mm 1.8497-1.8503 in
Maximum main journal off-round	0.005 mm 0.0002 in
Standard crank pin diameter	46.980-47.000 mm 1.8497-1.8503 in
Maximum crank pin off-round	0.005 mm 0.0002 in
Standard main journal oil clearance	0.016-0.039 mm 0.0007-0.0015 in
Maximum main journal oil clearance	0.084 mm 0.0033 in
Main bearing size	STD: 2.489-2.510 mm 0.0980-0.0988 in OS 0.25: 2.614-2.617 mm 0.10292-0.10303 in OS 0.50: 2.739-2.742 mm 0.10784-0.10795 in
Flywheel maximum runout	0.10 mm 0.0039 in
Standard cylinder head bolt length	145.2-145.8 mm 5.717-5.740 in
Maximum cylinder head bolt length	146.5 mm 5.768 in
Standard connecting rod bolt length	43.7-44.3 mm 1.73-1.74 in
Maximum connecting rod bolt length	45.0 mm 1.77 in
Rear oil seal press-in amount	0-0.5 mm 0-0.019 in
Front oil seal press-in amount	0-0.5 mm 0-0.019 in

ENGINE SST

1: Mazda SST number

2: Global SST number

E ample

1:49 E0111A0

2:

Ring gear brake

set

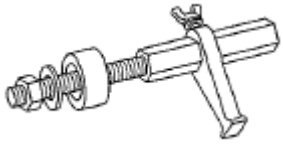
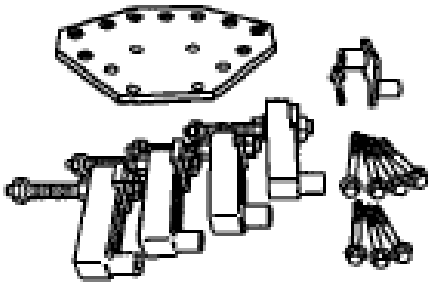
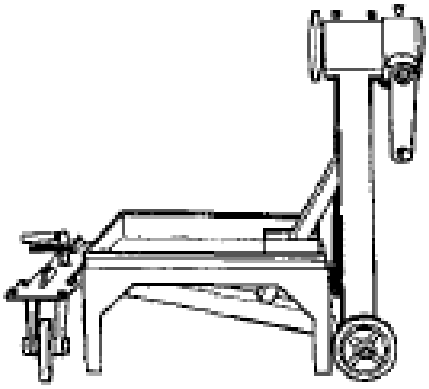
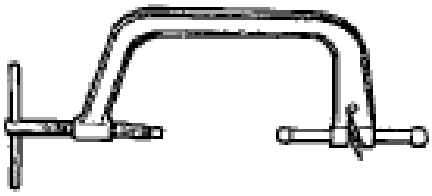
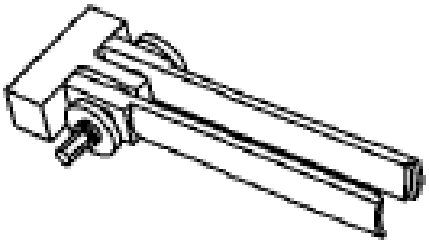
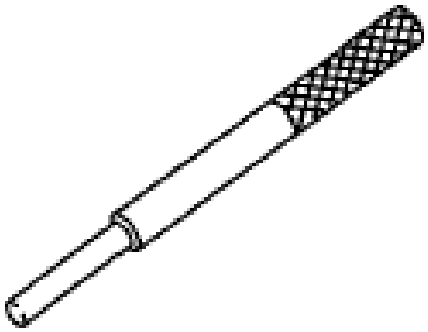
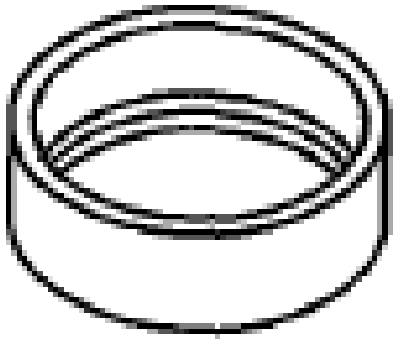
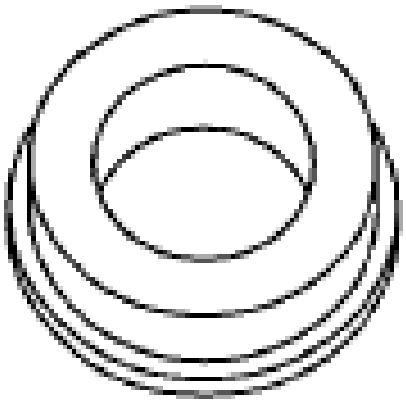


Fig. 167: Engine SST Chart

1:49L0101A0 2: Engine hanger  set	1:49 0107 680A 2: Engine  stand	1:49 E011 1A0 2: Ring gear brake  set
1:49 0636 100B 2: Valve spring lifter  arm	1:49B012 0A2A 2:  Pivot	1:49 S120 170 2: Valve seal  remover

1:49B012 015 2: Valve guide  installer	1:49 E033 101 2: Dust cover  installer	1:49B012 016 2:  Attachment
1:49 G028 205 2: Oil seal  installer	1:49 1285 071 2: Bearing  puller	

