ENGINE SECTION 1

This service manual has been prepared to provide SUBARU service personnel with the necessary information and data for the correct maintenance and repair of SUBARU vehicles.
This manual includes the procedures for maintenance, disassembling, reassembling, inspection and adjustment of components and diagnostics for guidance of experienced mechanics.
Please peruse and utilize this manual fully to ensure complete repair work for satisfying our customers by keeping their vehicle in optimum condition. When replacement of parts during repair work is needed, be sure to use SUBARU genuine parts.

All information, illustration and specifications contained in this manual are based on the latest product information available at the time of publication approval.

ENGINE SECTION 1

MECHANICAL

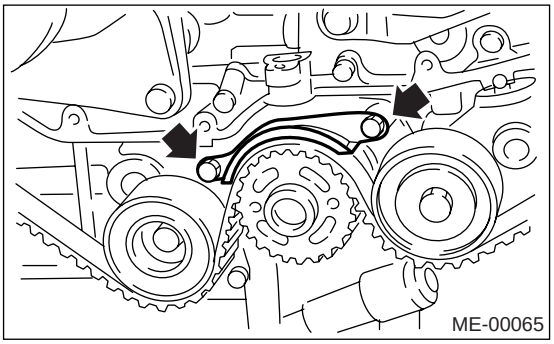
ME(H4SO 2.0)

15.Timing Belt

A: REMOVAL

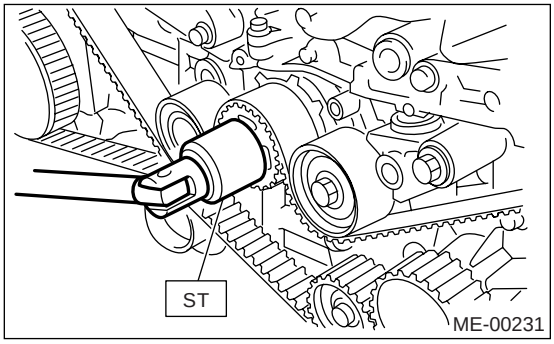
1. TIMING BELT

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt guide. (MT model)

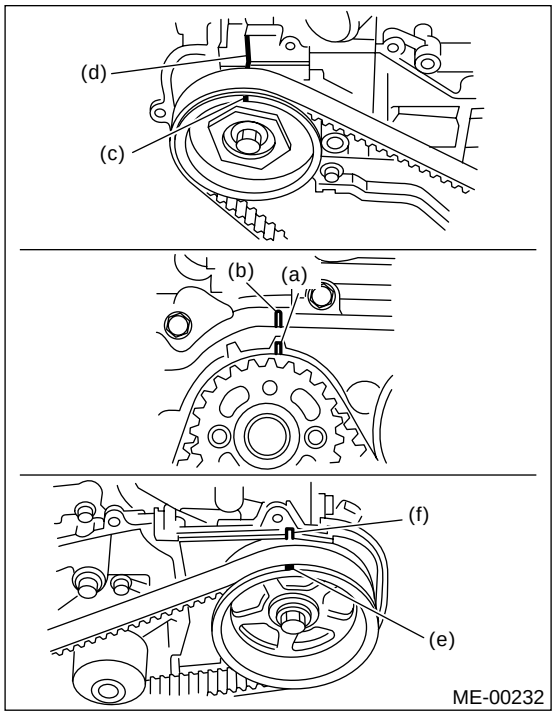

ME-00065

5) If the alignment mark (a) or arrow mark (which indicates rotation direction) on timing belt fade away, put new marks before removing the timing belt as shown in procedures below.
   (1) To turn crankshaft, use the ST: Align the mark (a) of sprocket to the cylinder block notch (b), and then ensure the right side cam sprocket mark (c), cam cap and cylinder head matching surface (d) or left side cam sprocket mark (e), timing belt cover notch (f) are properly adjusted.

ST 499987500 CRANKSHAFT SOCKET

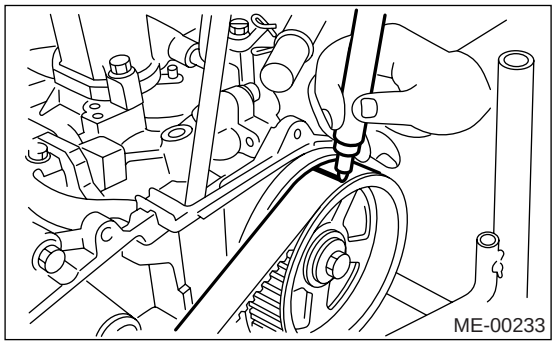


ME-00231

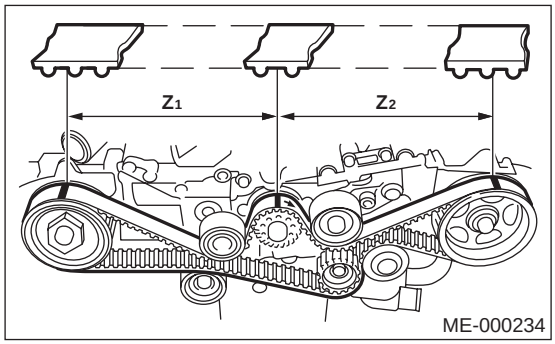


ME-00232

(2) Using white paint, put alignment marks or arrow marks on the timing belts in relation to the crank sprocket and cam sprockets.


ME-00233

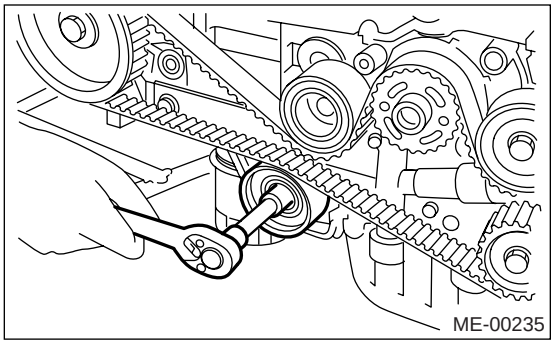
Specified data:
Z_1: Length of 46.8 teeth
Z_2: Length of 43.7 teeth



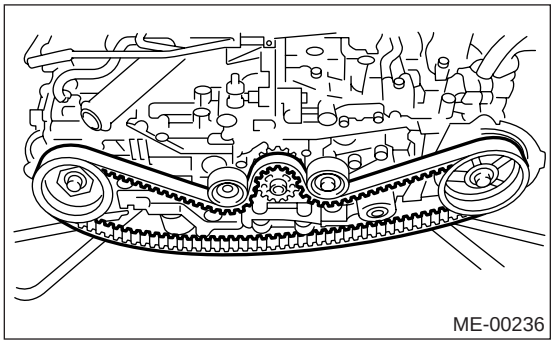
ME-000234

6) Remove the belt idler (No. 2).

7) Remove the belt idler No. 2.

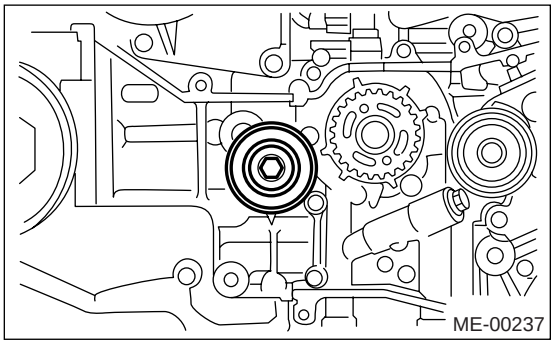


8) Remove the timing belt.

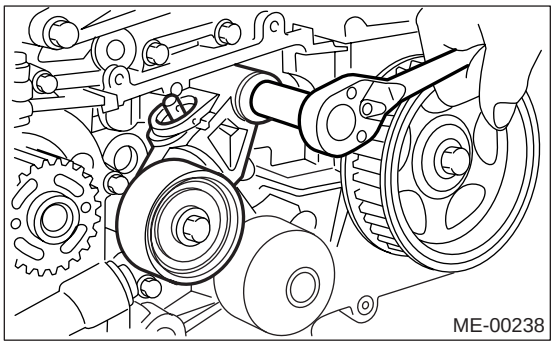


2. BELT IDLER AND AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY

1) Remove the belt idler (No. 1).



2) Remove the automatic belt tension adjuster assembly.



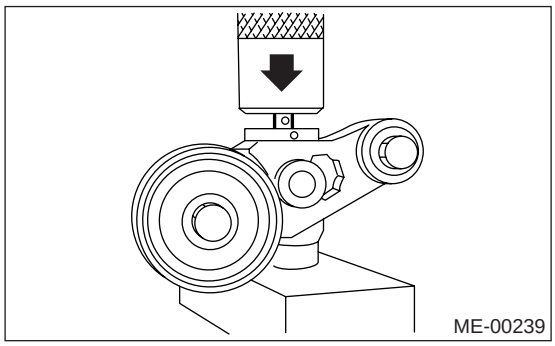
B: INSTALLATION

1. AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER

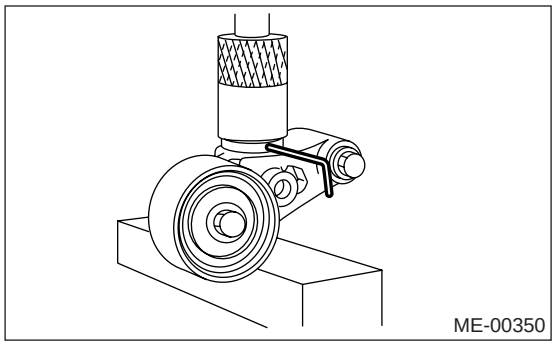
1) Preparation for installation of automatic belt tension adjuster assembly.

CAUTION:
• Always use a vertical type pressing tool to move the adjuster rod down.
• Do not use a lateral type vise.
• Push the adjuster rod vertically.
• Press-in the push adjuster rod gradually taking more than three minutes.
• Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
• Press the adjuster rod as far as the end surface of the cylinder. Do not press the adjuster rod into cylinder. Doing so may damage the cylinder.
• Do not release the press pressure until stopper pin is completely inserted.

(1) Attach the automatic belt tension adjuster assembly to the vertical pressing tool.
(2) Slowly move the adjuster rod down with a pressure of 294 N (30 kgf, 66 lb) until the adjuster rod is aligned with the stopper pin hole in the cylinder.

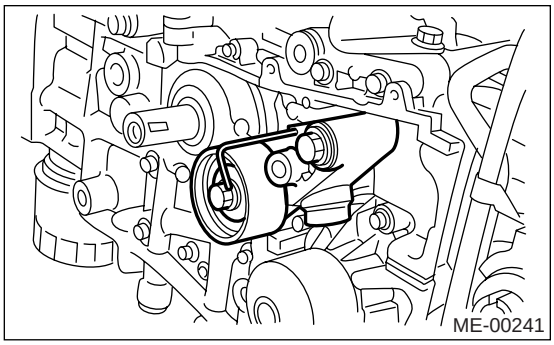


(3) With a 2 mm (0.08 in) dia. stopper pin or a 2 mm (0.08 in) (nominal) dia. hex wrench inserted into the stopper pin hole in cylinder, secure the adjuster rod.



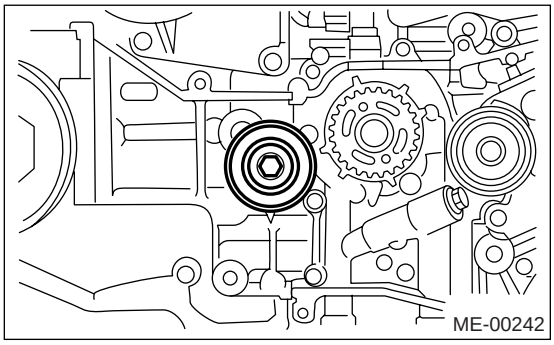
2) Install the automatic belt tension adjuster assembly.

Tightening torque:
39 N·m (4.0 kgf-m, 28.9 ft-lb)



3) Install the belt idler (No. 1).

Tightening torque:
39 N·m (4.0 kgf-m, 28.9 ft-lb)



2. TIMING BELT

1) Prepare for installation of automatic belt tension adjuster assembly. <Ref. to ME(H4SO 2.0)-44, AUTOMATIC BELT TENSION ADJUSTER ASSEMBLY AND BELT IDLER, INSTALLATION, Timing Belt.>

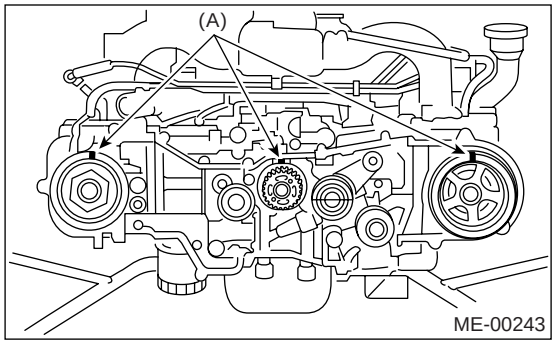
2) Installation of timing belt:

(1) Turn the cam sprocket No. 2 using ST1, and turn the cam sprocket No. 1 using ST2 so that their alignment marks (A) come to top positions.

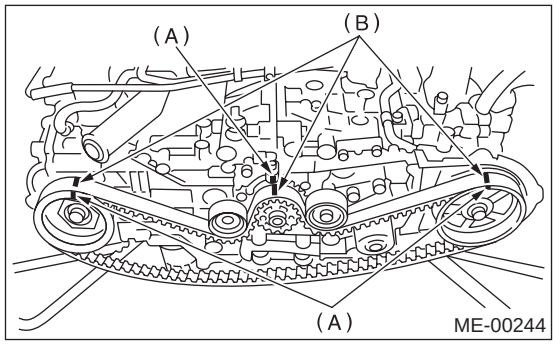
ST1 18231AA010 CAM SPROCKET WRENCH

NOTE:
CAM SPROCKET WRENCH (499207100) can also be used.

ST2 499207400 CAM SPROCKET WRENCH



(2) While aligning the alignment mark (B) on timing belt with the mark (A) on sprockets, position the timing belt properly.

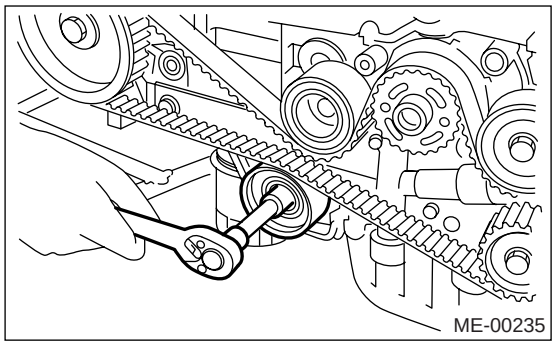


3) Install the belt idler No. 2.

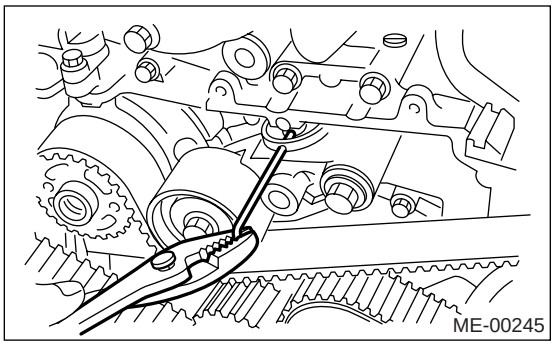
Tightening torque:
39 N·m (4.0 kgf-m, 28.9 ft-lb)

4) Install the belt idler (No. 2).

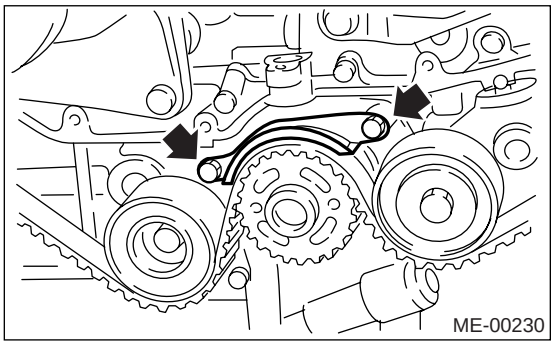
Tightening torque:
39 N·m (4.0 kgf-m, 28.9 ft-lb)



5) After ensuring the marks on timing belt and cam sprockets are aligned, remove the stopper pin from belt tension adjuster.

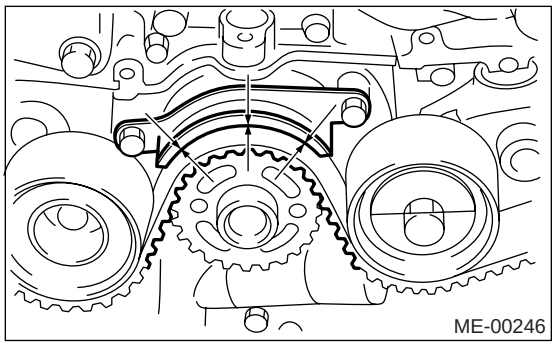


6) Install the timing belt guide. (MT model)
(1) Temporarily tighten the timing belt guide mounting bolts.



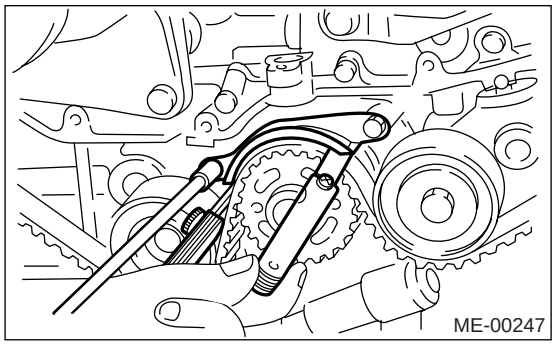
(2) Check and adjust the clearance between timing belt and timing belt guide by using thickness gauge.

Clearance:
1.0±0.5 mm (0.039±0.020 in)



(3) Tighten the timing belt guide mounting bolts.

Tightening torque:
10 N·m (1.0 kgf-m, 7.2 ft-lb)



7) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
8) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
9) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

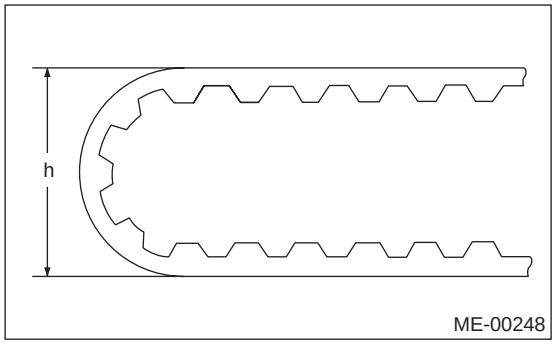
C: INSPECTION

1. TIMING BELT

1) Check the timing belt teeth for breaks, cracks and wear. If any fault is found, replace the belt.
2) Check the condition of the backside of belt. If cracks are found, replace the belt.

CAUTION:
• Be careful not to let oil, grease or coolant contact the belt. Remove quickly and thoroughly if this happens.
• Do not bend the timing belt sharply.

In radial diameter h:
60 mm (2.36 in) or more



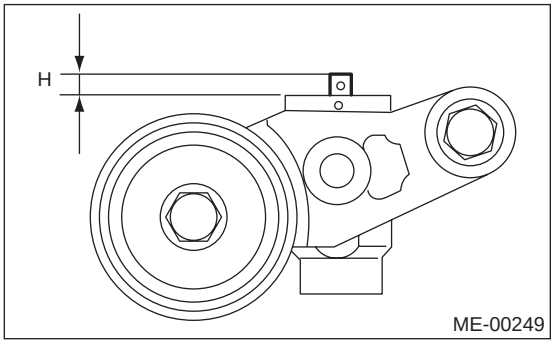
2. AUTOMATIC BELT TENSION ADJUSTER

1) Visually check the oil seals for leaks, and rod ends for abnormal wear or scratches. If necessary, replace the faulty parts.
2) Check that the adjuster rod does not move when a pressure of 294 N (30 kgf, 66 lb) is applied to it. This is to check adjuster rod stiffness.
3) If the adjuster rod is not stiff and moves freely when applying 294 N (30 kgf, 66 lb), check it using the following procedures:
   (1) Slowly press the adjuster rod down to the end surface of the cylinder. Repeat this operation two to three times.
   (2) With the adjuster rod moved all the way up, apply a pressure of 294 N (30 kgf, 66 lb) to it. Check the adjuster rod stiffness.
   (3) If the adjuster rod is not stiff and moves down, replace the automatic belt tension adjuster assembly with a new one.

CAUTION:
• Always use a vertical type pressing tool to move the adjuster rod down.
• Do not use a lateral type vise.
• Push the adjuster rod vertically.
• Press the adjuster rod gradually taking more than three minutes.
• Do not allow press pressure to exceed 9,807 N (1,000 kgf, 2,205 lb).
• Press the adjuster rod as far as the end surface of cylinder. Do not press the adjuster rod into cylinder. Doing so may damage the cylinder.

4) Measure the amount of rod protrusion beyond the body. If it is not within specifications, replace with a new one.

Amount of rod protrusion H:
5.7±0.5 mm (0.224±0.020 in)



3. BELT TENSION PULLEY

1) Check the mating surfaces of timing belt and contact point of adjuster rod for abnormal wear or scratches. Replace the automatic belt tension adjuster assembly if faulty.
2) Check the belt tension pulley for smooth rotation. Replace if noise or excessive play occurs.
3) Check the belt tension pulley for grease leakage.

4. BELT IDLER

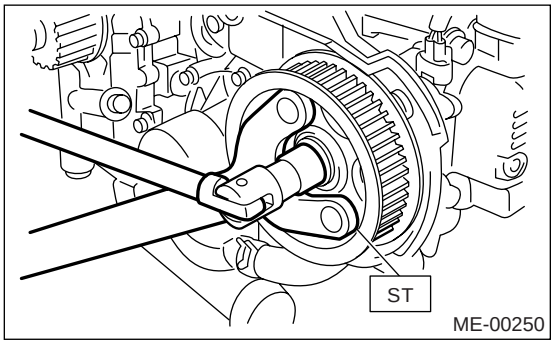
1) Check the belt idler for smooth rotation. Replace if noise or excessive play occurs.
2) Check the outer contacting surfaces of idler pulley for abnormal wear and scratches.
3) Check the belt idler for grease leakage.

16.Cam Sprocket

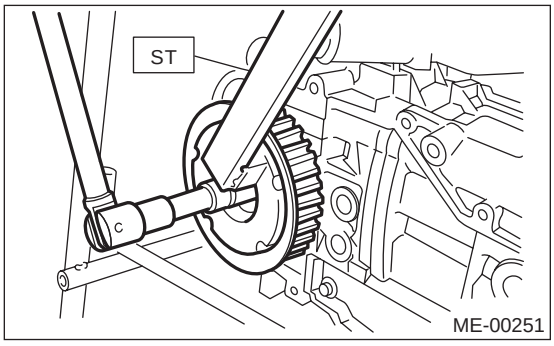
A: REMOVAL

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
5) Remove the camshaft position sensor. <Ref. to FU(H4SO 2.0)-22, REMOVAL, Camshaft Position Sensor.>
6) Remove the cam sprocket No. 2. To lock the camshaft, use ST.
ST 18231AA010 CAM SPROCKET WRENCH

NOTE:
CAM SPROCKET WRENCH (499207100) can also be used.



7) Remove the cam sprocket No. 1. To lock the camshaft, use ST.
ST 499207400 CAM SPROCKET WRENCH

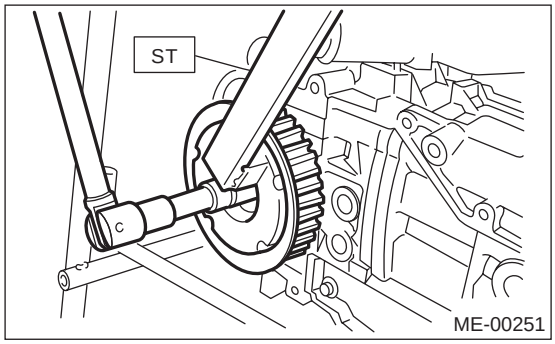


B: INSTALLATION

1) Install the cam sprocket No. 1. To lock the camshaft, use ST.
ST 499207400 CAM SPROCKET WRENCH

Tightening torque:
78 N·m (8.0 kgf-m, 57.9 ft-lb)

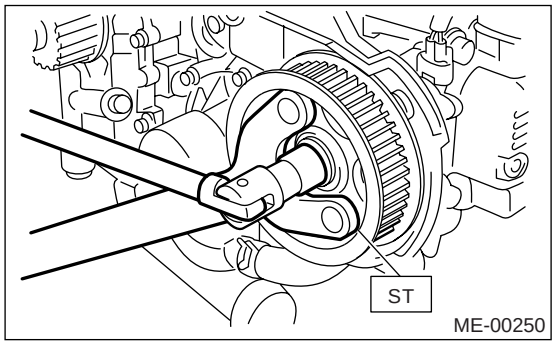
NOTE:
Do not confuse left and right side cam sprockets during installation. Cam sprocket No. 2 is identified by a protrusion used to monitor the camshaft position sensor.



2) Install the cam sprocket No. 2. To lock the camshaft, use ST.
ST 18231AA010 CAM SPROCKET WRENCH

NOTE:
CAM SPROCKET WRENCH (499207100) can also be used.

Tightening torque:
78 N·m (8.0 kgf-m, 57.9 ft-lb)



3) Install the camshaft position sensor. <Ref. to FU(H4SO 2.0)-22, INSTALLATION, Camshaft Position Sensor.>
4) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
5) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
6) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
7) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

C: INSPECTION

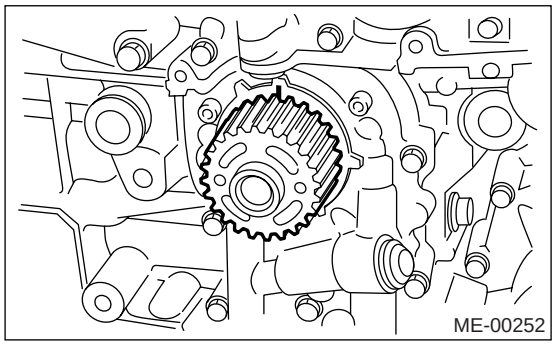
1) Check the cam sprocket teeth for abnormal wear and scratches.
2) Make sure there is no free play between cam sprocket and key.

3) Check the cam sprocket protrusion used for sensor for damage and contamination of foreign matter.

17.Crank Sprocket

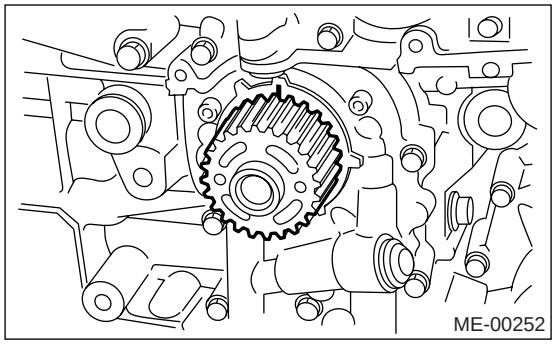
A: REMOVAL

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
5) Remove the cam sprocket. <Ref. to ME(H4SO 2.0)-48, REMOVAL, Cam Sprocket.>
6) Remove the crank sprocket.



B: INSTALLATION

1) Install the crank sprocket.



2) Install the cam sprocket. <Ref. to ME(H4SO 2.0)-48, INSTALLATION, Cam Sprocket.>
3) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
4) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
5) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
6) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

C: INSPECTION

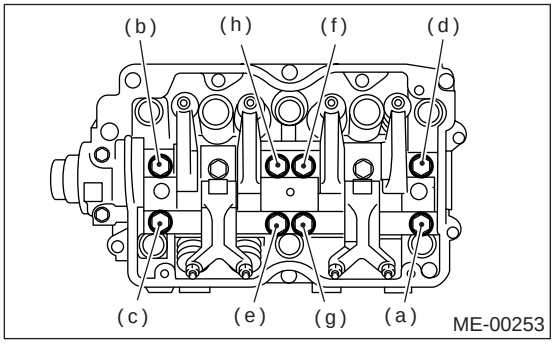
1) Check the crank sprocket teeth for abnormal wear and scratches.
2) Make sure there is no free play between crank sprocket and key.
3) Check the crank sprocket protrusion used for sensor for damage and contamination of foreign matter.

18.Valve Rocker Assembly

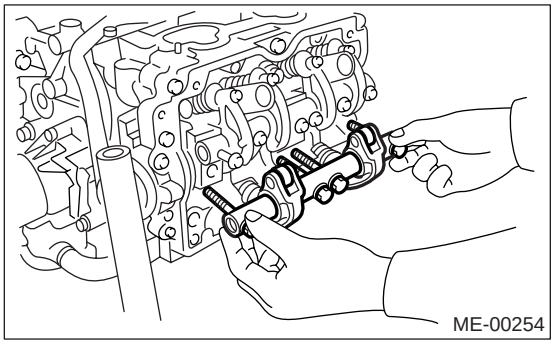
A: REMOVAL

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
5) Remove the cam sprocket. <Ref. to ME(H4SO 2.0)-48, REMOVAL, Cam Sprocket.>
6) Disconnect the PCV hose and remove the rocker cover.
7) Removal of valve rocker assembly
   (1) Remove the bolts (a) through (h) in alphabetical sequence.

NOTE:
Leave two or three threads of bolts (g) and (h) engaged in order to retain the valve rocker assembly.



   (2) Remove the valve rocker assembly.



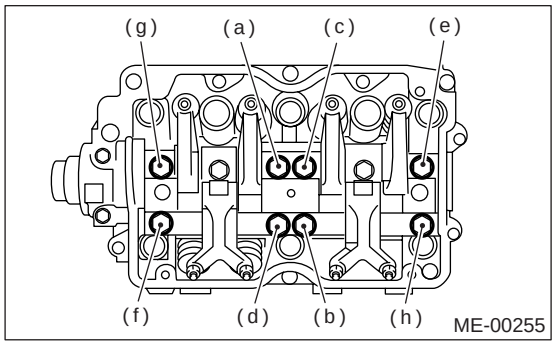
B: INSTALLATION

1) Install the valve rocker assembly.
   (1) Temporarily tighten the bolts (a) through (d) equally in order as shown in the figure.

NOTE:
Do not allow the valve rocker assembly to damage knock pins.

   (2) Tighten the bolts (e) through (h) to specified torque.
   (3) Tighten the bolts (a) through (d) to specified torque.

Tightening torque:
25 N·m (2.5 kgf-m, 18.1 ft-lb)



2) Adjust the valve clearance. <Ref. to ME(H4SO 2.0)-29, ADJUSTMENT, Valve Clearance.>
3) Install the rocker cover and connect PCV hose.
4) Install the cam sprocket. <Ref. to ME(H4SO 2.0)-48, INSTALLATION, Cam Sprocket.>
5) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
6) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
7) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
8) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

C: DISASSEMBLY

1) Remove the bolts which secure the rocker shaft.
2) Extract the rocker shaft. Remove the valve rocker arms, springs and shaft supports from rocker shaft.

NOTE:
Keep all the removed parts in order for re-installing in their original positions.

3) Remove the nut and adjusting screw from valve rocker.

D: ASSEMBLY

1) Install the adjusting screw and nut to valve rocker.
2) Arrange the valve rocker arms, springs and shaft supports in assembly order, and then insert the valve rocker shaft.

Tightening torque (Shaft supports installing bolts):
5 N·m (0.5 kgf-m, 3.6 ft-lb)

NOTE:
Valve rocker arms, rocker shaft and shaft supports have identification marks. Ensure the parts with same markings are properly assembled.

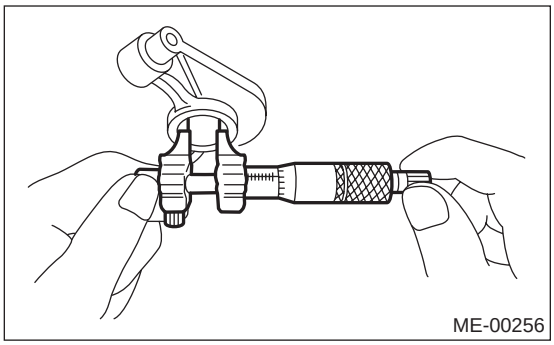
3) Install the valve rocker shaft securing bolts.

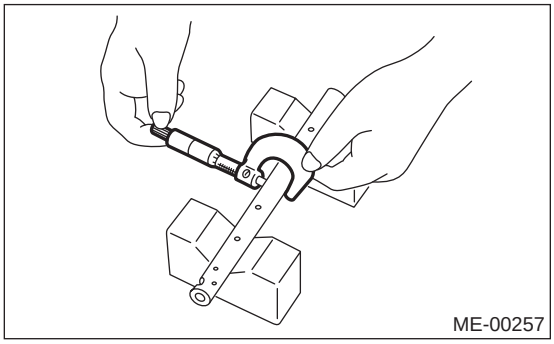
E: INSPECTION

1. VALVE ROCKER ARM AND ROCKER SHAFT

1) Measure the inner diameter of valve rocker arm and outer diameter of valve rocker shaft, and determine the difference (oil clearance) between the two values.

Clearance between arm and shaft:
Standard:
0.020 — 0.054 mm (0.0008 — 0.0021 in)


ME-00256


ME-00257

2) If the oil clearance exceeds the standard value, replace the valve rocker arm or shaft, whichever shows greater amount of wear.

Rocker arm inside diameter:
22.020 — 22.041 mm (0.8669 — 0.8678 in)

Rocker shaft diameter:
21.987 — 22.000 mm (0.8656 — 0.8661 in)

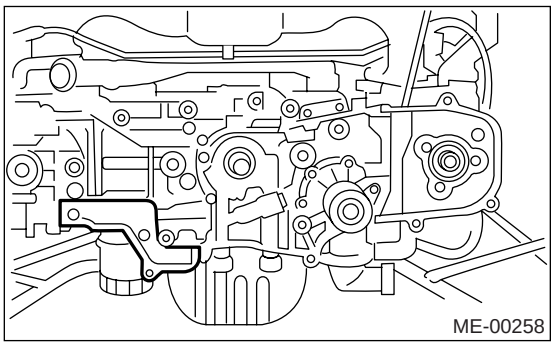
3) If the cam or valve contact surface of valve rocker arm is worn or dented excessively, replace the valve rocker arm.
4) Check that the valve rocker arm roller rotates smoothly. If not, replace the valve rocker arm.

19.Camshaft

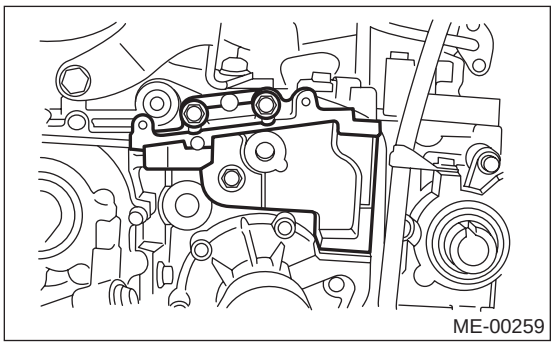
A: REMOVAL

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
5) Remove the cam sprocket. <Ref. to ME(H4SO 2.0)-48, REMOVAL, Cam Sprocket.>
6) Remove the crank sprocket. <Ref. to ME(H4SO 2.0)-50, REMOVAL, Crank Sprocket.>
7) Remove the timing belt cover No. 2 (LH).
8) Remove the timing belt cover No. 2 (RH).

NOTE:
Do not damage or lose the seal rubber when removing the timing belt covers.

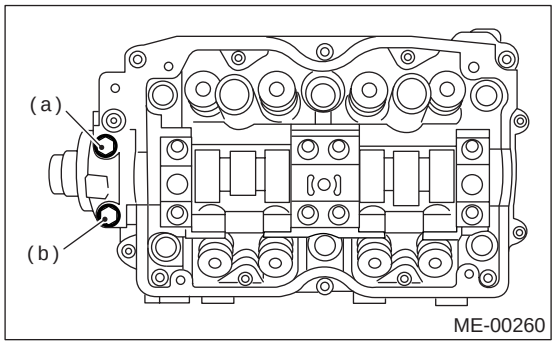

ME-00258

9) Remove the tensioner bracket.


ME-00259

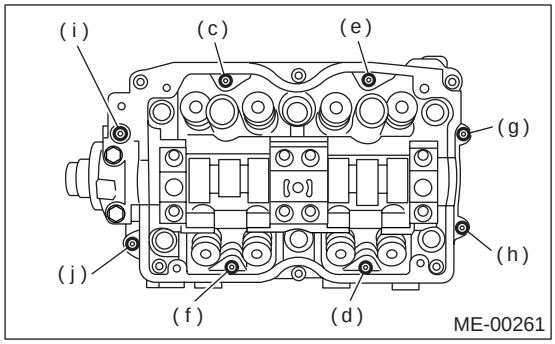
10) Remove the camshaft position sensor support. (LH side only)
11) Remove the oil level gauge guide. (LH side only)
12) Remove the valve rocker assembly. <Ref. to ME(H4SO 2.0)-51, REMOVAL, Valve Rocker Assembly.>
13) Remove the camshaft cap.

(1) Remove the bolts (a) and (b) in alphabetical sequence.



ME-00260

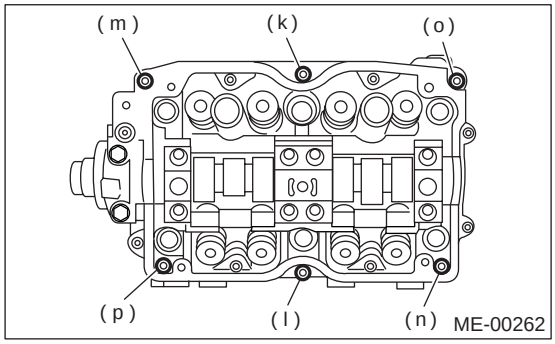
(2) Equally loosen the bolts (c) through (j) all the way in alphabetical sequence.



ME-00261

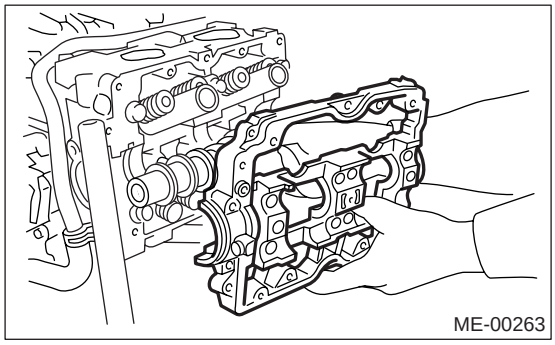
(3) Remove the bolts (k) through (p) in alphabetical sequence using ST.

ST 499497000 TORX® PLUS



ME-00262

(4) Remove the camshaft cap.


ME-00263

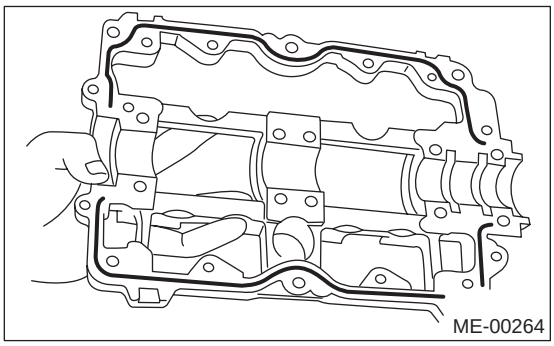
14) Remove the camshaft.
15) Remove the oil seal.
16) Remove the plug from the rear side of camshaft.

CAUTION:
• Do not remove the oil seal unless necessary.
• Do not scratch the journal surface when removing the oil seal.

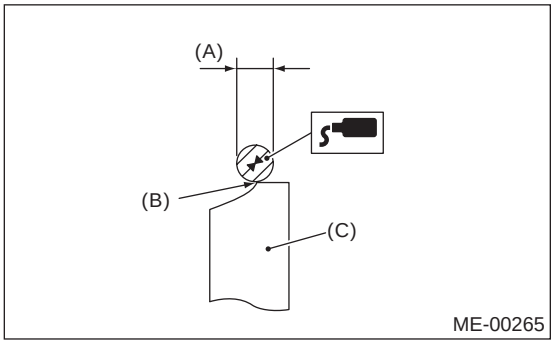
B: INSTALLATION

1) Apply a coat of engine oil to camshaft journals and install the camshaft.
2) Install the camshaft cap.
(1) Apply liquid gasket to the mating surfaces of camshaft cap.

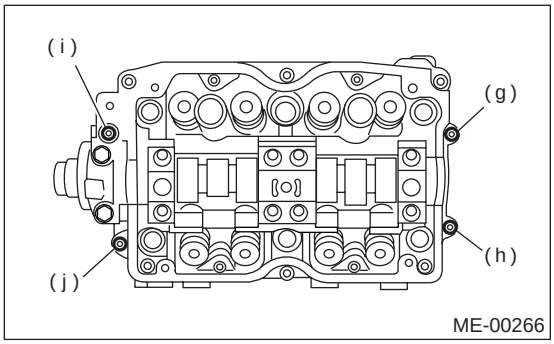
Liquid gasket:
THREE BOND 1280B (Part No. K0877YA018)



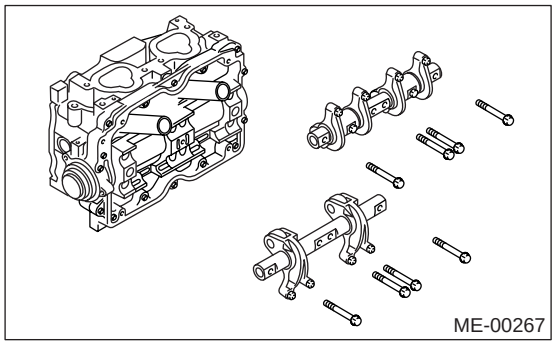
NOTE:
• Apply a coat of liquid gasket of 3 mm (0.12 in) in diameter (A) along the edge (B) of camshaft cap (C) mating surface.
• Assemble them within 20 min. after applying liquid gasket.



(2) Temporarily tighten the bolts (g) through (j) in alphabetical sequence.

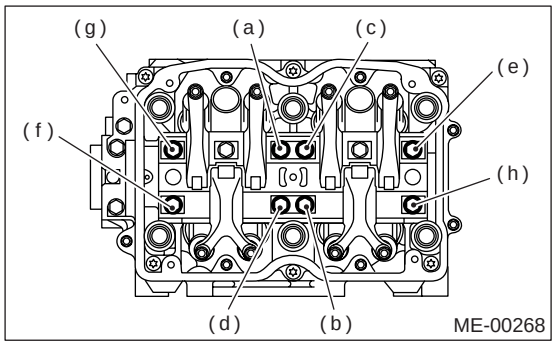


(3) Install the valve rocker assembly.



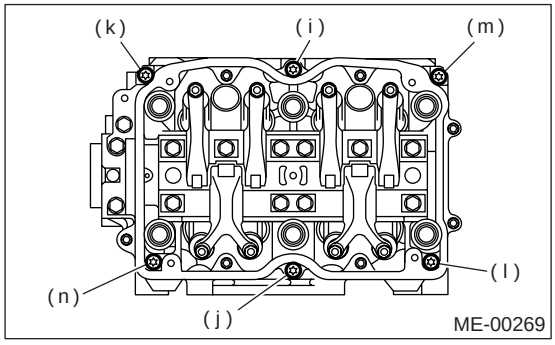
(4) Tighten the bolts (a) through (h) in alphabetical sequence.

Tightening torque:
25 N·m (2.5 kgf-m, 18.1 ft-lb)



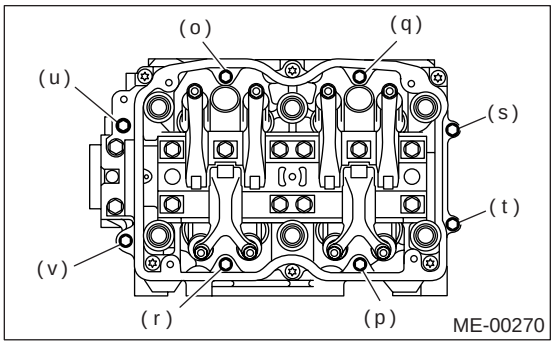
(5) Tighten the TORX® bolts (i) through (n) in alphabetical sequence using ST.
ST 499497000 TORX® PLUS

Tightening torque:
18 N·m (1.8 kgf-m, 13.0 ft-lb)



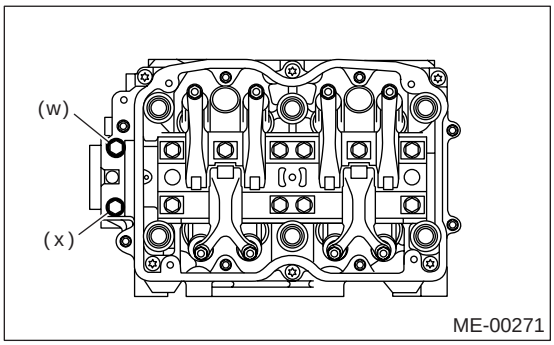
(6) Tighten the bolts (o) through (v) in alphabetical sequence.

Tightening torque:
10 N·m (1.0 kgf-m, 7.2 ft-lb)



(7) Tighten the bolts (w) and (x) in alphabetical sequence.

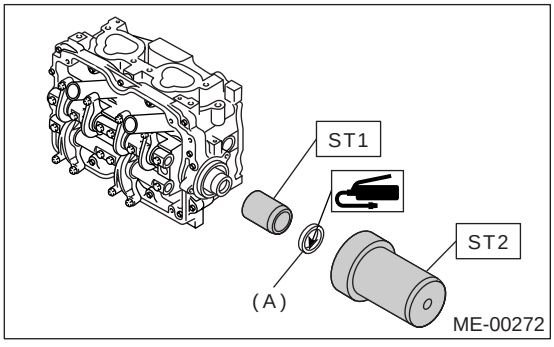
Tightening torque:
10 N·m (1.0 kgf-m, 7.2 ft-lb)



3) Apply a coat of grease to oil seal lips and install the oil seal (A) on camshaft using ST1 and ST2.

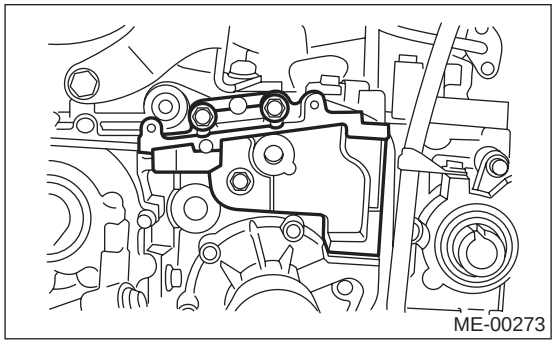
NOTE:
Use a new oil seal.

ST1 499597000 OIL SEAL GUIDE
ST2 499587500 OIL SEAL INSTALLER



4) Install the plug using ST.
ST 499587700 CAMSHAFT OIL SEAL INSTALLER
5) Adjust the valve clearance. <Ref. to ME(H4SO 2.0)-29, ADJUSTMENT, Valve Clearance.>
6) Install the rocker cover and connect PCV hose.
7) Install the oil level gauge guide. (LH side only)
8) Install the camshaft position sensor support. (LH side only)
9) Install the tensioner bracket.

Tightening torque:
25 N·m (2.5 kgf-m, 18.1 ft-lb)

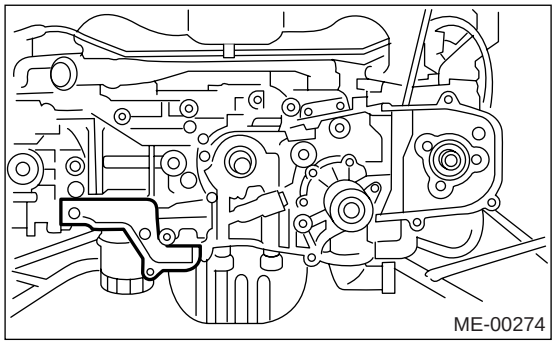


10) Install the timing belt cover No. 2 (RH).

Tightening torque:
5 N·m (0.5 kgf-m, 3.6 ft-lb)

11) Install the timing belt cover No. 2 (LH).

Tightening torque:
5 N·m (0.5 kgf-m, 3.6 ft-lb)



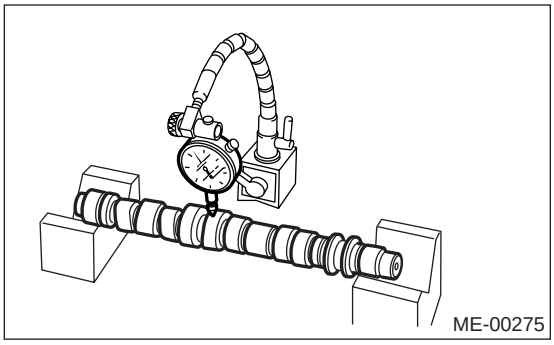
12) Install the crank sprocket.
<Ref. to ME(H4SO 2.0)-50, INSTALLATION, Crank Sprocket.>
13) Install the cam sprocket. <Ref. to ME(H4SO 2.0)-48, INSTALLATION, Cam Sprocket.>
14) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
15) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
16) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
17) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

C: INSPECTION

1. CAMSHAFT

1) Measure the bend, and repair or replace if necessary.

Service limit:
0.020 mm (0.00079 in)



2) Check the journal for damage and wear. Replace if faulty.
3) Measure the outer diameter of camshaft journal and inner diameter of cylinder head journal, and determine the difference (oil clearance) between the two values. If the oil clearance exceeds standard value, replace the camshaft or cylinder head as necessary.

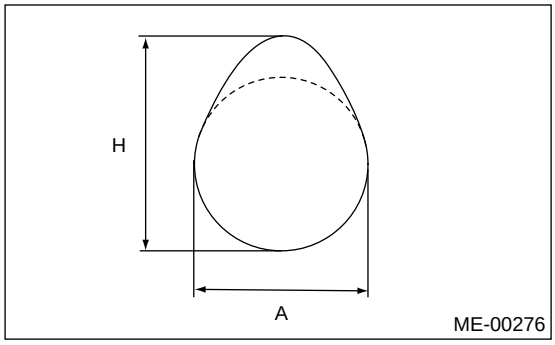
		Unit: mm (in)
Clearance at journal	Standard	0.055 — 0.090 (0.0022 — 0.0035)
Camshaft journal O.D.		31.928 — 31.945 (1.2570 — 1.2577)
Journal hole I.D.		32.000 — 32.018 (1.2598 — 1.2605)

4) Check the cam face condition, and remove the minor faults by grinding with oil stone. Measure the cam height H. If it exceeds the limit, replace it.

Cam height: H:

Model	Parts		Unit: mm (in)
2.0 L	Intake	Standard	39.646 — 39.746 (1.5609 — 1.5648)
	Exhaust	Standard	39.351 — 39.451 (1.5493 — 1.5532)
2.5 L	Intake	Standard	39.485 — 39.585 (1.5545 — 1.5585)
	Exhaust	Standard	39.904 — 40.004 (1.5710 — 1.5750)

Cam base circle diameter A:
Intake: 34.00 mm (1.3386 in)
Exhaust: 34.00 mm (1.3386 in)



2. CAMSHAFT SUPPORT

Measure the side clearance of camshaft with setting the dial gauge at end of camshaft. If side clearance exceeds the limit, replace the camshaft support.

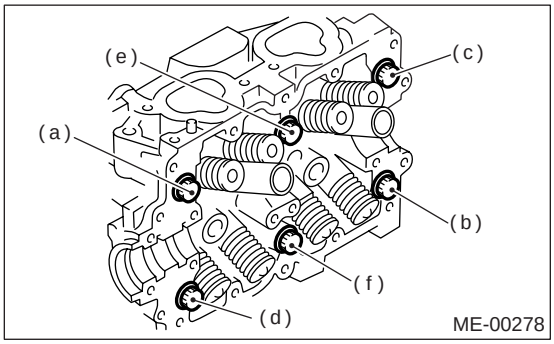
Standard:
0.030 — 0.090 mm (0.0012 — 0.0035 in)

20.Cylinder Head

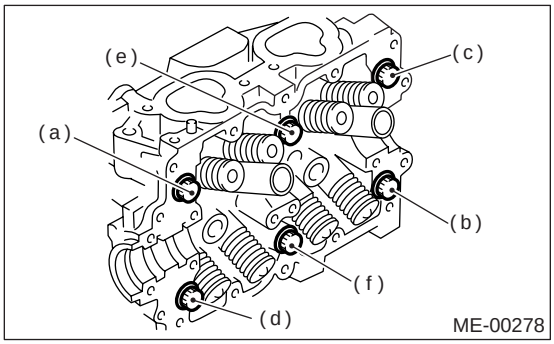
A: REMOVAL

1) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
2) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
3) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
4) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
5) Remove the cam sprocket. <Ref. to ME(H4SO 2.0)-48, REMOVAL, Cam Sprocket.>
6) Remove the intake manifold. <Ref. to FU(H4SO 2.0)-11, REMOVAL, Intake Manifold.>
7) Remove the bolt which installs the A/C compressor bracket on cylinder head.
8) Remove the valve rocker assembly. <Ref. to ME(H4SO 2.0)-51, REMOVAL, Valve Rocker Assembly.>
9) Remove the camshaft. <Ref. to ME(H4SO 2.0)-53, REMOVAL, Camshaft.>
10) Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

NOTE:
Leave bolts (a) and (c) engaged by three or four threads to prevent the cylinder head from falling.



11) While tapping the cylinder head with a plastic hammer, separate it from cylinder block.
12) Remove the bolts (a) and (c) to remove the cylinder head.



13) Remove the cylinder head gasket.

CAUTION:
Be careful not to scratch the mating surface of cylinder head and cylinder block.

14) Similarly, remove the right side cylinder head.

B: INSTALLATION

1) Install the cylinder head and gaskets on cylinder block.

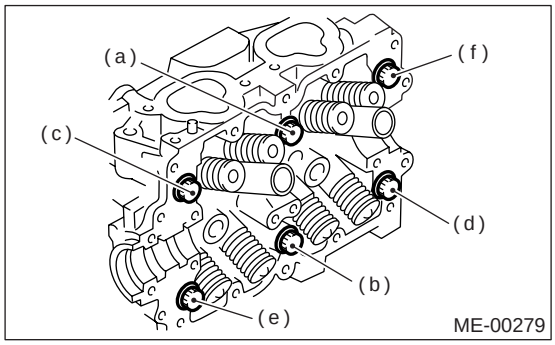
CAUTION:
- **Use new cylinder head gaskets.**
- **Be careful not to scratch the mating surface of cylinder block and cylinder head.**

2) Tighten the cylinder head bolts.
   (1) Apply a coat of engine oil to washers and bolt threads.
   (2) Tighten all bolts to 29 N·m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence.
   Then tighten all bolts to 69 N·m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.
   (3) Back off all bolts by 180° in reverse order of installation, and back them off again by 180°.
   (4) Tighten all bolts to 42 N·m (3.9 kgf-m, 31 ft-lb) in alphabetical sequence.
   (5) Tighten all bolts by 80° — 90° in alphabetical sequence.
   (6) Tighten all bolts by 40° — 45° in alphabetical sequence.

NOTE:
Do not tighten the bolts more than 45°.

   (7) Further tighten bolts (a) and (b) by 40°— 45°.

NOTE:
Ensure the total “re-tightening angle” in the [former two steps], do not exceed 90°.



3) Install the camshaft. <Ref. to ME(H4SO 2.0)-54, INSTALLATION, Camshaft.>
4) Install the valve rocker assembly. <Ref. to ME(H4SO 2.0)-51, INSTALLATION, Valve Rocker Assembly.>
5) Install the A/C compressor bracket on cylinder head.
6) Install the intake manifold.
<Ref. to FU(H4SO 2.0)-12, INSTALLATION, Intake Manifold.>

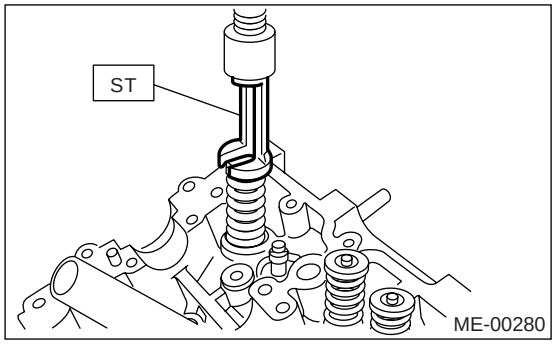
7) Install the cam sprocket. <Ref. to ME(H4SO 2.0)-48, INSTALLATION, Cam Sprocket.>
8) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
9) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
10) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
11) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>

C: DISASSEMBLY

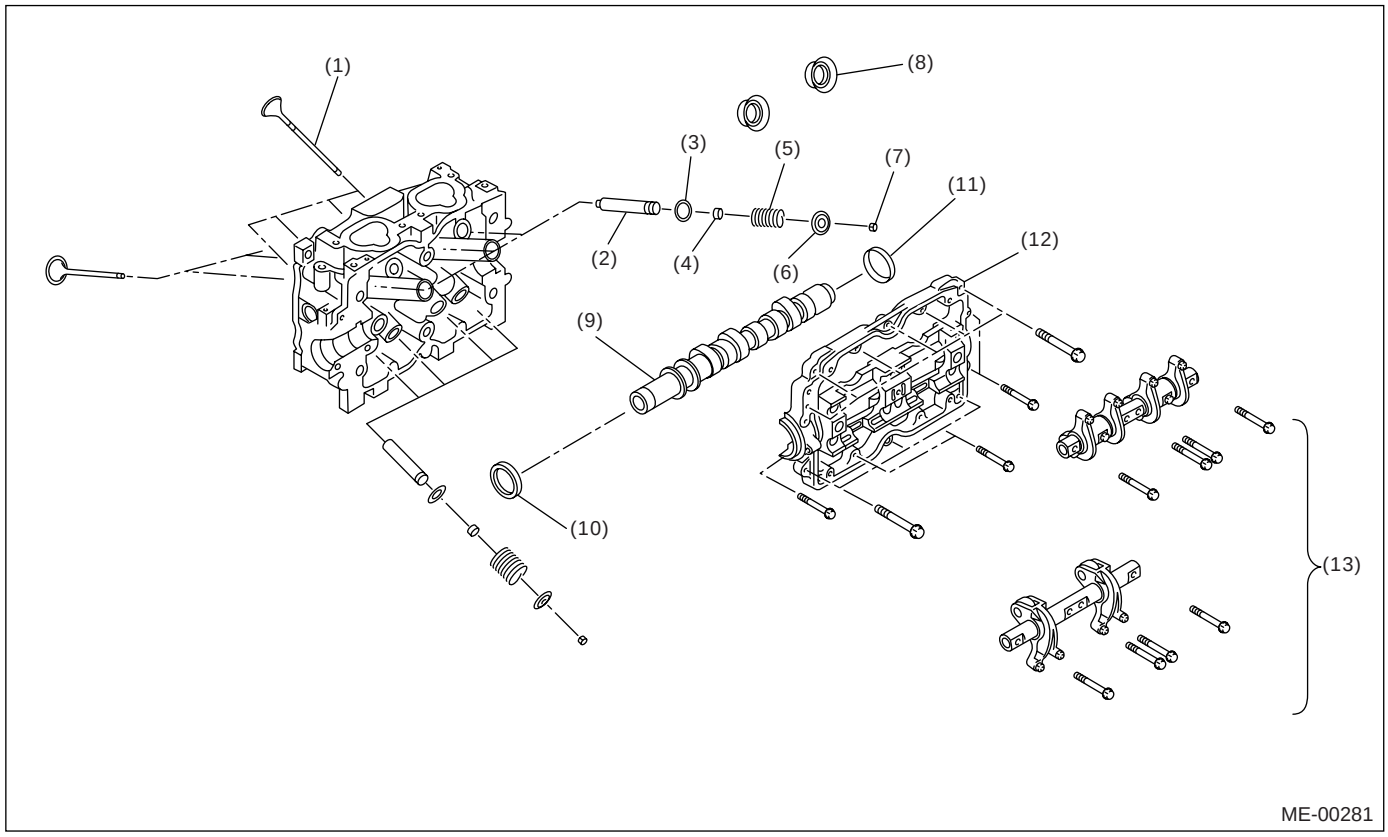
1) Place the cylinder head on the ST.
ST 498267800 CYLINDER HEAD TABLE
2) Set the ST on valve spring. Compress the valve spring and remove the valve spring retainer key. Remove each valve and valve spring.
ST 499718000 VALVE SPRING REMOVER

NOTE:
Keep all the removed parts in order for re-installing in their original positions.

CAUTION:
- **Mark each valve to prevent confusion.**
- **Use extreme care not to damage the lips of the intake valve oil seals and exhaust valve oil seals.**



D: ASSEMBLY



(1) Valve
(2) Valve guide
(3) Valve spring seat
(4) Oil seal
(5) Valve springs
(6) Retainer
(7) Retainer key
(8) Spark plug gasket
(9) Camshaft
(10) Oil seal
(11) Plug
(12) Camshaft cap
(13) Valve rocker ASSY

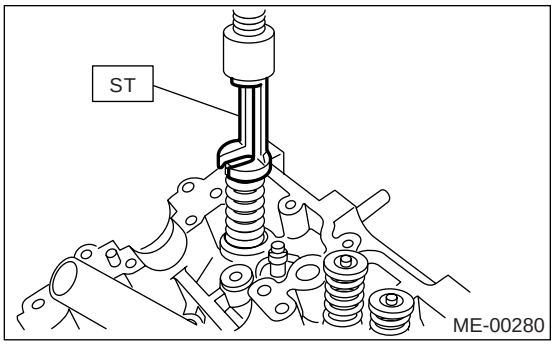
1) Installation of valve spring and valve:
(1) Place the cylinder head on the ST.
ST 498267800 CYLINDER HEAD TABLE
(2) Coat the stem of each valve with engine oil and insert the valve into valve guide.

CAUTION:
Use extreme care not to damage the oil lips when inserting the valve into valve guide.

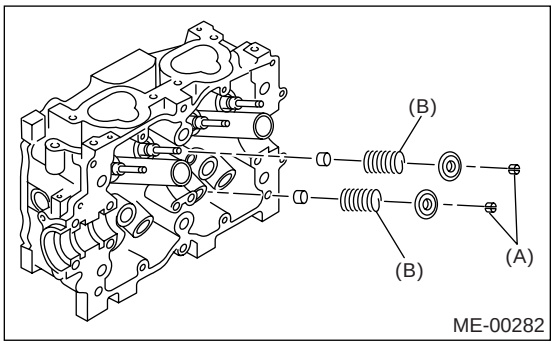
(3) Install the valve spring and retainer.

NOTE:
Be sure to install the valve springs with their close-coiled end facing the seat on the cylinder head.

(4) Set the ST on valve spring.
ST 499718000 VALVE SPRING REMOVER



(5) Compress the valve spring and fit the valve spring retainer key.



(A) Retainer key
(B) Valve springs

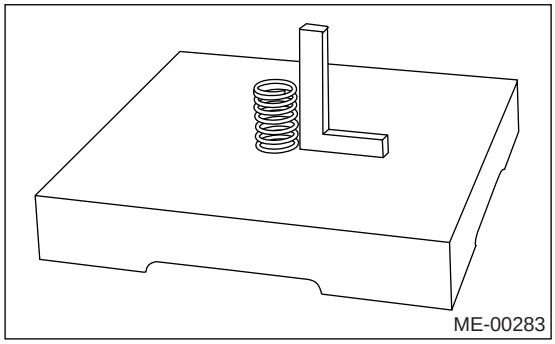
(6) After installing, tap the valve spring retainers lightly with a plastic hammer for better seating.

E: INSPECTION

1. VALVE SPRING

1) Check the valve springs for damage, free length, and tension. Replace the valve spring if it is not within the standard value presented in the table.
2) To measure the squareness of the valve spring, stand the spring on a surface plate and measure its deflection at the top of spring using a try square.

Free length mm (in)		54.30 (2.1378)
Tension/spring height N (kgf, lb)/mm (in)	Set	214 — 246 (22 — 25, 48 — 55)/45.0 (1.772)
	Lift	526 — 582 (54 — 59, 119 — 130)/34.7 (1.366)
Squareness		2.5°, 2.4 mm (0.094 in)



2. INTAKE AND EXHAUST VALVE OIL SEAL

In the following case, pinch and remove the oil seal from valve using pliers, and then replace it with a new one.
- When the lip is damaged.
- When the spring is out of the specified position.
- When readjusting the surfaces of intake valve and valve sheet.
- When replacing the intake valve guide.

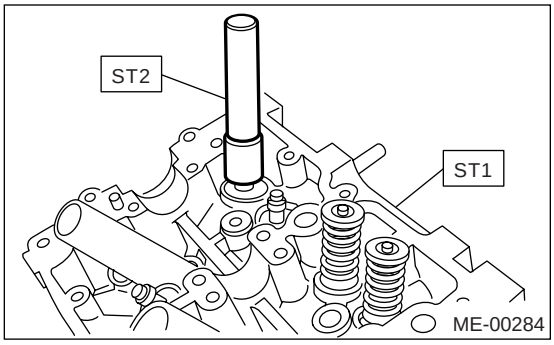
1) Place the cylinder head on ST1.
2) Using ST2, press-fit the oil seal.

CAUTION:
• Apply engine oil to oil seal before press-fitting.
• When press-fitting the oil seal, do not use a hammer or strike in.
• Differentiate between the intake valve oil seal and exhaust valve oil seal by noting their difference in color.

ST1 498267800 CYLINDER HEAD TABLE
ST2 498857100 VALVE OIL SEAL GUIDE

Color of rubber part:
Intake [Black]
Exhaust [Brown]

Color of spring part:
Intake [Silver]
Exhaust [Silver]



F: ADJUSTMENT

1. CYLINDER HEAD

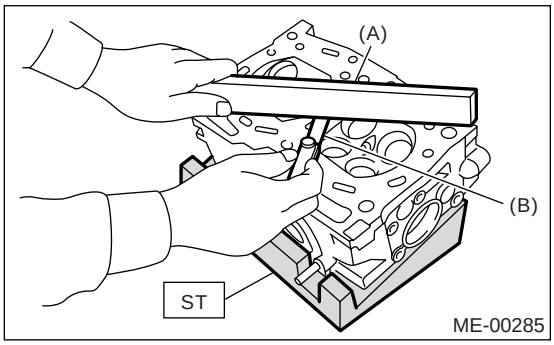
1) Make sure that no crack or other damage do not exist. In addition to visual inspection, inspect important areas by means of red lead check.
Also make sure the gasket installing surface shows no trace of gas and water leaks.
2) Place the cylinder head on the ST.
ST 498267800 CYLINDER HEAD TABLE
3) Measure the warping of the cylinder head surface that mates with crankcase using a straight edge and thickness gauge.
If the warping exceeds the limit, regrind the surface with a surface grinder.

Warping limit:
0.03 mm (0.0012 in)

Grinding limit:
0.1 mm (0.004 in)

Standard height of cylinder head:
97.5 mm (3.839 in)

NOTE:
Uneven torque for the cylinder head bolts can cause warping. When reassembling, pay special attention to the torque so as to tighten evenly.

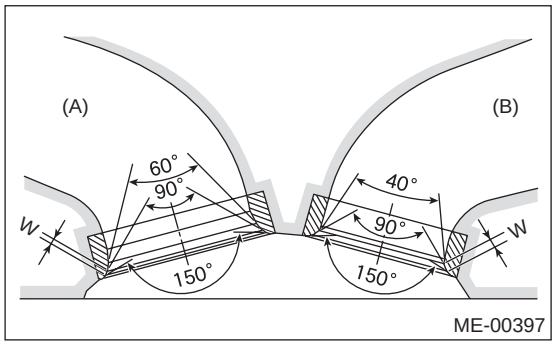


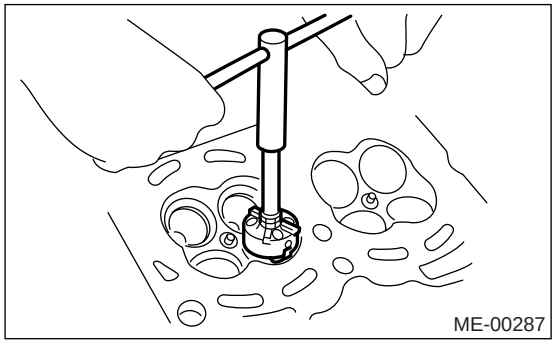
(A) Straight edge
(B) Thickness gauge

2. VALVE SEAT

Inspect the intake and exhaust valve seats, and correct the contact surfaces with a valve seat cutter if they are defective or when valve guides are replaced.

Valve seat width W:
Standard
Intake (A)
0.8 — 1.4 mm (0.03 — 0.055 in)
Exhaust (B)
1.2 — 1.8 mm (0.047 — 0.071 in)





3. VALVE GUIDE

1) Check the clearance between valve guide and stem. The clearance can be checked by measuring respectively the outer diameter of valve stem and inner diameter of valve guide with a micrometer.

Clearance between the valve guide and valve stem:

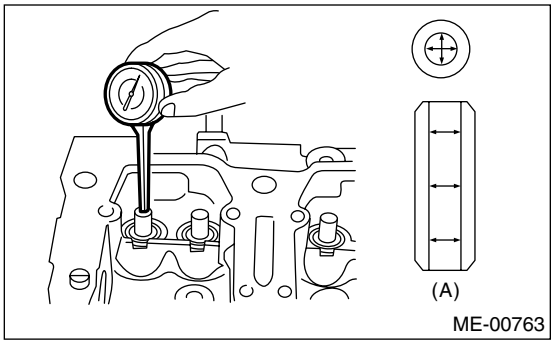
Standard

Intake

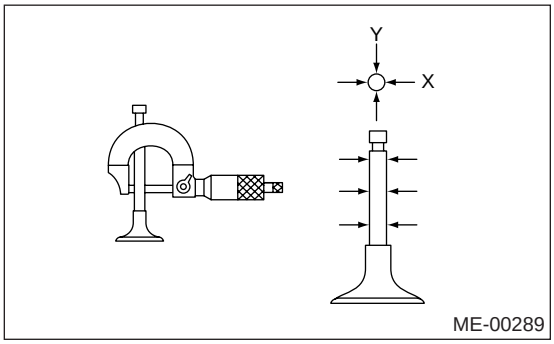
0.035 — 0.062 mm (0.0014 — 0.0024 in)

Exhaust

0.040 — 0.067 mm (0.0016 — 0.0026 in)



(A) Valve guide



2) If the clearance between valve guide and stem exceeds the standard value, replace the valve guide or valve itself whichever shows greater amount of wear. See the following procedure for valve guide replacement.

Valve guide inner diameter:

6.000 — 6.012 mm (0.2362 — 0.2367 in)

Valve stem outer diameters:

Intake

5.950 — 5.965 mm (0.2343 — 0.2348 in)

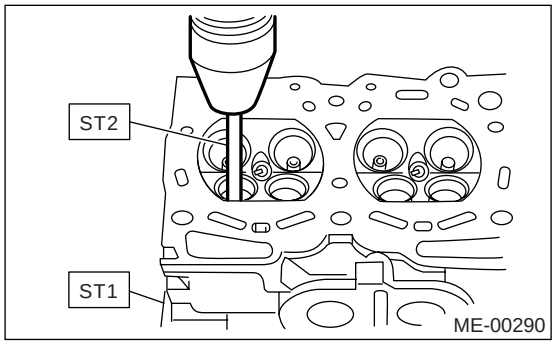
Exhaust

5.945 — 5.960 mm (0.2341 — 0.2346 in)

(1) Place the cylinder head on ST1 with the combustion chamber upward so that valve guides enter the holes in ST1.

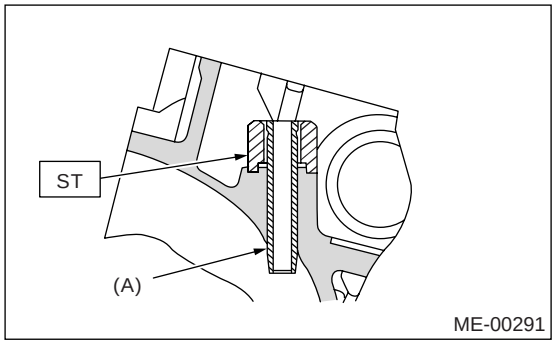
(2) Insert ST2 into the valve guide and press it down to remove the valve guide.

ST1 498267800 CYLINDER HEAD TABLE
ST2 499767200 VALVE GUIDE REMOVER



(3) Turn the cylinder head upside down and place the ST as shown in the figure.

Intake side:
ST 499767700 VALVE GUIDE ADJUSTER
Exhaust side:
ST 499767800 VALVE GUIDE ADJUSTER

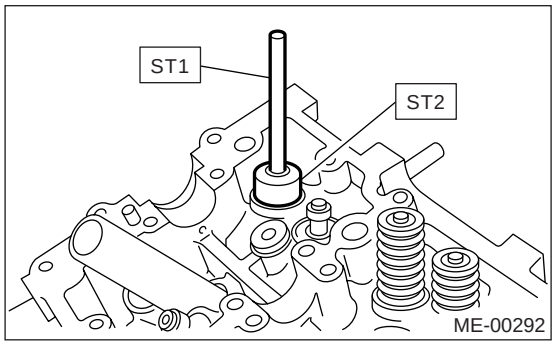


(A) Valve guide

(4) Before installing a new valve guide, make sure that neither scratches nor damages exist on the inside surface of the valve guide holes in cylinder head.

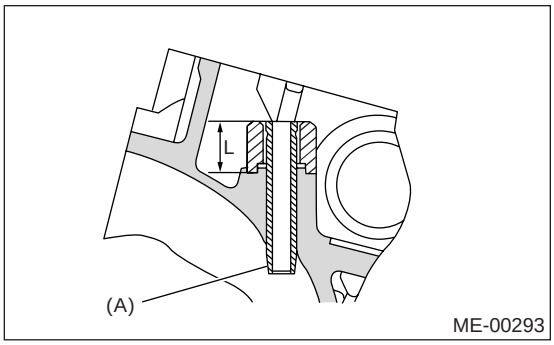
(5) Put a new valve guide, coated with sufficient oil, in cylinder, and insert the ST1 into valve guide. Press in until the valve guide upper end is flush with the upper surface of ST2.

ST1 499767200 VALVE GUIDE REMOVER
Intake side:
ST2 499767700 VALVE GUIDE ADJUSTER
Exhaust side:
ST2 499767800 VALVE GUIDE ADJUSTER



(6) Check the valve guide protrusion.

Valve guide protrusion L:
Intake
20.0 — 21.0 mm (0.787 — 0.827 in)
Exhaust
16.5 — 17.5 mm (0.650 — 0.689 in)

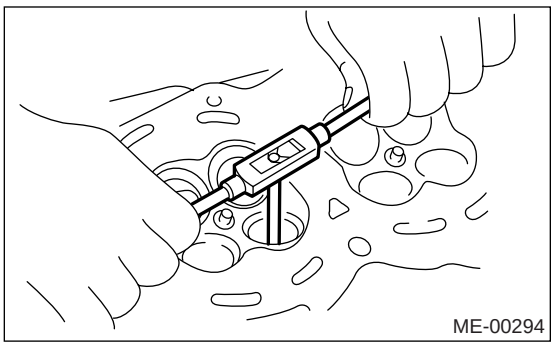


(A) Valve guide

(7) Ream the inside of valve guide using ST. Put the reamer in valve guide, and rotate the reamer slowly clockwise while pushing it lightly. Bring the reamer back while rotating it clockwise. After reaming, clean the valve guide to remove chips.

CAUTION:
• Apply engine oil to the reamer when reaming.
• If the inner surface of the valve guide is torn, the edge of the reamer should be slightly ground with an oil stone.
• If the inner surface of the valve guide becomes lustrous and the reamer does not chip, use a new reamer or remedy the reamer.

ST 499767400 VALVE GUIDE REAMER



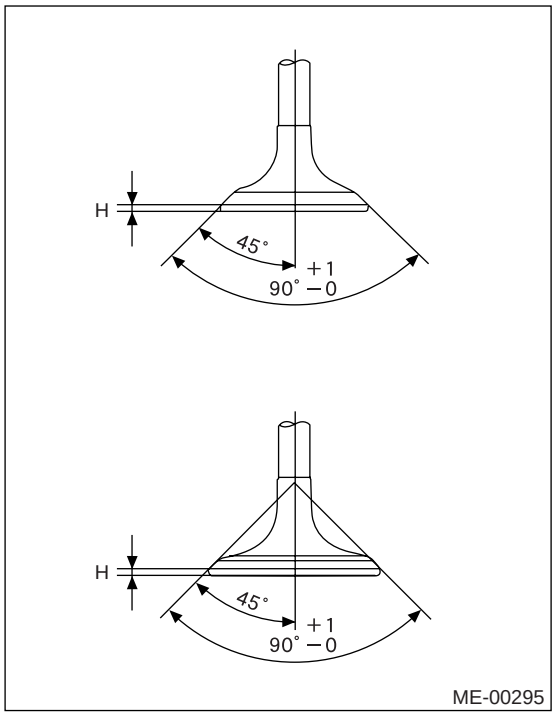
(8) Recheck the contact condition between valve and valve seat after replacing the valve guide.

4. INTAKE AND EXHAUST VALVE

1) Inspect the flange and stem of valve, and replace if damaged, worn or deformed, or if “H” exceed the standard value.

H:
Intake
Standard: 0.8 — 1.2 mm (0.03 — 0.047 in)
Exhaust
Standard: 1.0 — 1.4 mm (0.039 — 0.055 in)

Valve overall length:
Intake
120.6 mm (4.75 in)
Exhaust
121.7 mm (4.79 in)



2) Put a small amount of grinding compound on the seat surface and lap the valve and seat surface. <Ref. to ME(H4SO 2.0)-60, VALVE SEAT, ADJUSTMENT, Cylinder Head.> Install a new intake valve oil seal after lapping.

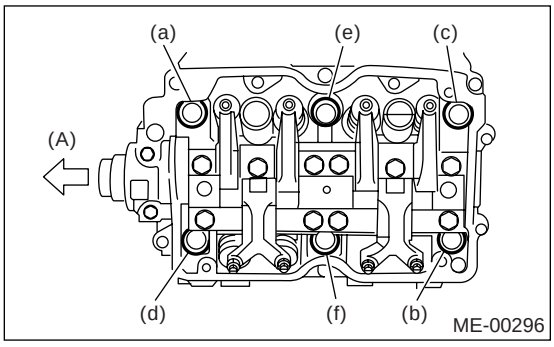
21.Cylinder Block

A: REMOVAL

NOTE:
Before conducting this procedure, drain the engine oil completely.

1) Remove the intake manifold. <Ref. to FU(H4SO 2.0)-11, REMOVAL, Intake Manifold.>
2) Remove the V-belts. <Ref. to ME(H4SO 2.0)-38, REMOVAL, V-belt.>
3) Remove the crank pulley. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
4) Remove the timing belt cover. <Ref. to ME(H4SO 2.0)-42, REMOVAL, Timing Belt Cover.>
5) Remove the timing belt. <Ref. to ME(H4SO 2.0)-43, REMOVAL, Timing Belt.>
6) Remove the cam sprocket. <Ref. to ME(H4SO 2.0)-48, REMOVAL, Cam Sprocket.>
7) Remove the crank sprocket. <Ref. to ME(H4SO 2.0)-40, REMOVAL, Crank Pulley.>
8) Remove the generator and A/C compressor with their brackets.
9) Remove the rocker cover.
10) Remove the cylinder head bolts in alphabetical sequence as shown in the figure.

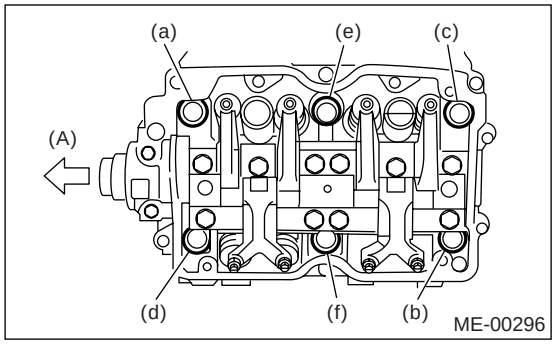
NOTE:
Leave bolts (a) and (c) engaged by three or four threads to prevent the cylinder head from falling.



(A) Front side

11) While tapping the cylinder head with a plastic hammer, separate it from cylinder block.

12) Remove the bolts (a) and (c) to remove the cylinder head.



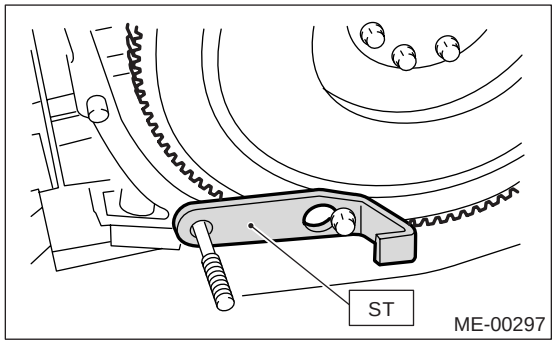
(A) Front side

13) Remove the cylinder head gasket.

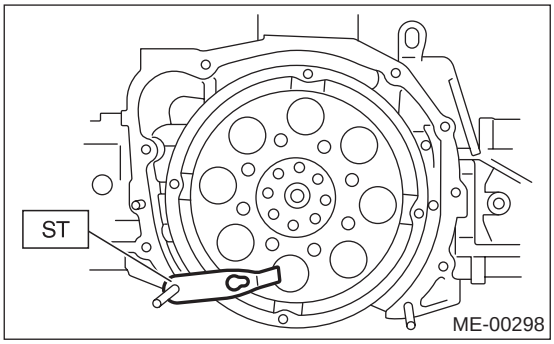
NOTE:
Do not scratch the mating surface of cylinder head and cylinder block.

14) Similarly, remove the right side cylinder head.
15) Remove the clutch housing cover. (MT model)
16) Remove the flywheel (MT model) or drive plate (AT model).
Lock the crankshaft using ST.
ST 498497100 CRANKSHAFT STOPPER

- MT model

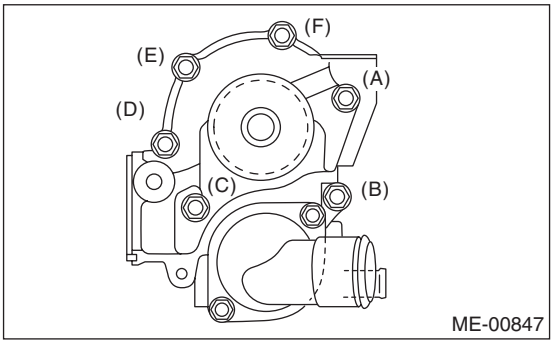


- AT model



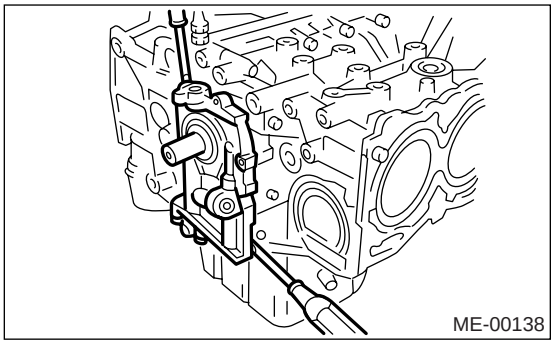
17) Remove the oil separator cover.
18) Remove the water by-pass pipe for heater.

19) Remove the water pump after loosening the bolts in alphabetical sequence as shown in the figure.



20) Remove the oil pump from cylinder block.
Use a flat tip screwdriver as shown in the figure when removing the oil pump.

CAUTION:
Be careful not to scratch the mating surface of cylinder block and oil pump.

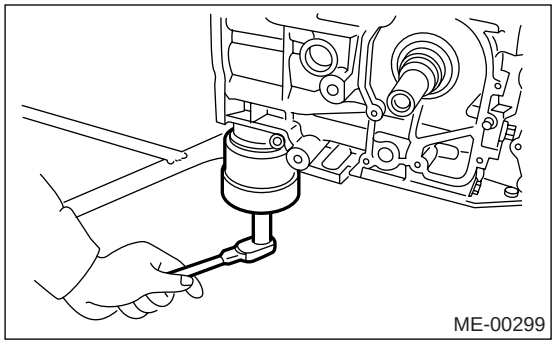


21) Remove the oil pan.
(1) Place the cylinder block to face the #2 and #4 piston side upward.
(2) Remove the bolts which secure oil pan to cylinder block.
(3) Insert a oil pan cutter blade between cylinder block-to-oil pan clearance and remove the oil pan.

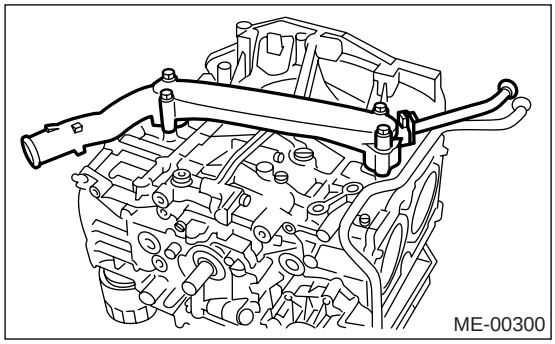
NOTE:
Do not use a screwdriver or similar tools in place of oil pan cutter.

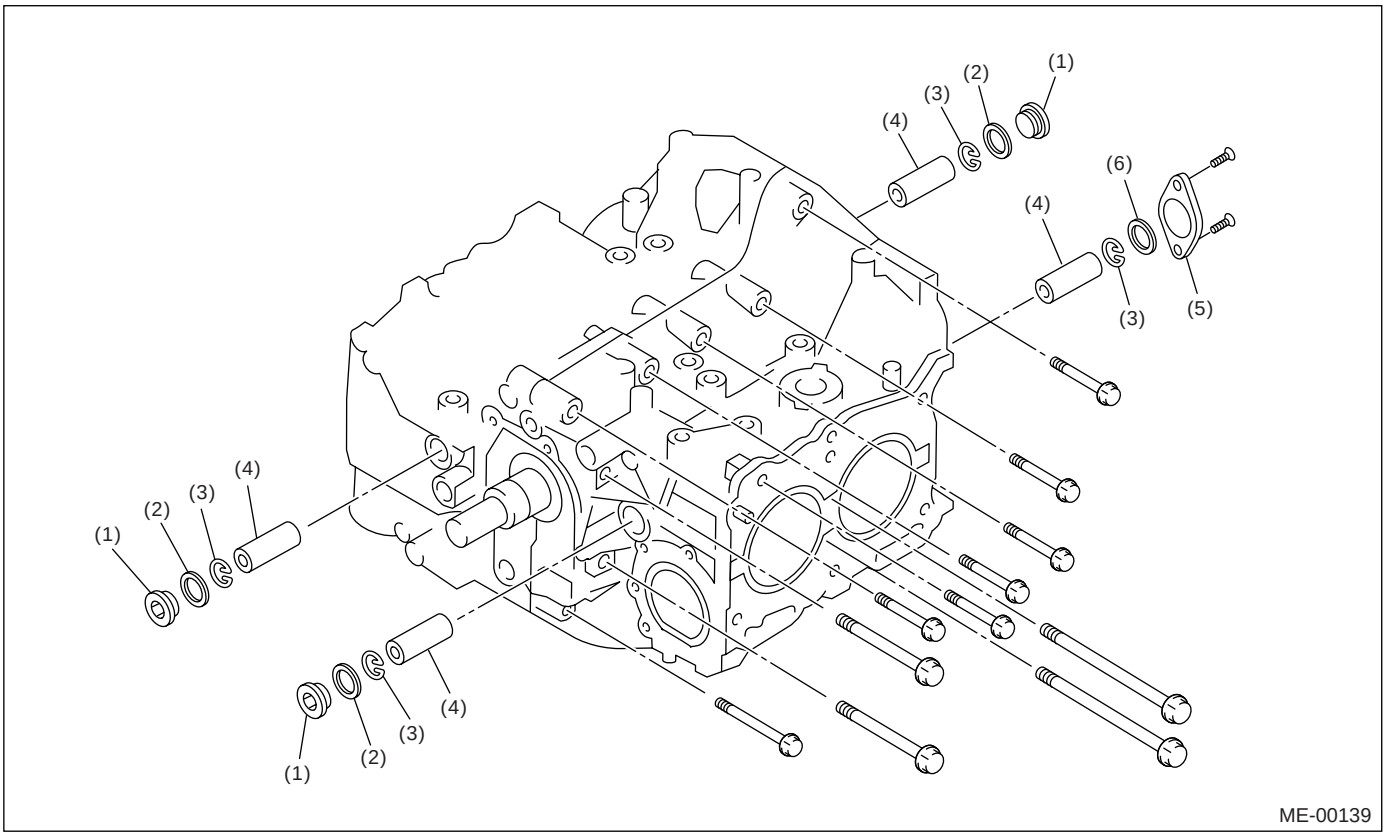
22) Remove the oil strainer stay.
23) Remove the oil strainer.
24) Remove the baffle plate.

25) Remove the oil filter.



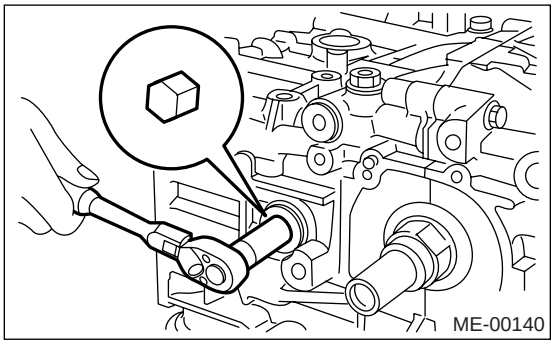
26) Remove the water pipe.



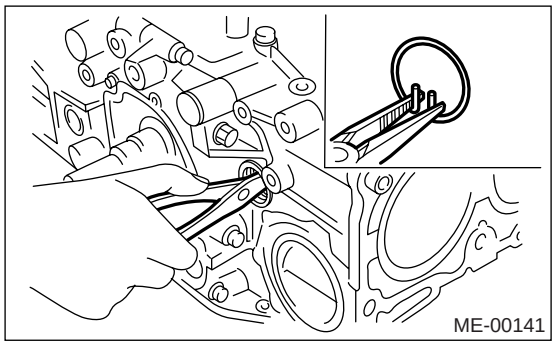


(1) Service hole plug
(2) Gasket
(3) Snap ring
(4) Piston pin
(5) Service hole cover
(6) O-ring

27) Remove the service hole cover and service hole plugs using a hexagon wrench (14 mm).

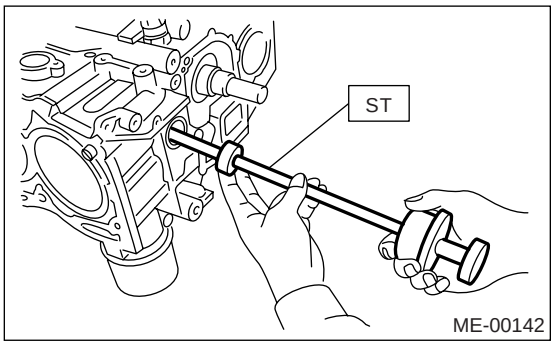


28) Rotate the crankshaft to bring #1 and #2 pistons to bottom dead center position, then remove the piston snap ring through service hole of #1 and #2 cylinders.



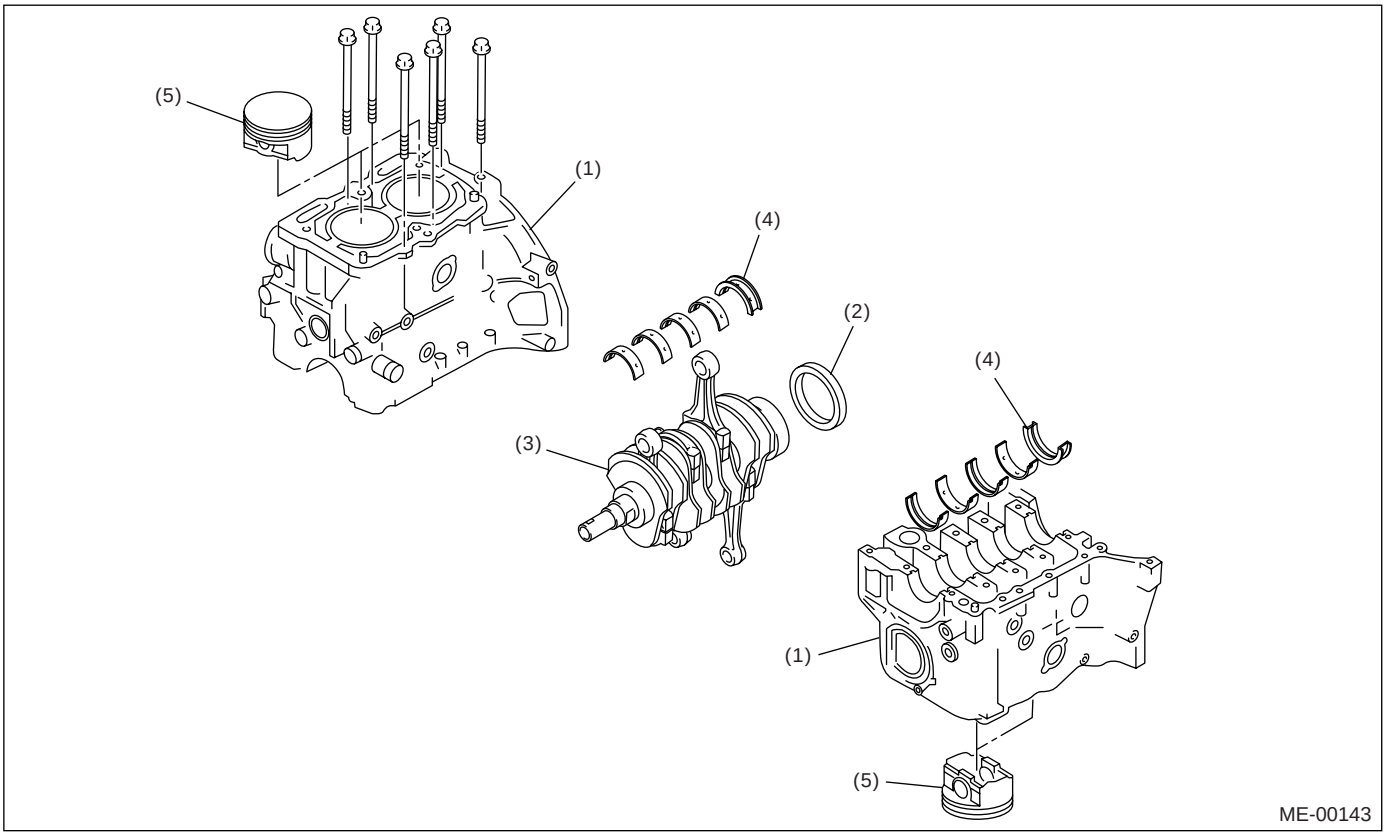
29) Draw out the piston pin from #1 and #2 pistons using ST.
ST 499097700 PISTON PIN REMOVER

NOTE:
Be careful not to confuse the original combination of piston, piston pin and cylinder.



30) Similarly remove the piston pins from #3 and #4 pistons.
31) Remove the bolts which connect cylinder block on the side of #2 and #4 cylinders.
32) Back off the bolts which connect cylinder block on the side of #1 and #3 cylinders two or three turns.
33) Set up the cylinder block so that #1 and #3 cylinders are on the upper side, then remove the cylinder block connecting bolts.
34) Separate the cylinder block (RH) and (LH).

NOTE:
When separating the cylinder block, do not allow the connecting rod to fall or damage the cylinder block.



(1) Cylinder block
(2) Rear oil seal
(3) Crankshaft
(4) Crankshaft bearing
(5) Piston

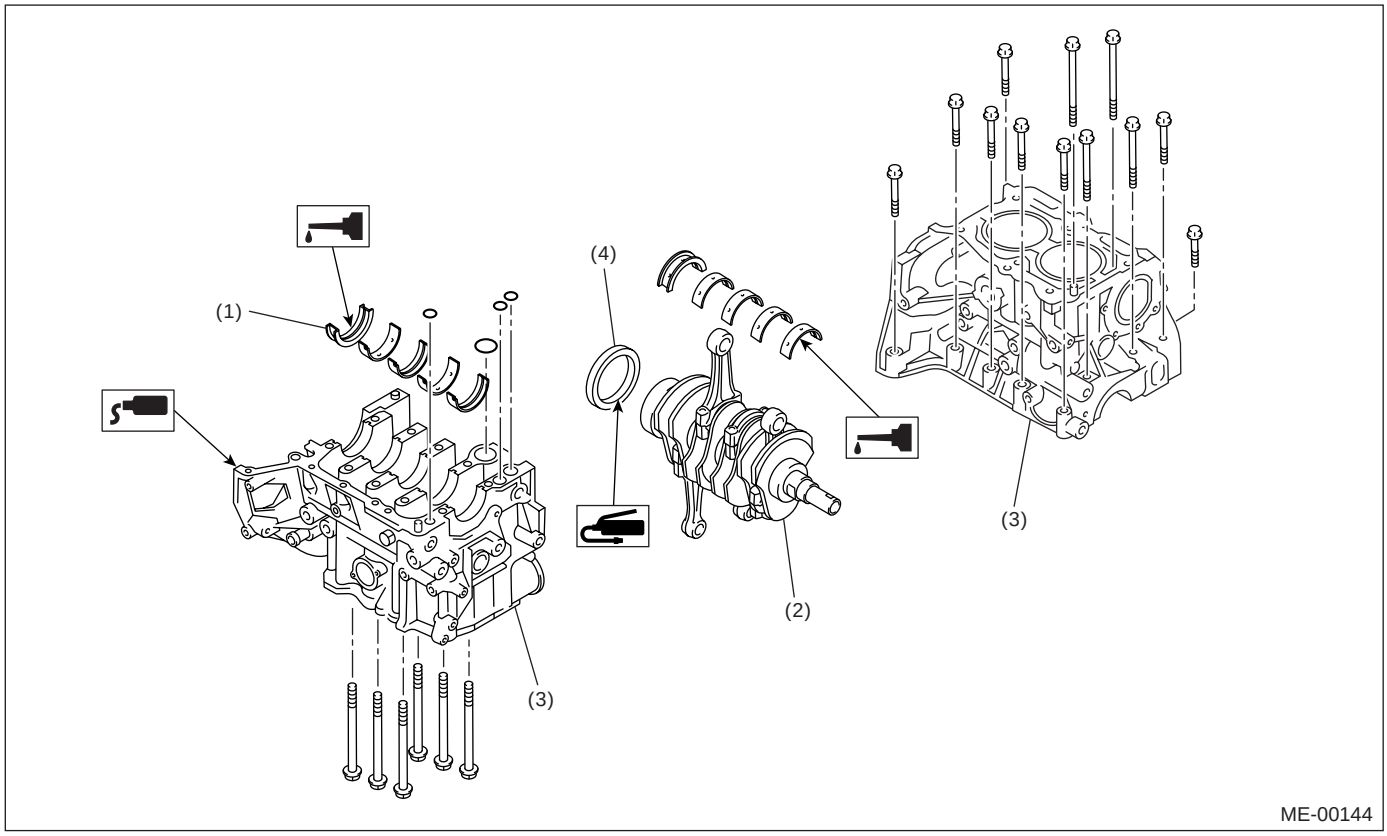
35) Remove the rear oil seal.
36) Remove the crankshaft together with connecting rod.
37) Remove the crankshaft bearings from cylinder block using a hammer handle.

NOTE:
Be careful not to confuse the crankshaft bearing combination. Press the bearing at the end opposite to locking lip.

38) Draw out each piston from cylinder block using a wooden bar or hammer handle.

NOTE:
Be careful not to confuse the original combination of piston and cylinder.

B: INSTALLATION



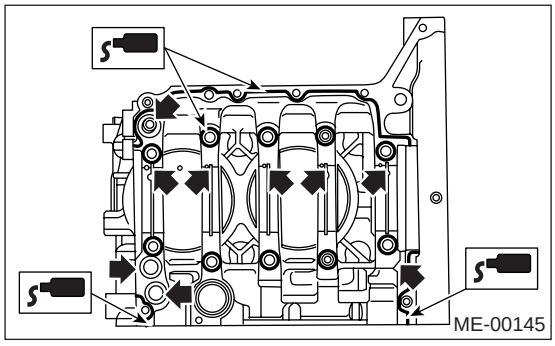
(1) Crankshaft bearing
(2) Crankshaft
(3) Cylinder block
(4) Rear oil seal

NOTE:
Remove oil on the mating surface of bearing and cylinder block before installation. Apply a coat of engine oil to crankshaft pins.

1) Position the crankshaft on the #2 and #4 cylinder block.
2) Apply liquid gasket to the mating surface of #1 and #3 cylinder block, and position it on #2 and #4 cylinder block.

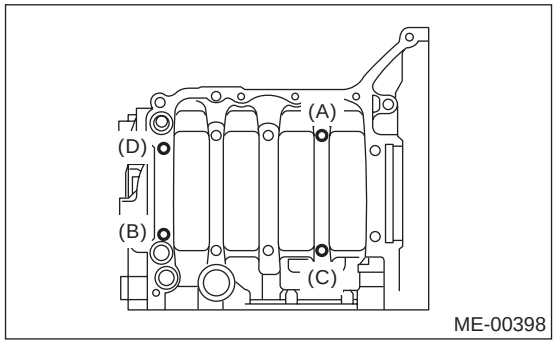
Liquid gasket:
THREE BOND 1215 (Part No. 004403007) or equivalent

NOTE:
Do not allow liquid gasket to flow into O-ring grooves, oil passages, bearing grooves, etc.



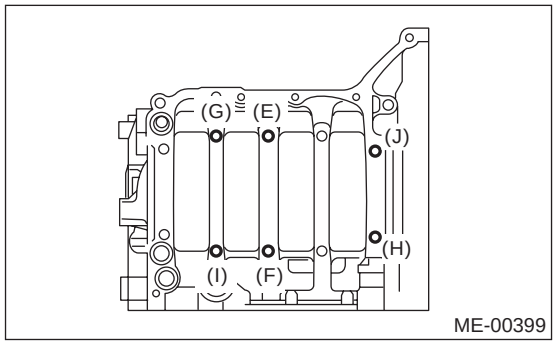
3) Tighten the 10 mm cylinder block connecting bolts on LH side (A — D) in alphabetical sequence.

Tightening torque:
10 N·m (1.0 kgf-m, 7.4 ft-lb)



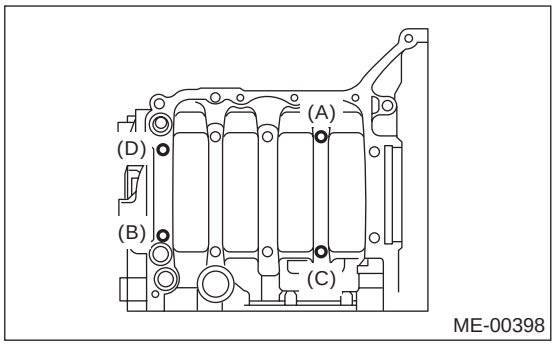
4) Tighten the 10 mm cylinder block connecting bolts on RH side (E — J) in alphabetical sequence.

Tightening torque:
10 N·m (1.0 kgf-m, 7.4 ft-lb)



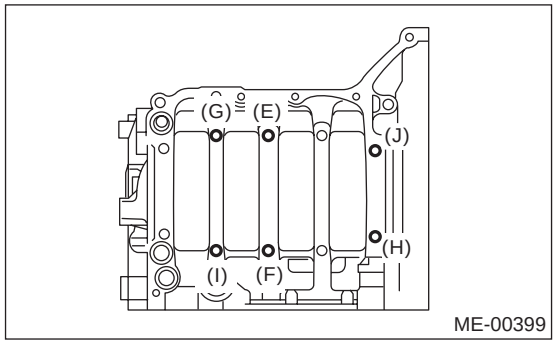
5) Further tighten the LH side bolts (A — D) in alphabetical sequence.

Tightening torque:
(A), (C): 20 N·m (2.0 kgf-m, 14.8 ft-lb)
(B), (D): 15 N·m (1.5 kgf-m, 10.8 ft-lb)

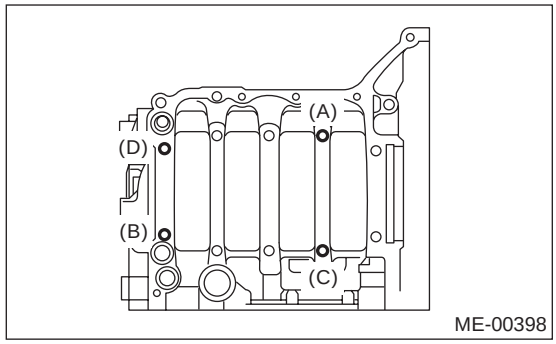


6) Further tighten the RH side bolts (E — J) in alphabetical sequence.

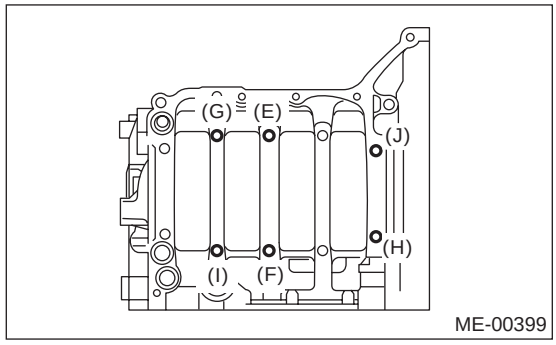
Tightening torque:
(E), (F), (G), (I): 20 N·m (2.0 kgf-m, 14.8 ft-lb)
(H), (J): 18 N·m (1.8 kgf-m, 13.3 ft-lb)



7) Further tighten the LH side bolts (A — D) to 90° in alphabetical sequence.

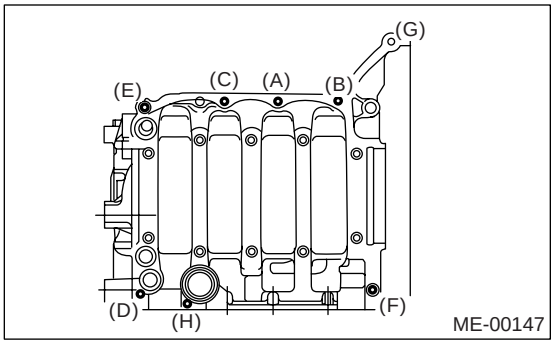


8) Further tighten the RH side bolts (E — J) to 90° in alphabetical sequence.

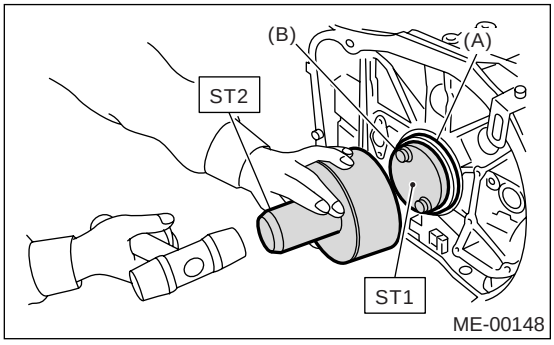


9) Tighten the 8 mm and 6 mm cylinder block connecting bolts on LH side (A — H) in alphabetical sequence.

Tightening torque:
(A) — (G): 25 N·m (2.5 kgf-m, 18.1 ft-lb)
(H): 6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

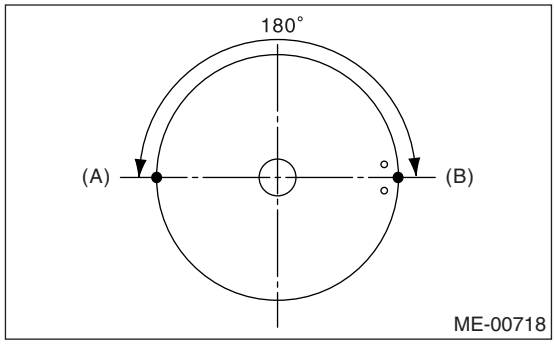


10) Install the rear oil seal using ST1 and ST2.
ST1 499597100 OIL SEAL GUIDE
ST2 499587200 OIL SEAL INSTALLER

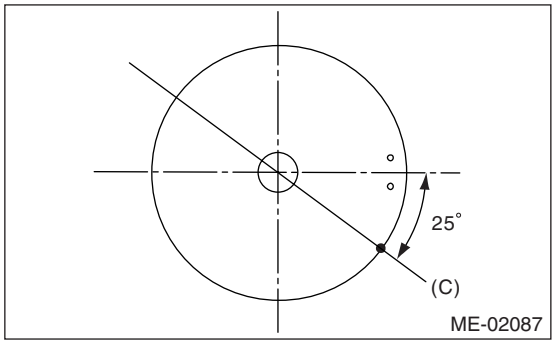


(A) Rear oil seal
(B) Flywheel attaching bolt

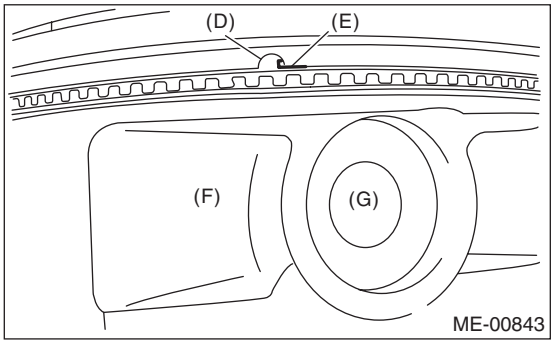
11) Position the top ring gap at (A) or (B) in the figure.
12) Position the second ring gap at 180° on the reverse side of the top ring gap.



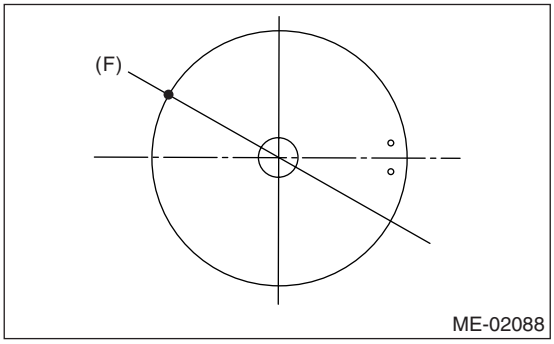
13) Position the upper rail gap at (C) in the figure.



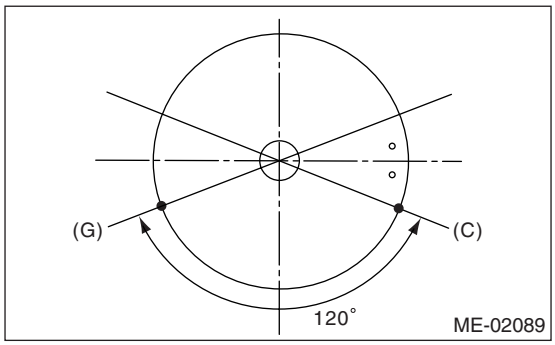
14) Align the upper rail spin stopper (E) to the side hole (D) on the piston.



15) Position the expander gap at 180° on the reverse side of (C) that shown (F) in the figure.



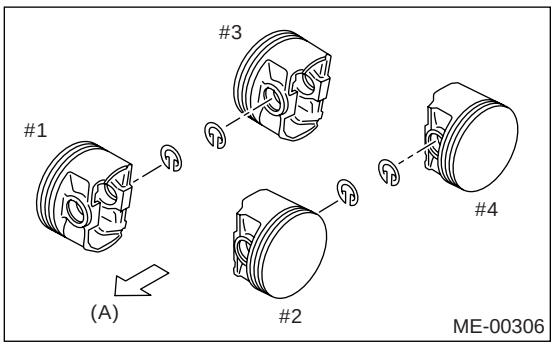
16) Position the lower rail gap at 120° on counterclockwise of (C) that shown (G) in the figure.



CAUTION:
• Ensure ring gaps do not face the same direction.
• Ensure ring gaps are not within the piston skirt area.

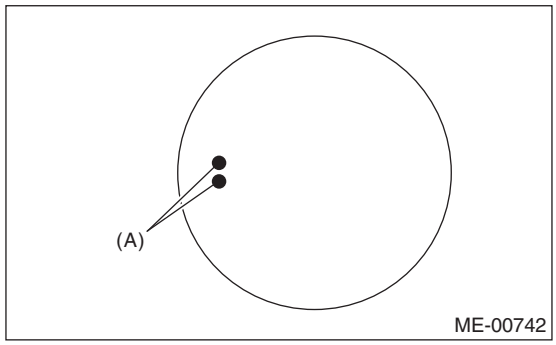
17) Install the snap ring.
Install snap rings in the piston holes located opposite to the service holes in cylinder block, when positioning all pistons in the corresponding cylinders.

NOTE:
Use new snap rings.

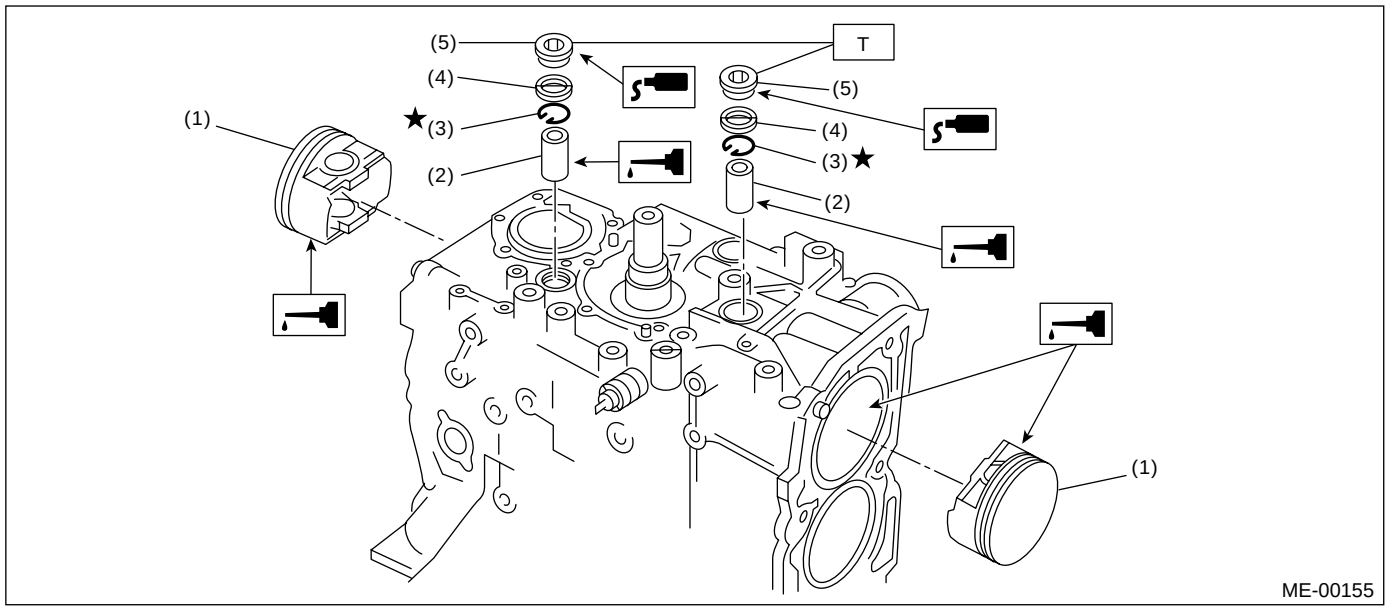


(A) Front side

CAUTION:
Piston front mark faces towards the front of engine.



(A) Front mark



(1) Piston
(2) Piston pin
(3) Snap ring
(4) Gasket
(5) Service hole plug

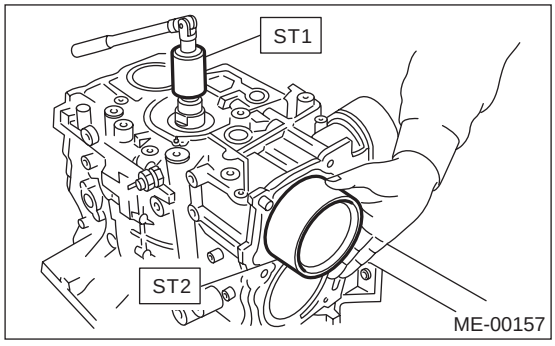
Tightening torque: N·m (kgf-m, ft-lb)
T: 70 (7.1, 50.6)

18) Install the piston.
(1) Place the cylinder block to face the #1 and #2 cylinder side upward.
(2) Using ST1, turn the crankshaft so that #1 and #2 connecting rods are set at bottom dead center.

ST1 499987500 CRANKSHAFT SOCKET

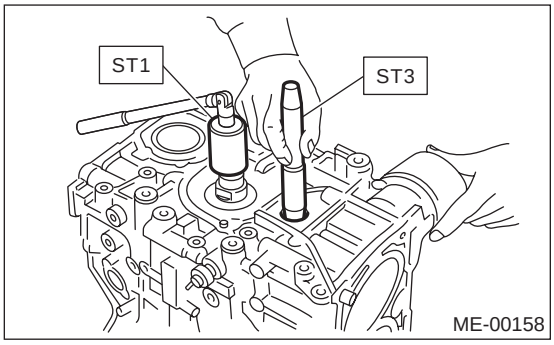
(3) Apply a coat of engine oil to the pistons and cylinders and insert pistons in their cylinders using ST2.

ST 2 398744300 PISTON GUIDE (2.0 L model)
ST 2 498747300 PISTON GUIDE (2.5 L model)



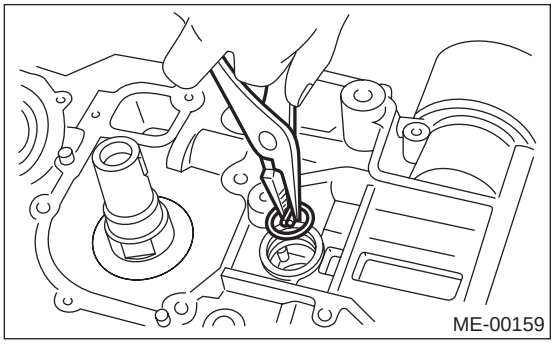
19) Install the piston pin.
(1) Apply a coat of engine oil to ST3.
(2) Insert ST3 into the service hole to align piston pin hole with connecting rod small end.

ST3 499017100 PISTON PIN GUIDE



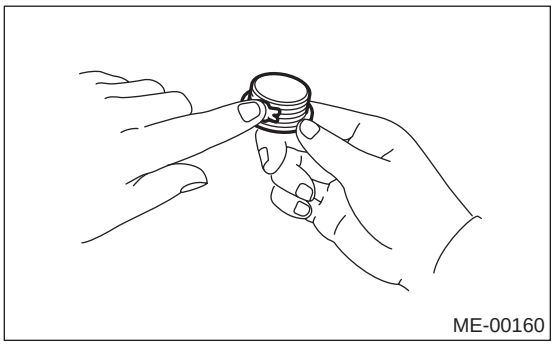
(3) Apply a coat of engine oil to piston pin, and insert the piston pin into piston and connecting rod through service hole.
(4) Install the snap ring.

NOTE:
Use new snap rings.



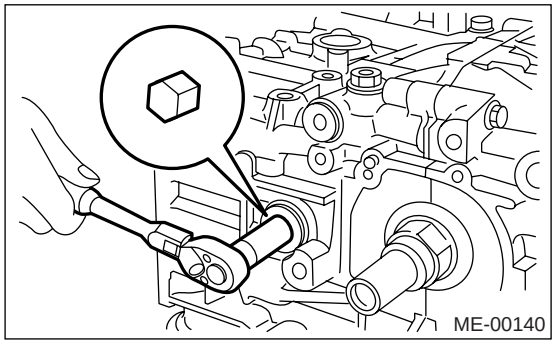
(5) Apply liquid gasket around the service hole plug.

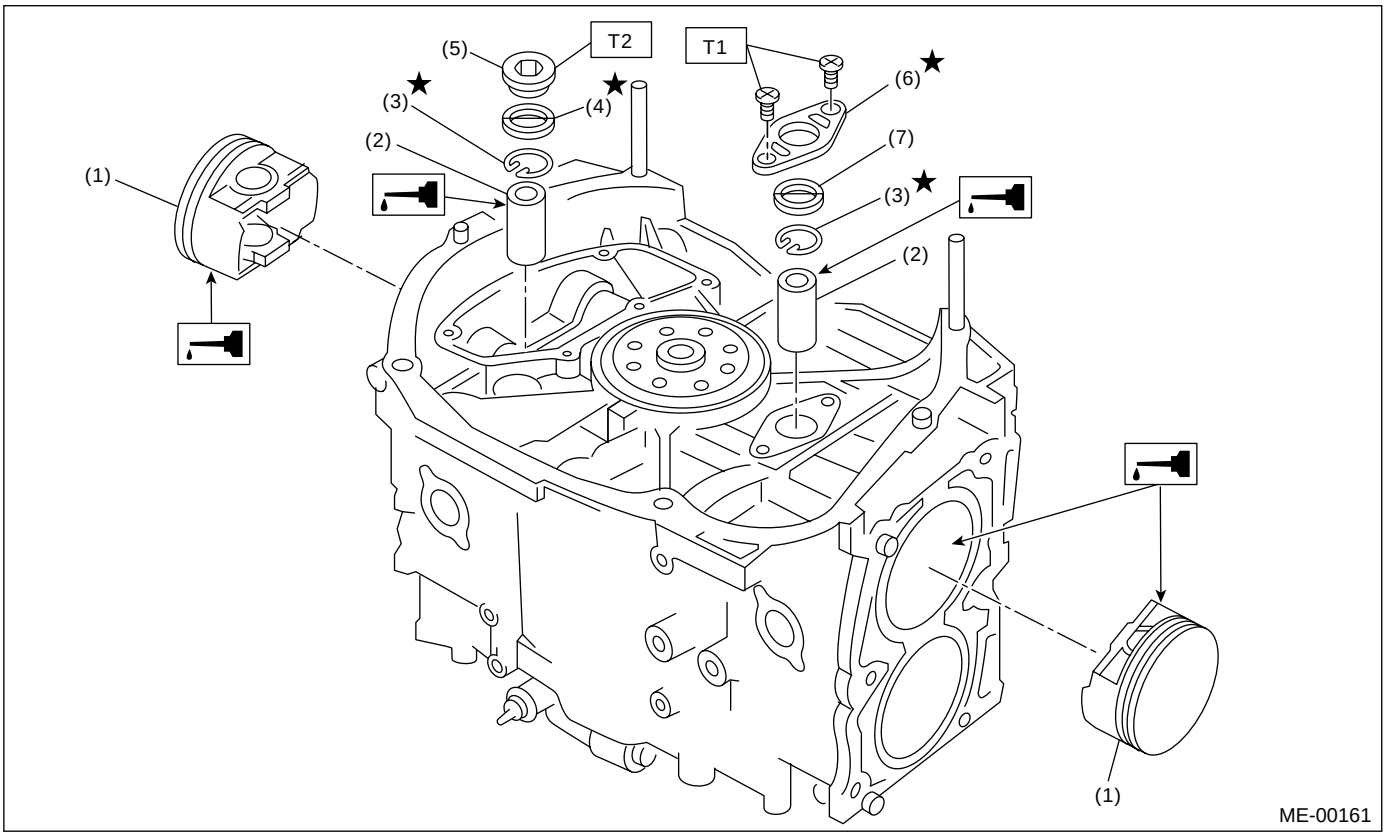
Liquid gasket:
THREE BOND 1215 (Part No. 004403007) or equivalent



(6) Install the service hole plug and gasket.

NOTE:
Use a new gasket.



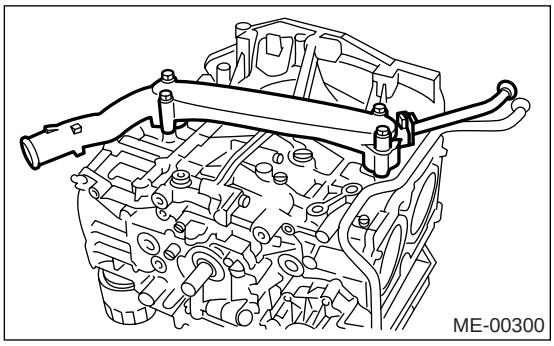


(1) Piston
(2) Piston pin
(3) Snap ring
(4) Gasket
(5) Service hole plug
(6) Service hole cover
(7) O-ring

Tightening torque: N·m (kgf-m, ft-lb)	
T1:	*6.4 (0.65, 4.7)*
T2:	*70 (7.1, 50.6)*

(7) Place the cylinder block to face the #3 and #4 cylinder side upward. Following the same procedures as used for #1 and #2 cylinders, install the pistons and piston pins.

20) Install the water pipe.



21) Install the baffle plate.

Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

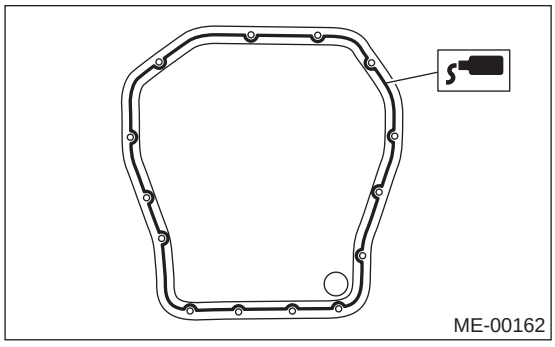
22) Install the oil strainer and O-ring.

Tightening torque:
10 N·m (1.0 kgf-m, 7.2 ft-lb)

23) Install the oil strainer stay.

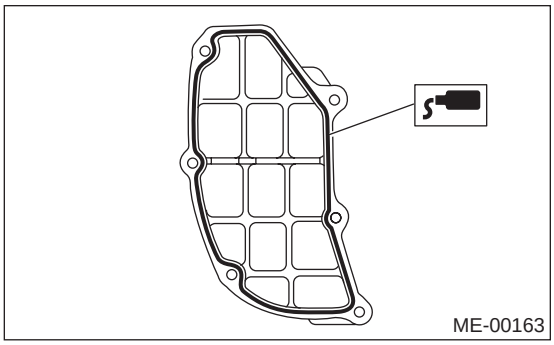
24) Apply liquid gasket to mating surfaces and install the oil pan.

Liquid gasket:
THREE BOND 1207C (Part No. 004403012) or equivalent



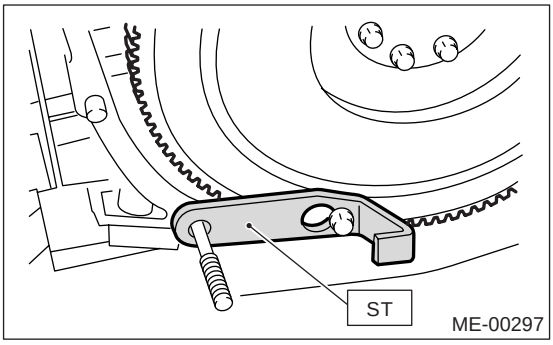
25) Apply liquid gasket to mating surfaces and install the oil separator cover.

Liquid gasket:
THREE BOND 1207C (Part No. 004403012) or equivalent



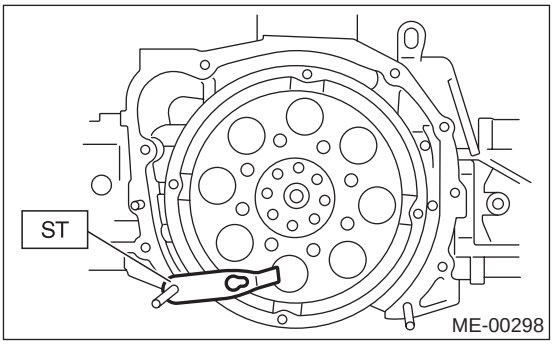
26) Install the flywheel. (MT model)
<Ref. to CL-16, INSTALLATION, Flywheel.>
To lock the crankshaft, use the ST.
ST 498497100 CRANKSHAFT STOPPER

Tightening torque:
72 N·m (7.3 kgf-m, 52.8 ft-lb)



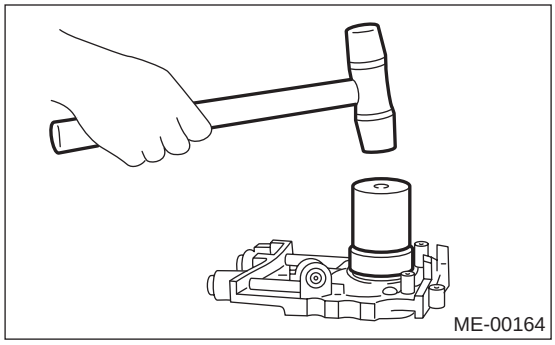
27) Install the drive plate.
To lock the crankshaft, use the ST.
ST 498497100 CRANKSHAFT STOPPER

Tightening torque:
72 N·m (7.3 kgf-m, 52.8 ft-lb)



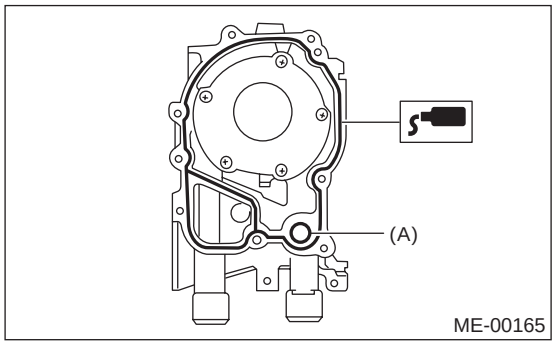
28) Install the housing cover.
29) Installation of oil pump:
(1) Discard the front oil seal after removal. Replace with a new one using ST.

ST 499587100 OIL SEAL INSTALLER



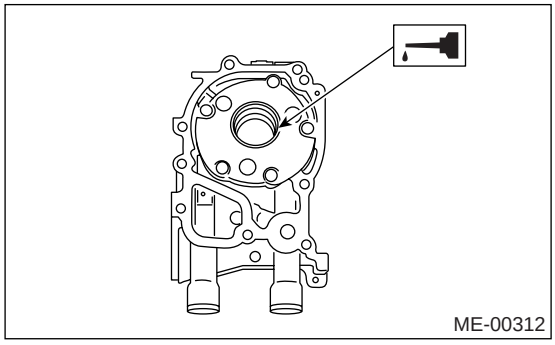
(2) Apply liquid gasket to the matching surface of oil pump.

Liquid gasket:
THREE BOND 1215 (Part No. 004403007) or equivalent



(A) O-ring

(3) Apply a coat of engine oil to the inside of oil seal.



(4) Install the oil pump on cylinder block. Be careful not to damage the oil seal during installation.

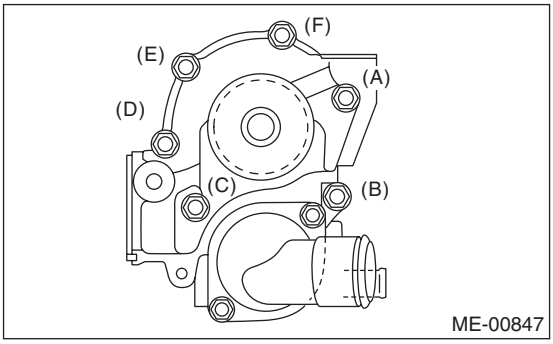
Tightening torque:
6.4 N·m (0.65 kgf-m, 4.7 ft-lb)

CAUTION:
• Do not forget to install the O-ring and seal when installing the oil pump.
• Align the flat surface of oil pump's inner rotor with crankshaft before installation.

30) Install the water pump and gasket.

Tightening torque:
First: 12 N·m (1.2 kgf-m, 8.7 ft-lb)
Second: 12 N·m (1.2 kgf-m, 8.7 ft-lb)

CAUTION:
• Be sure to use a new gasket.
• When installing the water pump, tighten bolts in two stages in alphabetical sequence as shown in the figure.

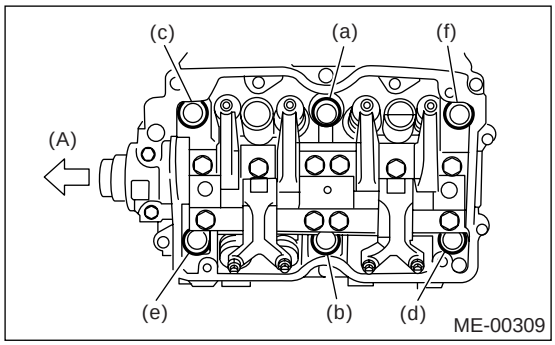


31) Install the water by-pass pipe for heater.
32) Install the oil filter.
33) Tighten the cylinder head bolts.
(1) Apply a coat of engine oil to washers and bolt threads.
(2) Tighten all bolts to 29 N·m (3.0 kgf-m, 22 ft-lb) in alphabetical sequence.
Then tighten all bolts to 69 N·m (7.0 kgf-m, 51 ft-lb) in alphabetical sequence.
(3) Back off all bolts by 180° first; and back them off again by 180°.
(4) Tighten the bolts (a) and (b) to 34 N·m (3.5 kgf-m, 25 ft-lb).
(5) Tighten the bolts (c), (d), (e) and (f) to 15 N·m (1.5 kgf-m, 11 ft-lb).
(6) Tighten all bolts by 80° — 90° in alphabetical sequence.

CAUTION:
Do not tighten the bolts more than 90°.

(7) Further tighten all bolts by 80° — 90° in alphabetical sequence.

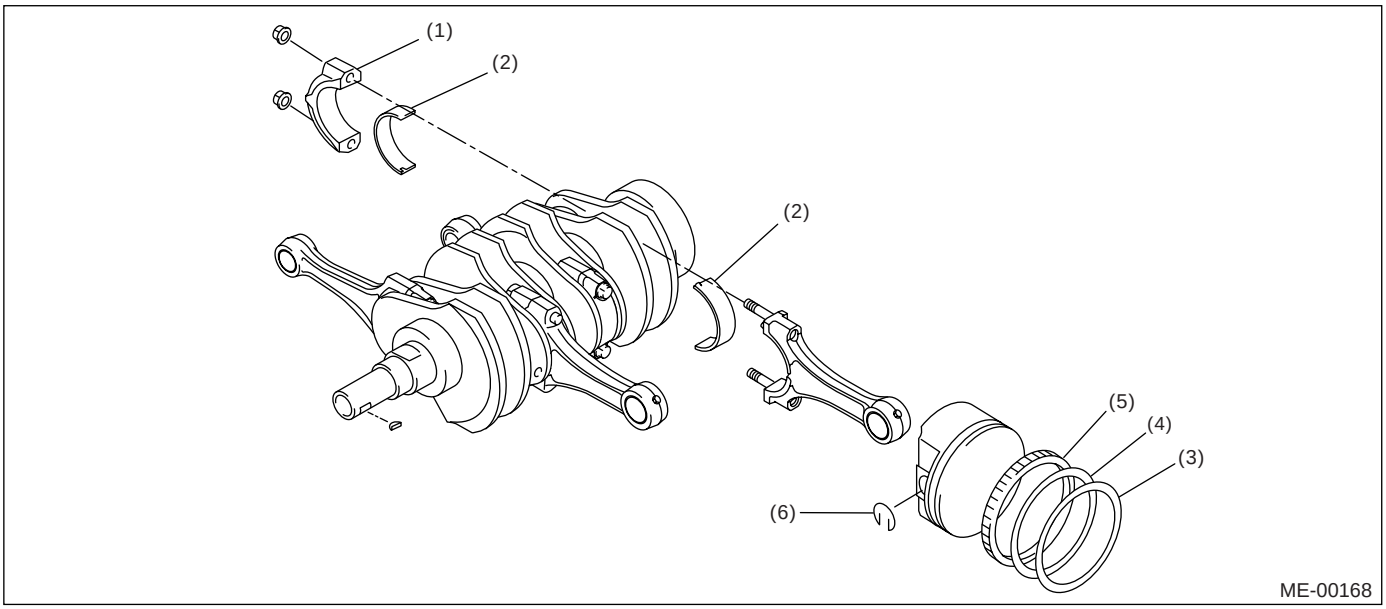
CAUTION:
Ensure the total "re-tightening angle" of the step (6) and (7) does not exceed 180°.



(A) Front side

34) Install the oil level gauge guide and tighten the bolt (left side only).
35) Install the rocker cover.
36) Install the crank sprocket.
<Ref. to ME(H4SO 2.0)-50, INSTALLATION, Crank Sprocket.>
37) Install the cam sprocket. <Ref. to ME(H4SO 2.0)-48, INSTALLATION, Cam Sprocket.>
38) Install the timing belt. <Ref. to ME(H4SO 2.0)-44, INSTALLATION, Timing Belt.>
39) Install the timing belt cover.
<Ref. to ME(H4SO 2.0)-42, INSTALLATION, Timing Belt Cover.>
40) Install the crank pulley. <Ref. to ME(H4SO 2.0)-40, INSTALLATION, Crank Pulley.>
41) Install the generator and A/C compressor brackets on cylinder head.
42) Install the V-belts. <Ref. to ME(H4SO 2.0)-38, INSTALLATION, V-belt.>
43) Install the intake manifold.
<Ref. to FU(H4SO 2.0)-12, INSTALLATION, Intake Manifold.>

C: DISASSEMBLY



(1) Connecting rod cap
(2) Connecting rod bearing
(3) Top ring
(4) Second ring
(5) Oil ring
(6) Snap ring

1) Remove the connecting rod cap.
2) Remove the connecting rod bearing.

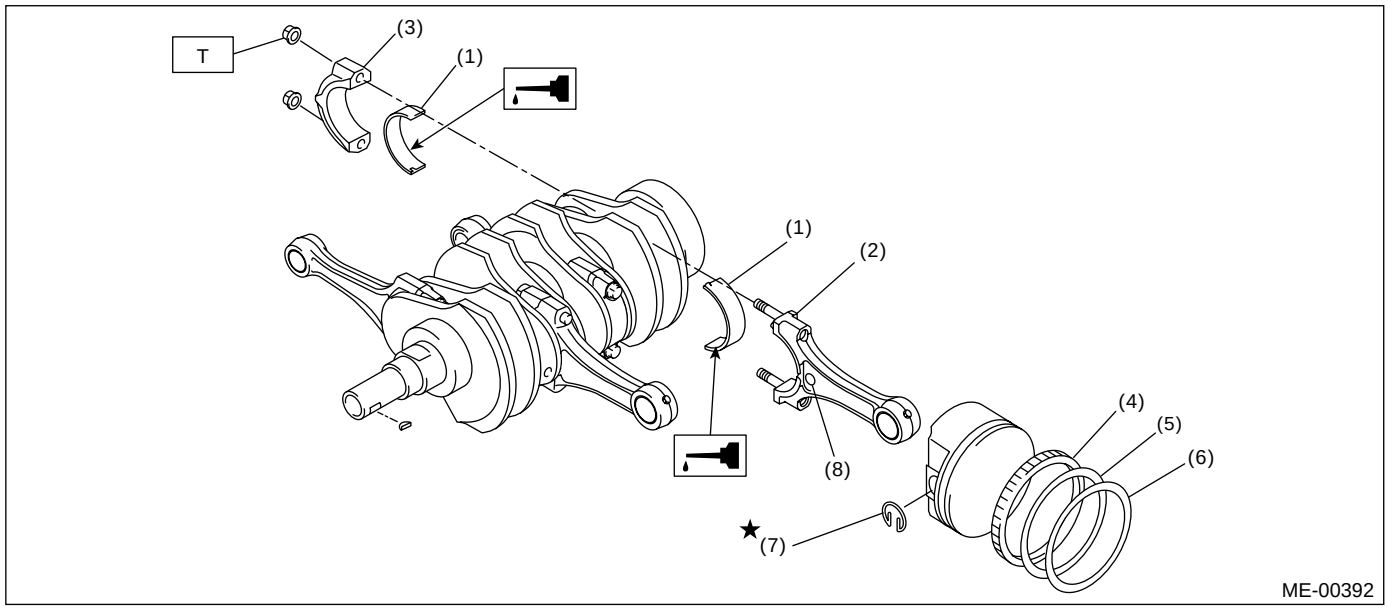
NOTE:
Arrange the removed connecting rod, connecting rod cap and bearing in order, to prevent confusion.

3) Remove the piston rings using the piston ring expander.
4) Remove the oil ring by hand.

NOTE:
Arrange the removed piston rings in proper order, to prevent confusion.

5) Remove the snap ring.

D: ASSEMBLY



(1) Connecting rod bearing
(2) Connecting rod
(3) Connecting rod cap
(4) Oil ring
(5) Second ring
(6) Top ring
(7) Snap ring
(8) Side mark

Tightening torque: N·m (kgf-m, ft-lb)
T: 45 (4.6, 33.3)

1) Apply oil to the surfaces of the connecting rod bearings.
2) Install the connecting rod bearings on connecting rods and connecting rod caps.
3) Position each connecting rod with the marked side facing forward, and install it.
4) Install the connecting rod cap with connecting rod nut.
Ensure the arrow on connecting rod cap faces toward front during installation.

CAUTION:
• Each connecting rod has its own mating cap. Make sure that they are assembled correctly by checking their matching number.
• When tightening the connecting rod nuts, apply oil on the threads.

5) Install the expander, lower rail and upper rail in this order by hand. Install the second ring and top ring with a piston ring expander.

E: INSPECTION

1. CYLINDER BLOCK

1) Visually check for cracks and damage. Especially, inspect the important parts by means of red lead check.
2) Check the oil passages for clogging.
3) Inspect the cylinder block surface that mates with cylinder head for warping by using a straight edge, and correct by grinding if necessary.

Warping limit:
0.025 mm (0.00098 in)

Grinding limit:
0.1 mm (0.004 in)

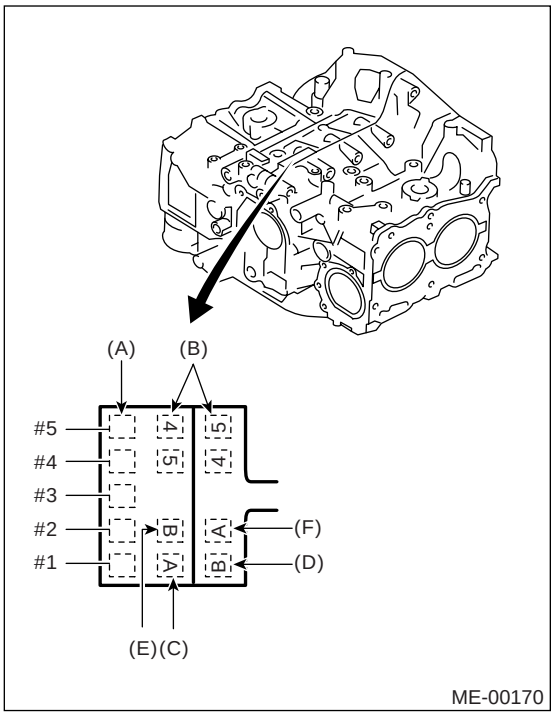
Standard height of cylinder block:
201.0 mm (7.91 in)

2. CYLINDER AND PISTON

1) The cylinder bore size is stamped on the cylinder block's front upper surface.

NOTE:
• Measurement should be performed at a temperature of 20°C (68°F).
• Standard sized pistons are classified into two grades, "A" and "B". These grades should be used as guide lines in selecting a standard piston.

Standard diameter:
2.0 L model
A: 92.005 — 92.015 mm (3.6222 — 3.6226 in)
B: 91.995 — 92.005 mm (3.6218 — 3.6222 in)
2.5 L model
A: 99.505 — 99.515 mm (3.9175 — 3.9179 in)
B: 99.495 — 99.505 mm (3.9171 — 3.9175 in)



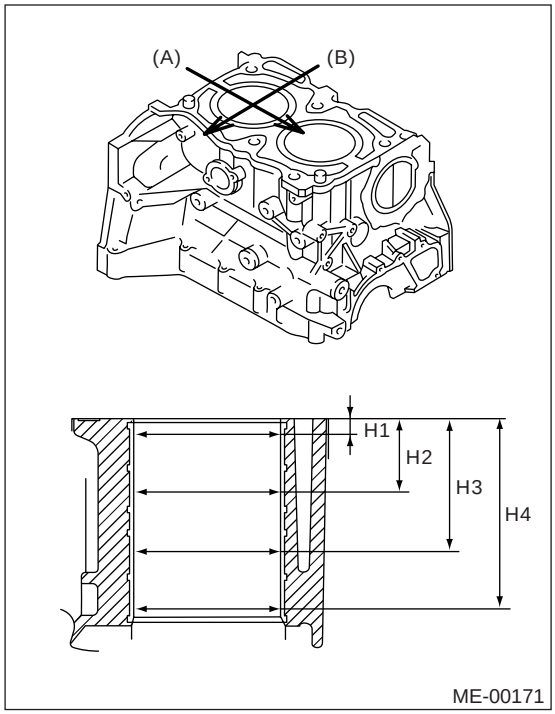
(A) Main journal size mark
(B) Cylinder block (RH)-(LH) combination mark
(C) #1 cylinder bore size mark
(D) #2 cylinder bore size mark
(E) #3 cylinder bore size mark
(F) #4 cylinder bore size mark

2) How to measure the inner diameter of each cylinder:
Measure the inner diameter of each cylinder in both the thrust and piston pin directions at the heights as shown in the figure, using a cylinder bore gauge.

NOTE:
Measurement should be performed at a temperature of 20°C (68°F).

Taper:
Standard
0.015 mm (0.0006 in)

Out-of-roundness:
Standard
0.010 mm (0.0004 in)



(A) Piston pin direction
(B) Thrust direction
H1 10 mm (0.39 in)
H2 45 mm (1.77 in)
H3 80 mm (3.15 in)
H4 115 mm (4.53 in)

3) When the piston is to be replaced due to general or cylinder wear, determine a suitable sized piston by measuring the piston clearance.
4) How to measure the outer diameter of each piston:
Measure the outer diameter of each piston at the height as shown in the figure. (Thrust direction)

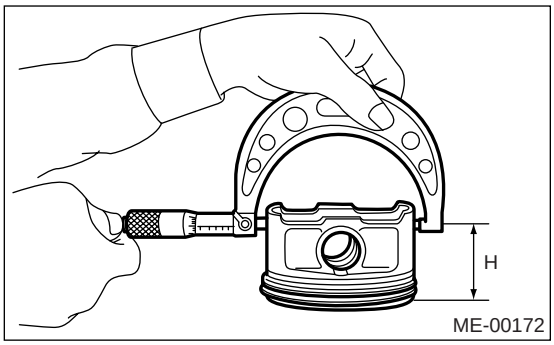
NOTE:
Measurement should be performed at a temperature of 20°C (68°F).

Piston grade point H:
2.0 L model
40.0 mm (1.575 in)
2.5 L model
37.0 mm (1.457 in)

Standard
2.0 L model
A: 92.005 — 92.015 mm (3.6222 — 3.6226 in)
B: 91.995 — 92.005 mm (3.6219 — 3.6222 in)
2.5 L model
A: 99.505 — 99.515 mm (3.9175 — 3.9179 in)
B: 99.495 — 99.505 mm (3.9171 — 3.9175 in)

0.25 mm (0.0098 in) oversize
2.0 L model
92.245 — 92.265 mm (3.6317 — 3.6325 in)
2.5 L model
99.745 — 99.765 mm (3.9270 — 3.9278 in)

0.50 mm (0.0197 in) oversize
2.0 L model
92.495 — 92.515 mm (3.6415 — 3.6423 in)
2.5 L model
99.995 — 100.015 mm (3.9368 — 3.9376 in)



5) Calculate the clearance between cylinder and piston.

NOTE:
Measurement should be performed at a temperature of 20°C (68°F).

Cylinder to piston clearance at 20°C (68°F):
Standard
–0.010 — 0.010 mm (–0.00039 — 0.00039 in)

6) Boring and honing
(1) If the value of taper, out-of-roundness, or cylinder-to-piston clearance measured exceeds the standard value or if there is any damage on the cylinder wall, rebore it to use an oversize piston.

CAUTION:
When any of the cylinders needs reboring, all other cylinders must be bored at the same time, and use oversize pistons. Do not perform boring on one cylinder only. Nor use an oversize piston for one cylinder only.

(2) If the cylinder inner diameter exceeds limit* after boring and honing, replace the cylinder block.

****: 2.0 L model***
92.515 mm (3.6423 in)

2.5 L model
100.015 mm (3.9376 in)

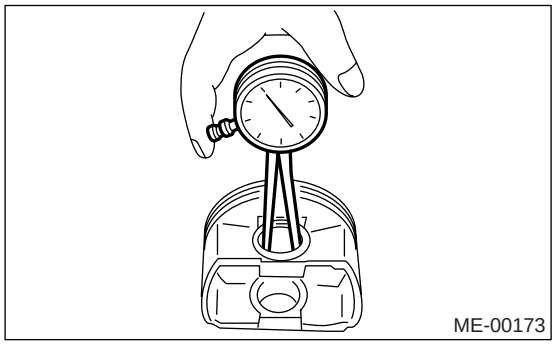
NOTE:
Immediately after reboring, the cylinder diameter may differ from its real diameter due to temperature rise. Thus, pay attention when measuring the cylinder diameter.

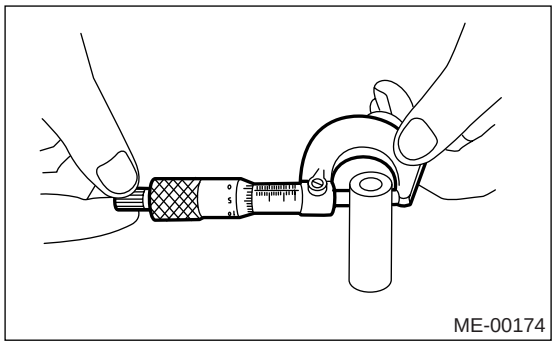
Limit of cylinder boring:
0.5 mm (0.020 in)

3. PISTON AND PISTON PIN

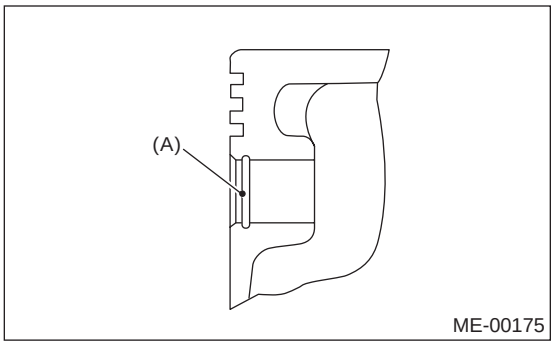
1) Check the pistons and piston pins for damage, cracks and wear, and the piston ring grooves for wear and damage. Replace if defective.
2) Measure the piston-to-cylinder clearance at each cylinder. <Ref. to ME(H4SO 2.0)-76, CYLINDER AND PISTON, INSPECTION, Cylinder Block.> If any of the clearances is not within the standard value, replace the piston. Or bore the cylinder to use an oversize piston.
3) Make sure that the piston pin can be inserted into the piston pin hole with a thumb at 20°C (68°F). Replace if defective.

Clearance between piston hole and piston pin:
Standard
0.004 — 0.008 mm (0.0002 — 0.0003 in)





4) Check the snap ring installation groove (A) on the piston for burr. If necessary, remove burr from the groove so that the piston pin can lightly move.

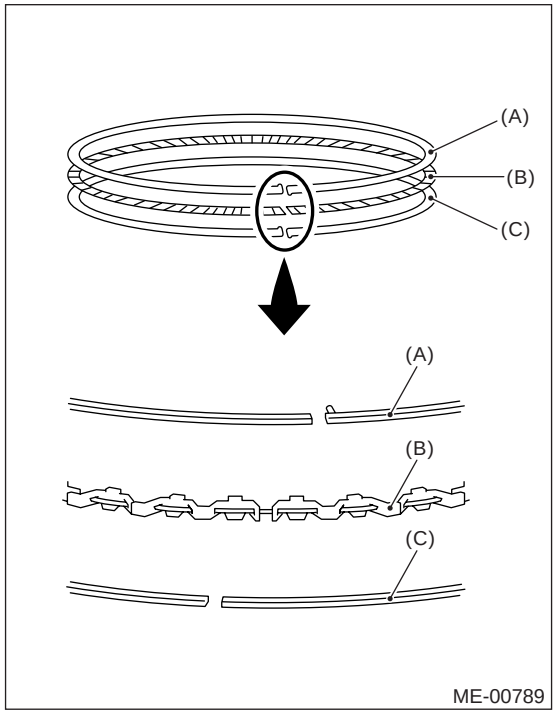


5) Check the piston pin snap ring for distortion, cracks and wear.

4. PISTON RING

1) If the piston ring is broken, damaged or worn, or if its tension is insufficient, or when the piston is replaced, replace the piston ring with a new one of the same size as the piston.

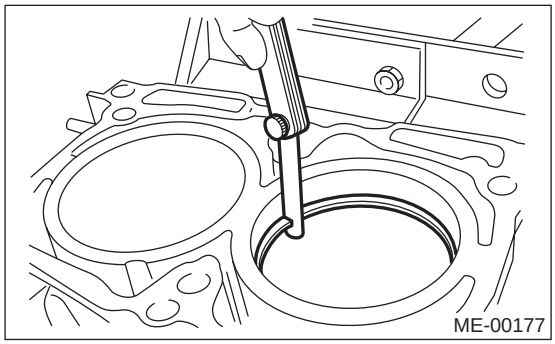
CAUTION:
• Mark is displayed on the end of top and second rings. When installing the rings to the piston, face these marks upward.
• Oil ring consists of the upper rail, expander and lower rail. Be careful about the direction of rail when installing the oil ring to piston.



(A) Upper rail
(B) Expander
(C) Lower rail

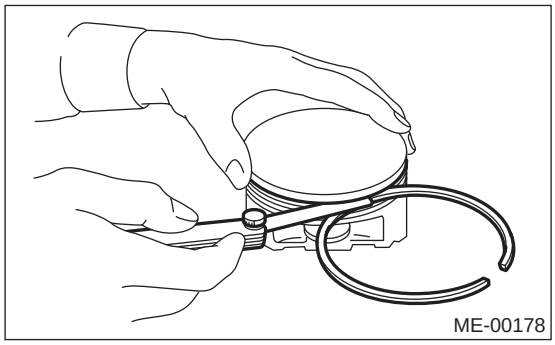
2) Clean the piston ring groove and piston ring.
3) Squarely place the piston ring and oil ring in cylinder, and measure the piston ring gap with a thickness gauge.

			Standard mm (in)
Piston ring gap	Top ring		0.20 — 0.35 (0.0079 — 0.0138)
	Second ring	2.0 L	0.40 — 0.50 (0.0157 — 0.0197)
		2.5 L	0.35 — 0.50 (0.0138 — 0.0197)
	Oil ring rail		0.20 — 0.50 (0.0079 — 0.0197)



4) Measure the clearance between piston ring and piston ring groove with a thickness gauge.

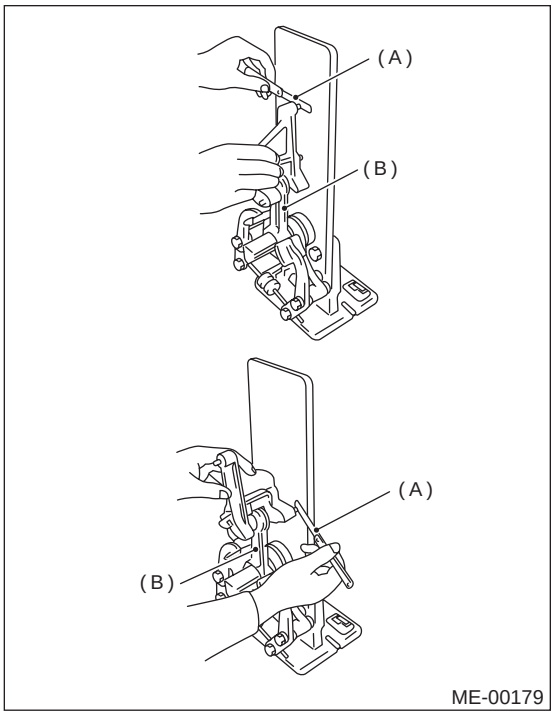
		Standard mm (in)
Clearance between piston ring and piston ring groove	Top ring	0.040 — 0.080 (0.0016 — 0.0031)
	Second ring	0.030 — 0.070 (0.0012 — 0.0028)



5. CONNECTING ROD

1) Replace the connecting rod, if the large or small end thrust surface is damaged.
2) Check for bend or twist using a connecting rod aligner. Replace the connecting rod if the bend or twist exceeds the limit.

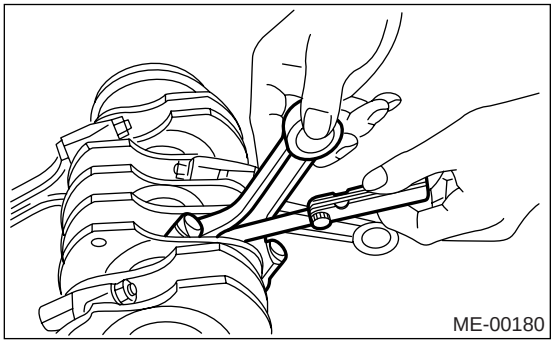
Limit of bend or twist per 100 mm (3.94 in) in length:
0.10 mm (0.0039 in)



(A) Thickness gauge
(B) Connecting rod

3) Install the connecting rod fitted with bearing to crankshaft and measure the side clearance (thrust clearance). If side clearance exceeds the limit, replace the connecting rod.

Connecting rod side clearance:
Standard
0.070 — 0.330 mm (0.0028 — 0.0130 in)



4) Inspect the connecting rod bearing for scar, peeling, seizure, melting, wear, etc.
5) Measure the oil clearance on individual connecting rod bearings by means of plastigauge. If any oil clearance is not within the specification, replace the defective bearing with a new one of standard size or undersize as necessary. (See the table below.)

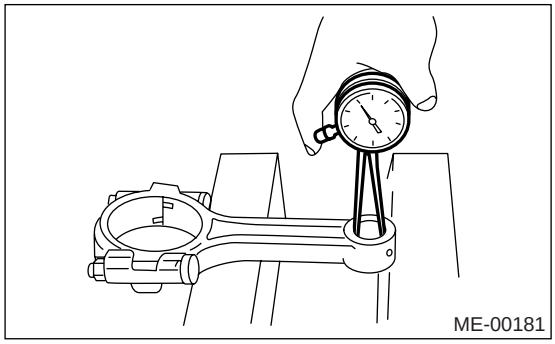
Connecting rod oil clearance:
Standard
0.016 — 0.044 mm (0.00063 — 0.0017 in)

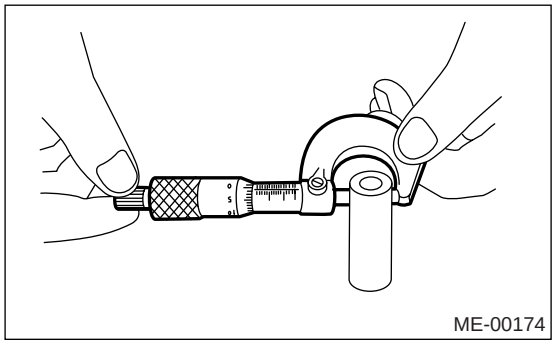
Unit: mm (in)

Bearings	Bearing size (Thickness at center)	Outer diameter of crank pin
Standard	1.492 — 1.501 (0.0587 — 0.0591)	51.984 — 52.000 (2.0466 — 2.0472)
0.03 (0.0012) undersize	1.510 — 1.513 (0.0594 — 0.0596)	51.954 — 51.970 (2.0454 — 2.0461)
0.05 (0.0020) undersize	1.520 — 1.523 (0.0598 — 0.0600)	51.934 — 51.950 (2.0446 — 2.0453)
0.25 (0.0098) undersize	1.620 — 1.623 (0.0638 — 0.0639)	51.734 — 51.750 (2.0368 — 2.0374)

6) Inspect the bushing at connecting rod small end, and replace if worn or damaged. Also measure the piston pin clearance at the connecting rod small end.

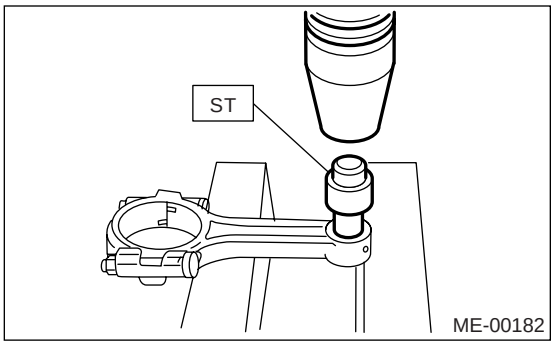
Clearance between piston pin and bushing:
Standard
0 — 0.022 mm (0 — 0.0009 in)





7) Replacement procedure is as follows.
(1) Remove the bushing from connecting rod with ST and press.
(2) Press the bushing with ST after applying oil on the periphery of bushing.

ST 499037100 CONNECTING ROD BUSHING REMOVER AND INSTALLER



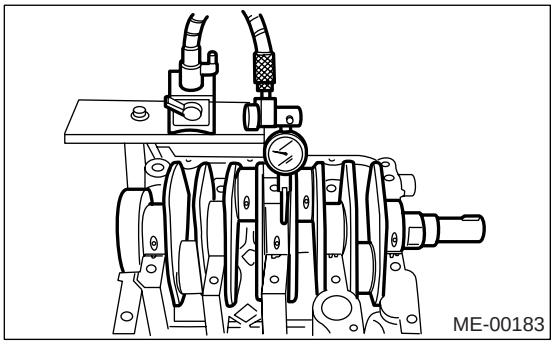
(3) Make two 3 mm (0.12 in)-holes in bushing. Ream the inside of bushing.
(4) After completion of reaming, clean the bushing to remove chips.

6. CRANKSHAFT AND CRANKSHAFT BEARING

1) Clean the crankshaft completely, and check it for cracks using red lead. Replace if faulty.
2) Measure the bend of crankshaft. If it exceeds the limit, repair or replace it.

NOTE:
If a suitable V-block is not available, install #1 and #5 crankshaft bearing on cylinder block, position the crankshaft on these bearings, and then measure the crankshaft bend using a dial gauge.

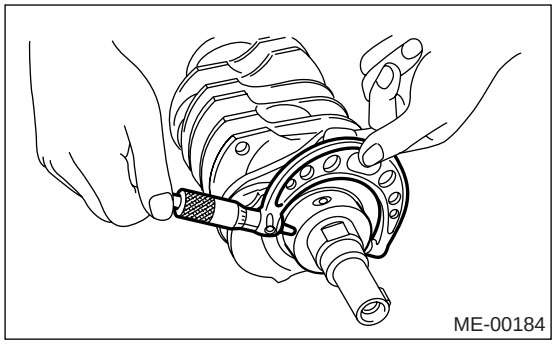
Crankshaft bend limit:
0.035 mm (0.0014 in)



3) Inspect the crank journal and crank pin for wear. If they are not within the specifications, replace the bearing with a suitable (undersize) one, and replace or recondition crankshaft as necessary. When grinding the crank journal or crank pin, finish them to the specified dimensions according to the undersize bearing to be used.

Crank pin:
2.0 L model
Out-of-roundness
0.005 mm (0.0002 in)
Cylindricality
0.006 mm (0.0002 in)
Grinding limit
To 51.750 mm (2.0374 in) dia.
2.5 L model
Out-of-roundness
0.003 mm (0.0001 in)
Cylindricality
0.004 mm (0.0002 in)
Grinding limit
To 51.750 mm (2.0374 in) dia.

Crank journal:
Out-of-roundness
0.005 mm (0.0002 in)
Cylindricality
0.006 mm (0.0002 in)
Grinding limit
To 59.750 mm (2.3524 in) dia.

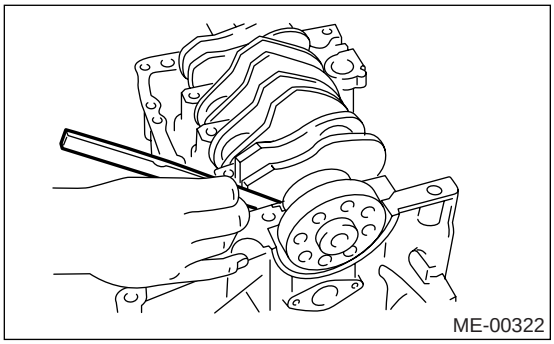


Unit: mm (in)

		Crank journal outer diameter		Crank pin outer diameter
		#1, #3	#2, #4, #5	
Standard	Journal O.D.	59.992 — 60.008 (2.3619 — 2.3625)	59.992 — 60.008 (2.3619 — 2.3625)	51.984 — 52.000 (2.0466 — 2.0472)
	Bearing size (Thickness at center)	1.998 — 2.011 (0.0787 — 0.0792)	2.000 — 2.013 (0.0787 — 0.0793)	1.492 — 1.501 (0.0587 — 0.0591)
0.03 (0.0012) undersize	Journal O.D.	59.962 — 59.978 (2.3607 — 2.3613)	59.962 — 59.978 (2.3607 — 2.3613)	51.954 — 51.970 (2.0454 — 2.0461)
	Bearing size (Thickness at center)	2.017 — 2.020 (0.0794 — 0.0795)	2.019 — 2.022 (0.0795 — 0.0796)	1.510 — 1.513 (0.0594 — 0.0596)
0.05 (0.0020) undersize	Journal O.D.	59.942 — 59.958 (2.3599 — 2.3605)	59.942 — 59.958 (2.3599 — 2.3605)	51.934 — 51.950 (2.0446 — 2.0453)
	Bearing size (Thickness at center)	2.027 — 2.030 (0.0798 — 0.0799)	2.029 — 2.032 (0.0799 — 0.0800)	1.520 — 1.523 (0.0598 — 0.0600)
0.25 (0.0098) undersize	Journal O.D.	59.742 — 59.758 (2.3520 — 2.3527)	59.742 — 59.758 (2.3520 — 2.3527)	51.734 — 51.750 (2.0368 — 2.0374)
	Bearing size (Thickness at center)	2.127 — 2.130 (0.0837 — 0.0839)	2.129 — 2.132 (0.0838 — 0.0839)	1.620 — 1.623 (0.0638 — 0.0639)

4) Measure the side clearance of crankshaft at center bearing. If clearance exceeds the limit, replace the bearing.

Crankshaft side clearance:
Standard
0.030 — 0.115 mm (0.0012 — 0.0045 in)


ME-00322

5) Inspect individual crankshaft bearings for signs of flaking, seizure, melting and wear.
6) Measure the oil clearance on each crankshaft bearing by means of plastigauge. If the measurement is not within the specification, replace the defective bearing with an undersize one, and replace or recondition the crankshaft as necessary.

Crankshaft oil clearance:
Standard
0.010 — 0.030 mm (0.0004 — 0.0012 in)

22.Engine Trouble in General

A: INSPECTION

NOTE:
“RANK” shown in the chart refers to the possibility of reason for the trouble in order (“Very often” to “Rarely”)
A — Very often
B — Sometimes
C — Rarely

Symptom	Problem parts, etc.	Possible cause	RANK
1. Engine does not start.			
1) Starter does not turn.	Starter	Defective battery-to-starter harness	B
		Defective starter switch	C
		Defective inhibitor switch	C
		Defective starter	B
	Battery	Poor terminal connection	A
		Run-down battery	A
		Defective charging system	B
	Friction	Seizure of crankshaft and connecting rod bearing	C
		Seized camshaft	C
		Seized or stuck piston and cylinder	C
2) Initial combustion does not occur.	Starter	Defective starter	C
	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Fuel line	Defective fuel pump and relay	A
		Lack of or insufficient fuel	B
	Belt	Trouble	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
3) Initial combustion occurs.	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Defective intake manifold gasket	B
		Defective throttle body gasket	B
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	Trouble	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B

Symptom	Problem parts, etc.	Possible cause	RANK
4) Engine stalls after initial combustion.	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked intake duct	B
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	C
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Dirty air cleaner element	C
	Fuel line	Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	Trouble	B
		Defective timing	B
	Compression	Incorrect valve clearance	C
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	B
		Improper engine oil (low viscosity)	B
2. Rough idle and engine stall	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	C
		Loosened oil filler cap	B
		Dirty air cleaner element	C
	Fuel line	Defective fuel pump and relay	C
		Clogged fuel line	C
		Lack of or insufficient fuel	B
	Belt	Defective timing	C
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
		Defective rocker cover gasket	C
	Cooling system	Over-heating	C
	Other	Evaporative emission control system malfunction	A
		Stuck or damaged throttle valve	B

Symptom	Problem parts, etc.	Possible cause	RANK
3. Low output, hesitation and poor acceleration	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	B
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	A
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of or insufficient fuel	C
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	B
		Loosened cylinder head bolt or defective gasket	B
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	B
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Lubrication system	Incorrect oil pressure	B
	Cooling system	Over-heating	C
		Over-cooling	C
	Other	Evaporative emission control system malfunction	A
4. Surging	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked intake duct	A
		Loosened or cracked PCV hose	A
		Loosened or cracked vacuum hose	A
		Defective intake manifold gasket	B
		Defective throttle body gasket	B
		Defective PCV valve	B
		Loosened oil filler cap	B
		Dirty air cleaner element	B
	Fuel line	Defective fuel pump and relay	B
		Clogged fuel line	B
		Lack of or insufficient fuel	C
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	C
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
		Improper engine oil (low viscosity)	B
	Cooling system	Over-heating	B
	Other	Evaporative emission control system malfunction	C

Symptom	Problem parts, etc.	Possible cause	RANK
5. Engine does not return to idle.	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked vacuum hose	A
	Other	Stuck or damaged throttle valve	A
6. Dieseling (Run-on)	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Cooling system	Over-heating	B
	Other	Evaporative emission control system malfunction	B
7. After burning in exhaust system	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened or cracked intake duct	C
		Loosened or cracked PCV hose	C
		Loosened or cracked vacuum hose	B
		Defective PCV valve	B
		Loosened oil filler cap	C
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	C
		Incorrect valve timing	A
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C
	Other	Evaporative emission control system malfunction	C
8. Knocking	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Loosened oil filler cap	B
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	C
		Incorrect valve timing	B
	Cooling system	Over-heating	A
9. Excessive engine oil consumption	Intake system	Loosened or cracked PCV hose	A
		Defective PCV valve	B
		Loosened oil filler cap	C
	Compression	Defective valve stem	A
		Worn or stuck piston rings, cylinder and piston	A
	Lubrication system	Loosened oil pump attaching bolts and defective gasket	B
		Defective oil filter seal	B
		Defective crankshaft oil seal	B
		Defective rocker cover gasket	B
		Loosened oil drain plug or defective gasket	B
		Loosened oil pan fitting bolts or defective oil pan	B

Symptom	Problem parts, etc.	Possible cause	RANK
10. Excessive fuel consumption	Engine control system <Ref. to EN(H4SO 2.0)(diag)-2, Basic Diagnostic Procedure.>		A
	Intake system	Dirty air cleaner element	A
	Belt	Defective timing	B
	Compression	Incorrect valve clearance	B
		Loosened spark plug or defective gasket	C
		Loosened cylinder head bolt or defective gasket	C
		Improper valve sealing	B
		Defective valve stem	C
		Worn or broken valve spring	C
		Worn or stuck piston rings, cylinder and piston	B
		Incorrect valve timing	B
	Lubrication system	Incorrect oil pressure	C
	Cooling system	Over-cooling	C

23.Engine Noise

A: INSPECTION

Type of sound	Condition	Possible cause
Regular clicking sound	Sound increases as engine speed increases.	• Valve mechanism is defective. • Incorrect valve clearance • Worn valve rocker • Worn camshaft • Broken valve spring
Heavy and dull clank	Oil pressure is low.	• Worn camshaft main bearing • Worn connecting rod bearing (big end)
	Oil pressure is normal.	Damaged engine mounting
High-pitched clank (Spark knock)	Sound is noticeable when accelerating with an overload.	• Ignition timing advanced • Accumulation of carbon inside combustion chamber • Wrong spark plug • Improper gasoline
Clank when engine speed is 1,000 to 2,000 rpm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (NOTE*)	• Worn camshaft main bearing • Worn bearing at crankshaft end of connecting rod
Knocking sound when engine is operating under idling speed and engine is warm	Sound is reduced when fuel injector connector of noisy cylinder is disconnected. (NOTE*)	• Worn cylinder liner and piston ring • Broken or stuck piston ring • Worn piston pin and hole at piston end of connecting rod
	Sound is not reduced if each fuel injector connector is disconnected in turn. (NOTE*)	• Unusually worn valve lifter • Worn cam gear • Worn camshaft journal bore in crankcase
Squeaky sound	—	Insufficient generator lubrication
Rubbing sound	—	Defective generator brush and rotor contact
Gear scream when starting engine	—	• Defective ignition starter switch • Worn gear and starter pinion
Sound like polishing glass with a dry cloth	—	• Loose drive belt • Defective water pump shaft
Hissing sound	—	• Loss of compression • Air leakage in air intake system, hoses, connections or manifolds
Timing belt noise	—	• Loose timing belt • Belt contacting with case/adjacent part
Valve tappet noise	—	Incorrect valve clearance

NOTE*)
When disconnecting the fuel injector connector, the malfunction indicator light illuminates and DTC is stored in ECM memory. Therefore, carry out the clear memory mode <Ref. to EN(H4SO 2.0)(diag)-38, OPERATION, Clear Memory Mode.> and inspection mode <Ref. to EN(H4SO 2.0)(diag)-32, OPERATION, Inspection Mode.> after connecting the fuel injector connector.